



Report of Project Manager

Michael S. Zisman

CENTER FOR BEAM PHYSICS

Neutrino Factory and Muon Collider Collaboration Project Manager

NFMCC Meeting-UCLA

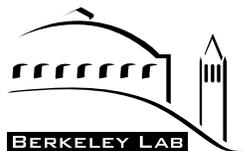
January 29, 2007



Outline



- Introduction
- FY06 accounting
- Recent R&D accomplishments
- FY07 budget
- FY07 plans
- 5-year R&D plan (reminder)
- Summary and outlook
- Issues for discussion



Introduction

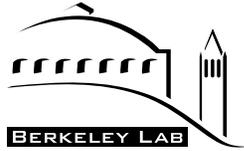


- Since FY03, the **NFMCC** budget has been nearly flat-flat
 - we remain hopeful of getting increased support from DOE and NSF

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
FY06	1.8	1.8	3.6

^{a)} Includes \$0.4M supplemental funds

^{b)} Includes \$0.3M supplemental funds



Introduction



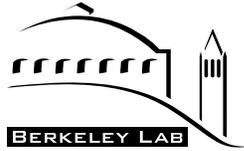
- We are presently committing funds to **MICE** and **MERIT**
 - and supporting the International Design Study (**ISS** → **IDS**)
- By juggling projects across fiscal year boundaries and careful prioritization, we continue to make progress, but
 - only “contingency” on deliverables is time
 - simulation effort weakened by lack of post-docs
 - BNL simulation effort has atrophied
- Hardware development continues as major focus of FY07 activity
- Simulation effort aimed at reducing Neutrino Factory cost (“Study IIa”) gave good results
 - **ISS** used this as its basis, upcoming **IDS** likely will also



Introduction



- Simulations of Muon Collider scenario also progressing well
 - **MCTF** created at Fermilab
 - schemes compatible with NF “front end” being explored
 - solidifies the R&D connection between the two types of facility
 - Muon Collider design will benefit greatly from this resource
 - but **we are stretched thin to provide our share of the effort**
- Here I will cover:
 - **FY06 accounting (incomplete) and R&D accomplishments**
 - **FY07 budget and status of current activities**



FY06 Accounting



- FY06 budget finalized by Spokespersons and PM in October, 2005
- Both MICE and MERIT are a significant draw on resources
 - substantial M&S funding now being used
- We are continuing to pursue opportunities for obtaining a coupling coil
 - two options in the U.S. being pursued for FY07
 - MRI grant from NSF (U.-Miss., just submitted)
 - negotiations with ICST-Harbin



FY06 Accounting



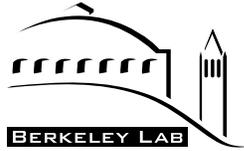
• FY06 **NFMCC** budget (only DOE-**NFMCC** funds)[†]

Institution	COOLING /MICE	TARGETRY	ACCEL./ COLLIDER	RESERVE	TOTAL (\$K)
BNL		405			405
FNAL	45				45
LBNL ^{a,b}	980			70	1050
ANL	150				150
IIT	85				85
Mississippi	20	25	20		65
Princeton		105			105
UCLA	25		45		70
UC-Riverside			20		20
ORNL		95			95
Jlab	5		5		10
TOTAL (\$K)	1310	630	90	70	2100

^aIncludes MICE funding of \$620K.

^bIncludes supplemental funding of \$300K for MUCOOL coupling coil.

[†]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



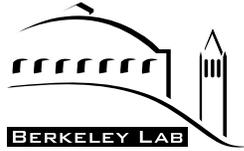
FY06 Accounting



- Supplemental request submitted to DOE in January 2006 (priority order)
 - priorities decided in discussions between Spokespersons and PM

<u>Item</u>	<u>Request (\$K)</u>
1) Coupling coil design and construction	975
2) Support for MICE design, commissioning, operations, and analysis	350
3) Support for International Scoping Study	100
TOTAL	1025

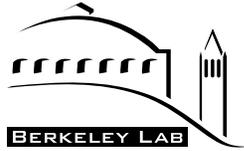
- \$300K for item 1 obtained from this request
 - in the hope that an NSF MRI award would cover the rest
 - which unfortunately did not happen



