Pro Lab
User Manual

tobii pro

Pro Lab User Manual

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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 screenbased eye tracker; *Glasses projects*, for when data is collected by Tobii Pro Glasses 2 or Pro Glasses 3; *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 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 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.

1.1.3 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.

1.1.4 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 Symbols used in this document

Three different symbols are used in this document:

The Information symbol means something is important or needs special attention.

The Tip symbol denotes additional information that can make a process or function easier.

The Warning symbol means there is a possible risk of harm if the warning is ignored.

1.4 Online-based help and support resources

Youcan access some online-based help and support resources in Tobii Pro Lab'smain 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.

1.5 How to cite Tobii Pro Lab

Here are two examples (APA and BIBTEX) of how to cite Tobii Pro Lab software or this manual.

Please make sure to update the version number in the example in case it does not match the version you are citing. The current version number of your Pro Lab software can be found in the *About and Updates* section.

1.5.1 APA example for Tobii Pro Lab (software)

Tobii Pro AB (2014). Tobii Pro Lab (Version x.xx) [Computer software]. Danderyd, Sweden: Tobii Pro AB.

1.5.2 APA example for Tobii Pro (User Manual)

Tobii Pro AB (2014). Tobii Pro Lab User Manual (Version x.xx). Tobii Pro AB, Danderyd, Sweden.

1.5.3 APA's own tex files (6th edition)

@SOFTWARE{TobiiProLab,
ENTRYSUBTYPE = \{Computer software},
AUTHOR = {Tobii Pro AB},
TITLE = {Tobii Pro Lab},
VERSION = {1.145},
PUBLISHER = {Tobii Pro AB},
URL = {https://www.tobiipro.com/},
DATE = {2014}
}

1.5.4 BIBTEX entries for Pro Lab (software and User Manual)

@software{TobiiProLab,
author = Tobii Pro AB,
title = {Tobii Pro Lab},
url = {http://www.tobiipro.com/},
howpublished = {Computer software},
address = {Danderyd, Stockholm},
version = {1.145},
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author = Tobii Pro AB,
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url = {http://www.tobiipro.com/},
howpublished = {Computer software},
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title = {Tobii Pro Lab User Manual},
url = {http://www.tobiipro.com/},
howpublished = {Computer software},
address = {Danderyd, Stockholm},
version = {1.145},
year = {2014},
}

2 Install or update 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 requirements. For more information, read System requirements & recommendations. You can also review the latest system requirements online at tobiipro.com or ask your sales representative.

2.1 Windows versions

Tobii Pro Lab is designed and tested to run on Windows 10 Pro.

2.2 Pro Lab License key

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

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

2.3 Install 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.

How to install Pro Lab:

1. Download the installation file for the latest version of Pro Lab, go to tobiipro.com
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. For more information, read Pro Lab licenses.
You cannot utilize roaming user profiles on the computer running Tobii Pro Lab.

If nothing happens when you start Tobii Pro Lab and there are no error messages, check which edition of Windows 10 you have on your computer. If it is one of the Windows 10 N editions, you need to install a Media Feature Pack from Microsoft. For more information, read the Connect article, Tobii Pro Lab does not start.

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 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 on tobiipro.com.

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 be asked 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 Activate a Pro Lab license

How to activate 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 Deactivate 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.

How to deactivate 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 Update Pro Lab

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.

How to update 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 tobiipro.com.

3 Start a project

When you start Pro Lab, 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 or Pro Glasses 3. In Glasses projects, only the Project Overview and Analyzer module are 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 many 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 or Pro Glasses 3, 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).

How to create a project:

1. Click **Create new Project** .
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, the Project Overview tab displays.

3.2 Project Overview

The Project Overview section is the starting point for working with a project in Pro Lab. It lets you easily jump to project specific content. You can export and import projects and more, as well as access many more tools at the top of Project Overview window. The tabs on the left-side toggle on and off the panels– when the icon is orange, the panel is displayed.

The amount and type of panels available on the left varies depending on the type of project.

Recordings: This lists all the recordings in the project. For more information, read Manage recordings.

Participant Variables: Participant Variables are used to filter data when generating visualizations, calculating eye tracking metrics and comparing the behavior of different participant groups. Click the plus button to add a new Participant Variable. For more information, read Participant Variables.

Participants: This is a list of the participants in your study, including which variables have been specified. Click the plus button to add a new Participant. For more information, read Participant Variables.

Snapshots: Snapshots are still images of environments and objects of interest. Click the plus button to add a new Snapshot. For more information, read Map eye tracking data.

Events: An Event Type is a definition of an Event that you want to mark in your recording. Click the plus button to add a new Event Type. For more information, read Manage Event Types.

Stimulus Variables: A Stimulus Variable is a specific feature of your stimulus that is a part of the context in which a behavior occurs. Click the plus button to add a new Stimulus Variable. For more information, read Stimulus/group variables.

4 Manage projects

4.1 Open an existing project

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

How to open 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 the desired project.
3. If the desired project isn't in the list, click the **Browse** button at the top right. Locate the .project file associated with the desired project and click **Open**.

If the project is already open, the Project Overview window will display.

If you want to open a project that was created in an older version of Pro Lab, the project will be migrated to the version of Pro Lab you currently have. When you attempt to open the project from the list, a pop-up message explains that after migration, your project won't open in earlier versions. It is important to back up your project if you plan to open it later in an older version of Pro Lab. Make sure the backup checkbox is checked in the pop-up message.

4.2 Rename or remove a project

In the **Open existing project** window, right-click a project name and select "Rename Project" or "Remove project from list." The project *will not be deleted*, only removed from the list of recently opened projects.

4.3 Export and import a project

There are three different reasons you may need to export and import a project.

- Your project may have more than one person collecting data (distributed data collection) and you need to share the recordings. For more information, read Export and import a project.

  or...
- Your project may have more than one person coding data (distributed manual coding) and you need to share the recordings. For more information, read Export and import a project.

  or...
- You want to back up your project using the export/import functionality. For more information, read Export and import a project.

4.3.1 Distributed data collection

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. For more information, go to the Tobii Pro Learning Center.

Researcher A:

1. Create a project. For more information, read 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. On the **Project Overview** tab, select **Export** >**Project** at the top.
6. In the **Project Export** dialog, in the **Export type** list, select "Project for data collection" in the drop-down and 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.

    You don't have to wait for one project to be finished before queuing the next one. When all the child projects are created, you can close the dialog.

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. On the **Project Overview** tab, select **Export** >**Project** at the top.
6. In the **Project export** dialog, select the export type "Project with recordings" in the drop-down list to view the list of recordings. Deselect any recordings you do not want to include.
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.

4.3.2 Distributed manual coding

When there is a lot of coding to do, it may help to do the work simultaneously on several computers.

Conflicting data during import can be overwritten so we advise that you make a backup of the target project before doing an import. For more information, read Distributed manual coding. This safeguard enables data recovery in case the data import causes the unplanned deletion of data that should have been preserved.

How to export coding data from another project:

1. In **Project Overview**, select **Export** >**Project** at the top.
2. In the **Project Export** dialog, select the Export type "Send events and mapped data" in the drop-down list at the top.
3. Click the **Export** button after choosing where to save the file locally. The file will be saved in the .plex format and will contain all the coding-related data.
4. Send the generated .plex file back to the researcher doing the analysis.

How to import coding data from another project:

1. Open the project into which you will import the coding data.
2. In **Project Overview**, select the **Import** drop-down menu.
3. Select “Coding data.”
4. Use the file browser to locate the project file (*.plex) associated with the parent project.
5. Click **Open** and select either:
    a. *Keep data from existing Project*: 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*: If you want to overwrite the data in the currently-open project with imported data.
6. Click **Start import**.
7. When the import is finished, click **Done**.

4.3.3 Back up projects

When there is a lot of coding to do, it may help to do the work simultaneously on several computers.

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

4.3.4 Import data from SD card

When you use either Pro Glasses 2 or Pro Glasses 3 to record data, you save the data on a SD card. You then need to import that data into a Glasses project in Pro Lab in order to be able to analyze it. Importing data from the SD card differs slightly between Pro Glasses 2 and Pro Glasses 3 as explained below.

Pro Glasses 2:

How to import recordings from Pro Glasses 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** drop-down menu.
3. Select *Glasses 2 Recording*. A file browser opens.
4. Locate the data file (*.ttgp) on the SD card using the file browser.
5. Import the data by clicking the **Open** button.
6. Select the recordings you want to import.

Pro Glasses 3:

1. Open the Glasses project into which you will import the recordings.
2. Go to Project Overview and select the **Import** drop-down menu.
3. Select *Glasses 3 Recording*. A folder browser opens.
4. Locate the SD card root folder using the folder browser.
5. Import the data by clicking the **OK** button.
6. Select the recordings you want to import.

4.4 Manage 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
- **Timeline:** The name of the recording's timeline
- **Duration:** The duration of the recording
- **Date:** The time and date when the recording was performed
- **Resolution:** The resolution of the recording
- **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.

4.4.1 Replay

- Open and replay a recording in the **Recordings** list by double-clicking it or by right-clicking and selecting *Open*. The replay tab displays in the **Analyze** module.
- If you want to open recordings *without* getting redirected to the **Analyze** module, right-click 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 the Analyze option in the top menu.

You can start and stop the recording replay using the space bar.

For more information, read Replay a recording.

4.4.2 Delete

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.

How to delete 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.

4.4.3 Import and Export recordings

For more information about distributed data collection, read Export a whole recording. For more information about exporting and importing a recording, read Export and import a project.

4.5 Manage 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.

4.5.1 Create an Event Type

How to create a new Event Type:

1. Click the plus symbol (+) in the top right corner of the Event Type list.
2. Enter a 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. In the drop-down menu to the right, select which keyboard shortcut creates an Event of that Event Type on the Timeline.
4. Click *OK*.
5. The named Event Type appears in the Event Types list.

4.5.2 Edit an Event Type

How to edit 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 drop-down list and making a new selection.
4. Click *OK*.

4.5.3 Delete 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.

How to delete 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 on the trash can.
3. Click *Delete Event*.
4. Click *OK*.

4.6 Analysis tools

The Project Overview contains links to the analysis tools in the Analyze module. When you click 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 drop-down 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 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.

5 Design 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 or Pro Glasses 3. 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, web pages, 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 Create a new timeline

How to create 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. For more information, read Stimulus properties.)
    - Click 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 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).

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. For more information, read Groups.
4. 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 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.
5. Add a Screen Recording stimulus by clicking **Add Screen Recording stimulus** in the **Add** section of the Design module. A new Screen Recording stimulus appears in the timeline. (For more information on Screen Recording stimulus properties, read Stimulus properties and Areas of Interest (AOIs) on how to analyze a screen recording).
6. Add a Text Stimulus by clicking **Add text** in the **Add** section of the Design module. A new Text stimulus appears in the timeline. Double-click the Text stimulus to open the text editor. Enter and edit your text in the text editor.
7. Add an Instruction element by clicking **Add instructions** in the **Add** section of the Design module. A new Instruction element appears in the timeline. Double-click the Instruction element to open the text editor. Enter and edit your text in the text editor.
8. The additions are saved automatically. You can continue 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 Delete a timeline

How to delete a timeline:

1. Go to Timelines to the right and hover the mouse cursor over the desired Timeline. 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 that you cannot make any more recordings with that Timeline, whereas the associated stimuli remain available for analysis.

5.1.3 Duplicate a timeline

How to duplicate 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 Change the name of a Timeline

How to change 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 Stimulus properties

5.2.1 Add a stimulus to the timeline

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.



Figure 1. The Add menu on the Timeline in the Design module.

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

	Add stimuli from your computer: .bmp, .jpg, or .png image files. Pro Lab will scale images according to the screen size. .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 text (or instructions)

	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.



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.

5.2.2 Advance on

The Advance on options you select in the Properties panel on the right are displayed as icons below the stimulus on the Timeline.

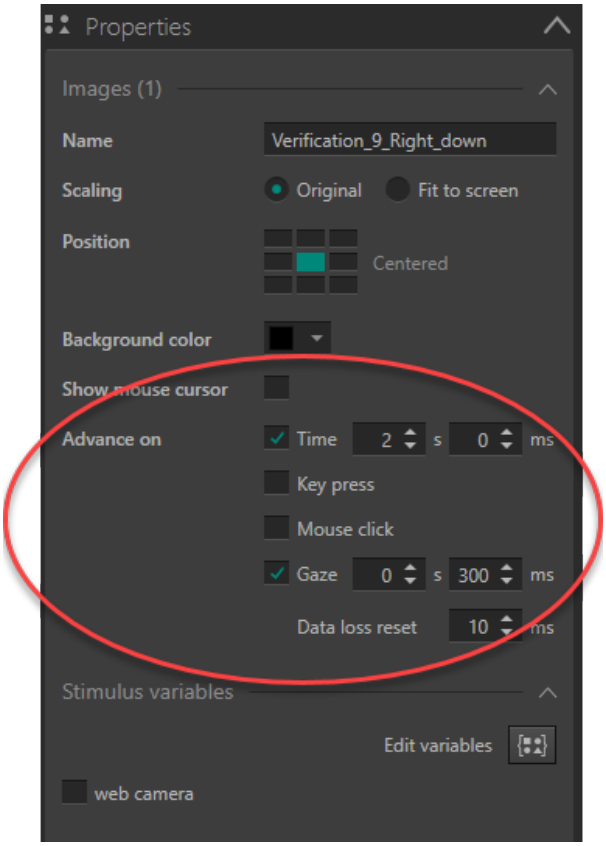


Figure 2. Advance on options in the Properties panel

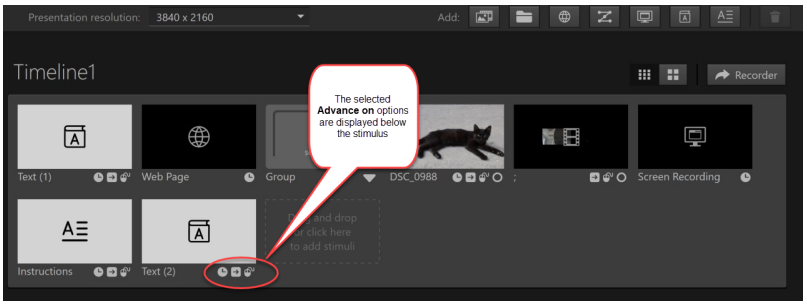


Figure 3. The selected Advance on options are displayed as icons below the stimulus on the Timeline.

5.2.3 Calibration stimulus

Add a calibration stimulus by toggling on **Eye tracking** in the Advanced settings section in 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.

The following calibration stimulus properties can be changed:

- **Validate calibration**: Determines if a calibration validation will happen after the calibration or not. When toggled on, the calibration will be validated.
- **Randomize target point order**: Determines if the targets are shown in a random order or not. When toggled on, the targets are shown in a random order.
- **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.

  Tobii Pro recommends using a calibration background color as close as possible to the stimuli background color.

  1. Select background color by opening the drop-down 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 Type**: Determines how the advancement from one calibration target 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 targets**: Specifies how many calibration targets (points) are displayed during the calibration procedure. The default value is 5.

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

- **Target color**: Determines the color of the targets (points) during the calibration.

1. Select target color by opening the drop-down and the color picker.
2. Click the desired color or enter a hexadecimal color code in the number entry field.

- **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**: 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 drop-down 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. Click the plus sign (+) next to the **Add video** option. A selection dialogue displays.
      2. Select your video file.



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.

5.2.4 Image stimulus

The following properties of an image stimulus can be changed:

- **Name**: By default, the stimulus name is identical to the file name 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 drop-down 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.
  - *Gaze*: The stimulus is displayed until the participant fixated a certain amount of time within a defined area (Trigger zone) on the stimulus. The time is specified in seconds and milliseconds. If there are gaze samples outside the Trigger zone, or there is >34ms of data loss before the trigger time is reached, the Gaze trigger time will start over from zero.
  - *Data loss reset*: The default value for data loss is 34 ms but you can adjust the time using the up and down arrows.



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

5.2.5 Video stimulus

The following properties of a video stimulus can be changed:

- **Name**: By default, the stimulus name is identical to the file name 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 drop-down 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.
  - *Gaze*: The stimulus is displayed until the participant fixated a certain amount of time within a defined area (Trigger zone) on the stimulus. The time is specified in seconds and milliseconds. If there are gaze samples outside the Trigger zone, or there is >34ms of data loss, before the trigger time is reached the Gaze trigger time will start over from zero.
  - *Data loss reset*: The default value for data loss is 34 ms but you can adjust the time using the up and down arrows.



Name and **Advance on** are the only video stimulus properties available for VR360 degree videos.

5.2.6 Stimulus editor (images and video)

To view and edit an image or video stimulus in a larger format, hover the mouse over the stimulus card on the timeline and click the **Edit** button (pencil) in the lower right corner. The selected image is then displayed in a larger format. If **Advance on Gaze** is selected you can edit the size and placement of the trigger zone in this view. For example, you may want to advance when the participant

looks at one part of the screen or at a particular object. The default zone is in the middle of the stimulus.

To navigate back to the Timeline view, use the **Back to Timeline** button in the upper left corner.

Sometimes stray coordinates end up outside the trigger zone and these can then restart the trigger time calculation. Tobii Pro recommends making the trigger zone as large as possible so that any stray coordinates are more likely to be inside the gaze trigger zone.

Note that any modifications to the Trigger zone will be reset if the option is deselected and then reselected.

5.2.7 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 when you select a web element on the Timeline on the **Design** tab:

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.

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.

Decription:A description of the web stimulus.

