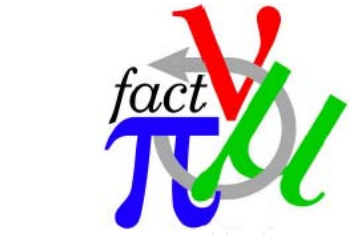
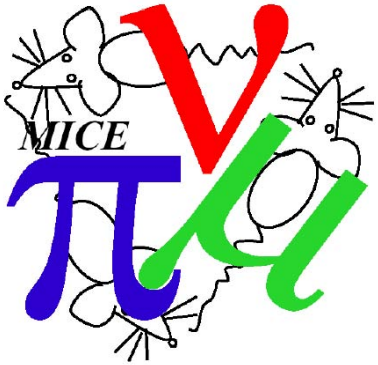


MICE-US: Status and Plans

Daniel M. Kaplan

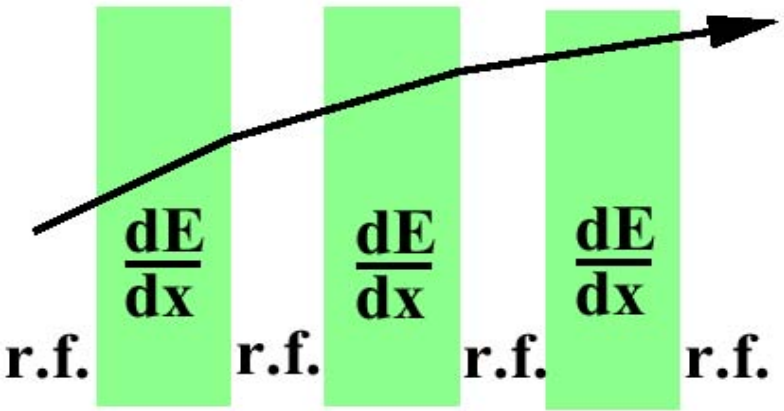


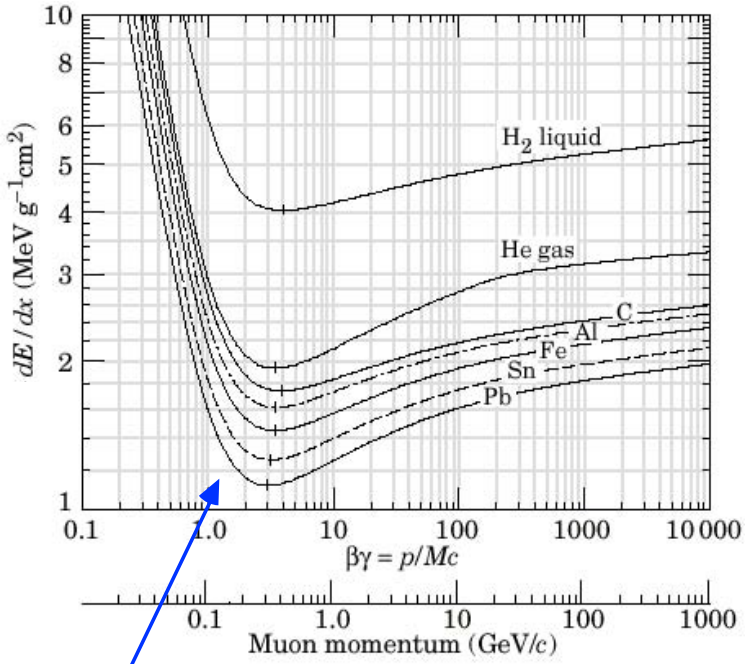
MUTAC Review
Lawrence Berkeley National Laboratory
April 25, 2005

Outline:

1. MICE
2. US Contributions to MICE
3. Funding
4. Summary

Ionization Cooling: Background





- Absorbers:

$$\begin{cases} E \rightarrow E - \left\langle \frac{dE}{dx} \right\rangle \Delta s \\ \theta \rightarrow \theta + \theta_{space}^{rms} \end{cases}$$

ionization energy loss

multiple Coulomb scattering

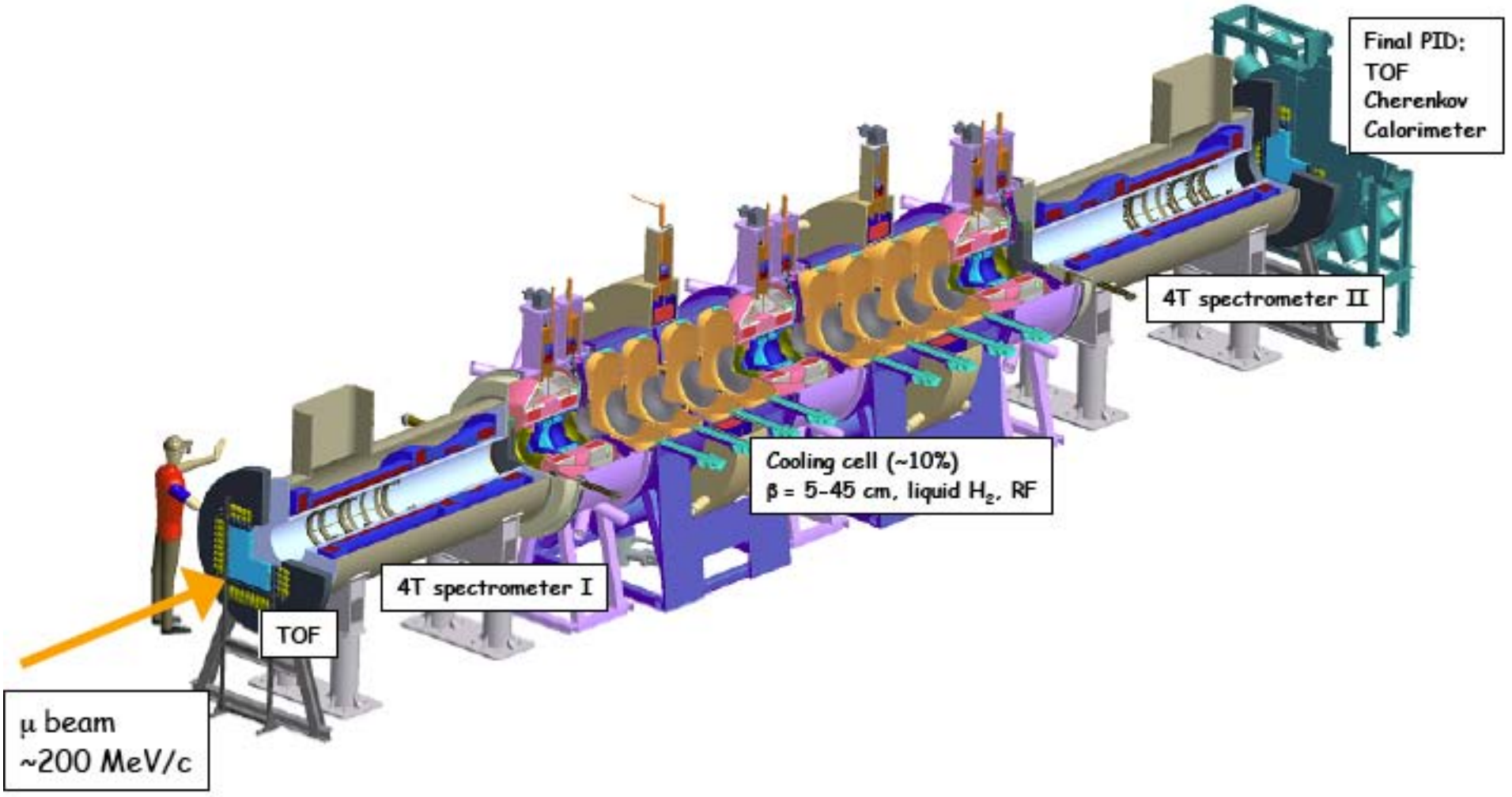
- RF cavities between absorbers replace ΔE
- Net effect: reduction in $p_\perp$ w.r.t. $p_\parallel$, i.e., transverse cooling

Note: The **physics** is not in doubt

$\Rightarrow$ in principle, ionization cooling **has** to work!

