MQXP001 Run Plan

February 6, 2001

Since MQXP1 is the first long magnet the runplan follows a conservative approach to minimize risk. At each step in the runplan, the data will be evaluated to determine that the magnet remains in a functional state. Furthermore, to protect the magnet the run plan can be changed or terminated at any time during the course of the test.

0.1 Outline

Test Cycle I

- Magnetic measurements
- Room Temperature Pretest and Cool down
- Between 4.5K and 1.9K

  Pre-Current excitation Checkout
- At 1.9K Operation

  3000 amp tfn and 6000 QI test

  Quench training (to get above 230 T/m)

  Magnetic measurements

  RRR

Test Cycle II

- Magnetic measurements (at room temp.)
- Between 4.5K and 1.9K

  Pre-Current excitation Checkout
- At 1.9K Operation

  3000 amp tfn test

  Quench Training (to get above 230 T/m or five quench above 220 T/m)

  Ramp rate studies - one quench at 300 A/sec

  Magnetic measurements

  Heater studies

  One quenche at 20A/sec (to check that full energy deposition hasn't affected the quench performance)

  Quench Current vs. temperature (at 20 A/sec) - one quench during warm up

  Hipot the maget cold at 1400V
- Magnetic measurements (at room temp.)

0.2 Test cycle I

0.2.1 Magnetic measurements

1. The magnet is located at Stand 4
   (a) Harmonics and stretched wire measurements (details of the measurements will be determined later)

0.2.2 Room Temperature Pretest/Cooldown

1. Follow present procedures for strain gauge, voltage taps, thermometer, and heater validation. Procedures include:
   (a) Hi pot the magnet in gaseous He environment. Maximum volts should not exceed $V_{max} = 1000V$ value.
   (b) 4 wire measurement of all strain gages.
   (c) 5 amps across magnet, measure voltage across taps Measure magnet resistance and compare it to the value measured at ICB.
   (d) 4 wire heater resistance, system resistance for all four heaters.
2. Monitor strain gauge data at room temperature and check values with post assembly readings.
3. Set strain gage and thermometer readings to 10 minute intervals
4. Cool down to 80K, then change strain gage and thermometer readings to 1 minute intervals. Cool to 4.5 K , 1.1 ATM with unrestricted cooldown following Stand 4 cool-down procedure.

0.2.3 During 4.5 K to 1.9 K cool down

1. Cold electrical tests prior to magnet testing
   (a) Check magnet resistance to ground.
   (b) Hi pot (1.1 ATM helium). Maximum volts should not exceed $V_{max} = 1000V$ value.

(c) Make sure that strain gauge readings are recorded.

(d) Protect magnet with a 60 mΩ dump resistor. $I_{max} * R_{dump} \leq 1000V$

(e) Heater Pretests

  i. Configure QLM to fire heater with 1 sec dump firing delay

  ii. Check outer heater and heater system resistance using 4 wire techniques. System capacitance should be set to approximately 7 mF.

  iii. Verify that outer heaters are wired in series check system continuity

  iv. Fire outer heaters from HFU gui. Verify RC, V heaters, I heaters from data logger plots

  v. Swap polarity of one heater and repeat the previus item

(f) Disable Digital QDC (or set to high thresholds)

(g) Balance quench detection circuitry for analog QDC

  i. Set dump delay to 0 sec

  ii. sawtooth ramps between 50 A and 450 A at 100 A/sec and 300A/s

  iii. Establish thresholds based on observed noise versus anticipated signals.

(h) Balance quench detection circuit for DQDC

(i) Set dump delay to 25msec and the heater delay to 0msec. Manual trip at 1000 A. **Every single analog QDC platform has to be checked separately. Power supply, dump switch, heater and interlock respond should follow the proper quench logic.** Delay heater firing to 1 sec dump delay = 0 sec. Do another manual trip and check L/R, look at all data logger voltage signals; compare V_{max} to $I * R_{dump}$

0.2.4 At 1.9 Operation

1. Quench Heater Protection test

   (a) Tfn test

i. Set dump resistor delay to 0 ms, no heater delay, no power supply phase off delay

ii. At 3000A magnet current, fire the SHFU at 900V and check that the t_{fn} value is less than 200 ms

iii. Check quench logic signal for proper quench timing sequence

(b) Quench Integral vs current test

i. Set dump resistor delay to 0 ms, no heater delay, no power supply phase off delay

ii. At 6000A magnet current, set the dump delay to 1 sec and perform a manual trip

iii. Check whether the MIITS value at 6000 amp is as expected. If not don't proceed.

iv. Check the pressure development during the quench.

v. Set the dump delay to 25 msec and the heater delay to 0 msec.

