THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY
12000 Jefferson Avenue
Newport News, VA 23606

HALL B PROCEDURE NO.:
B000000401 –P029 Rev -0

TITLE: **Hall B Torus Magnet Operation - A Guide for Shift Workers**

BY: R. Fair DATE: 12 /02 /2016

Intended Checker and Approvers:
CHK: P. Ghoshal
1. APP: C. Luongo
2. APP: 2nd Approver (if necessary)
3. APP: 3rd Approver (if necessary)

REV.	ECO#	DESCRIPTION	BY	CHK.	APP.	APP.	DATE
SUMMARY OF CHANGES FROM PREVIOUS REVISION:							

Contents

1. Introduction

This document summarizes the power up (energization) and power down (de-energization) procedure for the Hall B CLAS12 Torus superconducting magnet. It is primarily a guide for shift workers.

For a more detailed description of the full power up and power down procedure for the commissioning and post-commissioning operation of the magnet, refer to *B000000401-P020 Hall B Torus Power-Up and Power-Down Procedure.*

2. Emergency Contact Names

Should the need arise, first call the 'ENGINEER ON CALL' – his/her name and contact telephone number should be on the white board in the Hall B Counting Room.

The ENGINEER ON CALL will then (if necessary) call in the relevant Subject Matter Experts (SME).

Table 1 – Contact Names

Sub-System	SME
Magnet Power Supply	Krister Bruhwel
Magnet Fast Dump / Quench	Dave Kashy
Cryogenics System	Dave Kashy, Denny Insley
Vacuum System	Dave Anderson
Instrumentation and Control	Nick Sandoval

3. Pre-Energization Checklists

The following checks should already have been completed.

IF IN DOUBT PLEASE CONTACT THE 'ENGINEER ON CALL'

1. *B000000401-P021 Hall B Torus Operations Power Up Checklists*
2. *B000000402-P002 Hall B Superconducting Magnets Power Supply Maintenance Turn-On Checklist*
3. *B000000402-P001 Hall B Superconducting Magnets Pre-Power-Up Power Supply Internal Interlock Checklist*
4. *B000000401-P022 Hall B Torus Pre-Power-Up Water-Cooled Leads Checkout Procedure*
5. *B000000401-P023 Hall B Torus Pre-Power-Up Vapor-Cooled Leads Checkout Procedure*
6. *B000000401-P025 Hall B Pre-Power-Up Instrument Checkout Procedure*
7. *B000000401-P026 Hall B Pre-Power-Up Quench Detector Tuning Procedure*
8. *B000000401-P027 Hall B Pre-Power-Up Interlock Checkout Procedure*

4. Magnet Operation

The Operator controls the Magnet Power Supply (MPS) for the magnet and monitors the magnet and its sub-systems via a PLC using a series of EPICS screens. Bringing the Torus to operating field is done in a series of current steps at differing current ramp rates. Each time the operator establishes the desired current on the EPICS screen and clicks anywhere outside the 'Set point' box, the power supply begins the ramp to the set point current at the specified slew rate (Ramp rate).

Shift workers will typically operate the magnet using the Magnet Power Supply (MPS) Control Screen shown in Figure 1 below.

