121.06 – Requirements Flow Down

S. Dixon, Level 2 Manager

DOE CD-2/3a Independent Project Review

SC4 – Conventional Facilities

January 29, 2020

A Partnership of:

US/DOE

India/DAE

Italy/INFN

UK/UKRI-STFC

France/CEA, CNRS/IN2P3

Poland/WUST

About Me

- PIP-II Level 2 Manager for Conventional Facilities
- Relevant Experience
  - Licensed Architect;
  - Project Management Professional (PMP);
  - LEED Accredited Professional;
  - 27+ years at Fermilab;
  - NOvA Project L2 Manager for Site and Buildings;
    - 2014 CD-4
    - 2015 U.S. DOE Secretary's Award for Excellence
  - General Plant Project Manager for 17+ years
    - Short Baseline Neutrino (SBN) Near Detector Building;
    - Short Baseline Neutrino (SBN) Far Detector Building;
    - Experimental Operations Center;

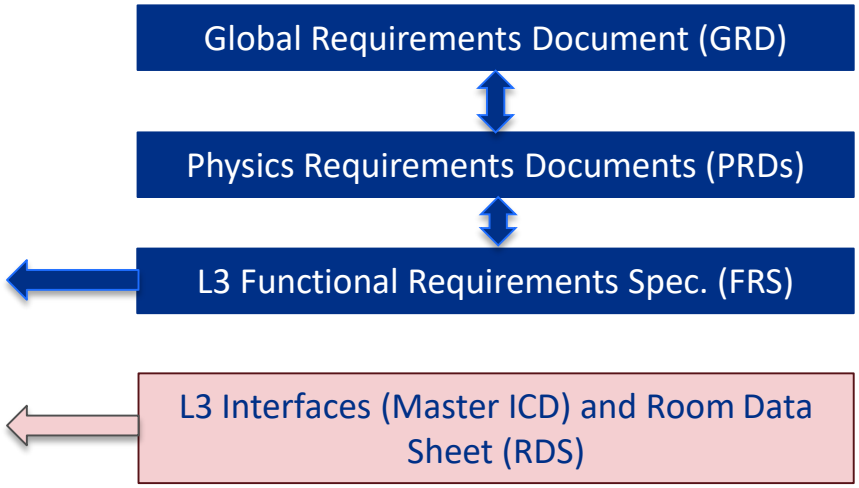
Outline

- Performance Requirements
- Technical Requirements
- Interfaces
- Space Allocation
- CAD Flow Down to CF
- Summary

1. Does the proposed technical design satisfy the performance requirements? Do the Key Performance Parameters (KPP's) provide a satisfactory indication of the project's completeness?
2. Are the interfaces to the existing accelerator complex identified and defined? Do the planned hardware upgrades to the existing complex fully support the ultimate performance goal of 1.2 MW operation of the complex?
3. Is the resource-loaded schedule complete, consistent and credible so that it can serve as the cost and schedule part of the project's performance baseline? Is it compatible with the funding guidance provided by High Energy Physics? Have the project's risks been fully analyzed and accounted for in the contingency estimate?
4. Is the project team properly staffed with individuals that have the required skills to deliver the proposed technical scope within the baseline budget and schedule?
5. In-kind international contributions are described in bi-lateral agreements called Project Planning Documents (PPD's). Does the project baseline and in-kind scope contributions defined in the PPD's present the complete scope required to meet the KPP's? Are the delivery dates for in-kind scope sufficiently understood to establish the credibility of CD-4 date? Does the Project have a credible plan for managing the deliverables including acceptance, Q/A, and risk management.
6. Does the project have a certified Earned Value Management System and have they demonstrated their ability to utilize it as an effective project management tool?
7. Is the documentation required by DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets* for CD-2 complete and in good order?
8. Are Environment Safety and Health aspects being properly addressed?
9. Has the project responded satisfactorily to the recommendations from the previous independent project review?
10. In regard to CD-3a; is the scope of the 3a package appropriate and justified? Are the associated designs sufficiently mature to support the requested CD-3a cost and schedule? Have the appropriate design reviews been completed?

Performance Requirements

- Requirements flow from the Global Requirements to Physics Requirements to Functional and Technical requirements;
- Requirements are supported by Interfaces and Room Data Sheet;



5 out of 30 L3 FRS's apply to Conventional Facilities (one for each L3 WBS)

104 out of 745 total interfaces involve Conventional Facilities (all interfaces are documented in the PIP-II Master ICD)

Teamcenter documents are located in PIP-II-doc-2492	Site Preparation	Cryogenics Plant Building	Utility Plant	Linac Complex	Booster Connection
	121.06.02	*121.06.03*	*121.06.04*	*121.06.05*	*121.06.06*
Functional Requirement Specification	**ED0006787**	**ED0006718**	**ED0006748**	**ED0008043**	**ED0006794**
	Complete	*Complete*	*Complete*	*Complete*	*Complete*
Technical Requirement Specification	**ED0006789**	**ED0006719**	**ED0006749**	**ED0010906**	**ED0006795**
	Complete	*Complete*	*To Be Updated*	*In Progress*	*To Be Updated*

Technical Requirements

Room Data Sheet [1]

- Information is collected/organized by Linac Installation and Commissioning subproject (F. G. Garcia,121.04)
- Organizes Equipment Requirements:
  - Spatial (size, height, quantity)
  - Electrical (type, voltage, UPS)
  - Cooling (LCW, heat load to air)
  - Cabling
  - Communication
  - Safety issues (electrical, X-Rays, ODH)
  - Estimate Uncertainty
- First Signed Off in January 2019
- Updated in September 2019 based on baseline change requests and transferred management to Technical Integration Team

[1] See Teamcenter document ED0009544 and PIP-II-doc-4408

Technical Requirements – Room Data Sheet

Fermilab

Room Data Sheet
PIP-II

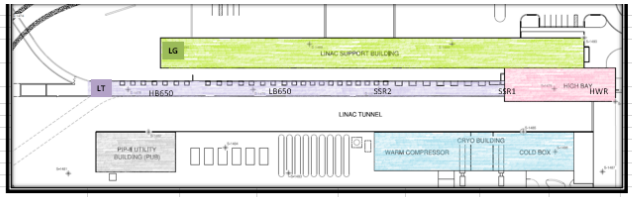
= Denotes missing information
#N/A = These cells are automatically calculated, no input require
= Data cells not applicable

-> Enter only relevant fields for items that take up floor space, require environmental control, cooling water, AC power, a rack, or networking.

