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FY2010 R&D Plan
Neutrino Factory and Muon Collider Collaboration

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Summary

A Neutrino Factory or a Muon Collider represents a potential future direction for the U.S. high-energy physics community. These challenging machines make use of stored beams of muons—a particle that is difficult to produce and has a short lifetime of only 2.2 μs at rest. The U.S. Neutrino Factory and Muon Collider Collaboration (NFMCC), comprising some 130 scientists from national laboratories, universities, and SBIR companies, has been carrying out a focused R&D program aimed at:

- producing conceptual designs for such facilities,
- developing and testing the required machine components, and
- carrying out system tests of a few key subsystems of such facilities.

In this document we summarize the R&D progress made during FY2009 and indicate the plans and milestones for FY2010. Because our University groups (IIT, Princeton, UC-Berkeley, UCLA, UC-Riverside, and U-Mississippi) all turn in detailed annual progress reports and summaries, and our SBIR partners (Muons, Inc., PBL, and Tech-X) write proposals that are reviewed by DOE, this document will cover only the status of the national laboratory programs (including the "sponsoring laboratories," BNL, FNAL, and LBNL, and the other laboratories with whom we collaborate, ANL, Jlab, and ORNL).

The NFMCC budget request for FY2010 (based on our guidance from DOE-OHEP) is $3,983K, of which "core funds" of $2,304K are requested to be distributed to the sponsoring laboratories as follows:

- BNL: $1,390K
- FNAL: $600K
- LBNL: $314K

The remaining $1,679K is requested to be distributed as indicated in Table 1.

The organization of the NFMCC is indicated in Fig. 1. The collaboration is managed by elected Co-spokespersons and a Project Manager appointed by the Muon Collaboration Oversight Group (MCOG) and approved by, and reporting to, DOE (and occasionally NSF). Each year, after getting budgetary guidance from DOE, the Technical Board meets to craft a program for the year. With these priorities, the Project Manager prepares a budget that is approved first by the Technical Board, then by the Executive Board, and finally by the Co-spokespersons. Before submitting the budget to DOE, the Project Manager and institutional representatives prepare a set of agreed-on milestones outlining what the collaborating groups will accomplish that year. Table 1 summarizes the results of this process for FY2010, and Attachment A lists the milestones for this year. Starting this year, we anticipate transforming the organization into the Muon Accelerator Program (MAP). The new MAP organization, described in Attachment B, is in the process of preparing a proposal for the MAP R&D program that will be submitted early in 2010.

In what follows we present the summary of FY2009 activities, plans for FY2010, and a list of recent NFMCC publications.

Table 1. FY2010 budget request for NFMCC funds. Because of the tight budget, there are no uncommitted reserve funds this year.

	Total ($K)	BNL	FNAL	LBNL	ANL	ORNL	Jlab	Princeton	UCB	UCLA	U-Miss	IIT	UC-R
Cooling	**80**												
MTA operation	30		30										
201- and 805-MHz cavity R&D	0												
Engineering	40			40									
Coupling coil preparations	10		10										
MTA beam line	0												
LiH absorber test	0												
Instrumentation	0												
Targetry	**180**												
MERIT analysis	10							10					
Target development	40	40											
MERIT decommissioning	40	20				20							
Facility design (IDS-NF)	40					30		10					
Targetry simulations	50	50											
Diagnostics	**190**												
Norem	190				190								
Hardware	0												
Beam Simulations	**268**												
Cooling/Theory	268	105							3	70		90	
Acceleration	**20**												
RLA/FFAG/RCS studies	20						10				10		
Collider	**112**												
SRF R&D	0												
Longitudinal cooling	112												112
MICE	**829**												
Common fund	80			80									
Absorber windows	18										18		
RF cavities	479			479									
Spectrometer solenoids	217			217									
Coupling coils	35			35									
Total Expended ($K)	**1679**	215	40	851	190	50	10	20	3	70	28	90	112
Operating ($K)	948	215	40	120	190	50	10	20	3	70	28	90	112
Equipment ($K)	731			731									
GPP ($K)	0												
Previously Allocated Funds ($K)	**0**												
Remaining Planned Expenditures ($K)	**0**												
Management Reserve [1]	**0**												
TOTAL BUDGET ($K)	**1679**												

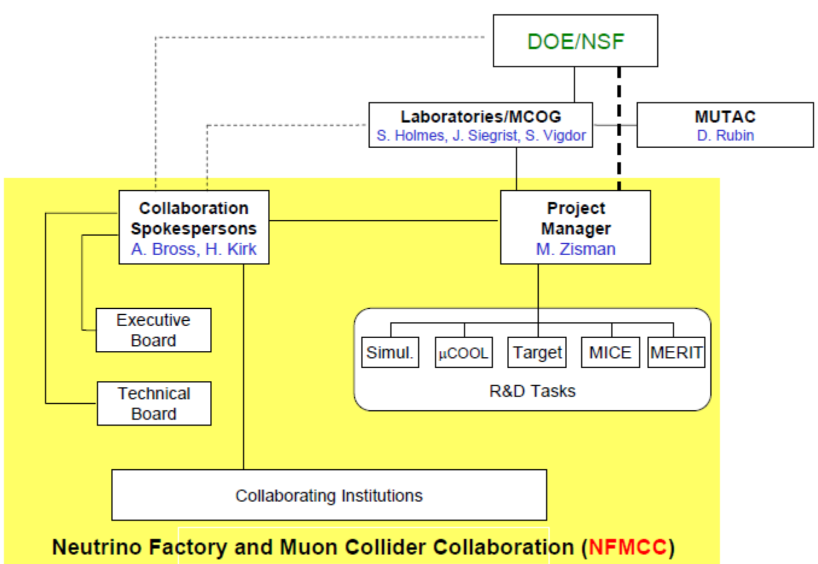

Fig. 1. NFMCC organizational chart. This organization will soon be succeeded by the MAP organization outlined in Attachment B.

1. FY2009 Progress and Accomplishments

Brookhaven National Laboratory

BNL provides a Co-Spokesperson for the NFMCC (Kirk), who also serves as a member of the Muon Collider Coordinating Committee (MCCC).[1] We also play a leadership role in the International Design Study of a Neutrino Factory (IDS-NF), providing the U.S. convener of the Accelerator Working Group (Berg).

A list of recent BNL papers is given in Section 3.

Muon Accelerator Design

In FY2009, a primary focus of our activity was aimed at design of a Muon Collider (see Fig. 2). We participated with colleagues at FNAL and LBNL, coordinated by the MCCC, in developing the MAP R&D plan aimed at delivering a Design Feasibility Study (DFS) for a Muon Collider and a Reference Design Report (RDR) for a Neutrino Factory. The RDR activity is being carried out under the auspices of the IDS-NF.

For the Muon Collider, we carried out several key tasks:

- updated our design of a complete Muon Collider cooling channel
- made first ICOOL simulations of Guggenheim 6D cooling channel with realistic fields
- designed a matching section between 50 T cooling channel stages
- made a preliminary design for a 50 T High Temperature Superconductor solenoid
- further developed our model for RF cavity breakdown in a magnetic field
- developed specific designs for magnetically insulated RF cavity lattices
- studied "bucked" cooling lattice configurations that minimize the magnetic field at the RF cavity locations as an approach to managing cavity breakdown

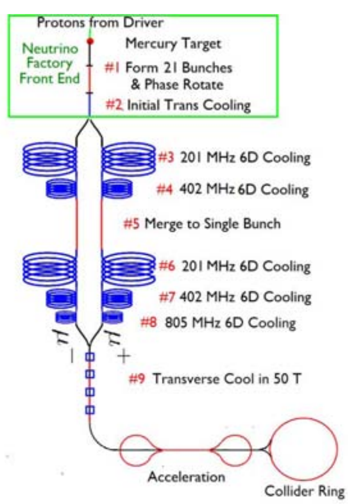

Fig. 2. Schematic layout of Muon Collider components.

