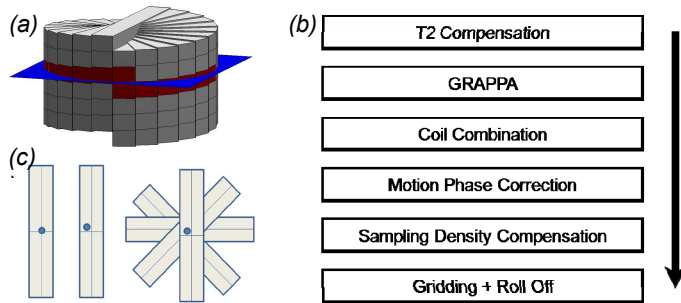# 3D PROPELLER-Based Diffusion Weighted Imaging with Improved Robustness to Motion

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Fig. 1. *Illustration of the ROTOR method. (a) Data acquisition scheme, The slabs in red contribute to the plane in blue. (b) reconstruction pipeline (c) blade without linear phase (right) blade with linear phase (middle) off-center gridding of linearly shifted blades (right). The blue dot represents the center of k-space.*

Introduction
The ROTOR (Radially Oriented Tri-Dimensionally Organized Readouts) pulse sequence has been proposed [1] for 3D DW imaging. This work applies an improved whole-blade [2] reconstruction pipeline to ROTOR in order to combine non-CPMG echoes, thus making a wider blade and improving robustness to motion.

Methods
The ROTOR trajectory is based on the Turboprop sequence where the gradient echoes are placed in the slab encoding direction. The slab selective blades spiral down in (kx, ky, z) space (Fig 1a).
The non-CPMG echo-train stability was improved by Le Roux phase cycling [3]. The reconstruction pipeline is described in (Fig. 1b). Separate calibration scans are used to train the GRAPPA weights. After GRAPPA, coil combination is performed separately for odd and even echoes [2]. Linear in-plane motion phase (corresponding to shifts in k-space) is added back to the phase-corrected blade images. The blades are then gridded at their proper locations based upon their estimated linear motion phase (Fig 1c).

Experiments and Results
A 6' DW scan (Fig. 2 & 3) of a healthy volunteer was acquired with 3+1 diffusion directions on a GE SIGNA 3T scanner with an 8-channel brain coil. The volume covered was 220x220x104 mm^3 with a resolution of 2x2x2 mm^3. The imaging parameters were b =1000, TR=1.5s, NSA =6, etl =8, turbo = 7, with a slab oversampling ratio of 7/5.

Fig. 2. *B$_0$ slices coronal sagital (c,d) axial*

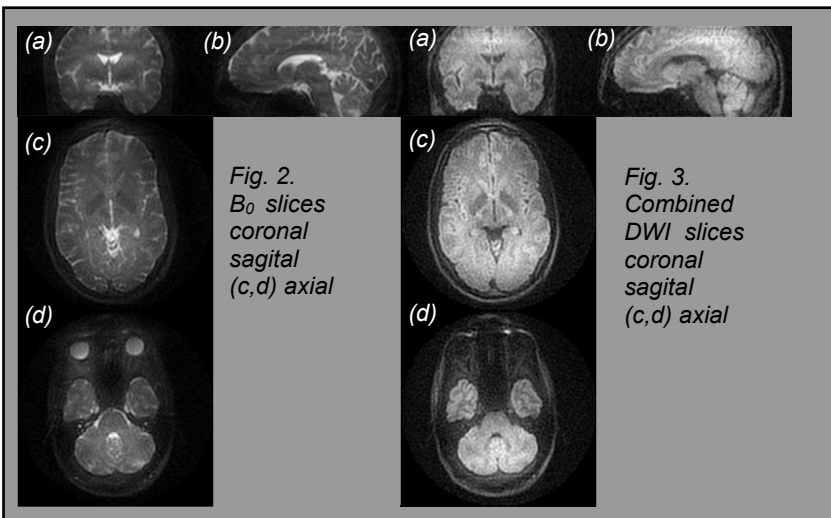Fig. 3. *Combined DWI slices coronal sagital (c,d) axial*

Discussion
Advantages of the method include reduced off-resonance artifacts (vs. EPI), lower SAR (vs. PROPELLER), higher SNR efficiency (vs. PROPELLER), 3D phase correction and 3D continuity.

References:
[1] Aboussouan et al. 2009 ISMRM Proc. #2632
[2] Pipe JG, et al, MRM (47), 42-53, 2002.
[3] Le Roux, P. JMR. v155, p278-292, 2002.