Report of Project Manager

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MUTAC Review–LBNL
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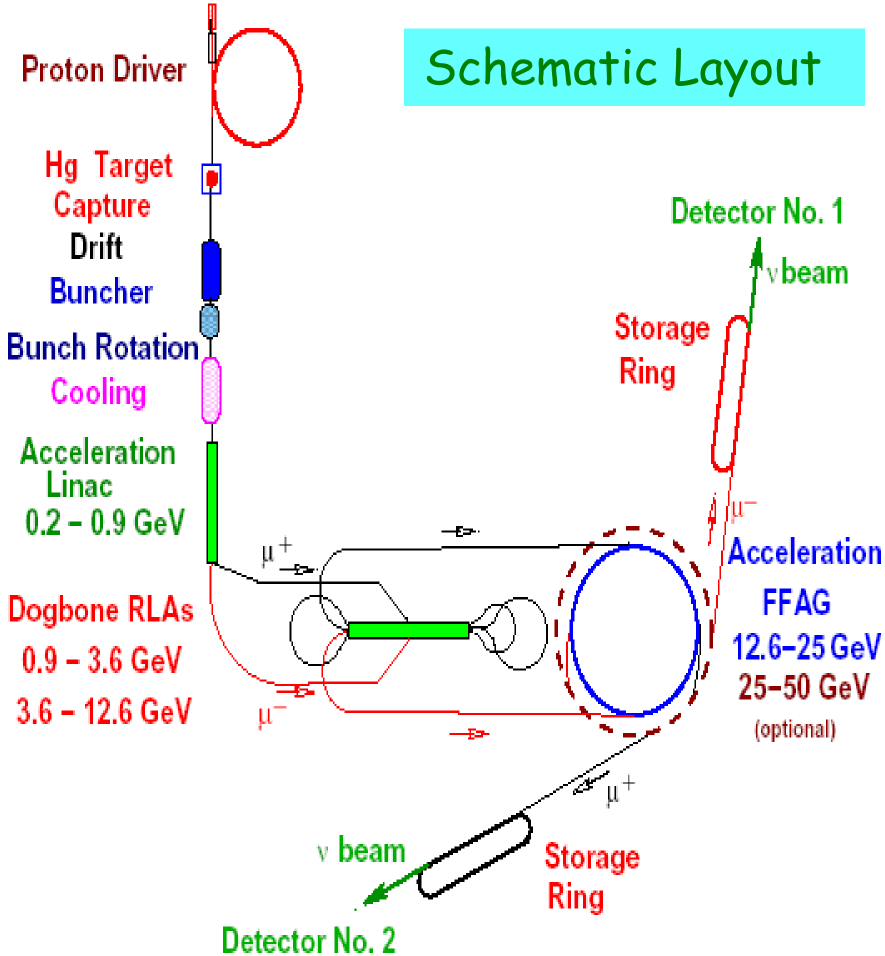
Introduction

- U.S. Neutrino Factory and Muon Collider Collaboration (NFMCC) explores techniques for producing, accelerating, and storing intense muon beams
  - near-term focus: muon storage ring to serve as source of well-characterized neutrinos ("Neutrino Factory") for long baseline experiments (~3000–7500 km)
  - longer-term focus: Muon Collider
    - Higgs Factory operating at few-hundred GeV or energy-frontier collider operating at several TeV
  - both types of machine will be difficult
    - but, both have high scientific potential
  - a common feature of these state-of-the-art machines is the need for a sustained R&D program
    - most modern projects (LHC, ILC, CLIC) share this need

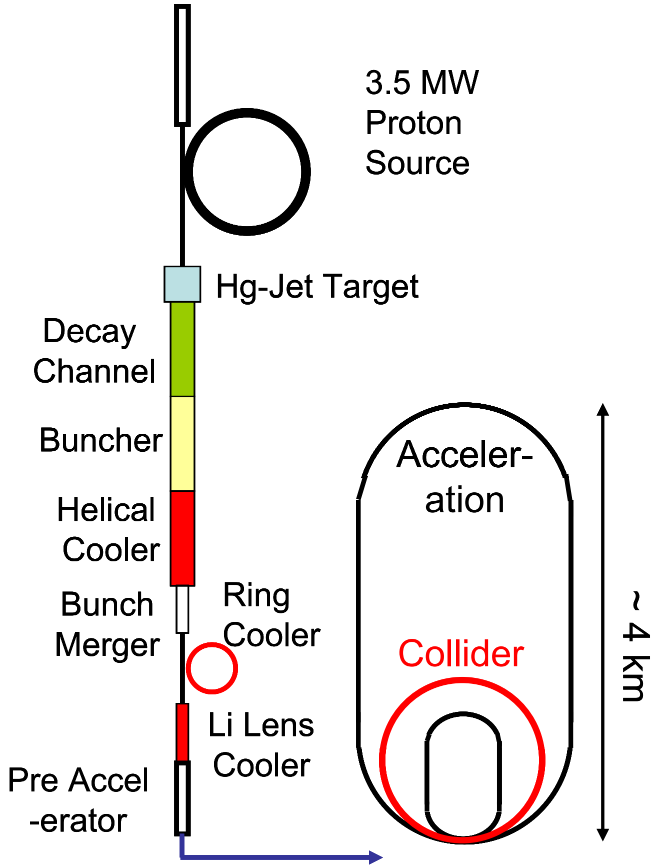
Neutrino Factory Ingredients

- Neutrino Factory comprises these sections
  - Proton Driver
    - primary beam on production target
  - Target, Capture, and Decay
    - create π; decay into μ ⇒ MERIT
  - Bunching and Phase Rotation
    - reduce ΔE of bunch
  - Cooling
    - reduce transverse emittance ⇒ MICE
  - Acceleration
    - 130 MeV → 20-50 GeV with RLAs or FFAGs
  - Decay Ring
    - store for 500 turns; long straight(s)



Muon Collider Ingredients

- Muon Collider comprises these sections (similar to NF)
  - Proton Driver
    - primary beam on production target
  - Target, Capture, and Decay
    - create π; decay into μ $\Rightarrow$ MERIT
  - Bunching and Phase Rotation
    - reduce ΔE of bunch
  - Cooling
    - reduce long. and transverse emittance $\Rightarrow$ MICE $\rightarrow$ MANX or equiv.
  - Acceleration
    - 130 MeV $\rightarrow$ ~1 TeV with RLAs or FFAGs
  - Collider Ring
    - store for 500 turns



Much of Muon Collider R&D is common with Neutrino Factory R&D

Muon Accelerator Advantages

- **Muon-beam accelerators can address several of the outstanding accelerator-related particle physics questions**
  - neutrino sector
    - Neutrino Factory beam properties

$$\mu^+ \rightarrow e^+ \nu_e \overline{\nu}_\mu \Rightarrow 50\% \nu_e + 50\% \overline{\nu}_\mu$$

$$\mu^- \rightarrow e^- \overline{\nu}_e \nu_\mu \Rightarrow 50\% \overline{\nu}_e + 50\% \nu_\mu$$

Produces high energy neutrinos

    - decay kinematics well known
      - minimal hadronic uncertainties in the spectrum and flux
    - $\nu_e \rightarrow \nu_\mu$ oscillations give easily detectable "wrong-sign" μ
  - energy frontier
    - point particle makes full beam energy available for particle production
      - couples strongly to Higgs sector
    - Muon Collider has almost no synchrotron radiation
      - narrow energy spread at IP compared with e^+e^- collider
      - uses expensive RF equipment efficiently ($\Rightarrow$ fits on existing Lab sites)

Muon Beam Challenges (1)

- Muons created as tertiary beam ($p \rightarrow \pi \rightarrow \mu$)
  - low production rate
    - need target that can tolerate multi-MW beam
  - large energy spread and transverse phase space
    - need solenoidal focusing for the low energy portions of the facility
      - solenoids focus in both planes simultaneously
    - need emittance cooling
    - high-acceptance acceleration system and decay ring
- Muons have short lifetime (2.2 μs at rest)
  - puts premium on rapid beam manipulations
    - high-gradient RF cavities (in magnetic field) for cooling
    - presently untested ionization cooling technique
    - fast acceleration system
- Decay electrons give rise to backgrounds in collider detector

Muon Beam Challenges (2)

- **Magnet challenges**
  - 20 T magnet in high radiation environment (target)
  - large aperture solenoids (up to 1.5 m) in cooling channel
  - very strong solenoids (~50 T) for final collider cooling stages
  - low fringe fields in acceleration system
    - to accommodate SC RF cavities
  - high mid-plane heat load in decay or collider ring

If intense muon beams were easy to produce, we'd already have them!

