



Progress in the Construction of the MICE Cooling Channel

International Workshop on Neutrino Factories,
Super Beams and Beta Beams
July 23-28, 2012
Williamsburg, VA USA

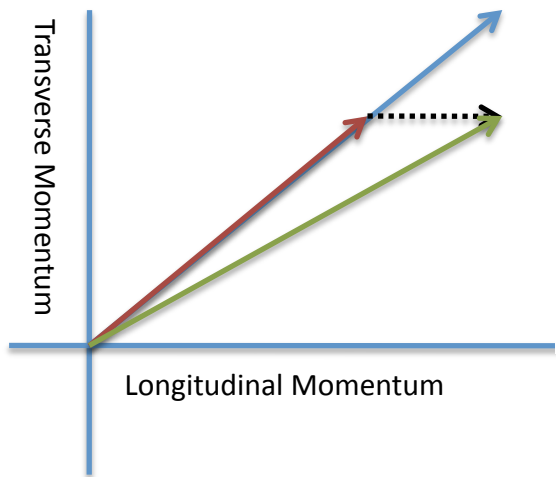
Tianhuan Luo, University of Mississippi
On Behalf of the MICE Collaboration

OUTLINE

- MICE Layout and Goals.
- MICE steps and current status.
- Progress on the construction.
 - Step IV
 - Step VI
- Summary and Conclusion.

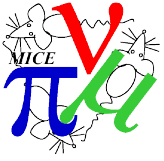
4D Emittance Ionization Cooling

- Protons hit the target -> Pion -> Muon. Need to cool the emittance of muon beam to fit into the accelerator acceptance.
- Short life time of muon: 2.2 μs in lab frame -> fast cooling -> ionization cooling.
- MICE: first experiment ever to demonstrate muon ionization cooling.



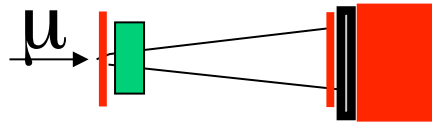
Transverse cooling effects:

$$\frac{d\varepsilon_N}{ds} = -\frac{1}{\beta^2 E} \frac{dE}{ds} \varepsilon_N + \frac{\beta\gamma}{2} \frac{\beta_{\perp}}{ds} \frac{d\langle\theta_{\text{rms}}^2\rangle}{ds}$$



MICE SCHEDULE
update: June 2012

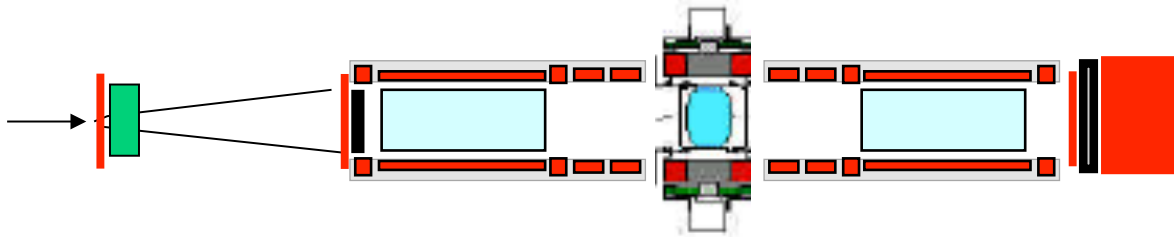
Run date:



STEP I

COMPLETED

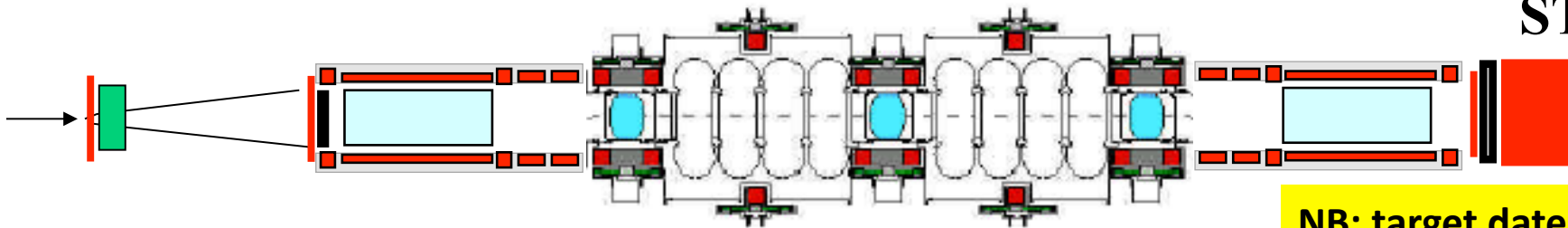
EMR run Feb 2013



STEP IV

**Q2 2013
till
Q2 2014**

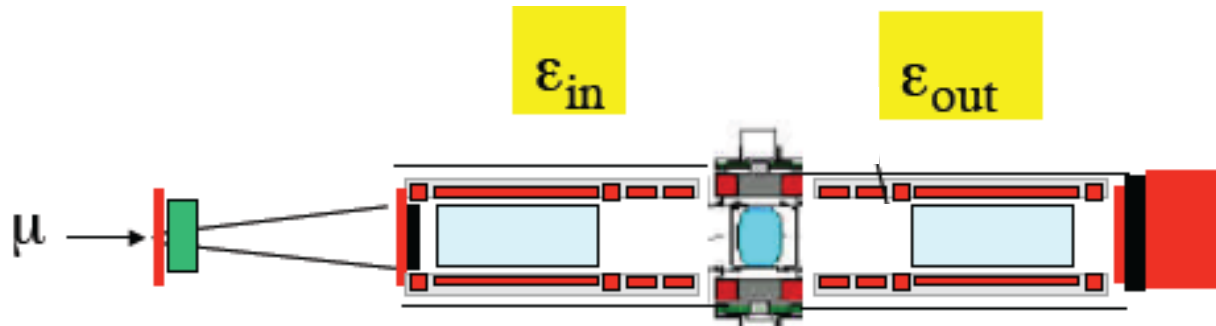
Under construction:



STEP VI

NB: target date 2016

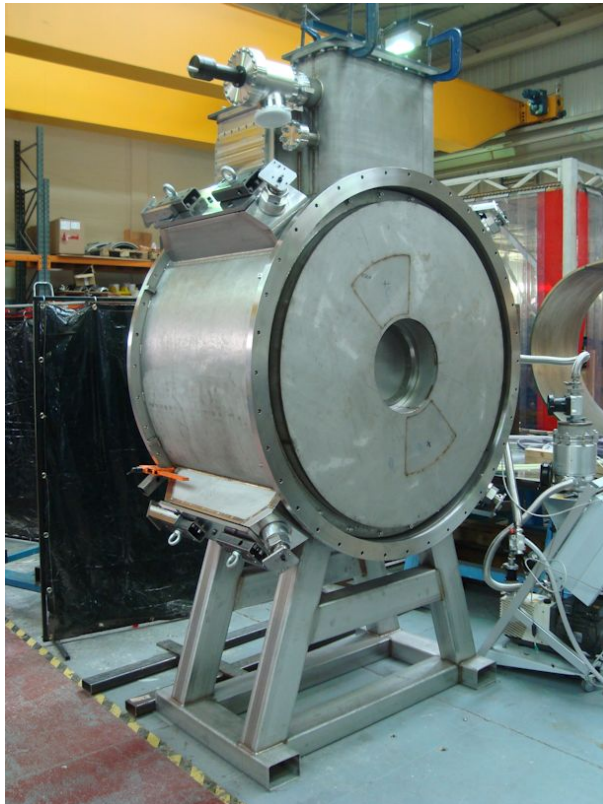
STEP IV: OVERVIEW



- Goal: measure the ratio of emittances before and after the absorber.
- Major remaining construction work for Step IV: spectrometer solenoid, focus coil and LH2 system.

Subsystem	Date
Spectrometer solenoid #1 + #2	Sept'12
Fibre tracker #1 + #2	Ready
Focus coil #1	Jul'12
LH ₂ system A	Aug '12
Solid absorber(s)	June '12
Liquid absorber	Ready
Diffuser	Ready
Virostek plate & TOF cage assy	Ready
Substation upgrade	Ready
EMR installation	Nov'12
Radiation shutter	June '12
AFC Moving platform #1	Ready
SS platforms Installation	Ready

