

# Dynamic Quantitative Brain Imaging by Multiscale Multimodal Integration

**Non-Invasive  
Observables**

**EEG/MEG**

**fMRI**

**Forward Models  
(Measurement Theory)**

**“Inverse Problem”**

**Physiology**

**Electrical  
Activity**

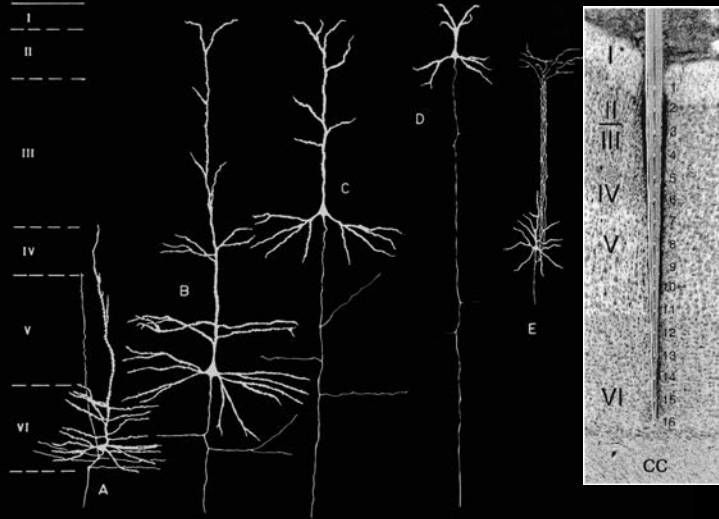
**Neurovascular  
Coupling**

**Hemodynamic  
Activity**

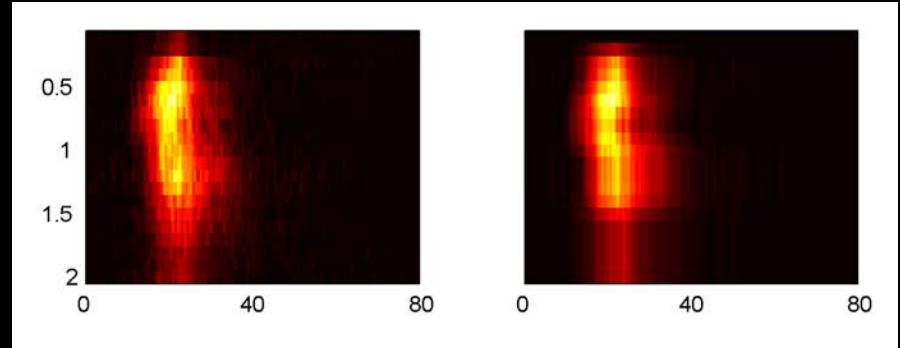


# Bridging the Microscopic and Macroscopic Scales

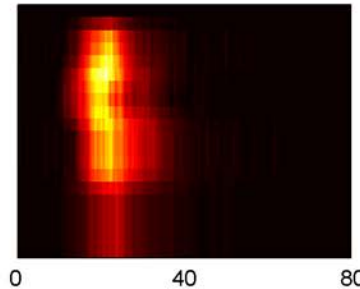
Extracellular multi-electrode recordings