FY06 Accounting



- Main goals for FY06
 - complete fabrication of Targetry test magnet
 - continue with Hg-jet target fabrication
 - continue development of MUCOOL Test Area (MTA) at FNAL (cryogenics)
 - continue high-power tests of 805 MHz NCRF cavity
 - begin tests of 201-MHz NCRF cavity
 - continue 201-MHz SCRF development (NSF supported)
 - obtain funding for MICE (ongoing struggle!)
 - continue exploring and optimizing 6D cooling performance



FY06 Accounting



- Before funds were distributed, each institution provided milestones agreed upon by PM
 - milestones (example below) reflect budget allocations for each institution, including base program funds

ANL [Norem]

Milestone

Begin 805 MHz cavity testing at MTA
 Begin studies of small sample materials in the 805 MHz cavity
 Write up initial experimental results on pulse length dependence of breakdown
 Write up initial experimental results on coatings with Atom Probe Tomography
 Write up model of conditioning, pulse length and frequency dependence of breakdown

<u>Date</u>	<u>Deliverable</u>
Feb-06	Inspection
Mar-06	Inspection
Jun-06	NFMCC note
Aug-06	NFMCC note
Sep-06	NFMCC note

BNL [H. Kirk]

Milestone

Test pulsed 15-T solenoid at MIT
 Complete fabrication of Hg-jet
 Begin integration test of Hg jet in pulsed solenoid
 Continue support for NFMCC web pages
 Test MERIT cryogenics cold valve box
 Simulation of FFAG ring for ISS

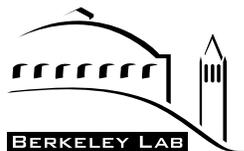
<u>Date</u>	<u>Deliverable</u>
Feb-06	NFMCC presentation
Jun-06	Inspection
Sep-06	NFMCC presentation
Sep-06	Inspection
Jul-06	Inspection
Aug-06	ISS report

ORNL [Gabriel]

Milestone

Award Hg loop fabrication contract
 Begin testing Hg loop at ORNL
 Ship Hg loop to MIT
 Complete acquisition of tool box items
 Complete initial testing of integrated system at MIT

<u>Date</u>	<u>Deliverable</u>
Feb-06	P.O. written
May-06	Inspection
Jul-06	Inspection
Jul-06	Inspection
Sep-06	Inspection



FY06 Accounting



- Summary of FY06 spending is shown below (presently incomplete)

Institution	Collaboration		Base Program	Overall	Contact
	Committed (\$K)	Uncommitted (\$K)	Committed (\$K)	Total (\$K)	
ANL	150	0	50	200	J. Norem
BNL [1]	515	260	921	1436	H. Kirk
FNAL [2]	0	170	0	0	S. Geer
LBNL [3]	226	419	316	541	M. Zisman
ORNL	135	50	85	220	T. Burgess
Princeton U.	105	0	200	305	K. McDonald
UCLA	70	0	57	127	D. Cline
UC-Riverside	16	0	0	16	G. Hanson
Mississippi	65	0	0	65	D. Summers
IIT [4]	87	9	0	87	D. Kaplan
Jlab	102	0	0	102	R. Rimmer
<i>NSF MICE Support [5]</i>	<i>445</i>	<i>505</i>	<i>0</i>	<i>445</i>	<i>D. Kaplan</i>
TOTALS [6]	1471	908	1628	3100	
	<i>1916</i>	<i>1413</i>		<i>3545</i>	

NOTES:

- [1] Uncommitted funds for MERIT experiment.
- [2] Uncommitted funds for MTA cryogenics (\$100K) and MTA beam line (\$70K).
- [3] Includes \$119K in uncommitted Project Reserve funds maintained by LBNL
- [4] Only DOE funds. NSF funding reported separately.
- [5] Funds allocated to IIT as primary contractor.
- [6] DOE totals in Roman type; *additional NSF funding shown in italics.*



