

Meeting of Dr. Nigel Lockyer, Director, Fermilab and Shri Sekhar Basu, Director, BARC, Dec 1, 2014

Present: Shri Sekhar Basu, Director, BARC; Dr. Nigel Lockyer, Director, Fermilab; Dr. Shekhar Mishra, Fermilab; Dr. B. Purniah, Advisor Science, DAE; Dr S.L. Chaplot, Director, Physics Group; Shri Chandra Kant Pithawa, Director, E&IG, BARC; Shri Y. S. Mayya, AD, E&IG;BARC; Dr. Pitamber Singh, Head, IADD,, BARC

Key Points:

1. Now that Annex I is in place, at least from the DAE side, a clear specification of each deliverable should be written and formally agreed up by Fermilab and DAE. The documentation, for the R&D and construction stages should have three levels, a) Functional Requirement Specification, b) Technical Requirement Specification and c) Interface Specification. It was also discussed that all the issues of QA, QC, fabrication details should be documented and formally signed off.
 - a. The procedure that the IIFC went through for Cryomodule Test Stand is an excellent example.
 - b. The design review process and schedule should be clearly specified and agreed.
 - c. Document approval and acceptance procedure for each deliverable should be specified.
 - d. Any Specification change subsequent to document approval, should be discussed, documented and approved to identify any impact on technical performance, cost & schedules. There will be cost implication to change in specification after acceptance by DAE and Fermilab. DAE-Fermilab should establish a Change Control Board that would formally look after and approve any such change.
 - e. Need to establish cost and quantity correlation
2. Team Center should be established at DAE laboratories as soon as possible. As agreed Fermilab should assist in this purchase, essentially helping with needed hardware configurations, US vendor and license agreement. All technical work and documentation must be done through Team Center.
 - a. It is absolutely essential to do Joint Development of every item.
3. In the interim, while DAE is working to establish a mirror Team Center site, colleagues from DAE laboratories should use the Citrix Interface to the Team center for all the design work. This will ensure that same design is being developed, reviewed and approved by the collaboration.
4. Initiate and document procedure that would lead to the placement of the cryogenic plant order.

5. Initiate and document procedure that would lead to the placement of the Nb order. How we will do the quality control of the Nb? RRCAT could also place this order.
6. Formal communication regarding organizational arrangement is needed. DAE-Fermilab organization chart for this collaboration through Sub-Project Manager (SPM) should be finalized. The R2A2 of each level should be clearly agreed.
 - a. Interaction levels
 - b. Decision making levels
 - c. Periodicity of meetings (Every Six months face to face meeting of senior management)
 - d. Video conferencing (Weekly IIFC Group meeting, Weekly SPM to SPM should be established)
 - e. Visits (2 years Guest Scientists visit, Technical managers)
 - f. Role of the Director of the host institutions
 - g. Review of the collaboration by end of 2016.
7. The terms and conditions of the 2 years Guest Scientists should be formally finalized.
8. A plan for FY15-FY18 was presented by Fermilab (Appendix –I).
 - a. Involvement of ECIL in the fabrication of MEBT magnets, 10 KWatt 325 MHz Solid State RF, 60 KWatt 650 MHz Solid State RF, RF Protection and LLRF was discussed.
 - b. It was clarified that DAE is responsible only to send Horizontally Tested Dressed Cavities (325 and 650 MHz) to Fermilab. Fermilab is responsible for assembling them in a cryomodule.
9. A table of information needed from Fermilab was presented by BARC (Appendix-II).
10. Technical development by other US institutes (i.e. ANL and LBNL) will be available to DAE as the terms and conditions in the Annex I.
11. Several discussions on cost and schedule. It was agreed that it will be addressed by Shekhar Mishra separately.
12. There is no warranty of the delivered components. Through joint development the collaboration is to ensure that the products are reliable. There are enough spare in the table to take into account of nominal breakdown of sub-systems.

