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Additional Information

VisualEyes™

Micromedical
by Interacoustics



Interacoustics

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Table of Contents

1 BASICS TO PERFORM TESTS 1
1.1 Moving through VisualEyes™ 1
1.2 Begin testing 2
1.3 Starting a test 4
1.4 Session tree 5
1.5 Eye image adjustment 6
1.6 Focus adjustment 9
1.7 Eye image contrast adjustment 9
1.8 Enlarging eye images 10
1.9 Monocular vs binocular eye recordings 10
1.10 Eye tracker selection 11
1.11 Common test functions 11
1.12 Add note 12
1.13 Keyboard marker for tracing 12
1.14 Fixation suppression 13
1.15 Add tests or delete tests 14
1.16 Repeating tests 14
1.17 Test review 15
2 CALIBRATION 16
2.1 Source selection 16
2.2 Performing calibration 16
2.3 Torsion calibration 19
2.4 Default calibration 21
2.5 Review calibrations 21
3 TESTING 22
3.1 Overview 22
3.2 Nystagmus marking and peak response 24
3.3 Video Frenzel Test 25
3.4 Nystagmus testing 26
3.4.1 Spontaneous nystagmus test 26
3.4.2 Dix-Hallpike test 26
3.4.3 Dix-Hallpike Advanced test 27
3.4.4 Positional testing 30
3.4.5 Lateral Head Roll test 30
3.5 Oculomotor testing 33
3.5.1 Gaze test 33
3.5.2 Cervical gaze test 34
3.5.3 Smooth pursuit test 36
3.5.4 Smooth Pursuit Neck Torsion Test (SPNT) 38
3.5.5 Random Saccade test 41
3.5.6 Self-Paced Saccades (SPS) test 41
3.5.7 Saccadometry 43
3.5.8 Optokinetic test 46
3.6 Head rotation testing 48
3.6.1 Active head rotation test (VORTEQ™ AHR) 48
3.6.2 Dynamic Visual Acuity (DVA) test 50
3.6.3 Gaze Stabilization Test 55
3.6.4 Functional Vision Head Impulse Test (fvHIT)™ 60
3.7 Video head impulse testing (vHIT) 70
3.7.1 vHIT VORTEQ™ 70
3.7.2 vHIT EyeSeeCam 72
3.8 Ocular counter roll 79
3.9 Caloric testing 80
3.10 Rotational chair testing 87
3.10.1 Safety checks before beginning rotary chair tests 87
3.10.2 Sinusoidal harmonic acceleration (SHA) test 88
3.10.3 Step Velocity test 95
3.10.4 VOR suppression test 102

3.10.5 Visual VOR test ... 106
3.10.6 Subjective visual vertical (SVV) test ... 109
3.10.6.1 Static SVV ... 109
3.10.6.2 Dynamic SVV ... 109
4 RESEARCH MODULE ... 111
4.1 Blinking Cue Light ... 111
4.2 Diagonal OPK Stimulus ... 111
4.3 Nystagmus parameters ... 112
4.4 Data export properties ... 115
4.4.1 General ... 120
4.4.1.1 EyePositionData Left/Right ... 120
4.4.2 VisualEyes 505/515/525 ... 120
4.4.2.1 Caloric (Summary file) ... 120
4.4.2.2 Dix Hallpike (Summary file) ... 122
4.4.2.3 Positional (Summary file) ... 122
4.4.2.4 Gaze (Summary file) ... 122
4.4.2.5 Ocular Counter Roll (Summary file) ... 122
4.4.2.6 Optokinetic (Summary file) ... 122
4.4.2.7 Random Saccade (Summary file) ... 123
4.4.2.8 Smooth Pursuit (Summary file) ... 123
4.4.2.9 aSPVResults ... 123
4.4.2.10 NystagmusPoint ... 124
4.4.2.11 TorsionNystagmusPoint ... 124
4.4.2.12 VisualStimulusData ... 125
4.4.2.13 Saccades ... 125
4.4.2.14 Statistics ... 126
4.4.2.15 ErrorRates (saccadometry) ... 126
4.4.2.16 CycleResults ... 127
4.4.2.17 HalfCycleResults ... 127
4.4.3 VORTEQ™ ... 127
4.4.3.1 Dix Hallpike Advanced (Summary file) ... 127
4.4.3.2 Dynamic Visual Acuity (Summary file) ... 127
4.4.3.3 Gaze Stabilization (Summary file) ... 128
4.4.3.4 Lateral Head Roll (Summary file) ... 128
4.4.3.5 vHIT for VORTEQ™ (Summary file) ... 128
4.4.3.6 VORTEQ™ AHR (Summary file) ... 128
4.4.3.7 IMUData ... 128
4.4.3.8 IMUDataSet (Dix Hallpike Advanced) ... 129
4.4.3.9 AHRCycleResults ... 129
4.4.3.10 AHRCycleStatistics ... 129
4.4.3.11 DVATestResults ... 130
4.4.3.12 GSTTestResults ... 130
4.4.3.13 fvHITTestResults ... 130
4.4.3.14 ImpulseData ... 130
4.4.3.15 VHITCalculatedData (VORTEQ™ vHIT) ... 130
4.4.3.16 VORTEQImpulse (VORTEQ™ vHIT) ... 131
4.4.4 Rotary Chair Test ... 132
4.4.4.1 Sinusoidal Harmonic Acceleration (Summary file) ... 132
4.4.4.2 Step Velocity (Summary file) ... 132
4.4.4.3 VisualVOR (Summary file) ... 133
4.4.4.4 VOR Suppression (Summary file) ... 133
4.4.4.5 CalculatedResults (Step Velocity) ... 133
4.4.4.6 CalculatedResults (Sinusoidal Harmonic Acceleration test) ... 134
4.4.4.7 CalculatedResults (VOR suppression test) ... 134
4.4.4.8 ChairData ... 135
4.4.5 SVV Testing ... 136
4.4.5.1 Subjective Visual Vertical (Summary) ... 136
4.4.5.2 SVVTestResults ... 136
4.4.6 EyeSeeCam ... 136
4.4.6.1 UncalibratedData (EyeSeeCam) ... 136

4.4.6.2 CalibratedEyeAndHead (EyeSeeCam) ... 136
4.4.6.3 CalibrationEyeLeft (EyeSeeCam) ... 137
4.4.6.4 CalibrationEyeRight (EyeSeeCam) ... 137
4.4.6.5 CalibrationHeadR (EyeSeeCam) ... 137
4.4.6.6 CalibrationHeadSensorOffset (EyeSeeCam) ... 137
4.4.6.7 Numerical (EyeSeeCam) ... 137
5 PATIENT SESSION ... 138
5.1 Selecting a session ... 138
5.2 Session review ... 139
6 VIDEO RECORDINGS ... 140
6.1 Recording patient videos ... 140
6.2 Video playback ... 140
6.3 Delete selected patient videos ... 143
6.4 Exporting patient videos ... 144
7 GENERAL AND EDITING TOOLS ... 146
7.1 Quick access test properties ... 146
7.2 Selecting eyes ... 146
7.3 Pupil diameters ... 146
7.4 Editing nystagmus ... 148
7.4.1 Add beats ... 148
7.4.2 Remove beats ... 149
7.4.3 Edit slopes ... 149
7.4.4 Smooth data ... 151
7.4.5 Zoom trace ... 151
7.4.6 Enable beats ... 152
7.4.7 Undo last action ... 152
7.4.8 Reset beats ... 153
7.4.9 Done Editing ... 153
7.5 Numerical value for graphical display ... 154
7.6 Editing saccade test results ... 156
7.6.1 General Editing Options ... 156
7.6.2 Numerical Results ... 156
7.7 Editing smooth pursuit test results ... 158
7.8 Editing rotary chair test results ... 159
7.8.1 Editing SHA tests ... 159
7.8.2 Editing step velocity tests ... 159
7.9 Editing video head impulse tests (vHIT for VORTEQ™) ... 160
7.9.1 Select multiple ... 160
7.9.2 Delete selected ... 160
7.9.3 Reset ... 160
7.9.4 Show all impulses ... 161
7.10 Editing video head impulse tests (vHIT for EyeSeeCam) ... 162
7.10.1 Delete ... 162
7.10.2 Reset / Cancel ... 162
7.10.3 Edit saccades ... 163
7.11 Editing ocular counter roll tests ... 164
7.11.1 Add marker ... 164
7.11.2 Zoom trace ... 164
7.11.3 Remove marker ... 164
7.11.4 Reset markers ... 164
7.12 Other functions available inside menu ... 165
7.13 Fixation suppression ... 167
7.14 Override test results ... 168
8 PROTOCOL MANAGEMENT ... 169
8.1 Protocols ... 169
8.2 Creating a new protocol ... 170
8.3 Adding customized test ... 171
8.4 Setting default protocol ... 171
8.5 Remove protocol ... 172
8.6 Exporting protocols ... 172

8.7 Importing protocols 172
8.8 Restore factory template 173
8.9 Selection of protocol 173
9 TEST PROPERTIES 174
9.1 Configuring the tests 174
9.2 Configuring Video Frenzel test 175
9.3 Configuring oculomotor tests 176
9.3.1 Computer settings for oculomotor tests 176
9.3.2 Configuring the gaze test 179
9.3.3 Configuration of Saccade test 181
9.3.4 Configuration of saccadometry test 183
9.3.5 Configuration of smooth pursuit tests 185
9.3.6 Configuring the OPK tests 187
9.4 Configuring the nystagmus tests 189
9.4.1 Computer settings for Nystagmus tests: 189
9.4.2 Configuring the spontaneous nystagmus test 192
9.4.3 Configuring the Dix-Hallpike tests 192
9.4.4 Configuring the Dix-Hallpike Advanced test 194
9.4.5 Configuring the positional tests 196
9.4.6 Configuring the Lateral Head Roll test 197
9.4.7 Configuring the caloric tests 199
9.5 Configuring rotary chair tests 203
9.5.1 Computer Settings for chair tests: 203
9.5.2 Configuring sinusoidal harmonic acceleration test 205
9.5.3 Configuring Step Velocity test 207
9.5.4 Configuring VOR suppression test 209
9.5.5 Configuring visual VOR test 211
9.5.6 Configuring subjective visual vertical test 213
9.6 Configuring active head rotation tests 216
9.6.1 Computer Settings for active head rotation tests: 216
9.6.2 Configuring VORTEQ™ AHR test 218
9.6.3 Configuring dynamic visual acuity test 220
9.6.4 Configuring Gaze Stabilization test 221
9.6.5 Configuration of fvHIT™ 224
9.7 Configuring video head impulse tests 226
9.7.1 Computer Settings for video head impulse tests: 226
9.7.2 Configuring vHIT VORTEQ™ test 227
9.7.3 Configuring vHIT for EyeSeeCam test 229
9.8 Configuring torsion tests 231
9.8.1 Configuring ocular counter roll test 231
10 SUGGESTED THRESHOLD VALUES 234
10.1 Updating test thresholds 234
10.2 Nystagmus tests 235
10.3 Caloric tests 236
10.4 Oculomotor tests: 237
10.4.1 Optokinetic tests 237
10.4.2 Smooth pursuit tests 237
10.4.3 Saccade tests 238
10.5 Saccadometry tests 239
10.6 Step velocity tests 239
10.7 Sinusoidal harmonic acceleration and VOR suppression tests 240
10.8 Active head rotation (AHR) tests 240
10.9 Dynamic visual acuity (DVA) tests 241
10.10 Video head impulse tests (vHIT) for EyeSeeCam 241
11 PATIENT REPORT 242
11.1 Write report editor 242
11.2 Text styles 242
11.3 Templates 243
11.4 Findings 245
11.5 Save report 246

12 PRINTING 247
12.1 Printing results 247
12.2 Printing patient demographics or De-identify printout 248
12.3 Printing calibration 248
12.4 Printing a single item 248
12.5 Preview / Printing a session 249
12.6 Printing traces (Print screen) 249
12.7 Create PDF 249
12.8 Print to database 249
13 SYSTEM DEFAULT SETTINGS 250
13.1 Input 250
13.2 Stimuli 251
13.2.1 TV stimulus 252
13.2.2 Laser and drum stimulus 254
13.3 Test type settings 256
13.4 General 257
13.5 Hardware registration and licensing 260
13.6 Threshold levels 263
13.7 Print 263
13.8 Optotype tests 264
13.9 ENG 265
13.10 Rotational chair 266
13.10.1 Off-axis center settings 266
13.10.2 Rotational safety settings 266
13.11 Head sensor 268
13.12 About this software 268
14 OTHER FUNCTIONS 270
14.1 Help button 270
14.2 Exit button 270
14.3 Minimize button 270

1 Basics to perform tests

1.1 Moving through VisualEyes™

The VisualEyes™ software is compatible with both touch capable (Figure 1.2-1) and standard (non-touch) computer systems. Maneuvering through the software can be done by touch, mouse, keyboard, foot pedal and remote control.

Selecting a patient profile:
The user can create or select a patient profile through OtoAccess® to enter the VisualEyes™ system. The user can also switch to the OtoAccess® screen to choose a different patient profile while using OtoAccess® version 2 and up. The user must exit the VisualEyes™ system to access the different patient profiles while using earlier versions of OtoAccess®.

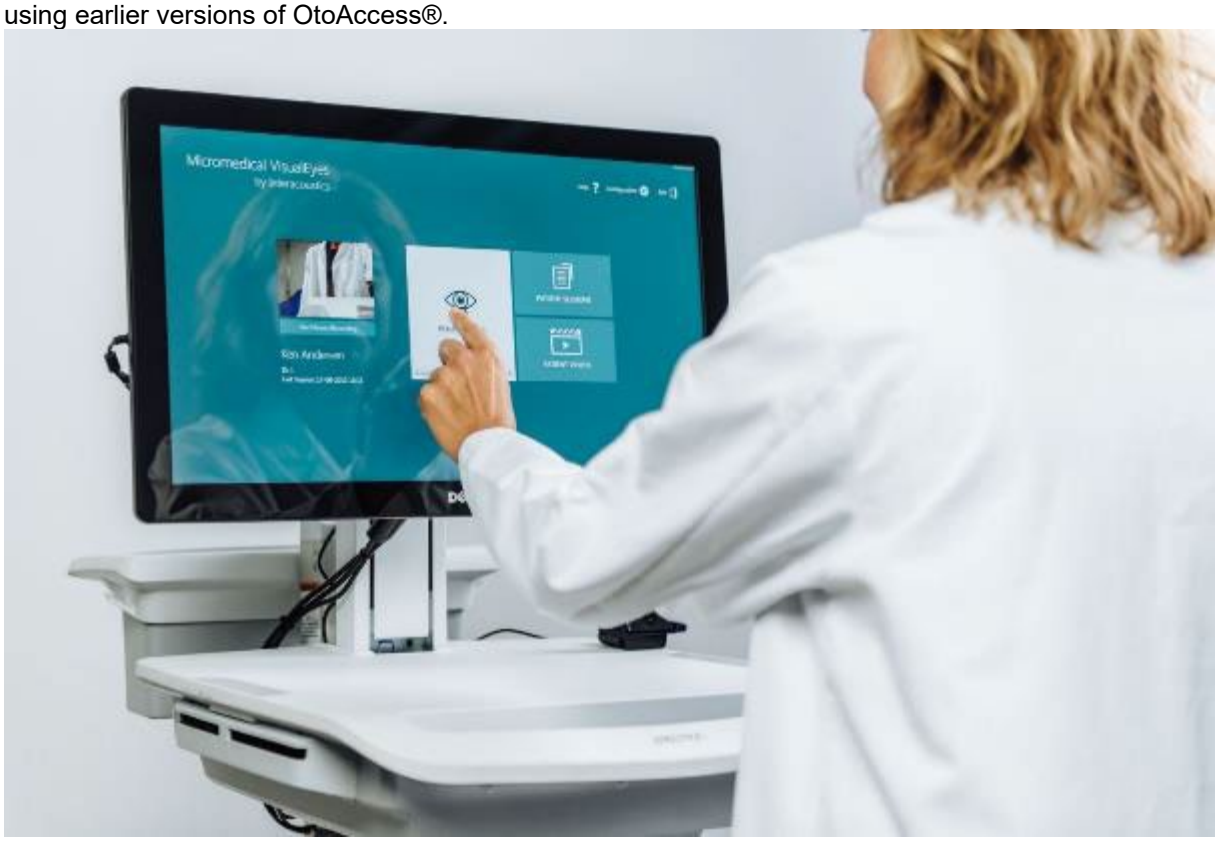


Figure 1.1-1 Touch user interface

1.2 Begin testing

To begin the testing process, select the **Begin Testing** button from the main screen (Figure 1.2-1). The software will enter the first test of the selected protocol. If you have not selected a protocol, the system will default to a default protocol. The user can change the protocol using the drop-down box below the Begin Testing button.

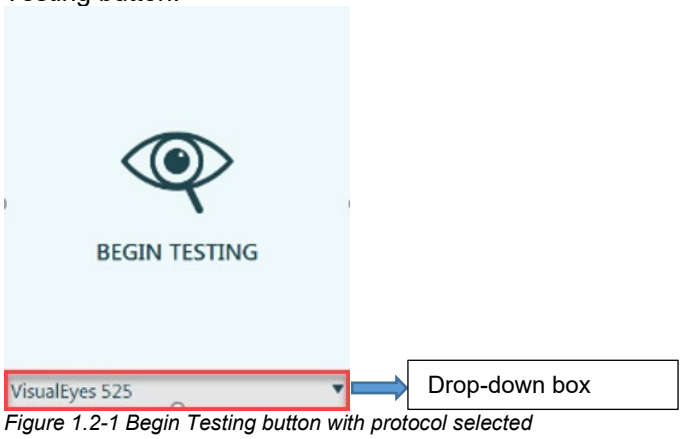


Figure 1.2-1 Begin Testing button with protocol selected

The VisualEyes™ system has a default protocol defined by the product(s) installed. Protocols with default settings allow the user to begin testing immediately. See Table 1.2-1 for an overview of default protocols. The *Dix Hallpike* and *Headshake* tests in *VisualEyes™ 505* are based on the Video Frenzel test. This means that the Dix Hallpike tests available in *VisualEyes™ 505* are different than the dedicated Dix Hallpike test available in *VisualEyes™ 515 and 525*, which includes eye tracking and where the test can be divided in different sections for sitting and supine positions.

Table 1.2-1: Default protocols with VisualEyes™ systems

VisualEyes™ 505	VisualEyes™ 515	VisualEyes™ 525	VORTEQ™ Assessments	VORTEQ™ Diagnostics	VisualEyes™ EyeSeeCam	VORTEQ Functional Assessments
• Dix Hallpike Left* • Dix Hallpike Right* • Headshake* • Spontaneous Nystagmus	• Spontaneous Nystagmus • Dix Hallpike • Positional • Caloric • Step Velocity** • Sinusoidal Harmonic Acceleration** • VOR Suppression** • Visual VOR**	• Spontaneous Nystagmus • Gaze • Smooth Pursuit • Random Saccade • Optokinetic • Dix Hallpike • Positional • Caloric • Step Velocity** • Sinusoidal Harmonic Acceleration** • VOR Suppression** • Visual VOR** • Subjective Visual Vertical** • Saccadometry • Ocular Counter Roll • Self Paced Saccades • Cervical Gaze • Smooth Pursuit Neck Torsion	• Dix Hallpike Advanced • Lateral Head Roll • Dynamic Visual Acuity • Gaze Stabilization Test • Functional Vision Head Impulse Test (fvHIT™)	• vHIT for VORTEQ™ • VORTEQ™ AHR	• Spontaneous Nystagmus • vHIT for EyeSeeCam	• Dynamic Visual Acuity • Gaze Stabilization • Functional Vision Head Impulse

* Customized Video Frenzel test
** Only present with the addition of the relevant rotary chair.

The process of creating custom protocols is explained in detail in section 8 of this manual.
Use your touch screen or mouse to select **Begin Test** and the first test in your test battery will appear on screen (Figure 1.2-2).

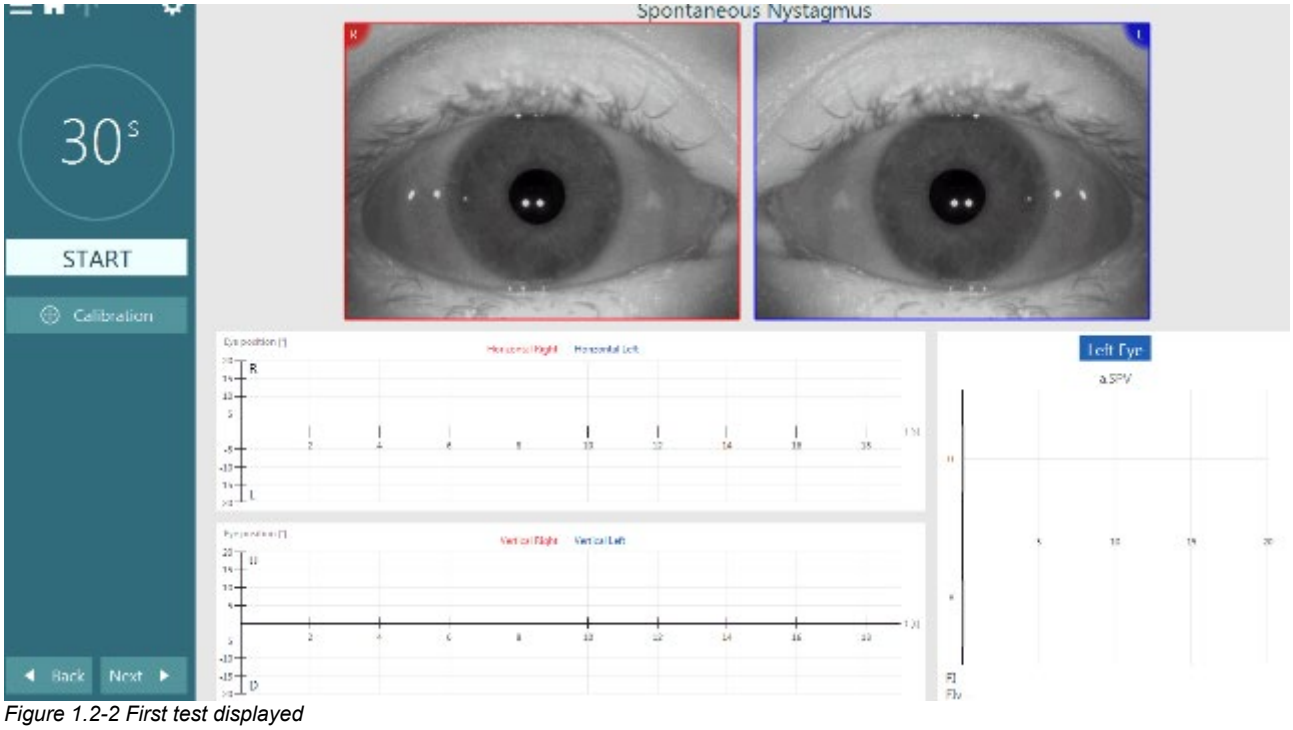


Figure 1.2-2 First test displayed

1.3 Starting a test

Tests can be started in multiple ways:

- Click the **Start** button on the test screen. This option is available for all tests.
- Press the **Enter** button on the RF remote (if available). Ideal for starting the test when not at the computer. This option is available for all VNG tests. Rotational chair tests do not respond to the RF remote's **Enter** button as a patient safety measure.
- On the top mount goggle, press the **goggle's switch** on the side of the goggles. The top mount camera goggle's switch is ideal for starting the test when at the patient's side such as in Dix Hallpike and positional tests.
- Press the **irrigator handle button** on the AirFx or AquaStim to start the irrigation and caloric test. This is only available in caloric tests.
- Press the **foot pedal** (if available). Ideal for starting the test when not at the computer. This option is available for all tests. Make sure the foot pedal is far enough away from the reclining chair so that the operator is outside the chair's path of rotation.

Moving through the screens:

- Test menu ☰ which is in the upper right corner of the test navigation bar allows a user to view the current test session.
- The home button will return to the main screen
- The up-arrow button will exit the current subtest and go to the individual subtest summary screen (Figure 1.3-1)
- The settings icon to the right of the up-arrow button allows the user to temporarily adjust the test parameters (Figure 1.3-1).
- The user can respond to pop up messages with the remote control

Restarting the test:

Tests can be restarted using the esc key on the keyboard or the RF remote. While the test is running, the esc key will abort the test and clear any collected data. In caloric tests, the software will require confirmation of this request.

Rotational chair tests can be restarted using the esc key on the keyboard. Pressing the esc key on the RF remote is ignored during rotational chair tests as a patient safety measure. The software will require confirmation of this request.

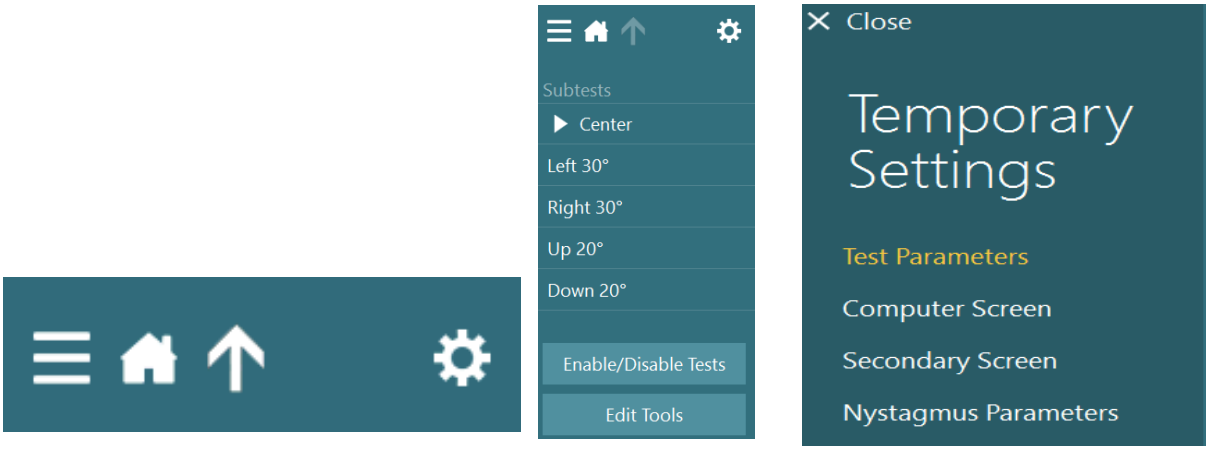


Figure 1.3-1 Test navigation bar, test summary with all subtests, Temporary Settings option (left to right)

NOTICE
No other PC programs should be running or minimized while testing the patient with the software. This can interfere with VisualEyes™.

1.4 Session tree

Clicking the icon will display the list of tests in the current session. The test listed in yellow is the active test. Tests that have been completed are given either a green checkmark or a red diamond depending on the test results. In case the operator decides to change the test result, she/he can manually change the green checkmark into a red diamond and vice versa by clicking or touching the respective icons (Figure 1.4-1). Clicking or touching the test title will navigate to the desired test.

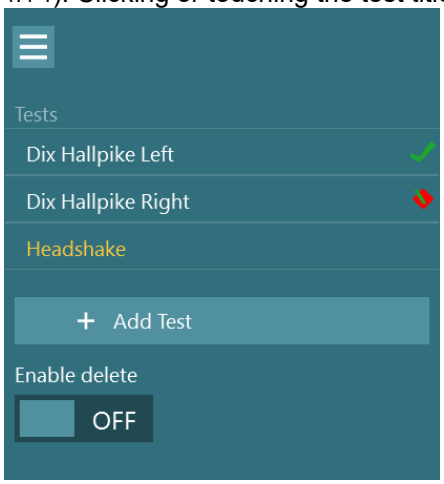


Figure 1.4-1 Session tree displaying tests completed

1.5 Eye image adjustment

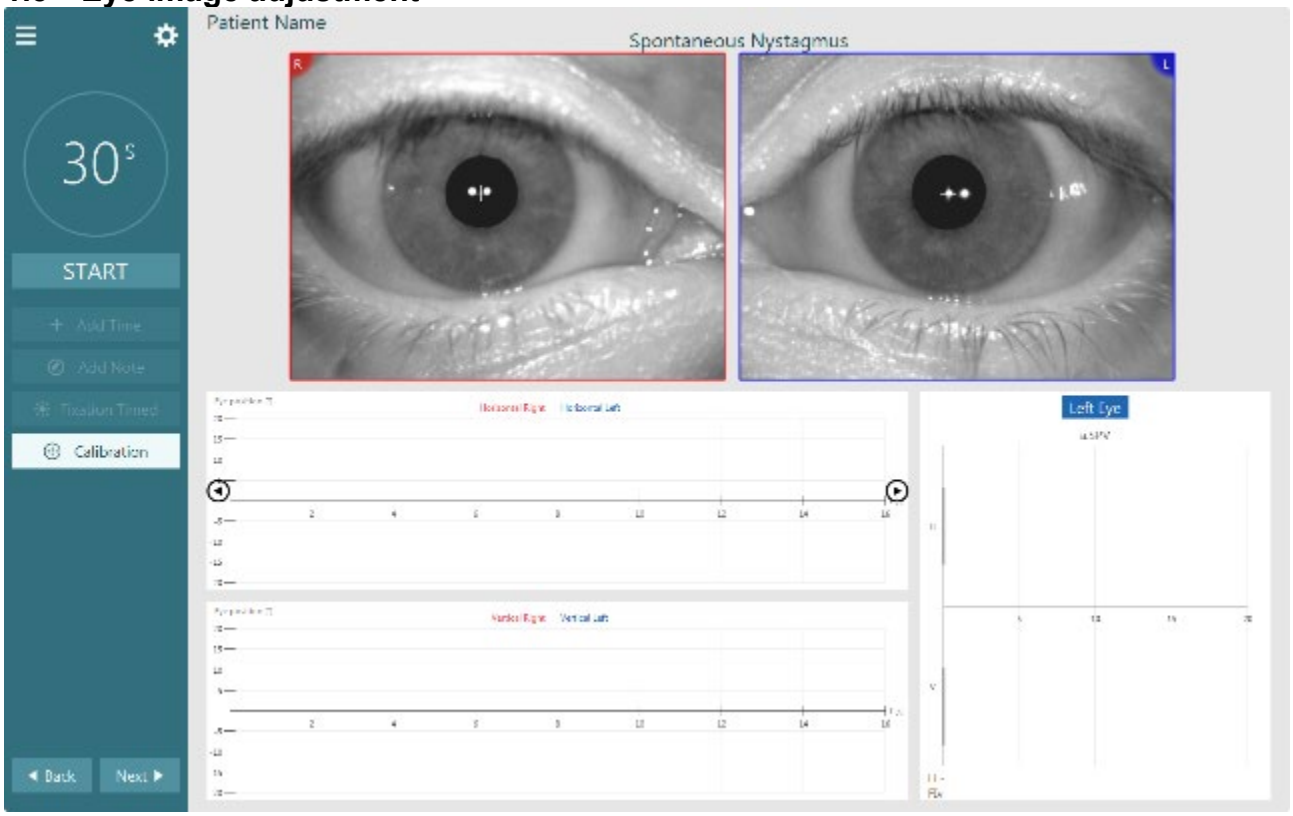


Figure 1.5-1 Test screen display (Spontaneous Nystagmus)

The user can see the patient's eye image as soon as the **Begin Testing** option is selected from the main menu display. This will open the first test and the image of the patient's eyes (Figure 1.5-1) will appear in the upper portion of the user display. Before testing, the eye images must be aligned (horizontally/vertically) so that the pupil is centered in the observed eye image.
The inner canthus of the right eye should be seen on the right side of the red outlined eye image. The inner canthus of the left eye should be seen on the left side of the blue outlined eye image. The eye images have L and R captions in the corners, which refer both to the eye selected and the direction the eye is looking.

NOTICE Before launching VisualEyes™, make sure that the cameras are connected. Missing eye images indicate that the cameras are disconnected, and a status will be displayed as shown in Figure 1.5-2.

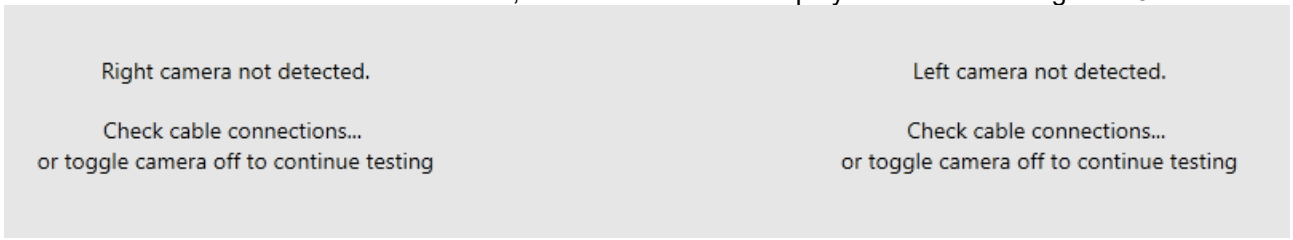


Figure 1.5-2 Cameras disconnected status

This can happen with one or both cameras. Check the camera cables to ensure a good connection between the camera and the computer.

How to adjust eye image using side-mounted camera goggles
To center the eye image on screen, move the camera horizontally/vertically using the knobs on the camera cabinet (Figure 1.5-3).



Figure 1.5-3 Side mount adjustment knobs for regulating image and focus

1. The upper knob moves the camera vertically.
2. The left knob moves the camera horizontally.
3. The center knob adjusts image focus.

The mirrors can also be rotated inward by holding the mirror edges. A gentle inward rotation of mirrors can help to adjust for smaller faces and narrow inner-canthal spaces. When the mirrors are rotated, the image will need to be re-centered and may need focus adjustment (Figure 1.5-4).



Figure 1.5-4 Mirror adjustment for smaller faces or narrow inner-canthal spaces

How to adjust eye image using top-mounted camera goggles
When the top-mount camera goggles are used, the user can see a ‘center eyes’ icon on screen where the eye images are displayed. By clicking or touching the center eyes icon (Figure 1.5-5), the eye images will be centered.
The same function can be performed by clicking the CENTER button on the IR handheld remote control.



Figure 1.5-5 Center eyes icon

Front mounted cameras
Position the front mounted camera unit on the viewport with the fixation light at the top center. Use the ball and socket mechanism on the camera unit to aim the camera and center the eye image approximately in the software. Next, with one hand on the back of the patient's head, push in gently on the camera to lock it in place. Lock the cable in the clip on top of the goggles.



Figure 1.5-6 Placement of front mount camera in goggles

How to adjust eye image using EyeSeeCam camera goggles
When the ESC camera goggles are used, move the whole camera unit to adjust the camera images in the screen (Figure 1.5-7).



Figure 1.5-7 ESC adjustment knobs for regulating image

1.6 Focus adjustment

The VisualEyes™ system requires a focused eye image for the pupil tracker to locate the pupil center to optimally record the eye movements. The pupil center is marked with a crosshair (Figure 1.6-1).

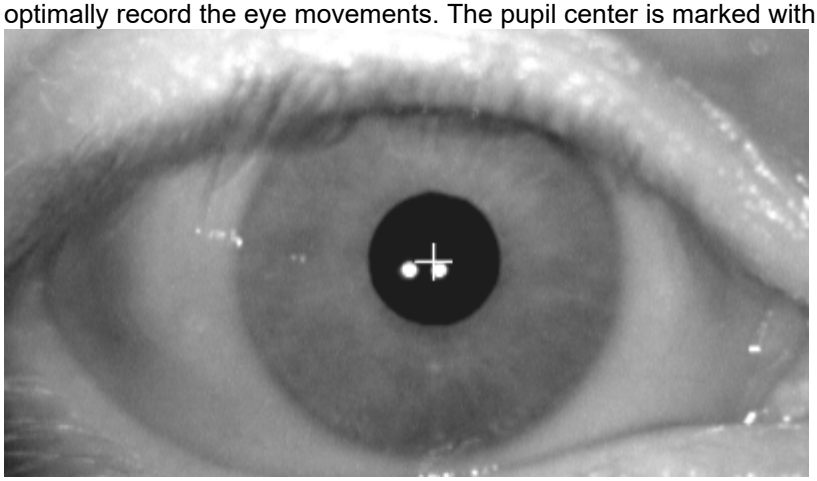


Figure 1.6-1 Pupil tracker (crosshair)

The camera image can be focused by adjusting the focus knob on each camera (Figure 1.6-2). Each image must be adjusted separately. Turn the knob clockwise or counterclockwise while watching the image on screen. Stop turning the knob when the pupil outline and iris pattern are clear, even if the eye surroundings may be blurry at this point.

If the image is not optimally focused, the eye tracker may fail to adequately record the eye movements which may lead to poor results.

NOTICE *This crosshair will also be present in the review videos for easier discrimination between abnormalities and technical difficulties.*



Figure 1.6-2 Adjustment control for focusing eye image on each camera

1.7 Eye image contrast adjustment

The VisualEyes™ system automatically adjusts the threshold (contrast) to display an optimized eye image. Nevertheless, it might be necessary to adjust the threshold. If so, the automatic threshold adjustment can be turned off before or during recording by clicking the threshold adjustment button (Figure 1.7-1). The button will be shown when the user touches the eye image or places the mouse over the eye images.



Figure 1.7-1 Threshold adjustment button

When the threshold adjustment button is selected, a scrollbar will appear for each eye's contrast level. By default, the A button will be highlighted indicating the system is automatically adjusting the contrast threshold level. Slide the scrollbar value with the mouse or finger to the position where the crosshair is viewable. Have the patient look left, right, up, and down to verify the threshold level and adjust as necessary so the crosshair tracks the pupil while looking in each direction (Figure 1.7-2). To reset it back to automatic threshold, click the  icon below each slider.

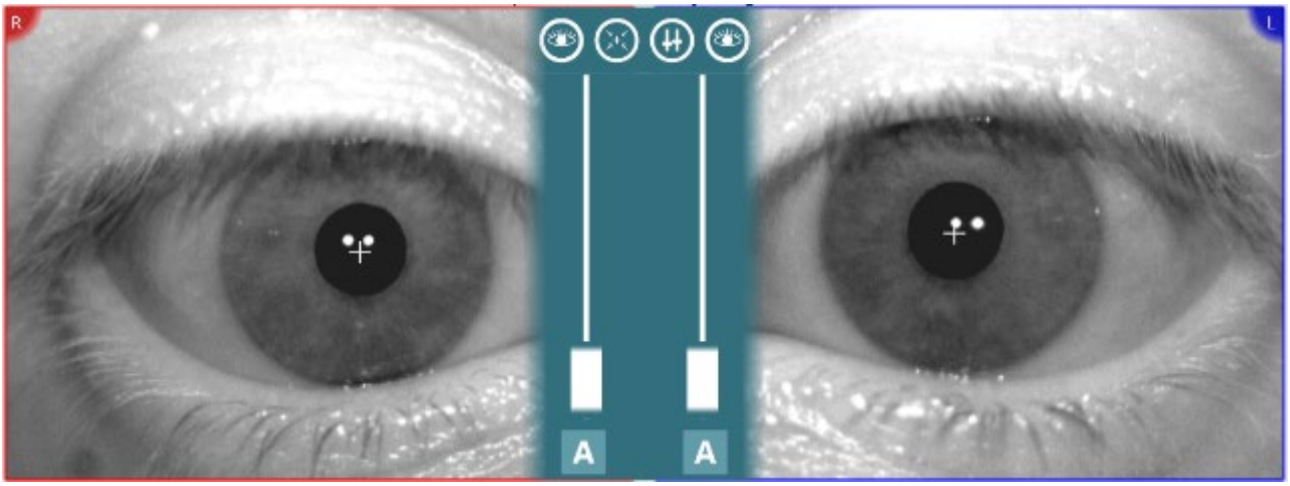


Figure 1.7-2 Threshold adjustment scrollbars

1.8 Enlarging eye images

Enlarging the eye images can help the clinician clearly visualize the eye image during eye image adjustments and within different tests. Alternatively, if a stimulus display is connected, the eyes are displayed on that screen when no target is used, providing an even larger image of the eyes for viewing. Double clicking on one of the displayed eyes will enlarge the eye windows on the screen (Figure 1.8-1 and Figure 1.8-2). The eye position traces screen is hidden while the eye images are enlarged. To exit this viewing mode, double click on the eyes again.

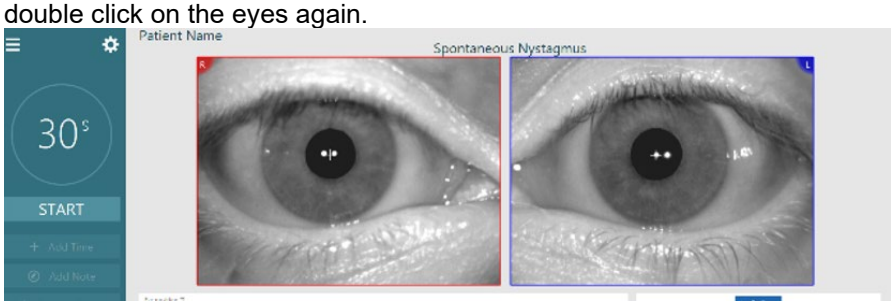


Figure 1.8-1 Before enlarging eye images

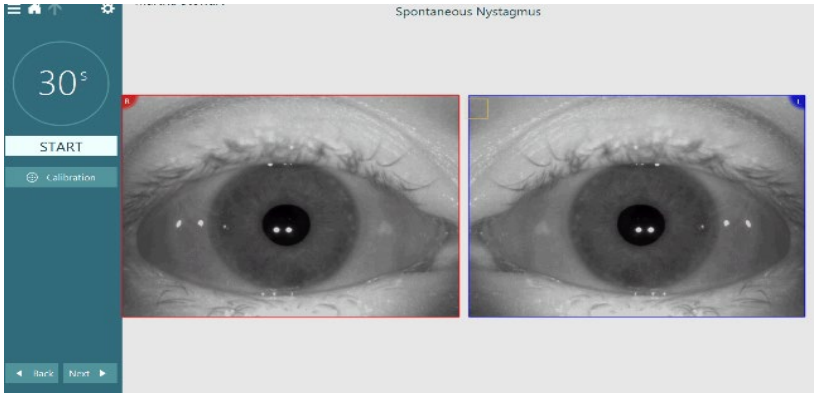


Figure 1.8-2 Enlarged eye images

1.9 Monocular vs binocular eye recordings

VisualEyes™ can record in either a monocular (one camera) or binocular (two cameras) mode. The monocular mode may be beneficial in cases where one of eyes cannot be tested (eye is artificial or severe ptosis). To deselect an eye during testing, touch the eye images or hover over with the mouse to display the eye tools menu (Figure 1.9-1). Click or touch the eye button to ignore the eye in question (Figure 1.9-2) during testing and the software will ignore the selected camera for the duration of testing. To track the pupil again, display the eye tools menu again and select the ignored camera.



Figure 1.9-1 Eye tools menu, as shown in the research module

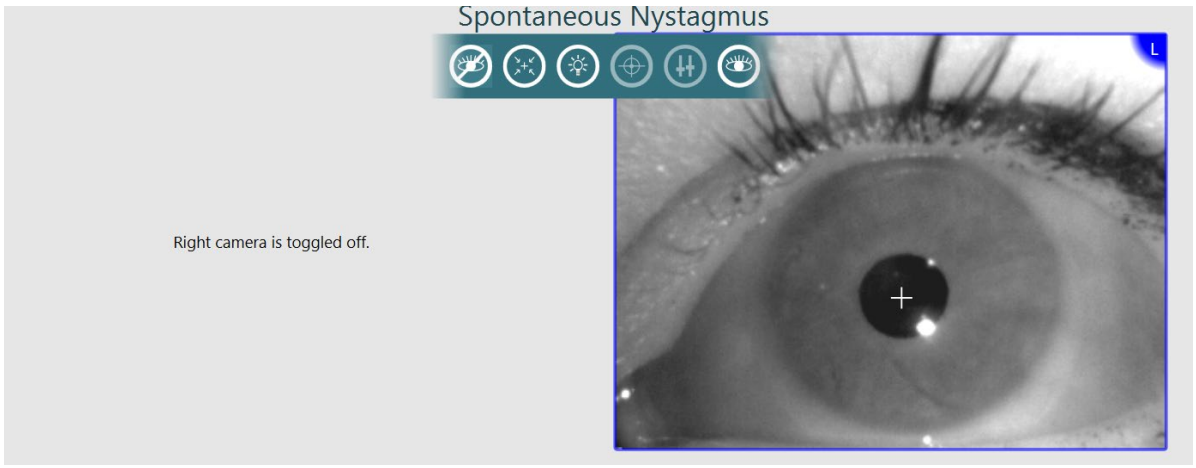


Figure 1.9-2 Left eye selected and right eye ignored

1.10 Eye tracker selection

VisualEyes™ can utilize different tracking methods depending on the test performed and the patient's eyes. The crosshair button in the eye tools menu allows the user to change the eye tracker when needed.

- Curve Tracker – Standard eye tracker that uses a curve recognition algorithm to isolate the pupil outline
- IPM Tracker – Blob analysis eye tracker that locates the pupil center for high speed vHIT tracking
- Convex Hull Tracker – Eye tracker with geometric compensation for torsional tracking. Also recommended for large pupil tracking e.g. in pediatrics.
- EyeSeeCam Tracker – Eye tracker used with the EyeSeeCam camera for high speed vHIT tracking (exclusive and default for ESC, so no need to select anything in the software)

When the test is complete, the eye tracker will be listed in the Temporary Settings for reference.

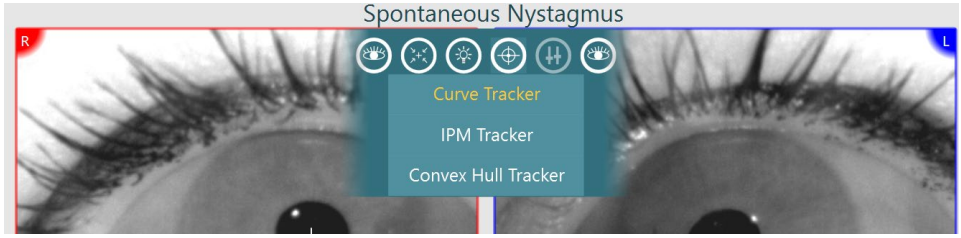
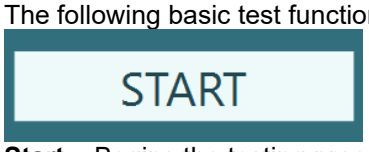


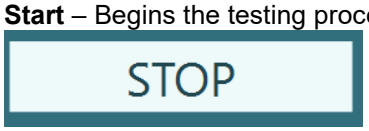
Figure 1.10-1 Curve tracker can be changed in the toolbar at the top of the eyes

1.11 Common test functions

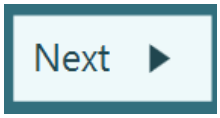
The following basic test functions apply to all tests within VisualEyes™ VNG.



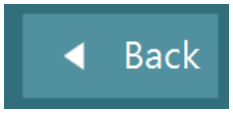
Start – Begins the testing procedure (video and eye trace recordings).



Stop – Stops the testing procedure (video and eye trace recordings).

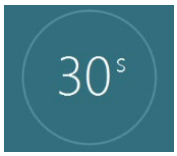


Next – Moves onto next test/subtest in the protocol.



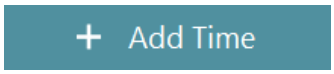
Back – Moves back one test/subtest in the protocol.

Timer



During all tests, the timer will display how much time has elapsed or remains in the current test based on the count style. With the default system settings, the timer will provide audible beeps and voice prompts at indicated intervals to prompt the examiner and provide audible feedback for the elapsed or remaining time in the test. To change these settings, see section 13.3.

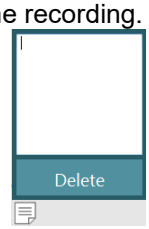
You can add time to the test by pressing the **Add Time** button. This will add a further 30 seconds (default) to the time remaining on the counter.



1.12 Add note

You can insert a note at a specific point in the raw trace, during or after testing, by selecting **Add Note** (Figure 1.12-1). You can also use this as an event marker to identify a unique event within the recording.

The time at which the note is inserted is shown with the symbol "". The text is limited to 33 characters. It will be hidden in the traces but will be uncovered when hovering over or clicking on the note symbol. When printing the test in the report, the note added will be displayed after the graphical printouts. You can also delete the note using the delete option located under the note.



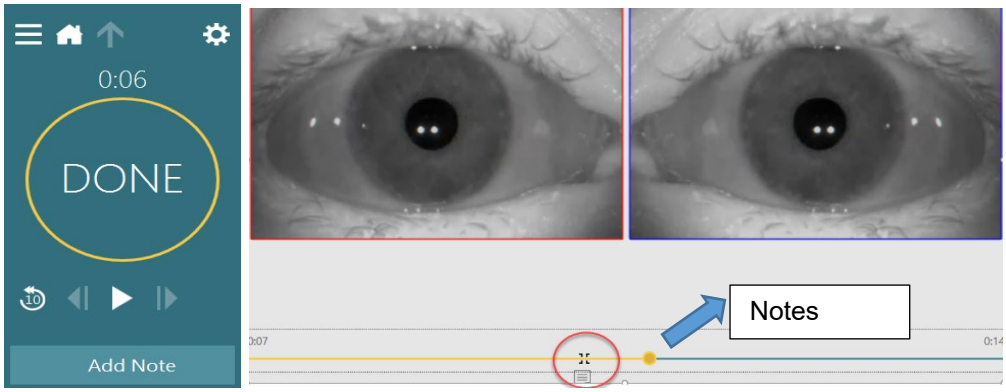


Figure 1.12-1 Add Note button and the location of note during the test.

1.13 Keyboard marker for tracing

You can add a marker on the eye tracing graph by pressing the keyboard letter "m". You can use this marker to identify when an external stimulus was presented during the test. When reviewing or printing results, the marker will be present.

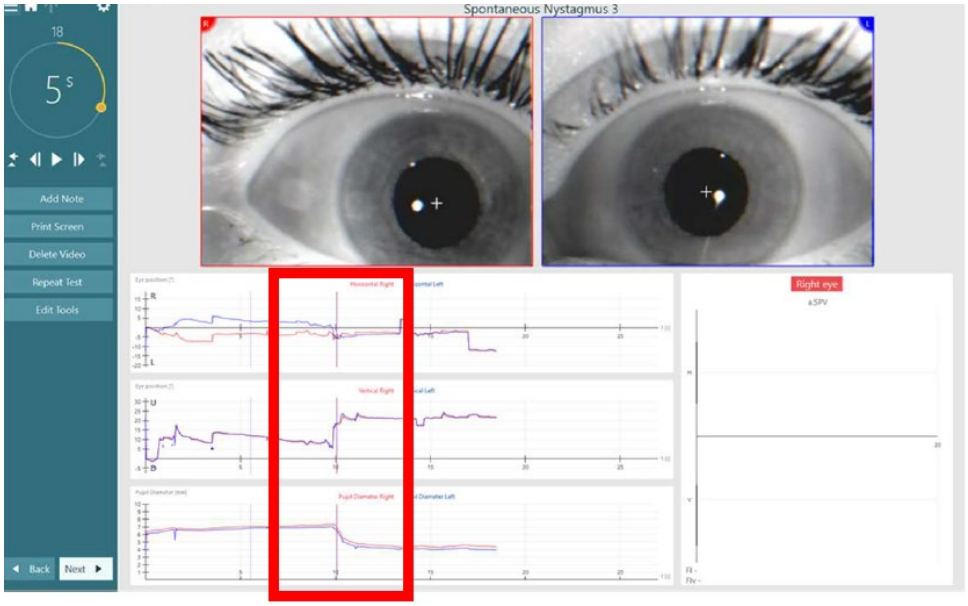


Figure 1.13-1 keyboard marker for tracing

Keyboard marker is active for these tests:

1. Oculomotor Assessments: Spontaneous Nystagmus, Gaze, Smooth Pursuit, Self-Paced Saccades, Random Saccade, Saccadometry and Optokinetic tests
2. Positional Tests: Dix-Hallpike, Advanced Dix-Hallpike, Positional and Lateral Head Roll tests
3. Rotational Assessments: Sinusoidal Harmonic Acceleration, Step Velocity, Visual VOR, VOR Suppression
4. Other Tests: VORTEQ™ AHR, SVV Static, SVV, Caloric, OCR

1.14 Fixation suppression

There may be times in certain tests where a fixation light is presented to the patient to differentiate peripheral from central abnormalities.

You can turn on the fixation light by pressing the ‘Fixation’ button (Figure 1.144-1) or by using the remote control.



Figure 1.144-1 Fixation light button

You can display the fixation light in either the left or right eye (default is left eye). This allows the examiner to select the better eye for fixation, particularly in patients with visual impairments. You can change this setting in the Input tab in the System Default Settings screen.

A yellow bar appears in the timeline when reviewing the test to mark the duration of the fixation light (Figure 1.144-2). The length of the bar determines the amount of time the fixation light was active.

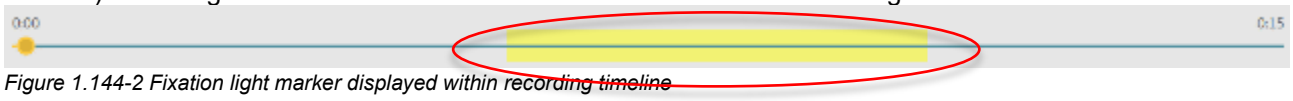


Figure 1.144-2 Fixation light marker displayed within recording timeline

1.15 Add tests or delete tests

Each test has a ‘test menu’ in the upper-left corner of the test panel. Clicking the ‘test menu’ will reveal a list of test options.



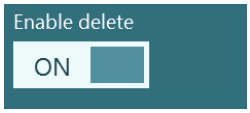
To add tests



The **Add Test** button adds your default or customized test of choice to the bottom of the patient’s test session.

Delete tests

You can also delete and/or replace any test (with or without data) to make a customized test list. To delete any test, activate the ‘**Enable delete’** option.





symbol appears besides each test in the test list. Clicking or touching this symbol will remove the test from the session. Refer to Figure 1.155-1 for sample pictures.

NOTICE: The current test will be highlighted in yellow and cannot be deleted. Once deleted, the test data cannot be recovered.

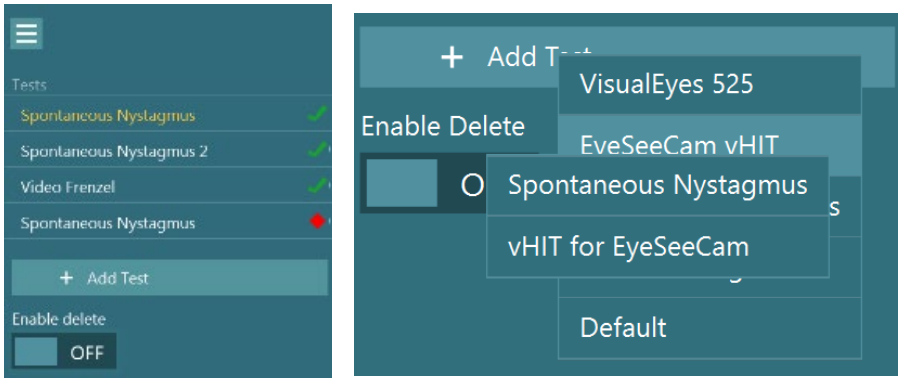


Figure 1.155-1 Test menu: addition of a test and deletion of a test

1.16 Repeating tests

You can repeat or replace a test. After you complete a test, click on the Repeat Test button (Figure 1.166-1). The software will ask if you want to overwrite the test or create a new test instance (Figure 1.166-2). If you overwrite the test, the name will remain the same. A number will denote a repeated test (e.g. Dix-Hallpike 2).

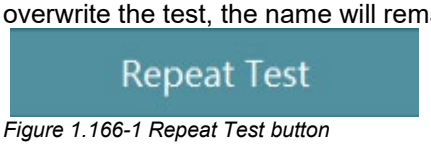


Figure 1.166-1 Repeat Test button

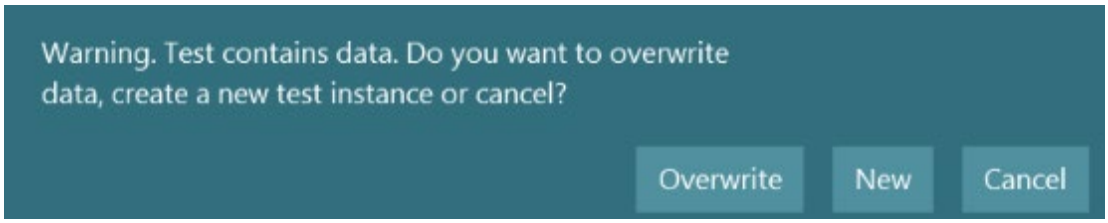


Figure 1.166-2 Overwrite or new confirmation prompt.

1.17 Test review

Upon test completion, you can review the patient's responses. The Test Review screen (Figure 1.7-1) contains the eye and room video recordings, a playback menu, and a timeline. The eye videos and room camera videos are played synchronously from the Test Review screen. Start the playback by clicking on the play button in the playback menu. A yellow circle will show the current position of the video on both the timeline and the playback timer. You can grab or drag this circle with your mouse to jump to a new location in the video playback. The size slider allows you to increase the size of the eyes or the room camera video.

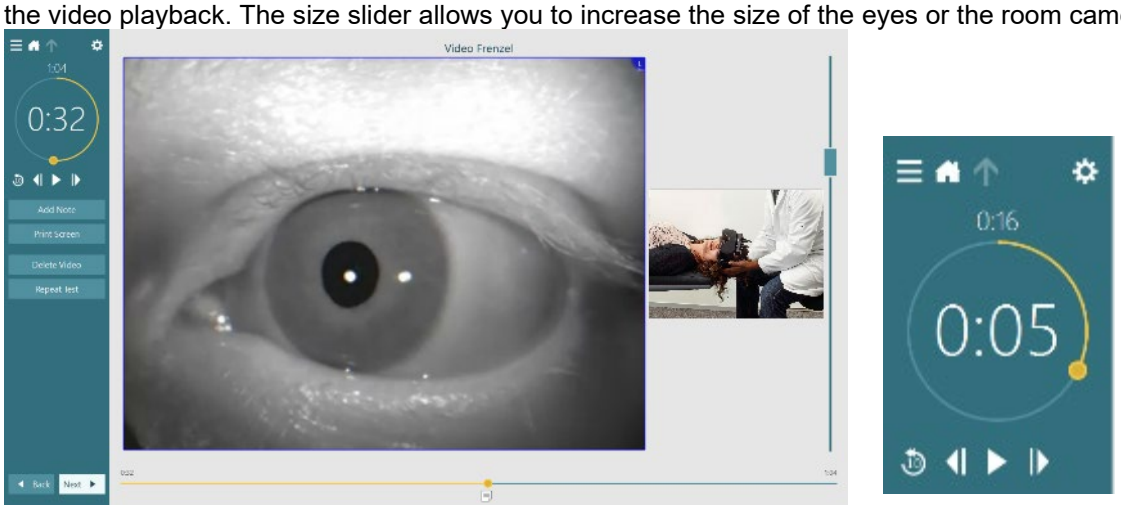


Figure 1.7-1 Test Review screen



Go to previous frame (hold to play backwards in slow motion).



Play/pause.



Go to next frame (hold to play forwards in slow motion).



Go back 10 secs in video playback.

Note: When the test is supported with 3D head model, the user can view the recorded head movement using this test video playback option.

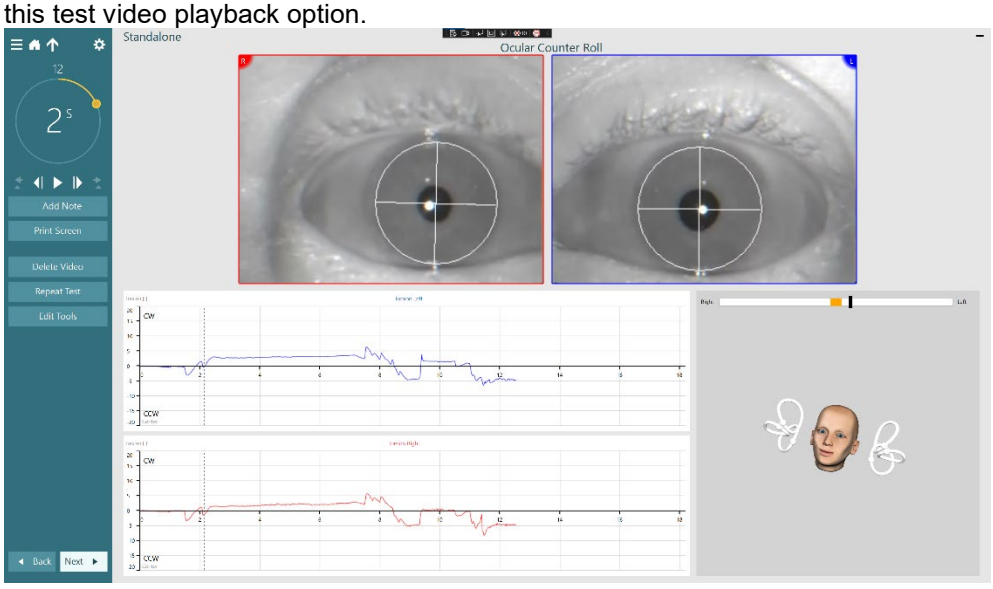


Figure 1.177-2 Test Review screen with 3D head model

2 Calibration

Calibrations are particularly important in tests where eye movements are compared with a given stimulus of a known position and/or velocity (e.g., Saccade test). Calibration can be performed on both eyes (binocular) or individually (monocular) by turning off the non-essential eye or using a monocular goggle. Calibration is strongly recommended for all tests to accurately measure the velocity of the nystagmus.

2.1 Source selection

Before selecting 'calibration option', you must select the hardware source (top mounted goggles / side mounted goggles / front mounted goggles / ESC/ pediatric observation camera) using the 'Select Source' option (Figure 2.1-1). The options are based on your available licenses.

After selecting the data source, select the stimuli (TV / Laser and Drum).



Figure 2.1-1 Hardware source selection

2.2 Performing calibration

In the test screen side panel, click the **Calibration** button (Figure 2.2-1).

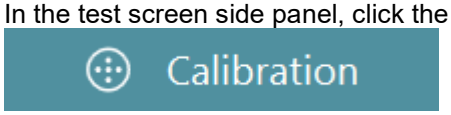


Figure 2.2-1 Calibration button

The Calibration dialog box will open (Figure 2.2-2).

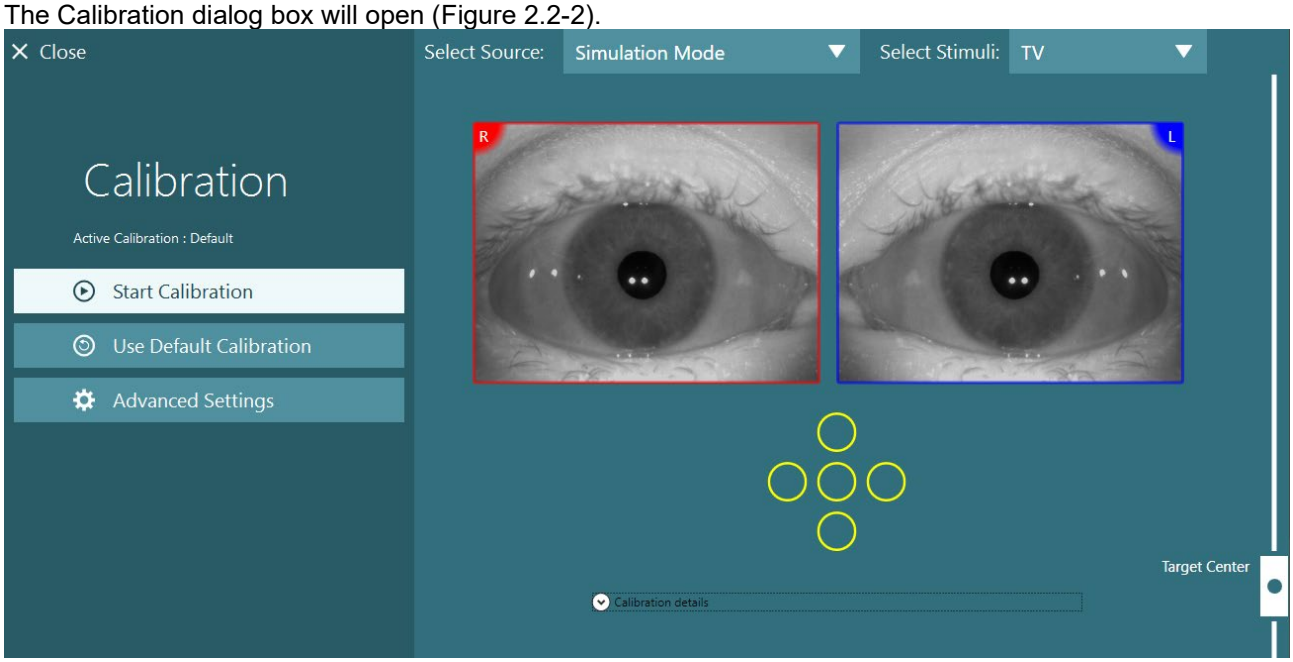


Figure 2.2-2 Calibration screen with cameras

Before calibrating, ensure that you have selected the hardware source which you will use for subsequent testing. Then center the calibration stimulus for the patient using the target center slider. Vertical tests will still display the target from the center of the screen, but horizontal tests will display the target centered at the target center position specified by the Target Center slider (Figure 2.2-3).

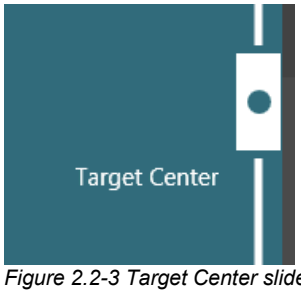


Figure 2.2-3 Target Center slider

When testing with a VNG source, the upper area of the dialog shows the video images of the eyes that are being calibrated. If necessary, adjust the pupil threshold to achieve optimal eye detection.
2.24

Click the **Start calibration** button to begin the calibration routine..

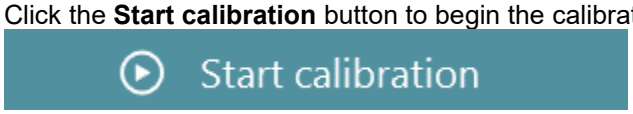


Figure 2.2-4 Start calibration button

Ask the patient to look at the first calibration point. After a few seconds of fixation, a target confirmed check mark (Figure 2.2-5) will appear to confirm calibration of the center point. If the patient fails to fixate on the center point, the software will present a warning message (Figure 2.2-6).


Figure 2.2-5 Target confirmed check mark

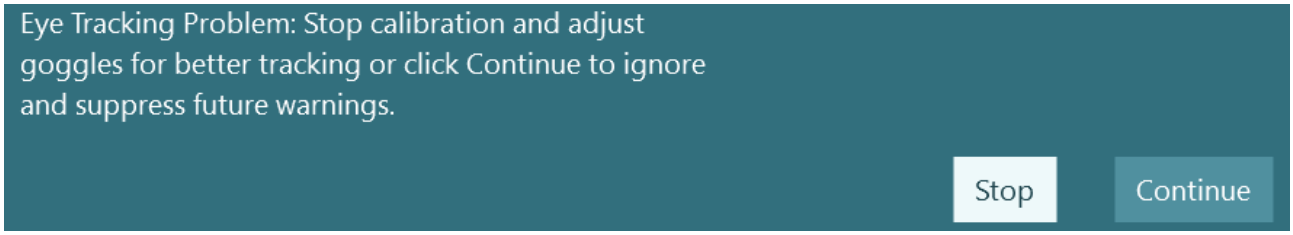


Figure 2.2-6 Eye tracking problem warning

You may not successfully achieve automatic fixation detection in some patients. If you believe that the patient has fixated upon the calibration point, you can click the **Accept point** button to accept the value and move on to the next target position (Figure 2.2-7).

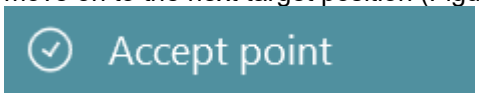


Figure 2.2-7 Accept point button

Ask the patient to fixate on the target to the left without moving his / her head. After a few seconds of fixation, a yellow check mark will appear to confirm calibration. The target will then move to the right, center, up, and down. You can see the patient's eye positions in the graph below the check marks (Figure 2.2-8).

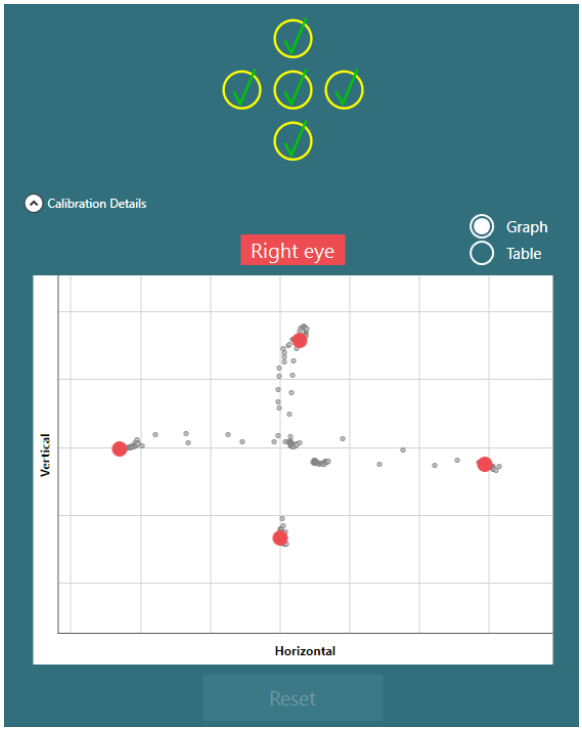


Figure 2.2-8 Calibration completed with all positions accepted

Once calibration is complete, the yellow check marks will turn green, indicating the patient has achieved appropriate calibration that is within tolerance at each of the calibration points (Figure 2.2-8). You can choose either a graphical or tabular explanation for the calibration (Figure 2.2-9).



Figure 2.2-9 Calibration failure with values and failure reason

If the patient could not fixate on one or more target positions, a red cross mark (Figure 2.2-10) will appear. The software will provide a **Redo Horizontal**, **Redo Vertical**, or **Redo All** button to clear the failure points and allow the calibration of the direction(s) again.



Figure 2.2-10 Unsuccessful cross mark

Upon successful calibration, the **Accept and Close** button will appear (Figure 2.2-11). Selecting this action will use the patient derived calibration values and close the calibration screen.

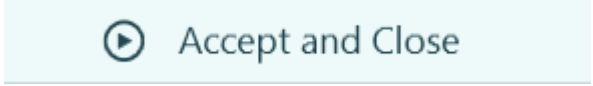


Figure 2.2-11 Accept calibration and close calibration screen button



Figure 2.2-12 Target Size option

Target Size: This option adjusts the size of the target in degree increments. If the target size is increased, the maximum angle will decrease (Figure 2.2-12).

2.3 Torsion calibration

You need to calibrate the torsional tracker before any tests that record torsion. Click on the “Torsion” button in the side panel to start the calibration process (Figure 2.3-1).

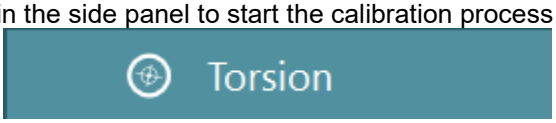


Figure 2.3-1 Torsion calibration button

Have the patient look straight ahead, then click on the Auto Detect button. The software will select an iris segment with good contrast to track rotation. You can adjust the tracking area using the sliders below the eyes.
Calibration should be performed in the same condition as the test. If you are going to use the torsional tracker in the dark with dilated pupils, it is very important to perform the torsion calibration in the dark with dilated pupils. If possible, ask the patient to look up slightly – this will make the iris more visible.

The white circle indicating the Tracking area must never be filled out by the pupil. This will lead to unstable torsional tracking (Figure 2.3-2).

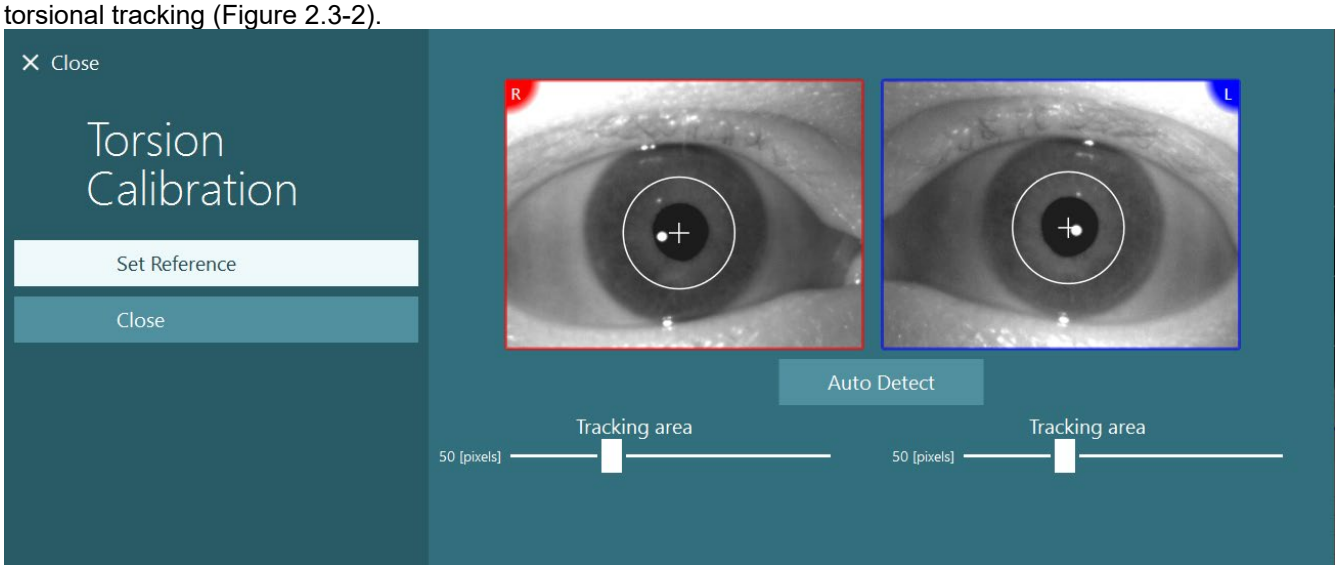


Figure 2.3-2 Adjusting the Tracking area

Once you have adjusted the Tracking area, click on the Set Reference button. The crosshair will now show a circle with a crosshair. Confirm that the torsion angle responds to the patient’s eye movements. If not, adjust the Tracking area and click on Set Reference to update. To return to the calibration settings, click on the Close button (Figure 2.3-3).

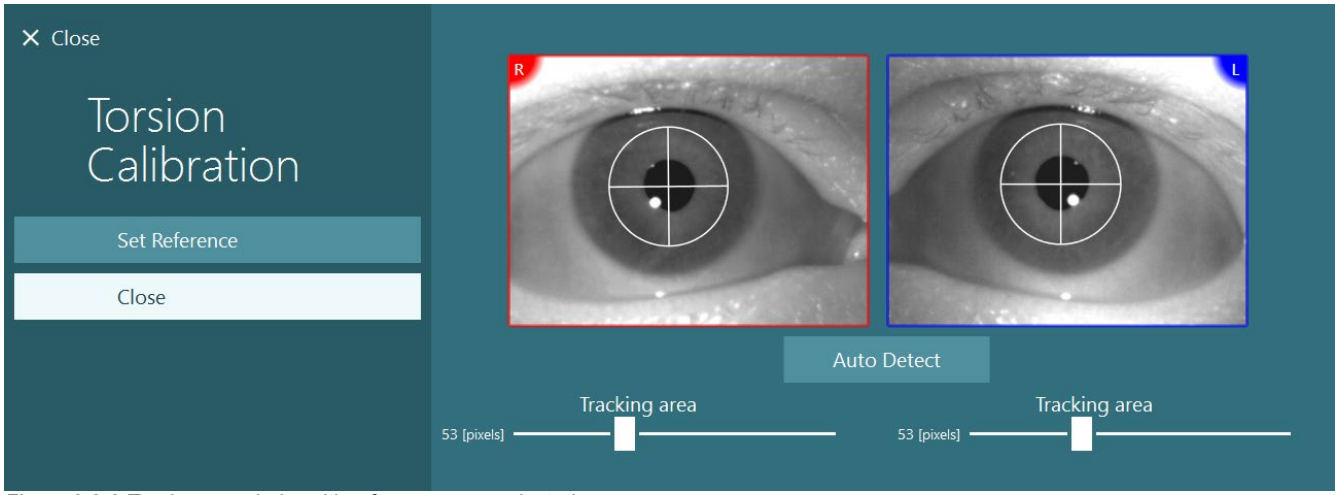


Figure 2.3-3 Torsion crosshairs with reference area selected

2.4 Default calibration

If you cannot complete a calibration, use the default calibration option (Figure 2.4-1). This sets the VisualEyes™ system to use default calibration settings which only provide an approximate calibration value. Be aware that results for oculomotor tests and nystagmus velocities need to be interpreted with caution.



Figure 2.4-1 Use default calibration button

2.5 Review calibrations

The patient's calibration traces (Figure 2.5-1) and videos are saved for later review. You can use these results to determine if the patient's eyes were properly calibrated before the VNG test. You can see which subtests are related to which calibrations, and if calibration was performed more than once. You can access the traces and videos from the **Session Review** and **Patient Sessions** screens.

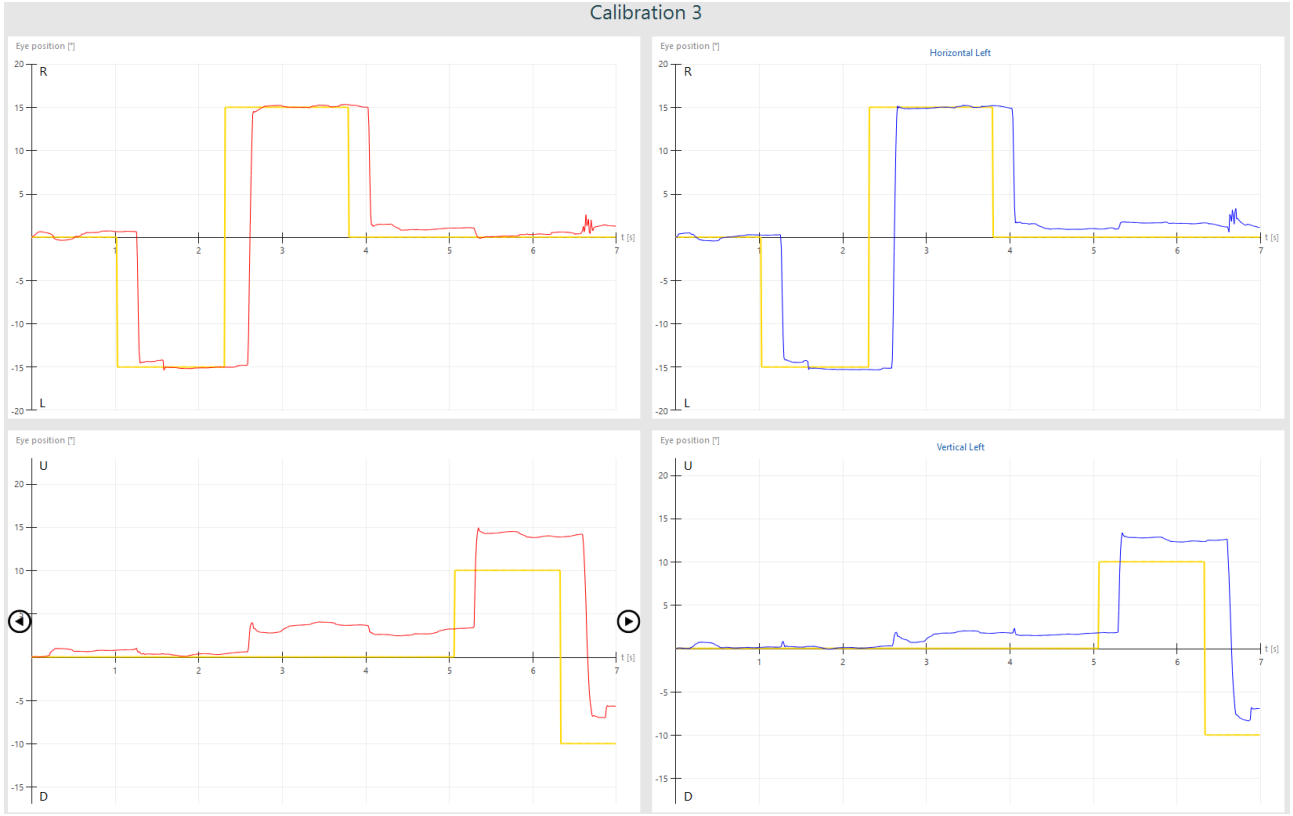


Figure 2.5-1 Calibration traces

The results are printed by default in the patient report (Figure 2.5-2).



Figure 2.5-2 Print Calibration from Session Review screen

3 Testing

3.1 Overview

To start testing, click on **Begin Testing** from the main menu. The first test in the chosen protocol is displayed. To begin testing with a different test in the protocol, select the desired test using the test menu button.

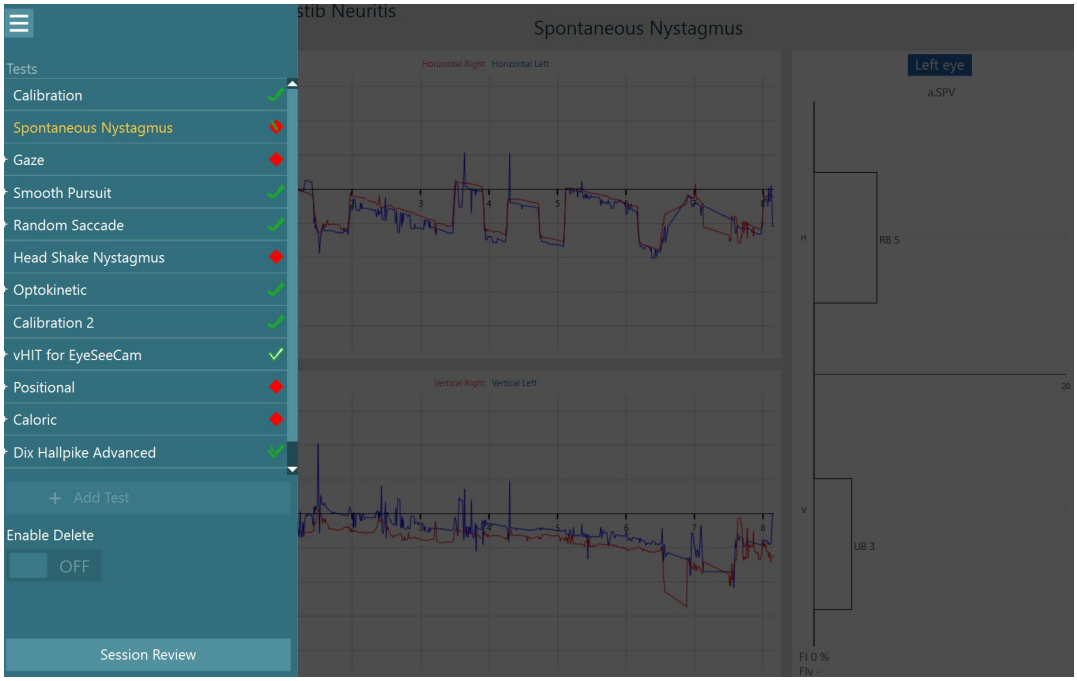


Figure 3.1-1 Session tree displayed

The left side panel displays a session tree, which shows all tests included in the current protocol (Figure 3. 1-1).

- The current test is displayed in yellow text.
- Completed tests that fall within test thresholds are marked with a green check mark.
- Completed tests that fall outside test thresholds are marked with a red diamond.
- Completed tests that fall outside test thresholds but have been marked as within limits are marked with a green check mark with a pencil.
- Completed tests where no test thresholds have been defined use a hollow green check mark
- Navigate to a test by clicking or touching the test title to perform (if incomplete) or review (if complete). By clicking or touching the plus button to the left of the test title, the test menu will expand to show the subtests available (Figure 3. 1-2).



Figure 3.1-2 Expanded test, displaying subtests

VisualEyes™ VNG offers an easy way to visualize video eye and trace recordings during data collection and review. The general display shows the eye images in the top portion of the screen and directly below it the raw tracings for the horizontal and vertical channels (Figure 3. 1-3). The eye images are presented in real time in synchrony with raw eye movement traces.

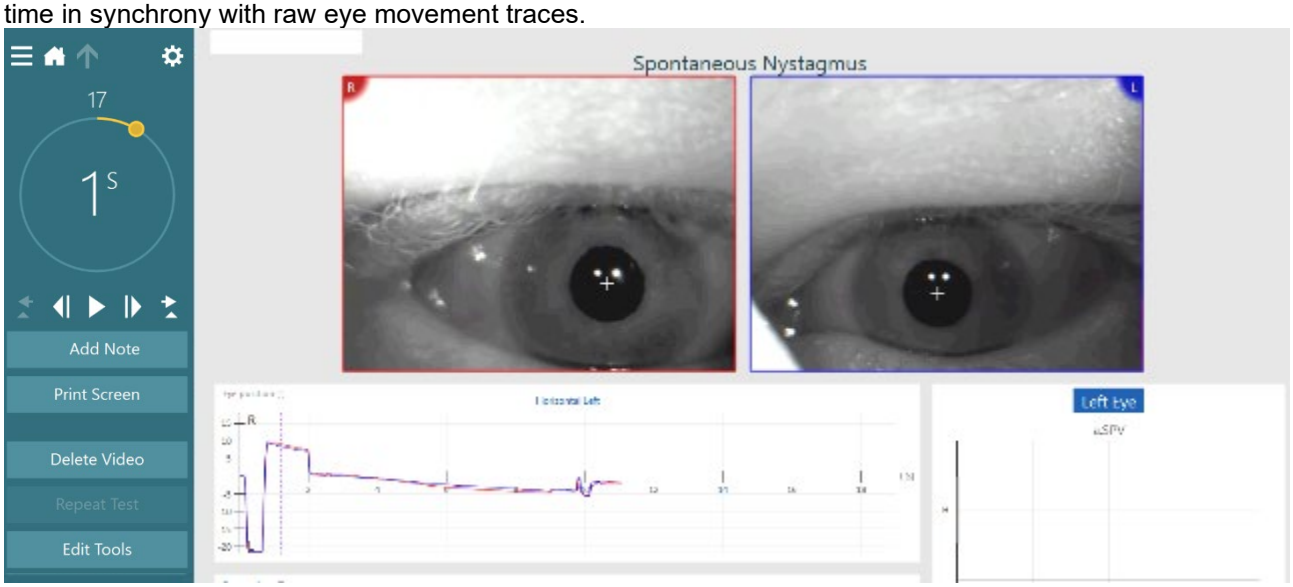


Figure 3.1-3 Test screen

Results are recorded and displayed in a large graphical display that shows the raw data tracing of the eye movements (Figure 3. 1-4). The right eye movements are red and the left eye movements are blue. The stimulus position is yellow.

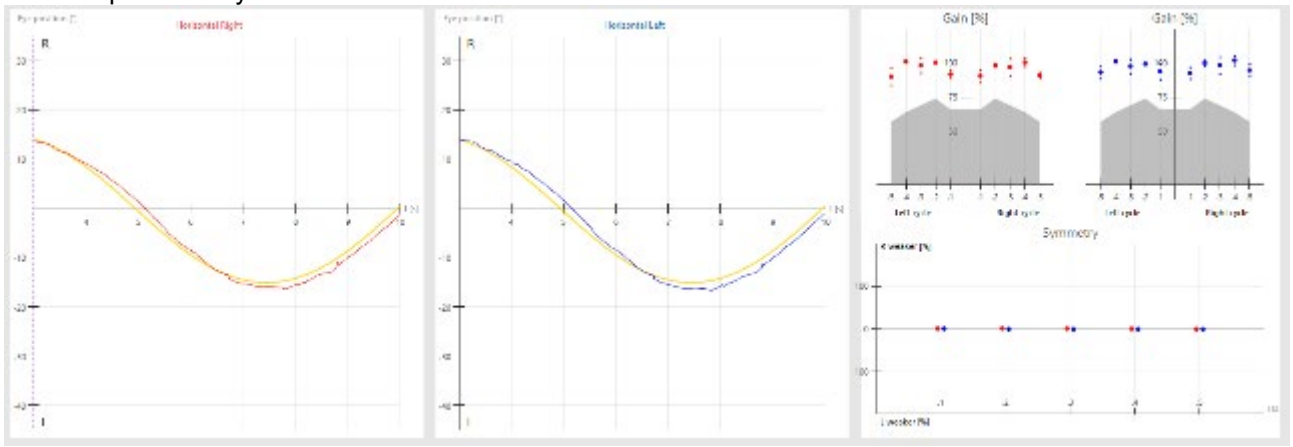


Figure 3.1-4 Waveform and results display

Both eye/s and raw tracings can be enlarged by double-clicking or double-touching the item of interest. The graphical area shows time (in seconds) on the horizontal axis and eye and stimulus movement (in degrees) on the vertical axis. Direction labels on the graph show the direction of the waveform.

3.2 Nystagmus marking and peak response

Nystagmus beats are marked by small triangles in the eye trace graphs. During data collection, the nystagmus beats are marked by triangles showing the inflection point between the slow and fast phases of the nystagmus beat. Triangles that point **upwards (below the tracing)** indicate right-beating nystagmus. Triangles that point **downwards (above the tracing)** indicate left-beating nystagmus (Figure 3.2-1).

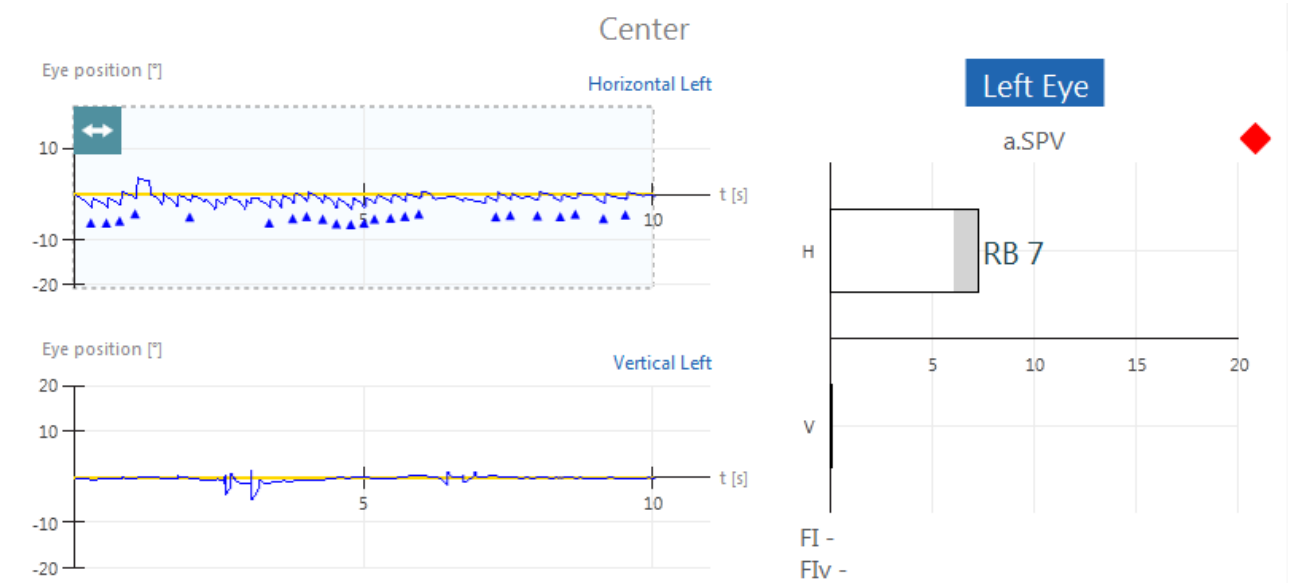


Figure 3.2-1 Nystagmus beats with triangles

After the test is complete, the software will show nystagmus beats and triangle nystagmus markers. You can select the 'highlight nystagmus slow phase' option to have the slow phases colored in green (Figure 3.2-2). You can also enable or disable triangle markers. This option can be set in System Default Settings under General settings.

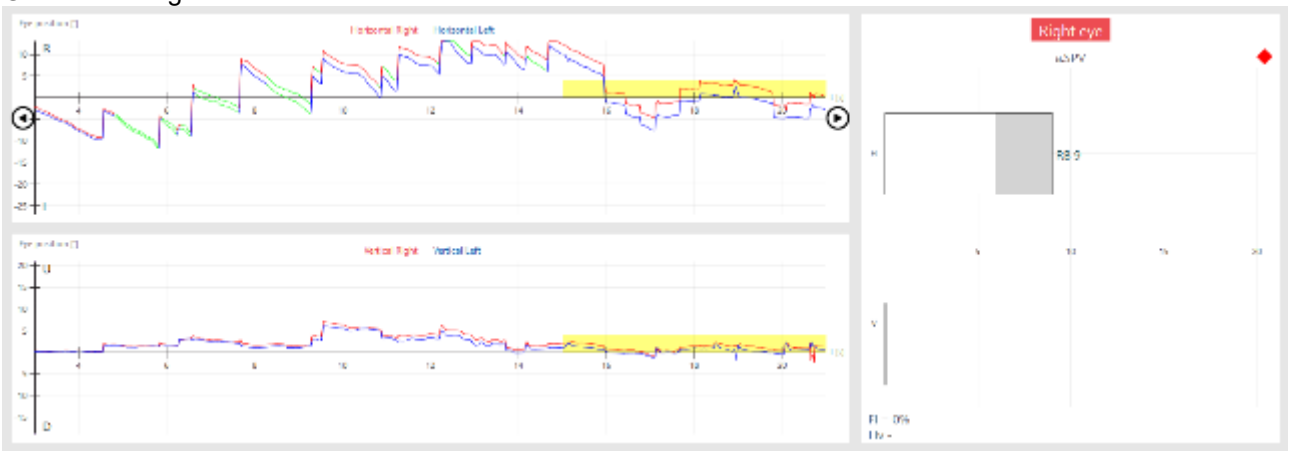


Figure 3.2-2 Nystagmus slopes marked green

The a. SPV (average slow phase velocity) is determined by averaging the slow phase values of each nystagmus beat in the selected peak response time. Three beats in the selected peak response time are required to calculate a. SPV. The peak response time is specified in the test's settings. The a. SPV is measured in degrees/second and displayed in the result graph beside the waveform. In nystagmus tests, the a. SPV graph only displays the results of one eye at a time. Clicking or touching the label for the eye selected will switch the a. SPV values for the other eye tested.

The Peak Response window is updated as the test progresses and is marked by a dashed window that is shaded in a light blue color (Figure 3.2-3) for the area with the largest a. SPV. You can move this window to the desired area by using the scroll button in the upper left corner of the Peak Response window. Reset to the default location by pressing the reset button in the upper right corner of the Peak Response window.

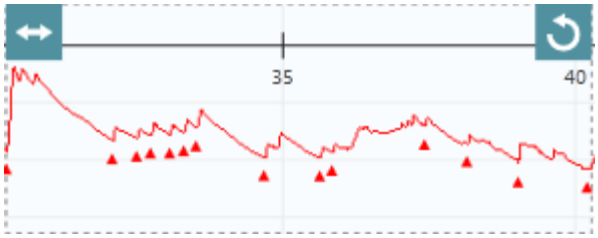


Figure 3.2-3 Peak Response window

You can adjust the time for determining the Peak Response in the test settings under Nystagmus parameters. The peak response cannot be longer than the allotted test time (Figure 3.2-4).

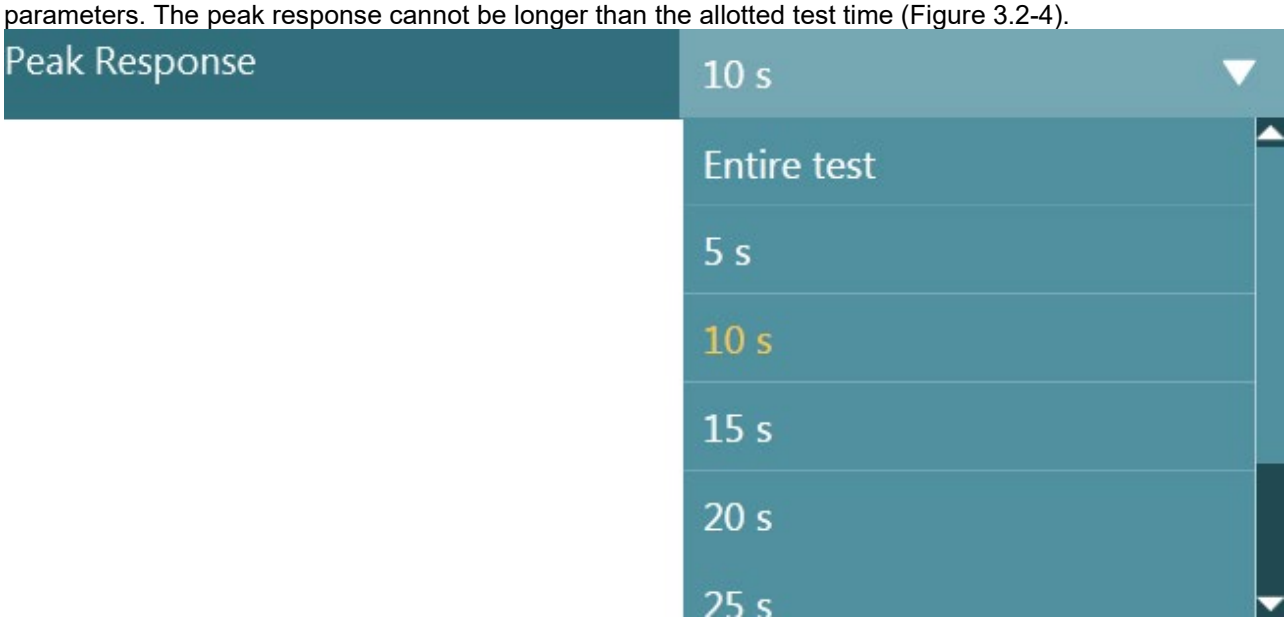


Figure 3.2-4 Peak Response times

3.3 Video Frenzel Test

Video Frenzel is a basic test, which can record patient eye movement without any analytical assessments. There is no time limit for eye recording in this test and there is no calibration requirement to perform this test.

Note: If the user has access to VORTEQ™ IMU, he is also supported with 3D head model during the test.

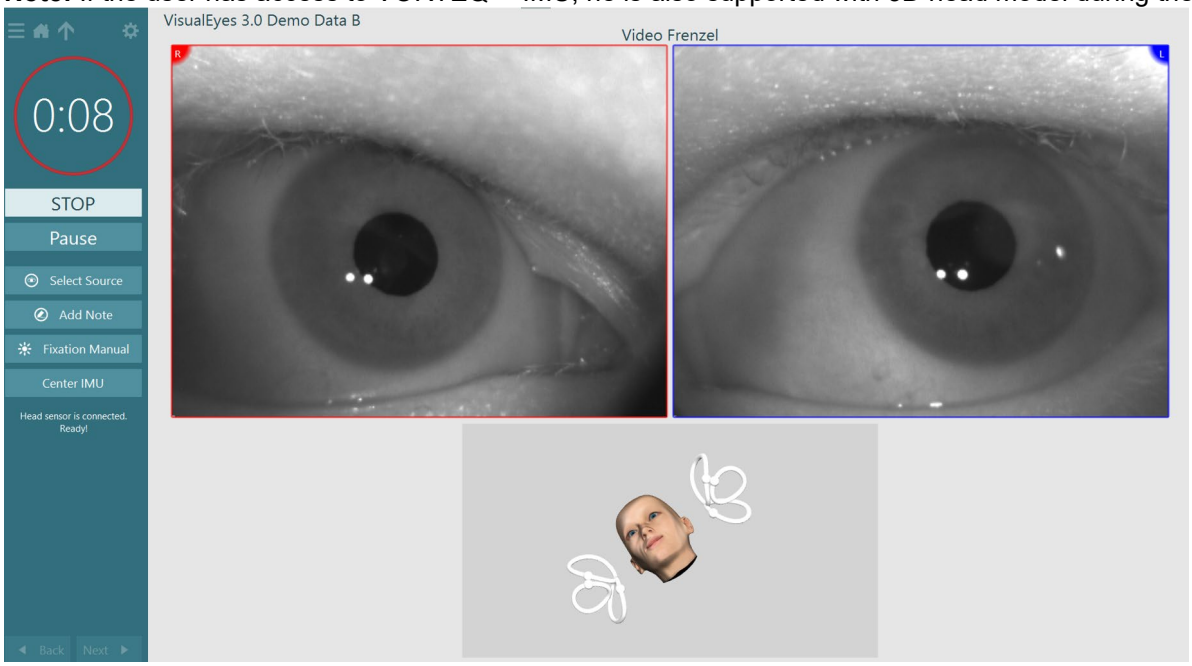


Figure 3.3-1 Video Frenzel test with 3D Head model (applicable only with VORTEQ™ IMU [hardware] with VORTEQ Assessments software add-on)

3.4 Nystagmus testing

Nystagmus tests (spontaneous, Dix-Hallpike, positional) measure the patient's nystagmus response when placed in different head and body positions. VisualEyes™ will measure the eye movements to detect the magnitude of any present nystagmus. In tests where the patient's nystagmus direction changes, the average slow phase velocity (a. SPV) will be measured separately in each direction and the results will be displayed in the a. SPV graph. Nystagmus tests are available in the VisualEyes™ 515 and VisualEyes 525™ configurations.

3.4.1 Spontaneous nystagmus test

The spontaneous nystagmus test records non-evoked eye movements. Perform this test with the patient's vision denied, using the cover attached to the front of the mask. This allows for recordings with the eyes open in complete darkness, eliminating any possibility of fixation. If nystagmus is detected, use the Add Time button to extend the testing time. The fixation light will switch on automatically at 15 seconds and last for 10 seconds. You can change this in the test settings to manually switch it on.

Note: You can perform this test with electrodes for ENG evaluations. To perform this test in an Orion rotational chair, you need to have the DataLink connection with Orion Reclining or the built-in EOG option with Orion Auto-Traverse/Comprehensive.

The average slow phase velocity (a. SPV) graph to the right side of the data graph shows the a. SPV for horizontal and vertical channels. The result value is displayed as a bar with the white portion representing values within test thresholds and grey portions exceeding the test threshold (Figure 3.44-1).

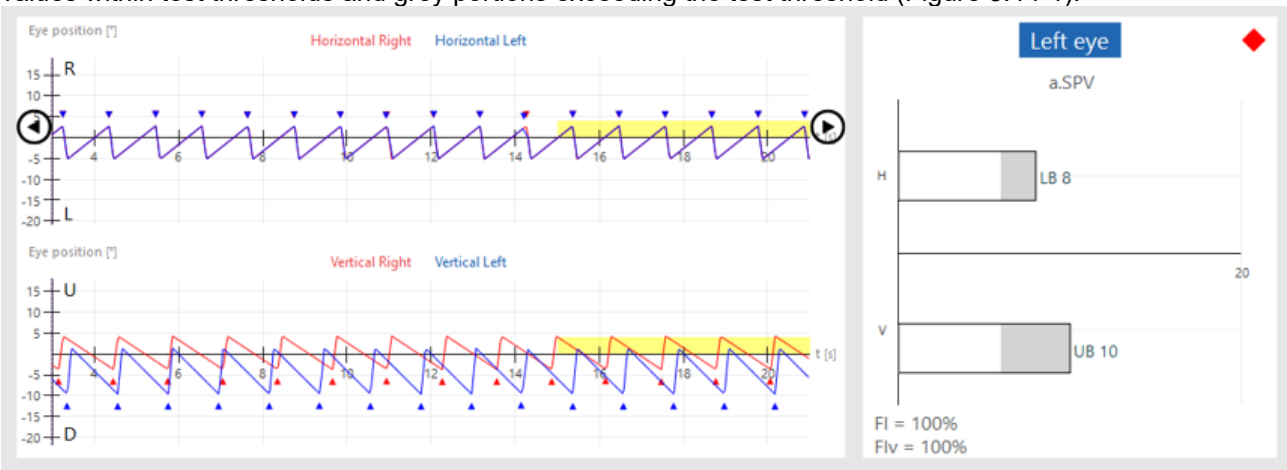


Figure 3.4-1 Spontaneous Nystagmus waveform and a. SPV graph

3.4.2 Dix-Hallpike test

The Dix-Hallpike test is a test used to diagnose benign paroxysmal positional vertigo (BPPV).

The Dix-Hallpike test is contraindicated in patients who exhibit the following:

- Current or past injuries of the neck or spine
- Brainstem malformations such as Arnold-Chiari
- Pre-existing neurological symptoms including but not to limited to:
  - Blurred vision
  - Numbness
  - Weakness of the arms or legs
  - Confusion

Perform the test by reclining the patient into a supine position with his/her head turned toward the test direction. After 60 seconds, the software will provide an audible "ding" sound and mark the waveform. Bring

the patient to a sitting position. The test will then continue for another 60 seconds. You can shorten each portion of the test by pressing the RF remote's Enter button, the side switch on the top mount goggles, or the Enter key on the keyboard.
The Dix-Hallpike test has two subtests, Left and Right. In the Dix-Hallpike summary, the Left test will be displayed on top, and the Right test will be displayed underneath. Horizontal and vertical eye positions are separated. You can switch eyes by clicking or touching on the eye title of the a. SPV bar graph (Figure 3.44-2).

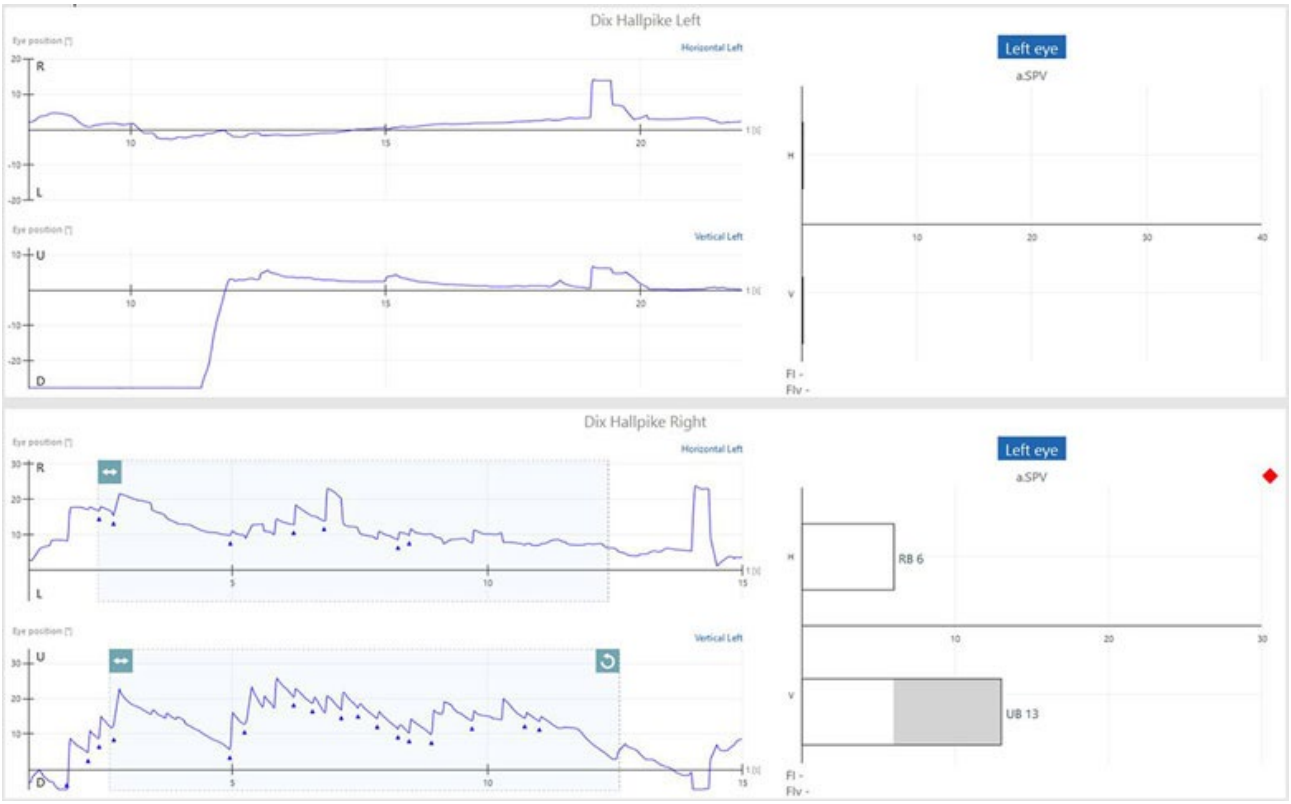


Figure 3.4-2 Horizontal and vertical eye positions in the Dix-Hallpike summary

3.4.3 Dix-Hallpike Advanced test

The Dix-Hallpike Advanced test is a part of the VORTEQ Assessments software add-on and uses the VORTEQ™ IMU to aid the examiner in placing the patient in the correct positions.

The Dix-Hallpike Advanced test is contraindicated in patients who exhibit the following:

- Current or past injuries of the neck or spine
- Brainstem malformations such as Arnold-Chiari
- Pre-existing neurological symptoms including but not to limited to:
    - Blurred vision
    - Numbness
    - Weakness of the arms or legs
    - Confusion

Before starting the test, verify that the VORTEQ™ IMU is connected to the computer (either a wireless Bluetooth connection or with a micro-USB cable). Switch on the VORTEQ™ IMU and verify the VORTEQ™ IMU is connected. Have the patient wear the goggles with the VORTEQ™ IMU attached and have the patient face forward while sitting upright. When the test begins, the software will center the VORTEQ™ IMU in preparation for the test (Figure 3.44-3).

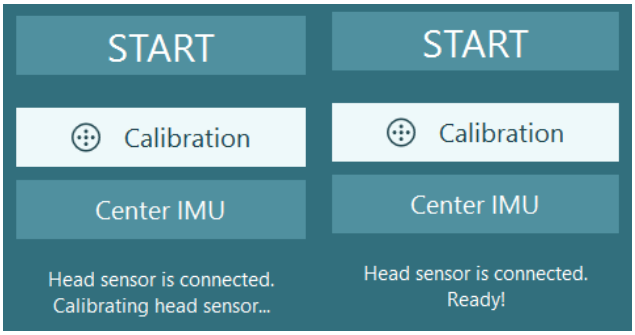


Figure 3.4-3 Head sensor connected, calibrating, and ready statuses

Once the subtest is started, recline the patient into the supine position with his/her head turned toward the test direction. The VORTEQ™ IMU's spatial location is shown with a black bar on the position sliders. As you move the head into position, the position marker updates on the slider alongside the head representation. When the head is pointing at the desired angle, the spatial target location will turn green instead of orange (Figure 3.44-4). Descriptive angle data is also shown in the top right corner of the 3D head model box. You can start collecting data even if the patient cannot reach a head position at the desired angle. Once you start the test, the software will run for 60 seconds, after which it will provide an audible "ding" sound and mark the waveform. Bring the patient to a sitting position. The test will then continue for another 60 seconds. You can shorten each portion of the test by pressing the RF remote's Enter button, the side switch on the top mount goggles, or the Enter key on the keyboard.

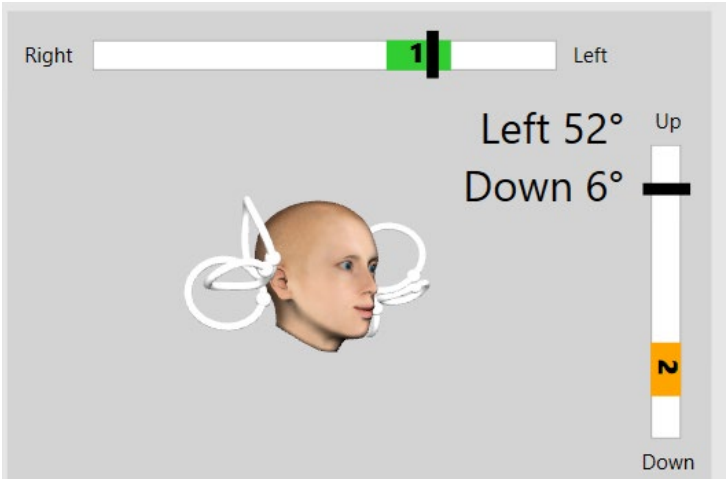


Figure 3.4-4 Head orientation

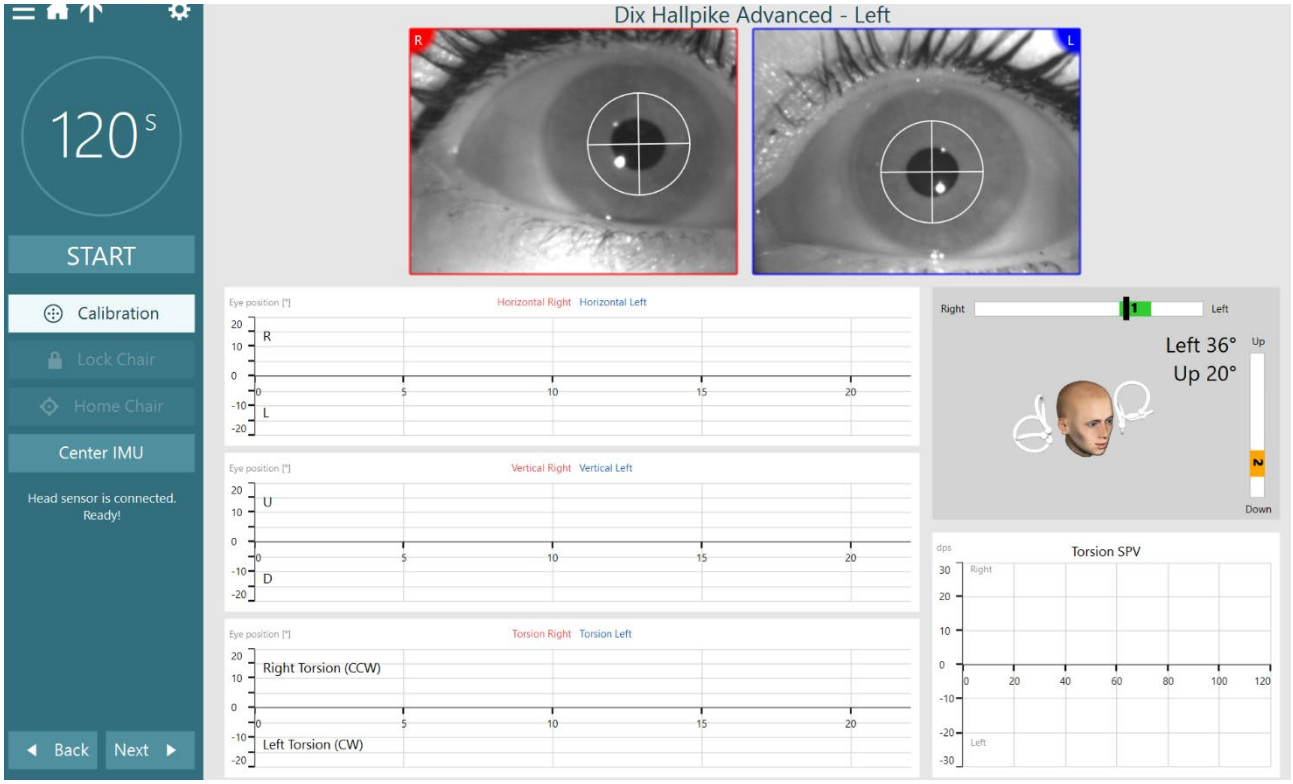


Figure 3.4-5 Dix-Hallpike Advanced subtest

The Dix Hallpike Advanced test has two subtests, Left and Right. In the Dix-Hallpike Advanced summary, the Left test will be displayed on the first page and the Right test will be displayed on the second page. Additional pages are created for repeated subtests. The graphs will display the eyes together and separate the horizontal, vertical, and torsional traces. You can switch the eye selected by clicking or touching on the eye title of the a.SPV bar graph (Figure 3.44-6). The Torsion Velocity graph will display both left and right torsional velocity values.

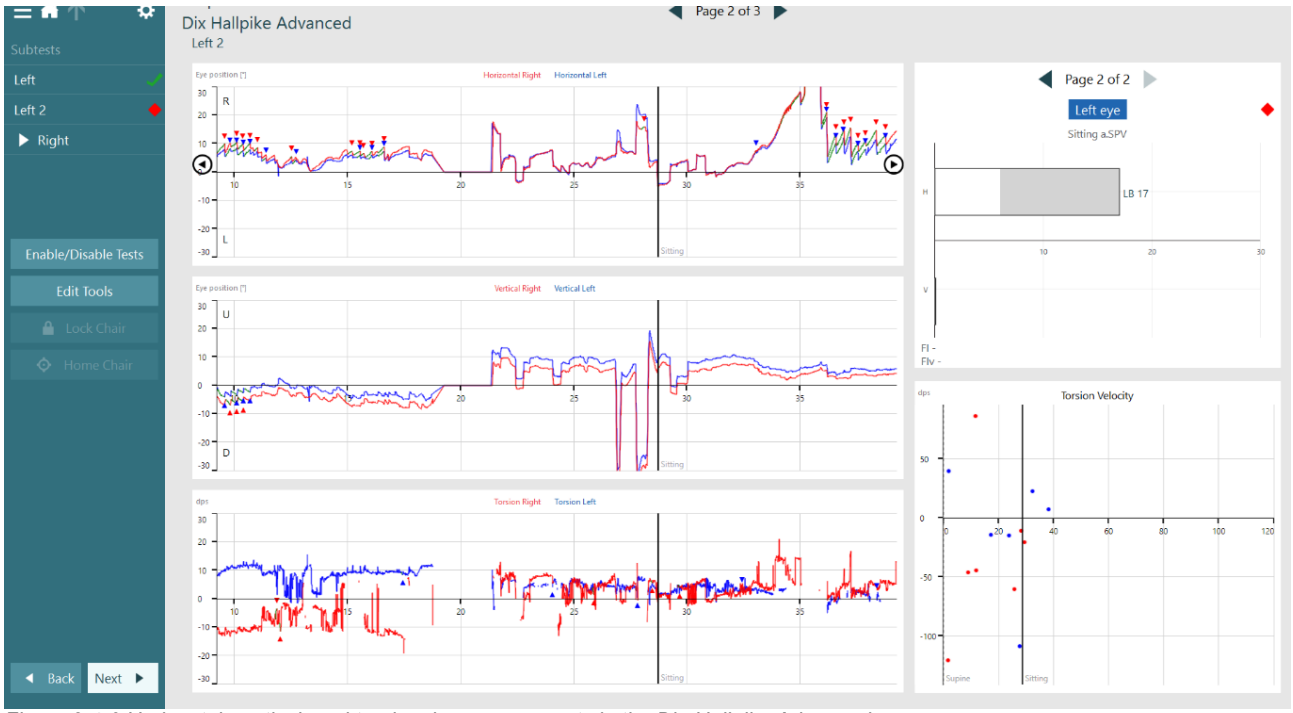


Figure 3.4-6 Horizontal, vertical, and torsional eye movements in the Dix-Hallpike Advanced summary

3.4.4 Positional testing

Positional testing allows you to compare several measurements collected with the patient in a variety of head and body positions. Each subtest is set to record for 30 seconds. The positional test can record the supine, head right, head left, body right, body left, bow, and lean positions.

Please note that positional testing is contraindicated in patients who exhibit the following:

- Current or past injuries of the neck or spine
- Brainstem malformations such as Arnold-Chiari
- Pre-existing neurological symptoms including but not to limited to:
    - Blurred vision
    - Numbness
    - Weakness of the arms or legs
    - Confusion

The Positional summary screen will display the subtests performed in a grid pattern. For each subtest, one eye's results are displayed with the corresponding eye movements. Horizontal and vertical eye movements are separated. The Positional summary can contain a mix of left eye and right eye results, based on the selected eye from each subtest. To change the selected eye in a subtest, click or touch on the eye title in the a. SPV bar graph (Figure 3.44-7).

