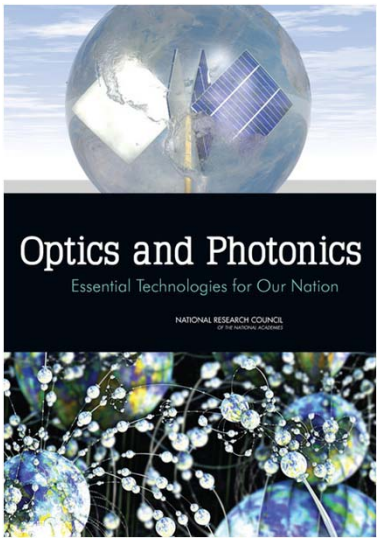
The Photonics Industry Neuroscience Group Support for the BRAIN Initiative

Dr. Thomas M. Baer
Stanford Photonics Research Center
Stanford University

Photonics is the Science and Technology of Light

Optics & Photonics: Essential Technologies for Our Nation



(http://www.nap.edu/catalog.php?record_id=13491)

NATIONAL PHOTONICS INITIATIVE

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What is the NPI?

A collaborative alliance seeking to unite industry, academia and government to identify and advance areas of photonics critical to maintaining US competitiveness and national security.

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Scientific Societies Involved

Founding Sponsors:

OSA The Optical Society

SPIE.

Sponsors:

APS physics

IEEE photonics SOCIETY
Transforming science into technology

LIA Laser Institute of America
Laser Applications and Safety

National Photonics Initiative

Focus on 5 areas of highest economic impact

- Information Technology & Telecom 
- Energy and Environment 
- Advanced Manufacturing 
- Defense and Homeland Security 
- Biomedicine 

Photonics Industry Neuroscience Group

Photonics Related BRAIN Initiative Goals (NIH Working Group)

1. Generate circuit diagrams that vary in resolution from synapses to the whole brain
2. Produce a dynamic picture of the functioning brain
3. Link brain activity to behavior with interventional tools that change neural circuit dynamics
4. Develop innovative technologies to understand the human brain and treat its disorders

Integrated Circuit Analogy

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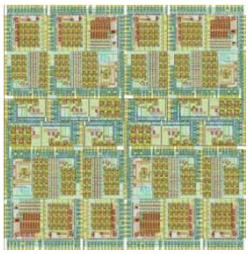
1. Integrated Circuit Analogy



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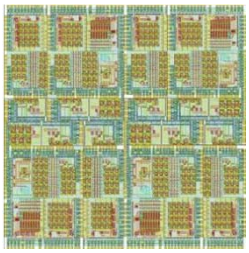
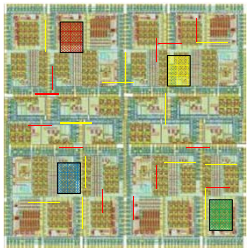
2. Integrated Circuit Analogy

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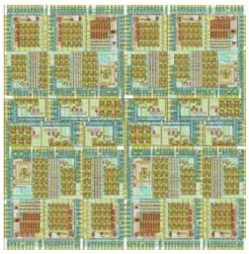
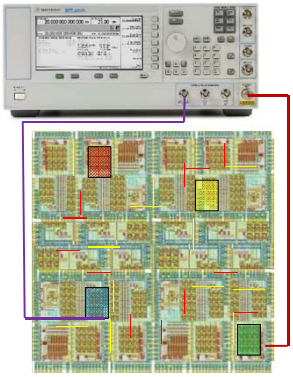
3. Integrated Circuit Analogy