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: High means that the screen is recorded at native resolution. Medium is 75% of native and Low is 50% of native resolution. Use high 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: If the box "Time" is checked, you can then set the amount of time before the recording moves to the next stimulus on the Timeline.

Web screenshots: Toggle on and off automatic screenshots. Alternatively, you can capture screenshots manually instead using the F8 key or clicking at the **Capture web screenshot** button at the bottom of the Moderator screen.

For more information about recording, read Screen-based recording and for more information about analyzing recordings with web stimuli, read Replay a recording.

5.2.8 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**: *High* means that the screen is recorded at native resolution. *Medium* is 75% of native resolution 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.

For more information about analyzing a Screen Recording, read Replay a recording.

5.2.9 Text stimulus (Reading studies and instruction)

Use the Text stimulus to write text you want the participant to read during the recording. This type of stimulus is intended for reading research but you can also use it to give instructions or anything else conveyed with text.

Tobii Pro Lab will compute AOI reading metrics on Automatic AOIs, generated on three levels (depending on what you choose): Characters, Words and Sentences.

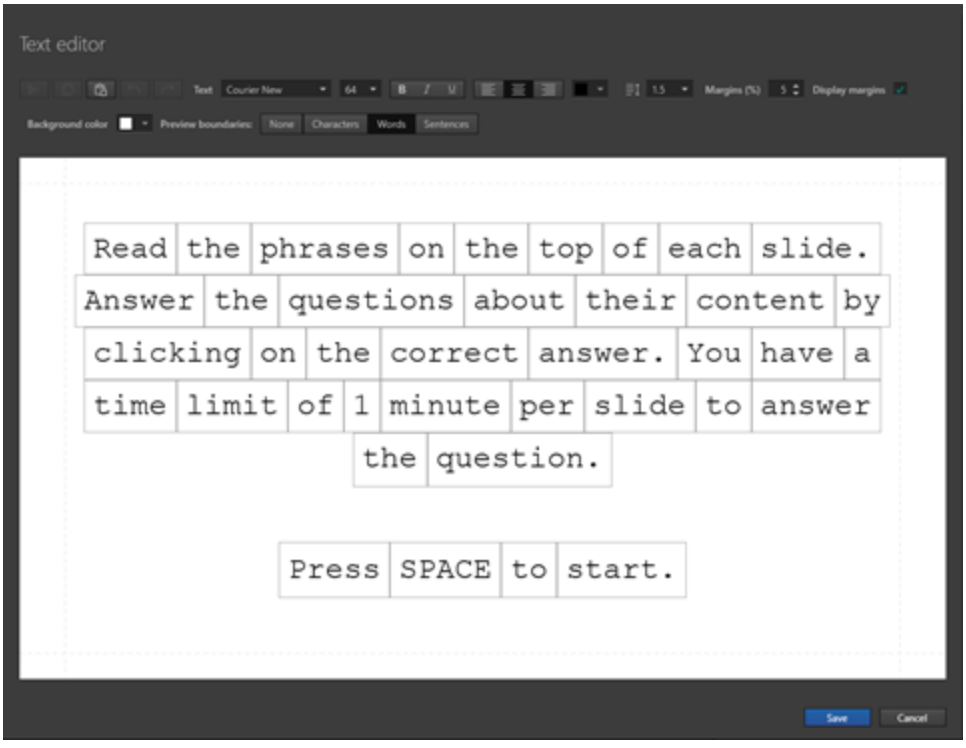


Figure 4. Sample instructions using the Text editor

Click the **Edit text** button (or double-click it the element on the Timeline) to write the text and to see the full editing interface with additional functionality including a font selector, font size, and margin control. You can also choose to visualize boundaries to see the Automatic AOIs' size.

The following Text stimulus properties can be changed:

Name: Enter an appropriate name. If left empty, Pro Lab sets the name to Texts with a unique number if there is more than one element with this name, e.g. Text (1).

Background color: Sets the background color of the entire Text 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 text** button to see the full editing interface with additional functionality including a font selector, font size, margin control and boundaries. Note that the line height will affect the vertical size of AOIs.

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**: 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.

Punctuation

Pro Lab supports the symbols "?" and "!" as an end to a sentence.

Text Editor

- The text editor supports Unicode characters in the Basic Multilingual Plane (BMP). Among other things, in the BMP, there are the Latin characters and symbols, transcriptions, other European characters and writing systems. For more information, search for unicode information online.
- The text editor does not support Input Method Editors (IME). Using an IME might cause instability and cause Pro Lab to stop working.
- The text editor supports copy and pasting from external text editors. Pay special attention to the font properties when copying and pasting because these are not always copied correctly.

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 Edit 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 unexpanded 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 Duplicate a group

How to duplicate 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 Delete a group

How to delete 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 Create variables

How to create 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 Assign variables

How to assign a stimulus/group variable:

1. Open the *Design* module.
2. Add stimuli by using the **Add** buttons located in the upper right and then browsing and selecting them on your computer.
3. Select the desired stimulus or group. Multiselect is enabled.
4. Assign a value by clicking the checkbox next to it in Stimulus variables on the Properties panel. Use the **Edit variables** button to add or edit variables.
5. Select the value you want to assign to the stimulus or group.

5.5 Use 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 to provide your setup with a precise stimulus timing.

How to activate 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.

How to change the TTL marker value for a stimulus:

1. Click the stimulus on the Timeline.
2. Enter the marker value you want to use for that stimulus in the TTL marker value input field.
3. 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 Change 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 Change 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 Emulate the screen resolution of the presentation screen

You use the drop-down 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 drop-down. 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.

5.7 Correct resolution and scaling of the presentation screen

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 stimulus shape and size is determined by global settings for resolution and scaling that will also determine the shape and size of the timeline element.

5.7.1 Set the screen resolution of the presentation screen

Use the drop-down list “Presentation screen resolution” to select what resolution should be used on your intended presentation screen. The shape of the stimuli cards gets the same aspect ratio as the screen on which the stimuli will be displayed. In addition, the stimuli are scaled on the cards to indicate how much screen area they cover during the presentation. When the recording starts the chosen resolution will be applied on the presentation screen and then reverted back if the screen had a different resolution.

All Tobii Pro eye trackers delivered with screens get their recommended screen resolutions listed in the drop-down. 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.



Always use the native resolution of the presentation screen to guarantee correct timing and correct aspect ratio.

5.8 Record in 100% scale

In order to start the recording, the scaling of the presentation screen must be 100% in order to ensure correct format of the stimuli. To change the scaling, adjust your computer’s Display Settings.

5.9 Timeline zoom

Sometimes you need to see the cards in your Timeline to be smaller or larger. In the top right corner of the Design module (next to the Recorder link button) you can switch between viewing large or small representations of the stimulus cards.

Change card size by clicking on the two symbols. The default setting is small cards.

6 Make 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 there is no need to access the Record module for Glasses projects.

6.1 Mouse Tracker

If you want to build and pilot a data project but you don't currently have access to an eye tracker,you can use the Mouse Tracker as a temporary substitute. This sensor produces gaze data at the location of the mouse cursor. Note that filters and analysis may not work like they do for real eye-tracking data therefore this feature is intended for piloting and demonstration and teaching purposes, not bona fide research. The data is sampled at 60 Hz or 250 Hz.

How to use the Mouse Tracker:

1. In the Record module, select "Mouse Tracker" from the list of eye trackers in the Eye Tracker card above the timeline.
2. Use the radio buttons to select between 60 Hz and 250 Hz.

6.2 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 record- ing" 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 does not support presentation screens that have the Windows screen duplication setting enabled

6.2.1 Start a screen-based recording

How to make 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). For more information, read Change device settings.
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 the participant you will record from the list of participant names. If that person has no previous recordings, select the **+New** button and enter the participant's name in the name field. Note that the **Start Recording** button is disabled until a participant is selected.

You can define or edit already defined participant variables. For more information, read Participant Variables.

4. Give the recording a name by entering it in the “Recording name” input field in the Recording section.
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. For more information, read Modify screen latency settings.
6. The recording can be stopped using the ESC key (default method) or Shift+ESC.

   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 recordings.

7. Start the recording by clicking the **Start recording** button.

6.2.2 Moderate 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.

6.2.3 Perform 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, 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 3D eye model in Tobii Pro Eye Trackers compensates for drift, so the calibration is done only once before starting to collect data and does not need to be adjusted during recording. However, keep in mind that fluctuations in pupil size may cause shifts in the indicated gaze position,

and the experiment should be designed accordingly. It is good practice to use a calibration background color that matches the stimuli.

Add a calibration stimulus to the Timeline in the **Design** module. For more information, read Timelines. 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. They can be reviewed and exported later, in the **Project Overview** section, or by using the Data Export tool. They are highly dependent on the calibration used at the time you do the validation. Any changes made to the calibration will have to be validated again.

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 selecting 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 Record section, under the Calibration controls list box. If you display the controls in the moderator view, you get better control of the calibration.

Perform a calibration validation:

1. Select a Timeline that contains a Calibration Stimulus, and Start a screen-based recording
2. The participant should sit comfortably 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 target object that appears on the screen once the calibration starts.
4. Click the **Start calibration** button on the presentation screen. The calibration procedure starts. If requested, the validation starts immediately after the calibration and presents four additional targets.

5. When the calibration data has been collected and validated, a visual representation of the calibration results displays on the presentation or moderator screen.
6. Inspect the calibration and validation results (see below). When the calibration and validation results are satisfactory, click **Continue**. The rest of the Timeline is presented to the participant.

Inspect the calibration and validation results

The visual 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 top right of the Calibration window: Average Results or Left and Right Eyes Results.

Each colored dot represents a gaze sample collected during the calibration or validation, green for the left eye and blue for the right eye. Orange dots represent the average gaze sample between left eye and right eye. White dots represent the average gaze sample across entire targets. Colored lines are drawn between targets and white dots to represent accuracy. Colored circles are drawn around white dots to represent precision.

The crosses indicate where the validation target objects appeared on the screen and the pluses where the calibration target objects appeared on the screen. When your cursor hovers over a target, a pop-up window appears with the target's accuracy and precision displayed in degrees and pixels as well as the number of related gaze sample.



Tobii Pro eye trackers display different numbers of gaze samples for calibration targets. Some eye trackers will display only one gaze sample per calibration target.

To the right of the window, the **Calibration average results** table helps you interpret the results. This is the average total results across all calibration targets for all the calibrations done with the current participant. These results represent the estimated error in the gaze estimation algorithm (3D eye model). They do not represent the real accuracy and precision you can expect during the recording. Instead, if the calibration you just did was validated, it will show validation average results below it. Validation average results are the estimate of the average total results across all validation targets for the relevant calibration. These results represent an estimate of the accuracy and precision you can expect during the recording.

If data is missing from some calibration targets, if data is mapped too far away from the targets or if the calibration average results are too high for your experiment, you should recalibrate. 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 all points** button. If you want to redo the calibration for selected points, select them by clicking on them and then click **Recalibrate**.

If data for the calibration is good enough, you should inspect the data for the validation. Ultimately, the validation data is what matters if you want good accuracy and precision during the recording. If data is missing from some validation targets, if data is mapped too far away from the targets, or if the validation average results are too high for your experiment, you should revalidate the calibration. If you want to revalidate the calibration, you cannot select individual points but instead must run the validation again, click **Revalidate**.

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.

Reuse calibration

In some circumstances you can reuse previously made calibrations (e.g. you are running multiple recordings in a row with the same participant). It is recommended to reuse calibrations only if conditions are similar from one recording to the next one: same participant, same experimental environment, same lighting conditions, similar stimuli background, etc. For each Participant, Tobii Pro Lab saves the last five calibrations.

How to reuse a calibration:

1. Start a screen-based recording with an existing Participant that was previously calibrated.
2. When the recording starts, you see the track box and click on Reuse calibration.
3. The calibration results window opens. Select the calibration to use from the Calibration average results table and click Continue or Validate (if validation is active).

Reused calibrations will have to be re-validated if validation is active.

6.2.4 End a screen-based recording

A recording can either end when the last stimulus has been displayed or by an action of the moderator. To stop an ongoing recording, the moderator can:

- press F10 on the keyboard or click the **Next** button in Moderator view
- press the ESC button or press Shift + ESC on the keyboard
- click the **Stop recording** button in the Moderator view

When the recording finishes, you can Save or Discard the recording. To save it, you must confirm that you have obtained participant consent. Alternately, you can select *Discard recording* to delete the recording. The participant will also see the dialog about their consent to store/transfer their eye tracking data on the target screen. For more information, go to Tobii's Data Transparency policy.

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

6.2.5 Lab browser

Dynamic web content

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

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

Technology-wise, 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.

You can capture screenshots manually using the F8 key; or by clicking the Capture web screenshot button at the bottom of the Moderator tool; or adding your own screenshot in the Custom Web TOI dialog.

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

On the Design tab, screenshot capturing can be turned off to save on performance during recording. Screenshots can then be captured manually using the F8 key or clicking the Capture web screenshot button at the bottom of the Moderator tool.

You can also import a screenshot in the Custom TOI dialog.

Move to Next and Stop: 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.

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, and cannot be installed. this 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.

*A Single-page application (SPA) is a web application or web site that dynamically rewrites the current page rather than loading completely new pages from a server.

6.3 Scene camera 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.

6.3.1 Start a scene camera recording

How to make 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. For more information, read Change device settings.

   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 the name that you will record from the list of Participant names. 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 , Pro Lab suggests a name, such as "Participant1." Note that the **Start Recording** button is disabled until a participant is selected.

   You can define or edit already-defined participant variables. For more information, read Participant Variables.

5. Enter the recording's name in the "Recording name" input field in the Recording section. If no name is entered, Pro Lab suggests one, such as "Recording1."
6. Start the recording by clicking the "Start recording" button.
7. When the recording finishes, you can Save or Discard the recording. To save it, you must confirm that you have obtained participant consent. Alternately, you can select *Discard recording* to delete the recording. The participant will also see the dialog about their consent to store/transfer their eye tracking data on the moderator screen. For more information, go to Tobii's Data Transparency policy.

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.

6.3.2 Moderate a scene camera 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.

6.3.3 Perform 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.

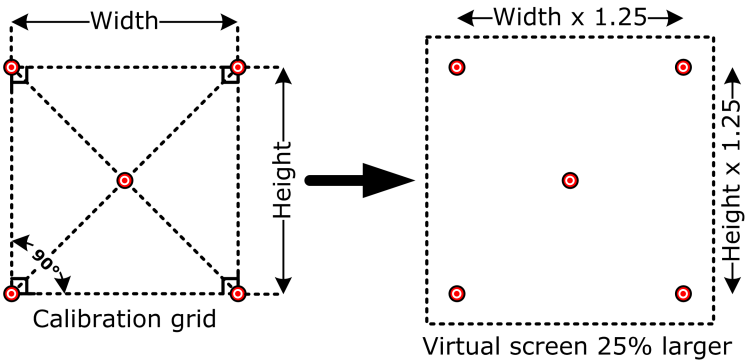


Figure 5. An example of a calibration target

The calibration controls are displayed in the Record module.

How to perform 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 s/he does so, click **Calibrate point**. Repeat this step for each calibration point.
4. You can stop the calibration by clicking **Abort calibration**.

6.3.4 End a scene camera 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 the “Stop recording” button in the moderator view or by pressing the “Esc” button on the keyboard.

When the recording finishes, you may Save or Discard the recording. To save it, you must confirm that you have obtained participant consent. Alternately, you can select *Discard recording* to delete the recording.

The participant will also see the dialog about their consent to store/transfer their eye tracking data on the Moderator screen. For more information, read Tobii's Data Transparency policy.

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

6.3.5 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.

Add 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. For more information, read Edit a participant variable.
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.

Add a new participant

How to add 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.

Edit a participant variable

How to edit an existing participant variable in 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 Add a new participant variable.

Options of 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.

Delete a participant

How to delete a participant:

1. Find the desired participant and click 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.**

6.4 VR 360 recording

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

Youcan 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.

6.4.1 Set 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 tobiipro.com/siteassets. It contains the drivers required for running the Tobii VR eye tracker.

6.4.2 Set 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: tobiipro.com/product-listing/vrintegration/#GetStarted
- SteamVR provides information on how to install and set up the Tobii Pro VR Integration headset. The installation instructions are here: support.steampowered.com/steamvr/HTC_Vive/

- You can view a Vive setup instruction video on YouTube: youtube.com/channel/UCiw1w2kYUHWQOkWIZbMqcaQ/
- Set up the room using SteamVR before making any VR 360 recordings with Pro Lab.

6.4.3 Start 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.

How to make a recording:

1. Set 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.

6.4.4 Moderate 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.

6.4.5 Perform 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 Timelineby dragging and dropping it. The calibration procedure starts when the stimulus is reached on the Timeline.

How to calibrate 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 redo the calibration by restarting the recording.

6.4.6 End 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.

6.5 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.



For more information, read Analysis of 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 Tobii Pro Lab Package (TPL) contains a collection of instructions that interact with Tobii Pro Lab. For example, it instructs Tobii Pro Lab to start recording.

6.5.1 Connect the computer and Tobii Pro eye tracker

How to connect 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.

6.5.2 Configure the computer and install the software

How to configure and install the software:

1. Install Tobii Pro Lab, E-Prime and E-Prime Extensions for Tobii Pro on the test computer. For more information, read Setting up an External presenter recording with E-Prime in Tobii Pro Learn & Support.
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): support.pstnet.com/hc/en-us
3. Reboot your computer.

6.5.3 Connect Tobii Pro Lab to the eye tracker

How to connect 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.

