29 Sept 2016

V1.1

Focus Coil Operating Notes

These notes are intended as a basic guide to the operation of the FC for non-experts; they are not a comprehensive instruction manual.

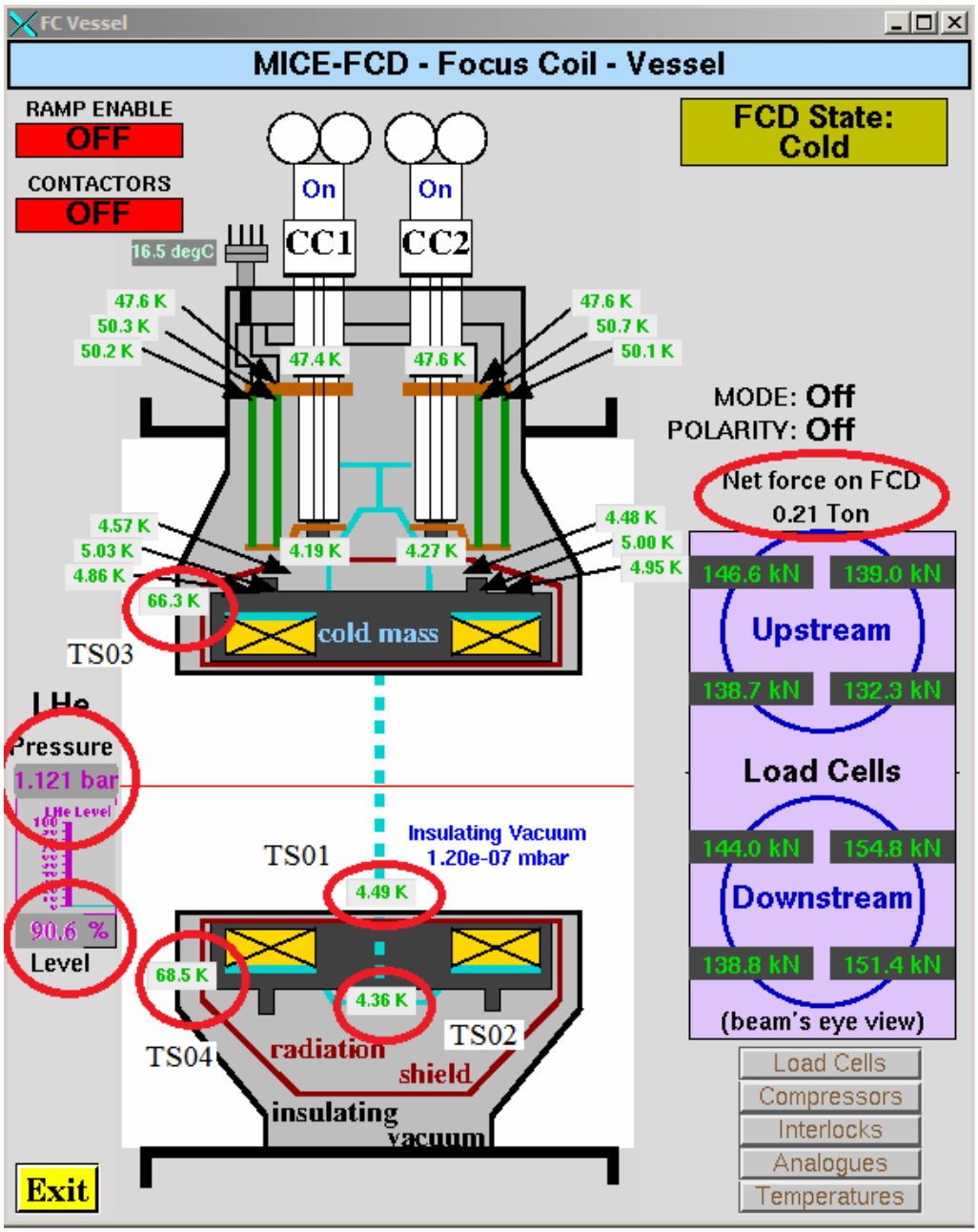

Figure 1 FC vessel mimic diagram

Pre-powering checks

Temperatures & pressures

Before powering the module a number of critical temperatures and pressures must be checked. They can be found:

1. On the mimic diagram, Figure 1, (circled in red);
2. On the (Lakeshore and other) units in RR2, and
3. In the data archive, accessed with the Archive Viewer (described later below).

