

Tobii Pro Spectrum

User Manual



Tobii Pro Spectrum User Manual

v 2.4

May 2022

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Please visit [Tobii Connect](#) for updated versions of this document.

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1 Introduction

1.1 Overview

Tobii Pro Spectrum can be used in various setups, either with an attached monitor or as a standalone unit, to perform eye tracking with physical objects. It supports research investigating blinks and eye closure dynamics, based on raw pupil and eye openness signal data (for example, constriction/dilation velocity, lid closure rate and acceleration).

The eye tracker's design enables the subject to move naturally during recording while still achieving high accuracy and precision. In 2022, Tobii introduced Eye Tracking modes so that researchers can choose between human and nonhuman primate modes. Read more about [Nonhuman primate modes](#).

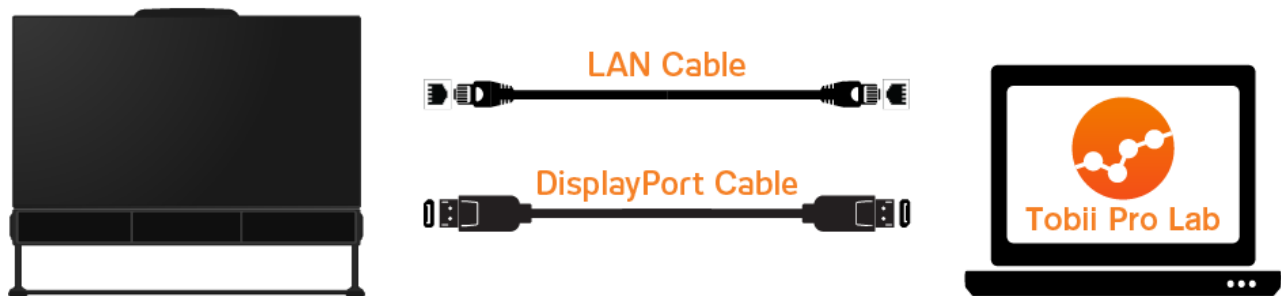


Figure 1. The typical setup is having Tobii Pro Spectrum connected to a PC running Pro Lab.

1.2 Basic operating principles

Tobii Pro Spectrum use infrared illuminators to generate reflection patterns on the corneas of the subject's eyes. These patterns, plus other visual data about the subject, are collected by image sensors. Sophisticated image-processing algorithms identify relevant features, including the eyes and the corneal reflection patterns. Complex mathematics is used to calculate the 3D position of each eyeball and the gaze point on the screen (or when a screen isn't used, for the gaze point on the object); in plain words, it tells you where the subject is looking.



Eye trackers from Tobii Pro are designed for use in indoor office environments and for tracking on humans.

1.3 Product versions

Tobii Pro Spectrum is available in three product versions: 1200 Hz, 600 Hz, and 300 Hz. The values denote the eye tracker's maximum sampling frequency, but it can be used at lower settings as well. The 600 Hz and 300 Hz versions can be upgraded to a faster version. For more information, contact your sales representative or visit Tobii [online](#).

1.4 Additional software options

Pro Lab tobiipro.com/product-listing/tobii-pro-lab/	Pro Lab is a comprehensive research software platform for eye tracking designed to meet the highest demands on different research scenarios with exact timing accuracy. This software offers an efficient workflow, making it easy to design experiments, record data, analyze and visualize eye tracking data, and to sync this data with other biometric data streams.
Pro SDK tobiipro.com/product-listing/tobii-pro-sdk/	Pro SDK offers a broad set of tools that makes it simple to develop a variety of niche applications or scripts across multiple platforms, using a wide range of programming languages. This SDK gives the researcher access to the full set of relevant gaze data streams, such as 3D eye coordinates, raw data, pupil data, etc.
Third-party software	This term refers to any application built on Pro SDK.