[1] The MCCC comprises the leadership of the NFMCC (Bross, Kirk, and Zisman) and that of the FNAL Muon Collider Task Force (Geer and Shiltsev), and coordinates the R&D program across the two groups.

MERIT

We successfully completed data-taking for the Mercury Intense Target (MERIT) experiment (see Fig. 3) at CERN, which is of relevance to both a Muon Collider and a Neutrino Factory. This work was carried out as an international collaboration including members from RAL, CERN, ORNL, and Princeton University. Data analysis is under way, and initial results have already been disseminated. Initial work on decommissioning and removal of the experiment began later in the year, aided by colleagues at ORNL and Princeton. The mercury-wetted equipment has been shipped back to ORNL for storage and detailed inspection. This inspection must necessarily await the time when the induced radioactivity of the experimental equipment has reached safe levels.

EMMA

We are continuing our work to prepare for running the EMMA experiment at Daresbury Laboratory in the UK. This experiment will test an electron model of a non-scaling Fixed-Field Alternating Gradient (FFAG) ring—a concept first proposed by NFMCC members. We have been involved in lattice design, injection and extraction considerations, and commissioning planning. If successful, EMMA will pave the way for the use of such rings for either a Neutrino Factory or a Muon Collider, and it will also open the possibility of using such devices for other purposes, e.g., a medical accelerator.

Fermi National Accelerator Laboratory

FNAL provides a Co-Spokesperson for the NFMCC (Bross), who thus serves as a member of the MCCC. Bross also leads the MuCool R&D program, which serves as the NFMCC component testing effort and is centered at FNAL in a dedicated area, the MuCool Test Area (MTA, see Fig. 4). The MTA houses the NFMCC's 805- and 201-MHz RF cavities, along with a 5-T solenoid used for testing them.

A list of recent FNAL papers is given in Section 3.

Fig. 3. MERIT experiment being installed in CERN TT2A tunnel.

Fig. 4. The MTA at FNAL.

MuCool

Essentially all of FY2009 was devoted to the MuCool Test Area (MTA) reconfiguration. This effort included installing the cryogen transfer line system, completing preparations to allow for beam operations in the MTA, continuing work on the MTA cryogenics plant, and completing an upgrade to the MTA (cleaning, floor painting, and clean-room modifications) that will give us a suitable environment in which to disassemble and inspect RF cavities. Our goal is to achieve a Class-100 environment inside the soft-wall clean room that resides in the MTA hall.

Preparations that were needed to allow beam operations in the MTA included:

- Reconfiguring the (201 MHz and 805 MHz) RF power feeds just upstream of the MTA–Linac shielding wall
- Re-stacking a newly configured shielding wall just upstream of the MTA–Linac shield wall.
- Removing all penetrations (gas and cryogen) from the pit area in the MTA hall.
- Installing a 13 ft wide by 15 ft deep by 23 ft high shield wall in the MTA pit.
- Completing installation of beam-line components in the MTA hall snout.

The LBL pillbox cavity underwent refurbishment at Jlab. The team at Jlab is now working to fix vacuum leaks in the refurbished cavity before shipping it back to Fermilab. A new 805-MHz box cavity has been designed and fabricated. It will be used in FY2010 to study magnetic field effects on RF operation. In addition, a second box cavity (with orthogonal geometry) has been designed and the copper for its fabrication has been purchased and delivered. A study of how to use it as a button cavity has also been completed.

MICE

During FY2009, Fermilab completed all of its remaining hardware tasks for MICE and now is supporting commissioning of the detector systems and beam running. In addition, Fermilab designed and constructed a LN_2 pre-cool system that was used in the most recent cool down of the MICE spectrometer solenoid at the manufacturer (Wang NMR). We have also supplied Wang with a modified LHe transfer line that allows for a more efficient and safer procedure for cooling and filling this magnet with LHe. The new system greatly reduces the risk of air or moisture contamination of the fill line, and thus avoids the troublesome problems with blockage of the fill line experienced earlier.

Simulation Effort

We continued studies for the front end of the Neutrino Factory and the Muon Collider, with the goal of developing a candidate release design for the IDS-NF study. Based on our MuCool R&D results, a significant concern is the impact of strong magnetic fields on the operation of high-gradient RF. In incremental studies, we considered the effects on performance that would result from a degradation in achieved gradient by up to a factor of two. The studies verified that, while some loss in capture occurs, that loss is moderate and relatively good capture can still be obtained with lower than nominal peak gradients. We also found that reducing the decay transport solenoid field from 1.75 T to 1.5 T did not degrade the buncher and phase rotator performance.

We are developing a release candidate that is shorter than the original ISS design, but longer than our initial short (muon collider) case and with somewhat reduced solenoidal focusing and RF gradients. In other studies, we considered modifications to the focusing such as alternating solenoid and magnetic insulation schemes. Thus far, these alternatives do not look promising enough to consider them for the baseline facility design.

Lawrence Berkeley National Laboratory

LBNL provides an Associate Spokesperson (Sessler) for the NFMCC and also provides the NFMCC Project Manager (Zisman). Zisman is also a member of the MCCC and serves as Deputy Spokesperson for the MICE experiment. We provide the RF physicist (Li) for the MuCool program. We also participate in many muon-related community activities. Zisman is a member of the IDS-NF Steering Group and served as a member of the NuFact09 Scientific Program Committee. Li served as U.S. convener for Working Group 3 of NuFact for the past three years, a role that ended after NuFact09.

We also fill key technical roles in the MICE experiment. Zisman serves as WBS Level 2 manager for the cooling channel components, and Li is Level 3 manager for the RFCC module. Virostek has played a key role in helping the MICE Project Manager at RAL develop the Phase 2 cost and schedule profile for the experiment.

A list of recent LBNL papers is given in Section 3.

MuCool

LBNL continued its involvement in program planning and coordination on the MTA RF test programs, including the 805-MHz button cavity tests, the 201-MHz cavity tests, and the studies of external magnetic effects on RF gradients. Most of the components being tested at the MTA were designed and built by LBNL. These include the 5-T, dual coil, "Lab G" solenoid, the 805-MHz pillbox cavity used for the "button" tests, the curved Be windows developed for the 805-MHz RF testing program, and the 201-MHz MICE prototype cavity (built in collaboration with Jlab) with its larger Be windows. Figure 5 shows the 201-MHz cavity placed next to the 5-T solenoid in the MTA.

The 805-MHz cavity has been completely refurbished at Jlab to remove and resurface the damaged areas and round the sharp corners of the RF coupling slot. The cavity is cleaned now and should be ready for tests during FY2010. We provided technical guidance on the cavity and prepared new tin seals to be used to seal it. Unfortunately, the cavity has developed a "stubborn" vacuum leak that has thus far defied efforts at Jlab to fix it.

