



# PIP-II Perspective on the Indian Institutions & Fermilab Collaboration (IIFC)

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DOE Independent Project Review of PIP-II

15 November 2016

# What are we trying to achieve?

## “Total Project Collaboration”

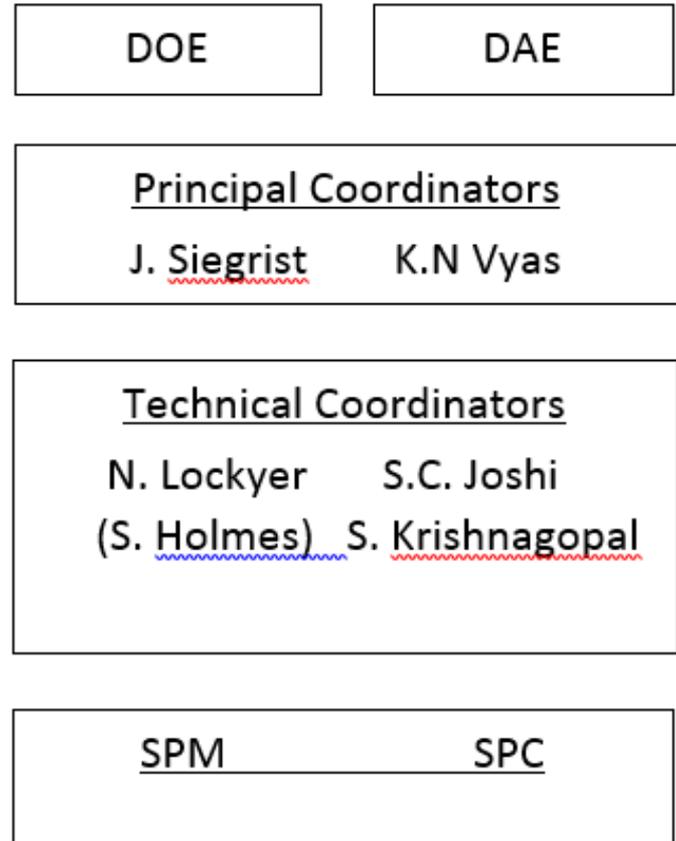
- R&D Phase
  - Develop capabilities, infrastructure, and working relationships at Fermilab and DAE labs, and allied vendors, that will support construction of the PIP-II linac
  - Develop capabilities and infrastructure in DAE labs and allied vendors that will support successful construction of high intensity proton accelerators in India
- PIP-II Construction Phase
  - Construct and commission PIP-II with a significant India/DAE in-kind contribution, and significant engagement of DAE staff
  - India/DAE contribution supports a very significant reduction in the cost to DOE of the PIP-II Project
  - In-kind contribution requires a successful R&D phase
- Many challenges
  - Success requires consistent attention and guidance from management
    - But not micromanagement
  - Constructive interaction at the technical level is essential in making this work

# Outline

- Organization
- Mapping IIFC onto PIP-II
- Challenges
- Moving Forward

# IIFC Organization

- Scope and deliverables schedule for R&D phase are governed by the Joint R&D document
  - Signed by S. Basu and J. Siegrist
- High level management via two Principal Coordinators, supported by two Technical Coordinators
  - TC weekly teleconference
- Technical integration of work via Fermilab SPMs and Indian SPCs
  - SPM/SPC weekly teleconferences
- Semi-annual meetings initiated
  - January/July 2016 (both at BARC)