R&D Management Process

- Each year R&D groups propose annual program to TB
  - based on overall NFMCC budget guidance from DOE
- PM prepares budget based on this input
  - note: budget determined by R&D program, not "institutional commitments"
  - subsequently approved by TB, EB, and Co-Spokespersons
- After budget finalized, PM negotiates milestones with each institution based on R&D plan
  - milestones specify both dates and deliverables
    - "report card" generated at year's end to audit performance
- PM summarizes spending and accomplishments each year in detailed report
  - given to MCOG and DOE at annual MUTAC review

R&D Overview (1)

- NFMCC R&D program has the following components:
  - simulation and theory effort
    - supports both Neutrino Factory and Muon Collider design
      - NF work presently done under aegis of IDS-NF
  - development of high-power target technology ("Targetry")
  - development of cooling channel components ("MuCool")

- We participate in system tests as an international partner
  - MERIT (high-power Hg-jet target)
  - MICE (ionization cooling demonstration)
  - EMMA (non-scaling FFAG electron model)

- Hardware development and system tests are major focus
  - simulation effort has led to cost-effective Neutrino factory design
    - and progress toward a complete Muon Collider scenario

R&D Overview (2)

- **NFMCC R&D program has already led to many innovative accelerator concepts and approaches**
  - **driven by our desire to solve challenging technical problems in support of the HEP experimental program**
    - **enhanced support will further such innovation**

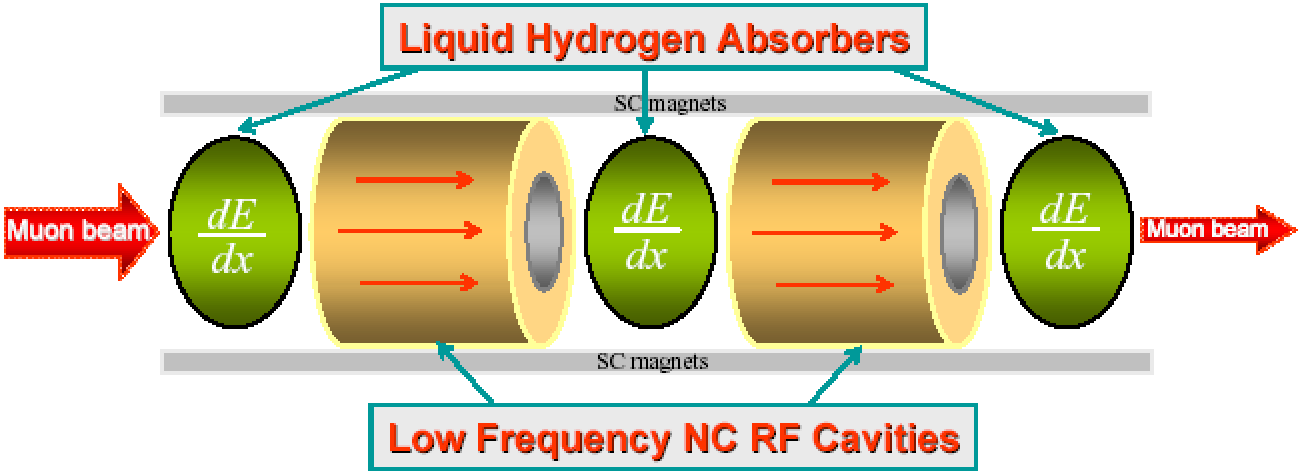
- **Examples:**

Solenoidal pion capture from target
RF phase rotation and bunching scheme
Non scaling FFAG concept
Muon cooling channels (linear, ring, helix)
Theory of breakdown and conditioning in RF cavities
High-pressure gas-filled cavities for cooling*
Linear 6D helical cooling channel*
Phase space manipulation techniques*
High-field HTSC solenoids for giving low emittance*

*Muons, Inc.

Ionization Cooling (1)

- **Ionization cooling analogous to familiar SR damping process in electron storage rings**
  - energy loss (SR or *dE/ds*) reduces p_x, p_y, p_z
  - energy gain (RF cavities) restores only p_z
  - repeating this reduces $p_{x,y}/p_z$ (⇒ 4D cooling)
  - presence of LH_2 near RF cavities is an engineering challenge
    - we get lots of "design help" from Lab safety committees!



Ionization Cooling (2)

- **There is also a heating term**
  - **for SR it is quantum excitation**
  - **for ionization cooling it is multiple scattering**

- **Balance between heating and cooling gives equilibrium emittance**

$$\frac{d\varepsilon_N}{ds} = -\frac{1}{\beta^2}\left|\frac{dE_\mu}{ds}\right|\frac{\varepsilon_N}{E_\mu} + \frac{\beta_\perp (0.014\,\text{GeV})^2}{2\beta^3 E_\mu m_\mu X_0}$$

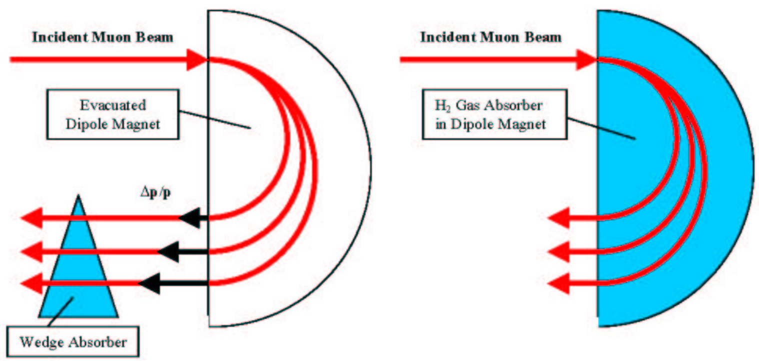
Cooling | Heating

$$\varepsilon_{x,N,equil.} = \frac{\beta_\perp (0.014\,\text{GeV})^2}{2\beta m_\mu X_0 \left|\frac{dE_\mu}{ds}\right|}$$

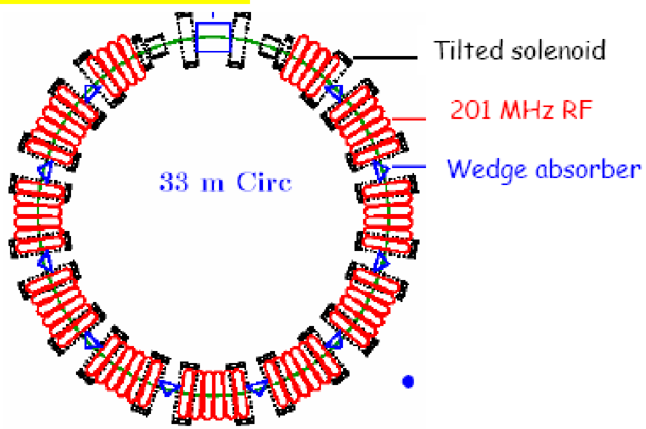
  - **prefer low $\beta_\perp$ (strong focusing), large X_0 and *dE/ds* (H_2 is best)**

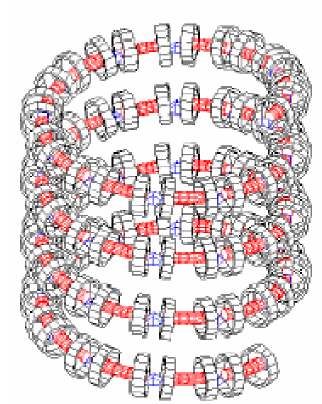
6D Cooling

- For 6D cooling, add emittance exchange to the mix
  - increase energy loss for high-energy compared with low-energy muons
    - put wedge-shaped absorber in dispersive region
    - use extra path length in continuous absorber



Cooling ring





"Guggenheim" channel

Single pass; avoids injection/extraction issues

Funding Status

- Since FY03, NFMCC budget has been nearly "flat-flat"
  - we desire to restore it to FY01–02 levels

Year	DOE-base ($M)	DOE-NFMCC ($M)	TOTAL ($M)
FY00	3.3	4.7	8.0
FY01	3.0	3.2	6.2
FY02	3.0	2.8	5.8
FY03	2.1	1.4	3.5
FY04	2.2	1.8[a)]	4.0
FY05	1.9	1.7	3.6
FY06	1.8	2.1[b)]	3.9
FY07	1.9	2.4	4.3[c)]
FY08	2.1[d)]	1.7	3.8

a) Includes $0.4M supplemental funds
b) Includes $0.3M supplemental funds
c) Includes $0.7M supplemental funds
d) Includes $0.25M funds at BNL previously designated as AARD

- – helped by NSF funding for MICE and DOE-SBIR funding for Muons, Inc.
  - NSF: $100K per year (FY05–07); $750K FY06 MRI grant (tracker electronics, spectrometer solenoid); $133K/year (FY08-10); FY08 MRI grant ($798K) (Coupling coils and MICE RF)

