

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 III: "Fermilab and Indian Accelerator Laboratories
Collaboration on High Intensity Proton Accelerator and SRF Infrastructure
Development"**

Feb 10, 2009

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 III. 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 III 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 III 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 two key areas of collaboration mentioned in the main MOU, which are (i) Superconducting Radio Frequency (SRF) Acceleration Science and Technology, including setting up test facilities and a high current proton driver, and (ii)

Superconducting Materials R&D for SRF acceleration related work. 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 that Fermilab, Raja Ramanna Center of Advanced Technology (RRCAT), Bhabha Atomic Research Center (BARC), Variable Energy Cyclotron Center (VECC), Inter University Accelerator Center (IUAC) and University of Delhi (DU) (referred to as the Indian Institutions in this document) plan to carry out for the development of SRF cavities and cryomodules for the high intensity proton accelerator (HIPA) and the development of SRF infrastructure to support these activities in their respective countries. RRCAT, BARC, IUAC and DU had applied, and were accepted as members of the TESLA Technology Collaboration (TTC), at the April 07 2007 meeting at Fermilab. All the terms and conditions of the TTC also apply to this MOU.

3. Background

Fermilab and Indian Institutions have been collaborating on high energy physics experiments since 1985, first on the fixed target experiment E706 and then on the D0 collider experiment. The visiting scientists have made valuable contributions to the development and commissioning of the detectors, data taking, analysis, and publication of physics results. Several students have received Ph.D. degrees under the Indian Institutions-Fermilab collaboration. This collaboration has been flourishing with continued participation of many scientists on D0 and the collaboration of Indian Institutions on accelerator development under Addendum (I and II) to the MOU. (Addendum I: "Fermilab, RRCAT, BARC, IUAC and VECC Collaboration on ILC Main Linac SRF Accelerator Technology R&D" and Addendum II: "SLAC, RRCAT, BARC, IUAC and VECC Collaboration on ILC RF Power Sources and Beam Dump Design R&D")

Indian Institutions have made significant progress on the work that was outlined in Addendum I and II. Six Indian scientific staff visited Fermilab to work on cavity and cryomodule Research, Design and Development (RD&D). One scientist visited SLAC to work on beam dump design for the International Linear Collider. His contributions were so significant that ILC Beam Detector Interface Group has made him the leader of that sub-group. Fermilab scientific staffs have also made several short visits to Indian laboratories for technical discussions.

Some of the highlights of Indian Institutions technical achievements for the scope of work defined in Addendum I include:

- I. Finished improvements on the design of the 1.3 GHz cavity fabrication tooling, including the die set. One set of tooling has been delivered to Fermilab and will be used for cavity fabrication in collaboration with TRIUMF.
- II. Construction of several Nb and copper prototype, 1-cell, 1.3 GHz cavities and performed RF tests to check fabrication techniques. These cavities will be used in

processing R&D at Indian Institutions and Fermilab. The copper cavities will be used for Atomic Layer Deposition R&D at Argonne National Laboratory (ANL).

- III. Proposed and prototyped a new end group design for the 9-cell, 1.3 GHz cavity using block Niobium.
- IV. Participated in the Type-IV cryomodule design at Fermilab and started working on this design from Indian Institutions. Proposed several value engineering design changes to the cryomodule design and fabrication.
- V. Designed, built and tested two different tuners for adjusting the frequency of the 9-cell, 1.3 GHz cavity. These tuners will be evaluated for use in the Project-X cryomodule.
- VI. In the process of fabricating two spoke resonator cavities for the HINS project at Fermilab.
- VII. Participated in SRF infrastructure design discussions. Indian engineers have spent 3 months at Fermilab learning about the present Vertical and Horizontal test stands and are active in design improvement discussions.
- VIII. Hosted meetings with Indian industry with the goal of involving them in the construction of SRF infrastructure, and components for SRF accelerators

Fermilab and Indian Institutions have proposed to build new proton accelerators in their respective countries while developing technical knowledge and infrastructure to participate in the construction of the International Linear Collider. Two years of collaborative work and recent developments in U.S. have led us to consider a similar design for these proton accelerators and discuss a concept of "Total Project Collaboration". In January 2008, Fermilab made a formal request to the management of the Indian laboratories (attached Appendix-I) to strengthen this collaboration further by jointly developing SRF cavity, cryomodule and infrastructure in both countries. Indian management has responded favorably to this request (attached Appendix-II). During 2008, Fermilab and the Indian laboratories held several meetings including a two day workshop at Indore in October 2008. The interest of this joint collaborative work is driven by accelerator projects in each country.

