Eyelink眼动仪原理和操作简介

SR—Research 中国代表处

北京博润视动科技有限公司

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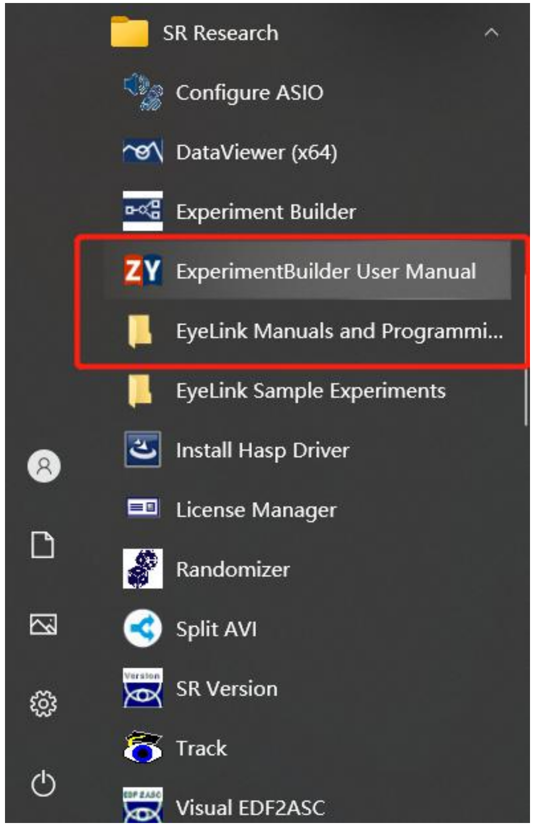
学习资源

SR Research官网：https://www.sr-research.com/

SR Research论坛：https://www.sr-support.com/

学习资源

手册



EyeLink® 1000 Plus User Manual

Desktop, LCD Arm, Tower, Primate and Long Range Mounts

Remote, 2000 Hz and Fiber Optic Camera Upgrades

Version 1.0.17

SR Research EyeLink

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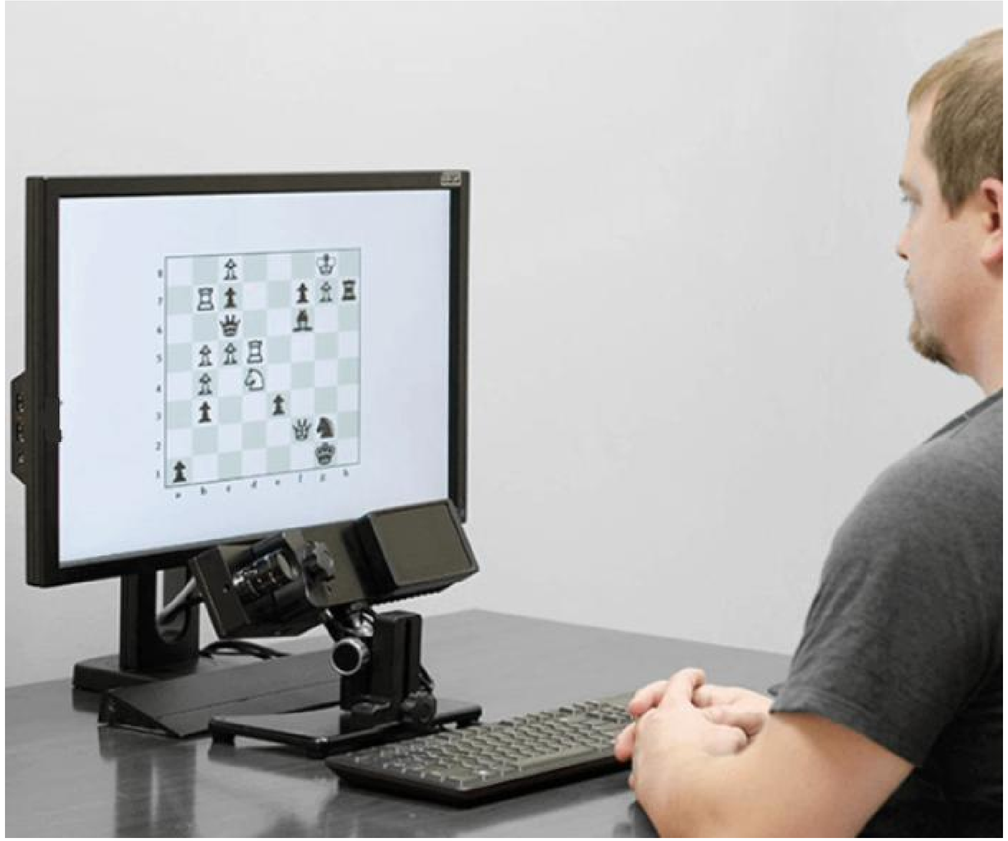
眼动原理

What——什么是眼动追踪？



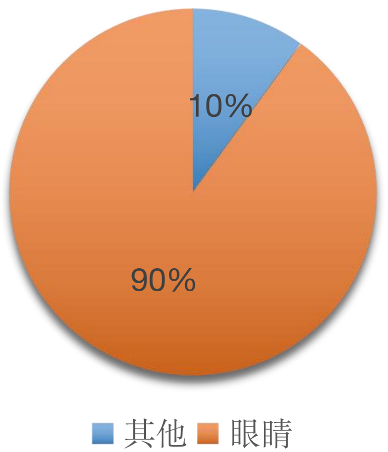
Why——为什么要进行眼动追踪

每天，我们从外部世界获得的信息中有90%以上来自眼睛。

心理学家认为眼球运动是视觉过程的直接反应，并且反映了多种人类认知活动，受到多种认知因素的影响，如眼球的运动与注意、预期、记忆、推理、阅读等认知活动都有密切的关系。

眼动追踪最常见的一个基本原理是“**脑-眼假说**”。它认为，我们在看某些信息时，这是我们的大脑在控制的。所以说，通过监测眼动的变化，就可以推断出大脑中正在发生的事情。

“心灵之窗”

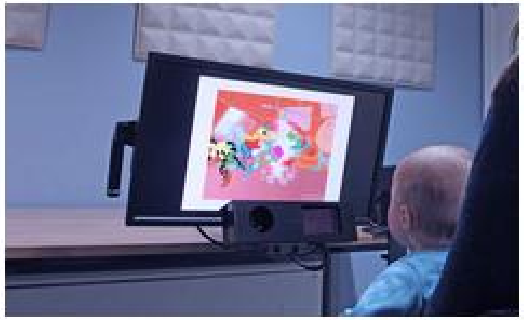


Why——为什么要进行眼动追踪

Reading & Language

Relevant Publications

Eye-tracking solutions for research in reading and spoken language comprehension.



Developmental

Relevant Publications

Understanding the development of cognitive, perceptual, social, and linguistic processes, from infants to the elderly.

fMRI & MEG

Relevant Publications

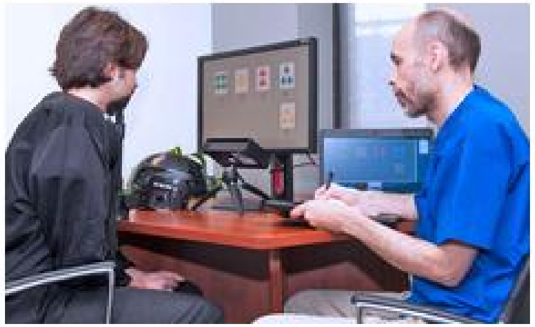
The world's most popular and effective solution for eye tracking in MRI/MEG environments.

EEG & fNIRS

Relevant Publications

Combine eye tracking with a range of other neurophysiological recording techniques for deeper insights.

Why——为什么要进行眼动追踪



Clinical & Oculomotor

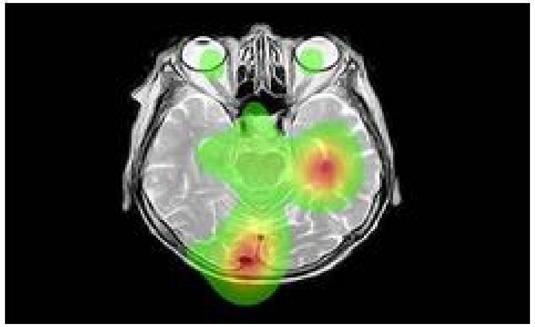
Relevant Publications

Research into oculomotor and cognitive dysfunction due to neuropsychiatric disorders.

Cognitive

Relevant Publications

Insights from eye tracking into attention, memory, decision making, and more.



Usability & Applied

Relevant Publications

Eye-tracking research out of the lab – solutions for usability and more.

Non-Human Primate

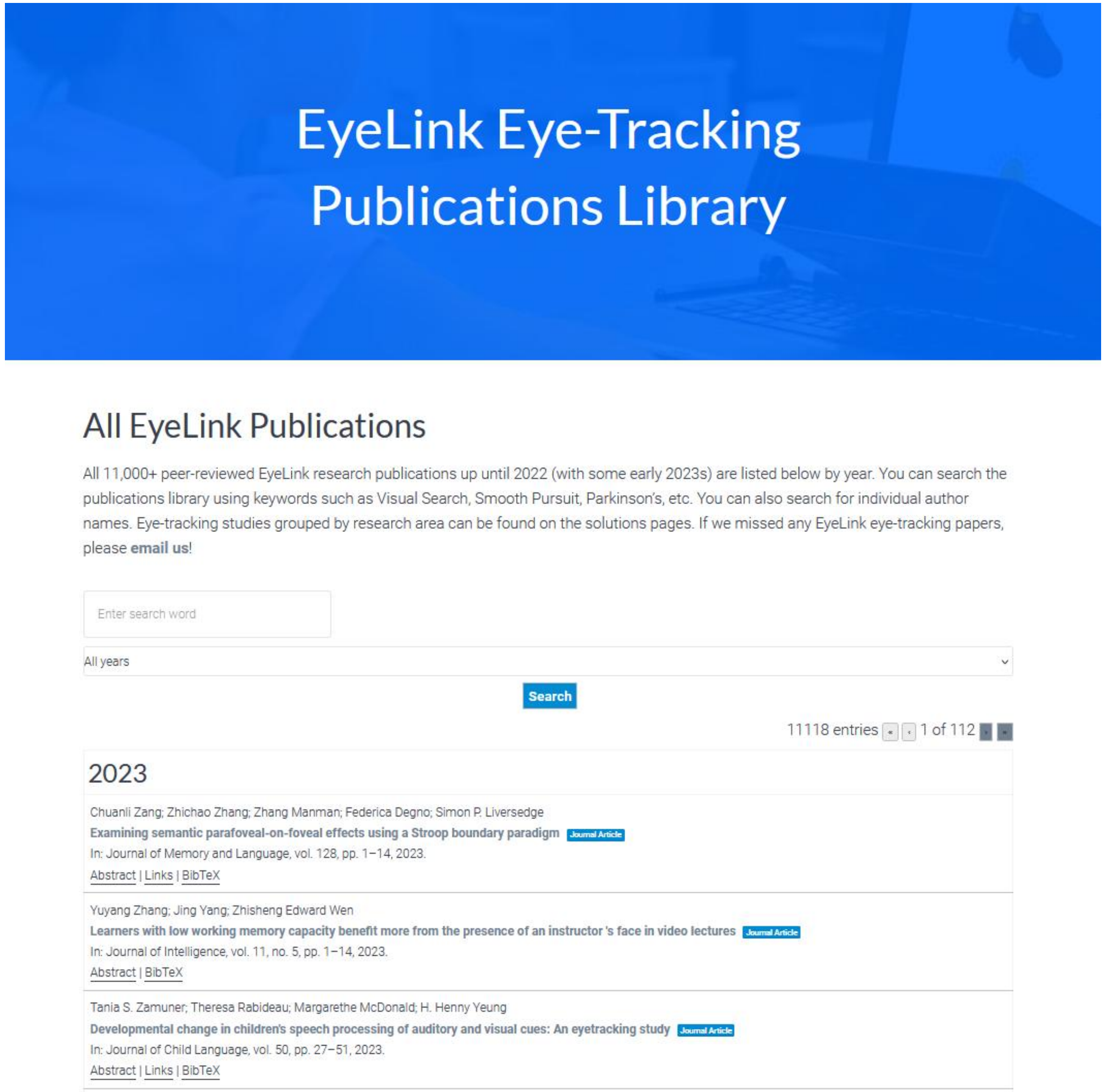
Relevant Publications

Fast, accurate, reliable, and non-invasive eye-tracking for non-human primates.

Why——为什么要进行眼动追踪

#眼动文章 详情 >

- 82. 香港理工大学研究人员利用EyeLink眼动仪揭示粤语和普通话双语者对L1和L2中情感同源词感知的瞳孔测量研究
- 81. 天津师范大学研究团队使用EyeLink眼动仪和Stroop边界范式揭示阅读过程中是否存在语义副中央凹-中央凹效应
- 80. 首都师范大学研究人员利用眼动追踪技术和快速自动命名任务揭示ADHD和发展性阅读障碍的共同发病机制
- 79. 中山大学中山眼科中心利用眼动技术揭示无弱视的斜视眼患者表现出视觉拥挤的情况
- 78. 广东外语外贸大学研究团队利用眼动技术揭示学习者的工作记忆能力（WMC）与视频授课中教师在场的影响作用
- 77. 西藏大学利用EyeLink眼动仪揭示音节边界在藏语阅读中的作用
- 76. 心理学报 | 南开大学研究团队利用眼动技术进行跨期决策中的维度差异的眼动偏好
- 75. 南方医科大学研究人员利用EyeLink 1000 Plus眼动仪揭示大学生失败内隐观与抑郁症状和情绪面孔加工的关系
- 74. 华中科技大学研究人员利用EyeLink揭示失恋经历对爱情相关刺激注意偏向的影响: 趋近还是回避?
- 73. 陕西师范大学体育学院利用EyeLink 1000 plus眼动仪对定向运动员识图决策与视觉搜索过程进行眼动研究



EyeLink Eye-Tracking Publications Library

All EyeLink Publications

All 11,000+ peer-reviewed EyeLink research publications up until 2022 (with some early 2023s) are listed below by year. You can search the publications library using keywords such as Visual Search, Smooth Pursuit, Parkinson's, etc. You can also search for individual author names. Eye-tracking studies grouped by research area can be found on the solutions pages. If we missed any EyeLink eye-tracking papers, please **email us**!

Enter search word

All years

Search

11118 entries 1 of 112

2023

Chuanli Zang; Zhichao Zhang; Zhang Manman; Federica Degno; Simon P. Liversedge
Examining semantic parafoveal-on-foveal effects using a Stroop boundary paradigm Journal Article
In: Journal of Memory and Language, vol. 128, pp. 1–14, 2023.
Abstract | Links | BibTeX

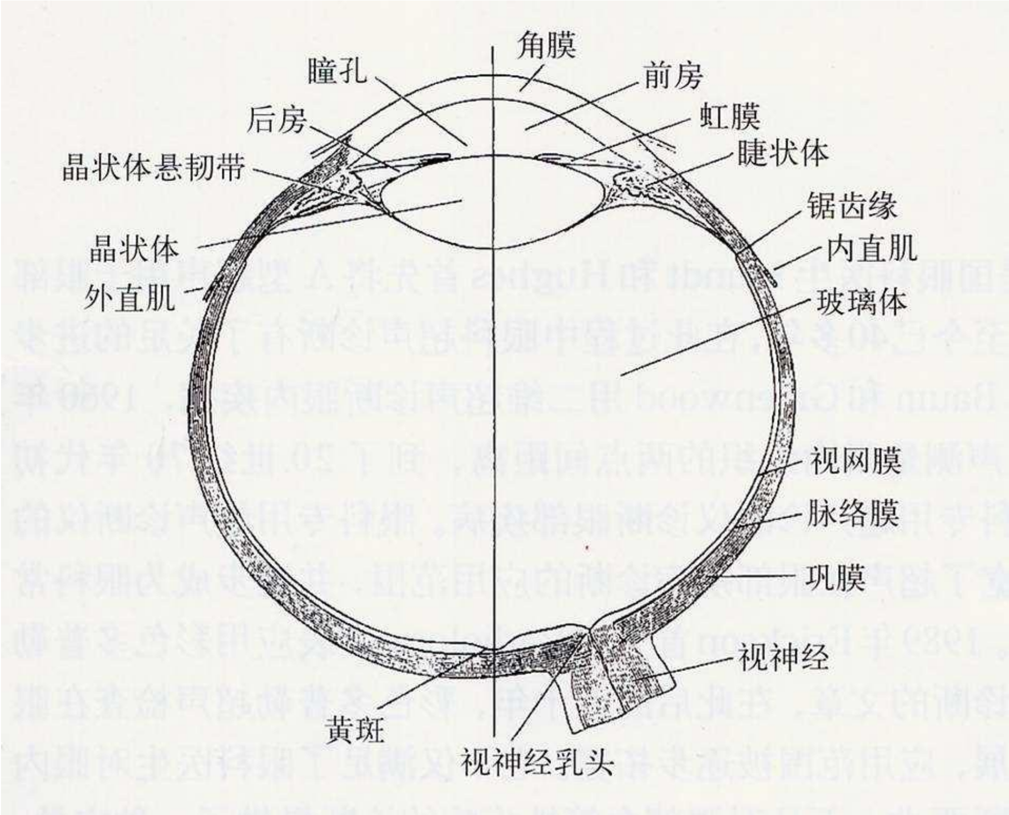
Yuyang Zhang; Jing Yang; Zhisheng Edward Wen
Learners with low working memory capacity benefit more from the presence of an instructor's face in video lectures Journal Article
In: Journal of Intelligence, vol. 11, no. 5, pp. 1–14, 2023.
Abstract | BibTeX

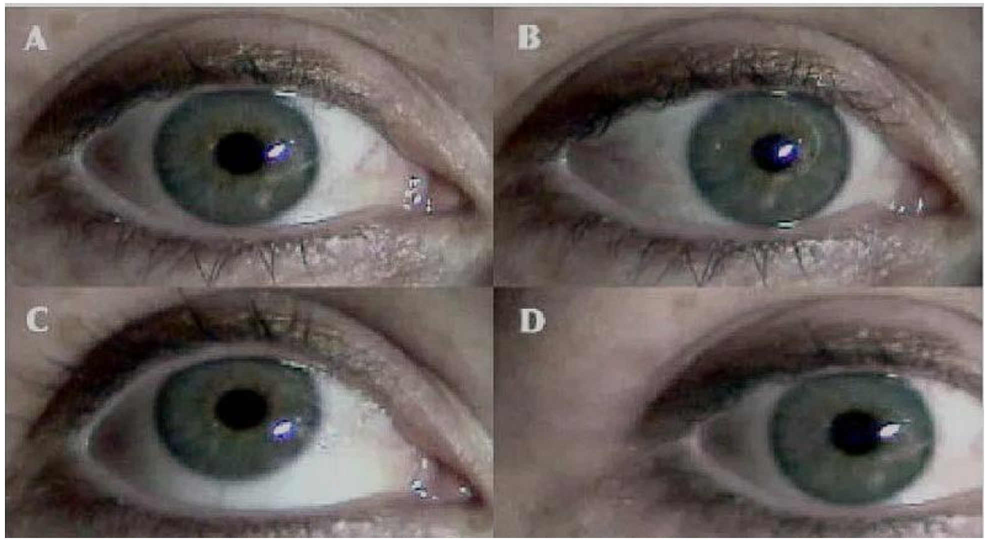
Tania S. Zamuner; Theresa Rabideau; Margarethe McDonald; H. Henny Yeung
Developmental change in children's speech processing of auditory and visual cues: An eyetracking study Journal Article
In: Journal of Child Language, vol. 50, pp. 27–51, 2023.
Abstract | Links | BibTeX

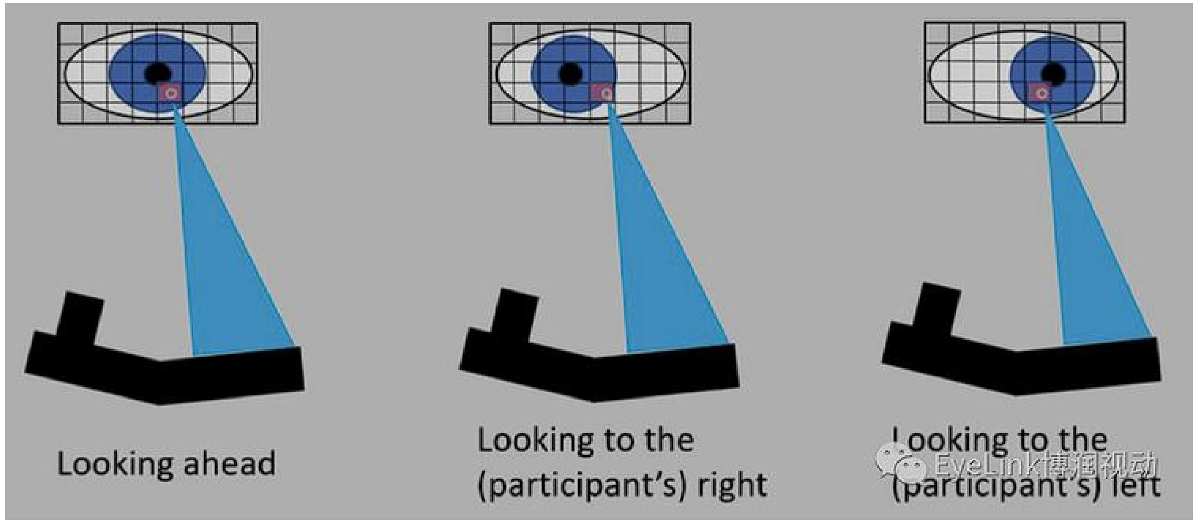
Where——眼睛的生理结构

https://www.bilibili.com/video/BV1Ro4y1C7Do?t=55.2

Where——眼睛的生理结构







How——怎么进行眼动追踪?