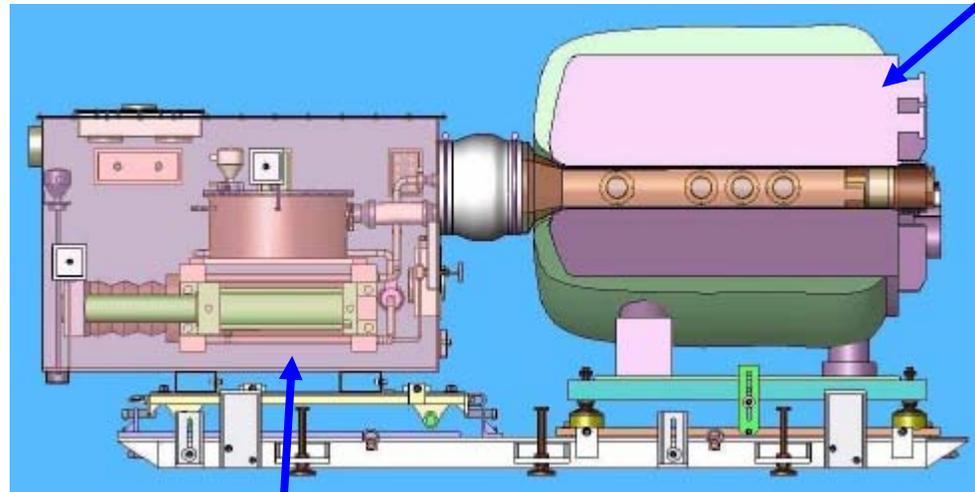
Recent R&D Accomplishments



- R&D progress was made on all fronts:
 - Targetry/**MERIT**
 - Cooling/**MICE**
 - Acceleration
 - Simulations/**ISS**

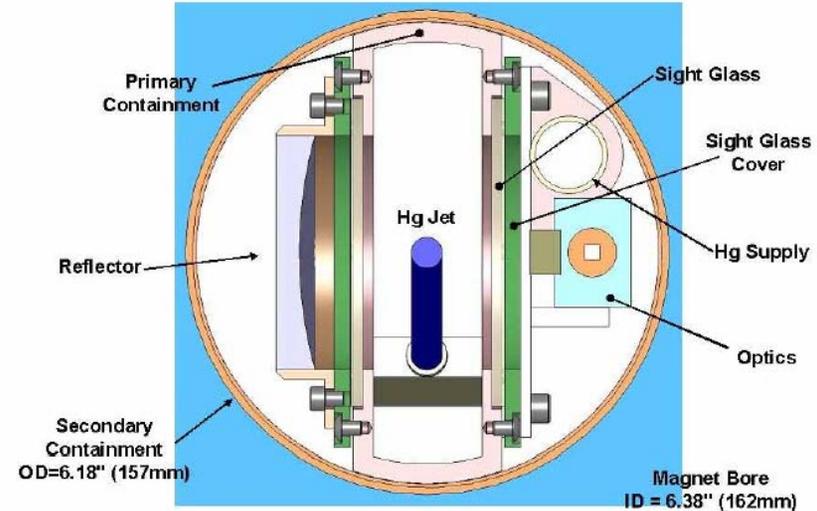
Recent R&D Accomplishments

- Proposal for MERIT experiment approved at CERN in April 2005
- Concept for Hg jet system for CERN target test experiment developed in collaboration with ORNL
 - first beam ~July, 2007



Hg circulation

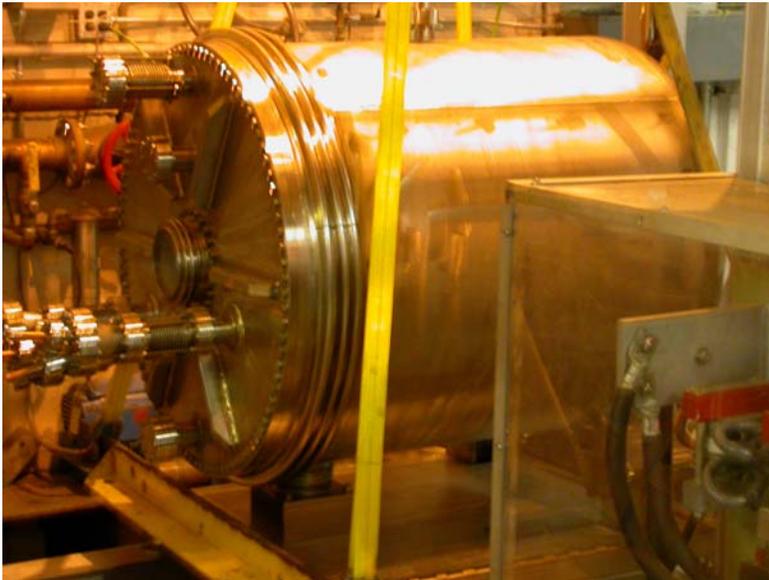
15-T pulsed solenoid



Optical diagnostics

Recent R&D Accomplishments

- Fabrication of 15 T magnet completed
 - test successfully to full field at MIT
- Hg-jet system assembled at ORNL and tested with water



