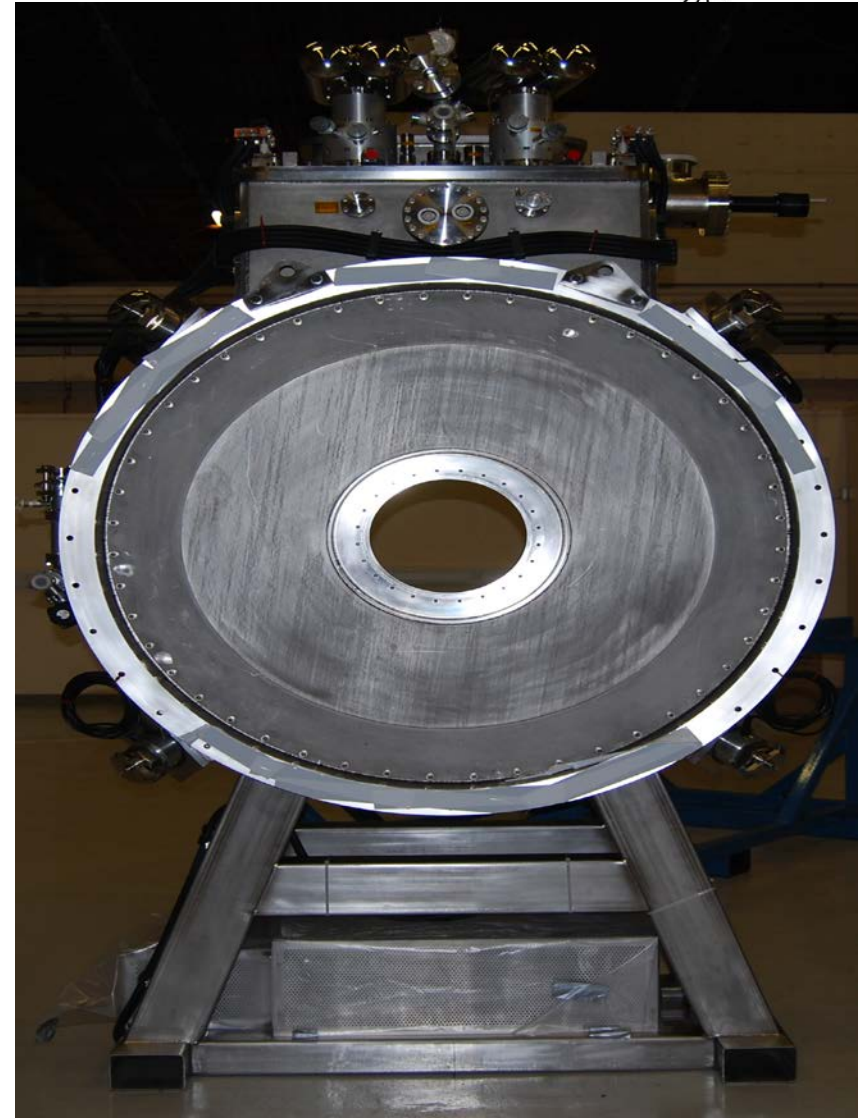


MICE Absorber and Focus Coil Magnet – Test Results

MICE Project Board
9th May 2013

Oxford University and RAL Cryogenics Group

Tom Bradshaw	Elwyn Baynham	Trevor Hartnett
John Cobb	Mike Courthold	Steve Griffiths
Wing Lau	Victoria Bayliss	Ian Mullacrane
Roy Preece	Victoria Blackmore	Adrian Oates
	Jason Tarrant	Chris White



Since the magnet was delivered and installed in R9 hall we have performed the following:

- System set-up and operation check
- Leak check magnet under vacuum and pressure
- Pre-cooling with LN2 to 80-90K
- Cool-down with Helium to 4K
- Steady state thermal performance check zero boil off
- Cryocooler excess performance check
- Step by step current ramp to full current (Solenoid mode)
 - Thermal performance check
- Step by step current ramp to full current (Flip mode)
 - Thermal performance check

This talk will go through the results of the powering tests, conclusions and the way ahead.