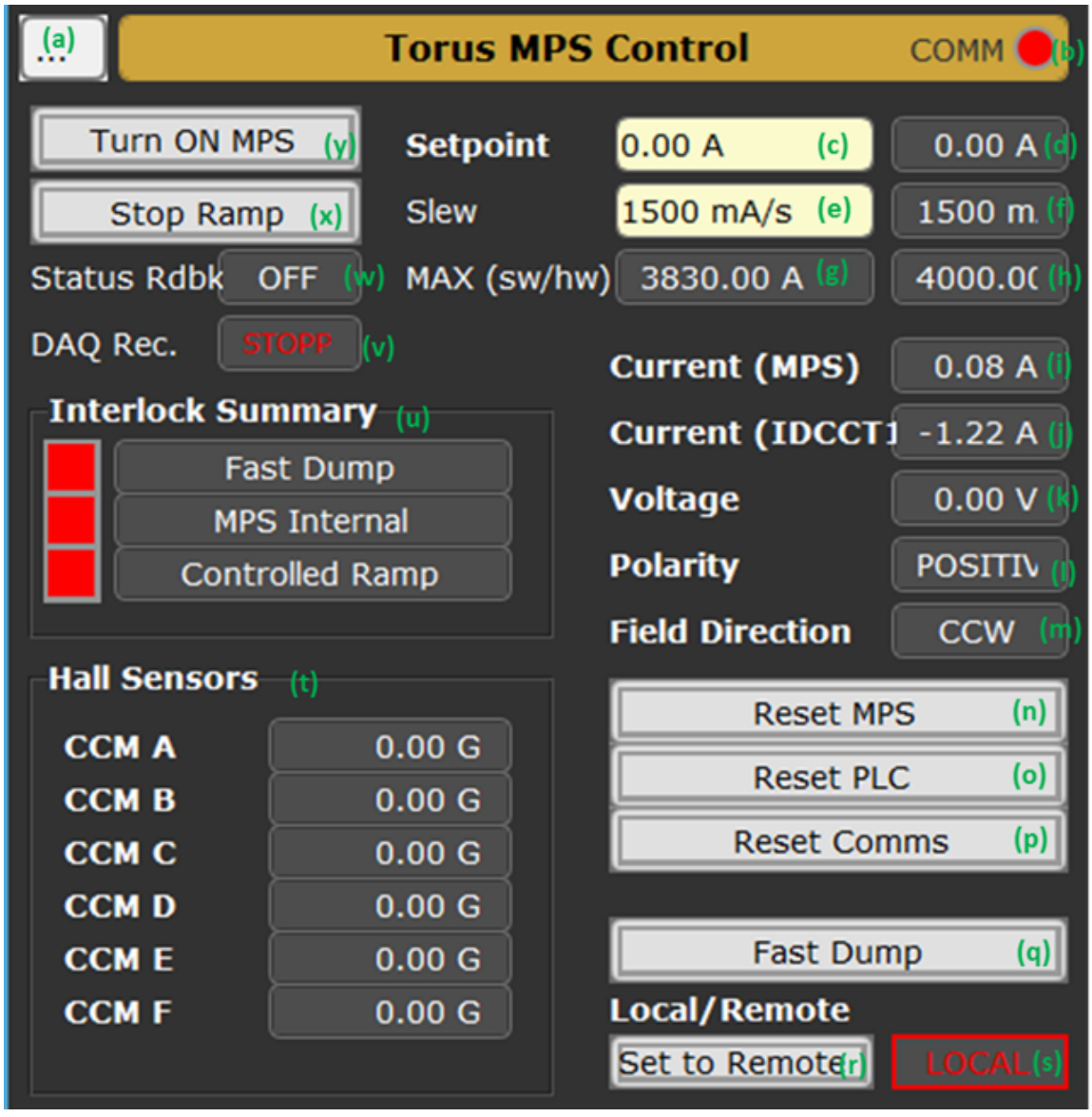


Figure 1 - JLab MPS Control – EPICS

Table 2 – Definition of items on MPS EPICS Control Screen

	Description	Expected value
(a)	Launches 3 additional windows: (i) Interlock Status (ii) Fast DAQ recording control (iii) Fast DAQ live data	N/A
(b)	Ethernet to RS232 communication between Torus PLC, 435NBX, and Magnet Power Supply	GREEN
(c)	Desired target current. User types value into the field shown and presses enter. Use a negative value if ramping to a negative polarity is required. User only needs to enter a number (no units are required). If the user enters a number greater than the software limit (see (g) below), the target current (c) will automatically be set to (g)	User Defined
(d)	Present target current.	N/A
(e)	Desired slew rate (ramp rate). The user is advised to set the slew rate first before setting the magnet current set point	User Defined
(f)	Present slew rate	N/A
(g)	Software (SW) magnet current limit set within the PLC code	User Defined within PLC
(h)	Hardware (HW) Power Supply Current Limit. This value will never change as long as the same power supply is used. (This value is needed to get PPM conversion from setpoint to PSU correct)	User Defined
(i)	Magnet current read back from magnet power supply, A/D 16 bit	N/A
(j)	Magnet current read back from buffered analog output of control crate (through cRIO)	N/A
(k)	Magnet Power Supply output voltage	N/A
(l)	Magnetic field direction (and therefore magnet current polarity).	CCW or CW
(m)	Magnetic field direction. Positive field direction is CCW when looking downstream.	N/A
(n)	Resets only the MPS internal interlocks	N/A
(o)	Resets only PLC interlocks	N/A
(p)	Resets only communications between the magnet power supply and PLC	N/A
(q)	Initiates a fast dump of the magnet current through the dump resistor. On clicking this button, the user will be prompted to confirm the action.	N/A
(r)	Used to switch between local and remote mode on the MPS display unit	N/A
(s)	Read back of MPS control state: will display 'LOCAL' in local mode, and 'REMOTE' in remote mode. Must be set to 'REMOTE' to allow changes on the MPS EPICS screen to affect the power supply.	N/A
(t)	Read backs from the 6 hall sensors mounted on the outside of the vacuum jackets of the individual coils	20000 Gauss @ 3770 A
(u)	Sum status of the three sets of interlocks	GREEN
(v)	Indicates whether the Fast DAQ system is writing data to disk. Always ensure this is 'RECORDING' before energizing the magnet	RECORDING
(w)	Magnet Power Supply On/Off status	ON
(x)	Stops the ramping of the magnet by EPICs changing the set point to a value close to the current read back	N/A
(y)	Button to turn on MPS after communications has been established (Enables output). On clicking this button, the user will be prompted to confirm the action.	ON

4.1 Power Up

Reference should be made to Figure 1 and Table 2.

<table>
<tr><th></th><th>Instruction</th><th>Action</th></tr>
