



Overview of 650MHz Test Stand and Results of PDR

Jerry Leibfritz

650 CTL FDR

September 24, 2020

A Partnership of:

US/DOE

India/DAE

Italy/INFN

UK/UKRI-STFC

France/CEA, CNRS/IN2P3

Poland/WUST



Introduction

- **Welcome** to the Final Design Review for the PIP2IT 650MHz Test Stand intermediate cryo transfer line (650 CTL FDR)
- Review Committee
 - **Bill Soyars** – Committee Chair - APS-TD Cryogenic Dept
 - **Mike White** – APS-TD Cryogenic Dept
 - **Jay Theilacker** – ASP-TD Cryogenic Dept

Project Team

- 650 CTL Project Team
 - ***Jerry Leibfritz*** – Review Coordinator - L2/L3M for PIP2IT Infrastructure (including the 650MHz Test Stand)
 - ***Ben Hansen*** – L4M for Cryo infrastructure at PIP2IT
 - ***Joe Hurd*** – Lead Cryo Engineer for the 650 CTL
 - ***Steve Wesseln*** – Designer for PIP2IT infrastructure
 - ***Clark Reid*** – Designer for 650 CTL
 - ***Jeremiah Holzbauer/Alex Martinez*** - PIP-II Technical Integration Team – oversight and guidance of PIP-II review process

Review Charge

- The PIP2IT 650 MHz Test Stand Intermediate Cryo Transfer Line Final Design Review (650 CTL FDR) is an independent evaluation of the final design of the new intermediate cryogenic transfer line that is needed to tie the existing PIP2IT cryo transfer line (CTL) to the 650 MHz cryomodules that will be tested in the PIP2IT cave. The review committee is requested to assess/answer the following questions:
 - *Is the 650 CTL design and its associated documentation at the final design level (~90% maturity)?*
 - *Is the design consistent with system and project requirements, as defined by the System Design Plan document deliverables list for this review?*
 - *Have the recommendations from the PDR been addressed?*
 - *Is the level of design sufficiently mature to proceed with the completion/release of final drawings, purchasing of materials, and fabrication of components?*
- The committee is requested to provide a final written report within 14 days of the 650 CTL FDR that addresses the specific charge questions, along with a list of any findings, comments, and recommendations to be addressed prior to the procurement/fabrication stage of the project.

Agenda

PIP2IT 650 MHz test stand CTL - FDR 📄

📅 Thursday Sep 24, 2020, 8:30 AM → 2:20 PM US/Central

📍 zoom meeting

zoom meeting

Description Review of the final design of the new cryogenic transfer line for testing 650 MHz cryomodules at PIP2IT

📎 650 CTL FDR Charg... 650 CTL FDR Revi... 3D Models - CTL 3D Models - CTL support stand

3D Model - Work Platform CTL Drawings False Floor and U-tube example drawings

PIP-II Project Level Reference documents SDP Document Deliverables

Jerry Leibfritz ✉️ Leibfritz@fnal.gov ☎️ 630-391-0319

8:30 AM → 8:45 AM **Introduction** ⌚ 15m 📄

Welcome & Logistics ⌚ 5m 📄

Speaker: Jerry Leibfritz (Fermilab)

PIP-II Review Guidance ⌚ 5m 📄

Speaker: Alex Martinez (Fermi National Accelerator Laboratory)

📄 PIP-II_Review_Introduc... 📄 PIP-II Review Introduc...

Perspective from Cryo Dept. ⌚ 5m 📄

Speaker: Benjamin Hansen

8:45 AM → 9:05 AM **Overview of 650 Test Stand and Results of PDR** ⌚ 20m 📄

Speaker: Jerry Leibfritz (Fermilab)

📄 PIP-II 650 CTL FDR... 📄 PIP-II 650 CTL FDR...

9:05 AM → 10:05 AM **650 CTL Final Design** ⌚ 1h 📄

Speaker: Joe Hurd

📄 650 CTL FDR.pdf 📄 650 CTL FDR.pptx

10:05 AM → 10:15 AM **Break** ⌚ 10m 📄

10:15 AM → 11:00 AM **Questions/Discussion** ⌚ 45m 📄

11:00 AM → 2:00 PM **Executive Session** ⌚ 3h 📄

2:00 PM → 2:20 PM **Closeout** ⌚ 20m 📄

Speaker: Bill Soyars (Fermilab AD/Cryo)

System Design Plan (SDP) Deliverables

- FDR SDP Deliverables List ([Project Level Ref. doc#6](#))

