

Deliverable for Addendum-III

The scope of work described by this Addendum will be executed within a three to four year time period and will cover the development phase of the HIPA project at Fermilab. This work will leave Indian institutions well positioned to provide in-kind contributions to HIPA at Fermilab, while simultaneously embarking on design and development of a similar facility in India. 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 deliverable dates are decided to meet the overall Fermilab schedule of developing the “Test Accelerators” and infrastructure.

The overall scope is divided in two major categories: SRF Linac and SRF Infrastructure. One of the major deliverables from Fermilab to Indian Institutions is developing accelerator experts in India. Indian physicists and engineers will initiate their work with Fermilab experts and slowly take the ownership of the project under the supervision of a Fermilab Project Manager for that project.

SRF Linac:

- Accelerator Physics: IIFC will work together with Fermilab in developing the design of the HIPA linac and associated hardware.
- Cavity and Cryomodule
 - Single Spoke Resonator (SSR1): Fermilab has shared the initial design of the SSR1 cavity with IUAC. IUAC has experience in cryomodule design. Fermilab would like to work with Indian Institutions in developing a cryomodule design for SSR1 cavities.
 - Spoke Resonator Cavity (two cavities in 2010)
 - Spoke Resonator cryomodule
 - $\beta = 0.9$ 650 MHz cavity and cryomodule design (finalize by end of 2010), prototype and fabrication: Building on its experience with Fermilab on $\beta = 1.0$ cavity and cryomodule, Indian Institutions would independently develop these items.
 - $\beta = 0.9$ 650 MHz Cavity (1-cell cavity mid 2011, 1st 5-cell cavity in 2012)
 - Helium Vessel
 - Tuner for $\beta = 0.9$ Cavity
 - Power Coupler for $\beta = 0.9$ Cavity
 - Cryomodule superconducting magnet
 - Instrumentation and Controls
 - $\beta = 0.9$ Cryomodule components (end of 2014)
- Deliverable (by 2014)

- Indian Institutions would fabricate additional 4 SSR1 Cavities for installation in a cryostat at Fermilab (End of 2013).
- Indian Institutions would fabricate half the components for one $\beta = 0.9$ 650 MHz cryomodule, including 4 + 1 spare cavities (Mid 2014).

Fermilab’s draft schedule for the development of Cavity and Cryomodule is shown in Fig 4. This integrated schedule has been developed in discussions with US-DOE-HEP, ART-ILC, and the Fermilab management of ILC, SRF and Project-X. It uses a funding profile provided to Fermilab by the US-DOE and our justification of technical milestones for the approval of Project-X.

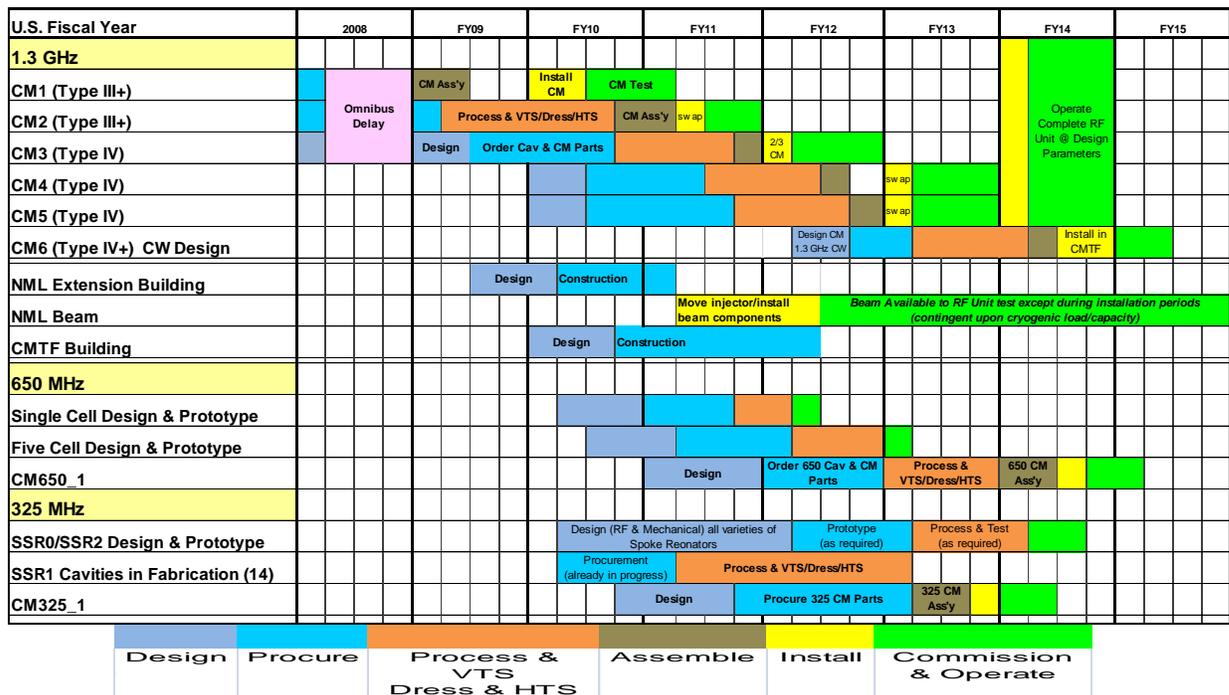


Fig. 4 Schedule for the 1.3 GHz program under the Addendum MOU III.

