LBNF Hadron Absorber

Preliminary Design Review

LBNF Hadron Absorber Overview

Abhishek Deshpande

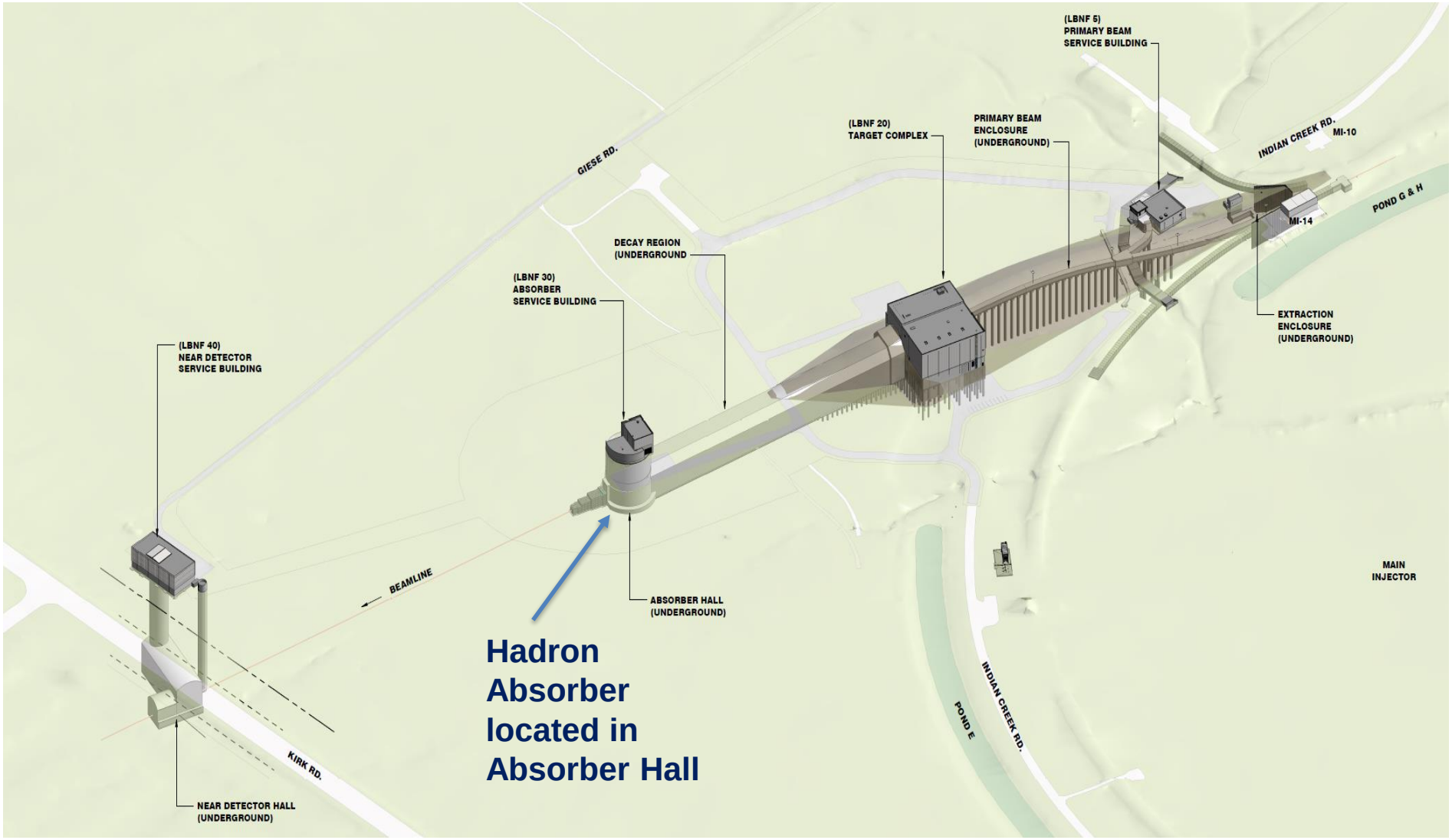
June 25 , 2020

Overview

- Introduction
- Scope of the Absorber
- Requirements, specifications, and recommendations
- Supporting documentation
- Questions and discussion

