



PIP-II BTL Workshop – Design Status

Overview

Lidija Kokoska

BTL Workshop

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PIP-II is a partnership of:

US/DOE

India/DAE

Italy/INFN

UK/STFC-UKRI

France/CEA, CNRS/IN2P3

Poland/WUST



Overview

- BTL Sub-Systems Overview
- Design Maturity by Sub-System
- BTL Interfaces
- Key Integration Activities Required

BTL Sub-Systems Overview

System
Accelerator Systems
Vacuum
MagPS
Beam Instrumentation
LI&C
Building Infrastructure
Linac Installation (<i>CAD Integration</i>)*
Accelerator Complex Upgrades
Transfer Line/Beam Absorbers
BTL Installation
Booster
Conventional Facilities
Booster Connection
<i>*Not a design review, but critical milestone for integration activities</i>

Design Maturity by Sub-System

System	PDR	FDR	PRR
Accelerator Systems			
Vacuum	✓	Feb-23	Feb-23
MagPS	-	-	-
<i>Dipoles</i>	-	-	✓
<i>Special Magnets</i>	-	-	✓
<i>Quads & Correctors</i>	-	-	Aug-24
Beam Instrumentation	✓	Oct-23	Jul-23
LI&C			
Building Infrastructure	-	-	-
<i>Electrical</i>	✓	✓	✓
<i>Mechanical</i>	✓	✓	Feb-23
Linac Installation (<i>CAD Integration</i>)*		Apr-24	
Accelerator Complex Upgrades			
Transfer Line/Beam Absorbers	✓	✓	Jun-23
BTL Installation	-	-	-
<i>Stands</i>	-	Jan-24	Jan-24
<i>Installation Plan Ready*</i>		Nov-23	
Booster	Jan-24	Mar-25	Apr-23
Conventional Facilities			
Booster Connection	✓	Dec-24	Mar-25
<i>*Not a design review, but critical milestone for integration activities</i>			

Summary based on P6 information.

Design Maturity by Sub-System

System	COMPLETED	2023				2024				2025			
		JAN	APR	JUL	OCT	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
Accelerator Systems													
Vacuum	PDR	FDR/PRR											
MagPS													
<i>Dipoles</i>	PRR												
<i>Special Magnets</i>	PRR												
<i>Quads & Correctors</i>								FDR					
Beam Instrumentation	PDR				FDR								
Linac Installation & Commissioning													
Building Infrastructure	-												
<i>Electrical</i>	PDR, FDR, PRR												
<i>Mechanical</i>	PDR, FDR	PRR											
Linac Installation (<i>CAD Integration</i>) *							X						
Accelerator Complex Upgrades													
Transfer Line/Beam Absorbers	PDR, FDR			PRR									
BTL Installation	-												
<i>Stands</i>							FDR/PRR						
<i>Installation Plan Ready*</i>						X							
Booster							PDR				FDR		
Conventional Facilities													
Booster Connection	PDR									FDR		PRR	

*Not a design review, but critical milestone for integration activities

Timeline view based on P6 information.



BTL Interfaces

- Currently have 37 interfaces identified with BTL-Installation as either the System Owner or Integrator (*336 identified for Linac Installation*)+
- L3 system owners to review existing interfaces and identify any new interfaces as final designs are completed
- Detailed interface definitions with drawing/model references required in ISDs.

L3 System # BTL Interfaces	
MagPS	12
BTLI	11
Vac	7
Cntrl	3
BI	3
Bldgl	4
LI	2
TLBA	17
Cmplx	2
BstrC	1
BSTR	6