The critical values, based on operating experience in R9, are given in Table 1. Note that the temperatures given on the mimic diagram currently have a resolution of only 0.1 K.

If the values exceed those given, ***speak to an expert***.

The stability of the temperatures for a few hours before powering should be checked with the Archive Viewer. If the temperatures look unstable, ***speak to an expert***.

Data logging

The slow data logger is a 'Picologger' connected to a Toshiba laptop in RR2. It should be running and updating a graph on the screen. If it is not running, ***speak to an expert***.

Parameter	PV Name	Before powering	During ramping and operation	
Cold mass temperature	...TS01	< 4.57 K	< 4.67 K	
He bath temperature	...TS02	< 4.45 K	< 4.51 K	He pressure 1.30 bar
Upper rad. shield temp.	...TS03	< 68 K		
Lower rad. shield temp.	...TS04	< 70 K		
Helium pressure	...Preg-01	< 1.2 bar	< 1.30 bar	Exceeding 1.35 bar will cause loss of helium, **monitor this pressure during magnet operation, press Pause if pressure goes higher than 1.30bar**
Helium level	...Level-01	> 80 %		Interlock set at 60%; disables PSU
Net Force	MICE-CHAN-FCD-01:FORCE	<12 ton		**Deviations from stable level are a reason for ringing expert**

Table 1 Critical parameters of FC

Powering

The power supply is controlled by a GUI accessed via the 'FCx PSU' option in the controls menu.

Before the GUI can be used, the AMI controller and PSU must be turned on in the correct sequence:

1. Turn on the AMI 430 controller. It will load its program. When finished it will say 'turn on the power supply'.
2. Turn on the PSU above the controller when indicated by the controller.
3. Press Enter on the AMI430 controller, only once (will beep)

To power the module from the GUI (which is accessible from the Controls Menu, App Launcher UI):

1. Choose AFCs => Focus coil => FCD or FCU power supply, password: Tesla
2. Click on 'Ramp Enable' => (On)
3. On AMI430 press Enter again to stop the Beeps
4. Click 'Close Contactor' => (On) => (clunk)
5. Set the desired current in Coil Window (for solenoid mode: max 90A, for flip mode: TBD, ask expert), Enter
6. In same Coil Window set the Voltage limit (typically 11V), Enter
7. Set the current limit (for safety, 2 amps above the desired current)
8. Press 'Ramp' from the 'Ramp / Pause / Zero' button to energise, Pause, or Zero to ramp down

The controller should then start to increase the current in the FC. The current and voltage will be displayed on the GUI, and also on the PSU and controller.

The ramp can be paused at any time with the 'Pause' button. If you want to ramp down, always press the Pause button first, then the Zero button.

Once the target current has been reached the GUI (and AMI controller) should indicate 'holding'.

If either the Ramp Enable or Close Contactor button is not green, there is an interlock failure. There are options to display and clear the interlocks. If they cannot be cleared, ***speak to an expert***.

Notes:

1. It may take several seconds before the control system responds to a command from the GUI – be patient!
2. The ramp rate (*dI/dt)* cannot be set from the GUI (despite the apparent option to do so). The programmed settings should only be changed by an expert.

Ramping

Ramping the current *either up or down* introduces heat into the cold mass due to 'AC losses'. The heating power is roughly proportional to the ramp rate squared and the cold mass temperature will rise to a value which is a balance between thls heating and the cooling power of the cryocoolers. The time constant is of the order of an hour. Care must be taken not to exceed the temperatures given in Table 1. Once a steady current has been reached, the temperatures will drop towards their starting values.