Indian Institutions' interest:

1) Indian Institutions have plans to build a High Intensity Proton Accelerator (similar to SNS, ADS etc.) using Superconducting Radio Frequency technology. At the same time, India aspires to participate in international SRF accelerator projects like ILC, Project-X, XFEL and the Radioactive Ion Beam Facility. Indian Institutions are collaborating with Fermilab and TRIUMF in many of these developments.

2) Indian laboratories would like to develop the design and fabrication capabilities for a SRF-based accelerator. This would also require development of SRF infrastructure (fabrication, processing and testing) at Indian Institutions and in Indian industries. Indian Institutions would like to collaborate with Fermilab in jointly developing this infrastructure for these future accelerator projects.

3) Indian laboratories would like to train their scientific and engineering staff while developing these accelerator components and infrastructure.

Fermilab's Interest:

1) Fermilab has proposed construction of a HIPA (Project-X). Fermilab would like the Indian Institutions to participate in Project-X research, design, development and construction. In the longer term, Fermilab is interested in participation in the International Linear Collider and other large future HEP projects that will require international collaboration.

2) In support of Project X and ILC Fermilab is developing SRF capability and infrastructure. Since both FNAL and India wish to develop this infrastructure collaboration will allow sharing of development costs and will benefit both countries.

3) Fermilab would like the Indian Institutions to develop in a phased manner the designs, prototypes and fabricate different components for the Project-X SRF accelerator. This would include spoke resonator (with IUAC and BARC) and $Q = 0.8$ cavity, tuner, helium vessel, etc. (with BARC, RRCAT and VECC) to produce a dressed cavity and cryomodule.

4) Work on the cost optimization of the prototype being developed.

5) Fermilab would like the Indian Institutions along with the Indian industries to design and fabricate a Vertical Test Stand, Horizontal Test Stand and Cryomodule Test Stand for installation at Fermilab as well as for the Indian laboratories.

6) Fermilab would scientifically and technically collaborate with the Indian Institutions in the development of HIPA. This would strengthen and increase the technical manpower for future accelerator development.

The goal of this Addendum is for Fermilab and Indian Institutions to define a high level scope of work for the future collaboration towards the development of HIPA and related SRF infrastructure in both countries. The details of the work to be performed will be given in the subsequent addenda and in the Project Management document to be signed by the Fermilab and Indian Institutions Collaboration - Coordinators and by the Fermilab and Indian Institutions Project Managers for that project.

4. Work to be performed

This collaborative work under this Addendum to the MOU will develop on two parallel paths.

1) Fermilab and the Indian Institutions will jointly work on the design, development, prototype and construction of the parts of $\beta = 0.8$ cavity and cryomodule for HIPA. Indian Institutions would take a lead in this effort.

2) Fermilab and Indian Institutions will jointly work on the design and construction of the SRF infrastructure that would be needed for HIPA projects at Fermilab and at Indian Institutions.

In particular, the goal for the Indian Institutions is to design, prototype and fabricate a 0.8 β , 1.3 GHz cavity and associated cryomodule components that would be shipped to and assembled at Fermilab. It will be tested in the Cryomodule Test Area at Fermilab in collaboration with staff from the Indian Institutions. If and when the Fermilab Project-X is approved for construction by US government, this development will be fully exploited in the form of "In-Kind" Indian contribution to Project-X.

Indian Institutions could also participate in the design of the HIPA at Fermilab. Fermilab and collaborating institutions are developing SRF infrastructure for cavity fabrication, processing and testing, cryomodule fabrication and testing. The goal for Fermilab is to support the Indian Institutions in gaining SRF expertise, developing accelerator components and SRF infrastructure at Indian laboratories. Fermilab would allow the participation of Indian Institution staff in the design of the accelerator components, operation of the existing infrastructure, construction and commissioning of new infrastructure. Efforts will be made so that one Indian Institution staff would be continuously present at Fermilab and will also act as a primary technical contact for the collaboration. It is also expected that the Indian Institutions and Fermilab will use extensive Web based communication tools to perform these work. Fermilab would assist Indian laboratories in this by sharing the design specifications, drawings, etc. of the existing accelerator components and infrastructure. This will constitute the principle "In-Kind" Fermilab contribution to India.

