



# *MICE: Controls & Monitoring*

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ILLINOIS INSTITUTE  
OF TECHNOLOGY

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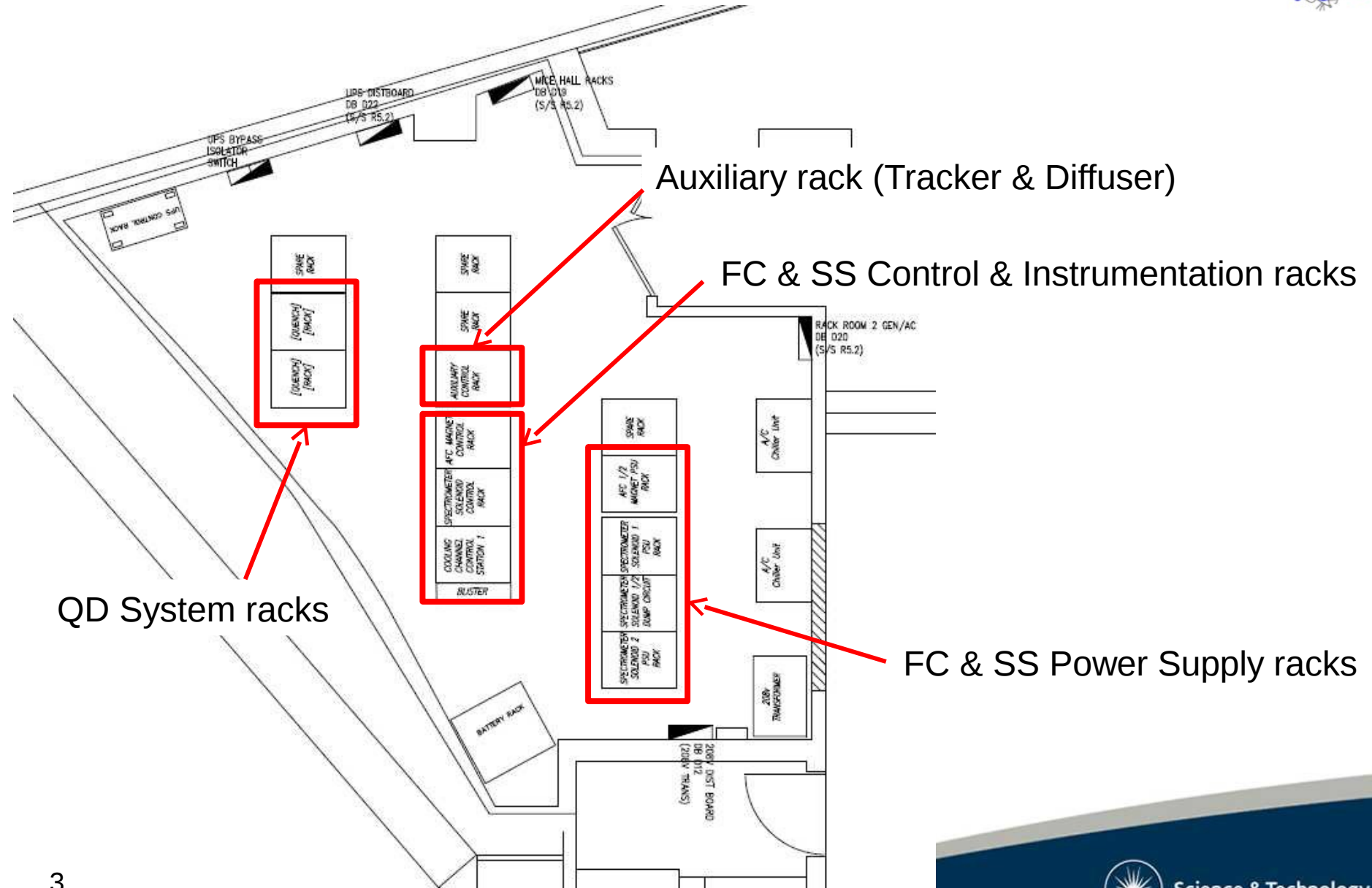




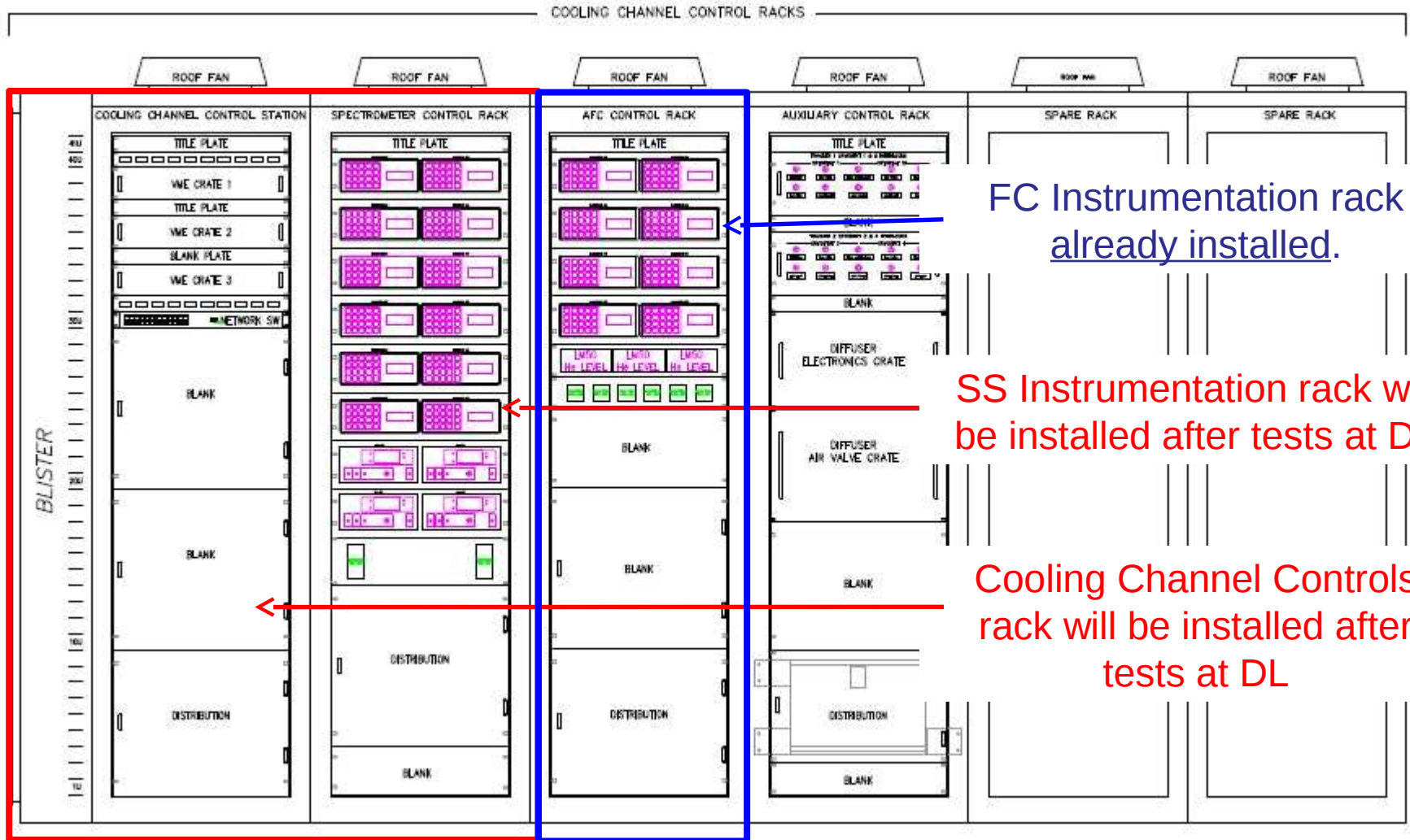
# Outline

- DL Efforts since CM39
- Progress since CM39
- C&M Organization
- IOC simulations to support State Machine development
- Preparing for Mock Data Run
- Odds and Ends

# RR2 Layout - rack allocation



# FC & SS Power Converter Rack



FC Instrumentation rack  
already installed.