<tr><td colspan="3">CHECKS AND INITIAL SETTINGS ON THE MPS CONTROL SCREEN BEFORE ENERGIZING MAGNET</td></tr>
<tr><td>1</td><td>Check that (b) COMM is GREEN</td><td>• If it is RED, click (p) Reset Comms
• If it does not turn GREEN, call the ENGINEER ON CALL</td></tr>
<tr><td>2</td><td>Check that (g) MAX sw (software) limit is set to a value higher than the final target current.</td><td>• If it isn’t, call the ENGINEER ON CALL</td></tr>
<tr><td>3</td><td>Check that (h) MAX hw (hardware) limit is set to a value higher than the final target current.</td><td>• If it isn’t, call the ENGINEER ON CALL</td></tr>
<tr><td>4</td><td>Set the (e) Slew Rate to 0 (zero) mA/s. Do this by typing in the field and click anywhere outside the field.</td><td>• If the control screen does not allow you to do this, call the ENGINEER ON CALL</td></tr>
<tr><td>5</td><td>Set the (c) Setpoint to 0 (zero) A. Do this by typing in the field and click anywhere outside the field.</td><td>• If the control screen does not allow you to do this, call the ENGINEER ON CALL</td></tr>
<tr><td>6</td><td>Check that (s) is displaying REMOTE.</td><td>• If it isn’t, click (r) Set to Remote to set it to REMOTE
• If it does not switch to REMOTE, call the ENGINEER ON CALL</td></tr>
<tr><td>7</td><td>Check that all the (u) Interlock Summary indicators are GREEN.</td><td>• If any of the indicators are RED, call the ENGINEER ON CALL
• From the pull-down menu: Select Interlock Status
• This will bring up another window (Torus MPS Interlock Status - PLC).
• Report to the ENGINEER ON CALL which indicators are RED.
• Go back to the MPS Control screen</td></tr>
<tr><td>8</td><td>Check that (v) DAQ Rec is displaying RECORDING</td><td>• If it says STOPPED, click (a) (upper left of screen).
• From the pull-down menu: Select Fast DAQ Recording Ctrl.
• This will bring up another window (Torus Fast DAQ ROOT File).
• Click the ‘Start Recording’ button.
• Check that a filename is displayed below and that the file size is increasing before continuing with magnet energization.
• Go back to the MPS Control screen</td></tr>
<tr><td colspan="3">ENERGIZING (POWERING UP) THE MAGNET</td></tr>
<tr><td>10</td><td colspan="2">Use the following ramp rates and target currents to power up the magnet to full field (3770 A)
Remember to always set the (e) Slew Rate first followed by the (c) Setpoint
<table>
<tr><th>From Current (A)</th><th>To Current (A)</th><th>Slew rate (mA/s)</th></tr>
<tr><td>0</td><td>2000</td><td>1500</td></tr>
<tr><td>2000</td><td>2500</td><td>800</td></tr>
<tr><td>2500</td><td>3000</td><td>500</td></tr>
<tr><td>3000</td><td>3770</td><td>400</td></tr>
</table></td></tr>
<tr><td>11</td><td colspan="2">If there are any trips (magnet, cryogenics, control, communications etc), one of more of the (u) Interlock Summary indicators will turn RED and the magnet with either Fast Dump or initiate a Controlled Ramp Down. If this happens call the ENGINEER ON CALL.</td></tr>
</table>

