Electrical Integration

CM39

Ian Mullacrane

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- Decay Solenoid
  - Power Supply replacement
  - QD System Upgrade
- AC Distribution
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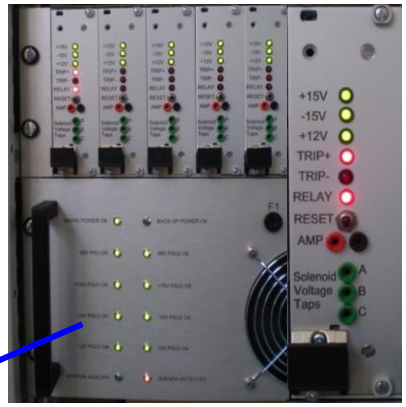
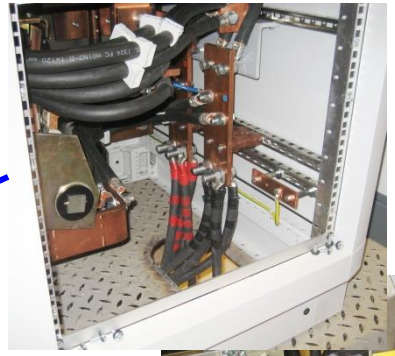
  - Power Quality system
  - Electrical network disturbances
- FC Power converters
- Cooling Channel Controls
  - Progress since CM38
  - Mods to SS Controls
  - Testing at DL
  - Vacuum Controls Progress

Decay Solenoid Power Supply & QD System Upgrade



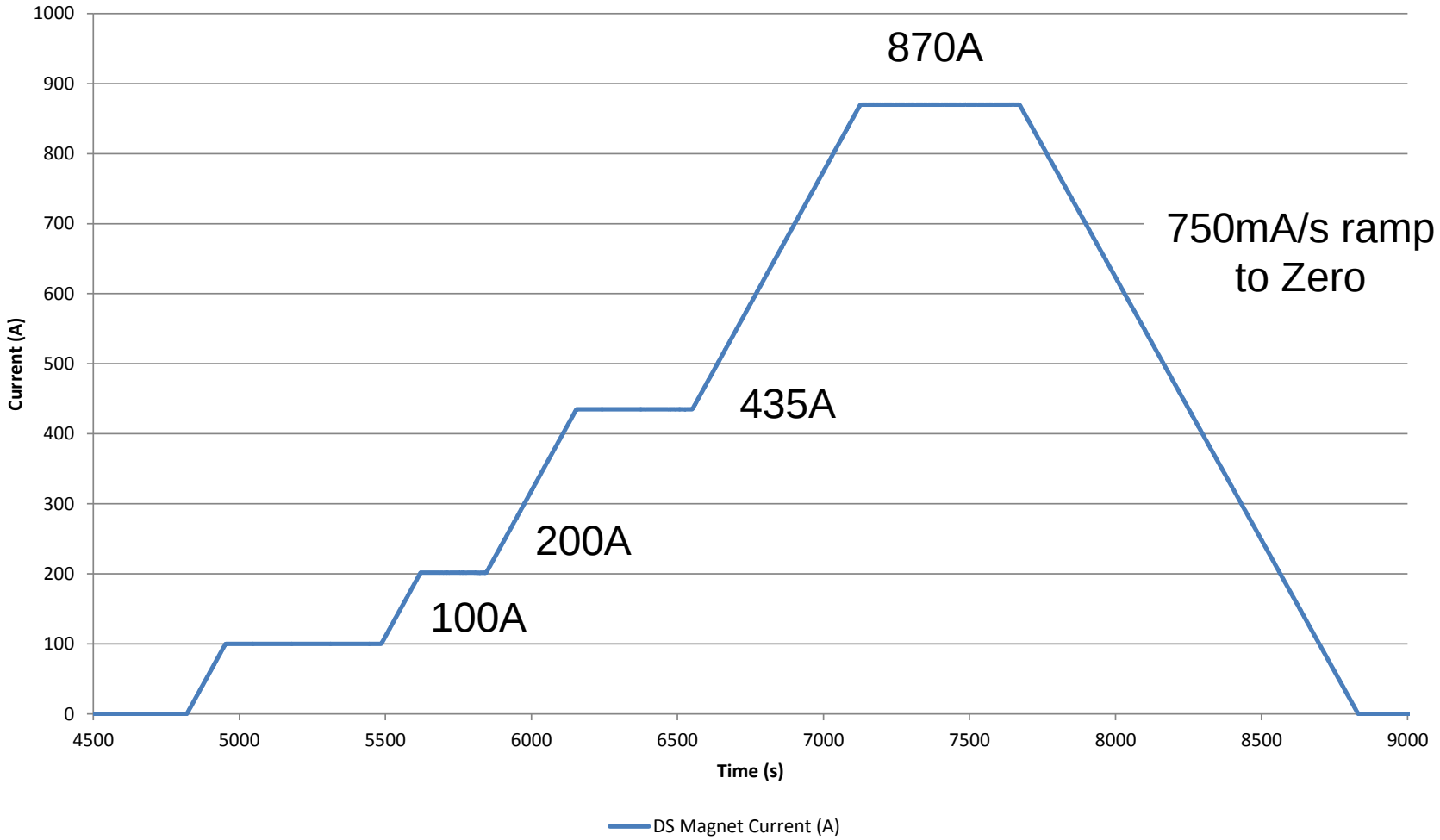


- The failed Solenoid current lead has been successfully repaired and tested at 870A.
- A new DL QD system has been installed and commissioning.
- The new FuG Power Supply has been installed and commissioned.

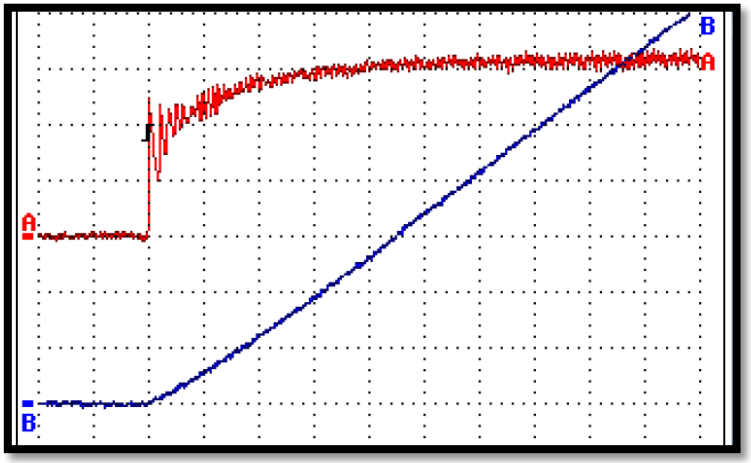
Decay Solenoid Power Supply - Installation

- PSU tested in manual control.
- Solenoid ramped to 870A and held for 2 hours.
- Performance verified at initiation and stopping of ramps.
- Various ramp up and down rates tested.
- Maximum ramp rate tested was 0.75A/s. (PSU capable of higher)
- Ramp time to maximum operating current ≈ 20 mins.
- Remote control to be implement within next 2 weeks.

