TABLE OF CONTENTS

1- DESCRIPTION

Eddy Current Measurement Tool (ECMT) is a One Button Touch service tool to compensate for eddy currents induced by the gradients in the conducting structures near the gradient coil. The tool provides an easy to use Graphical User Interface (GUI) that can be invoked from the Service Desktop Manager.

The use of ECMT requires a test fixture that includes 6 coils with 6 samples of $CUSO_4$ and a multiplexer board, which enables the collection of data from all 3 planes without having to reposition any coils.

ECMT will adjust and compensate for Linear Long and B_0 Eddy Currents. Short-term eddy currents will be compensated for with default values.

2- TIME, TOOLS, AND PREREQUISITE PROCEDURES REQUIRED

Time

Estimation of time required to perform this procedure is 1 (one) hour.

WARNING!

POISON HAZARD! THE PHANTOM CONTAINS $CUSO_4$. DO NOT INGEST. DISPOSE OF AS A HAZARDOUS WASTE ACCORDING TO STATE AND FEDERAL REGULATIONS.

Tools

Item	Description	Part Number	Qty.
1.	0.7T ECMT Kit	2274135	1
	Kit includes the following:		
	ECMT Fixture	2271646	1
	ECMT Cable (30 ft.) (To System Cabinet)	2219093	1
	ECMT Cables (30 ft.)	2219093-2	3
	Bottle of $CUSO_4$	2238315	1
	BNC Bullets	46-282886P1	6
	ECMT Cable with Balun (To QD box)	2219092	1
	Spare Coil (includes sample)	2271647	1
2.	Surface Coil Quick Disconnect (QD) Box	2275087	1

THE FOLLOWING PROCEDURES SHOULD BE PERFORMED PRIOR TO ECMT

1. ELECTRICAL ISOCENTER CALIBRATION
2. GEOMETRY VERIFICATION

3- PROCEDURE

3-1 Set-up

1. From the Scan Desktop, select **[New pt]**. Enter *geservice* for the **patient ID**, and **weight** of *111*.

2. Remove the ECMT fixture from the case and install the top coil which is removed for storage. Be sure to connect the coil to the multiplexer board at RF4.

3. Install the SPT Nesting Plate onto the cradle. Place the ECMT fixture in the Nesting Plate as shown in Illustration 3-1.

4. Connect the Surface Coil Quick Disconnect box (included in the kit) to the coil using the **Q** connection, and plug it into the Multicoil Select/Head Switch (MSHS) connection port (refer to Illustration 3-1).

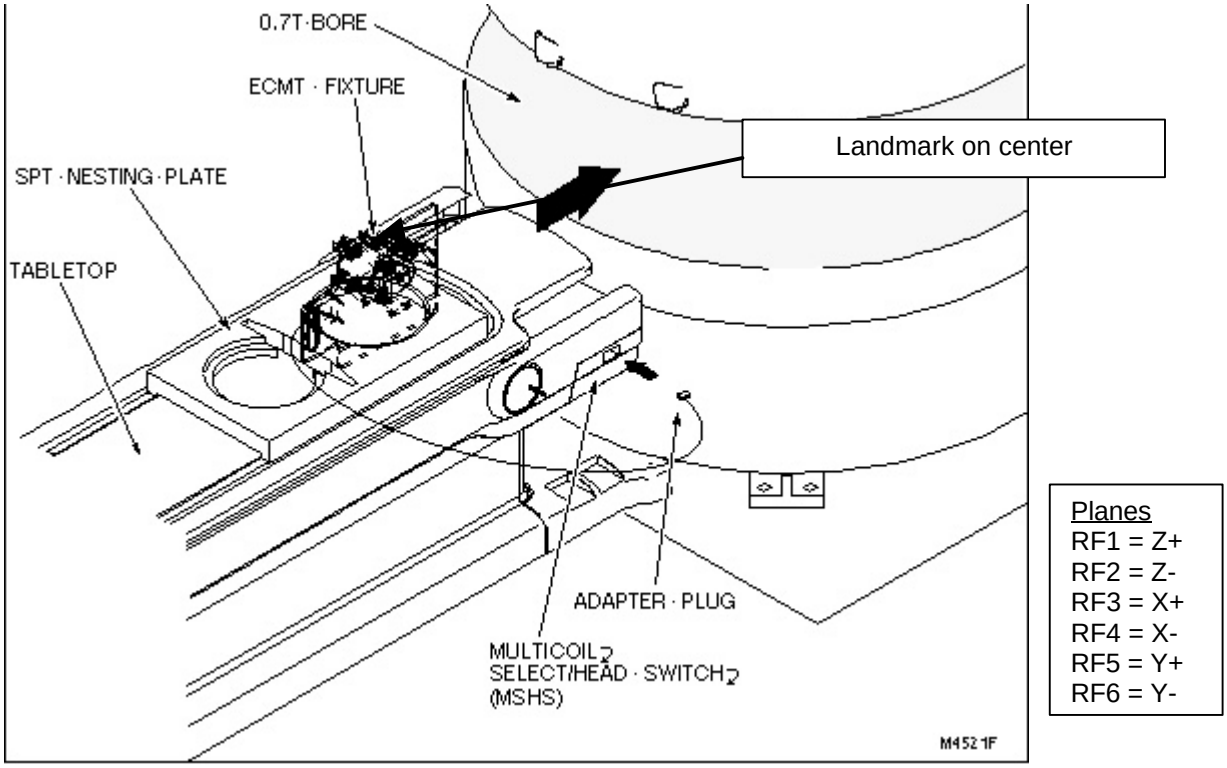
5. Connect one end of a 3 coaxial cable wire harness to the BNC connectors on the ECMT fixture labeled Mux A, Mux B, and Mux C. (See Illustration 3-2)

6. Landmark on the center of the ECMT fixture and Move to Scan. (See Illustration 3-1)

Note

You must select new exam, and landmark prior to the start of ECMT. Failure to do so may result in the SVAT script hanging the computer.

3-1 Set-up (continued)



ECMT FIXTURE
ILLUSTRATION 3-1

5. Connect one end of a 3 coaxial cable wire harness to the BNC connectors on the ECMT fixture labeled Mux A, Mux B, and Mux C. (See Illustration 3-2)

6. Landmark on the center of the ECMT fixture and Move to Scan. (See Illustration 3-1)

Note

You must select new exam, and landmark prior to the start of ECMT. Failure to do so may result in the SVAT script hanging the computer.

