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TEST PROCEDURE FOR THE RETEST OF D1L101 (LHC SINGLE APERTURE DIPOLE)IN HORIZONTAL TEST BAY E

RUN PLAN

This note documents the procedures (e.g., cold checkout, quench testing) used during magnet testing in Horizontal Test Bay C. The test history (quench currents, number of cooldowns, etc.) is recorded in a separate note.

Note: In the following run plan, some parameters, such as data logger sampling rate, quench detector settings, and ramp rate, may have been varied according to testing conditions and needs.

This magnet D1L101 has previously been tested. Since it was last tested, one of the quench protection heater (strip heater) circuits developed a short to the superconducting coil. Voltage measurements by John Escallier have placed the location of the short to the coil in the upper coil, in or near the lead end where the pole turn changes into the next turn.

Both heaters had performed as expected during the first test. One heater circuit is still OK and useable. This retest is being done to confirm that the quench performance is still acceptable for use at the LHC operating levels and also to provide magnetic field quality data that was not done previously. Both quench heater circuits have been left open and not connected to their power supplies and will not be used during testing. Quench protection heaters are not needed for safe quench testing at 4.5K. The unshorted circuit had tested acceptably during the first test.

Strip heaters should be open and not connected to their power supplies. The strip heater power supplies can be on but turned down to zero and the threshold voltage setting should be set to zero. This will override the strip heater interlocks to the main power supply and allow the main supply to operated without strip heaters. If it is done this way, make sure that the strip heater power supplies are on a dummy load and marked as such.

Note: D1 magnets have, by design, a more restricted space between the magnet cold bore tube and the ID of the magnet coils than the RHIC arc dipoles. This will reduce the flow of the helium to cool the conductor, especially after a quench or the introduction of heat leaks from the outside such as that from the warm bore tube (WBT). It is expected that this may lower the quench performance of the magnet until either the WBT is removed entirely or it is reconfigured to reduce heat leaks. The WBT has been reconfigured to reduce heat leaks since the first test of D1L101. The results from D1L103, which had the improved WBT installed, exhibited much less heat leak effects and quenched as expected.

NOTES:
Warm bore tube installed.
Cold magnetic field measurements to be done.
Energy extraction with dump resistor(SCR voltage nonzero)to be used.

I. INITIAL ROOM TEMPERATURE CHECKOUT AND MEASUREMENTS

Note: All warm and cold checks must be okayed at each step by appropriate personnel

I.1. Leak check of cryostat by vacuum group.

I.2. Standard electrical checkout by electrical and test groups.
Verify that the magnet is not under vacuum or not being pumped on when doing the level shift test. There should be at least one atmosphere present.

1. Hipot of main coils to ground; all other systems grounded
2. Hipot of each quench (strip) heater circuit to ground
3. With ohmmeter, measure the following resistances:
   a. Coil to ground, to strip heaters.
   b. Strip heaters to ground.
   c. Across all strip heaters.
   d. Check main taps for continuity by measuring the resistances of all taps (each tap has 200 ohm resistor).
   e. Series resistance check of all taps.

I.3. Record the total coil resistance for use later while monitoring the warmup.

I.4. Warm level shift test (1 A)
Verify that the magnet is not under vacuum or not being pumped on when doing the shift test. There should be at least one atmosphere present. Set loggers at 1kHz.

I.5. Warm magnetic field measurements in Bay C
NOTE: Before installing a mole into the aperture, the straightness of the warm bore tube must be verified by passing a dummy of the correct dimensions through.
Also, take reads in the permanent magnet before and after each z-scan.
There are 10 z positions for z-scans.

1. Install the mole into the magnet aperture.
2. Perform full z-scan. Take read of +/- 10A at each position.
3. Data from z-scan must be analyzed before beginning cooldown.

I.6. Miscellaneous checks

1. If any work has been performed on the main power supplies, such as repair of water leaks, make sure that all control equipment and buckets have been returned to nominal operational status. Operate the power supply in short circuit to 8.5KA to verify nominal operation.
2. The quench protection heaters are not being used during this test. Verify that the heater circuits are not connected to their power supplies and are left open and the heater power supplies are turned off.

COOLDOWN TO 4.5K BY FORCED FLOW COOLING AT 12 ATM

II. COLD CHECKOUT (PRELIMINARY MEASUREMENTS AT 4.5K, 12 atm)

NOTE: The cold checks in II.1 - II.5 (resistances, voltage tap checks, etc) can be done when the magnet temperature is 7K or less if this benefits the test schedule. Remember that all power supply shutoffs and strip heater quenches must be done only when the magnet has reached 4.5K.

II.1. Cooldown magnet to 7K or less. Prior to cooldown, the operators should verify that
a) cold mass leak check has been done by cryogenics group;
b) there is water to the leads; and
c) the fans and heaters for the leads are operating.

II.2. Make sure that SCR voltage is set to prescribed voltage for all tests. Dump resistor should be set as prescribed.