观察法

Javal在1897年曾用一面镜子直接观察被试的眼动……

Miles（1928）使用窥孔法（peep–hole method），在被阅读的材料中间挖一个直径为0.25英寸的小孔，主试与被试面对面坐着，主试为被试拿着材料并遮挡住自己的脸，于是可以通过小孔观察被试阅读该文章时的眼动……

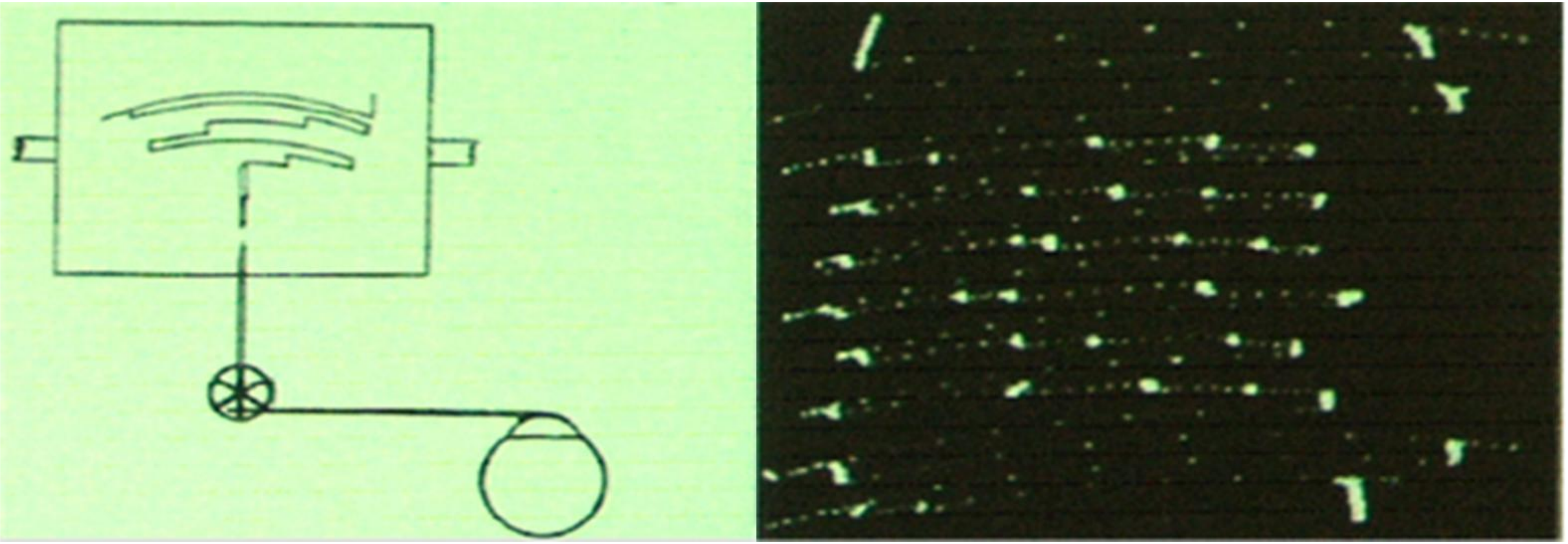
Freeman 1916年设计了一种装有镜子的小型头盔，使主试可以在被试身后进行观察……

Ohrwall 1912年使用了一架显微镜，放在离被试很近的地方，将显微镜的镜头对准被试眼睛中的一根小血管，主试注意观察血管的移动，借此来了解眼动情况。”

——《眼动研究心理学导论—揭开心灵之窗奥秘的神奇科学》(闫国利，白学军，2012)

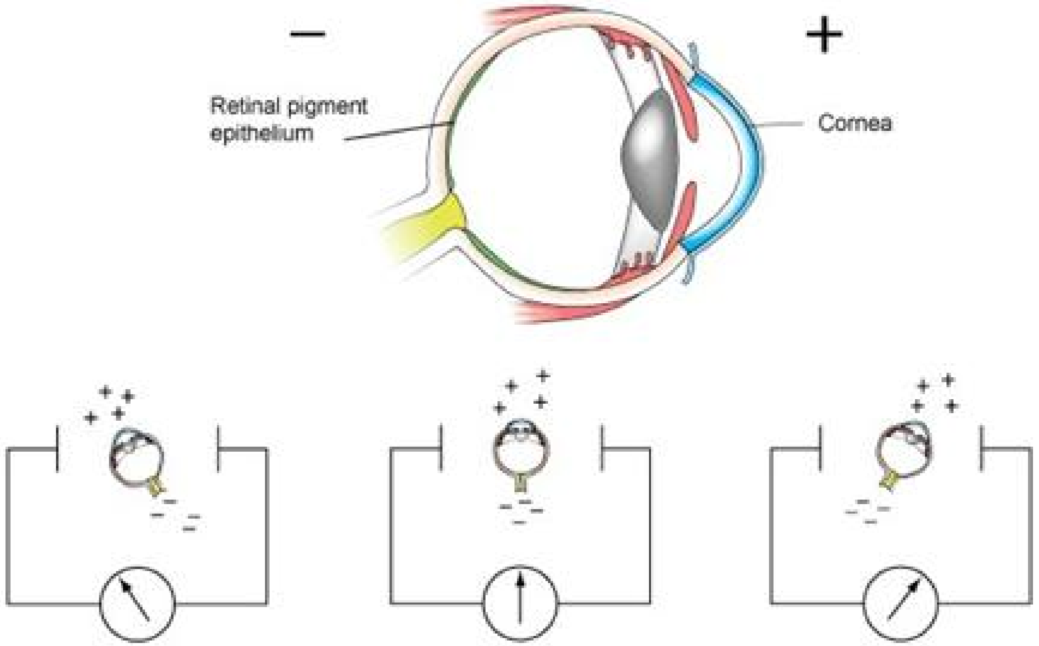
How——怎么进行眼动追踪?

早期尝试——机械记录法



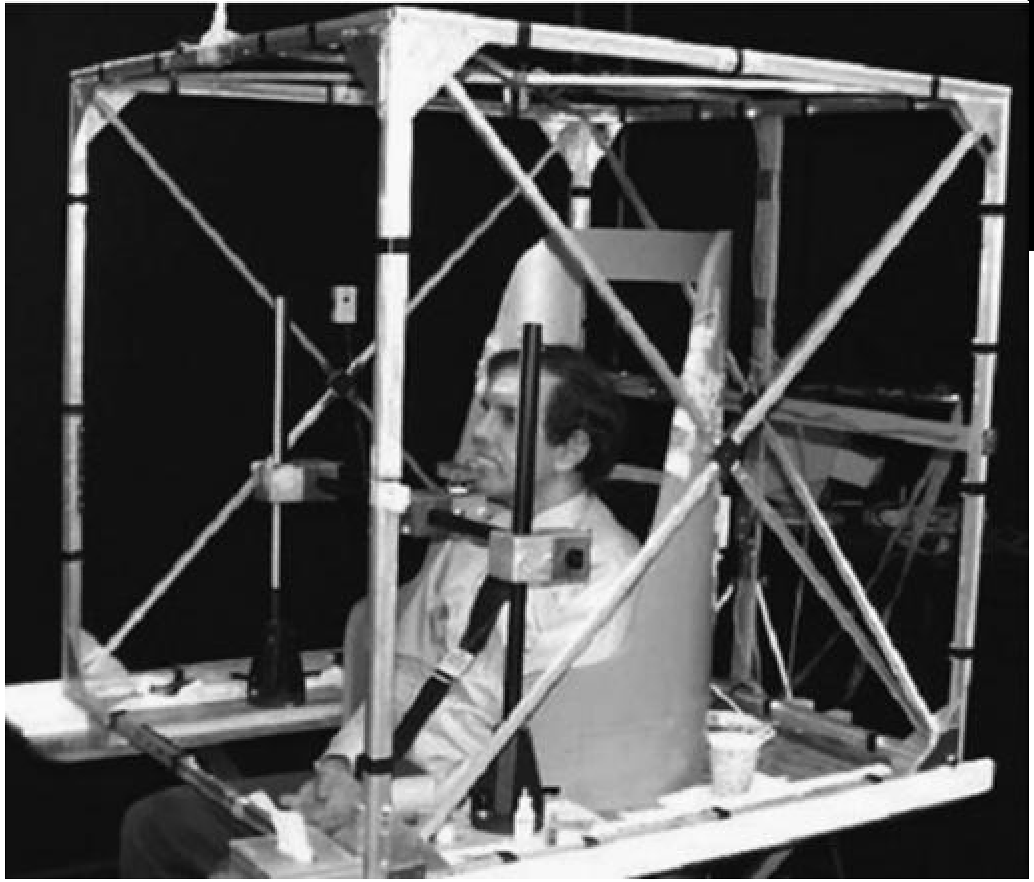
1897年，Delabrre将一个橡胶吸盘吸在眼球表面，发明了第一个可以记录数据的眼动仪。
1898年，第一次通过连杆记录了阅读过程中的眼球运动。

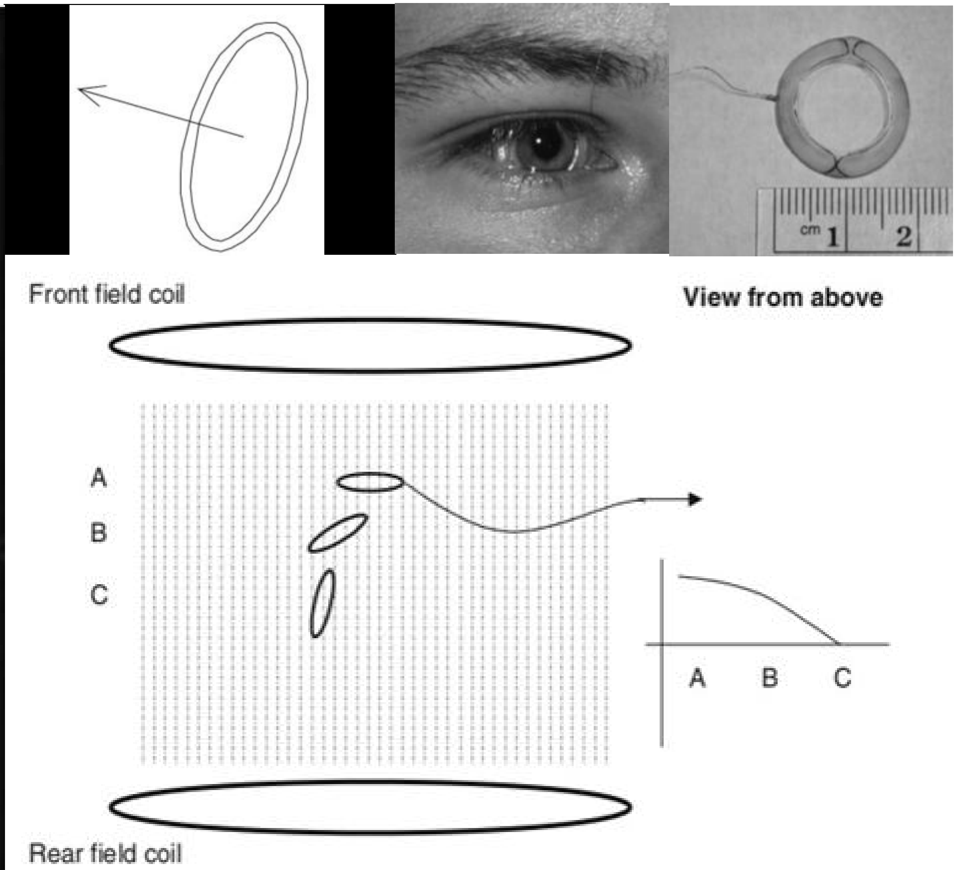
角膜-视网膜电位记录法
Cornea-Retinal Potential/Cornea +



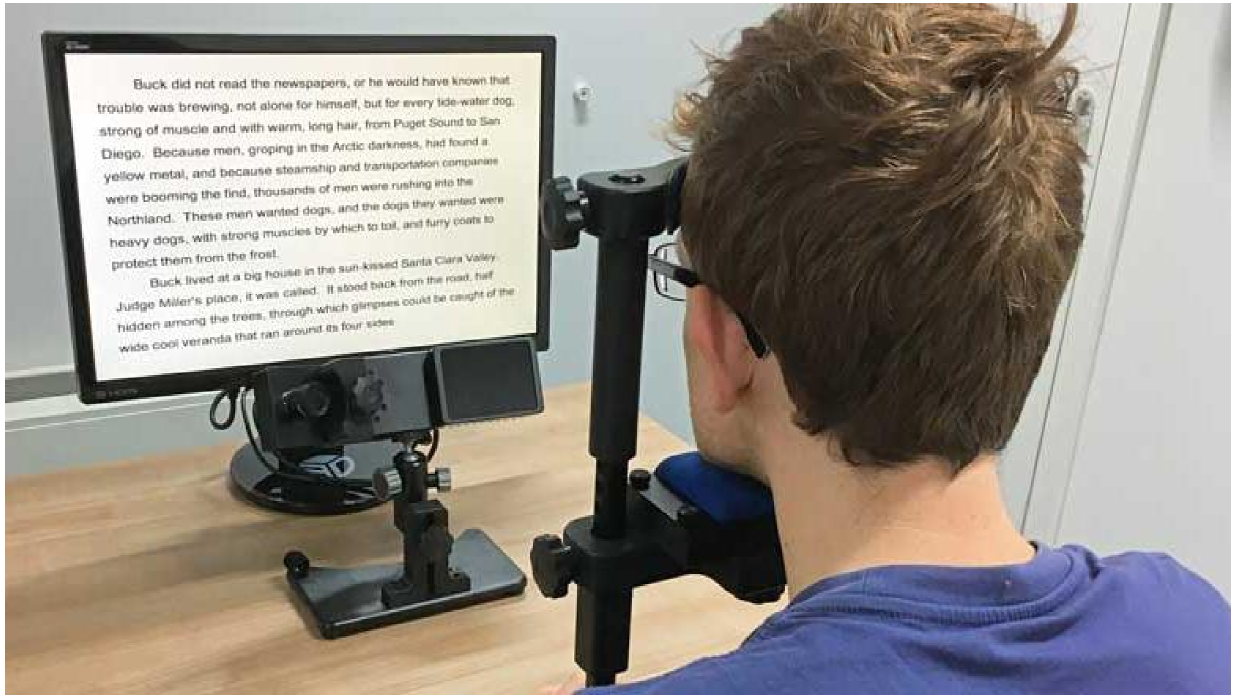
在眼动追踪技术发展中，眼电电位的记录也能记录下眼动轨迹的过程。但是这种方式不是很准确，常用于脑电中记录眼动产生的电位信号来消除眼电伪迹。

运动线圈法 Search Coil

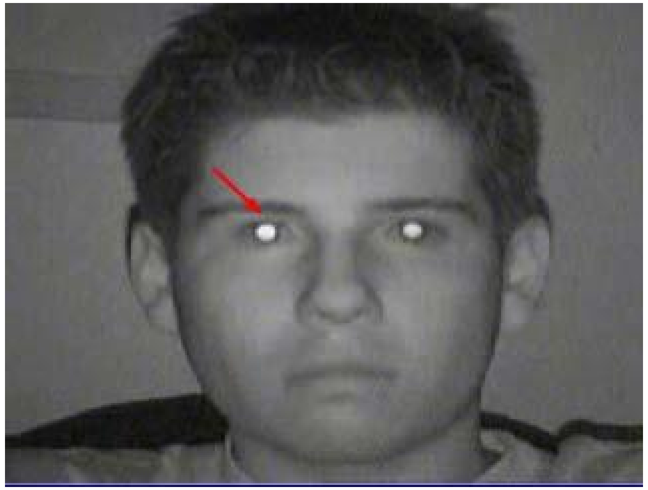


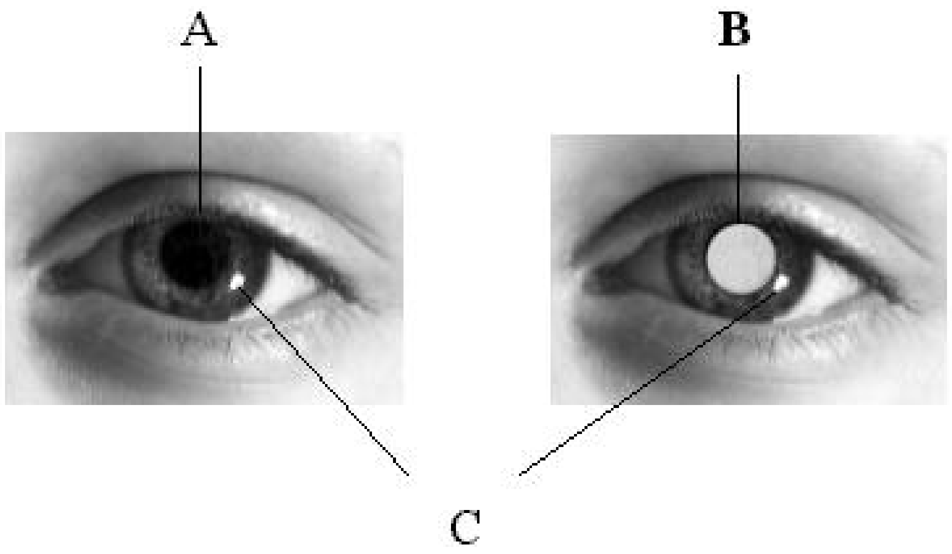


基于视频的眼动仪

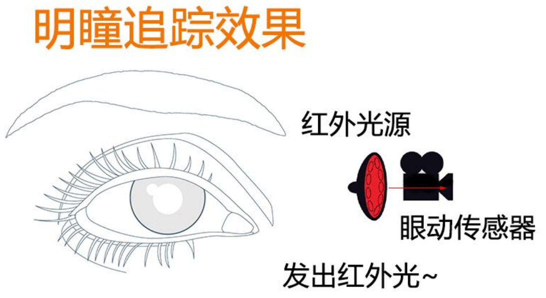

Buck did not read the newspapers, or he would have known that
trouble was brewing, not alone for himself, but for every tide-water dog,
strong of muscle and with warm, long hair, from Puget Sound to San
Diego. Because men, groping in the Arctic darkness, had found a
yellow metal, and because steamship and transportation companies
were booming the find, thousands of men were rushing into the
Northland. These men wanted dogs, and the dogs they wanted were
heavy dogs, with strong muscles by which to toil, and furry coats to
protect them from the frost.
Buck lived at a big house in the sun-kissed Santa Clara Valley.
Judge Miller's place, it was called. It stood back from the road, half
hidden among the trees, through which glimpses could be caught of the
wide cool veranda that ran around its four sides

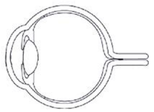
- 基本思想是将相机对准眼睛，并使用图像处理来确定显著特征的位置
- 两个显著特征：瞳孔（Pupil） 和角膜反射点（ Corneal Reflection ）
- 瞳孔追踪：暗瞳技术和明瞳技术

