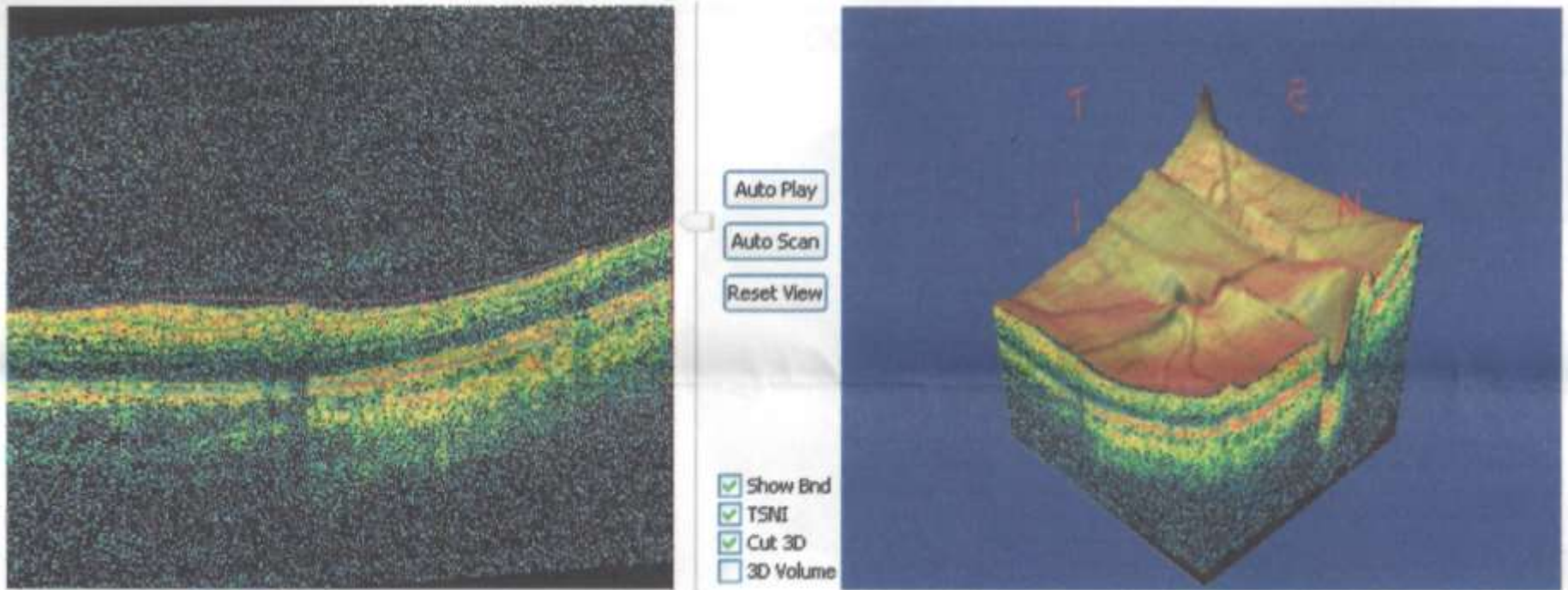




# The Biophysics of Vision

# Laser interferometers allows us to examine retinal details in microns



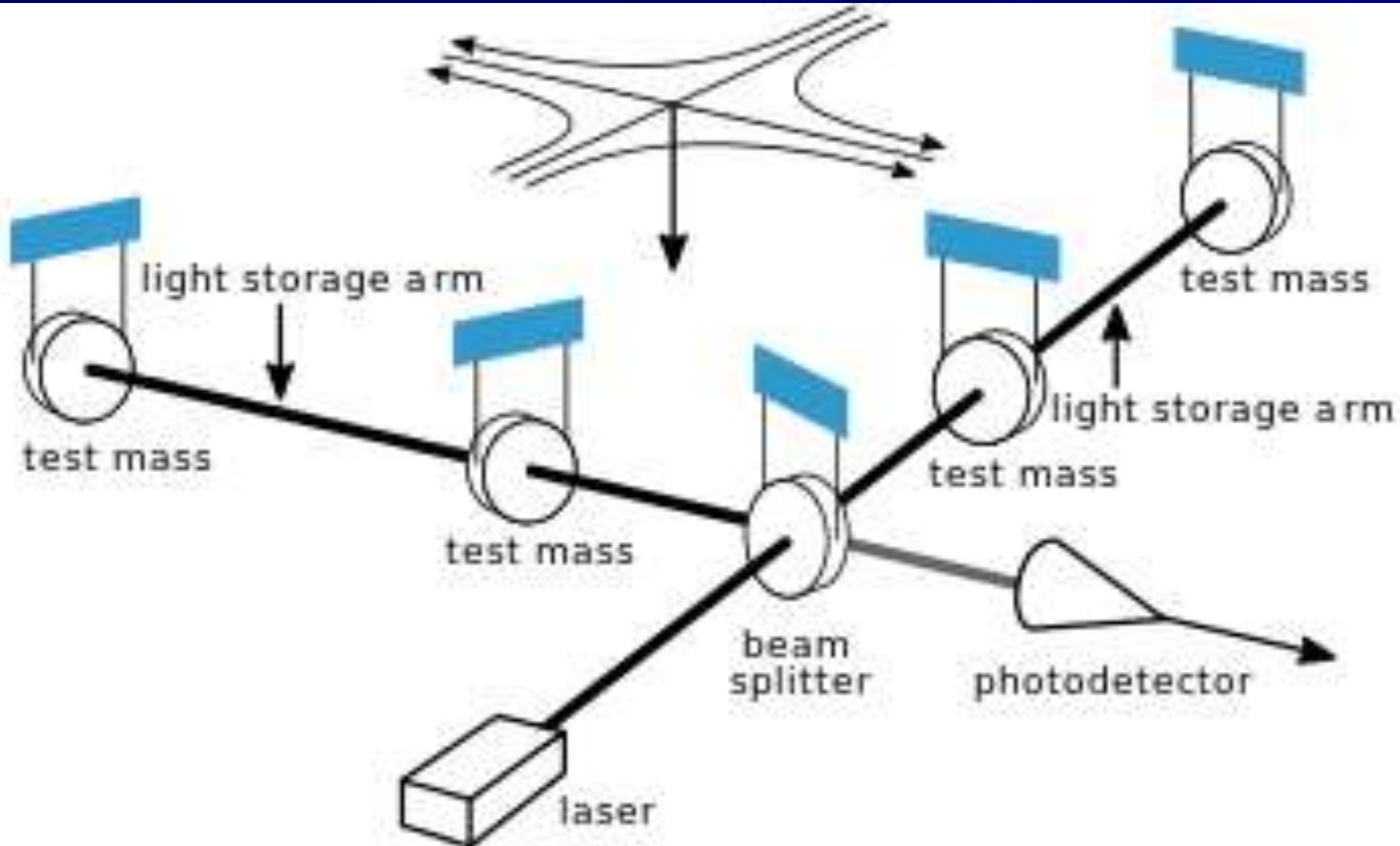
Diagnosis:



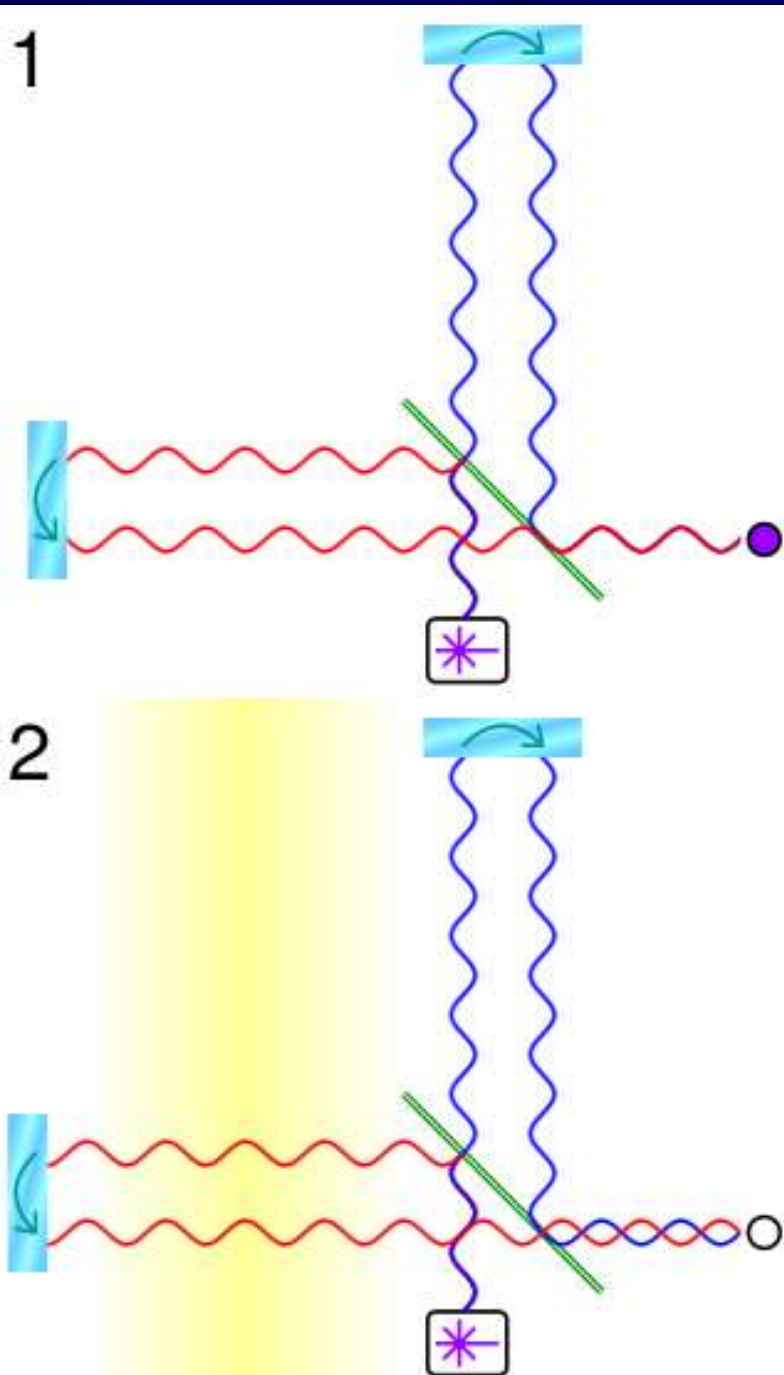
Two detectors thousands of miles apart  
receive the same signal from space



