Report of Project Manager

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Muon Collaboration Project Manager

Muon Collaboration Meeting–Columbia
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Outline

- Introduction
- FY03 budget
- FY03 R&D progress
- FY04 DRAFT budget
- FY04 plans
- Summary and outlook

Introduction

- In FY03, the MC budget was halved
  - $2.809M→$1.429M

Year	DOE-base ($M)	DOE-MC ($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[a]	?	1.4	

[a]Present guidance from DOE.

- We had expected better news in FY04
  - restoration to FY02 level was anticipated
    - no such luck!
- By juggling projects across fiscal year boundaries and careful prioritization, we have continued to make technical progress

Introduction

- Hardware development is major focus of FY03 activity
- Simulation effort aimed at ring coolers making good progress
- Effort toward MICE proposal is coming to fruition
- Here I will cover:
  - FY03 budget
  - FY03 R&D progress
  - FY04 DRAFT budget
  - FY04 plans

FY03 Budget

- FY03 budget prepared via iteration between Technical Board, Spokespersons and PM
- Budget exercise this year was *very* difficult
  - we've made progress in past few years and want to continue
- Supplemental funding request submitted in May, 2002
  - and subsequently ignored
- FY03 budget was finalized by Spokespersons and PM in November
- Simulations and Theory group has been reconstituted by Spokespersons
  - led by R. Raja, with lieutenants for various subgroups
- Another "initiative" requiring resources: International Muon Ionization Cooling Experiment
  - presently requires mostly "effort" (base program funds)

FY03 Budget

- Main goals for FY03
  - engineer target test magnet
  - continue development of MUCOOL Test Area (MTA) at FNAL
  - continue high-power tests of 805 MHz cavity
  - continue 201-MHz SCRF development (NSF supported)
  - continue with LH_2 absorber development (includes ICAR support)
  - begin fabrication of 201-MHz NCRF cavity
  - submit technical proposal for MICE
  - continue exploring and optimizing cooling ring performance
- Aspirations modest this year due to severe budget shortfall

FY03 Budget

- **FY03 MC budget (approved by MCOG):**

Institution	COOLING	TARGETRY	COLLIDER	EFFORT[a]	RESERVE[b]	TOTAL ($K)
BNL		300				300
FNAL	400					400
LBNL	204				26	320
ANL				144		144
IIT				75		75
Mississippi				50		50
Princeton		50				50
UCB			5			5
UCLA	25		50			75
ORNL						0
JLab				10		10
UC-Riverside				90		
TOTAL ($K)	**629**	**350**	**55**	**369**	**26**	**1429**

[a]Includes beam simulation and diagnostics effort.
[b]Modest project reserve used to account for uncertainties in R&D activity costs.

- **Also: salary support from BNL, FNAL, LBNL; support from NSF (mainly Cornell) of ≈$1M; and support from ICAR (≈15 FTE)**

FY03 Budget

- **Supplemental request submitted to DOE in May, 2002 (priority order)**
  - **no response from DOE (yet)**
    - **don't hold your breath**

Item	Request ($K)
0) AGS operation	50
1) 201 MHz RF cavity fabrication	350
2) Targetry magnet fabrication	400
3) Cooling simulation effort	200
4) 805 MHz RF cavity R&D	100
5) LH_2 absorber fabrication	100
6) Target studies	50
7) Solenoid coil design	150
8) Target simulations	50
TOTAL	1450

FY03 Budget

- **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**

FNAL [Geer]

Milestone	Date	Deliverable
Complete pillbox cavity tests with copper windows	Dec-02	Inspection
Install Be windows in pillbox cavity and begin testing	Dec-02	Inspection
Complete initial analysis of pillbox cavity results with copper windows	Jan-03	Presentation
Report surface analysis of copper windows	Apr-03	MC note prepared
Complete first tests of Be windows in pillbox cavity	Apr-03	Inspection
Complete report on analysis of RF tests	Apr-03	MC note prepared
Complete design of 805 MHz grid structure	Jun-03	MC note prepared
Sign contract for MUCOOL Test Area Phase-II construction	Dec-02	Signed contract
Begin MTA site mobilization	Jan-03	Inspection
Beneficial occupancy of MTA	Dec-03	Inspection
Organize emittance exchange workshop	Nov-02	Workshop
Implement ring cooler with realistic fields in GEANT	May-03	Presentation
Match		

ANL [Norem]