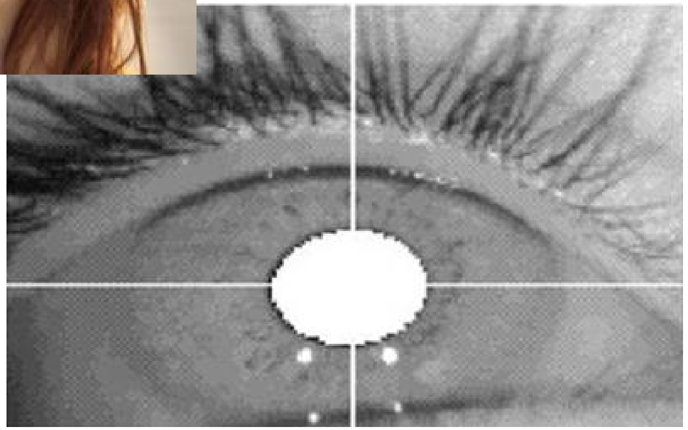




视频眼动仪——明瞳技术



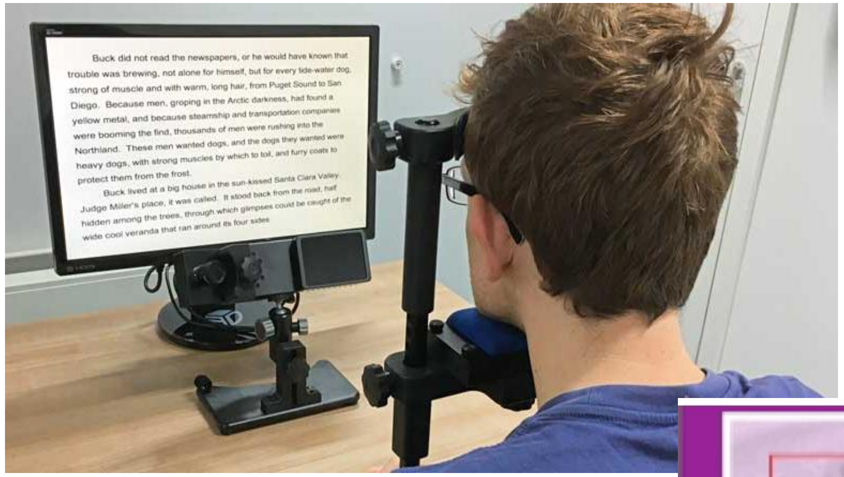


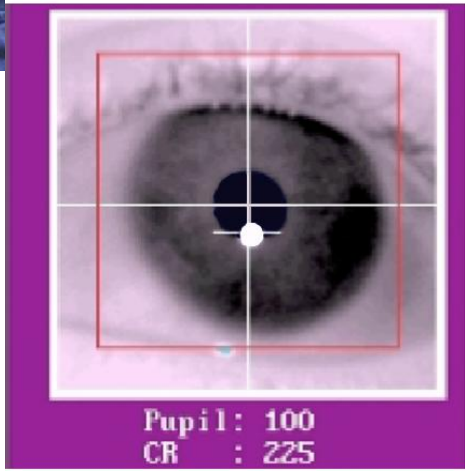


光源与视轴在一条直线上。此时，瞳孔呈现出亮色，而虹膜相对较暗。形成明瞳追踪效果。

- 要求相机与头的相对位置固定
- 明瞳追踪技术下，瞳孔的亮度大于虹膜。在这种追踪方法下，图像处理算法会将白色的椭圆形区域识别为瞳孔，通过瞳孔中心的位置计算出眼睛相对于头部的视角，即捕获眼动。
- 要求相机距离眼睛很近。

视频眼动仪——暗瞳技术





光源与视轴不在一条直线上。此时，瞳孔呈现出暗色，而虹膜相对较亮。形成暗瞳追踪效果。

- EyeLink 眼动仪使用的是暗瞳技术

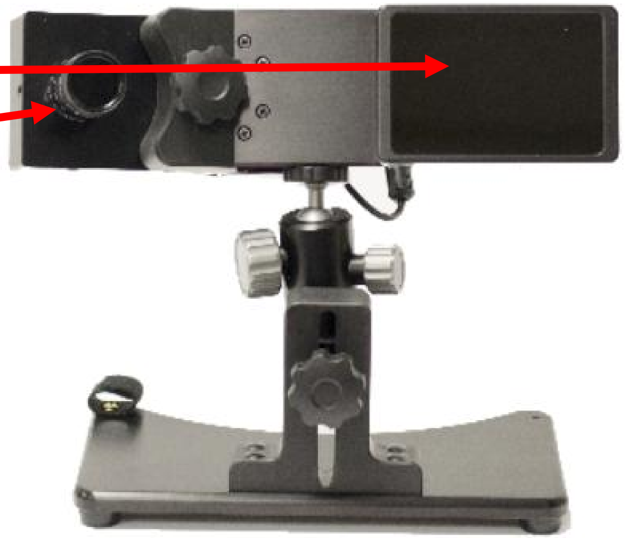
EYELINK

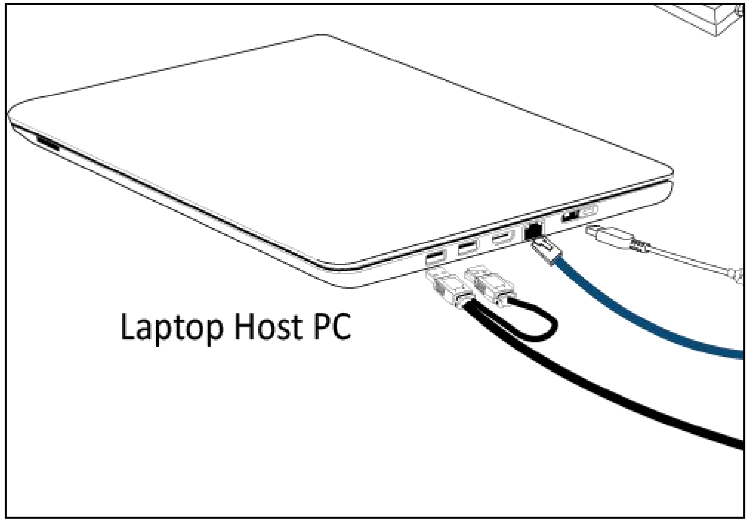
所有Eyelink系统都有三个关键部分：

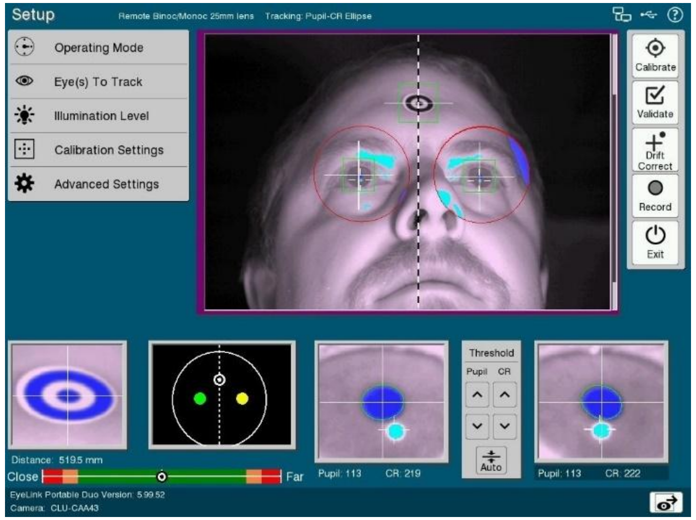
1）红外光源

2）高速摄像机

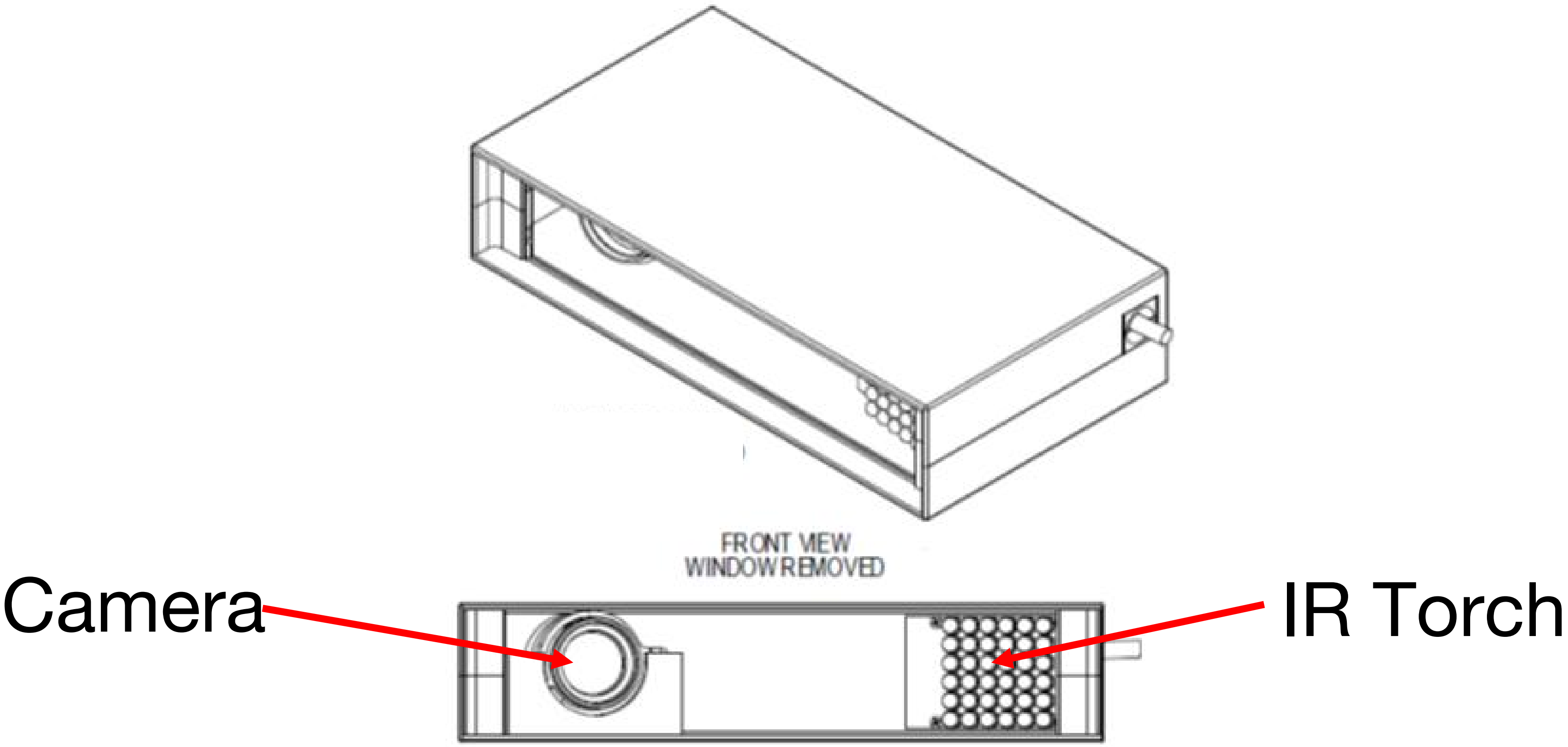
3）主机+眼动软件







Inside the Portable Duo:



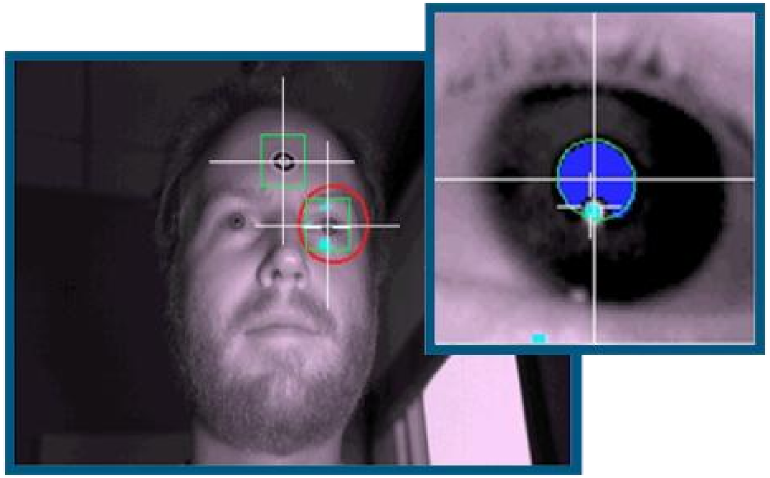
EyeLink Portable Duo Eye Tracker,
Showing Internal Camera Lens and Illuminator

EYELINK

1）红外光源
- 给眼睛照明
- 提供角膜反射点（CR）

2）高速摄像机
- 每秒最高可拍摄2000张照片

3）主机+眼动追踪软件
- 实时操作系统（RTOS）
- 接收并处理相机拍摄的图片
- 计算注视位置
- 分析数据
- 存储数据

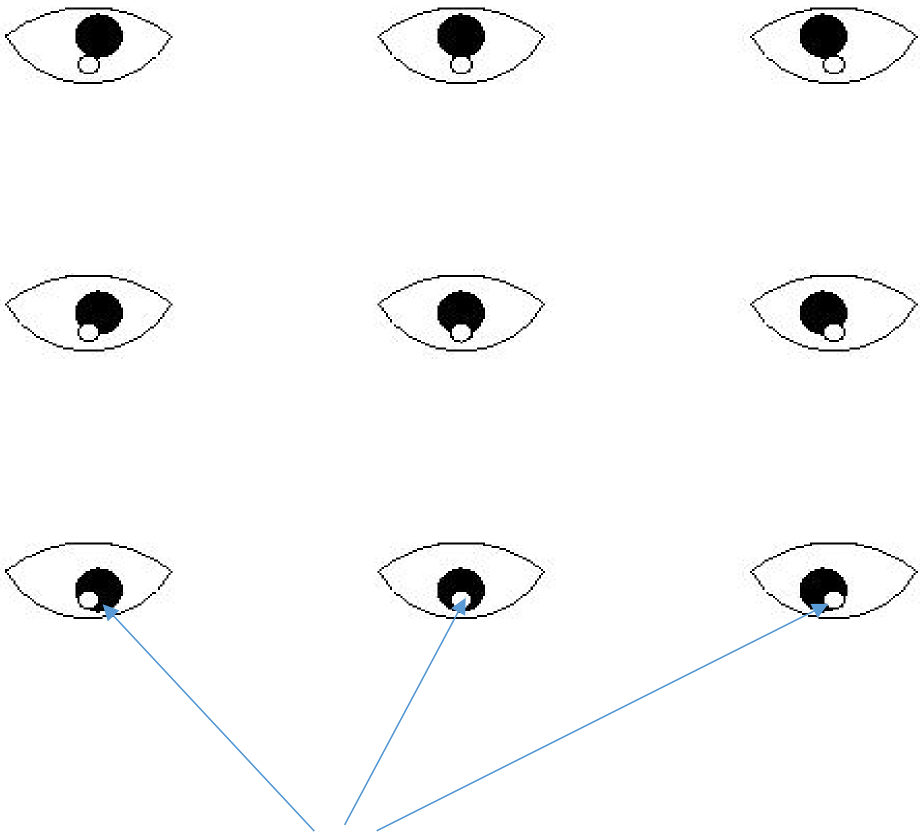


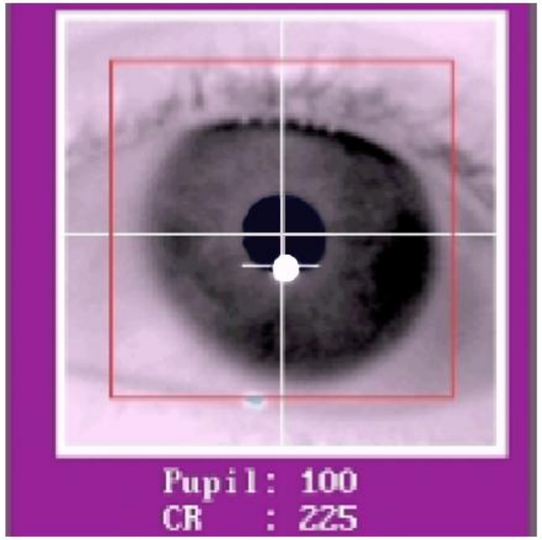
Pupil—CR Eye Tracking

Why we track both Pupil and CR？ ——Controlling for head movements

- 仅仅跟踪瞳孔并不是最佳的——它在相机传感器上的位置可能会因为眼睛旋转或因为人移动了头部而改变。
- 因此眼睛上需要两个参考点来区分眼睛运动和头部运动:
  - 瞳孔中心
  - 角膜反射点
- 瞳孔中心和角膜反射点之间的位置差异（Pupil - CR）随着眼睛转动而改变, 但随着头部轻微移动而保持相对恒定。
- EyeLinks 也可以设置只追踪瞳孔（pupil only eye tracking），但一般不建议, 只追踪瞳孔时要求头部非常固定。

