

Применения оптических методов в экспериментальной и клинической практике

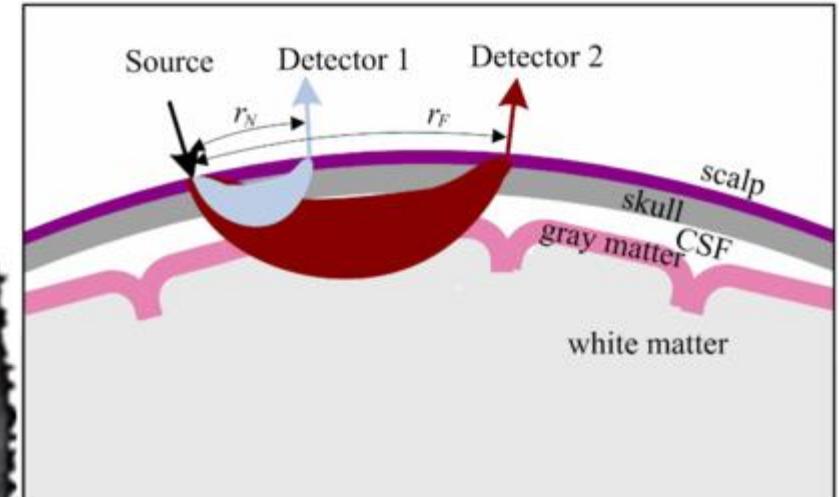
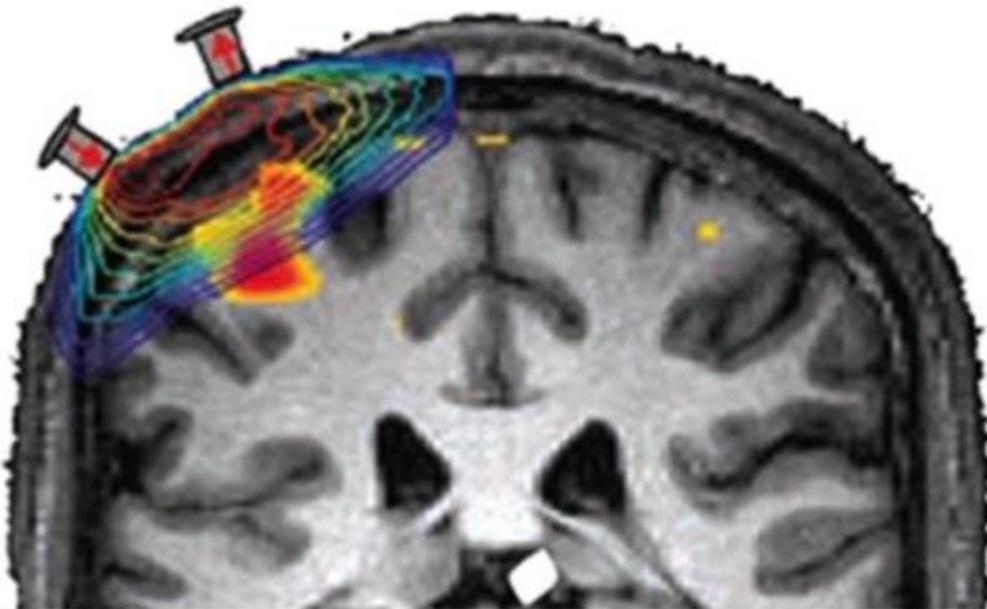
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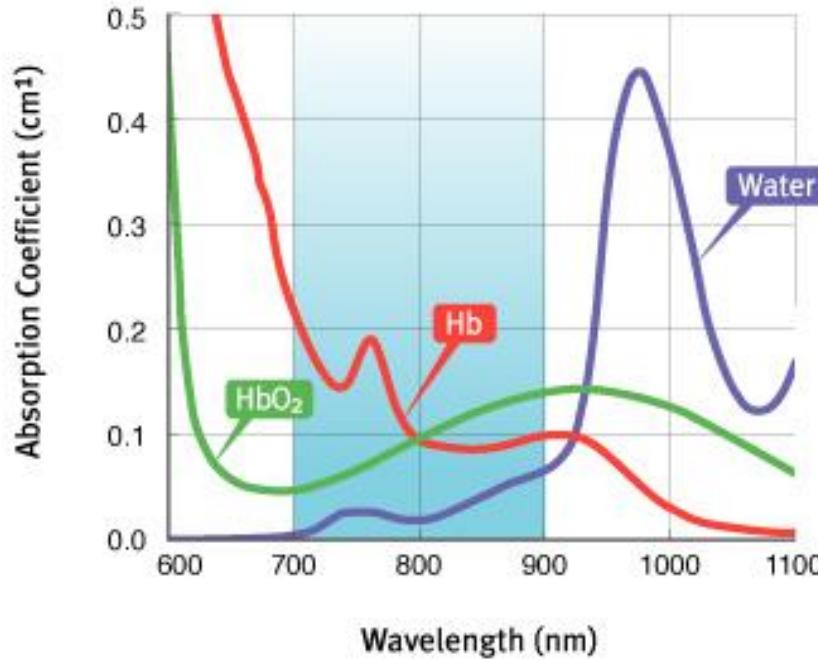
E-mail: tsytsarev@umaryland.edu

- Функциональная околоинфракрасная спектроскопия (functional nearinfrared spectroscopy (fNIRS))
- Быстрые оптические корреляты мозговой активности головного мозга - evoked response optical signal (EROS)
- Фотоакустика: перспективы использования в клинической нейрологии,
- Модели заболеваний нервной системы человека и их исследования оптическими методами: Эпилепсия (epileptic seizures), наследственный прогрессирующий сколиоз с горизонтальной офтальмоплегией (Horizontal gaze palsy with progressive scoliosis (HGPPS))

Near Infrared Spectroscopy (NIRS)

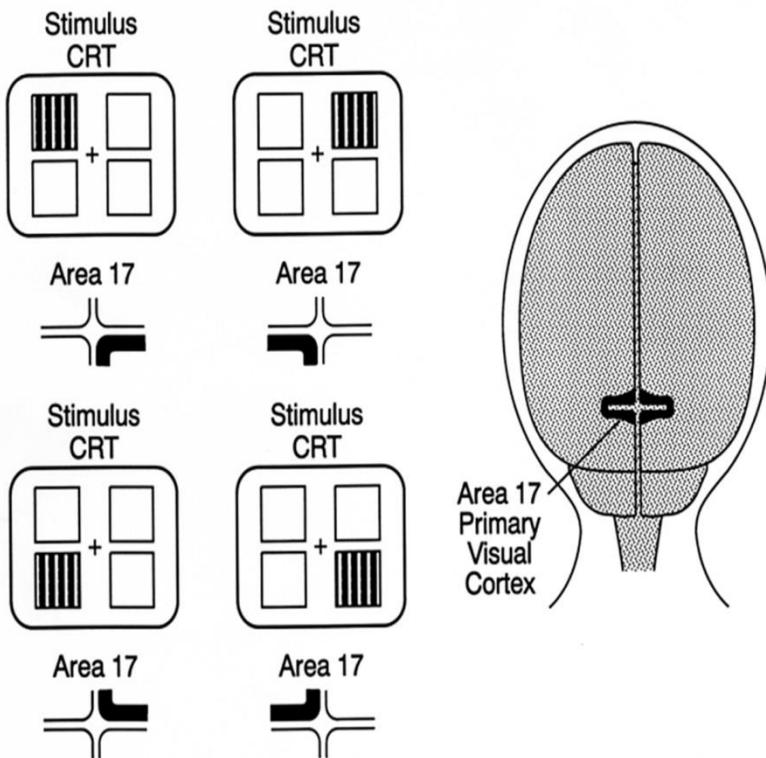


diffuse optical tomography (DOI)

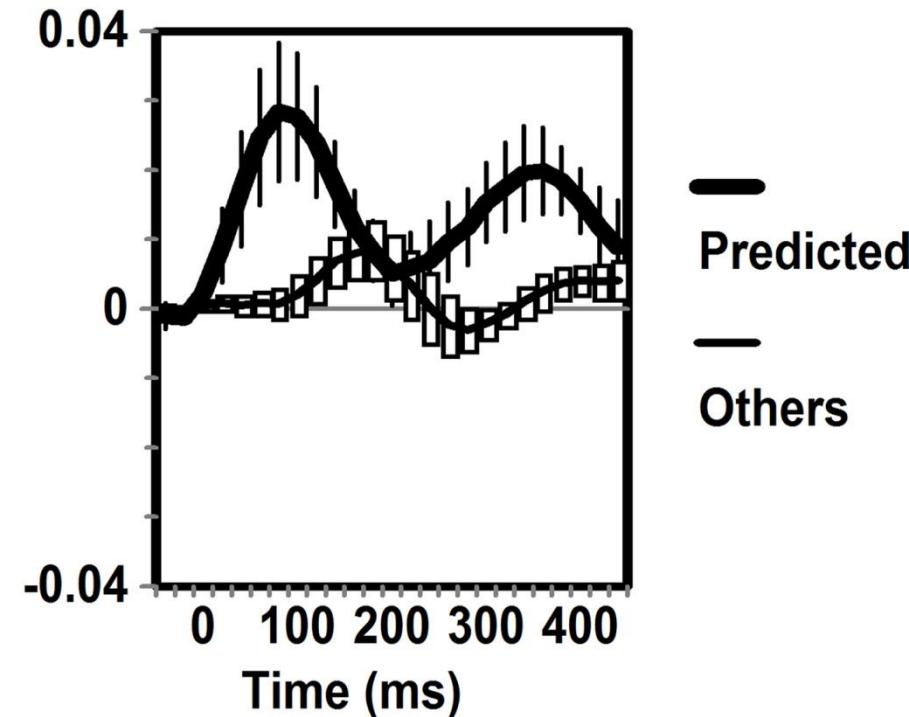


When used to create 3D volumetric models of the imaged material DOI is referred to as diffuse optical tomography, whereas 2D imaging methods are classified as diffuse optical topography.