BTL Interfaces

Interface ID	Interface Name	Interface Requirements Description	System A WBS	System A Scope	System B WBS	System B Scope	Integrator WBS	Integrator Scope
2599-001	BTL Dipole and Quad magnet vacuum beam tube and flanges	The BTL dipoles and quads must be compatible with the vacuum requirements of the beam line and must connect to other devices	121.3.06 Vac	The vacuum WBS needs to define flange sizes and adaptor pipes so that vacuum connections between the magnets and other devices can be made. Vac also needs to define the vacuum requirements	121.3.05 MagPS	MagPS will provide magnets with suitable beam pipes that have the required vacuum properties	121.5.03 BTLI	BTLI will install the magnets and be responsible for connections between magnets and other devices
2599-002	Vacuum interface for BTL specialty magnets	There are four specialty magnets in the BTL that will have unique designs that need to be compatible with the BTL vacuum requirements and systems	121.3.06 Vac	Vac will define the vacuum requirements for these devices and specify beam tube requirements	121.3.05 MagPS	MagPS will provide magnets with beam pipe properties compatible with the vacuum requirements	121.5.03 BTLI	Rinst will be responsible for installing the specialty magnets and for making the vacuum connections
2600-003	Timing signals	The fast switch magnet power supply will need timing signals	121.3.05 MagPS	MagPS will define the requirements for the timing	121.3.07 Cntrl	Controls will supply the appropriate system to deliver the required timing signals	121.5.03 BTLI	Rinst will run the timing cables from the controls system to the power supply
2614-002	Interface with Building Infrastructure to ensure there is adequate water cooling and power for BTL devices	The power supplies in the gallery and the magnets in the Beam Transfer Line will need water cooling and AC power.	121.3.05 MagPS	MagPS will provide estimates of heat loads from BTL power supplies and magnets as well as space requirements for power supplies. MagPS will also specify what devices will need water cooling, how much water will be needed, and what AC power is required for the various power supplies	121.4.04 Bldgl	Bldgl shall be responsible for the design of the water cooling system in the building and tunnel to account for heating due to power supplies and magnets. Bldgl will also be responsible for designing AC distribution and cable trays.	121.5.03 BTLI; 121.6.05 Cmplx	Linac Installation shall install secondary connections for the water cooling and AC power. Cmplx shall install the main supply and return headers for the water cooling system, AC power panels, and cable trays.



BTL Interfaces

Interface ID	Interface Name	Interface Requirements Description	System A WBS	System A Scope	System B WBS	System B Scope	Integrator WBS	Integrator Scope
2627-001	TLBA Magnets and Power Supplies (MagPS)	Magnets and Power Supplies (MagPS) should connect the design of Transfer Line and the Beam Absorber to obtain the specifications of all the magnets, and requirements of the power supplies.	121.5.02 TLBA; 121.3.05 MagPS	TLBA shall give the specification of the magnets and the power supplies and the tolerance of the error range	121.3.05 MagPS	Magnets and Power Supplies (MagPS) should provide all the magnets and the power supplies.	121.5.03 BTLI; 121.3.05 MagPS	rings installation(Rinst) should connect the the design of Transfer Line and the Beam Absorber to make sure to meet all requirements of all the elements (magnets including dipoles, quadrupoles and correctors)
2627-002	Interface with the Transfer Line and Beam Absorber WBS to insure magnet design is compatible with BTL design	This interface is to insure that the final design of the dipole, quad and Specialty magnets meet the requirements of the lattice design. In addition we need to provide to the lattice designers the slot length of the magnets and the transverse dimensions of the magnets	121.5.02 TLBA	TLBA will provide the design and specifications for all magnets in the transfer line	121.3.05 MagPS	MagPS will provide all magnets based on the results of TBLA specifications. In addition MagPS will provide all necessary cabling for installation	121.5.03 BTLI	Rinst will be responsible for installation of the BTL magnets, water connections, cable installation and alignment
2627-003	BTL magnets	Provide Beam Transfer Line magnet components as specified in the lattice	121.5.02 TLBA	TLBA and Rinst will specify field requirements and physical mounting specs	121.3.05 MagPS	MagPS will supply magnets with specified field requirements	121.5.03 BTLI	Rinst will receive, verify and install all BTL magnets and provide stands as needed
2627-004	BAL magnets	Provide Beam Abort Line magnet components as specified in the lattice	121.5.02 TLBA	TLBA and Rinst will specify field requirements and physical mounting specs	121.3.05 MagPS	MagPS will supply magnets with specified field requirements	121.5.03 BTLI	Rinst will receive, verify and install all BAL magnets and provide stands as needed
2628-001	BTL PS cable	Provide cabling and connectors to power the BTL and BAL magnet components	121.3.05 MagPS	MagPS will specify cable requirements based on loads serviced and identify service building termination locations	121.3.05 MagPS; 121.5.03 BTLI	MagPS will supply appropriate cable and identify termination locations	121.5.03 BTLI	Rinst will install cables from pre-determined locations to tunnel components
2628-002	MagPS systems common requirements alignment referencing	MagPS magnets shall come with permanently affixed fiducials. Fiducials shall accept standard 1.5" Dia. SMR balls or SMR nests. Fiducials shall be visible from the beam-right side of the accelerator. Redundant fiducials are encouraged. Adhesive bonded fiducials are discouraged. No magnetic fiducials permitted in close proximity to the beamline.	121.3.05 MagPS	MagPS will define the fiducial arrangement	121.5.03 BTLI	BTLI will install and coordinate alignment of the magnets	121.5.03 BTLI	Fiducials are used by BTLI-Alignment during integration



