Fermi National Accelerator Laboratory

Fermilab

Operation Readiness Clearance (ORC) of SpinQuest (E1039) Polarized Target (summary for the final walkthrough)

ORC - 2055

SpinQuest Collaboration

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1 Introduction

This ORC is basically including the list of all the sub-systems ORCs related to the SpinQuest (E1039) experiment's polarized target system, and also the Superconducting magnet operation procedure, 30-Gauss boundary of the magnetic field as well.

Figure 1: Left: From the beam-upstream view; Right: From the beam-downstream view

2 List of ORCs

ORC #	Description
2055	Polarized Target System Final Walkthrough
2056	Polarized Target Magnet Cooldown
2053	Helium and Nitrogen piping (in-cave)
2049	Superconducting magnet electronics (in-cave)
2050	Target fridge electronics (in-cave)
1847, 1847.03, 1983	Roots vacuum system
1982, 1853	Magnet power supply rack
1970	Annealing system
1895, 1969	Slow controls rack
1834, 1968	Microwave test setup at counting house
1954	Fridge valve control system
1934	Microwave motor control
1854, 1888, 1888.01	UVA-NMR system
1984	LANL-NMR system
1837, 1865, 1866, 1877	Target lifter
1857, 1938	Helium Liquefier (QT) system
1867	AC power distribution for Slow Controls Rack
1933	Quiet power for NMR
1941	ODH & Hazardous gas controls
2002	LN2 delivery piping
2008	Helium delivery piping

3 Superconducting magnet operation procedure (see ORC 2056 for more details)

Restrictions

DO NOT exceed the rate limits listed below, the magnet can quench
DO NOT allow persons with medical implants near a magnet – death can occur
AVOID the need for fill during ramping, warm gas can cause quench
Ensure safety prerequisites for magnet ramping are met

Figure 2: Power supply for the superconducting magnet

Factory: Oxford Instruments
Model: MercuryIPS (Master and Slave)
Function: Energize the superconducting magnet
Power requirement: 100-240 VAC, 800 Watt.
At 208 VAC, max. current is 3.85 A for both master and slave
Cables and connections: The MercuryIPS power the superconducting magnet via twisted pair and heavy gauge superconducting magnet power cables. The positive and negative terminals of the master and slave are connected via metal busbar. The master and slave also connected by the provided DB-9 female to male cable, which goes from the DB-9 'out' port on the master to the DB-9 'in' port on the slave. The master should then be connected via the DB-27 RS323 to the RS232-Ethernet converter (PK70EX-232CR). Both master and slave are powered from the AC power strip Trip Lite PDU1230.

Before initial use, the following checks should be complete:

1.) A magnetic material sweep of the cave: Look for any loose bits of metal or tools that may be caught in the magnetic field. The cave should be cleaned of debris and a metal sweep should be conducted using small handheld magnets to check for and remove any material. The sweep should be performed at least up to 4 m away from the outside of the magnet can.

2.) A 30 Gauss boundary should be indicated on the floor near the cave to warn people that a strong magnetic field is nearby. Signage should be posted as per FNAL ES&H safety requirements.

3.) Check magnet leads and shim power leads are connected to the magnet. Check that the sensor leads, and heater leads are also connected.

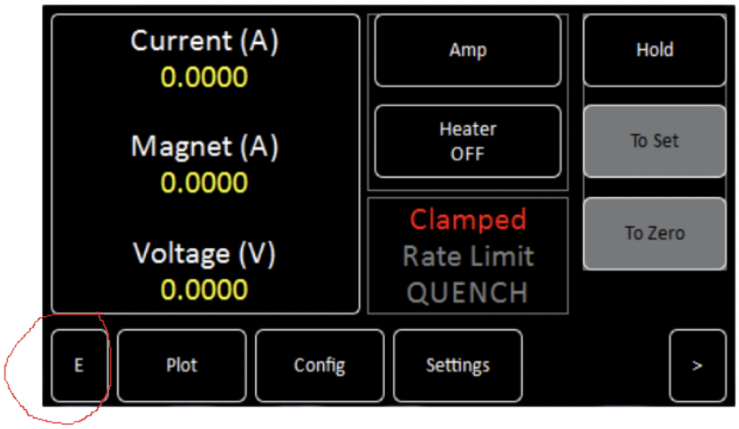
4.) Switch on MercryIPS, you should see on the LCD screen the options to run current to zero or to the setpoint. If the power supply and coils have successfully initialized, you will see the firmware version displayed.

