

Multi-Modality Imaging

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Expertise of the group

- *Neuroscience*
- *microMRI*
- *microCT*
- *Medical Physics*
- *Optical Imaging*
- *Optical Sensors*
- *Drug delivery*
- *Anesthesia*
- *Opioids, Pharmacokinetics*
- *Image Processing*
- *Anatomy*
- *Brain development*
- *Physiology*
- *Transgenic mice models of human diseases*
- *Pharmacology*
- *Engineering*
- *Neuro-informatics*

Methodology & Instruments

Multi-disciplinary Scientists

microCT



9.4T microMRI



Optical Imaging



PHENOTYPING

Behavior

Genotype

Micro-array



Morphology

microMRI

microCT

Physiology

*In vivo optical
Fluorescence imaging*

Biochemistry

PET

MR spectroscopy

Protein-expression

*Fluorescence
Microscope*

MRI versus MRM

- Spatial resolution
- Stronger magnetic field
- Stronger magnetic field gradients
- Smaller rf coils

MR Microscopy

Definition: “Images with a resolution of less than 100 μm in at least one dimension”
(Aiken et al., 1995, Benveniste and Blackband, 2003)

First attempts at MRM:

Water snail- μm range - isotropic acquisitions (Dr. Hedges, student of Dr. Lauterbur, 1984. PhD thesis, Stonybrook)

Plant stems (Eccles & Callaghan, 1986)

Rat brain (Johnson et al., 1986)

Single cells (Aguayo et al., 1986)

Sample preparation....



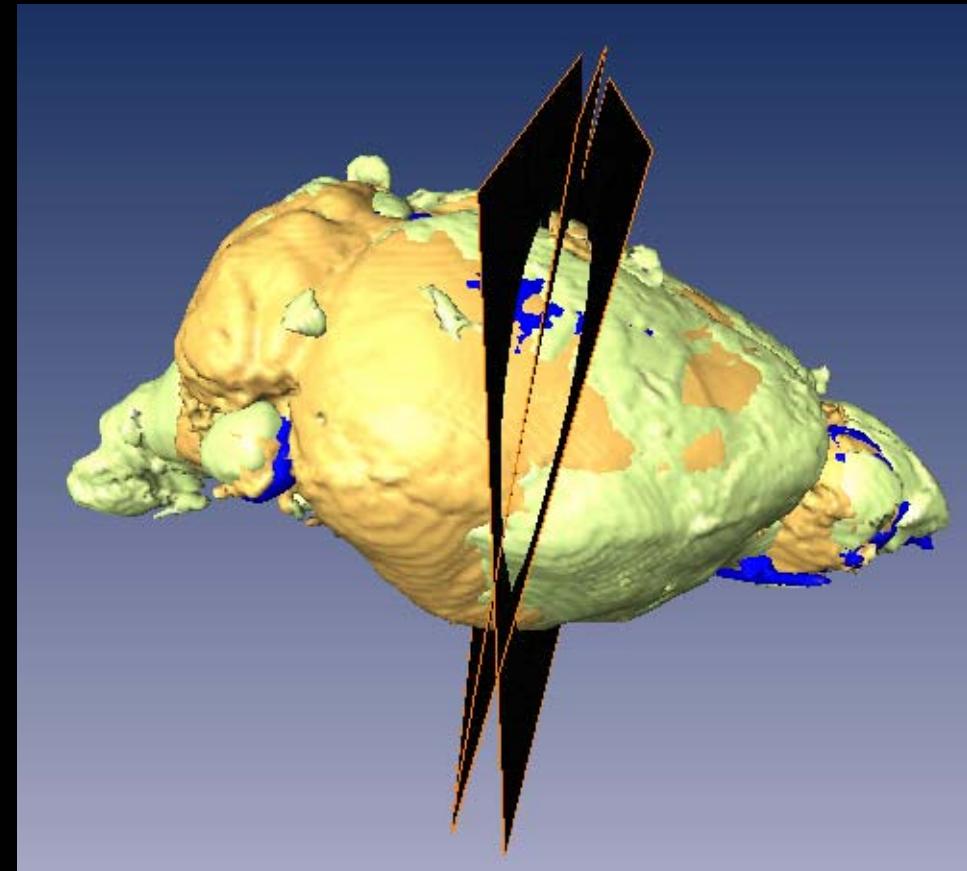
Phenotyping by MRM - *in vitro*:

3D - Non-invasive - Contrast

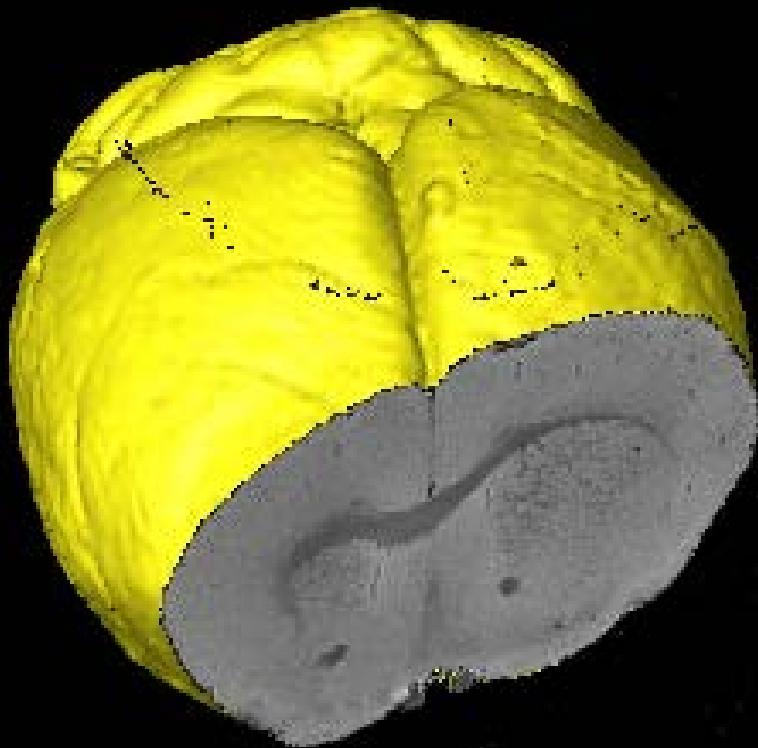
Surface



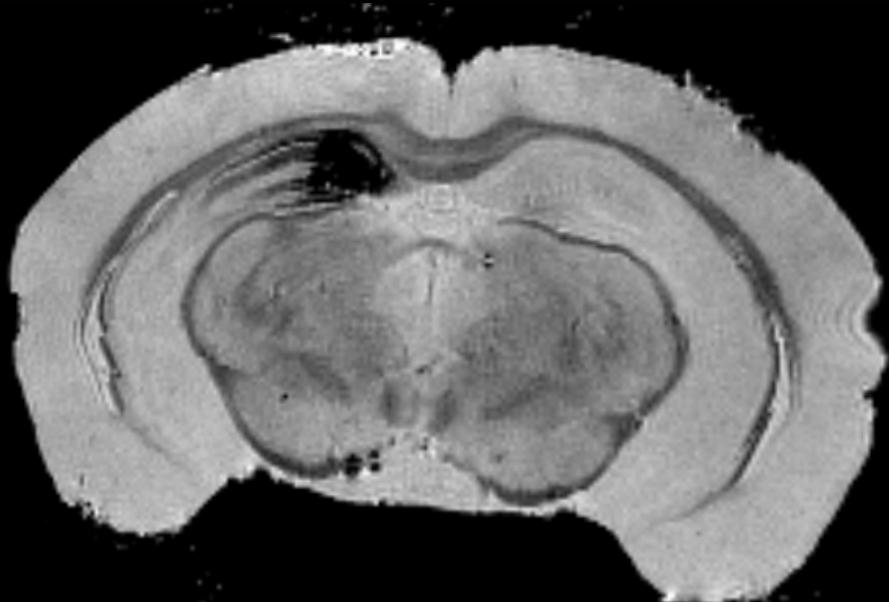
Registration - trends



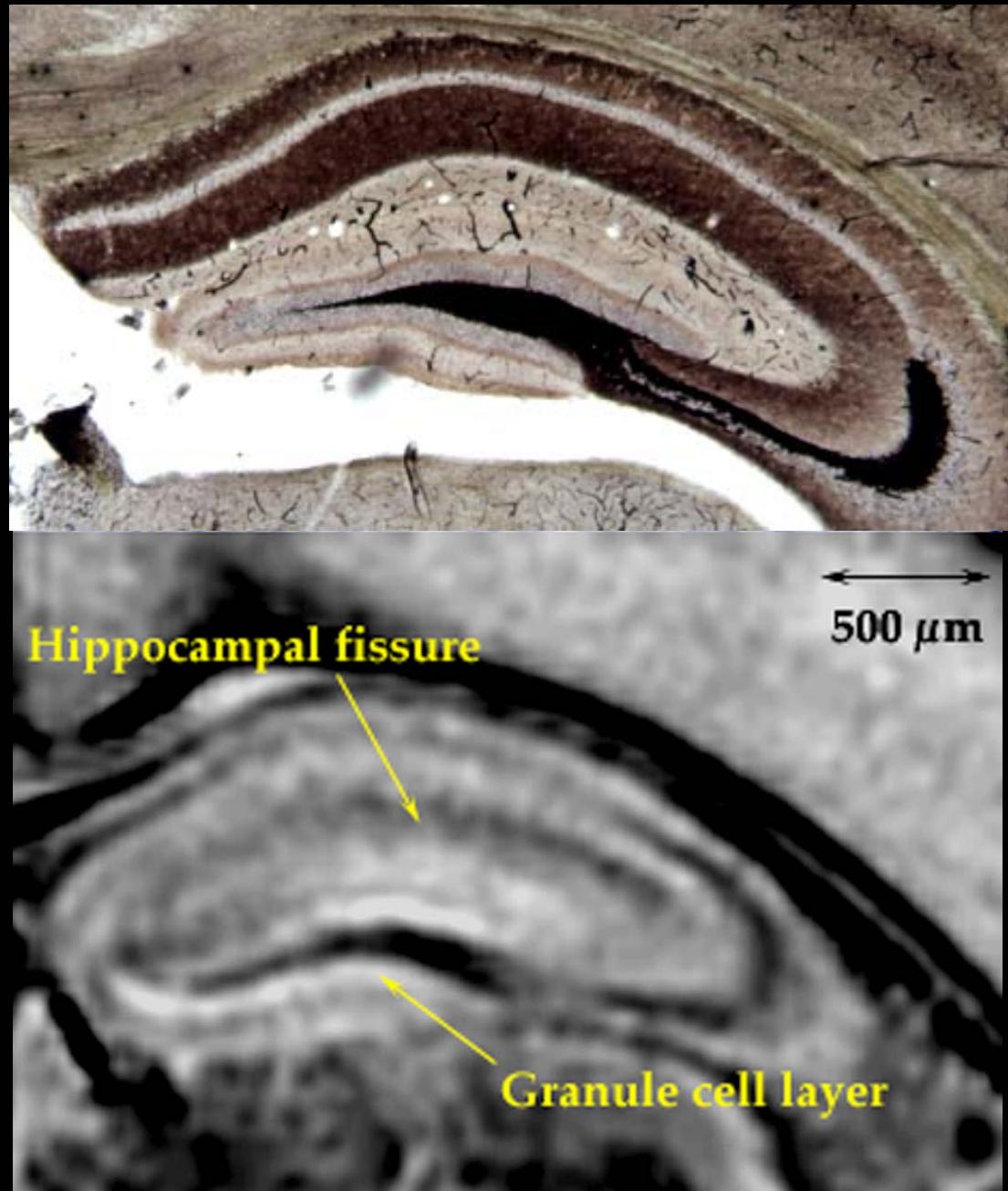
Texture - normal



Texture - abnormal