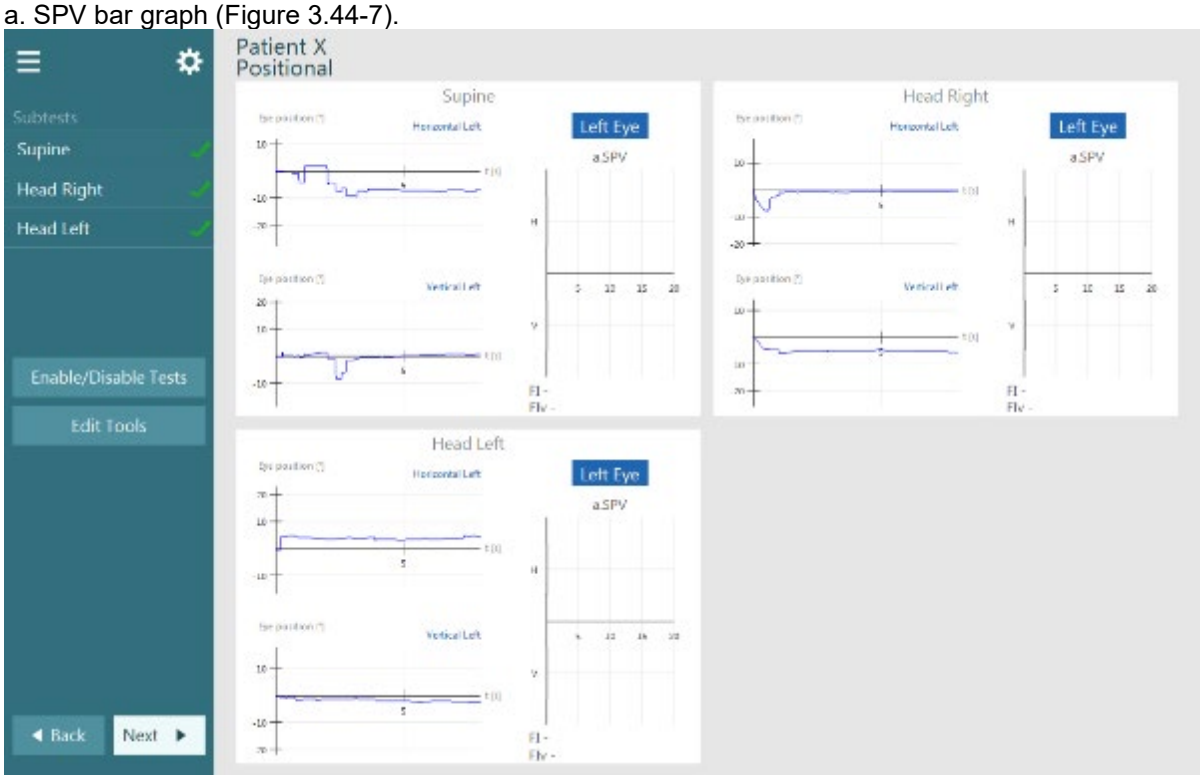


Figure 3.4-7 Positional summary screen

3.4.5 Lateral Head Roll test

The Lateral Head Roll test is part of the VORTEQ™ Assessment bundle. The Lateral Head Roll test can identify horizontal canal BPPV. It has two additional features that provide significant improvements over the standard positional tests:

1. 3D head model
2. Guide to assist in proper head placement

Select the Lateral Head Roll test from your test menu. Once the system is calibrated, you are ready to begin testing. You will use the 3D head model to guide you through the appropriate head/body positions for the Lateral Head Roll test. Make sure the VORTEQ™ IMU is attached to the goggle and switched on. Perform the test with the patient supine.

1. Turn the patient's head 45 degrees towards the right.
2. Turn the patient's head 45 degrees towards the left.

The black bar represents the head movement and when the head is in the correct position, the shaded area will turn green. Once you have reached the first position, you can record for a minimum of 20 seconds. Then press enter and proceed to the second step. Record another 20 seconds at minimum and then stop the test (Figure 3.44-8).

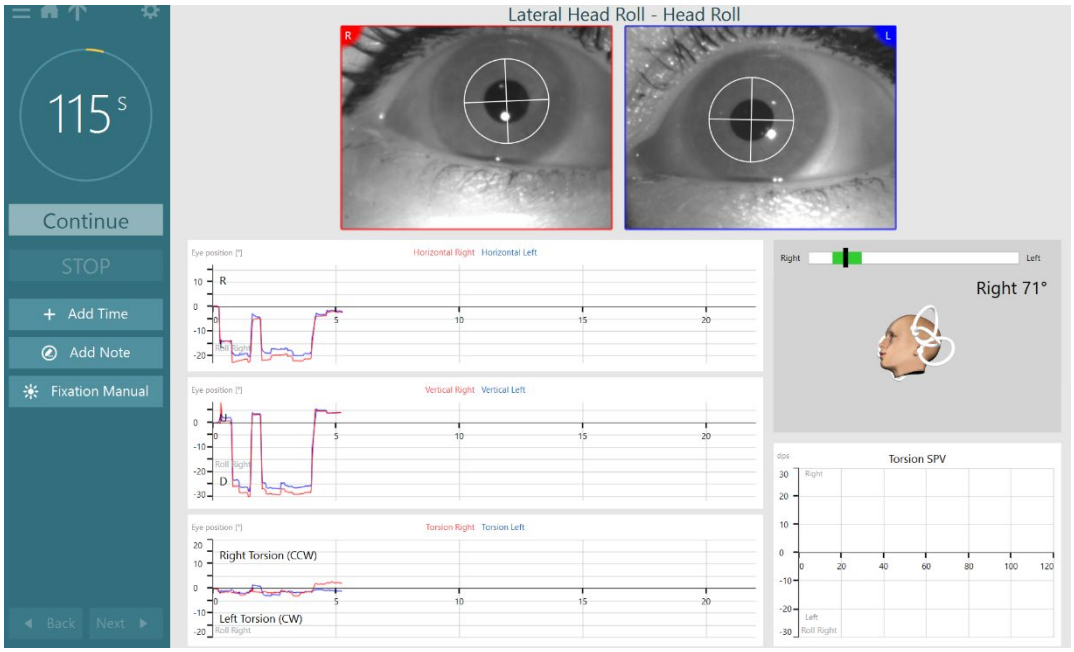
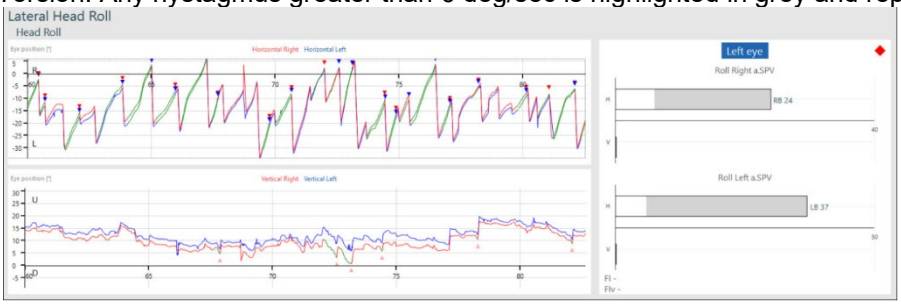


Figure 3.4-8 Thee Lateral Head Roll test

When you have completed the test (Figure 3.44-9) you will see a summary screen with bar graphs representing any nystagmus that was generated during the maneuver. There is also a SPV graph of the Torsion. Any nystagmus greater than 6 deg/sec is highlighted in grey and represents an abnormal finding.



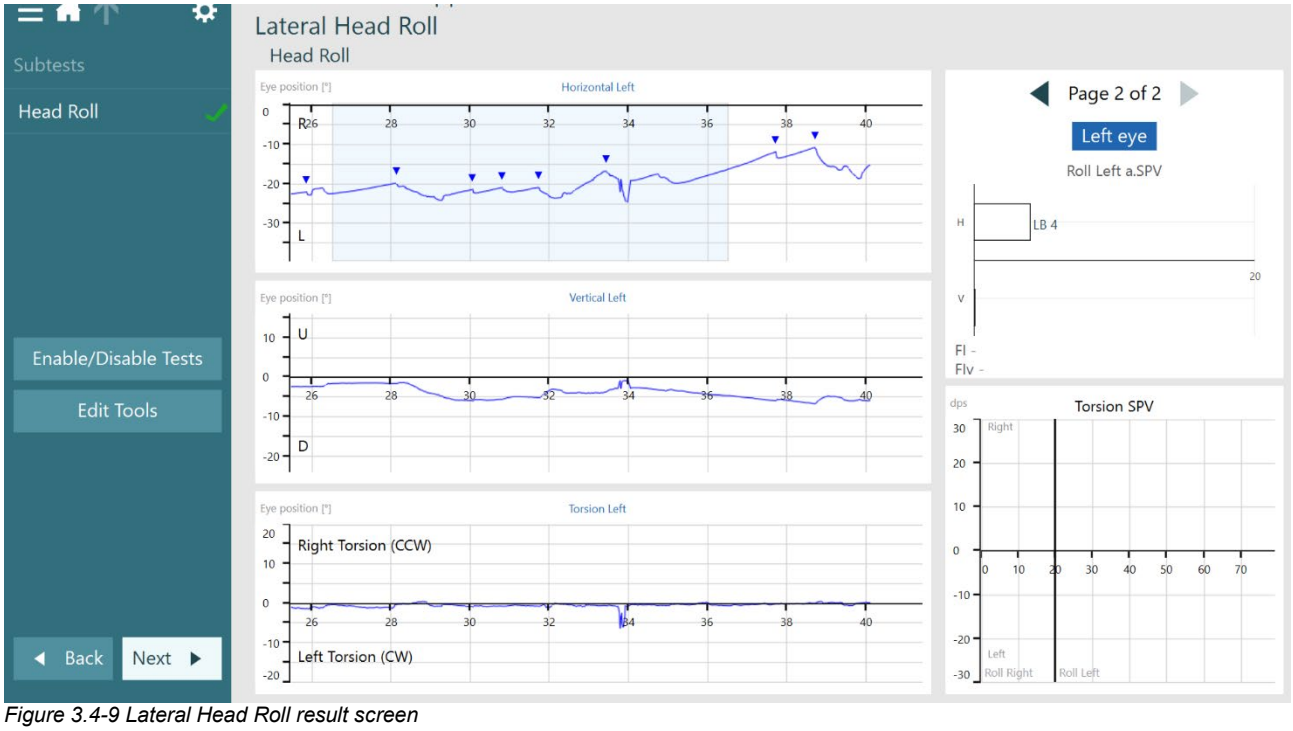


Figure 3.4-9 Lateral Head Roll result screen

3.5 Oculomotor testing

Oculomotor tests require the patient to follow a target stimulus or pattern. These tests require an external stimulus, such as a TVand you can find them in the VisualEyes™ 525 software configuration.

3.5.1 Gaze test

During a gaze test, eye movements are measured while the patient fixates on a stationary target. Each subtest has the patient look at a different target for a default time of 10 seconds. At the start of the test, the target is displayed in the center position of the screen for two seconds, then the target will be displayed in the location specified by the subtest properties. The default gaze test will test the following positions: center, left, right, up, and down. Each cardinal gaze direction is set close to the maximum angle provided in each direction. With a widescreen television as the stimulus, the gaze angles tested horizontally will be approximately 1.8 times larger than the vertical angles. An optional Center2 subtest is provided for testing center gaze again after testing the cardinal gaze directions. By default, the gaze subtests are run automatically. If needed, you can add time with the **Add Time** button.
The gaze summary screen will display all the subtests performed in a grid pattern. For each subtest, one eye's results are displayed with the corresponding eye movements. Horizontal and vertical eye movements are separated. The gaze summary can contain a mix of left eye and right eye results, based on the selected eye from each subtest. To change the selected eye in a subtest, click or touch the eye title in the a. SPV bar graph (Figure 3.5-1).

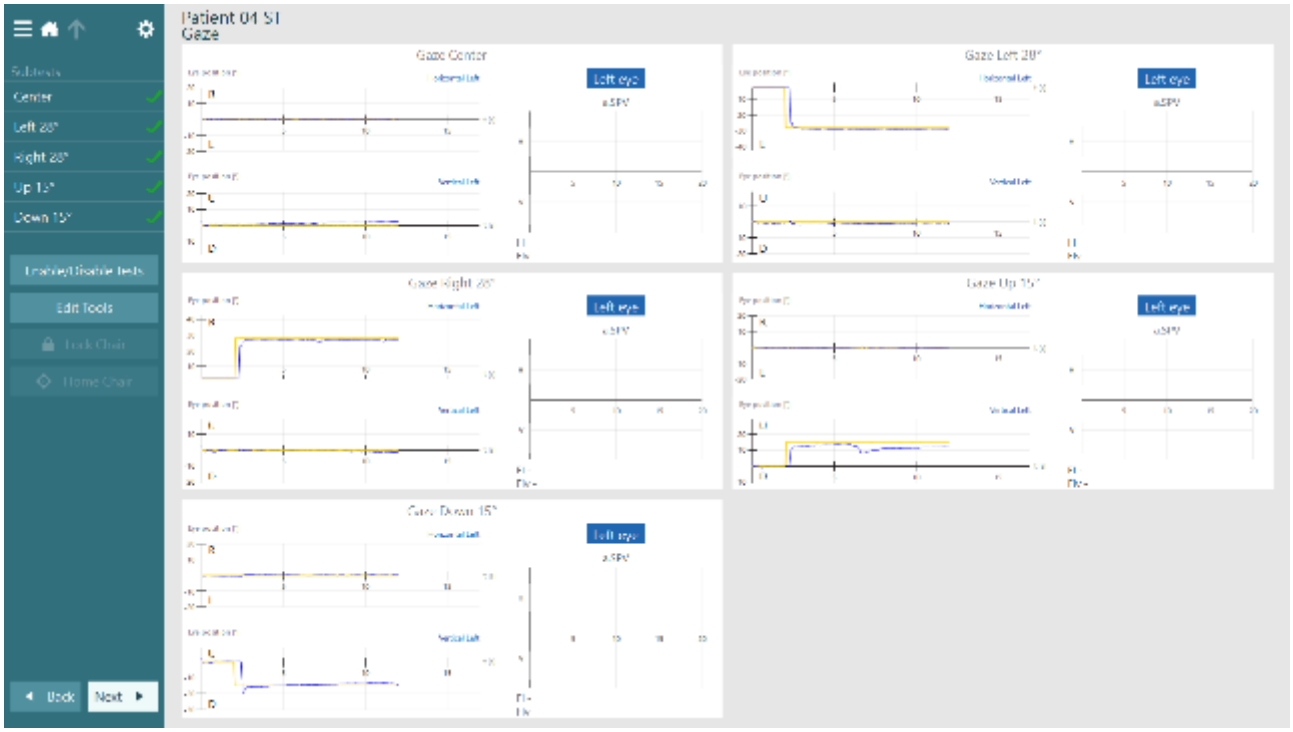


Figure 3.5-1 Gaze summary

3.5.2 Cervical gaze test

Cervical Gaze test is a subtest of the Gaze test. The subtest can be carried without or with the VORTEQ™ sensor. It is recommended to use the sensor for higher accuracy. If the IMU sensor is used, check that it is turned on and connected.

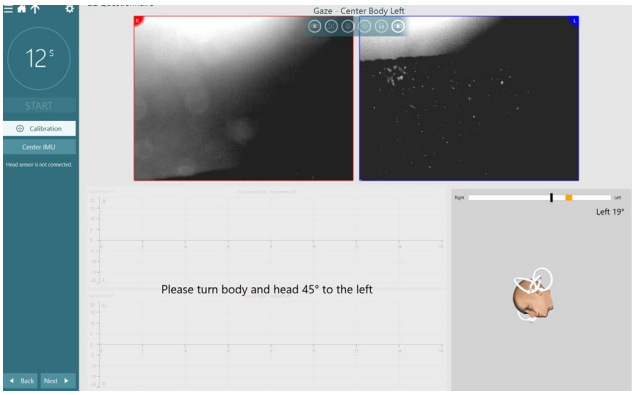


Figure 3.5-2 VORTEQ™ *IMU sensor connected*

Once the patient is facing the stimulus, center the IMU so the head model is facing forward (like the patient) and the angle by the head model reads 0 degrees.

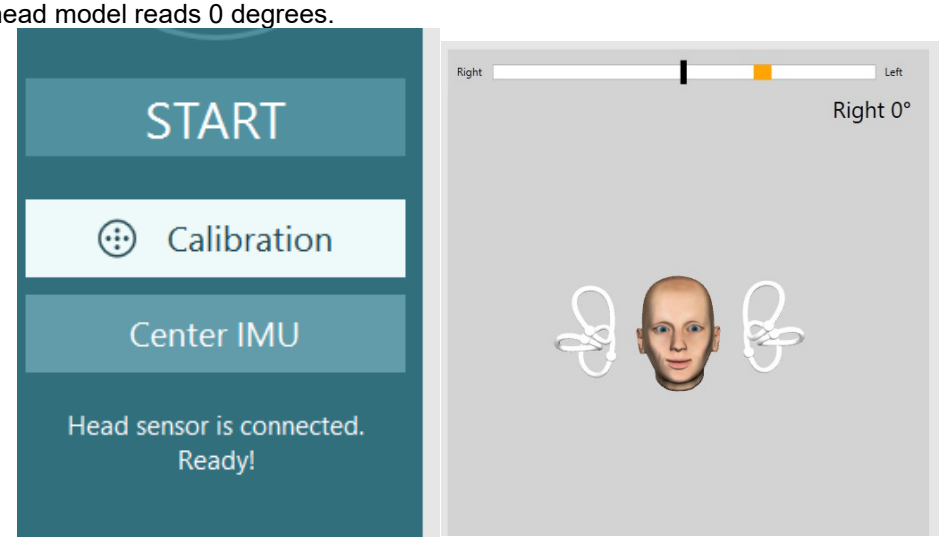


Figure 3.5-3 Head model 0 degrees

For the test, the software will instruct you to turn the patient's head and body 45 degrees to the left. When the patient is in the correct position, the orange target bar will turn green.

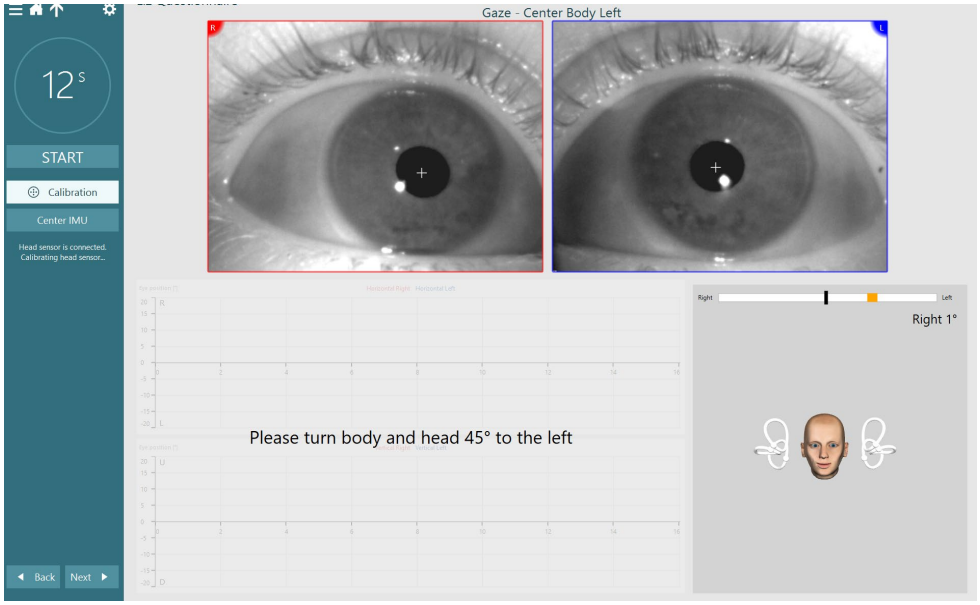


Figure 3.5-4 Software instructions

After two seconds of correct positioning, the target position will automatically advance to the 0 degree position indicating the patient's head only should turn back to center.

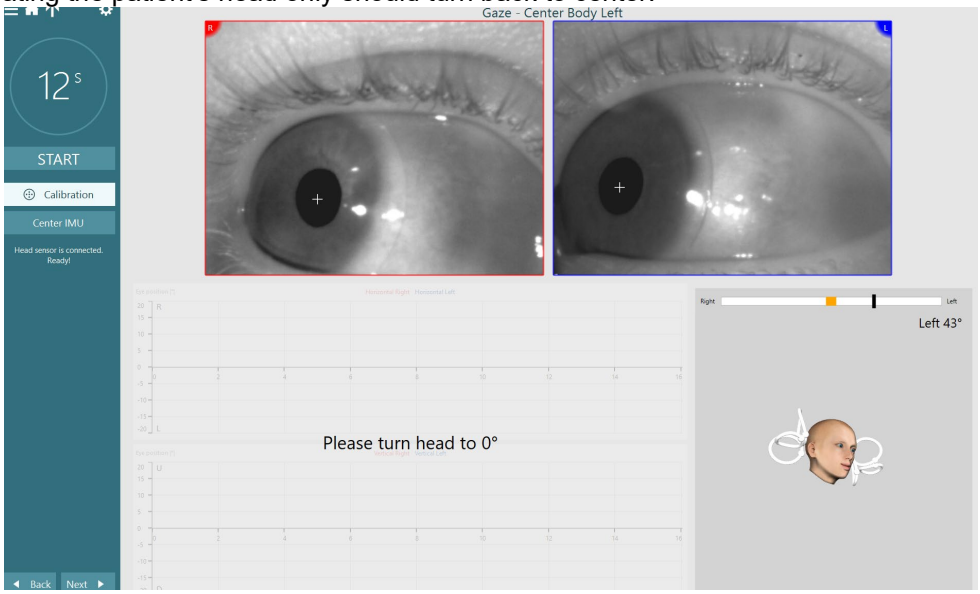


Figure 3.5-5 Turn head to 0 degree position

After **two seconds in the 0 position**, the test will automatically begin. The patient will be in a neck turned position for this test while staring at the stimulus on the screen (or performing vision denied).

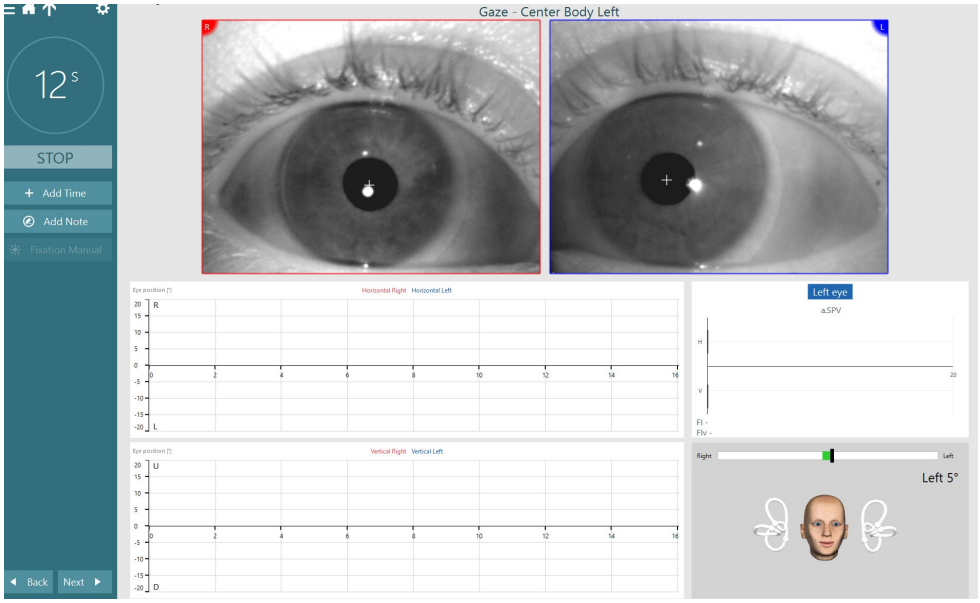


Figure 3.5-6 Test automatically begins

Test summary

The Cervical Gaze tests will show up on your summary screen. If you perform all the tests in Gaze (Center, right, left, up, down, body left, body right), the results will be split between two pages.

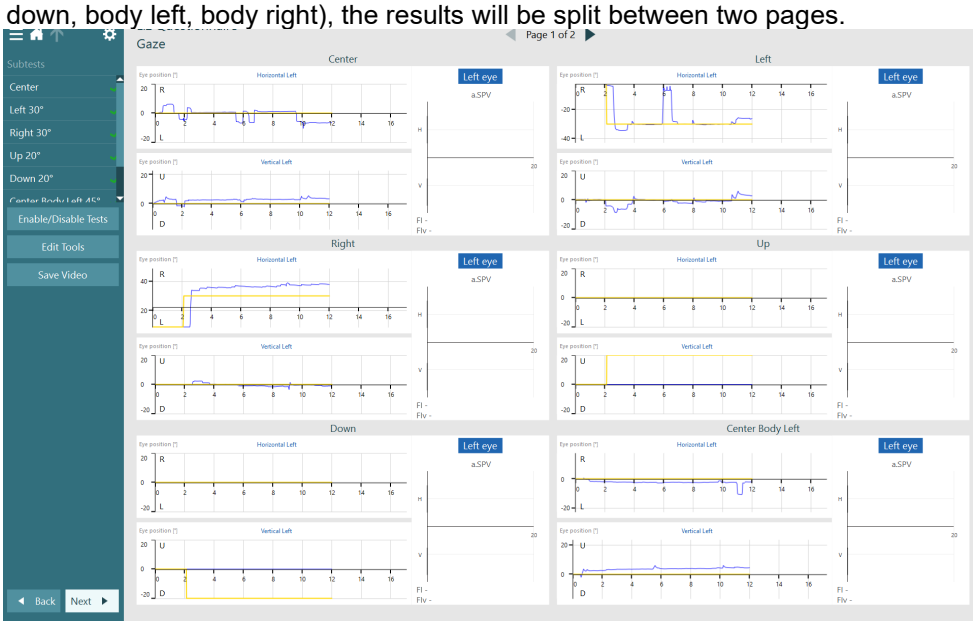


Figure 3.5-7 Cervical Gaze test summary

3.5.3 Smooth pursuit test

In the smooth pursuit test, the patient's eyes follow a target that is moving back and forth across the stimulus screen. The velocity of the target stimulus will increase with every two cycles. By default, both left and right eyes are displayed together in the waveform traces. The Gain and Symmetry graphs are also displayed to allow you to see if the patient has deconjugated eye movement. You can split the eyes into separate graphs if needed to better ascertain an eye's specific response. The default smooth pursuit test only tests horizontally. You can also enable the vertical subtest if needed (Figure 3.55-8).

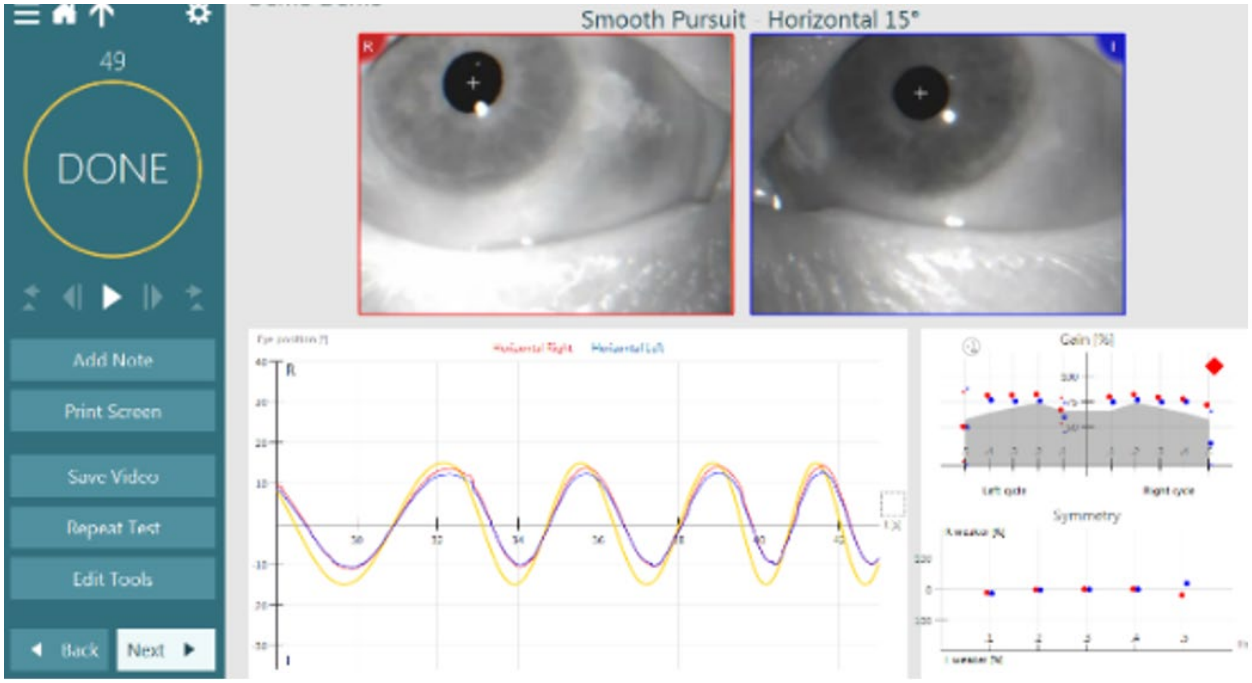


Figure 3.5-8 Smooth pursuit subtest

The Gain value is given as a percentage value representing the ability of the patient to track the sinusoidal target without saccadic intrusions (short jumps in the eye position to catch up to the target). Each eye's gain is measured for each cycle and displayed on the Gain graph as a small dot in either blue (for left eye) or red (for right eye). A larger dot is displayed on the Gain graph representing the average of the eye's gain at the selected frequency (e.g., 0.1 Hz). Test thresholds based on age-matched patient data studies are displayed as grey shaded areas and will vary based on the selected frequency. If the average Gain value (large dot) from either eye falls into the shaded area of the Gain graph, the software will mark the test as outside thresholds and use a red diamond (Figure 3.55-).

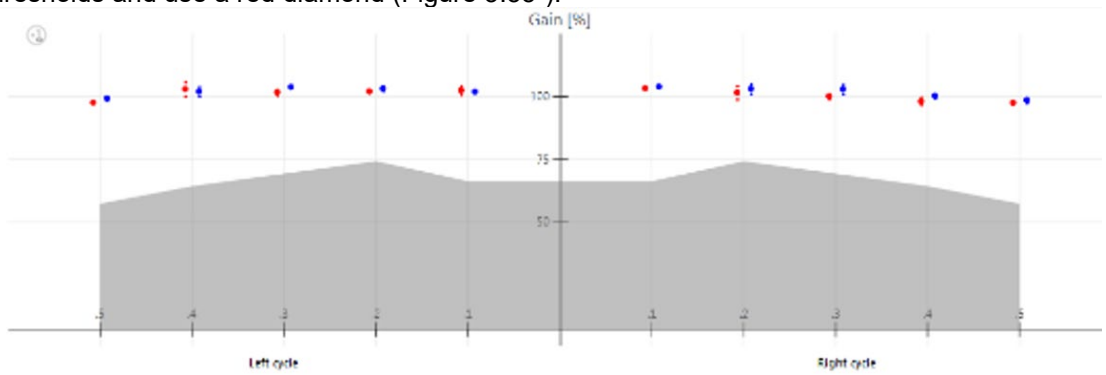


Figure 3.5-9 Gain graph with individual and average Gain values

Optionally, the ① Symmetry graph will compare the average left moving gain to the average right moving gain (up versus down in vertical subtests) and display this result for each eye and each frequency (Figure 3.5-10). By clicking the symbol, you can view the numerical values of Gain and Symmetry in the graphical representation (refer to section 7.5 for details).

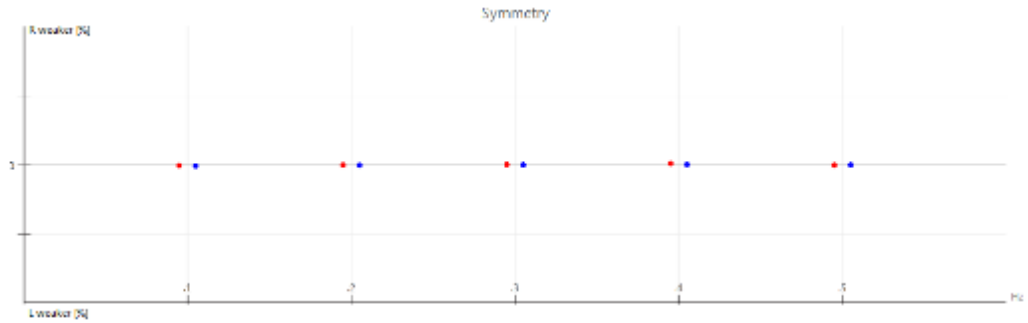


Figure 3.5-10 Symmetry graph

3.5.4 Smooth Pursuit Neck Torsion Test (SPNT)

SPNT is a subtest of the Smooth Pursuit. Goggles are necessary for this subtest. It is recommended to use the VORTEQ™ IMU for the SPNT test to verify positioning.

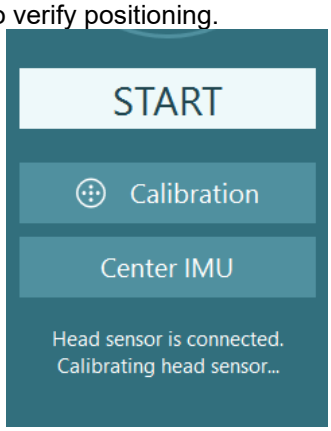


Figure 3.5-11 head sensor connected

When licensed for the test, option appears in screen. Check the Center Body Left / Center Body Right options to include in testing:

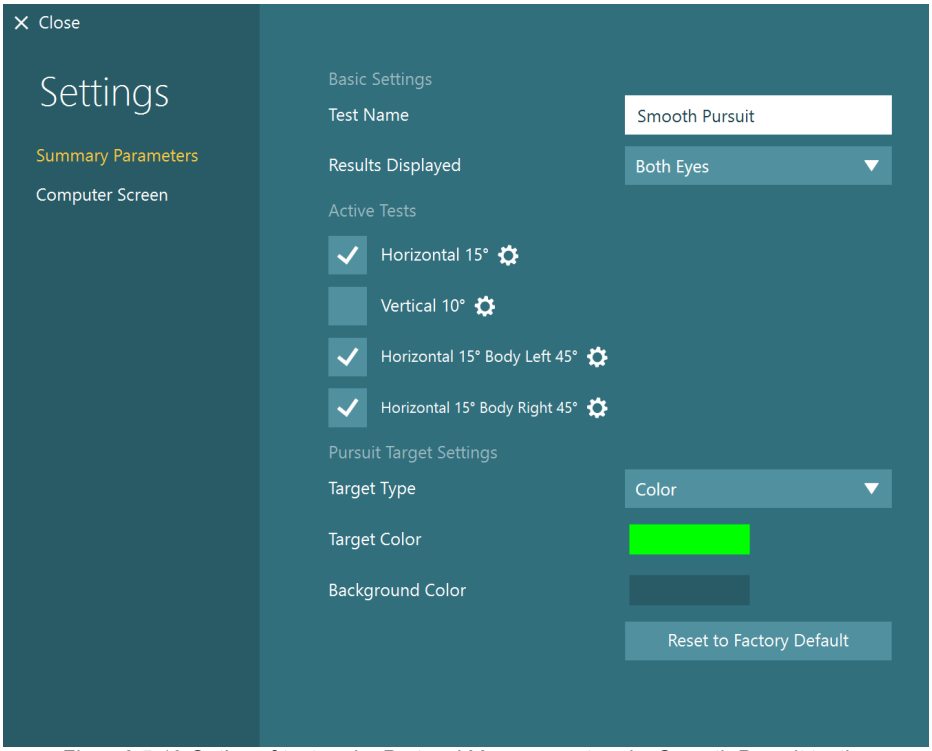


Figure3.5-12 Option of test under Protocol Management under Smooth Pursuit testing

Complete the horizontal smooth pursuit test.

Body Right:
Center the IMU before beginning the test so it reflects which way the patient is sitting.
Turn the patient's head and body to the right 45 degrees. Hold the ideal position for 2 seconds and the target position for the head will automatically move to 0 degrees.

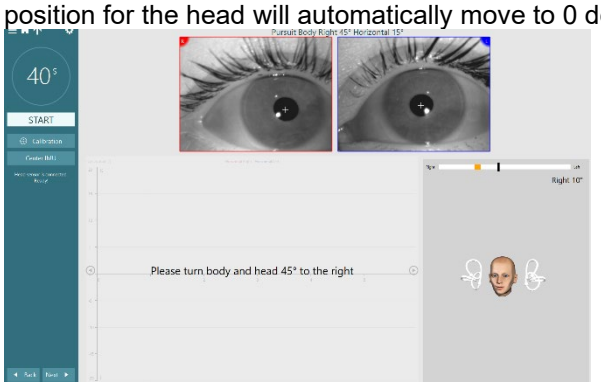


Figure 3.5-13 Position

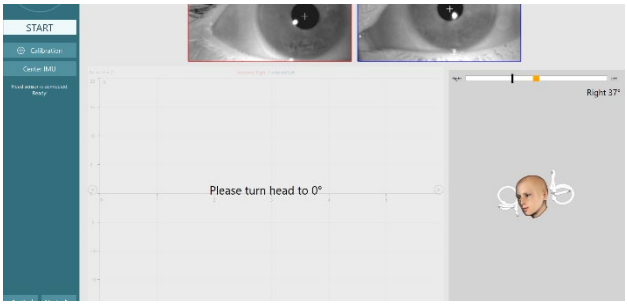
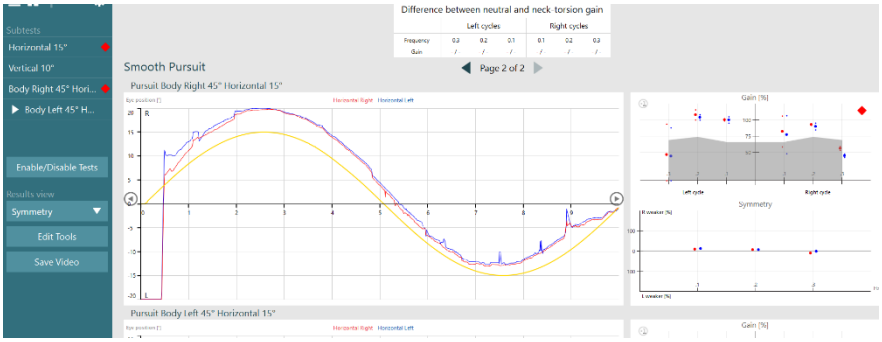


Figure 3.5-14 zero position

The smooth pursuit test will automatically begin after the patient's head is in zero position for 2 seconds.

Following testing, you will see the summary of body right.

Body left: Repeat process.



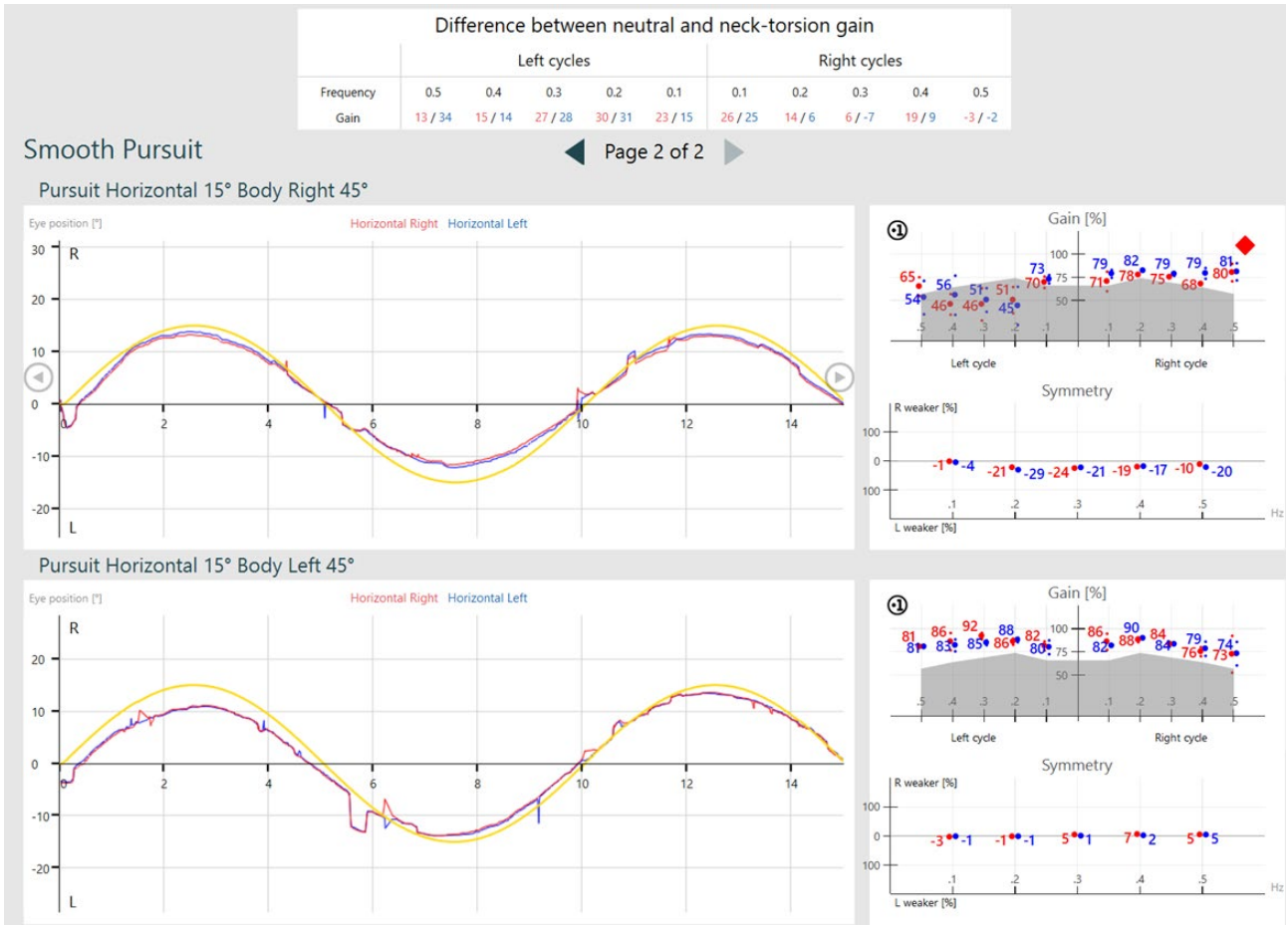


Figure 3.5-15 Summary body right and left

Smooth Pursuit Neck Torsion Difference

When both subtests are completed, a calculation will be shown that compares the gain from the neck neutral smooth pursuit test to when the patient is in a neck turned position: The Smooth Pursuit Neck Torsion Difference.

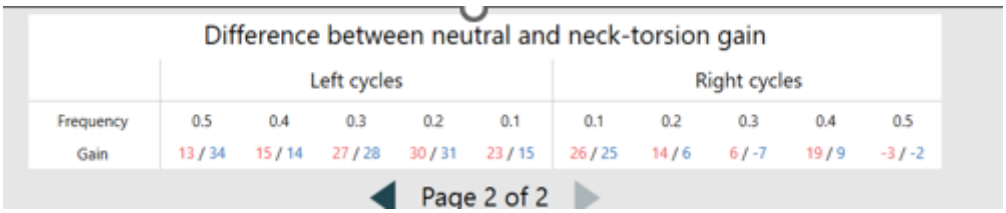
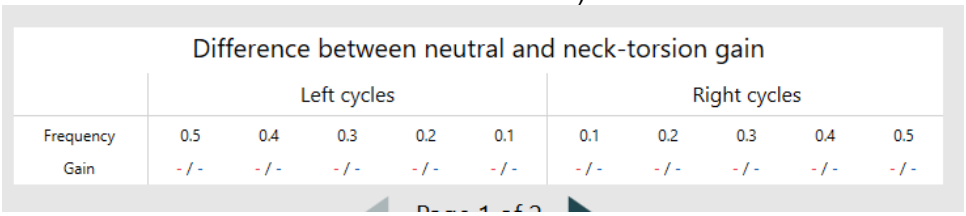


Figure 3.5-16 Smooth Pursuit Neck Torsion Difference

The red and blue represent the eyes. SPNTdiff = Gain in neck neutral - (Gain torsion L + Gain torsion R)/2 The higher the number, the larger the difference between neck torsion and neck neutral positions (aka higher chance of neck involvement in smooth oculomotor movements).



3.5.5 Random Saccade test

During the saccade test, the patient's eyes must follow a randomly moving target jumping from side to side. The default saccade test will have the target jump horizontally, but the test has optional vertical and combined subtests available. The patient must fixate on the target and then move to the next target with fast eye movements (saccades). Ideally, the saccades should consist of one single fast movement that leads to re-fixation on the next target. By default, both eyes are displayed on the same waveform graph and analysis graphs to show if the patient exhibits any dis-conjugate eye movements. You can split the eyes into separate graphs if needed to better ascertain each eye's specific response. Random saccades can be completed vertically, horizontally, or combined horizontal and vertical,

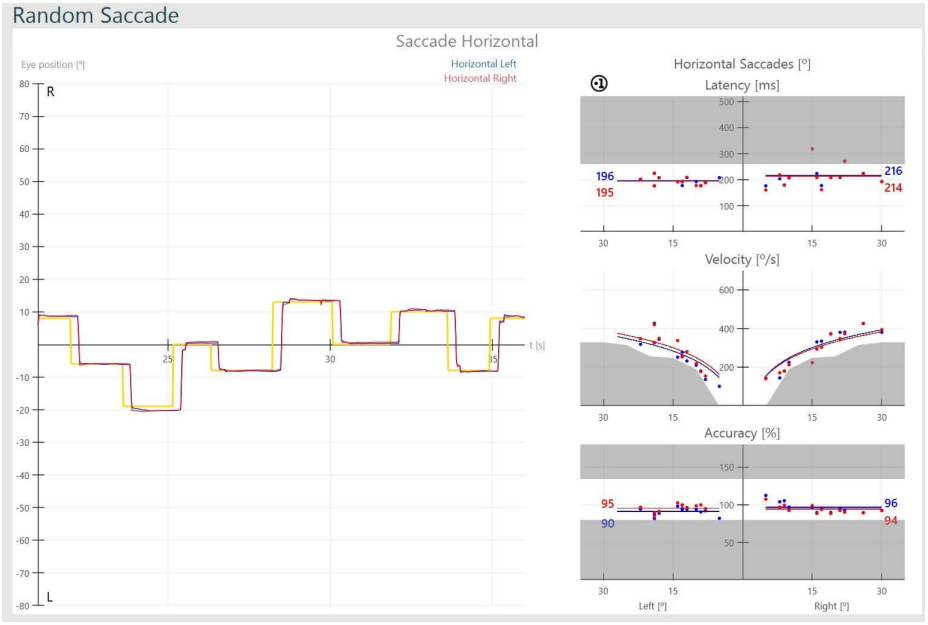


Figure 3.5-17 Saccade horizontal subtest

The saccades are automatically analyzed as the test is performed, and the results are displayed for latency, velocity, and accuracy for each saccade. Each eye will be analyzed separately with results plotted for each eye (default) or for a selected eye (right or left).

The three essential parameters (latency, velocity, and accuracy) are analyzed and displayed for both eyes for horizontal and vertical saccades (). In the combined subtest, the software will analyze the horizontal saccades separately from the vertical saccades (). The results will display each saccade jump as a dot colored for the respective eye. Average lines for the Latency and Accuracy graphs are calculated for each direction (e.g. left versus right movements) of saccade jumps and regression curve fits are calculated for each eye and direction for the saccade velocities. Test thresholds are available for horizontal saccades and will be marked in the graphs with grey shading. If one of the average lines or part of the regression curve fit falls into the shaded areas, the software will mark the analysis with a red diamond.

3.5.6 Self-Paced Saccades (SPS) test

The SPS test duration and degree can be adjusted as wanted. The default is 15 degrees for 30 seconds. The test can be performed vertically or horizontally.

Test

Before the test begins, there will be a single green dot in the center of the screen. As soon as you press start, the screen will show two stationary stimulus dots:



Figure 3.5-18 Patient screen SPS

Instruct the patient to move their eyes back and forth between the two dots as many times as they can in 30 seconds. As they complete the task, you will see the saccade counter increase as well as live data show up on the right side of the test screen.

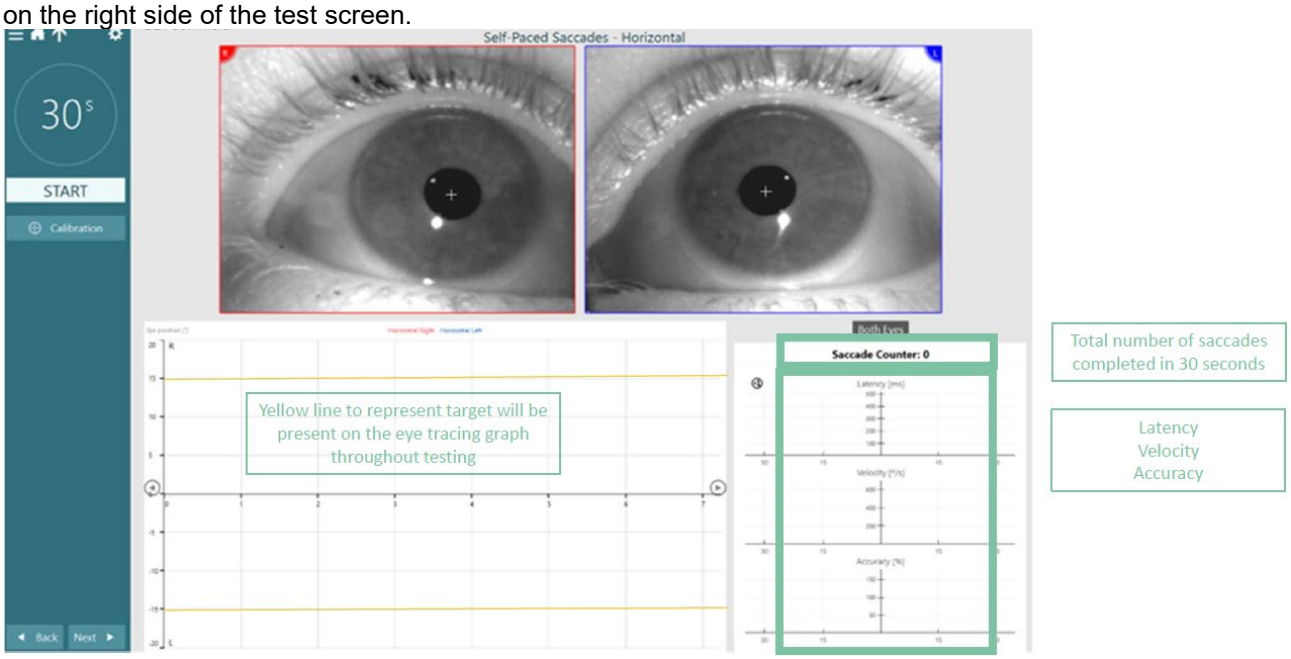


Figure 3.5-19 SPS test screen

Numerical Results
Following test collection, you have the option to look at detailed numerical results for each saccade completed. You can also edit or delete saccades as needed.

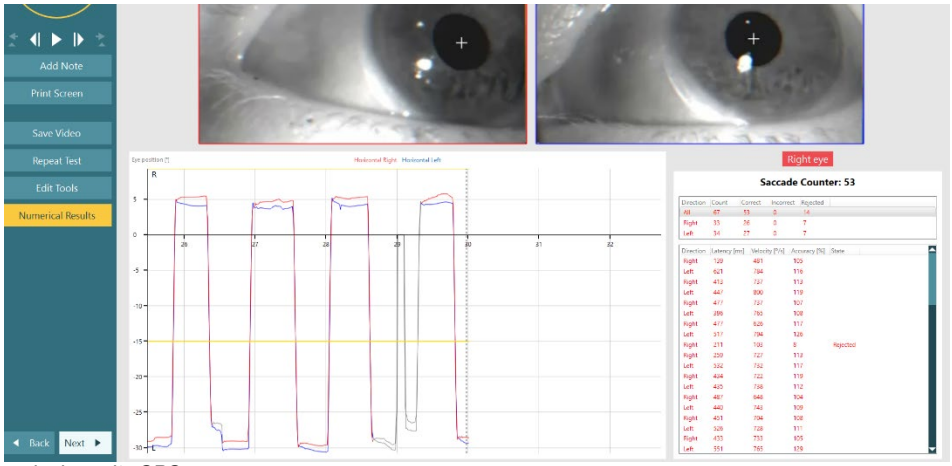


Figure 3.5-20 Numerical results SPS

3.5.7 Saccadometry

Saccadometry analyzes the patient's response to fixed saccades where the patient follows the target presented (Prosaccades) and looks in the opposite location to where the target is presented (Anti-Saccades). The default test has a subtest with 100 prosaccade jumps at 10° followed by a subtest with 100 Anti-Saccade jumps at 10°. Each subtest has three target positions. Saccadometry can be configured with up to five subtests (Figure 3.5-23). Saccadometry is long and repetitive, meaning patients may become inattentive or fatigued during the test.

Practice mode
You can choose to begin the test with a practice segment. Enable the practice segment from the temporary settings screen (or Protocol Management) to begin the test with ten jumps that the software will not contibute to data in he test. Using this practice mode can improve the patient's understanding of how to perform the test. If activated, the waveform will be dimmed at first and a practice mode counter will be displayed. Once the practice mode is completed, the test will begin recording data.

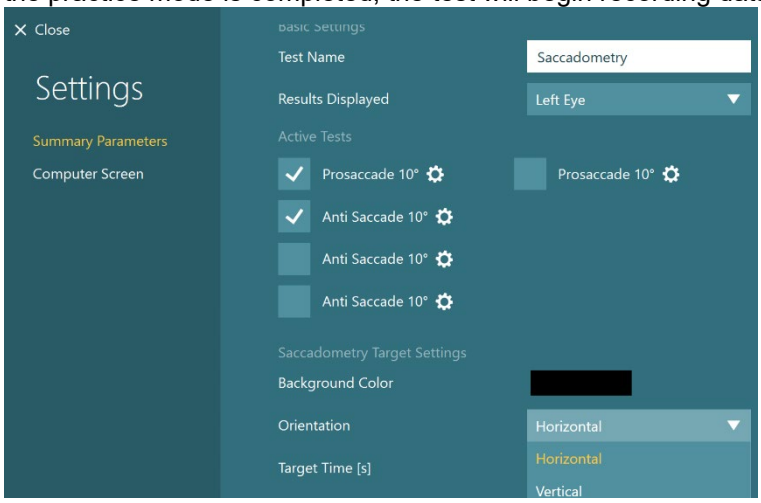


Figure 3.5-21 Configuration screen for Saccadometry test

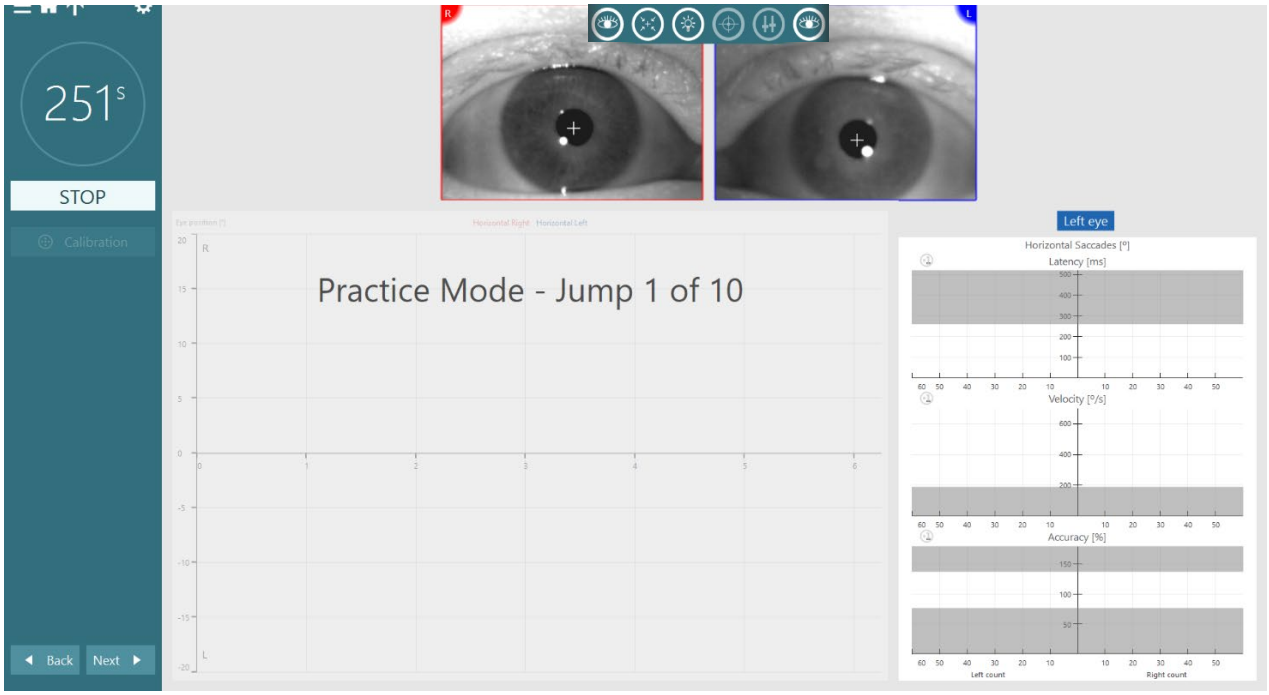


Figure 3.5-22 Prosaccade test screen

Prosaccade
The target will be displayed in the center of the stimulus screen. The target will jump back and forth between the two locations. The patient should follow the pattern of the moving target.

Using one target position
If the number of dots is set to one, then the target will alternate between the left and right position as defined in the Jump Size field. If the field is set to 10°, then the target will alternate between left 10° and right 10°.

Using two target positions
If the number of dots is set to two, then the center target will be displayed. The patient will look at the center dot, then look at the location of the target stimulus which will be displayed either left or right of the center dot, then return to the center position.

Anti-Saccade
The target will be displayed in the center of the stimulus screen. The target will jump back and forth between the two locations. The patient should look in the opposite location of the moving target.

Using one target position
If the number of dots is set to one, then the target will jump from the center position to the left or right position briefly then return to center.

Using two target positions
If the number of dots is set to two, then the center target will be displayed and the target position will briefly appear. The patient will need to look at the center target, then look at the opposite target than the one that flashed, then return to the center position.

Using three target positions
If the number of dots is set to three, then the center and both left and right dots will be displayed. The target will flash briefly. The patient will need to look at the center target, then look at the opposite target than the one that flashed, then return to the center position (Figure 3.5-25).

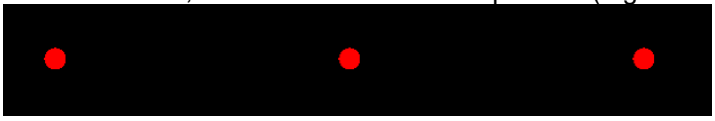


Figure 3.5-23 Anti saccade stimulus with three dots

Results displayed

The saccadometry results are displayed on the summary screen. The result for each eye or for both eyes can be selected by the user. The individual prosaccade and Anti-Saccade subtests are analyzed in the same manner as the standard saccade subtest. The summary screen shows each prosaccade or Anti-Saccade jump overlapped. Solid traces are saccades made in the correct direction, and dashed lines are saccades made in the incorrect direction. The A summary table is provided with the target movements, accepted saccades and average values for latency, velocity & accuracy. Solid traces are saccades made in the correct direction, and dashed lines are saccades made in the incorrect direction.The plot for the Directional Error Rate gives a quick glance at how effective the patient was able to perform the subtest. The clinician can choose to view combined/left/right directional error rates with a single click (Figure 3.55-). In additional to Directional Error Rate, the plot of Overall Error Rate includes errors such as the patient not looking at the target at all. The directional error rate graph compares to age based norms. If over the normative values, the bar graph will be shaded in gray and there will be a red diamond present in the top right corner of the Error Rate graphs section.

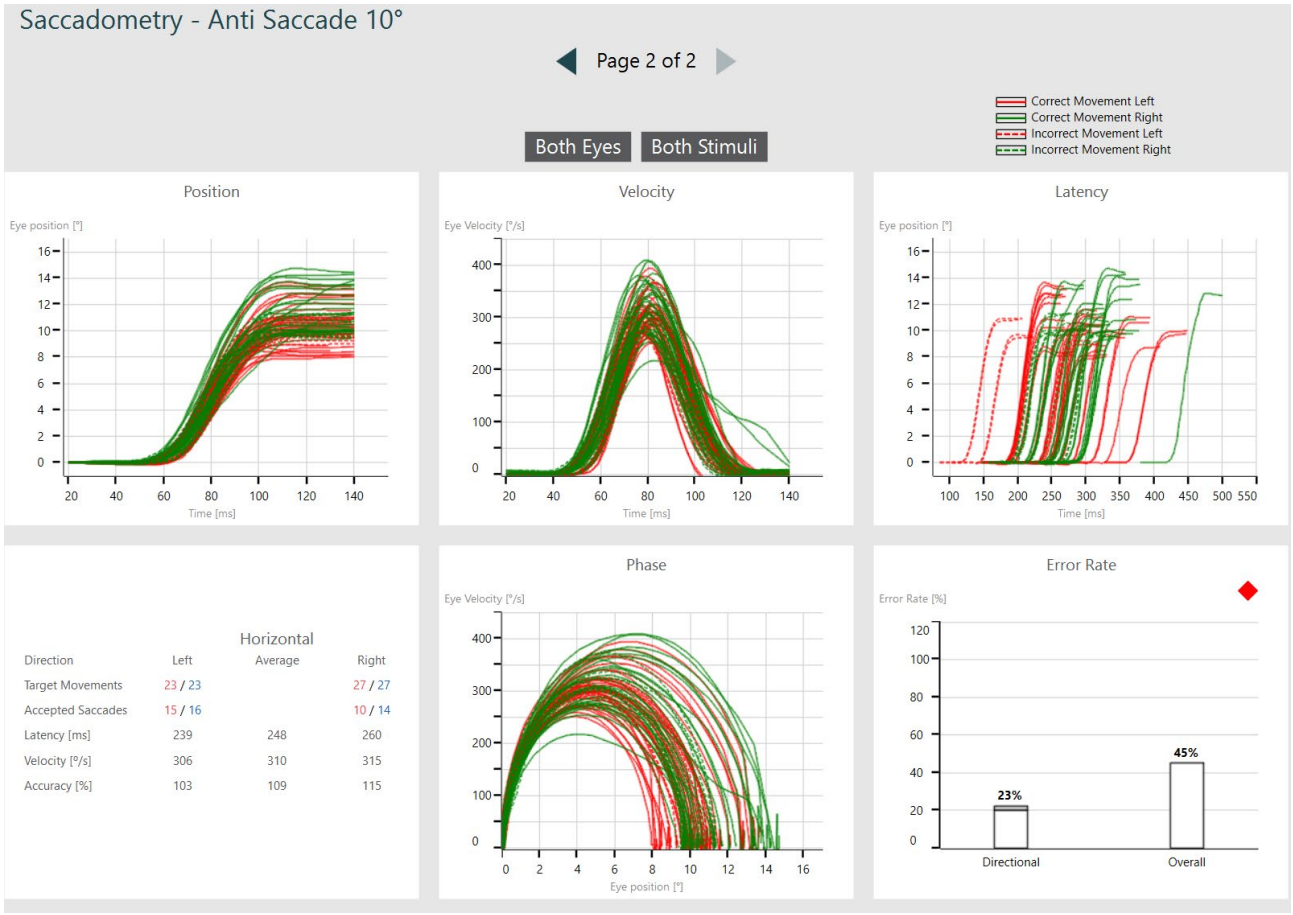


Figure 3.5-24 Anti-Saccade summary

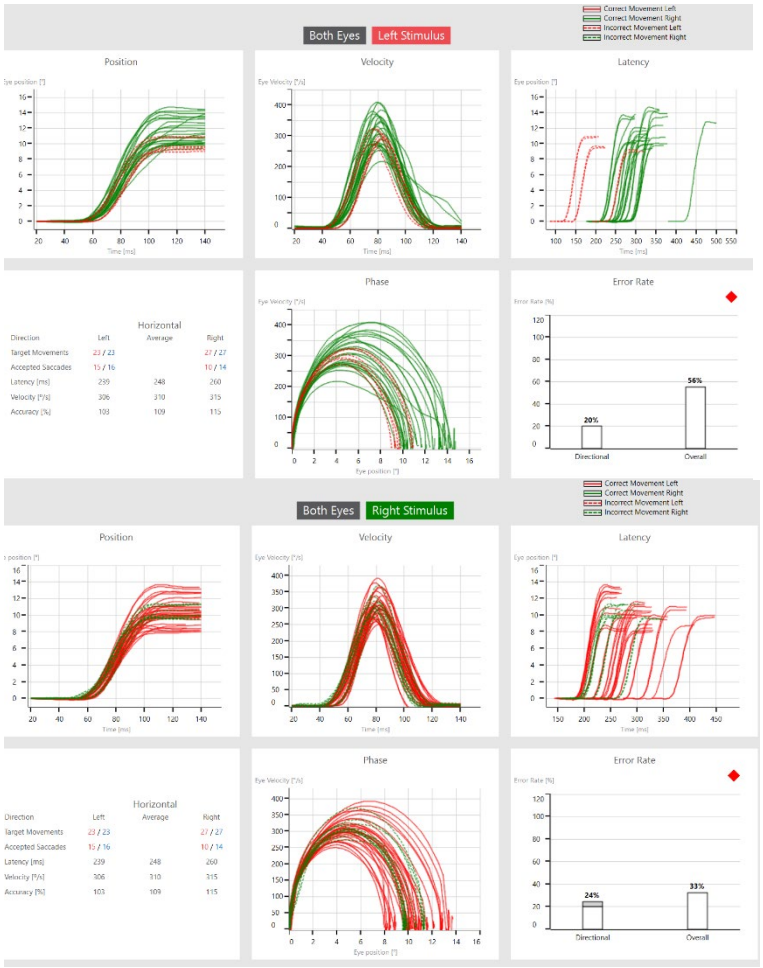
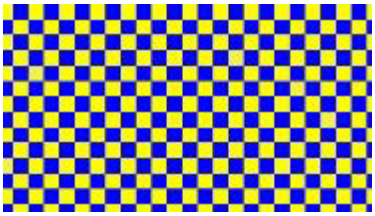


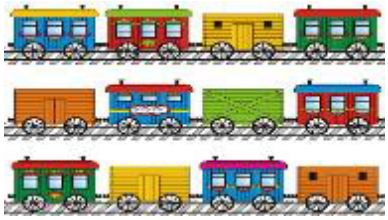
Figure 3.5-25 Anti-Saccade Result view- Directional Error Rate, can view by stimulus direction or by eye

3.5.8 Optokinetic test

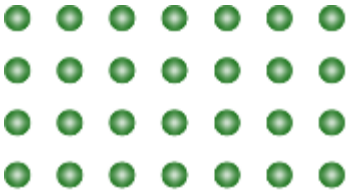
The optokinetic test is used to examine eye movement during stimulation from a large, moving pattern. The VisualEyes™ 525 software can generate various stimulus patterns that can move across the TV or projection screen in horizontal or vertical directions.



Checker board



Trains with tracks



Spheres

During the slow phase of the nystagmus, the eyes move with the velocity of the projection pattern. The eyes then make a fast corrective eye movement (saccade) back to center. This nystagmus continues to occur throughout the duration of the test. In the default optokinetic test, the patient's ability is assessed in four tests following moving stimulus patterns at 20 degrees per second (left moving and right moving) and 40 degrees per second (left moving and right moving). An optional pair of tests at 30 degrees per second are also available. These velocities can be changed if desired, though it is recommended to test each direction at default velocities which will then be shown in the Symmetry graph on the optokinetic summary.

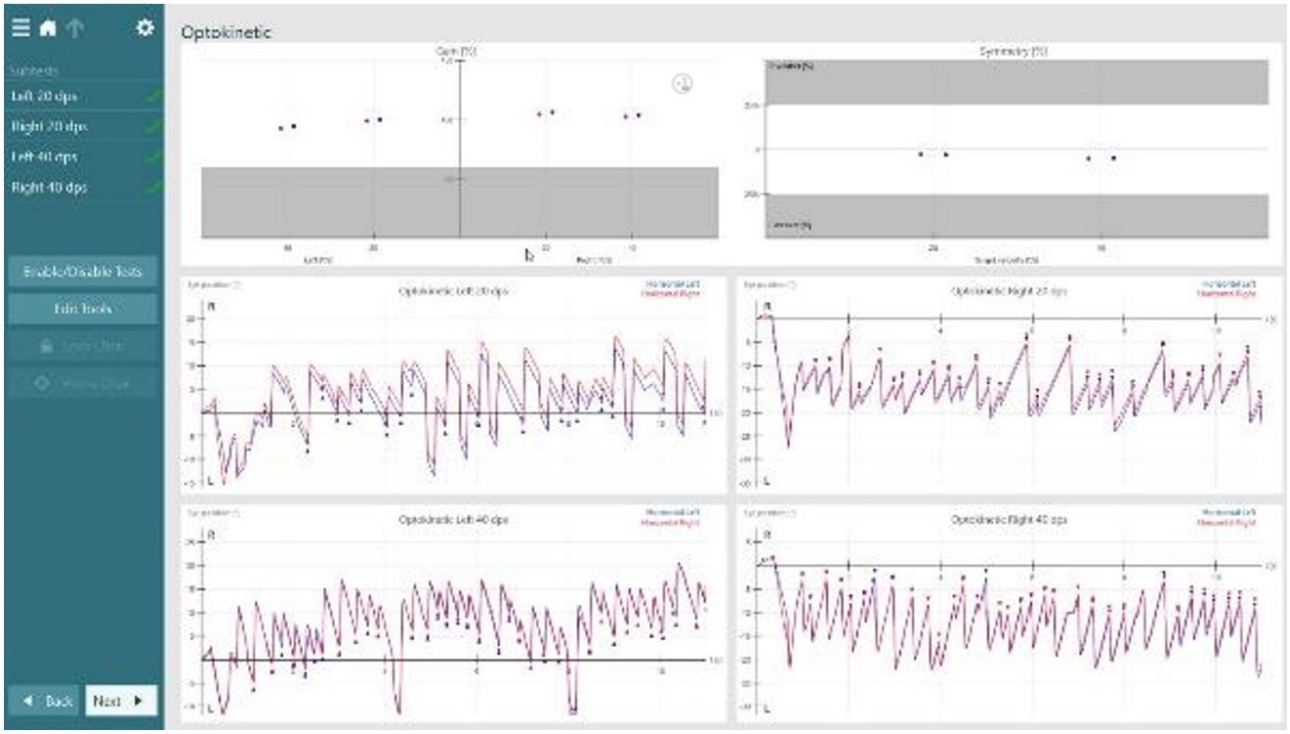


Figure 3.5-26 Optokinetic summary

The optokinetic subtest will display the stimulus pattern on the TV or projection screen. The test will last 15 seconds (though more time can be added with the **Add Time** button) and display the stimulus moving in the selected direction. Have the patient follow the targets as they go across the screen. Typically, the patient should focus on the center ±5° of the stimulus, picking up the target as it comes from one side, then as the target leaves the patient's field of focus, the patient will go back and pick up the next target. The optokinetic test is quite intensive, and the patient may not perform it correctly on the first attempt. If the patient does not appear to be following the target and producing a noticeable nystagmus pattern, you may need to instruct the patient again and redo the test.

During data collection, the Gain graph will display the average gain for each eye. The average gain is defined as the patient's average slow phase velocity divided by the stimulus velocity as a percentage. In the optokinetic summary (Figure 3.5), the average gain from each subtest is compared with the other subtests and the results are displayed in the Symmetry graph. If the average gain falls outside the test thresholds or the symmetry value at one of the velocity pairs falls outside the test thresholds, the test will be marked as outside thresholds and display a red diamond.

By clicking the symbol, you can view the numerical value of gain and symmetry in the graphical representation (refer to section 7.5 for details).

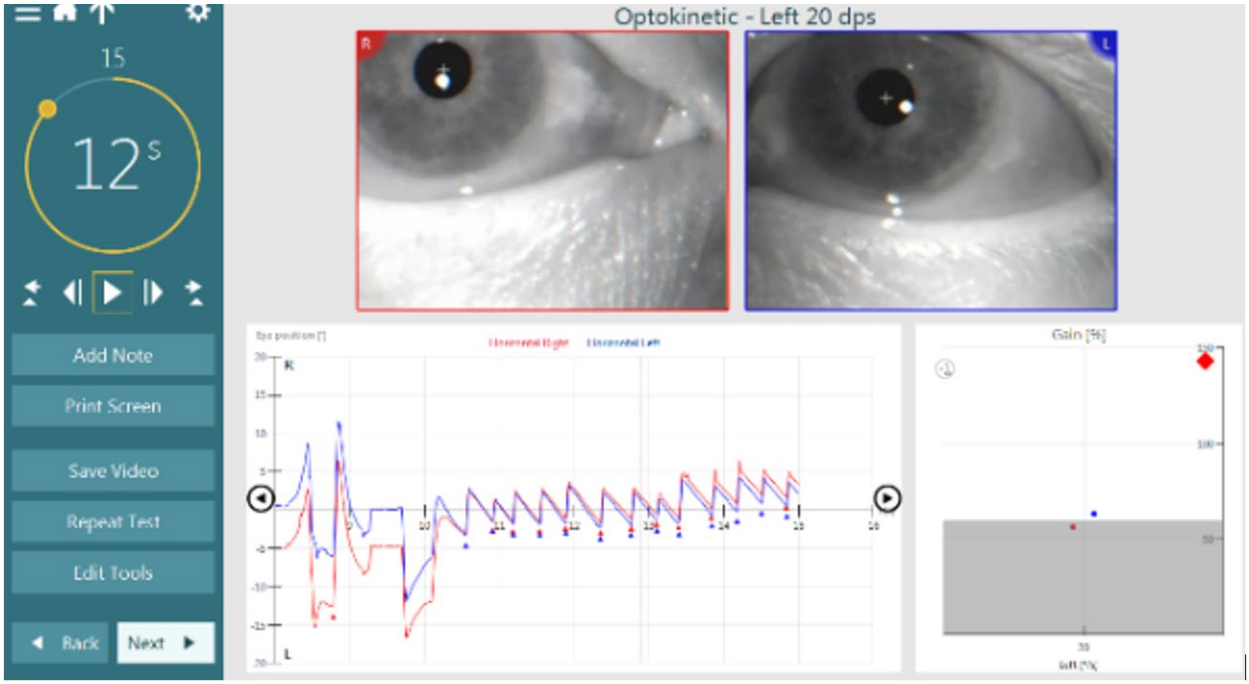


Figure 3.5-27 Optokinetic test display (during data collection)

3.6 Head rotation testing

Head rotation testing includes active head rotation, dynamic visual acuity, and head impulse testing. The tests utilize the VORTEQ™ IMU \ to measure head velocity along with eye position. In dynamic visual acuity testing, the patient is required to distinguish an optotype character while moving his / her head in the specified direction at the required velocity.

Active head rotation testing has the patient shake his / her head to the required velocity and frequency. When the patient is not able to achieve this action, the examiner may perform passive head rotation tests (horizontal/vertical) with the examiner moving the patient's head in time with the software metronome at low frequencies.

3.6.1 Active head rotation test (VORTEQ™ AHR)

AHR testing involves the patient shaking his/her head from side to side or up and down in rhythm to a pre-determined metronome pattern of beeps emitted by the computer. During the test, the software monitors the velocity of the turning head and matches this velocity data against the velocity of the patient's eyes. The resulting analysis of the data provides information about the efficiency of the vestibulo-ocular reflex (VOR). The tests are performed either actively by the patient or passively by the operator moving the patient's head.

The AHR test can be performed using the the VORTEQ™ IMU, which provides angular velocity data in three directions.

The target size using a TV or projector is defined by the size of the calibration target. If the patient is unable to see the target clearly, enter the calibration section and adjust the calibration target size accordingly. The target will remain at the larger size until it is reset from the Calibration screen.

The test will begin with a practice segment. At the start of the test the metronome will beep at the initial frequency for 5 seconds with "Practice Mode (5s)" displayed overlayed on the waveform (Figure 3.6-1).

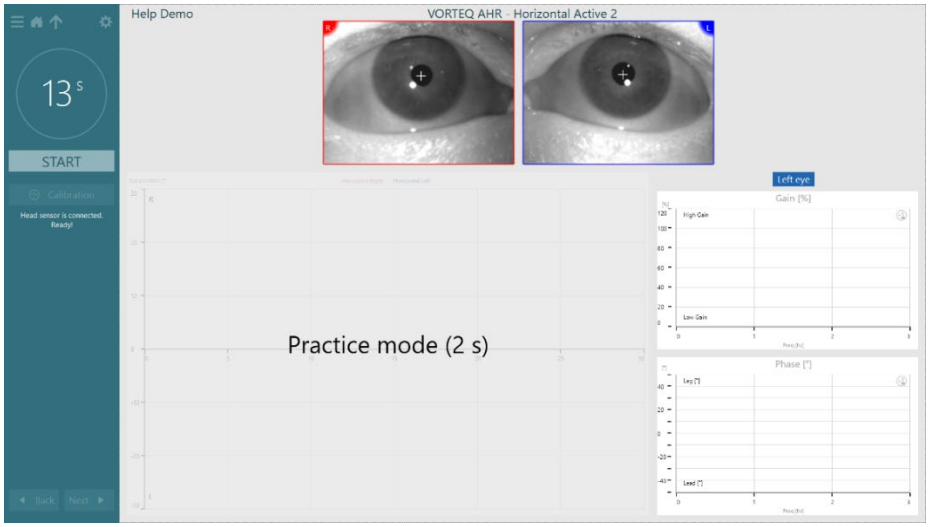


Figure 3.6-1 AHR practice mode

The patient will continue shaking his/her head to the sound of the metronome beep. After the minimum cycle count is reached, the metronome frequency will increase by 1 Hz. The test will end once the minimum cycle count is reached for the end frequency (default is 2 Hz). The program will then analyze the cycles and average the gain, phase, and symmetry values at each frequency.

By clicking the symbol , you can view the numerical values of gain and symmetry in the graphical representation (refer to Figure 3.6-2 and section 7.5 for details). If you choose to show the numerical values at each frequency, they will be displayed on the graph along with the number of cycles in parentheses.

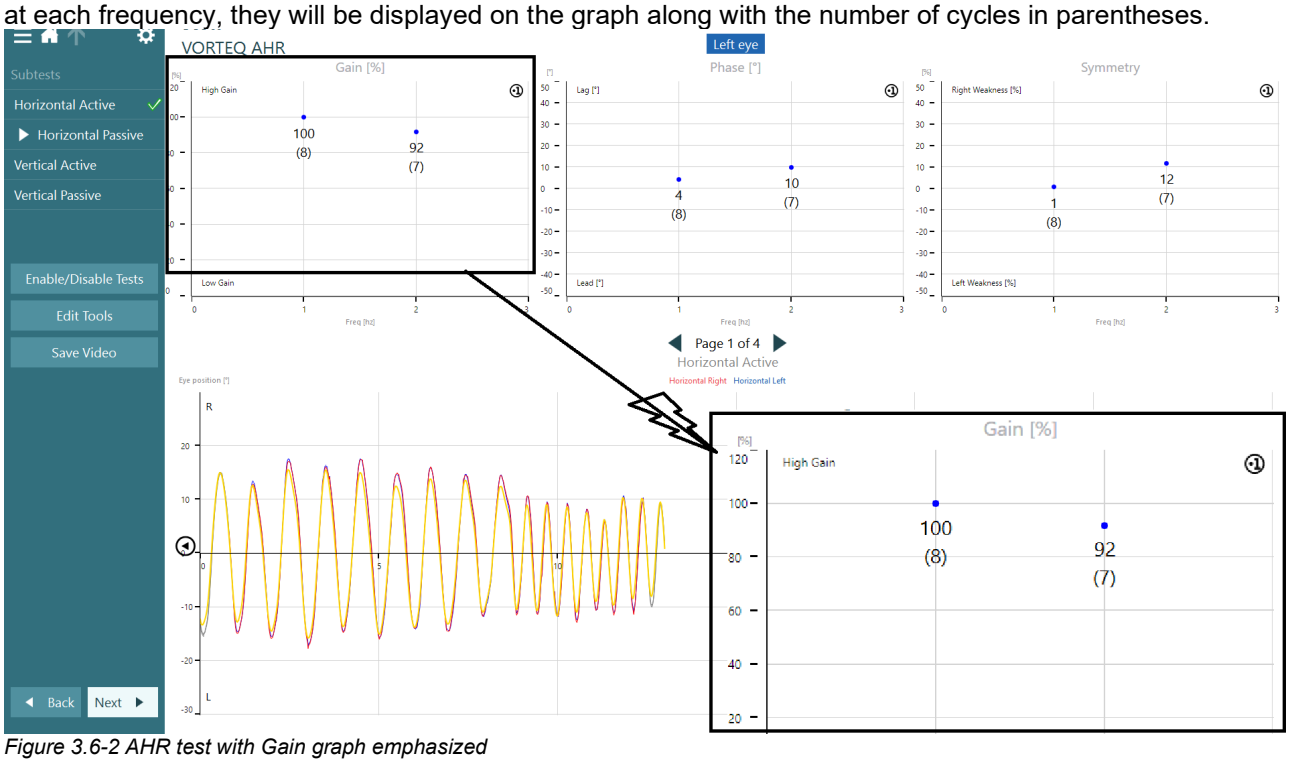


Figure 3.6-2 AHR test with Gain graph emphasized

3.6.2 Dynamic Visual Acuity (DVA) test

DVA testing has the patient distinguish the orientation of an optotype character as the patient moves his/her head at a specified velocity and direction. The DVA test is performed with the patient wearing the DVA headband instead of the binocular goggles. If the patient wears eyeglasses or contact lenses, then he/she should also wear these during the DVA test, and the DVA headband allows this.

The default patient distance to the stimulus is eight feet (2.4 meters) in a standard laptop setup. This distance and stimulus size can be configured from Configuration > System Default Settings > Optotype Stimuli. The Optotype stimuli can be displayed on a TV or on the primary computer screen if the office dimensions do not allow for the required patient distance. If the stimulus is set to a TV, the computer screen will show a large optotype for the operator instead of the required size for the DVA LogMAR assessment.

Note: Big TV screens do not allow proper resolution so either use the laptop as the test screen or a smaller monitor for best results. The clinician gets notified with the error message if the patient distance to screen is inappropriate to screen size as shown below.



Figure 3.6-3 Optotype stimulus requirement for Patient Distance to Screen

Static Visual Acuity (SVA)
The first subtest of the DVA test is SVA. Once the test begins (either by the operator or the patient), the optotype will appear in a random orientation. After setting the patient's static acuity, the software will display the static acuity in the DVA results graph as a dotted green line (Figure 3.6-4).

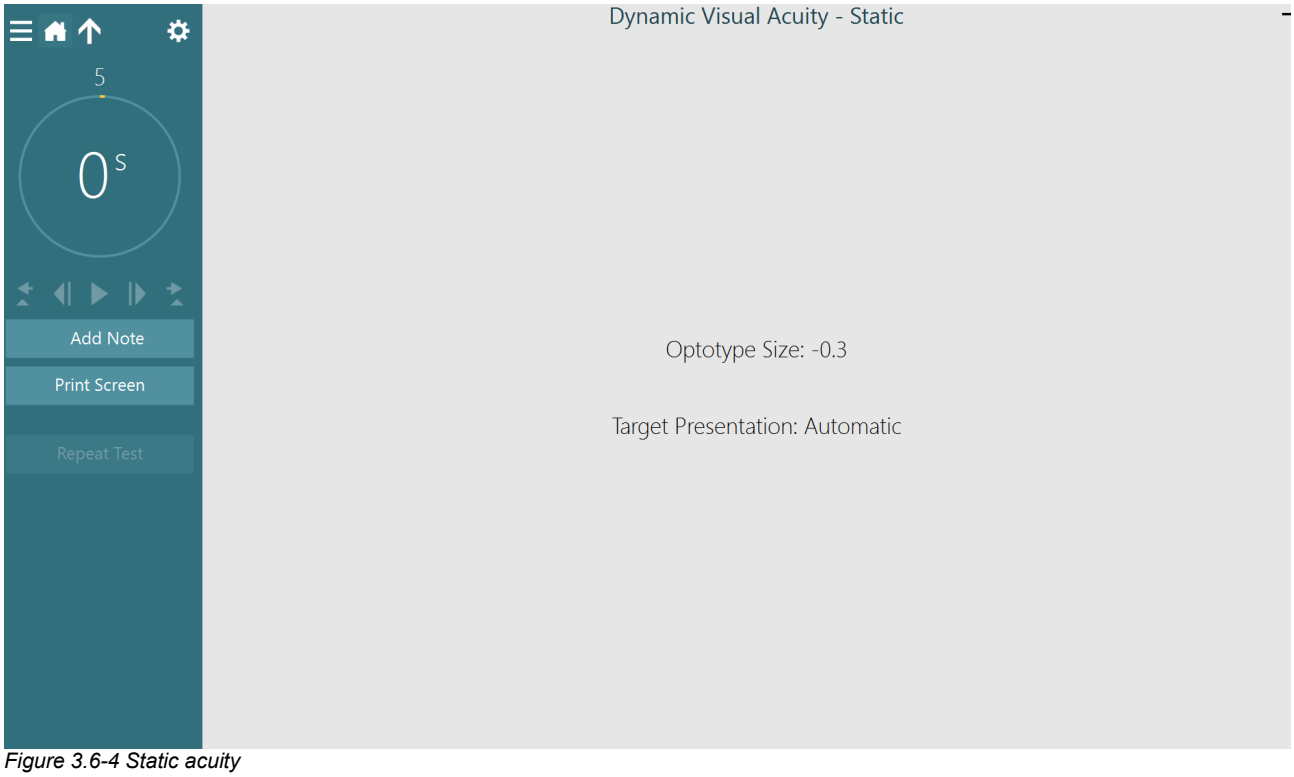


Figure 3.6-4 Static acuity

Automatic presentation
In the automatic presentation style, the patient can confirm the orientation of the optotype using the matching direction button on the RF remote control. Alternatively, the patient can say the orientation out loud and the operator can then use the keyboard arrow keys or the direction buttons in the side panel to enter the patient's response. When the patient correctly distinguishes the optotype, the size will decrease. If the patient incorrectly distinguishes the optotype, the size will increase. The static acuity is defined when the patient can distinguish the optotype orientation three times at a particular LogMAR level.

Manual presentation
In the manual presentation style, the operator sets the initial optotype size to LogMAR 0, then uses the Increase Size and Decrease Size buttons to adjust the optotype size to the size where the patient can clearly identify the orientation. The operator will then use the Rotate Optotype button to randomly change the orientation of the optotype. If the patient can correctly distinguish the optotype orientation at a specific LogMAR level three times, then the operator will use the Set Acuity button to lock in the value of the patient's DVA static acuity (Figure 3.66-).

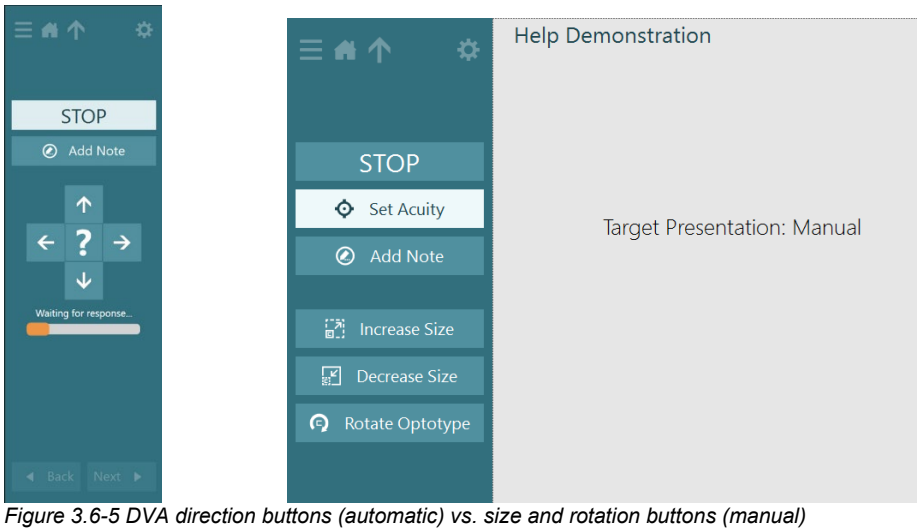


Figure 3.6-5 DVA direction buttons (automatic) vs. size and rotation buttons (manual)

Note: The user can use 'Copy Static Result' option, to avoid repeating this test when moving from DVA to GST or vice versa.



Figure 3.6-6 Copy Static test result

Visual Process Time

The next step is the test Visual Process Time. The patient is again to identify the direction of the optotype with their head still, but the test will vary the stimulus time. The time will get shorter.

a. Any response over 70 ms is considered an **invalid** response and any following results should be interpreted with caution.

b. This test is presented at an optotype size two lines above the static results.

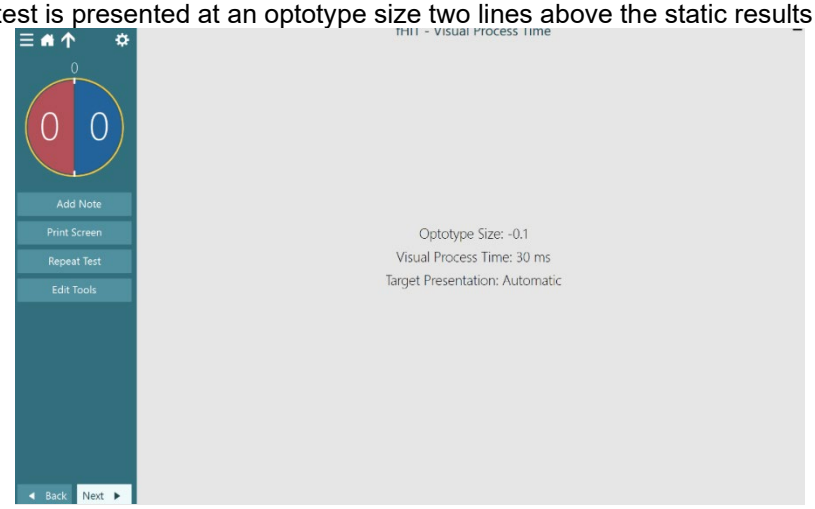


Figure 3.6-7 Visual Process Time

The user can use 'Copy Static Result' option, to avoid repeating this test when moving from DVA to GST or fvHIT™ or vice versa.

Dynamic Visual Acuity test
The remaining subtests of the DVA test are dynamic acuity assessment in different directions. Once the subtest begins (either by the operator or the patient), the optotype will appear in a random orientation. The patient will move his/her head in tune with the metronome.

Automatic presentation
In the automatic presentation style, the patient shakes his/her head and chooses the orientation of the optotype using the matching direction button on the RF remote control.

Alternatively, the patient can say the orientation out loud and the operator can then use the keyboard arrow keys or the direction buttons in the side panel to enter the patient's response.

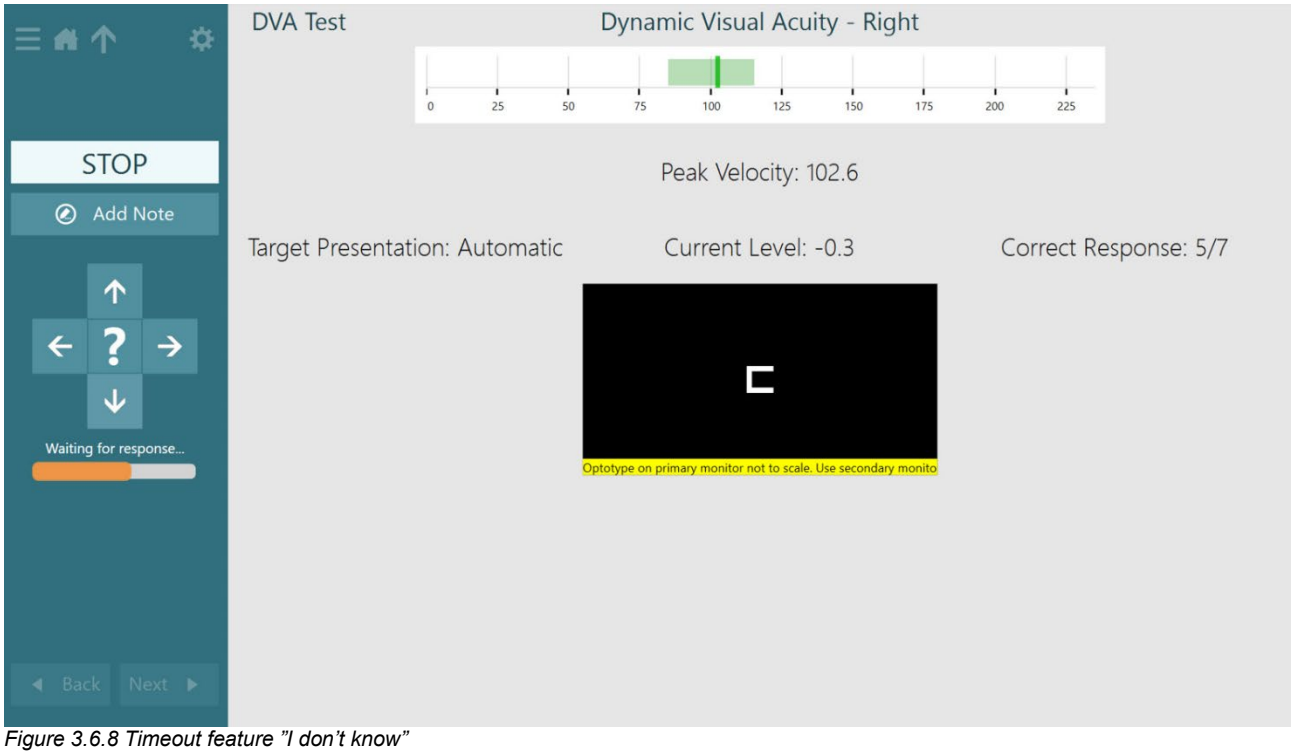


Figure 3.6.8 Timeout feature "I don't know"

When the patient correctly distinguishes the optotype, the size will decrease. If the patient incorrectly distinguishes the optotype, the size will increase. The dynamic acuity is defined when the patient can distinguish the optotype orientation three times at a particular LogMAR level. The optotype will only be displayed when the patient moves his/her head to the noted direction at the desired velocity. Horizontal subtests are set to 100 degrees per second, and vertical subtests are set to 75 degrees per second.

Note: When user has seen the optotype, he can stop shaking the head to register his response and continue to the next level of the test.

Manual presentation
In the manual presentation style, the operator sets the initial optotype size to LogMAR 0, then uses the Increase Size and Decrease Size buttons to adjust the optotype size to the size where the patient can clearly identify the orientation. The operator will then use the Rotate Optotype button to randomly change the orientation of the optotype. If the patient can correctly distinguish the optotype orientation at a specific LogMAR level three times, then the operator will use the Set Acuity button to lock in the value of the patient's DVA dynamic acuity.

The results will be displayed after each subtest is completed (Figure 3.6-9).

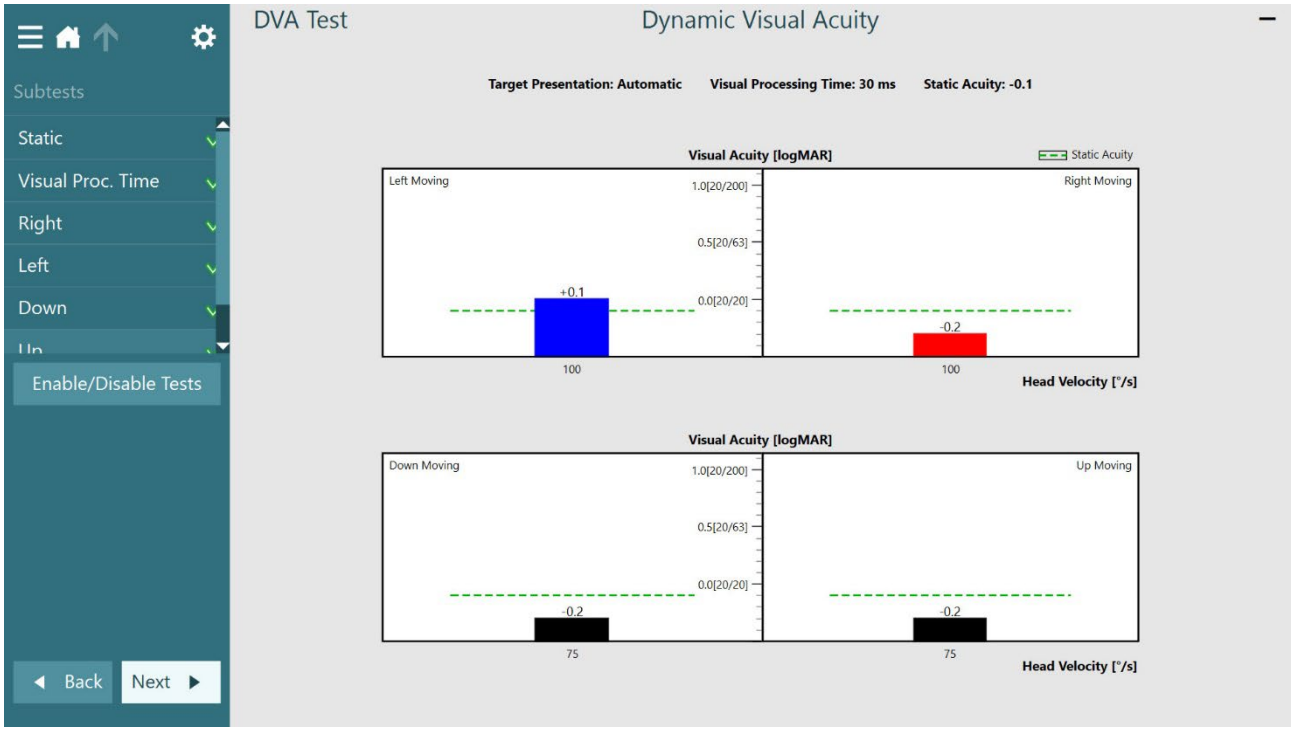
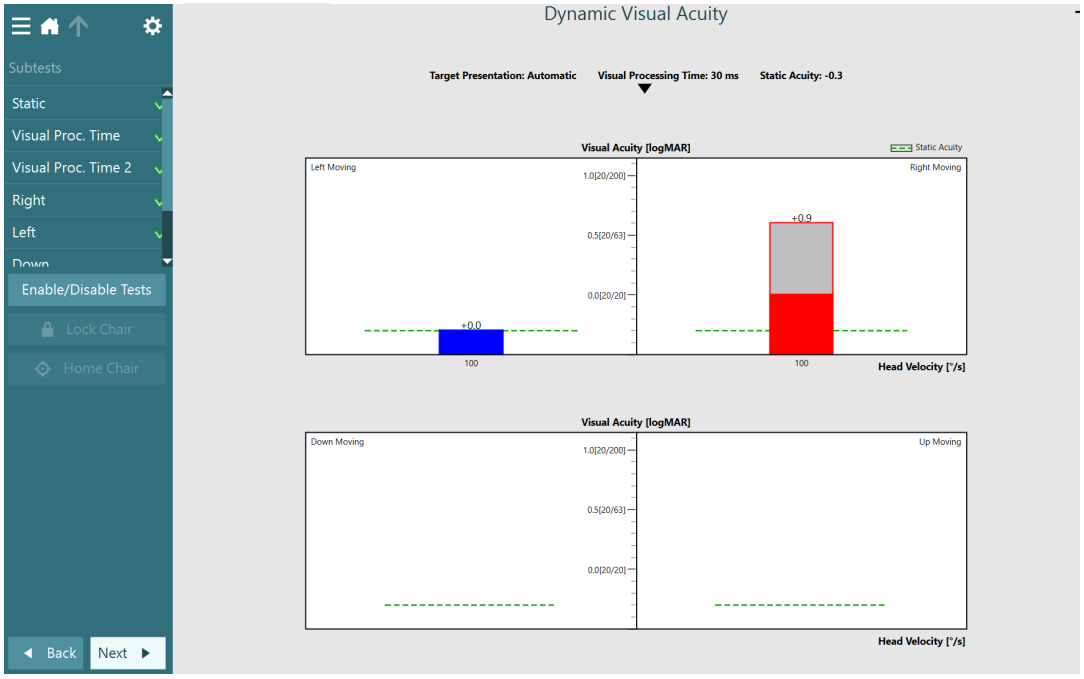
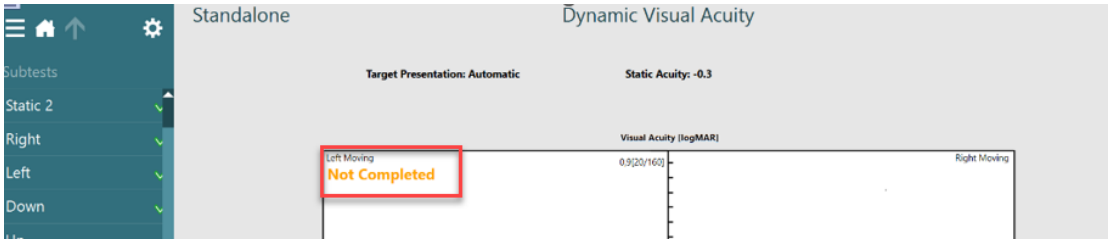


Figure 3.6-9 DVA results

Summary Graph:
The user gets to view a summary graph (see below screenshot) that allows the clinician to easily identify the patient's head speed threshold. This is especially beneficial for physiotherapists in order to make discrete decisions for a patient's treatment plan. If the user puts normative data into their software, they will be able to compare their patient's results to this normative data. The summary screen will then display results in a gray shaded region if the patient performs outside of the normal range.



When a patient is being more symptomatic and cannot finish all the subtests, that is notified in the summary graph with 'Not Completed' message (Refer below screenshot).



3.6.3 Gaze Stabilization Test

Before starting this test, make sure that the secondary screen is set. If the patient wears eyeglasses or contact lenses, then he/she should also wear these during the GST test, and the headband is compatible for this. And the patient is given a remote control to register the response to the test.

Static test is the first sub-test for GST. Please refer to DVA Static test procedure as it is same. The clinician can also copy the DVA static result as explained in section 3.6.2 if they have already done one with DVA.

Visual Process time is the second sub-test for GST. Please refer to DVA Visual Process Time as it is the same. The clinician can also copy the results if they have already done this test with DVA in that same session.

Note: Big TV screens do not allow proper resolution so either use the laptop as the test screen or a smaller monitor for best results. The clinician gets notified with the error message if the patient distance to screen is inappropriate to screen size as shown below.

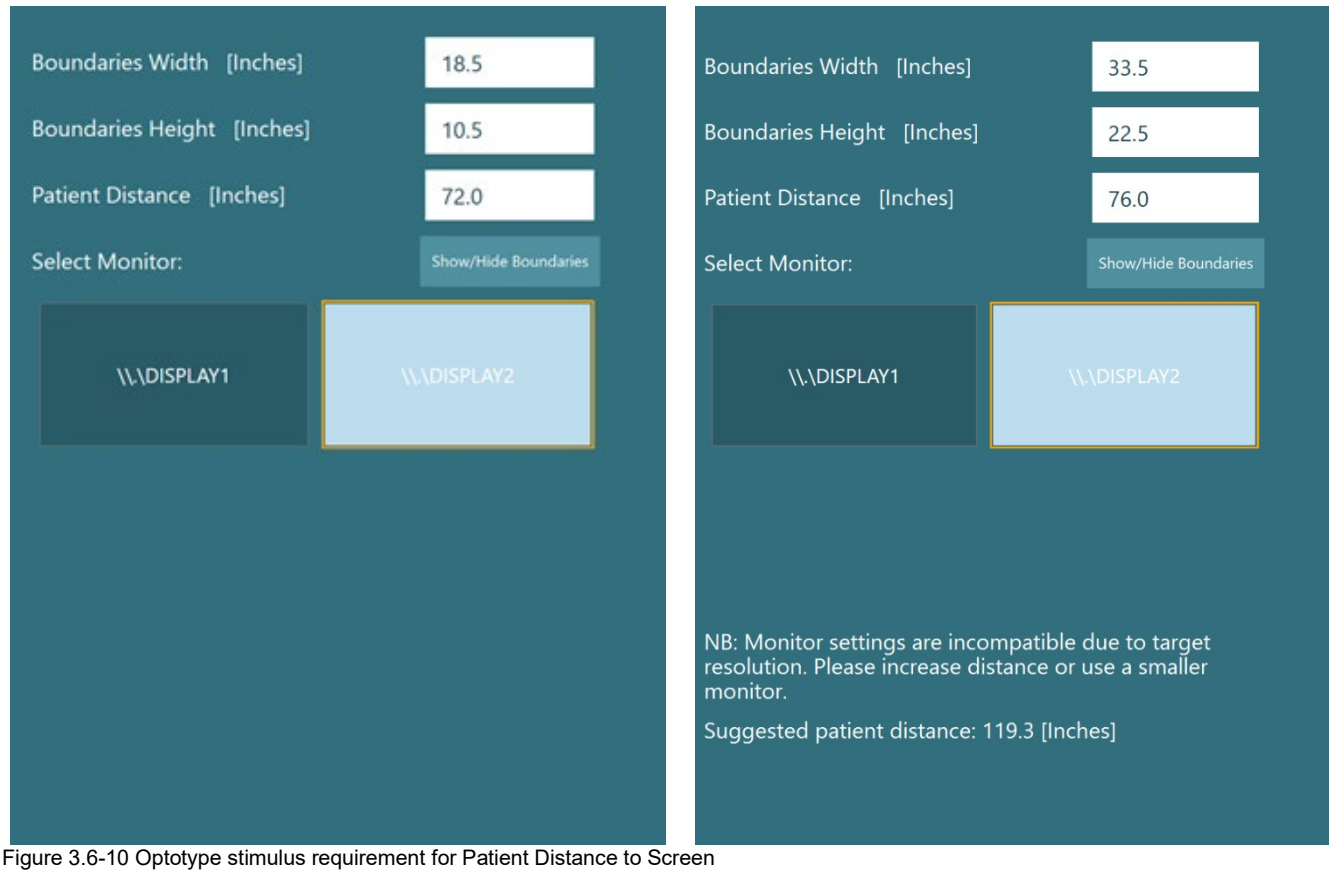


Figure 3.6-10 Optotype stimulus requirement for Patient Distance to Screen

In the GST test, the optotype size remains the same but the head velocity changes. The head velocity is measure in degrees per second (DPS). The results are plotted as a bar graph. Once everything is ready for the test, have the patient move their head so that the speed of their head movement peaks in the green area of the velocity bar. Their head movement is represented as the solid line. The acceptable range for head movement is the green shaded area. When the head movement in this area, the optotype will appear. You

can see this on the screen as the direction arrows will become highlighted in white when the optotype has appeared.

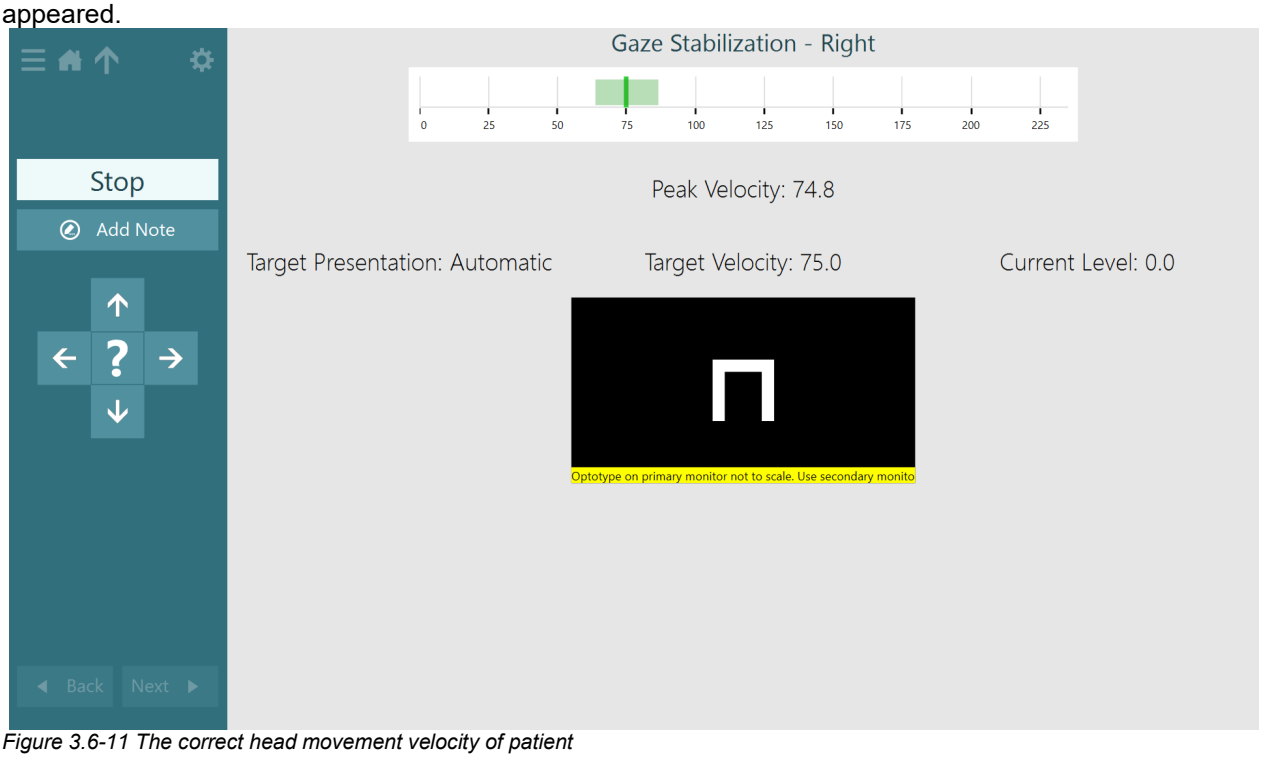


Figure 3.6-11 The correct head movement velocity of patient

If the patient is moving their head too slowly, then the solid line will be red and peak before the green shaded area. You will see the progress of the head movement as a grey bar that ends at the red solid line. Instruct the patient to move their head faster and follow the beat of the metronome so they can reach the green shaded area.

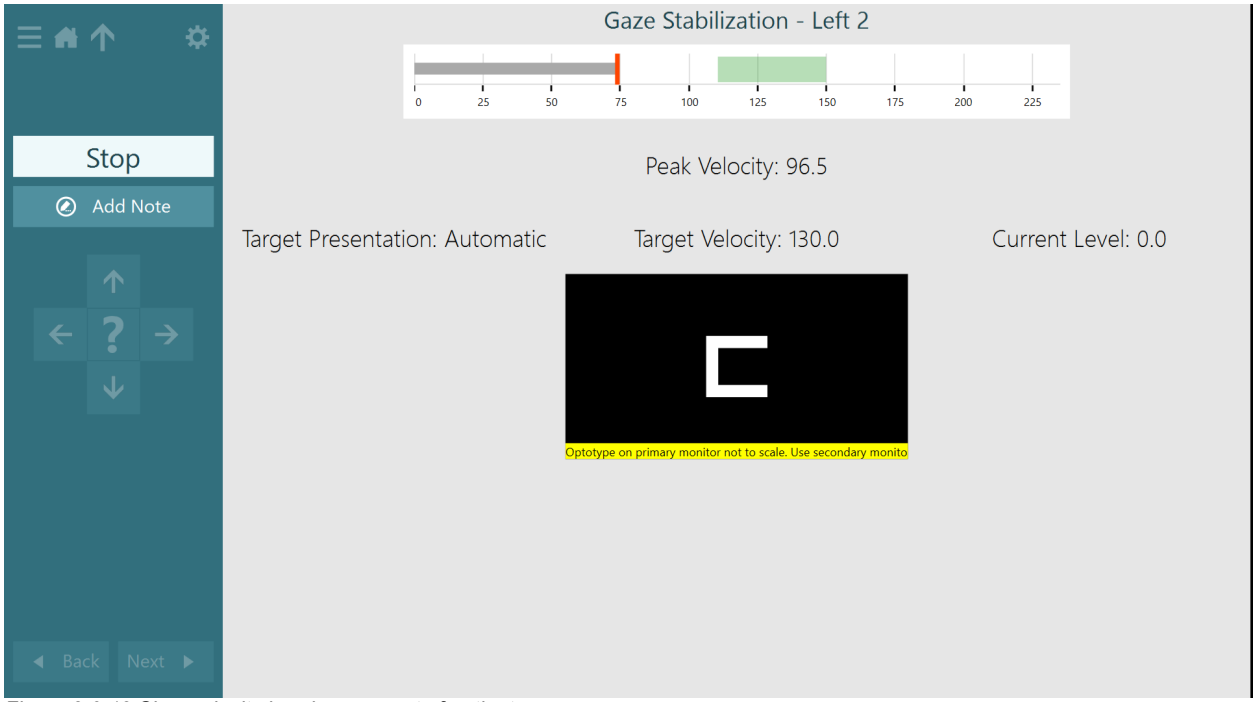


Figure 3.6-12 Slow velocity head movement of patient

If the patient is moving their head too quickly then the solid line will be red and peak after the green shaded area. You will see the progress of the head movement as a red shaded area that ends at the red solid line. Instruct the patient to slow down their head movements so they can reach the green shaded area.

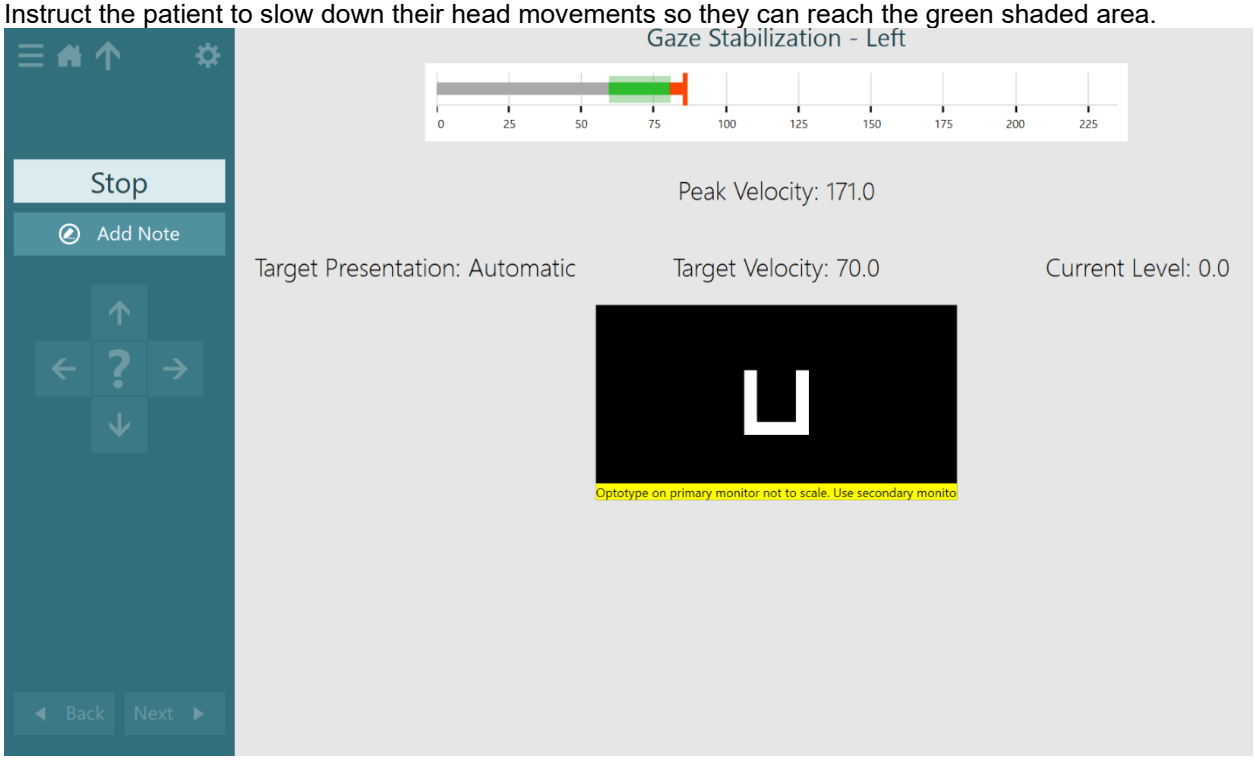


Figure 3.6-13 High velocity head movement of patient

The patient will use the remote control to enter the direction of the optotype, either left, right, up, or down. If a response is not chosen after 5 seconds, the response is automatically registered as “I don’t know”.

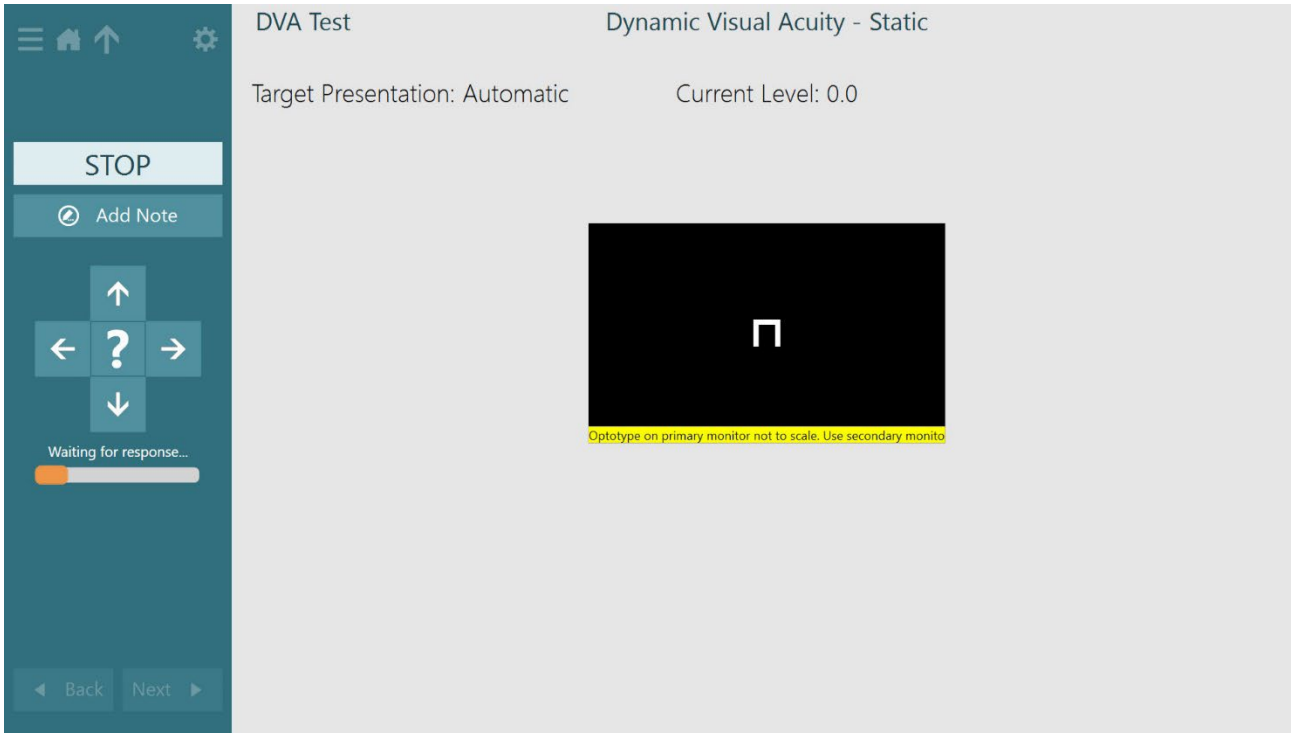


Figure 3.6-14 Remote for DVA, GST, fvHIT™

If they do not know the direction, they can tell you “I don’t know” and then you can click on the “?” on the screen to enter the “I don’t know” response for them. If a response is not chosen after 5 seconds, the response is automatically registered as “I don’t know”.

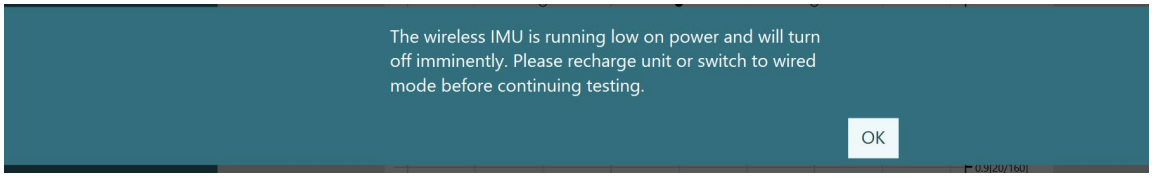


Figure 3.6-15 Timeout feature ”I don’t know”

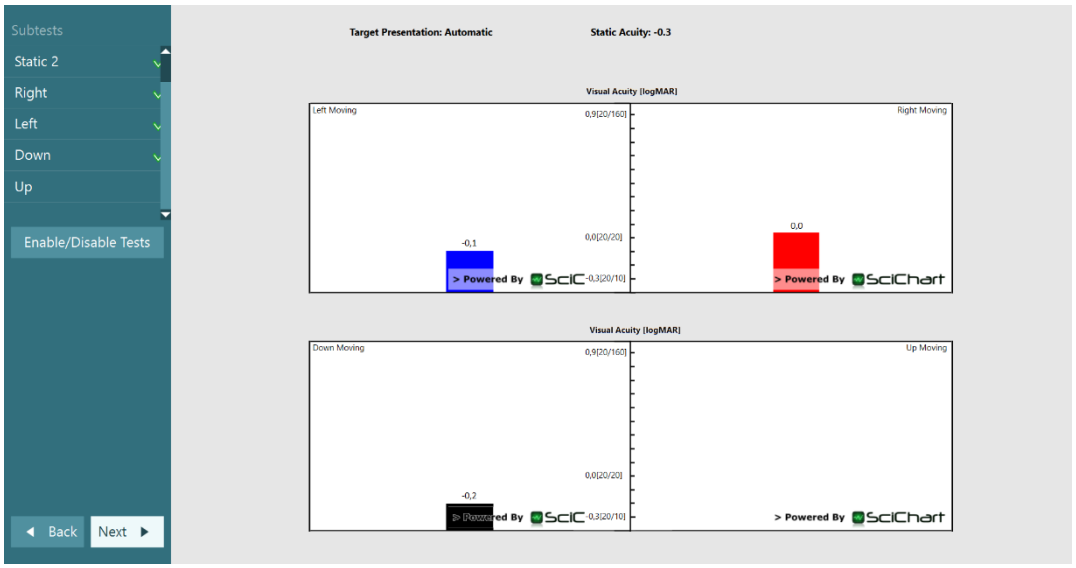


Manual Test Mode: There is also an option to run the test in Manual mode. In this mode, the user changes the head velocity speed manually. When they are confident the patient is accurately determining the optotype at a given speed they increase the speed until they reach the patient’s threshold and then set the velocity.

