

# U.S. MICE Status

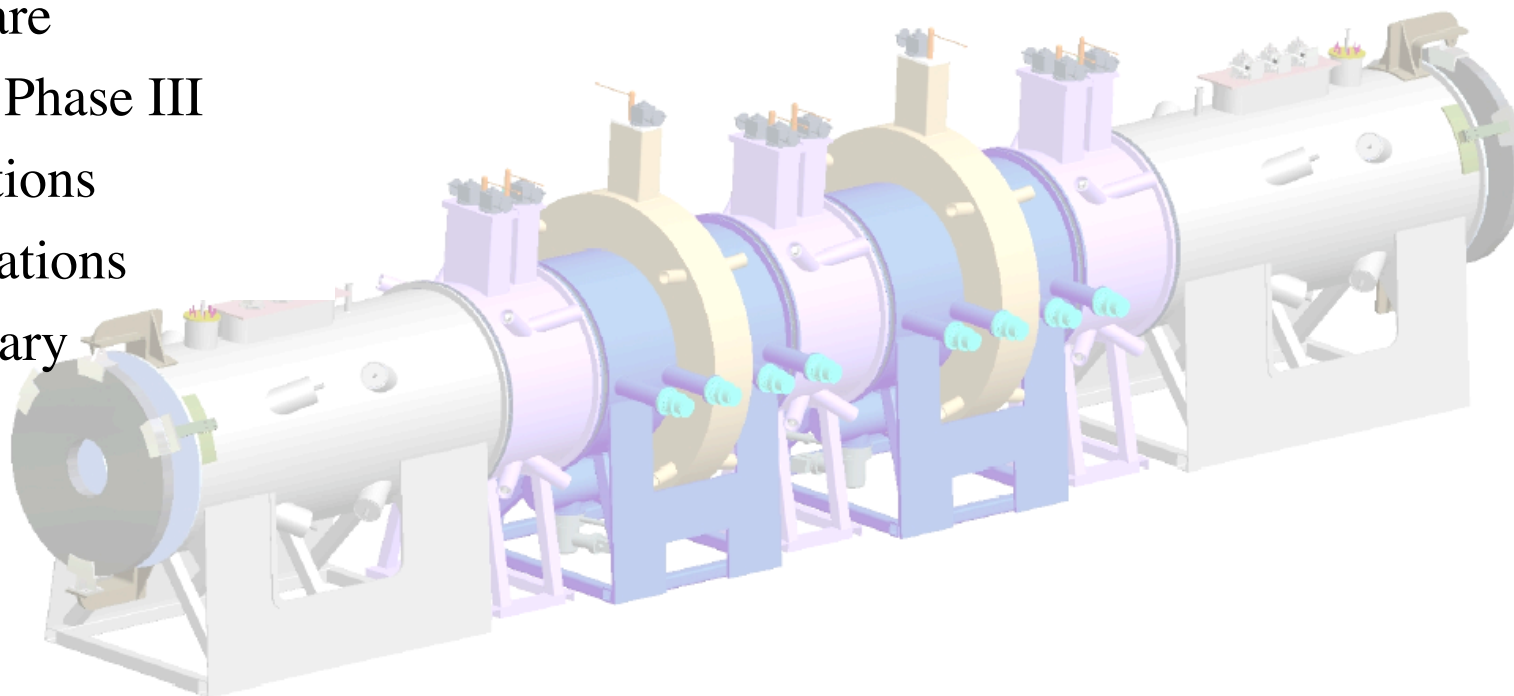
Daniel M. Kaplan  
US Spokesperson, MICE Collaboration



MuTAC Review  
Fermilab  
7 April 2009

# Outline

1. US MICE Personnel & Projects
2. Beamline
3. Particle ID Detectors
4. Muon Spectrometers
5. RFCC Module
6. Software
7. MICE Phase III
8. Operations
9. Publications
10. Summary





# US MICE Personnel

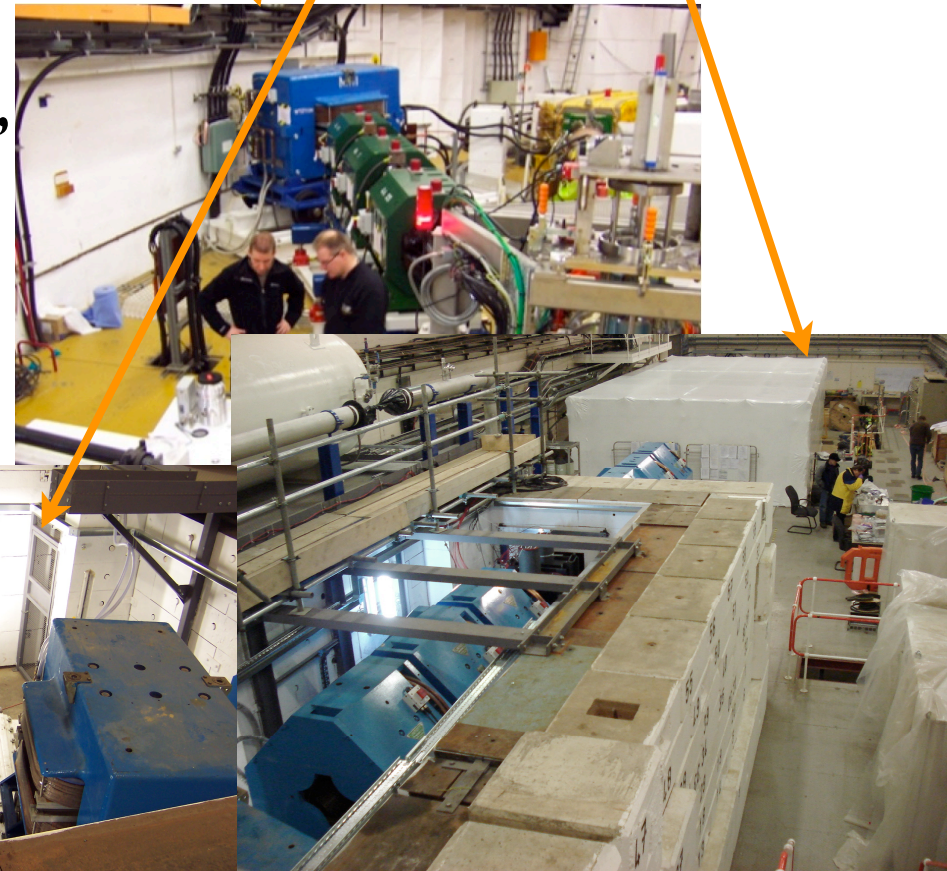
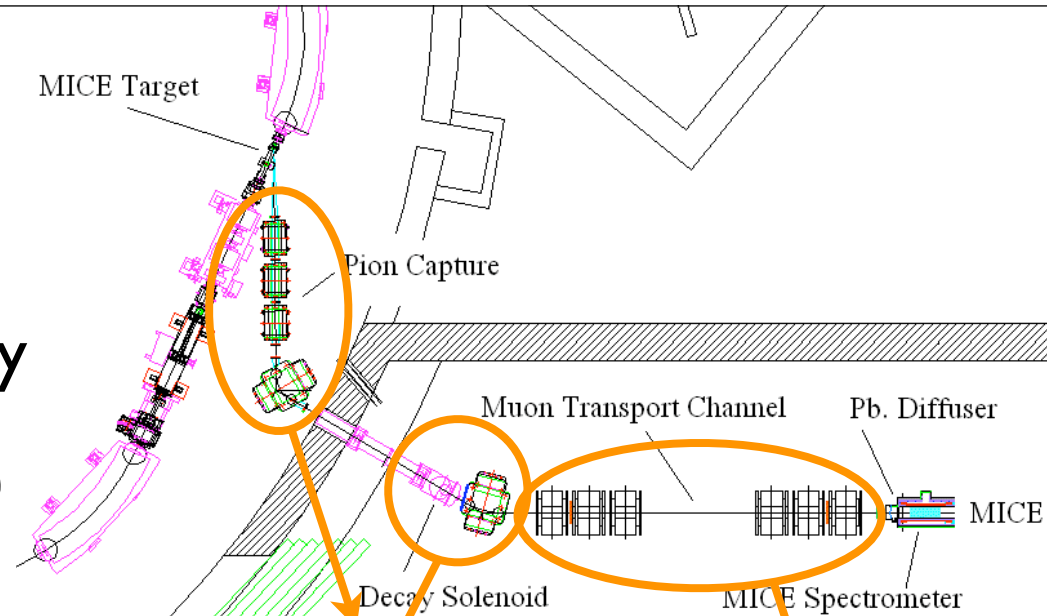
- IIT (NSF)
  - D. Kaplan, PI
  - Y. Torun, Fac. Assoc.\*
  - P. Hanlet, Lecturer
  - D. Huang, Postdoc
  - B. Freemire, Grad student†
  - undergrads
- Ulowa
  - Y. Onel \* joint with FNAL
- UMiss † full-time on MICE
  - D. Summers, PI
  - L. Cremaldi, Fac. Assoc.
  - T. Hart, Postdoc
  - D. Sanders, Assoc. Sci.
- UNH
  - U. Bravar, PI
- UCLA
  - D. Cline
- UCRiverside
  - G. Hanson, PI
  - L. Coney, Asst. Proj. Sci.†
  - G. Kafka, Grad student
  - P. Snopok, Postdoc
- ANL (DOE)
  - J. Norem
- BNL
  - R. Palmer
- FNAL
  - A. Bross
  - S. Geer
  - M. Popovic
  - T. Fitzpatrick, Eng.
  - P. Rubinov, Eng.
  - R. Rucinski, Eng.
  - M. Utes, Eng.
- JLab
  - R. Rimmer
- LBNL
  - M. Zisman, Deputy Spokes.
  - D. Li
  - A. DeMello, Eng.
  - M. Green, Eng.
  - S. Virostek, Eng.
- Muons, Inc.
  - T. Roberts

