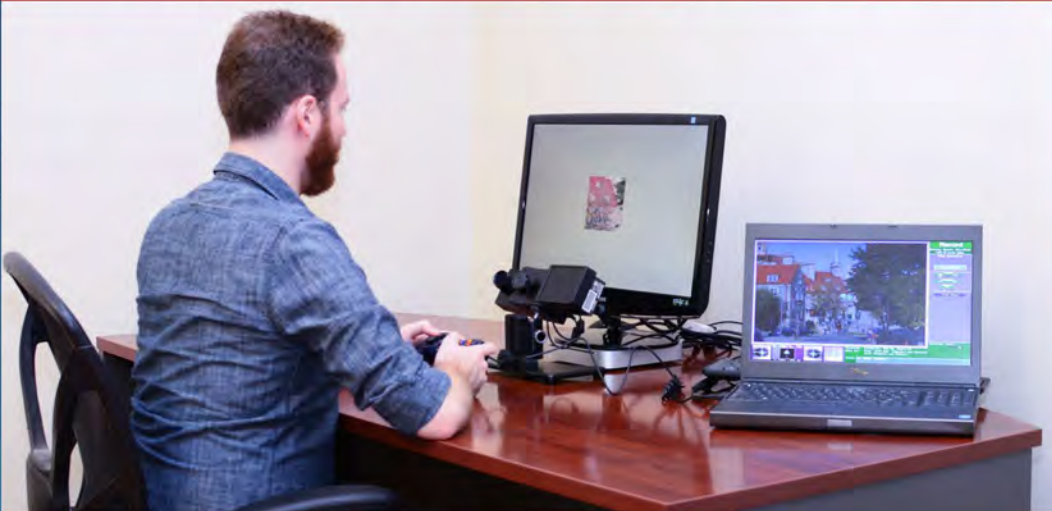


Fast, Accurate, Reliable Eye Tracking

EyeLink®

1000 PLUS

2000 Hz Standard with Every New EyeLink



Multiple Eye Tracking
Solutions in One



The EyeLink® 1000 Plus Eye Tracker

The EyeLink 1000 Plus is a uniquely flexible video-based eye tracking system, allowing researchers to customize their configuration for optimal data quality.

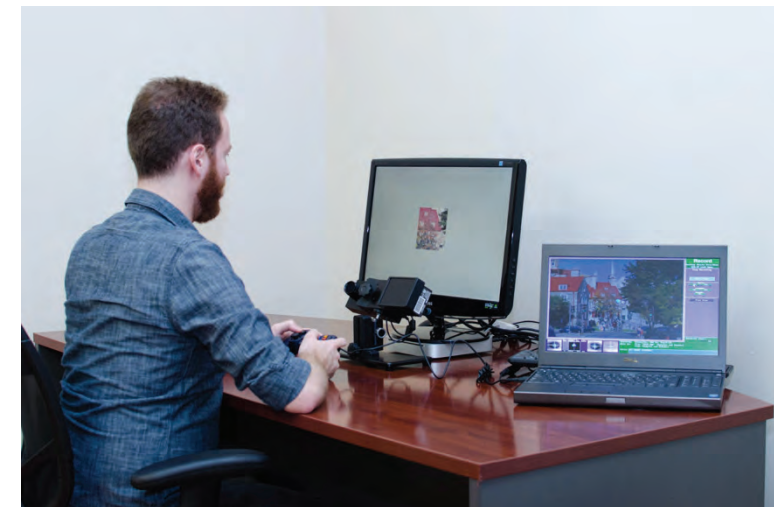
The EyeLink 1000 Plus:

- has outstanding technical specifications with low spatial noise and high sampling rates
- is the only eye tracker that allows seamless operation (software and technical performance) across environments from the behavioral laboratory to MRI to MEG to EEG and more
- has several interoperable camera mounting options (e.g., Desktop Mount, Arm Mount, Tower Mount, etc.) specialized to optimize particular eye-tracking tasks
- has interchangeable lenses to optimize image quality – this allows the experimenter to trade-off the size of allowable head movement against sample-level noise in Remote, head free-to-move mode

The EyeLink 1000 Plus is a high-performance measurement device that establishes the technical benchmarks that all video-based eye trackers strive to achieve.

One Camera, Many Different Eye Tracking Solutions

The EyeLink 1000 Plus camera has been designed specifically for eye tracking and interchangeably fits into different mounts that illuminate the eyes and position the camera in different ways to allow a flexible range of applications. From Head Free-to-Move Remote eye tracking with EEG, to tracking with fMRI or for high precision head-stabilized tracking, the same Core System (Host Computer and Camera) is used. The Core System can include either a Workstation or a Laptop Host PC for portability.