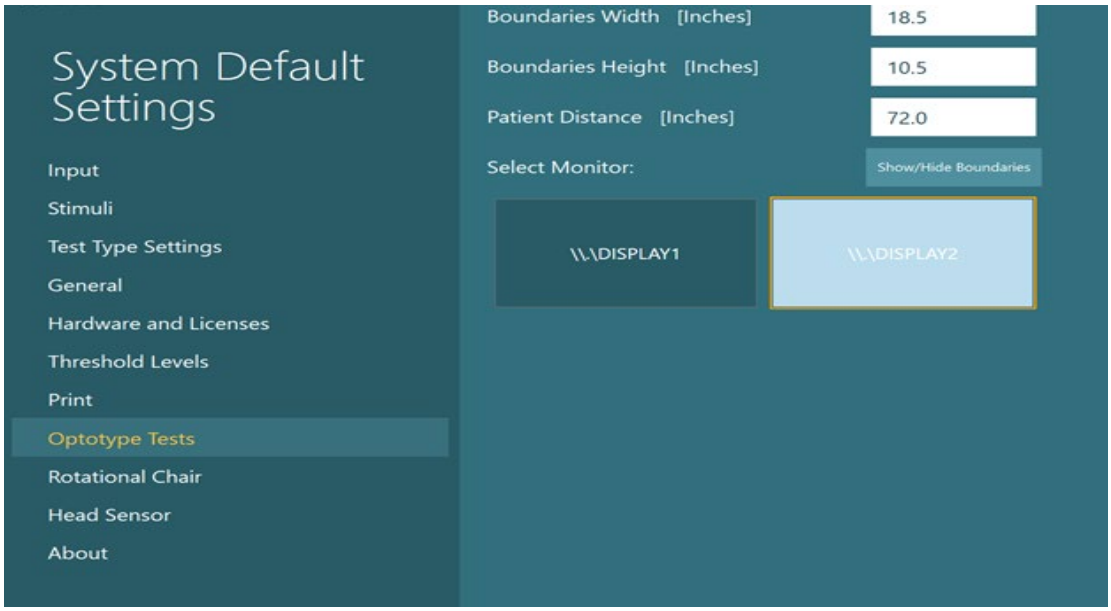
Note:
If the head sensor is attached with Bluetooth and the battery is getting low, you will see this error message as follows.



Summary Graph:
The user gets to view a summary graph (see below screenshot) that allows the clinician to easily identify the patient's head speed threshold. This is especially beneficial for physical therapists in order to make discrete decisions for a patient's treatment plan.



When a patient is being more symptomatic and could not finish all the subtests, that is notified in the summary graph with 'Not completed' message (Refer below screenshot).



3.6.4 Functional Vision Head Impulse Test (fvHIT)™

While in a test session with a patient, you can select fvHIT™ from VORTEQ™ Assessments or VORTEQ Functional Assessments protocol if you have not done so already.

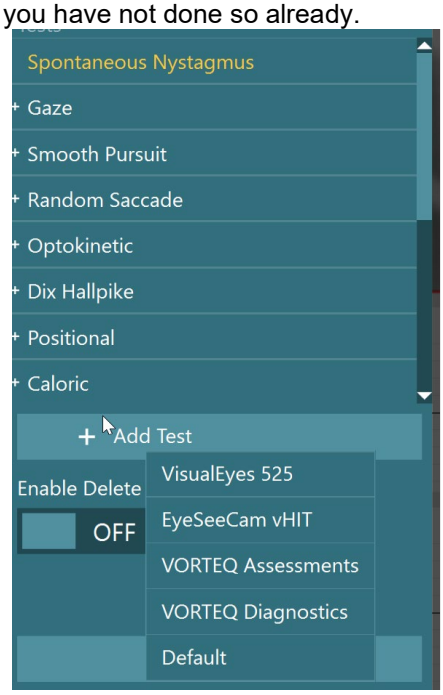
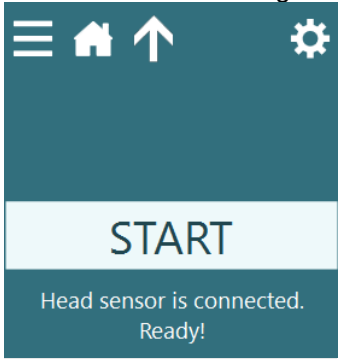


Figure 3.6-16 fvHIT™ protocol selection

fvHIT™ requires VORTEQ™ IMU sensor mounted on headband and turned on.



Head sensor should be on and connected to the software before beginning the test:



Factors that may impact testing and results:

- Screen distance
- Neck mobility
- Attention
- Cognition
- Fatigue
- Clinician experience
- Use of corrective lenses

Five subtests in fvHIT™
fvHIT™ has five subtests:

1. Static Visual Acuity (SVA)
2. Visual Process Time (VPT)
3. Lateral (Right Lateral, Left Lateral)
4. LARP (Left Anterior, Right Posterior)
5. RALP (Right Anterior, Left Posterior)

SVA and VPT tests can be copied from DVA or GST if they were previously performed in the same session.

Optotype Choices:

There are three optotype options available for DVA, GST, and fvHIT testing, which can be selected in Protocol Management > Test Settings under “Target Type”. These three types include a Tumbling E, Landolt C, and VisualEyes C. Whichever optotype is selected for Static Visual Acuity testing will be the defaulted option for VPT, and whatever dynamic tests are completed that session. Optotype can be changed also during testing in the Temporary Settings page.

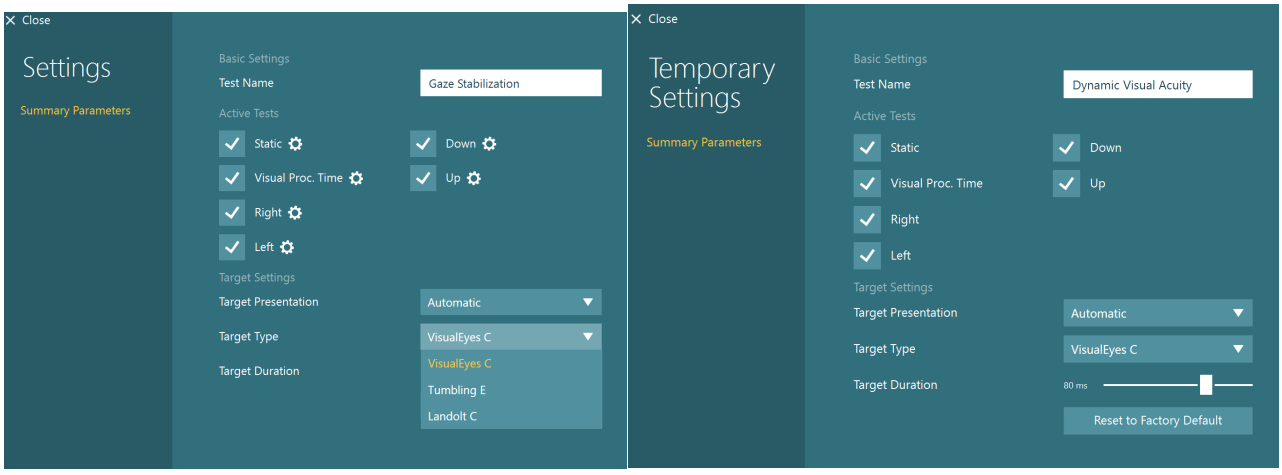


Figure 3.6-17 Optotype choices

Optotype selection can be accessed through protocol management settings before starting a test session or temporary settings when in the test session.

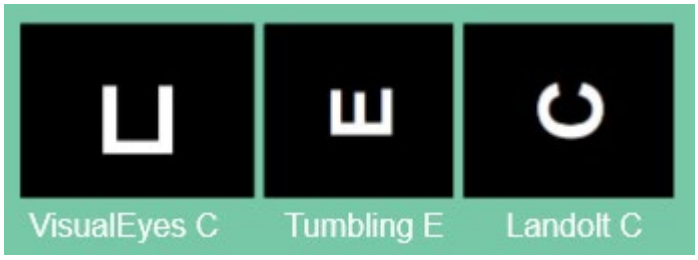


Figure 3.6-18 The three optotype choices in VisualEyes and how they will be viewed to the patient

Remote for DVA, GST, fvHIT™
If a response is not chosen after 5 seconds, the response is automatically registered as “I don’t know”.



Figure 3.6-19 Remote for DVA, GST, fvHIT™

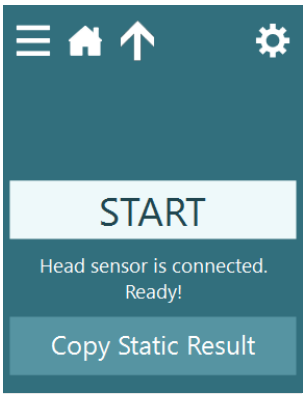
If they do not know the direction, they can tell you “I don’t know” and then you can click on the “?” on the screen to enter the “I don’t know” response for them. If a response is not chosen after 5 seconds, the response is automatically registered as “I don’t know”.



Figure 3.6-20 Timeout feature ”I don’t know”

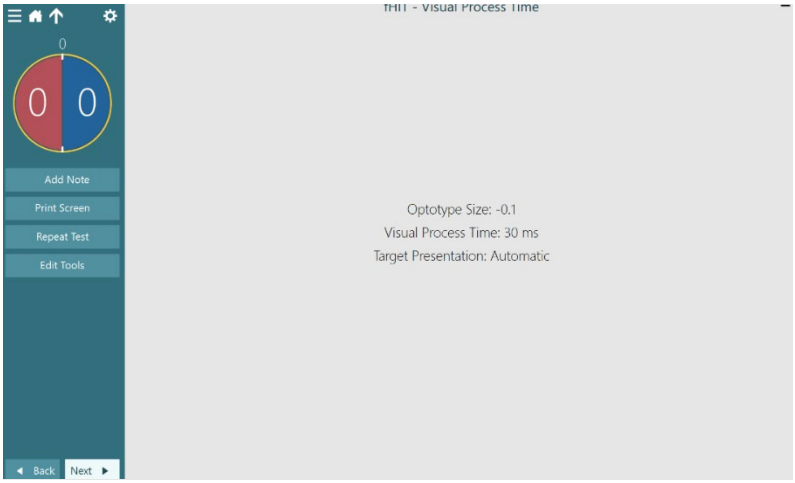
Static Visual Acuity (SVA) subtest
Begin with thresholding process. The patient is to identify which direction the open part of the U optotype is facing. The threshold is the smallest optotype which the patient can identify correctly twice with their head still.

Note: If you have already completed the DVA or GST test in this same test session, you can click “copy static result” to copy the results to fvHIT™:

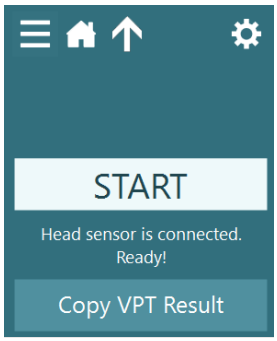


Visual Process Time
The next step is the test Visual Process Time. The patient is again to identify the direction of the optotype with their head still, but the test will vary the stimulus time. The time will get shorter.

a. Any response over 70 ms is considered an **invalid** response and any following results should be interpreted with caution.
b. This test is presented at an optotype size two lines above the static results.



Note: If you have already completed the DVA or GST test in this test session, you can click “copy VPT result” to copy the results to fvHIT™:



Lateral, LARP and RALP subtests
Lateral, LARP and RALP subtests are dynamic tests, where the clinician moves the patient’s head. The test procedure should be identical to vHIT testing, providing randomized and quick head impulses to the patient.

Test screen:

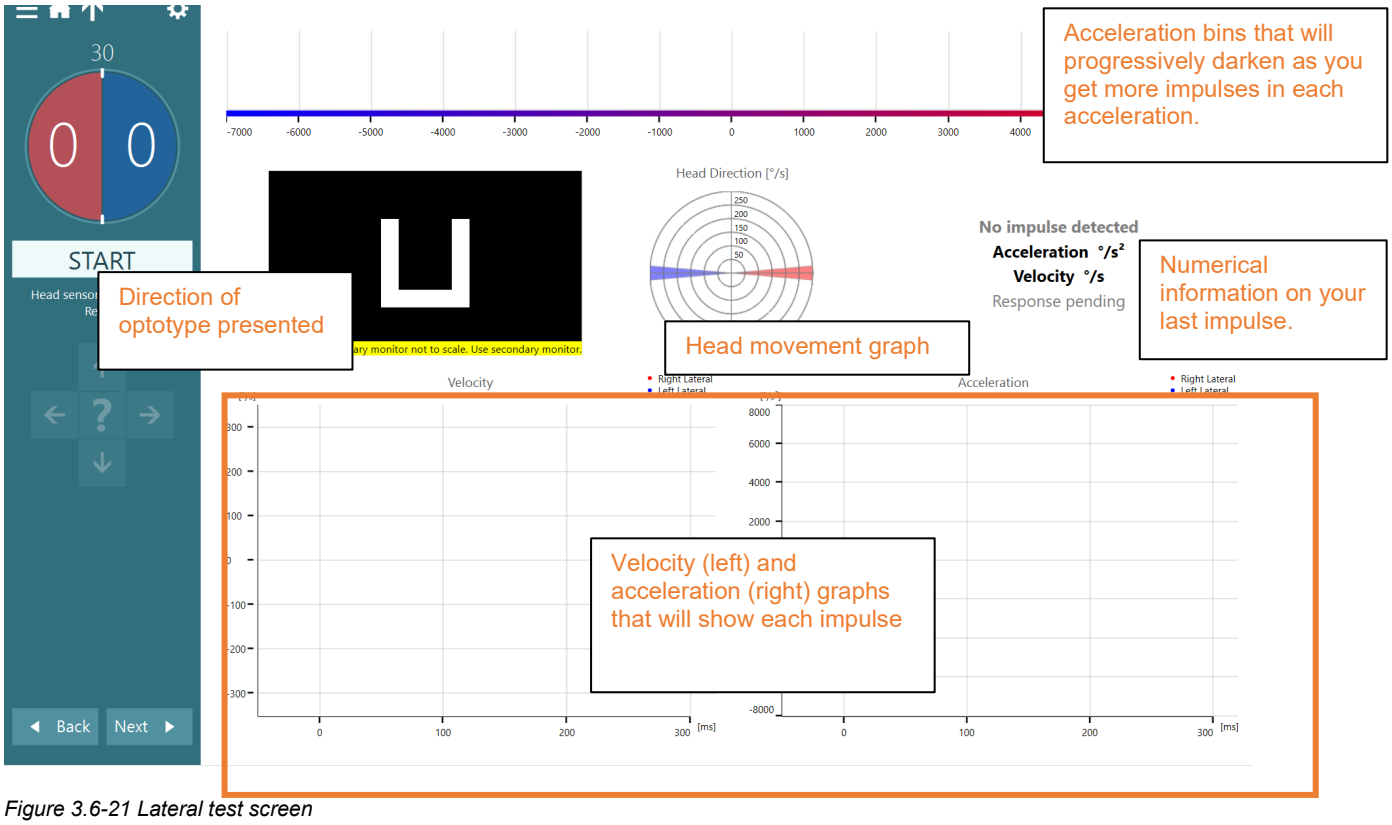


Figure 3.6-21 Lateral test screen

Accepted impulse:
The colour of the box around the head tracing graph indicates if it was an accepted acceleration impulse.
Green: Proper acceleration impulse
Orange: Redo impulse

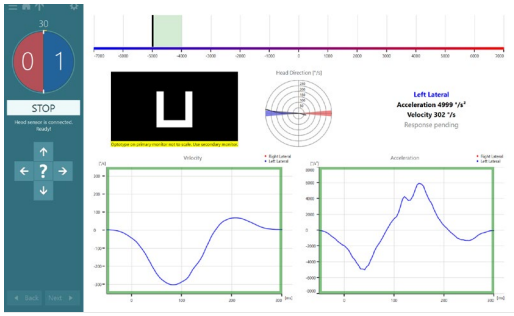


Figure 3.6-22 Green box: Proper acceleration impulse

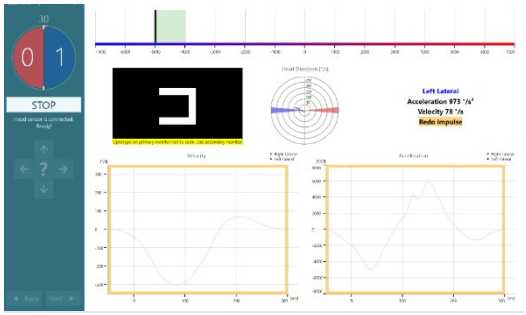


Figure 3.6-23 Orange box: Redo impulse

If a poor impulse was completed or the patient moved their head and the software included that impulse, there is a button “Reject last impulse” which will throw out the data of the previously collected head movement. This allows for cleaner data to be collected during testing.



Figure 3.6-24 Reject last impulse button in fVHIT testing

Patient response:
On the right side of the test screen, there will be a message to show if the patient response was correct (green highlighted text – Correct Answer) or incorrect (orange highlighted text).

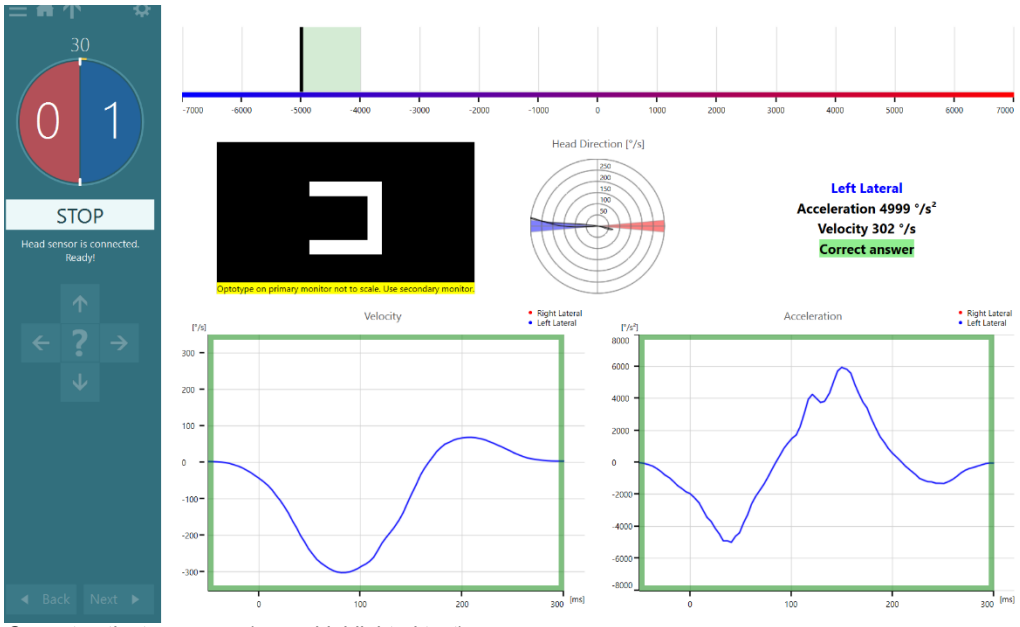


Figure 3.6-25 Correct patient response (green highlighted text)

Progress of test:
As the number of head impulses increases, you will see the counter on the left increase in number and the acceleration bins get progressively darker. As the bins get darker, you should focus head accelerations in the other bins.

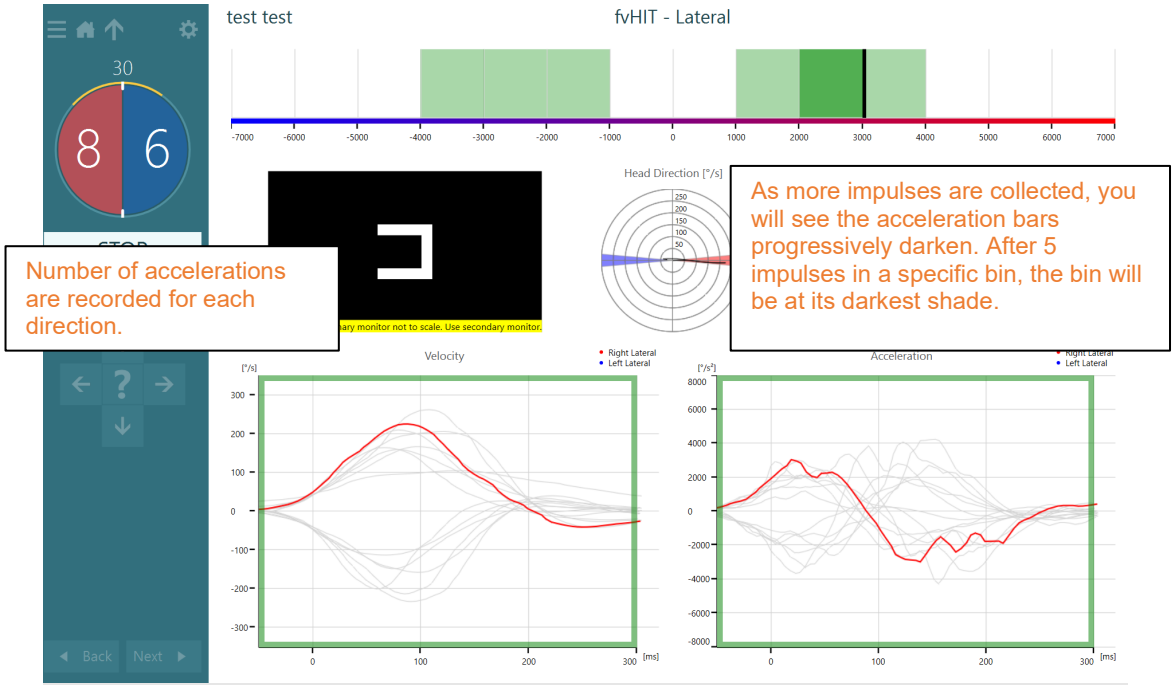


Figure 3.6-26 test progress

Summary screen
Following completion of one plane, you will see the following summary screen:

a. Acceleration and velocity graphs show raw tracings of each head movement.
b. On the right, you see two bar graphs, one that represents the percentage correct score for each acceleration bin and one that shows the number of correct responses versus total responses collected.
c. You should aim to get a total of at least 60 impulses and 5 impulses per bin. It is most important that you achieve at least 5 impulses in the middle acceleration bins (3000-6000).

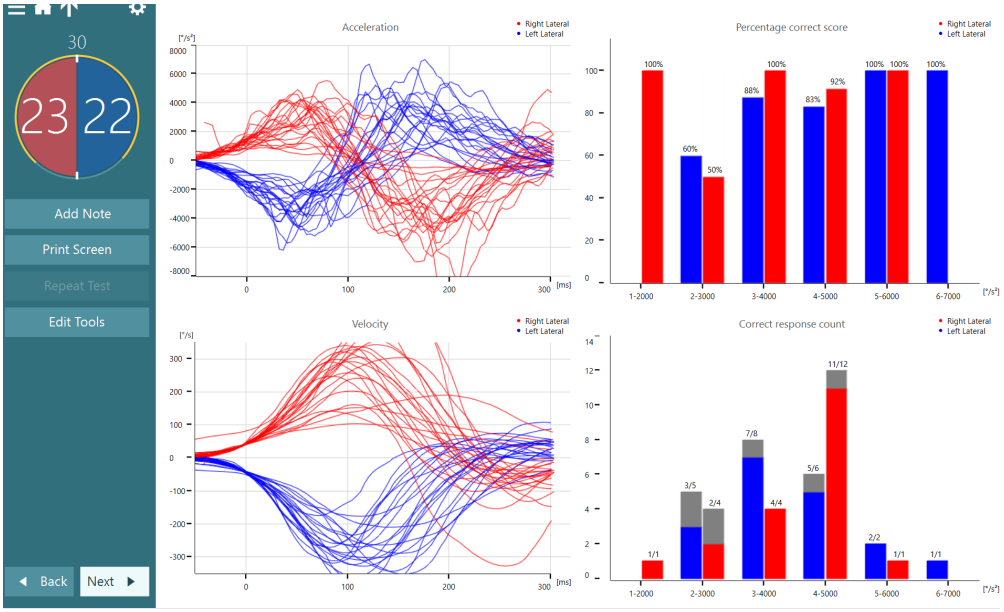


Figure 3.6-27 Impulses

If there are any artifacts, you can select edit tools, select the trace you want to remove, and click “delete”. The selected trace will be highlighted on the velocity and acceleration graphs, as well as in the bins on the right. To undo edit, press “Reset”.

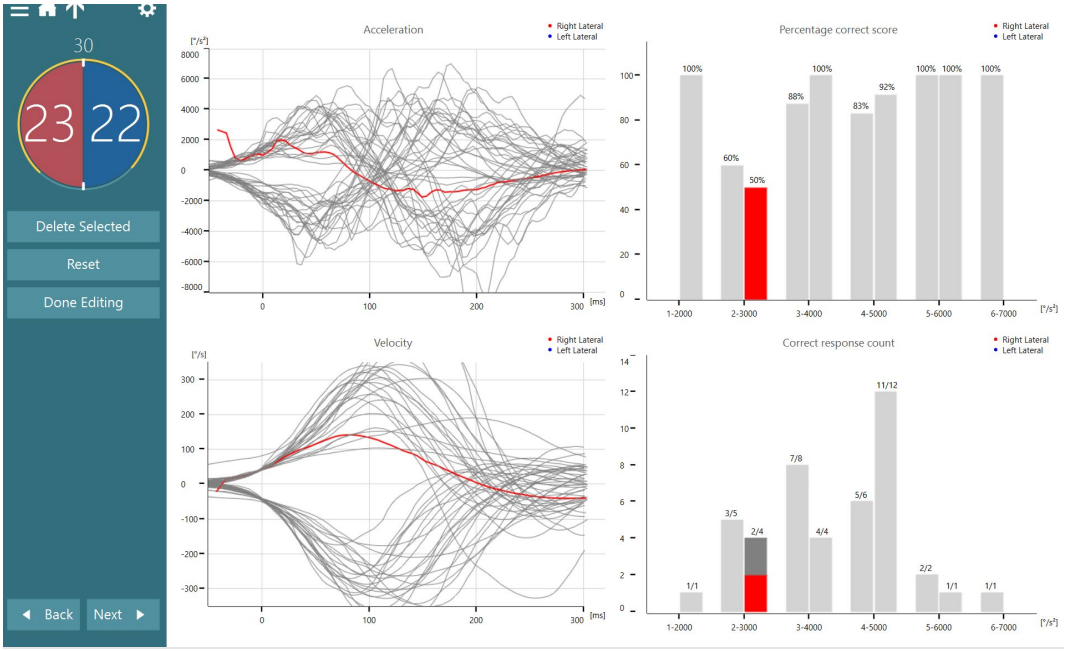


Figure 3.6-28 Edit tools

If you have completed multiple runs in the same canal plane, you have the option of which test you would like to display on the summary screen by selecting the black arrow by the appropriate canal plane name.

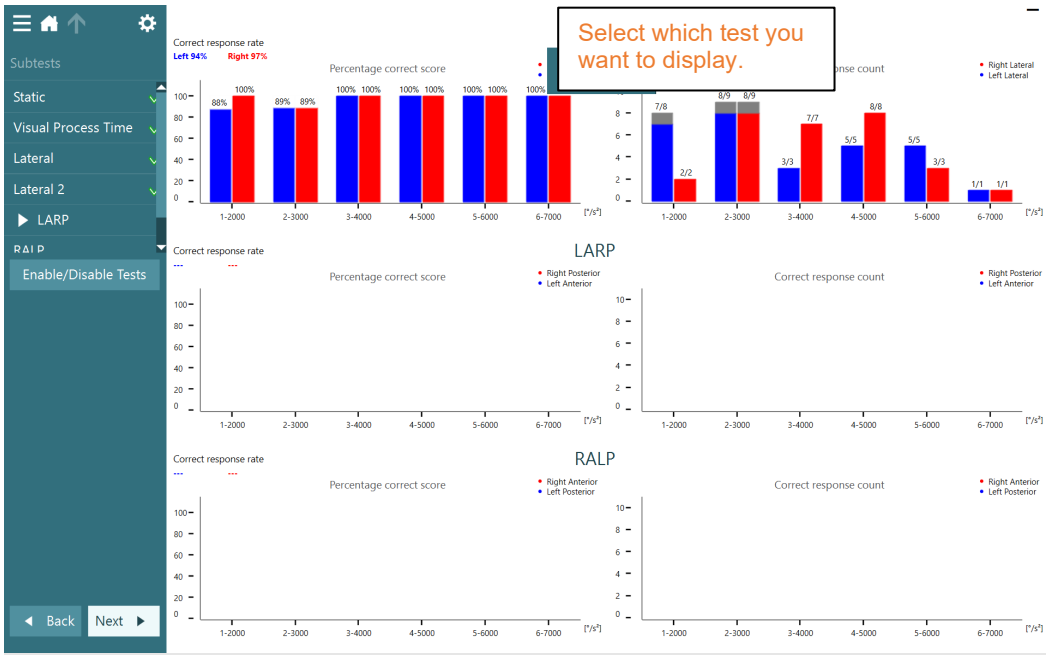


Figure 3.6-29 Option for selection of multiple runs

Following completion of all planes tested, you will see this summary. On the left side of each plane tested will be an average correct response rate which shows how well the patient did in each plane.

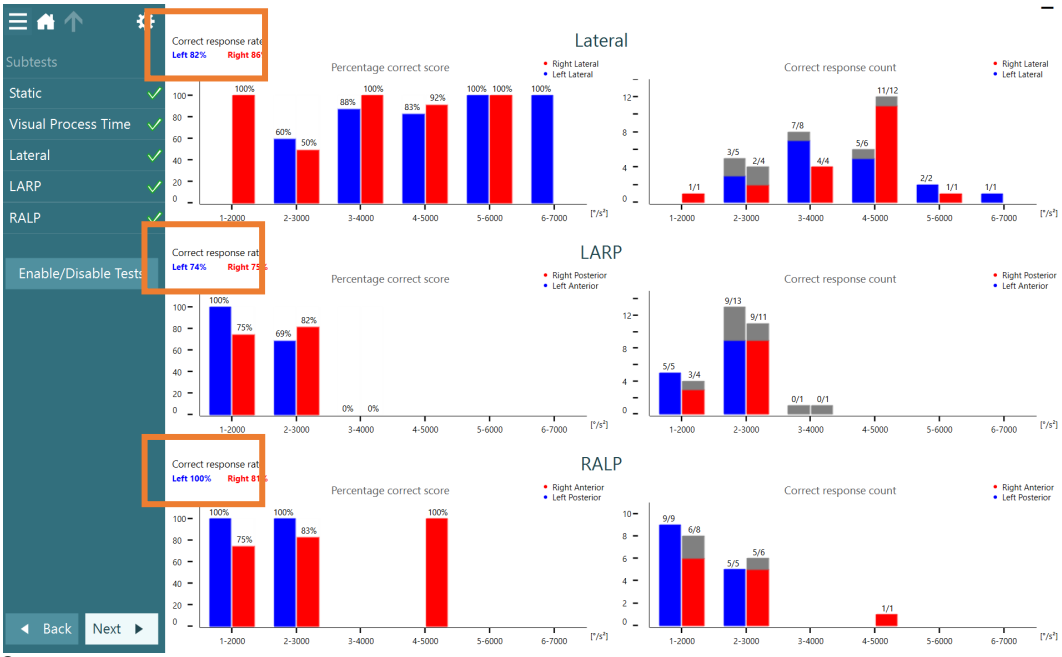


Figure 3.6-30 Summary screen

There is also an option to simplify the data on the fvHIT summary screen, which takes the 6 acceleration bins and combines them into 3 bins. The button can be found on the sidebar of the summary screen and is labeled “simplify data”.

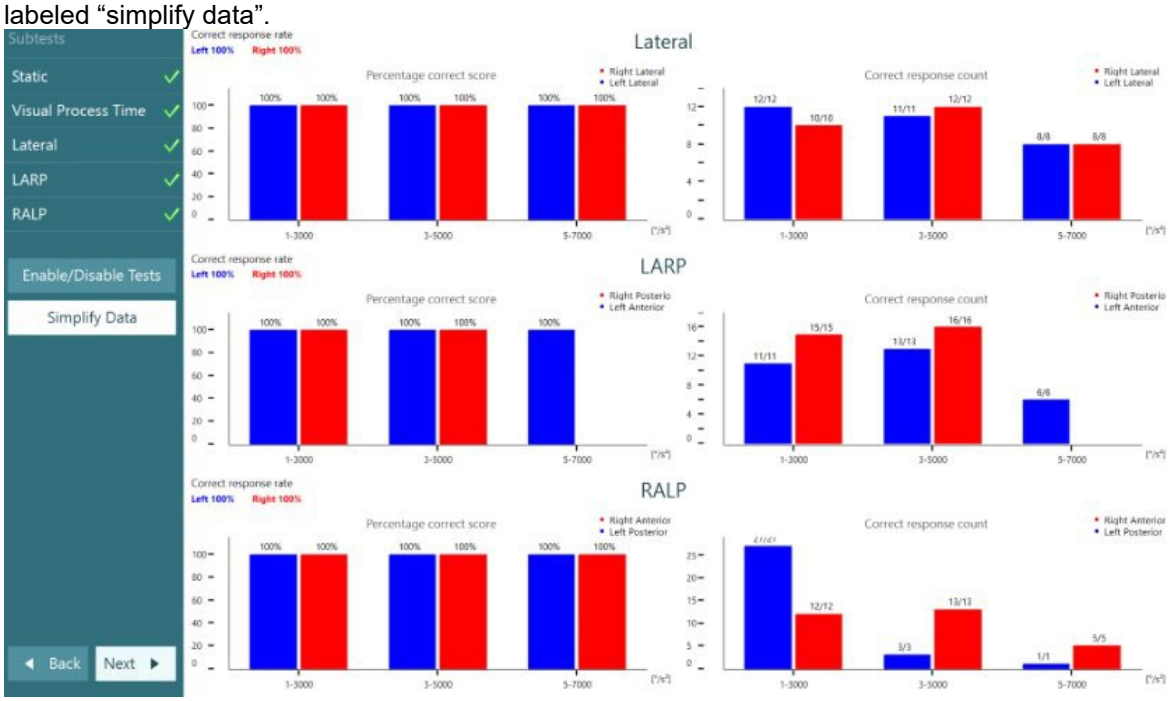


Figure 3.6-31 Simplify Data button selected on fvHIT Summary Screen

Notice that there are only 3 columns showing data for a slow (1000-2000 d/s2), medium (3000-4000 d/s2) and fast (5000-6000 d/s2) speeds. This allows the user to combine acceleration bins in the case where an optimal number of impulses were not collected in each bin. When the Simplify Data button is selected, you will see the simpler form of the data. When it is deselected, you will see a more detailed view of the data, as shown below.

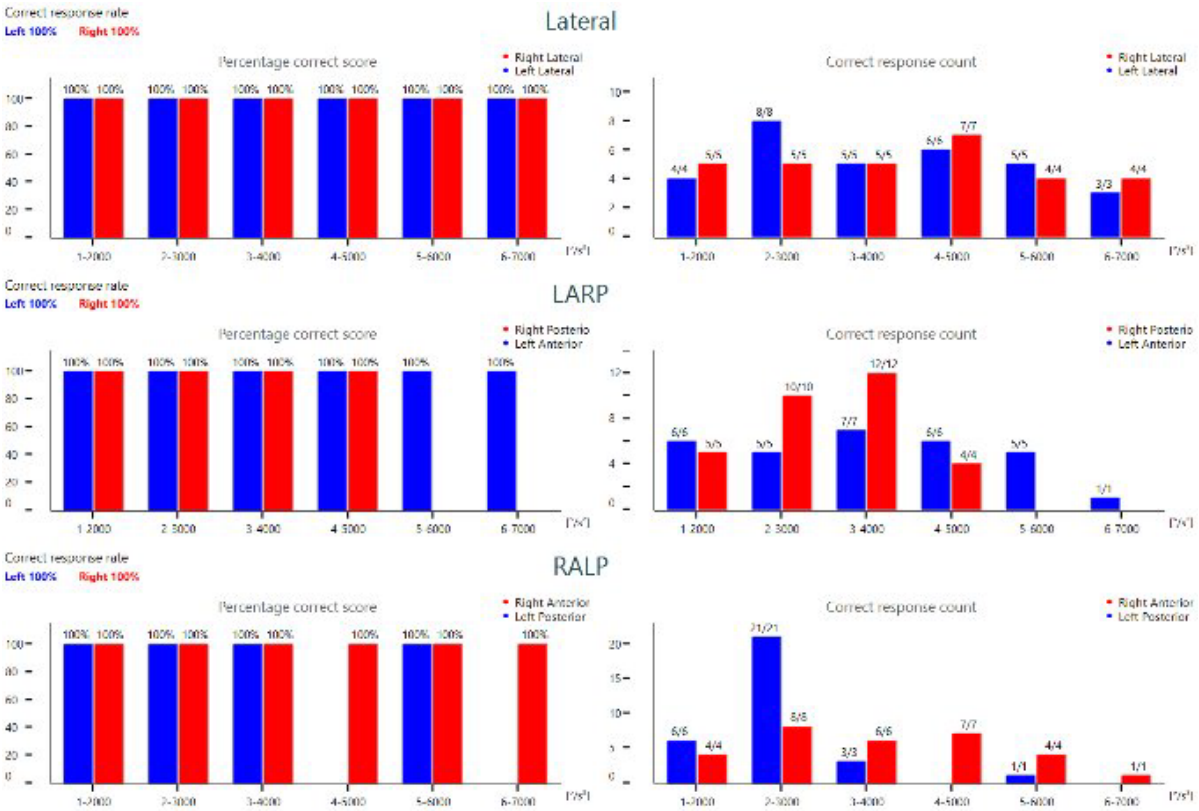


Figure 3.6-32 Example of detailed data when the Simply Data button is deseclected on fvHIT Summary Screen

3.7 Video head impulse testing (vHIT)

3.7.1 vHIT VORTEQ™

Using the top mount or side mount binocular goggles, you can perform the vHIT using the VORTEQ™ IMU sensor.

Instruct the patient to gaze at the target and keep the neck muscles relaxed. Let the patient know the head impulses will be of small amplitude so the patient can relax the neck muscles.

The vHIT VORTEQ™ tests use higher sampling rates than standard VNG tests. To accomplish this with the same cameras, the height of the eye windows is reduced to increase the temporal resolution. The eye windows are then scaled on the screen for optimal fit to maintain the video ratio.

Test type	Frame rate (Hz)	Width (pixels)	Height (pixels)	Ratio
Standard VNG Test	100	320	240	4:3
LARP / RALP vHIT	150	320	160	4:2
Lateral vHIT	250	320	80	4:1

Lateral vHIT
Perform the test by holding the patient's jaw while standing behind the patient (Figure 3.7-1). During the test, the patient's teeth should be clenched so the hand thrust will be transferred to the patient's head. Practice a few impulses before recording. This will also familiarize the patient with the stimulus. Do **not** allow the hands to touch or move the goggles during head impulses as that movement will affect the gain measurement.

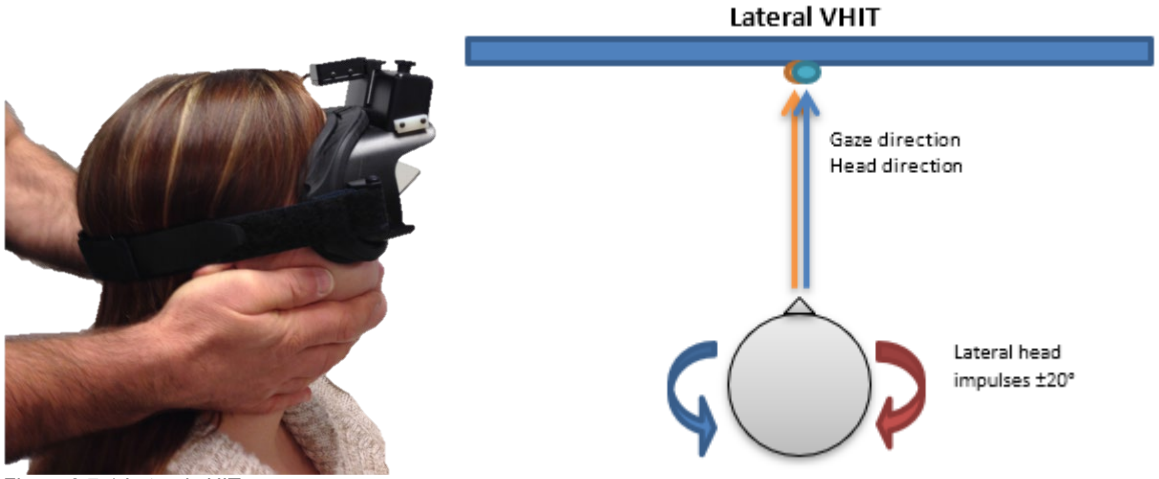


Figure 3.7-1 Lateral vHIT

Left Anterior Right Posterior (LARP) / Right Anterior Left Posterior (RALP) vHIT
The modified vHIT method allows for LARP and RALP vHIT to be performed using vertical eye tracking. Perform the test by placing both hands on top of the patient's head or by holding the patient's head with one hand on top and the other holding the chin. Administer vertical impulses with the patient's head turned to the side by 35 degrees (Figure 3.7-2). This orientation places the vertical canals in the direction of head travel producing a vertical eye movement response.

Turn the patient's head 35 degrees to the right for the LARP test and 35 degrees to the left for the RALP test (Figures 3. 7-2 and 3.7-3). The patient's gaze should be directed at the center target. Thrust the patient's head up/down 10-20 degrees.

To achieve 35 degrees, place a mark on the wall 25" / 64 cm from a center target with the patient seated 36" / 91 cm away from the center target.

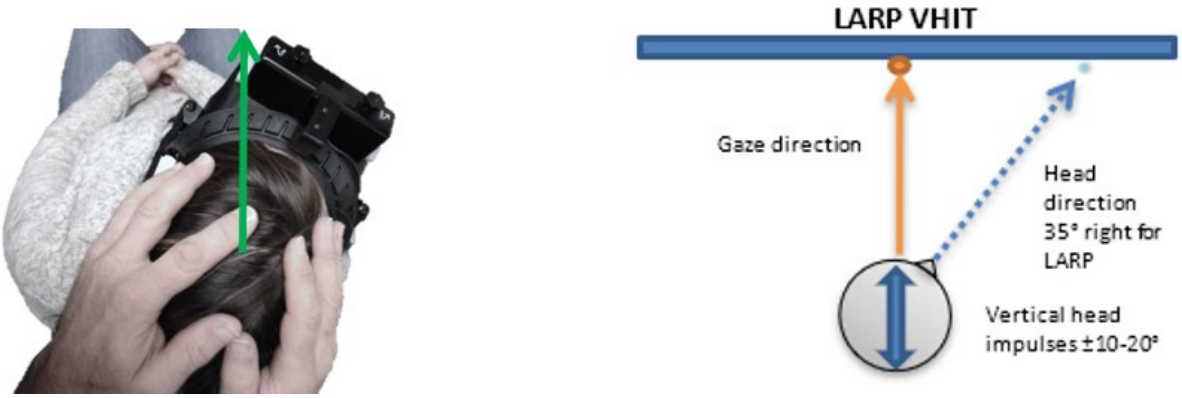


Figure 3.7-2 LARP vHIT

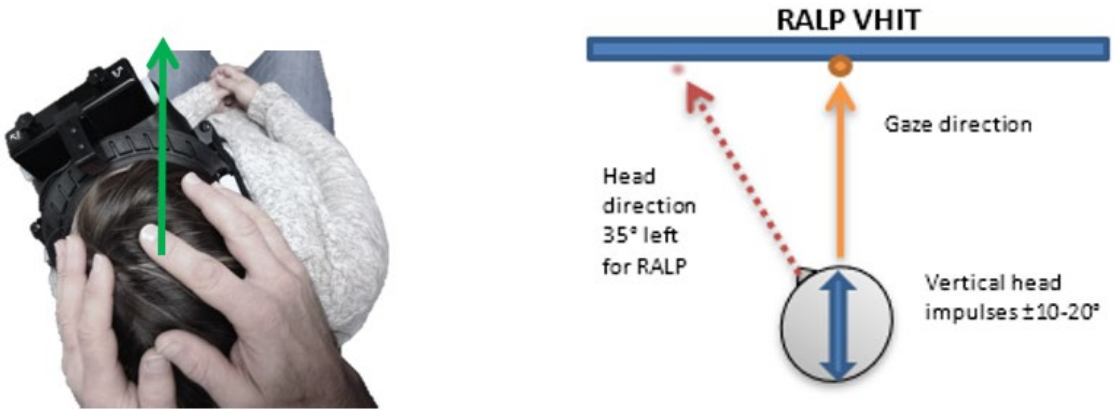


Figure 3.7-3 RALP vHIT

Performing the test

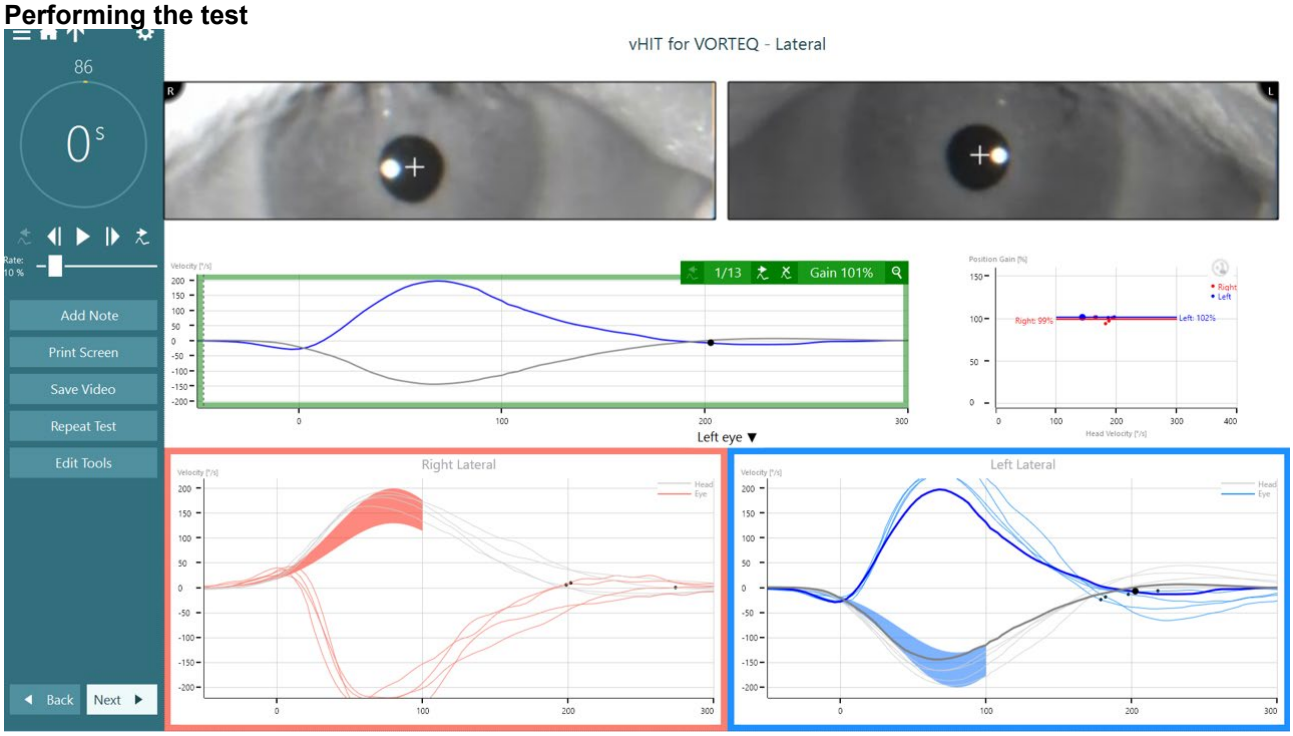


Figure 3.7-4 Reviewing the Lateral vHIT for VORTEQ™ test

During the test, the head impulses will be shown in the center of the screen as well as in the head impulse window at the bottom. Left head impulses are shown in the blue window on the right side, and right head impulses are shown in red on the left side. If the head impulse fits the swoosh pattern, the head impulse box

in the center will be outlined in green. If the head impulse is too slow, the box will be outlined in yellow. If the head impulse is performed too fast, the box is outlined in red.

Due to the speed in which the head impulse is performed, the video playback speed can be adjusted slower to better detect if saccades are present in the eye position data. The video playback speed is adjusted using the slider below the playback timer (Figure 3.7-4).

3.7.2 vHIT EyeSeeCam

Using the EyeSeeCam camera goggle, you can perform the vHIT with one camera recording either eye with minimal goggle slippage. As the clinician performs small head thrusts on the patient's head, the waveform will show the head impulse in the waveform trace window and a close-up of that head impulse below. If the head impulse and eye movement are in opposite directions and the head impulse was performed so that the impulse fell within the swoosh profile, then the software will accept the head impulse and show a green checkmark in the upper right corner of the respective head impulse window. If the head impulse failed the criteria, a red '**X'** will be displayed in the upper right corner. Accepted head impulses will increment the appropriate head impulse count in the timer on the side panel. When the accepted head impulse count reaches the defined amount (default is 7 head impulses in each direction), the test will end automatically. The clinician can also end the test manually by clicking on the STOP button.

You can perform 4 different subtests in the VisualEyes™ software including Lateral vHIT, LARP vHIT, RALP vHIT, and the SHIMP test. These tests are explained below in detail. Before starting any vHIT test using the EyeSeeCam goggle, you must have completed the standard and head calibrations. If you adjust the camera position during testing, then you must repeat the head calibration.

Standard calibration for ESC vHIT
When the user enters the test, the calibration options 'Start Calibration' and 'Head Calibration' will appear. You can also choose 'Use Default Calibration'.

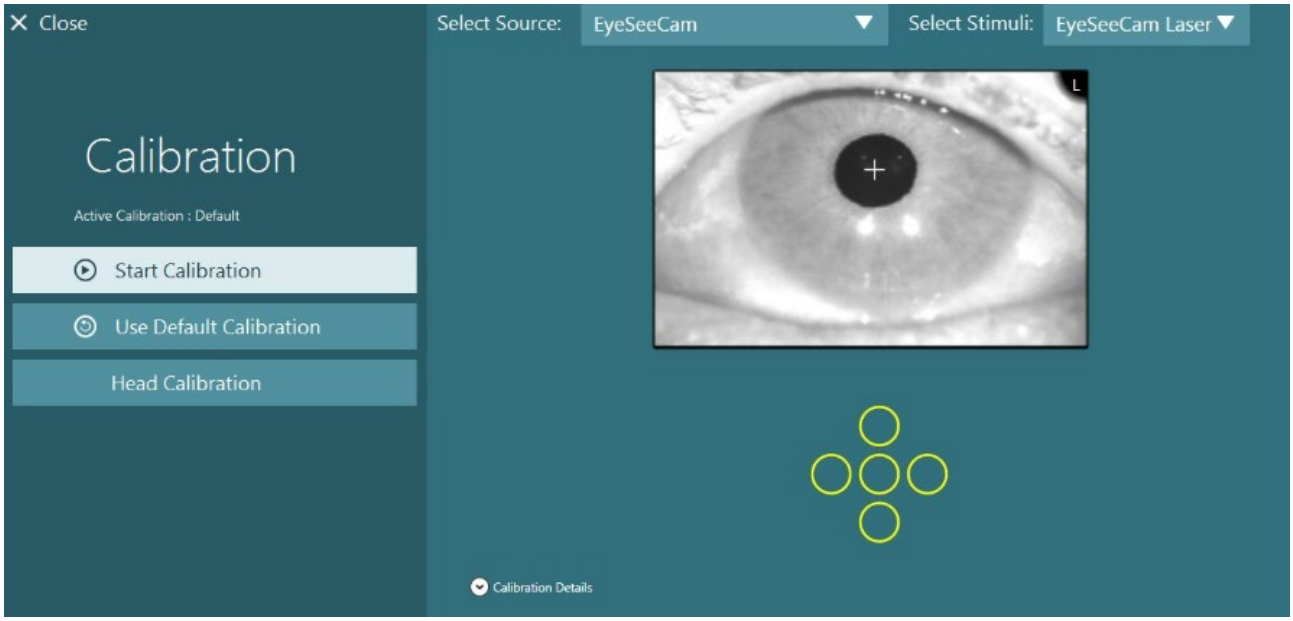


Figure 3.7-5 Standard calibration screen for ESC vHIT

Click 'Start Calibration' to do the standard 5-point calibration (Figure 3. 7-5). Refer to section 2 for details.

Once you have done the standard calibration, you can proceed to ‘Head Calibration’. Ask the patient to fixate on a point, then click ‘Head Calibration’ and ‘Start’ to start the head calibration. Ask the patient to shake his/her head slowly in a horizontal direction. When the system can track the head movement horizontally, you get a green bar in the screen. After a few seconds, the system moves to vertical calibration, and you must ask the patient to move his/her head slowly in a vertical direction. When the system can track the head movement vertically, you get a green bar in the screen. Once the calibration is done, you can get a report of the head calibration. You can now proceed with the subtest of your choice (Figure 3.7-6).

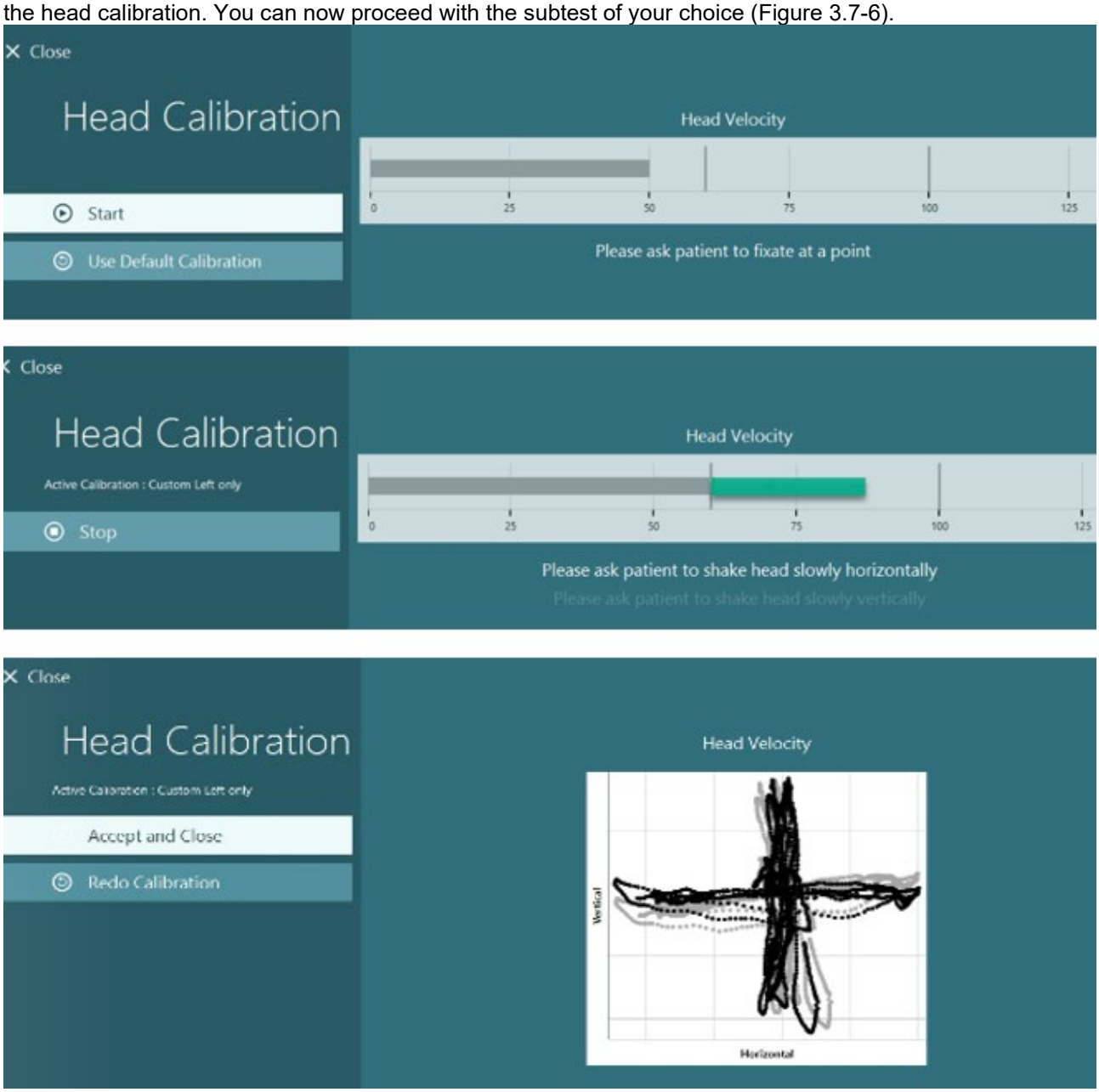


Figure 3.7-6 Head calibration procedure and result screen for ESC vHIT

Lateral vHIT

The Lateral vHIT test assesses the function of the lateral semicircular canals. For this test, hold the patient’s jaw while standing behind the patient (Figure 3.7-7). During the test, the patient’s teeth should be clenched so the hand thrust will be transferred to the patient’s head. Practice a few impulses before beginning the recording. This will also familiarize the patient with the stimulus. Do **not** allow the hands to touch or move the goggles during head impulses as that movement will affect the gain measurement.



Figure 3.7-7 Lateral vHIT hand placement

Left Anterior Right Posterior (LARP) / Right Anterior Left Posterior (RALP) vHIT

The LARP and RALP tests assess the function of the vertical semicircular canals. Rotate the patient's head right-downward to left-upward in the plane of the RALP canals or left-downward to right-upward in the plane of the LARP canals. Alternatively, you can rotate the patient's head 45 degrees to the right for LARP testing and 45 degrees to the left for RALP testing (Figure 3.7-8). The patient must always gaze straight ahead.

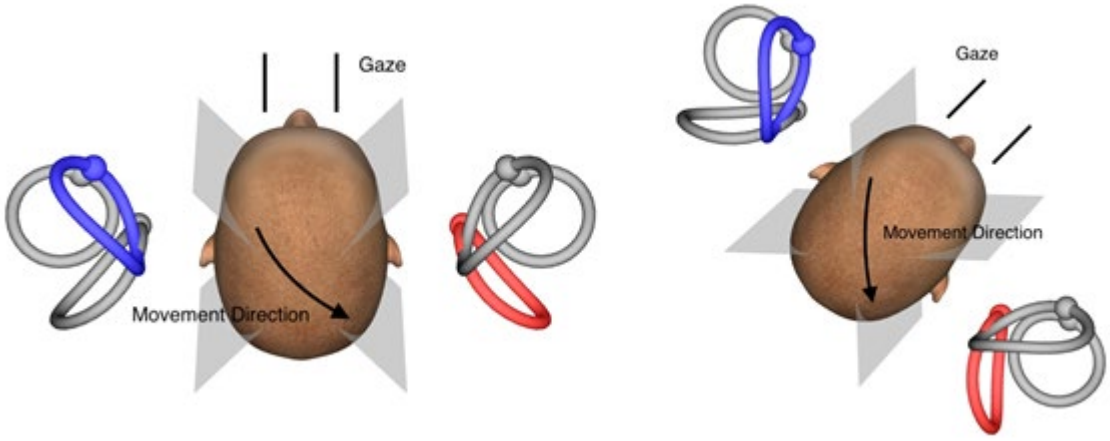


Figure 3.7-8 vHIT testing with head-on gaze and corrected straight gaze in LARP testing

Performing the test

A three-dimensional head model with the semicircular canals (Figure 3.7-9) is displayed in the upper right corner of the screen. The EyeSeeCam head sensor will automatically reset if the sensor is left still. At the start of the test, have the patient look straight ahead and keep the head still. The EyeSeeCam head sensor will then activate, and the head model should appear looking forward. As you perform the head impulses, the activated semicircular canal pair are highlighted in blue and red depending on the direction of the impulse.

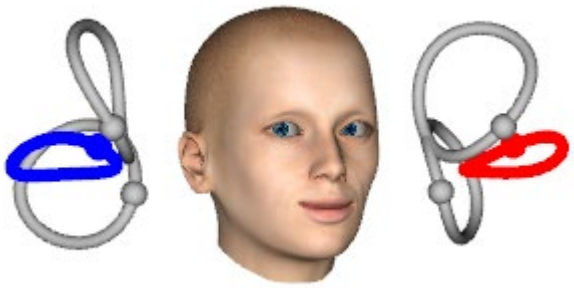


Figure 3.7-9 Head model with highlighted semicircular canals

When you perform the head impulse, the software will display the head and eye movements in the appropriate impulse graph depending on the impulse direction. If the head movement fits the swoosh velocity profile, the head impulse will be accepted and show a green check mark in the upper right corner of the impulse graph (Figure 3.7-10). Rejected head impulses will display a red x in the upper right corner.

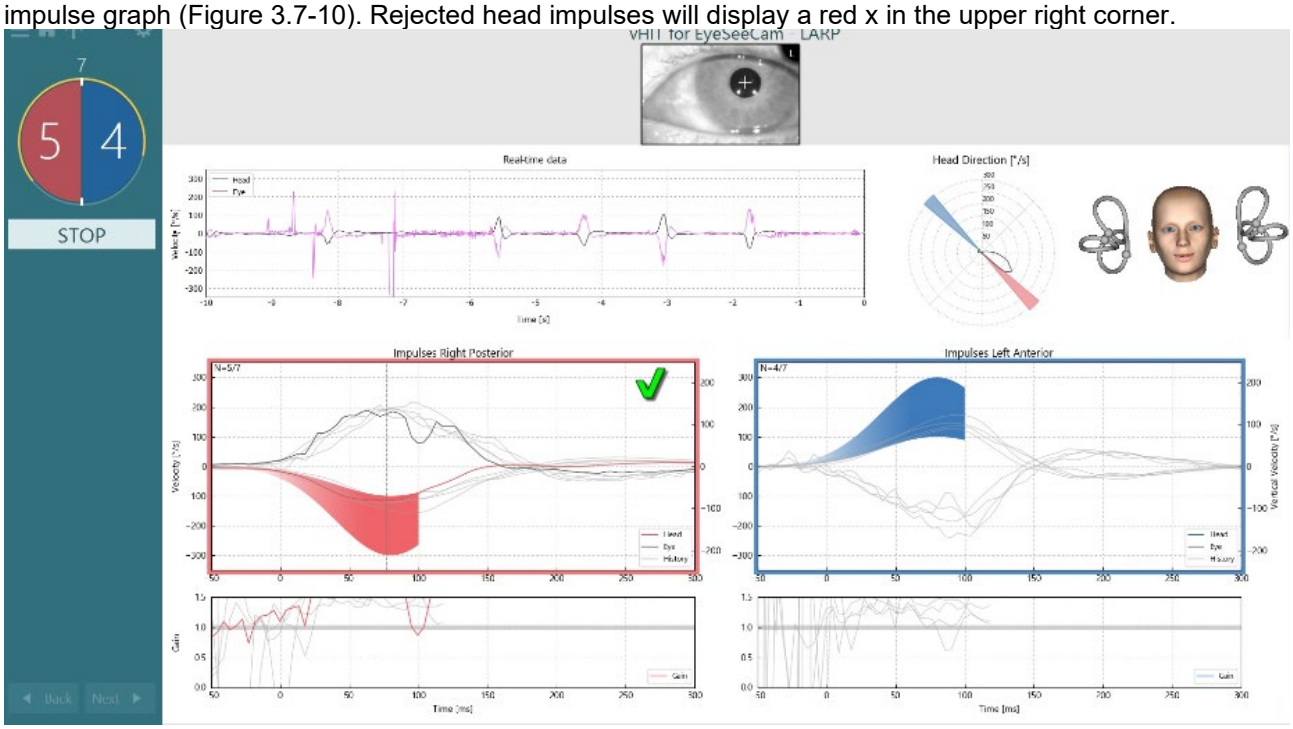


Figure 3.7-10 Example of EyeSeeCam test showing a green checkmark (LARP)

The test will end automatically once you have performed the required number of successful head impulses in both directions. The timer is replaced with the head impulse counter, which separates the head impulses according to direction. You can stop the test at any time using either the Enter key on the RF remote, the STOP button on the screen.

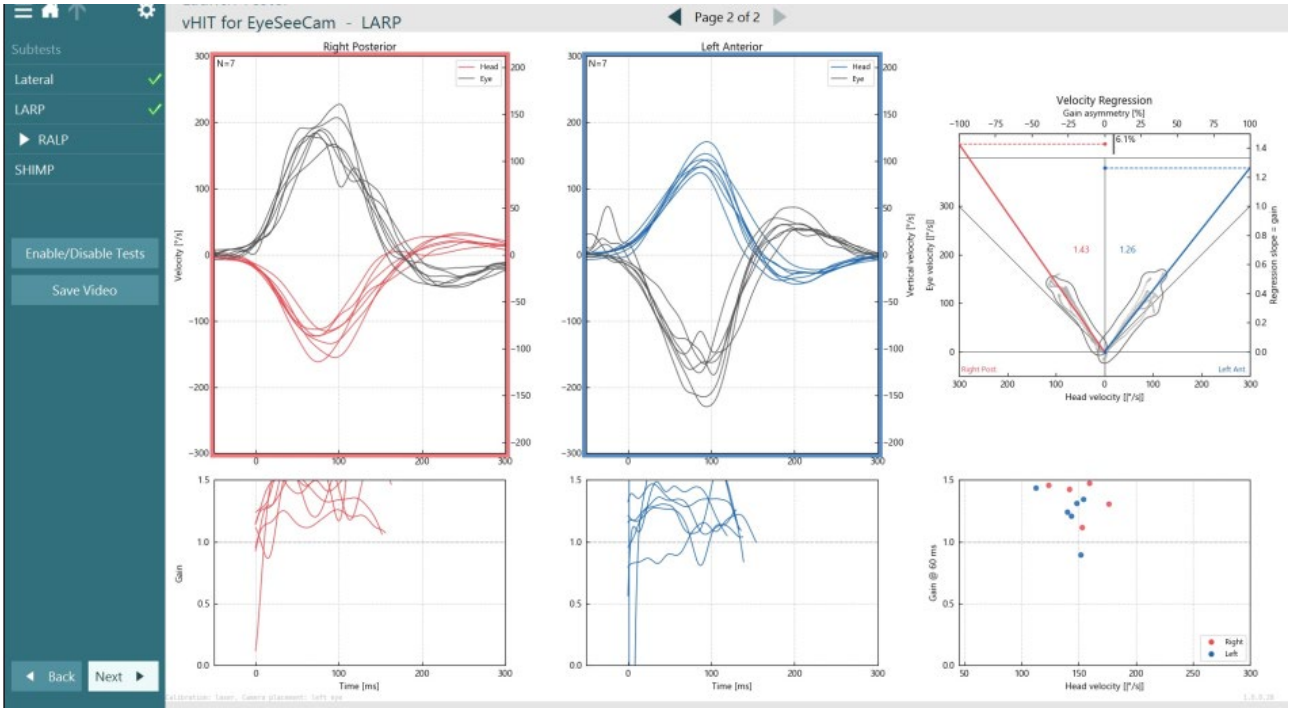


Figure 3.7-11 vHIT EyeSeeCam analysis

As you perform each subtest, the software displays each subtest's analysis on a separate page (Figure 3.7-11). The analysis displayed is defined by the page navigation at the top of the screen. Once you have performed the Lateral, LARP, and RALP tests, you can create the EyeSeeSix report from the summary's side panel. If you wish to repeat a subtest, select it from the combo boxes at the top of the EyeSeeSix report (Figure 3.7-12).

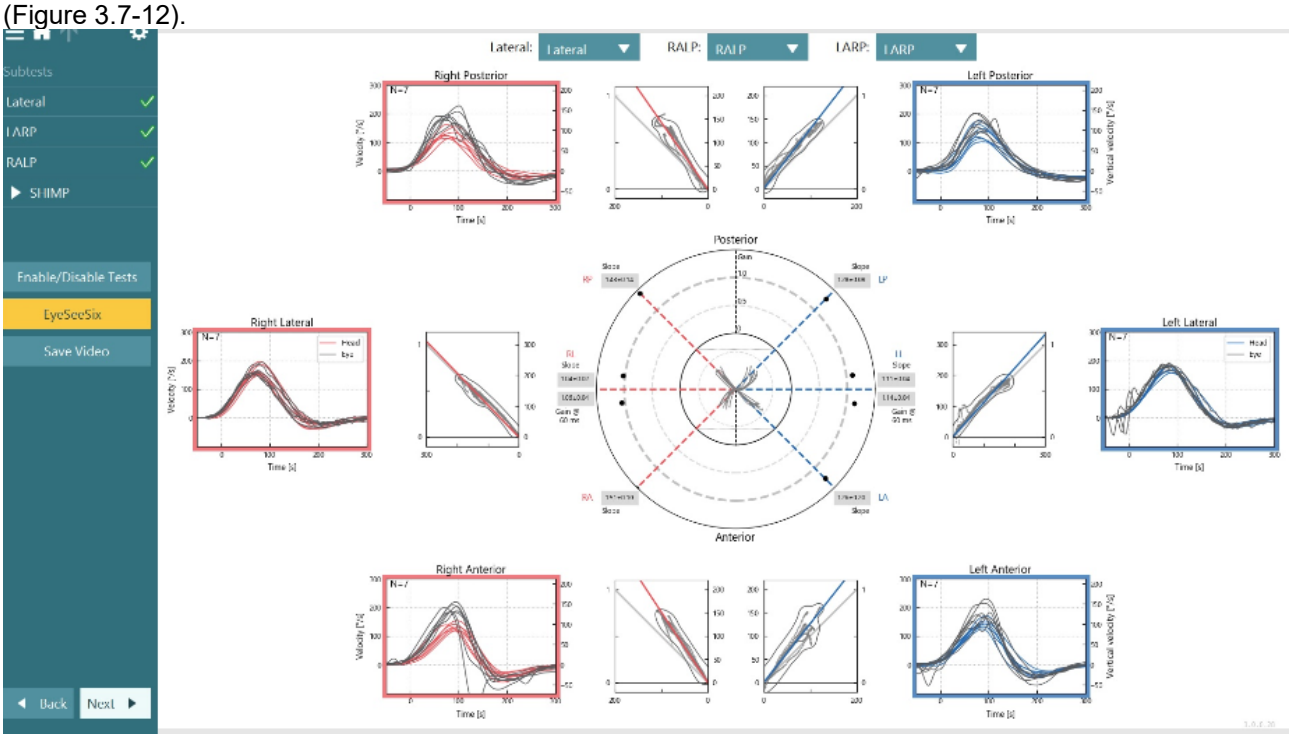


Figure 3.7-12 vHIT EyeSeeSix report

To view the information in a table, click on the Numerical Results button (Figure 3.7-13). You can copy the text (click and drag or by using Ctrl + A on the keyboard) and past it into Excel or other spreadsheet software.

Summary

Velocity Gain

	Right				Left			
	mean	std	median	iqr	mean	std	median	iqr
Gain @ 40 ms	0.75	0.05	0.75	0.06	0.96	0.08	0.96	0.12
Gain @ 60 ms	0.83	0.04	0.83	0.06	1.01	0.05	1.01	0.07
Gain @ 80 ms	0.90	0.05	0.90	0.07	1.02	0.02	1.02	0.02
Median 0-100 ms	0.80	0.05	0.80	0.07	1.02	0.07	1.02	0.10
Regression	0.86	0.03	0.86	0.05	1.03	0.04	1.03	0.06

Saccades

	Right			Left		
	1st Saccade	2nd Saccade	3rd Saccade	1st Saccade	2nd Saccade	3rd Saccade
Amplitude [°]	14.99 ± 000.92	-	-	13.58 ± 000.52	7.24 ± 002.52	-
Peak Velocity [°/s]	142.23 ± 004.12	-	-	136.61 ± 016.03	243.53 ± 050.31	-
Duration [ms]	185.50 ± 010.50	-	-	168.00 ± 011.00	83.00 ± 008.00	-
Latency [ms]	8.50 ± 010.50	-	-	22.00 ± 003.00	579.00 ± 024.00	-
Total	2	0	0	2	2	0

Data

Saccade Parameters

	Head Impulse			1st Saccade				2nd Saccade				3rd Saccade			
	Direction	Peak Time [ms]	Peak Velocity [°/s]	Amplitude [°]	Peak Velocity [°/s]	Duration [ms]	Latency [ms]	Amplitude [°]	Peak Velocity [°/s]	Duration [ms]	Latency [ms]	Amplitude [°]	Peak Velocity [°/s]	Duration [ms]	Latency [ms]
1	right	74.00	189.40	14.07	146.35	175.00	-2.00	-	-	-	-	-	-	-	-
2	left	95.00	190.06	14.10	152.64	157.00	25.00	9.76	293.84	91.00	603.00	-	-	-	-
3	right	92.00	197.11	15.90	138.10	196.00	19.00	-	-	-	-	-	-	-	-
4	left	79.00	160.99	13.07	120.58	179.00	19.00	4.72	193.23	75.00	555.00	-	-	-	-

Figure 3.7-13 Numerical results

Clicking on the 3D Waves button will toggle the display of the waveforms in 3D space (Figure 3.7-14).

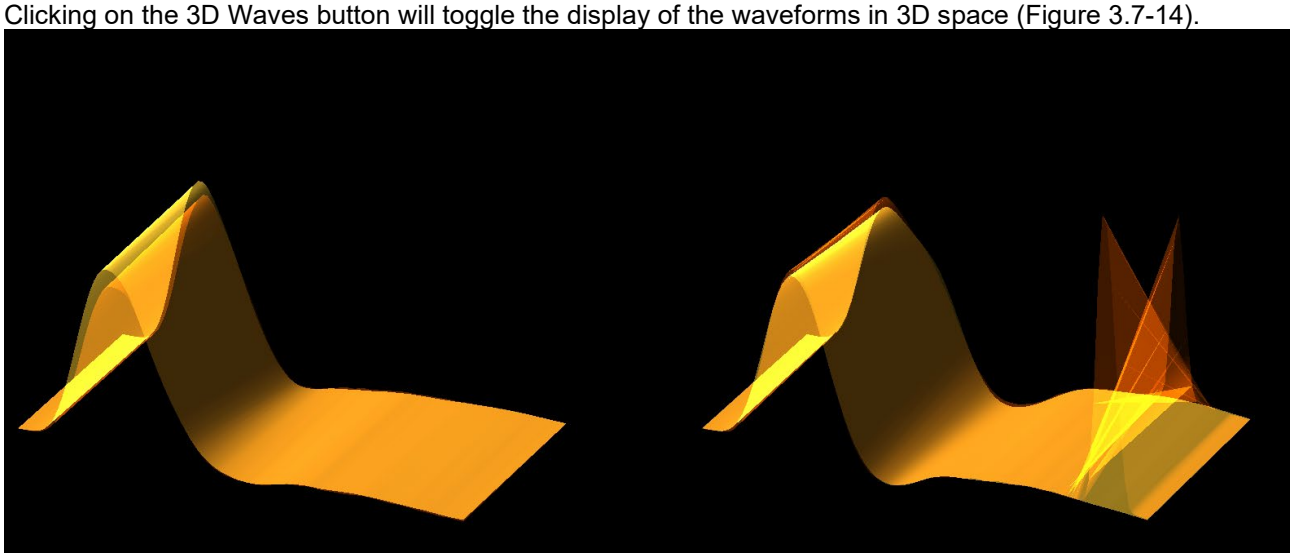


Figure 3.7-14 Eye movements rendered in 3D space

Suppression head impulse (SHIMP) test

Along with the vHIT, the SHIMP test helps you to determine residual vestibular function. This test resembles the lateral vHIT test and assesses the lateral semicircular canals. A laser target is used as the suppression medium for the SHIMP test.

Place the vHIT goggle on the patient head as in other vHIT tests. Center the eye in the viewing area and make sure that the reflections are beneath the pupil. After adjusting the patient, calibrating, and centering the laser fixed dots on the wall, you are ready to begin the SHIMP test.

Test preparation:

The head-fixed laser projects a 5-dot pattern on the wall as used for calibration. Instruct the patient to focus on the center dot for fixation and align it to the wall-fixed dot (for traditional vHIT testing). SHIMPs are performed on the lateral canal by turning the head 7 – 25 (depends on preset numbers) times at high velocities to the left and right sides.

Performing test:

1. Have the patient relax his/her neck, open his/her eyes wide, and fixate on the center dot in the 5-dot pattern.
2. Turn the patient's head to the right or the left. The 5-dot laser pattern will move with the head, so they are now located in a new position.
3. Instruct the patient to keep his/her eye on the center dot. When the head moves, the eyes should be focused on the newly positioned center laser dot.

The VOR gains should be similar in the vHIT and SHIMP tests. However, the pattern of saccades generated is different. vHIT rarely generates compensatory saccades in normal patients. In SHIMP testing, healthy subjects will make a large anti-compensatory saccade at the end of the head turn. This is referred to as a "SHIMP saccade". This pattern is exactly opposite for impaired patients. An impaired VOR system will lead to a catch-up saccade on the vHIT but no (or very few) compensatory SHIMP saccades. Sample test and result screens are provided below (Figure 3.7-15 and Figure 3.7-16).

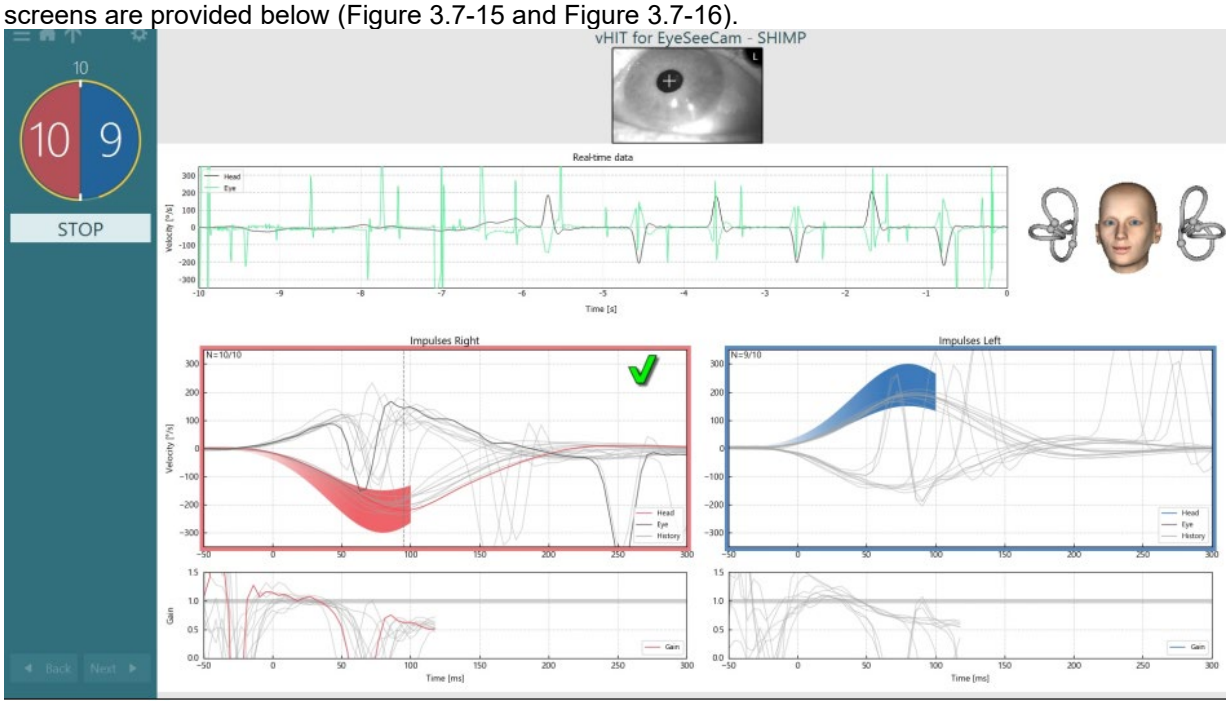


Figure 3.7-15 Test screen for SHIMP test

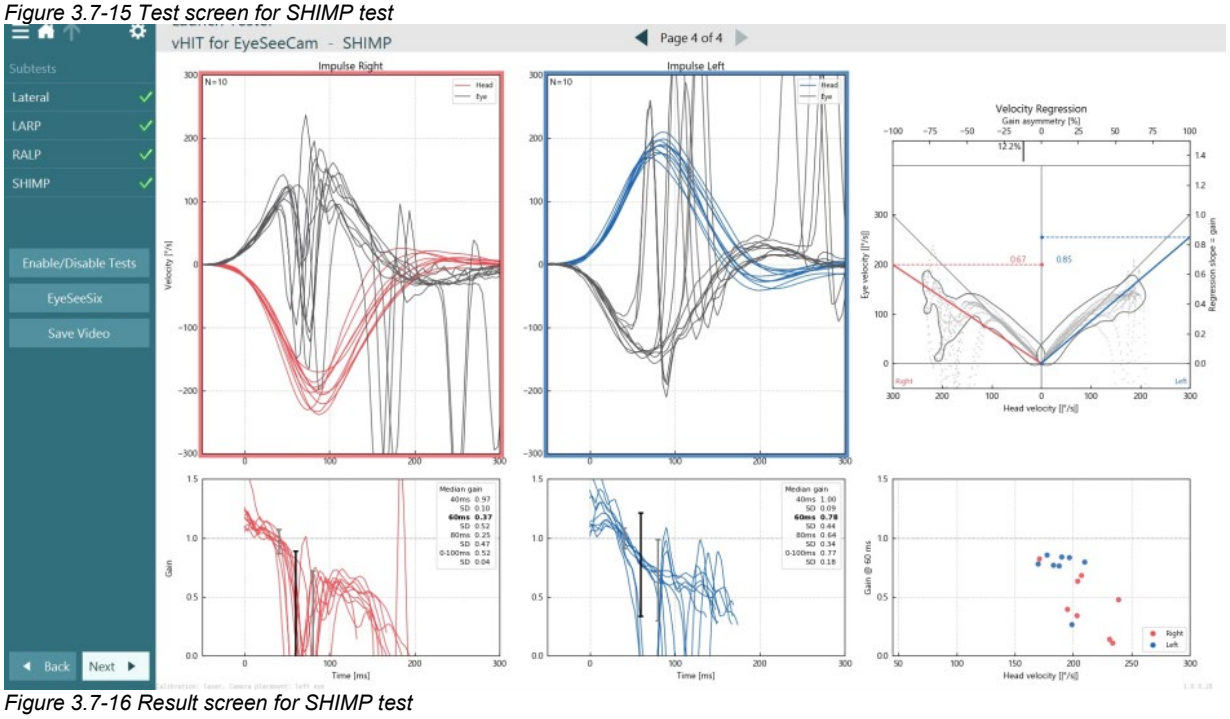


Figure 3.7-16 Result screen for SHIMP test

3.8 Ocular counter roll

The ocular counter roll test acquires torsional eye movement data while rolling the patient's head into specific positions. Note that the ocular counter roll test is contraindicated in persons with head or neck trauma.

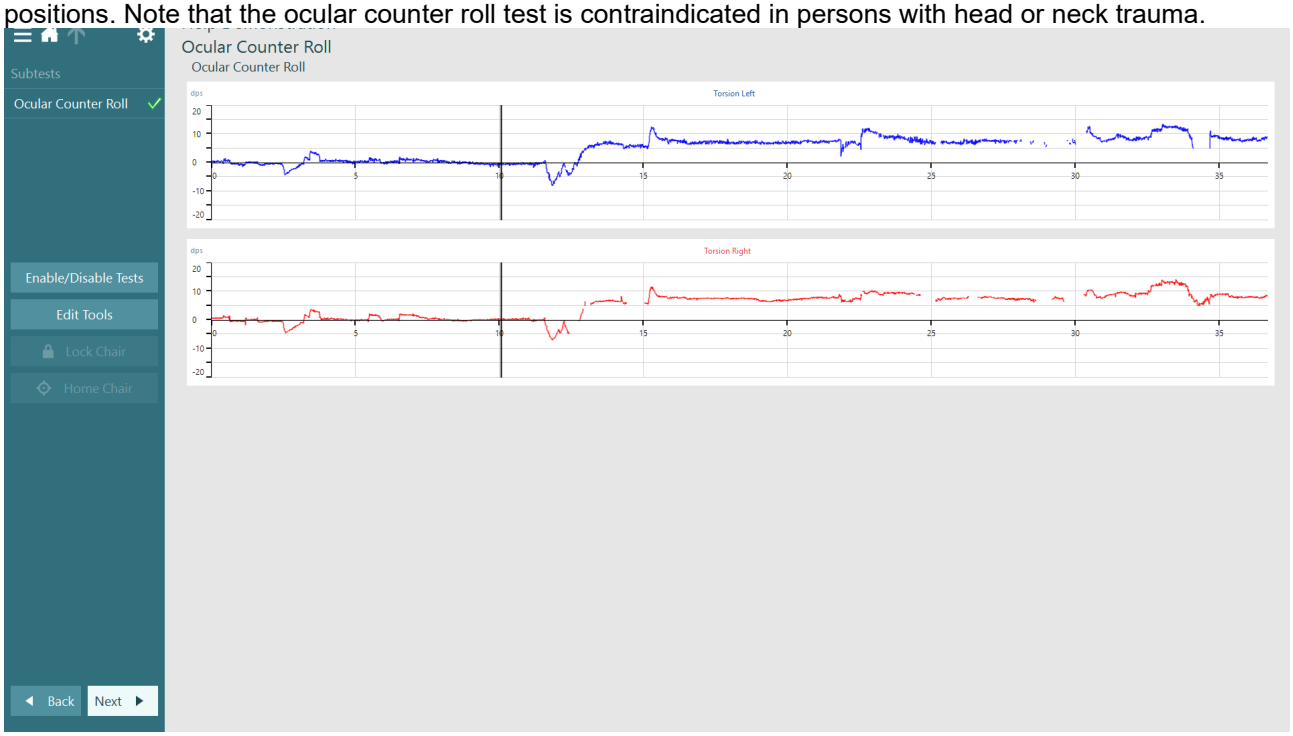


Figure 3.8-1 Ocular Counter Roll summary screen

Repeat tests are displayed sequentially in the summary screen (Figure 3.8-1). This test is configured to have three sections to test the patient with the head in the center, left, and right positions. You can modify these settings from the Temporary Settings screen.

The start button will be disabled if the patient's iris and eye diameters have not been defined from the Calibration screen. Once the test starts, the software will record the torsion angle displayed in separate trace windows. The patient will roll his/her head into the different positions according to your directions. The testing section is completed when the time has elapsed, or if you end the section early by pressing the Enter key on the RF remote or clicking on the Continue button on the test screen. The end of the section will be shown with a black vertical line and the name of the section will be displayed beside it.

During the ocular counter roll test (Figure 3.8-2), the software may not accurately be able to determine the torsion angle of the eye. In this case, the software will leave a blank space in the data trace indicating the gap in data. The video of the eye will show the larger torsion crosshair and outline of the iris when the torsion angle was calculated.

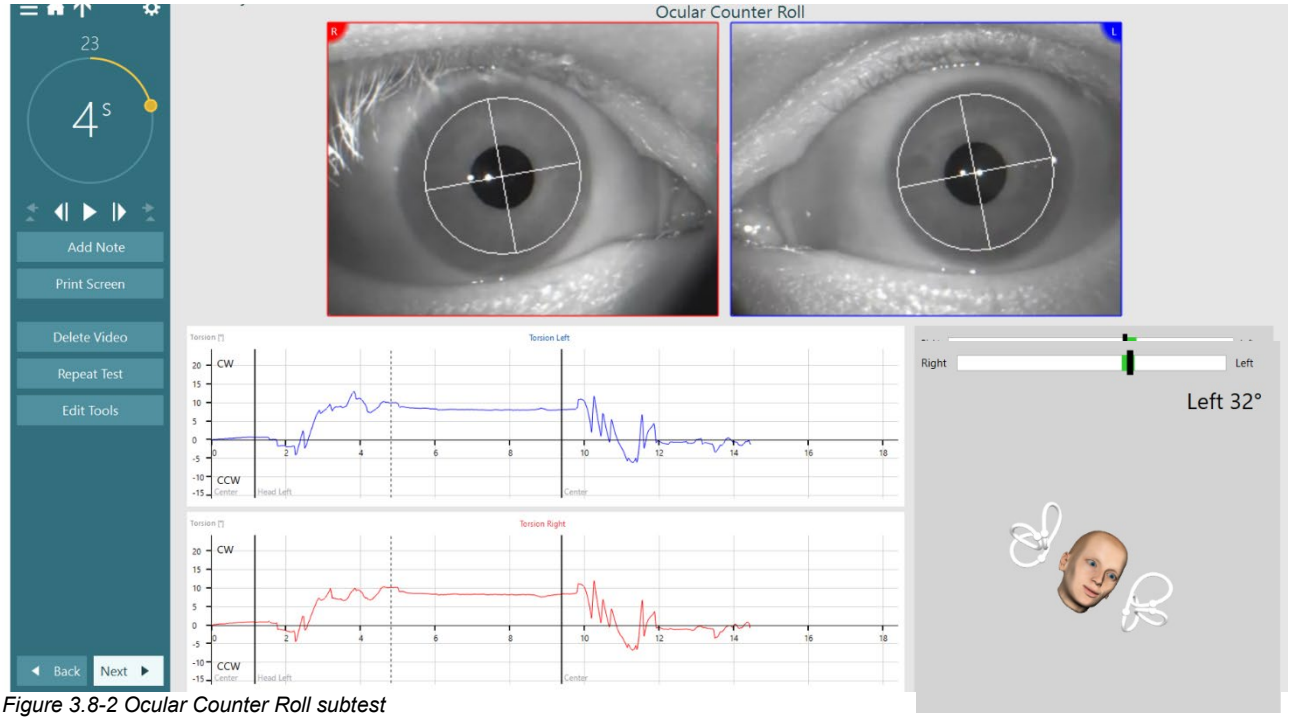


Figure 3.8-2 Ocular Counter Roll subtest

When reviewing the ocular counter roll test, click on Edit Tools to access the Add Marker and Remove Marker tools. Use the Add Marker tool and click on the waveform at the point of interest to display the current torsion angle. For more information on marking, see section 7.11.

When you print the test results, the printout will include the waveform and any markers (Figure 3.8-3). The section name will be shown above the selected trace.

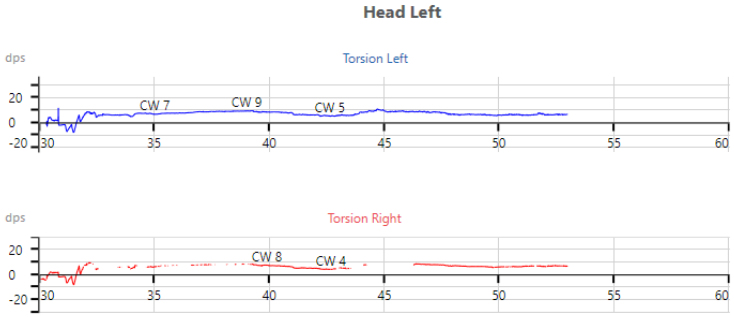


Figure 3.8-3 Ocular Counter Roll print layout

3.9 Caloric testing

The caloric irrigation test acquires eye movement data during direct stimulation of the vestibular end organ using an air or water irrigator to provide a temperature-controlled stimulus. Recorded data is analyzed for slow phase velocity and frequency of nystagmus beating and is displayed in various standard diagrams. Caloric testing is available in both VisualEyes™ 515 and VisualEyes™ 525.

Note: The user can get 3D head model support if they use VORTEQ™ IMU for testing (Figure 1.177-).

Please note that caloric testing is contraindicated in persons exhibiting the following:

- History of hypertension (uncontrolled, acute, or de-compensated phase)
- History of cardiac problems (arrhythmias especially bradycardia or Stokes-Adams attack; acute or de-compensated phase) e.g. if someone has unstable angina, a recent myocardial infarction (within last 3-6 months), or is undergoing cardiac investigations
- Psychotic/neurotic disorders (acute or de-compensated phase)
- Epilepsy (acute or de-compensated phase)
- Eye surgery (within the previous 3 months)
- Ear surgery (within the previous 6 months)
- Perforated eardrum (water stimulation is not allowed; air stimulation may be tolerated)

The caloric test will connect with the AirFx air caloric irrigator or Aqua Stim water caloric irrigator based on the test configuration. If you use a third-party caloric irrigator, you will have to configure the test for a manual irrigator setup where you run the irrigator independent of the software. In either case you should turn on the caloric irrigator before starting the test.

The default caloric test will start with the right warm subtest

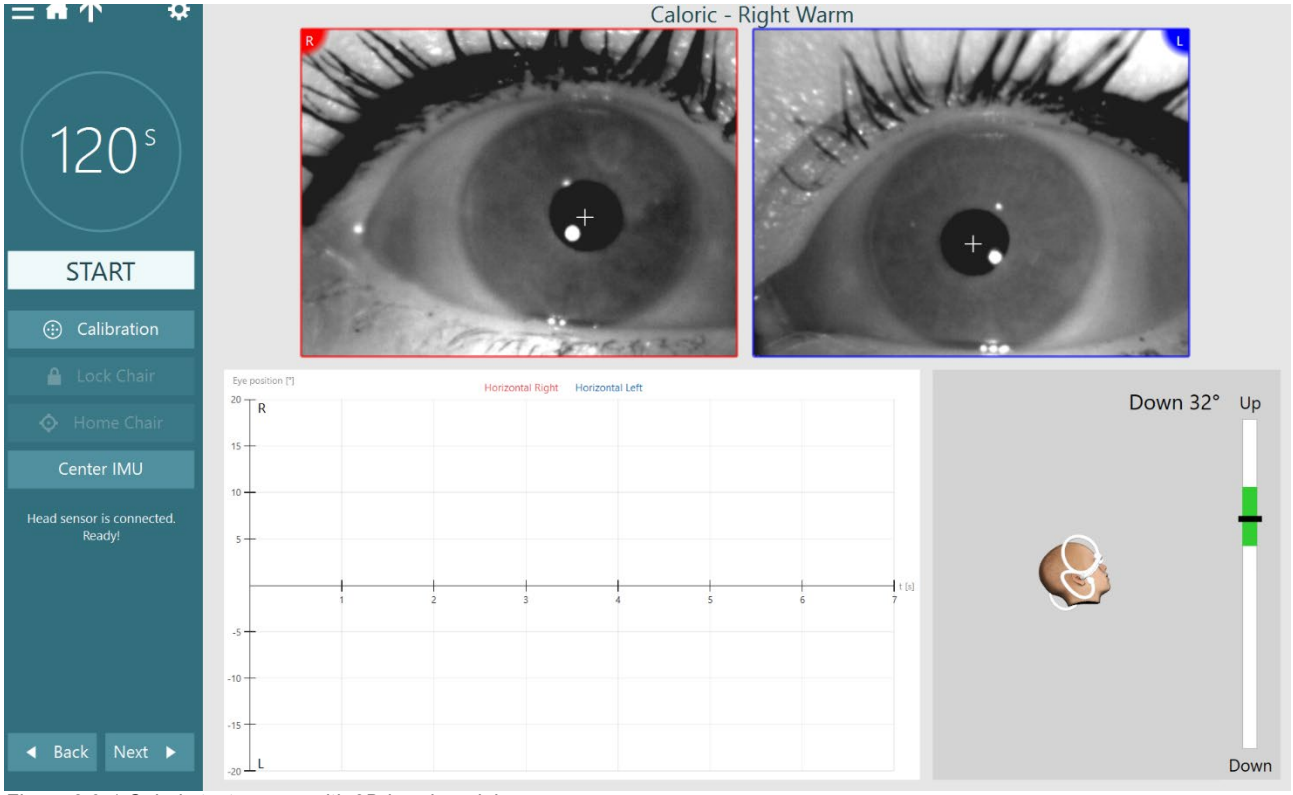


Figure 3.9-1 Caloric test screen with 3D head model

Note: When the irrigator is preparing the clinician can leave the test page to work with other activities inside the software and can return to the test page without interrupting the irrigator preparation. But if you exit the software or start another non-caloric test or 10 min of time passes, then the irrigator will shut off.

The connected irrigator should begin to warm up to the specific temperature as defined in the test settings. For third-party irrigators, turn on the irrigator and have it reach the warm temperature setting. When the irrigator is ready to dispense the warm water or air, the Start button will become available.

When the test is ready to begin, use the button on the AirFx or Aqua Stim handle to begin the irrigation and start recording in the software. For third-party irrigators, start the test using the RF remote or foot pedal and then begin irrigation. As the irrigation proceeds, the software will record the patient's eye movements. As the nystagmus beats are detected, the software will calculate the slow phase velocity for the beats and display the velocity in the Pod View graph on the right side of the screen. The average slow phase velocity (a. SPV)

will be calculated based on the peak response window settings (by default 10 seconds). As with nystagmus tests, the software will display triangles on the waveform indicating left beating or right beating nystagmus.

If you need to abort the irrigation, remove the speculum or silicone tube from the ear and direct the stimulus flow elsewhere. The irrigator stimulus flow will continue until the pre-selected irrigation time has elapsed, at which time an indicator tone will sound, and the irrigation will stop. Alternatively, press and hold the irrigator button for three seconds to abort the irrigation. A message will be displayed on the computer test screen asking, “Are you sure you want to stop?”. Click or touch ‘yes’ to stop recording. Click or touch ‘no’ to continue recording.

After the irrigation has completed, remove the irrigator handle from the patient’s side and have the patient begin alerting tasks to stay focused during the test and provide a stronger nystagmus response. As the patient continues alerting tasks, the patient’s a. SPV will rise. Once the a. SPV begins to drop by 10% of the maximum value, the fixation light will switch on inside the goggle. If the patient’s maximum a. SPV value is too low (such as with cool air calorics), the software may not detect the drop in the response, so you must watch the Pod View and intercede with activating the fixation light (using the Fixation button on the RF remote or the Fixation button on the screen). The fixation light will turn off after 10 seconds if activated automatically. Otherwise, you must turn off the fixation light manually after 10 seconds. This will allow the software to calculate the fixation index value. After the fixation light is turned off, the remaining nystagmus will still be tracked and recorded for post-fixation information.

When the test is completed (Figure 3.9-), the software will either highlight the slow phase portions of the waveform in green or leave the triangles depending on the System Default Settings. The peak response window will be displayed in the Pod View with a small, dashed box in a light blue color.

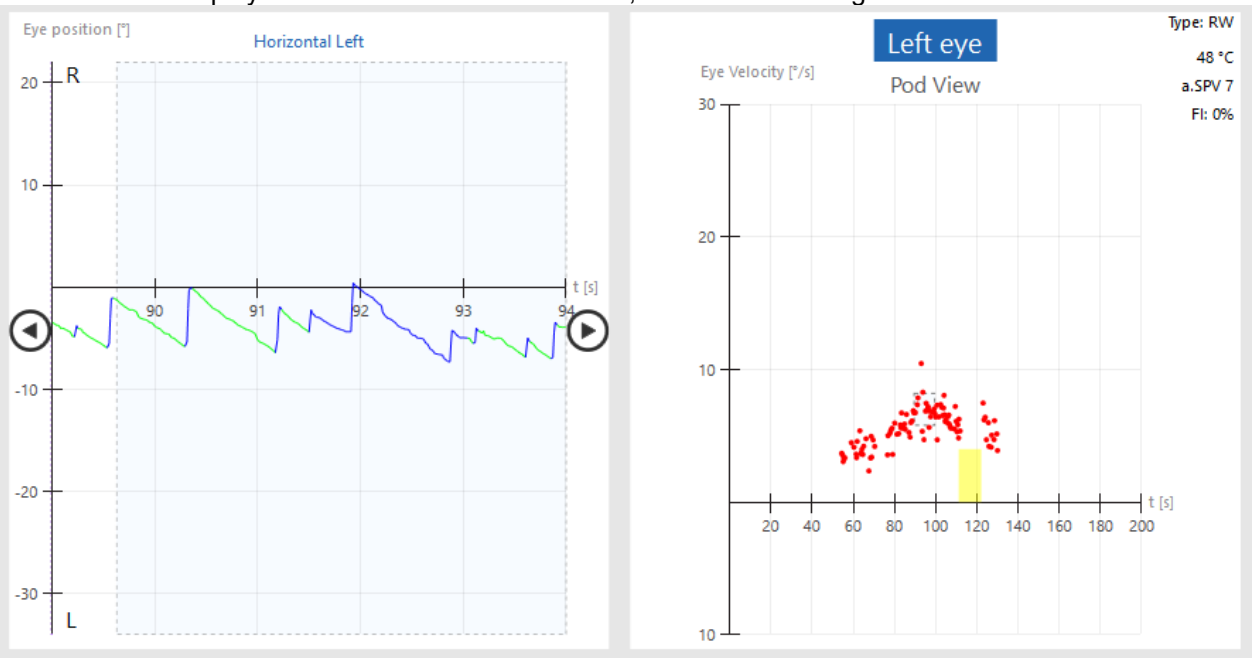


Figure 3.9-2 Caloric test results



Figure 3.9-3 Caloric summary

As you perform each caloric test, the caloric summary will display the results of the caloric subtests together. The caloric summary can be a mix of left eye and right eye results as desired. These results are displayed in the right upper corner of the caloric results display (Figure 3.9-).

Unilateral Weakness (UW)
UW is a value that compares the nystagmus strength induced by irrigation of the left ear with that of the right ear. It is calculated automatically by the software.
UW is given in percent [%]. The default threshold level is 25%.

Directional Preponderance (DP)
DP is a value that compares the nystagmus strengths in the right beating direction with the nystagmus strengths in the left beating direction.
DP is given in percent [%]. The default threshold level is 30%.

Fixation Suppression Index (FI)
FI quantifies the ability of a patient to deliberately suppress nystagmus by fixating on a given target. It is determined just after the peak response by switching on the fixation light within the mask (the default protocol automatically turns on the fixation lights at the appropriate time). This time interval is shaded in yellow on the graph.

The value for FI is a percentage with the test threshold of 50% used as a cut-off value.
0% indicates perfect nystagmus suppression during fixation, 100% indicates complete failure of fixation suppression.

Spontaneous Nystagmus Correction (SPN)
If you perform the spontaneous nystagmus subtest inside the caloric test, the software can correct the nystagmus values using the nystagmus value when the patient is laying in the supine position. If the patient experienced nystagmus in the supine position of the positional test or during the spontaneous nystagmus test, then change the test settings to include the spontaneous nystagmus subtest. After the spontaneous nystagmus subtest is performed, the spontaneous nystagmus switch will become available. The graphs will then display the corrected x-axis for adjusting the caloric response due to the patient's latent nystagmus (Figure).



Figure 3.9-4 Caloric summary with spontaneous nystagmus correction enabled

Monothermal Warm Screening Test (MWST)

If you only perform two warm irrigation subtests, the system will calculate an MWST value based on these subtests. It is not a separate test but will be calculated automatically in the default protocol setup or anytime the 2 warm caloric tests are performed as the first 2 tests.

When both warms are complete, the software will automatically generate an MWST score (Figure 9-5).

If you move on to perform cools, then the MWST score is replaced with a UW score.

The default suggested value is 30%. If the maximum result exceeds 30% then an out of threshold symbol (red diamond) will be present for this test.

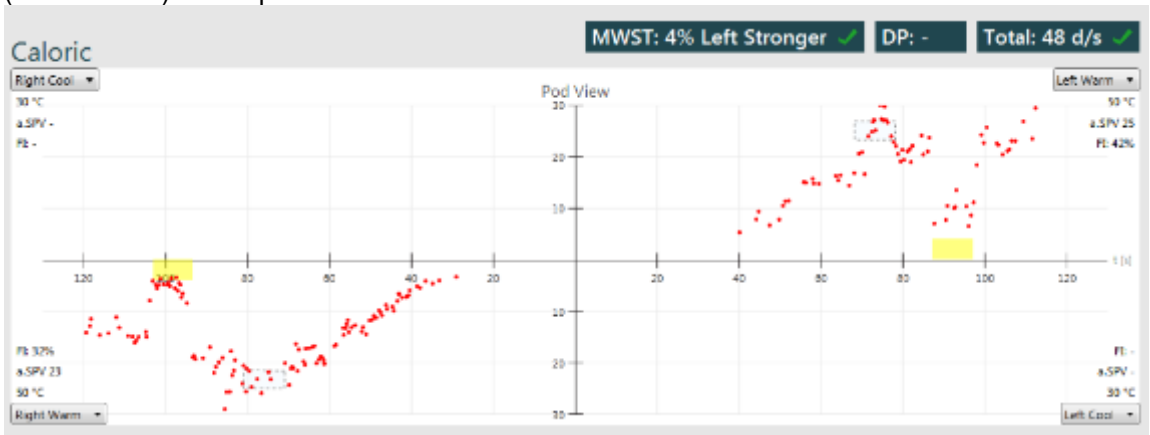


Figure 3.9-5 Caloric summary results for MWST

Monothermal Cold Screening Test (MCST)

If you only perform two Cold irrigation subtests, the system will calculate an MCST value based on these subtests. It is not a separate test but will be calculated automatically in the default protocol setup or anytime the 2 cold caloric tests are performed as the first 2 tests.

When both cools are complete, the software will automatically generate an MCST score (Figure 6).

If you move on to perform warms, then the MCST score is replaced with a UW score.

The default suggested value is 30%. If the maximum result exceeds 30% then an out of threshold symbol (red diamond) will be present for this test.

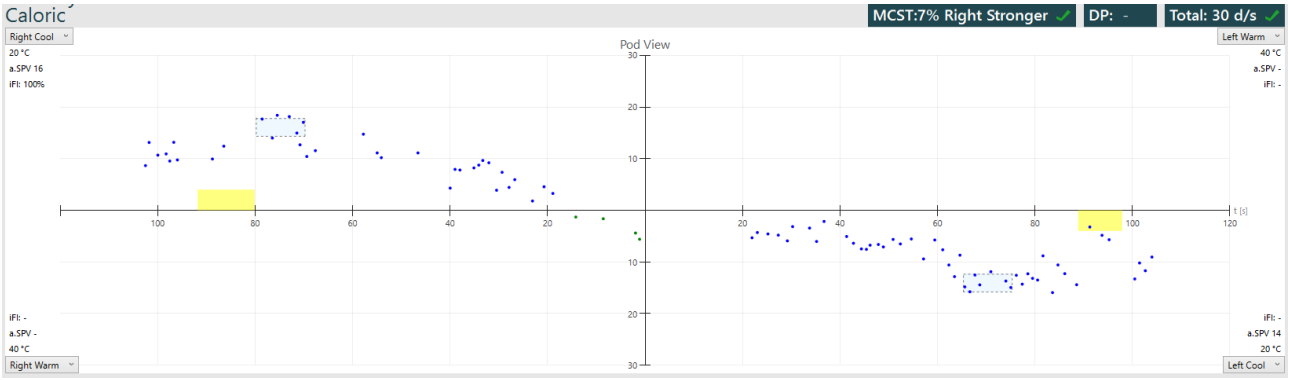


Figure 3.99-6 Caloric summary results for MCST

Caloric results views

The caloric results may be displayed in a few different standard diagrams (Figure). In addition to the Pod View, the caloric results can be displayed in the Bar Graph and Freyss diagram. In certain regions, the additional options of Scherer, Claussen, and Haid-Stoll graphs are available. To select an additional view, use the Results View selection box and choose the desired view.

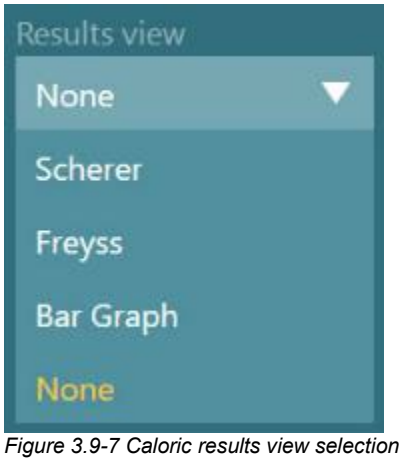


Figure 3.9-7 Caloric results view selection box

All diagrams are positioned in the upper portion of the review screen next to the pods diagram.

Pods

In the Pod View (Figure 3.9-), the slow phase velocity (SPV) of horizontal nystagmus beats is plotted over time.

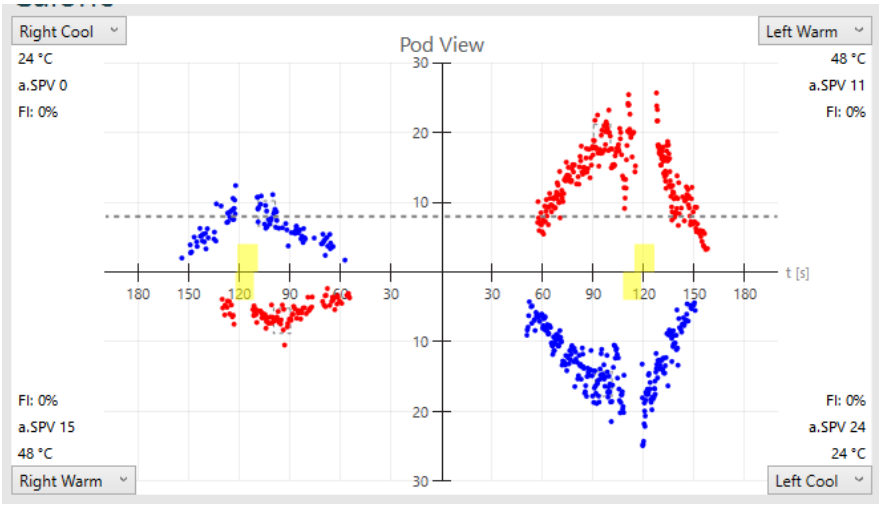


Figure 3.9-8 Pod View

The horizontal axis represents time (seconds) and the vertical axis is the SPV (degrees). In the corner of each quadrant is an area that displays the temperature of irrigation, a. SPV, and FI.
In subjects with normal vestibular function, this specific arrangement of data plots results in a shape like the outlines of a pea pod. Click on a beat in the pod diagram to open the edit mode.

Normally, nystagmus beats are illustrated by triangles in the same color as the waveform. However, if the data collected is contradictory to what would be expected, i.e., warm irrigation of the right ear resulting in all left-beating nystagmus, triangles will appear in a green color to alert the examiner of the unexpected outcome. An alert message will also appear indicating an unexpected result.

Bar graph

The bar graph (Figure 3.9-) represents the average slow phase velocity during the peak response of each irrigation. Warm irrigations are red and cool irrigations are blue. The graph is divided in two, with one side displaying the right eye and the opposite the left eye. The vertical axis displays the average slow phase velocities, which correspond to the height of each individual bar. The numerical value defines the maximum average slow phase eye velocity.

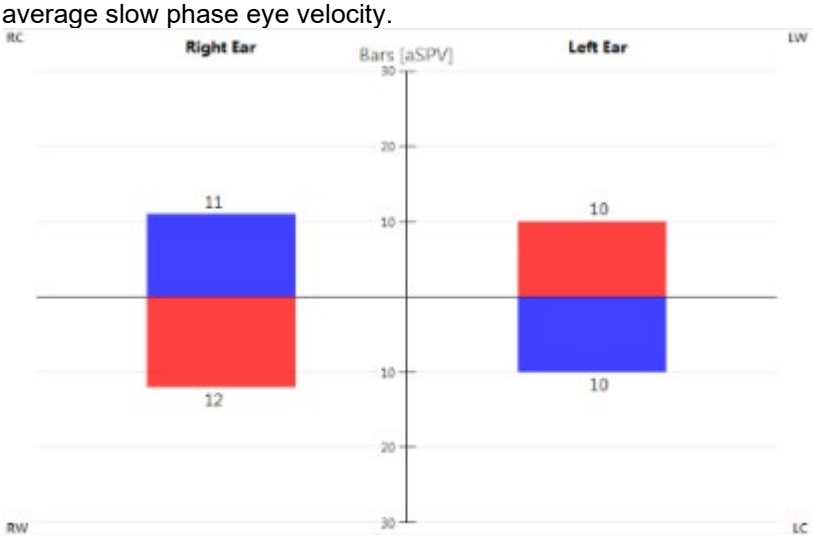


Figure 3.9-9 Bar graph

Freyss diagram

The Freyss Diagram (Figure 3.9-) graphically represents the average slow phase velocities (a. SPV) during the peak response of each irrigation.

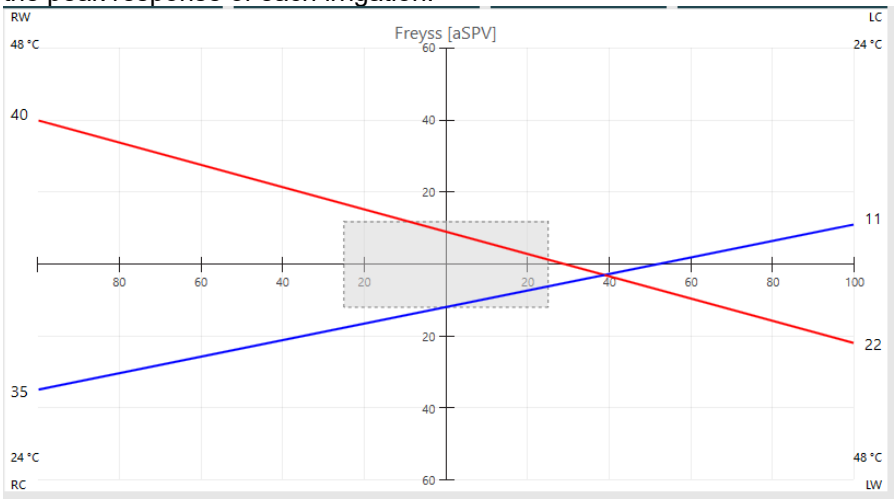


Figure 3.9-10 Freyss diagram

On the left vertical axis, the a. SPV calculated for the irrigations of the right ear are plotted; data points on the right vertical axis show the a. SPV values for left ear irrigations.
The rectangular box in the center of the Freyss diagram outlines the UW cut-off value.

The diagram is completed by two lines: one connecting the data points obtained for the two warm irrigations, the other one connecting the data points representing the two cool irrigations. The two lines described above will intersect either to the left or to the right of the rectangle in patients with a UW larger than the threshold value.

3.10 Rotational chair testing

Rotational chair testing is available in licensed VisualEyes™ 515 and VisualEyes™ 525 systems that utilize a rotational chair. The System 2000 reclining chairs utilize FireWire cameras, and the Orion Reclining, Auto-Traverse, and Comprehensive chairs utilize USB cameras.

3.10.1 Safety checks before beginning rotary chair tests

Before beginning the first rotary chair test in a rotational chair, a safety checklist will be presented to ensure the safety of the patient before the chair is set into motion. Please use the checklist as a guide to ensure patient safety during the test. Check each box after performing the task. The chair will not be able to move until you have checked all boxes and pressed the OK button (see below figures).

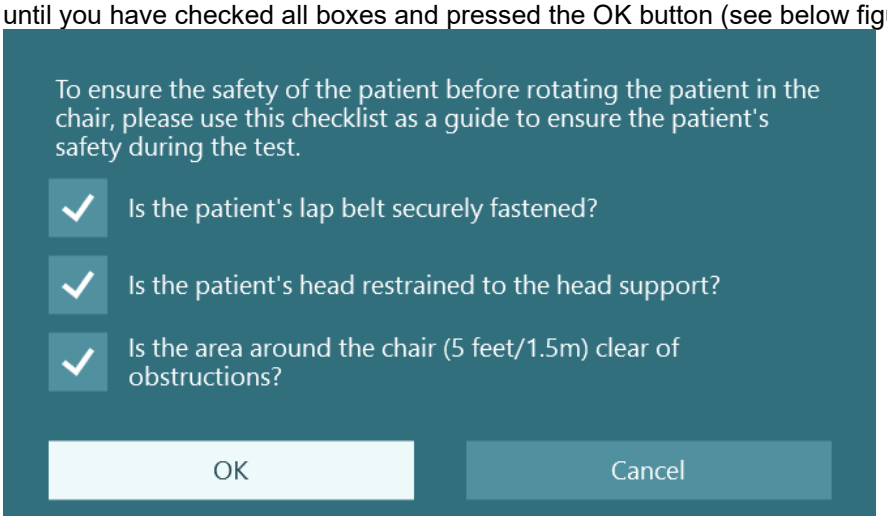


Figure 3.10-1 Safety checklist for reclining chair (Orion and System 2000)

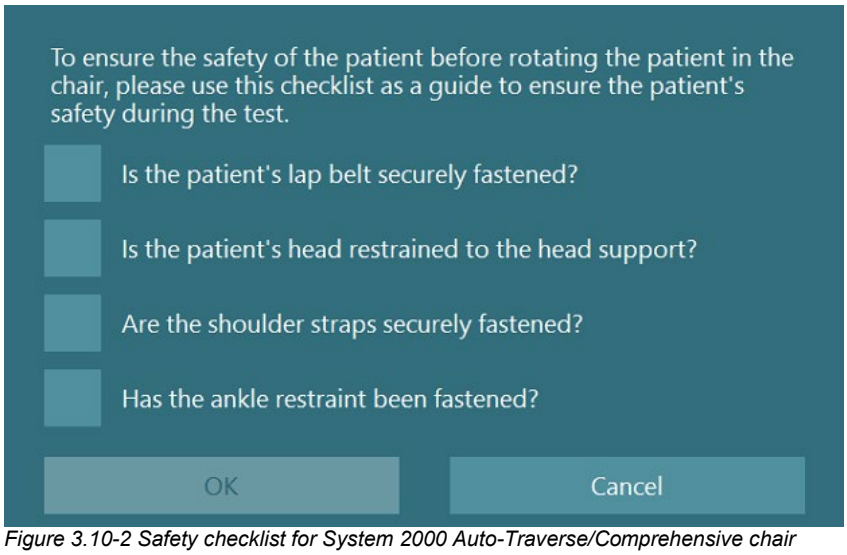


Figure 3.10-2 Safety checklist for System 2000 Auto-Traverse/Comprehensive chair

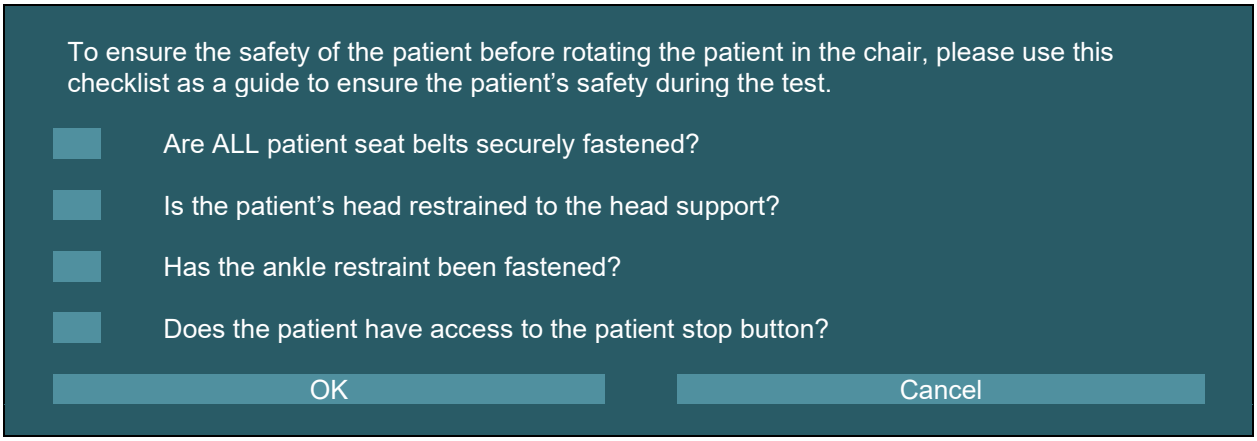
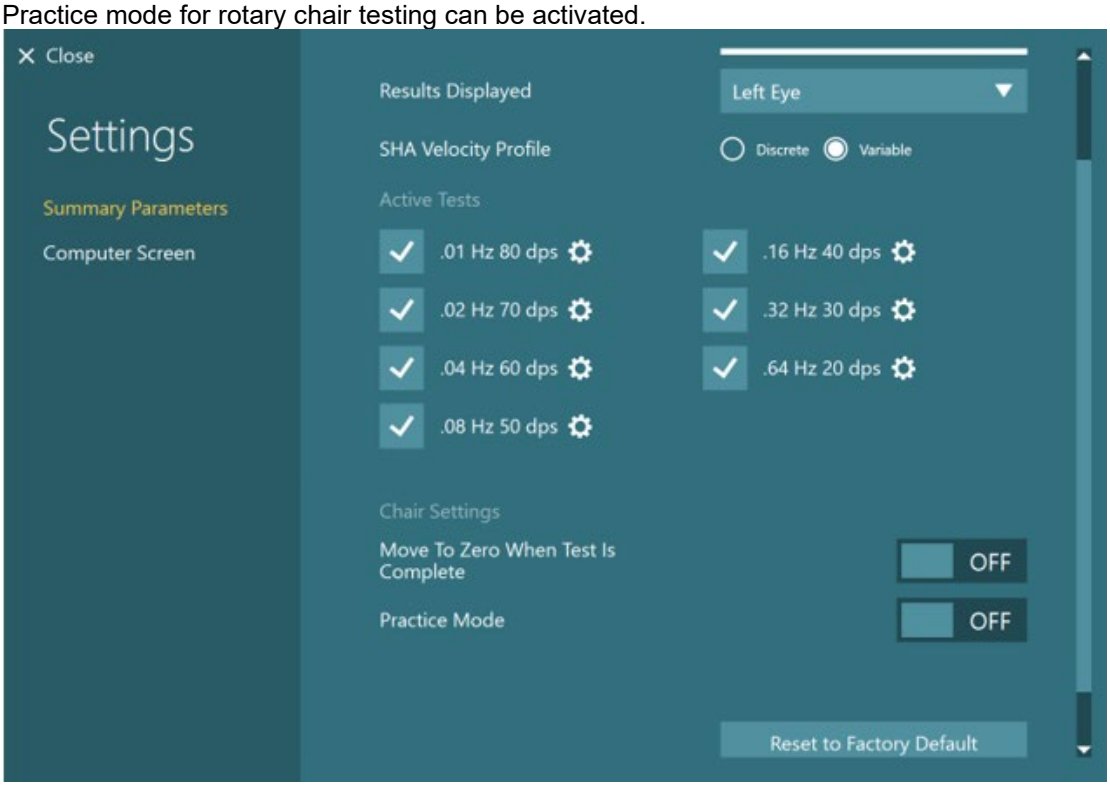


Figure 3.10-3 Safety checklist for Orion Auto-Traverse/Comprehensive chair

Practice mode

Practice mode for rotary chair testing can be activated.



