**INTRODUCTION**

Matched-filter fMRI was recently proposed [1] as a means of increasing BOLD sensitivity by matching acquisition density in k-space to the desired spatial response—which is a Gaussian kernel in the vast majority of statistical fMRI analyses. Theory predicts a significant SNR benefit from such acquisitions, which is maximal when thermal noise dominates and expected to be reduced with increasing physiological noise contributions. In this work, we explore the validity of this argument for different regimes of physiological noise in the brain and report robust and replicable SNR increase of 30–40 % compared to uniform EPI acquisitions. For task-based fMRI, we observe a corresponding increase in BOLD-sensitivity of 30 % (average t-value), and show reproducibility both within and between subjects (N=4).

**METHODS**

**Matched-filter Trajectory:** We designed a 2D Gaussian density weighting for a matched-filter EPI by varying traverse duration in phase encoding direction ([1], Fig. 1B) and modulating the frequency encoding gradient, such that $k = 1/d(k) \times d(k) \times \exp(-k^2 \cdot \sigma^2)$ ([2], Fig. 1B), where $\sigma^2$ determined a smoothing kernel of 4.5 mm FWHM. This trajectory was compared to a uniform reference EPI of equal TE (35 ms), readout duration (40 ms) and bandwidth (375 kHz). Both acquisitions shared all geometry parameters: FOV 230 mm, SENSE 2.5, resolution 1.8 mm, 5 slices (thickness 3 mm, gap 3 mm).

**Concurrent Field Monitoring & Image Reconstruction:**

To assess BOLD-sensitivity in task-based fMRI, we ran a visual paradigm with the same subjects (N=4) stimulating quarter-fields of the visual cortex: 2 uniform EPI and 2 matched-filter sessions were acquired (120 dynamics, order counterbalanced between subjects) to test for consistent inter-modality differences in BOLD sensitivity as well as intra-modality reproducibility both within and between acquisition schemes. Data was preprocessed and analyzed using SPM8. Peak- and average t-values as well as cluster sizes of activated voxels in the contrast images were considered as performance measures.

**RESULTS**

Trajectory assessment revealed successful implementation of a Gaussian density weighting (Fig. 1C) with minor deviations due to common eddy current delay behavior (Fig. 1D). Based on full model matching, we considered as performance measures.

**DISCUSSION**

Matched-filter fMRI combined with concurrent magnetic field monitoring has proven to be an fMRI acquisition technique recovering artifact-free, geometrically accurate images, temporal SNR gains of up to 40 % and resulting BOLD sensitivity increases in the same range—that are robust and reproducible both within and between subjects. The proposed matched-filter technique is versatile to accommodate any assumption about the spatial response function of the BOLD signal and can be generalized to optimize SNR for non-Gaussian kernels.

**REFERENCES**