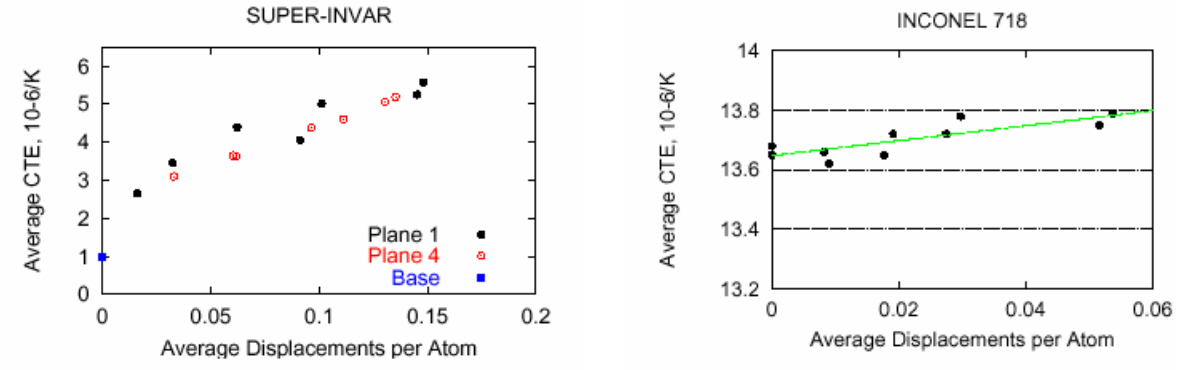
Milestone	Date	Deliverable
Study conditioning and dark currents with Be RF windows	May-03	MC report prepared
Continue optimization of dark currents and x-rays for MICE and MUCOOL	Sep-03	MC report prepared
Organize workshop on surface effects and breakdown in RF cavities	Apr-03	Inspection
Preliminary evaluation of RF breakdown mechanisms	May-03	PAC03 paper prepared
Complete experimental setup to study RF breakdown effects	Sep-03	Inspection
Perform (with IIT and NIU) experiment on e-beam generated turbulence in water with schlieren system	Jun-03	MC report prepared

FY03 R&D Progress

- R&D progress being made on all fronts:
  - Targetry
  - Cooling
  - Acceleration
  - Simulations

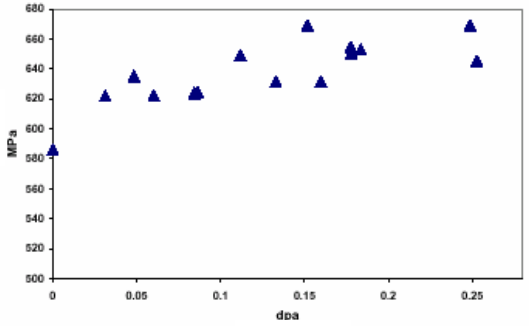
FY03 R&D Progress

- Radiation testing of candidate solid-target materials (Super-Invar and Inconel) carried out at BNL with 200 MeV p beam (Kirk, Simos)
  - looked at both CTE and tensile strength changes
    - big changes in Super-Invar CTE with dose, less with Inconel



    - yield strength increases but material gets more brittle

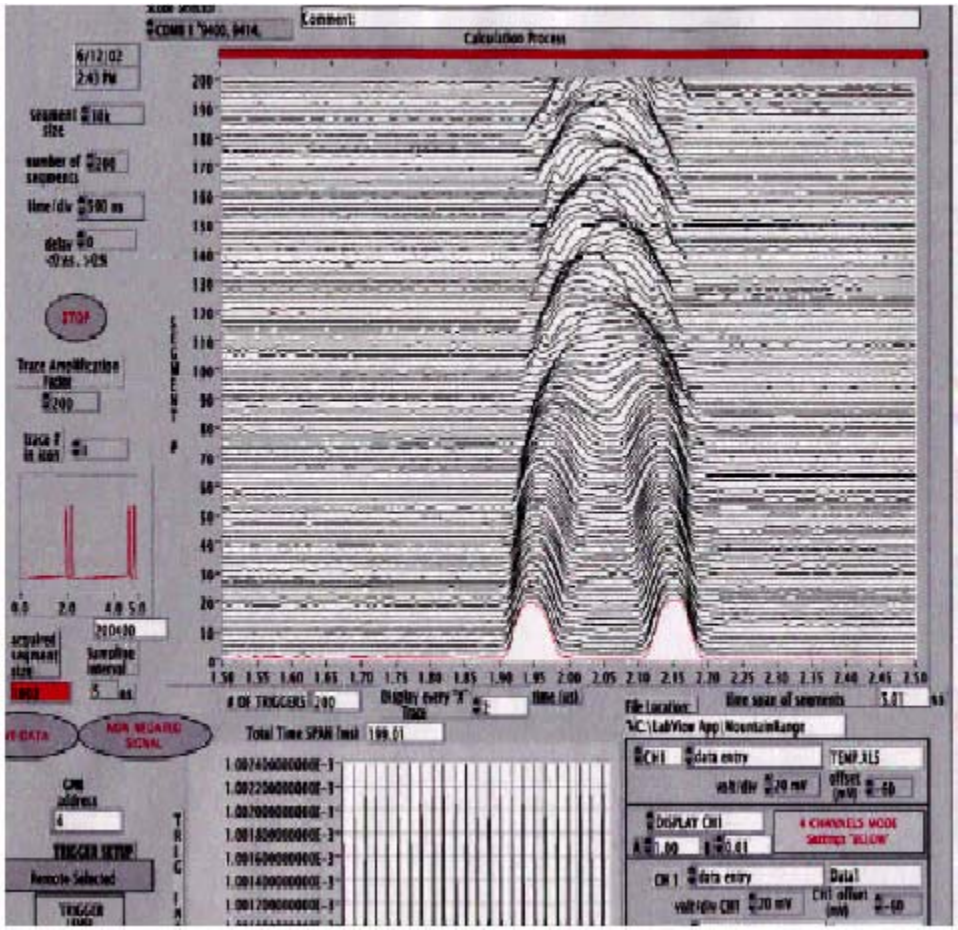
Yield (MPa)