# US MICE Projects

- Design Studies: BNL
- Background Studies: ANL
  - Analysis & Simulation Software: IIT
  - Beam Simulations: IIT, Muons Inc.
  - Beam Monitors: FNAL
    - Beam PID (Cherenkov): UMiss / (EMR) FNAL
    - Muon Spectrometers: FNAL, IIT, LBNL, UCR, UMiss
    - Absorber Windows: UMiss
      - RFCC Modules: LBNL, UMiss
      - On-Line Software: IIT, UCR
      - MICE Phase III

# Beamline

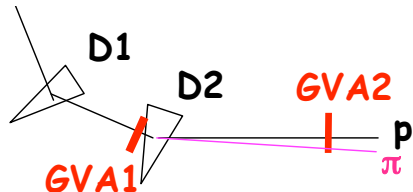
- Primarily a RAL responsibility
- T. Roberts developed (at IIT) G4beamline code for the purpose and continues to participate (now at Muons, Inc.), assisted by IIT postdoc D. Huang
- Beamline installed & working, except for Decay Solenoid (in repair)



U.S. MICE

# Recent Progress

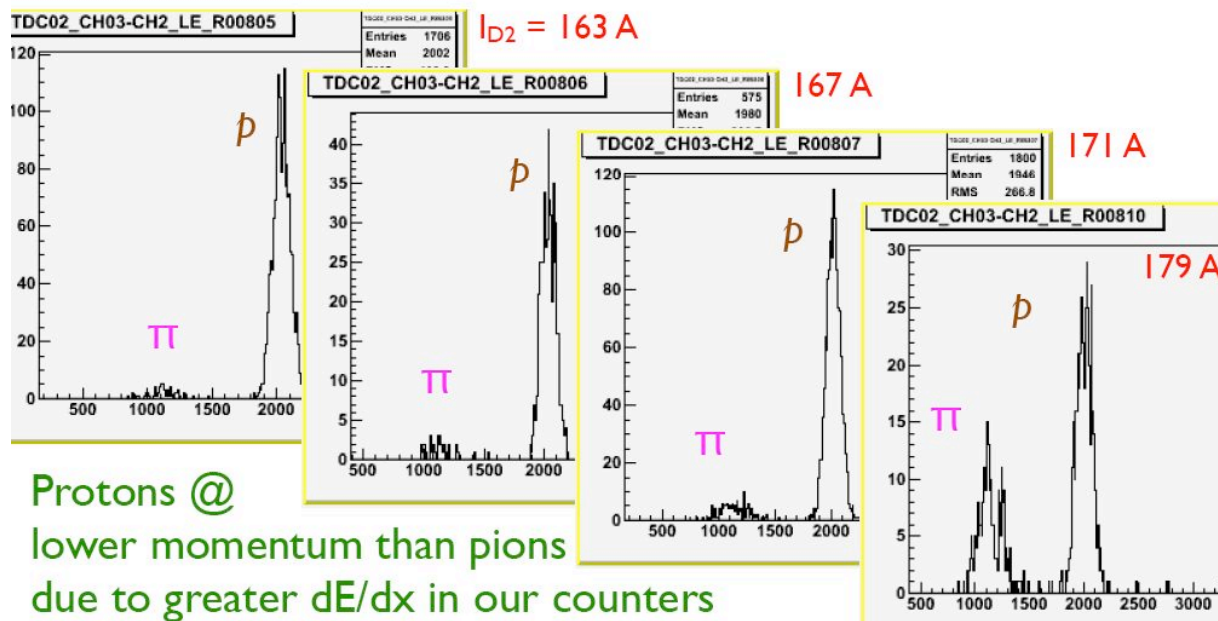
- Beamline characterized (w/o Decay Solenoid):



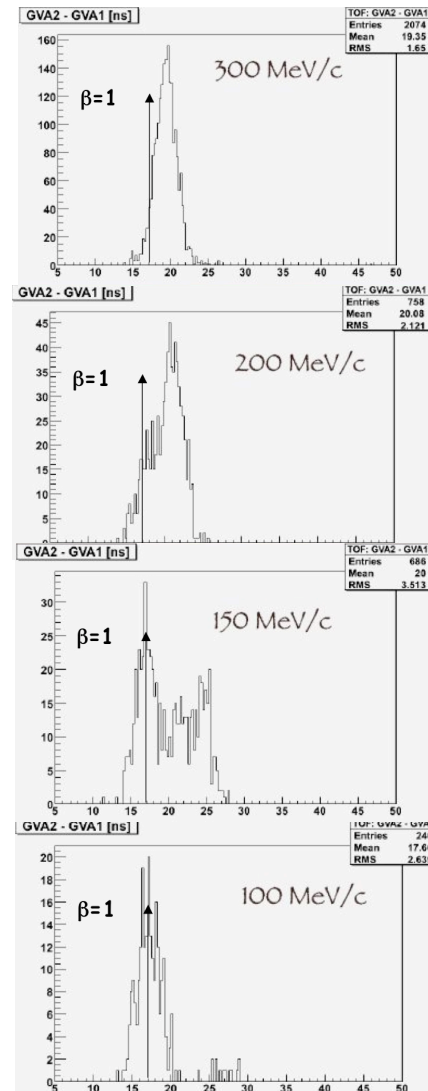
- Momentum scans  
 Oct. '08:

## Momentum Scans

- Example @ 460 MeV/c (on-line histograms):



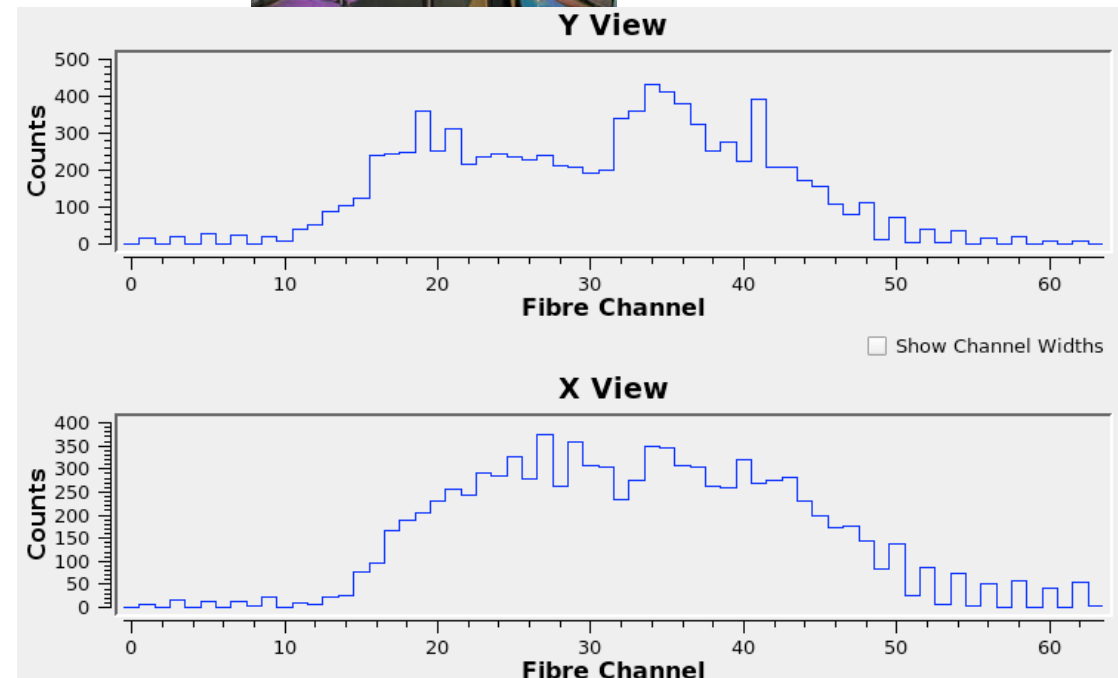
Protons @  
 lower momentum than pions  
 due to greater  $dE/dx$  in our counters





# FNAL Beam Monitors

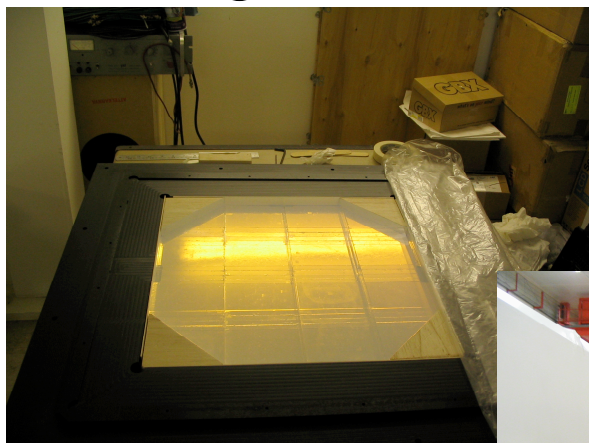
- Originally installed and tested in summer '08
- Worked well on bench, but found excessive noise at RAL
- Rebuilt with better EM shielding, noise eliminated
- Still need to optimize thresholds with beam