-> If equipment does not extend beyond the rack it does not need to be included. Including cables will allow us to determine equipment location based on access to power or networking.

-> If multiple cable types run to the same rack select the least flexible cable type going to the rack and provide the total number of all cables.

-> Columns D-H have a "red triangle" in the right-hand corner -- hoover the mouse over them to view additional information.



Automatic filled out cells **Start Here ↓**

											Design Uncertainty			Spatial Requirements					Floor Requirements			
Identifier	VBS Level 2	VBS ID	VBS Name	Building	Space Designation Location	Sub-System	User Defined Sub-System	Component	Description	Quantity	Level of Design	Source of Requirements	Uncertainty Multiplier	Space Type	Length (in)	Width (in)	Height (in)	Weight (lbs)	Floor Flatness	Vibration	Finishes	H
DM-001	121.03	121.03.07	Controls	LG	LG-BTL	Computers, Front End		Racks	Networking, permits etc.	3	Preliminary	Off the Shelf	5%	Floor	30	24	60				Sealed concrete	65 +/-1
DM-002	121.03	121.03.08	SS	LG	LG-BTL	Interlocks		Racks	ESS interface	1	Preliminary	Off the Shelf	5%	Floor	30	24	36				Sealed concrete	65 +/-1
DM-003	121.3	121.3.06	Controls	F3	BTL-F3 Building	PLC/LCW Controls		Racks, Fittal	Fittal half size cabinet	1	Preliminary	Off the Shelf	5%									
DM-004	121.03	121.03.06	Vacuum	F3	BTL-F3 Building	Ion Pump PS System		Racks	Bulk, Ion pump PS, gauge interface,	2	Preliminary	Off the Shelf	5%	Floor	30	24	60				Sealed concrete	65 +/-1
DM-005	121.03	121.03.09	Instrumentation	LG	LG-BTL	BPM		Racks		2	Preliminary	Prototype-Testing	25%	Floor	30	24	60				Sealed concrete	65 +/-1
DM-006	121.03	121.03.09	Instrumentation	F3	BTL-F3 Building	BPM		Racks		1	Preliminary	Prototype-Testing	25%	Floor	30	24	60				Sealed concrete	65 +/-1
DM-007	121.05	121.05.04	BTLBAL	LG	LG-BTL	Collimator Controls		Racks	will this be needed??	1	Preliminary	Off the Shelf	5%	Floor	30	24	60				Sealed concrete	65 +/-1
DM-008	121.03	121.03.05	Magnets	F3	BTL-F3 Building	Fast Dipole Switch		Racks	Pulse Magnet Power Supply	1	Conceptual	Expert Opinion	50%	Floor	30	24	60				Sealed concrete	65 +/-1
DM-009	121.03	121.03.05	Magnets	LG	LG-BTL Power Supply	Fast Dipole Switch		Cables		8	Preliminary	Prototype-Testing	25%									
DM-010	121.03	121.03.05	Magnets	LG	LG-BTL Power Supply	Fast Dipole Switch		Magnets		1	Conceptual	Expert Opinion	50%									
DM-011	121.03	121.03.05	Magnets	F3	BTL-F3 Building	Magnets, Dipole		Power Supplies	TeV PS	1	Preliminary	Expert Opinion	50%	Floor	60	24	96	3500			Sealed concrete	65 +/-1
DM-012	121.03	121.03.05	Magnets	Booster	Booster	Magnets, Dipole		Power Supplies	125KW Spange PS	2	Preliminary	Off the Shelf	5%	Floor	62	44	89	3500			Sealed concrete	65 +/-1
DM-013	121.03	121.03.05	Magnets	BTL	BTL-Beamline Tunnel	Magnets, Dipole		Cables	Dipole cables	20	Preliminary	Off the Shelf	5%									
DM-014	121.03	121.03.05	Magnets	BTL	BTL-Beamline Tunnel	Magnets, Dipole		Cables	Dipole cables	16	Preliminary	Off the Shelf	5%									
DM-015	121.03	121.03.05	Magnets	F3	BTL-F3 Building	Magnets, Regular Quadrupole		Racks	Quadrupole Power Supplies	3	Preliminary	Off the Shelf	5%	Floor	30	24	90				Sealed concrete	65 +/-1
DM-016	121.03	121.03.05	Magnets	BTL	BTL-Beamline Tunnel	Magnets, Regular Quadrupole		Cables	Quad Cables	32	Conceptual	Off the Shelf	5%									
DM-017	121.03	121.03.05	Magnets	BTL	BTL-Beamline Tunnel	Magnets, Regular Quadrupole		Magnets		57	Conceptual	Prototype-Testing	25%								Sealed concrete	65 +/-1
DM-018	121.03	121.03.05	Magnets	BTL	BTL-Beamline Tunnel	Magnets, Regular Quadrupole		Magnets	Booster inj. C Mag.	1	Preliminary	Prototype-Testing	25%								Sealed concrete	65 +/-1
DM-019	121.03	121.03.05	Magnets	F3	BTL-F3 Building	Magnets, Dipole Corrector		Racks	CE Dipoles	3	Preliminary	Off the Shelf	5%	Floor	30	24	90				Sealed concrete	65 +/-1
DM-020	121.03	121.03.05	Magnets	BTL	BTL-Beamline Tunnel	Magnets, Dipole Corrector		Cables		56	Preliminary	Off the Shelf	5%									
DM-021	121.03	121.03.05	Magnets	BTL	BTL-Beamline Tunnel	Magnets, Dipole Corrector		Magnets		56	Preliminary	Off the Shelf	5%								Sealed concrete	65 +/-1
DM-022	121.05	121.05.04	BTLBAL	BAL Area	BAL-Beam Absorber	RAW Absorber		Pumps	Pumps	1	Preliminary	Prototype-Testing	25%									
DM-023	121.05	121.05.04	BTLBAL	BAL Area	BAL-Beam Absorber	RAW Absorber		Racks	Controls	1	Preliminary	Prototype-Testing	25%									
DM-024	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep- HPRF		Power Amplifiers	SCL SS-70kW style	1	Pre-conceptual	Expert Opinion	50%	Floor	96	134	96					40-95
DM-025	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep-Magnets, Vert. Dip.		Racks	Need 2 vert. dip. corrector (SCL dip.-	1	Pre-conceptual	Expert Opinion	50%	Floor	32	24	96			No		78 +/-5
DM-026	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep-Magnets, Vert. Dip.		Power Supplies	Need 2 vert. dip. corrector (SCL dip.-	2	Pre-conceptual	Expert Opinion	50%									78 +/-5
DM-027	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep-Magnets, Lambertson		Racks	Need 3 (SCL quad-style PS)	1	Pre-conceptual	Expert Opinion	50%	Floor	32	24	96			No		78 +/-5
DM-028	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep-Magnets, Lambertson		Power Supplies	Need 3 (SCL quad-style PS)	3	Pre-conceptual	Expert Opinion	50%									78 +/-5
DM-029	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep-Spang		Power Supplies	75KW Spange PS	5	Preliminary	Off the Shelf	5%	Floor	31.5	24	51	645			Sealed concrete	65 +/-1
DM-030	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep-Magnets, BLQuads		Racks	Need 8 Quad PS - SCL quad-style PS	2	Pre-conceptual	Expert Opinion	50%	Floor	32	24	96			No		78 +/-5
DM-031	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep-Magnets, BLQuads		Power Supplies	Need 8 Quad PS - SCL quad-style PS	8	Pre-conceptual	Expert Opinion	50%									78 +/-5
DM-032	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep-BLVac		Racks	Rack Contains all Ion Pump Controllers,	1	Pre-conceptual	Expert Opinion	50%	Floor	24	32	96					78 +/-
DM-033	N/A	N/A	Upgrades	LG	LG-Upgrade	RFSep-BLVac		Power Supplies		1	Final	Off the Shelf	5%	Rack Mounted								

