# Tobii Pro Lab
# User's Manual

User's manual Tobii Pro Lab

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# 1 Introduction

Tobii Pro Lab provides a comprehensive platform for the recording and analysis of eye gaze data, which helps in the interpretation of human behavior, consumer responses, and psychology. Combining simple preparation for testing procedures and advanced tools for Visualization and analysis, eye-tracking data is easily processed for useful comparison, interpretation, and presentation. A broad range of studies are supported, from usability testing and market research, to psychology and oculomotor physiological experiments. Pro Lab's intuitive workflow, along with its advanced analysis tools, enables large and small studies in a timely and cost-efficient way without the need for extensive training.

In addition to offering powerful analysis tools, Pro Lab is also designed to work with other software commonly used for recording and analyzing data. This is done by synchronizing with recording software using TTL, as well as by enabling data exports in standardized formats, for example for Microsoft Excel, Matlab, and SPSS.

## 1.1 How Pro Lab is structured

The software comprises three modules and a Project Overview: The Design module, the Record module, and the Analyze module. Depending on which edition of Pro Lab you use, your available modules and functions vary. Access to the modules also varies depending on what kind of project you are working on.

Data about study layout, stimuli, participants, and recordings is stored in the projects section of Pro Lab. There are currently five kinds of projects: *Screen projects*, for when stimuli presentation and data collection are done using a screen-based eye tracker; *Glasses projects*, for when data is collected by Tobii Pro Glasses 2; *Scene Camera* projects, when you use an external video camera to record events in the real world; *VR 360* projects, when you analyze 360 degree images and videos using either a HTC VIVE Pro Eye VR headset or the Tobii Pro VR Integration (an HTC Vive VR headset retrofitted with an integrated Tobii Pro eye tracker) and *External Presenter* projects, where you use third-party equipment, such as E-Prime, together with Tobii Pro Lab..

In Glasses projects, only the Project Overview and Analyzer module is available.

### 1.1.1 The Project Overview

Regardless of whether you use a screen-based or a wearable eye tracker, the Project Overview section provides information about the elements of your project, such as what recordings are in it and what Events are associated with the recordings. It also provides quick access to some analysis tools.

### 1.1.2 The Design module

In the Design module, you outline how stimuli are presented to your participants. This includes what the stimuli look like on the screen, in which order they get displayed, as well as how to proceed to the next stimuli. In this module, you also define whether TTL output signals are provided during the stimuli presentation. You can create several different outlines, called Timelines, in the same project.

This module is unavailable to projects that don't use Pro Lab for stimuli presentation, such as wearable eye-tracking projects.

### 1.1.3 The Record module

The Record module is where you make recordings in Pro Lab. It enables you to select which Timeline to use for which recording and lets you control the recording process.

This module is unavailable for wearable eye-tracking projects that don't use the Tobii Pro Glasses Controller for making recordings.

### 1.1.4 The Analyze module

Analysis is necessary when you want to draw conclusions from the collected data. The Analyze module provides analysis tools that enable you to visualize and export the data you have collected.

The Analyze module is available for all project types. However, the analysis tools might differ somewhat, depending on your use case.

### 1.1.5 Different editions of Pro Lab

Pro Lab is available in four editions: **Full Edition**, **Presenter Edition, Analyzer Edition**, and **VR 360 edition**. Full Edition contains all three modules; Presenter Edition contains Designer, Recorder, and a part of Analyzer's functionality; Analyzer Edition contains only the Analyzer module;, and VR 360 Edition with Designer, Recorder, and Analyzer for use with VR 360 projects.

## 1.2 How to read this manual

The manual assumes that you use a computer running Pro Lab. Elements in the interface are referred to by name and location, but not necessarily by a description of their exact appearance. The manual is structured around actions that you can do by using the application and it describes such actions step by step. When writing about actions that involve dialogue messages, we only include the texts on the buttons that you are supposed to click, and not the messages in full.

The actions are grouped by the software module in which they are performed. If you have questions about your use of the modules, check the appropriate manual sections for the answers, i.e. *Design an experiment* for the Design module, *Make recordings* for the Recording module, and *Analyze data* for the Analyze module.

## 1.3 Online-based help and support resources

You can access some online-based help and support resources in Tobii Pro Lab's main window. In the main menu, select "Help and Learn" for access to links to the Pro Lab User's Manual, FAQs and the web-based Learn section. The help and support resources are also available via the help icon (?) to the right on the menu bar.

## 1.4 Windows versions

Tobii Pro Lab has been designed to run on Windows 7, 8.1 and 10. However, the software will stop supporting Windows 7 on June 30, 2019, and Windows 8.1 at the end of 2019.

# 2 Installing or updating Pro Lab

This chapter describes how you install and update Pro Lab on your Windows computer. For optimal performance, Pro Lab should be installed on a computer that adheres to the Pro Lab system recommendations. This document is available at tobiipro.com or it can be obtained from your sales representative.

## 2.1 Obtaining the Pro Lab installer

You get license key(s) and a link to the latest version of Pro Lab by e-mail when you purchase the software from Tobii Pro.

You need the license key information during your first-time installation on any new computer, so do keep it in a convenient place for future reference.

## 2.2 Installing Pro Lab

Pro Lab uses several Windows programming components and drivers. If they are not already on your computer, the Pro Lab installer automatically installs them.

**Procedure for installing Pro Lab:**

1. Download the installation file for the latest version of Pro Lab from http://www.tobiipro.com/support.
2. Locate and run the installation file on your computer and follow the instructions on the screen.
3. When prompted to accept the license agreement, read the license agreement and click *Accept*
4. When the installation is finished, start the application.
5. Enter the license key, provided in the product purchase e-mail, in the license key input fields and click *Activate*.

You must have local admin rights when installing Tobii Pro Lab.

If more than one person uses Pro Lab on the same computer, you must enter the license key for each user.

One license can only be used on one computer at a time. However, you can deactivate the license on one computer and activate it on another. Read *2.5 Handling Pro Lab licenses, page 4*.

You cannot utilize roaming user profiles on the computer running Tobii Pro Lab.

## 2.3 Updating Tobii Pro Lab

Tobii Pro frequently releases Pro Lab updates that introduce new functionalities and improve performance. When a new software version is available, you are notified by an alert symbol at the top of the user interface, provided that the computer is online. You can also download the latest software version from the Tobii Pro Support website: http://www.tobiipro.com/support. Please check our webpage regularly for update news in order to keep your Pro Lab software up to date. You need an active upgrade contract to download software updates.

## 2.4 Upgrade Contracts

Tobii Pro Lab is license-based software.

When you purchase a software license key, your purchase includes a one-year upgrade contract. The upgrade contract gives you access to updates for your software without additional charges in this one year period.

When your upgrade contract expires, your software keeps working as usual, but you will not be able to access any updates.

You can purchase upgrade contracts for additional years. The Tobii Pro Sales Team can help you find a plan that works for you. If you are using a subscription-based or temporary license, the upgrade contract is included in your purchase. When your subscription or temporary license expires, the upgrade contract expires as well, and your license will not be usable anymore.

If you would like to renew your subscription or purchase a temporary license, our Tobii Pro Sales Team can help you find a plan that works for you.

## 2.5 Handling Pro Lab licenses

In order to use Pro Lab, you need to have a license for it. The license is associated with a specific edition of the software, i. e. **Full Edition**, **Presenter Edition, Analyzer Edition** or **VR 360 Edition.** The different editions provide access to different modules and features in the software. Read more about the different editions in*Appendix D Software features and editions, page 97* in this manual.

A license can only be active on one computer at a time. If you attempt to use a license that is already active on another computer, you will see asking you to first deactivate the license on the other computer.

### 2.5.1 License models

Pro Lab has two different license models; a *perpetual* –based license model and a *subscription*–based license model. A subscription license provides you with access to the latest software versions as soon as they become available. A perpetual license grants you one year of free upgrades. One– to four–year upgrade contracts are available for perpetual licenses.

If you use the subscription–based model, your Pro Lab must connect to the internet at least once every 14 days to validate the license. If you fail to to do this, your software will cease to function.

### 2.5.2 Activating a Pro Lab license

Procedure for activating a license:

1. Ensure your computer is connected to the internet.
2. Start Tobii Pro Lab.
3. Enter the license into the license key input field.
4. Click *Activate*.

### 2.5.3 Deactivating a Pro Lab license

Before deactivating the license, check that you have saved the license key in a safe place. When the deactivation is completed, the software has no record of the license key. This means that, if you want to use the key again on this computer, you must enter it manually.

Procedure for deactivating a license:

1. Ensure your computer is connected to the internet.
2. Go to the application menu section in the software by clicking on the Pro Lab text or logo in the top left corner. This menu is what you see when you just start the software.
3. Click *License* in the left-hand menu.
4. Click *Deactivate*.

## 2.6 Keeping Pro Lab updated

If the computer running Pro Lab is connected to the internet, it automatically checks for application updates. If a newer version is available, a red symbol appears at “About and Updates” in the left-hand navigation panel when you start the software.

Procedure for updating Pro Lab:

1. Ensure your computer is connected to the internet.
2. Start Pro Lab.
3. Click *About and Updates* in the left-hand navigation panel.
4. Click *Install* and wait for the download to finish.
5. Click *Install now*. The installation is completed automatically, and the new version of the application starts as soon as the installation is finished.

If the computer running Pro Lab doesn't have an internet connection, you can download the installer manually from the Learn & Support section of the Pro Lab product page at http://www.tobiipro.com/.

# 3 Managing projects

When you start the Pro Lab software, you get the option to create a new project, open an existing project, enter or modify your license details, check for software updates, or read about the software. You can also access these options while working on a project by clicking on the Pro Lab logo or text in the top left corner.

Data about participants, recordings, stimuli, and study layout is stored in the projects section in Pro Lab. There are currently five kinds of projects:

- *Screen projects*, for when stimuli presentation and data collection are done by a screen-based eye tracker.
- *Glasses projects*, for when data is collected by Pro Glasses 2. In Glasses projects, only the Project Overview and Analyzer module is available.
- *Scene Camera projects*, for when you use an external camera to record events in the real world.
- *VR 360 projects*, used when you want to analyze data from 360 degree images or videos collected with the HTC VIVE Pro Eye or the Tobii Pro VR Integration (an HTC Vive VR headset retrofitted with an integrated Tobii Pro eye tracker).
- *External Presenter projects*, in which you use third-party equipment, such as E-Prime, together with Tobii Pro Lab.

A participant is the person whose gaze data will be recorded, i.e. the person in front of the eye tracker.

Each project can contain several recordings, participants, Timelines, Snapshots, mapped data, and Events, etc.

## 3.1 Create a new project

If you want to create a new, empty project, select “Create New Project.” Proceed by selecting Screen project, Glasses project, Scene Camera project, VR 360 or External Presenter project.

- In a Screen project, you use a computer monitor or similar for stimuli presentation and a screen-based eye tracker for data collection. Pro Lab also handles stimuli presentation during data collection.
- In a Glasses project, the data is collected by Pro Glasses 2, and it can only be reviewed and analyzed by Pro Lab.
- In a Scene Camera project, you use a separate video camera and an eye tracker to record events in the real world, e.g. recording how a participant looks at a mobile device, with the Mobile Device Stand accessory. Scene Camera projects are useful when you, for example, want to examine how a participant uses a mobile phone, observes a shelf, or interacts with some other sort of physical stimulus.
- In a VR 360 project, you can use either the HTC VIVE Pro Eye or the Tobii Pro VR Integration (an HTC Vive VR headset retrofitted with an integrated Tobii Pro eye tracker).
- In an External Presenter project, you use third-party equipment, such as E-Prime, together with Tobii Pro Lab.

Pro Lab doesn’t support projects stored on network disks, USB-disks, or folders synchronized to cloud storage services (such as Dropbox, OneDrive, etc).

Procedure for creating a project:

1. Click on the *Create new Project* option.
2. Select *Screen, Glasses, Scene Camera, VR 360* or *External Presenter* under Project type.
3. Enter the project’s name in the text input field. If you don’t enter a name, Pro Lab suggests one, e.g., “Project1”.
4. Select the folder where the project is supposed to be saved by clicking “Browse…”. If no selection is made, the project is saved in a subfolder named “Tobii Pro Lab” in the Documents folder of the user currently logged in to the computer.
5. Click “Create.”

When the project has been created, you are redirected to the Project Overview section. Read more about this in the “*4 Working with a project*” chapter of this manual.

## 3.2 Open an existing project

When you want to continue working with an existing project, select the *Open existing Project* option.

Procedure for opening an existing project:

1. Click on the *Open existing Project* option. A list of recently-opened projects appears. Information displayed about each project includes the name of the project, when it was created, and where it is stored.
2. Double-click on the desired project.
3. If the desired project isn't in the list, click *Browse*. Locate the .project file associated with the desired project and click *Open*.

When the project is open, you get redirected to the Project Overview section. Read more about this in "*4 Working with a project*".

## 3.3 Distributed data collection (exporting and importing projects)

Researchers can save time and money by doing multiple data collection sessions across different locations and eye tracking setups. For example, you can reduce the time needed to reach the goal sample size by running simultaneous data collection sessions with two or more eye tracking setups, or collaborate with other research teams to perform large scale and/or geographically separated studies. In this section you will learn how to conduct a distributed data collection in Pro Lab.

In this example, Researcher A designs the project and send it to a data collector, Researcher B.

Researcher A might even have more than one data collector for their project, in this case Researcher C and D.

If independent variables are used in this "best practice example," they are related to participant characteristics so the project should include predefined variables and values. These need to be assigned to the listed participants. Typically researchers create a protocol with information on recruitment and data collection procedure. Read more in the Tobii Pro Learning Center.

**Researcher A:**

1. Create a project. See *3.1 Create a new project*.
2. In Project Overview , create the participant variables and values.
3. Define the participant variables, values, and participants:
   **a) Independent variables** (these affect the recruitment related to a predefined sampling order):

   Create all the participants that should be recorded and specify their variables and variable values

   For more information, read the online Learning article Participant Variables and Groups in the Learning Center.

   **b) No independent variables** :

   Specify interesting variables for the Researcher B to provide for each recorded participant

   For more information, read the online Learning article What are experimental variables? in the Learning Center.
4. On the Design tab, create the timeline(s) that should be recorded, including all stimuli, groups, timings, etc.
5. In Project Overview, select export **Export** >**Project** at the top.
6. In the Project Export window, divide the participants into different "Child projects" by selecting/deselecting the participants. For example, if there are 10 participants, you could check five of them to send to Researcher B and later choose the remaining five to send to Researcher C.
7. Click the **Export** button after choosing where to save the file locally. The file will be saved in Zip format.
8. Repeat the process to select and send other Participants to Researcher C, etc.
9. Send the generated Zip files to Researcher B and C.

After a Participant has been exported from the list, a double check mark displays next to the name in the list until the Project Export window is closed.

**Researchers B and C:**

1. Unzip the project.
2. Open the unzipped project in Pro Lab.
3. Recruit participants (typically completed earlier according to the recruitment protocol:
   **a) Independent variables:**

   Match the specified variable values specified by Researcher A.

   **b) No independent variables:**

   No match required.

If additional participants need to be added, make sure to specify the variables and values that have been applied to previous participants.

Do not change anything in the Design module because this can make the analysis phase more difficult.

4. Make participant recordings.
5. In Project Overview, select export **Export** >**Project** at the top.
6. In the Project Export window, select the recordings you want to export. You can de-select any recordings you wish to omit.
7. Click the **Export** button after choosing where to save the file locally. The file will be saved in Zip format.
8. Send the generated Zip file back to Researcher A.

**Researcher A:**

1. Receive the zipped project file from Researcher B.
   Pro Lab can import a zipped file and you do not need to unzip it elsewhere.
2. Open the “parent” project and in Project Overview, select **Import** > **Project**.
3. Select the Zip file from the stored location.
4. In the Import dialog, select which recordings to import (typically all) and how to handle any merge conflicts (typically different participant names).
5. After import, review the confirmation dialog and the potential list of conflicts that were generated during import. The list displays so that you know about any duplicates that were created. Duplicates can be identified by the number in parenthesis after the name. You can manually adjust or delete any duplicated participants, variables, and/or values afterwards in Project Overview.
6. Repeat steps 1-6 for all the files you receive from external data collectors.
7. Start analyzing the aggregated data.

## 3.4 Backing up projects

It is always a good idea to back up your projects regularly. Use the Export functionality described in *3.3 Distributed data collection (exporting and importing projects) , page 7* to make a back-up of your project.

# 4 Working with a project

The Project Overview section is the starting point for working with a project in Pro Lab. It lists all recordings in the project, available Event Types, and, for Glasses projects, available Snapshots. It also provides tools for managing the project content and options to determine what panels are displayed.

## 4.1 Managing recordings

The Recordings list contains information about the recordings in the current project. Details displayed include:

- **Recording:** The name of the recording
- **Participant:** The name of the participant
- **Duration:** The duration of the recording
- **Date:** The time and date when the recording was performed

**Gaze Samples:** The percentage is calculated by dividing the number of correctly identified eye-tracking samples by the theoretical maximum. An eye tracker with a 50 Hz sampling frequency generates 50 samples per second. If the software can use all samples to calculate gaze points, the value in the Gaze Samples column would be 100%. However, this percentage is rare, because some samples are always lost due to the participant blinking, or looking away from the monitor in the case of a screen-based eye tracker. Blinking usually causes around 5-10% data loss during a recording.

### 4.1.1 Replaying a recording

- Open and replay a recording in the Recordings list by double-clicking on it or by right-clicking and selecting *Open*. The replay tab that appears is displayed in the Analyze module.
- If you want to open recordings without getting redirected to the Analyze module, right-click on the recording you want to replay and select the option *Open in background.*Pro Lab then opens the recording in the replay tab in the Analyzer module, but you won't see it until you go to that module by clicking on the Analyze option in the top menu.

### 4.1.2 Deleting a recording

If you no longer want to keep a recording in a project, you can delete it.

A deleted recording is permanently removed from the system. It cannot be restored after deletion.

Procedure for deleting a recording:

1. Right-click on the recording and select *Delete*. A warning message appears.
2. Confirm your choice by clicking the *Yes, delete this Recording* option.

### 4.1.3 Importing and Exporting

For more information about distributed data collection, read *8.3.2 Exporting a whole recording, page 46*.

For more information about exporting and importing a recording, read *3.3 Distributed data collection (exporting and importing projects)* .

## 4.2 Managing Event Types

The Event Types list in the Project Overview lists all Event Types that are associated with a project. An Event Type is a definition of an Event that you want to mark in your recording. The Event Types are used to highlight either single Events or the start and end of a sequence, i.e. a Time of Interest. In the Replay tab, you can mark a specific point in time with an Event Type to indicate something of interest. This creates an *Event* (an instance of that Event Type).

Details displayed in the Event Types list include:

- **Color of the Event marker:** The colored symbol to the left of the Event Type name represent the marker that will be displayed on the recordings Timeline when an Event of that type has been created. Each Event Type has a unique color that is assigned by Pro Lab.
- **Name:** The name of the Event Type, assigned when the Event Type was created.
- **Shortcut:** A keyboard shortcut can be used to add an Event of that type to a recording Timeline in the Replay tab in the Analyze module.

### 4.2.1 Creating an Event Type

Procedure for creating a new Event Type:

1. Click on the + symbol in the top right corner of the Event Type list.
2. Enter the desired name of the Event Type in the left input field of the dialogue window. If you don't enter a name, Pro Lab suggests one, e.g. My Event001.
3. Go to the dropdown menu to the right and select which keyboard shortcut creates an Event of that Event Type on the Timeline.
4. Click *OK*.
5. When the Event Type has been created, it appears in the Event Types list.

### 4.2.2 Editing an Event Type

Procedure for editing an Event Type:

1. Put the mouse pointer on the row of the Event Type you want to edit. A pen icon appears
2. Click the pen icon. A menu appears.
3. Edit the Event Type details you want to modify.
   - Edit the Event Type's name by selecting the current name and entering a new.
   - Edit the associated keyboard shortcut by opening the dropdown list and making a new selection.
4. Click OK.

### 4.2.3 Deleting an Event Type

Deleting an Event Type also deletes of all instances of it in every recording in the project, along with all Times of Interest associated with it.

Procedure for deleting an Event type:

1. Put the mouse pointer on the row of Event Type you want to edit. A trash can icon appears
2. Click the trash can.
3. Click *Delete Event*.
4. Click OK.

## 4.3 Using analysis tools

The Project Overview contains links to the analysis tools in the Analyze module. When you click on a tool, the software switches to the Analyze module and opens a tab for the indicated tool. You can also access these tools by clicking the dropdown symbol next to the Analyze option in the top navigation.

Analysis tools provide the following options:

- **Visualizations:** Here you create Visualizations (Heat Maps or Gaze Plots) based on the gaze data on top of your stimuli or Snapshots. Visualizations only appear on a Snapshot image if data from Pro Glasses 2 has been mapped onto the Snapshot.
- **AOI editor:** Here you draw areas of interest (AOIs) on your stimuli or Snapshot images. AOIs enable numerical/statistical analysis based on regions. When an AOI has been created, you can export eye-tracking metrics for the stimulus or Snapshot on which it is created.
- **Metrics Export:** Here you export your eye tracking metrics based on AOIs or Events for further analysis in third-party software, such as SPSS, Microsoft Excel, and Matlab.

- **Data Export:** Here you export your eye-tracking data for further analysis in third-party software, such as SPSS, Microsoft Excel, and Matlab. Unlike in Metrics Export, the data available here is not tied to AOIs. Instead, you access raw gaze data, such as gaze points in different coordinate systems, pupil diameters for each eye, the eye position, and information about the recordings in general. Information about whether gaze data fell within AOIs is also included, but metrics regarding AOIs are not provided.

  You can choose between two file formats, depending on which the intended third-party application. Go to the Settings pane and choose select either *Standard*, (a .tsv file suitable for any application, e.g. Matlab), or *Excel compatible* (suitable for use in Microsoft Excel). Both formats have the same data content.

## 4.4 Using Glasses project-specific tools and functions

Some tools and functions in the Project Overview are only available for Glasses projects, for example importing data from Pro Glasses 2 recordings, coding data, and Snapshots. These tools are also listed in the Analyze dropdown menu.

### 4.4.1 Importing data from Pro Glasses 2

When you use Pro Glasses 2 to record data, you save the data on an SD card. You then need to import that data into a Glasses project in Pro Lab to become able to analyze it..

Procedure for importing recordings from Pro Glasses 2 into a Pro Lab Glasses project:

1. Open the Glasses project into which you will import the recordings.
2. Go to Project Overview and select the *Import* dropdown menu.
3. Select *Glasses Recording*. A file browser appears.
4. Locate the data file (*.ttgp) on the SD card via the file browser.
5. Import the data by clicking *Open*.
6. Select the recordings you want to import.

### 4.4.2 Importing snapshots

Snapshots are still images used for making Visualizations, such as Heat Maps and Gaze Plots, and for AOIs and Metrics. Data from Pro Glasses 2 recordings are mapped onto Snapshots, either through manual coding or through the automatic mapping function that is available when you replay the recording. Read more about automatic mapping in*8.4.1 Using the Gaze Data Snapshots tool and gaze mapping*.

Requirements for Snapshot images:

- Less than 25 megapixels
- BMP, GIF, JPG, or PNG file format

You can use snapshots created from multiple images stitched together into one image as long as the final Snapshot file matches the requirements above. (A stitched image is assembled from a set of images that cover a greater area than what the camera can cover in one shot.)

Procedure for importing Snapshots:

1. Open the desired Pro Glasses project.
2. Go to Project Overview and select the *Import* dropdown menu.
3. Select *Snapshot*. A file browser appears
4. Locate the image file (or files) that you want to import via the file browser.
5. Click *Open*. The Snapshots are imported into the project. (However, if an identical Snapshot already exists in the project, a notification is displayed and that Snapshot is not imported.
6. Click OK.

### 4.4.3 Working with the same Glasses project data on multiple computers

In some cases, it is beneficial useful to be able to work with the same Recordings and Snapshots from a Glasses project simultaneously on several computers. This occurs when you need to manually code data onto Snapshots. That task can be very time-consuming, and, therefore, it makes sense to let several people work on it simultaneously.

Currently, coding data is the only thing that you can import from one project into another. A prerequisite is that the recordings and Snapshots associated with the data are available in the project you import it to. We advise strongly that you import the data from your Pro Glasses 2 SD card, as well as the Snapshots onto which you want to code data, before you export the project to another computer.

#### 4.4.3.1 Exporting and importing Glasses projects

Pro Lab lacks an internal export function. Instead, you use Windows functions for exporting or copying projects.

Procedure for exporting a project and importing it on another computer:

1. Make a copy of the desired project folder. (The default location for project folders is [user]\Documents\Tobii Pro Lab \)
2. Move the copy to the target computer.
3. Import an entire project into Pro Lab by opening the project. Read *3.2 Open an existing project*.

#### 4.4.3.2 Importing coding data from another project

Conflicting data during import can be overwritten so we advise that you make a backup of the target project before doing an import. See *3.4 Backing up projects*for more information. This safeguard enables data recovery in case the data import causes the unplanned deletion of data that should have been preserved.

Procedure for importing coding data from another Glasses project:

1. Open the Glasses project into which you want to import the coding data.
2. Go to Project Overview and select the *Import* dropdown menu.
3. Select *Coding data* .
4. Click *Select file to import…* A file browser appears
5. Use the file browser to locate the project file (*.project) associated with the source project.
6. Click *Open* and select either:
   a. *Keep data from existing Project*, that is, if there is conflicting data, you want to keep the data in the currently-open project and discard the corresponding imported data; or
   b. *Replace existing data with imported data*, that is, you want to overwrite the data in the currently-open project with imported data.
7. Click *Start import*.
8. When the import is finished, click *Done*.

# 5 Designing an experiment

Before you do a Recording in Pro Lab, you need to design an experiment in the Design module. An experiment can consist of one or more Timelines. A Timeline outlines the order in which stimuli are displayed to the study participant.

When you work with a Glasses project, the Design module is not be visible because Pro Lab doesn't handle stimuli presentation or recording in Pro Glasses 2. Hence, you don't need access to the Design module for Glasses projects.

When you work with a Scene Camera project, the Timeline is not visible because the stimulus is the video feed from the external camera.

## 5.1 Timelines

A Timeline can contain multiple stimuli of different types. Stimuli types currently supported are images (*.bmp,* .gif, *.jpg, and* . png), videos (*.avi and* .mp4), Screen Recording stimuli and calibration stimuli.

For VR 360 projects, the media files added to the timeline should be monoscopic 360 degree images, formatted in an equirectangular projection with 2:1 aspect ratio.

### 5.1.1 Creating a new Timeline

Procedure for creating a new Timeline:

1. Click *Design* in the top navigation.
   - If no Timeline is available, a Timeline with one stimulus gets created automatically.
   - If there already are Timelines, you create a new one containing one stimulus by clicking *New Timeline* in the *Add* section of the Design module interface.
   - The mentioned stimulus is a calibration object. When it is reached during a recording, the participant undergoes a procedure that calibrates the eye tracker to their eyes. Data collected before the calibration most likely has poor accuracy and precision and should therefore not be used for analysis.
2. Add more stimuli in one of the following ways. (When stimuli get added to the Timeline, visual representations of their contents appear on the Timeline. See section 5.2 for more about stimuli.)
   - Click on the empty stimulus container on the Timeline. A file browser appears; use it to locate the file(s) you want to use as stimuli. Make your selection and click *Open*.
   - Click *Add stimuli* in the *Add* section of the Design module interface. A file browser appears; use it to locate the file(s) you want to use as stimuli. Make your selection and click *Open*.
   - Locate the file(s) you want to add as stimuli by using the Windows File Explorer and drag them onto the Timeline.
   - Change the order of the stimuli by clicking on those you want to move and drag them it to the desired position (s).
   - If you want to make a Screen Recording, add a Screen Recording stimulus by clicking *Add Screen Recording stimulus*.
3. Add a Group by clicking *Add Group Element* in the *Add* section of the Design module interface. A new group appears in the timeline. You can drag and drop it to the desired place. (See section 5.3 for more about Groups.)
4. Add a Screen Recording Stimulus by clicking *Add Screen Recording stimulus* in the *Add* section of the Design module interface. A new Screen Recording stimulus appears in the timeline. (See section 5.2.4 regarding Screen Recording stimulus properties and section 8.7 regarding how to analyze a screen recording).
5. Go to the *Properties* panel, enter the group's name in the *Name* field, and set its desired *Action*, that is, determine in what way you want the content of the group to appear:

   a. **Show all**: All stimuli in the group are displayed sequentially.
      - *Shuffle*: All stimuli in the group are displayed in a random order. Each stimulus appears only once.

   b. **Repeat**: The group's content is displayed sequentially several times over. Enter the number of times the sequence shall be repeated. Max value is 100.

   c. **Sample**: One, and only one, stimulus in the group is displayed. Determine how it will be selected:

- *Sequential*: Each time the Sample Action is executed, it displays the next stimulus in strict order.
- *Random with replacement:* Each time the Sample Action is executed, a random stimulus from the group is displayed. It can reappear later in the action.
- *Random without replacement:* Each time the Sample Action is executed, a random stimulus from the group is displayed. It will not reappear in later in the action, unless there are more repetitions than stimuli. For example, if you set 20 repetitions and have 10 stimuli, the cycle restarts when all stimuli have been displayed once and all stimuli get displayed twice.

6. The additions are saved automatically. You can go on working with Pro Lab.

Displaying stimuli before the calibration stimulus may make the participant relax or catch their attention before the data collection begins. However, data collected before calibration is not supposed to be used during analysis because its accuracy and precision are highly likely to be poor.

### 5.1.2 Deleting a Timeline

Procedure for deleting a timeline:

1. Go to Timelines to the right and hover the mouse cursor over the desired Time Line. A trash can icon appears.
2. Delete the timeline by clicking on the trash can.

Deleting a Timeline doesn't affect the recordings made using it. This deletion means only that you cannot make any more recordings with that Timeline, whereas the associated stimuli remain available for analysis.

### 5.1.3 Duplicating a Timeline

Procedure for duplicating a timeline:

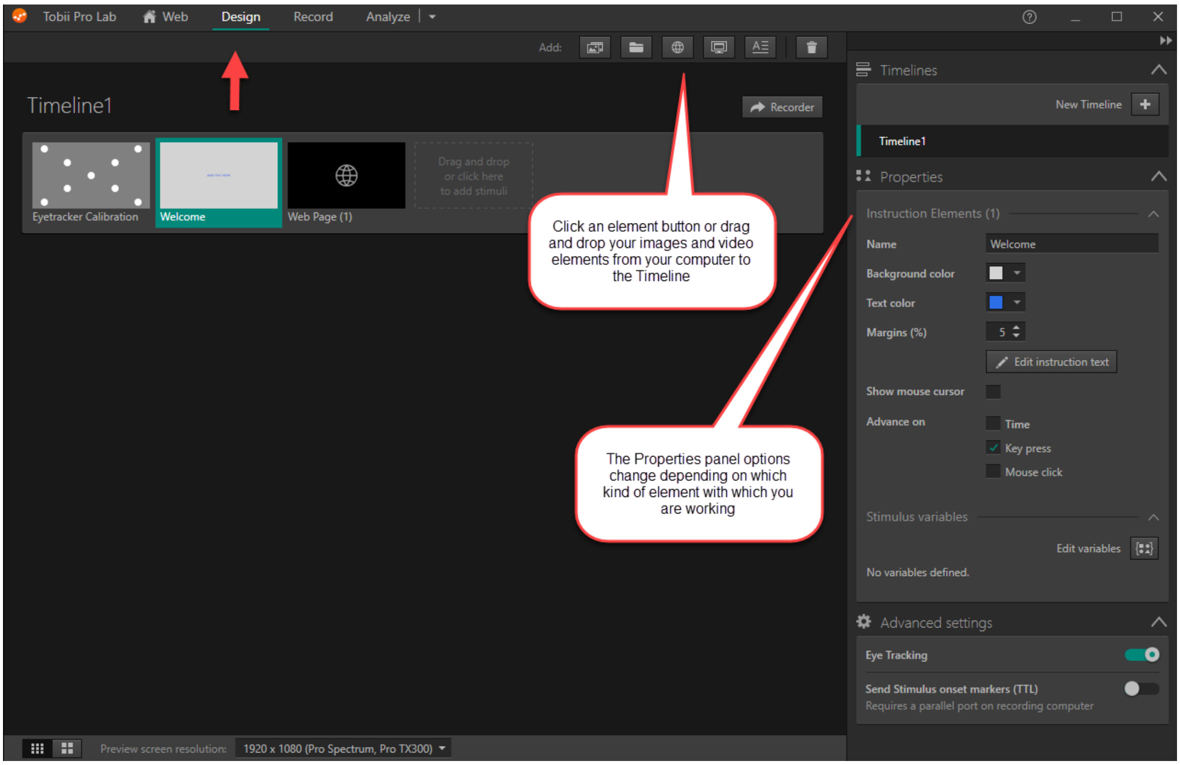
1. Go to Timelines to the right and hover the mouse cursor over the desired Timeline. A duplication icon appears.
2. Duplicate the Timeline by clicking on the icon. A copy of the Timeline appears.

### 5.1.4 Changing the name of a Timeline

Procedure for changing the name of a Timeline:

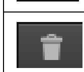
1. Click on the current Timeline name. (When a new Timeline is created, it is gets a name automatically, e.g., Timeline1.)
2. Delete the current name and enter the new name.
3. Press “Enter” on the keyboard.

## 5.2 Working with stimulus properties




On the **Design** tab, the **Properties** panel on the right-side of the screen changes depending on which kind of stimuli or element you are working with. Click a type of element button in the Add menu or drag and drop your images and video elements from a folder on your computer to the Timeline.


The elements that can be added from the Add menu are:

| | |
|---|---|
|  | Add stimuli from your computer:<br>.bmp, .jpg, or .png image files. Pro Lab will scale images according to the screen size.<br>.gif, .avi, or.mp4 movie files – Select video files to be presented to your participants. Pro Lab will scale images according to the screen size. |
|  | Add a group element (adds rules and actions to your presentation) |
|  | Add web stimulus |
|  | Add screen recording stimulus |
|  | Add Instruction element |
|  | Delete selected timeline elements |

Pro Lab defines a stimulus, for example an image file, video, or calibration stimulus, as one entity that can be used many times. As a consequence, properties set for that stimulus get applied to all of its instances on all Timelines in which it appears. For example, if the viewing time is changed for a particular image, that also changes the viewing time for all occasions it is shown during all recordings, regardless of what Timelines it appears on. If you want to use the same stimulus with different properties, each image or video of it must get a unique file name.

### 5.2.1 Calibration stimulus

Add a calibration stimulus by toggling on **Eye tracking** in the **Advanced settings** section of the right-hand side panel on the **Design** tab.

Click the Eye tracker Calibration card in the Timeline to display its properties in the **Properties** panel on the right-hand side.

These calibration stimulus properties can be changed:

- **Calibration Type**: Determines how the advancement from one calibration point to the next is handled.
  - *Timed*: If this option is selected, the next calibration point gets displayed when the eye tracker has signaled that it has sufficient data to proceed or when sufficient time has passed for the collection of a reasonable amount of data.
  - *Manual*: When this option is selected, you proceed to the next stimuli point by pressing the spacebar on the keyboard.
- **Number of points**: Specifies how many calibration points get displayed during the calibration procedure. The default value is 5.

  In VR 360 projects, the number of points is the only calibration stimulus property that can be changed.

- **Background color:** Determines what color the screen background gets when the calibration is done. The object that the participant will look at is displayed on top of this color.
  1. Select background color by opening the dropdown and the color picker.
  2. Click on the desired color or enter a hexadecimal color code in the number entry field.
  3. The background color is updated and appears in the Timeline as the background of the stimuli cards displayed there.
- **Calibration Target**: This property specifies the appearance of the object the participant is asked to look at during calibration. The Calibration Target object gets displayed at as many different locations on the presentation screen as is specified by the “Number of points” property. (The Calibration Target can only be set if the Calibration Type is set to Manual.)
  - *Point*: If this option is selected, the displayed calibration target is a simple filled-in circle.
    - ◊ *Point color*: This property specifies the color of the calibration Point.
      1. Select the Point color by opening the dropdown and the color picker.
      2. Click on the desired color or enter a hexadecimal color code in the number entry field.
      3. The Point color is updated and appears in the Timeline as the Point color on the calibration stimuli cards.
  - **Video**: If this option is selected, the study participant is shown a small video clip with accompanying sound in the location of the calibration target. This is particularly useful when the study participant is a child or someone else who has difficulty paying attention for long periods of time.
    - ◊ *Select video clip*: Select among seven thumbnails of video clips that you can use as the Calibration Target.
      1. Start a preview by clicking the *Play* button on a thumbnail.
      2. If you click elsewhere on the thumbnail, you set that clip as the Calibration Target for the calibration stimuli on all Timelines.
      3. A small visual representation of it appears on the calibration stimuli cards on the Timeline in the locations where the Calibration Target is displayed during the calibration procedure.
    - ◊ If you want to add your own video as a calibration target:
      1. Press the *plus sign* next to the *Add video* option. A selection dialogue appears.

