

Tracking Brain Plasticity in Cochlear Implant Patients Using the Event-Related Optical Signal (EROS)

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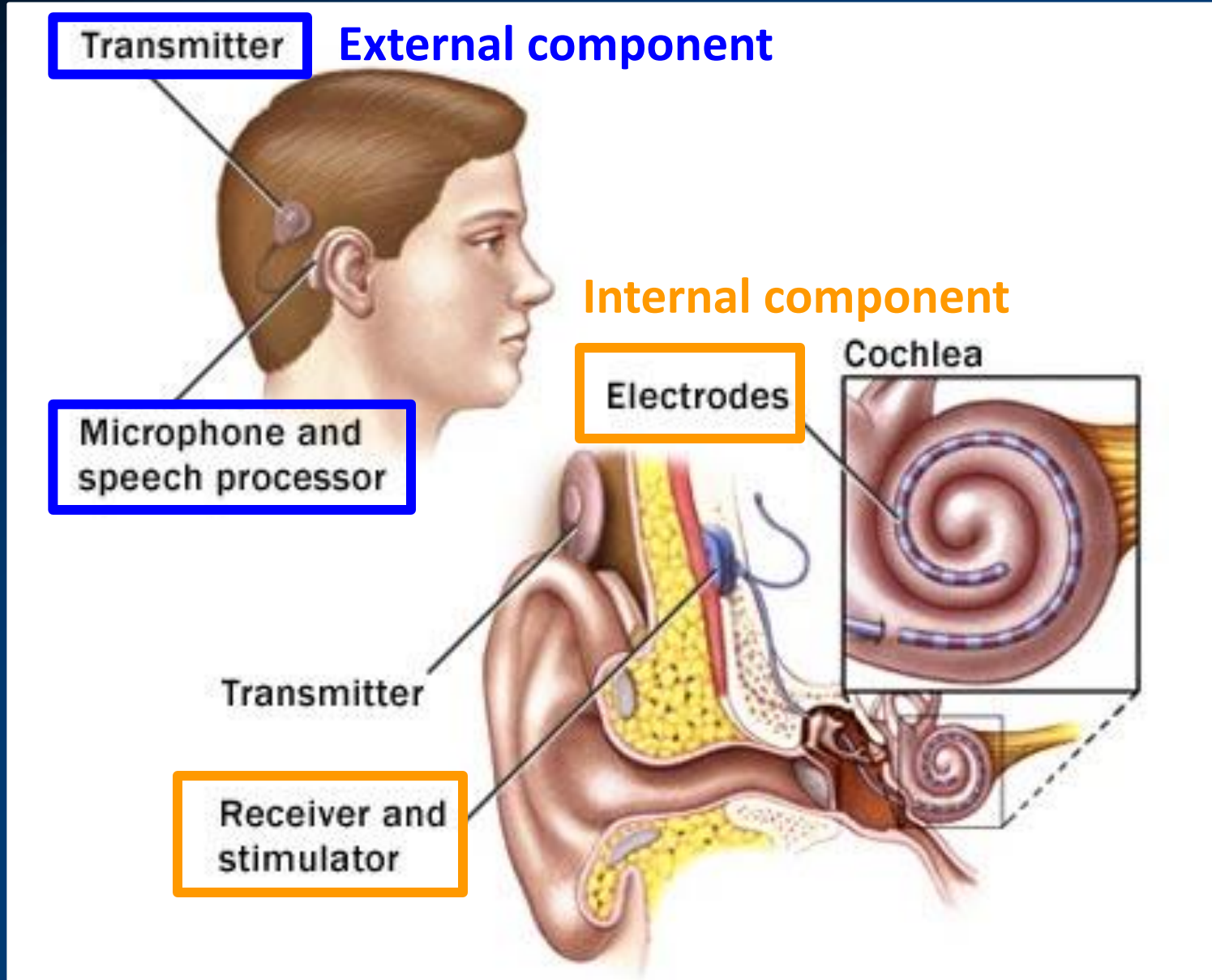
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Introduction

- Hearing ability deteriorates with age
 - Loss of hair cells in the cochlea diminishes the transduction of auditory signals
- Cochlear implants by-pass the transduction process by stimulating the auditory nerve
 - Induce changes in the auditory cortex

Cochlear Implant



Monitoring of Brain Plasticity in Cochlear Implant Patients

- MRI
 - Safety issue
- EEG/ERP
 - with artifact correction methods
(e.g., ICA; Gilley et al., 2006; Debener et al., 2008; Viola et al., 2011)

Aim

- Using the Event-related Optical Signal (EROS), an imaging method without interference from electrical stimulation, to track brain plasticity in cochlear implant patients prior to and after the implantation

Intrinsic Optical Signals

Fast optical signal

Neuronal signal

Event-related Optical Signal (EROS)

