U.S. MICE

Daniel M. Kaplan
US Spokesperson, MICE Collaboration

ILLINOIS INSTITUTE OF TECHNOLOGY
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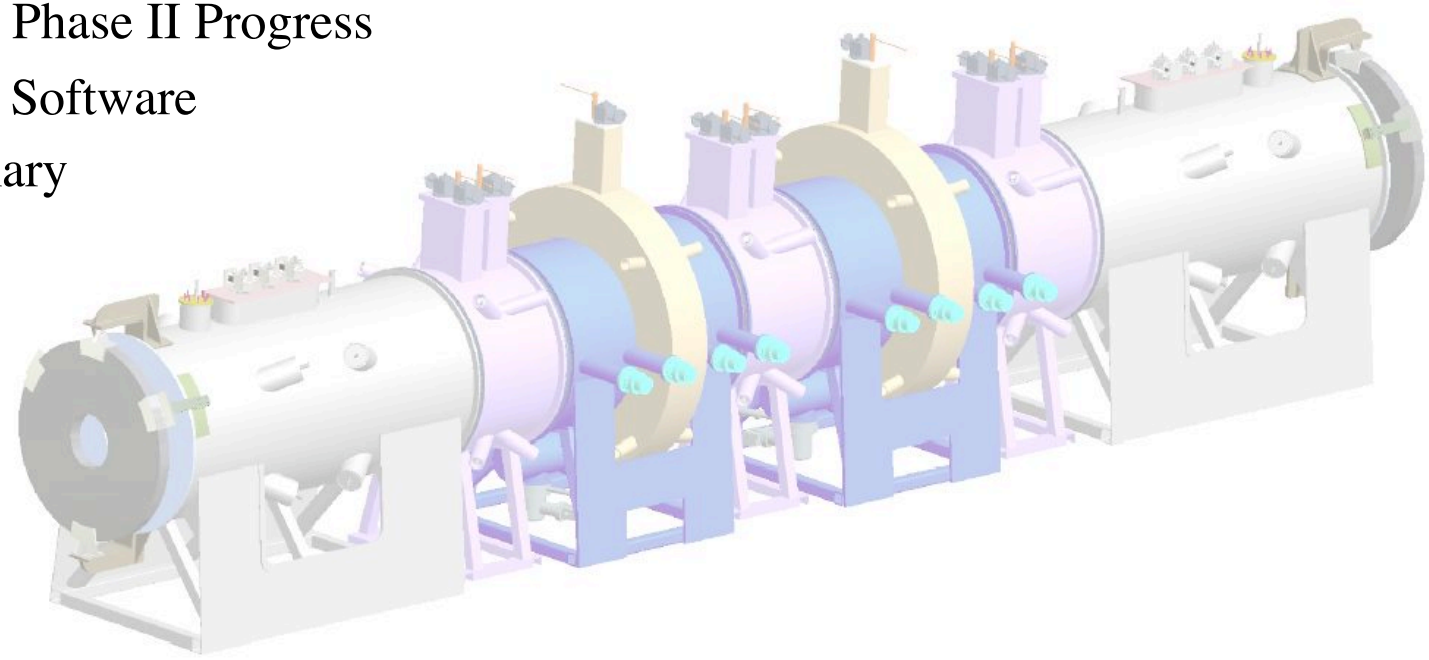
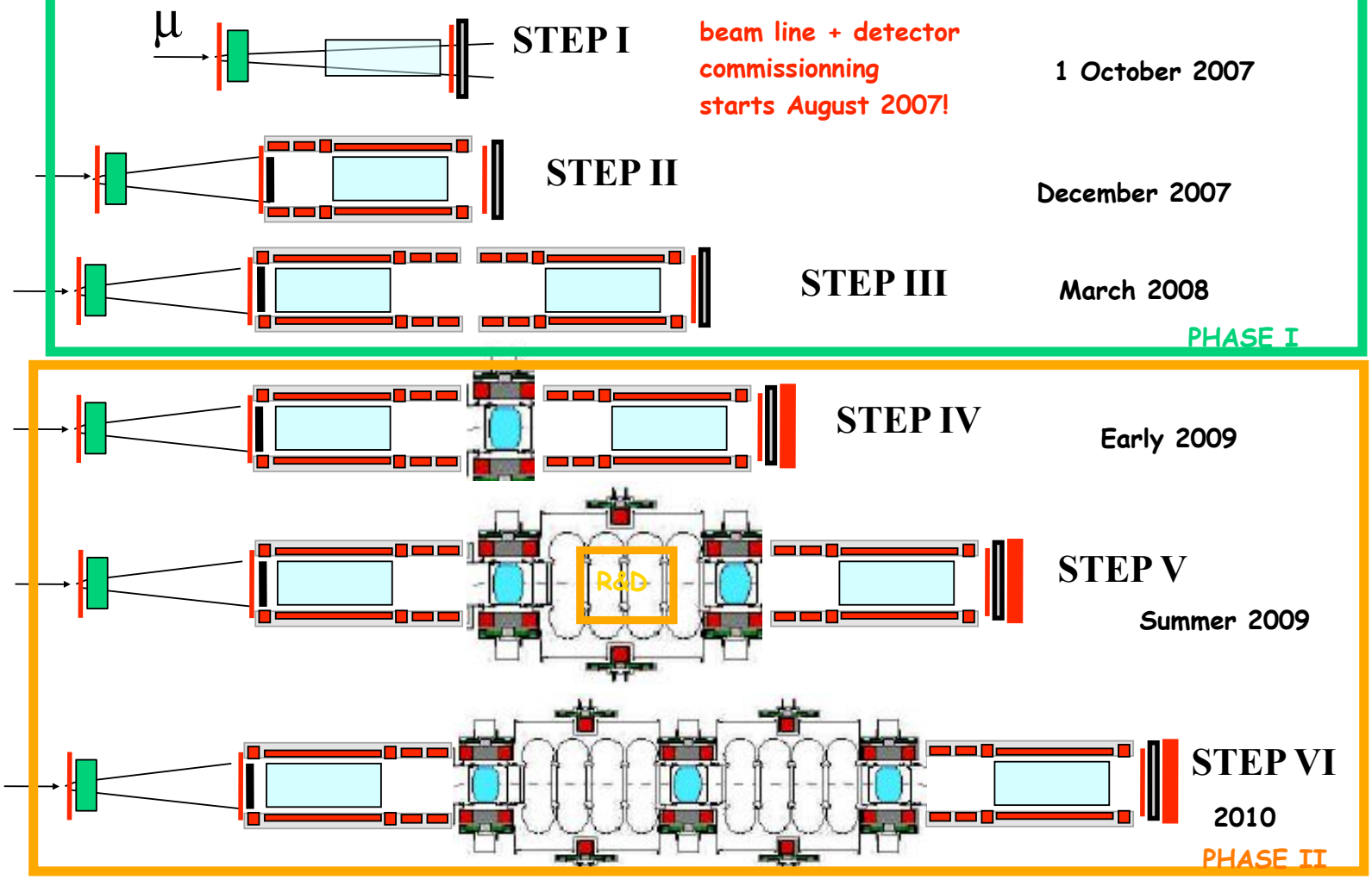
MuTAC Review
Brookhaven National Laboratory
18–19 April 2007

Outline

1. MICE Phases
2. PID Detectors
3. Spectrometer Solenoids
4. Tracking Detectors
5. Beamline Design
6. MICE Phase II Progress
7. MICE Software
8. Summary



Aspirational MICE Schedule now (~unchanged since march 2006)



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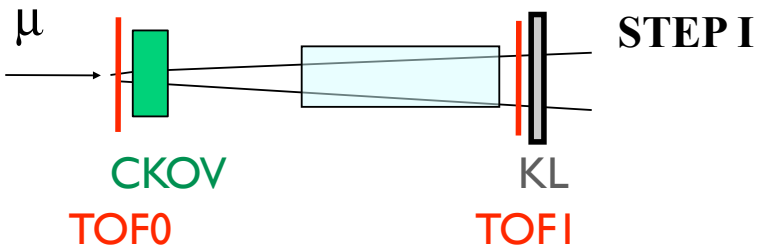

STEP I

1 October 2007

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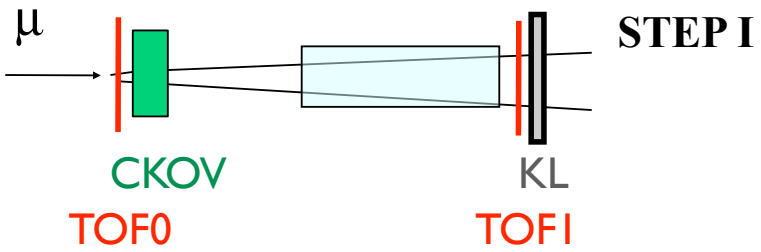

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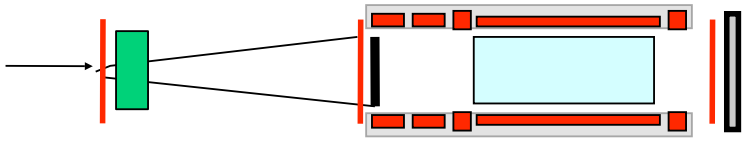

STEP II

December 2007

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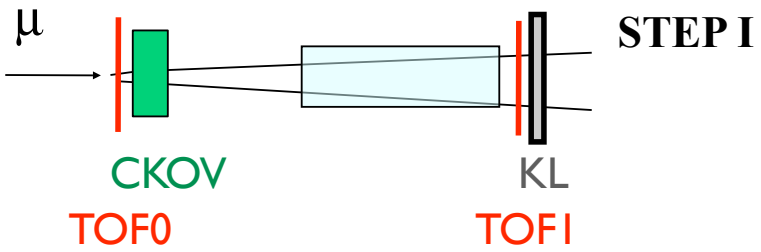

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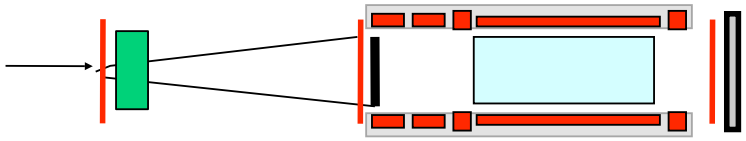
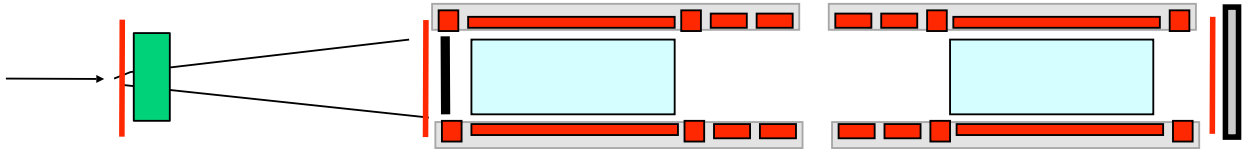


STEP II

December 2007

...and 2nd tracker a few months thereafter



STEP III

March 2008

MICE Phase I

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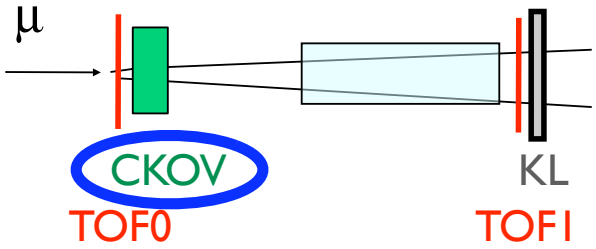

STEP I

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US Responsibilities

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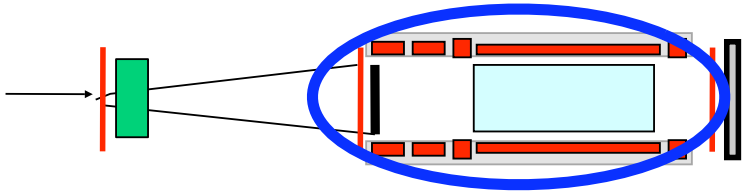

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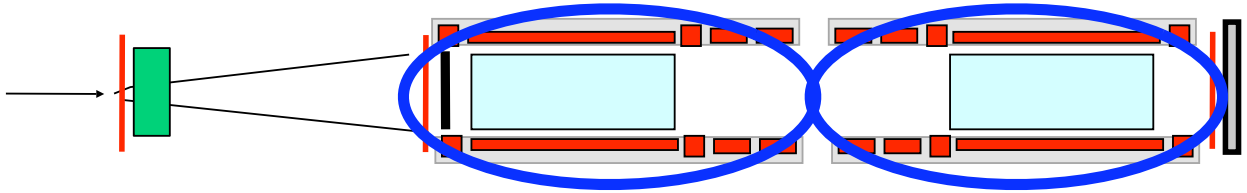

STEP III

March 2008

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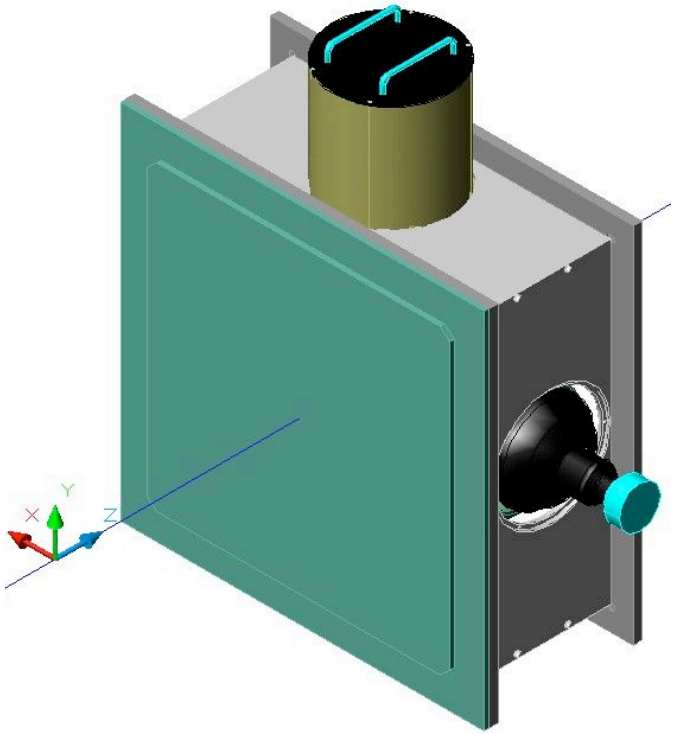