SS Instrumentation rack will  
be installed after tests at DL

Cooling Channel Controls  
rack will be installed after  
tests at DL

# FC Instrumentation Rack



FC instrumentation rack  
already installed.



- The Cooling channel controls rack will be installed early Nov.
- Inter-connecting controls cables can then be installed / terminated
- This rack has already been fully tested at DL.
- Instrumentation cables need to be installed between RR2 and FC magnet.



# SS Power Supply Racks

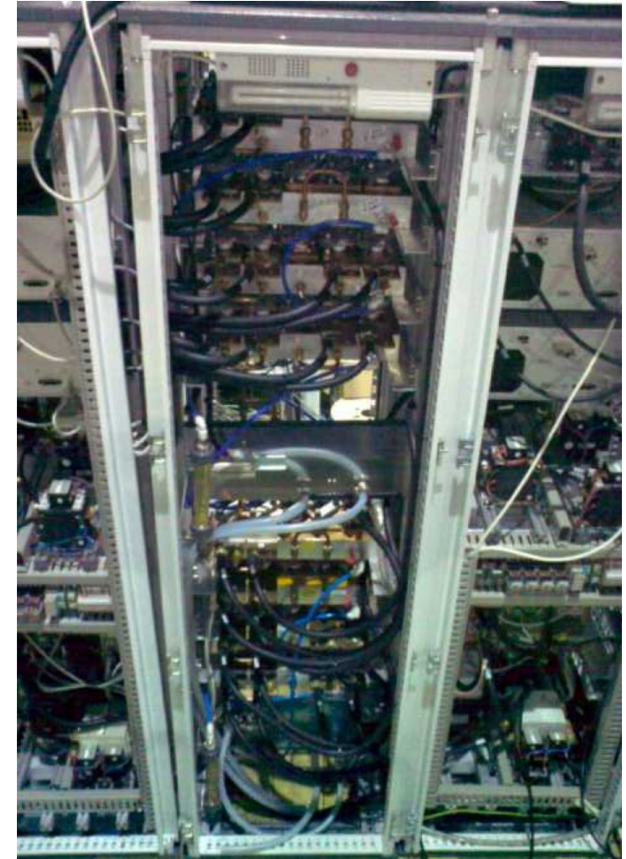


- Thermal testing to be completed at DL this week
- Installed in RR2 by end of October
- AC supplies and water cooling required in RR2
- Cable interconnections – need to be installed and terminated

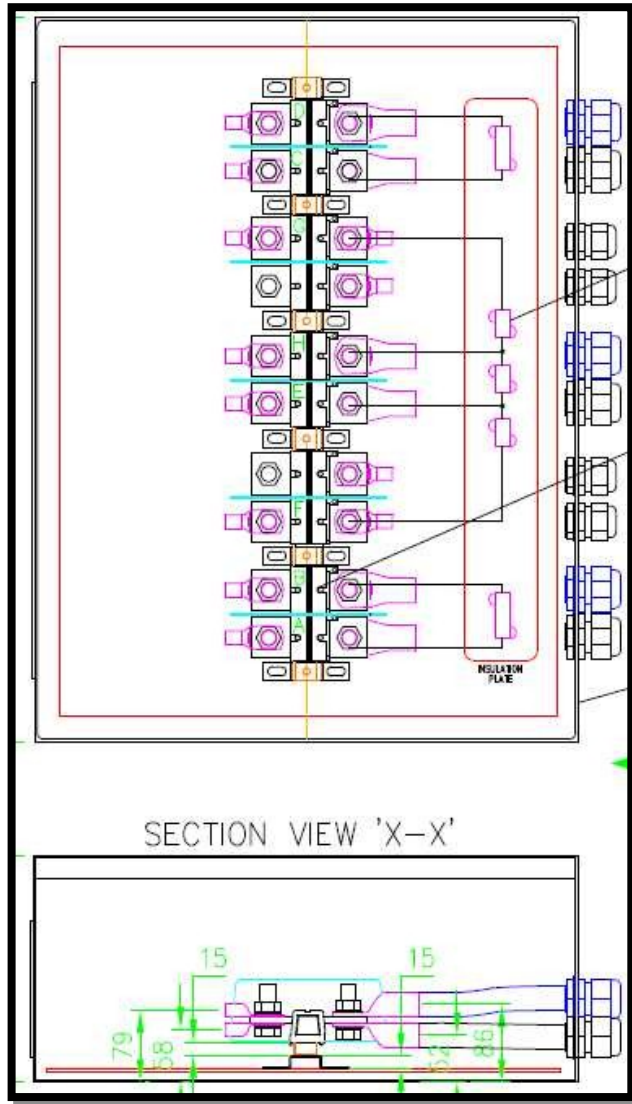
# SS Energy Absorber Rack



- Water connections changed from imperial to metric
- Insulation enhanced - maintaining thermal conductivity and electrical isolation
- Each diode module tested thermally to ensure optimum torque applied
- Water cooling arrangements agreed and installation initiated in RR2
- The water cooling will be maintained for a minimum of 1 hour during a loss of supply
- This will ensure the energy stored in the super conducting magnets is safely discharged.



