Fermi National Accelerator Laboratory

Fermilab

PIP-II Beam Instrumentation
Linac Installation Deliverable List

Document number: ED0011271-A

Managed by Fermi Research Alliance, LLC for the
U.S. Department of Energy Office of Science
www.fnal.gov

U.S. DEPARTMENT OF ENERGY | Office of Science

Document Approval

Signatures Required	Date Approved
Originator: Kyle Kendziora, LI Engineer	See Teamcenter
Approver: Curtis Baffes, LI L3 Manager	
Approver: Victor Scarpine, BI L3 Manager	
Approver: Sherese Humphrey, BI CAM	
Approver: Mike Geelhoed, LI CAM	

Revision History

Revision	Date Released	Description
-	2020-08-04	Initial release
A	2023-May	Updated for Invasive BProM FDR

Table of Contents

List of Tables

1. Introduction

This document is a shared document between the Beam Instrumentation (BI) and the Linac Installation (LI) on the agreed upon deliverables. These deliverables are to be reviewed at an Installation Readiness Review (IRR) as shown in the PIP-II LI Plan[9]. It is determined by the BI L3M when and how much of their deliverables will be reviewed by the LI team at a time. Deliverables require finer definitions to LI, and the condition of those deliverables at hand-off milestones.

1.1. Linac Installation (LI) Scope

The scope of the LI WBS element is defined at a high level in the PIP-II WBS dictionary [1]:

"Installation and systems checkout of the PIP-II linac, from the Warm Front End through the HB650 upgrade section. This includes integration of the linac's warm units; installation work occurring after AUP of the highbay, tunnel, and gallery spaces; and system checkout required to bring installed systems to the state where they are ready to attempt beam commissioning. Installation work includes connection to utilities, but major utilities runs (fluids headers, electrical cable tray and distribution from panels) is executed by Conventional Facilities. Accelerator Controls and Safety Systems installation scope is covered by those WBS elements. This WBS also includes the procurement of shielding required for linac major access points in the HBB and penetrations in the HBB and Linac Gallery."

1.2. Beam Instrumentation (LI) Scope

The scope of the BI WBS element is defined at a high level in the PIP-II WBS dictionary [1]:

"Design, procurement, fabrication, and testing of Beam Instrumentation Systems."

While BI systems will be used in the commissioning and operation of the PIP-II complex, installation and beam commissioning activities are outside of the scope BI. Consequently, definition (procedures, conditions, quantities, etc.) of the deliverables to LI at the time of the hand-off milestones.

1.3. Purpose

The purpose of this document is to define scope and programmatic interfaces for deliverables between the BI L3M and the LI L3M at hand-off milestones.

In addition, this document also becomes a template for the data to be reviewed at the IRR for each delivery.

Key cost, schedule, technical and programmatic assumptions are provided in PIP-II Project Assumptions[2].

All technical subsystem interfaces are defined in the MCID[3] and elaborated within subsystem-specifics ISDs. BI ISDs [14][16][18][20] are upwards traceable to the associated GRD[4], Physics Requirements Documents (PRDs)[5][10], FRS[11], and TRSs [12][13][15][17][19] where applicable.

2. Acronyms

ACCT	AC Current Transformer
AES	Allison Emittance Scanner
AMG	Alignment and Metrology Group
BCM	Beam Current Monitor
BI	Beam Instrumentation
BLM	Beam Loss Monitor
BPM	Beam Position Monitor
BProM	Beam Profile Monitor
BSM	Bunch Shaper Monitor
BTL	Booster Transfer Line
CAD	Computer Aided Design
DAQ	Data Acquisition
DCCT	DC Current Transformer
FRS	Functional Requirement Specifications
GRD	Global Requirements Documents
ICD	Interface Control Document
IRR	Installation Readiness Review
ISD	Interface Specification Document
L3	Level 3 (PIP-II Project Subsystem)
L3M	Level 3 Manager
L4M	Level 4 Manager
LI	Linac Installation WBS Element
LW	LaserWire
MICD	Master Interface Control Document
PIP2IT	PIP-II Injector Test
PIP-II	Proton Improvement Plan II
PRD	Physics Requirement Document
PRD	Physics Requirements Documents
QA	Quality Assurance
QC	Quality Control
RWCM	Resistive Wall Current Monitor
SCL	Superconducting Linac
TRS	Technical Requirement Specifications
TWS	Transverse Wire Scanner
WBS	Work Breakdown Structure