6.5.4 Set up an experiment in E-Prime Extension and Tobii Pro Lab

How to set 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 Tobii Pro Lab package and the TET package
3. Go to the *Devices* tab and add the Tobii Pro Lab device and the Tobii Eye Tracker (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 a 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* subobject 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.

6.6 Rename a recording

How to rename a recording:

1. Select the desired recording in the *Project Overview*.
2. Activate the renaming functionality 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.

6.7 Export 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 project typically contains a calibration validation. This will be exported in the same way as a calibration without validation.

6.8 Change 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.

6.8.1 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

6.8.2 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 section Add a device

6.8.3 Change 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.

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.

Microphone

Add a microphone by clicking the plus "+" button above the Timelines on the Record 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.

Replay 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.

6.8.4 Change 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.

Change which eye tracker to use during recording

How to select the eye tracker:

1. Click the eye tracker card.
2. Click the drop-down menu on the card. The menu lists which eye tackers are available on the network at 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.

Change 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.

How to select 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.

How to select the eye tracking mode for a recording:

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

6.8.5 Change 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).

How to select the parallel port:

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

6.9 Stimuli presentation timing data

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

6.9.1 Modify 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.

How to modify 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 Set 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 computer 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.

How to pair a Shimmer GSR sensor to your computer:

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.

How to add 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 Use 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).

How to enable 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 (read 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 auto-scaled 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 does the following:

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. For more information, read Metric export formats

A 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.

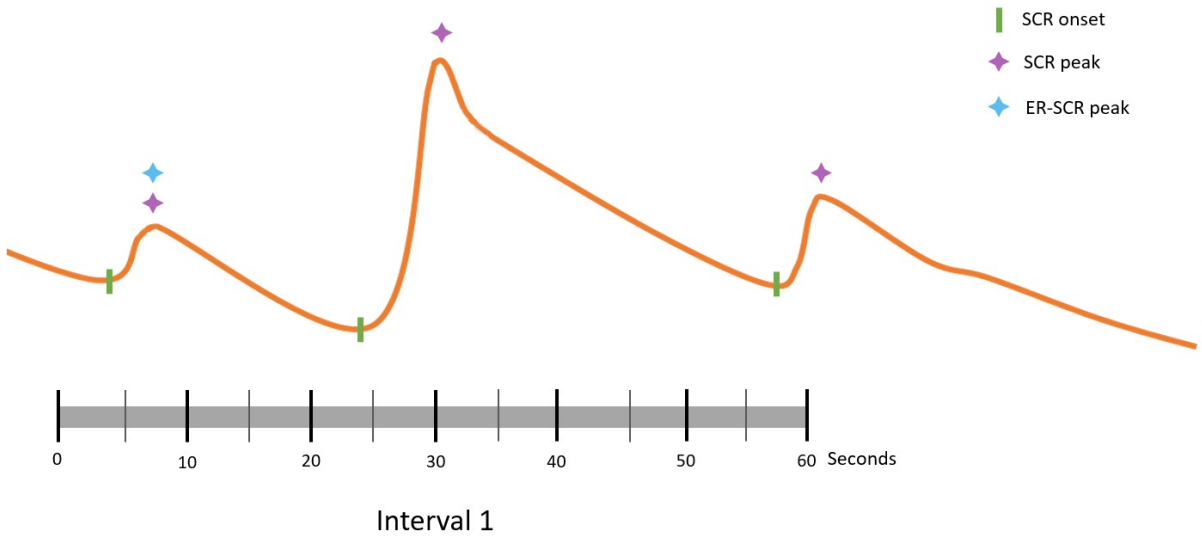


Figure 6. Example #1

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.

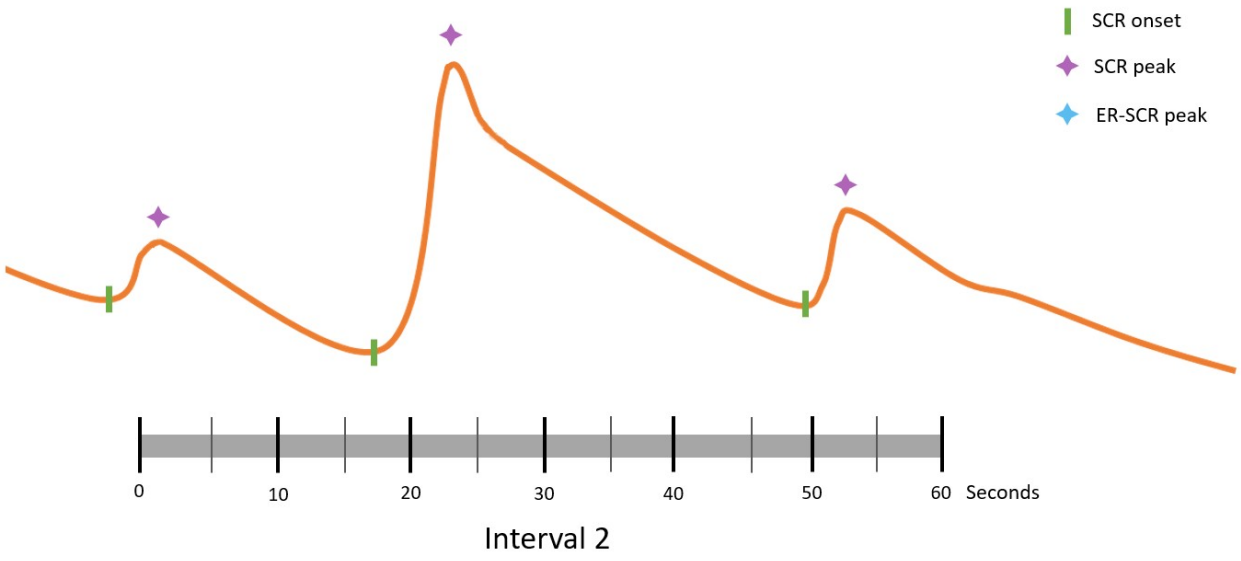


Figure 7. Example #2

7.3.4 ER-SCR classification

A 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. For more information, read Data export. 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 Analyze 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.

8.1 Replay a recording

Open a replay tab by clicking on a recording in the Project Overview's Recordings list or by selecting a recording from the Analyze drop-down menu.

8.1.1 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 Replay settings

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

How to increase or decrease 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.

How to increase or decrease 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.

How to change 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.

How to hide the calibration in a recording:

1. Click the Calibration button (looks like a "Z" drawn between calibration points) above the Timeline to hide it.
2. Click the Calibration button again to show it.



The calibration will always be included in the video export since it is part of the recording.

8.1.3 Timeline tools

Timeline tools help you work with your recordings.

Timeline navigation

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

In the upper timeline, open a zoomed-in visualization of the selected part by clicking the **Charts** list box and selecting the *Timeline preview* check box. The Timeline preview is affected by the applied *Time zoom* in the upper timeline.

Fast forward or through or jump to a location in the video replay:

1. Locate the red time needle handle (a red teardrop) on the Timeline below the video display area.
2. Click and drag the time needle to the desired starting point.

Move between event markers:

1. Use CTRL + arrow keys or your mouse to move the time needle to move the time needle between event markers.



When using the yellow selector tool, you can also press the CTRL button to snap to events.

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. For more information, read Map eye tracking data.

Snapshot Timeline Visualizations

If you use Snapshots in your Glasses, scene camera, screen or web stimulus project, and you have enabled the **Show snapshot** switch in the Gaze data section of the Analyze tab, each Snapshot gets a row below the Visualization. The Snapshot's file name appears to 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 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 assisted mapping is used for a snapshot, a diagram is added to the snapshot Visualization for the time when assisted mapping was used. This diagram indicates the similarity between the frames in the recorded video and the snapshot and how well the Real-world mapping algorithm managed to map the gaze point on the snapshot. A high value indicates high similarity and a low value means there is a low similarity score. A low similarity score does not necessarily mean that the data is incorrectly mapped, only that the Real-world mapping algorithm had less information to base the mapping on and the mapping is therefore labeled as less similar.

All points that are mapped by the assisted mapping tool will receive a similarity score. This score can be used to speed up the inspection of the mapping result by highlighting points that received a low similarity score.

In the tools panel to the right you can set the Similarity threshold. All mapped points with a score below this threshold will be marked in orange to make it easier to identify them. The higher you set the threshold the more points, or fixations, will be orange.

You can inspect the points, or fixations, by placing the time needle at the beginning of the section to which you applied assisted mapping, and then step to the next mapped point, or fixation. You can change the behavior of the step to next fixation buttons to step between points, or fixations, that are below or above the threshold. If a mapped point, or fixation, is mapped incorrectly you can map it manually by clicking the snapshot. This overrides the existing mapped point. Manually mapped points receive a similarity score of 100 and are shown in green. If a point, or fixation, has a low similarity score but is correctly mapped on the snapshot, you can confirm it by clicking the confirm button or use the keyboard shortcut "C".

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.

How to enable the Gaze Data Chart:

1. Expand the **Chart** menu to the left of the Timeline.
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 (read Timeline tools), 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 (read Timeline tools), 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.

Mapped Gaze Data Chart

This feature is only available when the **Snapshot** button in **Replay Settings** is 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 assisted mapping, for more information, read Map eye tracking data. 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.

How to enable the Mapped Gaze Data Chart:

1. Click the Charts drop-down menu to the left of the Timeline.
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 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 (read Timeline tools), 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 (read Timeline tools), 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 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.

8.1.4 Replay tools

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

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** field in Pro Lab when the recording was created. In Glasses projects, the participant name is entered when the recording is 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.

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 more details on how they work and what effect it has on your data, read appendix Gaze Filter functions and effects.

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

How to change the Gaze Filter preset:

1. In the Gaze Data section of the tools panel, select the Settings tab, and open the *Gaze Filter* drop-down menu.
2. In the drop-down 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.

How to create a Gaze Filter preset:

1. In the Gaze Data section of the tools panel, select the *Settings* tab and open the *Gaze Filter* drop-down menu.
2. In the drop-down 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* drop-down 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* drop-down menu.

How to change the Gaze Filter preset settings:

1. In the *Gaze Data* section of the tools panel, select the *Settings* tab and open the *Gaze Filter* drop-down menu.
2. In the drop-down menu, select the filter you want to modify.
3. Click on the cogwheel next to the *Gaze Filter* drop-down. 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 the Tobii Pro 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* drop-down menu.

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.

How to define an Event Types logging scheme:

1. Locate the **Events** section on the Analyze tab 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 displays.
3. Enter the name/description of the Event type in the left-hand input field.
4. Click the drop-down 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. For more information, read Manage Event Types.

How to edit an existing Event Type:

1. Locate the **Events** section on the Analyze tab in the tools panel on 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 drop-down 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. For more information, read Manage Event Types.

How to delete an Event Type from the Event Types scheme:

1. Locate the **Events** section on the Analyze tab in the tools panel on 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.

How to log 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.

Available Event groups include:

- **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*).
    Mouse events can have four possible values from the combinations of Up/Down, Left/Right.
    Down means that the mouse button is pressed. *Up* means that the mouse button is released.
    Left and *Right* refer to the left and the right mouse buttons). Keyboard events have values of all keys on the keyboard timestamped with the press moment.
  - **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.
  - **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*).

How to use 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.

Select a frame and pair 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. This includes screen, scene camera, external presenter, and VR 360 recordings.

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.

How to select and assign 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 Export recordings

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

8.3.1 Export 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 can also contain participant audio and video.

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

How to export a video clip with a gaze overlay:

1. Select the interval on the Timeline you want to export by dragging the yellow handles on either side of the red track slider to the desired start and the end.
2. Click the **Export** button  above the timeline of the recording.
3. Select the **Recording media** you want to export.
4. 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.
5. Select **Video resolution** for export. 1920x1080 is the default.
6. 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.
7. Save the .mp4 file to your computer. The default name is "Recording name Participant name" but you can change this to whatever you want.
8. Click the **Export** button to start the export. You can view exporting progress in the activity queue in the top right of Pro Lab. Clicking the activity queue and then clicking a specific export

allows you to cancel the export, open the file location when it's finished exporting, or delete it from the queue.



Figure 8. The Activity queue button lets you see and control the exporting process

8.3.2 Export 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. In the activity queue you can cancel the export, open the file location when its finished exporting, and delete it from the queue.



Figure 9. The Activity queue button lets you see and control the exporting process

8.4 Map eye tracking data

Wearable eye tracking devices, such as Pro Glasses 2 and 3, 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 kinds of statistical/numerical analysis to be meaningful, the collected eye tracking data needs to be mapped on to objects, or images, of interest and into a new coordinate system in order to be aggregated.

Remote eye tracking devices produce eye gaze data that is mapped to a coordinate system corresponding to the image/ video stimulus, Screenshot, or frame from the recording. When the

screenshots or frames are not corresponding to what the participant has seen the aggregating of data is not possible.

Pro Lab addresses these chal lenges with a solution called snapshot mapping.

8.4.1 Assisted and manual mapping

The gaze data mapping in Pro Lab lets you map eye gaze data onto still images (snapshots) of environments and objects of interest or external screenshots in two different ways: either semi-automatically using manual mapping or fully automatic using the assisted mapping function. The Snapshots images are typically photos, created by the data collector or the researcher using a screenshot tool or text editor. The assisted mapping function uses Pro Lab's Real-world Mapping software technology to automatically map gaze data from a recording onto a Snapshot.

Requirements for Snapshot images:

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

Requirements for Assisted mapping in screen and web recordings:

- Full HD (1920 x1080) or 1920 x 1200

Requirements for Assisted mapping in scene camera recordings:

- If the camera uses full HD, then (1920 x 1080) or 1920 x 1200

You can use snapshots created from multiple images that are stitched together into one image 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.)

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 the text "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**. An import progress bar displays.
5. When the Snapshot image has been imported, click **OK**.

How to import 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. For more information on how this affects the data, read Effect of mapping data onto Snapshots with Tobii I-VT or Raw Gaze Filter. If you have chosen to map data with 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. In the Gaze data section of the**Tools** panel, select the **Snapshots** tab.
2. Enable Mapping by toggling on **Show snapshot**.
3. Enable or disable the "Automatically step on next fixation" toggle switch. Enabling this 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 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. 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 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. 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.

How to map data onto a Snapshot automatically with assisted mapping:

1. In the Gaze Data section of the **Tools** panel, select the Snapshots tab.
2. Enable Mapping by toggling on **Show snapshot**.
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 Timeline 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 Timeline, and select “Run assisted mapping.” The interval is now placed in the processing queue. The built in Real-world mapping algorithm starts processing the mapping automatically according to the order in the processing queue. If another mapping is already in progress, that mapping will be completed before the next one is initiated. You can check the jobs placed in queue by clicking the number at the top right 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 assisted 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. The diagram indicates how confident the Real-world mapping algorithm is about the similarity of the gaze point in the recording and the mapped position in the snapshot. A high value indicates high similarity, and a low value, a low similarity level. A low similarity level does not necessarily mean that the data is incorrectly mapped, just that the Real-world mapping algorithm had less information on which to base the mapping. Therefore, it is labeled as less similar.
8. Sections with low similarity should be reviewed and, if necessary, remapped manually (if incorrect mappings are found). Adjust the similarity threshold, in the tool panel on the right, to a level that fits the requirements of your project. Sections above the threshold will be marked in green and sections below the threshold will be marked in orange for easier identification. If you are using a fixation filter, the highlight will be based on the mean similarity of all the mapped gaze points of each fixation. The individual similarity of each gaze point in a fixation can be seen as a green or orange dots.
9. Remap gaze points manually using the following steps:
   a. For each point or fixation, you can do one of three things:
      - remove it by pressing the **Delete** button on the keyboard or by right-clicking the point on theSnapshot and selecting“Delete current automatically mapped fixation point” in the dialog
      - correct it by manually clicking and moving the Snapshot to where it should be
      - leave it “as is” by clicking the **Accept** button or typing “C” on your keyboard



You can adjust the behavior of the **Step to next** button to step between mapped gaze points, or fixations, below the similarity threshold or step between all. Buttons for these settings are located to the right of the navigation buttons.



(A) displays when the point is automatically mapped and below the threshold. (M) denotes a new manually mapped point.



Figure 10. An automatically mapped point (A) and a manually mapped (M) point

b. Automatic color-coding:
   - In the row representing the Snapshot under the Timeline, manually remapped gaze points and fixations 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) points mapped by assisted mapping appear in a gray circle.

c. Repeat this procedure until you are done.

10. 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.

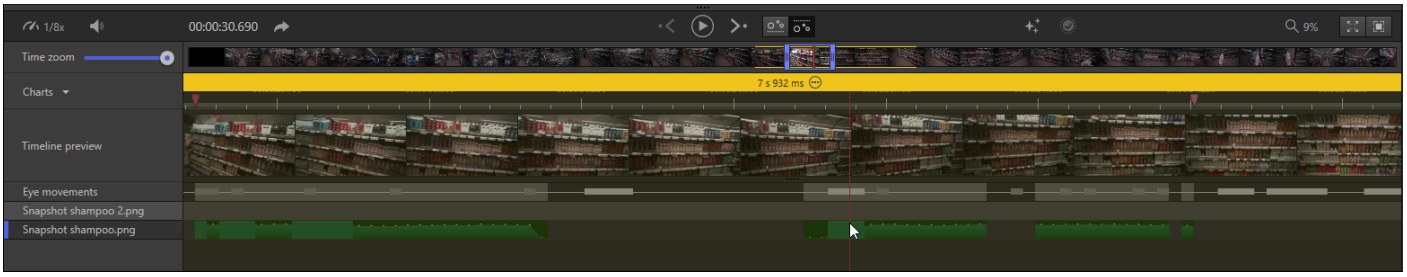


Figure 11. Step through the recording using the arrow keys oto compare the mapping on the Snapshot with the gaze locations

8.5 Visualize eye tracking data

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

8.5.1 Create and customize 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 Calculate heat maps.



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.