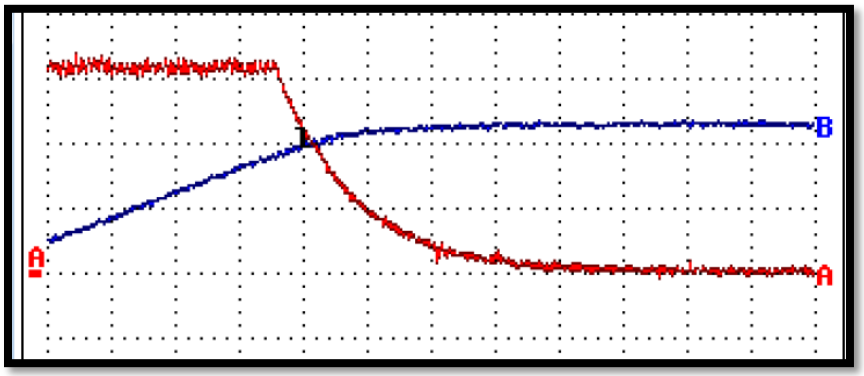
Decay Solenoid Power Supply - Commissioning



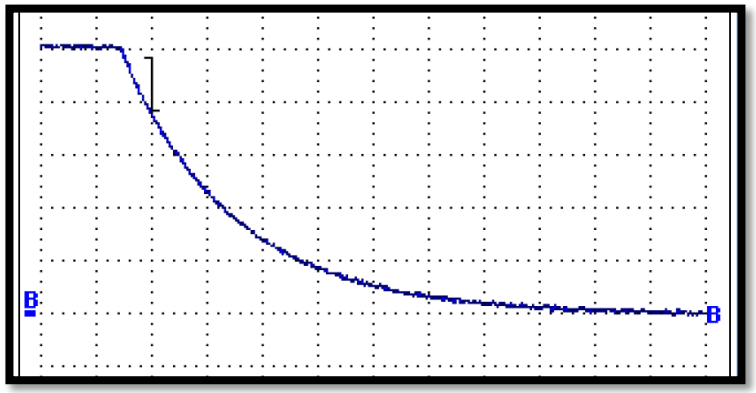
Decay Solenoid Power Supply - Commissioning



Smooth initiation to Ramp (No oscillations)



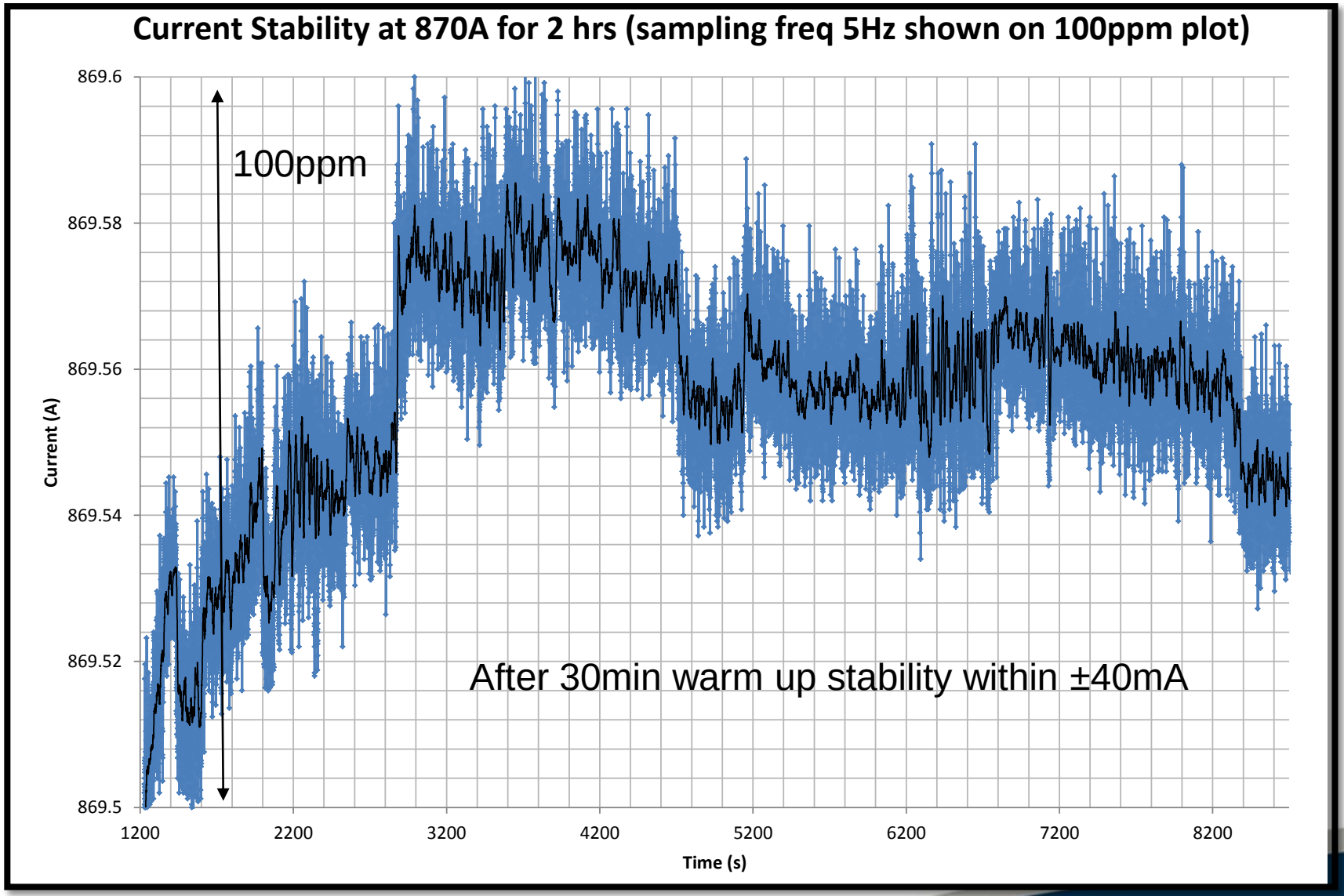
No overshoot at end of ramp (Voltage reduces before ramp complete)



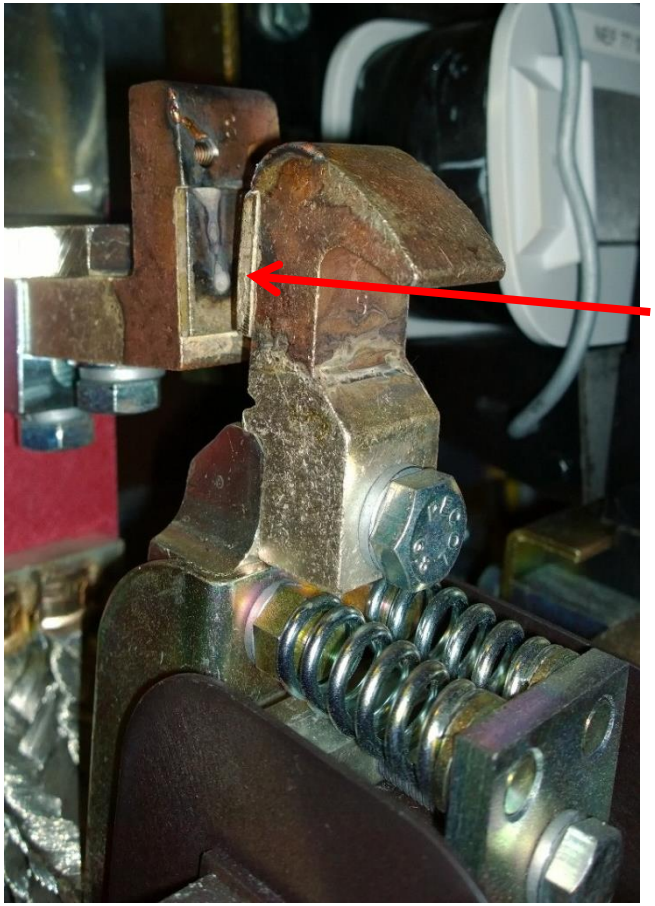
Fast discharge at 50A, from a simulated quench

- Old PSU operated QD system during initiation of ramps and at a set current of 120A.
- New PSU incurred no QD system trips.
- A simulated QD system activation at 50A was successful.
- A simulated QD system activation at 435A encountered DC contactor issues.

