

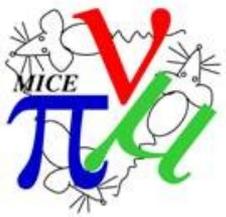
MICE: Controls & Monitoring

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ILLINOIS INSTITUTE
OF TECHNOLOGY

18 June 2013





Outline

- Structure and Existing C&M systems
- Personnel
- Integrating subsystems
 - Run Control
 - State Machines
 - Integrated Quench Protection System
- Issues/Risks
- ***Much of this came from MPB presentation***

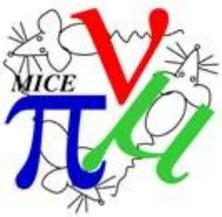


C&M Structure

- **Environment**
- **Beamline**
- **Particle ID**
- **DAQ/Computing/Electronics**

- **Spectrometers (SS & trackers)**
- **Absorbers (FC and absorbers)**

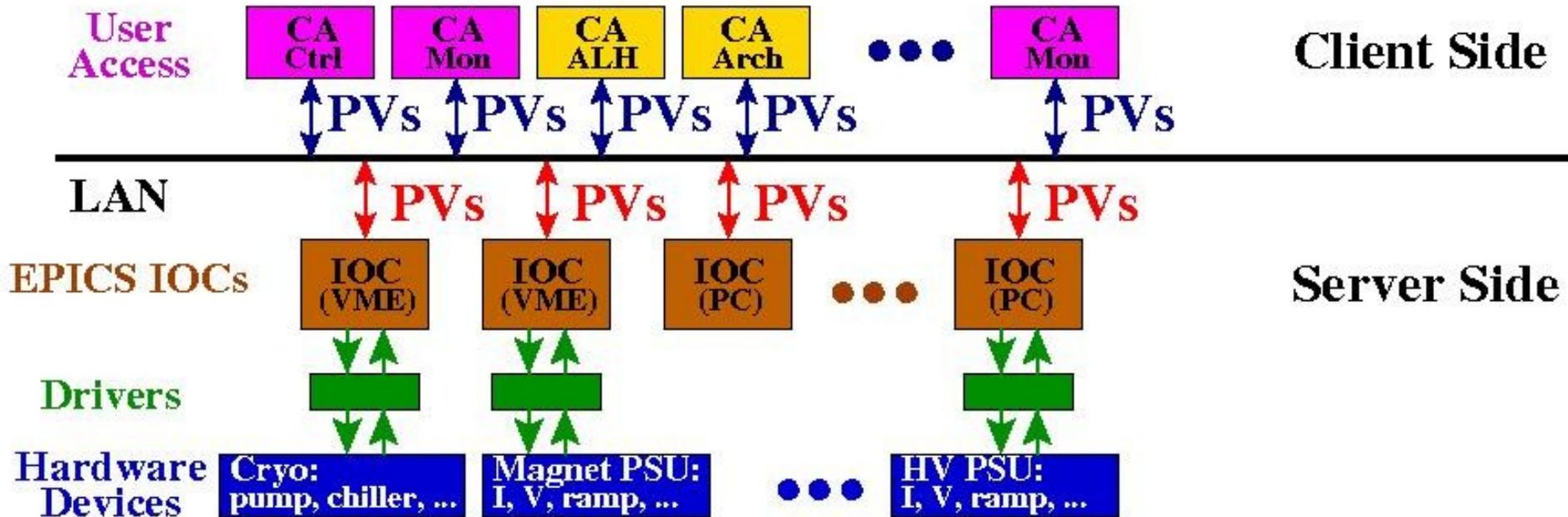
- **RF (CC and cavities)**

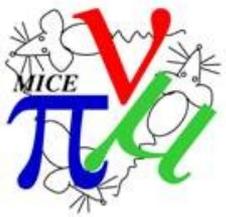


C&M Structure

EPICS based

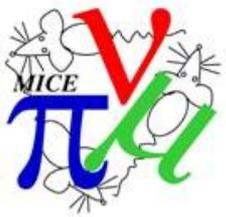
Experimental Physics & Industrial Control Systems





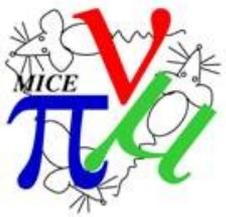
C&M Personnel

- **Large systems provided by controls team from Daresbury lab:**
 - **SS/FC/DS/conventional magnets**
 - **LH₂ system**
 - **Integrated cooling channel controls**
 - **FC/DS quench protection**
- **Target and Tracker controls provided by Leaver/Robinson**
- **Overall coordination/integration by Hanlet**