EyeLink 1000 Plus Core System EyeLink 1000 Plus Camera and Workstation or Laptop Host PC	Key Specifications	Head Supported	Remote (Head Free-to-Move)
	Sampling Rate	2000 Hz Monocular 2000 Hz Binocular	1000 Hz Monocular 1000 Hz Binocular
	Accuracy	Down to 0.15° (0.25° - 0.50° typical)	0.25-0.50° typical
	Resolution	0.01° RMS 0.05° Microsaccade resolution	0.05° RMS 0.25° saccade resolution
	Real-time Data Access	M = 1.4 msec (SD < 0.2 msec) @ 2000 Hz	M = 2.4 msec (SD < 0.3 msec) @ 1000 Hz
	Data Output	X, Y, and Pupil Size	
	Host PC	Workstation or Laptop Host PC	
	Participant Setup	Very simple and easy. Typically less than 2-5 minutes.	
Choose from five different mounts for your eye tracking tasks. Different infrared wavelengths available to minimize visibility or track in the dark.	Mounting Options		
	Desktop Mount	• Easy to transport • Track with the head free-to-move or with head supported • No electronics near the participant's head • Binocular or monocular eye tracking supported • Configurable 32° x 25° trackable range	
	Binocular Tower Mount	• Fast and easy setup • Ideal for close-up stimuli, touchscreens and reaching • 60° x 40° trackable range	
	LCD Arm Mount	• Bring the stimulus to the subject • Ideal for infant tracking or patients in a hospital bed • Configurable 32° x 25° trackable range	
	Long Range Mount	• Ideal for MRI or MEG • 60 - 150 cm eye-to-camera distances	
	Primate Mount	• Ideal for non-human primate tracking • 60° x 40° trackable range	
	The EyeLink 1000 Plus camera can be upgraded to allow extra functionality.	Camera Upgrades	
Remote (Head Free-to-Move)		A default Desktop or LCD Arm mount system can be transformed into a Binocular 1000 Hz Remote Head Free-to-Move eye tracker that does not require head stabilization.	
2000Hz		Beginning in the Spring of 2017, every new EyeLink 1000 Plus samples binocularly at up to 2000 Hz with the head stabilized, and 1000 Hz with the head free-to-move when the Remote Camera Upgrade is present. Existing owners can upgrade for a nominal fee. Please write info@sr-research.com for more information.	

Comprehensive Technical Support and Software

Every EyeLink 1000 Plus includes perpetual technical support at no additional cost or hidden annual fees. Our Research Support Specialist team spans two continents. They understand research, and they understand your need for fast assistance in collecting high-quality data.

All EyeLink eye tracking systems operate with the same application-programming interface for easy transitions between eye trackers and modes of eye tracking.

Free Software Development Kits (SDKs):

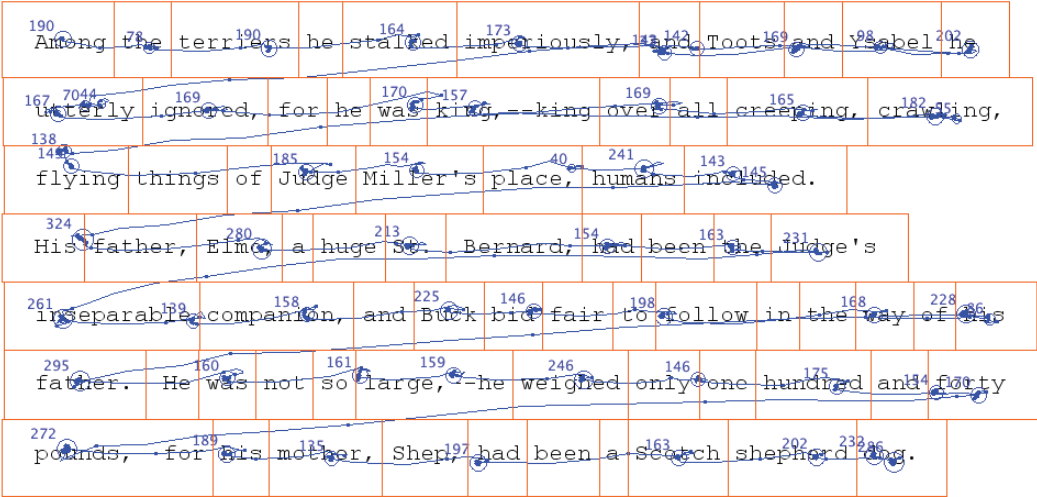
- are available for Windows XP / Vista / 7 / 8 / 10, Mac OS X, and Linux
- provide easy-to-follow examples written in C, COM interface, Python, Presentation, E-Prime, MATLAB via Psychtoolbox, and LabView

Free SR Research Screen Recorder software enables:

- video capture of eye movements overlaid on anything a Windows 7 computer can display (e.g., web browsing, interfaces, gaming, etc.)
- video and eye movement data to be imported into EyeLink Data Viewer where visualization and analysis tools can be used