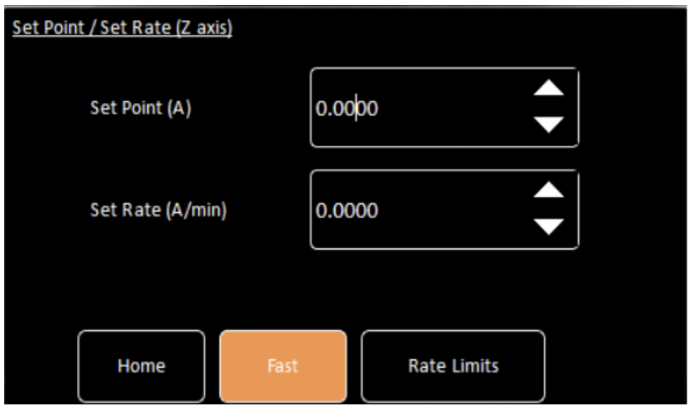
5.) Select the mode of display required, this can be in Amps or Tesla by pressing the button labeled CURRENT/FIELD on the LCD screen. Set this to Amps if not already done.

6.) Set this current to 0.5 A/min which is a safe current to start the magnet energizing procedure. This can be adjusted as needed later.

The magnet energizing can now be started by following these steps (Direct Manual Control):

A.) On the LCD screen push the bottom-left menu (Red circle labeled as "E") and change to "L". "L" means local control.





B.) Then push To Set to come to this display (to set the Set Point and Ramp Rate)

C.) Set the Set Point and Ramp Rate for the appropriate phase of the magnet energization accordingly,

Allowed Ramp Rate	Output Current
2 A/min	< 40 A
1 A/min	40-63 A
0.5 A/min	> 63 A

Remote Ramp-Up Procedure

Procedure: Instructions from Counting House which assumes: The magnet power supply is on and a sweep for magnetic objects from an area within 4m of the magnet has already been done

1. Put Magnet VI in "Monitor," if necessary, to allow updates from users

2. Press the "Unlock Magnet Controls" button in the Polarization Display Panel, VI

■ Verify that there is no current in the leads (Power supply icon, far left)

3. Press the "Hold" button

4. Hit the "Heater On" button and confirm this action in the dialog box that presents itself

■ Wait until the timer counts down to zero (maybe a little more)

5. The magnet must be ramped up in steps with the correct current rates, PDP should not allow you to exceed these rates, but be mindful. For 2.5T Set the Setpoint to 60.9135A and Set Rate to 3.0A/min. There is only one step in this case. For 5.0T there are four steps (seen below). At each step enter the Setpoint and corresponding Set Rate then press To SETPOINT

when the current has been reached press HOLD and changes the value to the Setpoint and Set Rate for the next step and press SETPOINT. After each change of Setpoint and Set, Rate check the Magnet Control display in PDP to make sure Labview is reading incorrectly

■ A.) Setpoint: 80A Set Rate: 3.0A/min

■ B.) Setpoint: 100A Set Rate: 2.0A/min

■ C.) Setpoint: 115A Set Rate: 1.0A/min

■ D.) Setpoint: 121.825A Set Rate: 0.5A/min

2. Press "Hold"

■ If persistent mode is not desired, stop here

3. Wait for a few seconds

4. Press the "Heater Off" button

■ Wait until the timer counts down to zero (maybe a little more)

5. To ramp down leads, press the "To Zero" button

6. Press the "Lock Magnet Controls" button

Remote Ramp Down Procedure

1. Press the "Unlock Magnet Controls" button in the Polarization Display Panel, PDP

2. If necessary, Ramp the Power Supply to the Magnet Current

■ Type the value of the magnet current (this is in Amps) into the "Setpoint" box

■ Press "To Setpoint"

■ Wait for the PS current to reach the Magnet current

3. Press the "Heater On" button and confirm this action in the dialog box that presents itself

■ Wait until the timer counts down to zero (maybe a little more)

4. Set the first Setpoint and Set Rate values. PDP should not allow you to exceed these rates, but be mindful. With 2.5T you can just press TO ZERO. With 5.0T the magnet must be ramped down in steps. At each step enter the Setpoint and the corresponding Set Rate then press To SETPOINT when the current has been reached press HOLD and change the value to the Setpoint and Set Rate for the next step and press SETPOINT. After each change of Set Point and Set Rate check the Magnet Control display in PDP to make sure Labview is reading incorrectly

■ A.) Setpoint: 115A Set Rate: 0.5A/min

■ B.) Setpoint: 100A Set Rate: 1.0A/min

■ C.) Setpoint: 80A Set Rate: 2.0A/min

■ D.) Setpoint: 0A Set Rate: 3.0A/min

5. Press the "Hold" button

6. Press the "Heater Off" button

7. Press the "Lock Magnet Controls" button

4 30-Gauss boundary of the magnetic field

To obtain the magnetic field inside and outside the magnet dewar, we use COMSOL to solve a set of Maxwell equation using finite element method.