3.10.2 Sinusoidal harmonic acceleration (SHA) test

During the sinusoidal harmonic acceleration (SHA) test, the patient is positioned in the rotational chair and is rotated in a sinusoidal pattern alternating from side to side. Analysis of the vestibular response is performed by recording the eye movements with VisualEyes™ VNG goggles in a fixation-denied condition. The patient is rotated in alternating directions at multiple individual frequencies. The frequencies most often tested during SHA testing are the octave frequencies 0.01 Hz, 0.02 Hz, 0.04 Hz, 0.08 Hz, 0.16 Hz, and 0.32 Hz. The frequency of 0.64 Hz is also available. It is recommended to start the test with a mid-frequency before going to very low frequencies to avoid making the patient nauseous.

The responses are displayed in real time (in relation to the stimulus). The eye position and eye velocity results are plotted within the test window along with two summary graphs showing gain and phase results for the frequency being tested (Figure).

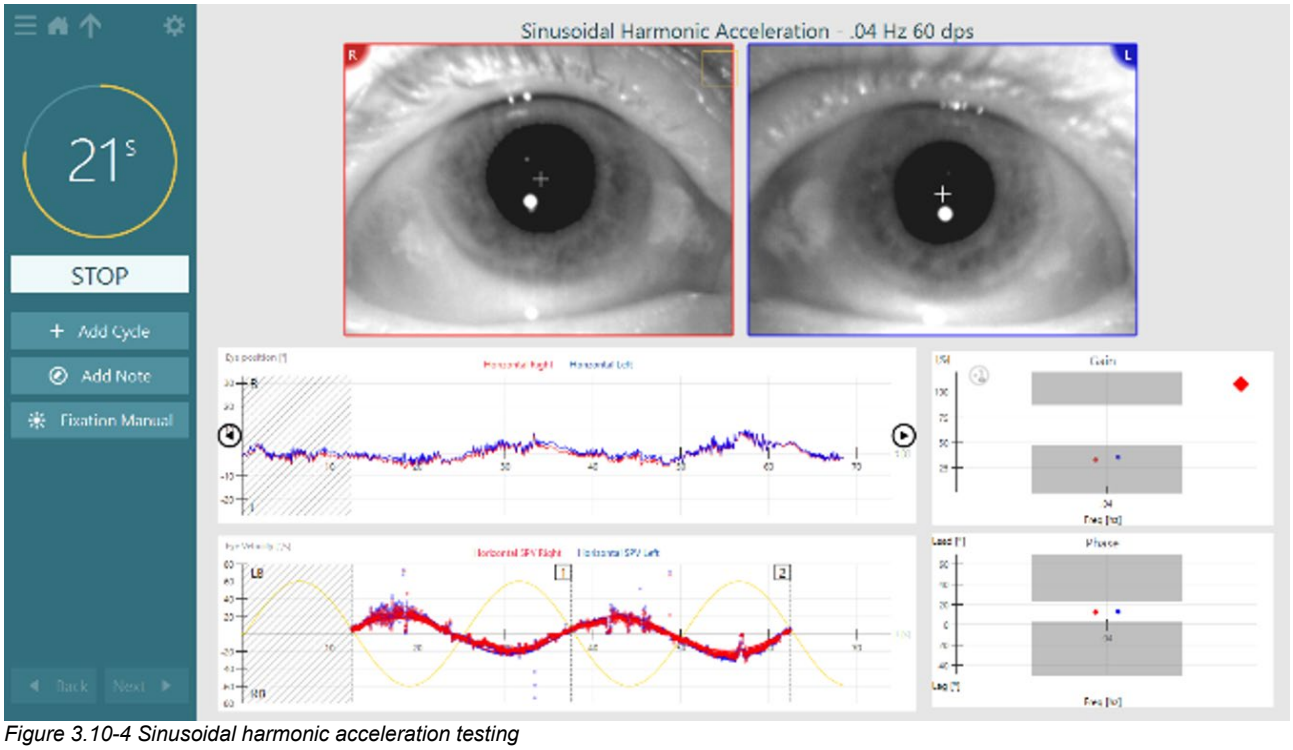


Figure 3.10-4 Sinusoidal harmonic acceleration testing

To begin the testing procedure, select ‘Begin Testing’ from the main VisualEyes™ menu.

The SHA test will be available within the protocol or may be selected directly from the side menu panel by tapping the ‘hamburger’ icon in the upper left corner of the test screen to view the test battery list. Select SHA to begin testing. This will open the first frequency within the SHA test sequence. Alternatively, if you choose to perform the SHA test frequencies out of sequence, tap the plus sign to the left of SHA which will expand to show all subtests, and select the desired frequency (Figure).

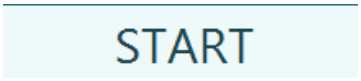


Figure 3.10-5 Expanded test battery view

Example instruction for the patient:
“You will feel yourself rotating back and forth slowly in the chair. While you are rotating, I will ask you several questions to keep you alert. We will test different frequencies and the entire test will take a few minutes. Please keep your eyes open the entire time.”

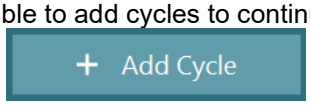
How to begin the test:

1. Select ‘START’ from the left menu panel.



2. The timer will begin counting down. The length of the test time is pre-defined by the number of cycles selected for the test frequency.

The chair will activate and begin moving in a sinusoidal pattern.
Camera recordings will begin at the onset of chair movement.
The stimulus and eye movements are displayed in real-time.

While the test is active, it is possible to add cycles to continue testing beyond the protocol-specified number of SHA cycles. Click or touch the 

button to add a cycle, which will increase the test time by the number of seconds associated with one full cycle of SHA rotation for that given frequency.

To abort the chair rotation before test completion, click or touch the Stop button. A message will be displayed on the computer test screen asking, “Are you sure you want to stop?”. Click or touch ‘yes’ to have the recording end. Click or touch ‘no’ to continue recording the tracing.

Once the test is complete, a summary test results page will appear (Figure).

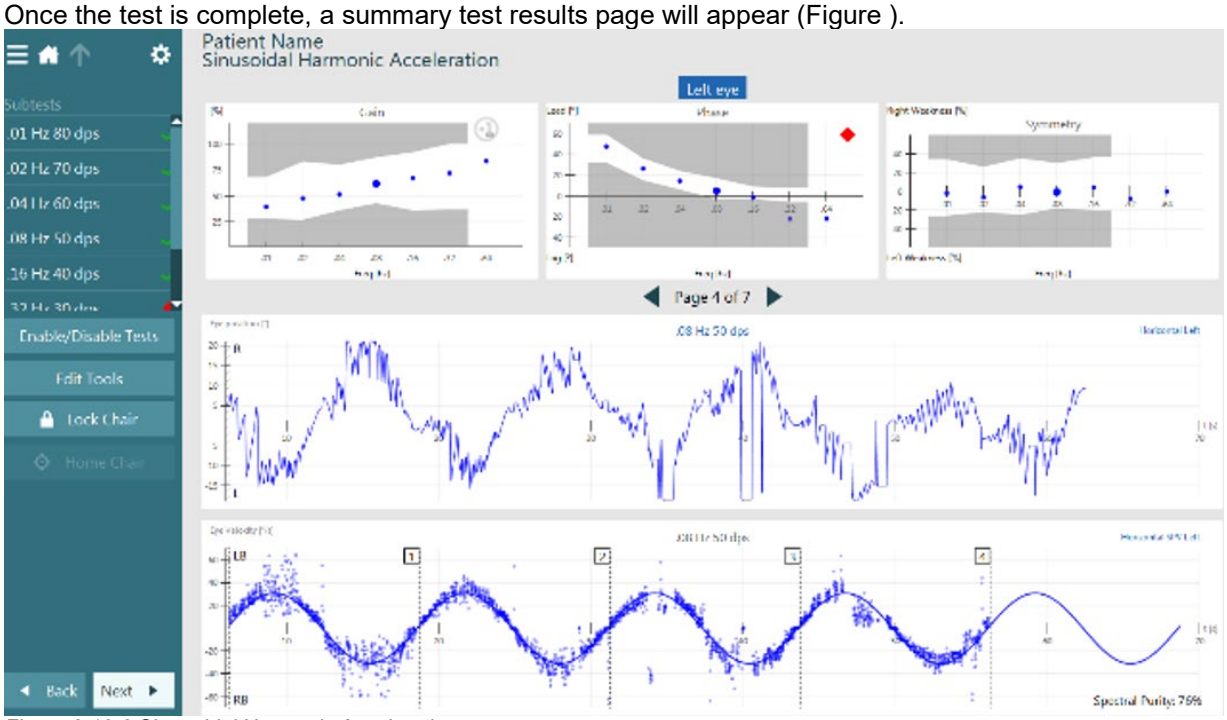


Figure 3.10-6 Sinusoidal Harmonic Acceleration summary

Sinusoidal harmonic acceleration analysis is performed on cycles of pendular movement for specific frequencies. One complete cycle represents the pendular movement period consisting of acceleration/deceleration in one direction, and acceleration/deceleration in the opposite direction.
Please note: The first half cycle (hatched region) is excluded from the analysis for improved test reliability.

Analysis of eye movements is performed separately for the right and left eyes and the results are displayed separately. Left eye results are displayed by default. You can change the displayed results to the right eye by selecting the eye title in the top center of the summary test results screen (Figure 3.10-7).

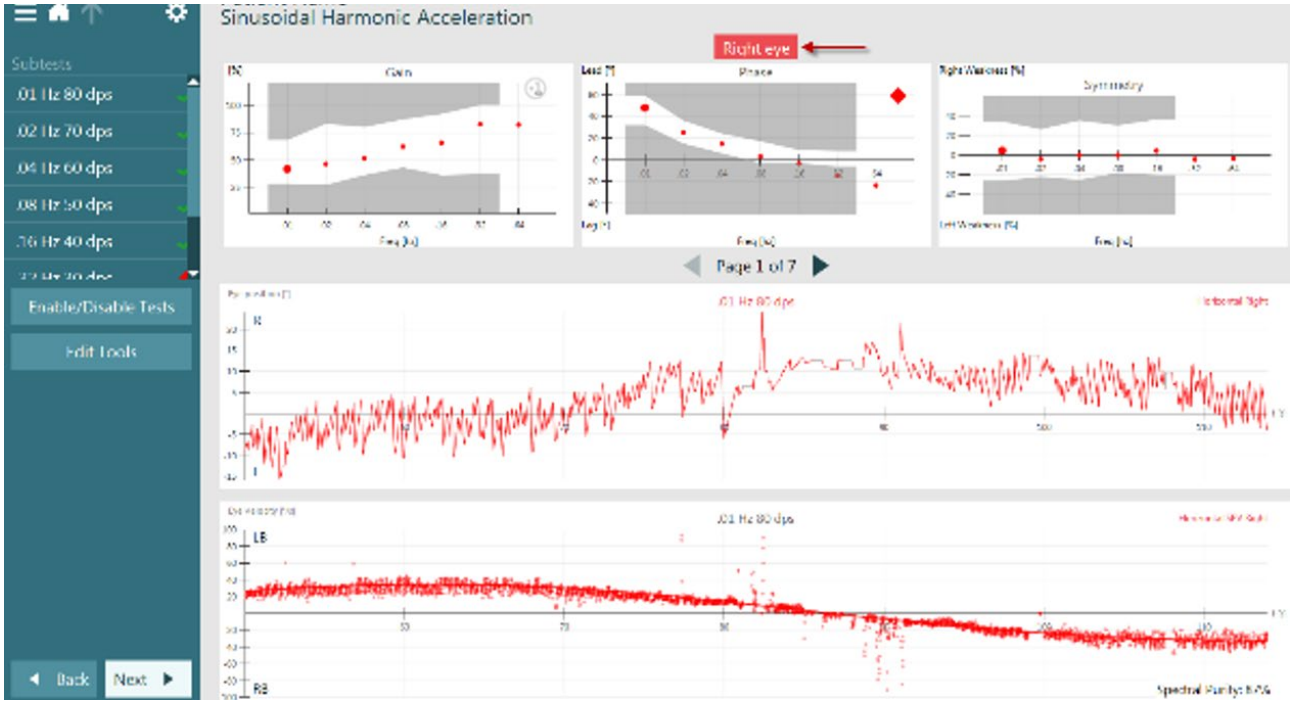


Figure 3.10-7 Right eye results for Sinusoidal Harmonic Acceleration test

The summary test results screen displays various analyses. The top portion of the summary results screen displays plots for Gain, Phase and Symmetry. These parameters are explained in detail in the following section.

Phase

Phase is the value, in degrees, to which compensatory eye movements lead or lag movement of the head. As such, phase measurements characterize the timing relationship between motion of the head and the resulting vestibulo-ocular reflex (VOR) response, allowing for quantification of the phase lead or lag. Mathematical functions are used to calculate the phase shift between the reclining chair stimulation (head movement) and the eye response. The resulting values are plotted within the phase graph (Figure 3.10-8).

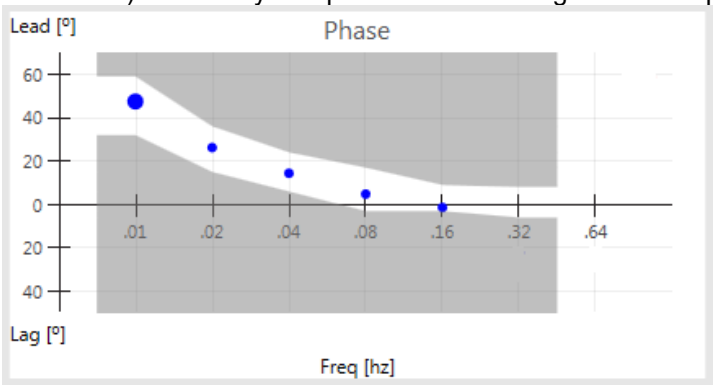


Figure 3.10-9 Phase graph

Phase values are expressed in degrees (°). A positive value indicates a phase lead. Values within the white region of the graph are within suggested threshold levels and those in the grey shaded regions are outside of the suggested threshold levels or criteria. When data points fall in the grey shaded regions, the graph will be marked with a red diamond to indicate that the patient's data was outside of the suggested threshold level.

Phase < 0°
Eye movement lags the head movement.

Phase > 0°
Eye movement leads the head movement.

Gain

Gain measurement provides an indication of the responsiveness of the peripheral vestibular system. If the function of the VOR is to produce an eye movement that compensates for head movement, then, under perfect conditions, the slow phase eye velocity of the response to rotation should be a mirror image of head velocity producing a gain of 60 %.

The gain is the relation between the amplitude of the sine wave function (generated from the eye-movement data) and the amplitude of the sine wave function fitted to the reclining chair data.

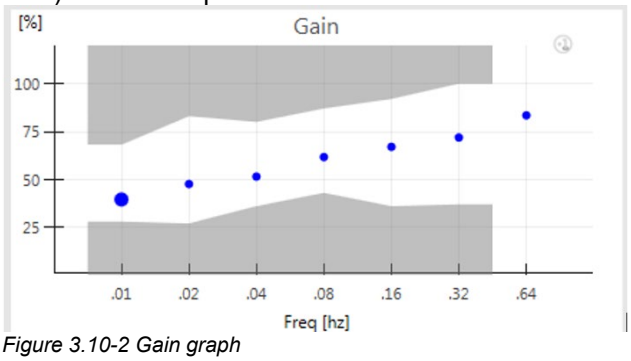


Figure 3.10-2 Gain graph

Gain values are expressed as a percentage (%). Values within the white region of the graph are within suggested threshold levels and those in the grey shaded regions are outside of the suggested threshold levels or criteria (Figure 3.10-3). When data points fall in the grey shaded regions, the graph will be marked with a red diamond to indicate that the patient's data was outside of the suggested threshold level.

Symmetry

Symmetry is measured as the difference between the maximum left-beating and right-beating eye velocities divided by the total of the left- and right-beating maximum slow phase eye velocities.

Values describing asymmetry of response are calculated by comparing slow-phase eye velocities with right-moving rotation and left-moving rotation. Calculation is based on the average maximum slow phase velocity for left and right cycles.

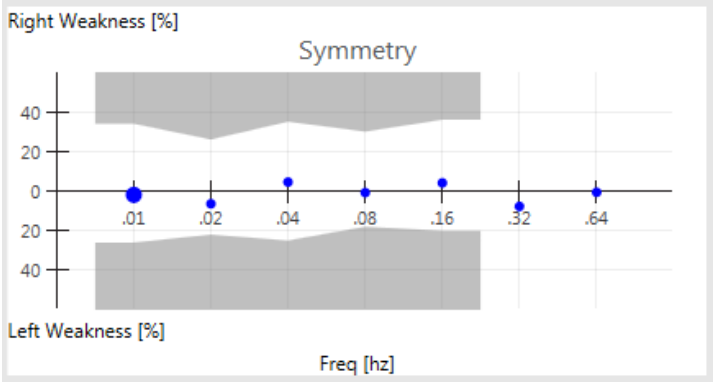


Figure 3.10-3 Symmetry graph

Symmetry values are expressed as a percentage (%). Values within the white region of the graph are within suggested threshold levels and those in the grey shaded regions are outside of the suggested threshold levels or criteria (Figure 3.10-4). When data points fall in the grey shaded regions, the graph will be marked with a red diamond to indicate that the patient's data was outside of the suggested threshold level.

Graph numerical values

You can choose to view the numerical values of the graph. By clicking the symbol , the numerical values will be shown for all the relevant graphs in the selected test. The symbol is in the right/left corner of the gain graph (refer to section 7.5 for details).

Eye position display

In the middle portion of the summary results screen, the eye position (°) tracing is displayed. The eye position tracing (Figure 3.10-5) represents eye movement during chair rotation and is displayed as a function of eye position in degrees (y-axis) over time in seconds (x-axis).

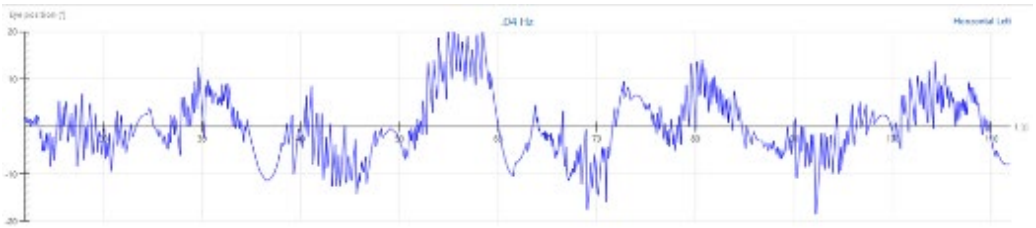


Figure 3.10-4 Eye position trace

Eye velocity display

The eye velocity in °/s (blue) relative to stimulus chair velocity (yellow) is displayed beneath the eye position tracing (Figure 3.10-6).

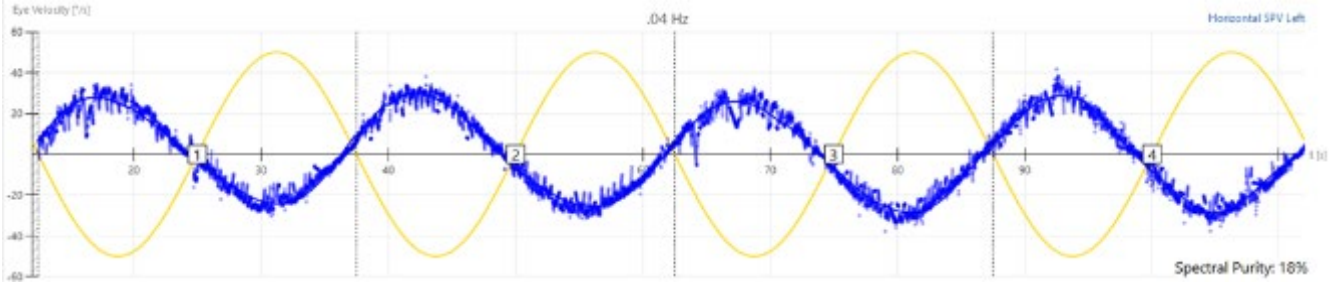


Figure 3.10-5 Display showing detailed individual cycles for eye velocity vs. stimulus velocity

This graphical display provides a detailed individual cycle view for the examiner to see the patient's results in relation to the stimulus. The user can also view the cycle numbers in this display. The VisualEyes™ software may display the stimulus and eye movement data opposite one another (as shown above) or overlapping each other, depending on user preference. You can select this preference in the Sinusoidal Harmonic Acceleration protocol setup. Both viewing methods are designed to provide you with an easy way to analyze results and crosscheck gain, phase, and symmetry.

Alternatively, you can also select a concise and combined cycles view (Figure 3.10-7). The eye position tracing is not available in this view.

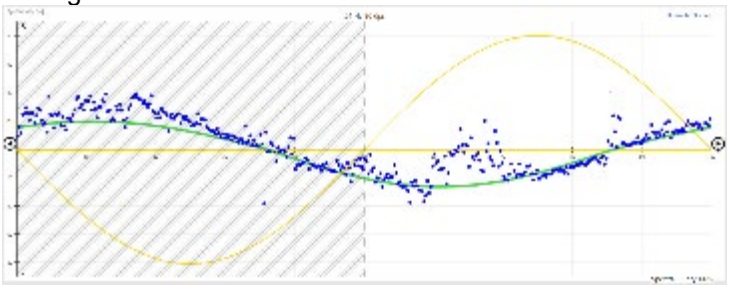


Figure 3.10-6 Concise and combined cycles view

When you need further details for review, you can select an individual frequency from the left side menu to see both eyes displayed together for the selected frequency. This view allows you to add notes, review or delete eye video recordings, print the screen, and edit the results for a specific frequency (Figure 3.10-8).

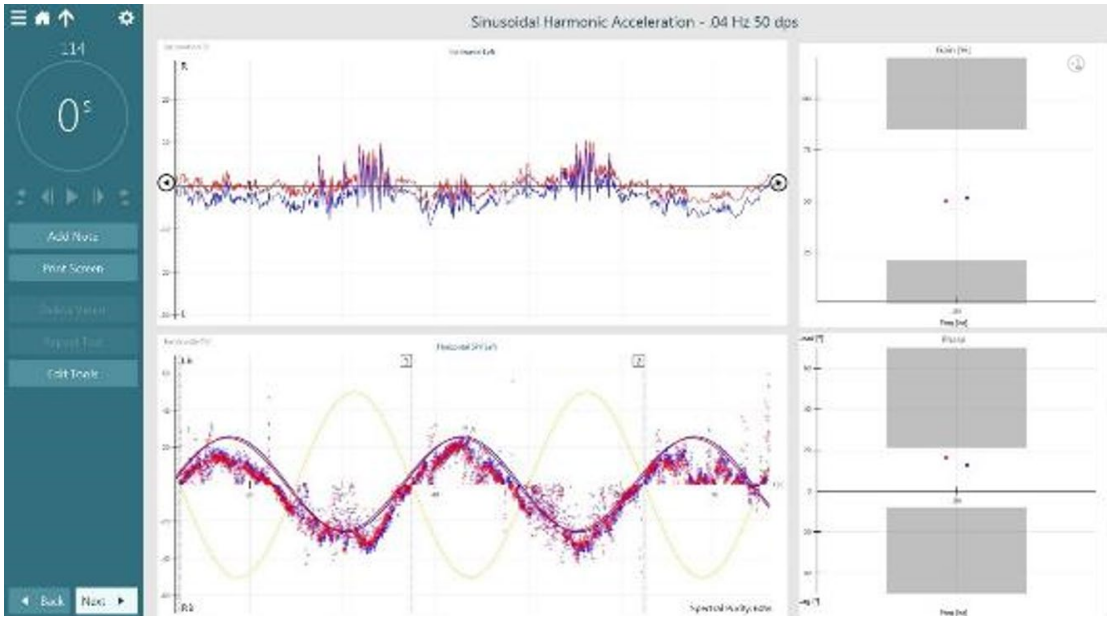


Figure 3.10-7 Review individual SHA frequency

Spectral purity

You can view a spectral purity value for each given frequency tested in the lower right corner of the eye velocity display (Figure 3.10-9). The spectral purity of the evoked nystagmus may be useful to indicate whether the test values have been influenced by artifact, for instance from failure to adequately alert the patient or from calibration errors affecting the peak eye velocity measurements. The higher the spectral purity value, the more reliable the sinusoidal harmonic acceleration result. Values are displayed as a percentage (%).

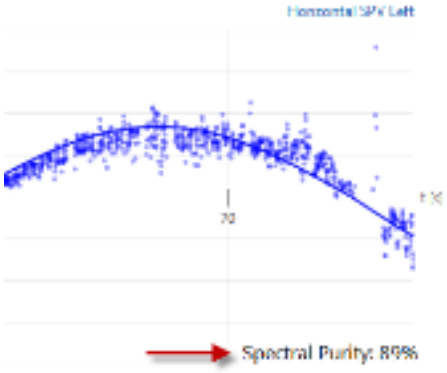


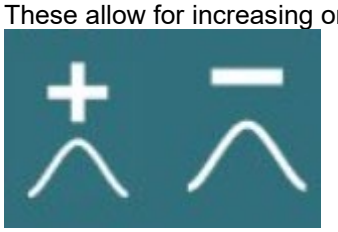
Figure 3.10-8 Spectral purity value

Editing Data

Clicking the “Edit Tools” button unlocks a variety of additional editing tools that are available after SHA testing.



These allow for increasing or decreasing overall gain:



This button allows for increasing or decreasing gain within one half-cycle:



This button allows for adjusting shifting phase:



3.10.3 Step Velocity test

During the step velocity test, the patient is positioned on a motor-driven rotational chair and the test has two parts. In the first part of the test, the chair rotation is initiated through the software and accelerates up to a defined speed (initial speed would be 50°/s^2). After the defined speed is attained, the chair rotates at a constant speed for 60 seconds and automatically stops by decelerating to 0°/s^2. Now the test moves to the second part, where the software continues to record the patient's eye movements for 60 seconds during non-rotation. Examine the patient in the same way in the opposite direction to complete the test.

The speeds of rotation most often tested are 50°/second and 100°/second. The speed of 180°/second is also available. Eye movements are recorded with VisualEyes™ VNG cameras and results are displayed in real-time on screen. The patient's eyes, along with both eye position tracings (°) and eye velocity tracings (°/s) are visible during the testing procedure. You can view the chair velocity information in the left menu panel, as well as above the patient's eyes (Figure 3.10-10).

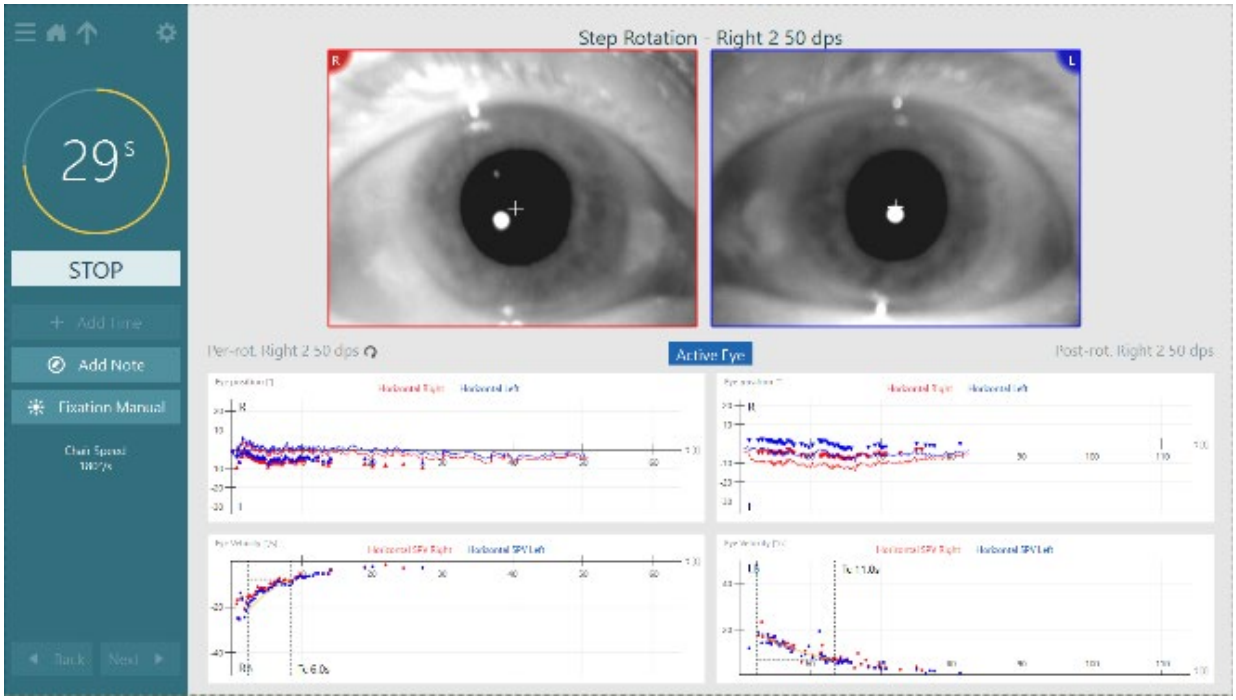


Figure 3.10-9 Step velocity testing

To begin the testing procedure, select ‘Begin Testing’ from the main VisualEyes™ menu.

The Step Velocity test will be available within the protocol. You can also select it directly from the side menu panel by tapping the ‘hamburger’ icon in the upper left corner of the test screen. Select Step Velocity to begin testing. Alternatively, if you choose to perform the Step Velocity test velocities/directions out of sequence, tap the plus sign to the left of Step Velocity which will expand to show all subtests, and select the desired velocity and direction (Figure 3.10-11).

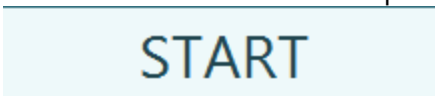


Figure 3.10-10 Expanded test battery view

Example instructions for the patient:
“You will feel yourself rotating in one direction for several seconds. During the rotation, I will be asking you several questions to keep you alert. As you are rotating, you may feel as though you are slowing down. When the chair stops, you will feel as though you are rotating in the opposite direction. There will be four segments and each segment will take approximately 1 minute. Please keep your eyes open during the entire test.”

To begin the test (for operator):

1. Select ‘Start’ from the left menu panel.



2. The timer will begin counting down. The amount of time is pre-defined by the test parameters.

The chair will activate and begin accelerating to a constant velocity in the selected direction.
Camera recordings will begin at the onset of chair movement.
The stimulus and eye movements will be displayed in real-time.

Once the per-rotary selected speed and direction has been completed, the chair will automatically stop after a pre-determined time. The recording will continue into the post-rotary segment. If the per-rotary segment in the opposite direction has not yet been completed, the software will automatically start the last per-rotary segment in the opposite direction immediately following the pre-defined stop time for the post-rotary segment. Again, after the final per-rotary condition has been completed, the chair will automatically stop, and the final post-rotary segment will begin recording. Each segment is pre-defined to last 60 seconds. If you want to stop before 60 seconds, tap the “Stop” tab from the left menu panel to move into the next test segment. Once the test is complete, a summary test results page will appear (Figure 3.10-12).

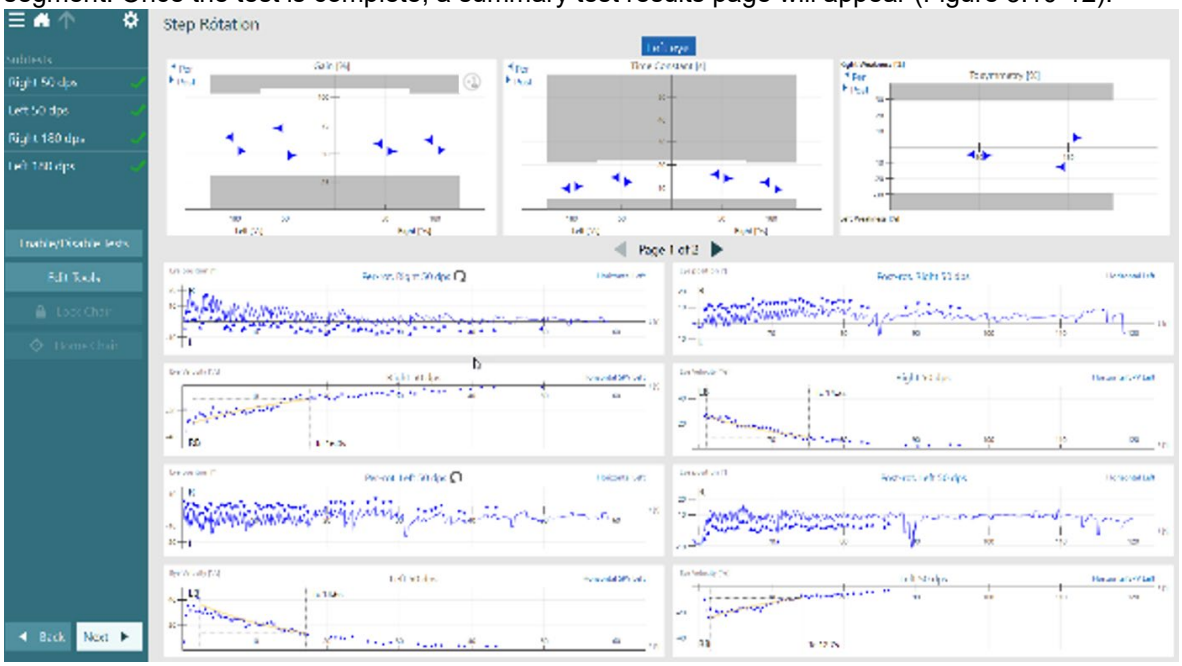


Figure 3.10-11 Step Velocity summary

If you have selected to move the chair to the zero position after testing, then the chair will move to this position after all four segments of an individual step velocity test have been completed.

It is optional to perform a spontaneous test as part of the step test battery. You can select this in the step test setup, which will enable a toggle for spontaneous nystagmus correction in the left panel menu (Figure 3.10-13). Spontaneous nystagmus correction adjusts the responses based on the nystagmus a. SPV collected during the spontaneous subtest. The degree and direction of correction will be displayed in the upper right corner of the summary results screen.

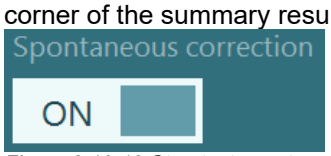


Figure 3.10-12 Step test spontaneous correction

Analysis of per-rotatory segments (acceleration + constant chair speed period) are separated from the post-rotatory segments (deceleration + chair stopped). One complete analysis consists of per- and post-rotary segments for rotations in both directions at a single speed.

Analysis of eye movements is performed separately for the right and left eyes and the resulting waveforms are displayed separately. Left eye results are displayed by default. You can change the displayed results to the right eye by selecting the eye title in the top center of the summary test results screen (Figure 3.10-14).

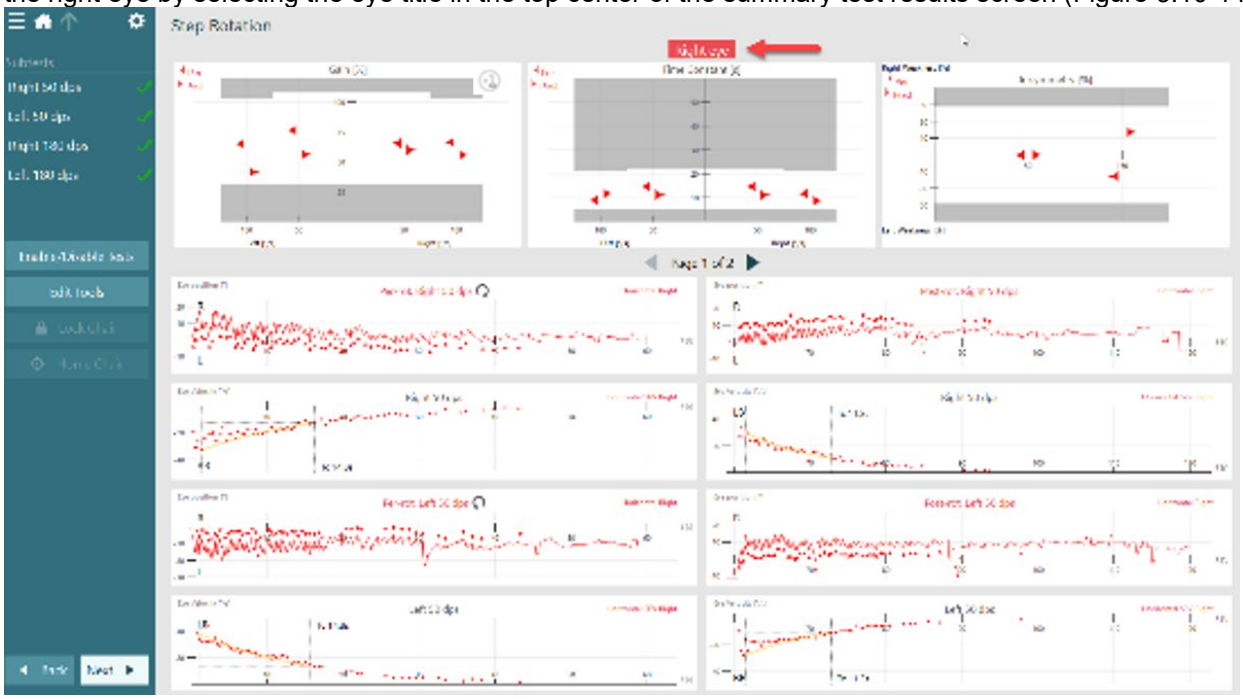


Figure 3.10-13 Right eye results for Step Velocity test

The summary test results screen displays various analyses. The top portion of the summary results screen displays plots for Gain, Time Constant, and Time Constant Symmetry. These parameters are explained in detail in the following section.

Gain

Gain is the relation between the patient's maximum slow phase velocity (SPV) of nystagmus and the maximum velocity of the rotary chair (stimulus). A total of four gain values will be present for each Step Rotation speed tested (per-rotary left, post-rotary left, per-rotary right, post-rotary right).

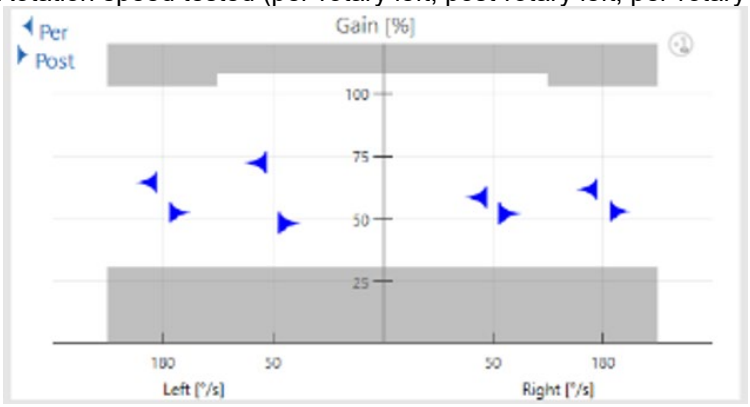


Figure 3.10-14 Gain graph

The gain values are expressed as a percentage (%). Values within the white region of the graph are within suggested threshold levels and those in the grey shaded regions are outside of the suggested threshold levels or criteria (Figure 3.10-15). When data points fall in the grey shaded regions, the graph will be marked with a red diamond to indicate that the patient's data was outside of the suggested threshold level.

Time constant (Tc)

Tc is the amount of time it took for the response to reach 33% of its maximum SPV value.

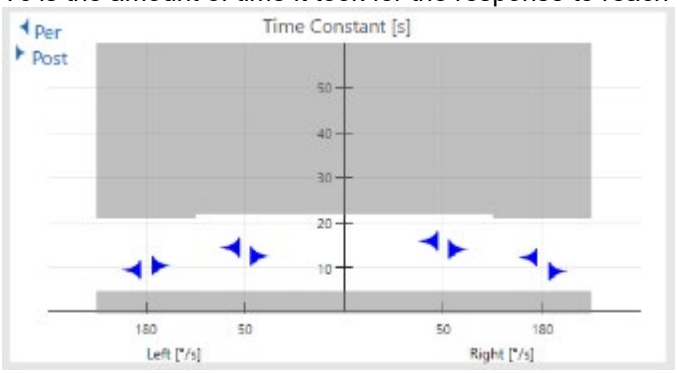


Figure 3.10-15 Time constant graph

Tc values are expressed in seconds (s). Values within the white region of the graph are within suggested threshold levels and those in the grey shaded regions are outside of the suggested threshold levels or criteria (Figure 3.10-16). When data points fall in the grey shaded regions, the graph will be marked with a red diamond to indicate that the patient's data was outside of the suggested threshold level.

Tc symmetry

Tc symmetry provides a way to compare the time constants during chair rotations to the left with time constants during chair rotations to the right. Tc symmetry is calculated for per- and post-rotatory comparisons.

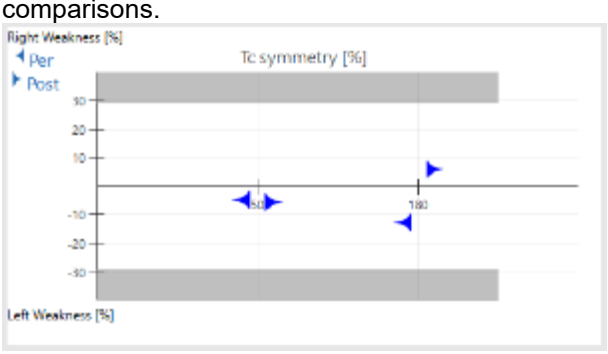


Figure 3.10-16 Symmetry summary plot

Tc symmetry values are expressed as a percentage (%). Values within the white region of the graph are within suggested threshold levels and those in the grey shaded regions are outside of the suggested threshold levels or criteria for Tc symmetry (Figure 3.10-17). Data points that fall in the upper grey shaded region are suggestive of a right weakness and data points that fall in the lower grey shaded region are suggestive of a left weakness. When data points fall in the grey shaded regions, the graph will be marked with a red diamond to indicate that the patient's data was outside of the suggested threshold level.

Graph numerical values

You can choose to view the numerical values of the graph. By clicking the symbol , the numerical values will be shown for all the relevant graphs in the selected test. You can find this symbol in the right/left corner of the gain graph (refer to section 7.5 for details).

Eye position and eye velocity display

The raw eye position tracings and corresponding slow phase velocity (SPV) results (Figure 3.10-18) are displayed underneath the Gain, Time Constant, and Tc symmetry graphs on the summary test results screen. These are placed one above the other for simplified viewing of all segments within a single Step Rotation speed tested.

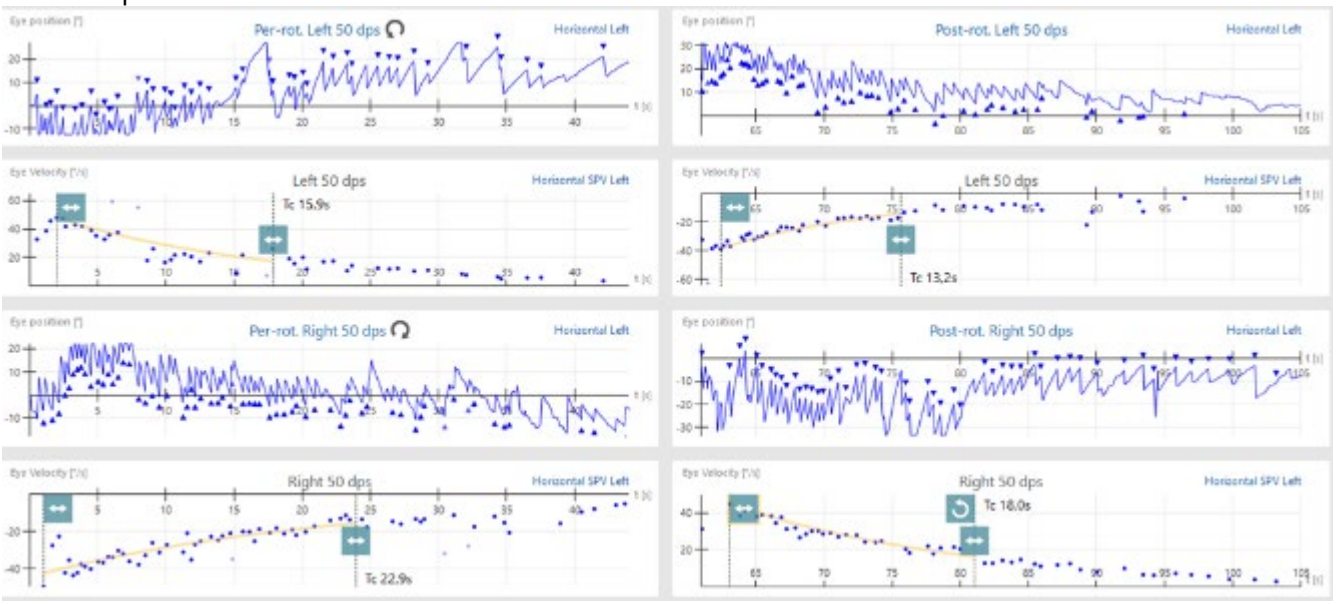


Figure 3.10-17 Raw eye movement data and time constant data for per- and post-rotary stimuli

The upper portion displays the raw eye position tracing for the specific condition (per/post-rotary and its relative velocity). Nystagmus beats are marked with triangles to identify left/right beating nystagmus (Figure 3.10-19).



Figure 3.10-18 Raw eye movement data trace with identified nystagmus

The lower portion displays data points for the corresponding SPV values for the detected beats of nystagmus as they reduce from a peak value to their relative time constant (Tc), or 37% of the maximum generated response. The initial vertical dashed line represents the point at which the peak maximum response was detected. The second vertical dashed line represents the point at which the response declined by 37% of the maximum peak response. The horizontal dashed line represents the amount of time between the two vertical dashed lines and indicates the time constant for that segment of the Step Velocity test. The yellow line represents the curve fit from the peak maximum evoked response to the Tc in seconds. The Tc numerical value is displayed next to the dashed line (Figure 3.10-20).

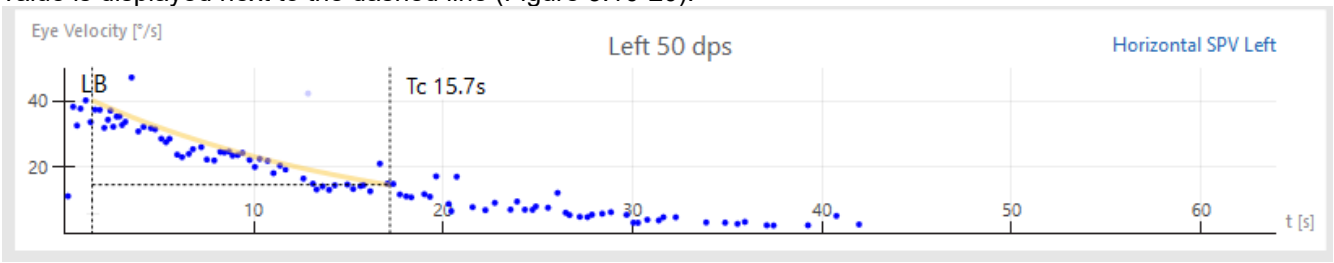


Figure 3.10-19 Eye velocity graph displaying peak response declining to 37% of its maximum (Tc)

SCEP calculations

Slow cumulative eye position (SCEP) information can be optionally displayed. SCEP is calculated by numerically integrating the area under the actual slow-phase velocity of the patient's RVS response. This integration starts from the point of initial SPV until end SCEP. Enabling this feature allows SCEP information for each step to be available within the eye velocity graph, along with the Tc information (Figure 3.10-21). SCEP calculation is not enabled by default but can be enabled within step test setup.

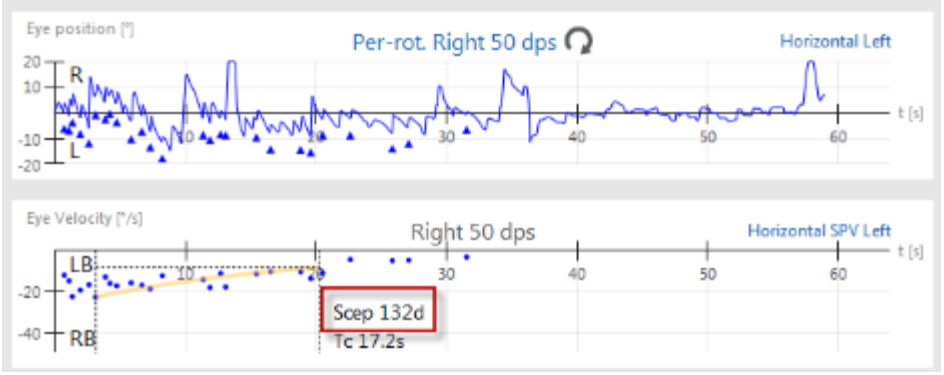


Figure 3.10-20 SCEP calculation

If you need further details for review, then you can select an individual velocity and direction from the left side menu panel to see both eyes displayed together for the selected segment (Figure 3.10-22). This view allows you to review both the per- and post-rotary segments for the selected Step Velocity test, add notes, review or delete eye video recordings, print the screen, and edit the results for a specific segment.

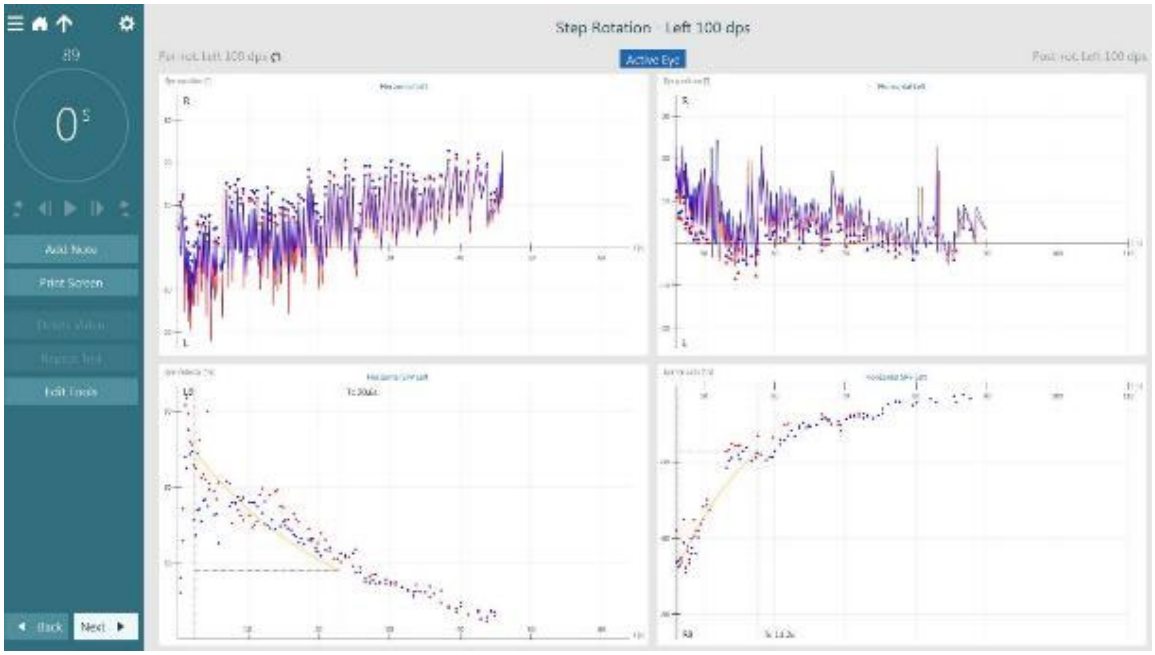


Figure 3.10-21 Review individual Step Velocity segment

3.10.4 VOR suppression test

During VOR Suppression, the patient is rotated in the same sinusoidal alternating pattern as in the SHA test, but this time with a fixation light illuminated within the VisualEyes™ VNG goggles or – in the Orion Auto-Traverse/Comprehensive chairs – projected onto the wall of the enclosure to assess the patient's ability to suppress the vestibulo-ocular reflex (VOR) while rotating.

The available test frequencies are octave frequencies from 0.01 Hz up to 0.64 Hz. By comparing the patient's vision-denied SHA results to the VOR suppression results at the same frequency of rotation, you can calculate a percentage of gain reduction. A failure to sufficiently suppress the VOR can be an indicator of possible central pathology.
Eye movements are recorded with the VisualEyes™ VNG cameras and the responses are displayed in real-time. The patient's eyes, along with eye position tracings (°), eye velocity tracings, and two graphs for gain (%) and reduction (%), are visible during the testing procedure (Figure 3.10-23).

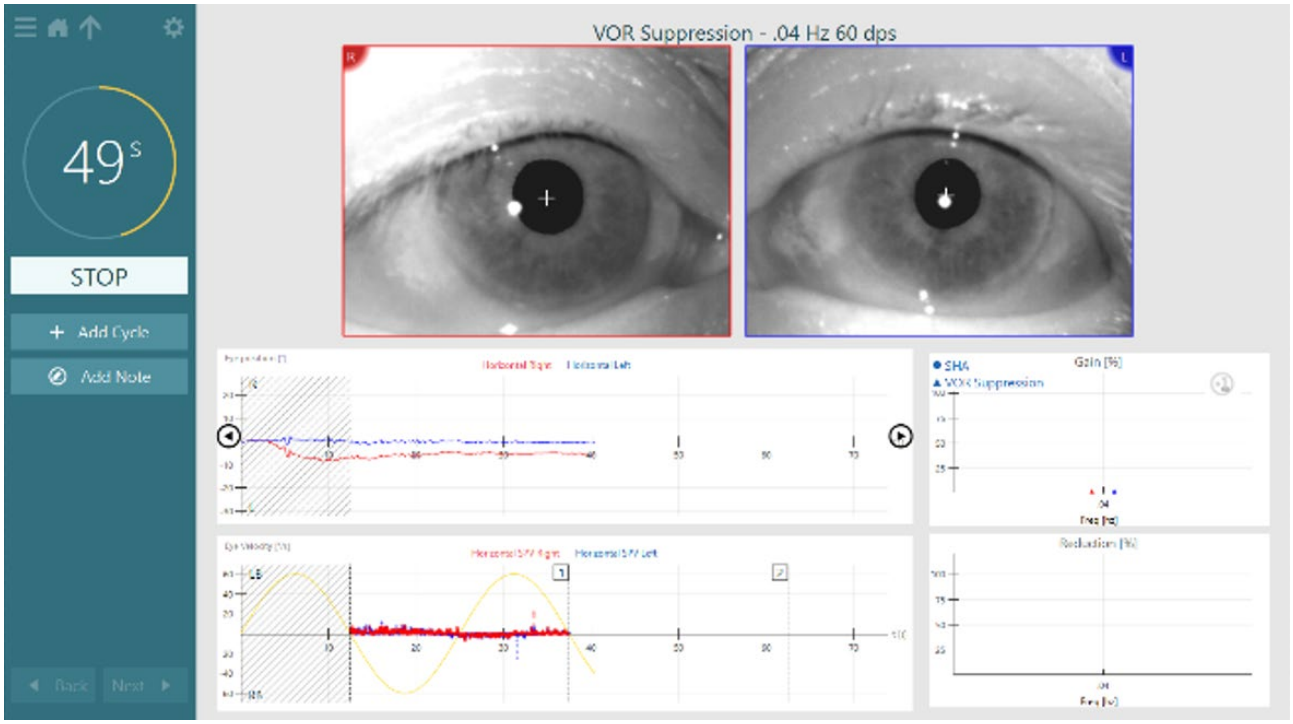


Figure 3.10-22 VOR Suppression testing

The VOR Suppression test will be available within the protocol. You can also select it directly from the side menu panel by tapping the ‘hamburger’ icon in the upper left corner of the test screen.

Example instructions for the patient:
“You will feel yourself rotating back and forth slowly in the chair. During the rotation, you will see a small light appear within the mask. Please keep your eyes open and focused on the light during the entire test. Try to prevent the light from ‘bouncing’ around in your view.”

To begin the test (for operator):

1. Select ‘Start’ from the left menu panel.
2. The timer will begin counting down. The test time is pre-defined by the number of cycles selected for the test frequency.

The chair will activate and begin moving in a sinusoidal pattern.
Camera recordings will begin at the onset of chair movement.
The fixation light will also appear within the goggles.
The stimulus and eye movements will be displayed in real time (Figure 3.10-24).
Once the test is complete, a summary test results screen will appear.

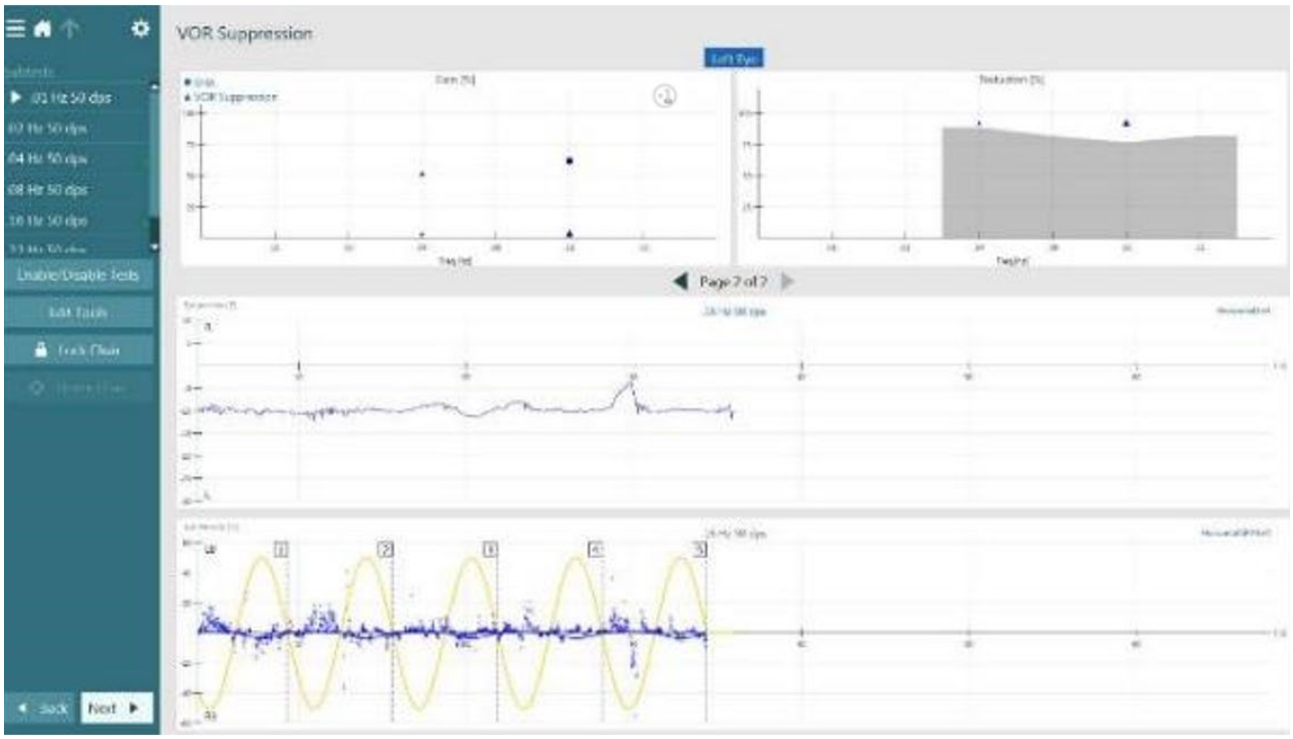


Figure 3.10-23 VOR Suppression summary

A patient with normal VOR Suppression results will produce a tracing that shows significantly reduced nystagmus as the patient is rotated from left to right in the chair. The data points for each frequency tested will appear as triangles in the Gain (%) and Reduction (%) graphs. The circular data points represent the previously recorded SHA results.

Please note: The first half cycle (hatched region) of each frequency tested is excluded from analysis for improved test reliability.

Analysis of eye movements is performed separately for the right and left eyes and the results are displayed separately. Left eye results are displayed by default. You can change the displayed results to the right eye by selecting the eye title in the top center of the summary test results screen.

The summary test results screen displays various analyses. The top portion of the summary results screen displays plots for Gain and Reduction. These parameters are explained in detail in the following section.

Gain

The software will automatically compare the patient's gain during a VOR Suppression test to the gain during a Sinusoidal Harmonic Acceleration test at the same frequency so that both can be plotted on the VOR Suppression gain graph. Sinusoidal Harmonic Acceleration results are plotted with circles and VOR Suppression results are plotted with triangles (Figure 3.10-25).

VOR Suppression gain is simply the raw value for the ratio of maximum slow phase nystagmus velocity to head (chair) velocity. The lower the gain value, the better the patient was able to suppress his/her nystagmus by fixating on a target during SHA rotation. An inability to sufficiently suppress the VOR is indicative of possible central vestibular pathology.

Values are expressed as a percentage (%).

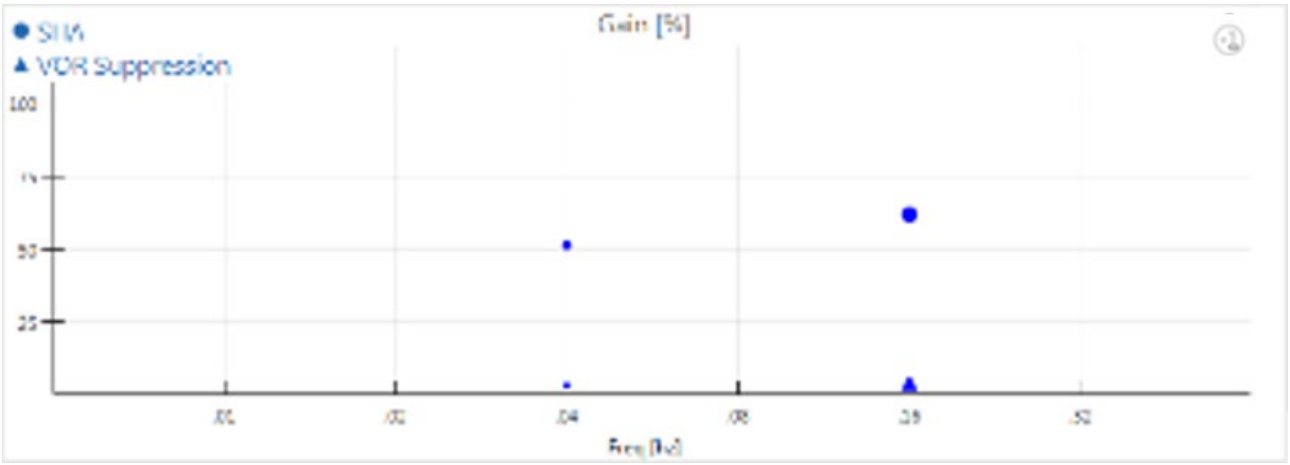


Figure 3.10-24 Gain graph with SHA and VOR Suppression tests

Gain reduction

The percent gain reduction result is obtained by comparing any given frequency of rotation with no visual fixation to the gain result at the same frequency of rotation with visual fixation. Percent gain reduction is a percentage by which the nystagmus has reduced because of fixating on a target. Among the normal population, it is not uncommon to see gain reduction of 50% (Figure 3.10-26).

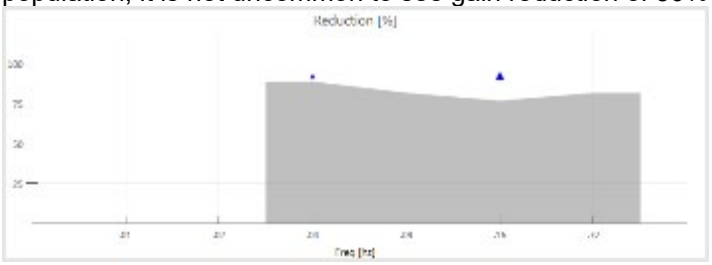


Figure 3.10-25 Gain reduction graph

The percent reduction results are plotted with triangles. Values are expressed as a percentage (%).

Graph numerical values

You can choose to view the numerical values of the graph. By clicking the symbol , the numerical values will be shown for all the relevant graphs in the selected test. You can find this symbol in the right/left corner of the gain graph (refer to section 7.5 for details).

Eye position display

The eye position (°) tracing is displayed in the middle portion of the VOR Suppression summary results screen. The eye position tracing (Figure 3.10-27) represents eye movement during chair rotation and is displayed as a function of eye position in degrees (y-axis) over time in seconds (x-axis). The tracing should appear relatively flat if the patient is able to suppress the nystagmus while fixating.

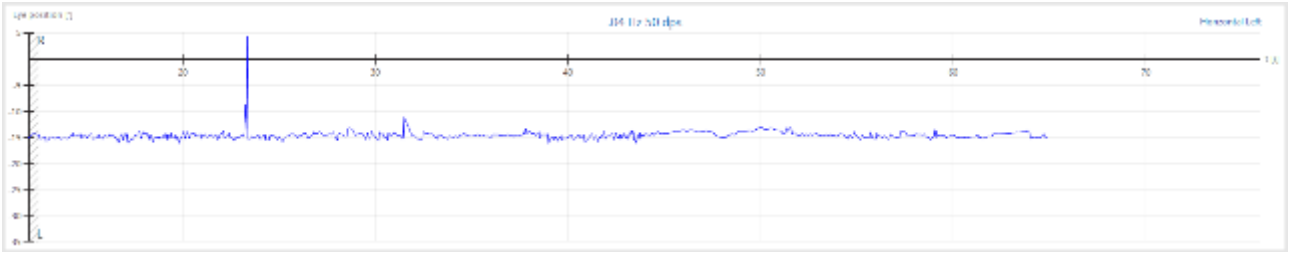


Figure 3.10-26 Eye position trace

Eye velocity display

The eye velocity in °/s (blue) relative to stimulus chair velocity (yellow) is displayed beneath the eye position tracing (Figure 3.10-28).

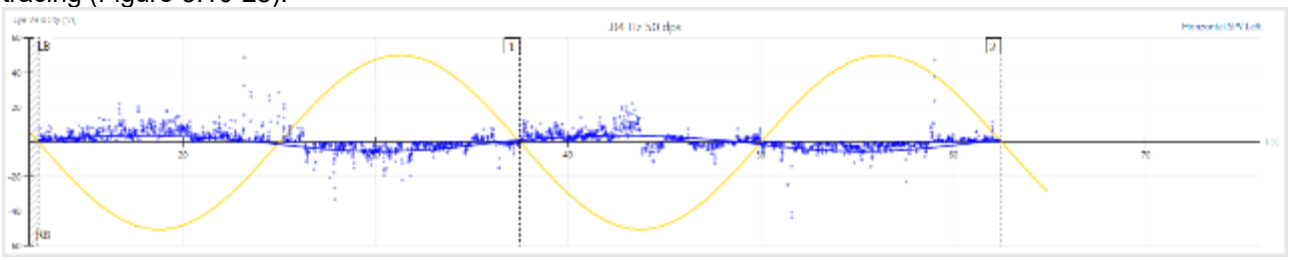


Figure 3.10-27 Display showing detailed individual cycles for eye velocity vs. stimulus velocity

This graphical display provides a detailed individual cycle view for the examiner to see the patient's results in relation to the stimulus. You can also view the number of cycles in this display. The eye velocity should be relatively flat compared to the stimulus chair velocity if the patient is able to suppress the nystagmus while fixating.

3.10.5 Visual VOR test

The visual VOR test requires the patient to be moved in a pendular motion, as in sinusoidal harmonic acceleration with the addition of a visual stimulus on screen. The fixation cover is removed from the goggles for this test and the patient is required to focus on a stationary target on the oculomotor screen during chair rotation from right to left and vice versa. This test provides the user with more information about the calibration, system function, as well as the patient's central vs. peripheral vestibular function.

You can perform the test at any SHA frequency, but it is most performed at 0.32 Hz, which is the frequency defined in the VisualEyes™ 515/525 default protocol.

The visual VOR test will be available within the protocol. You can also select it directly from the side menu panel by tapping the 'hamburger' icon in the upper left corner of the test screen.

Note: You can perform this test with either goggles or electrodes with Orion Auto-Traverse/Comprehensive in the enclosure. The target stimulus will be displayed on the enclosure wall.

Example instructions for the patient:
"You will feel yourself moving back and forth slowly in the chair. During the rotation, you will see a target appear on the screen in front of you. Please keep your eyes focused on the target during the entire test.

To begin the test (for operator):

1. Select 'Start' from the left menu panel.
2. The timer will begin counting down. The test time is pre-defined by the number of cycles selected for the test frequency.

The chair will activate and begin moving in a sinusoidal pattern.
Camera recordings will begin at the onset of chair movement.
The target will be displayed on the secondary monitor.
The stimulus and eye movements will be displayed in real time.

Once the test is complete, a summary test results screen will appear (Figure 3.10-29).

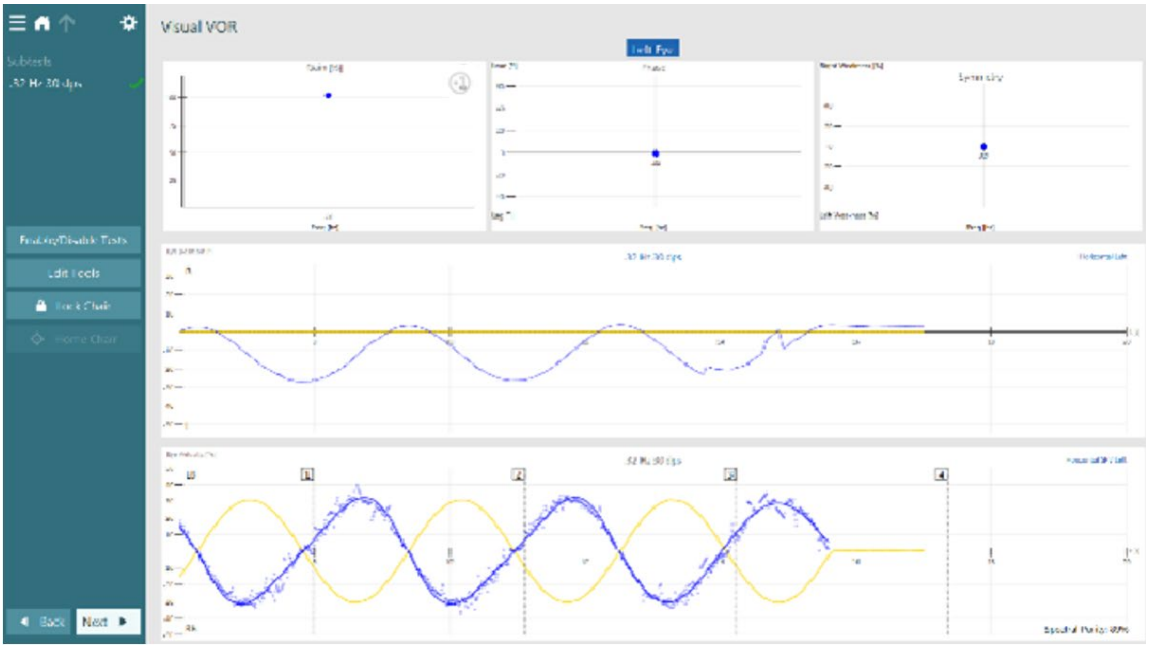


Figure 3.10-28 Visual VOR summary

In a patient with normal visual VOR results, the eyes will move equal and opposite to the chair while he/she is focused on a stationary target. Visual VOR analysis is performed in a similar manner to SHA in that gain, phase, and symmetry are calculated. The data points for each frequency tested will appear as circles in the graphs.

Please note: The first half cycle (hatched region) of each frequency tested is excluded from analysis for improved test reliability.

Analysis of eye movements is performed separately for the right and left eyes and the results are displayed separately. Left eye results are displayed by default. You can change the displayed results to the right eye by selecting the eye title in the top center of the summary test results screen.

The summary test results screen displays various analyses. The top portion of the summary results screen displays plots for Gain, Phase, and Symmetry. These parameters are explained in detail in the following section.

Gain

Gain (%) is the ratio of maximum slow phase eye velocity to maximum head (chair) velocity. The function of the VOR is to produce an eye movement that compensates for head movement. Thus, under perfect conditions, the eye velocity of the response to rotation should be a mirror image of head velocity producing a gain of 60 % (Figure 3.10-30).

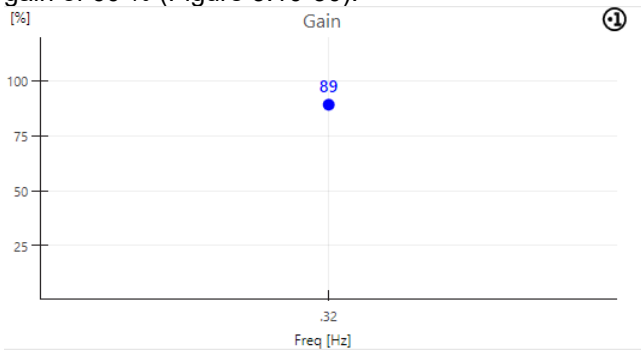


Figure 3.10-29 Visual VOR Gain graph

Phase

Phase (°) displays the timing relationship between the motion stimulus and the ocular response to that stimulus (Figure 3.10-31). Abnormal phase is associated with physiological damage to the VOR. The magnitude of the deviation from normal correlates with the severity of damage.

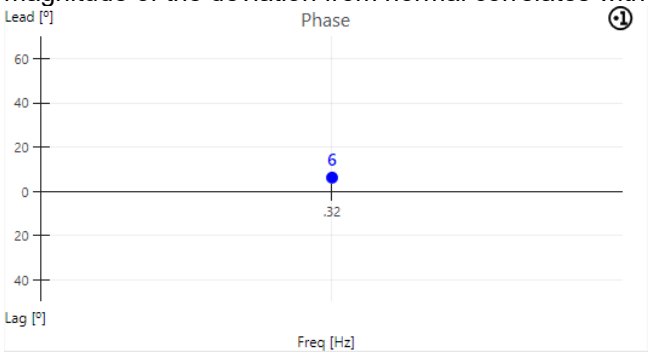


Figure 3.10-30 Visual VOR Phase graph

Symmetry

Symmetry (%) indicates the presence of an imbalance in the system and helps to identify which side is weaker (Figure 3.10-32). A normal finding would present with the data point positioned on the zero line.

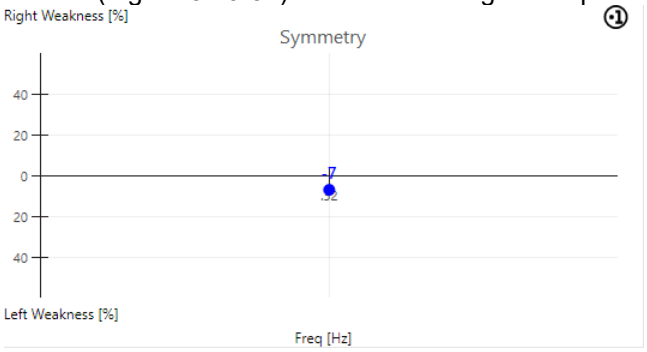


Figure 3.10-31 Visual VOR Symmetry graph

Numerical values for graph

You can choose to view the numerical values of the graph. By clicking the symbol , the numerical values will be shown for all the relevant graphs in the selected test. You can find this symbol in the right/left corner of the gain graph (refer to section 7.5 for details).

Eye position and eye velocity displays

Below the Gain, Phase, and Symmetry graphs are the eye position and eye velocity displays, just as in SHA and VOR suppression (Figure 3.10-33). The eye position tracing should resemble a sinusoid. The eye velocity should appear as a mirror image to chair velocity.

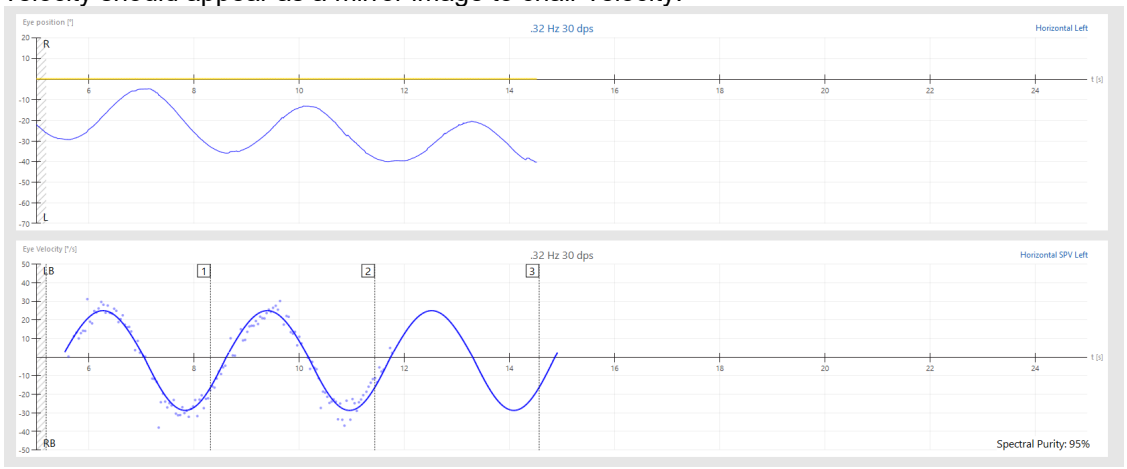


Figure 3.10-32 Visual VOR eye position and eye velocity displays

Spectral purity

You can view a spectral purity value for each frequency tested in the lower right corner of the eye velocity display. The spectral purity of the evoked nystagmus may be useful to indicate whether the test values have been influenced by artifact. The higher the spectral purity value, the more reliable the visual VOR result. Values are displayed as a percentage (%).

3.10.6 Subjective visual vertical (SVV) test

3.10.6.1 Static SVV

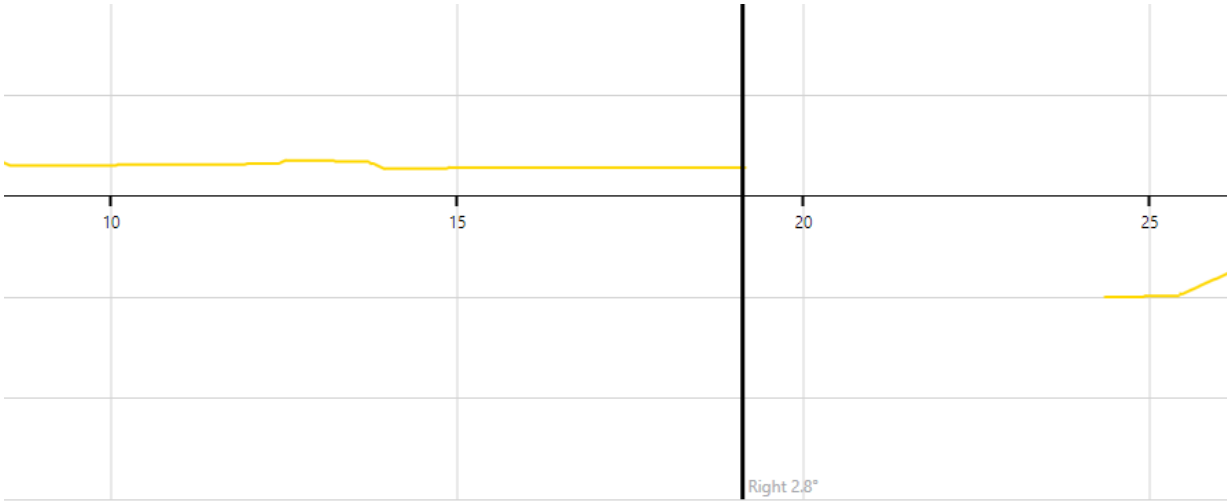
The static SVV test does not require the use of a rotary chair. However, this test is compatible with the AT/C chairs, which provide a light-tight testing environment inside the test booth. The user can also perform this test in a regular test room with the standalone SVV bundle, which is provided with a specific remote. The test procedure is described in section 3.10.6.2, but with the patient remaining static.

Note: It is important that the test room needs to be dark to improve test results.

3.10.6.2 Dynamic SVV

The SVV test checks the patient's otolith function by spinning the patient in the Auto-Traverse chair at a high velocity. A baseline vertical measurement is acquired in the static subtest where the laser line is displayed with the chair stopped. By shifting the patient from the chair's central axis to align the one ear over the chair's central axis, the patient has one otolith charged by the rotation and the other negated of rotation, causing an imbalance and resulting in a perceived variation of vertical. The laser line traced on the booth wall during the test can be adjusted by the patient with the left and right buttons of the chair SVV remote control. Unlike the operator's RF remote control, the patient's SVV remote control buttons can be held down to continually activate and adjust the laser line's angle of rotation.

When the test begins, the chair will begin spinning quickly to the desired velocity (typically 300 degrees/second). Once the velocity is reached, the chair will continue to rotate at the velocity until meeting the time delay setting to provide patient habituation to the chair velocity. The laser is then displayed at the start angle and chair offset settings. The patient must use the SVV remote control to rotate the line to perceived vertical, after which the operator will press the Continue button to move to the next angle and chair offset combination. A vertical line is drawn on the graph with the final vertical orientation recorded at the bottom of the trace. This value is also recorded in the table below the trace (Figures Figure 3.10-34 and Figure 3.10-35).

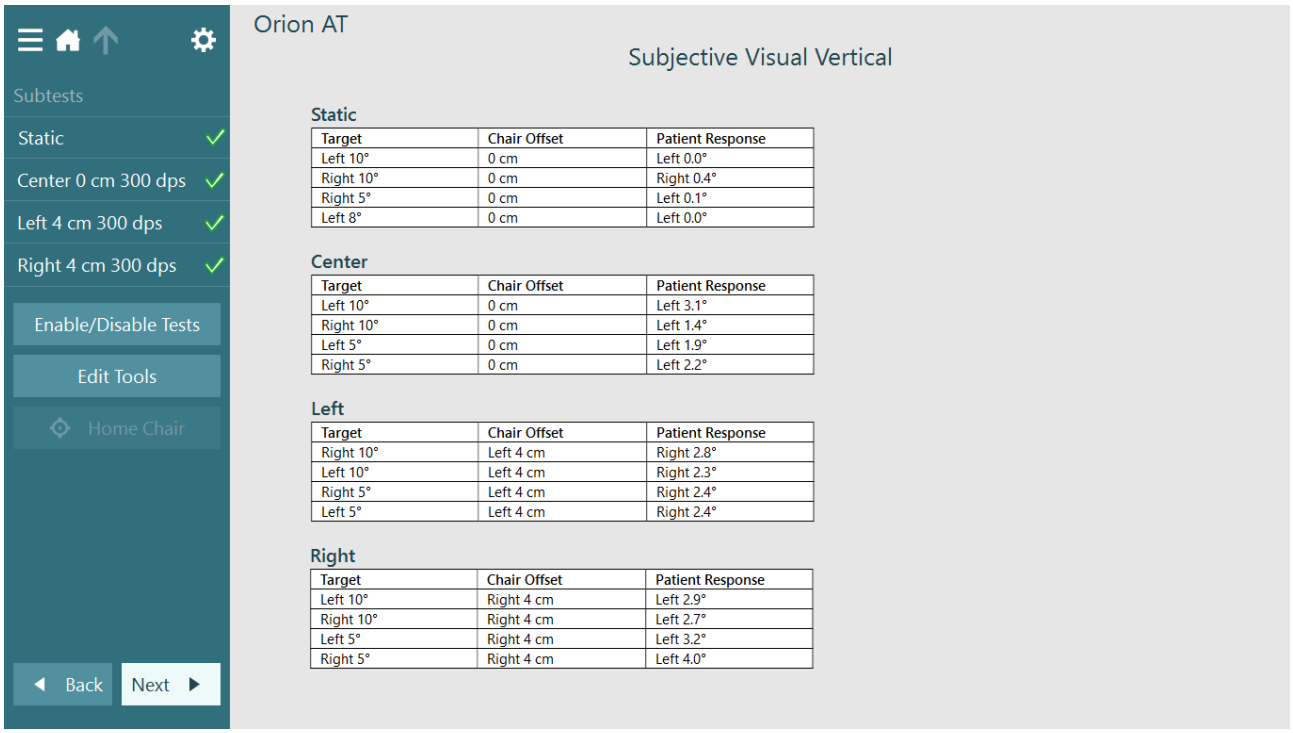


Chair Velocity 0 dps

Chair Offset 0 cm

Target	Chair Offset	Patient Response
Right 10°	Left 4 cm	Right 2.8°
Left 10°	Left 4 cm	Right 2.3°
Right 5°	Left 4 cm	Right 2.4°
Left 5°	Left 4 cm	Right 2.4°

Figure 3.10-33 SVV subtest waveform aligned



Static

Target	Chair Offset	Patient Response
Left 10°	0 cm	Left 0.0°
Right 10°	0 cm	Right 0.4°
Right 5°	0 cm	Left 0.1°
Left 8°	0 cm	Left 0.0°

Center

Target	Chair Offset	Patient Response
Left 10°	0 cm	Left 3.1°
Right 10°	0 cm	Left 1.4°
Left 5°	0 cm	Left 1.9°
Right 5°	0 cm	Left 2.2°

Left

Target	Chair Offset	Patient Response
Right 10°	Left 4 cm	Right 2.8°
Left 10°	Left 4 cm	Right 2.3°
Right 5°	Left 4 cm	Right 2.4°
Left 5°	Left 4 cm	Right 2.4°

Right

Target	Chair Offset	Patient Response
Left 10°	Right 4 cm	Left 2.9°
Right 10°	Right 4 cm	Left 2.7°
Left 5°	Right 4 cm	Left 3.2°
Right 5°	Right 4 cm	Left 4.0°

Figure 3.10-34 SVV summary

4 Research module

The research module is an advanced add-on feature for researchers and scientists who would like to:

- Edit the test settings
- Quickly export large amounts of data
- Customize the analysis of eye movement recordings

4.1 Blinking Cue Light

Blinking Cue Light is placed in the top menu where the video of the eyes is.
When selected, the patient sees a blinking light which centers their eyes to a primary gaze location.
The intermittent nature of this light is a short enough stimulus, so it does not activate the central suppression of nystagmus.

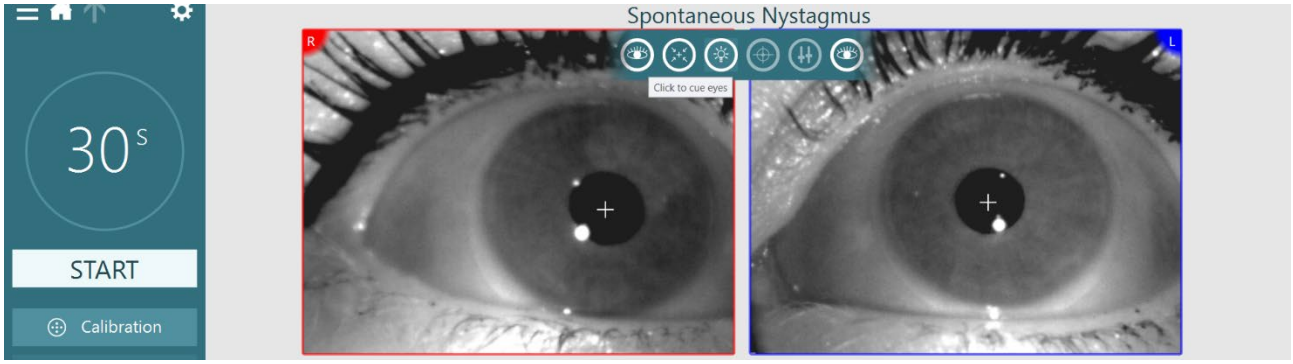


Figure 4.1 Optokinetic test screen, which now allows for change of stimulus angle and speed either before or during the test

4.2 Diagonal OPK Stimulus

Diagonal optokinetic stimulus (Diagonal OPK Stimulus) is available as an option under Test Set Up where the patient can choose the direction of the stimulus anywhere between 0 and 360 degrees. During testing, the clinician has the option to change the speed and direction of the stimulus for rehabilitation purposes.

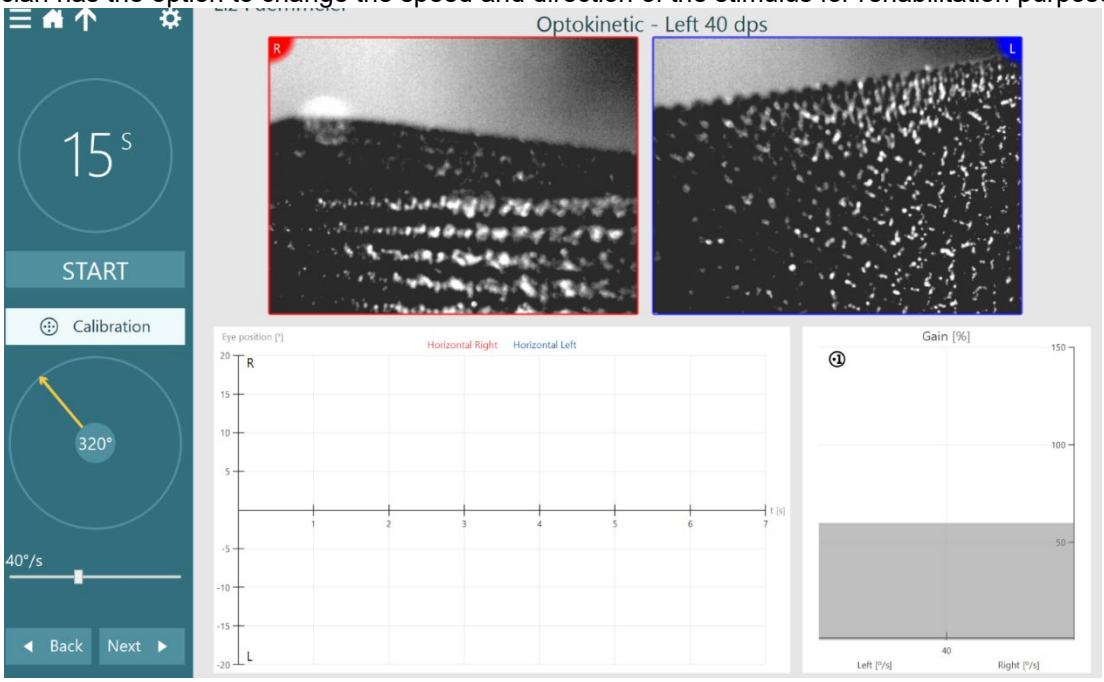
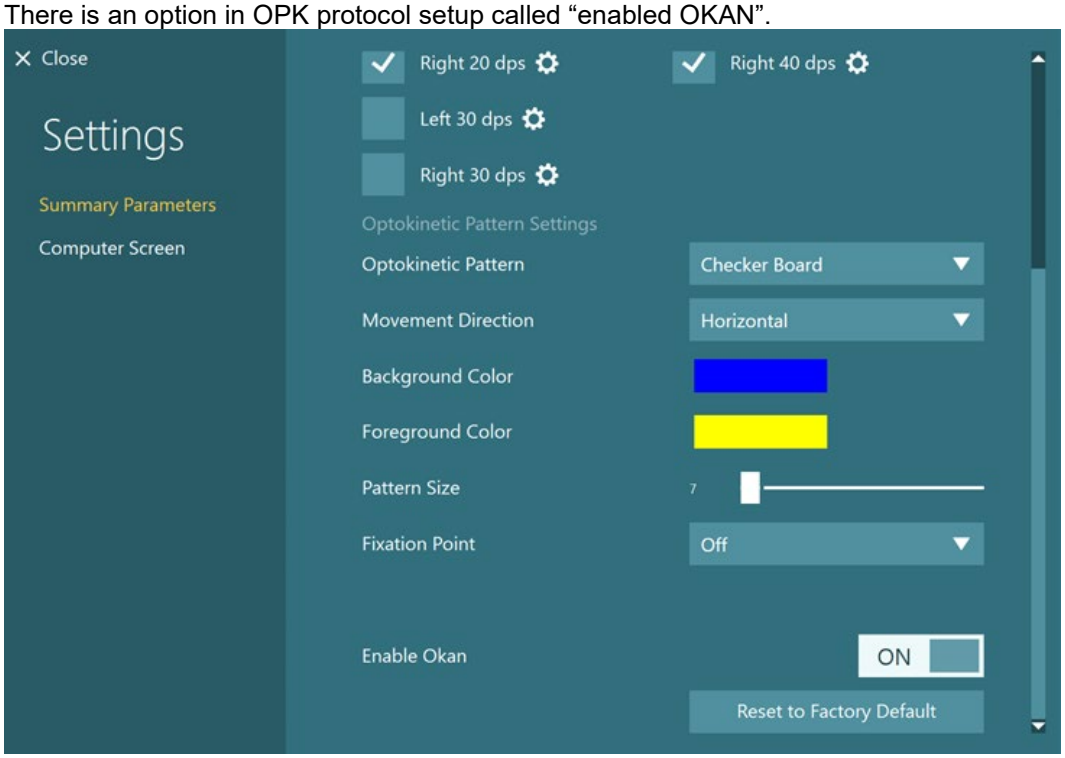


Figure 4.2 Optokinetic test screen, which now allows for change of stimulus angle and speed either before or during the test

Enabled OKAN

There is an option in OPK protocol setup called “enabled OKAN”.



4.3 Nystagmus parameters

If the clinician has the research module, they can adjust the test parameters (refer screen shot) for nystagmus tests.

The clinician can access this option via:

- Spontaneous Nystagmus → Temporaory Settings → Nystagmus Parameters
- Protocol Management → Spontaneous Nystagmus → Nystagmus parameters



Figure 4.3-1 Nystagmus parameters in the Research Module



Figure 4.3-2 Nystagmus parameters in the Research Module

Nystagmus Sensitivity is one of the options of research module. This option sharpens the sensitivity level of nystagmus detection by choosing the 'high sensitivity' option. The clinician can access this option using below listed paths.

- Configurations → System Default Settings → General
- Spontaneous Nystagmus → Temporaory Settings → Nystagmus parameters

In the factory default option, less artifact is detected, and you can therefore see less nystagmus beats in the data plots. In the 'High Sensitivity' option, more nystagmus beats are detected and plotted but you will also see more artifacts in the data. Using either algorithm, the operator can always use the edit tools to override the default nystagmus detected and add or delete the nystagmus beats they choose to have included their reports.

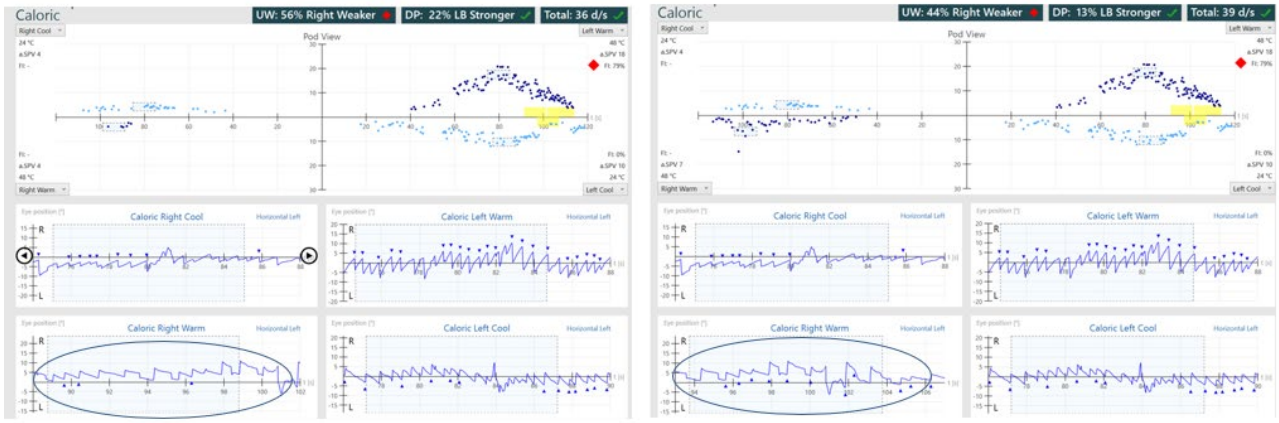


Figure 4.3-1 Factory Default nystagmus sensitivity and (b) more sensitive sensitivity

NOTICE: The clinician should handle the nystagmus parameters with extreme care, as any accidental change to the parameters can affect the test results. Also, if they want to set their own nystagmus parameters as the default, the factory default will be erased permenantly and the system shows a warning message.

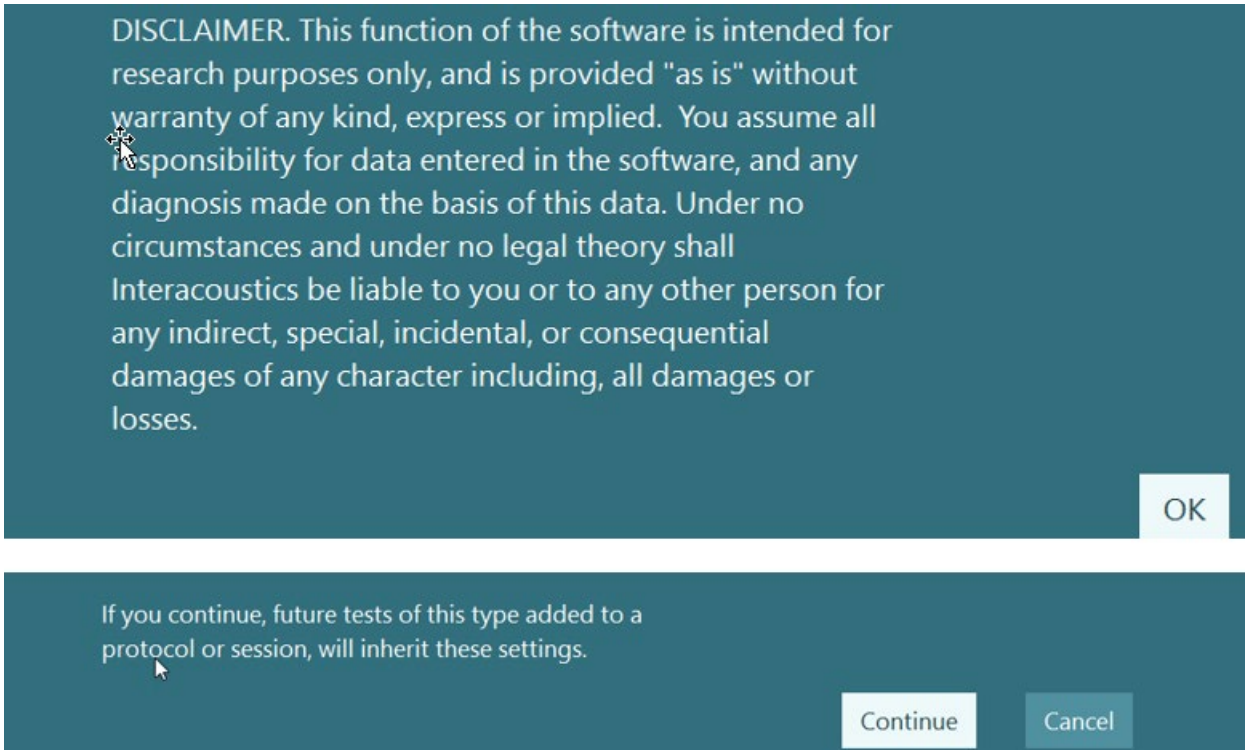


Figure 4.3-4 Warning messages related to Nystagmus sensitivity option

4.4 Data export properties

The Research Module offers the ability to export data from measurements in the system. This section includes descriptions of the exported data parameters

When you have completed your testing, in the Session Review you can choose to export the raw eye movements data to a csv file that is readable by the Excel spreadsheet program for further analysis (Figure 4.4-11).

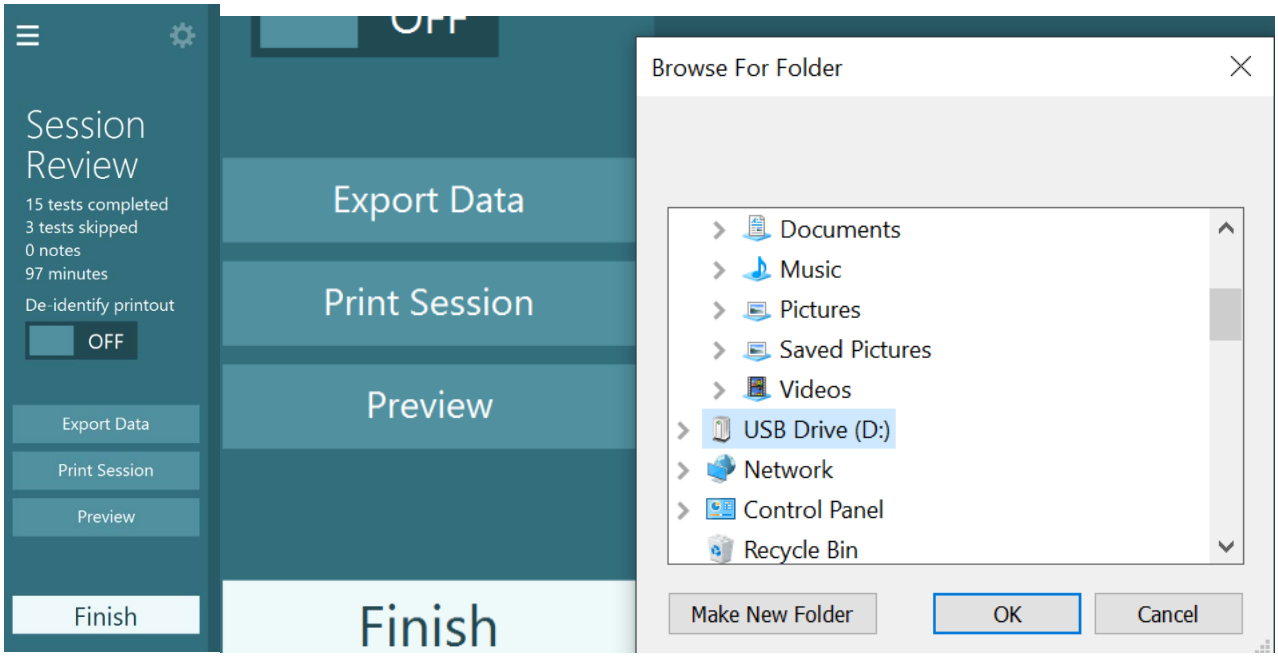


Figure 4.4-1 Export data option in research module

When exporting data from a session, click Export Data from the session review, and select the desired folder for storing the data. The data export will create a folder structure with naming similar to the PDF Filename Configuration defined under System Default Settings > Print.

If the PDF filename configuration is defined as default, the folder structure for the data export will contain a main folder named with the first 3 characters of the patients last name, the first three characters of the patients first name, and the patient identifier, with underscore as field delimiter.
E.g., for a patient called John Demant with patient identifier 1234, the main folder will be named DEM_JOH_1234.

The main folder then contains subfolders for each exported patient session. These folders are named after the date and time in format YYYYMMDD-HHMMSS.

Each patient session folder contains further subfolders for each test performed.

Keyboard marker for tracing: You can export the keyboard marker data. A keyboard marker file will be present in every test file and if you have used this function, the time points will be displayed in the Excel document.

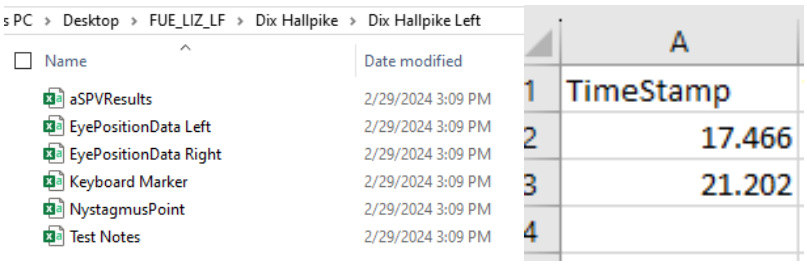


Figure 4.4-2 The left figure shows the exported results for research module users for the Dix Hallpike Left test. In this example (right photo), the keyboard marker was used two times during the testing (at approximately 17 and 21 seconds).

Pupil diameter information: Is exported for each test measured. See the data under the “Test Notes” file under each test.

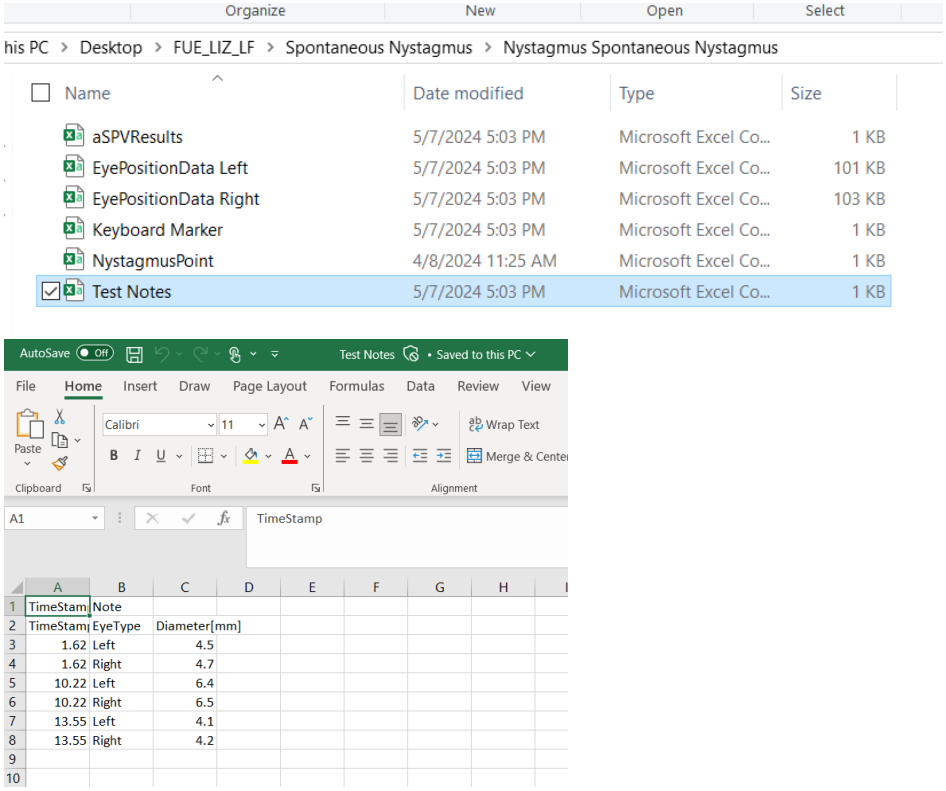
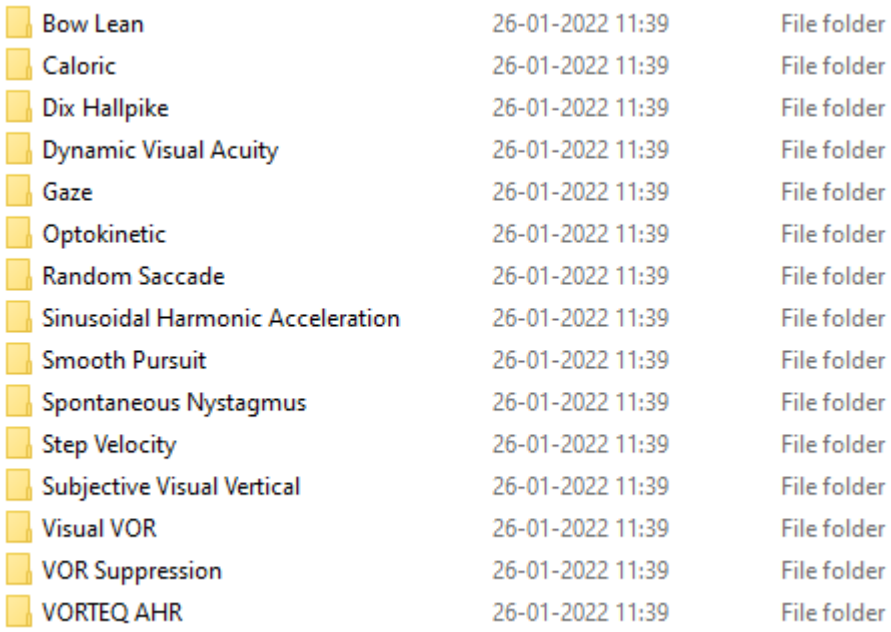
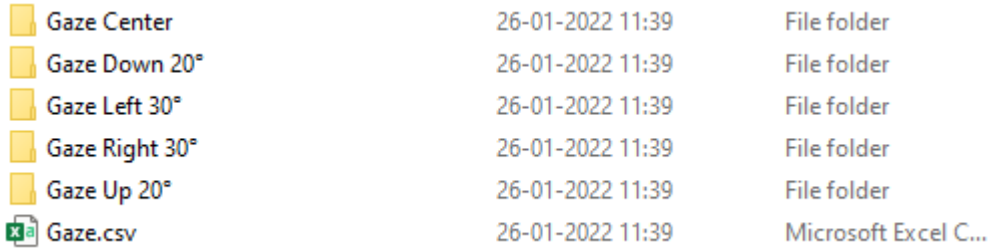


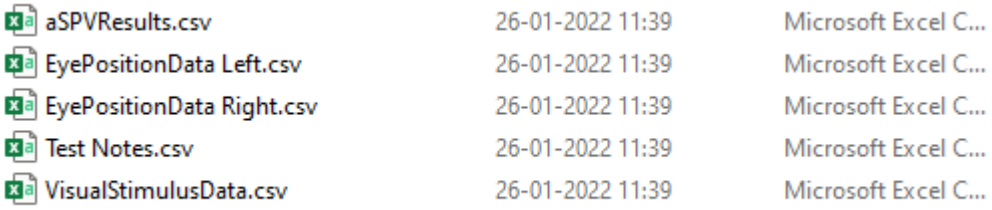
Figure 4.4-3 – The pupil diameter for right and left eye exported data for Research License users.



The test folders contain further subfolders for each subtest, along with one or more .csv files containing summary results for the overall tests.



The subtest folders then contain .csv files with relevant data for the specific subtest.



The available data files will vary depending on the performed measurement as described in table below.

Test	Exported Data files in VisualEyes
Caloric	**Summary file:** Caloric.csv, **For each subtest:** aSPVResults.csv, EyePosition Data Left/Right.csv, NystagmusPoint.csv, Test Notes.csv
Dix Hallpike	**Summary file:**Dix Hallpike.csv, **For each subtest:** aSPVResults.csv, EyePositionData Left/Right.csv, NystagmusPoint.csv, Test Notes.csv
Dix Hallpike Advanced	**Summary file:**Dix Hallpike Advanced.csv, **For each subtest:** aSPVResults.csv, EyePositionData Left/Right.csv, IMUDataSet.csv, NystagmusPoint.csv, TestNotes.csv, TorsionsNystagmusPoint.csv
Dynamic Visual Acuity	**Summary file:**Dynamic Visual Acuity.csv, **For each subtest:** DVATestResults.csv, IMUData.csv, TestNotes.csv
Gaze	**Summary file:**Gaze.csv, **For each subtest:** aSPVResults.csv, EyePositionData Left/Right.csv, NystagmusPoint.csv, Test Notes.csv, VisualStimulusData.csv
Gaze Stabilization	**Summary file:**Gaze Stabilization.csv **For each subtest:** GSTTestResults.csv, IMUData.csv, Test Notes.csv
fvHIT™	**Summary file:**Gaze Stabilization.csv **For each subtest:** fvHITTestResults.csv, ImpulseData.csv, IMUData.csv, Keyboard marker.csv, Test Notes.csv
Lateral Head Roll	**Summary file:**Lateral Head Roll.csv **For each subtest:** aSPVResults.csv, EyePosition Data Left/Right.csv, IMUDataSet.csv, NystagmusPoint.csv, Test Notes.csv
Ocular Counter Roll	**Summary file:**Ocular Counter Roll.csv **For each subtest:** EyePosition Data Left/Right.csv, IMUDataSet.csv, Test Notes.csv, VisualStimulusData.csv
Optokinetic	**Summary file:**Optokinetic.csv **For each subtest:** EyePosition Data Left/Right.csv, NystagmusPoint.csv, Test Notes.csv
Positional	**Summary file:**Positional.csv **For each subtest:** aSPVResults.csv, EyePosition Data Left/Right.csv, NystagmusPoint.csv, Test Notes.csv
Random Saccade	**For each subtest:** EyePosition Data Left/Right.csv, Saccades.csv, Statistics.csv, Test Notes.csv, VisualStimulusData.csv
Saccadometry	**For each subtest:** Error Rates.csv, EyePosition Data Left/Right.csv, Saccades.csv, Statistics.csv, Test Notes.csv, VisualStimulus.csv
Sinusoidal Harmonic Acceleration	**Summary file:** Sinusoidal Harmonic Acceleration.csv **For each subtest:** CalculatedResults.csv, ChairData.csv, EyePositionData Left/Right.csv, Test Notes.csv
Smooth Pursuit	**Summary file:** Smooth Pursuit.csv **For each subtest:** CycleResults.csv, EyePositionData Left/Right.csv, HalfCycleResults.csv, Test Notes.csv, VisualStimulusData.csv
Spontaneous Nystagmus	**For each subtest:** aSPVResults.csv, EyePositionData Left/Right.csv, NystagmusPoint.csv, Test Notes.csv
Step Velocity	**Summary file:** Step Velocity.csv **For each subtest:** CalculatedResults.csv, ChairData.csv, EyePositionData Left/Right.csv, Test Notes.csv
Subjective Visual Vertical Static	**Summary file:** Subjective Visual Vertical Static.csv **For each subtest:** ChairData.csv, SVVData.csv, SVVTestResults.csv, Test Notes.csv

Subjective Visual Vertical (Dynamic)	**Summary file:** Subjective Visual Vertical.csv **For each subtest:** ChairData.csv, SVVData.csv, SVVTestResults.csv, Test Notes.csv
vHIT for EyeSeeCam	**For each subtest:** aSPVResults.csv, EyePositionData Left.csv, ImuData.csv, IMUDataSet.csv, Numerical.csv, Test Notes.csv
vHIT for VORTEQ™	**Summary file:** vHIT for VORTEQ.csv **For each subtest:** EyePositionData Left.csv, IMUData.csv, Test Notes.csv, vHITResults.csv
Visual VOR	**Summary file:** VisualVOR.csv **For each subtest:** CalculatedResults.csv, ChairData.csv, EyePositionData Left/Right.csv, Test Notes.csv, VisualStimulusData.csv
VOR Suppression	**Summary file:** VOR Suppression.csv **For each subtest:** CalculatedResults.csv, ChairData.csv, EyePositionData Left/Right.csv, Test Notes.csv,
VORTEQ™ Active Head Rotation	**Summary file:** VORTEQ AHR.csv **For each subtest:** AHRCycleResults.csv, EyePositionData Left/Right.csv, IMUData.csv, Test Notes.csv

4.4.1 General

4.4.1.1 EyePositionData Left/Right

The *EyePositionData* section includes data for the position and velocity of the tracked pupil.

Parameter:	Description:	Unit:
TimeStamp	Timestamp in seconds	seconds
EyeType	The recorded eye. Can be either *Left* or *Right.*	
Horizontal	Horizontal eye position in degrees. - 0° is center gaze. - Positive values are rightward gaze. - Negative values are leftward gaze.	°
HorizontalRaw	- N/A internal use only	
HorizontalVelocity	N/A internal use only	
Vertical	Vertical eye position in degrees. - 0° is center gaze. - Positive values are upward gaze. - Negative values are downward gaze.	°
VerticalRaw	- N/A internal use only	
VerticalVelocity	N/A internal use only	
PupilDiameter	Pupil diameter in mm.	mm
PupilAngle	When the pupil is observed from the side it is shaped like an ellipse. This is the angle between horizontal and the ellipse in degrees.	
IrisDiameter	Iris Diameter in pixels	Pixels
Torsion	Pupil torsion in degrees (negative/positive values).	°
Deblinked	Determines in a blink is registered. - *True* if blink is registered. - *False* if blink is not registered.	True/False

4.4.2 VisualEyes 505/515/525

4.4.2.1 Caloric (Summary file)

The *CaloricSummaryData* section describes the overall results for the caloric tests.

Parameter:	Description:	Unit:
DP	Directional Preponderance	
DPDirection	Direction of the strongest nystagmus beating. Can be - *LeftBeatingStronger* - *RightBeatingStronger*	
DPLeftBeatingTotal	Sum of average slow phase velocity for Left Warm irrigation and Right cool irrigation (LWaSPV + RCaSPV)	
DPResultState	Evaluation of DP result. Can be: - Normal - Abnormal - Undefined - Unvalidated	
DPRightBeatingTotal	Sum of average slow phase velocity for Left Warm irrigation and Right cool irrigation (RWaSPV + LCaSPV)	
LCaSPV	Peak value of average slow phase velocity for left ear cool irrigation	°/s

LCFI	Fixation index for left ear cool irrigation.	
LCNystBeats	Number of nystagmus beats detected during culmination phase for left ear cool irrigation.	
LIaSPV	Peak value of average slow phase velocity for left ear ice irrigation.	°/s
LINystBeats	Number of nystagmus beats detected during culmination phase for left ear ice irrigation.	
LWaSPV	Peak value of average slow phase velocity for left ear warm irrigation	°/s
LWFI	Fixation index for left ear warm irrigation.	
LWNystBeats	Number of nystagmus beats detected during culmination phase for left ear warm irrigation.	
MWTotalLeft	Monothermal weakness left	
MWTotalRight	Monothermal weakness right	
RCaSPV	Peak value of average slow phase velocity for right ear cool irrigation	°/s
RCFI	Fixation index for left right cool irrigation.	
RCNystBeats	Number of nystagmus beats detected during culmination phase for right ear cool irrigation.	
RIaSPV	Peak value of average slow phase velocity for right ear ice irrigation.	°/s
RINystBeats	Number of nystagmus beats detected during culmination phase for right ear ice irrigation.	
RWaSPV	Peak value of average slow phase velocity for right ear warm irrigation	°/s
RWFI	Fixation index for left right warm irrigation.	
RWNystBeats	Number of nystagmus beats detected during culmination phase for left ear warm irrigation.	
SPN	slow phase velocity for spontaneous nystagmus	°/s
SPNDirection	Nystagmus beat direction of spontaneous nystagmus Can be *Left, Right, Up, Down*	
TotalEyeSpeed	Total slow phase velocity calculated by: RWaSPV + LWaSPV + RCaSPV + LCaSPV	°/s

TSPVResultState	Result state for total slow phase velocity. - Normal - Abnormal - Undefined - Unvalidated	
UW	Unilateral Weakness	
UWCalcStyle	Unilateral weakness calculation style: - Binaural - MWST (Monothermal warm) - Binaural	
UWDirection	Direction of unilateral weakness. Can be: - LeftEarWeakness - RightEarWeakness	
UWResultState	Result state for unilateral weakness. - Normal - Abnormal	
UWTotalLeft	Total slow phase velocity for left ear: LCaSPV + LWaSPV	°/s
UWTotalRight	Total slow phase velocity for right ear: RCaSPV + RWaSPV	°/s

4.4.2.2 Dix Hallpike (Summary file)
Please refer to section 4.4.4.4.2.9

4.4.2.3 Positional (Summary file)
Please refer to section 4.4.4.4.2.9

4.4.2.4 Gaze (Summary file)
Please refer to section 4.4.4.4.2.9

4.4.2.5 Ocular Counter Roll (Summary file)
Not Applicable

4.4.2.6 Optokinetic (Summary file)
The *OptokineticResult* section describes summary results for the optokinetic test.

Parameter:	**Description:**	**Unit:**
Test name	Name of the test	
Eye	The recorded eye. Can be either *Left* or *Right.*	
Gain	Gain value	% * 100
Spv	Slow phase velocity	°/s

4.4.2.7 Random Saccade (Summary file)

Not Applicable

4.4.2.8 Smooth Pursuit (Summary file)

Parameter:	Description:	Unit:
Test name	Name of the test	
Eye	The recorded eye. Can be either *Left* or *Right.*	
Trace	The direction of the trace. Can be *Horizontal* or *Vertical*	
Frequency	Frequency of the test	Hz
Asymmetry	Value of gain asymmetry comparing down/up or left/right gain. Can be: - **Positive if left or down has larger gain value** - **Negative if right or up has larger gain value**	% * 100
AverageGain	Average gain value	% * 100
AverageGainLeftOrDown	Average gain for left or right eye movement	% * 100
AverageGainRightOrUp	Average gain for right or up eye movement	% * 100

4.4.2.9 aSPVResults

The *aSPVResults* section includes data for nystagmus in the culmination phase.

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Direction	Direction of nystagmus beat. Can be *Left, Right, Up, or Down*	
Begin	Timestamp for the beginning of the culmination phase.	s
End	Timestamp for the end of the culmination phase.	s
aSPV	Average slow phase velocity during culmination phase.	°/s
mSPV	Maximum slow phase velocity during culmination phase	°/s
BeatCount	Number of nystagmus beats detected in the culmination phase	
BeatsPrSecond	Number of beats per 1000 seconds.	/1000s
OppositeDirectionBeatCount	Number of nystagmus beats in the opposite direction detected in the culmination phase	
Trace	The direction of the trace. Can be *Horizontal* or *Vertical*	
SetByUser	Indicates if the culmination phase has been manually modified by the user. True if the culmination phase has been modified. False if the culmination phase has not been modified	
Label	If the test is divided in multiple sections, this will describe the name of the section. For example for the default Dix Hallpike test, the section names can be *Supine* or *Sitting*	

4.4.2.10 NystagmusPoint

The *NystagmusPoint* section describes properties of individual detected nystagmus beats.