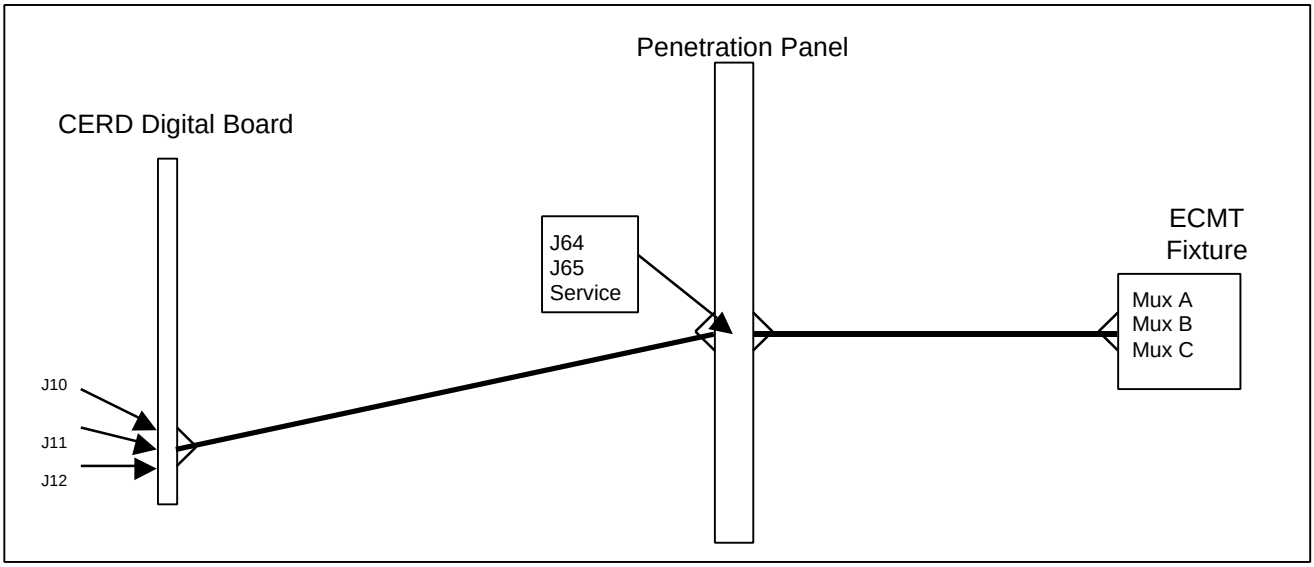
7. Connect the other end of a 3 coaxial cable wire harness to the penetration panel BNC feed-through connectors. (See Illustration 3-2) Use BNC bullets and additional cables as necessary.

Note

The following BNC feed-throughs have been reserved on the penetration panel for the ECMT cables (J64, J65, and Service).

CAUTION

Do not allow the BNC cables to dangle and short the Shield Cooler filters.



ECMT SETUP
ILLUSTRATION 3-2

8. Connect another 3 coaxial cable wire harness on the equipment room side of the penetration panel at the BNC feed-throughs. (i.e., J64, J65, and Service) (See Illustration 3-2)

9. Connect the other end of the 3 coaxial cable wire harness to the CERD Digital board at J10, J11, and J12. (See Illustration 3-2) Use BNC bullets and additional cables as necessary.

10. If this is **NOT** the first time to run ECMT, then backup the files using the following procedure:

    1. Open a C-Shell on the Service Desktop.
    2. At the prompt, type: **cd /usr/g/caldir <Enter>**
    3. For all systems, type: **cp ecccoeff.dat ecccoeff.bak <Enter>**

Note

You may want to also backup the grafidyx.cal, grafidyy.cal, and the grafidyz.cal, as these files are used to create ecccoeff.dat.

3-2 Start-up

1. From the Service Desktop, select **[Cal/Checks]**, highlight Eddy Current Measurement Tool and select **[Start]**. The ECMT Window will appear as shown in Illustration 3-5.

2. Select **[Start]** from the Eddy Current Measurement tool window, and an Operator Mode Window will appear. See Illustration 3-6.

3. Use the default selections for axis, and initialize the current grafidy calibration files. Select **[Continue]** to proceed.

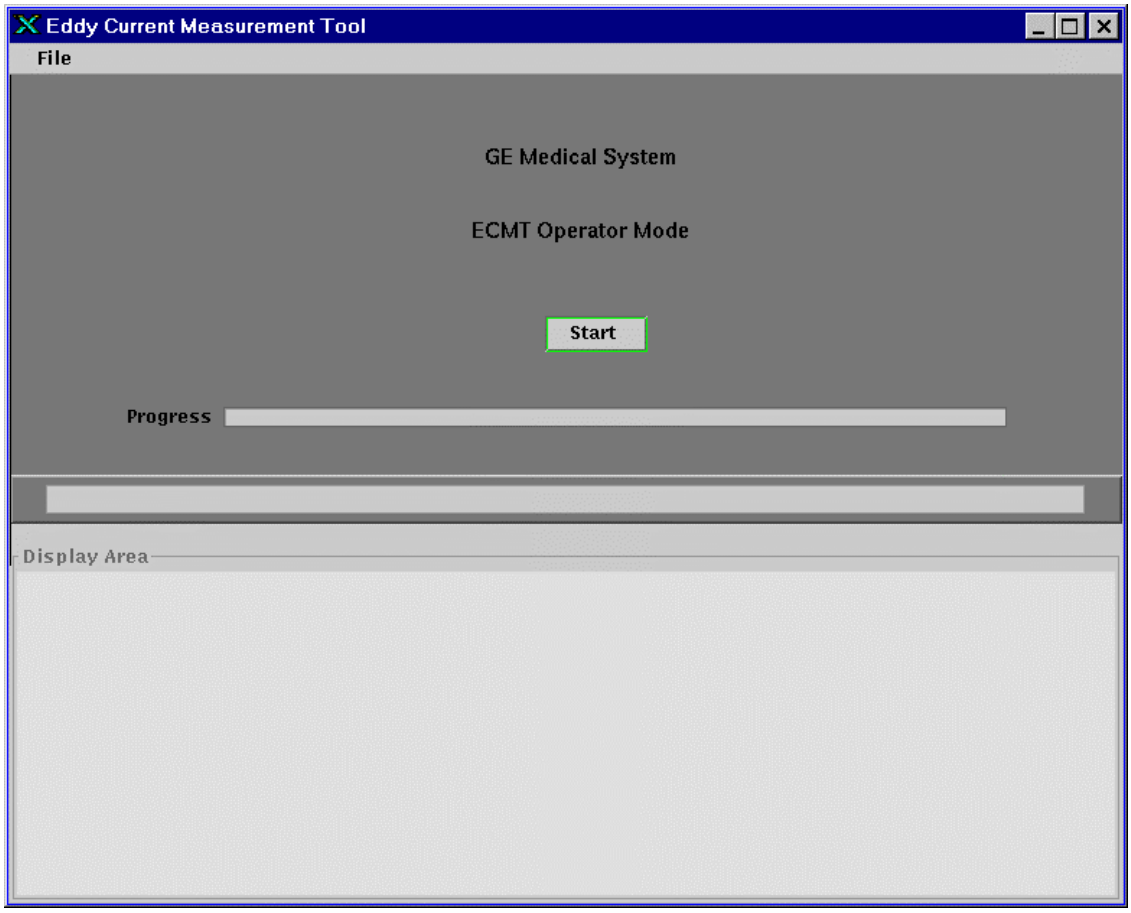
4. The SVAT script will begin, and the protocol will be downloaded, prescanned, and scanned. Be patient, the prescan takes approximately 3 minutes to complete. If the scan does not start, check the Signa message log for errors.

