Chapter 8 – Shimming

8. Shimming

Shimming is the process of measuring the magnet's field over a fixed volume, then calculating and installing passive (steel) shims to improve field homogeneity. Perform on-site shimming to compensate for the distribution of room steel that is affecting field homogeneity. Additional shimming may be required following any significant environmental changes near the magnet. It is important to perform shimming after the magnet is sited and ramped with the magnetic field stabilized.

- Use the ShimTool Software (GE PN 5102783) to calculate any additional shimming required on site. Always use the most recent revision of GE Shimtool Software.
- Allow the magnet to stabilize to <0.1 ppm/hr. main field drift before shimming. Perform other commissioning functions during this time.
- For 3.0T MR750w (UA Series), the Shim Tray Extraction Tool (STET) (5431812), must be used to insert and extract loaded shim trays. Refer to the STET manual (5431810) for more information.
- For UA Series Magnets: The shim trays must remain in the gradient to electrically center the shim camera. If there is difficulty in determining the correct electrical location of the shim camera, call the Online Center.
- Before beginning the shimming process and after each shim iteration, always confirm the shim trays are fully engaged (inserted) and locked. Rotate the shim tray knob 90° clockwise to secure the connection.
- The shim trays should remain in the gradient for the initial shim iteration.
- On some systems table will be lowered and not removed, use caution so table is not damaged during the shimming process.

DANGER

POTENTIAL FATAL INJURY!
BEFORE BEGINNING AND WHILE PERFORMING THIS PROCEDURE:
• MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS.
• FULLY COMPLY WITH ALL REQUIRED ITEMS IN CHAPTER 1, SAFETY.
• HAVE ALL MR SAFETY TRAINED PERSONNEL COMPLY WITH THE SECOND PERSON SERVICE REQUIREMENTS AS SPECIFIED IN THE MR SERVICE SAFETY MANUAL, 5452735.

WARNING

PERSONAL INJURY HAZARD!
INCORRECTLY INSERTING AND EXTRACTING SHIM TRAYS CAN CAUSE PERSONAL INJURY.
FOR THE 3.0T MR750W (UA SERIES MAGNET), THE SHIM TRAY EXTRACTION TOOL (STET) (5419765), MUST BE USED TO INSERT AND EXTRACT LOADED SHIM TRAYS. REFER TO THE STET MANUAL (P/N 5431810, 0.600 SECTION 6.OPERATING DOC IN MWS AND DOC0973916 IN CDL) FOR MORE INFORMATION.

WARNING

PERSONAL INJURY AND EQUIPMENT DAMAGE! STRONG MAGNETIC FIELD
WHEN SERVICING ANY MAGNETIC EQUIPMENT, IT IS CRITICALLY IMPORTANT THAT THE SERVICE ENGINEER CONSCIOUSLY PLAN THE PATH TO BE TAKEN WHEN MOVING HIGHLY FERROUS DEVICES IN THE MAGNET ENVIRONMENT. THE PATH SHOULD BE AS FAR FROM THE MAGNET AS PRACTICAL AND AVOID HIGH FLUX-DENSITY FIELDS.
SAFETY REQUIREMENTS
• MOVEMENT OF FERROUS MATERIAL IN THE MAGNET ROOM MUST FOLLOW THE GE SERVICE PROCEDURE FOR THAT DEVICE. WHEN EXITING, MOVE AWAY FROM THE MAGNET IN THE MOST DIRECT MANNER POSSIBLE. PASSIVE SHIM TRAY MUST BE INSERTED/REMOVED WITH THE SHIM TRAY POINTED TOWARDS THE MAGNET. THE SERVICE PERSONNEL SHOULD NEVER BE BETWEEN THE SHIM TRAY AND THE MAGNET. NOR SHOULD ANY SERVICE PERSONNEL BE ON THE SERVICE END OF THE MAGNET WHEN TRAYS ARE BEING INSERTED.
• TWO (2) MR SAFETY TRAINED PERSONNEL MUST BE PRESENT AT ALL TIMES WHEN SERVICING HIGHLY FERROUS DEVICES IN THE AREAS OF MAGNETIC FIELDS.
• WHEN PLANNING A SERVICE PATH, IT IS CRITICAL THAT THE PATH BE CLEAR AND SUFFICIENTLY WIDE. ENSURE THAT THERE ARE NO TRIP HAZARDS, OBSTACLES, CLUTTER, SLIPPERY SURFACES OR OTHER ITEMS EVEN PARTIALLY RESTRICTING THE PATH. IF THERE ARE PORTABLE OBSTACLES IN A PATH, REMOVE THEM FROM THE AREA AND REPLACE THEM AFTER THE SERVICE ACTION IS COMPLETED. IT IS REQUIRED TO WALK THE PATH PRIOR TO BEGINNING SERVICE TO ENSURE THAT THERE IS SUFFICIENT SPACE THROUGH WHICH TO PASS FOR YOURSELF AND THE OBJECT BEING SERVICED.

WARNING

POSSIBLE PERSONAL INJURY!
THE BØ POWER SUPPLY CONTAINS HIGHLY FERROUS MATERIAL. ANY FIELD STRENGTH >200 GAUSS WILL FORCIBLY ATTRACT THE BØ POWER SUPPLY. DO NOT BRING THE BØ POWER SUPPLY INTO THE MAGNET ROOM IF THE MAGNET IS RAMPED. REFER TO MAGNETIC FIELD SAFETY DOCUMENTATION FOR DETAILS.

WARNING

POTENTIAL PROJECTILE HAZARD!
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES. STEEL SHIMS IN A MAGNETIC FIELD ARE SUBJECT TO A FORCE PROPORTIONAL TO THE STEEL'S MASS AND STRENGTH. IN A 1.5 TESLA FIELD FORCES >50 POUNDS (22.6 KG) MAY BE ENCOUNTERED. AN ATTRACTING FORCE PULLING A SHIM TRAY INTO THE MAGNET WILL BE ENCOUNTERED WHEN A LOADED TRAY IS BROUGHT WITHIN 3 FT. (1 M) OF THE MAGNET BORE. AN ATTRACTING AND/OR REPELLING FORCE WILL BE ENCOUNTERED WHEN INSERTING/REMOVING A LOADED SHIM TRAY INTO/FROM A TRACK INSIDE THE MAGNET BORE. A REPELLING FORCE ON A SHIM TRAY INSIDE THE MAGNET'S BORE MAY PROPEL THE TRAY OUT FROM THE MAGNET WHEN THE TRAY IS RELEASED FROM ITS FIXED POSITION. MAKE SURE TO FOLLOW THESE SAFETY REQUIREMENTS DURING PASSIVE SHIM INSTALLATION/REMOVAL:

- ASSEMBLE ALL EQUIPMENT AND CHECK THE FUNCTIONALITY IN CONFORMANCE WITH THE PASSIVE SHIM INSTALLATION PROCEDURE,
- LOAD THE SHIM TRAYS OUTSIDE THE MAGNET ROOM AND NEVER LOOSEN THE INDIVIDUAL SHIMS INSIDE THE MAGNET ROOM,
- SECURE THE SHIMS IN THE SHIM TRAYS AND INSTALL THE TRAYS INTO THE MAGNET IN STRICT CONFORMANCE WITH THE PASSIVE SHIM INSTALLATION PROCEDURE,
- WEAR SAFETY GOGGLES/GLASSES DURING SHIM TRAY INSTALLATION/REMOVAL TO PREVENT EYE INJURY FROM SUDDEN TRAY MOVEMENT,
- HOLD THE SHIM TRAYS FIRMLY IN PLACE WHEN RELEASING THE INSTALLED TRAYS, AND MAKE SURE ALL LOADED SHIM TRAYS ARE RESTRAINED (BY HAND, SHIM TRAY PULLER, OR FIXED INTO ITS TRACK), ESPECIALLY THE TRAYS MARKED ON THE END FLANGE AS MOUNTED IN AN OUTWARD REPELLING FORCE,
- INSERT/REMOVE THE SHIM TRAYS WITH A GRADUAL MOTION,
- TWO PERSONS ARE REQUIRED TO INSTALL/REMOVE THE TRAYS,
- DO NOT LOAD THE SHIM TRAYS WHILE ANYONE IS DIRECTLY IN LINE WITH THE TRAY ON EITHER END OF THE MAGNET, AND
- NEVER POSITION YOURSELF BETWEEN A SHIM TRAY AND THE MAGNET.
- A CLEAR PATH PER CHAPTER 1, SAFETY, IS REQUIRED FOR PASSIVE SHIM REMOVAL AND INSERTION.

WARNING

POTENTIAL PROJECTILE HAZARD!
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES. NEVER BRING FERROMAGNETIC MATERIAL INTO THE MAGNET ROOM. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON-FERROMAGNETIC.

CAUTION

POTENTIAL PROJECTILE HAZARD!
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES. BE PREPARED TO MANAGE THE EFFECTS OF THE MAGNETIC FIELD ON THE SHIM TRAY DURING TRAY INSERTION/REMOVAL. ADHERE TO ALL SAFETY REQUIREMENTS.

CAUTION

POTENTIAL SKIN INJURY!
FIBERGLASS FROM THE SHIM TRAYS CAN SPLINTER WHILE INSERTING/REMOVING TRAYS. WEAR NO-SLIP GLOVES DURING SHIM TRAY INSERTION/REMOVAL TO PROTECT AGAINST FIBERGLASS SPLINTERS FROM TRAYS.

8.1. Shimming Tools and Equipment

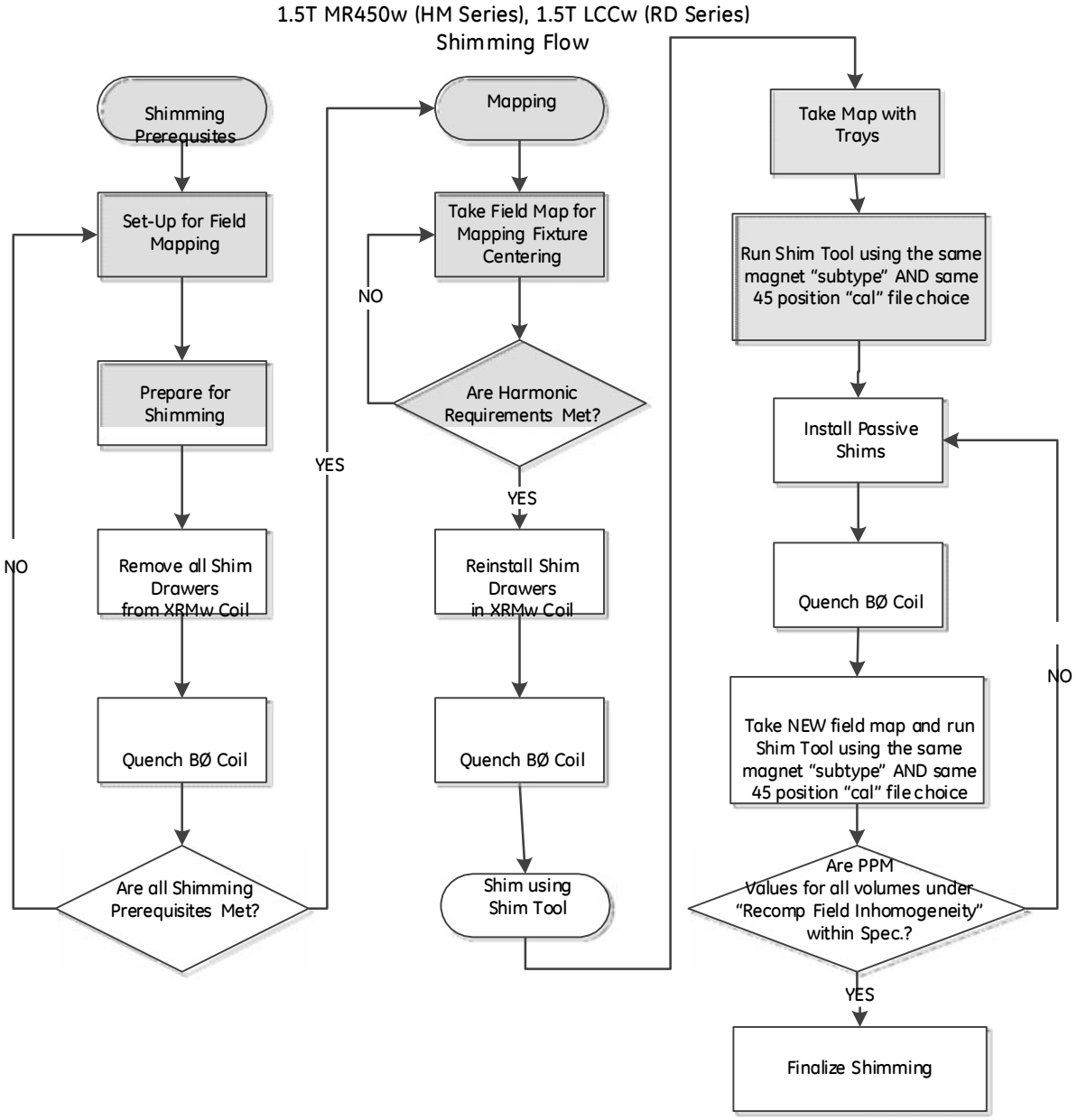
Tools & Test Equipment

Part Number	Quantity	Description
NA	1 per person	Pair: Nonferrous Safety Shoes
2386028-3	1	Shim Camera Kit
5102783	1	GE ShimTool Software
5266042-4	1	Universal Field Mapping Fixture Kit
5342951 or 5428096	1	1.5T DVw Field Passive Shim Kit (5342951) 3.0T DVw Field Passive Shim Kit (5428096)
5431812	1	Shim Tray Extraction Tool (for 3.0T MR750w, UA Series Magnets ONLY)
5431810	1	Shim Tray Extraction Tool Manual (for 3.0T MR750w, UA Series Magnets ONLY)
5113258 or 5112581	1 Kit	Titanium Tool Kit, Basic Set 5113258 or Titanium Tool Kit, Installation Set 5112581 or other non-ferromagnetic tools (magnets with magnetic fields >1.5T)
Refer to Service Platform Set-Up	1	Service Platform with Side Shield/Side Protection Plate
NA	1	Service Methods documentation for the magnet/enclosure (available through the support documentation library at gehealthcare.com or your local GE Healthcare Service Representative)
2141701	1	BØ Power Supply Kit (HIGHLY FERROUS ITEM)
NA	1	Stopwatch or other timer

Consumables – for the 3.0T MR750w (UA Series)

Part Number	Quantity	Description
NA	18	Panduit Cable Tie PLT3I-C (available in 750w Passive Shim Kit 5428096)

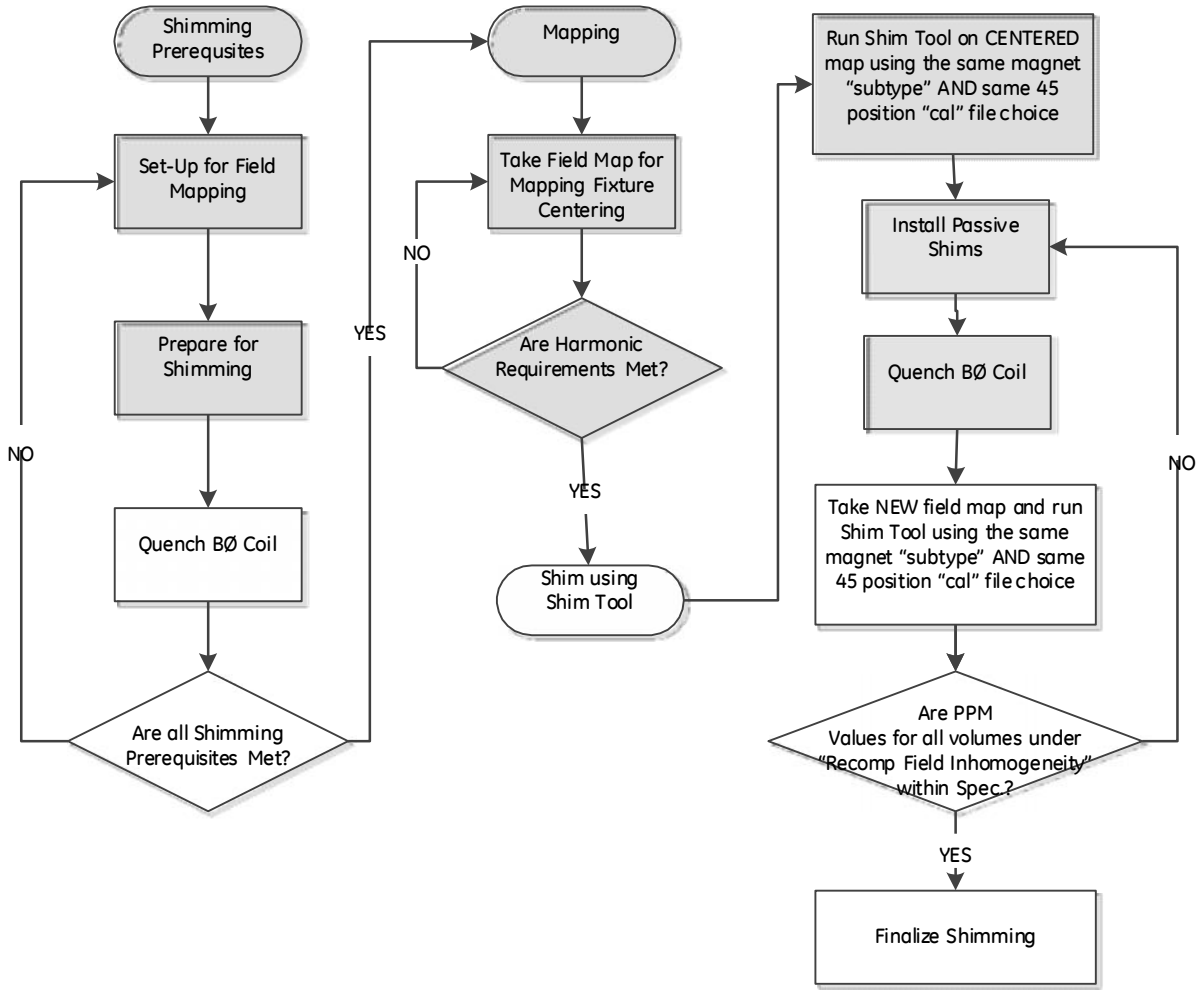
8.2. Shimming Flow



1.5T MR450w (HM Series), 1.5T LCCw (RD Series) Shimming Prerequisites:

Magnet Pressure: At operating pressure (e.g. 3.9 psig - 4.1 psig) and stable to within 0.1 psig	Magnet Temperature and Humidity within specifications defined in the Pre-Installation Manual
Drift Rate: < 0.1 ppm/hr	
Dock Installed	
Front Endbell Removed	Keep Electronics ON During Shimming
HEC Connected to Gradient Coil and Running	

3.0T MR750w (UA Series)
Shimming Flow



3.0T MR750w (UA Series) Shimming Prerequisites:

Magnet Pressure: At operating pressure (e.g. 3.9 psig - 4.1 psig) and stable to within 0.1 psig	Magnet Temperature and Humidity within specifications defined in the Pre-Installation Manual
Drift Rate: < 0.1 ppm/hr	
Dock Installed	STET Tool installed
Front Endbell Removed	Keep Electronics ON During Shimming
HEC Connected to Gradient Coil and Running	Shim Trays Installed

8.3. Shimming, Required Conditions

8.3.1. Make sure the area is secure and that all required Warning Signs are posted to meet the safety requirements.

8.3.2. Removal of some magnet enclosure components may be required to complete this procedure. Refer to the appropriate Service Methods documentation (available through the support documentation library at gehealthcare.com or your local GE Healthcare Service Representative) before continuing with this procedure if cover removal is required.