# Gravity waves move objects less than the diameter of a atomic nucleus



# Simplified operation of a gravitational wave observatory

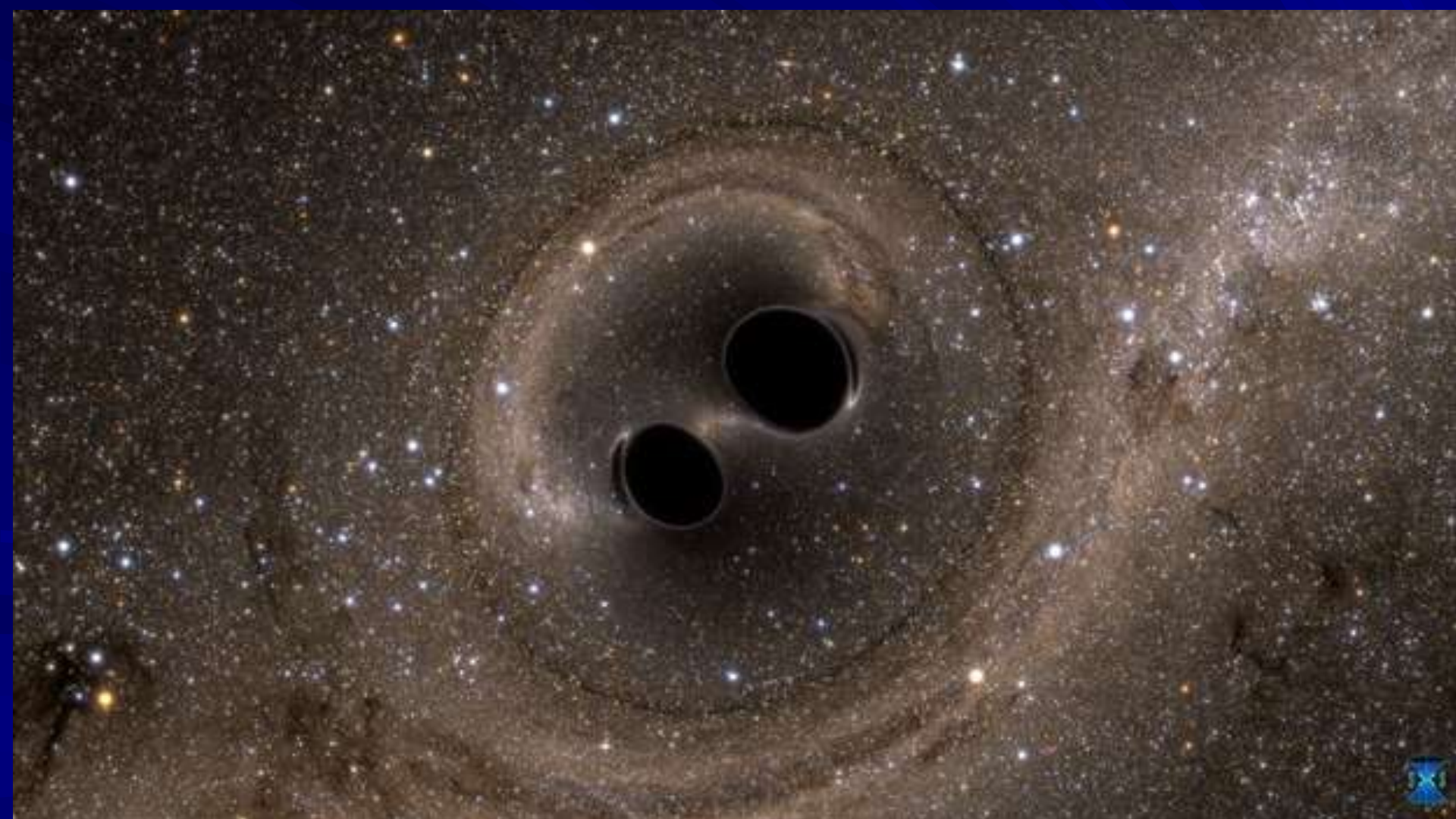


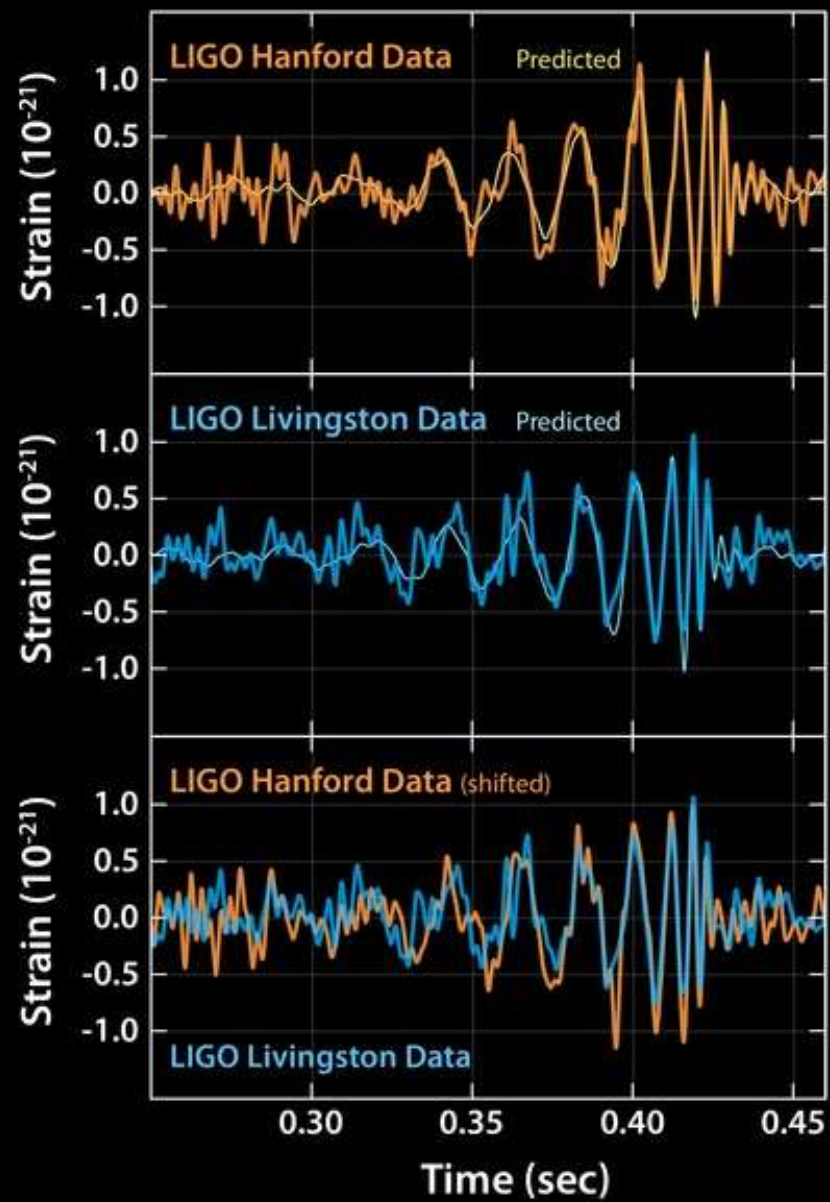
- **Figure 1:** A beamsplitter (green line) splits coherent light (from the white box) into two beams which reflect off the mirrors (cyan oblongs);
  - only one outgoing and reflected beam in each arm is shown, and separated for clarity.
  - The reflected beams recombine and an interference pattern is detected (purple circle).
- **Figure 2:** A gravitational wave passing over the left arm (yellow) changes its length and thus the interference pattern