STEP IV: Absorber-Focus Coil Module



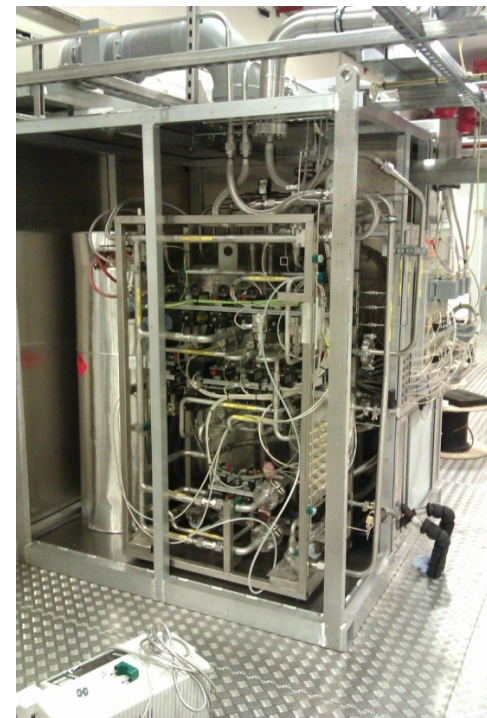
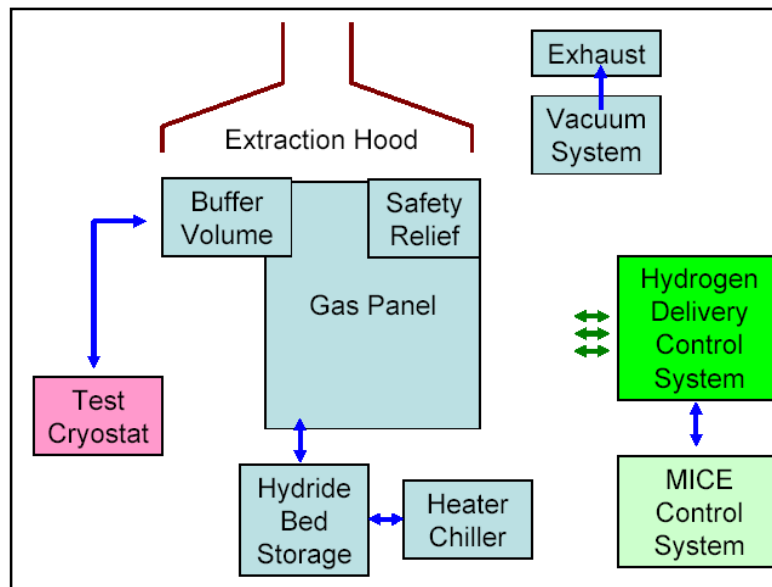
- Radiation shields fitted
- Cold mass installed
- Cold mass sensor wiring completed
- Supports tensioned
- Alignment of cold mass completed

Module/Activity	Due Date
AFC1 at RAL	July
Absorber integration and test	+3mths elapsed
AFC2 at RAL	September
Absorber integration and test	<3mths