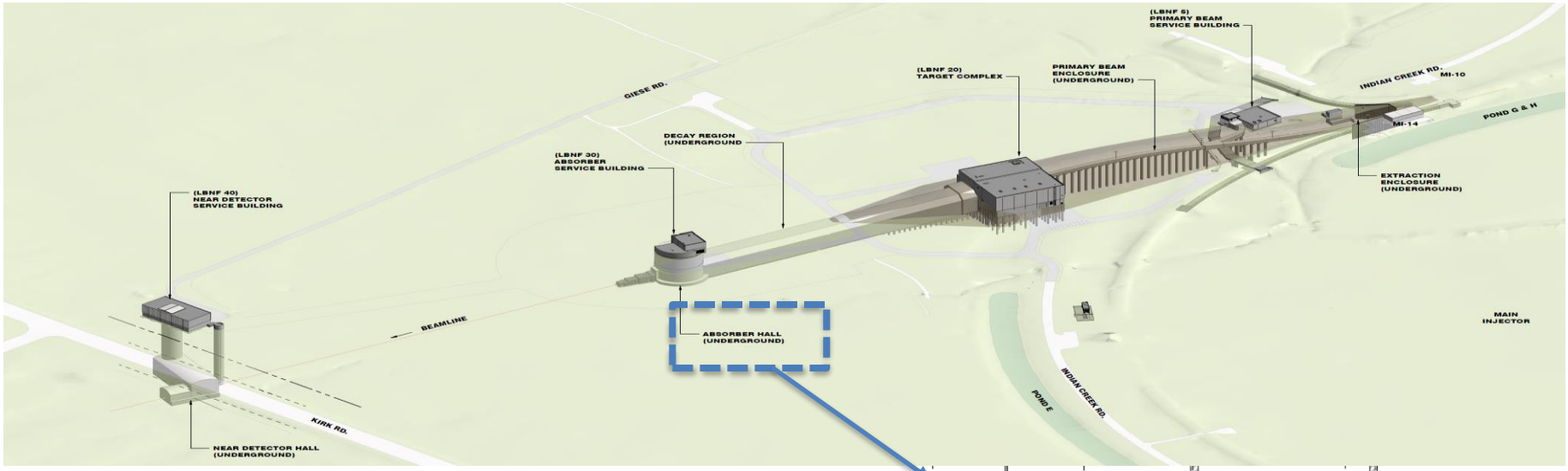
Introduction

Long-Baseline Neutrino Facility at Fermilab

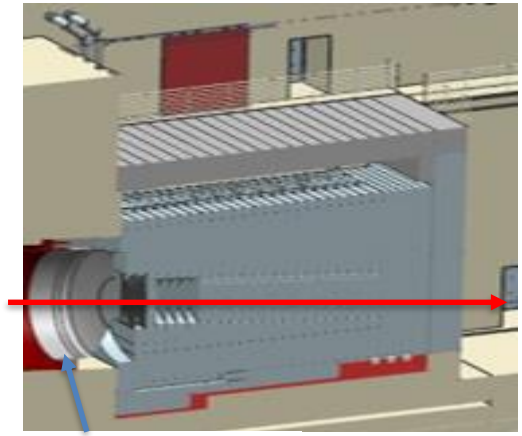


Introduction

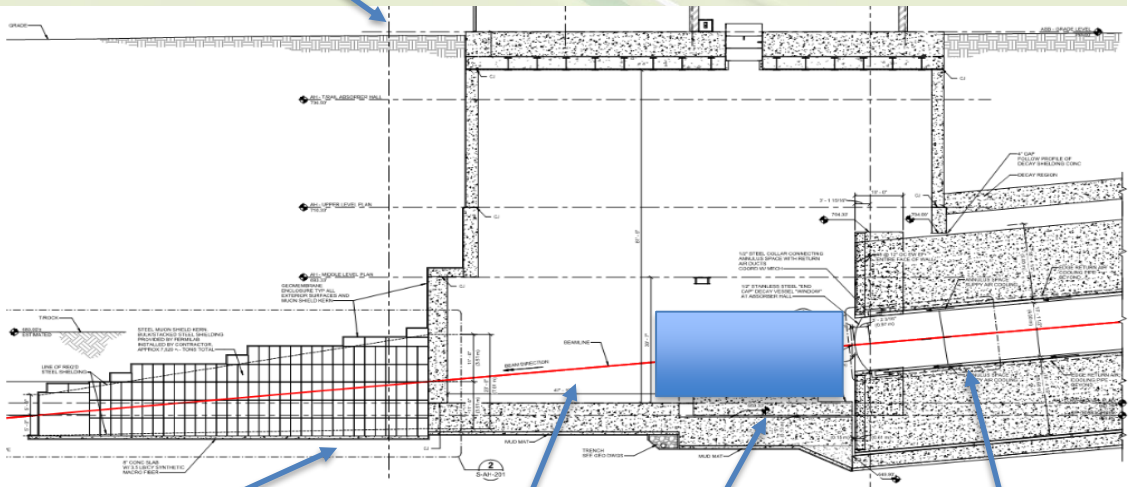
Long-Baseline Neutrino Facility at Fermilab



