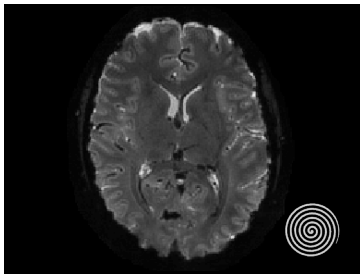
DATA SHEET - fMRI

skope

EXPLORE CUTTING-EDGE MRI ACQUISITION METHODS FOR fMRI

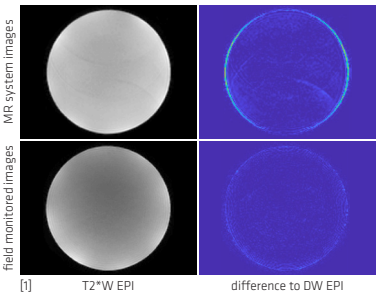
FOR A WIDENED SCOPE OF FUNCTIONAL MRI IN NEUROSCIENCE



single-shot spiral image (averaged)

Freedom to explore and use novel acquisition techniques

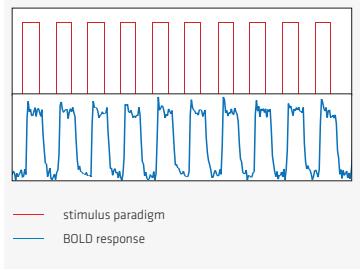
The prevalent single-shot EPI acquisition is limited in the type and range of physiological effects it can capture: E.g., its inherently long echo time needed for a high resolution prohibits the detection of BOLD activations at short T2*. This leads to a failure in identifying the full constellation of neural responses involved in a task. The NeuroCam allows the use of MR acquisitions such as spirals which can be optimized for sensitivity to the full range of BOLD responses. This freedom in sequence design also benefits the exploration of other physiological effects (e.g. perfusion).



[1] T2*W EPI difference to DW EPI

Geometrical congruence for multi-modal imaging

Fast MRI methods are plagued by distortions that arise from deviations of the encoding fields. The resulting geometrical misalignment between individuals in an fMRI study leads to erroneous anatomical allocation of the group-level BOLD signal or even a failure to detect a population effect. Moreover, multi-modal imaging studies can fail due to anatomical inconsistency between different contrasts (e.g., fMRI and DWI). Measuring the imperfect encoding fields, the geometrical congruence can be recovered, thus enabling reliable group-level analyses and multi-modal imaging studies.



Optimized temporal SNR

Functional MRI exploits changes in MR signal intensity that are small in comparison to temporal signal variation from perturbing sources: e.g., changing gradient delays or magnetic field drifts cause temporally varying signal levels in the images. The result is a reduced sensitivity towards detecting the BOLD signal. The NeuroCam in combination with skope-i removes noise contributions related to perturbations in image encoding. The gained temporal SNR provides the basis for a more reliable detection of the true BOLD response, for a heightened sensitivity when testing neuroscience hypotheses.

NeuroCam and skope-i

Detecting functional signal from the brain with high anatomical consistency is hindered by perturbations of encoding magnetic fields. This often results in a failure of detecting functional neurophysiological effects.

By concurrently measuring the field dynamics with the NeuroCam, one can correct for systematic and physiologic artifacts and achieve more accurate and consistent functional imaging. Based on the acquired MRI data the skope-i, image production software, produces exquisite images, which enable the investigation of novel neuroscientific questions.

DATA SHEET - fMRI

NeuroCam for 3T

Physical dimensions

Housing (w x d x h), incl. base	60 cm x 46 cm x 30 cm
Head fit	> 95% of adult population
Full face access	open view and possibility to use eye tracking tools

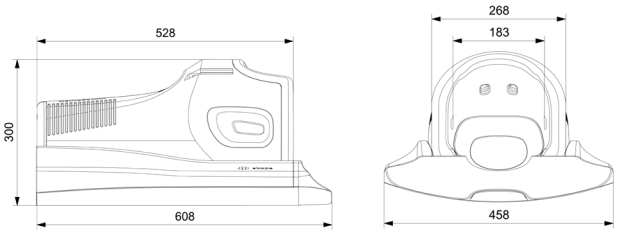
Dynamic field measurement

Measurable variable	Magnetic field magnitude
Temporal resolution	1 µs
intrinsic k_{max}	± 9580 rad/m

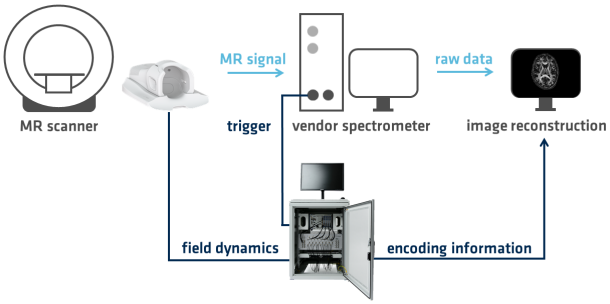
Spatial field expansion

Basis	Real-valued spherical harmonics up to 3rd order
Output terms for image correction	Generalized k-space (16 terms: k_0 – k_{15}) - 3D k-space (k_1- k_3) - Dynamic B_0 perturbation (k_0) - 2nd order perturbations (k_4 - k_8) - 3rd order perturbations (k_9 - k_{15})

NeuroCam - Technical illustration



NeuroCam - Integration into MRI set-up



Camera Acquisition System

The field sensor signals of the NeuroCam are acquired by the 16-channel Skope Camera Acquisition System and automatically processed to provide the actual magnetic field dynamics. The field dynamics can be conveniently displayed in the user interface or piped directly into the skope-i, image production software.

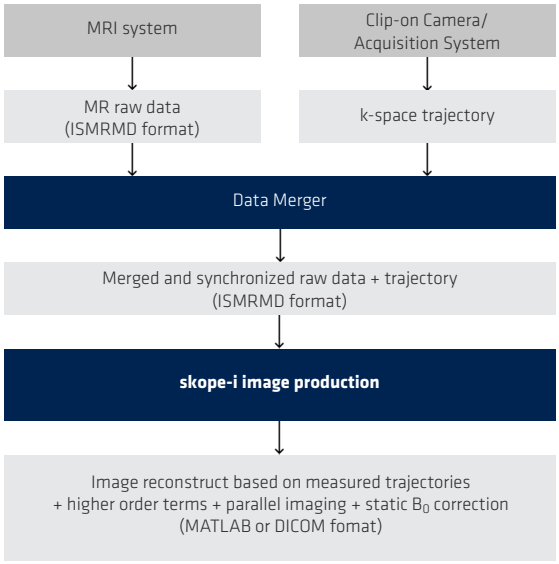
Camera Acquisition System

skope-i, image production software

The image production software complements the NeuroCam and takes into account

- Measured/simulated gradient encoding
- Coil sensitivity information (SENSE)
- Static B_0 maps
- Higher order field evolution

skope-i - Reconstruction pipeline



Publication related to MR images:

[1] Magnetic field monitoring improves geometrical consistency in a multi-modal imaging protocol. ISMRM Workshop on Advanced Neuro MR, Seoul, 2018.