Pre-cooling with liquid nitrogen and cooling down to 4K:



Operating points for the magnet in the various modes are as follows:

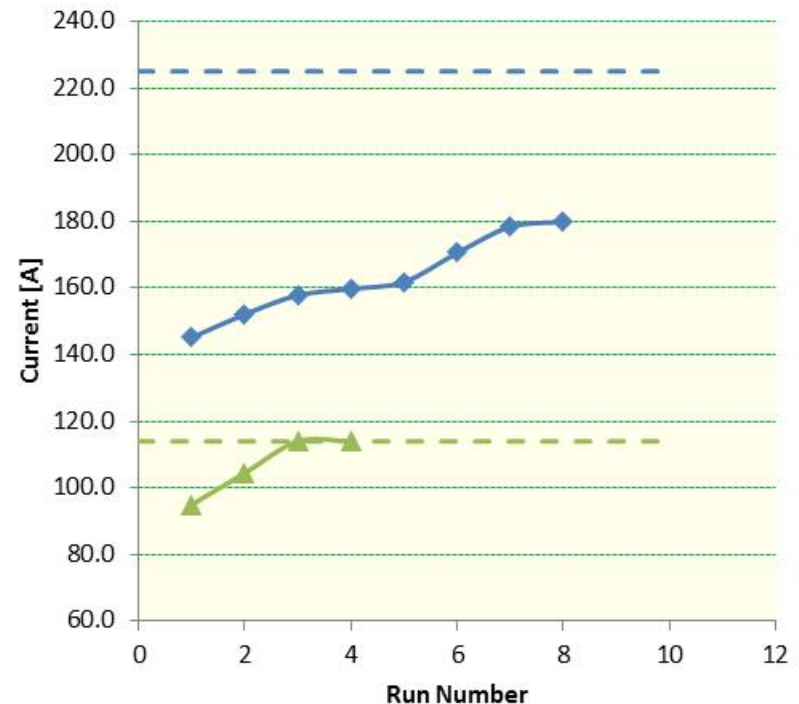
Operating points

	Flip mode		Solenoid mode	
	200 MeV/c	240 MeV/c	200 MeV/c	240 MeV/c
Current	187.14	224.75	94.15	113.09
Current density NbTi	584.82	702.35	294.23	353.41
Current density coil	104.75	125.80	52.70	63.30
Bz max	3.090	3.711	2.598	3.121
Bpeak conductor	6.264	7.523	3.763	4.520

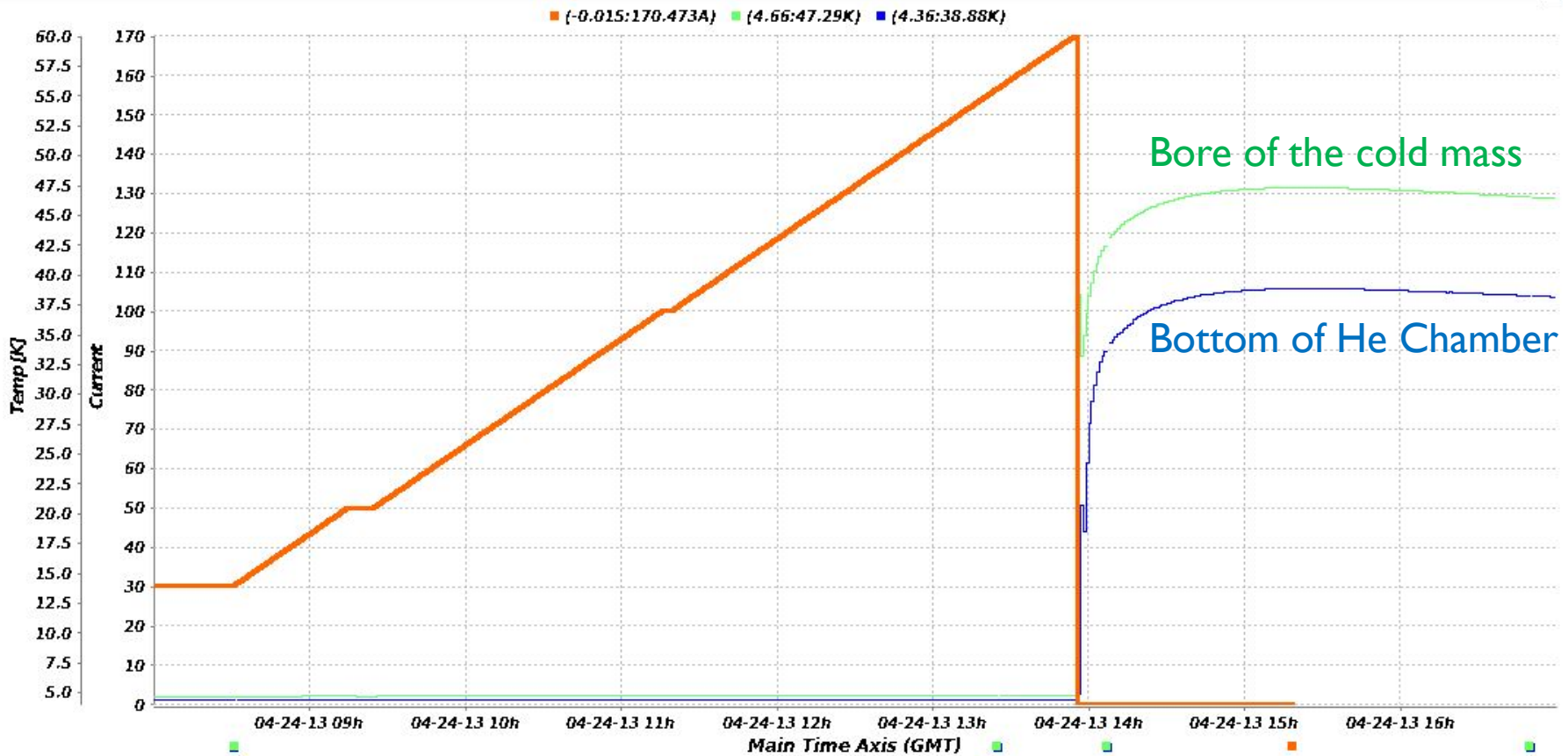
Quench history is such that the training is taking longer than expected (or we would like)
 Remember that this acceptance is the responsibility of Tesla although the process necessarily involves RAL personnel