4.2 Power Down

Reference should be made to Figure 1 and Table 2.

<table>
<tr><th></th><th>Instruction</th><th>Action</th></tr>
<tr><td colspan="3">DE-ENERGIZING (POWERING DOWN) THE MAGNET</td></tr>
<tr><td>1</td><td colspan="2">The power down process is simply a reverse of the power up process
Use the following ramp rates and target currents to power up the magnet to full field (3770 A)
Remember to always set the (e) Slew Rate first followed by the (c) Setpoint

<table>
<tr><th>From Current (A)</th><th>To Current (A)</th><th>Slew rate (mA/s)</th></tr>
<tr><td>3770</td><td>3000</td><td>400</td></tr>
<tr><td>3000</td><td>2500</td><td>500</td></tr>
<tr><td>2500</td><td>2000</td><td>800</td></tr>
<tr><td>2000</td><td>0</td><td>1500</td></tr>
</table>
</td></tr>
<tr><td>11</td><td colspan="2">If there are any trips (magnet, cryogenics, control, communications etc), one of more of the (u) Interlock Summary indicators will turn RED and the magnet with either Fast Dump or initiate a Controlled Ramp Down. If this happens call the ENGINEER ON CALL.</td></tr>
</table>

4.3 Reversing Polarity

Reference should be made to Figure 1 and Table 2.

<table>
<tr><th></th><th>Instruction</th><th>Action</th></tr>
<tr><td colspan="3">REVERSING POLARITY</td></tr>
<tr><td>1</td><td colspan="2">• Note that POLARITY is defined as follows:

CCW Field Direction (looking downstream) = POSITIVE POLARITY
CW Field Direction (looking downstream) = NEGATIVE POLARITY

• Typing a POSITIVE number in (c) Setpoint will cause the magnet to ramp in POSITIVE POLARITY MODE
• Typing a NEGATIVE number in (c) Setpoint will cause the magnet to ramp in NEGATIVE POLARITY MODE
• Note: If the magnet is in POSITIVE POLARITY MODE and you wish to run it in NEGATIVE POLARITY MODE, simply type in a NEGATIVE number in (c) Setpoint. The magnet will then ramp down to zero (0) Amps at whatever slew rate is presently active, the polarity reversal switch within the magnet power supply will activate and the magnet will then ramp up in the opposite direction to the target current that you have selected. And vice versa, if the magnet was originally in NEGATIVE POLARITY MODE.</td></tr>
<tr><td>2</td><td colspan="2">If there are any trips (magnet, cryogenics, control, communications etc), one of more of the (u) Interlock Summary indicators will turn RED and the magnet with either Fast Dump or initiate a Controlled Ramp Down. If this happens call the ENGINEER ON CALL.</td></tr>
</table>

Appendix A – Definition of Magnet Discharge Modes

Type of discharge	Definition	Discharge time
Normal ramp down	Discharge following the prescribed maximum ramp rate at a given current, through the Power Supply	~ 4000 sec (65 min) from full current (3770 A)
Controlled ramp down	Discharge at 1 A/sec irrespective of magnet current, through the Power Supply	3770 sec (63 min) from full current (3770 A)
Fast Dump	Discharge (emergency) through the Dump Resistor (dump switch) – this is also the discharge mode during a magnet quench	80 sec from full current (3770 A) to zero (16 sec time constant)

Appendix B – Magnet Power Supply Control Screens (EPICS)