2. Select your own video file. It appears among the preset video clips.

The video clips can be of many different formats. If Pro Lab can handle a file as video stimuli, then it should work as a calibration target as well. Note that the file is not scaled, so it should have as suitable size for your screen.

### 5.2.2 Image stimulus

The following properties of an image stimulus can be changed:

- **Name:** By default, the stimulus name is identical to the filename of the image file. You can change it to any desired name. However, each stimulus must have a unique name.
- **Scaling:** This determines how the stimulus appears on the screen.
  – If you select *Original*, the size (in pixels) of the image file is retained and displayed as is. This means that, if the resolution of the screen is lower than the image size, only parts of the image are shown.
  – If you select *Fit to screen*, the image is either enlarged or shrunk (keeping its aspect ratio) to fit on the screen during stimuli presentation.
- **Position:** This governs where on the screen the stimulus appears (e.g. centered or upper-left corner). Change the display position by clicking on one of the position boxes. The active position is represented by a turquoise square.
- **Background color:** Most stimulus images don't cover the entire screen. This setting determines the color of the unused part of the screen.
  1. Select the background color by opening the dropdown and the color picker.
  2. Click on the desired color or enter a hexadecimal color code in the number entry field.
  3. The background color is updated and appears in the Timeline as the background of the stimulus card for the selected stimulus.
- **Show mouse cursor:** Click to record and show the mouse cursor.
- **Advance on:** determines for how long a stimulus is displayed. This property has three settings that can be used one by one or in combination. For example, if both *Time* and *Key press* are selected, the next stimuli gets displayed when the time has run out or if any key has been pressed before the expiration of the time set in the Time setting. The available settings are:
  – *Time:* You specify for how long a stimulus is displayed, using seconds and milliseconds. The actual viewing time can vary dependent on the update frequency of your screen and the capabilities of your computer. The setting has a minimum value of 50ms; This value is selected based on tests showing that even high-end computers cannot guarantee consistent exposure times at lower values.
  – *Key press:* If this option is selected, you advance from the one stimulus to the next on the Timeline by pressing any key on the keyboard.
  – *Mouse click:* If this option is selected, you advance from the one stimulus to the next on the Timeline by clicking the mouse.

  **Name** and **Advance on** are the only image stimulus properties available for VR 360 degree images.

### 5.2.3 Video stimulus

The following properties of a video stimulus can be changed:

- **Name:** By default, the stimulus name is identical to the filename of the video file. You can change it to any desired name. However, each stimulus must have a unique name.
- **Scaling** determines how the stimulus appears on the screen.
  – If you select *Original*, the size (in pixels) of the video file is retained and displayed as is. This means that, if the resolution of the screen is lower than the video size, only parts of the video are shown.
  – If you select *Fit to screen*, the video is either enlarged or shrunk (keeping its aspect ratio) to fit on the screen during stimuli presentation.
- **Position** governs where on the screen the stimulus appears (e.g. centered or upper-left corner). Change the display position by clicking on one of the position boxes. The active position is represented by a turquoise square.
- **Background color:** Most stimulus videos don't cover the entire screen. This setting determines the color of the unused part of the screen.

1. Select the background color by opening the dropdown and open the color picker.
2. Click on the desired color or enter a hexadecimal color code in the number entry field.
3. The background color is updated and appears in the Timeline as the background of the stimulus card for the selected stimulus.

- **Advance on** determines for how long a stimulus is displayed. This property has two settings that can be used one by one or in combination. For example, if both *Key press* and *Mouse click* are selected, the next stimuli gets displayed when any key has been pressed or if any mouse button has been clicked. However, when the clip has reached its end, the next stimuli on the Timeline appears automatically. The available settings are:
  – *Key press:* If this option is selected, you advance from one stimulus to the next on the Timeline by pressing any key on the keyboard.
  – *Mouse click:* If this option is selected, you advance from the one stimulus to the next on the Timeline by clicking the mouse.

**Name** and **Advance on** are the only video stimulus properties available for VR 360 degree videos.

### 5.2.4 Web stimulus

The Web stimulus is used to display web pages to participants during a recording. In order to use this element during a recording, your computer must be connected to the Internet or the websites need to be stored locally on your computer. Tobii Pro Lab uses the website's URL or a local address to open the site in the built-in Lab browser. This browser automatically records all mouse clicks, keystrokes, and web pages visited during the experiment. The following properties of a Web stimulus recording can be changed:

**Name**: By default, the stimulus name will be Web page (n). You can change it to the name of the web page, however, each stimulus must have a unique name.

**URL**: Enter a URL or a local computer address (you do not need to type http://). If you leave it empty, the Lab browser will launch without a URL. For example, this might be useful if the researcher wants the participant to select their own starting web page. The Lab browser launches in full screen mode.

Note: The local files need to be available on the computer you are using. This is because the web stimulus is used to display webpages to participants during a recording. In order to use this element during a recording, your computer needs to be connected to the Internet or the websites need to be stored locally on your computer.

**Frame rate**: Available values are 5, 10, 15, 25 (default), and 30fps (frames per second). In most cases, the default rate of 25 fps is good enough.

**Video quality**: Native means that the screen is recorded at native resolution. Medium is 75% of Native and Low is 50% of native resolution. Use native resolution if possible. If you need to save computer CPU or disk space and do not require a detailed recording, select a lower video quality.

**Advance on**: To move to the next stimulus on the Timeline, press F10 or the **Next** button near the Record/Stop button.

See section *6.1 Making a screen-based recording* for more information on recording and *8.1 Replaying a recording* for more information on analyzing recordings with web stimulus.

### 5.2.5 Screen Recording stimulus

The following properties of a Screen Recording stimulus can be changed:

- **Name**: Enter an appropriate name. If left as-is, Pro Lab sets the name to Screen Recording with a unique number if there is more than one stimulus with this exact name, e.g. *Screen Recording (1).*
- **Frame rate**: Available values are 5, 10, 15, 25 (default), and 30 fps (frames per second). In most cases, 25 fps (default) is good enough.
- **Advance on**: If your experiment requires that you advance to the next stimulus after a set time period, check the Time checkbox and enter the length of the period.
- **Video quality**: *Native* means that the screen is recorded at native resolution. *Medium* is 75% and *Low* is 50% of native resolution. Use native resolution if possible. However, if you need to save computer CPU or disk space and you are not interested in details in the recording, select a lower video quality.

Read more on analyzing a screen recording in *8.1 Replaying a recording, page 40*

### 5.2.6 Instruction element

Use the Instruction element to write text the participant will read during the recording. You can give instructions, thank the participant, or whatever you need to write.

Click the **Edit Instruction text** button to write the text and to see the full editing interface with additional functionality including a font selector, font size, and margin control.

More information about the Instruction element properties that can be adjusted:

- **Name**: Enter an appropriate name. If left empty, Pro Lab sets the name to Instructions with a unique number if there is more than one element with this name, e.g. Screen Recording (1).
- **Background color**: Sets the background color of the entire Instruction element.
- **Text color**: Sets the font color
- **Margins** (%): Controls the amount of space between the edge of the element and the text. Click the **Display margins** button in the full editor to see the margin's dotted lines as you adjust the percentage. These dotted lines won't show in the element.
  Click the **Edit Instruction text** button to see the full editing interface with additional functionality including a font selector, font size, and margin control.
- **Show mouse cursor**: Select this to enable the participant to see their mouse cursor during the recording.
- **Advance on** determines what triggers the next stimuli to display.
  The available settings are:

  **Time**: The minutes and seconds clock appears on the **Properties** panel when this is checked. Participant advances to the next stimulus after the set amount of time.

  *Key press*: Participant advances to the next stimulus by pressing any key on the keyboard.

  *Mouse click*: Participant advances to the next stimulus by clicking the mouse.

## 5.3 Groups

Groups are containers of timeline elements and enable more compact timeline designs. The behavior of the elements inside a group is determined by the action property set for the group. You can nest groups within groups to create more complex stimuli presentation behaviors.

### 5.3.1 Editing a group's contents

How to edit the group properties and content:

1. There are 3 ways to open a group:
   - Click the triangle at the bottom right-hand corner of group's tile; or
   - Double-click the group; or
   - Highlight the group and press Enter on your keyboard.
2. The group's content appears below the group element and displays its contents.
3. Add a new stimulus or group:
   - by dragging-and-dropping; or
   - by clicking-and-browsing in the empty tile in the timeline; or
   - by dropping onto the un-expanded group icon.
   - If you wish to add a stimulus or to group them with another group, you must select the target group (click in the expanded area) and open it before doing a drag-and-drop.
4. Change the order of the group elements on the timeline by dragging-and-dropping its Stimuli and Groups in the desired order.
5. The addition is saved automatically. You can go on working with Pro Lab.

If you delete a stimulus in a group, your action only deletes that copy of it, whereas all other copies elsewhere among groups and timelines remain unaffected. However, if you change the properties of a stimulus in a group, your action affects that stimulus everywhere among groups and timelines, also in such instances that have been copy-pasted.

### 5.3.2 Duplicating a group

Procedure for duplicating a group:

1. Duplicate a group by selecting it and copying it (ctrl C).
   - All stimuli and groups nested inside it are duplicated, too.
   - This is an appropriate method when you want to nest a group inside another group.
2. Open the target group and select the item just to the left of the desired location.
3. Paste (ctrl V) the copy. It appears in the desired location.

You can change the timeline inside a duplicated group without affecting the original version, and vice versa. However, if you change the properties of a stimulus in a group, your action affects that stimulus everywhere among groups and timelines, also in such instances that have been copy-pasted

### 5.3.3 Deleting a group

Procedure for deleting a group:

1. Delete a group by selecting it and clicking on the garbage can icon, or by pressing the delete button on the keyboard.
2. This action also deletes all groups and stimuli nested inside it.

## 5.4 Stimulus/group variables

A stimulus/group variable is a specific feature of your stimulus or group of stimuli that are part of the context in which the behavior occurs. It is often an expression of or a subset of your independent variable and covariates. Examples include number of items, item category, stimulus crowdedness, color, brightness, and contrast.

In Tobii Pro lab, stimulus/group variables are a way of adding metadata related to the stimuli that you can use later during your analysis, e.g. independent variables or co-variate that you wish to add as a column in your data export.

### 5.4.1 Creating variables

Procedure for creating a stimulus/group variable

1. In Pro Lab, open your project in the *Project Overview*.
2. Open the *Stimulus* panel by clicking on “Stimulus Variables” in the left column.
3. Create a new variable by clicking on the plus sign in the top right corner of the *Stimulus* panel. A new variable appears with a default value.
4. Enter the variable’s name in its name field to the right of the chevron (single “arrowhead”).
5. Press enter after writing the name. The cursor moves to the first value field.
6. Enter the value’s name in its name field. Add a new value by pressing Enter or by clicking on the “Add value” plus sign.

### 5.4.2 Assigning variables

Procedure for assigning a stimulus/group variable

1. Activate the *Design* panel.
2. Add a stimulus or group by clicking in the timeline and browsing and selecting it on your computer.
3. Select the desired stimulus or group. Multiselect is enabled.
4. Assign a value by checking the checkbox located in the *Stimulus Variable* section of the *Properties* section. A drop-down appears, displaying the values for the variable to the right.
5. Select the value you want to assign to the stimulus or group.

## 5.5 Using TTL markers to indicate stimulus onset for external listeners

TTL signals are the current standard for synchronizing data between stimuli presentation software, biometric data sources (e.g., EEG, GSR), and data collection software. In Pro Lab, you can send TTL signals through a parallel port on the computer running the software. Pro Lab sends a TTL marker at every stimulus onset.

If this setting is activated, TTL markers are sent for all stimuli on the Timeline, unless manually specified otherwise. In addition, settings for marker value type and marker bit depth are also set for all stimuli collectively. Only the TTL marker value can be specified per stimulus, provided that you set this property to manual.

Pro Lab sends the TTL markers when it estimates that the stimulus has appeared on the screen. This estimation uses, unless otherwise specified, a zero lag display and a 10ms screen latency. If you need to high timing precision when sending TTL markers at stimulus onsets, read the *Timing guide for stimulus display in Pro Lab* to learn how provide your setup with a precise stimulus timing.

Procedure for activating the sending of TTL markers on stimulus onset:

1. Select a stimulus on the Timeline.
2. Click on the “Send Stimulus onset markers (TTL)” toggle switch under the Advanced settings in the right-hand panel.
3. Select Automatic or Manual for the marker value. The default setting is Automatic. If a stimulus appears several times on the same Timeline, all occasions get the same marker value

   If you select “Automatic”, Pro Lab automatically assigns a unique value to each stimulus on the Timeline, starting with 1 for the first and going up incrementally by 1 for each following stimulus. If you select “Manual”, Pro Lab still assigns a value to each stimulus, but you can modify that value in the properties of each stimulus.

   Procedure for changing the TTL marker value for a stimulus:

   a. Click on the stimulus on the Timeline.
   b. Enter the marker value you want to use for that stimulus in the TTL marker value input field.
   c. If you don’t want to send a TTL marker for a specific stimulus, set its TTL marker value to 0.

4. Select the desired marker bit depth. The default is 8 bits. This value governs how many marker values you can use and it depends on how much the listener to the TTL signal can handle. An 8-bit marker depth enables the use of up to 255 different marker values, whereas a bit depth of 3 or 1 enables 7 or 1 different markers.

   The marker signal is set to be active for approximately 34ms after the moment when Pro Lab assumes the stimuli starts to when it becomes visible on the presentation screen. This value was selected to allow for sampling frequencies of 30 Hz in devices listening to the signal while still being shorter than the shortest stimulus display time (i.e. 50ms).

## 5.6 Changing the appearance of the Timeline stimulus cards

Each stimulus instance is represented by a Timeline card. It contains information about the stimulus name, what it looks like, and what its background color is. These settings are governed by the stimulus properties. However, a card’s shape and size are determined by global settings that affect all cards at once.

### 5.6.1 Changing the size of the stimulus cards

In the bottom left corner of the Design module interface, there is a toggle switch that enables you to display large or small representations of the stimulus cards. Change card size by clicking on the left part of the switch for small, or on the right part for large. The default setting is small cards.

### 5.6.2 Emulating the screen resolution of the presentation screen

You use the dropdown list “Preview screen resolution” to select what resolution is used on your presentation screen. The shape of the stimuli cards gets the same aspect ratio as the screen on which the stimuli are displayed. In addition, the stimuli are scaled on the cards to indicate how much screen area they cover during the presentation.

All Tobii Pro eye trackers delivered with screens get their recommended screen resolutions listed in the dropdown. So if you know that you will use, for example, a Tobii Pro Spectrum, you can select it in the list and see on the stimuli cards how the stimuli appear on the Pro Spectrum screen.

# 6 Making recordings

The Recorder module in Pro Lab provides you with all controls required for making recordings for later analysis in the Analyze module.

If you work with a Glasses project, the Record module is not available because for Tobii Pro Glasses 2, recording is handled by the separate application Tobii Pro Glasses Controller. Hence, you have no need to access the Record module for Glasses projects.

## 6.1 Making a screen-based recording

If you only have one Timeline and approve of the selections in Pro Lab, you start a recording by pressing the “Start recording” button in the lower-right corner of the Record module. However, if you want to verify all selections, use the instructions below to start a recording.

A recording ends after the appearance of the last stimulus or by an action by the moderator.

Pro Lab doesn’t support presentation screens that have the Windows screen duplication setting enabled.

### 6.1.1 Starting a screen-based recording

Procedure for making a recording:

1. Ensure that the desired devices are enabled and selected. They (e.g. the eye tracker, participant camera, microphone, GSR, and TTL outport) are represented by cards above the Timeline(s). See “*6.7 Changing device settings*” for more information.
2. Select the desired Timeline by clicking it. The active Timeline is highlighted in purple. The number before the name of the Timeline indicates how many recordings have previously been made using it.
3. Select which participant you are recording. If that person has no previous recordings, select the “+New” button and enter the participant's name in the name field. If no name is entered given, Pro Lab suggests a name, such as “Participant1.”

   You can define or edit already defined, participant variables. See “*6.2.5 Participants and Participant Variables*” for more information.

4. Give the recording a name by entering it in the “Recording name” input field in the Recording section. If no name is entered, Pro Lab suggests a name, such “Recording1.”
5. Specify which of your connected screens will display the stimuli. The active screen is highlighted in purple in the Target Screen section of the interface. If you are unsure which screen is which, click on the “Identify” button. A number corresponding to the representations in Pro Lab then appears for a moment on all connected screens. You can also modify screen latency. Read more about this in “*6.8.1 Modifying screen latency settings*” .
6. The recording can be stopped using the ESC key (default method) Shift + ESC. *Note: The ESC key is sometimes custom-programmed on individual computers to close the browser or another application so it is recommended to use Shift + ESC for Web.*
7. Start the recording by clicking the “Start recording” button.

### 6.1.2 Moderating a screen-based recording

When a recording is running, the Pro Lab application window switches to the moderator view. It displays those stimuli that the participant sees on his/her screen and it additionally informs the recording moderator about whether the eye tracker is detecting a gaze, whether the participant is positioned in a way that enables data collection, for how long the recording has been running, and what participant name and recording name are used. It also provides the moderator with the opportunity to terminate the recording at any time.

The moderator view is only available if more than one screen is connected to the Pro Lab computer and the Target Screen is not the same as the screen on which the application window is shown.

The stimuli live view feature is disabled by default, but the moderator can enable it. This feature is performance-demanding and may cause timing issues with the stimulus display in computers with lower specifications. For more information, see the Learning Center article Stimulus presentation timing in Tobii Pro Lab.

### 6.1.3 Performing a screen-based calibration

**Calibration**

In human populations, there is a natural variation in the shape and geometry of the eyes. For example, the exact location of the fovea varies from individual to individual. Tobii Pro Eye Trackers, use a subject calibration procedure to optimize its gaze estimation algorithms (i.e. the 3D eye model) and account for this variation, resulting in a fully-customized and accurate gaze point calculation. Additionally, some eye trackers use the calibration procedure to select the detection mode (dark or bright pupil) that provides the best data, and then lock, or use that mode predominantly during the recording.

During the calibration the participant is instructed to look at calibration targets that appear at multiple locations on the plane (commonly the surface of the display monitor) where the stimulus is located. The data collected during this period is then mapped to those locations using, either, a standard configuration of the 3D eye model or the last configuration saved to the eye tracker, e.g. the last previous test participant. The calibration is done before starting to collect data. Add a calibration stimulus to the Timeline in the Design module (see “5.1.1 Creating a new Timeline” ). When that stimulus is reached on the Timeline, the calibration procedure is initiated.

**Validation**

In order to trust the quality of your recorded data, it is important to verify and quantify the eye tracking data quality during the recording. Consequently, to evaluate the performance of this new algorithm configuration it is best practice to test it with a new data set. This provides a more realistic estimate of the data quality of your recording.

This process of collecting new data to quantify and evaluate the data quality after calibration is called a calibration validation.

Calibration validation is on by default. This means that it occurs directly and seamlessly after the calibration is done. During the validation, the participant sees four additional calibration targets on the screen.

The results of the validation are displayed after the calibration validation procedure. It can be reviewed and exported later, in the Project overview section, or by using the Data export tool.

**Disable validation**

Calibration validation is a part of the normal calibration process. But sometimes it is necessary to disable the validation when it is hard to hold the subject’s attention, for example, when the participant is an infant. You can turn off the validation by clicking on the Calibration element in your timeline and then toggling the Validate Calibration switch in the Properties Panel, under Calibration.

The controls for the calibration can either be displayed on the target screen in front of the participant or in the moderator view. This setting is made on the Recording card, under the Calibration controls list box. If you display the controls in the moderator view, you get better control of the calibration.

**Performing a calibration validation:**

1. Use the **Calibration** section on the **Properties** panel to control the calibration validation. You can select the background color, number of targets, background, calibration type, calibration target, and target color of the calibration validation.
2. The participant should sit in front of the eye tracker in a way that provides the eye tracker with an unrestricted view of the participant’s eyes. Do this by using the graphical representation of the track box (i.e. the location of the eyes in relation to the eye tracker) in the Moderator view or the Presentation screen. If the eye tracker can see the eyes, it depicts them as two white dots that ideally appear in the center of the track box.
3. The participant should let their gaze follow the object that appears on the screen when once the calibration starts.
4. Click the **Start calibration** button on the presentation screen. The validation starts immediately after the calibration and presents 4 additional points.
5. When the calibration data has been collected and validated, a visual representation of the calibration result displays on the presentation screen.
   The results can be displayed either as averaged values for both eyes combined or separately for each eye. Select this using the two radio buttons at the bottom left of the window: **Average Results** and **Left and Right Eyes Results**.

If separated values are displayed, legends for the right and left eye appear at the top right of the window.

- Each dot represents a gaze sample, green for the left eye and blue for the right eye. Orange dots represent the average value for both eyes. The crosses indicate where the calibration objects appeared on the screen. The gaze data is mapped onto the crosses.
  If data is missing from some calibration points or if the data is mapped too far away from the targets, you should re-calibrate. When recalibrating, you can choose to either redo the entire calibration or to recalibrate only selected points. To redo the whole calibration, click the **Recalibrate** button. If you want to redo the calibration for selected points, select them by clicking on them and then click **Recalibrate**.
  If you want to revalidate the calibration, you cannot select individual points but instead must run the calibration again.
- When your cursor hovers over a point, a popup window appears with the gaze point's accuracy and precision displayed in degrees and pixels.
- At the bottom of the window a table displays with an estimate of the average total result across all validation points.

More information about accuracy and precision definitions can be found in our Metrics report on tobiipro.com.
Please note that the precision values are provided without applying a filter, such as a Stampe stage 2 algorithm.

### 6.1.4 Ending a screen-based recording

A recording either ends when the last stimulus has been displayed or by the moderator's interruption.

The Moderator can interrupt an ongoing recording several ways including:

- pressing F10 or the **Next** button in Moderator view
- pressing the ESC button or pressing Shift + ESC
- clicking the **Stop recording** button in the Moderator view

### 6.1.5 Working with Lab browser

**Dynamic web content**

Dynamic web content is a conceptually and technically difficult aspect of today's web pages.

*Conceptually*, it is difficult to compare data from several recordings when the dynamic content makes each interaction with a web page different for each participant.

*Technically*, it is challenging to capture content that changes over time in a useful way to be used in visualizations of eye tracking data—especially if the content only changes on some parts of a page. Pro Lab captures a screenshot of each page the participant visits and whatever is shown on the page at that time will be what is visible in the Visualizations tab.

**More info about Lab browser**: When pressing F10 for next stimuli or Esc/Stop for ending the recording; it will take a few moments before the browser has reloaded or closed down. Make sure to not press the button again.

When pressing F10 for next stimuli or Esc/Stop for ending the recording; it will take a few moments before the browser has reloaded or closed down. Make sure to not press the button again.

**Screenshots**: Lab browser will capture a screenshot for every viewport (the part of the page which is visible on the screen) and then stitch them together to a full screenshot. The screenshot is captured before leaving the page. Any fixed elements on the page will be displayed only once and on the place where they first appeared. Fixations on a fixed element will be transferred to the right place even if the page was scrolled. Pro Lab might not be able to do a screenshot for Single Page Applications (SPA).

**Move to next and Stop**:

**Tabs:** The Lab browser does not display tabs. It will not display web pages prompted to be opened in a new tab or window. Participants can use Ctrl + click to open in the same window.

**Full screen mode**: The web page can only be displayed in full screen mode.

**Download:** Downloading is disabled although participants can still click the download link.

**Bookmark:** It is not possible to add bookmarks. This is because there is a new session of the web browser every time so customizations such as bookmarking are not possible.

**Video content**: Flash player is not installed and cannot be installed which may cause some video content to not be displayed.

**Hamburger menu**: The hamburger menu in the upper right corner is visible but has no function.

## 6.2 Making a scene camera-based recording

When you have created a new scene camera project, or opened an existing one, the Project Overview window appears on your screen. Open the Record module by clicking the Record option in the main menu bar.

A recording is terminated by an action of the moderator

### 6.2.1 Starting a scene camera-based recording

Procedure for making a recording:

1. Check that the devices used for the recording are enabled and selected. They (e.g. the eye tracker, scene camera and TTL out port) are represented by cards at the top of the window. Note that there is no Timeline(s) in Scene Camera projects. See *6.7 Changing device settings* for more information.

   The Scene Camera card is only displayed when a Scene Camera is connected to the system.

2. Deactivate the scene camera's Autofocus function. See its user manual for more information. If the Autofocus function is active during a recording, focus may shift and cause incorrect data mapping.
3. Sound is recorded by a connected microphone by default. If you don't want to record sound, set this on the Scene Camera card by clicking on the card and disabling the "Use audio" switch. If more than one microphone are connected to your system, select which one to use in your recording.
4. Select which participant you are recording. If there are no recordings with that person, click on the "+New" button and enter the name of the participant in the name field. If no name is entered, Pro Lab suggests one, such as "Participant1."

   You can define or edit already-defined participant variables; see "*6.2.5 Participants and Participant Variables*" for more information.

5. Enter the recording's name in the "Recording name" input field in the Recording section. If no name is entered, Pro Lab suggests a one, such as "Recording1."
6. Start the recording by clicking the "Start recording" button.

When you use an eye tracker that is not attached to a monitor, it must be configured so that the application registers where the eye tracker is located in relation to the stimulus and what area is supposed to be measured. The eye tracker should be configured for stand-alone use using Tobii's free Eye Tracker Manager software. There is also configuration information included in your eye tracker's user manual.

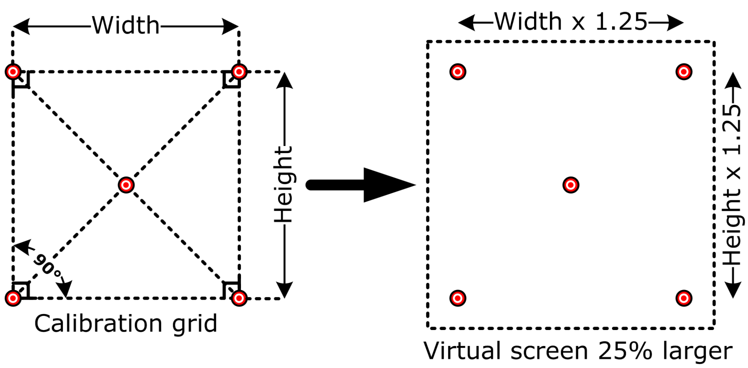
If you disregard configuring the eye tracker, you will get incorrectly mapped data.

### 6.2.2 Moderating a scene camera-based recording

When a recording starts, the Pro Lab application window switches to the moderator view. It displays the video of the scene camera and informs the moderator whether the eye tracker is detecting gaze, whether the participant is positioned in a way that enables data collection, for how long the recording has been running , and what participant name and recording name are used. It also provides the moderator with a way of terminating the recording at any time

### 6.2.3 Performing a scene camera-based calibration

You ensure good eye-tracking data by performing a calibration before starting data collection for analysis. When you use a scene camera, you can calibrate in two ways: either with a pre-made calibration board, such as the one included with Mobile Device Stand accessory (or with one you make by yourself) *or* by using any physical object, such as a mobile phone or table.




This image is an example of a calibration board

The calibration controls are displayed in the Record module.

Procedure for performing a calibration:

1. Put the calibration board or a physical object in front of the scene camera at the required distance.
   a. Set the active area that you want to measure by moving the four purple markers to the corners of your requested area.
   b. Add the desired calibration points by dragging them from the small box in the top right corner of the window. You must use at least two calibration points, but your calibration result improves with more points. We recommend five points: four about 25% inwards from the four corners and one in the middle.
   c. If you use a physical object, select points that can be easily defined as targets for the participant.
   d. When you are done, lock the calibration plane by clicking the pad-lock symbol on the right side of the window.
2. Start the calibration by clicking the “Calibrate” button. Two buttons appear: “Calibrate point” and “Abort calibration”.
3. The first calibration point is indicated. Instruct the participant to look at it. When she/he does it, press “Calibrate point”. Repeat this step for each calibration point.
4. You abort the calibration by pressing “Abort calibration”.

## 6.2.4 Ending a recording

A recording can either end when the last stimulus has been displayed or by an action of the moderator.

You stop a recording before the last stimulus has been completed by clicking on the “Stop recording” button in the moderator view or by pressing the “Esc” button on the keyboard.

A Scene Camera recording can only be stopped by the moderator, as the recording doesn’t follow a timeline.

## 6.2.5 Participants and Participant Variables

Participant Variables are used to filter data when generating visualizations, calculating eye tracking metrics and comparing the behavior of different participant groups. Variable and variable values are also included in the data export files for further statistical processing. Once created, you can select values for the participant variables when you edit your participants.

The participant variables are handled from the Participant card in the Record module or on the Project Overview. You can define participant variables before or after recordings.

### 6.2.5.1 Adding a new participant variable

You can add, edit, or remove participant variables from either the Project Overview or Record panels:

1. If you work from the Record tab, click the **Edit variables** button. If you work from the Project Overview window, the Participant Variables button is on the left-hand side. Click the button to display the Participant variables panel on the right-hand side of the screen. Use the panel to add, edit, or remove participant variables.

2. If this is the first time you are adding participant variables, use the Plus “+” button to add a new participant variable and a generic participant variable. If you already have participant variables defined for this participant, they are displayed in the **Participant variables** panel. Read *6.2.5.3 Edit a participant variable, page 28*”.
3. Enter the name of the first participant variable in the text field and press Enter.
4. Add a new value for the participant variable by clicking the “+” button. A new participant variable value is added.
   a. Enter the name of the value.
   b. Add the wanted values by using the Add Value button.
   c. If the participant variable is supposed to accept multiple values, select the “Allow multi selection” check box.
   d. You can also add a new value by pressing Enter in a value field.
5. When you have added the desired values, you can add another participant variable by repeating steps 2–4d.

#### 6.2.5.2 Adding a new participant

Procedure for adding a new participant:

1. Click the Plus “+” button and enter the participant’s name.
2. If there are already defined participant variables, select the values for the participants.

#### 6.2.5.3 Edit a participant variable

Procedure for editing an existing participant variable in the Project Overview:

1. If you need to expand the desired participant variable, click on the down arrow below it or click on the “Expand all” button to display all participant variables.
2. Edit the desired the data. When you are done, press Enter.
3. If you want to create new participant variables and values, see “*6.2.5.1 Adding a new participant variable*”.

Options for deletion:

- If you want to delete a value for a participant variable, click the trash can symbol to the right of the value.
- If you click the trash can symbol to the right of the participant variable name, you delete that participant variable and all of its values. A dialog box lists the affected participants.

#### 6.2.5.4 Deleting a participant

Procedure for deleting a participant:

1. Find the desired participant and press the trash can symbol to the right of the participant name.
2. If there are existing recordings for this participant, Pro Lab lists those that are about to get deleted. **If you want to keep these recordings, DON’T delete the participant.**

## 6.3 Making a VR 360 recording

You use the Tobii Pro Lab VR 360 Edition to record, replay and analyze eye tracking data of 360 degree images and videos.

You can make VR 360 recordings with Pro Lab by using an HTC VIVE Pro Eye or the Tobii Pro VR Integration (an HTC Vive VR headset retrofitted with an integrated Tobii Pro eye tracker).

Before doing a recording, you need to set up the VR headset.

### 6.3.1 Setting up your VR headset

**HTC Vive Pro Eye:**

- Follow the setup instructions for the HTC VIVE Pro Eye on the VIVE setup page.

**Tobii Pro VR Integration:**

- Go to the VIVE setup page and chose HTC Vive headset. Follow the instructions.
- Download the Tobii Core Software for VR at http://developer.tobii.com/?wpdmdl=205. It contains the drivers required for running the Tobii VR eye tracker.

### 6.3.2 Setting up the Tobii Pro VR Integration headset

- Download the Tobii Core Software for VR. It contains the required drivers for the VR eye tracker. Download the software by checking item 1 in the setup guide located at this link: https://www.tobiipro.com/product-listing/vr-integration/#GetStarted
- SteamVR provides information on how to install and set up the Tobii Pro VR Integration headset. The installation instructions are here: https://support.steampowered.com/steamvr/HTC_Vive/
- You can view a Vive setup instruction video on YouTube: https://www.youtube.com/channel/UCiw1w2kYUHWQOkWlZbMqcaQ/
- Set up the room using SteamVR before making any VR 360 recordings with Pro Lab.

### 6.3.3 Starting a VR 360 recording

You use the VR 360 project type when you make recordings and analyze eye-tracking data on 360 degree images and videos.

- You can create a VR 360 recording by adding a 360 degree image or video to your timeline in the Design tab. The 360 degree media is supposed to be monoscopic and formatted in an equirectangular projection, which is the most commonly used 360 degree media type. These images and videos have a 2:1 width to height proportion.
- SteamVR is started the first time you click the Record tab. SteamVR communicates to the VR headset and the controllers.

When recording with the HTC VIVE Pro Eye for the first time, you may experience a connectivity issue. Read how to solve this in the following FAQ: Tobii Pro Lab 1.123 compatibility with the Vive Pro Eye.

Procedure for making a recording:

1. Setting up the VR Headset:
   a. Ensure that the VR headset is connected and that SteamVR displays status “Ready”.
   b. Instruct the participant to put on the VR headset and make sure that it is correctly positioned by checking the track status in the VR Headset device card. That card is represented at the top of the window in the Record tab.
   c. If necessary, turn the knob on the headset to adjust the distance between the lenses, so that the circles in the track status are positioned in the middle of the squares.
   d. When the headset is positioned correctly, the track status turns green.
2. Select the desired Timeline for the recording.
3. Select the desired participant for the recording or create a new participant by clicking on the “+New” button.
4. Enter the recording’s name in the “Recording name” field in the Recording section.
5. Start the recording by clicking the “Start recording” button.

### 6.3.4 Moderating a VR 360 recording

When a recording starts, the Pro Lab application window switches to the moderator view. It displays the stimuli that the participant sees in the VR headset and it also informs the recording moderator whether the headset is positioned in a way that enables data collection, for how long the recording has been running, and what participant name and recording name are used. It also enables the moderator to terminate the recording at any time.

### 6.3.5 Performing a VR 360 calibration

You ensure good eye-tracking data by calibrating your headset before starting data collection for analysis. The Timeline in the Design module contains a calibration stimulus. If need be, you can modify its position in the Timeline by dragging and dropping it. The calibration procedure starts when the stimulus is reached on the Timeline.

Procedure for calibrating the eye tracker in the VR headset:

1. Ensure that the headset is positioned correctly on the head by using the track status. The track status is supposed to be green and the white circles are supposed to be in the middle of the squares. You might need to change the distance between the lenses in the VR headset using the knob on the VR headset.
2. Instruct the participant to let their gaze follow the dot.

3. When the calibration is completed, a message appears, saying either “Calibration succeeded” or “Calibration failed”. If the calibration failed, check that the headset is positioned correctly by using the track status, and then re-do the calibration by restarting the recording.

### 6.3.6 Ending a VR 360 recording

A recording ends either when the last stimulus has been displayed or by the moderator’s intervention. You stop an ongoing recording manually by clicking on the “Stop recording” button in the moderator view or by pressing “Esc” on the keyboard.

## 6.4 Making an External Presenter recording

An external presenter is a piece of software, for example E-Prime or other third-party software, that communicates with your Tobii Pro Lab software. This section describes how you install the relevant software and connect the eye tracker to the test computer, to Tobii Pro Lab, and to E-Prime.

Appendix I provides an example of how you can analyze an External Presenter project recorded by E-Prime.