15-T solenoid in test location at MIT



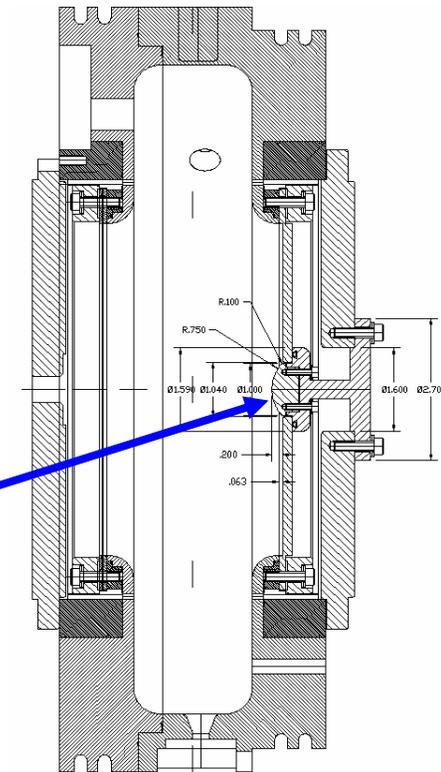
Hg jet system at ORNL

Recent R&D Accomplishments

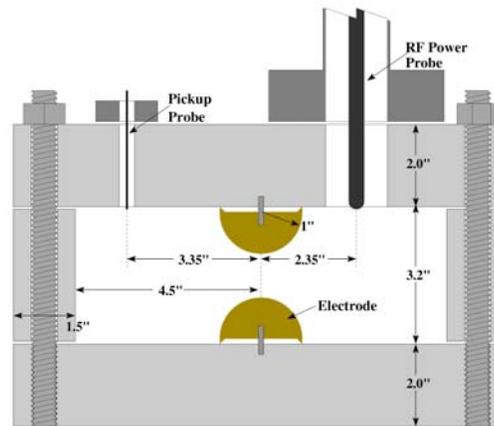
- RF test plan prepared for both 805 MHz and 201 MHz
- 805-MHz program (now resumed) uses **pillbox cavity** with replaceable windows or “buttons”
 - cavity fits in bore of MTA (née Lab G) solenoid
 - will study materials and coatings (**long overdue**)



“Button” for materials tests

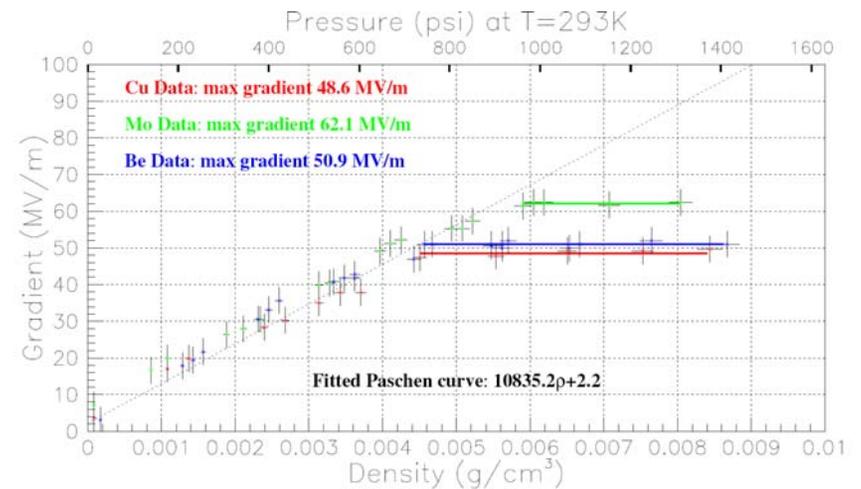
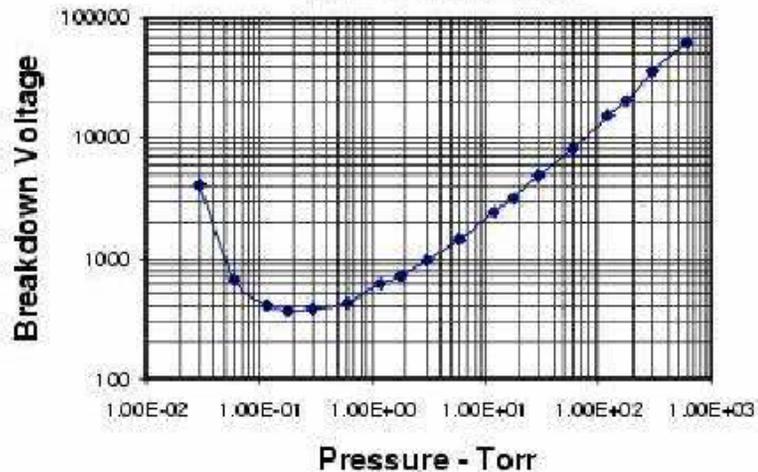