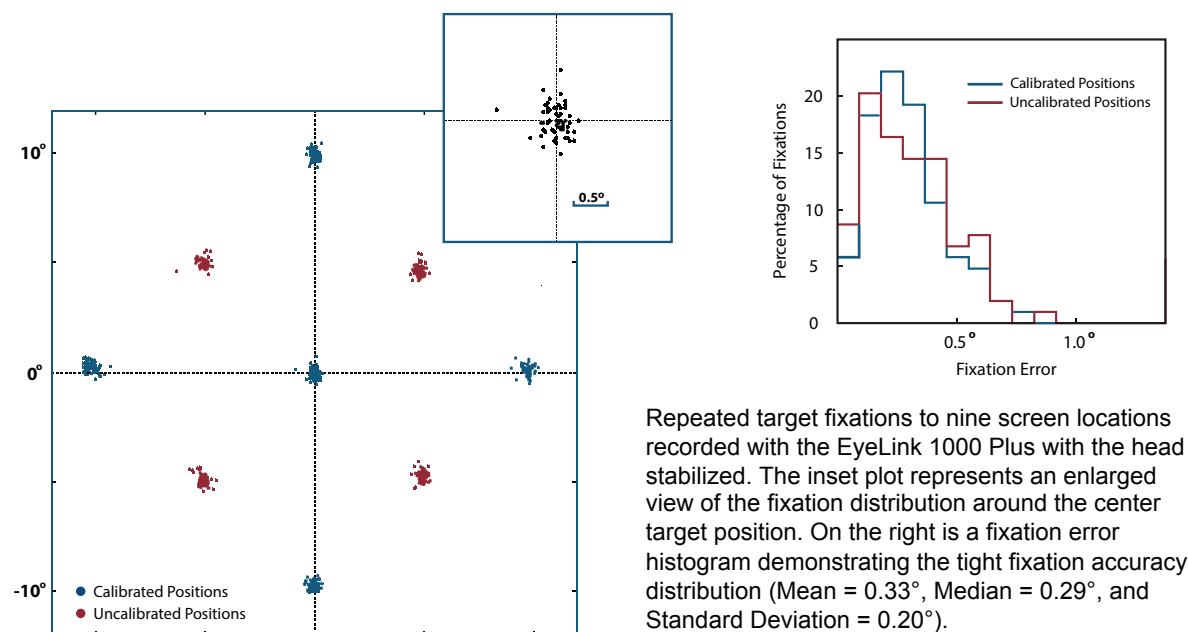
Experiment Builder and Data Viewer

SR Research makes cross-platform compatible Mac OS X and Windows software to assist users in working with the EyeLink 1000 Plus. SR Research Experiment Builder is a full-featured experiment delivery system designed to assist in quickly creating eye tracking paradigms. EyeLink Data Viewer allows quick visualization of the data and the creation of data reports that are formatted for import to statistical analysis programs. See pages 14 and 15 for details.



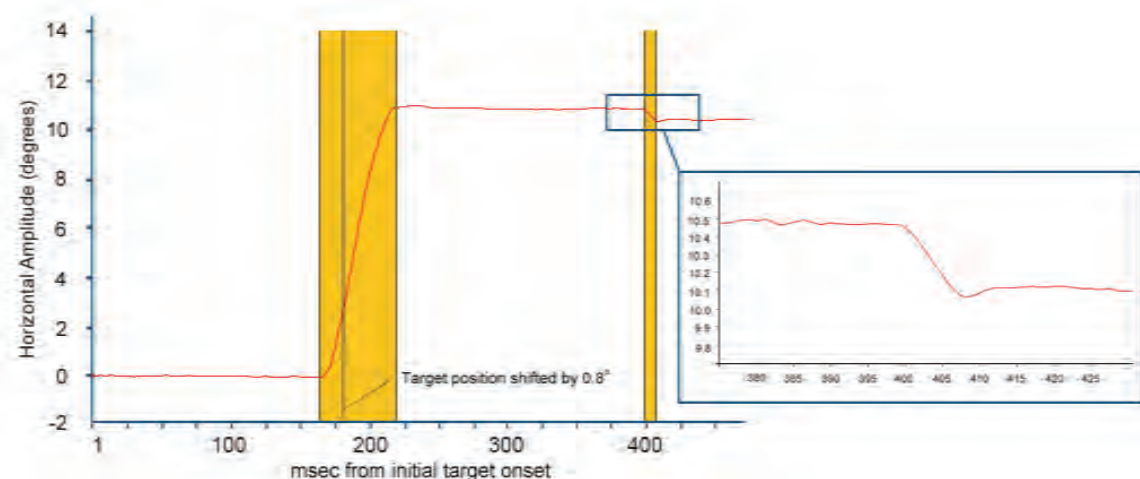
Simple reading data showing interest areas automatically generated by the Experiment Builder software, with eye traces and fixations overlaid using EyeLink Data Viewer.

Fixation Accuracy (Head Stabilized)



Saccade Resolution

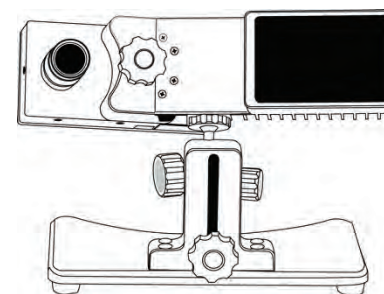
The EyeLink 1000 Plus has outstanding real-time data access to high-resolution data. Here, the participant made a saccade to a peripheral target that was moved by 0.8° about 21 msec after the saccade was initiated. A 0.33° corrective saccade lasting 8 msec occurred in the direction of the target position change.