2 What's in the Tobii Pro Spectrum box

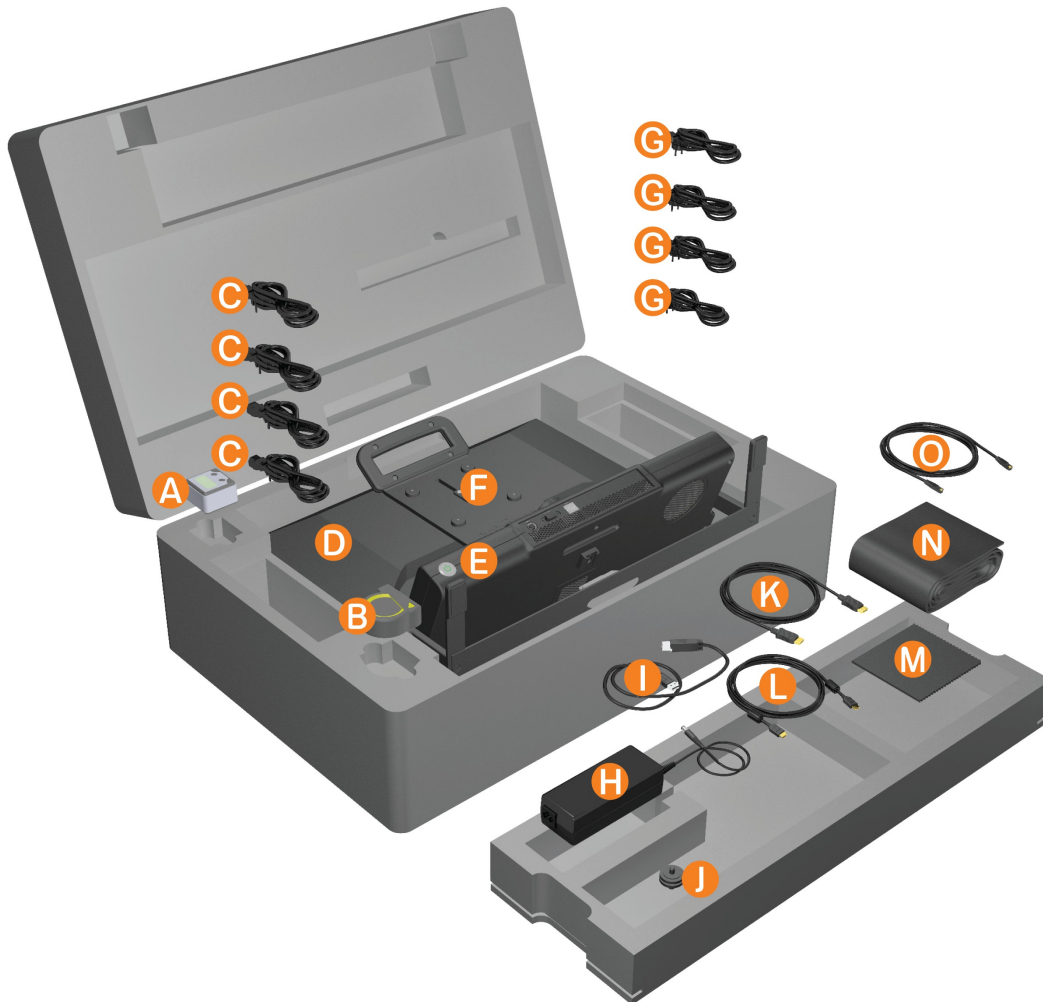


Figure 2. The contents of the Tobii Pro Spectrum box

A. Angle meter	I. USB cable for connection between the PC and the monitor's integrated USB hub
B. Measuring tape	J. Cold shoe for mounting of a user camera
C. Power cables for monitor (UK, US, EU and Aus/China)	K. DisplayPort cable
D. Monitor	L. HDMI cable
E. Eye tracker	M. Cleaning cloth
F. Monitor mounting bracket	N. Fabric cord sleeve for collecting the cables
G. Power cables for eye tracker (UK, US, EU and Aus/ China)	O. Ethernet cable

H. Power adaptor for eye tracker	
----------------------------------	--

3 Safety

3.1 Mounting warning



Tobii Pro Spectrum should be mounted according to the instructions of the approved mounts used. Tobii Pro AB or its agents are not liable for damage or injuries to a person or its property due to Pro Spectrum falling from a mounted configuration. The mounting of Pro Spectrum is done entirely at the user's own risk.

3.2 Emergency warning



Tobii Pro Spectrum is to be used for research purposes only. Be aware that due to the low, but possible risk of failure or distraction, Pro Spectrum should not be relied upon or used in dangerous or otherwise critical situations.

3.3 Infrared warning



When activated, Tobii Pro Spectrum emits pulsed infrared (IR) light. Certain medical devices are susceptible to disturbance by IR light and/or radiation. Do not use Pro Spectrum when in the vicinity of such susceptible medical devices as their accuracy or proper functionality could be inhibited.

3.4 Epilepsy warning



Some people with photosensitive epilepsy are susceptible to epileptic seizures or loss of consciousness when exposed to certain flashing lights or light patterns in everyday life. This may happen even if the person has no medical history of epilepsy or has never had any epileptic seizures.

A person with photosensitive epilepsy would also be likely to have problems with TV screens, some arcade games, and flickering fluorescent bulbs. Such people may have a seizure while watching certain images or patterns on a monitor, or even when exposed to the light sources of an eye tracker. It is estimated that about 3-5% of people with epilepsy have this type of photosensitive epilepsy. Many people with photosensitive epilepsy experience an “aura” or feel odd sensations before the seizure occurs. If you feel odd during use, move your eyes away from the eye tracker.

3.5 Child safety



Tobii Pro Spectrum is an advanced computer system and electronic device. As such it is composed of numerous separate, assembled parts. In the hands of a child certain of these parts have the possibility of being separated from the device, possibly constituting a choking hazard or another danger to the child.

Young children should not have access to, or use, the device without parental or guardian supervision.

3.6 Do not open Tobii Pro Spectrum



Non-compliance will result in loss of Warranty! There are no user serviceable components inside. Contact Tobii Customer Care if your Tobii Pro Spectrum is not working properly.

3.7 Environment



Tobii Pro Spectrum is designed for use in dry indoor environments. Avoid any exposure to direct sunlight as this will affect eye tracking quality and longer exposure can overheat the equipment. Avoid exposure to any liquids, gels, moist, rain, sweat or other damp materials or environments. Do not use the eye tracker near water - the device is not water resistant.

Keep the eye tracker in a clean and dust free environment. When using the equipment take adequate precautions against dust and dirt.

Do not place or use the equipment in places subject to extreme temperatures and humidity, such as on top of and or near a heating element, in a hot or damp room, or in a hot automobile in the sun.

4 Set up Tobii Pro Spectrum

4.1 Ventilation

As with most electronic devices, Tobii Pro Spectrum generates heat during use and needs adequate ventilation. Allow for free air flow around the unit and never cover it as this will restrict the air flow and lead to overheating.

4.2 Test environment

Tobii Pro Spectrum is best kept in dry conditions at room temperature. The recommended range for temperature and humidity during operation is as follows:

- **Temperature:** 15°C to 30°C (59°F to 86°F)
- **Humidity:** Max 20% to 95% (no condensation on the device)