Event-related optical signal (EROS)



EROS time course Selected Locations



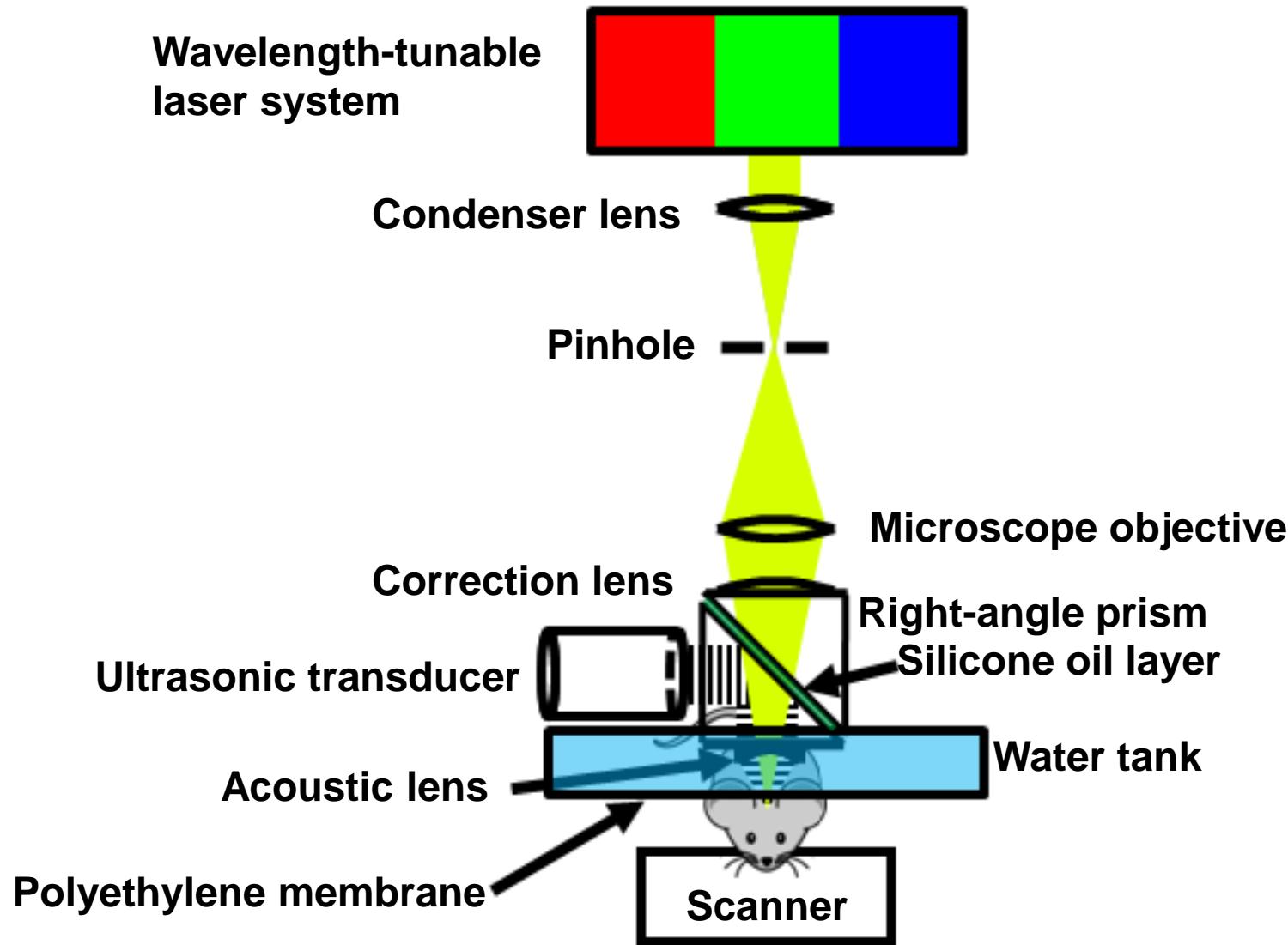
Photoacoustic Imaging

Photoacoustic Imaging is

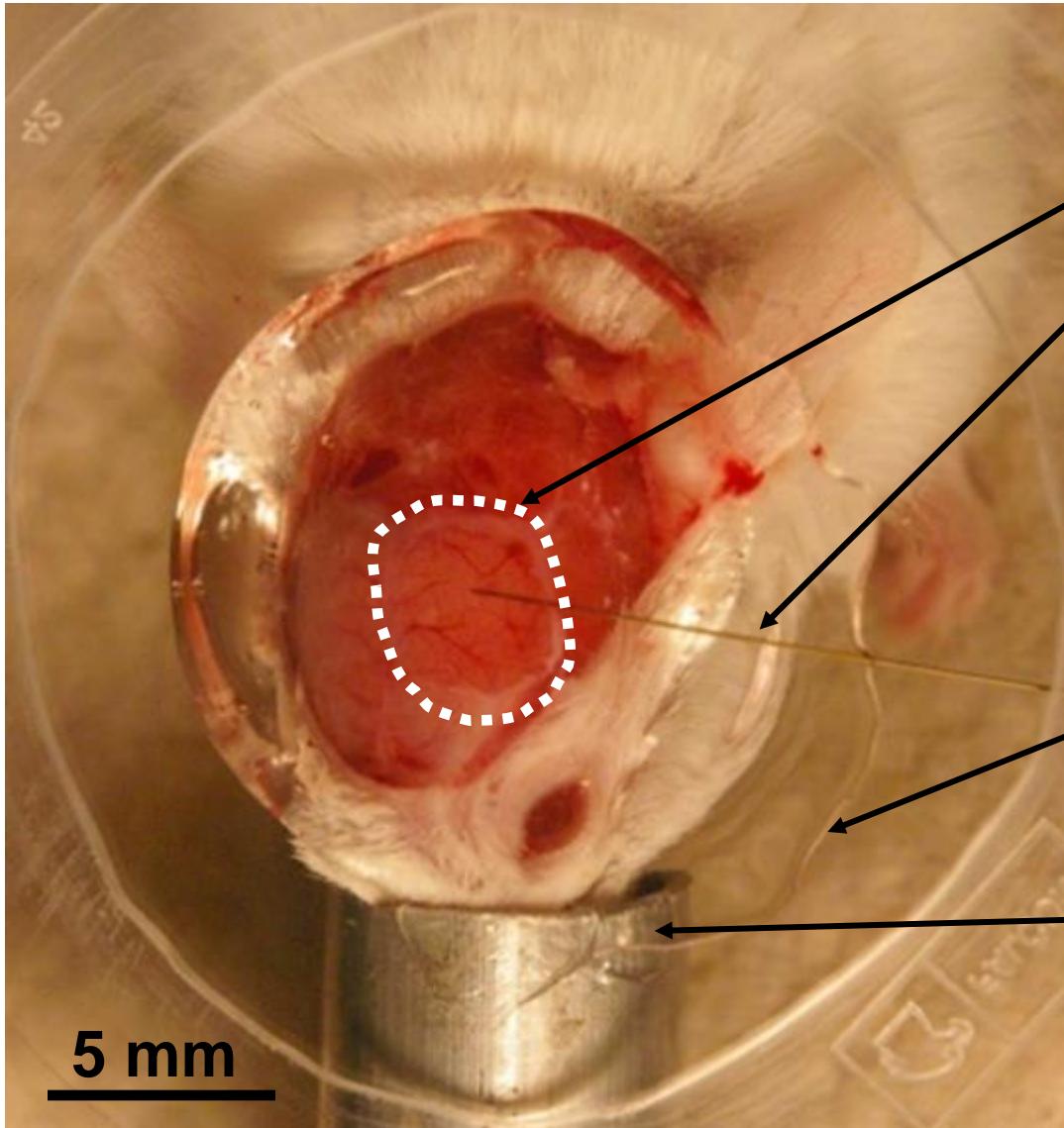
**A hybrid biomedical imaging modality based
on the photoacoustic effect**

***(transformation of the absorbed light energy
into kinetic energy, f.e. ultrasonic waves)***

Scheme of optical-resolution photoacoustic microscopy (OR-PAM)