BTL Interfaces

Interface ID	Interface Name	Interface Requirements Description	System A WBS	System A Scope	System B WBS	System B Scope	Integrator WBS	Integrator Scope
2628-003	MagPS power supply common requirements rigging	MagPS Power Supplies, or any dismountable part thereof bigger than what can be handled by a single individual, shall include rigging interfaces for vertical lifting with a crane as well as forklifting interfaces for lifting with a forklift or pallet jack. All lifting interfaces shall be clearly marked. Rigging components shall satisfy the requirements of the relevant FESHM chapters (e.g. marking of rigging components). All payload weights shall be clearly marked.	121.3.05 MagPS	MagPS will define the design	121.5.03 BTLI	BTLI will provide rigging for the power supplies	121.5.03 BTLI	BTLI will integrate these systems within the PIP2 footprint
2628-004	MagPS magnet requirements rigging	MagPS Magnets shall include rigging interfaces for vertical lifting with a crane, both as a complete unit and as halves or sectors. All lifting interfaces shall be clearly marked. Rigging components shall satisfy the requirements of the relevant FESHM chapters (e.g. marking of rigging components). All payload weights shall be clearly marked.	121.3.05 MagPS	MagPS will define the design	121.5.03 BTLI	BTLI will provide rigging for the magnets	121.5.03 BTLI	BTLI will integrate these systems within the PIP2 footprint
2649-002	BTL Instrumentation	Instrumentation required for the BTL and BAL beam lines	121.3.09 BI	BI will specify the appropriate instrumentation and Vac will assemble and leak check where appropriate	121.3.09 BI; 121.3.06 Vac	BI will supply instrumentation and verify electrical functionality. Vac will leak check and certify components that integrate with the vacuum	121.5.03 BTLI	Rinst will install provided instrumentation including stands where needed
2662-001	Linac/TLBA Interface Gate Valve - delivery	The interface between the Linac and the TLBA shall be a gate valve downstream of the final future-HB650 slot and upstream of the first bend dipole.	121.4.05 LI	All referenced WBSs converge at this interface and share ownership	121.3.06 Vac	Vac provides the gate valve, associated fasteners, underlying structure and pressure restraint	121.4.05 LI; 121.5.03 BTLI	LI performs particle-free assembly upstream of this gate valve. Rinst performs conventional assembly downstream of the gate valve
2672-001	BTL to Booster Connection	Coordinate interface between BTL vacuum and components and Booster injection girder	121.5.04 BSTR	Specify and provide and vacuum interface and isolation valve between the Booster and BTL vacuum sections	121.3.06 Vac	Provide the necessary vacuum components that meet the BTL and Booster vacuum requirements	121.5.04 BSTR; 121.5.03 BTLI	Oversee installation of the vacuum component interface