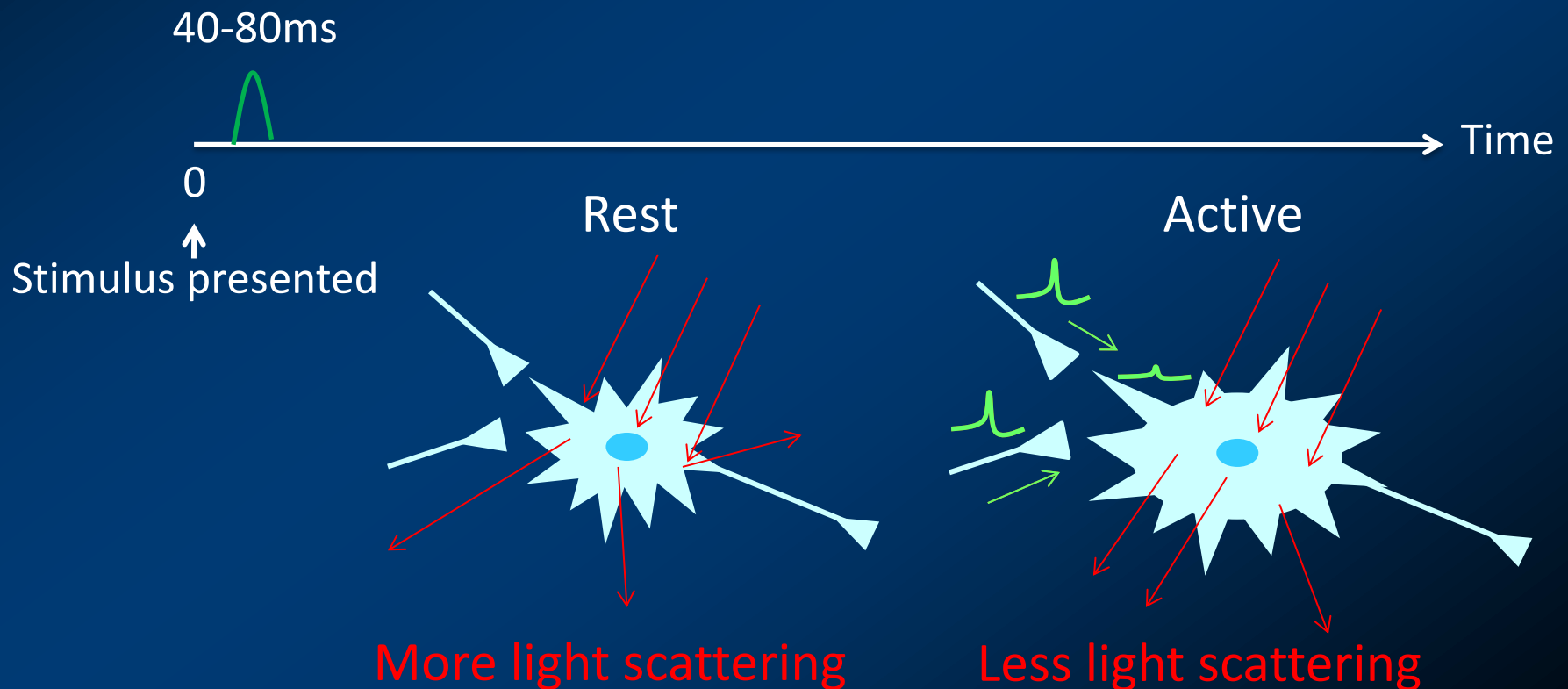


Intrinsic Optical Signals

Fast optical signal

Neuronal signal

Event-related Optical Signal (EROS)



Intrinsic Optical Signals

Fast optical signal

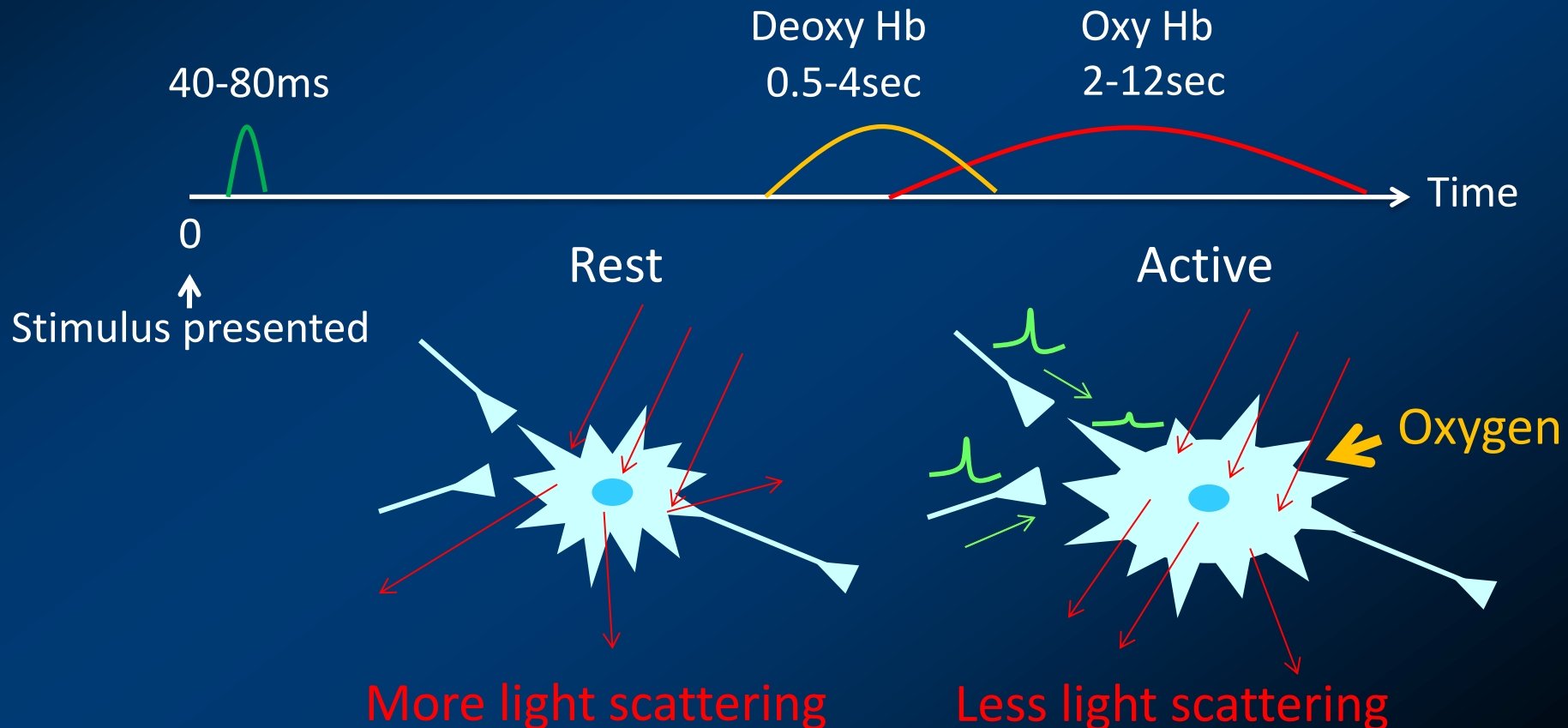
Neuronal signal

Event-related Optical Signal (EROS)

Slow optical signal

Hemodynamic signal

Near Infra-Red Spectroscopy (NIRS)