# SPC/SPM Assignments

## IIFC SPC/SPM Assignments 10/1/16

Sub-Project	Indian-DAE Sub-Project Coordinator	Fermilab Sub-Project Manager
Accelerator Physics	S. Krishnagopal, BARC	Valeri Lebedev
Ion Source	P. Roychowdhary, BARC	Alexander Shemyakin
RFQ	S V L S Rao, BARC	Alexander Shemyakin
LEBT/MEBT (Magnets)	Gopal Joshi, BARC	Stoyan E. Stoynev
Beam Dump	Jose V Mathew, BARC	Alexander Shemyakin
SSR1 Cavity Design	P. N. Prakash, IUAC	Leonardo Ristori
SSR2 Cavity Design	S. Krishnagopal, BARC	Leonardo Ristori
SSR1 + SSR2 Cavity Manufacture	Vinay Mishra, BARC	Leonardo Ristori
SSR Cryomodule	Vinay Mishra, BARC	Leonardo Ristori
650 MHz, $\beta = 0.61$ Dressed Cavity	Sumit Som, VECC	Tom Nicol
650 MHz, $\beta = 0.92$ Dressed Cavity	Avinash Puntambekar, RRCAT	Tom Nicol
650 MHz Cryomodule	Prashant Khare, RRCAT	Tom Nicol
Instrumentation	Gopal Joshi, BARC	Vic Scarpine
Accelerator Controls	Gopal Joshi, BARC	Jim Patrick
Solid State RF 325 MHz	Manjiri Pande, BARC	Jim Steimel
Solid State RF 650 MHz	Mahendra Lad, RRCAT	Jim Steimel
325 MHz RF Coupler	Rajesh Kumar, BARC	Leonardo Ristori
650 MHz RF Coupler	Rajesh Kumar, BARC	Tom Nicol
RF Protection Interlock	Gopal Joshi, BARC	Peter Prieto
Low Level RF	Gopal Joshi, BARC	Brian Chase
Cryogenic Plant and Distribution	Mukesh Goel, BARC	Arkadiy Klebaner
SRF Infrastructure	Satish Joshi, RRCAT	Allan Rowe
Vertical Test Stand	Satish Joshi, RRCAT	Alex Melnychuk
Horizontal Test Stand	Pradeep Kush, RRCAT	Joe Ozelis
HTS-2 Control Electronics	Pravin Fatnani, RRCAT	Joe Ozelis
650 MHz Cryomodule Test Stand	Vinay Mishra, BARC	Mike White
Team Center/Database	C S R Murthy, BARC	Tony Metz

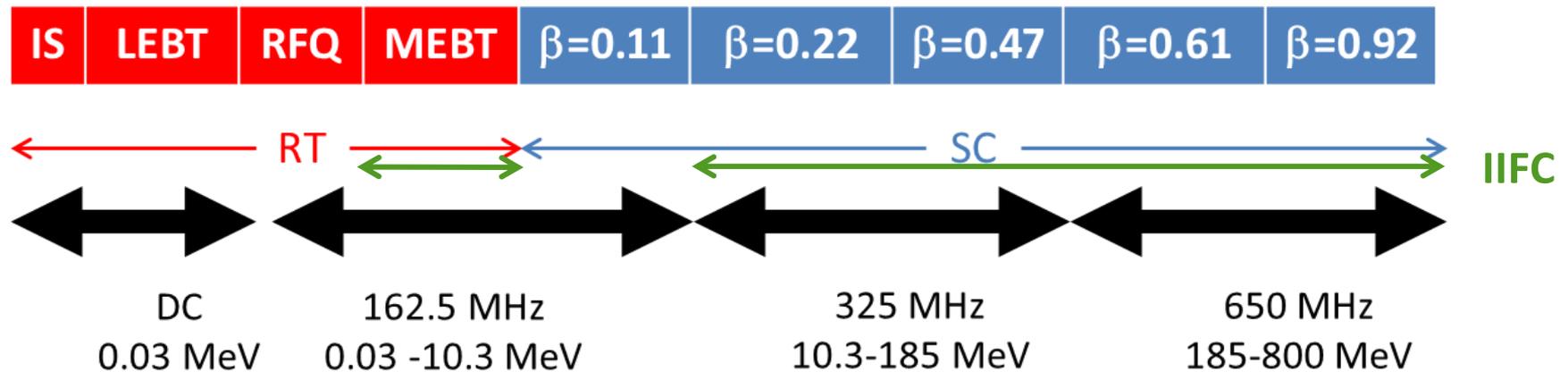
- Current SPM/SPC assignments
- Generally all are engineers or scientists
- Within Fermilab SPMs are typically level 3 managers within PIP-II Project

# Mapping IIFC onto PIP-II/Strategy

- Mapping based on consideration of:
  - DAE technology interests
  - PIP-II risk mitigation strategies
- R&D phase scope of work reflects vision of construction phase deliverables
  - Development and testing of prototypes
  - Development of infrastructure
  - Engineering documentation
- DAE interests
  - Primary interest is acquiring capabilities, intellectual and physical, to construct high power proton accelerators domestically
  - Result: DAE is engaged in all critical systems
- PIP-II interests/risk mitigation
  - All DOE projects are required to mitigate risks: technical and cost
  - Primary mechanisms for technically demanding components:
    - Multiple suppliers
    - Project host lab serves as “general contractor”

# Mapping IIFC onto PIP-II

- The DAE laboratories are completely integrated into nearly all aspects of the PIP-II superconducting linac



- Areas of collaborative development include:
  - Superconducting radio frequency accelerating modules
  - Radio frequency power sources
  - Radio frequency controls
  - Super- and normal-conducting magnets
  - Cryogenic Plant
  - Beam diagnostics
  - Controls