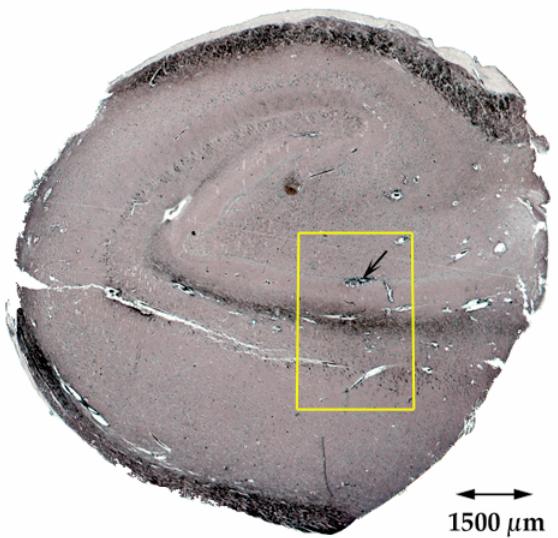


Mossyfiber Pathway

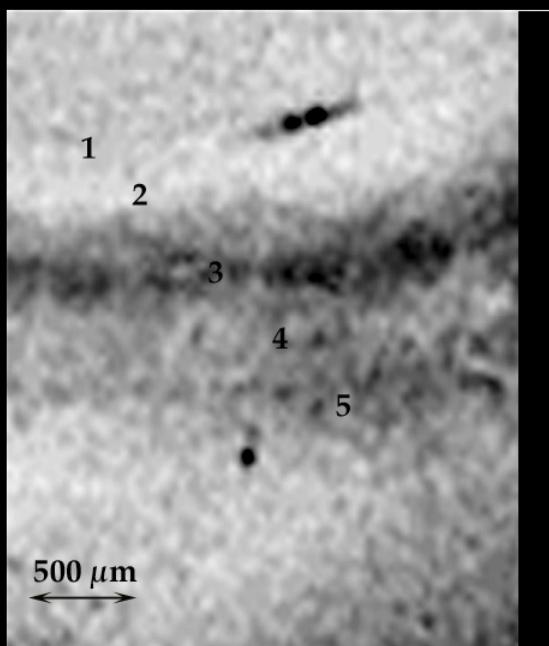
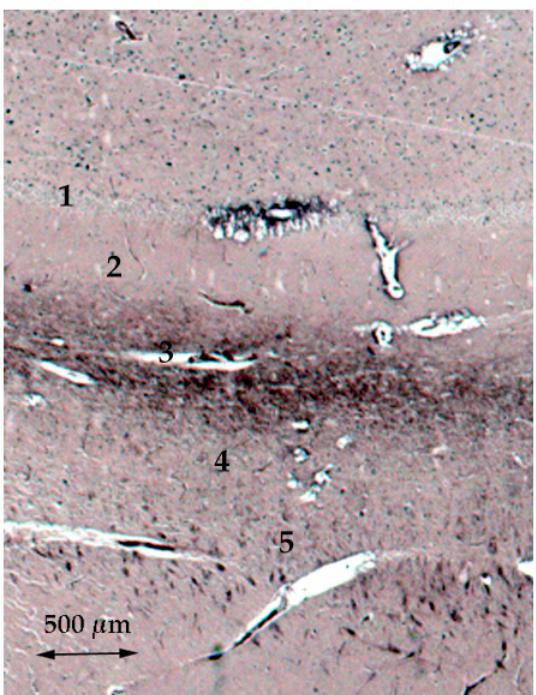
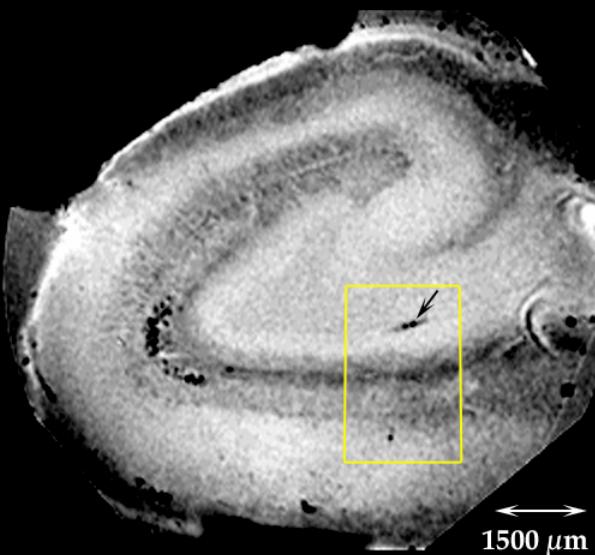


Benveniste et al., NeuroImage 2000
Zhang and Benveniste, in Prep.

