

ADDENDUM
to the
Memorandum of Understanding
between
US Universities & Accelerator Laboratories
and
Indian Universities & Accelerator Laboratories
concerning
Collaboration on R&D for Accelerator Physics and High Energy Physics
Projects

Addendum VII: "Fermilab and Indian Accelerator Laboratories
Collaboration on Instrumentation and Control for High Intensity Proton
Accelerator"

Feb 4, 2011

1. Authority and Limitations

Pursuant to the Memorandum of Understanding ("MOU") between the U.S. Universities & Accelerator Laboratories and Indian Universities & Accelerator Laboratories dated January 9, 2006, Fermilab and Indian Accelerator Laboratories (the "Parties") intend to undertake the work described in this Addendum VII. The Parties acknowledge that their intended work shall be consistent with the terms and conditions of the MOU, the terms and conditions of their respective contracts and programs, and subject to the availability of appropriated funds as provided to them. The Parties further acknowledge and understand that their agreement with and signature to Addendum VII does not create a legal, contractual obligation for either Party nor may form the basis of a claim for reliance thereon. The Parties agree to comport their activities under Addendum VII in conformance with all applicable U.S. and Indian laws and regulations, including those related to export control.

2. Introduction

The work detailed in this document falls within the scope of the MOU cited above. It addresses in some detail the key area of collaboration mentioned in the main MOU, which is Superconducting Radio Frequency (SRF) Acceleration Science and Technology,

including setting up test facilities and a high current proton driver. All terms and conditions under which the work will be carried out are found within the main MOU.

This Addendum to the MOU outlines the collaborative work between Fermilab and the Bhabha Atomic Research Center (BARC).

3. Background

Fermilab and Indian Institutions have been collaborating on high energy physics experiments and on the accelerator research and development under Addendums (I, II and III) to the MOU. Indian Institutions have made significant progress on the work that was outlined in these Addendums. The work outlined in this addendum is extension of the work in other areas of the High Intensity Proton Accelerator beyond the Superconducting Radio Frequency cavity and Cryomodule and related infrastructure, i.e. to accelerator instrumentation, beam diagnostics, beam manipulation and low-level RF controls.

Compared to SRF accelerating structures or high power RF installations, these instrumentation systems are less "visible", e.g. in the accelerator overall budget, however are not simple components. Long term experience at Fermilab in analog and digital signal processing, accelerator operation and beam dynamics go hand in hand with the development of these mission critical systems. They provide the ability to observe the beams and to optimize beam quality and performance of the SRF accelerator with the goal of minimum beam losses. For a success of this collaboration a training of BARC physicists and engineers by Fermilab senior instrumentation experts at Fermilab is mandatory.

4. Work to be performed

The collaborative work under this Addendum to the MOU is to develop some of the mission critical instrumentation & controls systems for a CW High Intensity proton Linac. Fermilab and the BARC will jointly work on the design, development, prototype and construction of:

1. Low-Level RF (LLRF) System
2. RF Protection Interlock System
3. Cryogenic Temperature Monitoring System
4. Beam Position Monitor (BPM) System

Here Fermilab will specify the requirements, but the collaborating Indian institutions will provide all the hardware, design and fabrication effort. There should be interactions between FNAL and India plus design reviews throughout the project.

In particular, the goal for BARC is to design, based on specification provided by Fermilab, prototype and fabricate the listed instrumentation systems and associated components that would be shipped to and assembled at Fermilab. They will be tested with beam from the High Intensity Neutrino Source (HINS) Test Accelerator at Fermilab in collaboration with staff from BARC. If and when the Fermilab Project-X is approved for construction by US government, this development may result in "In-Kind" Indian contribution to Project-X.

5. Scope of Work in CY11-14

It is expected that the scope of work described by this Addendum will be executed within a three to four year time period. The scheduled date of the start and end of a project may be staggered to meet the overall plan and available resources of the collaboration.

The Instrumentation and control R&D activities targets four important systems:

1. Low-Level RF (LLRF) System
2. RF Protection Interlock System
3. Cryogenic Temperature Monitoring System
4. Beam Position Monitor (BPM) System

While these instrumentation systems are mission critical, we may expand the scope to other instrumentation or beam diagnostics topics, as required.

The LLRF, RF protection interlock, and temperature monitoring systems are an integral part of the SRF Cryomodule Test Stands (CMTS) of the Cryomodule Test Facility (CMTF). The overall scope of that facility is described elsewhere (CRYOMODULE TEST FACILITY – Overall Scope of Work and Proposed Areas of Responsibility), including some details of the instrumentation & controls R&D deliverables and collaboration procedures. This includes the training of visiting scientists and engineers at Fermilab, as well as specifications, review procedures and approvals. A detailed understanding of the technology of these three systems is mandatory for the operations of SRF test stands, e.g. CMTS, as well as for beam operation of test accelerators and the final high power SRF linac.