8.5.2 Create a Heat Map

How to create a Heat Map:

1. Click on the *Visualizations* button - either in the *Project Overview* section or select it from the *Analyze* drop-down 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. For more information about Gaze Filters, read Gaze Filter functions and effects.
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 drop-down menu, and select the calculation basis for the Heat Map. For more information, read Calculate heat maps.

   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.

8.5.3 Customize 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. For more information, read Calculate heat maps. 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 drop-down 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%.

8.5.4 Save 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.

How to save 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*.

8.5.5 Create and customize 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.

8.5.6 Create a Gaze Plot

How to create a Gaze Plot:

1. Click the **Visualizations** button, either in **Project Overview** section or select it from the **Analyze** drop-down menu in the top navigation.
2. Use 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. For more information about Gaze Filters, read Gaze Filter functions and effects.
4. Use the **Times of Interest** tool and select the Time of Interest (TOI) that you want to use as the base for 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. Use the **Recordings** tool to select or deselect the recordings and/or intervals that you want to visualize in the Gaze Plot. 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 Gaze Plot is Transparent by default.

8.5.7 Customize 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 Gaze Plot 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 drop-down menu with a color picker which appears to the right of the setting. To select a custom color, click on the drop-down 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 drop-down menu to the right of the Fill color options drop-down 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."

8.5.8 Save 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.

How to save 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* drop-down 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*.

8.5.9 Modify 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 more information on how they work and what effect it has on your data, read Gaze Filter functions and effects.

How to change the Gaze Filter preset:

1. Go to the *Visualization Type and Settings* section of the tools panel and open the *Gaze Filter* drop-down 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.
- TobiiI-VT 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 IVT Fixation Filter's Default Values*" found on our website.

3. The new filter preset is now applied to the data used in the Visualization.

How to create a Gaze Filter preset:

a. Go to the *Visualization Type and Settings* section of the tools panel and open the *Gaze Filter* drop-down menu.
b. Select the *+ Create new Raw filter* or *+ Create new I-VT filter* option, depending on which kind of filter preset you want to create.
c. 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.
d. The filter is now automatically saved and set as the currently-used filter. It can be selected again from the *Gaze Filter* drop-down list by referring to the name given to it during creation.
e. Hide the filter preset configuration panel by clicking on the cogwheel next to the *GazeFilter* drop-down menu.

How to change the Gaze Filter preset settings:

a. Go to the *Visualization Type and Settings* section of the tools panel and open the *Gaze Filter* drop-down menu.
b. Select the filter you want to modify.
c. Click on the cog wheel next to the *Gaze Filter* drop-down menu. The *Filter Preset Configuration* panel appears. Built-in presets in Pro Lab cannot be modified.
d. 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.
e. The modifications to the filter are automatically saved and applied to the data in the Visualization.
f. Hide the filter preset configuration panel by clicking on the cogwheel next to the *Gaze Filter* drop-down menu.

8.5.10 Change 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.

8.6 Times of Interest (TOI)

Times of Interest (TOIs) are divided into two general types Automatic TOIs (sometimes called "System-generated 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.

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 time stamp, 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 Pro Learn & Support.

8.6.1 Automatic (System-generated) Times of Interest

Depending on the type of project you are running, Pro Lab will automatically generate different TOIs. These are Automatic (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	yes	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.

8.6.2 Custom Times of Interest

Custom TOIs are used to specify custom gaze data intervals for a visualization, metric calculation, or data export. When you create a custom TOI, you define the interval selection rules and the gaze data source.

A custom TOI's intervals are defined by Start Event types and End Event types with optional offsets. 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 generated automatically (eg. RecordingStart and RecordingEnd) or are logged manually. For more information, read Manage Event Types.

A Custom TOI's gaze data source will be the Recording Gaze data, mapped Snapshot Gaze data, or Web data (for a Web Time of Interest).

When you select a TOI for analysis, Pro Lab searches all recordings in the project and uses the gaze data intervals from the selected gaze data source to generate the visualization or to export metrics and data.

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. For more information, read Manage Event Types.
2. In the **Times of Interest** section of the tool panel, click the plus sign (+). Select *Custom Time of Interes*.
3. Name your custom Time of Interest with a descriptive name in the **Name** field.
4. Select the Events that define the start of your interval using the expandable lists under **Start point**.
5. Select the Events that define the end of your interval using the expandable lists under **End point**.
   To add an optional offset to either event, toggle the **Offset** switch to On. For more information, read Custom Times of Interest.
6. Select the gaze data source, Recording Gaze data or Snapshot Gaze data.

- Recording gaze data is collected during the recording. In a screen-based project, it is mapped to the Display Area Coordinate System. In a Glasses project it is mapped to the Head Unit Coordinate System. For more information, read Head Unit Coordinate System (HUCS).
- Snapshot Gaze data is mapped to a snapshot using Assisted or Manual mapping. This creates a new coordinate system, the Media Coordinate System. For more information, read Scene Camera Projects and the Media Coordinate System (MCS).
  If you select Snapshot Gaze data, also select the appropriate Snapshot.

1. Click **OK**.

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

8.6.3 Add offsets to Custom Times of Interest

If you want 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 Interest** 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.

8.6.4 Web Times of Interest

Web TOIs are created automatically for each URL that a participant visits. The intervals are all the different visits to the same URL. A sceenshot is captured and stored for each visit. The first screenshot captured will be the one associated with the TOI. For more information on how to change the screenshot, read Change screenshots by cloning a Time of Interest.

How to create a custom web 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. For more information, read Manage Event Types.
2. In the **Times of Interest** panel on the right-hand side, click the plus sign (+). Select *Custom Web Time of Interest*.
3. Name your custom Time of Interest by entering a descriptive name in the Name field.
4. 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.
5. Under End point, select the URLEnd point you want to use or select a Custom event type.
6. To add an optional offset to either event, toggle the offset switch. For more information, read Add offsets to Custom Times of Interest.
7. Select the screenshot you want to associate with this TOI.
    - Screenshots are sorted first by domain, then capture method, and then resolution.
    - Hover over the thumbnail to see a larger view of the screenshot.
    - Hover over the title to see the full title, domain, and resolution of the screenshot.

- Manually captured screenshots are shown with an M icon and imported screenshots are shown with a downward facing arrow icon.
- Select the plus button (+) to import a new screenshot. If you import a screenshot, it is very important to match the resolution with the resolution of the snapshot captured by Pro Lab.

8. Click **OK**.

Edit or **delete** your custom 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 webpages Tobii Pro Learn & Support.

Change screenshots by cloning a Time of Interest

How to change to a different screenshot:

1. Right-click the Web TOI and select Clone Time of Interest.
2. Name the custom Time of Interest* and create start and end points.
3. Select a screenshot.
   NOTE: It is very important to match the resolution with the resolution of the snapshot captured by Pro Lab.
4. Click OK.

The URL (web address) for the web Time of Interest is in the name by default. You can also right-click the Web TOI and select *Open in browser* or *Copy URL*.

8.7 Areas of Interest (AOIs)

Areas of Interest (AOIs) enable numerical and statistical analysis based on regions or objects of interest in your stimuli. AOIs come in different forms:

Manual AOIs refer to the ones the user creates herself by drawing an ellipse, rectangle, or polygon around some area in the stimulus or Snapshot. Manual AOIs can be either static or dynamic. Static AOIs are the normal kind, and these maintain the same position and shape during the exposure of the stimulus. Dynamic AOIs, however, change in size and shape over the stimulus exposure because the user changes the shape during the exposure. This is normally done in in videos, where an object of interest moves around in the video or possibly disappears and reappears again.

Automatic AOIs refer to AOIs that Pro Lab creates by having intricate knowledge of the objects presented on the screen, in this case characters, words, and sentences created in the text.

8.7.1 Draw AOIs on Snapshots, image stimuli, or frames saved as media

*this section applies to Manual AOIs

How to draw AOIs:

1. Activate the AOI tool by either clicking the **AOI Tool** button at the top on the **Project Overview** tab or select it from the **Analyze** drop-down menu in the top navigation.
2. Use the Media Selection panel on the right to open the snapshot, image stimuli, or frame saved as media on which you want to draw an AOI.
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.

How to name 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.

8.7.2 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 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.

8.7.3 Edit the shape of an AOI

*this section applies to Manual AOIs

How to change the shape of an existing AOI:

1. Make sure that the desired AOI is visible. (If it’s not, read Change 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.

8.7.4 Change the size of an AOI

*this section applies to Manual AOIs

How to change the size of an AOI:

1. Make sure that the desired AOI is visible. (If it's not, read Change 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.

8.7.5 Move an AOI

*this section applies to Manual AOIs

How to move an AOI:

1. Make sure that the desired AOI is visible. (If it's not, read Change 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.

8.7.6 Cut, copy or paste AOIs

*this section applies to Manual 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).

How to cut or copy 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 rightclicking 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.

How to paste 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).

8.7.7 Change the name, appearance, or visibility of an AOI

*this section applies to Manual and Automatic AOIs

How to change the name of 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.

How to change 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.

8.7.8 Undo or redo AOI actions

*this section applies to all AOI types

How to undo and redo 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 drop-down 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 drop-down list at the *Redo* button. Click the downwards pointing triangle and select the action you wish to redo.

8.7.9 Pan and zoom in the AOI editor

*this section applies to all AOI types

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.

How to pan 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.

8.7.10 Activate or deactivate an AOI

*this section applies to Dynamic AOIs

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.

How to activate or deactivate 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.

8.7.11 Export an image of the AOIs on the image or Snapshot

*this section applies to all AOI types

How to export 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*.

8.7.12 AOI tags

*this section applies to all AOI types

In Pro Lab you can assign Tags to both static and dynamic AOIs. This makes it possible to aggregate data from several AOIs for conditions that exist across multiple stimuli elements. This, in turn, creates an easier workflow for many experimental paradigms and research questions.

Tags can also be used to carry information about the AOI, or it's content, into the analysis in the form of metadata. Tags are supported in Metrics and Data export.

Create AOI Tags

How to create 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 cursor above it and click the x symbol that appears.
4. Continue creating the Tags you need.

Create 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.

How to create 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 on the right of the group.
5. Name the Tag as described above.



If you want to remove a group, hover the cursor 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.

Assign Tags to AOIs in the stimuli

When you have created your Tags it is time to assign them to the AOIs in the stimuli. How to assign 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 un-grouped Tags can be selected independently of each other.

3. The AOI now reflects the Tag/Tags that have been selected for it.

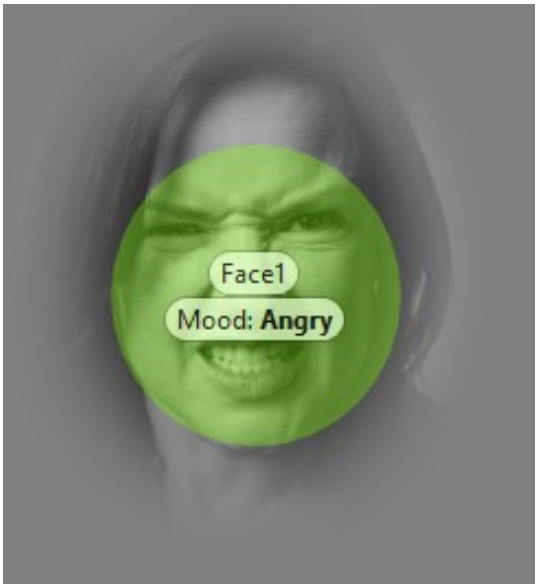


Figure 12. In this illustration the Face1 label is the AOI name, Mood is the group label and Angry is the tag name.

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.

Export data based on Tags

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

Export metrics based on Tags

How to export 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. For more information, read Metric export formats .

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.

8.7.13 Export and import AOIs

*this section applies to Manual AOIs

If you want to use the same AOI again with a different image, you can export AOIs and then import them into another project.

Any tags added to the AOIs will be exported/imported along with the AOIs and if you have added them they will be analyzed together (based on the assigned AOI tags). For more information, read AOI tags.

All AOIs in the media will be exported and imported when you select Export AOIs or Import AOIs.

How to export AOIs:

1. In **Project Overview**, select a recording.
2. Click the **AOI Tool** on the toolbar at the top.
3. Select the media in the Media Selection panel.
4. Right-click the media in the main viewer and select *Export AOIs*.
5. Save the file.

When no AOIs exist, the *Export* option is disabled.

How to import AOIs:

1. Click the **AOI Tool** on the toolbar at the top.
2. Select the media in the **Media Selection** panel.
3. Right-click the media in the main viewer and select *Import AOIs*.
4. The AOIs will be imported and shown on the media in the main viewer.

8.7.14 Automatic AOIs (Text stimulus)

In addition to drawing Manual AOIs, Automatic AOIs can be generated for a Text stimulus. Select the Text stimulus for which you want to generate Automatic AOIs in Media Selection. The **Select the media** section will then be active. Select the desired reading AOI level (Characters, Words or Sentences) to generate Automatic AOI and click **Generate**.

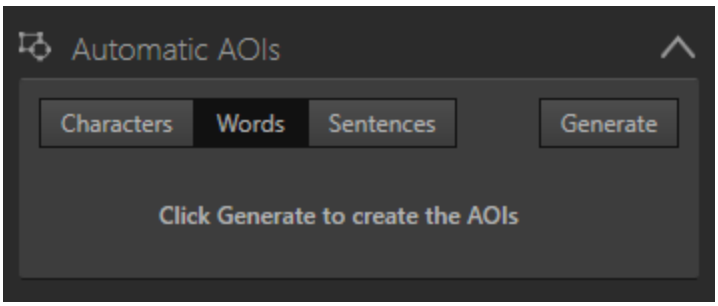


Figure 13. Select the level of AOI and click Generate.

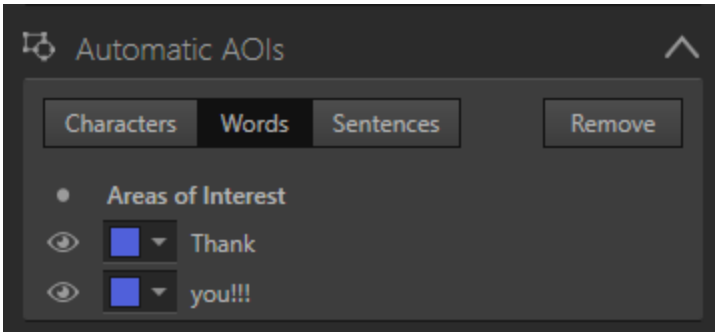


Figure 14. An example of words selected to generate Automatic AOIs

Characters: any type of letter or punctuation mark is one character.

Words: characters divided by [SPACE] are automatically interpreted as a word. Note that punctuation marks like a dot or a comma will count as a part of the Word AOI.

Sentences - A sentence is an array of words ending with a period, question mark, or an exclamation mark (and a space if there are other words after it). You can also create a sentence by using a line break (pressing ENTER).

The Chinese character "。" also marks an array of words combining to form a sentence (and a space if there are other words after it).

The AOIs will be created and visible once they are generated. You can hide them or change the color individually for each AOI the same way you would do for Manual AOIs.

To remove the Automatic AOIs click **Remove**. All Automatic AOIs on the selected level will be removed from this Text stimulus. Automatic AOIs can be regenerated and removed as many times as needed.

Automatic AOIs can not be imported or exported.

AOI tag groups and tags work for Automatic AOIs.

For more information, read Text stimulus (Reading studies and instruction).

8.8 Analyze a Screen Recording

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

- When you want to analyze a screen recording, you can log events, just like for any other type of recording. For more information, read Replay tools.
- When you want to aggregate data and create visualizations such as heat maps and gaze plots, you can create TOIs with frames. For more information, read Replay tools.
- 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”. For more information, read Dynamic AOIs.

9 Metrics

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 need to 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 a stimulus on the screen, a section of a trial, the time between when a stimulus 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.

9.1 Metric export formats

There are four kinds of Metric export formats in Pro Lab:

Interval-based TSV file

Use this format when you want to analyze your data at the TOI interval level. If you want to analyze the metrics data in a statistical analysis software, like R/SPSS/MATLAB etc. 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 contain calculations for the actual Times of Interval.

AOI-based TSV file

This format is preferred for an analysis where you want to have AOI as a grouping factor and thus the AOI name as its own column and gaze metric in their own columns. Every AOI for every interval for every recording gets its own row.

Event-based TSV file

Use this format when you want to analyze individual events during an interval. Each fixation will generate a row in the report and the selected metrics will be shown as columns. Like the Interval-based TSV file it is formated to be easily to import and analyse in statistical analysis software.

Excel report (.xlsx)

This format is compatible with most spreadsheet software such as Microsoft Excel (2007 and newer), 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. The data in this export is highly aggregated and is intended to use "as is." It is therefore not the best choice for further analysis in statistical software platforms such as R or SPSS.

9.1.1 Export 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. For more information, read Export metrics data to a file and Understand the metrics.