Note

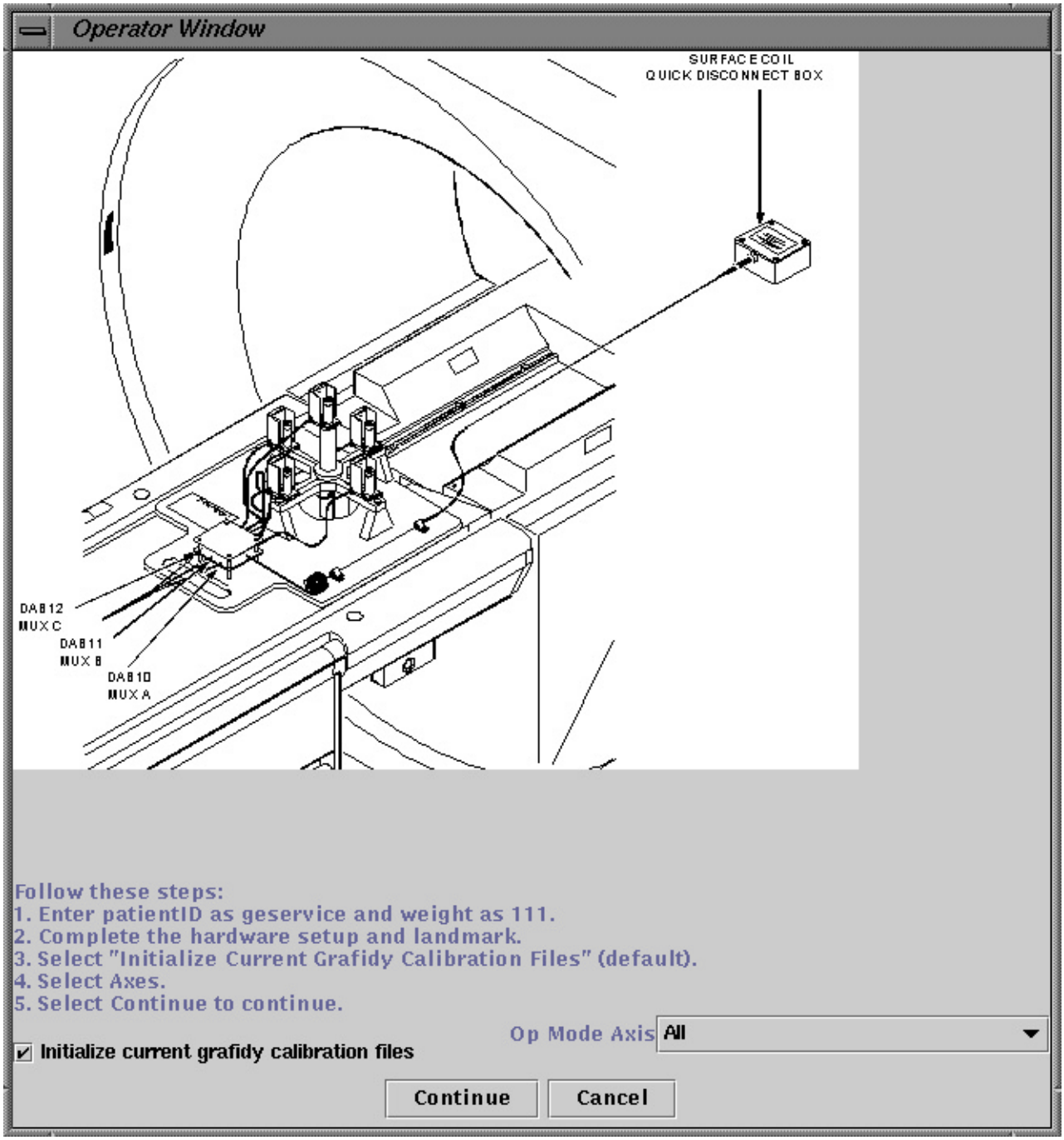
Samples need to be refilled periodically. See Appendix A.

5. Once the scan has started, it will take approximately 1 hour to calibrate the system.

6. When the calibration is completed, there will be a status message; “ECMT calibration is completed”. See Illustration 3-7.



EDDY CURRENT MEASUREMENT TOOL GUI
ILLUSTRATION 3-5



OPERATOR MODE GUI
ILLUSTRATION 3-6

3-3 Aborting ECMT

1. If **[Abort]** is selected, a confirmation window appears. The following message appears after selecting **[Abort]**:

1. Press Stop Scan Button on Keyboard.
2. Press OK button below on this dialog box.

2. Follow the on-screen directions to terminate ECMT properly. If the scanner is not operating correctly after aborting ECMT, reboot the system.

Note

If the ECMT SVAT script is not terminated properly, the scanner will not operate normally.

3-4 ECMT Results

1. The results of the ECMT procedure can be viewed on the bottom of the screen in the display area. See Illustration 3-7.

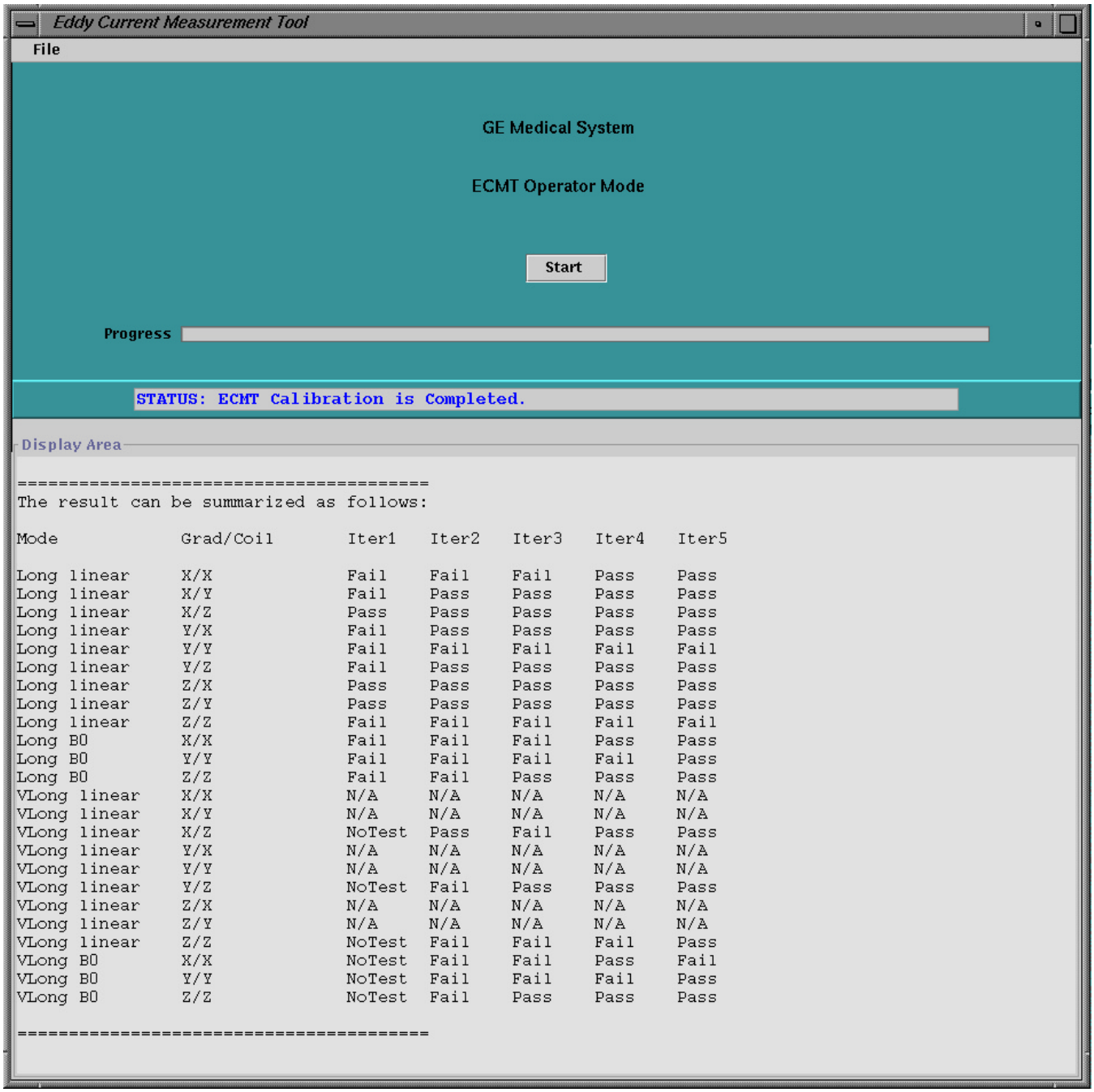
Note

You can expand the size of the display window by placing the mouse on one of the corners and dragging the corner away from the window.