... but in practice it is subtle and complicated so a test is important

MICE



Goals of MICE:

- to show that it is possible to design, engineer and build a section of cooling channel capable of giving the desired performance for a Neutrino Factory;
- to place it in a muon beam and measure its performance in a variety of modes of operation and beam conditions.

Current Status:

24 Oct '03: MICE approved!

- CCLRC (letter from John Wood, Chief Exec., Council for the Central Laboratory of the Research Councils)

  "...accepts the strong endorsement of the proposal by the Astbury panel and consequently considers the proposal to have full scientific approval."

  "...approves the project subject to satisfactory passage through Gateway."

20–21 Dec '04: Gateway 2/3 Review (prerequisite to funding – passed)

21 Mar '05: MICE (Phase 1) funded!

- UK Science and Innovation Minister, Lord Sainsbury:

  "It is a testament to the UK's world class science and facilities that leading experimental physicists from across the globe have supported conducting a project of this calibre in the UK. The Government's investment in this experiment will provide a unique showcase of UK scientific and engineering technology..."

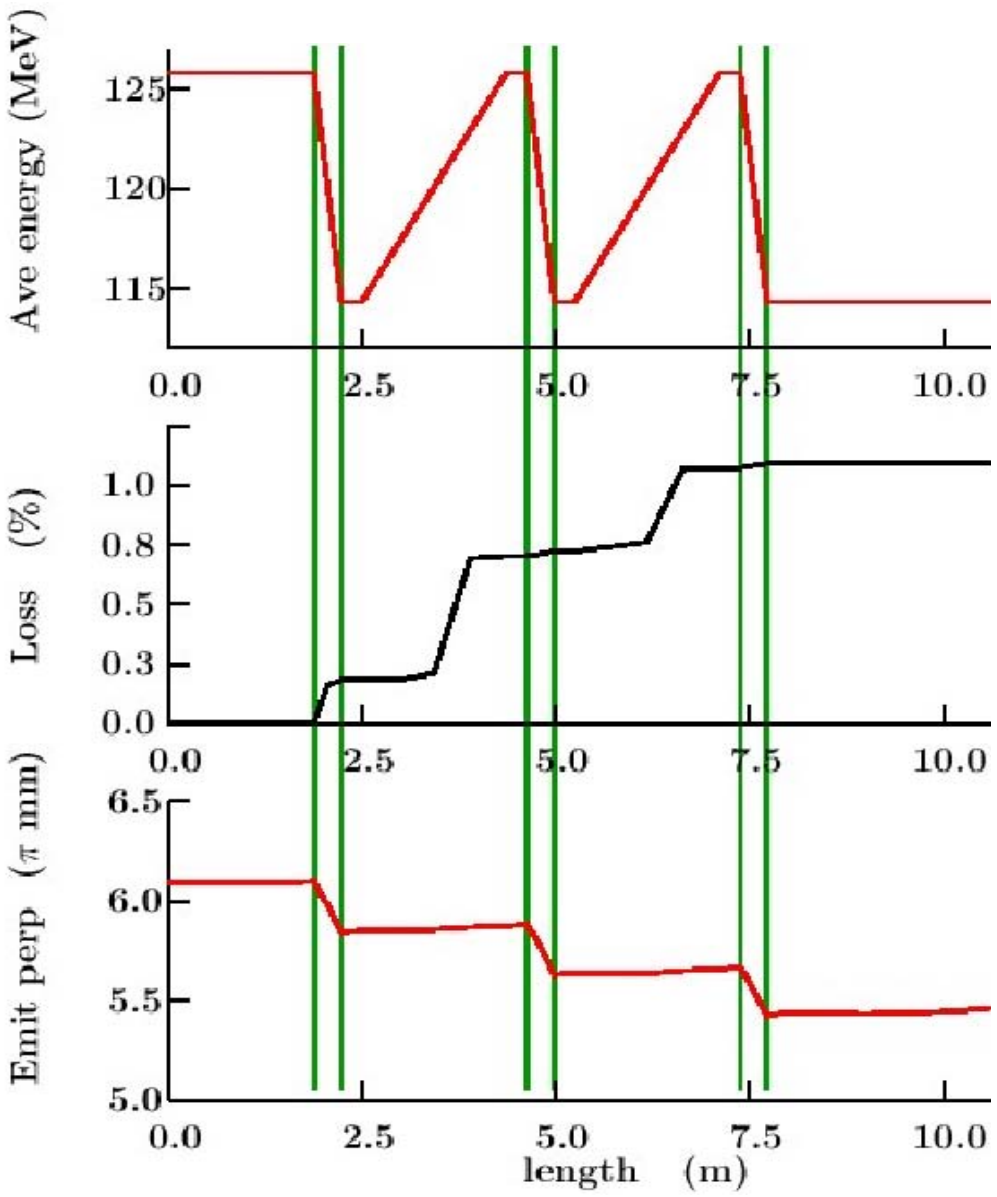
- £9.7M UK funds released ≈April '05

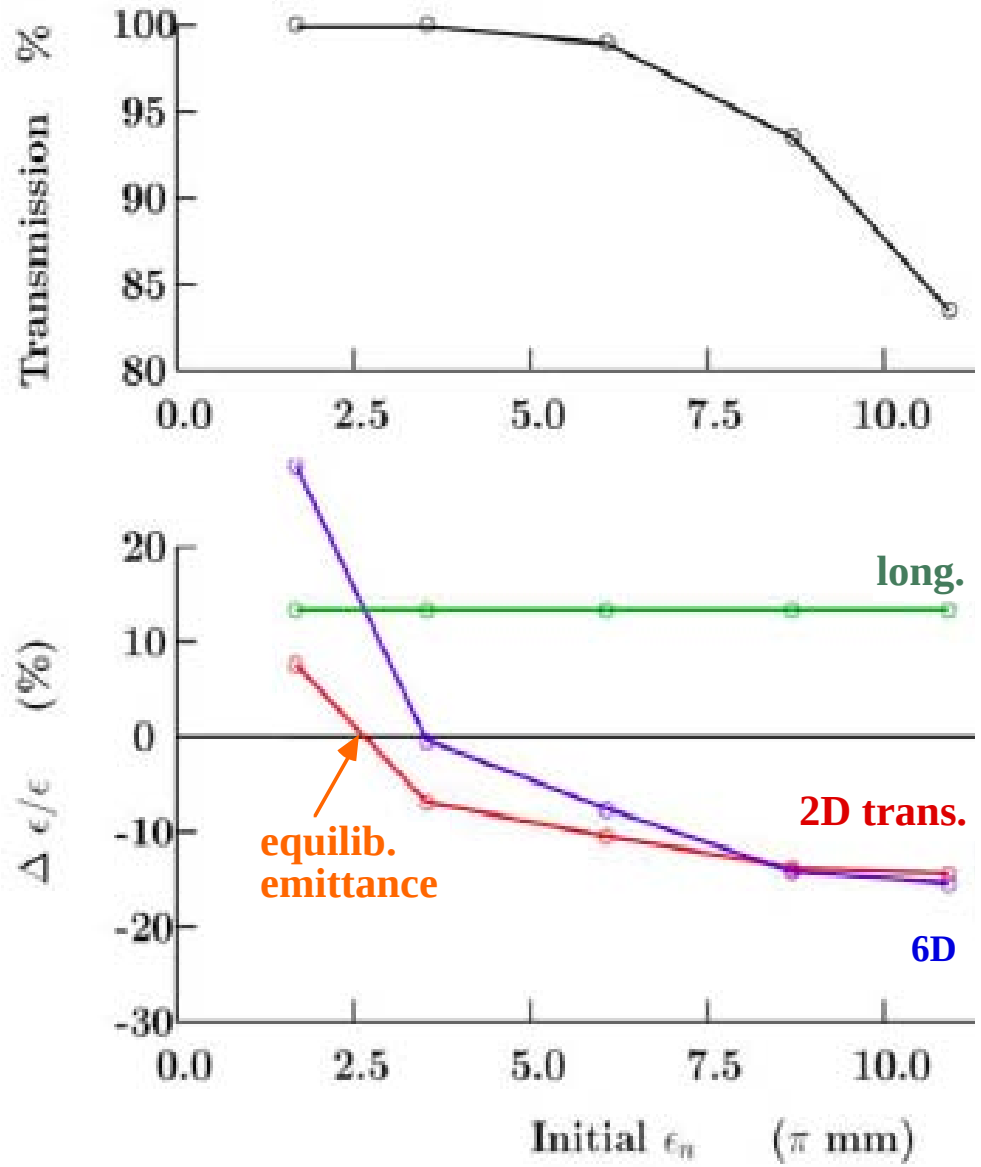
US Contributions to MICE:

- Muon Collaboration developing cooling-cell components to be tested in MICE, including
  - high-gradient 201-MHz RF cavities
  - LH_2 absorbers
- Within MICE, US collaborators responsible for
  - cooling-cell concepts and simulation (Palmer/Fernow/Gallardo, BNL)
  - beamline simulations (T. Roberts, Muons, Inc.)
  - software development and simulation (Y. Torun, IIT)
  - RFCC cooling-cell modules (LBNL)
  - thin windows for LH_2 absorbers (Cummings et al., NIU/IIT/FNAL/UMiss/Oxford)
  - upstream Cherenkov counter for incoming-muon ID (UMiss)
  - VLPC readout & fiber prep for SciFi trackers (FNAL/IIT/UCLA/UCR)
  - oversight & leadership (Zisman/Bross/Kaplan/Torun)
- Additional responsibilities we have taken on:
  - spectrometer solenoids (so far not funded by Italy, 1st one needed on “Day 1”)
  - RF power (2 surplus supplies contributed by LBNL)

Performance Simulation (nominal SFOFO mode):

(BNL ICOOL simulation)



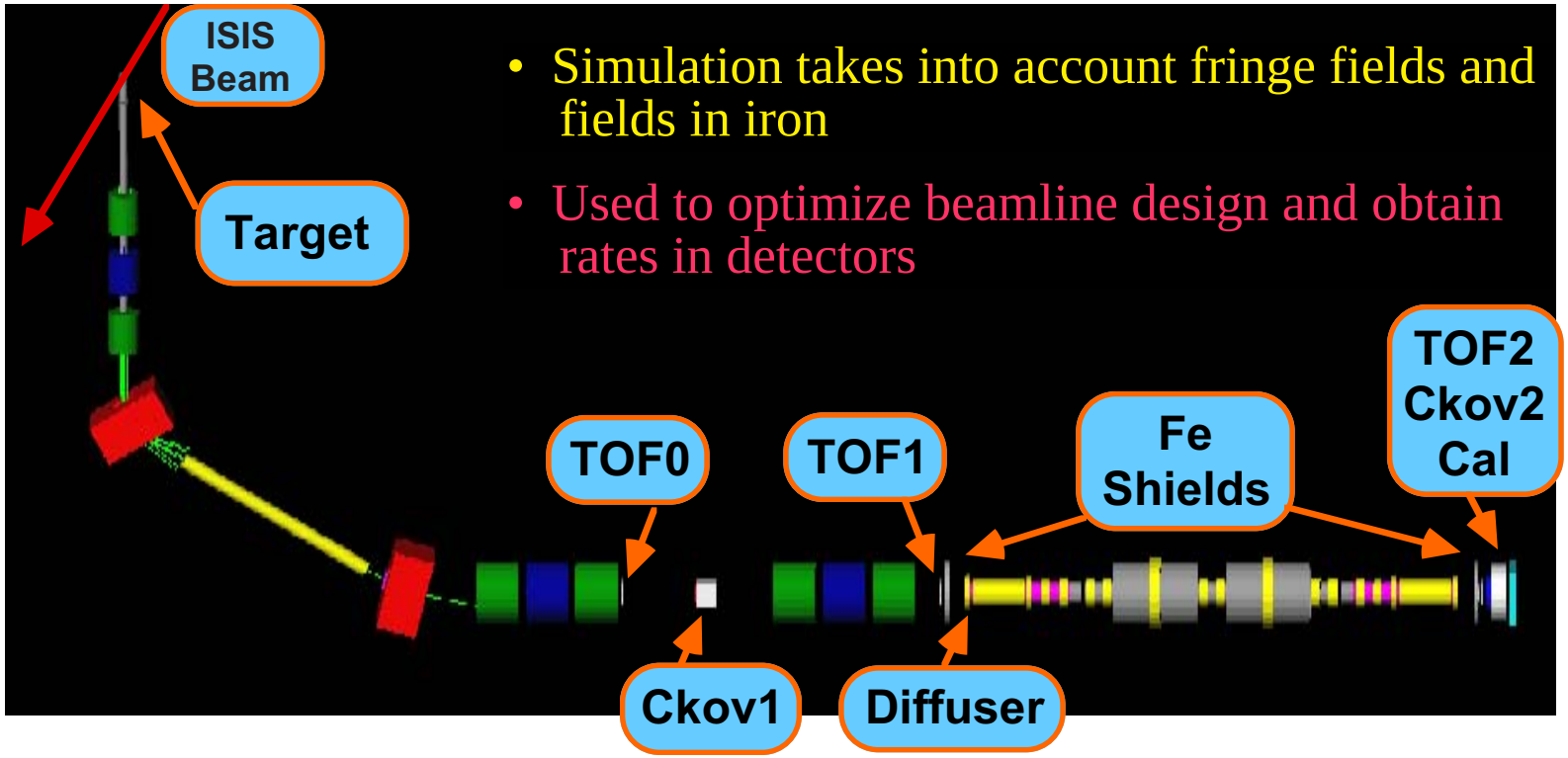


→ ≈10% transverse emittance reduction, measurable to 0.1% (abs.) given precise spectrometer, clean beam, and efficient, redundant particle ID

Beamline Simulation

(T. Roberts, Muons, Inc.)

- While at IIT, T. Roberts developed "g4beamline" to simulate MICE beam:



- Optimized beam rates per "target-in" ms (occuring once per s):

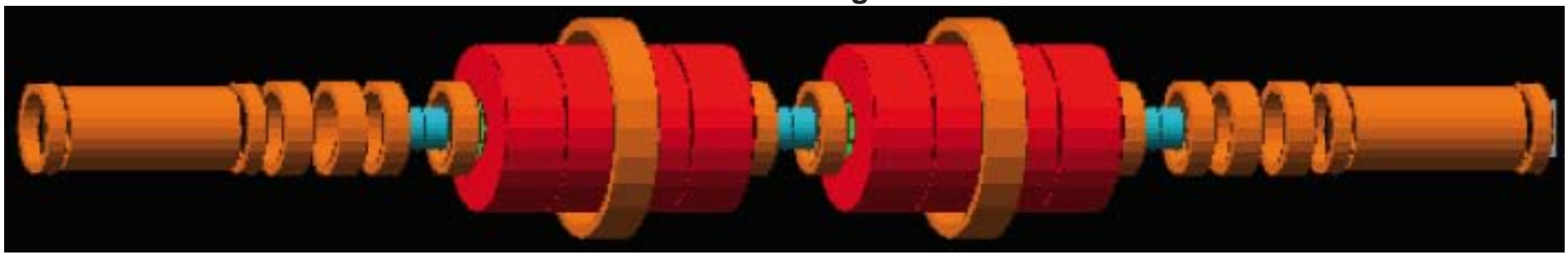
Description	LAHET	Geant4	MARS
1mm x 100mm, 10m from target			33,400
TOF0	2355	2693	2834
TOF1	462	529	557
Tracker1	422	482	507
Tracker2	284	324	342
TOF2	281	321	338
Good μ^+	277	316	333

G4MICE Experiment Simulation

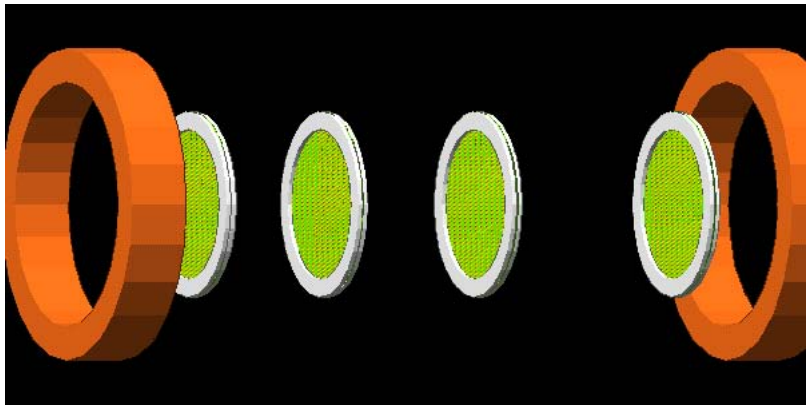
(IIT / BNL / Geneva / ICL / UCR et al.)