14-Aug-20	TI-733950	FDR- PIP2IT modifications for 650 MHz test stand and associated cryo transferline modifications
9/24/20		Requirements
		L3 Functional Requirements Specification for PIP2IT Test Infrastructure
		Interfaces
		Master Interface Control Document (PIP2IT Test Infrastructure Items)
		Interface Specification Document from 650 MHz HPRF
		Interface Specification Document from HB650 CM
		Risk & Safety
		Failure Mode Effect Analysis (FMEA) of CTL
		Prevention through Design Table for CTL
		Final ODH Calculations
		Project Documents
		Updated Schedule for 650 MHz CM Test Stand
		Resolution of all PDR review recommendations
		Design
		Final 3D Models of all CTL Components; 100% released drawings complete of all CTL systems
		Final P&ID
		Final Relief Calculations
		Approved System/Sub-System Engineering Calculations and Engineering Notes for CTL
		Procurement/Production/Installation
		Final QA/QC Plan for CTL
		Procurement Discussion with the Buyer
		CTL Installation and Validation Plan



Documents

PIP2IT 650 MHz test stand CTL - FDR

Thursday Sep 24, 2020, 8:30 AM → 2:20 PM US/Central

zoom meeting

5. Reference Documents

Table 1 – The below documents are PIP-II Project Level documents provided for reference and are not under review

1	PIP-II Technical Review Plan – TC ED0008163
2	PIP-II Quality Assurance Plan DocDB # 142
3	PIP-II Systems Engineering Management Plan – TC ED0008164
4	PIP-II IESH Management Plan DocDB # 141
5	PIP-II Value Engineering Plan DocDB # 2830
6	PIP-II Linac Install and Comm System Design Plan – TC ED0010553

Table 2 - Document Deliverables for this review from the System Design Plan

Document Title	Reference	Status	Comments
Requirements & Interfaces			
01 L3 Functional Requirements Specification for PIP2IT Test Infrastructure (FRS)	ED0001223	Released	These are the PIP-II requirements and interface documents used to guide the requirements for PIP2IT, including the 650 Test Stand. These documents are provided for reference and are not planned to be presented at this review.
02 Master Interface Control Document (ICD)	ED0010433	Released	
03 Interface Specification Document 650MHz RF Distribution	ED0012144	Released	
04 Interface Specification Document HB650 Cryomodule	ED0007562	Released	
05 Interface Specification Document LB650 Cryomodule	ED0007561	Prelim.	
Risk and Safety			
06 FMEA (and V&I List) for CTL	ED0012597	Final	Pending review at FDR
07 Prevention through Design (PtD) Table for CTL	ED0012596	Final	Pending review at FDR
08 ODH Calculations	Posted on Indico site	Final	Will be added to TC when ODH note (EN02827) is updated
Project Documents			
09 Schedule for 650 MHz Test Stand	PIP-II P6	Baseline	High level summary of P6 included in talks
10 PDR Review Response - including resolution of recommendations	Posted on Indico site	Final	Pending review at FDR

Description Review of the final design of the new cryogenic transfer line for testing 650 MHz cryomodules at PIP2IT

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3:45 AM Introduction

Welcome & Logistics
Speaker: Jerry Leibfritz (Fermilab)

PIP-II Review Guidance
Speaker: Alex Martinez (Fermi National Accelerator Laboratory)

Perspective from Cryo Dept.
Speaker: Benjamin Hansen

3:05 AM Overview of 650 Test Stand and Results of PDR
Speaker: Jerry Leibfritz (Fermilab)