2. If any of the Axis fails, you can either select **[Start]** again in the operator mode, and un-check the box for **Initialize current grafidy calibration files**, or go into the Expert Mode to only calibrate an individual axis. See Section 4 for Expert Mode.

3-5 Exiting ECMT

1. To exit ECMT, select **File**, **Quit**, then **OK** from the GUI.

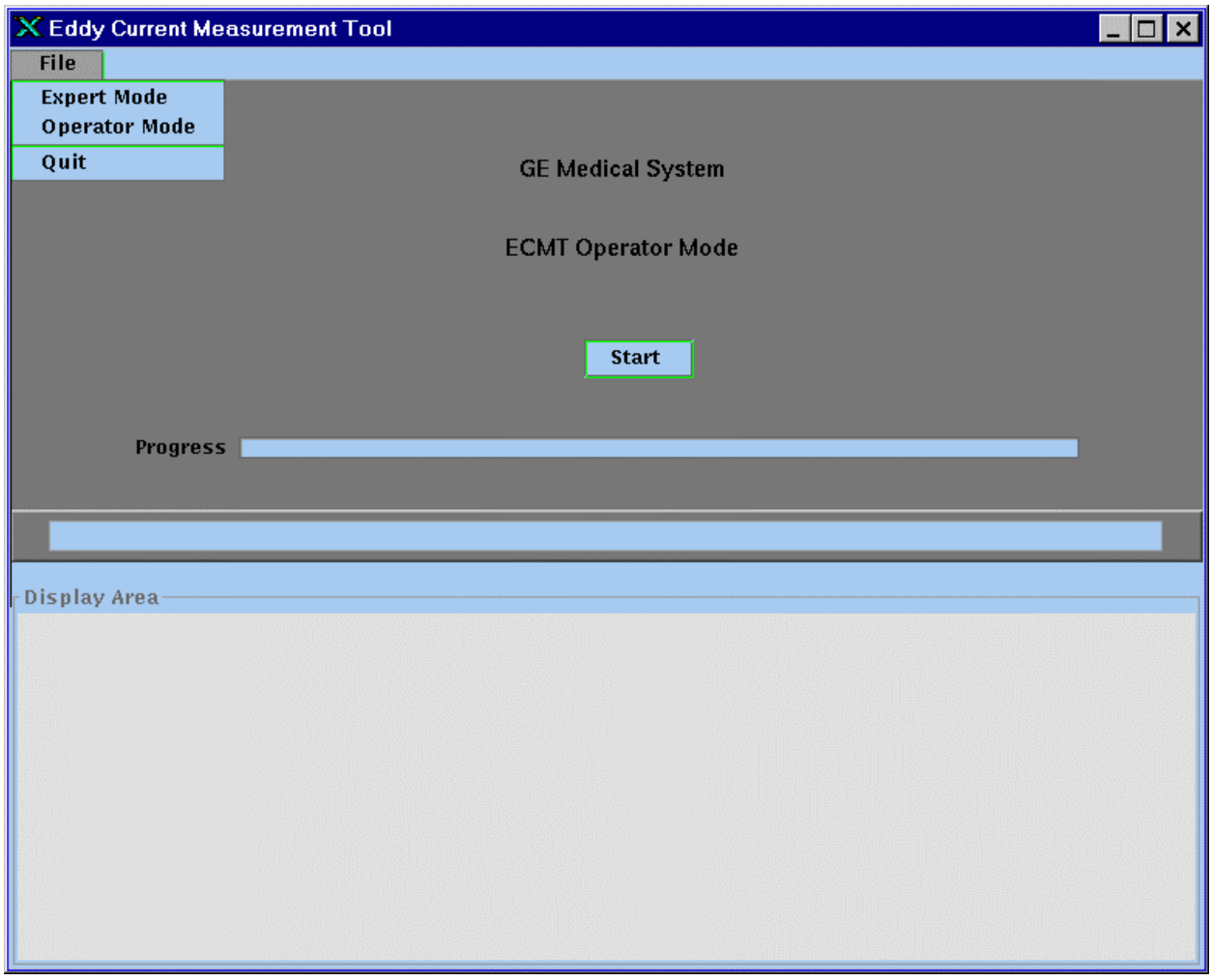


ECMT RESULTS
ILLUSTRATION 3-7

4- EXPERT MODE

4-1 Starting Expert Mode

1. From the Operator Mode window of ECMT, select **[File]**, **[Expert Mode]**. See Illustration 4-1.



ENTERING EXPERT MODE
ILLUSTRATION 4-1

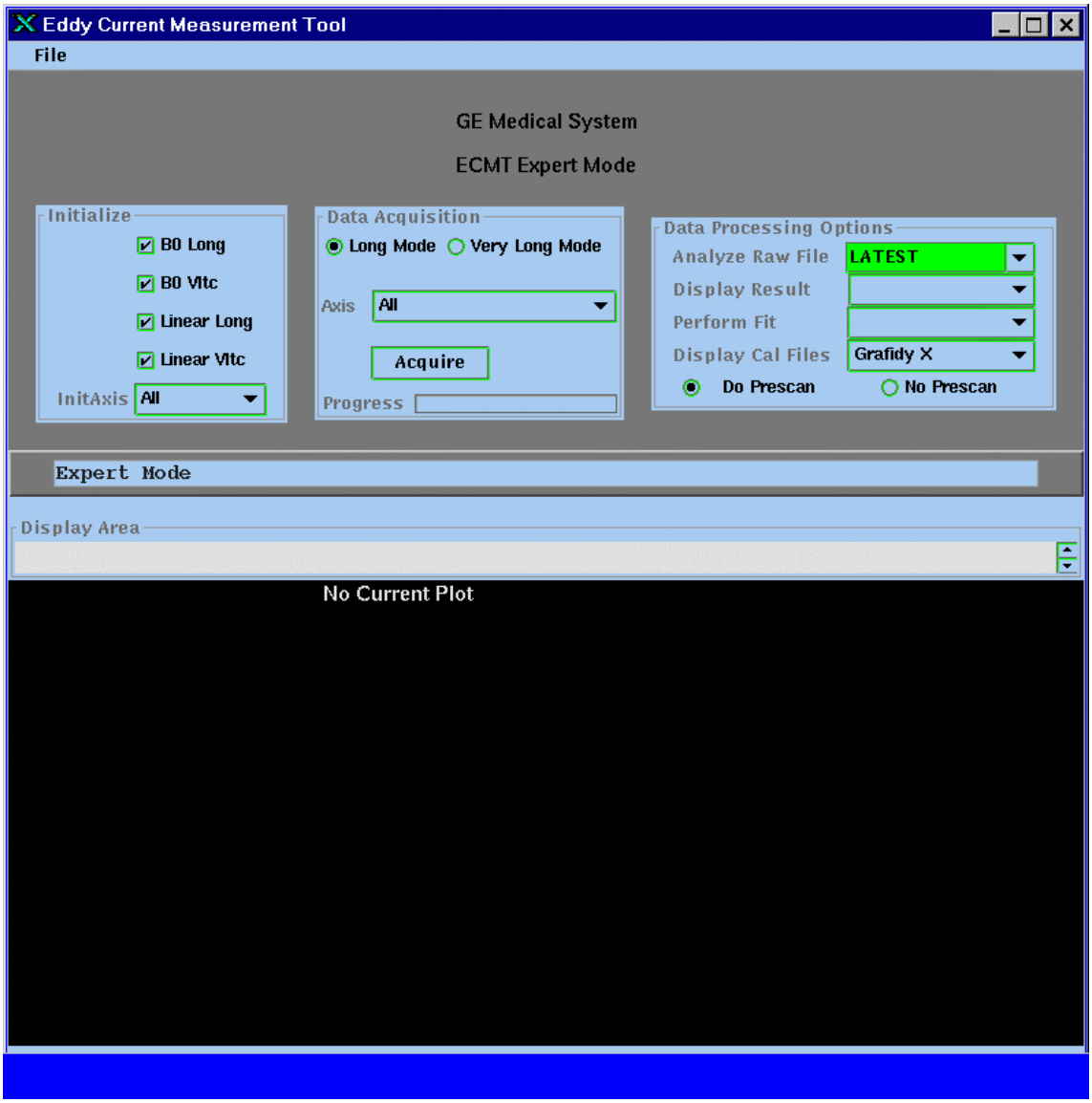
4-2 Expert Mode Options

1. Expert Mode allows the user to view plots, initialize calibration files, process raw data, and acquire raw data for individual axis. See Illustration 4-2.

   - Initialize - If the Initialize box is checked, the current grafidy cal files will be initialized with zeros when the **[Acquire]** button is selected.

   - Data Acquisition - The user can select between Long and Very Long Mode as well as the individual axis to calibrate. The scan starts when the **[Acquire]** button is selected.

   - Data Processing - The user can analyze raw data files, display plots, and perform fits for the collected data.



EXPERT MODE OPTIONS
ILLUSTRATION 4-2

4-3 ECMT Files

The following files pertain to and are used by ECMT.

/usr/g/service/cclass

ecmt1 - psd file
ecmt1.psd.o - psd file
ecmt_time.txt - Resource file for psd. Contains timing for RF pulses.
ecmt_time_vltc.txt - Resource file for psd. Contains vltc timing for RF pulses.
ecmt_coil.rf - Resource file for psd. Provides coil pattern instructions.
ecmt_coil_vltc.rf - Resource file for psd. Provides vltc coil paterns.
ecmt_graf.rf - Resource file for psd. Contains Nex, number of coils, resolution and bandwidth.
ecmt_graf_vltc.rf - Resource file for psd. Contains Nex, number of coils, resolution and bandwidth for vltc.