4.3 Mount the monitor to the eye tracker

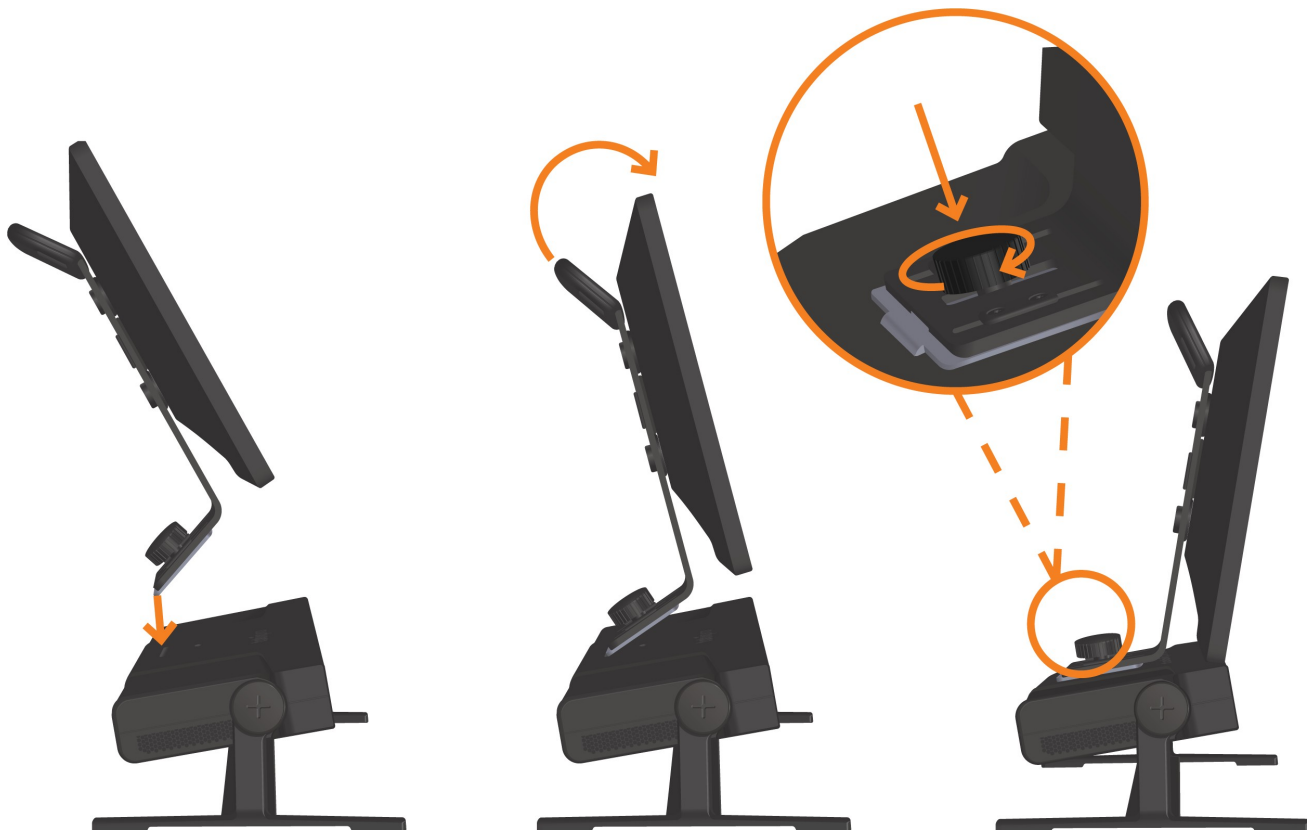


Figure 3. Mount the monitor to the eye tracker unit.

Tobii Pro Spectrum is delivered with the monitor already mounted. If this for any reason is not the case, e.g. someone has been using the unit as a standalone eye tracker, you need to reattach the monitor to the base. You mount and remove the monitor swiftly thanks to its one-screw fastening.

Procedure for affixing the mounting bracket:

1. Make sure the eye tracker is placed on an even and steady surface.
2. Hold the monitor firmly and insert the lower end of the mounting bracket into the slot on the top of the eye tracker.
3. When the lower end of the mounting bracket is fully inserted into the slot, gently tilt the screen forward.
4. When the mounting bracket is in place, secure it by pushing the lock knob downwards and turning it until it is firmly in place.

If you need to remove the monitor, repeat the above steps in the reverse order.

4.4 Connect the eye tracker

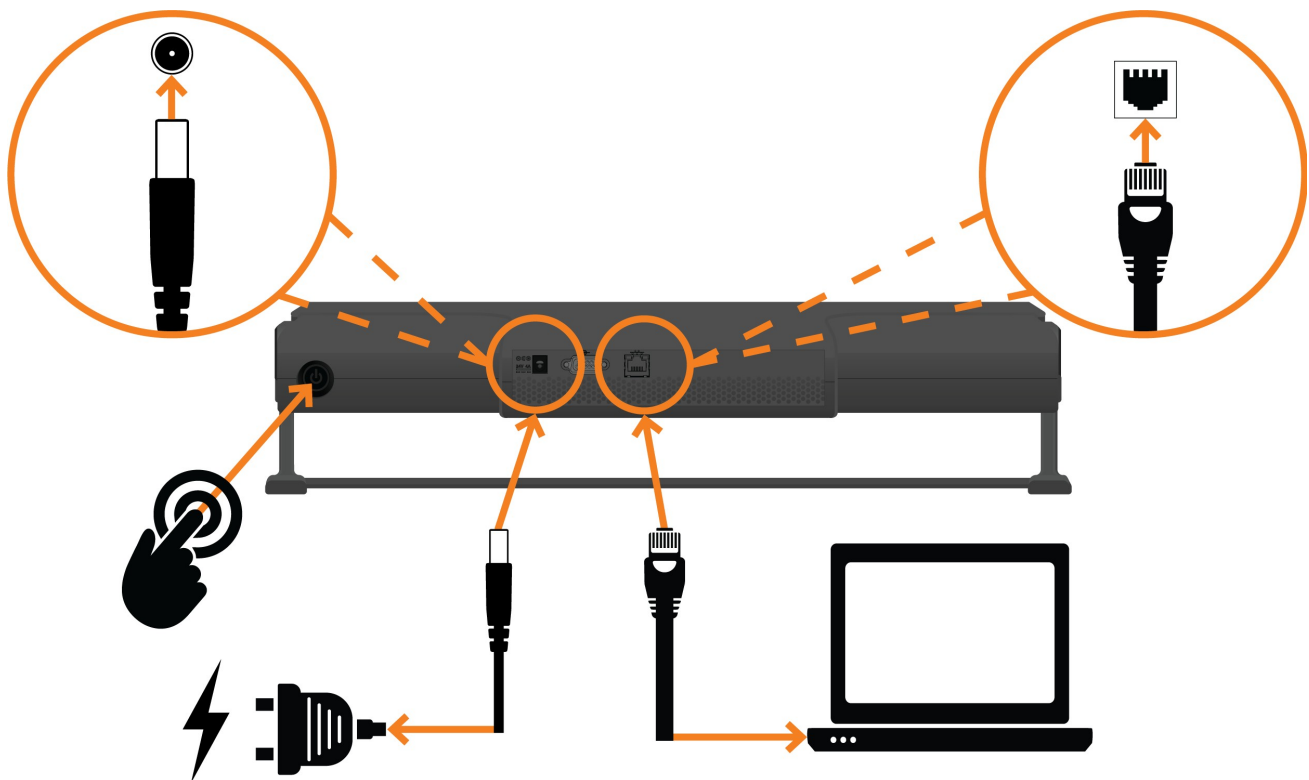


Figure 4. Tobii Pro Spectrum is connected to a standard Ethernet network with a RJ-45 connector.

How to attach the power supply:

1. Attach the supplied Ethernet cable to the corresponding Ethernet socket on the eye tracker.
2. Attach the other end of the Ethernet cable to the Ethernet socket on your PC. It is also possible to connect the eye tracker to a switch connected to your LAN.
3. Attach the supplied power adapter cable to the corresponding outlet on the eye tracker.
 - a. Choose the power cord with the power plug suited for the electrical outlet and connect the other end to the AC adapter.
 - b. If neither of the power plugs suits your needs, please contact your sales representative or Tobii Pro Support for assistance.
 - c. Insert the power cord plug to a mains power outlet.

4.4.1 Power on Tobii Pro Spectrum

Tobii Pro Spectrum power switch is located on its back side. We recommend that you shut off the unit after the workday or for longer periods of inactivity.

During startup, the illuminators in the front of Tobii Pro Spectrum, lit up one by one to indicate that the LED-hardware is OK.

Approximately 20 seconds after you power on, a short beep is heard, indicating that the processor module has loaded the BIOS and now begins to load the operating system.

After another 20 seconds two long beeps are heard, indicating that the system is ready for use.

If anything goes wrong (no matter the cause), you hear three short beeps about 40 to 50 seconds after the powering-on sequence, followed by a short pause and then another three short beeps.

You turn off the eye tracker by pressing the power switch. During shut down, the power switch indicator lamp flashes. Depending on the unit's internal state, powering down can take up to 20 seconds.