Intrinsic Optical Signals

Fast optical signal

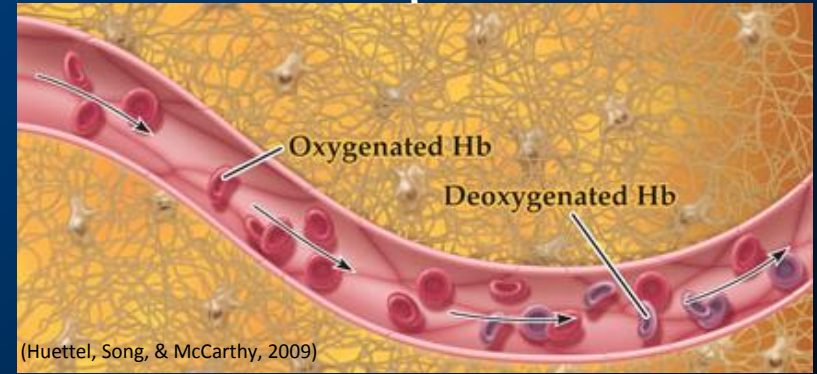
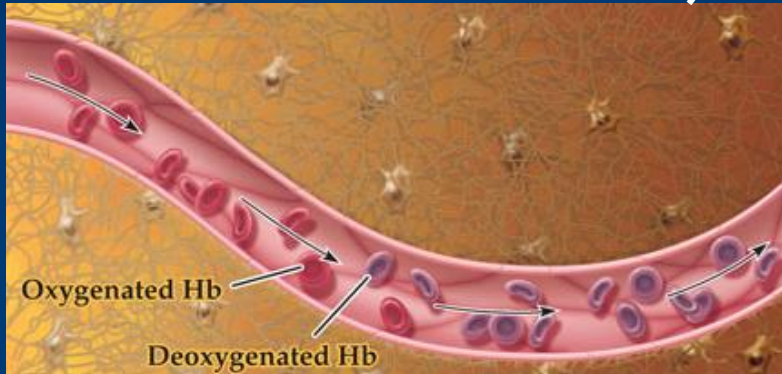
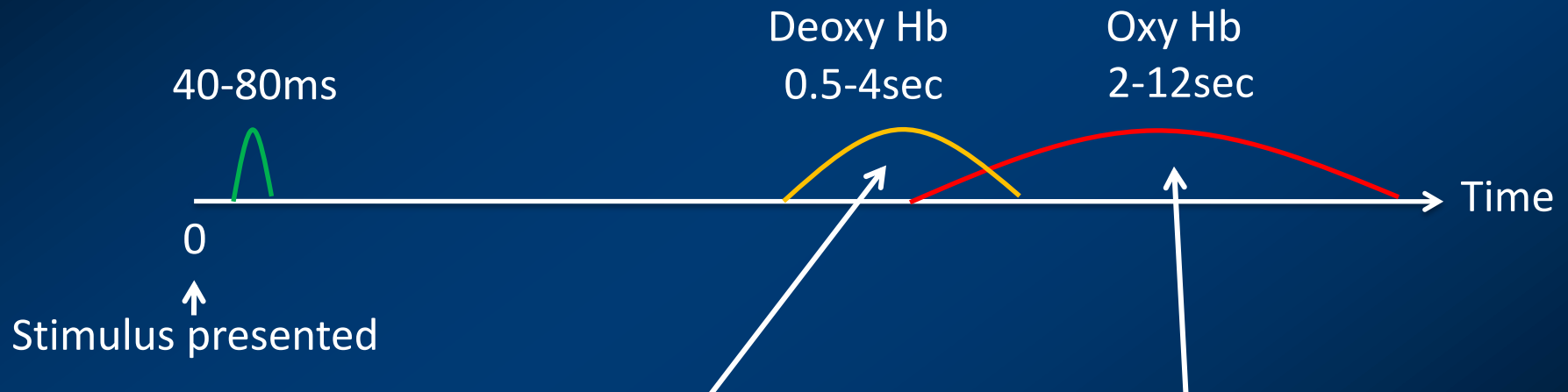
Neuronal signal

Event-related Optical Signal (EROS)

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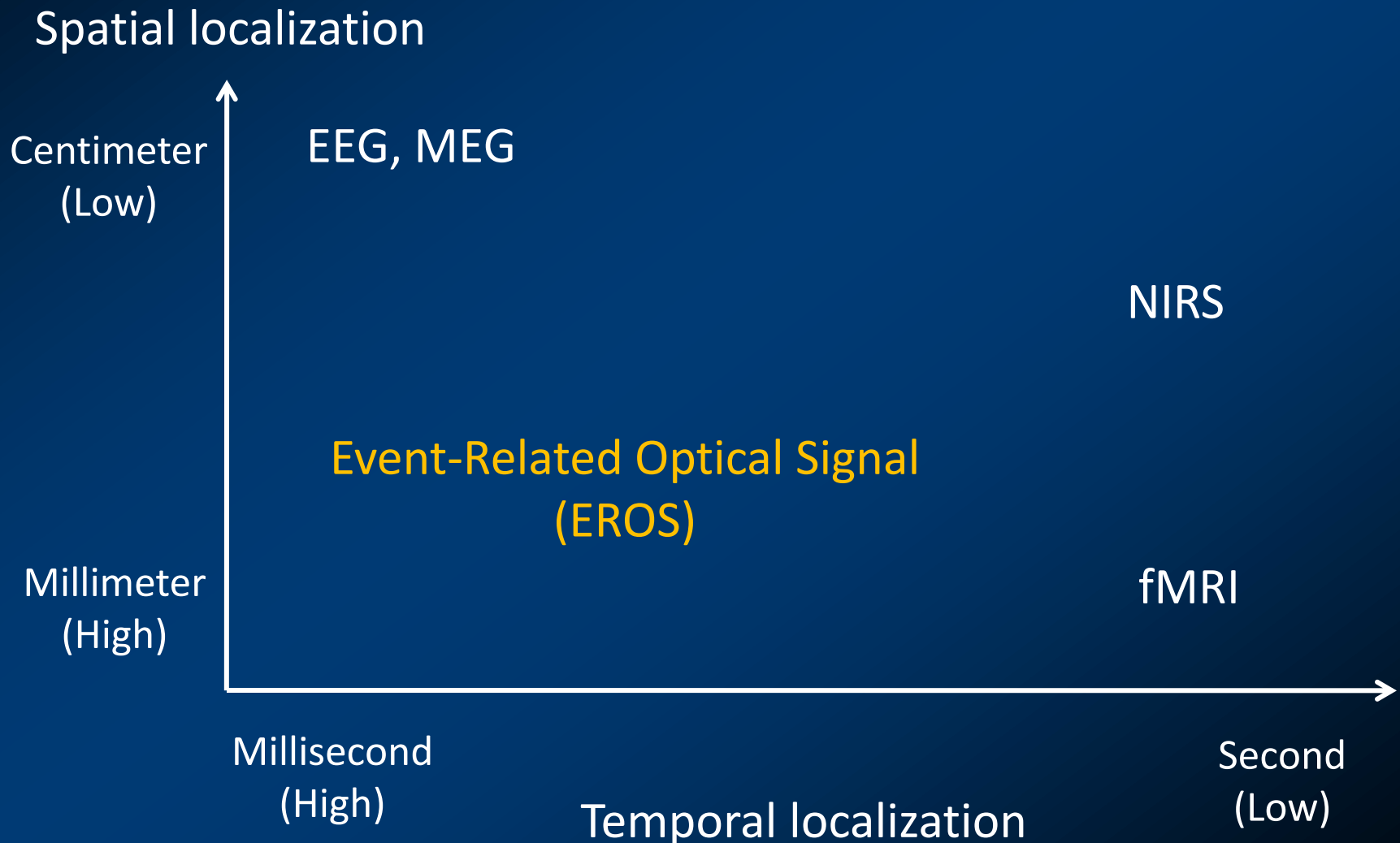
Near Infra-Red Spectroscopy (NIRS)