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 in the **Settings** panel. Select one of the three formats. For more information, read Export metrics data to a file
3. Select which Gaze Filter you want to apply to the data you will export. For more information, read Gaze Filter functions and effects.
4. 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 Interest**: 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 using the checkboxes.
      AOIs can also be selected by tags. To do this, select the tags in the drop-down menu "Select by tag" in the Areas of Interest section. All the AOIs associated with the selected tags will be selected automatically in the AOI selection tree. Deselecting one or several of the automatically selected AOIs will remove those tags from the list of selected tags in the Select by tag section. Note: Removing tags from the list will deselect the associated AOIs even if they were selected manually before using the Selected by tag option.

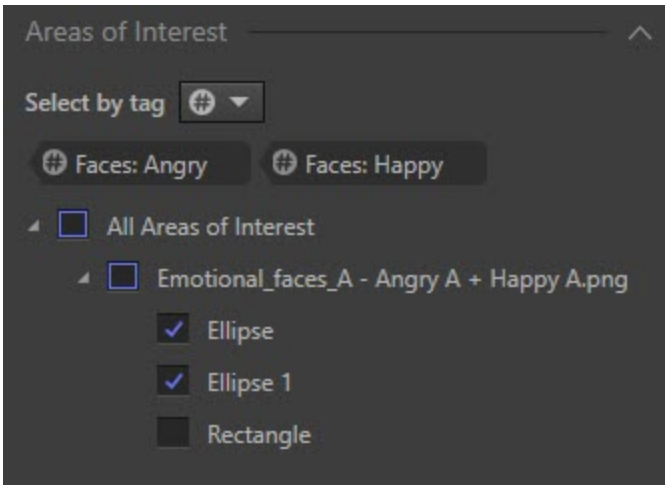


Figure 15. Click the drop-down arrow to select by tag in the Areas of Interest side panel

- **Tags**: Tags are labels given to AOIs, and these have two purposes. The first is aggregation of data across different AOIs. The second is carrying meta data to be used in analysis. For aggregation, select the tags in the Data Selection panel on the right. Every selected tag will function as its own AOI, so if you only want the aggregated AOIs in the metrics export the individual AOIs should not be selected. Note that the Select by tag function does not apply to AOI Tags selection.To include tags as metadata (will be added as a separate column) select *AOI Tags* in the metrics selection panel on the left.
- **Events**: you can select the recording custom events to include in the Event and interval metrics.

5. Select the metrics you want to include in the export (the selection varies depending on what you chose in step 2).
6. Use the **Select All** toggle to select or deselect all the metrics. Use the up and down arrows in the metric export selection list to collapse (hide) entire sections in the list.
7. Click the **Export** button at the top of the Metrics Export window.
8. In the file browser, locate the folder in which you want to save the file.
9. In the File name field, enter a file name for your exported file.
10. Click **Save**.

9.2 Understand the metrics

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 were very inclusive, in that they included all fixations in that Time of Interest (and Area of Interest). All fixations means both whole and partial fixations.

Whole events

An event that starts and stops within the given interval, and is not disrupted by unknown events or data loss at the beginning or end of the event. If any of these two criteria are fulfilled, then it is counted as a whole event.

Partial events

Events that do not fulfill the criteria for whole events are partial events.

Examples of partial events:

- the saccade starts before the interval starts, and stops inside the interval. In this case, there is ambiguity in how to treat this event. It has data outside of the interval you want to analyse, so it is not given that data outside the interval should be considered at all. At the same time, a key part of that event, e.g. the peak velocity, could happen outside of the interval yet be relevant to the entire event.
- A fixation starts before the interval starts. The duration of the fixation is ambiguous as a result. Should it be the time of the fixations that it has spent on the stimulus in question (current interval), or should it be the entire duration of the fixation?
- A fixation is followed by a saccade, but this saccade is interrupted by data loss. In this case, the end of the saccade is uncertain, because we cannot know whether the data samples lost were part of the saccade, or the subsequent event. Considering this ambiguity, this saccade is labelled as a partial event.

For eye movement researchers interested in fixations and saccades as such, it is important to distinguish between whole and partial events in order to exclude partial events from their studies.

For example, a whole saccade had a certain amplitude (e.g. 20 degrees). If it is cut by the TOI interval start (producing a partial saccade) the amplitude may shows 8 degrees, it can't be used and should be discarded.

On the other hand, for researchers interested in attention and visual exposure rather than eye movements per se, it is perfectly fine to include partial events.

For example, if an advertisement is suddenly shown (new stimulus) it will be seen and the event can be used, even if the stimulus-interval cuts an ongoing fixation.

Criteria for whole saccades

In order for a saccade to be labelled whole it must fulfil the following criteria:

- A saccade must be preceded and succeeded by a fixation event.

In addition, for the Interval-based export format, partial events pose additional problems as the metrics aggregate all events in an interval. For example, if the amplitude of a partial saccade (cut by the border of the TOI) is included in the calculation of "average amplitude of saccades", the result will be a lower average. This may lead to the wrong conclusion about the average length of saccades in the interval.

To avoid this risk, the following criteria applies for saccades in the interval-based TSV export format:

- A saccade must be wholly contained in the time of interest.

In the Interval- and AOI-based export format partial saccades are excluded from the metric calculation. In the Event-based export format partial saccades are shown as "partial" in the validity column. It is up to the individual researcher to exclude these events if needed.

Criteria for whole fixations

Some researchers are interested in both the saccades and fixations that occur in the same TOI.

For example, research suggests that 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 to follow the same strict definition as saccades.

Therefore, we also allow the export of “whole fixations”(i.e. "exclude partial fixations"). must fulfil the following criteria:

- 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 AOI metrics that exclude partial fixations there is an additional criteria.

- The whole fixation duration must be contained within the AOI

These metrics are found in the Interval- and AOI-based export format.

9.3 Reading metrics

In the example below, you can see a sample gaze path (fixation sequence) and a table showing the AOI word metrics available in Tobii Pro Lab (starting with version 1.162) for this specific sentence example: "The brown fox jumped over the fence despite me shouting."

- *(blank)* – means that the value will be an empty cell when the metrics are exported.
- *Numeric values* (1,0, …) refer to the actual value in the metrics export file.

- *Fixation bubbles* (1 2) mean that, in order to calculate the metric value, you need to add the duration of the fixations of the respective order number.
- *String metrics* are the actual values in the metrics export file.

The "Total duration of fixations" metric in the AOI reading metrics group (as seen in the table below) differs from the "Total duration of fixations" in the AOI fixation metrics group in the following ways:

- It can be calculated for Automatic AOIs (generated on a Text stimulus) only
- It equals “0” for skipped AOIs and gives blank values for AOIs that were never reached

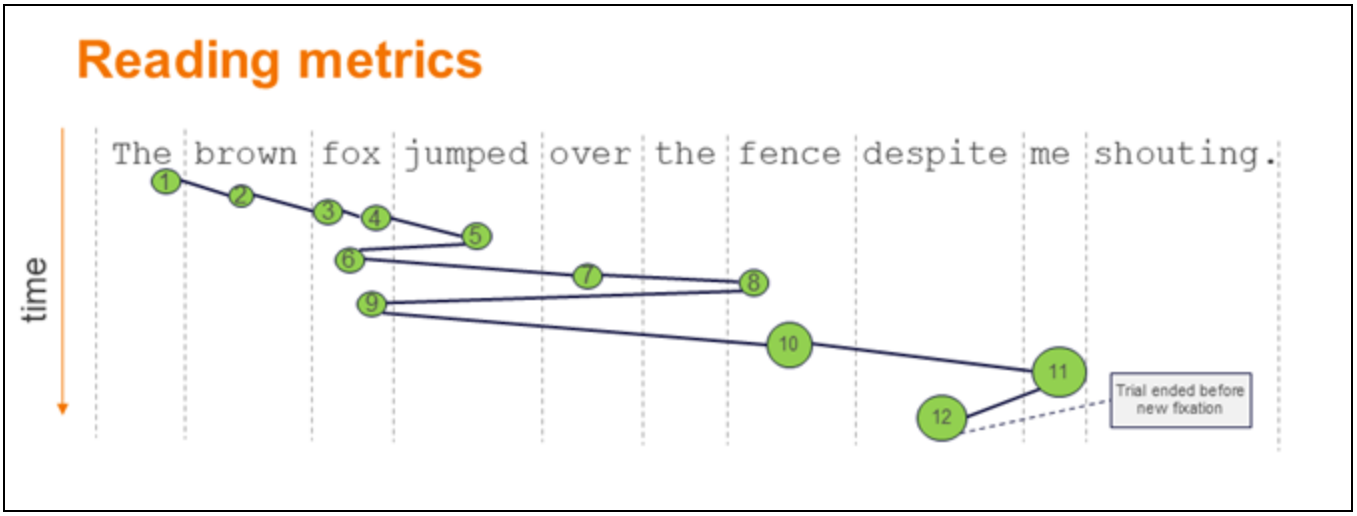


Figure 16. Sample gaze path (fixation sequence)

Metric name										
Character index	(blank)	(blank)	(blank)	(blank)	(blank)	(blank)	(blank)	(blank)	(blank)	(blank)
Word index	1	2	3	4	5	6	7	8	9	10
Sentence index	1	1	1	1	1	1	1	1	1	1
AOI string	**The**	**brown**	**fox**	**jumped**	**over**	**the**	**fence**	**despite**	**me**	**shouting.**
Text unit type	Word	Word	Word	Word	Word	Word	Word	Word	Word	Word
Number of units	3	5	3	6	4	3	5	7	2	9
First-pass first fixation duration	1	2	3	5	7	0	8	0	11	(blank)
First-pass duration	1	2	3+4	5	7	0	8	0	11	(blank)
Go-past duration	1	2	3+4	5	7	0	8+10	0	11	(blank)
First-pass regression	0	0	0	1	0	(blank)	1	(blank)	1	(blank)
Total duration of fixations	1	2	3+4+6+9	5	7	0	8+10	12	11	(blank)
Regression-path duration	1	2	3+4	5+6	7	0	8+9+10	0	11+12	(blank)
Re-reading duration	0	0	0	6	0	0	9+10	0	12	(blank)

Figure 17. This table shows all the AOI reading metrics for the sentence example

9.4 Interval-based, AOI-based, and Event-based TSV files

The metrics available for export in the Interval, AOI, and Event-based TSV file formats are shown in the tables below. An interval corresponds to one occurrence of a specific TOI. A TOI can occur multiple times during a recording which means there are multiple intervals. Events-based metrics refers the format where one row corresponds to one eye-movement event, as identified by the Gaze Filter in the top-right corner of the Metrics Export view. Currently, only fixations are supported.

9.5 Interval-based TSV file

The metrics available for export in the Interval-based TSV file formats 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.

Byte Order Marks (BOM) flags are removed in .tsv files. If you have scripts that rely on this flag, be sure to update them.

General

Metric name	Description	Unit
Recording name	Recording name	
Participant	Participant	
Participant variables	Variable value, or values, of the participant. One column for each participant variable.	
Timeline name	Timeline name	
TOI	The name of the current Time of Interest.	
Interval	The interval number of the current TOI interval.	
Media	The name of the media presented to the participant.	
Stimulus variables	Stimulus variable value or values of the stimulus. One column for each Stimulus variable.	

Interval metrics

Metric name	Description	Unit
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	Unit
Number of Events	The number of Events, including Custom Events and Logged live Events, for an interval.	Count
Time to first Event	The time to the first Event, including Custom Events and Logged live Events, for an interval.	Milliseconds

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 an interval (or an occurrence) of the TOI in separate rows in the exported spreadsheet.

Metric name	Description	Unit
Total duration of fixations	The total duration of the fixations inside an AOI during an interval.	Milliseconds
Average duration of fixations	The average duration of the fixations inside an AOI during an interval.	Milliseconds
Minimum duration of fixations	The duration of the shortest fixation inside an AOI during an interval.	Milliseconds
Maximum duration of fixations	The duration of the longest fixation inside an AOI during an interval.	Milliseconds
Number of fixations	The number of fixations occurring in an AOI during an interval.	Count
Time to first fixation	The time to the first fixation inside an AOI during an interval.	Milliseconds
Duration of first fixation	The duration of the first fixation inside an AOI during an interval.	Milliseconds

AOI fixation metrics (exclude partial fixations)

These metrics exclude fixations that don't fulfill the criteria for whole fixations (see previous section).

Metric name	Description	Unit
Total duration of whole fixations	The total duration of the fixations inside an AOI during an interval.	Milliseconds
Average duration of whole fixations	The average duration of the fixations inside an AOI during an interval.	Milliseconds
Minimum duration of whole fixations	The duration of the shortest fixation inside an AOI during an interval.	Milliseconds
Maximum duration of whole fixations	The duration of the longest fixation inside an AOI during an interval.	Milliseconds
Number of whole fixations	The number of fixations occurring in an AOI during an interval.	Number
Time to first whole fixation	The time to the first fixation inside an AOI during an interval.	Milliseconds
Duration of first whole 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	Unit
Total duration of Visit	The total duration of the Visits inside an AOI during an interval.	Milliseconds
Average duration of Visit	The average duration of the Visits insidean AOI during an interval.	Milliseconds
Minimum duration of Visit	The duration of the shortest Visit inside an AOI during an interval.	Milliseconds
Maximum duration of Visit	The duration of the longest Visit inside an AOI during an interval.	Milliseconds
Number of Visits	The number of Visits occurring in an AOI during an interval.	Count
Time to first Visit	Time in milliseconds to the first Visit inside an AOI during an interval.	Milliseconds
Duration of first Visit	The duration of the first Visit inside an AOI during an interval.	Milliseconds

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	Unit
Total duration of Glances	The total duration of the Glances inside an AOI during an interval.	Milliseconds
Average duration of Glances	The average duration of the Glances inside an AOI during an interval.	Milliseconds
Minimum duration of Glances	The duration of the shortest Glance inside an AOI during an interval.	Milliseconds
Maximum duration of Glances	The duration of the longest Glance inside an AOI during an interval.	Milliseconds
Number of Glances	The number of Glances occurring in an AOI during an interval.	Count
Time to first Glance	Time in milliseconds to the first Glance inside this area of interest during an interval.	Milliseconds
Duration of first Glance	The duration of the first Glance inside this area of interest during an interval.	Milliseconds

AOI Click metrics

All AOI Click metrics are based on the primary (left or right, depending on the Windows settings) button clicks only. By default, it is most commonly the left button.

A mouse click itself is a combination of two events - MouseEvent Down & MouseEvent Up where both have their timestamps and position. (Read Screen project-specific Event groups: for more information.)There are two sets of metrics related to mouse clicks:

- **Clicks**: computed based on MouseEvent Down events only
- **Clicks & Releases**: takes both MouseEvent Down & MouseEvent Up events into account

Click & Release in Pro Lab counts only if both events spatially happened inside an AOI or a group of AOIs labeled by the same tag in case of AOI tag selection (even if MouseEvent Up and MouseEvent Down events happened in two different AOIs labeled by the same tag) and MouseEvent Down event occurred in a TOI interval.

All Click & Release temporal (time) metrics are computed (in milliseconds)based on the timestamp of the MouseEvent Down event.



The definition of *Clicks* changed in version 1.162. In the versions 1.152 and earlier, *Clicks* were what we now call *Clicks & Releases*.

Metric name	Description	Unit
Number of mouse clicks	The number of times the mouse button is pressed in an AOI during an interval.	Count
Time to first mouse click	The time to when the mouse button is pressed insidean AOI during an interval.	Milliseconds
Time from first fixation to mouse click	The time from the first fixation to when the mouse button is pressed insidean AOI during an interval.	Milliseconds
Number of mouse clicks & releases	The number of times the mouse button was both pressed and released in the same AOI during an interval.	Count
Time to first mouse click & release	The time to the first mouse button is pressed the first time inside an AOI during an interval.	Milliseconds
Time from first fixation to mouse click & release	The time from first fixation to the first time the mouse button is pressed inside anAOI during an interval. This metric requires the mouse button is also released inside the same AOI.	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 specific ER-SCR.

Metric name	Description	Unit
Average GSR	The average galvanic skin response (GSR) signal, after filtering, for an interval.	Microsiemens
Number of SCR	The number of skin conductance responses (SCRs) for an interval.	Count
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

Fixation metrics (exclude partial fixations)

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 sta- tistics based on the fixations within an AOI. They present as an interval (or an occurrence) of the TOI in separate rows in the exported spreadsheet.

Metric name	Description	Unit
Total duration of whole fixations	The total duration of the fixations during an interval.	Milliseconds
Average duration of whole fixations	The average duration of the fixations during an interval.	Milliseconds
Number of whole fixations	The number of whole fixations occuring during an interval.	Count
Duration of first whole fixation	The duration of the first fixation during an interval.	Milliseconds

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.