dpa

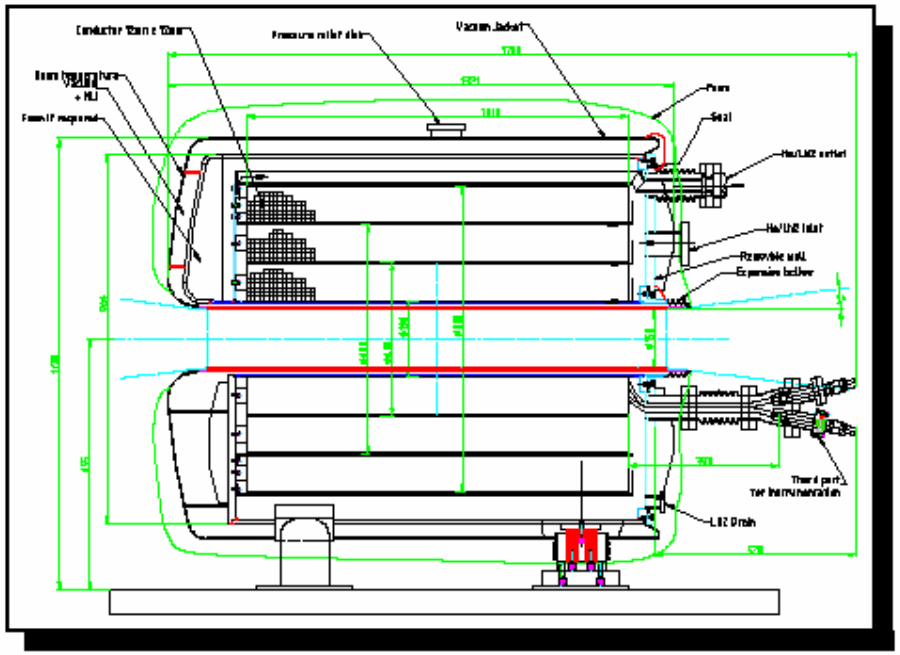
FY03 R&D Progress

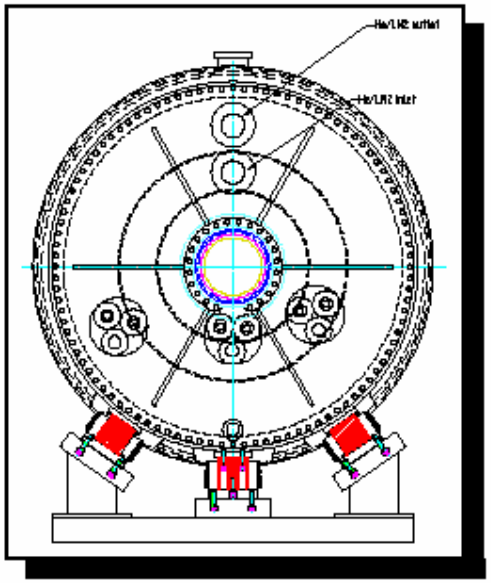
- Bunch merging (h = 12 → h = 6) at AGS gave extracted proton bunch of 10 Tp (desire 16 Tp)
  - technique needs development, but is clearly workable