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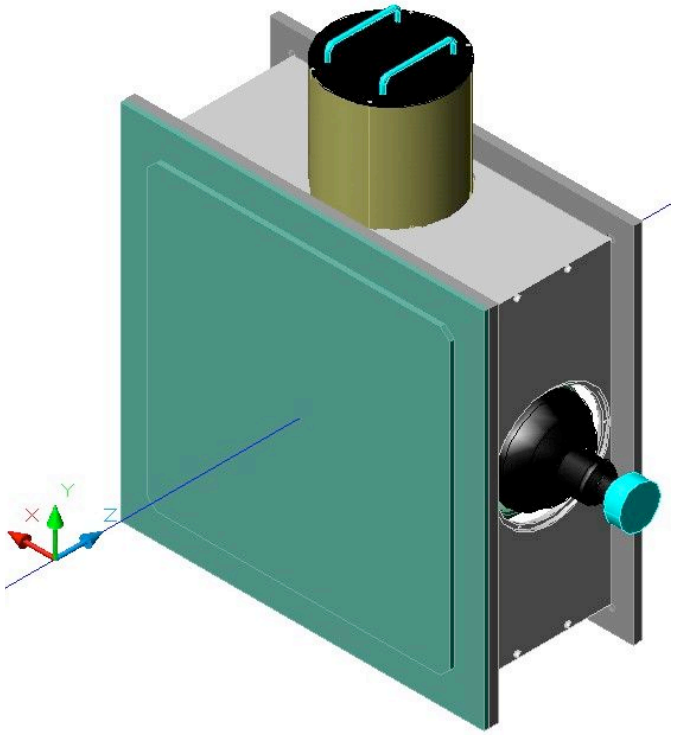

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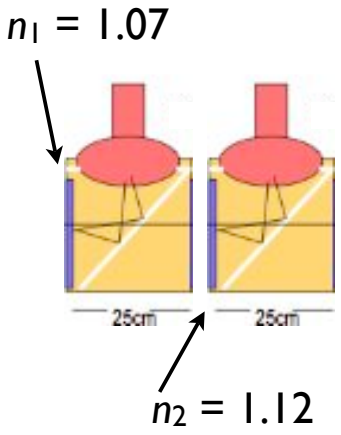

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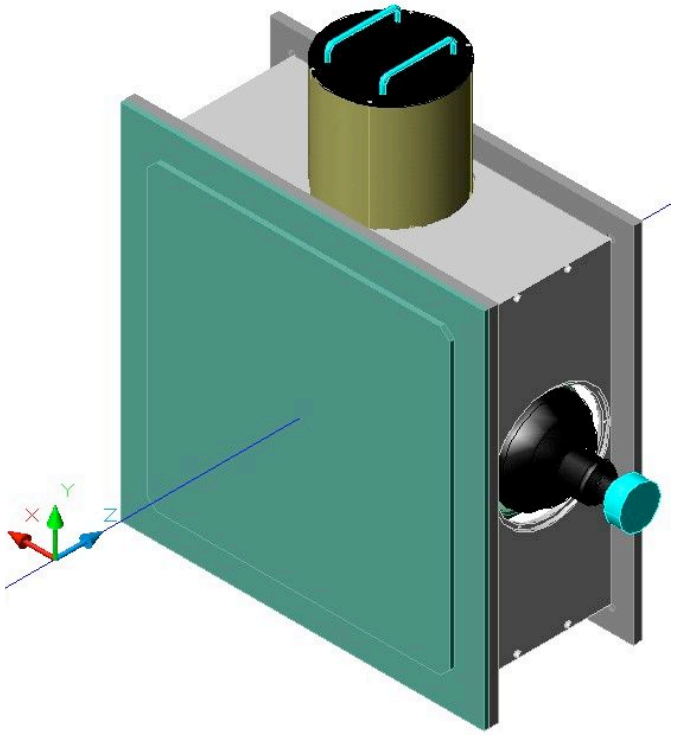

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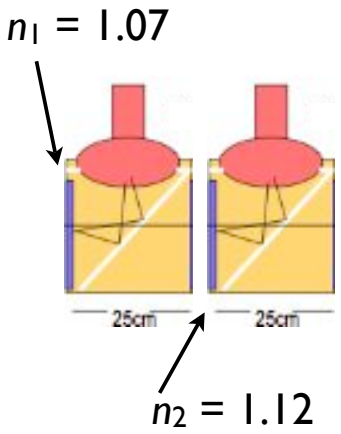

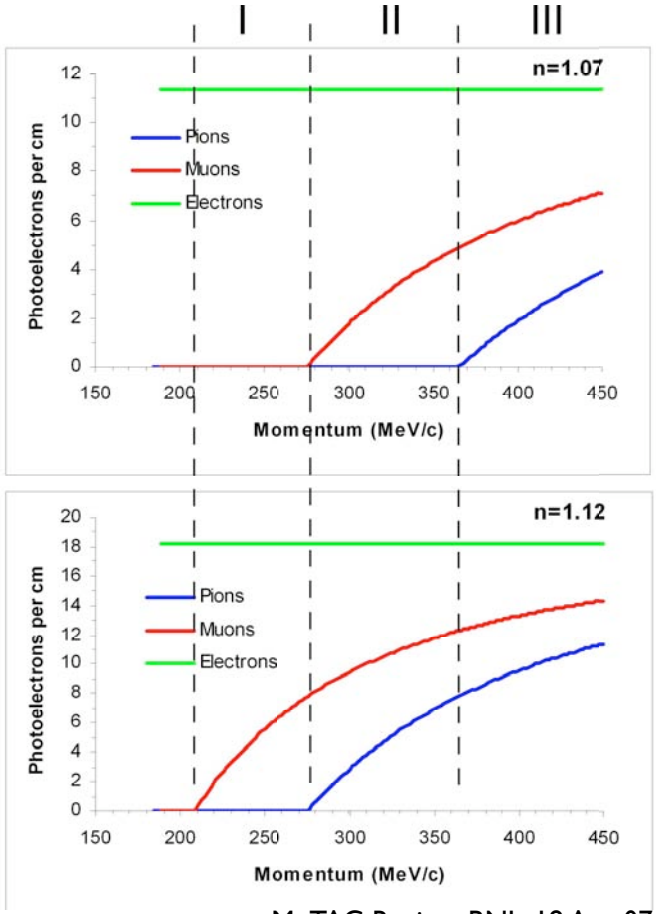

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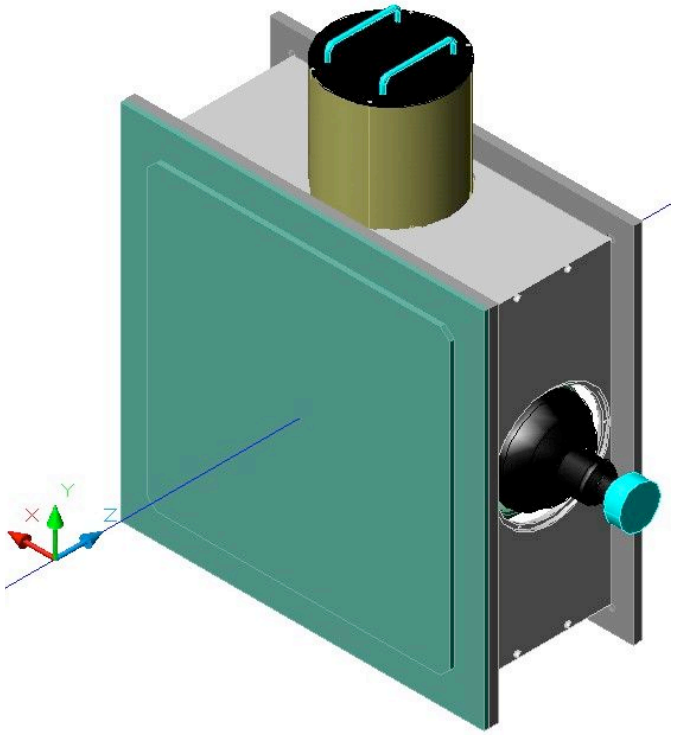

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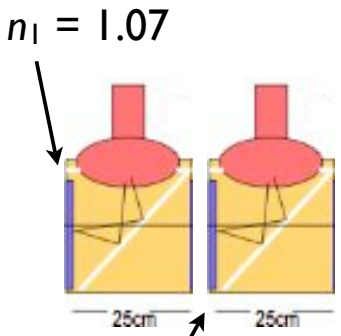
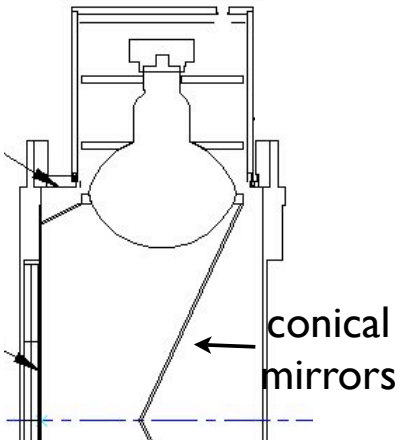
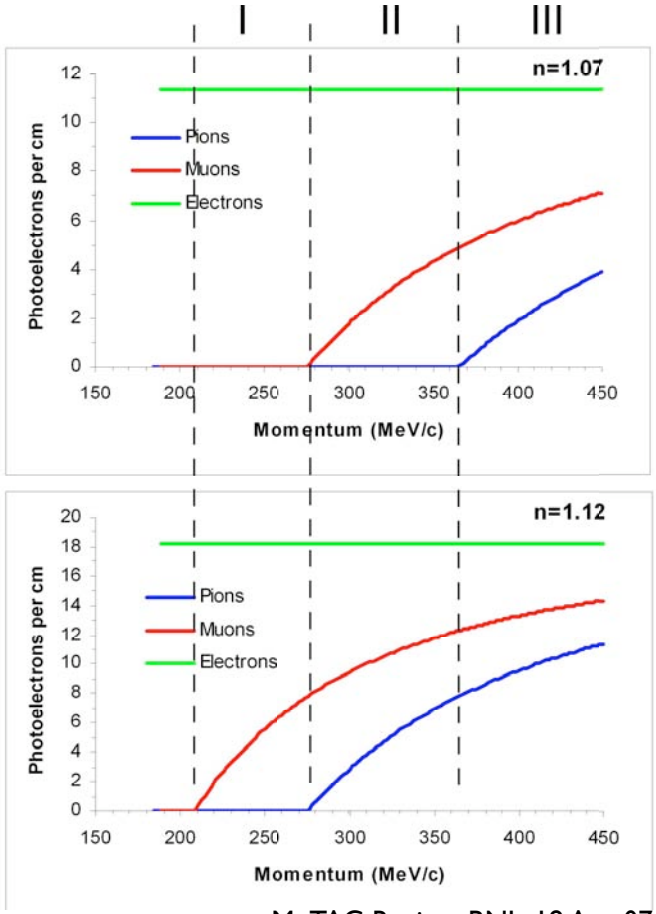
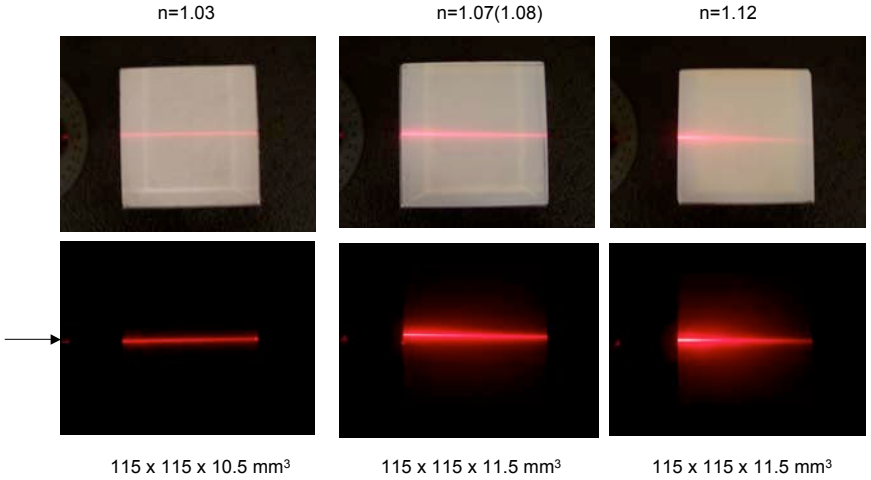






CKOV Design Tests

- Aerogel sample tests at UMiss:



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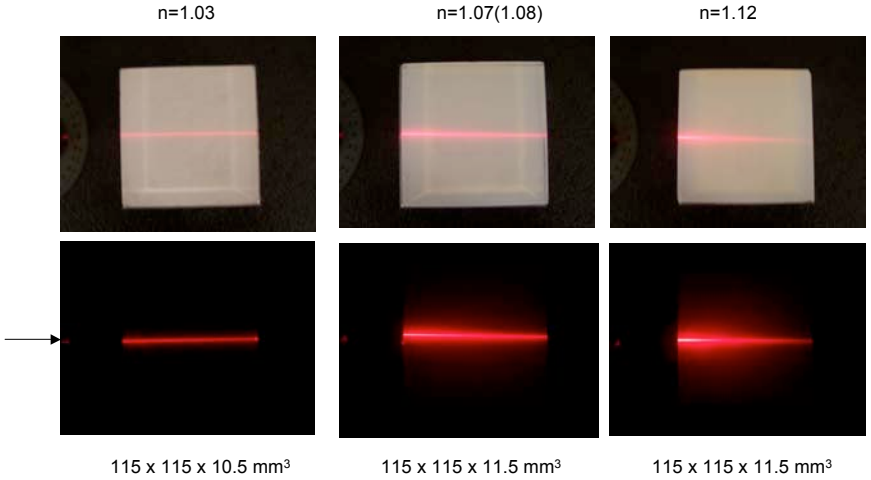

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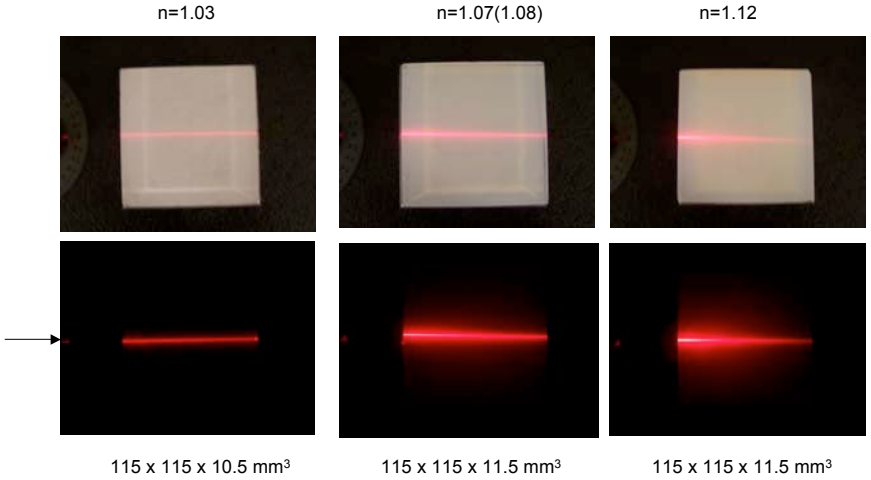