To study the external magnetic field effects for a realistic muon ionization cooling channel, a large diameter superconducting Coupling Coil is required. We have continued our collaboration with colleagues at the Institute of Cryogenics and Superconductivity Technology (ICST) at the Harbin Institute of Technology (HIT) in China to design and fabricate such a coil—identical to those to be used in MICE (see below)—for testing the 201-MHz RF cavity under field conditions similar to those that will exist in the MICE cooling channel. We have reviewed and monitored the design itself, and we have provided much of the material (e.g., superconducting cable) that goes into fabrication of the coil. There have been various personnel-related and budgetary difficulties at HIT that have slowed progress, and neither the test of the ICST large test coil nor the contract to fabricate the magnets was complete by the end of the year. We made several trips to China to review progress and to try to resolve some of the non-technical issues. The

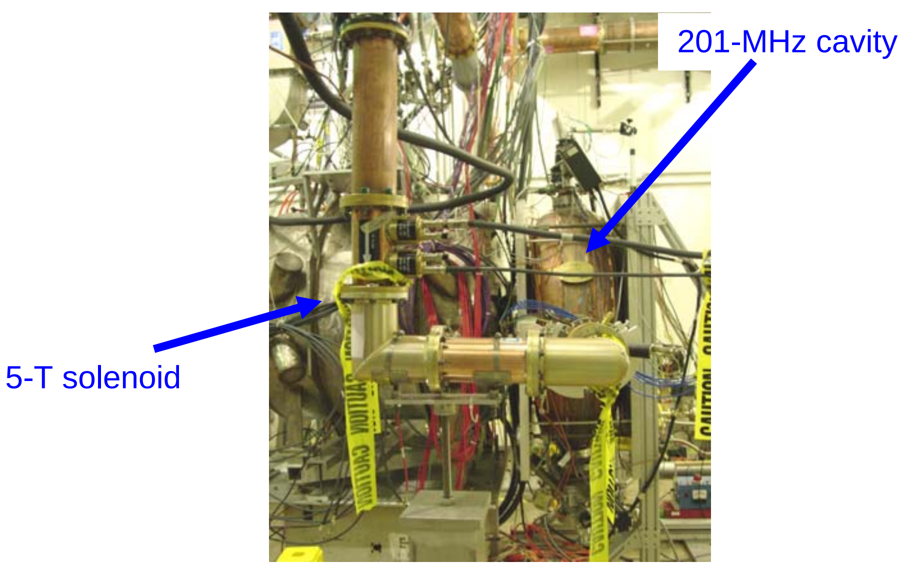

Fig. 5. 201-MHz cavity and 5-T solenoid in the MTA.

project leader, Prof. Li Wang, has taken a new position at SINAP in Shanghai, though she continues to guide the coupling Coil team in Harbin. This has added to the logistical complications, though her new employer has been very supportive of her continued efforts on our behalf. The main stumbling blocks seem to be the completion of a set of fabrication-ready drawings that are needed to commence the bid process and a management plan for how the work at HIT will proceed. As discussed later, some of these issues were resolved early in FY2010, and we are hopeful that more progress will soon be made.

Initial numerical simulations done by BNL collaborators with their CAVEL code indicate that the RF gradient degradation observed at the MTA due to the external magnetic fields most likely results from having electrons focused by the parallel RF electric and external magnetic fields. Electrons emitted from the high RF electric field region are focused by the external magnetic field and accelerated by the RF field to form "beamlets" that hit and damage the cavity surface on the opposite side. The damage on the far side appears to be reduced by using a low-*Z* material with a high melting point, such as beryllium. Therefore, as suggested by Bob Palmer, a cavity with Be walls may have a chance to overcome the observed accelerating gradient limitation. With the aid of FY2009 supplemental funds, we intend to embark on the design of such a cavity, with an eye toward fabricating and testing it in future years.

MICE

LBNL is responsible for the procurement of a pair of Spectrometer Solenoid magnets for MICE. In June of 2006, a contract was placed with Wang NMR in Livermore, CA to complete a detailed design of the superconducting, 5-coil solenoids and to fabricate and test the magnets. The design was completed by the end of FY2006 and construction has been under way since then.

During FY2008, the cold masses for both magnets were completed. This included winding of the five coils on the magnet mandrel, banding of the coils to increase strength, installation of instrumentation and the quench protection system, and final assembly and welding of the cold-mass cover plates. The final assembly of the entire first magnet was also completed during FY2008, and initial testing and training of the magnet took place. Unfortunately, several problems with the magnet performance were noted during the testing, and the first magnet was not accepted by LBNL.

During FY2009, several design improvements were jointly developed by LBNL and Wang NMR. These included an improved cold-mass cooling circuit, a (supposedly) more robust radiation shield thermal connection, addition of a liquid-nitrogen reservoir to speed up the magnet cooldown, addition of a second vent line to improve cold mass venting during a quench, support stand modifications to address interface issues, and incorporation of a method to improve the magnet assembly tolerances. Rather than immediately disassembling the first magnet, Wang NMR continued with the assembly of the second magnet with all of the prescribed fixes, so that the "second" magnet was actually tested next. During FY2009, the cold mass, radiation shield and vacuum vessel for the second magnet were assembled and tested (see Fig. 6).

Fig. 6. Second spectrometer solenoid under test at Wang NMR.

These tests were proceeding well, but the cryo-coolers were unable to completely manage the heat load. Despite our attempt to improve the thermal conductivity between the cooler stage 1 cold heads and the intermediate-temperature shield, the shield temperature was much too high. In addition, the temperature at the top of the HTS leads was marginal and ultimately one of the leads failed at a current of 238 A (~90% of design value). Stage 2 of the coolers performed better. In tests without current in the magnet, the LHe reservoir lost about 1% of its volume in a day. Ideally, we desire that the magnet be a closed system, that is, that the cryo-coolers be able to maintain the LHe level without loss, so even the stage 2 performance was somewhat subpar.

After a review by MICE experts and our own internal discussions, a plan was developed to add a 170-W single-stage cryo-cooler to magnet 2. This should solve the problem of the HTS lead temperature. The proposed modification required only changes in the turret area of the magnet, as opposed to a major disassembly. For magnet 1, which was still disassembled, more substantial changes were planned, including greatly improved thermal connections between the cooler stage 1 heads and the shield, the addition of a single-stage cooler as on magnet 2, and the modification of the cold mass to accommodate a fourth two-stage cooler if need be (see Fig. 7). These changes will be tested in FY2010, after magnet 2 has been retested with the additional cooler.

Fig. 7. Preparation of magnet 1 cold mass for reassembly at Wang NMR.
Provision for a possible fourth 2-stage cooler is visible in the upper right.

LBNL is also responsible for the detailed design and fabrication of the two RF and Coupling Coil (RFCC) modules for the MICE cooling channel. Prior to FY2008, LBNL had been working on the conceptual design of the module and had collaborated with Jefferson Lab to design and fabricate a prototype 201-MHz cavity, which is currently being tested at FNAL as part of the MuCool program. As mentioned above, in December 2006 LBNL began a collaboration with ICST at HIT to develop a design and then fabricate three superconducting Coupling Coils. The first unit will go to FNAL for MuCool experiments, and second and third units will be incorporated in the MICE RFCC modules.

During FY2008, a new mechanical engineer at LBNL was brought into the project in order to complete a detailed design of the RFCC module (see Fig. 8). During FY2009, the module design concepts were completed and assembled in the form of a detailed 3D CAD model. The detailed design of the RF cavities, including the fabrication drawings, was completed. After preliminary and final design reviews were held for the RFCC modules, with review panels assembled from collaborating institutions, LBNL was given the authorization to proceed with the fabrication of the RFCC modules. A list of qualified vendors was complied and LBNL staff met with representatives of the companies to discuss the cavity fabrication process. A contract was eventually signed with a local vendor and the first batch of five 201-MHz cavities has been delivered to LBNL (see Fig. 9). With help from an NSF MRI grant to University of Mississippi, three cryo-coolers for the Coupling Coils were ordered and received and the first batch of Be RF windows was ordered, two of which have been delivered (see Fig. 10) for verification.