FY03 R&D Progress

- **Engineering study of 5–15 T magnet for E951 completed (Kirk, Titus)**



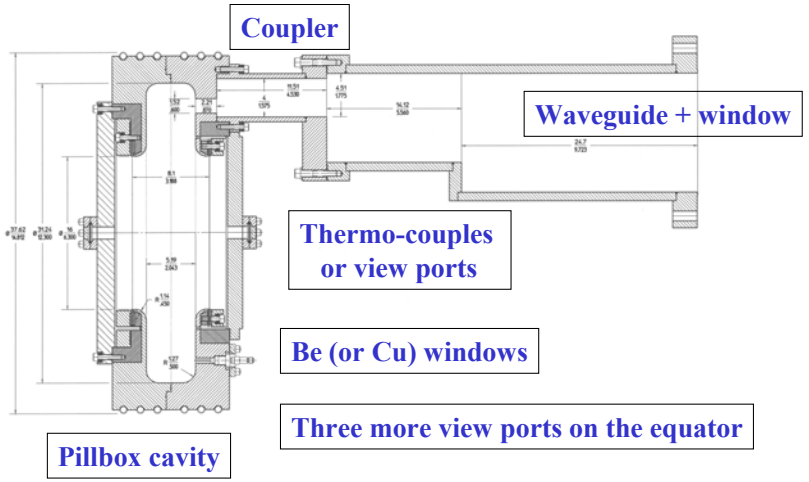


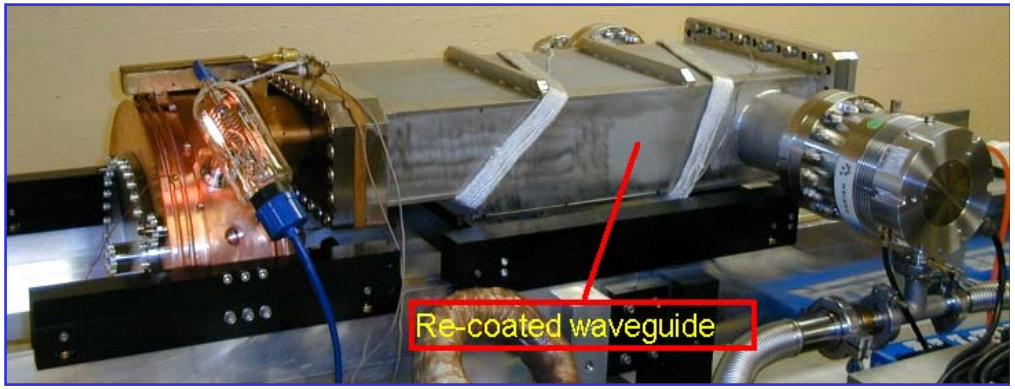
Stage	Field (T)	Power (MW)	Coolant	Temperature (K)
1	5	0.6	N_2	84
2	10	2.2	N_2	74
3	15	2.2	H_2	30
3a	15	4.5	N_2	70

- looking into using battery power

FY03 R&D Progress

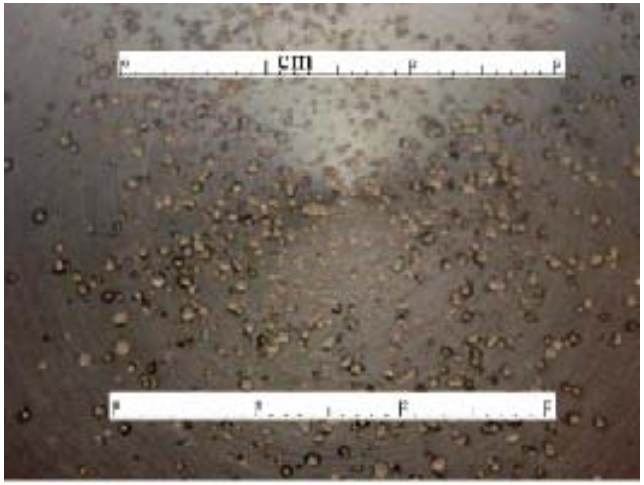
- Present tests use pillbox cavity with replaceable windows (or grids) (Li)
  - cavity fits in bore of Lab G solenoid





FY03 R&D Progress

- Pillbox cavity reached 34 MV/m in Lab G with no solenoid field (Moretti, Norem, Torun, Gruber, Li, Rimmer)
  - with solenoid performance worse (18 MV/m), radiation levels higher
    - field seemingly enhances likelihood of physical damage
      - but, some evidence for healing by reprocessing without field
- Cavity disassembled in December to inspect windows, internal surfaces
  - pitting of window seen, with copper "dust" at bottom of cavity

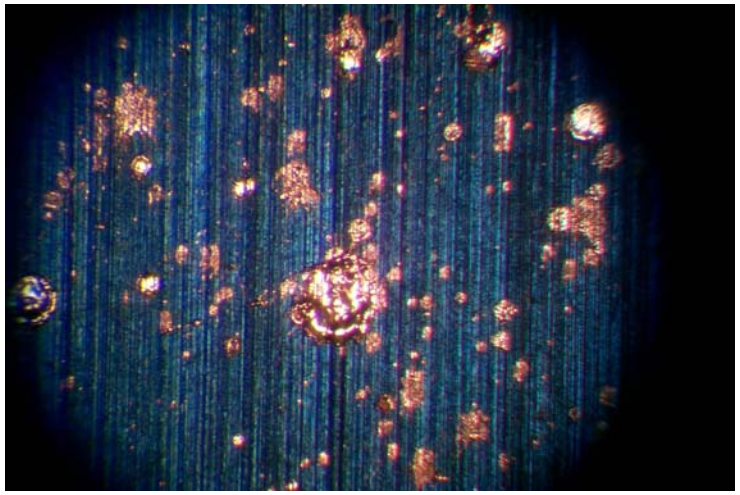


Copper window after using solenoid

FY03 R&D Progress

- TiN-coated Be windows were next installed and tested
  - no conditioning problems seen without magnetic field