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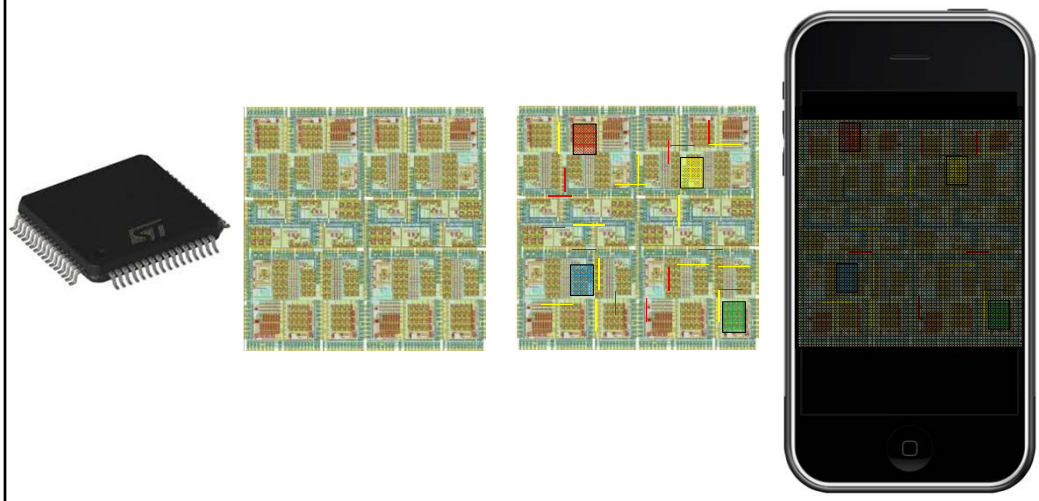
4. Integrated Circuit Analogy



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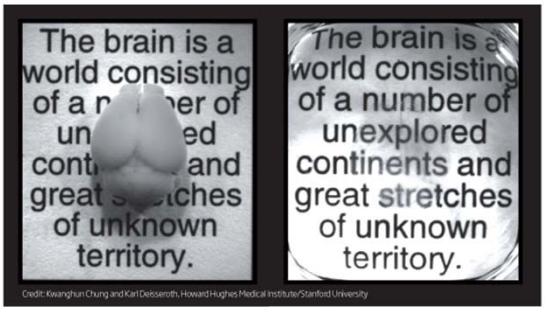
1. Mapping Neural Circuits

CLARITY: Clarifying Tissue Optics



(http://www.newscientist.com/data/images/archive/2912/29124301.jpg)
[*Nature Methods* **Volume: 10** Pages: 508–513 Year published (2013) (Chung, Deisseroth et al.)]

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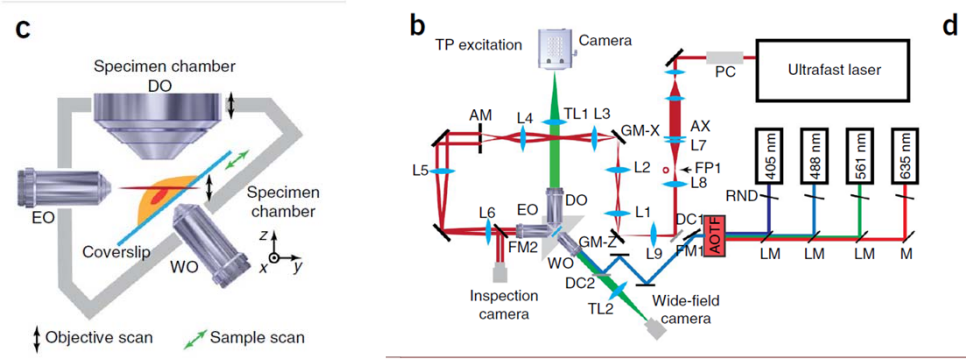
1. Mapping Neural Circuits

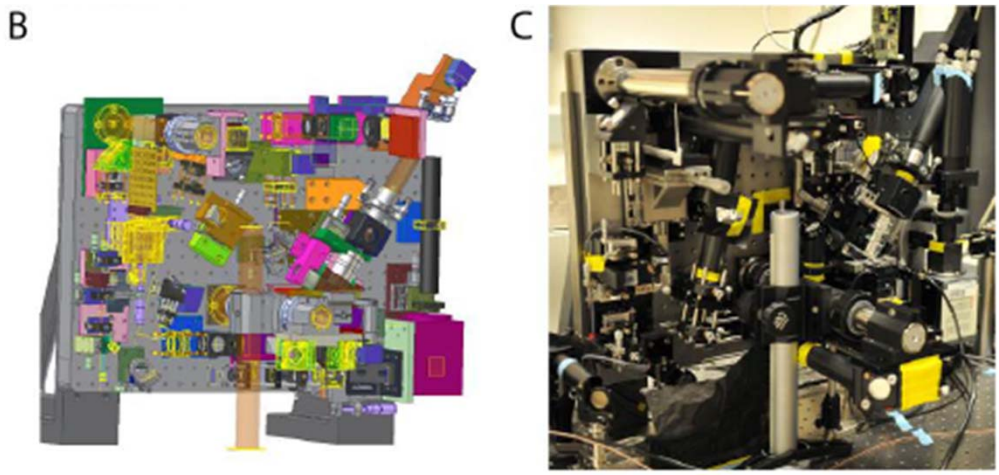
[*Nature Methods* **Volume: 10** Pages: 508–513 Year published (2013) (Chung, Deisseroth et al.)]