5. Scope of Work in CY09-12

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 of the start and end of a project may be staggered to meet the overall plan and available resources of the collaboration. The overall scope is divided in two major categories: Cavity & Cryomodule, and SRF Infrastructure.

I. Cavity and Cryomodule Design, Prototype, Construction and Testing

Fermilab and the Indian Institutions agree to undertake the Research, Design and Development (RD&D) of two accelerator subsystems, namely the Spoke Resonator

cavity (with IUAC and BARC) and $\beta = 0.8$ cavities (with RRCAT, BARC and VECC) for the superconducting HIPA. These areas are shown in Figure 1. Fermilab agrees to share the design of other subsystems of the HIPA linac with Indian Institutions for the development of a HIPA in India. It is also understood that both Indian Institutions and Fermilab would continue to collaborate on the ILC Cavity and Cryomodule RD&D.

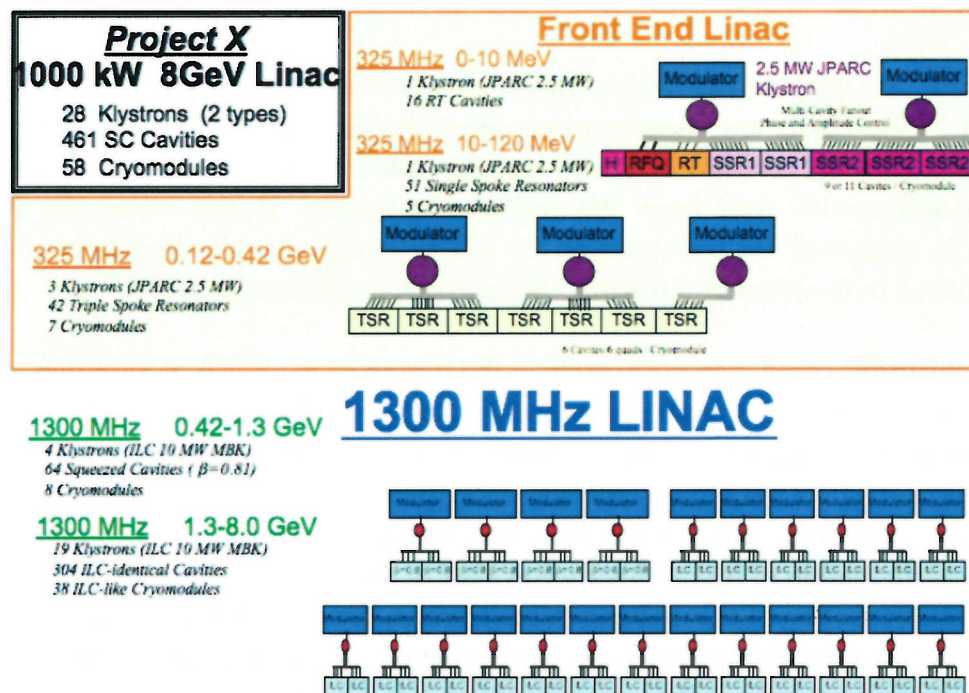


Fig. 1: Initial Schematic of the Project-X linac configuration

These can be broken down in the following subcomponents. Each of these subcomponents should be developed into its own Addendum to the MOU and a Project Management and Work Plan document.

a. Spoke Resonator Cavity

IUAC in collaboration with Fermilab is already working on the development of two SSR1 (325 MHz) cavities. After the successful initial test of these cavities in CY09-10 at Fermilab, Indian Institutions would work to develop a minimum of eight Spoke Resonator cavities and associated hardware for one cryomodule.

b. Spoke Resonator cryomodule

Fermilab is developing a design for the Spoke Resonator power coupler and cryomodule for High Intensity Neutrino Source Project (HINS). Indian Institutions would also consider fabrication of the power coupler and cryomodule-associated

hardware with Indian Industry. Indian Institution (BARC) would take up the fabrication of one SSR1 cryomodule for the Fermilab Project-X.

c. $\beta = 0.8$ Cavity

Starting with the Fermilab's preliminary design and design specification of the $\beta = 0.8$ cavity, Indian Institutions would develop and prototype a multi-cell cavity. Until the Indian Institution's SRF and fabrication infrastructure is commissioned these cavities may have to be fabricated, processed and tested with the help of Fermilab. Indian Institution would fabricate components for minimum of 8 cavities that could meet the Project-X design specification by the end of 2012. Fermilab would provide Niobium for this R&D.