C&M Personnel

- **Smaller systems provided by Hanlet**
 - **Environment**
 - **PID: HV—ToF/CKOV/Trigger**
 - **Radiation monitoring**
 - **Target monitoring**
 - **Beamline monitoring**
 - **LH₂ monitoring**
 - **Proton absorber**
 - **RF tuners**
 - **DAQ monitor**



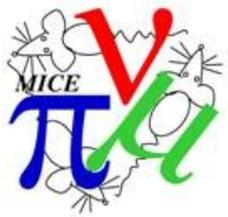
C&M Personnel

- **Hanlet continued:**
 - **Computer monitoring w/Robinson**
 - **A/C monitoring**
 - **Run Control**
 - **State machines**
 - **AutoSMS**
 - **Tools:**
 - **archiver/alarm handler/gateway**
- **New blood: Ian Taylor (Warwick)**



C&M Personnel

- **C&M group has grown by factor of 2!**
- **Ian Taylor (Warwick)**
 - more sys-admin expertise
 - will clean up alarm handler
 - will clean up archiver
 - will develop FC state machine
- **Already been helpful**
 - micecss2 at Wang
 - establishing C&M test machine
 - cleaned up code in bsr
 - developed scripts for automation



Integrating Subsystems

- To date, C&M systems modular
- OK for Step I
- Will not work for string of coupled superconducting magnets
- Must think globally
- Operations being addressed with:
 - Run Control
 - State Machines
 - Integrated Quench Protection System

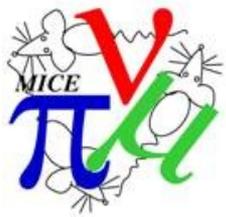


Run Control Goals

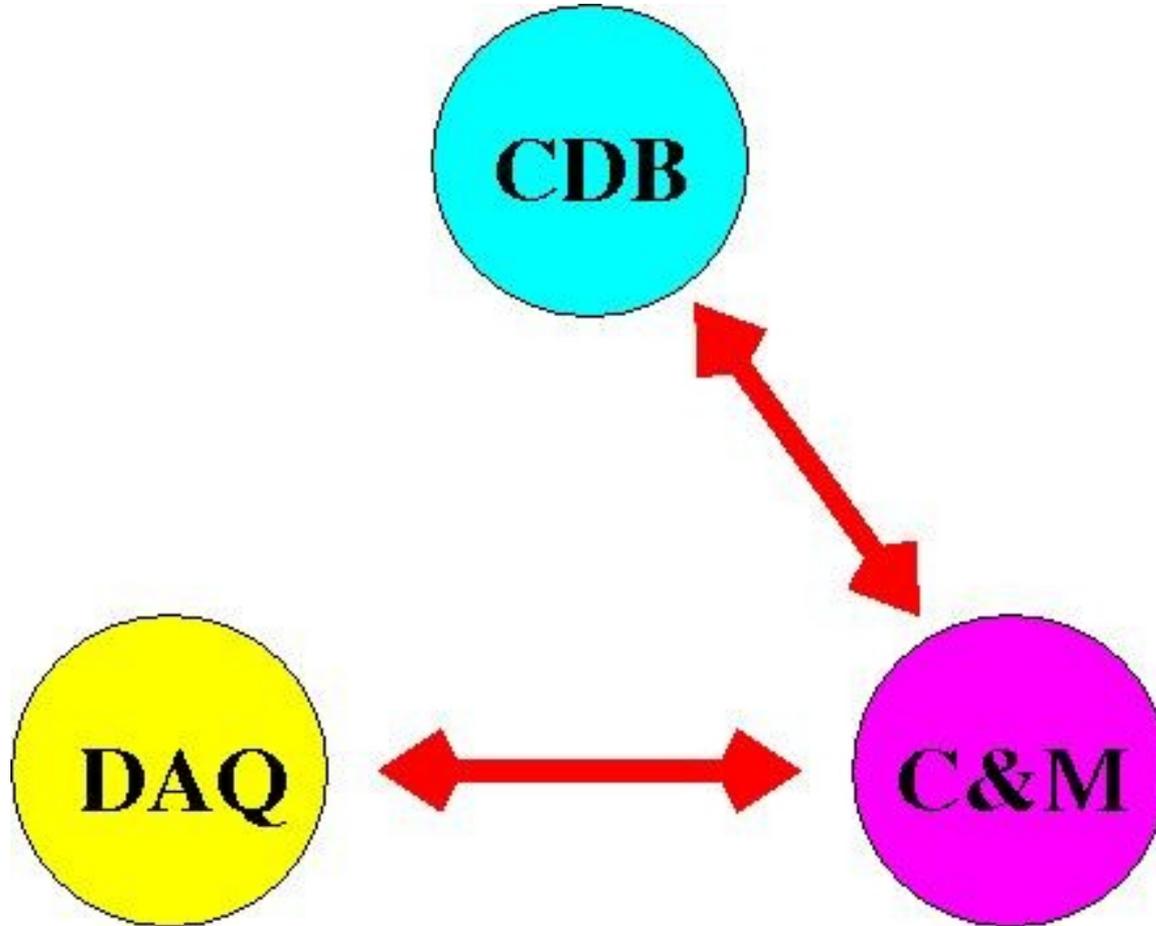
MICE is a precision experiment since we require 0.1% measurement. This requires careful documentation of run conditions. To date, we used “the spreadsheet”.