During FY2009, progress on developing the final design details of the Coupling Coils continued at ICST in Harbin. ICST also worked with LBNL on the integration of the Coupling Coil with the design of the rest of the RFCC module. Hardware related progress at ICST included the assembly of a coil winding facility as well as a coil test station. A full-diameter test coil was successfully completed at ICST. Cool-down of the test coil was attempted using the test station, but some cryogenic problems were encountered that

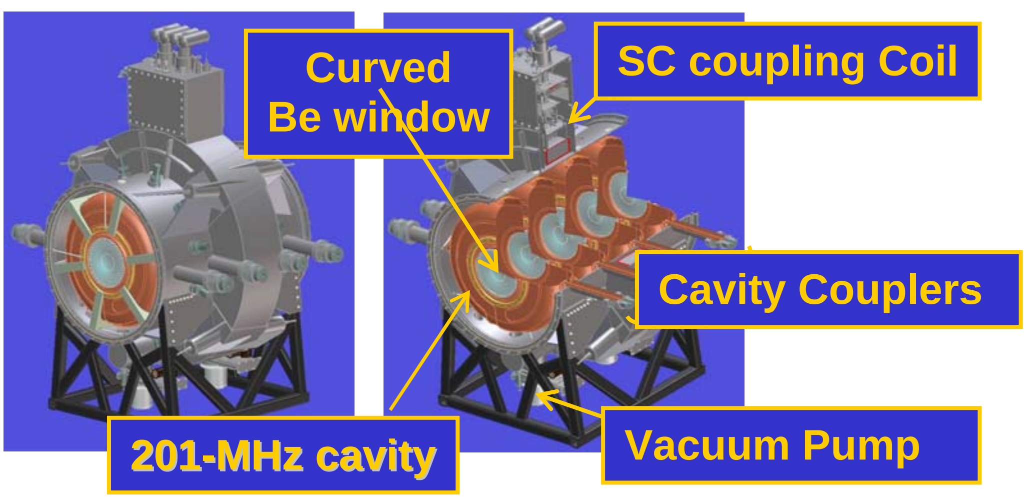

Fig. 8. CAD drawing of RFCC module.

Fig. 9. Completed 201-MHz cavity after acceptance by LBNL.

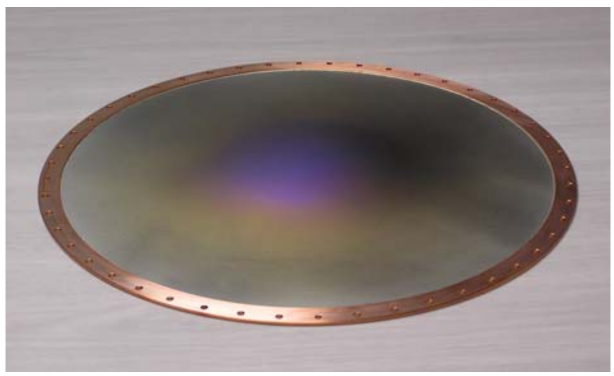

Fig. 10. First production Be window delivered to LBNL. The disk is 42 cm diameter.

will require re-plumbing the test station. We expect this work to be completed during FY2010. HIT has identified a qualified superconducting magnet fabricator in Beijing, the Qi Huan company, and has already entered into an R&D contract with them to develop some of the required fabrication processes. To make up for the fact that Prof. Li Wang is no longer nearby, HIT has also entered into a consulting contract with two senior magnet builders from IHEP. If the Qi Huan company is eventually selected as the successful bidder, having experienced consultants on our project and nearby the vendor will be a great help.

Argonne National Laboratory

ANL provided a staff member (Jim Norem) to help with the planning and execution of the MuCool RF test program at FNAL, in collaboration with the other MuCool institutions (FNAL, IIT, Jlab, and LBNL).

ANL work has provided a first iteration of a model that considers the plasma physics, materials constraints, RF aspects and operational issues of RF arcs in cavities. This model is based on OOPIC Pro simulations of the plasma, along with molecular dynamics simulations of surface failure, Coulomb explosion, fueling, and creep. The code incorporates results from x-ray and other measurements from our own experimental program. The model considers the process to be divided into four parts—surface failure, plasma initiation, exponential plasma growth, and surface damage. It also considers how the four parts are linked and how they can be separated. We believe that our model is the first to offer a detailed examination of this problem.

Both superconducting and normal-conducting RF technology developed over the last 20 years are presently unable to routinely reach the gradients required by high energy collider designs. Using Atomic Layer Deposition (ALD), it seems possible to manufacture thin composite materials that are, in principle, able to avoid all of the presently understood failure mechanisms of existing accelerating structures (both normal and superconducting). We have started an effort aimed at developing this technology to the point where it could be used to construct RF structures capable of operating in a Neutrino Factory or Muon Collider, or in optimized linear colliders, such as CLIC or ILC. An ALD program for superconducting structures has now been separately funded and is under way.

Superconducting structures fail due to quenches from various causes and/or field emission and other effects. It seems possible to inexpensively fabricate structures that:

1. coat a substrate with thick layers that increase local radii, decreasing local fields below field emission or breakdown thresholds;
2. can be layered, so critical fields are filtered (in SRF) or pulse heating is diffused (in normal metals);
3. are pure enough that local defects are not significant.

It is important to emphasize that this technology has the potential to significantly improve the performance of both SRF and normal-conducting cavities, and might also significantly reduce the cost of these structures.

We produced two papers, one on point-contact tunneling measurements that suggest the presence of magnetic oxides on the surface of cavity-grade niobium that could cause the observed high-field *Q* slope, and the other on the production of a sharp metal-oxide boundary by coating niobium with alumina and baking it at 700 °C.

We continue developing ALD as a method of coating RF cavities to permit them to reach higher gradients. An initial test of the approach was demonstrated at Jlab to improve the cavity behavior. We are now looking at the problems associated with heating coatings. This project is aimed at producing room-temperature copper accelerating structures that can operate without either breaking down or producing significant dark currents or x-rays. Recent results from the MuCool program have shown that it can be difficult to operate normal-conducting RF accelerating structures in high magnetic fields, as required by existing designs for muon cooling systems. Curing this problem has a very high priority in the muon program. Our measurements have shown that the likely cause of the magnetic field dependence, like the gradient limits of all structures, is due to high local electric fields associated with asperities on the surface of the cavity.

We will test whether ALD can be used to coat the inside of room-temperature structures in the same way we have successfully improved a superconducting cavity operating at many times the field we require for our copper structures. Since ALD synthesizes materials one atomic layer at a time, and other experiments have shown that the coatings produced are highly conformal, they should be able to smooth over rough asperities like snow on a rock pile, producing a minimum asperity radius greater than or equal to the thickness of the coating. This should lead to lowering the mechanical stresses, and thus field-emitted currents, by many orders of magnitude. Hopefully, this will greatly reduce the susceptibility to breakdown. The ALD process is fast, uses low temperatures and is simple enough to be used *in-situ*. The proposed experiment will coat medium and low frequency cavities in the MTA at Fermilab. This will involve building a new ALD system and some simulation and analysis of the data.

A list of recent ANL papers is given in Section 3.

Thomas Jefferson National Accelerator Facility

In FY2009, Jlab scientists continued to support the ongoing design work for the cooling and acceleration sections of a Neutrino Factory or Muon Collider. In particular, activities supported the refurbishment of the LBNL 805-MHz RF cavity for the high-gradient cavity test program at the MTA, some design activities for the 201-MHz RF cavities for the MICE experiment, and layout of the superconducting recirculating linac (RLA) for the IDS-NF. The last task finalized the lattices for all of the subsystems shown in Fig. 11, carried out a matrix-based end-to-end simulation of the acceleration system, and began an initial error sensitivity analysis.

A list of recent Jlab papers is given in Section 3.

Oak Ridge National Laboratory

MERIT

The MERIT experiment is a proof-of-principle demonstration of the feasibility of using an unconstrained jet of mercury as a target in a Neutrino Factory or Muon Collider. In such facilities, the mercury jet is impacted by a proton beam within a strong solenoidal magnetic field that captures the produced pions and muons while constraining the jet after impact. While previous experiments utilized either jet-plus-field or beam-plus-jet combinations, MERIT was the first effort that included simultaneous use of a mercury jet, a magnetic field, and a proton beam. The ORNL-designed mercury system produced a 1-cm-diameter, 20-m/s jet inside a high-field (15 T) solenoid magnet. A high-speed optical

Fig. 11. Layout of IDS-NF baseline acceleration system.

diagnostic system allowed observation of the interaction of the jet with both 14- and 24-GeV proton beams.

