Tailored RF pulses for optimized phase-constrained parallel imaging: initial experience on a clinical system

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Recent simulations show [1] that using virtual coil phase-constrained imaging could greatly decrease the g-factor in parallel imaging if the object background phase is favorable. In this work we aimed to use 2D tailored RF pulses for optimizing the object phase to achieve high acceleration factors with acceptable noise levels.

SE-EPI measurements were performed on a Siemens Prisma scanner on healthy consenting subjects with prototype sequences using 52 receiver channels. First a prescan was performed using non-selective excitation and slice-selective refocusing. From these data, object phase was extracted, and coil sensitivities were estimated with ESPIRiT [2]. Optimized phase distribution was calculated for acceleration factor R=8 as in [1]. Excitation target phase was taken as the difference of optimized and object phases. Tailored RF pulses were calculated from the target phase in the LFA approximation and subsequently applied in a second measurement with the same protocol. Accelerated measurements were reconstructed with iterative GRAPPA and iterative virtual coil GRAPPA. G-factor maps were calculated from GRAPPA kernels.

Reconstructed accelerated and full measurements are shown in Fig. 1. Noise enhancement in accelerated scans is significantly reduced by using the tailored pulse and virtual coil GRAPPA.

Fig. 1. Reconstructed SE-EPI images and calculated g-factors.
a) R=8 accelerated measurement with conventional excitation and standard GRAPPA recon. **d)** calculated g-factor map
b) R=8 accelerated measurement with tailored excitation and virtual coil GRAPPA. **e)** calculated g-factor map
c) reconstructed full measurement for comparison

[1] Blaimer, M. et al., MRM 61:93 2008,   [2] Uecker, M. et al., MRM 71:990, 2014