Hadron Absorber Cross-section



Decay Pipe



Muon shielding steel

Muon monitor alcove

Hadron Absorber

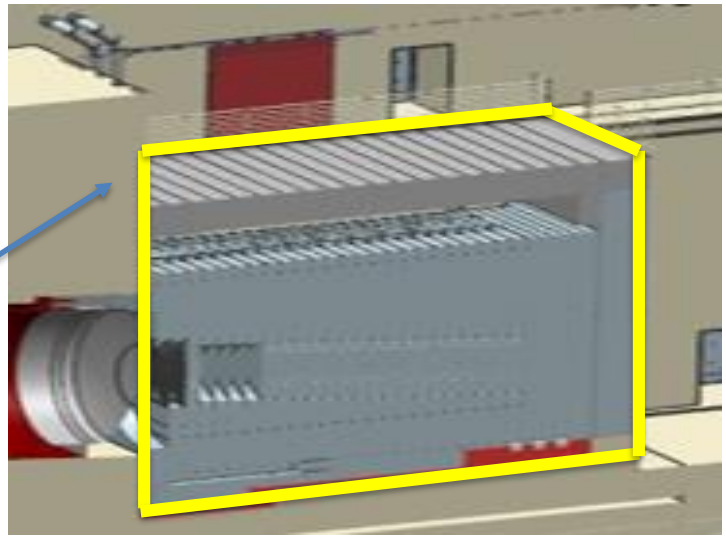
Decay Pipe

Introduction: Hadron Absorber

- Located directly downstream of the decay pipe –made up of actively cooled Aluminum and Steel blocks surrounded by concrete.
- Provides radiation protection to people and keeps soil/groundwater activation levels to below allowable limits.
- Designed for the worst case condition at 2.4 MW operation:
  - Shortest possible decay distance [221m from MCZero to end of decay pipe].
  - Helium filled decay pipe.
  - For a 1.5-m RAL style target.
  - Designed to sustain 2 successive beam accident pulses –interlock system limits the accident pulses to 1.

Scope of the Hadron Absorber

- The scope includes the Absorber core and surrounding supporting steel structure.
- Surrounding steel shielding.
- Accident condition beam interlock system.
- Remote handling system.



Requirements, specifications, and recommendations

- The requirements/specifications of the Absorber are highlighted in: https://edms.cern.ch/document/2322285/2
- They are:

Requirement	Description
Absorber - radiation protection	The absorber shall provide radiation protection to people, in compliance with the FRCM.
Absorber - energy absorption	The absorber shall absorb the energy of the particles exiting the decay pipe and transfer this energy away using an active cooling system.
Absorber - lifetime	The absorber shall keep its operational ability for the life of the LBNF experiment. Near Site Conventional Facility (NSCF or CF) life is 30-years. And, the LBNF/DUNE experiment life is 20-years.
Absorber - accident conditions	The absorber shall sustain the beam energy deposition under all accident situations that may occur with some reasonable probability.
AC - Absorber Bunker Liner	Beamline shall provide a 24 inch high, leak tight stainless steel pan liner at the bottom of the Absorber bunker

Requirements, specifications, and recommendations

- …continued

Specification	Description
Absorber - accident pulses	The absorber shall sustain at least 2 successive accident beam pulses without damage to components or loss of functional ability.
Absorber - accident pulses	The absorber shall include an interlock system that limits the accident pulses to 1.
Absorber - dose rate	The absorber shall have a residual dose at 1 foot (measured from outside the absorber shielding) after 100 day irradiation and 4 hr. cooling that does not exceed 20 mrem/hr.
Cooling System - heat removal	The cooling system shall remove 473 kW of dissipated heat during normal operation. 233 kW using water cooling and 240 kW using forced air/gas ventilation system. This assumes a 1.5-m RAL Target at 2.4-MW beam operations.