The MERIT experiment was successfully conducted at CERN during three weeks in October–November, 2007. After a 3-month radiation cool-down period, the MERIT equipment was decommissioned and extracted from the experimental area at CERN in February 2008. As planned, the equipment was then placed in storage at CERN for an additional cool-down period exceeding one year. During FY2009, ORNL, with the assistance of BNL and Princeton, segregated the experimental equipment and made arrangements for CERN personnel to package and ship it back to the U.S. While the original plan was to ship the equipment in January 2009, the actual shipment did not occur until October 2009 due to logistical delays in completing the shipping requirements. The equipment is now being stored at ORNL (see Fig. 12) to await further inspection when radiation levels permit.

ORNL staff also participated in an IDS-NF workshop at CERN in December 2008 and gave a presentation on the operational realities of mercury target systems based on actual experience at SNS. Progress was made on a conceptual design for a Neutrino Factory target vessel and beam dump within a pion capture solenoid. This work served to highlight some of the mechanical complexities associated with the target system concept.

A list of recent ORNL papers is given in Section 3.

2. FY2010 Plans

In this section, we describe plans for the NFMCC institutions, based on the budget summarized in Table 1. As noted earlier, agreed-upon milestones corresponding to the established funding levels have been developed with each institution and are included as Attachment A.

Fig. 12. MERIT equipment in storage at ORNL.

Brookhaven National Laboratory

During FY2010, BNL activities will fall into four main areas:

- Work on simulations for the design of a Muon Collider
- Work on developing the IDS-NF design of a Neutrino Factory
- Work on data analysis for the MERIT experiment
- Work on running the EMMA experiment

The first three of these activities are part of the MAP R&D plan that will soon be submitted to DOE for its approval. Even in the absence of enhanced funding, these tasks will be carried out at the level that present funding permits. The last activity, which involves the participation by Scott Berg in the EMMA experiment, makes use of the specialized expertise available in the U.S. to help in this project, which complements the experimental program under way in the U.S. BNL is collaborating on the preparation of the MAP R&D plan that will be sent to DOE this year.

Muon Collider

BNL has been on the forefront of Muon Collider design and simulations for many years, and is continuing that role. Ongoing development of ICOOL to handle the Muon Collider parameter regime will continue this year. One goal is to create an ICOOL model of a tapered Guggenheim channel that incorporates realistic fields. ICOOL results will be compared with G4Beamline models prepared by the UC-Riverside staff. With the help of our post-doc we will continue to investigate alternative cooling schemes. The primary issue here is the degradation in achievable gradient due to the influence of the magnetic field on the cavities. Our post-doc will continue to work toward developing a model of RF cavity asperities, as this is expected to be a key ingredient in understanding breakdown phenomena. This activity will be done in consultation with ANL staff.

IDS-NF

Our work for the IDS-NF will concentrate mainly in two areas, target facility design and acceleration system design. In the former case, we will work with ORNL engineers to define a baseline target facility for the Neutrino Factory RDR. We will provide the physics inputs and requirements and ORNL will be responsible for the engineering aspects of the facility, following the collaboration begun during Feasibility Study 2 some years ago. BNL staff (Berg) will also coordinate the acceleration system design activity for the IDS-NF, including work done at Jlab and RAL as well as at BNL. This is an ongoing activity for us, stemming back to the days of the International Scoping Study. We will also continue simulation work to improve the performance of the Neutrino Factory front end.

MERIT

We will continue our work in MERIT this year, with emphasis on data analysis with our colleagues at CERN and Princeton. We will work on completing the analysis of the optical data and participating in the analysis of the particle production data. Work on decommissioning the experiment will continue at a pace dictated by radiation cool-down of the equipment.

EMMA

EMMA, an electron model of a non-scaling FFAG ring, is primarily a UK-sponsored project at Daresbury Lab. Our task is to support, at a modest level, the lattice design effort, especially considerations of injection and extraction, based on our expertise in the lattice design and performance expectations for this type of machine. While this is a UK project, the NFMCC has a strong interest in its successful outcome and our service in an advisory capacity is of benefit to both sides.

Fermi National Accelerator Laboratory

MuCool

We will be bringing the MuCool Test Area (MTA) back online at the beginning of FY2010 after reconfiguration work. Upon restarting the RF program, our first tests will be with a high-pressure H_2 filled 805 MHz test cell. The first beam tests in the MTA will be done with this cavity.

Our next RF tests will use the refurbished 805 MHz pillbox cavity. The cavity, once delivered to Fermilab will be installed in the 5 T solenoid in the MTA and will first be reconditioned with Cu windows and magnetic field. Once commissioned, we will use the pillbox cavity to test Be buttons in a magnetic field. The new 805-MHz box cavity will then be commissioned and installed in the magnet to study the concept of using magnetic insulation to eliminate, or at least minimize, the RF breakdown problem when high-gradient cavities are operated in magnetic field. We envision some tests of the 201 MHz system, but these will be limited since we are waiting for our new SC magnet before continuing with extensive tests at 201 MHz.

In FY2010 we will take delivery of the LiH disks fabricated at Y12 and perform thermal tests on one of the disks. The disk to be used as a MICE absorber will have its carbon-fiber mounting hardware attached and will then be shipped to Rutherford Appleton Laboratory.

IDS-NF

We will continue our participation in the International Design Study for a Neutrino Factory, focusing on the front-end of the facility, a low-energy option for the facility, and detector simulations for that low-energy option. The simulation work on the front-end will aim to deliver a release candidate that is shorter than the present IDS-NF baseline design early in FY2010.

MICE

In FY2010 we will continue to commission the MICE experiment, in particular to support installation and commissioning of the two tracker systems. We also plan to complete the magnetic field mapping of the two MICE spectrometer solenoids.

Lawrence Berkeley National Laboratory

MuCool

During FY2010, we will resume the 805-MHz cavity button tests at the MTA. A more systematic RF button test plan will be developed in order to understand the RF gradient degradation and RF breakdown due to the external magnetic fields. LBNL will help with the cavity test plans and setup (calibration, coupler tuning, etc.), and we also expect to actively participate in the tests at the MTA. To aid in this, we are searching for a post-doc, to be paid for initially with FY2009 supplemental funds from DOE.

In collaboration with Fermilab, BNL, ANL, Jlab and SLAC, we will continue the computational RF breakdown studies and attempt to understand the effectiveness of a magnetically-insulated RF cavity. LBNL will complete the design for the Be-wall RF cavity and hopefully begin its fabrication.

LBNL will help with the planning of the test program of the 201-MHz cavity at the MTA, and actively participate in the test programs. In addition to studying the effects from external magnetic fields, we will measure the cavity frequency shifts as a function of input RF power and test the RF tuner range and sensitivity.

MICE

The goals for the Spectrometer Solenoids for FY2010 include completion of the fabrication of both magnet systems. Upon completion, each magnet will be cooled down and tested at the vendor at full design current. After acceptance of each magnet by LBNL, it will be shipped to FNAL for magnetic measurements and characterization. The testing at FNAL will include mounting of the iron shields at both ends of the first magnet and at one end of the second magnet. The iron shields were fabricated at a vendor in the Chicago area to minimize transportation costs. After completion of the magnetic measurements, each of the Spectrometer Solenoids will be shipped, in turn, to Rutherford Appleton Laboratory (RAL) for incorporation into the MICE beam line. In the current plan, at least one, and possibly both magnets, will be delivered to RAL before the end of FY2010. There will be a gap of about three months between the completion of the first and second magnet.

Goals for the RFCC module for FY2010 include the completion of the second set of five RF cavities for use in the second module. The copper material for the second set had previously been procured and spun into bowls and is in storage at LBNL. The contract with the local cavity vendor included an option for fabrication of the second set to be exercised shortly after delivery and acceptance of the first set. Upcoming tasks for the first five cavities needed to render them operational include RF measurement, cleaning, electropolishing, and installation of the ancillary devices (tuners, input couplers, Be windows). The final detailed designs for the remaining RFCC module components will be completed this year. This includes the design of the cavity support system, cavity tuners, module vacuum vessel, module support stand, and module vacuum pumping system. Additionally, the remaining thin beryllium windows for the second RFCC module (8 windows plus spares) will be procured by the University of Mississippi.

