# RECONSTRUCTION CHALLENGE 2010

## GENERAL INSTRUCTIONS

1. Each challenge takes a trajectory designed by an expert in the field, and generates data from a "truth" set of images via an inverse DFT. With the information specific to your challenge, you must attempt to reconstruct the best images possible using your own algorithm.
2. Any participant may download as many of the coordinate/data sets from each challenge as they wish. They may enter multiple submissions for each category, as long as each submission is for a different trajectory (i.e. they may enter only one submission, at most, for any particular trajectory for any challenge). Data from different trajectories (but the same challenge) may not be combined in any way - this includes using data from one trajectory to alter the reconstruction in any fashion for an alternative data set.
3. Reconstruction algorithms should not be iteratively optimized for the data set provided. In other words, all reconstruction parameters and algorithms should be optimized independent of the data provided. If there is inherent data-dependency in the parameters or algorithms, this should be designed prior to actually reconstructing the data provided. Basically, please use generic algorithms, not ones designed solely to win this contest.
4. Coordinates are given in 4-byte floating point doublets or triplets, representing (kx, ky) or (kx, ky, kz). The data are 4-byte floating point doublets, representing complex numbers. There are 8 times as many data points as coordinate points, representing 8 different receive coils. Within each coil, the data doublets are written in the same order as the corresponding coordinate files. In the coordinate file, the extent of k-space in which data are available is normalized to +/- 0.5 in each direction. Some coordinates go outside of this, i.e. |kx|, |ky|, or |kz| is greater than 0.5; for these coordinates, data are (0,0), and may be ignored.
5. The data format for the final images is floating point magnitude data (4 bytes/pixel) with no header. Files must be the exact file size listed below in the specific instructions for each challenge. For each challenge, example code for reading in the data and writing out the final images is provided for both C and Matlab. You do not have to use this exact code, but it should help guide you for the right data formats.
6. Please verify that the orientation of the B1, and (for double vision) B0 maps is consistent with your k-space data. Every effort has been made to keep this consistent, but, for example, your choice of a forward or backward FFT for the reconstruction may flip your image with respect to the provide B maps.
7. A panel of 6 radiologists will judge entries based entirely on diagnostic image quality. For any challenge, if the top entries have nearly identical image quality, **the panel may consider reconstruction time, at their discretion, to choose a winning entry**.
8. Final Reconstructed Images must be submitted by Wednesday, January 13, 2010, midnight EST in the format specified in this document. The process for submitting images will be announced later (October or November). After that, early submissions are appreciated!!! When you are ready to submit data, your will be asked to provide:
   a. Name and contact info for questions about your data set (this will remain anonymous)
   b. A brief (10-20 word) qualitative description of your method, e.g. "gridding, then 1D deblurring, then secret nonlinear filter" so that we can generically identify reconstruction algorithms.
   c. Provide the total reconstruction time for the entire reconstruction of all data (1 significant digit is fine) and the platform used (hardware/software, # of CPU's).

d. Include the submitted data in the required format (no header, floating point data, etc.); the file size must be exactly as specified (this should happen if you go by the provided code for writing out the final images).

9. In the event that more than 7 entries are received for any challenge, the entries will be given to groups of Radiology Residents and Fellows to rank, after which time a panel of experts will choose up to 7 finalists. They will include the 3 top-ranked entries in each category; the other four finalists in each category will generally be the next highest-ranked; however, some latitude may be given to include a greater variety of trajectories, reconstruction algorithms, image features, and reconstruction times, in order to make the plenary discussion more meaningful. "Truth" will also be included (blind) as an 8th set.
10. Finalists will be notified before the meeting, and asked to provide one slide describing their method and also sit near the front during the plenary session.

## DETAILED INSTRUCTIONS

### 1. Need for Speed.

Data were simulated using collected projection X-ray of an arterial bolus injection in a patient with an AVM. X-ray data were collected 3 frames per second, for a total of 10 seconds (31 collected frames) which span wash-in to wash-out. These were linearly interpolated in time between frames to create a total of 200 temporal images, each with 512x512 resolution. B1-maps derived from an axial slice through a water phantom using an 8-channel head coil were superimposed on the image to create 8 "coil" images. Independent noise was added to each channel. Contestants are provided with the B1 maps.

The data were synthesized over 200 trajectories, each with 2000 points. Data for each trajectory are synthesized from one temporal frame of the time series.

Contestants must attempt to recreate 37 frames corresponding to the time point of the 10th trajectory and every fifth trajectory after that up to trajectory 190. Put another way, if the trajectories number 1 - 200, the 37 time frames to reconstruct are {10, 15, 20, 25, ..., 185, 190}. Each temporal image ("frame") should be 512x512 pixels, floating point magnitude (i.e. 1,045,876 bytes per frame. Frames should be combined in a single file, with a final size of exactly 38,797,312 bytes. This is the file to submit for your entry. Please see the example read/write code for the order in which the data are written out.

### 2. Double Vision.

Data originate from 12 axial images in the abdomen (respiratory gated T2 FSE with Fat Sat) collected using a torso phase-array coil, collected at 320x320 matrix (40cm FOV). Field maps (breatheld, end-exhilation, with Fat Sat) were collected using gradient echo images at TE = 3 and 5, with a 96x96 collected matrix. Synthesized data were corrupted by off-resonance phase. Data from each of the 8 coils were generated. Contestants are provided $B_0$ and $B_1$ maps. (B0 maps are in units of Hz).

The data were synthesized over 8 trajectories, each with 20,000 points. The dwell time was 1usec, e.g. the time for each acquisition was 20msec.

Contestants must attempt to reconstruct and deblur all 12 slices. Note there may be slight undersampling in the images. Each image should be 320x320 pixels, floating point magnitude (i.e. 409,600 bytes per frame. Images should be combined in a single file, with a final size of exactly 4,915,200 bytes. This is the file to submit for your entry. Please see the example read/write code for the order in which the data are written out.

**3. Piece of the Puzzle.**

Data are from axially collected 3D unspoiled Gradient-Echo images of the knee, 320(X) x 320(Y) x 220(Z), with 0.5mm resolution in each direction (FOV = 160mm x 160mm x 110mm). Data are from an 8-channel phased-array, with coils in the x-y plane, i.e. very little coil orthogonality in Z. Contestants will get separate data for each coil. Independent noise was added to each channel.

The data were synthesized over 4,000 trajectories, each with 2,000 points, which results in total undersampling of rough R=5, depending on the trajectory set.

Contestants must attempt to reconstruct the entire 3D volume. The final data set should be a 320x320x220 volume of pixels, floating point magnitude, giving a file size of exactly 90,112,000 bytes. This is the file to submit for your entry. Please see the example read/write code for the order in which the data are written out.