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	Unit
Number of saccades	The number of saccades occurring during an interval.	Count
Average peak velocity of saccades	The average peak velocity of all saccades in this interval.	Degrees/second
Minimum peak velocity of saccades	The peak velocity of the saccade with the lowest peak velocity in this interval.	Degrees/second
Maximum peak velocity of saccades	The peak velocity of the saccade with the highest peak velocity in this interval.	Degrees/second
Standard deviation of peak velocity of saccades	The standard deviation of all peak velocities of the saccades in this interval.	Degrees/second

Metric name	Description	Unit
Average amplitude of saccades	The average amplitude of all saccades in this interval.	Degrees
Minimum amplitude of saccades	The amplitude of the saccade with the lowest amplitude in this interval.	Degrees
Maximum amplitude of saccades	The amplitude of the saccade with the highest amplitude in this interval.	Degrees
Total amplitude of saccades	The total amplitude of all saccades in this interval.	Degrees
Time to first saccade	The time to the first saccade during an interval.	Milliseconds
Direction of first saccade	The direction of the first saccade in the interval.	Degrees
Peak velocity of first saccade	The peak velocity of the first saccade in the interval.	Degrees/second
Average velocity of first saccade	The average velocity of the first saccade in the interval.	Degrees/second
Amplitude of first saccade	The amplitude of the first saccade in the interval.	Degrees

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	Unit
Number of saccades in AOI	The number of saccades occurring in an AOI during an interval.	Count
Time to entry saccade	The duration until the start of the first saccade that ends in an AOI during an interval.	Milliseconds
Time to exit saccade	The duration until the start of the first saccade that exits an AOI during an interval.	Milliseconds
Peak velocity of entry saccade	The peak velocity of the first saccade that ends inan AOI during an interval.	Degrees/second
Peak velocity of exit saccade	The peak velocity of the first saccade that exits an AOI during an interval.	Degrees/second

9.6 AOI-based TSV file

General

Metric name	Description	Unit
Recording name		
Participant	Participant	

Metric name	Description	Unit
Participant variables	Variable value, or values, of the participant. One column for each participant variable.	
Timeline name		
TOI	The name of the current Time of Interest.	
Interval	The interval number of the current TOI interval.	
Media	The name of the media presented to the participant.	
Stimulus variables	Stimulus variable value or values of the stimulus. One column for each Stimulus variable.	
AOI	The Area of Interest name of the current row.	
AOI Tags	The name or names of Tags connected to the AOI. One column for each Tag group and one for Ungrouped tags.	

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 an interval (or an occurrence) of the TOI in separate rows in the exported spreadsheet.

Metric name	Description	Unit
Total duration of fixations	The total duration of the fixations inside an AOI during an interval.	Milliseconds
Average duration of fixations	The average duration of the fixations inside an AOI during an interval.	Milliseconds
Minimum duration of fixations	The duration of the shortest fixation insidean AOI during an interval.	Milliseconds
Maximum duration of fixations	The duration of the longest fixation insidean AOI during an interval.	Milliseconds
Number of fixations	The number of fixations occurring in an AOI during an interval.	Count
Time to first fixation	The time to the first fixation inside an AOI during an interval.	Milliseconds
Duration of first fixation	The duration of the first fixation inside an AOI during an interval.	Milliseconds

AOI fixation metrics (exclude partial fixations)

These metrics exclude fixations that don't fulfill the criteria for whole fixations (see previous section).

Metric name	Description	Unit
Total duration of whole fixations	The total duration of the fixations inside an AOI during an interval.	Milliseconds
Average duration of whole fixations	The average duration of the fixations inside an AOI during an interval.	Milliseconds

Metric name	Description	Unit
Minimum duration of whole fixations	The duration of the shortest fixation insidean AOI during an interval.	Milliseconds
Maximum duration of whole fixations	The duration of the longest fixation insidean AOI-during an interval.	Milliseconds
Number of whole fixations	The number of fixations occurring inan AOI during an interval.	Count
Time to first whole fixation	The time to the first fixation insidean AOI during an interval.	Milliseconds
Duration of first whole fixation	The duration of the first fixation insidean AOI 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	Unit
Total duration of Visit	The total duration of the Visits insidean AOI during an interval.	Milliseconds
Average duration of Visit	The average duration of the Visits insidean AOI during an interval.	Milliseconds
Minimum duration of Visit	The duration of the shortest Visit insidean AOI during an interval.	Milliseconds
Maximum duration of Visit	The duration of the longest Visit insidean AOI during an interval.	Milliseconds
Number of Visits	The number of Visits occurring inan AOI during an interval.	Count
Time to first Visit	Time in milliseconds to the first Visit inside an AOI during an interval.	Milliseconds
Duration of first Visit	The duration of the first Visit insidean AOI during an interval.	Milliseconds

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	Unit
Total duration of Glances	The total duration of the Glances insidean AOI during an interval.	Milliseconds

Metric name	Description	Unit
Average duration of Glances	The average duration of the Glances inside an AOI during an interval.	Milliseconds
Minimum duration of Glances	The duration of the shortest Glance insidean AOI during an interval.	Milliseconds
Maximum duration of Glances	The duration of the longest Glance insidean AOI during an interval.	Milliseconds
Number of Glances	The number of Glances occurring inan AOI during an interval.	Count
Time to first Glance	Time in milliseconds to the first Glance inside an AOI during an interval.	Milliseconds
Duration of first Glance	The duration of the first Glance insidean AOI during an interval.	Milliseconds

AOI Click metrics

All AOI Click metrics are based on the primary (left or right, depending on the Windows settings) button clicks only. By default, it is most commonly the left button.

A mouse click itself is a combination of two events - MouseEvent Down & MouseEvent Up where both have their timestamps and position. (Read Screen project-specific Event groups: for more information.)There are two sets of metrics related to mouse clicks:

- **Clicks**: computed based on MouseEvent Down events only
- **Clicks & Releases**: takes both MouseEvent Down & MouseEvent Up events into account

Click & Release in Pro Lab counts only if both events spatially happened inside an AOI or a group of AOIs labeled by the same tag in case of AOI tag selection (even if MouseEvent Up and MouseEvent Down events happened in two different AOIs labeled by the same tag) and MouseEvent Down event occurred in a TOI interval.

All Click & Release temporal (time) metrics are computed (in milliseconds)based on the timestamp of the MouseEvent Down event.



The definition of "Clicks" changed in version 1.162. "Clicks & Releases" was called simply "Clicks" in earlier versions.

Metric name	Description	Unit
Number of mouse clicks	The number of times the mouse button is pressed in an AOI during an interval.	Count
Time to first mouse click	The time to when the mouse button is pressed inside an AOI during an interval.	Milliseconds
Time from first fixation to mouse click	The time from the first fixation to the first time the mouse button is pressed inside an AOI during an interval.	Milliseconds
Number of mouse clicks & releases	The number of times the mouse button was both pressed and released in the same AOI during an interval.	Count

Metric name	Description	Unit
Time to first mouse click & release	The time to when the mouse button is pressed inside an AOI during an interval. This metric requires the mouse button is also released inside the same AOI.	Milliseconds
Time from first fixation to mouse click & release	The time from the first fixation to the first time the mouse button is pressed inside an AOI during an interval. This metric requires the mouse button is released inside the same AOI.	Milliseconds

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	Unit
Number of saccades in AOI	The number of saccades occurring in an AOI during an interval.	Count
Time to entry saccade	The duration until the start of the first saccade that ends in an AOI during an interval.	Milliseconds
Time to exit saccade	The duration until the start of the first saccade that exits an AOI during an interval.	Milliseconds
Peak velocity of entry saccade	The peak velocity of the first saccade that ends in an AOI during an interval.	Degrees/second
Peak velocity of exit saccade	The peak velocity of the first saccade that exits an AOI during an interval.	Degrees/second

AOI reading metrics

AOI reading metrics are only available for text stimuli and are AOI-based metrics on Automatic AOIs, generated for a text stimulus.

These metrics follow the writing system order. AOI1 comes before AOI2 which comes before AOI3, etc. (This determines the occurrence of regressions, progression, and skipping). Metrics for AOIn are computed using other AOIs as well (AOIn-2, AOIn-1, AOIn+1). The AOI-selection determines what gets displayed in the data but if the calculations use the data from adjacent AOIs (even if they are not selected) the calculations will still be correct.

AOIs have 3 different levels and all reading metrics are level dependent. Reading metrics on different level AOIs are computed independently from each other. Several Automatic reading-related AOIs can exist at the same time (with their own AOI order):

- Character AOIs
- Word AOIs
- Sentence AOIs

Reading metrics are based only on fixations.

- A regression/progression is determined if there is a fixation afterwards on an area of interest with a respective lower/higher index of the same level (Word, Character, Sentence) regardless of the direction of the saccade itself.
- If the trial/interval ends in the middle of a saccade that would have resulted in a fixation in a regressive position, it will not count as a regression.

Non-AOI data is ignored.

- Fixations landing outside of text AOIs are disregarded, and will not contribute to any metrics calculation, nor terminate any metric calculation.
- A fixation in an AOI, followed by a fixation outside of it, and then followed by a fixation inside the AOI again, will be equivalent to having two fixations in the AOI directly followed by each other. Both fixations in the AOI will count as part of the same pass.

Metric name	Description	Unit
Character index	Index of character-level AOI inside its word-level AOI.	Position
Word index	Index of word-level AOI inside its sentence-level AOI.	Position
Sentence index	Index of sentence-level AOI inside this text stimulus.	Position
AOI string	Text string contained in an AOI.	
Text unit type	Type of text unit: character, word, sentence, or custom.	
Number of units	Number of units.	Count
First-pass first fixation duration	The duration of the first fixation during first-pass inside an AOI during an interval.	Milliseconds
First-pass duration	The total duration of the fixations during first-pass inside an AOI during an interval.	Milliseconds
Go-past duration	The total duration of the fixations from first fixation in this area of interest until a fixation occurs in an area of interest progressive to this one, during an interval.	Milliseconds
First pass regression	Indicates whether the reader exits the AOI with a regression (1) or reads on progressively (0) during an interval.	Boolean
Total duration of fixations	The total duration of the fixations inside an AOI during an interval.	Milliseconds
Regression-path duration	The total duration of the fixations from first fixation in this area of interest until a fixation occurs in an AOI progressive to this one, including fixations in regressive AOIs, during an interval.	Milliseconds

Re-reading duration	Regression path duration excluding first pass fixations during an interval.	Milliseconds

9.7 Event-based TSV file

Use this format when you want to analyze individual events during a trial or interval. Each fixation will generate a row in the report and the selected metrics will be shown as columns. Just like the Interval-based TSV file, it is formatted to be easy to import and analyze in statistical analysis software.

General

Metric name	Description	Unit
Recording name	Recording name	
Participant	Participant	
Participant variables	Variable value, or values, of the participant. One column for each participant variable.	
Timeline name	Timeline name	
TOI	The name of the current Time of Interest.	
Interval	The interval number of the current TOI interval.	
Bin duration	The duration of the current bin.	Milliseconds
Media	The name of the media presented to the participant.	
Stimulus variables	Stimulus variable value or values of the stimulus. One column for each Stimulus variable.	
AOI Tags	The name or names of Tags connected to the AOI. One column for each Tag group and one for Ungrouped tags.	

Event properties

These properties are shared for all events types that are covered by the event-based metrics. Currently, only fixations are supported.

Metric name	Description	Unit
Event type	The type of event of the current row.	Fixation; Saccade
Validity	The validity of the event of the row, either whole or partial.	Partial; Whole
EventIndex	Represents the order of the events in the current TOI interval. The index is an auto-increment number starting with 1 for each event type.	Position
Start bin	The bin the event starts in.	Count
Stop bin	The bin the event ends in.	Count
Duration	The duration of the event.	Milliseconds

Fixation properties

Information specific to each fixation as well as to the general event properties.

Metric name	Description	Unit
AOI	The name of the AOI (s) which the current fixation hits.	
AOI proportion	The proportion of the fixation that occurs within the AOI.	
Fixation point	The normalized horizontal and vertical coordinate of the fixation point.	Normalized coordinates
Average pupil size	The average size of the pupil of the fixation. Note: If the fixation is cut by TOI interval borders, only the gaze samples within the TOI are included.	Millimeters

9.8 Excel Report

General

Metric name	Description	Unit
Recording name	Recording name	
Participant	Participant	
Participant variables	Variable value or values of the participant. One column for each participant variable	
TOI	The name of the current Time of Interest.	
Interval	The interval number of the current TOI interval.	

Interval metrics

Metric name	Description	Unit
Duration of interval	The duration of all time Intervals for each Time of Interest, with averages, medians, sums, counts, variances and standard deviations (n-1).	Seconds
Start of interval	The start time of all time Intervals for each Time of Interest, with averages, medians, counts, variances, and standard deviations (n-1).	Seconds

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	Unit
Number of Events	The number of Events, including Custom Events 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.	Count

Metric name	Description	Unit
Number of Events (include zeroes)	The number of Events, including Custom Events and Logged live Events, for each Time of Interest, with averages, medians, counts, variances, and standard deviations (n-1). Descriptive statistics also include recordings where no Events occur.	Count
Time to first Event	The time to 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

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 an interval (or an occurrence) of the TOI in separate rows in the exported spreadsheet.

Metric name	Description	Unit
Total duration of fixation in AOI	The total time each participant has fixated each AOI on all Media, with averages, medians, sums, variances, and standard deviations (n-1); the share of total time spent in each AOI out of all AOIs; and the percentage of Participants that fixated within each AOI at least once. Descriptive statistics 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 each AOI on all Media, with averages, medians, sums, variances, and standard deviations (n-1); the share of total time spent in 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 0 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

Metric name	Description	Unit
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 Recording Durations. Descriptive statistics only based on Recordings with fixations within the AOIs.	Count
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 Recording Durations. Descriptive statistics also include Recordings with 0 fixations within the AOIs.	Count
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

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	Unit
Total duration of Visit	The total time each participant has visited each AOI on all Media, with averages, medians, sums, variances, and standard deviations (n-1); 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, sums, variances, and standard deviations (n-1); 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 0 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, medians, variances, and standard deviations (n-1); and the percentage of Participants that fixated within each AOI at least once. Descriptive statistics only based on Recordings with fixations within the AOIs.	Count
Number of Visits (include zeroes)	The number of Visits within each AOI on all Media, with averages, medians, variances, and standard deviations (n-1); and the percentage of Participants that fixated within each AOI at least once. Descriptive statistics also include Recordings with 0 fixations within the AOIs.	Count

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	Unit
Number of clicks & releases in AOI	The number of times the mouse button is both pressed and released 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.	Count
Number of clicks & releases in AOI (include zeroes)	The number of times the mouse button is both pressed and released 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 0 clicks within the AOIs.	Count
Time to first click & release in AOI	The time to first mouse button is pressed for each AOI on all Media, with averages, medians, counts, variances, standard deviations (n-1) and Recording durations.This metric requires the mouse button is also released inside the same AOI.	Seconds
Time from first fixation to mouse click in AOI	The time from first fixation to next time the mouse button is pressed 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. This metric requires the mouse button is also released inside the same AOI.	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 specific ER-SCR.

Metric name	Description	Unit
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

Metric name	Description	Unit
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 does 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 (SCRs), for each Interval in Time of Interest, with averages, medians, counts, variances, and standard deviations (n-1).	Number

10 Data export

10.1 Export 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.

10.1.1 How to export data:

1. Click the **Data Export** button, either in the Project Overview section or select it form the **Analyze** drop-down menu in the top navigation.
2. Select which Gaze Filter you want to apply to the data you will export. For more information about Gaze Filters, read Gaze Filter functions and effects.
    - 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**.

10.2 Data Export formats

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). You can choose whether the timestamp shows milliseconds or microseconds. The timestamp starts at zero at the beginning of each recording. Since all recorded eye gaze data samples are recorded in a sequence, all eye gaze data points in a recording will have different timestamps. 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 tables list 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.