(Huettel, Song, & McCarthy, 2009)

EROS and NIRS can be measured simultaneously

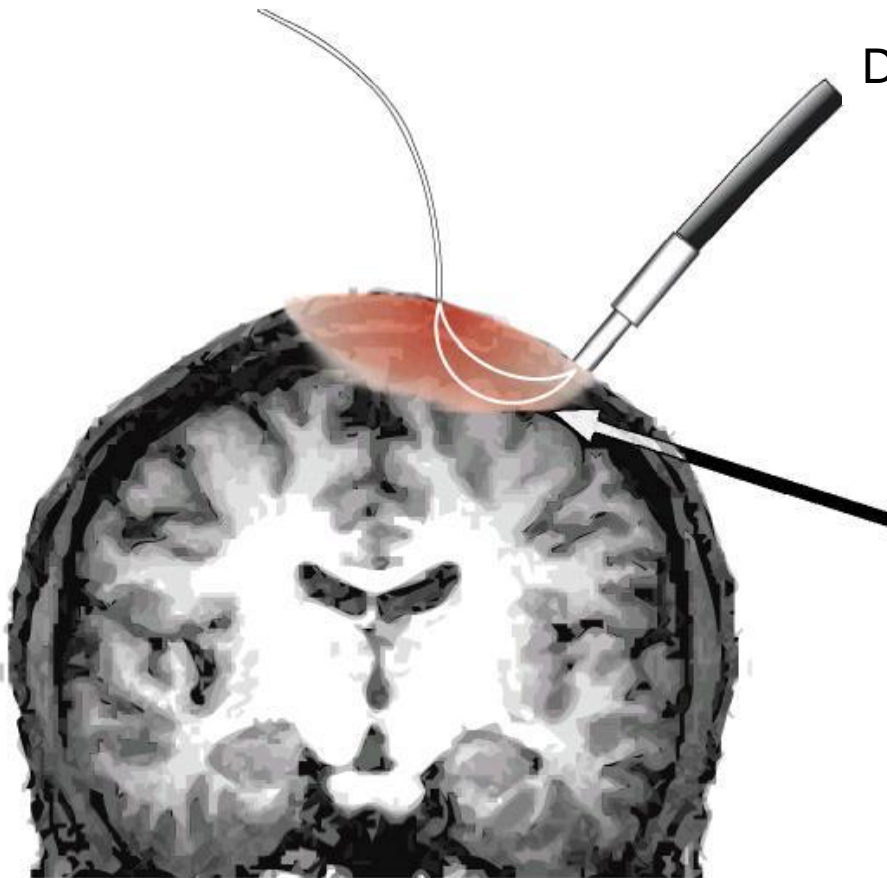
Non-invasive Functional Brain Imaging Methods



Recording Optical Signals

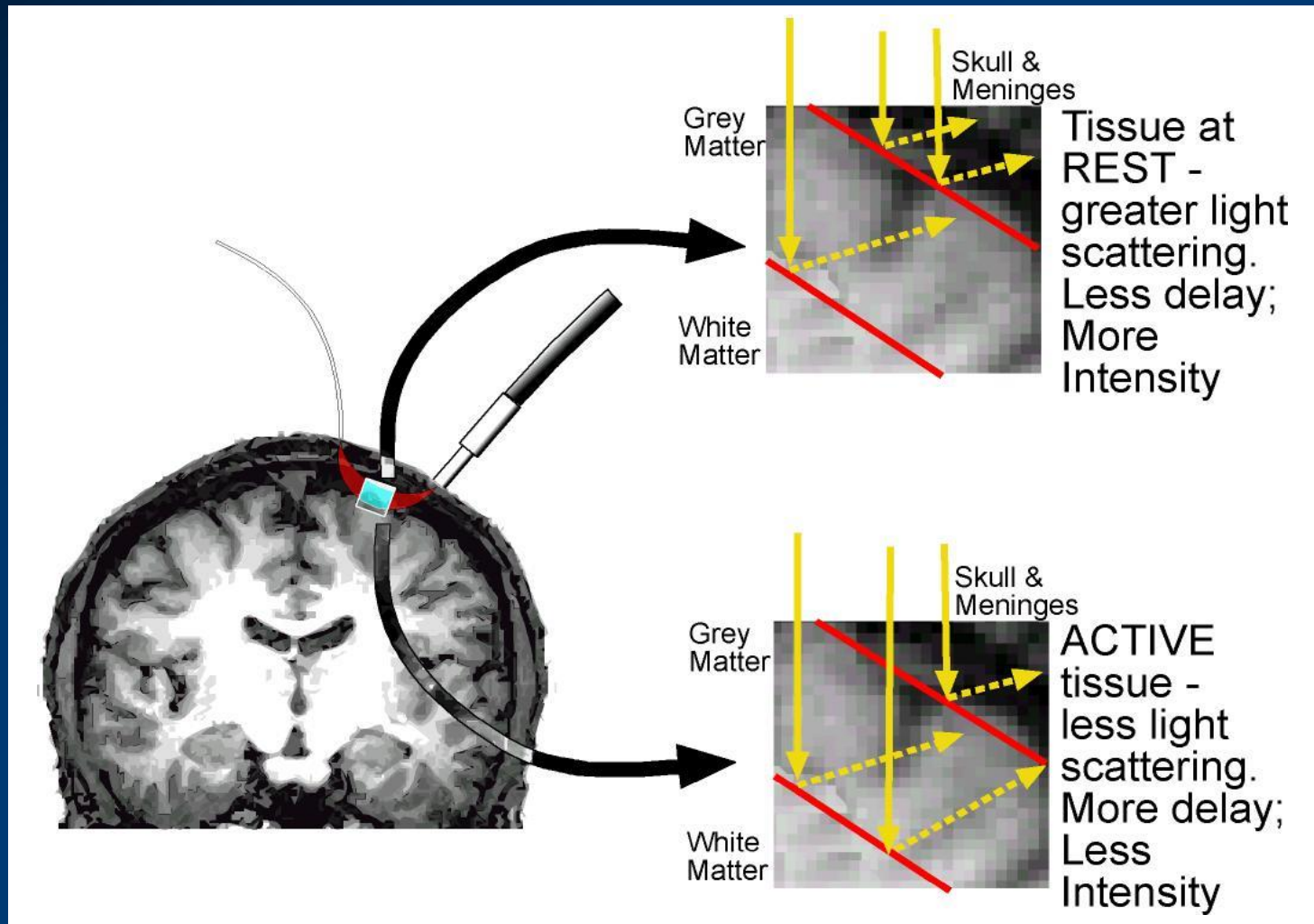
Source Optical Fiber (e.g., 830nm)

