PIP-II AccU-BSTR -Dampers-CHG0

Functional Requirements Specification

Document number:

Document Approval

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| --- | --- | --- |
| Revision | Date of Release | Description of Change |
| - | 1-20-2021 | Initial Release. |
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# PURPOSE

Functional Requirements Specification (FRS) document describes the project needs and/or requested behavior of a system or component. The FRS typically outlines what is needed by the end user as well as the requirements and requested properties of inputs and outputs. The FRS specifies the functions that a system or component must perform and establishes consensus among stakeholders on what the system is expected to provide. FRS statements are upwards traceable to the associated Physics Requirements Documents (PRDs)[10][11] and Global Requirements Documents (GRDs)[9], where applicable.

# SCOPE

This FRS addresses the functional requirements of the new Booster Beam Current Monitor (BCM) systemof the **AccU – Booster-Damper-CHG0 Task**, 121.05.04.04.03 PIP-II Project. The main purpose of this task is to replace the existing B:CHG0 with a detector with a higher charge range to accommodate the continued increase in cycle intensity and to provide for a finer resolution and linearity due to the strict requirement for increased acceleration efficiency to the 98% range for PIP-II.

# KEY ASSUMPTIONS

The Booster BCM systems shall also abide by requirements outlined in FEM [1]. Key cost, schedule, technical and programmatic assumptions are provided in PIP-II Project Assumptions [8]. Additional assumptions include the following:

* Alignment, welding, and vacuum-work in the enclosure will be provided during installation. Aside from the fiducial markers, functional requirements for such services are not covered in this document.
* Vacuum lab infrastructure, such as cleanrooms and pumping carts, shall be provided. Functional requirements for such facilities and equipment are not covered in this document.
* AC power, ground, cable trays, conduits and penetrations, and relay racks shall be provided to the system. Functional requirements for such systems are beyond the scope of this document.
* Event-based triggers, event-encoded clock signals, and RF signals, and Ethernet network infrastructure will provide for accessible and usable connections to the system. The function requirements for those signals are beyond the scope of this document.
* Functional requirements for capabilities for the client applications in Control System is beyond the scope of this document.

# REFERENCE

|  |  |  |
| --- | --- | --- |
| # | Reference | Document # |
| 1.
 | [Fermilab Engineering Manual](http://directorate-docdb.fnal.gov/cgi-bin/RetrieveFile?docid=34) (FEM) | - |
| 1.
 | [Fermilab Environmental Safety and Health Manual](http://eshq.fnal.gov/manuals/feshm/) (FESHM) | - |
| 1.
 | [Fermilab Radiological Control Manual](https://eshq.fnal.gov/manuals/frcm/) (FRCM) | - |
| 1.
 | [Fermilab Quality Assurance Manual](https://eshq.fnal.gov/manuals/qam/) (QAM) | - |
| 1.
 | PIP-II Procurement Plan | PIP-II docDB 522 |
| 1.
 | PIP-II 121.03 Accelerator Systems Quality Assurance (QA) Plan | PIP-II docDB 4805 |
| 1.
 | PIP-II Beam Instrumentation Quality Control (QC) Plan | PIP-II-Doc-5520 |
| 1.
 | PIP-II Project Assumptions | PIP-II docDB 144 |
| 1.
 | PIP-II Global Requirements Document (GRD) | ED0001222 |
| 1.
 | PIP-II Parameters Physics Requirements Document (PRD) | ED0010216 |
| 1.
 | PIP-II Booster BCM Physics Requirements Document | ED00xxxxx |

# ACRONYMS

|  |  |
| --- | --- |
| BCM | Beam Current Monitor |
| DCCT | DC Current Transformer |
| EPDM | Engineering Process Document Management |
| FEM | Fermilab Engineering Manual |
| FESHM | Fermilab ES&H Manual |
| FRCM | Fermilab Radiological Control Manual |
| FQAM | Fermilab Quality Assurance Manual |
| FRS | Functional Requirements Specification |
| GRD | Global Requirements Document |
| PRD | Physics Requirements Document |
| PIP-II | Proton Improvement Plan II Project  |
| QA | Quality Assurance |
| QC | Quality Control |

# FUNCTIONAL REQUIREMENTS

The Booster BCM system will utilize a DC current transformer (DCCT) pickup to characterize and monitor the average beam current in the Booster ring.

Table ‑. Functional Requirements

|  |  |
| --- | --- |
| Requirement # | Requirement Statement |
| F-xxx.xx.xx-A001 | The Booster BCM system shall measure the average beam current, for ramp rates up to 20 Hz. |
| F-xxx.xx.xx-A002 | The Booster BCM system shall work with PIP and PIPII operational currents as well with low current for tuning.  |
| F-xxx.xx.xx-A003 | The Booster BCM system’s current measurements shall provide 0.1% accuracy at HEP intensities. |
| F-xxx.xx.xx-A004 | The Booster BCM system’s current measurements shall not be affected by the beam bunch structure. |
| F-xxx.xx.xx-A005 | The Booster BCM system’s current measurements shall not saturate at PIPII peak beam currents. |

# DESIGN & CONSTRUCTION STANDARDS

The following codes and standards in their latest edition shall be applied to the engineering, design, fabrication, assembly and tests of the given system:

* + - NFPA 70 – National Electrical Code
		- IEC Standards for Electrical Components
		- UL61010 - Laboratory equipment
		- IPC-JSTD-001 – Soldering
		- IPC2221 – PCB spacing and design
		- IPC-A-600 -- PCB acceptance and testing
		- IPC-A-610 -- Electronics assembly

In cases where International Codes and Standards are used, the Booster BCM system shall follow *FESHM Chapter 2110 Ensuring Equivalent Safety Performance Using International Codes and Standards* [2].

# SAFETY REQUIREMENTS

The Booster BCM system shall abide by FESHM [2] and FRCM [3] requirements, including but not limited to:

|  |
| --- |
| Electrical Safety |
| * FESHM Chapter 9110 Electrical Utilization Equipment Safety
* FESHM Chapter 9160 Low Voltage, High Current Power Distribution Systems
* FESHM Chapter 9190 Grounding Requirements for Electrical Distribution and Utilization Equipment
 |
| Radiation Safety  |
| * FRCM Chapter 8 ALARA Management of Accelerator Radiation Shielding
* FRCM Chapter 10 Radiation Safety Interlock Systems
* FRCM Chapter 11 Environmental Radiation Monitoring and Control
 |
| General Safety |
| * FESHM Chapter 2000 Planning for Safe Operations
* FESHM Chapter 10000 Material Handling and Transportation
 |

Any changes in the applicability or adherence to these standards and requirements require the approval and authorization of the PIP-II Technical Director or designee.

Additional safety requirements, which are not listed in this document, shall be elaborated in the Booster BCM TRS.

# QUALITY ASSURANCE PROVISIONS

At a minimum, the Booster BCM system shall adhere to FQAM [4], PIP-II Procurement Plan [5], PIP-II 121.03 Accelerator Systems QA Plan [6], and PIP-II Beam Instrumentation QC Plan [7]. Additional roles, provisions, and procedures are described in the Booster BCM TRS document.