Requirements, specifications, and recommendations

- Recommendations from the 2015 advanced conceptual review:

LBNE Hadron Absorber Core Advanced Conceptual Design Review
Jan 20-22 2015 at FNAL
Review Report Dated Feb 02 2015
Teamcenter: ED0002423 Rev-
LBNE Doc DB: 10279

Reviewers
Curtis Baffes (FNAL) – Chair
Chris Densham (RAL)
Ilias Efthymiopoulos (CERN)
Peter Kasper (FNAL)
Ang Lee (FNAL)
Antonio Perillo Marcone (CERN)
Andy Stefanik (FNAL)

Lbne-doc-10279

Post-Closeout Actions: disposition by next review
Summary only - details of each action are captured in the sections above

1. Include a smoother representation of the spherical sculpted recess in the aluminium core blocks in MARS analysis
2. Include possible long-term static misalignment of the target/absorber/far detector system in MARS and thermal/structural analysis of the absorber.
3. Develop a QA plan for aluminium core blocks
4. Consider alternate connection methods for piping to the core blocks in lieu of welding. Regardless of the chosen technique, estimate expected reliability of system.
5. Address high predicted temperatures in dump steel. Specifically, confirm that dump steel corrosion-protection coating can survive predicted temperature regime.
6. Calculate stresses due to differential expansion between steel T-blocks and aluminium core blocks.
7. Consider whether it is possible to exclude by design the possibility of a non-disrupted beam pulse from interacting with the hadron absorber.
8. Assess required and expected reliability of beam permit system.
9. Consider if an accident pulse can hit the intersection of gun-drilled channels, where internal sharp features would exist. If so, analyze this case
10. Consider the gap between modules w.r.t. remote handling. Incorporate features to ensure that planned tolerances can be held and modules can be removed without binding.
11. Consider whether air needs to circulate through absorber, specifically w.r.t. local corrosion effects.
12. Future design reviews should consider the absorber system as a whole, including peripheral shielding that is absorbing significant power.
13. Consider a longer core (i.e. more solid aluminium blocks before the steel)
14. Consider system-level implications of air-handling scheme, especially release of activated air to service building. Consider intermediate barrier enclosure with differential pressure.
15. Develop top-level requirements for absorber system reliability and availability, and trace these requirements down to show that the entire system meets reliability requirements, especially water system interfaces.

Supporting documentation

- The supporting documentation for the design review has been assembled at: DUNE-doc-19734-v1.
- During this review, we will show that the design meets the requirements.
- Also, that previous review recommendations have been addressed.

LBNF Hadron Absorber Preliminary Design Review Schedule
June 25, 2020 and June 26, 2020

Day -1, Thursday, June 25, 2020

Time	Presentation Title	Presenters
8:00 AM-8:15 AM	Introductions	Mandy Rominsky
8:15 AM - 8:30 AM	LBNF Hadron Absorber Overview	Abhishek Deshpande
-Discussion-		
8:45 AM – 9:30 AM	LBNF Hadron Absorber Mechanical Design	Vladimir Sidorov and Abhishek Deshpande
-Discussion-		
9:45 AM-10:30 AM	LBNF Hadron Absorber Core Blocks and Steel Shielding Energy Deposition and Thermal and Stress Analyses	Vladimir Sidorov and Abhishek Deshpande
-Discussion-		

Day -2, Friday, June 26, 2020

Time	Presentation Title	Presenters
8:00 AM-8:45 AM	LBNF Hadron Absorber Plan for Final Design, Procurement, and Assembly	Vladimir Sidorov
-Discussion-		
9:00 AM-9:20 AM	LBNF Hadron Absorber Interfaces	Abhishek Deshpande
9:20 AM-9:45 AM	LBNF Hadron Absorber Costs, Schedule, and Overall Summary	Abhishek Deshpande

Questions and discussion