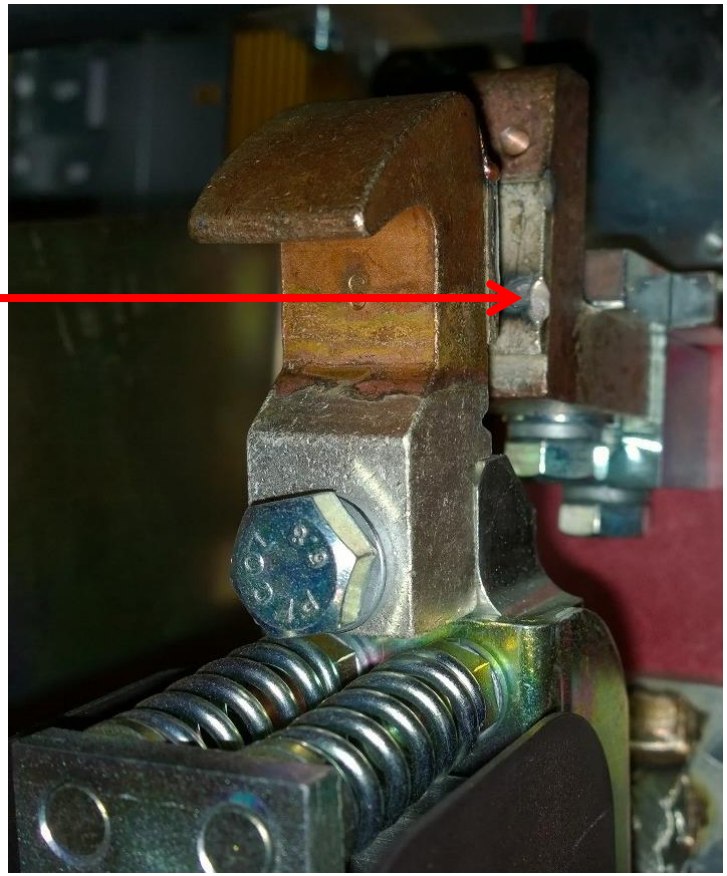
Decay Solenoid Power Supply – Current Stability



Decay Solenoid Power Supply – DC contactor



Damage to
DC Contactor
+ & - terminal

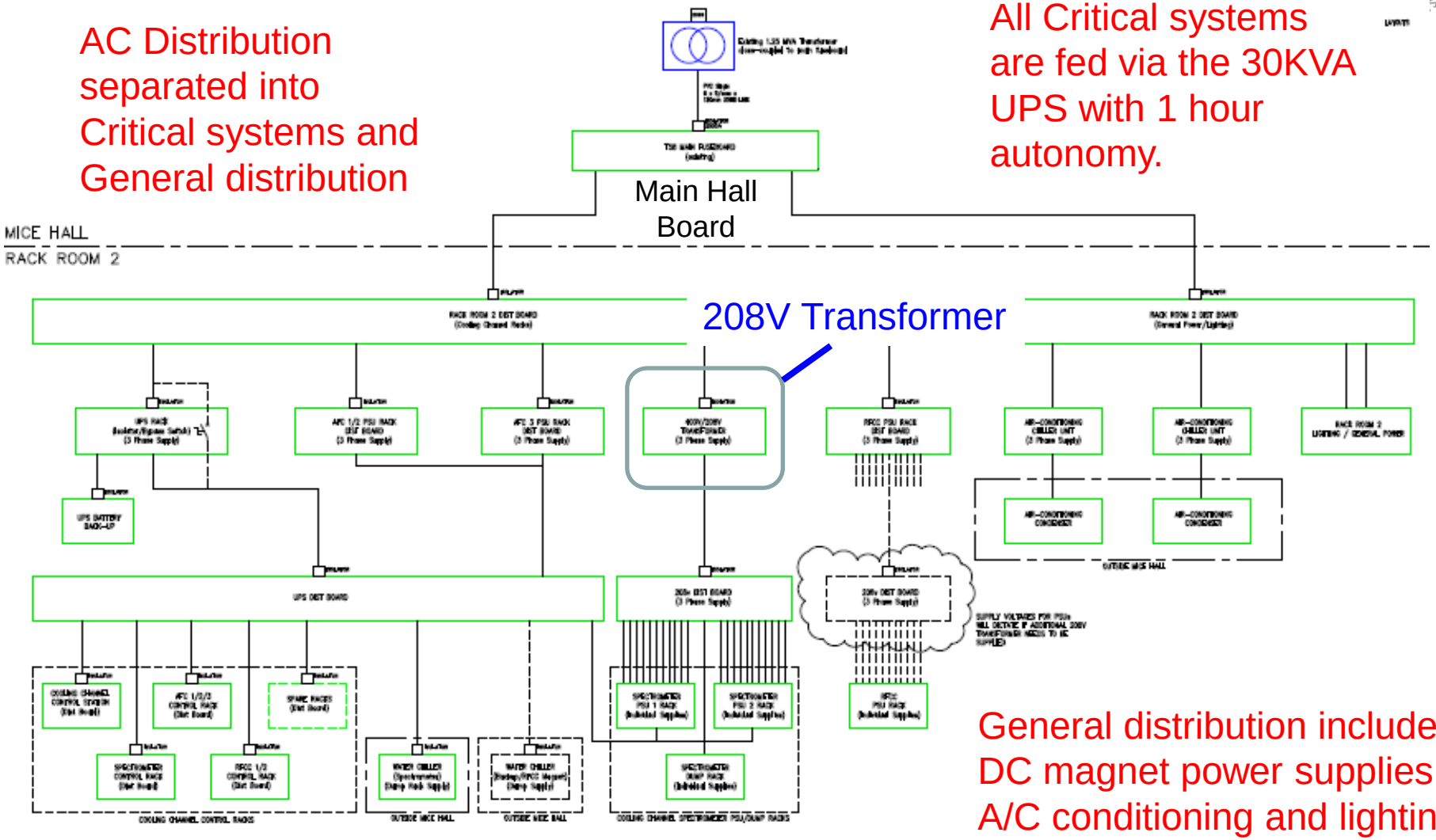


- Arcing seen across both + & - terminals.
- Suspected slow operating time of contactor.
- FuG believe circuit components specified correctly to minimise switching transient.
- Contactor company to review issue.

AC Distribution for RR2 up to Step VI

AC Distribution separated into Critical systems and General distribution

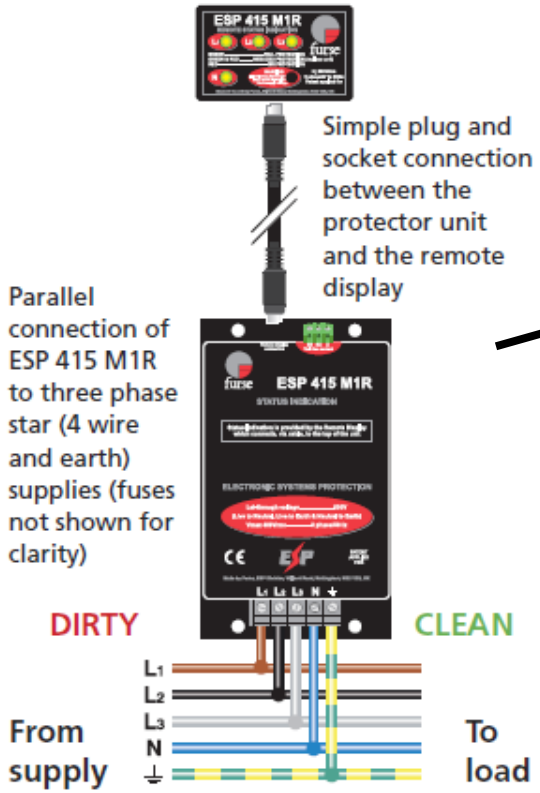
All Critical systems are fed via the 30KVA UPS with 1 hour autonomy.

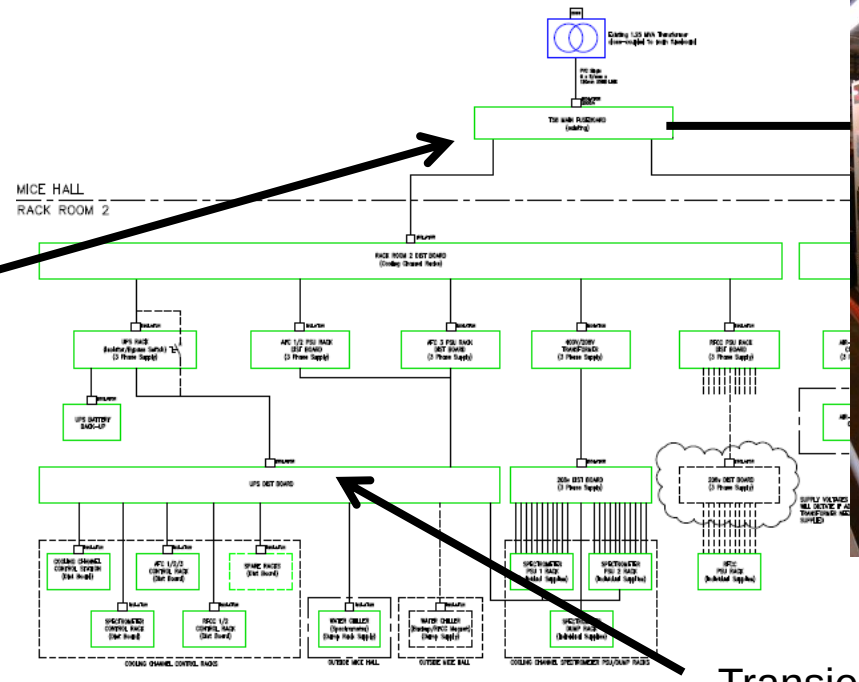


General distribution includes DC magnet power supplies, A/C conditioning and lighting.