10:05 AM 650 CTL Final Design
Speaker: Joe Hurd

10:15 AM Break

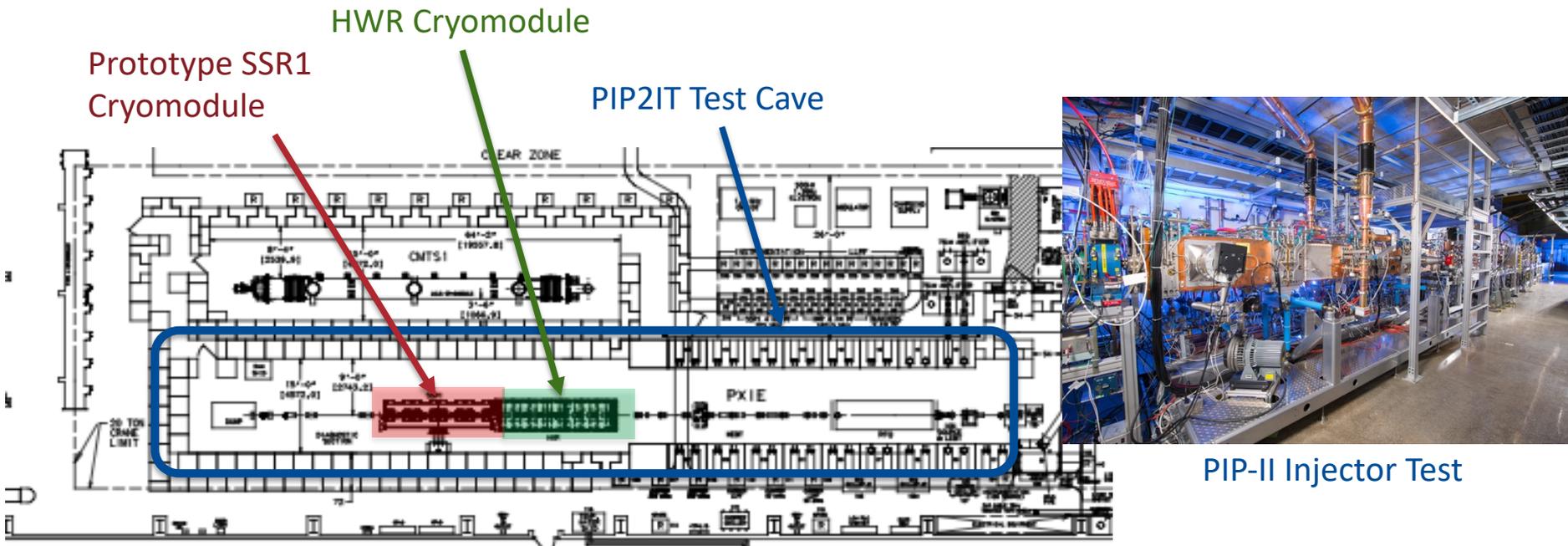
11:00 AM Questions/Discussion

- 1-ED0008163 PIP-II_Technical_R...
- 2-PIP-II QA Plan _ Dec 2019 v4.0
- 3-ED0008164 PIP-II Systems Eng...
- 4-PIP II IESH Management Plan C...
- 5-PIP-II Value Engineering Plan_2...
- 6-ED0010553 PIP-II Linac Install...
- 01-ED0001223--FRS_PIP2IT Rev B.3...
- 02-ED0010433 PIP-II Consolidated IC...
- 03 - PIP2IT 650MHz RF Distribution L...
- 04-ED0007562 ISD - HB650 CM.pdf
- 05-ED0007561 ICD-LB650 CM.pdf
- 06-650 MHz CTL V&I list (FMEA).xlsx
- 07-650MHz CTL Prevention through ...
- 08-PIP2IT ODH analysis calculations...
- 09-TI-650MHz P6 schedule.pdf
- 10-Review Response of 650 CTL PDR...
- 13-PIP2IT_CRYO_PID_F10042546_65...
- 14-650MHz CTL Flexibility and Relief...
- 15-650MHz CTL Flexibility and Relief...
- 16.1-FESHM 5034 650 CTL Pressure ...
- 16-650MHz CTL Piping note.doc
- 17-PIP-II Quality Control Plan - 650 C...
- 18.1-Schedule:Validation Plan HB650...
- 18-Schedule:Validation Plan HB650 C...
- 19-HB650 U-tube Insertion and Isolati...
- 20-650 CTL EAC_Risk_Assessment...