d. Helium Vessel

Indian Institutions would develop a stainless steel design for the $\beta = 0.8$ cavity Helium vessel. These vessels are required for dressing of cavities. After a successful review and a prototype test Indian Institution would build eight Helium Vessel for the first $\beta = 0.8$ cryomodule. Fermilab would help in material procurement if required.

e. Tuner for $\beta = 0.8$ Cavity

Indian Institutions have already advanced on developing some of the tuner designs and also worked on the prototypes of the two most promising versions. After a joint review with Fermilab one of these designs would be selected as a tuner for the $\beta = 0.8$ cavity. This prototype tuner could be tested at Fermilab Horizontal Test Facility. After a successful review and test Indian Institution would build eight Tuners for the first $\beta = 0.8$ cryomodule.

f. Power Coupler for $\beta = 0.8$ Cavity

In collaboration with DESY, Fermilab has developed a 1.3 GHz 500 KW power coupler. These couplers are industrially fabricated. There are several improvements to this design under discussion. Indian Institutions would collaborate with Fermilab in the design and fabrication of the coupler. A prototype coupler could be tested at the Fermilab Horizontal Test Stand or a Coupler test stand built at Indian Institutions. After a successful review and test Indian Institution would build eight Power Couplers for the first $\beta = 0.8$ cryomodule.

g. Cryomodule superconducting magnet

The $\beta = 0.8$ Cryomodule is expected to have either one or two superconducting magnets package (dipole correctors and quadrupole). Building on experience with LHC magnets, Indian Institutions would work on the design, fabrication and testing

of these magnets to be included in the cryomodule package. Two magnets will be needed for the first $11 = 0.8$ cryomodule.

h. Instrumentation and Controls

Indian Institutions would collaborate with Fermilab in the development of instrumentation such as Beam Position Monitors, HOM Signal, coupler instrumentations etc. and their associated readout devices.

i. $11 = 0.8$ Cryomodule components

Indian Institutions engineering staff has already been members of the cryomodule design team developing the Type-IV cryomodule design for ILC. They have suggested several value engineering improvements to this design. In collaboration with Fermilab, Indian Institutions would lead the design effort for $11 = 0.8$ cryomodule. In this design Indian Institutions could include components that would be designed and fabricated (items c-h described above) in India. The main cryomodule components to be fabricated beside those described above would include cryogenic pipes, insulation, stands etc. It is anticipated that Indian Institutions would only assemble components up to the unit of a "Dressed Cavity" and that the final assembly of the cryomodule would take place at Fermilab.

j. Niobium Material R&D

Indian Institutions have started development of high purity niobium in India. The present RRR of this Nb is 40. Fermilab and Indian Institutions are collaborating on the fabrication of a 3.9 GHz 1-cell cavity to test this material. Indian laboratories are also fabricating a 1-cell 1.3 GHz cavity to learn how to handle Nb in a clean environment and develop proper fabrication techniques.

In collaboration with Fermilab, KEK and JLab, Indian Institutions have established a material R&D program. Recent results of the processed Nb samples have led to interesting observations about different surface processing techniques. Indian Institutions are also developing copper cavities for Atomic Layer Deposition R&D at ANL. Fermilab and Indian Institutions would continue to collaborate on Nb material R&D.

II. SRF Infrastructure Development

Since 2005, Fermilab has been developing SRF infrastructure to support the cavity and cryomodule R&D program in collaboration with DESY, KEK, TJNAF, Cornell and ANL. Fermilab has received valuable technical assistance from the TTC collaboration. By the end of 2008, Fermilab has one each of a Vertical Test Stand, a Horizontal Test Stand, and a cavity processing facility (ANL/FNAL) operational. In

order to meet the capacity demand of the ILC initial phase construction, industrial participation, and the needs of Project-X; Fermilab has proposed to upgrade the existing facilities and build new ones such as the Cryomodule Test Stand and Joint Industry-Laboratory cavity processing facility.

a. Vertical Test Stand

The Vertical Test Stand (VTS) is used to test bare cavities. The VTS is used to measure the low-field cavity quality factor (Q) vs. temperature and Q vs. accelerating gradient at 2 deg Kelvin by submersing the bare cavity in a liquid He tank. In 2007, Fermilab constructed (based on DESY and JLab design and operational experience) and commissioned a VTS-1 with a capacity to test up to about 40 cavities per year. Fermilab has gained valuable experience in the design and operation of VTS.