Runs and results

Solenoid mode	#	Current	
17th January 2013		50.0	Deliberately induced quench
25th January 2013	1	95.0	Quench
29th January 2013	2	104.5	Quench
30th January 2013	3	114.0	Target achieved - no quench
31st January 2013	4	114.0	Target achieved and held for several hours
Flip mode			
12th February 2013	1	145.1	Quench
27th February 2013	2	152.1	Quench
28th February 2013	3	157.8	Quench
1st March 2013	4	159.7	Quench
7th March 2013	5	161.8	Quench
24th April 2013	6	170.6	Quench
2nd May 2013	7	178.4	Quench
8th May 2013	8	179.9	Quench (2nd coil?)



A “run” occupies approximately two people from RAL for 2-3 days although we have previously had 3-4 people from DL in attendance to capture events.

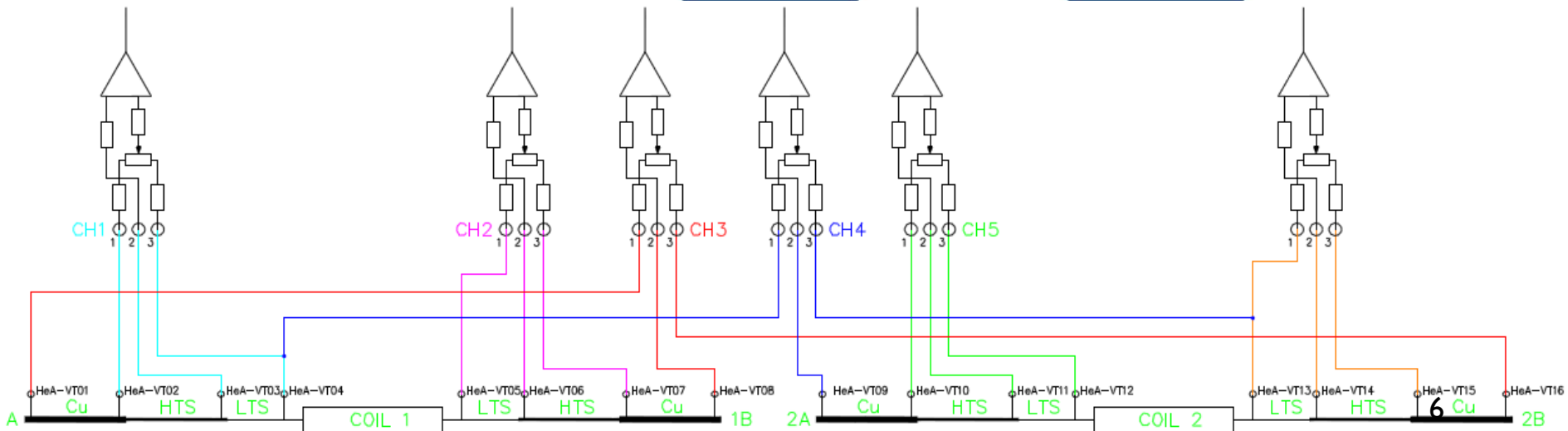
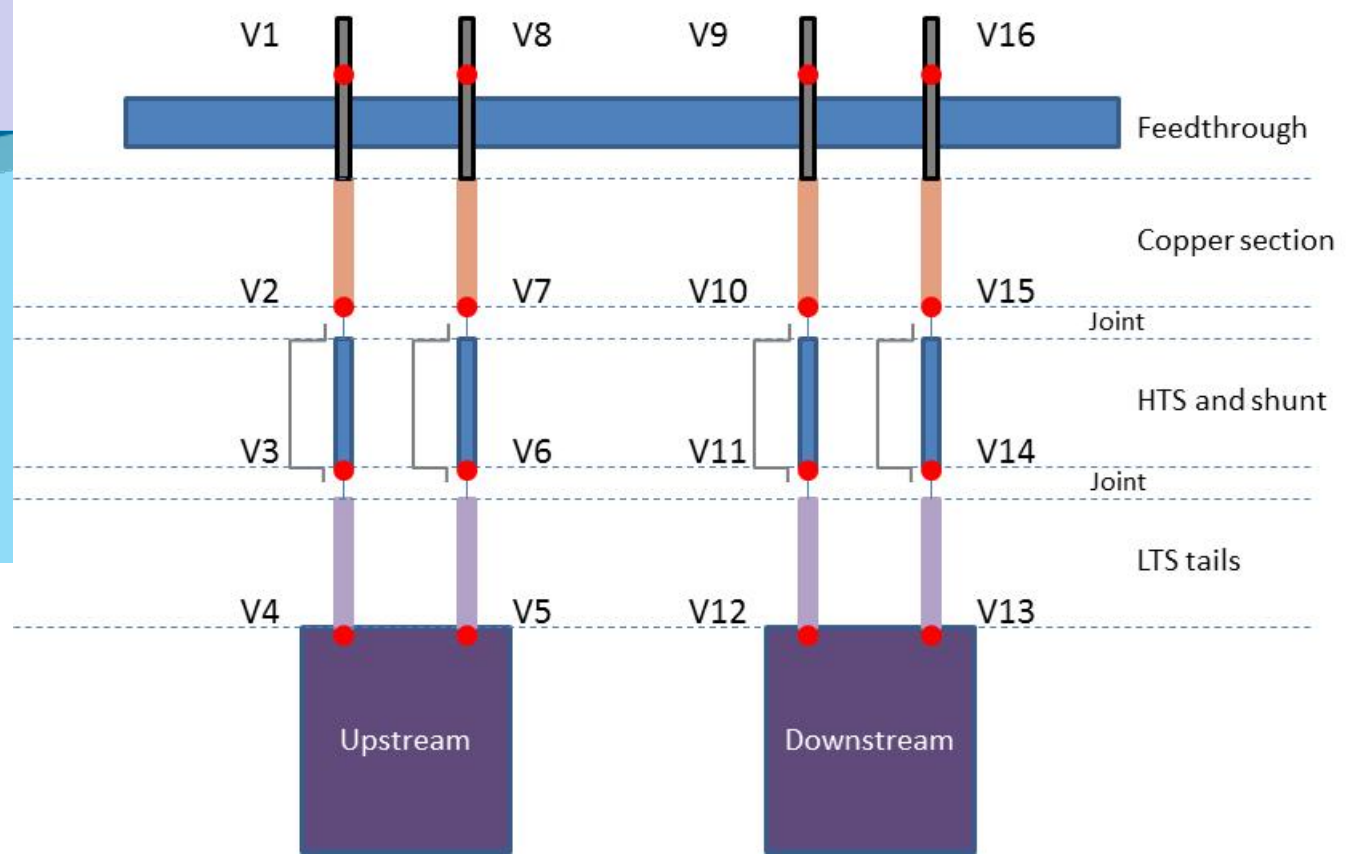