FY07 Budget

- **FY07 budget finalized by Spokespersons and PM in December 2006**
  - both MICE and MERIT were big-ticket items this year
    - finally getting a start on MuCool and MICE coupling coil fabrication
      - thanks to ICST collaboration (Jia, Li, Green) and NSF MRI (Summers)

MEMORANDUM OF UNDERSTANDING
Between
HARBIN INSTITUTE OF TECHNOLOGY
and
LAWRENCE BERKELEY NATIONAL LABORATORY

The parties to this Memorandum of Understanding hereby confirm and acknowledge their agreement to be bound by its terms by the following signatures:

HARBIN INSTITUTE OF TECHNOLOGY

By ______
Shu-Guo Wang, President

Date ______

LAWRENCE BERKELEY NATIONAL LABORATORY

By ______
Steven Chu, Director

Date ______

Addendum
To
Memorandum of Understanding
Between
Harbin Institute of Technology and Lawrence Berkeley National Laboratory
Regarding Design, Fabrication, and Testing of Coupling Coil Magnets

The parties to this Addendum to the Memorandum of Understanding hereby confirm and acknowledge their intentions as set forth above by the following signatures:

HARBIN INSTITUTE OF TECHNOLOGY

By ______
Bin Guo, Director
Science and Technology Office

Date 2007. 9. 28

LAWRENCE BERKELEY NATIONAL LABORATORY

By ______
Stephen Gourlay, Director
Accelerator & Fusion Research Division

Date 2007/9/28

FY07 Funding Distribution

- FY07 NFMCC budget (only DOE-NFMCC funds)†

  †Also: salary support from BNL, FNAL, LBNL; support from NSF of $1M ($750K MRI + $100K 3-yr grant); support of Muons, Inc. via SBIR grants

Institution	COOLING /MICE	TARGETRY	ACCEL./ COLLIDER	RESERVE	TOTAL ($K)
BNL		440			440
FNAL	50				50
LBNL[a,b]	1310				1310
ANL	185				185
IIT	85				85
Mississippi	42		18		60
Princeton		45			45
UCLA	25		45		70
UC-Riverside			95		95
ORNL		80			80
Jlab	5		5		10
TOTAL ($K)	**1702**	**565**	**163**		**2430**

[a]Includes MICE funding of $680K.
[b]Includes supplemental funding of $630K for MUCOOL and MICE coupling coils.

Incremental Funding

- Request this year was different than past years
  - DOE asked for scenarios for funding increase of 10% and 20%
  - submitted in October 2006
- For +20%, proposed fabricating MuCool coupling coil
  - if Harbin arrangement worked out, remaining funds would be put toward MICE RF cavities (8 needed)
- For +10%, proposed fabricating MuCool coupling coil if Harbin was collaborating with us
  - if not, we would advance the schedule by purchasing the superconducting cable and preparing bid package for the fabrication
- Actually got $695K, of which $50K went to BNL base and $15K to LBNL base
  - also awarded $798K NSF MRI to U.-Miss. (Summers)

Budget Comments

- By juggling projects across fiscal year boundaries and careful prioritization, we continue to make progress
  - all our R&D efforts, including our international project commitments, have no contingency
    - only recourse for "contingent events" is delay (schedule slippage)
      - thus far, we've been fairly lucky
  - MICE schedule may be delayed 1 year due to inability to provide components in sufficiently timely way
- Emphasis on hardware development for international experiments came at price of attrition in effort level
  - trying this year to augment post-docs
    - need growth in this area; many interesting problems to work on
  - BNL staff decreased by 1 FTE and budget remains severely strained
  - need common funds for MICE or we will not be co-authors on papers

FY07 R&D Goals

- Main goals for FY07 included:
  - carry out MERIT experiment
  - continue development of MuCool Test Area (MTA)
    - needed enhanced vacuum system to accommodate RF tests in B field
    - continue implementation of cryogenic system
  - continue high-power tests of 805-MHz cavity
  - continue high-power tests of 201-MHz cavity
    - in particular, prepare for magnetic field tests
  - begin fabrication of MICE spectrometer solenoids
  - begin simulation effort in support of IDS-NF
  - continue exploring and optimizing 6D cooling performance
    - in conjunction with MCTF

FY07 Milestones

- Prior to distribution of funds, each institution provided milestones agreed upon by PM
  - these (example below) reflect budget allocations for each institution, including base program funds

UCLA [Cline]

Milestone	Date	Deliverable
Continue support of MICE 5-station fiber tracker construction, assembly, and testing	Sep-07	MICE presentation
Design tabletop cooling ring with LiH absorbers	Jun-07	PAC07 paper
Simulate curved Li lens ring configuration to understand emittance exchange process	Sep-07	NFMCC note
Continue study of Li lens pion capture channel followed by Li lens cooling channel	Sep-07	NFMCC note
Compare 6D cooling ring schemes and dipole cooler for muon collider development	Jun-07	PAC07 paper
Continue study of scientific goals of muon collider	Sep-07	NFMCC note

U-Miss. [Summers]

Milestone	Date	Deliverable
Provide fabrication support for MICE RF cavities	Sep-07	Inspection
Manufacture and measure thin Al absorber windows for MICE	Sep-07	Inspection
Manufacture MUCOOL coupling coil support	Sep-07	Inspection
n = 1.07, 1.12 aerogel studies for MICE Cherenkov	Jul-07	Paper written
Participate in design of 50-T solenoid for 6D cooling studies	Mar-07	Conference paper
Participate in design of 750 GeV muon acceleration in the Tevatron tunnel	Jul-07	Conference paper

IIT [Kaplan]

Milestone	Date	Deliverable
Continue web support for MICE experiment	Sep-07	Inspection
Carry out MTA radiation measurements with 805- and 201-MHz cavities	Feb-07	NFMCC presentation
Document MTA phototube magnetic shielding and force analysis	Jan-07	NFMCC note
Carry out MICE beam line optimization	Apr-07	MICE note
Carry out MICE background analysis based on MTA data	Jun-07	MICE presentation
Update MTA DAQ system documentation	Aug-07	Inspection
Carry out RF cavity breakdown simulation	Jun-07	PAC07 paper

UC-Riverside [Hanson]

Milestone	Date	Deliverable
Hire NFMCC simulation post-doctoral research associate	Sep-07	Inspection
Continue simulations of 6D muon cooling	Sep-07	NFMCC note
Participate in MICE tracker commissioning and simulations	Sep-07	MICE note
Participate in muon cooling simulations for the International Design Study	Sep-07	NFMCC note

FY07 Accounting

- **Summary of FY07 spending:**

Institution	Collaboration Committed ($K)	Collaboration Uncommitted ($K)	Base Program Committed ($K)	Overall Total ($K)	Contact
ANL	188	0	66	253	J. Norem
BNL [1]	564	136	1200	1764	H. Kirk
FNAL [2]	134	36	2616	2750	A. Bross
LBNL [3]	698	1698	346	1044	M. Zisman
ORNL	139	4	0	139	T. Burgess
Princeton U.	45	0	150	195	K. McDonald
UCLA	70	0	28	98	D. Cline
UC-Riverside [4]	1	94	373	374	G. Hanson
Mississippi	60	0	10	70	D. Summers
IIT [5]	64	30	0	64	D. Kaplan
Jlab	6	6	0	6	R. Rimmer
NSF MICE Support [6]	*347*	*77*	*97*	*443*	*D. Kaplan*
TOTALS [7]	**1967**	**2004**	**4790**	**6757**	
	2314	*2081*		*7104*	

NOTES:

[1] Uncommitted funds for MERIT experiment.
[2] Uncommitted funds for MTA cryogenics and beam line.
[3] Includes $119K in uncommitted Project Reserve funds maintained by LBNL
[4] Base funds are UC-Riverside startup funds.
[5] Only DOE funds. NSF funding reported separately.
[6] Funds allocated to IIT as primary contractor.
[7] DOE totals in Roman type; *additional NSF funding shown in italics*.