Detector Optical Fiber

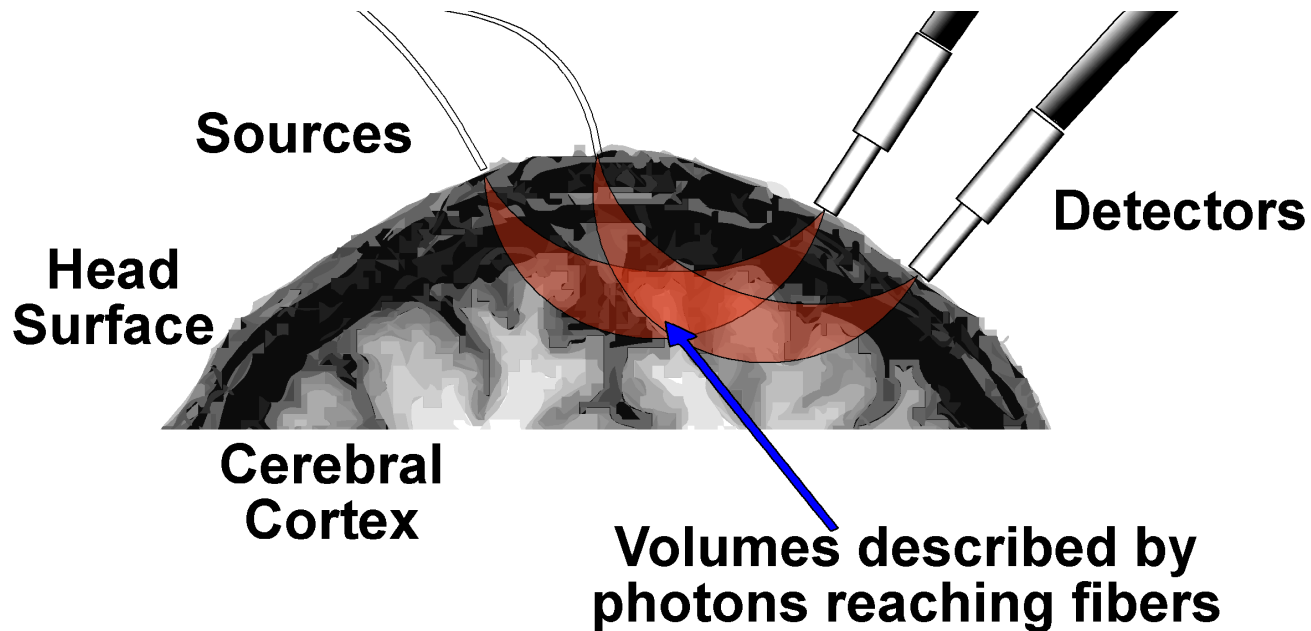


The "banana-shaped" path followed by light that reaches the detector.

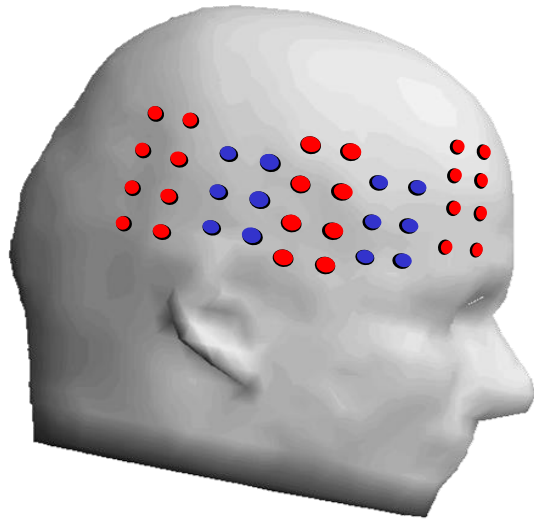
Scattering in the Brain



Locating Optical Signals



Recording Optical Signals

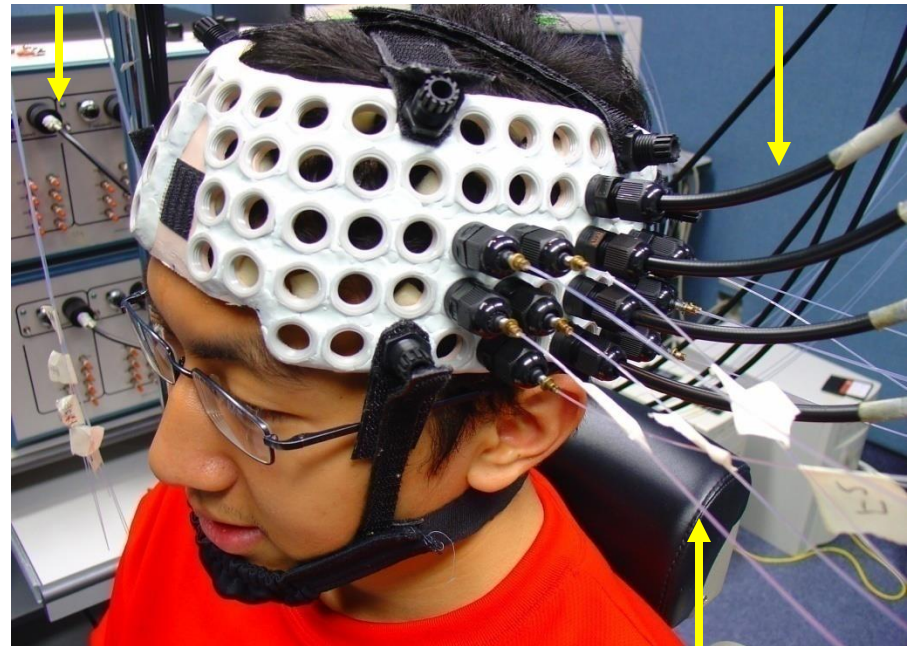


- Detector
- Source

Recording Montage

Optical Imaging Machine

Detector Fibers



Source Fibers

Recording System

Methods

- Six cochlear implant patients with profound hearing loss in the high frequency range (>1000 Hz)
 - onset after 45 years of age
- Three brain imaging (EROS and EEG/ERP) sessions
 - pre-surgery
 - 1-month post-surgery
 - 6-months post-surgery

Methods

Active Oddball Paradigm

Low Frequency Auditory Block (LA):