Michael Courthold (STFC – RAL), MICE CM33

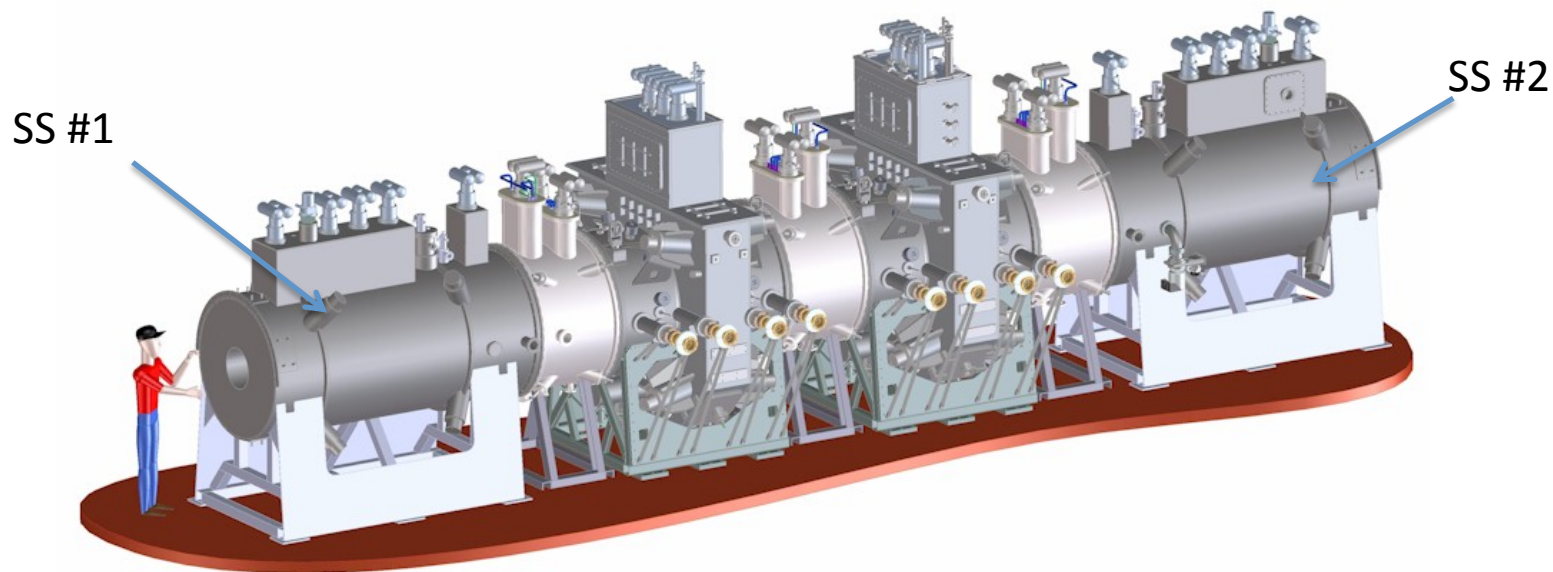
STEP IV: LH2 System

- All hardware completed.
- Commissioning: vacuum check, helium check and heater-chiller check completed.
- System test with a Test Cryostat is in progress.



STEP IV: SPECTROMETER SOLENOIDS

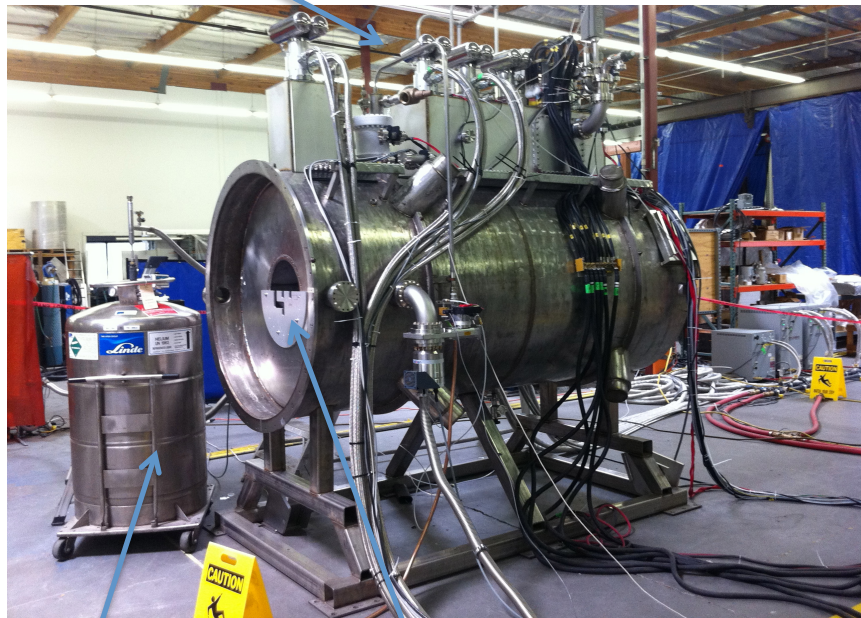
- With the lessons learnt from previous tests, the SS has been revised and rebuilt.
- SS #1: vessel closed, now under testing and training at the vendor Wang NMR.
- SS #2: under construction, training will start soon.



Training of 1st SS: setup

Enhanced cooling power.

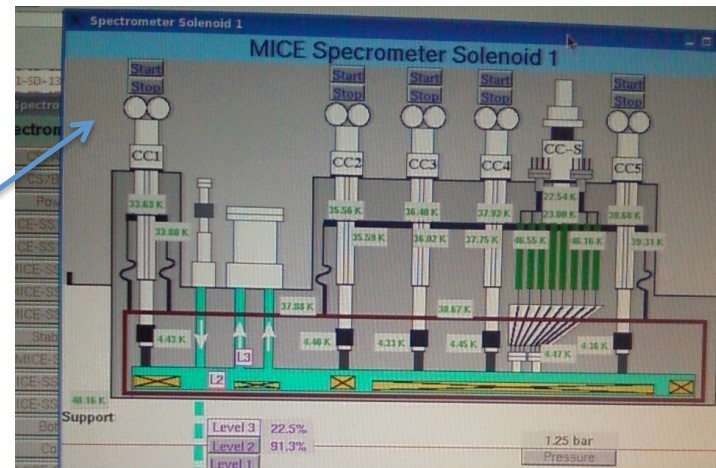
Quench protection system, power supply and detection system.



LHe.