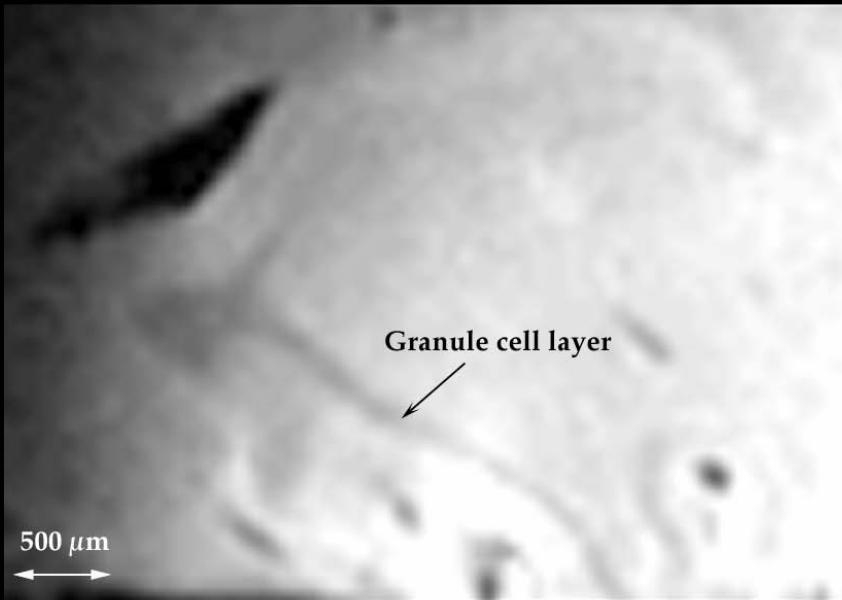
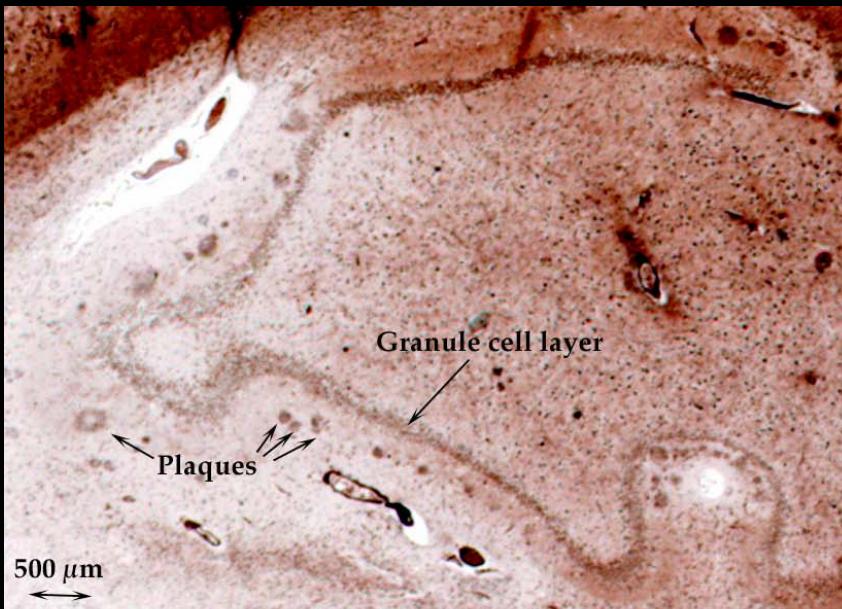
MK SILVER STAIN