10.2.1 General

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External Presenter project
Project name	Project name	Text	●	●	●	●	●
Export date	Date when the Data Export is done.	YYYY-MM-DD	●	●	●	●	●
Participant name	Participant name	Text	●	●	●	●	●
Participant variables	Variable value or values of the participant.	Text	●	●	●	●	●
Recording name	Recording name	Text	●	●	●	●	●
Recording date	Date when the Recording was performed in this time zone.	YYYY-MM-DD	●	●	●	●	●
Recording date UTC	Date when the Recording was performed in UTC.	YYYY-MM-DD	●	●	●	●	●
Recording start time	Start time of the Recording in this time zone.	HH:MM:SS:FFF	●	●	●	●	●
Recording start time UTC	Start time of the Recording in UTC format	HH:MM:SS:FFF	●	●	●	●	●
Recording duration	Total duration of the recording	Milliseconds	●	●	●	●	●
Timeline name	Name of the Timeline used during the Recording.	Text	●	●		●	

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External Presenter project
Recording Fixation filter name	The name of the Fixation Filter applied to the Re- cording eye tracking data in the export.	Text	●	●	●	●	●
Recording soft- ware version	The version of the software used to make the Recording.	Text	●		●	●	●
Recording resolution	Screen resolution used during the Recording.	Pixels	●		●		●
Recording monitor latency	The monitor latency setting for the Recording. Stimulus start and end Event timestamps have been offset by this number to account for the monitor latency.	Milliseconds	●				●
Calibration results	Average accuracy and precision of calibration.	Millimeters, degrees and pixels.	●		●		●
Validation results	Average accuracy and precision of validation.	Millimeters, degrees and pixels.	●				
Eye tracker timestamp	The Recording timestamp in the eye tracker clock.	Microseconds	●		●		●
Event	Name of the Event.	Text	●	●	●	●	●
Event value	The event value.	Text	●	●	●	●	●

10.2.2 Eye tracking data

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External Presenter project
Gaze point 2D	Raw gaze coordinates for each eye individually.	Pixels (DACS)	●				●

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External Presenter project
Gaze point 2D	Raw gaze coordinates for both eyes combined.	Pixels (MCS)		●	●	●	
Gaze point 3D	The vergence point of left and right gaze vectors.	Millimeters (HUCS)		●			
Gaze direction	The unit vector for the direction of the gaze, for each eye individually.	Normalized coordinates (DACS)	●		●		●
Gaze direction	The unit vector for the direction of the gaze, for each eye individually.	Normalized coordinates (HUCS)		●		●	
Pupil position	The 3D coordinates of the pupil position for each eye individually.	Millimeters (HUCS)		●			
Pupil diameter	Estimated size of the pupils.	Millimeters	●	●	●	●	●
Validity of eye data	Indicates if the eyes have been correctly identified.	Valid/invalid	●	●	●	●	●
Eye position (DACSmm)	3D position of the eyes.	Millimeters (DACS)	●		●		●
Gaze point 2D (DACSmm)	Raw gaze coordinates for each eye individually.	Millimeters (DACS)	●				●
Gaze point (MCSnorm)	Raw gaze coordinates for each eye individual on the Media.	Normalize coordinates (MCS)	●		●		●
Assisted mapping gaze point	Assisted mapping gaze point coordinates.	Pixels (MCS)	●	●	●		●
Manually mapped gaze point	Manually mapped gaze point coordinates.	Pixels (MCS)	●	●	●		●

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External Presenter project
Mapped gaze point	The combination of the manually and assisted mapped gaze point coordinates. Manual mapping overrides assisted.	Pixels (MCS)	●	●	●		●
Assisted mapping gaze point score	Similarity score of assisted mapping gaze points.	Normalized	●	●	●		●

10.2.3 Media

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External presenter project
Presented Stimulus name	The name of the Stimulus being presented to the Participant.	Text	●			●	●
Presented Media name	The name of the Media presented to the Participant.	Text	●			●	●
Recording Media name	The name of the Recording Media.	Text		●			
Presented Media dimensions	The dimensions of the Media as presented on the screen to the Participant, including any scaling set in the Stimulus properties.	Pixels	●				●
Recording Media dimensions	The dimensions of the Recording Media.	Pixels		●			
Presented Media position	The position of the Media on the screen. The value represents the positions of the top left corner of the Media in relation to the top left corner of the screen.	Pixels (DACS)	●				●

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External presenter project
Original Media dimensions	The original size of the Media presented to the Participant.	Pixels	●			●	●
Media dimensions	The original size of the Snapshot.	Pixels	●	●	●		●

10.2.4 Gaze events

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External Presenter project
Mapped eye movement type	Type of eye movement event classified by the selected Fixation filter for mapped gaze data.	Fixation Saccade Unclassified EyesNotFound	●	●	●		●
Mapped eye movement type index	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.	Number	●	●	●		●
Mapped fixation point	Mapped fixation point. This column is affect by the settings of the Fixation Filter.	Pixels (MCS)	●	●	●		●
Eye movement type	Type of eye movement event classified by the fixation filter settings applied during the gaze data export.	Fixation Saccade Unclassified EyesNotFound	●	●	●	●	●
Gaze event duration	The duration of the currently active eye movement.	Milliseconds	●	●	●	●	●

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External Presenter project
Eye movement type index	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.	Number	●	●	●	●	●
Fixation point	Coordinates of the fixation point. This column is affected by the settings of the Fixation Filter.	Pixels (DACS)	●	●	●	●	●
Fixation point (MCSnorm)	Coordinates of the fixation point on the Media.	Normalized coordinates (MCS)	●				●
AOI hit	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.	Number	●	●	●	●	●

10.2.5 Web data

Data name	Description	Format/Units	Screen Project	Glasses project	Scene Camera project	VR 360 project	External presenter
Browser client area position	The position of a web browser's client area on the screen. The value represents the position of the top left corner of the client area in relation to the top left corner of the screen.	Pixels (DACS)	●				
Viewport position	The position of the visible area of a web page. The value represents the position of the top left corner of the visible area of a web page in relation to the full web page size.	Pixels	●				
Viewport dimensions	The dimensions of the visible area of a web page.	Pixels	●				
Full page size	The full size of the web page. Limited by 5000 px horizontally and 15000 px vertically.	Pixels	●				

10.2.6 Other sensor data

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External presenter project
Mouse position	The position of the mouse.	Pixels (DACS)	●				
Gyro	Rotation along the X, Y and Z axes.	Degrees/second (HUCS)		●			
Accelerometer	Acceleration along the X, Y and Z axes.	Meters/second^2 (HUCS)		●			
Magnetometer	Magnetic field along the X, Y and Z axes.	Microteslas (HUCS)		●			

Data name	Description	Format/Units	Screen project	Glasses project	Scene Camera project	VR 360 project	External presenter project
Galvanic skin response (GSR)	The raw galvanic skin response signal of the Participant.	Microsiemens	●		●	●	●
Head rotation	The coordinates of the participant's head rotation quaternion.	Normalized coordinates (WCS)				●	

10.3 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.

Appendix A Coordinate systems and data mapping

Pro Glasses 2 and Pro Glasses 3 use 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)

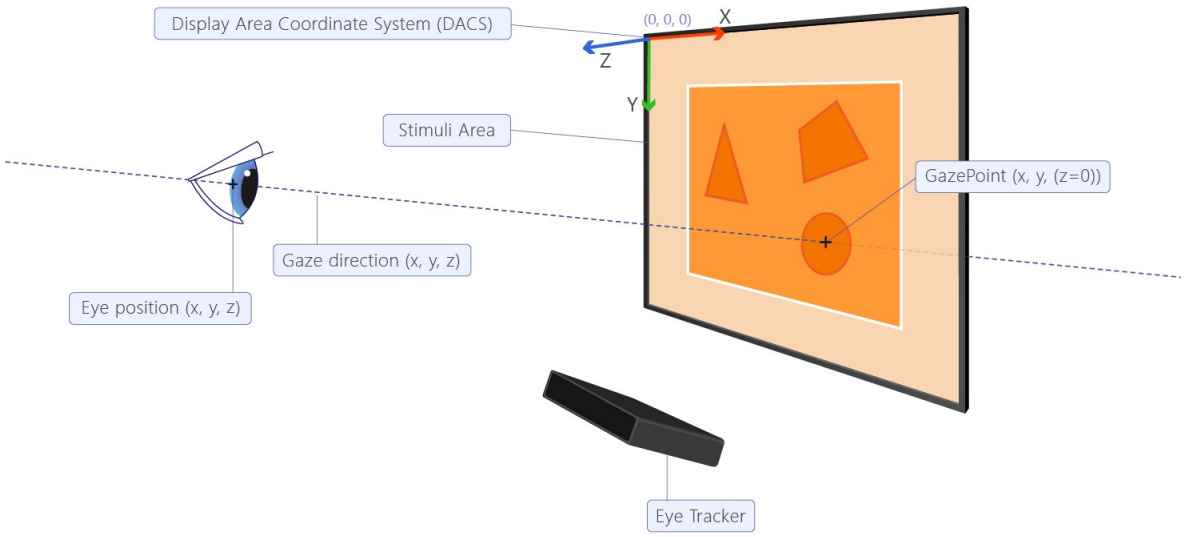


Figure 18. Display Area Coordinate System (DACS)

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.

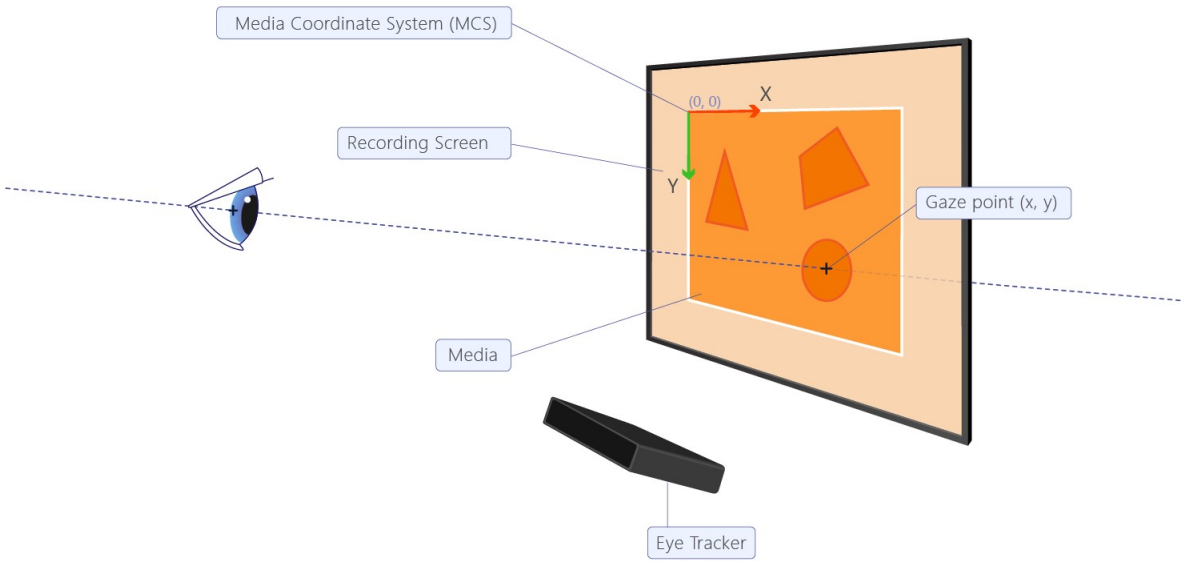


Figure 19. In a Screen project, the data is mapped onto what is seen on the screen.

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 (scene 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.

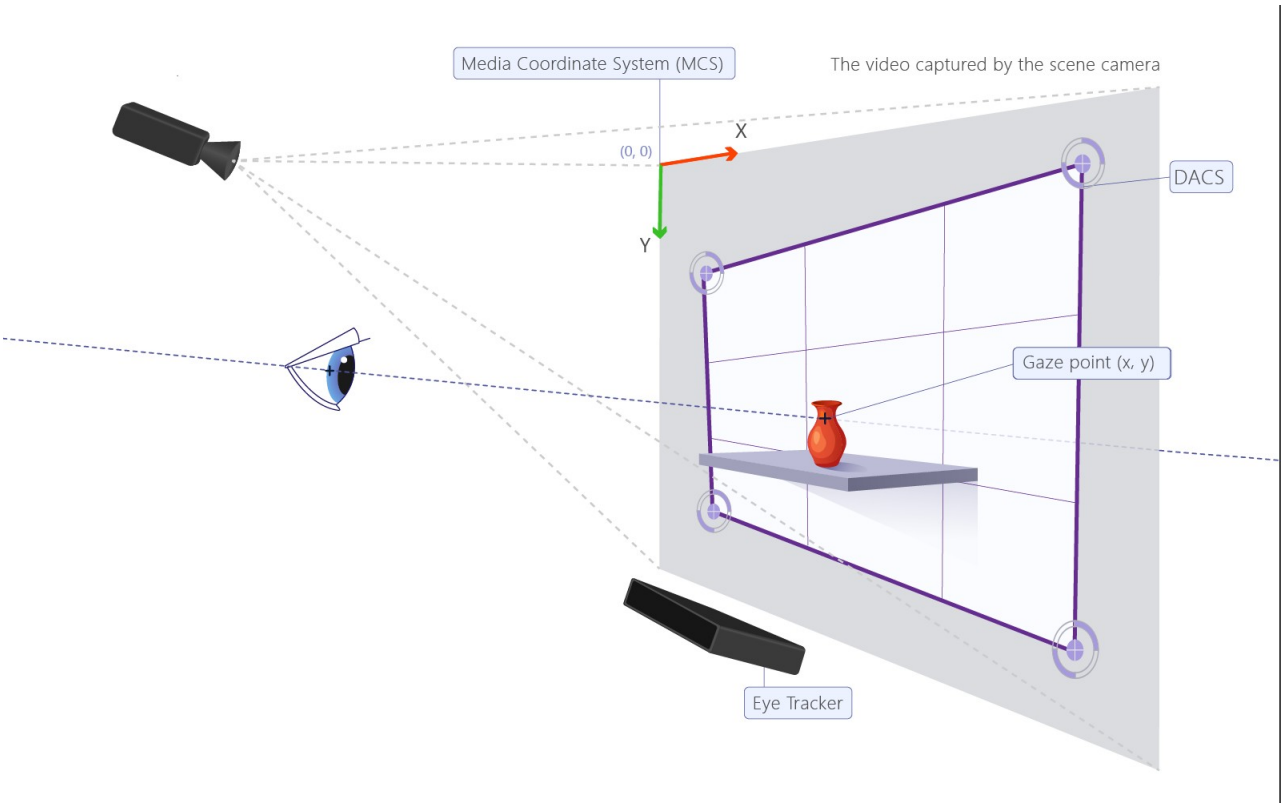


Figure 20. Scene Camera Projects and the Media Coordinate System (MCS)

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)

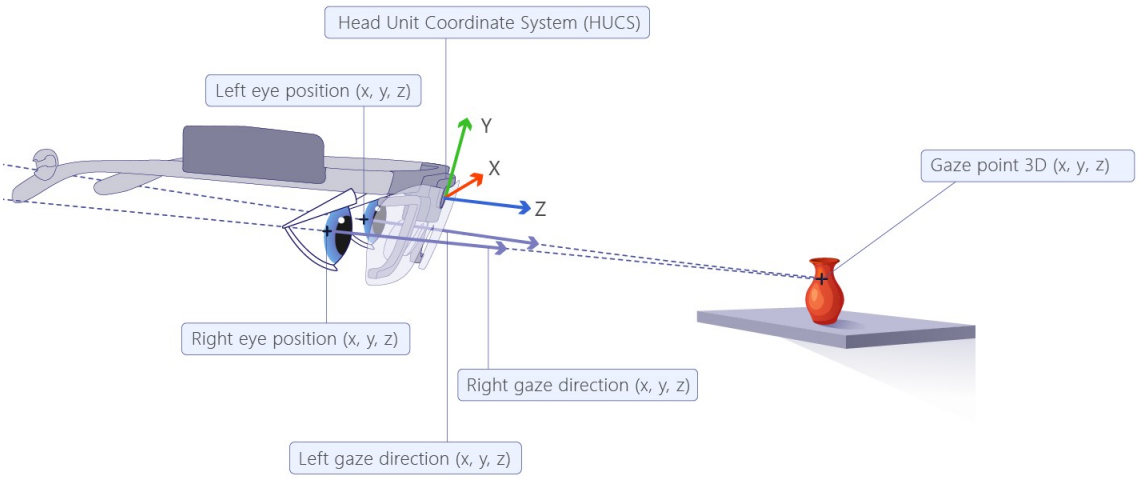


Figure 21. Head Unit Coordinate System (HUCS)

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).

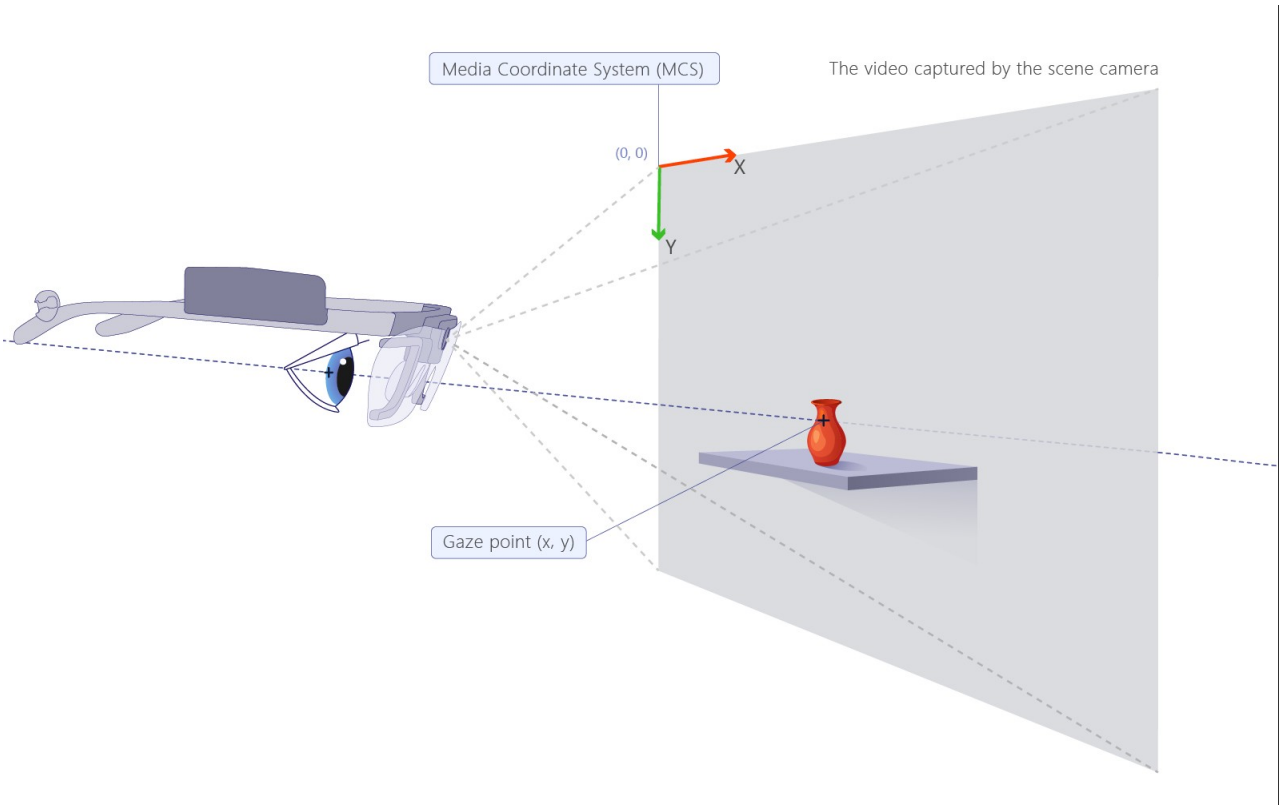


Figure 22. The glasses measures everything in a 3D coordinate system

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 Pro Lab, this will be exported as MCS in pixels or relative coordinates. There is no information about physical dimensions in the video.