Pupil—CR Tracking

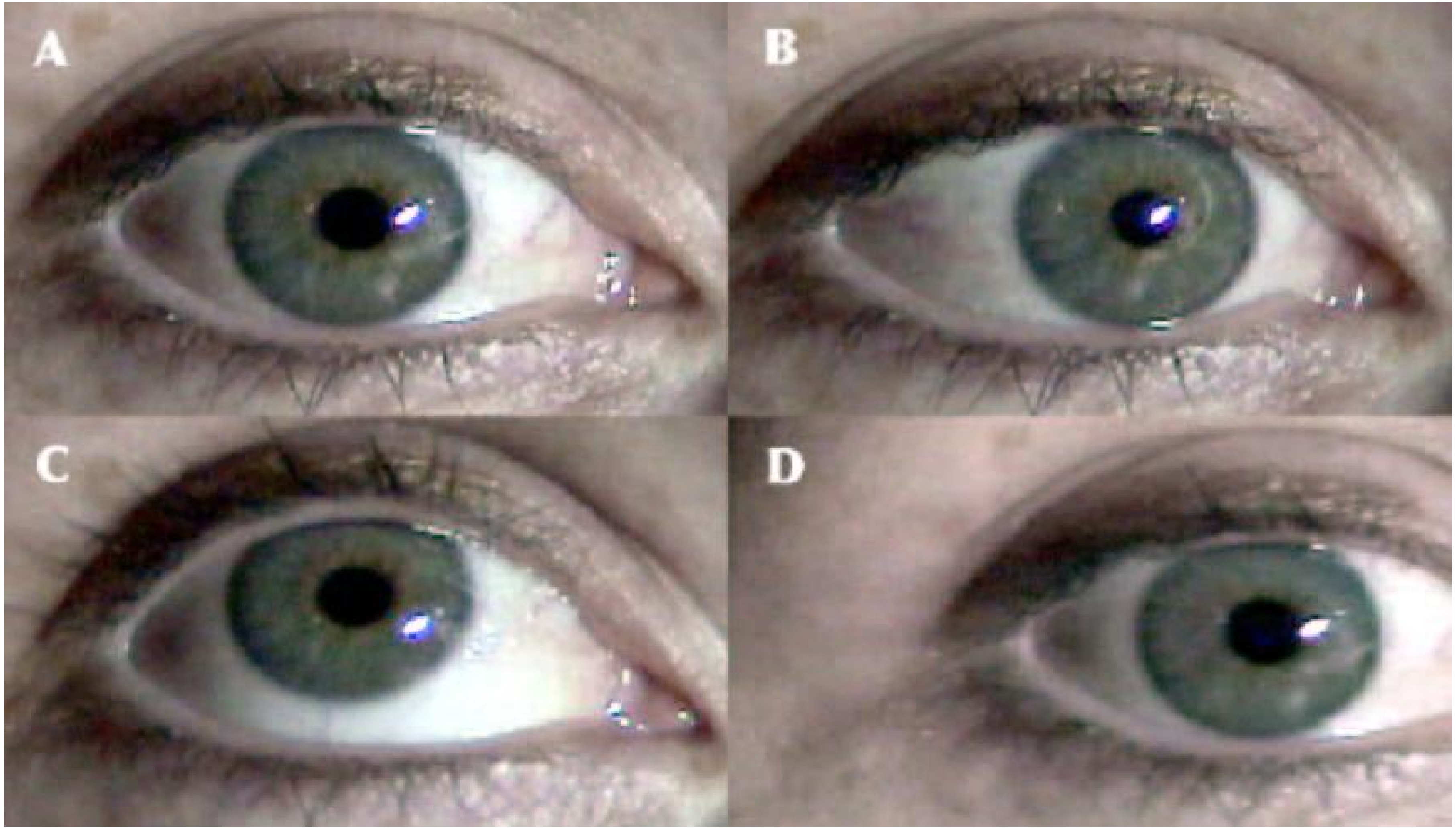




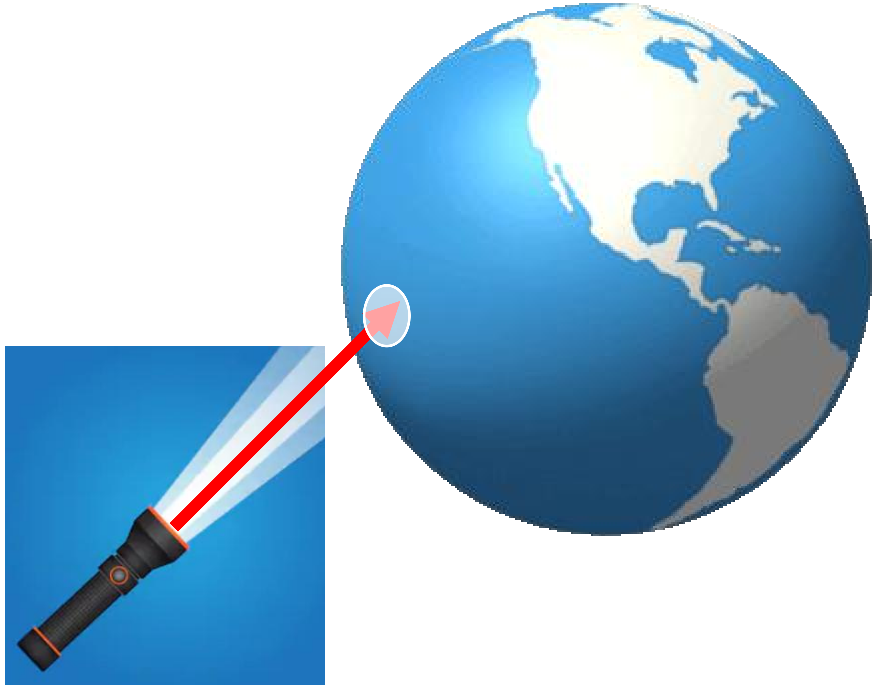
眼动仪相机拍到的瞳孔和角膜反射点

在眼动仪相机的画面中，CR的位置相对固定（因为红外光源固定）

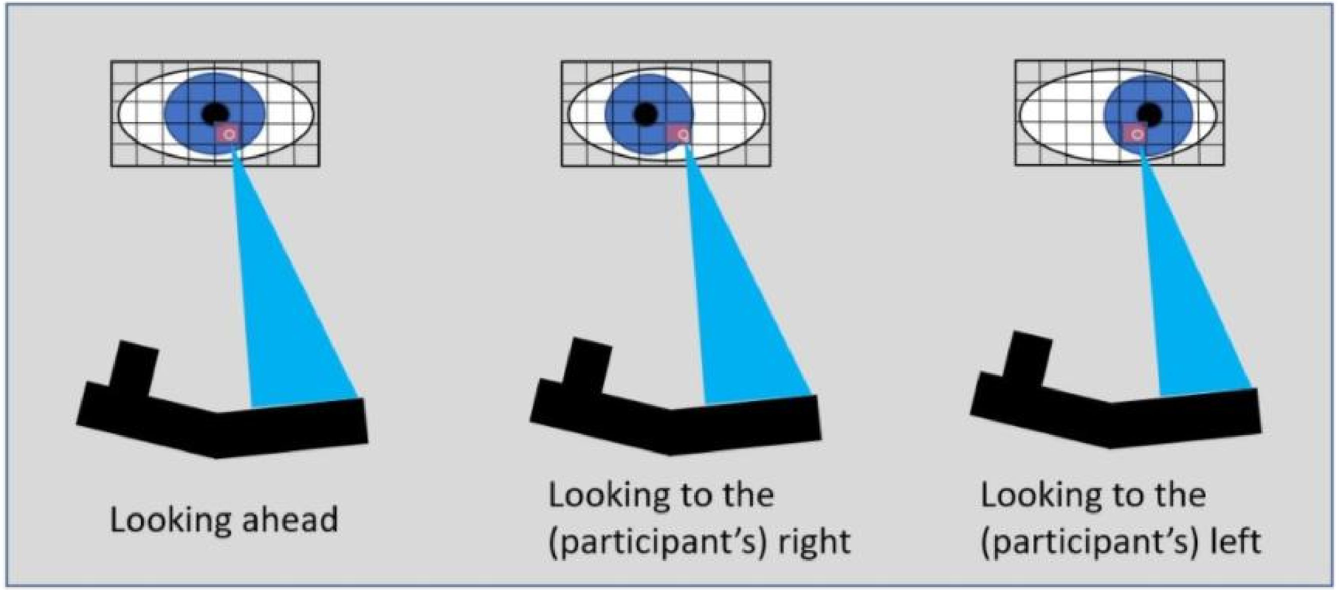
Video-based systems



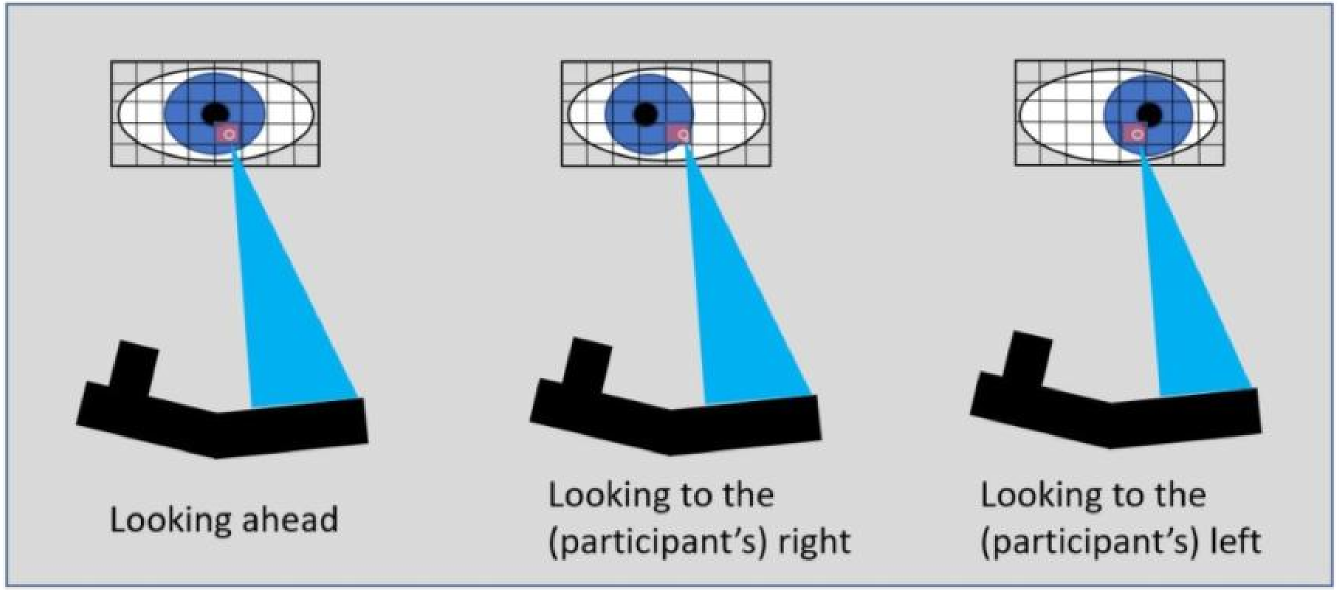
CR 相对固定 – 但瞳孔会随着扫视而运动



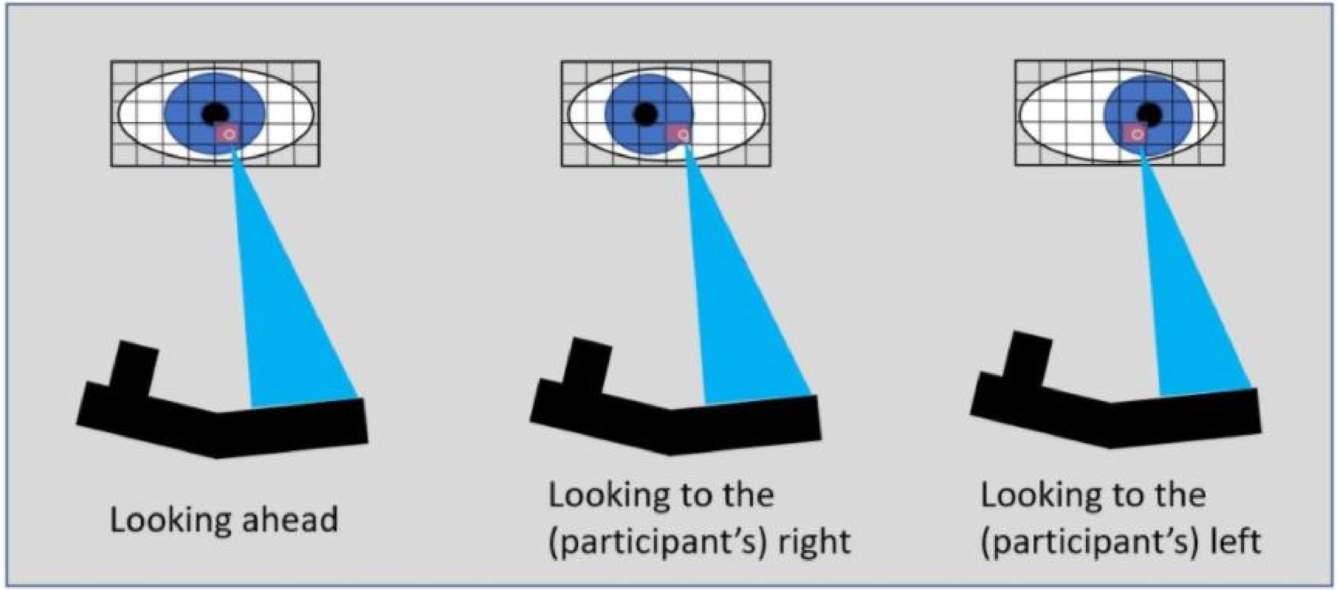
因此，瞳孔和CR之间的“矢量”随着眼睛旋转而改变。



瞳孔和CR之间的关系随着眼睛转动而改变
但如果头部相对于相机移动，则保持不变



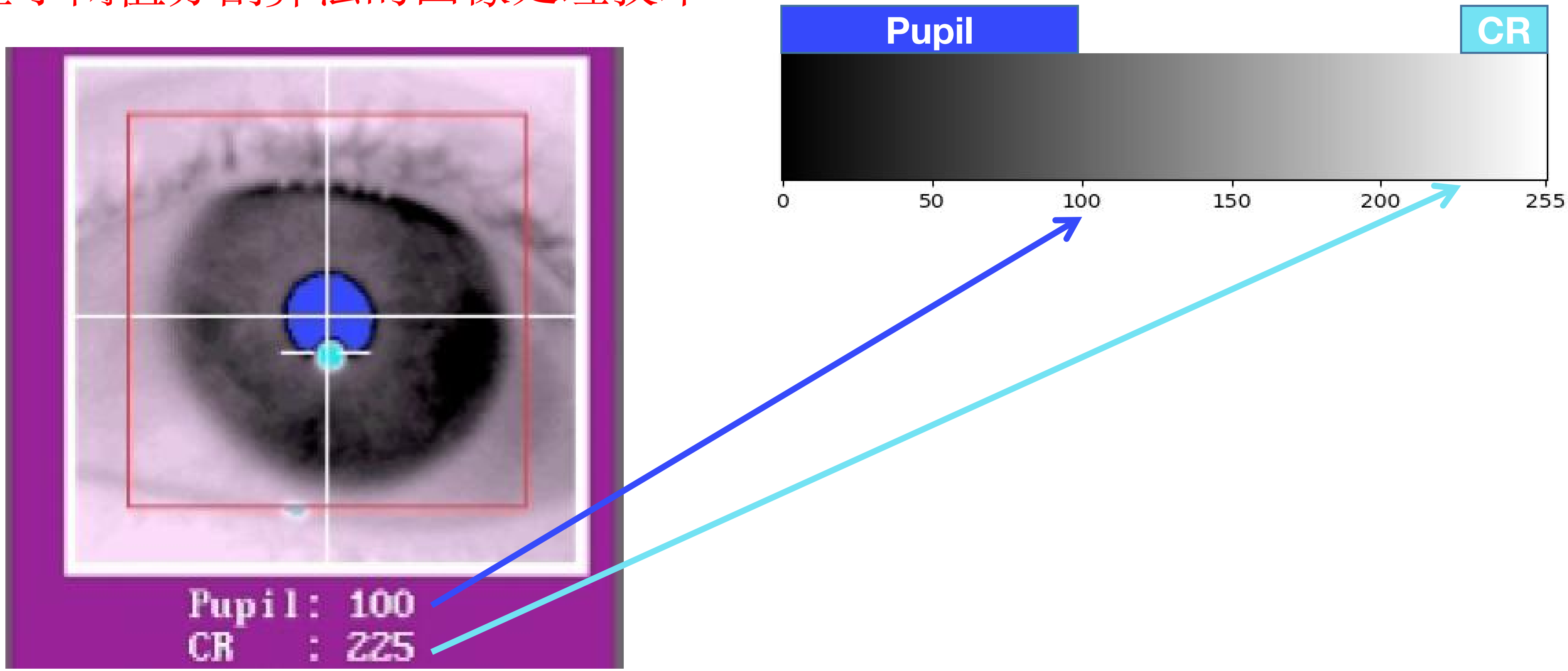
眼动主机软件会计算瞳孔位置减去CR位置，消除了头部微动引起的混淆。



因此，准确地识别瞳孔中心和CR（最高2000 Hz...）对于准确的眼睛跟踪来说非常重要!

主机上的图像分析：
瞳孔和CR是怎么被识别出来的？

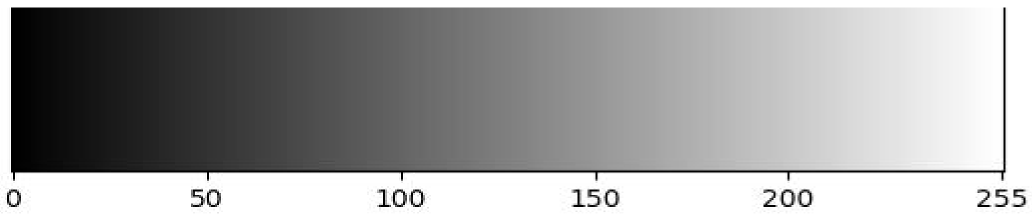
- 基于阈值分割算法的图像处理技术:

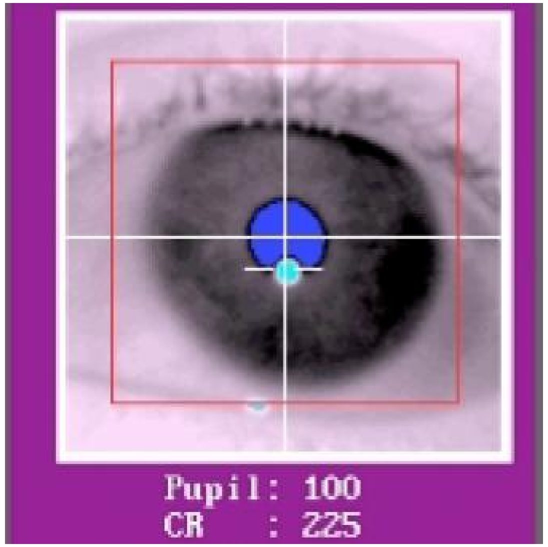


EYELINK

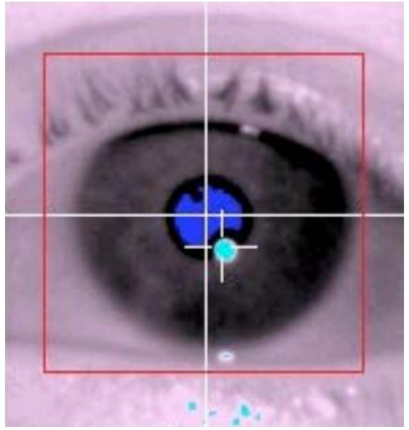
Why thresholds are so important

Pupil and CR thresholds are greyscale values that can vary from 0 (black) to 255 (white).

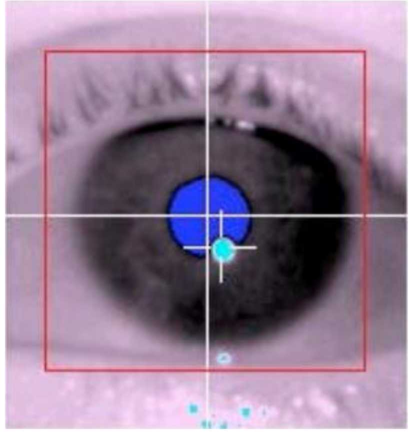




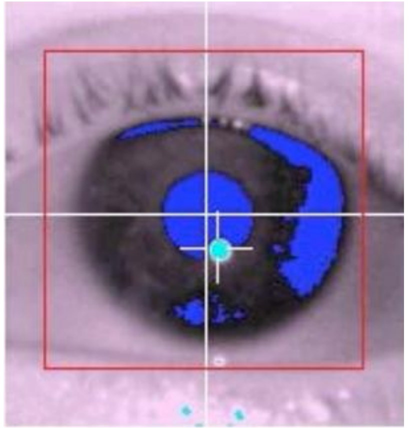
You are basically telling the host how "black" or "white" something has to be to be considered as either pupil or CR.