Left at 30A overnight then started from that position the next day

Stable temperatures right up to the event

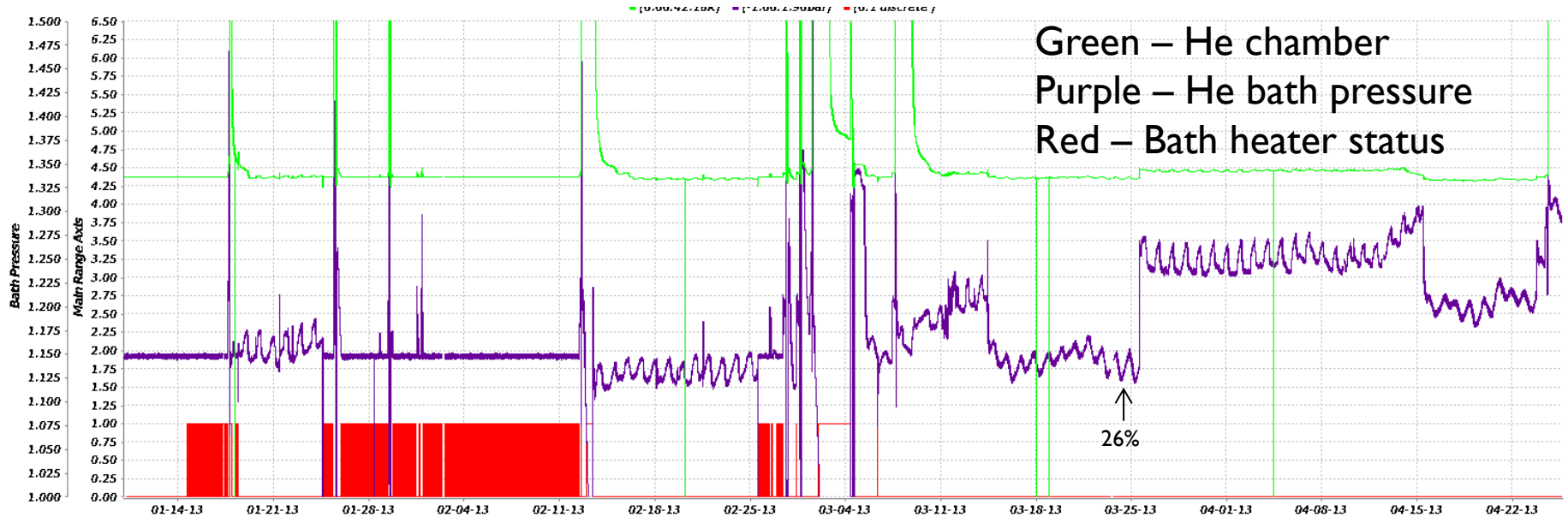
Voltage taps

- Showing the location of the voltage taps and how they are wired into the QD system
- Thresholds are set at 600mV across the coils Ch3&4 and 20mV for the HTS and LTS leads