The effort to fabricate the MuCool and MICE coupling coils at ICST in China will continue during FY2010. Testing and training of the scaled-down test version of the coupling coil will be reattempted toward the end of the fiscal year, depending on how the modifications to the cryogenic test system proceed. The test coil has the same diameter and number of layers as the actual coupling coils but is only one-quarter its axial length. In parallel with the successful operation of the test coil, ICST will complete the detailed magnet fabrication drawings and put in place a contract with a qualified vendor for the fabrication of the three coupling coils. Before the end of FY2010, it is hoped that at least one of the coils will be wound on its mandrel, and that, after testing and training at HIT, the MuCool coil cold mass will be complete and ready for installation in its vacuum vessel. ICST and LBNL engineers will also finalize the detailed design of a dedicated support stand—to be fabricated by the University of Mississippi—for the operation of the MuCool coupling coil at FNAL. During FY2010, LBNL will continue to procure and provide to ICST any additional materials, such as superconductor, cryocoolers, epoxy and electrical components, necessary to complete the fabrication and testing of the magnets.

LBNL staff will continue to help manage the MICE collaboration. Not surprisingly, these roles require significant travel to carry out.

Argonne National Laboratory

FY2010 funding for ANL supports the effort on MuCool of Jim Norem. Plans for this year include continuing modeling efforts to describe RF cavity breakdown phenomena. Norem will also participate in the ongoing MuCool cavity measurement program, including both materials tests at 805 MHz and prototype cavity tests at 201 MHz. Separate funding will support studies of ALD for superconducting cavities.

An expanding focus this year will be on the use of Atomic Layer Deposition (ALD) to tailor the surface properties of RF cavities. Initial tests on a superconducting cavity carried out in collaboration with Jlab showed that the approach has promise for superconducting cavities. That effort will continue this year to develop an understanding of what ALD might eventually offer for the performance of 201-MHz superconducting cavities, which are required in the acceleration system of a Neutrino Factory or Muon Collider. Additional work will be carried out to explore whether ALD techniques offer potential benefit for improving the breakdown effects for copper cavities. If these studies look encouraging, plans for fabricating an 805-MHz ALD-treated test cavity will be developed.

Our simulation modeling describes, in varying detail, all stages of an RF discharge, from initial fracture of the surface, through ionization of the plasma, development of the plasma, plasma interactions with the surface, and formation of new breakdown sites. It has been submitted to Journal of Physics D. We are continuing to study the interactions of magnetic fields with arcs, and are finding that the processes are not simple. Our arcing model is consistent with that used in other fields and we are hosting a workshop on "Unipolar Arcs" at Argonne to look at different ways that tokamaks, accelerators, e beam welding, etc., confront this problem.

Recent results have shown that we can produce NbN coatings by ALD that are comparable to the best bulk Nb, and straightforward methods of reducing contamination should produce even better results. This technology will, in principle, increase the available gradient and reduce the cryogenic and power requirements of the SRF components of the Neutrino Factory and Muon Collider. We are planning the construction of a new ALD facility for SRF cavities that will be able to coat and heat deposited layers in an arbitrary order. This will allow us to produce layered structures that hopefully reach the maximum allowable fields. To be successful, considerable time will need to be spent on surface chemistry and surface models.

We are exploring the options of coating a room-temperature cavity in the MTA to test the idea of breakdown-resistant RF cavities, i.e., cavities whose breakdown sites have been smoothed over to make them inactive. This MuCool experiment will be done in cooperation with Fermilab, who will provide the cavities, the support hardware, and some of the people.

Thomas Jefferson National Accelerator Facility

Jlab staff will continue their involvement in the NFMCC program at a low, but extremely important, level. Rimmer will continue to participate in the MuCool RF program, where his experience provides invaluable guidance. He also serves as a member of the NFMCC Technical Board. During FY2009, Jlab provided technical help in refurbishing the existing 805-MHz pillbox cavity and getting it ready to run again. During this year, the program will be to continue providing RF expertise to both the MuCool and MICE programs.

Jlab staff will also continue to provide leadership in the IDS-NF acceleration system area. Bogacz has carried out most of the beam optics design and layout work (see Fig. 11) for the acceleration system, and is continuing that effort as a member of the IDS-NF accelerator working group. This year, the main task will be to contribute to the IDS-NF Interim Design Report. We will also organize a working meeting on fringe field effects and RF modeling for the SRF linac.

As a community contribution, Bogacz will serve for the next three years as U.S. convener of Working Group 3 for NuFact.

Oak Ridge National Laboratory

During FY2010, ORNL will focus mainly on two tasks—completing the decommissioning of MERIT and carrying out design studies for the IDS-NF. That is, ORNL will receive and store the MERIT mercury system equipment in Oak Ridge. Partial dismantlement of the mercury system will be performed in order to allow inspection of the primary mercury containment interior to determine if any mercury-induced mechanical damage is apparent. In addition, any residual mercury left in the system will be drained, and a cost estimate will be prepared so that a decision can be made as to whether the mercury system can be economically refurbished or should be disposed of.

For the second task, ORNL engineers will participate in IDS-NF workshops and begin to revisit the target facility design developed in Feasibility Study 2 some years ago. The initial goal will be to refine the original concepts and begin to flesh out details that can be used for an updated costing exercise. Ultimately, we plan to produce a document describing a conceptual mercury target system for a Neutrino Factory.

3. Publications

In this section we list recent publications by institution. Because much of the NFMCC work involves multiple institutions, there will inevitably be some duplication in such a list.

Brookhaven National Laboratory

1. J. Scott Berg, "R&D Topics for Neutrino Factory Acceleration," Proc. of Ninth International Workshop on Neutrino Factories, Superbeams, and Betabeams, Okayama University, Okayama, Japan, August 6–11, 2007, AIP Conf. Proc. 981, 327 (2007).
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Attachment A: 2010 Milestone Table

Prior to distribution of FY2010 funds, the following milestones were agreed upon by the NFMCC Project Manager and the various institutional representatives.

FNAL [Bross]

Milestone	Date	Deliverable
Restart 805-MHz cavity button tests	Feb-10	NFMCC note
Restart 201-MHz cavity tests in magnetic field	May-10	NFMCC note
Complete detailed internal inspection of 201-MHz cavity	Jan-10	MICE note
Commission MICE tracker detector in Hall	Jun-10	MICE note
Perform thermal tests on LiH disk	Apr-10	Engineering report
Complete commissioning of MTA cryogenics plant	Feb-10	Engineering report
Complete mapping of MICE spectrometer solenoids	Aug-10	Engineering report
Support MICE operation	Sep-10	Inspection
Complete initial beam tests in MTA	May-10	FNAL technical note
Continue NFMCC management task	Sep-10	Inspection
Continue design work for muon collider cooling channel	Sep-10	NFMCC note
Continue design work for muon collider ring	Sep-10	NFMCC or MCTF note
Test 805-MHz box cavity with variable orientation to magnetic field	Mar-10	NFMCC or MCTF note

ANL [Norem]

Milestone	Date	Deliverable
Order plasma ALD system	Jan-10	Order placed
Delivery of plasma ALD system	Mar-10	Paper submitted
Complete initial studies of high-field Q slope and magnetic oxides	Sep-10	Paper submitted
Design system for plasma enhanced ALD (PEALD)	Sep-10	NFMCC presentation

BNL [H. Kirk]

Milestone	Date	Deliverable
Design tapered Guggenheim channel	Jul-10	NFMCC note
Organize acceleration activities for IDS-NF	Sep-10	Inspection
Complete study of re-optimized capture section field taper	May-10	NFMCC note
Document expanded MERIT pump-probe analysis	May-10	IPAC10 paper
Continue NFMCC management duties	Sep-10	Inspection
Begin MAP management duties	Mar-10	Inspection

ORNL [Burgess]