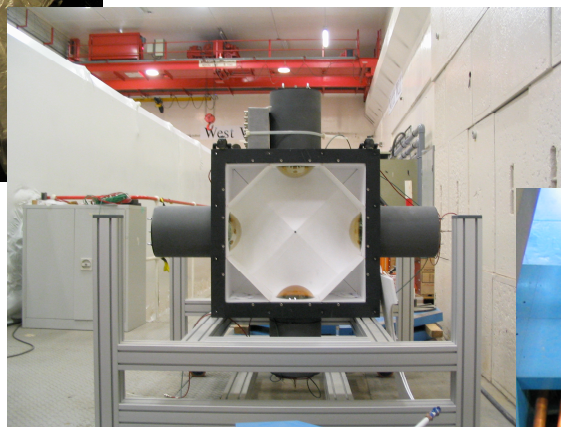
# CKOV

UMiss (with help from UCLouvain, IIT, & Iowa)

- Distinguish  $\mu$  from  $\pi$  via dual aerogel threshold counters:

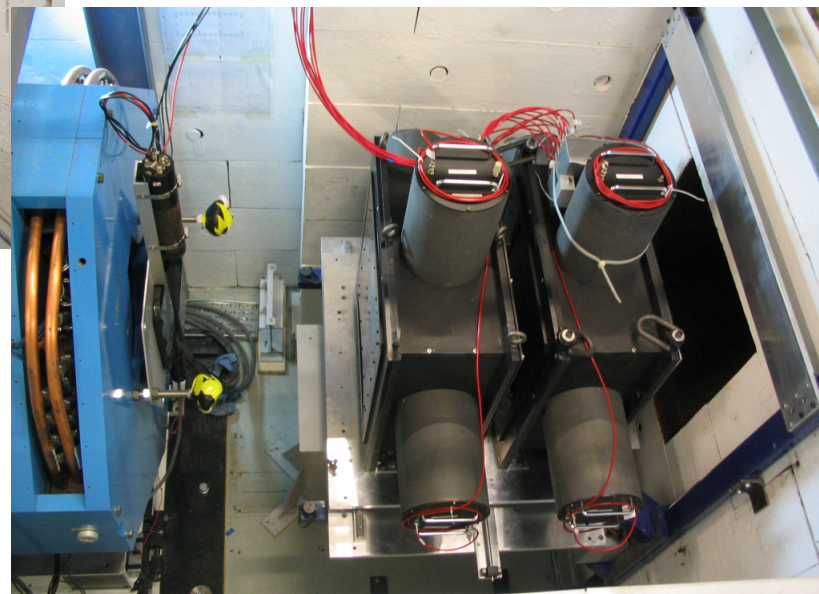


- $n = 1.07$  &  $1.12$
- New Matsushita high-index aerogel



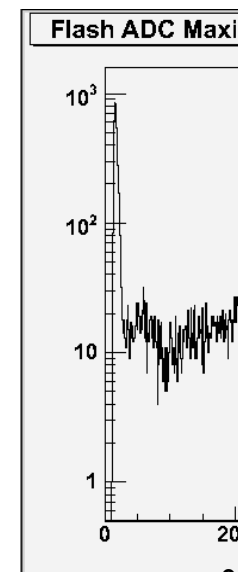
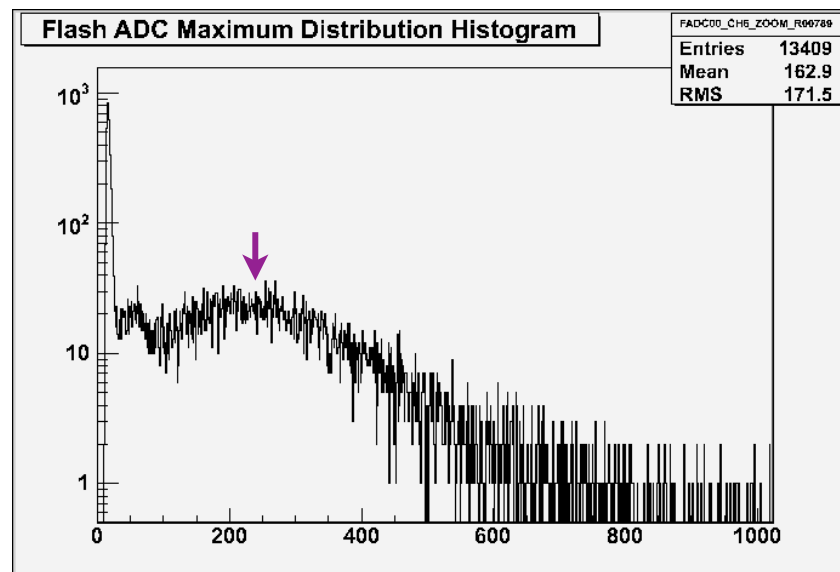
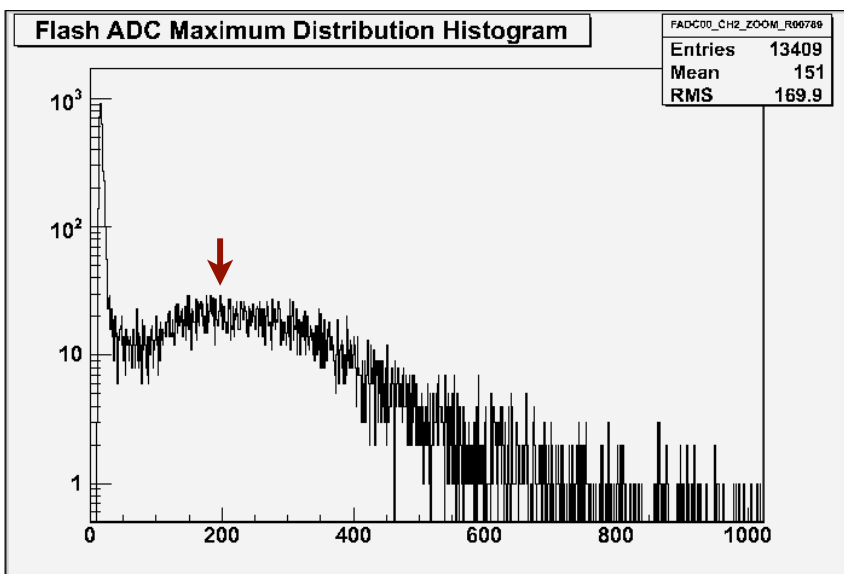
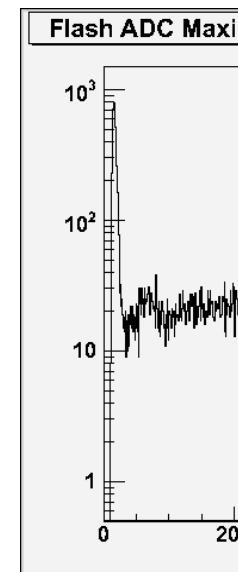
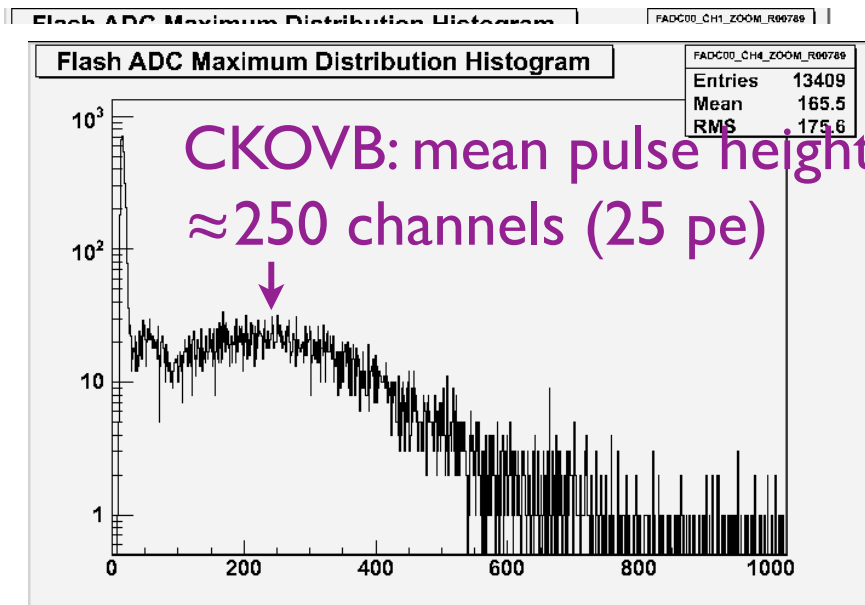
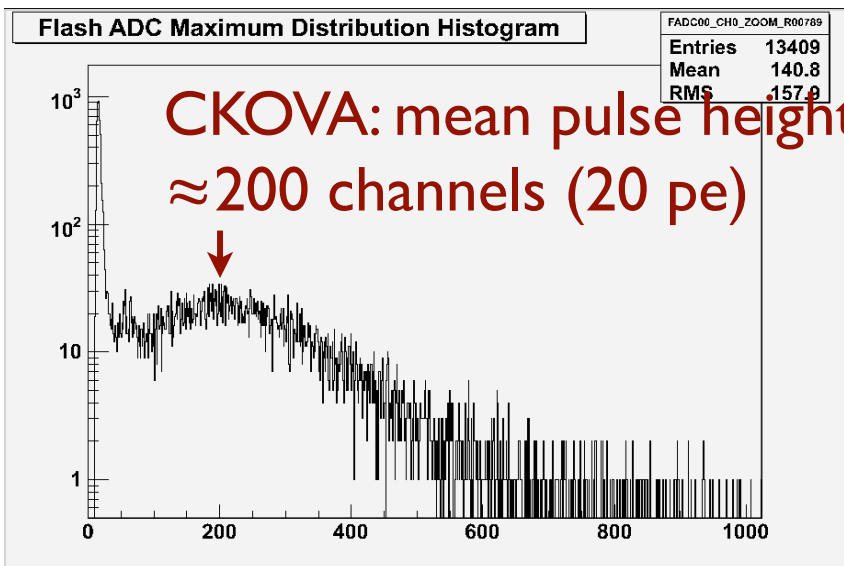
- Detectors in place in MICE:  
(since summer 2007)

- Current status: detectors  
working, performance verified...