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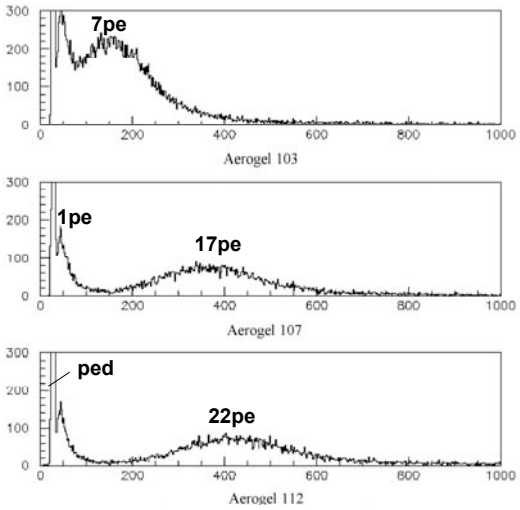

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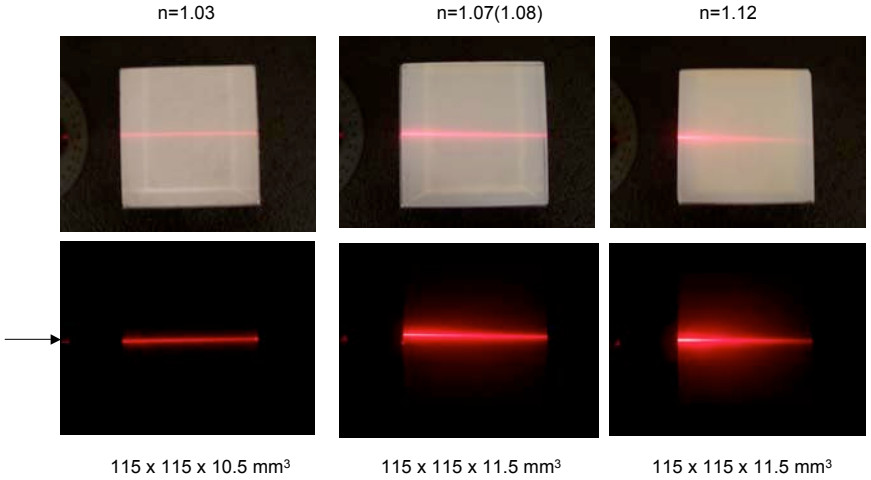

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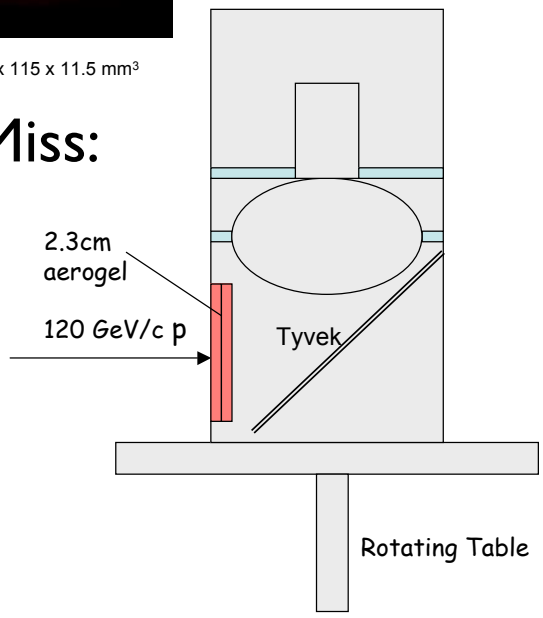
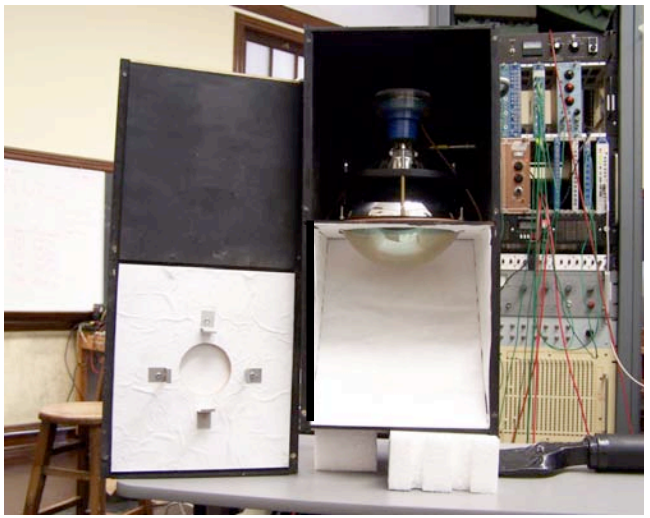


- Fermilab Meson Test July'06
- Beam 120 GeV p (β=1)
- Aerogel 1.03, 1.07, 1.12



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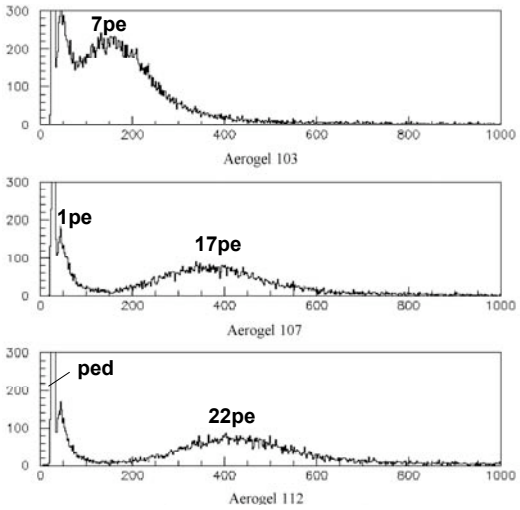

CKOV Design Tests

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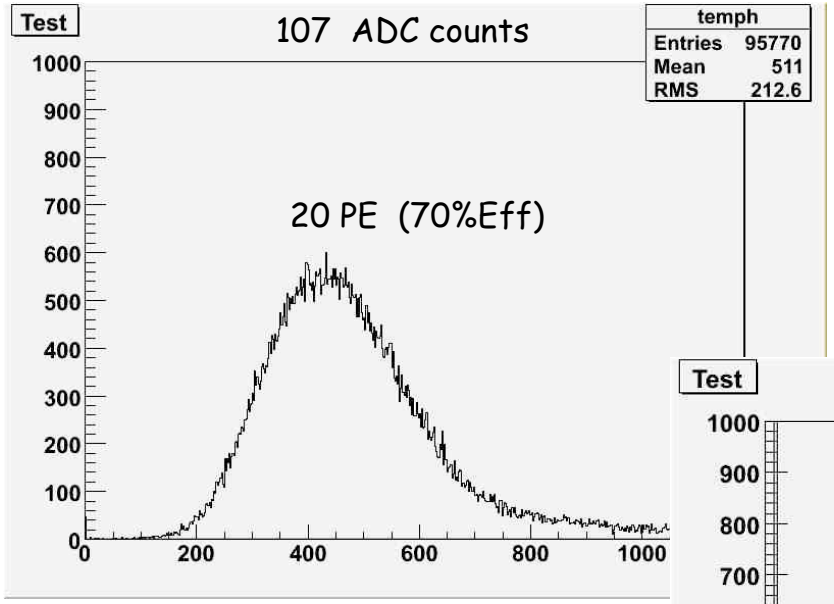

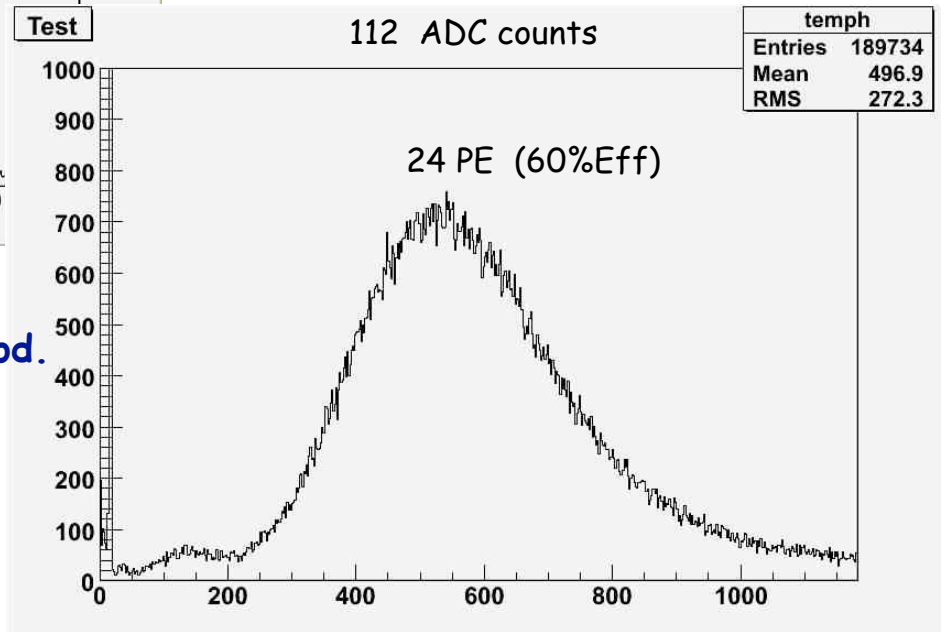

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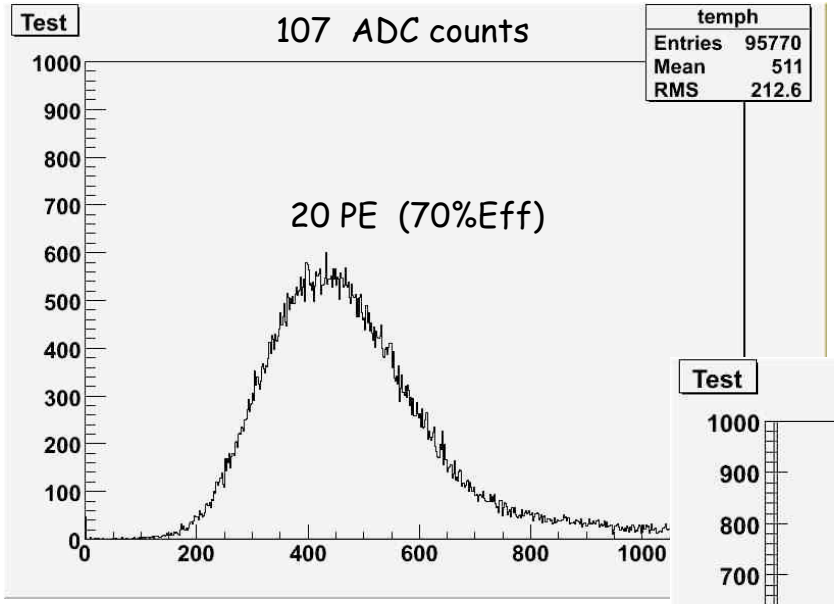
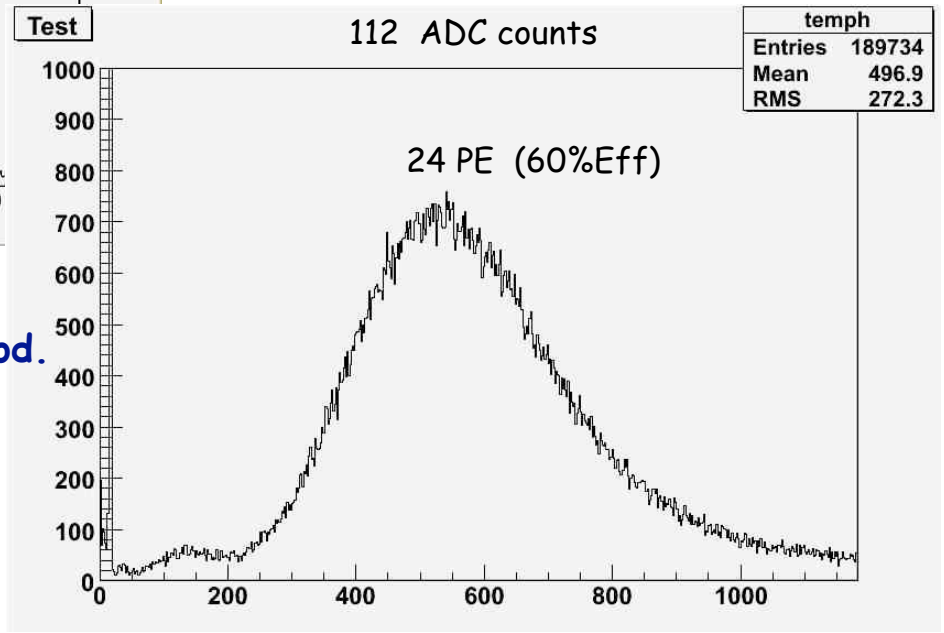


Conclusions:

- Little true absorption at 2.3 cm thickness
  → dominated by scattering
- ~1/2 PE easily visible for threshold counting



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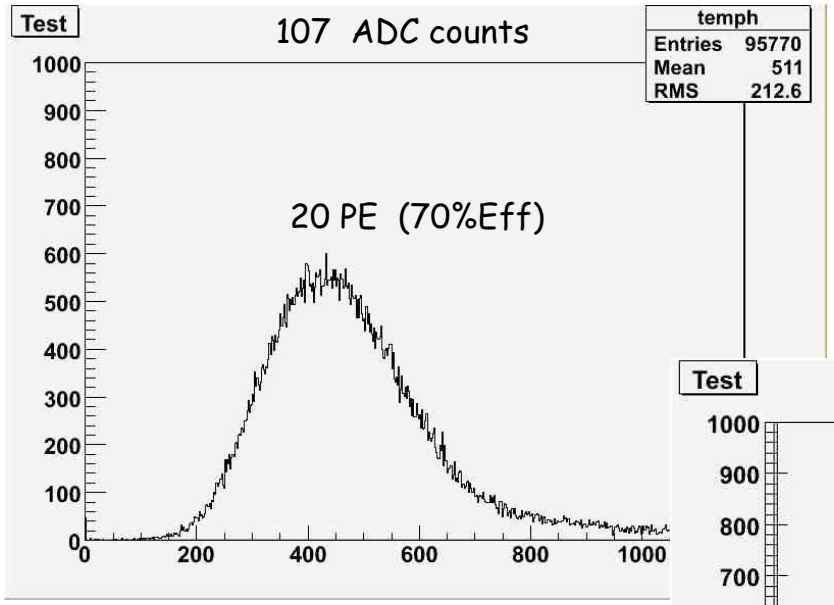