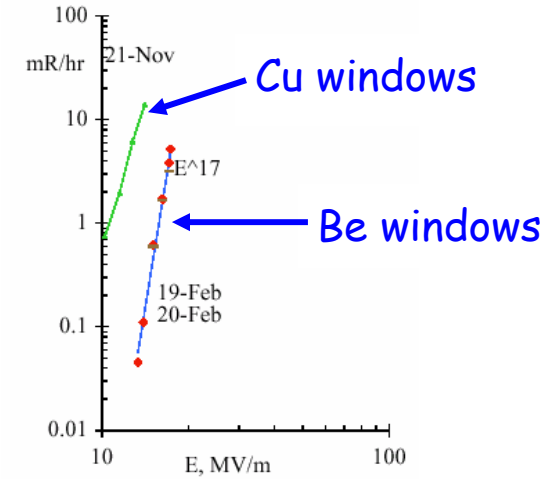
    ⇒parallel plate geometry does not cause big problems
- Found no damage to Be surface, but sputtered Cu is present
  - suggests need to focus more on copper body than on windows
- We will explore coatings that may help



Be windows with sputtered copper

FY03 R&D Progress

- Even with magnetic field present, background rates for Be are lower than for Cu under comparable conditions



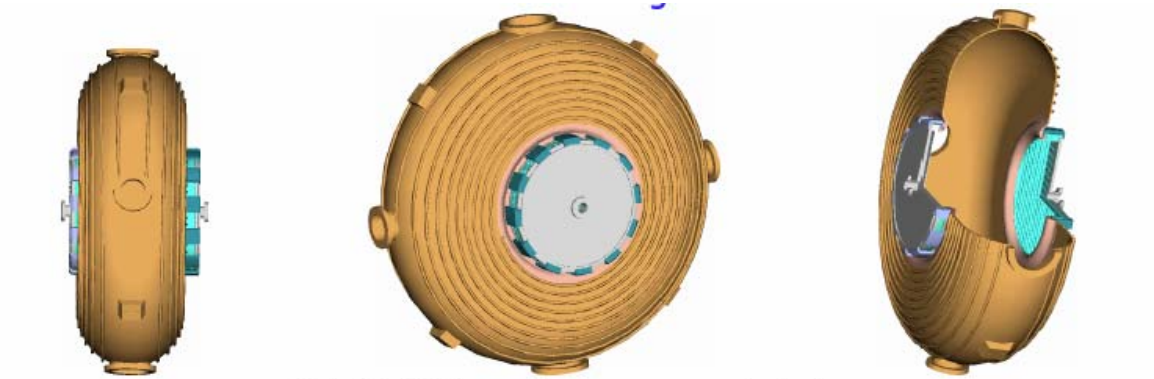
- Workshop on high-gradient rf limitations to be held at ANL, October 7–9, 2003

http://www.hep.anl.gov/rf/

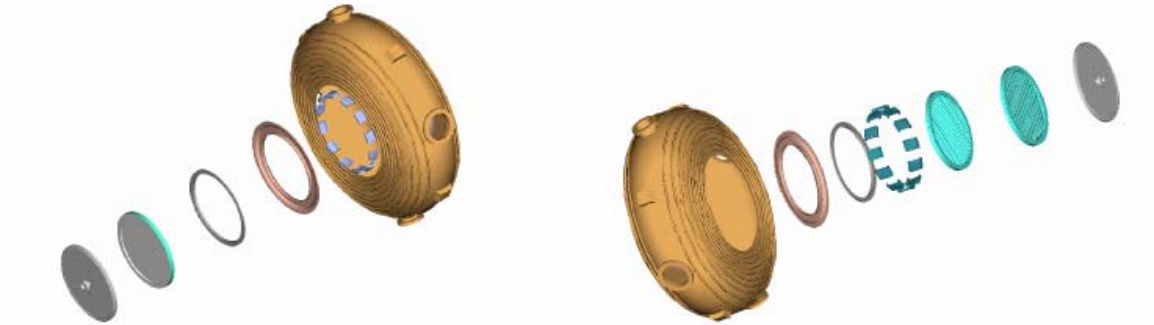
— contact: Jim Norem

FY03 R&D Progress

- 201 MHz rf cavity design nearly complete (Rimmer, Li, Ladran, Virostek)