Critical systems includes instrumentation and control systems

Protection Against Transient Overvoltage



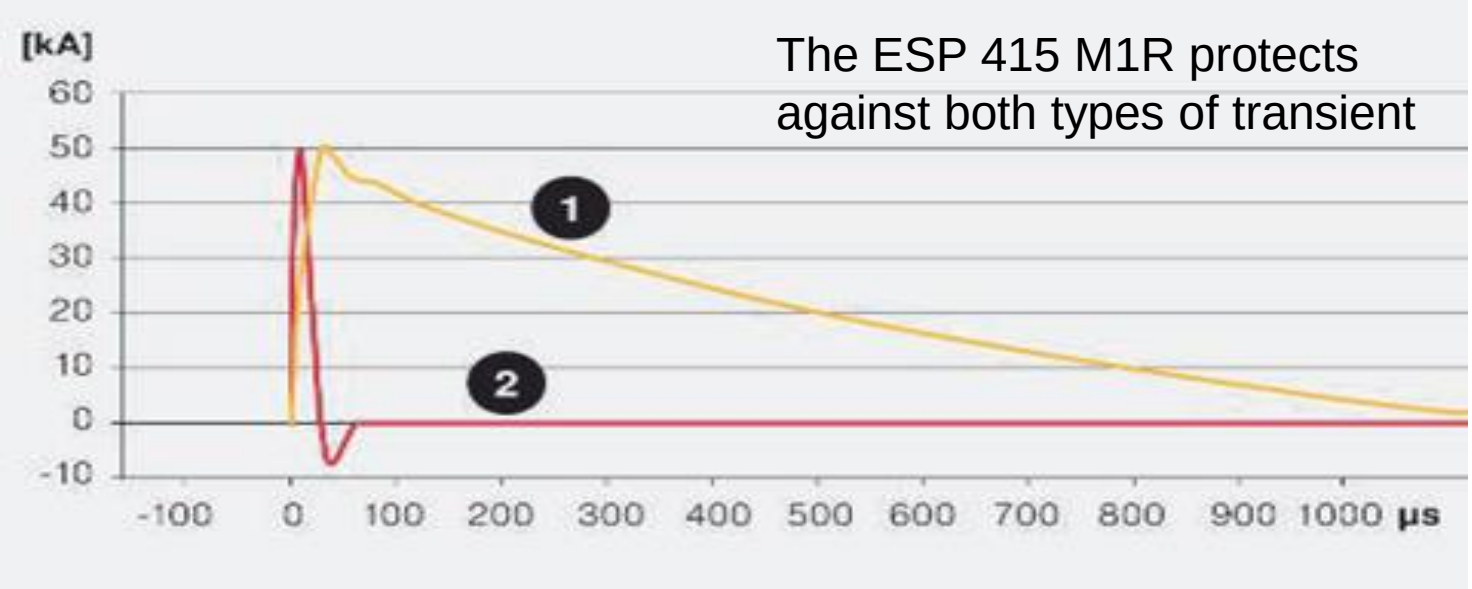


MICE Hall main Sub-station

Transient Suppression also installed on UPS board

- Transient Suppression installed on main distribution board.
- Preventing lightning strikes and disturbances on the supply network damaging equipment.
- Transient suppression also being fitted on UPS board due to isolated double conversion technology.

Protection Against Transient Overvoltage



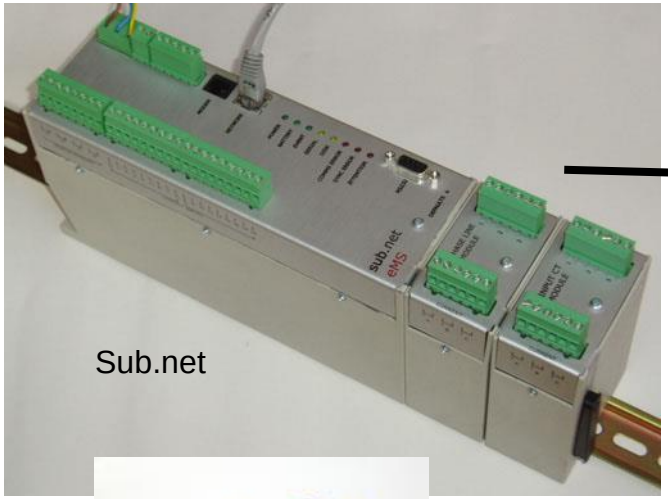
Direct lightning strike: Pulse shape 1

Lightning currents that can occur during a direct lightning strike can be imitated with the surge current of wave form 10/350 µs. The lightning test current imitates both the fast rise and the high energy content of natural lightning.

Remote lightning strikes or switching operations: Pulse shape 2

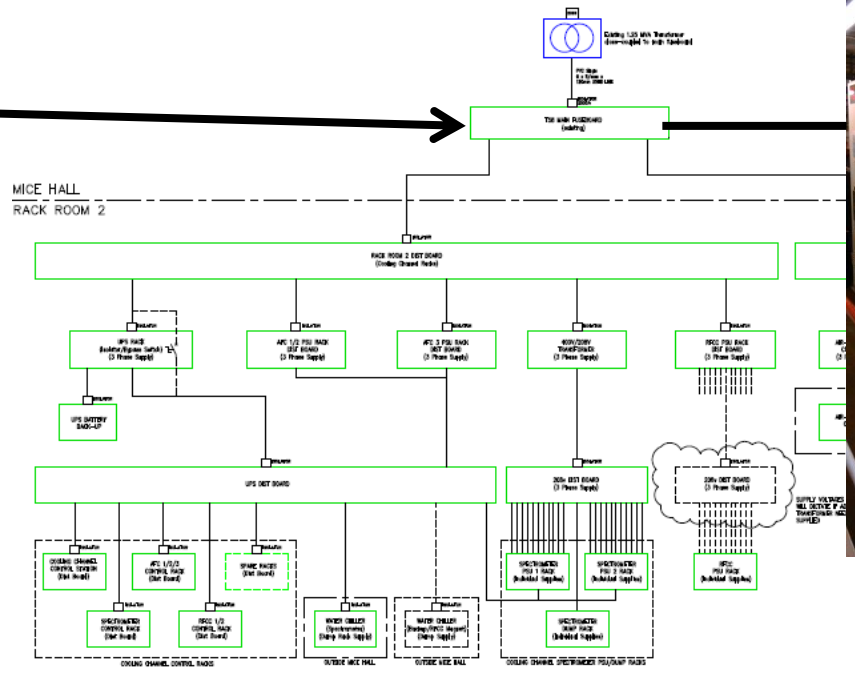
The surges created by remote lightning strikes and switching operations are imitated with test impulse 8/20 µs. The energy content of this impulse is significantly lower.