Desktop Mount

Key Features:

- Supports
 - Remote Camera Upgrade, allowing Head Free-to-Move tracking
 - Monocular and binocular high-speed, high-precision recording
- No electronics near participant's head
- Camera-to-eye distances that are optimal between 40 and 70 cm
- Can track any computer monitor, projection screen or wall with a default 32° horizontal x 25° vertical trackable range above the camera
- 940 nm illuminator available for dark adapted environments



Our most popular mounting option for the EyeLink 1000 Plus, the Desktop Mount typically sits just below the tracked area the participant is viewing, whether it is a monitor, projection screen or wall. Since the EyeLink 1000 Plus camera and the infrared illuminator are 40-70 cm from the subject, no electronics need to be near the participant's head, perfect for EEG.

The EyeLink 1000 Plus with the Desktop Mount can be used with head support as an ultra-high resolution system, or as a highly accurate head free-to-move eye tracker without a head support (Remote Camera Upgrade sold separately).

Pupil Size Accuracy – Desktop and Tower Mounts

Pupil size data are available with every data point collected by the EyeLink 1000 Plus. To evaluate the level of accuracy obtained in pupil size measures, dots between 2.0 and 5.0 mm in diameter were laser printed, and the pupil area was measured for each. The diameter of each dot in system units was computed, and the percentage difference in reported diameter compared to the expected difference for each dot was:

5 mm (118 pixels - 125.53% of 4 mm) - 2652 area - 51.4976 diameter - 125.60% for +0.07% error
 4 mm (94 pixels - 100.00% of 4 mm) - 1681 area - 41.0000 diameter - 100.00% for 0.00% error
 3 mm (71 pixels - 75.53% of 4 mm) - 964 area - 31.0483 diameter - 75.73% for +0.20% error
 2 mm (47 pixels - 50.00% of 4 mm) - 435 area - 20.8567 diameter - 50.87% for +0.87% error

Measurement error is below 1% with under 0.2% error for 3 mm or greater sizes.

The second test was to see how well the system picked up smaller changes, so we used 4 dots of 4.1, 4.0, 3.9 and 3.8 mm and compared the reported sizes in relation to the 4.0 mm standard:

4.1 mm (96 pixels - 102.13% of 4 mm) - 1758 area - 41.9285 diameter - 102.26% for +0.13% error
 4.0 mm (94 pixels - 100.00% of 4 mm) - 1680 area - 40.9878 diameter - 99.97% for -0.03% error
 3.9 mm (92 pixels - 97.87% of 4 mm) - 1611 area - 40.1373 diameter - 97.90% for +0.03% error
 3.8 mm (90 pixels - 95.74% of 4 mm) - 1537 area - 39.2046 diameter - 95.62% for -0.12% error

Remote Camera Upgrade

Key Features:

- Make your EyeLink 1000 Plus the most accurate Remote, Head Free-to-Move eye tracker available
- Consistent sampling rate at up to 1000 Hz binocularly
- 0.5 degree average accuracy
- 2 msec blink recovery time
- Access eye position data with a 2.4 msec delay
- 40 × 40 cm (horizontal × vertical) head box at a 70 cm camera distance
- Extends functionality of the Desktop Mount or LCD Arm Mounts

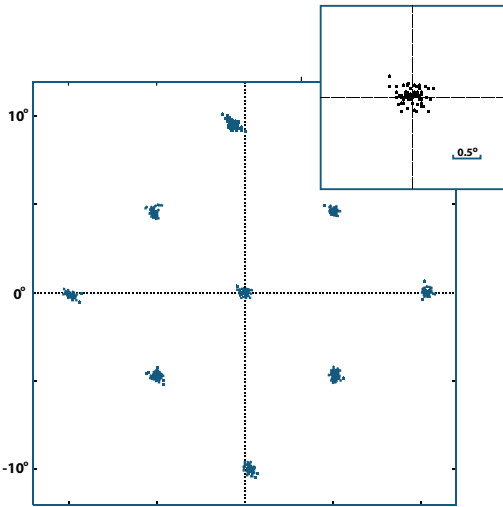
The Remote Camera Upgrade is designed for areas of eye tracking research where head stabilization is not desirable (e.g., EEG, TMS or for use with infants, children and special populations), but high accuracy and resolution are still important. With the Remote Camera Upgrade and the Desktop or LCD Arm Mount, the EyeLink 1000 Plus can be switched between head supported and remote operating modes in under a minute.

Head distance is accurately measured at up to 1000 Hz using a small target sticker allowing head compensation even during blinks, and providing an extremely fast 2 msec blink recovery time.

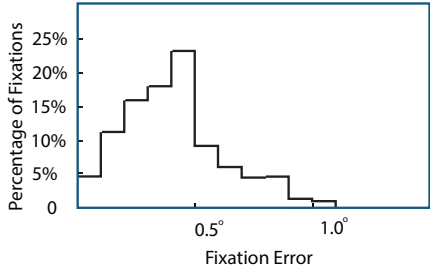
With true 1000 Hz binocular recording, the Remote Camera Upgrade provides reliable fixation, saccade, and blink event onset times and durations. The real-time data access and consistent temporal resolution make it the ideal head-free remote eye tracker for gaze-contingent and gaze-controlled applications.