# **Gravitational Waves Detected 100 Years After Einstein's Prediction**

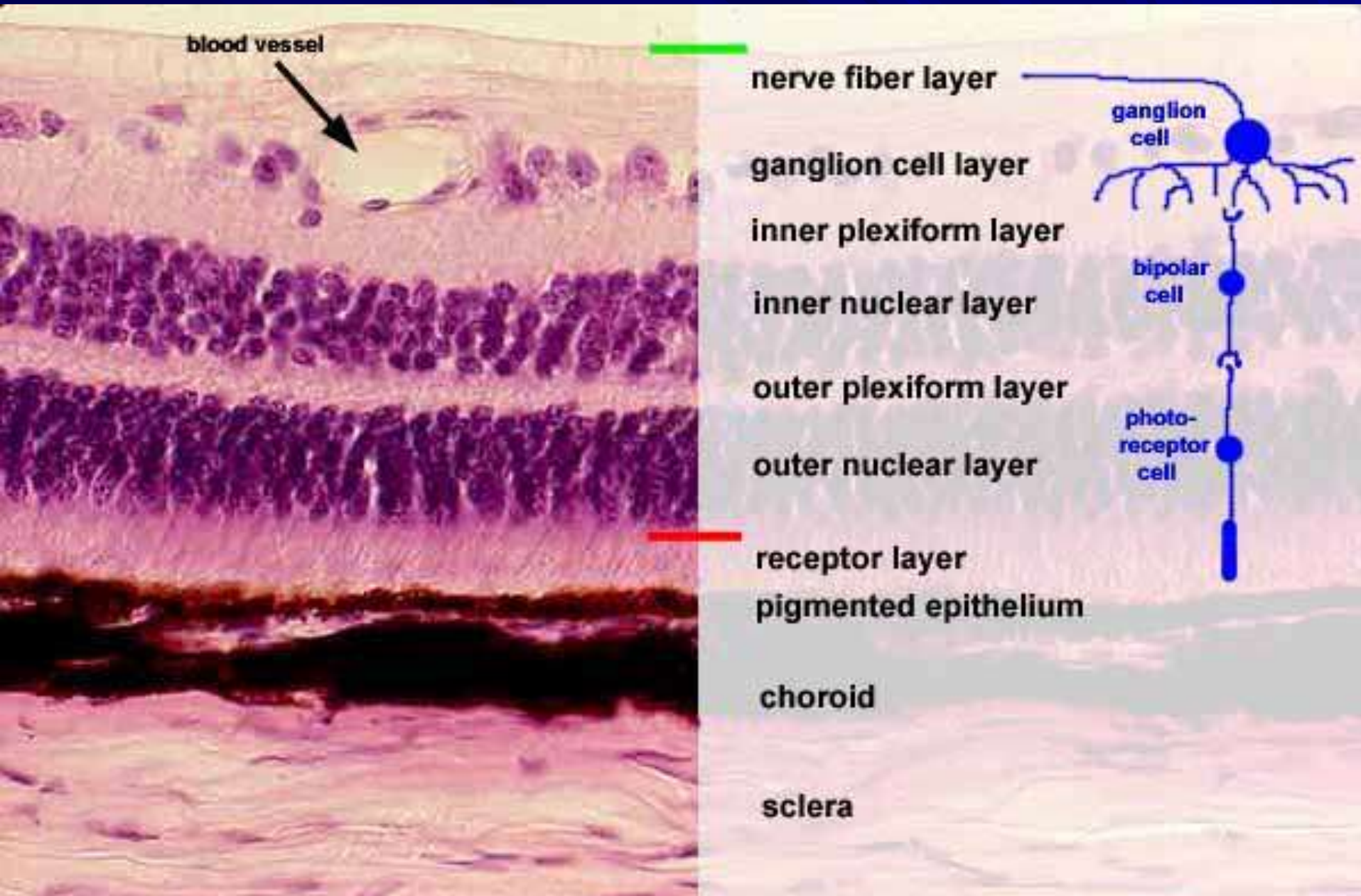
## **News Release • February 11, 2016**





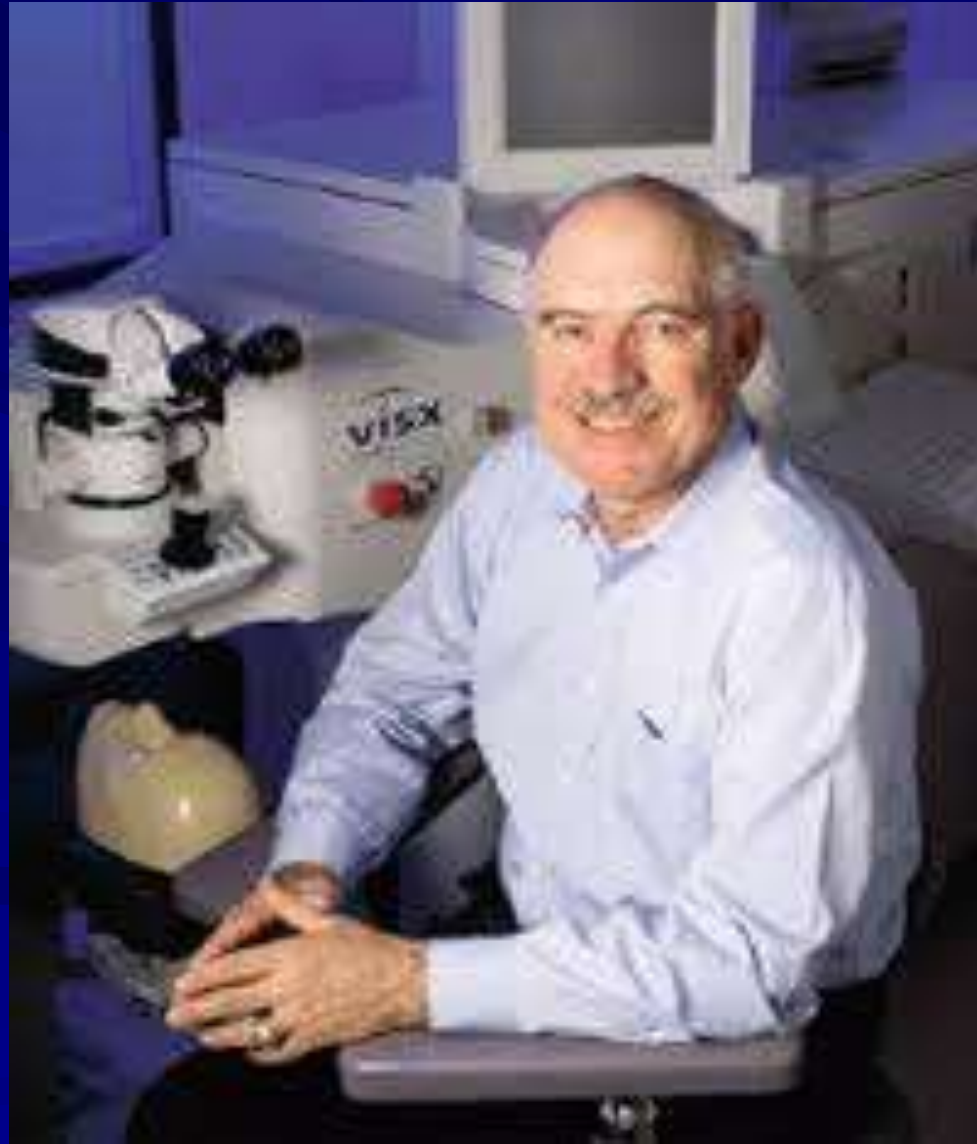


# Outer Photoreceptor Layer is 40 Microns





# Charles Munnerlyn

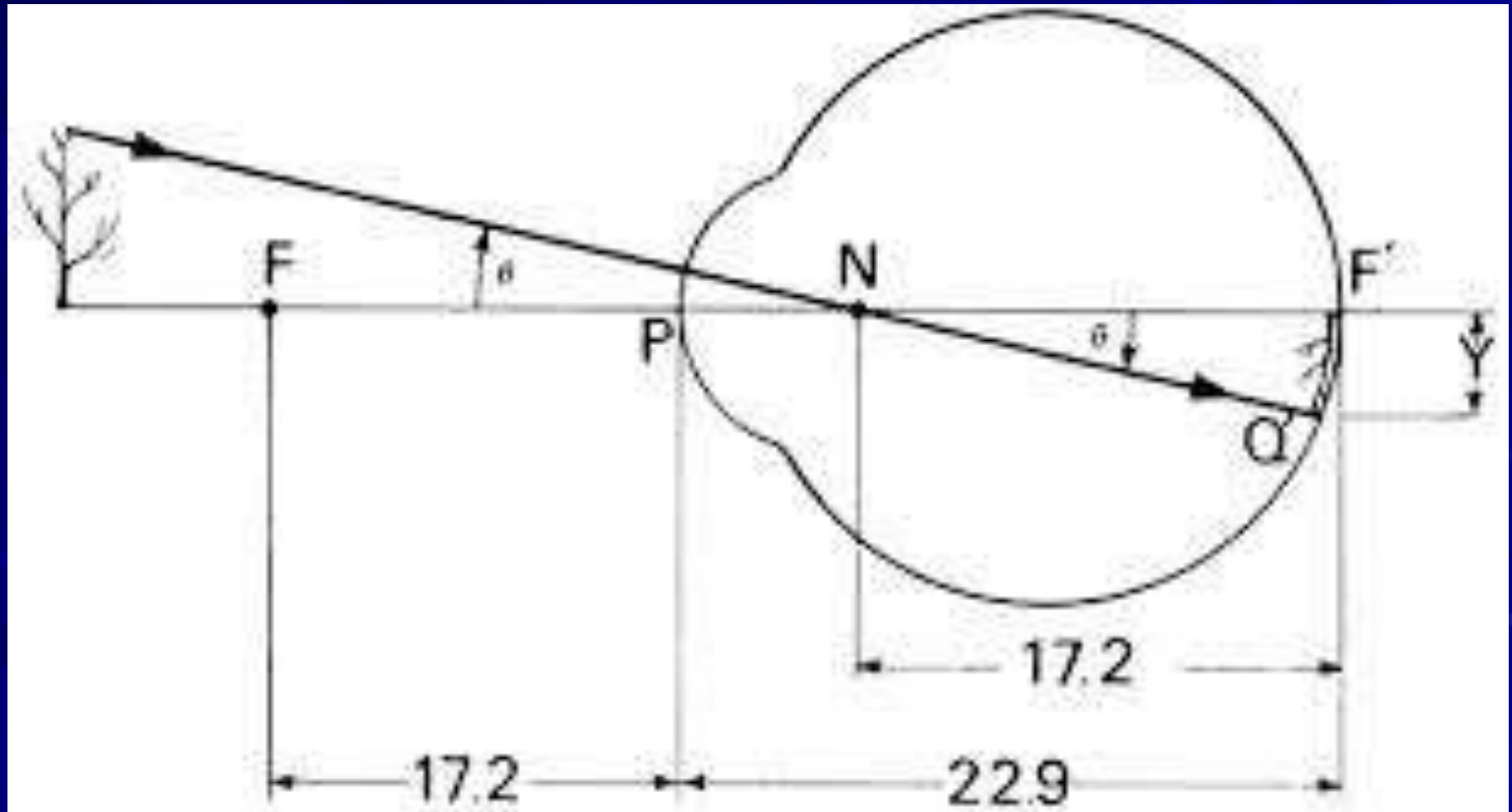


# One diopter is 12 Microns

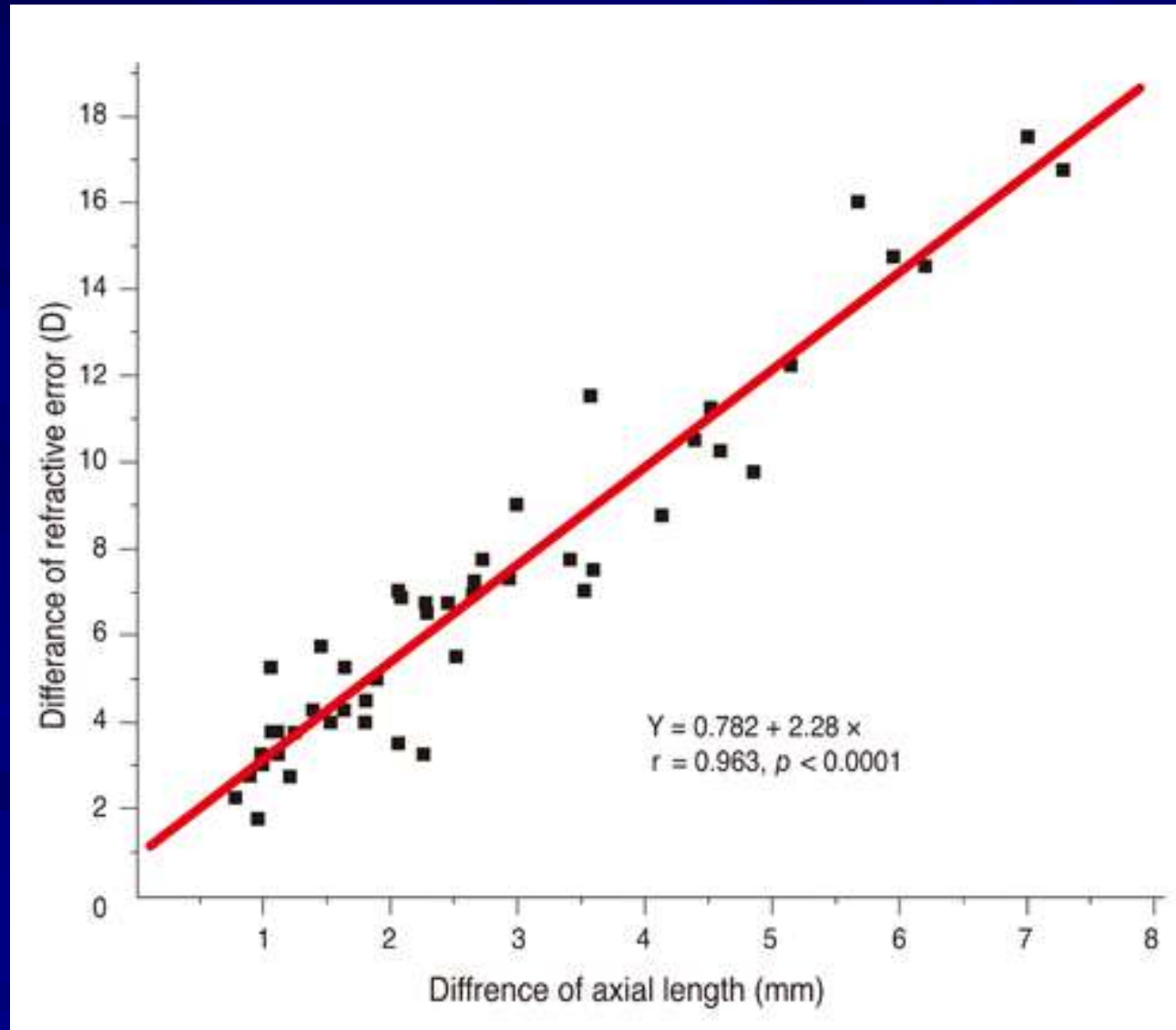
Required Correction	For diameter (mm)		
	5 mm	6 mm	7 mm
	ablation depth (um)		
Diopters	um	um	um
- 1.00	- 8.3	- 12.0	- 16.3
- 2.00	- 16.7	- 24.0	- 32.7
- 3.00	- 25.0	- 36.0	- 49.0