Too Low

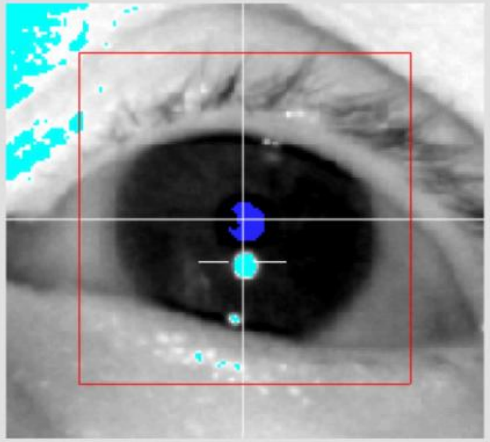
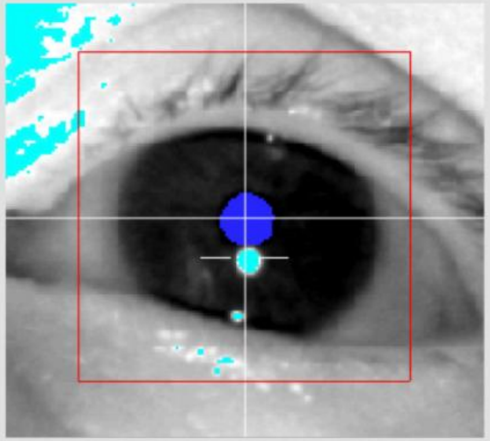
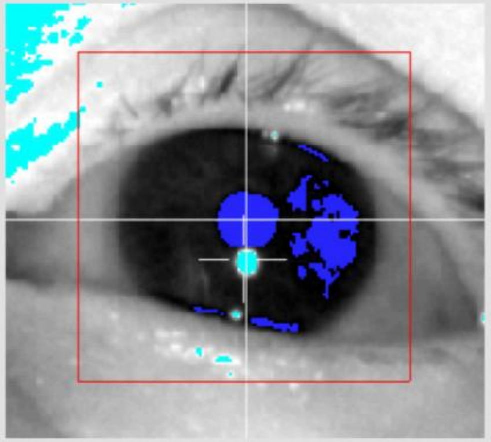
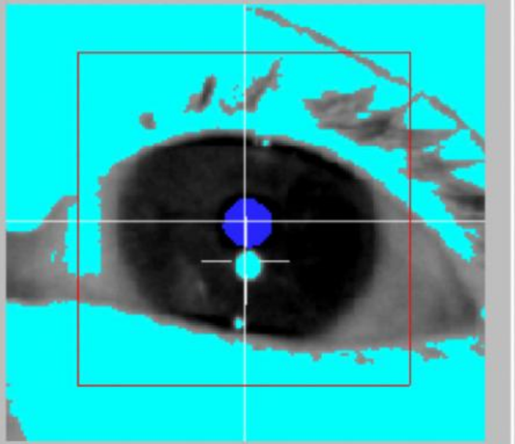
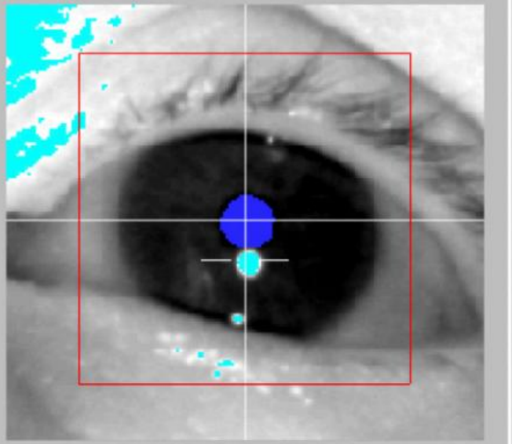
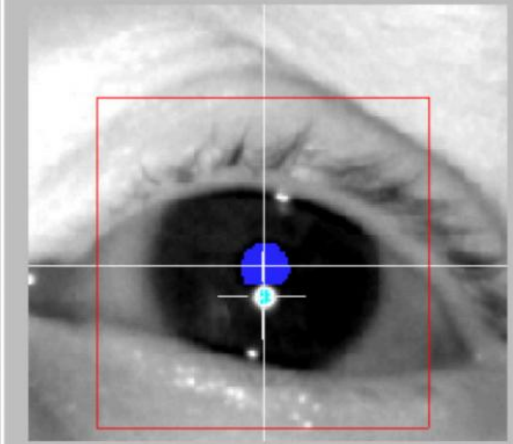


Good



Too High

Why thresholds are so important

	Too Low	Just Right	Too High
PUPIL			
CR			

小结

眼动研究应用领域

眼睛是如何工作的

眼动仪是如何工作的（Pupil–CR）

眼动仪系统组成

详见手册

EyeLink 1000 Plus Installation Guide

EyeLink 1000 Plus User Manual

EyeLink 1000 Plus Quick Start Guide

Eyelink 1000 Plus

- Camera Mount

以桌面式为例，通常由相机和红外光源组成。

- Host PC

眼动仪的主机，内置eyelink系统，通常每台眼动仪都有一台专用的主机，不可用普通电脑替代。通过网线与相机和被试机连接。

- Display PC

用于呈现实验刺激的电脑

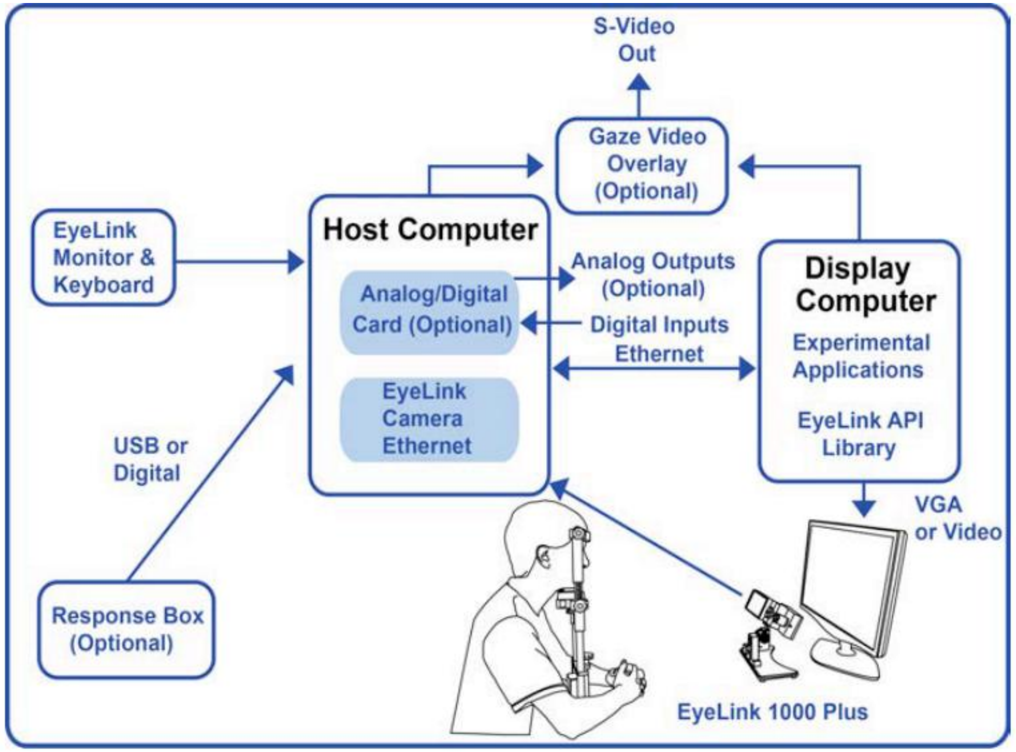
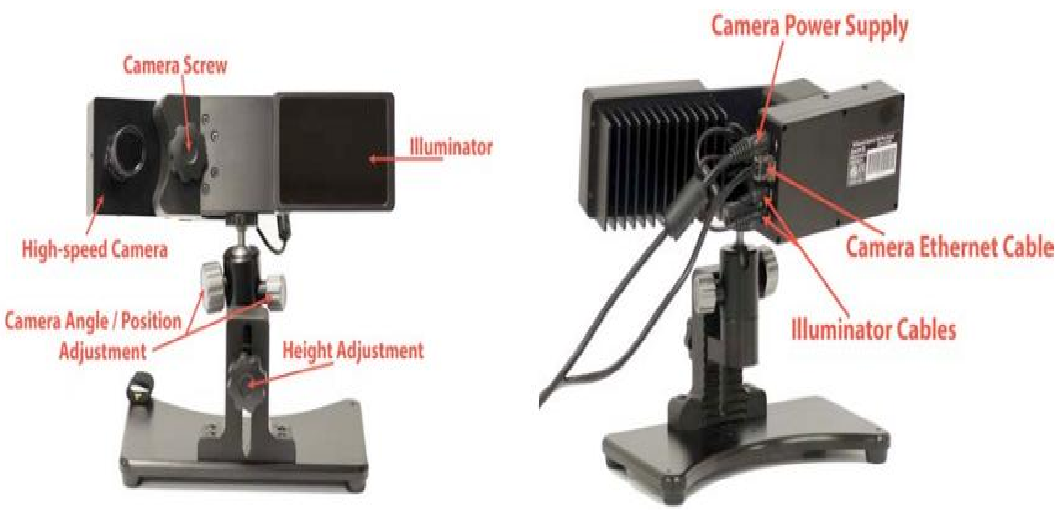


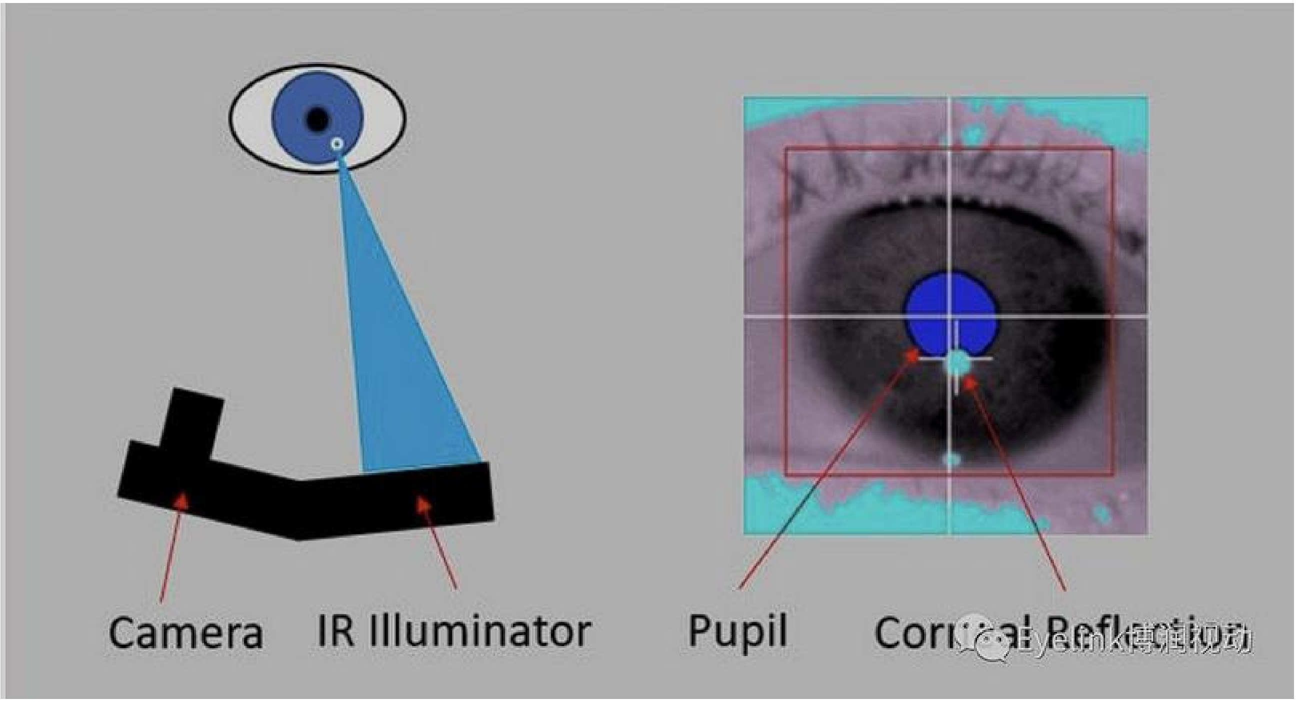
Figure 1-1: Typical EyeLink 1000 Plus Configuration with a Desktop Mount

眼动跟踪软件使用图像处理算法来识别眼睛跟踪相机发送的每个图像上的两个关键位置—瞳孔中心和角膜反射中心。角膜反射点是固定光源（红外照明器）的发出的光在角膜上反射回来的点，如下图所示。

Camera Mount

以桌面式为例，通常由支架、相机和红外光源组成。





Eyelink 1000 Plus

Host PC

- 监视相机画面
- 控制相机采集参数，例如采样率（250，500，1000，2000）
- 计算被试观看显示器上的注视位置
- 执行在线检测和分析眼动事件（眼跳、眨眼和注视）
- 储存眼动数据文件，并可发送到被试机
- 输出模拟信号

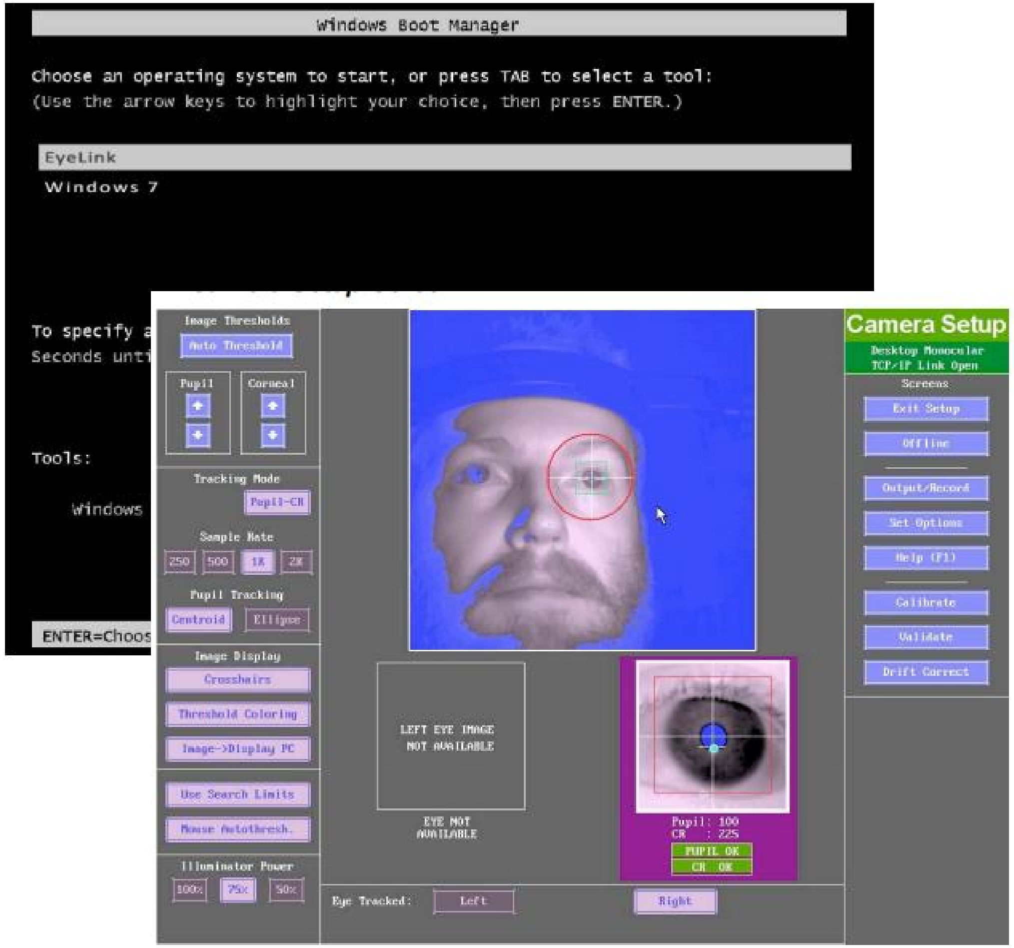


Figure 2-4: Example Camera Setup Screen

Eyelink 1000 Plus

Display PC

通过Experiment Builder（官方）或其他第三方软件（如e-prime、psychtoolbox）编写实验程序，呈现实验刺激

通过网线连接到主机，可以控制主机进行校准、数据采集等功能，还可以获取到实时眼动数据（注视位置、眼动事件），以实现注视追随等功能

通过Data Viewer和数据转换工具（EDF2ASC），进行数据文件可视化和转换

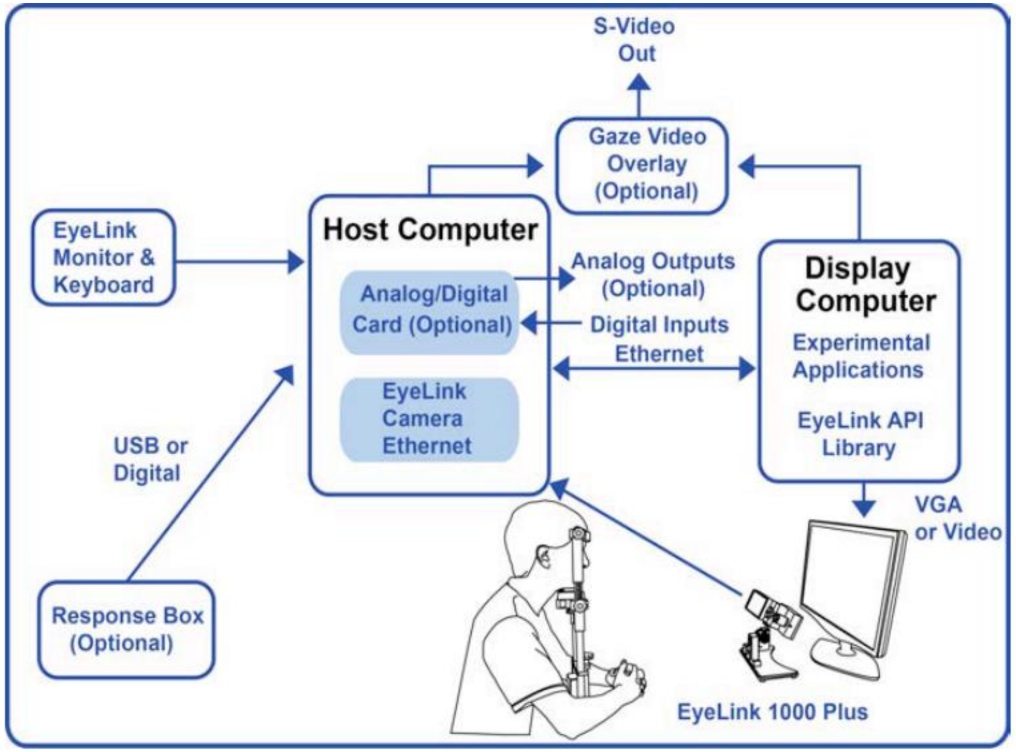


Figure 1-1: Typical EyeLink 1000 Plus Configuration with a Desktop Mount

1.3 System Specifications

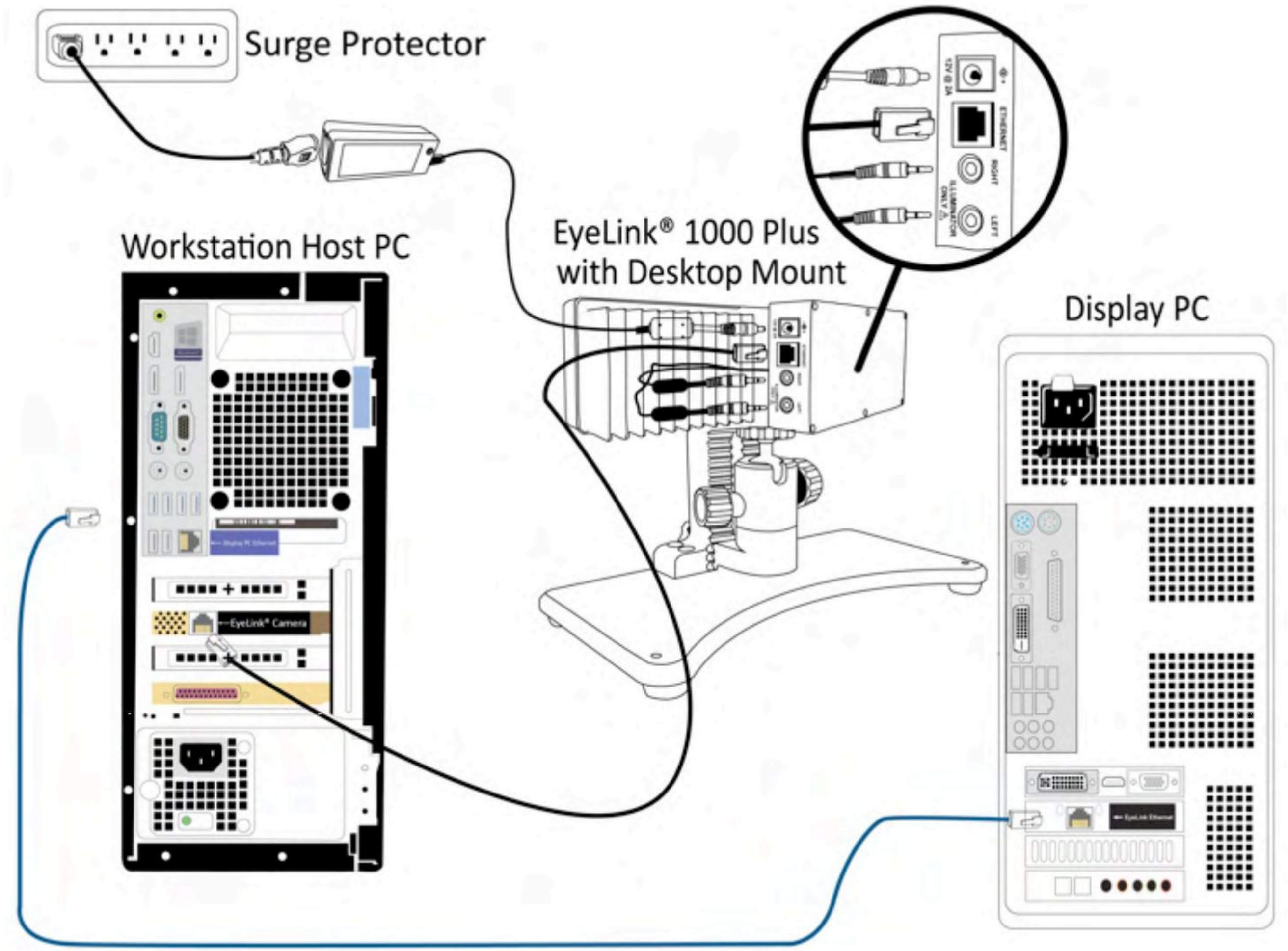
1.3.1 Operational / Functional Specifications

	Tower Mount /Primate Mount	Desktop and LCD Arm Mounts: Base System	Desktop and LCD Arm Mounts: Remote Tracking (Remote Camera Upgrade required)
Average Accuracy[1]	Down to 0.15° (0.25° to 0.5° typical)	Down to 0.15° (0.25° to 0.5° typical)	0.25-0.5° typical
Sampling rate[2]	Monocular: 250,500,1000,2000 Hz Binocular: 250,500,1000,2000 Hz	Monocular: 250,500,1000,2000 Hz Binocular: 250,500,1000,2000 Hz	Monocular: 250,500,1000 Hz Binocular: 250,500,1000 Hz
End-to-End Sample Delay[3]	1000 Hz: M = 1.97 ms, SD = 0.39 ms 2000 Hz: M = 1.34 ms, SD = 0.20 ms	1000 Hz: M = 1.97 ms, SD = 0.39 ms 2000 Hz: M = 1.34 ms, SD = 0.20 ms	500 Hz: M = 3.29 ms, SD = 0.58 ms 1000 Hz: M= 2.19 ms, SD = 0.30 ms
Blink/Occlusion Recovery	1.0 ms @ 1000 Hz 0.5 ms @ 2000 Hz	1.0 ms @ 1000 Hz 0.5 ms @ 2000 Hz	2.0 ms @ 500 Hz 1.0 ms @ 1000 Hz
Spatial Resolution[4]	0.01°		
Noise with Participants[5]	Filter (Off/Normal/High) 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°	Filter (Off/Normal/High) 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°	Filter (Off/Normal/High) 500 Hz: 0.03°/0.02°/0.01° (25 mm lens) 0.06°/0.03°/0.01° (16 mm lens) 1000 Hz: 0.05°/0.03°/0.01° (25 mm lens) 0.08°/0.04°/0.02° (16 mm lens)
Eye Tracking Principle[6]	Dark Pupil - Corneal Reflection		
Pupil Detection Models	Centroid or Ellipse Fitting	Centroid or Ellipse Fitting	Ellipse Fitting
Pupil Size Resolution[5]	0.1% of diameter	0.1% of diameter	0.2% of diameter (16 mm lens) 0.1% of diameter (25 mm lens)
Gaze Tracking Range	60° horizontally, 40° vertically	Customizable Default is 32 ° horizontally × 25° vertically	
Allowed Head Movements Without Accuracy Reduction	±25 mm horizontal or vertical	±25 mm horizontal or vertical	16 mm lens: 35×35 cm at 60 cm 40×40 cm at 70 cm 25 mm lens: 22×22 cm at 60 cm 25×25 cm at 70 cm
Optimal Camera-Eye Distance	Tower: 48 cm Primate: 30 - 45 cm	40 - 70 cm	
Infrared Wavelength	Tower: 940 nm Primate: 910 /940 nm	850 to 940 nm	
Glasses Compatibility	Good	Excellent	Good
On-line Event Parsing	Fixation / Saccade / Blink / Fixation Update		
EDF File and Link Data Types	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.		