Interfaces

Interfaces

Charge #2

- Interfaces are defined and controlled at the following levels:
  - PIP-II to Fermilab Accelerator Complex;
  - L3 to L3;
  - Partner interfaces (Partner to Fermilab, Partner to Partner);
  - Any level at the discretion of the L2M (Design Authority).
- Single database ➔ Master ICD (MICD) - 746 interfaces;
- All interfaces are managed utilizing Teamcenter® workflow. Integration Coordinator manages the database;
- Periodic Master ICD self-assessment by L3MS is conducted;
- Integration Coordinator releases updates to MICD monthly;
- PIP-II Interface Management Plan is documented
  - Teamcenter® document ED0007942 (PIP-II-doc-3232)

From A. Klebaner's Plenary talk

Interfaces

Fermi National Accelerator Laboratory

Fermilab

PIP-II Interface Management Plan

Document number: ED0007942

Document Approval

Signatures Required	Date Approved
Originator: Integration Team	Approved in Teamcenter
Approver: Alex Martinez, Integration Coordinator	Approved in Teamcenter
Approver: Allan Rowe, Project Engineer	Approved in Teamcenter
Approver: Arkadiy Klebaner, Technical Director	Approved in Teamcenter

Revision History

Revision	Date of Release	Description of Change
-	7/12/2019	Initial Release

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Note that the Integration Coordinator may determine that the requested interface change exceeds a certain threshold as described in the PIP-II Configuration Management Plan [7] which requires referral to the Design Change Board (DCB) for further action. These are typically changes that impact technical scope across multiple L2 systems, impact cost and/or schedule or exceeds a monetary threshold.

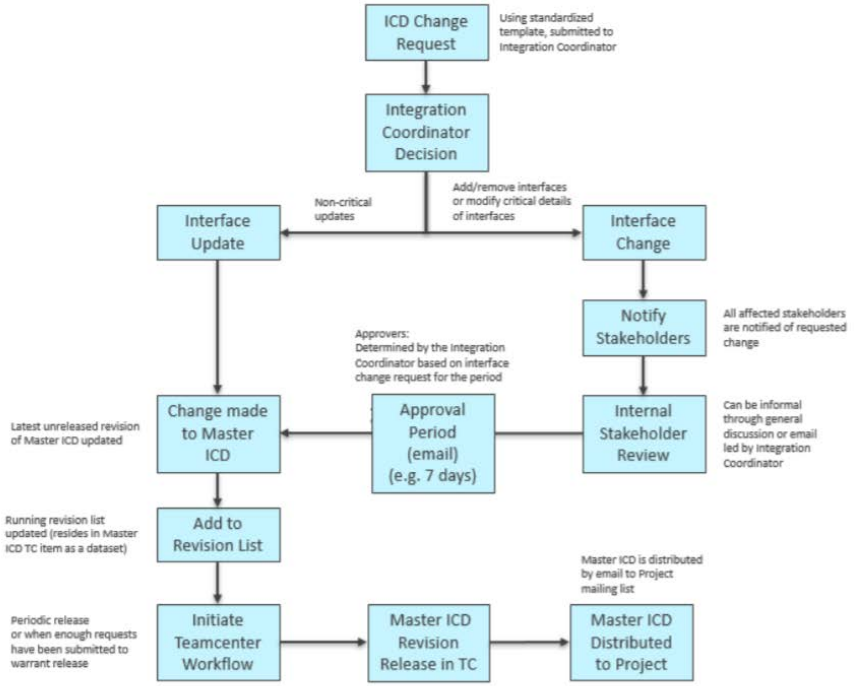


Figure 8-1. Interface Management Flow Chart

8.2. Interface Update

Since an Interface Update consists of a non-critical update to an interface, the update is made directly to the Master ICD document and the change noted on the Revision List. No additional stakeholders need

Interface Management Plan – Teamcenter ED0007942 and PIP-II-doc-3232

PIP-II

Interfaces

PIP-II Master Interface Control Document (ICD) List

Warning: This ICD is subject to change. The current version is maintained in Teamcenter (ED0010433).