- 4.00	- 33.3	- 48.0	- 65.3



Nodal point to retina 17.2mm  
Nodal point to Cornea 5.7 mm  
(Radius curvature to vitreous is 3.01)



# One diopter of axial length is 438 microns





# Enhancements allow focus in the retina

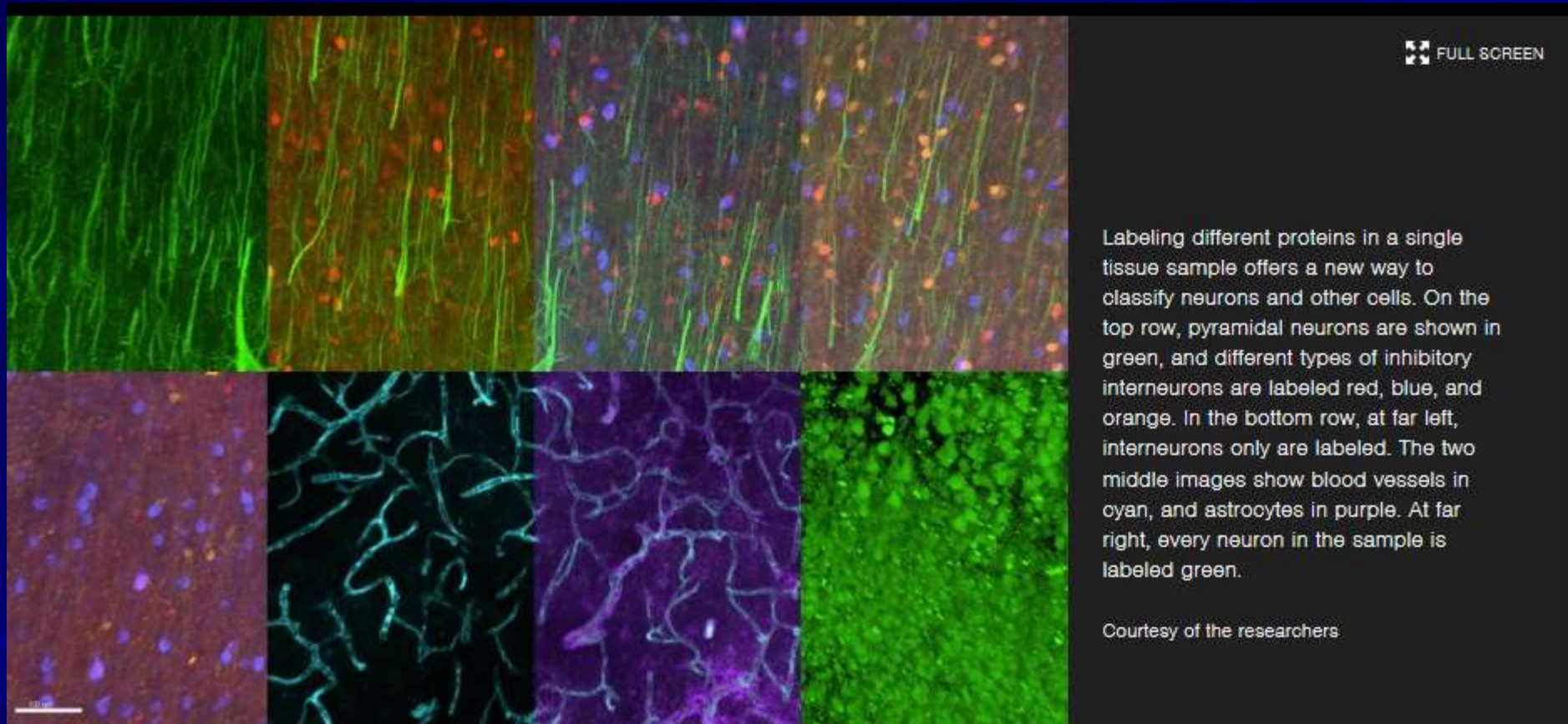
- Clinically significant enhancement is
  - 0.50 D or 6  $\mu\text{m}$  ablation
- This is equivalent to about 220 microns at the retinal
- Foveal thickness is about 150-180  $\mu\text{m}$
- The outer photoreceptor layer is about 40  $\mu\text{m}$
- 20/20 vision is about 25  $\mu\text{m}$  width



