3D FSE Reduces Scan Time, Generates Thinner Slices

Clinicians can view smaller lesions with greater confidence

By Reed Busse, PhD, Senior Scientist, GE Healthcare

In fast spin echo sequences, scan time can be reduced by increasing the Echo Train Length (ETL). If the ETL is too long, however, signal decay results in a disappointing blurring of the images. Today, this challenge is resolved with a new, unique method developed by GE Healthcare to modulate the refocusing flip angles, called Cube,™ which extends and reshapes the signal decay curve. Cube is a single-slab 3D FSE imaging sequence only available on GE's Signa® HDxt 1.5T and 3.0T platforms.

When refocusing flip angles that are less than 180° are used, natural equilibrium exists between encoded longitudinal and transverse magnetization, which is a function of the refocusing flip angle. Cube utilizes this powerful phenomenon, modulating the refocusing flip angle to drive this equilibrium. At the beginning of the echo train, flip angles are rapidly reduced to store excess magnetization in an encoded longitudinal state. By increasing the flip angle, this sequence converts the slowly decaying longitudinal magnetization back to transverse magnetization to provide signal over a much longer train.

These advantages are compounded by advances in parallel imaging – simultaneous acceleration in two directions with GE's innovative auto-calibrating data-driven parallel imaging method, ARC*. Very large 3D data matrices may now be acquired in relatively few echo trains, revolutionizing T2-weighted imaging.

The large increase in efficiency allows additional and thinner slices to be acquired, producing voxels that are no larger in the slice direction than in-plane. With this isotropic resolution, the plane of acquisition becomes immaterial – as the volume is prescribed in a manner that yields the high image quality and efficiency. Images are reconstructed in axial, sagittal and coronal planes, or any oblique orientation, from a single short acquisition. Cube removes prior limitations that result in a small number of relatively thick sections, giving clinicians new capabilities to acquire wide anatomic coverage in a high-resolution 3D dataset.

Figure 1A

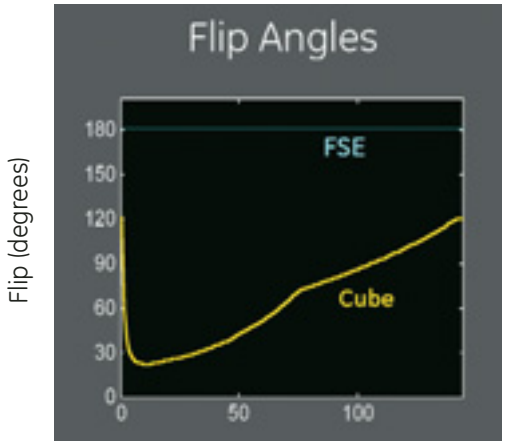


Figure 1B

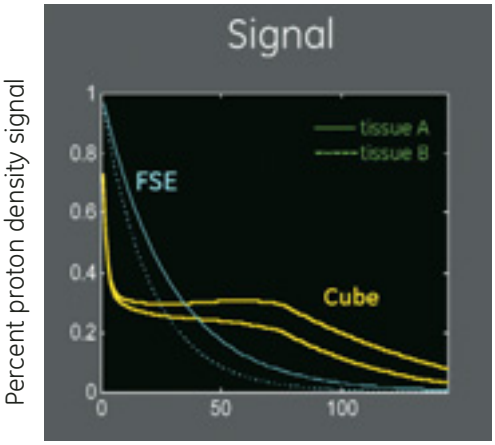


Figure 1A: A modulated flip angle refocusing train of RF pulses establishes a low-angle pseudo-steady state, and then increasing throughout the remainder of the train. Figure 1B: This serves to decouple much of the signal modulation from the development of contrast. Signals from tissues with different T2 values diverge, producing contrast, while remaining relatively constant, producing sharp images with the highly efficient Cube acquisition.

*ARC: Autocalibrating Reconstruction for Cartesian imaging

This highly efficient technique enables Cube to join the ranks of GE's other rapid 3D volumetric sequences, and complement them by providing important contrast options, such as T2, T2-FLAIR and PD. While it has the potential of being applied to a wide range of anatomic areas, Cube is initially intended for Neuro and MSK applications. When used in conjunction with GE's other 3D applications, Cube may allow technologists to perform a complete MR study in a 3D acquisition mode.

