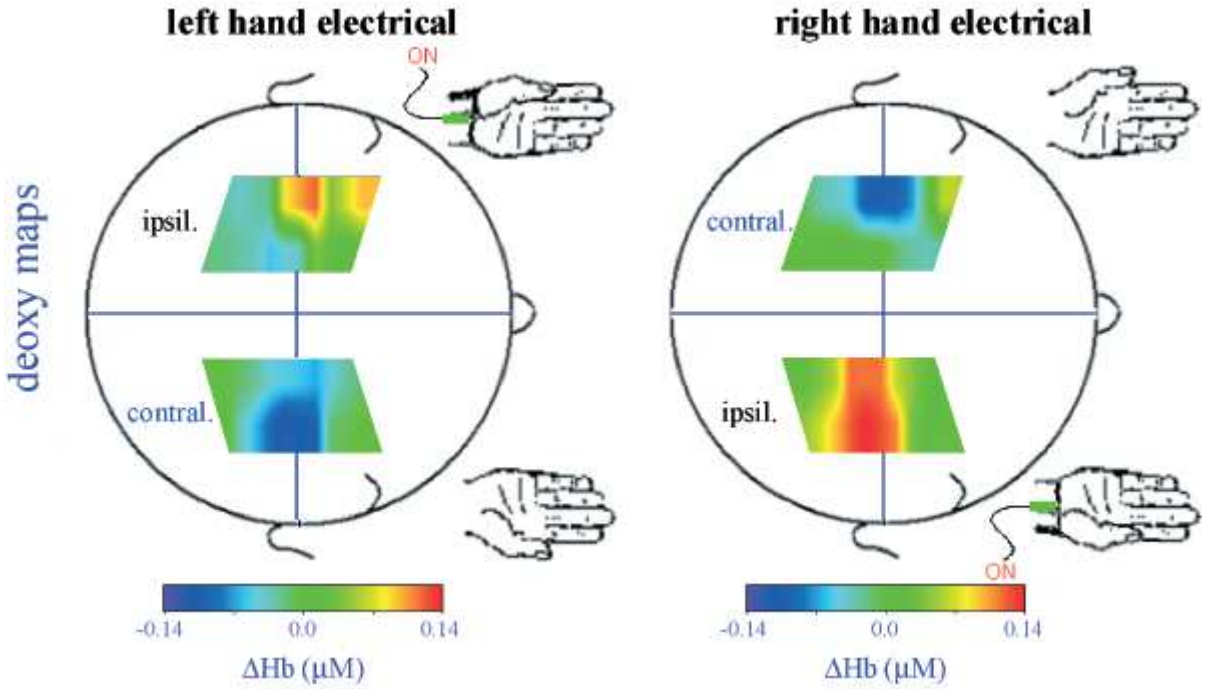
Three-dimensional superposition of DOT results and subjacent anatomical structures

Christina Habermehl

Berlin NeuroImaging Center,
Charité University Hospital,
Department of Neurology,

NIRS is an accepted tool to measure cortical activation.



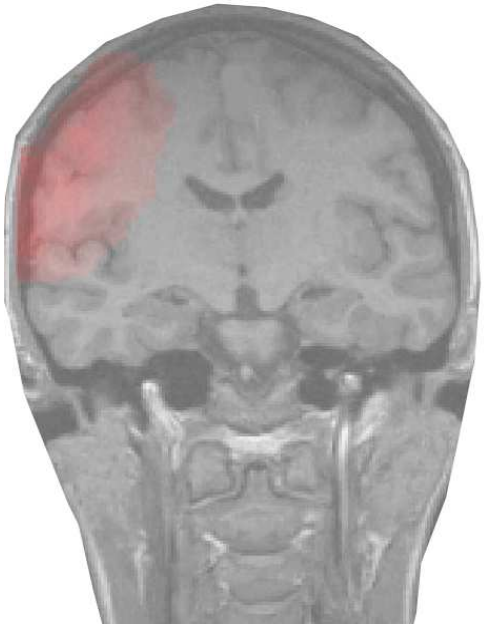
from: **M. A. Franceschini**, S. Fantini, J. H. Thompson, J. P. Culver, and D. A. Boas, "**Hemodynamic evoked response of the sensorimotor cortex measured noninvasively with near-infrared optical imaging**," Psychophysiology **40**, 548-560 (2003)

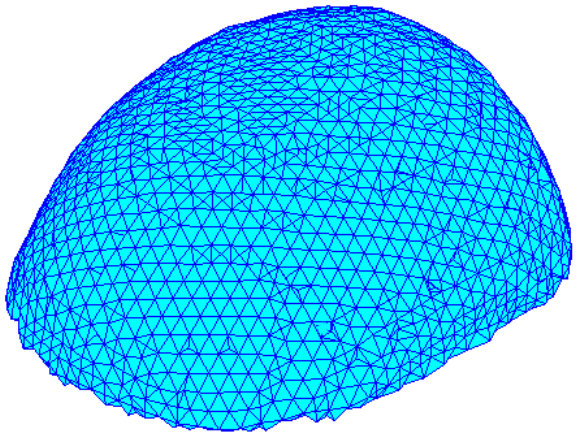
Tomography can enhance spatial resolution.

Activation map from a fingertapping task of the left hand, measured with high-density DOT (un-published data).

- multi-distance-measurements
- dense fiber grid
- results in a 3D volume

DOT needs a forward model and image reconstruction





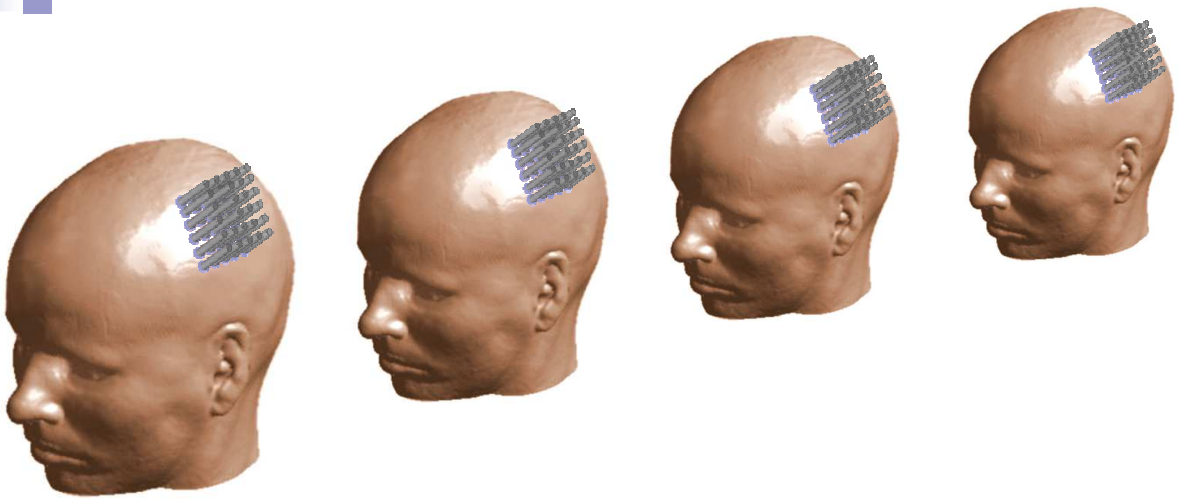
- Forward problem:

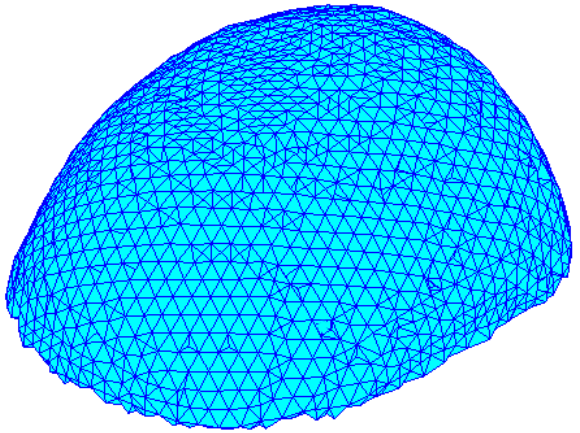
  Simulation of light propagation leads to a weight matrix W

- Inverse problem:

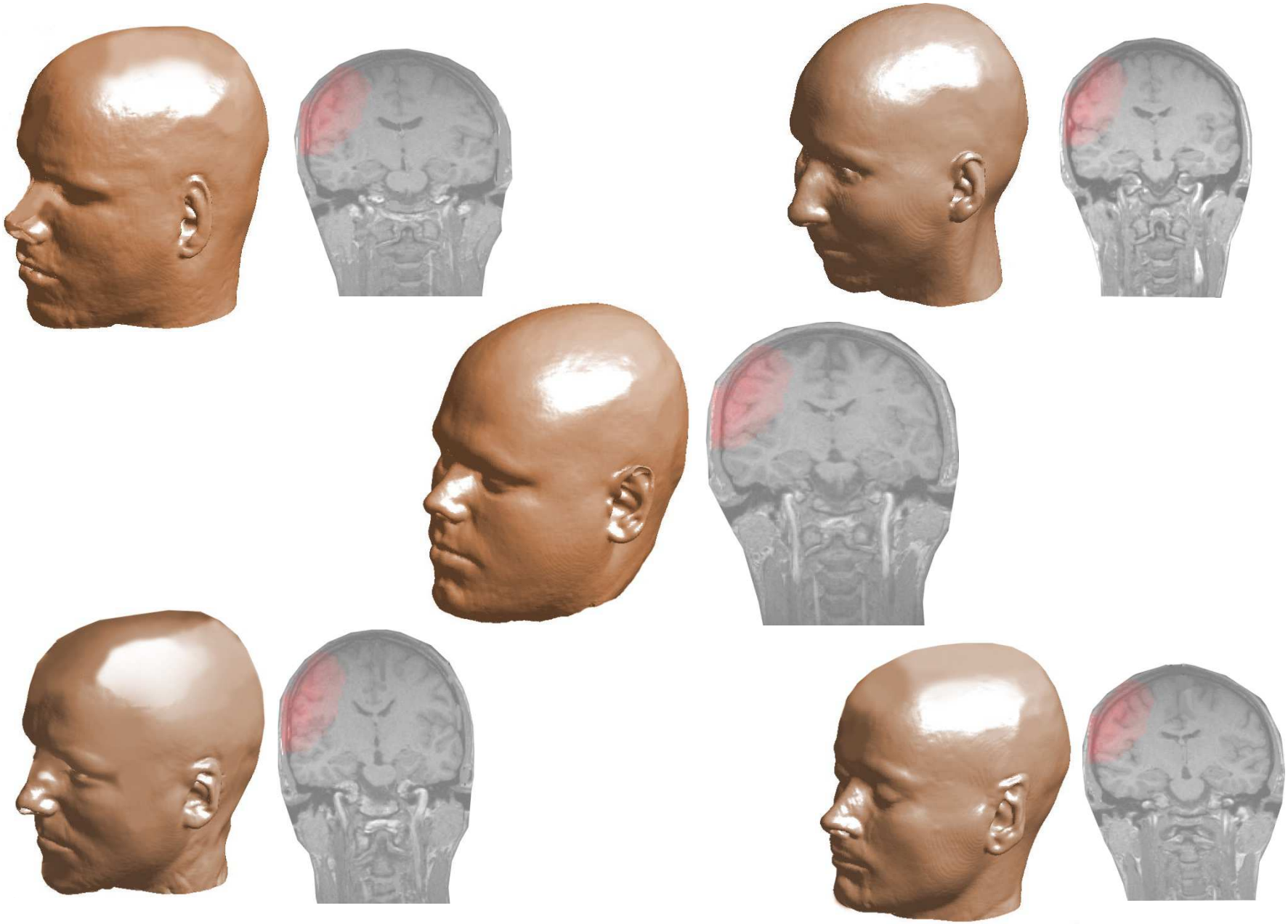
  Surface data * W^{-1} = interiour optical properties