only as good as the shifter can type

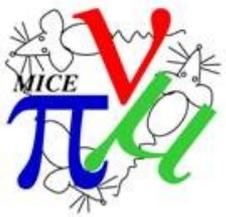
- C&M and DATE has complete knowledge of all running parameters**
- CDB has ability to record this on a run-by-run basis**
- RC gathers parameters and stores in CDB**
- RC sets control parameters from CDB**



Run Control Goals



Successfully implemented



Run Control

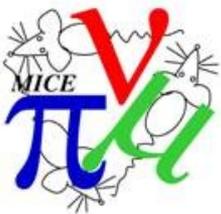
- **Query operator for run information**
- **Query CDB for run parameters**
- **Set and verify beamline**
- **Set and verify PID**

- **Query operator for cooling channel information**
- **Query CDB for cooling channel parameters**
- **Set and verify cooling channel**



Run Control

- **When DAQ started, collect statistics**
- **At end of run compute sums, averages, and rms for scalers**
- **Write end-of-run comment**
- **Write target, DAQ, and scaler statistics and comment to CDB**
- **Offer user opportunity to tag run parameters**
- **Initiate data copy to grid**



Run Monitoring

MICE Run Control

DATE status Taking Data

Begin Run

Run Type

Trigger Type

Beam Optics

Comment

what else?

EXIT

event 000685 2011/12/15 09:50:50

Run 3511 Event 104394

Max Target Depth 15.616

Beam Current 2.885

Beam Loss Total 2.659

Beam Loss S7 -0.892

Beam Loss S8 -0.946

Beam Position 0.0006

EXIT

MICE Run Status

Run number 3511 Target Set BCD 38.30 mm

Run type Special Data

Trigger Type TOF1 Target Set Delay 13.50 ms

Spill Gate Width 2.99 ms

DATE status Taking Data

EXIT

	Spill: 506	Integrated
# Particle Triggers	14	1.90e+04
# Requested Triggers	15	1.99e+04
# GV1 Triggers	288	3.24e+05
# ToF0 Triggers	174	1.04e+05
# ToF1 Triggers	37	2.00e+04
	LMC-12	825
	LMC-34	854
	LMC-1234	189

TargetMon.stp Graph

09:50:53 Dec 15, 2011

- MICE-BL-TGT-01:evtBMC (0, 10) VAL=2.88534 Average ISIS beam current
- MICE-BL-TGT-01:maxTgtDepth (0, 40) VAL=15.6163 Computed Maximum depth
- MICE-BL-TGT-01:sumBMLT (0, 15) VAL=2.65923 Summed ISIS total beam loss
- MICE-BL-TGT-01:sumBML8 (-20, 0) VAL=-0.945612 Summed ISIS 8 beam loss
- MICE-BL-TGT-01:sumBML7 (-20, 0) VAL=-0.891568 Summed ISIS 7 beam loss
- MICE-BL-TGT-01:pIBMPY (-11, 11) VAL=0 ISIS beam event y-position

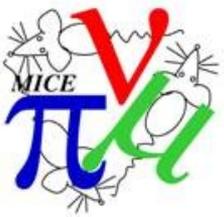
Graph

09:50:53 Dec 15, 2011

- MICE-DA-DATE-01:TrgRatio (0, 1) VAL=0.956522 Acc/Req Trigger Ratio
- MICE-DA-DATE-01:SCL00 (0, 200) VAL=36 # Particle Triggers
- MICE-DA-DATE-01:SCL01 (0, 200) VAL=37 # Requested Triggers

Taskbar: Target, BeamLine, DecaySol, PID, Tracker, epics@miceiocpl..., edm 1-12-17, Remote Client Launch, Graph, TargetMon.stp Gra, Microsoft Word - 2008