Measurements

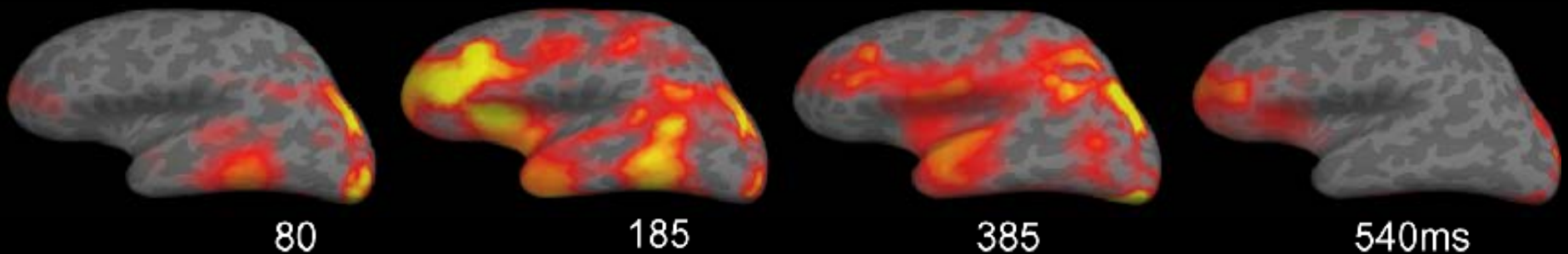


Model



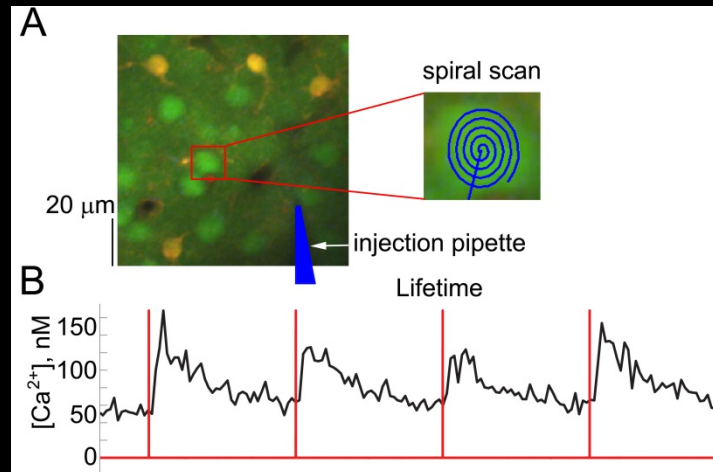
Einevoll, J Neurophysiol., 2007  
Also part of recently funded EU HBP Grant

Spatiotemporal “Movies” of Human Brain Activity Based on Non-Invasive Multimodal Recordings

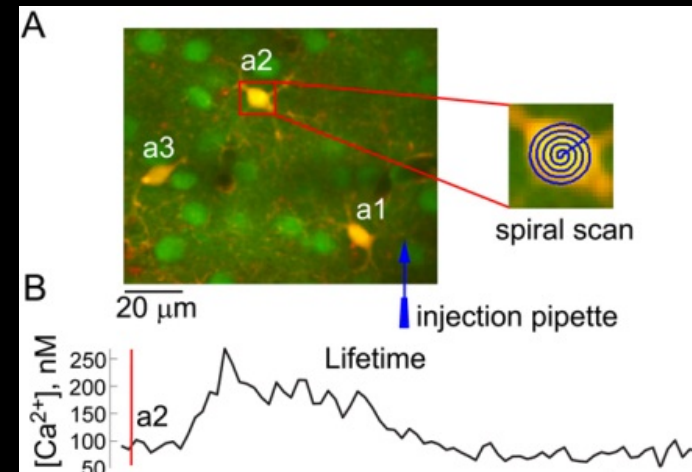


# *in vivo* Microscopic Imaging of Neuroglial and Vascular Networks

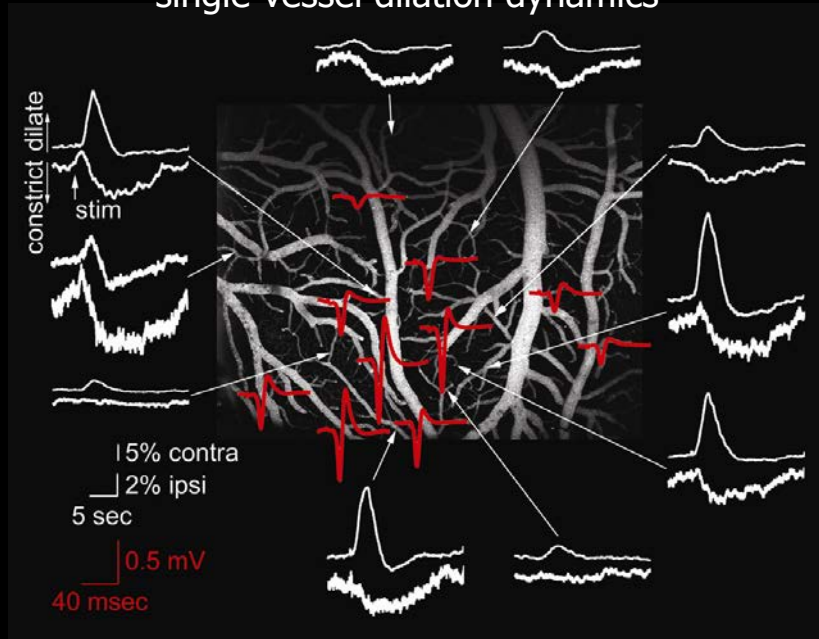
## *in vivo* $[Ca^{2+}]$ measurement in neurons



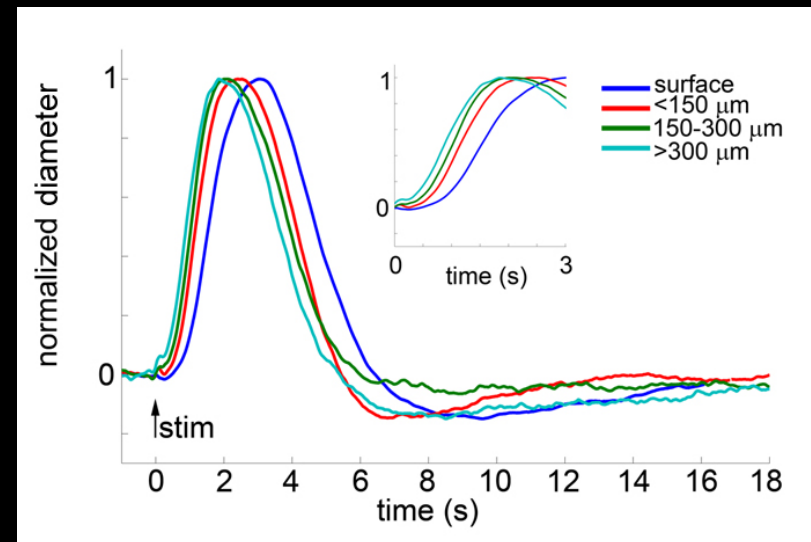
## *in vivo* $[Ca^{2+}]$ measurement in astrocytes



