Fermilab

# Mu2e Proton Beam Absorber Requirements

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**Change Log**

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# 1. Overview

The Mu2e [1] Proton Absorber stops primary beam particles and secondary particles downstream of the production target. This document describes top-level requirements and derived specifications for this device.

# 2. Requirements

## 2.1. Absorbed Beam Parameters

2.1.1. Primary Beam: The Proton Absorber shall absorb primary beam and secondary particles generated as the beam passes through the production target. The beam parameters are as follows:

- 8GeV KE 8kW primary beam on target
- Beam structure as defined in [2]
- Beam size and composition at Absorber as calculated by MARS analysis
- 8E20 protons on target total (Experimental program requires 4E20, allow 100% additional for commissioning, diagnostics, etc.)
- Beam applied continuously for long periods of time (thermal steady-state)

2.1.2. Diagnostic Beam: For diagnostic purposes, the Proton Absorber shall be capable of absorbing direct primary beam with the following parameters:

- 8GeV KE primary beam (i.e. beam intentionally missing the target)
- 10% intensity, 0.8kW total beam power
- Beam structure as defined in [2]
- Beam size at absorber 1.3cm
- 2E19 protons on absorber total (~1y of continuous running at stated intensity. This far exceeds the amount of time anticipated to be spent in this diagnostic mode)
- Beam applied continuously for long periods of time (thermal steady-state)

2.1.3. Accident Condition: In order to survive the plausible accident scenario where the primary beam misses the target, the proton absorber shall absorb full-intensity primary beam with the following parameters:

- 8GeV KE primary beam
- 8kW total beam power
- Beam structure as defined in [2]
- Beam size at absorber 1.3cm
- 2E19 protons on absorber lifetime total in this scenario
- Beam applied for 10 minutes maximum per accident event

2.1.4. Future Upgrade: The Proton Absorber shall not be designed to accommodate any hypothetical future power increases. However, see requirement [2.3.4] for retrofit requirements.

## 2.2. Radiation Considerations

2.2.1. Proton Absorber shielding shall be sufficient to protect Extinction Monitor and Target Hall equipment from prompt radiation. This requirement shall be evaluated in integrated MARS model of the Target Station.

2.2.2. The Proton Absorber shall include an albedo trap to protect the Production Solenoid and Target Hall equipment from secondary neutrons.

2.2.3. Cooling Scenario: For the purposes of Proton Absorber Design, the assumed cooling scenario shall be 1 year of operation followed by one week of cooling prior to any personnel access into the target hall

2.2.4. Residual Radiation: The Proton Absorber shall include any shielding required to protect workers in the Target Hall during servicing scenario. It is anticipated that meeting this requirement will require installing movable shielding in front of the Proton Absorber aperture during access periods.

2.2.5. Water Activation: Since the dump is separated from the target by >>5m, it is considered an isolated source for ground and surface water activation [4, Appendix 11B]. Activation of surface and ground water due to the Proton Absorber shall be less than the limits established in the FRCM [4, Table 3-1].

2.2.6. Air Activation: Air activation in the target hall due to the Proton Absorber after the cooling period shall be less than the limits established in the FRCM [4].

## 2.3. Lifetime and Reliability

2.3.1. The Proton Absorber shall be designed to survive the particle flux defined in section 2.1, and a calendar duration no less than 10 years.

2.3.2. No component within the Proton Absorber core (the permanently installed dump shielding and anything within it) shall require inspection, servicing, or maintenance over the life of the experiment. This requirement does not apply to components outside the Proton Absorber core, for example, any remote cooling system components.

2.3.3. Any fluid circuit within the Proton Absorber core shall be insensitive to leaks (i.e. an air system) or fully redundant.

2.3.4. For the purposes of decommissioning and/or retrofit, it shall be possible to remove the metallic portion of the absorber core into the Target Hall. This requirement is intended to ensure that the metallic portion of the core is not permanently "cast" into the facility. Though interfaces should be provided on the metallic core, it is not planned to design and/or build equipment to perform such a removal at this time.

### 2.4. Instrumentation

2.4.1. The Proton Absorber shall be fitted with thermometry sufficient to monitor temperature and health of the absorber

2.4.2. Proton Absorber thermometry shall be tied into the machine protection system.

2.4.3. If the proton absorber incorporates active cooling, status of the cooling system shall be monitored and tied into the machine protection system

# 3. Interfaces

### 3.1. Interfaces

3.1.1. Proton absorber will provide appropriate interfaces for installation during facility construction. These interfaces are captured in document [5]

3.1.2. Proton absorber will provide accommodations and interfaces for the extinction monitor as shown in drawing [6]

# 4. References


1. Mu2e-doc-1169, Mu2e CDR
2. Mu2e-doc-48, Mu2e Numbers, C. Dukes, Jan. 2012.
3. The Concentration Model Revisited, J. D. Cossairt, A. J. Elwyn, P. Kesich, A. Malensek, N. Mokhov, and A. Wehmann, Fermilab EP Note 17, June 24, 1999.
4. Fermilab Radiological Control Manual, D. Cossairt, http://esh.fnal.gov/xms/ESHQ-Manuals/FRCM, Oct 2013.
5. Mu2e-doc-1529-v2, Mu2e Accelerator Systems Interface Document, V. Nagaslaev, March 2012.
6. Mu2e-doc-2024, Extinction Monitor Status, P. Kasper, Jan 2012.