An upgrade of the VTS system is needed to support the cavity testing capacity needed for Project-X construction. Fermilab has proposed to significantly increase the VTS capacity by adding two additional VTS (2 & 3) to the system and support it with an upgraded cryogenic system. The cryogenic upgrade is already in progress at Fermilab. Based on the experience with VTS-1 and the need to test larger size cavities, Fermilab has proposed several design changes to the VTS cryostat and the helium handling system.

Indian Institutions in collaboration with Fermilab will develop a revised design for the VTS based on the specifications provided by Fermilab. After a successful design review, Indian Institutions would fabricate up to four VTS cryostats, with up to two going to Fermilab. Indian Institutions with the help of Indian Industries would need an operational VTS to support the activities described in the cavity development section of this Addendum. Fermilab would provide the design specification, drawings and operational details of the RF system, DAQ and control systems for the VTS. Fermilab would allow Indian Institution scientific staff to participate in the operation of VTS to gain valuable experience. Fermilab would also provide assistance in installation and commissioning of VTS systems at Indian Institutions.

b. Horizontal Test Stand

The Horizontal Test Stand is used to high power test a dressed cavity before it is installed in a string of cavities to build a cryomodule. The cavity gets tested horizontally (in its beam configuration) with high power RF inside a helium-cooled cryostat, with the power coupler and tuner installed. In 2007, Fermilab built and commissioned a HTS-1 based on the DESY design. The maximum test capacity of this HTS is approximately twenty four cavities/yr. The construction of Project-X would require significantly larger capacity. Fermilab has proposed the construction

of a second HTS that would have twice the capacity of the HTS-1. The HTS-2 would have a cryo vessel that will accommodate either two cavities or one cavity and one cryogenic magnet package.

Indian Institution would develop the design of HTS-2 based on design specification and drawings of the HTS-1. Indian Institutions with the help of Indian Industries would build and deliver a cryo vessel for HTS-2 to Fermilab. Fermilab would share the design specification, drawings, RF power specification, DAQ and control information with Indian Institutions for installation and commissioning of an HTS in India. Indian Institutions staff would visit Fermilab to work on the operation of HTS-1 to gain experience that would aid in design and fabrication of HTS-2.

c. Cryomodule Test Stand

The Cryomodule Test Stand (CTS) is used to test a completed cryomodule before it would be installed in an accelerator. DESY has built one CTS and plans to build additional CTS needed for the XFEL Project. The first several cryomodules at Fermilab would be tested at Fermilab's ILCTA_NML. Fermilab has proposed to build three CTS for the Project-X construction. Fermilab has designs for most of the subcomponents needed for the fabrication of a CTS, but an integrated design needs to be developed.

Fermilab would share subcomponent designs with Indian Institutions for the CTS design. Indian Institutions with the help of Indian Industries would fabricate one CTS (Feed Can, End Can, Cryo distribution, stands etc.) for installation and commissioning at Fermilab. Indian Institution staff would visit Fermilab to work at ILCTA_NML to gain experience that would aid in the design and fabrication of CTS.

d. Cavity Processing Facility

A Cavity Processing Facility (CPF) consists of several components including Buffered Chemical Polishing, Electro Polishing, High Pressure Rinse, Ultra-sonic cleaner, ovens (800 and 200 deg C) and clean rooms (Class 10 and 100). An industrially fabricated cavity may cycle through the CPF and VTS several times before it is ready for dressing. The details of this technology are still under development. Fermilab and KEK have shared their available design documents with Indian Institutions. Indian Institution staff has gained valuable experience in cavity processing and testing at KEK. Both Fermilab and KEK are in the process of designing a higher capacity CPF. Fermilab proposes to do this in collaboration with the material processing industrial vendors and ANL. Fermilab would share the design specification and design documents with Indian Institutions for construction of a CPF in India and provide assistance in establishing these facilities.

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 a Fermilab-India Institution Account (FIIA) 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. 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 FIIA 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 or are necessary to develop Indian laboratory infrastructure. FIIA funds may not be used to purchase hardware components from non-U.S. vendors.

