

High Order Shimming

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Introduction

Shimming is a process whereby the magnetic field is made more uniform.

Shimming is important in fMRI and other rapid scanning **especially at 3T** because EPI or Spiral sequences are much more sensitive to off-resonance than conventional imaging.

Even if the magnet is well shimmed during servicing, the insertion of a human in the magnet destroys the homogeneity (on the ppm level).

The AutoShim function on the MR scanner performs a linear shim, i.e. corrects for linear gradients in the field, by adjusting DC currents in the gradient coils.

In addition, the spiral reconstruction program performs a linear shim correction on a slice-by-slice basis.

However, the shape of heads and bodies guarantees that residual higher-order heterogeneities remain.

It is desirable to correct for them as much as possible to avoid blurring and signal loss.

The High Order Shim software program acquires scans using a spiral sequence, calculates the field map and shim correction needed, and downloads the resistive shim power supply, gradients and spectrometer center frequency.

The shim terms thus optimized are zero (Z0), first (X, Y, Z1), all the second order components (XY, X²-Y², ZX, ZY, Z2), and Z3.

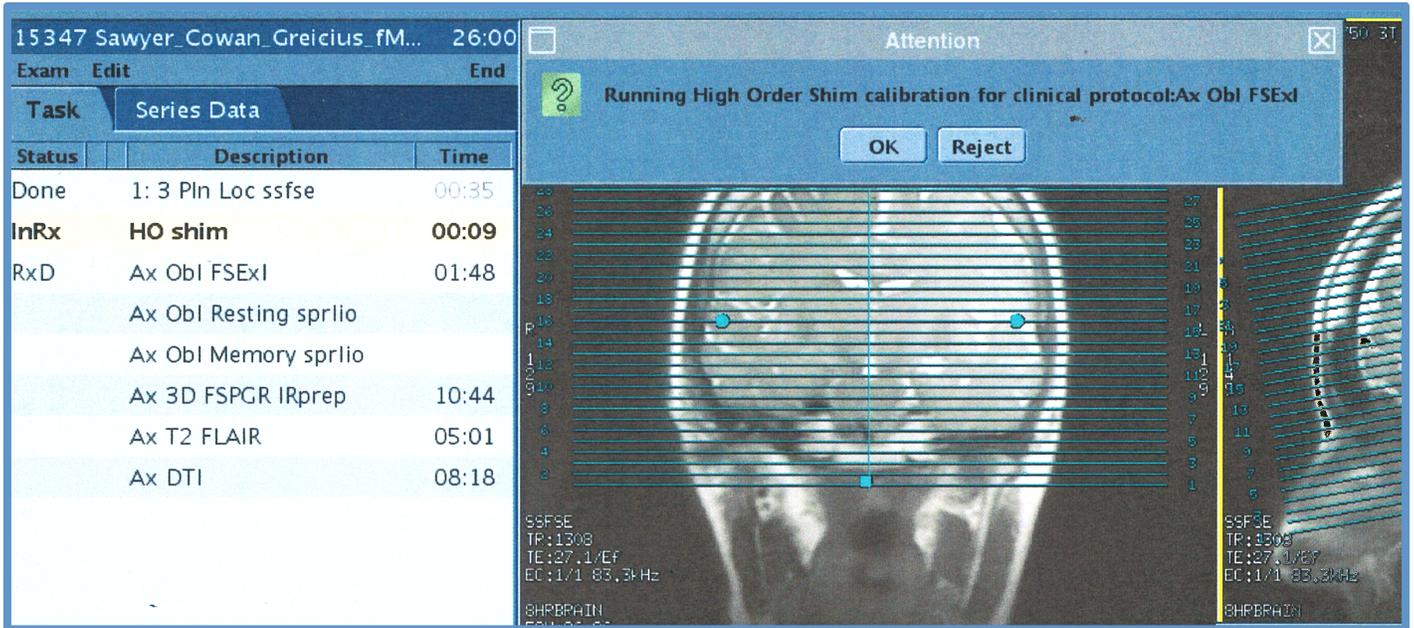
The High Order Shim software automatically adjusts the shim prescription in order to avoid moving the table during the shim.

- It does this by capturing the S/I values from the scan just performed previous to the shim.
- Thus the anatomic scan should be prescribed and saved but not actually run, and then the shim can be prescribed and run.
- After performing the High Order shim, the anatomic scan can be acquired, followed by any functional scans.
- For **head** imaging,
 - > you can prescribe and perform the anatomic imaging, prescribe and run the shim and finally the functional scans.
 - > it is not as critical to shim before performing the anatomic images
- For **body** imaging, prescribe but do not run the anatomic images, then prescribe and perform the shim scan, and then acquire the anatomic images without using the normal AutoShim.