2. Quench training

Before each quench measure the inductance of the magnet. Make sure that the inductance remain unchanged. With ramp rate = 20 A/sec, train the magnet. If the quench current produce more than 230 T/m field gradient do not do more quenches. Make sure to run "fast strain gauge" and "snap-shot" scripts.

3. Magnetic measurements

The default ramp rate is 20 A/sec.

The nominal data set is 25 rotations of the coil.

All measurement sequences should begin with a "cleansing" quench at $\sim$ 10000A. A cleansing quench is done by firing the magnet heaters with magnet current high enough to produce a small remnant field.

(a) Set the heater delay to 0 msec, dump delay to 25 msec, and dump resistance to 60 mΩ.

(b) Determine the minimum magnet current for a cleansing quench: check the effect of a cleansing quench at 10000 A by checking the remnant magnetic field. If the remnant field is substantial increase the current and quench the magnet again. Repeat this procedure until the minimum current is found. Use this value of the current for all cleasing quenches needed for this test plan.

   (c) Take harmonics and stretched wire measurements (details of the measurements will be determined later)

4. RRR

   Perform 4 wire measurement using DMM. The applied current should be 5amps and applied only during data taking. Take reading in every couple hours, however make sure that there is a measurement taken when the magnet temperature is between 15 - 20 K.

0.3 Test cycle II

0.3.1 Magnetic measurements

1. At Stand 4

   (a) Take harmonics and stretched wire measurements (details of the measurements will be determined later)

0.3.2 During 4.5 K to 1.9 K cool down

1. Cold electrical tests prior to magnet testing

   (a) Check magnet resistance to ground.

   (b) Hi pot (1.1 ATM helium). Maximum volts should not exceed V_{max} value (to be determined).

   (c) Make sure that strain gauge readings are recorded.

   (d) Protect magnet with a 60 mΩ dump resistor. $I_{max} * R_{dump} \leq 1000V$

   (e) Check whether every QDC and DQCD settings are the same as was at the first test cycle.

(f) Set dump delay to 25msec and the heater delay to 0msec. Manual trip at 1000 A. **Every single analog QDC platform has to be checked separately. Power supply, dump switch, heater and interlock respond should follow the proper quench logic.**

0.3.3 At 1.9K Operation

1. Quench Heater Protection test ($t_f n$ test)

   (a) Set dump resistor delay to 25 ms, no heater delay, no power supply phase off delay

   (b) At 3000A magnet current, determine voltage required to quench heaters with $t_{fn} < 200$ ms

   (c) Check quench logic signal for proper quench timing sequence

2. Quench Training

   Before each quench measure the inductance of the magnet. Make sure that the inductance remain unchanged. With ramp rate = 20 A/sec, train the magnet above 230 T/m but don't take more than 5 quenches above 220 T/m. If the magnet doesn't quench at 230 T/m slowly ramp down the power supply. Make sure to run "fast strain gauge" and "snap-shot" scripts.

3. RAMP RATE dependence studies.

   Ramp to quench at 300 A/s,

4. Magnetic measurements

   Repeat Test cycle I procedures, as desired.

5. Heater studies

   (a) For heater study the default setting for the dump resistor delay is 1 s (except for the $V - min$ study where the dump delay is 25 msec), no heater delay, no power supply phase off delay or delay it within MIITs limit (15 MIITs)

(b) Outer Heater study. Adjust the SHFU capacitor bank value and/or the system resistance to obtain RC time constant to be in the $\sim$ 100 msec range and the heater power per unit area to be the same as the expected CERN strip heater can provide at 900 V. These likely to be satisfied with 19.2 mF capacitor bank setting and the heaters connected in series.

DO NOT EXCEDE MAXIMUM HFU VOLTAGE

(c) Spot heater study. Make sure to be within the MIITS limit.

i. Check whether the 1n - 1m voltage segment gain was set properly (by injecting a signal at the instrumentation tree and read back with num. disp.). Use the strip heater for protection. Set SHFU to the desired voltage value ($55W/cm^2$). Use outer pole (Q1) heater to initiate quench. Set the spot heater HFU to 25V. Fire the spot heater at following magnet current values: 10000A, 12000A.

6. Ramp up the current untill the magnet reach 230 T/m with 20 A/s ramp rate or the last quench current value the magnet had. If the magnet doesn't quench slowly ramp down the PS.

7. Quench Current vs. temperature

   Set the heater delay to 0 msec, dump delay to 25 msec, and dump resistance to 60 mΩ.

   Ramp once the magnet to quench at 20 a/s between 1.9k - 4.5K temperatures.

8. Perform a cold (between 1.9K and 4.5K) Hipot at 1400V.

9. Warm magnet measurements

   (a) Take harmonics and stretched wire measurements (details of the measurements will be determined later)