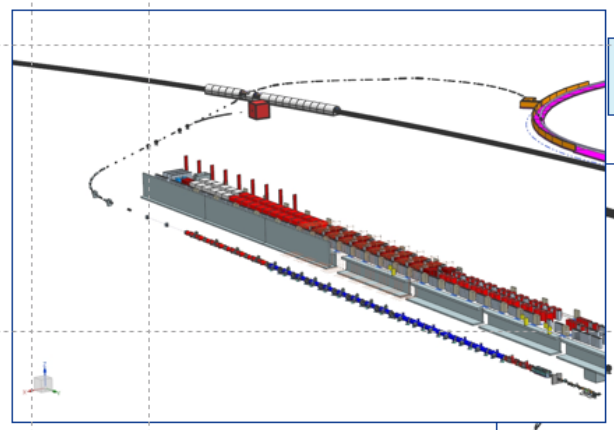
Search Criteria				
Enter Search Criteria using yellow drop down box * includes all entries	System A WBS	System B WBS	Integrator WBS	749 ←←← Number of entries satisfying this search criteria.
	121.6.05 Cmplx	*121.6.05 Cmplx*	*121.6.05 Cmplx*	

Unique L3-L3 ID	Interface #	Interface ID	Interface Name	Interface Requirements Description	Requirements Clarification	Verification Method	System A WBS	System A Scope	System B WBS	System B Scope	Inte
1764	001	1764-001	HWR CM cryogenic process piping (CPP)	Cryogenic process piping (CPP) shall connect the HWR to the CDS to deliver helium cryogenic cooling to various HWR Cryomodule process circuits as required. CPP also includes insulating vacuum with vacuum barriers, alignment and installation of CPP, and acceptance testing	HSIB shall connect the HWR to the CDS to deliver helium cryogenic cooling to various HWR Cryomodule circuits as required. The interface consists of a cryogenic bayonet connection for each of the cryogenic circuits , pressure gauges and LHe level probes	Inspection; Demonstration; Measurement; Analysis	121.2.02 HWR	HWR shall specify helium operating and design parameter requirements at the interface; CDS and HWR shall define geometry, location, and alignment requirements of connections	121.2.06 CDS	CDS shall provide interconnect U-tubes to HWR Cryomodule bayonets for each process circuit, and supply helium to HWR requirements.	121.
1764	002	1764-002	HWR CM warm helium piping	HWR requires helium vent headers for CM relief devices and purge and mixing helium for helium guard and warm-up	The interface consists of a relief system connected to the HWR.	Inspection; Measurement; Analysis	121.2.02 HWR	HWR shall specify helium purge gas and pressure safety requirements for CM devices, and supply appropriately sized relief piping within the CM and external connections to CDS warm helium headers	121.2.06 CDS	CDS shall size relieving system based on pressure safety requirements specified by HWR, and supply relief devices and headers which mate to the CM external connections	121.
1764	003	1764-003	HWR Cryogenic Controls	The CDS cryogenic control system shall integrate HWR CM devices and provide controls and signal readback for HWR instrumentation and heaters and interface with the global control system		Inspection; Demonstration	121.2.02 HWR	HWR shall specify control devices to be included in the CDS cryogenic control system and requisite details for integration into CDS controls	121.2.06 CDS	CDS shall provide the cryogenic control system	121. 121. 121. 121.
1764	005	1764-005	HWR CM Thermometry	HWR CM Thermometry interface shall include information about		Inspection; Demonstration; Measurement	121.2.02 HWR	HWR shall provide specification of	121.2.06 CDS	CDS shall review and approve specifications	121.

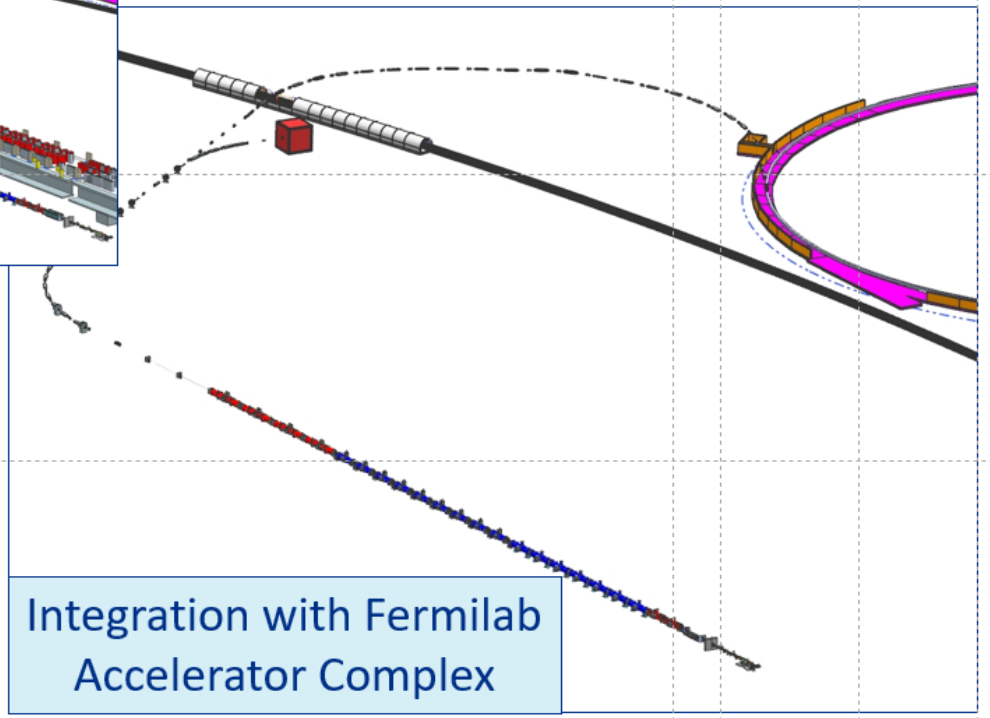
Current version can be found in PIP-II-doc-2492

Space Allocation

Integrated 3-D Model is being utilized



RDS ➔Space Allocation ➔CF Integration



- Automated lattice import implemented;
- Date exchange procedure with lattice and Conventional Facility is documented;
- Coordinated by the Integration Coordinator, Installation L3, and Conv Fac L2 Manager.