A4 Map 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.

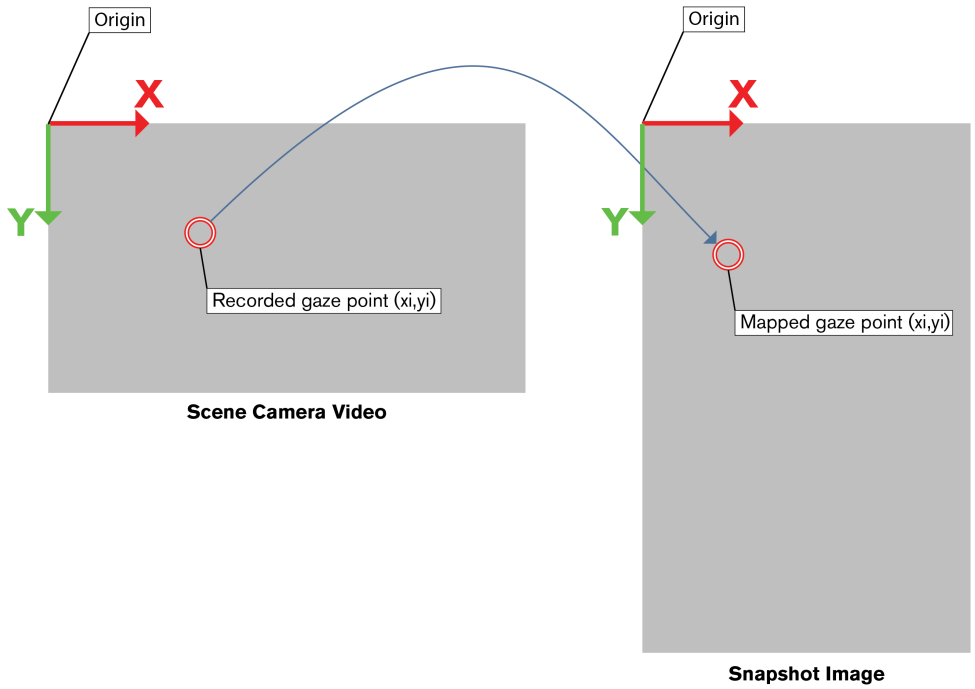


Figure 23. The coordinate system for recorded data in a Glasses project is based on the scene camera video in the Glasses

A5 Coordinate systems in VR 360 projects

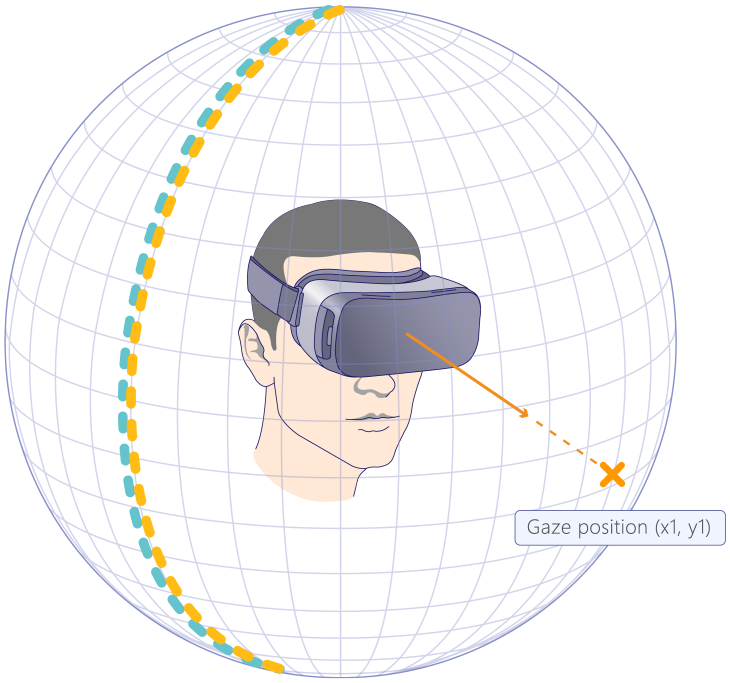


Figure 24. Coordinate systems in VR 360 projects

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)

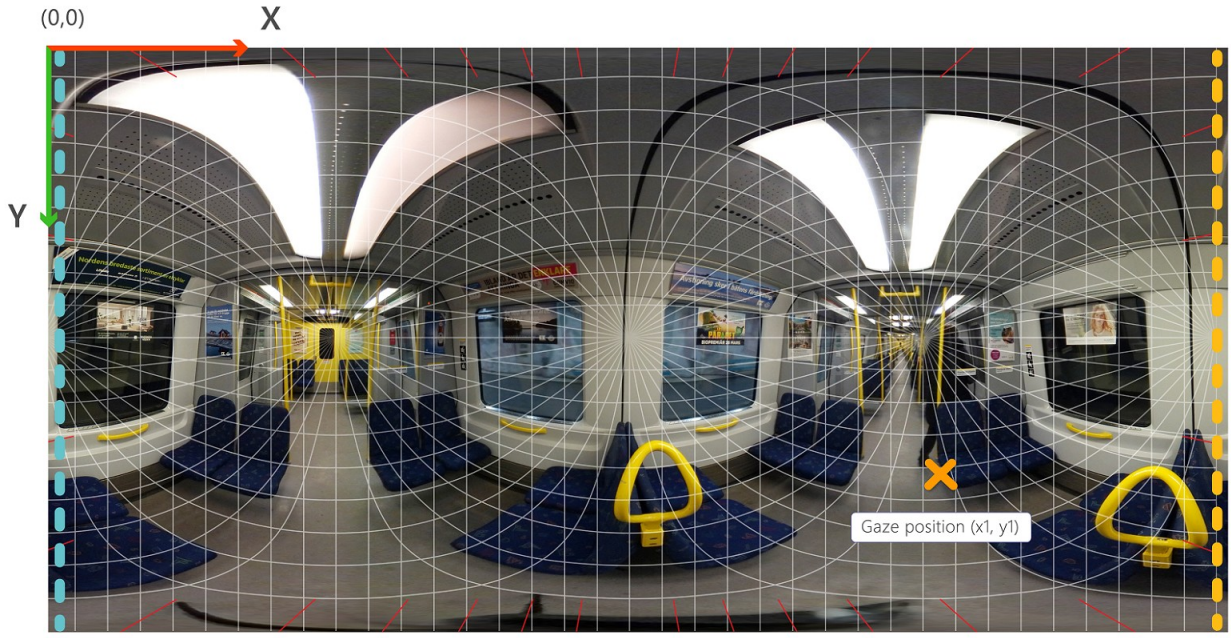


Figure 25. The DACS image is a representation of a sphere just as a Mercator projection makes it easier to depict the world map onto a flat surface

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)

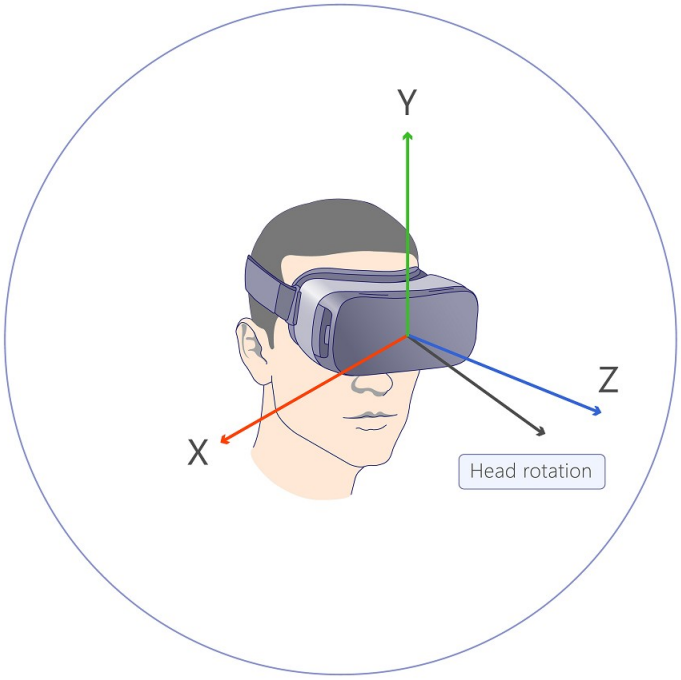


Figure 26. The Unity World Coordinate System is used for the head rotation data in Tobii Pro Lab Data Export

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 Filter functions and effects

During a recording, Tobii Pro eye trackers 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 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 drop-down 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 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 drop-down 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 and Pro Glasses 3 due to various factors. Read more about I-VT gaze filters in the Learn & Support section of the Tobii Pro website

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 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 or Pro Glasses 3 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 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 classified fixations that you believe have too short of a duration to be a meaningful fixation. These short fixations may result from head-movements, post-saccadic oscillations, or as inter-saccadic intervals when one saccade execution overrides another. If fixations are used in order to gauge in-depth processing of some visual information, it may make sense to exclude short fixations. The Discard short fixation function can be used to reclassify an incorrectly classified fixation into an Unknown event. That is, velocity-wise it is not a saccade, but duration-wise it is not a fixation either, consequently placing it in this third category.

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 events belonging to fixations shorter than the threshold value will be reclassified as Unknown events. The “Reclassify as saccade” functionality will merge two

saccades that are interrupted by an Unknown event. This can typically be useful when exporting Glance or saccade metrics where saccades are terminated by such Unknown events when transitioning into fixations. The data samples belonging to both the preceding saccade, the Unknown event, and the succeeding saccade will all merge into a single saccade and its saccade properties will be recalculated.

B2.9 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 drop-down menu and change the appropriate variables. Your custom filter settings will be saved as a new filter available in all parts of the application.

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.

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: Saccadeor 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-ocularreflex → Fixation filter result: Saccade or Unknown Eye Movement
Head kepts till	Smooth pursuit → Fixation filter result: Saccade or Unknown Eye Movement	Fixation → Fixation filter result: fixation

B3.3 Object, gaze, and snapshot in the eye tracker'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 Effect of mapping data onto Snapshots with 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 Calculate 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:

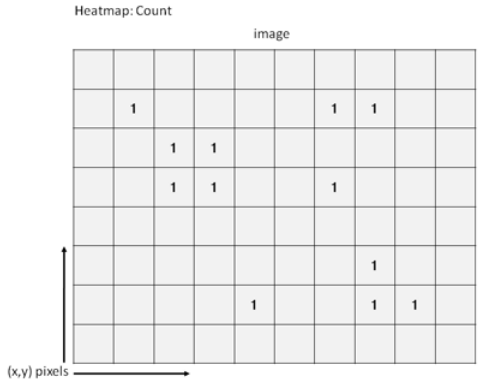
Fixation: 1 Start: 132 msec. Duration: 132 msec. Location: (415,711)

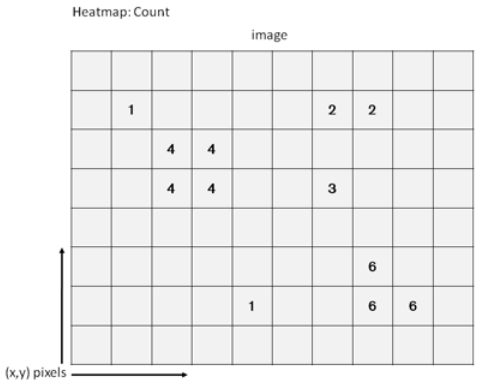
Fixation: 2 Start: 264 msec. Duration: 735 msec. Location: (711,491)

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

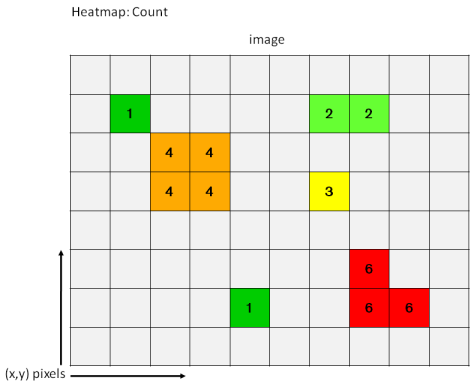
C1 Basic concept

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.

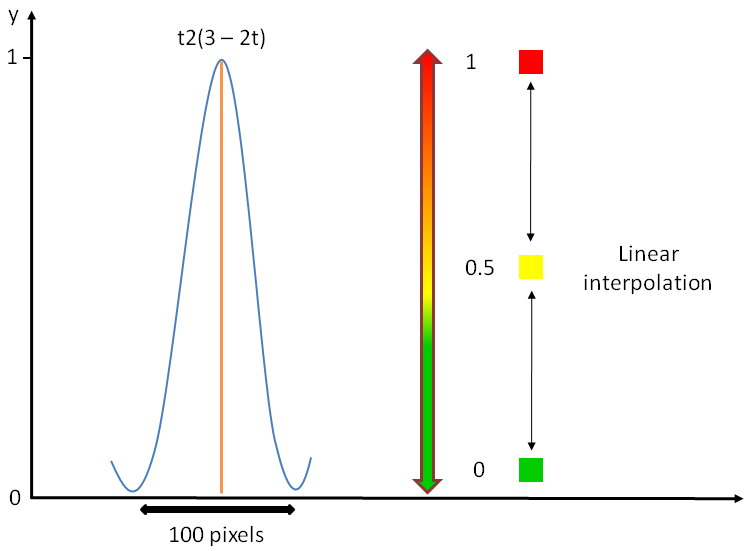


C2 The Heat Map

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.)

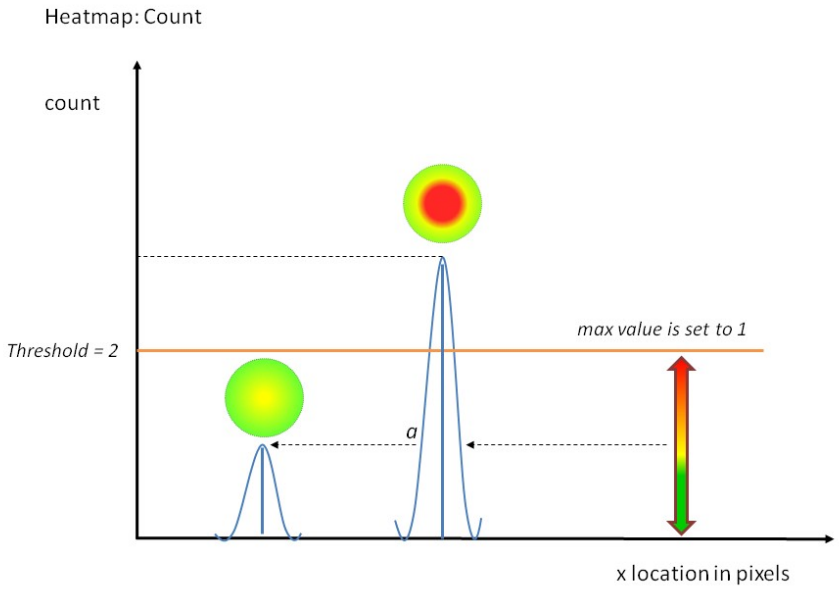
Heatmap: Colour distribution, Cubic Hermite Spline polynomial



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.

The illustration below shows how the 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.


Heatmap: Count
count
Threshold = 2
max value is set to 1
a
x location in pixels

Appendix D System requirements & recommendations

Tobii Pro Lab and Recommended System Configuration

Tobii Pro publishes up-to-date basic requirements for Pro Lab software systems on our website on this page: 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 Assisted Mapping. For more information, read the *Timing Guide for Stimulus Display in Tobii Pro Lab* and the *Timing Guide for Tobii Eye Trackers and Eye Tracking Software* documents that can be supplied by Tobii Pro.

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 your Microsoft Windows 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 setup 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.
- Always use the native resolution and 100% scaling of the presentation screen to guarantee correct timing and correct aspect ratio. To change the scaling, adjust your computer's display settings .

Appendix E 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
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	-

E1 Configure display settings

You can ensure smooth running of Tobii Pro Lab by setting the display scale to 100% for all presentation 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 using your computer's display settings.

E2 Merge coding data in Glasses projects

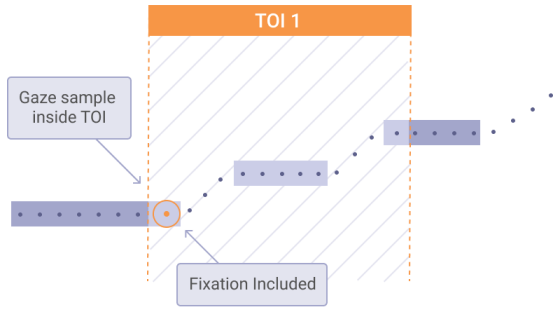
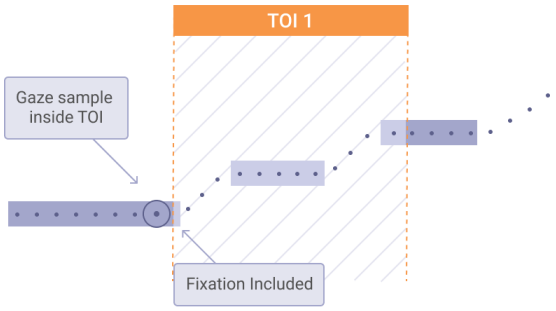
Merging coding data in Glasses projects by importing coding data from another project does not support merging multiple sets of mapped gaze data for a single Recording-Snapshot combination. This means that the coding work needs to be split by either Recordings or Snapshots. Multiple people cannot work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

Appendix F Data computation

F1 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 G Analysis of 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.

What to do:

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 on 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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