Photograph of exposed mouse brain surface with introduced microelectrode



Cranial opening

Microelectrode

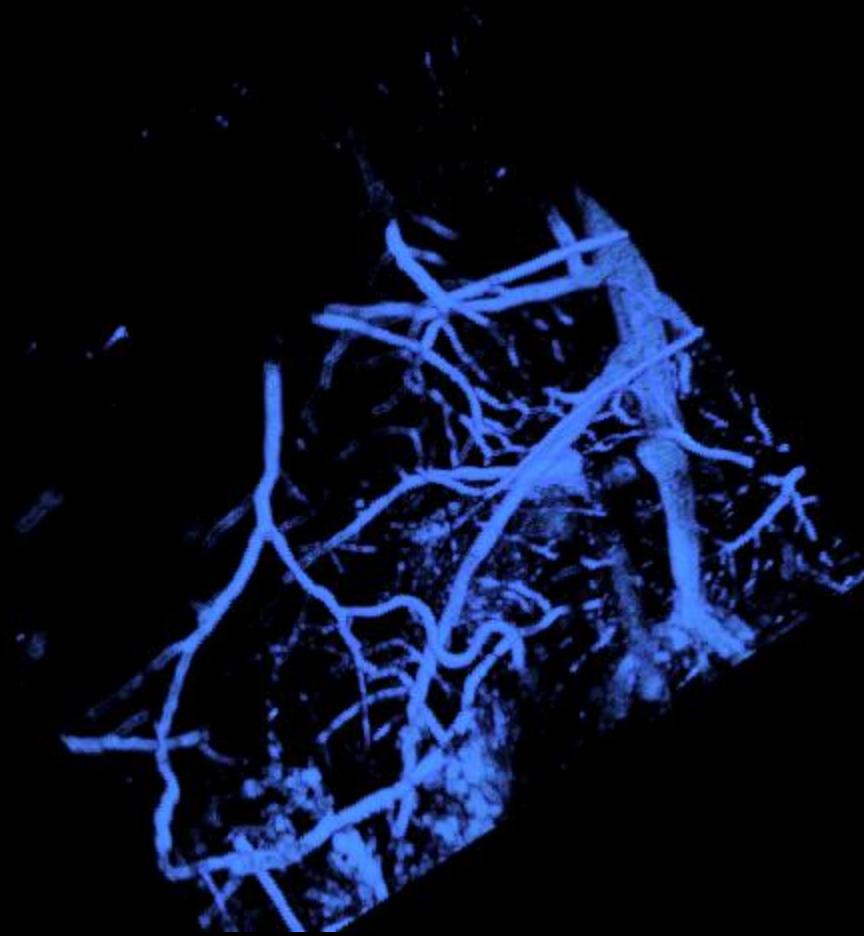
Water tank

Gas mask

5 mm

Photoacoustic open brain 3D imaging

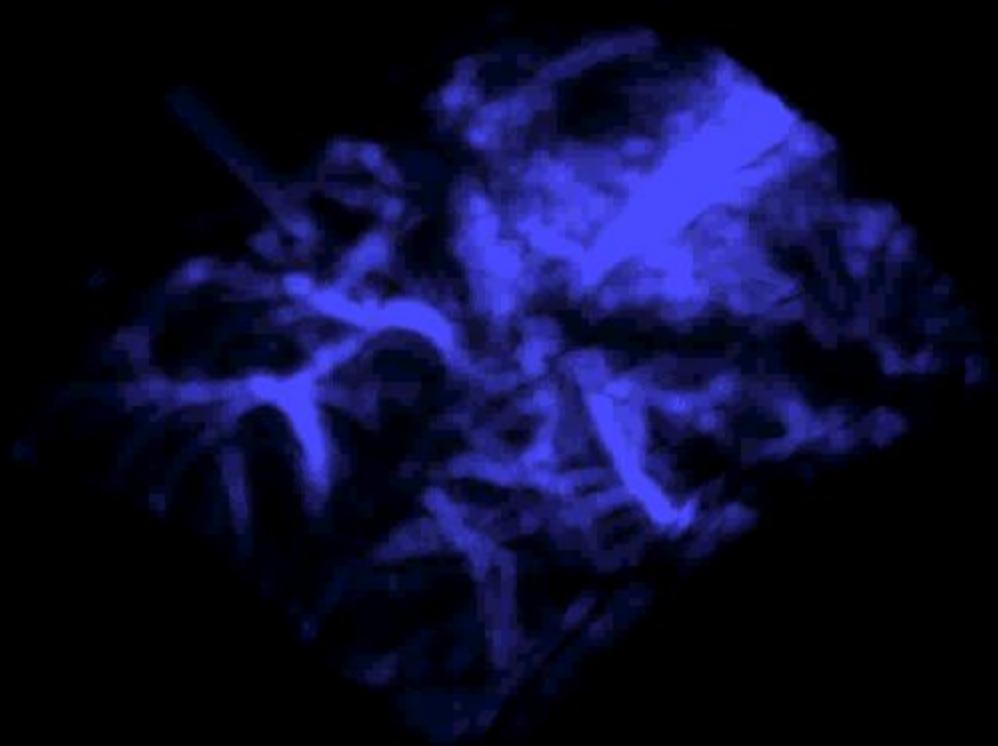
1 mm



PA open brain imaging

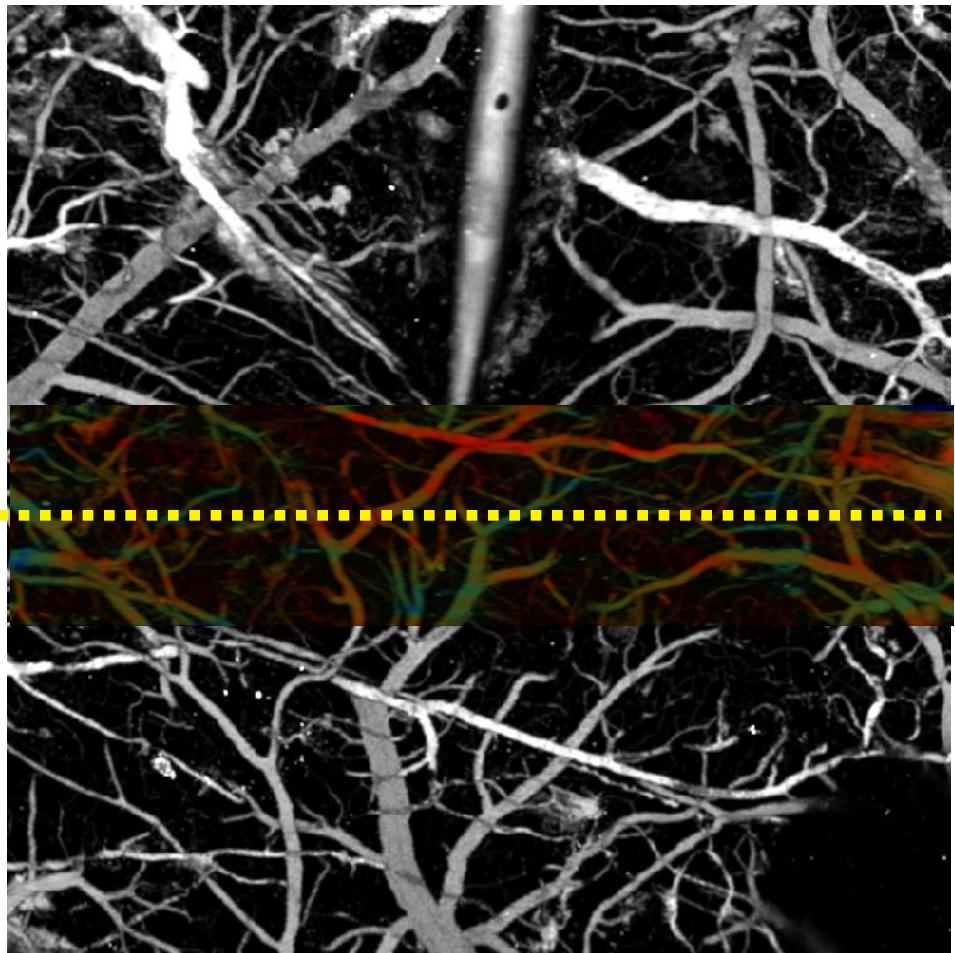
Photoacoustic open brain 3D imaging

1 mm

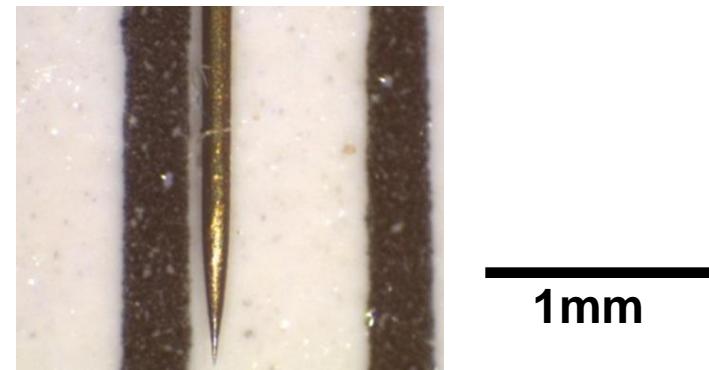


PA open brain imaging

Photoacoustic imaging of the brain microvasculature

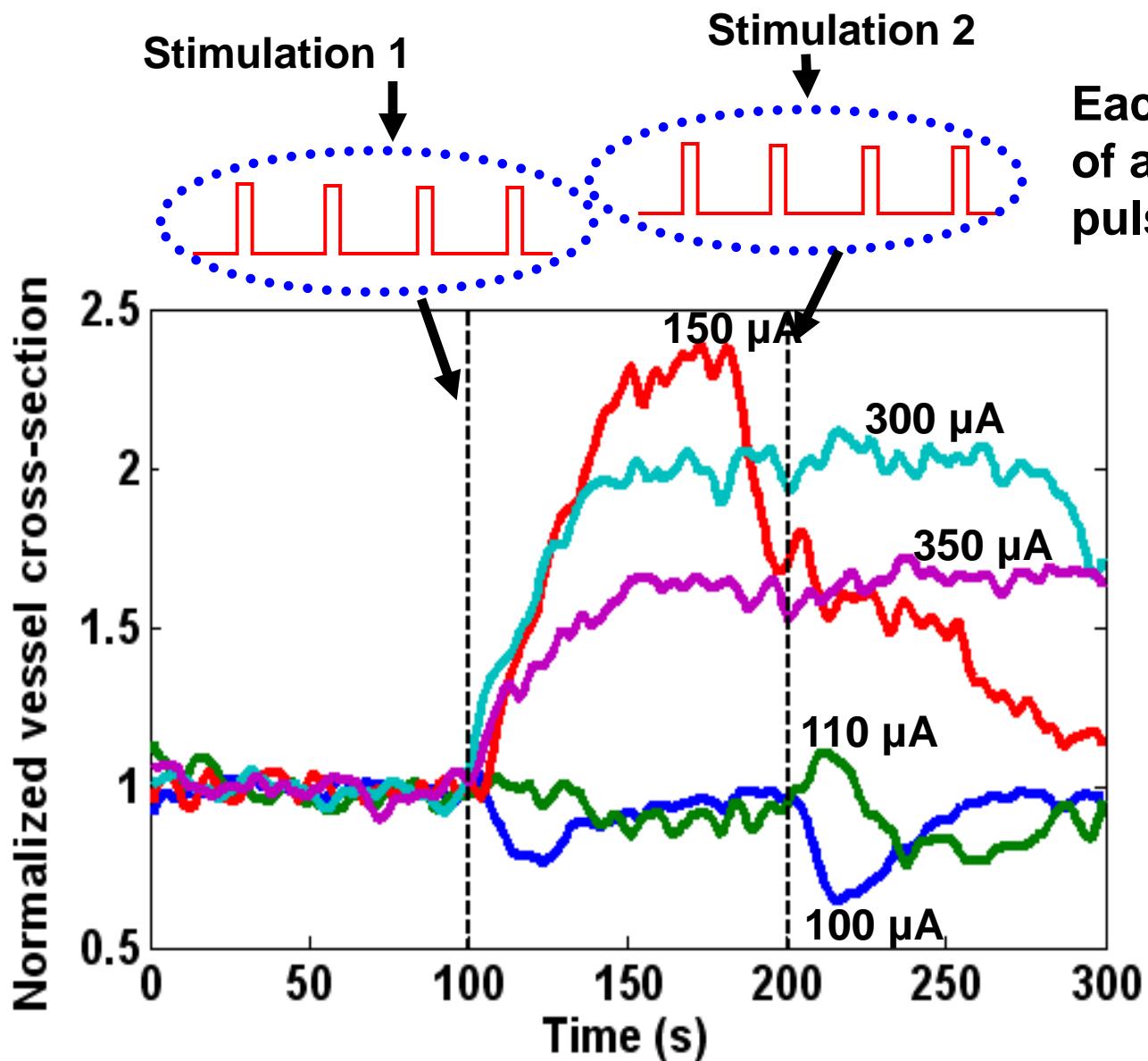


The oxygen saturation (SO_2) mapping is shown as a superposition in color scale. A line-scan monitoring of the vascular response was performed along the dashed yellow line