- Tested pressurized version of button cavity (Muons, Inc.)
 - use high pressure H₂ gas to limit breakdown



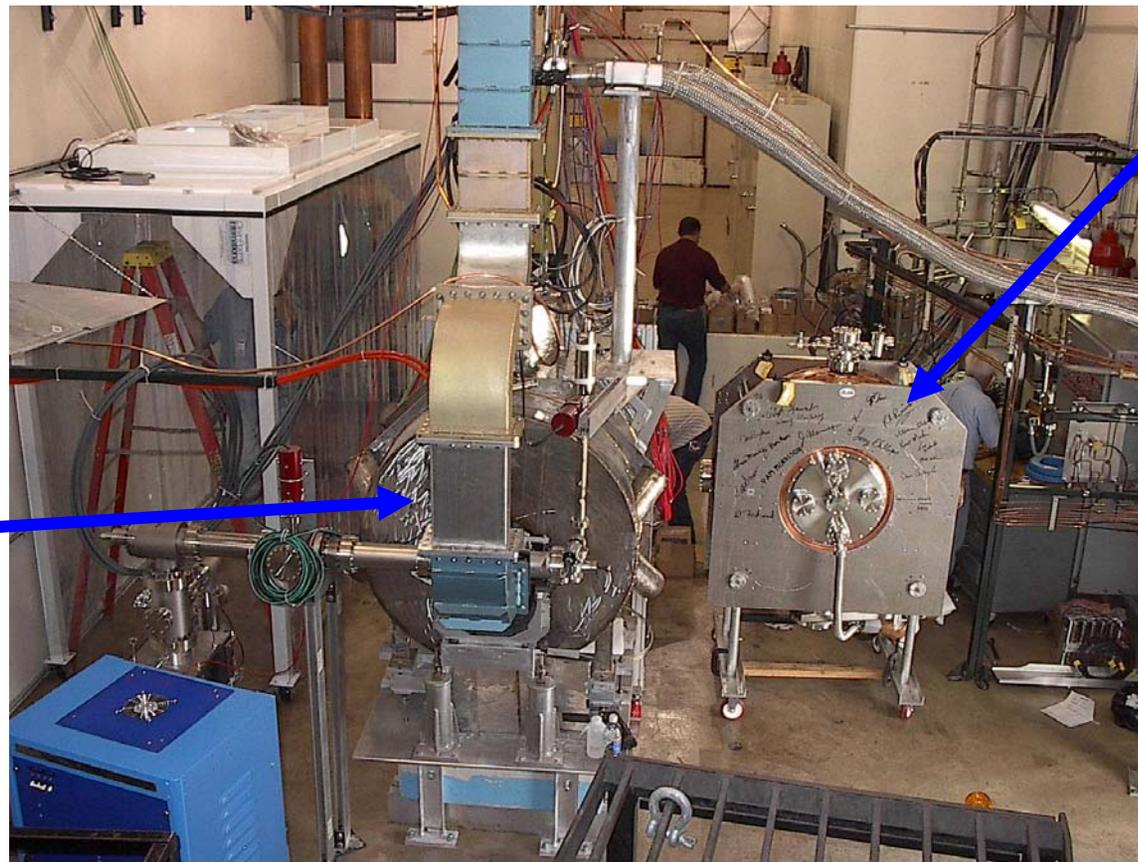
Offers hope of handling breakdown problem