201.25 MHz cavity conceptual design

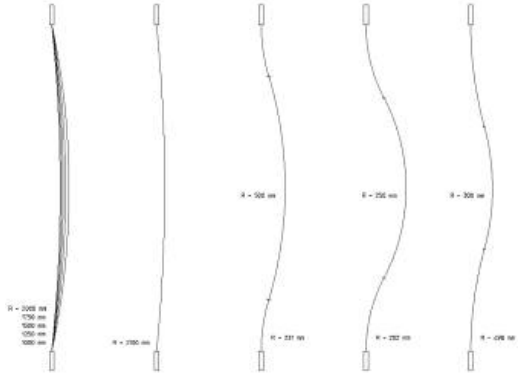


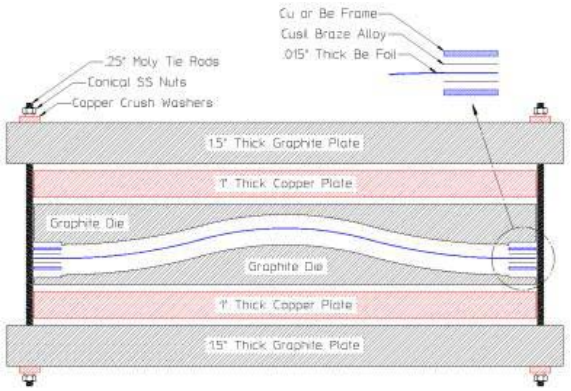
Exploded views showing foil and grid mounting hardware

- fabrication began this year; completion in about 1 year
- Jlab collaborating on cavity fabrication

FY03 R&D Progress

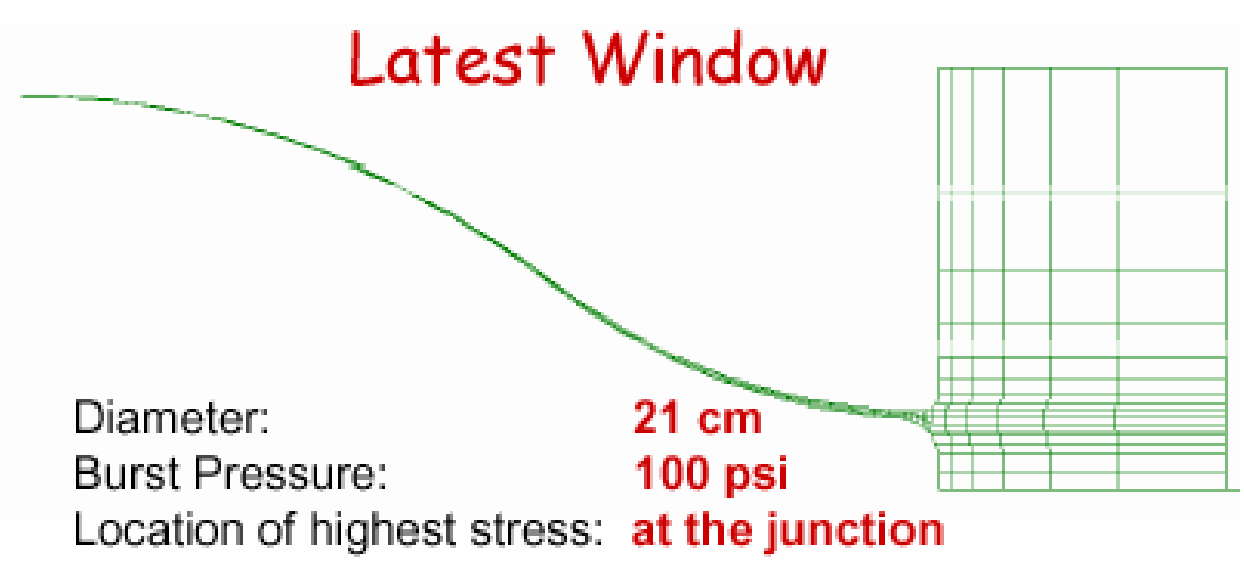
- Ideal cavity termination would be perfectly conducting and transparent to muon beam, and would not affect cavity frequency
  - initial concept was to use prestressed flat Be foils
    - even at 805 MHz, difficult to maintain flatness when window is heated by rf
    - frame must be very thick, making windows costly
  - new concept (Virostek, Lau, Li, Rimmer) uses pre-curved windows that bow predictably
    - with proper design, stresses remain quite low as the foil heats





FY03 R&D Progress

- Absorber group has developed strong, thin windows (Cummings, Kaplan)
  - windows as thin as 125 μm machined from solid Al (Summers)
  - new stronger (⇒thinner) design (Lau, Black) to be built and tested next



FY03 R&D Progress

- To test hardware, building MUCOOL Test Area at Fermilab (Popovic)
  - absorber, solenoid, and 201 MHz rf cavity will be integrated here