# DC magnet and Control Cables for SS & FC

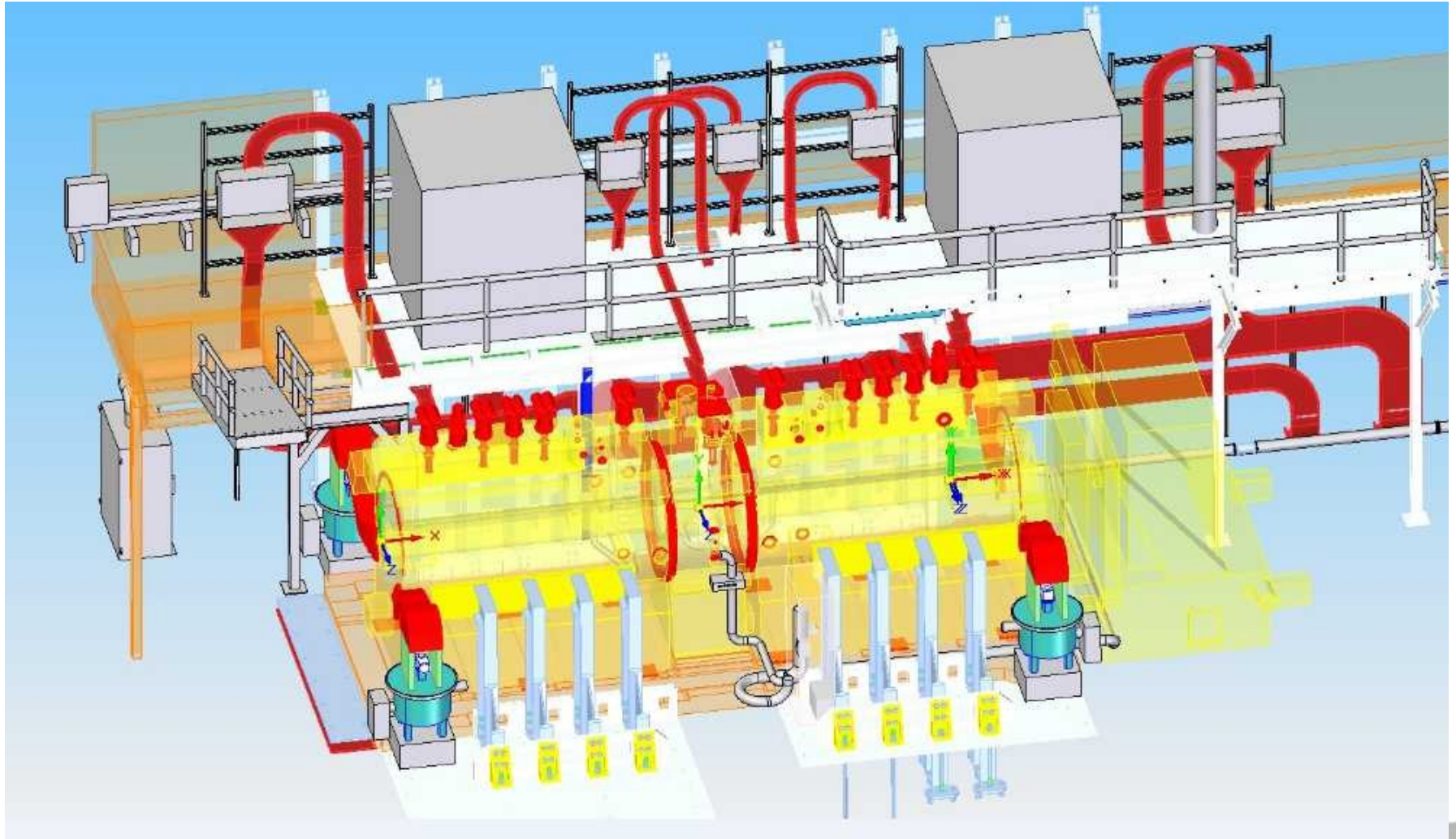


DC Link Box

- DC link boxes designed and delivered to RAL.
- Currently installing DC link boxes / cable management on upper South mezzanine.
- There are 14 x 240mm<sup>2</sup> and 4 x 70mm<sup>2</sup> cables from RR2 to link boxes to install.
- DC cable installation will require 4 staff due to length and weight. Possibly completed before January.
- Controls cabling needs to be installed from RR2 to magnets - approx. 40 multicore cables with connectors.
- Estimated to be completion including terminations by end of February.
- Final dressing of cable / cable management installation after PRY installed is approx. 3 weeks.



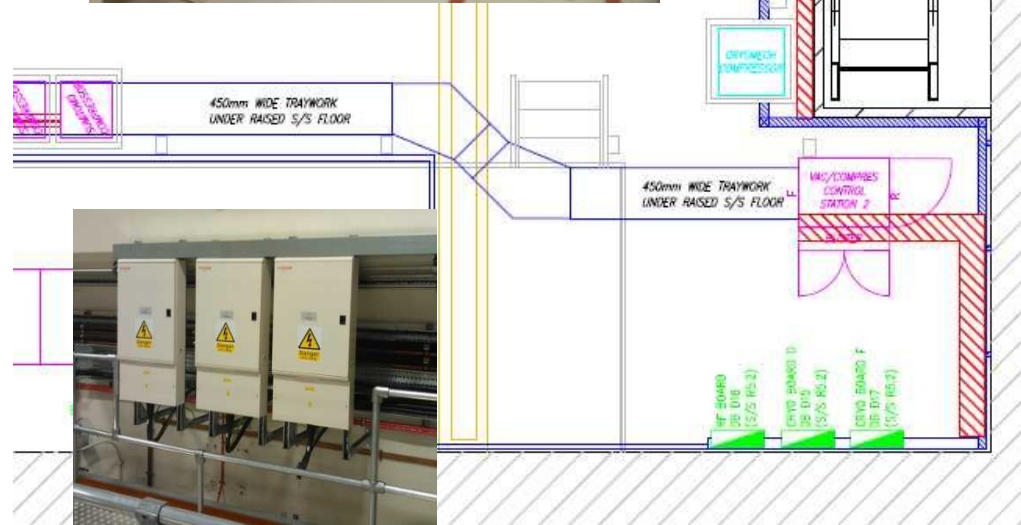
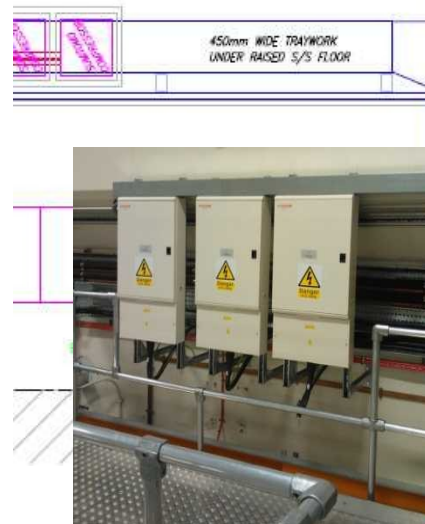
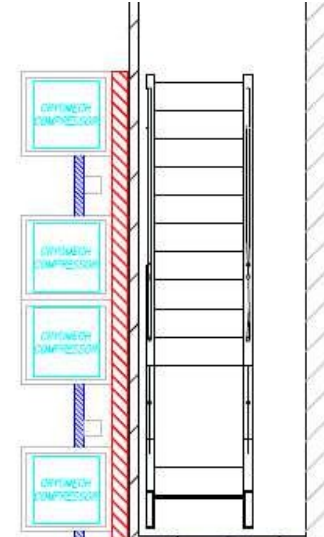
# Cable management for DC cables and link boxes for SS & FC



# Compressor and Vacuum Rack



- Vacuum / compressor rack positioned as shown.
- Sumitomo compressors relocated and some cable management installed.
- Cryomech compressors powered and control cables installed, but need terminating.





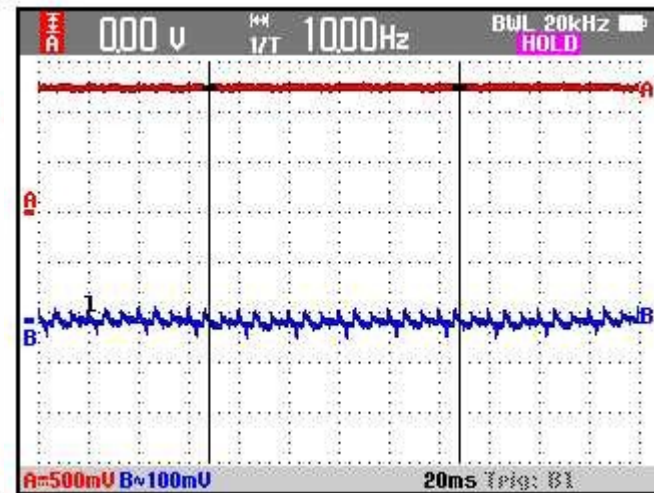
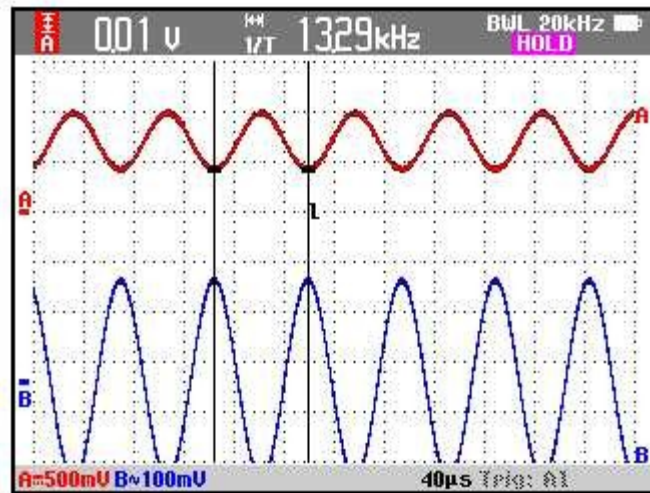
# EMR Rack