MICE Sub-station - Power Quality System



Sub.net

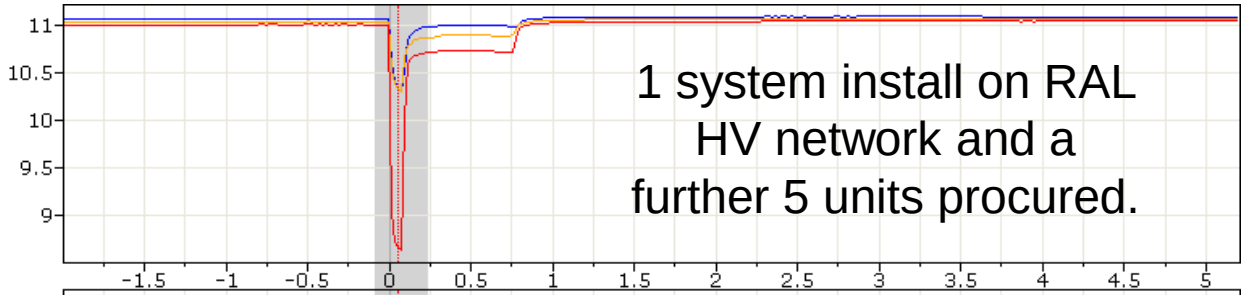
CT – Current monitor



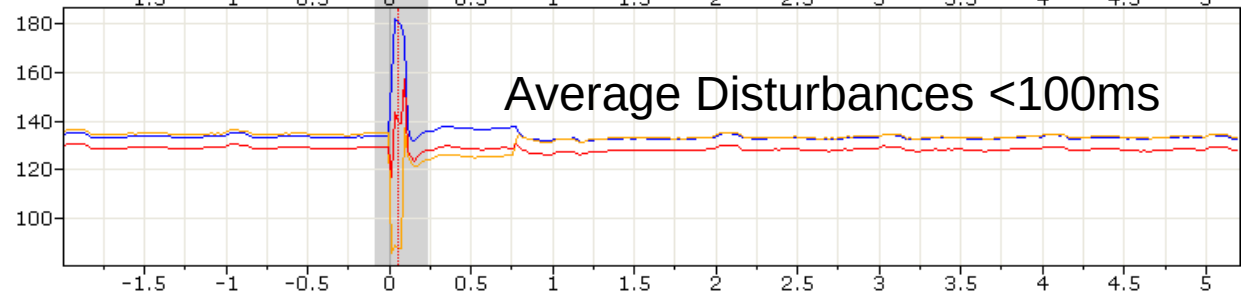
MICE Hall main Sub-station

- Sub.net is a commercially available substation monitoring instrument.
- It is capable of power metering, power quality recording and real time monitoring.
- It has an embedded web server and a client emailing application.
- Its primary function will be to monitor LV network disturbances at the MICE Hall main substation.
- Planned Installation Summer 2014.

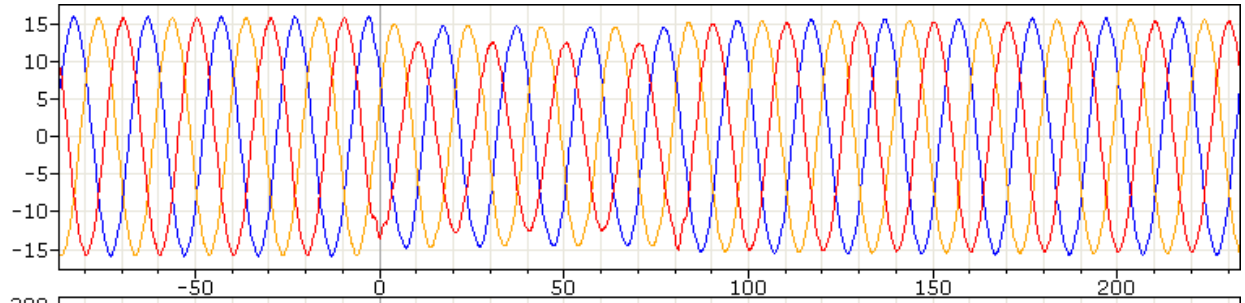
Power Quality System – HV Substation 15 (ISIS)



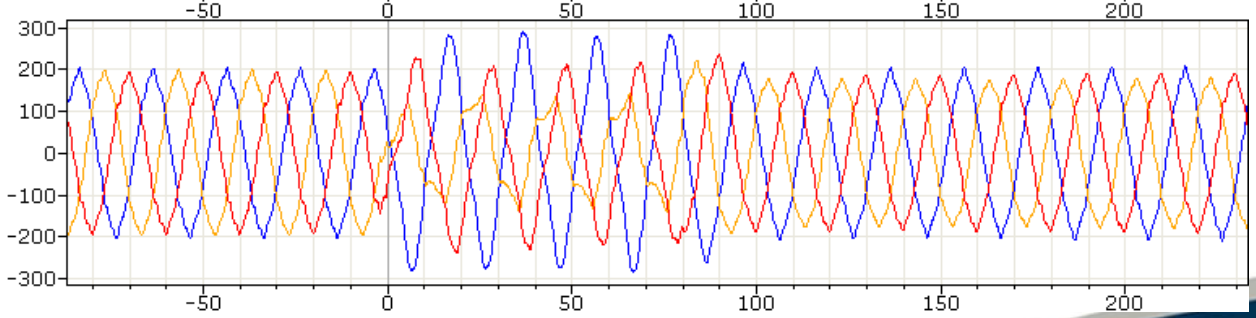
HV Line Voltages (rms)



HV Line Current (rms)



HV Voltages

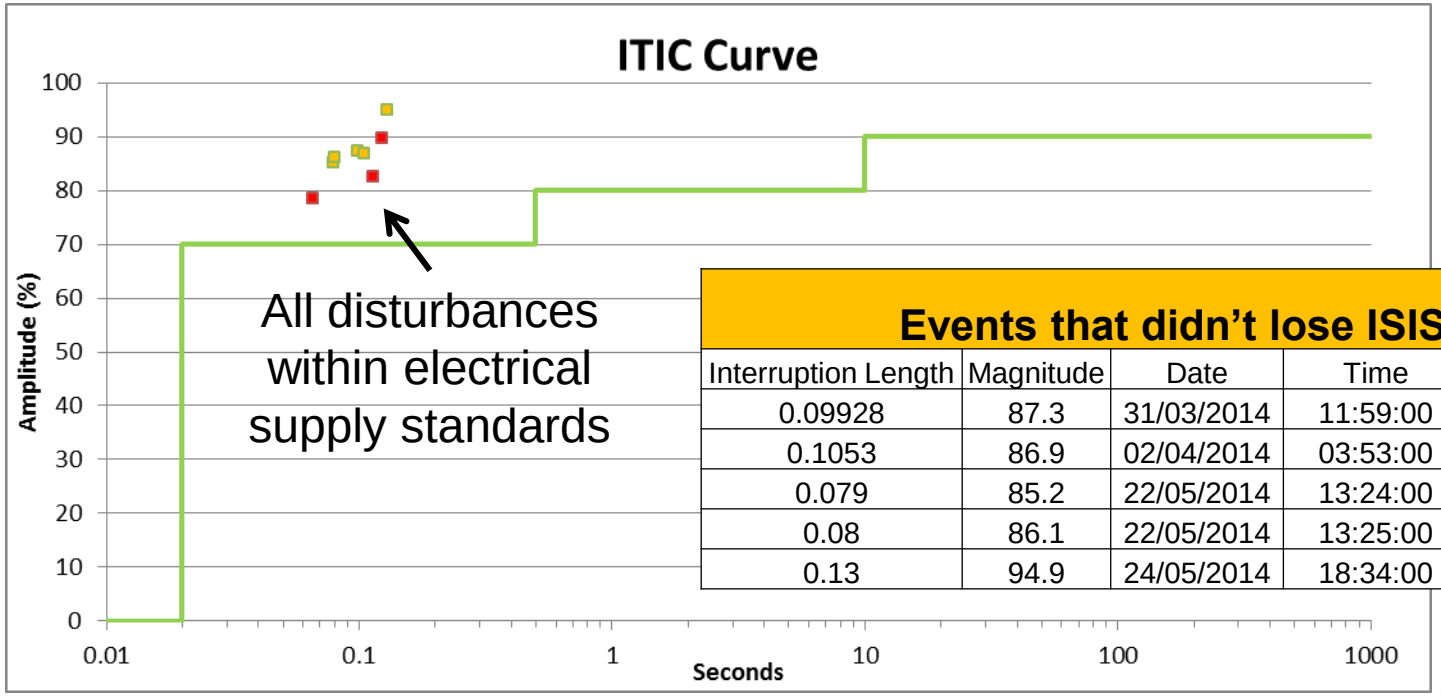


LV Voltages

Power Quality System – Substation 15 (ISIS)

Events that lost ISIS Beam				
Interruption Length	Magnitude	Date	Time	Daylight Savings Tme
0.124	89.6	28/02/2014	21:28:00	21:28:00
0.1144	82.6	31/03/2014	21:22:00	22:22:00
0.0654	78.6	22/05/2014	12:57:00	13:57:00