The E-Prime Eye Tracking Extensions for Tobii Pro enable you to combine E-Prime’s experiment design and stimulus presentation with Tobii Pro Lab’s visualizations and AOI analysis. The extensions enable E-Prime to communicate with the Tobii Eye Tracker (TET package) and the Tobii Pro Lab software through a set of instructions (Routines). These instructions are organized in two E-Prime packages:

- The TET Package contains instructions that interact directly with the eye tracker.
- The TobiiProLab Package (TPL) contains a collection of instructions that interact with Tobii Pro Lab. For example, it instructs Tobii Pro Lab to start recording.

### 6.4.1 Connecting the computer and Tobii Pro eye tracker

Procedure for connecting your computer and the Tobii Pro eye tracker:

1. Connect peripherals (keyboard, mouse and other peripherals that you are supposed to use during your eye-tracking experiments) and power cable to the test computer.
2. Assemble the eye tracker (if necessary) and connect its power cable if there is one. For more information, check the user manual for your Tobii Pro eye tracker.
3. Connect the LAN cable and video cable to the eye tracker and the computer.
4. *Optional:* Connect the secondary screen to the computer. This requires a dual output graphic card or a splitter.
5. Switch on your computer and your eye tracker.
   - If no image appears on the eye tracker’s screen, click the Source button located in the front of your eye tracker.

### 6.4.2 Configuring the computer and installing the software

Procedure for configuring and installing:

1. Install Tobii Pro Lab, E-Prime and E-Prime Extensions for Tobii Pro on the test computer. For more information, see: https://www.tobiipro.com/learn-and-support/learn/steps-in-an-eye-tracking-study/setup/setting-up-pro-lab-with-e-prime/
2. Connect the E-Prime dongle to one of the USB ports of the computer and install the dongle driver. Windows detects and installs the correct driver automatically. If Windows doesn’t to find the correct driver, check this support page for advice (login is required): https://support.pstnet.com/hc/en-us
3. Reboot your computer.

### 6.4.3 Connecting Tobii Pro Lab to the eye tracker

Procedure for connecting Tobii Pro Lab to the eye tracker:

1. Launch Tobii Pro Lab on your computer.
2. Create a new *External Presenter* project and a new test.
3. Go to the *Record* tab and check that the eye tracker is up and running.
4. Switch to E-Prime.

### 6.4.4 Setting up an experiment in E-Prime Extension and Tobii Pro Lab

Procedure for setting up a simple experiment using various package calls to control the eye tracker and Tobii Pro Lab. (For more information about available routines and parameters, check the manual for E-Prime Extensions for Tobii Pro.) Before you start, make sure that E-Prime Extensions for Tobii Pro has been installed.

1. Open E-Studio and create a new *Basic experiment*.
2. Go to the *Experiment Object*, select the *Packages* tab, and add the TobiiProLab package and the TET package
3. Go to the *Devices* tab and add the TobiiProLab device and the TobiiEyeTracker (TET) device.
   - Leave the default parameters for these two devices as they are, unless you have problems connecting to your eye tracker (for example, if you use several eye trackers on the same network).
4. Start Tobii Pro Eye Tracker Manager and select your eye tracker. Eye Tracker Manager is free Tobii Pro software available on the Tobii Pro Products webpage.
5. Open the *SessionProc*, which is the topmost procedure in the experiment.
6. At the beginning of the *SessionProc*, add the following routines in order:
   a. TETOpen *(comment: opens a connection to the eye tracker)*
   b. TETCalibRegular *(comment: performs a calibration of the user)*
   c. TPLOpen *(comment: opens a connection to Tobii Pro Lab)*
   d. TPLStartRecording *(comment: instructs Tobii Pro Lab to start the recording)*
7. At the end of the *SessionProc*, add the following routines in order:
   a. TPLStopRecording *(comment: instructs Tobii Pro Lab to stop the recording)*
   b. TPLClose *(comment: closes the connection to Tobii Pro Lab)*
   c. TETClose *(comment: close the connection to the eye tracker)*
8. Open the trial-level procedure in the experiment, called *TrialProc*.
9. In the beginning of the *TrialProc*, add the *TPLSetDisplayEvent*. This entails setting a few parameters:
   - <MediaName>: Enter the name of the media that you want to use for Tobii Pro Lab. The media name is also the main channel for send information about the conditions applied to this stimulus.
   - In this case: we write "Stim_[Text]" as the parameter. This appears in Tobii Pro Lab as "Stim_Cat" if the Text variable in that trial was "Cat". All relevant experiment factors are supposed to be included in the name. Example: If you have Position (left/right) and Animal (cat/dog) as factors and they exist as E-Prime variables, your parameter may be "[Position]_[Animal]_[Image]".
   - <ObjectName>: This is the name of the E-Prime object that you create as a stimulus image and send to Tobii Pro Lab. In this experiment, use the name of the object *Stimulus*, so add "Stimulus" as the parameter.
10. If you have AOIs that correspond to the positions and sizes of E-Prime objects, define the AOIs and send them to Tobii Pro Lab. Add a TPLSetAOI routine after the previous routine but before your experiment stimuli. By default this routine has *c* (context) as a parameter, but you are supposed to add more parameters:
    - The media name argument from the *TPLSetDisplayEvent*, to make sure that you put the AOIs on the right image.
    - The name of the AOI, e.g. "AOI1". If the name isn't unique, Tobii Pro Lab changes it to make it unique.
    - The E-Prime object that defines the AOI. Example: An E-Prime Slide object "Stimulus" has a *SlideImage* sub-object called "AOIleft", and therefore you are supposed to pass "Stimulus.AOIleft".
    - You may pass more AOI arguments, as long they come in pairs of the name of the AOI and the of corresponding E-Prime object.
    - A full parameter list can look like: c, "Stim_[Text]", "AOI1", "Stimulus.AOIleft", "AOI2, "Stimulus.AOIright"
11. If you intend to have AOI tags, insert the *TPLSetTag* routine and add the following arguments:
    a. The media name from the two previous routines.
    b. The pairs of AOI names and tags, for example:
       - "AOI1"
       - “left" or "Animal.cat" with the former being an ungrouped tag, and the latter being a tag of the tag group Animal.
12. At the end of the *TrialProc*, add a *TPLCompleteLabEvents* routine.
13. Your simple experiment is now ready for execution.

## 6.5 Renaming a recording

Procedure for renaming a recording:

1. Select the desired recording in the *Project Overview*.
2. Activate the renaming functionality by
   - by pressing F2, *or*
   - by clicking on the recording's name. A drop-down appears. Select "Rename Recording".
3. Enter the new name in the field.

## 6.6 Exporting calibration results

For Screen and Scene camera projects, calibration results can be viewed and exported after data collection. This facilitates the evaluation of individual recordings for inclusion or exclusion in the data analysis and specification of calibration quality in reports and publications.

When viewing the recordings list in the Project Overview, you can:

- check whether a calibration has been performed by clicking on the arrow to the left of each recording. If you see a calibration icon, click it to display a results image
- review calibration data by hovering your cursor over the corresponding points in the image
- select one of the view options "Average Results" or "Left and right eyes results" in the bottom left-hand corner of the image
- save the calibration results image as a .png file.

**Exporting the calibration data in spreadsheet format**

1. Select a participant's row in Project Overview.
2. Click the down arrow to see more information.
3. If there is a calibration result, you'll see the estimated accuracy of the result.
4. The calibration results display with the total average results shown in a table at the bottom.
5. To save the image, click the Save image to file button at the bottom right and navigate to where you want to save the .png file. The export file contains the data of all recordings in the recordings list. The values in the export file are average values.

A screen camera project will usually contain a calibration validation. This will be exported in the same way as a calibration without validation.

## 6.7 Changing device settings

Pro Lab can interact with several devices during a recording, for example eye trackers, TTL parallel ports, external scene cameras, GSR units or monitors. Before the recording, you need to configure the devices that are represented as cards above the Timelines on the Record tab.

### 6.7.1 Add a device

Use the Plus (+) button in the upper right on the Record tab. Here you can add a Shimmer GSR, microphone, and/or participant camera.

The color of the device card indicates its current state:

- *Gray* = active
- *Red* = inactive

### 6.7.2 Remove a device

For some recordings, you might not want to use all devices connected to your Pro Lab computer. For this reason, you can remove them and add them back when you need them.

How to remove a device:

1. Click to expand the card for the desired device.
2. Click the Remove button. The device is now inactive during recordings.

Add the device back again or for the first time using the steps in *6.7.1 Add a device*

## 6.7.3 Changing participant camera and microphone settings

Pro Lab does not support Bluetooth cameras and microphones. References in this manual to cameras and microphones assume a wired connection to the computer.

### 6.7.3.1 Participant camera

- Use the Plus “+” button on the right-hand side of the Record tab to add a Shimmer GSR, microphone, and/or participant camera.
- If a participant camera is added, click the card to see the drop-down list of available cameras and select one. Click the drop-down list of video resolutions to select one. (See notes below)
- You can drag the participant camera view anywhere within the replay window using the Move button. You can expand the size of the participant camera view by clicking the expand button at the top right of the view window.
- The expander at the top right of the participant camera view window allows you to increase the window size.

Pro Lab displays a list of your camera’s available resolutions. Pro Lab selects the best possible frames per second (fps).” Click the **Remove** button on the card to remove the camera.

Choose a lower resolution if you require a smaller file size.

### 6.7.3.2 Microphone

Add a microphone by clicking the Plus button above the timelines on the Design tab. To use a microphone, click the card to see the drop-down list of available microphones and select one. Or click the Remove button on the card to remove it.

### 6.7.3.3 Replaying a recording

In replay there are separate sliders for the sound in the video (stimulus) and the sound from the microphone. Click the sound icon to control recording sound (stimuli sound) or microphone sound. Drag the slider to zero if you don’t want to hear any sound at all.

If you record participant video or audio you can only use x1 (normal) speed to replay it in order for the synchronization between participant video/audio and Stimuli video to function correctly.

## 6.7.4 Changing the eye tracker settings

The eye tracker card informs you about the eye tracker’s type, in what frequency it delivers gaze data, and in which mode it operates.

If the participant is positioned correctly in front of the eye tracker, their eyes are represented in the black square on the right side of the eye tracker’s card at the top.

If you click on the eye tracker card, information appears about the eye tracker’s serial number and firmware version. If there is a participant in front of the eye tracker, you will also see where in the track box she is positioned.

### 6.7.4.1 Changing which eye tracker to use during recording

Procedure for selecting eye tracker:

1. Click the eye tracker card.
2. Click the drop-down menu on the card. The menu lists what eye tackers are available on the network for the moment (appear as light grey text) or that have been available previously to the Pro Lab computer (appear as dark grey text).
3. Select the desired eye tracker.

You can select an eye tracker which is currently not connected to the Pro Lab computer. If a recording is initiated using such a setting, a warning will be displayed to the moderator. The moderator can then select to abort the recording or to continue without recording gaze data.

#### 6.7.4.2 Changing settings for an eye tracker

Some eye tracker properties can be set and adjusted in the eye tracker card. When you have selected an eye tracker from the list of available ones, its setting options are displayed.

All settings are not available for all eye tracker models. Refer to your eye tracker's manual for more about available settings and how they affect gaze data. This is particularly important for the Eye Tracking Mode settings, as those can impact how gaze data is collected.

Procedure for selecting gaze data frequency for a recording:

1. Click on the eye tracker card.
2. In the *Frequency* section of the card, select the desired frequency.

Procedure for selecting eye tracking mode for a recording:

1. Click on the eye tracker card.
2. Open the drop-down menu in the *Eye Tracker Mode* section.
3. Select the desired eye tracker mode.

### 6.7.5 Changing TTL parallel port settings

The TTL parallel port is used for signaling to external listeners about Pro Lab's estimates about how soon a stimulus appears on the presentation screen.

You make the TTL parallel port card visible by enabling the option "Send Stimulus onset markers (TTL)" in the Design module.

When you click on the TTL parallel port card, it provides information about the LPT port number (i.e. LPT1).

Procedure for selecting parallel port:

1. Click on the TTL parallel port card.
2. Open the drop-down menu.
3. Select the desired parallel port.

## 6.8 Ensuring good stimuli presentation timing data

When analyzing gaze data, you need to know what the participant of the study saw during the data collection. Read more in the Tobii Pro Learning Center article, *Stimulus presentation timing in Tobii Pro Lab*.

### 6.8.1 Modifying screen latency settings

Pro Lab timestamps the moment when the application assumes that a stimulus was displayed to the participant. This enables the application to associate the correct stimuli with the data, Its assumption is based on the screen latency, that is, the delay between sending a stimulus to the screen and the screen displaying it. However, a screen usually don't share this information with the connected computer, so if precise timing is required, you must enter this value manually. It is usually listed in the screen's technical specifications.

Pro Lab sends the TTL markers when it estimates that the stimulus has appeared on the screen. This estimation is based, unless otherwise specified, on a zero lag display and a 10ms. screen latency. If you need to send TTL markers at stimulus onsets with higher timing precision, read the Tobii Pro Learning Center article, *Stimulus presentation timing in Tobii Pro Lab* about how to set up precise stimulus timing.

Procedure for modifying the estimated screen latency setting of the presentation screen:

1. Click on the screen in the *Target Screen* section of the desired *Record module* interface.
2. Click on the text ending with "ms*" under the representation of the presentation screen.

3. Enter the estimated latency of the desired screen.

# 7 Biometrics

## 7.1 Setting up a Shimmer GSR sensor

A Shimmer GSR sensor measures the conductance in the participants' skin during the experiment. Tobii Pro Lab records these values over time.

Before using a Shimmer GSR sensor with Pro Lab. you need to pair the unit to your PC via Bluetooth. This is only necessary the first time you connect the sensor. After the initial pairing, the sensor appears in Pro Lab until you manually unpair it from your PC.

Procedure for pairing a Shimmer GSR sensor to your PC:

1. Open the Windows Bluetooth dialogue.
2. Switch on the Shimmer sensor. This enables other Bluetooth units to discover it.
3. When Windows detects the Shimmer sensor, it asks for a four-digit passcode. The default is “1234”.
4. Enter the code. After a few seconds, the sensor's indication LED starts flashing slowly in blue to indicate the Bluetooth link is active. You can now use the Shimmer GSR sensor in Pro Lab.

Procedure for adding the Shimmer GSR sensor in Pro Lab:

1. Make sure that Shimmer's recording application — “Consensys Software” — is not running when you open Pro Lab.
2. Open the *Record* tab in Pro Lab.
3. Click on the plus (+) button in the upper-right corner.
4. Click on the *Shimmer GSR Add* button.
5. A new card for the Shimmer GSR sensor appears among the other recording device cards. It displays basic information about the sensor, such as its serial number, firmware version and frequency settings. The card also displays a GSR live-data representation, which is useful for checking the GSR data quality and see whether you need to adjust the participant's GSR sensor to improve the signal. Pro Lab can only record from one GSR sensor at a time. If you have more than one sensor paired, select the desired one.

## 7.2 Using the GSR Data Chart

This feature is only available for Screen Projects that use a Shimmer GSR+ sensor for recording GSR data.

The GSR Data Chart plots the galvanic skin response data recorded with the Shimmer GSR+ sensor. The GSR plot shows the participant's skin conductance over time, expressed in microsiemens (μS).

Procedure for enabling the GSR Data Chart:

1. Click on the downward pointing triangle next to “Visualizations” to the left of the Timeline. A menu appears.
2. Check the *GSR Data Chart* checkbox.
3. Close the menu by clicking anywhere outside of it.
4. Make all of the GSR Data Chart visible by clicking and dragging on the border between the video display area and the replay controls.

The chart shows the skin conductance value for each sampled GSR data point. If no time zoom is used (see “*8.1.2 Using replay settings*”), the data gets down-sampled to fit the resolution of the Gaze Data Chart window and then not all individual data points will appear.

The “Use Autoscaling” toggle switch is located to the left of the GSR Data Chart. When it is off, the chart displays the signal's complete range from zero to max. When it is on, the chart's Y axis is autoscaled to the signal's working range in the selected time window. The autoscaling function is limited to 0.5μS. If the GSR signal's working range in the selected time window is below this value, the GSR signal appears centered on the Y axis with a range of 0.5μS.

When you let your the mouse cursor hover over the GSR Data Chart, a cross appears with the mouse cursor at its center. You get information to the left of the cursor about where the horizontal line of the cross meets the GSR value axis. If the GSR data is not down-sampled, you will also get precise information to the left of the cursor about the GSR value and the time where the cross is placed.

## 7.3 GSR data filtering and analysis

Identifying skin conductance responses (SCRs) and determining their main characteristics is a common practice in galvanic skin response (GSR) research. SCRs can be produced in response to a specific event (e.g., stimulus onset), known as event-related skin conductance responses (ER-SCR), or appear spontaneously with varying rates.

In Pro Lab, the GSR analysis is made in the following way:

### 7.3.1 GSR data filtering

The GSR signal varies slowly over time. Rapid changes in the GSR signal are therefore considered to be external noise. When you analyze your GSR data, you need to remove two common types of noise or artifacts: high-frequency noise and rapid-transient artifacts. Pro Lab removes them by applying a median filter with a time window of 500 ms, followed by a mean filter with a time window of 1000 ms.

### 7.3.2 SCR detection analysis

After data filtering, Pro Lab applies a SCR detection algorithm to identify SCRs in the GSR data and calculate their main characteristics. Pro Lab uses the following procedure:

1. Pro Lab down-samples the GSR by an integer factor (only samples are deleted, not interpolations). Shimmer3 GSR + uses a down-sample factor of 8, resulting in a final sampling rate of approximately 15 Hz
2. Pro Lab applies a standard peak detection method (trough-to-peak) to identify local maxima and minima in the GSR signal. Trough-to-peak pairs get classified as SCRs when their amplitude is higher than the minimum amplitude threshold of 0.03µS.
3. Pro Lab calculates the main characteristics for each SCR detected:
   - *SCR amplitude*: Amplitude difference between GSR level at SCR onset and GSR level at SCR peak.
   - *SCR rise time*: Time difference between SCR peak time and SCR onset time.
   - *SCR half recovery time*: Time difference between the time when the GSR level has recovered to 50% of the SCR amplitude and the SCR peak time. In two cases Pro Lab don’t calculate this characteristic for a certain SCR(a): (1) when a second SCR(b) starts before the GSR level has recovered to 50% of the SCR(a), or (2) if the recording finishes before the GSR level has recovered to 50% of the SCR(a).

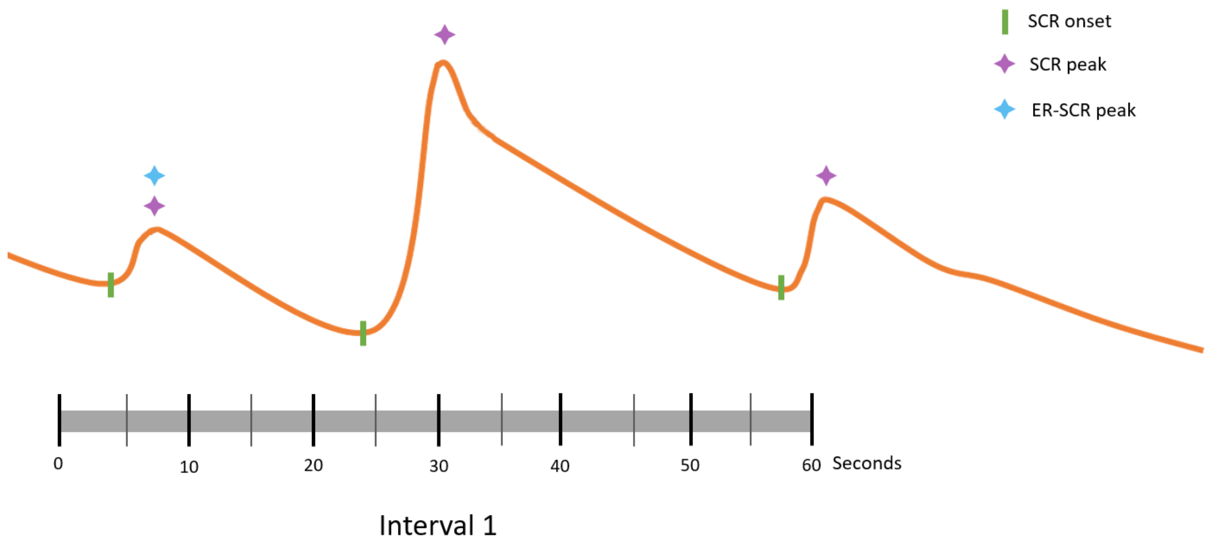
### 7.3.3 GSR metrics

SCRs can be generated as a response to an specific event (e.g., visual stimulus or unexpected question) known as event-related SCR (ER-SCR). ER-SCRs are the most common measure used in research to relate changes in emotional arousal to a specific stimuli. A good stimulus design that allows enough time between stimuli is necessary to avoid uncertainties about which stimulus caused a certain ER-SCR. Read more: *8.13.2 Understanding the metrics*

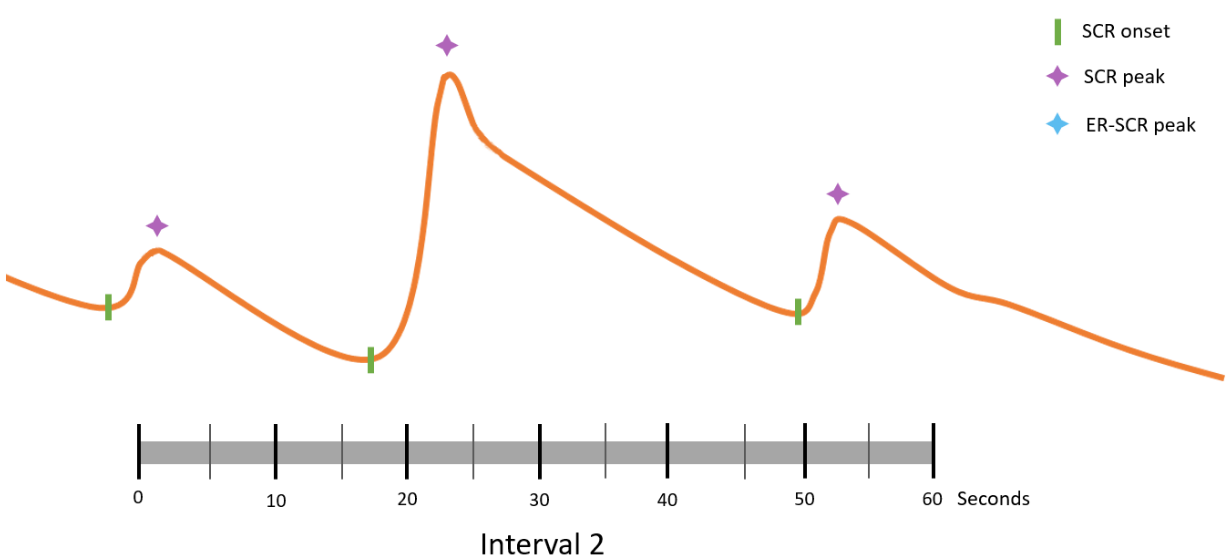
An SCR or ER-SCR is included in an interval when the SCR onset time is within the interval, even when part of the SCR (e.g., SCR peak) is outside of the interval. The reason is that the GSR signal changes very slow, and the closest moment to the external event that triggers the SCR is the SCR onset time.

Here are two examples of when SCR/E-SCR events are valid/counted in a TOI interval:

In Example #1 (below), the SCRs and ER-SCRs with peaks outside a given interval *will be* included in the interval as long as their SCR onset time happened within the interval.




In example #2 (below), the SCRs and ER-SCR with peaks within an interval *will not* be included in a given interval if their SCR onset time happened outside the interval.




## 7.3.4 ER-SCR classification

An SCR is considered to be a response to a specific event (e.g., stimulus onset) when the its onset falls within a specific time window after the event. In Pro Lab, all identified SCRs with their onset at 1s to 5s after a stimulus onset and custom time-of-interest (TOI) interval start get classified as ER-SCRs.

For each ER-SCR, Pro Lab calculates:

- **Event**: Name of the event that caused the ER-SCR.
- **Latency**: Time difference between the SCR onset time and the event time.

## 7.4 Export GSR Data

The data from the Shimmer GSR sensor is recorded in microsiemens (µS) and can be exported in sync with other sensor streams. See *8.14 Exporting data* for more information. The data can be exported in raw or filtered form. Raw data keeps the original sampling rate of 125Hz, whereas filtered data is down-sampled to 15Hz. When you export GSR data, you select between raw GSR data or filtered GSR data with the Tobii GSR filter on the Galvanic skin response (GSR) column.

# 8 Analyzing data

The Analyzer module provides you with tools that analyze your recordings or export data for further analysis in applications such as Matlab, Microsoft Excel, or SPSS.

For Pro Glasses 2, you need to import your data. See section 4.4.1 for details.

## 8.1 Replaying a recording

You open a replay tab by clicking on a recording in the Project Overview's Recording list or by selecting a recording from the Analyze dropdown menu.

### 8.1.1 Using replay controls

The replay controls are located under the panel showing the video (i.e. the video display area).

- Start video replay in the Replay tab by clicking the Play button at the bottom center.
- Pause the replay of a recording by clicking the Pause button at the bottom center. When a replay is in progress, the Play button is transformed into a Pause button.
- Step frame by frame in a recording by clicking the arrows at either side of the Play button to step forward or backward frame by frame in the video.

### 8.1.2 Using replay settings

The replay settings are located under the panel showing the video (i.e. the video display area).

Procedure for increasing or decreasing video replay speed:

1. Click on the *Replay speed control* icon on the bottom left. The *Replay speed* slider appears.
2. Increase (up) or decrease (down) replaying speed by clicking and dragging the slider's handle.

Procedure for increasing or decreasing replay audio volume:

1. Click on the *Audio volume control* icon on the bottom right. The *Audio Volume* slider appears.
2. Increase (up) or decrease (down) volume by clicking and dragging the slider's handle.

Procedure for changing the Recording Timeline Zoom Range:

1. Zoom in to a specific location on the Replay Timeline by clicking and dragging the *Zoom* handles above it.
2. If you need a higher zoom level for the entire Timeline, use the *Time Zoom* slider above to the left of the Timeline.

### 8.1.3 Using Timeline tools

Timeline tools help you work with your recordings.

#### 8.1.3.1 Navigating on the Timeline

The Timeline contains a series of thumbnails that facilitates your finding your desired recording section. In Glasses projects you can also display a second timeline preview below the first one.

Open a zoomed-in visualization of the selected part in the upper timeline by clicking on the *Visualizations* list box and selecting the 'Timeline preview' check box. The Timeline preview is affected by the applied *Time zoom* in the upper timeline.

Procedure for skimming through or jumping to a location in the video replay:

1. Locate the track slider on the Timeline below the video display area: the red object with a head resembling an upside-down droplet.
2. Click and drag the head to the desired starting point.

#### 8.1.3.2 Understanding the eye movements Visualization

Timeline has a section where you can check whether gaze data is recorded for that time and if so, how the current Gaze Filter classifies it (i.e. fixation, saccade, or unknown). Fixations appear as solid bars, saccades as thin lines, and unclassified data as grey bars.

When you hover the mouse pointer over one of the three elements in this Visualization, a small overlay window appears with information about the eye movement data at that point in the recording:

- **Type:** The gaze point's kind of eye movement: "Fixation," "Saccade," or "Unknown". If a Raw Gaze Filter preset is used, all gaze points become "Fixation." If no gaze data is available for that point on the Timeline, the type is "No gaze data."
- **Gaze samples:** The number of gaze samples indicates how many samples are assigned to each eye movement classification (i.e. how many samples belong to the current "Fixation," "Saccade," or "Unknown" eye movements).
- **Start:** The time here indicates when in the recording, the current eye movement started. It uses the format HH:MM:SS:mmm.
- **Duration:** The time here indicates the duration of the current eye movement. It uses the format HH:MM:SS:mmm.

If you work in a Glasses project where gaze mapping onto a Snapshot has been performed, a gray background is displayed for the recording parts where gaze data has been mapped onto the Snapshot. Read more about mapping data onto a Snapshot in the "*8.4.1 Using the Gaze Data Snapshots tool and gaze mapping*" section in this manual.

#### 8.1.3.3 Understanding the Snapshot Timeline Visualizations (Glasses projects )

If you have Snapshots in your Glasses project and have enabled the switch just below the video display area, each Snapshot gets a row below the Visualization. The Snapshot's file name appears at the left of its row.

If no data is mapped onto the snapshot, the row appears empty except for the Snapshot's file name. If data has been manually mapped to the Snapshot, each fixation is represented by a square whose width corresponds to the fixation's duration on the Timeline. When a Raw Gaze Filter preset is selected, the mapped data is represented by squares whose width correspond to the time between two samples from the eye tracker (e.g. 20ms for data from Pro Glasses 2 with a 50Hz data rate).

When the automatic mapping has been used for a snapshot, a diagram is added to the snapshot Visualization for the time when automatic mapping was used. This diagram indicates how confident the Real-World Mapping software was of the correctness of each mapped gaze point for that position in the recording. A high value indicates high confidence and a low value means there is a low confidence level. A low confidence level does not necessarily mean that the data is incorrectly mapped, but only that the software is not sure it is correct.

#### 8.1.3.4 Using the Gaze Data Chart

The Gaze Data Chart plots the angular eye velocity, gaze coordinates (raw or processed), and the classified fixation coordinates of a recording. The chart's main purpose is to help you set the parameters in the Gaze Filter, particularly when using an I-VT fixation filter, but it also provides you with direct access to the raw data when replaying a recording.

Procedure for enabling the Gaze Data Chart:

1. Click on the downwards pointing triangle next to "Visualizations" to the left of the Timeline. A menu appears
2. Check the *Gaze Data Chart* checkbox.
3. Close the menu by clicking anywhere outside it.
4. Make the whole Gaze Data Chart visible by clicking and dragging on the border between the video display area and the replay controls.

The data in the Gaze Data Chart can be toggled on or off using toggle switches. The axis to the left of the chart shows pixels, while the axis to the right is in degrees per second.

The available data in the chart is:

- **Gaze X:** This is the x-coordinate for each sampled gaze point. If no time zoom is used (see the "*8.1.2 Using replay settings*" section in this manual), the data gets down-sampled to fit the resolution of the Gaze Data Chart window (not all individual data points will appear).
- **Fixation X:** This is the x-coordinate of the fixations determined by the currently-used Gaze Filter.
- **Gaze Y:** The y-coordinates for each sampled gaze point. If no time zoom is used (see the "*8.1.2 Using replay settings*" section in this manual), the data gets down-sampled to fit the resolution of the Gaze Data Chart window (not all individual data points will appear).

- **Fixation Y:** This is the y-coordinate of the fixations determined by the currently-used Gaze Filter.
- **Gaze velocity w. threshold:** The thin line denotes the velocity calculated by the currently-used Gaze Filter, while the thick line indicates the threshold used when determining whether the data gets classified as a fixation or not. (Data with velocities above the thick line is classified as saccades, and data with velocities below is classified as fixations.)
- **Cursor Quick Data:** When you hover your mouse cursor over the Gaze Data Chart, a cross with the mouse cursor at its center appears. If this setting is enabled, you get information to the right of the cursor about where the horizontal line of the cross meets the velocity axis. To the left of the cursor, you get an indication where it meets the pixel axis. Placing the cursor on a point in one of the graphs in the chart displays the value of that point in both pixels and velocity.

#### 8.1.3.5 Using the Mapped Gaze Data Chart

This feature is only available in Glasses Projects using Snapshots and with the button “Snapshot” in the Replay Settings toggled *on*.

The Gaze Data Chart plots the angular eye velocity, gaze coordinates (raw or processed), and the classified fixation coordinates of a Snapshot. The data in the Mapped Gaze Data Chart is based on the fixations that are mapped onto it, either manually or by automatic mapping (see the “*8.4.1 Using the Gaze Data Snapshots tool and gaze mapping*” section in this manual). If the data was mapped using an I-VT Gaze Filter, all individual gaze points in the same fixation get the same x- and y-coordinates, and there is no data between fixations. This arrangement always sets the gaze velocity below the velocity threshold.

Procedure for enabling the Mapped Gaze Data Chart:

1. Click on the downwards pointing triangle next to “Visualizations” to the left of the Timeline. A menu appears.
2. Check the *Mapped Gaze Data Chart* checkbox.
3. Close the menu by clicking anywhere outside it.
4. Make the whole Gaze Data Chart visible by clicking and dragging on the border between the video display area and the replay controls.

The data in the Mapped Gaze Data Chart can be switched on or off by toggle switches. The axis to the left of the chart shows pixels while the axis to the right is in degrees per second.

The available data in the chart is:

- **Gaze X:** These are the x-coordinates for each sampled gaze point. If no time zoom is used (see the “*8.1.2 Using replay settings*” section in this manual), the data will be down-sampled to fit the resolution of the Mapped Gaze Data Chart window (not all individual data points will be shown).
- **Fixation X:** This is the x-coordinate of the fixations determined by the currently-used Gaze Filter.
- **Gaze Y:** These are the y-coordinates for each sampled gaze point. If no time zoom is used (see the “*8.1.2 Using replay settings*” section in this manual), the data will be down-sampled to fit the resolution of the Mapped Gaze Data Chart window (not all individual data points will be shown).
- **Fixation Y:** This is the y-coordinate of the fixations determined by the currently-used Gaze Filter.
- **Gaze velocity w. threshold:** The thin line denotes the velocity calculated by the currently-used Gaze Filter, while the thick line shows the threshold used when determining if the data should be classified as a fixation or not. (Data where the velocity is above the thick line is classified as saccades, and data with velocities below is classified as fixations.)

**Cursor Quick Data:** When you hover your mouse cursor over the Mapped Gaze Data Chart, a cross with the mouse cursor at its center appears. If this setting is enabled, you get infotmation to the right of the cursor about where the horizontal line of the cross meets the velocity axis. To the left of the cursor, you get an indication where it meets the pixel axis. Placing the cursor on a point in one of the graphs in the chart displays the value of that point in both pixels and velocity.

### 8.1.4 Using replay tools

The replay tools are located in the tools panel to the right of the Analyzer module interface.

#### 8.1.4.1 Understanding the Recording information

Recording Information is associated with the recording that was generated at the time of its creation. This information cannot be modified.

The Recording Information includes:

- **Recording**: The name that was entered in the *Recording Name* input field in Pro Lab when the recording was created. In Glasses projects, the recording name is generated automatically when the recording is created.
- **Participant**: The name that was entered in the *Participant Name* input field in Pro Lab or the Participant input field in the Pro Glasses Controller when the recording was created.
- **Duration**: The duration of the recording displayed as HH:MM:SS,mmm (hours, minutes, seconds, and milliseconds).
- **Date & Time**: The date and time when the recording was started.

#### 8.1.4.2 Using Gaze Data Settings tools

During the replay of a recording, gaze data is first processed and classified by the Gaze Filter and then superimposed on the recorded video. The eye movement classification algorithm (the Gaze Filter) and the appearance of the visualized gaze data can be customized to fit the needs of the researcher. The Gaze Filter processes and classifies the recorded gaze data samples into fixations and other eye movements. The settings of the filter can be saved as presets. In Pro Lab, there are currently three built-in presets. For details on how they work and what effect it has on your data, see the "*Appendix B Gaze Filters' functions and effects*" appendix.

When the Tobii I-VT (fixation) filter preset is enabled, the classified eye movements (fixations, saccades, unknown eye movements) are visualized below the Timeline in the replay view. Fixations are visualized as light gray, thick lines, saccades are visualized as light gray, thin lines, and unknown eye movements are visualized as striped gray, thick lines. Due to the short duration of eye movements, it might be necessary to zoom into the Timeline in order to distinguish between individual eye movement instances

Procedure for changing Gaze Filter preset:

1. In the Gaze Data section of the tools panel, select the Settings tab, and open the *Gaze Filter* dropdown menu.
2. In the dropdown menu, select the filter of your choice. The available options before any custom presets are created are:
   - **+ Create new Raw filter:** This option creates a custom filter and opens the filter preset configuration panel. See the steps below to create a new Raw filter preset.
   - **+ Create new I-VT filter:** This option creates a custom filter and opens the filter preset configuration panel. See the steps below to create a new I-VT filter preset.
   - Raw: If this preset is used, no classification of fixations, saccades, or unknown eye movements is done.
   - **Tobii I-VT (Attention):** This preset is optimized for wearable eye trackers and is used as the default preset for Glasses projects.
   - **Tobii I-VT (Fixation):** This preset is optimized for screen-based eye trackers and is used as the default preset for Screen projects. Read more about the preset settings in the whitepaper titled "*Determining the Tobii Pro I-VT Fixation Filter's Default Values"* on our website.
3. The new filter preset is now applied during replay.