Specifications are preliminary and subject to change without notice.
[1] Measured with real eye fixations at multiple screen positions on a per subject basis.
[2] Availability depends on having the appropriate hardware and camera programming.
[3] Time from physical event until first registered sample is available via Ethernet or Analog output. Optional data filter algorithm adds one sample delay for each filtering level.
[4] Measured with an artificial eye.
[5] Measured with real subject fixations.
[6] Pupil-Only tracking mode is available for use in head fixed conditions.

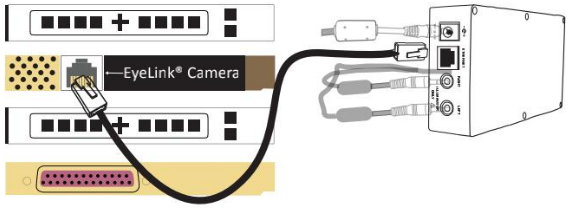
1.3.2 Physical Specifications

Physical	Anodized aluminum enclosure.
GL (EyeLink 1000 Plus Camera)	Standard thread (¼"-20) centered on optical axis from 3 sides. M8 thread on front for DM and AM mounts. Power requirements: +12VDC, 800 mA for camera alone, 1.8A maximum when used with illuminator(s). Imaging rates up to 2000 fps.
OC (Fiber Optic Camera Head)	M3 tapped holes on body. Adapter for ¼"-20 mounting available. Supply: 3.6-5.7VDC, 700mA via LEMO connector and power harness. Imaging rates up to 2000 fps. Non-magnetic (< 0.5g of iron or nickel). Radio-quiet case and cable design for use in research environments.
FL-890, FL-940 (890/940 nm Fresnel Illuminator Module)	Standard thread (¼"-20) at center and sides. Adjustable focus and beamwidth. Wavelength: 890 or 940 nm. Supply: 3.6-5.7VDC, 1.1A via LEMO connector and power harness. Non-magnetic (< 0.5g of iron or nickel). Radio-quiet case and cable design for use in research environments.
PM-910, PM-940 (910/940 nm Illuminator Module)	Wavelength: 910 or 940 nm. Eye illumination level: less than 1 mW/cm² at >200mm from illuminator. Illuminators powered from camera through supplied cables.
DM-850W, DM-850L, DM-890, DM-940, AM-890, AM-940 (DM and AM Series Illuminators)	Wavelength: 850 to 940 nm. Eye illumination level: less than 1 mW/cm² at >450mm from illuminator. Powered from camera via integrated cables.
Camera Ethernet	Cabling: Unshielded CAT5e or CAT6 cables up to 30 meters in length. Requires host computer with supported Ethernet hardware capable of gigabit speeds.
Power Supply Specifications	GL camera: 12VDC, 2A external power supply with 2.5mm coaxial ("barrel") power connector (5.5 × 2.5 × 9.5mm). OC camera head and FL illuminator: 3.6-5.6VDC@2A minimum. When used with supplied power harness, DB-9 connector is required (contact SR Research for pinout). Power supply must have EN 60950, UL 950, CSA 22.2 No. 950, or other equivalent safety approval, with LPS or Class 2 rating.
Operating conditions	10°C to 30°C, 10%-80% humidity (non-condensing) For indoor use only.
Storage conditions	-10°C to 60°C, 10%-90% humidity (non-condensing). Allow to warm to room temperature before unpacking or use after storage at temperatures below 10°C to prevent condensation.
Safety Standards	IEC 60950-1:2005 (2nd Ed.) + Am 1:2009 IEC 60825-1:1993 + A1:1997 + A2:2001 IEC 62471:2006 (1st Ed.) UL 62368-1:2014 Ed.2 CSA C22.2#62368-1:2014 Ed.2 FDA 21 CFR laser products, under Laser Notice No. 50.
Fiber Optic Link (GL and OC modules)	Class 1 laser product, IEC 60825, CFR 21 850 nm, multimodal duplex fiber, LC connector.



2 **Camera Connection**

Using the **black** Ethernet cable, connect the Host PC Ethernet port labeled "EyeLink Camera" to the Ethernet port on the EyeLink 1000 Plus camera.

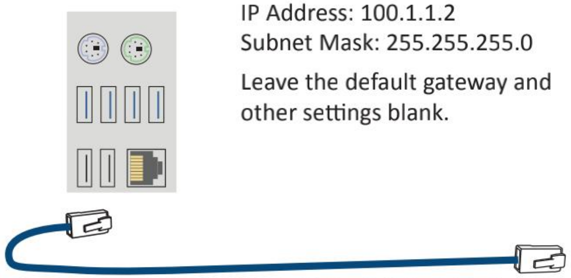


3 **Host PC to Display PC Connection**

Using the **blue** Ethernet cable, connect the Host PC Ethernet port labeled "Display PC Ethernet" to an Ethernet port on your Display PC. Configure that port with the following static IP address:

IP Address: 100.1.1.2
Subnet Mask: 255.255.255.0

Leave the default gateway and other settings blank.



See Chapter 9 of the EyeLink 1000 Plus Installation Guide for detailed instructions

被试机设置IP address

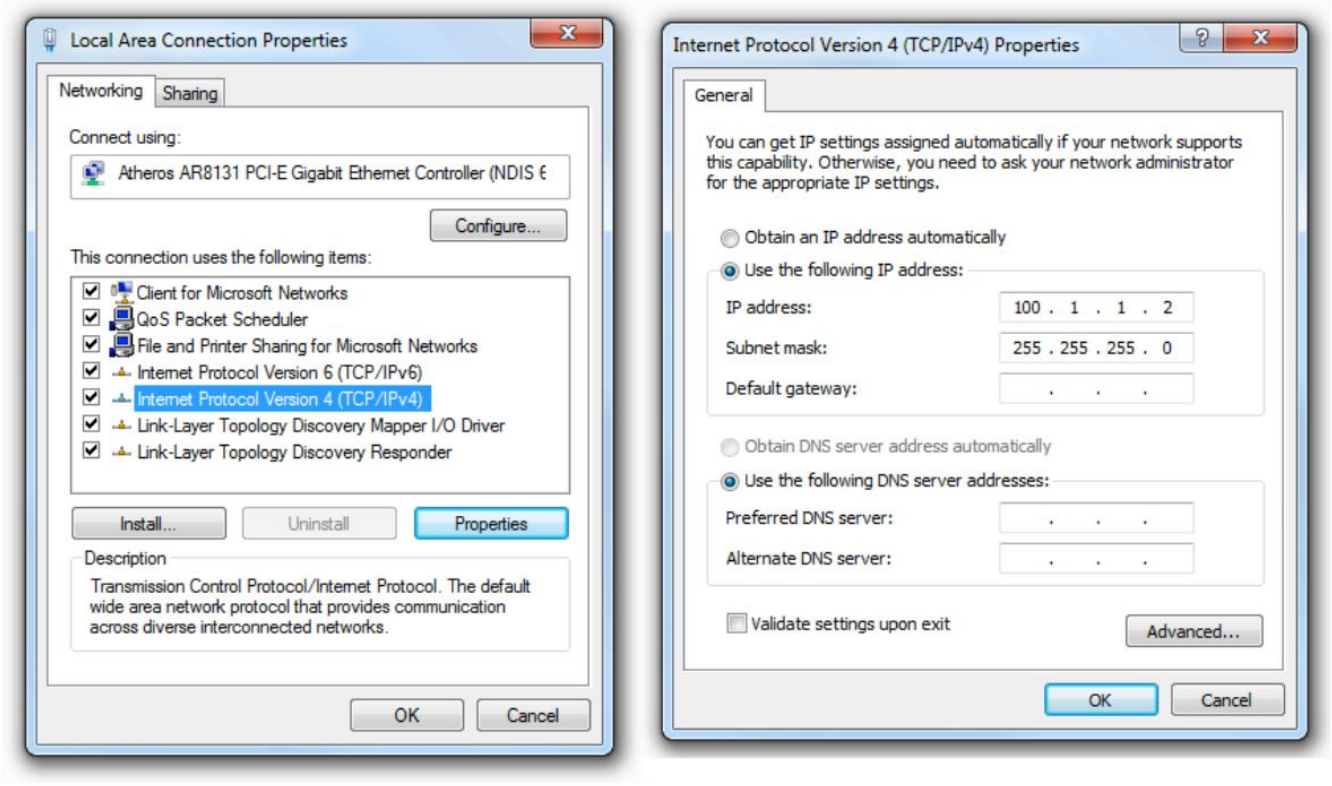
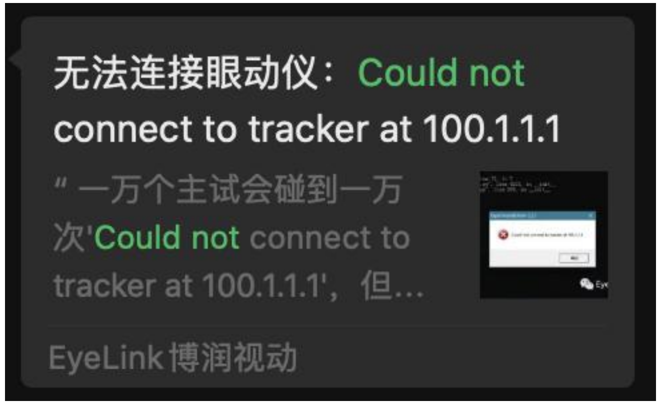


Figure 9-2: Configure IP address on Windows 7



被试机安装eyelink软件

EyeLink Developers Kit / API
https://www.sr-support.com/thread-13.html

Experiment Builder
https://www.sr-support.com/thread-1.html

Data Viewer
https://www.sr-support.com/thread-7.html

也可以通过公众号Eyelink博润视动获取

实验环境配置

详见手册
EyeLink 1000 Plus Installation Guide
EyeLink 1000 Plus User Manual
EyeLink 1000 Plus Quick Start Guide

实验室布置

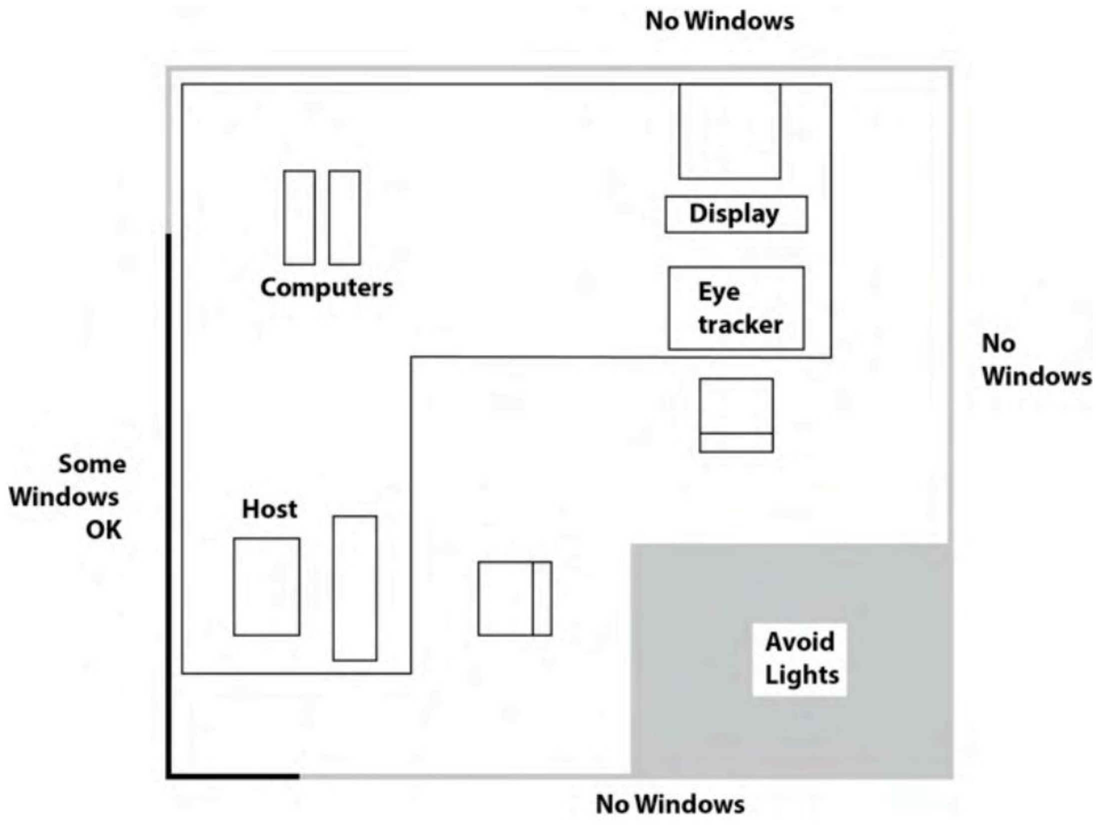
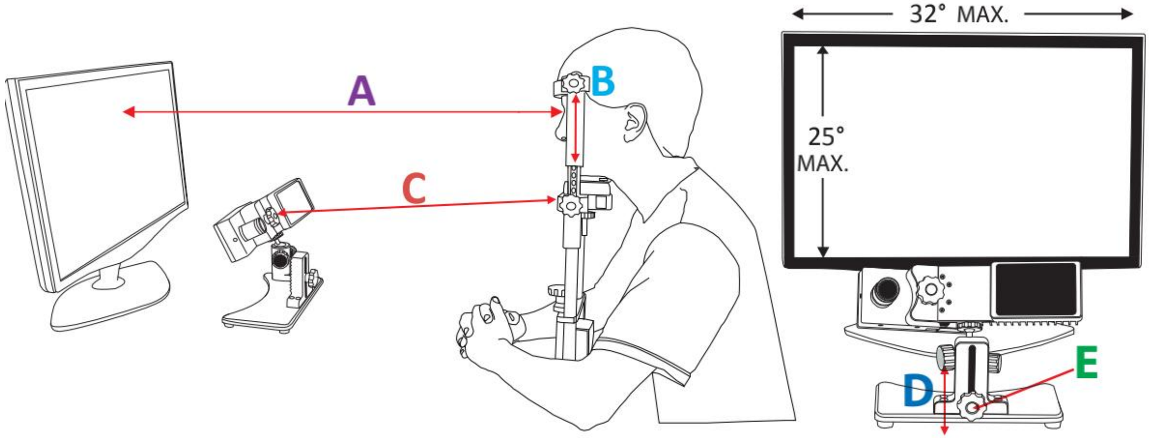


Figure 1-1: Suggested 1000 Plus System Layout

- 理想情况下，使用L型布局。
- 使用下巴托时，保证桌子的深度和稳定度
- 桌子应足够宽，至少为显示器显示区域宽度的1.75倍
- 实验室要保证光线充足，但要避免照明灯或窗户外的光线对被试机屏幕和主试机显示器屏幕造成影响
- 避免其他环境因素对被试造成干扰，如实验过程中的噪声。让被试面对着墙壁，也能减少干扰。
- 配备一把舒适的可以调节高度的椅子

被试位置及眼动仪摆放



Step A) Position the monitor so that it subtends no more than 32 degrees of visual angle horizontally and 25 degrees of visual angle vertically for the participant. The eye-to-monitor distance should be at least 1.75 times the display width to ensure that it falls within the trackable range.

Step B) Position the participant so that the eyes align with the top quarter of the monitor – adjust the chair and/or head support to ensure this alignment.

Step C) Position the eye tracker so that the distance from the top knob on the front of the Desktop Mount to the front of the chinrest is 50-55 cm. If using Remote Mode, make sure that the reported target distance on the Host PC is around 60 cm (55-60 cm is ideal for calibration).

Step D) Adjust the height of the eye tracker so that it is as high as possible without blocking the participant's view of the display.

Step E) Position the eye tracker so that its bottom knob is centered horizontally on the front of the monitor.

See Chapter 3 of the EyeLink 1000 Plus User Manual for detailed instructions

修改显示器参数

7 Enter Screen Settings

Exit to the File Manager if the Host Application is running (press Ctrl-Alt-Q or click Offline and then Exit EyeLink).

From the File Manager, press the Configuration Button.

Configuration

From the Configuration screen press the Screen Settings button.

Screen Settings

Follow the instructions that appear to enter the Screen Dimensions, Display Resolution, Eye-to-Screen Distance, and Camera-to-Screen Distance.