- System installed early February
- 8 recorded network disturbances in 4 months
- Trigger set at >5% variation
- Average duration <100ms
- Largest voltage drop – 21.4%

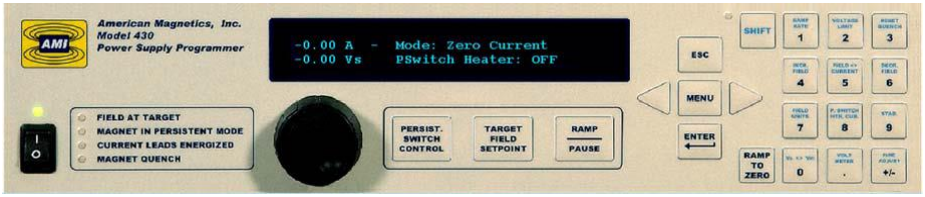


Events that didn't lose ISIS Beam				
Interruption Length	Magnitude	Date	Time	Daylight Savings Tme
0.09928	87.3	31/03/2014	11:59:00	12:59:00
0.1053	86.9	02/04/2014	03:53:00	04:53:00
0.079	85.2	22/05/2014	13:24:00	14:24:00
0.08	86.1	22/05/2014	13:25:00	14:25:00
0.13	94.9	24/05/2014	18:34:00	19:34:00

Step IV - Power Converters and Controllers susceptibility to network disturbances

- Currently only the main control system and instrumentation is supported by the RR2 - 30kVA UPS.
- Power converters and controllers will be vulnerable to network disturbances.
- Tests have shown that discharging SC magnets at ramp rates dictated by circuit components (only) is likely to initiate a quench.

FC – AMI 430 Controller (SS use AMI 420)



230 Vac (operating range 176 - 264 Vac) – 76% of 230Vac

SS – Lakeshore 625 power converter (Trim)

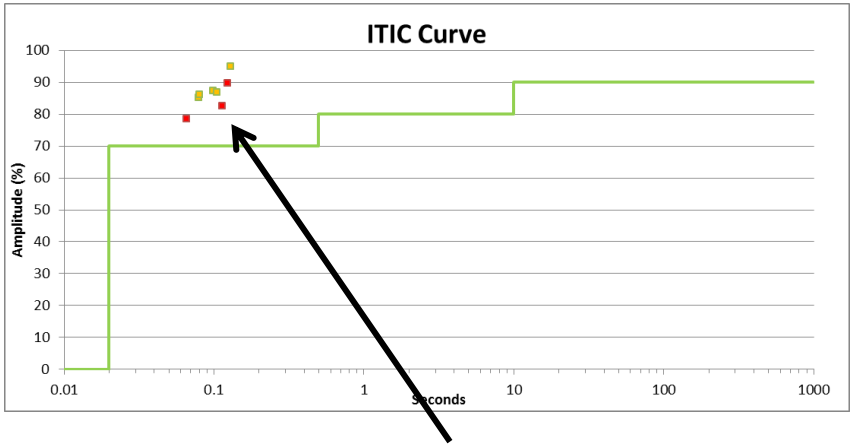
120 Vac (operating range 108 - 126 Vac) – 90% of 120Vac

FC - Sorensen 250A power converter (main)

400 Vac (operating range 342 - 440 Vac) – 85% of 400Vac

Step IV - Power Converters and Controllers susceptibility to network disturbances

- **FC - AMI 430 Controller** – AC supply threshold measured at 159V (spec -176V).
- Once AC supply lost the AMI resets and output is set to ZERO.
- This will cause a fast ramp (circuit components limited) – likely to cause a quench – tested and verified.
- DCCT supply failure is also likely to cause a quench.
- **FC – Sorensen 250A PSU** – if AC supply is lost then a fast ramp will be initiated until power returns.
- Again likely to cause a quench.
- Maximum input power occurs during ramp and is approx. 2kW.

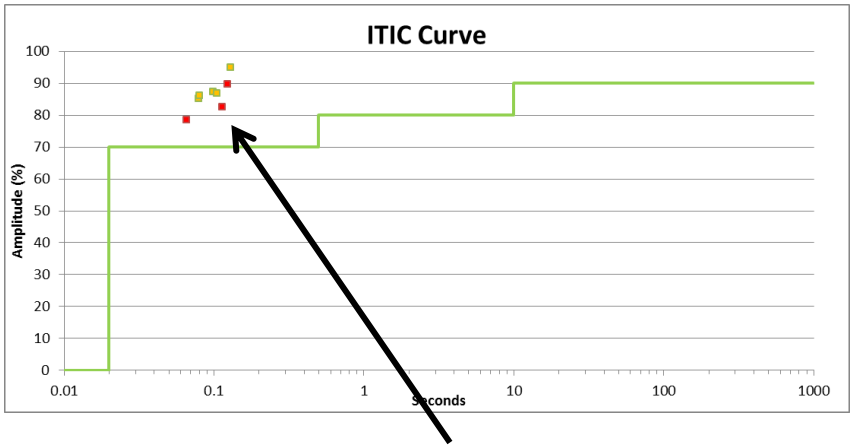


Some of the recorded network disturbances could have affected the FC power converter.
(short duration – unlikely to cause quench)

Recommendation – supply all FC Instrumentation, Power Converter and controller from UPS – additional loading 2.5kW.

Step IV - Power Converters and Controllers susceptibility to network disturbances

- **SS - AMI 420 Controller** – No AC test completed, expected to be equivalent to 430 unit.
- Once AC supply lost the AMI resets and output is set to ZERO.
- This will cause a fast ramp (circuit components limited) – likely to cause a quench – tested and verified.
- Upgrade to QD system required to prevent?
- **SS – Centre & Outer PSU** – if AC supply is lost then a fast ramp will be initiated until power returns.
- Again likely to cause a quench.
- Maximum input power occurs during ramp and is approx. 11kW x 2 systems.
- **SS – Lakeshore 625 PSU** - if AC supply is lost then a fast ramp will be initiated.
- Again likely to cause a quench.



Most of the recorded network disturbances could have affected the SS power converters.

The current 30kVA UPS rating is not large enough to support the power converters for Centre and Outer coils.

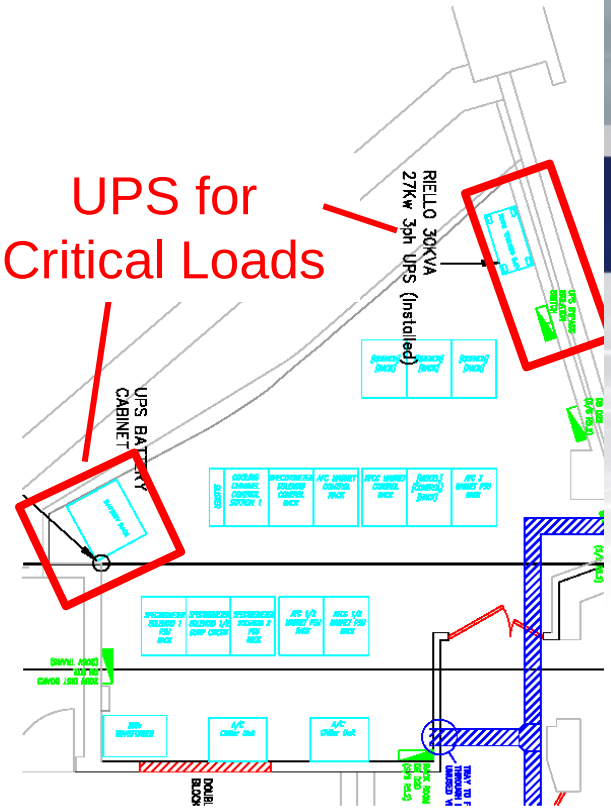
However the UPS can be used to support AMI Controllers and Trim power converters. (Change AC supply to 230V)

Step IV – SS Energy Absorber Rack

- Energy absorber rack will be positioned in RR2.
- Originally water cooling to be supplied from a stand alone 6kW Chiller.
- ISIS prefer water cooling to be supply from their central system.
- The water cooling must be maintained for a minimum of 1 hour after a mains lose, to allow energy in solenoid to be discharged.
- ISIS cooling system has sufficient capacity to cope with absorber energy.
- Details of scheme including pipe routing is to be finalised.