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Direction	Direction of nystagmus beat. Can be *Left, Right, Up, or Down*	
Trace	The direction of the trace. Can be *Horizontal* or *Vertical*	
SlowPhaseStartTime	Timestamp at the beginning of the slow phase	ms
SlowPhaseStartPosition	Eye position at the beginning of the slow phase	°
SlowPhaseEndTime	Timestamp at the end of the slow phase	ms
SlowPhaseEndPosition	Eye position at the end of the slow phase	°
SlowPhaseVelocity	Slow phase velocity	°/s
FastPhaseStartTime	Timestamp at the beginning of the fast phase	ms
FastPhaseStartPosition	Eyeposition at the beginning of the fast phase	°
FastPhaseEndTime	Timestamp at the end of the fast phase	ms
FastPhaseEndPosition	EyePosition at the end of the fast phase	°
FastPhaseVelocity	fast phase velocity	°/s
State	State of beat. Calculated means it is detected by analysis. ManuallyAdded means it is manually added by user. Disabled means it is disabled by analysis or user.	

4.4.2.11 TorsionNystagmusPoint

The *TorsionNystagmusPoint* section describes properties of individual detected torsional nystagmus beats.

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
TorsionDirection	Direction of torsional nystagmus beat. Can be *CW* (clockwise) or *CCW* (Counter clockwise)	
Trace	Not in use	
SlowPhaseStartTime	Timestamp at the beginning of the slow phase	seconds
SlowPhaseStartPosition	Eyeposition at the beginning of the slow phase	°
SlowPhaseEndTime	Timestamp at the end of the slow phase	seconds
SlowPhaseEndPosition	EyePosition at the end of the slow phase	°
SlowPhaseVelocity	Slow phase velocity	°/s
FastPhaseStartTime	Timestamp at the beginning of the fast phase	seconds
FastPhaseStartPosition	Eyeposition at the beginning of the fast phase	°
FastPhaseEndTime	Timestamp at the end of the fast phase	seconds
FastPhaseEndPosition	EyePosition at the end of the fast phase	°
FastPhaseVelocity	fast phase velocity	°/s
State	See 4.4.2.10	

4.4.2.12 VisualStimulusData

The *VisualStimulusData* section includes data for the presented visual stimulus.

Parameter:	Description:	Unit:
TimeStamp	Timestamp in seconds	seconds
HorizontalPosition	Horizontal stimulus target position in degrees. - **0° is center.** - **Positive values are rightward direction.** - **Negative values are leftward direction.**	°
HorizontalPositionRaw	Not in use	
VerticalPosition	Vertical stimulus target position in degrees. - **0° is center.** - **Positive values are upward direction.** - **Negative values are downward direction.**	°
VerticalPositionRaw	Not in use	

4.4.2.13 Saccades

The *Saccades* section describes properties of individual detected nystagmus beats.

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Direction	Direction of nystagmus beat. Can be *Left, Right, Up, or Down*	
Trace	The direction of the trace. Can be *Horizontal* or *Vertical*	
StartTime	Timestamp for target movement	seconds
MaxVelocityTime	Timestamp for maximum eye velocity	seconds
Accuracy	Saccade accuracy	%
Latency	Saccade latency	ms
Velocity	Peak eye velocity during saccade	°/s
CorrectDirection	Indication if the eye moved in the correct direction - ***True* if eye moved in the correct direction** - ***False* if the eye did not move in the correct direction**	
EyeInitialPosition	Eye position before saccade movement	°
EyeFinalPosition	Eye position after saccade movement	°
TargetPreviousPosition	Target position before saccade	°
TargetNewPosition	Target position after saccade	°
State	State of the saccade acceptance. - ***Empty* if saccade is accepted** - ***"Incorrect"* if saccade is in the wrong direction** - ***"Rejected"* if saccade is filtered due to artifact rejection**	

4.4.2.14 Statistics

The *Statistics* section describes summary statistics for eye- and direction specific saccades.

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Direction	Direction of nystagmus beat. Can be *Left, Right, Up, or Down*	
AcceptedSaccadeCount	Number of well performed saccades in the specific direction, that meet the acceptance criterias in the VisualEyes software.	
SaccadeCount	Number of stimuli saccade jumps	
Incorrect	Number of accepted saccades, but in the wrong direction	
Rejected	Number of filtered saccades due to artifact rejection	
AccuracyAverage	Average value of accuracy	%
LatencyAverage	Average value of latency	ms
VelocityAverage	Average value of peak eye velocity	°/s

The *Statistics* section furthermore contains a *Horizontal/Vertical average* subsection:

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Direction	Direction of nystagmus beat. Can be *Left, Right, Up, or Down*	
Latency	Average value of latency	ms
Velocity	Average value of eye velocity	°/s
Accuracy	Average value of accuracy	%

4.4.2.15 ErrorRates (saccadometry)

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Direction	Direction of nystagmus beat. Can be *Left, Right, Up, or Down*	
Directional Error	Directional error rate in percent	%
Overall Error	Overall error rate in percent	%

4.4.2.16 CycleResults

The *CycleResults* section describes

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Trace	The direction of the trace. Can be *Horizontal* or *Vertical*	
Frequency	Frequency of the test	Hz
Asymmetry	Value of gain asymmetry comparing down/up or left/right gain. Can be: - **Positive if left or down has larger gain value** - **Negative if right or up has larger gain value**	% * 100
AverageGain	Average gain value	% * 100
AverageGainLeftOrDown	Average gain for left or right eye movement	% * 100
AverageGainRightOrUp	Average gain for right or up eye movement	% * 100

4.4.2.17 HalfCycleResults

The *HalfCycleResults* section describes

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Direction	The direction of the half cycle movement. Can be either *Left* or *Right.*	
Trace	The direction of the trace. Can be *Horizontal* or *Vertical*	
CycleFrequency	Half cycle frequency	Hz
EyeMovementDelay	Delay between eye and target intersection	ms
Gain	Gain value for halfcycle	% * 100
TargetStartTime	Timestamp for starting time	seconds
TargetStartPosition	TargetPosition at start time	°
TargetEndTime	Timestamp for end time	seconds
TargetEndPosition	TargetPosition at end time	°

4.4.3 VORTEQ™

4.4.3.1 Dix Hallpike Advanced (Summary file)

Please Refer to section 4.4.2.9

4.4.3.2 Dynamic Visual Acuity (Summary file)

Parameter:	Description:	Unit:
TestName	Name of test	
Direction	Direction of head movement. - **Up** - **Down** - **Left** - **Right** - **Static.**	
HeadVelocity	Head velocity in degrees per second	°/s
LogMARValue	Size of optotype	

4.4.3.3 Gaze Stabilization (Summary file)

Parameter:	Description:	Unit:
TestName	Name of test	
LogMARValue	Size of optotype for static test	
Visual Proc. Time	Time optotype is presented to patient	ms
TargetHeadVelocity	TargetHeadVelocity in degrees per second	°/s
	-	

4.4.3.4 Lateral Head Roll (Summary file)

Please Refer to section 4.4.2.9

4.4.3.5 vHIT for VORTEQ™ (Summary file)

Parameter:	Description:	Unit:
TestName	Name of test	
EyeType	Tested eye	
RightGain	- **Average gain for right ear in percent**	%
LeftGain	- **Average gain for left ear in percent**	%

4.4.3.6 VORTEQ™ AHR (Summary file)

Parameter:	Description:	Unit:
TestName	Name of the test	
Eye	Not in Use	
Direction	Not in Use	
Trace	Not in Use	
Frequency	Cycle frequency in Hz	Hz
AverageGain	Average Gain value in percent	%
AveragePhase	Average Phase value in degrees	°
AverageSymmetry	Values > 0 shows a right weakness Values < 0 shows a left weakness	
CycleCounter	Number of performed cycles	

4.4.3.7 IMUData

The *IMUData* section includes data from the IMU describing the head position and velocity.

	Description:	Unit:
TimeStamp	Timestamp in milliseconds	ms
Xpos	X Axis angular head position - **0° is center.** - **Positive values are ....** - **Negative values are .**	°
XPosOffSet	X axis calibration offset, compensating for drift in Active Head Rotation test.	°
XVelo	X axis velocity	°/s
AdjustedXPos	*XPos compensated for offset*	°
Ypos	Y Axis angular head position	°
YVelo	*Y axis velocity*	°/s
Zpos	Z Axis angular head position	°
ZPosOffset	Z axis calibration offset	°
Zvelo	Z axis velocity	°/s
AdjustedZPos	*Zpos compensated for offset*	°

4.4.3.8 IMUDataSet (Dix Hallpike Advanced)

Parameter:	Description:	Unit:
TimeStamp	Timestamp in seconds	seconds
X	Quaternion data X	
Y	Quaternion data Y	
Z	Quaternion data Z	
W	Quaternion data W	

4.4.3.9 AHRCycleResults

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Direction	The direction of the half cycle movement. Can be either *Left* or *Right.*	
Trace	The direction of the trace. Can be *Horizontal* or *Vertical*	
CycleStartTime	Timestamp in seconds for beginning of cycle	Seconds
CycleEndTime	Timestamp in seconds for end of cycle	seconds
Frequency	Frequency of the test	Hz
Gain	Gain value in percent	%
Phase	Phase value in degrees	°

4.4.3.10 AHRCycleStatistics

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Direction	The direction of the half cycle movement. Can be either *Left* or *Right.*	
Trace	The direction of the trace. Can be *Horizontal* or *Vertical*	
Frequency	Cycle frequency in Hz	Hz
AverageGain	Average Gain value in percent	%
AveragePhase	Average Phase value in degrees	°
AverageSymmetry	Values > 0 shows a right weakness Values < 0 shows a left weakness	
CycleCounter	Number of performed cycles	

4.4.3.11 DVATestResults

Parameter:	Description:	Unit:
TotalResponses	Number of overall user responses	
CorectResponses	Number of correct user responses	
Direction	Direction of head movement Can be *Left, Right, Up, Down,* or *Static*	
HeadVelocity	Head Velocity	°/s
LogMARValue	Minimum logMAR size for recognizable optotype	
AnswerGiven	- Correct - Incorrect - Don't know	

4.4.3.12 GSTTestResults

Parameter:	Description:	Unit:
LogMARValue	Size of opto type	
ThresholdVelocity	Final velocity that patient was able to give correct response at.	°/s
TargetHeadVelocity	Head velocity in degrees	°/s
AnswerGiven	- Correct - Incorrect - Don't know	

4.4.3.13 fvHITTestResults

Parameter:	Description:	Unit:
TestName	Name of test performed	
ImpulseTimeStamp	Start time of impulse	Seconds
Acceleration	Peak acceleration of impulse	°/s2
Response	Patient response to optotype	
Acceleration	Acceleration bin	°/s2
Correct count	Correct count in acceleration bin	
Incorrect count	Incorrect count in acceleration bin	
Rate	Rate of correct vs incorrect answers	%

4.4.3.14 ImpulseData

Parameter:	Description:	Unit:
Timestamp	Sample timestamp	Seconds
Combined velocity	5 point center weighted smoothed value. For Lateral it is Z velocity on Imu, for LARP and RALP it is a combination of X and Y velocity.	°/s
Acceleration	Current acceleration of sample	°/s2
Horizontal velocity	Velocity of Z axis unsmoothed	°/s
Pitch velocity	Velocity of X axis unsmoothed	°/s
Roll velocity	Velocity of Y axis unsmoothed	°/s

4.4.3.15 VHITCalculatedData (VORTEQ™ vHIT)

Parameter:	Description:	Unit:
TestName	Name of the test	
EyeType	Tested eye	
RightGain	Average gain for right ear in percent	%
LeftGain	Average gain for left ear in percent	%

4.4.3.16 VORTEQImpulse (VORTEQ™ vHIT)

Parameter:	Description:	Unit:
State	Edit state of the impulse: Calculated, DisabledByUser, Filtered or EnabledByUser	
NotAnImpulse	True if impulse is invalid	
BeginTimeStamp	Timestamp in milliseconds. Indicates first datapoint of impulse.	ms
EndTimeStamp	Timestamp in milliseconds. Indicates last datapoint of impulse.	ms
ZeroTimeStamp	Timestamp in milliseconds. Indicates timestamp when impulse velocity reaches thresholdvalue.	Ms
EyeSide	Tested eye.	
EarCanal	Tested ear canal	
Gain	Gain value in percent	%* 100
Peak	Peak velocity in degrees pr second	°/s
PeakHeadVelocityStamp	Timestamp in milliseconds for peak velocity	Ms
SaccadeDetected	True if saccade have been detected	

4.4.4 Rotary Chair Test

4.4.4.1 Sinusoidal Harmonic Acceleration (Summary file)

The *Sinusoidal Harmonic Acceleration* section describes calculated results for the Sinusoidal Harmonic Acceleration test, and VOR suppression test

Parameter:	Description:	Unit:
Eye	The recorded eye. Can be either *Left* or *Right.*	
Gain	Gain value	% * 100
Phase	Phase value presented in degrees	°
SpectralPurity	Value describing signal purity. - **1.00, describes a perfect clean signal.** -	
Symmetry	Value describing the summetry between right/left rotation. - **> 0 indicates a right weakness** - **< 0 indicates a left weakness**	% * 100

4.4.4.2 Step Velocity (Summary file)

Parameter:	Description:	Unit:
RotationDirection	Direction of chair rotation Can be *Left* or *Right*	
Velocity	Velocity of chair rotation	°/s
Eye	The recorded eye. Can be either *Left* or *Right.*	
Phase	Rotation phase. - **PerRotation: During rotation** - **PostRotation: After rotation**	
Gain	Calculated gain value	% * 100
AdjustedGain	Gain value adjusted for spontaneous nystagmus, if SPN correction is turned on.	% * 100
Gain Correction	Correction value based on spontaneous nystagmus, if SPN correction is turned on.	% * 100
Lambda	Inverse of timeconstant: 1.0/TimeConstant	
PeakTimeStanp	Timestamp for peak slow phase velocity	ms
Scep	Slow Cumulative Eye Position.	°
TimeConstant	Amount of time for the response to reach 37% of it's maximum SPV value.	s
Y0	Calculated intersection with Y axis based on fit	
Correct for SPN	True or false depending on what user has chosen	
PerSymmetry	Time constant symmetry per rotation	%
PostSymmetry	Time costant symmetry post rotation	%

4.4.4.3 VisualVOR (Summary file)

Parameter:	Description:	Unit:
Frequency	Frequence of test in Hz	**Hz**
Eye	The recorded eye. Can be either *Left* or *Right.*	
Gain	Gain value	% * 100
Phase	Phase value presented in degrees	°
SpectralPurity	Value describing signal purity. - **1.00, describes a perfect clean signal.**	
Symmetry	Value describing the summetry between right/left rotation. - **> 0 indicates a right weakness** - **< 0 indicates a left weakness**	% * 100

4.4.4.4 VOR Suppression (Summary file)

Parameter:	Description:	Unit:
Frequency	Frequency of the test	Hz
EyeType	The recorded eye. Can be either *Left* or *Right.*	
Gain	Gain value	% * 100
GainSHA	Gain value imported from SHA test at similar frequency.	% * 100
Phase	Phase value	°
Reduction	Reduction value	% * 100
SpectralPurity	Value describing signal purity. - **1.00, describes a perfect clean signal.**	
Symmetry	Not used	

4.4.4.5 CalculatedResults (Step Velocity)

The *CalculatedResults* section under the *Step Velocity* test describes calculated results for the Step Velocity Test.

Parameter:	Description:	Unit:
RotationDirection	Direction of chair rotation Can be *Left* or *Right*	
Velocity	Velocity of chair rotation	°/s
Eye	The recorded eye. Can be either *Left* or *Right.*	
Phase	Rotation phase. - **PerRotation: During rotation** - **PostRotation: After rotation**	
Gain	Calculated gain value	% * 100
AdjustedGain	Gain value adjusted for spontaneous nystagmus, if SPN correction is turned on.	% * 100
Gain Correction	Correction value based on spontaneous nystagmus, if SPN correction is turned on.	% * 100
Lambda	Inverse of timeconstant: 1.0/TimeConstant	
PeakTimeStanp	Timestamp for peak slow phase velocity	ms
Scep	Slow Cumulative Eye Position.	°
TimeConstant	Amount of time for the response to reach 37% of it's maximum SPV value.	S
Y0	Calculated intersection with Y axis based on fit	

4.4.4.6 CalculatedResults (Sinusoidal Harmonic Acceleration test)

The *CalculatedResults* section under the Sinusoidal Harmonic Acceleration test describes calculated results for the Sinusoidal Harmonic Acceleration test.

Parameter:	Description:	Unit:
Frequency	Frequency of the test	Hz
EyeType	The recorded eye. Can be either *Left* or *Right.*	
Gain	Gain value	% * 100
GainSHA	Not in use	
Phase	Phase value	°
Reduction	Not used	
SpectralPurity	Value describing signal purity. - **1.00, describes a perfect clean signal.**	
Symmetry	Value describing the summetry between right/left rotation. - **> 0 indicates a right weakness** - **< 0 indicates a left weakness**	% * 100

4.4.4.7 CalculatedResults (VOR suppression test)

The *CalculatedResults* section under the VOR suppression test describes calculated results for the VOR supression test.

Parameter:	Description:	Unit:
Frequency	Frequency of the test	Hz
EyeType	The recorded eye. Can be either *Left* or *Right.*	
Gain	Gain value	% * 100
GainSHA	Gain value imported from SHA test at similar frequency	% * 100
Phase	Phase value	°
Reduction	Reduction value	% * 100
SpectralPurity	Value describing signal purity. - **1.00, describes a perfect clean signal.**	
Symmetry	Not used	

4.4.4.8 ChairData

The *ChairData* sections includes data from the connected Rotary chair.

Parameter:	Description:	Unit:
TimeStamp	Timestamp in seconds	seconds
BoothDoorOpen	Indicates if the booth door is open. Only relevant for Orion Auto-Traverse/Comprehensive and System2000 Auto-Traverse/Comprehensive - ***True* if booth door is open** - ***False* if booth door is closed, or if the connected chair does not include a booth door.**	
ChairReclined	Indicates if the chair is in reclined state. Only relevant for the Orion Reclining, System2000 Reclining. - ***True* if the chair is reclined** - ***False* if the chair is not reclined, or the connected chair is not a reclining chair.**	
ChairState	Indicates the state of the chair. - ***Moving* if the chair is rotating** - ***Idle* if the chair is not moving** - ***Enabled* if the chair is powered on and connected to the system but not used in the specific test.**	

EStopPressed	Indicates if the emergency stop has been activated. - ***True* if the emergency stop has been pressed** - ***False* if the emergency stop has not been pressed**	
PatientSafetySwitchPressed	Indicates if the patient safety switch in the Auto-Traverse/Comprehensive chair has been pressed. - ***True* if the patient safety switch has been pressed** - ***False* if the patient safety switch has not been pressed, or if the connected chair is not an Auto-Traverse/Comprehensive chair.**	
PPRBitState	*Not in use*	
SignalVelocity	*Not in use*	
StepperOffAxisPosition	Off axis position in cm. Only relevant for Auto-Traverse chairs.	cm
Velocity	Angular velocity of the rotary chair	°/s

4.4.5 SVV Testing

4.4.5.1 Subjective Visual Vertical (Summary)

Parameter:	Description:	Unit:
Test name	Name of test	
Target #	Target number	
Timestamp	Test time in seconds	seconds
ChairOffset	Chair offset in cm	cm
TargetAngle	Intial target angle in degrees	°
ResponseAngle	Target angle at response time	°

4.4.5.2 SVVTestResults

Parameter:	Description:	Unit:
TimeStamp	Timestamp in seconds	seconds
ChairOffset	Chair offset in cm	Cm
TargetAngle	Intial target angle in degrees	°
ResponseAngle	Target angle at response time	°
Visible	If false, patient response is disabled	

4.4.6 EyeSeeCam

4.4.6.1 UncalibratedData (EyeSeeCam)

Parameter:	Description:	Unit:
LeftTime	Time of sample in seconds	seconds
LeftSystemTime	System time in seconds	seconds
LeftFrameIndex	Internal index of sample	
HeadIntertialTime	Time of head sample in seconds	Seconds
HeadIntertialFrame	Internal index of sample	
HeadIntertialAccelX	Head acceleration X	°/s2
HeadIntertialAccelY	Head acceleration Y	°/s2
HeadIntertialAccelZ	Head acceleration Z	°/s2
HeadIntertialVelX	Head velocity X	°/s
HeadIntertialVelY	Head velocity Y	°/s
HeadIntertialVelZ	Head velocity Z	°/s
LeftPupilCol	Pupil tracking horizontal	Pixels
LeftPupilRow	Pupil tracking vertical	Pixels
LeftPupilMethod	Internal use only	
LeftPupilCovXX	Internal use only	
LeftPupilCovXY	Internal use only	
LeftPupilCovYY	Internal use only	
LeftReflexCenterX	Internal use only	
LeftReflexCenterY	Internal use only	

4.4.6.2 CalibratedEyeAndHead (EyeSeeCam)

Parameter:	Description:	Unit:
Time	Sample time in seconds	Seconds
EyePositionHorizontal	Hprizontal eye position	°
EyePositionVertical	Vertical eye position	°
HeadVelocityHorizontal	Horizontal head velocity	°/s
HeadVelocityVertical	Vertical head velocity	°/s
HeadVelocityTorsional	Torsional head velocity (roll)	°/s
StartOfImpulse	1 if sample is at start of impulse, otherwise 0	
PeakOfImpulse	1 if sample is at peak of impulse, otherwise 0	

4.4.6.3 CalibrationEyeLeft (EyeSeeCam)
3x2 Calibration matrix used to convert raw pixel coordinates to degrees for left eye

4.4.6.4 CalibrationEyeRight (EyeSeeCam)
3x2 Calibration matrix used to convert raw pixel coordinates to degrees for right eye

4.4.6.5 CalibrationHeadR (EyeSeeCam)
3x3 R Calibration matrix used for head calibration

4.4.6.6 CalibrationHeadSensorOffset (EyeSeeCam)
1x3 Calibration matrix with head sensor offsets used for calibration

4.4.6.7 Numerical (EyeSeeCam)
Numerical values from Eyeseecam analysis.

5 Patient session

5.1 Selecting a session

The VisualEyes™ system easily allows review of current and or previous sessions for the selected patient. After selecting the desired patient profile, select the **Patient Sessions** button from the main screen. This helps to review a previous test session of the selected patient (Figure 5.1-1).



Figure 5.1-1 Patient Sessions button

The Patient Sessions screen (Figure 5.1-2) displays a list of all previous test sessions in the side panel menu. Selection of a specific session date will display all the tests performed on that date and an indication of whether the test results were completed (green checkmark). Tests outside of the threshold will be marked with a red diamond.

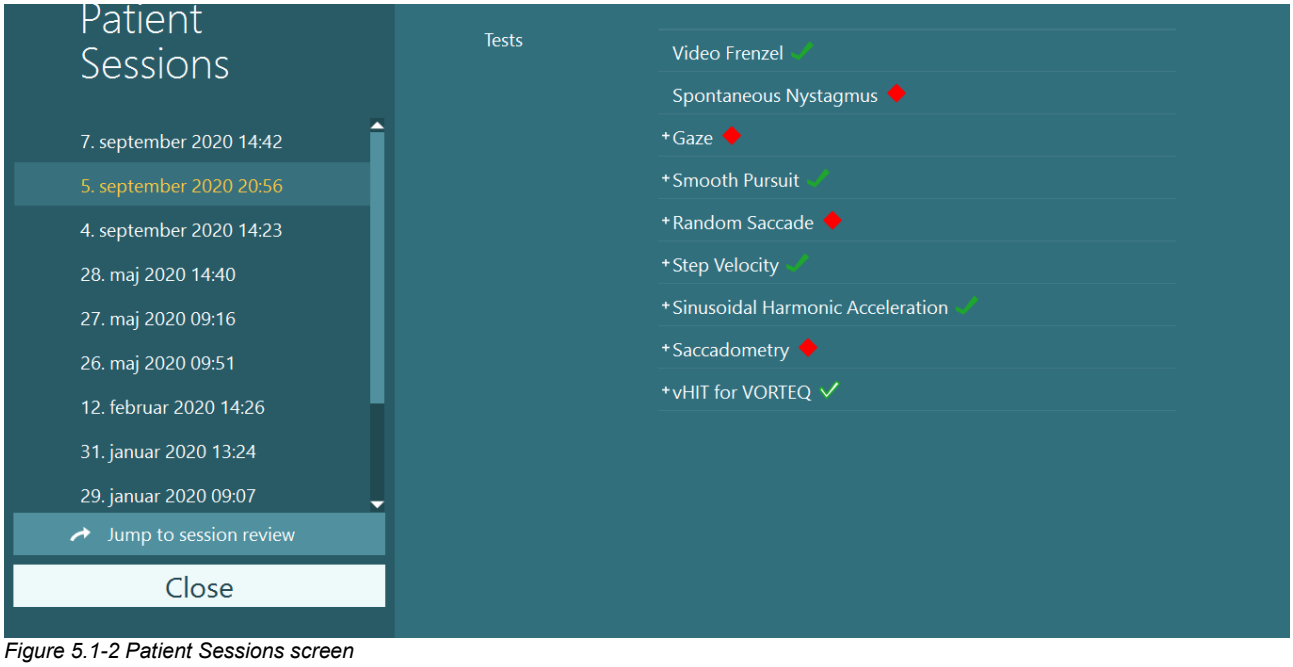


Figure 5.1-2 Patient Sessions screen

After selecting the patient session, click **Jump to session review** to go to the Session Review screen (Figure 5.1-3). This will provide further options like data export, print session, preview, print to database and so forth.

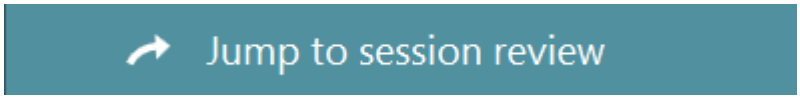


Figure 5.1-3 Jump to session review button

5.2 Session review

You can review results from the test screen by selecting the test menu button in the top left corner of the test screen.



A drop-down menu will appear with the 'Review Session' button displayed at the bottom (Figure 5.2-1).



Figure 5.2-1 Review Session button

Review Session will list the tests within the protocol that have been or are yet to be completed (Figure 5.2-2). A symbol will be present next to completed test names indicating whether the test resulted in a within threshold (green tick) outcome or an outside of threshold (red diamond) outcome. From the Session Review screen, you can review tests, write clinical reports, and print test results.

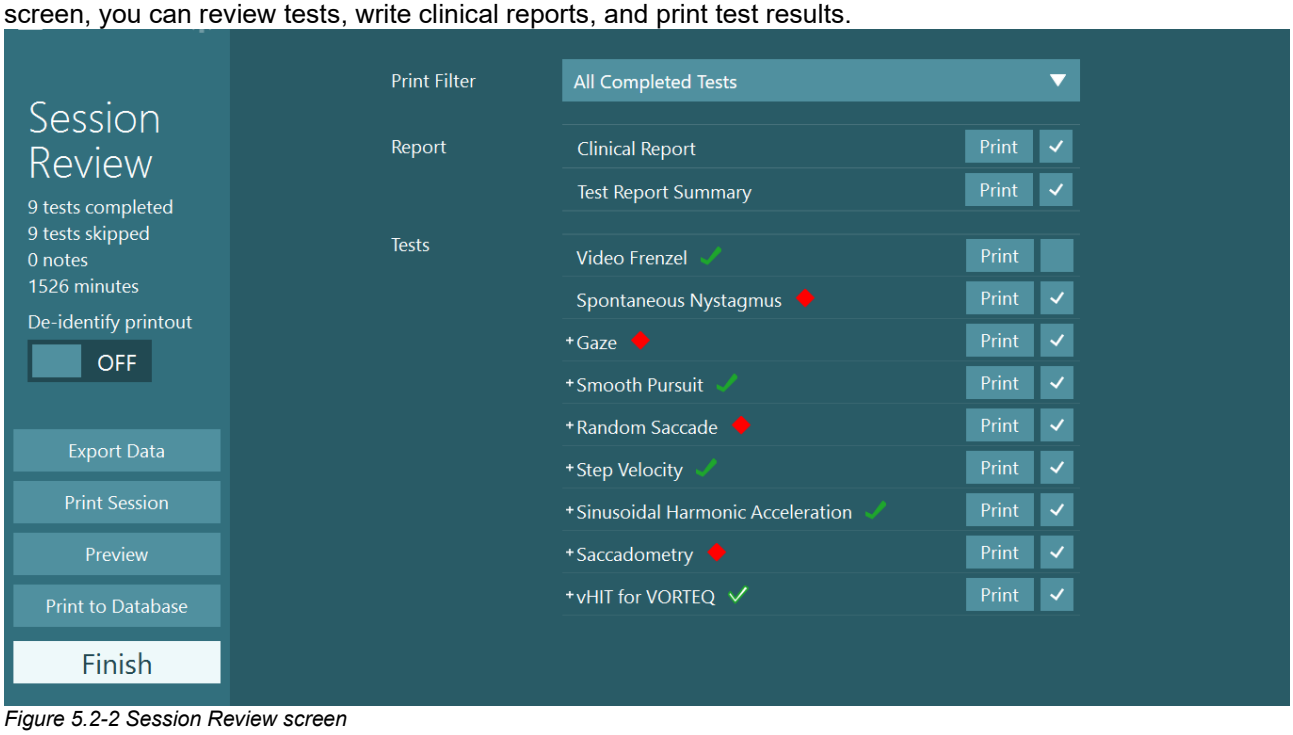


Figure 5.2-2 Session Review screen

Click or touch the **Finish** button in lower left corner of the Session Review screen to return to the main screen.

6 Video recordings

6.1 Recording patient videos

Video recording is set to record some tests in the protocol by default. You can configure video recording for each test in Protocol Management:

- Select **Configuration**
- Select **Protocol Management**
- Highlight the protocol from the list for editing
- Select a test from the protocol
- Select **Edit Test** (the gear icon next to the subtest)
- Select **Test Parameters**

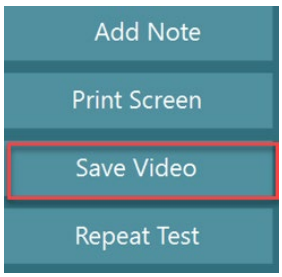


- A Video Auto-Save Settings dialog box will appear (Figure 6.1-1)



Figure 6.1-1 Activate/deactivate Eye and or Room recordings

VisualEyes™ also provides a manual video save option for tests. Following the completed test, a **Save Video** button will appear in the left side panel. By pressing this button, video recordings of the eyes will be automatically saved to the patient session for current or later review.



6.2 Video playback

The videos recorded during the patient session may be reviewed during and/or after testing.
If the operator is within a current test session and has not yet completed the entire protocol, it is possible to view the videos after each subtest.

This can be done by clicking on the play button within the review screen (Figure 6.2-1). A number above the timer will specify how much recording time in seconds is available for review. The video playback will play the full recording from beginning to end.

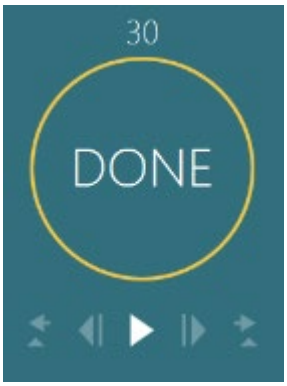


Figure 6.2-1 Video playback display

You can control the video playback with the buttons (Figure 6.2-2) displayed in the playback menu bar underneath the timer:



Figure 6.2-2 Playback menu



Go to previous frame (hold to play backwards in slow motion).



Play/pause.



Go to next frame (hold to play forwards in slow motion).



Go to previous visible nystagmus point.



Go to next visible nystagmus point.

The video playback presents both eyes and raw trace data in parallel. If the test is supported with 3D head model and the user can also view the recorded head movement in the playback mode.
The eye movements can be reviewed on both primary and secondary screens. The eye recordings will show the crosshair for easier identification of abnormal eye movements.
A moving dashed line (Figure 6.2-3) within the raw trace indicates the current point of the video playback.

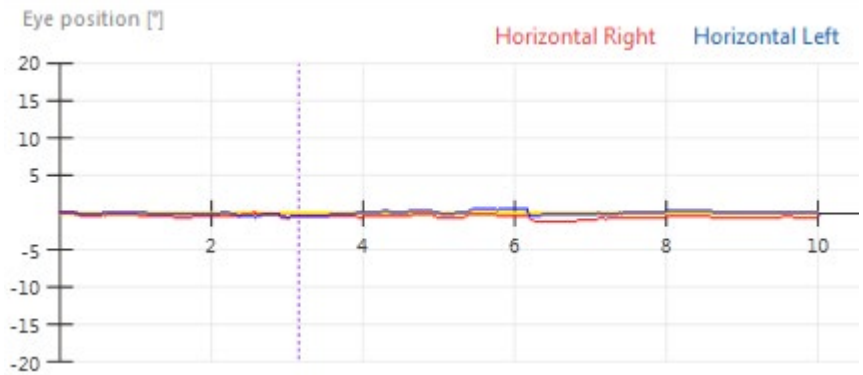


Figure 6.2-3 Dashed line indicating point of video playback

Following a completed session, the recorded videos are archived in the Patient Videos menu.
The video for each individual test can be reviewed by selecting the **Patient Videos** menu from the main screen (Figure 6.2-4).



Figure 6.2-4 Patient Videos button

The tests are categorized by date and test type (Figure 6.2-5).

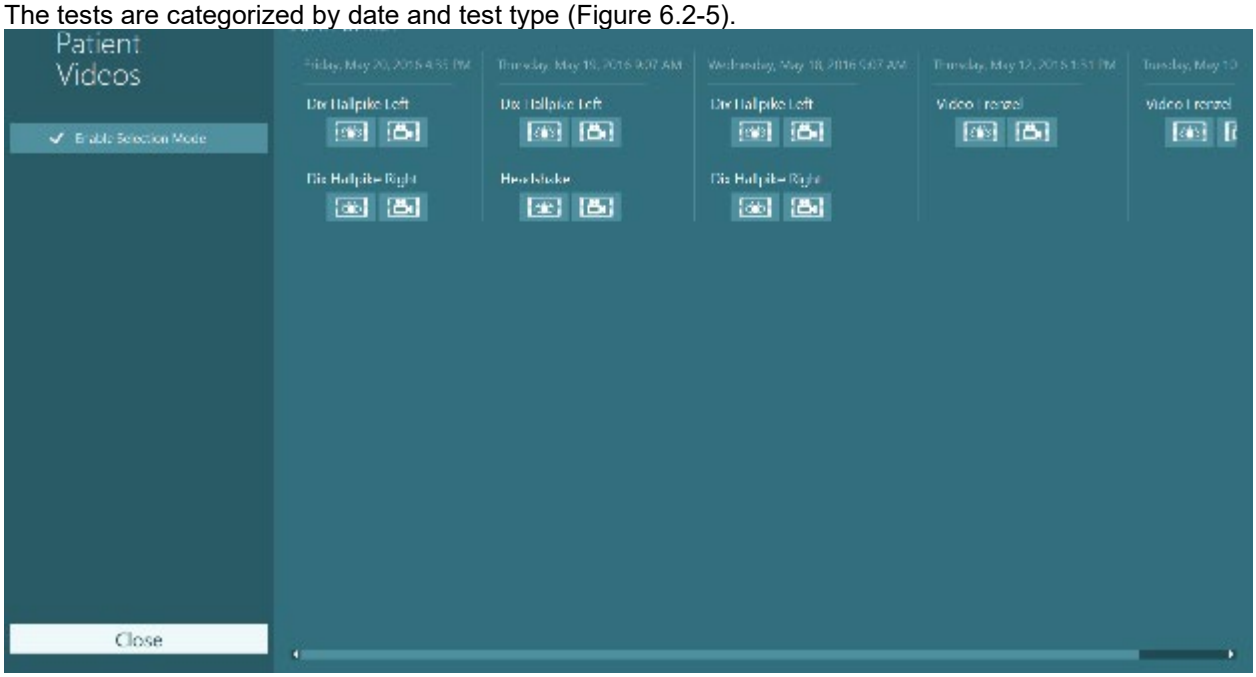


Figure 6.2-5 Patient videos display categorized by date and type of test

To playback the video, click on the video file of interest. It will be launched in a compatible video player (Figure 6.2-6).



Video of eye recordings (no raw data).



Video of room recording

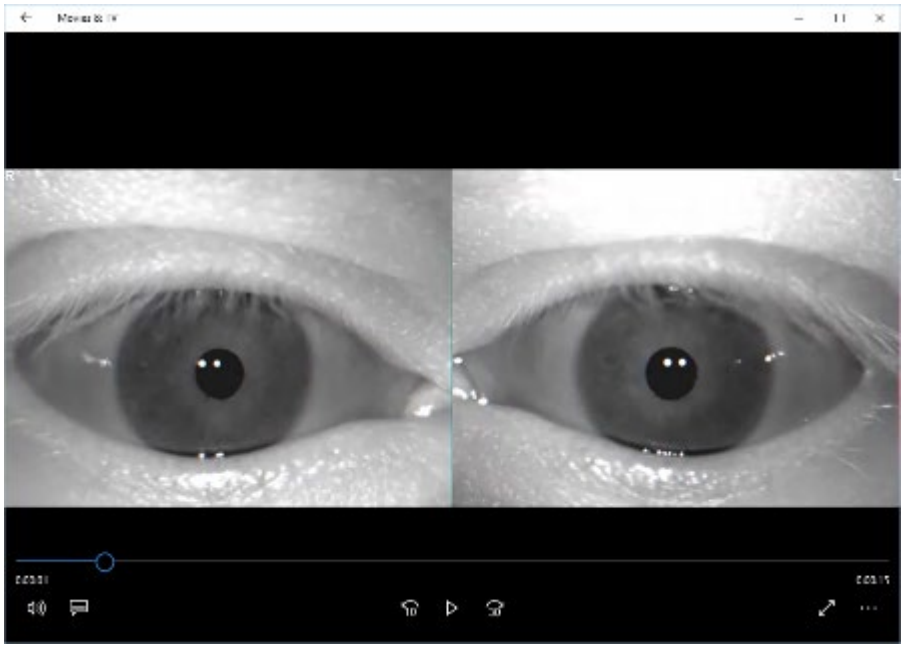


Figure 6.2-6 Video playback within a compatible video player

6.3 Delete selected patient videos

Video recordings can be deleted after the test is complete.

Select the 

from the side bar menu.

A prompt to confirm the deletion will appear (Figure 6.3-1):

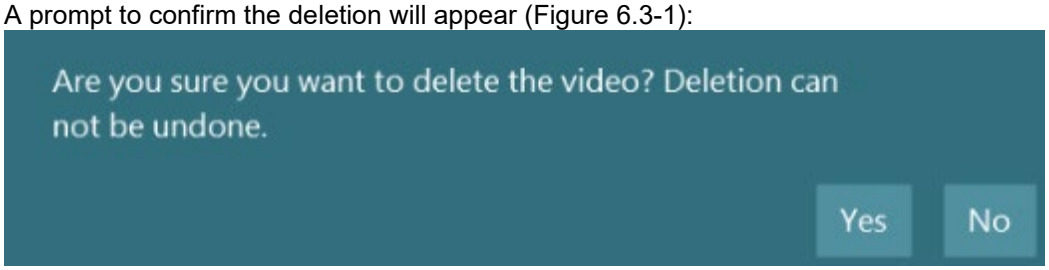


Figure 6.3-1 Warning to delete video

Select **Yes** to continue or N**o** to cancel.

You can also delete videos from the Patient Videos menu:

- Open **Patient Videos**
- Select **Enable Selection mode** (Figure 6.3-2). This will highlight the option in yellow color to indicate the option is turned on.



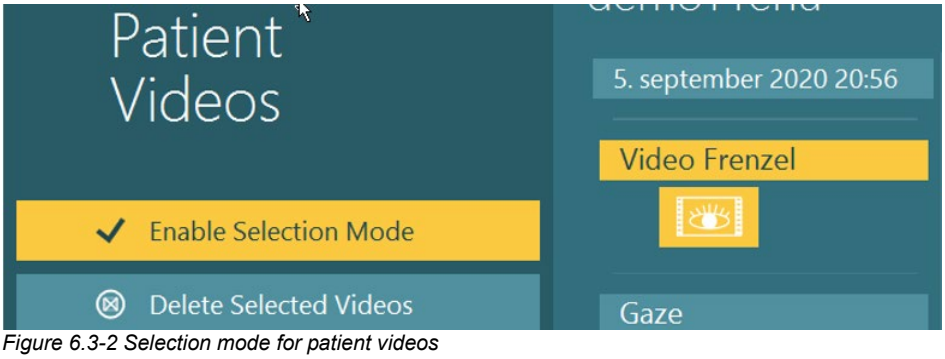


Figure 6.3-2 Selection mode for patient videos

- Touch or click the videos for removal. Both room and eye recordings can be deleted.
- The files will highlight yellow to indicate that these are the chosen files for removal (Figure 6.3-3)


Figure 6.3-3 Highlighted selected videos

- Select the **Delete Selected Videos** option



- A prompt will appear to confirm if you want to delete the selected videos (Figure 6.3-4)



Figure 6.3-4 Prompt to confirm removal of selected videos

- Touching or clicking OK will delete the videos permanently from the VisualEyes™ system

6.4 Exporting patient videos

VisualEyes™ can export videos to another directory or onto an external device. This option is useful if you would like to use the recorded video material for teaching purposes or for confirmation of results.

Touch or click on the Enable Selection Mode button to activate video selection mode. When the video selection mode is active, multiple videos can be selected. When the selection mode is inactive, clicking or touching the video will play the video.

To export selected videos:

- Open **Patient Videos**
- Select **Enable Selection Mode**



- Touch or click the videos of interest for export, which can be room and eye recordings
- The files will highlight yellow to indicate that these are the chosen files for export (Figure 6.4-1)


Figure 6.4-1 Highlighted selected videos

Select the **Export Selected Videos** button.



Figure 6.4-2 Export Selected Videos button

The Export Video Files dialog will be displayed. Select the destination directory for exporting the files of interest (Figure 6.4-23). By default, the eye and room recordings will be merged (if both the eye and room recordings are selected) to make it easier to use in presentations. Uncheck **Combine eye and room videos** to export the videos without merging.



Figure 6.4-3 Destination selection for export video files

When completed, a dialogue message will appear confirming the successful transfer of video files: ‘Export succeeded’.

7 General and editing tools

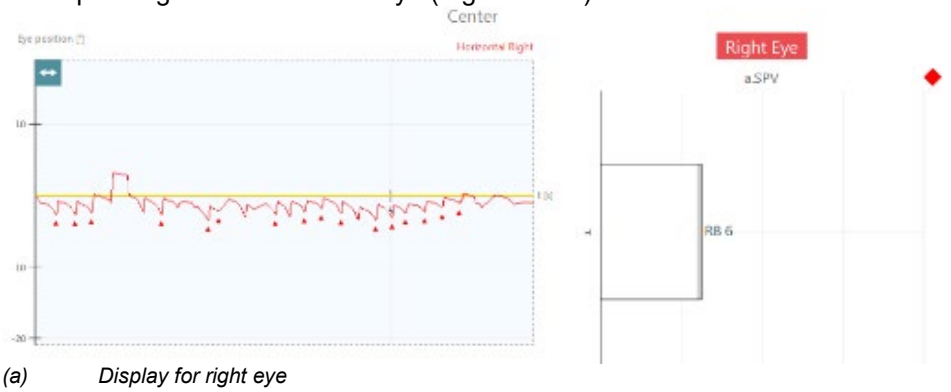
7.1 Quick access test properties

There may be times where it is necessary to make a quick change to a specific test in the protocol. The VisualEyes™ software suite allows for temporary changes to be made to a test. This can be accessed by selecting the configuration icon in the side panel.

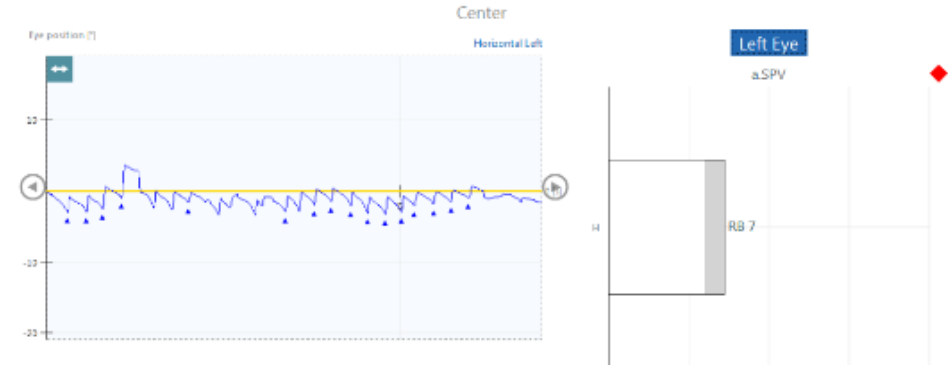
The temporary settings that can be changed will depend on the type of test. Any changes made will be to the patient's current session and will not be saved in the selected protocol.

7.2 Selecting eyes

By default, the VisualEyes™ system shows results for the best eye in nystagmus tests. However, there may be times where the best eye varies from one subtest to another. If so, you can change the eye displayed by clicking or touching the Eye display title (i.e., left/right eye). This will change the Eye display title and all the corresponding data to the other eye (Figure 7.2-1).



(a) Display for right eye



(b) Display for left eye

Figure 7.2-1 Results display for right (a) and left (b) eyes

You can display individual eye traces (i.e., right, or left only) for all nystagmus tests. The default SPV indicator (a. SPV bar graph) is set to display the eye with the larger response.

7.3 Pupil diameters

This graph shows how the pupil diameter changes over time. It is used for pupillometry assessment. The value is given in millimeters and refers to the pupil size shown on the camera.

To activate this trace, select 'Pupil Diameter' (Figure 7.3-1) in Temporary Settings>Computer Screen.



Figure 7.3-1 Pupil Diameter option

Measurement of the pupil diameter is also possible for a specific time point by marking the pupil. After test data collection, go to go to “Edit Tools”, “Add Beat” and click on the Pupil Diameter graph where you wish to measure. You can add multiple measurements.

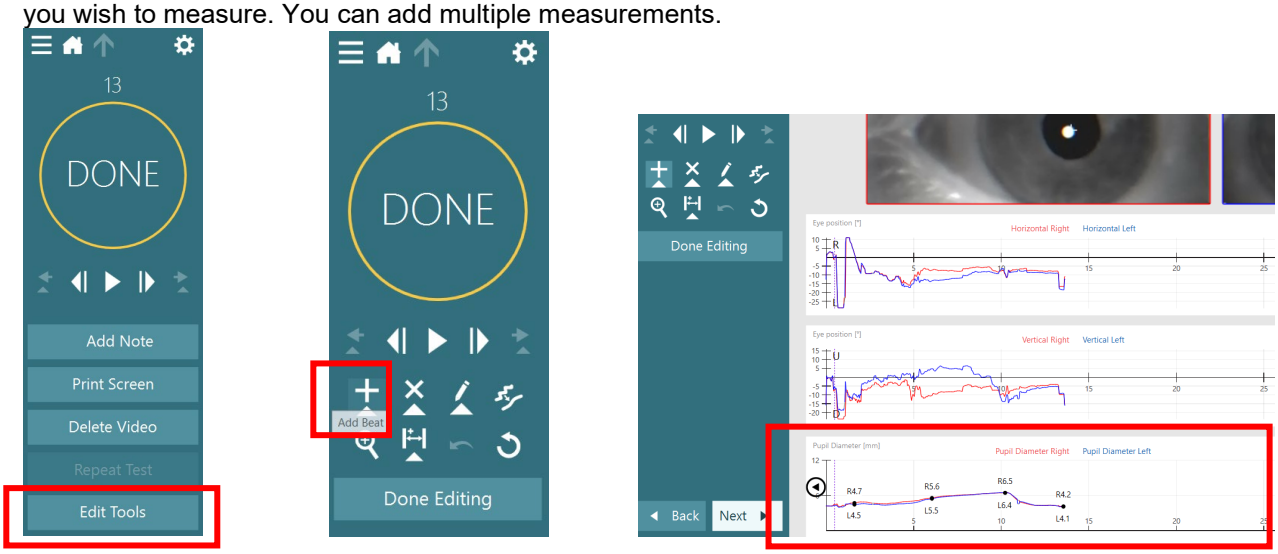


Figure 7.3-2 – The process for adding a pupil measurement: Edit Tools, the + sign and click on the pupil diameter tracing.

To remove the pupil measurement, select X and click on the point you wish to remove.

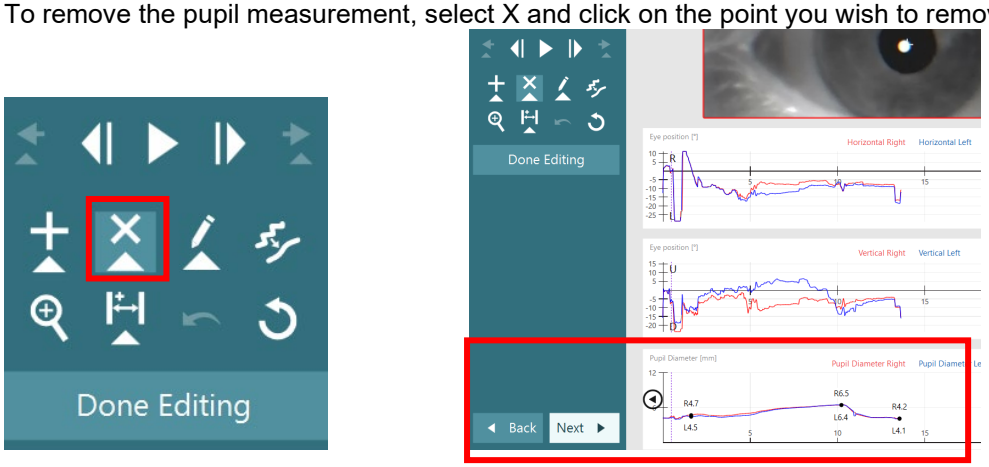
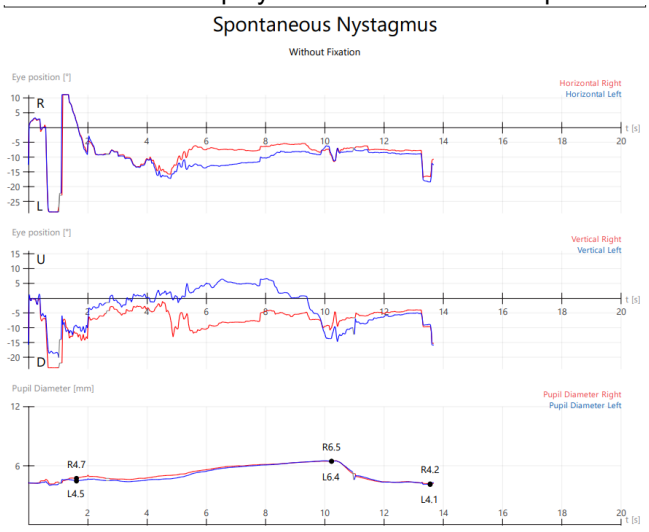


Figure 7.3-3 – The process for removing a pupil measurement: Edit Tools, the x sign and click on the specific pupil measurement you want to remove.

Print:
The data will be displayed at the bottom of the print.



Pupil Diameter from Spontaneous Nystagmus
L - 1.6[s] - 4.5[mm] R - 1.6[s] - 4.7[mm] L - 10.2[s] - 6.4[mm] R - 10.2[s] - 6.5[mm] L - 13.5[s] - 4.1[mm] R - 13.5[s] - 4.2[mm]

Figure 7.3-4 – The pupil diameter print out.

7.4 Editing nystagmus

There is an **Edit Tools** item (Figure 7.4-1) for editing the nystagmus in the recordings. This menu will be available in spontaneous, gaze, optokinetic, positional, Dix Hallpike, caloric, and step velocity tests.



Figure 7.4-1 Edit Tools button

The editing options in this menu include (Figure 7.4-2):

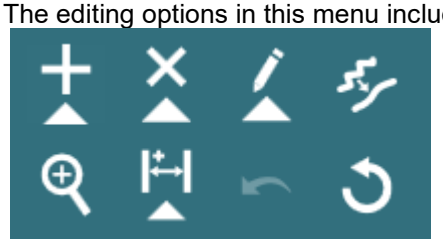


Figure 7.4-2 Edit Tools menu for nystagmus configuration

7.4.1 Add beats

	Selecting this function allows insertion of nystagmus beats that were not originally detected by the nystagmus algorithm (Figure 7.4-3).

- Use the selection box to define the start and end points of a nystagmus beat's slow phase velocity to add to the analysis
- The software will measure the slope identified in the tracing and place an SPV marker in this position or highlight the slope green depending on the system setting

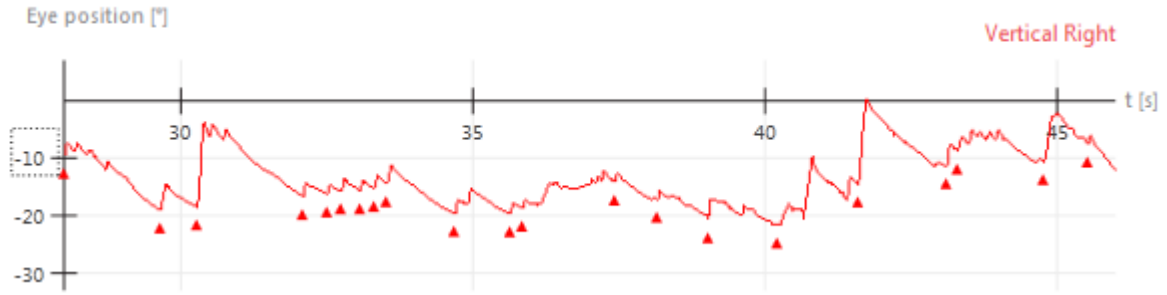


Figure 7.4-3 Added beats to nystagmus trace

7.4.2 Remove beats

	This function will remove multiple nystagmus beats at the operator's discretion (Figure 7.4-4)

- Use the selection box to define the start and end points of the time to remove all nystagmus beats in the selected time frame
- Once removed, the beats become translucent and are removed from the analysis

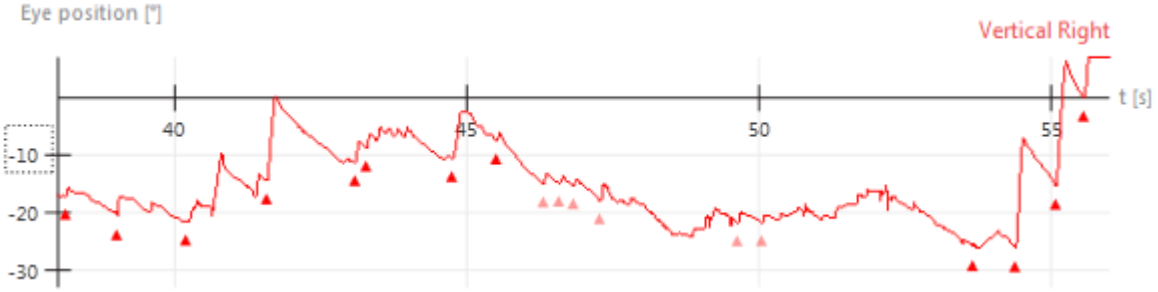


Figure 7.4-4 Removed beats with translucent triangles

7.4.3 Edit slopes

	This function enables overriding the current slope measurement and toggle inclusion of the nystagmus beat in analysis.

- Selecting the tool, the slope of the nystagmus beat will be highlighted in bright green (Figure 7.4-5)



Figure 7.4-5 Selected nystagmus slope

- You can tab through individual beats using the left and right arrow keys on the keyboard or by using the touch screen
- For each beat, the current SPV value will be displayed on the graph
- Use the up and down arrow or buttons in the tool bar to increase or decrease the slope respectively, 1 degree at a time
- During slope editing (
  Figure 7.4-6), the slope line color changes from green to red. Accepting the new value will change the slope line color to green

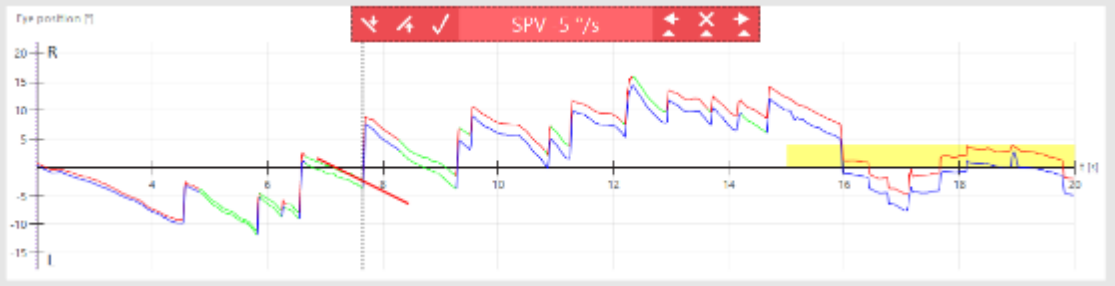


Figure 7.4-6 Editing selected nystagmus slope

- One cannot reverse the phase of the slope, i.e. change a right beating slope into a left beating slope
- The slope value cannot be zero, instead, reject the slope from the analysis using the exclude button
- The toolbar displays the current beat's slow phase velocity in the center of the toolbar. To examine the slope values for each nystagmus beat, use the right and left arrow keys to move through the nystagmus beats and note the slow phase velocity value for each beat

Alternative display for viewing nystagmus

- VisualEyes™ can either display triangles to show the location and direction of nystagmus beats or highlight the nystagmus slow phase in green. In addition to a system wide setting in System Default Settings (see Section 13.4 General), you can change the current test settings (
  Figure 7.4-7) if needed
- Access the test settings from the gear button on the side panel. Select **Nystagmus Parameters**
- **Display nystagmus markers** will control whether the nystagmus triangle markers are displayed
- **Highlight nystagmus slow phase** will control whether the nystagmus slow phase is drawn in green color. This setting is applied after the test collection is complete

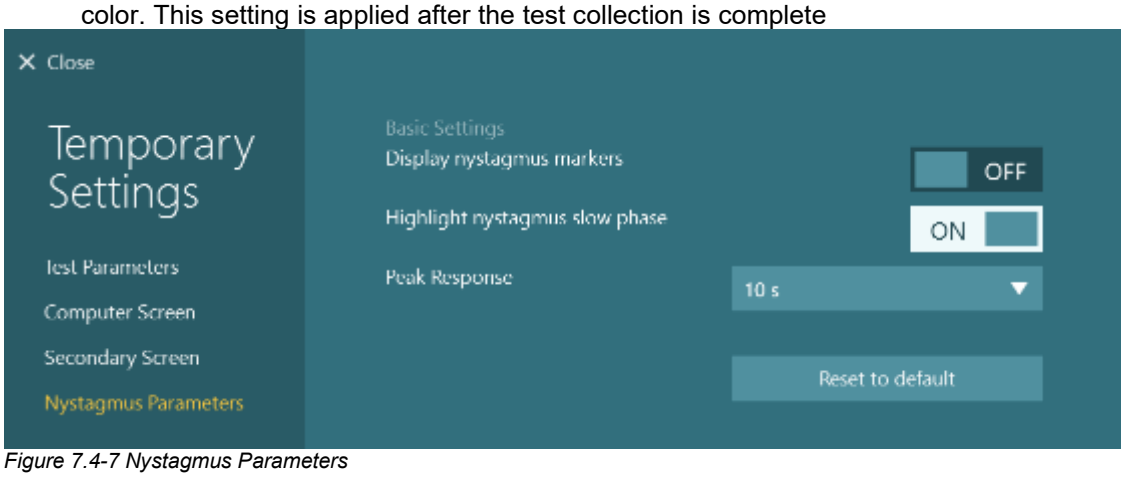


Figure 7.4-7 Nystagmus Parameters

- This will give a quick view of the actual slow phase velocity of the nystagmus (
  Figure 7.4-8)

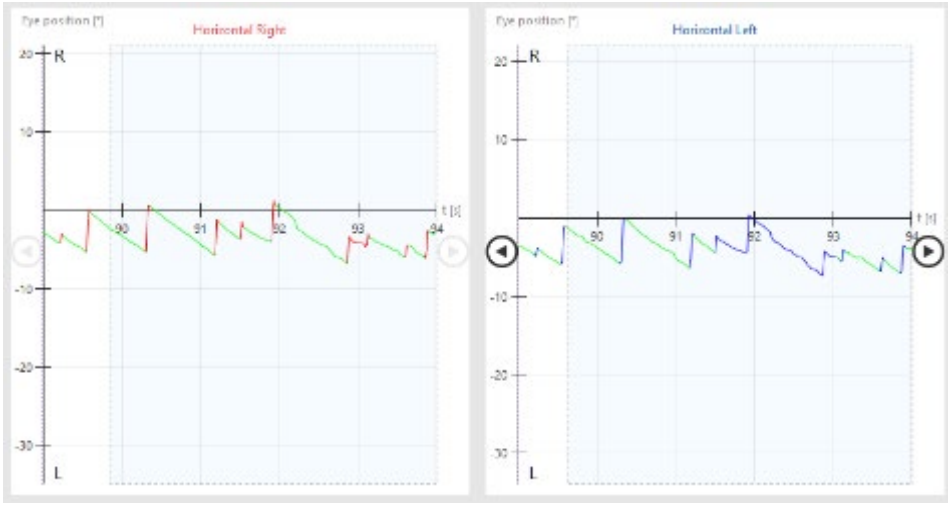


Figure 7.4-8 Slow phase velocities highlighted, and eyes split into separate graphs

7.4.4 Smooth data

	Data smoothing uses an algorithm to remove noise from a dataset, allowing important patterns to stand out

7.4.5 Zoom trace

	The zoom trace function provides the ability to zoom in and enlarge segments of the completed test graph for a closer look of the raw data (Figure 7.4-9 andFigure 7.4-10). The magnification allows the operator to look at the fine details of the waveform to help determine if a beat is noise or a real response.

- Select the tool and click on the area of interest
- The area selected will be magnified 2x
- To exit magnification, click anywhere on the graph and it will return to the original view

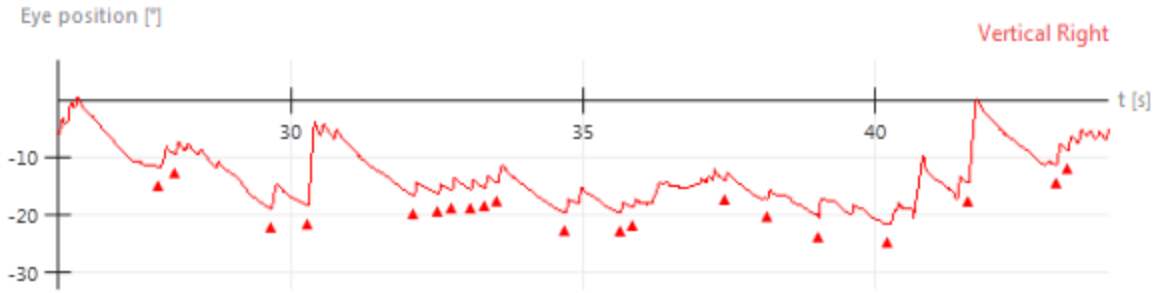


Figure 7.4-9 Gaze test right 30 degrees raw results (no zoom)

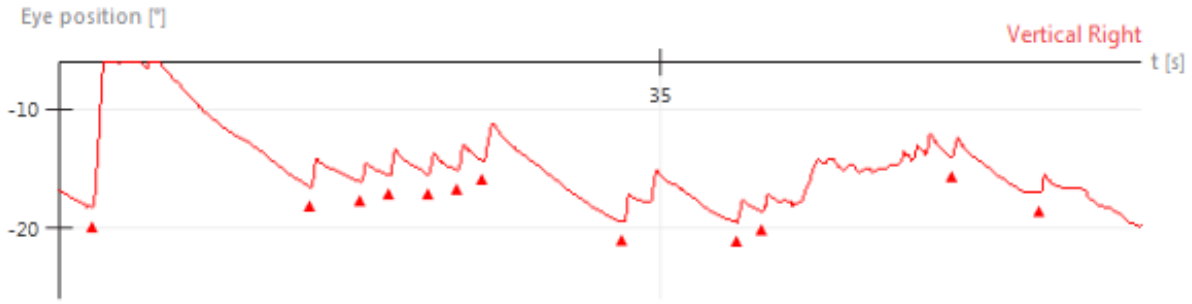


Figure 7.4-10 Gaze test right 30 degrees 2X magnification (time and amplitude)

7.4.6 Enable beats

	This option enables previously deleted beats in the selected trace area.

7.4.7 Undo last action

	This option allows the user to undo the last action.

7.4.8 Reset beats

	This feature resets the waveform back to the original software analysis (Figure 7.4-11 and Figure 7.4-12).

- By selecting this tool, all data altered will return to its original software analysis

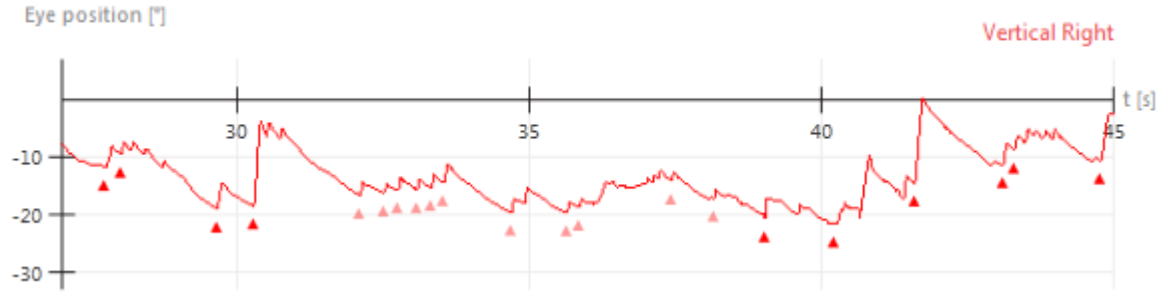


Figure 7.4-11 Nystagmus waveform with removed beats

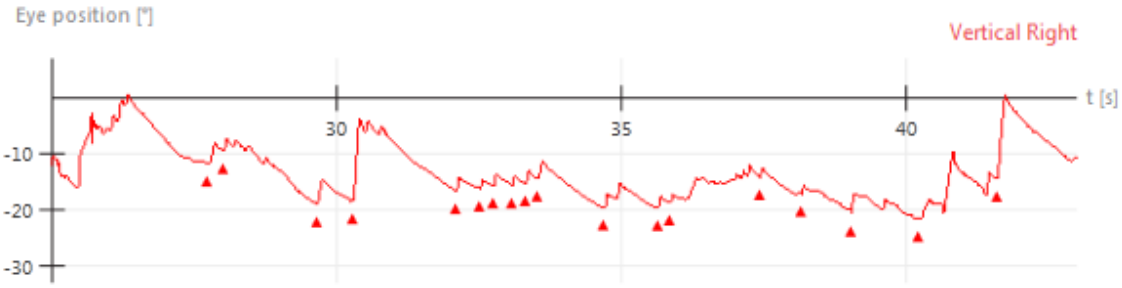


Figure 7.4-12 Nystagmus reset to original software analysis

7.4.9 Done Editing



Figure 7.4-13 Done Editing button

This function saves the edits made to the data and hides the editing tools (Figure 7.4-13).

7.5 Numerical value for graphical display

For some of the tests, the results are measured using parameters like gain, gain reduction, symmetry, eye velocity and so forth. When these parameters are displayed graphically, you can turn on the numerical value option by clicking symbol ① which presents on the top (either right or left) of the gain graph. After clicking the symbol, you will see all the numerical values for the selected test. The example view is given below (Figure 7.5-1,
Figure 7.5-2, Figure 7.5-3, and Figure 7.5-4).

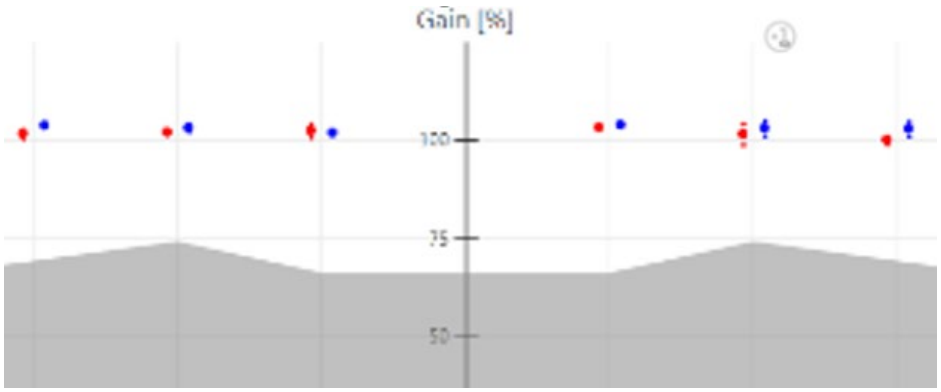


Figure 7.5-1 Graphical display of gain data without numerical value to display

①

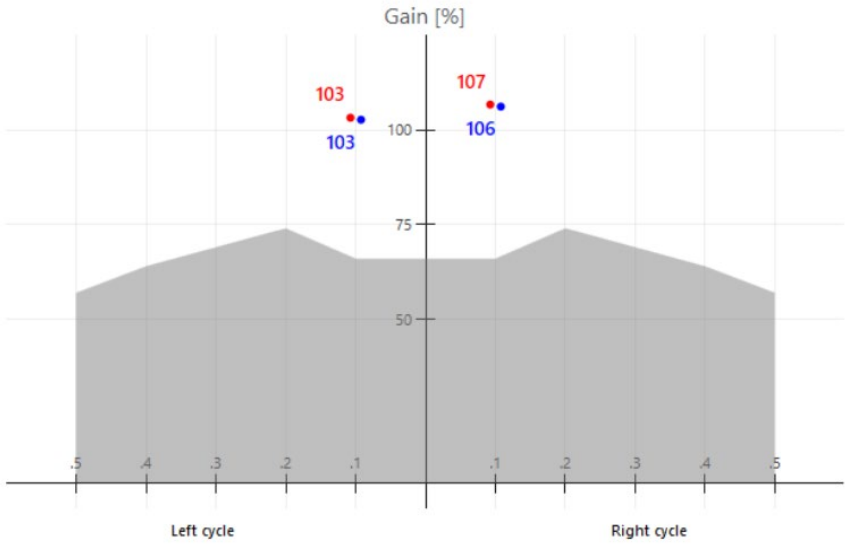


Figure 7.5-2 Graphical display of gain data with numerical values turned on

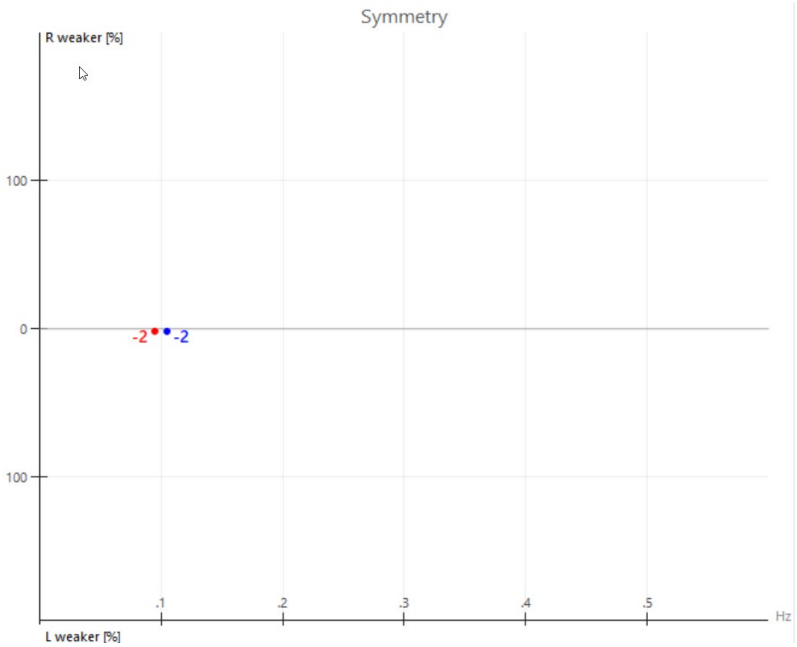


Figure 7.5-3 Graphical display of Symmetry data with numerical display turned on

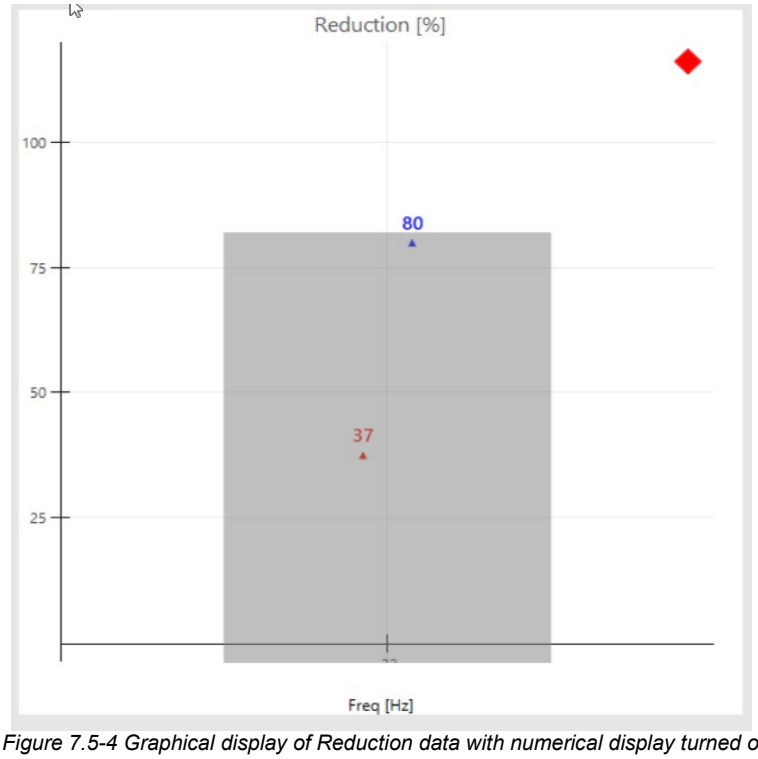


Figure 7.5-4 Graphical display of Reduction data with numerical display turned on

7.6 Editing saccade test results

7.6.1 General Editing Options

Editing tools are available for viewing and editing saccades. These tools are accessed after the data collection is complete by selecting the **Edit Tools** button (Figure 7.6-1). These tools are also available from the Saccade summary view. If accessed from the Saccade summary, select the tool then select the test to edit (Figure 7.6-2). Saccadometry subtests can be edited but the summary page cannot.

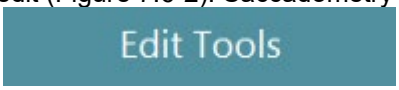


Figure 7.6-1 Edit Tools button for Saccade tests

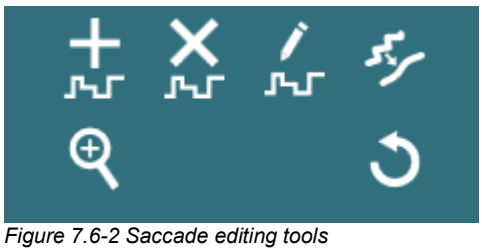


Figure 7.6-2 Saccade editing tools

	Click or touch the **Enable Saccades** button. The selection box that the user creates on the waveform will enable any saccades that were disabled by the analysis.
	Click or touch the **Disable Saccades** button. The selection box that the user creates on the waveform will disable any saccades and remove them from the saccade analysis.
	The **Edit Saccades** button highlights the first visible saccade in the waveform and displays the individual saccade results in the editing toolbar (latency, velocity, and accuracy). Use the previous saccade and next saccade buttons or the left and right arrows on the keyboard to move through the saccades. Use the disable / enable saccade button to toggle the saccade from the analysis. To switch between the left and right eye saccades (if the saccades are not split in separate graphs), select one of the three analysis results in the editing toolbar. Select the **Edit Saccades** button again to exit editing.
	The **Smooth Data** button reduces noise in the data tracing.
	The **Zoom Trace** button provides the ability to enlarge segments of the completed test graph for a closer look of the raw data.
	The **Reset** button will restore the waveform to the original program analysis.

Select the **Done Editing** button to exit the editing tools and keep the edits to the saccade analysis.

7.6.2 Numerical Results

For specific tests, the user gets an option to see the test results in the table format by turning on the option called ‘show result table’ in the protocol management. By clicking the ‘Numerical Results’ option in the test screen, the clinician can view the numerical value of individual saccades in the table presented as shown below. If the clinician clicks any numerical value in the table, this will highlight the selected saccade which enhance the quality of the test review (refer below pictures).

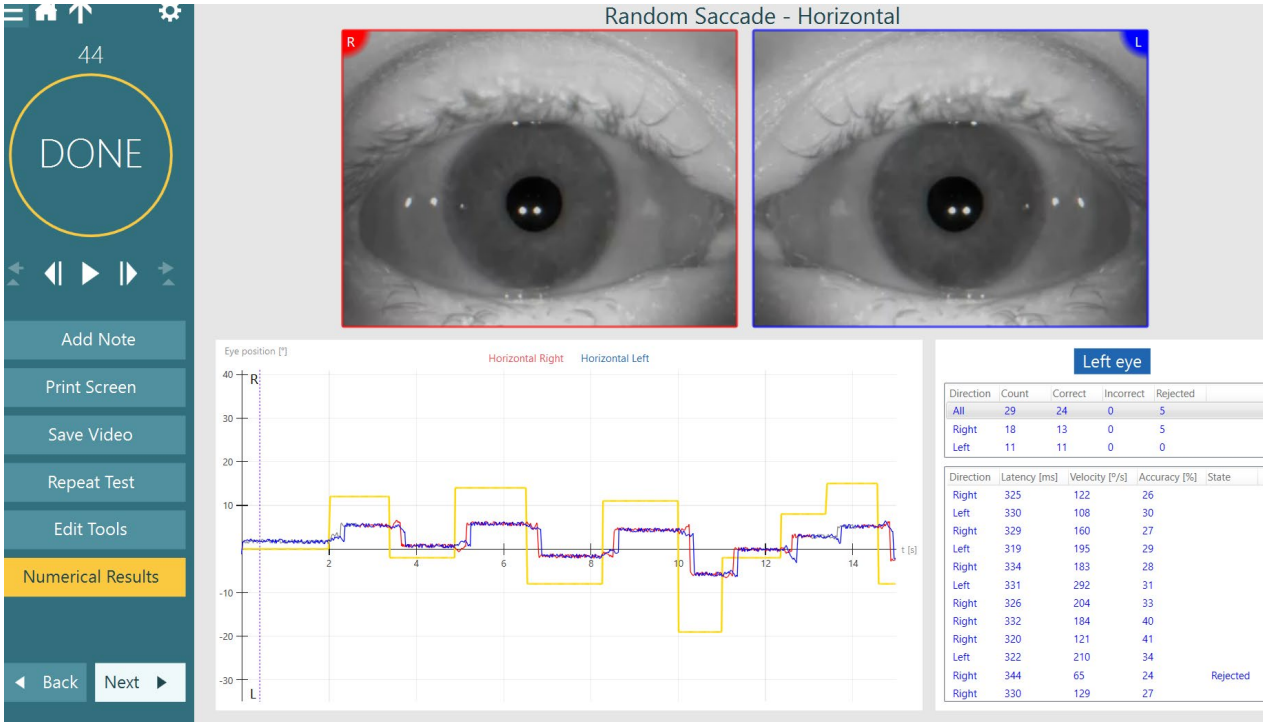


Figure 7.6-3 Numerical display of test

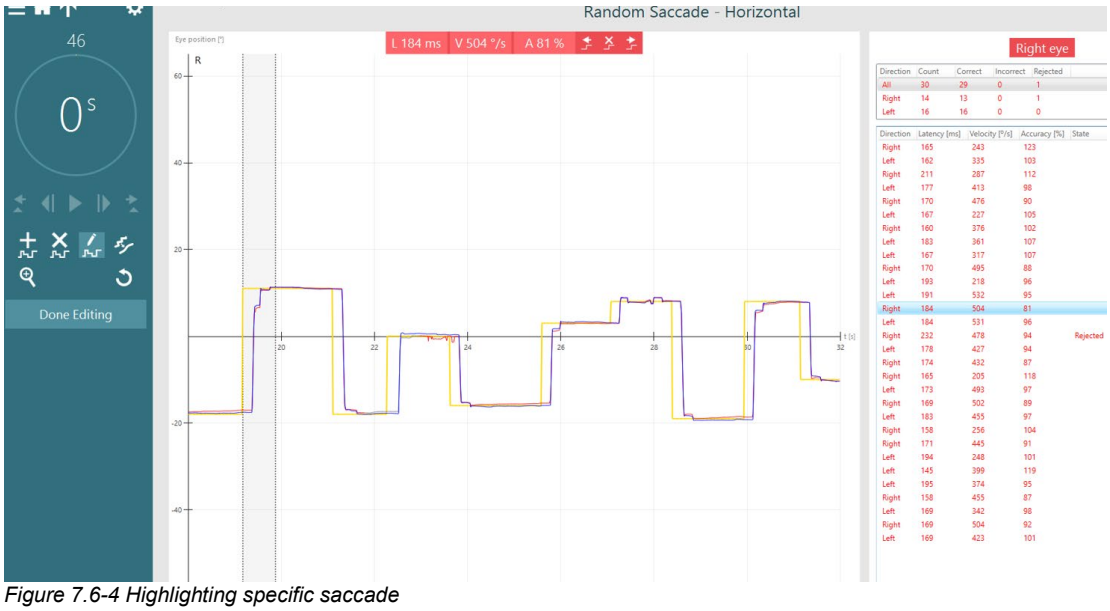


Figure 7.6-4 Highlighting specific saccade

7.7 Editing smooth pursuit test results

Editing tools are available for viewing and editing the smooth pursuit tests. These tools are accessed after the data collection is complete by selecting the **Edit Tools** button. These tools are also available from the Smooth Pursuit summary view (Figure 7.7-1 and Figure 7.7-2). If accessed from the Smooth Pursuit summary, select the tool then select the test to edit.



Figure 7.7-1 Smooth Pursuit editing tools

1. Click or touch the **Enable Half-cycles** button. The selection box that the user creates on the waveform will enable each half cycle that was disabled in the analysis.
2. Click or touch the **Disable Half-cycles** button. The selection box that the user creates on the waveform will disable each half cycle and remove it from the analysis.
3. The **Edit Half-cycles** button highlights the first visible half cycle in the waveform and displays the individual half cycle gain results in the editing toolbar. Use the previous half cycle and next half cycle buttons or the left and right arrows on the keyboard to move through the pursuit cycles. Use the disable / enable half cycle button to toggle the half cycle from the analysis. To switch between the left and right eye waveforms (if the pursuit waveforms are not split in separate graphs), select the gain value in the editing toolbar. Select the **Edit Half-cycles** button again to exit editing.
4. Click or touch the **Zoom Trace** button. Click or touch on a spot on the waveform to magnify that area by 2X (in time and amplitude). Select another spot or select the **Zoom Trace** button again to exit magnification.
5. The **Reset Half-cycles** button discards the user's edits and returns the waveform to the original software analysis.

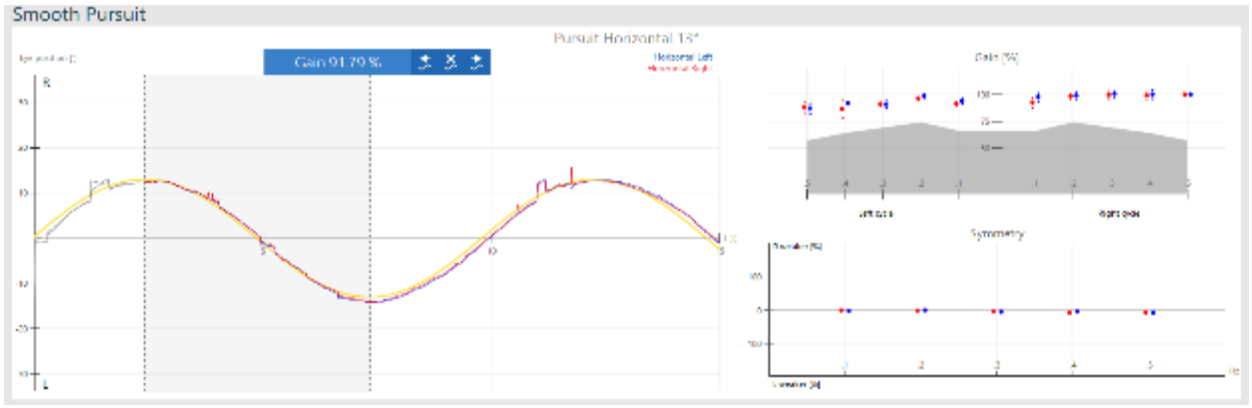


Figure 7.7-2 Smooth Pursuit editing

6. Select the **Done Editing** button to exit the editing tools and keep the edits to the pursuit analysis.

7.8 Editing rotary chair test results

7.8.1 Editing SHA tests

This section pertains to all tests in which the rotary chair rotates in a sinusoidal harmonic acceleration pattern (SHA, VOR Suppression, and Visual VOR). The following editing tools can be accessed by tapping the Edit Tools button in the left side menu available within a specific test review screen, or from the summary test results screen.

	The **Enable Section** tool allows the user to include a section of the response in the analysis. Once you have activated the **Enable Section** tool, click and drag over the section of the eye velocity trace that you want included in the analysis of the response.
	The **Disable Section** tool allows the user to exclude a section of the response from the analysis. With the **Disable Section** tool activated, click, and drag over the section of the eye velocity trace that you want excluded from the analysis (i.e., artifact). A dashed line box will appear around the section you are disabling. The disabled section will turn grey to indicate that it is no longer included in the analysis (Figure 7.8-1). You can re-enable the section by using the enable section tool.
	The **Reset Graph** button discards all user edits and returns the waveform to the original software analysis.
	Select the **Done Editing** button to exit the editing tools and keep the edits to the analysis.

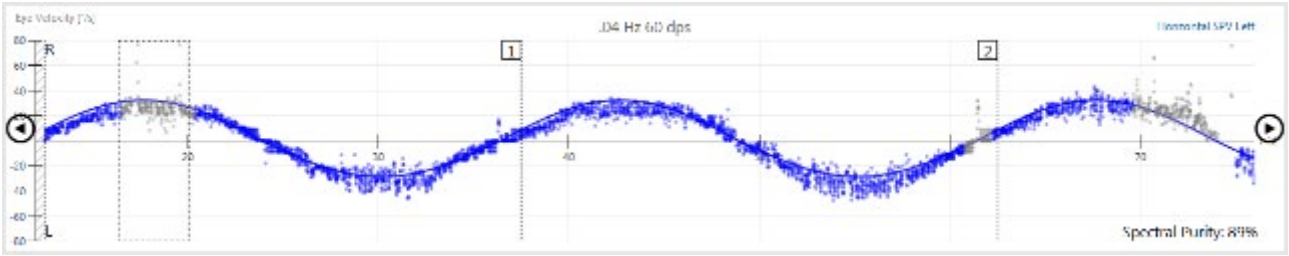


Figure 7.8-1 Disable section editing tool in SHA tests

7.8.2 Editing step velocity tests

The editing tools available for Step velocity tests are the same tools available for all nystagmus tests. Please refer to section 6.4. Access the Step Velocity editing tools by tapping the Edit Tools button in the left side menu available within a specific test review screen, or from the summary test results screen.

7.9 Editing video head impulse tests (vHIT for VORTEQ™)

The video head impulse test compares the patient's eye movement to the head impulse. The clinician can override accepted head impulses either from the center graph showing the currently selected head impulse and eye movement, or the clinician can select multiple head impulses at once and remove them from the analysis. To access the tools, the user must click on the Edit Tools button, and the user will need to click on the Done Editing button to exit the tools.

7.9.1 Select multiple

Selecting this tool will highlight the tool in yellow and set the program to highlight each trace the user selects, whether that trace is selected by the head velocity line or the eye velocity line. Selected traces will be plotted with thicker lines, though the current trace is not included unless the user clicks on the trace (Figure 7.9-1).

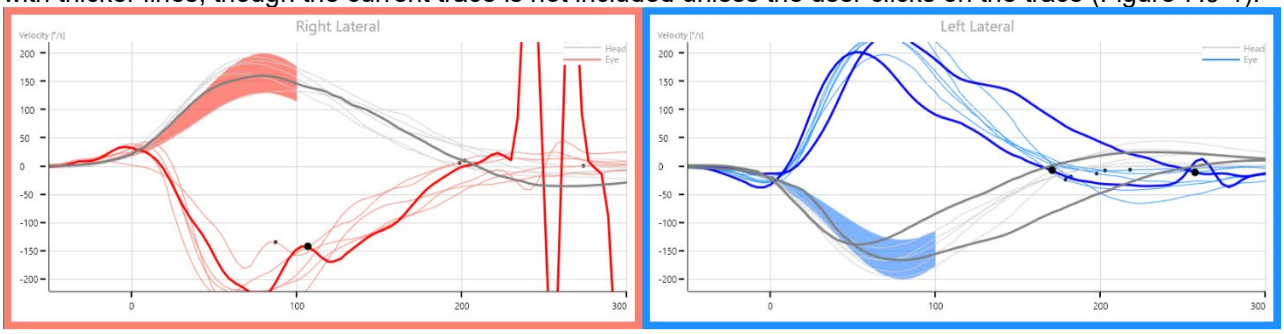


Figure 7.9-1 Multiple impulses selected

7.9.2 Delete selected

Selecting this tool will reject the selected impulses and remove them from the analysis (Figure 7.9-2).

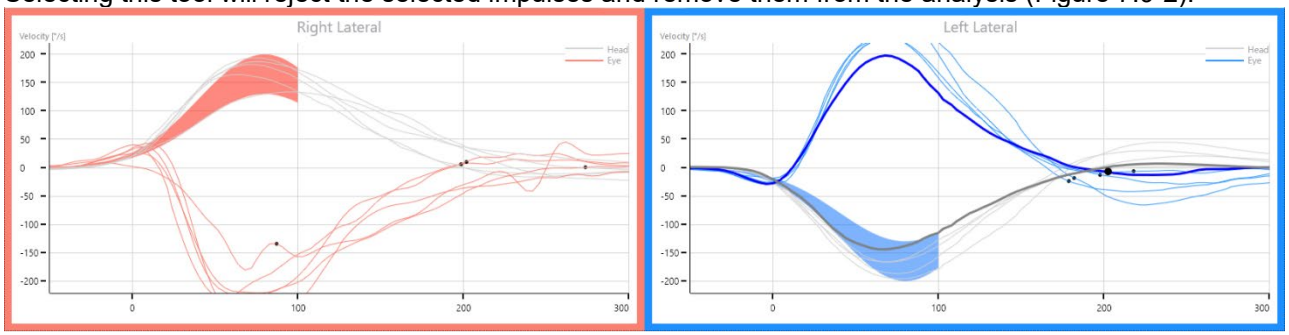


Figure 7.9-2 Selected impulses removed

7.9.3 Reset

Selecting this tool will restore the default analysis with only traces that meet the swoosh velocity criteria selected (Figure 7.9-3).

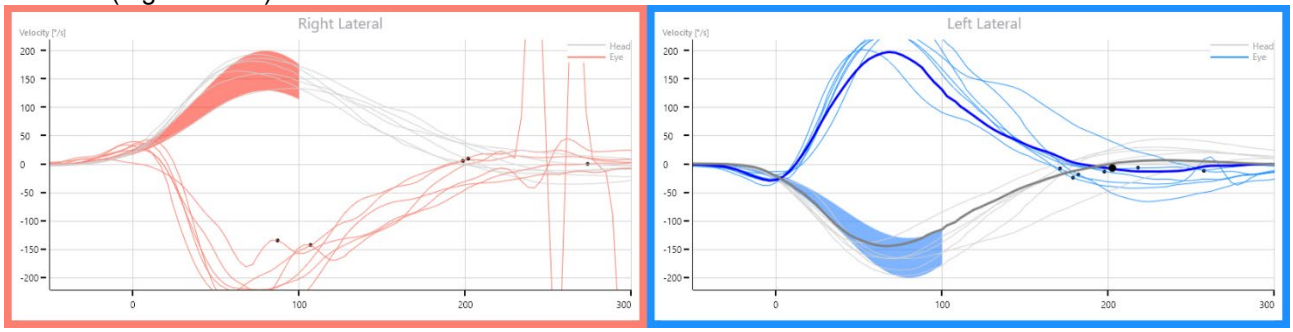


Figure 7.9-3 Impulses reset to analysis defaults

7.9.4 Show all impulses

Selecting this tool will accept all head impulses, even if they failed to fall within the swoosh velocity criteria. You should then review each of the head impulses to see which ones were performed correctly (Figure 7.9-4).

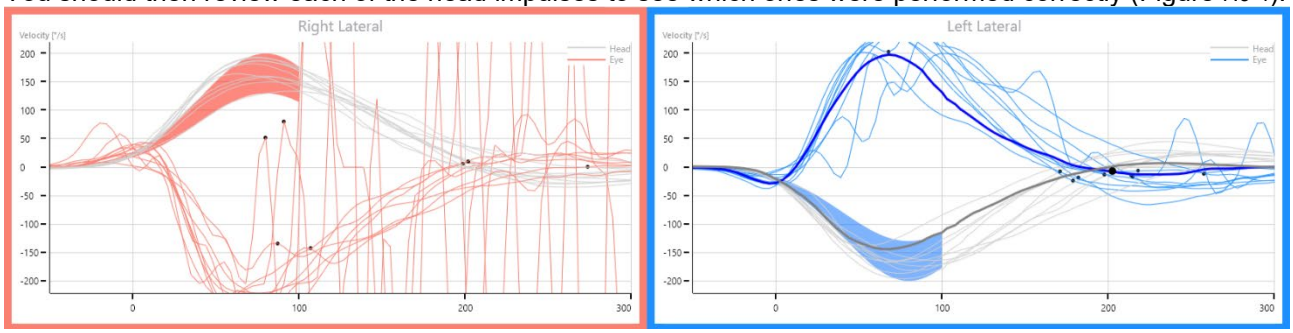


Figure 7.9-4 Show all impulses performed which includes impulses that did not conform to standards

7.10 Editing video head impulse tests (vHIT for EyeSeeCam)

The video head impulse test compares the patient's eye movement to the head impulse. You can override accepted head impulses either from the center graph showing the currently selected head impulse and eye movement, or you can select multiple head impulses at once (Figure 7.10-1) and remove them from the analysis. To access the tools, click on the Select Traces button. Click on the Accept button to exit the tools.

7.10.1 Delete

Select the trace that you want to remove with a left mouse click. To remove multiple traces at a time, hold the Ctrl key on the keyboard and select the additional traces. Click on the Delete button to remove the selected traces (Figure 7.10-2). Deleted traces will be shown in this edit view with light gray lines. Click on the Accept button to keep those changes and return to the analysis.

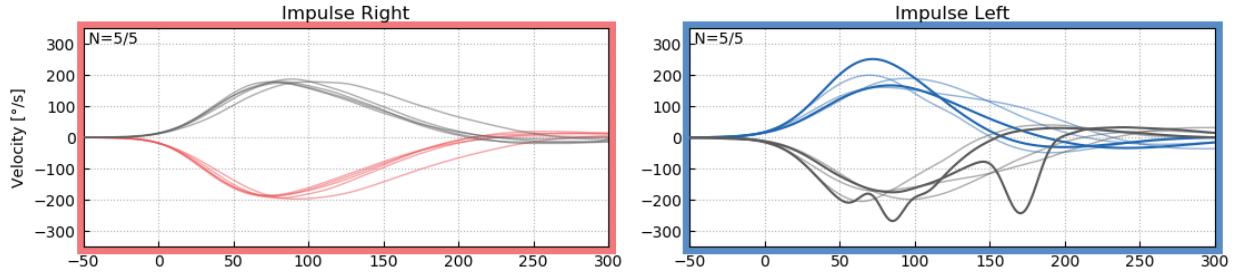


Figure 7.10-1 Multiple impulses selected

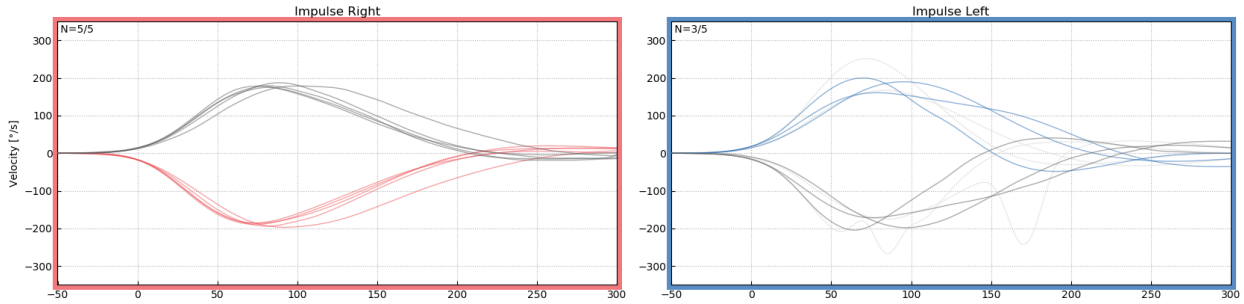


Figure 7.10-2 Outlier traces deleted

7.10.2 Reset / Cancel

Selecting the reset tool will restore the default analysis with only traces that meet the swoosh velocity criteria selected (Figure 7.10-3). The cancel tool will exit the select traces screen, abandoning traces that were removed.

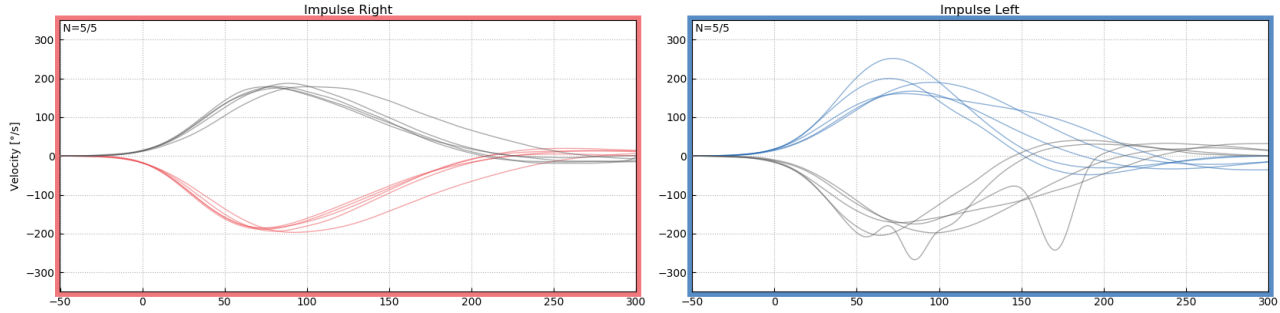


Figure 7.10-3 Impulses reset to analysis defaults

7.10.3 Edit saccades

Selecting the Edit Saccades tool will allow you to fine-tune the length of time of the head impulse as well as the length of time of any saccades detected for the impulse. Adjust the length of time by dragging the edge of the highlighted area. A small window will overlay the trace, displaying the change in the shape of the waveform selected and a dashed line between the endpoints of the selection window. Click on the Accept button to keep the changes and Cancel to discard the changes. To move to another accepted head impulse, click on the head impulse in the timeline window at the bottom of the screen (Figure 7.10-4 and Figure 7.10-5).

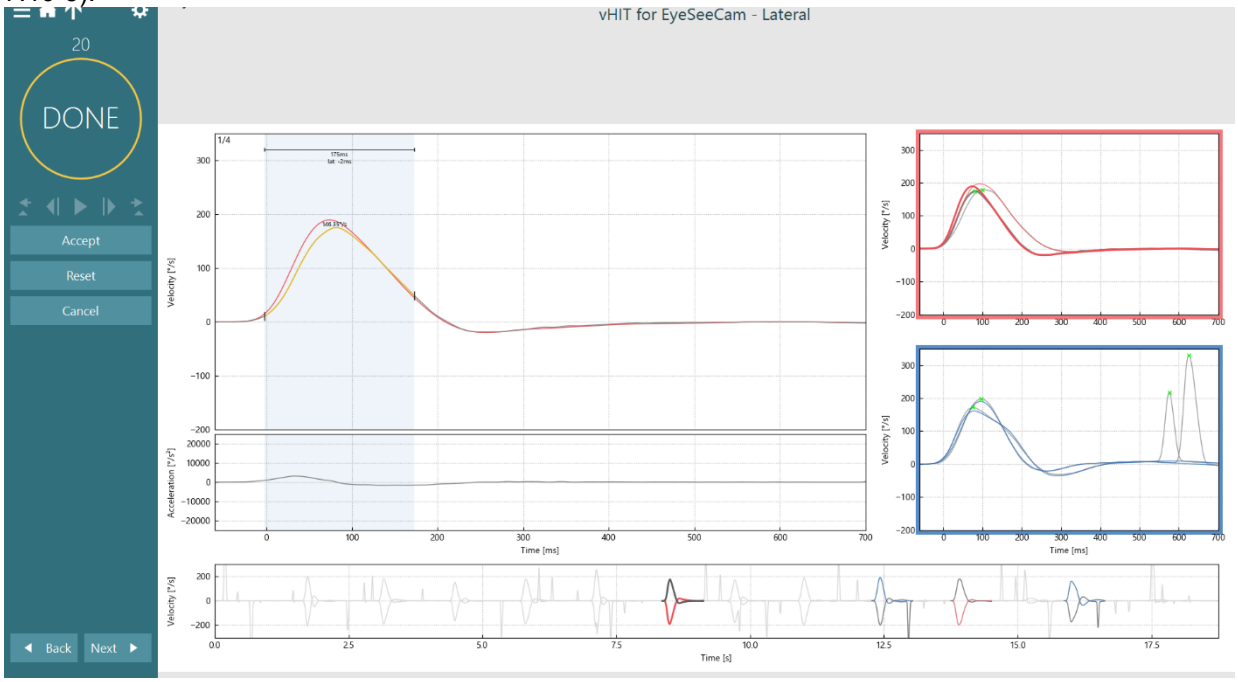


Figure 7.10-4 Edit Saccades

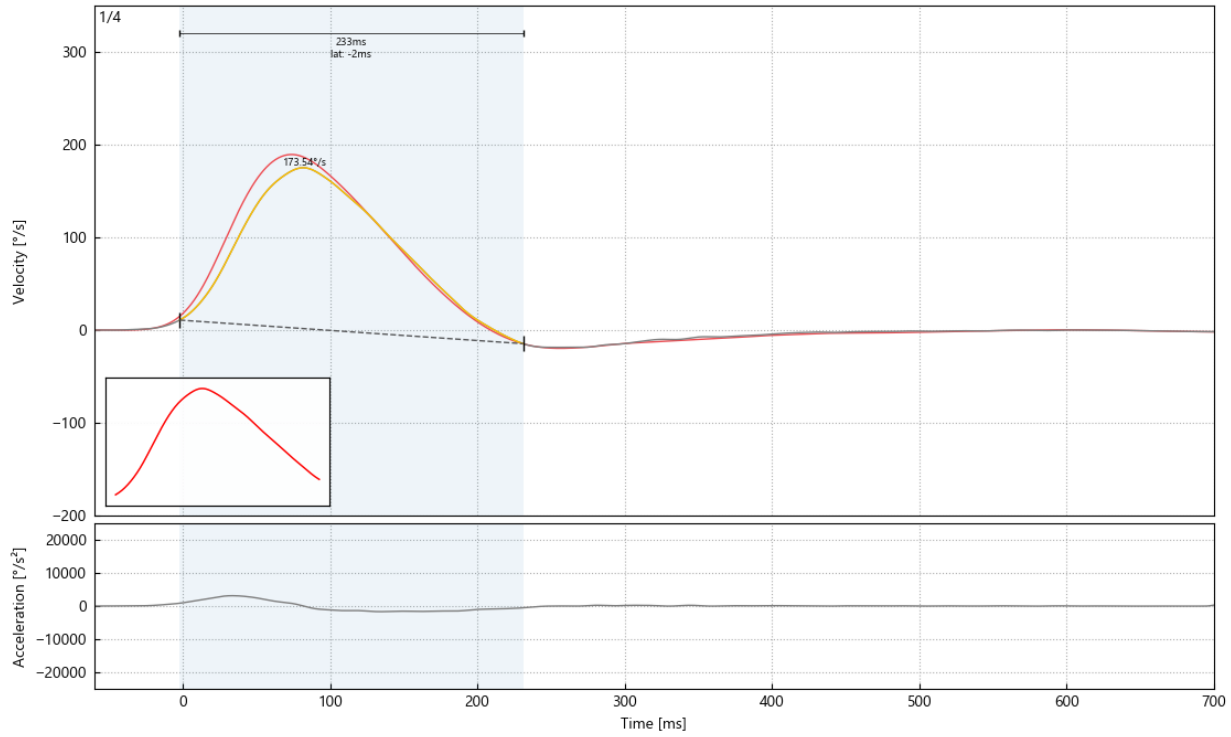


Figure 7.10-5 Adjusting the time

7.11 Editing ocular counter roll tests

The ocular counter roll test has the user mark positions on the waveform graph that are of interest. These markers will display the current torsion angle and can be used to detect torsional nystagmus qualitatively.

7.11.1 Add marker

	Selecting this function will display a mark at the current location. The direction of rotation and magnitude will be displayed where the user clicked (Figure 7.11-1).

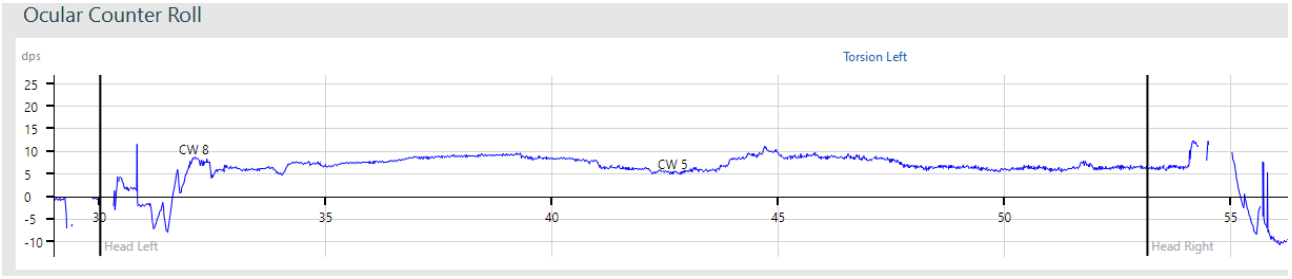


Figure 7.11-1 Torsion trace with markers added

7.11.2 Zoom trace

	The zoom trace function can zoom in on and enlarge segments of the completed test graph for a closer look at the raw data. The magnification allows you to look at the fine details of the waveform to help determine if a beat is noise or a real response.

7.11.3 Remove marker

	This function will remove the torsion marking at the current location.

7.11.4 Reset markers

	This feature will clear all markers added by the user.

7.12 Other functions available inside menu

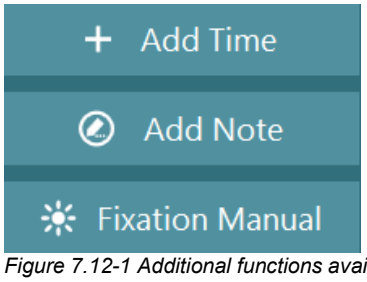


Figure 7.12-1 Additional functions available during testing

Add Time: Adds 30 seconds to the test recording (Figure 7.12-1).
Add Note: Insert a note at the current time during recording.
Fixation Manual: Turns on the selected fixation light defined in the System Default Settings (see Chapter 13.1 Input) (controlled by user, not automatic). You can also activate the fixation light with the RF remote.

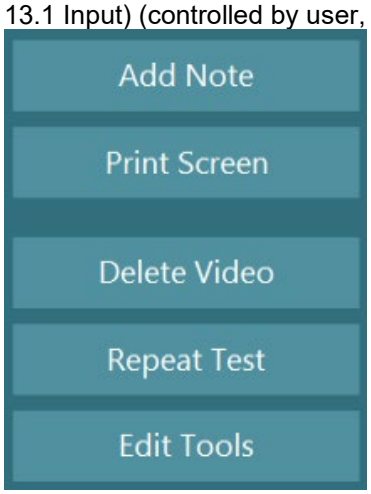


Figure 7.12-2 Additional functions available after testing is complete

After the test has finished the following options will be available (Figure 7.12-2).
Add Note: Adds a note to the end of the test.
Print Screen: Will print whatever is present on screen at the current time.
Delete Video: Deletes the video of the eye recording and room camera (if recorded) from the computer for this test.
Edit Tools: Provides access to tools used to override the analysis results.
Repeat Test: Repeat / replace the current test. A dialog box will be presented asking if you would like to overwrite the current test (replace) or create a new instance (repeat) (Figure 7.12-3).

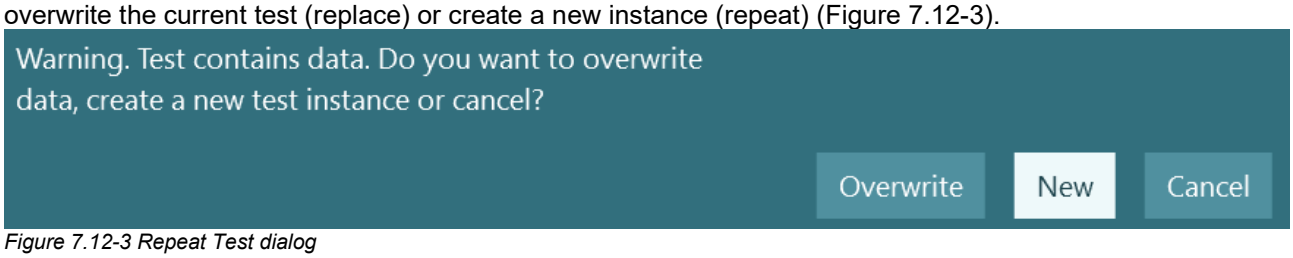


Figure 7.12-3 Repeat Test dialog

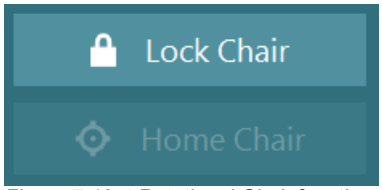


Figure 7.12-4 Rotational Chair functions

When a reclining rotary chair is configured with VisualEyes™ 515/525 there may be additional side menu functions available to the user (Figure 7.12-4).

Lock chair:

Orion Reclining
This function immobilizes the chair to ensure patient safety when seating and/or disembarking the patient. It is also used to keep the chair immobile during the VNG test battery. The lock chair function is only available before the test, and you cannot activate it during testing. This will automatically be switched off when performing a rotational chair test. To lock or unlock the chair at any other time, tap the **Lock Chair** button. The chair is locked when the button is yellow and unlocked when the button is light green. You can also unlock the chair using the electronic locking mechanism (ELM) switch found (Figure 7.12-5) on the top left of the chair. While depressing the ELM switch, the chair can be rotated freely. Releasing the ELM switch will lock the chair approximately in that position (may require minor rotation to allow the gear lock to engage properly).

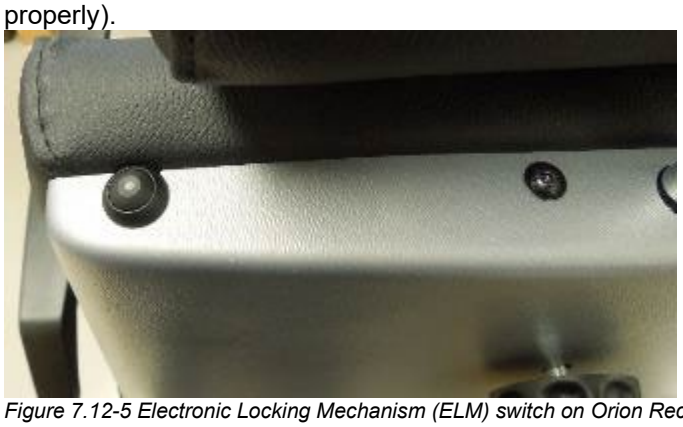


Figure 7.12-5 Electronic Locking Mechanism (ELM) switch on Orion Reclining chair

System 2000 Reclining
The System 2000 Reclining chair does not have an electronic braking system. A manual foot brake is found on the side of the chair drum. The operator should apply the brake to keep the chair in place for patient entry and VNG testing. When reclining the chair for Dix Hallpike, Positional, and Caloric tests, release the foot brake (Figure 7.12-6) to rotate the chair if needed due to space constraints. Then re-apply the foot brake (Figure 7.12-7) when the chair is reclined to the appropriate position to keep the chair from rotating during the test. When you perform rotational chair tests, verify that the foot brake is released.



Figure 7.12-6 Foot brake released



Figure 7.12-7 Foot brake applied

Home Chair: Orion Reclining
The chair will have a default position to which it will move before testing. This position is called the home position. Ideally, you should put the chair in front of the television or projection screen, so the home position is lined up with the center of the screen. If you install the chair with the home position not centered with the screen, you can adjust the Zero Position to the new location. You can find this value in the System Default Settings (see Chapter 13.7 Print). The **Home Chair** button will move to this override location.

7.13 Fixation suppression

There may be times in certain nystagmus tests (i.e. spontaneous and positional) where a fixation light is presented to the patient to differentiate peripheral from central abnormalities.
The fixation suppression index (FI) quantifies the ability of a patient to deliberately suppress nystagmus by fixating on a given target. It is determined by switching on the fixation light within the goggles. The value quantified will be displayed as a percentage in the bar graph in both horizontal and vertical channels.
A yellow bar appears in the trace to acknowledge the presence of the fixation light (Figure 7.13-1). The length of the bar determines the length of time the fixation light was active.

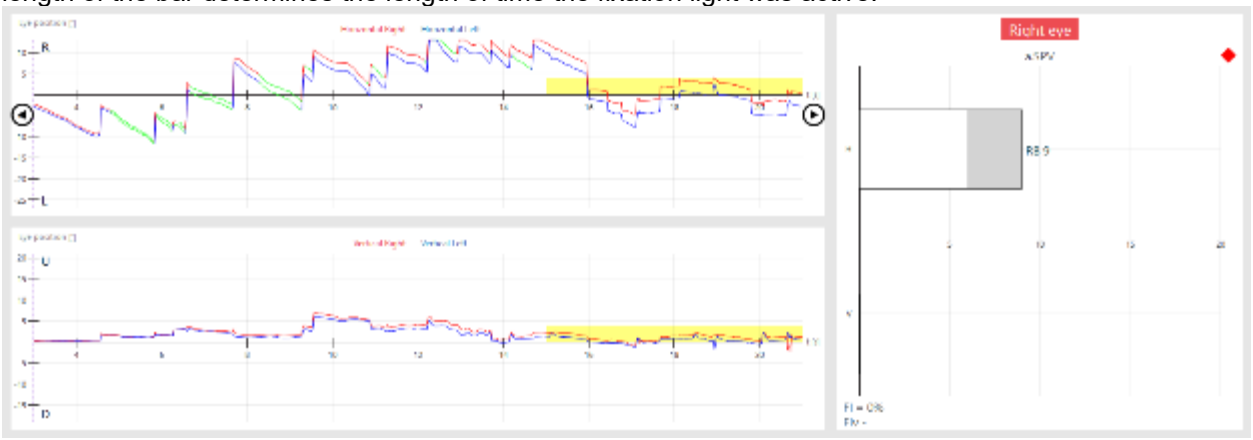


Figure 7.13-1 Yellow bar shows presence of fixation light in eye recording trace

You can turn on the fixation light in three different ways:

- Manually: Using the RF remote or **Fixation Manual** button
- Timed: Time predefined in the test settings. If you turn on the fixation light manually before the time set in the test settings, the software will change to manual mode
- Automatic: In the caloric test, the fixation light is turned on automatically post detection of peak response

You can also display the fixation light in either the left or right eye (see 13.1 Input).

7.14 Override test results

Results will automatically be classified whether inside or outside threshold levels based on the criteria set in the suggested threshold tables in the system settings. The red diamond will indicate results outside of threshold and the green tick will indicate results within threshold. Should you decide to overrule an outside of threshold test result, clicking on the red diamond (next to the title of the test/subtest) will convert it to a green checkmark with a pencil symbol, indicating that you changed the results to within threshold levels.

Symbol	Explanation
	Within Suggested Thresholds
	Altered Result
	Outside of Suggested Thresholds

Should any subtests outside the threshold ranges be altered, then the overall test will convert to a within threshold result.

8 Protocol management

8.1 Protocols

A protocol is a list of tests, and you can customize this list to perform specific tests in a specific order. A protocol could depend on your testing style, test purpose, or to create a default protocol template for your clinic. There is no limit to the number of protocols that you can create.

Access the protocols from the Protocol Management button under the Configuration menu on the main screen (Figure 8.1-1 and Figure 8.1-2).

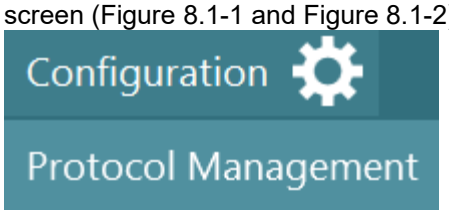


Figure 8.1-1 Configuration drop down menu with Protocol Management displayed

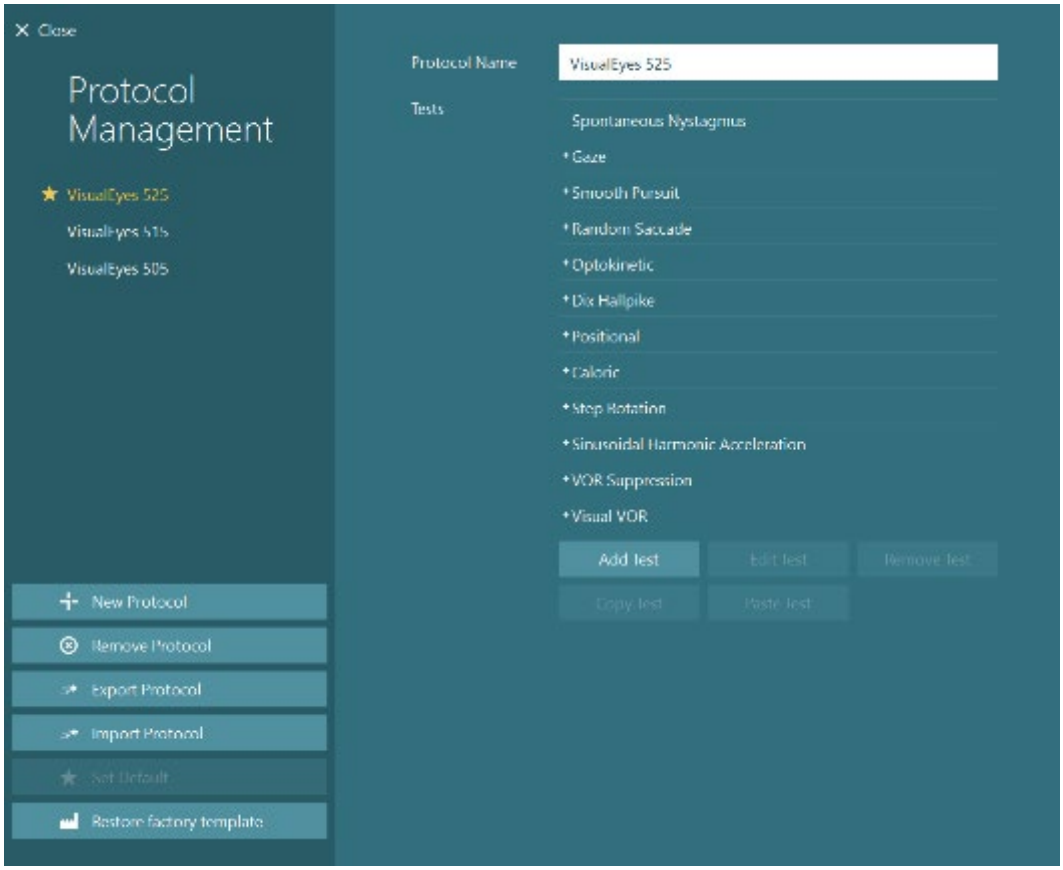
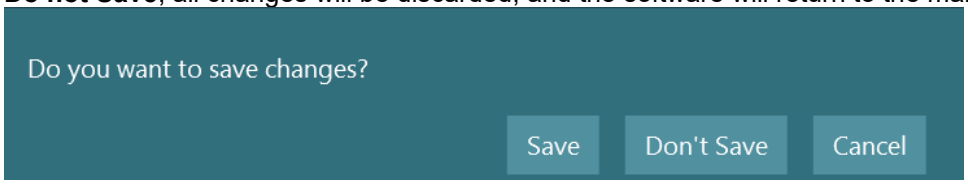


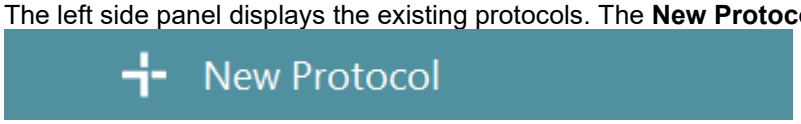
Figure 8.1-2 Protocol Management screen

Upon exiting Protocol Management, you will be asked to save your changes to the protocols. If you choose **Do not Save**, all changes will be discarded, and the software will return to the main screen.



8.2 Creating a new protocol

The left side panel displays the existing protocols. The **New Protocol** button creates a new blank protocol.



Enter a name for the new protocol (Figure 8.2-1). By default, this will be called New Protocol 1.