See Section 8.4 of the EyeLink 1000 Plus Installation Guide for detailed instructions

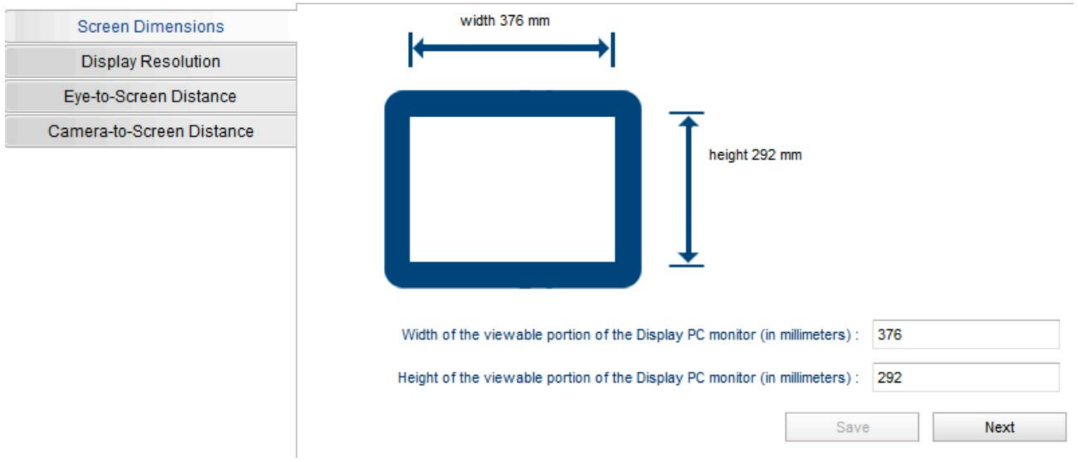


Figure 8-5: Updating Screen Dimensions

数据采集操作

详见手册 EyeLink 1000 Plus User Manual

EyeLink 1000Plus 官方教学视频

基本步骤

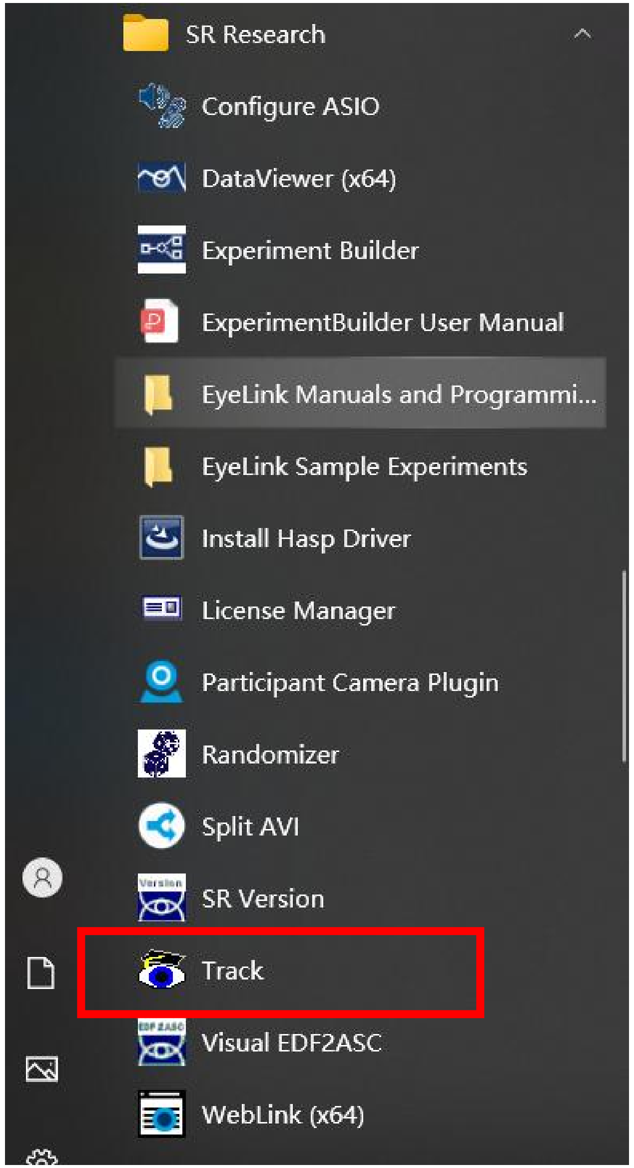
- 第一步：打开实验程序
- 第二步：调节相机角度，选择追踪模式
- 第三步：调节相机焦距
- 第四步：调节瞳孔（Pupil）和角膜反射点（CR）阈值
- 第五步：四点检查
- 第六步：校准（Calibration）
- 第七步：验证（Validation）
- 第八步：开始记录

第一步：打开实验程序

示例程序：开始 → **SR Research文件夹 → Track.exe**

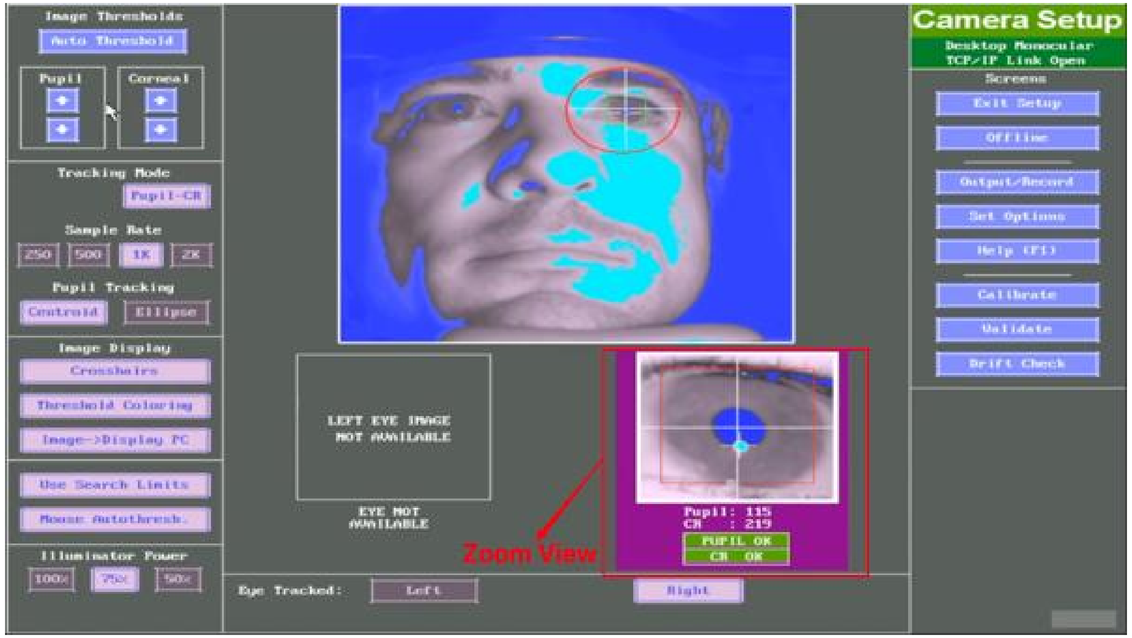
（需安装 EyeLink Developers Kit / API）

眼动仪工作的参数（比如采样率）可以在程序里设置好

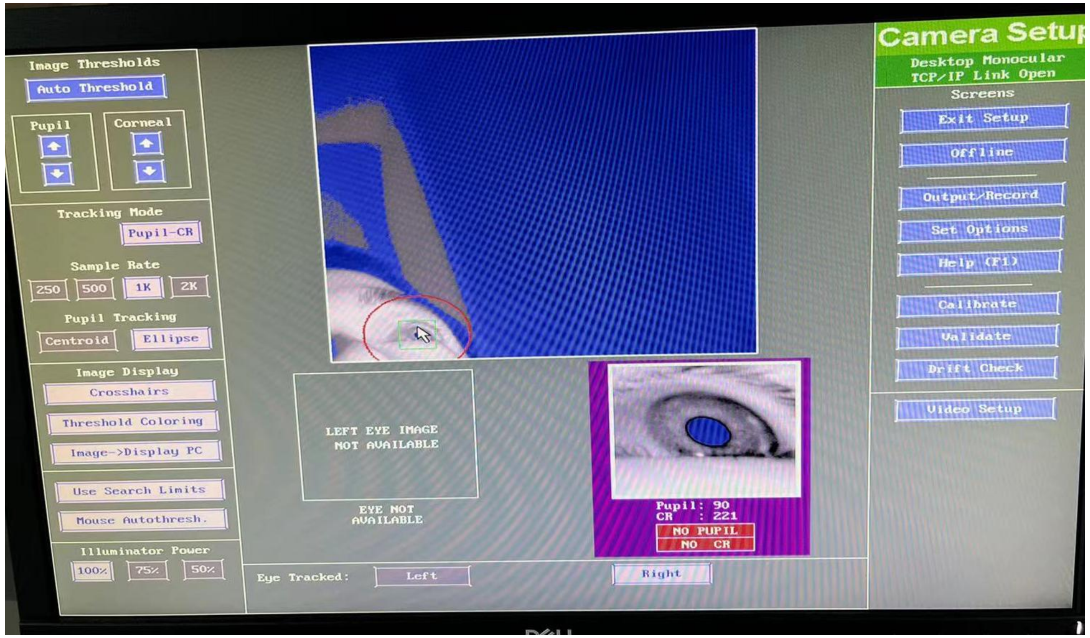


第二步：调节相机角度，选择追踪模式

要点：调整好眼动仪相机的拍摄角度，**让追踪的眼睛位于相机视野中间**



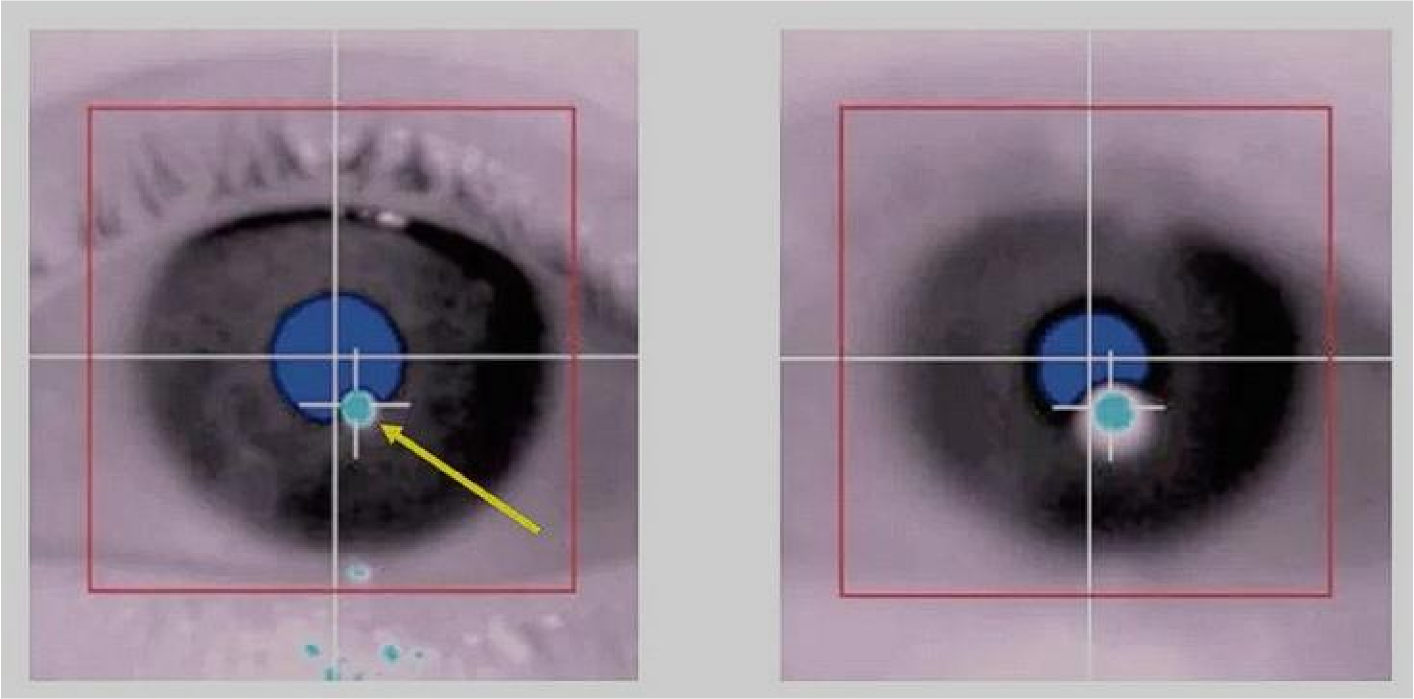
角度较好的情况



这个角度看起来并不是很好。。。

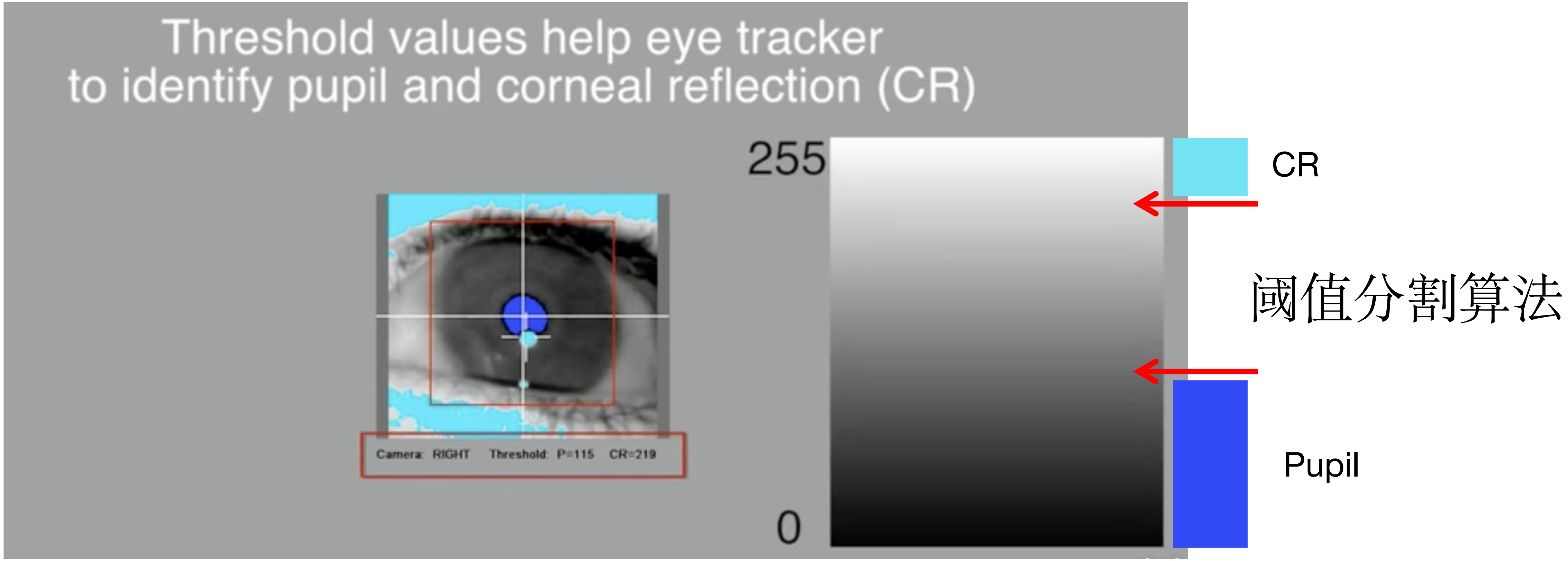
第三步：调节相机焦距

要点：旋转相机镜头，调节焦距，让画面中CR点最小



第四步（非常重要）：调节瞳孔（Pupil）和角膜反射点（CR）阈值

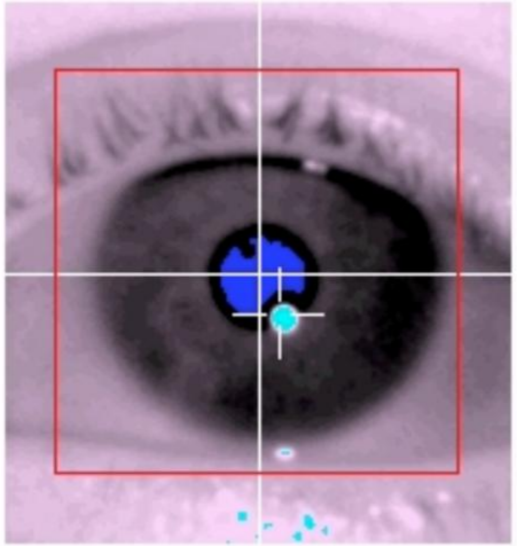
要点：先按a自动调节阈值，然后手动微调

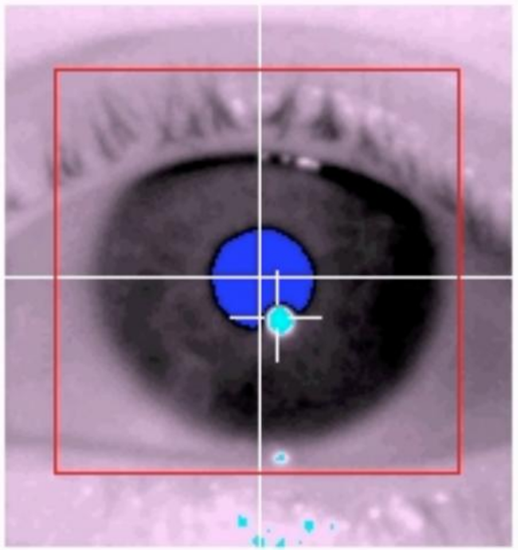


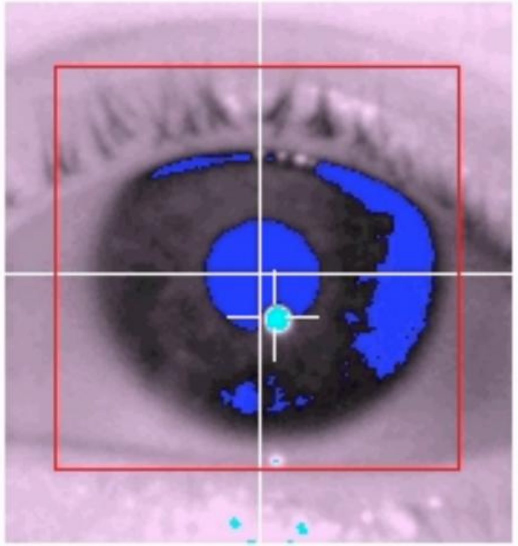
调节瞳孔（Pupil）和角膜反射点（CR）阈值

操作：按“A”自动调节阈值，再根据实际情况手动微调。

瞳孔阈值过低、刚好和过高的三种情况：


Threshold Too low: Noisy

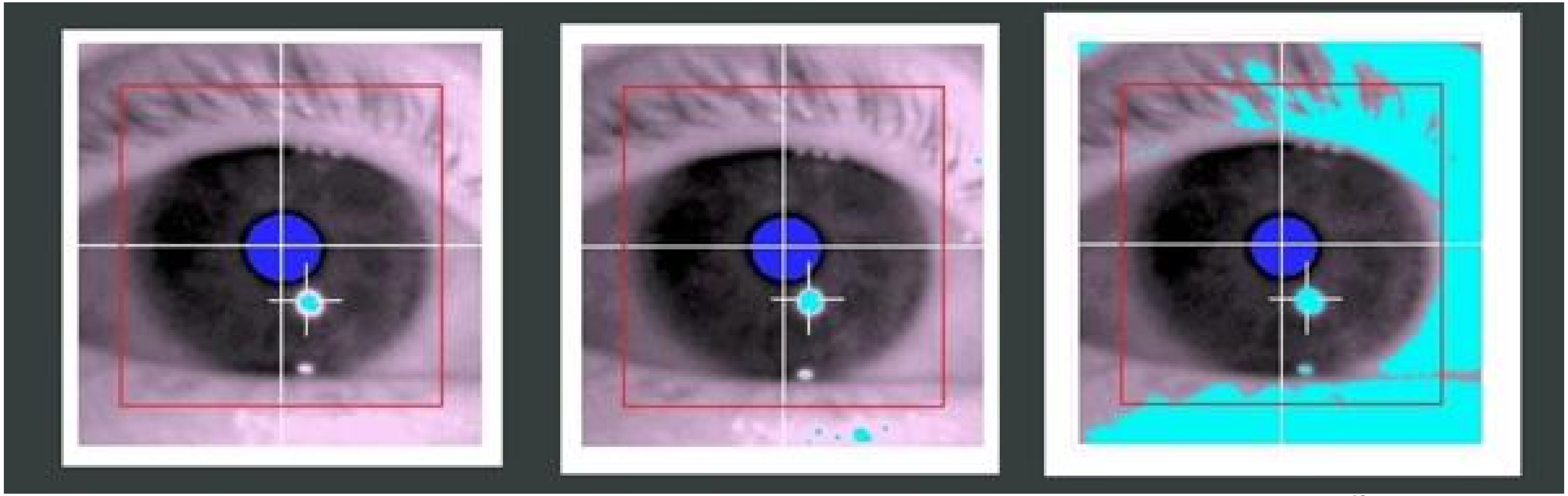

Good Pupil Threshold


Threshold too high: Shadows

快捷键：按方向键↑和↓可以调节瞳孔阈值。

调节瞳孔（Pupil）和角膜反射点（CR）阈值

CR阈值过高、刚好和过低的三种情况：



pupil

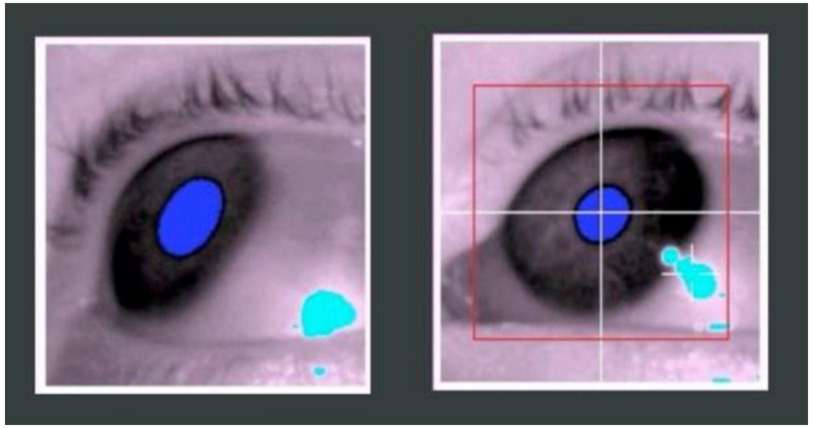
快捷键：按 + 和 - 调节CR阈值。CR的阈值可以稍微设置得低一点点。

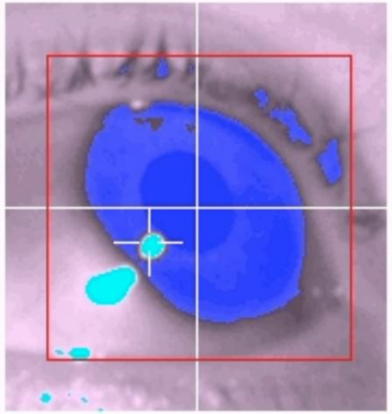
第五步：四点检查

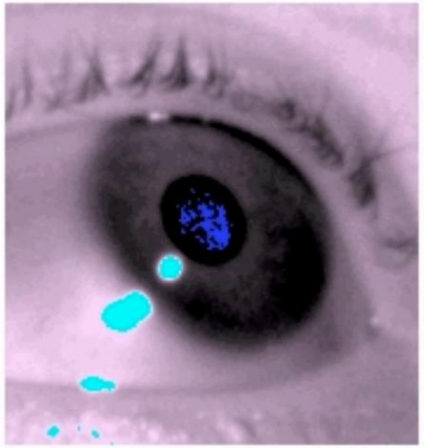
要点：让被试依次看屏幕四个角落，同时观察瞳孔和CR的识别情况

“请看屏幕的左上角…… “ -> 观察CR和Pupil的识别情况
” 请看屏幕的左下角…… “ -> 观察CR和Pupil的识别情况
” 请看屏幕的右上角…… “ -> 观察CR和Pupil的识别情况
” 请看屏幕的右下角…… “ -> 观察CR和Pupil的识别情况