EMR Rack



# Decay Solenoid Power Supply - Commissioning

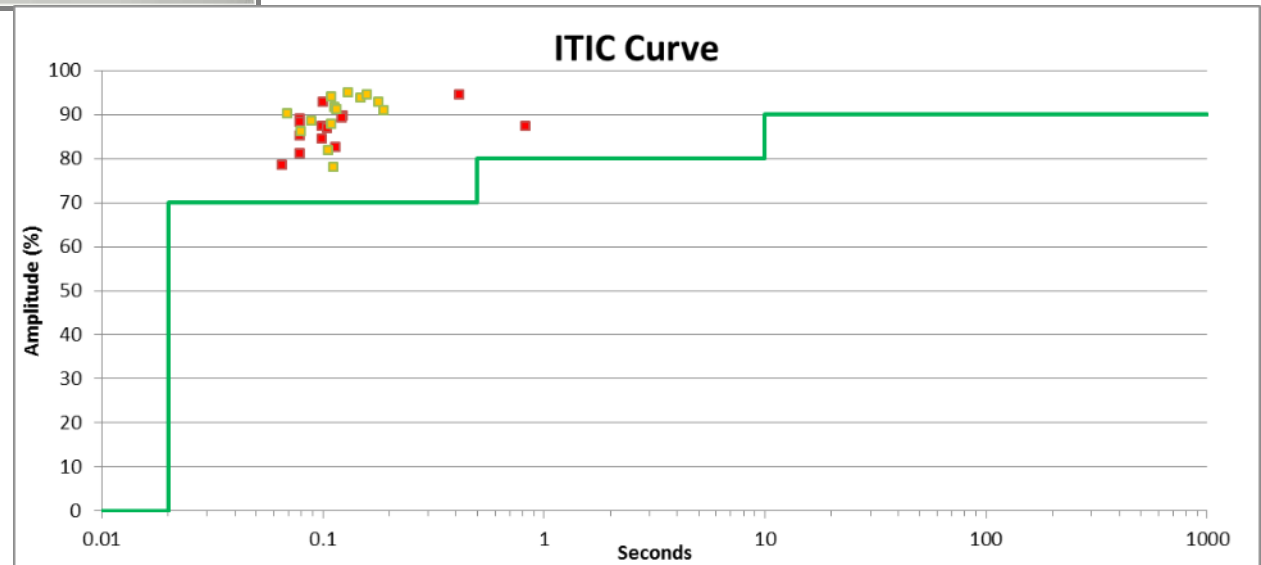




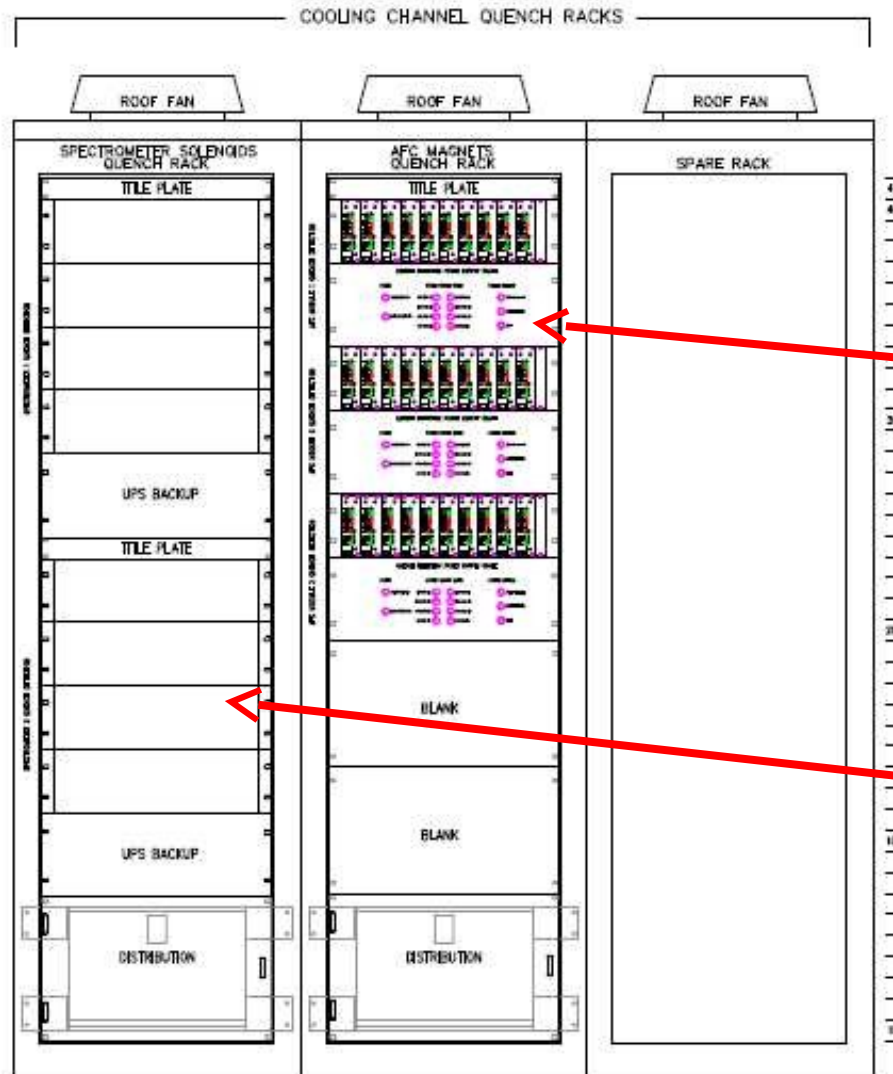
# Power Quality Measurement



- Sub.net power quality measurement system has been built and tested in the MICE hall
- Awaiting full commissioning of the system
- ISIS have used the same system to monitor disturbances since February 2014
- 28 events have been logged, 50% of which resulted in beam loss.



# Quench Detection System Racks



2 QD systems installed in 1 rack for FC 1 & 2

2 QD systems installed in 1 rack for SS up & down stream



# DL Summary

- Weekly meetings with S.Griffiths
- 7 racks complete for RR2, 5 more to be installed next week
  - power supply racks
  - instrumentation racks
  - awaiting delivery of remaining US PSUs and instrumentation
- ~40 control cables to be run from RR2
- 7 240 mm<sup>2</sup> + 8 70 mm<sup>2</sup> power cables to DC link boxes, then 70 mm<sup>2</sup> cables to magnet terminal blocks by Christmas
- vacuum rack – mid November
- 2<sup>nd</sup> UPS to be installed in RR2
- re-torque energy absorber diodes after Step IV
- QPS integration



# Since CM39

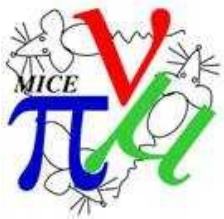
- Production version of epics
- New paradigm for IOCs
- UPS monitoring
- A/C unit monitoring
- p Absorber
- EMR
- CKOV
- Diffuser
- Vacuum
- Focus Coil 2 (FC2) State Machine
- ISIS beam loss





# Since CM39

- **Production version of C&M software**
  - CM39 – reported that build environment was incomplete and buggy
  - With help from Chris Rogers, these problems now solved
  - Chris Heidt assisted in establishing release procedure
  - Now have epicsPRO for running and epicsDEV for final development/testing
  - **Outstanding issues:**
    - cleaning up build scripts
    - pushing code to launchpad
    - establishing policy for archive viewer scripts



# Since CM39

- **New paradigm for IOCs**
  - For several years, I have struggled with some of the higher level IOCs (RunControl and State Machines) not playing nicely with the lower level IOCs (DL developed)
  - Model was J. Leaver legacy to run multiple IOCs on the same PC with different IP ports – works only sometimes
  - This model violates the standard EPICS procedure
  - New paradigm is to use NUCs as IOCs
  - Successfully tested BeamLine and FC2 State Machine





# Since CM39

- **UPS monitoring**
  - Several UPSs in RR1, larger ones in RR2 and LH<sub>2</sub> room
  - Required to allow safe shutdown of devices in case of power failure
  - All RR1 UPSs run from NUT server – all re-instated and server operation documented (thanks Henry)
  - RR2 and LH<sub>2</sub> room UPSs are Riello – now networked and properly monitored

The screenshot shows a window titled "MICE UPS Monitoring" with a table of data for six different locations: loc-server, loc-client, network, daq-server, RR2, and LH2. The table includes rows for UPS status, Charge on UPS battery, Load on UPS, UPS battery Run Time, Voltage on UPS battery, Input AC Voltage, Output AC voltage, and UPS temperature. Each row has a corresponding value for each location. At the bottom, there are "Exit" and "RR2 UPS" buttons, and a row of green status indicators.

	loc-server	loc-client	network	daq-server	RR2	LH2
UPS status :	Online	Online	Online	Online	Online	Online
Charge on UPS battery :	100.00 %	100.00 %	100.00 %	100.00 %	100 %	100 %
Load on UPS :	19.5 %	16.9 %	24.7 %	9.1 %	0.0 %	0.0 %
UPS battery Run Time :	1320.00 min	4140.00 min	2100.00 min	4620.00 min	4094 min	1980 min
Voltage on UPS battery :	27.7 V	27.7 V	27.4 V	55.3 V	272.60 V	272.60 V
Input AC Voltage :	240.4 V	237.6 V	239.0 V	237.6 V	240.0 V	0.0 V
Output AC voltage :	239.0 V	237.6 V	239.0 V	237.6 V	241.0 V	229.0 V
UPS temperature :	21.1 C	22.9 C	22.9 C	22.9 C	23 C	22 C



# Since CM39

- A/C units monitoring
  - Several A/C units:
    - MICE Hall – critical for Decay Solenoid and temperature stability for ToF
    - RR1 – critical for DAQ and computers
    - RR2 – critical for power supplies & instrumentation
  - Hall and RR2 are now monitored – **2<sup>nd</sup> controller broken**
  - RR1 – John Govans installed ???