Milestone	Date	Deliverable
Inspect MERIT primary containment vessel for surface damage	Jun-10	NFMCC note
Carry out target facility CAD studies for IDS-NF	Sep-10	IDS presentation

LBNL [Zisman]

Milestone	Date	Deliverable
Continue project management of NFMCC	Sep-10	Inspection
Prepare MAP proposal and budget for review by DOE	Feb-10	Proposal submitted
Deliver first Spectrometer Solenoid magnet to Fermilab for magnetic measurements	May-10	Inspection
Deliver second Spectrometer Solenoid magnet to Fermilab for magnetic measurements	Sep-10	Inspection
Install first Spectrometer Solenoid at RAL	Sep-10	Inspection
Finish Be wall cavity design	Jul-10	NFMCC review
Begin Be cavity fabrication	Sep-10	Contract signed
Measure first five MICE RF cavities	Jun-10	MICE note
Complete MICE tuner prototype tests	Jun-10	MICE presentation
Complete RF coupler design and begin fabrication	Jul-10	MICE review
Continue oversight of MTA RF test program	Sep-10	Inspection
Begin fabrication of first coupling coil cold mass	Jun-10	Inspection
Continue management of MICE	Sep-10	Inspection
Participate in NuFact10 organization	Sep-10	Inspection
Participate in MICE Executive, Technical, and Collaboration Boards	Sep-10	Inspection
Participate in NFMCC/MAP Executive and Technical Boards	Sep-10	Inspection

Princeton [McDonald]

Milestone	Date	Deliverable
Continue leadership of MERIT experiment	Sep-10	Inspection
Continue MERIT data analysis and publish MERIT results	May-10	IPAC10 paper
Participate in preparation of Target section of IDS-NF Interim Design Report	Sep-10	IDR prepared
Study effects of containment vessel erosion due to Hg droplets (with ORNL)	Jun-10	NFMCC note
Begin participation in MAP collider R&D effort	Feb-10	Inspection

Jlab [Rimmer]

Milestone	Date	Deliverable
Continue planning of, and participation in, RF cavity test program	Sep-10	Attend RF meetings
Continue lattice studies for muon acceleration schemes	Sep-10	IDS-NF report
Support MICE RF system design and fabrication	Sep-10	Attend MICE meetings

UCLA [Cline]

Milestone	Date	Deliverable
Carry out emittance reduction studies of Li lens linear channel	May-10	IPAC10 paper
Study Muon Collider lattice having open midplane dipoles	May-10	IPAC10 paper
Study 50 T solenoid for final muon cooling	Sep-10	NFMCC note
Develop liquid Li lens prototype design for final cooling	Sep-10	NFMCC note
Continue work on scientific goals for muon collider Higgs Factory	Sep-10	NFMCC presentation

U-Miss. [Summers]

Milestone	Date	Deliverable
Fabricate parts for Be RF button tests	Dec-09	Inspection
Carry out absorber window burst tests	Mar-10	MICE presentation
Complete absorber window fabrication (9 remaining)	Jun-10	Inspection
Estimate impedance of 400-Hz small bore synchrotron	Sep-10	NFMCC talk

IIT [Torun]

Milestone	Date	Deliverable
Reinstall radiation detectors in MTA hall and recommission data acquisition system	Feb-10	Inspection
Operate 805-MHz button cavity with Be buttons and determine stable gradient vs. magnetic field	May-10	IPAC10 paper
Continue multipacting simulations	Feb-10	NFMCC note
Study effect of orientation of external B vs. E with 805-MHz rectangular box cavities	May-10	IPAC10 paper
Continue analyses of ionization cooling performance	Aug-10	NFMCC note
Study effect of gas pressure and use of optical spectroscopy with pressurized 805-MHz cavity	Feb-10	NFMCC presentation
Study effect of beam on performance of pressurized 805-MHz cavity	May-10	IPAC10 paper
Contribute to MICE operations	Sep-10	Inspection
Maintain MICE website and communications infrastructure	Sep-10	Inspection

UC-Berkeley [Wurtele]

Milestone	Date	Deliverable
Participate in NFMCC/MAP Executive Board	Sep-10	Inspection
Provide theory guidance on Muon Collider and Neutrino Factory design issues	Sep-10	Inspection

UC-Riverside [Hanson]

Milestone	Date	Deliverable
Investigate use of wedge absorber for emittance exchange in MICE	Sep-10	MICE note
Co-organize MICE CM26 at Riverside	Mar-10	Inspection
Participate in muon cooling studies for IDS-NF	Sep-10	IDS-NF note
Participate in MICE operations, including three MOM shifts	Sep-10	Inspection
Maintain and improve MICE Wiki	Sep-10	Inspection
Continue Muon Collider ring layout simulations and pursue alternative designs	Sep-10	NFMCC note
Continue simulations of 6D cooling, including alternative designs and layouts	May-10	IPAC10 paper
Participate in Spectrometer Solenoid magnetic field measurements at Fermilab	Jul-10	MICE note
Design and implement software and infrastructure for MICE on-line reconstruction	Sep-10	Inspection
Organize monthly MICE videoconferences	Sep-10	Inspection

NOTES:

Prior to distribution of FY10 funds, agreed-upon milestone dates and deliverables must be in place.

Attachment B: Muon Accelerator Program

B-1. Introduction

Here we describe the organization being set up by Fermilab in response to the request it has received from DOE/OHEP asking that it serve as the host laboratory for an integrated national muon R&D program. The intent is to execute a multi-year program aimed at completing a Muon Collider Design Feasibility Study (DFS), participating in the ongoing International Design Study for a Neutrino Factory (IDS-NF), and providing a supporting muon accelerator technology R&D program.

The current muon accelerator R&D organization consists of two closely coordinated efforts—the U.S. Neutrino Factory and Muon Collider Collaboration (NFMCC) and the Fermilab-sponsored Muon Collider Task Force (MCTF). Responding to the charge from DOE requires integratiion of these two organizations into a single national Muon Accelerator Program (MAP) organization that enables an appropriate level of oversight and direction by the host laboratory (Fermilab). In the near term, an interim MAP organization has been formed, and is charged initially with revising the original 5-year proposal and then preparing for a DOE review of the revised proposal. Assuming a successful reviw, the final version of the new organization will assume responsibility for executing the plan subsequent to the review when the permanent Program Director has been designated.

B-2. Muon Accelerator Program Organization

The goal of MAP is to provide:

- a coherent, national muon accelerator R&D program
- a multi-laboratory and multi-university program
- a streamlined organization with clear reporting lines

The organizing principles of MAP (see Fig. B-1) are listed below:

- Fermilab will provide overall leadership of the national Muon Accelerator Program (MAP).
- The MAP will be a collaborative effort, integrating participants from the existing NFMCC and MCTF.
- Existing commitments of NFMCC, such as to the Muon Ionization Cooling Experiment (MICE) and the International Design Study for a Neutrino Factory (IDS-NF), will be supported.
- The MAP organization will maintain the U.S. portion of the MICE organization in its current form.
- The MAP will have a dedicated management team, led by a Program Director reporting to the Fermilab Director. The Program Director provides the primary point of management contact to DOE/OHEP.

- The MAP Program Director will control the allocation of funds to the collaborating institutions.
- DOE-OHEP will establish a Muon Program Manager who will oversee the MAP program from within the agency.
- The MAP will be organized and managed utilizing project management tools.
- An oversight group will be formed with representation drawn from the participating institutions.
- Activities undertaken by the MAP and the associated resource support will be agreed upon with DOE, with a mutually understood ~7-year time horizon for development of the DFS, IDS-NF, MICE, and carrying out a supporting technology development program.
- An advisory committee will monitor progress of the program and report to the oversight group and/or the Fermilab Director.
- The organization will provide a mechanism for interacting with international organizations that have common interests, such as the IDS-NF and the MICE collaboration.