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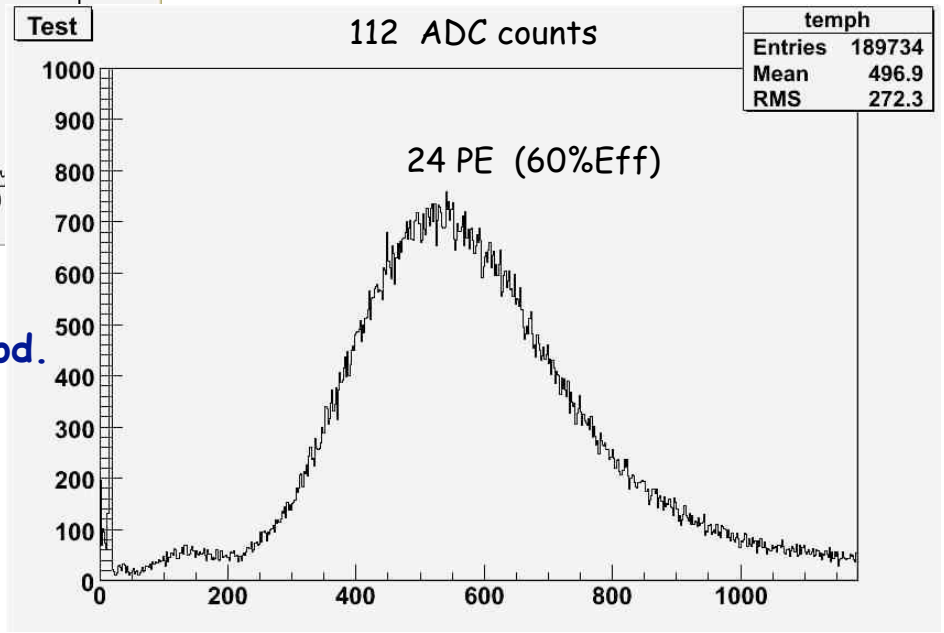

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➡ Successful design review held Oct. 13, '06 at RAL

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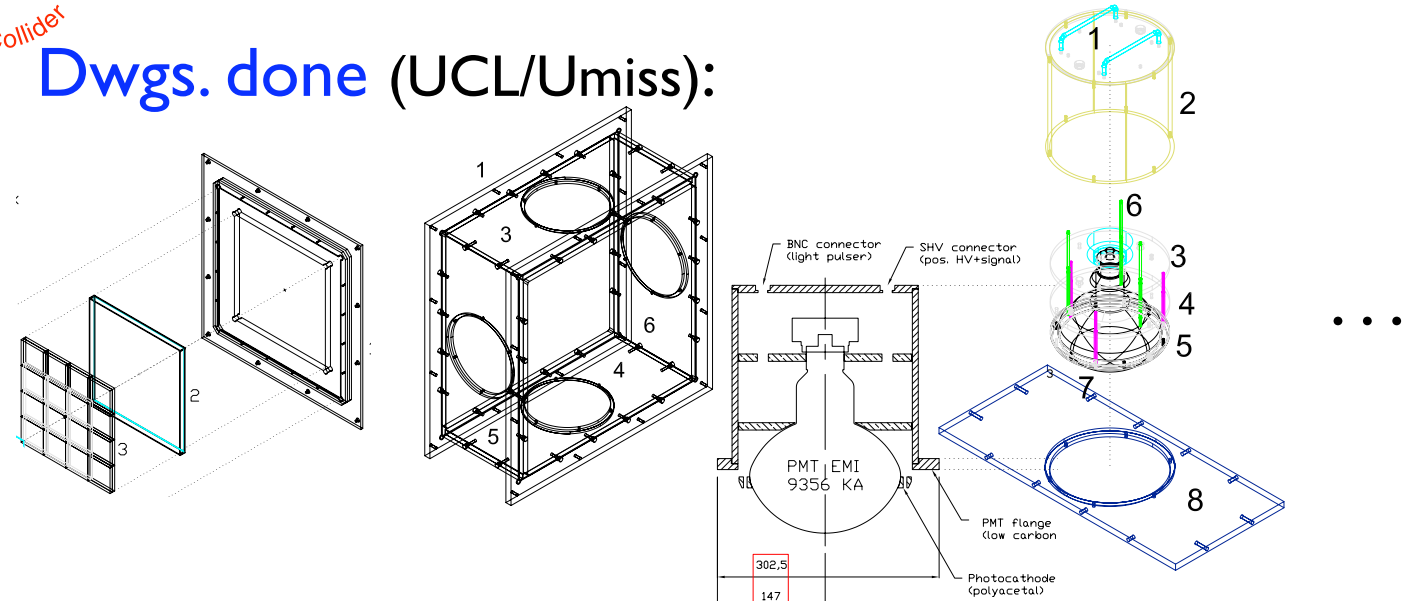

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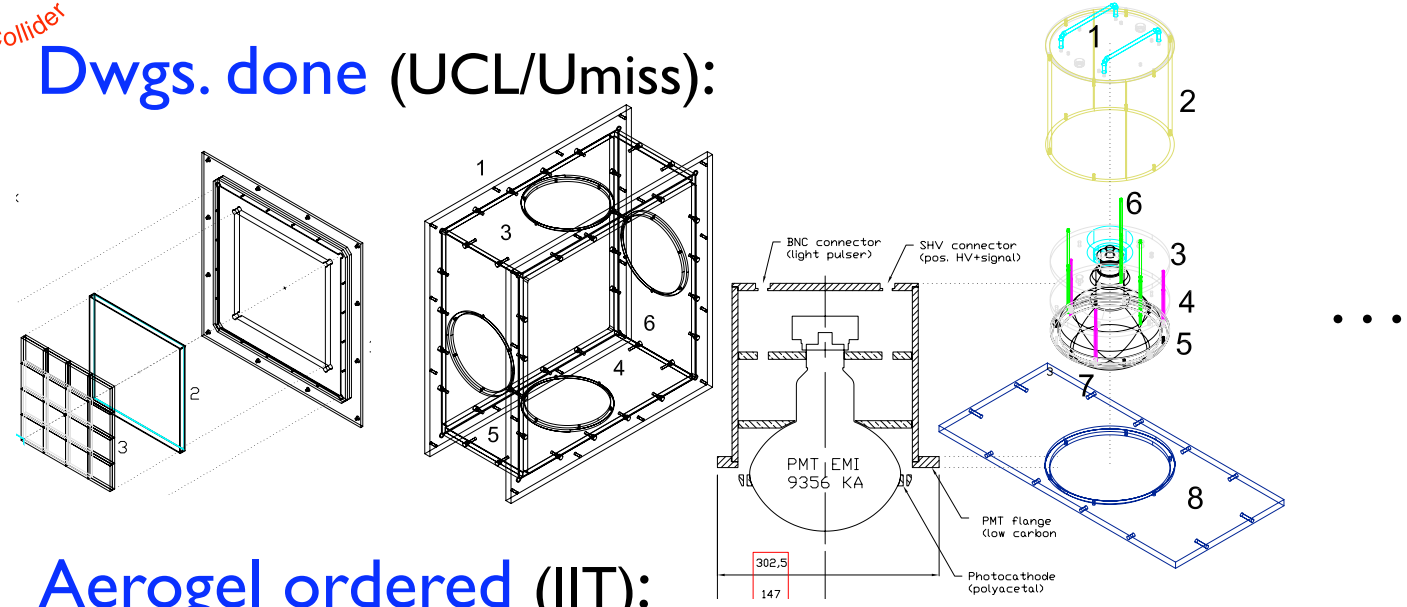

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  52 pcs. ea of Matsushita hydrophobic Silica Aerogel:

  HY-80, n = 1.07
  HY-12, n = 1.12

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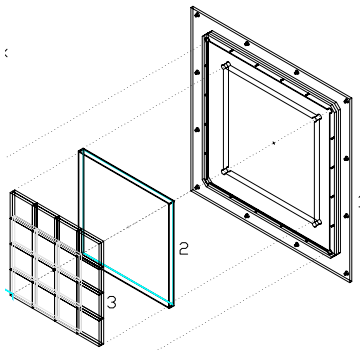

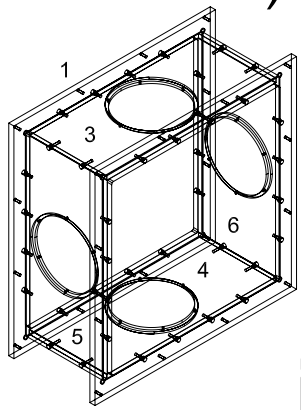

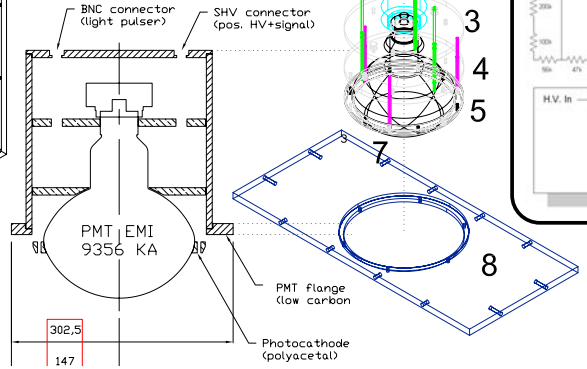

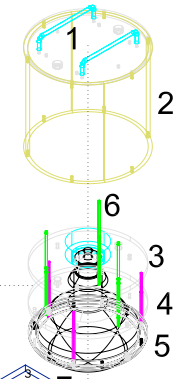

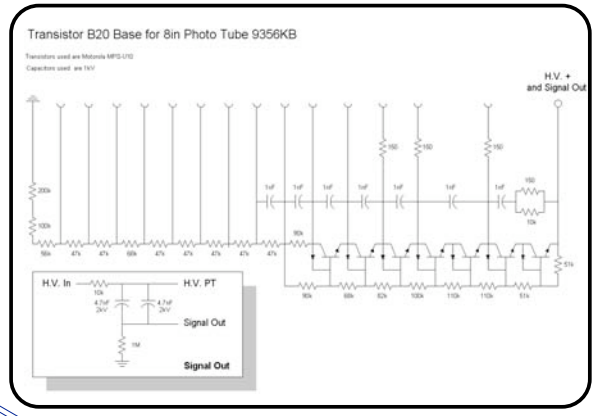

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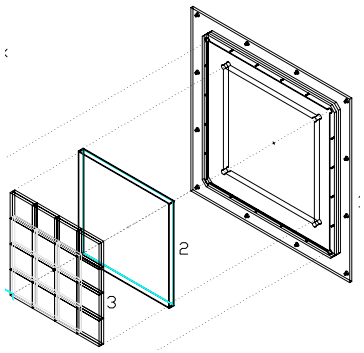

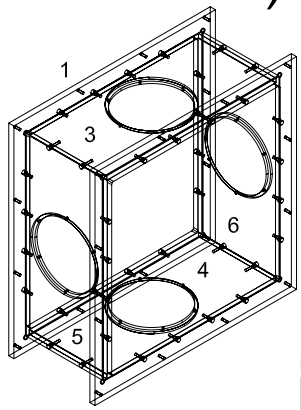

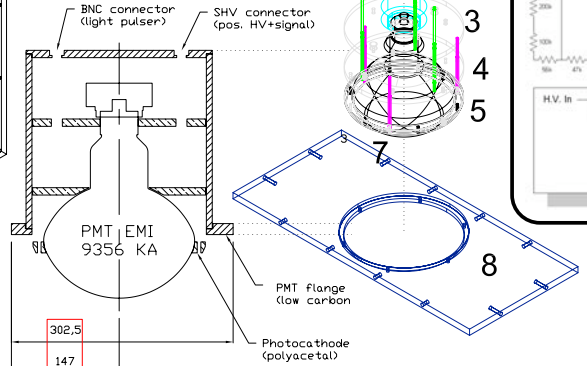

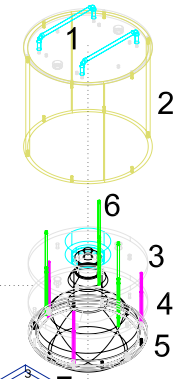

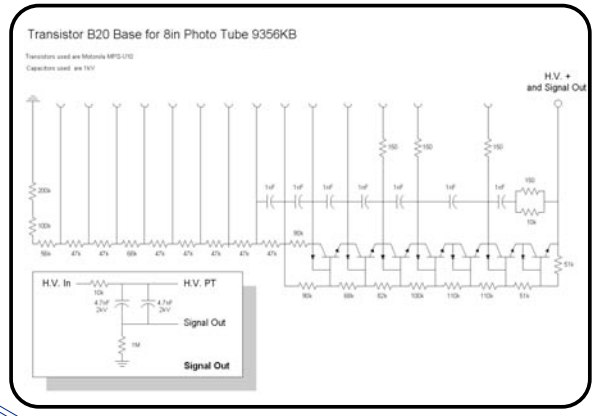

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- Machining starting at
  - IIT (PMT housings)
  - Iowa (radiator box)
  - UMiss (aerogel containers & mirrors)

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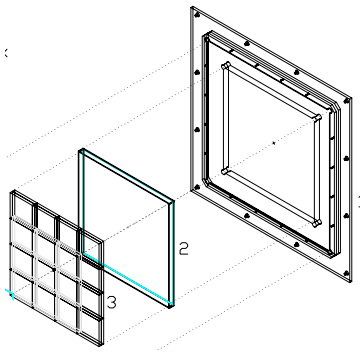
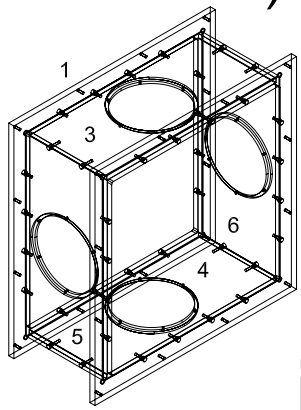
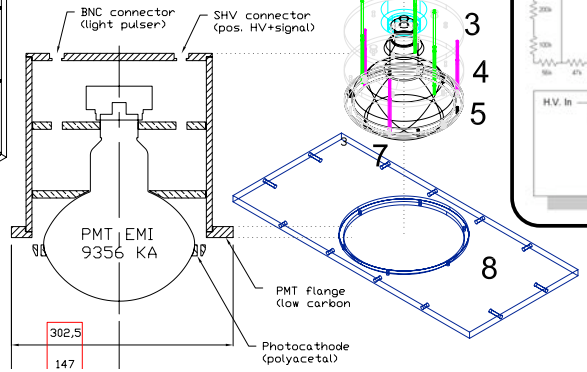
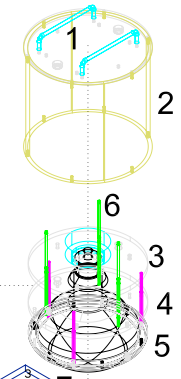
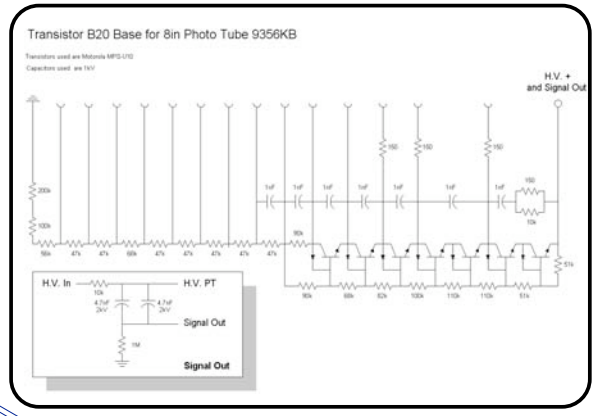