Tones with frequency within the audible range



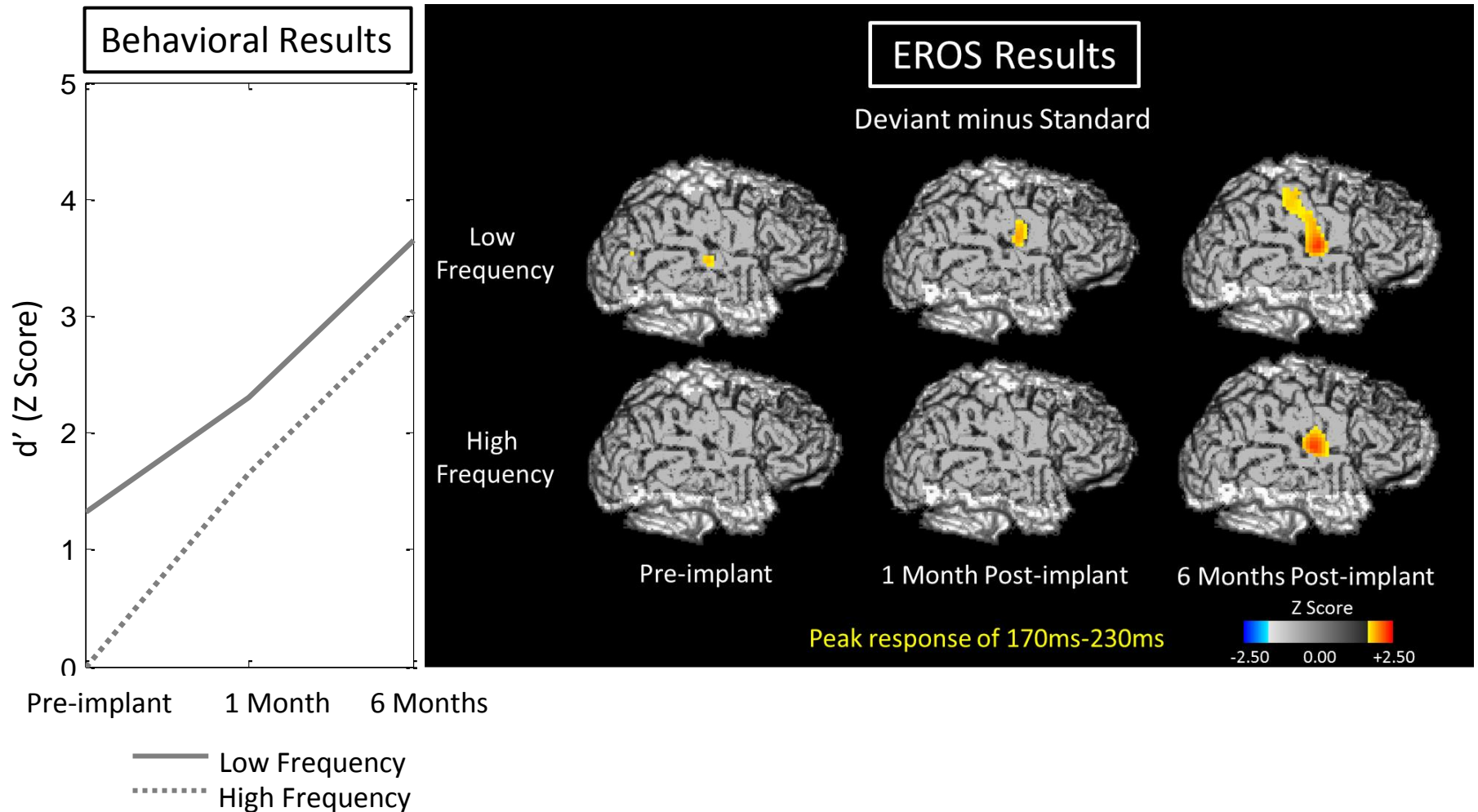
High Frequency Auditory Block (HA):

Tones with frequency above the audible range of individual patients prior to implant