Rack Room 2 – UPS Inverter and Batteries

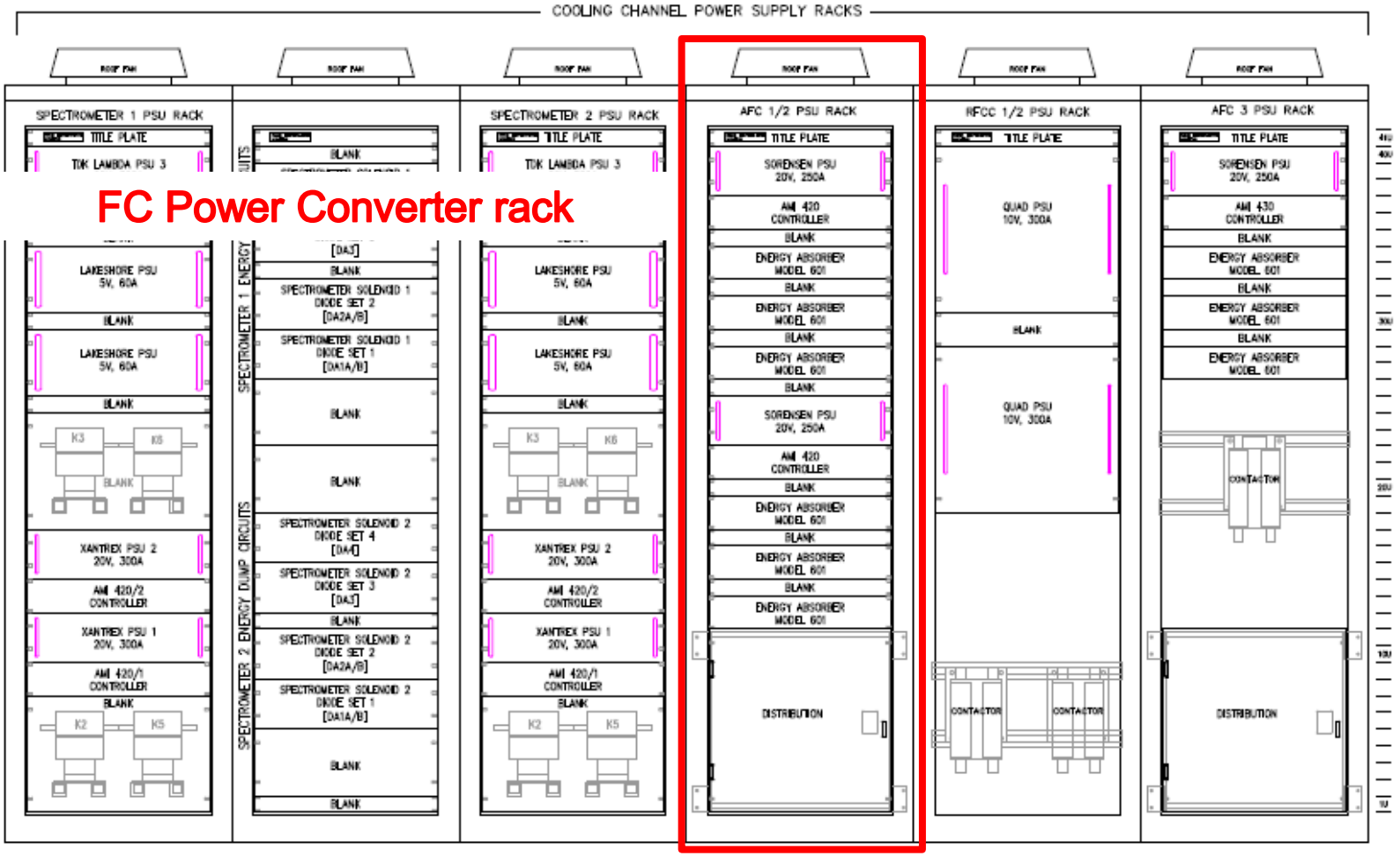
UPS for Critical Loads



As the total load will be significantly lower than 30KVA the autonomy will be >1hour

Riello UPS – Sentry unit
3 Phase - Double Conversion Technology

Focus Coil Power Converter Rack



- Controllers, absorbers and power converter commissioned.
- Rack will be transported to RAL June 2014.

FC – Power Converter Rack Thermal Test

Temperature Controller (upper)

Sorensen 250A Power Supply #1

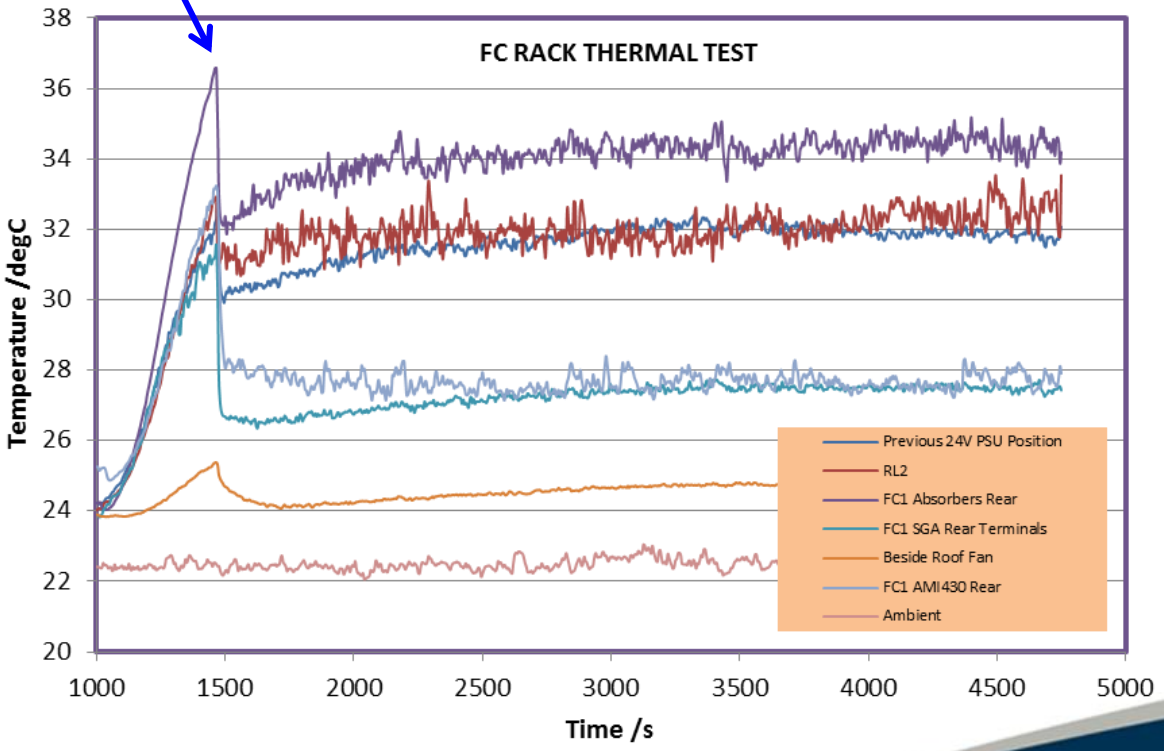
AMI Power Supply Controller #1

Energy Absorbers #1

Temperature Controller (lower)