Recent R&D Accomplishments

- R&D progress made on most fronts:
  - Simulations/ISS + IDS-NF
  - Targetry/MERIT
  - Cooling/MICE
- Acceleration work on hold due to lack of funding at Cornell

Simulations

- NFMCC has been engaged in a number of efforts
  - Feasibility Study I (with FNAL)
  - Feasibility Study II (with BNL)
  - APS Multi-Divisional Neutrino Study ("Study IIa," see http://www.aps.org/policy/reports/multidivisional/neutrino/)
  - International Scoping Study (see http://www.hep.ph.ic.ac.uk/iss/)
    - Accelerator Working Group Report (finally!) completed (see http://www.cap.bnl.gov/mumu/project/ISS/iss-accel-report.pdf)
  - follow-on IDS-NF to develop engineered facility design and corresponding cost estimate is under way (see http://www.hep.ph.ic.ac.uk/ids/)
    - Berg playing a lead role in this enterprise
- Accomplishments
  - simplification of NF front-end design while maintaining performance
    - "simplification" $\Rightarrow$ cost savings of roughly 1/3 cf. study II
  - development of international consensus on NF design aspects
  - working with MCTF toward MC facility design (increasing interest here)

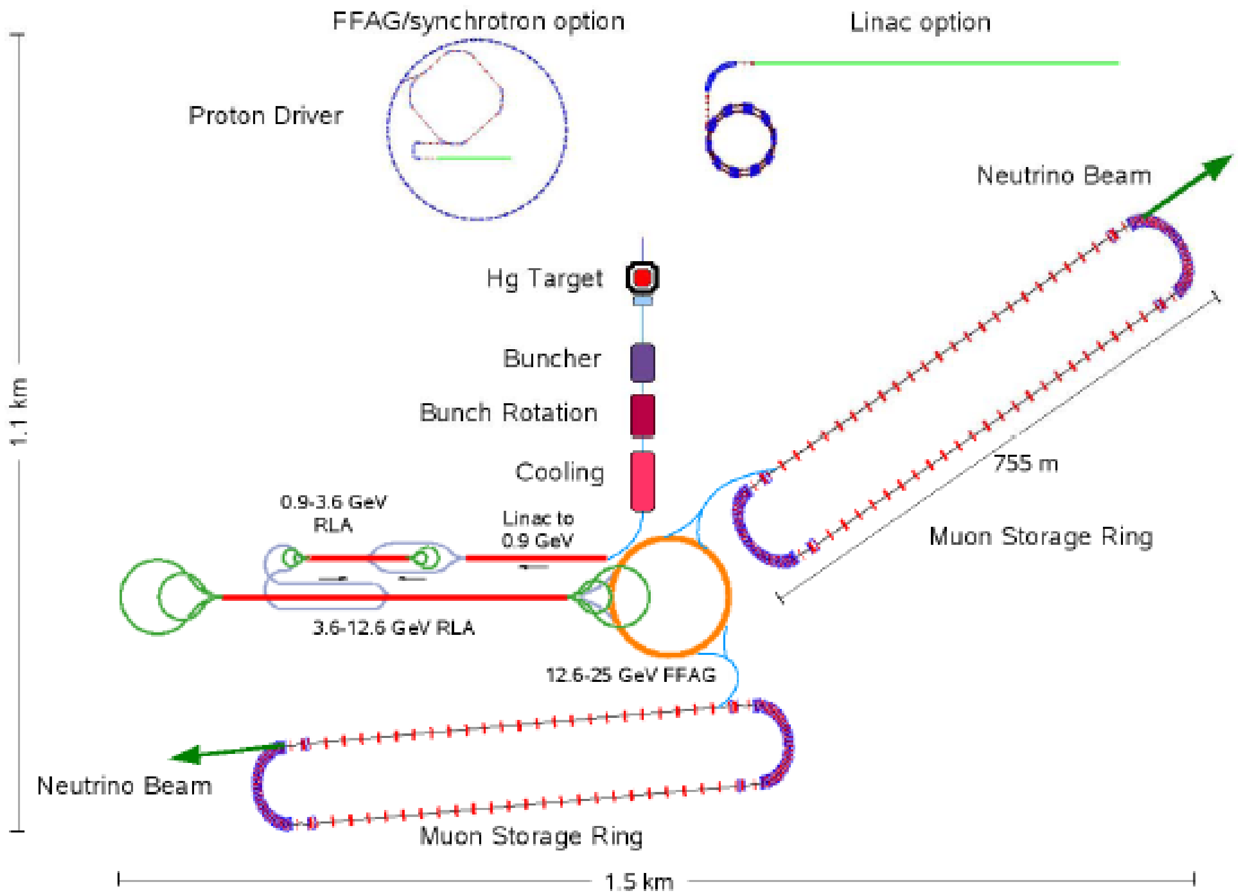
ISS Main Findings

- ISS compared existing NF designs to identify the most promising approaches

- Findings:
  - optimum proton driver energy is 10 ± 5 GeV
  - Hg-jet target gives optimal muon production for protons in preferred energy range
  - Study IIa front end design is preferred, using simultaneous operation with both muon signs
  - non-scaling FFAG beam dynamics limits performance and preferred approach will use only one, or at most two, such systems
  - both racetrack and triangular rings possible (two rings needed in either case)
    - triangle more efficient if two suitable sites are operating simultaneously
    - racetrack better for a single detector site, and has no directional constraints

IDS-NF Baseline

- A baseline configuration for the Neutrino Factory has been specified
  - based in large measure on the Study IIa design



IDS-NF Baseline Parameters

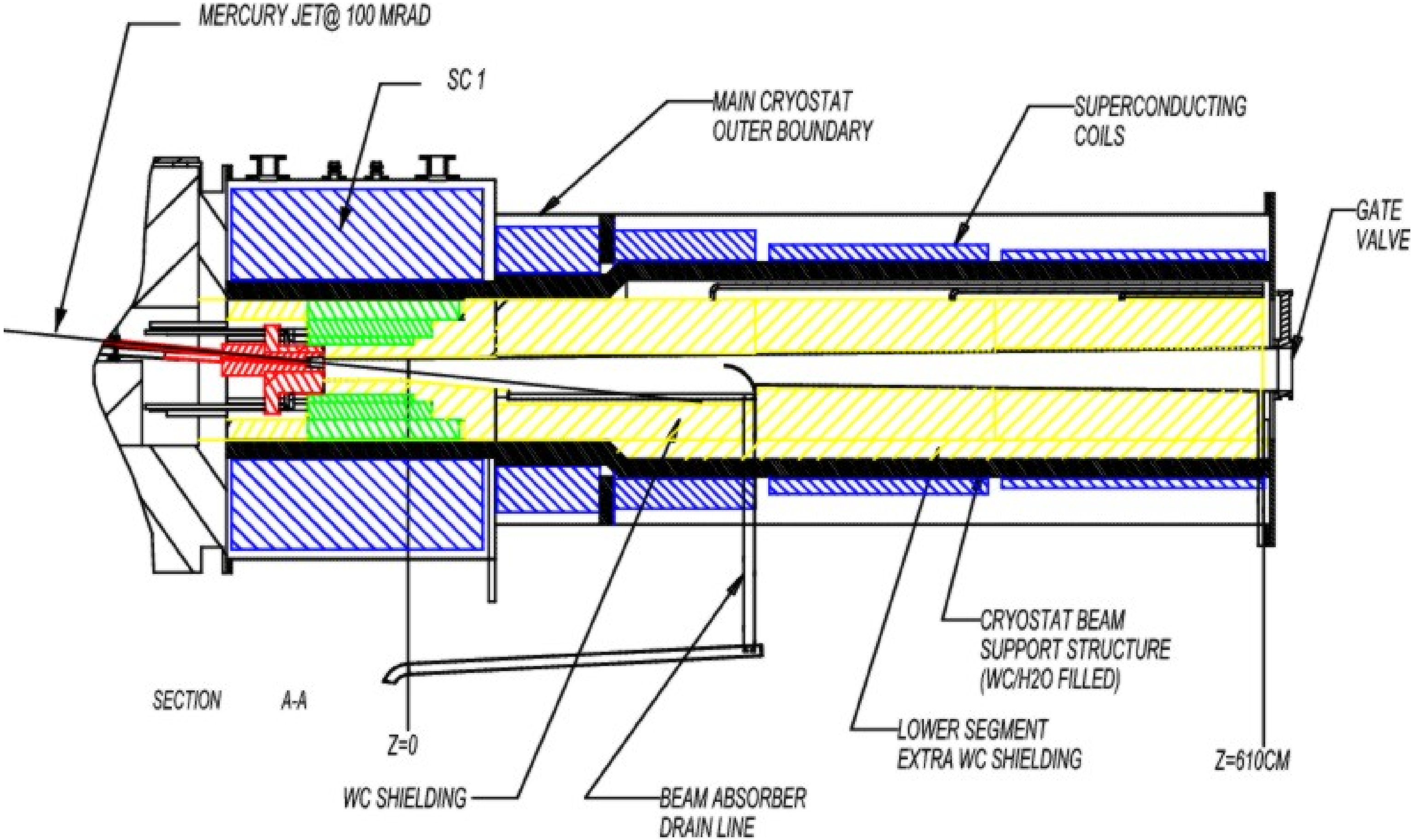
Proton Driver	
Proton power	4 MW
Proton kinetic energy	5–15 GeV
Pulses per second	50
Bunches per pulse	3
Minimum time between bunches	17 μs
Maximum time for all bunches	40 μs
RMS proton bunch length	1–3 ns
Target	
Material	Hg
Type	Liquid jet
Jet diameter	1 cm
Jet velocity	20 m/s
Jet angle to axis	100 mrad
Jet angle to proton beam	33 mrad
Proton beam angle to axis	67 mrad
Front End	
ICOOL input files	for001.dat for030.dat for031.dat