Procedure for creating a Gaze Filter preset:

1. In the Gaze Data section of the tools panel, select the *Settings* tab and open the *Gaze Filter* dropdown menu.
2. In the dropdown menu, select the *+ Create new Raw filter* or *+ Create new I-VT filter* option, depending on which kind of filter preset you want to create.
3. Modify the settings of your choice in the filter. For details about what each setting is and what affect it might have on the gaze data, please refer to the whitepaper called "*Tobii Pro I-VT Fixation Filter"* on our website.
4. The filter is now automatically saved and set as the currently-used filter. It can be selected again from the *Gaze Filter* dropdown list by referring to the name given to it during creation.
5. Hide the filter preset configuration panel by clicking on the cogwheel next to the *Gaze Filter* dropdown menu.

Procedure for changing Gaze Filter preset settings:

1. In the *Gaze Data* section of the tools panel, select the *Settings* tab and open the *Gaze Filter* dropdown menu.
2. In the dropdown menu, select the filter you want to modify.
3. Click on the cogwheel next to the *Gaze Filter* dropdown. This opens the filter preset configuration panel. Built-in presets in Pro Lab cannot be modified.
4. Modify the settings of your choice in the filter. For details about what each setting and what affect it might have on the gaze data, please refer to the whitepaper called "*Tobii Pro I-VT Fixation Filter"* on our website.

5. The modifications to the filter are automatically saved and applied to the data in the currently-replayed recording. These settings are per recording and not global settings.
6. Hide the filter preset configuration panel by clicking on the cogwheel next to the *Gaze Filter* dropdown menu.

#### 8.1.4.3 Using Events tools

Tools for logging interesting and important Events in the recordings are included in the software. These Event Types (e.g. "Participant picks up item 1") can also be exported together with all the other data collected during a recording. The logged Events, as well as automatically-generated Events, appear on the Timeline and in the Events List in the Events section of the tools panel on the right.

To manually log Events, you must first define the Event Types scheme that contains the Events you want to log and define which keyboard keys you want to use for logging the Events.

It is not possible to create two Event types with the same name within a project. If Event Types are created with the same name but on different computers and coding data from these projects are later merged into the same project, the Event types will also be merged.

Procedure for defining an Event Types logging scheme:

1. Locate the *Events* section in the tools panel on the right.
2. Click the *New Event Type* button at the top right of the panel. The *New Event Type* dialogue appears.
3. Enter the name/description of the Event in the input field to the left of the dialogue.
4. Click the dropdown menu and select the keyboard shortcut that you would like to use for logging this Event.
5. Click OK.

An Event Types logging scheme can also be created in the Project Overview section of the application. Please refer to the "*4.2 Managing Event Types*Managing Event types" section in this manual for more information.

Procedure for editing an existing Event Type:

1. Locate *Events* section in the *Tools* panel to the right.
2. Place the mouse cursor over the custom Event you want to edit. Three icons appear to the right.
3. Click the *Pen* edit icon. An *Edit Event Type* dialogue appears.
4. Edit the name/description of the Event in the input field at the left of the dialogue.
5. Click the dropdown menu and select the keyboard shortcut that you would like to use for logging this Event.
6. Click OK.

Event Types can also be modified in the Project Overview section of the application. Please refer to the "*4.2 Managing Event Types*Managing Event types" section in this manual for more information.

Procedure for deleting an Event Type from the Event Types scheme:

1. Locate Events in the *Tools* panel to the right.
2. Place the mouse cursor over the custom Event you want to edit. Three icons appear to the right.
3. Click the *Delete* icon that looks like a trash can. A Delete Event Type dialogue opens.
4. Click Delete Event to confirm.

Event Types can also be deleted in the Project Overview section of the application. Please refer to the "*4.2 Managing Event Types*Managing Event types" section in this manual for more information.

Procedure for logging an Event manually:

1. Make sure you have defined the Event Types that you would like to log.
2. While replaying or pausing a recording, press the shortcut key on your keyboard associated to the Event you want to log. Alternatively, click the Log icon that appears when placing the mouse cursor over an *Event Type* in the *Event Types* list in the *Events* section of the tools panel on the right.

You can filter which kinds of Events are visible in the Events list. The different kinds of Events are grouped into Event groups. The filter also affects which Events are visible on the Timeline.

The available Event groups are:

- **Recording Events:** Events included in this group are general Events relating to the recording (e.g. *Recording Start, Recording End, Eye Tracker Calibration start*, and *Eye Tracker Calibration end*).
- **Custom Events:** Events included in this group are Events generated from the Event Types created by the user.

- **Sync Events:** Events included in this group are Events generated in order to synchronize the gaze data with data from another data source (e.g. *Sync Port Out High, TTL in*, and *TTL out*).
- Screen project-specific Event groups:
  - **Participant Events:** Events included in this group are Events generated by the participant (e.g. *Mouse Events* and *Keyboard Events*).
  - **Stimuli Events:** Events included in this group are Events relating to the stimulus presentation (e.g. *Image Stimulus Start, Image Stimulus End, Video Stimulus Start*, and *Video Stimulus End*).
- **Glasses project-specific Event groups:**
  - **Logged live Events:** Events included in this group are user-created Events generated during recording using the Pro Glasses Controller (e.g. *Logged live Event*).
  - **Snapshot mapping Events:** Events included in this group are generated when mapping gaze from a recording onto a Snapshot (e.g. *Interval Start* and *Interval End*).

Procedure for using Events to navigate on the Timeline:

1. Locate the Event you want to navigate to in the Events list.
2. Click on the Event. The track slider on the Timeline will now have moved to the time of the Event on the Timeline.

#### 8.1.4.4 Selecting a frame and pairing it with Times of Interest

When analyzing dynamic content, you may select a background image and assign it to a section of a recording. The same background image can also be assigned to multiple sections of multiple recordings. This workflow is used to produce visualizations and extract AOI statistics from media elements that display dynamic content, such as scene camera recordings, video stimuli or Screen Recording stimuli.

Example: when analyzing interaction with a phone using the Mobile Device Stand, you may select the starting screen of the phone as the background image and assign the times in each recording when this screen was shown.

Procedure for selecting and assigning a background image:

1. Find a frame in the video that you would like to use as the background image.
2. Click the plus sign list box just above the timeline to the right and select “Save frame as media.”
3. Name the file in the popup box that appears and press OK.
4. You can assign a time interval to the background image by defining a Custom Time of Interest or by using an auto-generated Times of Interest (TOI). The background image can be selected for the TOI when you are editing the TOI.

You are also able to create a TOI and assign a background image (frame) in one step. If you select the plus sign list box just below the window to the right and select “Create TOI with frame.”

Selecting a frame and pairing it with a Time of Interest is only available in Screen and Scene Camera projects.

## 8.2 Multi-select recordings

You can multi-select recordings on the Project Overview tab using CTRL + click.

Right-click and select *Open in background tab* to open multiple recordings on the Analyze tab simultaneously.

*or*

Right-click and select *Delete recordings* to delete multiple recordings.

## 8.3 Exporting recordings

You can export a video clip or an entire audio and/or video recording.

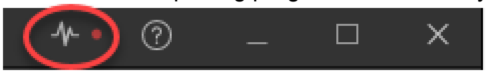
### 8.3.1 Exporting a video clip

You can export video clips with a gaze overlay from Pro Lab by using the recording’s Timeline within a Replay tab.

Exported video clips will not contain participant audio or video.

In VR 360 projects, the Export video feature is not available.

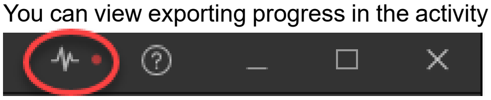
Procedure for exporting a video clip with a gaze overlay:

1. Select the interval on the Timeline you want export by dragging the yellow handles on either side of the red track slider to the desired start and the end.
2. Right-click on the interval or click the ellipsis (...) located directly over the timeline. A menu appears.
3. Select the *Export video clip* option. A file browser appears.
4. Enter the desired clip name in the “File name” input field.
5. Navigate in the file browser to the folder where you want to save the clip and click **Save**. The export starts.
6. You can view exporting progress in the activity queue in the top right of Pro Lab.
 In the activity queue you can cancel the export, open the file location when it’s finished exporting, and delete it from the queue.

### 8.3.2 Exporting a whole recording

You can export participant or stimulus audio and video as separate or merged files.

1. Select a recording from the list on the Analyze tab or from the left-hand side menu on the Project Overview tab.
2. Click the **Export** button above the timeline of the recording.
3. The Export Recording dialog opens.
4. Select the **Recording media** you want to export.
5. If you export **Sound** from a stimuli *and* participant recording, you need to select which source to use. You can only choose one source which means you can not export both the stimuli and the participant sound recordings.
6. Select **Video resolution** for export. 1920x1080 is the default.
7. If Participant video is selected, you can specify the size of it (in % of total screen). You can also choose to display video using *Picture in picture* or *Side by side* mode.
   a. **Picture in picture** enables you to click and drag the participant recording around in the preview window.

   b. **Side by side** enables you to show participant video on the left or right side using the arrows.
8. Save the .mp4 file to your computer. The default name is “Recording name Participant name” but you can change this to whatever you want.
9. Click the **Export** button to start the export.
   You can view exporting progress in the activity queue in the top right of Pro Lab.
    In the activity queue you can cancel the export, open the file location when its finished exporting, and delete it from the queue.

## 8.4 Mapping eye tracking data

Wearable eye tracking devices, such as Pro Glasses 2, produce eye gaze data mapped to a coordinate system relative to the wearable eye tracker and the recorded video, not to static objects of interest in the environment. For most statistical/numerical analysis to be meaningful, the collected eye tracking data needs to be mapped on to objects of interest and into a new coordinate system with its origin fixed in the environment around the participant. Pro Lab addresses this challenge with a solution called Real-World Mapping – Mapping gaze data in the real world.

Remote eye tracking devices produce eye gaze data that is then mapped to a coordinate system corresponding to the screenshot or frame.

### 8.4.1 Using the Gaze Data Snapshots tool and gaze mapping

The gaze data mapping in Pro Lab allows the user to map eye gaze data onto still images (Snapshots) of environments and objects of interest in two different ways: either semi-automatically by manual mapping or fully automatically with the automatic mapping function. The automatic mapping function uses our Real-World Mapping software technology to automatically map gaze data from Pro Glasses 2 onto a Snapshot (such as a supermarket shelf). The Snapshots images are typically created by the data collector or the researcher by using a standard digital camera.

Requirements for Snapshot images:

- Less than 25 megapixels
- PNG, JPG, GIF, or BMP file format

You can use Snapshots created from multiple images that are stitched together into one image are allowed as long as the final Snapshot file matches the Snapshot requirements above. (Stitched images are images that are put together from a series of images covering a greater area than the camera was capable of covering in just one shot.)

Procedure for importing a Snapshot from the Tools panel in the Replay tab:

1. In the *Gaze Data* section of the tools panel, select the *Snapshots* tab.
2. To the right of the text “Snapshot images,” click the “+” icon. A file browser opens.
3. Locate the image file (*.bmp, *.gif, *.png, or *.jpg) on your computer that you want to use as a Snapshot.
4. Click *Open*. An import progress bar appears.
5. When the Snapshot image has been imported, click OK.

Procedure for importing multiple instances of the same Snapshot image:

1. Create and save multiple copies of the image file you want to use as Snapshots.
2. Give each image file a unique file name.
3. For each copy of the image file, follow the instructions in the section above to import the Snapshot images.

To make the manual mapping process efficient, Pro Lab lets you map entire fixations onto a Snapshot with just one click, rather than mapping each gaze point individually. (To learn how this affects the data, read *B4 The effect of mapping data onto Snapshots with the Tobii I-VT or Raw Gaze Filter* in this manual.) If you have chosen to map data when the Raw Data Gaze Filter preset selected, the data will be mapped gaze point by gaze point. Gaze data from a recording can be mapped on one or several Snapshots.

Procedure for mapping data onto a Snapshot manually:

1. If not already enabled, enable mapping by clicking the *Snapshots* switch just below the video display area.
2. In the *Gaze Data* section of the tools panel, select the *Snapshots* tab.
3. Enable or disable the “Automatically step to next fixation” toggle switch. Enabling the “Automatically step to next fixation” switch will cause the paused reply to automatically jump to the next fixation/raw data point on the Timeline when a gaze point has been manually mapped. This eliminates the need to use arrow keys to step forward manually on the time line.
4. In the grid/list of Snapshot images, select the Snapshot onto which you want to map data. You can also select which Snapshot to map data onto from the list of Snapshots located below the replay Timeline. There, each Snapshot is represented by a thumbnail as well as a row on which it will be displayed for which parts of the recording data has been mapped. At any time during the mapping of data, you can switch back and forth between different Snapshots without losing mapped data.
5. While skimming through the recording replay, locate and pause the video at the start of the section that you want to map onto the selected Snapshot.
6. To map data onto the Snapshot, first locate the gaze data point (circle superimposed on the video) in the recorded video. Click once in the corresponding location on the Snapshot image as precisely as possible.
7. Continue this process until all data has been mapped onto the active Snapshot. As data points are mapped onto the Snapshot, the Snapshot time line will indicate at which times data points have been mapped.
8. Replay or manually step through the recording using the arrow keys once the mapping is completed and compare the mapping on the Snapshot with the gaze locations in the video to verify that data has been mapped correctly. If you want to move a mapped point, right click on it and select “Delete current manually mapped fixation point” from the menu. Then click on the Snapshot to map the gaze point in a new location.

Procedure for mapping data onto a Snapshot automatically with automatic mapping:

1. If not already enabled, enable mapping by clicking the *Snapshots* switch just below the video display area.
2. In the Gaze Data section of the tools panel, select the Snapshots tab.
3. In the grid/list of Snapshot images, select the Snapshot onto which you want to map data. You can also select which Snapshot to map data onto from the list of Snapshots located below the replay Timeline. There, each Snapshot is represented by a thumbnail as well as a row on which it will be displayed for which parts of the recording data has been mapped. At any time during mapping of data, you can switch back and forth between different Snapshots without losing mapped data.
4. Select the interval on the Timeline you want the gaze points to be to mapped automatically in. To select an interval, drag the yellow handles on either side of the red track slider to where you want the start and the end of the interval

to be. If needed, you can zoom in on the time line to make the interval selection easier. This is most often the part of the recording where the location or object shown on the Snapshot comes into view.

5. Right-click on the selected interval or click the ellipsis (...) located directly over the time line, and select "Run automatic mapping." The interval is now placed in the processing queue. The built in Real-World Mapping software starts processing the mapping automatically according to the order in the processing queue. If another mapping is already in progress, that mapping will completed before the next one is initiated. You can check the jobs placed in queue by clicking the number on the top right end of the window.
6. You can choose to create another mapping task by repeating steps 4 to 6 and place it in the processing queue, or, if you don't have any more pending tasks, continue to step 8.
7. When the automatic mapping is completed, a diagram is added to the section of the recording for which the mapping has been done on the row representing the Snapshot under the Timeline. This diagram indicates how confident the Real-World Mapping software is of the correctness of each mapped gaze point for that position in the recording. A high value indicates high confidence, and a low value, a low confidence level. A low confidence level does not necessarily mean that the data is incorrectly mapped – just that the software is not entirely sure it is correct.
8. Sections with low confidence levels should be reviewed and, if necessary, re-mapped manually (if incorrect mappings are found). Re-map gaze points manually by the following procedure:
   a. For each point, you can either
      - remove it by pressing the Delete button on the keyboard or by right-clicking on the point on the Snapshot and selecting "*Delete current automatically mapped fixation point"* in the menu that appears
      - correct it by manually clicking on the Snapshot where it should be, just like you learned in the manual mapping section, or
      - leave it as it is.
   b. Automatic color-coding:
      - In the row representing the Snapshot under the Timeline, manually-coded frames appear in solid green without a graph.
      - In the Snapshot image, automatically-generated mappings appear in a green circle, whereas manually mapped points appear in a red circle.
      - Overridden (i.e. deleted) automatically-mapped points appear in a grey circle.
   c. Repeat this procedure until you are satisfied.
9. Replay or manually step through the recording using the arrow keys once the mapping is completed and compare the mapping on the Snapshot with the gaze locations in the video to verify that data has been mapped correctly.

### 8.4.2 Using the Gaze Data Snapshots tool and gaze mapping for screen-based recordings (manual mapping)

The gaze data mapping in Pro Lab lets you map eye gaze data on images (Snapshots) from Screenshots, or manually created mapping images semi-automatically, using manual mapping. The Snapshots images are typically created by the data collector or the researcher using a screenshot tool or text editor.

Requirements for Snapshot images:

- Less than 25 megapixels
- PNG, JPG, GIF, or BMP file format

**How to import a Snapshot from the Tools panel in the Replay tab:**

1. In the Gaze Data section of the tools panel, select the Snapshots tab.
2. To the right of "Snapshot images," click the "+" icon. The file browser opens.
3. Locate the image file (*.bmp, *.gif, *.png, or *.jpg) on your computer that you want to use as a Snapshot.
4. Click Open.
5. When the Snapshot image has been imported, click OK.

To make the manual mapping process efficient, Pro Lab lets you map entire fixations onto a Snapshot with just one click, rather than mapping each gaze point individually. (To learn how this affects the data, see "*B4 The effect of mapping data onto Snapshots with the Tobii I-VT or Raw Gaze Filter*" section in this manual. If you have chosen to map data when the Raw Data Gaze Filter preset selected, the data will be mapped gaze point by gaze point. Gaze data from a recording can be mapped on one or several Snapshots.

**How to map data onto a Snapshot manually:**

1. If not already enabled, enable mapping by clicking the Snapshots switch just below the video display area.
2. In the Gaze Data section of the tools panel, select the Snapshots tab.
3. Enable or disable the "Automatically step to next fixation" toggle switch. Enabling this switch will cause the paused replay to automatically jump to the next fixation/raw data point on the Timeline when a gaze point has been manually mapped. This eliminates the need to use arrow keys to step forward manually on the timeline.
4. In the grid/list of Snapshot images, select the Snapshot onto which you want to map data. You can also select which Snapshot to map data onto from the list of Snapshots located below the replay Timeline. On the Timeline, each Snapshot is represented by a thumbnail as well as a row on which it will be displayed for which parts of the recording data has been mapped. At any time during the mapping of data, you can switch back and forth between different Snapshots without losing mapped data.
5. While skimming through the recording replay, locate and pause the video at the start of the section that you want to map onto the selected Snapshot.
6. To map data onto the Snapshot, first locate the gaze data point (the circle superimposed on the video) in the recorded video. Click once in the corresponding location on the Snapshot image as precisely as possible.
7. Continue this process until all data has been mapped onto the active Snapshot. As data points are mapped onto the Snapshot, the Snapshot timeline will indicate at which times data points have been mapped.
8. Replay or manually step through the recording using the arrow keys once the mapping is completed and compare the mapping on the Snapshot with the gaze locations in the video to verify that data has been mapped correctly. To move a mapped point, right-click it and select "Delete current manually mapped fixation point" in the menu. Then click the Snapshot to map the gaze point in a new location.

## 8.5 Visualizing eye tracking data

In the Visualizations tool in Pro Lab, data can be visualized using Heat Maps and Gaze Plots.

## 8.6 Creating and customizing a Heat Map

Heat Maps can be of great value when creating reports, papers, or presentations as they help you summarize large quantities of data in an intuitive way. Heat Maps are created on top of stimuli such as Snapshots or images. A Heat Map uses different colors to illustrate the number of fixations participants made within certain areas of the stimulus or for how long they fixated within that area. Red usually indicates the highest number of fixations or the longest time fixating there, and green the least, with varying levels in between. For more detailed information about Heat Maps, read the appendix "*Appendix C Calculating heat maps* " in this manual.

To be able to create Heat Maps on Snapshots in Glasses projects, at least one Snapshot in the project must have gaze data mapped onto it.

### 8.6.1 Creating a Heat Map

Procedure for creating a Heat Map:

1. Click on the *Visualizations* button - either in the *Project Overview* section or select it from the *Analyze* dropdown menu in the top navigation.
2. Go to the *Visualization Type and Settings* tool in the tool panel, to the right of the Visualization interface and select *Heat Map*.
3. Select what Gaze Filter to use when generating your Heat Map. Read more about Gaze Filters in the "*Appendix B Gaze Filters' functions and effects*" in this manual.
4. Go to the *Times of Interest* tool and select the Time of Interest (TOI) that you want to use as the base of your Visualization. TOIs based on start and end Events for stimuli, such as images or Snapshots, are represented by a thumbnail of that stimulus.
5. Go to the Recordings tool and select or deselect the recordings and intervals that you want to visualize in the Heat Map. Note that all TOIs generated per recording are represented by one interval in that recording. If the same stimulus was displayed multiple times, each time generates a TOI which then gets represented by an interval in that recording. This means that it is possible to analyze, for example, all data collected when a participant saw a stimulus during a recording or only parts of that data such as the first-time exposure. For TOIs relating to Snapshots in Glasses projects, the segments are generated by Snapshot start and Snapshot end Events. If there is a gap in the

data mapped onto a Snapshot of five seconds or more, a Snapshot end Event is generated automatically at the time of the last mapped gaze point and a Snapshot start Event when the next gaze point is mapped after the gap. To see the intervals included, click the arrows to the left of the recording checkboxes to expand the view.

6. Go to the Visualization Type and Settings tool in the tool panel at the right of the Visualization interface, open the Type dropdown menu, and select the calculation basis for the Heat Map (for more information about how this works, read the appendix “*Appendix C Calculating heat maps* ” in this manual.)
   The available options are:
   - *Absolute count* — calculated by the number of fixations (or gaze data samples if using a Raw data Gaze Filter).
   - *Absolute duration* — calculated by the duration of fixations (or gaze data samples if using a Raw data Gaze Filter).
   - *Relative count* — calculated by the number of fixations relative to the total number of fixations made by the participants during the Time of Interest (or gaze data samples instead of fixations if using a Raw data Gaze Filter).
   - *Relative duration* — calculated by the duration of the fixations relative to the sum of all fixation durations mapped in the Time of Interest on the Snapshot (or gaze data samples instead of fixations if using a Raw data Gaze Filter)
7. The Heat Map is now generated.

If the selected TOI is not associated with a Snapshot or image stimulus, the background for the generated Heat Map is set to Transparent by default.

## 8.6.2 Customizing the appearance of a Heat Map

The appearance of a Heat Map can be modified to better convey research findings. No underlying data is affected by changing any of the properties listed below.

The following properties of a Heat Map can be modified to change its appearance:

- **Background:** This setting modifies what the Heat Map is generated onto. It provides the following options:
  – **Image:** If this option is selected, the Heat Map will be rendered on top of the stimulus image or Snapshot associated with the selected TOI.
  – **Transparent:** Selecting this option results in a Heat Map generated on a transparent background. This is useful if exporting the Heat Map as an image for further work in (e.g. an image processing tool where it will be combined with some other background image).
  – **Black:** This option produces a Heat Map rendered on a black background.
  – **White:** This option produces a Heat Map rendered on a white background.
- **Radius:** This setting adjusts the size of each fixation’s contribution to the Heat Map. Read more about this the appendix “*Appendix C Calculating heat maps* ” in this manual. The property can be changed by using the slider - dragging it to the left will make the area smaller and, to the right, will make it larger. You can also click on the number to the right of the slider. Clicking on the number transforms it into an input field where you can type the desired radius of the fixation contribution.
- **Color:** This setting governs the appearance of the scale used for the Heat Map. To the left is what a low level of fixations or time fixating will look like, while the right side represents what an area with a lot of fixations or time fixating will appear as. The setting allows you to specify the color for the low, mid, and high level on the scale individually by offering a dropdown menu with a color picker for each level. Click on the color you want to use or enter a hexadecimal color code in the number entry field.
- **Opacity:** This setting determines the transparency of the Heat Map data.

**Scale max value:** This setting adjusts the value for which the max level (color to the right) in the color scale specified by the Color setting is reached. By default, the checkbox for this setting is unchecked, which means that the value is set automatically by Pro Lab. This setting is unavailable for Heat Maps for Relative count or Relative duration where the max value is always set to 100%.

## 8.6.3 Saving a Heat Map as an image

Heat Maps can be saved as image files to be incorporated later into reports or further modified in image-processing software. Available image file formats are *.png and *.jpg.

Procedure for saving a Heat Map:

1. Right-click within the Heat Map area. A Context menu appears,
2. Select *Save to File…* A file browser opens.
3. Locate the folder you want to save the file in.
4. In the *File name* field, enter a file name for your Heat Map.
5. Open the *Save as Type* drop-down menu and select the desired file type (*.png or *.jpg). (For Heat Maps with transparent backgrounds, the file type must be *.png to maintain the transparency.)
6. Click *Save*.

## 8.7 Creating and customizing a Gaze Plot

The Gaze Plot Visualization shows the sequence and position of fixations (dots) on a stimulus, such as an image or Snapshot. The size of the dots indicates the fixation duration and the numbers inside the dots represent the order of the fixations. Gaze Plots can be used to illustrate the gaze pattern of a single test participant throughout an entire recording or of several participants in a short time interval (e.g. when a specific stimulus was shown).

When you create Gaze Plots on Snapshots in Glasses projects, at least one Snapshot in the project must have gaze data mapped onto it.

### 8.7.1 Creating a Gaze Plot

Procedure for creating a Gaze Plot:

1. Click on the *Visualizations* button, either in the *Project Overview* section or select it from the *Analyze* dropdown menu in the top navigation.
2. Go to the *Visualization Type and Settings* tool in the tool panel to the right of the Visualization interface and select *Gaze Plot*.
3. Select the desired *Gaze Filter* for generating your Gaze Plot. Read more about Gaze Filters in the "*Appendix B Gaze Filters' functions and effects*" in this manual.
4. Go to the *Times of Interest* tool, select the Time of Interest (TOI) that you want to use as the base of your Visualization. TOIs based on start and end Events for stimuli such as images or Snapshots are represented by a thumbnail of that stimulus.
5. Go to the *Recordings* tool and select or deselect the recordings and/or intervals that you want to visualize in the Heat Map. All TOIs generated for a recording are represented by one interval in that recording. If the same stimulus was displayed multiple times, each time generates a TOI which then is represented by an interval in that recording. This means that it is possible to analyze, for example, all data collected when a participant saw a stimulus during a recording or only parts of that data, such as the first-time exposure. For TOIs relating to Snapshots in Glasses projects, the segments are generated by the Snapshot start and Snapshot end Events. If there is a gap in the data mapped onto a Snapshot of five seconds or more, a Snapshot end Event is generated automatically at the time of the last mapped gaze point and a Snapshot start Event is made when the next gaze point is mapped after the gap. To see the intervals included, click the arrows to the left of the recording checkboxes to expand the view.
6. The Gaze Plot is now generated.

If the selected TOI is not associated with an image or Snapshot stimulus, the background for the generated Heat Map is Transparent by default.

### 8.7.2 Customizing the appearance of a Gaze Plot

The appearance of a Gaze Plot can be modified to better convey research findings. No underlying data is affected by changing any of the properties listed below.

The following properties of a Heat Map can be modified to change its appearance:

- **Background:** This setting modifies what the Gaze Plot is generated onto. It provides the following options:
  – **Image:** If this option is selected, the Gaze Plot will be rendered on top of the stimulus image or Snapshot associated with the selected TOI.
  – **Transparent:** Selecting this option results in a Gaze Plot generated on a transparent background. This is useful if you are exporting the Gaze Plot as an image to work further with (e.g. an image-processing tool where it will be combined with some other background image).
  – **Black:** This option produces a Gaze Plot rendered on a black background.

- – **White:** This option produces a Gaze Plot rendered on a white background.

- **Fixation:** This setting specifies what determines the size of each fixation point in the Gaze Plot. The options are the following:
  - – **Duration:** The size of the point is determined by the duration of the fixation it represents. A long fixation is represented by a large point and a short fixation by a small point.
  - – **Same size:** If this option is selected, all points will get the same size independent of the duration of the underlying fixation.
- **Scale:** This property can be changed by using the slider - dragging it to the left will make the point smaller and moving it to the right makes it larger (or by clicking on the number to the right of the slider). Clicking on the number transforms it into an input field where you can type the desired radius of the fixation point.
- **Border color:** This setting governs the color of the border surrounding the gaze points. There are two options available:
  - – **Custom color:** If this option is selected, you can select which border color to use by using a dropdown menu with a color picker which appears to the right of the setting. To select a custom color, click on the dropdown menu to expand it and then on the color you want to use. You can also enter a hexadecimal color code in the number entry field. The same color will be used for all gaze points in the Gaze Plot.
  - – **None:** Selecting this option results in the gaze points being shown without any border at all.
- **Fill color:** This setting governs the fill color of the gaze points. There are two options available:
  - – **Recording colors:** If this option is selected, the color associated with each recording, as listed in the Data Selection tool, will be used for gaze points representing fixations from that recording.
  - – **Same color:** If this option is selected, all gaze points will have the same fill color. To select a fill color, click on the dropdown menu to the right of the Fill color options dropdown menu to expand it. Then, click on the color you want to use. You can also enter a hexadecimal color code in the number entry field.
- **Show gaze order:** This setting either shows or hides the order in which the fixations were made, represented by numbers in the gaze points in the Gaze Plot.
- **Show gaze trail:** This setting either shows or hides the lines connecting the gaze points, which represent fixations that happen sequentially.
- **Opacity:** This setting determines the transparency of the gaze points in the Gaze Plot. This setting only changes the opacity of the gaze point fill. The gaze point border opacity will always be set to 100% unless the “Border color” setting is set to “None.”

### 8.7.3 Saving a Gaze Plot as an image

Gaze Plots can be saved as image files that can be incorporated later into reports or further modified in image-processing software. Available image file formats are *.png and *.jpg.

Procedure for saving a Gaze Plot:

1. Right-click within the Gaze Plot area. A menu appears.
2. Click *Save to File…* A file browser appears.
3. Locate the folder you want to save the file in.
4. In the *File name* field, enter a file name for your Gaze Plot.
5. Open the *Save as Type* dropdown menu and select the desired file type (*.png or *.jpg). (For Gaze Plots with a transparent background, the file type must be *.png to maintain the transparency.)
6. Click *Save*.

## 8.8 Modifying the Gaze Filter setting

The eye movement classification algorithm (the Gaze Filter) and the appearance of the visualized gaze data can be customized to fit the needs of the researcher. The Gaze Filter processes and classifies the recorded gaze data samples into fixations and other eye movements. The settings of the filter can be saved as presets. In Pro Lab, there are currently three built-in presets. For details on how they work and what effect it has on your data, see the “*Appendix B Gaze Filters’ functions and effects*” in this manual.

Procedure for changing Gaze Filter preset:

1. Go to the *Visualization Type and Settings* section of the tools panel and open the *Gaze Filter* dropdown menu.

2. Select the desired filter. The available options (before any custom presets are created) are:
   - **+ Create new Raw filter:** This option creates a custom filter and opens the filter preset configuration panel. See the instructions below on how to create a new Raw filter preset.
   - **+ Create new I-VT filter:** This option creates a custom filter and opens the filter preset configuration panel. See the below instructions on how to create a new I-VT filter preset.
   - Raw: If this preset is used, no classification into fixations, saccades, or Unknown Eye Movements is done.
   - **Tobii I-VT (Attention):** This preset is optimized for wearable eye trackers and is used as the default preset for Glasses projects.
   - **Tobii I-VT (Fixation):** This preset is optimized for screen-based eye trackers and is used as the default preset for Screen projects. Read more about the preset settings in the whitepaper called "*Determining the Tobii Pro I-VT Fixation Filter's Default Values"* found on our website.
3. The new filter preset is now applied to the data used in the Visualization.

Procedure for creating a Gaze Filter preset:

1. Go to the *Visualization Type and Settings* section of the tools panel and open the *Gaze Filter* dropdown menu.
2. Select the *+ Create new Raw filter* or *+ Create new I-VT filter* option, depending on which kind of filter preset you want to create.
3. Modify the desired settings in the filter. For details about what each setting means and what effect it might have on the gaze data, read the whitepaper "*Tobii Pro I-VT Fixation Filter"* which is available on the Tobii Pro website.
4. The filter is now automatically saved and set as the currently-used filter. It can be selected again from the *Gaze Filter* dropdown list by referring to the name given to it during creation.
5. Hide the filter preset configuration panel by clicking on the cogwheel next to the *Gaze Filter* dropdown menu.

Procedure for changing Gaze Filter preset settings:

1. Go to the *Visualization Type and Settings* section of the tools panel and open the *Gaze Filter* dropdown menu.
2. Select the filter you want to modify.
3. Click on the cogwheel next to the *Gaze Filter* dropdown menu. The *Filter Preset Configuration* panel appears. Built-in presets in Pro Lab cannot be modified.
4. Modify the desired settings within the filter. For details about what each setting means and what effect it might have on the gaze data, read the whitepaper called "*Tobii Pro I-VT Fixation Filter"* which is available on the Tobii Pro website.
5. The modifications to the filter are automatically saved and applied to the data in the Visualization.
6. Hide the filter preset configuration panel by clicking on the cogwheel next to the *Gaze Filter* dropdown menu.

## 8.9 Changing the Gaze Trail settings

The Gaze Data Settings tab includes the following settings for the Gaze Trail feature:

- *Fill Color* — This is the fill color for the gaze point.
- *Contrast Color* — This is the color of the gaze point's border.
- *Opacity* — This value decides the transparency of the gaze point. A value of 0 means that the gaze point is completely transparent, just like if no fill color was selected. A value of 100 means that the gaze point is completely solid, filled with the color selected in *Fill Color*.
- *Size* — This is the initial radius size of the gaze point, where 100% represents a tenth of the replay window's height.
- *Fading duration* — This value decides how long a trail point is shown before it fades out. A longer value creates a longer gaze trail.
- *Maximal size* — This value decides the maximum size the gaze point reaches (where 100% represents a tenth of the replay window's height, as for *Size* above). If this value is smaller than the *Size* value, no animation will be displayed.

For glasses recordings, please note that the gaze trail only consists of lines. That is, no gaze points will be shown.

## 8.10 Working with Times of Interest (TOI)

Times of Interest (TOIs) are divided into two general types - System-generated TOIs (sometimes called Automatic TOIs) which are based on recording, media, web navigation and snapshot events; and custom TOIs created manually by the user.

You can create custom Times of Interest and web Times of Interest.

**Times of Interest (TOI)**

Times of Interest (TOI) is a Pro Lab concept that provides an amazing degree of analytical flexibility. When used properly, it allows researchers and analysts to organize the recording data according to intervals of time during which meaningful behaviors and events take place.

Examples of TOI use:

- selecting data for visualizations such as heat maps and gaze plots
- selecting and aggregating data to calculate metrics associated with a coded task or subtask periods in your recording (recording task or trial analysis) selecting and aggregating data to calculate metrics associated with coded subject behaviors or actions (behavioral coding)
- selecting and aggregating data associated with media exposure and snapshot coverage (media or snapshot restricted task or trial analysis)

Times of Interest are created by specifying events and intervals, either of which can be automatic (system-generated or custom (user-generated).

**Events**

Events are multipurpose markers that can be used to locate important occurrences on the eye tracking timeline. Events as markers can be generated automatically by Pro Lab (RecordingStart, ImageStimulusStart, sync events), the participant (Keypress), or the researcher/analyst (Custom events). Events have an associated timestamp, the exact time the event marker was applied. They can be counted but they do not have any duration since they simply mark a meaningful point in time. In Pro Lab parlance, the creation of a named event type creates a class of events and any instance thereafter is referred to simply as an “event.” Once you have a few event markers, though, you can do more than just count them and that brings us to the next key concept, intervals.

**Intervals**

Intervals are spans of time on the recording Timeline that have a start and end point. Just as with events, intervals can be generated automatically by the system or the experiment (using the corresponding system-generated events). For example, there will always be an interval that corresponds to the entire duration of the recording from start to finish. And if you are running a screen-based study where images as stimuli are shown to the participant, then the system will automatically generate an interval in the timeline of each experiment that spans the period of time when an image appears on the screen. A helpful aspect of how Pro Lab implements intervals is that data on all intervals are available in the metrics output. This means that statistics on the duration and start/end point time stamps of all intervals can be obtained just by checking a box.