Light Sheet Microscopy Schematic



B Chen et al. Science 2014;346:1257998

Light Sheet Microscopy Apparatus



B Chen et al. Science 2014;346:1257998

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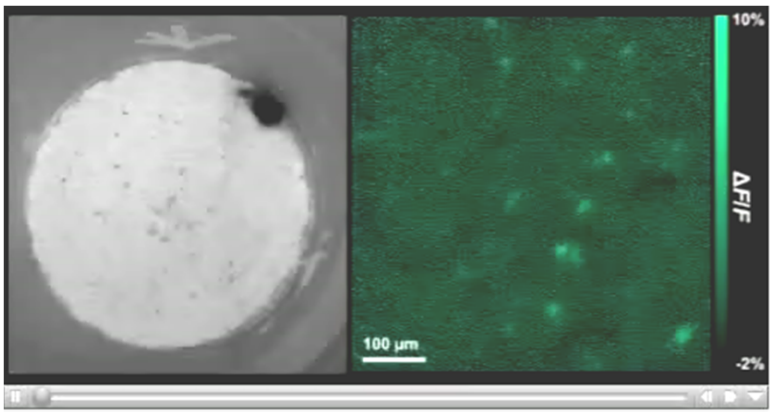
2. Imaging of Neural Dynamics



(http://pyramidal.stanford.edu/movies/Ziv2013-Movie1.mov)

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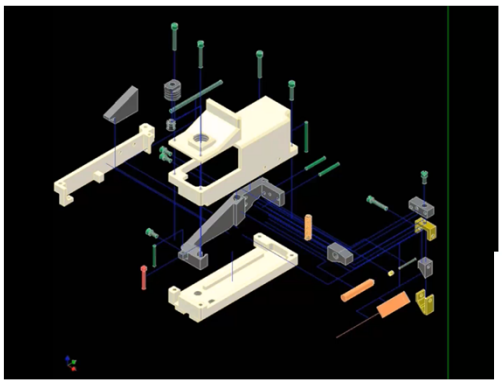
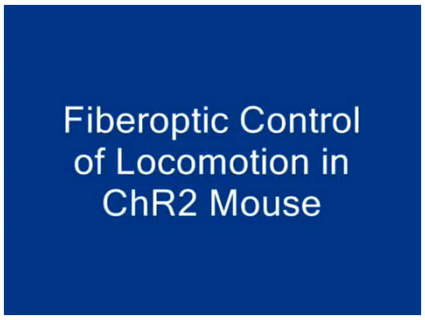
Designing a ‘Wearable’ Microscope



(Schnitzer Lab, Stanford)

(Inscopix)

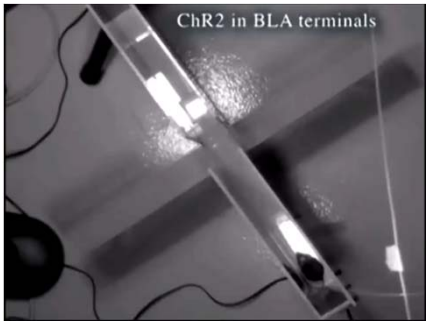
3. Controlling Neurons Using Optogenetics



Light Activated Motion Control

(Deisseroth, http://www.youtube.com/watch?v=88TVQZUfYGw)

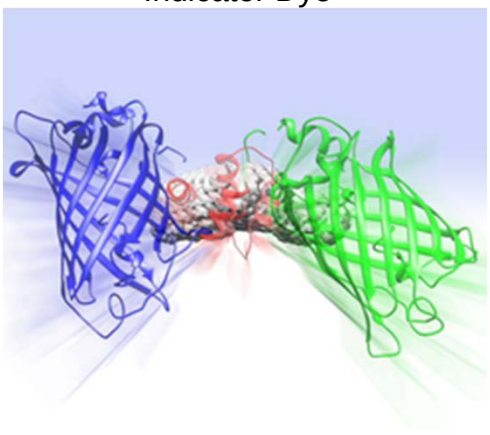
Light Activated Fear Reduction



(Deisseroth, http://vimeo.com/12302544)