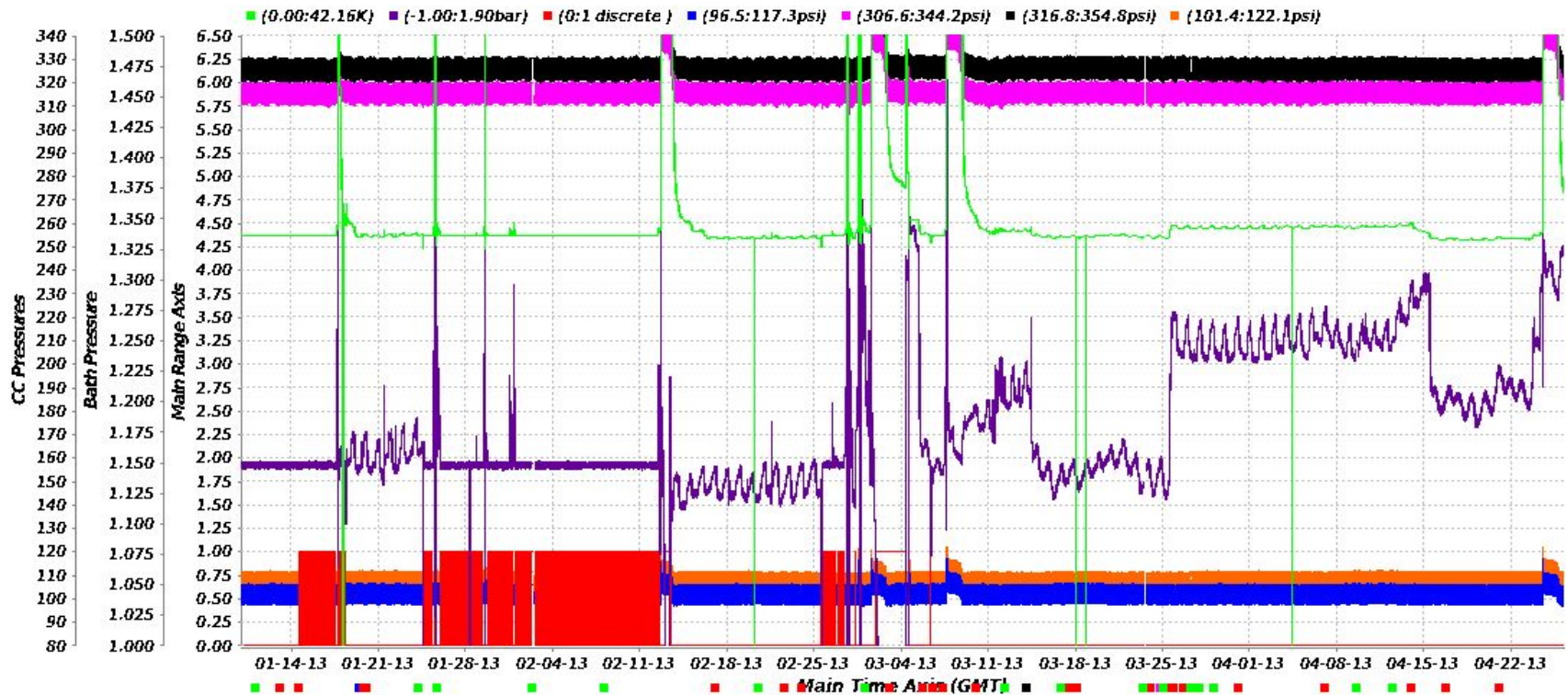
Cryocooler Cooling Power

The cryocooler cooling power is decreasing and/or the heat load is increasing: ..



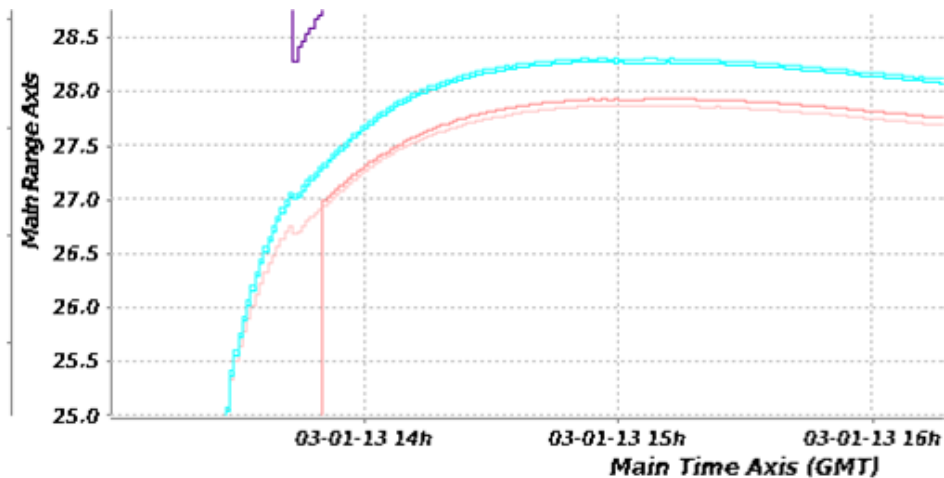
- The red line is the bath heater that is activated when the pressure falls too low
- In recent times the heater has not been active
- A lot of this time the gas pack was attached and the cooler was condensing – this is not recorded
- Certainly the period leading up to the quench on the 24th April all valves were shut
- Bath pressure rises until the cryocooler cooling power matches the heat load

Checked that the pressures in the closed cycle refrigerators has not dropped:



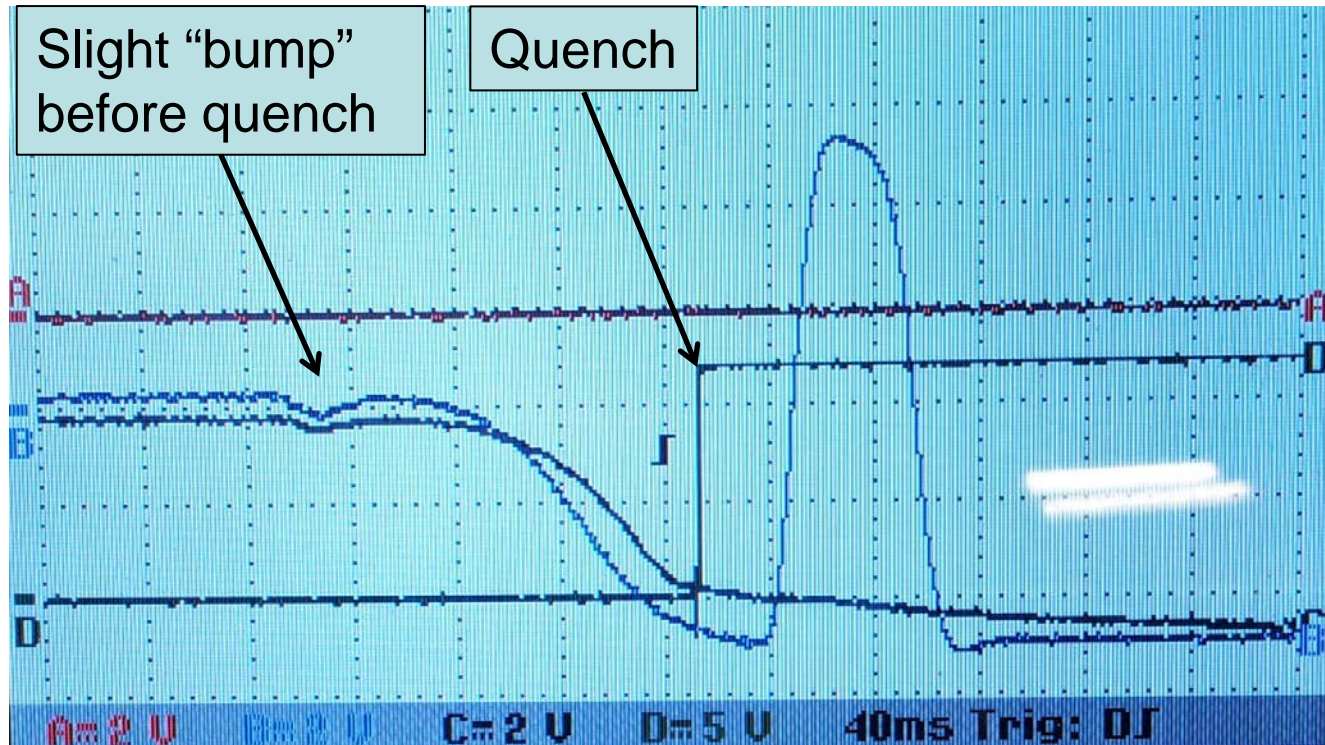
No issue with this – remains a puzzle

Not a huge indicator of where the problem lies but ..



Temperatures at top of coil#1 hotter than #2

Temperature sensors 11&15
(top) off coil #1 and 12&16
(bottom) off coil#2 – HTS
leads near the coils