T2* PROTON STAIN



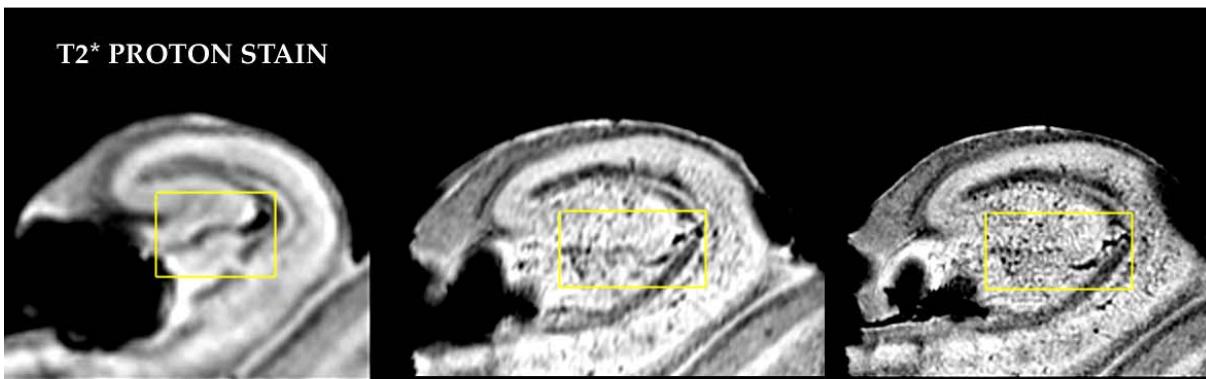
Diffusion



MK SILVER STAIN



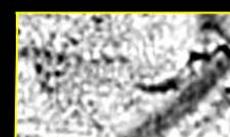
T2* PROTON STAIN



0.003 mm^3

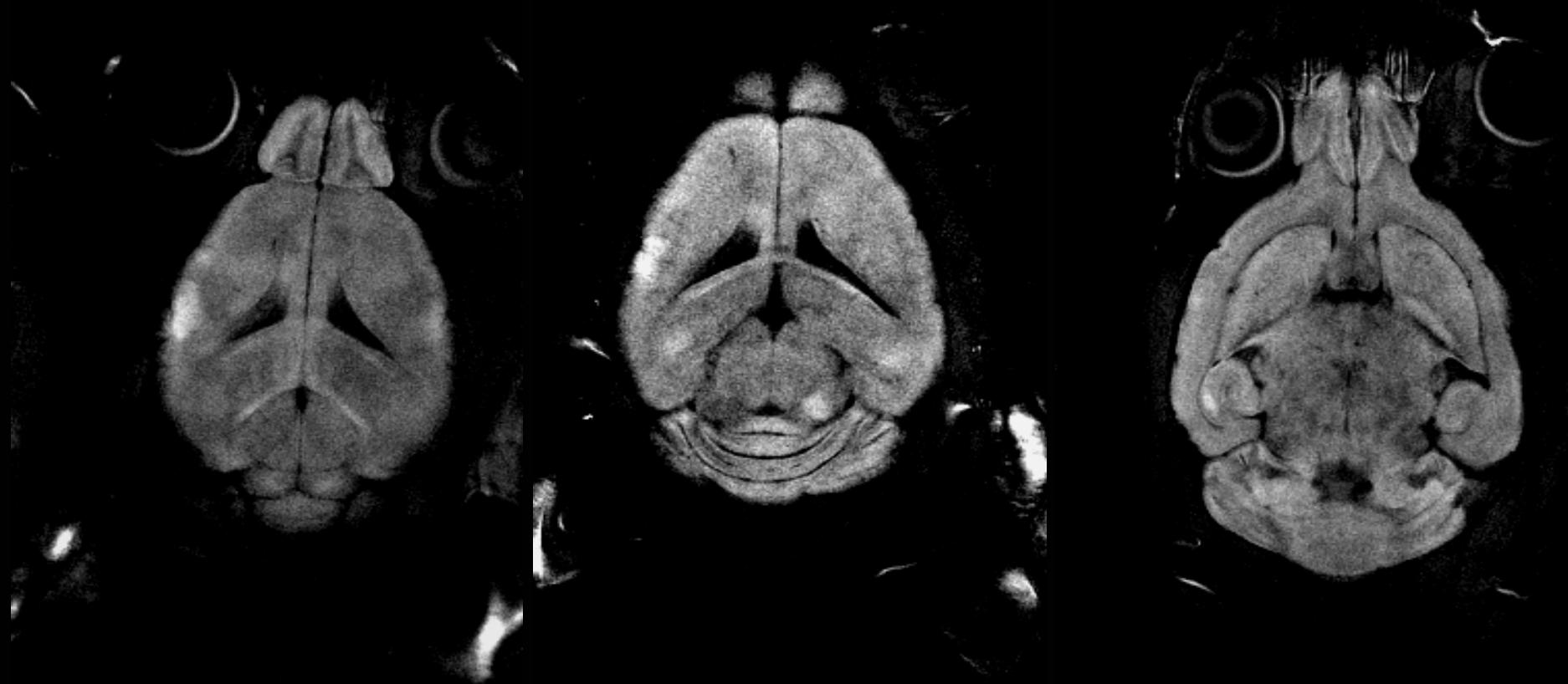


0.00024 mm^3



0.000059 mm^3

In Vivo APOE-deficient mice after 3 days after transient forebrain ischemia

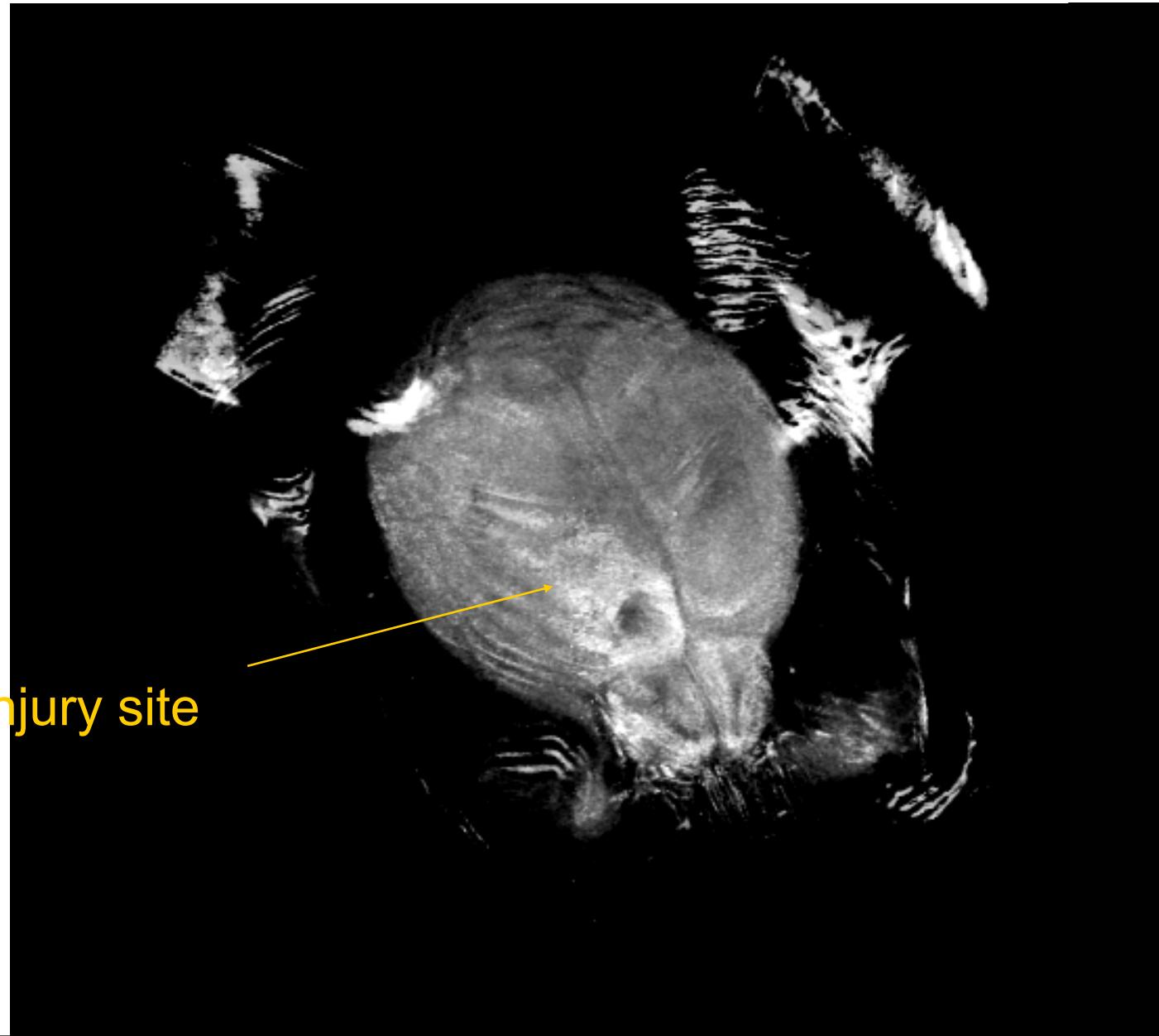


McDaniel, Sheng, Warner, Hedlund, Benveniste. NeuroImage, 2002

The majority of ApoE -/- mice die prematurely 3-5 days after transient cerebral ischemia. These mice all show “spots” of high signal intensity dispersed throughout the forebrain. The hyperintensity spots coincides with areas of pan-necrosis/infarction.....