8.3.3. Verify that the magnet's magnetic field drift rate is <0.1 ppm/hr. before starting Section Running ShimTool.

8.3.4. Verify that Magnet Monitor is on and operational at required operating pressure (e.g. 3.9 psig - 4.1 psig) and stable to within 0.1 psig. If using proprietary Magnet Monitor software, verify that Magnet Monitor Pressure Control is enabled and operational. (Note that for GE owned and operated sites, improved (alternative) pressure configurations may be permissible. Contact your Regional Magnet & Cryogen (MAC) Team Leader or the Magnet Support Team at the Online Center for more information pertaining to alternative pressure configurations.)

8.3.5. Remove BØ currents in conformance with Section Zeroing Currents in the BØ Coil, before starting Running ShimTool.

8.3.6. Verify that the dock is properly installed.

8.3.7. Verify that the gradient coil is connected to the Heat Exchanger Cabinet (HEC) and that the HEC is turned on.

8.3.8. Keep electronics ON during shimming.

8.3.9. For 3.0T MR750w (UA Series) magnet: Install STET tool (5431812) per STET manual (5431810) and verify it is operational. STET has to be present from the time the 1st map on site is taken.

8.3.10. Verify the magnet room is within the operating temperature range indicated in the pre-installation manual.

8.3.11. Moving articles or equipment in the Magnet Room may affect field readings. Do NOT move articles or equipment in the Magnet Room while shimming.

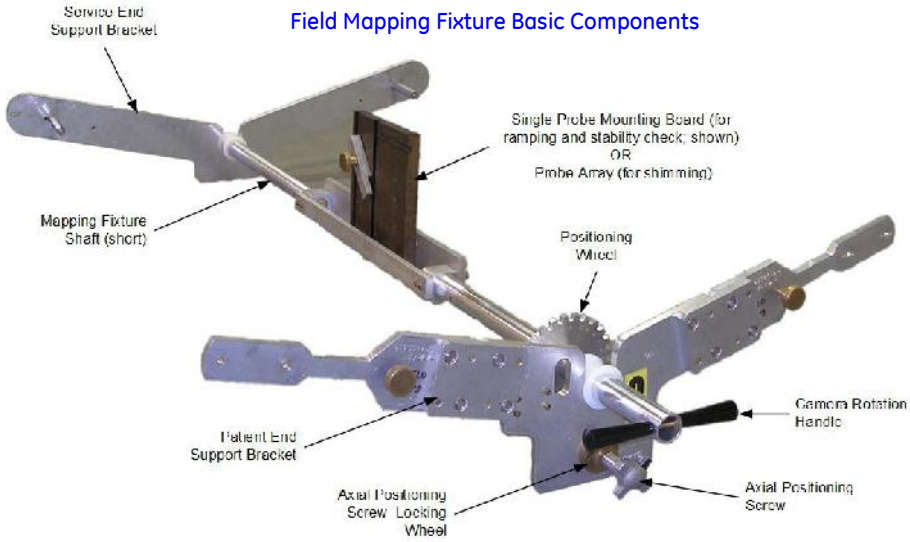
8.3.12. ONLY use nonmagnetic tools when working in the Magnet Room.

8.4. Shimming Equipment Installation

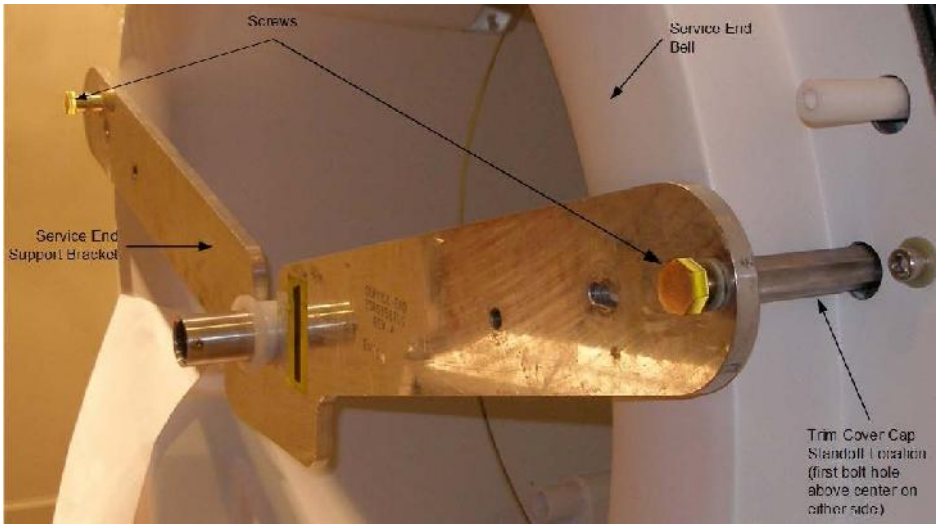
8.4.1. Remove the first trim cover cap screw above magnet center on either side of the service end bell, shown below.

8.4.2. Insert two standoffs (5338453) into hole locations shown below.

Field Mapping Fixture Basic Components

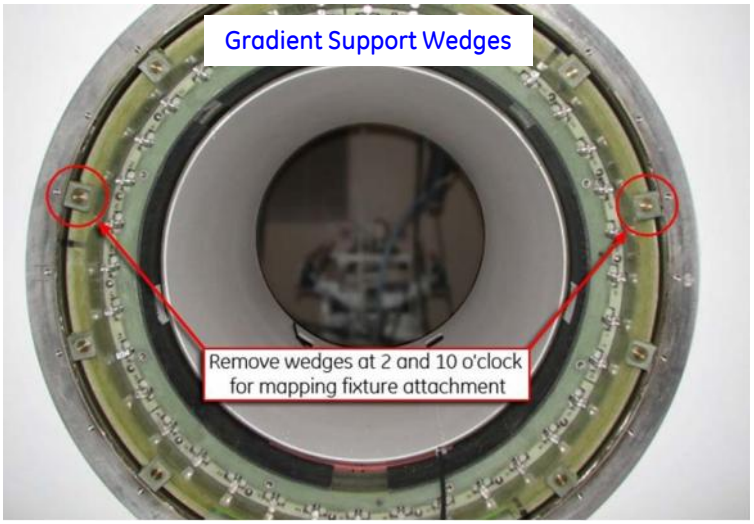


Removing Trim Cover Cap Screw



8.4.3. Attach the support end service bracket of the mapping fixture to the magnet interface ring using two screws that are provided in the mapping fixture kit.

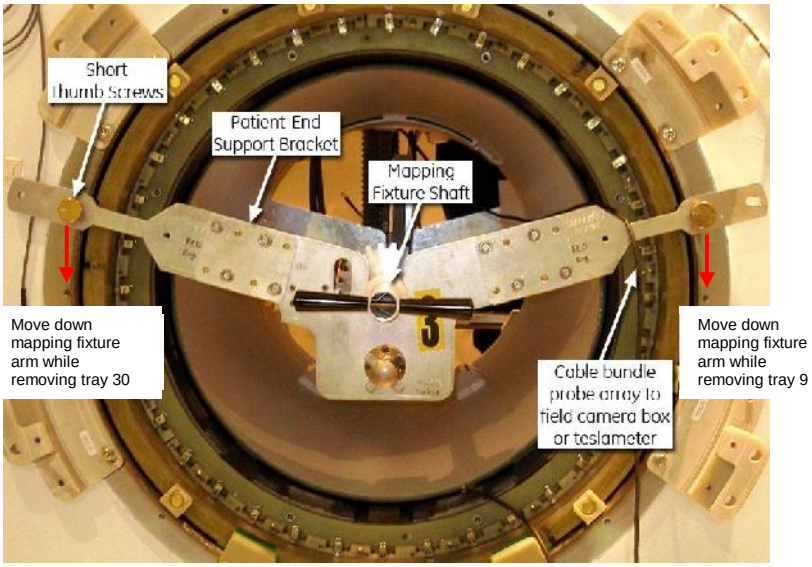
8.4.4. IF PRESENT: Remove gradient support wedges at the 2 and 10 o'clock positions, shown below.



8.4.5. Attach the mapping fixture's patient end support bracket to the magnet interface ring — at the first bolt holes above magnet center on either side of the magnet — using two shorter thumb screws, shown below.

Note: For LCCw (RD Series) magnet with BRM2 gradient coil, **tray 30** and **tray 9** may cover up by mapping fixture arm. When removing **tray 30** or **tray 9**, the mapping fixture arm should be moved down first. See below picture:

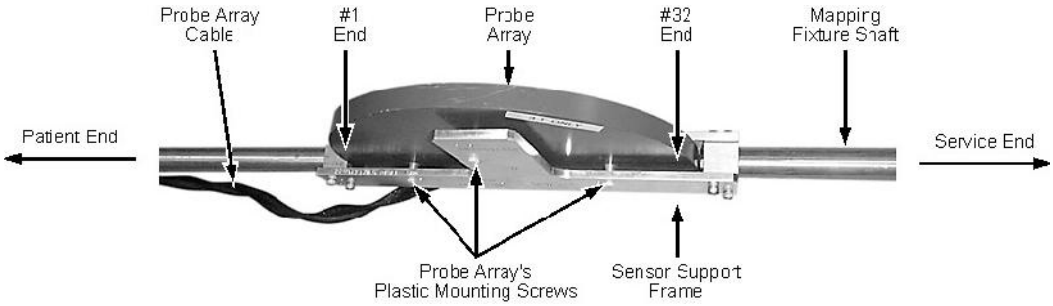
Attaching the Patient End Support Frame



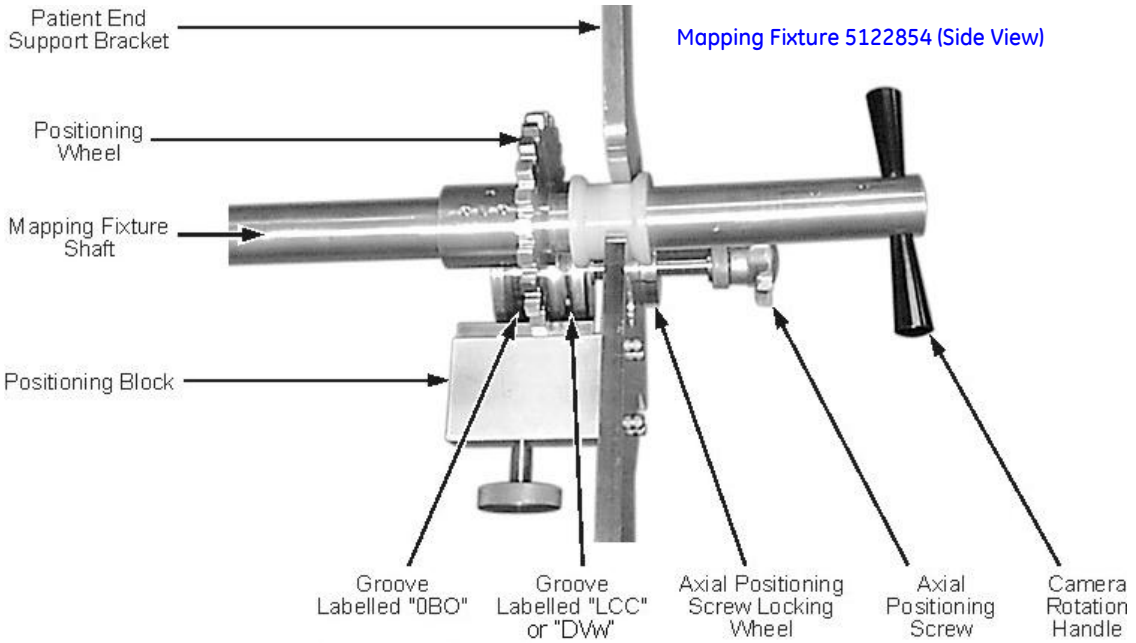
8.4.6. Attach the probe array

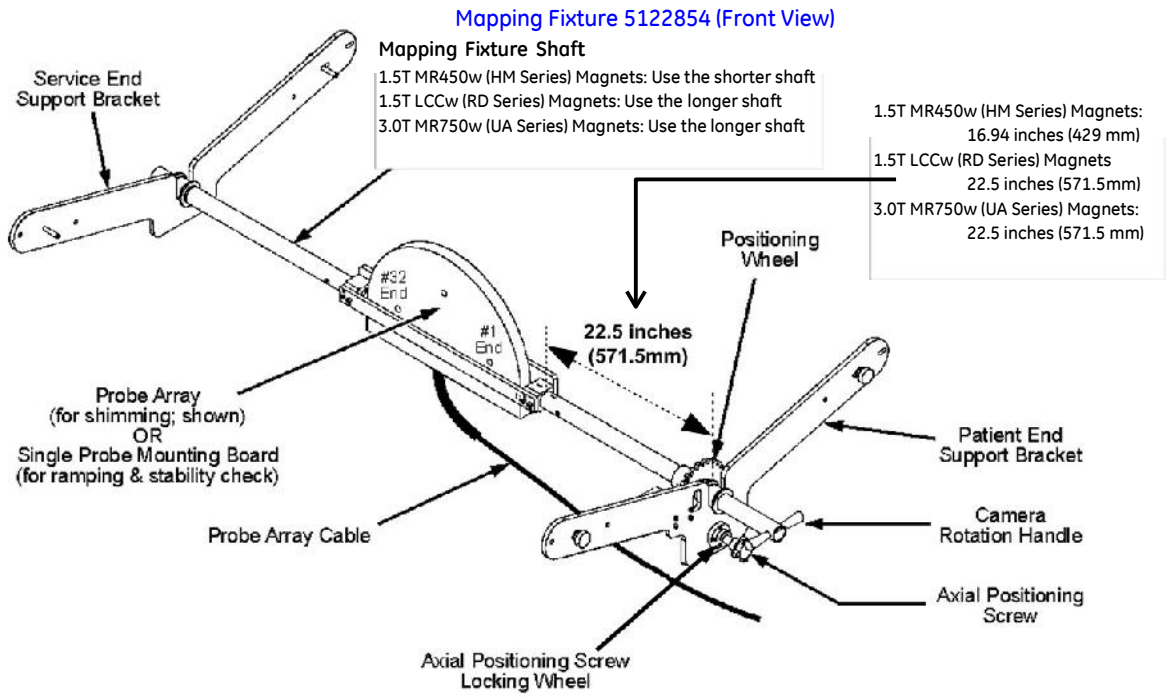
- Probe Array is Type HM32-500
  - 1.5T MR450w (HM Series) Magnets: Use 2276277-14 (probe array marking: 64 MHz)
  - 1.5T LCCw (RD Series) Magnets: Use 2276277-14 (probe array marking:64 MHz)
  - 3.0T MR750w (UA Series) Magnets: Use 2276277-13 (probe array marking: 127 MHz)
- Make sure all fasteners along the mapping fixture shaft and at the support frame are tight to prevent probe/array misalignment.
- There are two shafts included in the plotting fixture.
  - 1.5T MR450w (HM Series) Magnets: Use the shorter shaft
  - 1.5T LCCw (RD Series) Magnets: Use the longer shaft
  - 3.0T MR750w (UA Series) Magnets: Use the longer shaft
- For field mapping while running ShimTool, attach the probe array using the plastic screws of the array, shown below.

Attaching Probe Array to Mapping Fixture Shaft



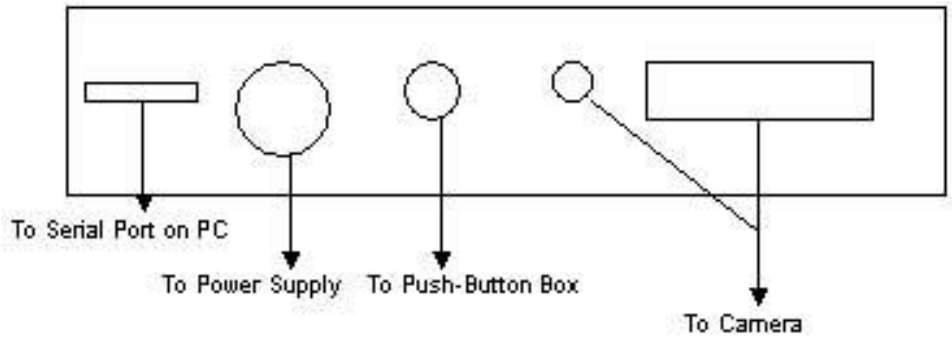
8.4.7. Verify that the positioning wheel occupies the LCC/DVw slot of the pulley beneath it, and that the fixture is approximately centered as shown below.





8.4.8. Run all cables between the shim camera and the applicable devices.
8.4.9. Connect cables to the shim camera as shown below.

Camera Interface Connections



8.4.10. Prepare for field mapping in conformance with Preparations for Field Measurement before shimming if not already done.
8.4.11. Allow the magnet to stabilize to <0.1 ppm/hr. main field drift before shimming. Perform other commissioning functions during this time.
8.4.12. Check magnetic field stability in conformance with Field Stability Check.
8.4.13. Turn the Cryocooler off for 10 minutes. (This quenches the Superconducting Shield around the Coldhead.)
- Turn off the Cryocooler only before the initial shimming and not between each shimming iteration.

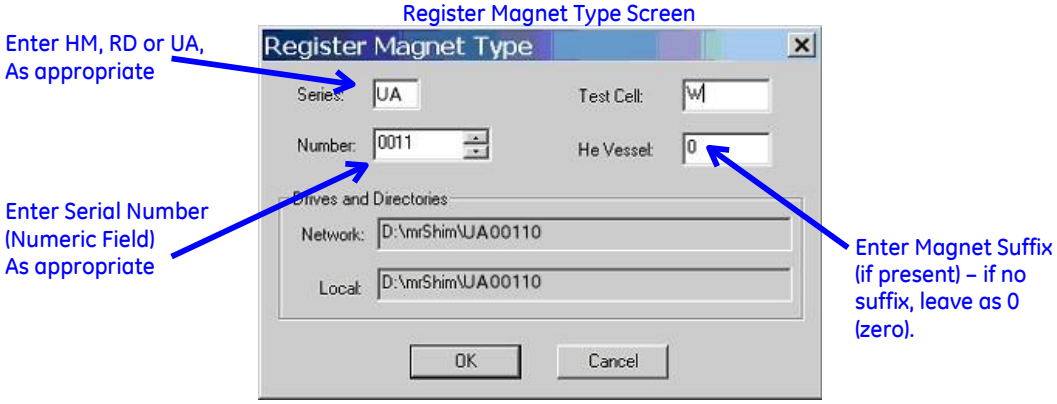
8.4.14. For 1.5T MR450w (HM Series) Magnets and 1.5T LCCw (RD Series): Remove all shim trays from the magnet for centering the probe array in the magnet.
8.4.15. Connect the Shim Camera to the PC's COM port. Make sure all connections are secure.
8.4.16. Install the Mapping Fixture's Probe Array (if not done already) in conformance with Preparations for Field Measurement.
8.4.17. If the most recent version of GE Shimtool Software is not installed on the computer being used:
- Insert the CD into the computer, automatically launching the installation program (install.cmd).
- When asked, select the installation drive for the computer in use. The CD should automatically install all ShimTool files at
  - D:\MRshim or
  - C:\MRshim.
- The latest revision of Shimtool software ships with the Magnet Documentation collector.
- Always use the most recent revision of GE Shimtool Software.

