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Large Hadron Collider
Magnet Division Procedure

Proc. No.: LHC-MAG-R- 1061

Issue Date: January 5, 2005

Rev. No.: A

Rev. Date: January 5, 2005

Title: LHC D3 Final Assembly

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REVISION RECORD

Rev. No.	Date	Page	Subject	Approval
A	1/5/05		Initial Release	

1 Scope:

This procedure describes the steps for final assembly & electrical testing of LHC D3 magnets.

2 Applicable Documents:

14060290	D3 Dipole Magnet Assembly
14019011	D3 Wiring Diagram
LHC-MAG-R-1051	Electrical Testing of Level & Temperature Sensors
RHIC-MAG-Q-1004	Discrepancy Reporting Procedure

3 Requirements:

3.1 Material/Equipment:

None

3.2 Safety Precautions:

3.2.1 All lifting of the cryostatted magnet shall to conform to Appendix A.

3.2.2 No welding shall take place unless all welding screens are in place around the welding station, and all personnel not directly involved with the welding process are outside the screens. Any personnel inside the screens shall wear protective gear to prevent eye injury, and shall be clothed to prevent burns caused by intense ultra-violet light.

3.2.3 Operators shall be trained by their cognizant technical supervisor and qualified in the operation of the required welding equipment.

3.2.4 All lifting and handling operations requiring overhead crane operations shall be performed by holders of valid Safety Awareness Certificates. Operators shall also be briefed in the use of the appropriate lifting device by the Cognizant Engineer or Technical Supervisor.

3.2.5 Technicians shall be instructed by their cognizant technical supervisor in the operation of the required electrical test equipment and the electrical testing procedures. They shall be familiar with the latest revisions of the applicable documents referenced in section 2. In addition, some of these tests require the technician to have special training.

3.2.6 Some of the electrical test procedures have specific safety requirements. The technicians performing these specific tests shall rigorously follow all the safety requirements listed as well as those prescribed by the BNL ES & H Standard.

3.2.7 Hypot testing poses a Class "C" electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point where the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading "DANGER HIGH VOLTAGE" and warning lights shall be turned on.

4 Procedure

4.1 Final Survey

4.1.1 Install the six Taylor-Hobson fiducial sockets. Each fiducial has three set screws which are adjusted to protrude 2mm from the bottom surface. Plug threaded holes as well as perimeter of ring with Apiezon sealant.

4.1.2 Pour in enough epoxy to come up the sides of the fiducial by only 1-3mm (approximately 60 ml.). Center the fiducial in the ring and tighten socket cap screws over Belleville washers. Allow epoxy to cure for 24 hours before proceeding to next step.

4.1.3 Complete final optical survey per LHC-MAG-R-1038 Section 4.3 and attach data to traveler.

NOTE

This will tie in the T-H fiducials with the BNL cryostat fiducials and the end volume fiducials.

4.1.4 Perform optical survey of the eleven lines at the LE and two lines at the NLE of the cryostat. Determine X, Y & Z coordinates for the point @ the center of the tube at the tube's extreme end. See Figure 1 for naming convention for these data points. Attach data sheet to traveler.

NOTE

Longitudinal measurements taken here are preliminary. Final measurements will be performed after trimming of lines.