Fixation Accuracy (Remote, Head Free-to-Move)



Accuracy was assessed without a head support using the Remote Camera Upgrade. Repeated target fixations to nine screen locations resulted in the low error levels demonstrated by the fixation error histogram below (Mean = 0.41°, Median = 0.40° and Standard Deviation = 0.22°). The inset plot is an enlarged view of the fixation distribution around the center target position. See Page 4 for analogous data using head-stabilized tracking.



Arm Mount

Key Features:

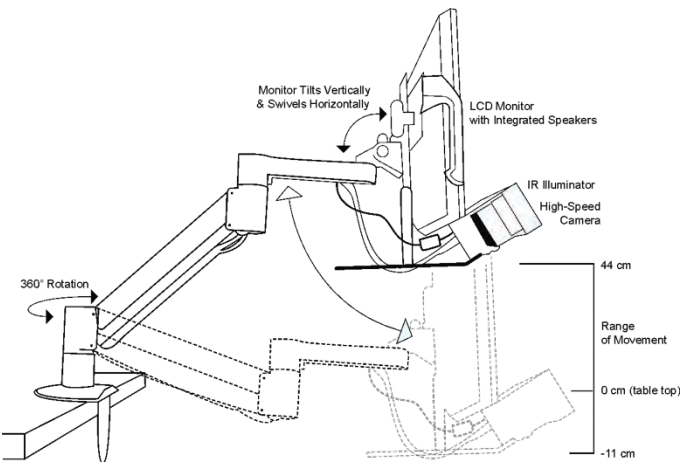
- Easily position the eye tracker and integrated LCD monitor in front of the subject
- Supports the Remote Camera Upgrade, allowing Head Free-to-Move tracking
- Perfect for tracking infants or patients from the bedside
- 32° horizontal x 25° vertical trackable range above the camera
- 940 nm illuminator available for dark adapted environments or infant research

The EyeLink 1000 Plus LCD Arm Mount is an easily-positioned hydraulic arm holding an LCD monitor with the camera and illuminator mounted beneath it. The entire eye tracking apparatus and display can be easily moved into place in front of the participant.

Combined with the Remote Camera Upgrade, this solution is ideal for reaching viewers in difficult-to-record positions or where head stabilization is simply not desirable.



(Photo: Boaz Ben-David)



Tower Mount

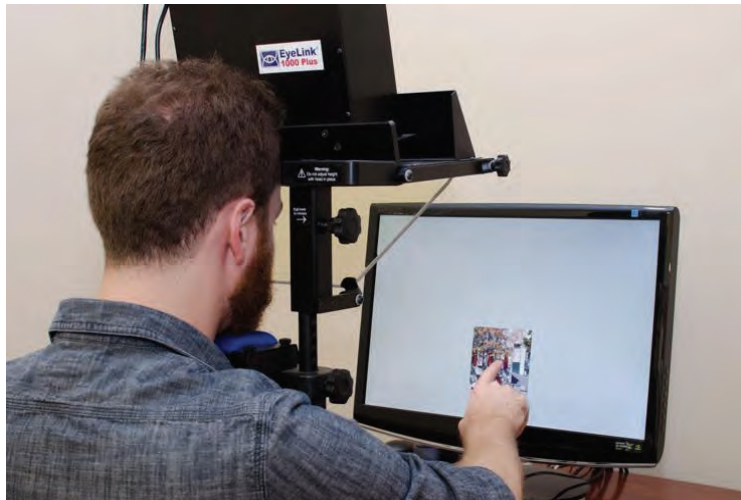
Key Features:

- Binocular or monocular 2000 Hz high-speed, high-precision recording
- Large 60° horizontal x 40° vertical trackable range
- Integrated high quality headrest; chinrest usage is optional
- Useful for experiments that use a touch screen monitor or require pointing, writing or drawing
- 940 nm illuminator ideal for dark adapted environments

The Tower Mount for the EyeLink 1000 Plus uses an infrared hot mirror to maximize the field of view. The mirror is transparent to visible light but reflects the infrared light used to illuminate the participant's eye.

Since the camera views the eye from above, participants are free to use their arms in tasks such as reaching to a touch screen monitor. Ask us how to customize the Tower Mount for pointing, writing, or drawing applications.

The EyeLink 1000 Plus camera can be easily detached from the Tower Mount and transferred to any other mount.