For low currents, the ramp rate can be high (~25 mA/sec); for higher currents (>50A) it must be kept low (~10 mA/sec). Since we do not yet have enough experience with FC1 in the Hall to know precisely what the ramp rate should be, it is best to keep it low.

For the above reasons ***the temperatures of the cold mass and helium bath must be monitored during a ramp.*** If the temperatures or helium pressure appear to be rising too fast the ramp can be paused with the 'Pause' button on the GUI.

The temperatures can be monitored with the Archive Viewer or the Strip Tool, invocable from the controls menu under 'Utilities'.

The ramp rate can only be changed from the front panel of the AMI controller, ***ask an expert***).

Ramping down

Pause the ramp up (if not paused or holding already); press Zero button. The controller will then ramp down the current. The ramp down can be paused.

Alternatively the red button at the top of the AFC control rack can be pushed. However, this is not desirable since it will cause the control system to lose contact with the Controller / PSU which will ramp the current to zero (with no hope of stopping it).

After the magnet current has reached Zero press 'contactors off' to isolate PSU from magnet (=> clunk)

Turn off: first the AMETEK PSU, then controller AMI430

Changing mode or polarity

This requires an ***expert***, an electrician and a 'key dance' at present.

Archive Viewer

The Archive Viewer can be invoked from the controls menu. Once it is running use `File` and `Open` to open a file called `fcd.xml*` which is set up to display temperatures etc. Change the 'start' and 'end' times to -6H and 'now', and click on 'plot'.

Note that the data archiver is a bit slow in updating so there is a time lag.

Figure 2 is an example of the Archive Viewer traces during a ramp up (in steps) of FCD to 90 Amps at 10 mA/sec, and a subsequent ramp down. The heating of the cold mass is obvious.