8.4.18. Double-click the ShimTool*.exe listing in the ShimTool directory in Windows Explorer.

8.4.19. When the Register Magnet Type screen displays:

- Check that the entry next to Series:
  - 1.5T MR450w (HM Series) Magnets: Enter HM
  - 1.5T LCCw (RD Series) Magnets: Enter RD
  - 3.0T MR750w (UA Series) Magnets: Enter UA
- Type W into the box next to Test Cell:. (Use W for all shimming done at a customer's site.)
- Adjust the numerical value next to Number: to the serial number of the magnet to be shimmed.
- If there is a suffix on the Magnet Serial Number (e.g. HM0520A), enter the suffix (e.g. A) in the He Vessel field. If no suffix, leave as 0 (zero).
- Click [OK].

Register Magnet Type Screen

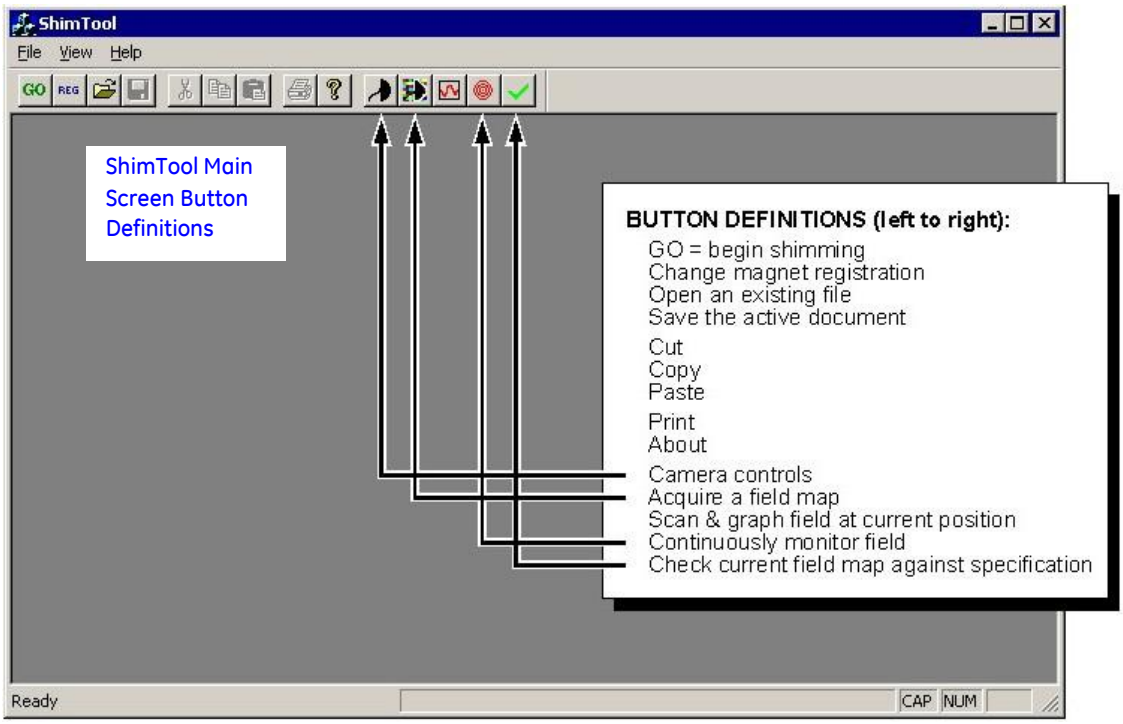


8.4.20. ShimTool automatically creates a subdirectory for storing all .map, .cur, and .shm files at D:\MRshim\HM####0 for 1.5T MR450w (HM Series) magnets or D:\MRshim\RD####0 for 1.5T LCCw (RD Series) magnets or D:\MRshim\UA####0 for 3.0T MR750w (UA Series) magnets. (Note that some installations/operating systems may use the C:\ drive instead of the D:\ drive.)

8.4.21. Load the passive shim (.psm) file that was created when the magnet was shimmed at the Florence facility onto the laptop.

- This file is stored on the Field Report (ATR) DVD. Load the .psm file into the proper directory for the magnet type.
- For 1.5T MR450w (HM Series) magnets, the directory is D:\MRshim \HM####0, where #### is the serial number of the magnet. (Note that some installations/operating systems may use the C:\ drive instead of the D:\ drive.)
- For 1.5T LCCw (RD Series) magnets, the directory is D:\MRshim \RD####0, where #### is the serial number of the magnet. (Note that some installations/operating systems may use the C:\ drive instead of the D:\ drive.)
- For 3.0T MR750w magnets, the directory is D:\MRshim \UA####0, where #### is the serial number of the magnet. (Note that some installations/operating systems may use the C:\ drive instead of the D:\ drive.)
- If the magnet has been shimmed on site previously, load the needed files from the latest completion of shimming.

8.4.22. Select [Camera Controls] (fifth button from right) when the ShimTool main screen displays, shown below.



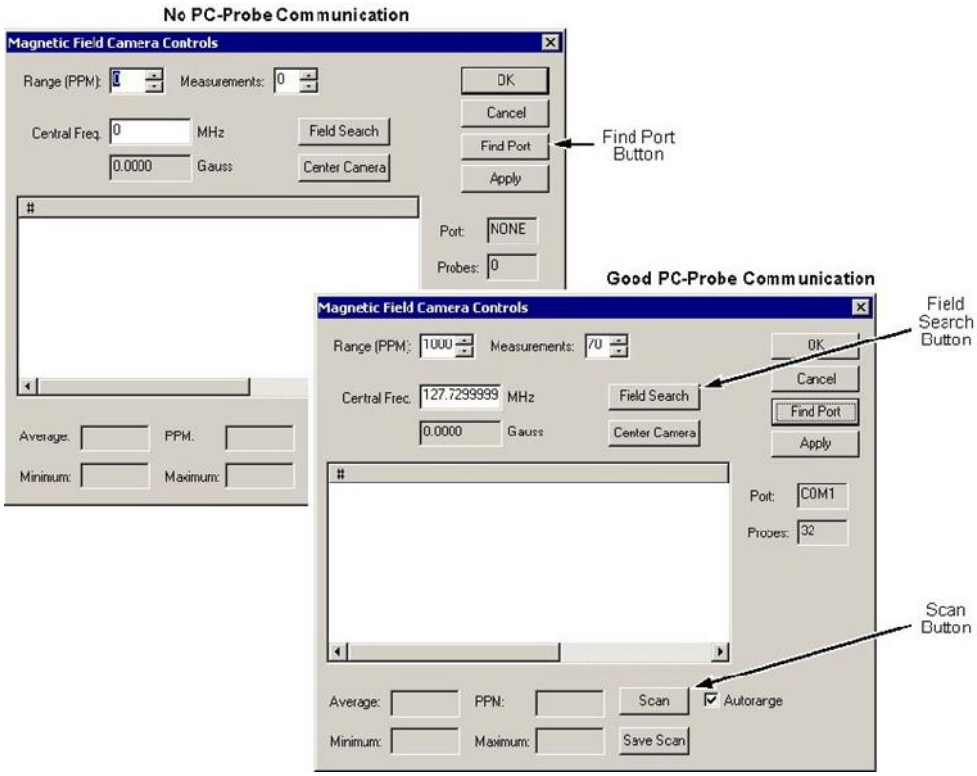
8.4.23. Make sure the Magnetic Field Camera Controls window (see Illustration Magnet Field Camera Controls: PC-Probe Communication) displays

- 1.5T MR450w (HM Series) Magnets: Center Freq: of 63.8 MHz (rounded).
- 1.5T LCCw (RD Series) Magnets: Center Freq: of 63.8 MHz (rounded).
- 3.0T MR750w (UA Series) Magnets: Center Freq: of 127.7 MHz (rounded)

8.4.24. If the program did not find a camera attached to the PC's COM port (Port – NONE displays in upper left of Illustration Magnet Field Camera Controls: PC-Probe Communication):

- Check that power to the camera is turned on and all connections between the probe array, camera, and PC are secure.
- Click the [Find Port] button to reestablish Camera-PC communications.
- Exit any programs that Windows Task Manager (accessed by pressing <Ctrl> + <Alt> + <Delete>) is running on the PC besides ShimTool and Windows Explorer.

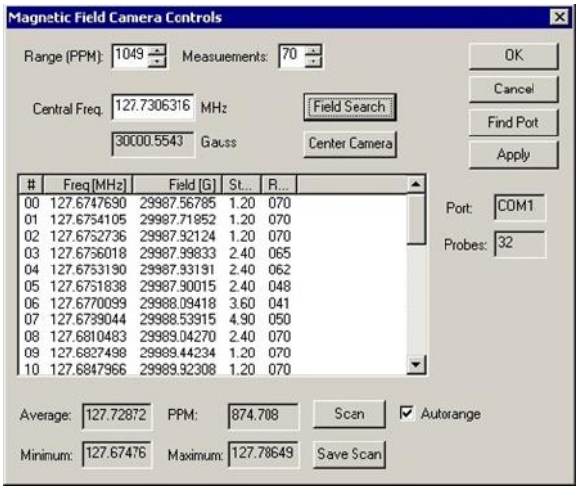
Magnet Field Camera Controls: PC-Probe Communication
3.0T MR750w (UA Series) Example shown



8.4.25. Choose an option on the Magnetic Field Camera Controls screen shown above:

- Click the [Field Search] button to automatically find the center frequency of the magnet, and update the Center Freq: field shown in Illustration Magnet Field Camera Controls (After Choosing Field Search Button). An initial listing from left to right in the scrolling text box:
  - Probe number: #,
  - Frequency in MHz: Freq (MHz),
  - Magnetic field strength in Gauss: Field (G),
  - Standard deviation in Gauss, and
  - Measurement count readings from each probe. (The measurement counts should all read close to the number next to Measurements: at the top of the screen.)

Magnet Field Camera Controls (After Choosing Field Search Button)
3.0T MR750w (UA Series) Example shown



8.4.26. Click the [OK] button to finish the camera setup and close the Magnetic Field Camera Controls screen.

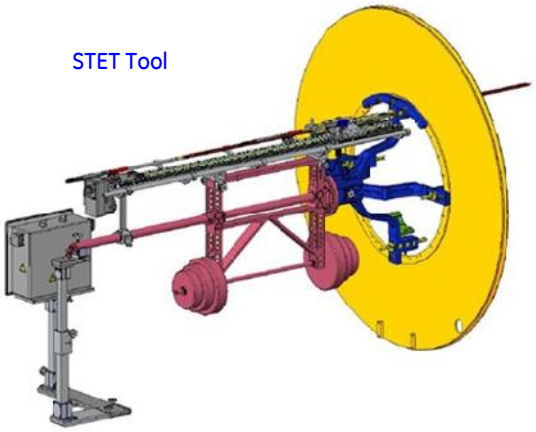
8.4.27. Proceed to Zeroing Currents in the BØ Coil.

8.5. Install Shim Tray Extraction Tool (STET)

8.5.1. This process applies ONLY for the 3.0T MR750w (UA Series) Magnet

8.5.2. The STET tool is to be at the 12 o'clock position and kept on the system during shimming.

8.5.3. Install the Shim Tray Extraction Tool (STET) according to the STET manual (5431810).



8.5.4. Once electrical center has been found, if the shimtray/STET at the ~10 or 2 o'clock position interferes with the mapping fixture bracket, follow these steps:

a. Use the Axial Positioning Screw Locking Wheel to keep the camera in the electrical center.

b. Continue to pull or push on the Camera Rotation Handle as necessary.

c. Remove the pole from the brackets.

d. Remove the Patient-End bracket from the Interface Ring, taking note of the thumbscrew setup (with or without washers.)

e. The shim ring on the gradient will be damaged if the shim tray knob is not released before extracting it with the STET tool. Make sure the shim tray knob is released before extracting it with the STET tool.

f. Complete the shim tray extraction (or insertion) at the ~10 and ~2 o'clock positions.

g. Once shim trays are back in the gradient, reapply the mapping fixture elements by reversing steps Step "e" through Step "a."

8.5.5. Proceed to Zeroing Currents in the BØ Coil.

8.6. Zeroing Currents in the BØ Coil

Induced current must be removed from the BØ coil before shimming the magnet. The BØ Coil Power Supply Kit (2141701) is used to quench the induced currents in the BØ Coil Circuit. The BØ Coil Power Supply is switchable from 115/230 VAC, 50/60 Hz. The BØ Coil current must be removed before each map/iteration or whenever a shim drawer has been moved during the shimming process. The BØ Power Supply is a ferrous tool and the appropriate precautions should be taken when approaching the magnet or working with the power supply around a ramped magnet.

8.6.1. Connect the BØ Coil Power Supply output cable to P304-1 on the magnet connector box.

8.6.2. Connect the BØ Coil Power Supply input cable between the power supply and the voltage source. Make sure the red switch underneath the power supply matches the input source (115 or 230 VAC).

8.6.3. Press the BØ Coil Power Supply switch (this switch is spring-loaded) and hold for one minute. The LED lights to indicate the power supply is supplying output current.

8.6.4. Wait for three minutes for the magnet to recover before taking a field map.

8.6.5. Do not move articles or equipment in the Magnet Room while shimming.

8.6.6. Proceed to Running Shim Tool – Field Map Acquisition.

8.7. Running Shim Tool – Field Map Acquisition

8.7.1. Items to Note:

- The magnet's center frequency must be stable in conformance with Field Stability Check before any alteration to the magnet's shims is made.
- Moving articles or equipment in the Magnet Room may affect readings of magnetic field strength.
- Locate the Mapping Fixture and Shim Camera at the magnet's approximate center in conformance with Preparations for Field Measurement before centering the Probe Array using ShimTool.
- Make sure you are using the correct 50 cm probe array for the magnet:
  - ◊ 1.5T MR450w (HM Series) Magnets: Use 2276277-14 (probe array marking: 64 MHz)
  - ◊ 1.5T LCCw (RD Series) Magnets: Use 2276277-14(probe array marking: 64 MHz)
  - ◊ 3.0T MR750w (UA Series) Magnets: Use 2276277-13 (probe array marking: 127 MHz)
- 1.5T MR450w (HM Series) magnet or 1.5T LCCw (RD Series) magnet ONLY: All shim drawers must be removed to center the probe.
- 3.0T MR750w (UA Series) Magnets ONLY: Set STET to the 12 o'clock position, and make sure it is fully retracted.

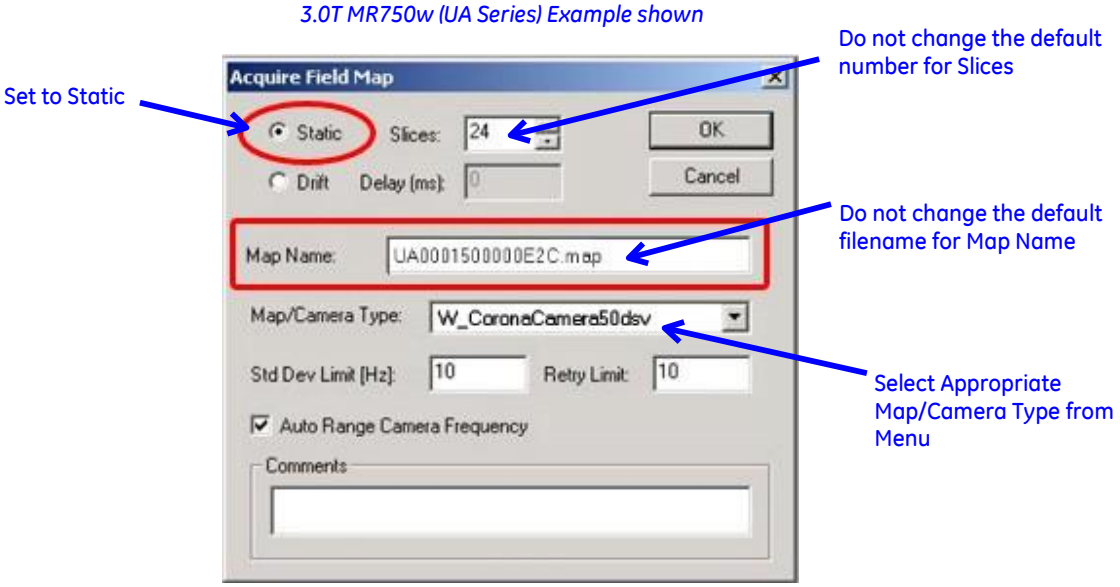
8.7.2. Click [Acquire Field Map] (fourth button from right) on the ShimTool main screen. (Shown below.)

Acquire Field Map Button on ShimTool Main Screen

8.7.3. Click the [Static] radio button on the Acquire Field Map screen (shown below), then select W_CoronaCamera50dsv (or appropriate) from the Map/Camera Type: drop-down menu.

- Do not change the default number for Slices:
- Do not change the default filename for Map Name:

Static Button on Acquire Field Map Screen
3.0T MR750w (UA Series) Example shown



8.7.4. Make sure the curved part of the field camera's probe array faces directly up (0° position).

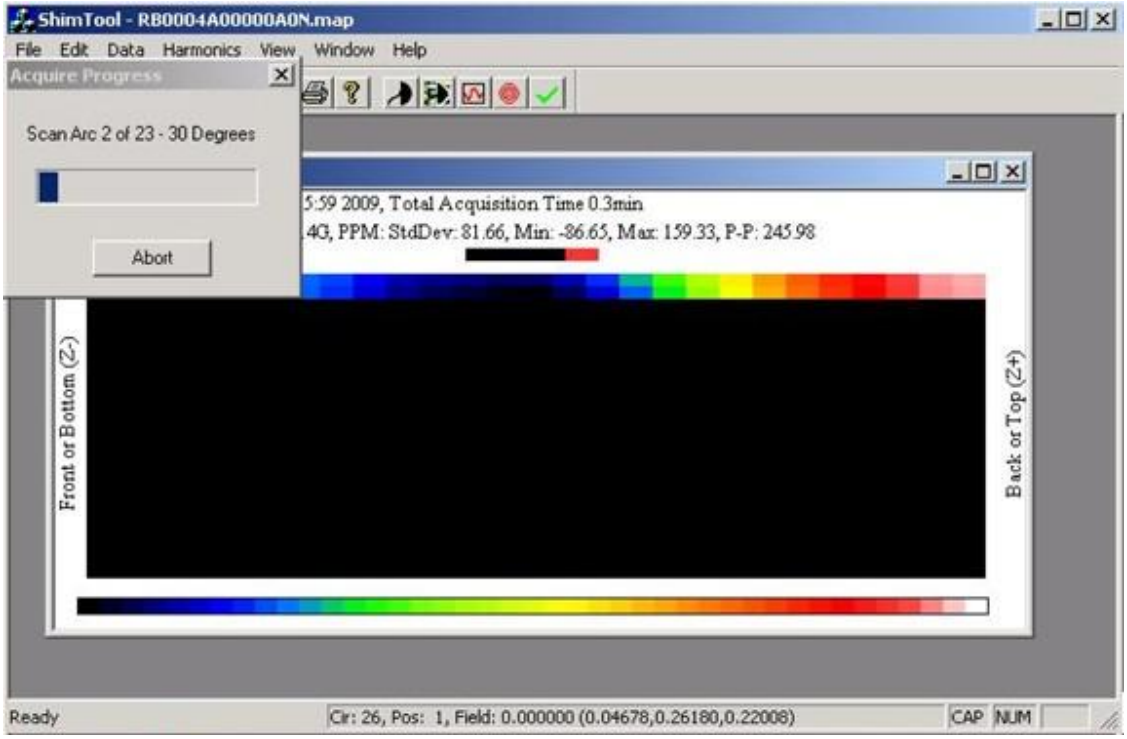
8.7.5. Moving any articles or equipment in or near the Magnet Room may affect the field map. Do not allow nonessential conversation/distractions during the map acquisition. If an error occurs during field map acquisition:

- Click the [Abort] button on the Acquire Progress window shown in Illustration below.
- Press the field camera's remote box switch one more time.
- Retake the map.