/usr/g/service/cclass/ecmt

runecmt - ecmt startup file
ecmt.log - results file with specifications.
ecmt_spec - spec file, and also the last line contains the fit iteration limit.
Ecmt.jar - Java based GUI. Invokes SVAT scripts.
ecmt_init_sys_params - reads the system and grafidy config files, creates ecmt.sys.
ecmt_update_fit - writes grafidy*.cal files, which updates ecccoeff.dat and gram_tune.dat.
ecmtAPS1 - Autoprescan SVAT script.
ecmt_process_raw - processes raw data files in sdf format. Creates pdf files.
ecmt_zero_fit_params - initializes the grafidy*.cal files and updates ecccoeff.dat and gram_tune.dat files.
ecmtDL - download SVAT script.
ecmt_read_raw_hdr
endscan - SVAT script to end exam
ecmtSCAN - SVAT script to perform scan
ecmt_setup.gif - hardware setup picture.
Prescribe - SVAT script to setup protocol.
ecmt_eval_processed - computes maximum deviations between the compensated gradient waveform and the ideal waveform at various times.
ecmt_sort_raw - reformats and analyzes raw data gathered from an ECMT scan. Creates sdf files for ecmt_process_raw.
ecmt_fit_processed - calculates the compensation needed to restore correct gradient shape. Updates the ecmt.results file.
swing.jar - system java class library file

/usr/g/caldir

grafidyx.cal - x-axis calibration file. Used to create ecccoeff.dat and gram_tune.dat.
grafidyy.cal - y-axis calibration file. Used to create ecccoeff.dat and gram_tune.dat.
grafidyz.cal - z-axis calibration file. Used to create ecccoeff.dat and gram_tune.dat.
ecccoeff.dat - contains B_0 correction data. Coefficient file for the WARP.
gram_tune.dat - contains linear long and very long correction data. Not used on SR20.
short_tc.sgd.ssn - contains short time constant correction for SGD.
short_tc.120.ssn - contains short time constant correction for SR120 (EchoSpeed).
short_tc.77.ssn - contains short time constant correction for SR77 (HiSpeed).
short_tc.default - contains short time constant correction for SGD.