每次下指令后，都停顿一下，观察Pupil和CR的识别是否出现下图所示异常：



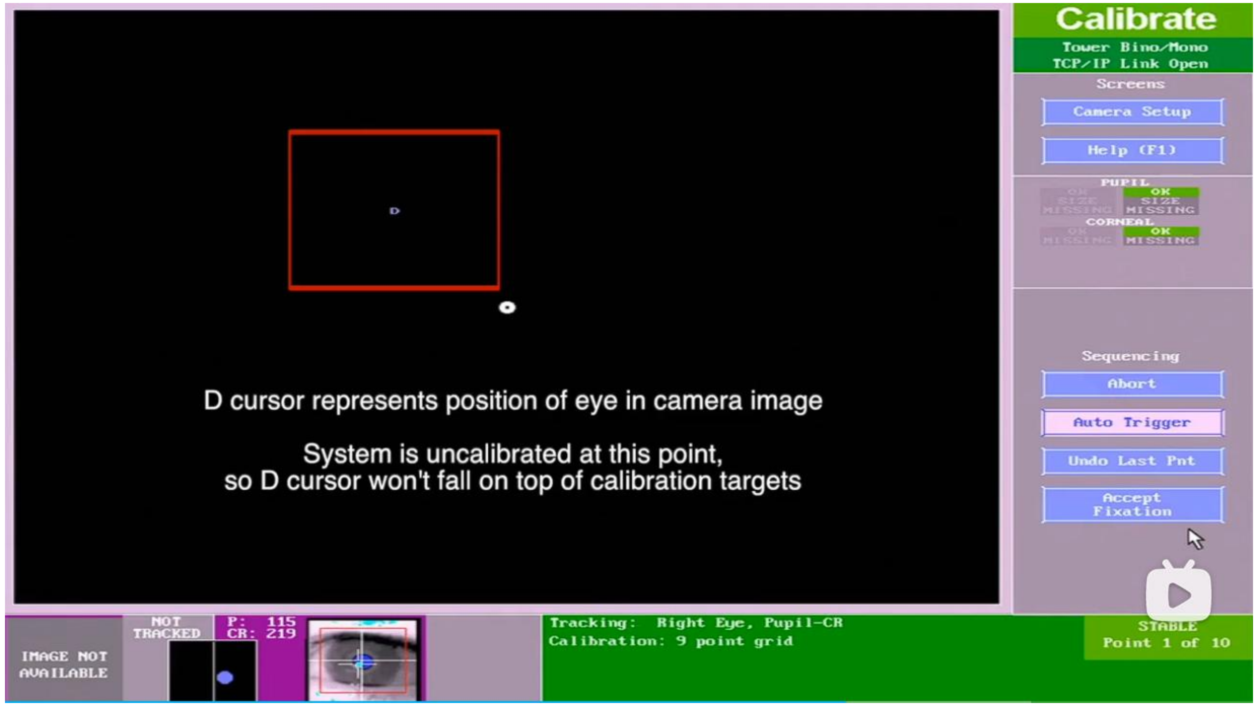




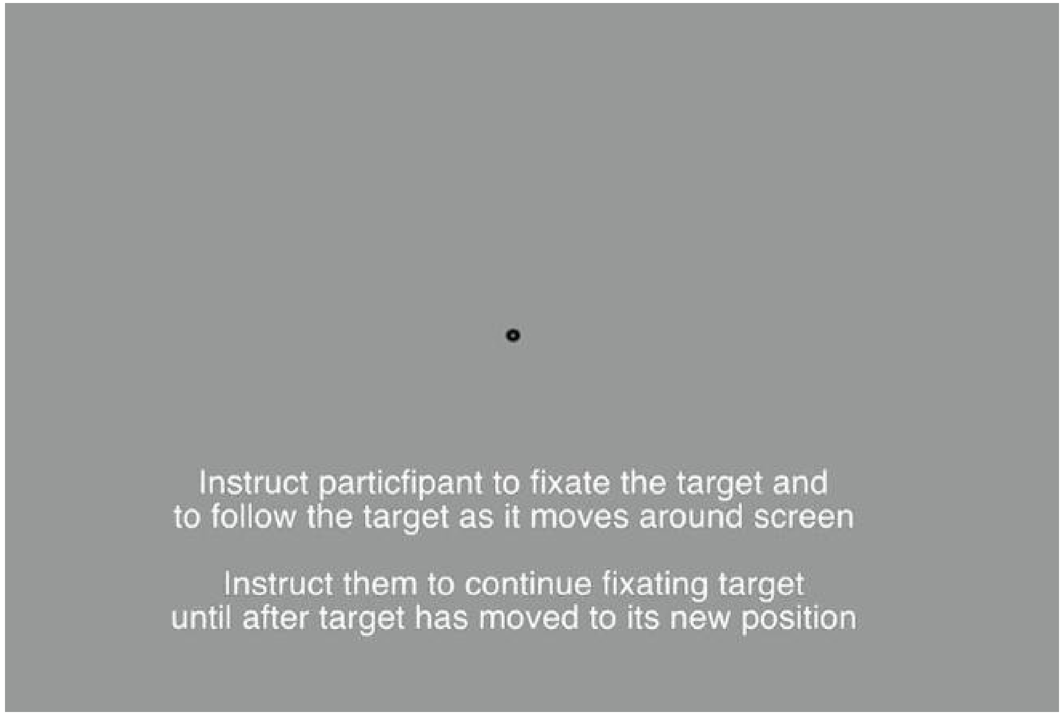
如出现异常，则参照实验室环境设置重新设置眼动仪设备摆放。

第六步：校准（Calibration）

在Camera Setup界面，鼠标点击Calibration选项或按快捷键C。



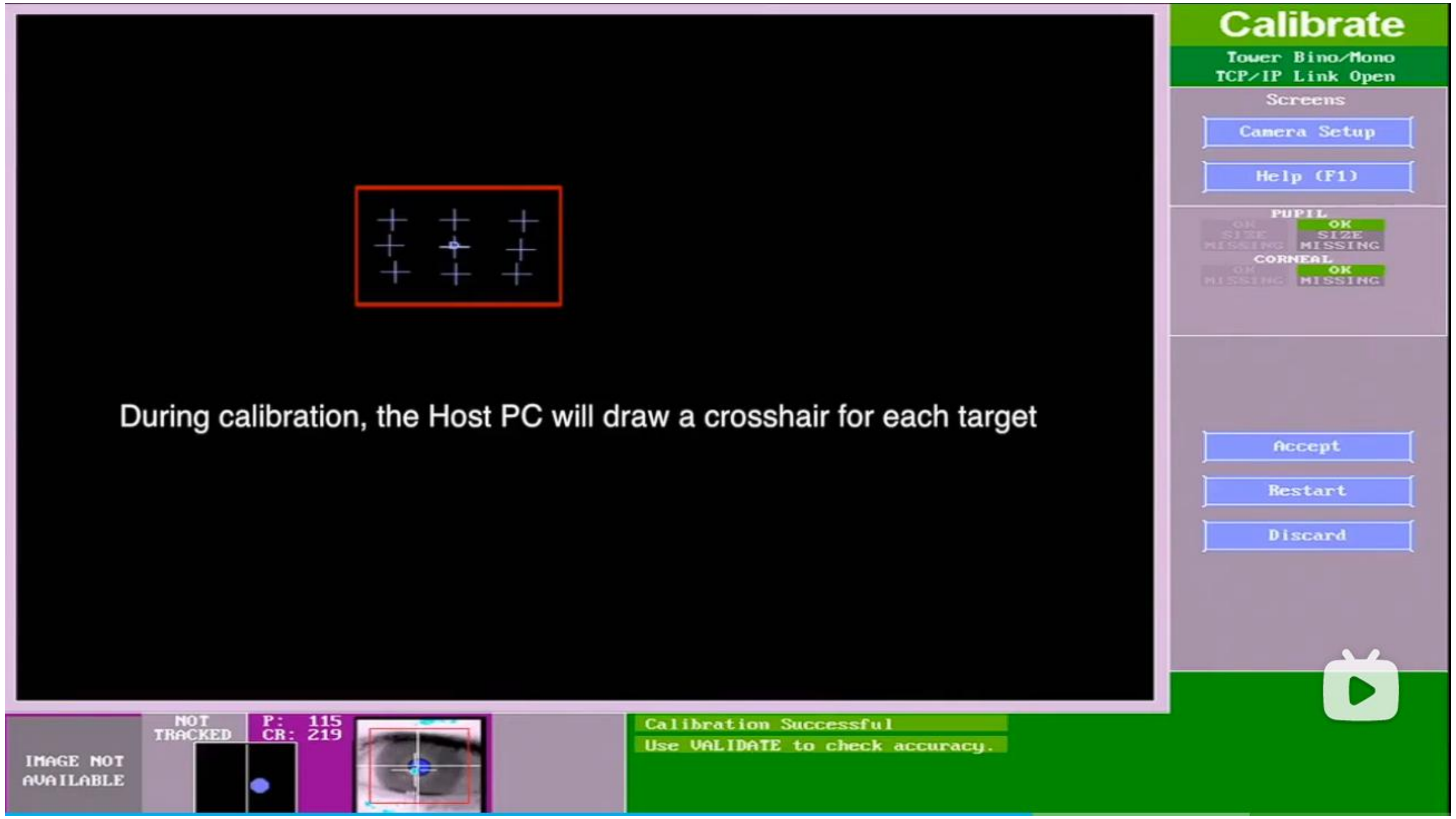
主机上的画面



被试机上的画面

第六步：校准（Calibration）

在被试盯好校准点后，按空格键。



校准技巧：

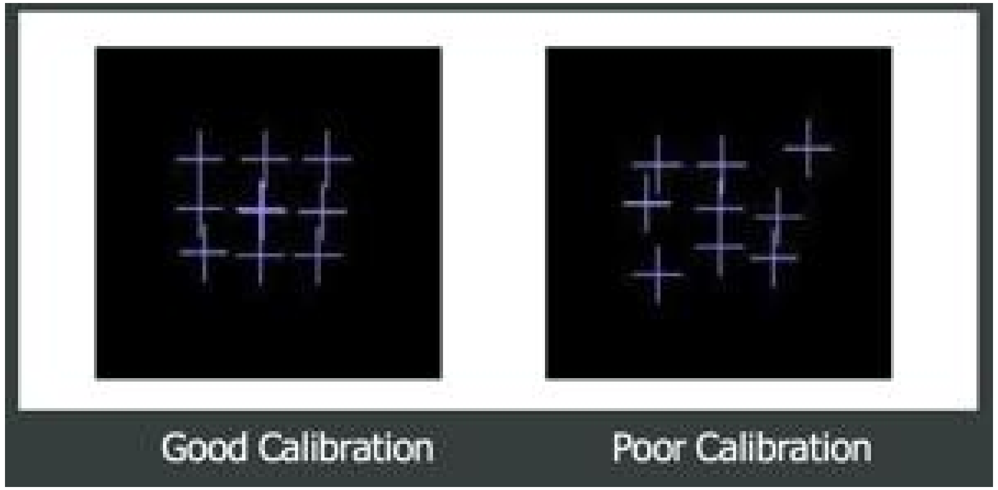
- 使用手动校准效果更好
- 鼓励被试
- 尝试追踪优势眼
- 告诉被试盯住校准点的中心
- 当被试没盯好校准点后及时按下空格（不要过快或过慢）

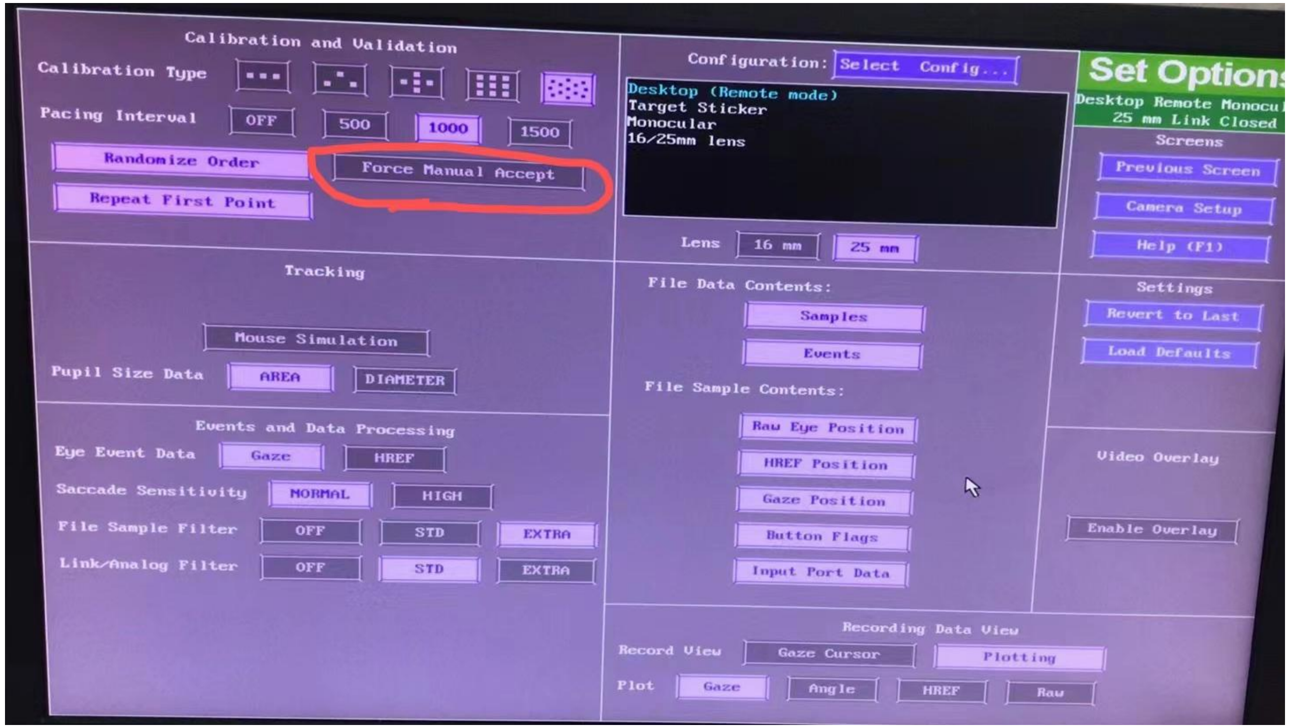
更多技巧请查阅手册**EyeLink® 1000 Plus User Manual 83**页校准的详细介绍。

第六步：校准（Calibration）

注意：校准完成后，如果结果较好，按accept接受校准结果。

如果校准结果不好，请按照实验环境设置的内容仔细检查仪器摆放位置，并改用手动校准。

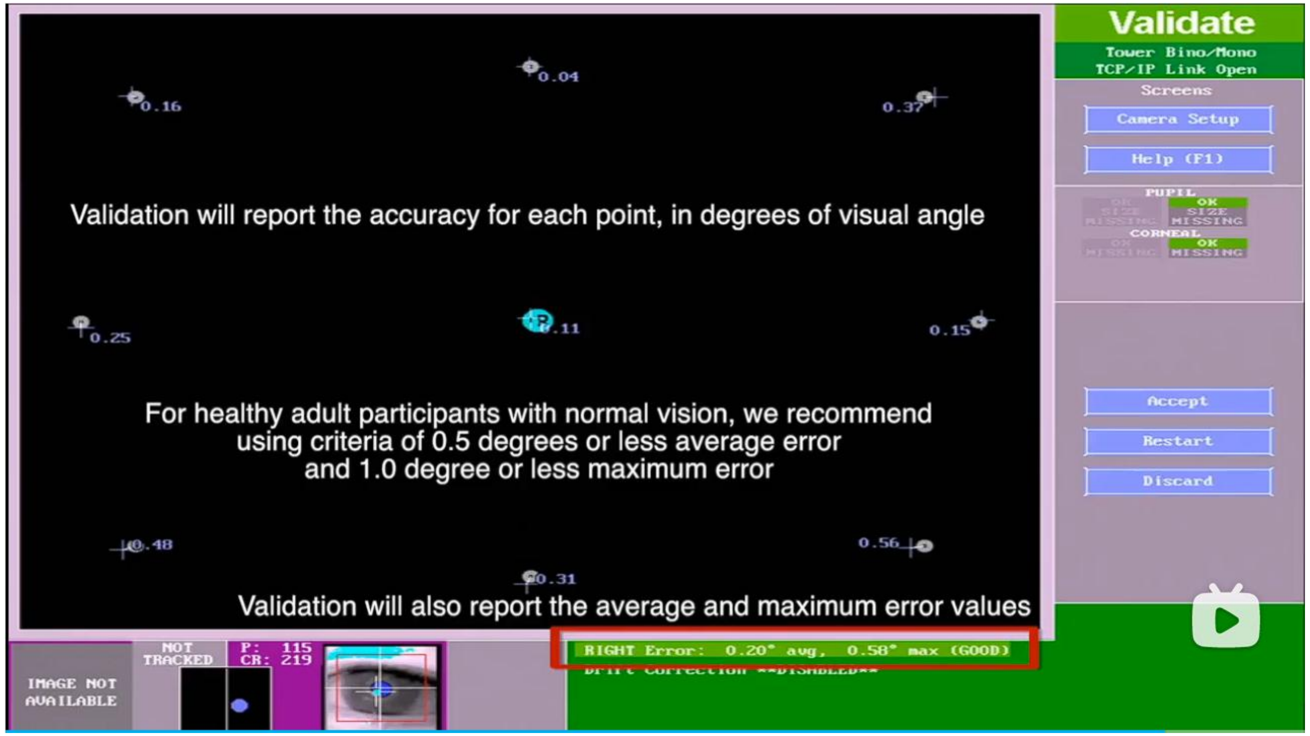




基本步骤

验证

在Camera Setup界面，鼠标点击Validation或按快捷键V。



当被试盯住验证点后，按空格键。

使用手动验证效果更好

建议平均误差小于**0.5**°，最大误差小于**1**°

最后。。

有关主机和设备的更多说明和操作通过查阅手册学习

有问题联系工程师