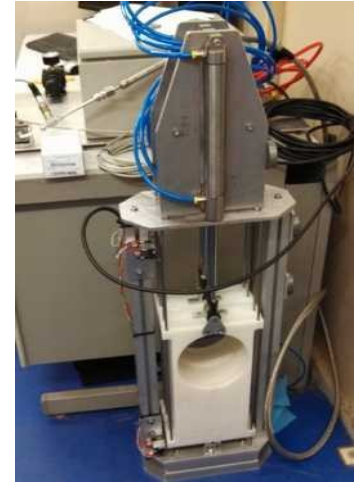
MICE A/C Monitoring							EXIT
MICE Hall	Status	Cool	set T	read T	read humid	Alarms and Errors	Reset
AC1 Status	Off by Keyboard	Off	22 C	28.9 C	33 %	0 None	
AC2 Status	Off by Keyboard	Off	23 C	30.0 C	32 %	1 Fltr	<input type="checkbox"/>
AC3 Status	On	On	22 C	25.0 C	36 %	1 Fltr	<input type="checkbox"/>
AC4 Status	On	On	22 C	22.6 C	42 %	1 Fltr	<input type="checkbox"/>
MICE RR1							
MICE RR2							
AC5 Status	Off by Keyboard	Off	25 C	25.0 C	44 %		<input type="checkbox"/>





# Since CM39

- Proton Absorber controls
  - CM39 – in place and working, but not fully tested
  - Installed in beamline
  - Soak test was all that remained
  - FINISHED!!!



Proton Absorber Control

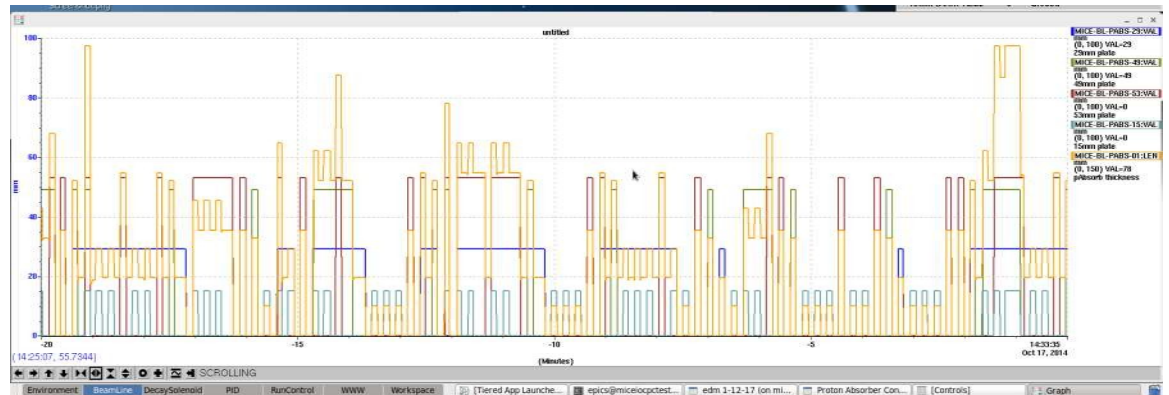
Device Name: "TCW181-CM"  
 Software version: "v1.01"  
 Release date: "August 2012"  
 IP Address: 172.16.246.156  
 SubNet Address: 255.255.255.0  
 Gateway Address: 172.16.246.254  
 MAC Address: 00 04 A3 AA 11 3  
 DHCP Config: 0

**AllOn**  
**AllOff**

**Status** 5.7 bar Supply air pressure  
**Exit** 1.0 bar Relief IN air pressure  
 1.0 bar Relief OUT air pressure

p Absorber Switch	Limit Switches	p Absorber Plates
29mm Up value	1 Open	0 mm
49mm Up value	1 Open	0 mm
53mm Up value	0 Closed	53 mm
15mm Up value	0 Closed	15 mm
29mm Down value	0 Closed	
49mm Down value	0 Closed	
53mm Down value	1 Open	
15mm Down value	1 Open	

**p Absorber 68 mm**





# Since CM39

- **EMR Controls and Monitoring**
  - **Several new devices**
    - Power distribution controller (remote contacts)
    - VME crate
    - CAEN SY8800 low voltage power supply (2)
    - CAEN SY4527 high voltage power supply
    - temperature monitors
  - **All devices now networked (hardest part)**
  - **Remote contacts near completion – full testing**
  - **Several problems**
    - HV crate problems – only limited remote control, investigating
    - new and unknown temperature devices



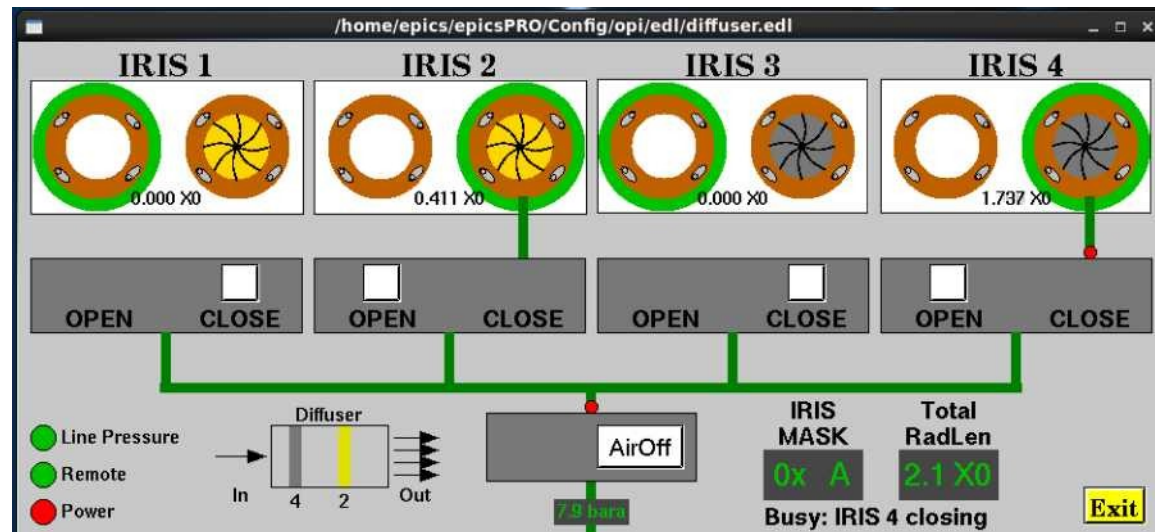
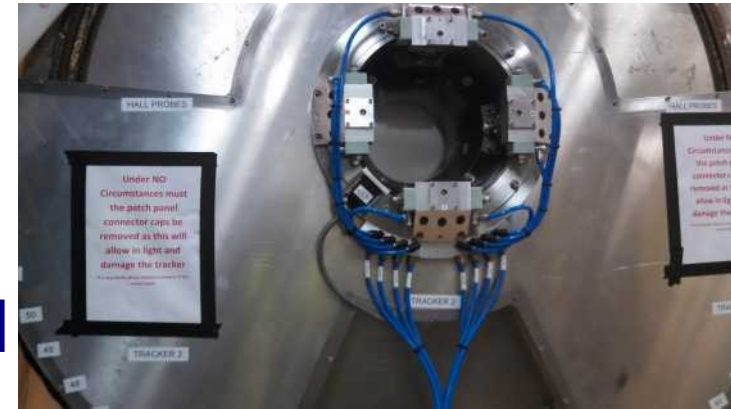
- CKOV purge