You can force a shutdown of Tobii Pro Spectrum by pressing the power switch for at least 5 seconds.

4.5 Monitor settings

Tobii Pro Spectrum is supplied with a pre-mounted 23.8" monitor.



Note that the monitor has two power switches: one main power switch on the backside and one ON/OFF switch on the front. Make sure the main switch is ON before starting the monitor with the ON/OFF switch.

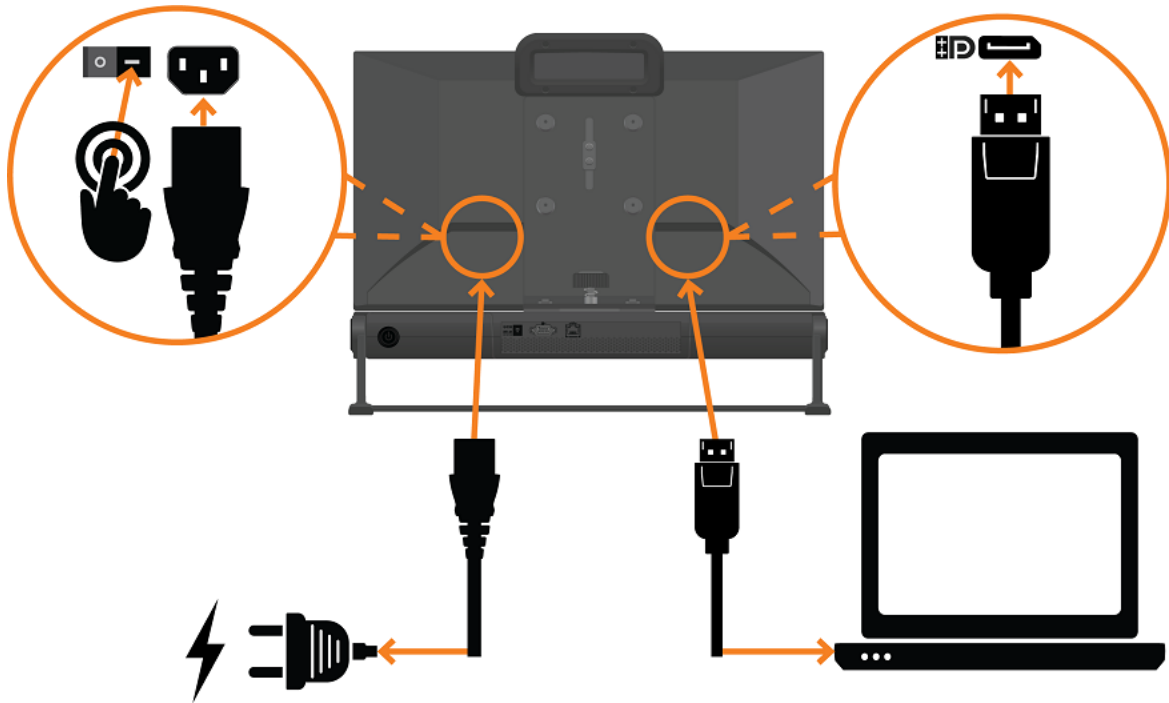


Figure 5. Monitor settings for power ON/OFF Tobii Pro Spectrum.

1. Attach the supplied Display Port or HDMI cable to the corresponding connector on your computer.



It is possible to use any of the other display interfaces on the monitor as well. However, for the best performance we recommend Display Port or HDMI, depending on what your PC is equipped for.

2. Choose the power cable with the plug suited for the wall outlet and connect the other end to the corresponding outlet on the monitor.
3. Insert the power cable plug to a power outlet.
4. If neither of the plugs work with your power outlet, please contact your sales representative or Tobii Pro Support for assistance.

5 Display settings



Figure 6. Display options for Tobii Pro Spectrum.

1. Tobii Pro Spectrum shown as delivered with the monitor mounted on the eye tracker.
2. Tobii Pro Spectrum as a standalone eye tracker without the monitor.
3. Eye tracker and monitor together on a VESA 100x100 mount.
4. Standalone with monitor.



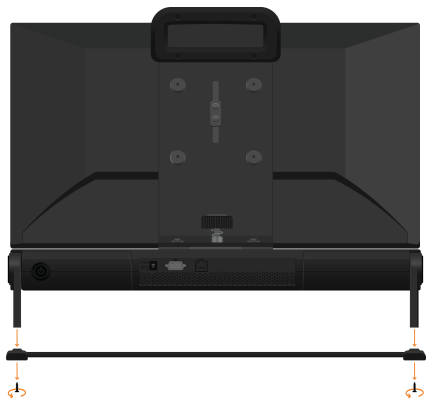
You can use the eye tracker with another monitor, but it is not recommended. For more information, read [Recommended monitor](#).

5.1 VESA mount

Tobii Pro Spectrum can be mounted on a standard VESA 100 x 100 mount.

Here's what to do:

Remove the stand by unscrewing the two screws from the underside (see image below).



1. Fold the two legs upwards so they lie neat against the eye tracker's side panels (as in setup 3 in the Setup Options-image above). Make sure they don't cover the ventilation holes on the side panel.
2. Attach the VESA mount to the bracket with four screws.

5.2 Scene camera mount

Beneath the eye tracker there is a mount used for attaching a scene camera (purchased separately).

Here's what to do:

1. Attach the enclosed mounting bracket to your camera unit.
2. Slide the assembly into the scene camera mount and tighten the screw.

6 Tobii Pro Spectrum configuration

Tobii Pro Spectrum is configured using Tobii Pro Eye Tracker Manager.

6.1 Tobii Pro Eye Tracker Manager

Tobii Pro Eye Tracker Manager is free software available on [Tobii Connect](#).

Pro Eye Tracker Manager helps you manage your Tobii Pro eye tracker. It lets you see which eye tracker firmware and software versions you are running and also facilitates updates (where applicable). It provides:

- Drivers and Firmware installation or updates
- Display setup
- Eye tracking mode selection
- Positioning guide
- User calibration
- Gaze visualization¹
- Eye images²



References in product documentation to Tobii Pro Eye Tracker Manager refer to the latest version available on Tobii Pro's website.

6.2 Keep your eye tracker software and display setup updated

Updates

From time to time, Tobii Pro releases updates for an eye tracker's applicable driver and firmware in order to improve performance and/or introduce new functionality. Please check the Tobii Pro website regularly for news and information about updates about your eye tracker. We recommend that you activate updates and notifications in Tobii Pro Eye Tracker Manager.

How to activate notifications and updates in Pro Eye Tracker Manager:

1. Click to expand the drop-down list at the top of Pro Eye Tracker Manager.
2. Toggle the switches for notifications. Orange means they are activated.
3. If a software update is available, the available update has a clickable orange link.
4. Select an interface language. The default is English.