- Aerogel ordered (IIT):

  52 pcs. ea of Matsushita hydrophobic Silica Aerogel:

  HY-80, n = 1.07
  HY-12, n = 1.12

  - suff. for 4 x 4 array, 3 layers thick (1 cm ea) in each detector

➡ On schedule for 7/07 delivery

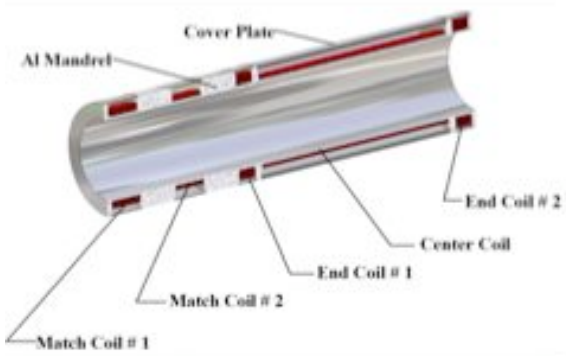
- PMT-base mods in progress (FNAL)

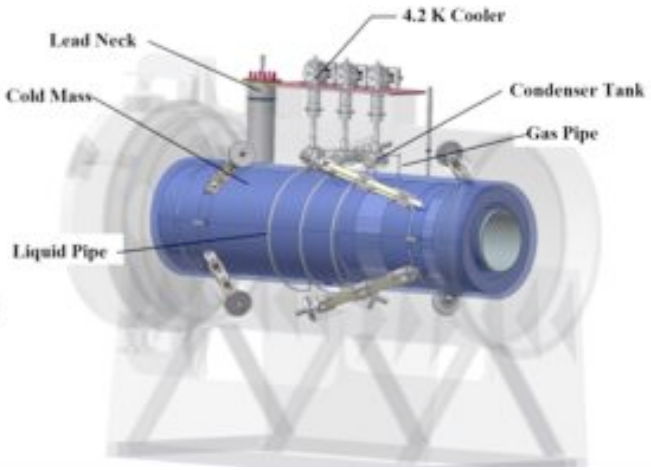
- Machining starting at
  - IIT (PMT housings)
  - Iowa (radiator box)
  - UMiss (aerogel containers & mirrors)

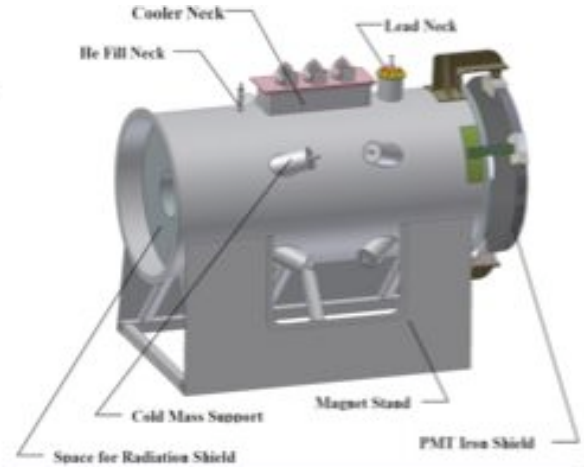
Spectrometer Solenoids

LBNL, IIT

- At last year's MuTAC Review, designs (M. Green, S. Virostek, LBNL) were ≈complete & SC was on order







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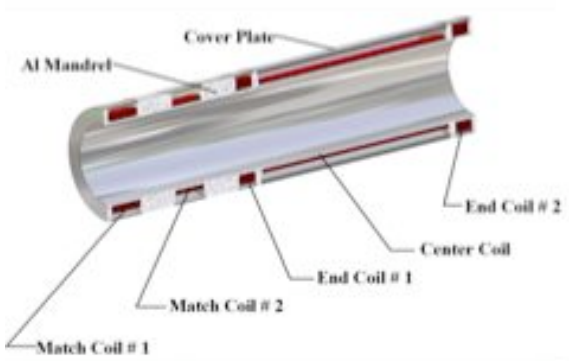

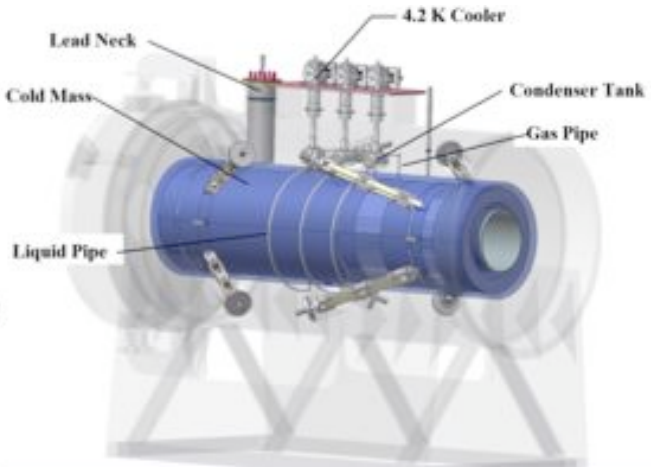

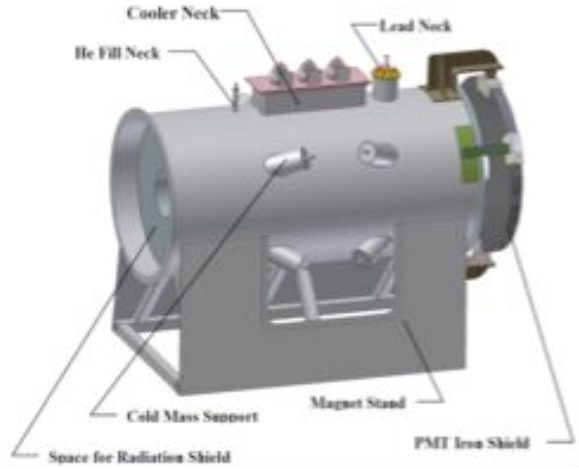

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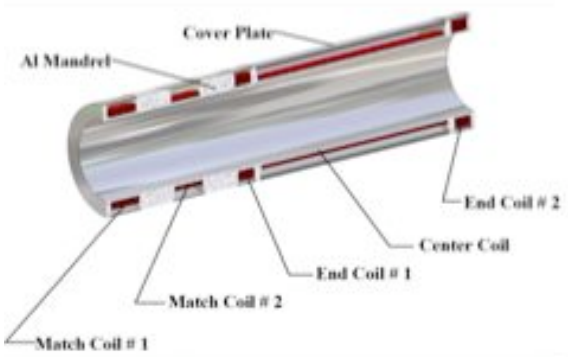

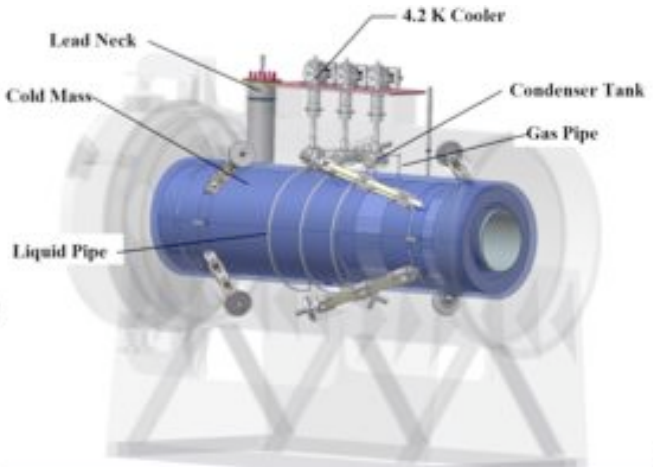

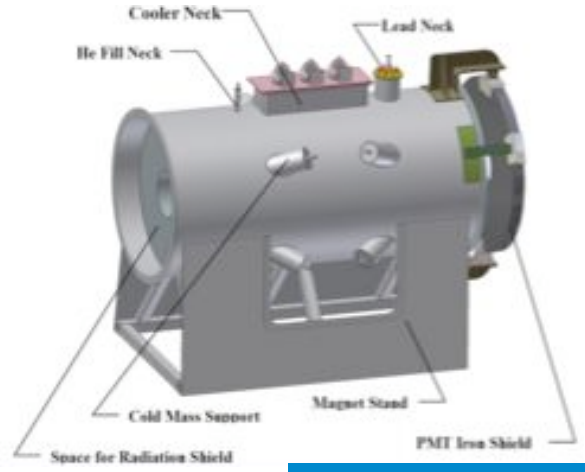

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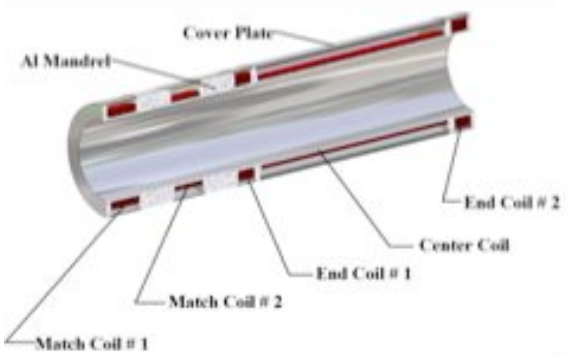

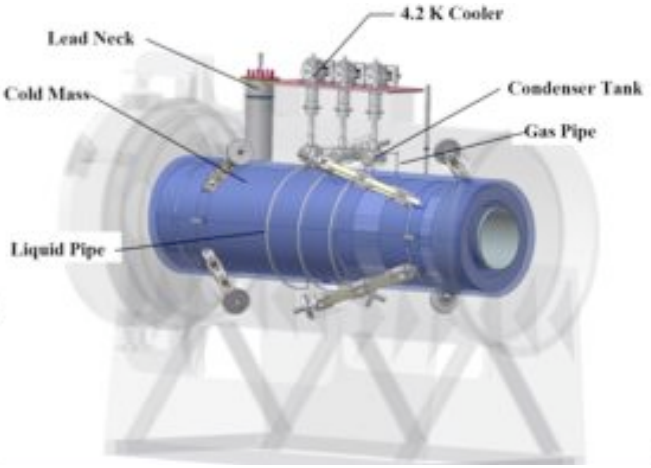

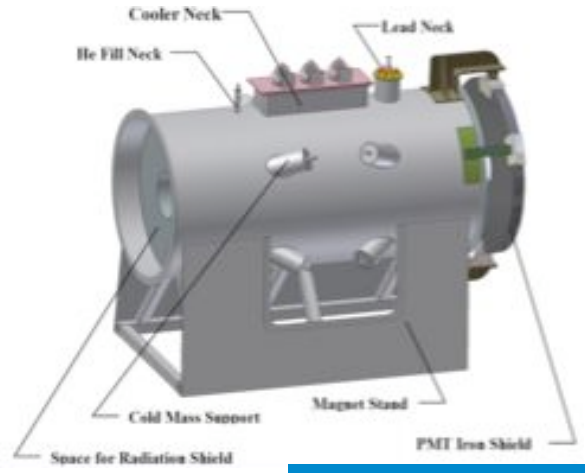

- Solenoid ass'y now in progress at Wang NMR (Livermore, CA)
- 4 cryocoolers purchased & delivered to Wang
- P/S spec out, supplies to be ordered soon

Assembly Progress

Assembly Progress

- Mandrels built

Assembly Progress

- Mandrels built

& passed vacuum tests

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- Winding of 1st-solenoid main coil nearly done as of 1 week ago

Assembly Progress

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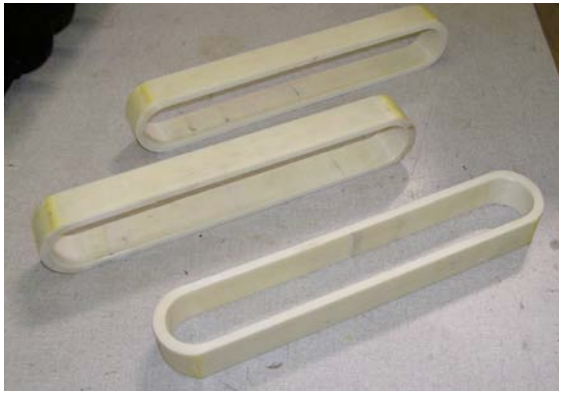

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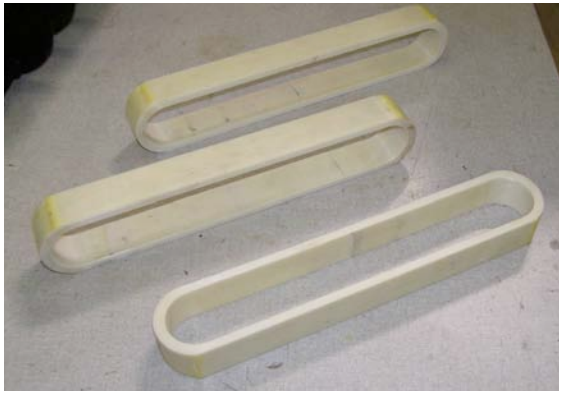