3. References

Table 3-1 : PIP-II Project-Level Documentation

#	PIP-II Project Documents	Document #
1.	PIP-II WBS Dictionary	PIP-II-docDB 599
2.	PIP-II Project Assumptions	PIP-II-docDB 144
3.	PIP-II Master Interface Control Document	ED0010433
4.	PIP-II Global Requirements Document (GRD)	TC# ED001222
5.	PIP-II Parameters Physics Requirements Document (PRD)	TC# ED0010216
6.	PIP-II 121.03 Accelerator Systems Quality Assurance (QA) Plan	PIP-II-docDB 4805
7.	PIP-II Misalignment Tolerances PRD	ED0010231

Table 3-2 : PIP-II LI Documentation

#	PIP-II LI Documents	Document #
8.	Linac Installation Functional Requirements Specification (FRS)	ED0007996
9.	PIP-II Linac Installation Plan	ED0007915

Table 3-3 : PIP-II BI Documentation

#	PIP-II BI Documents	Document #
10.	PIP-II BI Physics Requirement Document (PRD)	ED0010230
11.	PIP-II BI Functional Requirements Specification (FRS)	ED0008303
12.	PIP-II BI Digital Electronics Technical Requirements Specification (TRS)	ED0013715
13.	PIP-II BI BPM TRS	ED0013710
14.	PIP-II BI BPM Interface Specification Document (ISD)	ED0016037
15.	PIP-II BI BLM TRS	ED0013711
16.	PIP-II BI BLM ISD	ED0016034
17.	PIP-II BI BCM TRS	ED0013712
18.	PIP-II BI BCM ISD	ED0016033
19.	PIP-II BI Invasive BProM TRS	ED0013713
20.	PIP-II BI Invasive BProM ISD	ED0016035
21.	PIP-II BI NonInvasive BProM TRS	ED0013714
22.	PIP-II BI NonInvasive BProM ISD	ED0016036
23.	PIP-II BI Quality Control (QC) Plan	PIP-II-docDB 5520

Table 3-4 : Other Reference Documentation

#	Other Relevant Documents	Document #
24.	FERMILAB Energy Control Program (LOCKOUT/ TAGOUT)	FESHM 2100
25.	PIP-II Rack Specification	PIP-II-docDB 5363
26.	PIP-II Rack Bank Power	PIP-II-docDB 5360
27.	PIP-II Cryoplant Network Relay Rack Specification	PIP-II-docDB 5511
28.	PIP-II Linac Gallery Rack Allocation	PIP-II-docDB 5390

4. Documentation Deliverables Definitions

4.1. Assembly, Test & QC-QA

These documents define acceptance criteria for hardware, firmware, and/or software deliverables, prior to the LI handoff. Related assembly procedures, bench test procedures, and acceptance travelers are listed in the PIP-II BI QC Plan [23]. This plan is consistent with the overarching Accelerator Systems Quality Assurance (QA) Plan [6]. If inconsistencies between these two documents are discovered, Accelerator Systems QA Plan has precedence.

4.2. Transportation & Installation

These documents articulate the transfer of deliverables for LI, including information on the following:

- Starting and ending location of the deliverable as well as point of contact, if applicable
- The physical path of transport as well as any special handling requirements
- Method and resources required to install the hardware or equipment into their designated location.

These plans are generally prepared by the L4M and converted into handoff travelers, which are listed in the PIP-II BI QC Plan [23]. For Electronics Rack equipment, a Transportation and Installation Traveler is not required. However, rack locations as well as rack layouts should be documented and tracked [25][26][27][28].

4.3. Connections, ORC & Checkout Travelers

These documents describe the connections across physical interfaces and data pathway to all other L3's. These are included within the PIP-II MICD[3] as well as elaborated in the ICDs listed in Table 3-3. In addition, these documents include related test procedures as well as checkout travelers, which describe requirements and qualifications for a deliverable to obtain operational readiness. These are listed in the PIP-II BI QC Plan[23].

4.4. Interfaces MICD

L3 Interfaces are defined globally in the PIP-II MICD[3]. This document is generated prior to the IRR and elaborated through ISDs listed in Table 3-3.

4.5. TRS/FRS Checklist

The technical and functional requirements of deliverables are specified in L3 FRS and TRS documents, where are generated prior to the IRR and are listed in Table 3-3. These provide the basis for the LI's checklist to accept the deliverable for installation at the IRR.