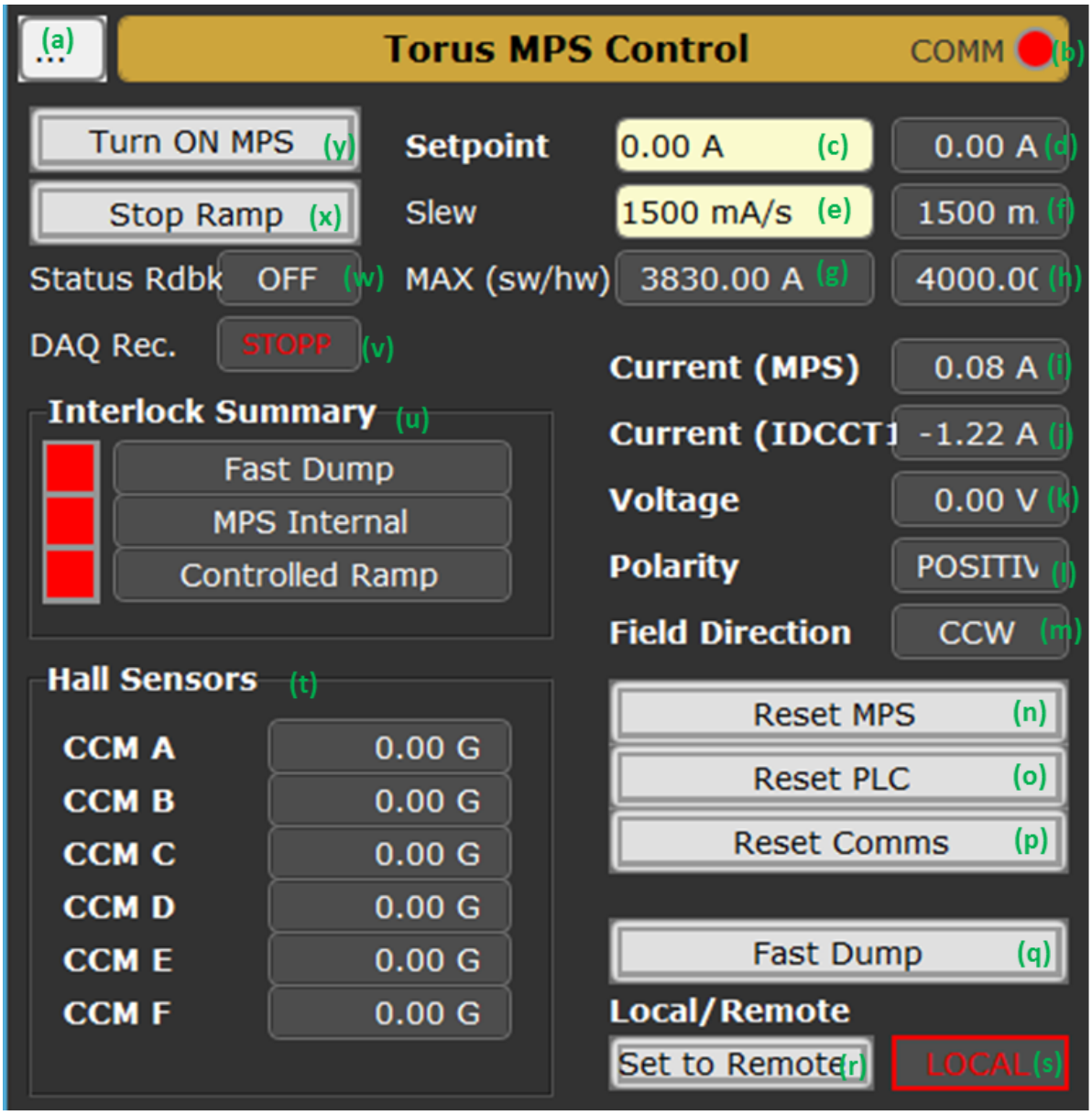
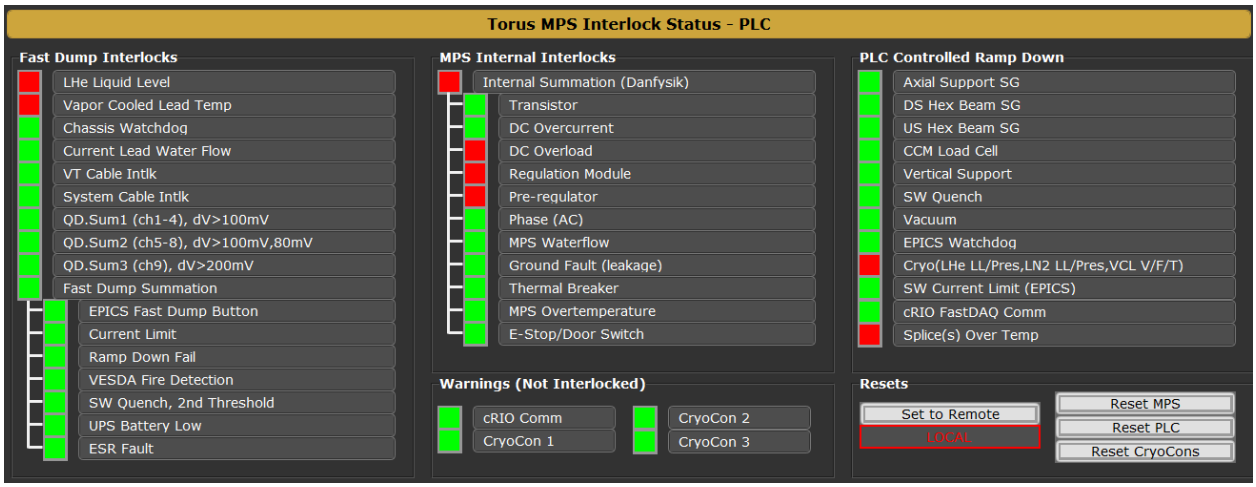