In a perfect DOT world…

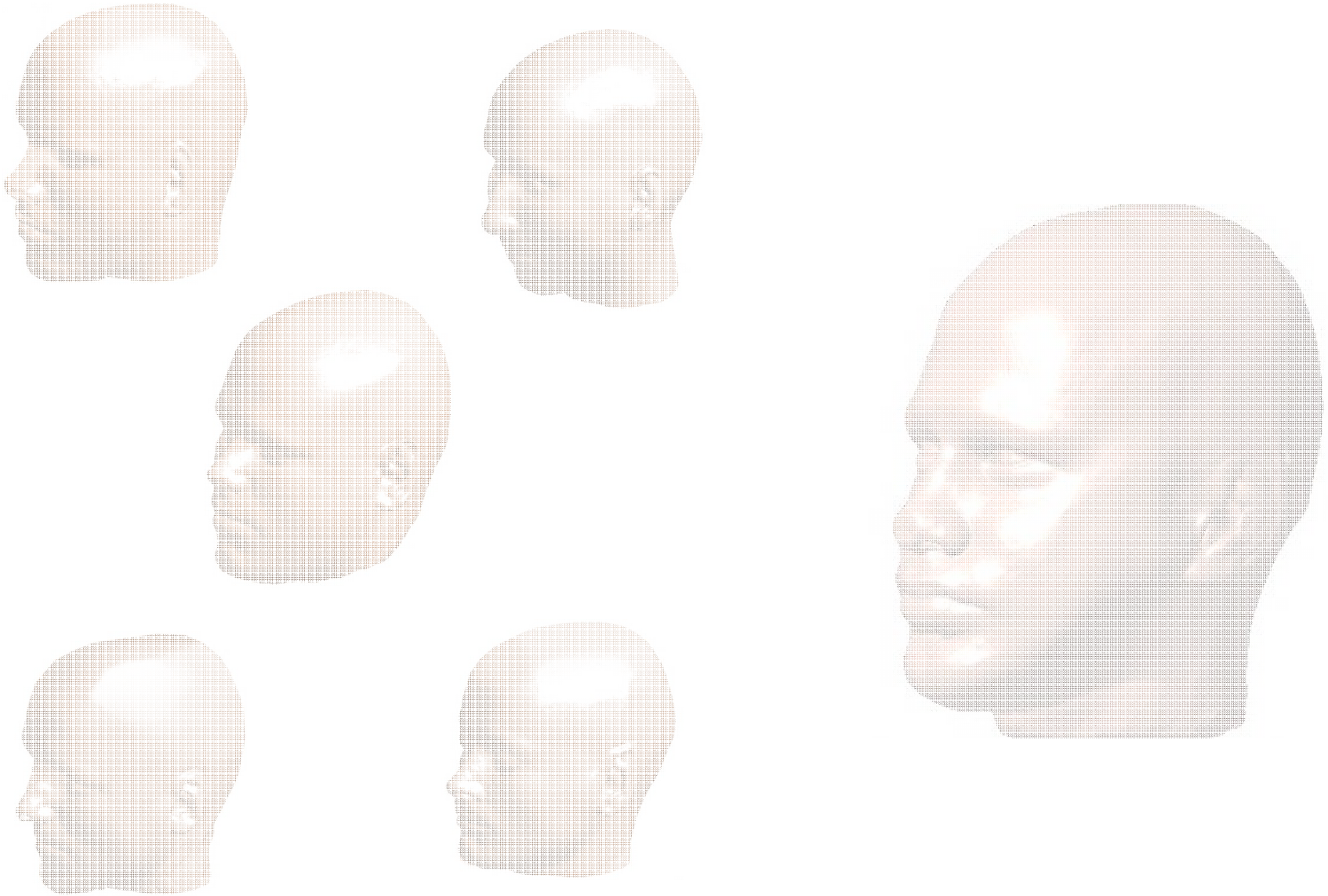




The real world…

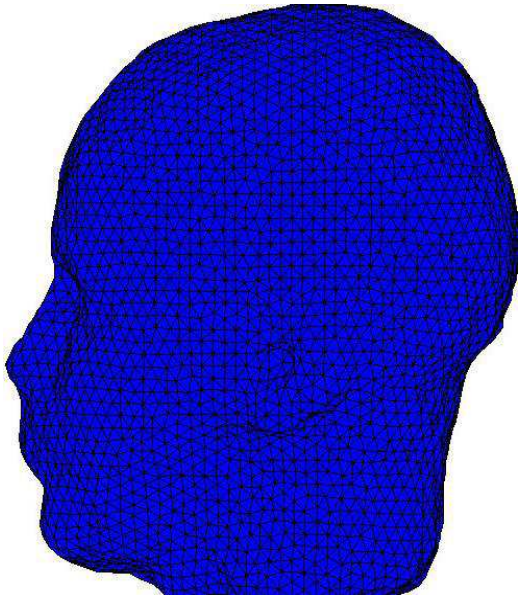


I show two ways to superimpose DOT results and anatomy.



Prerequisite

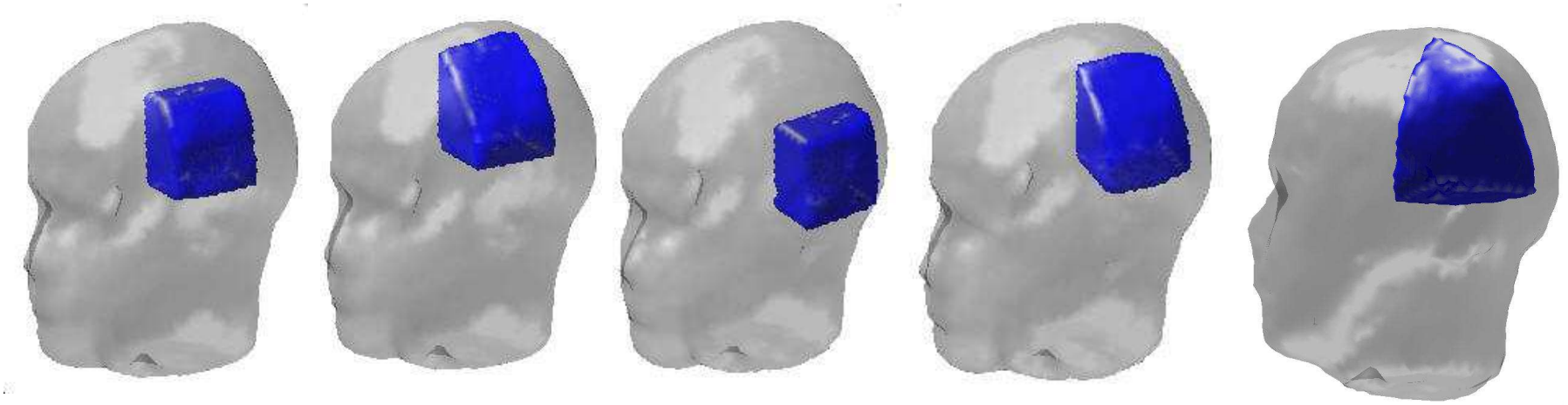
single subject MR scan serves as generic head model



FE mesh with homogeneous optical properties

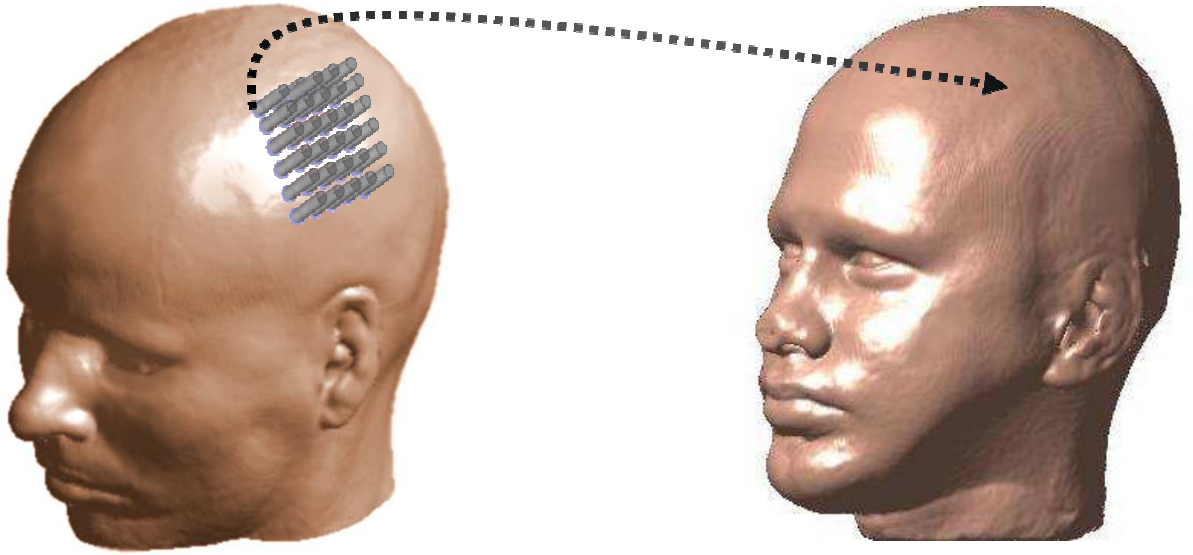
- Reconstruction:
  relative changes in HbO & HbR concentration
  (Pei et al., 2001)