Benefits of Cube

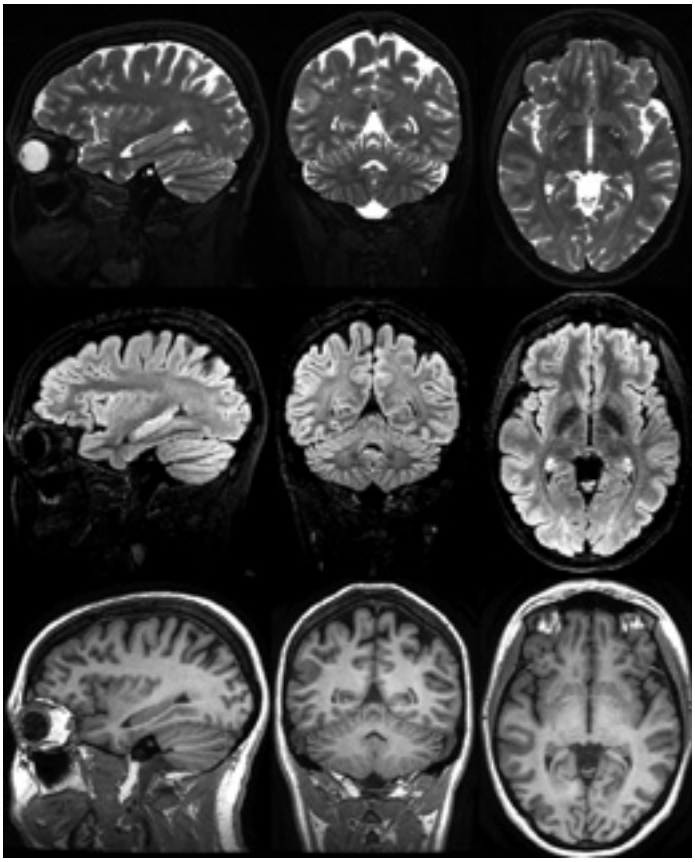
With a single acquisition, the radiologist can visualize the entire data set in axial, sagittal, coronal and any oblique orientation. The need for image retakes due to missing slices or planes is minimized and submillimeter voxels may help clinicians detect small 2-3 mm lesions. Automated protocols optimize sequences for clinical use, facilitating ease-of-use and consistency across imaging studies.

Cube is convenient for patients with less SAR than conventional FSE. ■

Reed Busse, PhD

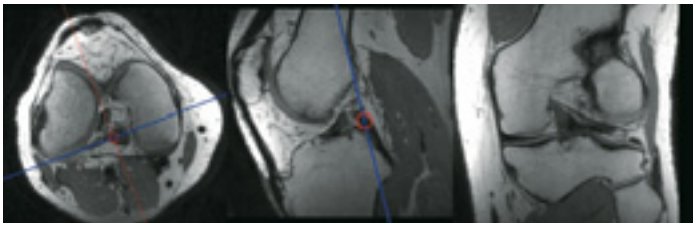
Reed Busse, PhD is a Senior Scientist at the GE Healthcare Applied Science Lab at the University of Wisconsin, Madison. As a lead innovator at GE, Dr. Busse holds five patents and five patents pending for his developments in MR imaging. He received his doctorate degree in Biomedical Sciences from Mayo Graduate School and a B.A. in Physics, with magna cum laude distinction, from Carleton College. Dr. Busse is a member of the International Society for Magnetic Resonance in Medicine and American Association of Physicists in Medicine.

Figure 2



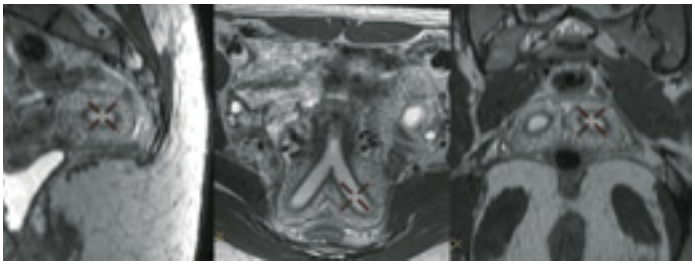
Whole Brain Imaging. T2-weighted 3D-FR Cube (a) and CSF-nulled 3D-FLAIR Cube (b) complement T1-weighted 3D-IR-SPGR (c) to provide a whole brain exam in just 10 minutes (2:15 for the T2 Cube, 5:00 for the FLAIR Cube, 2:45 for the T1-IR-SPGR). Acquisition matrix of 256x256x128 (zipped to 512x512x256). (Courtesy Dr. Howard Rowley, University of Wisconsin, Madison)

Figure 3



Whole knee imaging with 0.6mm isotropic resolution in 4min 40sec. (Courtesy Dr. Garry Gold, Stanford University)

Figure 4



T2-weighted volumetric imaging for evaluation of uterine anomalies with 3D-Cube. (Courtesy Dr. Elizabeth Sadowski, University of Wisconsin, Madison)