Photograph of the microelectrode

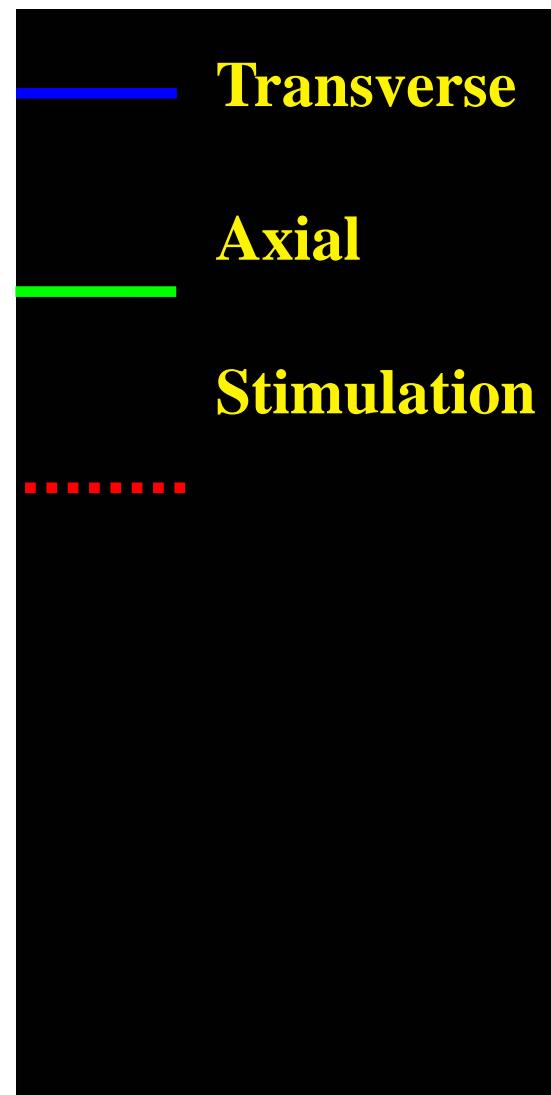
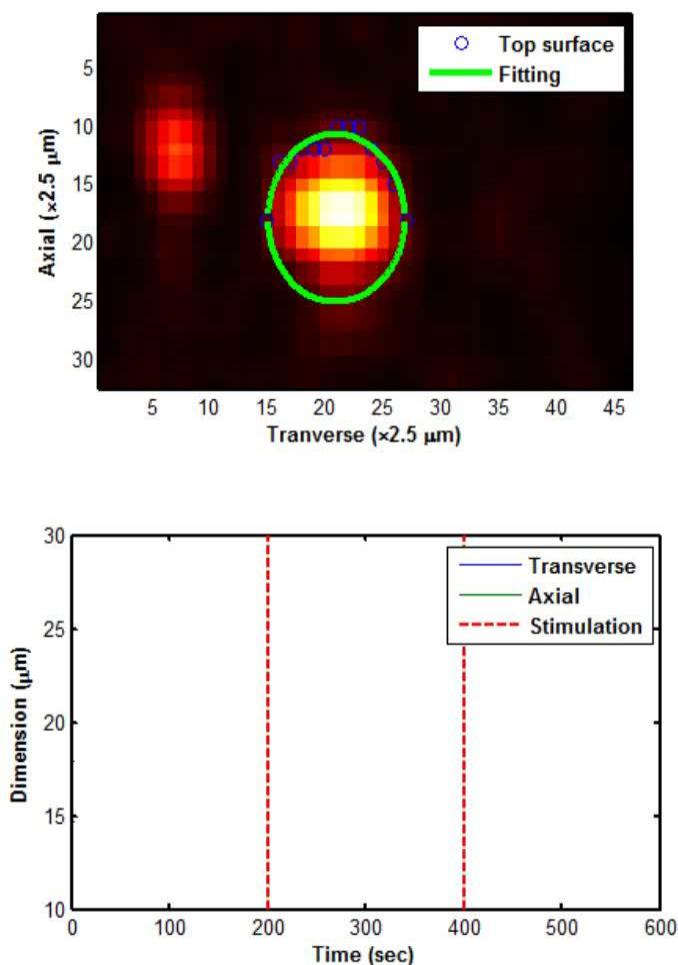
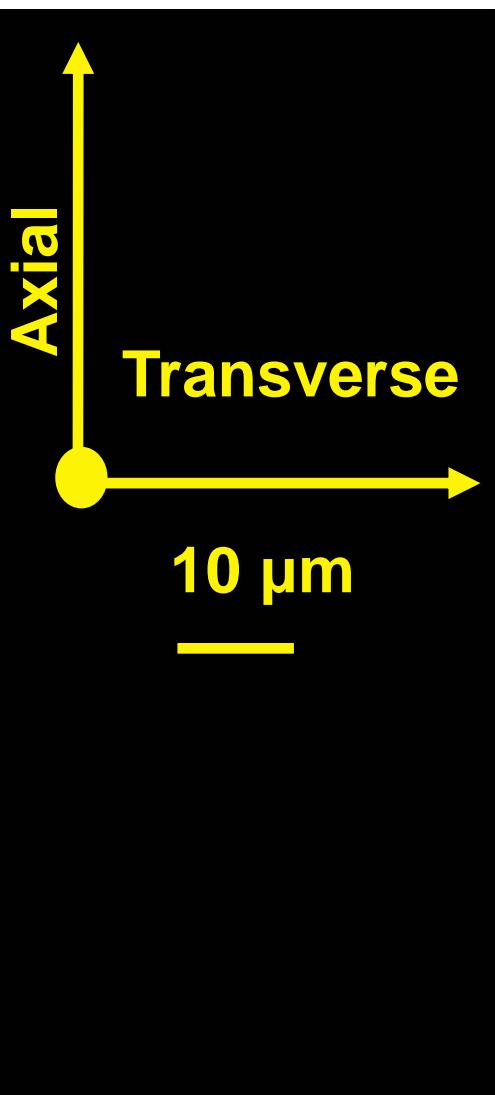
Time courses of the vessel cross-sectional area under various stimulation intensities



Each stimulation consisted of a train of four 0.3 ms pulses at 300 Hz

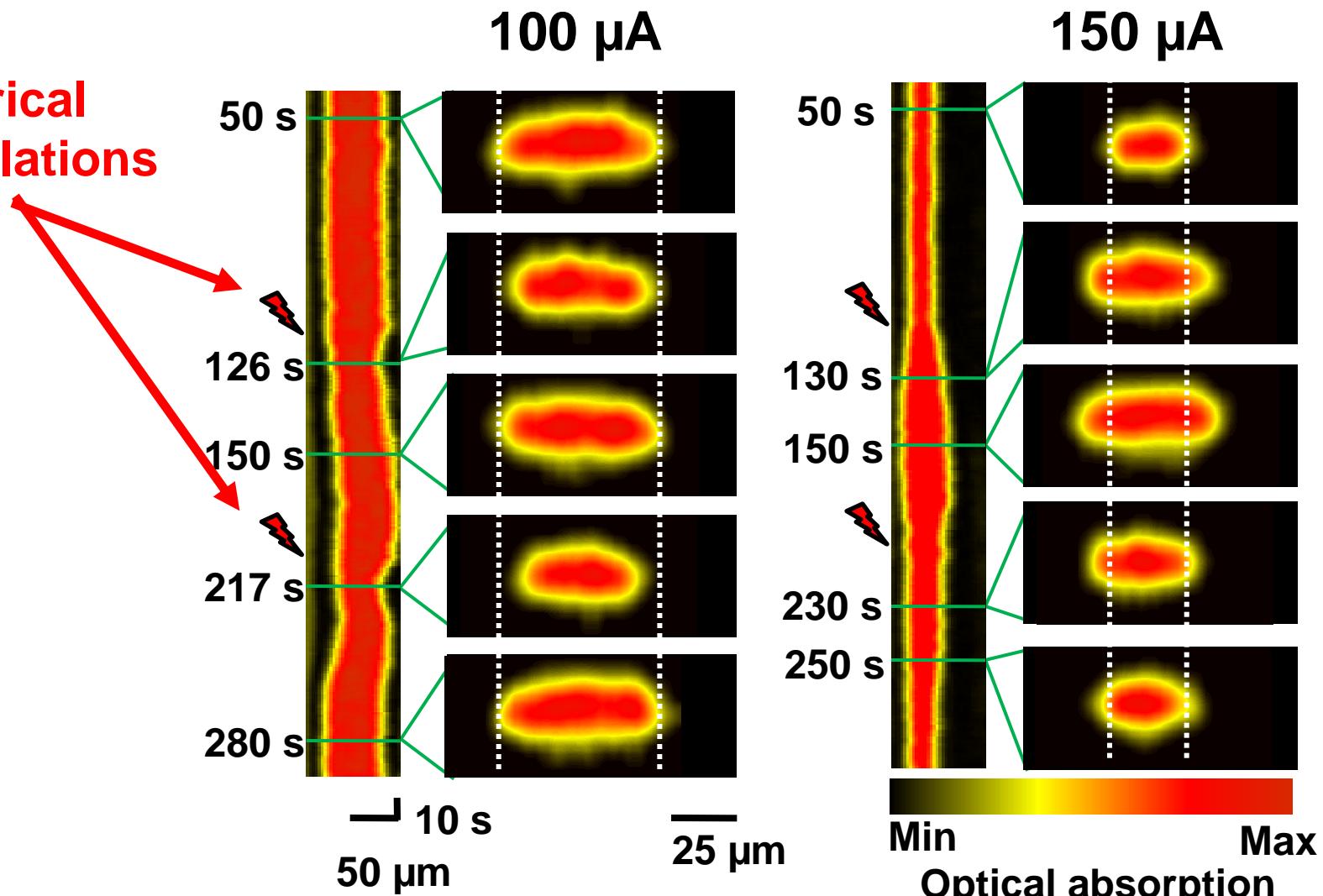
Vasoconstriction and vasodilatation are observed, and the response duration is positively correlated with stimulation intensity