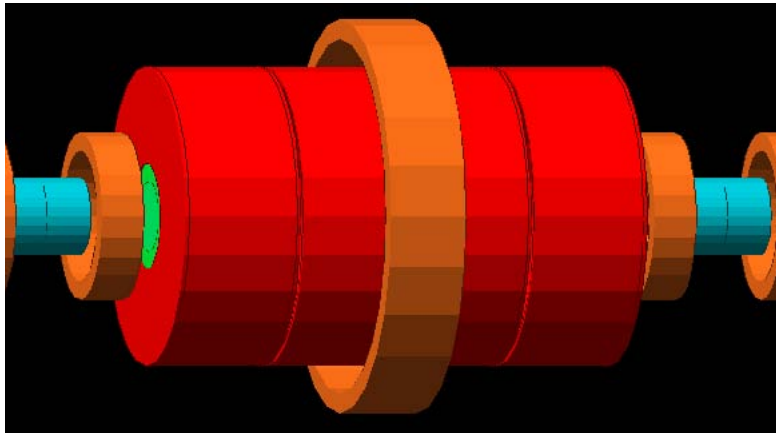
- Under development by international team under leadership of Y. Torun

Screen shot of the magnetic lattice:



View with the solenoid removed showing scintillating-fiber tracking stations:





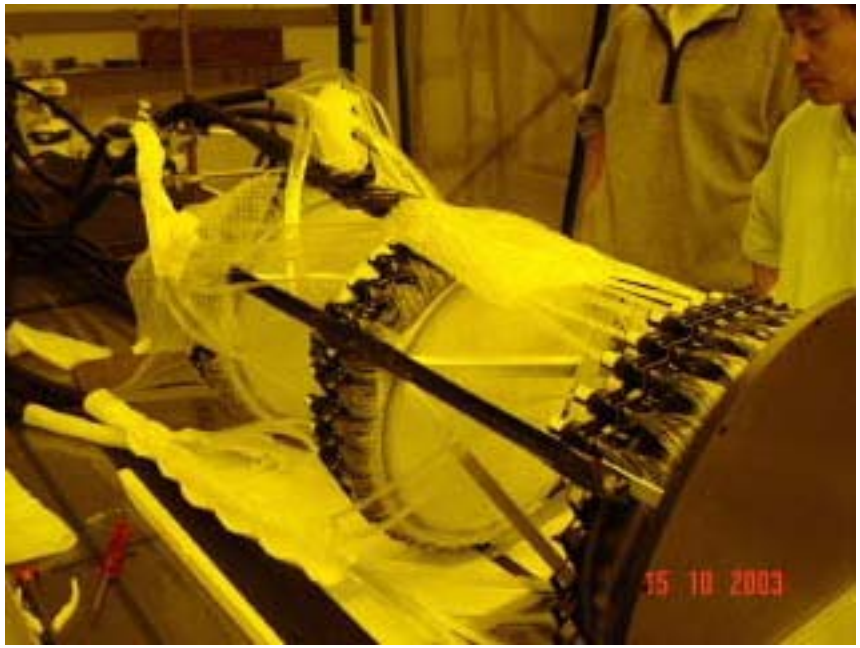
Cooling 1/2-cell: two absorbers (blue), three coils (brown), two focusing and one coupling, and four rf cavities (red)

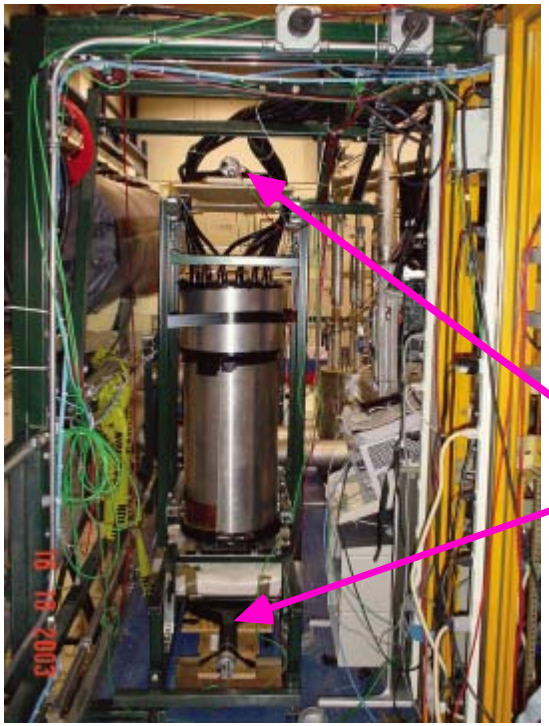
- Geant 4 simulation generates hits on detectors taking all relevant physics processes into account
- Used to study effectiveness of PID, systematics of emittance reconstruction, etc.

Tracker Progress:

(UK / FNAL / IIT / KEK / Osaka / UCLA / UCR)