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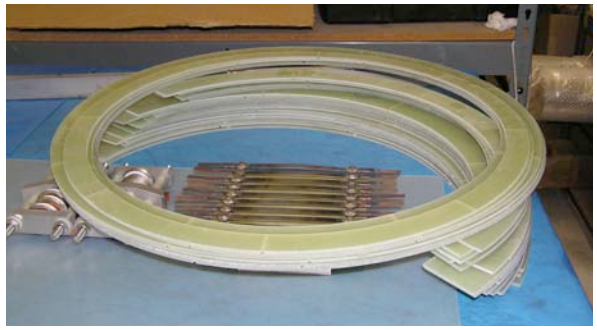
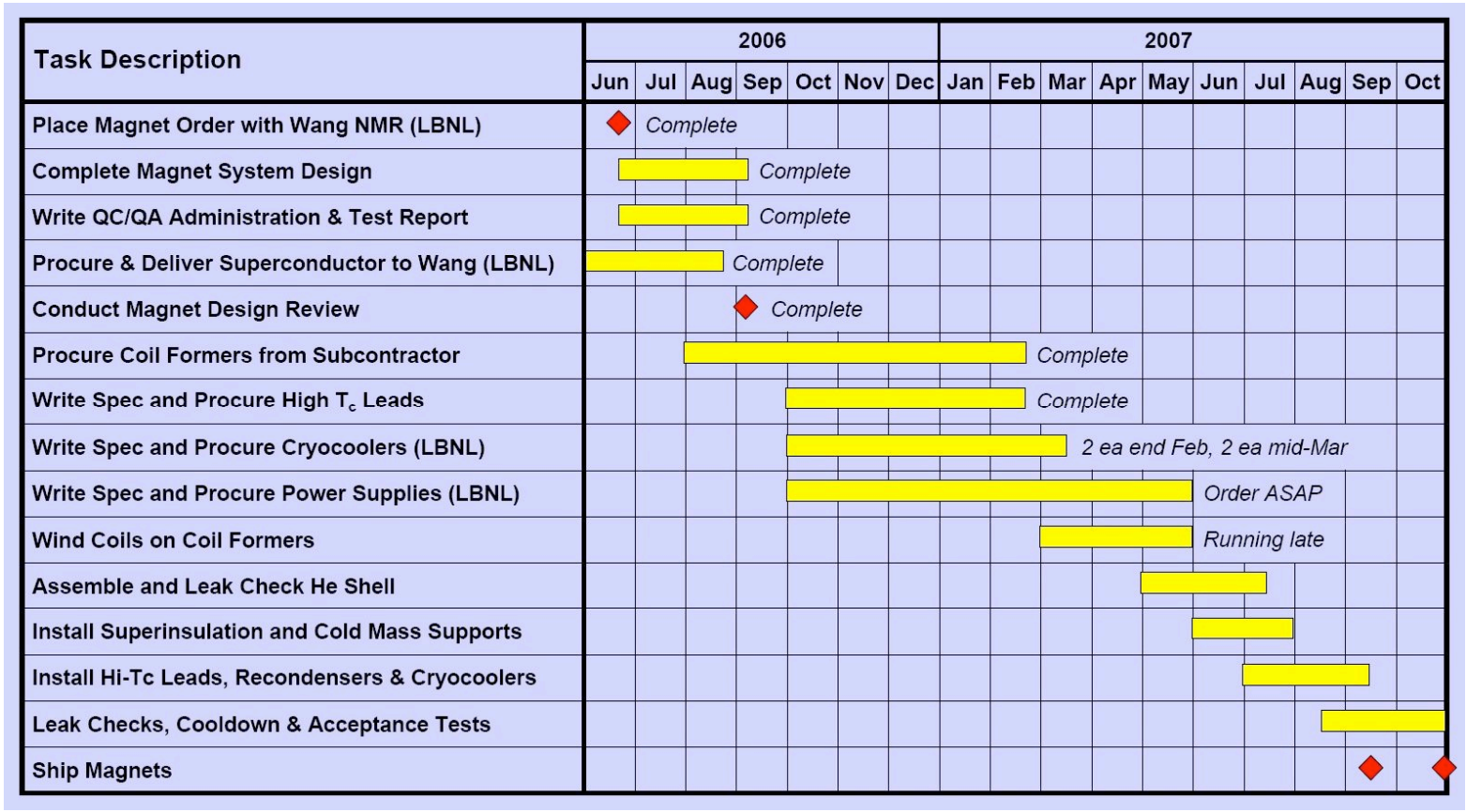


- Insulators & quench-protection parts on hand - also HTS leads

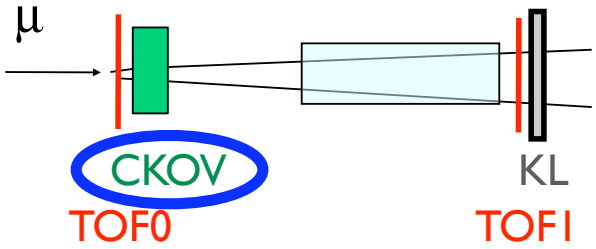
Spect. Solenoid Schedule



- Will ship 1st to FNAL for field mapping, then to RAL

MICE Phase I

- Want 1st PID detectors installed & working when beam turns on (Aug. '07):

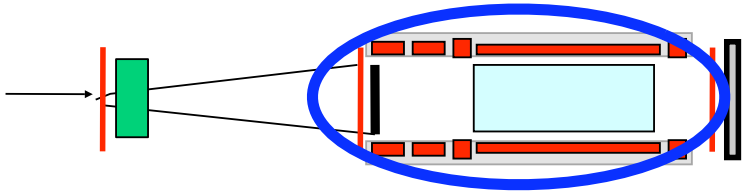


STEP I

1 October 2007

US Responsibilities

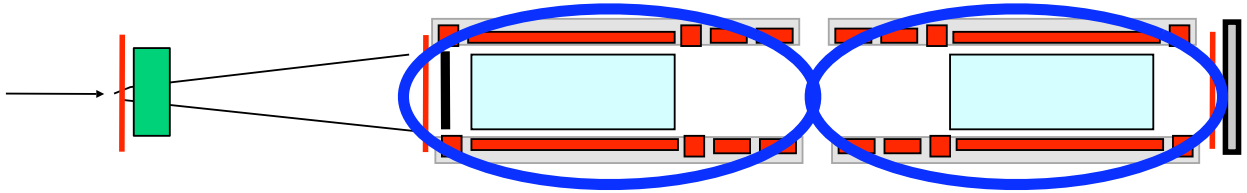
- Want 1st tracker installed & working by Oct. '07...



STEP II

December 2007

...and 2nd tracker a few months thereafter



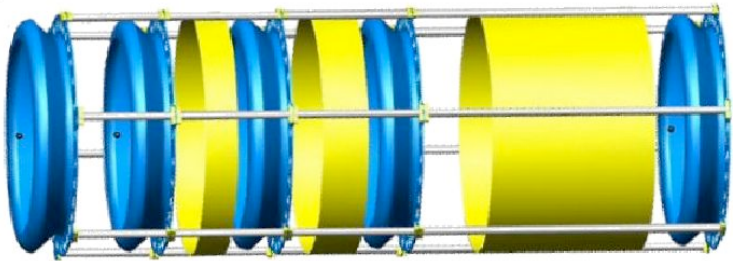
STEP III

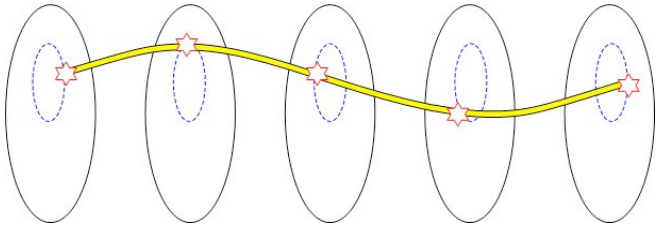
March 2008

SciFi Trackers

UK / US / Japan

- Will sit inside solenoids, reconstruct helical muon tracks





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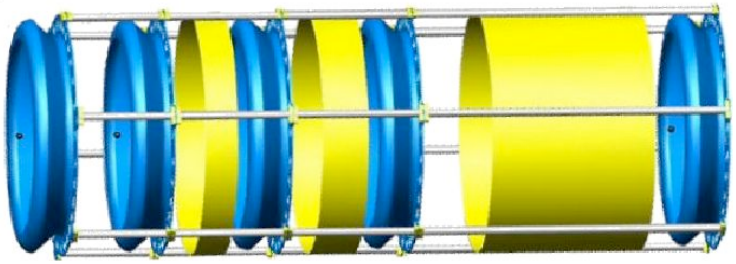
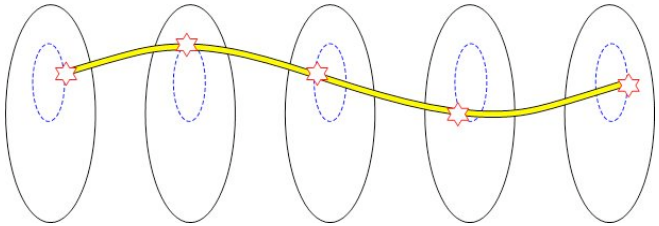
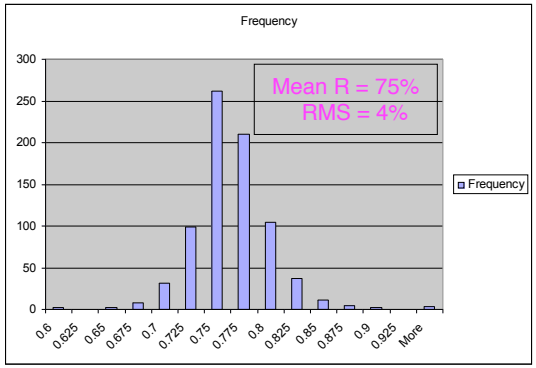




- Fiber-end mirroring complete (FNAL)



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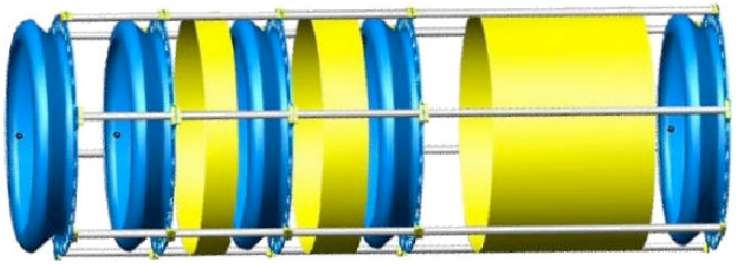

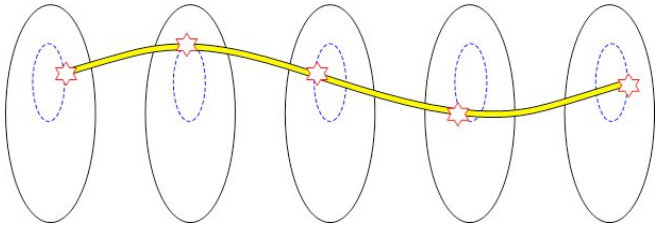

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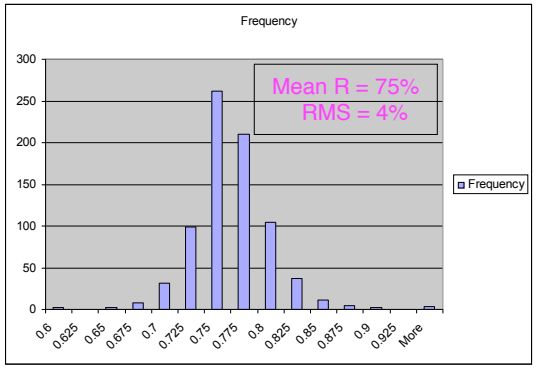
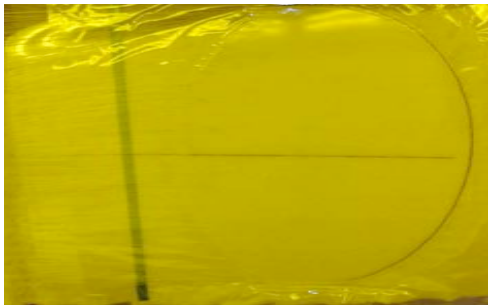


- Ribbon production complete (FNAL)



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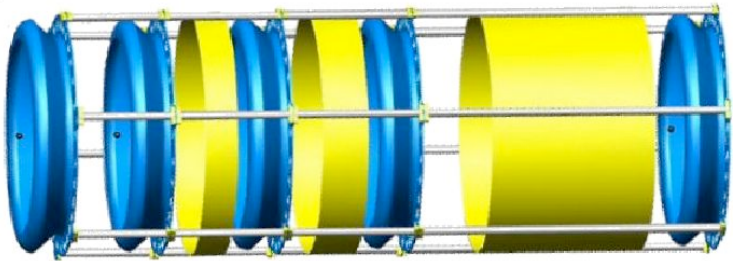

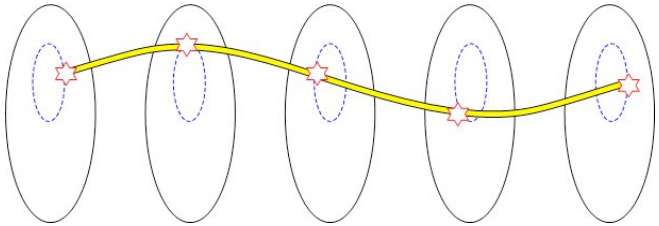

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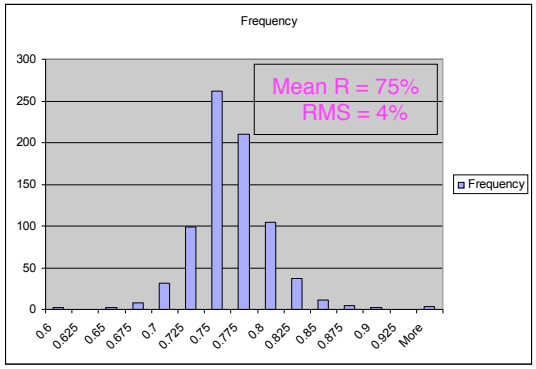

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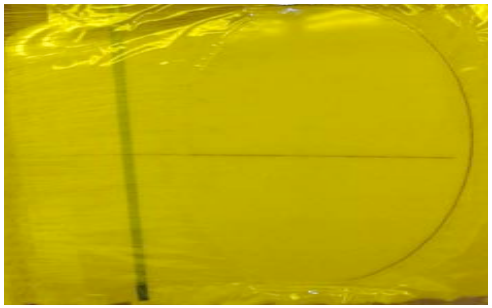

- Station 5 built (UK, US, Osaka) & under cosmic test at FNAL

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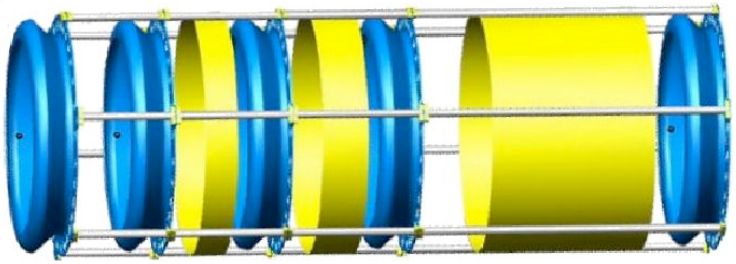

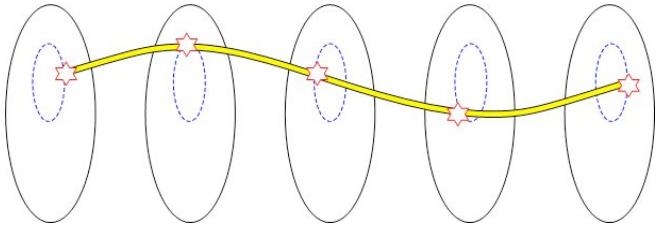

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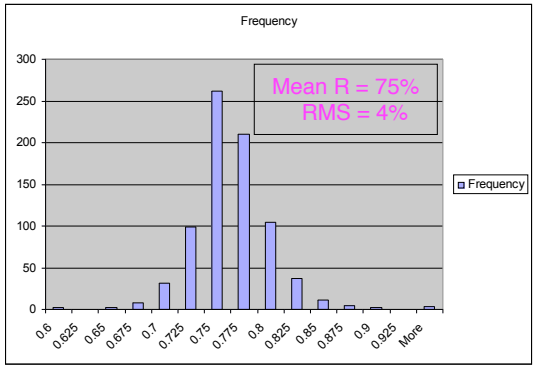