IIFC R&D Deliverables to Fermilab by 2018

Shekhar Mishra

DAE-DOE Discovery Science Collaboration
Deputy Project Manager
PIP-II, Fermilab



FY15 IIFC: R&D Focus PIP-II

- We are focusing on one areas in SRF
 - HB650 Dressed Cavity and CM design
- We are focusing on two areas in SRF Infrastructure
 - HTS2
 - CMTS-I (May 2015)
- Solid State RF Power with control
 - 325 MHz
 - 650 MHz
- Warm Magnets for PXIE (MEBT)



FY15-17: 650 MHz, $\beta = 0.92$ Dressed Cavity

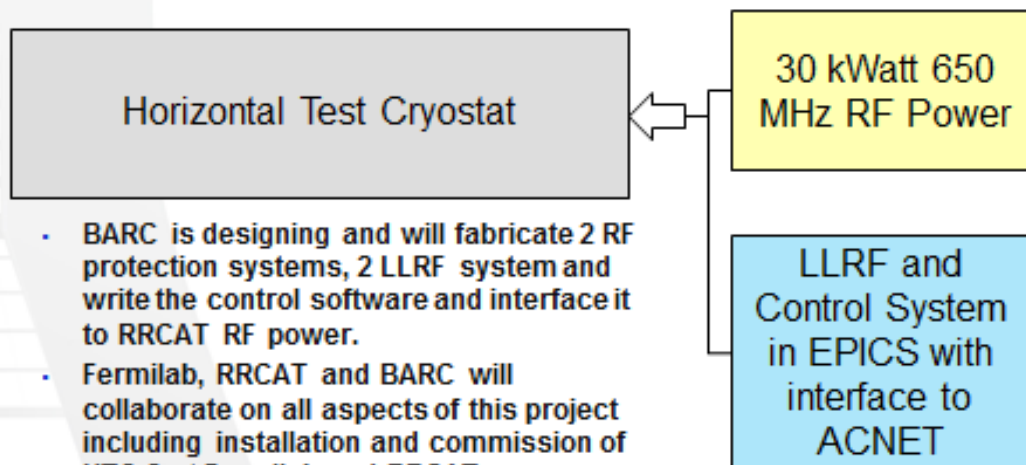
- **Elements of Dressed Cavity**
 - Bare Cavity with End groups and stiffening rings
 - End group interface to Helium Vessel
 - Helium Vessel with magnetic shield
 - Slow mechanical tuner (End)
 - Fast Pizo tuner (End with slow tuner)
 - 60 kWatt RF Coupler
- **Current Status**
 - **Bare cavity design has been finalized**
 - Mechanical design calculation of the stiffening ring has not been done
 - There are three possible option of the end group design, final selection is needed based on mechanical stability and fabrication
 - **Based on the selected End group design its interface to He vessel needs to be designed**
 - **Design need to be finalized**
 - Helium Vessel with magnetic shield
 - Slow mechanical tuner (End)
 - Fast Pizo tuner (End with slow tuner)
 - 60 kWatt RF Coupler



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FY15-17: Integrated Horizontal Test Stand

- RRCAT is designing and will fabricate 2 Horizontal Test Stand for the high power test of the 650 MHz dressed cavity. One will be installed at Fermilab and one at RRCAT.
- RRCAT will fabricate two 30 kW, 650 MHz Solid State RF Power for the two HTS.



- BARC is designing and will fabricate 2 RF protection systems, 2 LLRF system and write the control software and interface it to RRCAT RF power.
- Fermilab, RRCAT and BARC will collaborate on all aspects of this project including installation and commission of HTS-2 at Fermilab and RRCAT.



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IIFC R&D: PIP-II Cavity, CM and Infrastructure

- **SSR1 (PIP-II, Fermilab/DAE)**
 - 2 Bare cavities (Q1FY15)
 - 4 Dressed cavities (Q4FY17) ← Open to discussion
- **SSR2 (PIP-II, DAE/Fermilab)**
 - 4 Dressed cavity (Q2FY17)
 - 2 Horizontal Tested (Q4FY17)
- **LB650 (PIP-II, CERN/DAE/Fermilab)**
 - 2 Cavity VTS (Q2FY17)
 - 2 Dressed Cavity Horizontal Tested (Q2FY18)
- **HB650 (PIP-II, DAE/Fermilab)**
 - 4 Dressed Cavity HTS (Q4FY17)
 - CM Design finished (Q4FY16)
- **HB650 CM (PIP-II, Fermilab/DAE)**
 - 1 CM (Q1FY17)
- **HTS-2 (Q1FY17) (DAE/Fermilab)**
- **650 MHz CMTF (Q3FY18) (DAE/Fermilab)**