8.7.6. Click [OK] to begin mapping the magnet's magnetic field.

- The Field Map screen displays with the Acquire Progress window overlaid as shown below.
- The field camera's remote box switch should start to repeatedly flash.

Field Map Being Acquired



8.7.7. Press the field camera's remote box switch when it starts to flash repeatedly. (The light stops flashing and remains illuminated while the system acquires one slice of the field map. After the last slice, the light goes off).

8.7.8. When the camera's remote box switch starts to flash repeatedly again, slowly and smoothly rotate the camera one position (15°) clockwise.

8.7.9. Repeat the above two steps (copied below) to take 24 map slices: Slice 0 at 0°/360° through Slice 23 at 345°. Refer to Table "Field Camera Mapping Slices (Positions)" for a summary of the slices.

- Step 1: Press the field camera's remote box switch when it starts to flash repeatedly. (The light stops flashing and remains illuminated while the system acquires one slice of the field map. After the last slice, the light goes off).
- Step 2: When the camera's remote box switch starts to flash repeatedly again, slowly and smoothly rotate the camera one position (15°) clockwise.

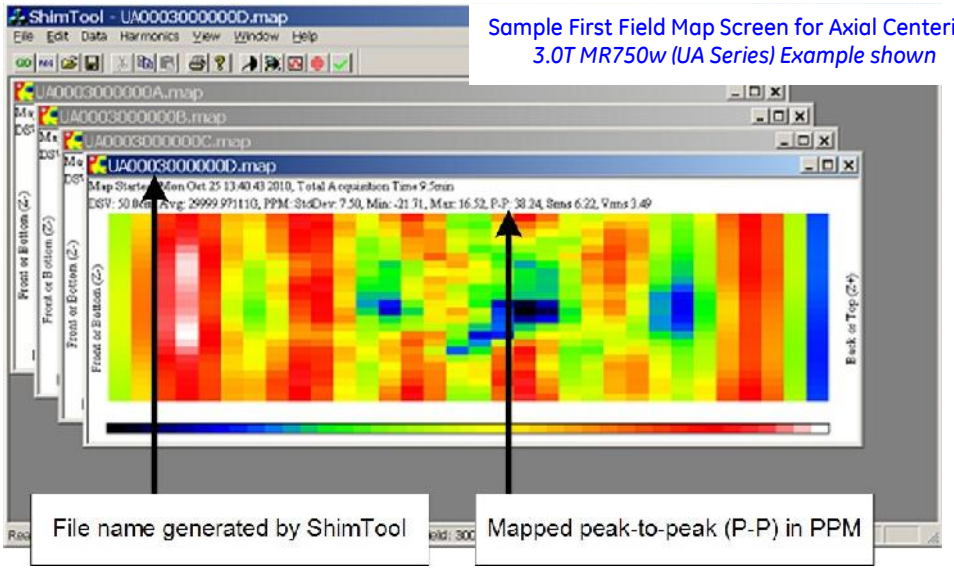
Field Camera Mapping Slices (Positions)

Slice/Arc Position	Degrees	Slice/Arc Position	Degrees	Slice/Arc Position	Degrees	Slice/Arc Position	Degrees
0	0/360	6	90	12	180	18	270
1	15	7	105	13	195	19	285
2	30	8	120	14	210	20	300
3	45	9	135	15	225	21	315
4	60	10	150	16	240	22	330
5	75	11	165	17	255	23	345

- The Slice/Arc Position number shown here and in ShimTool corresponds with the number stamped on the mapping fixture's positioning wheel.
- The remote box flashes slower at the 0/360°, 90°, 180° and 270° positions.

8.7.10. After taking all 24 slices, the finished map displays on the Field Map screen shown below. The ShimTool automatically assigns a sequential alphabetic filename (at the start of the map) to both the displayed map and the .map file it creates.

- For Magnet Series: and Number: entered on the Register Magnet Type screen: HM + 0009 becomes HM0009, RD + 0009 becomes RD0009, UA + 0009 becomes UA0009. (for example).
- A sequential alphabetic character A, B, ... C becomes: 0000A, 0000B, ... 0000C.
- For Test Cell: entered on the Register Magnet Type screen: Use W when shimming at a customer site.

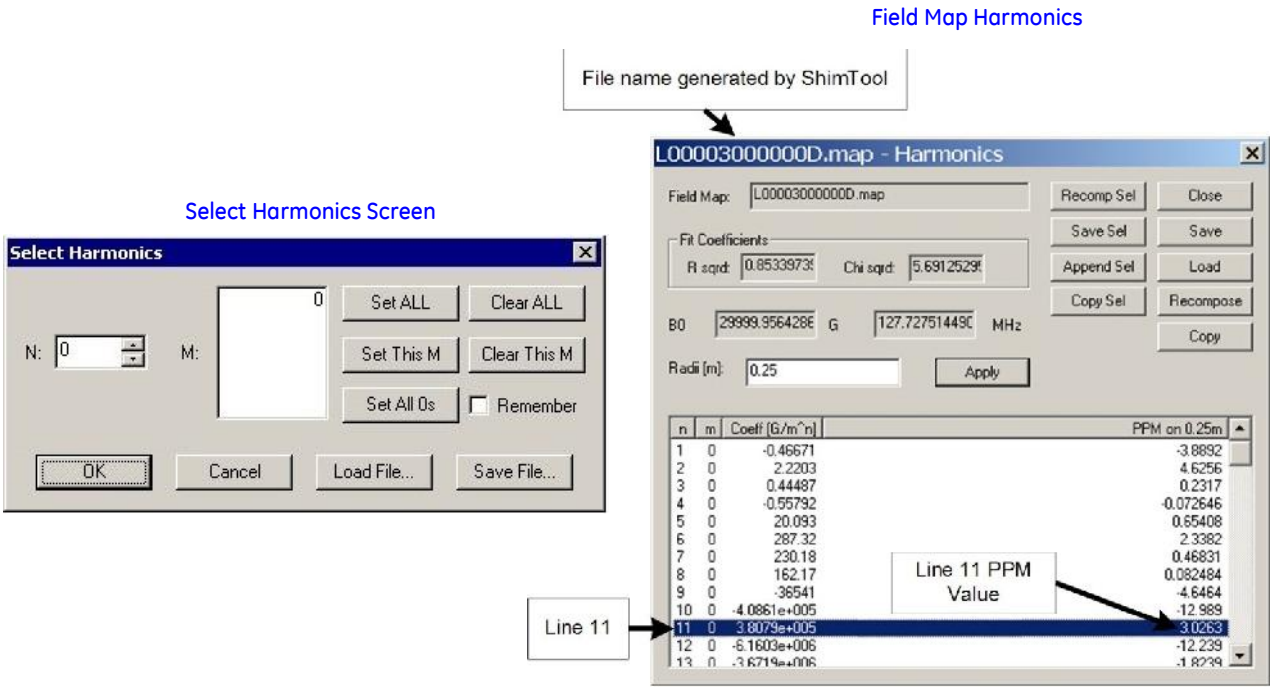


Sample First Field Map Screen for Axial Centering
3.0T MR750w (UA Series) Example shown

8.7.11. If this is the first field map taken since the mapping fixture was installed or moved in any substantial way, use this map to axially center the probe array. (To center the MR450w (HM Series) magnet and LCCw (RD Series), the shim trays need to be removed before taking the map used for centering.)

8.7.12. Select the Harmonics menu (fourth item from the left at the top of Field Map Screen (above) and click Decompose (F6).

8.7.13. Click [OK] when the Select Harmonics screen displays, shown below.



8.7.14. 1.5T MR450w (HM Series):

a. Look at the PPM value displayed on the right side of lines 9 and 11 when the Field Map Harmonics screen shown above displays.
   - ◊ If the PPM value on lines 9 and 11 is > -0.8 ppm and < +0.8 ppm, the probe array is centered axially. Proceed with "Reinsert shim trays in conformance with Shim Tray Insertion Section."
   - ◊ If the PPM value is outside of the desired specification noted, verify that the Positioning Wheel on the Mapping Fixture is in the groove labeled LCC (shown in Mapping Fixture Side View Illustration).

b. Divide the PPM value obtained above for line 9 by 1.2 and the value for line 11 by 1.4. (See example below.)
   - ◊ If the calculated values are significantly different, go back to verify mechanical centering and check that you are using the correct 50 cm probe array for the 1.5T MR450w (HM Series) and 1.5T LCCw (RD Series): Type HM32-500, 2276277-14.
   - ◊ If both mechanical centering and the correct probe array are being used and both of the harmonics cannot be brought to within ± 0.8 ppm, then require both to be of opposite signs and within one turn of center, i.e., the (9,0) within ± 1.2 ppm and (11,0) within ± 1.4 ppm, and proceed with "Reinsert shim trays in conformance with Shim Tray Insertion Section."

$$\frac{\text{PPM Value on Line 9}}{1.2} = \text{Number of Turns of Mapping Fixture's Axial Positioning Screw Required to Axially Center Probe Array}$$

$$\frac{\text{PPM Value on Line 11}}{1.4} = \text{Number of Turns of Mapping Fixture's Axial Positioning Screw Required to Axially Center Probe Array}$$

c. Loosen the Axial Positioning Screw Locking Wheel, carefully turn the Axial Positioning Screw (see Mapping Fixture Illustrations) the number of full turns calculated with the above formula, with either formula, or the average of both formulas.
   - ◊ For a positive (+) PPM value: Turn the Axial Positioning Screw clockwise.
   - ◊ For a negative (-) PPM value: Turn the Axial Positioning Screw counterclockwise.

d. Tighten the Locking Wheel.

e. Close the ShimTool Harmonics window(s).

f. Repeat process to verify axial centering of the probe array.

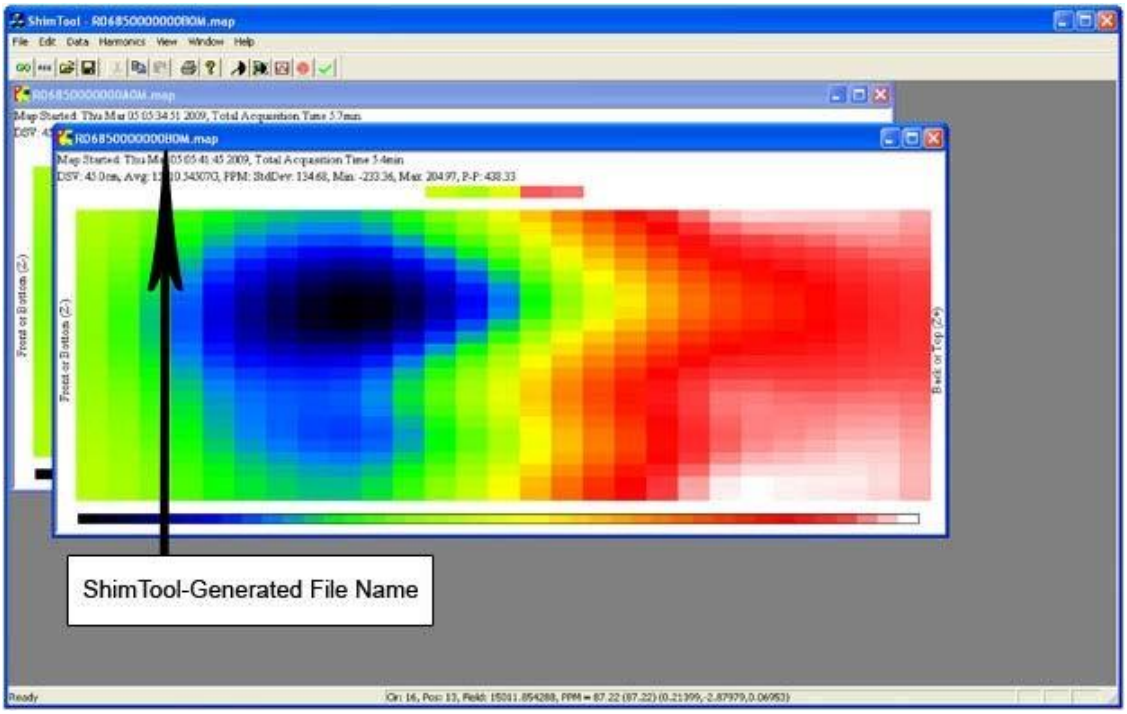
g. Once centered, reinsert shim trays in conformance with Shim Tray Insertion section.

h. Quench BØ.

i. Repeat "Running Shim Tool – Field Map Acquisition" process to acquire another field map.

j. See the ShimTool generated .map filename (shown below).

Sample Field Map Screen for Shimming



8.7.15. 1.5T LCCw (RD Series):

k. Look at the PPM value displayed on the right side of line 11 when the Field Map Harmonics screen shown above displays.
   - ◊ If the PPM value on line 11 is > -0.75 ppm and < +0.75 ppm, the probe array is centered axially. Proceed with "Reinsert shim trays in conformance with Shim Tray Insertion Section."
   - ◊ If the PPM value is outside of the desired specification noted, verify that the Positioning Wheel on the Mapping Fixture is in the groove labeled LCC (shown in Mapping Fixture Side View Illustration).

l. Divide the PPM value obtained above for line 11 by 2.6. (See example below.)
   - ◊ If the calculated values are significantly different, go back to verify mechanical centering and check that you are using the correct 50 cm probe array for the 1.5T LCCw (RD Series): Type HM32-500, 2276277-14.

$$\frac{\text{PPM Value on Line 11}}{2.6} = \text{Number of Turns of Mapping Fixture's Axial Positioning Screw Required to Axially Center Probe Array}$$

m. Loosen the Axial Positioning Screw Locking Wheel, carefully turn the Axial Positioning Screw (see Mapping Fixture Illustrations) the number of full turns calculated with the above formula, with either formula, or the average of both formulas.
   - ◊ For a positive (+) PPM value: Turn the Axial Positioning Screw clockwise.
   - ◊ For a negative (-) PPM value: Turn the Axial Positioning Screw counterclockwise.

n. Tighten the Locking Wheel.

o. Close the ShimTool Harmonics window(s).

p. Repeat process to verify axial centering of the probe array.

q. Once centered, reinsert shim trays in conformance with Shim Tray Insertion section.

r. Quench BØ.

s. Repeat "Running Shim Tool – Field Map Acquisition" process to acquire another field map.

8.7.16. 3.0T MR750w (UA Series):

a. Look at the PPM value displayed on the right side of line 11 when the Field Map Harmonics screen displays.
   - ◊ If the PPM value on line 11 of the .map file is within 0.4 ppm of the value obtained in Florence (found in the Field Report (ATR) and/or in the latest .hrm file), the probe is centered axially. Proceed to "Record the ShimTool generated .map filename (shown below) into Shimming Process Data and Passive Shimming Data" below.
   - ◊ If the PPM value is outside of the 0.4 ppm spec, verify that the Positioning Wheel on the Mapping Fixture is in the groove labeled LCC.

b. Subtract the PPM value obtained in Florence from the PPM value obtained above. This determines the number of probe turns required for axial centering.

Example:

Current axial 11 value = **-3.026** Axial 11 value from Florence = **2.09**

-3.026 ppm – (**2.09** ppm) = **5.116** turns

In this case, the probe must be rotated approximately 5 turns for centering.

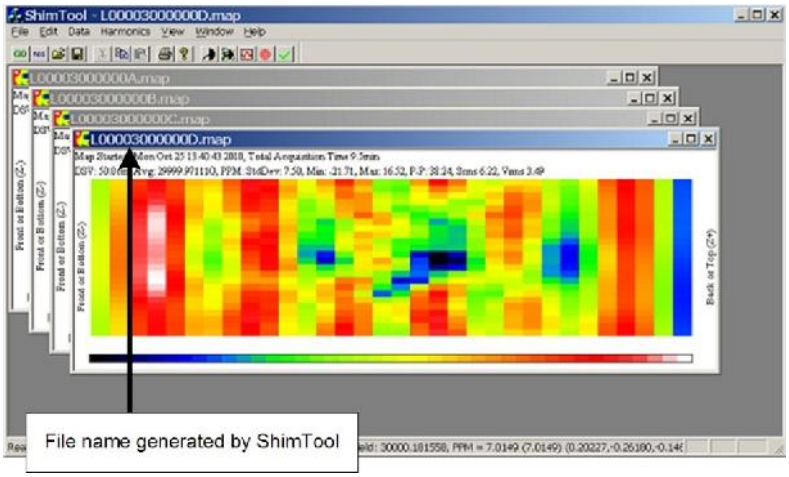
c. Loosen the Axial Positioning Screw Locking Wheel, carefully turn the Axial Positioning Screw the number of full turns calculated with the above formula, with either formula, or the average of both formulas.
   - ◊ To create a more positive (+) PPM value: Turn the Axial Positioning Screw counterclockwise.
   - ◊ To create a more negative (-) PPM value: Turn the Axial Positioning Screw clockwise.

d. Tighten the Locking Wheel.

e. Repeat process to verify axial centering of the probe array.

f. Close the ShimTool Harmonics window(s).

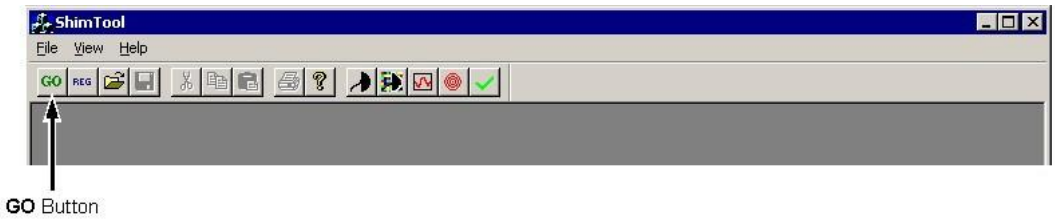
Sample Field Map Screen for Shimming



8.8. Running Shim Tool - Acquiring a Shim File

8.8.1. Click [GO] (button farthest left) on the ShimTool main screen, shown below.

GO Button on ShimTool Main Screen



8.8.2. If the following menu appears, click [Shim or Reshim a Magnet], and then click [GO].

8.8.3. When the Select the Type of Shim to Perform screen (shown below) displays:

a. Check that the Magnet Type: field reads Cylindrical.

