# NFMCC 5-year Plan Update

Michael S. Zisman
NFMCC Project Manager
Center for Beam Physics
Lawrence Berkeley National Laboratory

MUTAC Review–LBNL
April 9, 2008

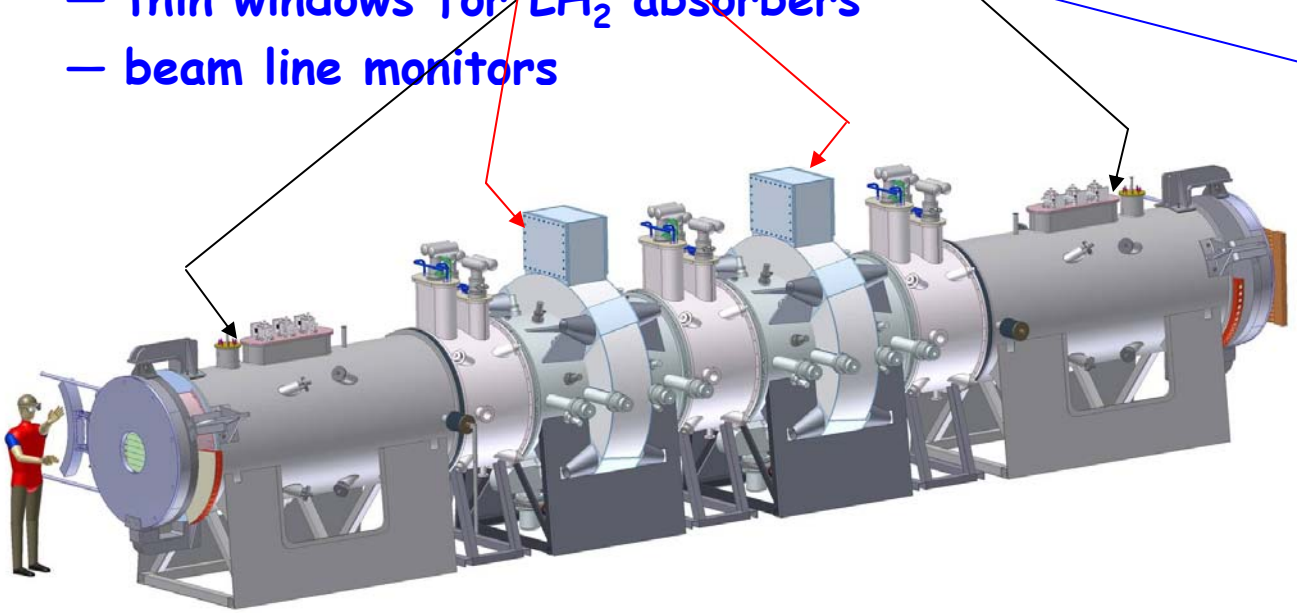
# Introduction

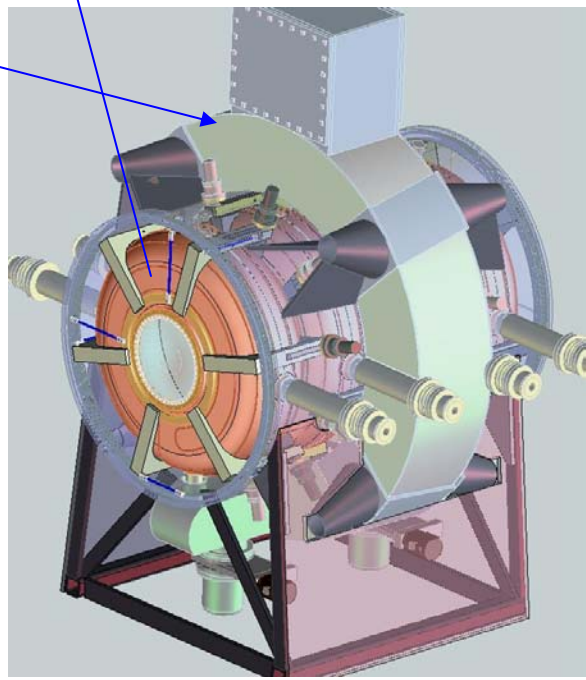
- A 5-year R&D plan was originally prepared three years ago at the behest of MCOG
  - purpose: demonstrate practicality of a funding plan to accomplish the proposed NFMCC R&D program at the expected funding level
    - two funding levels were assumed for planning purposes
      - a baseline case of continued "flat-flat" funding at the $3.6M level
      - a more optimistic scenario where our funding was augmented to $4.0M per year

