

➤ **Tuesday November 6th, 9:30 a.m. – 12:30 p.m.**

Combining optical imaging, electrophysiology and magnetic resonance imaging
- An new integrated experimental strategy to unravel the BOLD signal formation

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Abstract:

By integrating different brain imaging methods into one experimental setup we will be able to gather multimodal data within one experiment from the very same animal on a single trial basis. The setup will include electrophysiological recording (Ephys), optical recording of intrinsic signals (ORIS), recording of neuronal activity using voltage sensitive dyes (VSD) and functional magnetic resonance imaging (fMRI-BOLD), all set up within a standard animal scanner (Bruker, Biospin, 4.7 T).

Thus we aim at a combined experimental and theoretical breakthrough in the registration and interpretation of spatially extended and at the same time spatially highly resolved data of brain activity. This will be achieved by a combination of exploiting the complementary advantages of each method such that after registration of all data, we will be able to constrain the BOLD model used for interpretation by the data of the other functional methods, gathered simultaneously.

For this purpose, the exact knowledge of blood vessel geometries plays an important role, not only in clinical applications (stroke diagnosis, detection of stenosis), but also for the analysis of functional data, such as fMRI. Moreover, since the brain vasculature is visible in all methods we integrate here (MR, ORIS, VSD and EPHYS), an exact geometric reconstruction of the vasculature can be used as a basis for the registration of our multimodal data. Such a reconstruction will furthermore provide valuable information which allows us to constrain BOLD models used for the functional analysis finally aimed at improving the spatio-temporal resolution of functional non-invasive measurements.

In our ongoing research we are constructing a processing pipeline, including i) data collection (simultaneous measurements of MR, fMRI-BOLD, ORIS, VSD and EPHYS), ii) data preprocessing (bias removal, EPI artifact correction), iii) data registration (using geometrically exact reconstructions of the brain vasculature), iv) data segmentation (structural brain segmentation using machine learning techniques and contour based methods) and v) constructing a dynamic reference system for rodent brains integrating all gathered data within a consistent framework, finally allowing us to increase the interpretability of the functional data.

Such a dynamic reference system will boost the usefulness of transgenic animal models in medical diagnostics and pharmacological testing with respect to human applications, because it will allow analyzing data from several individuals within a common frame.

We present here the initial experimental setup, integrating ORIS and MR, as well as methods for automatically reconstruction of blood vessels (Gaudnek et. al 2005), thus demonstrating the feasibility of our approach.

For details of the reconstruction method, please visit Poster Nr. 535.20/JJJ21

- Gaudnek M., Hess A., Obermayer K., Budinsky L., Brune K., and Sibila M. Geometric reconstruction of the rat vascular system imaged by mra. IEEE ICIP, 1278-1281, 2005
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- Pielot, R., Scholz, M., Obermayer, K., Gundelfinger, E. D. and Hess, A. A new method of point-based warping to reduce inter-individual variations in brain imaging." *Neuroimage* 19, 1716-1729, 2003