3D view



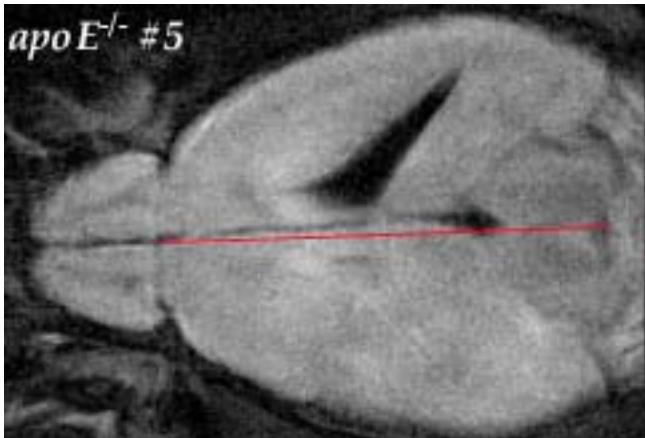
Injury site

ApoE deficient mouse
24 hrs after closed head injury

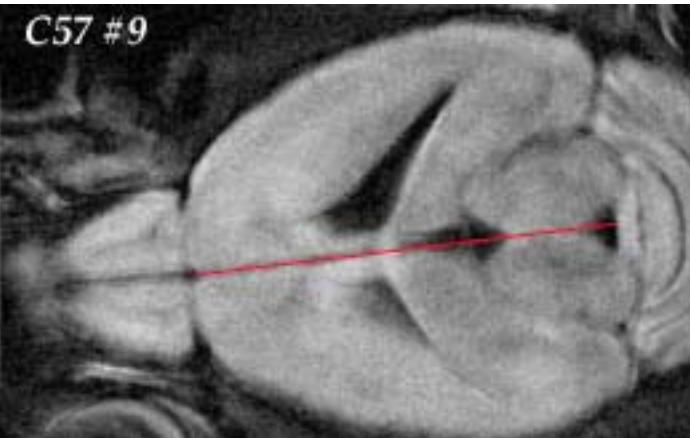
Obliteration of left lateral ventricle

High signal intensity in impact area

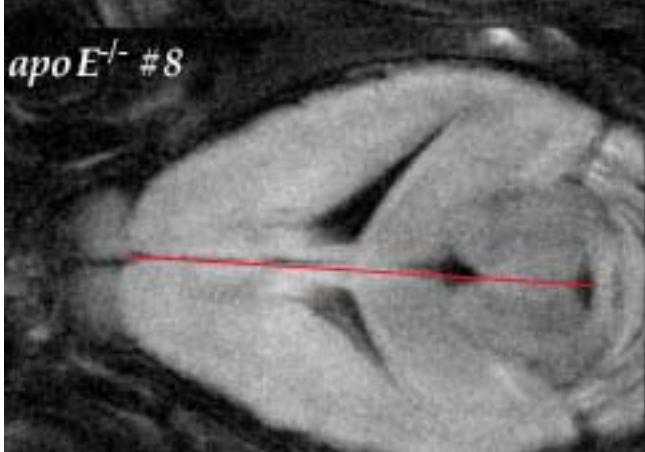
apoE^{-/-} #5



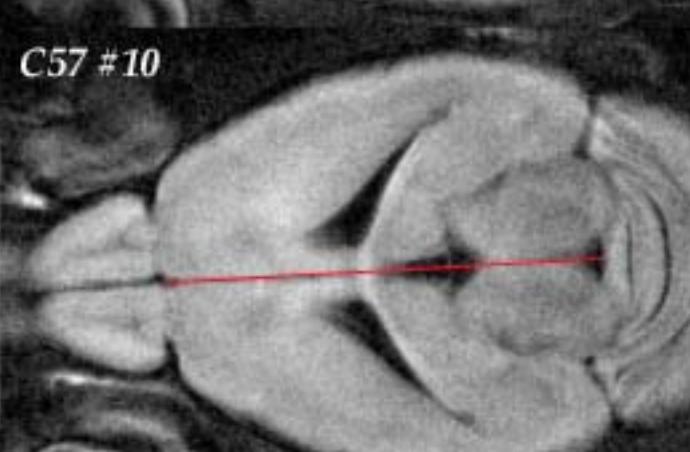
C57 #9



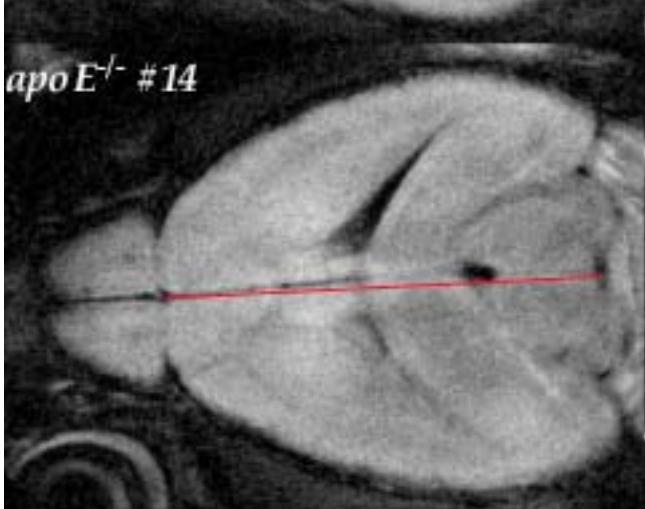