BTL Interfaces

Interface ID	Interface Name	Interface Requirements Description	System A WBS	System A Scope	System B WBS	System B Scope	Integrator WBS	Integrator Scope
2674-002	TLBA Vacuum (Vac)	Vacumm should connect the design of Transfer Line and the Beam Absorber to obtain the size of the beam pipe.	121.5.02 TLBA;	TLBA shall give the size of beam profile	121.3.06 Vac	Vac should supply the beam pipes and support stands for the elements	121.5.03 BTLI; 121.3.06 Vac	rings installation(Rinst) should connect the the design of Transfer Line and the Beam Absorber to install the stands and beam pipes
2675-001	Linac to BTL Connection	Coordinate interface between Linac particle free vacuum and BTL conventional vacuum	121.5.03 BTLI	Specify and provide and vacuum interface and isolation valve between the Linac and BTL vacuum sections	121.3.06 Vac	Provide the necessary vacuum components that meet the Linac and BTL vacuum requirements	121.4.05 LI; 121.5.03 BTLI	Oversee installation of the vacuum component interface
2720-001	Absorber Instrumentation		121.5.02 TLBA	TLBA shall specify requirements for the absorber instrumentation, and describe layout of electrical pin connections	121.3.07 Cntrl	Cntrl shall review and approve requirements for the absorber instrumentation, provide installation guidance and develop an acceptance testing procedure	121.5.03 BTLI	BTLI and Cntrl shall provide installation support and acceptance testing for the Absorber instrumentation.
2720-002	BTL collimator motor control connections	Interface between BLTA and Controls for connection and readback of BTL collimator motor controls, LVDTs and thermocouples	121.5.02 TLBA	TLBA will specify motor control specifications, LVDT and thermocouple interface details.	121.3.07 Cntrl	Cntrls shall connect motor controls, LVDT and thermocouples to the control system and provide readback/controls based on specifications provided by TLBA.	121.5.03 BTLI	BTLI will provide installation support.
2809-001	TLBA Beam instrumentation	Provide all the instrumentation required to ensure the efficient operation of the Tranfer and Beam Absorber lines.	121.5.02 TLBA; 121.3.09 BI	TLBA shall give the request for the type and the number of beam instruments, and leave enough space in the lattice for the instruments.	121.3.09 BI	Beam Instrument should supply the BPM, Loss monitors, Toriods, beam current monitors, beam profile monitors such as multiwires and emittance measurements devisecs.	121.5.03 BTLI	Rings installation(Rinst) should connect the the design of Transfer Line and the Beam Absorber to install all the beam instruments.



BTL Interfaces

Interface ID	Interface Name	Interface Requirements Description	System A WBS	System A Scope	System B WBS	System B Scope
3259-001	LCW Supply and Return Piping	Bldgl shall provide LCW piping for transfer line magnets	121.5.02 TLBA	121.5.02 TLBA shall define cooling requirements for transfer line magnets	121.4.04 Bldgl	121.4.04 Bldgl shall provide LCW supply and return piping and define pipe size requirements between the main supply and return flanges into the building and the interface flanges for 121.5.02 TLBA
3259-003	Water connection from RAW Skid to the Absorber	This interface details the water connections from the RAW skid to the beam absorber.	121.5.02 TLBA	TLBA shall provide the flow rate, pipe size connections, and pressure requirements for the RAW Skid interface with the Beam Absorber	121.4.04 Bldgl	Bldgl shall design and provide the RAW Skid to the correct specifications to support the Beam Absorber
3260-001	Water connection from RAW Skid to the Absorber	This interface details the water connections from the RAW skid to the beam absorber.	121.5.03 BTLI	BTLI shall provide pipe size connections for the RAW Skid interface with the Beam Absorber	121.4.04 Bldgl	Bldgl shall design and provide the RAW Skid to the correct specifications to support the Beam Absorber
3290-003	TLBA common requirements - geometry and envelope	TLBA shall meet the geometry and interface requirements of the referenced interface specification drawing	121.5.02 TLBA	TLBA will define the geometry of the systems	121.4.05 LI	LI establishes the transverse available space within the tunnel.
3546-001	Connect Transfer Line Vacuum to Booster	Provide the vacuum connection from the Linac Transfer line to the new Booster Injection Region	121.5.04 BSTR	Specify vacuum connection requirements to the new Booster Injection Girder.	121.5.03 BTLI	Connect the Transfer line vacuum to the new Booster Injection Girder
3585-001	BTL component location	Generate lattice coordinates for locating tunnel components	121.5.02 TLBA; 121.5.03 BTLI	TLBA will provide and maintain lattice coordinates in a standard format used by metrology to locate tunnel component	121.5.02 TLBA	TLBA will provide lattice coordinates in a standard format used by metrology to locate tunnel component for initial alignment