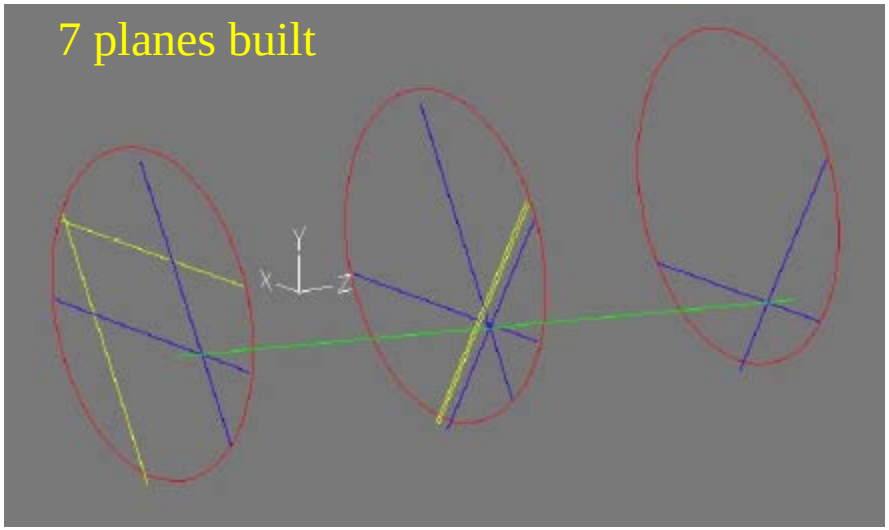
Assembly of 3-station SciFi prototype



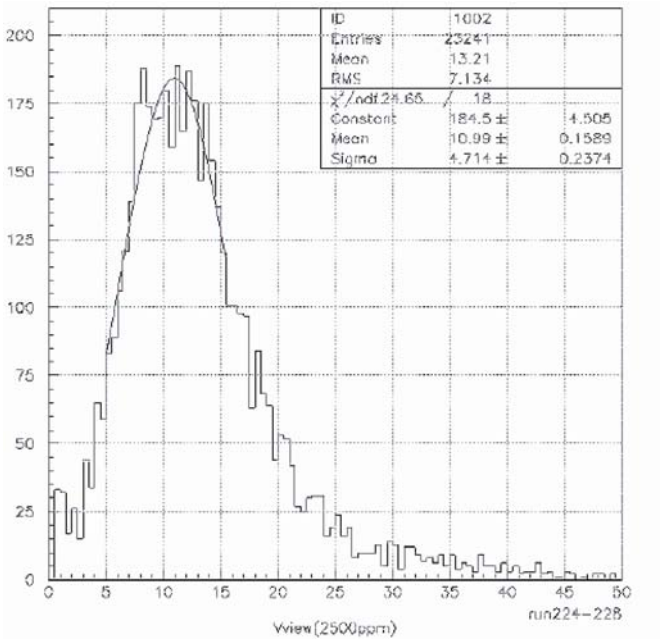


Mounted in D0 cosmic test stand

trigger scintillators



"Typical" event

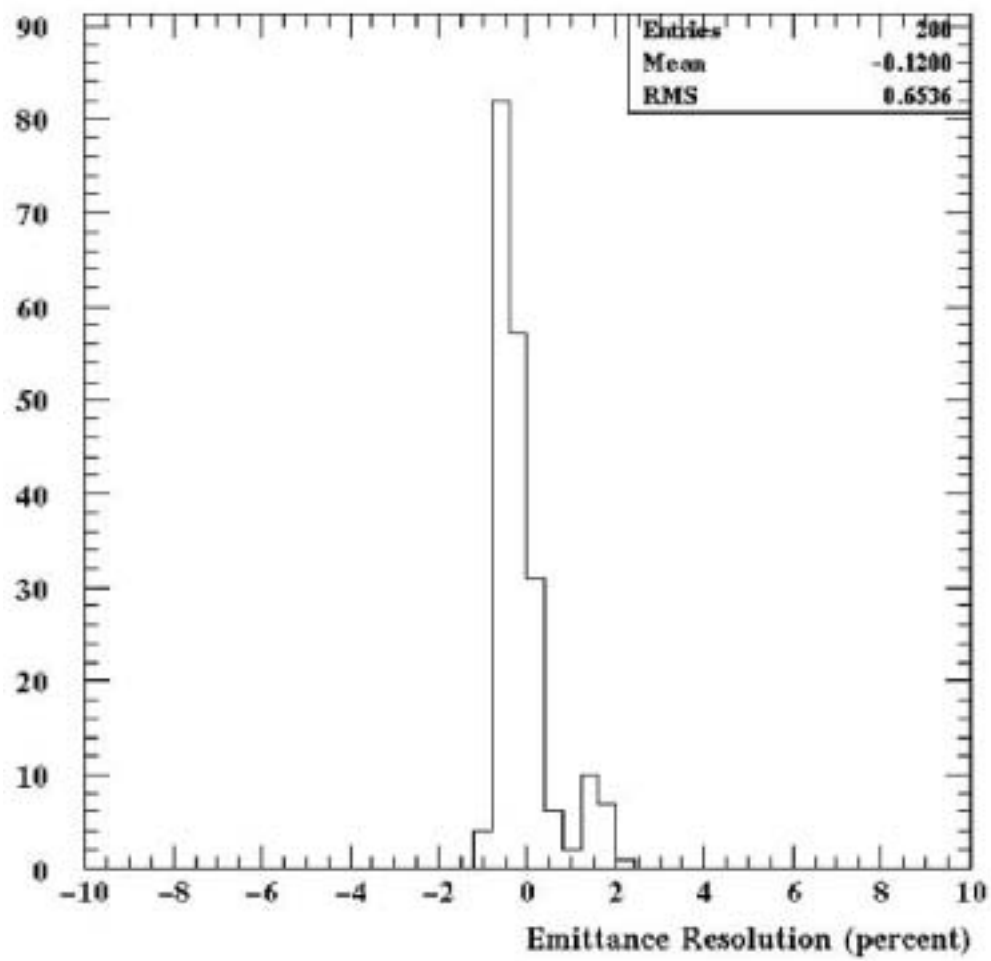


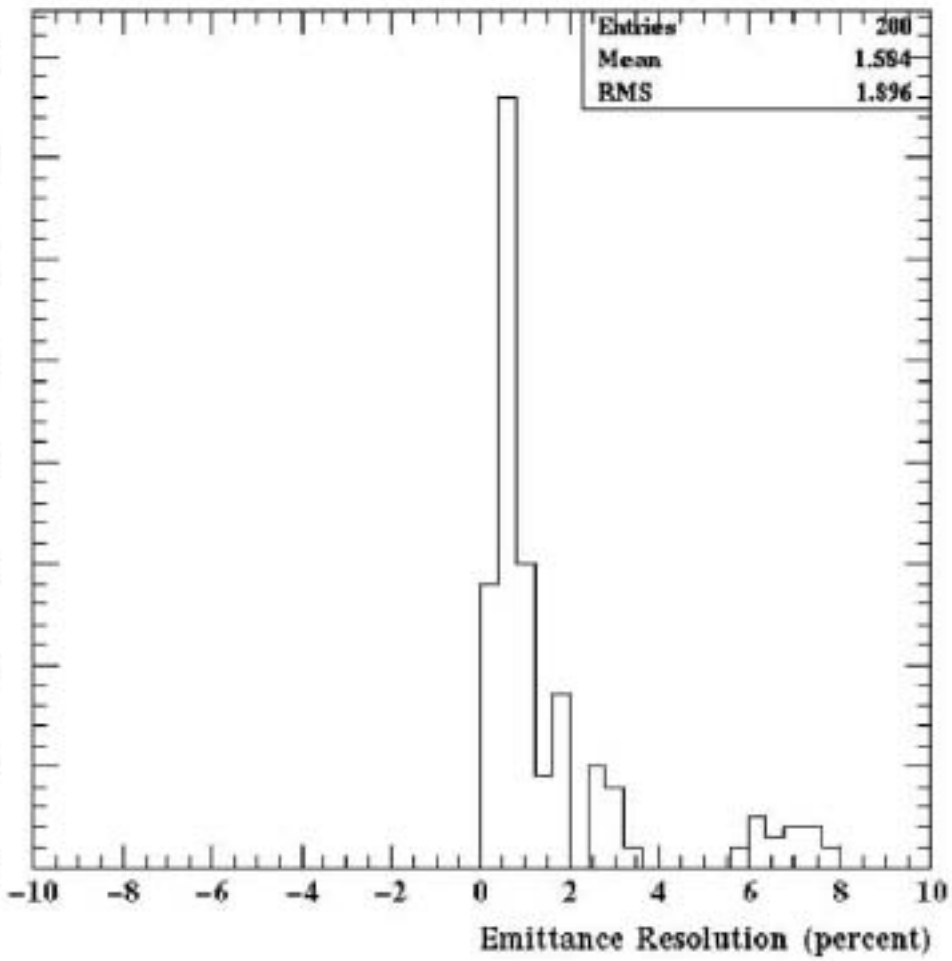
Pulse-height spectrum (mean ≈ 11 p.e.)

Tracker Performance Simulation:

(C. Rogers, ICL G4MICE simulation)

- Correctable ~1% bias due to scattering in detectors:



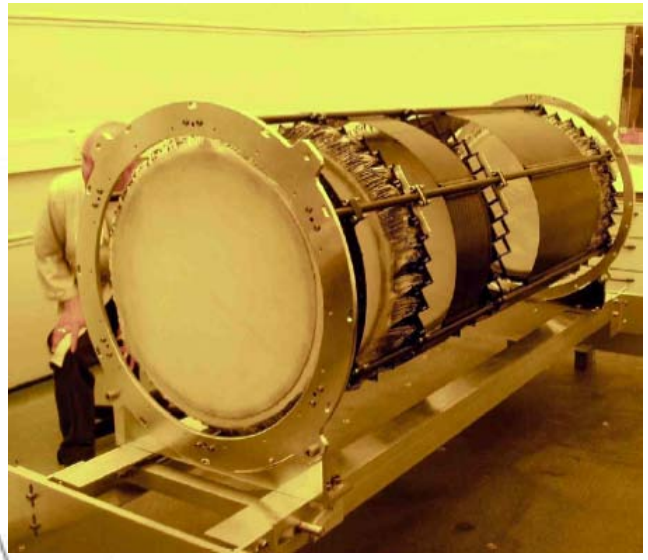


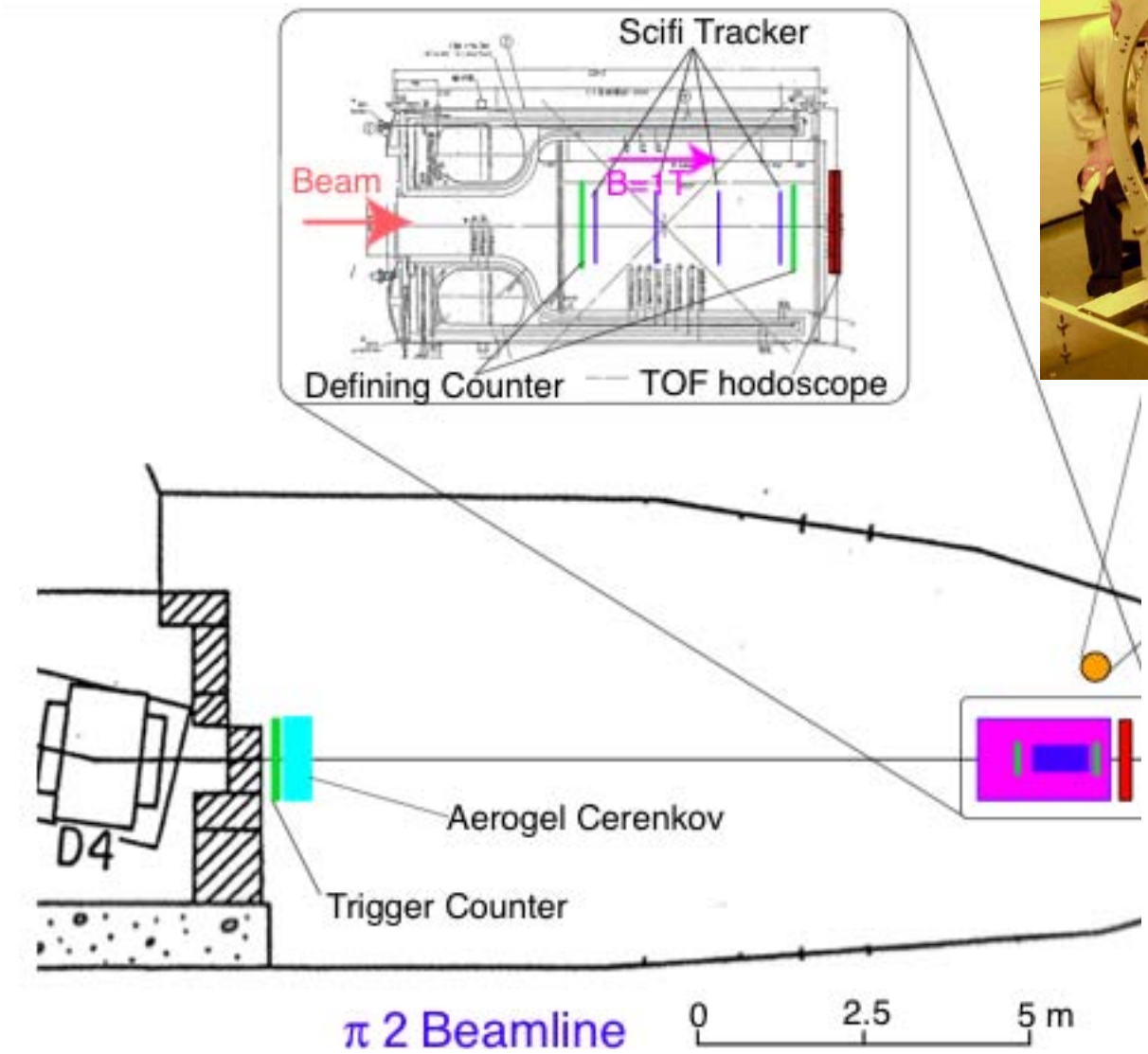
- Key physics goal of NSF MRI proposal:
  - demonstrate bias correction to <10% of itself, as needed for 0.1% emittance measurement
  - requires 2 spectrometers

SciFi Tracker Test at KEK

(KEK / UK / FNAL / IIT / UCR / Osaka)

- Assembling 4-station prototype to operate in 1T SC solenoid:



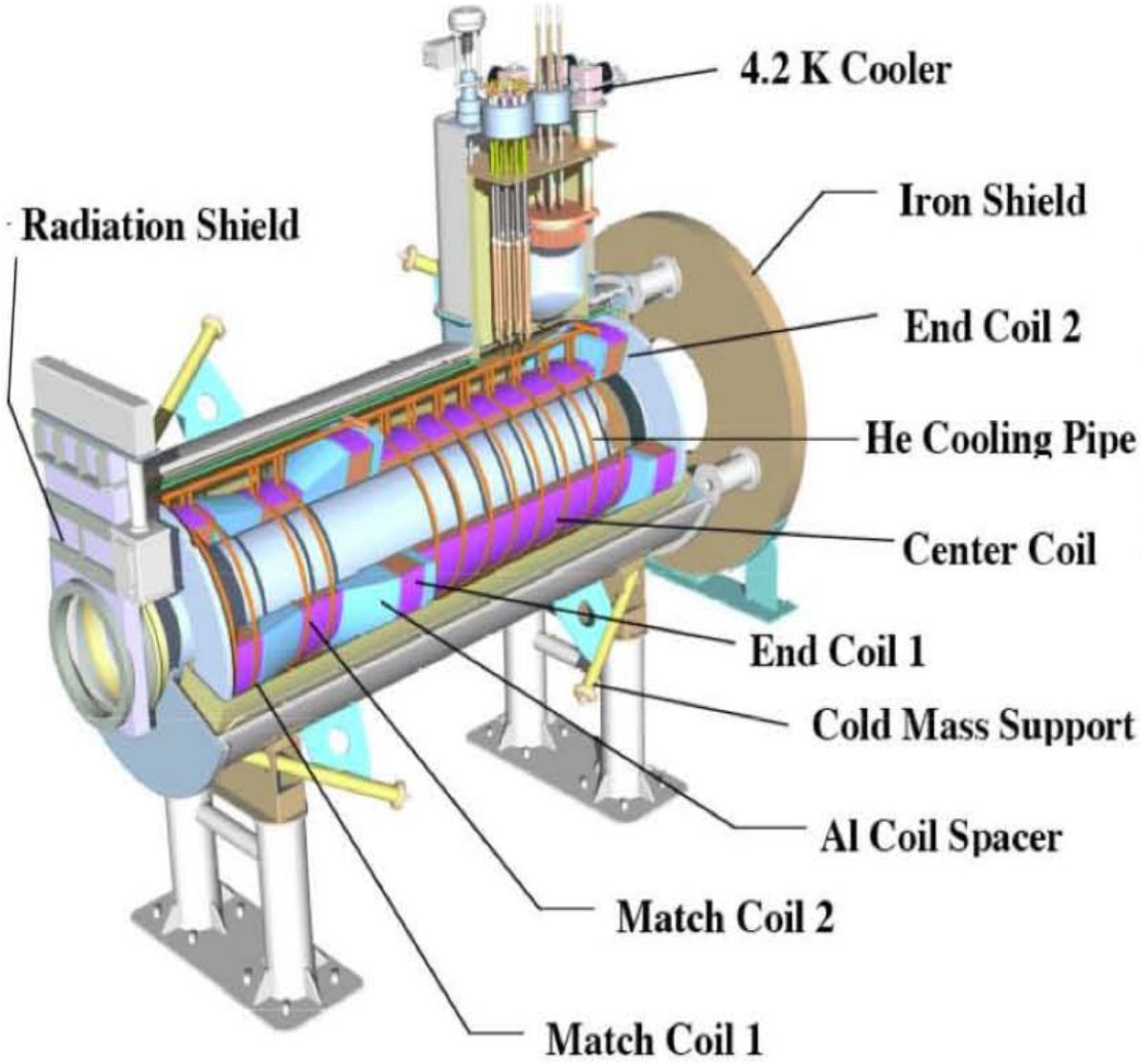


- 1st run ≈end May; 2nd run Sept. or Oct.