Vascular response to electrical stimulation



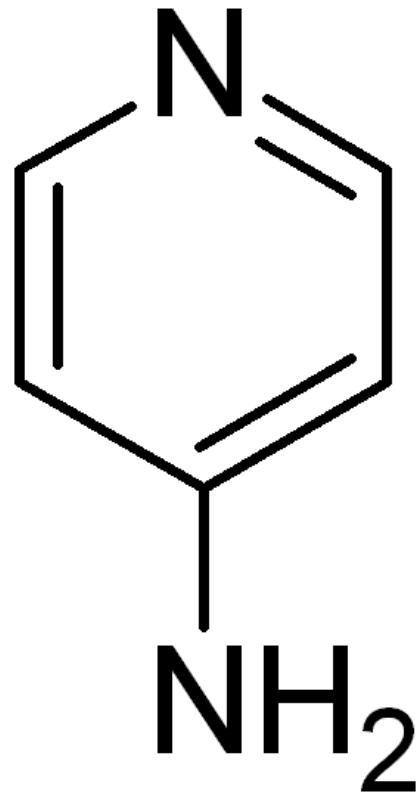
Vasoconstriction and Vasodilatation

Electrical stimulations



4-AP Model of the Cortical Epileptic Seizures

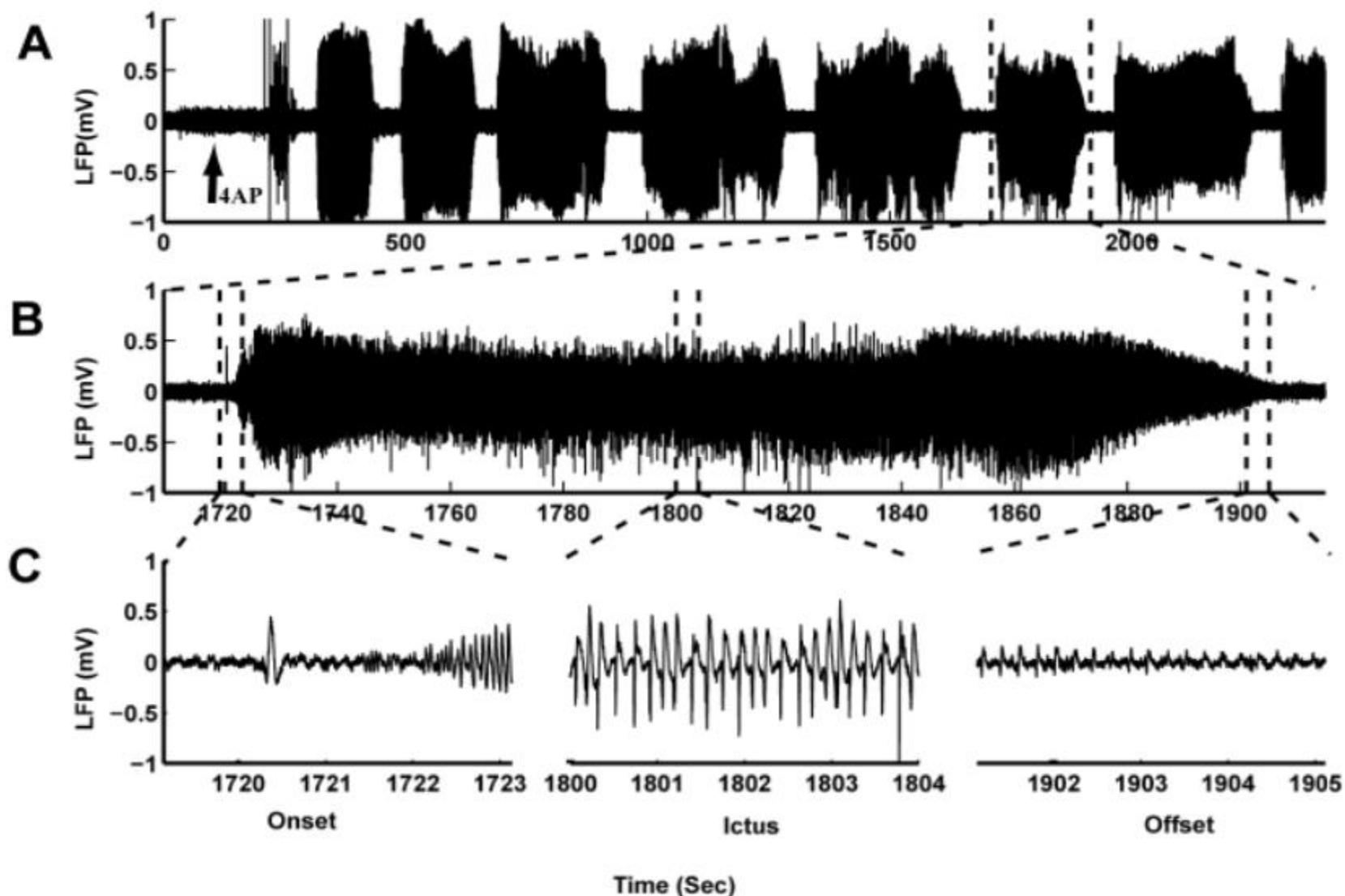
4-aminopyridine blocks a potassium current and in consequence enhances both EPSPs and IPSPs

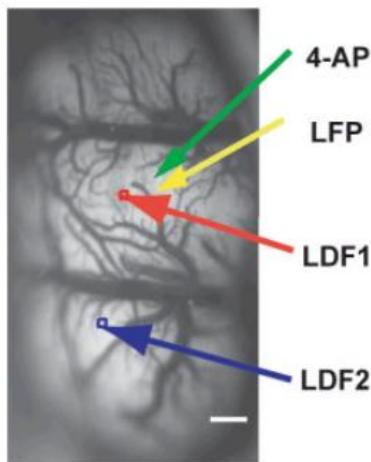
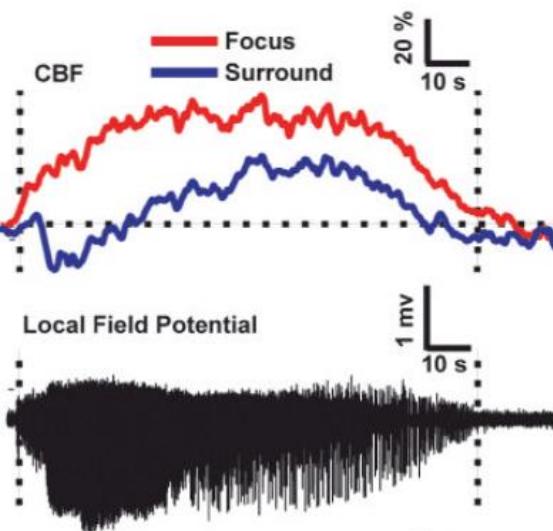
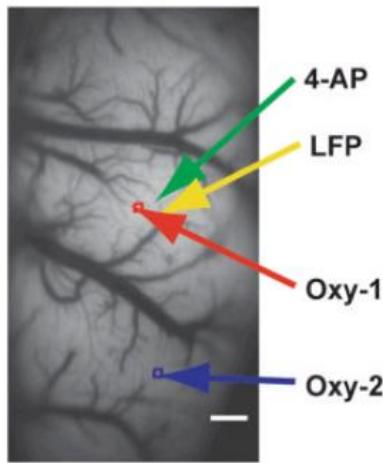
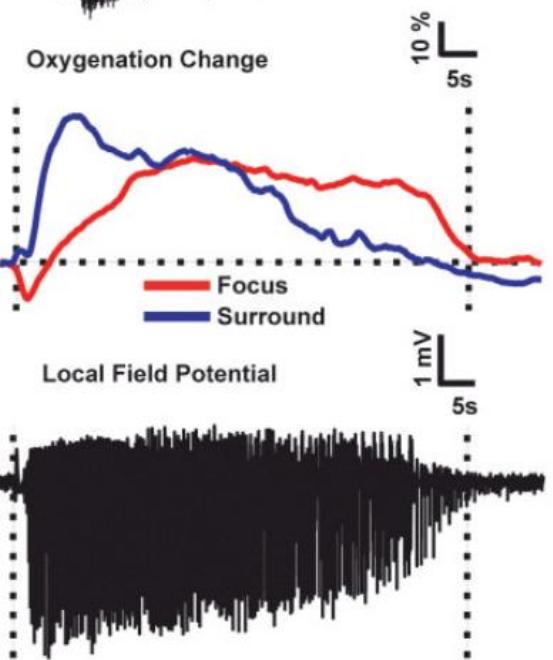


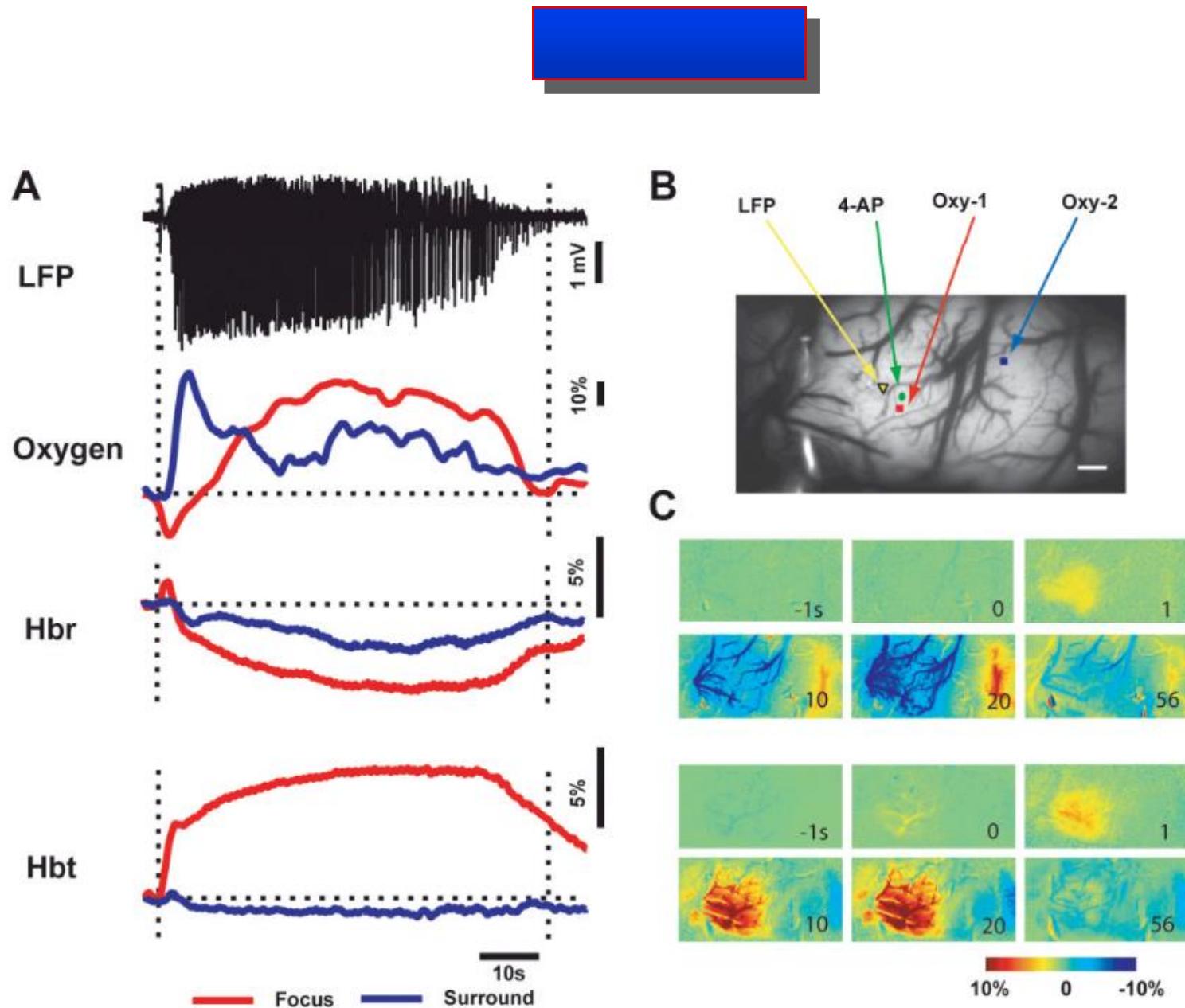
4-AP at doses less than $10 \mu\text{M}$, blocks potassium currents and enhances the release of synaptic neurotransmitters \Rightarrow