Storage Ring	
Total muon energy	25 GeV
Type	Racetrack
Number of rings	2
RMS angular divergence, production straight	$0.1/\gamma$
Gap between bunch trains	100 ns
Possible simultaneous signs per ring	2
Total production straight μ decays in 10^7 s	10^{21}
Short baseline	3000–5000 km
Long baseline	7000–8000 km

Acceleration	
RF frequency	201.25 MHz
RF type	Superconducting
Total energy at injection	244 MeV
Transverse normalized acceptance at input	30 mm
Longitudinal normalized acceptance at input	150 mm
Stage 1, type	Linac
Stage 1, lattice cell	Solenoid FOFO
Stage 1, lattice files	linac_sol.opt linac_sol.mad
Total energy, stage 1–2 transition	0.9 GeV
Stage 2, type	Dogbone RLA
Stage 2, cavity aperture diameter	30 cm
Stage 2, energy gain per cavity cell	12.75 MV
Stage 2, lattice cell	FODO
Stage 2, linac passes	4.5
Total energy, stage 2–3 transition	3.6 GeV
Stage 3, type	Dogbone RLA
Stage 3, cavity aperture diameter	30 cm
Stage 3, energy gain per cavity cell	12.75 MV
Total energy, stage 3–4 transition	12.6 GeV
Stage 4, type	Linear non-scaling FFAG
Stage 4, cavity aperture diameter	30 cm
Stage 4, energy gain per cavity cell	12.75 MV
Stage 4, lattice cell	FODO
Stage 4, cavity cells per lattice cell	2

Targetry R&D

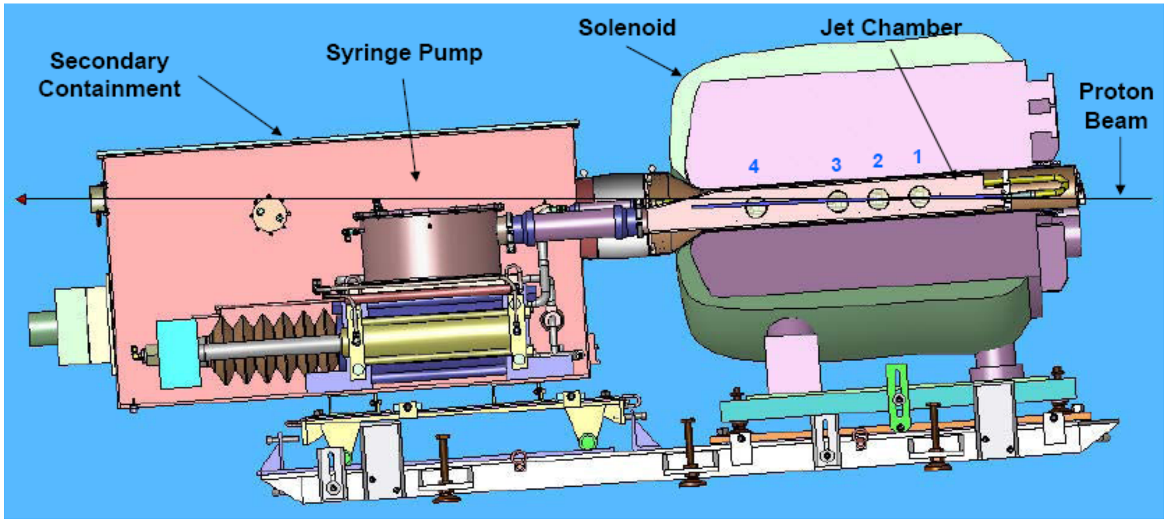
- Target concept uses free Hg jet in 20-T solenoidal field
  - jet velocity of 20 m/s establishes "new" target for each beam pulse
  - this approach serves as basis of MERIT experiment

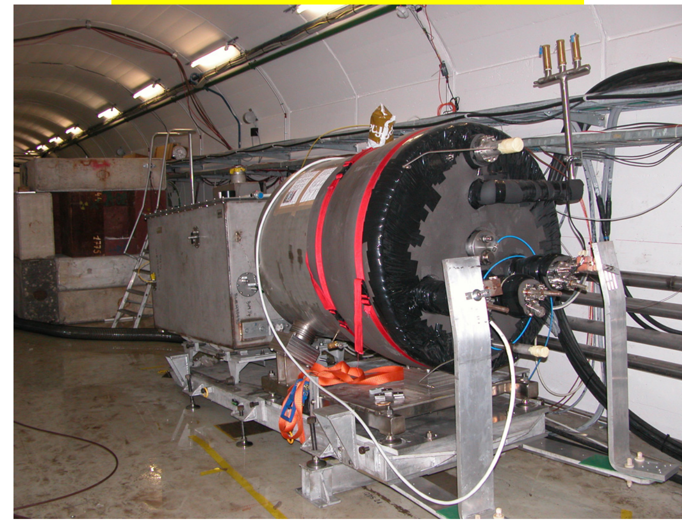


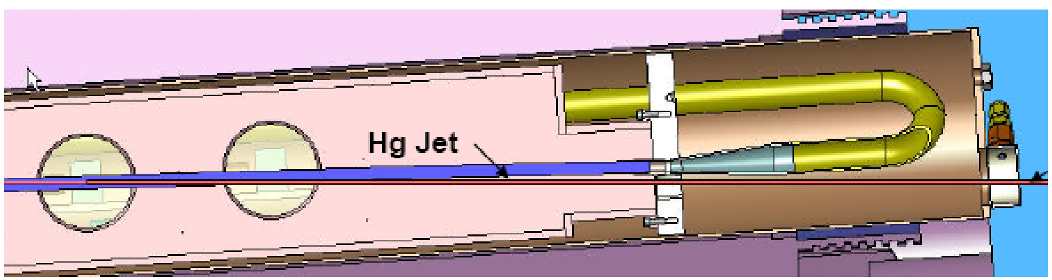
MERIT Experiment

- MERIT recently carried out beam test of Hg-jet target in 15-T magnetic field using CERN PS