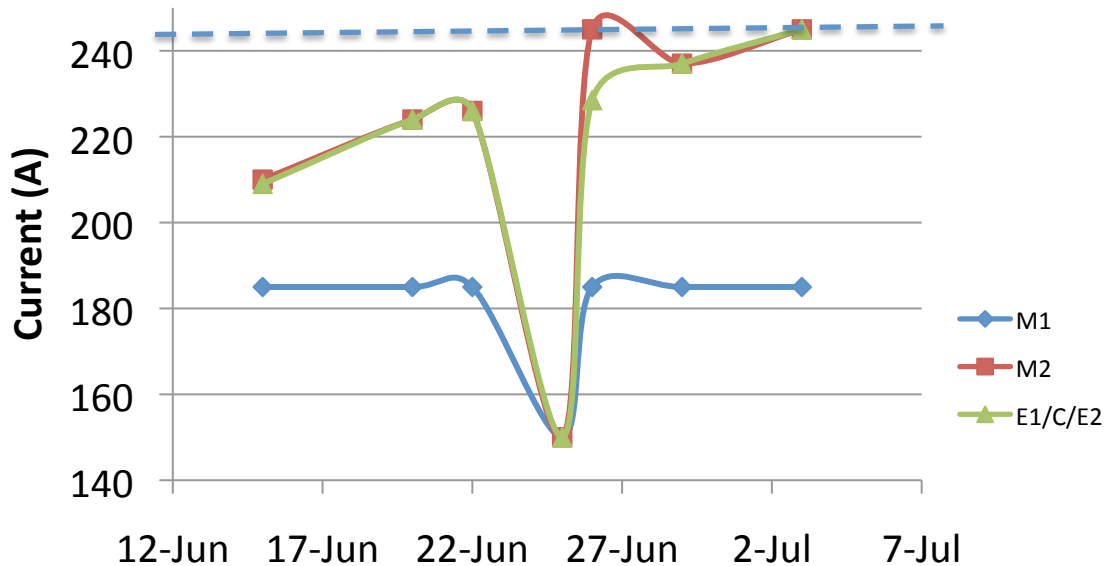
Field mapping fixture

Temperature Monitor System.

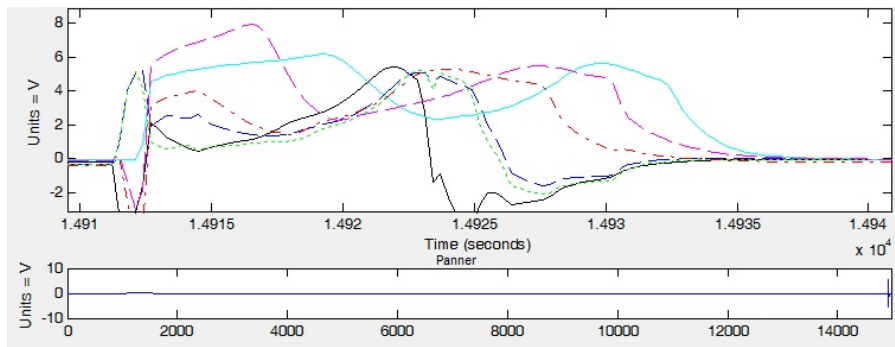


Training of 1st SS: Training Progress

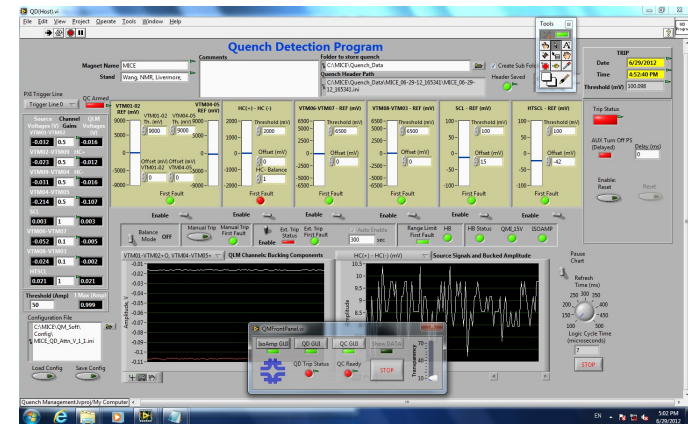
SS Coil Training Progress



The scene of quench



Voltage records of Quench Protection System at the moment of quench.