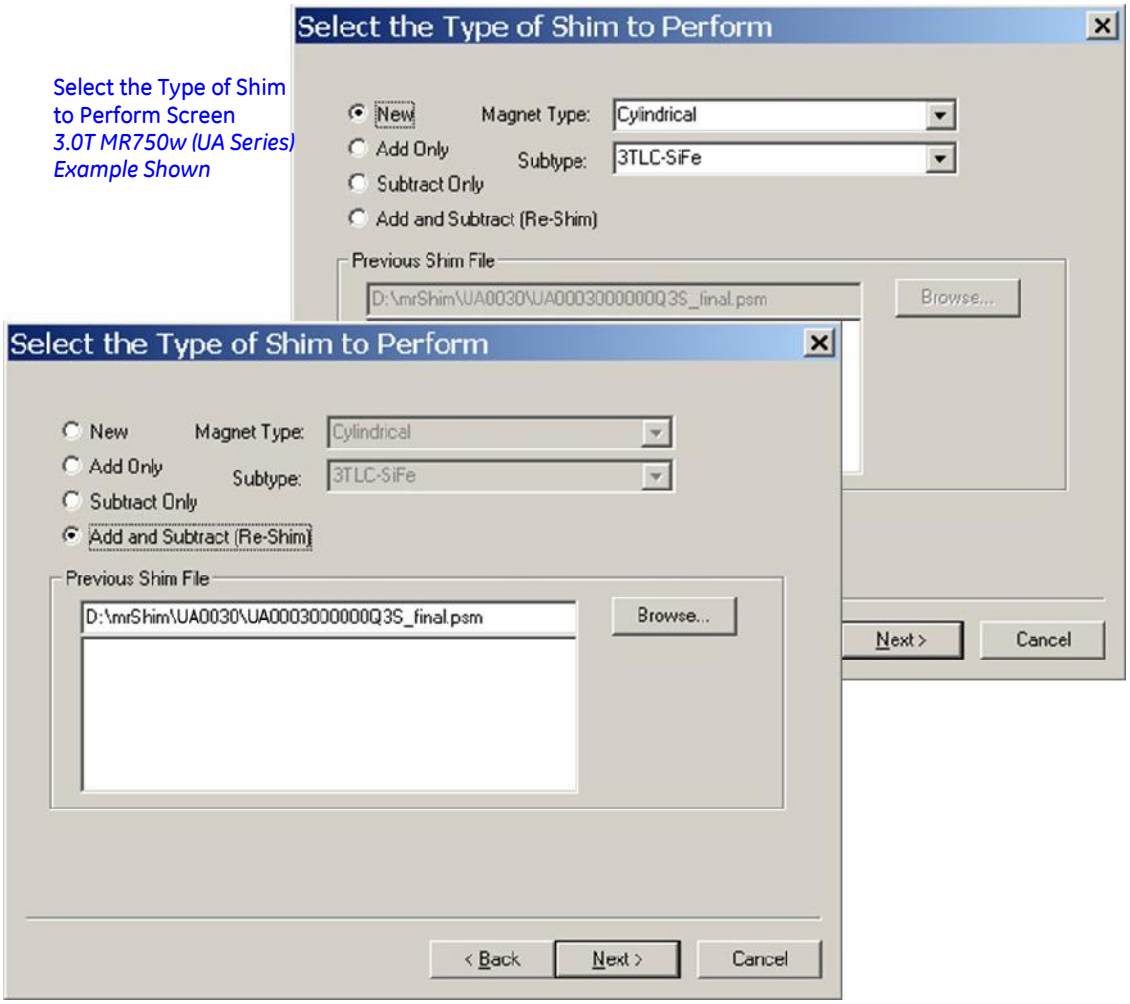
b. Select the appropriate Subtype:

- ◊ 1.5T MR450w (HM Series): DVw_SiFe
- ◊ 1.5T LCCw (RD Series): LCCw_SiFe
- ◊ 1.5T LCCw (RD Series) with BRM2: LCCw_BRM2_SiFe
- ◊ 3.0T MR750w (UA Series): 3TLC_SiFe

c. Check the [Add and Subtract (ReShim)] radio button.

d. (ShimTool can only run with the [New] radio button selected at the factory.)

Select the Type of Shim to Perform Screen
3.0T MR750w (UA Series)
Example Shown



Magnet Subtype and Calibration File Choices

Series	Positions	Correct Choices		
		Magnet Subtype	Passive Calibration File	Active Calibration
HM	45	DVw_SiFe	DVw_PassiveSiFe.cal	Disabled
RD	45	LCCw_SiFe	LCCw_PassiveSiFe.cal	Disabled
UA	45	3TLC_SiFe	3TLC_PassiveSiFe.cal	Disabled
RD	45	LCCw_BRM2_SiFe	LCCw_BRM2_PassiveSiFe.cal	Disabled

Directory Path, Filenames and File Format

Magnet	Series	File Type	Directory Path to File	
			C Drive	D Drive
DVw_ SiFe	HM	Passive	C:\MRshim\HM####0\HM#### 0.psm	D:\MRshim\HM####0\HM#### 0.psm
		Map	C:\MRshim\HM####0\HM#### 0.map	D:\MRshim\HM####0\HM#### 0.map
LCCw_SiFe/ LCCw_BRM2_SiFe	RD	Passive	C:\MRshim\RD####0\RD#### 0.psm	D:\MRshim\RD####0\RD#### 0.psm
		Map	C:\MRshim\RD####0\RD#### 0.map	D:\MRshim\RD####0\RD#### 0.psm
3TLC_ SiFe	UA	Passive	C:\MRshim\UA####0\UA#### 0.psm	D:\MRshim\UA####0\UA#### 0.psm
		Map	C:\MRshim\UA####0\UA#### 0.map	D:\MRshim\UA####0\UA#### 0.map

Format for Directory Path: Drive letter + :\MRshim\ + seven character (maximum) subdirectory name + \ + filename.
Format for Seven-Character Subdirectory Name: Series number (box beside Series: + Magnet number (box beside Number:) + Helium vessel number (assigned at the factory).

e. Avoid using incorrect filenames.
f. Keep track of filenames and iterations used (and what they were used for).

8.8.4. If the output file is not located as stated in Table "Directory Path, Filenames and File Format" and the full path to the correct shim file cannot be recalled, click [Browse], locate the correct file, select it, and open the file.

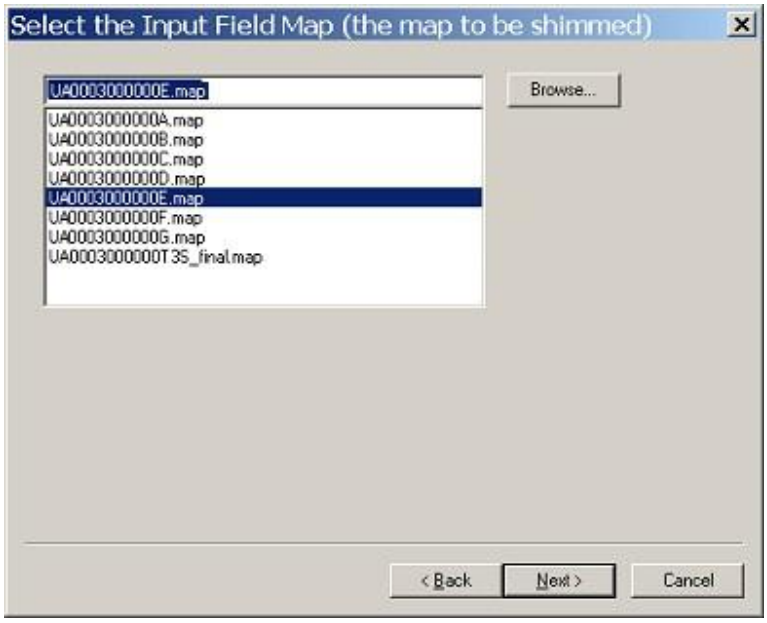
8.8.5. Accurately select the "Previous Shim File" name (the last file with a .PSM extension) from the list beside "Previous Shim File".

8.8.6. Check that all information on the Select the Type of Shim to Perform screen (see Illustration Select the Type of Shim to Perform Screen, above) is accurate, then click [Next >].

8.8.7. When the Select the Input Field Map screen (see below) displays, accurately enter the filename of the last field map with .map extension taken in Section Field Map Acquisition.

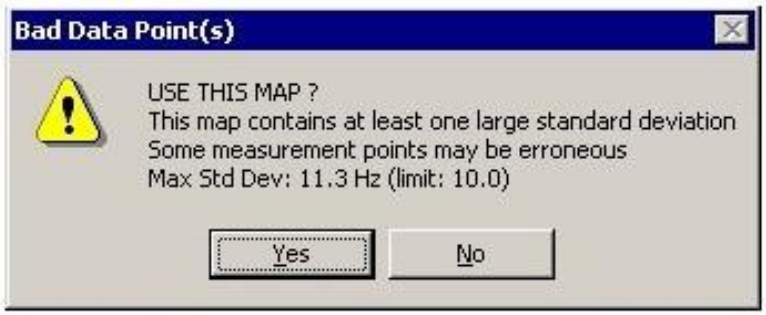
- If the output file is not located as stated in Table "Directory Path, Filenames and File Format" and the full path to the correct map file cannot be recalled, click [Browse], locate the correct file, select it, and open the file.

Select the Input Field Map Screen

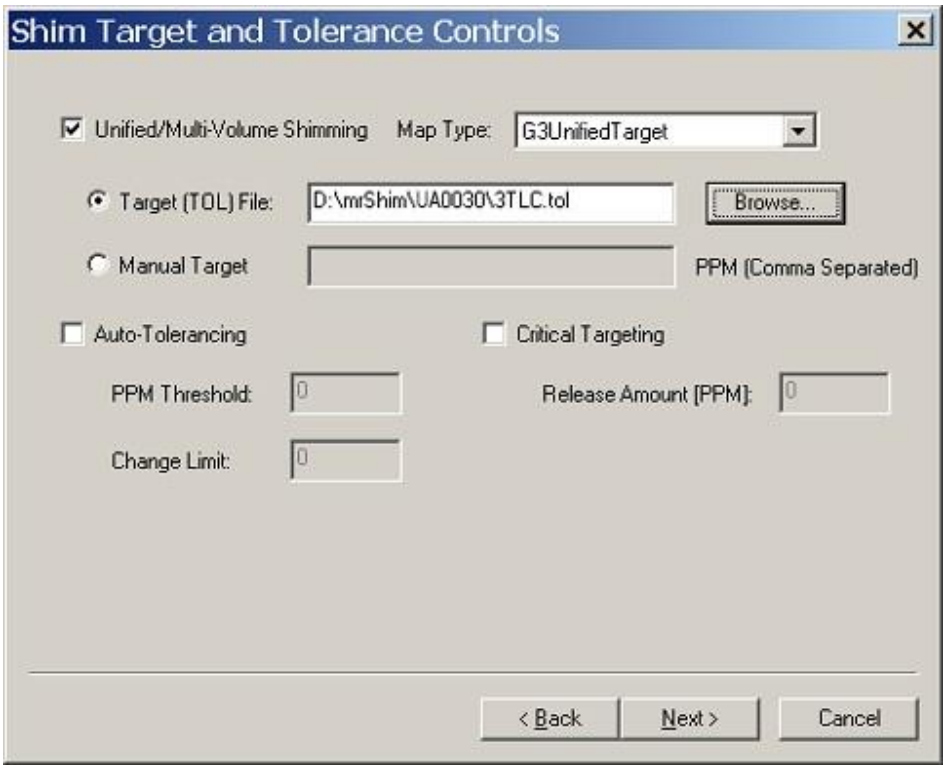


8.8.8. Click [Next >].

- The ShimTool looks at the data contained in the file specified earlier.
- If that map file contains bad data, the alert shown below displays. (If the specified map file is good, this alert should not display.)
- Click [No], and retake the map in conformance with Section Field Map Acquisition. Ensure that all connections are good and the cable is not wrapping around the mapping fixture.



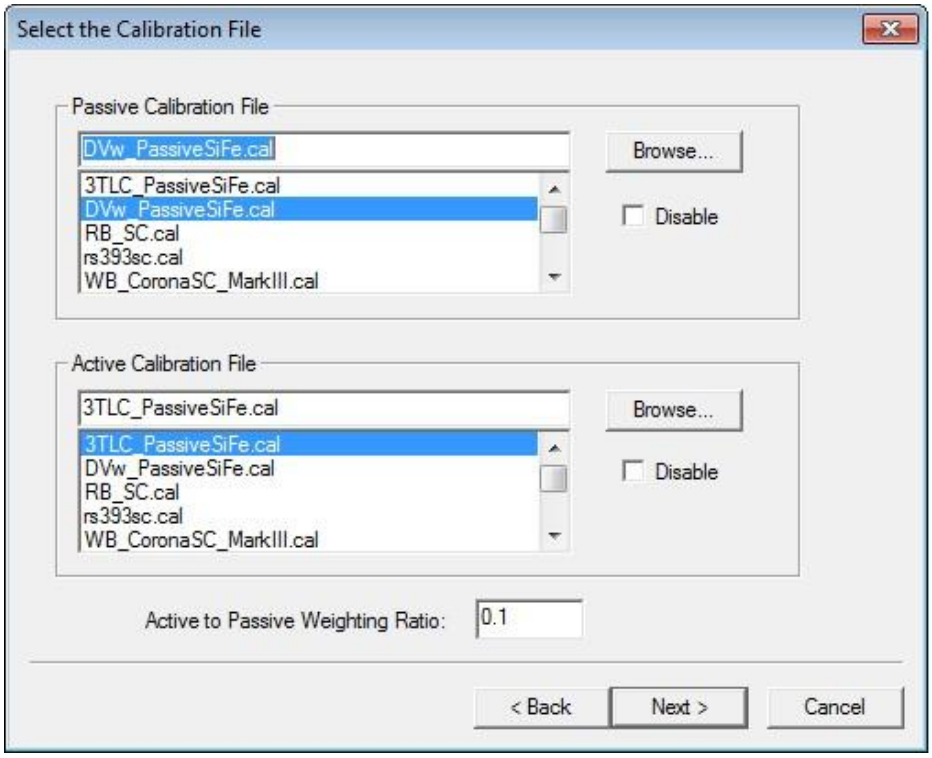
8.8.9. Click the [Unified/Multi-Volume Shimming] radio button when the Shim Target and Tolerance Controls screen (3.0T MR750w (UA Series) example shown below) displays.



Shim Target and Tolerance Controls

Magnet type	Map Type	Tolerance File	Path to Tolerance File C Drive	Path to Tolerance File D Drive
HM Series	DVw-45fov-Unified	DVw.tol	C:\MRshim\ShimTool\DVw.tol	D:\MRshim\ShimTool\DVw.tol
RD Series	LCCw-4vol-Unified	LCCw.tol LCCw_T17.tol	C:\MRshim\ShimTool\LCCw.tol	D:\MRshim\ShimTool\LCCw.tol
UA Series	G3UnifiedTarget	3TLC.tol	C:\MRshim\ShimTool\3TLC.tol	D:\MRshim\ShimTool\3TLC.tol
If the correct tolerance file is not located in above file structure and the full path to the correct location cannot be recalled, click [Browse], locate the correct file, select it, and open the file. **Note:** A new tolerance file "LCCw_T17.tol" is introduced for RD magnet with BRM2 gradient coil configuration. "LCCw_T17.tol" is only available in shimming software (GE PN 5102783) version 17 and above. For RD magnet with VRMw gradient coil, the tolerance file should be "LCCw.tol".				

8.8.10. Click [Next >] to proceed to the Select the Calibration File screen (example shown below).



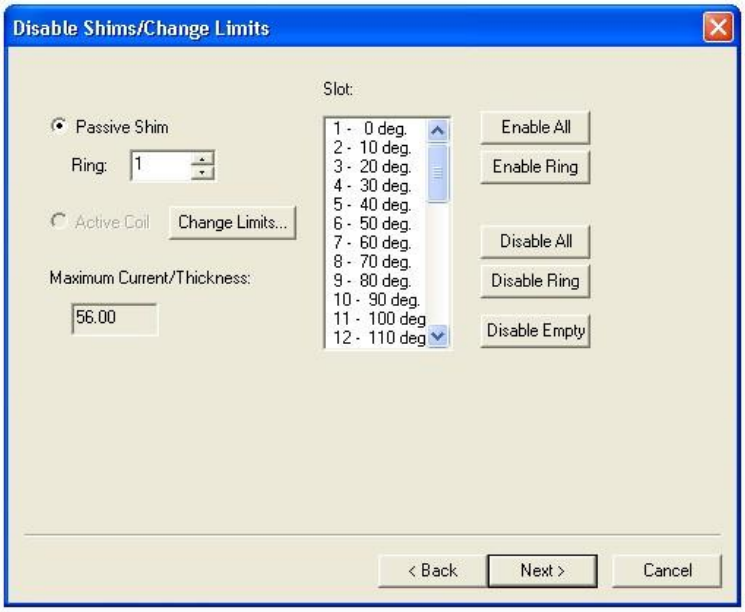
8.8.11. Select the .cal file from the Passive Calibration File scrolling list (see above) to match the file stated in the .psm on included CD and the magnet subtype. (Table "Magnet Subtype and Calibration File Choices" shows the correct selection choices.)

- If the Passive Calibration file does not display in the scrolling list, click [Browse], locate the correct file, select it, and open it.
- The path to the calibrations files should be D:\MRshim\Shimtool*.cal (where the * represents the correct calibration file as stated in Table "Magnet Subtype and Calibration File Choices)." (Note that some installations/operating systems may use the C:\ drive instead of the D:\ drive.)

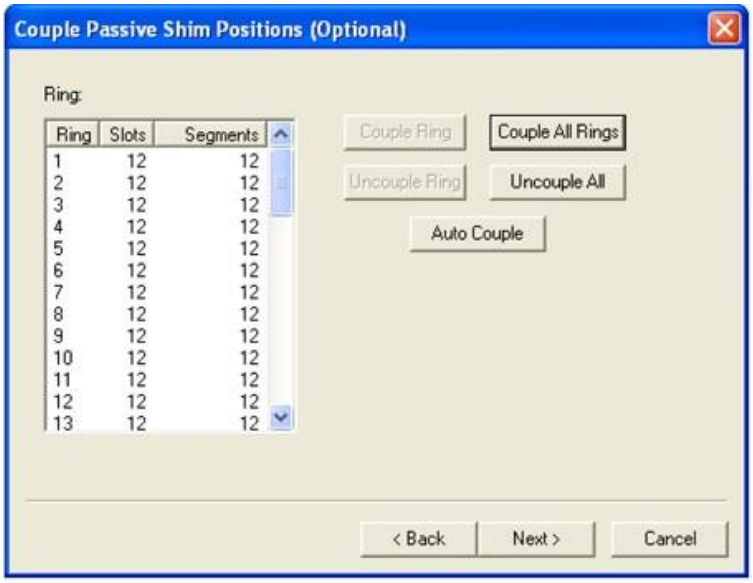
8.8.12. Click [Disable] next to Active Shim Calibration File.

8.8.13. Click [Next >].

8.8.14. If the Disable Shims/Change Limits screen appears (example shown below), Click [Next>] without making changes.

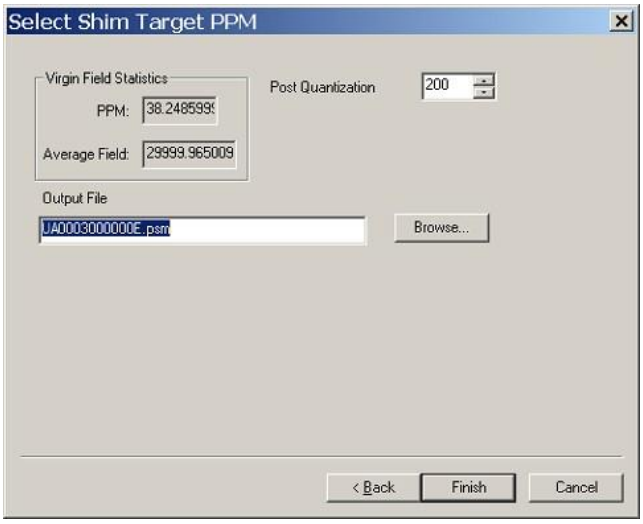


8.8.15. If the Couple Passive Shim Positions (Optional) screen appears (shown below), Click [Next>] without making changes.