¹Gaze visualization in Pro Eye Tracker Manager lets you quickly evaluate the quality of the eye tracking data. The Gaze visualization overlaps data only on the Pro Eye Tracker Manager screen while Pro Eye Tracker Manager is open.

²Applicable when Pro Eye Tracker Manager is used with eye trackers that support eye images (Tobii Pro Spectrum and Tobii Pro Fusion).

Display setup updates

Use Pro Eye Tracker Manager whenever you change computers or display setups.

6.3 Upgrade and downgrade the eye tracker's firmware

You can determine which firmware version your connected Tobii Pro Spectrum uses by reading the details on the displayed card with your eye tracker's name in Tobii Pro Eye Tracker Manager. Firmware versions are listed on the Drivers & Firmware tab.

You can upgrade or downgrade the firmware by resetting the eye tracker to factory defaults and then reinstalling the desired firmware version.

Downgrading:

1. Turn on the eye tracker and confirm that it appears in Tobii Pro Eye Tracker Manager.
2. Restart Tobii Pro Spectrum by inserting a pointy device (i.e. a straightened paper clip) into the recessed reset button hole, located between the power connector and the data port on the connector panel at the back of the eye tracker. Keep pressing the reset button till you hear a beep.
3. Tobii Pro Spectrum eye tracker restarts one or more times. This is not an error. After a while, your eye tracker appears in Tobii Pro Eye Tracker Manager again.
4. On the Drivers & Firmware tab in Tobii Pro Eye Tracker Manager, select the desired firmware version from the list and click the Install button.

Upgrading:

1. Turn on the eye tracker and confirm that it appears in Tobii Pro Eye Tracker Manager.
2. On the Drivers & Firmware tab in Tobii Pro Eye Tracker Manager, select the desired firmware version from the list and click the Install button.

6.4 Configure your eye tracker in Tobii Pro Eye Tracker Manager

In Tobii Pro Eye Tracker Manager you can change some settings for your eye tracker. For example, you can create and recall setups for using the eye tracker in standalone mode and change the eye tracker's frequency.

6.4.1 Change Tobii Pro Spectrum frequency setting

1. Start Tobii Pro Eye Tracker Manager. Tobii Pro Spectrum will display as a "card" in the list of available eye trackers at the top.
2. Select Tobii Pro Spectrum.
3. On the Drivers & Firmware tab, you can select the desired frequency setting from the drop-down list.



Option with reduced infrared light: If you change the sampling frequency to 60 or 120 Hz, you reduce the brightness of the infrared light from the eye tracker. This is useful when you want a highly unobtrusive setup for the participant. This low visibility option is only available for 60 and 120 Hz.

6.4.2 Configure Tobii Pro Spectrum for standalone use

1. Start Tobii Pro Eye Tracker Manager on your computer. All available eye trackers appear in the "Connected Eye Trackers" pane.
2. Select Tobii Pro Spectrum by clicking on it.
3. On the Overview tab, locate Display Setup and click the ellipsis button to the right. On the drop-down menu, click New.
4. Follow the instructions in each configuration step, including naming your new setup.
5. When finished, your new setup appears in the drop-down list of display setups.
6. To confirm that Tobii Pro Spectrum can detect the participant's eyes, enable the Position Guide at the bottom left of Pro Eye Tracker Manager. Once activated, you should be able to see two circles in a face contour.

7 Additional features

7.1 User calibration for Tobii Pro Spectrum

Tobii Pro Spectrum calibration procedure allows for robust eye tracking research by facilitating workflows that take into consideration your research questions, as well as the characteristics of your participant.

Tobii Pro Spectrum supports:

- Binocular calibration
- Monocular calibration

7.1.1 Binocular calibration

The binocular calibration is successful if enough data has been collected to successfully calibrate both eyes. Calibration results are presented for all the points in which data has successfully been collected for both eyes. To improve a calibration, you can redo the entire calibration or recalibrate the points for which data is missing or not good enough for your research. This is an efficient and powerful method to calibrate your participant's eyes, suitable for most research questions and for most participants.

Available in:

- Tobii Pro Lab, when selecting the Calibration stimuli in the Design Timeline
- Tobii Pro SDK, when using screen-based calibration class/methods

7.1.2 Monocular calibration

Tobii Pro Spectrum's monocular calibration functionality lets you to collect eye tracking data optimized for each of the eyes of the participant. Tobii Pro Spectrum can robustly identify the left and right eyes, irrespective if only one eye or both are visible to the eye tracking sensors. For increased confidence in some cases, you could choose to cover the eye that is *not* tracked, but this is not required.

This functionality is useful if one eye causes the binocular calibration process to fail. This could happen, for example, due to severe strabismus, or if one eye is a prosthetic.

Separate calibration for the two eyes is also useful for research into binocular coordination and fixation disparity, or in situations where you would like the calibration to pass even if only one eye could be tracked.

Note that a default calibration is used for the eye that was not selected for calibration or that has failed to calibrate. During the recording, Tobii Pro Spectrum will continue to search for both eyes because it is less likely to find data for the uncalibrated eye. Nevertheless, Tobii Pro Spectrum will report the data for the uncalibrated eye when available.

Tobii Pro Spectrum allows for two types of monocular calibration:

- Both eyes
- Only one eye - left or right

Depending on how the calibration flow is implemented in the software, you can choose to perform a calibration for both eyes at a time; calibrate only one eye - left or right; or calibrate first one eye, and then the other.

Calibrating both eyes at a time:

Using the Monocular calibration functionality provides more granularity for your calibration results, reporting on whether the participant's left, right or both eyes have been successfully calibrated. Results will be presented for each point. In this case you can successfully calibrate even if only one eye was correctly calibrated. You can improve a successful calibration by redoing the calibration, or by selecting to calibrate first one eye and then the other. In this case one can successfully calibrate even if only one eye was successfully calibrated. One can improve a successful calibration by redoing the calibration, or by selecting to calibrate only one eye, and then the other.

Calibrating only one eye at a time:

Using the Monocular calibration functionality lets you calibrate only one of the participant's eyes, while ignoring the other eye. In this case, a calibration is successful if enough data has been collected for the eye of interest and the other eye is ignored. The calibration results report how good the calibration was for the eye of interest. If the data is not good enough for your research, you can improve a calibration by redoing the entire calibration or recalibrating the points with missing data for the eye of interest. Proceed with calibrating the other eye if desired.

Available in:

- Tobii Pro Eye Tracker Manager, when selecting Calibration mode you can choose between: Both eyes, Right eye or Left eye
- Tobii Pro SDK, when using Screen based Monocular calibration class/methods

For more information on how to calibrate Tobii Pro Spectrum using Tobii Pro Eye Tracker Manager, read the Learn article, [Performing a monocular calibration with the Tobii Pro Spectrum](#).