**25 microns**

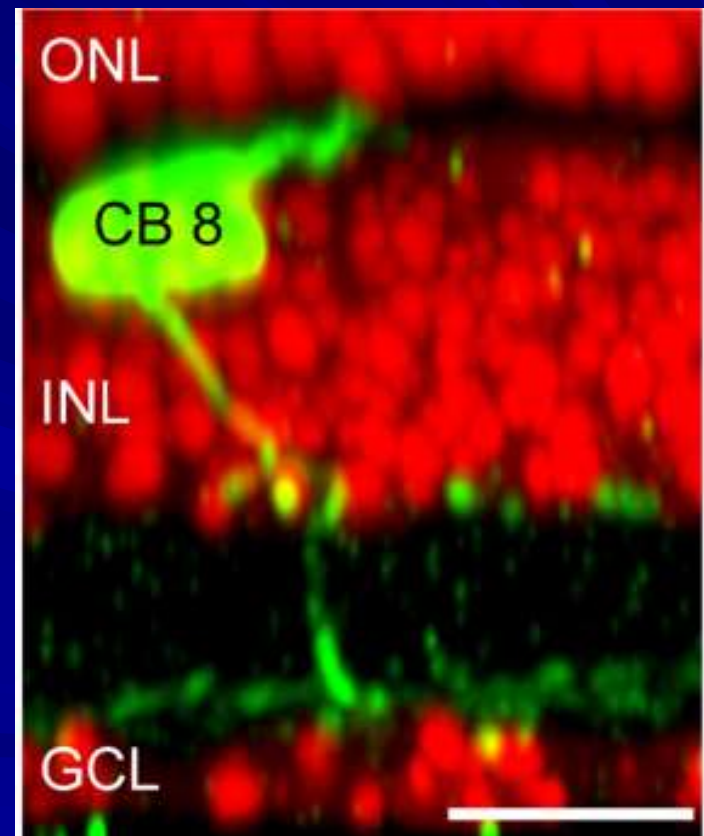
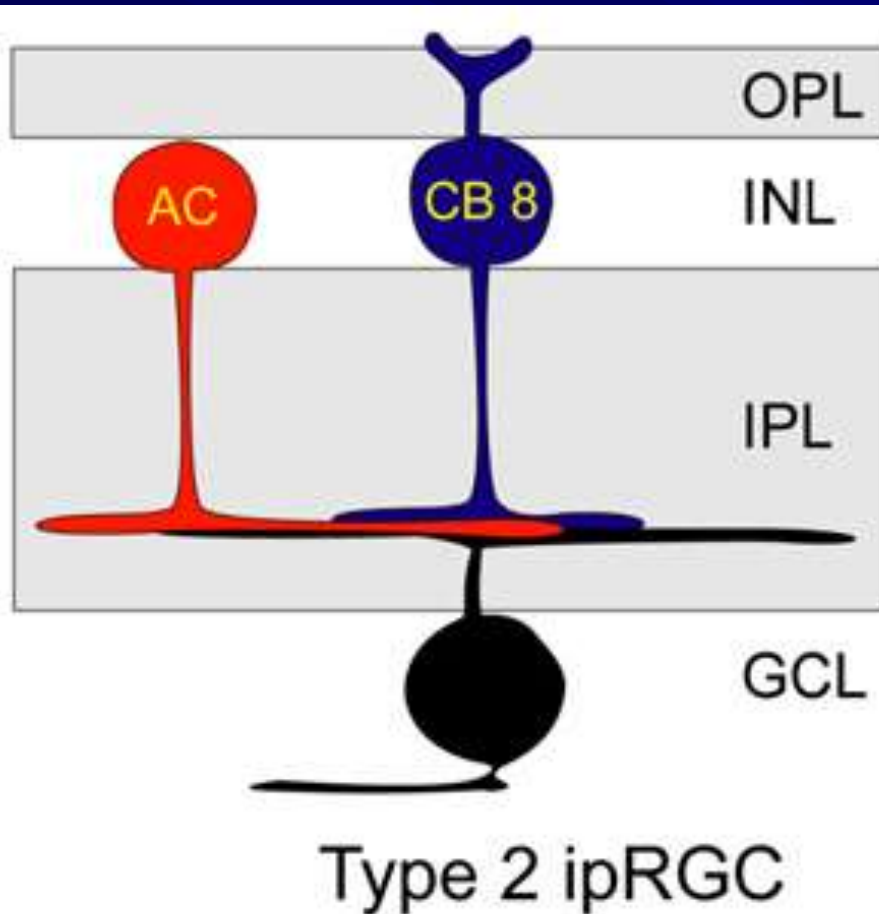


# Protein imaging reveals brain architecture



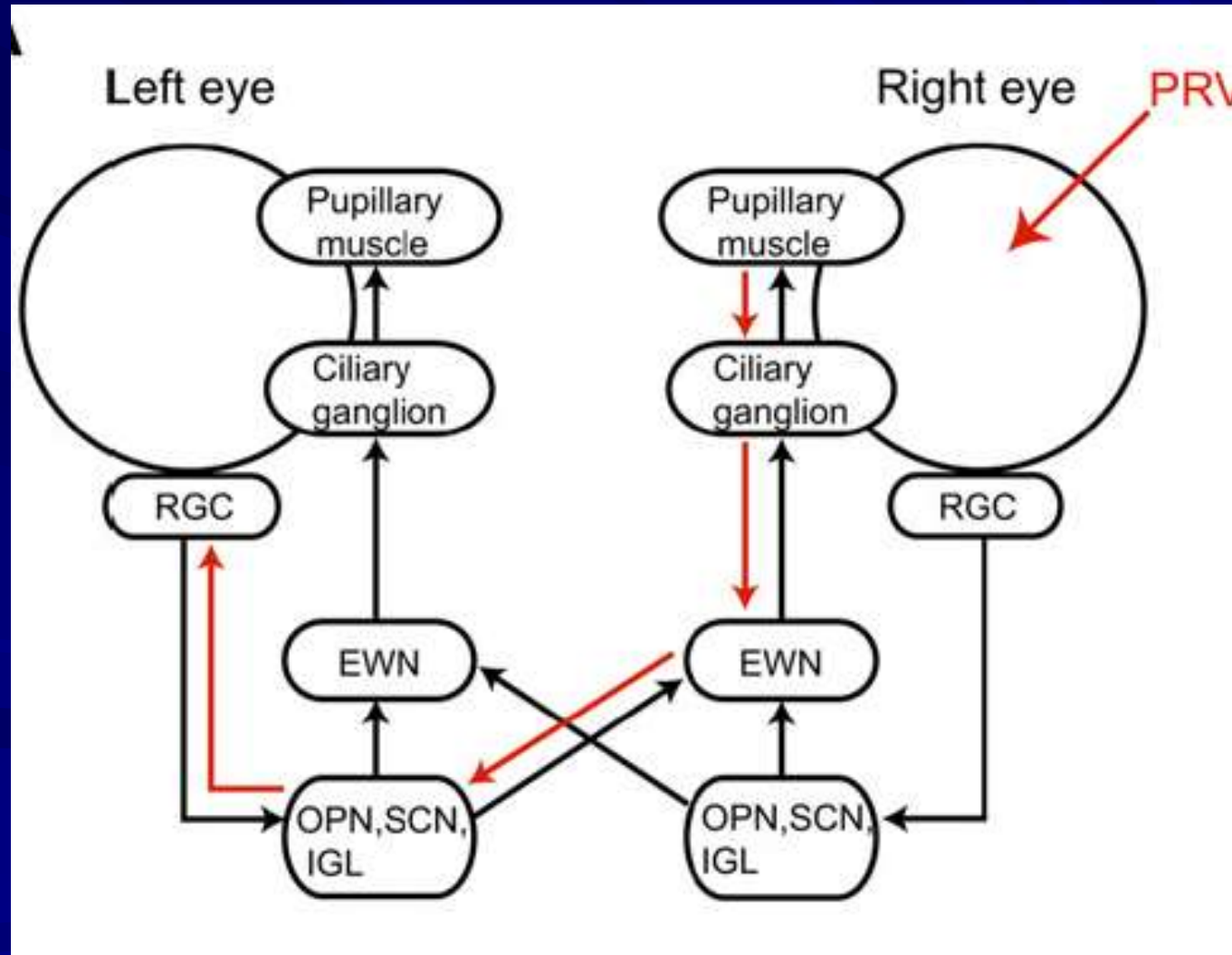
Cell, Volume 163, Issue 6, p1500–1514, 3  
December 2015