Times of Interest is a highly flexible data analytic tool in Pro Lab. Together with Areas of Interest, they provide useful and fine-grained capabilities for defining not only the spatial extent of your analyses (AOIs) but also the temporal span (TOIs). Used appropriately and with care, researchers can apply these tools to carry out powerful, sophisticated analyses of the most demanding stimulus presentations.

Read more about intervals and TOI on Tobii Pro’s Learn & Support webpage [Tobii Learn & Support]

### 8.10.1 System-generated (Automatic) Times of Interest

Depending on the type of project you are running (Screen, Glasses, or Scene Camera, Pro Lab will automatically generate different TOIs. These are Automatic or System-generated TOIs. The table below shows which types of automatic TOIs are created in recordings of different project types.

| | | | Project type | | | |
|---|---|---|---|---|---|---|
| **System-generated TOI** | **Intervals** | **Events** | **Screen** | **VR360** | **Glasses** | **Scene Camera** |
| Recording | Whole recording | RecordingStart, RecordingEnd | yes | yes | yes | yes |
| Media | Images and videos | ImageStimulusStart, ImageStimulusEnd; VideoStimulusStart, VideoStimulusEnd | yes | yes | no | no |
| Web navigation | Unique URL visits (Webpage visits) | WebStimulusStart, WebStimulusEnd; URLStart, URLEnd | yes | no | no | no |
| Screen recording | Whole screen recording | ScreenRecordingStart, ScreenRecordingEnd | yes | no | no | no |
| Snapshot* | Intervals (TOI) mapped to a snapshot | Snapshot[name] Interval Start, Snapshot[name] Interval End | no | no | yes | no |

*Snapshot TOI's are created automatically when eye tracking data is mapped onto a snapshot or stimuli. When you select a snapshot for analysis, your TOI will be composed of all the intervals defined by the two events ”Snapshot[name] Interval Start” and ”Snapshot[name] Interval End”. The ”Snapshot[name] Interval Start” event is created by the first gaze point/fixation mapped onto the snapshot. The ”Snapshot[name] Interval End” event is created by the last gaze point/fixation mapped onto the snapshot. If there is a gap of 5 s between two mapped gaze points, a ”Snapshot[name] Interval End” event is created for the last gaze point/fixation before the gap, and a ”Snapshot[name] Interval Start” event is created on the gaze point after the gap.

### 8.10.2 Custom Times of Interest

When you create a custom TOI, you define interval selection rules and a gaze data source. When you have created a TOI and select it in a Visualization, Pro Lab will look into all of the recordings in the project and find the intervals defined by the selected intervals. The software uses the selected gaze data collected during the intervals to create the Visualization.

You create a custom TOI by selecting a Start Event type and an End Event type that define the TOI's interval. Depending on the number of occurrences of the Start and End Events, the TOI can consist of one or several intervals in one or more recordings. The Event types that can be used to define the start and end of intervals are either generated automatically or logged manually. Examples of automatically generated Events are Recording start and Recording end. Examples of Custom Event types can be “entered supermarket aisle,” “looked at the banner,” “pressed a button,” etc.

**How to create a custom Time of Interest:**

1. In the **Times of Interest** section of the tool panel, click the plus sign (+). Select *Create Custom Time of Interest* .
2. Name your custom Time of Interest by entering a descriptive name in the *Name* field.
3. Decide whether you want your events to have an offset. Read *8.10.3 Adding offsets to custom Times of Interest, page 56*
   .
4. Select the Events that define the start of your interval using the expandable lists below Start point.
5. Select the Events that define the end of your interval using the expandable lists below End point.
6. Click OK.

**Edit** or **delete** your custom TOI by clicking the menu (vertical dots) next to the name and select the option, *Edit custom Time of Interest* or *Delete custom Time of Interest.*

## 8.10.3 Adding offsets to custom Times of Interest

If you wish to collect data before or after one specific event, you create a Custom Time of Interest with one event as both start and stop point and add offset time as buffers to extend the time window. You can also use this procedure to tighten the time window, which for example is useful if you want to check the closure of a test subject's action without having to watch his initial considerations.

- You remove time after the start point and add time after the end point by setting positive offset values.
- You add time before the start point and remove time before the end point by setting negative offset values.

**How to add offsets:**

1. In the **Times of Interes**t section in the right-hand panel on the **Design** tab, double-click the name of the TOI to which you want to add an offset.
2. Select the desired event types.
3. Toggle on the **Start point** and/or **End point** offset buttons.
4. Set the desired offsets in seconds and milliseconds (limits are +/- 100s). Note: The timer displays only when the buttons are set to "on."
5. Click **OK**. The offsets are applied to all event types that you selected in step 2.
6. Check that the offsets have been properly set by taking a close look at the regular visualizations.

## 8.10.4 Web Times of Interest

**How to create a custom Time of Interest:**

1. On the **Analyze** tab, make sure that you have defined the events you need. If necessary, create them using Custom Events. Read *4.2 Managing Event Types, page 9*
   .
2. In the **Times of Interest** panel on the right-hand side, click the plus sign (+). Select *Create Web Time of Interest*.
3. Name your custom Time of Interest by entering a descriptive name in the Name field.
4. Use the Start point and End point toggles to create an offset. Read *8.10.3 Adding offsets to custom Times of Interest, page 56*
5. Use the Expand all arrow to view all web related events starting with Custom events and then all start and end event types for all URLS your participants have visited.
   - When you want to group URLS, select the URLStart point you want to use for each of the URLs.
   - To create shorter intervals, select a URLStart point or the Custom event you want to use.
6. Under End point, select the URLEnd point you want to use or select a Custom event type.
7. Click OK.

**Edit** or **delete** your web TOI by clicking the dots next to the name and select the option, *Edit custom Time of Interest* or *Delete custom Time of Interest*.

Read more about aggregating data across several participants in web recordings on Tobii Pro's Learn & Support webpage

## 8.11 Working with Areas of Interest (AOIs)

Areas of Interest (AOIs) enable numerical and statistical analysis based on regions or objects of interest in your stimuli. AOIs are drawn around objects in your image, Snapshot or video (dynamic AOIs) in order for you to analyze them further in third-party software, such as SPSS, Matlab, or Excel. AOIs can be any shape. Once an AOI has been drawn onto an image, Snapshot or video and data is mapped onto the Snapshot (in the case of a Glasses project), the Data Export output file will include data on whether the participant's gaze point is inside or outside of the AOI.

### 8.11.1 Drawing AOIs on Snapshots, image stimuli, or frames saved as media

Procedure for drawing AOIs:

1. Open the snapshot, image stimuli, or frame saved as media that you want to draw an AOI on.
2. Click the *AOI Editor* button - either in the *Project Overview* section or select it from the *Analyze* dropdown menu in the top navigation.
3. Draw an AOI by selecting one of the following:
   - *Polygons*: Select the *Polygon* tool in the AOI toolbar above the AOI Visualization or press P on the keyboard. Click where you want the AOI to start and then click wherever you want to add vertices. Close the shape by clicking on the first vertex.
   - *Rectangles or ellipses*: Select the *Draw rectangle* or *Draw ellipse* tool in the AOI toolbar above the AOI Visualization, or press E (ellipse) or R (rectangle) on the keyboard. Click and drag the mouse cursor on the image or Snapshot until you have created the shape and size you want. Make the shape a perfect square or circle by pressing the *Shift* key while you drag to draw.

Procedure for naming an AOI:

Select the AOI in one of the following ways:

- Go to the list of AOIs, double-click the current AOI name and enter the new name.
- Go to the AOI shape, double-click the name label and enter the new name.
- When an AOI is selected in the list of AOIs, press F2 on the keyboard. The "Rename area" dialogue appears.
- Enter a new name In the input field and click OK.

### 8.11.2 Dynamic AOIs

The difference between a static AOI and Dynamic AOIs is that the dynamic AOI can be moved around to match an object's location in a video – The shapes and behaviors of dynamic AOIs in Tobii Pro Lab are defined by so called Keyframes. Each Keyframe is a user defined shape and position of the AOI that corresponds to a certain point on the timeline of the media. Dynamic media containing dynamic AOIs will typically have numerous Keyframes for each AOI. In-between these Keyframes, Pro Lab will interpolate the shape and position of the AOI, so that the AOI moves smoothly from one Keyframe to the next. Any changes that are made to an AOI somewhere on the timeline, for example dragging an AOI or moving AOI vertices, will create a new Keyframe unless you are changing an existing Keyframe.

### 8.11.3 Editing the shape of an AOI

Procedure for changing the shape of an existing AOI:

1. Make sure that the desired AOI is visible. (If it's not, read the section "*8.11.7 Changing the name, appearance, or visibility of an AOI*."
2. Go to the AOI toolbar above the AOI Visualization and select the *Select/Move Vertices* tool or press V on the keyboard.
3. Drag the vertices to transform the AOI.

Currently, there is no way to add or delete vertices on existing AOIs.

### 8.11.4 Changing the size of an AOI

Procedure for changing the size of an AOI:

1. Make sure that the desired AOI is visible. (If it's not, read the section "*8.11.7 Changing the name, appearance, or visibility of an AOI*."
2. Go to the AOI toolbar above the AOI Visualization and select the *Select/Move AOI* tool or press 2 on the keyboard.
3. Click on the AOI that you want to resize. A rectangle with sizing handles in the corners appears around the selected AOI.
   - Increase or decrease the size by clicking and dragging one of the sizing handles.
   - Maintain the object's proportions by pressing the *Shift* while you drag the sizing handle.
   - The size of a selected AOI can also be adjusted by modifying the width (W:) and height (H:) values in the property fields on the AOI toolbar.

### 8.11.5 Moving an AOI

Procedure for moving an AOI:

1. Make sure that the desired AOI is visible. (If it's not, read the section "*8.11.7 Changing the name, appearance, or visibility of an AOI*."
2. Go to the AOI toolbar above the AOI Visualization and select the *Select/Move AOI* tool or press S on the keyboard.
3. Click on the AOI that you want to move. A rectangle appears around the selected AOI.
4. Drag the AOI to its new location.
   - You constrain an AOI so that it moves only horizontally or vertically by pressing the Shift key while dragging the object.
   - The position of a selected AOI can also be adjusted by modifying the X: and Y: values in the property fields on the toolbar.

### 8.11.6 Cutting, copying, and pasting AOIs

An AOI can be cut or copied from one image or Snapshot and pasted onto another Snapshot, as well as into the same image or Snapshot as an identical copy of the original (apart from the name).

Procedure for cutting or copying the shape of an AOI:

1. Select the *Select/Move AOI* tool on the AOI toolbar.
2. Right-click on the AOI that you want to cut or copy and select *Copy* or *Cut* from the menu. You can do this by right-clicking either the AOI shape on the image/ Snapshot or the AOI name in the Areas of Interest list in the tool panel to the right.

Procedures for pasting the AOI:

1. Paste the AOI in the middle of the image or Snapshot by right-clicking on the Snapshot and selecting *Paste*.
2. Paste the AOI in the same location where the copied AOI was by right-clicking on the Snapshot and selecting *Paste in Place*.

The quickest way to duplicate an AOI is by pressing *Ctrl* on the keyboard while clicking and dragging the desired AOI to a new location. You can also copy and paste AOIs by using the Edit menu on the AOI toolbar or by using the keyboard shortcuts Ctrl+C (to copy), Ctrl+X (to cut), and Ctrl+V (to paste).

### 8.11.7 Changing the name, appearance, or visibility of an AOI

Options for changing the name an AOI:

- Go to the list of AOIs in the tools panel on the right, double-click the current AOI name and enter the new name.
- Go to the AOI shape, double-click the name label and enter the new name.
- Select an AOI in the list of AOIs in the tools panel on the right and press F2 on the keyboard. The "Rename area" dialog´box appears. Go to the input field, enter a new name and click OK.

Options for changing the appearance of an AOI:

- Change the color of an AOI by clicking the AOI color indicator rectangle next to the AOI name in the *Areas of Interest* list. Pick a new color and click OK.
- Change the opacity of the AOIs by adjusting the AOI's *Opacity* slider in the *View Options* section in the tool panel on the right.

- Display or hide the AOI name labels in the AOIs by checking or unchecking *Show AOI Names* in the *View Options* section in the tools panel on the right.
- Display or hide the AOI fill colors by checking or unchecking *Show Fill Color* in the *View Options* section in the tools panel to the right.

### 8.11.8 Undoing/redoing AOI Actions

Procedures for undoing and redoing actions::

- You undo your most recent action by clicking the *Undo* button in the top left corner of the AOI tab interface or by pressing Ctrl+Z.
- You undo an action that was not the most recent via the dropdown list at the *Undo* button. Click the downwards-pointing triangle and select the action you wish to undo.
- You redo the action you have just undone by clicking the *Redo* button next to the *Undo* button in the top left corner of the AOI tab interface.
- You redo an action you have previously undone via the dropdown list at the *Redo* button. Click the downwards pointing triangle and select the action you wish to redo.

### 8.11.9 Panning and zooming in the AOI editor

When you work with large images or Snapshots (e.g. Snapshots that cover an entire shopping shelf stitched together by multiple image files), you might find it difficult to see the details. In such cases, it's useful to zoom in to parts of the interface.

How to zoom in to an image or Snapshot:

- Select the *Zoom* tool that looks like a magnifying glass in the Navigation section of the AOI toolbar. Click on the image or Snapshot where you want to zoom in.
- Click on the *Zoom* tool that looks like a magnifying glass below the AOI Visualization. This opens a zoom slider. Drag the slider to the zoom percentage setting that you want.
- Press *Ctrl* on the keyboard while scrolling the mouse wheel to zoom in or out.
- Click the buttons labeled “Fit to window” or “Actual size” located under the AOI Visualization to switch between the two zoom levels.

When you have zoomed into an image or Snapshot, you cannot always see it in its entirety. It is then useful to pan your field of vision so that you get the desired area in view.

Procedure for panning in the image or Snapshot:

1. Select the *Move Canvas* tool that resemble hand on the *Navigate* section of the AOI toolbar.
2. Drag the Snapshot image to pan it to a new location.

### 8.11.10 Activating/deactivating an AOI

When an AOI is active it collects and records data during the replay. You can choose to deactivate an AOI for any period on the timeline.

Procedure for activating/deactivating an AOI:

1. Select the AOI that you want to activate/deactivate.
2. Right-click on the AOI and select *Activate/Deactivate Selected AOIs* in the context menu. You can also use the *AOI Active* toggle switch in the function bar above the recording.

### 8.11.11 Exporting an image of the AOIs on the image or Snapshot

Procedure for exporting an image of the AOIs on the image or Snapshot:

1. Right-click on the image or Snapshot in the AOI Visualization.
2. Click *Export Image* in the context menu.
3. In the *Save As* dialogue, enter a file name in the *File name* input field.
4. Navigate to the folder into which you want to save the image and click *Save*.

## 8.11.12 Managing AOI tags

In Pro Lab you can assign Tags to both static and dynamic AOIs, which makes it possible to aggregate data from several AOIs for conditions that exist across multiple stimuli elements. That enables an easier workflow for many experimental paradigms and research questions. Tags are supported in *Metrics* and *Data export*.

### 8.11.12.1 Creating AOI Tags

Procedure for creating AOI Tags:

1. Open AOI Tags Manager by clicking on the *Create and edit Tags* button on the *Tags* panel.
2. Press the plus sign to the right of *Ungrouped Tags*. A Tag is now created.
3. Name the Tag with a descriptive name.
   - If you want to remove a Tag, hover the mouse pointer above it and click the x symbol that appears.
4. Continue creating the Tags you need.

### 8.11.12.2 Creating Tag Groups

Groups can be considered the top designator of Tags. You can for example have the group *Vehicle type* with the Tags *Car*, *Motorcycle* and *Bicycle*, and another group *Brand* with the Tags *Volvo*, *BMW*, *Audi*, *Honda*, *Yamaha*, *Cannondale* and *Specialized*. This way you can export metrics for different types of transportation means, and also drill down by selecting the Tags that denote different vehicle brands.

Procedure for creating Tag Groups:

1. Open AOI Tags Manager by clicking the *Create and edit Tags* button on the *Tags* panel. The *AOI Tags Manager* dialog appears.
2. Click the *New Group* button and name the group in the field that appears.
3. Continue creating groups until you are satisfied. You can always come back here and create/edit/delete groups later.
4. Create and add Tags to groups by clicking the plus sign to the right of the group.
5. Name the Tag as described above.

If you want to remove a group, hover the pointer over its name and click the trash can symbol that appears. If the group has Tags assigned to it you need to confirm that you want to remove the group and all associated Tags with it.

### 8.11.12.3 Assigning Tags to AOIs in the stimuli

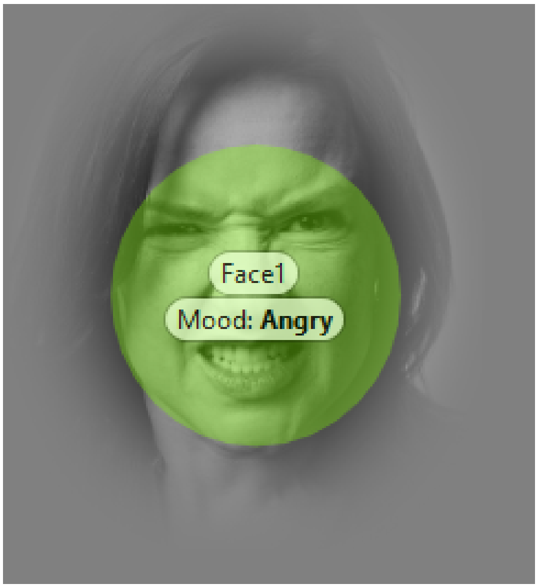
When you have created your Tags it is time to assign them to the AOIs in the stimuli.

Procedure for assigning Tags:

1. Click the AOI for which you want to assign the Tags. Select several AOIs by Shift-clicking or by clicking a point in the stimuli and then drag a selection box to include the wanted AOIs.
2. Click the Tags you want to associate to the AOI/AOIs on the Tags panel.

   Grouped Tags are mutually exclusive, i.e. only one Tag per group can be selected for the selected AOI/AOIs; but several ungrouped Tags can be selected independently of each other.

3. The AOI now reflects the tag/tags that have been selected for it.




In this illustration the *Face1* label is the AOI name, *Mood* is the group label and *Angry* is the tag name.

If you have many tags selected for the AOI, the groups and tag labels may clutter and obscure the AOI. For this reason you can hide the labels by switching off the *Show AOI Tag Names* selector switch in the *View Options* panel. You can still display the tag names by hovering over the "#" symbol on the AOI label.

#### 8.11.12.4 Exporting data based on Tags

When you export data, you can select to export only such data that is relevant to your selected Tags.

Procedure for selecting export data:

1. Select *Data Export* on the *Analyze* menu.
2. Expand the *Tags* section on the *Data selection* panel.
3. The default selection is *All Tags*. If you want to select only some of the Tags, click on the *All Tags* check box. The groups you have created are displayed. Continue to open the different groups to select only a few of their Tags.
4. Then continue to select the data you want to export.

The data export for Tags will not be affected by the selected AOIs in the *Data selection* panel. The data export will still be based on all AOIs for the selected Tags.

#### 8.11.12.5 Exporting metrics based on Tags

Procedure for exporting metrics:

1. Select *Metrics* on the *Analyze* menu.
2. Expand the *Tags* section on the *Data selection* panel.
3. As default *All Tags* is selected. If you want to select only some of the Tags, click on the *All Tags* check box. The groups you have created are displayed. Continue to open the different groups to select only a few of their Tags.
4. Then continue to select the data you want to export. Read *8.13 Exporting metrics data, page 62*
   .

The metrics export for Tags will not be affected by the selected AOIs in the Data selection panel. The metrics export will still be based on all AOIs for the selected Tags.

## 8.12 Defining metrics

In order to set up a successful eye tracking study you need to define and calculate the appropriate measures for your research question. In addition to choosing the right eye tracking measure, you should define where and when to calculate this measure, i.e. the Areas of Interest (AOI) that are associated with operationalization of your research question. You also should calculate Times of Interest (TOI), the intervals of the recording when your stimulus or behavior of interest are predicted to occur. Some examples are: the duration of the exposure of an image on the screen, a section of a trial, the time between when an image appears on the screen and when a participant presses a key on the keyboard, the moment someone enters a supermarket aisle and places a product in the shopping basket, etc.

In Pro Lab, the term "metric" is used to define the different measures that are calculated from the recording data. These measures can be exported in different table/file formats that can either be used to get an overview of the data and extract summary statistics, or to organize the data for further processing in statistical software platforms such as R or SPSS.

For best practice, and unless your study is an explorative one, measures should be defined during the planning and design phase of the study.

## 8.13 Exporting metrics data

Exports from Metrics Export in Pro Lab can be saved in two formats.

If you want to analyze the metrics data in a statistical analysis software, like R/SPSS/MATLAB etc., the default option is to save the export data in an Interval based TSV file (UTF-8). This format can be interpreted by the user, but is also especially designed for use in analysis software with meta information and metrics in a column format where the rows contains calculations for the actual Times of Interval.

The second format is an Excel report (.xlsx), which is compatible with most spreadsheet software such as Microsoft Excel (2007 and later), Google Sheets, OpenOffice.org, etc. In this file, each metric is saved in a separate spreadsheet. Each image, Snapshot, or Time of Interest has its own table in the spreadsheet.

### 8.13.1 Exporting metrics data to a file

You can select the metrics to export in order to create custom spreadsheets or “reports”. Different metrics are available for export depending on which export format you choose (see above for more information about export formats) Read more about metrics below.

**Exporting metrics**

If the Export button is inactive (grayed out), hover the cursor over the Export button to see why it is inactive. For example, the tool tip will tell you that at least one recording, one metric, and one TOI must be selected to start the metrics export..

1. Click the **Metrics** button - either in the **Project Overview** section or select it from the Analyze drop-down menu in the top navigation.
2. Select the output format for the export file by clicking the **Export format** drop-down list box in the **Settings** panel. Select either Interval based TSV file (default) for the .tsv format or Excel report for the .xlsx format.
3. Select the metrics you want to include in the export (the selection varies depending on what you chose in step 2).
4. Select which Gaze Filter you want to apply to the data you will export. Read more about Gaze Filters in the “*Appendix B Gaze Filters’ functions and effects*” in this manual.
5. Select the data you want to include in the Data Selection section of the tool on the right side of the interface. The options are:
   - **Recordings**: Choose to export metrics from All Recordings or only the recordings of your choice. Expand the checkbox to see all available recordings.
   - **Participant variables**: Choose to export metrics based on a selection of participant variables. Use the checkboxes to select which participant variables the export will be filtered on. All checkboxes are selected as default.
   - **Times of Interes**t: Choose to export metrics from the complete recordings (selected above) or metrics only from selected TOIs. To simplify the selection, there are two groups of TOI data: Media gaze data, where automatically created TOIs based on when Snapshots or images were active are presented, and Recording gaze data, where your custom TOIs are listed. In the Media gaze data list, each image or Snapshot associated with the project that has AOIs is listed. For each of them, you can also select TOIs which include data from when they were active. Expand the checkbox next to each group to see and select the individual TOIs.
   - **Areas of Interest**: Choose to export data relating to all or some of the AOIs created in the project.
   - **Tags**: Tags are labels given to AOIs. Choose to export data relating to all or some of the tags created in the project. The Tag selection and AOI selection are independent, i.e. when a tag is selected, the AOI labeled with that tag will be exported even if the AOI is unselected in the AOI section.
   - **Events**: you can select the recording custom events to include in the Event and interval metrics.

6. Click the Export button at the top of the Metrics Export window..
7. In the file browser, locate the folder in which you want to save the file.
8. In the File name field, enter a file name for your export..
9. Click Save.

### 8.13.2 Understanding the metrics

Some metrics in Pro Lab relate to a specific area of interest (AOI), for example, how much time a participant spends looking at advertisements, or the eyes of a person talking. Other metrics are general for that time of interest interval, for example, the average fixation duration during the interval, regardless of what the user specifically looked at. The former says something about the object in the area of interest, but the latter can put this number in context of how the participant behaves in general and when seeing everything else that is visible during this stimulus presentation.

If you select an AOI-based metric, you will get one metric computed per AOI. If it is a saccade metric, then the AOI will determine if a saccade is an "entry saccade" (moving into the AOI) or an "exit saccade" (moving out of the AOI).

However, if you choose a metric that is AOI-independent, then you will get a metric that is computed for the entire interval. For example, an average fixation duration that is AOI-independent will give you the average fixation duration of all fixations occurring in that TOI interval, regardless of what they looked at.

**AOI-based metrics vs. AOI-independent metrics**

Some metrics in Pro Lab relate to a particular area of interest (AOI) for example, how much time a participant spends looking at advertisements, or the eyes of a person talking. Other metrics are general for that time of interest interval, for example the average fixation duration during the interval, regardless of what the user specifically looked at. The former says something about the object in the area of interest, but the latter can put this number in context of how the participant behaves in general and when seeing everything else that is visible during this stimulus presentation.

If you select an AOI-based metric, you will get one metric computed per AOI. If it is a saccade metric, then the AOI will determine if a saccade is an "entry saccade" (moving into the AOI) or an "exit saccade" (moving out of the AOI).

However, if you choose a metric that is AOI-independent, then you will get a metric that is computed for the entire interval. For example, an average fixation duration that is AOI-independent will give you the average fixation duration of all fixations occurring in that TOI interval, regardless of what they looked at.

**Partial and whole events**

Previously Pro Lab offered only fixation-based metrics and these have also been very inclusive, in that they include all fixations in that Time of Interest (and Area of Interest). All fixations means both whole fixations (they start and end within the TOI), but also partial fixations (they start before the TOI interval starts, so we don't know for how long that fixation has been going on). On many types of research, this is perfectly fine. If the study participant is looking in one direction and an advertisement suddenly appears there, the participant will see the ad even though they don't move their eyes and trigger a new fixation.

For saccade metrics, partial events provide little value. If you want to calculate the peak velocity of a saccade, and that velocity peak happens outside of the TOI but the rest of the saccade is inside it, it is not obvious that the peak velocity should be included. The same challenge exists for saccade amplitude as well. Usually, experiments are set up in way that exclude these type of challenges, for example, by using a fixation cross to constrain what position the gaze at the onset of the stimulus. If you are an eye movement researcher, you are interested in the full and representative event, and the saccade had a certain amplitude (e.g. 20 degrees) even if it was cut by the TOI start so it is only 8 degrees now.

Additionally, if there is any uncertainty with the start and end of a saccade event, for example the fixation/saccade filter producing some unknown event (fulfilling the criteria of neither eye movement type), then we cannot rule out the possibility of the samples constituting this unknown event are not really a part of the actual saccade. In this case, with a non-fixation event preceding and succeeding the saccade, the saccade is rejected from analysis.

For these reasons, saccades follow strict criteria for when they should be included in the calculations:

- A saccade must be preceded by a fixation event.
- A saccade must be succeeded by a fixation event.
- A saccade must by wholly contained in the time of interest.

Furthermore, some research is interested in both the saccades and the fixations that occur in the same time of interest. For example, some research suggests there are phases of visual exploration, with an early orienting phase with high-amplitude saccades and short-duration fixations, followed by an inspection phase with low-amplitude saccades and long-duration fixations.

To explore this in a meaningful way, we want fixations that are similarly strictly defined as the saccades are. Therefore, we also allow the export of “whole fixations”, which are defined as:

- A whole fixation must be preceded by a saccade.
- A whole fixation must be succeeded by a saccade.
- A whole fixation must be wholly contained in the time of interest

Finally, for fixations that related to particular AOIs, there is an additional criterion that:

- A whole fixation must be wholly contained in the area of interest.

**Interval-based TSV file**

The Interval based TSV file format is intended to be loaded into a statistical software, like R or SPSS, for further analysis. It is formatted as a tab-separated text file where every row holds the results for one time of interest interval. Every metric or other property is presented as a column in this format. This format has the most metrics available for selection. If you want to use saccades, you need to use an I-VT filter. For more information, see *B2 The Tobii I-VT Gaze Filter definition*

## 8.13.3 Understanding the metrics —TSV file

The metrics available for export to the Interval based TSV file format are shown in the table below:

An interval corresponds to one occurrence of a specific time of interest. The interval start is defined as the starting event for the TOI. The interval end is defined as the ending event for the TOI. A specific TOI can occur multiple times during a recording which means there are multiple intervals.

| Metric name | Description | Format |
|---|---|---|
| Duration of interval | The duration of an interval. | milliseconds |
| Start of interval | The start time of an interval. | milliseconds |

**Event metrics**

Events can also be used in measures. Event metrics allow you to measure behavior and calculate statistics based on your event coding scheme.

| Metric name | Description | Format |
|---|---|---|
| Time to first Event | The time to the first Event, including Custom Events and Logged live Events, for an interval. | milliseconds |
| Number of Events | The number of Events, including Custom Events and Logged live Events, for an interval. | number |

**AOI fixation metrics**

AOI fixations correspond to fixations that fall within an AOI. The fixations are defined based on the gaze filter you use (e.g. if you use the Raw gaze filter, every valid eye tracking sample is a fixation). AOI fixations metrics allow you to measure statistics based on the fixations within an AOI. They present as interval (or occurrence) of the TOI in separate rows in the exported spreadsheet.

| Metric name | Description | Format |
|---|---|---|
| Total duration of fixation | The total duration of the fixations inside this area of interest during an interval. | milliseconds |
| Average Duration of fixation | The average duration of the fixations inside this area of interest during an interval. | milliseconds |
| Number of fixations | The number of fixations occurring in this area of interest during an interval. | number |

| Metric name | Description | Format |
|---|---|---|
| Time to first fixation | The time to the first fixation inside this area of interest during an interval. | milliseconds |
| Duration of first fixation | The duration of the first fixation inside this area of interest during an interval. | milliseconds |

**AOI visit metrics**

An AOI visit corresponds to all the data between the start of the first fixation inside and AOI to the end of the last fixation in the same AOI. From the first fixation inside the AOI until the last fixation inside the AOI, all data is considered as part of the AOI visit (even saccades, blinks or invalid gaze data).

AOI visit metrics allow you to measure statistics based on visits inside an AOI (e.g. calculating revisiting rate of an AOI).

| Metric name | Description | Format |
|---|---|---|
| Total duration of Visit | The total duration of the visits inside this area of interest during an interval. | milliseconds |
| Average duration of Visit | The average duration of the visits inside this area of interest during an interval. | milliseconds |
| Number of Visits | The number of visits occurring in this area of interest during an interval. | number |

**AOI glance metrics**

All data is considered to be part of the AOI glance (even saccades, blinks or invalid gaze data) from the first saccade leading into the AOI until the last fixation inside the AOI.

| Metric name | Description | Format |
|---|---|---|
| Total duration of Glances | The total duration of the glances inside this area of interest during an interval. | milliseconds |
| Average duration of Glances | The average duration of the glances inside this area of interest during an interval. | milliseconds |
| Maximum duration of Glances | The duration of the longest glance inside this area of interest during an interval. | milliseconds |
| Minimum duration of Glances | The duration of the shortest glance inside this area of interest during an interval. | milliseconds |
| Number of Glances | The number of glances occurring in this area of interest during an interval. | number |

**AOI click metrics**

One click is defined as the combination of when the participant presses the primary (left or right) button of the mouse, and when he or she releases it again.

| Metric name | Description | Format |
|---|---|---|
| Number of clicks | The number of clicks in this area of interest during an interval. | number |
| Time to first click | The time to the first click inside this area of interest during an interval. | milliseconds |
| Time from first fixation to mouse click | Time from first fixation to the next mouse click inside this area of interest during an interval. | milliseconds |

**GSR metrics**

SCRs can be generated as a response to an specific event (e.g., visual stimulus or unexpected question) known as event-related SCR (ER-SCR). ER-SCRs are the most common measure used in research to relate changes in emotional arousal to a specific stimuli. A good stimulus design that allows enough time between stimuli is necessary to avoid uncertainties about which stimulus caused a certain ER-SCR. Read more: *7.3.3 GSR metrics*

| Metric name | Description | Format |
|---|---|---|
| Average GSR | The average galvanic skin response (GSR) signal, after filtering,, for an interval. | microsiemens |
| Amplitude of event related SCR | The amplitude of each event-related skin conductance response (ER-SCR) for an interval. ER-SCRs are calculated using filtered GSR data. | microsiemens |
| Number of GSR | The number of skin conductance responses (SCR) for an interval. | number |

#### Saccade metrics

Saccade metrics let you measure statistics based on saccades within an interval (occurrence of a TOI). You can get general indicators on the velocity, amplitude and direction of saccades.

Note: If you have unrecognizable data, try adjusting the fixation filter settings. This is not a problem that can be fixed in the metrics.

| Metric name | Description | Format |
|---|---|---|
| Number of saccades | The number of saccades occurring during an interval. | number |
| Average peak velocity of saccades | The average peak velocity of all saccades in this interval. | degrees per second |
| Minimum peak velocity of saccades | The peak velocity of the saccade with the lowest peak velocity in this interval. | degrees per second |
| Maximum peak velocity of saccades | The peak velocity of the saccade with the highest peak velocity in this interval. | degrees per second |
| Standard deviation of peak velocity of saccades | The standard deviation of all peak velocities of the saccades in this interval. | degrees per second |
| Average amplitude of saccades | The average amplitude of all saccades in this interval. | degree |
| Minimum amplitude of saccades | The amplitude of the saccade with the lowest amplitude in this interval. | degree |
| Maximum amplitude of saccades | The amplitude of the saccade with the highest amplitude in this interval. | degree |
| Total amplitude of saccades | The total amplitude of all saccades in this interval. | degree |
| Time to first saccade | | milliseconds |
| Direction of first saccade | The direction of the first saccade in the interval. | degree |
| Peak velocity of the first saccade | The peak velocity of the first saccade in the interval. | degrees per second |
| Average velocity of the first saccade | The average velocity of the first saccade in the interval. | degrees per second |
| Amplitude of the first saccade | The amplitude of the first saccade in the interval. | degree |

#### AOI saccade metrics

AOI saccades are saccades that start, end, or are within an AOI. AOI saccade metrics let you measure statistics based on saccades within an AOI. You can get general indicators on the velocity, amplitude and direction of these saccades..

| Metric name | Description | Format |
|---|---|---|
| Number of saccades in AOI | The number of saccades occurring in this area of interest during an interval. | number |
| Time to entry saccade | The duration until the start of the first saccade that ends in this area of interest during an interval. | milliseconds |
| Time to exit saccade | The duration until the start of the first saccade that exits this area of interest during an interval. | milliseconds |
| Peak velocity of entry saccade | The peak velocity of the first saccade that ends in this area of interest during an interval. | degrees per second |
| Peak velocity of exit saccade | The peak velocity of the first saccade that exits this area of interest during an interval. | degrees per second |

## 8.13.4 Understanding the metrics—Excel file

This format presents the metrics in an aggregated form, intended to be viewed directly in Microsoft Excel. Every metric is presented as a separate sheet in the Excel workbook. It contains tables showing the results, including averages and totals, for every time of interest.

The metrics available for export to an Excel report are shown in the table below:

All Glance metrics comply with ISO 15007–1.