Overview – PIP2IT

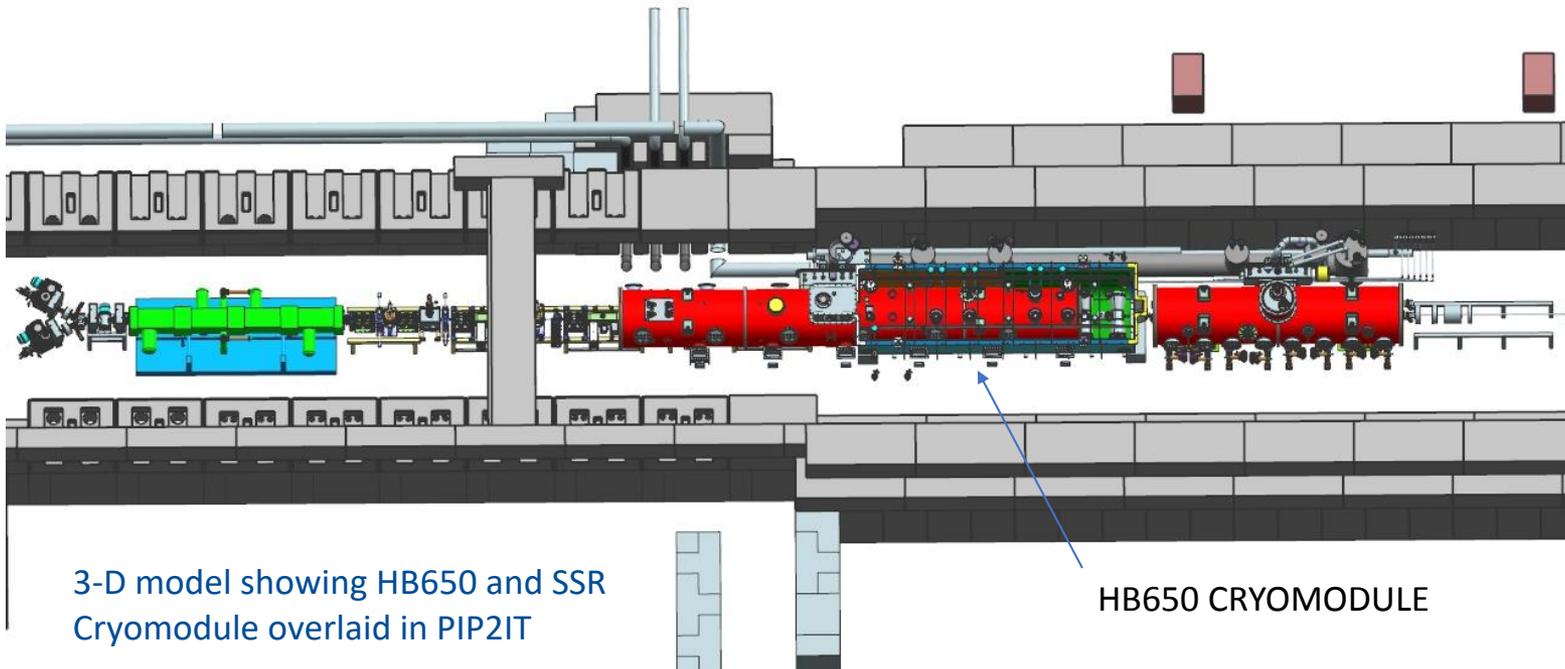
- PIP2IT (PIP-II Injector Test)
 - Near full-scale test of the PIP-II front-end with beam (located at CMTF)
 - The first two PIP-II cryomodules: Half Wave Resonator (HWR) and prototype SSR1 will be tested in PIP2IT as part of front-end test



PIP-II Injector Test

650 MHz Cryomodule Test Stand

- After beam testing is complete (FY21), **PIP2IT is converted into two cryomodule test stands for testing 650 MHz & SSR cryomodules (without beam)**

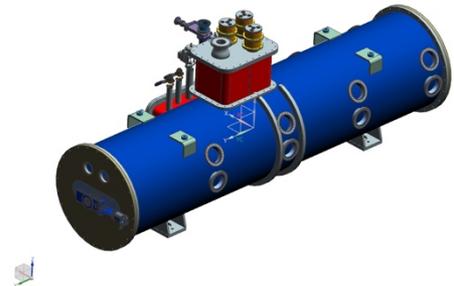
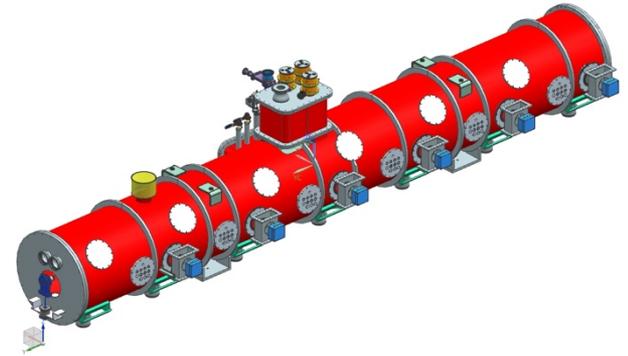


3-D model showing HB650 and SSR Cryomodule overlaid in PIP2IT

HB650 CRYOMODULE

650 MHz Cryomodule Testing

- HB650 Cryomodule (6-cavity)
 - (4) HB650 CM's will be tested
 - 1st one arrives for testing Aug 2021
 - HB650 CM has recently completed their Final Design Review
 - This review will focus on the HB650
- LB650 Cryomodule (4-cavity)
 - (9) LB650 CM's will be tested
 - 1st one arrives for testing Oct 2022
 - LB650 CM design is being worked on
 - Interfaces being negotiated, plan is for cryogenic interfaces to be essentially identical
 - We will plan (budget) for a second set of u-tubes in case there are slight geometric differences (does not affect this review)