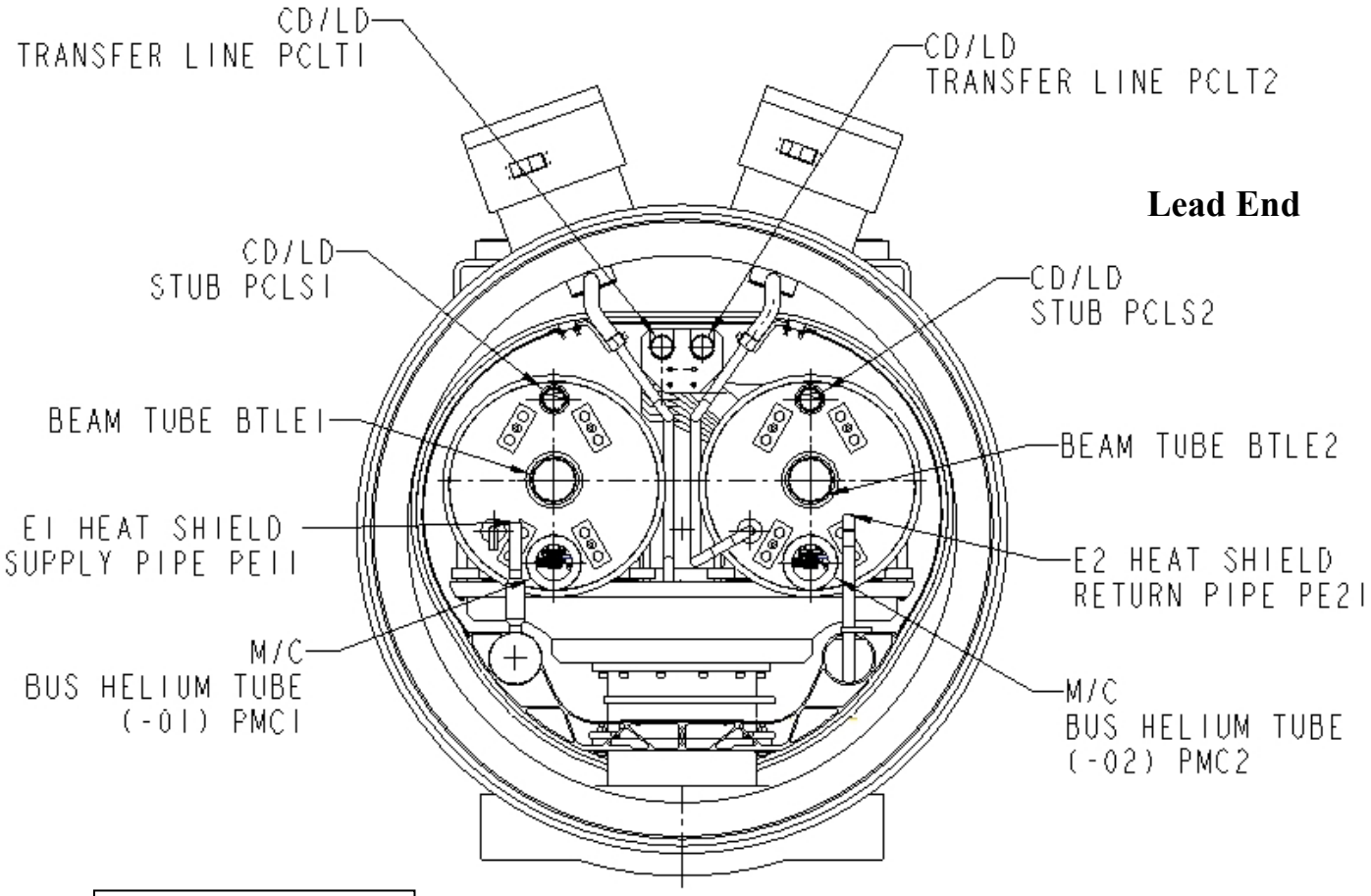
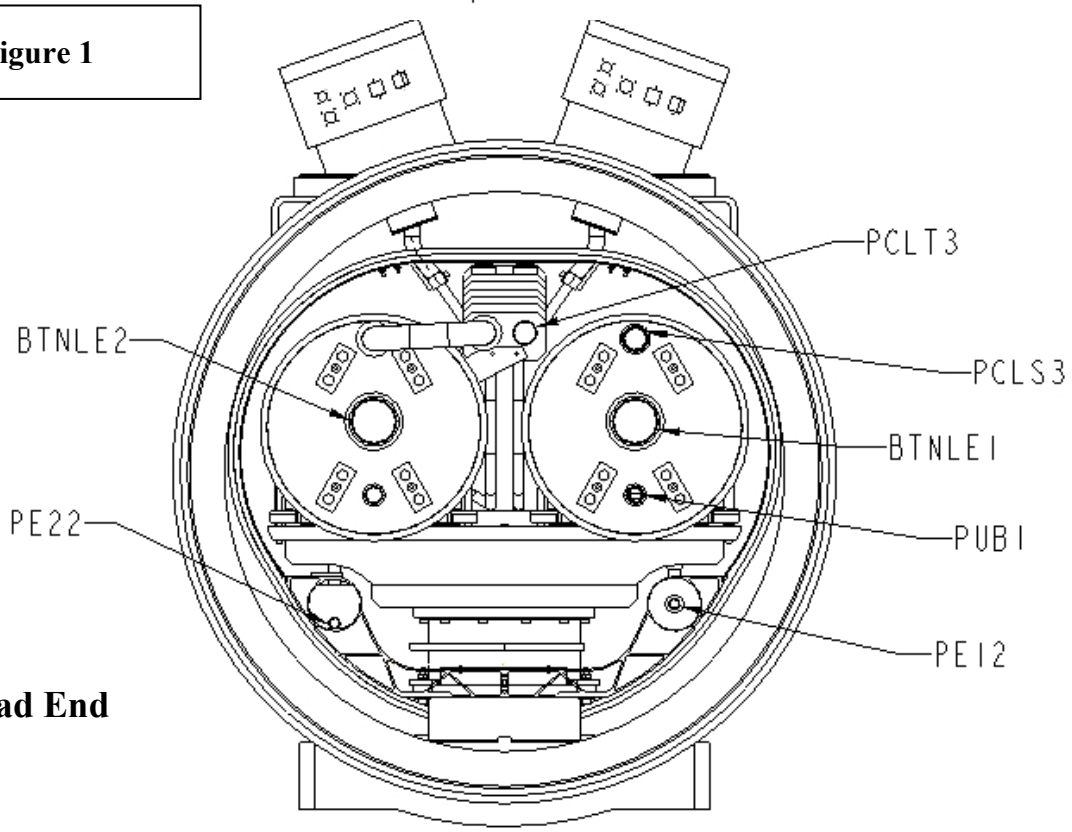