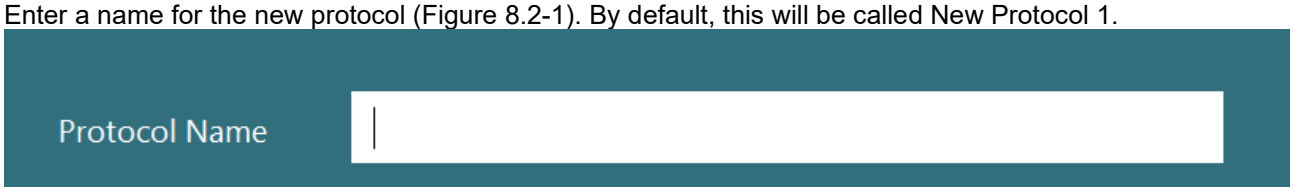


Figure 8.2-1 Enter Protocol Name

To add tests to the protocol, press the **Add Test** button (Figure 8.2-2) and select one of the tests. Tests that don't match one of the default test types (e.g. Fistula test, Head shake test) can usually be entered as a basic Spontaneous Nystagmus test.

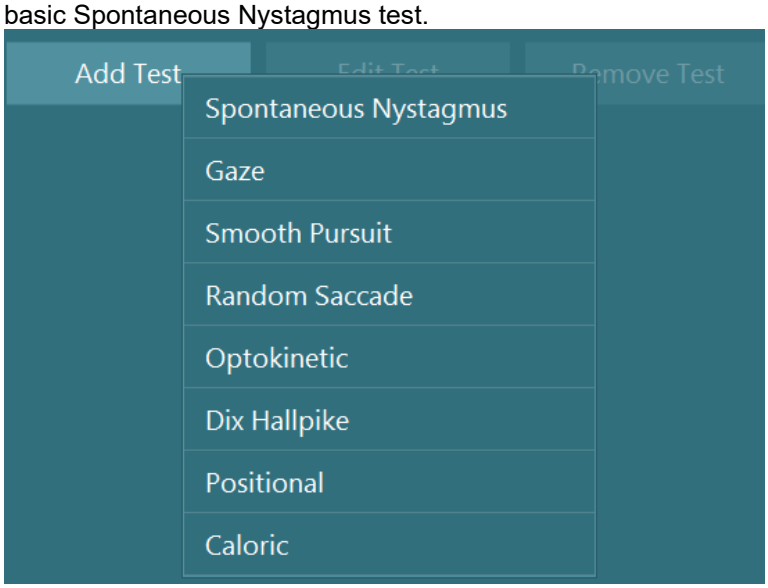


Figure 8.2-2 Add Test button

If you need two or more of the same test types, click on the test of interest. The test title will appear with an additional numeric ending to indicate its position (i.e., Spontaneous Nystagmus2, Spontaneous Nystagmus3). You can rename these test titles for easier identification or customization.

When added to the protocol, these tests will appear in the bottom of the protocol test sequence. You can reorder the tests within the protocol by clicking the specific test and dragging it up or down the list.

8.3 Adding customized test

If the user wishes to add a new test to a protocol, it can be chosen from either default protocol or from any other available protocols which are with customized test settings. The user can add any test of their choice during the test session using tempo.

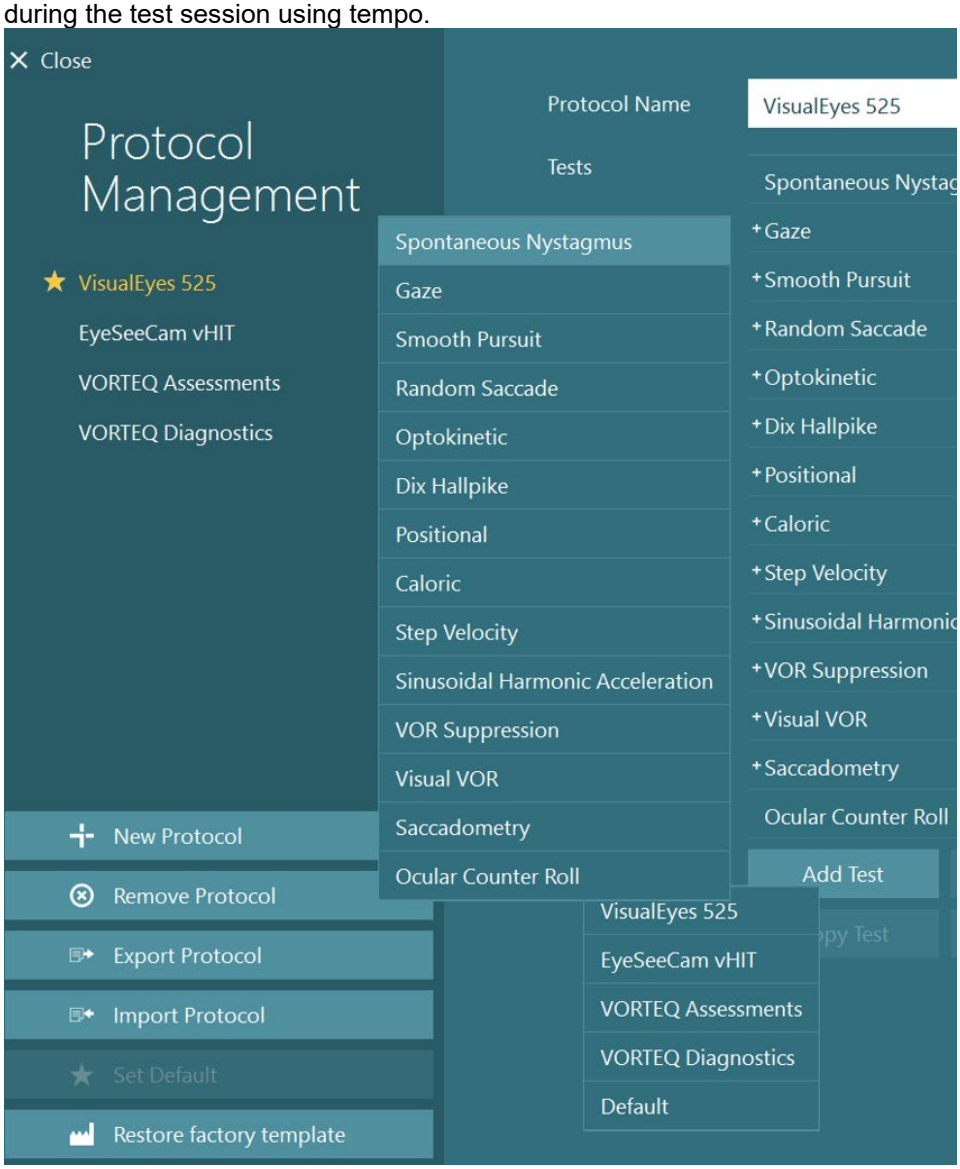


Figure 8.33-1 Adding customized test

8.4 Setting default protocol

The default protocol will be marked in the side menu with a star (Figure 8.4-1). When a new patient is entered into OtoAccess® and the VisualEyes™ software is started, this default protocol will be selected automatically.



Figure 8.4-1 Default protocol

Select the protocol of interest, then select the **Set Default** button (Figure 8.4-2) to confirm its designation as the default protocol. A star will appear next to the protocol name to symbolize the change.

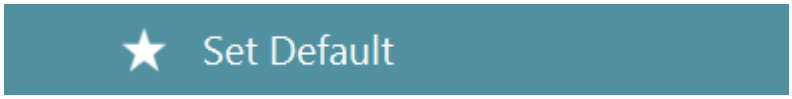


Figure 8.4-2 Set Default button

8.5 Remove protocol

To permanently remove a protocol and all tests in the selected protocol, select the Remove Protocol button. The software will ask to confirm the protocol removal (Figure 8.5-1).

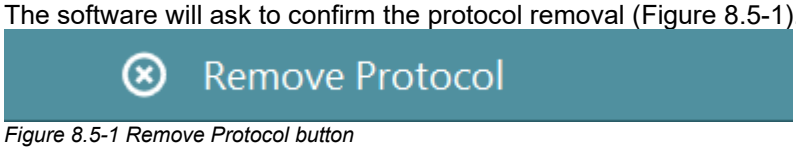


Figure 8.5-1 Remove Protocol button

8.6 Exporting protocols

You can export protocols for later use. Highlight the chosen protocol and select the **Export Protocol** button from the left menu panel (Figure 8.6-1).

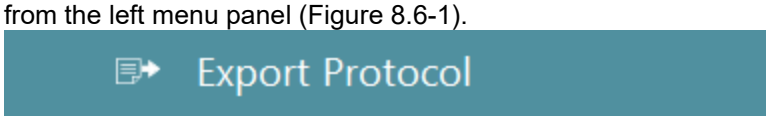


Figure 8.6-1 Export protocol button

An export dialog with a destination folder location will appear (Figure 8.6-2). Select the desired destination folder for the exported protocol and select the **Export** button. This will save the protocol to the selected location for later use (e.g., to import into another VisualEyes™ 515/525 system). Select **Close** to return to the Protocol Management screen.



Figure 8.6-2 Export Protocol dialog

8.7 Importing protocols

Previously exported protocols can be imported into Protocol Management using the **Import Protocol** button (Figure 8.7-1).



Figure 8.7-1 Import Protocol button

An import dialog with a source folder location will appear (Figure 8.6-2). Select the folder with the protocol file and select the **Import** button. This will save the protocol to the selected location for later use (e.g., to import into another VisualEyes™ 515/525 system). Once imported, you can edit the protocol or set it as default like other protocols. Select **Close** to return to the Protocol Management screen.



Figure 8.7-2 Import Protocol dialog

8.8 Restore factory template

The VisualEyes™ software has a default test template for each test type licensed in the system. You can override the settings for the default test template using the **Set as default** button in each page of the test and subtest settings pages. To restore the default test template back to the system default settings, select the Restore factory template button (Figure 8.8-1). Any protocols currently created will not be affected, but any new protocols and tests will be created using the default test template settings.



Figure 8.8-1 Restore factory template button

8.9 Selection of protocol

Select the protocol for testing by accessing the drop-down menu below the **BEGIN TESTING** button. The default protocol will be selected initially. The drop-down menu will list the available protocols. After selecting the desired protocol, click or touch the BEGIN TESTING button to begin the first test of the selected protocol (Figure 8.9-1).

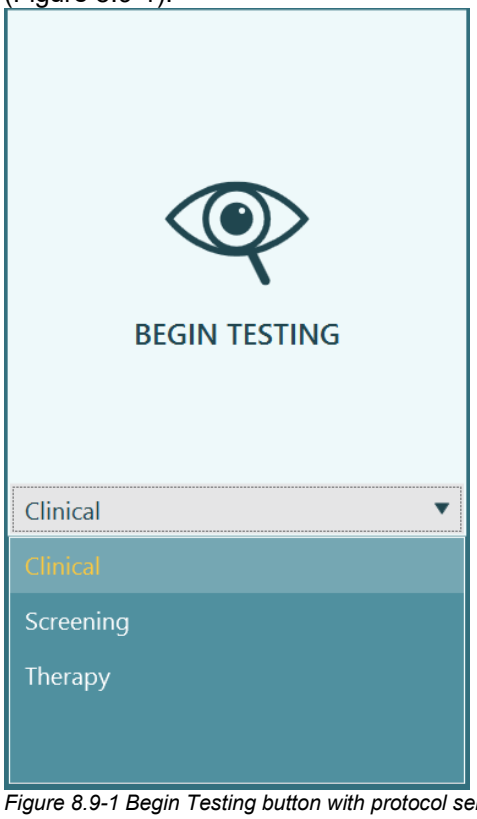


Figure 8.9-1 Begin Testing button with protocol selection

9 Test properties

9.1 Configuring the tests

You can configure all tests in the VisualEyes™ software suite to your preference.
You must do this before the test (cannot be changed post-test).

You can adjust the specific test in 2 ways:

1. From the main screen select **Protocol Management** (Figure 9. 1-1).

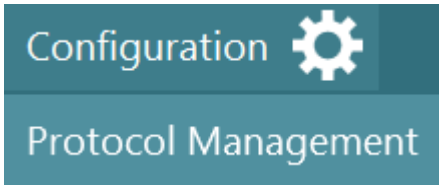


Figure 9.1-1 Configuration drop down menu with Protocol Management displayed

Select the test in Protocol Management and choose **Edit Test**.
Settings changed in Protocol Management are permanent.

2. In the test screen, by clicking the Configuration button:



Figure 9.1-2 Configuration button

Settings changed with the configuration button are temporary and only apply to the current patient.

Temporary test settings will also have fewer options to alter compared to those in the Protocol Management menu.

Each test will have some unique features to it that other tests may not. However, there are many similar features that you can adjust.

Once you are satisfied with the changes made to the test parameters, you can incorporate the settings into the protocol by selecting **Set as default**. These parameters will now be applied to that test within the specific protocol. A prompt will ask for confirmation to inherit the settings (Figure 9.1-3):

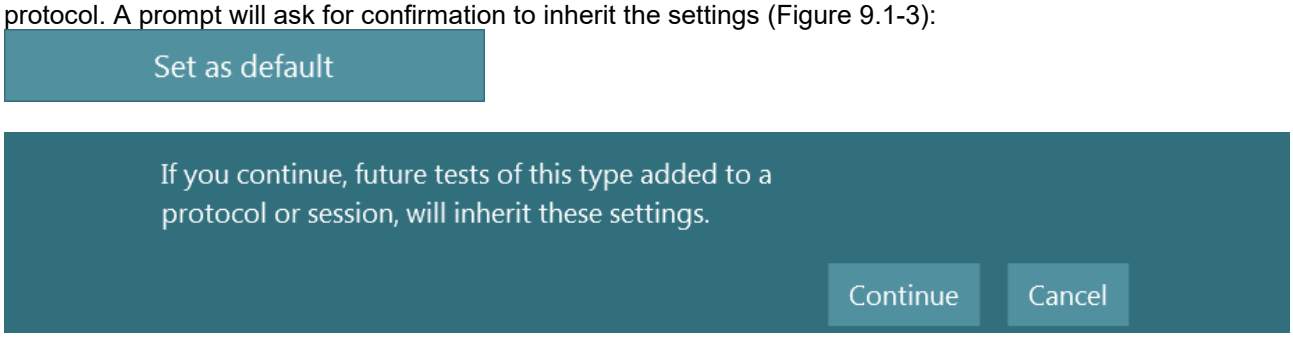


Figure 9.1-3 Saving test parameters to the protocol's default settings

By selecting **Reset to default**, all settings for the page of settings with that test will return to the factory default settings (Figure 9.1-4).



Figure 9.1-4 Reset to default button

9.2 Configuring Video Frenzel test

Sub-test Parameters Configuration options through Protocol Management or Temporary Settings

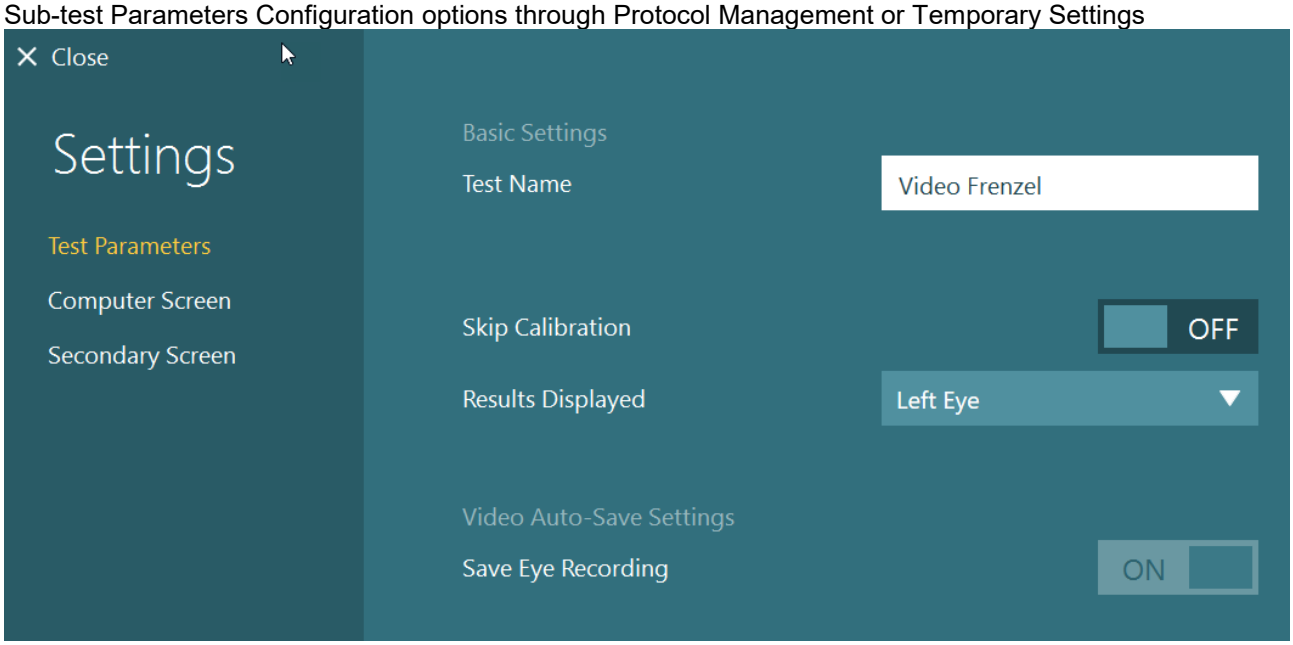


Figure 9.2-1 Video Frenzel Sub-test settings

Test Name: Name of subtest
Skip Calibration: You can skip calibration to proceed with the test
Save Eye Recording: Choice to save eye video recordings.
Results Displayed: Selects which eye is shown by default. Mixed Eyes will allow you to choose the best eye for each subtest. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.

Computer Screen Settings through Temporary Settings/Protocol management Settings

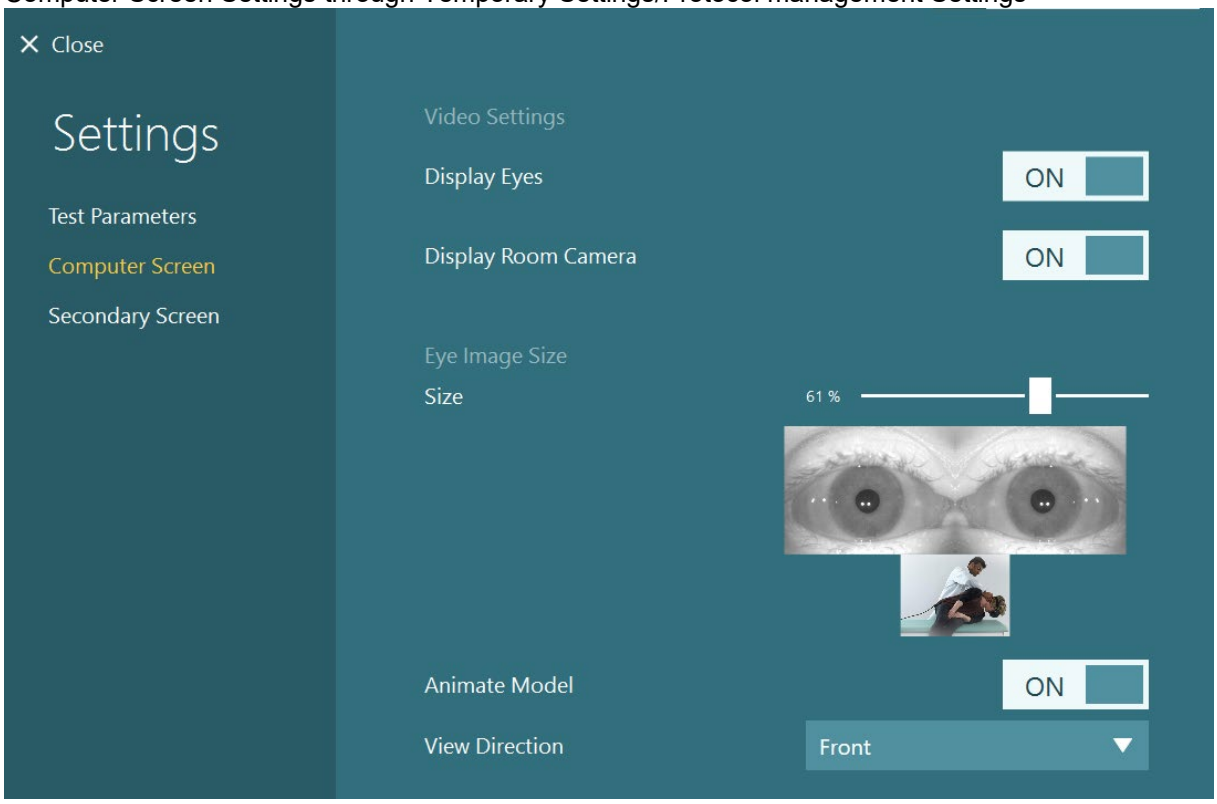


Figure 9.2-2 Video Frenzel Sub-test settings-Computer Screen

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Display Room Camera: If enabled, records the test room during testing.
Eye Image Size: Adjust the screen display size of test eyes.
Animate Model: Guides to view head movement with 3D model to ensure head rotation on both side correct and symmetrical.
View Direction: Select direction to view 3D model from.

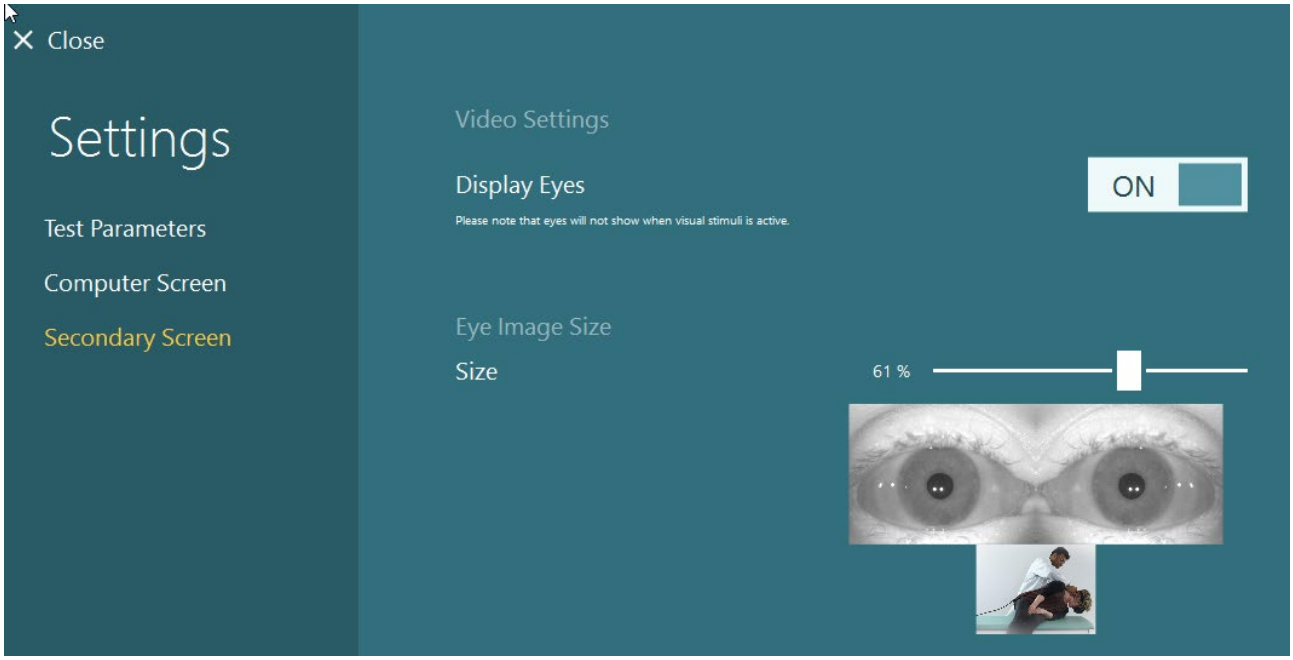


Figure 9.2-3Video Frenzel subtest settings-Computer Screen

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Eye Image Size: Adjust the screen display size of test eyes.

9.3 Configuring oculomotor tests

Individual test summary or subtest configuration options are discussed in this section. However, computer screen settings are mostly common for all the tests under oculomotor tests. The available computer setting options are shown below.

9.3.1 Computer settings for oculomotor tests

Access Computer Screen Settings through Temporary Settings → Protocol Management Settings.

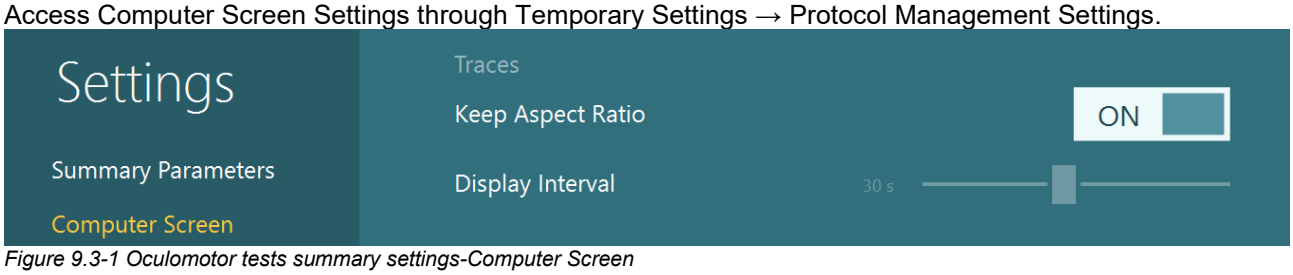


Figure 9.3-1 Oculomotor tests summary settings-Computer Screen

Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test.

In addition to the above options, the optokinetic and smooth pursuit tests have a few additional options as described below.

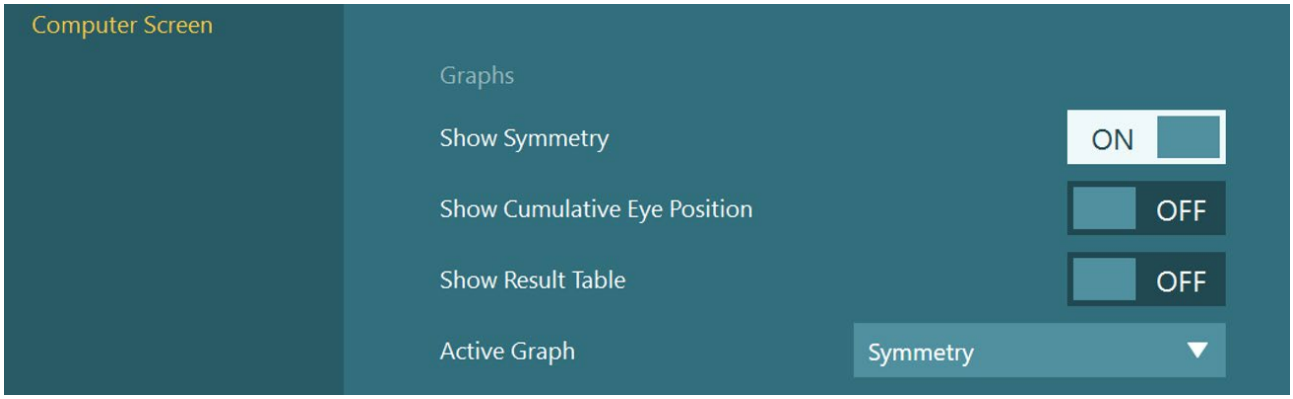


Figure 9.3-2 Test-specific Computer Screen settings

Show Symmetry: If enabled, shows the symmetry graph on screen.
Show Cumulative Eye Position: If enabled, shows the cumulative eye position graph on screen.
Show Result Table: If enabled, shows the test result in the table format.
Active Graph: The user can select the desired graphical display from the given drop-down list.

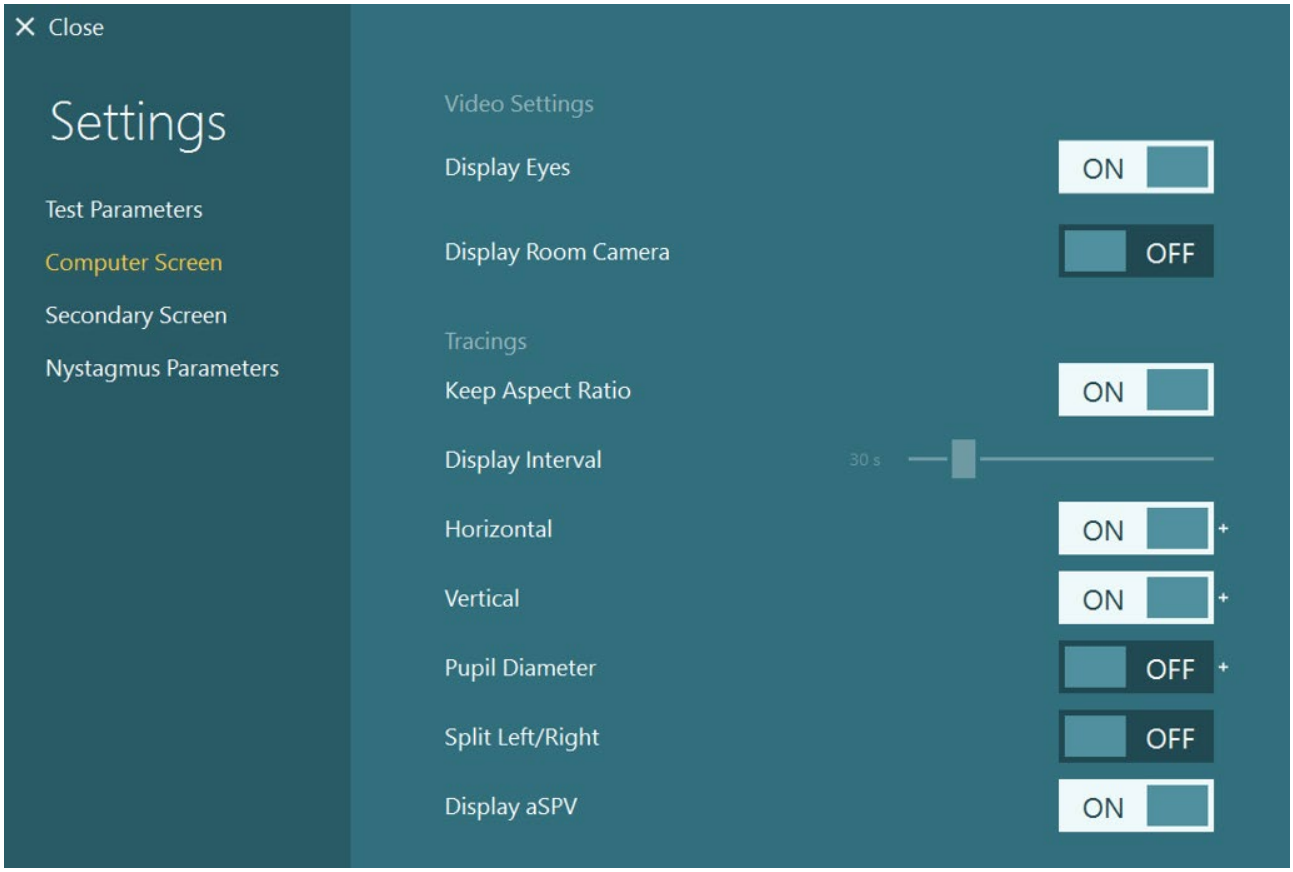


Figure 9.3-3 Oculomotor tests Subtest Settings-Computer Screen

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Display Room Camera: If enabled, records the test room during testing.
Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test.
Horizontal: If enabled, it shows the graphical display of horizontal eye movements.
: by clicking this + symbol, the user can adjust the upper and lower limits for eye position axis (horizontal).
Vertical: If enabled, it shows the graphical display of vertical eye movements.
: by clicking this + symbol, the user can adjust the upper and lower limits for eye) position axis (vertical).
Pupil Diameter: If enabled, shows a graphical display of pupil diameter.

: by clicking this + symbol, the user can adjust the upper and lower limits for pupil diameter axis.
Split Left/Right: If enabled, splits the graph into two, one for left and another for right.
Display aSPV: If enabled, shows the graphical display of average slow phase velocity. This option is available only with Gaze test in the category of oculomotor tests.

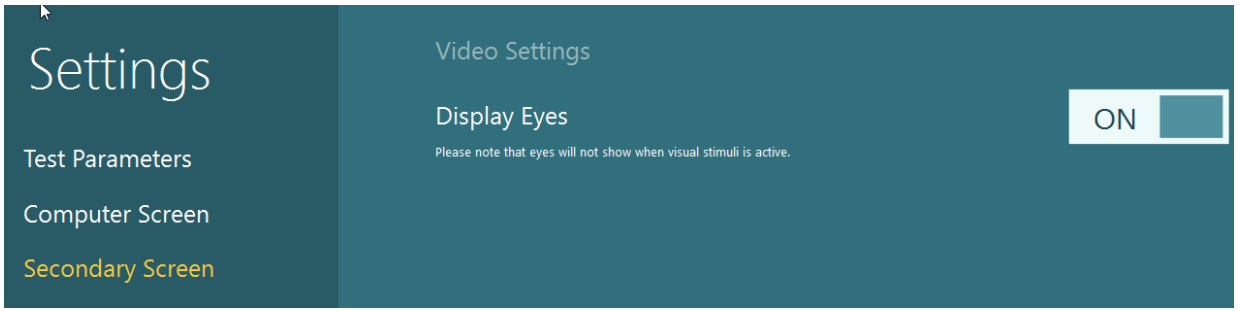
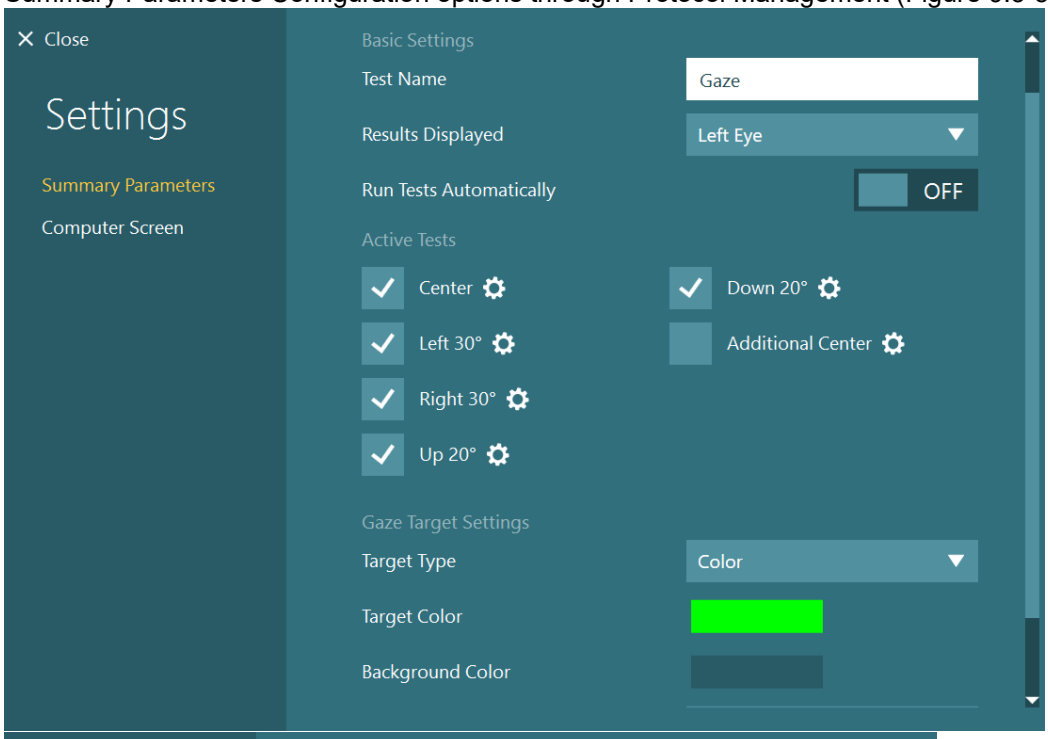


Figure 9.3-4 Oculomotor tests – Secondary Screen settings

Display Eyes: If enabled, it shows the test eye image on secondary screen.

9.3.2 Configuring the gaze test

Summary Parameters Configuration options through Protocol Management (Figure 9.3-5):



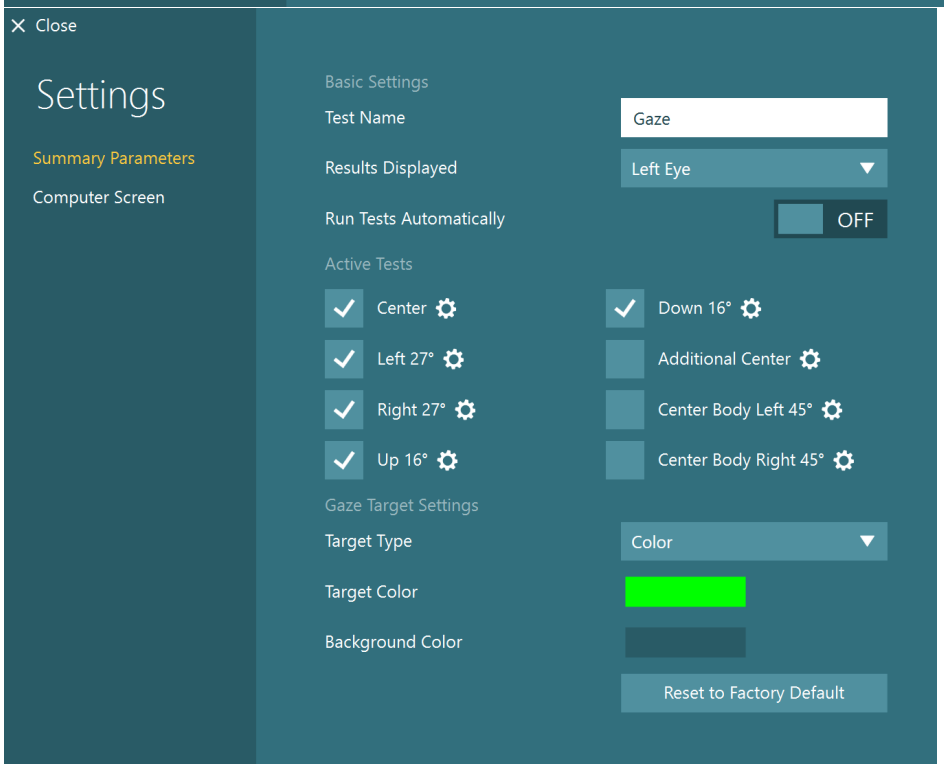


Figure 9.3-5 Gaze summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Mixed Eyes will allow you to choose the best eye for each subtest. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Run Tests Automatically: If enabled, when the subtest completes, the next subtest will be loaded and started automatically.

Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. By default, the active tests would be Center, Left, Right, Up, and Down. Center 2 is optional for a follow-up center gaze.
Gaze Target Settings: [missing]
Target Type: Selects the stimulus for all Gaze subtests (circle of solid color, flower, potato head, or smiley face).
Target Color: If the target type is set to color, this option will change the target color.
Background color: Select different colors for the background.

Test parameters Configuration options through Temporary Settings/Protocol management (Figure 9.3-6):

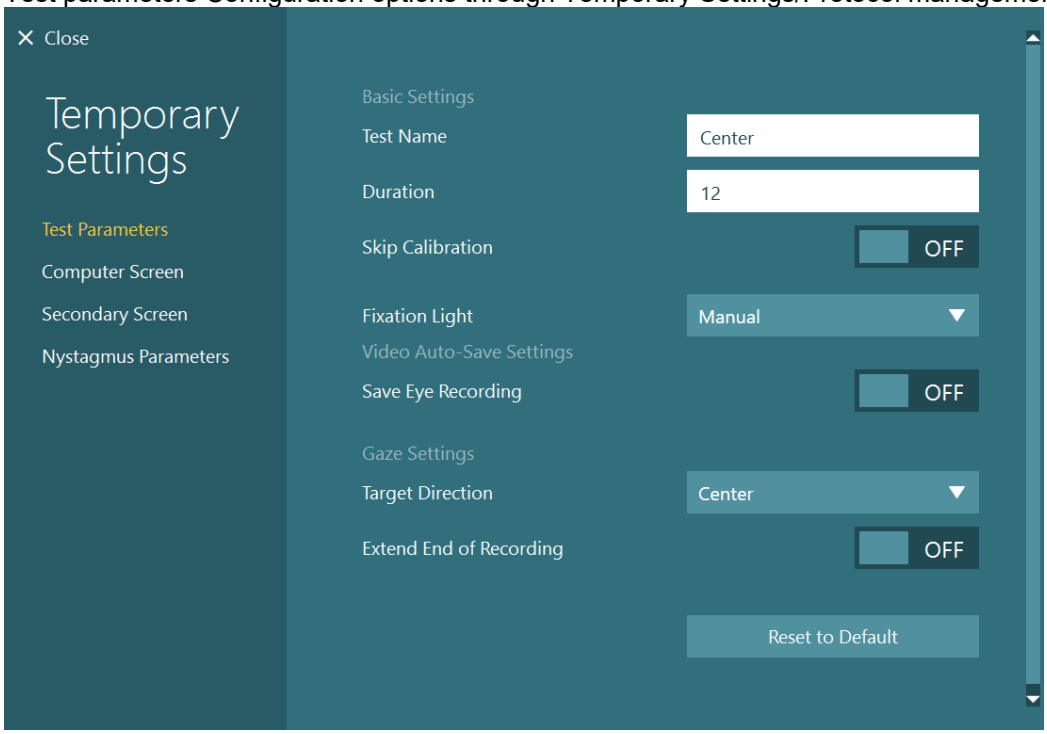


Figure 9.3-6 Gaze subtest settings

Test Name: Name of subtest
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds).
Skip Calibration: You can skip calibration to proceed with the test
Fixation Light: Determines when the fixation light in the goggles is displayed. Manual (default) will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time.
Save Eye Recording: Choice to save eye video recordings.
Target Direction: Defines direction of target movement.
Extend End of Recording: If enabled the test will return the target back to center for two seconds. Not recommended if the tests are run automatically.

9.3.3 Configuration of Saccade test

Summary parameters Configuration options of Saccade test through Protocol Management (Figure 9.3-7):

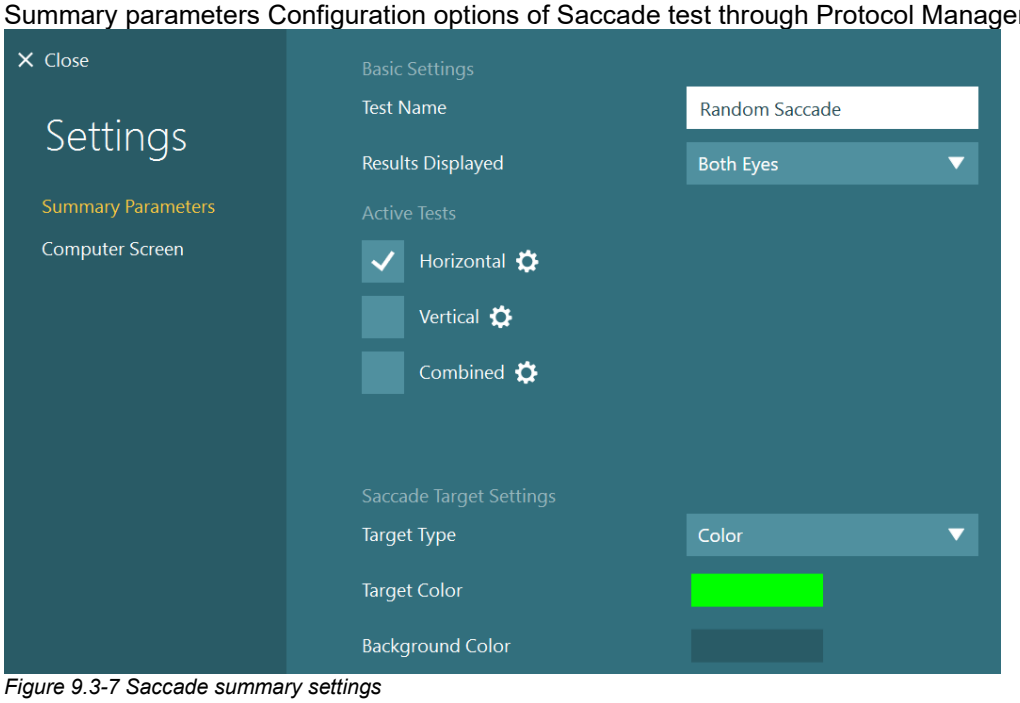


Figure 9.3-7 Saccade summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Both Eyes will show both eyes overlapping to allow easy viewing of deconjugate eye movements. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. Horizontal is selected by default. Vertical and Combined tests are optional tests. In the Combined subtest the target will jump horizontally or vertically randomly for each jump.
Saccade Target Settings:
Target Type: Selects the stimulus for all Saccade subtests (circle of solid color, flower, potato head, or smiley face).
Target Color: If the target type is set to color, this option will change the target color.
Background color: Select different colors for the background.

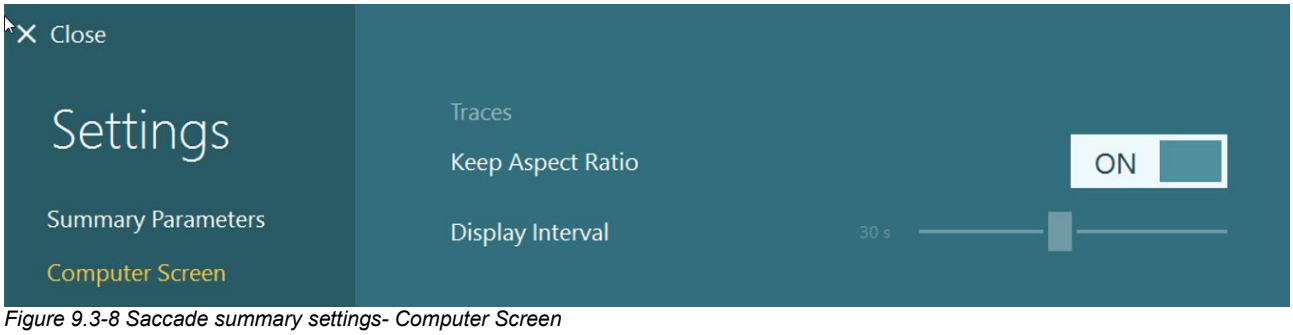


Figure 9.3-8 Saccade summary settings- Computer Screen

Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test.

Subtest settings through Temporary Settings / Protocol management (Figure 9.3-9):

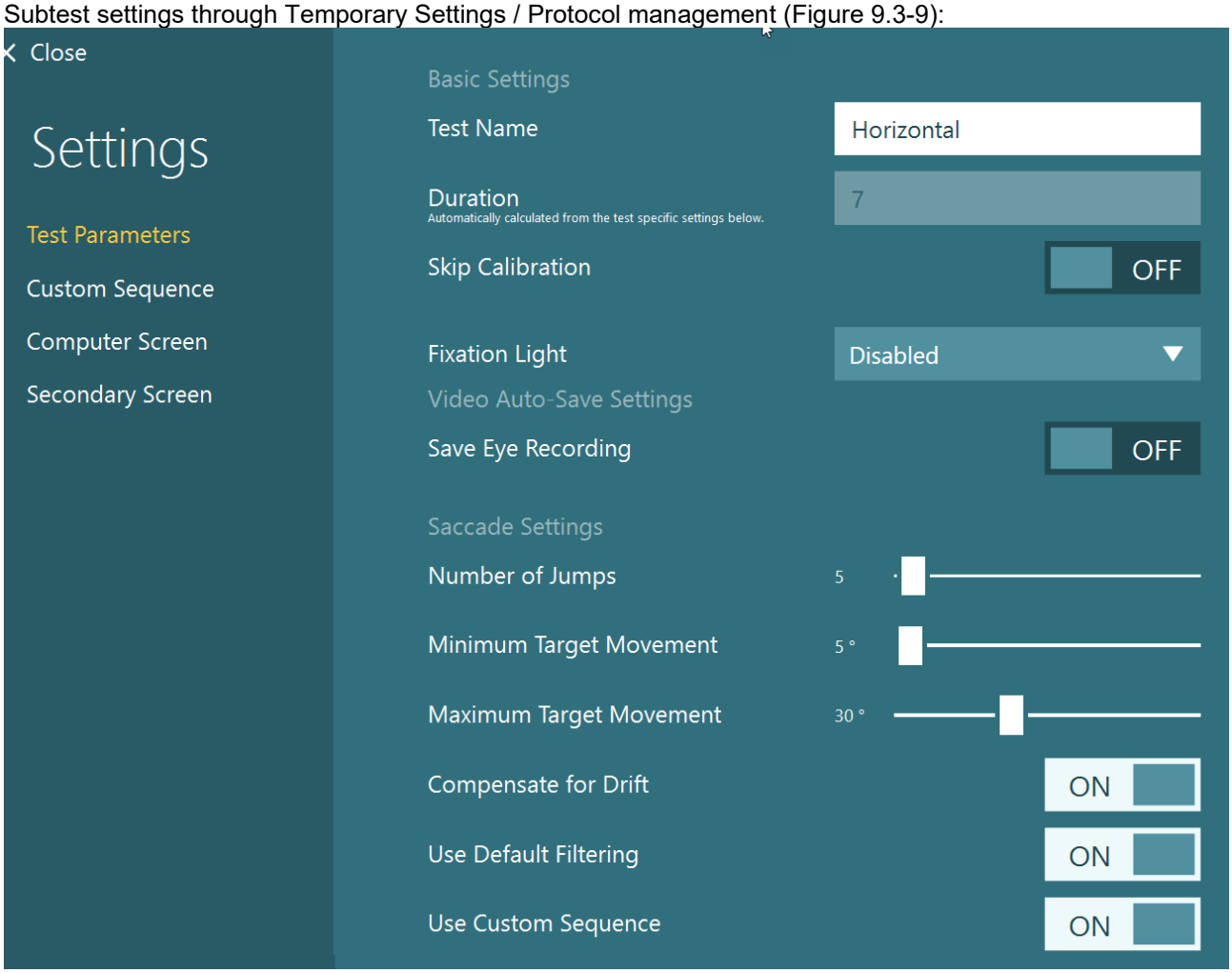


Figure 9.3-9 Saccade subtest settings

Test Name: Name of subtest
Duration: Length of time to perform the test based on the number of saccades
Skip Calibration: You can skip calibration to proceed with the test
Fixation Light: Determines when the fixation light in the goggles is displayed. Manual will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time. Disabled (default) will block the fixation light from turning on in the test.
Save Eye Recording: Choice to save eye video recordings.
Number of Jumps: Defines how many saccade jumps the patient will follow.
Minimum Target Movement: Define minimum degrees target can move relative to previous target position.
Maximum Target Movement: Define maximum degrees target can move relative to previous target position.
Compensate for Drift: If enabled, the software will adjust the patient's response to better align with the target.
Use Default Filtering: enables or disables the default filter for noise reduction
Use Custom Sequence: If enabled, this includes a tab called 'Custom Sequence'. This tab allows a clinician to design their own pattern on the target movement by edit the test parameters (discussed below).

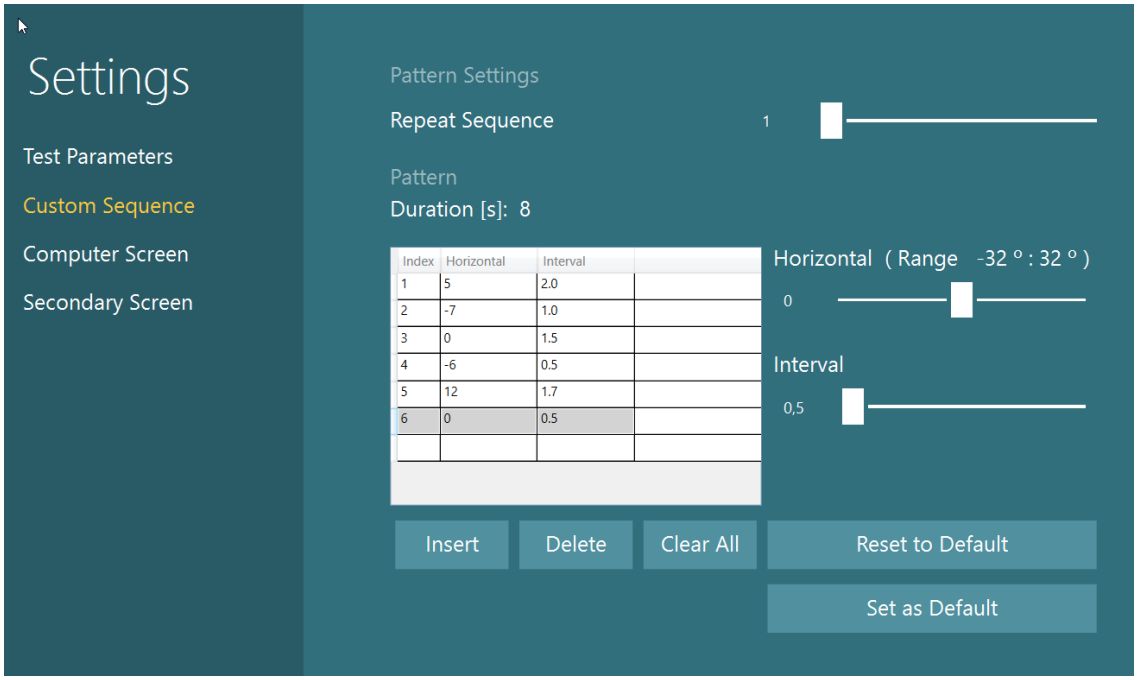


Figure 9.3-10 Saccade subtest settings-Custom Sequence

Custom Sequence: This option can be accessed either under temporary settings of the test or under protocol management. Both horizontal and vertical jumps can be changed using this option.
Repeat Sequence allows user to repeat the sequences.
Insert: Allows user to include new rows.
Delete: Allows user to delete the selected rows.
Clear All: Allows the user to clear the values on the screen for the fresh input.

9.3.4 Configuration of saccadometry test

Configuration options of Summary Parameters through Protocol Management (Figure 9.3-11):

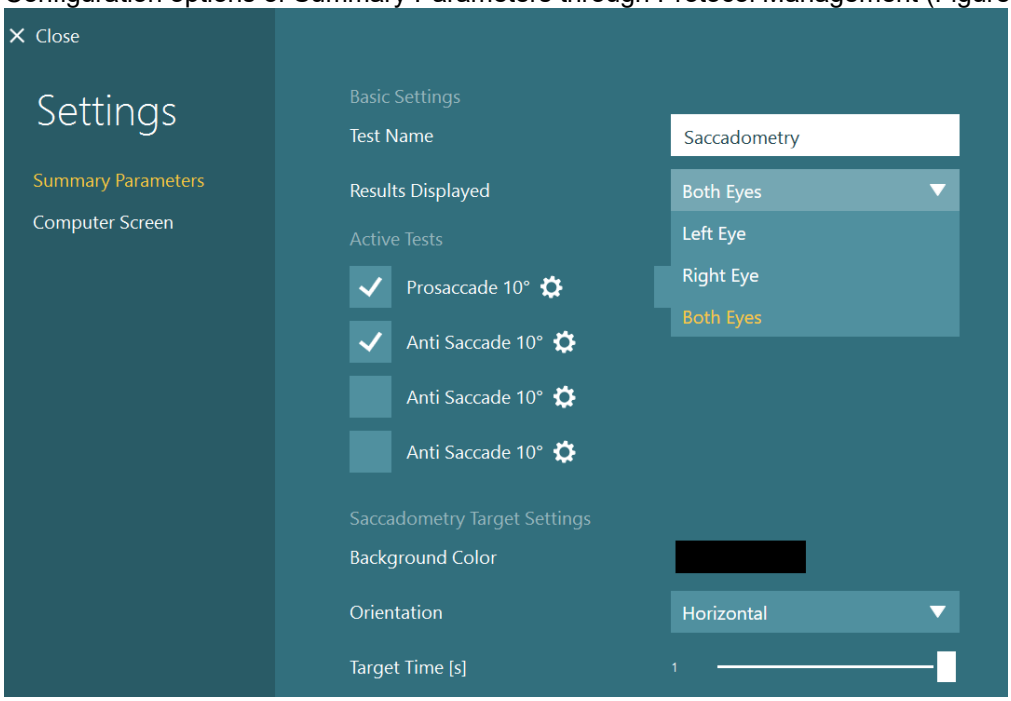


Figure 9.3-11 Saccadometry summary settings

Test Name: Name of the test

Results Displayed: The user has options to select Left eye or Right eye or Both Eyes as they prefer.
Active Tests: The user can select the preferred subtests. The configuration gear button beside each test will open the subtest settings.
Saccadometry Target Settings:
Background Color: User can select the different color for the target stimulus and for the background.
Orientation: The user can select either horizontal or vertical orientations.
Target Time: The user can adjust the display time of the target.

Subtest settings through Temporary Settings (Figure 9.3-):

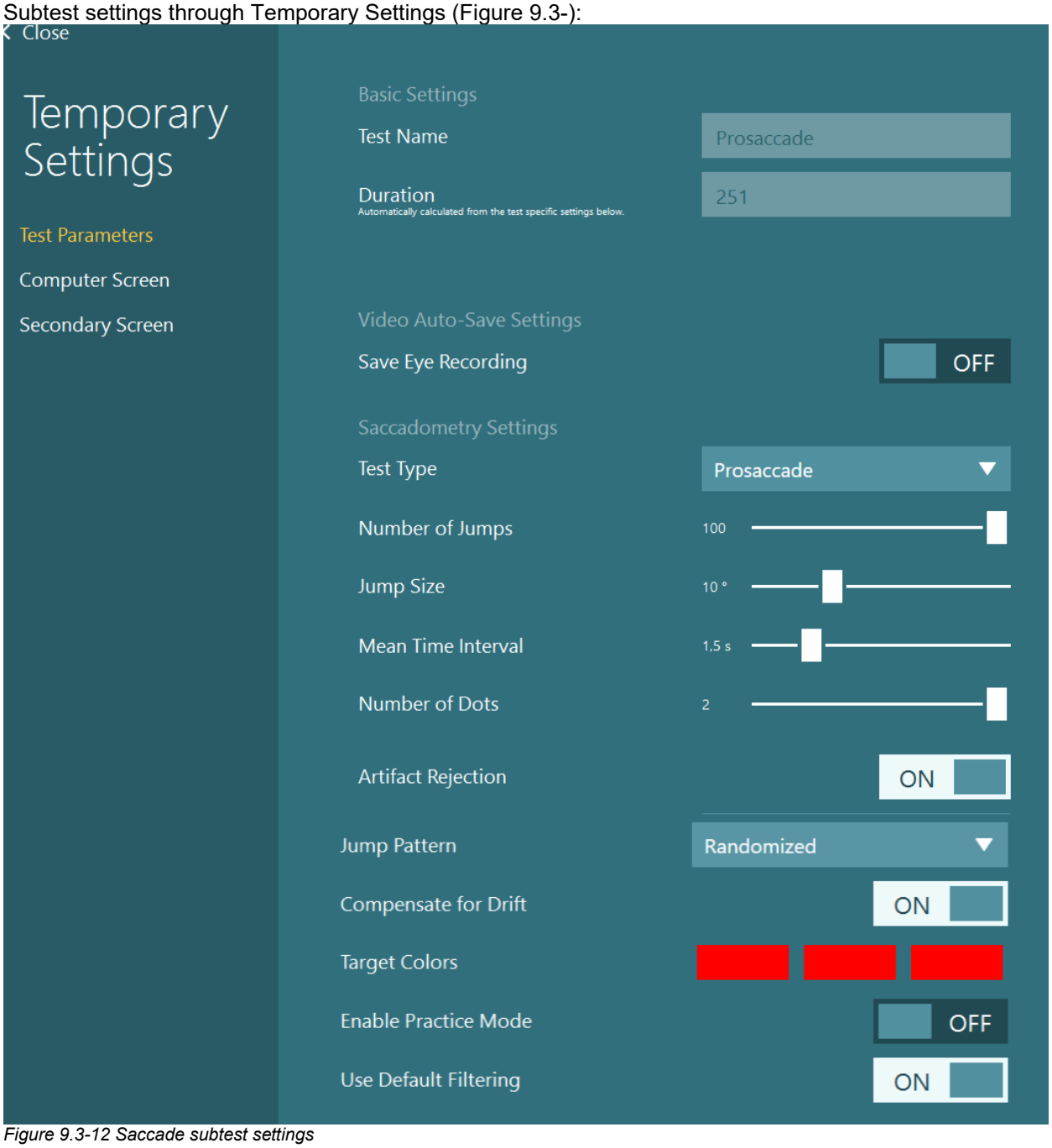


Figure 9.3-12 Saccade subtest settings

Test Name: Name of subtest, defined by the Test Type and Jump Size
Duration: Length of time to perform the test based on the number of saccade jumps
Save Eye Recording: Choice to save eye video recordings.
Test Type: Specifies whether the subtest is a Prosaccade or Anti-Saccade subtest
Number of Jumps: Defines how many jumps the patient will follow (maximum of 100).
Jump Size: Defines the degrees the target will be displayed left or right from the center of the stimulus.

Mean Time Interval: Defines the average amount of time between saccade jumps.
Number of Dots: Changes the style for displaying the dots on the screen. In Prosaccade subtests, the maximum number of dots is 2, Anti-Saccade tests may use 3 dots.
If the number of dots is set to one, then the target will alternate between the left and right position as defined in the Jump Size field. If the number of dots is 2, then the center target is displayed, and the left or right position is briefly shown. If the number of dots is 3, then the center target, left target, and right target are displayed, with the left or right target flashing briefly to indicate the direction not to look at in Anti-Saccades.
Artifact Rejection: If enabled, this filters the saccades fall outside of the following parameters 100<Velocity<1000; 100<Latency 700; 20<accuracy<350. The user can turn off this option if the user wants to include all the saccades for analysis.
Jump Pattern: If performing the Anti-Saccade subtest, this setting will determine if the target randomly flashes between sides or performs a standard jump pattern where the target will flash between the left and right positions evenly.
Compensate for Drift: If enabled, the software adjusts the patient's response to better align with the target.
Target Colors: Displays the selected colors for the left, center, and right targets.
Enable Practice Mode: If enabled, the test will run ten saccade jumps as a trial for the patient to perform and get used to the test style.
Use default Filtering: enables or disables the default filter for noise reduction

9.3.5 Configuration of smooth pursuit tests

Configuration options of Summary Parameters through Protocol Management (Figure 9.33-13):

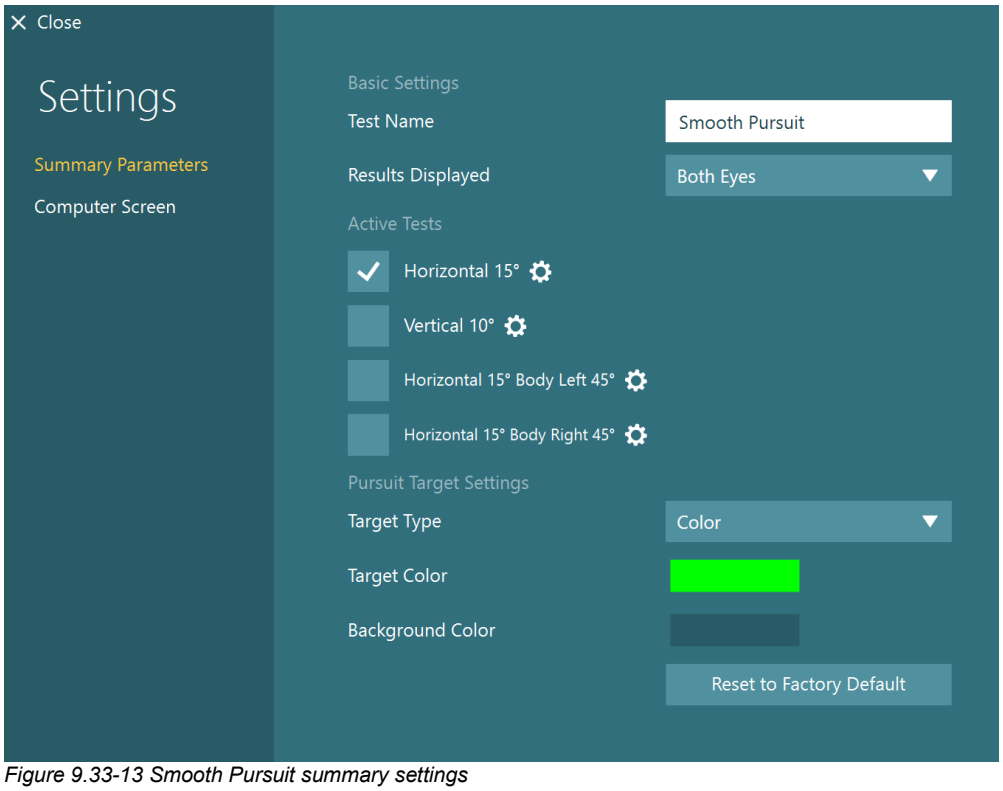


Figure 9.33-13 Smooth Pursuit summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Both Eyes will show both eyes overlapping to allow easy viewing of disconjugate eye movements. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. Horizontal 15° is selected by default, and the clinician can choose to perform the Vertical 10° if desired.
Pursuit Target Settings:

Target Type: Selects the stimulus for all Gaze subtests (circle of solid color, flower, potato head, or smiley face).
Target Color: If the target type is set to color, this option will change the target color.
Background Color: Select different colors for the background.

Subtest settings through Temporary Settings (Figure 9.3-14):

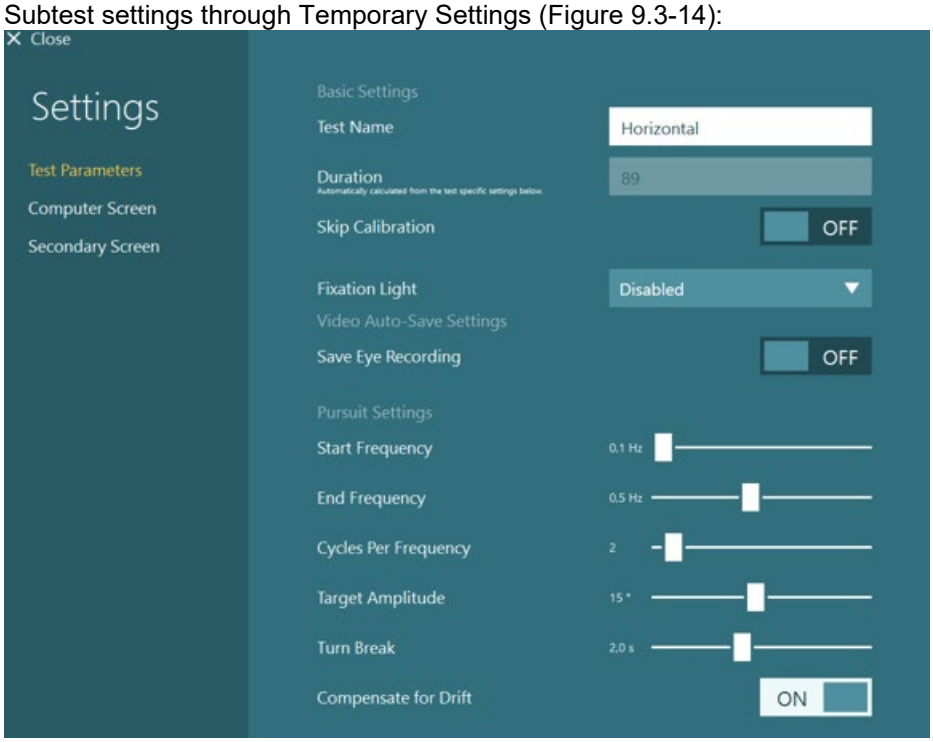


Figure 9.3-14 Smooth Pursuit subtest settings

Test Name: Name of subtest
Duration: Length of time to perform the test based on the number of pursuit cycles and frequencies tested
Skip Calibration: You can skip calibration to proceed with the test
Fixation Light: Determines when the fixation light in the goggles is displayed. Manual will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time. Disabled (default) will block the fixation light from turning on in the test.
Save Eye Recording: Choice to save eye video recordings.
Start Frequency [Hz]: Initial frequency of the smooth pursuit test
End Frequency [Hz]: End frequency of the smooth pursuit test
Cycles Per Frequency: Determines how many cycles will be required for each frequency step to be performed
Target Amplitude: Sets the distance the target can move (in degrees)
Turn Break: Sets the duration (max. 5 seconds) of the break when the target take turn in direction.
Compensate for Drift: If enabled, the software will adjust the patient's response to better align with the target.

9.3.6 Configuring the OPK tests

Configuration options of Summary Parameters through Protocol Management (Figure 9.3-15):

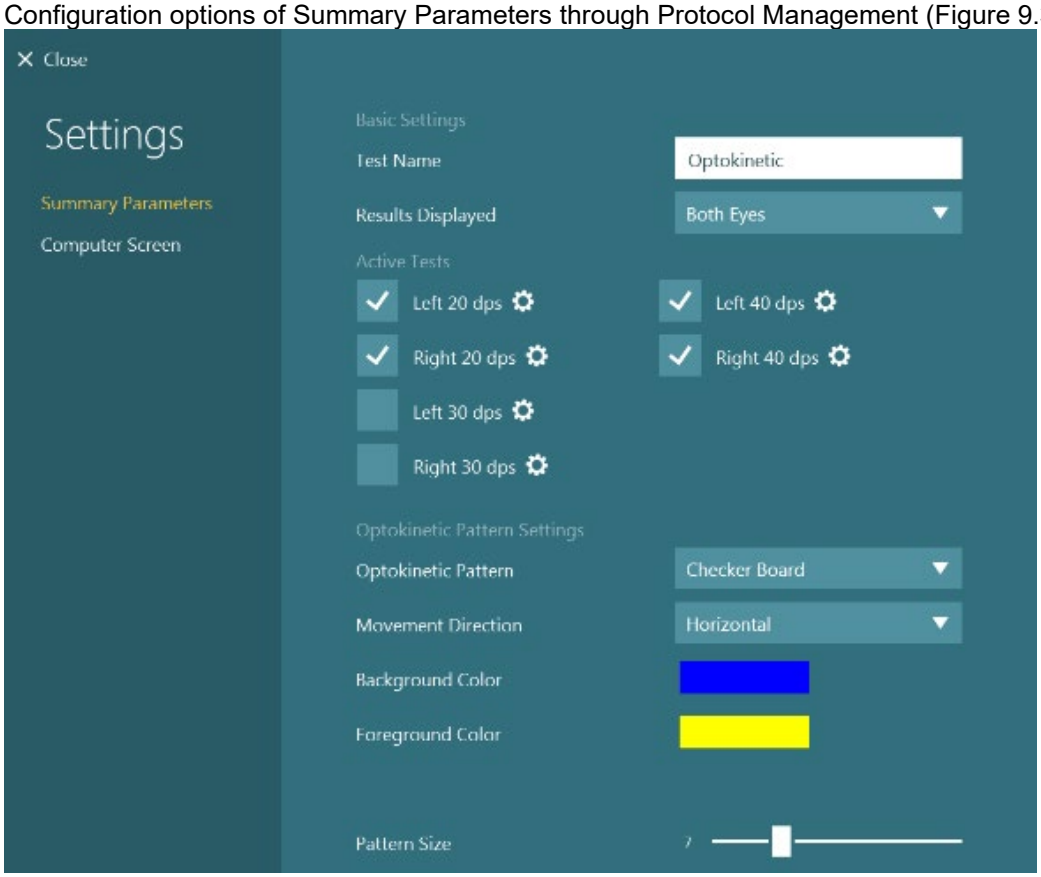


Figure 9.3-15 Optokinetic summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Both Eyes will show both eyes overlapping to allow easy viewing of disconjugate eye movements. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. By default, the active tests are Left 20 dps, Right 20 dps, Left 40 dps, and Right 40 dps. Left 30 dps and Right 30 dps are optional.
Optokinetic Pattern Settings:
Optokinetic Pattern: Creates a tessellation pattern or stretches a background image across the stimulus screen. Tessellation patterns include checkerboard, stripes, and spheres. Stretched image patterns include firetruck, pilot and airplane, landscape, toy train, yellow airplane, and trains and tracks.
Foreground Color: If the Optokinetic pattern is a tessellation pattern, this selection will change the color of the primary shape.
Alternate Color: If the Optokinetic pattern is set to Spheres, this selection will change the color of the even rows of spheres.
Background color: If the Optokinetic pattern is a tessellation pattern, this selection controls the background color or fill color depending on the tessellation pattern.
Pattern Size: Adjusts the size of the pattern used in the pattern tessellation. As the target size is increased, the number of shapes used in the pattern will decrease. Only available with Optokinetic patterns of Checkerboard, Stripes, and Spheres.

Configuration options through Temporary Settings (Figure 9.3-16):

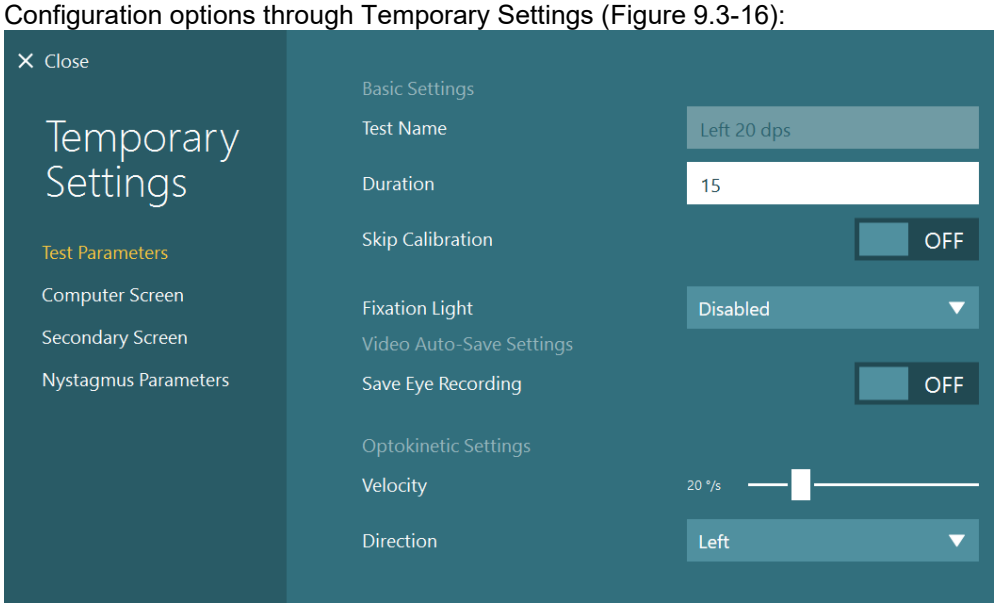


Figure 9.3-16 Optokinetic subtest settings

Test Name: Name of subtest
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds).
Skip Calibration: The user can skip calibration to proceed with the test
Fixation Light: Determines when the fixation light in the goggles is displayed. Manual will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time. Disabled (default) will block the fixation light from turning on in the test.
Save Eye Recording: Choice to save eye video recordings.
Velocity: Defines the speed at which the target pattern is displayed on the screen. Confirm that the Velocity value is used by another Optokinetic subtest with the Direction set to the opposite direction to ensure that the Optokinetic Symmetry graph can be populated.
Direction: Defines direction of target movement.

9.4 Configuring the nystagmus tests

9.4.1 Computer settings for Nystagmus tests:

All the nystagmus tests except spontaneous nystagmus tests have a summary setting for computer screen as discussed below



Figure 9.4-1 Nystagmus tests summary settings-Computer Screen

Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test.

In addition to above mentioned features, the caloric test has following additional features to facilitate the tests.

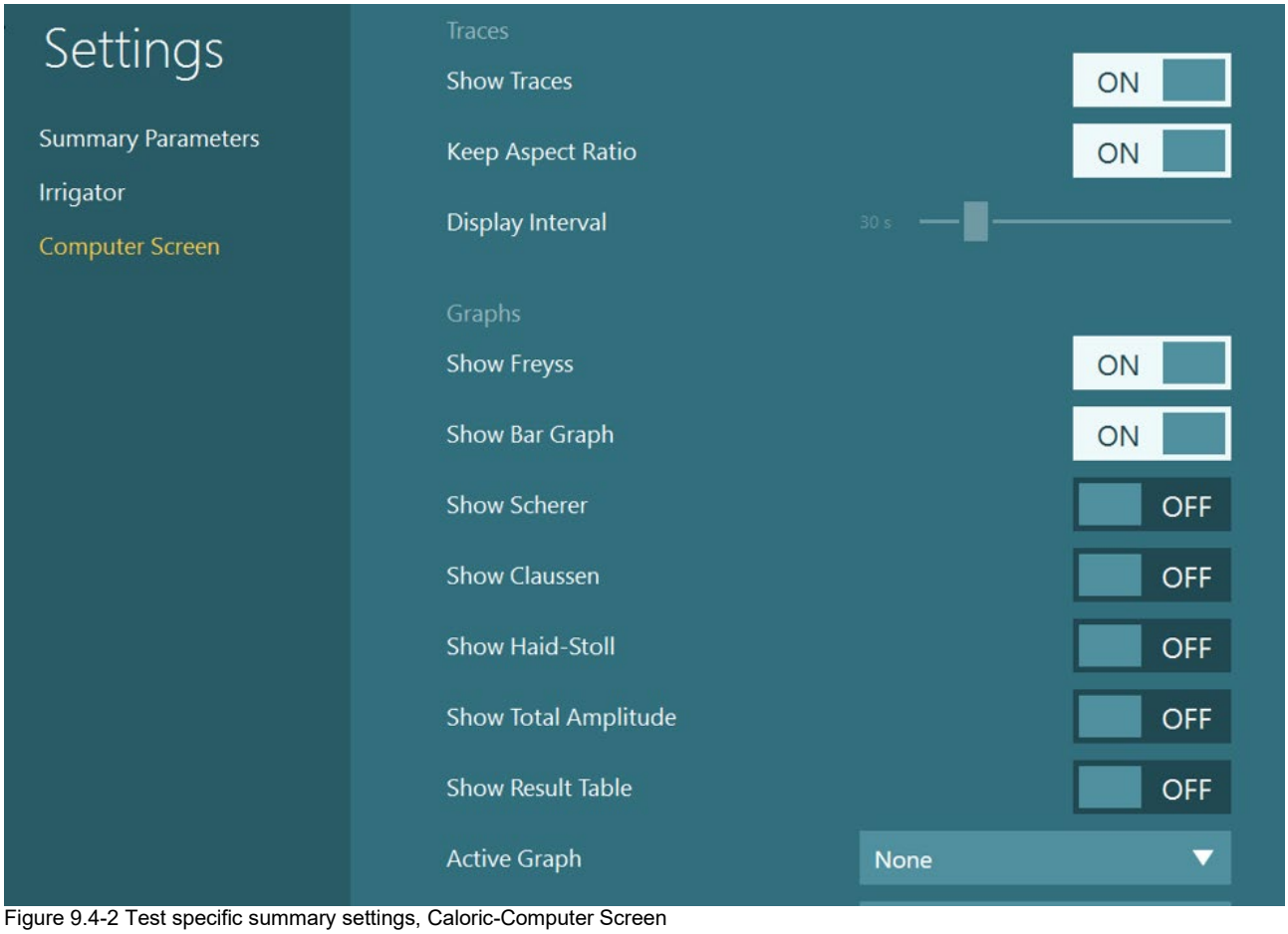


Figure 9.4-2 Test specific summary settings, Caloric-Computer Screen

Show traces: if enabled, this displays the eye position graphs.
Graph: Allows user to select the graphical view of the test result of the choice (Freyss. Bar, Scherer, Claussen, Haid-Stoll, Total Amplitude, result table are listed)
Active Graph: The clinician can select their choice for the active graph (only one can be selected) from the list of enabled graph options.

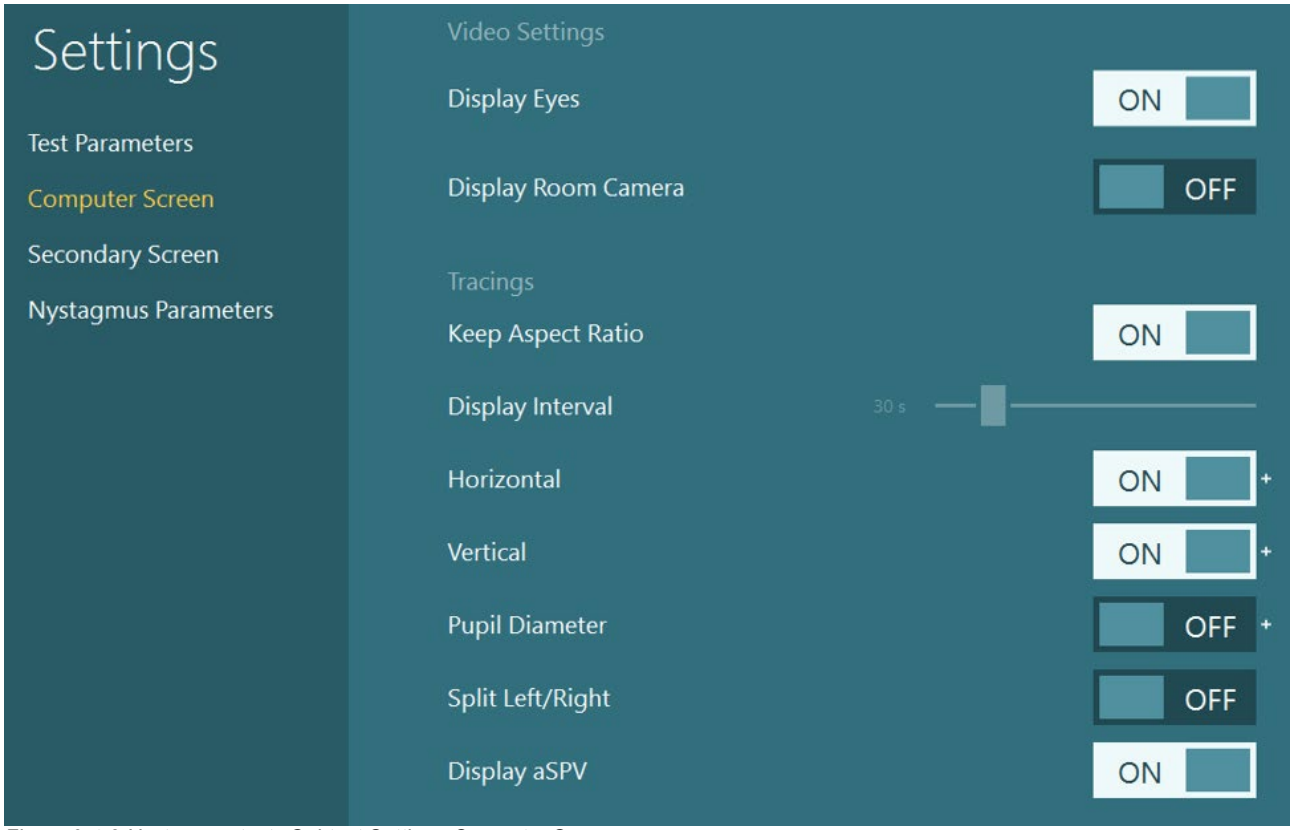


Figure 9.4-3 Nystagmus tests Subtest Settings-Computer Screen

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Display Room Camera: If enabled, records the test room during testing.
Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test.
Horizontal: If enabled, it shows the graphical display of horizontal eye movements.
: by clicking this + symbol, the user can adjust the upper and lower limits for eye position axis (horizontal).
Vertical: If enabled, it shows the graphical display of vertical eye movements.
: by clicking this + symbol, the user can adjust the upper and lower limits for eye) position axis (vertical).
Pupil Diameter: If enabled, shows a graphical display of pupil diameter.
: by clicking this + symbol, the user can adjust the upper and lower limits for pupil diameter axis.
Split Left/Right: If enabled, splits the graph into two, one for left and another for right (available only with Dix- Hallpike tests in the category of nystagmus tests).
Display aSPV: If enabled, shows the graphical display of average slow phase velocity (this option is available only for few nystagmus tests).

Dix-Hallpike advanced test and Lateral head roll test have few additional test specific features in computer settings as shown below.

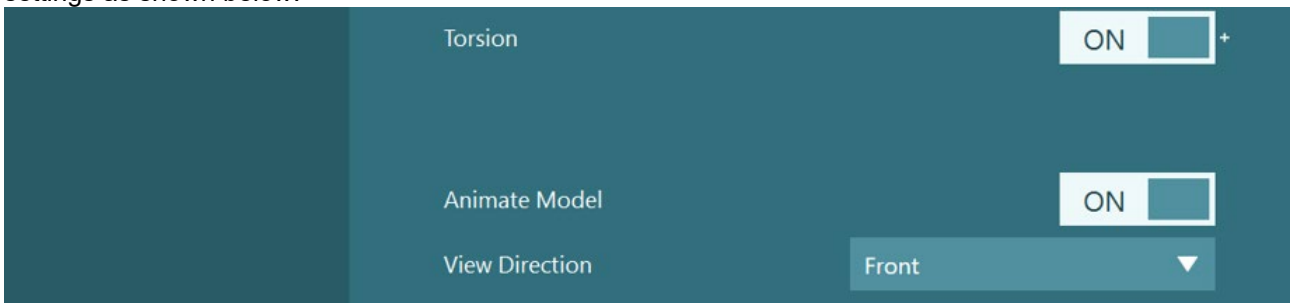


Figure 9.4-4 Test Specific Subtest Settings, Dix-Hallpike Advanced-Computer Screen and Lateral Head Roll tests

Torsion: Enable to show torsion traces on screen (available only with DHA test).
Animate Model: guides to view head movement with 3D model to ensure head rotation on both side correct and symmetrical.
View Direction: Select direction to view 3D model from.

Caloric test has following test specific feature.

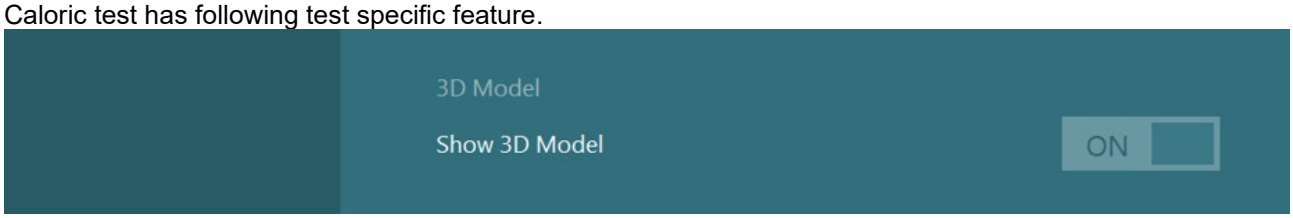


Figure 9.4-5 Test Specific Subtest Settings, Caloric-Computer Screen

Show 3D Model: guides to view head movement with 3D model to ensure head position.

If the user has secondary screen, the following settings are available.

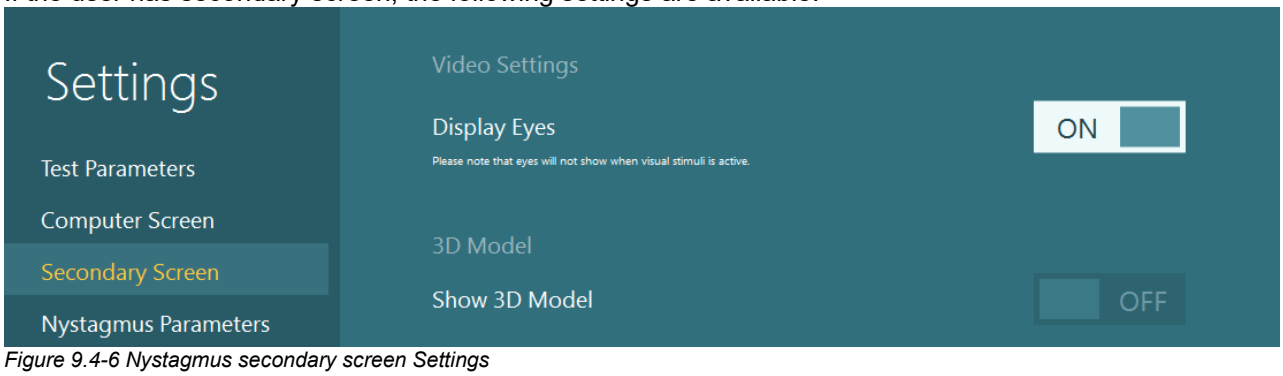


Figure 9.4-6 Nystagmus secondary screen Settings

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Show 3D Model: guides to view head movement with 3D model in order to ensure head position.

9.4.2 Configuring the spontaneous nystagmus test

Configuration options through Temporary Settings (Figure 9.4-7):

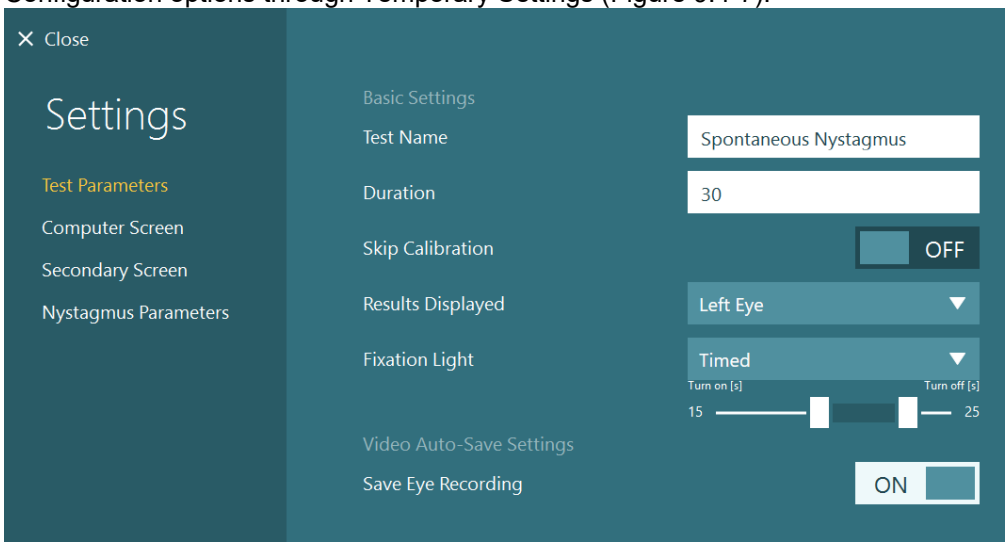


Figure 9.4-7 Spontaneous Nystagmus test settings

Test Name: Name of test
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds).
Skip Calibration: The user can skip calibration to proceed with the test
Results Displayed: Selects which eye is shown by default. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Fixation Light: Determines when the fixation light in the goggles is displayed. Manual (default) will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time.
Save Eye Recording: Choice to save eye video recordings.

9.4.3 Configuring the Dix-Hallpike tests

Configuration options of Summary Parameters through Protocol Management (Figure 9.4-8):

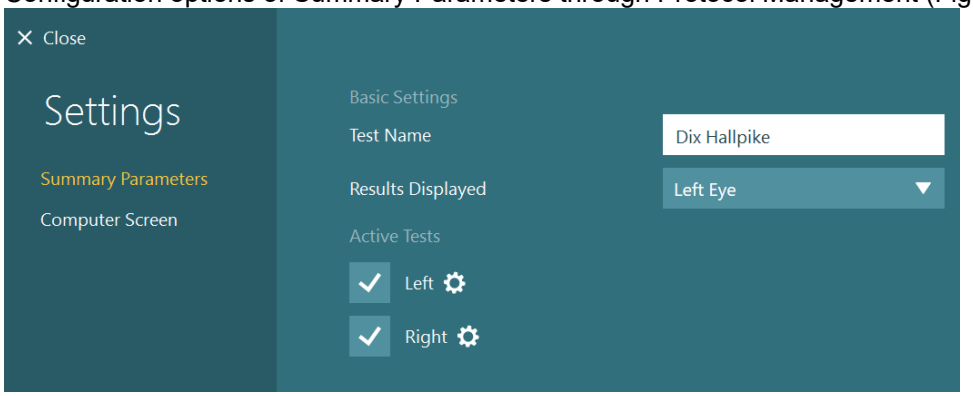


Figure 9.4-8 Dix Hallpike summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Mixed Eyes will allow the user to choose the best eye for each subtest. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. The active tests are Left and Right.

Configuration options through Temporary Settings (Figure 9.4-9):

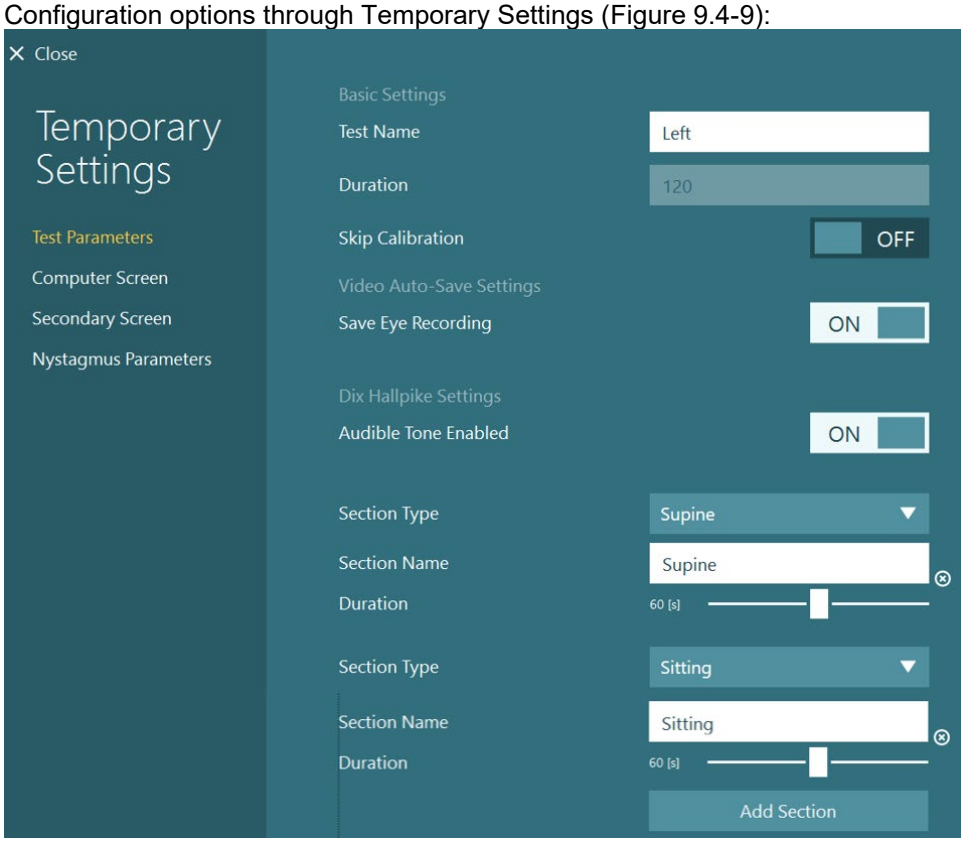


Figure 9.4-9 Dix Hallpike subtest settings

Test Name: Name of test
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds).
Skip Calibration: The user can skip calibration to proceed with the test
Video Auto-save settings:
Save Eye Recording: Choice to save eye video recordings.
Dix Hallpike Settings:
Audible Tone Enabled: If enabled, the software will provide an audible beep after the Audible Tone Time has elapsed to signify to the operator to raise the patient to a sitting position.
Section Type: The user can select patient position type using this option.
Section Name: The user can create a new name (e.g.: to identify the individual test done in the same patient position).
Duration: The user can adjust the test duration for each position using this option.

9.4.4 Configuring the Dix-Hallpike Advanced test

The Dix-Hallpike Advanced test is an optional test that uses the VORTEQ™ IMU to ensure accurate head position during the test and uses torsional tracking to detect torsional nystagmus.

Configuration options of Summary Parameters through Protocol Management (Figure 9.4-10):

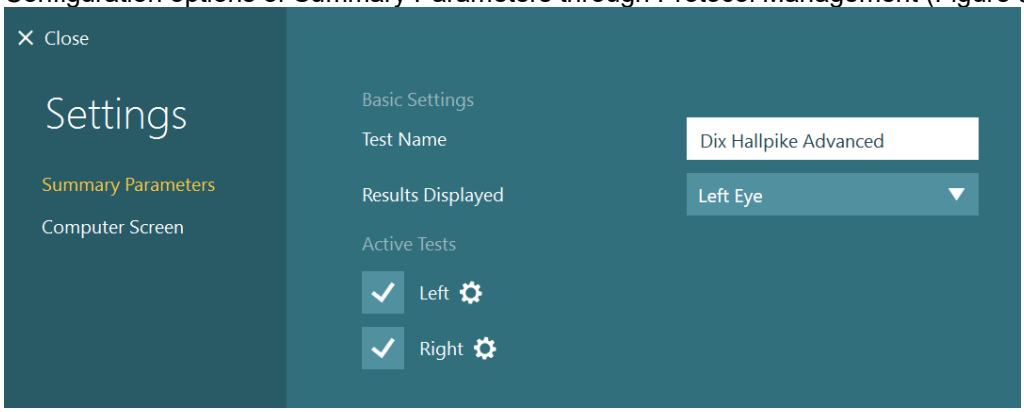


Figure 9.4-10 Dix-Hallpike Advanced test Summary Parameters

Test Name: Name of test
Results Displayed: Selects which eye is shown by default. Mixed Eyes will allow the user to choose the best eye for each subtest. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. The active tests are Left and Right.

Configuration options through Temporary Settings (Figure 9.4-11):

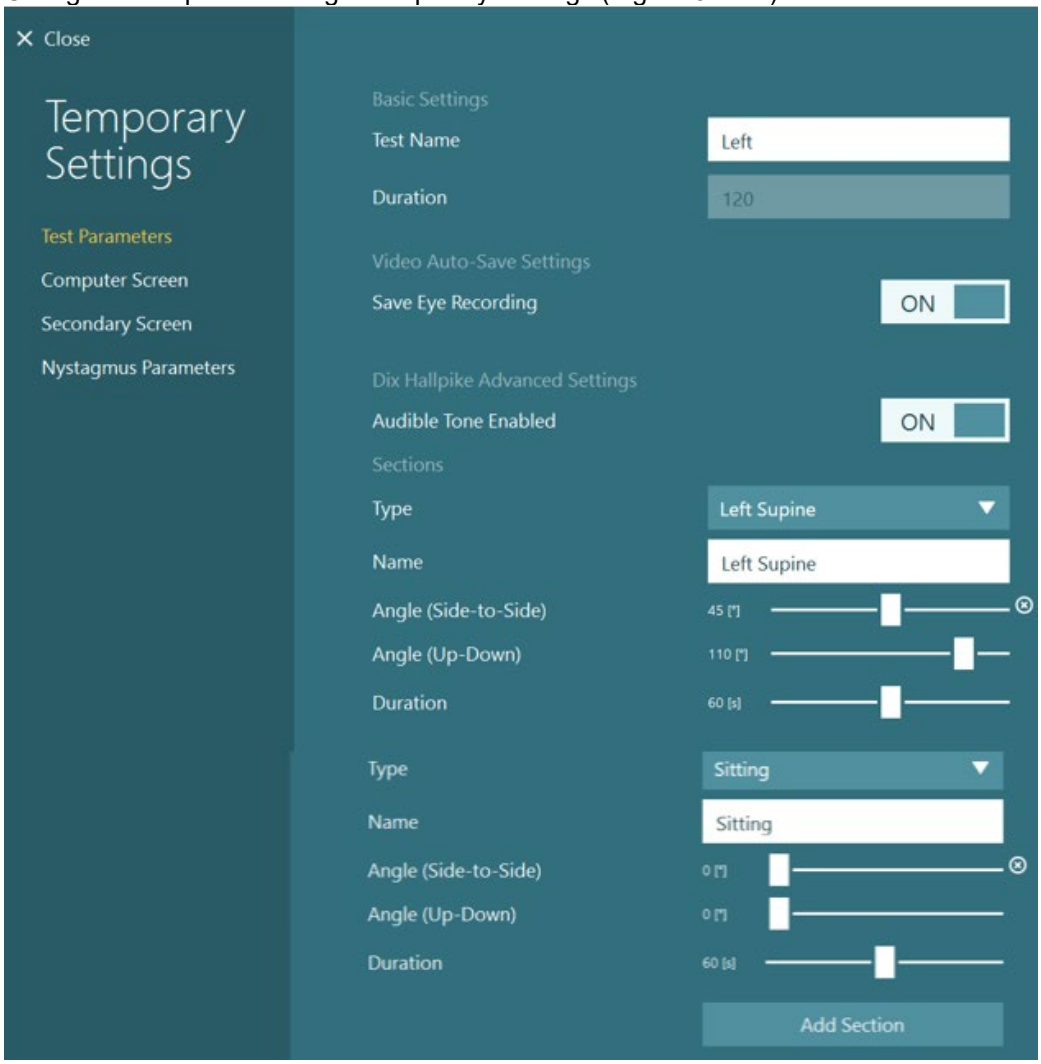


Figure 9.4-11 Dix-Hallpike Advanced subtest settings

Test Name: Name of subtest
Duration: Defines how long the eye movement is to be recorded and analyzed (in seconds)
Save Eye Recording: Choice to save eye video recordings.

Dix Hallpike Advanced Settings:
Audible Tone Enabled: If enabled, the software will provide an audible beep after the Audible Tone Time has elapsed to signify to the operator to raise the patient to a sitting position. If the test is ended early by the operator, this tone is not played.
Sections:
Type: Method used to define the section style. This sets the plane to anticipate the target in a specific section of 3D space. The software can be set to Left Supine, Right Supine, Sitting, or Generic.
Name: Name displayed on the waveform for the current section
Angle (Side-to-Side): Angle the patient must have the head rolled when laying in the left supine or right supine position. This value ranges from 0 degrees (looking straight ahead) to 180 degrees (looking behind). Typical value is 45 degrees.
Angle (Up-Down): Angle the patient must have the head raised or lowered when laying in the left supine or right supine position. This value ranges from 0 degrees (head upright) to 180 degrees (head upside down). Typical value is 110 degrees.
Duration: Length of time in seconds of the current section.

9.4.5 Configuring the positional tests

Configuration options of Summary Parameters through Protocol Management (Figure 9.4-12):

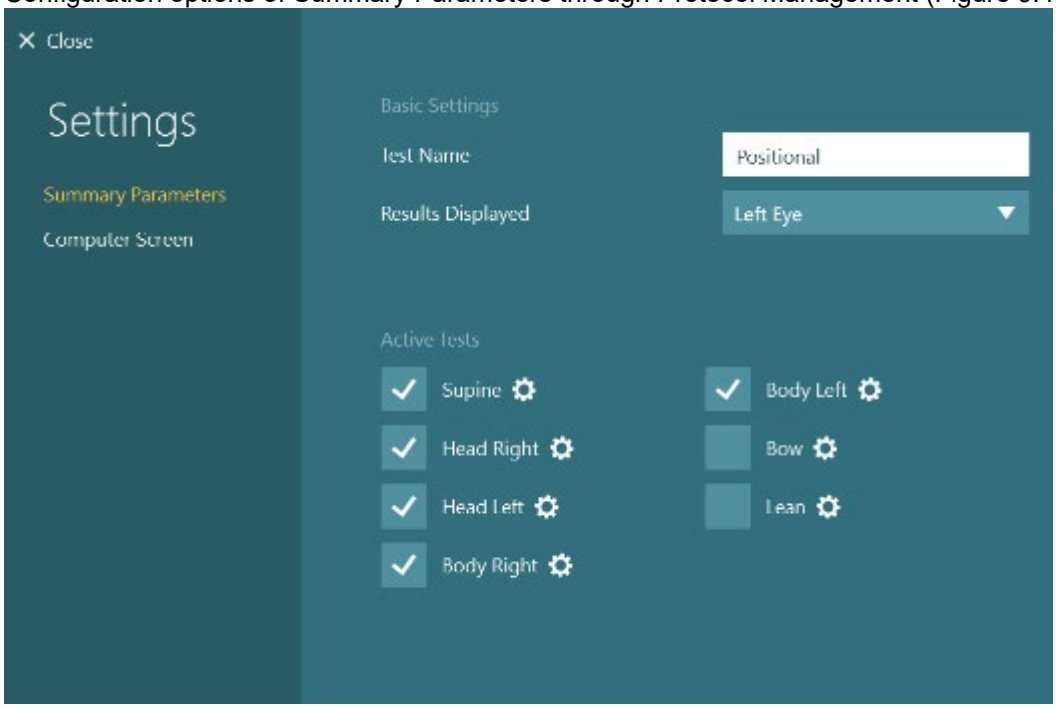


Figure 9.4-12 Positional Summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Mixed Eyes will allow the user to choose the best eye for each subtest. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. By default, the active tests would be Supine, Head Right, Head Left, Body Right, and Body Left. Bow and Lean are optional body positions.

Configuration options through Temporary Settings (Figure 9.4-13):

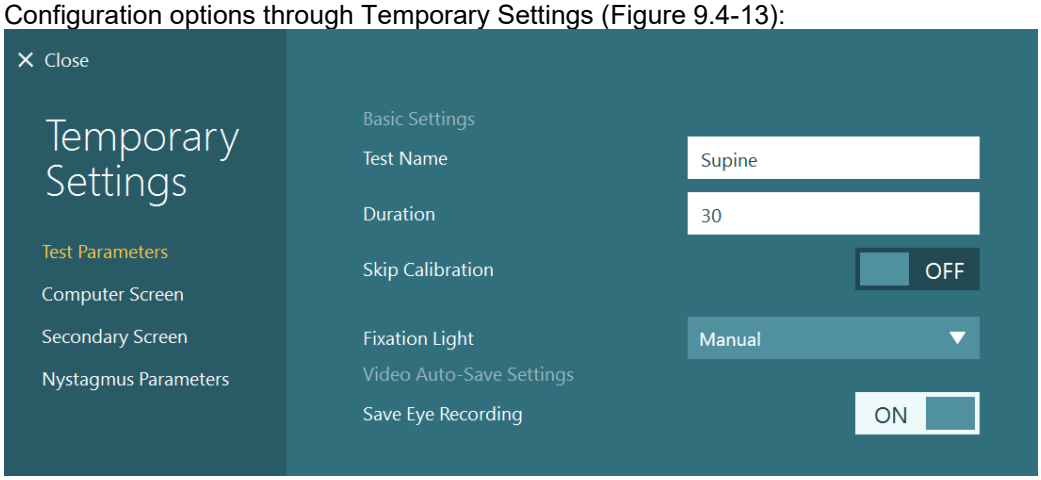


Figure 9.4-13 Positional subtest settings

Test Name: Name of test
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds).
Skip Calibration: The user can skip calibration to proceed with the test
Fixation Light: Determines when the fixation light in the goggles is displayed. Manual (default) will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time.
Save Eye Recording: Choice to save eye video recordings.

9.4.6 Configuring the Lateral Head Roll test

Configuration options of Summary Parameters through Protocol Management

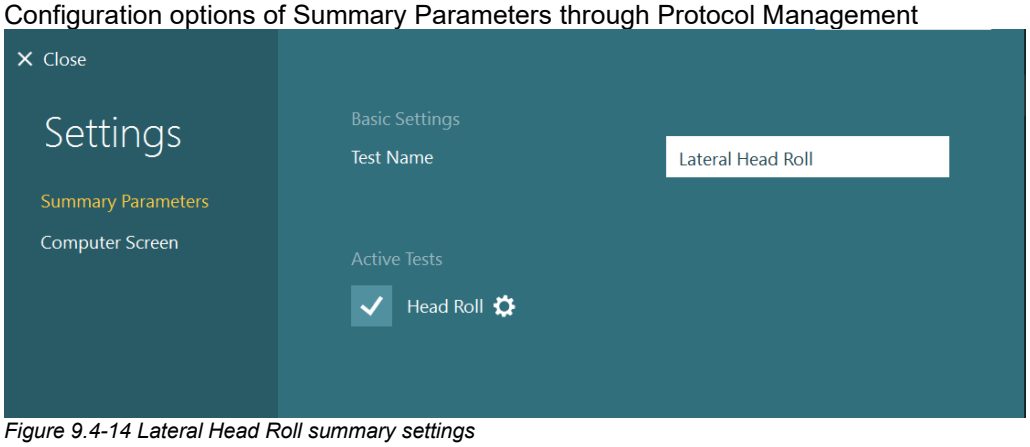


Figure 9.4-14 Lateral Head Roll summary settings

Configuration options of Sub-test Parameters through Protocol Management or Temporary Settings

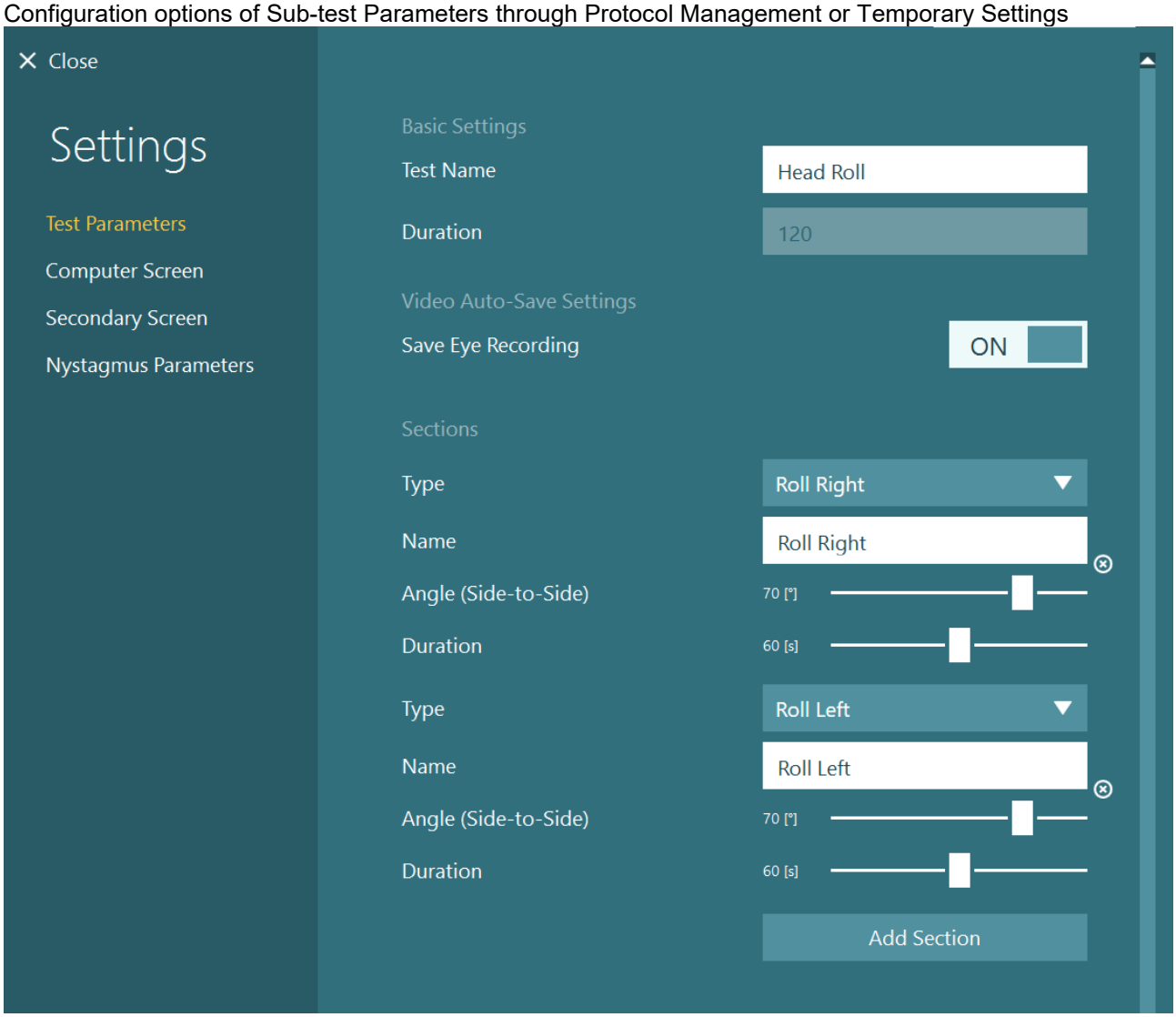


Figure 9.4-15 Lateral Head Roll subtest settings

Test Name: Name of subtest
Duration: Defines how long the eye movement is to be recorded and analyzed (in seconds)
Save Eye Recording: Choice to save eye video recordings.
Sections:
Type: Method used to define the section style. This sets the plane to anticipate the target in a specific section of 3D space. The software can be set to Left Supine, Right Supine, Sitting, or Generic.
Name: Name displayed on the waveform for the current section
Angle (Side-to-Side): Angle the patient must have the head rolled when laying in the left supine or right supine position. This value ranges from 0 degrees (looking straight ahead) to 180 degrees (looking behind). Typical value is 45 degrees.
Duration: Length of time in seconds of the current section.

9.4.7 Configuring the caloric tests

Configuration options of Summary Parameters through Protocol Management (Figure 9.4-16):

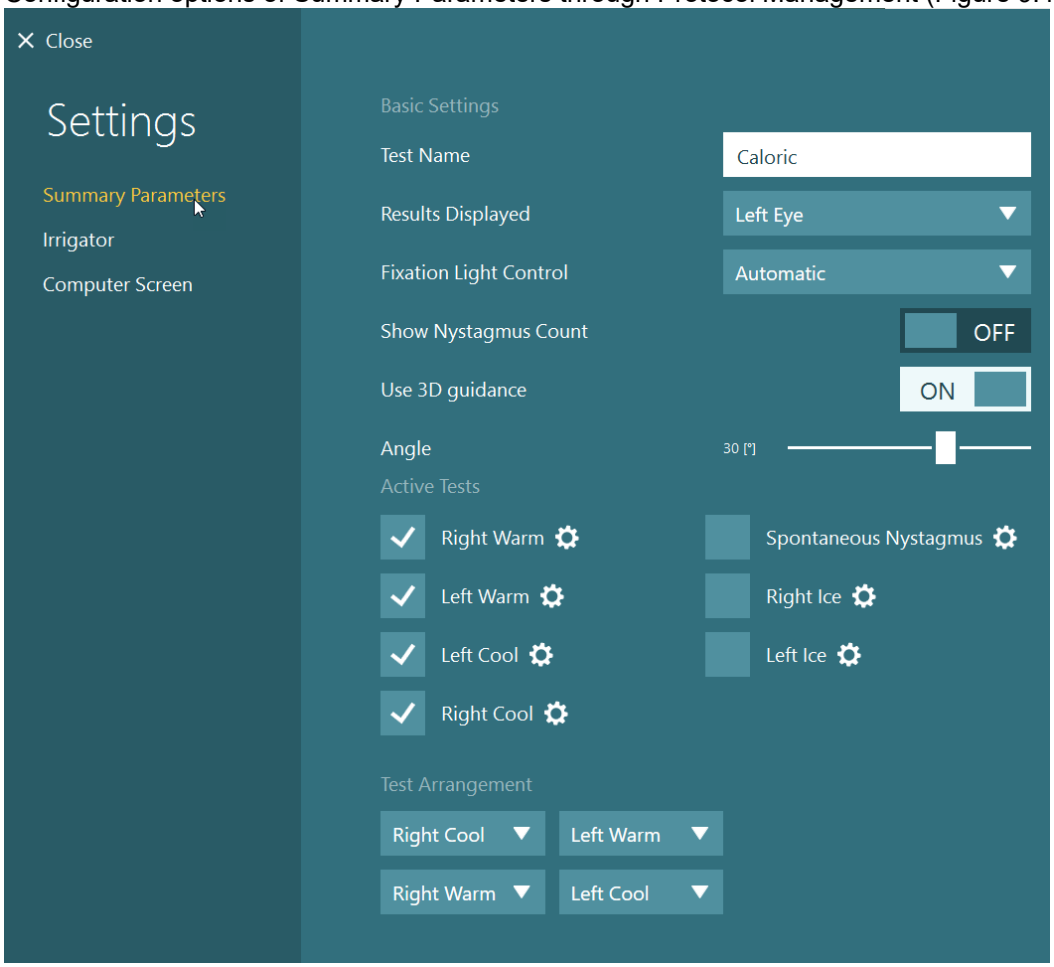


Figure 9.4-16 Caloric summary settings

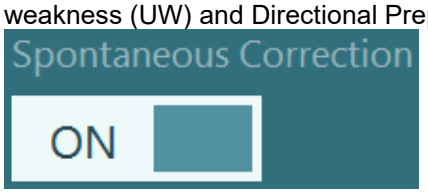
Test Name: Name of test
Results Displayed: Selects which eye is shown by default. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Fixation Light Control: Determines when the fixation light in the goggles is displayed. Automatic (default) will have the fixation light turn on after the current average slow phase velocity has dropped 10% compared to the maximum average slow phase velocity. Manual will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time. The fixation index will not be calculated if the operator has turned the fixation light on early in the subtest.
Show Nystagmus Count: If enabled, the software will display the number of detected nystagmus beats in the peak response window and display the beat count in the pod view above the fixation index value.
Use 3D Guidance: guides to view head movement with 3D model to ensure head rotation on both side correct and symmetrical.
Active tests: allows to select subtests
Test Arrangements: This allows the clinician to arrange the subtests in the part view and the related eye position graphs.

Before you perform the caloric irrigation test, you can do a spontaneous nystagmus test. This is recommended for patients that have shown nystagmus in conditions without stimulation. The average slow phase velocity determined during the caloric spontaneous nystagmus test is used in the calculation of directional preponderance.

Under the Summary Parameters choose ‘Spontaneous Nystagmus’.



Once a sub test is complete, you can enable ‘Spontaneous Correction’.
The calculations consider the presence of underlying spontaneous nystagmus in the analysis of unilateral weakness (UW) and Directional Preponderance (DP).



Test Arrangement: You can change the order of the caloric subtests and how they are displayed on the screen. Analysis results will also display the test results in the test arrangement if possible.

Configuration options of Irrigator through Protocol Management (Figure 9.4-17):

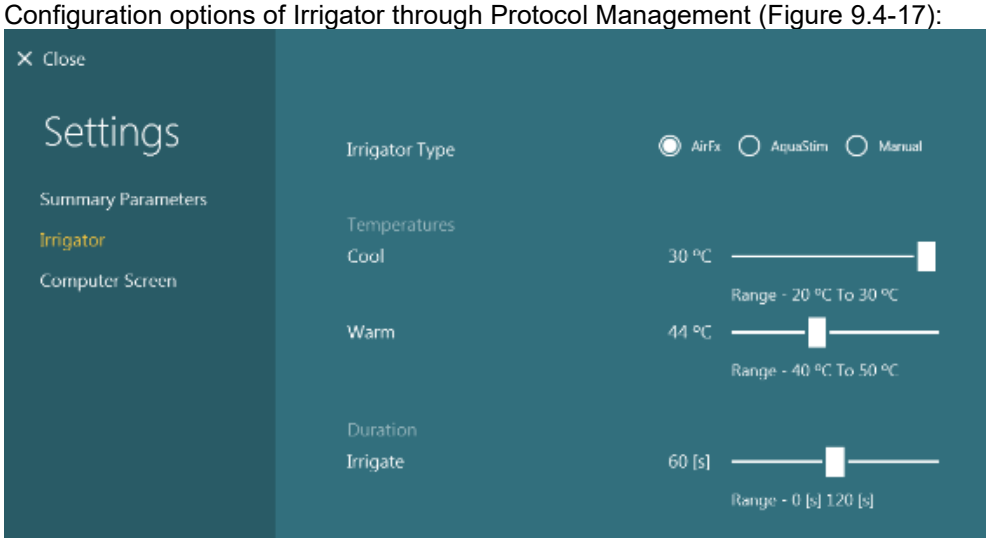


Figure 9.4-17 Caloric Irrigator settings

1. VisualEyes™ is compatible with the AquaStim and AirFx caloric irrigators. These irrigators interact with the software allowing for automatic temperature adjustment and activation of the test via the irrigator handle push button. Selecting the Manual option allows any third-party caloric irrigator, but the software will not directly communicate with the irrigator.
2. Enter the temperature of the cold and warm irrigations (Figure 9. 3-9). If set with the AirFx or AquaStim, the irrigator will operate with these settings. If using a third-party irrigator, these values only provide a note to the desired temperature and will be shown in the caloric result graphs.
3. You can set the irrigation duration to stop the flow of the air or water after a certain amount of time. This is useful with a compatible irrigator.

Caloric Subtest settings: can be accessed via protocol management / temporary settings.