For more information on the Binocular and Monocular calibration using Tobii Pro SDK, visit developer.tobii.com.

7.2 Use the TTL input port for external event recording

Tobii Pro Spectrum is equipped with a digital data input port that records events in up to eight parallel TTL signals. The events are recorded with a timestamp accuracy better than 50 µs. The detected events are available in decimal format (0-255) through either Pro Lab or Pro SDK. The TTL signal can be combined to obtain up to 256 different events.

Any digital signal source fulfilling the electrical specification can be connected to the tracker, for example the Cedrus Stimtracker.

Interface: 8-bit parallel TTL input (DBc9)

TTL levels: $V_{in} < 0,8 V \Rightarrow$; $V_{in} > 2 V \Rightarrow$ Logical 1

Pinning: pin 1-8: inputs; pin 9: GND

Input voltage interval: 0-5 V

Connector shielding: connect to system chassis ground

Input configuration: inputs (pin 1-8) are connected to pull up resistors and are opto-isolated.

7.3 Eye images

Eye images are available in 10 Hz from Tobii Pro Spectrum eye tracker. Each eye tracking camera provides a 5 Hz image stream. During tracking mode (i.e. when the eye tracker detects eyes), the image resolution is 496 x 175 px, except for 1200 Hz when the resolution is 384 x 105 px. During gaze recovery (i.e. when the eye tracker does not detect eyes), the image resolution is 640 x 512 px.

The eye images are accessed via Tobii Pro SDK. They are also visible in Tobii Pro Eye Tracker Manager.

7.4 Eye openness

Tobii Pro Spectrum provides a raw, unprocessed eye openness signal. The eye openness data is provided in mm, for the left and the right eye individually, at the same frequency as the gaze. (For example, in 1200 Hz when the eye tracker's frequency is set to 1200 Hz and 600 Hz when the frequency is set to 600 Hz.)

The eye openness signal can be used independently of the other signals. The timestamp of the eye openness signal will match those in the gaze stream, as they are based on the same eye images.



The eye openness signal is available in FW version 2.6.1 or later. It also requires Tobii Pro SDK version 1.10 or later.

8 Product care and liability

8.1 Transportation and storage

Before storage or shipping, disconnect all cables and use the travel case and packaging materials provided.

For transportation and storage, the recommended range for temperature and humidity for the device is as follows:

- **Temperature:** -40°C to 70°C (-40°F to 158°F)
- **Humidity:** 20% to 95% (no condensation on the device)



Tobii Pro Spectrum is not waterproof or water resistant. The device should not be kept in excessively humid, damp or wet conditions. Do not submerge the device in water or in any other liquid. Be careful not to spill liquids on the device.

8.2 Cleaning

Before cleaning Tobii Pro Spectrum, unplug all cables. Use a soft, slightly damp, lint-free cloth. Avoid getting moisture in openings on the device. Don't use window cleaners, household cleaners, aerosol sprays, solvents, alcohol, ammonia, or abrasives to clean the device.



Keep in mind that scratches on the front surface of the eye tracker may cause impaired eye tracking performance.

8.3 Disinfection

The surfaces of Tobii Pro Spectrum can be cleaned with Isopropyl alcohol using a moist, soft, lint-free, non-scratching cloth. Do not let liquid Isopropyl alcohol enter into the unit. Be careful not to scratch the front filter surface as it is part of the optical system and scratches will reduce the product's performance.

8.4 Disposal of the eye tracker

Do not dispose of your Tobii Pro eye tracker in general household or office garbage receptacles. Follow your local regulations for the proper disposal of electrical and electronic equipment.

8.5 Limitation of liability

Except where prohibited by law, Tobii AB is not liable for any loss or damage arising from the use or misuse of a Tobii eye tracker or the mounting plate, whether direct, indirect, special, incidental or consequential, regardless of the legal theory asserted, including warranty, contract, negligence, or strict liability.

9 Technical specifications

9.1 Eye tracking specifications

The characteristics of the gaze data from an eye tracker are described in terms of accuracy and precision. Accuracy indicates the angular average distance from the actual gaze point to the one measured by the eye tracker. Gaze precision indicates the spatial variation between successive samples collected when the subject fixates at a specific point on a stimuli.

Eye tracking technique	Video-based pupil- and corneal reflection eye tracking with dark and bright pupil illumination modes. Two cameras capture stereo images of both eyes for robust, accurate measurement of eye gaze and eye position in 3D space, as well as pupil diameter.
Eye tracking mode	Tobii Pro Spectrum has three different eye tracking modes for different groups of primate species: • Human • Monkey • Great ape Read about Nonhuman primate modes .
Sampling frequency	60, 120, 150, 300, 600 or 1200 Hz (max. frequency depends on hardware version)
Precision*	0.01° RMS at optimal conditions** 0.06° RMS at optimal conditions (raw signal)
Accuracy*	0.3° at optimal conditions
Binocular eye tracking	Yes
Eye tracker latency***	Mean latency < 2 ms at 1200Hz (SD < 0.2 ms)
Blink recovery time	One frame (immediate)
Gaze recovery time	Less than 150 ms
Data Sample Output****	Timestamp Gaze origin Gaze point Pupil diameter

Eye openness data stream	Eye openness stream has the same frequency as frequency selected for the gaze stream and will have the same timestamps. Eye openness data is provided in millimeters, for each eye individually.
Eye image data stream	Eye image stream frequency is approximately 10 Hz (one image with both eyes). Zoomed-in eye images available in tracking mode. Full-frame camera images are available in gaze recovery mode.
TTL input stream	8-bit timestamped data (256 event codes). Event driven detection with a timestamp accuracy of 50 μ s.
Tracker and client time synchronization	Integrated between the eye tracker time domain and the client computer time domain with an accuracy of 100 μ s.

* Tobii Pro uses an extensive test method to measure and report performance and quality of data with human participants. Please download the [Tobii Pro Spectrum Eye Tracker Data Quality Test Report](#) for more detailed information. To learn more about Monkey mode and Great ape mode data quality, please contact your Sales representative.

** Applying Savitzky-Golay filtering (settings listed in the [Tobii Pro Spectrum Eye Tracker Data Quality Test Report](#)).

*** Visit [Tobii Connect](#) for more information on how to optimize your Pro Spectrum setup.

Note: FW v.2.2.3 and Pro SDK v.1.9 or later are required to obtain the stated performance.

**** For more information about output data and the supplementary data stream, please read the [Tobii Pro SDK documentation](#).