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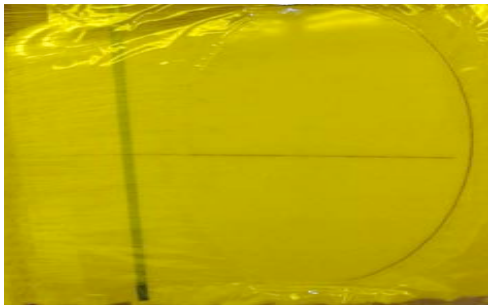

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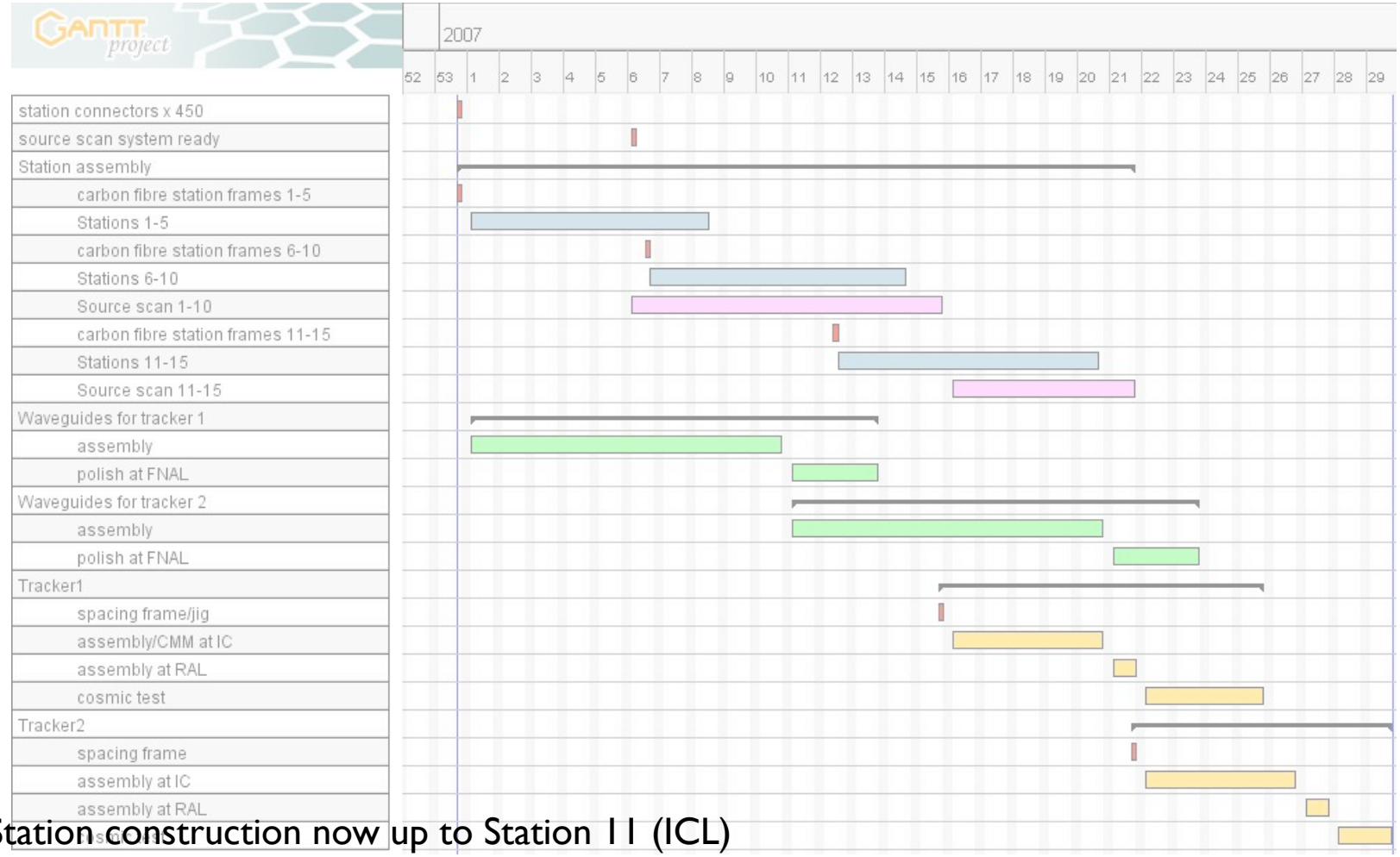
- Station construction now up to Station 11 (ICL)
- Fermilab techs participating @ ICL

SciFi Trackers

UK / US / Japan



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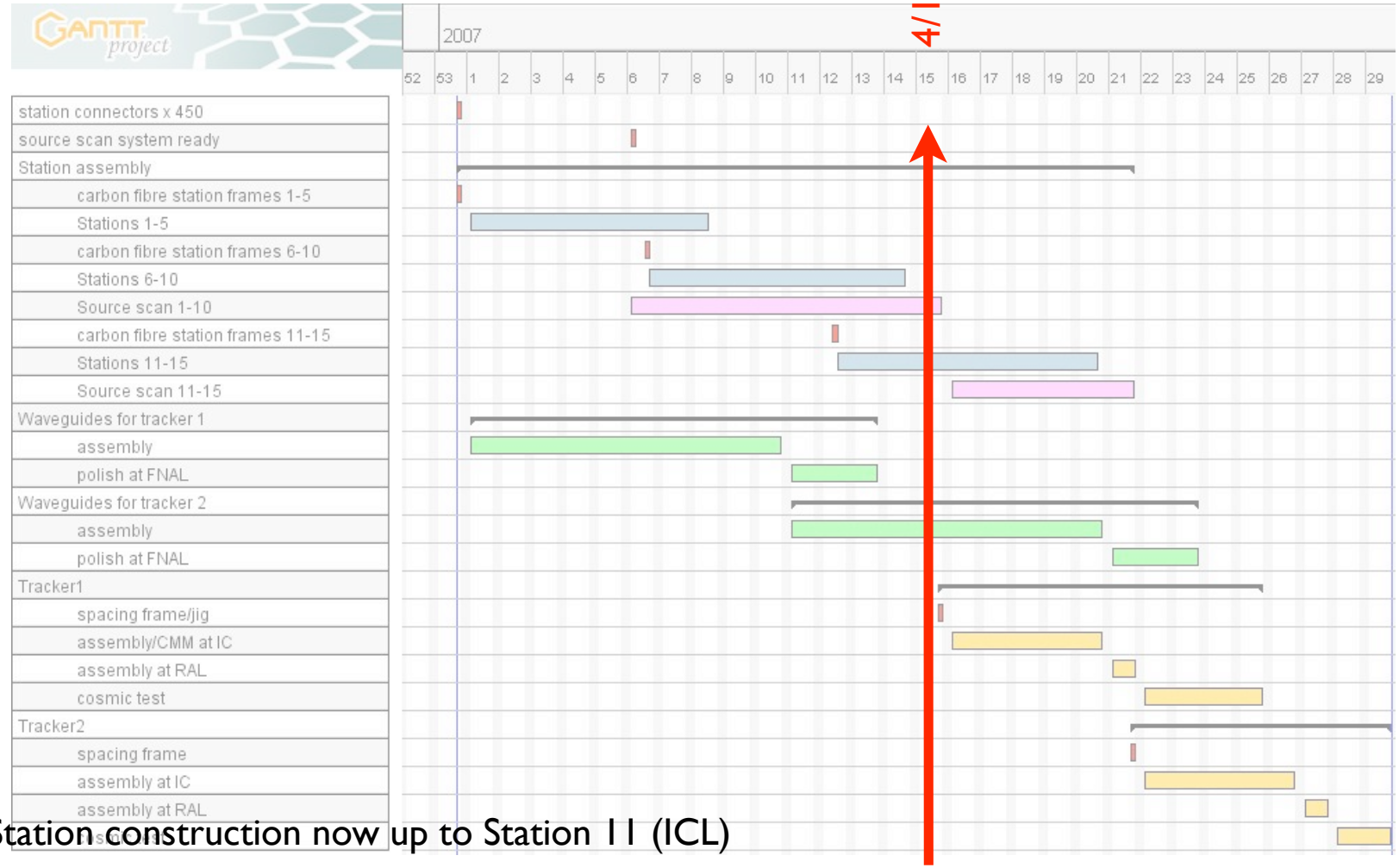

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⇒ ≈ 2 weeks behind (hope to make it up)...

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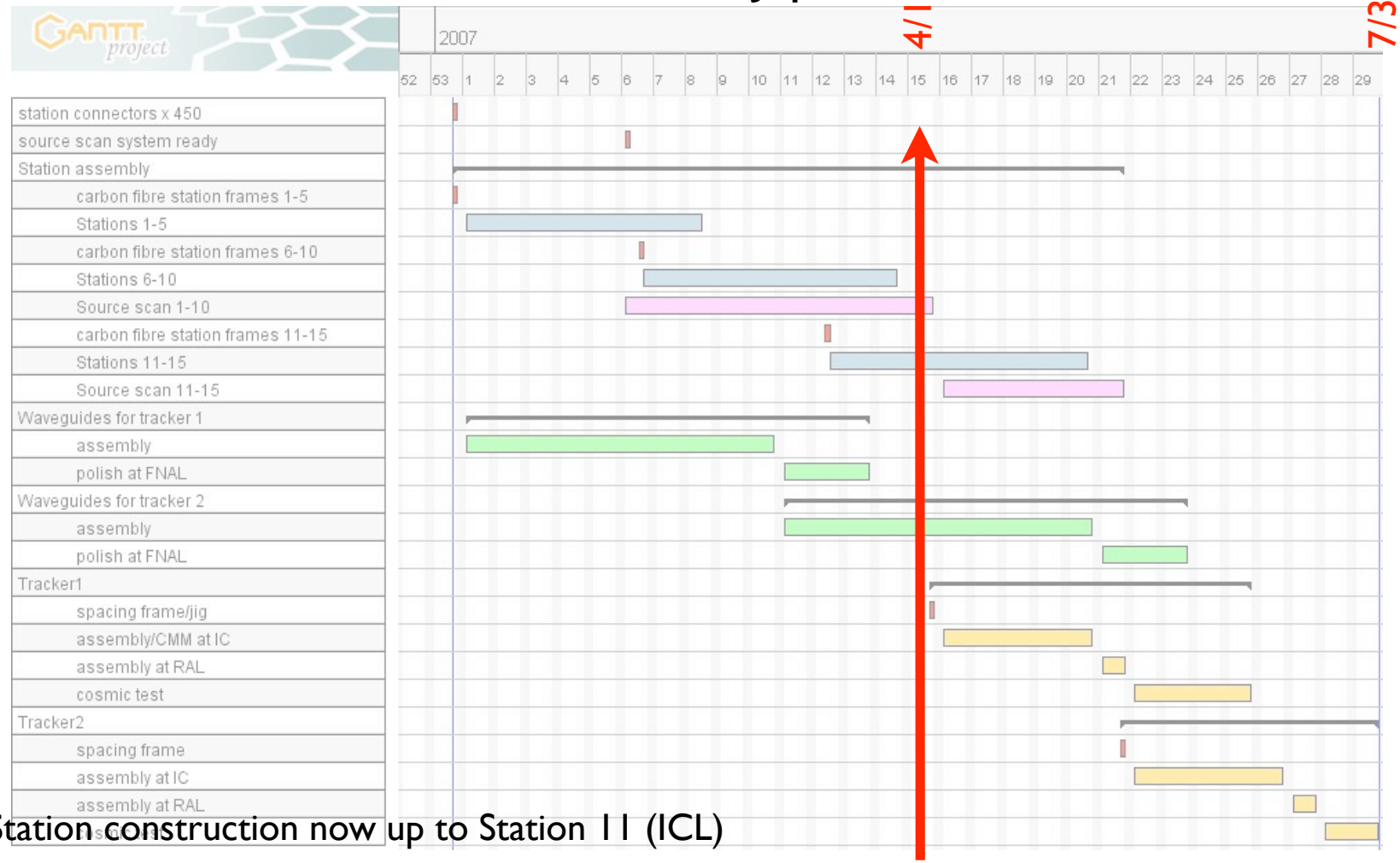
UK / US / Japan



- Station construction now up to Station 11 (ICL)

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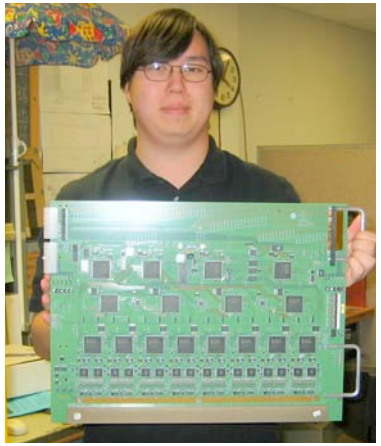
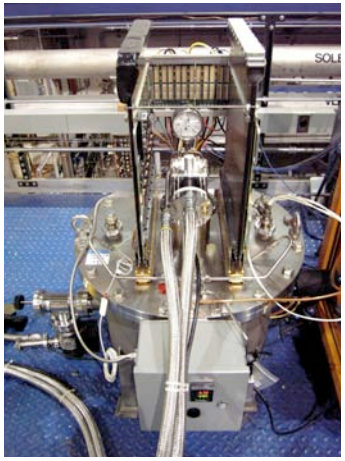
Tracker DAQ