The BPM system (point 4.) is one of the most critical and complex beam diagnostics systems. It is used not only for observing the beam orbit along the accelerator, but for many other beam dynamics and accelerator improvement activities, including the phasing of SRF acceleration structures to the beam, based on a time-of-flight (beam phase) measurement. The prototype R&D on this activity will be tested at the Fermilab MDB HINS test accelerator, it includes RF analog techniques, digital signal processing

and sub-ps timing electronics, based on a VME/VXS form factor under a Motorola 5500 CPU running VxWorks, or similar. Collaboration deliverables are a complete prototype system, i.e. the different VME/VXS hardware modules, Altera FPGA firmware as part of the VME digitizer and timing modules, and all the read-out and system control software, ACNet/EPICS drivers, etc.

6. Schedule and Review

The detailed schedule of work described in this Addendum to the MOU would be elaborated in the Technical Annexes and Technical Project Management document. The schedule would be approved by the respective Project Managers in consultation with the Collaboration Coordinators. The schedule and progress will be jointly reviewed every six months and tasks may be added, deleted, or modified by mutual agreement. Both groups agree to report and evaluate progress at individual laboratory reviews by their respective funding agencies.

7. Funding

Consistent with General Provision 2.3 of the MOU, each Party shall be responsible for funding its participation activities. All participation activities and related procurements are subject to the availability of appropriated funds, personnel, and resources.

Fermilab and the Indian Institutions agree to establish an India Institutions and Fermilab Collaboration Account (IIFCA) at Fermilab. This account will be funded by Fermilab through a credit of fifty percent of the U.S. cost for each hardware component provided by Indian Institutions for use at Fermilab during the R&D phase. If the U.S. cost is unavailable, the amount of Fermilab credit for each component will be decided by mutual agreement of the Parties. The IIFCA would be managed by Fermilab-Indian Institutions for SRF technology-related R&D expenses. Such expenses may include: (1) supporting the local expenses of all Indian scientists and engineers visiting Fermilab for work and meetings under this Addendum and (2) procuring materials and technical components not available in India that will return to Fermilab. IIFCA funds may not be used to purchase hardware components from non-U.S. vendors. If India needs these materials and technical components for their own use, Fermilab will assist in its procurement.

All labor, materials and components available in India will be supplied by the Indian Institutions. Any hardware needed for use and development of the Indian laboratory infrastructure for the work to be performed under this Addendum will be paid by Indian Institutions. Fermilab will not charge for any technical assistance provided for the design of SRF infrastructure at Indian Institutions. Indian Institutions will provide

visiting US scientists and engineers with local accommodations when possible at the laboratory site. The cost of travel for Fermilab staff to India will be covered by Fermilab funds. The Parties mutually agree that costs associated with shipping materials and components shall be borne by the shipping Party and that any customs or duties applied to the items so shipped shall be borne by the receiving party.

8. Proposed mechanism for IPR sharing

The Intellectual Property Rights (IPR) sharing has already been well defined and described in detail between the Institutes involved in two documents: (1) Memorandum of Understanding between U.S. Universities and Accelerator Laboratories and Indian Universities and Accelerator Laboratories concerning collaboration on R&D for various Accelerator Physics and High Energy Physics Projects and (2) Tesla Technology Collaboration Memorandum of Understanding. (http://tesla-new.desy.de/sites/site_tesla/content/e19/e24/infoboxContent581/MoU.pdf). It is to be noted that for all collaborative work under this MOU the proposed mechanism for IPR sharing will be exactly as envisaged in these two documents.

9. Project Management, Responsibilities and Approval:

The Project management, responsibilities and approval authorities are described in detailed in the document "Management Plan for Fermilab Participation in the Indian Institutions and Fermilab Collaboration"

(http://iifc.fnal.gov/IIFC_FNAL%20Management%20Plan-Final-102210.pdf)

The following concur on the terms of this Memorandum of Understanding Addendum:


Dr. R. K. Sinha,
Director, BARC

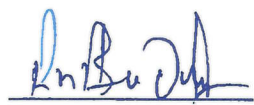
Date

22-08-2011


Dr. Piermaria Oddone
Director, FNAL

Date

8/22/2011


Dr. Rakesh Bhandari,
Chair, IC-IIFC

Date

22/08/2011


Dr. Shekhar Mishra,
Project-X,
International Collaboration Coordinator

Date

8/22/11