SRF Infrastructure

- Niobium Material R&D and related infrastructure established at Indian laboratory
- SRF Infrastructure
 - Vertical Test Stand:
 - Based on a specification and design documents from Fermilab, Indian engineers will work to develop an improved design of a Vertical Test Stand (2009).
 - Fermilab and Indian Institutions would fabricate cryostats that would best fit the funding, technical and schedule constrains. At present we are

- working with a plan of purchasing three cryostats from a US vendor. One will be paid by India and will be shipped to India (Q2 2011).
- At the same time at least one cryostat will be installed at Indian laboratories with all associated hardware including RF power, controls and cryogenics. Fermilab will work with Indian laboratories in establishing such a facility (2013).
- Horizontal Test Stand (2 Cavity cryostat design for CW operation (mid 2011) and 1 cryostat (mid 2012))
- Based on a specification and design documents from Fermilab, Indian engineers will work to develop an improved design of a Horizontal Test Stand (2010). Using the same design principles Indian Institutions will develop a design for a two cavities beam test cryomodule.
 - A minimum of two cryostats will be fabricated by Indian Institutions with Fermilab's help. One of these cryostats will be delivered to Fermilab (Q3 of 2012)
 - At the same time one cryostat with two cavities will be installed at Indian laboratories with all associated hardware including RF power, controls and cryogenics for beam test in India. Fermilab will work with Indian laboratories in establishing such a facility (2013).
- Cryomodule Test Stand
- Based on a specification and design documents from Fermilab, Indian engineers will work to develop an improved design of a Cryomodule Test Stand (Q3 2012). This design will use a CW mode of operation.
 - A minimum of one Test Stand will be fabricated by Indian Institutions with Fermilab's help. It would be delivered to Fermilab (Q3 of 2014)
- Cavity processing facility at Indian laboratories (2011)
- Indian Institutes will participate in the development of the components of such a facility at Fermilab. Fermilab will work with them in developing such a facility at Indian laboratories.

U.S. Fiscal Year	2008	FY09	FY10	FY11	FY12	FY13	FY14	FY15	
Nb Scan/Dress Cavity Facility Upgrade	Omnibus Delay	Upgrade Complete					Upgrade Complete		
325/650 MHz Cavity Facility Upgrade					Upgrade Complete				
CAF Assembly Upgrade		Upgrade Complete							
325/650 MHz CAF Upgrade						Upgrade Complete			
VTS 2 & 3 Upgrade			VTS2 Procure FNAL	VTS2 Complete	VTS2 Complete	VTS3 Procure India	VTS3 Complete	VTS3 Complete	
325/650 MHz VTS Upgrade				Upgrade Complete					
HTS 2 Construction				Design	Procure India	HTS2 Complete			
NML Beam Line		Design	Procure		Install	NML Complete			
NML Refrigerator			Design	Procurement				Operate NML Ref	
NML Cryo Distribution System							CDS Complete		
SLAC Refrigerator				Design SLAC Ref Interface (as req'd)			SLAC Refrig Oper		
CMTF CM Test Stand (1.3 GHz)						Procure FNAL		1.3 CMTS Complete	
650 MHz CM Test Stand						Procure India		650 CMTS Complete	
CMTF Cryo Distribution System						Procure FNAL		CMTF Dis Complete	
MDB Spoke Test Cryostat 2k Upgrade					325 HTS Upgraded				
325 MHz CM Test Stand @ MDB					Procure FNAL			325 CMTS Complete	
325 Cryo Distribution Upgrade				Up TL to 325 HTS		TL to 325 CMTS		325 CDS Complete	
MDB Cryo Upgrade (FY15 & beyond)								Des/add 4th Refrig	
ANL & JLAB EP upgrades		ANL EP Oper	JLab Upg Des	Procure	Upgrade Complete				
325/650 MHz Proc. Upgrade				ANL Upg Des		Upgrade Complete			

Fig. 5. Schedule for the SRF Infrastructure development under the Addendum MOU III.

Fermilab's schedule for the development of the SRF infrastructure is shown in Fig 4. Several aspects of this schedule rely on the IIFC collaboration. We are expecting the collaborative effort will enable the participating Indian institutions to construct, commission and operate needed basic infrastructure in a similar time frame.