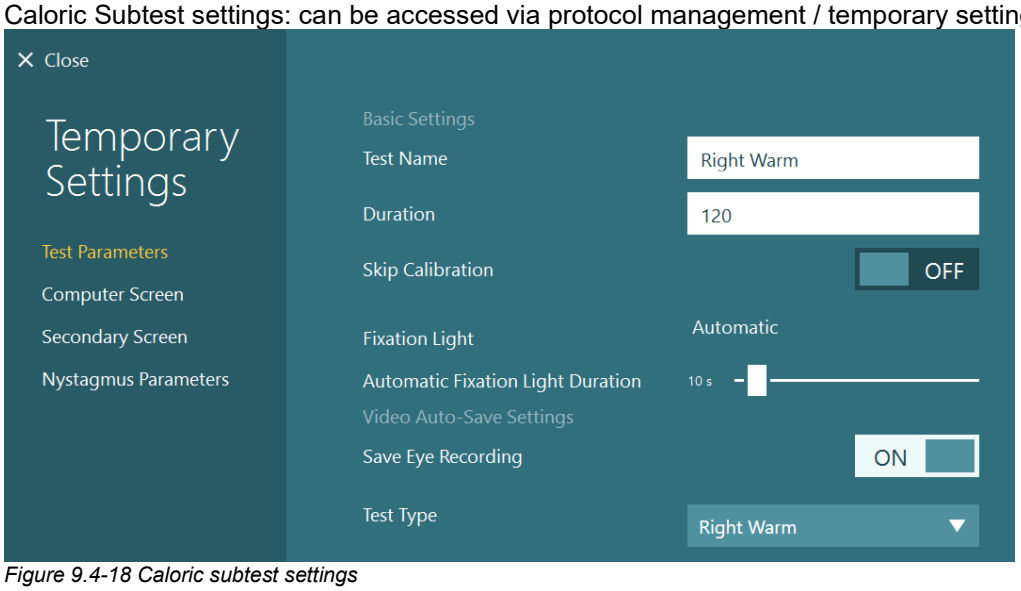
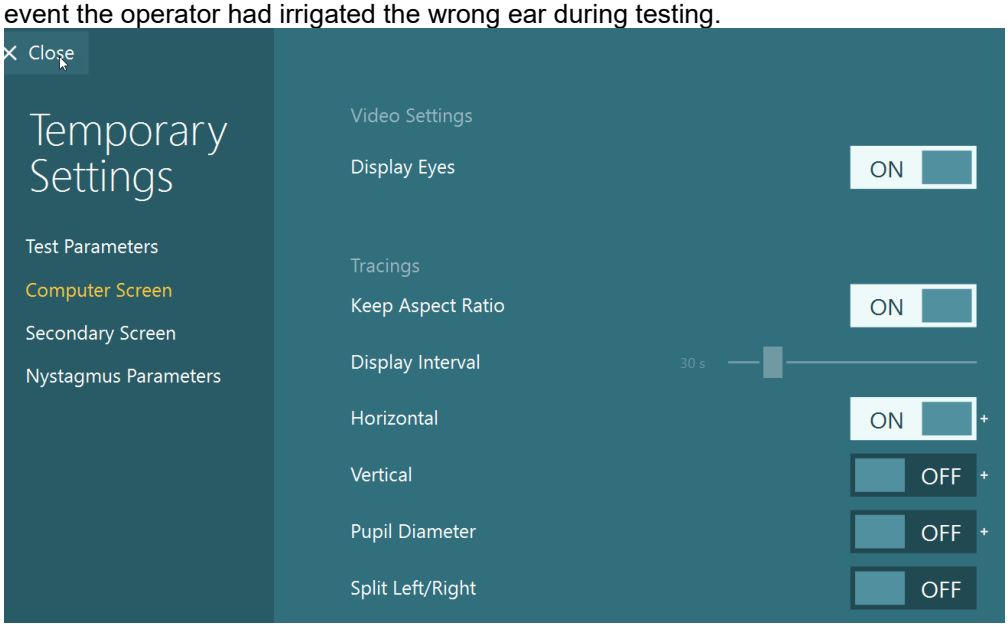
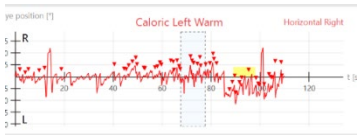


Figure 9.4-18 Caloric subtest settings

Test Name: Name of test
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds).
Skip Calibration: The user can skip calibration to proceed with the test
Fixation Light: Determines when the fixation light in the goggles is displayed. This value is set by the Caloric summary settings.
Automatic Fixation Light Duration: If the subtest is set to use Automatic Fixation Light, the length of time the light is displayed to the patient can be set using the slider.
Save Eye Recording: Choice to save eye video recordings.
Test Type: After the test has been performed, this setting is available to change the type of caloric test in the event the operator had irrigated the wrong ear during testing.

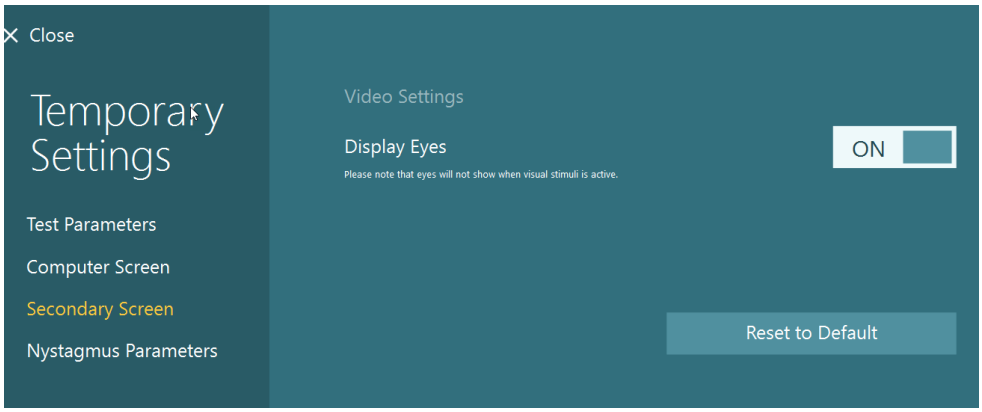


Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test. When the display interval is set to a longer time you can see more data on the graph but the data that you can see will be more condensed.

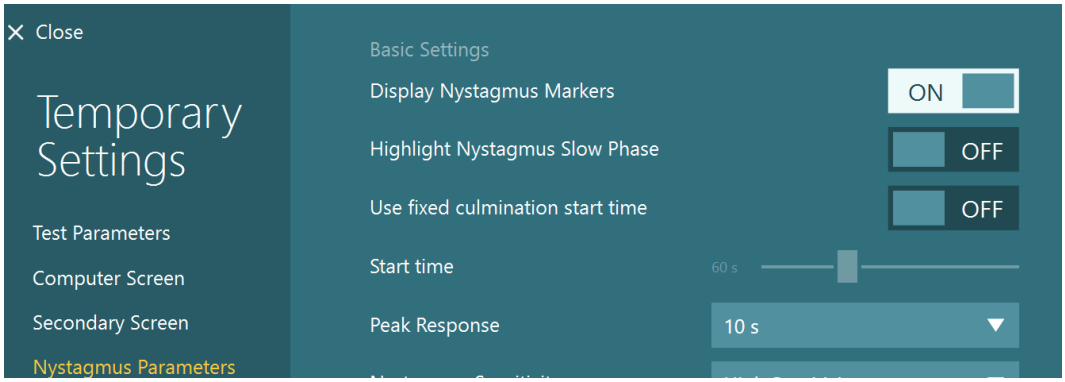


Horizontal: If enabled, it shows the graphical display of horizontal eye movements.
+: by clicking this + symbol, the user can adjust the upper and lower limits for eye position axis (horizontal).

Vertical: If enabled, it shows the graphical display of vertical eye movements.
: by clicking this + symbol, the user can adjust the upper and lower limits for eye) position axis (vertical).
Pupil Diameter: If enabled, shows a graphical display of pupil diameter.
: by clicking this + symbol, the user can adjust the upper and lower limits for pupil diameter axis.
Split Left/Right: If enabled, splits the graph into two, one for left and another for right (available only with Dix- Hallpike tests in the category of nystagmus tests).



Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.



Display nystagmus markers: Enabling this feature will display a triangle above the nystagmus fast phase slope to assist with the identification of a nystagmus beat. The triangle may face upwards (right/up beating nystagmus) or downwards (left/down beating nystagmus).
Highlight nystagmus slow phase: By default, the slow phases are the same color as the rest of the trace. However, should you want to differentiate the slow phases amongst the trace data, enabling this feature will mark the slow phases in green.
Use Fixed culmination start time: If enabled, allows the user to specify the analysis are by selecting the culmination 'start time' manually in the provided slide bar.
Peak Response: Selecting the drop-down menu presents several options to define the length of time for the analysis of the peak response. By default, the entire test will be included in the peak response for accuracy purposes.

9.5 Configuring rotary chair tests

9.5.1 Computer Settings for chair tests:

The below described summary setting for computer screen are common for Sinusoidal Harmonic Acceleration, VOR suppression, Visual VOR tests.

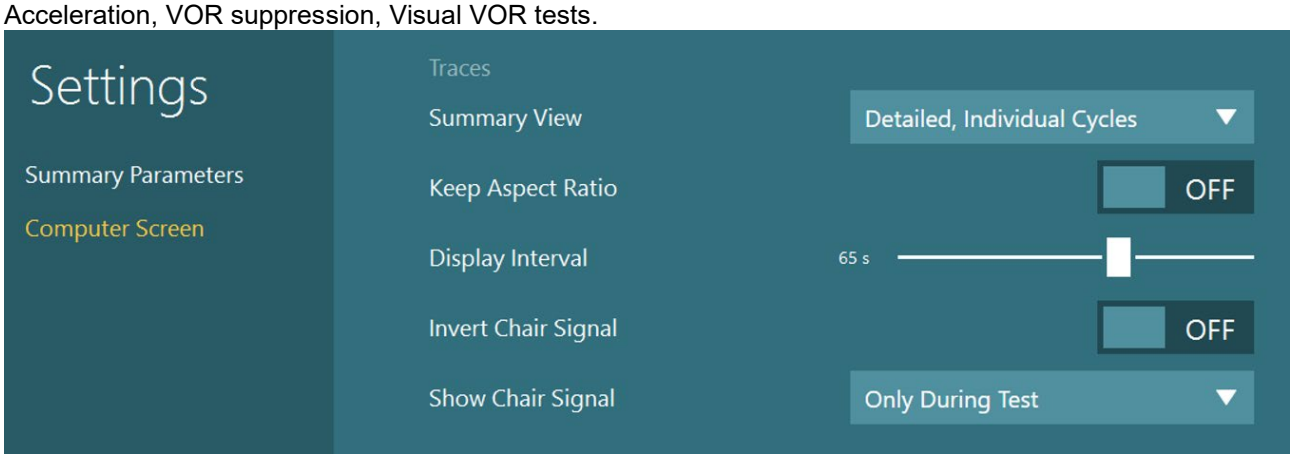


Figure 9.5-1 Chair tests summary settings-Computer Screen

Summary view:

Detailed, Individual Cycles: The detailed view will draw each cycle individually and fit a line to each cycle.

Concise, Combined Cycles: The concise view will show every cycle overlapped and a single fitted line is drawn through the concise view.

The choice is also used in the report. Below the gain, phase, and symmetry graphs, the cycles will be printed in either Detailed or Concise view.

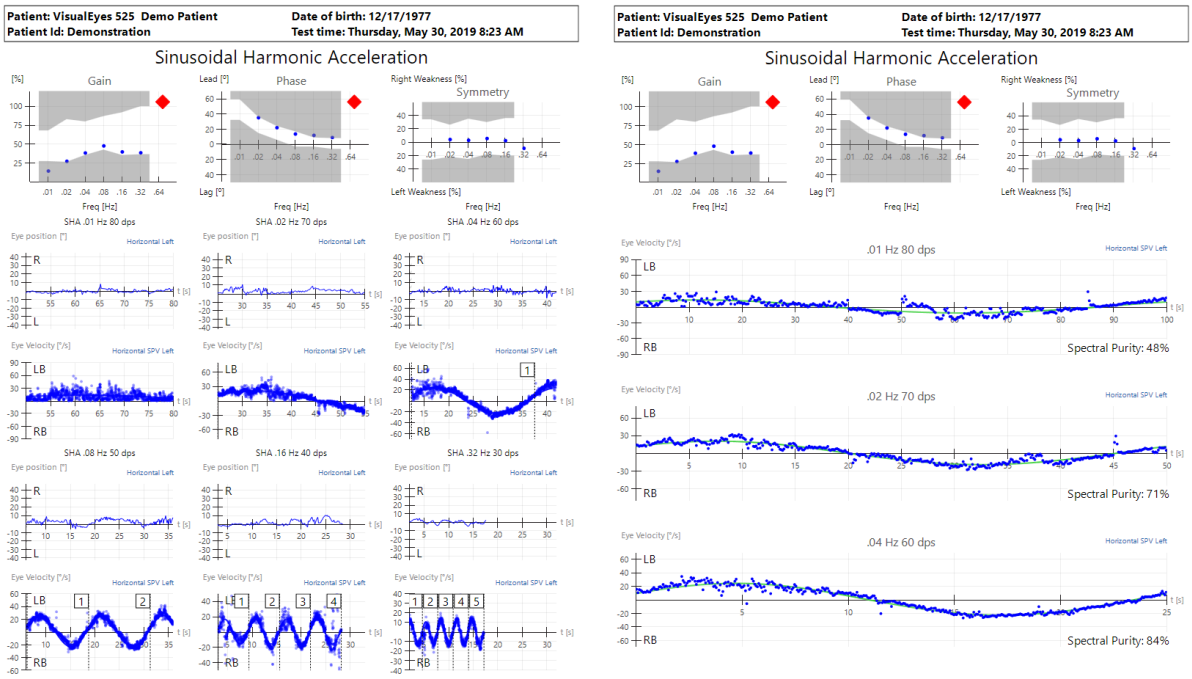


Figure 9.5-2 Print tests with Detailed, Individual Cycles (left), or Concise, Combined Cycles (right)

Keep Aspect Ratio: This allows the nystagmus to be displayed in a non-compressed form, allowing for easy recognition of the slow phase velocities of nystagmus. Disabling this feature will cause the nystagmus to appear more compressed.

Display Interval: Set the desired length of time (in seconds) to display data in the test window. This feature only becomes available when “Keep Aspect Ratio” is disabled.

Invert Chair Signal: Enabling this feature sets the eye trace to overlap the stimulus trace, providing a different view for comparing results. By default, this setting is disabled.

Show Chair Signal: Enabling this feature shows the chair velocity trace. You can either choose to view the trace all the time or only during the test.

In addition to the common features of keep Aspect ratio and Display Interval, the Step Velocity has following additional features to facilitate the test.



Figure 9.5-3 Test specific summary settings, Step Velocity-Computer Screen

Show Eye Position Traces: if enabled, this displays the eye position graphs
Show SPV Traces: If enabled, shows the graphical display of average slow phase velocity.
Show Scep Calculation: If enabled it will show the slow cumulative eye position graph.



Figure 9.5-4 Chair tests Subtest settings, -Computer Screen

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Display Room Camera: If enabled, records the test room during testing (SVV test has this feature only).
Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test.
Horizontal: If enabled, it shows the graphical display of horizontal eye movements.
+: by clicking this + symbol, the user can adjust the upper and lower limits for eye position axis (horizontal).
Vertical: If enabled, it shows the graphical display of vertical eye movements.
+: by clicking this + symbol, the user can adjust the upper and lower limits for eye) position axis (vertical).
Pupil Diameter: If enabled, shows a graphical display of pupil diameter.
+: by clicking this + symbol, the user can adjust the upper and lower limits for pupil diameter axis.
Split Left/Right: If enabled, splits the graph into two, one for left and another for right (available only with Dix- Hallpike tests in the category of nystagmus tests).

9.5.2 Configuring sinusoidal harmonic acceleration test

Configuration options of Summary Parameters and Computer Screen through Protocol Management (Figure 9.5-5 and 9.5.6):

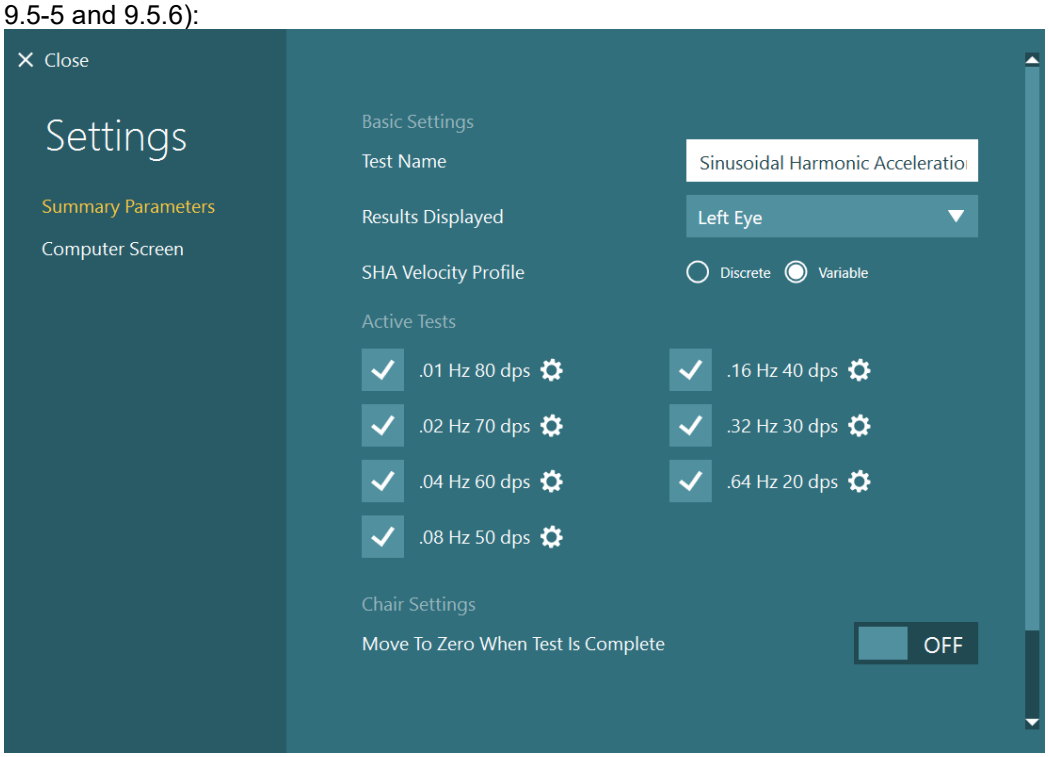


Figure 9.5-5 Sinusoidal Harmonic Acceleration summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
SHA Velocity Profile: This option defines whether the SHA subtests use a discrete standard velocity of 60 dps or use a variable velocity which is higher at lower frequencies (80 dps at 0. 01 Hz and drops 10 dps for each increase in frequency to 20 dps at 0.64 Hz). The default setting is Variable.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. The Orion Reclining and System 2000 Reclining chairs can test up to 0.64 Hz.
Move To Zero When Test Is Complete: If enabled, the chair Orion Reclining) will return to the zero position as set in System Default Settings.

Subtest settings through Temporary Settings (Figure 9.5-6 andFigure 9.5-9.5.7):

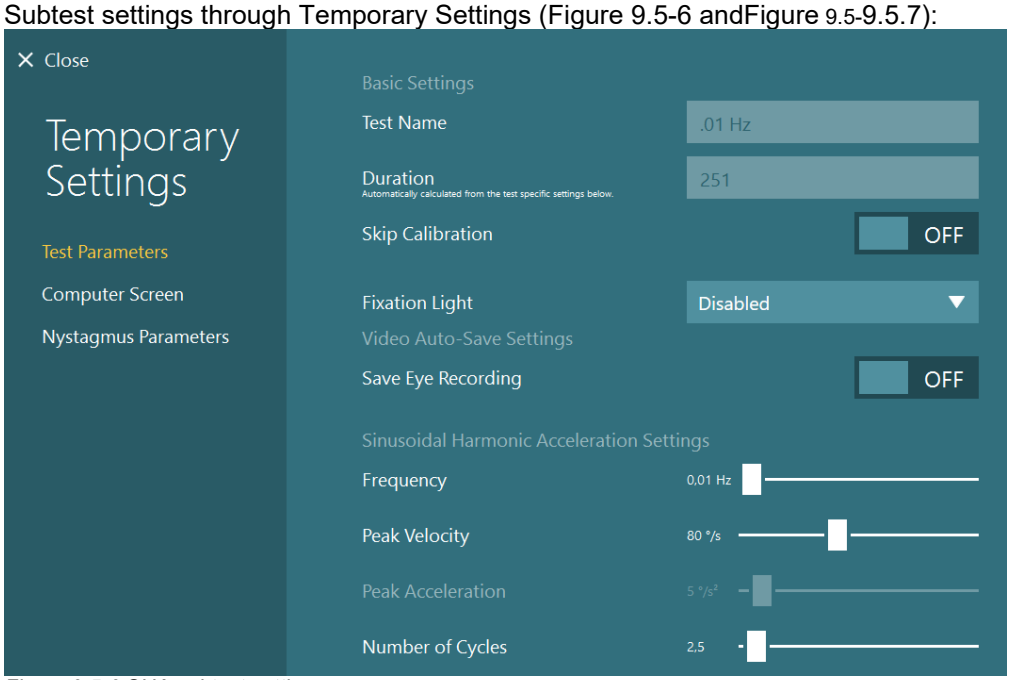


Figure 9.5-6 SHA subtest settings

Test Name: Name of subtest
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds). This value is calculated based on the Frequency, Peak Velocity, and Number of Cycles.
Skip Calibration: The user can skip calibration to proceed with the test
Fixation Light: Determines when the fixation light in the goggles is displayed. Manual (default) will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time.
Save Eye Recording: Choice to save eye video recordings.
Sinusoidal Harmonic Acceleration Settings:
Frequency: Define the frequency (Hz) of stimulus. The frequencies available include 0.01 Hz to 0.32 Hz with increments of 0.01 Hz.
Peak Velocity: Define the peak velocity (in degrees per second) at which the chair will rotate. The range of velocities is 1 to 200.
Peak Acceleration: The maximum rate at which the chair can accelerate (in m/s^2). This is automatically calculated based on the Sinusoidal Harmonic Acceleration Settings.
Number of Cycles: The total number of cycles to be performed for this frequency of chair movement. The initial half cycle is rejected automatically.

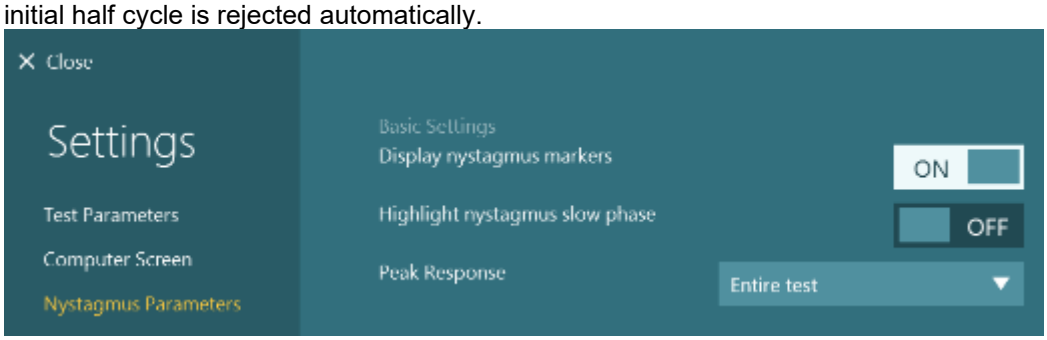


Figure 9.5-7 SHA subtest Nystagmus Parameters

Display nystagmus markers: Enabling this feature will display a triangle above the nystagmus fast phase slope to assist with the identification of a nystagmus beat. The triangle may face upwards (right/up beating nystagmus) or downwards (left/down beating nystagmus).
Highlight nystagmus slow phase: By default, the slow phases are the same color as the rest of the trace. However, should you want to differentiate the slow phases amongst the trace data, enabling this feature will mark the slow phases in green.

Peak Response: Selecting the drop-down menu presents several options to define the length of time for the analysis of the peak response. By default, the entire test will be included in the peak response for accuracy purposes.

9.5.3 Configuring Step Velocity test

Configuration options of Summary Parameters through Protocol Management (Figure 9.5-8):

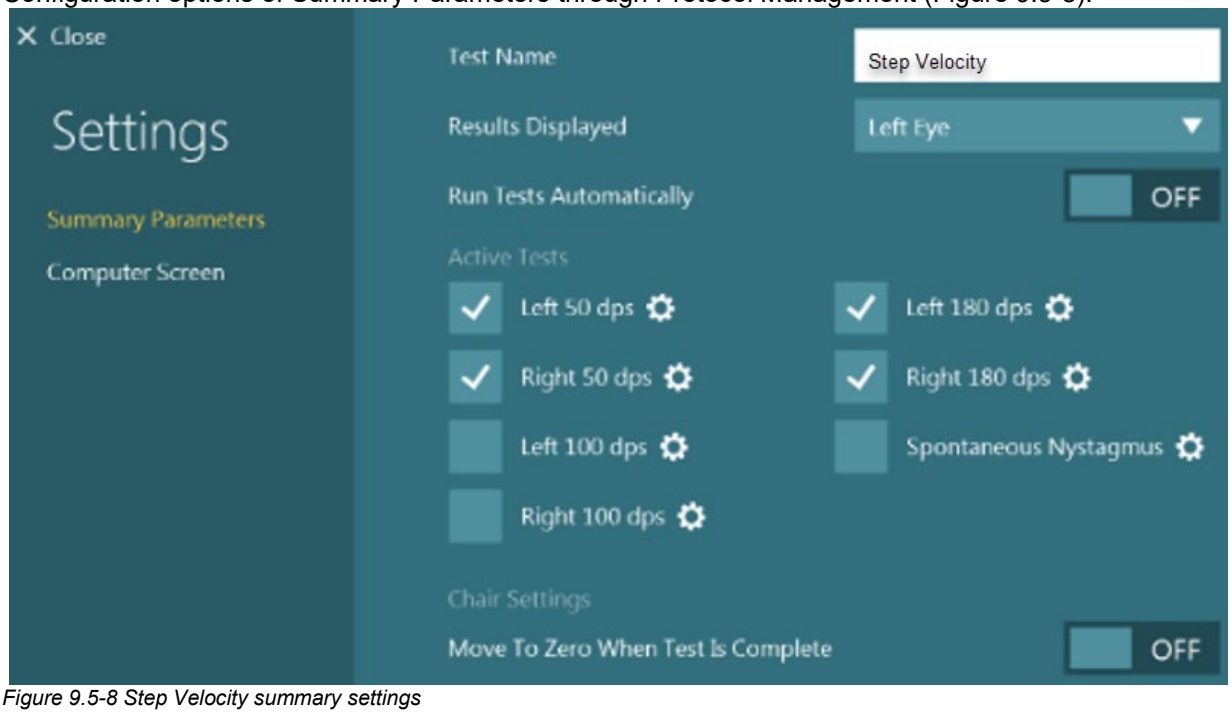


Figure 9.5-8 Step Velocity summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
Run Tests Automatically: If enabled, when the subtest completes, the next subtest will be loaded and started automatically.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. By default, the Step Velocity test will test the patient in both directions at 50 and 180 dps. Optionally, the test can also spin the patient at 100 dps.
Move To Zero When Test Is Complete: If enabled, the chair Orion Reclining) will return to the zero position as set in the System Default Settings.

Subtest settings through Temporary Settings (Figure 9.5-9 Figure 9.5-10):

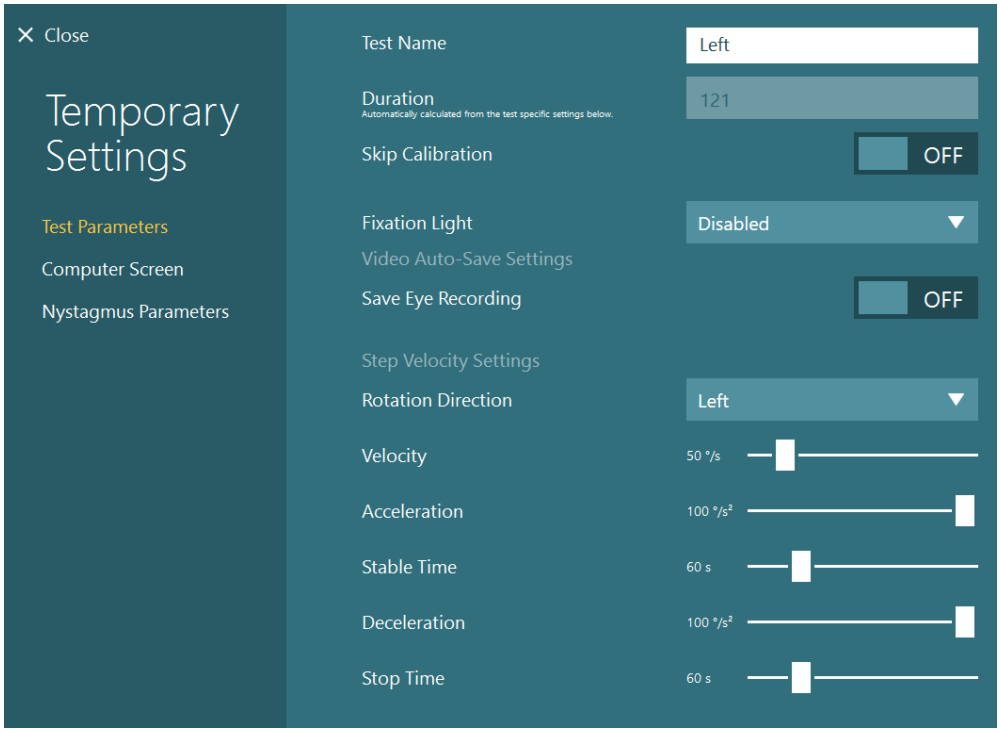


Figure 9.5-9 Step Velocity subtest settings

Test Name: Name of subtest
Duration: Length of time (in seconds) the test shall run. This is automatically calculated from the test settings. The length of time is dependent on the Step Velocity Settings.
Skip Calibration: The user can skip calibration to proceed with the test
Fixation Light: Determines when the fixation light in the goggles is displayed. Manual (default) will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time.
Save Eye Recording: Choice to save eye video recordings.
Step Velocity Settings:
Rotation Direction: Defines the direction of rotation; Left (counterclockwise) or Right (clockwise).
Velocity: The peak velocity of chair movement
Acceleration: The rate at which the chair accelerates to reach the Velocity value.
Stable Time: Length of time the chair will rotate at the Velocity value
Deceleration: Defines the rate at which the chair decelerates to standstill
Stop Time: Length of time (in seconds) the test will continue recording after the chair has stopped.

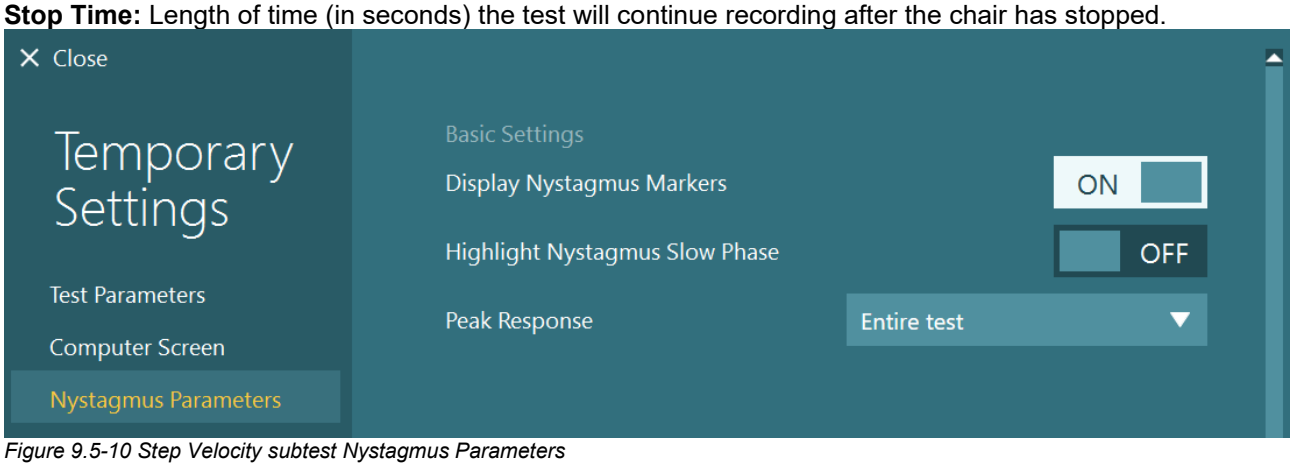


Figure 9.5-10 Step Velocity subtest Nystagmus Parameters

Display Nystagmus Markers: Enabling this feature will display a triangle above the nystagmus fast phase slope to assist with the identification of a nystagmus beat. The triangle may face upwards (right/up beating nystagmus) or downwards (left/down beating nystagmus). Nystagmus markers are enabled by default.
Highlight Nystagmus Slow Phase: By default, the slow phases are the same color as the rest of the trace. However, should you want to differentiate the slow phases amongst the trace data, enabling this feature will mark the slow phases in green.
Peak Response: Selecting the drop-down menu presents several options to define the length of time for the analysis of the peak response. By default, the entire test will be included in the peak response for accuracy purposes.

9.5.4 Configuring VOR suppression test

Configuration options through Protocol Management (Figure 9.5-11 and 9.5-12):

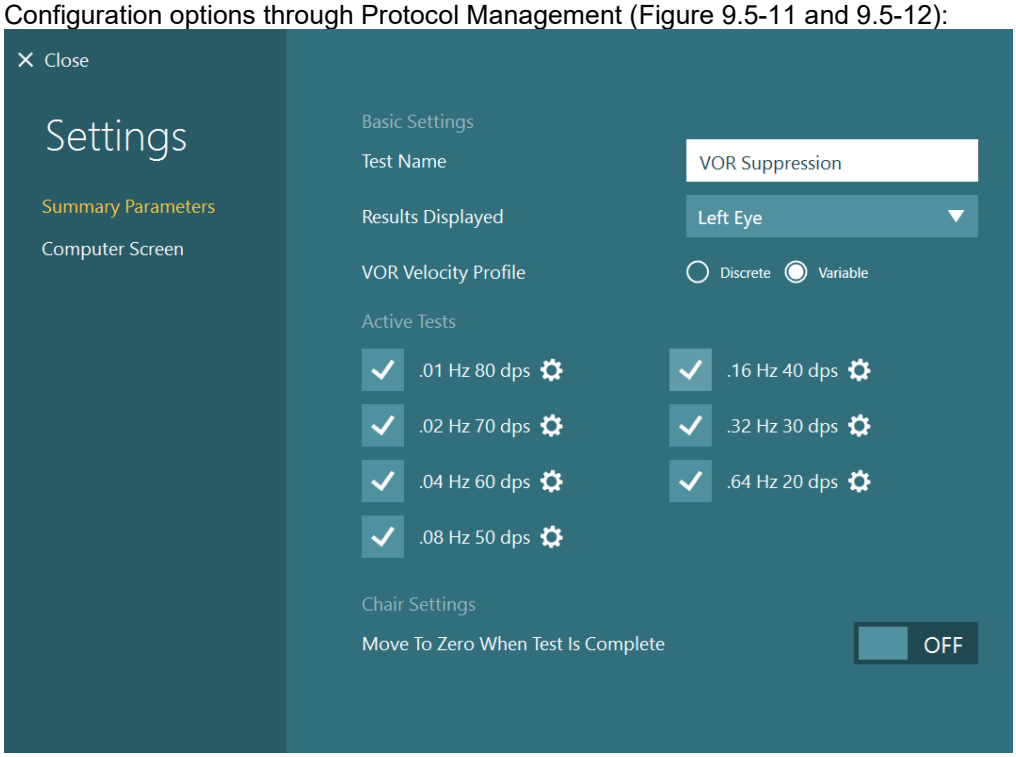


Figure 9.5-11 VOR Suppression summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
VOR Velocity Profile: This option defines whether the VOR Suppression subtests use a discrete standard velocity of 60 dps or use a variable velocity which is higher at lower frequencies (80 dps at 0.01 Hz and drops 10 dps for each increase in frequency to 20 dps at 0.64 Hz). The default setting is Variable. This value should be the same as the VOR tests that the VOR Suppression test will compare against.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. and the Orion Reclining and System 2000 Reclining chairs can test up to 0.64 Hz.
Move To Zero When Test Is Complete: If enabled, the chair (Orion Reclining) will return to the zero position as set in the System Default Settings.

Subtest settings through Temporary Settings (Figure 9.5- and Figure 9.5-):

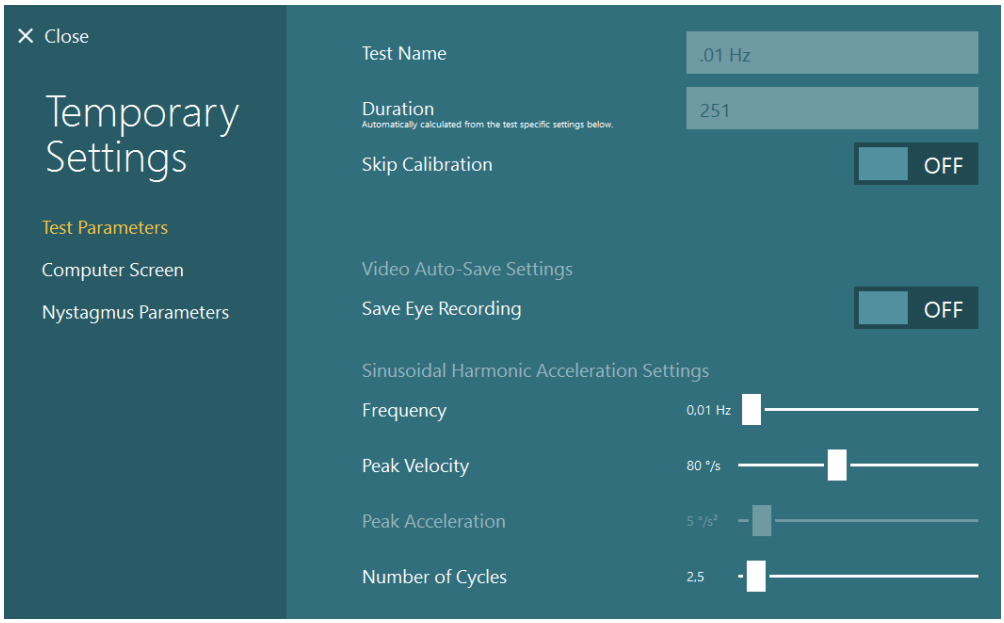


Figure 9.5-12 VOR Suppression subtest settings

Test Name: Name of subtest
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds). This value is calculated based on the Frequency, Peak Velocity, and Number of Cycles.
Skip Calibration: The user can skip calibration to proceed with the test
Save Eye Recording: Choice to save eye video recordings.
Sinusoidal Harmonic Acceleration Settings:
Frequency: Define the frequency (Hz) of stimulus. The frequencies available include 0.01 Hz to 0.32 Hz with increments of 0.01 Hz.
Peak Velocity: Define the peak velocity (in degrees per second) at which the chair will rotate. Range of velocities is 1 to 200.
Peak Acceleration: The maximum rate at which the chair can accelerate (in m/s^2). This is automatically calculated based on the Sinusoidal Harmonic Acceleration Settings.
Number of Cycles: The total number of cycles to be performed for this frequency of chair movement. The initial half cycle is rejected automatically.

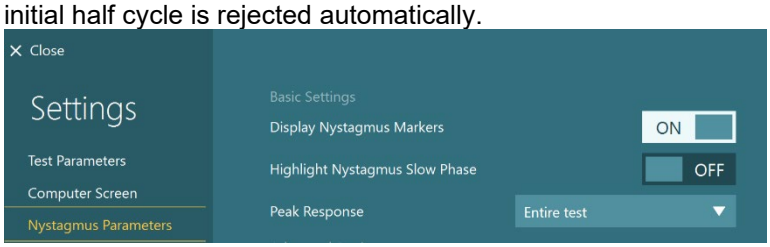


Figure 9.5-2 VOR Suppression subtest Nystagmus Parameters

Display Nystagmus Markers: Enabling this feature will display a triangle above the nystagmus fast phase slope to assist with the identification of a nystagmus beat. The triangle may face upwards (right/up beating nystagmus) and downwards (left/down beating nystagmus).

Highlight Nystagmus Slow Phase: By default, the slow phases are the same color as the rest of the trace. However, should you want to differentiate the slow phases amongst the trace data, enabling this feature will mark the slow phases in green.

Peak Response: Selecting the drop-down menu presents several options to define the length of time for the analysis of the peak response. By default, the entire test will be included in the peak response for accuracy purposes.

9.5.5 Configuring visual VOR test

Configuration options through Protocol Management (Figure 9.5- and **Error! Reference source not found.**):

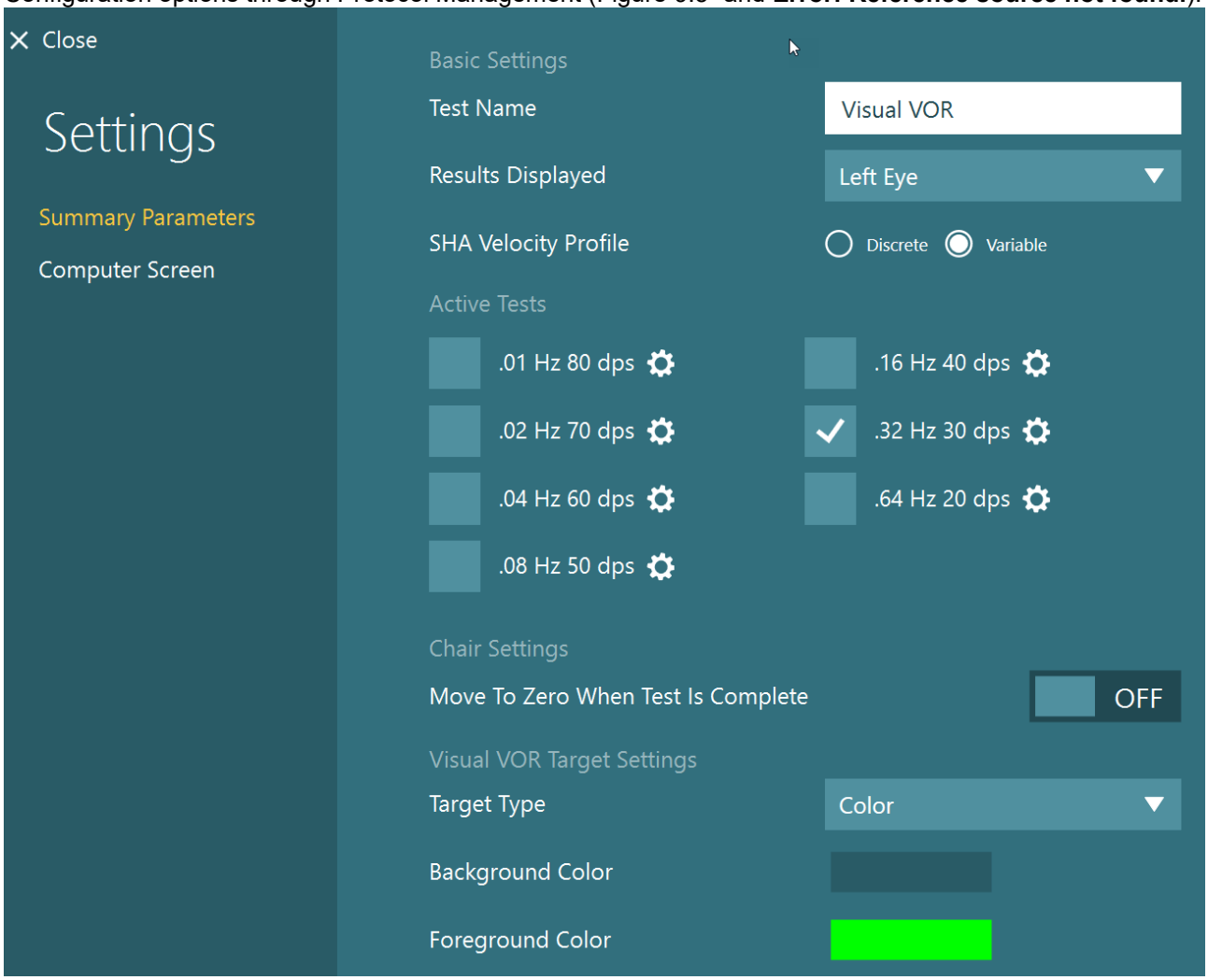


Figure 9.5-3 Visual VOR summary settings

Test Name: Name of the test
Results Displayed: Selects which eye is shown by default. Left Eye will set each subtest to display the left eye. Right Eye will set each subtest to display the right eye.
SHA Velocity Profile: This option defines whether the SHA subtests use a discrete standard velocity of 60 dps or use a variable velocity which is higher at lower frequencies (80 dps at 0.01 Hz and drops 10 dps for each increase in frequency to 20 dps at 0.64 Hz). The default setting is Variable. This value should be the same as the VOR and VOR Suppression tests.
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings. The Orion Reclining and System 2000 Reclining chairs can test up to 0.64 Hz. By default, only the 0.32 Hz test is selected.
Move To Zero When Test Is Complete: If enabled, the chair Orion Reclining) will return to the zero position as set in the System Default Settings.
Visual VOR Target Settings:
Target Type: Creates a tessellation pattern or stretches a background image across the stimulus screen. Tessellation patterns include checkerboard, stripes, and spheres. Stretched image patterns include firetruck, pilot and airplane, landscape, toy train, yellow airplane, and trains and tracks.
Background Color: If the Target Type is a tessellation pattern, this selection controls the background color or fill color depending on the tessellation pattern.
Foreground Color: If the Target Type is a tessellation pattern, this selection will change the color of the primary shape.
Alternate Color: If the Target Type is set to Spheres, this selection will change the color of the even rows of spheres.

Pattern Size: Adjusts the size of the pattern used in the pattern tessellation. As the target size is increased, the number of shapes used in the pattern will decrease. Only available with Target Type of Checkerboard, Stripes, and Spheres.

Configuration options through Temporary Settings (Figure 9.5-4):

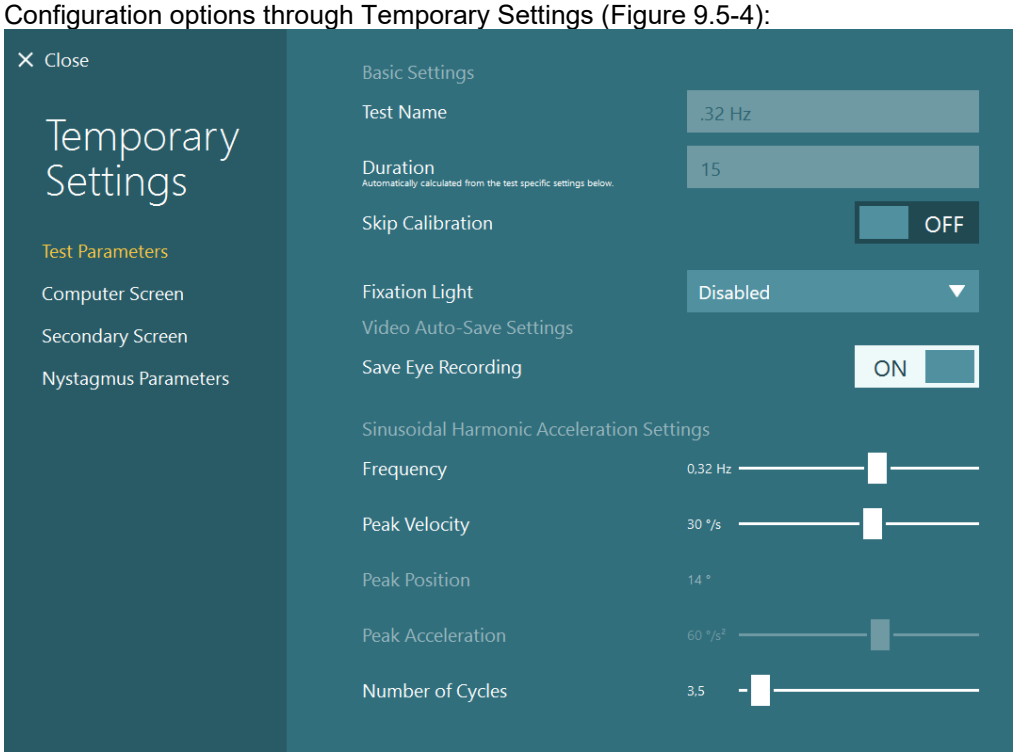


Figure 9.5-4 Visual VOR temporary test parameter settings

Test Name: Name of the test
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds). This value is calculated based on the Frequency, Peak Velocity, and Number of Cycles.
Skip Calibration: The user can skip calibration to proceed with the test
Fixation Light: Determines when the fixation light in the goggles is displayed. Manual (default) will leave the operator to determine when the fixation light should be displayed. Timed will have the fixation light come on automatically at the designated time.
Save Eye Recording: Choice to save eye video recordings.
Frequency: Define the frequency (Hz) of stimulus. The frequencies available include 0.01 Hz to 0.32 Hz with increments of 0.01 Hz.
Peak Velocity: Define the peak velocity (in degrees per second) at which the chair will rotate. Range of velocities is 1 to 200.
Peak Position: Define the maximum amplitude of the eye movement (right or left)
Peak Acceleration: The maximum rate at which the chair can accelerate (in m/s2). This is automatically calculated based on the Sinusoidal Harmonic Acceleration Settings.
Number of Cycles: The total number of cycles to be performed for this frequency of chair movement. The initial half cycle is rejected automatically.

9.5.6 Configuring subjective visual vertical test

The summary settings for the subjective visual vertical test will list the name of the test and the names of the five subtests. The name for the subtest will combine the position of the chair and the speed of rotation, provided that these values are only set to one value. If multiple off-axis chair positions are available, then the name of the subtest will not list the position.

Configuration options through Protocol Management (Figure 9.5-5):

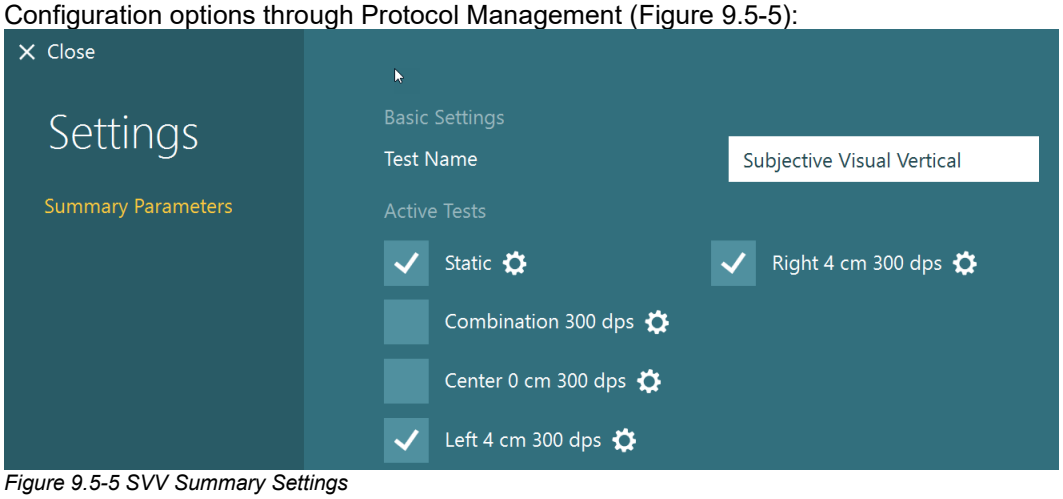


Figure 9.5-5 SVV Summary Settings

SVV (Static) Subtest settings through Temporary Settings or protocol management (Figure 9.5-6):

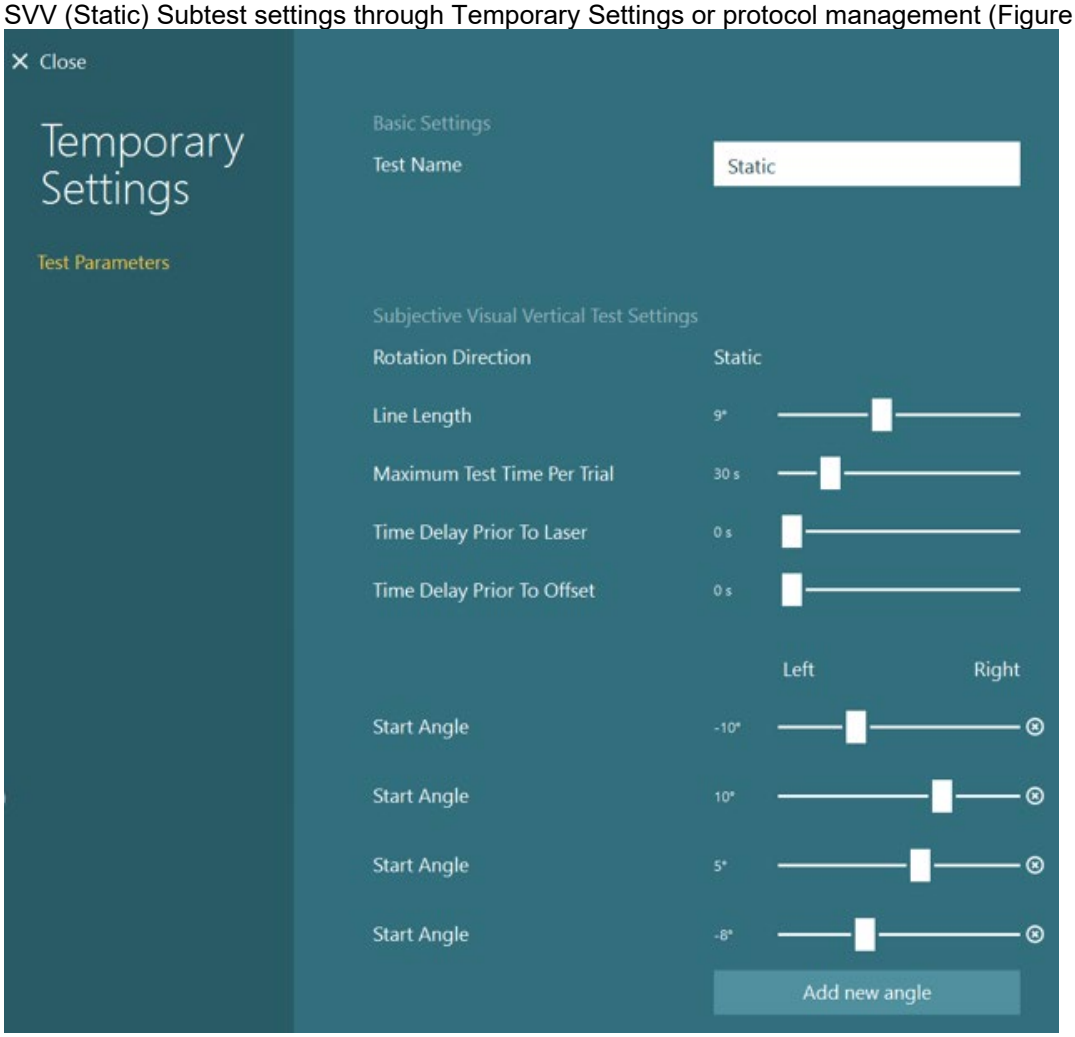


Figure 9.5-6 SVV Static Subtest Settings

Test Name: Name of test or subtest
Rotation Direction: Direction the chair is to rotate. Patients typically tolerate spinning forward better than backward, so if the patient is seated left of the center axis, the rotation direction should be set to right. Combination tests where the chair moves to different off-axis positions will only use one direction.
Line Length: Length of the laser line measured in degrees from the center. The default value is 9 degrees.
Maximum Test Time Per Trial: Sets the time limit for each trial of angle and chair offset.
Time Delay Prior To Laser: Time required before the laser will be turned on after moving to the chair offset position in the next trial.
Time Delay Prior To Offset: Time required for the patient to habituate to the chair velocity before moving the patient to the first chair offset value.
Test Velocity: Maximum velocity the patient will spin during the test.
Start Angle: Angle of rotation the laser line will be initially

SVV (Left/Right) Subtest settings through Temporary Settings or protocol management:

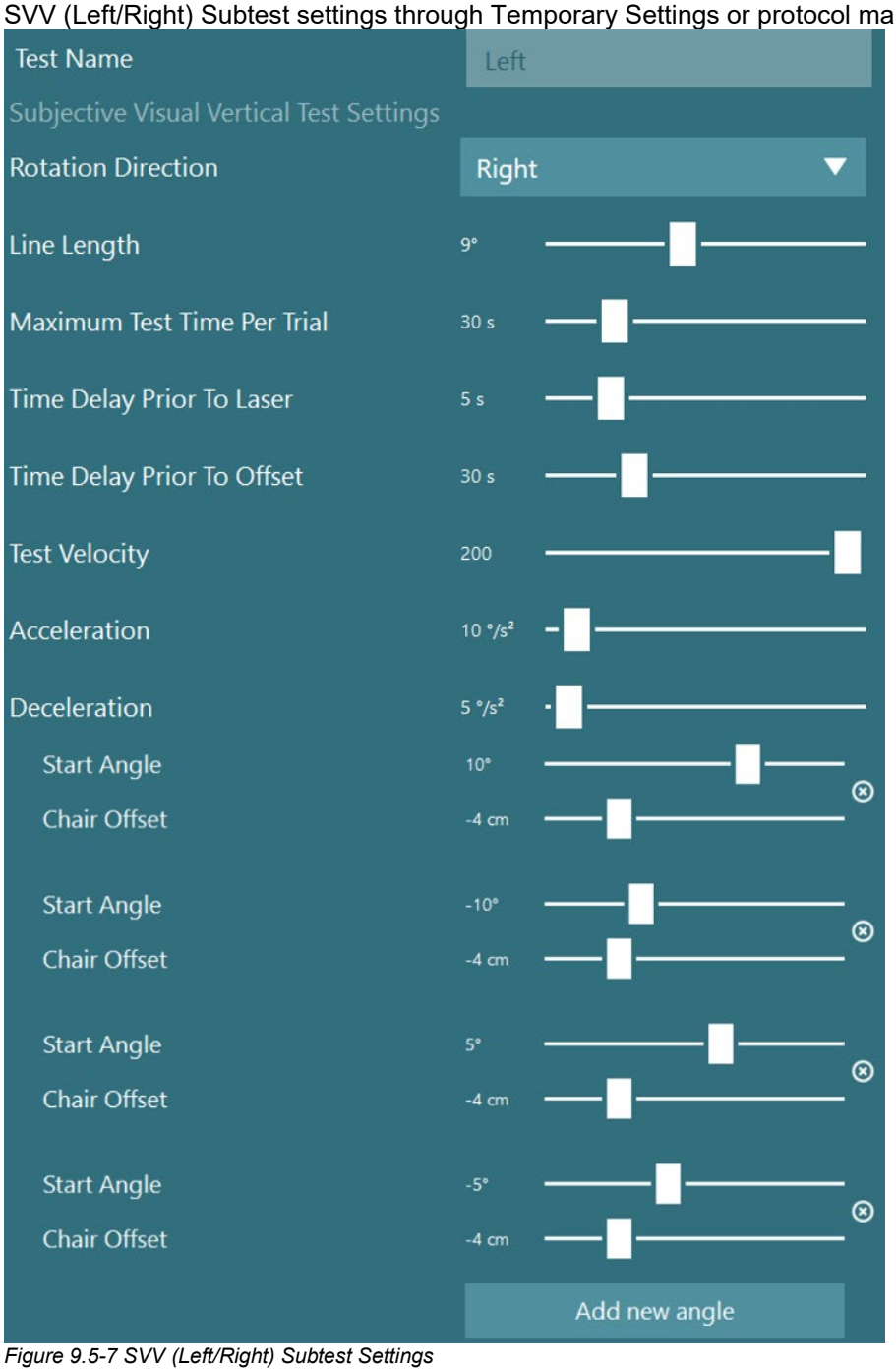


Figure 9.5-7 SVV (Left/Right) Subtest Settings

Test Name: Name of test or subtest
Rotation Direction: Direction the chair is to rotate. Patients typically tolerate spinning forward better than backward, so if the patient is seated left of the center axis, the rotation direction should be set to right. Combination tests where the chair moves to different off-axis positions will only use one direction.
Line Length: Length of the laser line measured in degrees from the center. The default value is 9 degrees.
Maximum Test Time Per Trial: Sets the time limit for each trial of angle and chair offset.
Time Delay Prior To Laser: Time required before the laser will be turned on after moving to the chair offset position in the next trial.
Time Delay Prior To Offset: Time required for the patient to habituate to the chair velocity before moving the patient to the first chair offset value.
Test Velocity: Maximum velocity the patient will spin during the test.
Acceleration: acceleration of the chair when it is ramping up to target velocity.
Deceleration: deceleration of the chair when it is stopping rotation.
Start Angle: Angle of rotation the laser line will be initially.

9.6 Configuring active head rotation tests

9.6.1 Computer Settings for active head rotation tests:

Dynamic Visual acuity test and Gaze stabilization test has common computer settings and VORTEQ™ AHR test has different computer settings as discussed in this section.

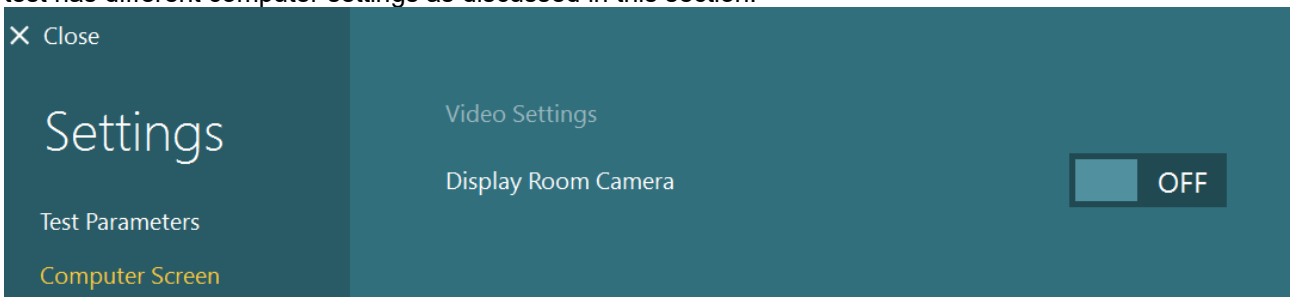


Figure 9.6-1 DVA/GST Subtest Properties- Computer Screen

Display Room Camera: If enabled, records the test room during testing.

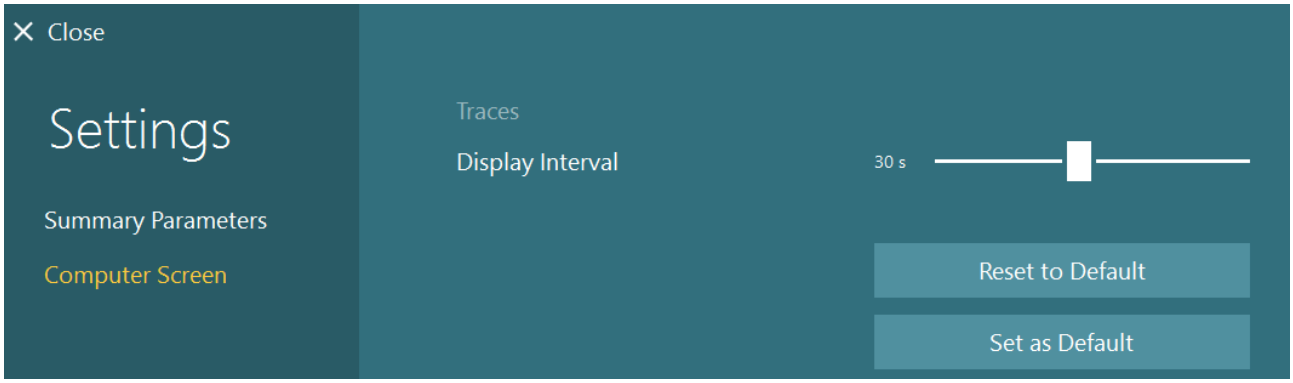


Figure 9.6-2 VORTEQ™ AHR Summary Properties- Computer Screen

Display Interval: Displayed time axis of the test.

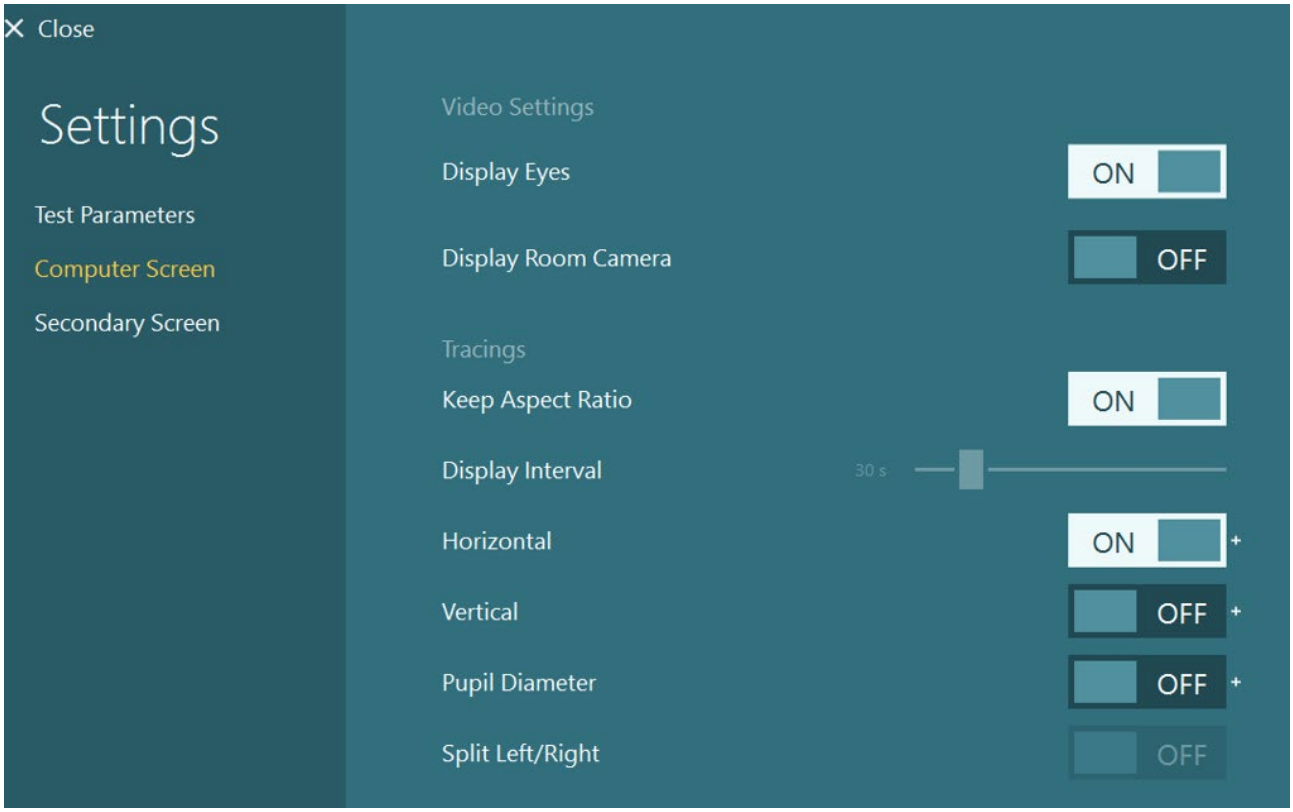


Figure 9.6-3 VORTEQ™ AHR Subtest Properties- Computer Screen

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Display Room Camera: If enabled, records the test room during testing.
Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test.
Horizontal: If enabled, it shows the graphical display of horizontal eye movements.
: by clicking this + symbol, the user can adjust the upper and lower limits for eye position axis (horizontal).
Vertical: If enabled, it shows the graphical display of vertical eye movements.
: by clicking this + symbol, the user can adjust the upper and lower limits for eye) position axis (vertical).
Pupil Diameter: If enabled, shows a graphical display of pupil diameter.
: by clicking this + symbol, the user can adjust the upper and lower limits for pupil diameter axis.
Split Left/Right: If enabled, splits the graph into two, one for left and another for right.

9.6.2 Configuring VORTEQ™ AHR test

Summary configuration options through Protocol Management (Figure 9.6-4):

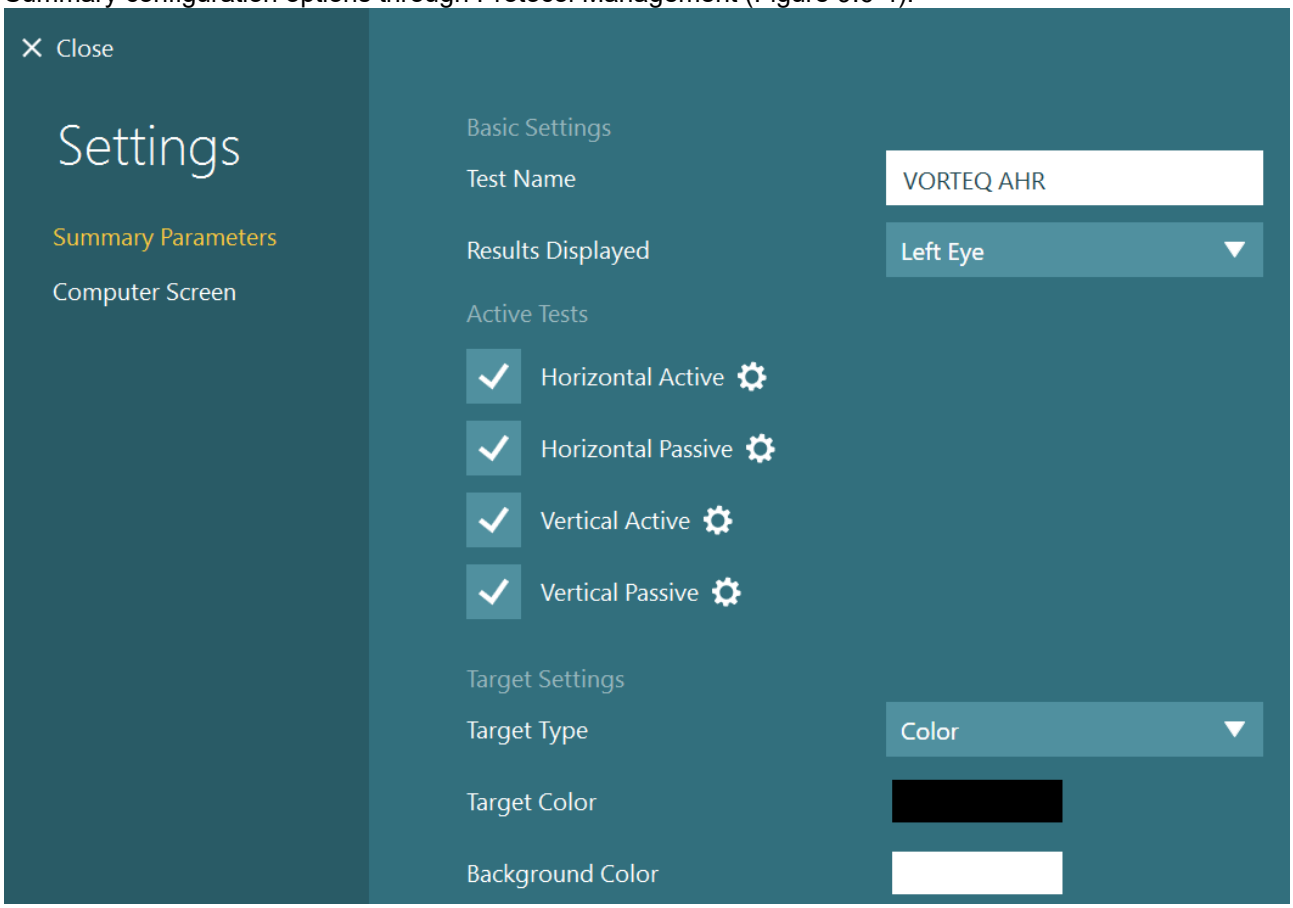


Figure 9.6-4 VORTEQ™ AHR Summary Properties

Test Name: Name of test or subtest
Results Displayed: Sets the default eye results to be displayed, which may be Left Eye or Right Eye.
Active Tests: This area lists the active and passive tests for the horizontal and vertical directions. The gear icon will access the subtest properties.
Target Type: Type of target displayed on the TV or projection screen, either a circle of a solid color or an image file. The size of the target is set by the calibration target size.
Target Color: Sets the Target color of the circle target or the desired target image to be used as the focus point for the VORTEQ™ AHR tests on the TV or projector stimulus. This field is not available with the Digital Light Bar or Laser and Drum stimulus.
Background Color: Selects the color used for the background of the TV or projector stimulus. This field is not available with the Digital Light Bar or Laser and Drum stimulus.

Subtest configuration options through Temporary settings or protocol management (Figure 9.6-5):

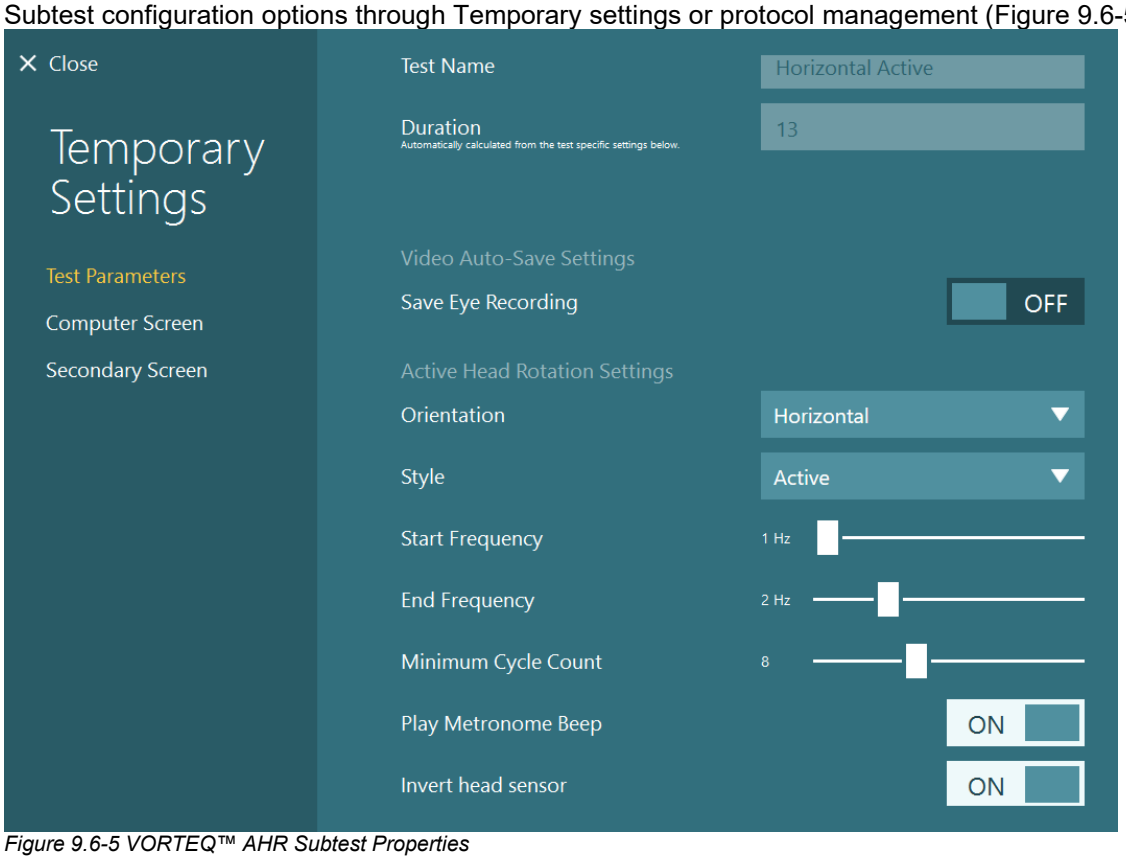


Figure 9.6-5 VORTEQ™ AHR Subtest Properties

Test Name: Name of test or subtest
Duration: Length of time the subtest will run calculated on the number of minimum cycles and frequencies tested rounded up to the nearest second. This time does not include the practice time of five seconds at the start of the test for the patient to practice the head shake.
Save Eye Recording: If set the software will automatically keep the eye and room camera videos after the test is reviewed. By default, this setting is off, therefore the software will delete the eye and room camera videos
Orientation: Sets the direction the test will be performed.
Style: Sets the method the test is intended to be performed. If the style is set to Active, the test is intended to be performed by the patient shaking his / her head to the metronome beep. If the style is set to Passive, the test is intended to be performed by the operator moving the patient's head back and forth.
Start Frequency: This is the initial frequency for the metronome beep.
End Frequency: This is the final frequency for the metronome beep. The software will start the test using the start frequency value for the number of cycles defined by the minimum cycle count value, and then increase the frequency by one hertz and for the minimum cycle count until the end frequency is reached.
Minimum Cycle Count: This is the number of cycles the patient will have to shake his / her head at each frequency.
Play Metronome Beep: By default, this value is set to ON to play an audible beep when the patient is to swing his / her head to the side.
Invert head sensor: During the VORTEQ™ AHR test, the head direction moves in the opposite direction to the eye position. By setting this value to ON (the default value), the head sensor trace is vertically flipped to align the trace to the eye position movement trace.

9.6.3 Configuring dynamic visual acuity test

Summary configuration options through Protocol Management (Figure 9.6-6):

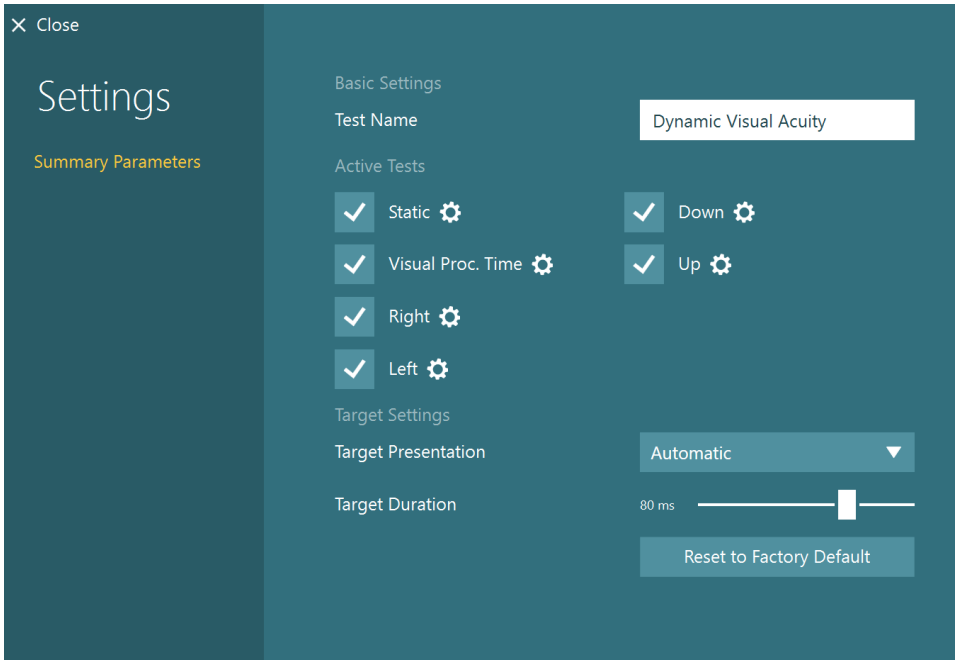


Figure 9.6-6 DVA Summary Properties

Test Name: Name of test or subtest
Active Tests: This area lists the Static Acuity test and four direction subtests. The gear icon will access the subtest properties.
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds).
Target Type: Method of displaying the optotype used in testing, currently limited to Optotype C where a C character is displayed in one of four orientations during the test
Target Presentation: Determines the method of presenting the optotype – Automatic will increase or decrease the optotype during the test based on the patient's response, Manual will require the operator to adjust the size of the optotype based on the patient's response
Target Duration: The optotype will be visible only during the time the patient's head velocity exceeds the required velocity for the direction.

Configuration of sub-test options through temporary settings or protocol management (Figure 9.6-7):

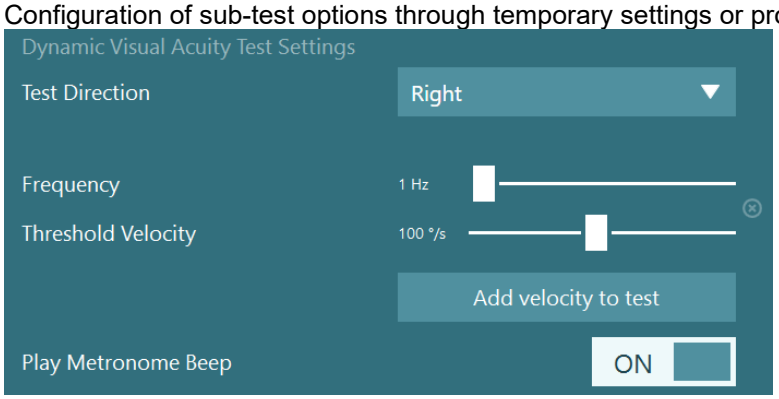


Figure 9.6-7 DVA Subtest Properties

Test Direction: Selects the direction the patient will have to achieve the required velocity. The name of the subtest will be the same as the test direction selected.
Frequency: Frequency the metronome will beep. By default, this is 1 Hz, though it can be set up to 5 Hz.
Threshold Velocity: Velocity needed for the patient to achieve in the test direction before the optotype is displayed.
Play Metronome Beep: By default, the metronome beep will be played at the desired frequency. If this is set to OFF, then the metronome beep will not be played during the test.

9.6.4 Configuring Gaze Stabilization test

Summary configuration options through Protocol Management.

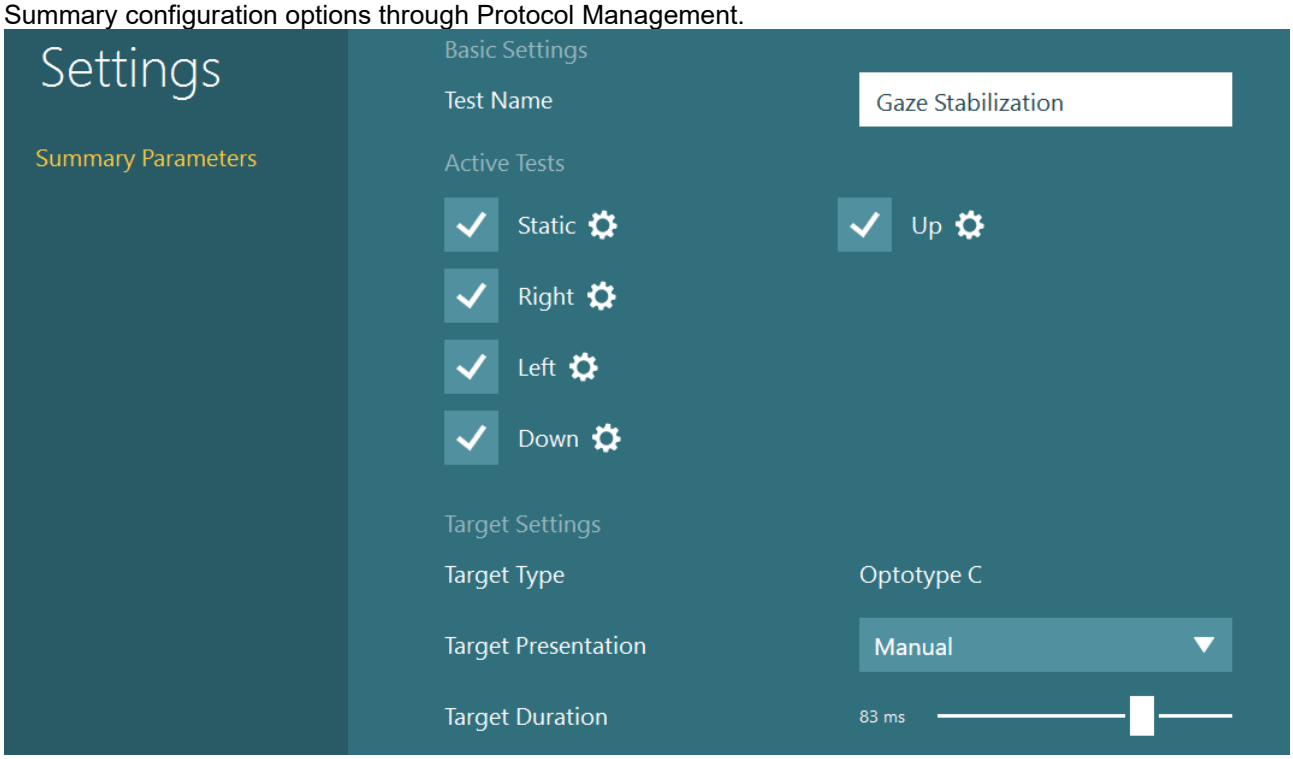


Figure 9.6-8 Gaze Stabilization Test Summary Properties

Test Name: Name of test or subtest
Active Tests: This area lists the Static Acuity test and four direction subtests. The gear icon will access the subtest properties.
Target Type: Method of displaying the optotype used in testing, currently limited to Optotype C where a C character is displayed in one of four orientations during the test
Target Presentation: Determines the method of presenting the optotype – Automatic will increase or decrease the optotype during the test based on the patient's response, Manual will require the operator to adjust the size of the optotype based on the patient's response

Target Duration Enabled and Target Duration: If turned ON, the optotype will remain visible for the time set in the Target Duration field after the patient's head velocity decreases from the required velocity for the direction. If left OFF, the optotype will be visible only during the time the patient's head velocity exceeds the required velocity for the direction.

Configuration of sub-test options through temporary settings or protocol management.

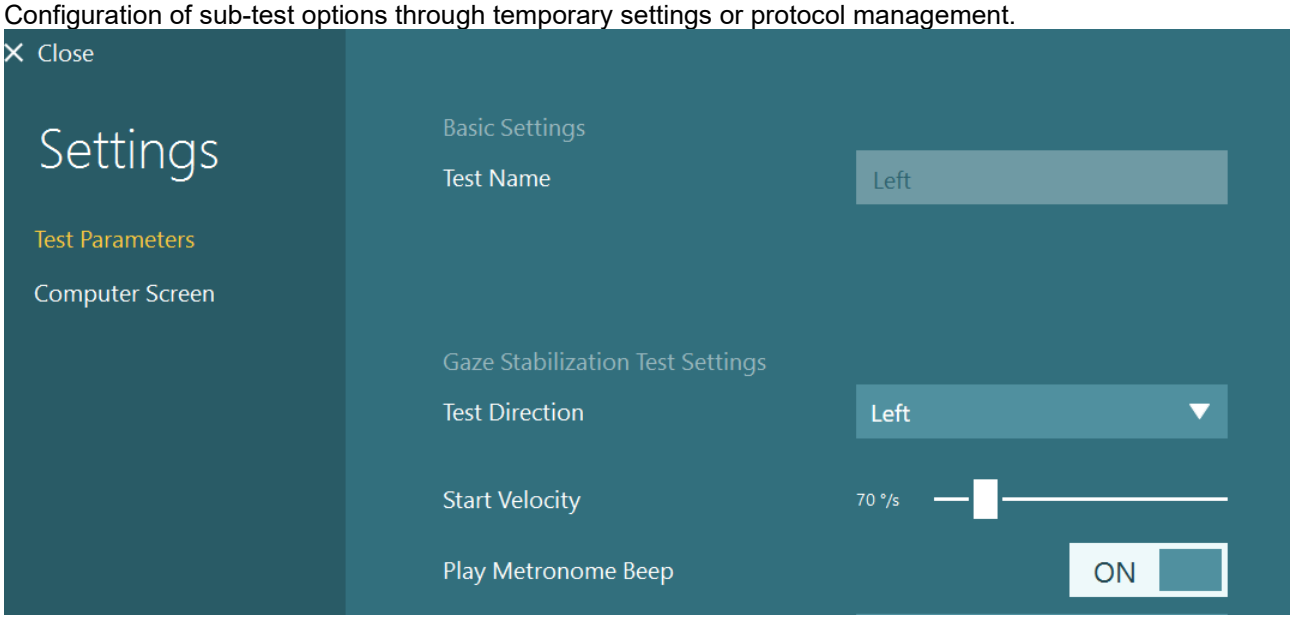
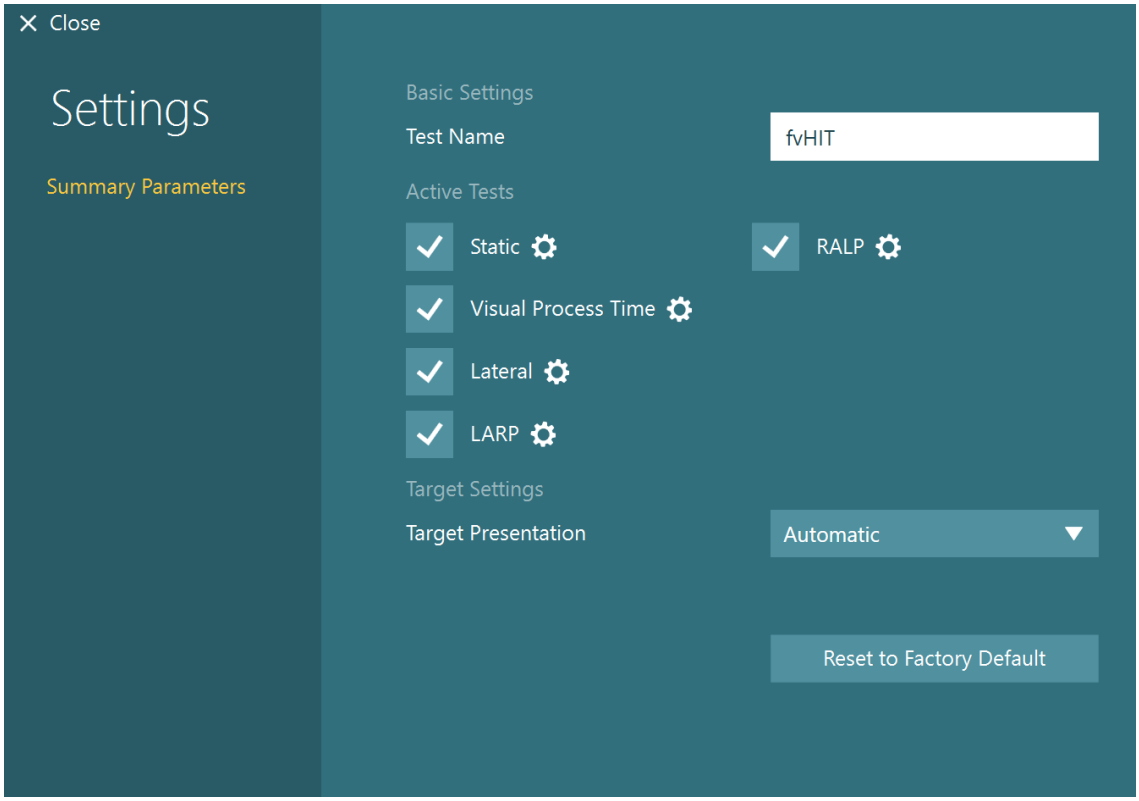


Figure 9.6-9 Configuration

Test Name: Name of test or subtest
Test Direction: Selects the direction the patient will have to achieve the required velocity. The name of the subtest will be the same as the test direction selected.
Start Velocity: Velocity needed for the patient to achieve in the test direction before the optotype is displayed.
Play Metronome Beep: By default, the metronome beep will be played at the desired frequency. If this is set to OFF, then the metronome beep will not be played during the test.



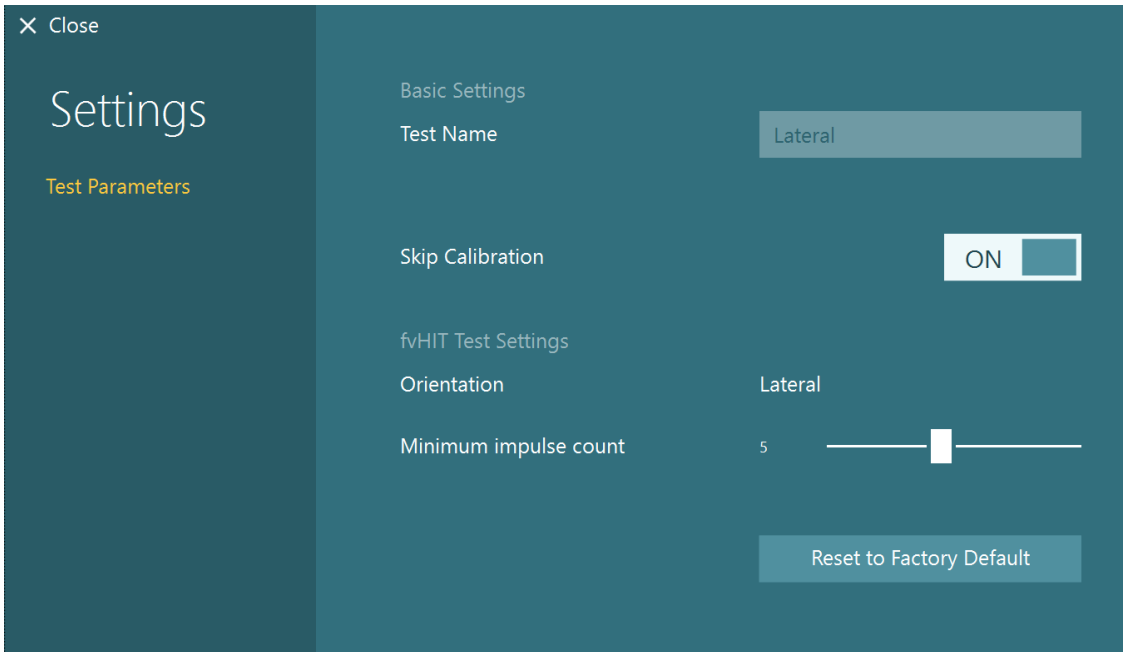


Figure 9.6-10 Configuration

9.6.5 Configuration of fvHIT™

Computer set up

A high speed monitor (240 Hz) is recommended to ensure most accurate optotype display time at the peak of the head impulse. There is also the option to adjust the refresh speed rate for your stimuli display. Go to computer display settings and advanced display settings. Choose the highest refresh speed rate you have for your stimuli.

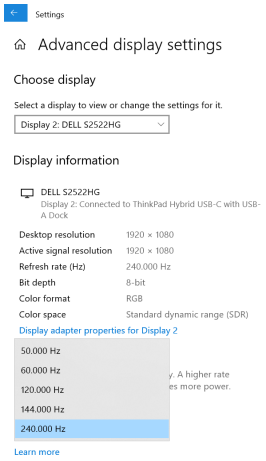


Figure 9.6-11 Choose the highest refresh speed rate on your monitor to make sure all optotype tests (DVA, GST, fvHIT™) are as accurate as possible.

Screen set up

Select the Optotype Stimuli display source and set the screen size and patient distance in the System Default Settings before beginning the first test. A suggested patient distance will be identified for your screen dimensions. If the distance is too much for your room set up, then choose a smaller display input. It is suggested to consider utilizing a smaller monitor than your oculomotor screen for optotype tests (DVA, GST, fvHIT™).

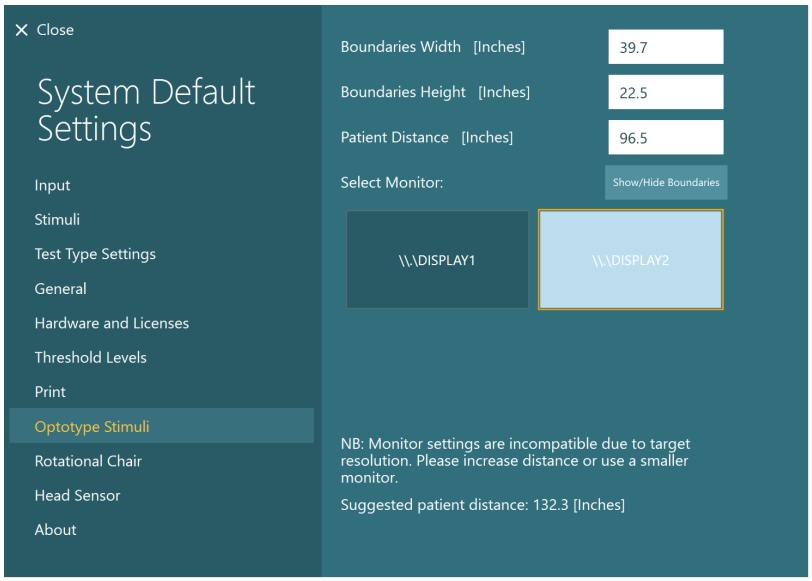


Figure 9.6-12 System Default Settings for monitor set up for fvHIT™

Protocol set up
The default protocol is automatic, but you can also choose a manual target presentation for Static Visual Acuity and Visual Process Time tests in the fvHIT™ protocol. You can choose the options in Summary Parameters.

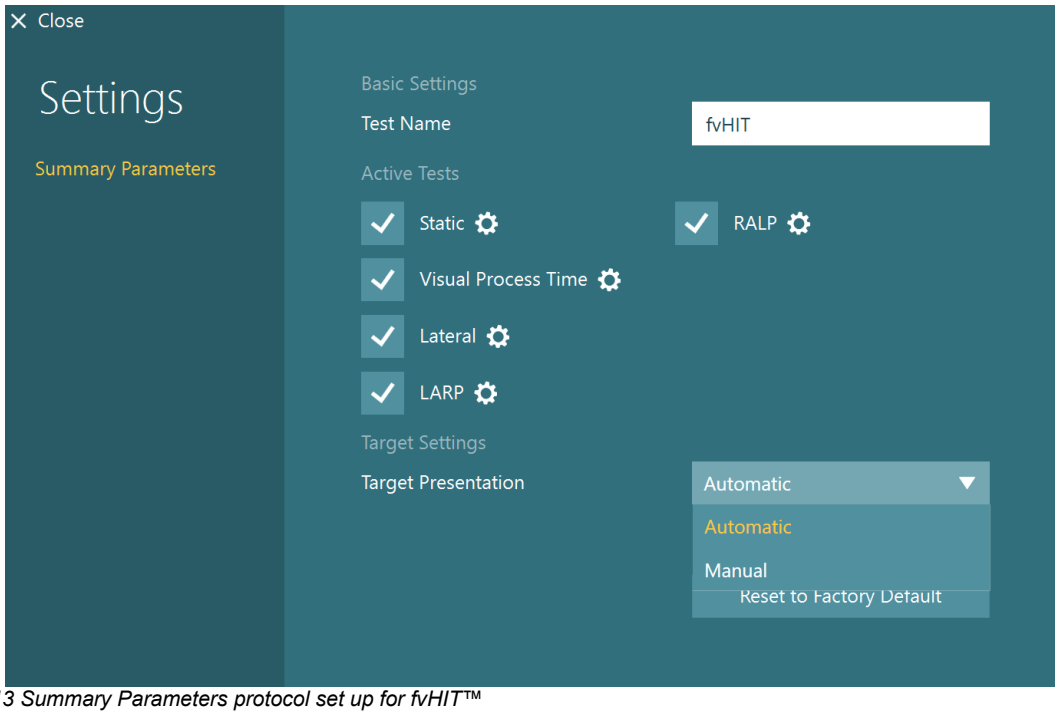


Figure 9.6-13 Summary Parameters protocol set up for fvHIT™

9.7 Configuring video head impulse tests

9.7.1 Computer Settings for video head impulse tests:

Both vHIT for VORTEQ™ and vHIT for EyeSeeCam have the common summary properties for computer screen.



Figure 9.7-1 vHIT for VORTEQ™ and vHIT for EyeSeeCam Summary Properties- Computer Screen

Impulse End Time: Adjust to setup how many milliseconds to view of the impulse.
Show Overlapped: Enable to show head trace and eye trace overlapped.

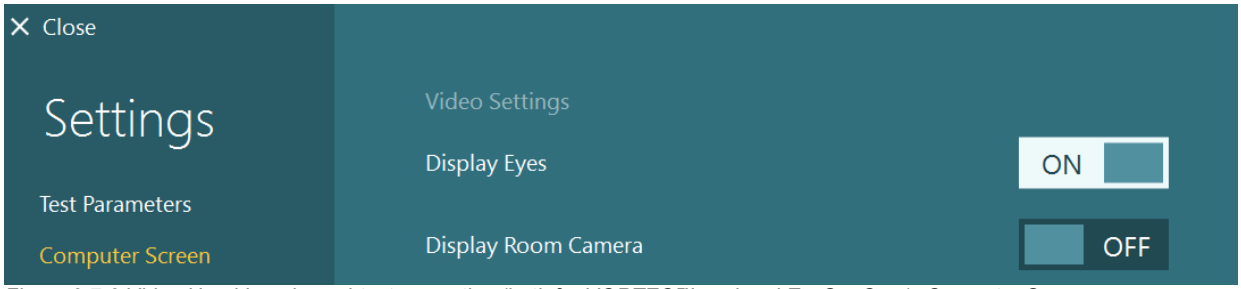


Figure 9.7-2 Video Head Impulse subtest properties (both for VORTEQ™ and and EyeSeeCam)- Computer Screen

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Display Room Camera: If enabled, records the test room during testing.

In addition to the above-mentioned sub-test computer settings, vHIT for VORTEQ™ has few additional features shown below.

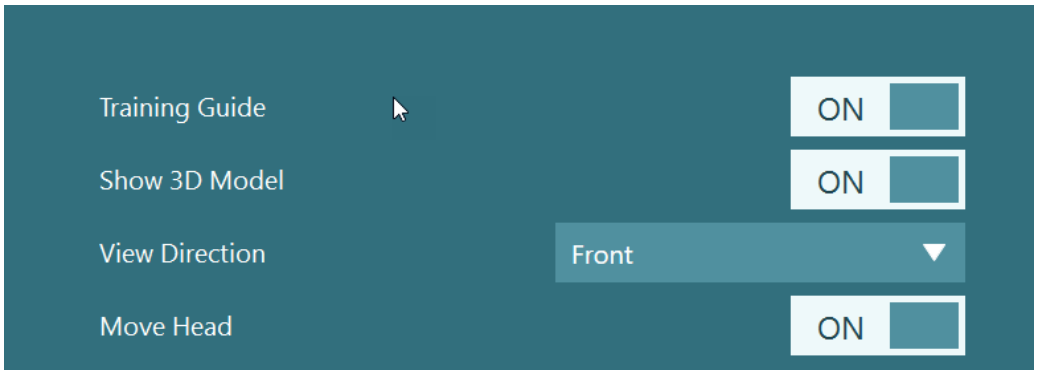


Figure 9.7-3 Video Head Impulse additional subtest properties for VORTEQ™- Computer Screen

Training Guide: Enable to show target velocity for head movement on graph.
Show 3D Model: guides to view head movement with 3D model to ensure head position.
View Direction: Setup from what angle to view the 3D model.
Move Head: Enable to move the 3D model when the head moves.

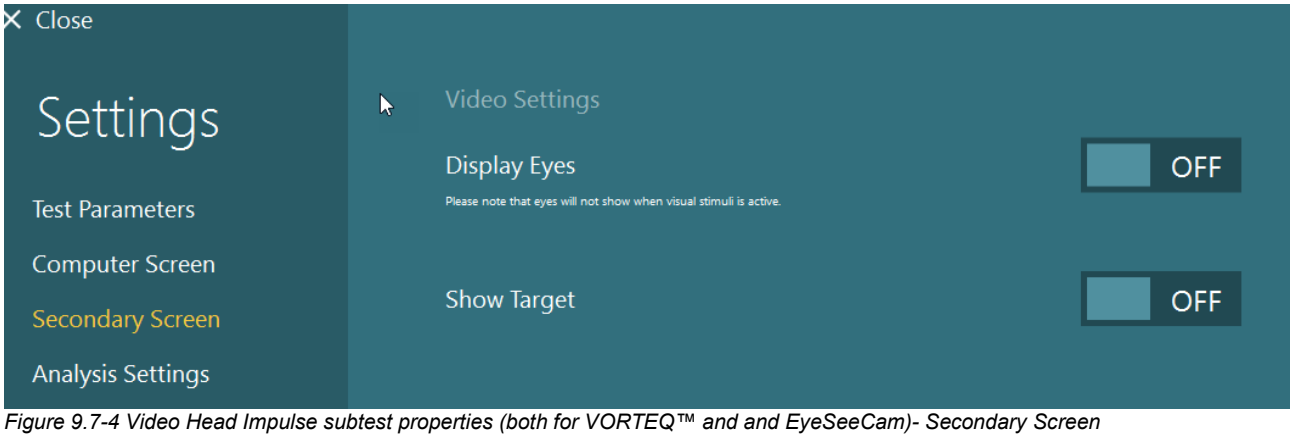


Figure 9.7-4 Video Head Impulse subtest properties (both for VORTEQ™ and and EyeSeeCam)- Secondary Screen

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Show Target: If enabled, target dot will be shown on secondary screen during test.

9.7.2 Configuring vHIT VORTEQ™ test

Summary configuration options through Protocol Management (Figure 9.7-5):

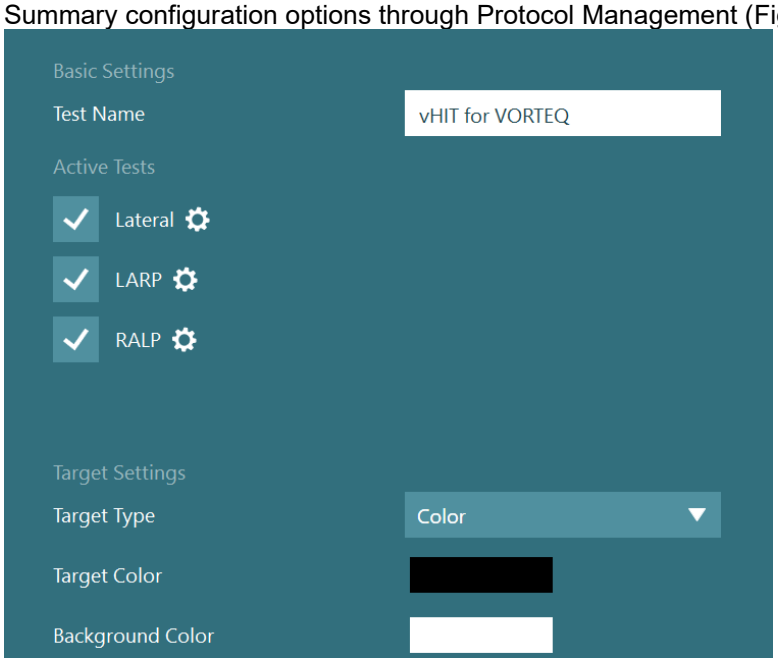


Figure 9.7-5 vHIT for VORTEQ™ Summary Properties

Test Name: Name of test or subtest
Active Tests: This area lists the video head impulse tests for Lateral, LARP, and RALP planes.
Target Type: Method of displaying the stimulus on a TV or projector. This can be color for a solid background color with a dot in the center or image for a specific image.
Target Color: If the Target Type is set to color, then the Target Color refers to the color of the solid dot in the center of the screen for fixation. The default color is set to black.
Target Image: If the Target Type is set to image, then the target image is the selection of the stimulus image rendered instead of a solid-colored circle. The Target Image is often used with pediatric patients.
Background Color: This is the color of the stimulus background. The default color is set to white. With a white background the pupils constrict more due to the extra ambient light. This results in a pupil that can be more easily tracked in smaller viewing windows, which is required to achieve the higher temporal rates (up to 250 Hz) in vHIT tests.

Sub-test configuration options through Temporary Settings or protocol management (Figure 9.7-6):

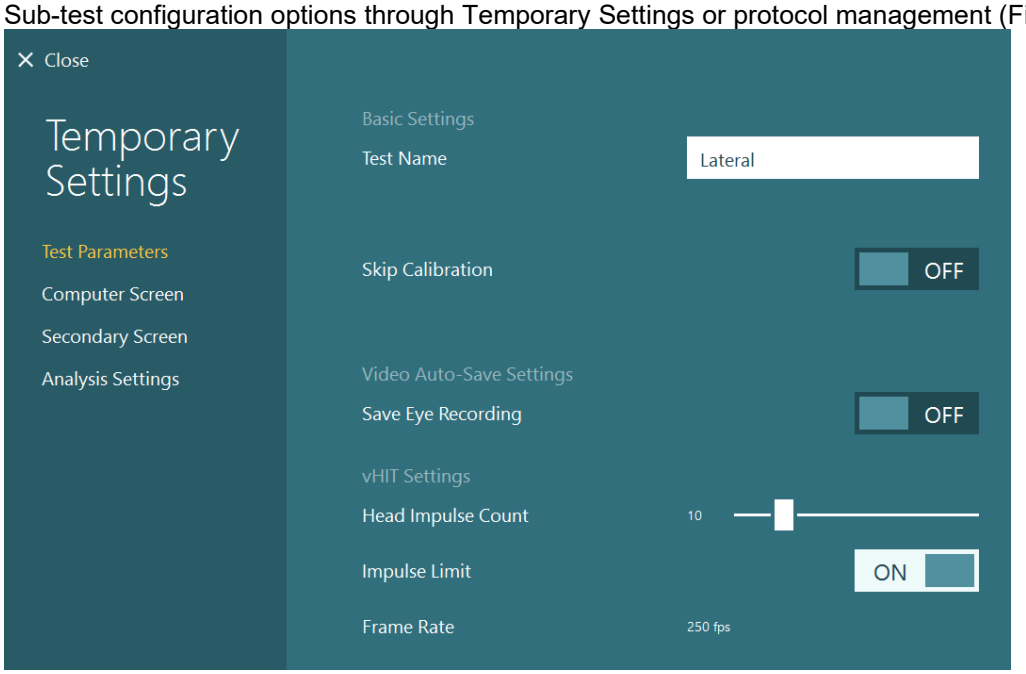


Figure 9.7-6 Video Head Impulse subtest properties

Test Name: Name of test or subtest
Skip Calibration: If set, the software will not set the Calibration button as the default action if a valid calibration has not yet been performed. By default, this setting is off.
Save Eye Recording: If set, the software will automatically keep the eye and room camera videos after the test is reviewed. By default, this setting is off, therefore the software will delete the eye and room camera videos.
Head Impulse Count: This setting is the number of head impulses that must be performed successfully in each direction and is configurable if the Impulse Limit setting is set to on.
Impulse Limit: This setting will automatically end the test after the Head Impulse Count has been achieved in both directions.
Frame Rate: The test's sample rate is listed here. This is not configurable by the end user. This value is seen in vHIT for VORTEQ™ subtests.

In addition to these settings are the Analysis Settings (Figure 9.7-7) for the video head impulse subtests.



Figure 9.7-7 Video Head Impulse subtest analysis properties

Peak Head Velocity Limits: These settings define the size of the swoosh pattern expected for the head impulse. The lower limit is displayed to the left of the slider, and the upper limit is displayed to the right of the slider. Expanding this range will allow more head impulses to be treated as acceptable by the software.
Smoothing Level: This setting will reduce the noise seen in the data traces. The smoothing level indicates the size of the window used to smooth the data – larger window sizes will smooth the data greater. The default value is two. Setting the smoothing level to zero will bypass smoothing. This setting is available in vHIT for VORTEQ™ tests.
Reject Noisy Eye Velocity: By enabling this option, the software will throw out head impulses that meet the swoosh criteria but have excessive variation in the eye or head velocity trace. By default, this value is set to ON. This setting is available in vHIT for EyeSeeCam tests.

9.7.3 Configuring vHIT for EyeSeeCam test

Summary configuration options through Protocol Management.

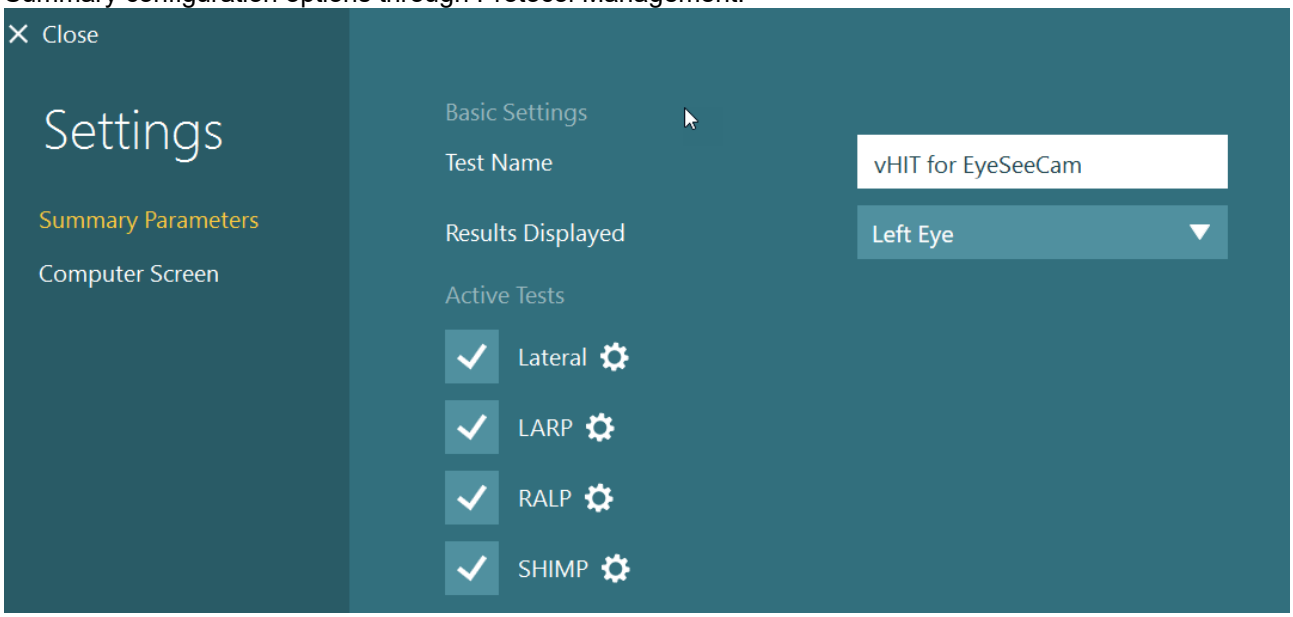


Figure 9.7-8 Video Head Impulse for EyeSeeCam Summary properties

Test Name: Name of the Test
Results Displayed: Option to choose either left or right for the results display
Active Tests: Shows the selected subtests

Sub-test configuration options through Temporary Settings or protocol management

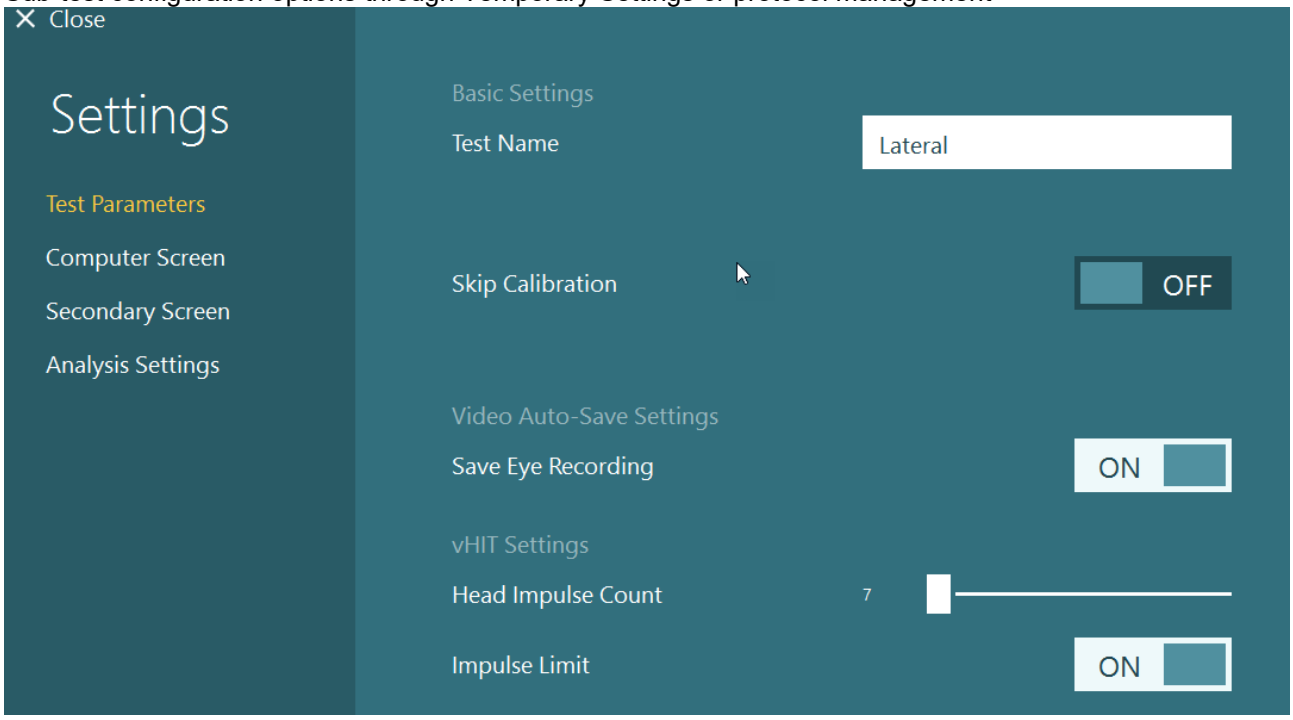


Figure 9.7-9 Video Head Impulse for EyeSeeCam Sub-test properties

Test Name: Name of test or subtest
Skip Calibration: If set, the software will not set the Calibration button as the default action if a valid calibration has not yet been performed. By default, this setting is off.
Save Eye Recording: If set, the software will automatically keep the eye and room camera videos after the test is reviewed. By default, this setting is off, therefore the software will delete the eye and room camera videos.

Head Impulse Count: This setting is the number of head impulses that must be performed successfully in each direction and is configurable if the Impulse Limit setting is set to on.
Impulse Limit: This setting will automatically end the test after the Head Impulse Count has been achieved in both directions.

9.8 Configuring torsion tests

9.8.1 Configuring ocular counter roll test

Configuration options of summary settings through protocol management

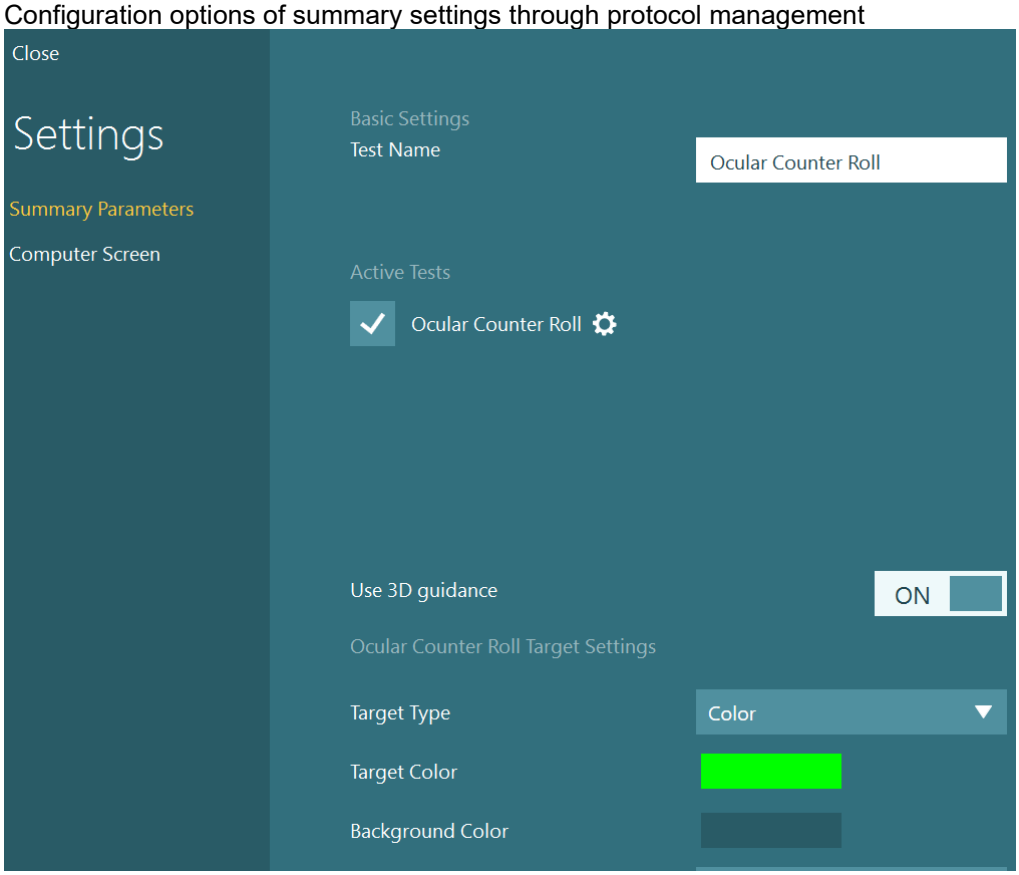


Figure 9.8-1 Ocular Counter Roll Summary properties

Test Name: Name of the test
Active Tests: The subtests selected will appear in the testing screen. The configuration gear button beside each test will open the subtest settings.
Use 3D Guidance: guides to view head movement with 3D model to ensure head rotation on both side correct and symmetrical.
Target Type: Selects the stimulus for all Gaze subtests from the drop-down list.
Target Color: If the target type is set to color, this option will change the target color.
Background color: Select different colors for the background.

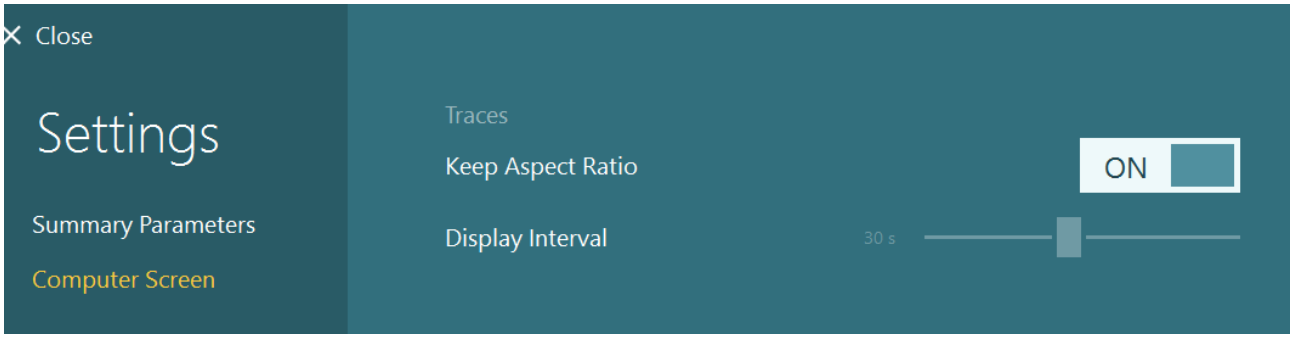


Figure 9.8-2 Ocular Counter Roll Summary properties- Computer Screen

Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test.