Figure 1



Non-Lead End

4.2 Final Assembly & Cryogenic Line Trimming

4.2.1 Cut off the conflat test flange from the left vertical heat shield supply line ($e_{1)}$ at the LE and install the specified reducer. The tube must be trimmed so that the end is at the specified height relative to the beam tube horizontal centerline after weld shrinkage.

4.2.2 Install the specified reducer onto the right vertical heat shield return line ($e_{2)}$ at the LE. If necessary, the tube must be trimmed so that the end is at the specified height relative to the horizontal beam tube centerline after weld shrinkage.

NOTE

The beam tubes SHALL NOT be trimmed to final length at this time.

4.2.3 On both cold masses, cut off the conflat test flange from the m/c (main bus) stub at the LE and install the specified roll flange in its place. The stubs must be trimmed such that the front face of the flange will be at the specified dimension from the face of the lead end volumes after weld shrinkage. Be extremely careful not to damage the bus cables in the pipe. Install adequate shielding sleeve and weld slowly, air cooling periodically to minimize heat buildup.

4.2.4 Cut off the conflat test flanges from the two CL/LD transfer lines at the LE. The tubes must be trimmed so that their ends are at the specified dimension from the face of the lead end volume.

4.2.5 Cut off the conflat test flanges from the two CL/LD stubs at the LE. These stubs are just above the beam tubes. They must be trimmed so that their ends are at the specified dimension from the face of the lead end volumes.

4.2.6 Cut off the conflat test flange from the heat shield supply line ($e_{1)}$ at the non-lead end and install the specified reducer. The tube must be trimmed to length as specified..

4.2.7 Install the specified reducer onto the heat shield return line ($e_{2)}$ at the NLE. The tube must be trimmed to length as specified.

4.2.8 Cut off the conflat test flanges from the undulator bus stub at the non-lead end of the (-01) cold mass. Be careful not to damage the bus while cutting and deburring the stub. The stub must be trimmed to length as specified.

4.2.9 Cut off the conflat test flange from the CL/LD transfer line at the non-lead end. The tube must be trimmed so that its end is at the specified dimension from the face of the lead end volume.

4.2.10 Tube end labeling: Affix a white label to the end of each pipe end using the designations per Figure 1. Print boldly and clearly. Securely tape over each label to avoid washout or smudging.

4.3 Final Measurement of Lead End Lines

4.3.1 Using MANCAT, the survey group shall measure the location of each tube end from the LE end volume to the end of each tube listed in figure 1. The survey group shall review this data and then forward it in Microsoft Excel format to the cognizant engineer.

4.3.2 Cognizant engineer to review data and compare to LHC interface specification. Sign off "Ok to Proceed".

4.4 Final Electrical Checks

4.4.1 With the two umbilical cables connecting the feed throughs installed, perform electrical checks on each cold mass as noted in Appendix B.

4.5 Electrical Lead Labeling

4.5.1 Remove any temporary labels from leads. For each cold mass, add permanent labels according to convention noted below:

Lead "A": Connection to Upper Coil

Lead "B": Connection to Lower Coil

Reference is Interface Specification LHC-LBRS-ES-0002

4.6 Cryostat Labeling

4.6.1 Apply decal with BNL logo as shown on assembly drawing.

4.6.2 Complete all information on cryostat nameplates using metal stamps. Leave the "manufactured date" blank.

4.6.3 Obtain date of "Acceptance Certificate" from the Magnet Division Magnet Acceptance Committee. Affix this date to the cryostat nameplate as the “Manufactured Date”.