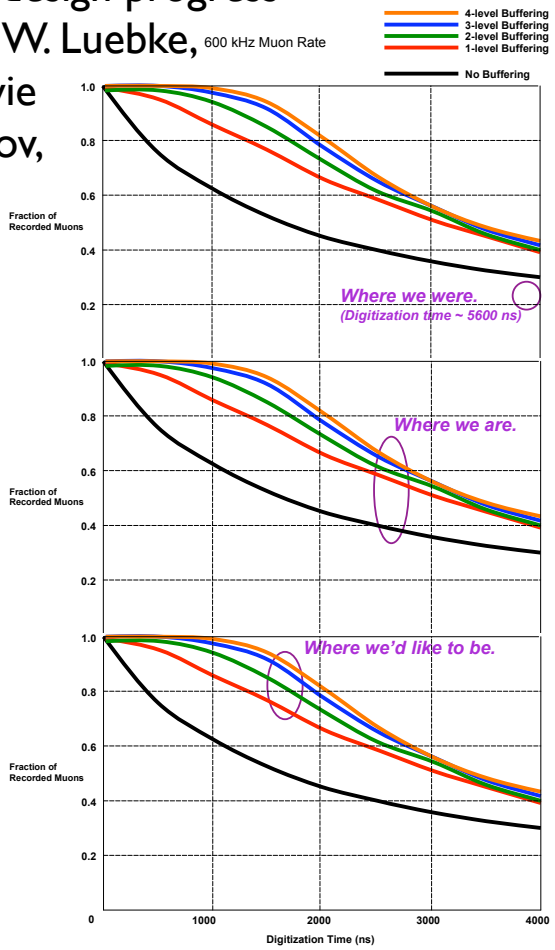
IIT / FNAL / RAL

- Uses AFE-IIt boards designed & built for D0 upgrade
  - Tested last summer by IIT summer students (shown: M. Wojcik)
  - Require new firmware for MICE now under devl. by IIT/FNAL/RAL team
  - Use VLPC photo-detectors at 9 K

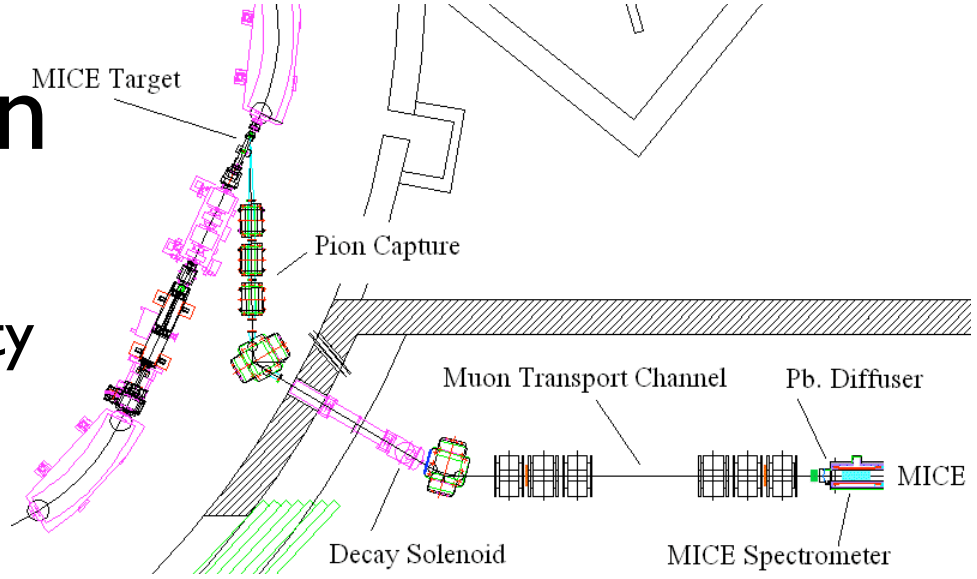




  - 1st MICE VLPC cryostat (R. Rucinski et al., FNAL)
  - Now working stably with sufft. margin for UK 50 Hz AC
  - Firmware design progress (T. Hart & W. Luebke, IIT, K. Bowie & P. Rubinov, FNAL):



Beamline Design



- 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
- G4beamline consistently reports substantially larger emittances than Turtle (used by RAL)
- We believe G4beamline since Turtle neglects fringe fields
- Discrepancy under study by UK groups
- Meanwhile, installation underway since ISIS now in shutdown
- Design passed 6/12/06 external review

Beamline Design

(mm.rad)

Beamline Design

- Need to fill in matrix of running conditions by devising beamline tune for each

p_μ \ ε	1 (mm.rad)	6	10
140 (MeV)	?	?	?
200	?	?	?
240	?	?	?

Beamline Design

- Need to fill in matrix of running conditions by devising beamline tune for each
  - now have preliminary tunes for 6π and 10π mm-rad emittances (G4BL) at 200 MeV/c

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- TOF0 is the major source of beam loss in the muon channel & prevents achieving emittances < ≈4π mm-rad
- Need to evaluate low-emittance running implications:
  - move TOF0 to low-β point? (⇒high rates/channel)

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- Need to fill in matrix of running conditions by devising beamline tune for each
  - now have preliminary tunes for 6π and 10π mm-rad emittances (G4BL) at 200 MeV/c

p_μ \ ε	1 (mm.rad)	6	10
140 (MeV)	?	?	?
200	?	√	√
240	?	?	?

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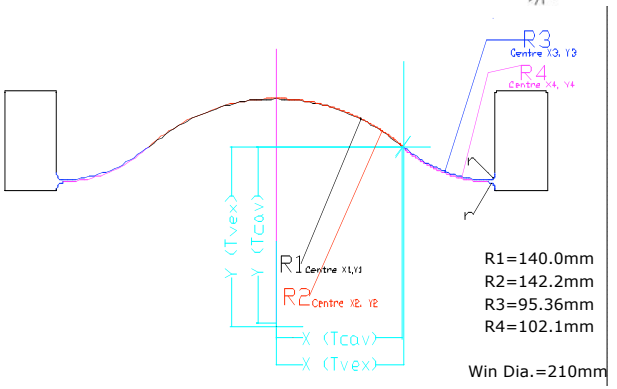
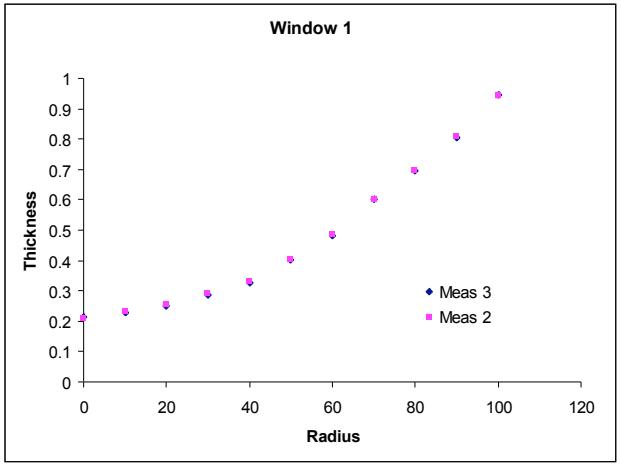
- Installation on track for ≥ Aug. 1 commissioning

Phase II Progress

- Absorber Window progress:
  - Absorbers have thin, custom windows designed by W. Lau (U. Oxford) & E. Black (IIT)
  - Challenging to certify that as-built windows meet specs
  - FNAL & IIT exploring acceptance test using CMM with microforce probe
  - Measurements reproduce:



Specs:
Trigger Force < 10 mg ~ 0.1 mN
Measuring Error ~ 1 μm
Mounted on an table with a robotic arm.



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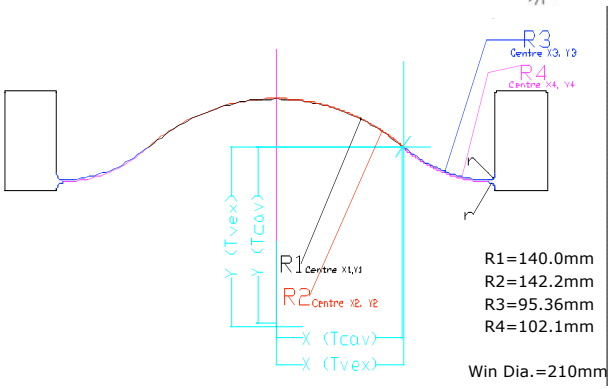

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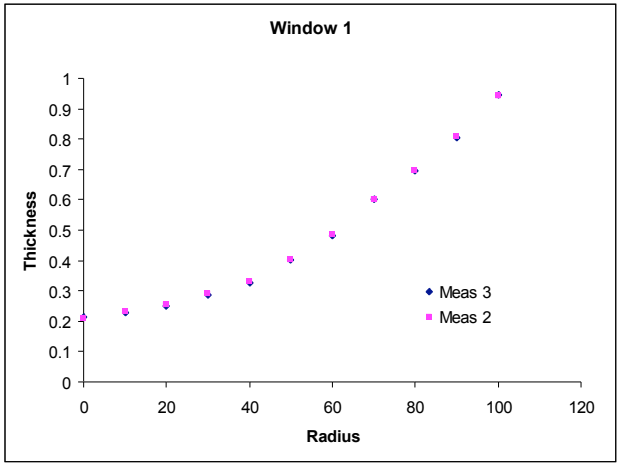

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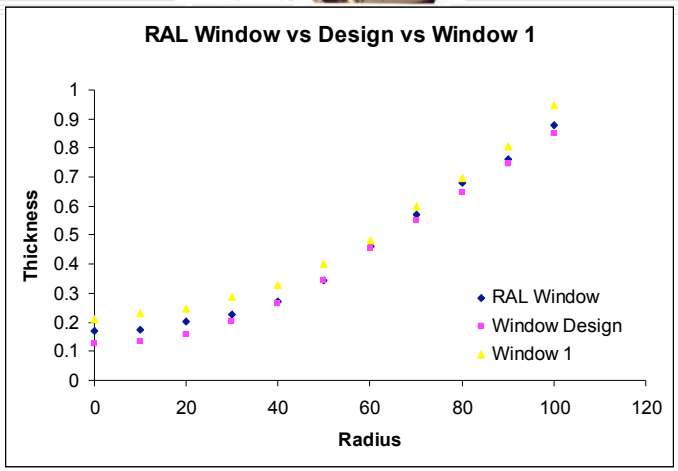

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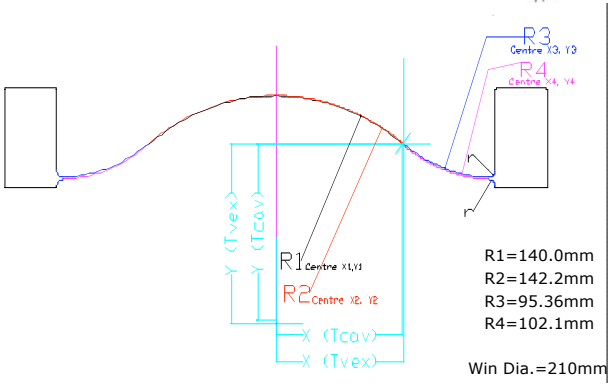

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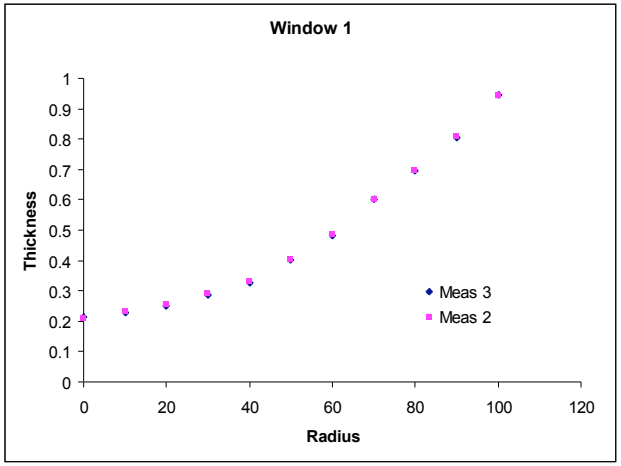

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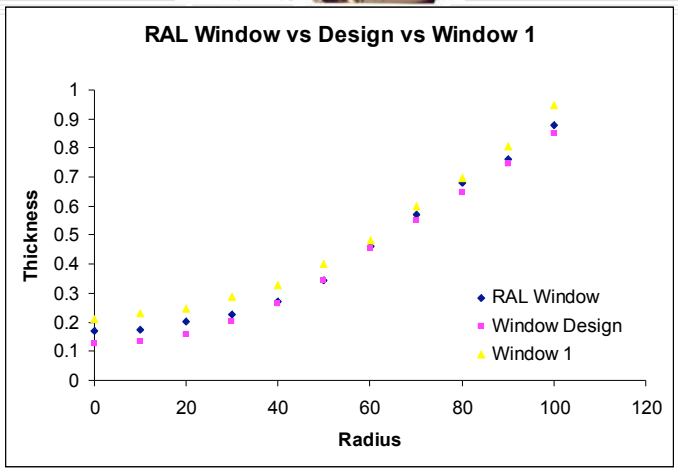
- R&D ongoing



Phase II Progress

- Coupling Coil
  - LBNL has pursued successful negotiations with the Institute for Cryogenic and Superconductivity Technology of the Harbin Institute of Technology, Harbin, PR China
  - ICST has joined MICE Collaboration
  - they have requested funds from HIT
  - expect to learn soon whether request is successful

Phase II Progress

- Coupling Coil Update (as of 4/12/07):
  - ICST is in the process of incorporating and analyzing coil design changes: longer coil, cooling tube scheme
  - Final detailed design of the coupling coil will take place at ICST during the next 4 weeks
  - Mike Green (LBNL) is currently at ICST until next week to assist with design process
  - Coupling coil design review to take place at ICST from May 16th through 19th
  - LBNL and MICE Collaboration representatives will attend the design review

MICE Software

- G4MICE: M. Ellis (FNAL) is MICE Software Coordinator, M. Wojcik (IIT) helping with testing
  - used for extensive studies of tracker test beam results & reconstruction
  - also for PID simulation and reconstruction
- Development work ongoing:
  1. About to release first draft of specs for the Online DB
  2. About to release "final version" (release 1.9) of G4MICE for use in tracker station-spacing studies and GRID jobs
  3. Making progress on PID simulations and reconstruction (thanks to Sofia & Geneva groups)
  4. G4MICE now being used by the MANX experiment proto-collaboration for design studies

MICE Software

- Y. Torun (IIT) was MICE Analysis Forum Convener last year
- Organized the study of a long list of important issues:
  - Time of flight measurements and relation to trigger
  - Algorithm for rf voltage calibration
  - Effects of collimation, scraping in beamline
  - Downstream geometry (sizes of TOF2, EMCal, shields)
  - Rf-induced background in TOF (and with different optics)
  - Global PID performance (up/downstream) in different optics/momentum
  - Beam envelope interference with spectrometer cryostat
  - Effect of variations in window shape, absorber density, etc.
  - Scraping/beam envelope/acceptance through cooling channel and detectors
  - Weighting/virtual beam
  - Performance indicators (transmission, emittance, phase space density,...)
  - Run plan
- Torun now joint Asst. Prof. starting SC cavity R&D pgm at Fermilab
  - J. Cobb (Oxford) has taken over Analysis Forum

Recent Publications

D. Li et al.	201 MHz Cavity R&D for MUCOOL and MICE	EPAC06 Proceedings	2006
D. E. Baynham et al.	A Liquid Cryogen Absorber for Mice	Adv. in Cryogenic Engineering	2006
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- All except the last have important US contributions

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- Deadlines growing more serious
- Manpower a bit thin
- Continuing to attract new collaborators and seek add'l funds
- Things are getting exciting!

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