Prerequisites



BrainModeler software (NIRx Medical Technology LLC, Glen Head, NY, USA) contains overlapping subvolumes with precalculated inverse parameters

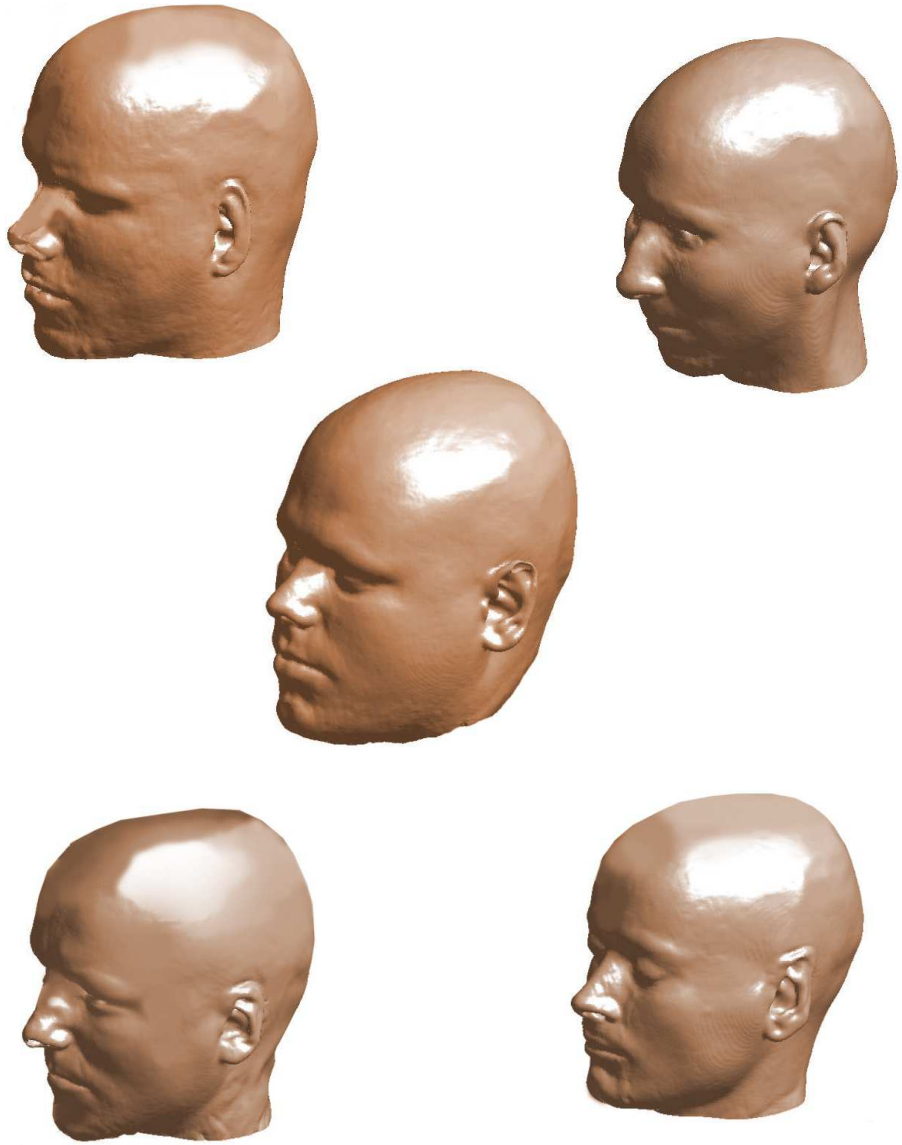
Prerequisites

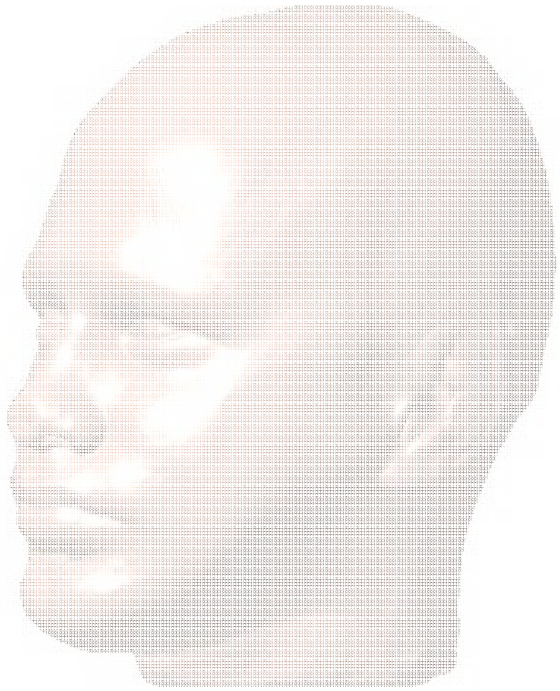


Real World Space ***Forward Model Space***

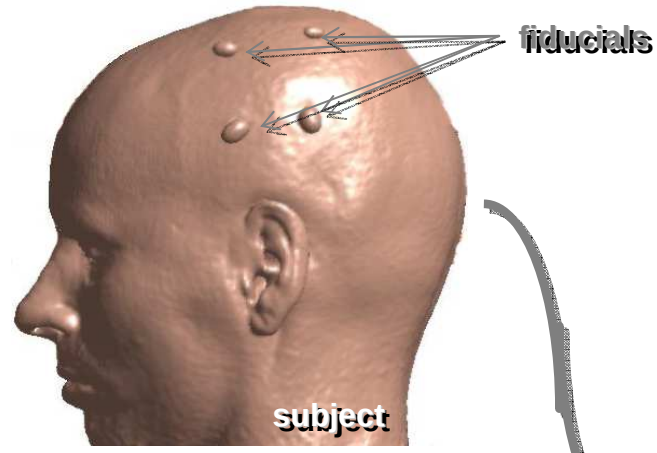
Main Task: translocate the optical fiber position from subject's space to forward geometry space

I show two ways to superimpose DOT results and anatomy.