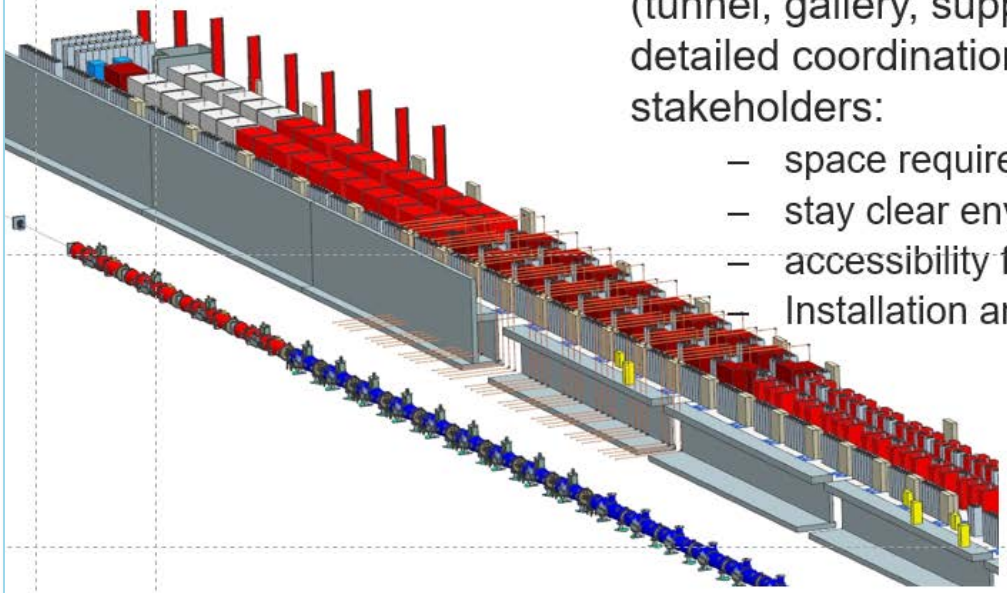
Integration with Fermilab Accelerator Complex

From A. Klebaner's Plenary talk

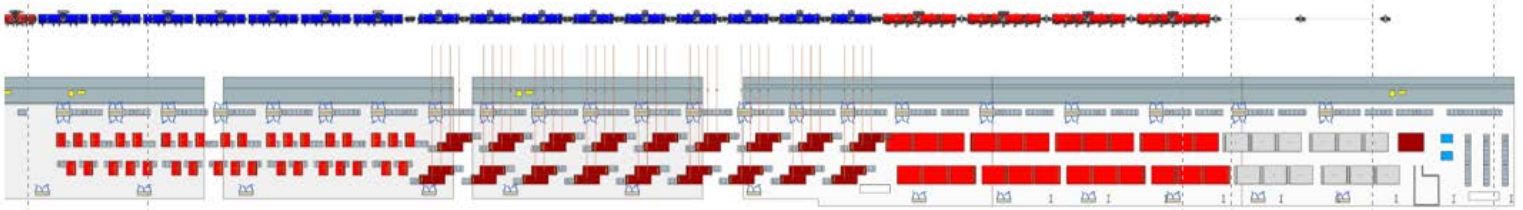
Space Allocation

Space Allocation

- Allocation of space within the Linac Complex (tunnel, gallery, support buildings, etc.) requires detailed coordination between the various stakeholders:
  - space requirements;
  - stay clear envelopes;
  - accessibility for egress;
  - Installation and maintenance.