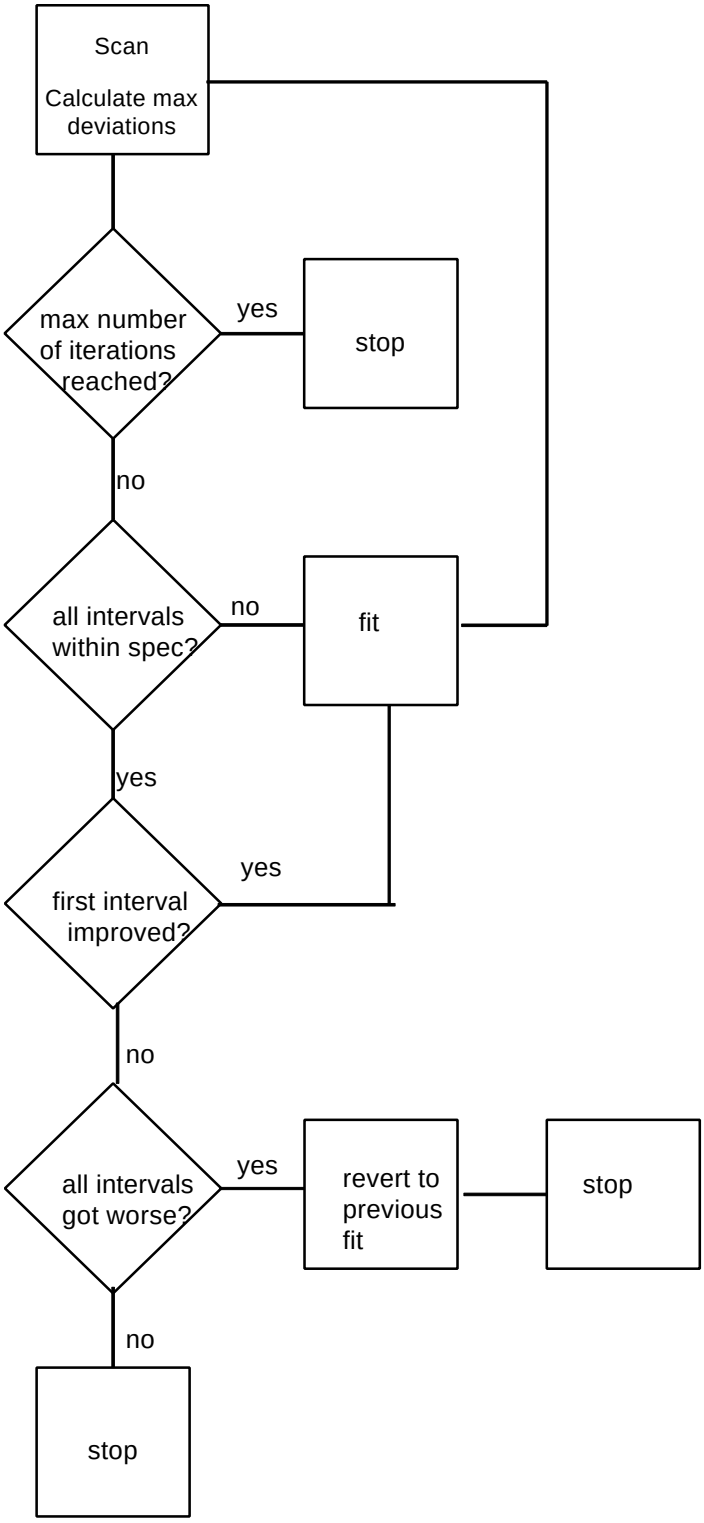
Table 4-1 shows the detailed breakdown of the grafidy.cal files.

TABLE 4-1
EDDY CURRENT CALIBRATION FILE STRUCTURE
(grafidyx.cal, grafidyy.cal and grafidyz.cal)

taus	***alphas***		***grafidyx.cal***	***grafidyy.cal***	***grafidyz.cal***
0.000000	0.000000		X	Y	Z
0.000000	0.000000	B0 Longtime Constants	X	Y	Z
0.000000	0.000000		X	Y	Z
0.000000	0.000000		X	Y	Z
0.000000	0.000000		**X - X**	Y - X	Z - X
0.000000	0.000000		**X - X**	Y - X	Z - X
0.000000	0.000000		**X - X**	Y - X	Z - X
0.000000	0.000000		**X - X**	Y - X	Z - X
0.000000	0.000000		X - Y	**Y - Y**	Z - Y
0.000000	0.000000	On Axis Linear and Crossterm Long Time Constants (4 time constants per term)	X - Y	**Y - Y**	Z - Y
0.000000	0.000000		X - Y	**Y - Y**	Z - Y
0.000000	0.000000		X - Y	**Y - Y**	Z - Y
0.000000	0.000000		X - Z	Y - Z	**Z - Z**
0.000000	0.000000		X - Z	Y - Z	**Z - Z**
0.000000	0.000000		X - Z	Y - Z	**Z - Z**
0.000000	0.000000		X - Z	Y - Z	**Z - Z**
0.000000	0.000000		X	Y	Z
0.000000	0.000000	On Axis Short Time Constants (4 time constants)	X	Y	Z
0.000000	0.000000		X	Y	Z
0.000000	0.000000		X	Y	Z

5- ECMT LOGIC

5-1 ECMT Process Flow



ECMT PROCESS FLOW
ILLUSTRATION 5-1

5-2 ECMT Fit/Rejection Criteria

Long Linear (on axis and crossterms)

1. If the performance data is in spec for all three time periods, then
   a. If the third time period max deviation is less than or equal to 0.01, then stop.
   b. If the third time period max deviation delta (between current and previous fit) is less than or equal to 0.005, then stop.
   c. Else, continue to fit.
2. If any one of the max deviation values diverge out of spec (all were in spec in the previous iteration), then revert to the previous fit parameters and stop.
3. Else, continue to fit.

Long B_0 (on axis only)

1. If it is the first iteration, do not fit.
2. If the performance data are in spec for all three time periods, then
   a. If the third time period max deviation is less than or equal to 0.05, then stop.
   b. If the third time period max deviation delta (between the current and previous iteration is less than or equal to 0.01, then stop.
   c. Else, continue to fit.
3. If any one of the max deviation values diverge out of spec (all were in spec in the previous iteration), then revert to the previous fit parameters.
4. Else, continue to fit.

6- SAVING/RESTORING GRAFIDY FILES

This section details how to back up the ecccoeff.dat, and the gram_tune.dat files before a pass of Grafidy is performed. This is useful if you are in troubleshooting mode, and want to restore the system to its original calibration.

It is possible to back up grafidy files in either of two ways: from the Install GUI, or from a C-shell on the Service desktop. The Install GUI will also backup all of the grafidy.cal files which are the files used to create ecccoeff.dat.

6-1 Backing Up Grafidy Files From the Install GUI:

1. Click on **[Install]**.
2. Place an MOD in the appropriate drive.
3. Click on **[Save Info]**.

6-2 Restoring Grafidy Files From the Install GUI:

1. Click on **[Install]**.
2. Click on **[Restore Info]**, and answer the appropriate questions.

6-3 Backing Up Grafidy Files From a C-Shell on the Service Desktop:

1. At the prompt, type: **cd /usr/g/caldir <Enter>**

2. For all systems, type: **cp ecccoeff.dat ecccoeff.bak <Enter>**

Note

You may want to also backup the grafidyx.cal, grafidyy.cal, and the grafidyz.cal, as these files are used to create ecccoeff.dat.

6-4 Restoring Grafidy Files From a C-Shell on The Service Desktop

1. Ensure that you are in the */usr/g/caldir* directory.

2. Type: **cp ecccoeff.bak ecccoeff.dat <Enter>**

7 - TROUBLESHOOTING

7-1 Prescan Failures

The first step in troubleshooting ECMT prescan failures is to check the SIGNA message log for errors. The prescan failure in the log should give a descriptive message as to why it failed, and which axis it had trouble with. All of the following can cause prescan errors:

1. Bad landmark. See illustration 3-1 for proper landmark.

2. Cables hooked up incorrectly. Re-check cable connections.

3. Electrical ISO-CENTER calibration not completed. Complete Electrical ISO-CENTER calibration before ECMT.

4. Empty sample cylinders. Refill sample vials with $CUSO_4$ before running ECMT. See Appendix A.

5. Top coil not installed, or not hooked up to RF4 on Multiplexer.

6. RF disabled on Exciter.

7. Loose Quick Disconnect Box.

8. SVAT script problem. Log into TPS and observe SVAT script run to see where the failure is occurring.

9. Geometry Verification not completed. Complete Geometry Verification prior to ECMT.

10. Low signal failures. Modify CV prescan_coil using values 0-5.

7-2 Cannot Meet Specifications

If the cables are hooked up incorrectly, ECMT will not converge. Recheck the cable connections at the Digital board, Pen Wall, and ECMT fixture.