5 Quality Assurance Provisions

5.1 The Quality Assurance provisions of this procedure require that the technician shall be responsible for performing all operations in compliance with the procedural instructions contained herein and the recording of the results on the production traveler.

5.2 The technician is responsible for notifying the technical supervisor and/or the cognizant engineer of any discrepancies occurring during the performance of this procedure. All discrepancies shall be identified and reported in accordance with RHIC- MAG-Q-1004.

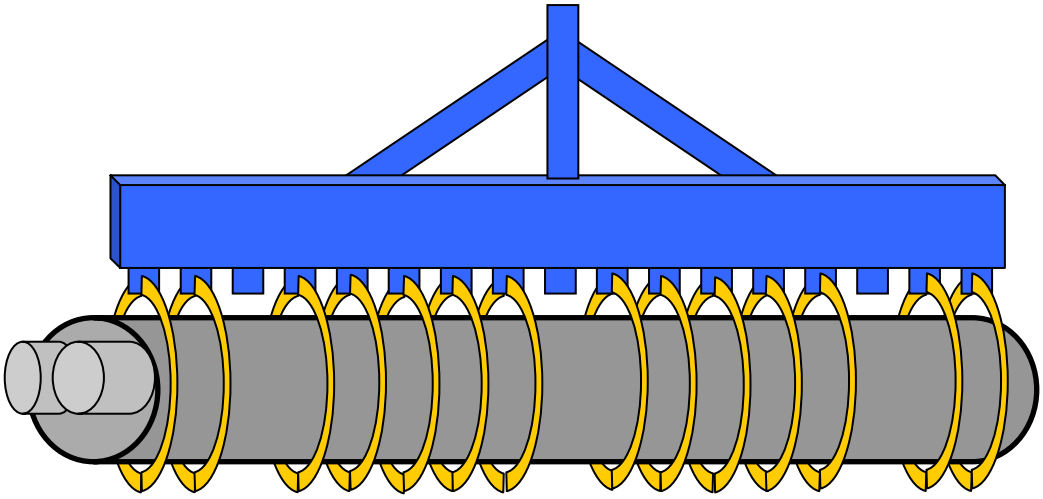
5.3 Measuring and test equipment used for this procedure shall contain a valid calibration label in accordance with RHIC-MAG-Q-1000, where applicable.

Appendix A - Lifting Scheme for Cryostatted D3 Magnet

CAUTION

Make sure load is equally distributed on 14 of 17 lifting lugs (center lug and lugs 3 from each end are not used).

Using 14 slings and Lifting Beam 25-1782.02 as shown below to move the magnet assembly. Verify all slings are of equal length.



Magnet Assembly Rigging

Appendix B - Electrical tests

NOTE

See Table 1 and Table 2 of this appendix for connector layouts on each cold mass

1. Connect beam tube, all quench protection resistors & iron to each other and to ground. Connect coils together and perform 5 kV Hypot between coils and ground per RHIC-MAG-R-7242 and RHIC-MAG-R-7243.

NOTE

The leakage current must be less than 50 μa.

2. Connect beam tube, coils & iron to each other and to ground. Perform 2.5kV Hypot between each of two quench protection resistor circuits and ground per RHIC-MAG-R-7242.

NOTE

The leakage current must be less than 50 μa.

3. Connect beam tube, coils & iron to each other and to ground. Perform 5kV Hypot between each of two quench protection resistor circuits and ground per RHIC-MAG-R-7242. Record the leakage.

4. Connect beam tube, all coils, iron & quench protection resistors to each other and to ground. Perform 2kV Hypot between each warm-up heater circuit and ground per RHIC-MAG-R-7242.

NOTE

The leakage current must be less than 50 μa.

5. Perform DC resistance tests per RHIC-MAG-R-7320 to measure voltage drops across the entire magnet winding and the voltage drop across each individual coil. Perform measurements using regular and redundant voltage taps individually.