Difficult to interpret the traces – after the “event” all sorts of things happen – we did get some sparking in the dump resistors which has now been fixed.
Trace indicates that coil#1 is more resistive than coil 2

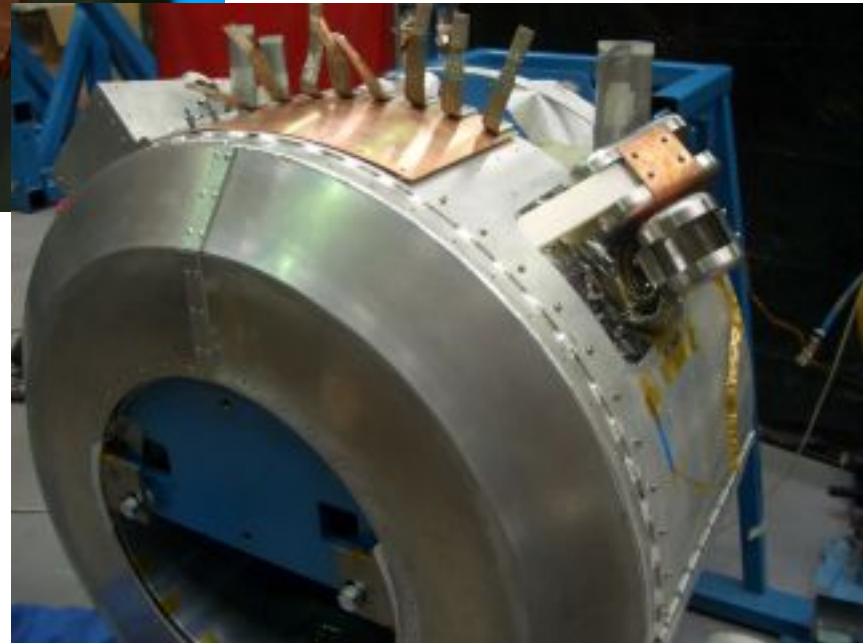
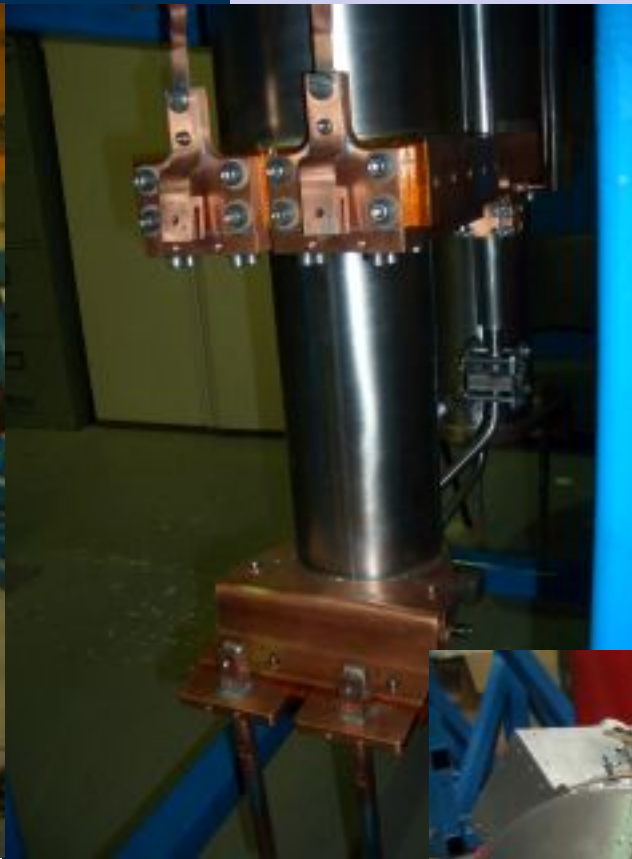
Quench is not too dramatic ...