Breakdown Voltage vs. Pressure
(Air - 0.1 inch Gap)



Recent R&D Accomplishments

- Initial tests of 201 MHz cavity very successful
 - cavity quickly reached design gradient of 16 MV/m (no magnetic field)

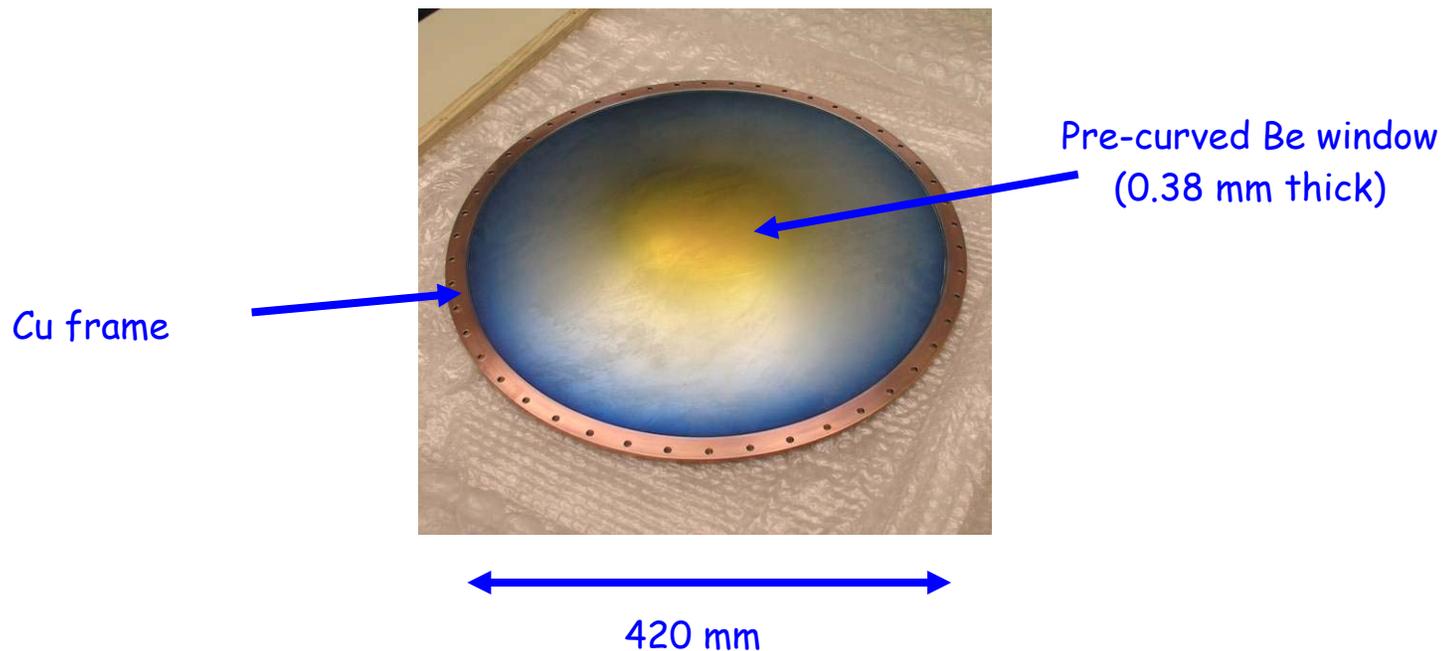


5-T solenoid
+
805 MHz

201 MHz Cavity

Recent R&D Accomplishments

- Curved Be windows for 201-MHz cavity fabricated and TiN coated in industry
 - two windows completed
 - not installed in cavity yet (using thick Cu windows with TiN)
 - on the program this year



Recent R&D Accomplishments

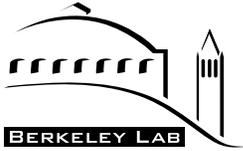
- Work on 201 MHz scrf cavity for the acceleration system has shifted gears
 - now trying to understand Q slope in terms of Nb coating properties
- Several 500-MHz cavities prepared to study fabrication techniques
 - hot isostatic pressed Nb-Cu; explosion bonded Nb-Cu
 - spinning of bonded cavity preferred