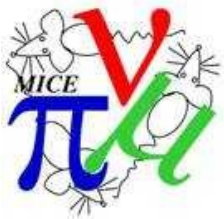
- New purge monitoring
- hardware from UMiss
- installed
- reading out
- needs calibration
- need to add to gui



- Diffuser
  - Device installed in SSU
  - Controls installed in RR2
  - Controls complete/commissioned

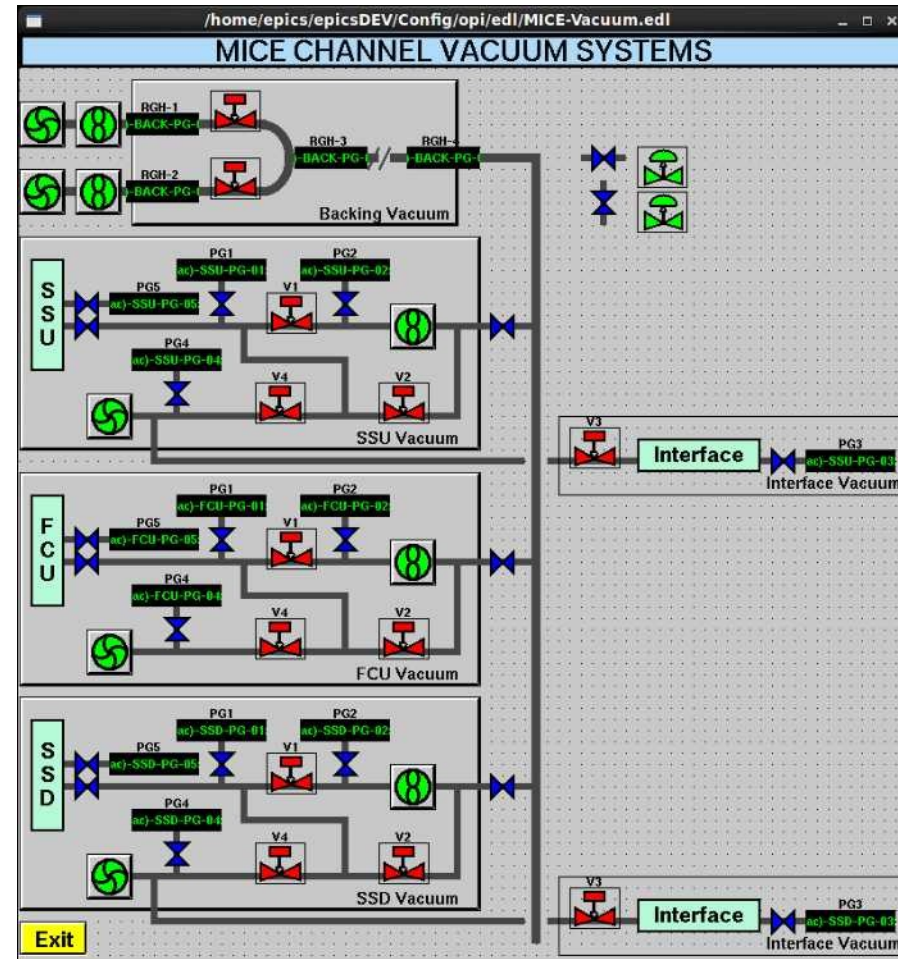




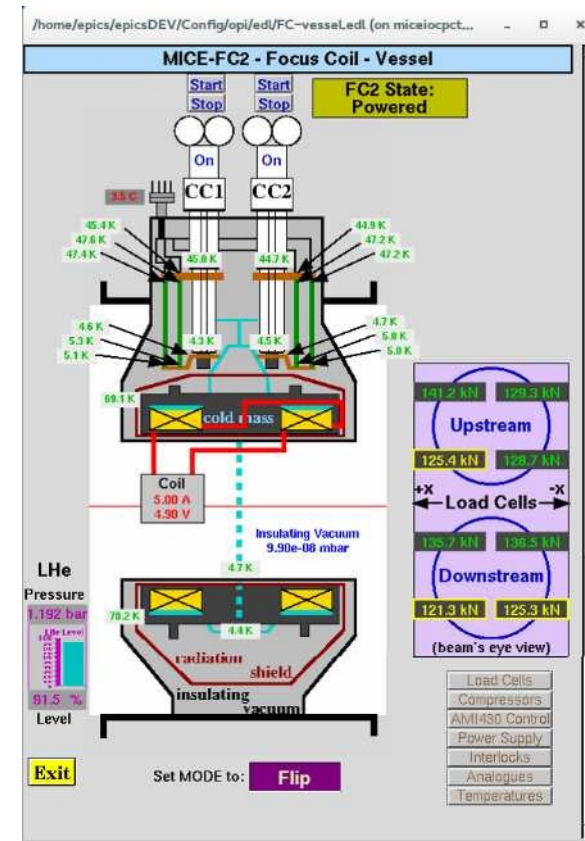


# Since CM39

- Vacuum system
  - design essentially complete
  - series of meetings with DL team
  - user interface nearly complete
  - pumping stations being built
    - FC station complete
    - SS parts arrived from US
    - SS instrumentation shipped



- **FC2 State Machine**
  - Fully functional – see caveat below
    - Transitions defined and tested
    - Archiver tested
    - Alarms tested
  - Used with FC2 training and mapping
  - Completely passive
  - Still needs expert input for:
    - tightening of alarm limits
    - definitions and transitions for error states
    - add interlocks to archiver