# CKOV: Some Results

L. Cremaldi, UMiss

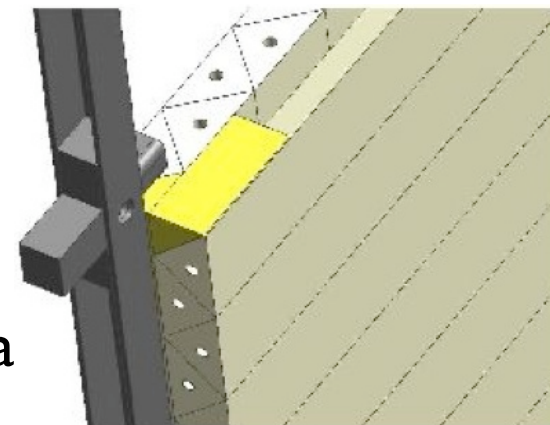


# EMR

FNAL / UGeneva / UTrieste

- Decay electrons eliminated via Electron-Muon Ranger downstream of KL calorimeter

- multilayer fine-grained scintillator stack à la MINERvA
- design based on simulation studies @ UGeneva

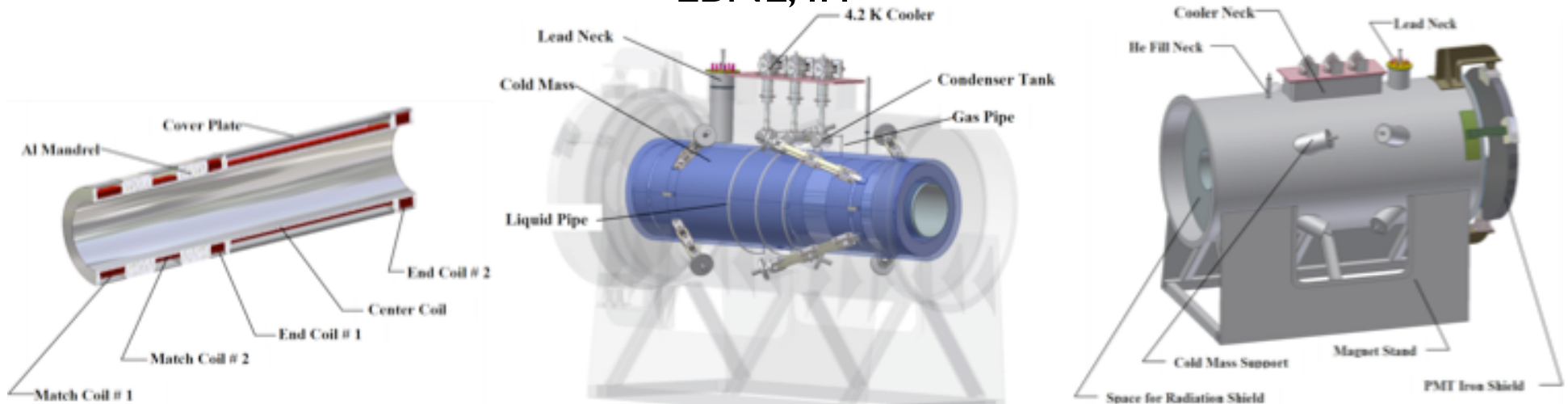


- FNAL extruding scintillator, Geneva to integrate
- 150 scintillator bars already shipped from Fermilab (20% of total)



# Spectrometer Solenoids

LBNL, IIT



- At last year's MuTAC Review, solenoid ass'y at Wang NMR (Livermore, CA) was well along
- Tests of Solenoid #1 revealed design & assembly flaws → design revisions
  - implemented first on Solenoid #2 (see next talk for details)
- Solenoid #2 now done, test starting, shipping in May
  - to be followed by modification of Solenoid #1



# Spectrometer Solenoid Field Mapping

FNAL, IIT, UMiss

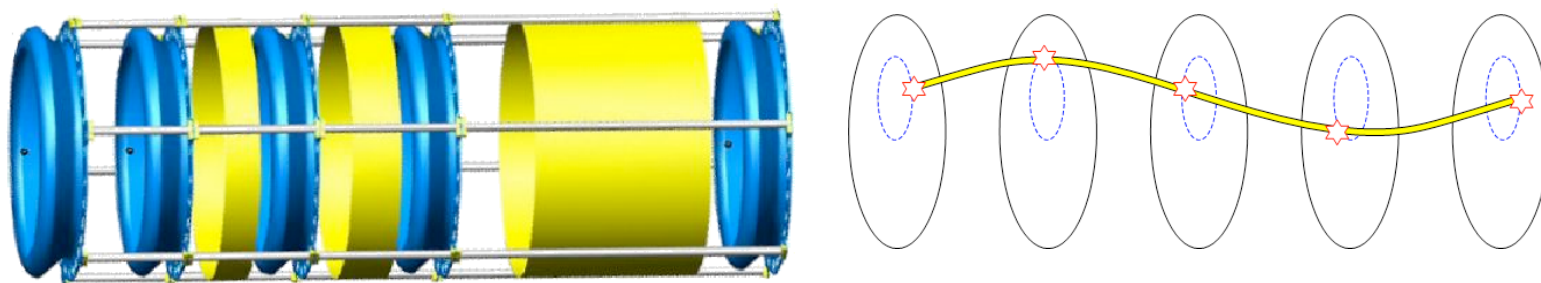
- Will be done by FNAL Alignment Group using Fermilab “ZipTrack”
  - well-developed system, translates cart carrying Hall probes through magnet under computer control
  - has been used for decades, e.g. for fixed-target spectrometer magnets
- Plan worked out by T. Hart
- Software developed by B. Freemire
- Ready to commence when magnet arrives



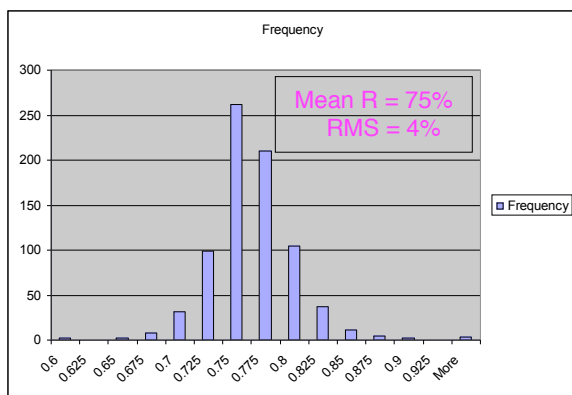
# SciFi Trackers

UK / US / Japan

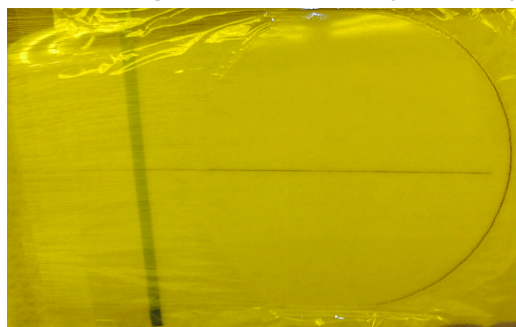
- Will sit inside solenoids, reconstruct helical muon tracks



- Fiber-end mirroring (FNAL)



- Ribbon production (FNAL)



- Station assembly & QC (UK, FNAL, Osaka)