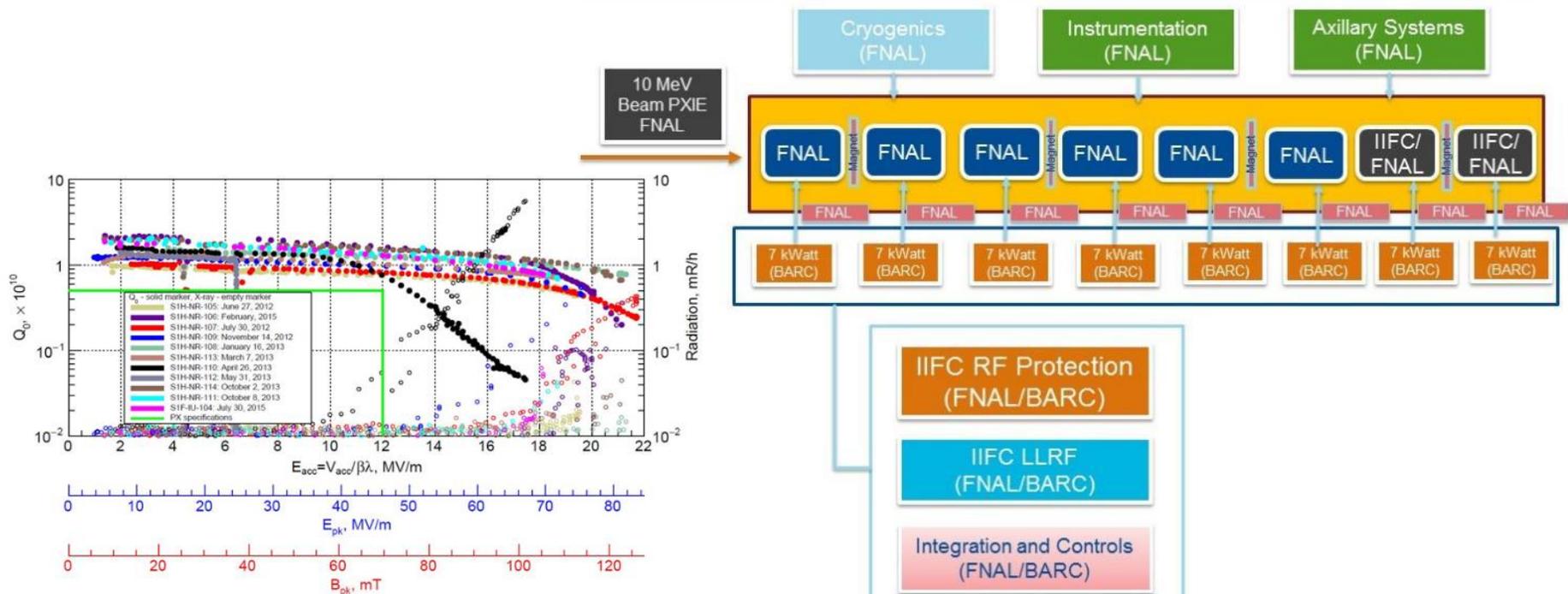
# Mapping IIFC onto PIP-II/Major IIFC Deliverables

System/Component	R&D Deliverable	Construction Deliverable*
SSR1	2 dressed cavities	NA
SSR2	2 dressed cavities	✓
LB650	2 dressed cavities	✓
HB650	4 dressed cavities	✓
SC solenoids	4 magnets (SSR2)	✓
Warm magnets	All PIP2IT/MEBT magnets 2 focusing magnets (650)	✓
RF Power Sources/325	9 sources (SSR1)	✓
RF Power Sources/650	7 sources (HB650)	✓
LLRF/RFPI	4 systems (SSR1, 2xHTS-2, CMTF)	✓
HTS-2	2 test stands (FNAL & RRCAT)	
LHe Cryoplant		✓