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 Fermilab Director, assisted by the Associate Director for Accelerators and the ILC/SRF Program Director, along with the Directors of the various Indian Institutions have the ultimate responsibility and approval authority for the scope of work contained in this Addendum. Collectively this group represents the Institutional Management for their respective partners. A schematic view of the collaboration management is shown in Figure 2.

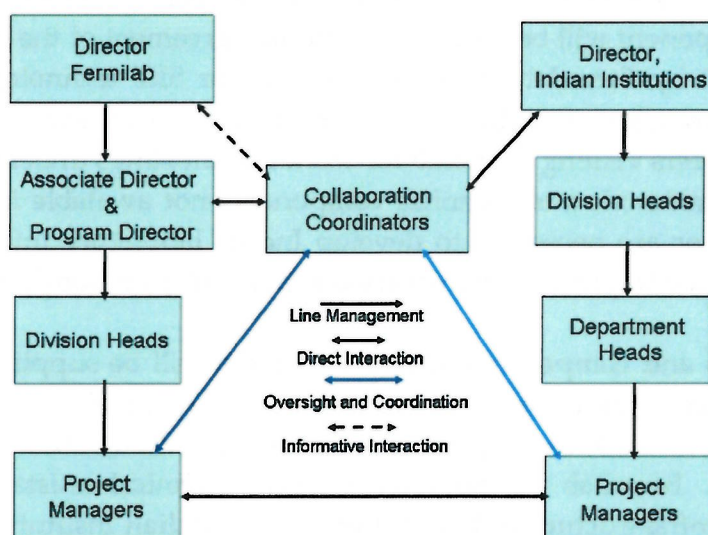


Fig. 2 Management of Fermilab-Indian Institutions Collaboration

The Fermilab and Indian Institutions in this collaboration will provide oversight for the programs through a joint Collaboration Committee to be nominated by the undersigned. The committee will be co-chaired by the Collaboration Coordinators. Collaboration Coordinators have the overall responsibility to provide oversight and coordinate the work done under this Addendum. They represent the institutions in their respective countries and serve as a single point of contact. At present Dr. Shekhar

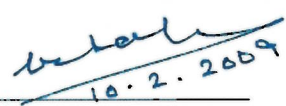
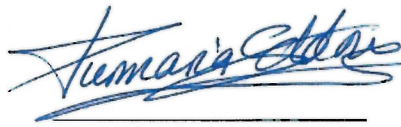
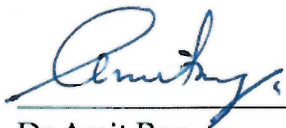
Mishra, Fermilab and Dr. Vinod C. Sahni, India serve as the Collaboration Coordinators.

The Fermilab Associate Director Accelerators and the ILC/SRF Program Director in consultation with the appropriate Fermilab Division Head and the Fermilab Collaboration Coordinator will appoint a Project Manager for each of the projects described in this Addendum. Indian Institutions will also appoint a Project Manager in consultation with the Indian Collaboration Coordinator and assign a lead laboratory for each project to help coordinate the work.

The Project Managers have the responsibilities of developing and managing the technical design, budget and schedule of the project. They will provide technical leadership, negotiate for required labor, conduct project reviews, prepare needed safety documents, and get necessary safety approvals and certifications in order to carry out the work. Project Managers are also expected to manage the daily aspects of their projects and keep the respective Institutional Management and Collaboration Coordinators informed of progress.

The Collaboration Coordinator in consultant with the Project Managers will call for periodic reviews of the project. They, in consultation with their respective Institutional Management will approve the plans developed by the Project Managers and decide on future direction of a project.

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

 10.2.2009	Feb 10, 2009	 2/10/2009	2/10/2009
Dr Vinod C. Sahni, Director, RRCAT	Date	Dr. Piermaria Oddone Director, FNAL	Date
 Feb 11, 2009	Feb 11, 2009	 Feb 11, 2009	Feb 11, 2009
Dr Srikumar Banerjee, Director, BARC	Date	Dr Amit Roy, Director, IUAC	Date
 Feb 12, 2009	Feb 12, 2009		
Dr Bikash Sinha, Director, VECC	Date		

Appendix – I



Fermi National Accelerator Laboratory
P.O.Box 500 • Batavia, IL • 60510-0500
630-840-3211 FAX 630-840-2900