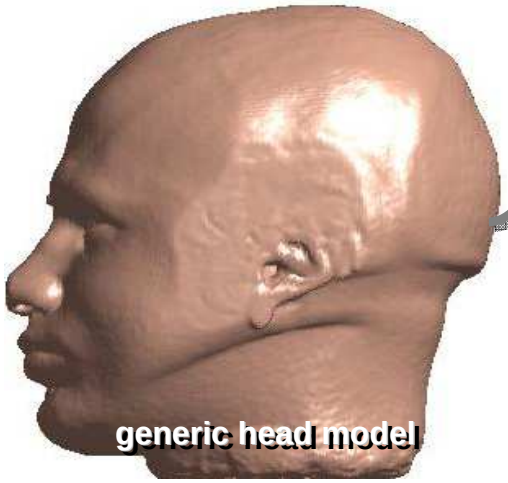




Case 1: There is an MR scan of the subject:

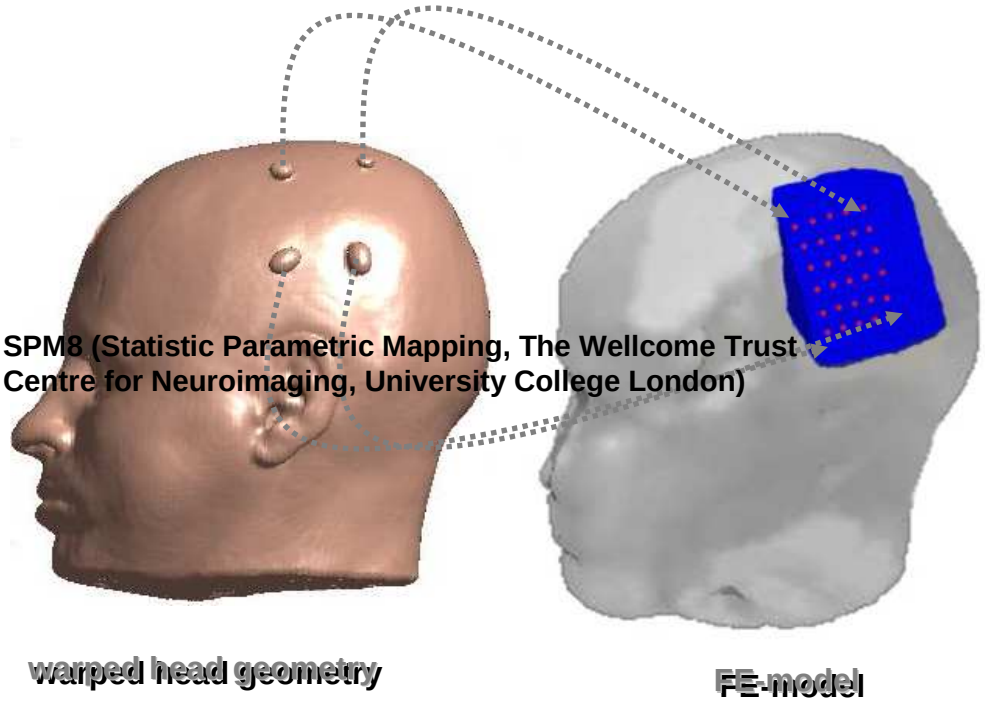


Real World Space



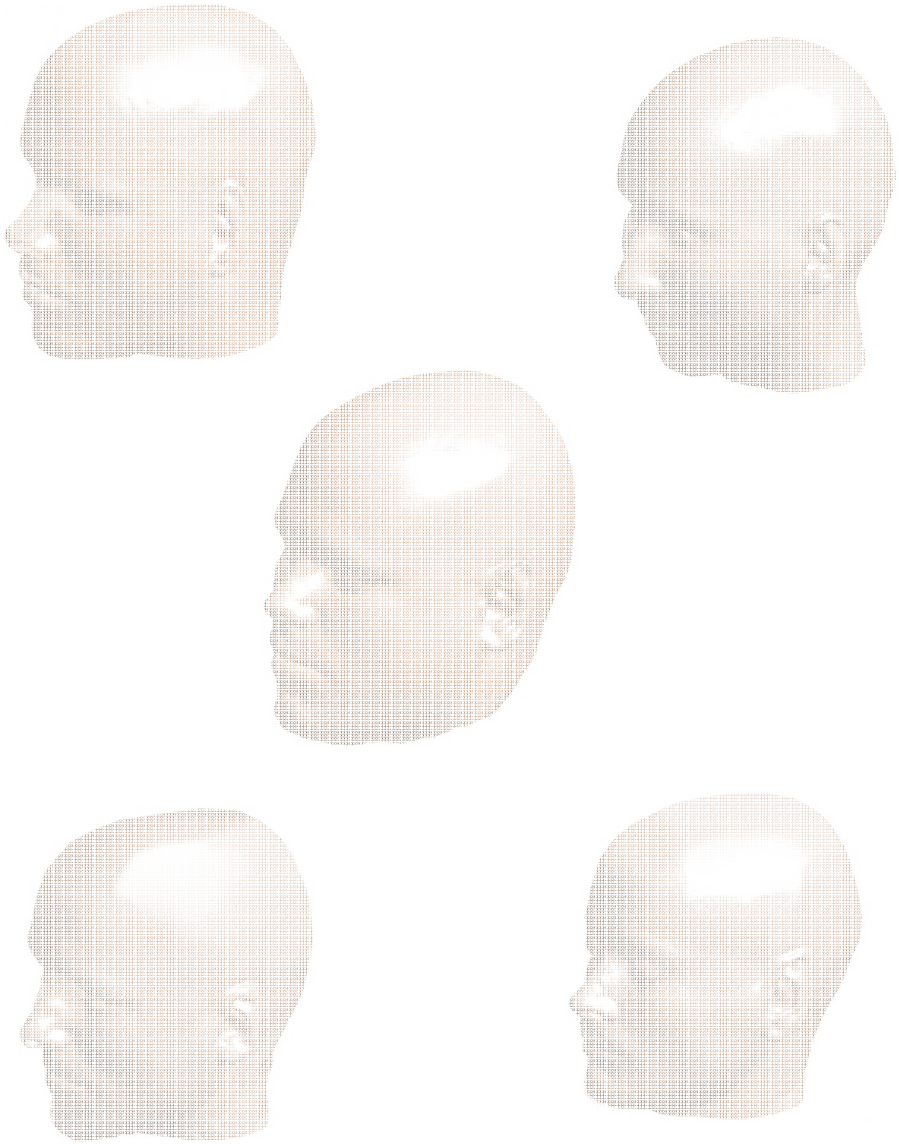
Forward Model Space

SPM8 (Statistic Parametric Mapping, The Wellcome Trust Centre for Neuroimaging, University College London)