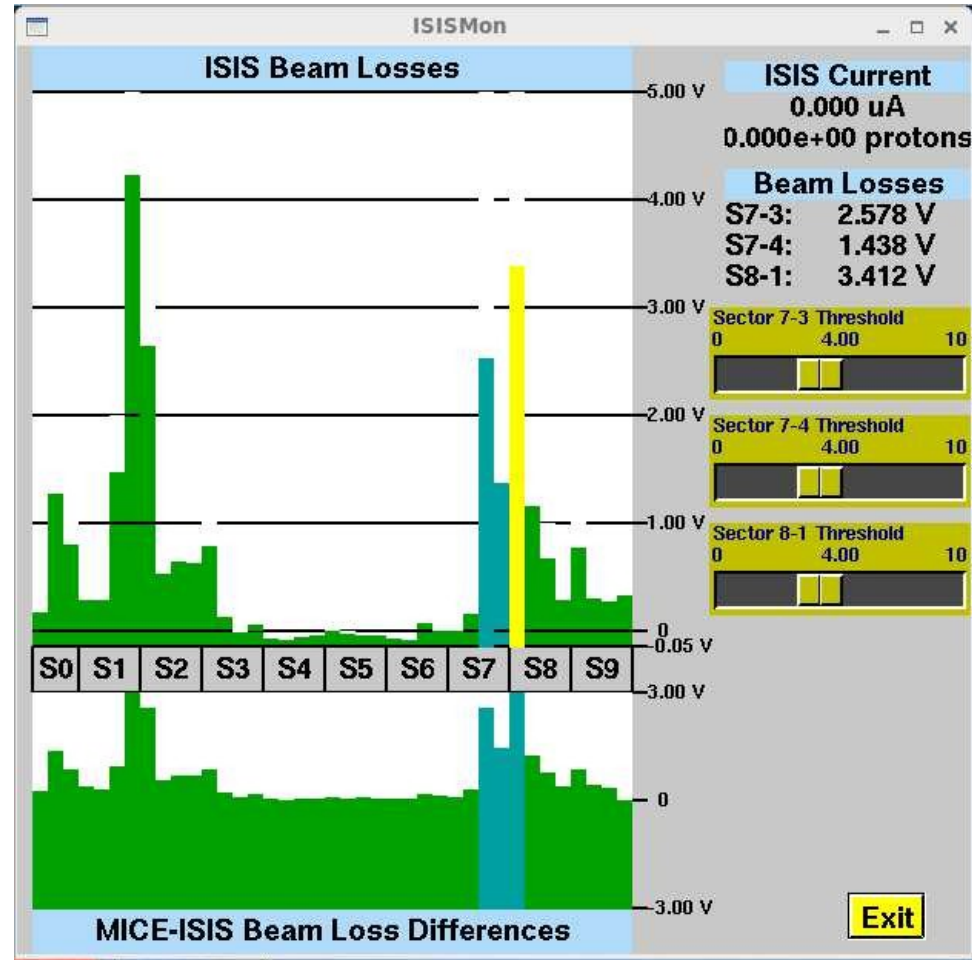


**Knowledge from this model simplifies all other SMs**



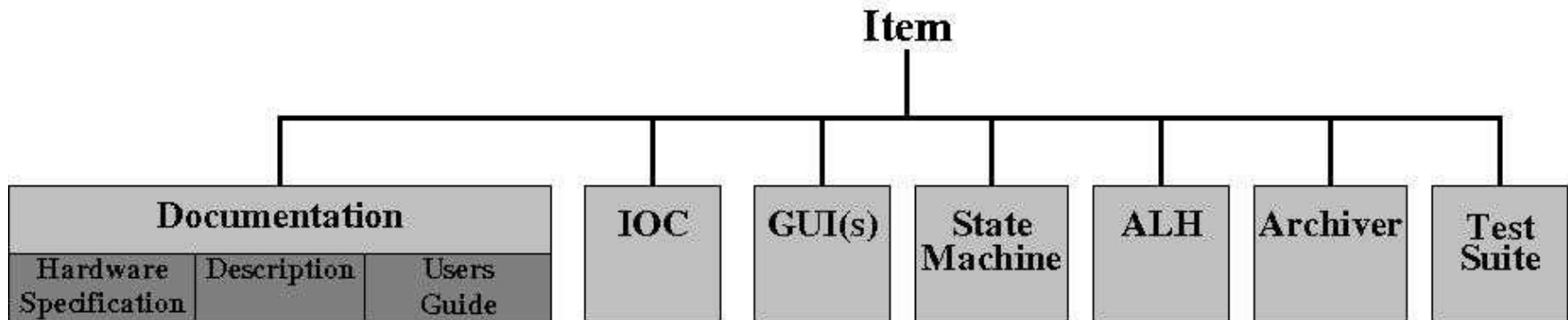
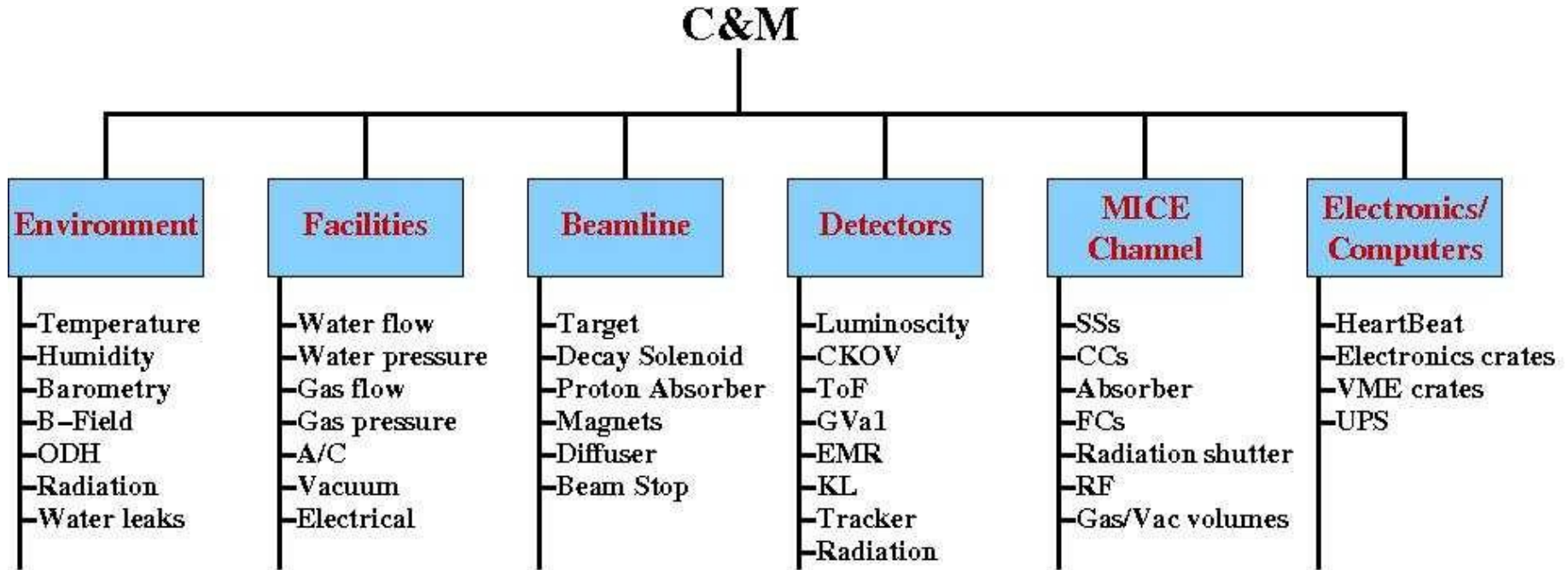
# Since CM39

- **ISIS Beam Loss monitor**
  - initiated by ISIS
  - will be used with ALH to inform users if we approach ISIS limits
  - tested during last ISIS run
  - plot
    - losses MICE dip
    - difference with ISIS average
  - modified since then:
    - added average ISIS BL
  - now use log plots