4.6. Alignment Reference

If the hardware interacts with the beam, as in installed in the beamline, a deliverable has been referenced with its own fiducials. This exterior fiducial map is required for final alignment within the Linac enclosure. This reference ensures the LI team that a deliverable has been reviewed by the AMG team. At a minimum, PIP-II Misalignment Tolerances PRD [7] will be followed.

4.7. Control System List

This document lists the parameters that will be directly created into the controls system. It should include parameters associated with general control, readback, alarms, etc.

4.8. Cable Database

This should list the cable database entries to ensure LI that deliverables entries have been made aware for the BI team.

4.9. Operational Documentation

This documentation should provide Beam Commissioning the necessary documents to incorporate any beamline deliverable towards commissioning of the beam. This documentation will also be incorporated with a transition to operations.

4.10. Potential Energy Isolation

The document identifies a deliverable's potential energy and describes how to safely isolate that potential energy for operational maintenance or repair. This documentation will be included for a transition to operations. The document should follow the guidance of Fermilab's FESHM Chapter 2100[24].

4.11. CAD Models & Drawings

Documentation of a technical deliverable includes CAD models and or drawings. These models and drawings should be produced for historical content and will be associated with documentation for a transition to operations where applicable.

5. Deliverable and Scope Definition

5.1. Components to be integrated in the PIP-II tunnel enclosure (including the high-bay floor).

Table 5-1 : BPM Components Within PIP-II Enclosure

Deliverable	Qty	Delivery/Handoff Location and Delivery trigger	Shipping/Packaging Configuration	Configuration at Handoff	Support Hardware, Labor, and Logistics	Documentation (to be presented at IRR)	Notes and Comments (to be presented at IRR)	Accepted for Installation (to be filled at IRR)

WFE BPM Pickups	11	CMTF cleanroom or MEBT Unit Integration Location	Set of individual components	• Vacuum components
				  ○ BPM housing
				  ○ BPM buttons
				  ○ Flanges
					Vacuum components would need to be assembled particle-free and then:
					• Leak Checked
					• RGA certified
					• Low-particulate condition
					
					If, reuse PIP2IT MEBT BPMs, BPMs are already assembled.
						☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	

						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI BPM TRS [13]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☐ Operational Documentation		
						☐ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI BPM ISD [14]	

SCL BPM Pickups	18	Not a deliverable to LI
		Will be delivered to VAC at CMTF cleanroom or Warm Unit Integration Location
			Set of individual components	• Vacuum components
				  ○ BPM housing
				  ○ BPM buttons
				  ○ Flanges
					Vacuum components would need to be assembled particle-free and then:
					• Leak Checked
					• RGA certified
					• Low-particulate condition
					• Backfilled
						☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	

						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI BPM TRS [13]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☐ Operational Documentation		
						☐ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI BPM ISD [14]	

Table 5-2 : BLM Components Within PIP-II Enclosure

Deliverable	Qty	Delivery/Handoff Location and Delivery trigger	Shipping/Packaging Configuration	Configuration at Handoff	Support Hardware, Labor, and Logistics	Documentation (to be presented at IRR)	Notes and Comments (to be presented at IRR)	Accepted for Installation (to be filled at IRR)
MEBT BLM Detectors	12	High-bay Dock	• 8 PMT Loss Monitors and associated mounting hardware • 4 Neutron Loss Monitors and associated mounting hardware	• Self-contained loss-monitor units • Support stands and 80/20 mounting hardware	Detectors are installed externally to beamline	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI BLM TRS [15]	
						☐ Alignment Reference	Installed externally to beamline	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☒ Operational Documentation	Vendor-Provided Documentation	
						☒ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI BLM ISD [16]	
SCL BLM Detectors	128	High-bay Dock	• 46 Ionization Loss Monitors and associated mounting hardware • 63 PMT Loss Monitors and associated mounting hardware • 46 Neutron Loss Monitors and associated mounting hardware	• Self-contained loss-monitor units • Support stands and 80/20 mounting hardware	Detectors are installed externally to beamline	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation		
						☒ Connections, ORC & Checkout		
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI BLM TRS [15]	
						☐ Alignment Reference	Installed externally to beamline	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☒ Operational Documentation	Vendor-Provided Documentation	
						☒ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI BLM ISD [16]	