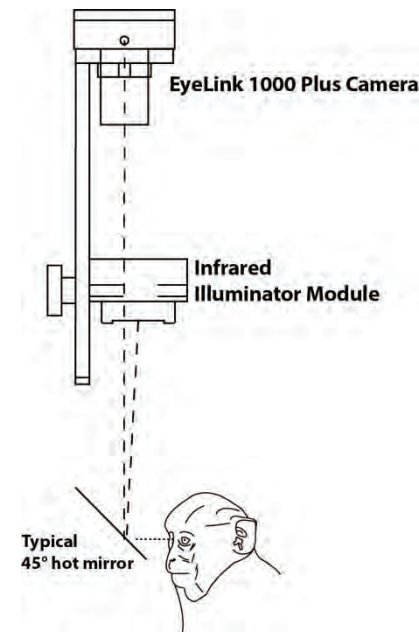


Primate Mount

Key Features:

- Binocular or monocular 2000 Hz high-speed, high-precision recording
- Large 60° horizontal x 40° vertical trackable range
- 910 and 940 nm illuminators available for low visibility
- Camera-to-eye distances between 35 and 45 cm
- Analog output option provides simple replacement for existing coil setups
- Digital gain and offset adjustments of data from the Host Software

The Primate Mount for the EyeLink 1000 Plus system holds the camera and an infrared illuminator in a compact bracket that is typically affixed to a vertical surface such as a primate chair. An infrared reflecting hot mirror is used to project the viewer's eye to the camera. This allows accommodation of a wide range of unique viewing setups within very small space requirements. The higher wavelength 940 nm illuminator minimizes the visibility to non-human species.



The EyeLink 1000 Plus eye tracker outputs eye position and pupil size data in either digital or analog formats. Both outputs can be linearly calibrated using the built-in offset and gain adjustments. The gain and offset adjustment states can be saved and reloaded at a later date, allowing for easy switching between participants.

It is also possible to calibrate the participant using our built-in calibration procedures for non-linear data calibration.

Many non-human primate researchers use our Desktop Mount. This approach has a fast and easy setup that does not require the use of a hot mirror or any custom mounting to the chair. See Key Features of the Desktop Mount on Page 5.

MRI and MEG Long Range Eye Tracking

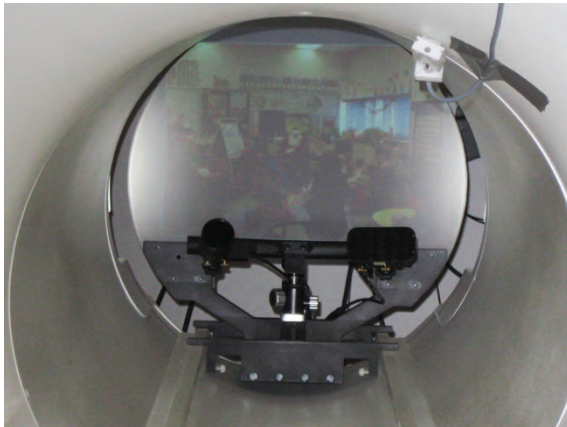
Key Features:

- The EyeLink 1000 Plus is the most accurate and lowest noise eye-tracker for MRI and MEG
- Seamless software operation and identical interface for laboratory and scanner eye-tracking
- Every EyeLink 1000 Plus is dual-use in MRI and behavioral laboratory with appropriate mounts
- A Fiber Optic Camera Head extends the EyeLink 1000 Plus for use in MRI and MEG
- Supports high-speed (up 2000 Hz monocular), high-precision recording with < 0.5° error
- Long camera-to-eye distances between 60 and 150 cm
- Compatible with multiple head coils and scanners
- 32° x 25° trackable range
- 940 nm illuminator available for dark adapted environments

Every EyeLink 1000 Plus core system has the potential for dual-use in the behavioral laboratory and in MRI/MEG where it is the world's most accurate and highest spatial and temporal resolution eye tracker. With the addition of a Fiber Optic Camera Head, Long Range Illuminator, and appropriate accessory components, the core 1000 Plus can be used in MRI and MEG.

A range of specialized Long Range mounts position the Camera Head and Long Range Illuminator for tracking in these sensitive environments. Installation is relatively easy and between-subject setup is typically very quick.

The EyeLink 1000 Plus for MRI operates optimally when positioned on the head-side of the subject with an out-of-bore screen or our own in-bore back-projection screen. Based on your site's operating environment we will recommend the optimal set of components – ask for our MRI Questionnaire.



Installations with CTF, Elekta, 4D Yokohama and other MEG manufacturers.

Compatible with a wide range of MRI scanner models to date, including:

- Philips Achieva
- Siemens Prisma, Trio, Skyra, Verio, Allegra and Magnetom 7T systems
- GE Signa and Discovery series
- Bruker and other MRI manufacturers

Works with multiple head coils, including:

- Siemens 8, 12, 20, 32, and 64 channel head coils
- Philips 32 channel head coil
- GE 32 channel head coil
- Nova Medical head coils

Inquire about your scanner, head coil and MRI eye tracking needs, and we will propose solutions.

MRI Tray Mount with Back Projection Screen

Key Features:

- Rests in end of scanner bore supported by bed rails
- Holds optional high-quality back projection screen
- Compatible with out-of-bore projection screens or LCD displays
- Screen-holder available for user-supplied screen
- Optimally positions EyeLink 1000 Plus Fiber Optic Camera Head and Illuminator mounting bar
- Easily removed when not in use

EyeLink 1000 Plus Tray Mounts are inserted into the head-side of the bore where they hold both the eye tracker and an optional high-quality back-projection screen. The entire apparatus is easily inserted or removed from the bore.

Tray Mounts with screens are available for the Philips Achieva, and Siemens Prisma, Trio, Verio and Skyra scanners.