BTL Interfaces

Interface ID	Interface Name	Interface Requirements Description	System A WBS	System A Scope	System B WBS	System B Scope
3585-002	BTL Collimators	Design and produce three collimators for BTL line	121.5.02 TLBA; 121.5.03 BTLI	Design three collimators for the BTL	121.5.02 TLBA	Fabricate, test, leak check and deliver three collimators with control cables and identify cable termination locations
3585-003	BAL Absorber	Design and produce the BAL Absorber	121.5.02 TLBA; 121.5.03 BTLI	Design a 25 kW beam absorber	121.5.02 TLBA	Fabricate, test, leak check and deliver a 25 kW beam absorber
3585-004	Linac straight-ahead absorber beamline - delivery	TLBA shall deliver and Rinst shall install all hardware in the tunnel downstream of the Linac/TLBA Interface gate valve, including the straight-ahead commissioning beamline and dump	121.5.02 TLBA	TLBA owns this design	121.5.02 TLBA; 121.5.03 BTLI	TLBA delivers the hardware
3585-005	TLBA common requirements - rigging	TLBA components, or any dismountable part thereof bigger than what can be handled by a single individual, shall include rigging interfaces for vertical lifting with a crane and/or forklifting interfaces for lifting with a forklift or pallet jack. All lifting interfaces shall be clearly marked. Rigging components shall satisfy the requirements of the relevant FESHM chapters (e.g. marking of rigging components). All payload weights shall be clearly marked.	121.5.02 TLBA	TLBA will define the design	121.5.02 TLBA; 121.5.03 BTLI	TLBA will provide the rigging interfaces
3597-001	Beam Absorber	The Beam Transfer Line portion of the Linac Complex shall accommodate the beam absorber	121.5.02 TLBA; 121.6.05 Cmplx	Determine the spatial and installation requirements for the beam absorber	121.6.05 Cmplx	Design and construct the space needed to house the beam absorber
3615-001	Main Ring Crossing	Construction of the Beam Transfer Line portion of the Linac Complex will cross the existing Main Ring tunnel.	121.6.05 Cmplx; 121.5.03 BTLI	Determine the quantities and extents of the existing Main Ring technical components will need to be removed for construction of the Beam Transfer Line portion of the Linac Complex	121.6.05 Cmplx	Design and construct the conventional portion of the Beam Transfer Line that crosses the existing Main Ring tunnel.



BTL Interfaces

Interface ID	Interface Name	Interface Requirements Description	System A WBS	System A Scope	System B WBS	System B Scope
3616-001	Floor Flatness/Levelness	The Booster Connection tunnel floor construction and equipment stands will need to accommodate normal construction tolerances	121.6.06 BstrC; 121.5.03 BTLI	121.05.05 and 121.06.06 shall determine construction tolerances	121.6.06 BstrC	Design and construct floor slabs within the specified tolerances
4040-001	Booster Beam Current Monitor beamline connection.	The Booster shall have a high-resolution beam current monitor capable of measuring beam current intensities found in PIP and PIP-II.	121.5.04 BSTR	121.5.04 BSTR shall provide flange connection details as well as flange to flange length from vendor provided specifications and drawings.	BstrRing (External)	BstrRing shall install and interface to the current monitor based on the specifications and interface details provided.
4040-004	Injection Girder Interface	The Injection Girder system shall be integrated into the existing Booster.	121.5.04 BSTR	121.5.04 BSTR shall design all components in the Injection Girder including interfaces to external systems.	BstrRing (External)	BstrRing will work with BSTR and BTLI to coordinate and match interfaces to existing systems and infrastructure.
4340-001	Booster Beam Current Monitor mechanical support stand.	The Booster shall have a high-resolution beam current monitor capable of measuring beam current intensities found in PIP and PIP-II.	121.5.04 BSTR	121.5.04 BSTR shall provide a specification and interface drawings for the mechanical support stand.	ADMech (External)	ADMech shall design the mechanical support stand based on specifications and interface details provided.
4443-001	Main Ring Crossing Interface	Main Ring remnant removal and reinstallation interfaces.	121.5.03 BTLI	121.5.03 BTLI shall coordinate all interfaces for Main Ring removal and reinstallation.	ExtBeams (External)	External Beams Group shall work with BTLI to coordinate and match interfaces to existing Main Ring systems and infrastructure.



Key Integration Activities Required

- Design & CAD Model Integration
 - Understand the L3 system's CAD responsibilities for management & integration (to be discussed further by Curt)
 - Interface & Space Allocation discussions required with system stakeholders
- Component Verification Planning
 - Critical for procurement & integration/installation planning
 - Identification of deliverable acceptance criteria prior to hand-off
- Installation Planning & Review
 - Continue development of deliverable installation plans & continue to detail and review integrated installation approach
- Detailed ORC & Commissioning Plans
 - Traveler Development with ORC activities
 - Commissioning Plan expansion with detailed sub-system commissioning