Intracortical injection of 4-AP causes epileptic activity within few hours

Epilepsy



**A****B****C****D**



Zhao et al., J Neurosci . 2009 March 4; 29(9): 2814–2823

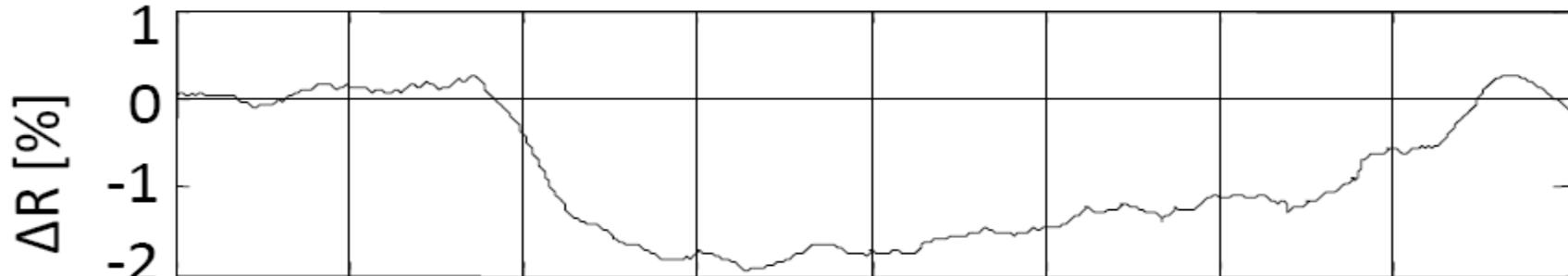
<http://oilab.seas.wustl.edu> -- 17

Optical Coherent Tomography of the Epileptic Seizures

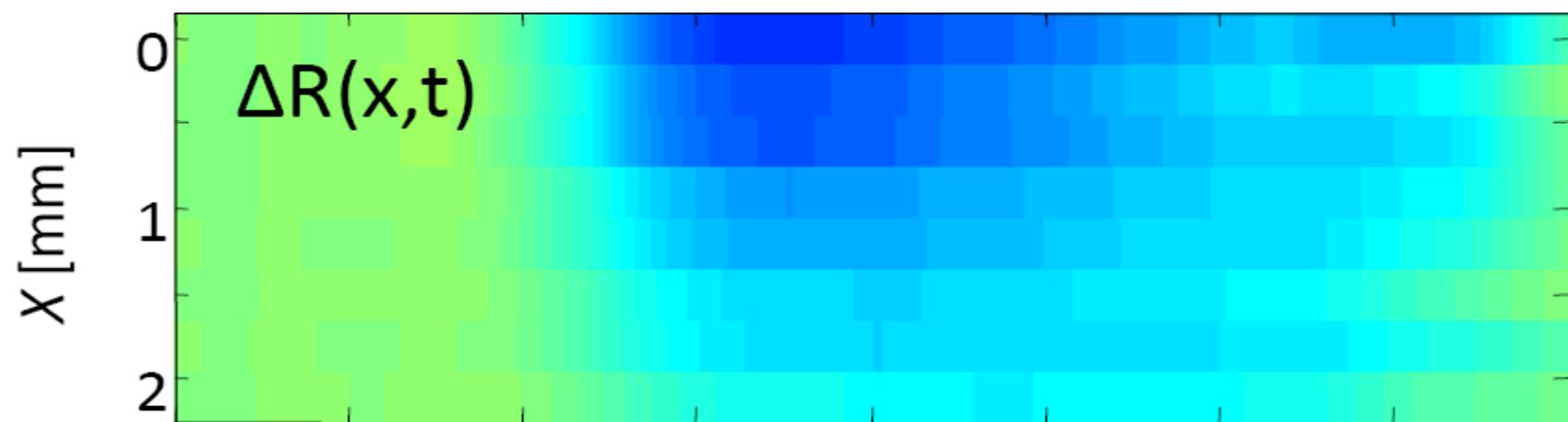
EEG



10 s / 2 mV



ΔR [%]



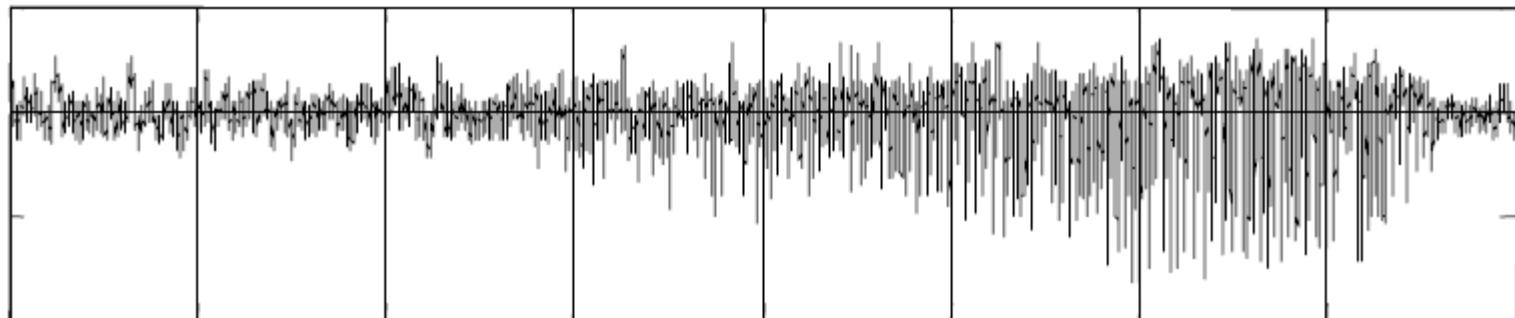
X [mm]

Epileptic seizures accompanied by two vessels vasodilatation (PA Imaging)