Screen Clamp Mount and Stand

Key Features:

- General purpose Long Range Mount
- Allows lateral adjustment of the eye tracker without disrupting the visual display
- Can be clamped to many user-supplied out-of-bore back-projection screens
- Ready to be affixed to an optional stand
- Easily removed when not in use



The Screen Clamp Mount is a Long Range Mount for MRI or MEG.

In MRI the Mount clamps to an optional Aluminum Stand and positions the eye tracking hardware outside of the bore where it is easily accessed and adjusted.

In MEG the Screen Clamp Mount affixes directly to the bottom of an Elekta or user-supplied back-projection screen.

Other MRI and MEG solutions exist ... ask us about your setup!

Analog Card (for Workstation Host PC)

Key Features:

- Converts the x, y and pupil size data into analog voltages
- Consistent and accurate analog time base, with very little inter-sample jitter
- Digital input/output can be used for synchronization with external devices

The Analog Card accessory converts the native digital eye data to 16-bit analog signals in real-time using hardware interrupt driven processing. The X and Y position data (gaze position, HREF or RAW) and pupil size data are sent out every sample (up to 2000 Hz) in a programmable range between +/- 10 volts. The Analog Card also features 16-bits of digital input/output, which can be used for the TTL triggering of recording start / end or synchronization of the digital eye data file with external devices. The analog output option is only available for the Workstation Host PC.

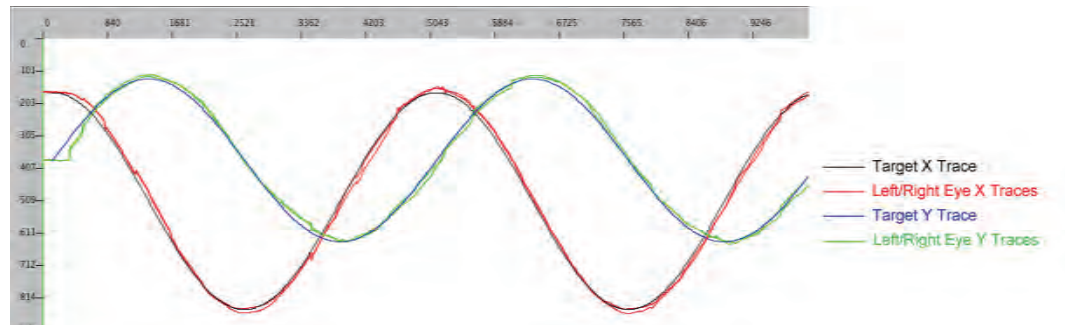


2000 Hz Camera Upgrade

Key Features:

- Enables up to 2000 Hz binocular high-speed sampling rate
- Enables low noise 2000 Hz monocular sampling mode
- With the Remote Camera Upgrade allows 1000 Hz binocular head free-to-move tracking
- Access eye position data with <1.4 msec delay
- Included standard with every new EyeLink 1000 Plus

The 2000 Hz Binocular High Speed Camera Upgrade allows the EyeLink 1000 Plus camera to sample eye movements at up to 2000 Hz binocularly or in a low-noise 2000 Hz monocular mode. With the Remote Camera Upgrade, the same camera can sample at up to 1000 Hz binocularly with head free-to-move tracking. The 2000 Hz upgrade provides the fastest possible eye position access, and is therefore ideal when the system is being used for gaze-contingent display manipulations. The following figure shows a 1000 Hz binocular recording of X, Y eye traces in a sinusoidal pursuit task.



Onsite Training

Key features:

- Includes
 - Onsite software training tailored to individual research goals
 - Installation and commission of standard hardware
 - All travel expenses
- You decide how large of an audience to include

Our Research Support Specialists are highly experienced with academia and eye tracking as well as being technically knowledgeable and capable. Staff consists of former faculty and graduates of Cognitive Neuroscience, Vision Sciences, Reading and Psychology, with extensive expertise in all aspects of eye tracking research. We are keenly aware of the research methods and considerations involved in obtaining the highest quality data possible.

During Onsite Training, one of our Research Support Specialists will visit your lab, set up the EyeLink equipment, and train you and your colleagues on best practices for collecting eye movement data. The training session can be tailored to your research goals, and often includes creation of an initial Experiment Builder project that can be used immediately to start collecting usable data. Typical site visits are one and a half days.

Onsite installation is highly recommended for MRI and MEG to ensure the system is functioning optimally in these highly variable environments.

SR Research Head Support

Key Features:

- Robust, high quality design and manufacturing
- Clamps on top of the table so there is no interference with participant's legs
- Allows separate adjustment of chin position in depth, or remove chin or forehead support components completely
- Can be used with or without the supplied gel pads
- Ideal for Eye Tracking, Psychophysics, or any Psychology experiment

The SR Research Head Support is an extremely sturdy, high quality chin and forehead rest suitable for use in any behavioral research laboratory. It was specially designed for the EyeLink 1000 Plus in head-supported modes and forms the base of the Tower Mount.

Importantly, the chin support can be adjusted in depth for extra comfort and better head positioning. The design of the head support allows for use of just the chin rest if desired (e.g., useful for EEG experiments in which you want to avoid putting pressure on the frontal electrodes), or just the forehead rest (e.g., useful for tasks involving speech production).