Table 5-3 : BCM Components Within PIP-II Enclosure

Deliverable	Qty	Delivery/Handoff Location and Delivery trigger	Shipping/Packaging Configuration	Configuration at Handoff	Support Hardware, Labor, and Logistics	Documentation (to be presented at IRR)	Notes and Comments (to be presented at IRR)	Accepted for Installation (to be filled at IRR)
WFE BCM Pickups	7	CMTF cleanroom or MEBT Unit Integration Location	• 3 ACCT (sensor, electronics, 20m cable) • 3 DCCT sensor • 1 WCM	• Support stand and 80/20 mounting hardware • Assembled beamline section	Beamline assemblies need to be: • Leak Checked • RGA certified • Low-particulate condition	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI BCM TRS [17]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☒ Operational Documentation	Vendor-Provided Documentation	
						☐ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI BCM ISD [18]	
SCL BCM Pickups	5	CMTF cleanroom or Warm Unit Integration Location	• 3 ACCT (sensor, electronics, 20m cable) • 1 DCCT • 1 WCM	• Support stand and 80/20 mounting hardware • Assembled beamline section	Beamline assemblies need to be: • Leak Checked • RGA certified • Low-particulate condition	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI BCM TRS [17]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☒ Operational Documentation	Vendor-Provided Documentation	
						☐ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI BCM ISD [18]	

Table 5-4 : Invasive BProM Components Within PIP-II Enclosure

Deliverable	Qty	Delivery/Handoff Location and Delivery trigger	Shipping/Packaging Configuration	Configuration at Handoff	Support Hardware, Labor, and Logistics	Documentation (to be presented at IRR)	Notes and Comments (to be presented at IRR)	Accepted for Installation (to be filled at IRR)

WFE AES Assemblies	6	CMTF cleanroom or MEBT Unit Integration Location	Set of assembled major subcomponents	• Vacuum section components
				  ○ Leak checked
				  ○ RGA certified
				• Subcomponents to be integrated into stand and supports following lifting and assembly plans
					LEBT AES are installed into ion source housings provided by WFE.	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	

						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Invasive BProM TRS [19]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI Invasive BProM ISD [20]	

MEBT TWS Vacuum Assemblies	4	CMTF cleanroom or MEBT Unit Integration Location	Set of assembled major subcomponents	• Vacuum section components
				  ○ Leak checked
				  ○ RGA certified
				• Subcomponents to be integrated into stand and supports following lifting and assembly plans
					MEBT TWS are installed into scraper housings provided by WFE	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	

						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Invasive BProM TRS [19]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI Invasive BProM ISD [20]	

BTL / Diagnostic Cart
 	
TWS Vacuum Assemblies
	22	This is not a deliverable to LI	Set of assembled major subcomponents	• Vacuum section components
				  ○ Leak checked
				  ○ RGA certified
				• Subcomponents to be integrated into stand and supports following lifting and assembly plans
					4 BTL TWS will be initially installed in the diagnostic card during phased commissioning. Later, these will be uninstalled and moved into the BTL.	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	.

						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Invasive BProM TRS [19]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI Invasive BProM ISD [20]	

Table 5-5 : Noninvasive BProM Components Within PIP-II Enclosure

Deliverable	Qty	Delivery/Handoff Location and Delivery trigger	Shipping/Packaging Configuration	Configuration at Handoff	Support Hardware, Labor, and Logistics	Documentation (to be presented at IRR)	Notes and Comments (to be presented at IRR)	Accepted for Installation (to be filled at IRR)
MEBT Laserwire Vacuum Assembly	1	CMTF cleanroom or MEBT Unit Integration Location	Set of individual subcomponents	• Assembled vacuum section components • Viewports protected • Subcomponents to be integrated into stand and supports following lifting and assembly plans	Vacuum components would need to be assembled particle-free and then: • Leak Checked • RGA certified • Low-particulate condition • Backfilled	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI NonInvasive BProM TRS [21]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI Invasive BProM ISD [22]	
SCL Laserwire Vacuum Assemblies	11	CMTF cleanroom or Warm Unit Integration Location	Set of individual subcomponents	• Assembled vacuum section components • Viewports protected • Subcomponents to be integrated into stand and supports following lifting and assembly plans	Vacuum components would need to be assembled particle-free and then: • Leak Checked • RGA certified • Low-particulate condition • Backfilled	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI NonInvasive BProM TRS [21]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☐ Control System List	See Section 5.2	
						☒ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI NonInvasive BProM ISD [22]	
Warm Unit Optical Benches	11	High-bay Dock	Assembled Units	Support stands and 80/20 mounting hardware		☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI NonInvasive BProM TRS [21]	
						☒ Alignment Reference	PIP-II Misalignment Tolerances PRD [7]	
						☒ Control System List	BI Electronics DAQ Database Entry	
						☒ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-II BI NonInvasive BProM ISD [22]	