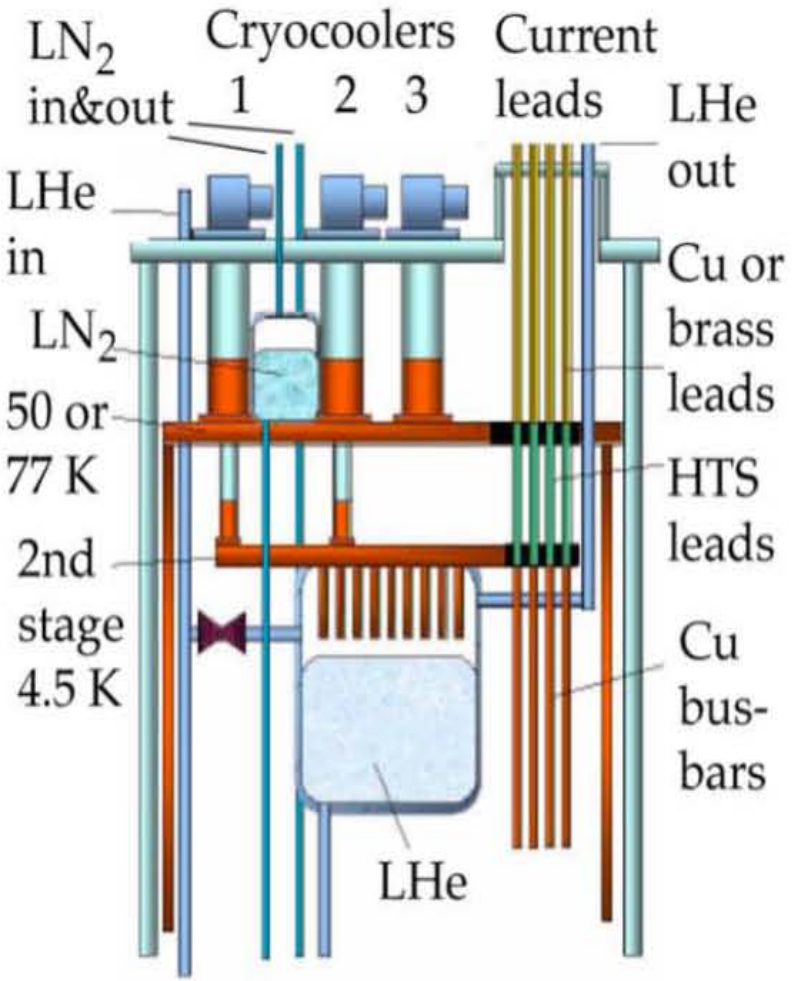
Tracker Solenoid Design

(Genoa / LBNL / Oxford)

- Cutaway 3D rendering:



- Turret detail:



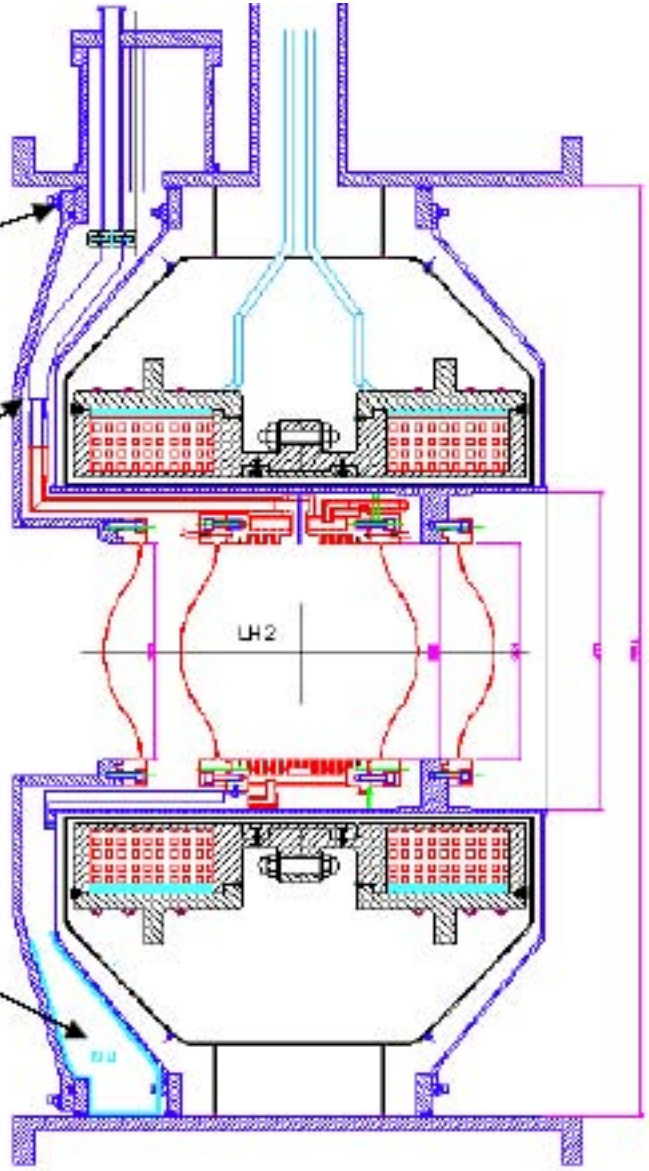
Absorber/Focus-Coil Module Engineering

(IIT / KEK / LBNL / NIU / Oxford)

a) Windows are mounted off RT interface

b) Space for change in pipe dimension close to magnet

c) Large "bucket" at base to contain any rupture

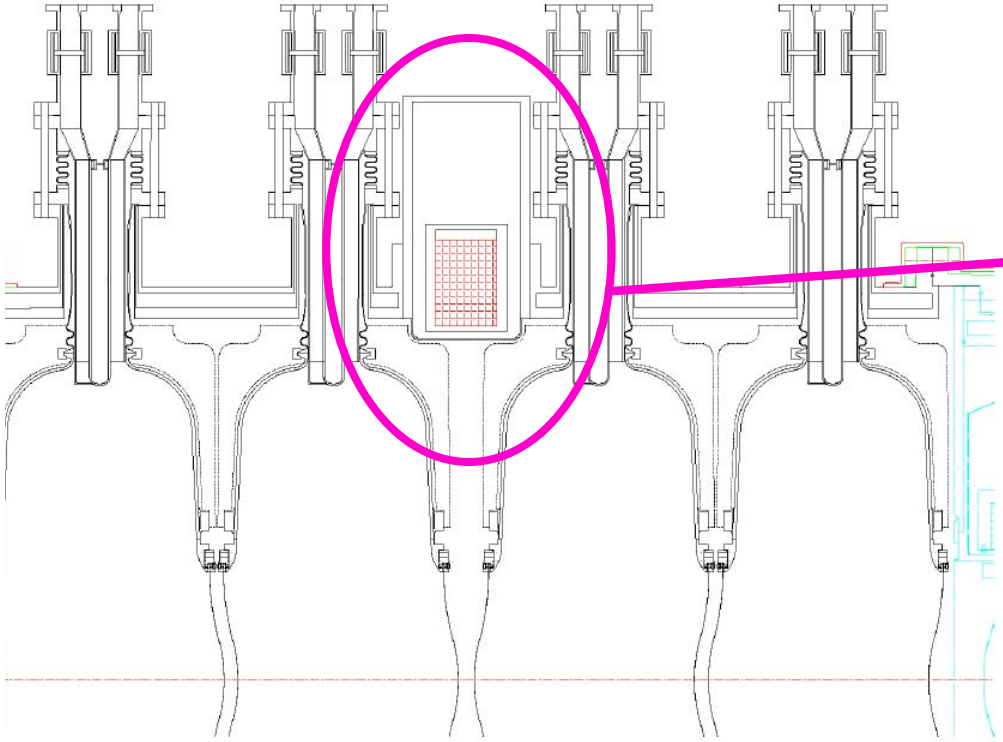


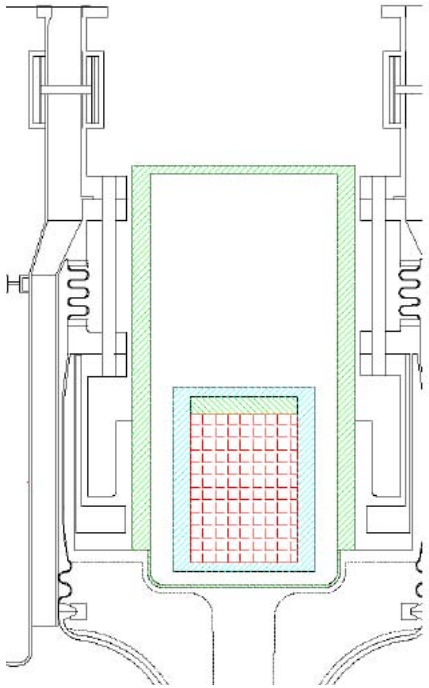
- Internal safety review passed 12/03

RF Cavity/Coupling-Coil Module

(LBNL)

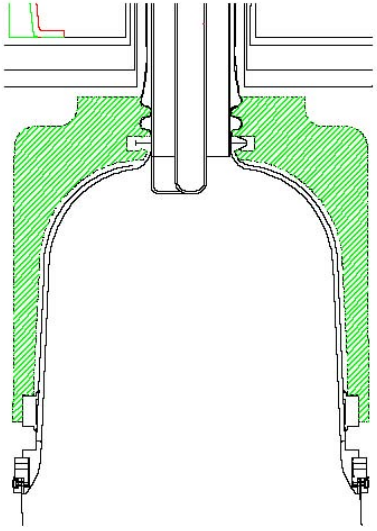
- Detailed module engineering proceeding:





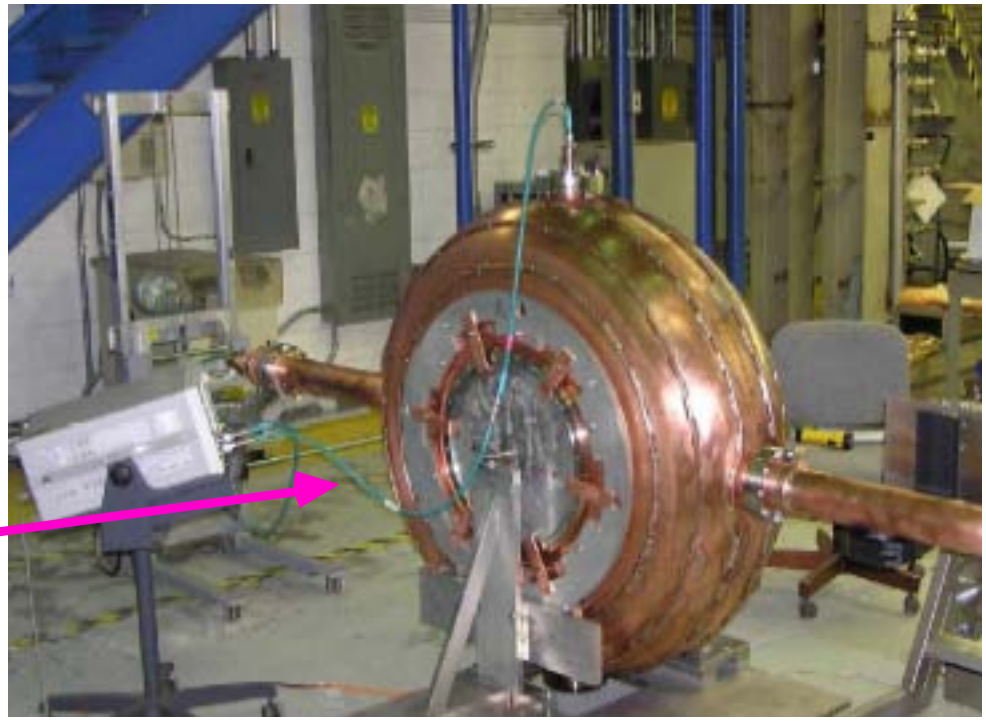
Revised coil design much narrower than previously

allows normal coupler geometry and increases interior clearance for tuners



Tuner design verified by FEA

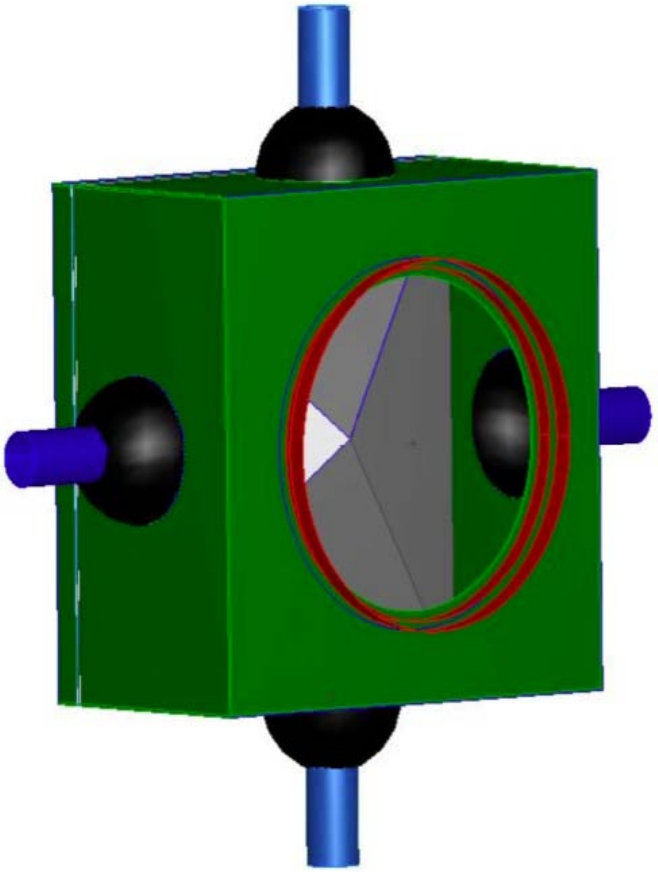
Prototype now under low-power test at JLab



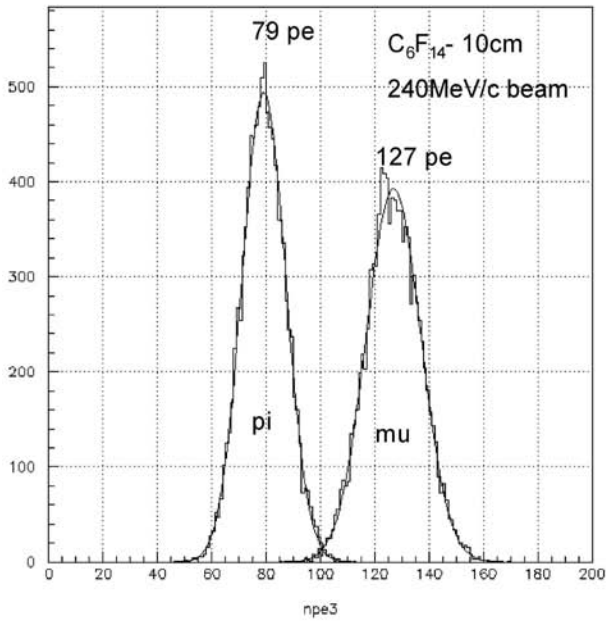
Upstream Cherenkov Detector

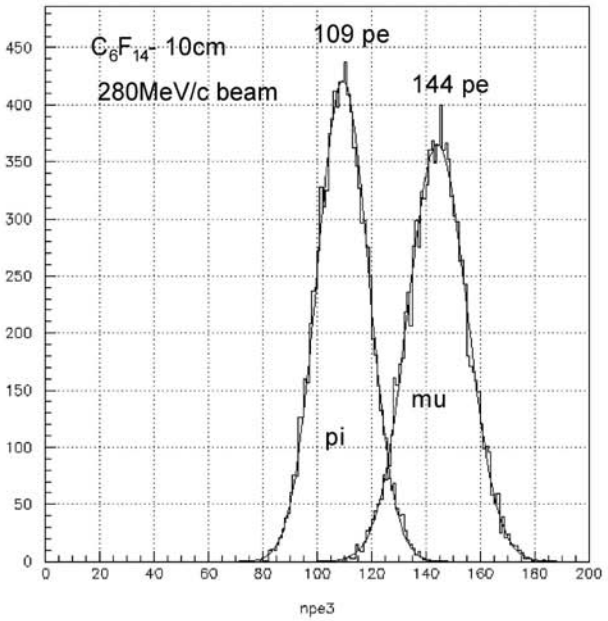
(UMiss)

- Concept: liquid radiator w/ mirrors focusing Cherenkov light on PMTs



– Simulated performance for 2 beam momenta:





- Approach looks workable
- Optimization studies in progress...

US MICE Funding:

- Funds currently available:
  - DOE: $300k/y for 3 years starting in FY05
  - NSF: $100k/y for 3 years starting in FY05
  - DOE/MC: variable year by year depending on other priorities (see Zisman R&D talk)
- Additional funds requested from NSF:
  - MRI proposal (DMK, PI): $2M over 2 years for 1st tracking solenoid and US tracker contributions
  - University Consortium proposal (G. Hanson, PI): $3.5M requested over 3 years for muon-cooling R&D and MICE
- MICE US plan must be understood in context of MC 5-year R&D plan

→ see Zisman's talk tomorrow for the details

Summary

- MICE is now approved and Phase 1 is funded
- Progressing well technically
- Some US MICE funding in place, more requested
- US has played a major role
- On track to exploit first beam in 2007