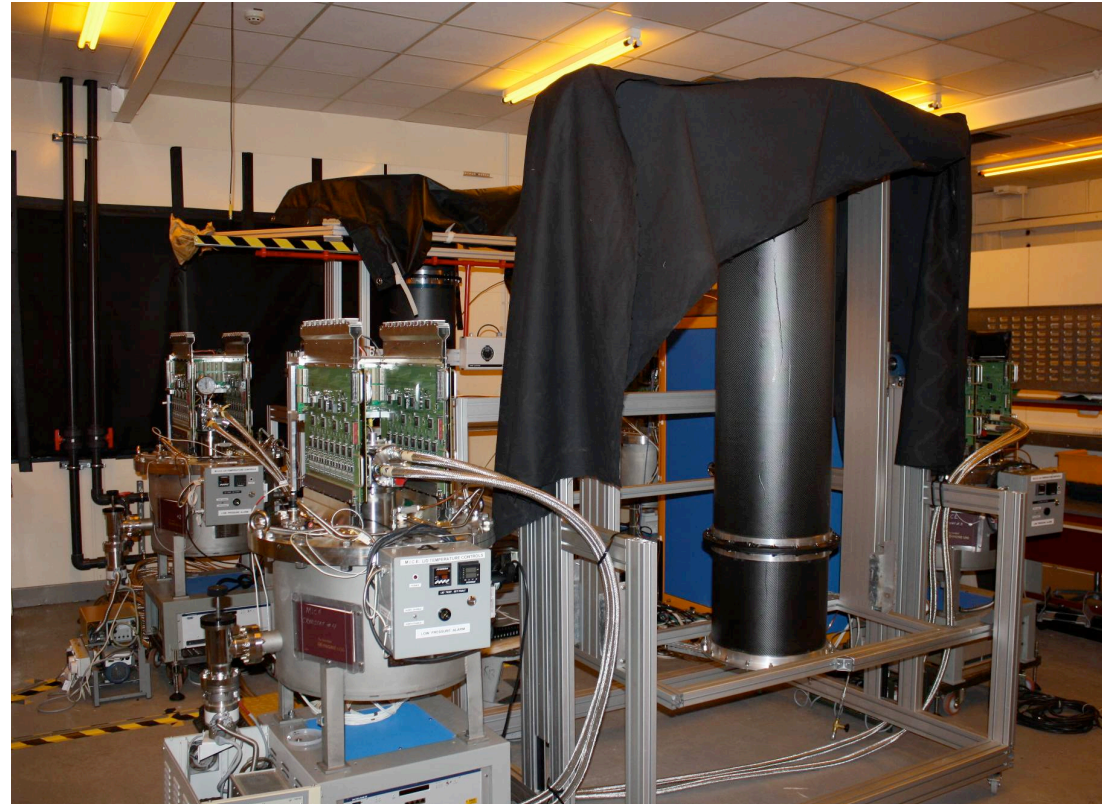


# SciFi Trackers

UK / US / Japan

- Both trackers complete

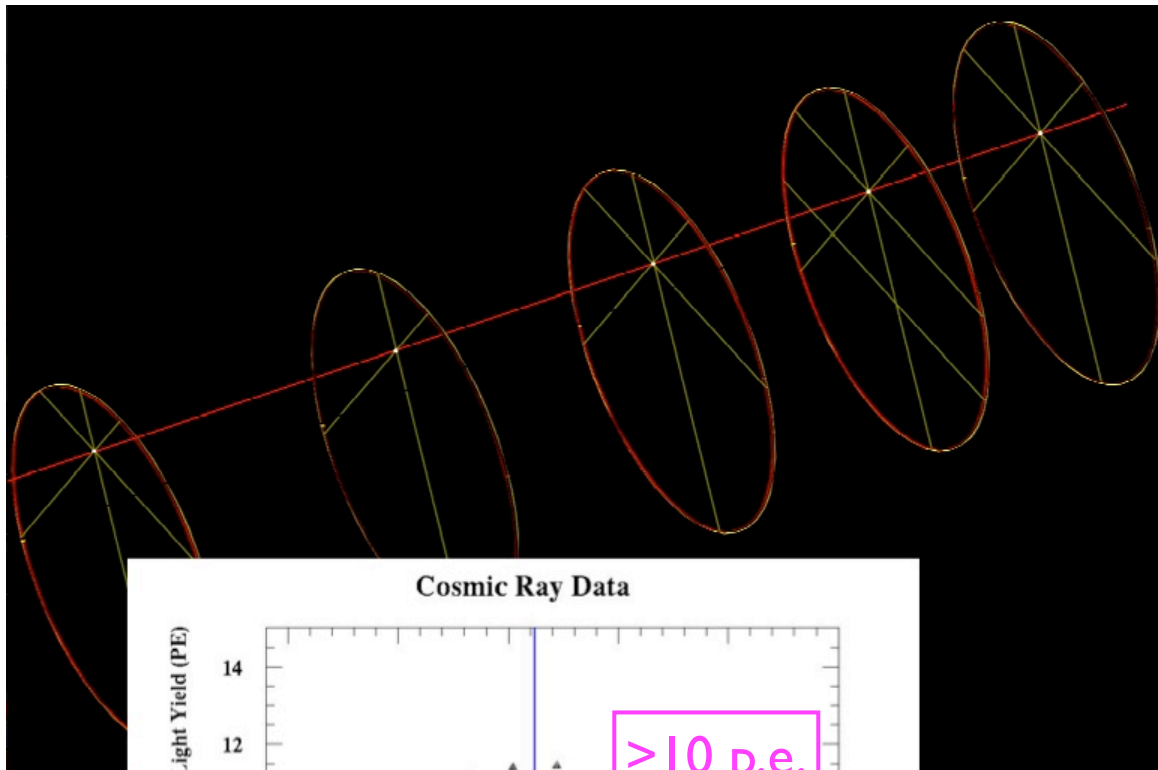
- Tracker 1 tested at RAL in cosmic-ray test stand
- Tracker 2 now installed and will soon be under cosmic test as well



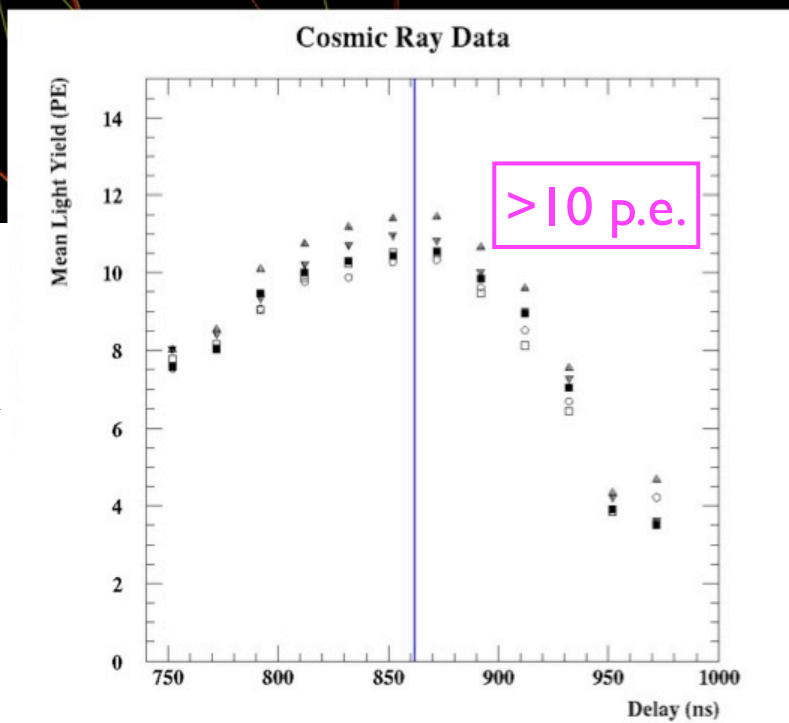
- DAQ developed by FNAL & IIT using spare VLPCs & electronics from DØ
  - using new cryo-cooled cryostat design by FNAL

# SciFi Trackers

- Typical cosmic-ray track:



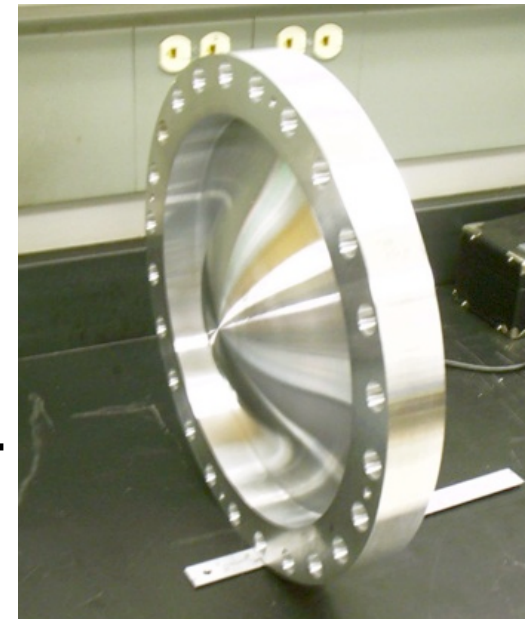
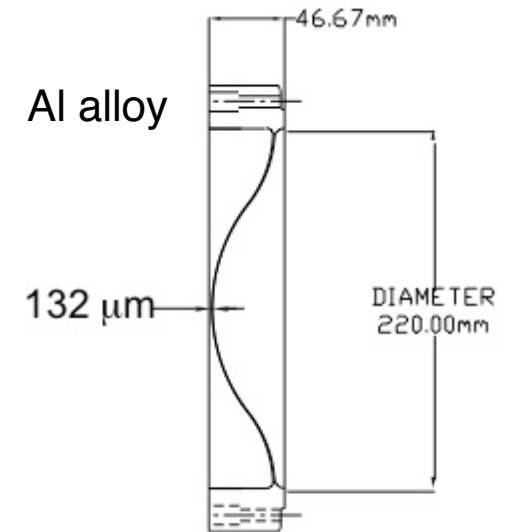
- Light yield vs trigger delay:



# Absorber Windows

UMiss

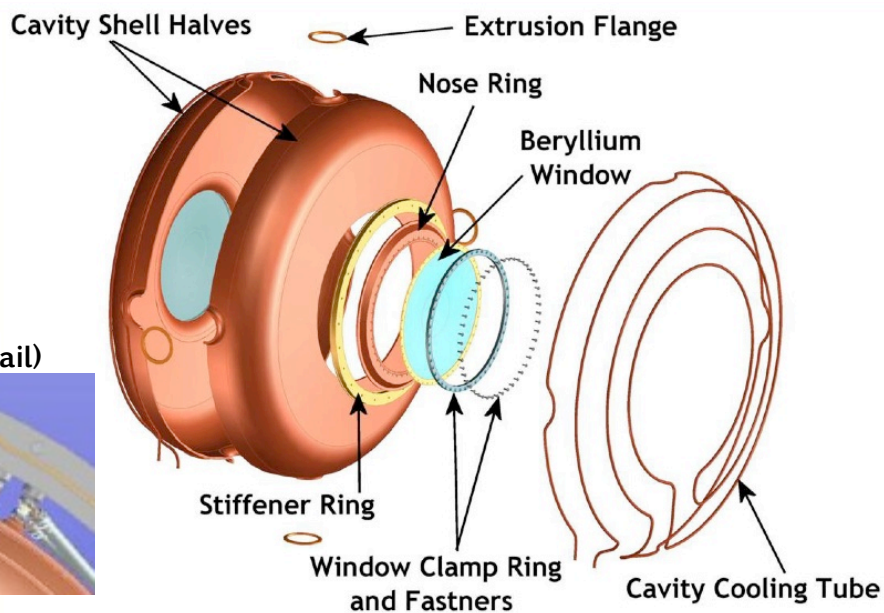
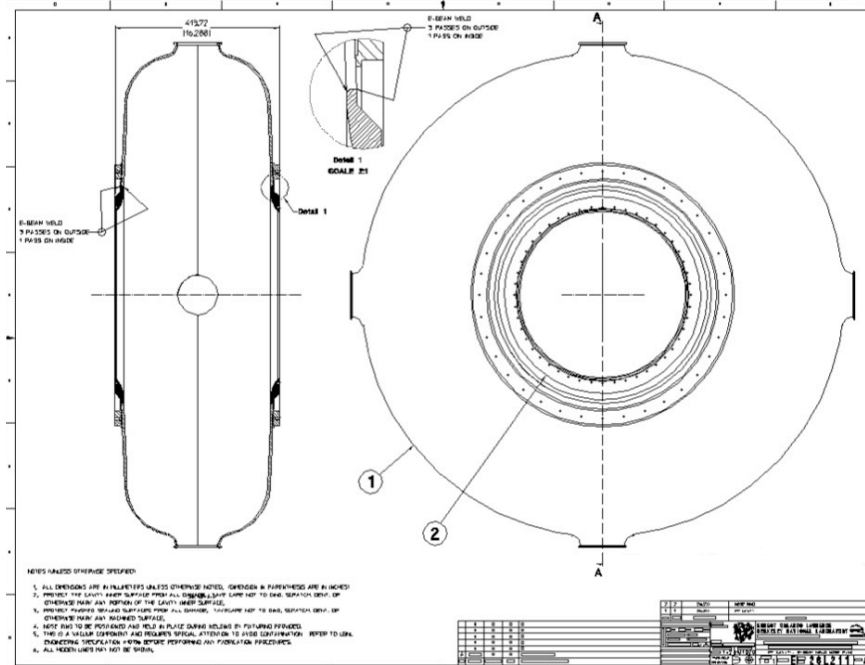
- Based on design by IIT & UOxford
- Manufactured on NC lathe @ UMiss
- Series of burst tests 2001–4 at NIU established safety of windows as manufactured
- Needed by Fall 2009
- 1st MICE window already made
- Expect to QC & test at UMiss & LBNL



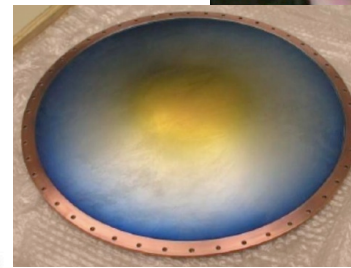
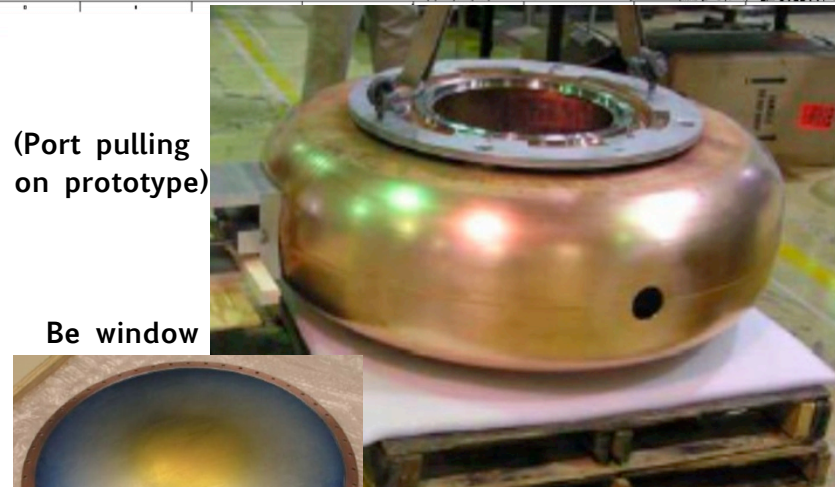
# RFCC Design

LBL

- Preliminary design review June '08
- Final design review Oct '08
- Detailed design being completed and 1st fabrication contracts let
  - 1/2-shell spinning started
  - 5 cavities ordered (option for 5 more)



(Suspension detail)



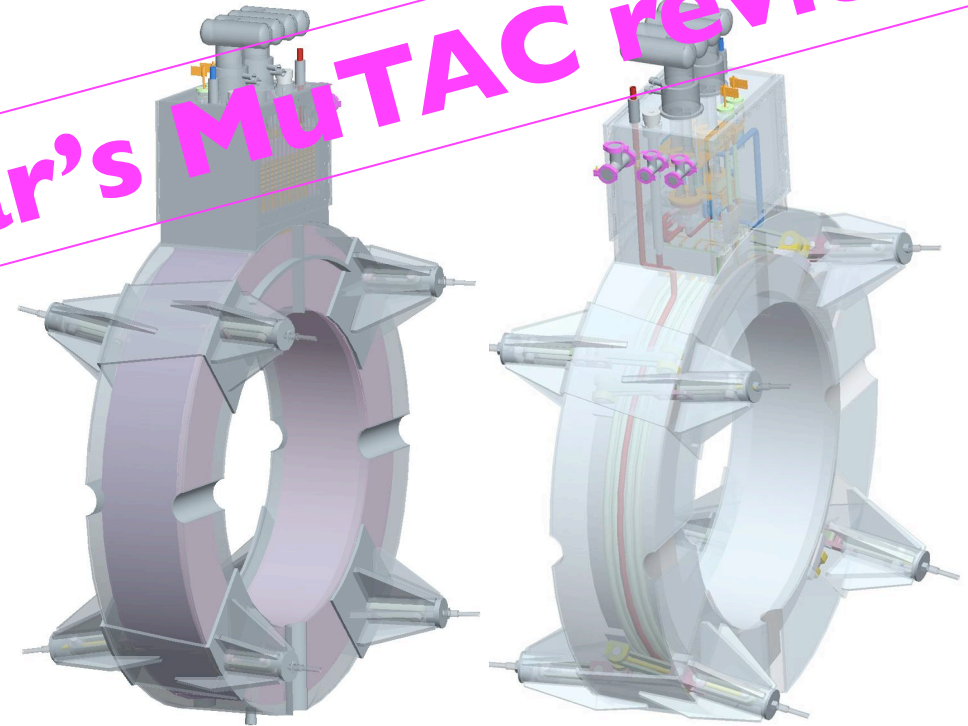
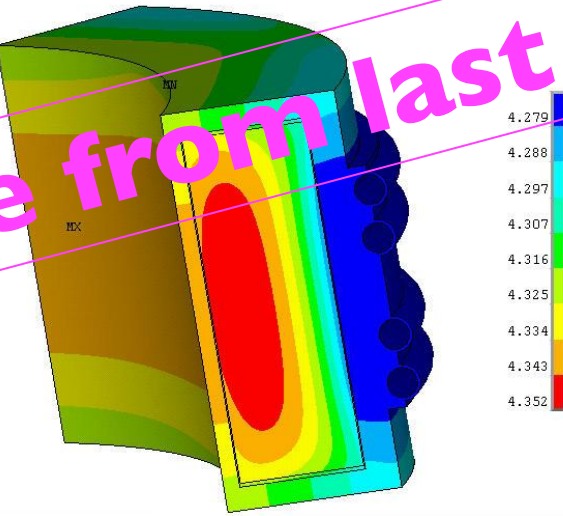