PIP2IT 650 Test Stand Modifications

- Several infrastructure/system modifications to PIP2IT are required for the 650 Test Stand
 - Responsibility for design of many of the modifications falls under other PIP-II sub-systems
 - Removal of PIP2IT beamline and cryomodules – *Linac Installation*
 - Installation of new stands (in procurement – *Linac Installation*)
 - New RF Amplifiers and RF distribution – *HPRF*
 - Vacuum systems (already exist, just need to be re-located) – *Vacuum*
 - Controls, LLRF, Instrumentation, etc. – *Accelerator Systems*



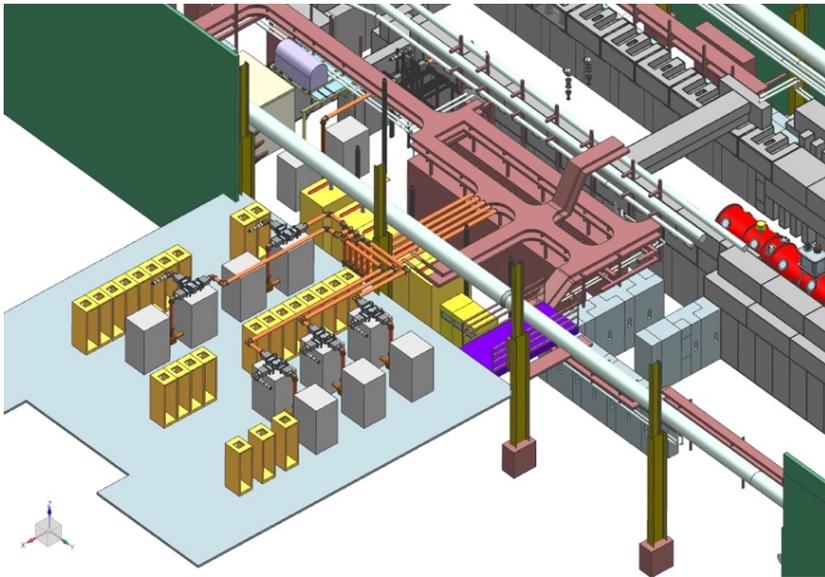
Cryomodule Stands



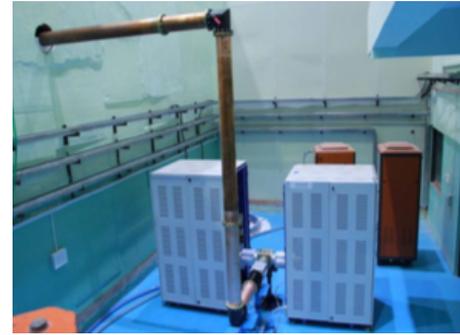
RF Amplifiers - India

Example of HPRF design effort for 650 Test Stand

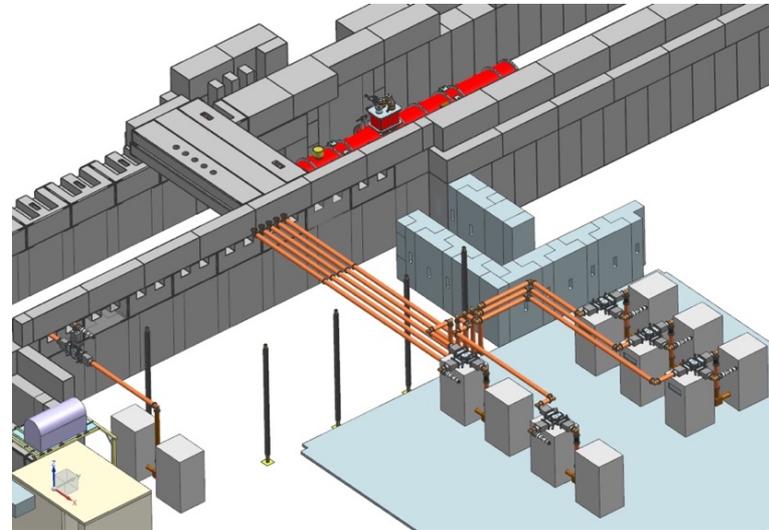
- RF amplifier and distribution modeling and layout
- FDR took place in August 2020