- When originally presented, the MUTAC chairperson judged the plan to be "almost plausible"
  - this judgment has—so far—stood the test of time ☺
    - more seriously, we have been able to roughly maintain our technical progress despite being held at the baseline scenario for the past several years
      - and despite having no contingency

# MICE Commitments

- US hardware responsibilities (ongoing) include:
  - two Cherenkov detectors (delivered)
  - tracker electronics + contributions to scintillating fiber tracker itself
  - two spectrometer solenoids
  - two RFCC modules
    - each comprising a coupling coil and four RF cavities
  - thin windows for $LH_2$ absorbers
  - beam line monitors





# 5-year Plan (Original)

- **Activities lumped into four broad categories**
  - **Cooling: MuCool component R&D**
  - **MICE: purchase or fabrication of components for the experiment**
  - **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 (e.g., IDS-NF)**

- **Baseline case funding plan (M&S only) was**

| Activity | FY05 | FY06 | FY07 | FY08 | FY09 | FY10 |
|---|---|---|---|---|---|---|
| Cooling | 492 | 345 | 345 | 705 | 615 | 225 |
| MICE | 300 | 620 | 635 | 700 | 790 | 1280 |
| Targetry | 713 | 640 | 625 | 100 | 100 | 100 |
| System studies | 195 | 195 | 195 | 295 | 295 | 195 |
| TOTAL | 1700 | 1800 | 1800 | 1800 | 1800 | 1800 |

# Assumptions

- Base program funds (i.e., staff costs) remain fixed
  - BNL = $0.9M
  - FNAL = $0.6M
  - LBNL = $0.3M
- Completing MERIT was a priority in FY06-07
- MuCool R&D coupling coil and (essentially identical) MICE coupling coils accounted for separately
  - but, recognized that MICE/MuCool split was flexible
- "Pessimistic" assumption of flat-flat funding at $3.6M
  - thus far has remained true ☹
    - with continuing resolution in place, FY09 not likely to be much different

# What Has Changed

- Addition of ICST/Harbin as a MICE collaborator lowered cost of the three required coupling coil magnets ☺
  - $2.4M → $1.2M
- Arrangements with D0 to use spare VLPC electronics permitted redirecting some of IIT's NSF-MRI grant toward purchase of spectrometer solenoids ☺
- DOE provided supplemental funds in both FY06 ($0.3M) and FY07 ($0.63M) in support of MICE ☺
- NSF recently provided MRI ($0.8M, through U.-Miss.) to be used for MuCool and MICE magnets and RF cavities ☺
- Delay in MERIT operations meant that funding roll-off was less steep than planned ☹

# 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.

# Status

- Based on current estimate, there is a shortfall for MICE in FY08-09
  - with reasonable contingency expectations, need ~$1.5M for remaining work
    - present budget projects to only $1.2M
      - completion will depend on how much contingency is actually required

- There is likelihood of slipping into FY10 to complete our cooling channel hardware responsibilities
  - spectrometer solenoid, tracker and CKOV obligations will be done on time

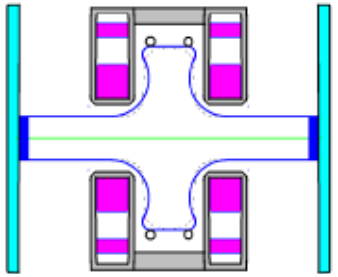
# Update Process

- Now beginning process of creating a follow-on R&D plan
  - note that our existing major funding commitments (MERIT and MICE) should be satisfied by FY10 at the latest

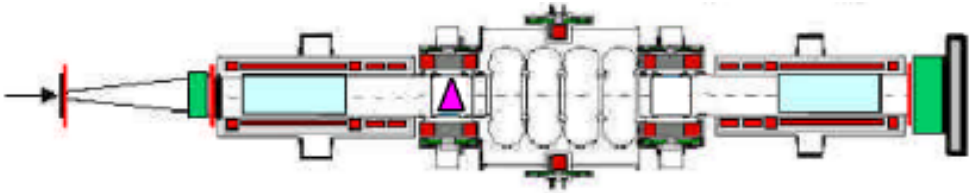
- Process:
  - Spokespersons and PM defining a list of R&D questions we believe should be answered in the next several years (in consultation with MCCC)
    - influenced by needs of IDS-NF and desire to carry out Muon Collider feasibility study by FY12 (⇒ ~3x funding increase; see Shiltsev talk)
      - these demands imply
        - substantial strengthening of simulation effort
        - enhanced emphasis on understanding NCRF cavity behavior in strong magnetic fields
        - renewed emphasis on Nb coated copper SRF cavities
  - proposals to answer questions will be solicited for TB evaluation in August
    - in consultation with MCTF, TB and PM will develop plans and budgets for next few years (based on DOE guidance, if available)

