



The Real Time Heart Exam



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The unique technical and clinical properties of magnetic resonance imaging made it an attractive diagnostic tool for cardiac imaging. Cardiac MR is the only imaging modality that offers the ability to conduct a complete cardiac study (anatomy, structure, pathology, function, flow, myocardial tissue viability) in one minimally invasive, radiation-free exam. Difficult-to-image fine peripheral plaques and silent Myocardial Infarction (MI) cases may be reliably detected with MR, while other imaging modalities occasionally fail to provide conclusive data. Yet, the complexity of a cardiac exam, and a need to simultaneously capture fine anatomical detail and intricacies of the heart's contractivity, as well as to record blood flow dynamics, introduced the need for faster MR platforms, specialized applications and postprocessing tools. These technologies, however, were not available until recently.

While several 1.5T MR systems available today offer full cardiac MR functionality including a real-time cardiac imaging capability pioneered by GE Healthcare in 2003, 3.0T technology has lagged behind.

The technical challenges of 3.0T high-field cardiac MR, including:

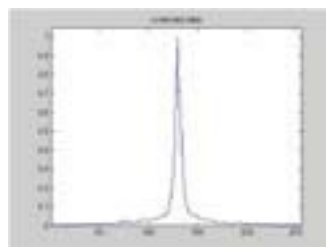
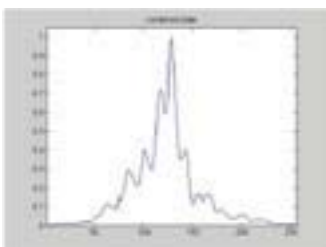
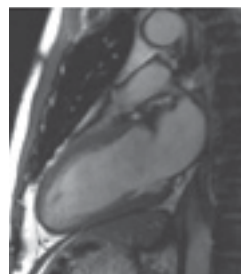
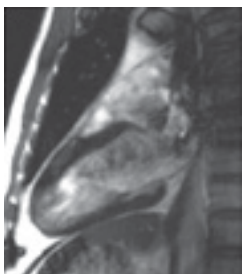
1. Special Absorption Rate (SAR) limitations due to the increase in RF deposition required at 3.0T, theoretically four times greater than 1.5T.
2. Increased sensitivity to susceptibility artifacts, in particular steady state free precession sequences such as FIESTA.
3. Elevated ECG T-waves due to more pronounced magneto-hydrodynamic effects present additional challenges for ECG gating. Vector ECG (VCG) gating waveforms are essential at the higher field strength to ensure good gating waveforms.
4. Off resonance artifacts with steady state free precession sequences may display a muddied blood pool. It is essential that SSFP techniques considered to be leading technology in functional cardiac MR, such as FIESTA, perform well at 3.0T.



With the new Signa® MR750 3.0T, the power of a high-field system baseline signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) is combined with a full portfolio of robust cardiac applications and tools. This includes MR Echo™, the first real-time cardiac application available for 3.0T MR, which offers:

- Real-time FIESTA with a high frame acquisition mode at a temporal resolution of 65 ms enables localization and qualitative ventricular assessment without cardiac gating or breath holding
- Gated, breath-held FIESTA for high definition imaging
- FGRE or FIESTA blood-flow dynamics compatible with parallel imaging
- 2D Myocardial Delayed Enhancement (MDE)

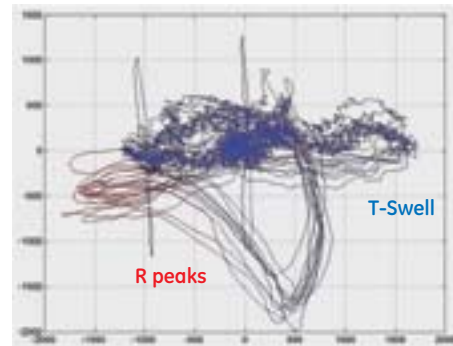
Another GE innovation is the Center Frequency Adjustment, which combines the small volume gradient shim and slice prescription to exclude frequencies not within the pertinent imaging volume from prescan. This new IR-PRESS pulse helps eliminate FIESTA off resonance artifacts at 3.0T, ensuring a consistent and homogenous signal.



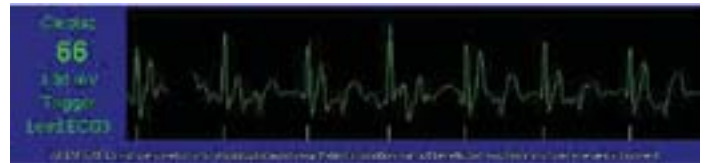
Typical FIESTA image (top image) with inhomogeneities caused by spurious frequencies (graph) originating in the surrounding tissue.

By locating ROI within the slice the frequencies (graph) not related to imaged tissue are eliminated, resulting in a clear image (top).

An easy-to-set VCG gating helps eliminate false image triggers caused by elevated T-wave that result from an increase in the blood magneto-hydrodynamic effect.



2D projection of vector cardiogram.



Gating ECG signal inside magnet with typical elevated T-wave.



Gating signal inside magnet with VCG.

ReportCARD™ 4.0 is significantly enhanced to streamline cardiac MR reporting with useful tools such as automatic left ventricle (LV) segmentation and analysis, T2* iron mapping in the heart and liver, a research database and macro reporting.

As a result of these advancements, the Signa MR750 3.0T GE is the first cardiac MR system to deliver all the versatile capabilities that currently exist on 1.5T MR with the SNR and CNR benefits of a 3.0T system. ■