# C&M Organization







# C&M Organization

Task ID

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Owner	Support	Required Time (Hours)	Proportion Done	Person Occupancy	Modifier	Estimated Task Time (Days)	Actual Time Taken	Priority	Dependencies																																							
Controls and Monitoring										MICE Channel				SSs	IOC	DL		90.0%	510.0%	1	0.00	1	hardware																									
															GUI(s)	Hanlet	5	95.0%	600%	1	0.05	1	144																									
															ALH	Hanlet	1	95.0%	600%	1	0.01	2	144																									
															Archiver	Hanlet	1	95.0%	600%	1	0.01	2	144																									
															StateMachine	Hanlet	160	95.0%	600%	1	1.67	1	144																									
															TestSuite	Virostek	80	0.0%	1.0%	1	1000.00	2	144																									
															Documentation	Virostek	1	0.0%	1.0%	1	12.50	3	149																									
																				FC				LH <sub>2</sub> Absorber Monitor	IOC	DL		90.0%	510.0%	1	0.00	1	hardware															
																									GUI(s)	Hanlet	10	100.0%	600%	1	0.00	1	151															
																									ALH	Hanlet	1	98.0%	600%	1	0.00	2	151															
																									Archiver	Hanlet	1	98.0%	600%	1	0.00	2	151															
																									StateMachine	Hanlet	80	90.0%	600%	1	1.67	1	151															
																									TestSuite	Watson	80	5.0%	1.0%	1	950.00	2	151															
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																				Solid Absorbers				PRY Movement Monitor	IOC	Hanlet	60	80.0%	600%	1	2.50	2	hardware															
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Documentation	Witte	3	0.0%	5.0%	1	7.50	3	173																																								
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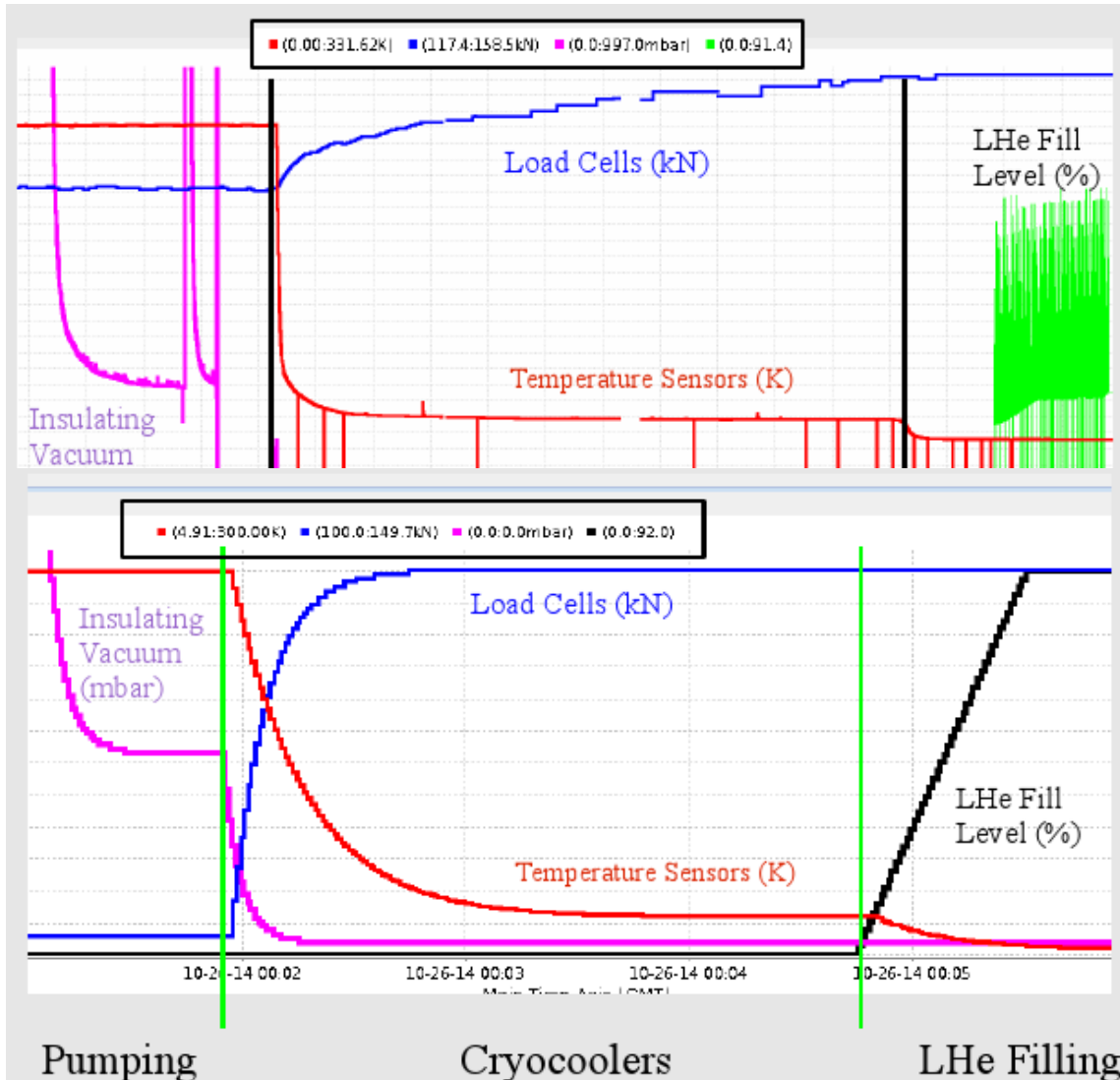
# IOC Simulations

## Goals of the Simulation

- The simulation should:
  - Recreate behavior of the PVs in each state
    - Focus Coil → Currently developing
    - Spectrometers
    - Beamline
  - Model error conditions
- The simulation should/is not:
  - Monte Carlo
  - Impose state specific conditions
  - A full physics simulation



# IOC Simulations



Data from Archiver

Simulation



# Preparing for Mock Data Run

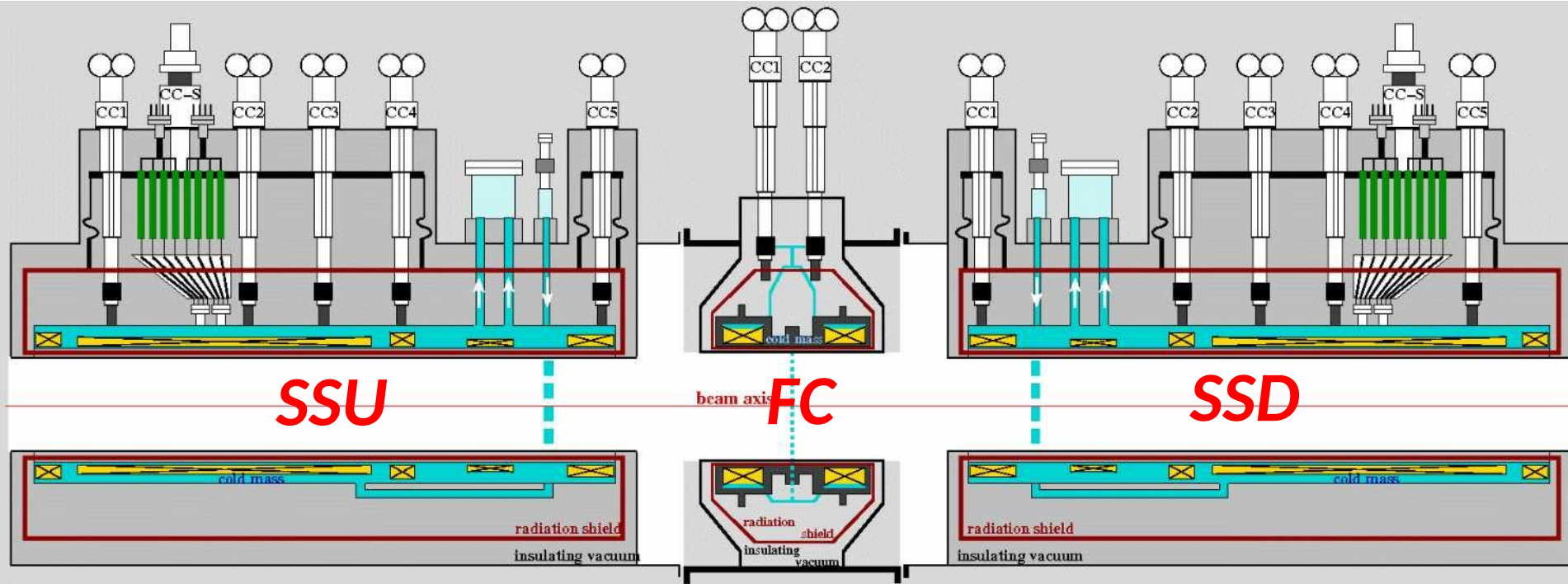
- Commissioning meeting
- Mock data run 21<sup>st</sup> January – welcome focus for C&M
- Need functional:
  - BeamLine
  - PID
  - DAQ
  - RunControl
    - State machines for BeamLine, PID, and DAQ
- Biggest challenges are EMR and RC



# ***Odds and Ends***

- **Ed Overton to help with target/tracker SMs**
- **Outstanding Online issues:**
  - **establish reliable ssh keys**
  - **proper setup of heplnv154 so as to build EPICS**
  - **complete build scripts**
  - **expand Nagio's role to cover:**
    - **updating uniform software versions of code on C&M machines**
    - **ensure requisite processes are running on specified machines**

# Step IV Operations



- Vacuum
- Compressors
- Cryogenics
- Pressure
- Power Supply

- Vacuum
- Compressors
- Cryogenics
- Pressure
- Power Supply

- Vacuum
- Compressors
- Cryogenics
- Pressure
- Power Supply





# Summary

- **Much progress since CM39:**
  - Substantial progress with DL installation
  - New hardware arriving ~weekly
  - Production version of C&M software
  - New paradigm for IOCs
  - Completed: p Absorber, Diffuser, Ckov, FC2 SM, ISIS Beam Loss
  - Nearly complete: UPS and A/C monitoring
  - New effort: EMR and vacuum
  - Not started: PRY movement and hall probes
- **IOC simulations to support SM development/testing**
- **Mock data run challenge – a welcome challenge**