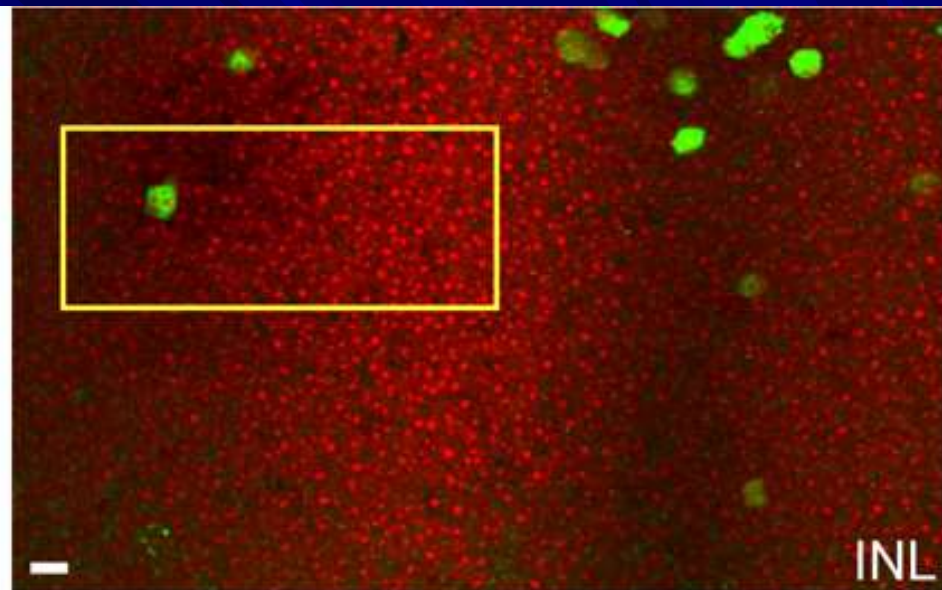
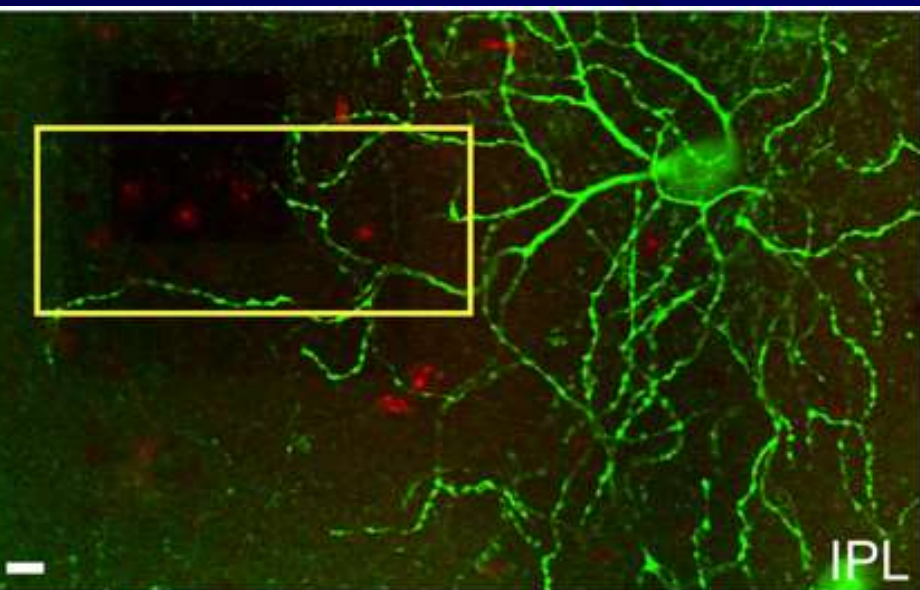
# Dopamine and Ganglion Cells System involved in light adaptation