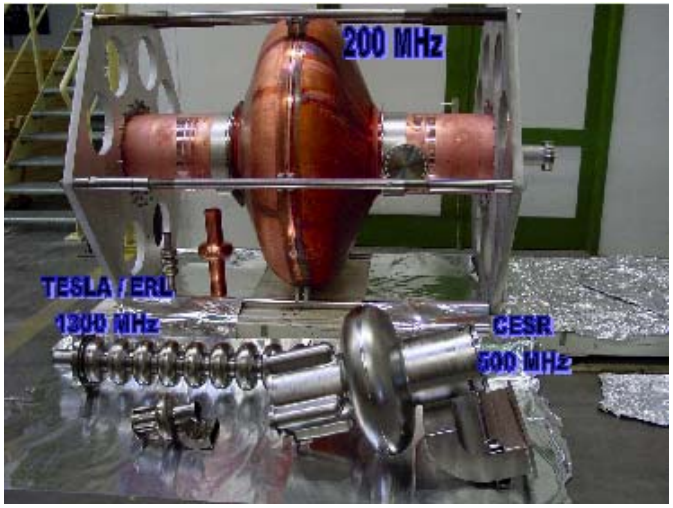
Original area

Stage 2 construction area

What it will look like when completed

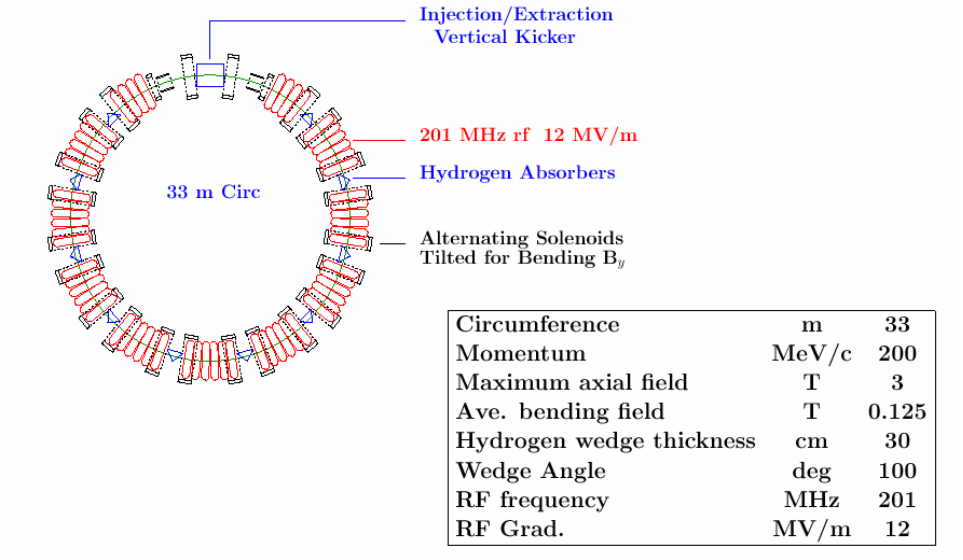
FY03 R&D Progress

- Work on 201 MHz scrf cavity for the acceleration system made good progress (Hartill, Padamsee; NSF)
  - focusing on achieving gradient, Q, mechanical stability
    - reached 11 MV/m after re-cleaning cavity
    - low-power $Q = 10^{10}$
  - still need to develop designs for ancillary items (input coupler, HOM coupler, tuner) based on existing experience, e.g., KEKB

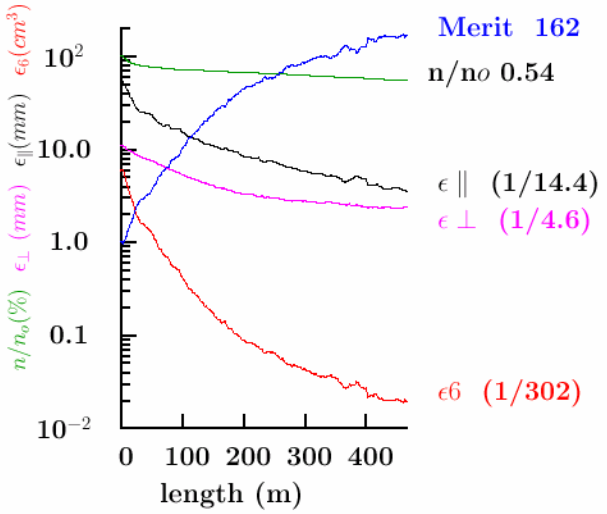


FY03 R&D Progress

- **Simulations**
  - **main focus on emittance exchange**
  - **ring coolers (Balbekov, Palmer) important due to potentially significant cost reduction (Neutrino Factory and/or Collider)**
    - **6D cooling looks promising; injection is an issue**