## single-vessel dilation dynamics



## depth-resolved vasodilation

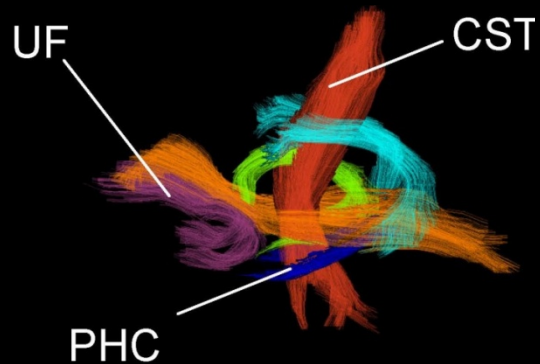


Tian et al., PNAS, 2010

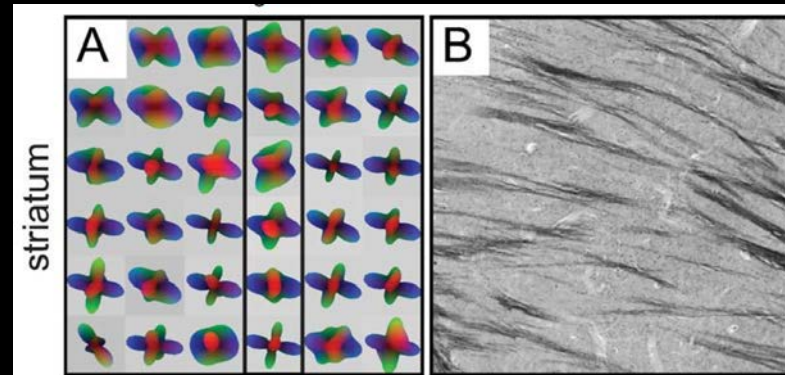
# Connecting to the Human Connectome Project

## Probing Tissue Microstructure with Advanced Diffusion Imaging

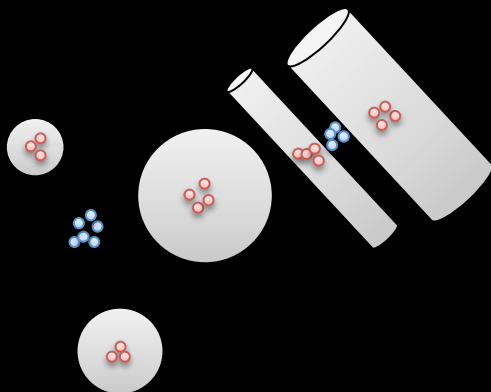
Macroscopic Connectivity by Diffusion MRI



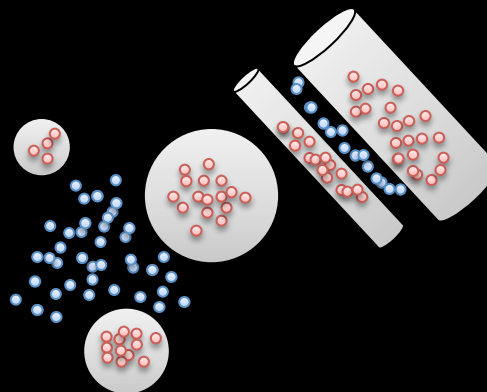
Mesoscopic Connectivity by Advanced Diffusion MRI



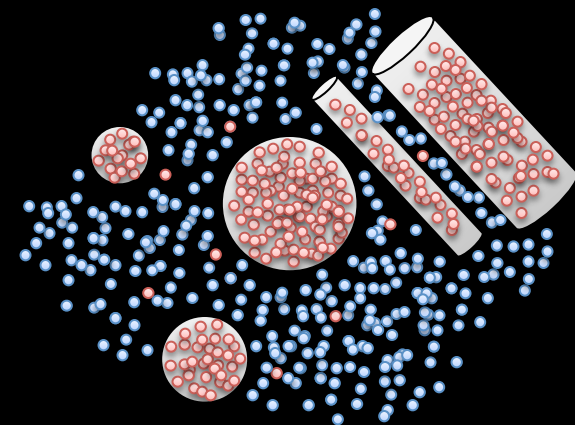
$\Delta = 1\text{ms}$



$\Delta = 20\text{ms}$



$\Delta = 100\text{ms}$



# Big Data in Practice: Beyond the Hype