8.8.16. Check that the Output File name on the Select Shim Target PPM screen (see example below) that displays next matches the .map filename, but with a .psm extension.

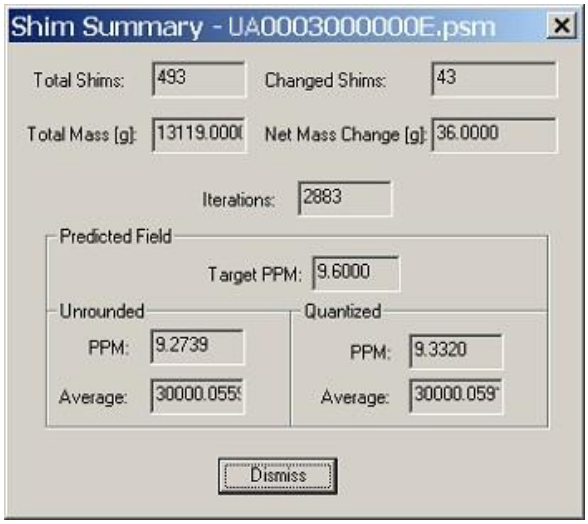
- Make no other changes on this screen.
- If the output file is not located as stated in Table "Directory Path, Filenames and File Format" and the full path to the correct map file cannot be recalled, click [Browse], locate the correct .map file, select it, and open the file.
- Once opened, change the file extension to .psm.



8.8.17. Click [Finish] to begin processing the shimming information with ShimTool.

- A Shim Status window displays while the ShimTool is processing, and closes when processing is completed.

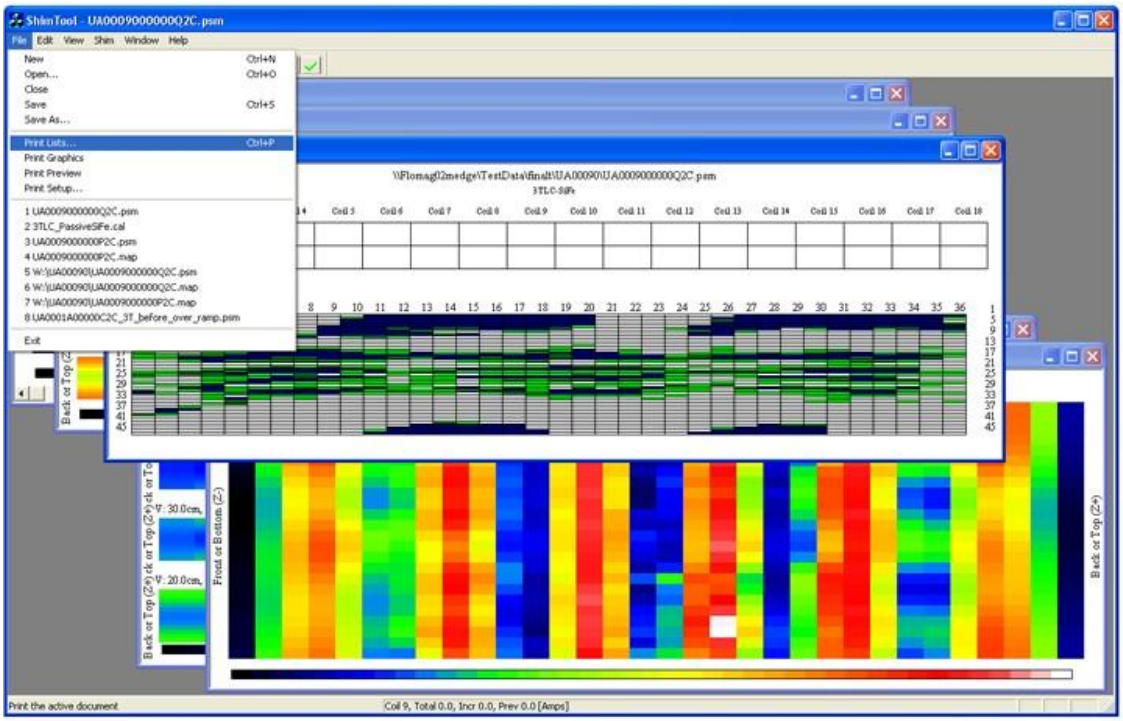
8.8.18. Click [Dismiss] when the Shim Summary screen (similar to below) displays.



8.8.19. When the more complete display of the shim iteration results displays (similar to Illustration below), print the ShimTool results.

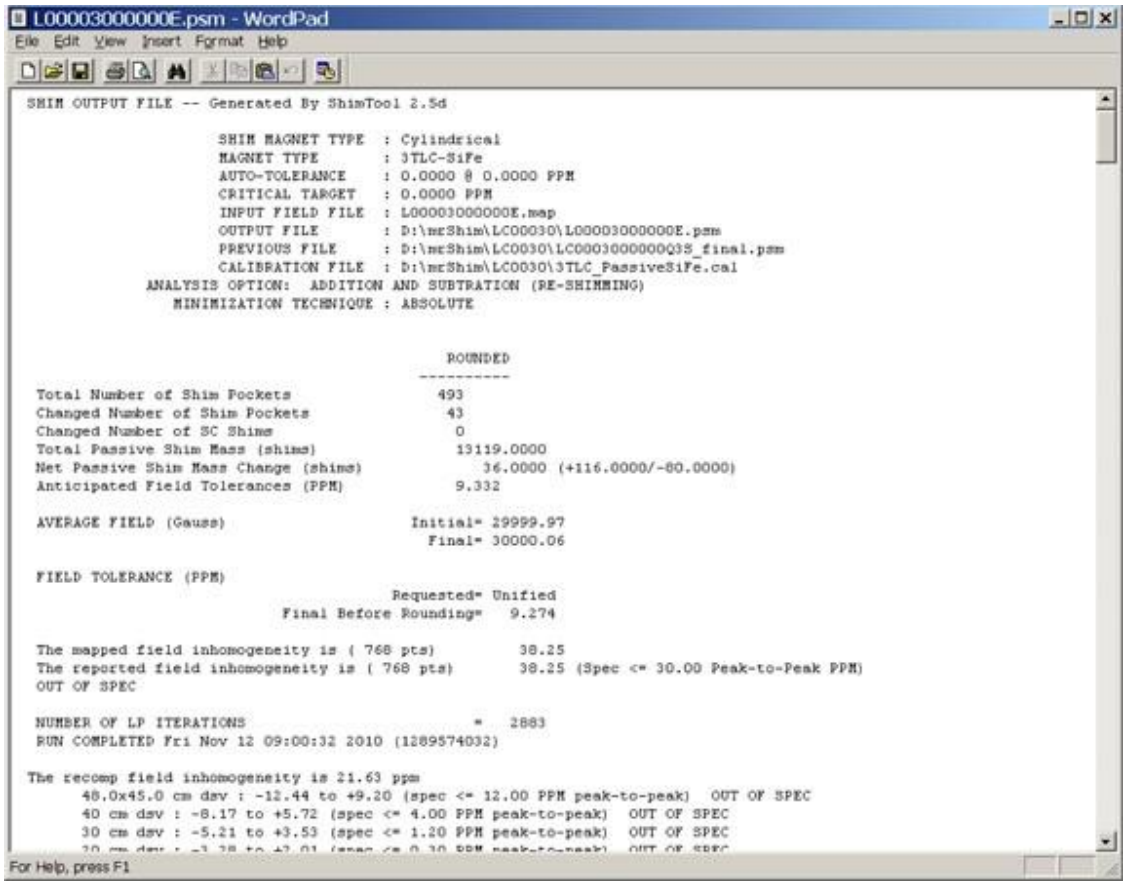
- Illustrations show the D:\ drive directory paths used by ShimTool installations. (Note that some installations/operating systems may use the C:\ drive instead of the D:\ drive.)
- The .PSM text file is automatically saved by the ShimTool.

Shim Iteration Results Displays



- One can print the file from NotePad, WordPad, or a word processor for pages similar to Illustration below.
- ShimTool can open previously saved files for on-screen viewing by selecting Show the output SHM file from the Shim menu.

Sample ShimTool Text File



```
L00003000000E.psm - WordPad
File Edit View Insert Format Help

SHIM OUTPUT FILE -- Generated By ShimTool 2.5d

                    SHIM MAGNET TYPE  : Cylindrical
                    MAGNET TYPE       : 3TLC-SiFe
                    AUTO-TOLERANCE    : 0.0000 @ 0.0000 PPM
                    CRITICAL TARGET   : 0.0000 PPM
                    INPUT FIELD FILE  : L00003000000E.map
                    OUTPUT FILE       : D:\mrShim\LC00030\L00003000000E.psm
                    PREVIOUS FILE     : D:\mrShim\LC0030\LC00030000000Q3S_final.psm
                    CALIBRATION FILE  : D:\mrShim\LC0030\3TLC_PassiveSiFe.cal
            ANALYSIS OPTION:  ADDITION AND SUBTRATION (RE-SHIMMING)
               MINIMIZATION TECHNIQUE : ABSOLUTE


                                          ROUNDED
                                         ----------
 Total Number of Shim Pockets              493
 Changed Number of Shim Pockets             43
 Changed Number of SC Shims                  0
 Total Passive Shim Mass (shims)             13119.0000
 Net Passive Shim Mass Change (shims)           36.0000 (+116.0000/-80.0000)
 Anticipated Field Tolerances (PPM)          9.332

 AVERAGE FIELD (Gauss)                    Initial= 29999.97
                                            Final= 30000.06

 FIELD TOLERANCE (PPM)
                                        Requested= Unified
                            Final Before Rounding=   9.274

 The mapped field inhomogeneity is ( 768 pts)        38.25
 The reported field inhomogeneity is ( 768 pts)      38.25 (Spec <= 30.00 Peak-to-Peak PPM)
 OUT OF SPEC

 NUMBER OF LP ITERATIONS                       =   2883
 RUN COMPLETED Fri Nov 12 09:00:32 2010 (1289574032)

The recomp field inhomogeneity is 21.63 ppm
      48.0x45.0 cm dsv : -12.44 to +9.20 (spec <= 12.00 PPM peak-to-peak)  OUT OF SPEC
      40 cm dsv : -8.17 to +5.72 (spec <= 4.00 PPM peak-to-peak)  OUT OF SPEC
      30 cm dsv : -5.21 to +3.53 (spec <= 1.20 PPM peak-to-peak)  OUT OF SPEC
For Help, press F1
```

8.8.20. To obtain a multi-page paper version of the ShimTool results that look similar to Illustration below:

- Select Print Lists... from the File menu (select landscape mode), and
- Click [OK].
- The multi-page paper version is easier to use while placing shims in the shim trays.
- Passive Shims–Incremental Rounded Shim information on Page 3 and Passive Shims–Total Rounded Shim information on Page 4 of the ShimTool printout (see Illustrations below) is the same information contained under Incremental–Quantized (for Incremental Rounded Shim) and Total–Quantized (for Total Rounded Shim) in the .psm file (see Illustrations below, which now shows the amount of change and the resulting total at each shim position to be changed).

Sample ShimTool Printed Report - Pages 1 and 2

D:\HDw\45cmFOV\HM0001 Shimfiles\MKE-Files\HM0007000000H13.psm
DVw-SiFe
Pg. 1 of 4

Shim File :	D:\HDw\45cmFOV\HM0001 Shimfiles\MKE-Files\HM0007000000H13.psm
Magnet Type :	Cylindrical - DVw-SiFe
Shim Solution Time :	Fri May 22 17:27:43 2009
Total Number of Shims Positions:	285
Changed Number of Shims Positions:	13
Total Shim Mass :	3335.0000 mil
Net Mass Change :	0.0000 (+7.0000/-7.0000) mil
Anticipated Field Inhomogeneity :	0.000 PPM

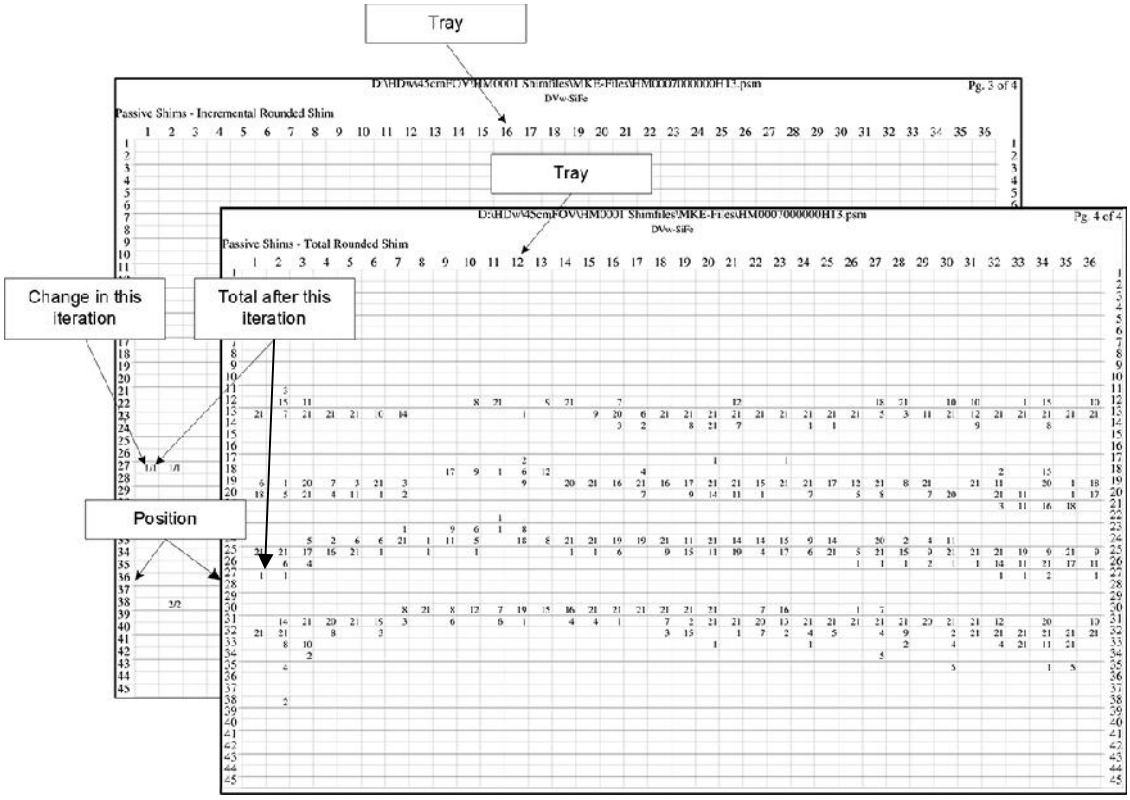
Input Field Fil
Previous File :

D:\HDw\45cmFOV\HM0001 Shimfiles\MKE-Files\HM0007000000H13.psm
DVw-SiFe
Pg. 2 of 4

Active Shim Currents

Coil / Supply	Previous	Change	New
Coil 1	0.000 A	0.000 A	0.000 A
Coil 2	0.000 A	0.000 A	0.000 A
Coil 3	0.000 A	0.000 A	0.000 A
Coil 4	0.000 A	0.000 A	0.000 A
Coil 5	0.000 A	0.000 A	0.000 A
Coil 6	0.000 A	0.000 A	0.000 A
Coil 7	0.000 A	0.000 A	0.000 A
Coil 8	0.000 A	0.000 A	0.000 A
Coil 9	0.000 A	0.000 A	0.000 A
Coil 10	0.000 A	0.000 A	0.000 A
Coil 11	0.000 A	0.000 A	0.000 A
Coil 12	0.000 A	0.000 A	0.000 A
Coil 13	0.000 A	0.000 A	0.000 A
Coil 14	0.000 A	0.000 A	0.000 A
Coil 15	0.000 A	0.000 A	0.000 A
Coil 16	0.000 A	0.000 A	0.000 A
Coil 17	0.000 A	0.000 A	0.000 A
Coil 18	0.000 A	0.000 A	0.000 A

Sample ShimTool Printed Report - Passive Shimming, Pages 3 and 4



8.8.21. Use these ShimTool results for Section Passive Shim Installation.

8.8.22. Shim mass (shims) refers to the total number of shims in all shim tray positions.

8.8.23. Compare the volumes listed under The recomp field inhomogeneity is … (see Illustration "Sample ShimTool Text File") to the specifications shown below.

1.5T MR450w (HM Series) Volumetric Specifications	
Elliptical Volume	Peak-to-Peak ppm Specification
50 x 45 cm	≤ 25 ppm (peak to peak)
45 x 40 cm	≤ 10 ppm (peak to peak)
42 x 36 cm	≤ 4 ppm (peak to peak)
30 x 27 cm	≤ 1 ppm (peak to peak)
20 x 18 cm	≤ 0.5 ppm (peak to peak)

1.5T LCCw (RD Series) Volumetric Specifications	
Spherical Volume	Peak-to-Peak ppm Specification
45 cm DSV	≤ 12 ppm (peak to peak)
40 cm DSV	≤ 4 ppm (peak to peak)
30 cm DSV	≤ 1 ppm (peak to peak)
20 cm DSV	≤ 0.5 ppm (peak to peak)

3.0T MR750w (UA Series) Volumetric Specifications	
Elliptical Volume	Peak-to-Peak ppm Specification
48 x 45 cm DSV	≤ 12 ppm (peak to peak)
40 cm DSV	≤ 4 ppm (peak to peak)
30 cm DSV	≤ 1.2 ppm (peak to peak)
20 cm DSV	≤ 0.3 ppm (peak to peak)

8.8.24. If all volumes listed under "The recomp field inhomogeneity is ..." are within specification, the magnet is shimmed and if the screen shown below displays, Click [No].

- Check the PPM values to spec to ensure values are in spec
- Exit the ShimTool
- Proceed with Shim Finalization.
- (The Congratulations! screen indicates the magnet is shimmed to within specification. Writing a Field Report (ATR) file is not needed after the magnet has left the factory.)

8.8.25. If any volume listed under "The recomp field inhomogeneity is ..." is not within specification:

- Install the passive shims called for by ShimTool in conformance with Section Passive Shim Installation.
- Once the passive shims are installed, remove the currents from the BØ coil in conformance with Section Zeroing Currents in the BØ Coil.
- Return to Section Field Map Acquisition to take a new map and run the ShimTool for passive shimming.

8.9. 1.5T MR450w (HM Series) and 1.5 LCCw (RD Series): Passive Shim Installation/Removal

8.9.1. Do not attempt to passive shim a 1.5T DVw (HM Series) or a 1.5T LCCw (RD Series) magnet without reading, understanding, and following ALL safety alerts and requirements associated with the shimming process.

8.9.2. Slide the DVw shim tray puller (5325761) over the shim tray to be removed and align the center post with the hole on the shim tray handle. Rotate the puller 90 degrees counterclockwise to secure/release the connection, shown below.

8.9.3. Carefully pull the shim tray straight out from its track, and have the work assistant hold onto the tray as soon as possible, shown below.