Configuration options of sub-tests through Temporary Settings or protocol management (Figure 9.8-3):

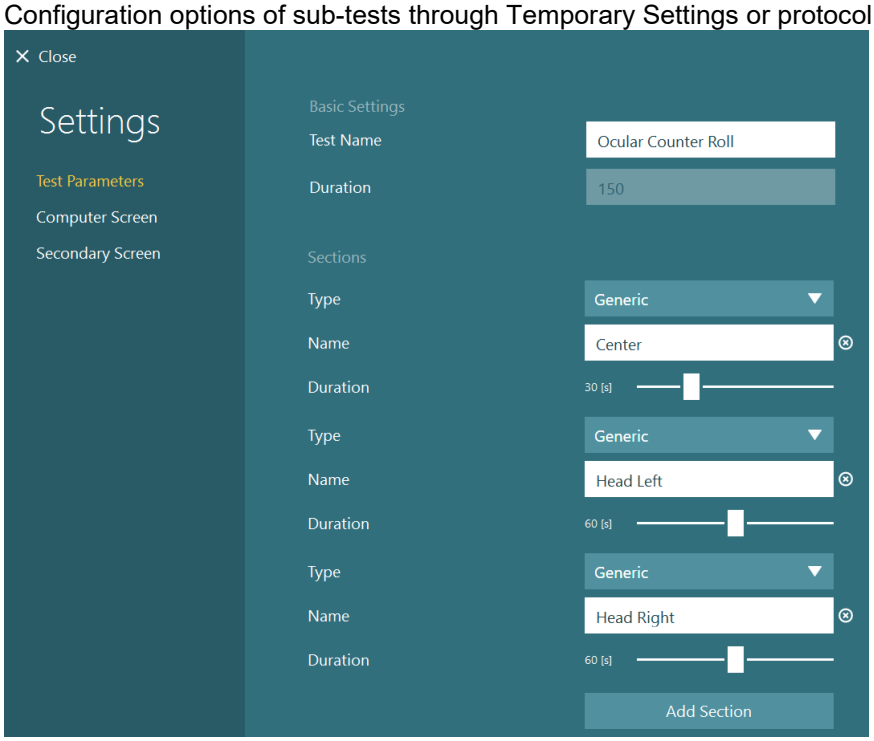


Figure 9.8-3 Ocular Counter Roll subtest properties

Test Name: Name of subtest
Duration: Define how long the eye movement is to be recorded and analyzed (in seconds).
Section Type: Method used to define the section style. This is set as Generic.
Section Name: Name given to the specific section. Clicking on the x button beside the name will delete this section's name
Section Duration: Amount of time set to perform the specific section (in seconds)

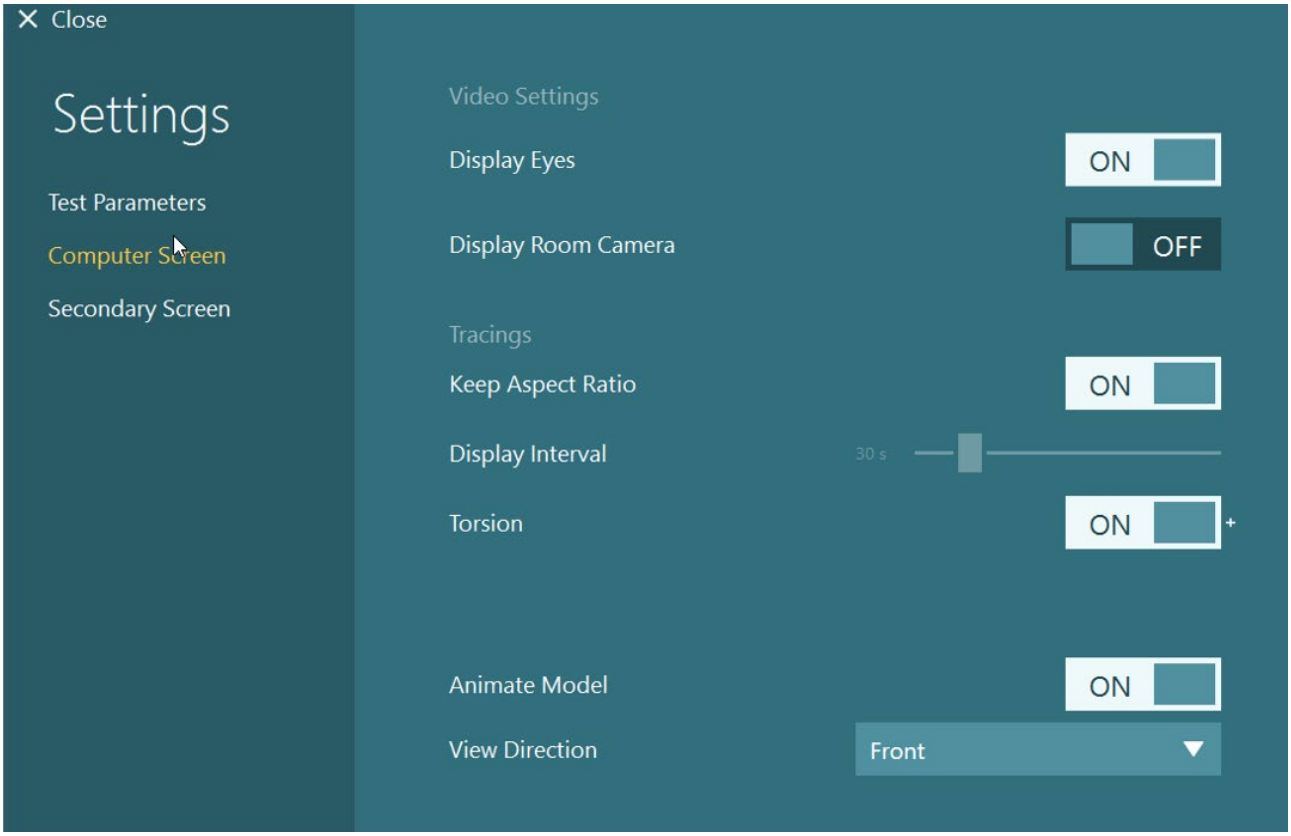


Figure 9.8-4 Ocular Counter Roll subtest properties- Computer Screen

Display Eyes: enabling this option allows a clinician to view the patient eyes while testing.
Display Room Camera: If enabled, records the test room during testing.
Keep Aspect Ratio: If disabled, the user can manually adjust the display interval.
Display Interval: Displayed time axis of the test.
Torsion: Enable to show torsion traces on screen.
Animate Model: guides to view head movement with 3D model to ensure head rotation on both side correct and symmetrical.
View Direction: Select direction to view 3D model from.

10 Suggested threshold values

The VisualEyes™ system software suite has suggested threshold tables. The values in these tables are suggested threshold values as published from the textbook of Gary Jacobson and Neil Shepard, Balance Function Assessment and Management 2nd edition unless otherwise referenced.

NOTICE It is recommended that the clinician collects a sample of data from the clinic, using the customized protocols and settings and document any differences to the findings in these tables. If the clinic decides to use custom test thresholds, the test thresholds can be updated to reflect the clinic settings.

10.1 Updating test thresholds

- Tap the **Configuration** option from main screen
- Select **System Default Settings**
- Choose **Threshold Levels** from the list in the side panel menu
- A disclaimer will appear (Figure 10.1-1) before allowing access to the suggested threshold values. Click **OK** to accept the disclaimer and move onto the threshold data tables.

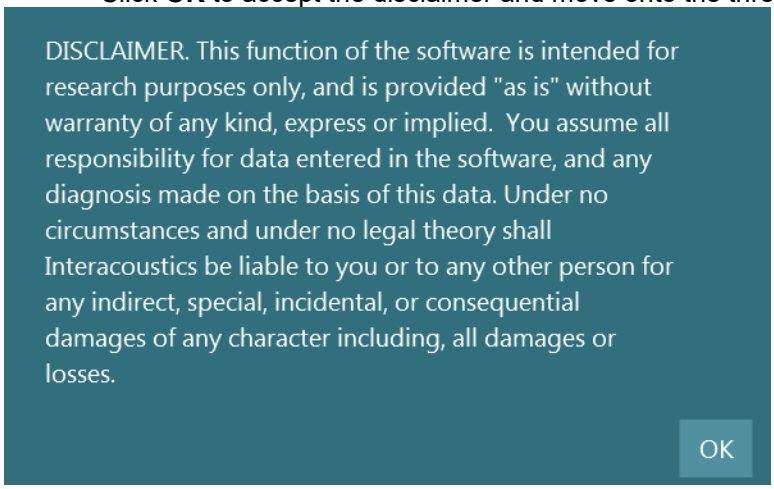
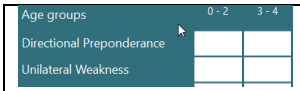


Figure 10.1-1 Disclaimer for suggested threshold values

	You can change the threshold data by entering new values into the appropriate fields. When entering the threshold values into the 5-6 age group, click on the copy values button to copy all of the values to the remaining age groups.

	Use the plus button to add a new threshold level. Use the cross button to delete a threshold level.

	The clinician can add threshold values for younger age groups if they wish

An **Undo** button is available to restore all values back to the values prior editing. To save the new laboratory specific threshold data for use with all patients (new or previously tested), click the **Save** button. To reload the default suggested threshold data, click the **Reset all Thresholds to Default** button. You can also **Import** or **Export** threshold data based on the requirements.

10.2 Nystagmus tests

The average slow phase velocity (a. SPV) bar graph displays the a. SPV of 3 or more beats found within the peak response time period defined in the test properties. The Max Slowphase Velocity value of 6 degrees per second is treated as within threshold limits and will be displayed as a white bar. Values exceeding this threshold will have the threshold value portion in white and the remaining displayed in grey. (Figure 10.2-1Figure 10.2-2).

NOTICE The Advanced Dix Hallpike and Lateral Head Roll tests are standard nystagmus detection tests and use the same threshold value suggested in nystagmus test.

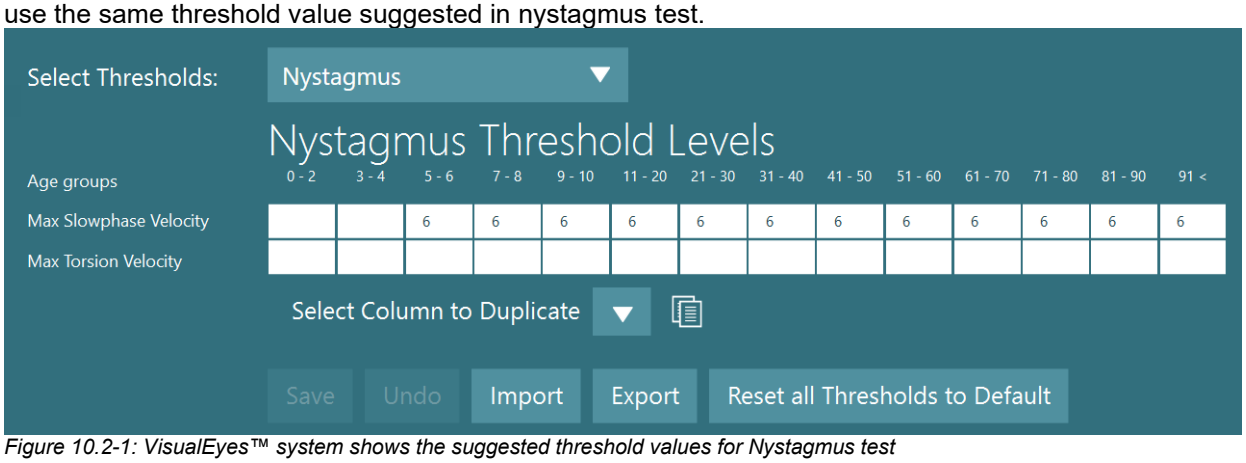


Figure 10.2-1: VisualEyes™ system shows the suggested threshold values for Nystagmus test

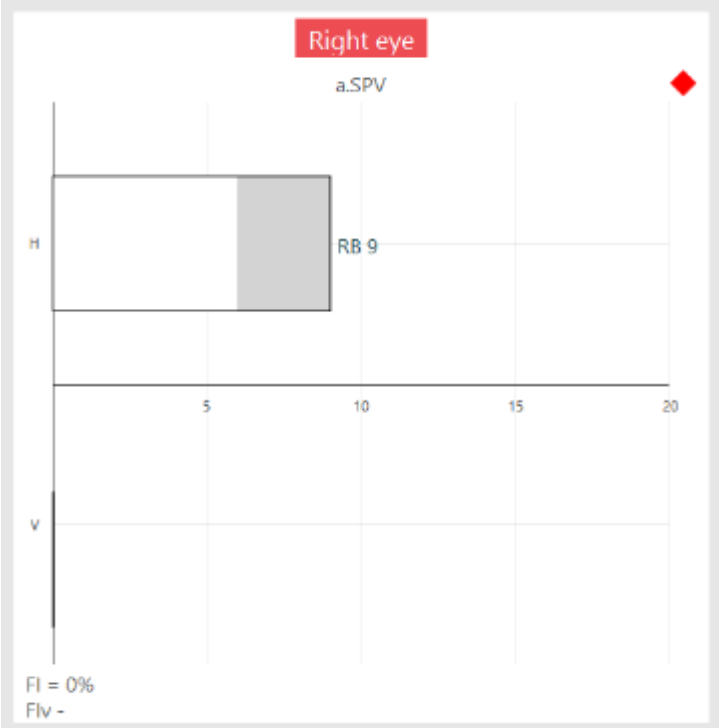


Figure 10.2-2 Average Slow Phase Velocity bar graph with 6 dps threshold

10.3 Caloric tests

Unilateral Weakness and Directional Preponderance are calculated using Jongkees formula. Values can be calculated using the direct values or compensated values that are adjusted with the nystagmus value from the caloric spontaneous nystagmus subtest.

$$Total\ Eye\ Speed = Left\ Cool + Left\ Warm + Right\ Cool + Right\ Warm$$

$$Unilateral\ Weakness\ (UW) = \frac{(Left\ Cool + Left\ Warm) - (Right\ Cool + Right\ Warm)}{Total\ Eye\ Speed} \times 100\%$$

$$Directional\ Preponderance\ (DP) = \frac{(Left\ Cool + Right\ Warm) - (Right\ Cool + Left\ Warm)}{Total\ Eye\ Speed} \times 100\%$$

$$Monothermal\ Warm\ Screening\ Test\ (MWST) = \frac{Right\ Warm - Left\ Warm}{Right\ Warm + Left\ Warm} \times 100\%$$

If you have performed the caloric test with only the warm caloric tests, then the software will use the Monothermal Warm Screening Test (MWST) threshold value to measure the patient's weakness. Directional Preponderance is not calculated in the MWST.

If you perform the cool caloric test, the software will use the Unilateral Weakness threshold value. Unilateral weakness is 25%. Directional Preponderance is 30%. Bilateral Weakness is defined if the total slow phase velocity is less than 11 degrees per second. The Fixation Index threshold is 50%. Patients with a Fixation Index higher than 50% are said to have a failure to suppress nystagmus with fixation (Figure 10.3-1).

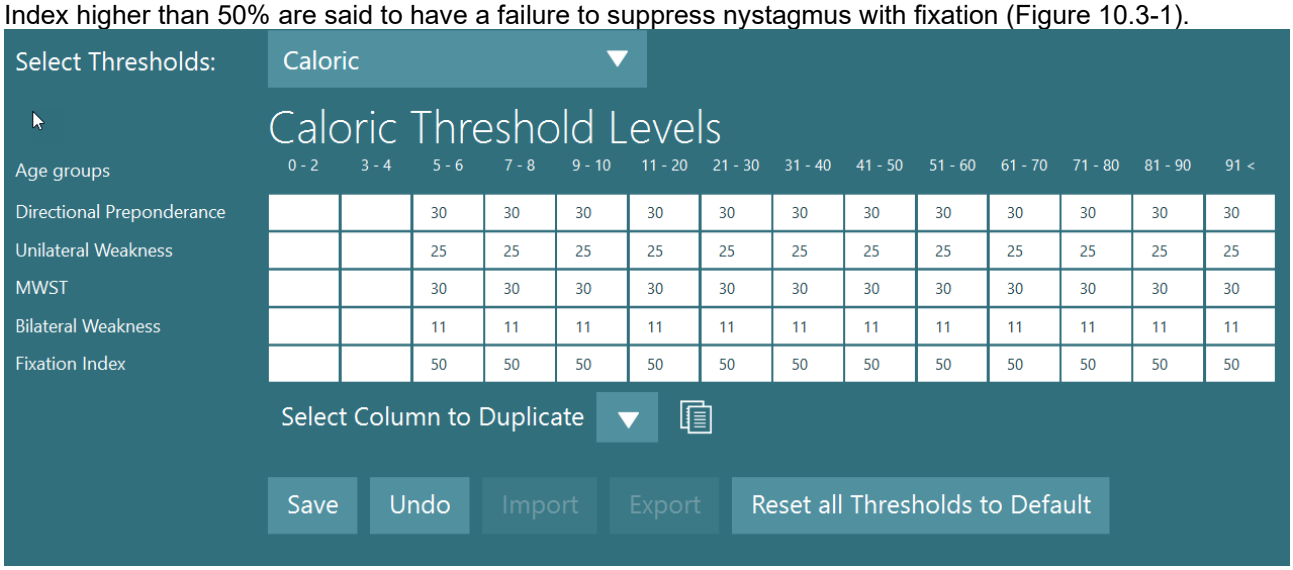


Figure 10.3-1 VisualEyes™ system shows the suggested threshold values for caloric test

10.4 Oculomotor tests:

The suggested threshold levels for oculomotor tests cover the optokinetic, smooth pursuit, and saccade tests. The individual threshold values for each test are described below.

10.4.1 Optokinetic tests

The Optokinetic test measures nystagmus and displays gain and symmetry. The analysis of the optokinetic test calculates the average velocity of the movement during the peak response window (a. SPV) and compares this velocity with the stimulus velocity. The relation of velocity values is called gain.

$$Gain = \frac{a.SPV}{Stimulus\ Velocity}$$

$$Asymmetry = \frac{Left\ Moving\ Gain - Right\ Moving\ Gain}{Left\ Moving\ Gain + Right\ Moving\ Gain}$$

Data acquired in the first three seconds of a measurement is not included in the analysis. The difference between the 2 eyes is the symmetry value. When shown in the symmetry chart, the asymmetry will be displayed as a percentage, though the value in the Threshold values table will be a decimal value.
The default OPK Minimum Gain is 0.60 and the OPK Maximum Asymmetry is 0.25 (Figure 10.4-1).

Age groups	0 - 2	3 - 4	5 - 6	7 - 8	9 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	61 - 70	71 - 80	81 - 90	91 <
OPK Minimum Gain			0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60
OPK Maximum Asymmetry			0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25

Figure 10.4-1 VisualEyes™ system shows the suggested threshold values for Optokinetic test

10.4.2 Smooth pursuit tests

Gain is measured for each frequency. For each frequency between 0.1 Hz and 0.5 Hz, the average gain value for all cycles for the selected frequency is compared to the minimum gain value in the table of thresholds. If the average gain value is less than the minimum gain value specified in the table, then the test will be labeled as outside threshold. Smooth Pursuit threshold data varies on the patient's age (Figure 10.4-2).

Age groups	0 - 2	3 - 4	5 - 6	7 - 8	9 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	61 - 70	71 - 80	81 - 90	91 <
Smooth Pursuit Min Gain 0.1 Hz			0,66	0,66	0,66	0,66	0,66	0,66	0,66	0,66	0,53	0,40	0,40	0,40
Smooth Pursuit Min Gain 0.2 Hz			0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,70	0,68	0,68	0,68
Smooth Pursuit Min Gain 0.3 Hz			0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,69	0,61	0,61	0,61	0,61
Smooth Pursuit Min Gain 0.4 Hz			0,64	0,64	0,64	0,64	0,64	0,64	0,64	0,64	0,49	0,51	0,51	0,51
Smooth Pursuit Min Gain 0.5 Hz			0,57	0,57	0,57	0,57	0,57	0,57	0,57	0,57	0,36	0,41	0,41	0,41

Figure 10.4-2 Pursuit threshold values

10.4.3 Saccade tests

Saccade tests measure three values: velocity, latency, and accuracy. Saccade thresholds do vary with patient age. To create the velocity graph, minimum velocities at velocities between 5 degrees and 30 degrees are used to create a velocity profile (Figure 10.4-3).

Age groups	0 - 2	3 - 4	5 - 6	7 - 8	9 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	61 - 70	71 - 80	81 - 90	91 <
Saccade Max Accuracy			137	137	137	137	137	137	137	137	134	121	121	121
Saccade Max Latency			260	260	260	260	260	260	260	260	260	270	270	270
Saccade Min Accuracy			77	77	77	77	77	77	77	77	80	85	85	85
Saccade Min Velocity 5º			0	0	0	0	0	0	0	0	0	0	0	0
Saccade Min Velocity 10º			191	191	191	191	191	191	191	191	191	191	191	191
Saccade Min Velocity 15º			249	249	249	249	249	249	249	249	249	249	249	249
Saccade Min Velocity 20º			257	257	257	257	257	257	257	257	257	257	257	257
Saccade Min Velocity 25º			315	315	315	315	315	315	315	315	315	315	315	315
Saccade Min Velocity 30º			329	329	329	329	329	329	329	329	329	329	329	329

Figure 10.4-3 Saccade threshold values

10.5 Saccadometry tests

Saccadometry tests measure the three values in saccades of velocity, latency, and accuracy at each target deflection. The software has thresholds for every 5-degree deflection up to 30 degrees. Saccade thresholds do vary with patient age. To create the velocity graph, minimum velocities at velocities between 5 degrees and 30 degrees are used to create a velocity profile. Thresholds are separated for prosaccades (patient looking at the target) and antisaccades (patient looking at the opposite location of the target). Normative data is included in pro- and Anti-Saccades tests.

***NOTICE**: For update from VE3.1 to VE3.2:*
If you have added your own threshold data in your software, this will be overwritten by new data when you upgrade.

10.6 Step velocity tests

Step Velocity tests display threshold values for gain, time constants, and time constant asymmetry. The threshold values are applicable for all ages (
Figure 10.6-1).

Reference:
Step Velocity threshold values referenced from the Leen Maes et al. Publication: Normative Data and Test-Retest Reliability of the Sinusoidal Harmonic Acceleration test, Pseudorandom Rotation Test and Step Velocity Test. Journal of Vestibular Research 14 (2004) 153–204.

Threshold	**50°/s**	**100°/s**	**180°/s**
Minimum Gain	0. 31	0. 31	0. 31
Maximum Gain	1. 08	1. 06	1. 03
Minimum Time Constant	5	5	5
Maximum Time Constant	22	21	21
Maximum Asymmetry	0. 29	0. 29	0. 29

Figure 10.6-1 Summary of suggested threshold values for Step Velocity test for all age groups.

10.7 Sinusoidal harmonic acceleration and VOR suppression tests

For Sinusoidal harmonic acceleration (SHA) tests, threhold values for gain, phase, and symmetry are displayed (Figure 10. 7-1). There are values for both discrete velocity tests (based on 60 deg/sec for all frequencies) and variable velocity (increased velocity with decreased frequency). The threshold values are the same for all ages. VOR suppression tests will compare the patient's gain with fixation to the corresponding VOR test without fixation to calculate the VOR Gain reduction value according to the following formula:

$$VOR\ Gain\ Reduction = \frac{VOR\ Gain_{without\ fixation} - VOR\ Gain_{with\ fixation}}{VOR\ Gain_{without\ fixation}}$$

All values are listed as decimals though the analysis graphs for gain and reduction will display these values as percentages.

Reference:
SHA Variable or Discrete Velocity threshold values referenced from Henry, D. F. publication: Closed-Loop, Sinusoidal Harmonic Acceleration, and Active Head Rotation Tests Norms and Reliability. Otolaryngol Head and Neck Surg. 1553; 65: 531-43.

Threshold	**0. 01 Hz**	**0. 02 Hz**	**0. 04 Hz**	**0. 08 Hz**	**0. 16 Hz**	**0. 32 Hz**	**0. 64 Hz**
Minimum Gain	0. 28	0. 27	0. 36	0. 43	0. 36	0. 37	
Maximum Gain	0. 68	0. 83	0. 80	0. 87	0. 92	1. 00	
Minimum Phase	32	15	6	-3	-3	-6	
Maximum Phase	59	36	24	17	9	8	
Minimum Symmetry	-0. 26	-0. 22	-0. 25	-0. 18	-0. 20		
Maximum Symmetry	0. 34	0. 26	0. 35	0. 30	0. 36		
Minimum VOR Gain Reduction			0. 89	0. 82	0. 77	0. 82	0. 74

Figure 10.7-1 Summary of suggested threshold values for SHA test for all age groups

10.8 Active head rotation (AHR) tests

Active Head Rotation supports threshold values for minimum and maximum gain, phase, and symmetry for frequencies between 1 and 5 Hz. For AHR tests, there are no published threshold values available. Hence, no suggested threshold values are provided in the VisualEyes™ system. However, you can collect and enter your own normative thresholds to customize your reference values (Figure 10.8-1).

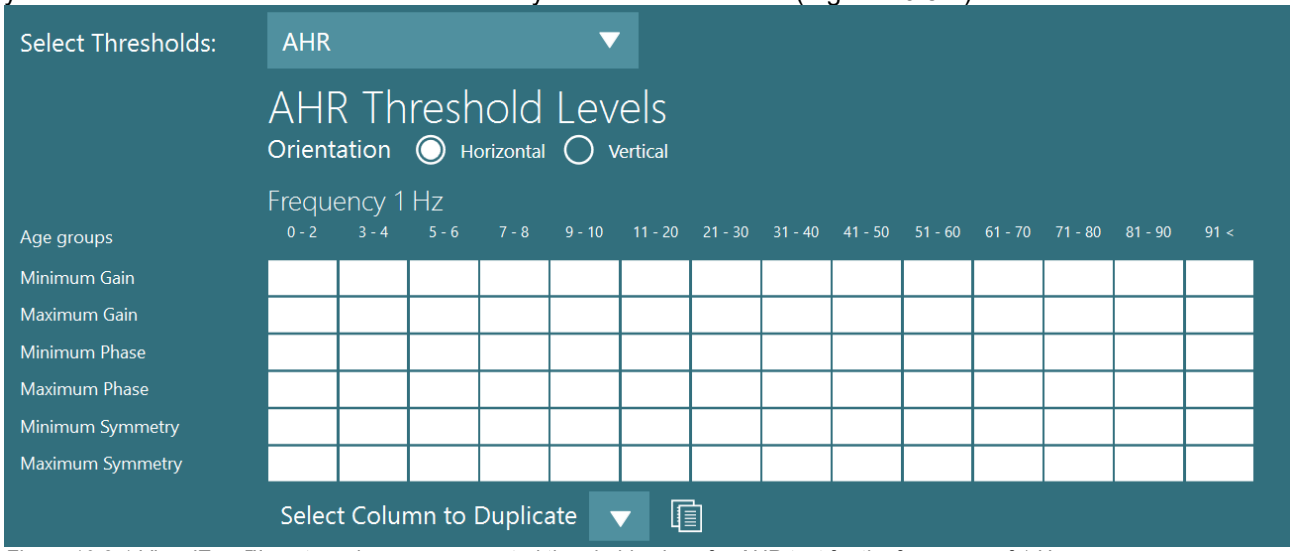


Figure 10.8-1 VisualEyes™ system shows no suggested threshold values for AHR test for the frequency of 1 Hz

10.9 Dynamic visual acuity (DVA) tests

Dynamic Visual Acuity thresholds are applied to the patient's static visual acuity (SVA). The relative threshold (RT) which is the same for all ages is applied to the patient's static acuity logMAR value to determine the dynamic visual acuity value at that velocity. If the velocity is not one of the listed values, the relative threshold at that velocity is averaged linearly between the neighboring relative thresholds. For DVA tests, there are no published thresholds available. Hence, no suggested threshold values are provided in the VisualEyes™ system. However, you can collect and enter your own normative thresholds to customize your reference values (Figure 10.9-1).

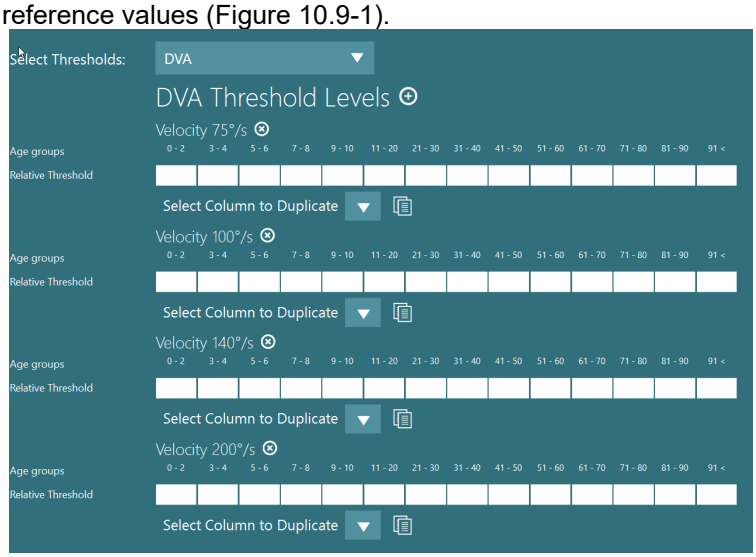


Figure 10.9-1 VisualEyes™ system shows no suggested threshold values for DVA test

$$DVA_{velocity} = SVA + Velocity \times \frac{RT_{upper\ velocity} - RT_{lower\ velocity}}{Velocity_{upper} - Velocity_{lower}}$$

So the DVA at 150 degrees per second with a patient's static visual acuity of -0.1 would be calculated as follows:

$$DVA_{150} = -0.1 + 150 \times \frac{0.40_{200} - 0.28_{140}}{200_{200} - 140_{140}} = 0.2_{150}$$

10.10 Video head impulse tests (vHIT) for EyeSeeCam

Video Head Impulse Tests using the EyeSeeCam goggles measure the gain of the eye position with the head position and calculate the regression line for the head impulses. The threshold values are applicable for all ages. For vHIT tests, there are no published threshold values available. Hence, no suggested threshold values are provided in the VisualEyes™ system. However, you can collect and enter your own normative thresholds to customize your reference values (Figure 10.10-1).

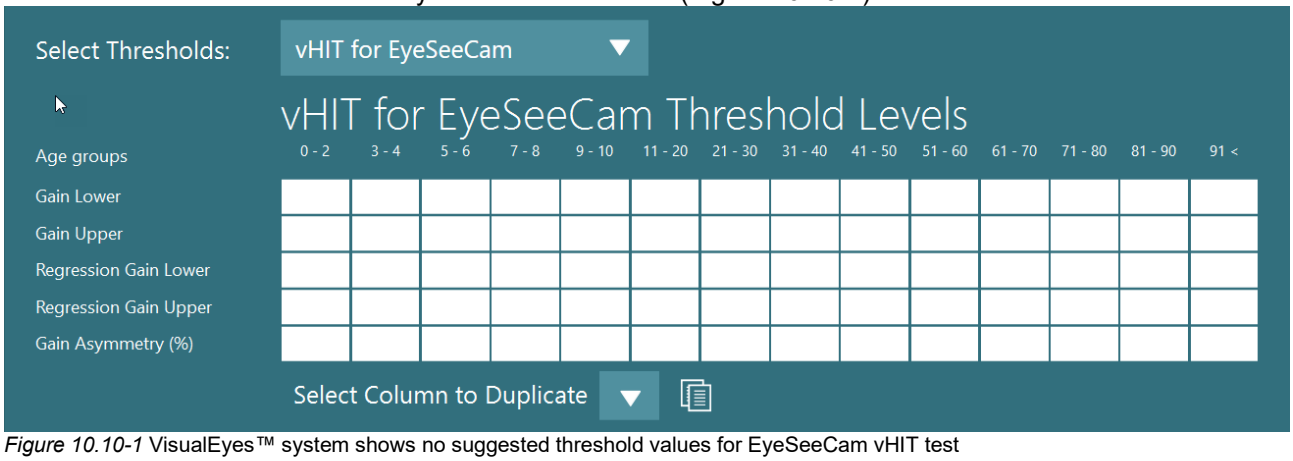


Figure 10.10-1 VisualEyes™ system shows no suggested threshold values for EyeSeeCam vHIT test

11 Patient report

11.1 Write report editor

You can create a written report within the VisualEyes™ 515/525 software. This is a word processor that saves the created document in the patient review sessions for later viewing or printing. You can access the write report editor from the session review screen by selecting ‘Write Report’ (Figure 11.1-1).



Figure 11.1-1 Write Report feature

11.2 Text styles

There are options within the left menu panel in the Report Editor (Figure 11.3-1) to change the font, size, and alignment of the text, as well as the font weight of bold, italics, and underline.

11.3 Templates

The templates section (Figure 11. 3-2) gives you the option to customize the patient report using patient information from OtoAccess® Database, keywords, and findings templates. Creating a template allows you to then access the predefined template from the Templates button to use in the report. Using a predefined template will erase the current report and replace it with the template. Use the Manage Templates item from the Templates button to enter the Template Editor (Figure 11. 3-1).



Figure 11.3-1 Manage templates from the templates menu



Figure 11.3-2 Template Editor screen

With a new installation of VisualEyes™ 515/525, there are four predefined templates included: Normal vHIT and VNG, Normal vHIT detailed, Normal VNG, and Normal VNG Detailed. To view these templates, select one of the templates from the pull-down box. Otherwise click **New template** (Figure 11.3-3) to create a report template.

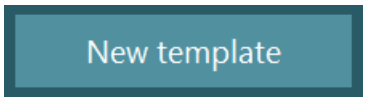


Figure 11.3-3 New template button

By default, the name of the template will be New Template 1. You can change this name at the top of the screen. The report template is then populated with text and can have both keywords and findings added to the template. Select the position in the template report to add the keyword, then select the keyword on the right side of the screen. Click on the add keyword button to add the keyword to the template text. The keyword will be shown with double arrows around the keyword text, e. g. <<Client_FirstName>>. To add a specific finding, click on the Show Findings option in the upper right, then select the appropriate finding from the list and add it with the add finding button (Figure 11.3-4).



Figure 11.3-4 Add keyword or finding button

Once you have written the template text, tap the Save template button (Figure 11.3-5).

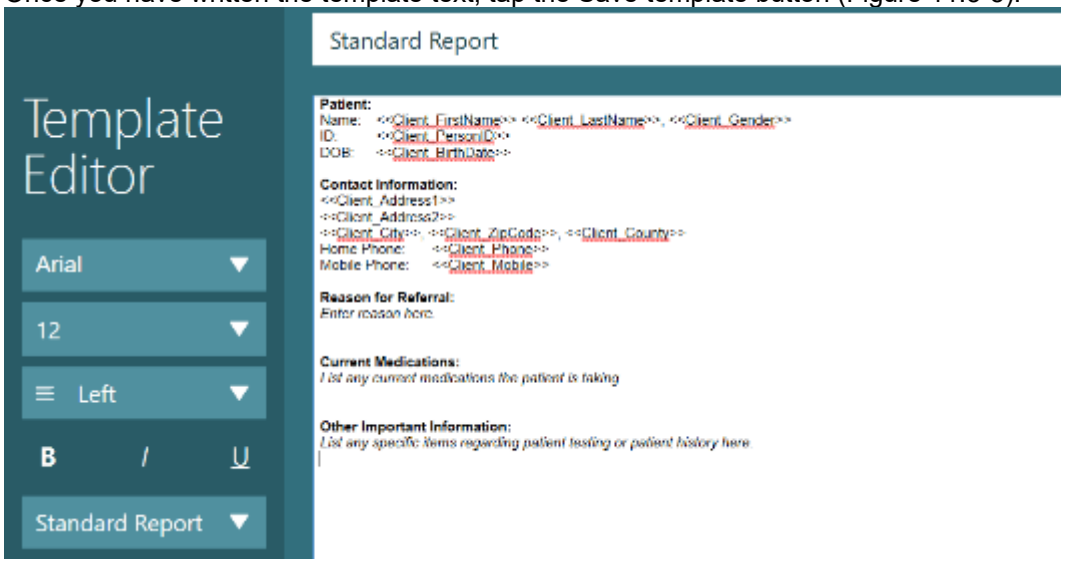


Figure 11.3-5 Template Editor displaying sample template

You can import/export report templates using the Import/Export button (Figure 11.3-6).

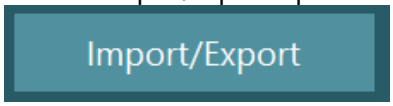


Figure 11.3-6 Import/Export templates button

Tap the Close editor button (Figure 11.3-7) to exit the Template Editor screen and return to the Report Editor screen.

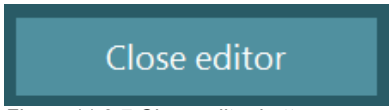


Figure 11.3-7 Close editor button

Within the Report Editor screen, use the Templates selection box and select the template you created. VisualEyes™ 515/525 will ask to confirm (Figure 11.3-8) replacing the report with the selected report template.

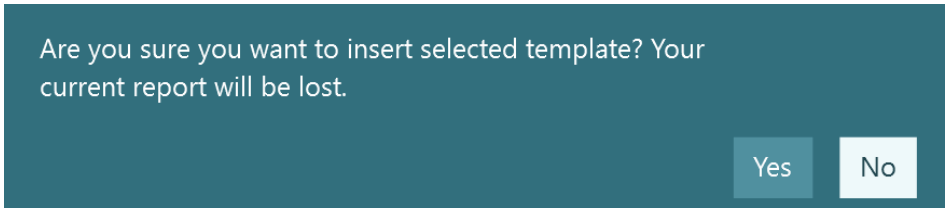


Figure 11.3-8 Confirm insert selected template message

When the report template is applied, the keywords will be filled with the information from the patient demographics in OtoAccess® Database. Fields that are not filled will be blank in the report (Figure 11.3-9).

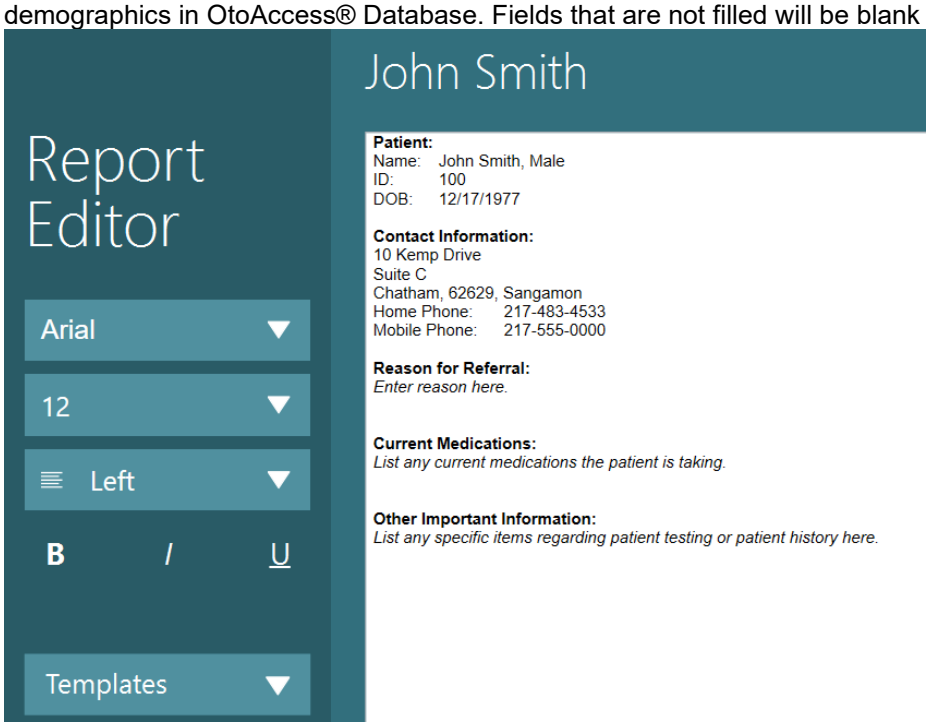


Figure 11.3-9 Report Editor with example template

11.4 Findings

Findings are predefined templates that you can add into the written report within the Report Editor. They are used to quickly add a comment regarding the patient's test result into the report. To use one of the findings in the report, move the cursor to the location in the report to insert the finding, then select the desired finding from the Findings selection menu (Figure 11.4-1).

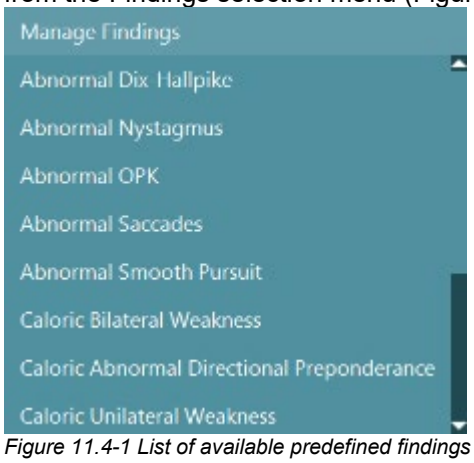


Figure 11.4-1 List of available predefined findings

To add a new finding to the list of findings, choose Manage Findings from the Findings menu. This will launch the Findings Editor screen (Figure 11.4-2).

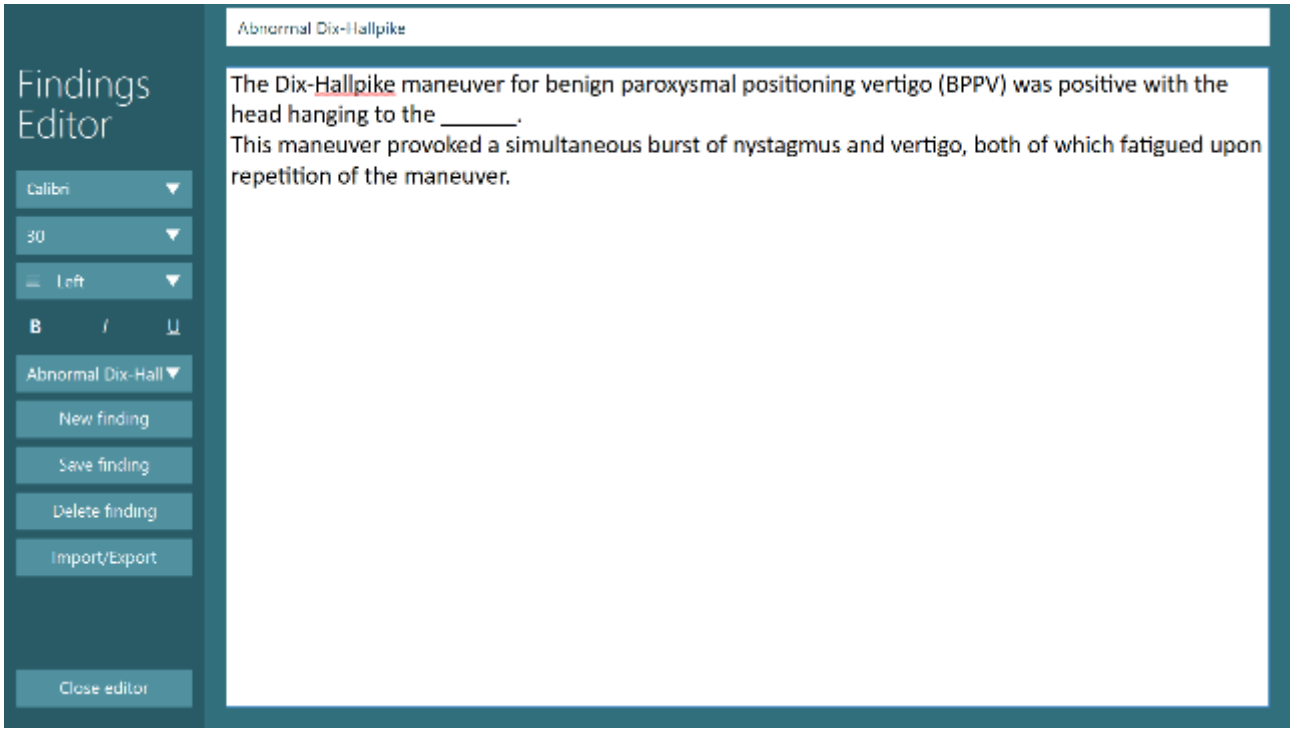


Figure 11.4-2 Findings Editor screen

To create a new finding, tap **New finding**. A new finding called New Finding 1 will be displayed. Overwrite New Finding 1 in the upper white text box with the desired keyword for the finding. Next, enter the text for the finding in the lower white text box. The font name, size, and other style attributes will be kept with the text and will be displayed as such when added to the report. Click on the Save finding button when finished, then click on the Close editor button to return to the Report Editor screen. The new finding will now appear within the dropdown menu when selecting the Findings button.

11.5 Save report

Once a report is complete, select the Close editor button to save the report with the patient's current session (Figure 11.5-1).



Figure 11.5-1 Session saved confirmation

12 Printing

12.1 Printing results

The VisualEyes™ system can print either a single test or several tests from an individual patient session. A clinical report, test report summary, or individual test results can be printed out from the session review screen (Figure 12.1-1).



Figure 12.1-1 Session review and printing options

The Print Filter will by default select all the completed tests for printing a report from the session. You can set other default settings by clicking the drop-down menu. You can select the individual tests with the check boxes. Clicking the **Print Session** button (Figure 12. 1-2) will print the report with the selected tests and the clinical report (if you have written a report summary).

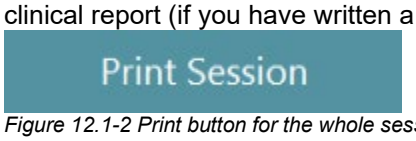


Figure 12.1-2 Print button for the whole session

Once printing commences, a status bar (Figure 12.1-3) will appear to show the progress.



Figure 12.1-3 Icon to show printing progress

12.2 Printing patient demographics or De-identify printout

When you print a report, the patient demographics in OtoAccess® Database will automatically be displayed as identifiers on each page of the printout. Activating the De-identify printout feature (Figure 12.2-1) will create the results without displaying vital information about the patient (Figure 12.2-2). This allows for patient data to be printed without disclosing any patient health information (PHI) but information useful for patient research studies will be available.



Figure 12.2-1 De-identify printout option

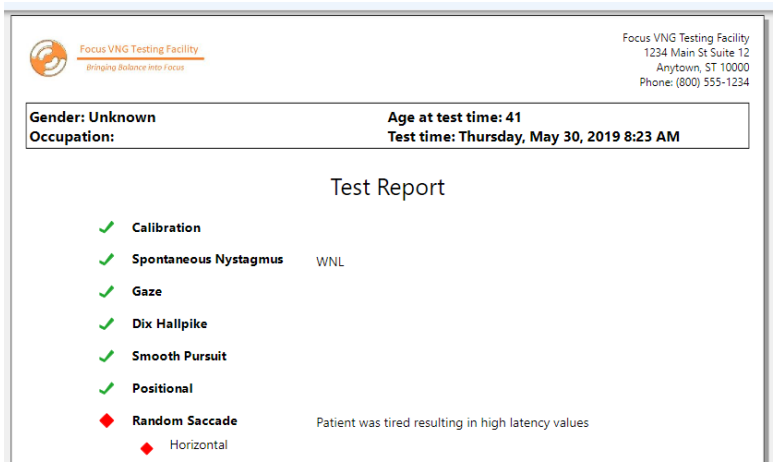


Figure 12.2-2 De-identified Patient Report

The examiner who administered the tests in OtoAccess® Database will be listed in the footer of the report pages (Figure 12.2-3).



Figure 12.2-3 Examiner in Report Footer

12.3 Printing calibration

Calibration waveforms can be printed for monocular and/or binocular recordings and for both horizontal and vertical eye movement calibrations. These waveforms can provide proof of acceptable calibrations vs technical errors.

12.4 Printing a single item

You can print the clinical report individually using the Print button next to the Clinical Report. Similarly, you can print the test report summary using the Print button next to the Test Report Summary.

You can print a single test report by clicking or touching the Print button beside the test name in the Session Review screen (Figure 12.4-1). The printed report will contain the notes for the test only.



Figure 12.4-1 Example of test printed from Session Review screen

12.5 Preview / Printing a session

Click on the Print Session button to print the report directly to the selected printer. Click on the Preview button to review the report first. The report can be sent to the printer from the preview screen.

12.6 Printing traces (Print screen)

To print the entire trace for an individual test, open the desired test or subtest from the Session Review screen. A Print Screen button (Figure 12.6-1) will show up in the left menu panel. Click or touch this button to print the entire trace and graphs for the specific test or subtest.

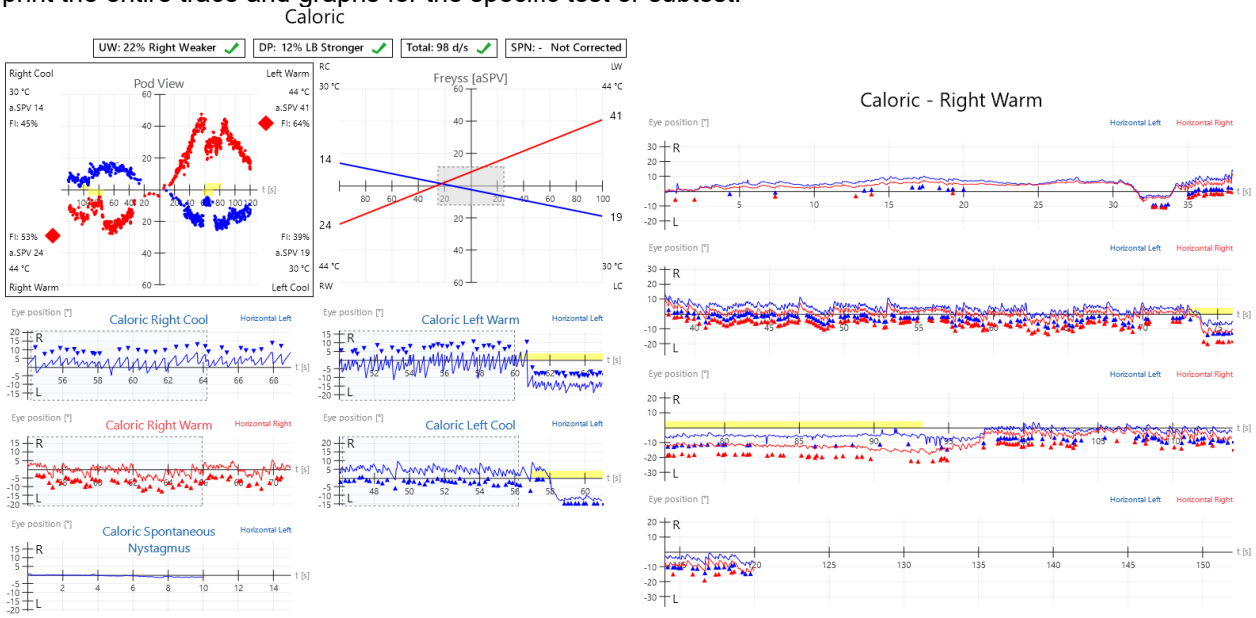


Figure 12.6-1 Printing Test (left) versus Printing Traces (right)

12.7 Create PDF

By selecting Create PDF the file is saved in the defined data location. For further information see Section 13.7 Print.

12.8 Print to database

By selecting Print to Database, the report is saved in the open XML paper specification (XPS) format into OtoAccess® Database. You can then review the report from OtoAccess® Database without having to access the VisualEyes™ software. For more information on how to view the XPS file in OtoAccess® Database, please consult the OtoAccess® Database documentation.

The user can trigger automatic print to the database when finishing the test by turning on the appropriate option in system default settings (refer to 13.7).

13 System default settings

By selecting the Configuration button and choosing System Default Settings (Figure 12.8-1), you can access the various hardware and software settings.

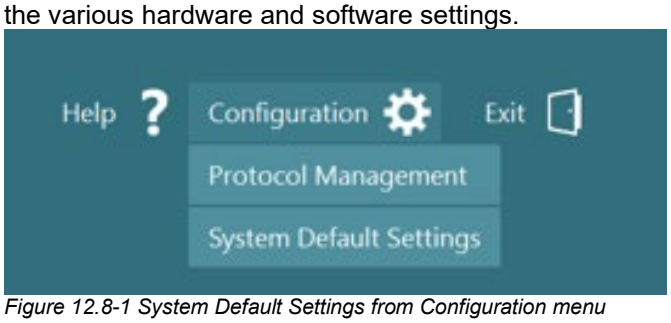


Figure 12.8-1 System Default Settings from Configuration menu

13.1 Input

The Input settings screen provides access to the recording hardware (Figure 13.1-1).

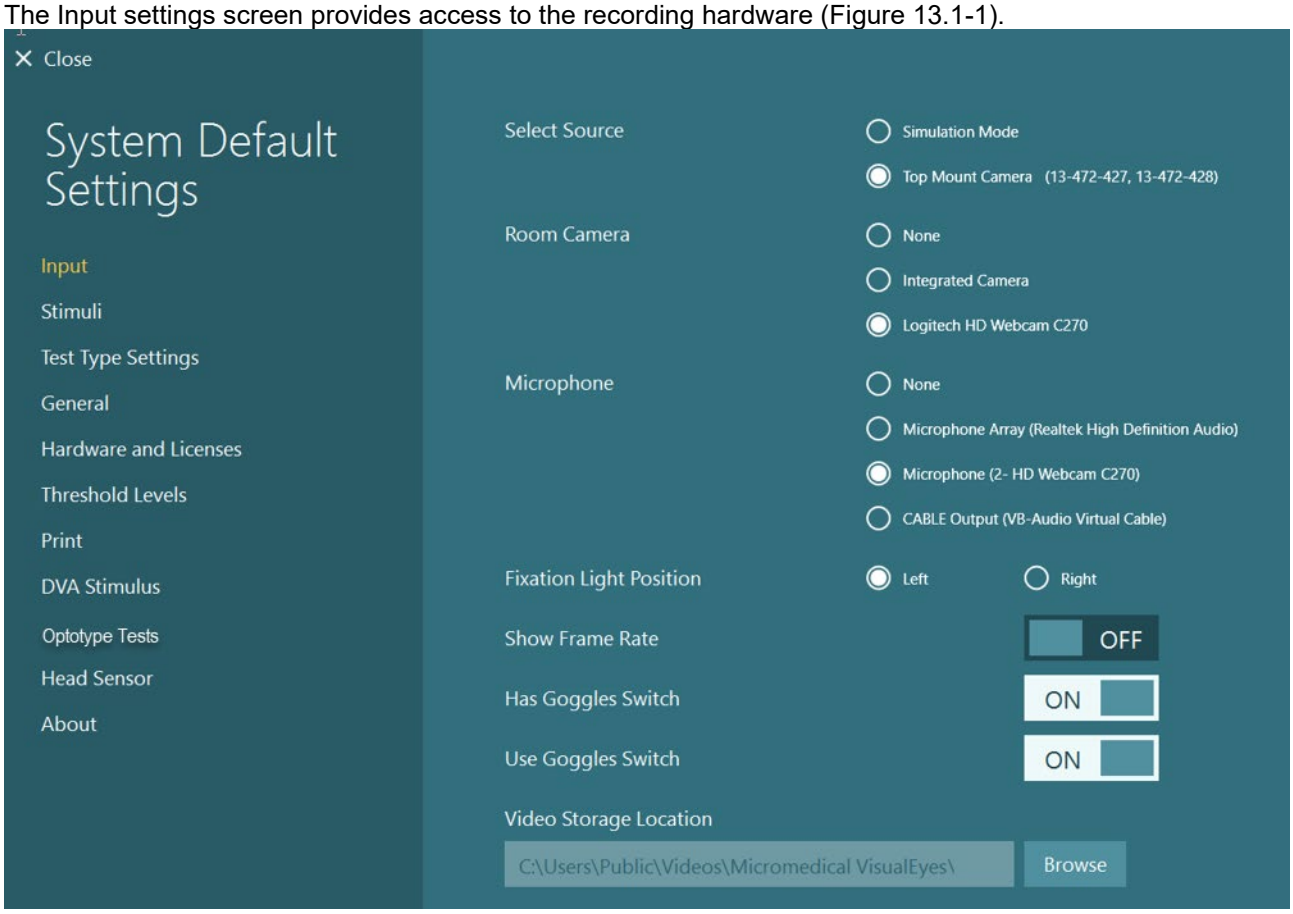


Figure 13.1-1 Input settings

Select Source determines which hardware will be used for data acquisition.

- Simulation Mode – demonstration option showing only an image of the eyes
- Top Mount Camera – binocular goggle mask with two cameras above the eyes
- Front Mount Camera – monocular camera pressed into the viewport in front of the eye
- Side Mount Camera – monocular or binocular camera configuration with cameras on the outside of the eyes
- Data-Link – Electrode recording option using the Data-Link box
- VLink – VORTEQ™ head sensor selected in DVA standalone systems
- ENG in Chair – Electrode recording option using the amplifier in the back of the Orion Comprehensive / Auto Traverse chair
- Pediatric Observation Camera – Single camera pointed at the pediatric patient from the front of the Orion Comprehensive / Auto Traverse chair

The Room Camera selection will choose the camera for room recording. Choosing None will not initialize any room camera and will prevent the recording of the patient interview.

The Microphone selection will choose the audio recording source combined with the room recording and patient interview. If the Room Camera selection is set to None, the Microphone selection is not used.

The Fixation Light Position selects which fixation light to use in the top mount camera goggles and the side mount camera goggles.

The Show Frame Rate option displays the frame rate of the cameras as they are capturing video. This is a diagnostic tool used to check if the cameras are working correctly with the computer. It is normally off.

The Has Goggles Switch option is available only with the top mount camera goggles and defines the goggle type as having the side switch. If the camera model does not have a side switch, you should turn this option off. The default setting is on.

The Use Goggles Switch option is a user preference option available only with the top mount camera goggles. If the camera model has a side switch, but you do not wish to use it, then you should turn this option off. The default setting is on.

The Video Storage Location is by default the Micromedical VisualEyes™ subfolder under the public videos folder. You can change this to use a network location instead if you wish.

13.2 Stimuli

VisualEyes™ 525 systems utilize an external display for the stimulus or target pattern required for the test. This can be a TV or second computer monitor, digital light bar, video projector, or the laser and drum combination for the Comprehensive and Auto Traverse rotational chairs. The active stimulus is automatically selected depending on what is connected to the PC.

You can change active stimuli from the Calibration screen. The option for laser and drum will not be available unless the rotational chair is configured for an Orion or System 2000 Comprehensive or Auto Traverse chair.

13.2.1 TV stimulus

TV stimulus allows you to configure the software to use a TV or second computer monitor as the target stimulus. Setting the Secondary Monitor to ON will indicate that you want to use the TV for stimuli. Setting the Secondary Monitor to OFF will disable TV for stimuli (Figure 13.2-1).

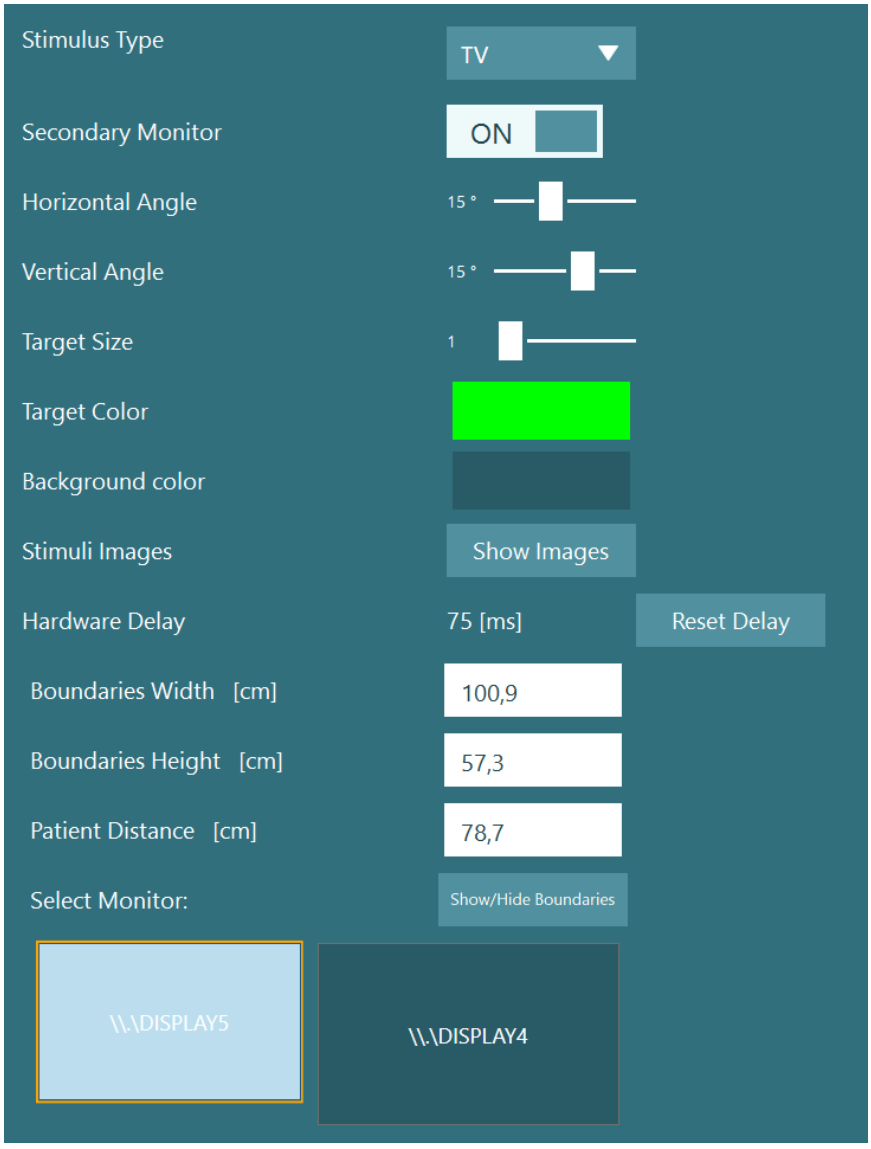


Figure 13.2-1 TV Stimulus Settings

The calibration angles are set by the Horizontal Angle and Vertical Angle sliders. The Target Size slider will adjust the maximum Horizontal Angle and Vertical Angle values and will be used by the software as the target size for tests that display the target (e. g. gaze, saccade, pursuit). The Target Color and Background color choices will apply to the calibration target and will be the default color choices for tests that display the target unless specified otherwise in the test properties.

Stimuli Images (Figure 13.2-2) allows the user to add or remove target and background images for use during testing. Background Images can be tiled if needed. To remove an image, click on the x button to the left of the image name.

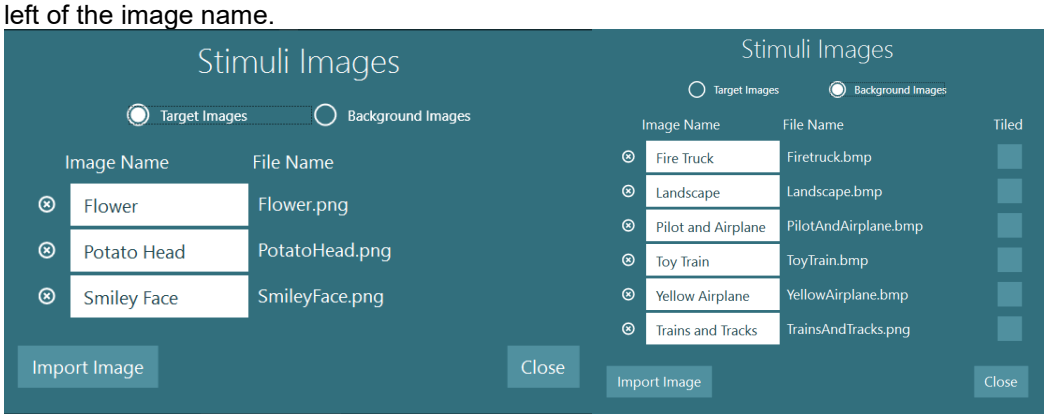


Figure 13.2-2 Stimuli Images

Hardware Delay is the amount of time to factor into the calculations for the TV or monitor to render the stimulus. By default, this value is set to 75 ms, but you can adjust this value when performing the smooth pursuit test. For more information, see the section on configuring the smooth pursuit tests. You can reset the value by using the Reset Delay button.

Select which Monitor will show the TV stimulus. The monitors will be sized graphically by resolution. Click on the Show/Hide Boundaries button to display the grid boundaries where the target can be placed on the screen. Measure the width and height of the TV's screen boundaries and enter them into the Boundaries Width and Boundaries Height fields (measurements are defined by the computer's region settings). Enter the Patient Distance the patient will be seated from the TV screen during testing other than DVA testing.

13.2313.23

13.2.2 Laser and drum stimulus

Selecting the Laser and Drum stimulus (Figure 13.2-4) allows you to configure the laser and drum stimulus inside the booth enclosure. Select the desired peripheral under the Settings and Calibration selector. Laser and drum will automatically be used for stimuli if the correct chair is connected to the PC.

The laser and drum will not be disabled while the booth door is open to enable the operator to adjust the settings. Make sure the laser beam is turned away from the door to prevent direct exposure to the eyes.



Figure 13.2-4 Laser and Drum Settings with Laser selected

The patient distance is the default patient distance between the patient's eyes and the booth wall. This value is set to 36 inches (91. 4 cm) by default. The Horizontal Angle and Vertical Angle are used in calibration. The Vertical Offset value provides a numerical offset to adjust the initial rotation value of the SVV line. If a plumb line shows that the laser at 0.0 degrees is not true vertical, then the offset can be set to compensate.

The Laser Angle test will display the laser dot in the center or each of the directions at the 15- and 25-degree positions based on the selection. Click on the Go button to display the laser position in the desired location. Click on the Stop button to turn off the laser.

The Sine Wave Test will run the laser in a sinusoidal pattern starting at the center at the Frequency value and Amplitude value specified. Click on the Run Sine X Axis or Run Sine Y Axis to run the sine wave test and click on Stop when finished.

The SVV Angle test will display the SVV line as defined on the booth wall enclosure. Select the angle to display and the length of the SVV line (default is 9 degrees or 4.5 degrees on either side of center), then click on the Go button beside the Angle value. Negative values will be rotated counter-clockwise from vertical.

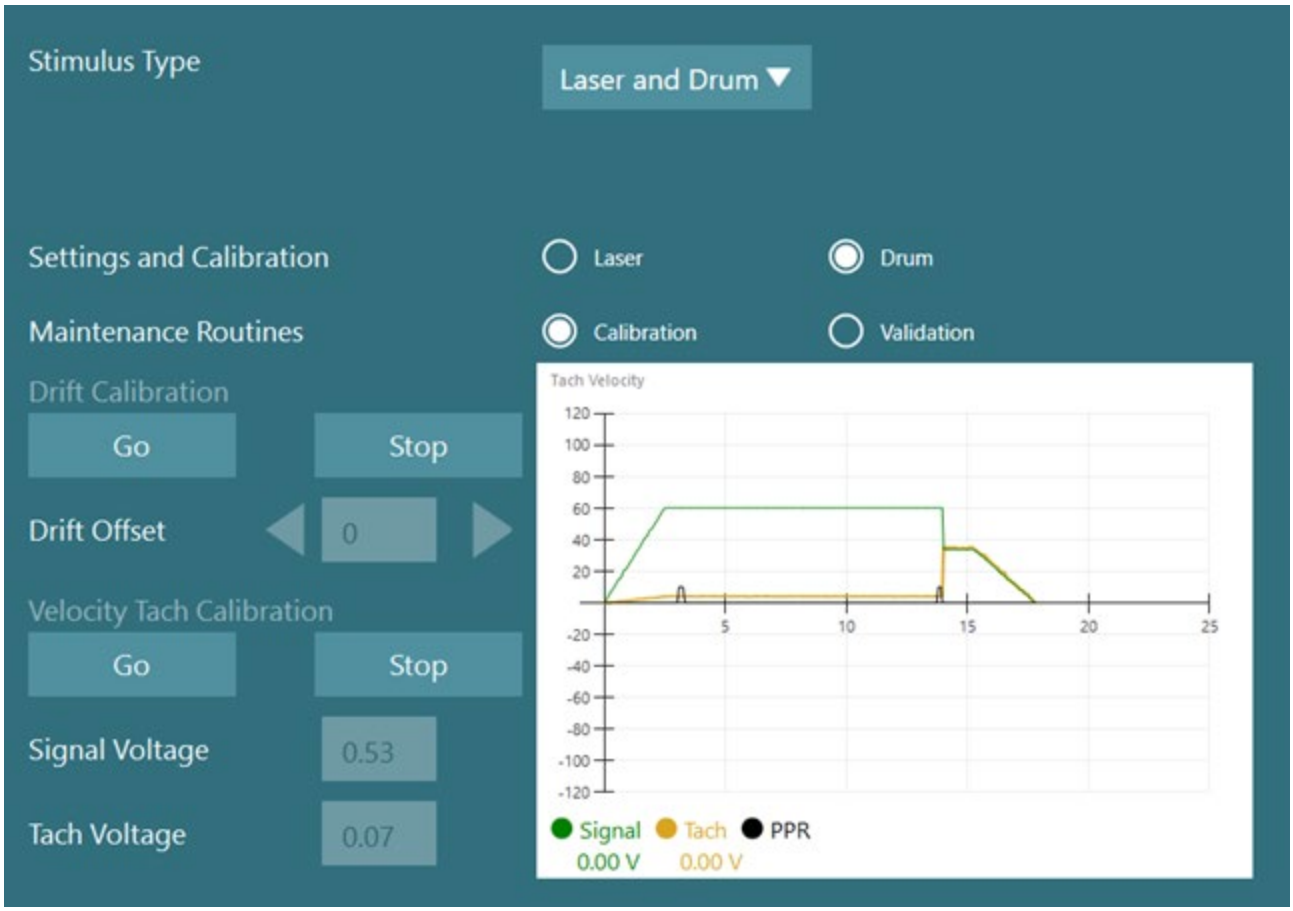


Figure 13.2-5 Laser and Drum settings with the Drum Calibration settings selected

Setting the Drum as the hardware to view will display the Maintenance Routines for Calibration and Validation of the drum stimulus. A graph to the right displays the voltage signal, tachometer voltage, and the pulse per revolution (PPR) trace which shows when the drum passes over the default Home position of the drum.

The Drift Calibration test will calibrate the drum to determine the voltage needed to hold the drum still. If the drum rotates, click on the Go button, then use the left and right arrows to adjust the Drift Offset value. Click on Stop when the drum no longer drifts.

The Velocity Tach Calibration test will adjust the signal and tach voltage values to spin the drum correctly. Click on the Go button to run the calibration routine. The software will spin the drum and will calculate the signal and tach voltages needed (Figure 13.2-5).



Figure 13.2-6 Laser and Drum Settings with Drum Validation Selected

After the drum has been calibrated, set the maintenance routine to Validation (Figure 13.2-6). Clicking on the Go button will run the Sine Wave Validation test using the specified frequency, velocity, and cycle count values. The drum will be run according to the parameters and the results will be displayed in the graph. The signal and tach lines should coincide. If the waveform is shifted up and down, then the drift offset should be reset; if the tach magnitude differs from the signal trace, then the velocity tach calibration should be performed again.

13.3 Test type settings

The Test Type Settings menu (Figure 13.3-1) presents options to customize the numerical values for graphs, timer function, and intervals between irrigations depending on the selected test.

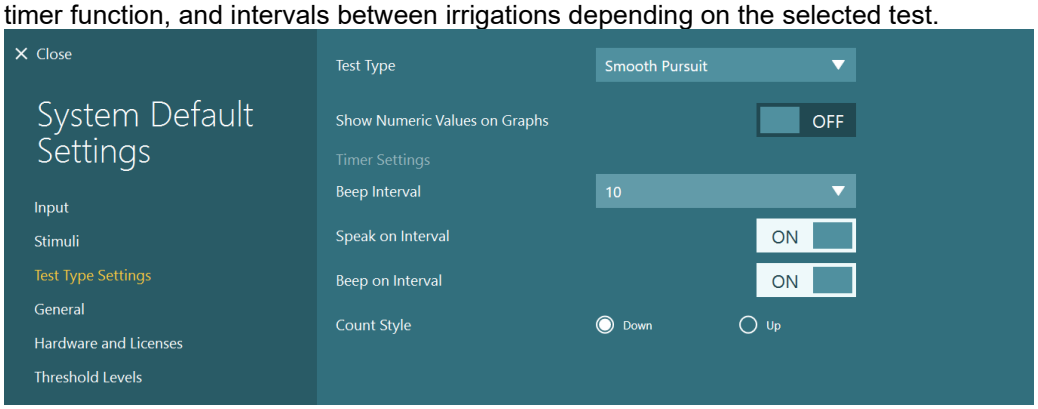
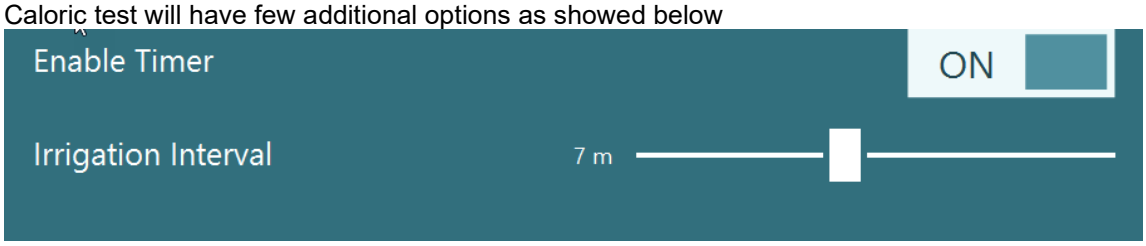


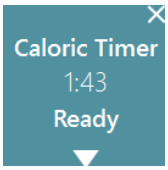
Figure 13.3-1 Test type settings

Beep Interval: Assigns the length of time between presentations of the beep and/or speaker. Selecting the numerical field will provide a drop-down menu with interval options of 5, 10, 20, and 30 seconds.
Speak on Interval: Activating this feature will enable a vocal alert in English for each interval. The voice pronounces the time at the interval.
Beep on Interval: Activating this feature will enable a tonal alert to be presented at each specified interval.
Show Numeric Values on Graphs: Activating this feature will enable the option to view the numerical values in the graphical display.
Count Style: Choice to choose the ascending or descending order of counting style dependent on the choice of the test.

Caloric test will have few additional options as showed below



Enable Timer: If enabled, this presents the caloric timer as pop-up between the subtests. The caloric timer will say ready with the sound notification when the set interval time is reached.



Irrigation Interval: the clinician can set the time between the subtests.

13.4 General

The General Settings (Figure 13.4-1) page contains additional program settings.

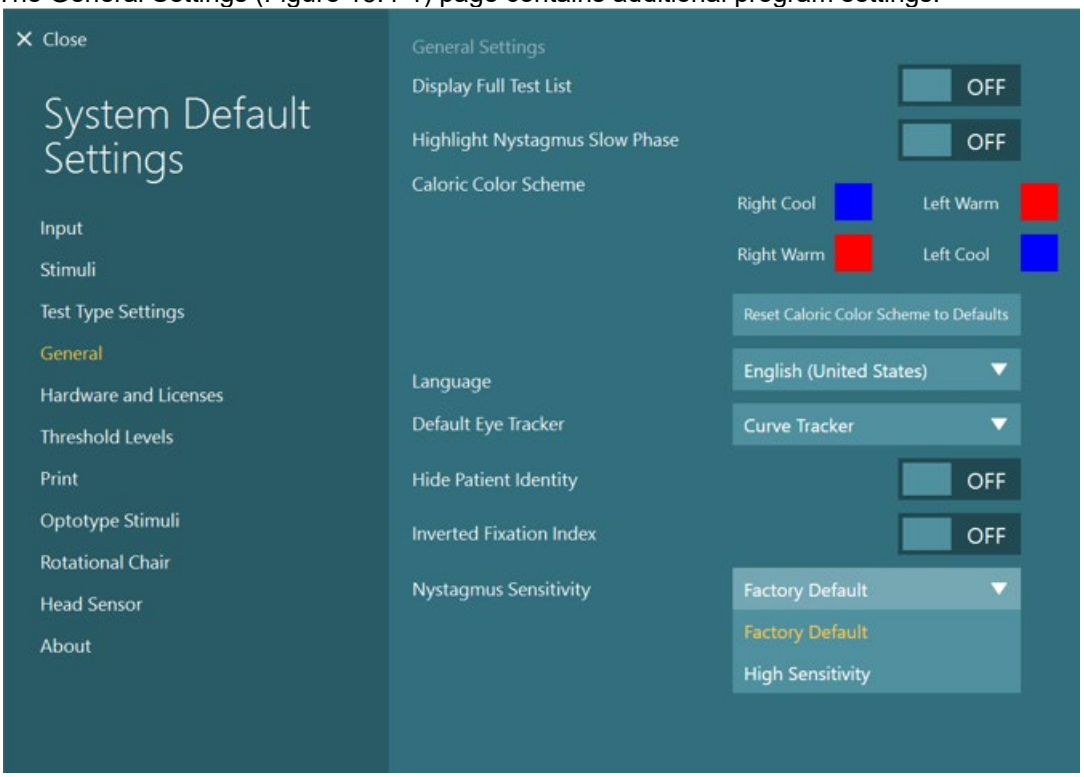
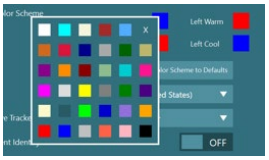


Figure 13.4-1 General settings

Display Full Test List: This allows the entire session tree with all tests and subtests to be displayed in expanded view. By default, the test list is condensed to only show test headings. Clicking or touching the plus sign next to the test expands the heading to show subtests. Enable the Display Full Test List option to display heading expanded always (Figure 13.4-2).

Highlight nystagmus slow phase option: If this option is enabled, then nystagmus-based tests will display the slow phase of the nystagmus beat with a green highlight after the test is completed (Figure 13.4-3). When the test is reviewed, you can toggle the appearance of the highlight from the test's temporary settings.

Caloric Color Scheme: By default the tests with cool temperature are coded by Blue color and the tests with warm temperature are coded by Red color. The user can (Figure 13.4-4) set different color to differentiate the test temperature and the test side. The user can come back to the default color codes by using option 'Reset Caloric Color Scheme to Defaults'.



Language: The user can select the language from the drop down list that are supported by the software. Changing the program language will display the text in the selected language. The software will ask if you want to change the names of the tests in all of the protocols to the new language. You will have to restart the software after changing the program language.

The Default Eye Tracker: is used as the eye tracking algorithm unless otherwise specified for a specific test.

- Curve Tracker – **Default, effective for majority of patients**
  - Standard eye tracker using a curve recognition algorithm for isolating the pupil outline
  - Recommended for standard eye movement tests and beneficial towards patients wearing mascara
  - Not recommended for high speed vHIT, large pupils or very low-contrast images
- IPM Tracker
  - Blob analysis eye tracker for locating the pupil center for high speed vHIT tracking
  - Recommended for high-speed vHIT testing, VORTEQ vHIT
  - Not recommended for torsional tracking
- Convex Hull Tracker
  - Eye tracker with geometric compensation for torsion tracking
  - Recommended for patients with long eyelashes and large pupils
  - Not recommended for patients wearing mascara
- Eyeseecam Tracker
  - Eye tracker used with EyeSeeCam camera for high speed vHIT tracking
  - Recommended for ESC vHIT
  - Not recommended for non-ESC vHIT tests

Hide Patient Identity: will hide the patient name and ID from the software screens and report. The report will print blank values in the header and the clinical report. The patient name and ID will still be available in OtoAccess® Database.

Inverted Fixation Index:
If enabled, Inverted Fixation Index calculation shows the percentage of suppressed nystagmus whereas the standard Fixation Index (Fixation Index) shows the percentage of nystagmus that could not be suppressed. (This option is caloric, Dix-Hallpike, spontaneous nystagmus, gaze). In the graphical display you will be able to identify the inverted fixation index by the "I" before FI (Figure 13.4-5).

Nystagmus Sensitivity: This option is available only with the research module where the user can select 'high sensitivity option' and enable the system to edit the nystagmus parameters. The nystagmus parameters are discussed under research module (section 4.3). **Note:** When the 'high sensitivity' option is selected, the system displays a disclaimer to remind how these changes will affect the data interpretations and their responsibility. Please refer to section 4.3 for detailed explanation.



Figure 13.4-2 Display Condensed Test List (left) vs. Display Full Test List (right)

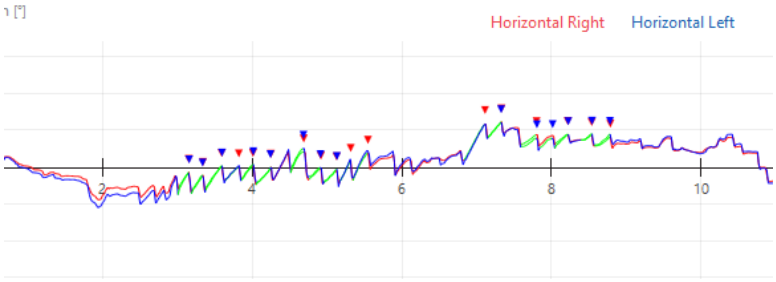


Figure 13.4-3 Highlight Nystagmus Slow Phase

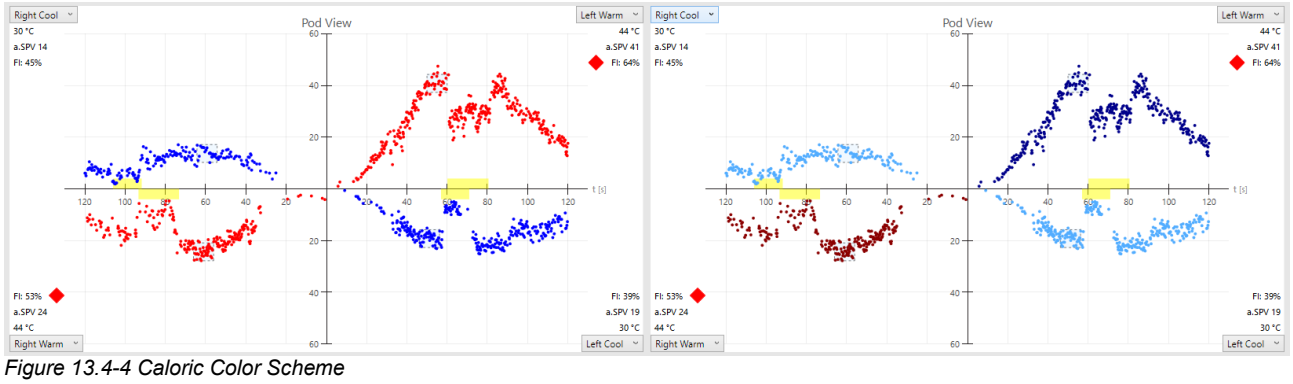


Figure 13.4-4 Caloric Color Scheme

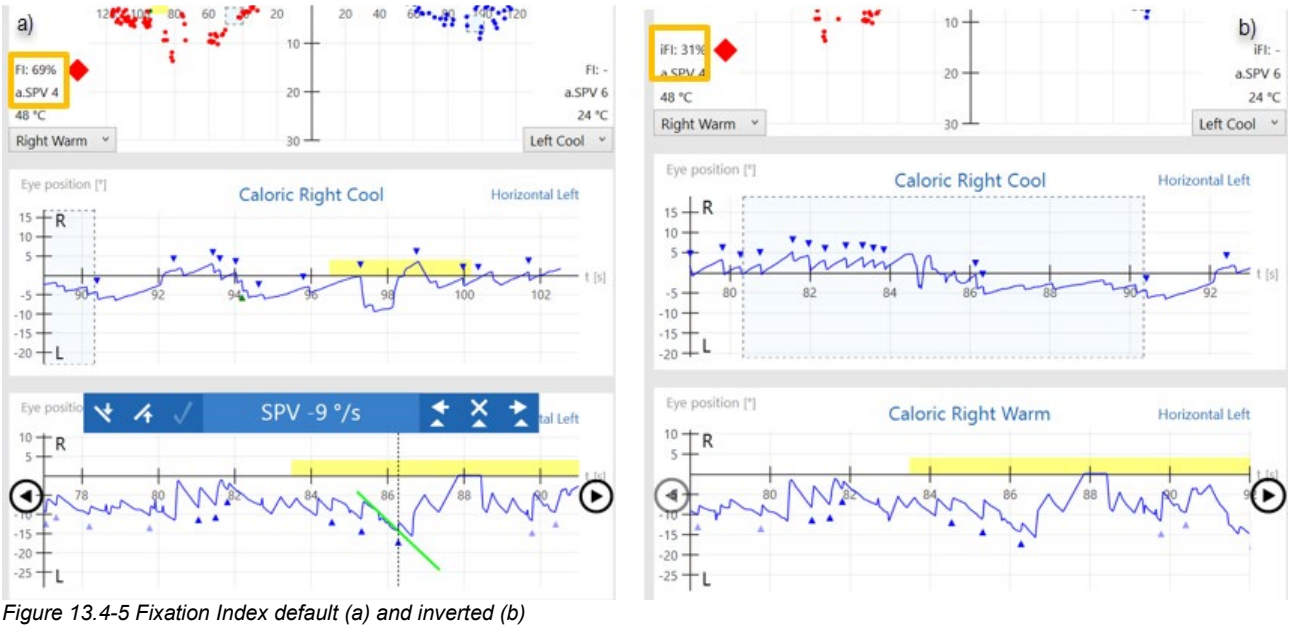
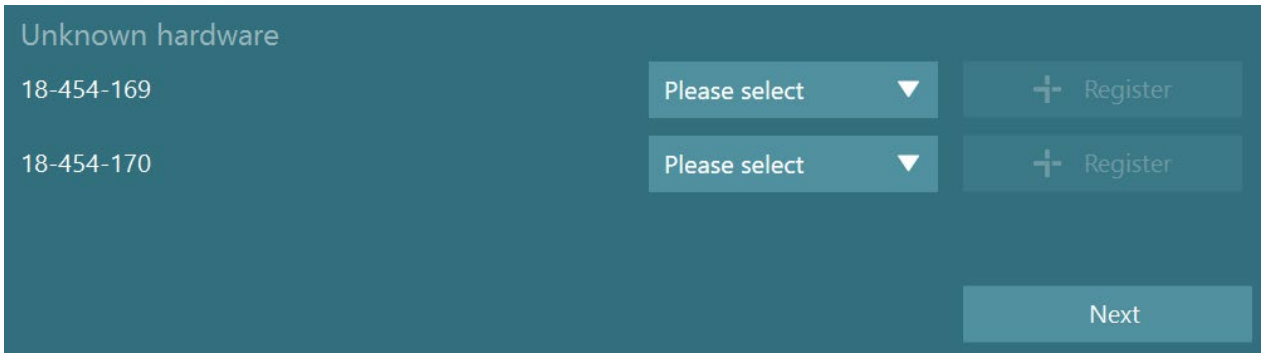


Figure 13.4-5 Fixation Index default (a) and inverted (b)

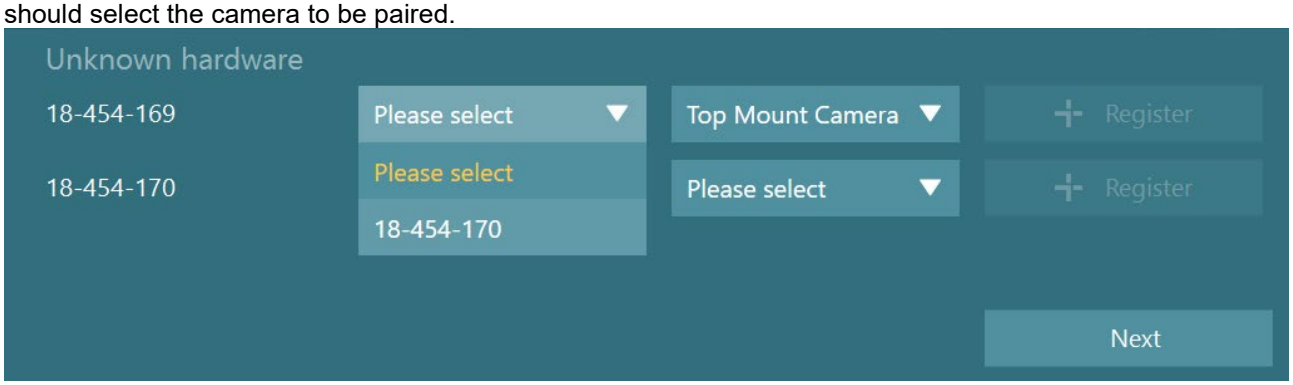
13.5 Hardware registration and licensing

When new hardware is connected to the VisualEyes™ system, this needs to be registered in the software to be recognized correctly. The VNG and vHIT goggles also need to be licensed in the system.

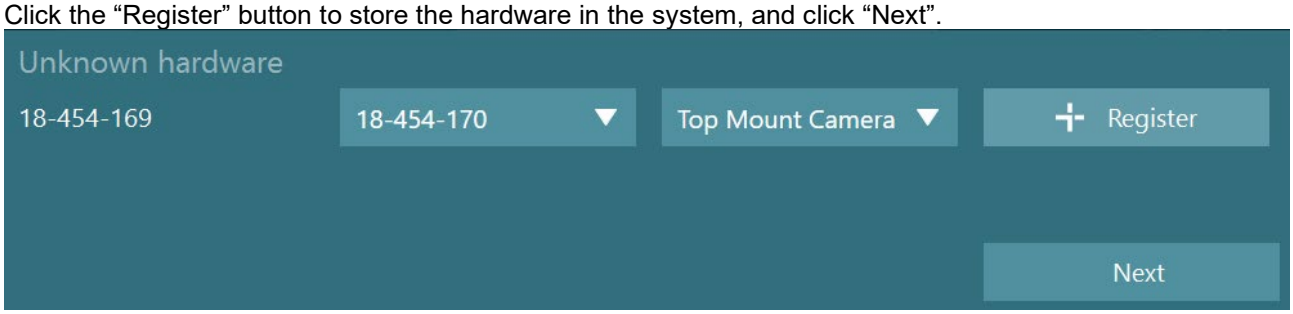
When launching the VisualEyes™ software with new hardware connected, the software automatically detects the new hardware, and the pop up below will appear in the software. This presents the unique hardware numbers for the specific hardware connected. You must specify the type of hardware connected in the drop-down selection menu. It is important that the VNG goggle is registered and licensed prior to the rest of the hardware.



If the selected hardware is a binocular goggle, another drop-down menu will appear to the left, where you should select the camera to be paired.

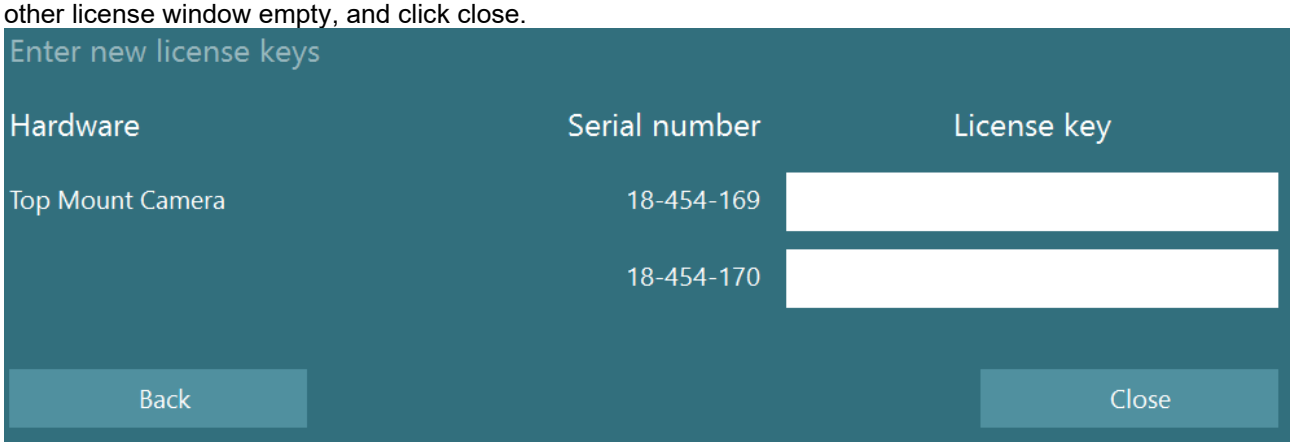


Click the “Register” button to store the hardware in the system, and click “Next”.

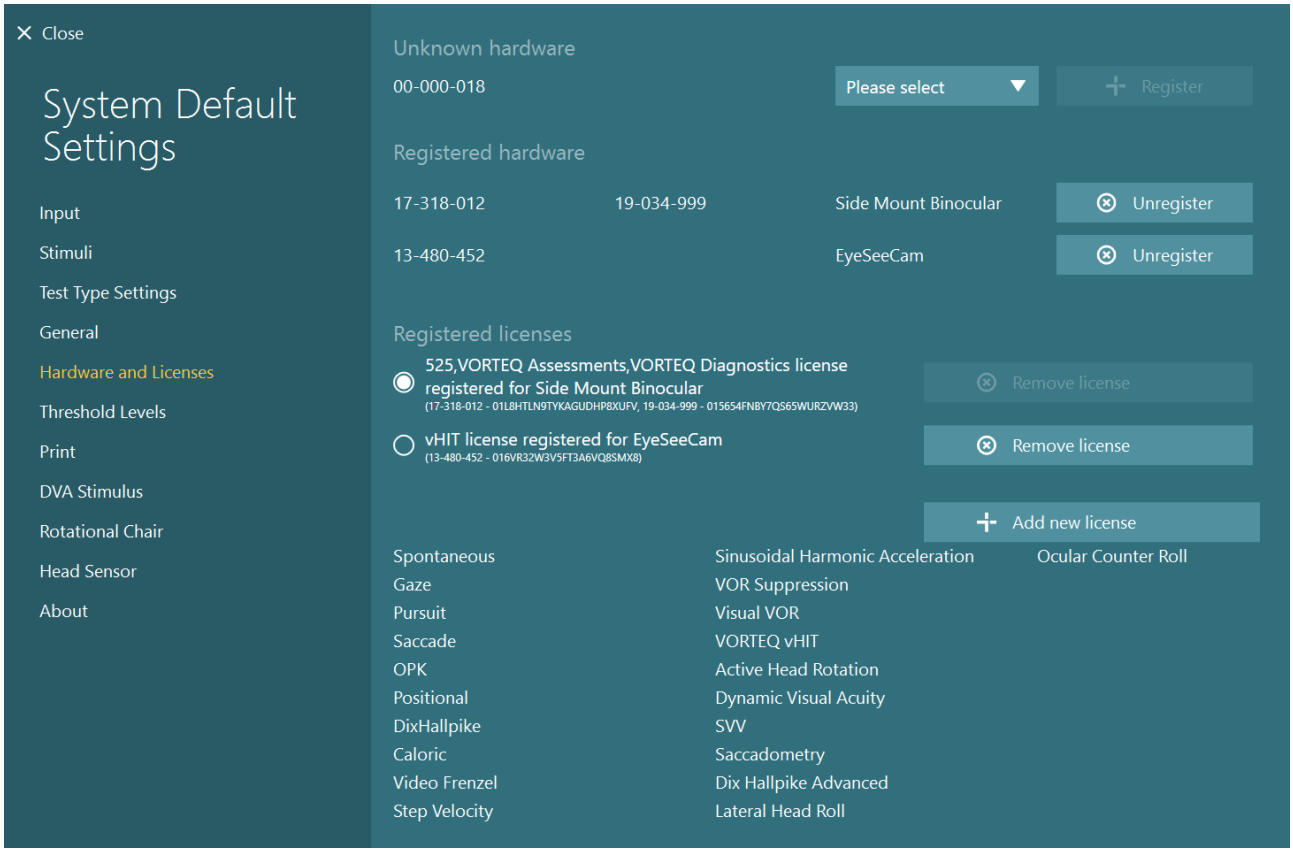


A new window for entering license keys will appear. Enter the license delivered with the system for the newly registered hardware.

NOTICE If the VisualEyes™ system combines more than one VNG goggle e.g. an adult and pediatric VNG goggle, only one license will be included with the system. Enter the license for this goggle, and leave the other license window empty, and click close.



After registering and licensing the VNG goggle, you can register any additional hardware.
To do this, restart the software with the new additional hardware connected, and follow the same steps as above.
Alternatively, you can connect the new hardware and navigate to *System Default Settings* > *Hardware and Licenses*. This presents an overview of all registered hardware along with the registered licenses. Any unknown hardware will be visible at the top of the screen as well. You can select the type of hardware from the drop-down selection menu and click “Register”.


Close
System Default Settings
Input
Stimuli
Test Type Settings
General
Hardware and Licenses
Threshold Levels
Print
DVA Stimulus
Rotational Chair
Head Sensor
About
Unknown hardware
00-000-018
Please select
Register
Registered hardware
17-318-012
19-034-999
Side Mount Binocular
Unregister
13-480-452
EyeSeeCam
Unregister
Registered licenses
525,VORTEQ Assessments,VORTEQ Diagnostics license registered for Side Mount Binocular
(17-318-012 - 01L8HTLN9TYKAGUDHP8XUFV, 19-034-999 - 015654FNBY7QS65WURZVW33)
Remove license
vHIT license registered for EyeSeeCam
(13-480-452 - 016VR32W3V5FT3A6VQ8SMX8)
Remove license
Add new license
Spontaneous
Gaze
Pursuit
Saccade
OPK
Positional
DixHallpike
Caloric
Video Frenzel
Step Velocity
Sinusoidal Harmonic Acceleration
VOR Suppression
Visual VOR
VORTEQ vHIT
Active Head Rotation
Dynamic Visual Acuity
SVV
Saccadometry
Dix Hallpike Advanced
Lateral Head Roll
Ocular Counter Roll

13.6 Threshold levels

The *Threshold Levels* menu presents the threshold tables for specific tests. The tables are used by the software during testing, presenting the grey shaded area in test graphs. If the test values fall outside the suggested thresholds, the measurement will be marked with an out-of-threshold symbol (red diamond).
The operator can customize the threshold levels by changing the values in the tables. The Threshold Levels settings screen contains age-matched thresholds for various VNGand Rotary Chair tests. The theshold levels are explained in detail in Chapter 10 Suggested threshold values.

13.7 Print

The Print settings (Figure 13.7-1) screen provides access to PDF document settings and report printing settings. From here it is also possible to enable PDF printing to a specified data location and configure the Clinic Header on the printed report with facility information from OtoAccess® Database.

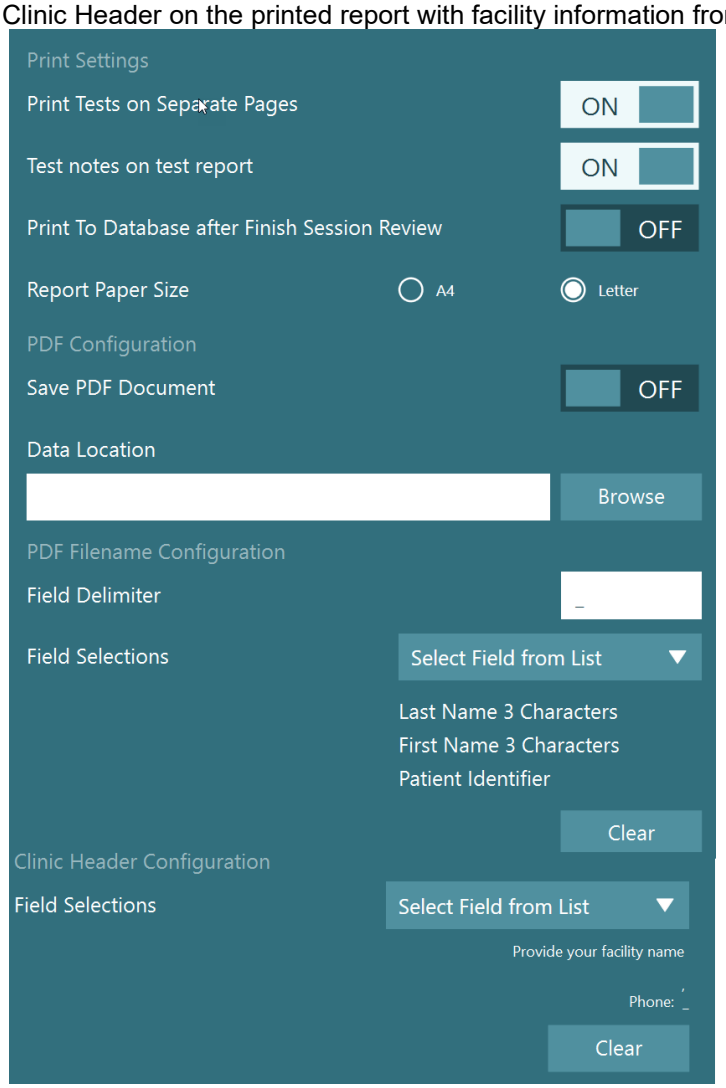


Figure 13.7-1 Print settings

Print Tests on Separate Pages: Selects whether page breaks should be added before each test is printed in the report. This option can be set to 'Off' in VisualEyes™ 505 systems to reduce the extra space printed between tests, as only the notes are printed for Video Frenzel tests.
Test notes on test report: This option will print the test notes (Figure 13.7-2) in a second column on the test list. If this option is set to 'Off', then the test list will list the names of the tests in the center of the page.

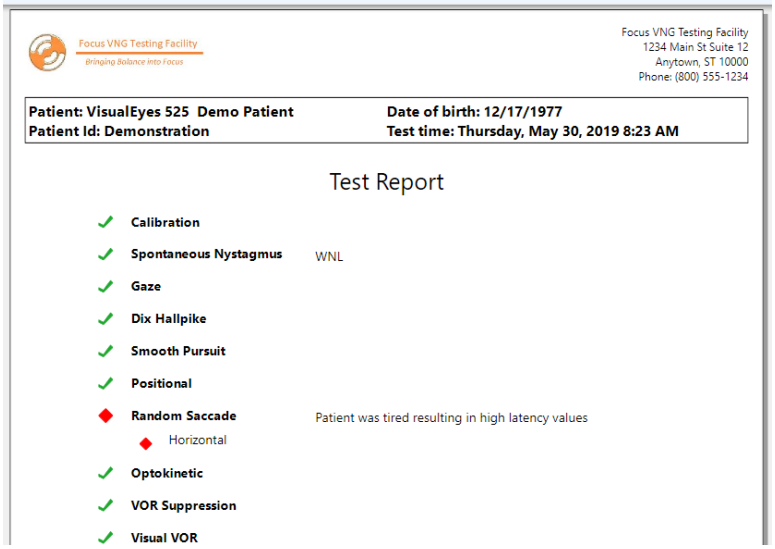
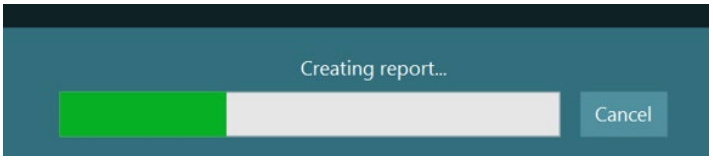


Figure 13.7-2 Test Report with Test Comments

Print To Database after Finish Session Review: If enabled, it automatically prints the test report to OtoAccess® Database whenever the test session is finished.



Report Paper Size: Selects the paper format to print and/or save the report to (choice of A4 or letter format)
Save PDF Document: If this option is selected, the Create PDF button is available from the Session Review screen to print the report to PDF to the specified location.
Data Location: This is the folder where the PDF report is created. Use the Browse button to select the folder.
PDF Filename Configuration: These fields define the naming structure of the PDF report.

- Field Delimiter: Select a character to function as a field delimiter, typically a period, hashtag, or hyphen
- Field Selections: Select what is to be displayed on the report from following list:
  - First Name 3 Characters
  - Last Name 3 Characters
  - Module (Micromedical VisualEyes™)
  - Patient Identifier
  - Report Date and Time Created
  - Session Date and Time Created
  - Session Identifier

Clinic header configuration:
These fields define the naming structure of the clinic information printed in the top-right corner of each page of the report. If the VisualEyes™ software is launched from OtoAccess® Database, then the company logo set in OtoAccess® Database will be displayed in the top-left corner of each page. Otherwise a default clinic icon will be displayed in the top-left corner. To create the clinic header, use the Field Selections combination box to insert the components of the clinic address, using the Line Break option to insert a line break in the address and the comma option to separate Clinic City and Clinic State. If a field is inserted after another field, the program will insert a space automatically to separate the fields (e.g. Clinic State and Clinic Zip code). Use the Clear button to clear the current address and restart if needed.

13.8 Optotype tests

The Optotype Tests settings screen (Figure 13.8-1) provides the measurements for the stimulus used for the Optotype tests. If the TV screen is too large for Optotype testing, then you can select the computer monitor for the Optotype test stimulus. Select the monitor to be used for Optotype testing, then confirm the measurements for the display (as this can be the primary laptop / desktop screen, you must enter the boundaries for the display selected). If the Patient Distance value is not adequate for displaying on the display selected, the optotype will be drawn as much as possible, but may not be discernable at the lowest logMAR values.

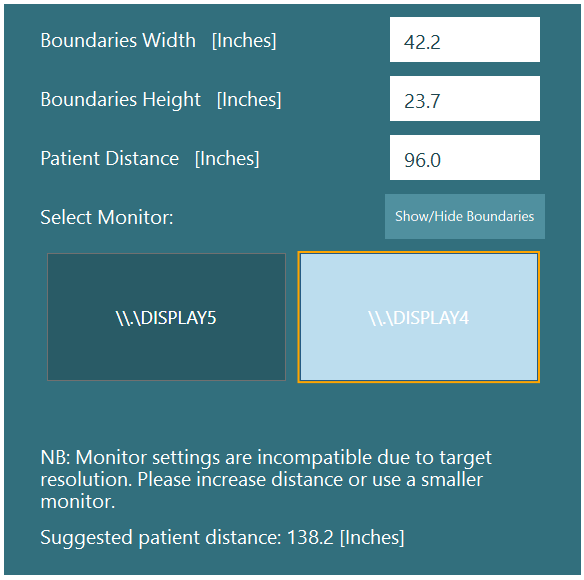


Figure 13.8-1 Optotype Test Settings with insufficient patient distance entered

13.9 ENG

The ENG settings screen (Figure 13.9-1) provides the default settings for recording electrode signals. You can change these values per patient from the Calibration screen.

Amplifier Gain: Magnification level of the patient's electrode signals. Default value is Medium.

Electrode Montage: Method of the electrode placement. Bi-temporal recording will average the left and right horizontal potentials, providing a cleaner signal but preventing the ability to record deconjugated eye movement. Binocular recording records each eye's horizontal movements separately by adding an electrode to the side of the inner canthi. The default setting is Bi-temporal Left Vertical (2-channel).

Test Impedance: By clicking on the Start Test button, the software will check the impedance values for each connected electrode lead as defined by the Electrode Montage. The impedance values will be displayed and color-coded – good (green) for an impedance level of 10 or less, medium (yellow) for an impedance level of 11 to 15, and poor (red) for an impedance level of 16 to 20.

Enable Auto-Centering: By default, the software will center the eye position traces if the traces drift during the test.

The software will record the electrode-based ENG test data at ideal frequency and filter settings. These options are designed based on the test that is performed. By default, tests are recorded using DC coupling and a filter frequency of 24 Hz. Saccade tests will be recorded using a filter frequency of 40 Hz and VORTEQ™ Active Head Rotation tests will use AC coupling.

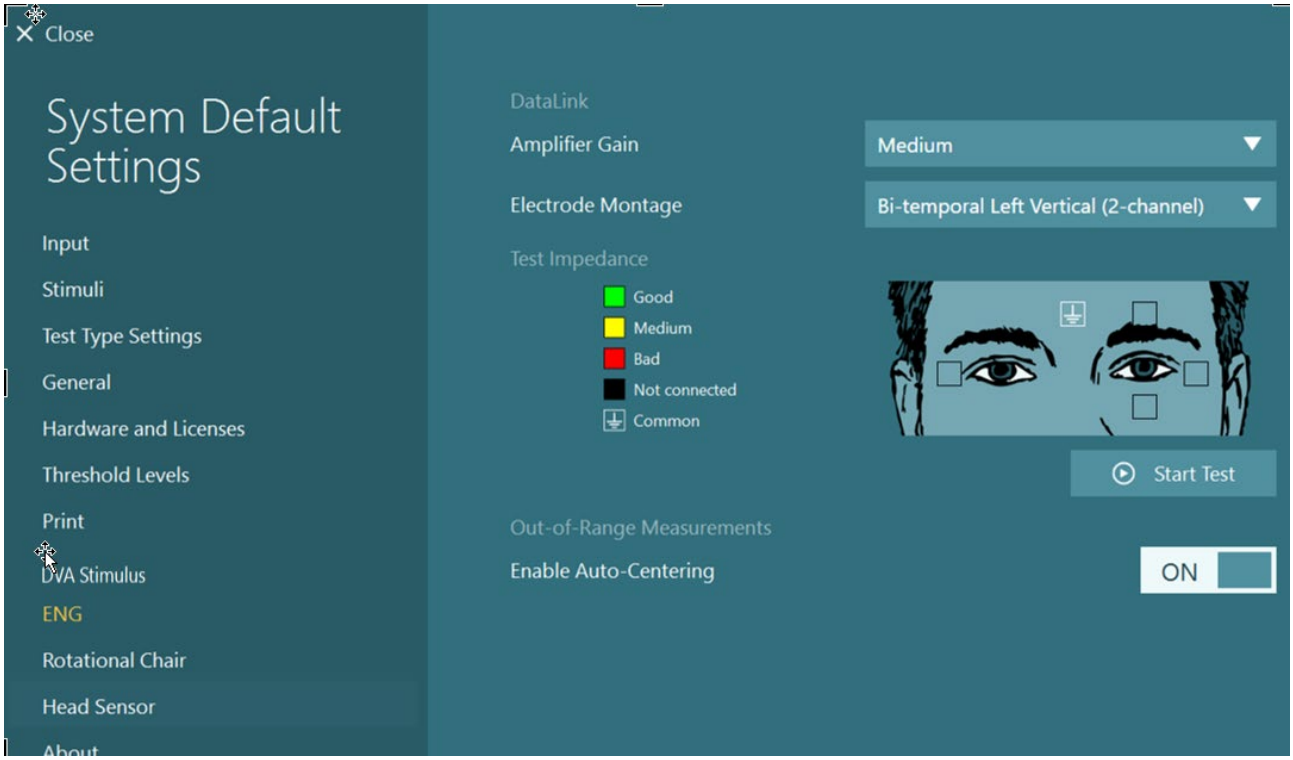


Figure 13.9-1 ENG System Settings

13.10 Rotational chair

13.10.1 Off-axis center settings

System 2000 Auto Traverse/Comprehensive and Orion Auto Traverse rotational chairs can be moved laterally off the central axis for subjective visual vertical testing (
Figure 13.10-1). If the chair is off center, enter the current position on the scale and specify which direction from center the chair is located, then click on the Center Laterally button to move the chair back to the center location.



Figure 13.10-1 Off-Axis Center Settings

13.10.2 Rotational safety settings

Young patients may be tested in the reclining rotational chair. For the patient's safety, the reclining rotational chair will not allow faster tests to be performed for young patients. The software is configured to prevent the test from running if the patient's age falls within the values (Figure 13.10-2). In step tests the Max frequency is set to 1 as the setting is not used in step tests.

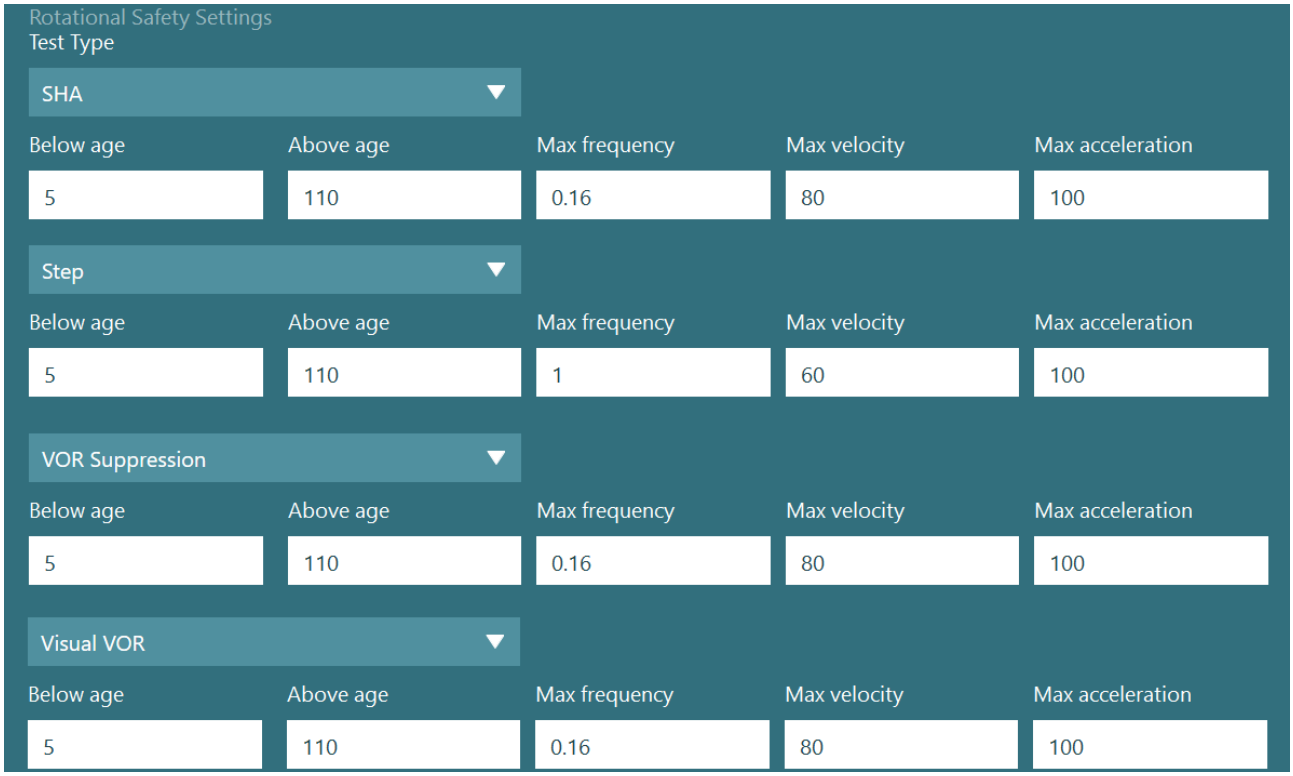


Figure 13.10-2 Rotational safety settings for each chair test

Using these default values, a patient below the age of 5 cannot be tested in Step tests with a max velocity greater than 60 degrees per second. If so, the software would produce an error message (Figure 13.10-3).

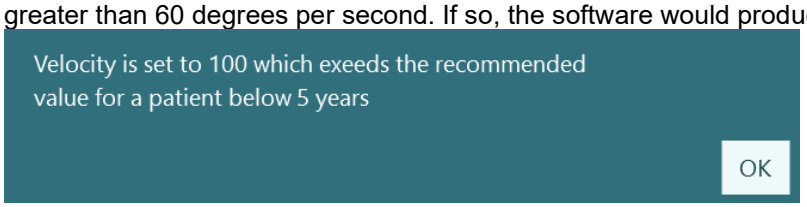


Figure 13.10-3 Warning message preventing the clinician from testing a young patient based on the test settings

13.11 Head sensor

You can select the head sensor type connected and calibrate it from the Head Sensor settings screen (Figure 13.11-1).

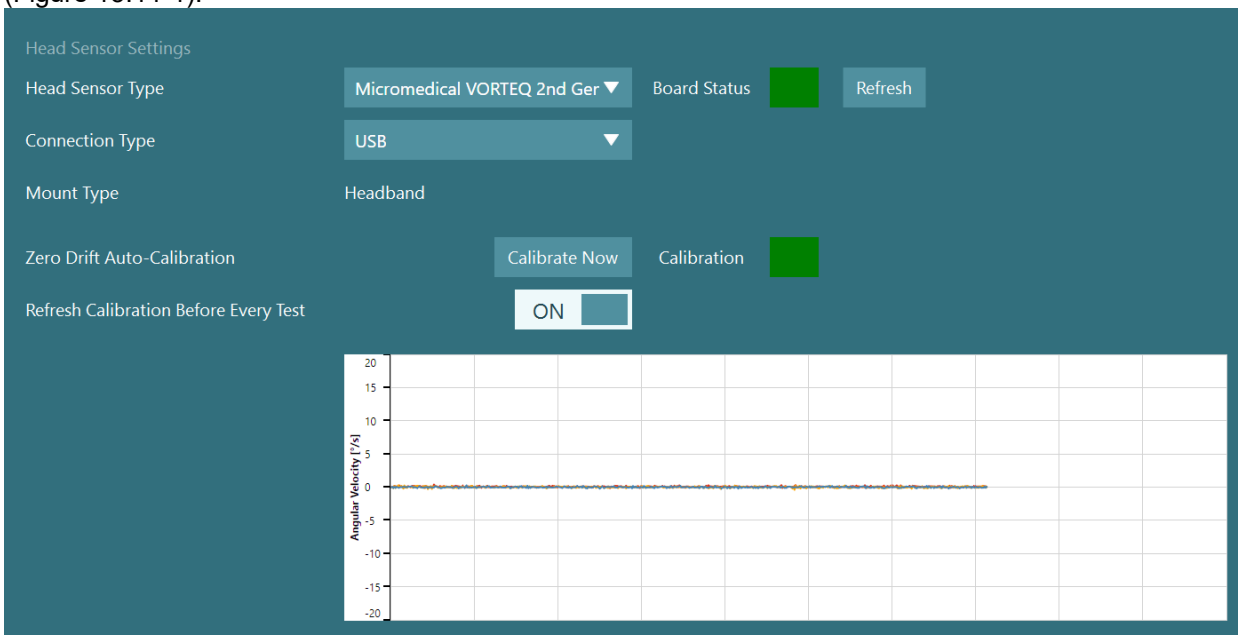


Figure 13.11-1 Head Sensor settings with VORTEQ™ IMU

Head Sensor Type	**Rotation Axis**	**Connection**	**Goggle**
EyeSeeCam IMU	Multiple	USB	EyeSeeCam
Micromedical VORTEQ™ IMU	Multiple	USB or Bluetooth	Side Mount, Top Mount, Headband

Select the goggle type in the input settings screen, labeled as ‘Mount Type’ in Figure 13. 12-1. Headband is also available if the camera configuration will not attach directly to the selected goggle type. The Micromedical VORTEQ™ IMU has the additional Connection Type selection, where you can choose between USB or Bluetooth. Calibrate the head sensor by placing it on a flat stable surface and clicking on the Calibrate Now button. The trace lines (EyeSeeCam IMU, Micromedical VORTEQ™ IMU) should be centered on the angular velocity graph with minimal noise.

13.12 About this software

The About screen (Figure 13.12-1) lists the software version number and licenses used by the software. The VisualEyes™ software will collect data about how the software is used to improve the software. This option will send back the system configuration information, test configuraton information for each test performed (no personal identifiable information is reported other than the patient’s age), and any unhandled exceptions in the software from testing anomalies. This will require data transmitted along ports 80 and 443 on the testing computer.

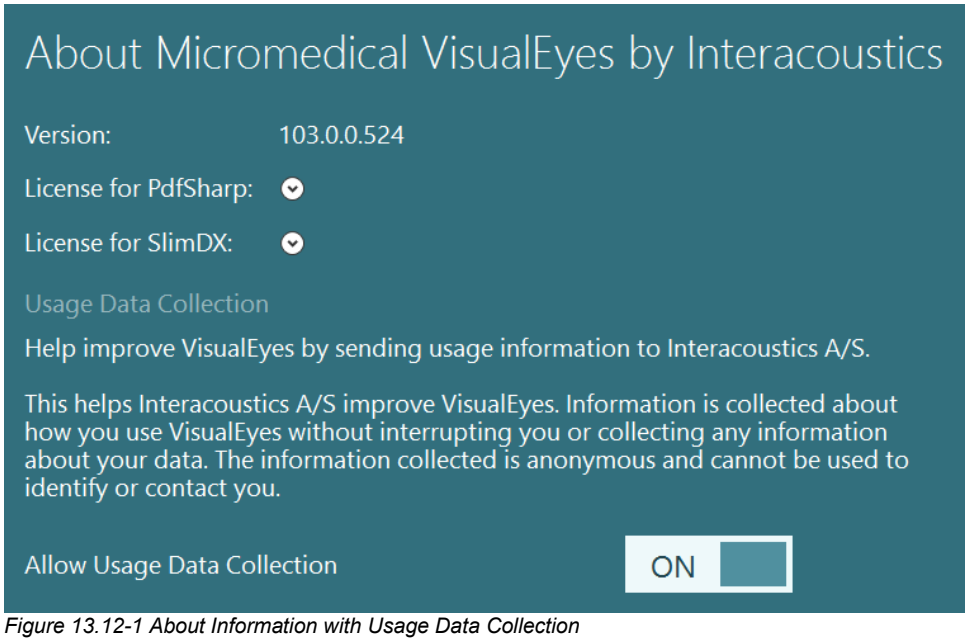


Figure 13.12-1 About Information with Usage Data Collection

14 Other functions

14.1 Help button

This manual and IFU for VisualEyes™ are accessible by clicking or touching the Help button on the main screen or by pressing the F1 key within the software.



14.2 Exit button

Press the ‘Exit’ button from the main screen to leave the VisualEyes™ suite and return to OtoAccess® Database.



14.3 Minimize button

Press the ‘Minimize’ button to minimize the main screen of the VisualEyes™ suite without exit the program.