**Interval metrics**

AOI saccades are saccades that start, end, or are within an AOI. AOI saccade metrics let you measure statistics based on saccades within an AOI. You can get general indicators on the velocity, amplitude and direction of these saccades.

| Metric name | Description | Format |
|---|---|---|
| Duration of interval | The duration of all time intervals for each Time of Interest, with averages, medians, sums, counts, variances, and standard deviations. | seconds |
| Start of interval | The start time of all time intervals for each Time of Interest, with averages, medians, and counts, variances, and standard deviations. | seconds |

**Event metrics**

Events can also be used in measures. Event metrics let you measure statistics based on your event coding scheme.

| Metric name | Description | Format |
|---|---|---|
| Time To First Event | The time to the first Event, including Custom Events and Logged live Events, for each Time of Interest, with averages, medians, counts, variances, and standard deviations (n-1). | seconds |
| Number of events | The number of Events, including Custom Event Types and Logged live Events, for each Time of Interest, with averages, medians, counts, variances, and standard deviations (n-1). Descriptive statistics only include recordings where Events occur. | number |
| Number of events (include zeroes) | The number of Events, including Custom Event Types and Logged live Events, for each Time of Interest, with averages, medians, counts, variances, and standard deviations (n-1). Descriptive statistics only include recordings where Events occur. | number |

**AOI fixation metrics**

AOI fixations correspond to fixations that fall within an AOI. The fixations are defined based on the gaze filter you use (e.g. if you use the Raw gaze filter, every valid eye tracking sample is a fixation). AOI fixations metrics will allow you to measure statistics based on the fixations within an AOI. They are specific intervals (or occurrences) of the TOI and each one will be on its on row in the exported TSV file.

| Metric name | Description | Format |
|---|---|---|
| Total duration of fixation in AOI | The total time each participant has fixated each AOI on all Media, with averages, medians, sums, variance, and standard deviations (n–1); the share of total time spent on each AOI out of all AOIs; and the percentage of Participants that fixated within each AOI at least once. Descriptive statistics are only based on Recordings with fixations within the AOIs. | seconds |
| Total duration of fixation in AOI (include zeroes) | The total time each participant has fixated on each AOI on all Media, with averages, medians, sums, variance, and standard deviations (n–1); the share of total time spent on each AOI out of all AOIs; and the percentage of Participants that fixated within each AOI at least once. Descriptive statistics also include Recordings with zero fixations within the AOIs. | seconds |
| Average duration of fixation in AOI | The average duration of the fixations within each AOI on all Media, with averages, medians, variances, and standard deviations (n-1); the total Time of Interest; and Recording durations. | seconds |
| Number of fixations in AOI | The number of fixations within each AOI on all Media, with averages, medians, sums, variances, and standard deviations (n-1); the percentage of Participants that visited each AOI at least once; total number of fixations within the Time of Interest; and the total Time of Interest and Record durations. Descriptive statistics are only based on Recordings with fixations within the AOIs. | number |
| Number of fixations in AOI (include zeroes) | The number of fixations within each AOI on all Media, with averages, medians, sums, variances, and standard deviations (n-1); the percentage of Participants that visited each AOI at least once; total number of fixations within the Time of Interest; and the total Time of Interest and Record durations. Descriptive statistics are only based on Recordings with zero fixations within the AOIs. | number |
| Time to first fixation in AOI | The time to first fixation for each AOI on all media, with averages, medians, counts, variances, standard deviations (n-1) and Recording durations. | seconds |
| Duration of first fixation in AOI | The duration of the first fixation for each AOI on all media, with averages, medians, counts, variances, standard deviations (n-1) and Recording durations. | seconds |

**AOI visit metrics**

AOI visit metrics allow you to measure statistics based on visits inside an AOI (e.g. calculate revisiting rate of an AOI).

| Metric name | Description | Format |
|---|---|---|
| Total duration of Visit | The total time each participant has visited each AOI on all Media, with averages, medians, and sums; the share of total time spent in each AOI out of all AOIs; and the percentage of Participants that visited each AOI at least once. Descriptive statistics are only based on recordings with fixations within the AOIs. | seconds |
| Total duration of Visit (include zeroes) | The total time each participant has visited each AOI on all Media, with averages, medians, and sums; the share of total time spent in each AOI out of all AOIs; and the percentage of Participants that visited each AOI at least once. Descriptive statistics also include Recordings with zero fixations within the AOIs. | seconds |
| Average duration of Visit | The average duration each participant has visited each AOI on all Media; with averages, medians, sums, variances, and standard deviations (n-1). | seconds |
| Number of Visits | The number of visits within each AOI on all Media, with averages and medians; and the percentage of Participants that fixated within each AOI at least once.<br><br>Descriptive statistics are based on Recordings with fixations within the AOIs. | number |
| Number of Visits (include zeroes) | The number of visits within each AOI on all Media, with averages and medians; and the percentage of Participants that fixated within each AOI at least once.<br><br>Descriptive statistics also include Recordings with zero fixations within the AOIs. | number |

**AOI click metrics**

One click is defined as the combination of when the participant presses the primary (left or right) button of the mouse, and when he or she releases it again.

| Metric name | Description | Format |
|---|---|---|
| Number of clicks in AOI | The number of clicks within each AOI on all Media, with averages, medians, variances, and standard deviations (n-1); and the percentage of Participants that clicked within each AOI at least once. Descriptive statistics only based on Recordings with fixations within the AOIs. | number |
| Number of clicks in AOI (include zeroes) | The number of clicks within each AOI on all Media, with averages, medians, variances, and standard deviations (n-1); and the percentage of Participants that clicked within each AOI at least once. Descriptive statistics also include Recordings with zero clicks within the AOIs. | number |
| Time to first click in AOI | The time to first mouse click for each AOI on all Media, with averages, medians, counts, variances, standard deviations (n-1) and Recording durations. | seconds |
| Time from first fixation to mouse click in AOI | The time from first mouse click for each AOI on all Media, with averages, medians, counts, variances, standard deviations (n-1) Recording durations, and the percentage of Participants that fixated and then clicked within each AOI at least once. | seconds |

**GSR metrics**

SCRs can be generated as a response to an specific event (e.g., visual stimulus or unexpected question) known as event-related SCR (ER-SCR). ER-SCRs are the most common measure used in research to relate changes in emotional arousal to a specific stimuli. A good stimulus design that allows enough time between stimuli is necessary to avoid uncertainties about which stimulus caused a certain ER-SCR. Read more: *7.3.3 GSR metrics*

| **Metric name** | **Description** | **Format** |
|---|---|---|
| GSR Average | The average galvanic skin response (GSR) signal, after filtering, for each Time of Interest, with averages, medians, and counts for each participant. | microsiemens |
| ER-SCR amplitude | The amplitude of each event-related skin conductance response (ER-SCR) for each Interval in Time of Interest, with mean amplitudes, mean magnitudes, response frequencies, and counts for each participant. Time of Interest intervals that do not have an ER-SCR are shown with the symbol "—". ER-SCRs are calculated using filtered GSR data. | microsiemens |
| SCR count | The number of skin conductance responses (SCR) for each interval in Time of Interest, with averages, medians, counts, variances, and standard deviations (n-1). | number |

# 8.14 Exporting data

## 8.14.1 Exporting eye tracking, GSR and recording data in a *.tsv file

Gaze filter selection is applicable for eye tracking data only. These settings do not affect the GSR data export.

Procedure for exporting data:

1. Click the *Data Export* button, either in the *Project Overview* section or select it form the *Analyze* dropdown menu in the top navigation.
2. Select which Gaze Filter you want to apply to the data you will export. Read more about Gaze Filters in *Appendix B Gaze Filters' functions and effects*" in this manual.
   - Select the data you want to include in the *Data Selection* section of the tool on the right of the interface.
     – Under *Recordings*, you can select to export data from All Recordings or only the recordings of your choice. Click on the triangle next to the checkbox to see all available recordings.
     – Under *Times of Interest*, you can select to export data metrics from the complete recordings (selected above) or data only from selected TOIs. To simplify the selection, you are presented with two groups of TOI data: Media gaze data, where automatically-created TOIs, based on when Snapshots or images were active, are presented, and Recording gaze data, where your custom TOIs are listed. In the *Media gaze* data list, each image or Snapshot associated with the project is listed and, for each of them, you can also select TOIs which include data from when they were active. Click the triangle next to the checkbox by each group to see and select the individual TOIs.
     – Under *Areas of Interest*, you can choose to export data relating to all, or just some, of the AOIs created in the project.
3. Click the *Export* button at the top right of the interface. A file browser appears.
4. Locate the folder you want to save the file in. In the *File name* field, enter a file name for your export.
5. Click *Save*.

## 8.14.2 Understanding the Data Export format

Exports from Data Export are saved in a tab-separated values file (.tsv) that follows the Unicode standard. The *.tsv output file contains columns. Each column contains data of a type given by the data type name found in the top row for the corresponding column. All data types are described in the table below. Images and Snapshots have a set of their own columns with information about the image or Snapshot itself and the gaze data mapped to it. Thus, each added image or Snapshot produce additional columns in the output file. The same is true for Areas of Interest, where each AOI will get its own column in the Data Export.

All rows in a Data Export file have a Recording Timestamp value (except the first row, which contains the column data type name). The timestamp is shown in milliseconds and starts at 0 at the beginning of each recording. Since all recorded eye gaze data samples have been recorded in a sequence, all eye gaze data points in a recording will have different time-stamps. However, some Events may have the same timestamp as eye gaze data points and others may have timestamps between two eye gaze data point timestamps. Since gaze data points and Events have their own rows in the export file, the relationship between the number of rows and time is not linear. Instead, timestamps must be used when plotting/charting eye gaze data from a Data Export file.

The following table lists the type of information and data types available for Export from Pro Lab. Each type has its own column in the Data Export output file.

| **General data** | **Description** | **Format/ Units** | **Screen project** | **Glasses project** | **Scene Camera project** | **VR 360 project** |
|---|---|---|---|---|---|---|
| Project name | | | ● | ● | ● | ● |
| Export date | | | ● | ● | ● | ● |
| Participant name | | | ● | ● | ● | ● |
| Participant variables | | | ● | ● | ● | ● |
| Recording name | | | ● | ● | ● | ● |
| Recording date | | YYYY-MM-DD | ● | ● | ● | ● |
| Recording start time | | HH:MM: SS:mmm | ● | ● | ● | ● |
| Recording duration | | Millisec-onds | ● | ● | ● | ● |
| Timeline name | Name of the Timeline used during the Recording (Screen projects only) | | ● | ● | ● | ● |
| Recording Fixation filter name | The name of the Gaze Fil-ter applied to the Record-ing eye tracking data in the export | | ● | ● | ● | ● |
| Snapshot Fixation filter name | The name of the Fixation filter applied to the Snap-shot eye tracking data in the export (Glasses proj-ects only) | | | ● | | |
| Recording soft-ware version | | | ● | | ● | ● |
| Recording resolu-tion width | | Pixels | ● | | ● | ● |
| Recording resolu-tion height | | Pixels | ● | | ● | ● |
| Recording monitor latency | The stimulus start and Event timestamps have been offset by this number to account for the monitor latency. (Screen projects only) | Millisec-onds | ● | | ● | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Calibration results | Average accuracy and precision of calibration in millimeters, degrees and pixels | | • | | • | |
| Recording Timestamp | Timestamp counted from the start of the recording (t0=0) | Millisec-onds | • | • | • | • |
| Participant Video Start | Start Participant video | Millisec-onds | • | | | |
| Participant Video End | End Participant video | Millisec-onds | • | | | |
| Participant Audio Start | Start Participant audio | Millisec-onds | • | | | |
| Participant Audio End | End Participant audio | Millisec-onds | • | | | |
| Eye tracker timestamp | The Recording Timestamp in the eye tracker clock. | Millisec-onds | • | | • | |
| Gaze Point X | Horizontal coordinate of the averaged left and right eye gaze point | Pixels (DACS) | • | • | • | • |
| Gaze Point Y | Vertical coordinate of the averaged left and right eye gaze point | Pixels (DACS) | • | • | • | • |
| Gaze point left X | Horizontal coordinate of the left eye gaze point. | Pixels (DACS) | • | | • | • |
| Gaze point left Y | Vertical coordinate of the left eye gaze point. | Pixels (DACS) | • | | • | • |
| Gaze point right X | Horizontal coordinate of the right eye gaze point. | Pixels (DACS) | • | | • | • |
| Gaze point right Y | Vertical coordinate of the right eye gaze point. | Pixels (DACS) | • | | • | • |
| Gaze 3D position combined X* | Combined X coordinate of the gaze position in the scene camera coordinate system (Glasses projects only) | Millimeter (HUCS) | | • | | |
| Gaze 3D position combined Y* | Combined Y coordinate of the gaze position in the scene camera coordinate system (Glasses projects only) | Millimeter (HUCS) | | • | | |
| Gaze 3D position combined Z* | Combined Z coordinate of the gaze position in the scene camera coordinate system (Glasses projects only) | Millimeter (HUCS) | | • | | |
| Gaze direction left | Gaze direction (X, Y, Z) of the left eye. For details, see “The Gaze Direction Coordinate System” in this manual. | Millimeters | • | • | • | • |

| | | | | | | |
|---|---|---|---|---|---|---|
| Gaze direction right | Gaze direction (X, Y, Z) of the right eye. For details, see “The Gaze Direction Coordinate System” in this manual. | Millimeters | • | • | • | • |
| Pupil position left | Pupil Position (X, Y, Z) of the left eye (Glasses projects only) | Millimeters | | • | | |
| Pupil position right | Pupil Position (X, Y, Z) of the right eye (Glasses projects only) | Millimeters | | • | | |
| Pupil diameter left | Estimated size of the left eye pupil | Millimeters | • | • | • | • |
| Pupil diameter right | Estimated size of the right eye pupil | Millimeters | • | • | • | • |
| Validity left | Indicates the confidence level that the left eye has been correctly identified. The available values are *valid* and *invalid*. (Screen projects only) | | • | | • | |
| Validity right | Indicates the confidence level that the right eye has been correctly identified. The available values are *valid* and *invalid*. (Screen projects only) | | • | | • | |
| Eye position left (DACSmm) | (X, Y, Z) coordinate of the 3D position of the left eye. (Screen projects only) | Millimeters | • | | • | |
| Eye position right left (DACSmm) | (X, Y, Z) coordinate of the 3D position of the right eye. (Screen projects only) | Millimeters | • | | | |
| Gaze point left left (DACSmm) | (X, Y, Z) coordinate of the 3D position of the unprocessed gaze point for the left eye on the screen. (Screen projects only) | Millimeters | • | | | |
| Gaze point right left (DACSmm) | (X, Y, Z) coordinate of the 3D position of the unprocessed gaze point for the right eye on the screen. (Screen projects only) | Millimeters | • | | | |
| Gaze point left (DACSpx) | (X, Y, Z) coordinate of the 3D position of the unprocessed gaze point for the left eye on the screen. (Screen projects only) | Pixels | • | | | |
| Gaze point right (DACSpx) | (X, Y, Z) coordinate of the 3D position of the unprocessed gaze point for the right eye on the screen (Screen projects only) | Pixels | • | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Gaze point (MCSnorm) | The normalized X-, Y-coordinate of the averaged left and right eye gaze point in the scene camera coordinate system. | Pixels | • | • | • | • |
| Gaze point left (MCSnorm) | The X, Y coordinate of the gaze point in scene camera coordinates for the left eye. | Pixels | • | • | • | • |
| Gaze point right (MCSnorm) | The X, Y coordinate of the gaze point in scene camera coordinates for the right eye. | Pixels | • | • | • | • |
| Eye movement type | Type of eye movement classified by the fixation filter | Fixation, Saccade, Unclassified, Eyes Not Found | • | • | • | • |
| Gaze Event duration | The duration of the currently active eye movement | Milliseconds | • | • | • | • |
| Eye movement type index | Count is an auto-increment number starting with 1 for each eye movement type | Number | • | • | • | • |
| Fixation point X | Horizontal coordinate of the averaged gaze point for both eyes | Pixels | • | • | • | • |
| Fixation point Y | Vertical coordinate of the averaged gaze point for both eyes | Pixels | • | • | • | • |
| Event | Name of the Event | | • | • | • | • |
| Event value | The value of any Event parameter, if applicable | | • | | • | • |
| Recording media name | | | | • | | |
| Recording media width | | Pixels | | • | | |
| Recording media height | | Pixels | | • | | |
| Presented Stimulus name | (Screen projects only) | | • | | | • |
| Presented Media name | (Screen projects only) | | • | | | • |
| Presented Media width | The horizontal size of the Media presented on the screen to the Participant, including any scaling set in the Stimulus properties (Screen projects only) | Pixels | • | | | |
| Presented Media height | The vertical size of the Media presented on the screen to the Participant, including any scaling set in the Stimulus properties (Screen projects only) | Pixels | • | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Presented Media position X (DACSpx) | The horizontal position of the Media on the screen. The value represents the horizontal position of the left edge of the Media in relation to the left edge of the screen. (Screen projects only) | Pixels | • | | | |
| Presented Media position Y (DACSpx) | The vertical position of the Media on the screen. The value represents the vertical position of the top edge of the Media in relation to the top edge of the screen. (Screen projects only) | Pixels | • | | | |
| Original Media width | The original horizontal size of the Media presented to the Participant (Screen projects only) | Pixels | • | | | |
| Original Media height | The original vertical size of the Media presented to the Participant (Screen projects only) | Pixels | • | | | |
| Gaze point X (MCSnorm) | The normalized horizontal position of the averaged left and right eye gaze point on the media (Screen projects only) | Normalized coordinates | • | | • | |
| Gaze point Y (MCSnorm) | The normalized vertical position of the averaged left and right eye gaze point on the media (Screen projects only) | Normalized coordinates | • | | • | |
| Gaze point left X (MCSnorm) | The normalized horizontal position of the unprocessed gaze point for the left eye on the media (Screen projects only) | Normalized coordinates | • | | • | |
| Gaze point left Y (MCSnorm) | The normalized vertical position of the unprocessed gaze point for the left eye on the media (Screen projects only) | Normalized coordinates | • | | • | |
| Gaze point right X (MCSnorm) | The normalized horizontal position of the unprocessed gaze point for the right eye on the media (Screen projects only) | Normalized coordinates | • | | • | |
| Gaze point right Y (MCSnorm) | The normalized vertical position of the unprocessed gaze point for the right eye on the media (Screen projects only) | Normalized coordinates | • | | • | |
| Fixation point X (MCSnorm) | The normalized horizontal position of the fixation point on the Media (Screen projects only) | Normalized coordinates | • | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Fixation point Y (MCSnorm) | The normalized vertical position of the fixation point on the Media (Screen projects only) | Normalized coordi- nates | • | | | |
| Media width | Enabling this column generates one column per Snapshot in a Glasses project. | Pixels | | • | | |
| Media height | Enabling this column generates one column per Snapshot in a Glasses project. | Pixels | | • | | |
| Mapped gaze data X [Snapshot Name] | Horizontal coordinate of the gaze point mapped to a Snapshot (Glasses projects only) | Pixels | | • | | |
| Mapped gaze data Y [Snapshot Name] | Vertical coordinate of the gaze point mapped to a Snapshot (Glasses projects only) | Pixels | | • | | |
| Mapped eye movement type [Snapshot Name] | Type of eye movement classified by the default fixation filter (Glasses projects only) | Fixation, Saccade, Eye Not Found Movement, Unknown Eye Movement 2 | | • | | |
| Mapped eye movement index [Snapshot Name] | An auto-increment number starting with 1 for each mapped eye movement type (Glasses projects only) | Number | | • | | |
| Mapped fixation X [Snapshot Name] | Horizontal coordinate of a fixation mapped to a Snapshot (Glasses projects only)<br>Column is empty if the EyeMovement- Type is other than Fixation.<br>Column is not affected by settings in the Fixation Filter. Default fixation filter is applied. | Pixels | | • | | |
| Mapped fixation Y [Snapshot Name] | Vertical coordinate of a fixation mapped to a Snapshot (Glasses projects only)<br>Column is empty if the EyeMovement- Type is other than Fixation.<br>Column is not affected by settings in the Fixation Filter. Default fixation filter is applied. | Pixels | | • | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Automatically-mapped gaze data score [Snapshot name] | Validity score of the automatically-mapped gaze point- enabling this column generates one column per Snapshot (Glasses projects only) | Pixels | | • | | |
| Automatically-mapped gaze data X [Snapshot name] | Horizontal coordinate of the automatically-mapped gaze point (Glasses projects only) | Pixels | | • | | |
| Automatically-mapped gaze data Y [Snapshot name] | Vertical coordinate of the automatically-mapped gaze point (Glasses projects only) | Pixels | | • | | |
| Manually-mapped gaze data X [Snapshot name] | Horizontal coordinate of the manually-mapped gaze point. | Pixels | | • | | |
| Manually-mapped gaze data Y [Snapshot name] | Vertical coordinate of the manually-mapped gaze point (Glasses projects only) | Pixels | | • | | |
| AOI hit [Snapshot/ Image Name – AOI Name] | Reveals if there is a fixation within a given AOI on a given Snapshot<br>0 = No fixation within AOI<br>1 = Fixation within AOI | 0;1 | | • | | • |
| Gyro | Rotation along the X, Y, and Z axis in degrees/second (Glasses projects only) | degrees/ second | | • | | |
| Accelerometer | Acceleration along X, Y, and Z axis in degrees/second^2 (Glasses projects only) | meter/ second^2 | | • | | |
| Galvanic skin response (GSR) | The raw galvanic skin response signal of the participant received from the Shimmer GSR sensor. | micro Siemens | • | | • | • |
| Head rotation | The coordinates of the participant's head rotation quaternion. | Normalized coordinates | | | | • |
| Mouse Position X and Y | Mouse position along the X and Y axis. | Pixels | • | | | |

*The following limitations impact your data when using Gaze 3D position: Gaze 3D position is a vector pointing in the direction of the gaze rays from the left and the right eye. Because these rays are almost parallel, the length of this vector is not accurate. Since the error in the length of the vector increases with viewing distance, the length of the vector Gaze 3D position and combined Z can, therefore, only be used to roughly estimate distances, eg. distinguish between "looking at phone" and "looking at scenery." Three approximations can be assumed: between 0-1m = near; between 1-2m = uncertain; and 2m-infinity = far.

### 8.14.3 Plof file format

The Pro Lab Output Format (plof) exports all data in a machine-readable format. The main goal for this format is to enable third-party software and researchers an easy and robust import of Tobii Pro eye tracking data. All data stored in Pro Lab can be exported, including raw eye tracking data, eye movement data, manual event coding data, stimulus information data, areas of interest data, raw GSR data and GSR events.

For more detailed information about plof, request the “Tobii Pro Lab Output Format Reference guide” from Tobii Pro Sales.

## 8.15 Analyzing a Screen Recording

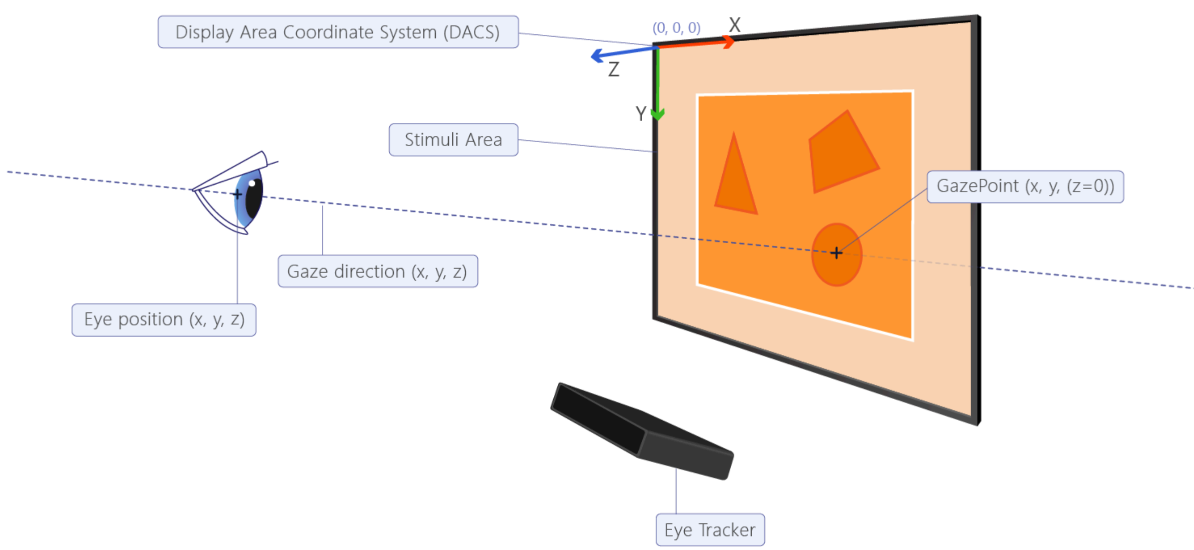
You record the screen by using a Screen Recording stimulus. Adding a Screen Recording stimulus is explained in section 5.1.1 and editing Screen Recording stimulus properties in section 5.2.4.

- When you want to analyze a screen recording, you can log events, just like for any other type of recording. Logging events is described in section 8.1.4.4.
- When you want to aggregate data and create visualizations such as heat maps and gaze plots, you can create TOIs with frames, as explained in section 8.1.4.5.
- When you want to analyze a screen recording, you can create AOIs and dynamic AOIs in the AOI Editor just like for other types of recordings. The name of the recording in the AOI Editor will be “Screen Recording + recording name”. For example, if you made a screen recording with the name Version A, the recording name in the Media Selection in the Aoi Editor is “Screen Recording Version A”. Create dynamic AOIs using your Screen Recording, by following the steps in section 8.4.2.

# Appendix A Coordinate systems and mapping of data

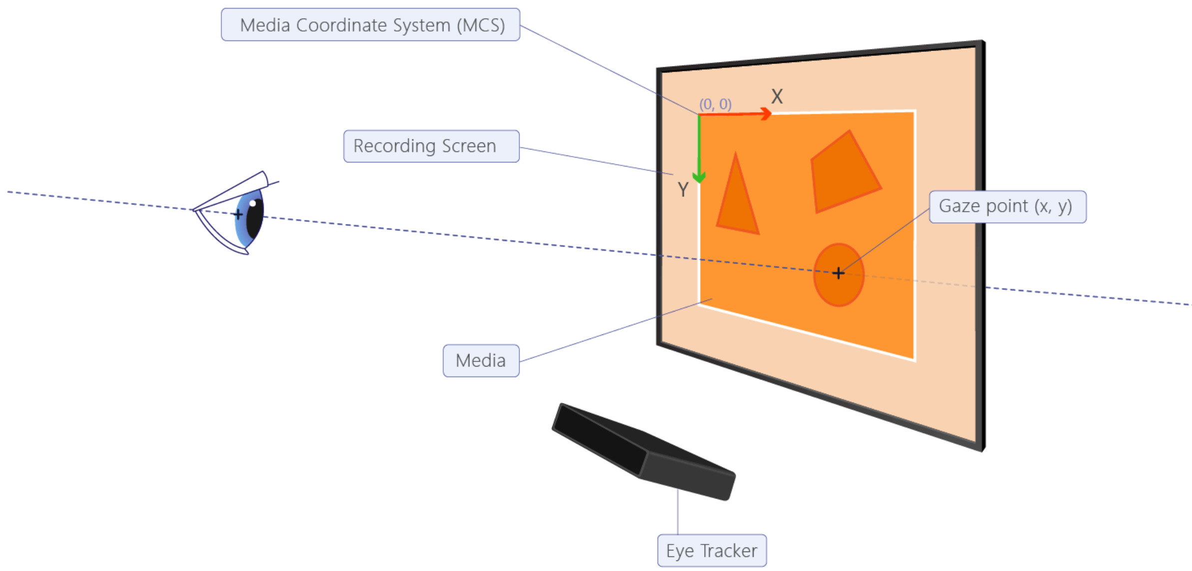
Pro Glasses 2 uses the intersection of the gaze vectors from the two eyes to calculate the distance at which the participant is looking. If the eye tracker loses tracking for one of the eyes, it will continue using the last known distance until it gets gaze data from both eyes again.

## A1 Display Area Coordinate System (DACS)




When working in a Screen project, the data is mapped onto what is seen on the screen.

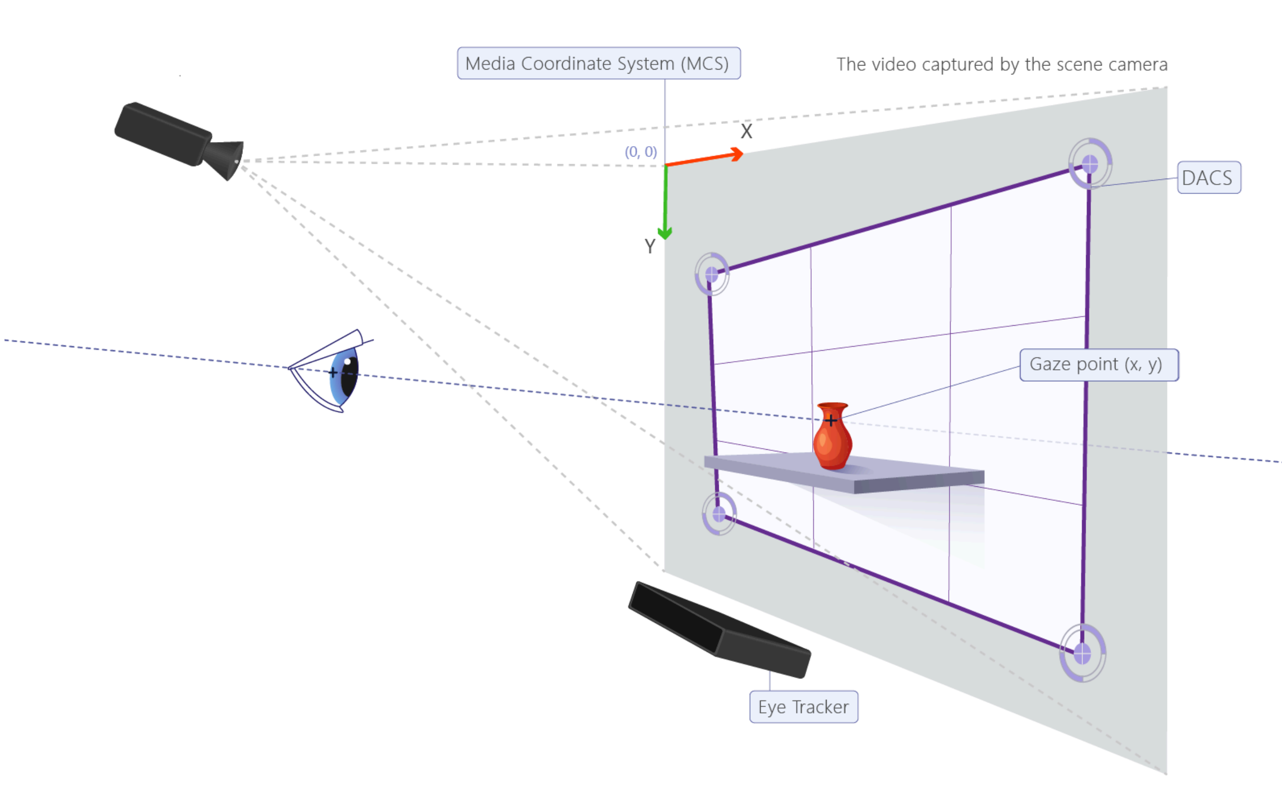
DACS is a 3D coordinate system with its origin in the top left corner of the screen (stimuli area) with Y pointing downwards. (A coordinate that is lower on the screen will have a higher Y-value). This may feel unintuitive for a 3D coordinate, but it is common in screen-based coordinate systems. It is oriented so that it is aligned with the plane of the screen, so any coordinate on the screen will have its z-coordinate equal to zero. Gaze points, eye positions, and gaze directions are all available in DACS. The 3D coordinates for gaze point and eye position are expressed in millimeters. Screen positions in pixels or normalized coordinates can easily be translated to DACS 3D coordinates. The User Coordinate System in Tobii eye trackers uses this during the screen setup of the eye tracker. The screen setup defines the three corners of the screen in UCS coordinates (ULLLUR, Upper Left, Lower Left and Upper Right). This data is then used by Pro Lab to transform UCS coordinates into DACS coordinates.




When media is presented on the screen, it typically extends over a portion of the screen. Pro Lab keeps track of exactly where on the screen the media is displayed and transforms coordinates (gaze points, mouse cursor positions) from DACS (the entire screen) to media coordinates (MCS). MCS coordinates are either in pixels (media pixels, not necessarily screen pixels) or normalized in order to be comparable between recordings. If the same media was displayed on two different screens, with “fit to screen” scaling, both pixel coordinates and normalized coordinates can still be compared and the same coordinate will always refer to the same position on the media. Origin in MCS is the top left corner of the media. Y is pointing downwards.

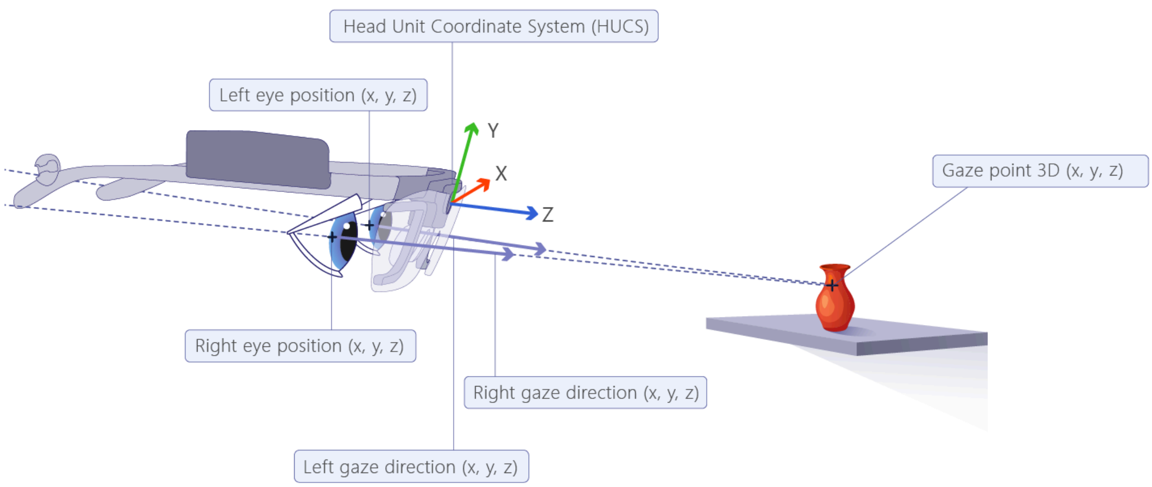
## A2 Scene Camera Projects and the Media Coordinate System (MCS)

When eye tracking is done in a real-world environment (screen camera projects), what is seen by the study participant is filmed using a scene camera. When viewing the recording, the gaze data is mapped from the coordinate system of the eye tracker to the 2D coordinate system of the scene camera video.




In scene camera recordings there is not necessarily a computer screen, but there is a surface that the eye tracker is configured on which to map gaze. This could be a computer screen, but it could also be a whiteboard on the wall, a flat surface on a table, or a virtual surface in the scene. If the user is focusing on objects that are not in the plane of the configured surface, the eye tracking data will be incorrect. In order to map gaze from this surface to the scene camera video, it is important that the edges of the surface configured in the eye tracker are marked in the scene camera video image. This allows Pro Lab to calculate a transformation (homography) from the DACS coordinate system to the scene camera video (MCS). Since the scene camera video does not have any physical dimensions and the homography only allows translation in 2D, coordinates in MCS can only be provided in relative coordinates or pixels

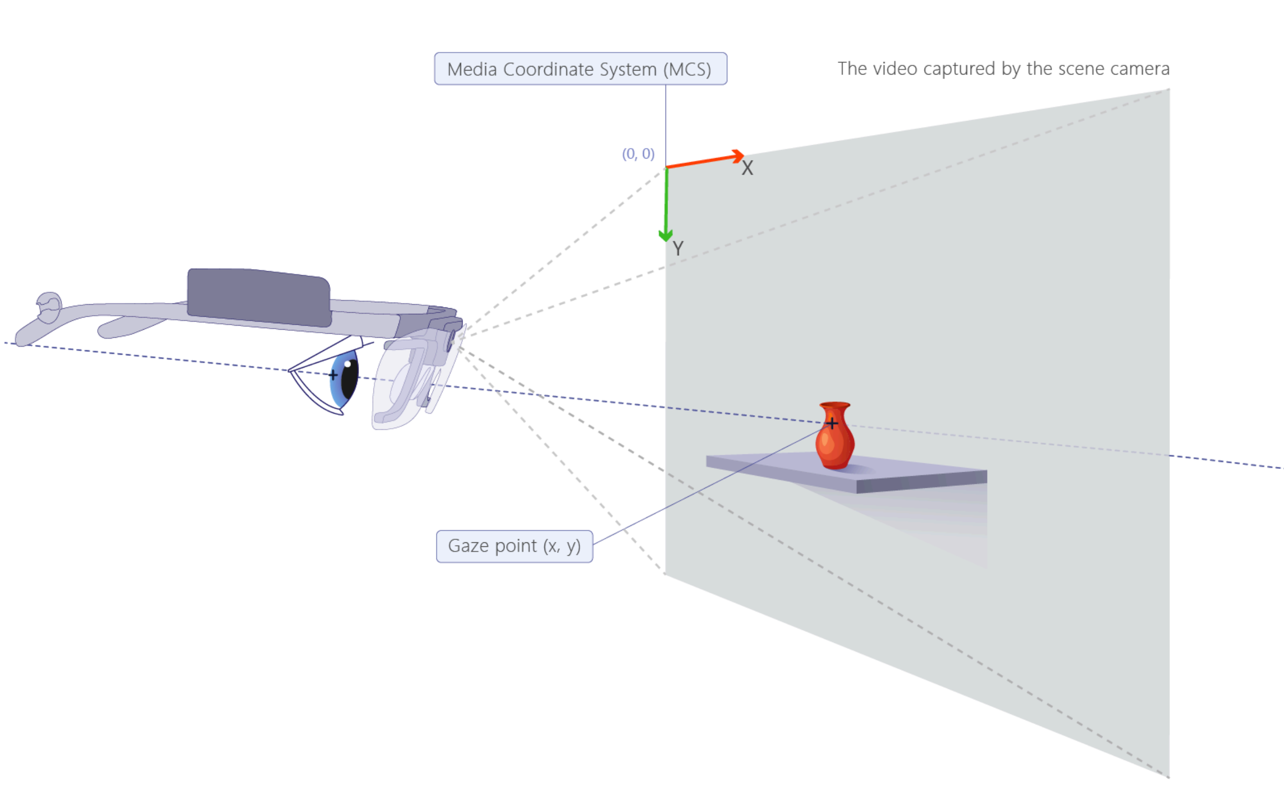
# A3 Head Unit Coordinate System (HUCS)




Just like for screen-based trackers, the glasses measures everything in a 3D coordinate system. Eye position and gaze vectors are calculated from the eye images using a 3D eye model that gives positions and angles in a coordinate system with its origin in the center of the scene camera.

