Field Map Correction for the GE Scanners at UCSD CFMRI  
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Overview
This document describes the procedure for field map correction of EPI images acquired with the product EPI sequence (e.g. EPI DICOM files). A 2dflash sequence is used to acquire the field maps and various tools (FSL, AFNI, etc) are used for post-processing. This approach mirrors the field map correction method that is being developed for use by the fBIRN consortium.

Acquiring the Field Maps
The protocols for field map acquisition are under site/head/fBIRN_fmap. The directions below assume that you are using the 8ch head coil for EPI acquisition. If you are using the split head coil (single channel) then you should use that coil for the field maps.

Step by step instructions:
1. Enable research mode.
2. Perform a localizer scan.
3. Load the protocols fm_TE1_NFS and fm_TE2_NFS
4. View edit fm_TE1_NFS. Note the system will indicate that you are switching to the body coil. Accept this (unless you are using the split head coil). The body coil will be used for the field map acquisition, while EPIs will typically use the 8-channel head coil.
5. Prescribe the slices that you will be using for the functional run. Verify that auto-shim is checked. Save the series for fm_TE1_NFS.
6. View edit fm_TE2_NFS. Copy the graphical prescription from fm_TE1_NFS (use original loc option). Verify that auto-shim is not checked. Save the series.
7. At this point, the easiest way to proceed is to check the auto-scan button. This will then automatically run the two series of the field map. Warning: if you prescribe additional series while auto-scan is enabled, it will automatically run these as well!
8. Once the field map is acquired, disable auto-scan.
9. NOTE: It is good practice to visually inspect the field map images for motion or operator errors (e.g. different prescription for TE1 and TE2). The TE1 and TE2 images are acquired as magnitude, phase, real, and imaginary for each slice. In particular, if there is a significant motion or physical between the TE1 and TE2 images (most easily seen in the magnitude images), the field map computations will not work. Warning: if the TE1 and TE2 prescriptions are not identical, the correction algorithm will not work!
10. Prescribe your EPI run. Typically, this will use the 8 channel head coil. Copy the graphical prescription from fm_TE1_NFS. (NOTE: in order to copy the prescription, the FOV, slice thickness, slice spacing, and matrix size must match that of the TE1 and TE2 images. Also make sure to use the original loc option). It is also recommended that you disable auto-shim, but it probably doesn’t make a huge difference. Warning: if the field map and EPI prescriptions are not identical, the correction algorithm will not work!
Unwarping your images

There are two scripts: `ppge` and `epidewarp.ucsd` that have been written to apply field map correction to the images. Most users will only have to use `ppge`. These scripts and associated helper functions are available on cfmri. We recommend that each lab install the script and necessary software on a Linux machine in their lab, and run the dewarping on their local machine. See Installation notes below.

Overview:

1. Before starting you should know the study numbers for the TE1, TE2, and EPI datasets.
2. Most users will only need to learn how to use `ppge`. For usage instructions, type `ppge` without any arguments.
3. By default `ppge` will output an unwarped AFNI BRIK.

Examples: In the examples below TE1 data is in s207074, TE2 data is in s207183 and EPI data are in s207292

1. Default usage:
   `ppge -d1 s207074 -d2 s207183 -i s207292 -o brikname -TR 2000`

2. By default, motion correction using FSL mcflirt is on. To disable use the –nomoco option:
   `ppge -d1 s207074 -d2 s207183 -i s207292 -o brikname -TR 2000 –nomoco`

3. By default, the field map magnitude images are used to mask the brain region of the unwarped volume. To disable masking, use the –nomask option:
   `ppge -d1 s207074 -d2 s207183 -i s207292 -o brikname -TR 2000 –nomask`

4. By default, the program unwarps in the +y image direction. This should work fine for standard default EPI’s acquired with phase-encode in the A/P direction (frequency L/R). However, if you acquire differently, you can change the warping direction with the –unwarpdir option. For example:
   `ppge -d1 s207074 -d2 s207183 -i s207292 -o brikname -TR 2000 –unwarpdir x`
INSTALLING SOFTWARE

To run the unwarping scripts you will first need to install AFNI and FSL on your machine. The scripts have been tested with AFNI version 2.56a and the Linux version of FSL (fugue version 2.2 and prelude version 2.0). In addition you will want to copy and make executable the following scripts and binaries from /mnt/raid3/sdc/data/bin on cfmri:

1. ppge
2. epidewarp.ucsd
3. dicom2
4. dicom2bxh
5. bxh2analyze

If you are using FSL version 3.2 or higher, you may need to change the default output image type in the fsl.sh file from NIFTI to ANALYZE

BUGS
For now, please send bug reports and suggestions to ttliu@ucsd.edu.