Resistance - Section 1 (lead → midplane):	1.543-1.606
Resistance - Section 2 (lead → lead):	3.109-3.172

6. Perform complete measurements of RL&Q per RHIC-MAG-R-7228. Measured values should be:

   R: 3.109-3.172 Ω
   L: 27.19-28.30 mH
   Q: 3.636-4.444

7. Perform resistance check of Level Probes as noted in LHC-MAG-R-1051.

8. Perform resistance check of Cold Mass Temperature Sensors as noted in LHC-MAG-R-1051.

9. Perform resistance check of Warm-Up heaters. Allowable resistance is 95-105Ω

10. Perform resistance test between normal and redundant voltage tap wire at each point. Resistance to be 320Ω - 480Ω.

11. Perform resistance test on each of two Quench Protection Resistor circuits. Allowable resistance is 5.6-6.8 Ω

Appendix B - Table 1
Master Feed-Through Box (Right Hand Magnet)

Description	Connector ID	Feed-through ID
Level Probe – 1	C32-4	LT821 I-
Level Probe - 1	C32-3	LT821 I+
Level Probe - 1	C32-2	LT821 U-
Level Probe - 1	C32-1	LT821 U+
Level Probe - 2	C32-8	LT822 I-
Level Probe - 2	C32-7	LT822 I+
Level Probe - 2	C32-6	LT822 U-
Level Probe - 2	C32-5	LT822 U+
V-Tap Upper 1st	P30-2	EE211
V-Tap Upper 2nd	D31-6	EE212
V-Tap Mid 1st	D31-7	EE231
V-Tap Mid 2nd	D31-8	EE232
V-Tap Lower 1st	D31-9	EE251
V-Tap Lower 2nd	D31-10	EE252
Warm-Up Heater Circuit 1	C31-2	EH821 I-
Warm-Up Heater Circuit 1	C31-1	EH821 I+
Warm-Up Heater Circuit 2	C31-4	EH822 I-
Warm-Up Heater Circuit 2	C31-3	EH822 I+
Yoke Temperature Sensor 1	C30-4	TT821 I-
Yoke Temperature Sensor 1	C30-3	TT821 I+
Yoke Temperature Sensor 1	C30-2	TT821 U-
Yoke Temperature Sensor 1	C30-1	TT821 U+
Yoke Temperature Sensor 2	C30-8	TT822 I-
Yoke Temperature Sensor 2	C30-7	TT822 I+
Yoke Temperature Sensor 2	C30-6	TT822 U-
Yoke Temperature Sensor 2	C30-5	TT822 U+
Description	**Connector ID -** *Master Box*	
Quench Protection Circuit “A”	P31-1	
Quench Protection Circuit “A”	P31-3	
Quench Protection Circuit “B”	P31-4	
Quench Protection Circuit “B”	P31-2	
V-Tap LH Magnet Lower 2nd (EE152)	P30-1	

Note: *Quench Circuit “A” consists of circuits YT311 from each magnet wired in series. Quench Circuit “B” consists of circuits YT312 from each magnet wired in series. The identifiers “A” and “B” are arbitrary and serve merely to designate the separate circuits for testing purposes.*

Appendix B - Table 2
Slave Feed-Through Box (Left Hand Magnet)

Description	Connector ID	Feed-through ID
Level Probe – 1	C32-4	LT821 I-
Level Probe - 1	C32-3	LT821 I+
Level Probe - 1	C32-2	LT821 U-
Level Probe - 1	C32-1	LT821 U+
Level Probe - 2	C32-8	LT822 I-
Level Probe - 2	C32-7	LT822 I+
Level Probe - 2	C32-6	LT822 U-
Level Probe - 2	C32-5	LT822 U+
V-Tap Upper 1st	D31-1	EE111
V-Tap Upper 2nd	D31-2	EE112
V-Tap Mid 1st	D31-3	EE131
V-Tap Mid 2nd	D31-4	EE132
V-Tap Lower 1st	D31-5	EE151
Warm-Up Heater Circuit 1	C31-2	EH821 I-
Warm-Up Heater Circuit 1	C31-1	EH821 I+
Warm-Up Heater Circuit 2	C31-4	EH822 I-
Warm-Up Heater Circuit 2	C31-3	EH822 I+
Yoke Temperature Sensor 1	C30-4	TT821 I-
Yoke Temperature Sensor 1	C30-3	TT821 I+
Yoke Temperature Sensor 1	C30-2	TT821 U-
Yoke Temperature Sensor 1	C30-1	TT821 U+
Yoke Temperature Sensor 2	C30-8	TT822 I-
Yoke Temperature Sensor 2	C30-7	TT822 I+
Yoke Temperature Sensor 2	C30-6	TT822 U-
Yoke Temperature Sensor 2	C30-5	TT822 U+