Additional Host Computer

Key Features:

- A complete EyeLink 1000 Plus Host computer, with all necessary cabling
- Choose from a Laptop or a Workstation PC
- Useful for tracking in multiple settings
- Cost effective - one eye tracker can be easily used at different locations



With multiple Host PCs, you can easily move the camera and mount between eye-tracking locations. Or if you have multiple mounts, move only the camera!

Example scenarios:

- A Workstation Host PC could be set up in a behavioral laboratory and another one could be stationed in an MRI control room, requiring only the camera to be transported between sites
- A Laptop Host PC could be used for school, hospital, or home visits while leaving a Workstation Host PC setup in the lab

Stimulus Presentation Hardware

SR Research carefully measures audio and visual stimulus delivery times and can provide highly optimized Display PCs with known timing properties. These computers are provided as a service to our customers and come preconfigured with SR Research software allowing high performance for even the most demanding tasks.

All of our PCs have:

- ASIO hardware for +/- 2 msec audio synchronization accuracy under Windows
- Under 2 msec visual synchronization with appropriate LCD or CRT monitors
- Parallel port hardware options for TTL synchronization with other devices
- An extra Ethernet Port dedicated and configured for the EyeLink
- A DVD R/W device
- Windows 7 or 10

In addition to Display PC hardware, SR Research can provide LCD displays and CRTs with known timing properties (up to 240 Hz vertical refresh rates) that are ideal for gaze-contingent paradigms. Please inquire about the hardware we have available.

EyeLink 1000 Plus Technical Specifications

	EyeLink 1000 Plus					
	Binocular Tower	Primate	Desktop	Arm Mount	Long Range	Remote Option
Sampling Rate	Monocular or Binocular 250, 500, 1000, 2000 Hz					Monocular or Binocular 250, 500, 1000 Hz
Eye Tracking Principle ¹	Pupil with CR	Pupil-only Pupil with CR	Pupil with Corneal Reflection (CR)			
Average Accuracy ²	Down to 0.15° (0.25° to 0.5° typical)					0.25 to 0.5° typical
Saccade Event Resolution	0.05° microsaccades					0.25°
Spatial Resolution ³	0.01°					
Noise with Participants ²	1000 Hz: 0.02°/ 0.01°/ 0.01° 2000 Hz (monoc): 0.03°/ 0.02°/ 0.01° 2000 Hz (binoc): 0.04°/ 0.02°/ 0.02°					25 mm lens 500 Hz: 0.03°/ 0.02°/ 0.01° 1000 Hz: 0.05°/ 0.03°/ 0.01° 16 mm lens 500 Hz: 0.06°/ 0.03°/ 0.01° 1000 Hz: 0.08°/ 0.04°/ 0.02°
Filter (Off / Normal / High)						
End-to-End Sample Delay ⁴	M = 1.34 msec, SD = 0.20 msec @ 2000 Hz M = 1.97 msec, SD = 0.39 msec @ 1000 Hz					1000 Hz: M=2.19 msec, SD = 0.30 500 Hz: M=3.29 msec, SD=0.58
Blink Recovery Time	1.0 msec @ 1000 Hz 0.5 msec @ 2000 Hz					2 msec @ 500 Hz 1 msec @ 1000 Hz
Pupil Detection Models	Centroid or Ellipse Fitting					Ellipse Fitting
Pupil Size Resolution ²	0.1% of diameter					0.2% with 16 mm lens 0.1% with 25 mm lens
Gaze Tracking Range	60° horizontally X 40° vertically		Customizable - 32° horizontal X 25° vertical			
Allowable Head Movement	±25 mm horizontal or vertical					35 x 35 cm at 60 cm 40 x 40 cm at 70 cm (horizontal x vertical)
Optimal Camera-Eye Distance	Fixed at 48 cm	30 - 45 cm	40 - 70 cm		60 - 150 cm	40 - 70 cm
Glasses Compatibility	Good		Excellent			Good
Infrared Wavelength	940 nm	910 /940 nm	850 nm to 940 nm			
On-line Event Parsing	Fixations / Saccade / Blink / Fixation Update					
EDF File and Link Data Type	Gaze, Raw, and HREF eye position data / Pupil size / Online events / Buttons / Messages / Digital inputs					
Real-time Operator Feedback	Eye position gaze cursor superimposed on static image or position traces with camera images and tracking status					
Safety and Certifications	Safety: IEC 60950 (ITE) and national variants. Illuminators: Class 1 LED product, IEC 62471 or IEC 60825. Fiber link: Class 1 laser product, IEC 60825-1, 21 CFR (Laser Notice 50).					

Specifications are subject to change without notice. Availability of some features depends on options purchased.

- 1. Pupil-only tracking mode is available for use in head fixed conditions.
- 2. Measured with real subject fixations.
- 3. Unfiltered data measured with an artificial eye.
- 4. Time from physical event until first registered sample (unfiltered) is available via Ethernet or Analog output.

SR Research

Fast, Accurate, Reliable Eye Tracking

www.sr-research.com

SR Research



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