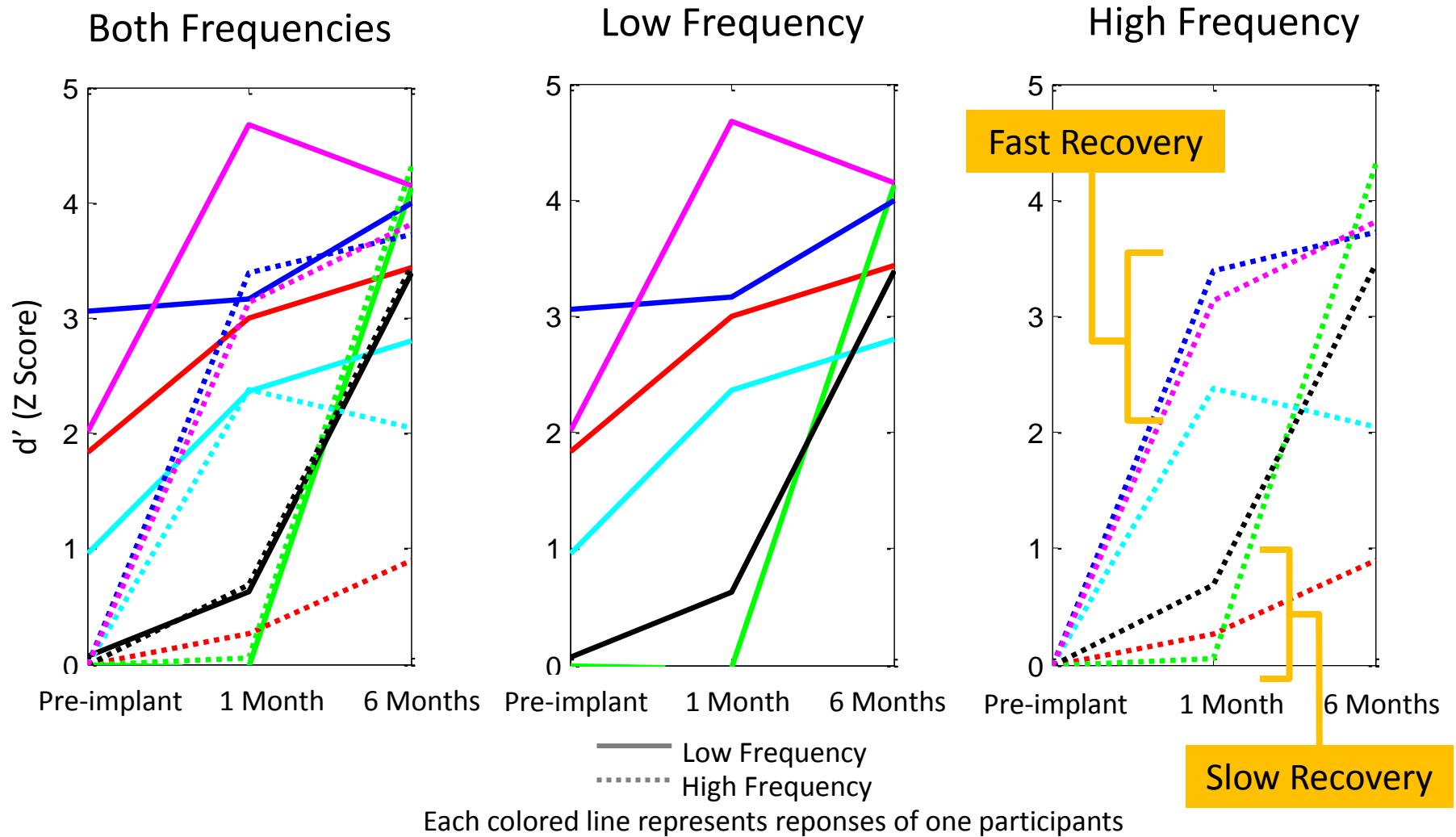


Task: Classifying the long and short tones by button press

Results - All Participants

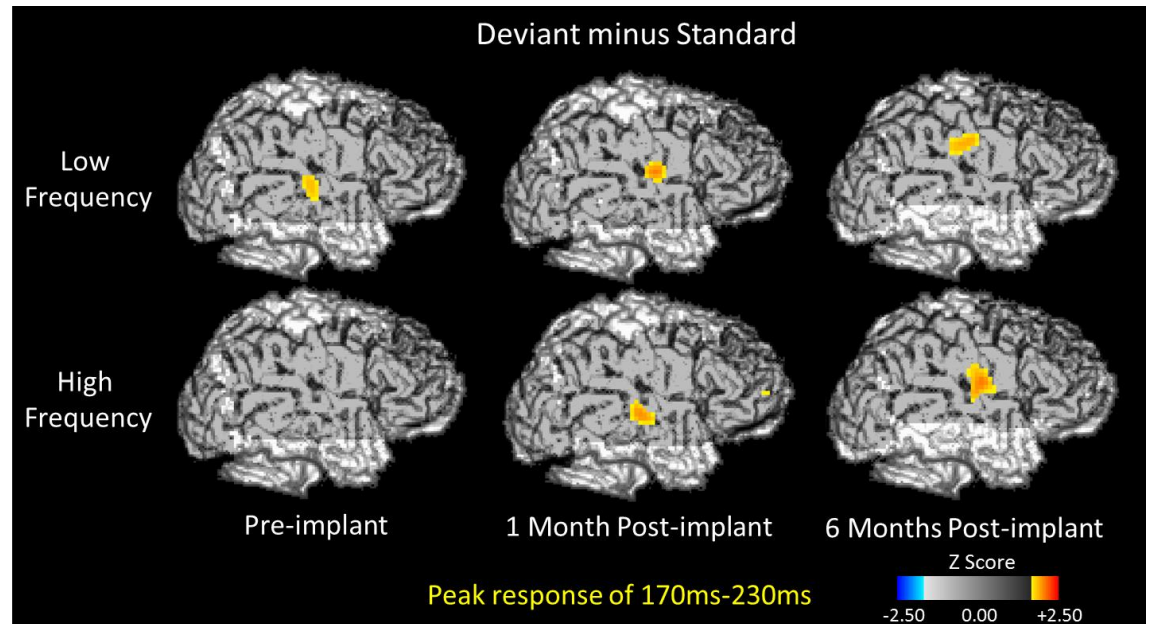
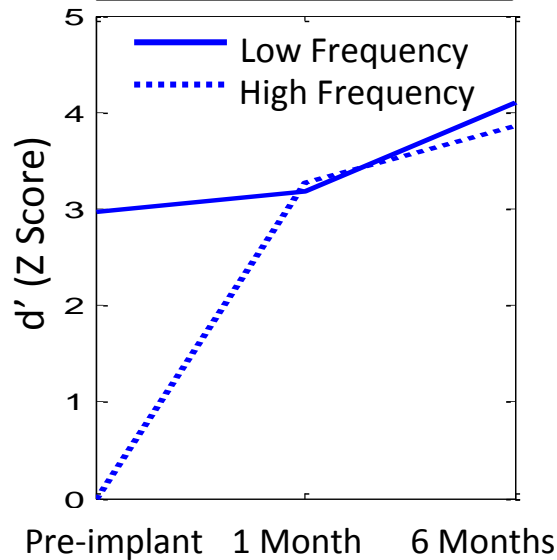