Table 5-6 : Other BI Components Within PIP-II Enclosure

Deliverable	Qty	Delivery/Handoff Location and Delivery trigger	Shipping/Packaging Configuration	Configuration at Handoff	Support Hardware, Labor, and Logistics	Documentation (to be presented at IRR)	Notes and Comments (to be presented at IRR)	Accepted for Installation (to be filled at IRR)
Lifting Fixture for warm unit laser wire optical benches	1	High-bay Dock		Note released and legal for use at FNAL.	Delivering L3 provides interface fasteners	☐ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI NonInvasive BProM TRS [21]	
						☐ Alignment Reference		
						☐ Control System List		
						☐ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☐ CAD Models & Drawings		
Specialty tooling, fixtures or test equipment for BI	TBD	High-bay Dock	Lab equipment and various assembled units	Note released and legal for use at FNAL.	Anything non-standard must be provided by BI	☐ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☐ Interfaces MICD		
						☐ TRS/FRS Checklist		
						☐ Alignment Reference		
						☐ Control System List		
						☐ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☒ CAD Models & Drawings		

Warm Unit girders and adjustable stands	25	High-bay Dock	Palletized	Support stand kits and 80/20 mounting hardware	LI provides girders and interface fasteners instrumentation-to-stand interface	☐ Assembly, Test & QC-QA	PIP-II LI QC Plan	
						☒ Transportation & Installation	PIP-II BI QC Plan [23]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3]	
						☐ TRS/FRS Checklist		
						☐ Alignment Reference		
						☐ Control System List		
						☐ Cable Database		
						☐ Operational Documentation		
						☐ Potential Energy Isolation		
						☒ CAD Models & Drawings	PIP-BI BPM ISD[14] PIP-BI BLM ISD[16] PIP-BI BCM ISD[18] PIP-BI Invasive BProM ISD[20] PIP-BI NonInvasive BProM ISD[22]	

5.2. Components to be integrated in the PIP-II electronic galleries (including those in xxx)

Deliverable	Qty	Delivery/Handoff Location and Delivery trigger	Shipping/Packaging Configuration	Configuration at Handoff	Support Hardware, Labor, and Logistics	Documentation (to be presented at IRR)	Notes and Comments (to be presented at IRR)	Accepted for Installation (to be filled at IRR)
Bergoz DCCT Electronics	3	Gallery Dock	Individual Units	Vendor-assembled rack-wide chassis, which is uniquely matched to a specific interconnect cable and pickup into the tunnel.	BI will handle the installation of the electronics into the pre-allocated relay racks.	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II Linac Gallery Rack Allocation[28]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3] PIP-II BI BCM ISD[18]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Electronics TRS[12] PIP-II BI BCM TRS [17]	
						☐ Alignment Reference		
						☐ Control System List	See DAQ Electronics for BCM Systems	
						☒ Cable Database		
						☒ Operational Documentation	Vendor Provided Documentation	
						☐ Potential Energy Isolation		
						☐ CAD Models & Drawings		
Bergoz ACCT Electronics	8	Gallery Dock	Individual Units	Wall-/girder-/cable tray- mountable electronics enclosure box, containing vendor-assembled module. Each module is uniquely matched to a specific	BI will handle the installation of the electronics near gallery penetrations, due to interconnect cable length restriction.	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☒ Transportation & Installation	PIP-II Linac Gallery Rack Allocation[28]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3] PIP-II BI BCM ISD[18]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Electronics TRS[12] PIP-II BI BCM TRS [17]	