Bonded



Pressed

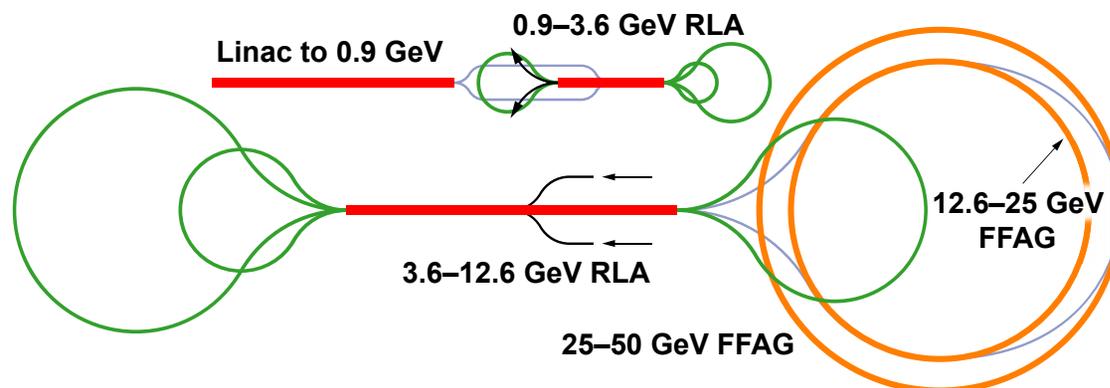


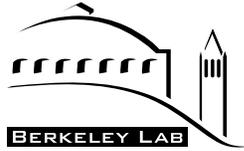
Recent R&D Accomplishments



- Simulations

- main focus in past year was to complete **ISS**
- considerable progress made in simplifying front-end systems while maintaining performance
 - developed RF bunching and phase rotation scheme; simplified cooling channel; FFAG scheme for final acceleration stages
- NFMCC front end scheme adopted as baseline
 - also played key role in definition of acceleration scheme...not so simplified

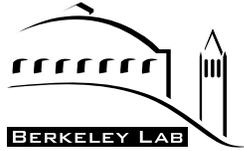




Recent R&D Accomplishments



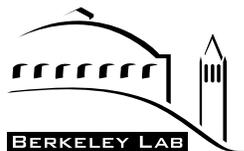
- Summary of main findings from **ISS** (report in preparation)
 - preferred proton driver energy is 10 ± 5 GeV
 - Hg-jet target gives optimal muon production for protons in preferred energy range
 - Study IIa front end design is preferred, using simultaneous operation with both muon signs
 - non-scaling FFAG beam dynamics limits performance, so 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 2 suitable sites operating simultaneously
 - racetrack better for single detector site, and has no directional constraints
- WDS unlikely before late 2007 so **continue with IDS until then**



FY07 Budget



- Prepared initial budget for FY07 based on guidance of flat budget
 - Tech and Exec Boards discussed and approved it
- Budgetary “goal” is to maintain university programs while making some progress on key fabrication activities
- Choices based on the following R&D obligations
 - start on RFCC modules for MICE
 - provide remaining components for MERIT experiment
- Continue seeking funds for coupling coil for RF cavity tests at MTA
 - NSF, DOE, China



FY07 Budget



- **FY07 NFMCC budget (only DOE-NFMCC funds)[†]**

Institution	COOLING /MICE	TARGETRY	ACCEL./ COLLIDER	RESERVE	TOTAL (\$K)
BNL		440			440
FNAL	50				50
LBNL ^a	680			35	715
ANL	150				150
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)	1037	565	163	35	1800

^aIncludes MICE funding of \$500K.