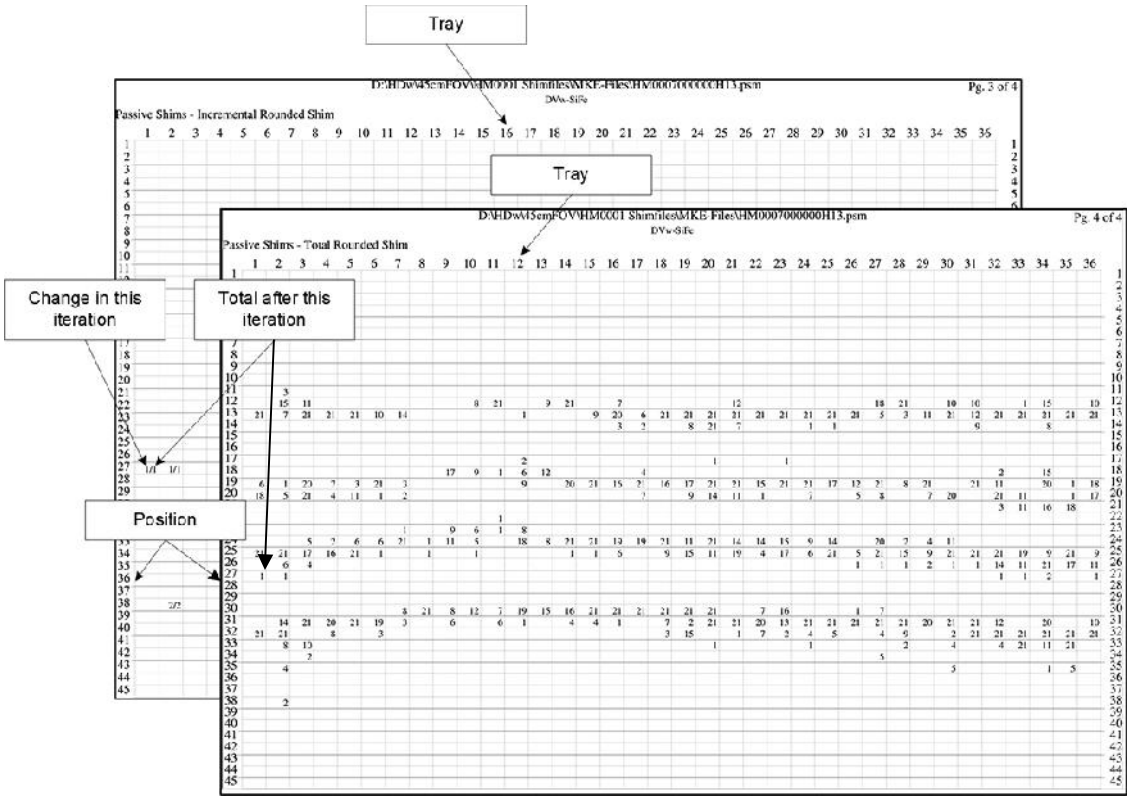
Shim Tray Removal

8.9.4. Work Assistant: Securely hold the shim tray, and carry the tray and the puller away from the magnet's field to a shim tray loading area in another room. Load shims into the shim tray in a room away from the magnet's field.

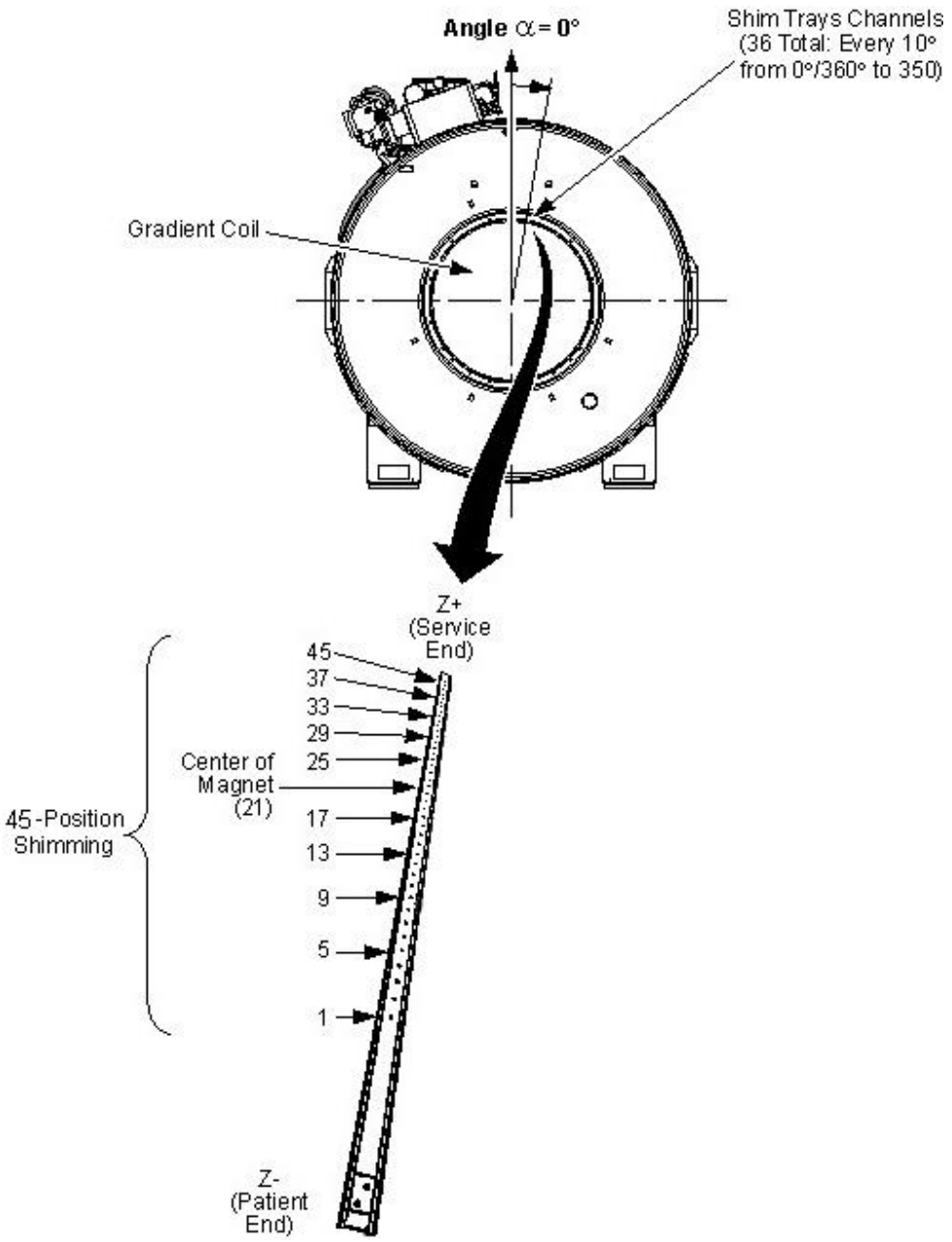
8.9.5. First person: Identify which component shims are required to meet the incremental shim mass change specified by ShimTool for each position in each tray.

- See Illustration "Sample ShimTool Printed Report, Pages 3 and 4" for a sample ShimTool shimming report, Illustration "Shim Tray Layout" for the DVw and LCCw shim tray layout, and Illustration "Assembly of Component Shims Per Shim Position" for assembly of component shim per shim position.
- Illustration "Sample ShimTool Printed Report, Pages 3 and 4" shows the D:\ drive directory paths used by ShimTool installations. (Note that some installations/operating systems may use the C:\ drive instead of the D:\ drive.)

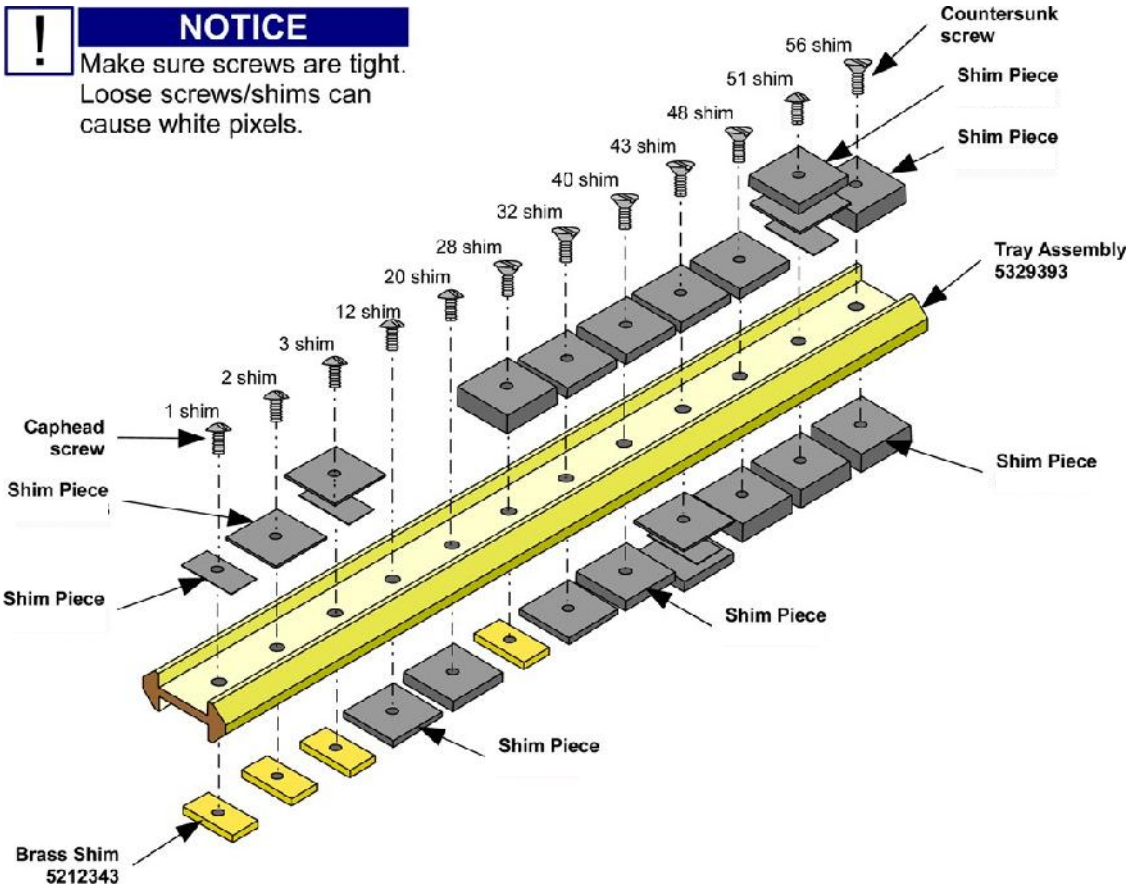
Sample ShimTool Printed Report - Passive Shimming, Pages 3 and 4



Shim Tray Layout



Assembly of Component Shims Per Shim Position



Shims

Shim Size	Thread Status	Color	Part Number
1 Shim	Feed-Through	Orange	5430878-4
2 Shim	Feed-Through	Grey	5430878-3
4 Shim	Feed-Through	Pink	5430878-9
8 Shim	Feed-Through	Light Green	5430878-10
12 Shim	Threaded	Green	5430878
20 Shim	Feed-Through	Black	5430878-6
20 Shim	Threaded	Black	5430878-5
28 Shim	Feed-Through	Grey	5430878-2
28 Shim	Threaded	Grey	5430878-7

- Do not stack shims on top of Size 28 shims.
- Use only shims with the part numbers shown above. Do not use shim material that may have been used on other systems.
- Size 1, Size 12 and Size 20 may be grey in older magnets.
- Size 4 and Size 8 are used for factory shimming only and may be reused in the field, if available.
- If there is a 5430878-2 or 5430878-7 shim at a position on one side of the shim tray, do not stack other shims on that side at the same position.

Shim Combinations (Number of Shims 1 through 14)

	Shims Requested													
Parts Used	1	2	3	4	5	6	7	8	9	10	11	12	13	14
5430878-4 (Size 1 Shim)	1		1		1		1		1		1		1	
5430878-3 (Size 2 Shim)		1	1	2	2	3	3	4	4	5	5			1
5430878-9 (Size 4 Shim)														
5430878-10 (Size 8 Shim)														
5430878 (Size 12 Shim)												1	1	1
5430878-5 (Size 20 Shim)														
5430878-6 (Size 20 Shim)														
5430878-7 (Size 28 Shim)														
5430878-2 (Size 28 Shim)														
Cap Screw (1) or Countersunk Screw (2)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5212343	1	1	1	1	1	1	1	1	1	1	1			

Shim Combinations (Number of Shims 15 through 28)

	Shims Requested													
Parts Used	15	16	17	18	19	20	21	22	23	24	25	26	27	28
5430878-4 (Size 1 Shim)	1		1		1		1		1		1		1	
5430878-3 (Size 2 Shim)	1	2	2	3	3			1	1	2	2	3	3	
5430878-9 (Size 4 Shim)														
5430878-10 (Size 8 Shim)														
5430878 (Size 12 Shim)	1	1	1	1	1									
5430878-5 (Size 20 Shim)						1	1	1	1	1	1	1	1	
5430878-6 (Size 20 Shim)														
5430878-7 (Size 28 Shim)														
5430878-2 (Size 28 Shim)														1
Cap Screw (1) or Countersunk Screw (2)	1	1	1	1	1	1	1	1	1	1	1	1	1	2
5212343														1

Shim Combinations (Number of Shims 29 through 42)

	Shims Requested													
Parts Used	29	30	31	32	33	34	35	36	37	38	39	40	41	42
5430878-4 (Size 1 Shim)	1		1		1		1		1		1		1	
5430878-3 (Size 2 Shim)		1	1			1	1	2	2	3	3			1
5430878-9 (Size 4 Shim)														
5430878-10 (Size 8 Shim)														
5430878 (Size 12 Shim)				1	1	1	1	1	1	1	1			
5430878-5 (Size 20 Shim)												1	1	1
5430878-6 (Size 20 Shim)				1	1	1	1	1	1	1	1	1	1	1
5430878-7 (Size 28 Shim)														
5430878-2 (Size 28 Shim)	1	1	1											
Cap Screw (1) or Countersunk Screw (2)	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5212343	1	1	1											

Shim Combinations (Number of Shims 43 through 56)

	Shims Requested													
Parts Used	43	44	45	46	47	48	49	50	51	52	53	54	55	56
5430878-4 (Size 1 Shim)	1		1		1		1		1		1		1	
5430878-3 (Size 2 Shim)	1	2	2	3	3			1	1	2	2	3	3	
5430878-9 (Size 4 Shim)														
5430878-10 (Size 8 Shim)														
5430878 (Size 12 Shim)														
5430878-5 (Size 20 Shim)	1	1	1	1	1									
5430878-6 (Size 20 Shim)	1	1	1	1	1	1	1	1	1	1	1	1	1	
5430878-7 (Size 28 Shim)						1	1	1	1	1	1	1	1	1
5430878-2 (Size 28 Shim)														1
Cap Screw (1) or Countersunk Screw (2)	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5212343														

8.9.6. Securely screw the component shim arrangement to the shim tray position as shown in Illustration "Assembly of Component Shims Per Shim Position."

- Torque each screw to 10 lb-in using Torque Screwdriver (46-294167P81, included in Universal Field Mapping Fixture Kit 5266042-4). (Loose shims/screws can cause white pixels.)
- Orient every position in each tray identically (screw heads facing the same way, etc.)
- Do not stack shims on top of Size 28 shims.
- The 5430878 series shims are triple-weld shims. While single weld shims are permitted on the 1.5T DVw (HM Series) magnets and 1.5T LCCw (RD Series) magnets, if removed, DO NOT re-use these older, singles weld shims. (See image below.)

Single Weld vs. Triple Weld Shims

8.9.7. Second person (NOT first): Check that the incremental shims were added/subtracted in conformance with the Passive Shims–Incremental Rounded Shim information on Page 3 of the ShimTool printout.

8.9.8. Both people separately: Check that the total shims at each tray position equal the total shims for that tray position specified in the Passive Shims–Total Rounded Shim information on Page 4 of the ShimTool printout.

- If the actual shim totals in each position match the .psm file in the ShimTool printout, continue with Section Shim Tray Insertion.
- If the incorrect shims were installed on this iteration, correct the shims.
- If the actual shim totals in any position do not match the .psm file in the ShimTool printout form a previous iteration:
  - Edit the .psm file in this iteration of Total–Quantized pages to reflect the actual steel on the trays.
  - Save the edited .psm file using its existing name. Do NOT change the name of the .psm file. During the next shimming iteration, the ShimTool uses the steel quantity/location information from this iteration's .psm file and a new map of the field with that steel quantity installed to calculate its new report.
  - Continue with the next section, Shim Tray Insertion.

8.10. 1.5T MR450w (HM Series) and 1.5T LCCw (RD Series) Shim Tray Insertion

8.10.1. Securely carry the puller and tray to the magnet.

8.10.2. Begin to carefully slide the shim tray straight into its track using both hands as shown below.

- Have the work assistant help guide the tray into the track.
- Keep the tray straight and moving slowly to prevent the shim pieces in full pockets from being damaged by the gradient coil.
- If tray is labeled Cryostat side, that side may be placed toward the outside of the magnet. The tray will lock in either orientation.

Hand Guidance of Shim Tray Insertion

8.10.3. Slide the DVw and LCCw shim tray puller over the shim tray to be inserted.

8.10.4. Fully insert the shim tray into the magnet. (Illustration below shows Shim Tray 6 not fully inserted.) Keep the tray straight and moving slowly to prevent the shim pieces in full pockets from being damaged by the gradient coil.

Shim Tray Not Fully Inserted

8.10.5. Rotate the shim tray knob 90° clockwise to secure the connection.

8.10.6. Disengage the puller from the shim tray.

8.11. 1.5T MR450w (HM Series) and 1.5T LCCw (RD Series) Shim Finalization

8.11.1. Make sure the shimming results are available to other personnel for future shimming:

- Copy all .map and .psm files generated during shimming to a CD,
- Copy the .map and .psm files to the system in directory /usr/g/service/data
- Keep track of the directory path of the files copied to the console on site, and
- Leave the CD on site with this Magnet and Cryogens Subsystem manual.

8.11.2. Return the magnet to its normal operating condition in conformance with Field Adjustments After Shimming and the appropriate Service Methods documentation.

8.12. Passive Shim Installation, 3.0T MR750w (UA Series)

8.12.1. Do not attempt to passive shim a 3.0T magnet without reading, understanding, and following ALL safety alerts and requirements associated with the shimming process.

