TS-SSC 90-073
S. Delchamps
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Test Objectives

Test objectives for magnet 311 are to make the standard quench, strain gage and harmonics measurements through two thermal cycles. Some of the field measurements will be made both with the standard magnetometer and with the partially completed HAL2 system. All standard magnetometer tests will be made with probe #11.

The instrumentation on magnet 311 is identical to that of magnet 310, except for the addition of two return end can external deflectometers, and two extra voltage taps on each inner-outer coil splice. An accidental difference between 310 and 311 is that the lead end voltage taps from the upper and lower outer coils of 311 were both lost during end can installation.

Mechanically, 311 differs from 310 in a) its pole shimming and b) its return end collet pieces (the "transverse" G10 pieces are used in 311.) The return end can (the one with the strain gages on it) was rotated during installation, so that the azimuthal positions of the strain gages are different from 310.

Finally, all active and compensating bullet gages on DS0311were replaced with the set from DS0309, when it was found that two of the original DS0311 active gages were shorted to ground.

This plan follows the DS0310 plan documented in TS-SSC 90-038 quite closely.

THERMAL CYCLE I

1) **Cool to 4.2 K** monitoring all thermometers and strain gages at 10 minute logging intervals.

2) Protect magnet with a 30 mohm dump resistor. Delay dump firing 50 msec after quench detection, but phase back power supply promptly. Evacuate the warm bore tube.

3) Check safety circuit balances:

a) sawtooth ramps between 100 A and 200 A at 50 A/sec.

b) manual trip from 1000 A.

4) Set data logger sampling frequencies and pre-quench windows:

a) data loggers 1 and 2: 2 kHz and 25% pre-quench.

b) data loggers 3 and 4: 5 kHz and 50% pre-quench.

STRAIN GAGE AND QUENCH TESTING

5) **Bring magnet to 4.35 K (850 Torr or 16.5 psia.)** Ramp rate = 16 A /sec.

a) Take strain gage runs, one file per current loop, using the sequences of currents below. Take data at all currents on the way up, and for the currents marked "*" on the way down.

Run 1: 0*, 2200, 3100*, 3800, 4400*, 4900 A

Run 2: 0*, 2200, 3100*, 3800, 4400*, 4900, 5400*, 5800 A

Run 3: 0*, 2200, 3100*, 3800, 4400*, 4900, 5400*, 5800, 6200 A

Run 4: 0*, 2000, 3100*, 3800, 4400*, 4900, 5400*, 5800, 6200*, 6600 A

Run 5: 0*, 2000, 3100*, 3800, 4400*, 4900, 5400*, 5800, 6200*, 6600, 7000 A

6) With ramp rate = 16 A/sec, train the magnet until 4 plateau quenches have occurred. Do not do more than 15 quenches. The predicted short sample limit currents at 4.2K, B=6T are

Inner coil: 9400 A, Outer coil: 7600 A

7) Take a strain gage run to $I_{plateau}$ - 100 A.

HARMONICS MEASUREMENTS

8)

a) **Bring the magnet to 4.2K.** Establish I_{quench} under these conditions. (Note: At this point the warm bore tube is still evacuated.)

b) Bring the warm bore tube to room temperature, insert probe #11, and establish the flow of room temperature purge gas. Quench the magnet twice to establish I_{quench} under these conditions.

9) Measure harmonics at 4.2 K.

a) Power the magnet with 200 A. Locate the ends of the magnet relative to the tape measure on the probe mounting fixture by moving the probe vertically and identifying the points at which the dipole field is 1/2 its central value. Define the magnet center to be half way between the two end points.

b) Ramp the magnet to quench at 16 A/sec.

c) Position the probe at the center of the magnet and measure the harmonics as a function of current: Do one sawtooth cycle at 16 A/sec from 0 to 6500 A or I_{quench} - 200 A, whichever is lower. Record data every 6 seconds (approximately every 100 A) starting from 0 A.

d) Ramp the magnet to quench at 16 A/sec.

e) Ramp the magnet at 12 A/sec to 6500 A or I_{quench} - 200 A, whichever is lower, hold a flattop for 2 minutes, ramp down at -12 A/sec to 110 A, hold for 2 minutes, ramp at 6 A/sec to 5000 A. (If $I_{quench} < 5500$ A, the final ramp should be to I_{quench} - 500 A.)