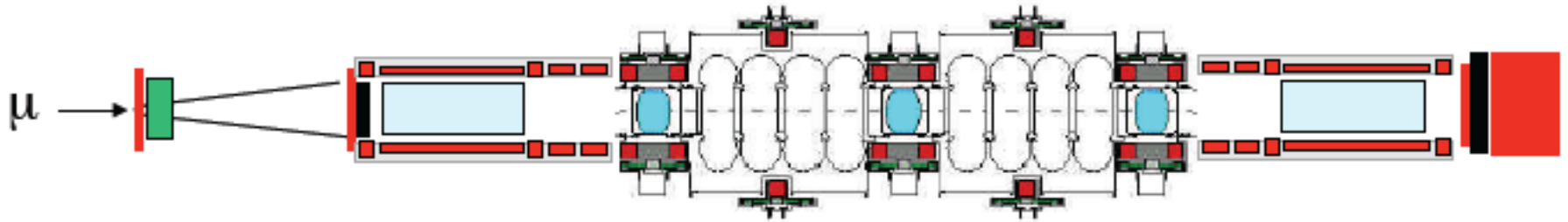
Quench Protection System

Construction of 2nd SS

- LTS lead and cooled resistor assemblies installed.
- Cold mass cover re-welded/leak checked.
- Instrumentation and MLI wrap done.
- Radiation shield has been installed and wrapped with MLI.
- Cold mass/shield assembly is complete and ready for installation in the vacuum vessel.



STEP VI: OVERVIEW

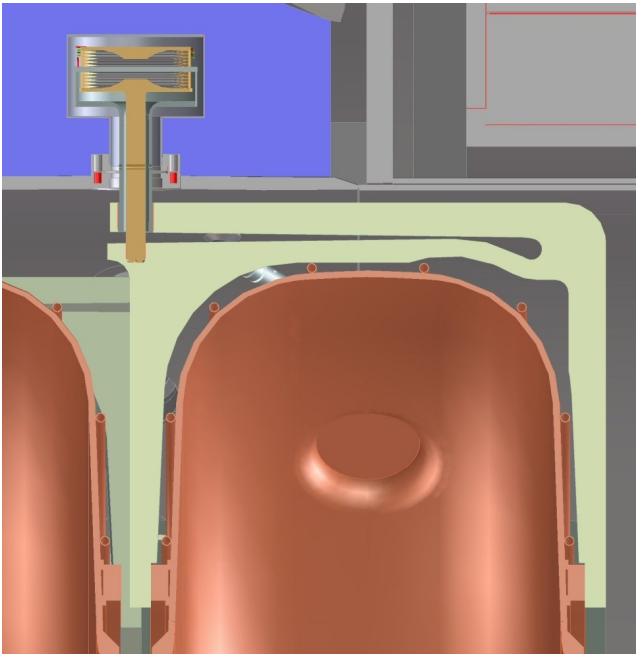
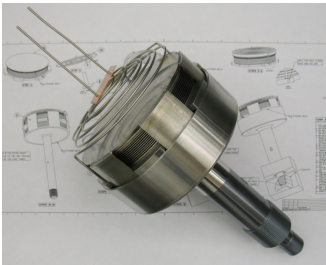


- Goal: Full demonstration of muon ionization cooling, 10% emittance reduction.
- Plan: beginning data-taking in 2016.
- Major parts needed from Step IV to Step VI: RF cavities and coupling coils.

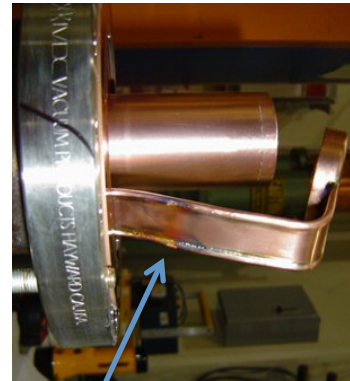
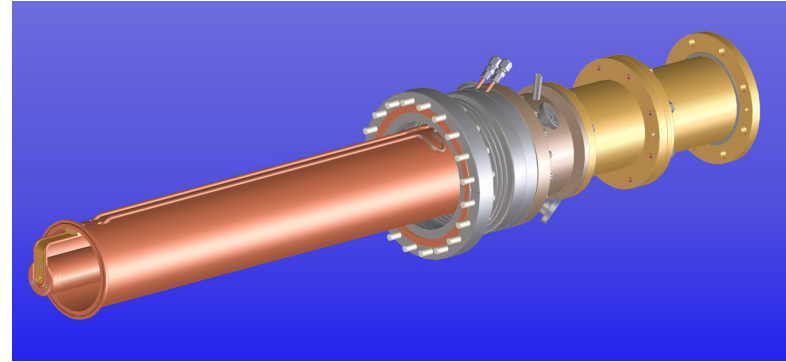
STEP VI: 201 MHz RF CAVITY

- 10/10 Cavity bodies, 11/18 beryllium windows and 10/18 RF windows have been manufactured. Low power RF measurement, stud and water tube welding, etc have been carried out at LBNL.
- Cavity tuners and couplers are in progress.
- Single cavity vessel has been built.
- One cavity has been electropolished and will be tested with high power RF in magnetic field at Fermilab.