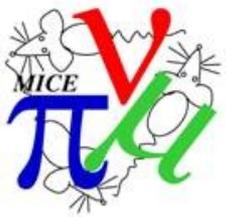
System tray: 09:50 2011-12-15



State Machines

Defining State Machines for MICE allows:

- **selecting *only* parameters of interest**
- **limited control of system**
- **selecting whether these are monitored or required to maintain strict tolerance on value**
- **setting alarms based on these limits**
- **invoking the autoSMS for selected variables which go out of tolerance**
- **determining archiving parameters:**
 - **scanning and scanning frequency**
 - **monitoring and dead band**



State Machines

A state machine is:

- **“... an abstract machine that can be put in one of a finite number of states.”**
- **“... a mathematical model of computation used to design both computer programs and sequential logic circuits.”**
- **“... is defined by a list of its states and the triggering condition for each transition.”**



State Machines

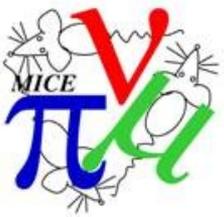
- **Major subsystems have many PVs of varying importance depending on the state of the subsystem**
 - **E.g. temperatures, LHe levels, currents are of no value when pumping insulating vacuum space of SC magnet**
- **Subsystem state machines are being developed to organize PVs according to their states**
- **State machines ensure alarms and archiving are appropriately handled**



State Machines

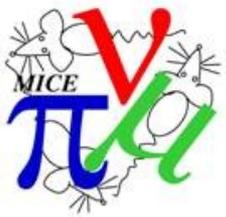
Example: SS states

- **offline**
- **pumping**
- **pumped & warm**
- **cooling & LHe filling**
- **cold & stable**
- **ramping**
- **running**
- **error**



State Machines

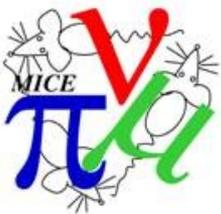
- **Lists of PVs and their fields in CDB:**
 - **alarm limits (upper major/minor, lower major/minor)**
 - **archiver scanning/monitoring frequency**
 - **archiver dead band**
 - **AutoSMS switch**
 - **state transitions**
- **Little control in state machines**
 - **e.g. SS – turn on/off compressors, ps's**



State Machines

State Machine Sequence:

- **transition**
- **read CDB for new state**
- **set PV fields**
- **enable/disable alarm handler group**
- **re-initialize archiver**
- **check for errors**
- **check for next transition**



State Machines

Alarm Handler: SS2 (on micccss2)

File A Help

E S

E

V **PSUChecking** <-----> (0,2,)

Center <----->

Match1 <----->

Match2 <----->

V Trim1 <-----> (0,1,0,0,4)

V Trim2 <-----> (0,1,0,0,5)

CC1 Compressor P <-D--->

CC2 Compressor P <-D--->

CC3 Compressor P <-D--->

CC4 Compressor P <-D--->

CC5 Compressor P <-D--->

MICE-SS2-COMP-01:LOWFLOW <-D--->

MICE-SS2-COMP-04:LOWFLOW <-D--->

Execution Status: Local Active

Mask <CDATL>: <Cancel,Disable,noAck,noackT,noLog> H=noAck 1hr timer

Group Alarm Counts: (ERROR,INVALID,MAJOR,MINOR,NOALARM)

Channel Alarm Data: <Status,Severity>,<Unack Severity>

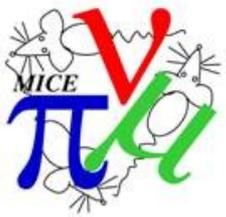
Filename: /home/epics/Config/ALHConfig/SS2.alhConfig

SilenceOneHour

SilenceCurrent

Silence Forever: Off

ALH Beep Severity: MINOR



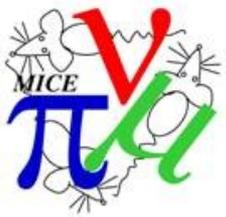
Risks

- **Personnel**
- **Expertise**
- **Time**
- **Need to identify SS/FC differences in stand-alone and integrated systems**



MPB-4 Recommendations

- **SS C&M review completed and changes made and tested, caveats:**
 - **Lakeshore PSU issues**
 - **New scheme for LHe level**
 - **HTS leads now monitored**
 - **Plan under development for operating integrated magnets**



Conclusions

- **MUCH** progress in C&M
- **Most recently for SS2**

- 
- A photograph of a glass of wine on a beach at sunset. The sun is low on the horizon, casting a golden glow over the water and sky. The glass is in the foreground, and the beach is in the middle ground.
- **Added help with Ian Taylor**
 - **RunControl/MICEStates regular operation**