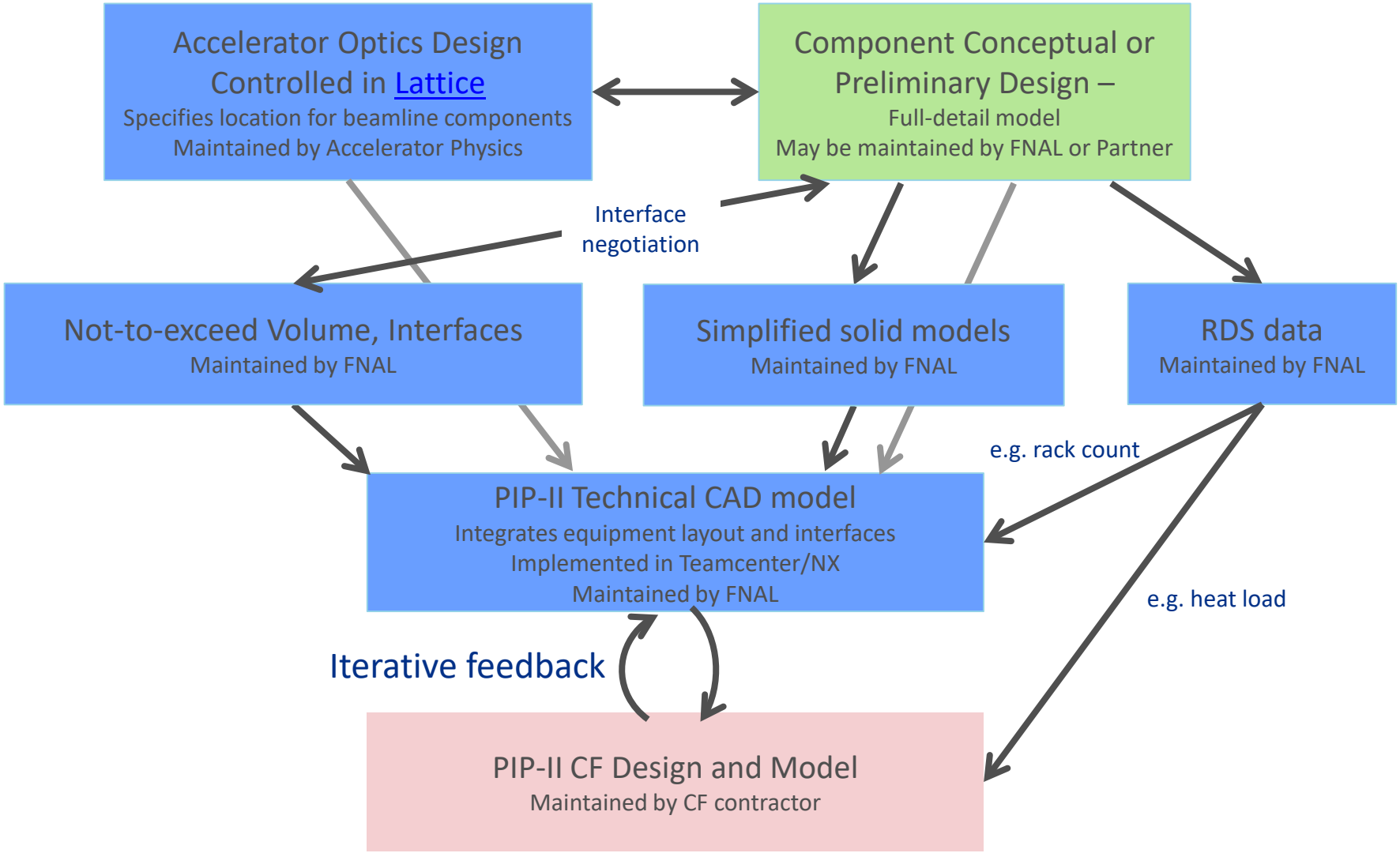


Managed by Integration Coordinator, L3 Installation, and L2M Conv Fac



From A. Klebaner's Plenary talk

CAD flowdown to CF



CAD flowdown to CF

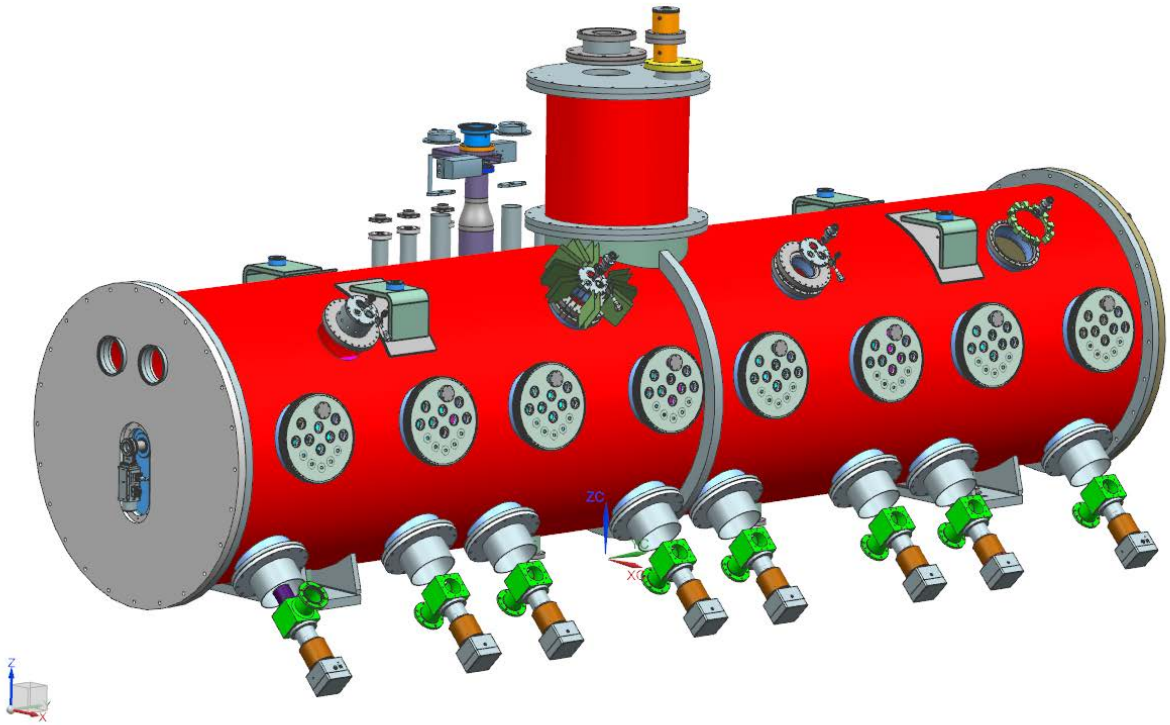
Accelerator Optics Design
Controlled in Lattice
Specifies location for beamline components
Maintained by Accelerator Phys

Component Conceptual or
Preliminary Design –
Full-detail model
May be maintained by FNAL or Partner