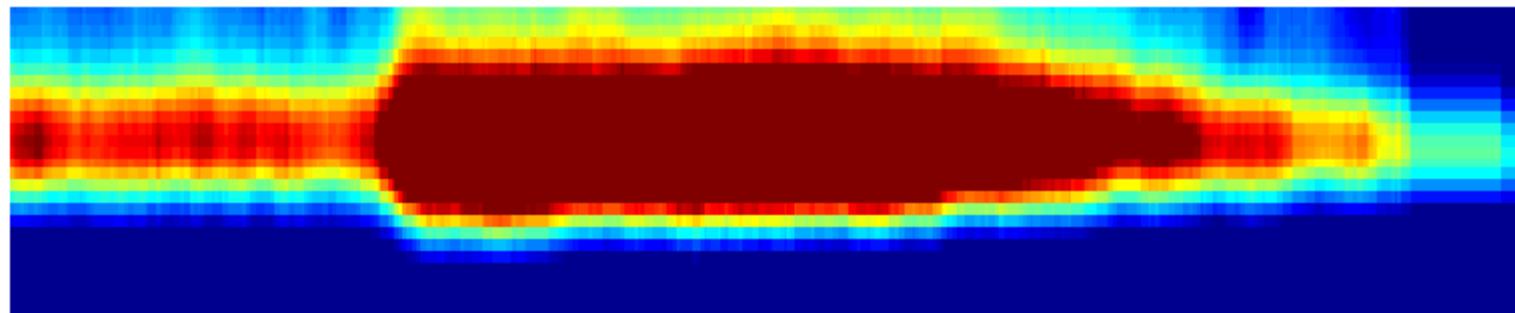
EEG



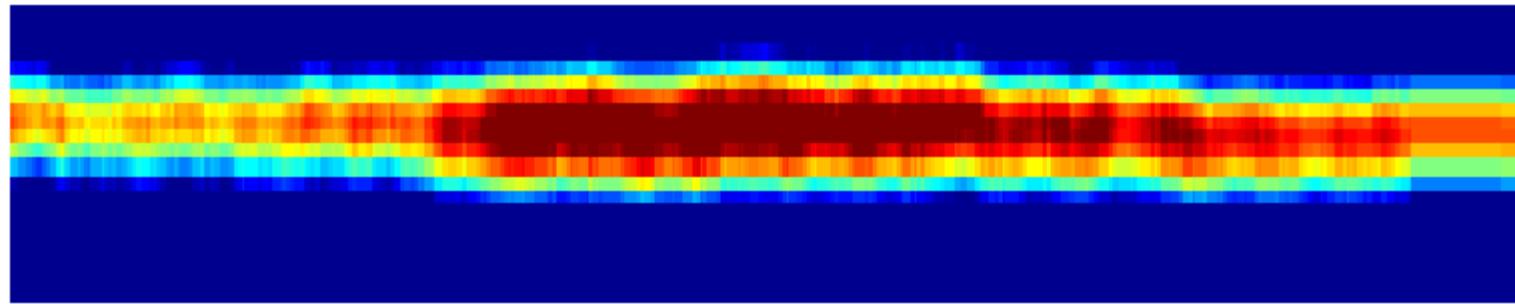
10 s / 2 mV



Vessel 1

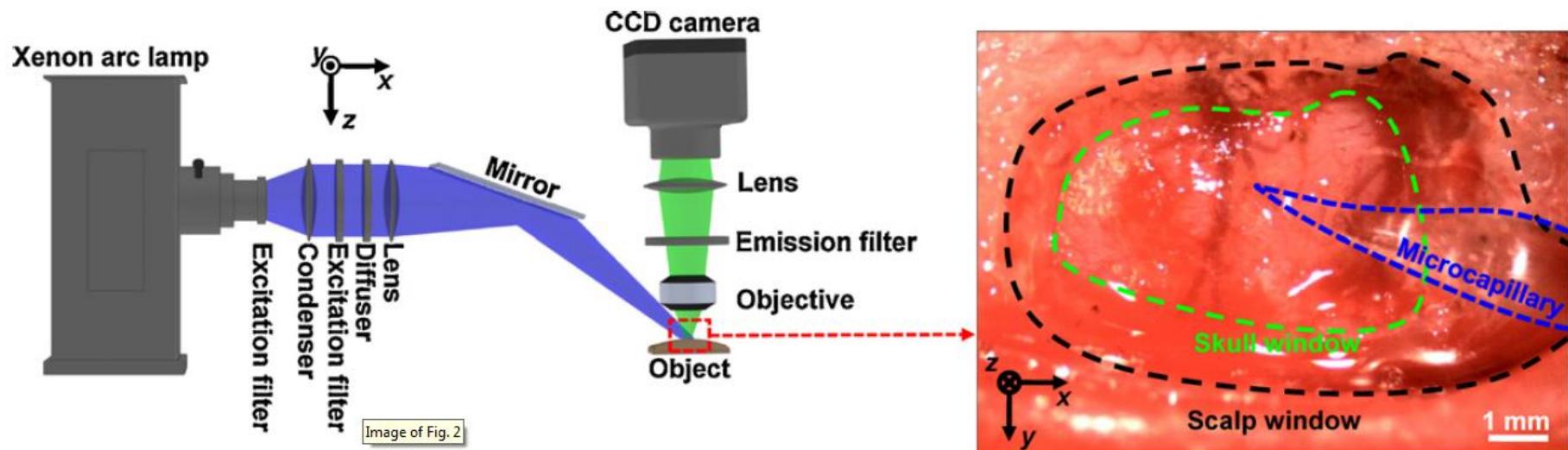
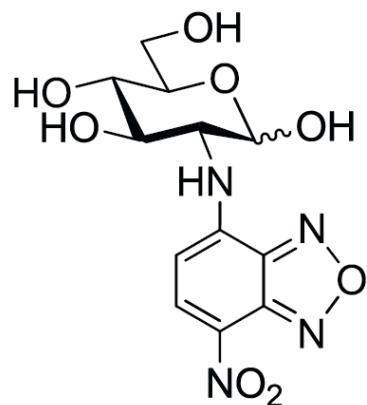


Vessel 2

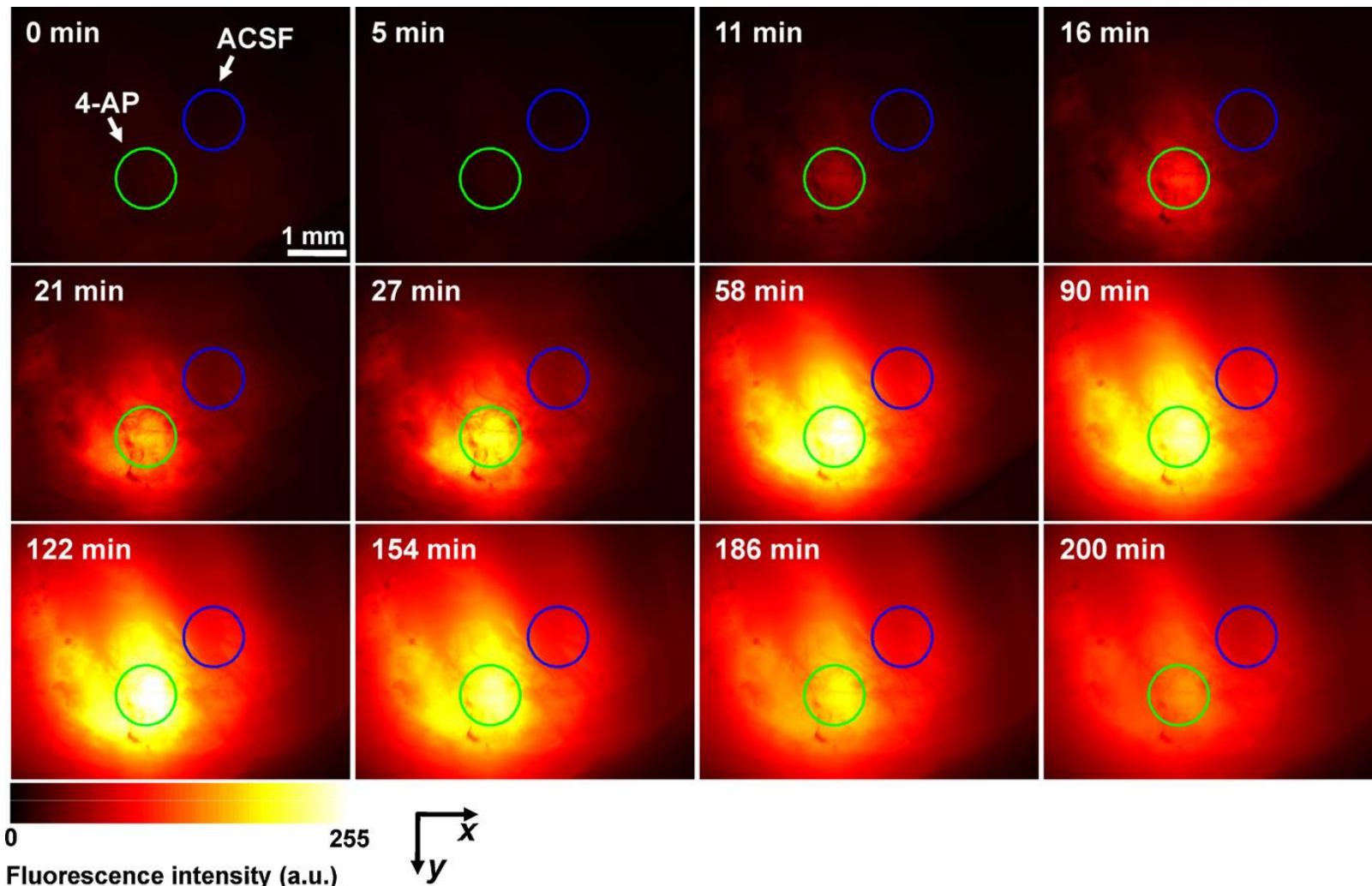


25 μ m

2-NBDG: a fluorescent deoxyglucose analog as a marker of the epileptic seizures



In Vivo 2-NBDG imaging of the epileptic seizures



Horizontal gaze palsy with progressive scoliosis (HGPPS)



Scoliosis (X-ray)