9.2 Setup

Head movement tolerance	Excellent -Dual-camera system, with more images than a one camera system, gives a more accurate data calculation and the best level of precision and robustness for head movement.
Freedom of head movement* (at 65 cm distance)	Width x height: 34 cm x 26 cm (13.5" x 10") (At least one eye tracked)
Freedom of head movement* (at 75 cm distance)	Width x height: 42 cm x 26 cm (16,5" x 10") (At least one eye tracked)
Operating distance (mounted on screen)	55 to 75 cm (22" and 30") from the eye tracker

Optimal screen size	24" (16:9 aspect ratio)
Tracker setup options**	
Recommended monitor	Supplied 23.8" monitor

* Describes the region in space where the participant can move his/her head and still have at least one eye within the eye tracker's field of view (trackbox) at the specific distance.

** Tracker mounted on stand, allows for even larger screens and physical objects to be tracked.

9.3 Software compatibility

Software and framework compatibility	Tobii Pro Lab Tobii Pro Eye Tracker Manager Tobii Pro SDK Any applications built on Tobii Pro SDK
Operating system	Windows, macOS, Linux

9.4 Hardware versions

300 Hz
600 Hz
1200 Hz

9.5 Pro Spectrum eye tracker specifications

Tobii Pro Spectrum is an integrated eye tracker with a removable 23.8" monitor. Removing the monitor transforms the integrated eye tracker into a standalone eye tracker.

Eye tracker

Dimensions (L x H x W) in cm/inches	55 x 18 x 6 (22" x 7" x 2") The eye tracker is mounted on a stand, which raises it from the surface by 9 cm (approximately 4").
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Weight	5.1 kg (11.4 lbs.) With the power supply unit, the weight is 5.7 kg (12.9 lbs.)
Connectors	TTL input: 8-bit (DB-9 connector) Communication: Ethernet (RJ-45 connector) Power supply: 24 VDC (5.5 mm connector)
Data processing	Fully embedded data processing
Eye tracking cameras	2
Illuminators	Dark pupil Illumination Modules, Bright pupil Illumination Modules
User camera mount	Standard 1/4" thread
Power Consumption	Typical power consumption: 60 W Max. rated power consumption: 96 W
Power Options	Input: 100-240 VAC 50/60Hz Max. rated power consumption: 120 W No load power consumption: <0.15 W Energy efficient level: VI Complies with EISA 2007/DoE, NRCAN, AU/NZ MEPS, EU ErP and CoC Version 5

Monitor

Monitor model name	EIZO FlexScan EV2451
Panel type	IPS, LED backlight
Screen size (diagonal)	23.8"
Weight	3.8 kg (8.4 lbs), incl. mounting
Aspect ratio	16:9
Resolution	1920 x 1080 pixels
Screen response time	5 ms (gray-to-gray)
Connectors	DVI VGA HDMI Display port 1 port for monitor control (USB 3.0) 2-port USB hub (USB 3.0) C13 power connector Audio input connector: 3.5 mm Headphone jack: 3.5 mm
Built in speakers	1.0 W + 1.0 W

Power supply	100-240 VAC 50/60 Hz
Power	Maximum rated power consumption: 42 W Typical power consumption: 13 W Power save Mode: 0.5 W Power Management: Power Save (VESA DPM, Display Port- Rev 1.1a, and DVI DMPM)

10 Compliance

The certification and compliance statements in this section are only valid for the eye tracker unit. For compliance and certification of the monitor and external power supply, please see the separate compliance documentation of those.

Safety

Safety standards:	IEC 60950-1:2005 (Second Edition) + Am 1:2009 + Am 2:2013 EN 62368-1:2014 +A11:2017 UL 60950-1 Edition 2 +A1 +A2 CSA 60950-1 Edition 2 + A1 + A2 J60950-1 (H29) National differences for Australia to IEC 60950-1, 2nd Edition IEC 62471:2006 (First Edition) IEC 62368-1:2014
Certification and declaration of conformance:	ETL Listed (US & Canada) CB Certificate CE UKCA

EMC

EMC standards:	EN 55032: 2015, Class B
	EN 55024: 2010 + A1
	EN 61000-6-1: 2007
	EN 61000-6-3: 2007 + A1
	FCC 47 CFR Part 15 (2015): Class B
	ICES-003 Issue 6: Class B
	CISPR 32: 2015, Class B
	CISPR 35: 2016
	KN 32:2015, class A
	KN 35:2015
	KN 61000-4-2:2013
	KN 61000-4-3:2011
	KN 61000-4-4:2011
	KN 61000-4-5:2008
	KN 61000-4-6:2013
	KN 61000-4-11:2008
Certification and declaration of conformance:	FCC, CAN ICES-3 (B)/NMB-3(B), ACMA (RCM), CE, UKCE, KC* *Test coverage for KC certification doesn't include use of the TTL Input port.

See ETL and CB certificates for details.

Sustainability

Directives:	RoHS Directive 2011/65/EU REACH Directive EC 1907/2006 Restriction of hazardous substances (RoHS). UK SI 2012 No. 3032
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This product is exempt from CCC.

Appendix A Nonhuman primate modes

Tobii worked closely with primate labs around the world to develop new image collections to train our systems and continually develop our software. By capturing eye movements while untrained and with naturalistic head movement, primates can choose for themselves whether to interact with the screen or not during an eye tracking study. The improved calibration process makes it easier to calibrate energetic participants.

Tobii Pro Spectrum has different eye tracking modes for different groups of nonhuman primate species, due to differences in physical appearance (facial and eye features). Each eye tracking mode was developed using data from the respective species or group of species.

A1 Monkey

The following species are currently supported by Tobii Pro Spectrum:

- **Rhesus macaque** (*Macaca mulatta*) - adults and infants
- **Long-tail macaque** (*Macaca fascicularis*) - adults

A2 Great ape

The following species are currently supported by Tobii Pro Spectrum:

- **Chimpanzee** (*Pan troglodytes*) - adults
- **Bonobo** (*Pan paniscus*) - adults
- **Gorilla** (*Gorilla gorilla*) - adults
- **Orangutang** (*Pongo abelii*) - adults

Appendix B Recommended monitor

Tobii Pro Spectrum is supplied with a thoroughly tested and approved 23.8" 16:9 LCD monitor. Our recommendation is to use this monitor, which has been tested for weight, dimension and center of gravity for the system set up with the eye tracker unit and screen mounting solution. If you need to use a different monitor, we recommend that you choose a black monitor without any colored décor elements and that the screen bezel is as slim/thin as possible. No connections or buttons should be located underneath the monitor as this could interfere with the mounting of the eye tracker. The monitor must be equipped with a standard 100 x 100 mm VESA mounting interface on the back and it should not weigh more than the supplied monitor.



The eye tracker has undergone tipping tests with the supplied monitor attached. If you choose to use a different monitor, Tobii cannot guarantee the safety of such a combination and you will use it at your own risk.

Appendix C Customer Care, training, and warranty

C1 Customer Care

If you need help, please contact Tobii [Customer Care](#). In order to receive assistance as quickly as possible, make sure you have access to your Tobii device and, if possible, an Internet connection. You should also be able to supply the serial number of the device, which is located on the device.