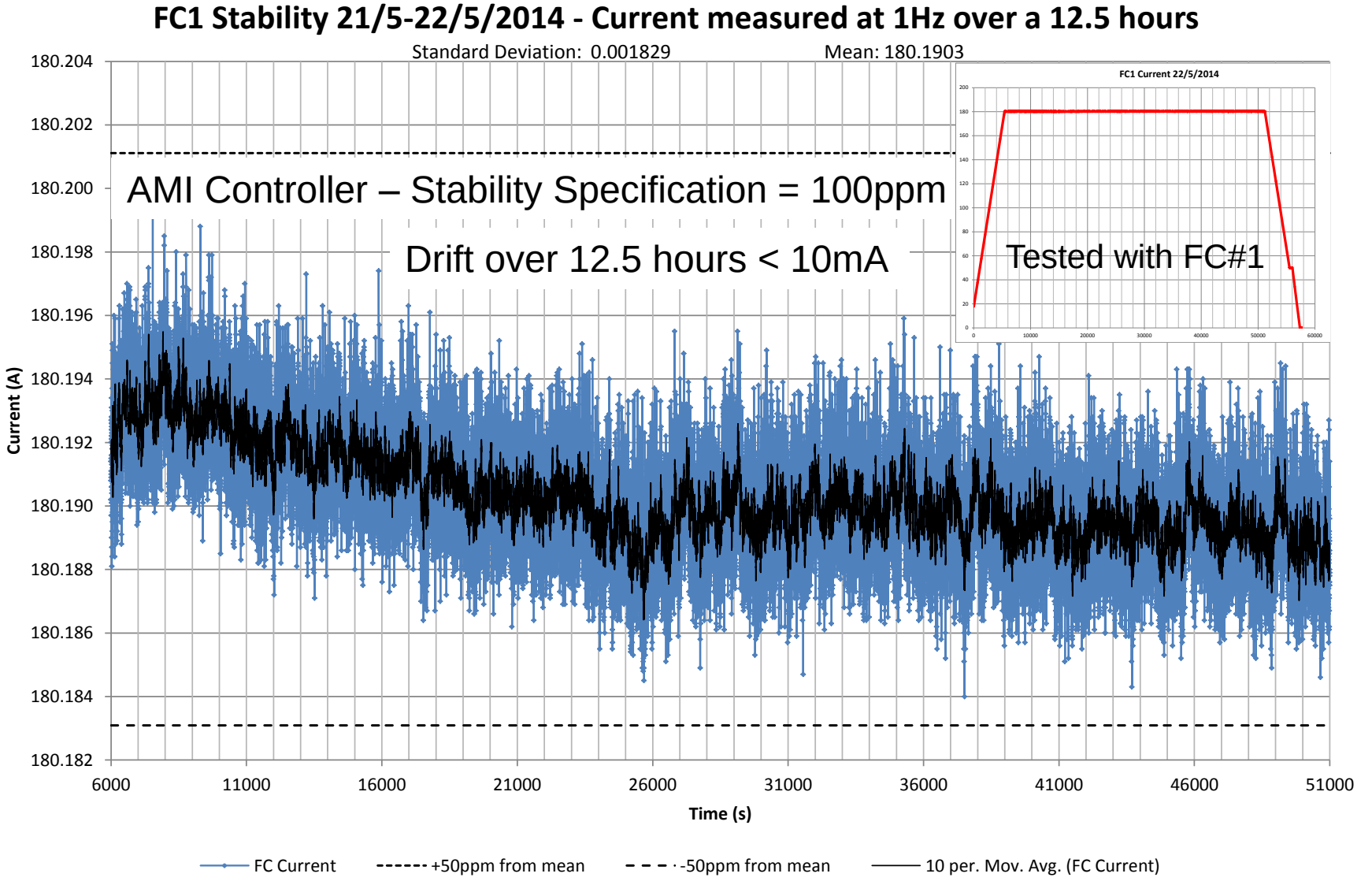
1.5kW heater (simulated #2)

Fans Activate

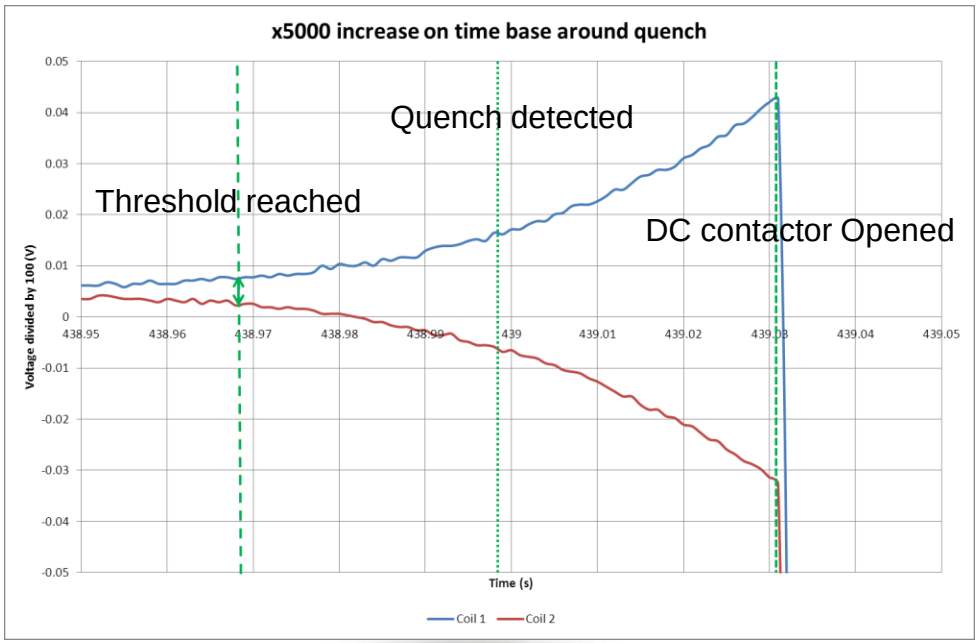


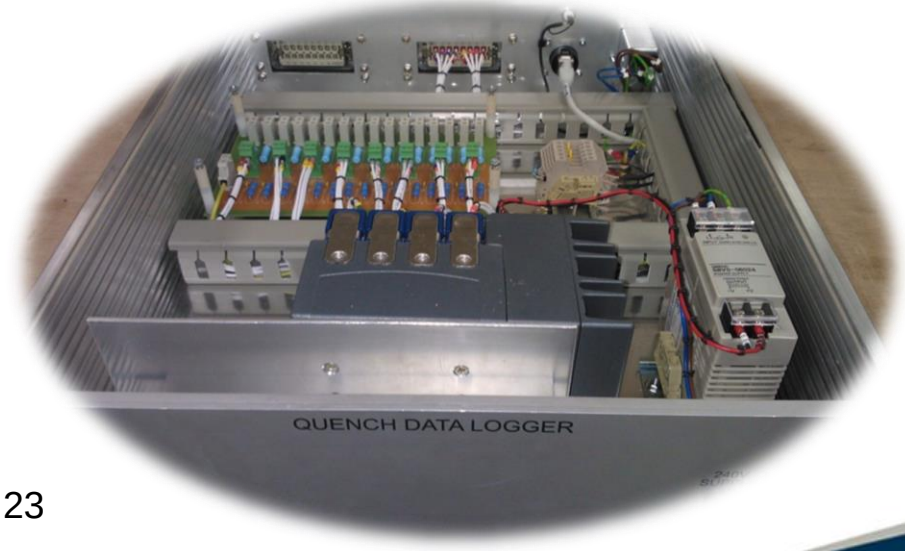
Science & Technology Facilities Council

FC#1– Current Stability Measurement



FC – Quench Protection and Data Logging





- FC#1 has been commissioned with the DL QD System.
- A second DL QD system has been assembled and tested.
- It was been commissioned with FC#1 and operated successfully with 40m cables from the voltage tap signals.
- The data logging system has been successfully operated on FC#1.
- The software is now being developed to provide operational functionality.
- Signals will be received from SS QD system to synchronise events.

Cooling Channel Controls

Mag PSU Racks

- FC PSU rack is complete and was delivered to RAL yesterday.
- SSU rack has been modified to include PULSE IN/OUT of contactors, has agreed at CM38. Tests of PSU's will start next week.
- Delivery to RRM2 anticipated in July.
- SSD PSU rack due at DL end of July from Wang NMR for repackaging as per SSU Rack. To include energy absorbers
- Anticipated availability in RRM2 mid September.

Cooling Channel Controls

Control racks

- FC control rack is complete and was also delivered yesterday. Requires Instrumentation, Lakeshore 218's etc.
- Plan to replace the LM500 level gauge with an AMI 135. Information required on FC level gauge.
- SS control rack has been modified to include a CT to detect wire break in BTM heaters and allow remote SP via RS232.
- Pulse IN/OUT of contactor control provided. Full control system will be delivered when all rack tests are complete.
- Cryomech 970 compressors will be modified to allow remote STOP/START and basic status feedback.

Cooling Channel Controls

Vacuum system/rack progressing, control sequences and interlocks are required to complete the rack assembly. System also includes Tracker Vacuum.

Also monitored and controlled via RS232, the Vacuum rack will incorporate the Cryo Compressors that are located on the West Mezzanine.

Questions?

CM39

Ian Mullacrane

Acknowledgements

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