Director's Office

January 4, 2008
(By E-Mail and Facsimile)

Dr. Anil Kakodkar
Chairman, Atomic Energy Commission of India
Secretary, Department of Atomic Energy
Anushakti Bhavan
CSM Marg
Mumbai – 400001, India

Dear Dr. Kakodkar,

I am very pleased to inform you that accelerator collaboration between Fermilab and Indian Institutions has started with regular visits of Indian scientific staff (RRCAT and BARC) to Fermilab. I had a chance to sit through the presentation of Mr. Prashant Khare and Mr. Avinash Puntambekar summarizing their accomplishments at the end of their short stay of three months. I am very impressed with the proposed new design of the cavity end group and several suggestions to improve the cryomodule design for manufacturing. These could help reduce the cost significantly.

We were delighted to host Dr. Sahni during his short visit to Fermilab and he and I had a very useful discussion. The senior scientific and technical management of Fermilab also had a chance to have detailed discussions with him regarding our collaborative efforts; progress to date; and how to strengthen this effort in the future. Dr. Sahni also had a chance to see the developing Fermilab Superconducting Radio Frequency (SRF) infrastructure and spend some time with the technical staff leading those efforts.

Last year I convened the Fermilab Steering Group to develop a strategic roadmap for the evolution of the accelerator-based High Energy Physics program, focusing on facilities at Fermilab that would provide discovery opportunities in the next two to three decades. The steering group has submitted its report; it calls for the development of ILC and Project-X (a high intensity proton linac injecting into the Main Injector complex), while strongly supporting the Tevatron and LHC operations.

During Dr. Sahni's visit, we had a chance to discuss possible Indian collaboration on Project-X. The Project-X SRF linac and the Indian accelerator programs (ADS and SNS) have considerable overlap. I am proposing that we collaborate on these accelerator developments in a phased manner, starting with the development of SRF infrastructure and R&D. On Jan 30th 2008 the US-DOE P5 subcommittee will review our future programs. Fermilab plans to present the Project-X plan to P5 with the support of its collaborators. We would like to invite Indian laboratories to officially join this collaboration and seek your consent for this. We imagine initial collaboration on SRF Cavity and Cryomodule R&D and infrastructure in both countries, with the longer term possibility of joint construction of these accelerators.

I have asked Shekhar Mishra to provide you with additional technical details on the present collaborative efforts, Project-X R&D and its commonality with Indian accelerator programs, when he meets you on Jan 15th.

Sincerely,



Piermaria J. Oddone,
Laboratory Director

Appendix -II



सत्यमेव जयते
सत्य सरकार

Government of India

डॉ. अनिल काकोडकर
Dr. Anil Kakodkar

अध्यक्ष, परमाणु ऊर्जा आयोग
स
सचिव, परमाणु ऊर्जा विभाग
Chairman, Atomic Energy Commission
&
Secretary, Department of Atomic Energy

No. 22 - 2008

January 21, 2008

Dear Prof. Oddone,

Thank you for your letter dated January 4, 2008 and very supportive views about the collaboration between Fermilab and Indian Institutions. I am glad that this collaboration is moving so well.

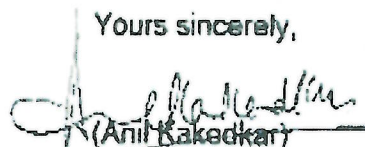
I am also happy to inform you that Dr. Mishra met me as scheduled on January 15, 2008. He apprised me with the details of 'Project X' and its linkage with the R&D required for ILC. I also learnt from him that Joint Accelerator School 2008, currently going on at RRCAT (with the help of Fermilab and KEK), is running very well and I wish to thank you for your help for the same.

I am happy to respond positively to your invitation to Indian laboratories to collaborate with Fermilab on the 'Project X' in a phased manner. I suggest that Dr. Sahni (and Dr. Mishra from your side) can work out the details that are consistent with the projected programs of both sides.

I certainly hope that the partnership between Indian laboratories and Fermilab in accelerator R&D, particularly in the area of SCRF cavity and cryo-module development, will grow in the coming years and do look forward to our working jointly.

With best regards,

Yours sincerely,


(Anil Kakodkar)
Jan 21, 08

Prof. Piermaria J. Oddone,
Laboratory Director,
Fermi National Accelerator Laboratory
P.O.Box 500,
Batavia IL 60510-0500, USA