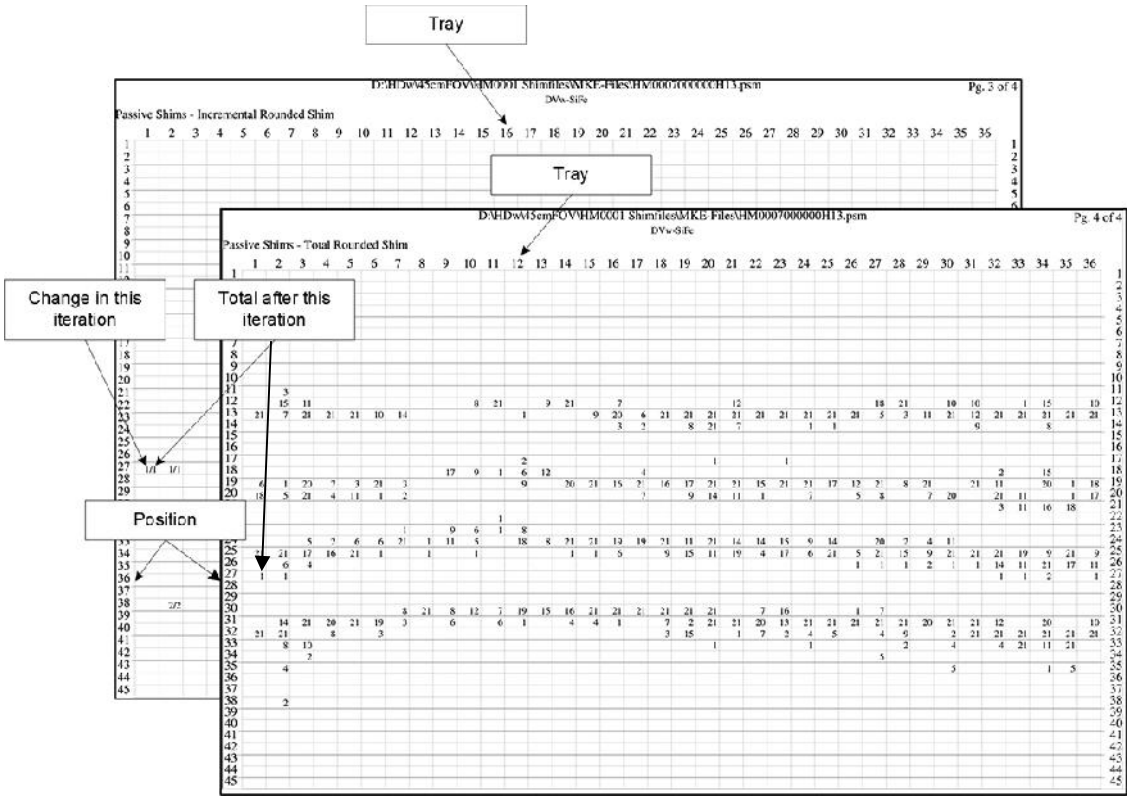
8.12.2. For 3.0T MR750w (UA Series), the Shim Tray Extraction Tool (STET) (5431812), must be used to insert and extract loaded shim trays. Refer to the STET manual (5431810) for more information.

8.12.3. Load shims into the shim tray in a room away from the magnet's field.

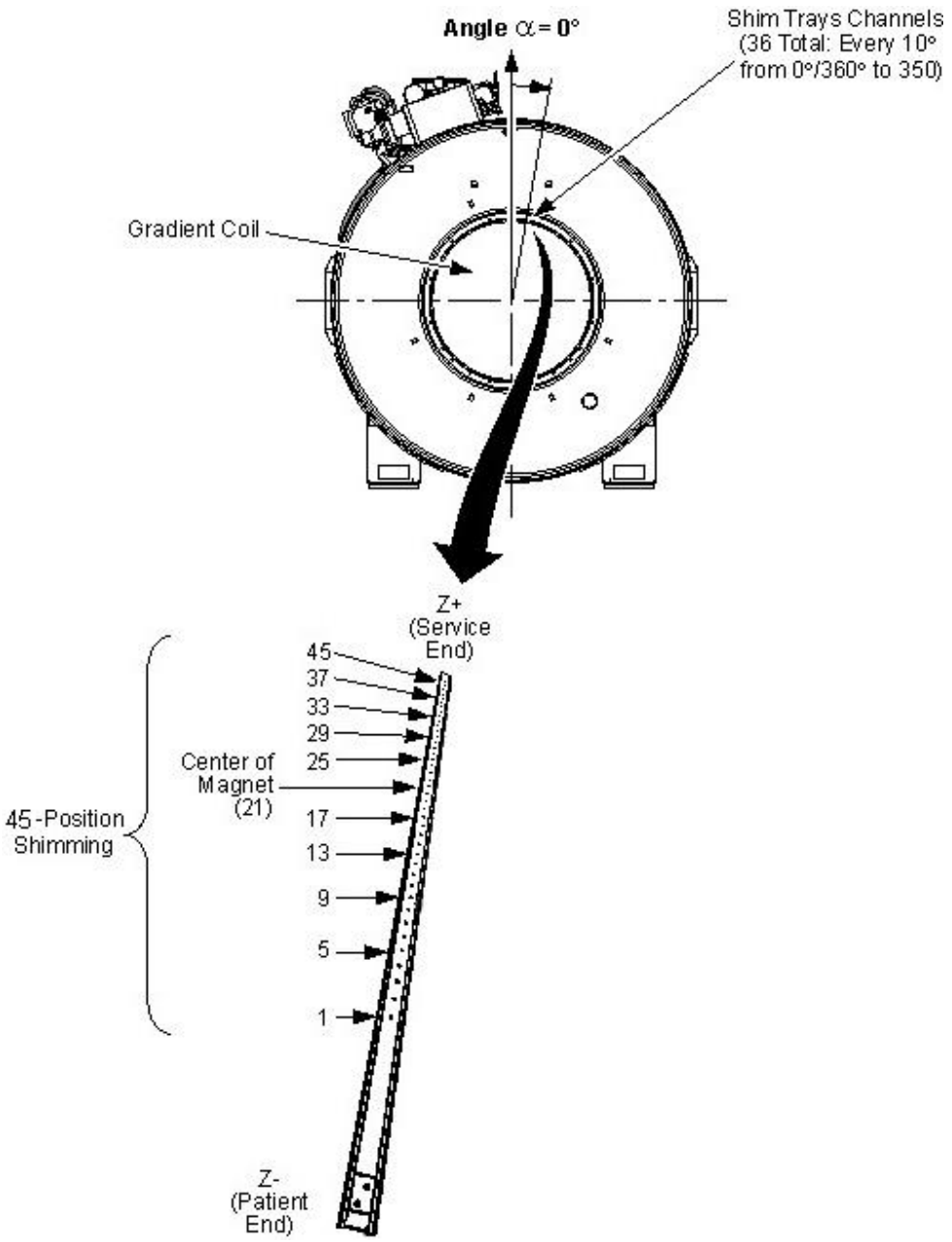
8.12.4. First person: Identify which component shims are required to meet the incremental shim mass change specified by the ShimTool for each position in each tray.

- See Illustration "Sample ShimTool Printed Report, Pages 3 and 4" for a sample ShimTool shimming report, Illustration "Shim Tray Layout" for the DVw shim tray layout, and Illustration "Assembly of Component Shims Per Shim Position" for assembly of component shim per shim position.
- Illustration "Sample ShimTool Printed Report, Pages 3 and 4" shows the D:\ drive directory paths used by ShimTool installations. (Note that some installations/operating systems may use the C:\ drive instead of the D:\ drive.)

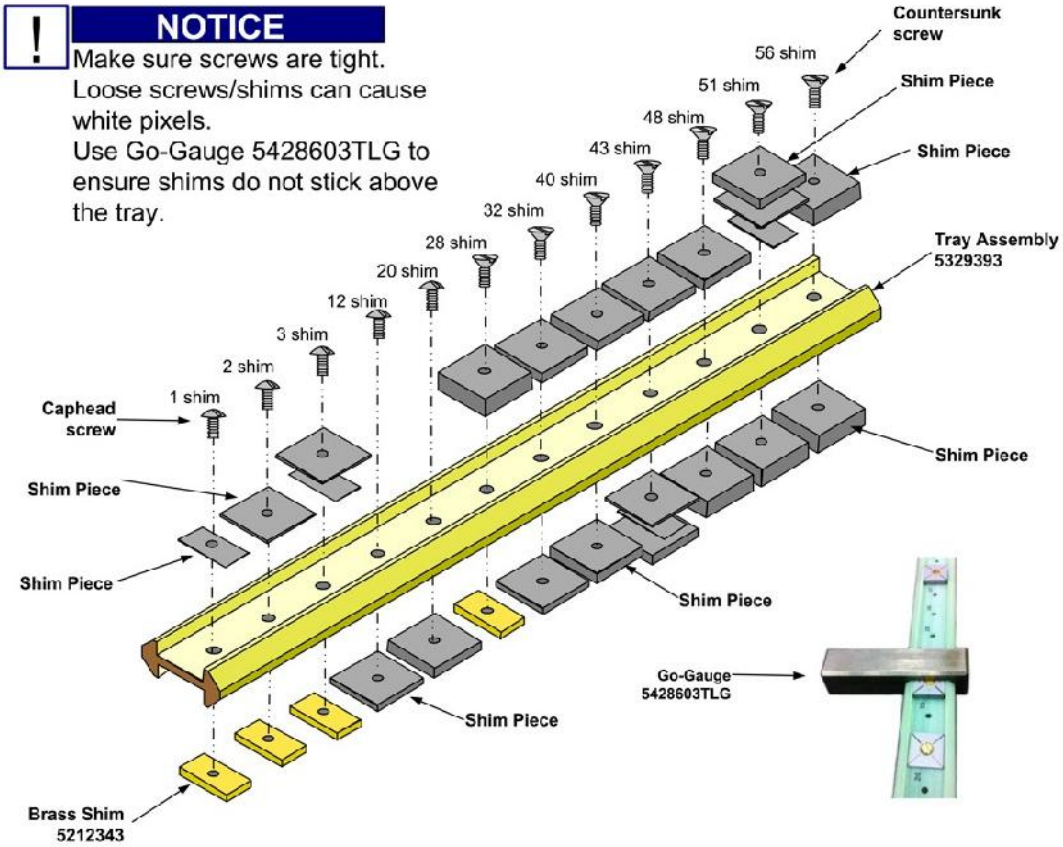
Sample ShimTool Printed Report - Passive Shimming, Pages 3 and 4



Shim Tray Layout



Assembly of Component Shims Per Shim Position



Shims

Shim Size	Thread Status	Color	Part Number
1 Shim	Feed-Through	Orange	5430878-4
2 Shim	Feed-Through	Grey	5430878-3
4 Shim	Feed-Through	Pink	5430878-9
8 Shim	Feed-Through	Light Green	5430878-10
12 Shim	Threaded	Green	5430878
20 Shim	Feed-Through	Black	5430878-6
20 Shim	Threaded	Black	5430878-5
28 Shim	Feed-Through	Grey	5430878-2
28 Shim	Threaded	Grey	5430878-7

- Do not stack shims on top of Size 28 shims.
- Use only shims with the part numbers shown above. Do not use shim material that may have been used on other systems.
- Size 1, Size 12 and Size 20 may be grey in older magnets.
- Size 4 and Size 8 are used for factory shimming only and may be reused in the field, if available.
- If there is a 5430878-2 or 5430878-7 shim at a position on one side of the shim tray, do not stack other shims on that side at the same position.

Shim Combinations (Number of Shims 1 through 14)

	Shims Requested													
Parts Used	1	2	3	4	5	6	7	8	9	10	11	12	13	14
5430878-4 (Size 1 Shim)	1		1		1		1		1		1		1	
5430878-3 (Size 2 Shim)		1	1	2	2	3	3	4	4	5	5			1
5430878-9 (Size 4 Shim)														
5430878-10 (Size 8 Shim)														
5430878 (Size 12 Shim)												1	1	1
5430878-5 (Size 20 Shim)														
5430878-6 (Size 20 Shim)														
5430878-7 (Size 28 Shim)														
5430878-2 (Size 28 Shim)														
Cap Screw (1) or Countersunk Screw (2)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5212343	1	1	1	1	1	1	1	1	1	1	1			

Shim Combinations (Number of Shims 15 through 28)

	Shims Requested													
Parts Used	15	16	17	18	19	20	21	22	23	24	25	26	27	28
5430878-4 (Size 1 Shim)	1		1		1		1		1		1		1	
5430878-3 (Size 2 Shim)	1	2	2	3	3			1	1	2	2	3	3	
5430878-9 (Size 4 Shim)														
5430878-10 (Size 8 Shim)														
5430878 (Size 12 Shim)	1	1	1	1	1									
5430878-5 (Size 20 Shim)						1	1	1	1	1	1	1	1	
5430878-6 (Size 20 Shim)														
5430878-7 (Size 28 Shim)														
5430878-2 (Size 28 Shim)														1
Cap Screw (1) or Countersunk Screw (2)	1	1	1	1	1	1	1	1	1	1	1	1	1	2
5212343														1

Shim Combinations (Number of Shims 29 through 42)

	Shims Requested													
Parts Used	29	30	31	32	33	34	35	36	37	38	39	40	41	42
5430878-4 (Size 1 Shim)	1		1		1		1		1		1		1	
5430878-3 (Size 2 Shim)		1	1			1	1	2	2	3	3			1
5430878-9 (Size 4 Shim)														
5430878-10 (Size 8 Shim)														
5430878 (Size 12 Shim)				1	1	1	1	1	1	1	1			
5430878-5 (Size 20 Shim)												1	1	1
5430878-6 (Size 20 Shim)				1	1	1	1	1	1	1	1	1	1	1
5430878-7 (Size 28 Shim)														
5430878-2 (Size 28 Shim)	1	1	1											
Cap Screw (1) or Countersunk Screw (2)	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5212343	1	1	1											

Shim Combinations (Number of Shims 43 through 56)

	Shims Requested													
Parts Used	43	44	45	46	47	48	49	50	51	52	53	54	55	56
5430878-4 (Size 1 Shim)	1		1		1		1		1		1		1	
5430878-3 (Size 2 Shim)	1	2	2	3	3			1	1	2	2	3	3	
5430878-9 (Size 4 Shim)														
5430878-10 (Size 8 Shim)														
5430878 (Size 12 Shim)														
5430878-5 (Size 20 Shim)	1	1	1	1	1									
5430878-6 (Size 20 Shim)	1	1	1	1	1	1	1	1	1	1	1	1	1	
5430878-7 (Size 28 Shim)						1	1	1	1	1	1	1	1	1
5430878-2 (Size 28 Shim)														1
Cap Screw (1) or Countersunk Screw (2)	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5212343														

8.12.6. Securely screw the component shim arrangement to the shim tray position as shown in Illustration "Assembly of Component Shims Per Shim Position."

- Torque each screw to 10 lb-in using Torque Screwdriver (46-294167P81, included in Universal Field Mapping Fixture Kit 5266042-4). (Loose shims/screws can cause white pixels.)
- Orient every position in each tray identically (screw heads facing the same way, etc.)
- Do not stack shims on top of Size 28 shims.
- The 5430878 series shims are triple-weld shims. DO NOT utilize the older, singles weld shims on the 3.0T DVw (UA Series) magnets. If found, single weld shims should be replaced with triple weld shims. (See image below.)

Single Weld vs. Triple Weld Shims

8.12.7. Second person (NOT first): Check that the incremental shims were added/subtracted in conformance with the Passive Shims–Incremental Rounded Shim information on Page 3 of the ShimTool printout.

8.12.8. Both people separately: Check that the total shims at each tray position equal the total shims for that tray position specified in the Passive Shims–Total Rounded Shim information on Page 4 of the ShimTool printout.

- If the actual shim totals in each position match the .psm file in the ShimTool printout, continue with Section Shim Tray Insertion.
- If the incorrect shims were installed on this iteration, correct the shims.
- If the actual shim totals in any position do not match the .psm file in the ShimTool printout form a previous iteration:
  - Edit the .psm file in this iteration of Total–Quantized pages to reflect the actual steel on the trays.
  - Save the edited .psm file using its existing name. Do NOT change the name of the .psm file. During the next shimming iteration, the ShimTool uses the steel quantity/location information from this iteration's .psm file and a new map of the field with that steel quantity installed to calculate its new report.
  - Continue with the next section, Shim Tray Insertion.

8.13. 3.0T MR750w (UA Series) Shim Tray Insertion and Retention

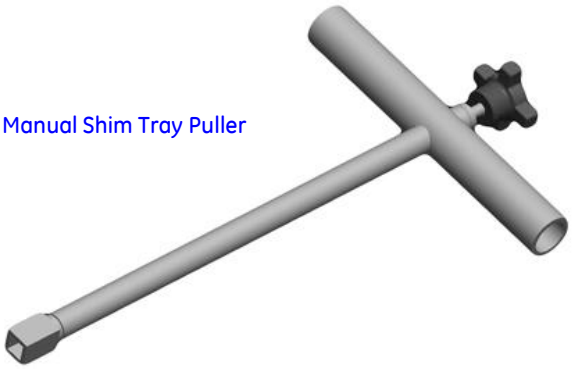
8.13.1. Use the Shim Tray Extraction Tool (STET) to insert the shim tray. Refer to the STET manual (5431810) for more information.

8.13.2. Rotate the shim tray knob 90° clockwise to secure the connection.

8.13.3. Disengage the STET tool from the shim tray. Make sure the shim tray is fully inserted.

8.13.4. IF IT IS NECESSARY TO USE THE MANUAL SHIM TRAY PULLER:

- The manual shim tray puller may only be used on an EMPTY trays or an UNRAMPED MAGNET. IT MAY NOT BE USED ON A RAMPED MAGNET TRAY THAT CONTAINS SHIM STOCK.
- Slide the shim tray puller (5423147) over the shim tray to be removed and align the center post with the hole on the shim tray handle. Rotate the thumbscrew 1 to 2 full turns to secure the connection, shown below.
- If necessary, carefully pull the empty shim tray straight out from its track, and have the work assistant hold onto the tray as soon as possible, shown below.
- Work Assistant: Securely hold the shim tray, and carry the tray and the puller away from the magnet's field to a shim tray loading area in another room.

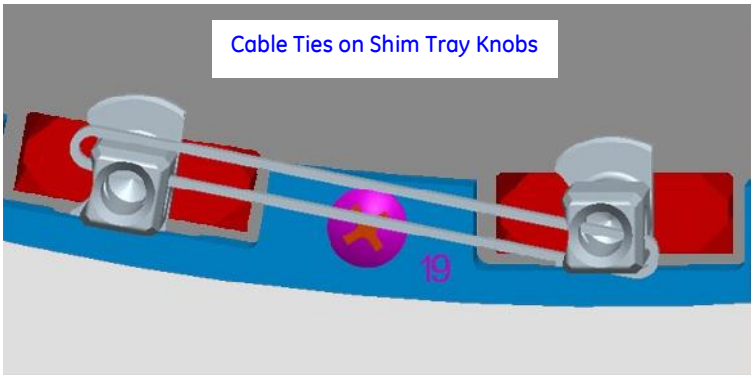


8.14. 3.0T MR750w (UA Series) Shim Finalization

8.14.1. Remove the STET tool according to the directions in the STET Operator Manual (5431810).

8.14.2. Use cable ties to tie the shim tray knobs together in pairs as shown in the following illustration. (It does not matter which knobs are tied together.) Tie the knobs so the knobs are prevented from rotating counterclockwise (as shown in the illustration). (To prevent shim trays from unlocking due to vibration during system operation, shim tray knobs must be tied together using cable ties.) Trim the excess off of the cable ties.

8.14.3. Work Assistant: Verify that all trays are fully inserted and locked in place. Confirm presence of cable ties as noted in previous step.



8.14.4. Make sure the shimming results are available to other personnel for future shimming:

- Copy all .map, .psm and .hrm files generated during shimming to a CD,
- Copy all .map, .psm and .hrm files to the system in directory /usr/g/service/data,
- Keep track of the directory path of the files copied to the console on site, and
- Leave the CD on site.

8.14.5. Return the magnet to its normal operating condition in conformance with Field Adjustment after Shimming.

8.15. After Field Mapping

8.15.1. Turn off the power to the field camera at the Field Camera Power Supply.

8.15.2. Ensure the input power to the field camera is disconnected. Use a DVM (or equivalent measuring device) to check that no voltage is present.

8.15.3. Disconnect the cables from the Field Camera.

8.15.4. Dismount the shaft of the mapping fixture from the support brackets. Remove the shaft from the bore of the magnet.

8.15.5. Dismount the Probe Array or the No. 6 Probe and Single Probe Mounting Board and from the shaft of the mapping fixture.

8.15.6. Dismount the patient end support bracket of the mapping fixture.

8.15.7. Dismount the service end support bracket of the mapping fixture.

8.15.8. Reinstall any enclosure components removed during the process.