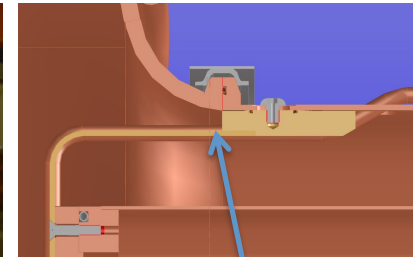
Tuner



Coupler

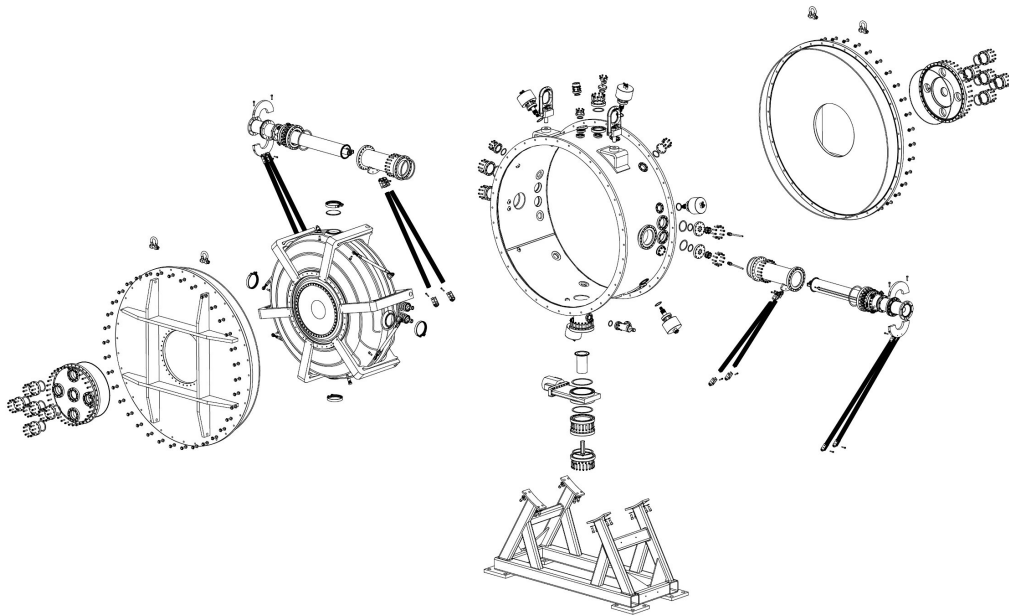


Damage observed on the old coupler.



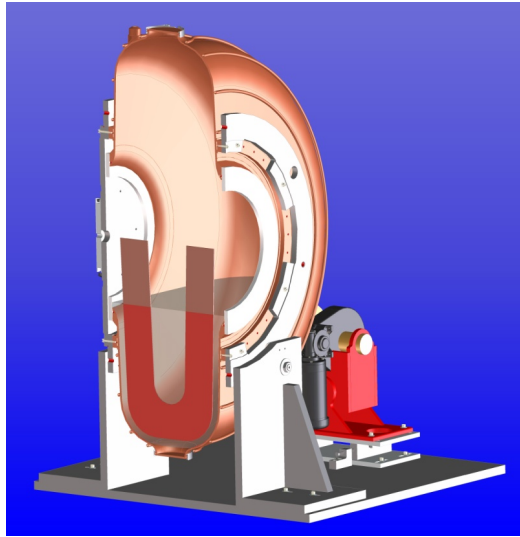
New design fills the narrow gap to suppress multipacting.

Single Cavity Vacuum Vessel



- Single cavity vacuum vessel, fabricated at Keller Technology in Buffalo NY, is complete and is at Fermilab now.