3-D Models of 650 MHz
RF amplifiers and RF
distribution at PIP2IT

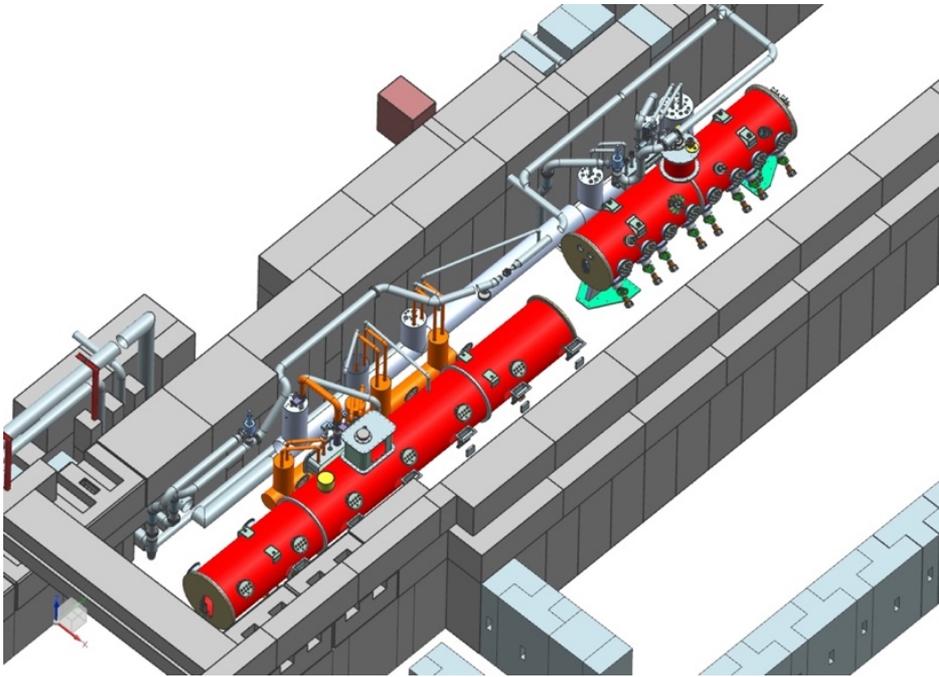


RF amplifier
from India



650 Test Stand Modifications

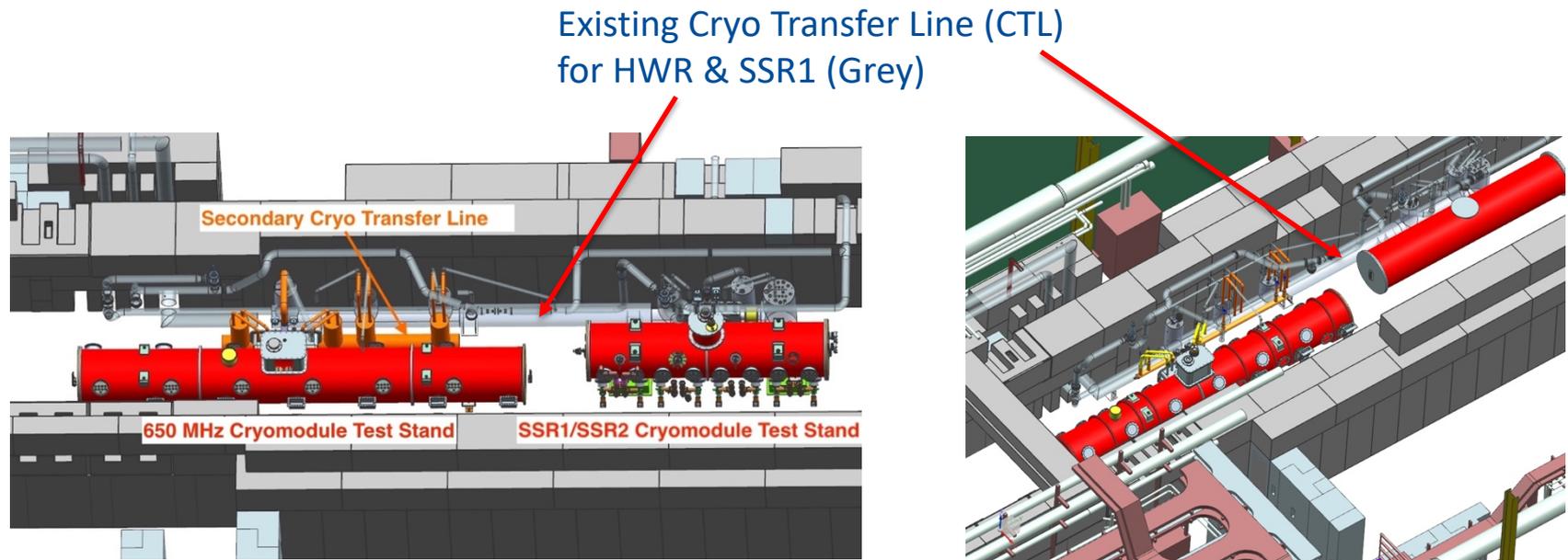
- Modifications that are responsibility of Test Infrastructure
 - Electrical and mechanical infrastructure & utilities
 - Integration and installation support of all sub-systems
 - *Cryogenic Transfer Line – This Review*