II.3. Hipot tests by electrical group.
It is OK to perform this test at 7K, but verify that there is at least 2 atm He pressure.
1. 500V hipot of main coils to ground; all other systems grounded
2. 500V hipot of each quench (strip) heater circuit to ground

II.4. With ohmmeter, measure the following resistances:
1. Coil to ground, to strip heaters.
2. Strip heaters to ground.
3. Across all strip heaters.
4. Check main taps for continuity by measuring the resistances of all taps (each tap has 200 ohm resistor).
5. 1A ac measurements of coil inductances

II.5. 1A level shift test (to be done only if there was an unusual result in the cold checks in Part II.4). Set LeCroy fast data loggers to 1kHz.

II.6. Connect magnet to main power supply at link box.

NOTE: The magnet must be at 4.5K for the remainder of the cold checks.

II.7. Balance Idot quench detection circuit for ramp rate of 20A/s.

II.8. Standard test conditions:

1. Quench Detection Circuit (QDC) Threshold

1: Left-Right Magnet (delta)	0.6 V
2: Magnet - Idot	4 V
	10V (when turning on power supply)

2.

Function	Delay
Delta QDC	1 ms
Idot QDC	1 ms

3. Threshold for gas-cooled lead voltages:
Set flags on monitor page to 80mV.
Critical threshold is 150mV.

4. Dump resistor at 35 mohms.

NOTE: A fuse in the power supply circuitry protects the power supply from ground faults and ground fault currents are indicated by a warning

light in the control room. Ground fault current is fully instrumented to both fast and slow data loggers.

II.9. Crash button tests at 25A (if necessary).

II.10. 1000A power supply shutoff:
Purpose: to check quench detection, power supply, and data acquisition systems before actually initiating a quench.
1. Set LeCroy logger time base to 1kHz.
2. Set SCR voltage to 500V.
3. Strip heaters unconnected and open.
4. Ramp magnet to 1000A at 20A/s.
5. Manually trip the delta (voltage difference) quench detector circuit.
6. Examine all quench signals for proper behavior

III. QUENCH TESTS AT 4.5K, 12 atm

III.1. Quench Tests
Strip heaters should be open and not connected to their power supplies. The strip heater power supplies can be on but turned down to zero and the threshold voltage setting should be set to zero
Set SCR voltage to 1700V. Dump resistor at 35 mohms.

1. For the first quench, ramp up to 5000A at 20A/s, and remain at 5000A and carefully monitor lead voltages until lead voltages are at safe levels. Then continue to ramp at 20A/s until the magnet quenches. During the entire ramp, observe the lead voltages carefully and verify that they are at safe levels. Also watch for unusual increases in lead voltages. Take monitor page reads during the entire ramp and 5000A step. Fast data loggers at 1kHz sampling rate.

If the magnet quenches before reaching 6400A, then continue training the magnet, by repeating the above quench test, until it can reach 6400A without quench.

Perform a 500V Hipot test after each quench.

2. If the magnet first quenched at 6400A or higher, perform a second quench test to verify no problems from first quench.

3. Perform a 500V Hipot test.

III.2. 5 power cycles to 6400A (if time allows).
SCR voltage at 1700V. Dump resistor at 35 mohms.
Fast data loggers at 1kHz sampling rate.
Perform five current cycles at 20 A/s ramp rate.
For each cycle wait at 6400A flattop for 5 min.
Take monitor reads during cycles and flattops.

III.3. Operation at 6400A (if time allows).
SCR voltage at 1700V. Dump resistor at 35 mohms.
Fast data loggers at 1kHz sampling rate.
Ramp magnet to 6400A at 20A/s.
Take monitor reads during 1 hour flattop.

IV. PROCEDURE TO RESOLVE D2 TRANSFER FUNCTION CHANGE

This test should be done if it is determined that the cause is the change of the current readout devices. Keep the WBT closed for this test.

IV.1. Read DCCT with both systems for the currents used in the present D2 DC loop measurements up to 5 kA.

IV.2. Data should be evaluated before proceeding.

V. MAGNETIC FIELD MEASUREMENTS WITH MOLE RA2 AT 4.5K, 12 ATM

Open WBT and allow it to reach nominal operating temperature before insertion of the mole.

Take reads in the permanent magnet before starting measurements and after finishing measurements for the day.

V.1. Set up and align the transporter.

V.2. Take read in the permanent magnet.

V.3. Install the mole RA2 into the WBT.

V.4. Perform the following DC loop at position #5 and a DC loop up ramp at each of the other 9 axial z positions. These should be the same positions that were used for the warm z-scan.

DC loop to 6400A.
Specific current levels should include the following: 200A; 300A; 350A; 400A; 600A; 1000A; 1400A; 2000A; 3000A; 3600A; 4200A; 4400A; 4600A; 5000A; 5400A; 5800A; 6000A; 6200A; 6400A.

The same set of currents should be used for the down ramp at one axial position (#5), and for the up ramp at all 10 positions.

1) AC cycle to 6400A at 10A/s.
2) DC loop to 6400A at 10A/s.

Note: The Imax current may vary depending on the magnet quench performance with the warm bore tube open and warm.

Perform 500V Hipot test before start of warmup. Warmup should not start until Hipot data is checked.

VI. WARMUP

VI.1. Monitor the total magnet coil resistance as warmup proceeds.

VI.2. When the total magnet coil resistance reaches the value measured in Part I.1, stop the warmup.

VI.3. Perform Hipot test at room temperature.