Interface

Not-to

ata
by FNAL



CAD flowdown to CF

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Interface

Not-to-exceed Volume, Interfaces
Maintained by FNAL

PIP-II T
Integrates eq
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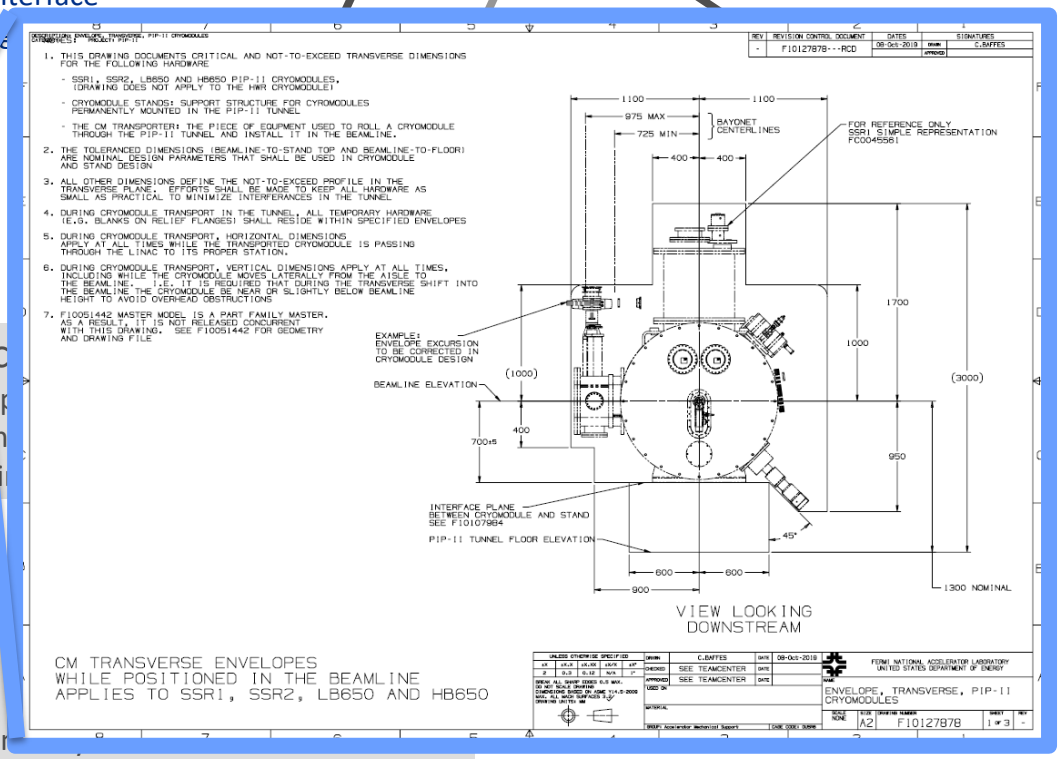
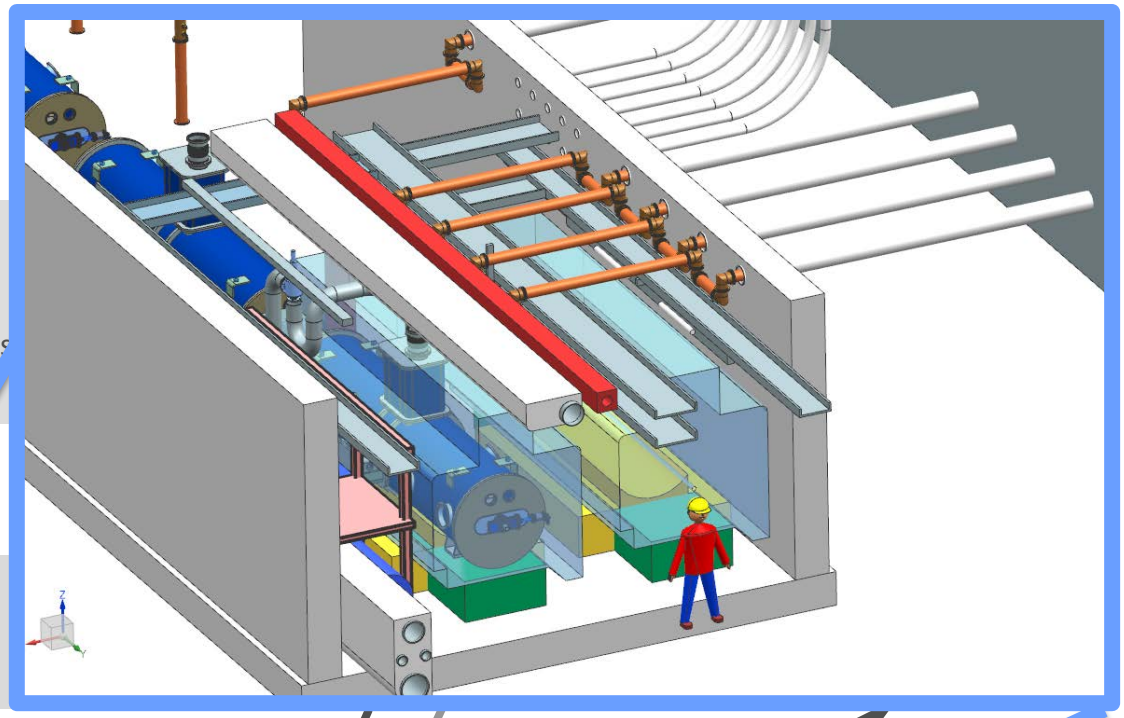
Iterative feedback

PIP-II CF
Maintai



CAD flowdown to CF



Accelerator Optics Design
Controlled in Lattice
Specifies location for beamline components
Maintained by Accelerator Physics

Not-to-exceed Volume, Interfaces
Maintained by FNAL

PIP-II Technical CAD model
Integrates equipment layout and interfaces
Implemented in Teamcenter/NX
Maintained by FNAL