Surface Smoothing: Electropolishing

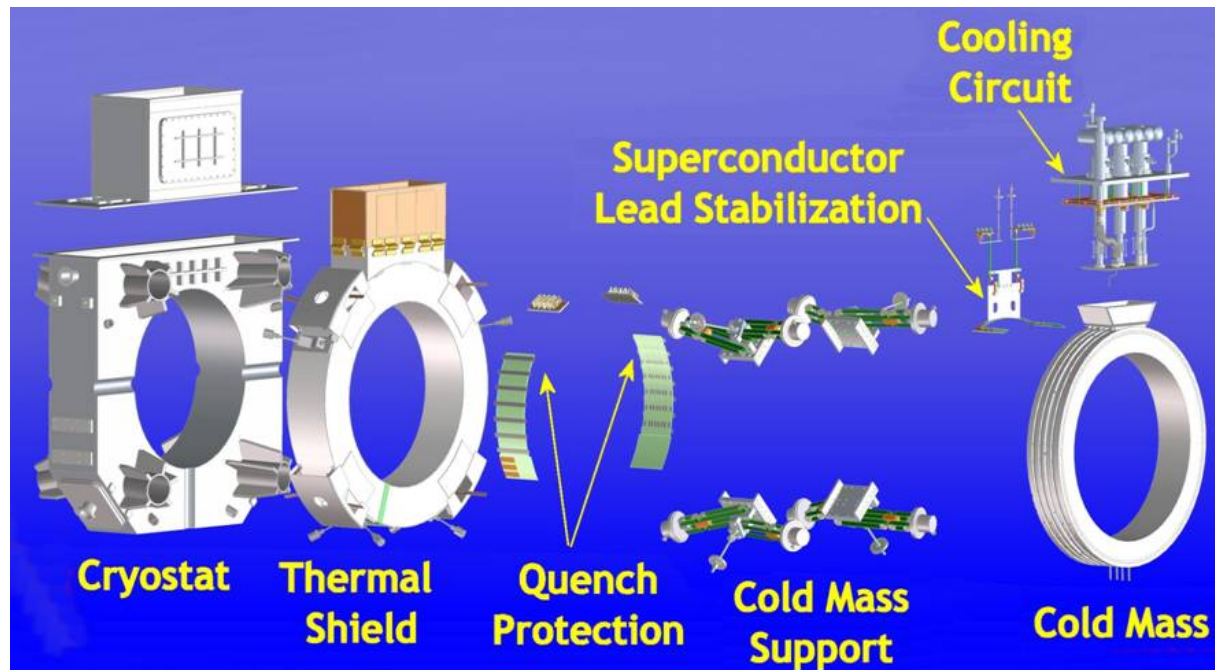


- Purpose of electropolishing: reduce field emission electrons, thus to increase the RF breakdown voltage.
- Challenge: Large surface area and curved irregular shape.
- Customized rotating fixture and hydrogen ventilation system built for EP.
- Have obtained smoothy and shiny surface after EP.



STEP VI: Coupling Coil

- Detailed design of CC has been finalized.
- LBNL and Fermilab preparing the full current test of 1st CC cold mass.
- Fabrication plans of cryostats and 2 more CC prepared.



Cold Mass Test Preparation at LBNL

- Cooling tube welding.
- Interface with FNAL test facility.
- Quench protection, leads, instrumentation.
- Vacuum potting.
- High pressure test.

Quench Protection Stabilizer Plates



Cold Mass



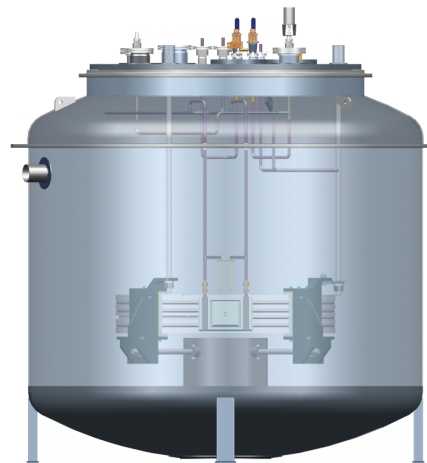
Potting fixture

Cold Mass Test Preparation at Fermilab

- Installing and preparing coil test cryostat



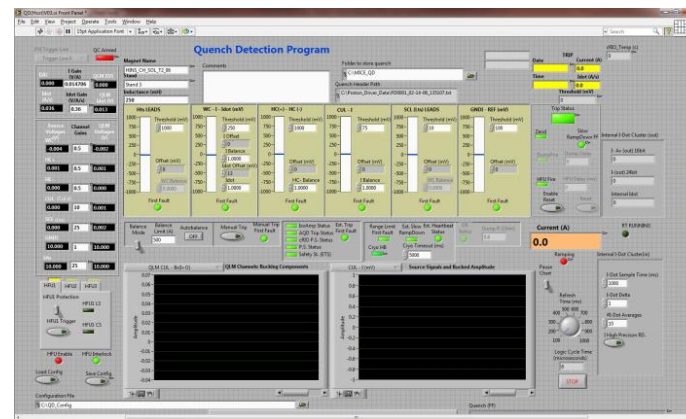
Cryostat arrives at Fermilab



Instrumentation racks



Top plate modification



Quench protection system

Summary

- The construction work of MICE is going well. Much progress made in last year.
 - Step IV: AFC, LH2 system, SS, etc.
 - Step VI: Cavity, CC, etc.
- Aim to complete the construction for Step IV in Q2 2013, and run experiment from Q2 2013 to Q2 2014.
- Target date of Step VI: 2016, the full demonstration of muon ionization cooling.