# Coupling-Coil Status

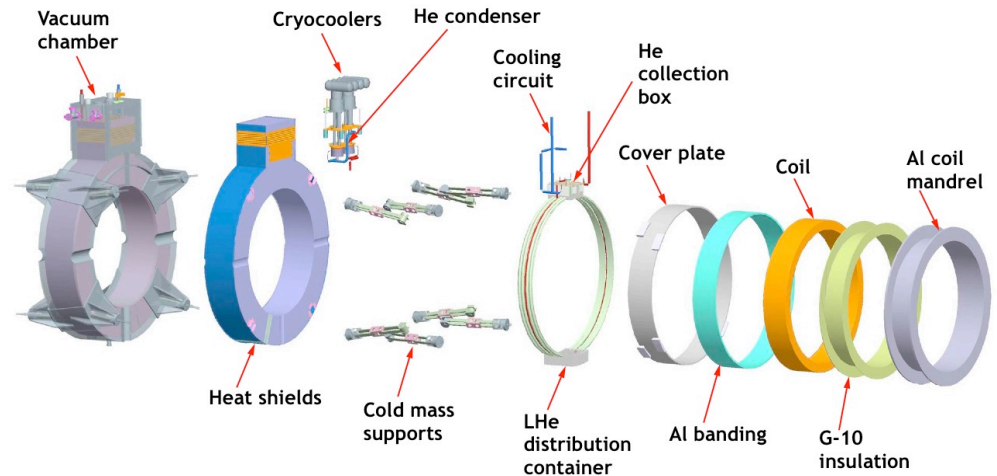
ICST Harbin / LBNL

- Detailed design studies and analyses completed at ICST

SUB =1  
 TIME=12201  
 TEMP (AVG)  
 RSYS=0  
 SMN =-4.27  
 SMX =4.352



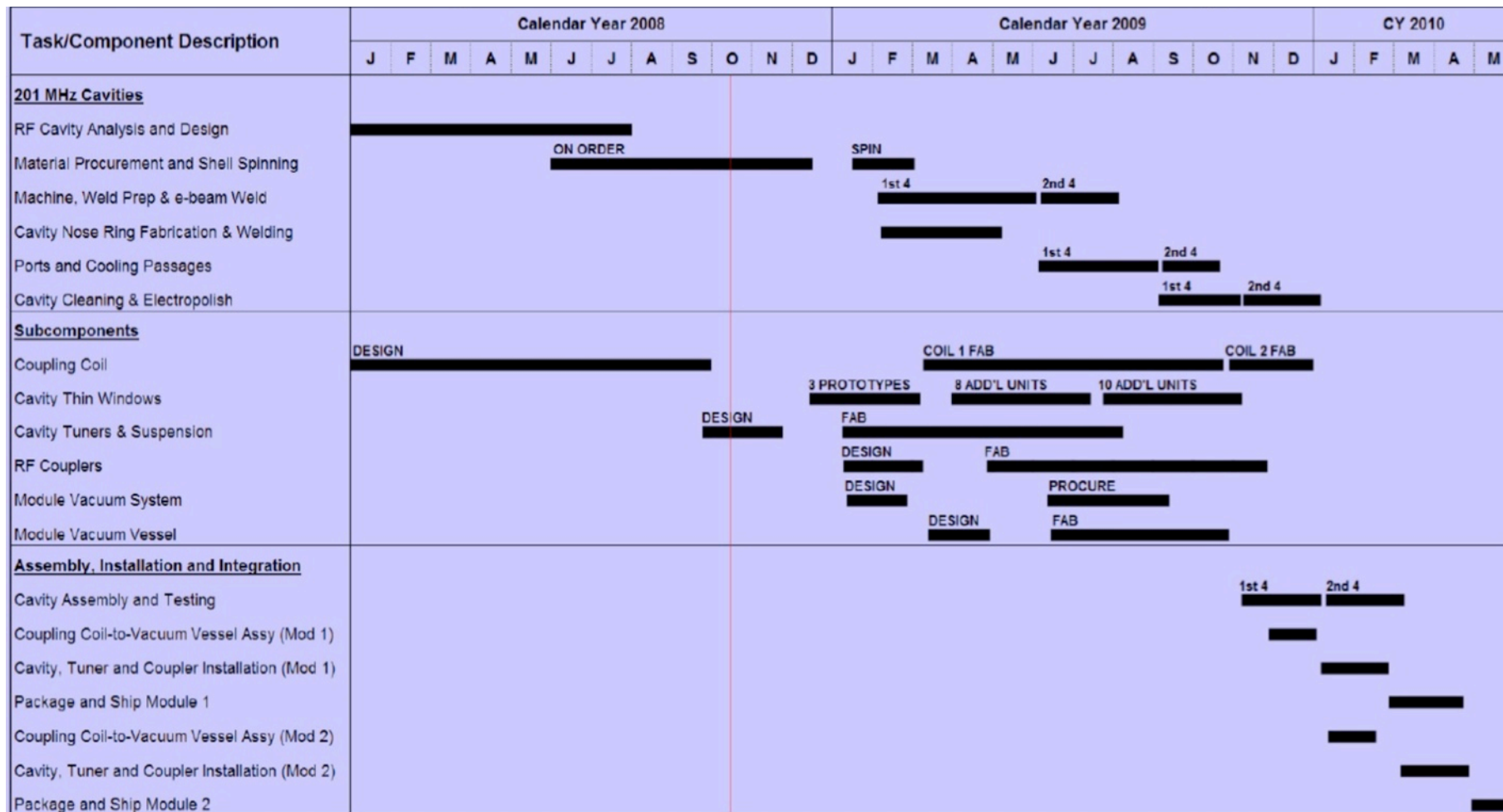
- Materials ordered for delivery to Harbin
- MOU w/ LBNL in place
- Plan MICE Coupling Coil ass'y fall '08 (1st CC is for MuCool) '09 (see next talk)





# RFCC Schedule

ICST Harbin / LBNL



 Done ~ April 2010

# Software

IIT / UCR

- On-line software:
  - minimal systems developed by respective groups, e.g.,
    - ▶ DAQ: Geneva
    - ▶ Target Control: Sheffield
    - ▶ Target & Beam Monitoring: ICL
    - ▶ Decay Solenoid Cryo: RAL
  - these work but are far from user-friendly
    - ⇒ **improvement & integration badly needed!**
- ➔ MICE On-line Group formed Jan '09, meeting regularly & working well
  - includes P. Hanlet (IIT) & L.Coney (UCR)
  - for example...

# Integrated Alarm Handler

P. Hanlet, IIT

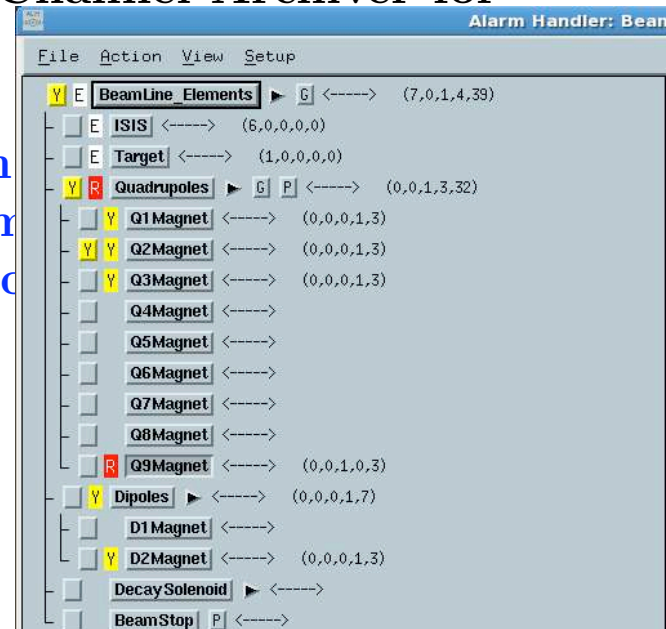
Since joining MICE, I have agreed to take responsibility for implementing and testing the Alarm Handler and the Channel Archiver for each system as it comes online.

I have two undergraduate students working with me to begin cataloguing all of the systems, subsystems. My intent is to have a tree structure down to the project level. The program will allow us to:

- Monitor our own progress
- Create skeleton lists of new devices
- Use skeleton lists to solicit input from experts

The other student is working on a backend remote viewing of the PVs archived. He is learning about databases and interfacing to the web. His first task is to create a catalog database and make it web searchable.

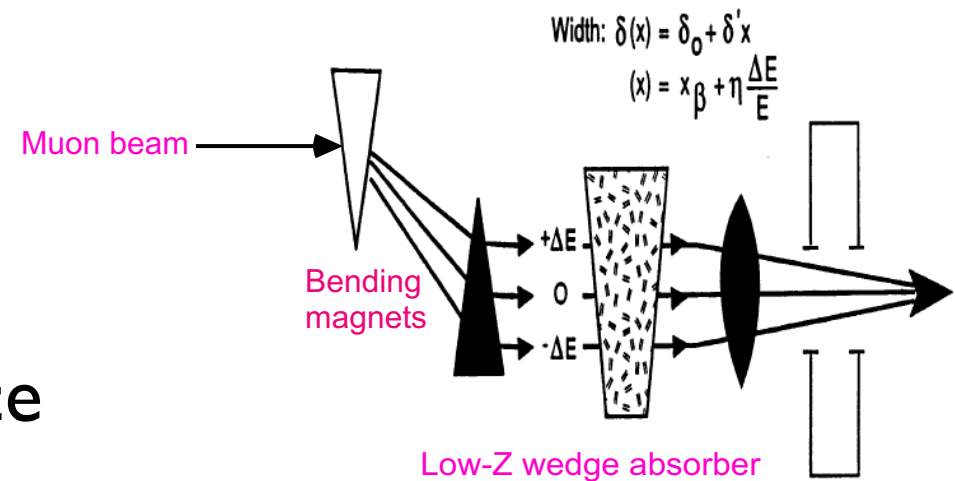
I am developing the alarm handler and learning about the channel archiver.



# MICE Phase III

- MICE will demonstrate transverse ionization cooling
- Direct longitudinal ionization cooling ineffective (straggling), but possible via transverse cooling + emittance exchange

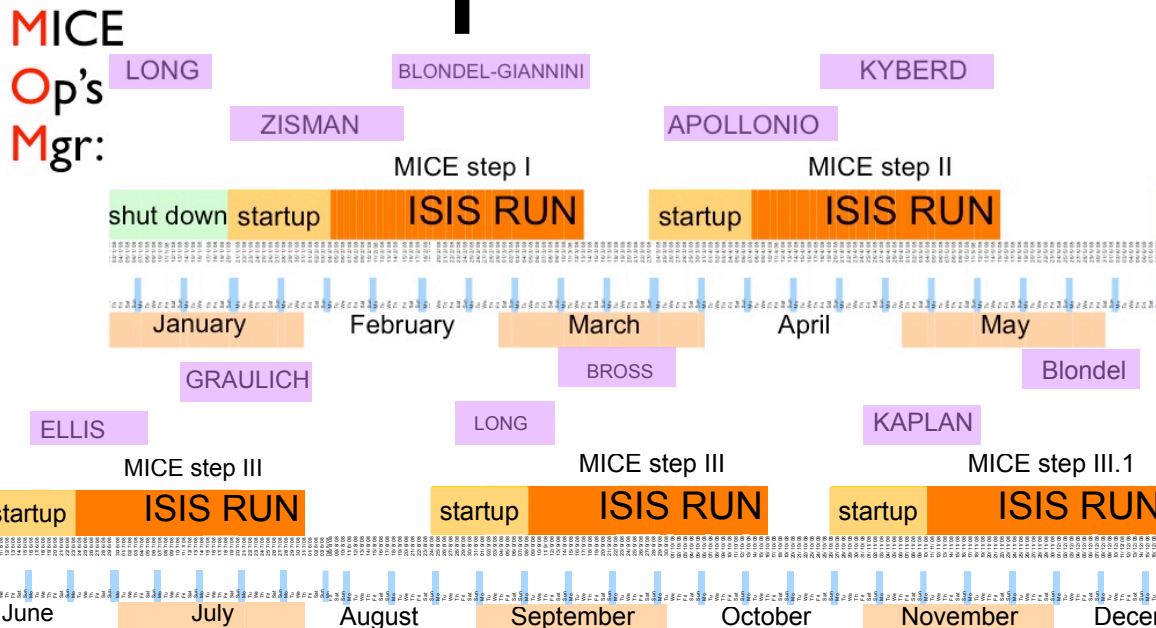
- crucial to muon collider
- uses wedge absorbers at dispersive points of lattice