The gaze point is calculated as the vergence point between the two gaze vectors. This means that there can be only one 3D gazepoint even though both eyes are tracked. This is because the eye tracker has no way of knowing how far away (or close) you are looking. A screen-based eye tracker uses the intersection of the screen plane and the gaze direction, but in glasses, there is no known screen plane. The user can be looking at his nose or at a mountain miles away. The vergence point will indicate how far away the user is looking (the error in distance is small at short distances and increases rapidly as the distance grows. The distance value can't be used at distances greater than a few meters.

Keep in mind that the coordinate system follows the orientation of the head unit. When the head moves, the coordinate system moves with it. They eyes are typically located in approximately the same position relative to the head unit, but gaze angles and gaze points typically change when you turn your head (and keep your eyes fixed on a stationary object).




In order to get a coordinate on the scene camera image, the 3D gazepoint is projected onto the video surface using the camera parameters. This yields a 2D gazepoint in relative coordinates to the video. In Lab, this will be exported as MCS in pixels or relative coordinates. There is no information about physical dimensions in the video.

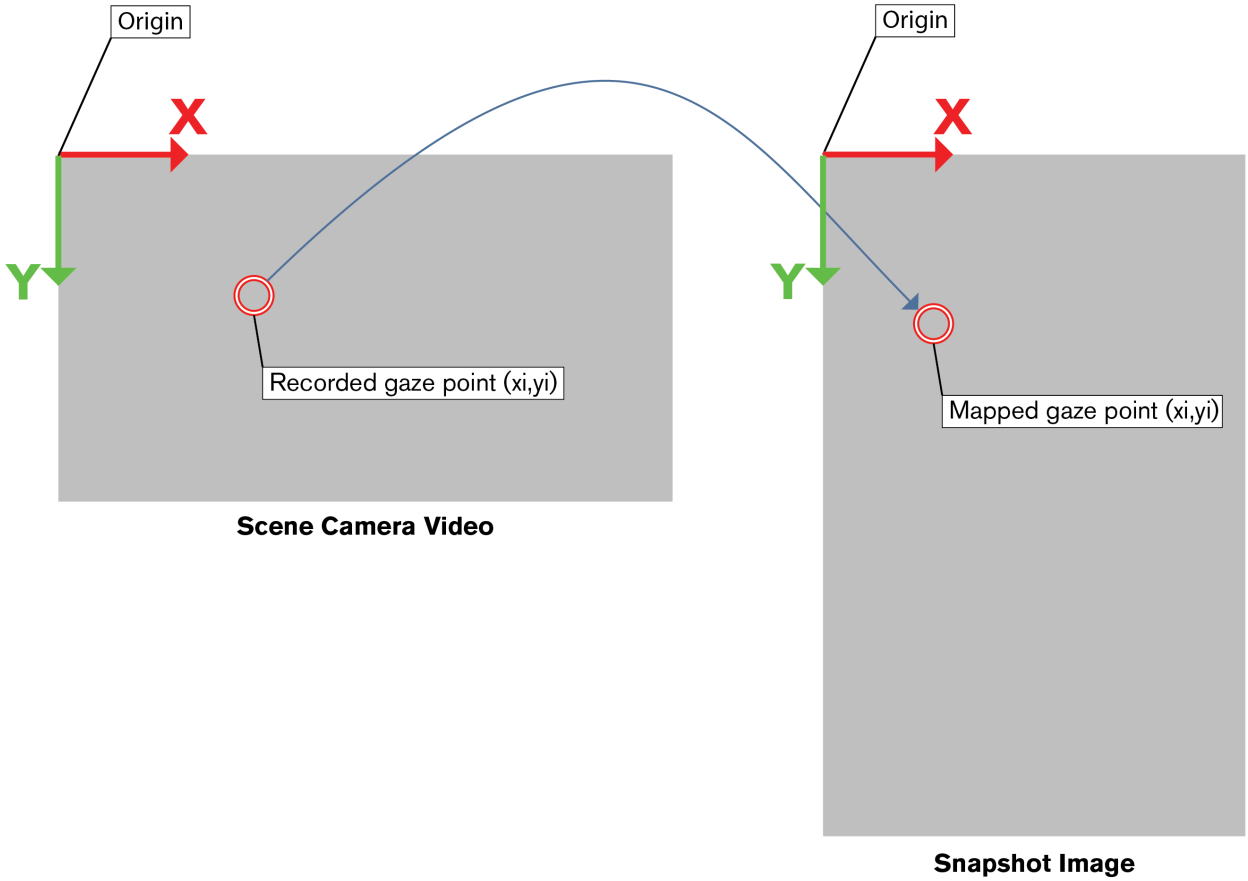
## A4 Mapping data from Glasses recordings onto Snapshots

The coordinate system for recorded data in a Glasses project is based on the scene camera video in the Glasses, as seen in the picture below. When mapping data onto a Snapshot, a new coordinate system is automatically created. The Media Coordinate System is based on the resolution of the Snapshot image, and its origin is located in the upper-left corner.

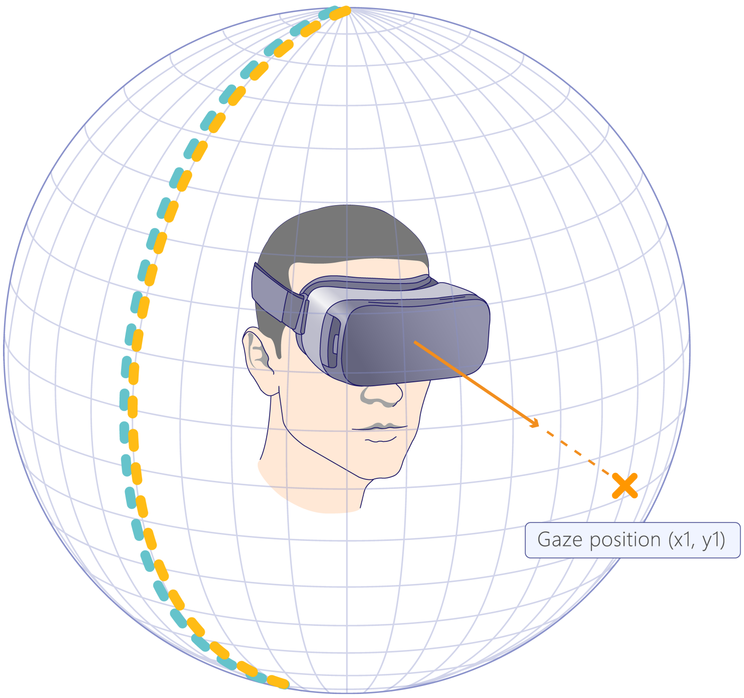
All gaze data point coordinates in the Data Export output file relating to gaze points are given in pixels. To understand where a gaze point (xi, yi) is located on the scene camera video or on the Snapshot, the size in pixels of the scene camera video or the Snapshot need to be taken into consideration.

For detailed information about the scene camera resolution, please refer to the product description for your wearable eye tracker.

The width of a Snapshot can be derived from the Width [Snapshot Name] column in the Data Export file. The height of a Snapshot can be derived from the Height [Snapshot Name] column in the Data Export file.

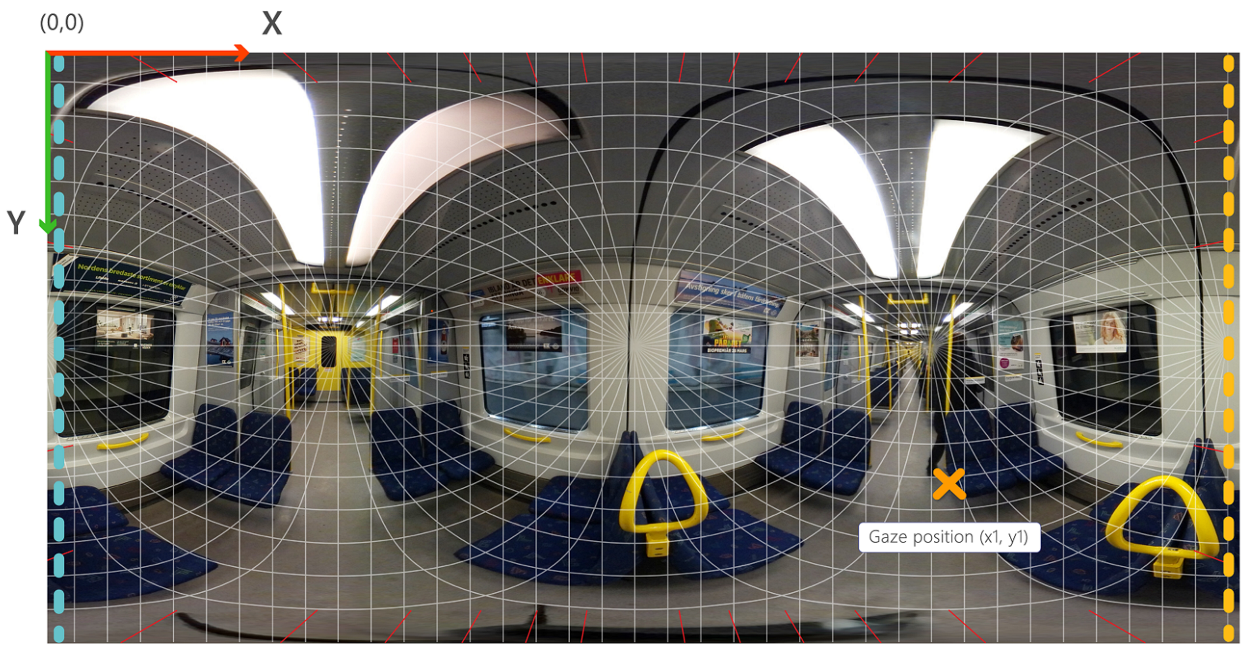

Origin
X
Y
Recorded gaze point (xi,yi)
Scene Camera Video
Origin
X
Y
Mapped gaze point (xi,yi)
Snapshot Image

# A5 Coordinate systems in VR 360 projects



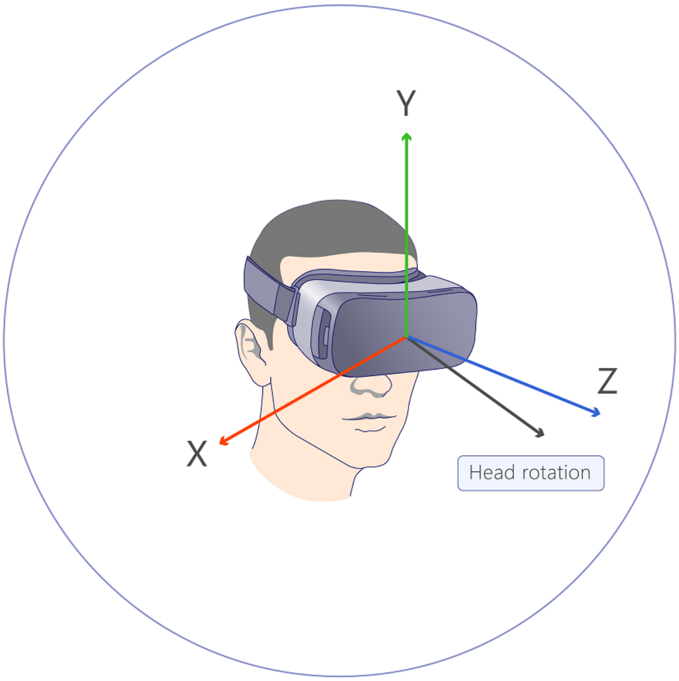

The equirectangular- panoramic image is projected onto the inside of a sphere, with the VR headset in the center of the sphere. Your experience wearing the VR headset is that you are standing in the same place as the 360 camera that created the image or video. The gaze position shown on the sphere above is the same gaze position shown on the flattened 360 image below.

## A5.1 Display area coordinate system (DACS)




The image that is used as media input in VR 360 projects in Pro Lab is warped and has an equirectangular format with aspect ratio 2:1. The orange and blue dotted lines on the sphere correspond to the orange and blue edges to the left and right of the image. Think about it as if you were folding the image to make a cylinder at first and then shaping it to a sphere. Another way to think about this is that the image is a representation of a sphere just as a Mercator projection makes it easier to depict the world map onto a flat surface. In the VR world, your head will be located at the middle of the sphere and you are able to turn around to look at the image or video in any direction you want.

## A5.2 World coordinate system (WCS)




The rotation of the headset is expressed in World Coordinate System in Unity. Since VR 360 projects in Tobii Pro Lab are using Unity technology for recording and replaying in VR, the Unity World Coordinate System is used for the head rotation data in Tobii Pro Lab Data Export.

The head rotation in Tobii Pro Lab Data Export is expressed as a quaternion. A rotation can be mathematically described with a quaternion or a rotation matrix. Quaternions are widely used in coding as they are almost always unique, as opposed to Euler angles. For Euler angles, 0 degrees around an axis is the same rotation as 360 around the same axis, which is the same rotation as 720 degrees around the axis, etc. A quaternion is made up of 4 numbers, whose values all have a minimum of -1 and a maximum of 1, i.e (0,0,0,1) is a quaternion rotation that is equivalent to “no rotation” or a rotation of 0 around all axis.

Given a normalized (length 1) axis representation (x,y,z) and an angle A. The corresponding quaternion is equal to:

Q = [sin(A/2)*x, sin(A/2)*y, sin(A/2)*z, cos(A/2)] (corresponding to [x, y, z, w].

Given an Euler rotation (x,y,z), using orthogonal axes, the corresponding quaternion is equal to:

x = sin(Y)sin(Z)cos(X)+ cos(Y)cos(Z)sin(X)

y = sin(Y)cos(Z)cos(X)+ cos(Y)sin(Z)sin(X)

z = cos(Y)sin(Z)cos(X)- sin(Y)cos(Z)sin(X)

w = cos(Y)cos(Z)cos(X)- sin(Y)sin(Z)sin(X) Q = [x,y,z,w]

# Appendix B Gaze Filters' functions and effects

During a recording, eye trackers from Tobii Pro collect raw eye movement data points every 1.6 to 33 msec. (depending on the sampling data rate of the eye tracker). Each sample will, along with other data, contain a timestamp and gaze coordinates. These coordinates can then be processed further into fixations, which can be overlaid on a video recording of the stimuli used in the study or used to calculate eye tracking metrics. This process is conducted by applying an eye movement classification algorithm, or Gaze Filter, to the data.

## B1 The Raw Gaze Filter preset type

The Raw data preset type in the Gaze Filter settings does not classify the gaze data into fixations, saccades, or any other eye movement. This preset type only offers the possibility to apply three data processing functions to the data: Gap fill-in (interpolation), Eye selection, and Noise reduction.

Pro Lab includes one built-in preset for the Raw Gaze Filter preset type. The default parameters for this preset are defined below. If you wish to modify the filter settings for you project, select the option "Create new Raw filter" from the Gaze Filter dropdown menu and change the appropriate variables. Your custom settings will be saved as a new preset available in all parts of the application.

The default parameters in the Raw Gaze Filter built in preset are:

- Gap fill-in (interpolation): Off
- Eye selection: Average
- Noise reduction: Off

## B2 The Tobii I-VT Gaze Filter definition

The general idea behind an I-VT filter (Velocity-Threshold Identification Gaze Filter) is to classify eye movements based on the velocity of the directional shifts of the eye. The velocity is most commonly given in visual degrees per second (°/s). If the velocity of the eye movement is below a certain threshold, the samples are classified as part of a fixation. If the velocity is above the threshold, it is classified as a saccade.

The Tobii I-VT filter has been developed to work best in stationary situations, and the default values of the I-VT fixation filter parameters have been set to provide accurate fixation classifications for the most common eye tracking use cases in stationary situations. However, depending on the type of eye tracking study conducted, the settings in the I-VT filter can be adjusted to better suit a particular study, to get finer grained fixation data, or to compensate for high levels of noise. The data processing functions within the I-VT fixation filter are described in the sections below.

Pro Lab includes several presets for the Tobii I-VT filter. The default parameters for these are defined below. If you wish to modify the filter settings for your project, select the option "Create new I-VT filter" from the Gaze Filter dropdown menu and change the appropriate variables. Your custom filter settings will be saved as a new filter available in all parts of the application.

The I-VT fixation filter may fail to correctly classify all eye movement recorded with Pro Glasses 2 due to various factors. For more information, please read "Gaze Filters and wearable eye trackers, when they succeed and when they fail".

If accurate fixation and saccade data is required for your study, it is strongly recommended that you always verify the performance of the fixation filter for your data.

For additional information about the fixation filters, please read the following whitepapers, which can be found on our website:

- Tobii I-VT Fixation Filter — Algorithm Description
- Determining the Tobii I-VT Fixation Filter's Default Values

## B2.1 Gap fill-in (interpolation)

The purpose of the Gap fill-in function is to fill in data where gaze data points are missing. For example, this prevents a fixation in which a few samples are missing as being interpreted as two separate fixations. This loss of gaze data can occur due to temporary interference of eyelashes or other factors. In these cases, the data loss is usually limited to a short period of time, typically less than 50 msec.

Data can also be lost due to other reasons, such as the participant blinking or looking away. This kind of data loss usually results in data gaps longer than 100 msec. Losing data in these latter cases may be perfectly fine for applications of eye tracking where visual attention is measured, since participants do not see anything while blinking or looking away anyway.

In Pro Lab, you can control the limit of how large the gaps (in msec.) in gaze data are that should be filled in by setting the parameter "Max gap length."

Data is filled in in the data gap through linear interpolation. Data points are added along a straight line between neighboring valid data points. Interpolation is done for each eye separately.

## B2.2 Eye selection

The eye selection function enables you to choose to discard the gaze data collected from one of the eyes (left or right) or to average the data from both eyes for fixation classification. The only setting available for Glasses projects is Average, which makes an average of the position data from the left and the right eye. If only one eye is detected, it uses the data from that eye.

## B2.3 Noise reduction — Moving Median

All measurement systems, including eye trackers, experience noise. Noise can come from imperfections in the system setup, as well as from influences and interferences around the environment in which the measurement takes place. In eye tracking research where the fixation is the eye movement of interest, other minor eye movements, such as tremor and microsaccades, can also be seen as noise. In the most basic form, I-VT filters calculate the velocity by multiplying the change in position between two consecutive sample points. If the sampling interval is long, the eye will have time to do quite large shifts of direction between two samples, which makes it easy for the eye tracker to distinguish between real eye movements and noise. The higher the sampling frequency, the smaller the eye movement will be between two consecutive samples at a given eye velocity. Noise will therefore have a greater impact in a high frequency system even though it has the same magnitude as in a low frequency system.

The Moving Median noise reduction function is accessible using the Tobii I-VT fixation filter and the Raw data filter.

The median noise reduction function is a symmetric Moving Median filter. It produces output data by calculating the median value of the number of consecutive data points from the input data series. The number of input data points used to produce each output data point is controlled by the Window size parameter. Each produced output data point is given the timestamp of the input data point that was in the center of the window: the median point of the input window (the window size parameter must be an odd number). In cases where the window is not entirely filled with input data points, no output data will be produced. Most often, this happens when the window is short of data points due to the fact that the window stretches outside a data series with valid gaze or when small fractions of data points are missing within the window. Typically, the window stretches outside a valid data series at the beginning and end of a blink or at the beginning and end of a recording. The loss of small fractions of data can occur as a result of temporary reflections, occlusions, etc. This can partly be solved by using the Gap fill-in function.

## B2.4 Noise reduction — Moving Average

All measurement systems, including eye trackers, experience noise. Noise can come from imperfections in the system setup, as well as from influences and interferences from the environment in which the measurement takes place. In eye tracking research where the fixation is the eye movement of interest, other minor eye movements, such as tremor and microsaccades, can also be seen as noise. In the most basic form, I-VT filters calculate the velocity by multiplying the change in position between two consecutive sample points. If the sampling interval is long, the eye will have time to do quite large shifts of direction between two samples, which makes it easy for the eye tracker to distinguish between real eye movements and noise. The higher the sampling frequency, the smaller the eye movement will be between two consecutive samples at a given eye velocity. Noise will therefore have a greater impact in a high frequency system even though it has the same magnitude as in a low frequency system.

The Moving Average noise reduction function is accessible using the Tobii I-VT fixation filter and the Raw data filter.

The Moving Average noise reduction function is a symmetric Moving Average filter. It produces output data by creating an arithmetic mean of a number of data points from the input data. The number of input data points used to produce each output point is controlled by the Window size parameter. Each produced output data point is given the timestamp of the input data point that was in the center of the window: the input median point (the window size parameter must be an odd number). The window size is dynamically adjusted so that the window never stretches outside the valid data series.

## B2.5 The Velocity calculator

The Velocity calculator function assigns an angular velocity (visual degrees/second) to each gaze data point. Angular velocity refers to the angular velocity of the eyes relative to the stimuli.

To calculate the gaze velocity on a stimulus (e.g. a stimulus or a Snapshot), it uses three points: the eye position and two gaze points on the stimulus. For a stationary stimulus, such as an image when using a screen-based eye tracker, this is fairly straight forward, but, for data from a wearable eye tracker, it gets a little more complicated. When it comes to calculating the gaze velocity when using a Snapshot and data mapped from a Pro Glasses 2 recording, Pro Lab uses the Gaze Position 3D coordinates. The Velocity calculator function estimates the eyes' angular velocity for each data point by dividing the angular difference between a preceding and a subsequent data point with the time interval between them. The time interval is set by the parameter window length in the Velocity calculator function. The Velocity calculator will only produce velocity output data if the entire window contains input data. This means that gaps in the input data (like the ones caused by blinks) will result in larger gaps in the output data. The size of the output gap will be equal to the input gap plus the number of data points included by the window length parameter.

## B2.6 The I-VT fixation classifier

The I-VT fixation classifier is based on the I-VT (Velocity-Threshold identification fixation filter), as described by Salvucci and Goldberg (Salvucci & Goldberg, 2000) and Komogortsev et. al. (Komogortsev, Gobert, Jayarathna, Do Hyong Koh, & Gowda, 2010). It is a threshold function that operates on eye tracking data where each data point has an assigned angular velocity. In Pro Lab, angular velocity is assigned to eye tracking data in the Velocity calculator data processing function, as described in the previous section.

The I-VT fixation classifier applies an angular velocity threshold on each data point. The threshold value is given in degrees/second and is adjusted by setting the parameter Velocity threshold in the Gaze Filter settings. Data points with angular velocity below the threshold value are classified as being part of a fixation, and data points above are classified as being part of a saccade.

According to the I-VT fixation classifier, a fixation is an unbroken chain of raw data points all classified as fixation data points. If the velocity cannot be calculated for a raw data point, it is classified as an Unknown Eye Movement. The fixation coordinate is calculated as the arithmetic mean value of the coordinates of the data points belonging to the specific fixation.

## B2.7 Merge adjacent fixations

The purpose of the Merge adjacent fixations function is to merge fixations that have been incorrectly classified as multiple short fixations instead of the same, long fixation. Noise and other disturbances can cause the I-VT classifier to incorrectly classify data points that should belong to a fixation as not being part of it. This will split the fixation into multiple fixations, which are all located close together. The Merge adjacent fixations function can be set to merge these multiple fixations into one fixation.

The Merge adjacent fixations function has two threshold parameters:

- Max time between fixations defines the maximum time interval between separate fixations that should be merged.
- Max angle between fixations defines the maximum visual angle of the eyes between separate fixations that should be merged.

## B2.8 Discard short fixations

The purpose of the Discard short fixation function is to remove incorrectly classified fixations that have too short of a duration to be real fixations. As the brain needs to take in visual input for a while before it has enough data to process it, a fixation (which is when this visual input is collected) cannot be infinitely short. The Discard short fixation function can be set to remove these incorrectly-classified fixations. The Discard short fixations function can also be used to decrease the temporal resolution of fixation data.

The parameter Minimum fixation duration sets the threshold of how short of a duration a fixation can have to be classified as a “fixation.” All data points belonging to fixations shorter than the threshold value will be reclassified as non-fixation data points.

## B2.9 The Tobii I-VT Gaze Filter default parameters

Pro Lab includes a few preset settings for the Tobii I-VT Gaze Filter. The default parameters for these filters are defined below. If you wish to modify the filter settings for your project, select the option “Create new I-VT filter” from the Gaze Filter dropdown menu and change the appropriate variables. Your custom filter settings will be saved as a new filter available in all parts of the application.

### B2.9.1 Tobii I-VT (Fixation)

This filter is suitable for controlled studies where only fixations and saccades are present in the collected data. As with other velocity-based filters, this filter will not classify smooth pursuit and VOR eye movements correctly. To calculate the gaze velocity for data mapped onto Snapshots, this preset uses the Gaze Position 3D coordinates to calculate the true eye velocity.

- Gap fill-in (interpolation)
  - Default: Disabled
- Eye selection
  - Default: Average
- Noise reduction
  - Default: Moving Median
  - Window size: 3 samples
- Velocity calculator
  - Default: window length 20 msec.
- I-VT fixation classifier
  - Default: Threshold 30 degrees/second
- Merge adjacent fixations
  - Default: Enabled
  - Max time between fixations: 75 msec.
  - Max angle between fixations: 0.5 degrees
- Discard short fixations
  - Default: Enabled
  - Minimum fixation duration: 60 msec.

### B2.9.2 Tobii I-VT (Attention)

The Attention Filter in Pro Lab is essentially the Tobii Pro IV-T Filter, with the velocity threshold parameter set to 100 degrees/second instead of the default 30 degrees/second.

The Attention Filter was created to handle eye tracking data from glasses recordings, which are conducted under dynamic situations, where either the subject is constantly moving or the objects or targets are moving around the subject. In these situations, we use a large array of eye movements to help us keep our fovea aligned with objects and other visual features in the environment – fixations, saccades, smooth pursuits and VOR. (See our article “Types of Eye Movements” for more information.)

We use the filter to separate the moments when we are trying to stabilize our fovea onto something (fixation, smooth pursuit and vestibular ocular reflex), thus potentially extracting information from the location or object, from the moments the eyes are moving too fast to extract information (saccades).

By setting the threshold to 100 degrees/second, we classify fixation, smooth pursuit and most VOR data as “Attention”. However, we also classify 10-15% of saccades as “Attention” as well, which means we overestimate “Attention” slightly.

Setting the IV-T Filter to the default setting of 30 degrees/second will result in underestimation of the periods of “Attention” or information gathering, since quite a large portion of data belonging to smooth pursuits and VOR periods will be classified as saccades.

When using the “Attention” filter, any fixation based AOI metrics will become “foveal S time to first fixation will become “time to the first moment the fovea is stabilized on an AOI”

# B3 Gaze Filters and wearable eye trackers, when they succeed and when they fail

One of the greatest challenges with fixations filters for wearable eye tracking solutions is the fact that the head with the eye tracker typically moves in relationship to the stimulus (the object being researched). Gaze data produced by the eye tracker is associated with a coordinate system that belongs to the wearable eye tracker, not the stimulus. In this eye tracker coordinate system, as the participant is moving his/her head, the stimulus will appear to be moving although it is static in the real world. To be able to aggregate gaze data in relationship to the stimulus, the data needs to be remapped into a coordinate system that is fixed to the stimulus instead of the eye tracker. Pro Lab enables remapping of data by allowing the user to map gaze data onto still images (Snapshots), picturing environments and objects that are being researched.

The tables below give a rough indication of how the Tobii I-VT Gaze Filter reacts to gaze data when a participant is looking at an object in different circumstances. Green = Gaze Filter classifies data correctly. No color = Gaze Filter fails to classify the data correctly. The aim of the Gaze Filter is to map fixations correctly on or around the object of interest.

## B3.1 Object and gaze in the eye tracker’s coordinate system

In this example, the fixed point is the origin of the eye tacker coordinate system. That means that everything else is moving in relation to one point on the eye tracker. It also means that, if the eye tracker moves, it appears that everything else moves as well. Keep in mind that the eyes and, therefore, gaze also moves more or less independent of the eye tracker.

| | Object of interest is moving | Object of interest is still |
|---|---|---|
| Head moving | Combination of Vestibulo-ocular reflex and smooth pursuit ➔ Fixation filter result: Saccade or Unknown Eye Movement | Vestibulo-ocular reflex ➔ Fixation filter result: Saccade or Unknown Eye Movement |
| Head kept still | Smooth pursuit ➔ Fixation filter result: Saccade or Unknown Eye Movement | Fixation ➔ Fixation filter result: fixation |

## B3.2 Object and gaze in MCS

In this example, the fixed point is related to a fixed area in the real world which is illustrated by a Snapshot. In relation to the fixed area, both the object of interest and the participant’s eyes, as well as gaze, move independently.

| | Object of interest is moving | Object of interest is still |
|---|---|---|
| Head moving | Combination of Vestibulo-ocular reflex and smooth pursuit ➔ Fixation filter result: Saccade or Unknown Eye Movement | Vestibulo-ocular reflex ➔ Fixation filter result: Saccade or Unknown Eye Movement |
| Head kept still | Smooth pursuit ➔ Fixation filter result: Saccade or Unknown Eye Movement | Fixation ➔ Fixation filter result: fixation |

## B3.3 Object, gaze, and Snapshot in the object’s coordinate system

In this example, the coordinate system moves with the object. As the aim of the Gaze Filter is to correctly map attention to the object, it doesn’t matter if that attention manifests itself in the form of fixations, smooth pursuit ,or Vestibulo-ocular reflex movements. The gaze will appear to be more or less stationary during the time of attention on the object as the coordinate system moves with the object.

| | Object of interest is moving | Object of interest is still |
|---|---|---|
| Head moving | Combination of Vestibulo-ocular reflex and smooth pursuit ➞ Fixation filter result: Saccade or Unknown Eye Movement | Vestibulo-ocular reflex ➞ Fixation filter result: Saccade or Unknown Eye Movement |
| Head kept still | Smooth pursuit ➞ Fixation filter result: Saccade or Unknown Eye Movement | Fixation ➞ Fixation filter result: fixation |

## B4 The effect of mapping data onto Snapshots with the Tobii I-VT or Raw Gaze Filter

When mapping data onto a Snapshot with the I-VT fixation filter turned on, the replay window will only display data points that were classified as fixation data. Taking the previous section into consideration, the conclusion is that the replay will only display fixations if both the participant's head and the object being researched was still (or in a special case, the participant's head and the wearable eye tracker follow along with a moving object). To be sure to map all available data in all circumstances, make sure you use a Raw Gaze Filter when mapping data onto Snapshots. The Tobii I-VT (Attention) filter preset is suitable for situations where you only want to study attention without separating any eye movements. This preset has the I-VT fixation classifier set to 100 degrees/second and will, in addition to classifying typical fixations, also classify most VOR (Vestibulo-ocular reflex), smooth pursuit eye movements, and slow saccades as fixations.

Always make sure to double check mapped data by replaying the recording with the Snapshot showing mapped data and the Gaze Filter set to Raw.

# Appendix C Calculating heat maps

The Heat Map can be based on either fixation data or raw data, depending on whether you are using one of the I-VT Gaze Filters or a Raw data filter. In both cases, data entries consist of a timestamp, duration, and spatial location (X and Y coordinates). There are four different settings for Heat Maps in Pro Lab:

- **Absolute count**: calculated by the number of fixations (or gaze data samples if using raw data)
- **Absolute duration**: calculated by the duration of fixations (or gaze data samples if using raw data)
- **Relative count**: calculated by the number of fixations relative to the total number of fixations made by the participants in the Time of Interest (or gaze data samples instead of fixations if using raw data)
- **Relative duration:** calculated by the duration of the fixations relative to the sum of all fixation durations mapped in the Time of Interest on the Snapshot (or gaze data samples instead of fixations if using raw data)

Eye tracking raw data is composed of fixation and noise data points. The noise includes eye samples during saccades and other small fixation-related movements. A Heat Map based on raw data will, therefore, contain more noise and show larger areas with high color value. When a Heat Map is based on raw data, each entry corresponds to a raw gaze point from the eye tracker, sampled every 1,6 to 33 msec. (depending on the sampling data rate of the eye tracker). Duration values for each entry are constant as they are defined by the duration of the sampling interval.

When the input is based on fixation data, the eye tracker will group the raw data entries into fixations, and the duration of each fixation depends on the Gaze Filter used to identify the fixations. The input data will typically look like this:

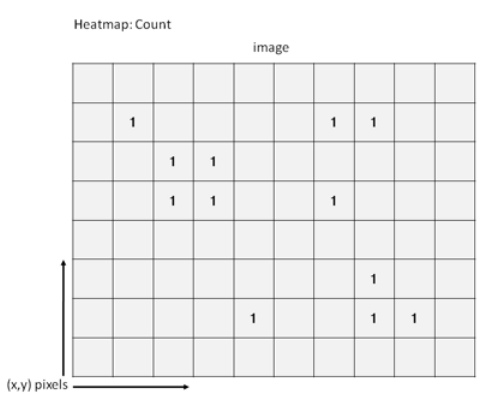
Fixation: 1 Start: 132 msec. Duration: 132 msec. Location: (415,711)

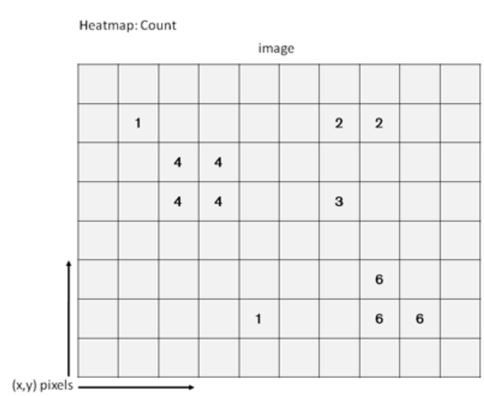
Fixation: 2 Start: 264 msec. Duration: 735 msec. Location: (711,491)

Fixation: 3 Start: 999 msec. Duration: 101 msec. Location: (301,10)

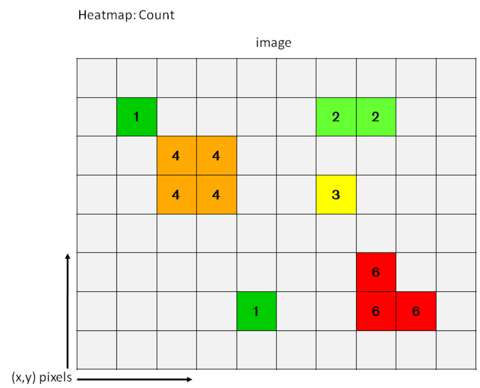
## C1 Basic concept

The first step in creating a Heat Map is to map the fixations on the stimulus. This is done by going through all the fixations in all selected recordings one by one and adding their values whenever a fixation shares the same X and Y pixel location as another (see figures below). If Count is selected, Pro Lab adds the number of fixations at the same location. If Absolute duration is selected, Pro lab instead sums the duration of all fixations in the same location. For Relative duration, the duration of each fixation is divided first by the media viewing time and then added.