3-D Model of 650 MHz
and SSR cryomodule test
stands

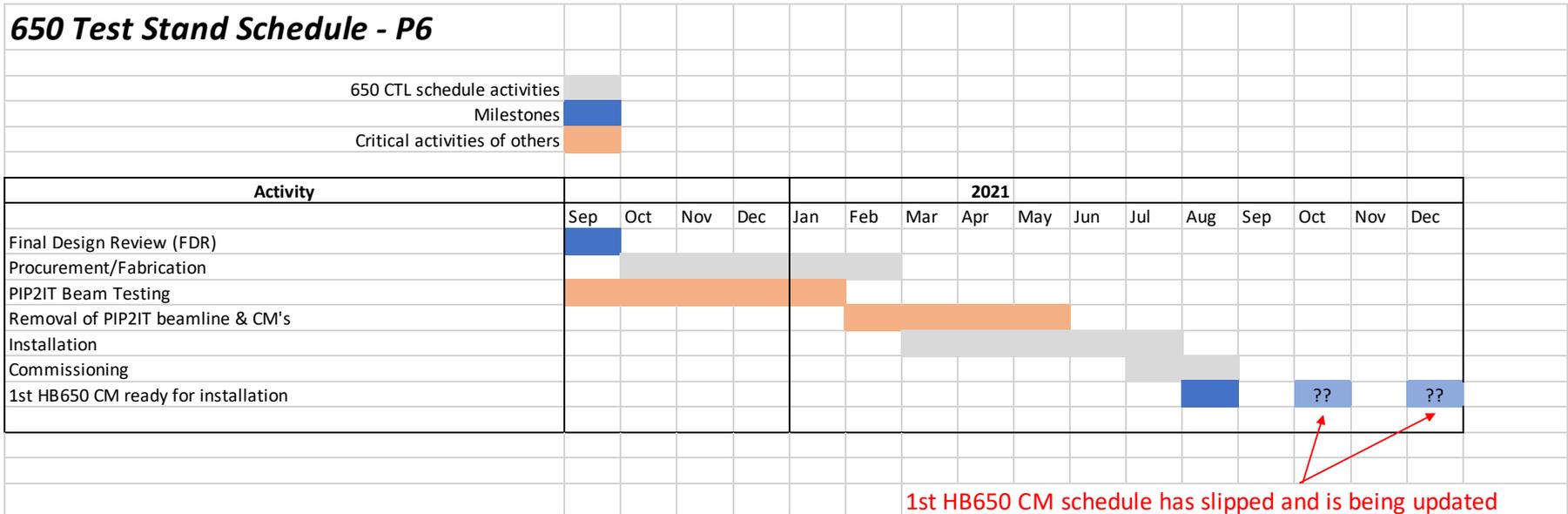
650 Intermediate Cryo Transfer Line (650 CTL)

- The existing CTL was designed for the HWR cryomodule and does not mate up directly with the 650MHz cryomodules
- A secondary or “intermediate” CTL was designed to tie the existing CTL to the 650 cryomodule – *Joe’s talk*



Conceptual model of 650 Test Stand showing intermediate CTL (orange)

Schedule



- 650 Test Stand P6 Baseline Schedule
 - Procurement/Fabrication – 5 months
 - Installation – 5 months
 - Ready for 1st CM installation in Aug. (CM now delayed until Oct. or Dec?)
- 650 CTL schedule fits well within the baseline schedule
 - Completion (System ready for cooldown – end of July)
 - Push out of CM delivery adds additional cushion to CTL schedule

Preliminary Design Review (PDR)

- Held on April 22nd
- Same Review Committee
- 7 Recommendations - detailed in the [Review Response form \(SDP doc#10\)](#)