C1.1 Get help

Many questions can be answered by visiting Tobii Connect. It contains the latest information about contacting Customer Care, helpful articles and FAQs, links to downloads, and much more. Log in or register to see information about your account and to reach Customer Care on [Tobii Connect](#).

C2 Training and education services

If you are new to eye tracking, or want to extend your knowledge about eye tracking research, sign up for one of our online sessions, onsite trainings, Tobii Academy, and more on [training and education services](#).

C3 Warranty information

Read more online about [Tobii limited warranty and Tobii Care](#).

Appendix D Limitations and considerations

D1 Intended use



Tobii Pro eye trackers are intended to be used in research activities about human behavior including eye movements, in a dry and dust free indoor environment. The product should only be used as described in this User's Manual. Please read the User Manual and other supplied documentation thoroughly before using the product.

D2 Light conditions



Tobii Pro recommends that eye tracking studies be performed in a controlled environment. Sunlight should be avoided since it contains high levels of infrared light which will interfere with the eye tracker system. Sunlight affects eye tracking performance severely and longer exposure can overheat the eye tracker. This eye tracker is not designed for exposure to (direct) sunlight. Eye tracking generally does not work in strong direct sunlight.

Shielding the eye tracker adequately from the sun may prevent sunlight from interfering with eye tracking.

D3 Eyelashes



Long eyelashes can be obstructive when the participant's eyes are less open, especially if the participant is wearing mascara. In rare cases, eyelashes may completely block the view of the participant's pupils, making eye tracking impossible.

D4 Droopy eyelids



Droopy eyelids or otherwise obstructive eyelids can block the view of the participant's pupils. In rare cases, such eyelids may completely block the view of the participant's pupils, making eye tracking impossible.

Appendix E Glossary

Accuracy	The angular average distance from the actual gaze point to the one measured by the eye tracker. For more details on how accuracy is calculated, please read the Data Quality Test Report for this eye tracker on tobiipro.com .
Binocular calibration	The eye tracker collects data from both eyes the same time and processes the data for each eye independently. The calibration is valid when it succeeds in collecting and processing data from both eyes.
Binocular eye tracking	Tracks and reports data for both left and right eye.
Blink recovery time (time to tracking recovery for blinks)	When a participant blinks, the eye tracker loses the ability to track eye gaze because the eye is covered by the eyelid. If the pupil is occluded for only a short period (a few hundred milliseconds), the system will regain tracking immediately when the pupil becomes visible again, but only if the subject has maintained approximately the same head position during the blink. Data during blinks are only lost when the pupil is occluded, i.e. during the eye lid movement itself or when the eye is closed.
Bright pupil tracking	The process of capturing and processing eye images, with a set of illuminators that are placed close to the optical axis of the camera. This causes the pupil to appear lit up in the image (this is the same phenomenon that causes red eyes in photos). The eye tracking algorithms identify the pupil by searching for a bright elliptical form in the image.
Dark pupil tracking	The process of capturing and processing eye images, with a set of illuminators that are located further from the optical axis of the camera. This causes the pupil to appear darker than the rest of the eye in the image. The eye tracking algorithms identify the pupil by searching for a dark elliptical form in the eye image.
Data sample output	Type of data provided by the eye tracker
Eye image data stream frequency	The number of eye images per second outputted in the eye image data stream, expressed in Hz units. These images can be used to help to troubleshoot tracking issues.
Eye openness	Eye openness is defined as the diameter in millimeters of the largest sphere that can be fitted between the upper and lower eyelids. Upper and lower eyelids are defined by the contrast lines between the sclera and the lashes/lid structure. The eye openness data is provided for the left and the right eye individually. If the eye openness for an eye cannot be estimated, this will be marked invalid. The timestamps of the eye openness signal will match those in the gaze stream, as they are based on the same eye images.
Freedom of head movement	Describes the region in space where the participant may move his/her head and still have at least one eye within the eye tracker's field of view

(trackbox).

Gaze recovery time	An eye tracker working in a natural user environment may occasionally lose track of the subject's eyes, e.g., when the subject completely turns away from the tracker. If a period of a few hundred millisecond elapses during which the eye tracker is unable to detect the eyes near where they were last detected, the eye tracker will start searching for the eyes within the entire head movement box. The stated measurement is the typical time to tracking recovery once the eyes return to the field of view of the cameras again, i.e. when the subject is within the trackbox limits, with the eyes open and facing the eye tracker.
Maximum gaze angle	The maximum gaze angle for which the eye tracker can perform robust and accurate tracking on the eyes. The gaze angle is the angle ABC with A = center of the eye tracker (midpoint between the two eye tracking sensors), B = eye position (midpoint between the left and the right eye) and C = stimuli point.
Maximum screen size	The maximum screen size supported by the standard eye tracker setup (i.e. mounting the eye tracker directly on the screen).
Monocular calibration	Tracks and reports data for only one eye.
Operating distance	The minimum and maximum distances between the subject's eyes and the surface covering the eye tracker sensors at which eye tracking can be done while maintaining robust tracking.
Optimal conditions	Please download the Data Quality Test Report from tobiipro.com to read more about optimal conditions for this eye tracker.
Precision	Describes the spatial angular variation between individual and consecutive gaze samples (Root Mean Square), calculated on raw data. For more details on how precision is calculated, please read your eye tracker's Data Quality Test Report on tobiipro.com .
Sampling frequency	The number of data samples per second output for each eye. Expressed in Hz units, where 1 Hz = 1 sample per second.
Eye tracker latency	The duration from the mid-point of the eye image exposure, to when a sample is available via the API on the client computer. This includes half of the image exposure time, image read-out and transfer time, processing time and time to transfer the data sample to a client computer.
Tracker and client time synchronization	The eye tracker and software client clocks can drift naturally during operation. To compensate for this, the Pro SDK will periodically ask the eye tracker about its current time stamp, noting the system time stamp when the request is sent and received. This data is then used to calculate how the system time corresponds to the device time.
Video-based pupil and corneal reflection eye tracking	At the center of this technique is a hardware setup that consists of one or two video cameras and one or multiple sets of infrared-light illuminators. The cameras capture images of the eyes and the illuminators produce reflections on its surface. These images are processed by

algorithms that identify the pupil and the reflections caused by the illuminators. This information is then combined with different parameters from a 3D model of the eye and used to map the gaze onto the stimulus.



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Support for your Tobii Pro product

Get help

Visit [Tobii Connect](#) for help with your Tobii device. It contains the latest information about contacting Customer Care, documentation, courses, articles, and more.

Contact your solution consultant or reseller

For questions or issues with your product, contact your Tobii sales representative or authorized reseller for assistance. They are most familiar with your personal setup and can help you with tips and product training.