# PRV152 (virus): Retrograde Spread from the Right Eye to Subtypes of Ganglion Cells in the Left Retina



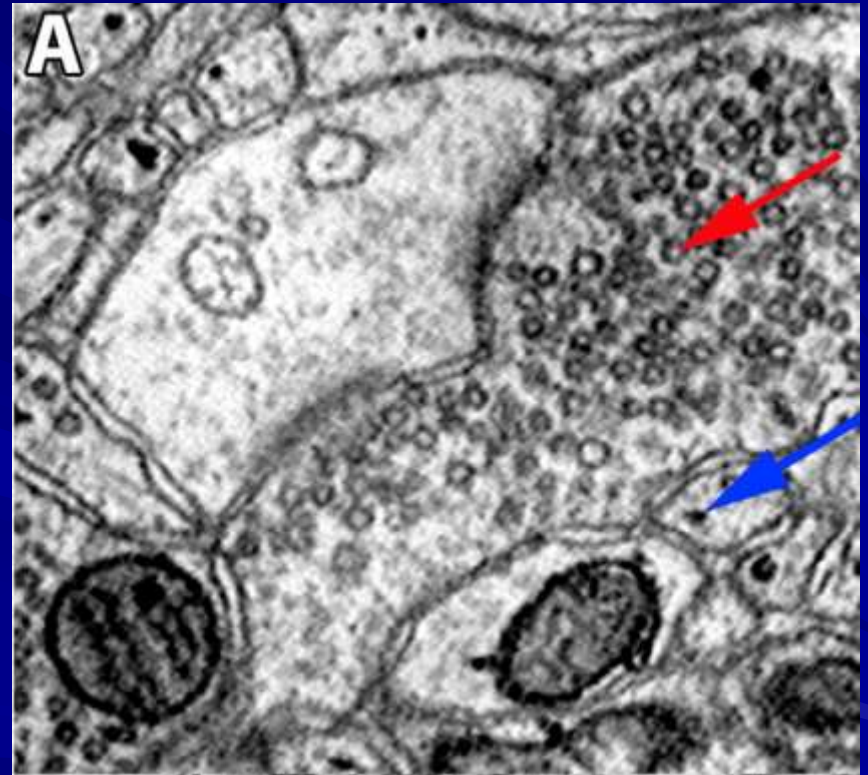


## **Local Retinal Circuits of Melanopsin-Containing Ganglion Cells Identified by Transsynaptic Viral Tracing**

Current Biology 17, 981–988, June 5, 2007

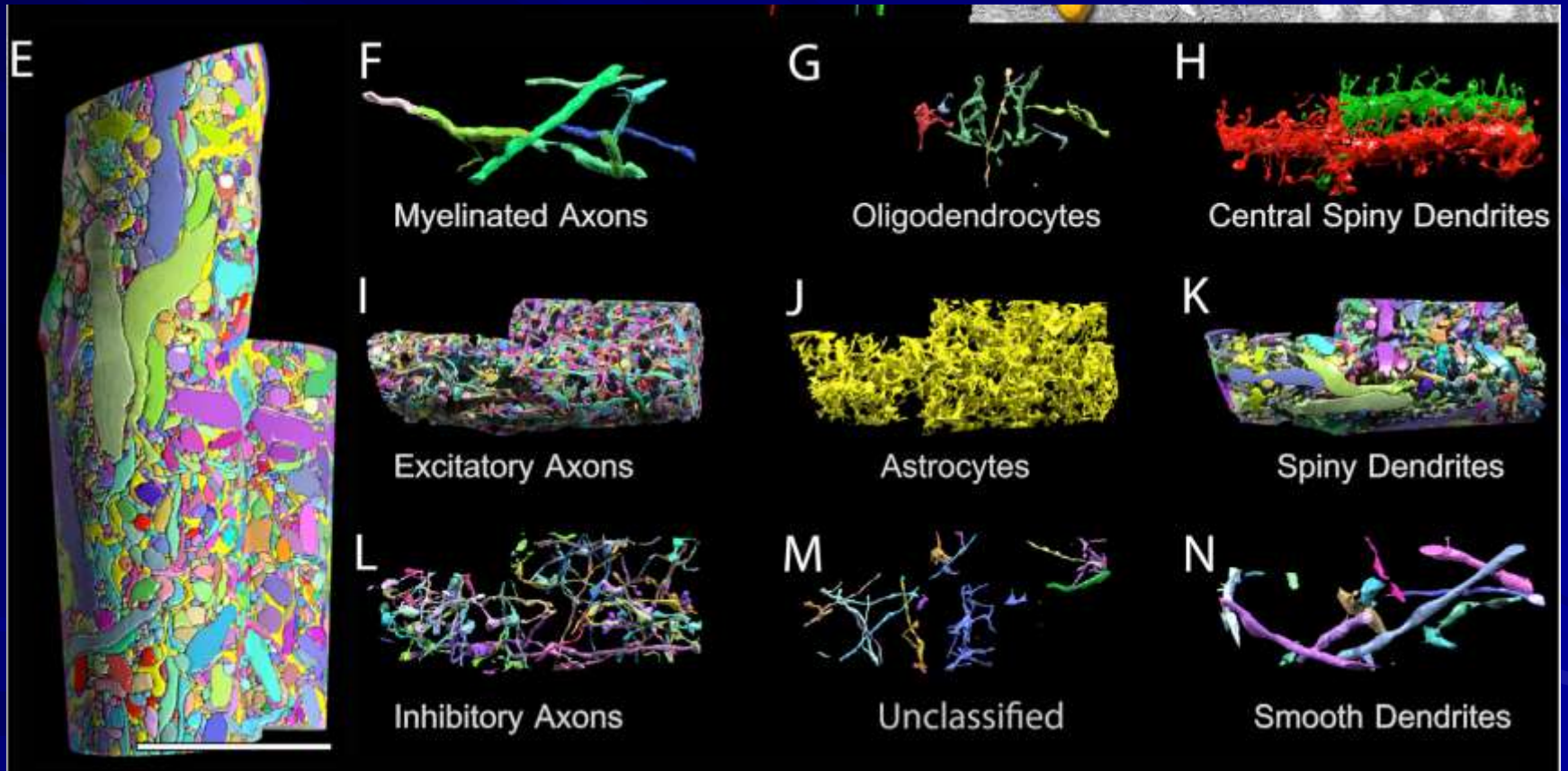
# Imaging Brain Sections

- A section of somatosensory neocortex imaged in a scanning electron microscope.
  - The red arrow shows synaptic vesicles.
  - The blue arrow shows a strongly labeled membranous tube found in unmyelinated axons.

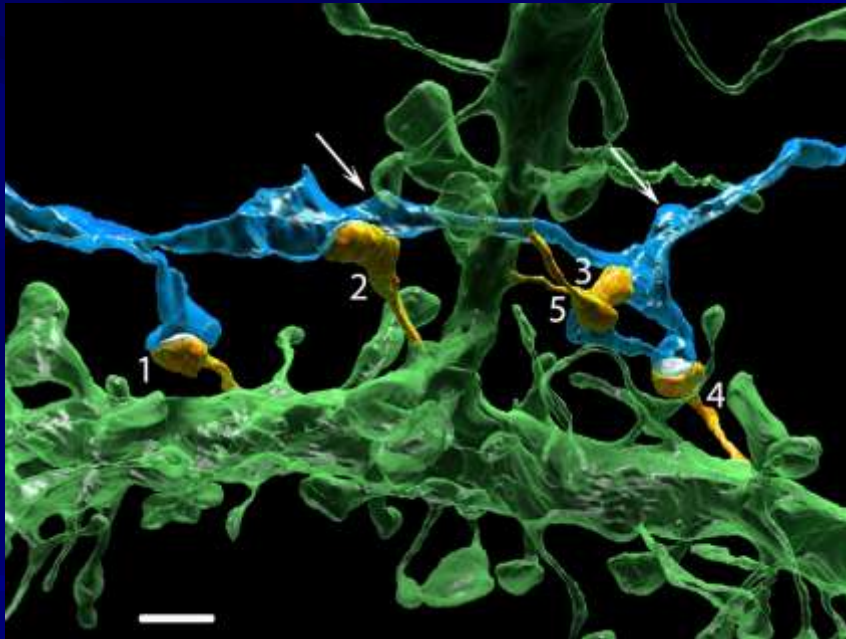




# Multi-Scale Reconstruction in Neocortex



# Multiple Synapses of the Same Axon Innervate Multiple Spines of the Same Postsynaptic Cell

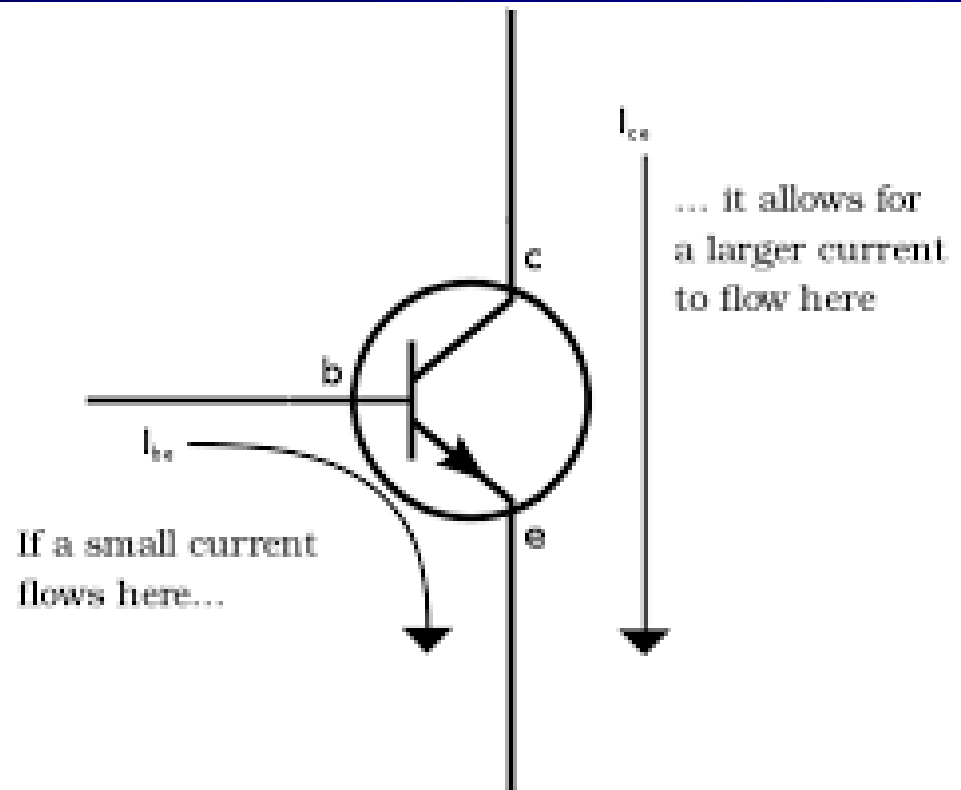


- The best predictor of whether an axon would establish a synapse with a particular dendrite was its synaptic connectivity with that dendrite at other sites.
- An excitatory axon that established a spine synapse with a dendrite, had a 40% probability of establishing another synapse on the same dendrite whereas excitatory axons that only came adjacent to, but did not innervate, a dendrite's spine had a 25-fold lower probability (1.6%) of establishing a synapse with that dendrite at another site

# Computers only decides if transistors are ON or Off (Zero or One)



**Three wires**



If a small current flows here,  
it allows for a larger current to flow here