- P. Snopok & L. Coney (UCR) investigating wedge absorber test in MICE (dispersion via off-line selection)
- Discussions started on 6D cooling test (MICE  $\Phi$  III)
  - e.g. MANX

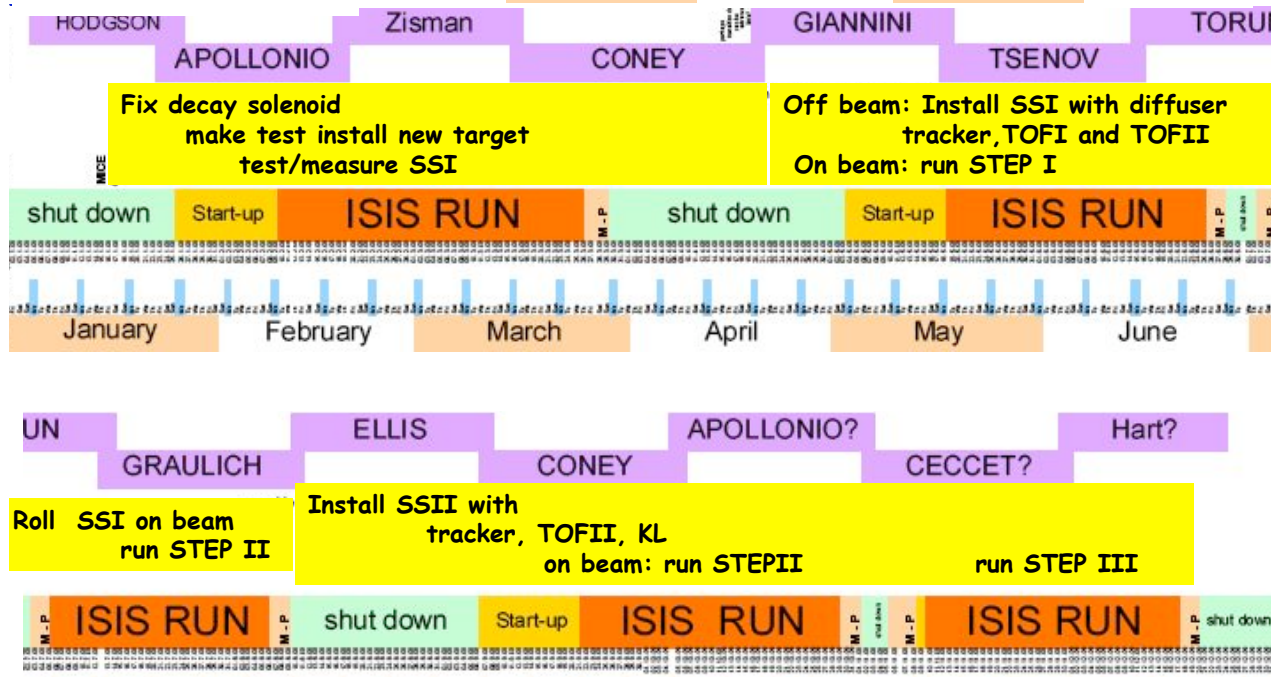
# Operations

2  
0  
0  
8

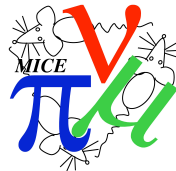


- Note 1/3 of MOMs are US MICE

2  
0  
0  
9



# Recent MICE Publications

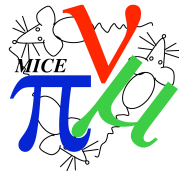


M. Bonesini	The Design of the time-of-flight system for MICE	EPS-HEP200, J. Phys.: Conf. Ser. 110, 092004	2008
M.A. Green, H. Witte	Using High Temperature Superconducting Leads in a Magnetic Field	CEC2007, AIP Conf. Proc. 985:1251	2008
M.A. Green, H. Witte	The Use of Small Coolers in a Magnetic Field	CEC2007, AIP Conf. Proc. 985:1299	2008
M.A. Green et al.	Progress on the MICE Tracker Solenoid	IEEE Trans. Appl. Supercond. 18:933	2008
L. Wang et al.	The Engineering Design of the 1.5 m Diameter Solenoid for the MICE RFCC Modules	IEEE Trans. Appl. Supercond. 18:937	2008
L. Wang et al.	The Helium Cooling System and Cold Mass Support System for the MICE Coupling Solenoid	IEEE Trans. Appl. Supercond. 18:941	2008
M.A. Green et al.	The Effect of Magnetic Field on the Position of HTS Leads and the Cooler in the Services Tower of the MICE Focusing Magnet	IEEE Trans. Appl. Supercond. 18:1447	2008
M. Bonesini et al.	The Design of the time-of-flight system for MICE	EPS-HEP2007, J. Phys. Conf. Ser. 110:092004	2008
M. Apollonio et al.	Emittance measurement in MICE	EPS-HEP2007, J. Phys. Conf. Ser. 110:122002	2008
T. Matsushita et al.	The MICE scintillating-fibre tracker	EPS-HEP2007, J. Phys. Conf. Ser. 110:122016	2008
R. Sandstrom et al.	Status of MICE, the international Muon Ionization Cooling Experiment	NuFact07, AIP Conf. Proc. 981:107	2008
F. J.P. Soler et al.	Measurement of particle production from the MICE target	NuFact07, AIP Conf. Proc. 981:259	2008
M. S. Zisman	MICE construction status	NuFact07, AIP Conf. Proc. 981:293	2008
D. Li et al.	MUCOOL/MICE RF cavity R&D programs	NuFact07, AIP Conf. Proc. 981:299	2008
M.A. Green	The Effect of Extending the Length of the Coupling Coils in a Muon Ionization Cooling Channel	NuFact07, AIP Conf. Proc. 981:339	2008
H. Wu et al.	A Single-band Cold Mass Support System for MICE Superconducting Coupling Magnet	ICCR-22, Shanghai, China	2008
D. Li et al.	A 201-MHz Normal Conducting RF Cavity for the International MICE Experiment	EPAC08-MOPP098	2008
D. M. Kaplan, IIT	U.S. MICE	MuTAC Review, FNAL, 7 Apr 09	24





# Recent MICE Publications



A. J. Moss et al.	MICE RF System	EPAC08-MOPP099	2008
A. D. Bross, T. L. Hart	MICE: The International Muon Ionization Cooling Experiment: Diagnostic Systems	EPAC08-TUPC012	2008
C. T. Rogers	Statistical Weighting of the MICE Beam	EPAC08-TUPC088	2008
M. Apollonio et al.	The MICE Diffuser System	EPAC08-WEPP108	2008
K. Tilley	Commissioning Status of the MICE Muon Beamline	EPAC08-WEPP122	2008
C. N. Booth et al.	Design and Operational Experience of the MICE Target	EPAC08-WEPP110	2008
A. D. Bross, D. M. Kaplan	Status of MICE	ICHEP08, arXiv:0809.4795	2008
T. L. Hart, D. M. Kaplan	Emittance Measurement in MICE	ICHEP08, arXiv:0809.4796	2008
M. Bonesini	The MICE PID Instrumentation	NuFact08, arXiv:0810.0420	2008
D. Forrest, F.J.P. Soler	Alignment errors on emittance measurements for MICE	NuFact08	2008
M. S. Zisman	Experimental Tests of Cooling: Expectations and Additional Needs	NuFact08	2008
D. Huang, D. M. Kaplan, M. S. Zisman	Status of MICE: The International Muon Ionization Cooling Experiment	LINAC08	2008
W. Li et al.	Design of Current Leads for the MICE Coupling Magnet	Proc. ICCR-3, p 347	2008
H. Wu et al.	A Single Band Cold Mass Support System for the MICE Superconducting Coupling Magnet	Proc. ICCR-3, p 351	2008
M.A. Green et al.	Tests of Four PT-415 Coolers Installed in the Drop-in Mode	Proc. ICEC-22	2009
H. Wu et al.	AC Loss Analysis on Superconducting Coupling Magnets for MICE	Proc. ICEC-22	2009
L. Wang et al.	Design and Construction of Test Coils for the MICE Coupling Solenoid Magnet	IEEE Trans Appl Sup 19	2009
L. Wang et al.	Magnetic and Cryogenic Design of the MICE Coupling Solenoid System	IEEE Trans Appl Sup 19	2009
B. Wang et al.	The Design and Construction of the MICE Spectrometer Solenoids	IEEE Trans Appl Sup 19	2009
X. L. Guo et al.	Quench Protection for the MICE Cooling Channel Coupling Magnet	IEEE Trans Appl Sup 19	2009
S. P. Virostek et al.	Preliminary Test Results for the MICE Spectrometer Superconducting Solenoids	IEEE Trans Appl Sup 19	2009

# Summary

- Much accomplished since last year
  - Going more slowly than hoped (but par for the course!)
  - Installation & shakedown ongoing
- ...and will continue until measurement program completed in 2012
- US contributing strongly to MICE construction and shakedown
- ➡ Support for a few more students & postdocs would help us reap the scientific benefit!