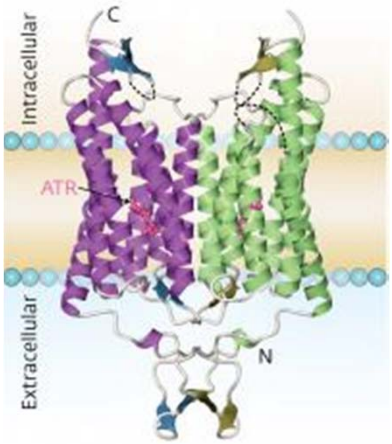
Developing New Protein Structures for Neural Imaging and Control

"Twitch" Calcium Indicator Dye



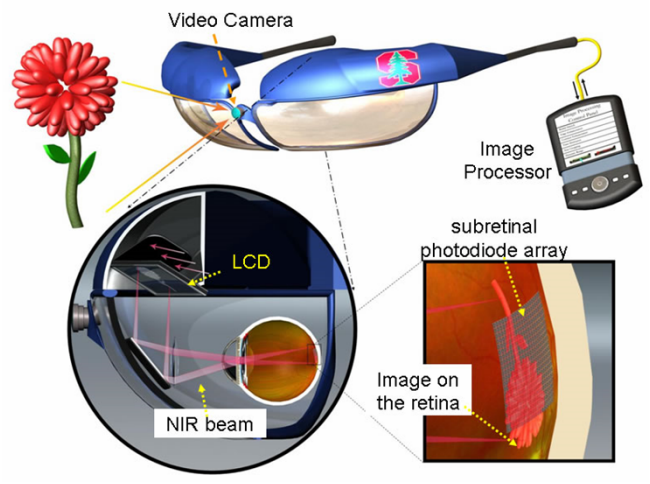
(http://www.neuro.mpg.de/2614850/1402_Griesbeck)

ChannelRhodopsin Ion Channel Control



(http://phys.org/news/2012-06-algal-proteins.html)

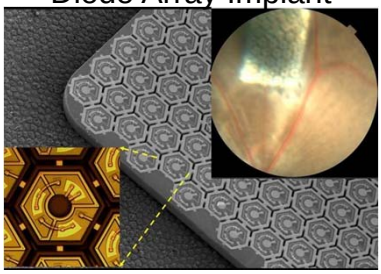
4. Innovative Technologies for Brain Diseases: Restoring Vision with Retinal Implants



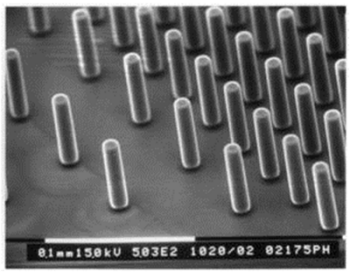
(Palanker Lab, Stanford)

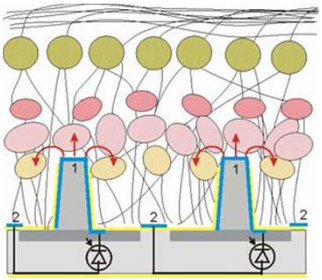
Interfacing Optoelectronic Circuits to Neurons

Diode Array Implant

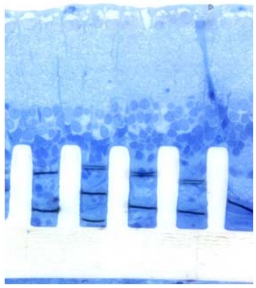


Diode Neuron Interconnect





(Palanker Lab, et al.)



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Essential Photonics Technologies

- Optical components
  - Filters, fiber optics, custom objectives
- Laser sources
- Low noise cameras
- Precision motion mechanics
- Advanced microscope designs
- Big data 3D image analysis software
- Novel protein light activators and sensors

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Photonics Industry Neuroscience Group

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PING Planned Activities

- Enhance industry academia BRAIN dialogue
  - Quarterly meetings at major scientific conferences
- Develop and publish BRAIN technology roadmaps
- Promote collaboration activities:
  - Pre-competitive research
  - Cooperative research and development agreements
  - Recommend funding opportunities to agencies
- Develop mechanisms for technology transfer and training through industry intern programs

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