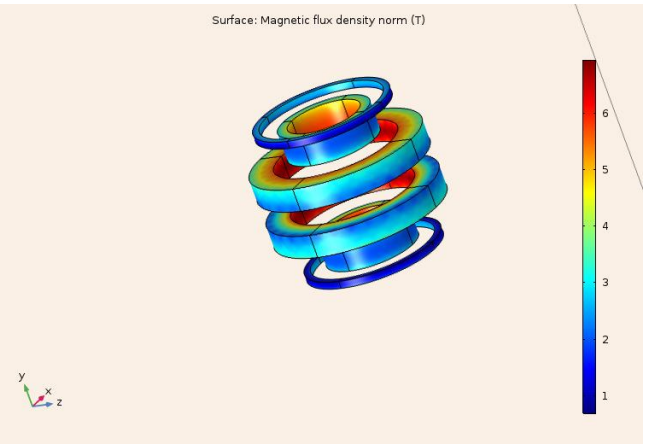
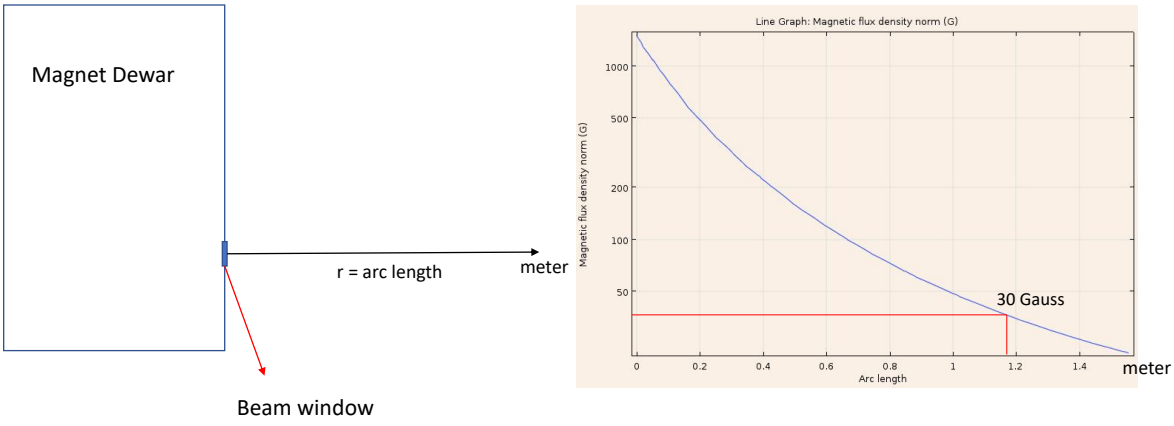


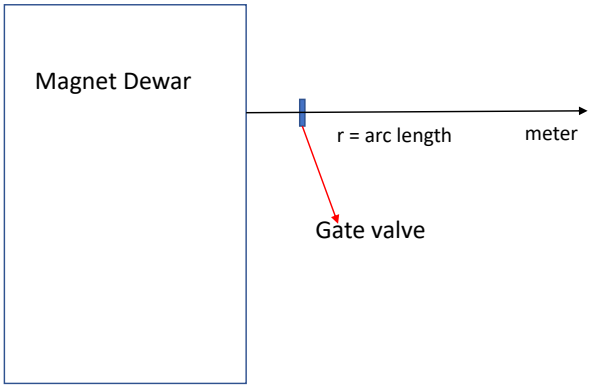
Figure 3: Magnetic field in the magnet obtained from COMSOL

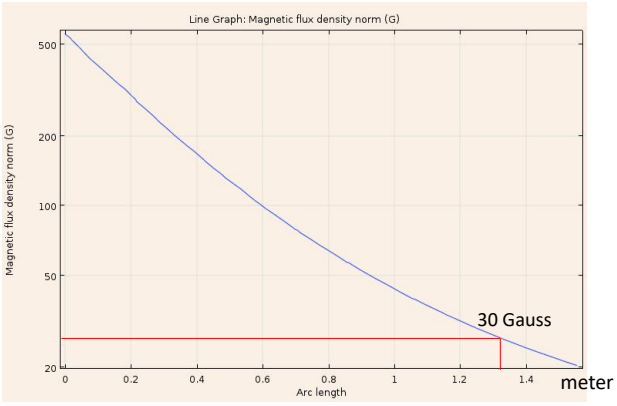
Magnetic field from the Dewar surface at the vertical position of the beam line.



The 30 Gauss boundary is at radius 1.18 meters from the Dewar surface at the vertical position of the beam line.

Magnetic field from the Dewar surface at the vertical position of the gate valve.





The 30 Gauss boundary is at radius 1.32 meters from the dewar surface at the vertical position of the gate valve.

Therefore, considering the calculations for 30-Gauss boundary, we can consider marking the bottom of the ladder (see the Fig. on the right-hand side) to the target cave as the 5-Gauss boundary to ensure the safety.

References

[1] All mentioned ORCs on section 2.

[2]https://seaquest-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=10060

[3]https://seaquest-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=10062

[4]https://seaquest-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=10053

[5]https://seaquest-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=9670

[6]https://seaquest-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=10032

[7]https://seaquest-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=9651