Behavioral Results - Individual Participants

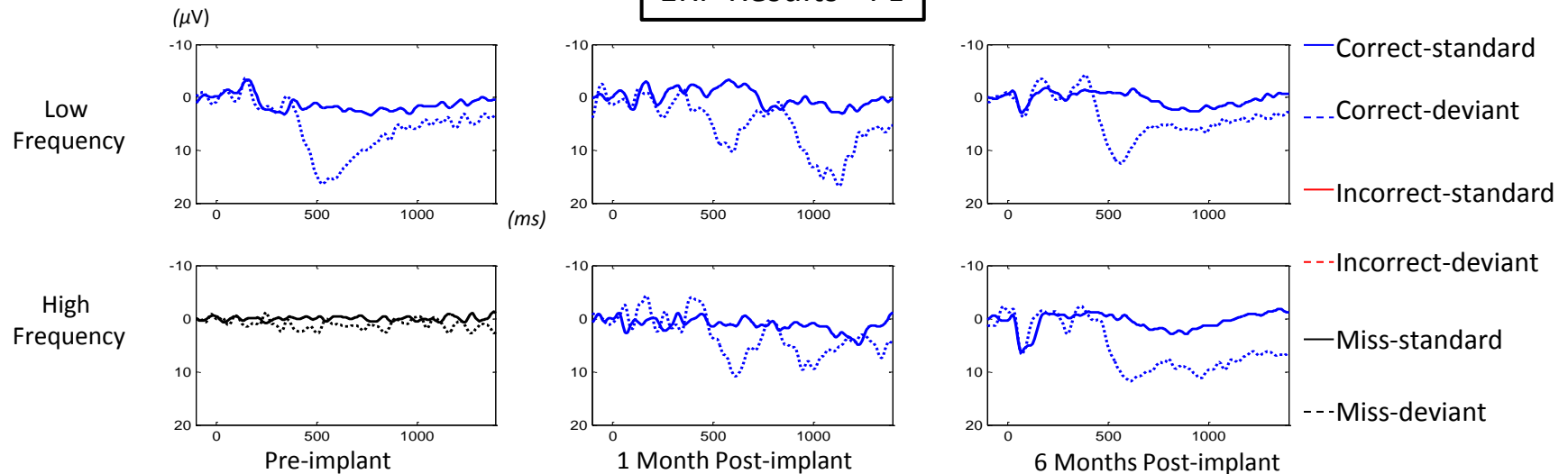


Single Subject – Fast Recovery

Behavioral Results

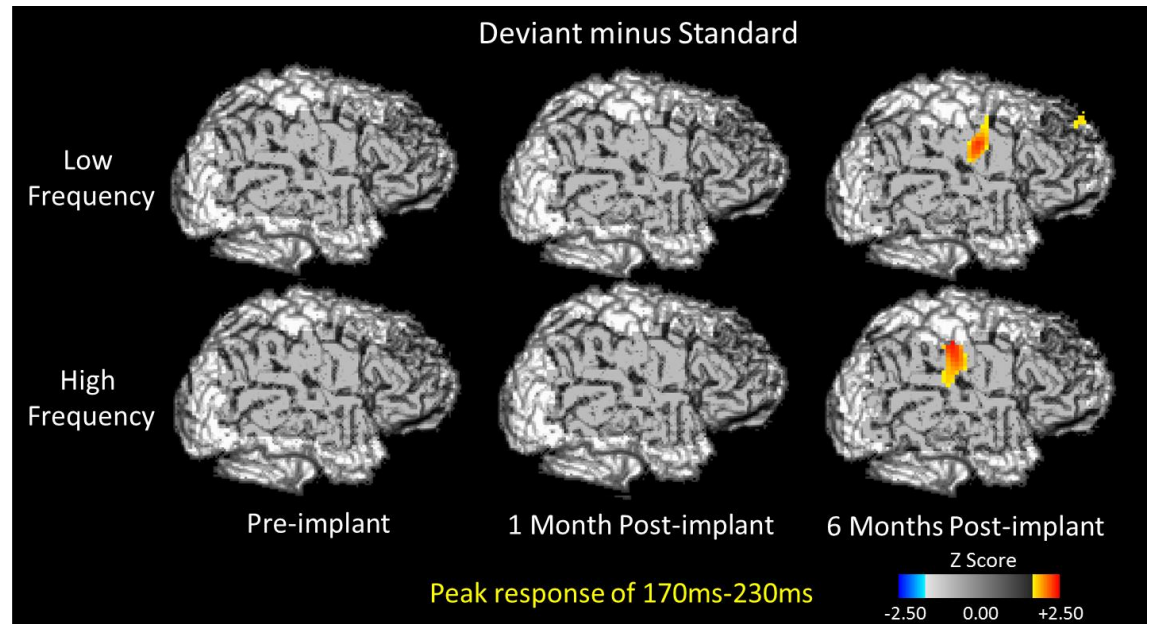
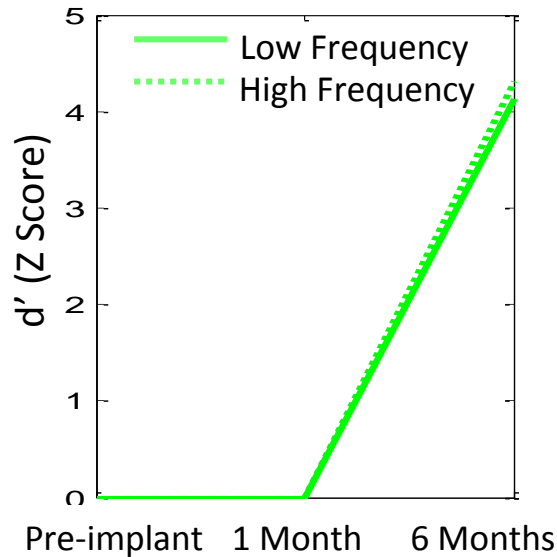


ERP Results - Pz

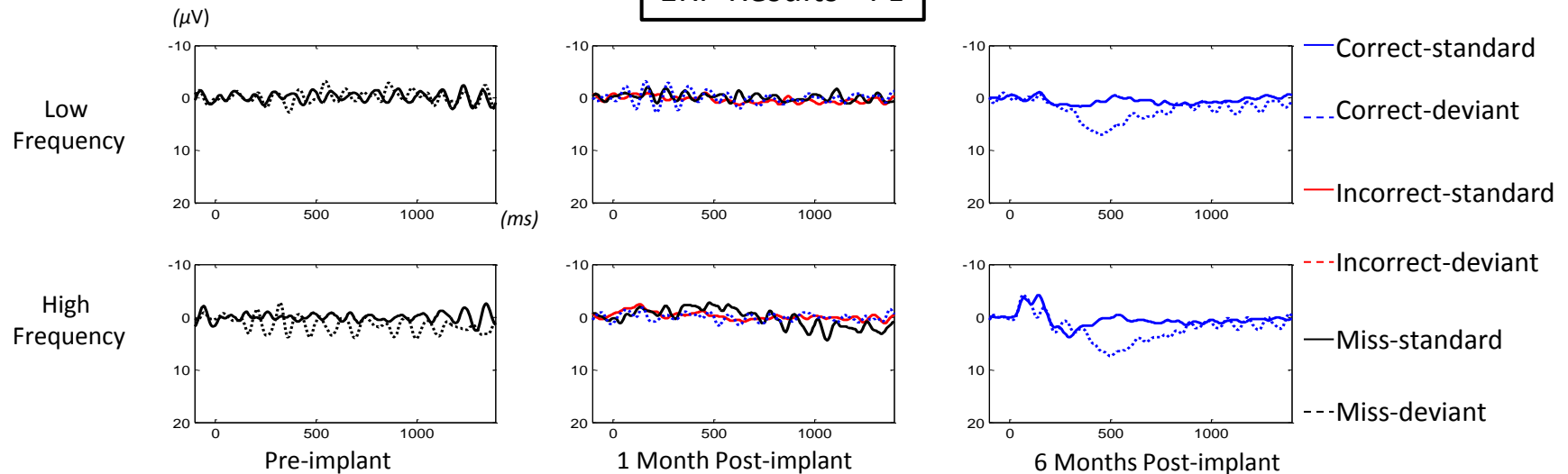


Single Subject – Slow Recovery

Behavioral Results



ERP Results - Pz



Summary

- The results revealed a correspondence between EROS/ERP and the behavioral response
- This study demonstrated
 - the possibility of applying EROS to monitor the reorganization of brain responses associated with recovery of hearing ability
 - optical imaging is useful for recoding brain signals during electrical stimulation

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Questions and Answers

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Recording Optical Signals

