# Conjugate Kz 3D Spiral-in/out Sequence

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**Introduction:** Since the conventional 3D stack-of-spiral imaging sequence [1] collects only one z-phase encoding for each RF excitation, it can not simultaneously achieve high temporal and high spatial resolution. Based on the spiral in-out technique [2], we developed a new 3D fast acquisition method. It uses spiral-in to cover one half of kz-space and spiral-out to cover the other half, i.e., two z-phase encodings for each RF excitation. Therefore, the scan time needed for our new 3D sequence to cover the complete k-space is only half of that necessary for the traditional method. We believe this technique may be useful in fMRI, where both high spatial resolution and high temporal resolution are desirable.

**Method:** Figure 1 gives the scheme of our new 3D fast sequence. After each RF excitation, one set of phase encoding and rewinding z-gradients will be added just before and after spiral-in gradients. Then we change the signs of phase encoding and rewinding gradients and add them just before and after spiral-out gradients. 2D spiral data acquisitions are performed during spiral-in and spiral-out gradients to provide two kx-ky planes of k-space coverage. Experiments were performed on normal subjects using a 1.5 Tesla whole-body scanner (Signa, GE Medical Systems, Milwaukee, WI) with normal head coil. Two sets of data were collected for comparison. One uses our new 3D fast sequence and the other uses traditional 3D stack-of-spiral-out sequence. Imaging parameters for both sequences are given by TR/TE/FA/MAT/NSLC/TH = 200ms/40ms/37/64*64/16/3mm. TR/vol is 1.6 s for the new sequence and 3.2 s for the traditional method.

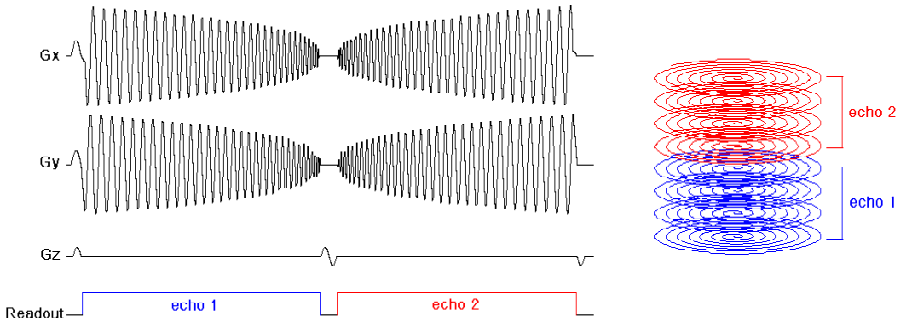


Figure 1. Scheme of 3D fast sequence with combination of spiral-in and spiral-out

**Results:** Representative results are shown below. Figure 2 gives the comparison of reconstructed images between new and traditional acquisition methods. From this figure we can see that reconstructed images from the two methods are similar in those areas with less susceptibility induced gradients. However, in frontal orbital and lateral parietal regions where susceptibility dephasing is severe due to air/tissue interfaces, the new 3D sequence provides greater signal recovery. Figure 3 gives the comparison of Signal to Fluctuation Noise Ratio (SFNR). It shows the same pattern as that in the reconstructed image comparison.

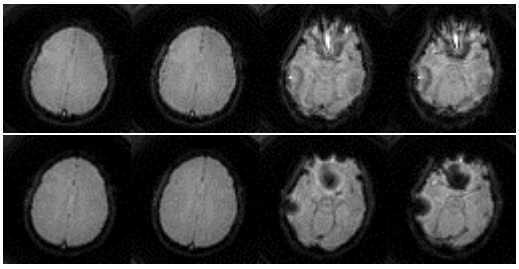

Figure 2. Comparison of reconstructed images. 1st row uses new 3D sequence and 2nd row uses traditional 3D sequence. 1st 2-column is from one slab and 2nd 2-column is from another slab.

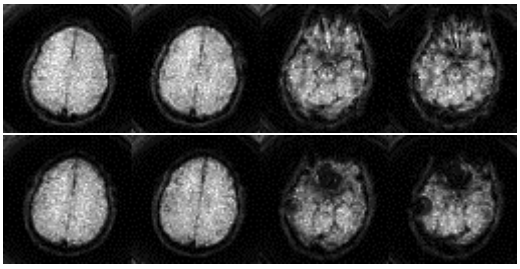

Figure 3. Comparison of SFNR. 1st row uses new 3D sequence and 2nd row uses traditional 3D sequence. 1st 2-column is from one slab and 2nd 2-column is from another slab.

**Discussion:** In this work we present a new 3D fast imaging sequence that can achieve similar or even better images with only half of the scan time necessary for a traditional sequence. This technique is beneficial to dynamic MRI in general and to fMRI in particular. In fMRI high spatial resolution means accurate localization and less susceptibility-dephasing. However time resolution will be intolerable. With our new 3D sequence we can solve this problem and obtain even better images. Future work will be focused on combining this technique with multi-slab technique to attack the physiological noise problem and fully achieve the potential of 3D acquisition methods.

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**Reference:**

1. S. Lai, G. H. Glover, Three-Dimensional Spiral fMRI technique: a comparison with 2D spiral acquisition. Mag. Reson. Med., 39:68-78 (1998)
2. G. H. Glover, C. S. Law, Spiral-in/out BOLD fMRI for increased SNR and reduced susceptibility artifacts. Mag. Reson. Med., 46:515-522 (2001)