- Recovery from a run is difficult – best to leave on cryocoolers for a few days to bring temperature down then top up with Helium
- Otherwise – use a lot of helium..
- Run cycle is probably 4-5 days

Victoria Blackmore was quick enough to catch this....



OVC and Helium Turret



- AFC#2 is being completed and will be tested in R9 on delivery from Tesla.
- The experience from the testing of module #1 will be invaluable.
- AFC#2 should be finished June

Radiation Shield

- Looks as though training on module #1 will continue but may take ~ 6 runs (~4 weeks?)
- If magnet is not training then we may want to take decision to switch horses and start work on module #2
- Commissioning of module #2 may be delayed because of module #1



Summary of where we are and what has been achieved:

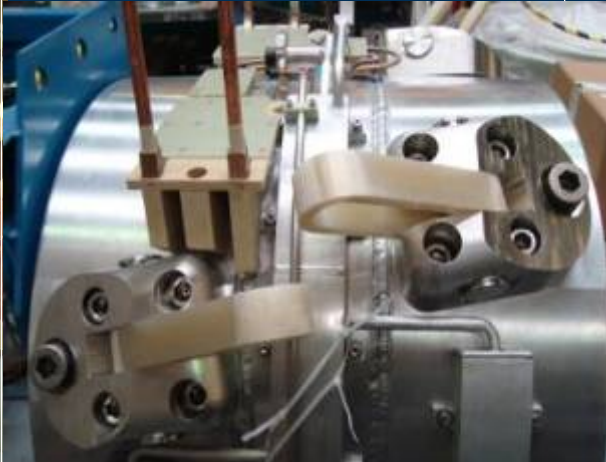
Test	Result Summary
System set-up and operational check	Achieved
Leak check magnet under vacuum and pressure	Achieved
Pre-cooling with LN2 to 80-90K	Achieved
Cool-down with Helium to 4K	Achieved - actually filled on cryocoolers in first instance
Steady state thermal performance check zero boil-off	Achieved although some issues later...
Cryocooler excess performance check	Estimated to be 0.2W initially but seems to have degraded still checking this
Step by step current ramp to full current (solenoid mode)	Achieved
Thermal performance check	Cold mass slightly higher than expected by ~0.1K
Step by step current ramp to full current (flip mode)	Getting there?
Thermal performance check	Still work to do to understand this

- Note that there is little to say on Controls and monitoring – we had a few minor glitches but the DL group did very well.....
- Had issues with networking
- Level indicator not on board yet ...

There are some things that we don't yet fully understand or need to do: Cryocooler cooling power and related pressure; Cryocooler sock insulation to reduce load (?); suspension system tension; Training behaviour

Module/Activity	Due Date
AFC1 at RAL	Achieved Nov 2012
Absorber integration and test	+5mths elapsed (Christmas Break)
AFC2 at RAL	June 2013
Absorber integration and test	<3mths
Negotiate on 3 rd Module	This FY

- The schedule is regularly reviewed but we don't have a clear view because of the training required. Have to decide, based on training how to proceed when module #2 is available – do we jump horses ?
- CERN mapper won't be back until August .. – would it be better to keep #1 cold ? Make our own checks ...?
- Need to confirm planning with CERN over this.



END