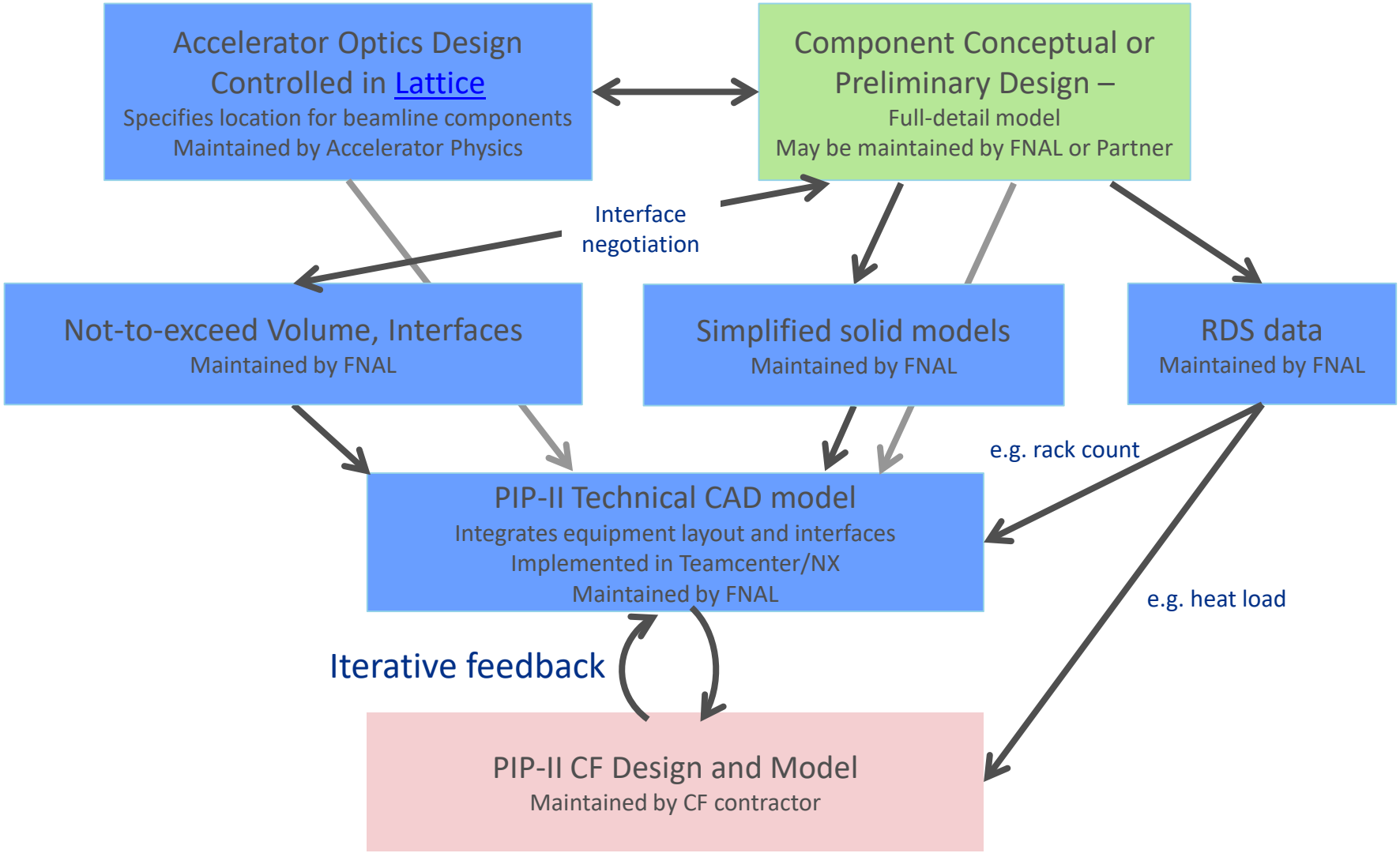
e.g. rack count

e.g. heat load

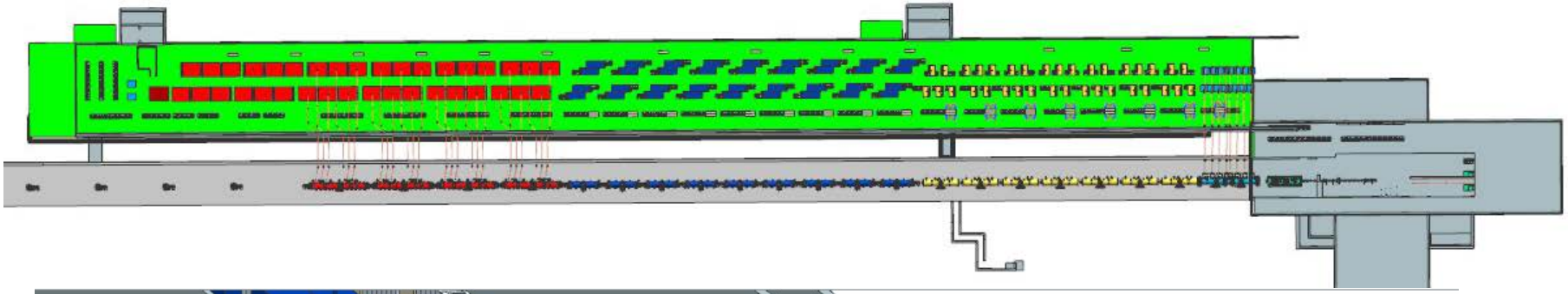
Iterative feedback

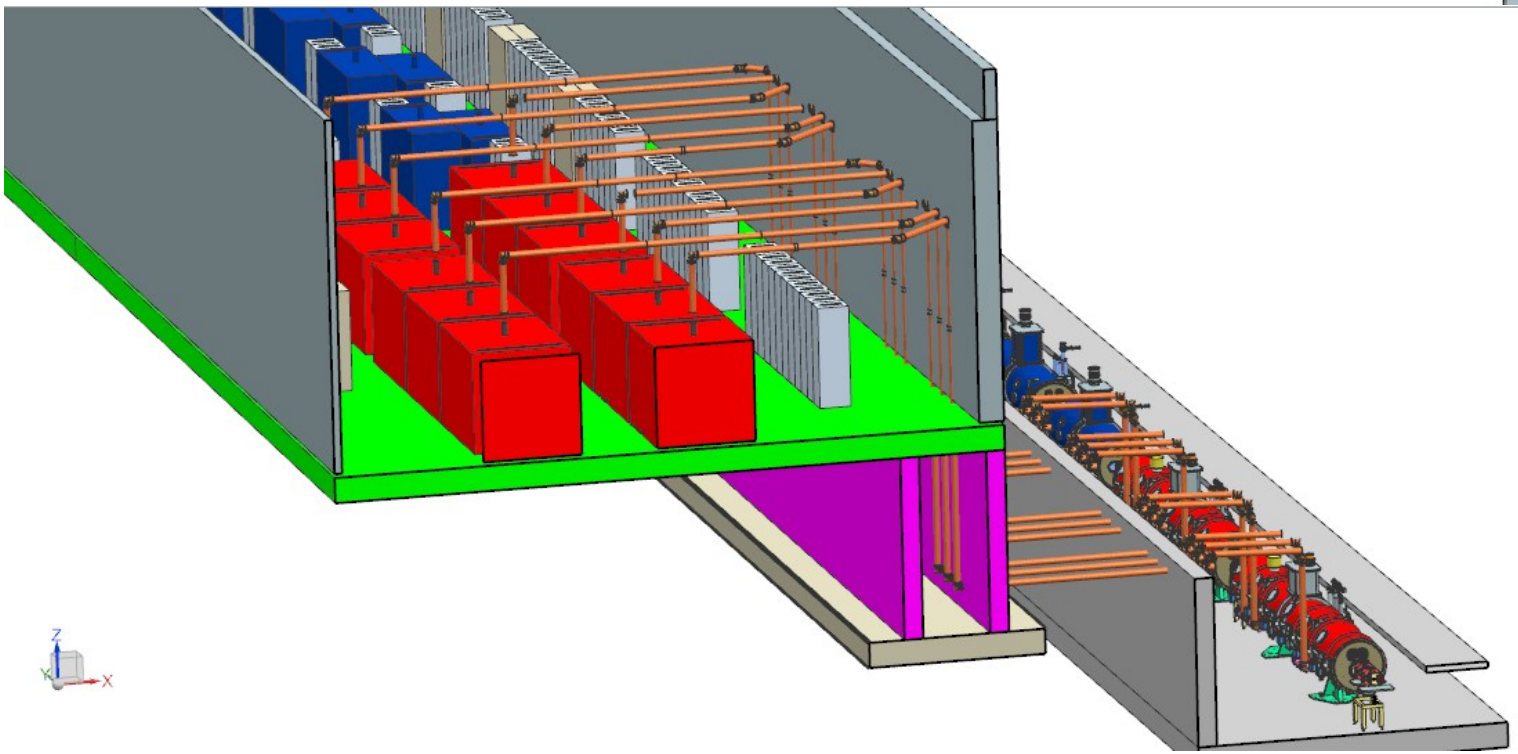
PIP-II CF Design and Model
Maintained by CF contractor

CAD flowdown to CF



Example





Summary

- Room Data Sheets provides the technical requirements
- CAD model integration provides the spatial configuration of technical components
- Interface control manages connections to other systems

- Processes in place for:
  - Configuration control of Room Data Sheets
  - Transfer of CAD model to CF
  - Interface control