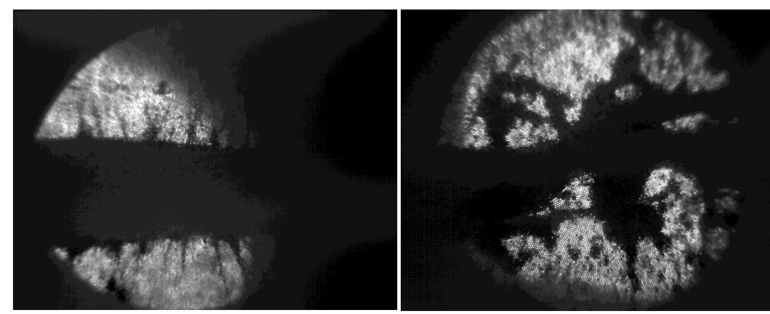
Installation at CERN







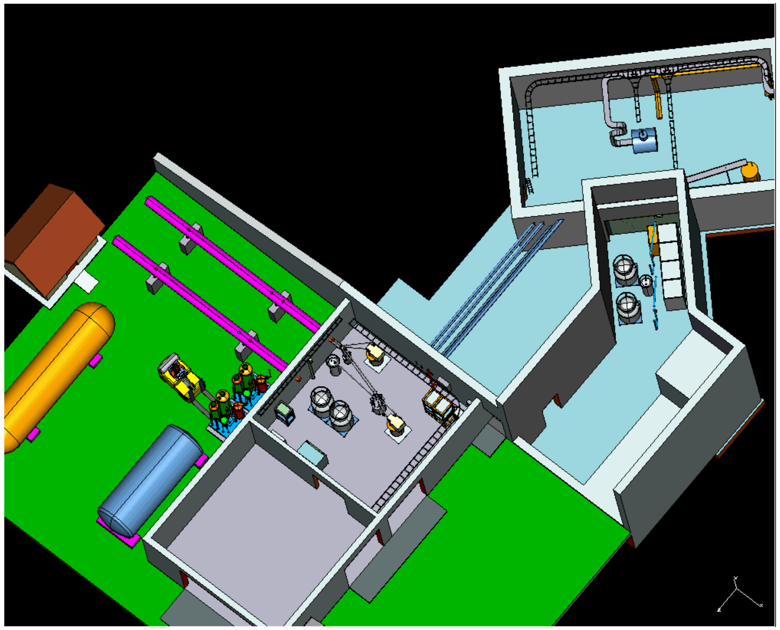
Schematic of MERIT experimental setup



During After
10 Tp

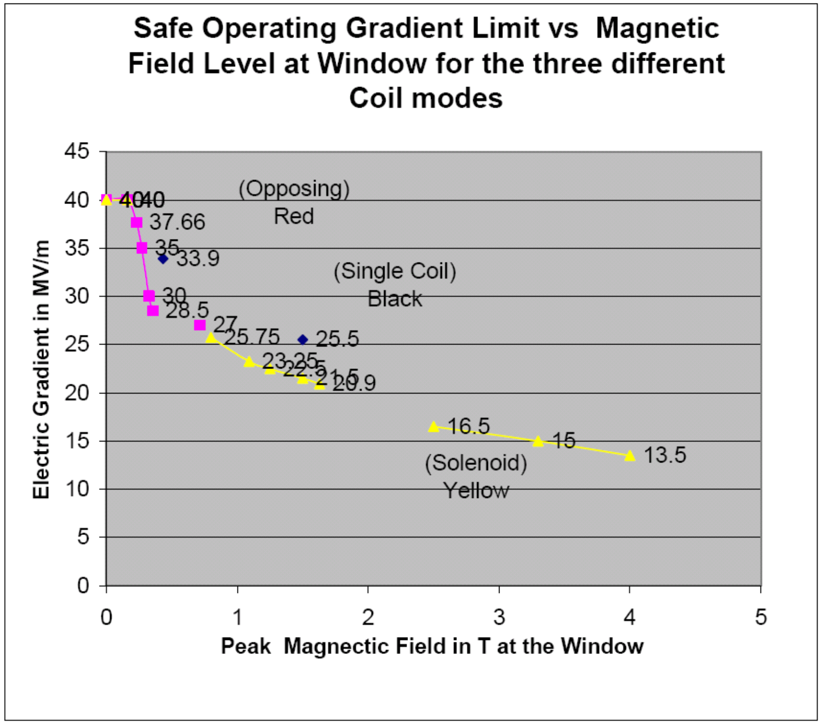
MuCool R&D (1)

- MuCool program does R&D on cooling channel components
  - RF cavities, absorbers
- Carried out in MuCool Test Area (MTA) at Fermilab (funded by NFMCC)
  - located at end of 400 MeV linac and shielded for eventual beam tests



MuCool R&D (2)

- **Motivation for cavity test program: observed degradation in cavity performance when strong magnetic field present**
  - 201 MHz cavity easily reached 19 MV/m without magnetic field
  - initial tests in fringe field of Lab G solenoid now under way



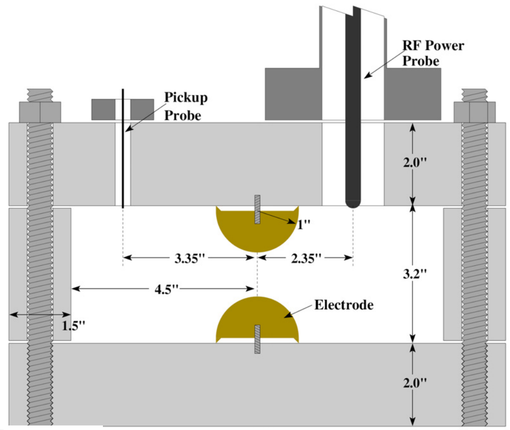
201 MHz cavity

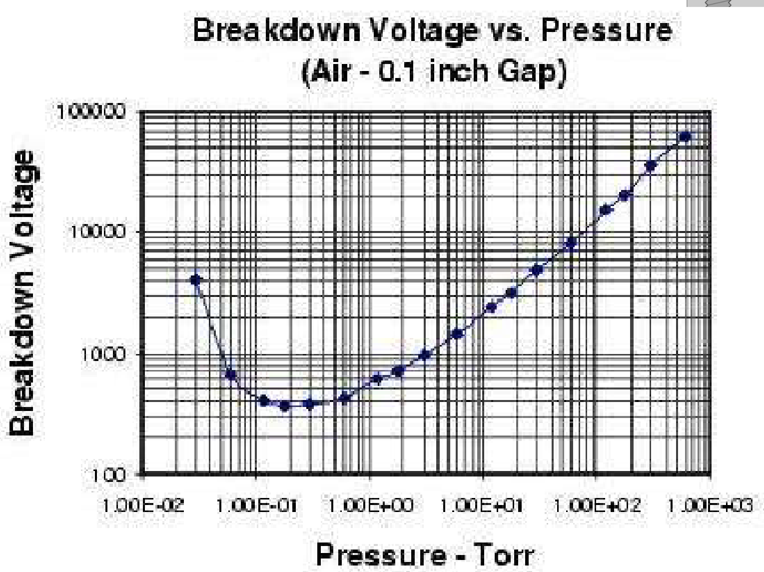
5-T solenoid + 805-MHz cavity

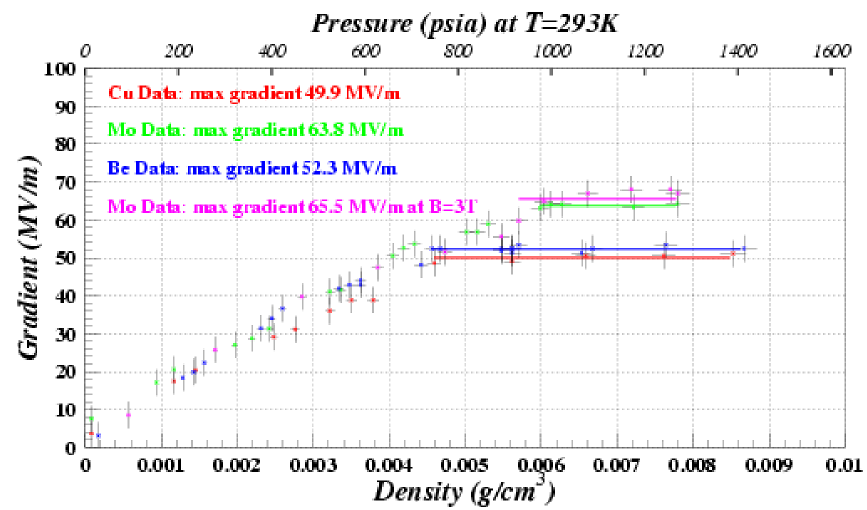
MuCool R&D (3)

- **Tested pressurized button cavity at MTA (Muons, Inc.)**
  - **use high-pressure H_2 gas to limit breakdown (⇒ no magnetic field effect)**

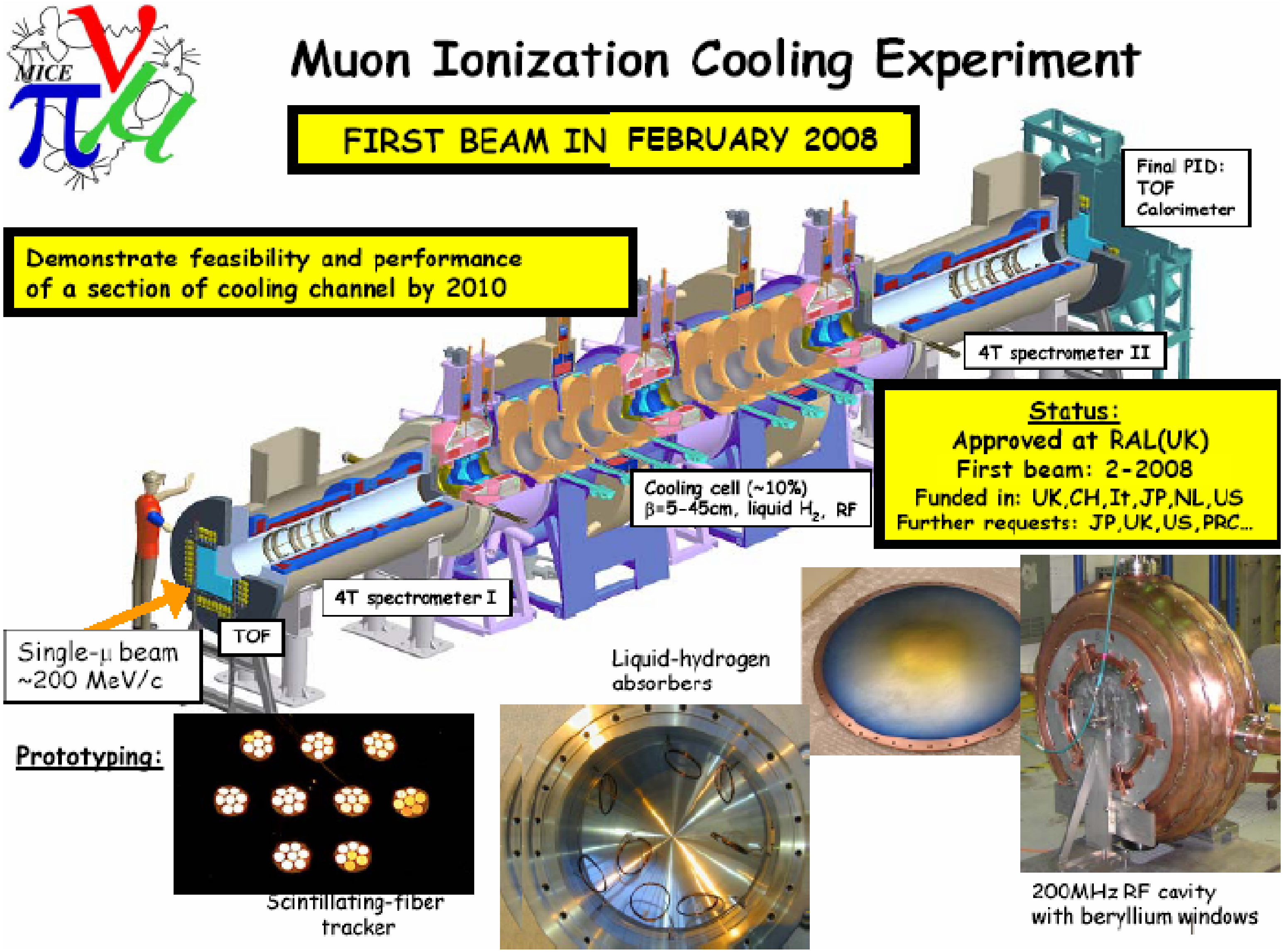
Remaining issue:
What happens when high intensity beam traverses gas?