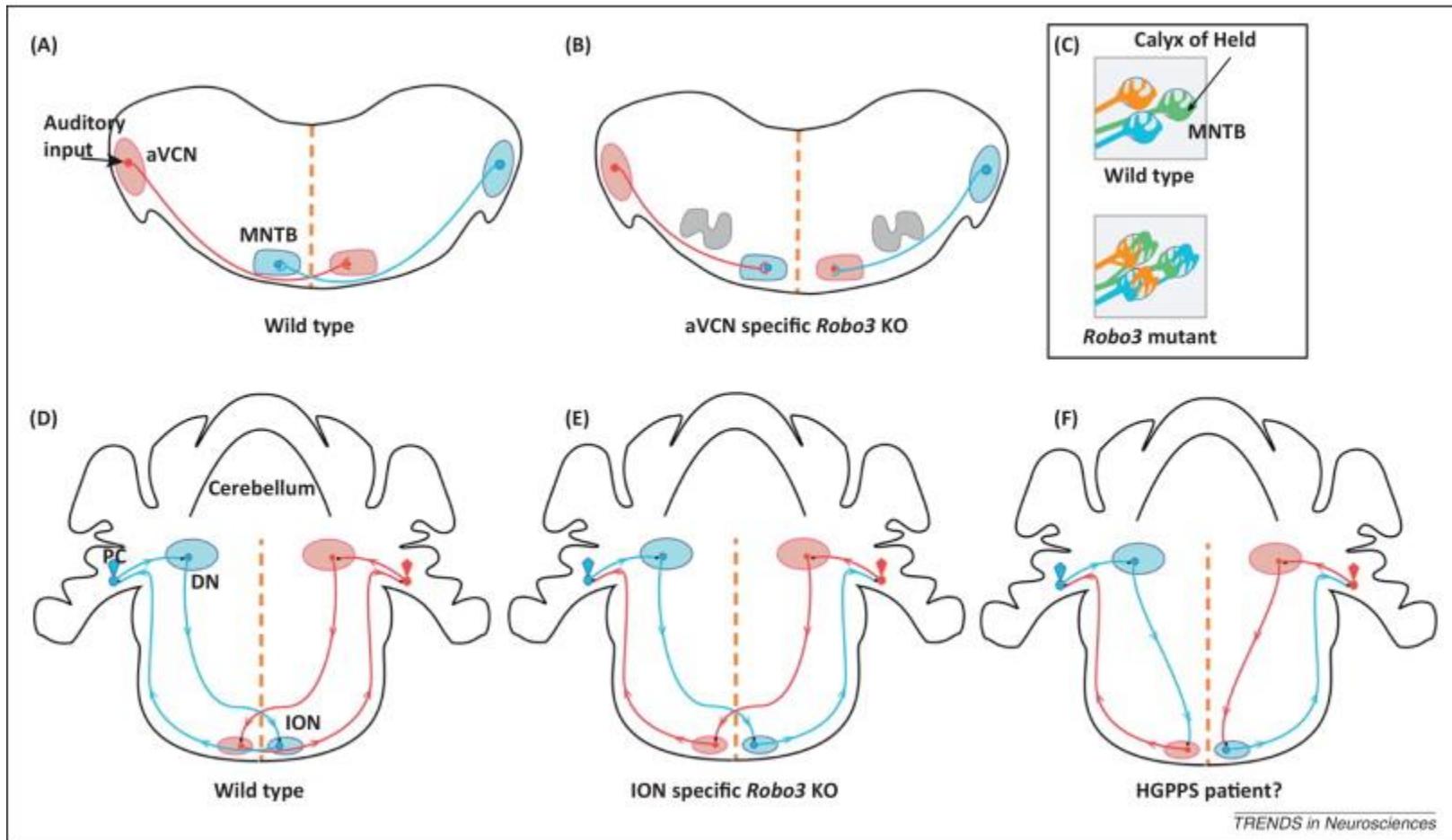


Horizontal gaze palsy



Brainstem hypoplasia

ROBO3 Gene: key of the HGPPS



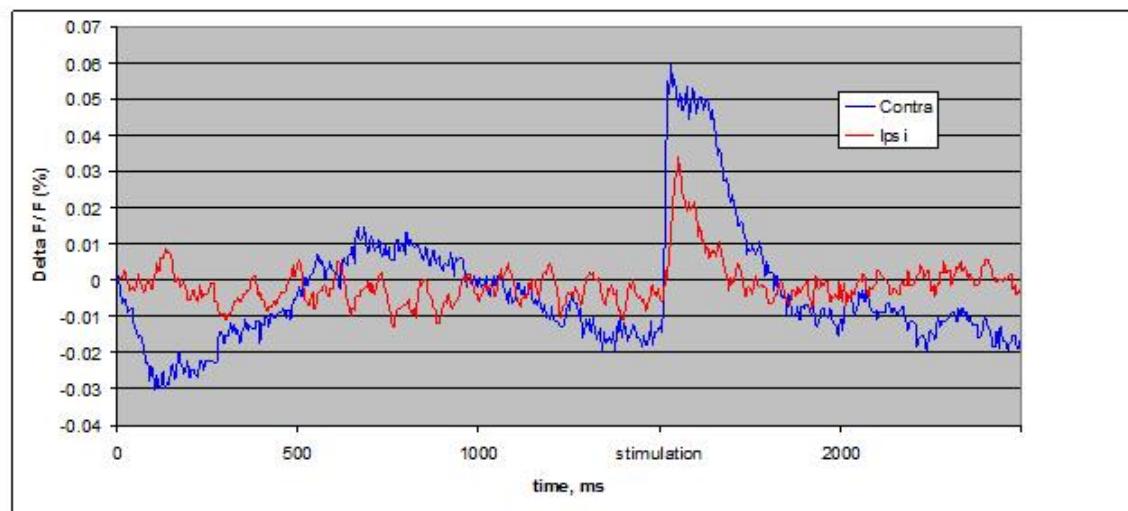
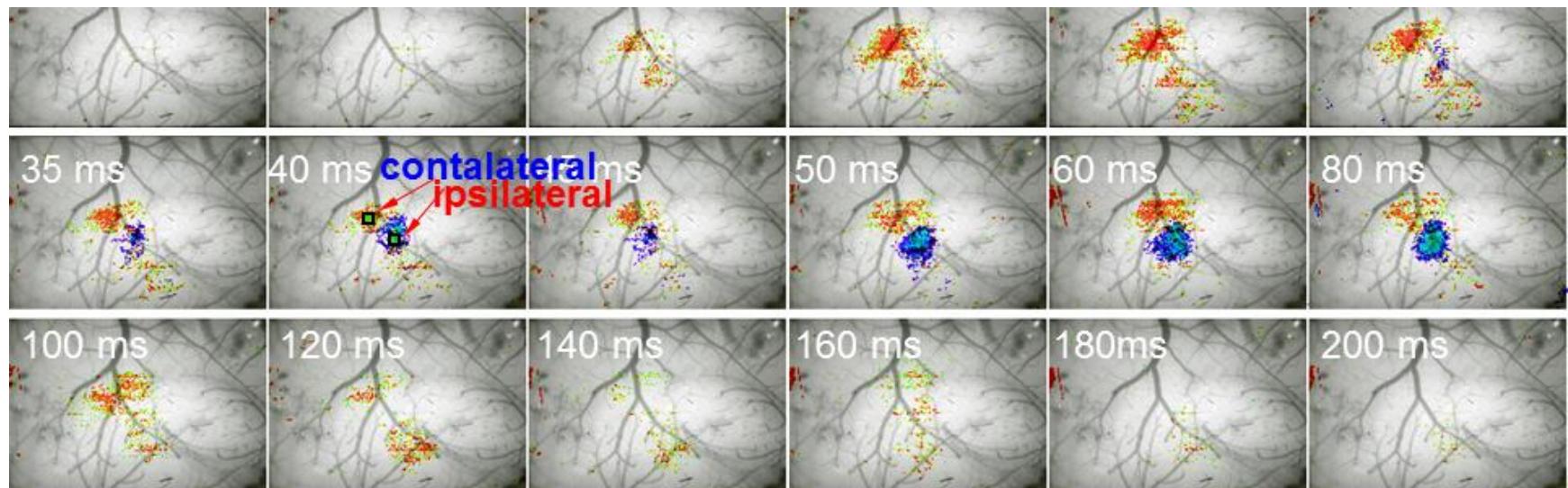
aVNC - anterior ventral cochlear nucleus

MNTB- medial nucleus of the trapezoid body

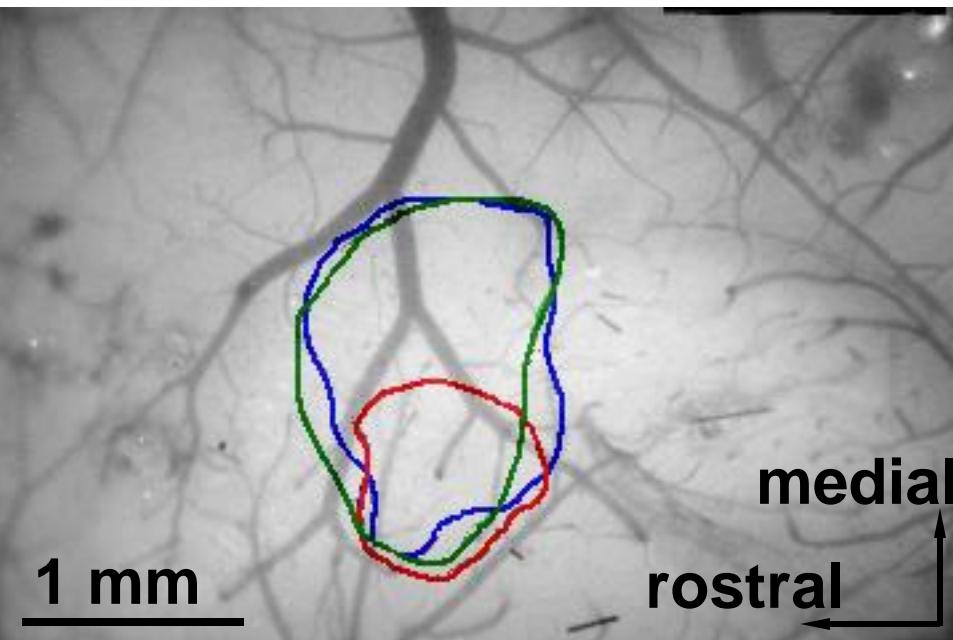
ION - inferior olivary nucleus

DN - dentate nucleus

ROBO3 Mutants Barrel Field Imaging



ROBO3 Mutants Barrel Field Imaging



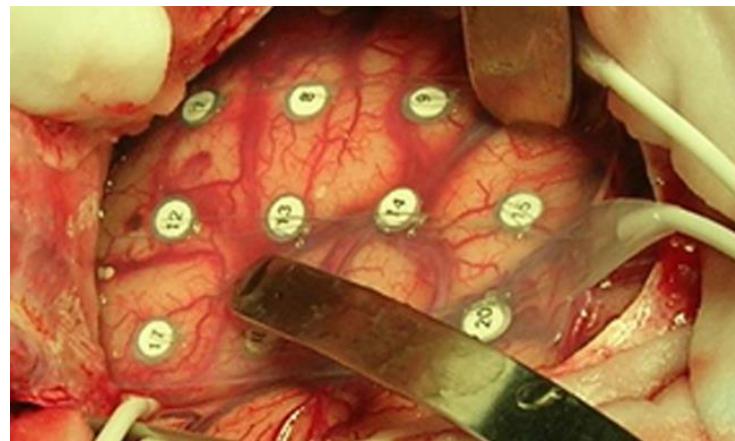
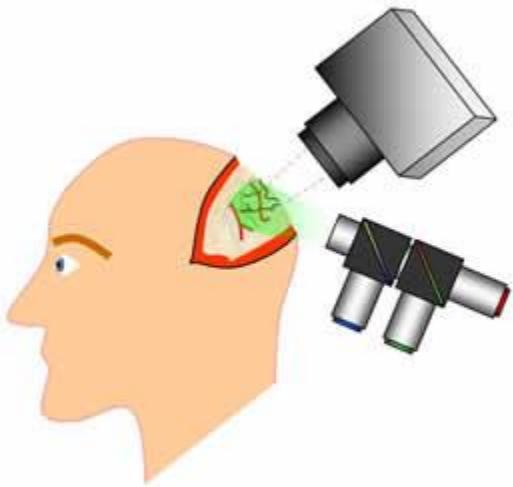
**Boundary of activity patterns
(Example 2), 50 ms after
stimulus onset.**

- Contralateral
- Bilateral
- Ipsilateral

Preliminary conclusion:

- In contrast to control animals, ROBO3 mutants demonstrate not only contralateral response in reply to the whisker stimulation, but also ipsilateral, as well as bilateral.
- Activity pattern, elicited by ipsilateral stimulation, is smaller and located inside the contralateral.
- The distance between centers of activity patterns, elicited by ipsi- and contralateral stimulation, is 0.4 ± 0.1 mm ($n=6$).
- Activity patterns, elicited by contra- and bilateral stimulations, are equal.

.. And Brain Optical Imaging Within the Neurosurgery



Thank you very much for your attention