apoE^{-/-} #8



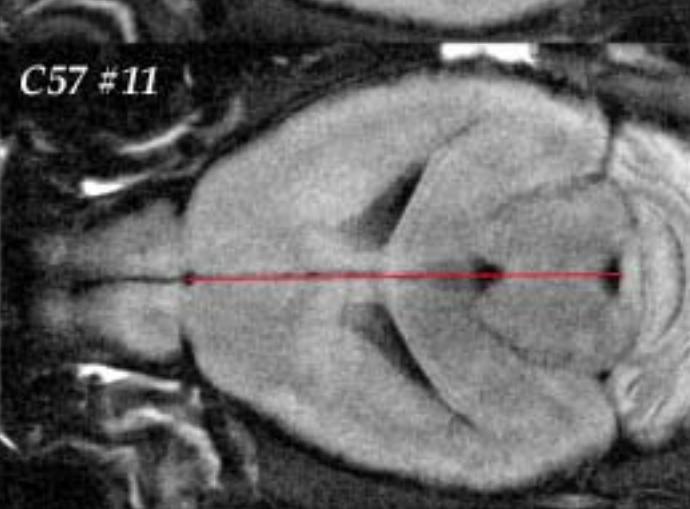
C57 #10



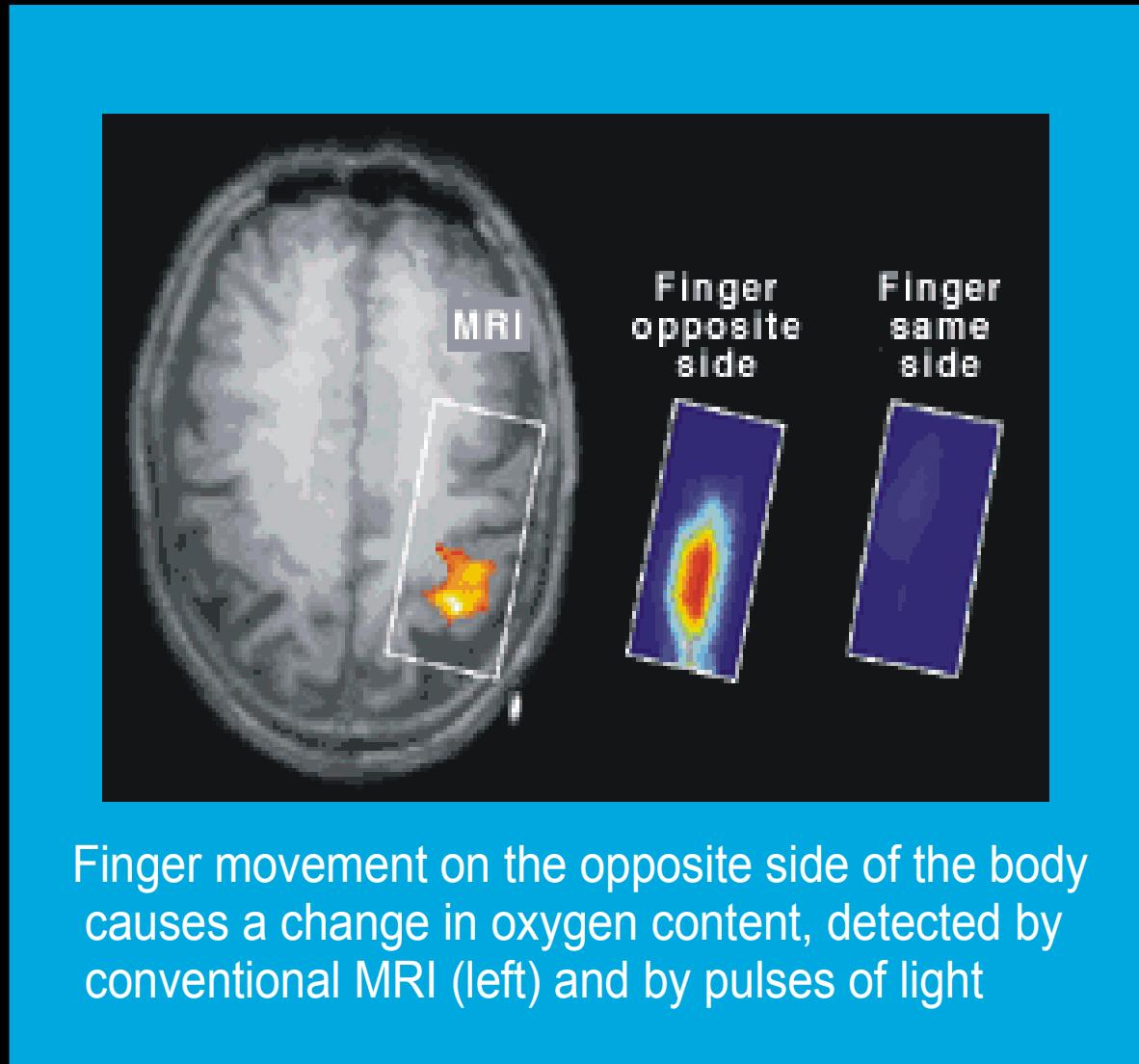
apoE^{-/-} #14



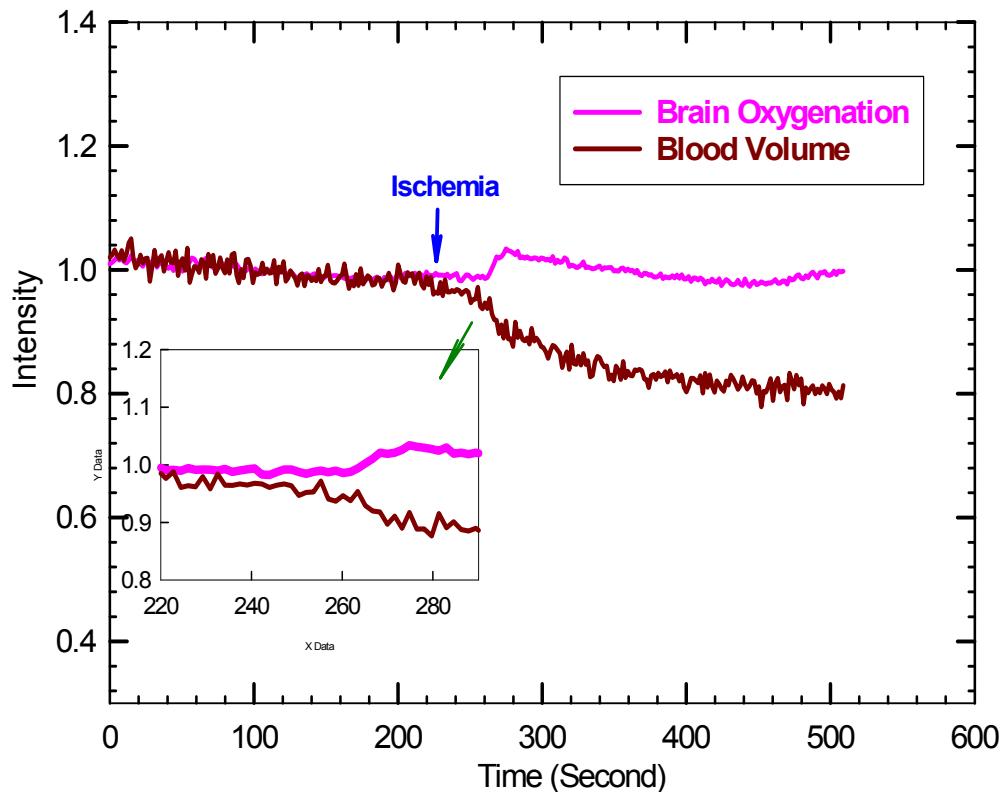
C57 #11



Brain Functional Imaging: Optical Possibility



Changes in hemoglobin oxygenation blood volume of rat brain due to ischemia



Spectral changes in hemoglobin of rat brain due to ischemia