The file /usr/g/service/cclass/ecmt/ecmt_spec can be edited to change the number of iterations ECMT will do when trying to fit data. The last line of the file can be increased to allow ECMT to do more iterations. The default value is 4.

Contact the OLC for additional information about not meeting specifications.

APPENDIX A – CLEANING & REFILLING $CUSO_4$ SOLUTION

Due to evaporation and leakage, crust and/or residue of $CUSO_4$ builds up in the sample vial that holds the solution. The sample vial must be cleaned before refills to ensure the correct concentration of $CUSO_4$ solution is in the vial.

Required Tools & Materials

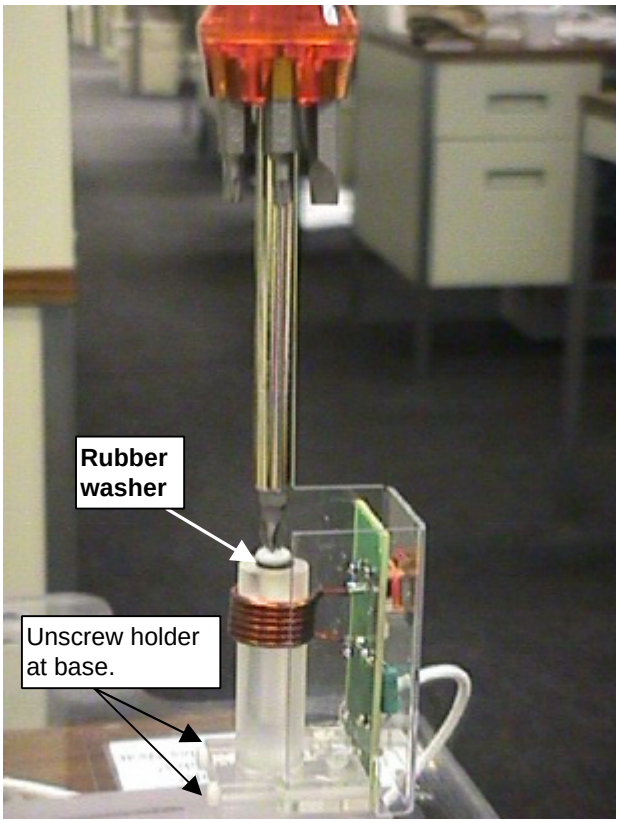
- Syringe (obtain locally)
- Bottle of $CUSO_4$ (located in ECMT Kit, GE P/N 2238315)
- Phillips Screwdriver
- Water

Procedure

1. Remove the ECMT fixture from the magnet room. Place on a clean work surface.

2. Remove the sample holder from the ECMT fixture by unscrewing at the base of the sample holder. See Illustration A-1.

3. Use a phillips screwdriver to remove the screw that seals the $CUSO_4$ solution in the sample vial that is surrounded by the coil. See Illustration A-1.



ECMT FIXTURE SAMPLE HOLDER
ILLUSTRATION A-1

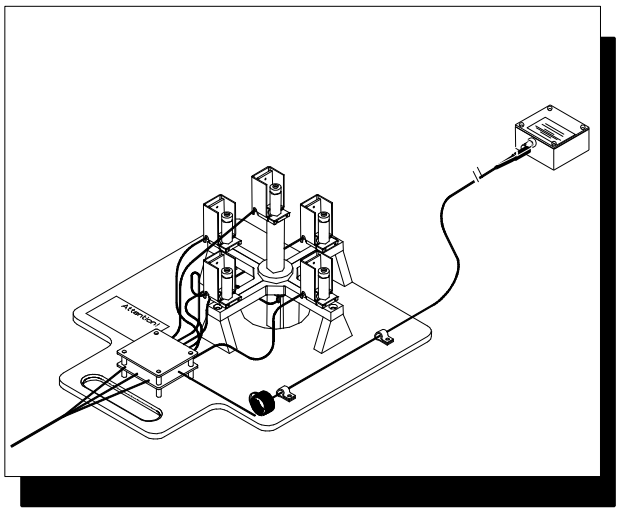
4. Remove the rubber washer on the vial.

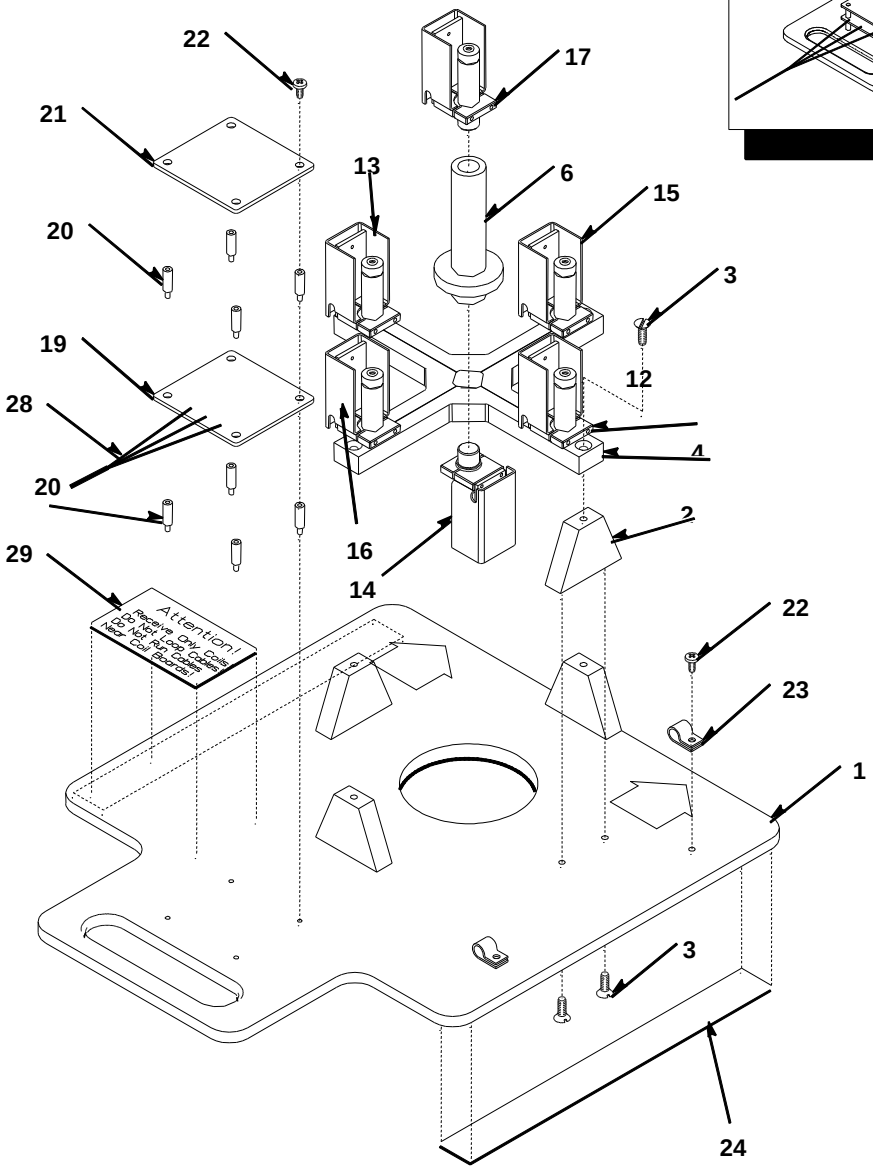
5. Empty vial.
6. Hold vial upside down and flush the vial with water using the syringe.
7. Use syringe to force any remaining water out by pumping air into vial.
8. Fill the syringe with CUSO4 and fill the cylinder. Be sure to leave enough room to put the screw back in.
9. Replace the rubber washer removed in step 4.
10. Replace the phillips head screw removed in step 3.
11. Replace the sample holder on the ECMT fixture.