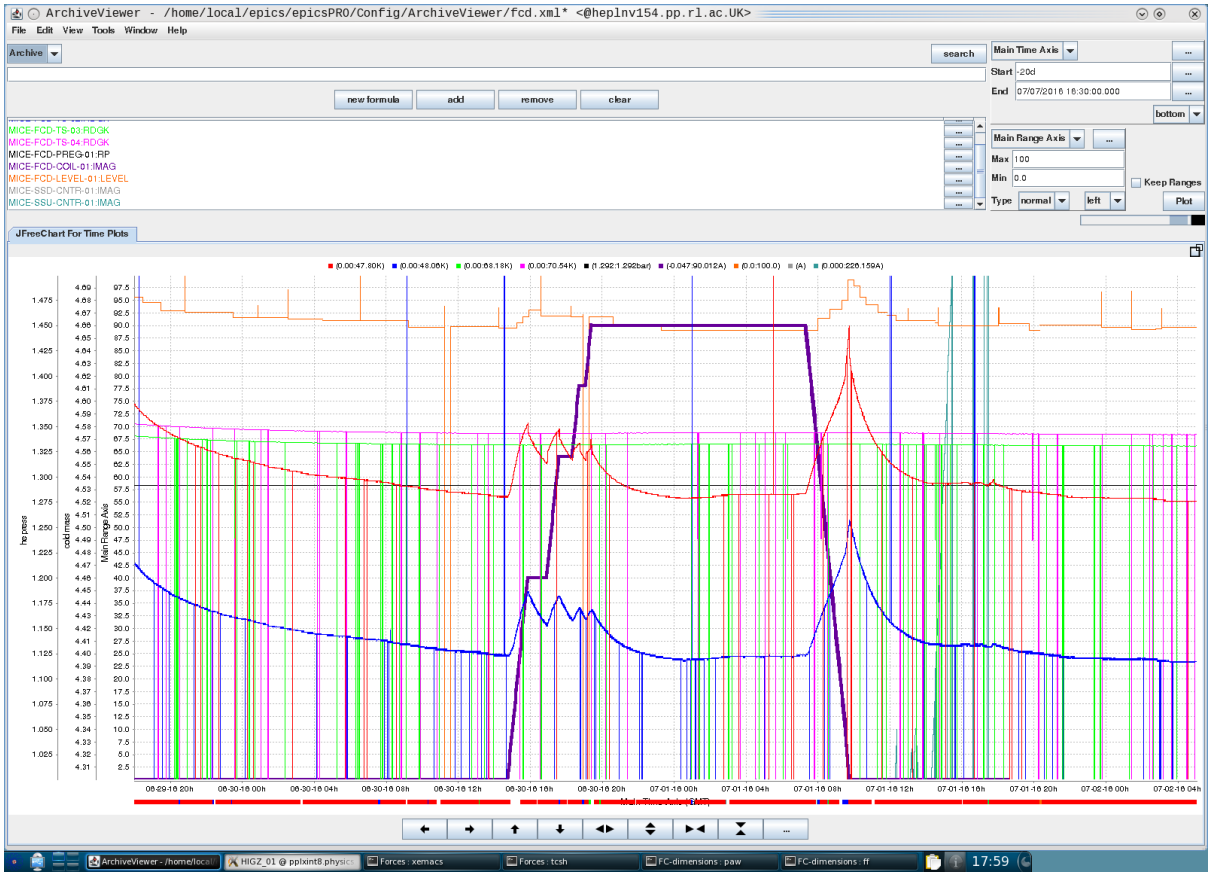

Figure 2 Archive Viewer traces of a ramp up and down of FCD. Red line = cold mass temperature (TS01); blue line = He bath temperature (TS02); thick purple line = current (up to 90 Amps).

Quenches

If the FC quenches, a couple of things must be must be done fairly soon afterwards (within ten minutes or so) to protect the helium system from contamination:

1. The helium supply valve, which is located on top of the module (Figure 3) must be opened, and
2. Condensation and ice/snow on the pressure relief valve should be removed with a hot air blower. Do not blow **into** the opening of the relief valve as this would force air into the cryostat

An ***expert*** should be notified.

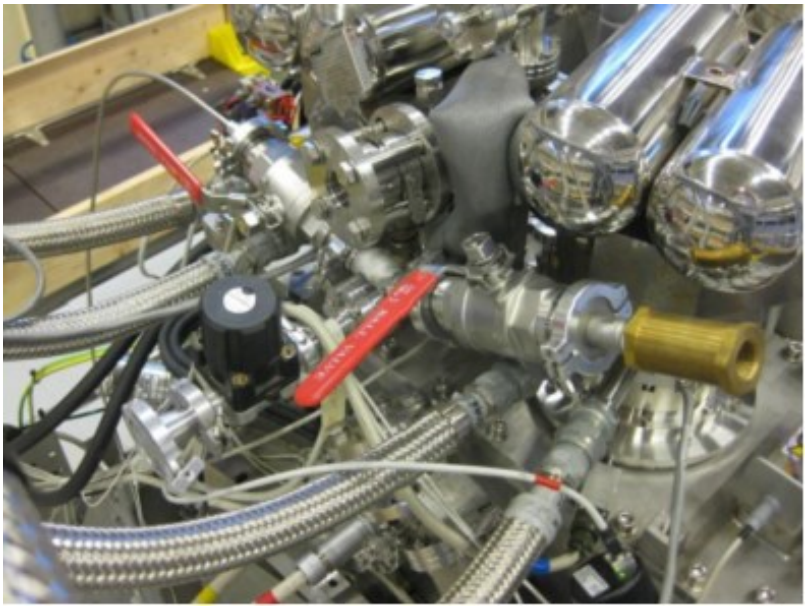

Figure 3 Helium supply valve (red handle on the left) and pressure relief valve (right) of the FC. The supply valve is open when the red handle is in line with the He supply pipe, as shown.

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