Implementation and application of a novel tool for functional neuroimaging in mouse models

Rick M. Dijkhuizen, Ph.D.
Biomedical MR Imaging & Spectroscopy group
Center for Image Sciences
University Medical Center Utrecht

Our aim was to set up and apply a novel optical imaging method with a recently purchased electron-multiplying CCD camera for in vivo functional neuroimaging in mouse brain. This method, which allows measurement of neural activity based on hemodynamics in a similar manner as functional MRI, has been developed by Drs. Adam Bauer and Joseph Culver at Washington University.[1,2] To install and test our experimental set-up, we arranged a visit by Dr. Adam Bauer and his PhD student, Matt Reisman, which was kindly funded by a NCU Short Visit grant.

Adam Bauer and Matt Reisman, who visited our lab in April 2015, helped us to establish a fully operational optical imaging system, and assisted us in the first pilot experiments. Thereafter, we have successfully applied this technique to map functional connectivity and activation responses in mouse brain (see figure), which has been used as pilot data for a number of grant proposals. Two of these have recently been awarded, which will allow us to apply our optical imaging system to measure hemodynamics and functional activity acutely after experimental stroke (funded by CVON) (with Dr. Bart van der Worp (Dept. Neurology)) and chronically in a mouse model for cerebral amyloid angiopathy (funded by ZonMW) (with Prof. Marc Fatar (UMC Mannheim)). Furthermore, we are currently planning experiments to measure chemogenetically induced brain activation (with Prof. Roger Adan (Dept. Translational Neuroscience)) and to elucidate underlying mechanisms of fMRI signals (with Dr. Natalia Petridou (7T group)).

Our optical imaging equipment for in vivo experiments in small rodents expands the arsenal of preclinical neuroimaging tools and clinically translatable assays for neural network function studies within the NCU program. Other NCU researchers are more than welcome to employ our method.

References:

1. White BR, Bauer AQ, Snyder AZ, Schlaggar BL, Lee JM, Culver JP. Imaging of functional connectivity in the mouse brain. PLoS One. 2011;6:e16322.
2. Bauer AQ, Kraft AW, Wright PW, Snyder AZ, Lee JM, Culver JP. Optical imaging of disrupted functional connectivity following ischemic stroke in mice. Neuroimage. 2014;99:388-401.

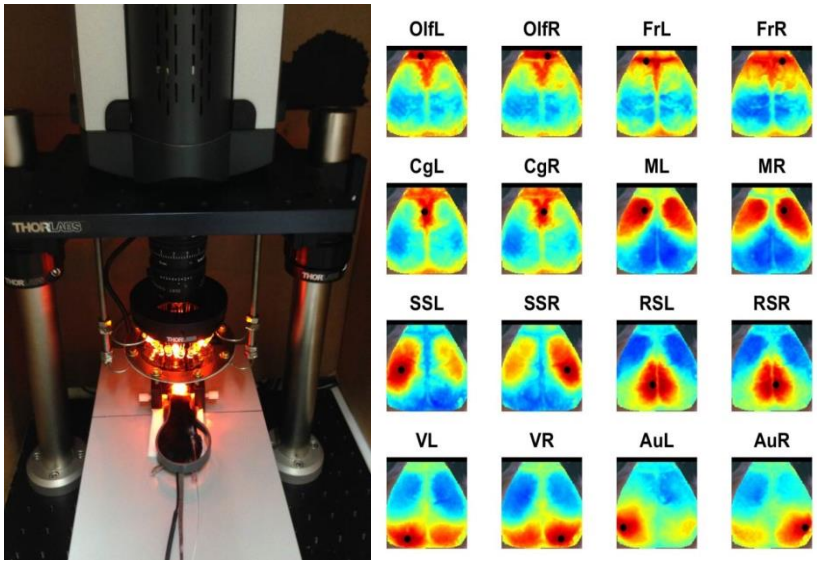

Figure: Resting-state functional connectivity maps of the mouse cortex (right), acquired with an optical intrinsic signal imaging system (left). Different seed regions on the left (L) and right (R) hemispheres were applied, as indicated by the black circles (Olf=olfactory, Fr=prefrontal, Cg=cingulate, M=motor, SS=somatosensory, RS=retrosplenial, V=visual and Au=auditory).