f) Measure harmonics as a funciton of position at 5000 A (or I_{quench} -500 A.) Take data at the following positions relative to the center of the magnet (positive is towards the lead end, i.e. up.) z = -20", -18", -16", -14", -12", -10", -8", -6", 0", 6", 8", 10", 12", 14", 16", 18", 20".

g) Ramp the magnet to 5500 A (or I_{quench} -200 A), then back to 5000 A (or I_{quench} -500 A.) Measure harmonics as a function of position at z = -20", -18", -16", -14", -12", -10", -8", -6", 0", 6", 8", 10", 12", 14", 16", 18", 20".

h) Position the harmonic probe at the center of the magnet and measure the harmonics as a function of current: Ramp the magnet from 5000 A down to 110 A, then to I_{quench} - 200 A, back to 110 A, then to 1000 A, all at 16 A/sec. Record data every 6 seconds (approximately every 100 A) starting from 500 A on the first down ramp until 1000 A on the second up ramp.

i) Measure harmonics and ramp splice voltage taps (for splice resistance measurement) at the following set of currents with the probe centered in the magnet using instrumentation of

1 - standard magnetometer
2 - HAL2

0 A
50 A
100 A
200 A
400 A
600 A
800 A
1000 A
1500 A
2000 A
3000 A
4000 A
5000 A
6000 A (or I_{quench} - 200 A)
7000 A

10) Remove the harmonic probe and evacuate the warm bore. **Take the magnet to 4.35K (850 Torr or 16.5 psia.)**

RAMP RATE AND FURTHER STRAIN GAGE STUDIES

11) Ramp value studies (with chart recorder on power supply):

a) Ramp to quench at 16, 25, 50, 75, 100, 125, 150, 200 A/sec.

b) Ramp to 6500 A at 16 A/sec, then ramp down from 6500 A to 4000 A at 100, 200, 300, and 400 A/sec.

12) **Take the magnet to 3.8 K.** Using 16 A/sec ramp rate, quench the magnet at 3.8 K until 3 quenches have occurred on plateau or a total of 10 quenches have been taken, whichever comes first.

13) Take a strain gage run at 3.8K to I_{quench} - 100 A.

THERMAL CYCLE II

14) **Warm the magnet to within 10 K of the pretest temperature** (the dewar temperature before it was cooled down the first time.) Record the strain gages and thermometers at 10 minute intervals during the thermal cycle.

15)

a) Repeat steps 2 - 8 and steps 9 e-i from the first thermal cycle, except in steps 9 f and 9 g record data only at the center of the magnet.

b) If time permits, go to step 16), the optional test.

OPTIONAL TEST (If time permits)

16) Optional test: **Bring the magnet to 4.35K (850 Torr or 16.5 psia.)**

a) From the ramp rate study (step 11), choose a ramp rate well above the "knee" for which the quench current is at least 300 A below the low ramp rate value. Ramp the magnet to quench at this ramp rate, and verify the quench current.

b) Perform a series of ramp cycles between 100 A and progressively higher peak currents. Each ramp cycle consists of an up ramp, at the rate chosen in step 16 a, from 100 A to the peak current, a 20 second flattop at that current, a down ramp to 100 A at the chosen ramp rate and a 10 second dwell at 100 A. Five successive ramp cycles should be performed to the same peak current before increasing the peak current. The first 5 ramps should be to 200 A below the quench current found in step 16 a, the next five should be to 175 A below the quench current, and so on. Continue this sequence until the magnet quenches. (This procedure will require the use of the table-driven ramp function.)

c) Perform 50 ramp cycles to the last current at which all 5 cycles were completed without quenching. (25 A below the quench current in step 16 b.)

17) **Warm to room temperature.** Monitor all strain gages and thermometers at 10 minute logging intervals until T > 100 K, then at 30 minute intervals. Continue to monitor until the magnet is within 5 K of its pretest temperature.

Distribution:

K. Coulter
T. Jaffery
W. Koska
M. Lamm
J. Strait