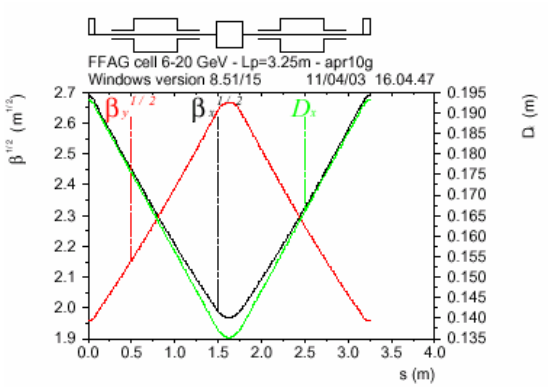


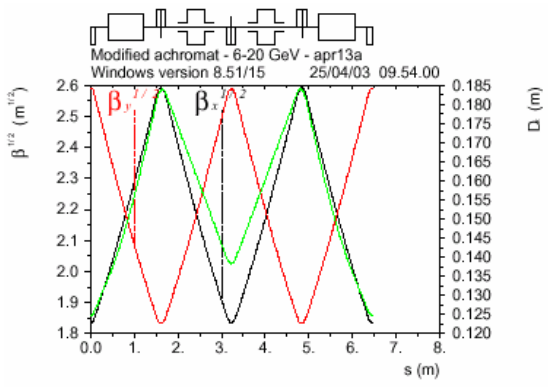
Circumference	m	33
Momentum	MeV/c	200
Maximum axial field	T	3
Ave. bending field	T	0.125
Hydrogen wedge thickness	cm	30
Wedge Angle	deg	100
RF frequency	MHz	201
RF Grad.	MV/m	12



FY03 R&D Progress

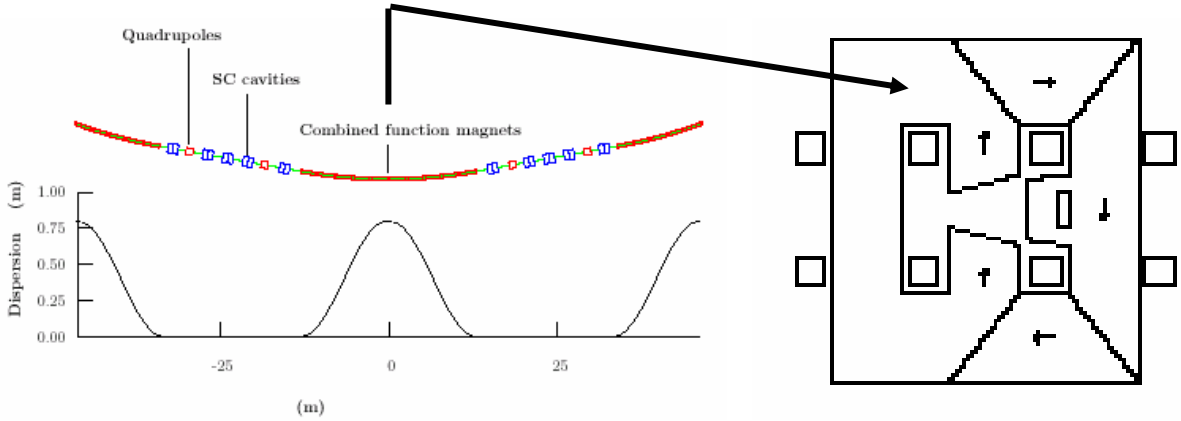
- Looking at alternative acceleration schemes
  - RLA with FFAG arcs (Berg, Johnstone, Keil, Sessler, Trbojevic)





  - very rapid cycling booster (Summers)

Grain-oriented Si steel



FY04 DRAFT Budget

- Prepared draft budget for FY04 based on present budget guidance
  - Tech Board has met twice to discuss it
- Changes to individual budgets at the level of ±10% may occur, based on Tech Board input
  - along with inputs from this meeting
- Tech Board will meet again to finalize budget and make minor adjustments after the actual budget number is known
  - we will meet even sooner if there are significant changes that arise as a result of discussions here
- Budgetary goal is to keep university programs operational while making some progress on key fabrication activities

FY04 DRAFT Budget

- **FY04 MC budget (DRAFT):**

Institution	COOLING	TARGETRY	COLLIDER	EFFORT[a]	RESERVE[b]	TOTAL ($K)
BNL		265				265
FNAL	385					385
LBNL	200				10	220
ANL				180		180
IIT				75		75
Mississippi				50		50
Princeton		50				50
UCB			10			5
UCLA	25		50			75
ORNL						0
JLab				10		10
UC-Riverside			90			
TOTAL ($K)	**610**	**315**	**150**	**315**	10	**1400**

[a] Includes beam simulation and diagnostics effort.
[b] Modest project reserve used to account for uncertainties in R&D activity costs.

FY04 Plans

- Targetry
  - fabricate 15 T magnet
- Cooling
  - fabricate and test 201 MHz high-gradient cavity (17 MV/m)
  - fabricate and test LH_2 absorber with all safety aspects
- Acceleration
  - develop full prototype of 201 MHz SCRF cavity module
- Ring coolers
  - develop engineered concept of complete ring
- MICE
  - design and fabricate our portion of required components (if funded)

Summary and Outlook

- The past year was productive for the MC
  - engineering design of Targetry test magnet completed
  - NCRF cavity tests made progress (at 805 MHz)
  - 201 MHz NCRF cavity fabrication launched
  - approaches to study cooling rings developed
  - absorber windows fabricated and tested successfully; improved design developed
  - SCRF cavity testing started
- Serious planning effort under way toward MICE
  - proposal submitted to RAL and U.S. funding proposal to NSF
- Lack of funding is our biggest issue
  - strong MUTAC and MCOG endorsements of R&D accomplishments and plans this year will hopefully help