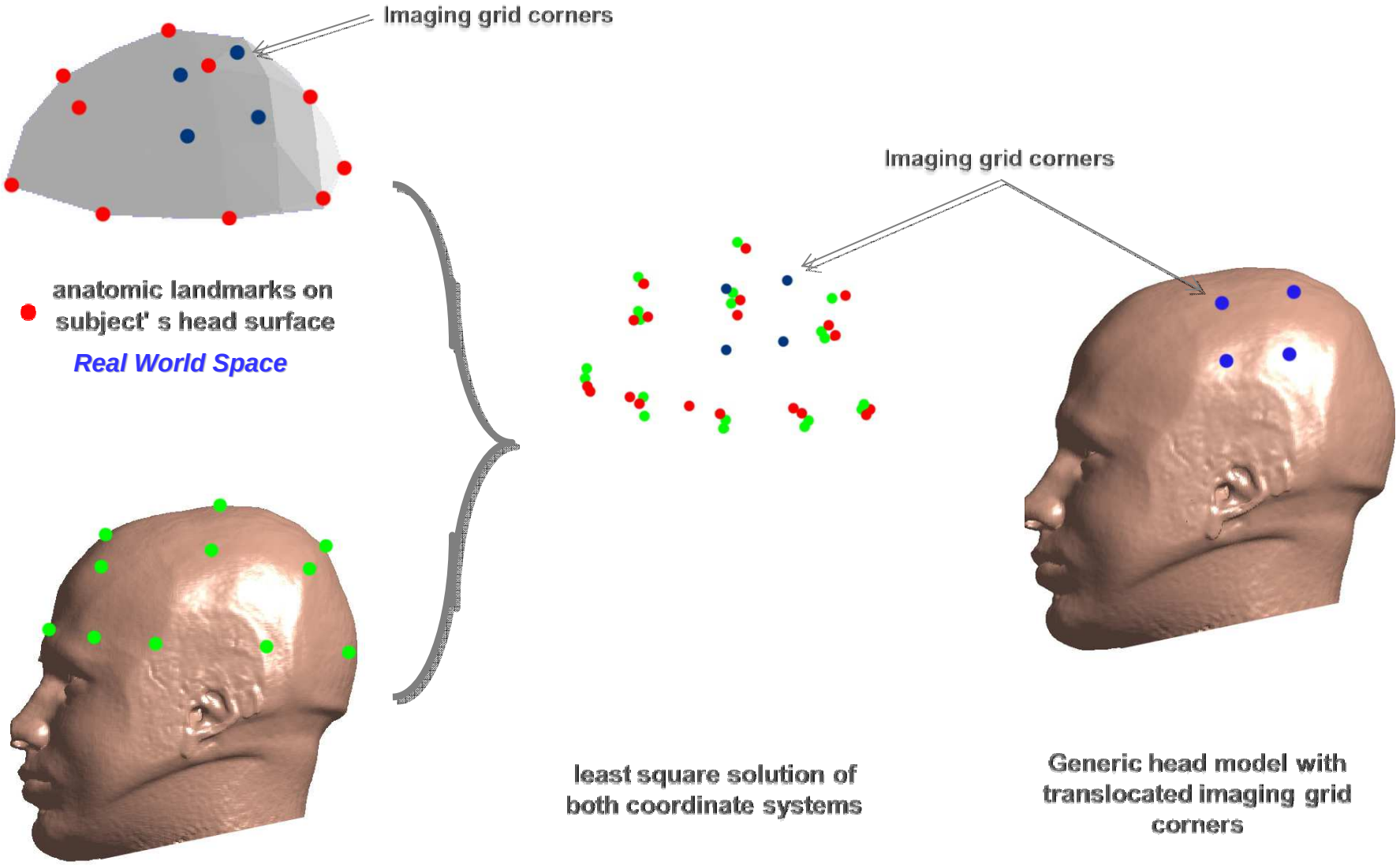


Forward Model Space

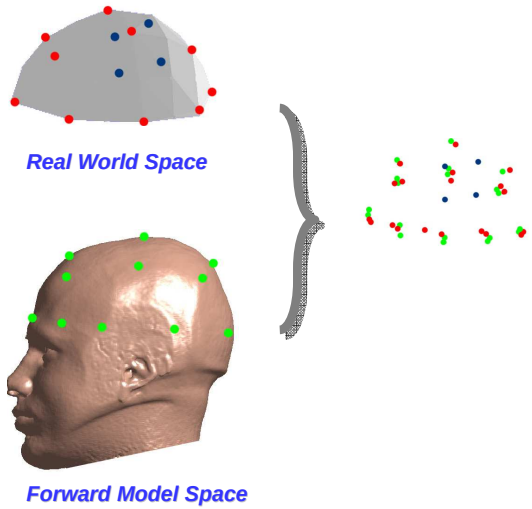
I show two ways to superimpose DOT results and anatomy.

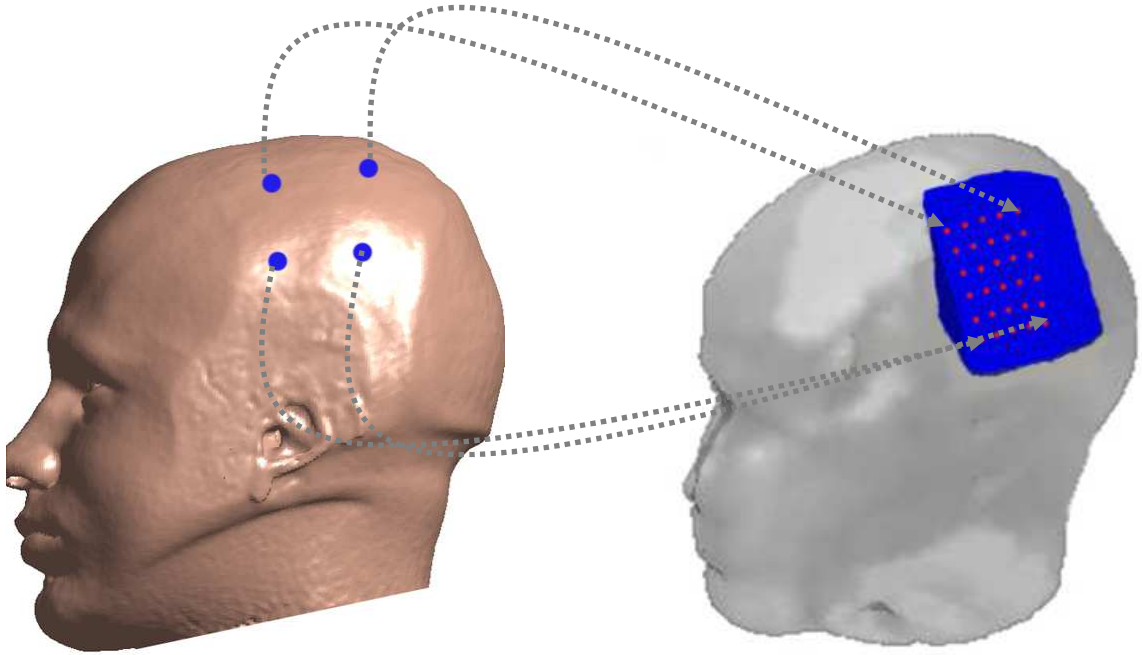


Case 2: There is no MR scan of the subject:



Case 2: There is no MR scan of the subject:



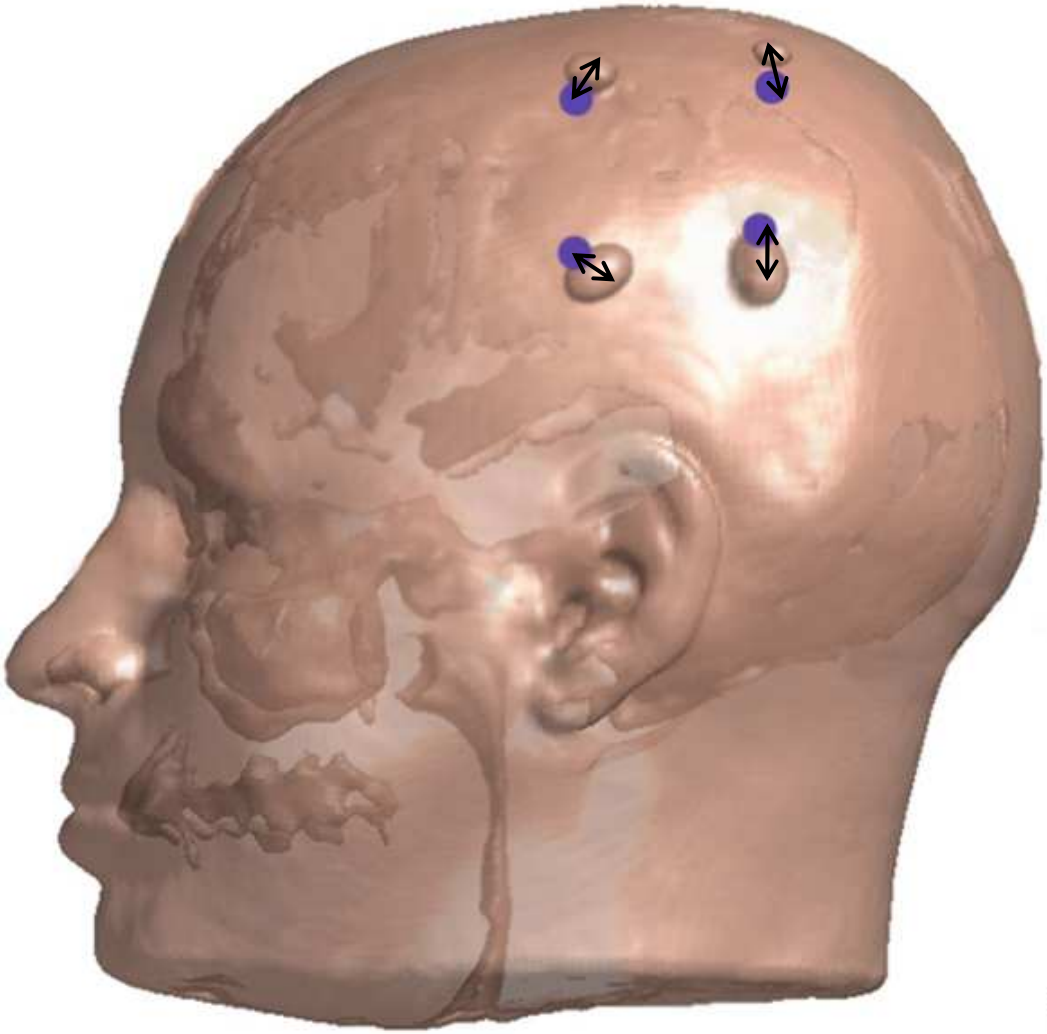


Generic head model with translocated imaging grid corners

FE-model

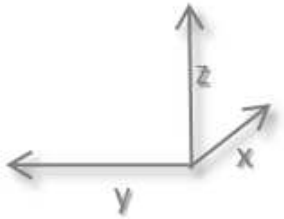
Forward Model Space

Comparision of translocation results show a good agreement.



Averaged distance

Y-direction:
4.5mm
Z-direction:
6mm



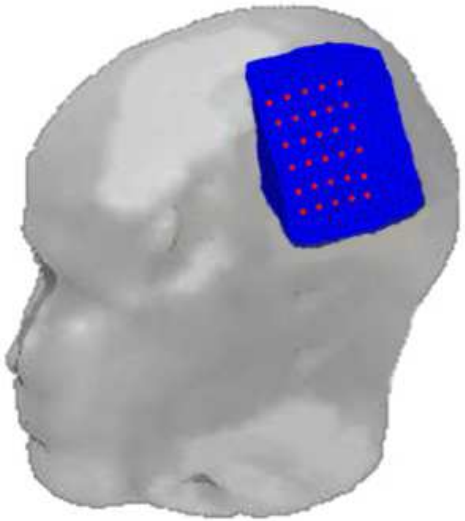
Brain activation was measured by a 900 channel DOT system.

Experimental Setup

Imager: DYNOT (NIRx)