Proposed organization

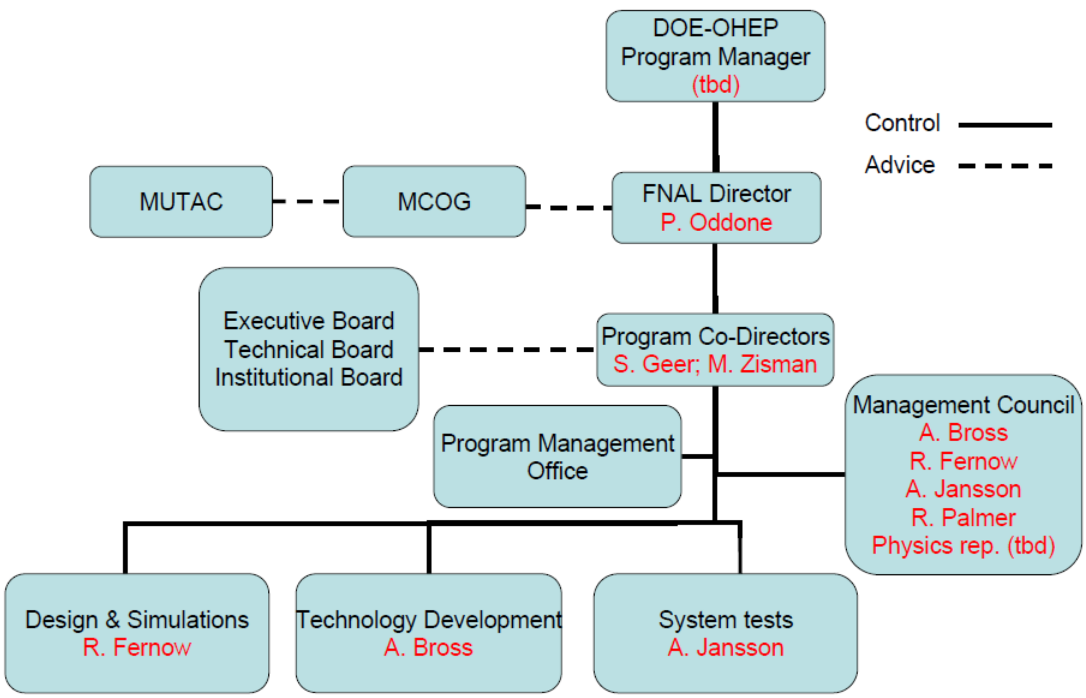

Fig. B-1. MAP organization. Level 1 leaders are interim appointments, pending the selection of a permanent MAP Director.

- The Fermilab Director has appointed the MAP Program interim Co-Directors, and will later appoint the Program Director. The Program Director will be generally charged to:
    - Update, as necessary, and maintain a multi-year plan for MAP activities including
        - Definition of major goals and objectives: technical, cost, and schedule
        - Identification of required resources
        - Definition of responsibilities within the collaboration
    - Establish an organization to execute the MAP program
    - Define and execute the supporting R&D program
    - Provide periodic technical, cost, schedule reports at a frequency agreed to with the Fermilab Director and DOE/OHEP

- A Muon Collaboration Oversight Group (MCOG) will provide oversight by the participating institutions
    - MCOG will be constituted from one representative from each participating laboratory plus some representatives from the university community
    - MCOG will advise the Fermilab Director

- A Muon Technical Advisory Committee (MUTAC) will be appointed by MCOG as the primary body for technical advice and for review of the MAP activities.

- Distribution of funds to the collaborating institutions will be based upon the direction of the MAP Program Director.

- Various committees designated by the Program Director will aid in the following functions: development of the technical strategy, management of the program, and coordination of the participating institutions. These are represented schematically by the Technical Board, the Executive Board, and the Institutional Board in Fig. B-1. The detailed structure and accompanying responsibilities and authorities will be defined by the Program Director, subject to some guidance from MCOG.

- It is assumed that university collaborators will participate in the MAP. They will participate in planning and coordination via membership on the Institutional Board, and representation on MCOG.

- It is assumed that a complementary Muon Collider Physics and Detector Collaboration will be formed, supported by a separate funding stream from the DOE. In order to provide close coordination between this Collaboration and the MAP it is proposed that the MCP&D Collaboration Spokesperson be an *ex officio* member of the MAP Executive Committee. In addition a Machine-Detector Interface task has been created within the MAP to serve as the primary technical contact point between the two organizations.

- The interim Level-2 structure for the MAP organization is shown in Fig. B-2. The details of this organization have been determined jointly by the interim Project Co-Directors and the interim Level-1 managers.

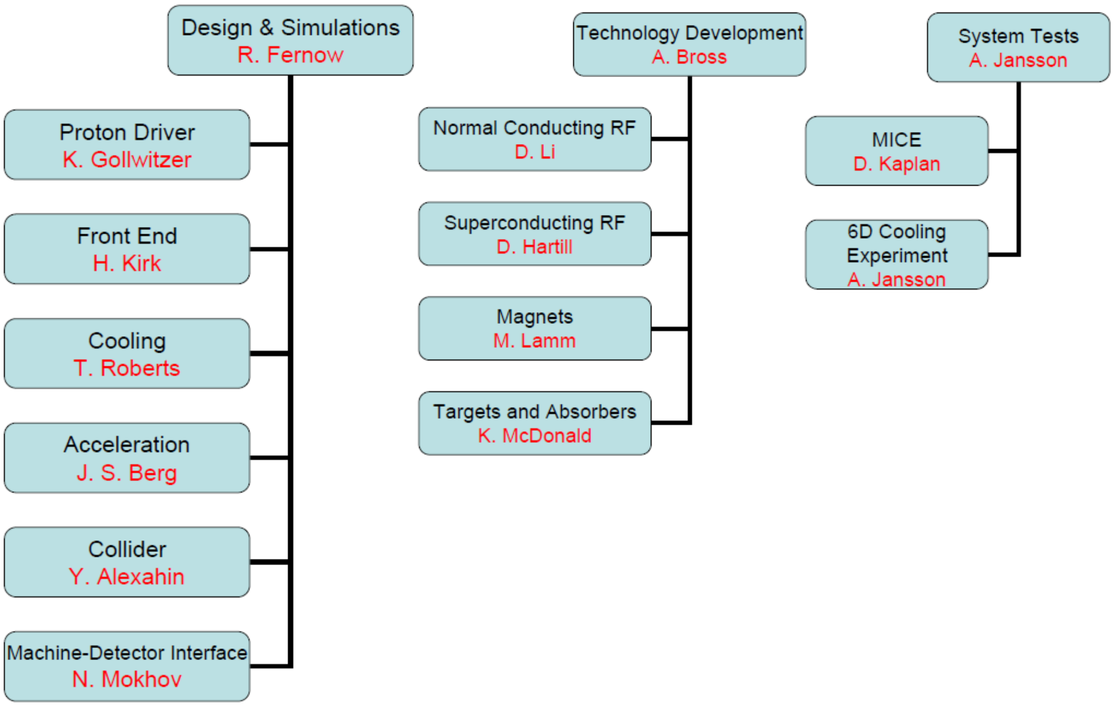

Fig. B-2. MAP Level-2 organization. Level 2 leaders are interim appointments, pending the selection of a permanent MAP Director.

B-3. Transition Plan

- Because the new organization is just being formed, the funding distribution for FY10 among the NFMCC insitutions will be organized as in the past, i.e., via the NFMCC Project Manager and approved by MCOG.
- The Fermilab Director designated two members of the current Muon Collaboration Coordinating Committee as interim Co-Directors, with responsibility for coordinating editing of the revised multi-year proposal, submitting it to DOE, and preparing for the DOE review. During this period the NFMCC and MCTF will formally exist but will closely coordinate activities via the existing MCCC.
- The Fermilab Director will form a search committee for a permanent Program Director.
- MCOG will draw up relevant governing documents and MOUs to establish the new organization. These will be approved by the DOE and the Fermilab Director.
- Once the new organization is in place NFMCC and MCTF will cease to exist as independent entities.