# Typical Candidate Activities

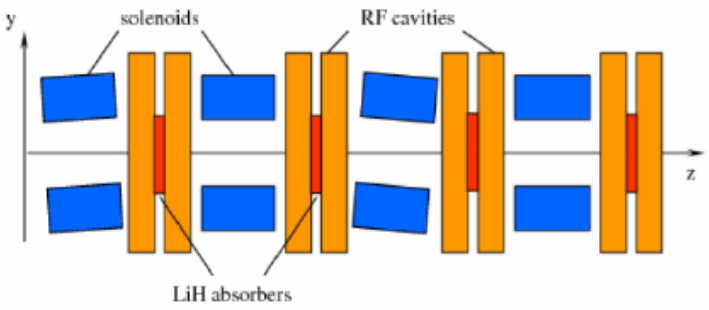
- Understanding behavior of "vacuum cavities" with magnetic insulation
  - open-cell or Be windows

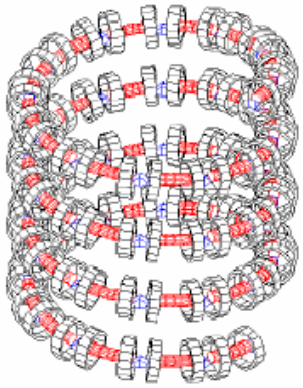


- "Poor man's" test of 6D cooling in MICE

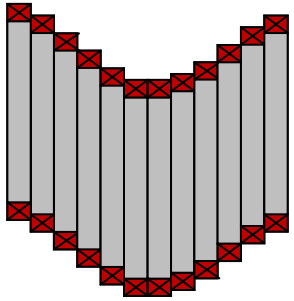


- "Rich man's" test of 6D cooling, e.g., FOFO snake, Guggenheim, HCC



"Type I"



# Issues (1)

- Some aspects of the R&D plan are tightly linked to results from MuCool RF tests with coupling coil
  - expect initial results by the next MUTAC review
- Presently difficult to get "long range" budget guidance from DOE for planning purposes
  - here, long range ⇒ 3–5 years
    - even getting guidance on next year has proved difficult recently
  - this problem affects the entire field, not just muon effort
- Exploitation of MICE experiment requires post-docs, as does RF R&D program
  - shortage of effort will hamper progress
    - recruiting young people into our field has become increasingly difficult
  - participating intellectually in experiment and data analysis are important
    - simply providing the hardware must not be considered sufficient

# Issues (2)

- SRF program "revival" will need expertise at Jlab + FNAL
  - will it be available?
- Serious participation in IDS-NF and preparing RDR require significant engineering effort
  - ideally want Lab sponsorship for this
  - only some of this is expected to come from US (~$1M/year)
- Completing feasibility study for Muon Collider in a timely way will likewise require substantial engineering resources
  - presently not clear there is much international interest in this goal
    - we need to work on this!
  - partnership with MCTF critical to success in this endeavor
- Need for 6D cooling demonstration must be assessed
  - it will not be cheap; cost-benefit ratio must be evaluated

# Issues (3)

- Presently, work on topics of interest to Neutrino Factory and Muon Collider not considered legitimate activity for core program funding
  - work toward high-field dipoles, aimed at DLHC or VLHC seemingly okay
    - work on high field solenoids, perhaps based on HTS, is presently not
  - Fermilab has partially addressed this with MCTF activities
  - BNL and LBNL staff would be interested in our challenges and I believe would participate more strongly if DOE gives its blessing
    - encouragement from MUTAC and P5 would help here
    - examples: magnets, NCRF, SCRF, lattice design and beam dynamics,...
  - SLAC could also be a help in several areas
    - NCRF, RF power source, lattice design and beam dynamics
    - such activities aimed at Muon Collider seem (to me) consistent with SLAC's stated aim of pushing the energy frontier
      - it would be nice for DOE to encourage their participation in this national program

# Summary and Outlook

- Execution of original 5-year R&D plan remains on track
  - this is due to a combination of luck and skill
    - not necessarily in equal proportions
  - NFMCC has maintained its focus on technical goals
- Process of defining next phase of muon R&D program is under way*
  - Step 1: define questions, in consultation with MCTF management
  - Step 2: decide how to answer them (also with MCTF)
  - Step 3: assess resource requirements ($, people, NFMCC/MCTF split)
  - Step 4: develop plan consistent with goals of NF RDR and MC FS by 2012
    - Step 4a: also try to get budgets into line with R&D needs
- New R&D plan, agreed to by MCCC, ready for review at next MUTAC meeting

*Note that MCTF has already begun this process