				interconnect cable and pickup into the tunnel.		☐ Alignment Reference		
						☐ Control System List	See DAQ Electronics for BCM Systems	
						☒ Cable Database		
						☒ Operational Documentation	Vendor Provided Documentation	
						☐ Potential Energy Isolation		
						☐ CAD Models & Drawings		
DAQ Electronics for MEBT Scrappers	4	Gallery Dock	Set of Individual Units	Rack-mounted crate, patch panels, transition boards	BI will handle the installation of the electronics into the pre-allocated relay racks.	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☐ Transportation & Installation	PIP-II Linac Gallery Rack Allocation[28]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3] PIP-II BI BCM ISD[18]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Electronics TRS[12] PIP-II BI BCM TRS [17]	
						☐ Alignment Reference		
						☒ Control System List	DAQ Readout/Control Database Device Entries	
						☒ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☐ CAD Models & Drawings		
DAQ Electronics for MEBT / BTL TWS systems	4	High-bay Dock	Set of Individual Units	• Rack-mounted electronics, HV power supplies, motion control, programmable digitizer cards • Associated components such as patch panels, controller cards, timing cards	BI will handle the installation of the electronics into the pre-allocated relay racks.	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☐ Transportation & Installation	PIP-II Linac Gallery Rack Allocation[28]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3] PIP-II BI Invasive BProM ISD[20]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Electronics TRS[12] PIP-II BI Invasive BProM TRS [19]	
						☐ Alignment Reference		
						☒ Control System List	Motion System and Measurement DAQ Readout/Control Database Device Entries	
						☒ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☐ CAD Models & Drawings		
DAQ Electronics for WFE AES Systems	1	High-bay Dock	Set of Individual Units	• Rack-mounted electronics, HV power supplies, PC, motion control • Associated components such as patch panels, controller cards, timing cards	BI will handle the installation of the electronics into the pre-allocated relay racks.	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
						☐ Transportation & Installation	PIP-II Linac Gallery Rack Allocation[28]	
						☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
						☒ Interfaces MICD	PIP-II MICD [3] PIP-II BI Invasive BProM ISD[20]	
						☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Electronics TRS[12] PIP-II BI Invasive BProM TRS [19]	
						☐ Alignment Reference		

						☒ Control System List	Motion System and Measurement DAQ Readout/Control Database Device Entries	
						☒ Cable Database		
						☒ Operational Documentation		
						☒ Potential Energy Isolation		
						☐ CAD Models & Drawings		

Deliverable	Qty	Delivery/Handoff Location and Delivery trigger	Shipping/Packaging Configuration	Configuration at Handoff	Support Hardware, Labor, and Logistics	Documentation (to be presented at IRR)	Notes and Comments (to be presented at IRR)	Accepted for Installation (to be filled at IRR)	
DAQ Electronics for MEBT/ SCL Laserwire systems	2	High-bay Dock	Set of Individual Units		• Rack-mounted electronics, HV power supplies, motion control, programmable digitizer cards • Associated components such as patch panels, controller cards, timing cards	BI will handle the installation of the electronics into the pre-allocated relay racks.	☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
							☐ Transportation & Installation	PIP-II Linac Gallery Rack Allocation[28]	
							☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
							☒ Interfaces MICD	PIP-II MICD [3] PIP-II BI NonInvasive BProM ISD[22]	
							☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Electronics TRS[12] PIP-II BI NonInvasive BProM TRS [21]	
							☐ Alignment Reference		
							☒ Control System List	Motion System and Measurement DAQ Readout/Control Database Device Entries	
							☒ Cable Database		
							☒ Operational Documentation		
							☐ Potential Energy Isolation		
							☐ CAD Models & Drawings		
DAQ Electronics for WFE / SCL / BTL / BAL Multiple BI Systems	10	High-bay Dock or Gallery Dock	Sets of individual assembled components		MFTU-based system consisting of rack-mounted crate with RTM cards, AMC cards, and MTCA.4 modules		☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
							☐ Transportation & Installation	PIP-II Linac Gallery Rack Allocation[28]	
							☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
							☒ Interfaces MICD	PIP-II MICD [3] Multiple PIP-II BI ISDs [14][16][18]	
							☒ TRS/FRS Checklist	PIP-II BI FRS [11] Multiple PIP-II BI TRSs[12][13][15][17]	
							☐ Alignment Reference		
							☐ Control System List		
							☒ Cable Database		
							☒ Operational Documentation		
							☒ Potential Energy Isolation		
							☐ CAD Models & Drawings		

DAQ Servers for BI Systems	2	High-bay Dock	Sets of individual assembled components		Rack-wide servers and installation supports		☒ Assembly, Test & QC-QA	PIP-II BI QC Plan [23]	
							☐ Transportation & Installation	PIP-II Linac Gallery Rack Allocation[28]	
							☒ Connections, ORC & Checkout	PIP-II BI QC Plan [23]	
							☒ Interfaces MICD	PIP-II MICD [3] PIP-II BI BPM / BLM / BCM ISD[14][16][18]	
							☒ TRS/FRS Checklist	PIP-II BI FRS [11] PIP-II BI Electronics TRS[12]	
							☐ Alignment Reference		
							☒ Control System List	Network Identification and DAQ Readout/Control Database Device Entries via BI Front End Interface	
							☒ Cable Database		
							☒ Operational Documentation		
							☒ Potential Energy Isolation		
							☐ CAD Models & Drawings		