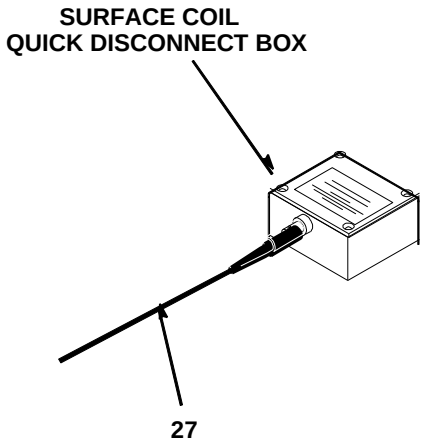
APPENDIX B - ECMT DATA SHEET

ECMT DATA SHEET (B0, Long, Very Long)				
Grad/Coil	**Mode**	**Time Interval (M Sec)**	**Spec**	**Max. Deviation**
X / X	Linear Long	1.0 - 10.0 (ms)	< 0.090	
X / X	Linear Long	10.0 - 100.0 (ms)	< 0.030	
X / X	Linear Long	100.0 - 2000.0 (ms)	< 0.018	
X / X	Long B_0	1.0 - 10.0 (ms)	< 0.10	
X / X	Long B_0	10.0 - 100.0 (ms)	< 0.10	
X / X	Long B_0	100.0 - 2000.0 (ms)	< 0.10	
X / Y	Linear Long	1.0 - 10.0 (ms)	< 0.090	
X / Y	Linear Long	10.0 - 100.0 (ms)	< 0.030	
X / Y	Linear Long	100.0 - 2000.0 (ms)	< 0.018	
X / Z	Linear Long	1.0 - 10.0 (ms)	< 0.090	
X / Z	Linear Long	10.0 - 100.0 (ms)	< 0.030	
X / Z	Linear Long	100.0 - 2000.0 (ms)	< 0.018	
Y / X	Linear Long	1.0 - 10.0 (ms)	< 0.090	
Y / X	Linear Long	10.0 - 100.0 (ms)	< 0.030	
Y / X	Linear Long	100.0 - 2000.0 (ms)	< 0.018	
Y / Y	Linear Long	1.0 - 10.0 (ms)	< 0.090	
Y / Y	Linear Long	10.0 - 100.0 (ms)	< 0.030	
Y / Y	Linear Long	100.0 - 2000.0 (ms)	< 0.018	
Y / Y	Long B_0	1.0 - 10.0 (ms)	< 0.10	
Y / Y	Long B_0	10.0 - 100.0 (ms)	< 0.10	
Y / Y	Long B_0	100.0 - 2000.0 (ms)	< 0.10	
Y / Z	Linear Long	1.0 - 10.0 (ms)	< 0.090	
Y / Z	Linear Long	10.0 - 100.0 (ms)	< 0.030	
Y / Z	Linear Long	100.0 - 2000.0 (ms)	< 0.018	
Z / X	Linear Long	1.0 - 10.0 (ms)	< 0.090	
Z / X	Linear Long	10.0 - 100.0 (ms)	< 0.030	
Z / X	Linear Long	100.0 - 2000.0 (ms)	< 0.018	
Z / Y	Linear Long	1.0 - 10.0 (ms)	< 0.090	
Z / Y	Linear Long	10.0 - 100.0 (ms)	< 0.030	
Z / Y	Linear Long	100.0 - 2000.0 (ms)	< 0.018	
Z / Z	Linear Long	1.0 - 10.0 (ms)	< 0.090	
Z / Z	Linear Long	10.0 - 100.0 (ms)	< 0.030	
Z / Z	Linear Long	100.0 - 2000.0 (ms)	< 0.018	
Z / Z	Long B_0	1.0 - 10.0 (ms)	< 0.10	
Z / Z	Long B_0	10.0 - 100.0 (ms)	< 0.10	
Z / Z	Long B_0	100.0 - 2000.0 (ms)	< 0.10	
X / X	Very Long Linear	2.0 - 100.0 (ms)	N/A	
X / X	Very Long B_0	2.0 - 100.0 (ms)	< 0.100	
X / Y	Very Long Linear	2.0 - 100.0 (ms)	N/A	
X / Z	Very Long Linear	2.0 - 100.0 (ms)	< 0.018	
Y / X	Very Long Linear	2.0 - 100.0 (ms)	N/A	
Y / Y	Very Long Linear	2.0 - 100.0 (ms)	N/A	
Y / Y	Very Long B_0	2.0 - 100.0 (ms)	< 0.100	
Y / Z	Very Long Linear	2.0 - 100.0 (ms)	< 0.018	
Z / X	Very Long Linear	2.0 - 100.0 (ms)	N/A	
Z / Y	Very Long Linear	2.0 - 100.0 (ms)	N/A	
Z / Z	Very Long Linear	2.0 - 100.0 (ms)	< 0.018	
Z / Z	Very Long B_0	2.0 - 100.0 (ms)	< 0.100	

APPENDIX C - RENEWAL PARTS







0.7T ECMT CALIBRATION FIXTURE 2271646 FRU N

Item	Part Number	FRU	Name	Quantity	Description (Remarks)
1	2233008	N	PLATFORM	1	CLEAR POLYCARBONATE PLATFORM
2	2233009	N	BLOCK	4	CROSS SUPPORT
3	2137220-2	2	M6 NYLON SCR	12	M6 X 10 FLAT HEAD SLOTTED NYLON
4	2271644	N	CROSS	1	CROSS
6	2271645	1	ADAPTER	1	CENTER ADAPTER
7	2271647	N	SAMPLE VIAL	6	0.7T ECMT SAMPLE ASSEMBLY
13	2222706	1	CIRCUIT BOAR	1	ECMT MULTIPLEXER BOARD
14	2237786	N	STANDOFF HEX	8	5/8 MALE/FEM NYLON 8-32 THD 1/4 HEX
15	2233015	N	COVER	1	COVER
16	46-208922P10	N	SCREW	6	SCREW
17	46-208713P2	2	CLAMP OR CLI	2	CLAMP OR CLIP
18	46-170124P1	2	TAPE OLD	AR	DOUBLE COAT FOAM TAPE, 72 YD, .031TK
19	2219092	2	CABLE	1	COAX CABLE
20	2219093	2	CABLE	1	CABLE
21	2219093-2	2	CABLE	1	CABLE
22	2238723	N	LABEL	1	ATTENTION! RECEIVE ONLY COILS...
23	46-282886P1	2	BNC FEMALE/FEMALE	6	BNC FEMALE//FEMALE COAXIAL ADAPTER
24	2271774	N	SCREW	12	SCREW-INCH HEXAGON HEAD .19 INCHES
25	2138069	2		1	PRODUCT IDENTIFIER

REVISION HISTORY

REV	DATE	AUTHOR	PRIMARY REASONS FOR CHANGE
0	May 31, 2000	K. L-P	Initial Release for 0.7T