\* Scope to be agreed between DAE and DOE at CD-2

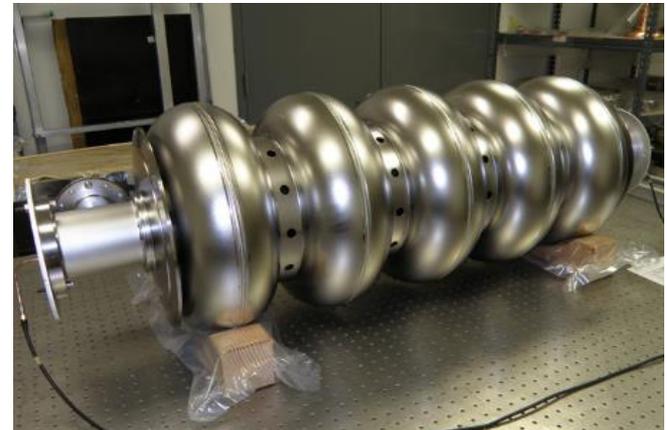
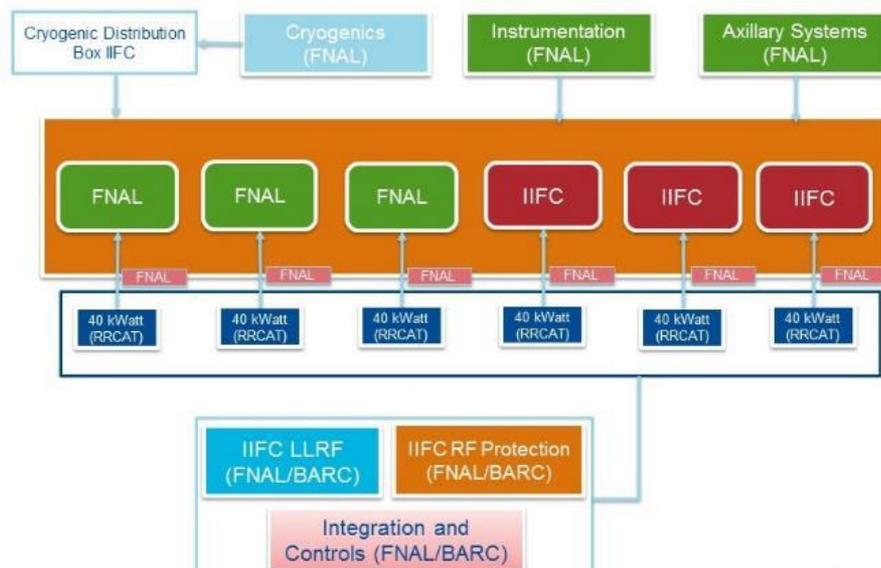
# Integrated Systems Tests/SSR1 (w/beam)

- SSR1 cryomodule under development by IIFC
  - Install in PIP2IT
  - Plan: 6 U.S. cavities + 2 (successfully tested) Indian cavities
  - RF sources from India (8 x 325 MHz, 7 kW)
  - Goal: Late 2018



# Integrated Systems Tests/HB650 (w/ RF)

- HB650 MHz Prototype Cryomodule
  - 3 U.S. + 3 Indian cavities (RRCAT)
  - Test at full RF power (CMTS)
    - RF sources from RRCAT (650 MHz, 40 kW)
    - LLRF and RF Protection (BARC w/Fermilab)
  - Goal: Early 2020



# Challenges

- PIP-II, as far as I am aware, is the first attempt by DOE to construct a domestic accelerator incorporating international in-kind contributions
  - Creates a set of generic challenges in how to organize and manage
  - India creates a number of specific challenges...
- Conducting a collaboration between institutions separated by 11 time zones and 8000 miles
  - Communications/information flow
  - Visits
  - Equipment exchange
- Export regulations and Third-part IP
  - India is classified as a “sensitive country” with BARC subject to special scrutiny
- Differences in engineering and management cultures also need to be recognized
  - Many discussions on what “design” means
  - Control of documentation
  - (Fermilab processes codified in Fermilab Engineering Manual)

# Moving Forward

- Most important: Establish and maintain confidence among the partners
  - In process...
- Several things have been particularly successful (my opinion)
  - FRS/TRS
    - Establish the basic requirements, including interfaces to other systems
    - Generally involve significant discussion and iteration
    - Signed off by both Fermilab and DAE lab
  - Guest engineers/scientists
    - Our goal for these visits is to provide an experience that is both professionally and personally fulfilling
    - 7 engineers/scientists at Fermilab for 2-year residencies
      - Augmented by a set of shorter term (1-3 months) visitors
    - Provide direct support to efforts at Fermilab
    - Provide interface to home laboratories
    - Upon return will be in unique position to facilitate interactions between Fermilab and DAE labs as well as carrying home knowledge & experience
  - Weekly teleconferences
    - SPM/SPC
    - TC/TC
  - These elements form a strong basis for moving forward

# Moving Forward

- Areas requiring management attention:
  - Management of shared engineering documentation
  - Horizontal Test Stand
    - Preparing for identical test stands at Fermilab and RRCAT
  - Cryoplant
    - Very long lead item
  - Export licensing
    - Involves multiple agency interactions: Dept of Commerce, DOE
  - Intellectual Property
    - Especially third-party
  - DAE Chairman's Report (March 2017)
    - Review of R&D progress and extension to 2020
  - Prioritization in face of resource limitations
  - SPC/SPM interactions
    - This is the foundation of everything we do together

# Summary

- IIFC has been going for seven years
- Interactions have picked up considerably over the last two years, and deliverables are starting to arrive at Fermilab
  - In most cases these meet requirements
- The approach to requirements and specifications has been formalized
  - Jointly developed and jointly approved
- Communications have improved over the last two years, both at the SPM/SPC and higher levels
- DAE staff at Fermilab for extended visits have had significant positive impact
- Challenges remain, but both sides are committed to making this work

# Backups