Figure A.1 - JLab MPS Control – EPICS

Clicking on Item (a) (Figure A.1), will provide the user with access to three further EPICS screens as follows:

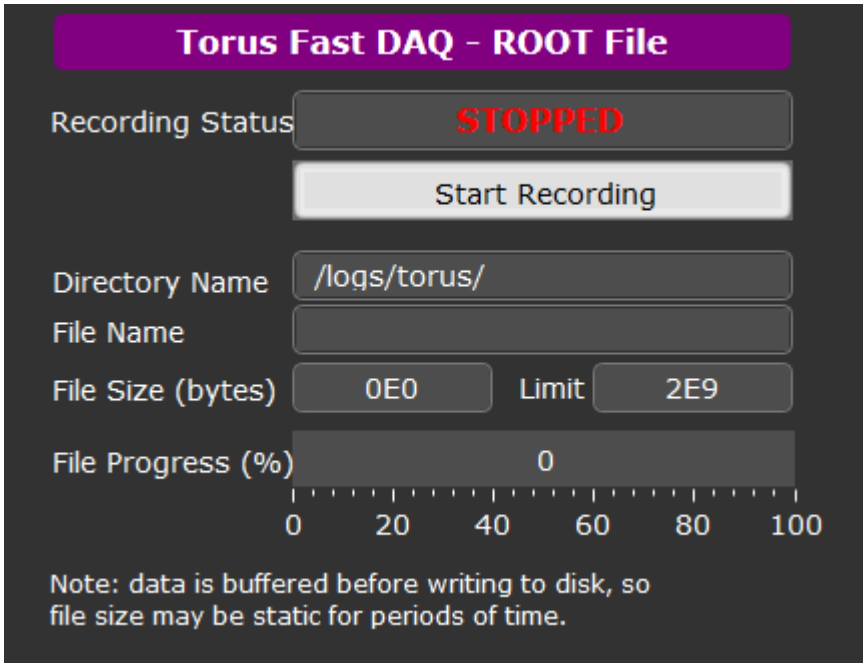
Interlock Status

All interlock indicators should be GREEN before start of magnet energization



Fast DAQ Recording Status

The Recording Status should be RECORDING before start of magnet energization. Click the 'Start Recording' button if necessary. Check that a filename is displayed below and that the file size is increasing before continuing with magnet energization.



Fast DAQ Live Voltage Data

This displays live voltage tap data for all the voltage channels as well as the magnet current IDCCT1 – i.e. as read by the Fast DAQ National Instruments cRIO modules.