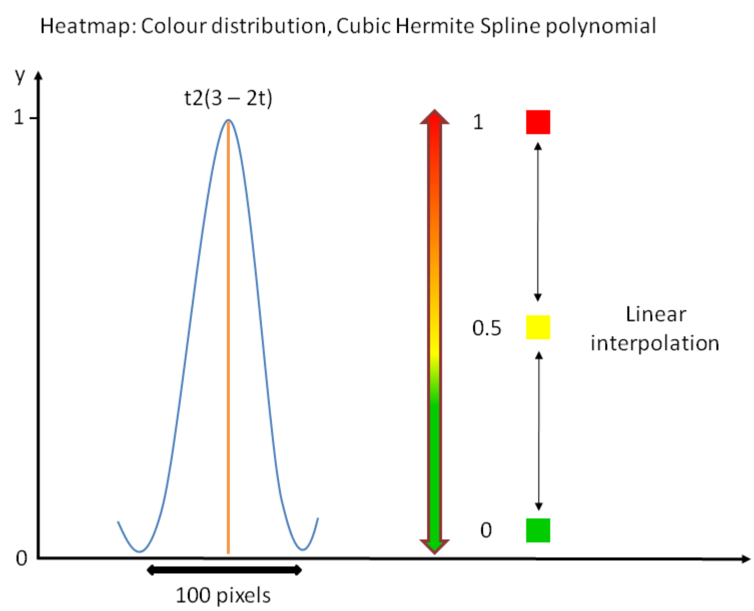

Once all of the fixation values have been added together, color values are assigned to all the points with the warmest color usually representing the highest value. However, the colors that are used can be customized in the Heat Map settings.




## C2 The Heat Map

The basic concept described in the previous chapter would result in a rather useless image, with small colored dots distributed over the picture. Instead, the application sums up the color values from all the points within a certain distance of the fixation location, and the color values gradually decrease as we move away from the fixation point. This process ensures that the color distribution results in a more “smooth” Heat Map image and gives some biological relevance to the color mapping.

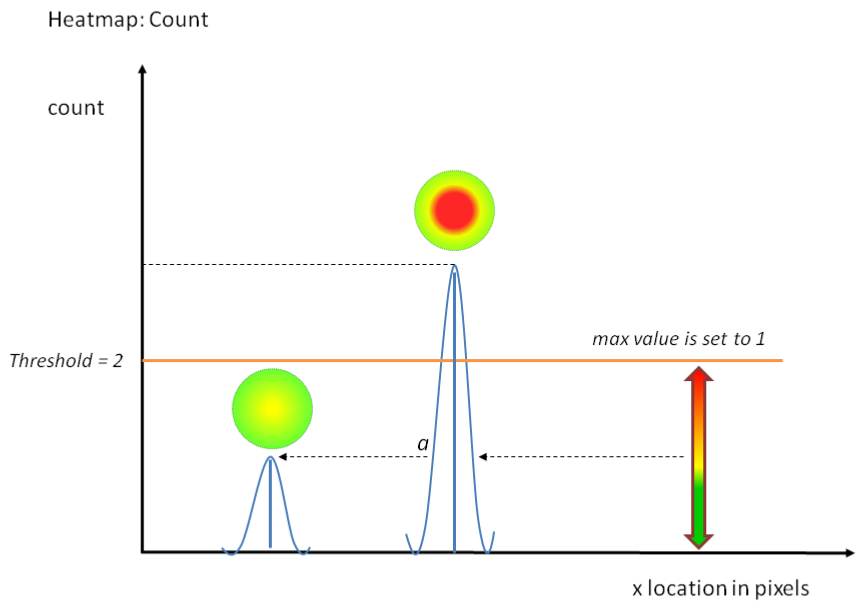
The distribution of values around a fixation point is accomplished by using an approximation to the Gaussian curve that is commonly used in 2D image processing, a cubic Hermite spline polynomial (cspline). The specific function of the polynomial used is t2(3 - 2t) – represented by the blue line in the graph below. (The orange line represents the fixation point and maximum color value.)




The radius of the function can be adjusted in the Visualization Type and Settings tool, where the option “Heat Map” is selected in a Visualization tab. The default value is set to 50 pixels, corresponding to a total kernel of 100 pixels.

Since the kernel is set in pixels, our Heat Maps are dependent on screen or scene camera video resolution and less representative of the individual’s foveal vision, if the participant varies his distance greatly to the stimulus.

Below is illustrated how our Heat Map calculations using fixation count are done to assign colors to the fixations: For Absolute and Relative duration the calculations are the same. However, instead of using the number of fixations as values, we use the fixation duration or fixation duration/media viewing time, respectively:



# Appendix D Software features and editions

## D1 The Design module

| Feature | Presenter | Analyzer | Full | VR 360 |
|---|---|---|---|---|
| Design experiments with multiple Time-lines, image, and video stimuli | • | | • | • |
| Batch editing of stimuli settings | • | | • | • |
| Use multiple stimuli advance options, either alone or in combination (advance on time, key press, mouse click) | • | | • | • |
| Configure stimulus onset markers (TTL) for synchronization purposes | • | | • | • |

## D2 The Record module

| Feature | Presenter | Analyzer | Full | VR 360 |
|---|---|---|---|---|
| Scene camera project (support for real world experiments using screen based eye trackers) | • | | • | |
| Configure eye tracker settings | • | | • | |
| Define experiment participants | • | | • | • |
| Calibrate eye tracker (regular and infant calibration) | • | | • | • |
| Numeric calibration results (accuracy and precision values) | • | | • | |
| Present image and video stimuli | • | | • | • |
| Record eye tracking, mouse, and keyboard data | • | | • | • |
| Recording of galvanic skin response data from Shimmer3 GSR+ sensors | • | | • | • |
| Moderator view: track status, stimuli dis-played and gaze data live | • | | • | • |
| Send stimulus onset markers (TTL) for syn-chronization purposes | • | | • | • |
| Receive TTL-in markers and the value for synchronization (available for Pro Spec-trum and Tobii Pro TX300 eye trackers only) | • | | • | |

## D3 The Analyze module

| **Feature** | **Presenter** | **Analyzer** | **Full** | **VR 360** |
|---|---|---|---|---|
| Replay of recordings | • | • | • | • |
| Import Tobii Pro Glasses 2 recordings | | • | • | |

| **Feature** | **Presenter** | **Analyzer** | **Full** | **VR 360** |
|---|---|---|---|---|
| Manual fixation mapping onto Snapshot images (Pro Glasses 2 projects only) | | • | • | |
| Automatic fixation mapping onto Snapshot images (Pro Glasses 2 projects only) | | • | • | |
| Create and edit static and dynamic Areas of Interest (AOIs) on images and videos | | • | • | • |
| AOI Tags and Grouping (static and dynamic AOIs) | | • | • | • |
| Log Events for behavioral coding | | • | • | • |
| Times of Interest: define time intervals based on recording and logged Events | | • | • | • |
| Selecting a frame as background and pairing it with Time of Interest (Screen and Scene camera projects only). | | • | • | |
| Plot gaze x and y coordinates as well as eye movement velocity over time | | • | • | • |
| Plot and visualize galvanic skin response (GSR) data over time (together with gaze video replay and eye movements) | | • | • | • |
| GSR data analysis: noise reduction filters and detection of Skin Conductance Responses (SCRs) and Event Related SCRs | | • | • | • |
| Static Heat Map Visualizations on images | | • | • | • |
| Static Gaze Plot Visualizations on images | | • | • | • |
| Video export of recordings and recording segments | • | • | • | |
| Export eye tracking metrics | | • | • | • |
| Export Event and time interval based metrics | | • | • | • |
| Export GSR Metrics | | • | • | • |
| Export visualizations as images (.png and .jpg) | | • | • | • |
| Export numeric calibration results (accuracy and precision values) | • | • | • | |
| Export calibration results as images (.png format) | • | • | • | |

## D3.1 Data Export

| Feature | Presenter | Analyzer | Full | VR 360 |
|---|---|---|---|---|
| Recording data to text file (.tsv) | • | • | • | • |

# Appendix E Software system requirements

### Tobii Pro Lab and Recommended System Configuration

Tobii Pro publishes up-to-date basic requirements for Pro Lab software systems Lab on its web site at this page: https://www.tobiipro.com/product-listing/tobii-pro-lab/system-requirements/

A system that complies with those specifications is sufficient to run and analyze most experiments with good performance. Certain operations can still take a significant time to perform, such as calculating Metrics and Statistics for large Projects, encoding exported videos of Recordings and running Real-World Mapping. Please check the *Timing Guide for Stimulus Display in Tobii Pro Lab* and the *Timing Guide for Tobii Eye Trackers and Eye Tracking Software* documents for more details.

### General recommendations

- Pro Lab made for research purposes that rely on tight control of the operating system and hardware components for optimal stimulus presentation and sensor recording. Because of this we strongly recommend that you keep the research computer clean of third party applications that run as background processes.
- Codec packs can interfere with Pro Lab. Therefore, install only those video and audio codecs that are supported by the software and required for your experiments.
- Check that the energy saving options of your machine don't slow down the processor and other sub-systems to save power or battery life. This is very important for laptops running on battery power.
- Avoid interference from other machines on the same network by using a direct connection between your computer and the Tobii Eye Tracker. More information on how to connect the computer and the Tobii Eye Trackers is available in the section "Connecting the eye tracker unit" in your Eye Tracker User's Manual.
- Don't run your study at excessive screen resolutions. Instead, select one that is good enough for your purpose.
- Set Windows 8.1, Windows 7 or Windows 10 appearance and performance settings to "best performance".
- Running two displays simultaneously (Dual-display) requires more graphic card RAM and processor resources in your graphics card, plus some additional management overhead in the graphics driver. This can cause lower graphics performance.
- If you arrange a dual screen setups with the Tobii T60XL, you should use a wide screen with 1920 x 1200 resolution.
- You can improve performance and limit connectivity issues by disabling or disconnecting unused Bluetooth, WLAN/Wireless and network connectors and unloading CD or DVD disk drives.

# Appendix F Tobii Pro Lab project and media limitations

| Media Type | Maximum resolution recommended system | Maximum resolution minimum system |
|---|---|---|
| Image Stimuli | 2560 x 1440 | 1280 x 720 |
| Snapshot Images | 50 MP | 10 MP |
| Video Stimuli | 1920 x 1080 @ 30 fps | 1280 x 720 @ 30 fps |
| Video Stimuli | 1920 x 1080 @ 30 fps | 1280 x 720 @ 30 fps |
| Web and Screen Stimuli | 1920 x 1080 @ 30 fps | |
| 360 degree Image Stimuli (used in VR 360 projects) | 8192 x 4096* | 4096 x 2048 |
| 360 degree Video Stimuli (used in VR 360 projects) | 4096 x 2048 @ 30 fps | 4096 x 2048 @ 30 fps |

The resolution displayed in the VR headset and during replay is always scaled to 4096 x 2048. The recommended 360 degree image and video resolution is 4096 x 2048. Recommended image sizes should be a power of two for optimal performance in Unity. Unity is the game engine used for recording and replaying 360 degree media in VR 360 projects.

| Project type | Number of Recordings with recommended system | Number of Recordings with minimum system |
|---|---|---|
| Glasses | 500 of 20 minutes each | 50 of 20 minutes each |
| Screen based Project with Images | 200 with 400 Images | 30 with 100 Images |
| Screen based Project with Videos | 200 with 1 x 90 min video or 50 x 2 min videos | 30 with 1 x 60 min video or 20 x 2 min videos |

| Supported file formats | Format | Video codecs |
|---|---|---|
| Image Stimuli and Snapshots | jpeg, png, bmp | - |
| Video | mp4 (recommended), avi | H264 (recommended), DIVX, XVID |
| Audio | mp3, aac, ac3, pcm | - |

## F1 Configuring display settings

You ensure smooth running of your Tobii Pro Lab by setting the display scale to 100% for all screens and displays in the relevant settings panel of your operating system. If you use other scales, it may cause errors in gaze data and visualizations. Therefore, before you start Pro Lab for the first time on a computer, double-check and correct the scale settings.

## F2 Merging coding data in Glasses projects

Merging coding data in Glasses projects by importing coding data from another project does not support merging multiple sets of mapped gaze data for a single Recording-Snapshot combination. This means that the coding work needs to be split by either Recordings or Snapshots. Multiple people cannot work on the same Recording/Snapshot pair in parallel.

# Appendix G Export Data Types

| Name | Group | Project | Description | Columns |
|---|---|---|---|---|
| Gaze point 2D | Eye tracking data | Screen | Raw gaze coordinates for each eye individually. | Gaze point X, Gaze point Y, Gaze point left X, Gaze point left Y, Gaze point right X, Gaze point right Y |
| Gaze point 2D | Eye tracking data | Glasses | Raw gaze coordinates for both eyes combined. | Gaze point X, Gaze point Y |
| Gaze point 2D | Eye tracking data | Scenecam | Raw gaze coordinates for each eye individually. | Gaze point X, Gaze point Y, Gaze point left X, Gaze point left Y, Gaze point right X, Gaze point right Y |
| Gaze point 2D | Eye tracking data | VR360 | Raw gaze coordinates for each eye individually. | Gaze point left X (norm), Gaze point left Y (norm), Gaze point right X (norm), Gaze point right Y (norm), Gaze point average X (norm), Gaze point average Y (norm) |
| Gaze point 3D | Eye tracking data | Glasses | The vergence point of left and right gaze vectors. | Gaze point 3D X, Gaze point 3D Y, Gaze point 3D Z |
| Gaze direction | Eye tracking data | Glasses | The unit vector for the direction of the gaze, for each eye individually. | Gaze direction right X, Gaze direction right Y, Gaze direction right Z, Gaze direction left X, Gaze direction left Y, Gaze direction left Z |
| Pupil position | Eye tracking data | Glasses | The 3D coordinates of the pupil position for each eye individually. | Pupil position left X, Pupil position left Y, Pupil position left Z, Pupil position right X, Pupil position right Y, Pupil position right Z |
| Pupil diameter | Eye tracking data | Glasses, Screen, Scenecam, VR360 | Estimated size of the pupils. | Pupil diameter left, Pupil diameter right |
| Validity of eye data | Eye tracking data | Screen, Scenecam | Indicates if whether the eyes have been correctly identified. Available values: Valid/Invalid. | Validity left, Validity right |

| | | | | |
|---|---|---|---|---|
| Eye position (DACSmm) | Eye tracking data | Screen, Scenecam | 3D position of the eyes. | Eye position left X (DACSmm), Eye position left Y (DACSmm), Eye position left Z (DACSmm), Eye position right X (DACSmm), Eye position right Y (DACSmm), Eye position right Z (DACSmm) |
| Gaze point 2D (DACSmm) | Eye tracking data | Screen | Raw gaze coordinates for each eye individually. | Gaze point left X (DACSmm), Gaze point left Y (DACSmm), Gaze point right X (DACSmm), Gaze point right Y (DACSmm) |
| Gaze point (MCSnorm) | Eye tracking data | Screen, Scenecam | Raw gaze coordinates for each eye individually on the Media. | Gaze point X (MCSnorm), Gaze point Y (MCSnorm), Gaze point left X (MCSnorm), Gaze point left Y (MCSnorm), Gaze point right X (MCSnorm), Gaze point right Y (MCSnorm) |
| Automatically mapped gaze point | Eye tracking data | Glasses | Automatically mapped gaze point coordinates. | Automatically mapped gaze point X, Automatically mapped gaze point Y |
| Manually mapped gaze point X | Eye tracking data | Glasses | Manually mapped gaze point coordinates. | Mapped gaze point X, Mapped gaze point Y |
| Mapped gaze point | Eye tracking data | Glasses | The combination of the manually and automatically mapped gaze point coordinates. Manual mapping overrides automatic. | Mapped gaze point X, Mapped gaze point Y |
| Automatically mapped gaze point score | Eye tracking data | Glasses | Validity score of automatically mapped gaze points. | |
| Mapped eye movement type | Gaze events | Glasses | Type of eye movement eventis classified by the selected Fixation filter for mapped gaze data. | |

| | | | | |
|---|---|---|---|---|
| Mapped eye movement type index | Gaze events | Glasses | Represents the order in which an eye movement was recorded for mapped gaze data. The index is an auto-increment number starting with 1 for each eye movement type. | |
| Mapped fixation point | Gaze events | Glasses | Mapped fixation point. This column is affected by the settings of the Fixation Filter. | Mapped fixation point X, Mapped fixation point Y |
| Eye movement type | Gaze events | Glasses, Screen, Scenecam, VR360 | Type of eye movement eventis classified by the fixation filter settings applied during the gaze data export. | |
| Gaze event duration | Gaze events | Glasses, Screen, Scenecam, VR360 | The duration of the currently active eye movement. | |
| Eye movement type index | Gaze events | Glasses, Screen, Scenecam, VR360 | Represents the order in which an eye movement was recorded. The index is an auto-increment number starting with 1 for each eye movement type. | |
| Fixation point | Gaze events | Glasses, Screen, Scenecam, VR360 | Coordinates of the fixation point. This column is affected by the settings of the Fixation Filter. | Fixation point X, Fixation point Y |
| Fixation point (MCSnorm) | Gaze events | Screen | Coordinates of the fixation point on the Media. | Fixation point X (MCSnorm), Fixation point Y (MCSnorm) |
| AOI hit | Gaze events | Glasses, Screen, Scenecam, VR360 | Reports whether the AOI is active and whether the fixation is located inside of the AOI: -1 = AOI not active; 0 = AOI active, the fixation is not located in the AOI; 1 = AOI active and the fixation is located inside of the AOI; empty cell indicates that the media of the AOI was not visible. | |
| Project name | General | Glasses, Screen, Scenecam, VR360 | - | |
| Export date | General | Glasses, Screen, Scenecam, VR360 | - | |
| Participant name | General | Glasses, Screen, Scenecam, VR360 | - | |

| | | | | |
|---|---|---|---|---|
| Participant variables | General | Glasses, Screen, Scenecam, VR360 | Variable value or values of the participant. | |
| Recording name | General | Glasses, Screen, Scenecam, VR360 | - | |
| Recording date | General | Glasses, Screen, Scenecam, VR360 | Date when the Recording was performed. | |
| Recording start time | General | Glasses, Screen, Scenecam, VR360 | - | |
| Recording duration | General | Glasses, Screen, Scenecam, VR360 | Total duration of the Recording. | |
| Timeline name | General | Screen | - | |
| Recording Fixation filter name | General | Glasses, Screen, Scenecam, VR360 | The name of the Fixation filteris applied on the Recording eye tracking data in the export. | |
| Snapshot Fixation filter name | General | Glasses | The name of the Fixation filteris applied on the Snapshot eye tracking data in the export. | |
| Recording software version | General | Screen, Scenecam, VR360 | The version of the software used to make the Recording. | |
| Recording resolution | General | Screen, Scenecam | - | Recording resolution height, Recording resolution width |
| Recording monitor latency | General | Screen | The monitor latency setting for the Recording. Stimulus start and end Event timestamps have been offset are offset by this number to account for the monitor latency. | |
| Calibration results | General | Scenecam | Average accuracy and precision of calibration in millimeters, degrees and pixels | Average calibration accuracy (mm), Average calibration precision (mm), Average calibration accuracy (degrees), Average calibration precision (degrees) |
| Calibration results | General | Screen | Average accuracy and precision of calibration in millimeters, degrees and pixels | Average calibration accuracy (mm), Average calibration precision (mm), Average calibration accuracy (degrees), Average calibration precision (degrees), Average calibration accuracy (pixels), Average calibration precision (pixels) |

| | | | | |
|---|---|---|---|---|
| Eyetracker timestamp | General | Screen, Scenecam | The Recording time-stamp in the eye tracker clock. | |
| Event | General | Glasses, Screen, Scenecam, VR360 | Name of the Event. | |
| Event value | General | Glasses, Screen, Scenecam, VR360 | The event value. | |
| Recording media name | Media | Glasses | Name of the Record-ing Media. | |
| Recording media dimensions | Media | Glasses | Dimensions of the Recording Media. | Recording media width, Recording me-dia height |
| Presented Stimulus name | Media | Screen, VR360 | The name of the Stimulus being pre-sented to the Participant. | |
| Presented Media name | Media | Screen, VR360 | The name of the Me-dia presented to the Participant. | |
| Presented Media dimensions | Media | Screen | The dimensions of the Media as pre-sented on the screen to the Participant, in-cluding The dimen-sions include any scaling set in the Stimulus properties. | Presented Media width, Presented Me-dia height |
| Presented Media position | Media | Screen | The position of the Media on the screen. The value represents the position of the top left corner of the Me-dia in relation to the top left corner of the screen. | Presented Media po-sition X (DACSpx), Presented Media po-sition Y (DACSpx) |
| Original Media dimensions | Media | Screen, VR360 | The original size of the Media presented to the Participant. | Original Media width, Original Media height |
| Media dimensions | Media | Glasses | - | Media width, Media height |
| Gyro | Other sensor data | - | Rotation along the X, Y, and Z axes. | Gyro X, Gyro Y, Gyro Z |
| Accelerometer | Other sensor data | - | Accelerometer | Accelerometer X, Ac-celerometer Y, Accel-erometer Z |
| Galvanic skin re-sponse (GSR) | Other sensor data | - | The raw galvanic skin response signal of the Participant. | |
| Head pose | Other sensor data | - | The coordinates of the participants head pose. | Head pose X, Head pose Y, Head pose Z |
| Head rotation | Other sensor data | - | The coordinates of the participants head rotation quaternion. | Head rotation X, Head rotation Y, Head rotation Z, Head rotation W |

| | | | | |
|---|---|---|---|---|
| Project name | Recording | Glasses, Screen, Scenecam, VR360 | - | |
| Export date | Recording | Glasses, Screen, Scenecam, VR360 | - | |
| Participant name | Recording | Glasses, Screen, Scenecam, VR360 | - | |
| Participant variables | Recording | Glasses, Screen, Scenecam, VR360 | Variable value or values of the participant. | |
| Recording name | Recording | Glasses, Screen, Scenecam, VR360 | - | |
| Recording date | Recording | Glasses, Screen, Scenecam, VR360 | Date when the Recording was performed. | |
| Recording start time | Recording | Glasses, Screen, Scenecam, VR360 | - | |
| Recording duration | Recording | Glasses, Screen, Scenecam, VR360 | Total duration of the Recording. | |
| Timeline name | Recording | Screen, VR360 | - | |
| Recording Fixation filter name | Recording | Glasses, Screen, Scenecam, VR360 | The name of the Fixation filter applied on the Recording eye tracking data in the export. | |
| Snapshot Fixation filter name | Recording | Glasses | The name of the Fixation filter applied on the Snapshot eye tracking data in the export. | |
| Recording software version | Recording | Screen, Scenecam, VR360 | The version of the software used to make the Recording. | |
| Recording resolution | Recording | Screen, Scenecam | - | Recording resolution height, Recording resolution width |
| Recording monitor latency | Recording | Screen | The monitor latency setting for the Recording. Stimulus start and end Event timestamps have been offset are offset by this number to account for the monitor latency. | |
| Calibration results | Recording | Scenecam | Average accuracy and precision of calibration in millimeters, degrees and pixels | Average calibration accuracy (mm), Average calibration precision (mm), Average calibration accuracy (degrees), Average calibration precision (degrees) |

| | | | | |
|---|---|---|---|---|
| Calibration results | Recording | Screen | Average accuracy and precision of calibration in millimeters, degrees and pixels | Average calibration accuracy (mm), Average calibration precision (mm), Average calibration accuracy (degrees), Average calibration precision (degrees), Average calibration accuracy (pixels), Average calibration precision (pixels) |
| Media information | Media | Glasses, Screen, Scenecam, VR360 | Information about all media in the export. | Media name, Media type, Media width, Media height, Media path, Media duration, Media id |
| Gaze point 2D | Data | Screen | Raw gaze coordinates for each eye individually. | Gaze point X, Gaze point Y, Gaze point left X, Gaze point left Y, Gaze point right X, Gaze point right Y |
| Gaze point 2D | Data | Glasses | Raw gaze coordinates for both eyes combined. | Gaze point X, Gaze point Y |
| Gaze point 2D | Data | Scenecam | Raw gaze coordinates for each eye individually. | Gaze point X, Gaze point Y, Gaze point left X, Gaze point left Y, Gaze point right X, Gaze point right Y |
| Gaze point 2D | Data | VR360 | Raw gaze coordinates for each eye individually. | Gaze point left X (norm), Gaze point left Y (norm), Gaze point right X (norm), Gaze point right Y (norm), Gaze point average X (norm), Gaze point average Y (norm) |
| Gaze point 3D | Data | Glasses | The vergence point of left and right gaze vectors. | Gaze point 3D X, Gaze point 3D Y, Gaze point 3D Z |
| Gaze direction | Data | Glasses | The unit vector for the direction of the gaze, for each eye individually. | Gaze direction right X, Gaze direction right Y, Gaze direction right Z, Gaze direction left X, Gaze direction left Y, Gaze direction left Z |
| Pupil position | Data | Glasses | The 3D coordinates of the pupil position for each eye individually. | Pupil position left X, Pupil position left Y, Pupil position left Z, Pupil position right X, Pupil position right Y, Pupil position right Z |
| Pupil diameter | Data | Glasses, Screen, Scenecam, VR360 | Estimated size of the pupils. | Pupil diameter left, Pupil diameter right |

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| Validity of eye data | Data | Screen, Scenecam, | Indicates if Indicates whether the eyes have been correctly identified. Available values: Valid/Invalid. | Validity left, Validity right |
| Eye position (DACSmm) | Data | Screen, Scenecam | 3D position of the eyes. | Eye position left X (DACSmm), Eye position left Y (DACSmm), Eye position left Z (DACSmm), Eye position right X (DACSmm), Eye position right Y (DACSmm), Eye position right Z (DACSmm) |
| Gaze point 2D (DACSmm) | Data | Screen | Raw gaze coordinates for each eye individually. | Gaze point left X (DACSmm), Gaze point left Y (DACSmm), Gaze point right X (DACSmm), Gaze point right Y (DACSmm) |
| Gaze point (MCSnorm) | Data | Screen, Scenecam | Raw gaze coordinates for each eye individually on the Media. | Gaze point X (MCSnorm), Gaze point Y (MCSnorm), Gaze point left X (MCSnorm), Gaze point left Y (MCSnorm), Gaze point right X (MCSnorm), Gaze point right Y (MCSnorm) |
| Automatically mapped gaze point | Data | Glasses | Automatically mapped gaze point coordinates. | Automatically mapped gaze point X, Automatically mapped gaze point Y |
| Manually mapped gaze point X | Data | Glasses | Manually mapped gaze point coordinates. | Mapped gaze point X, Mapped gaze point Y |
| Mapped gaze point | Data | Glasses | The combination of the manually and automatically mapped gaze point coordinates. Manual mapping overrides automatic. | Mapped gaze point X, Mapped gaze point Y |
| Automatically mapped gaze point score | Data | Glasses | Validity score of automatically mapped gaze points. | |
| Eyetracker timestamp | Data | Screen, Scenecam | The Recording timestamp in the eye tracker clock. | |
| Gyro | Data | - | Rotation along the X, Y, and Z axes. | Gyro X, Gyro Y, Gyro Z |

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| Accelerometer | Data | - | Accelerometer | Accelerometer X, Accelerometer Y, Accelerometer Z |
| Galvanic skin response (GSR) | Data | - | The raw galvanic skin response signal of the Participant. | |
| Head pose | Data | - | The coordinates of the participants head pose. | Head pose X, Head pose Y, Head pose Z |
| Head pose rotation | Data | - | The coordinates of the participants head pose rotation quaternion. | Head pose rotation X, Head pose rotation Y, Head pose rotation Z, Head pose rotation W |
| Eye movement | Event | Glasses, Screen, Scenecam, VR360 | Exports Eye movements, with temporal and spatial information. | Recording timestamp, Event Category, Event type, Event duration, Eye movement type index, Fixation point X, Fixation point Y |
| Mapped Eye movement | Event | Glasses | Exports mapped Eye movements, with temporal and spatial information. | Recording timestamp, Event Category, Event type, Event duration, Eye movement type index, Fixation point X, Fixation point Y, Media name, Media id |
| AOI hit | Event | Glasses, Screen, Scenecam, VR360 | Exports AOI hits, with temporal and media information. | Recording timestamp, Event Category, Event type, Event duration, AOI name, Media name, Media id |
| AOI inactivity | Event | Glasses, Screen, Scenecam, VR360 | Exports periods of AOI inactivity for dynamic AOIs, with temporal and media information.. | Recording timestamp, Event Category, Event type, Event duration, AOI name, Media name, Media id |
| AOI visit | Event | Glasses, Screen, Scenecam, VR360 | Exports AOI visits, with temporal and media information. | Recording timestamp, Event Category, Event type, Event duration, AOI name, Media name, Media id |
| AOI glance | Event | Glasses, Screen, Scenecam, VR360 | Exports AOI glances, with temporal and media information. | Recording timestamp, Event Category, Event type, Event duration, AOI name, Media name, Media id |

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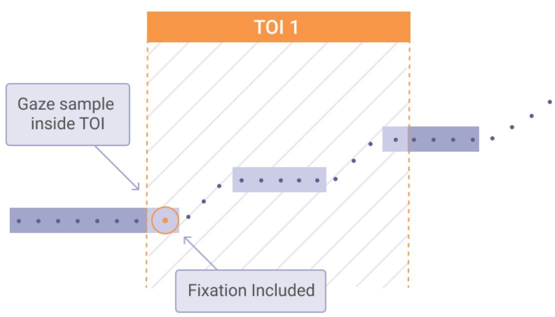
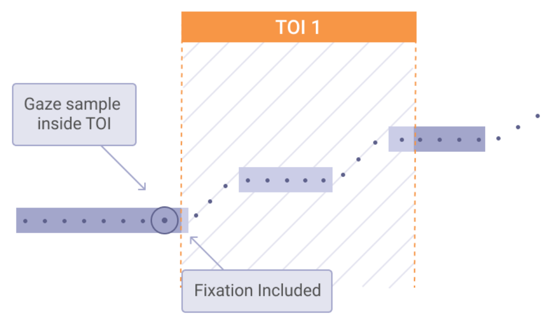
|---|---|---|---|---|
| Event | Event | Glasses, Screen, Scenecam, VR360 | Exports Events, with temporal and event specific information. | Recording timestamp, Event Category, Event type, Event value, Mouse button |
| Stimulus exposures | Event | Screen, VR360 | Exports Stimulus exposures, with temporal and spatial information. | Recording timestamp, Event Category, Event type, Event duration, Stimulus name, Media name, Media id, Presented Media width, Presented Media height, Presented Media position X (DACSpx), Presented Media position Y (DACSpx) |

# Appendix H Data computation

## H1 Change log, January 22, 2019

Tobii Pro changed the calculation of the eye movements included in Times of Interest. Previously, short fragments of fixations (less than half a sampling interval) in the beginning or end of a Time-of-Interest interval were discarded. Pro Lab 1.108 instead includes these fragments. That may in rare cases affect data that relies on eye movements filtered by Time of Interest, such as fixation-based and AOI-based metrics.

**Graphic explanations of the difference between the old (1.107) and new (1.108) calculation methods**

| | |
|---|---|
|  |  |
| The last sample of the left fixation is inside the Time of Interest. Therefore, the fragment inside TOI 1 is included in the calculation according to both the old and the new calculation method. | The last sample of the left fixation is outside the Time of Interest. Therefore, software version 1.107 and older discards the fragment inside TOI 1 from its calculation, whereas software version 1.108 and newer includes it. |

The new method doesn't affect fixations whose cropped intervals are longer than one sample interval (20ms in G2/50hz, 16.6ms for 60hz, 1.66 ms for 600hz).

Impacted metrics:

- *Fixation count* can differ by none, one, or two for a TOI interval
- *Fixation duration* can differ by max 2 × sample interval for a TOI interval
- *Time to first fixation:* If the previously discarded (short) fixation was inside the AOI, the TTF can get lower with the new behavior.
  – The same applies to *Visits/Glances*.

The issues above are not supposed to affect experiment designs that use fixation crosses to avoid fixations in AOIs at the stimulus onset. Glasses experiments that use snapshot TOIs are also unaffected because their TOI intervals are strictly defined by mapped fixations.

# Appendix I Example of analyzing an External Presenter project recorded by E-Prime

**Prerequisites**:

- If you want to log manual responses, make sure that the relevant E-Object in the experiment is defined in the TPLSetDisplayEventStimulus routine. If this E-Object is defined, you get RESP and ACC values from E-Prime for it as events in Tobii Pro Lab.
- All relevant stimulus variables are encoded in the media name that is sent to Tobii Pro Lab.
- In the example, we assume that you analyze the sample experiment called "TPLFixedPositionAOI" found in your My Experiments folder after installing E-Prime Extensions for Tobii Pro Lab.

**Procedure**:

1. Create a *Time of Interest* (TOI) definition for your trials. In this example, participants have responded manually to the stimulus, either correctly or incorrectly. This accuracy value (0 or 1) has been sent to Tobii Pro Lab and appears in the timeline if you have checked Imported Events (enabled by default). Because of the presence of manual responses, we need to define two Times of Interest: one for correct responses (ACC 1) and one for incorrect responses (ACC 0).
   a. Create a new custom TOI by clicking on the *plus sign* of the Time of Interest panel.
   b. Give the first TOI a name, for example *Correct responses*.
   c. For its *Start* point, go to *Remote Event* types and pick the event "Stimulus_ACC_1" (it marks all correct responses of the stimulus object in E-Prime).
   d. For its *End* point, go to *Remote Event* types and select the event "Stimulus_End", which marks the end of all of the objects called "Stimulus" in the E-Prime experiment.
   e. Create a similar custom TOI for all "Incorrect responses".
2. If you want visualizations of the gaze on your stimuli, go to the *Visualizations* tab and decide what type of visualization you want.
   a. Select the graphical nature of the visualization: *gaze replay* or *heat map*, and their parameters.
   b. Determine what data you want to visualize.
      - You can easily visualize the data from one particular stimulus in the list of Media TOIs in the *Time of Interest* panel to the right.
      - If you want to visualize all data of a similar type, click on the custom TOIs you created previously ("Correct responses" and "Incorrect responses"). That way, you visualize the gaze for those intervals of data.
      - However, the background is empty (a grey checkerboard pattern) because there is no stimulus that can be exclusively mapped to a custom TOI (you have probably used several stimuli). If you want a background for a custom TOI, go to the replay of the recording, locate a part of the recording that displays the stimulus you want as a background, and do a *Create TOI with frame* by clicking on the plus sign near the time counter.
      - It is better that you only create this TOI for visualization, because any metrics you export for this TOI will be calculated from AOIs drawn on this separate media frame, and not from the stimuli and AOIs generated from the external presenter client, E-Prime.
3. When you are ready to export metrics for further analysis, select *Analysis - Metrics Export*.
   a. Select the desired metrics.
   b. Go to the *Data selection* panel to the right and select all desired recordings.
   c. Select the desired TOIs. In the example they are "Correct responses" and "Incorrect responses", both mentioned above.
   d. Finally, select the desired areas of interest. However they are unique per stimulus so they will create many columns in your export. Rather, use AOI tags to group many unique AOIs into a few categories.
   e. In this experiment, only the ungrouped tags "Non-target" and "Target" are relevant. Deselect all other AOIs, click *Export* and save your file.

4. Now you have exported your data in a text file with rows and columns. Open the file in Excel or a similar spreadsheet program. (You may need to do a text-to-column operation to properly delimit the file on the tab character.) Every row is a trial (an interval of a TOI), and every column is a property of the trial or the experiment. Before running statistical analysis, you need to recover your experimental variables, which are encoded in the media name of the stimuli, looking like "cow-horse-Target=horse".
   a. Move this *Media* column to the end after all the other columns.
   b. Select it and perform a text-to-column operation with "-" as the delimiter, and you will now have three new columns. The left column will be the image to the left, and the center one the image to the right.
   c. Go ahead and name them as "LeftImage" and "RightImage" now. The final column has content in the form of "Target=horse".
   d. Do a text-to-column operation with "=" as the delimiter, and delete the first column from this operation.
   e. You now have the column with just the target name. Name this column "TargetImage". Now you are ready.
5. For your next experiment, you can use the same delimiter so you have to do only one text-to-column operation. Note that you can use the TOI column, due to the names you gave the TOIs, to separate correct responses from incorrect responses in your analysis.

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