PIP-II Review Response

Recommendation	Response	Action Item	Schedule to Complete Action	Responsible Party	Status	Completion Date	Evidence of Completion	
1	Add vacuum parallel plate by the FDR. Make sure location good for u-tube pulls. Make sure stands and platform do not interfere.	Will be done in Final Design phase	Add parallel plate relief and verify it is in a safe location	Prior to FDR	J. Hurd	Completed	8/7/20	3D model and drawings presented at FDR (F10126703)
2	Finish preliminary helium relief requirements by the FDR. Apply this to size the relieve valves.	Will be done in Final Design phase	Complete relief calculations and size reliefs appropriately	Prior to FDR	J. Hurd	Completed	8/12/20	Relief calculations presented at FDR. Will be part of Engineering Note EN04344
3	Develop preliminary design for CTL supports and platforms necessary for U-tube installation/removal by the FDR.	Will be done in Final Design phase	Design CTL support and access platform as required	Prior to FDR	J. Hurd	Completed	9/1/20	3D models of preliminary designs of CTL supports and work platform presented at FDR
4	Develop preliminary procedure for isolation, depressurization, and U-tube installation/removal by the FDR. Verify that technicians have sufficient access to perform all steps in the procedure.	Will be done in Final Design phase	Develop u-tube installation/removal procedure	Prior to FDR	J. Hurd	Completed	8/30/20	Presented at FDR (ED0012574)
5	Check tolerance specifications and investigate U-tube design to ensure that a common U-tube set can be used for all cryomodules by the FDR.	Will be done in Final Design phase	Verify CM tolerances and design u-tube interface accordingly	Prior to FDR	J. Hurd/J. Leibfritz	In-Process		Tolerance specification for 650 cryomodule bayonets is still in process. This effort is being led by A. Dalesandro of the PIP-II Technical Integration group
6	Consider a means to ensure that a flex hose is not overstressed should a spider hang up by the FDR.	Will be done in Final Design phase	Finalize design of flex hoses and look at failure scenarios	Prior to FDR	J. Hurd	Completed	8/17/20	CTL Flexibility analysis presented at FDR. Will be part of Engineering Note EN04344. Line length of the flex hoses can take the entire length of pipe contraction
7	Consider lowering the elevation of the horizontal section of the CTL toward the floor to help simplify the CTL stand and to allow a platform over it to make U-tube access easier by the FDR.	Will be done in Final Design phase	Optimize location of CTL in cave (vertically and laterally) for access and functionality	Prior to FDR	J. Hurd/J. Leibfritz	Completed	9/1/20	3D models of CTL location (vertically and laterally) and preliminary design of CTL work platform presented at FDR
8								



PDR Recommendations

- 1 - Add vacuum parallel plate by the FDR. Make sure location good for u-tube pulls. Make sure stands and platform do not interfere.
 - Included in Joe's presentation and (drawings/3D models)
- 2 - Finish preliminary helium relief requirements by the FDR. Apply this to size the relieve valves.
 - Included in Joe's presentation and (SDP doc#14)
- 3 - Develop preliminary design for CTL supports and platforms necessary for U-tube installation/ removal by the FDR.
 - Included in Joe's presentation and (drawings/3D models)

PDR Recommendations

- 4 - Develop preliminary procedure for isolation, depressurization, and U-tube installation/removal by the FDR. Verify that technicians have sufficient access to perform all steps in the procedure.
 - Included in Joe's presentation and (SDP doc#19 & 3D models)
- 5 - Check tolerance specifications and investigate U-tube design to ensure that a common U-tube set can be used for all cryomodules by the FDR.
 - Discussed in Joe's presentation

PDR Recommendations

- 6 - Consider a means to ensure that a flex hose is not overstressed should a spider hang up by the FDR.
 - Included in Joe's presentation and (SDP doc#15)
- 7 - Consider lowering the elevation of the horizontal section of the CTL toward the floor to help simplify the CTL stand and to allow a platform over it to make U-tube access easier by the FDR.
 - Included in Joe's presentation and (drawings/3D models)

Summary

- PIP2IT will be converted into two cryomodule test stands after beam testing is complete - the first will be the 650MHz test stand
- Several infrastructure modifications are necessary to accommodate the 650 test stand – including the addition of an “intermediate cryogenic transfer line”
- A PDR of the 650 CTL design was held in April
- We believe the design is now at a final stage, all recommendations from the PDR have been addressed, and we are ready to begin procurement/fabrication
- We look forward to your evaluation, comments, and recommendations

- Thank You!