[†]Also: salary support from BNL, FNAL, LBNL; support from NSF of \$0.1M + \$0.75M MRI grant; support of Muons, Inc. via SBIR grants

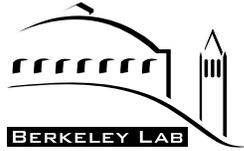
- Also submitted MRI request for coupling coil to NSF



FY07 Plans



- **Targetry**
 - complete **MERIT** experiment and publish results
- **Cooling/MICE**
 - complete testing of 805 MHz and 201 MHz high-gradient cavities
 - complete **MICE** experiment and publish results
- **Acceleration**
 - optimize system design for performance and cost
 - participate in **EMMA** test program
- **Simulations**
 - continue developing **cost-optimized front-end** for Neutrino Factory
 - participate in **International Design Study** (follow-on to **ISS**)
 - continue **collider studies** with aim of completing **feasibility study**
 - collaborate on **MCTF** test program



5-Year Plan



- Continued low funding and launching of **MICE** and **MERIT** pose challenges for the **NFMCC**
 - prepared 5-year R&D plan two years ago to indicate funding needs
 - baseline plan assumed “flat-flat” funding
 - incremental plan assumed \$0.4M increase (no luck yet)
- Strawman budgets developed for both funding scenarios
 - activities lumped into four broad categories
 - **Cooling**: MUCOOL component R&D
 - **Targetry**: development of high power targets and collection systems, including beam tests at BNL, CERN, or elsewhere
 - **System Studies**: work on acceleration, ring coolers, colliders, performance studies
 - **MICE**: purchase or fabrication of MICE components



5-Year Plan

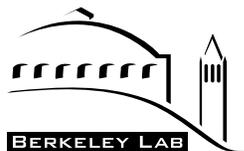


- Summary of baseline (flat-flat) case is

<u>Activity</u>	<u>FY05</u>	<u>FY06</u>	<u>FY07</u>	<u>FY08</u>	<u>FY09</u>	<u>FY10</u>
Cooling	492	345	345	705	615	225
Targetry	713	640	625	100	100	100
System Studies	195	195	195	295	295	195
MICE	300	620	635	700	790	1280
TOTAL	1700	1800	1800	1800	1800	1800

— comments:

- assumes base program funds remain as in FY06: BNL (\$0.9M); Fermilab (\$0.6M); LBNL (\$0.3M)
- priorities in FY06-07 are MERIT experiment and MICE solenoids
- split between Cooling and MICE somewhat flexible



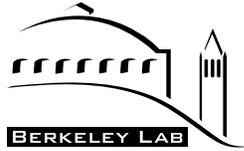
5-Year Plan



- Budget details for **baseline** case

	FY06 (\$K)	FY07 (\$K)	FY08 (\$K)	FY09 (\$K)	FY10 (\$K)	Sum (\$K)
Available	965	980	1405	1405	1505	6260
Cooling	345	345	705	615	225	2235
staff	280	180	180	180	180	1000
absorber	20	20				40
MTA ops.	45	45	45	45	45	225
CC-MUCOOL		100	480	390		970
MICE	620	635	700	790	1280	4025

- **MICE** needs only \$3.4M for Step 5, so extra funds are available
 - for contingency, if needed; for Step 6, if not
- Step 6 requires 1 more year, depending on contingency experience and getting additional help from NSF
 - ability to reduce costs by partnerships continues to be explored
 - coupling coils with ICST-Harbin
 - RF cavities with UK groups



Summary and Outlook



- Past year productive but difficult for the **NFMCC**
 - fabrication of **MERIT** hardware mostly completed
 - **201 MHz NCRF cavity** reached no-field design goal
 - **ISS** completed
 - **MICE** component fabrication launched (spectrometer solenoids and tracker)
 - progress toward self-consistent design of **Muon Collider**
 - Muons, Inc. initial **gas-filled cavity** tests encouraging
- Presented our program to HEPAP AARD Subpanel in February
 - got recognition that we were under funded (but no relief yet)
- Strong **MUTAC** endorsement of our R&D accomplishments and plans will be needed to maintain or enhance our budget
 - ***NFMCC will continue to hold up its end of the bargain!***



Issues for Discussion



- Resources
 - lack of control over MTA R&D program (klystrons, technician availability, cryogenics, ...)
 - lack of post-docs for simulations and for MICE “exploitation”
 - atrophy of BNL simulation group
- Membership
 - stagnant for quite a while
 - involvement with MCTF effort should help enhance our membership
- Science
 - uncertainty in magnitude of θ_{13}
 - apparent inability of HEP to think about multiple (expensive) scenarios