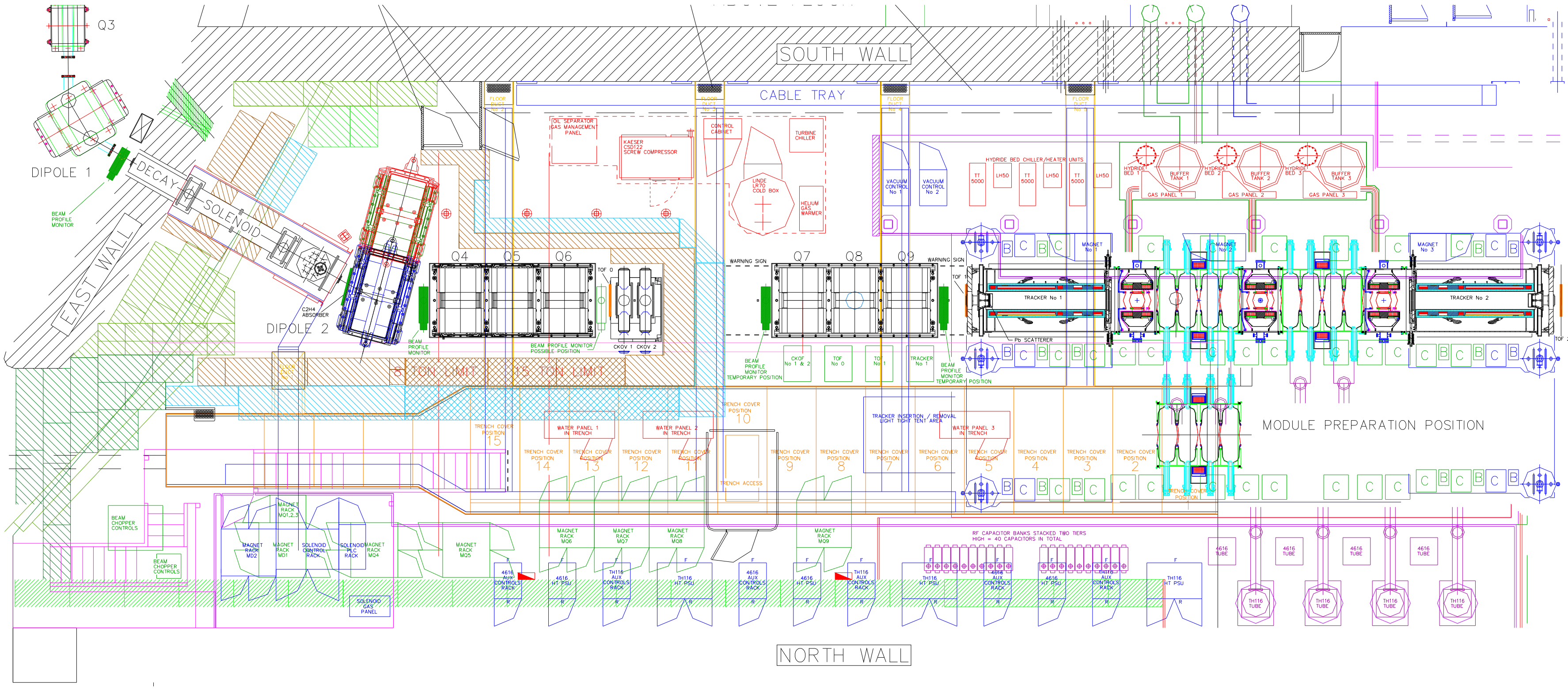


MICE Schematic



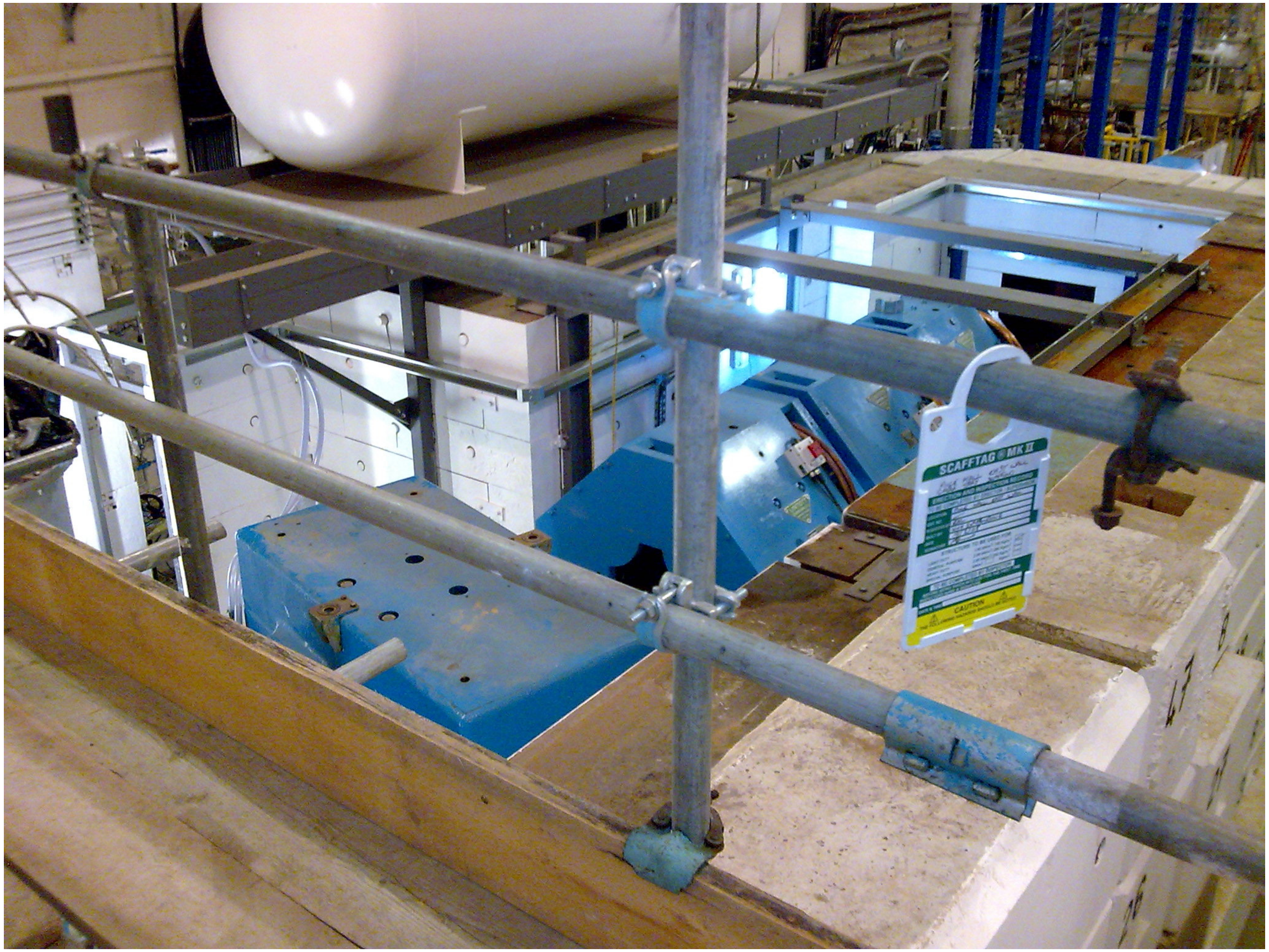
MICE Hall (1)