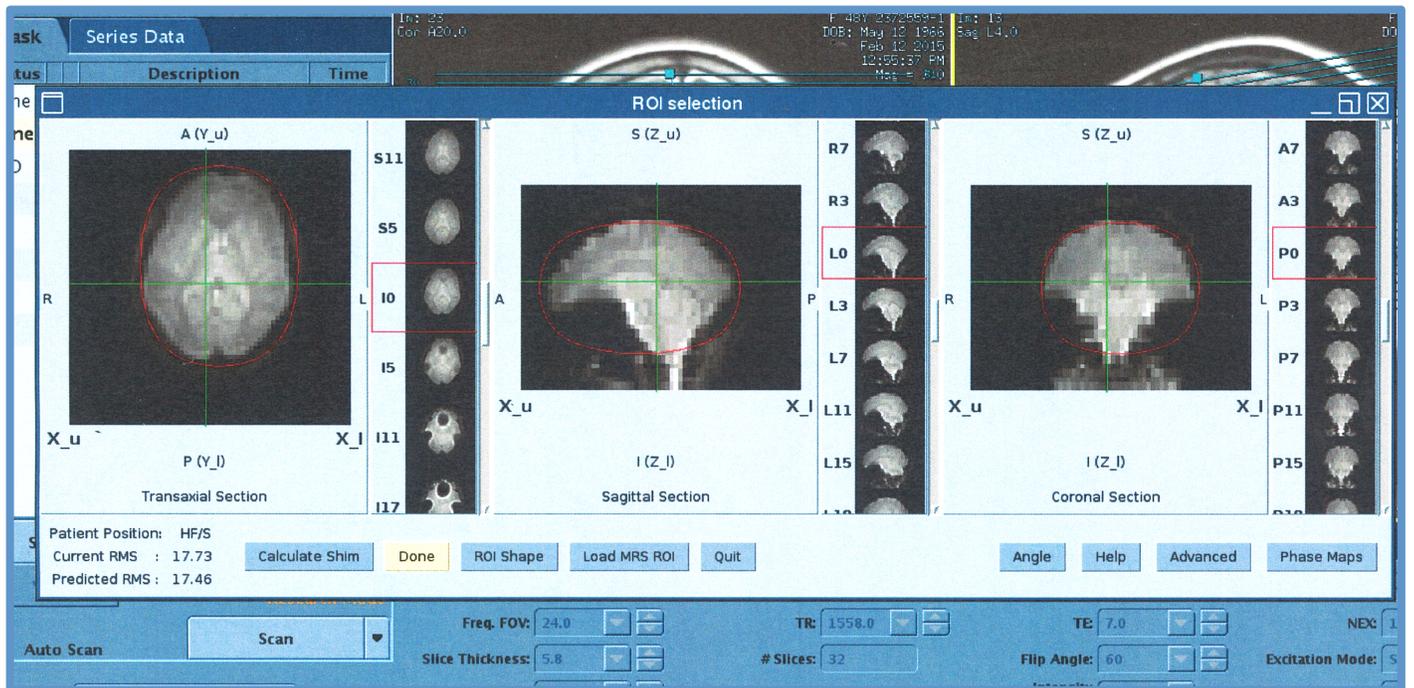
"AutoShim" should **NOT** be done after performing the high-order shim, as you will **erase** the High Order shim you just optimized.

High Order Shim Usage

1. The anatomic scan corresponding to the functional scans should be prescribed before the shim.
 - a. Copy protocol from Head, "head-shim" (see below).
 - b. For body scanning with a larger field of view, use "Other/body-shim".
 - c. Specify the coil being used (e.g. 8HRBRAIN)
 - d. Make sure that the "Frequency Direction" is set to A/P and AutoShim is set to "off"
 - e. Do **NOT** alter any other parameters in the protocol
 - f. The start and end locations are automatically filled in when the protocol is uploaded by selecting "Setup". It will use the prescription from the **"just-uploaded"** previous scan series to determine this. When you save the shim prescription a message window will notify you of its choice of prescription: "Running High Order Shim calibration for clinical protocol: Xxxx Xxxx" (see next page for pop-up). Once the shim prescription has been saved, do **NOT** select Setup or View-Edit it again as that deletes the shim locations.
 - If this occurs inadvertently, upload the series with the scan locations, Save, then upload the High Order shim series and Save; the new copy will load with the proper prescription.



2. Run the Shim procedure (see below):
 - a. Select Scan; after 6 secs, a Graphic User Interface (GUI) window will appear as shown below.
 - b. Adjust ROI as desired in any 2 of the 3 planes.
 - c. Select "Calculate Shim".
 - d. Note Current RMS and Predicted RMS (values in Hz).
 - e. Select "Done". A few seconds elapse while the shim values are downloaded.



3. Now verify the shim by doing another scan as in step 2. Usually these two iterations are adequate.