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FY17-18 IIFC Annex I : PIP II RF Power

- 325 MHz RF Power for **PXIE** (Q2FY17)
 - 10, 10 KW RF Power system
 - LLRF System
 - RF Protection System
 - Interface to Accelerator
- 650 MHz RF Power (2) **HTS-2** and (6) **CMTF** (Q1FY17, Q2FY18)
 - 8, 30 kW Solid State RF System
 - LLRF System
 - RF Protection System
 - Interface to Accelerator



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IIFC Annex I: PIP II

- **MEBT**
 - 51 Magnets with Power Supply (Q1 FY16)
- **SRF Linac Magnet (Initiate work on Annex I)**
 - Superconducting Solenoid
 - ♦ SSR1 and SSR2
 - Warm Magnet
 - ♦ 650 MHz CM
- **12th plan Annex I work to be initiated by DAE/Fermilab**
 - Cryogenic Plant design and order
 - Nb order for PIP-II Cavities



Overall R&D Schedule

Activity	FY 2014-15												Status	R&D Funding	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
MEBT															
MEBT Design															
MEBT Magnets															
MEBT Power Supply															
MEBT Installation															
MEBT Commissioning															
SRF Linac Magnet															
SRF Linac Magnet Design															
SRF Linac Magnet Fabrication															
SRF Linac Magnet Installation															
SRF Linac Magnet Commissioning															
12th Plan Annex I															
Cryogenic Plant Design															
Cryogenic Plant Order															
Nb Order															
PIP-II Cavities															



Summary

- We are working on several R&D topics under IIFC. These R&D should conclude by the end of FY18.
- We propose to initiate work on a few projects for the Phase I of Annex I consistent with our R&D and PIP-II/HISPA plans as outlined in the DAE DPR.
- **At the conclusion of these R&D in FY18, Fermilab, DOE and DAE will decided on the final deliverable table from DAE → DOE for PIP-II by 2023.**
- **Remaining deliverable will be for PIP-III after 2023.**



Appendix –II

Issues to be discussed with Director, FNAL by Director, BARC for Fermilab jobs:

Sr. No.	Title/item description	Issue to be discussed
1	325 MHz, 10 kW SSR1 and SSR2 RF power amplifier	Specifications and design documents to be confirmed.
2	650 MHz couplers, 120 kW max.	Specifications not available.
3	Cryo module stand, Tuners, Cryostat parts and supports etc for 325 MHz	Specifications not available.
4	Establishment of Engineering Data Management system in India based on Teamcenter software, server hardware and network infrastructure.	<ol style="list-style-type: none"> 1. Procurement of software to be done through FNAL. For this purpose a Draft supplement to Addendum MOU VIII is sent to FNAL. Comments awaited. 2. Specification of the hardware needs to be provided by FNAL.
5	SSR1 Solenoid Magnets (included corrector coils)	Specifications awaited
6	Super conducting Solenoid Magnets	Specifications awaited
7	650 MHz Magnets warm and superconducting	Specifications awaited
8	Beam Position Monitoring System – Sensor and electronics	Specifications awaited
9	Beam loss monitoring system	Specifications awaited
10	Low level RF (LLRF) system	Specifications awaited
11	Timing system	Specifications awaited
12	<ol style="list-style-type: none"> 1. Control System Software 2. General purpose Data Acquisition Software 3. Machine Protection System 4. Vacuum Control System 5. Water system controls 6. Motion control system 	<p style="text-align: center;"><u>Following are awaited:</u></p> <ul style="list-style-type: none"> • System Requirements Document • Interface Requirement Specifications • Quality assurance plans • Acceptance Criteria • List of Free issue items • Standards, Certification

		<p>requirements</p> <ul style="list-style-type: none"> • Software tools, packages i.e. EPICS, Control System Studio, data communication protocols to be identified. • Inputs about Hardware platform and software tools to be used for deploying control
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Items to be supplied by FNAL, USA for Feed Cap & End Cap

Sr.No.	Description	Needed by
1	Temperature Sensors	Dec 14
2	Finned Tubes	Jul 15
3	Shock Monitors (for shipping)	Mar 15
4	Gasket (E-600)	Feb 15