- Hall will contain a *lot* of equipment



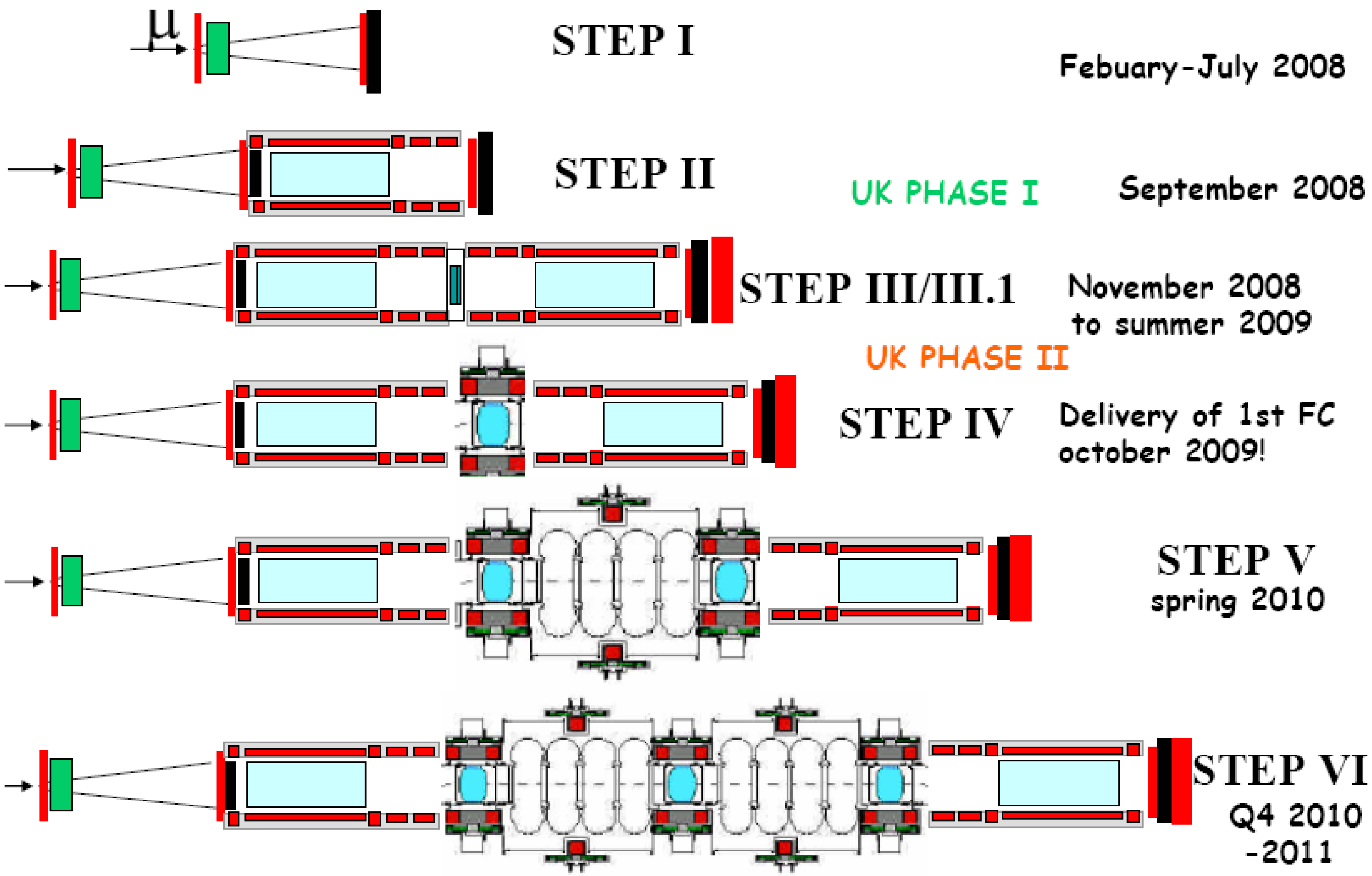
MICE Hall (2)

- The beam line portion of which is now in place and being commissioned



MICE Stages

- Present staging plan (some delays have occurred)



MICE Collaborators

- **Collaborating institutions**

Europe
- Bari
- Brunel
- CERN
- Daresbury Lab
- Edinburgh
- Genève
- Genova
- Glasgow
- Imperial College
- Legnaro
- Liverpool
- LNF Frascati
- Louvain la Neuve
- Milano
- Napoli
- NIKHEF
- Novosibirsk
- Oxford
- Padova
- PSI
- RAL
- Roma III
- Sheffield
- Sophia
- Trieste

Asia
- ICST-Harbin
- KEK
- Osaka

U.S.
- ANL
- BNL
- Chicago-Enrico Fermi Institute
- FNAL
- Illinois Institute of Technology
- TJNAF
- LBNL
- Mississippi
- Muons, Inc.
- Northern Illinois
- UCLA
- UC-Riverside

Shows broad international support for muon cooling study

International Perspective

- International community holds annual "NuFact" workshops
  - provides opportunity for physics, detector, and accelerator groups to plan and coordinate R&D efforts at "grass roots" level
  - venue rotates among geographical regions (Europe, Japan, U.S.)

Year	Venue
1999	Lyon, France
2000	Monterey, CA
2001	Tsukuba, Japan
2002	London, England
2003	New York, NY
2004	Osaka, Japan
2005	Frascati, Italy
2006	Irvine, CA
2007	Okayama, Japan
2008	Valencia, Spain

FY08 Budget

- Prepared initial budget for FY08 based on (usual) guidance of flat-flat funding
  - from there it went downhill...but not drastically
- Discussed and approved by TB, EB, and MCOG
- Goal: keep simulation activities viable while making some progress on key fabrication activities
- R&D obligations
  - proceed with MICE RFCC module fabrication
  - complete and decommission MERIT experiment
  - participate in IDS-NF and MICE (⇒ common fund payment)
  - continue RF test program at MTA
  - enhance effort on collider design

FY08 Funding Distribution

- FY08 NFMCC budget (only DOE-NFMCC funds)†

  †Also: salary support from BNL, FNAL, LBNL; support from NSF of $1M ($798K MRI + $133K 3-yr grant); support of Muons, Inc. via SBIR grants

Institution	COOLING /MICE	TARGETRY	ACCEL./ COLLIDER	RESERVE	TOTAL ($K)
BNL		145	90		235
FNAL	55				55
LBNL[a]	810			22	832
ANL	190				190
IIT	80				80
Mississippi	30				30
Princeton		40			40
UCLA			55		55
UC-Riverside			95		95
ORNL		85			85
Jlab	3		10		13
TOTAL ($K)	**1168**	**270**	**250**	**22**	**1710**

[a]Includes MICE funding of $575K.

FY08-09 Plans

- Targetry
  - decommission MERIT and publish results
- Cooling/MICE
  - continue testing 805- and 201-MHz cavities
    - with magnetic field
    - test gas-filled cavity with beam at MTA (MCTF)
  - begin MICE beam line commissioning
- Acceleration
  - participate in EMMA design
- Simulations
  - participate in IDS-NF
  - continue collider studies with MCTF
    - aim for feasibility study in FY11-FY12

Also developing updated 5-year plan (tomorrow's talk)

Issues

- Three categories where additional support is needed:
  - completing our hardware commitments to international experiments
    - MICE hardware commitments will be honored at present budget levels, but may be 1 year late
      - any substantial need for contingency would risk further delays
  - restoring the health of our simulations and theory effort
    - manpower has eroded away after years of flat budgets
      - need effort for IDS-NF, MICE analysis, EMMA design, and MCTF work
        - need to assess resource needs (not just $ issue)
  - providing common funds for the MICE experiment
    -
- Hope for strong endorsement from P5 to help improve our fortunes
  - support from MUTAC will likewise be very beneficial

Summary and Outlook

- Despite limited funding, NFMCC continues to make excellent progress on carrying out its R&D program
  - 201 MHz cavity tests with magnetic field have begun
  - MICE spectrometer solenoid fabrication nearly completed
  - completed ISS; write-up posted
    - launched IDS-NF
  - completed MERIT beam run
    - data analysis under way
- Our work provides potential choices for HEP community
  - muon-based accelerators/colliders offer advantages over other approaches
    - they also provide an intense source for low-energy muon physics
- We have been disciplined and effective in carrying out our R&D tasks continue to make good use of our funding