Wavelengths: 760nm & 830nm

Sampling rate 1.8 Hz

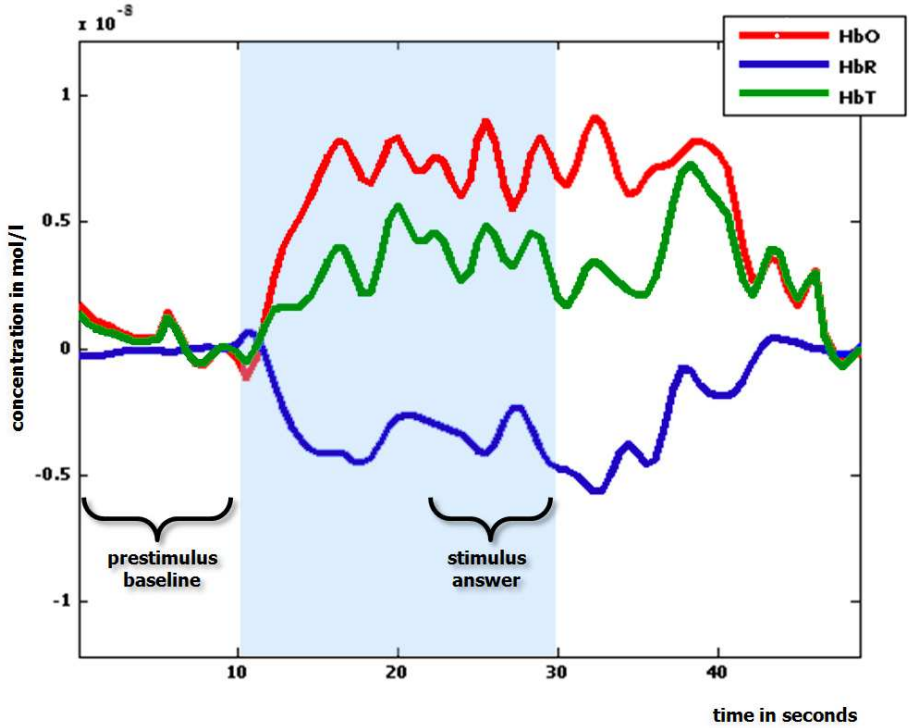


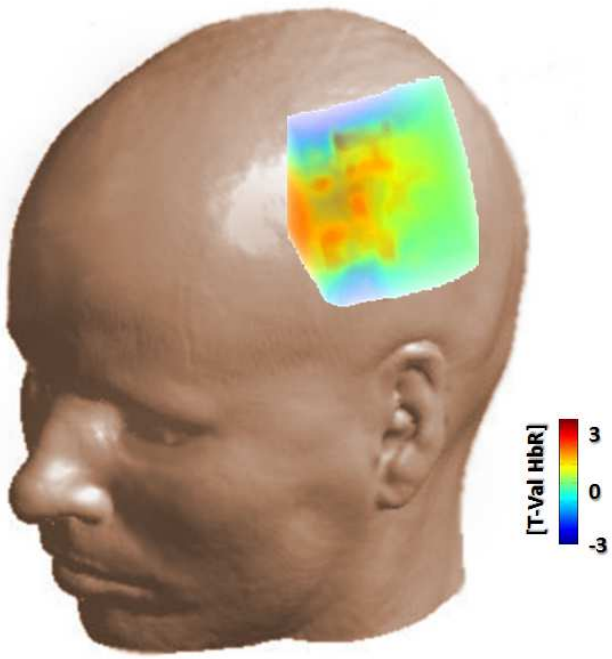
Translocation to Forward Model and Reconstruction

5 x 6 co-located optical fibers

900 overlapping optical data channels

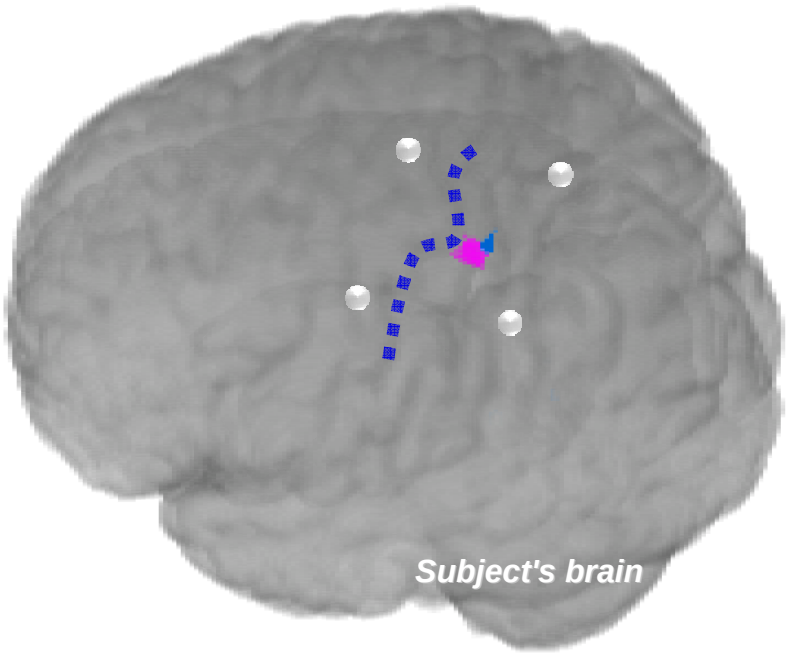
Statistics identified voxels with a significant decrease of HbR.



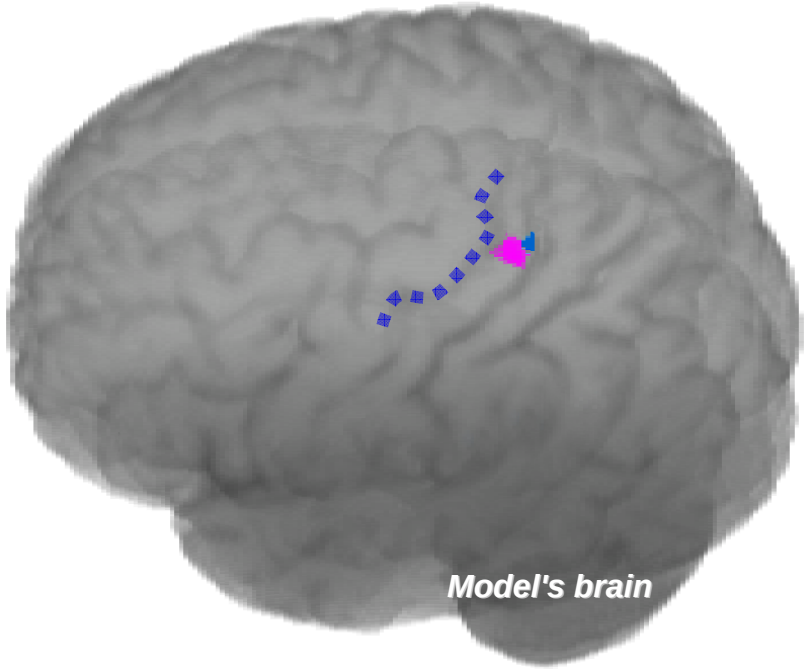


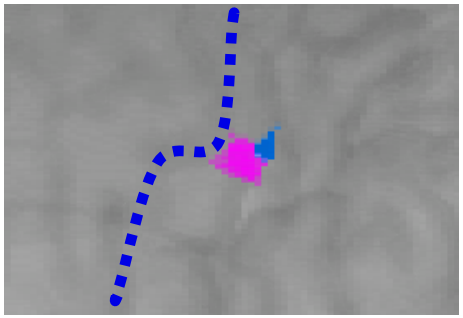
Comparison of two approaches show sufficient accuracy.

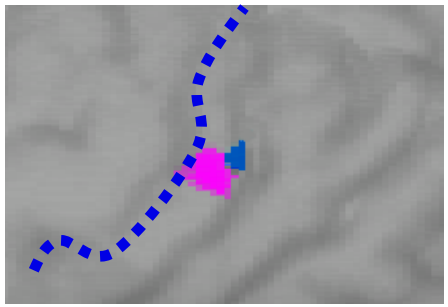
Fiduciary mark approach with individual brain



Anatomic landmark approach with model's brain







fiber grid corner

sulcus centralis

Conclusions

The proposed methods…

- …allow the use of a generic, pre-calculated light propagation model.
- …allow the mapping of DOT results onto individual brain structures or a generic atlas.

Thanks to…

Christoph Schmitz
(Charité & NIRx)

Jens Steinbrink
(Charité)

& Susanne Holtze, Jan Mehnert, Paul Koch

Thank you!