PIP-II SSR Conduction Cooled Solenoid Final Design Review _ Session 1
- Charge -

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Document Approval

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Revision History

Revision	Date Release	Originator: Role:	Description of Change
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1. Introduction

The PIP-II project at Fermilab, is building a superconducting Linac to fuel the next generation of intensity
frontier experiments. Capitalizing on advances in superconducting radio-frequency (SRF) technology, five families of superconducting cavities will accelerate H− ions to 800 MeV for injection into the Booster.
Upgrades to the existing Booster, Main Injector, and Recycler Rings will enable them to operate at a 20 Hz repetition rate and will provide a 1.2 MW proton beam for the Long Baseline Neutrino Facility. The superconducting Linac currently has a set of frequencies (162.5 MHz, 325 MHz, 650 MHz) and energy range (2.1 MeV to 800 MeV). The relativistic β for the H− ions goes from 0.07 to 0.854 over this energy range. Taking into consideration the number of cavities, acceleration efficiencies, cavity types and performance with an eye to costs, the design choices of a half wave resonator (HWR), two types of single spoke resonators (SSR1, SSR2), and two types of elliptical cavities (HB650, LB650) is made.

The current PIP-II beam optics design requires that each SSR1 cryomodule contains eight cavities (C) and four focusing solenoids (S) in the following order: C–S–C–C–S–C–C–S–C–C–S–C (beam direction), and each SSR2 cryomodule contains five cavities (C) and three focusing solenoids (S) in the following order: S–C–C–S–C–C–S–C (beam direction). The solenoids in both SSR1 and SSR2 are identical.

PIP-II requires a significant design coordination and integration oversight. As part of the oversight strategy, a design review plan specific to PIP-II has been developed. The primary goal of the Project design review is to increase the likelihood of success by identifying potential or actual design problems as early as possible to minimize the cost, schedule, and performance impact. In this case, the review comprises of the Final Design Review (FDR) for the production conduction-cooled solenoids.

- Final Design Reviews (FDRs) are technical and programmatic reviews conducted to give assurance that the completed design achieves all functional, technical, and interface requirements (~90-100% design maturity). The technical areas addressed during the review include the design configuration of the selected design; verification planning, requirements, and compliance; operations planning; support equipment; and systems compatibility.

The purpose of this review is to seek a recommendation from the Review Committee to proceed with the fabrication of 29 production conduction-cooled solenoids for both SSR1 and SSR2 cryomodules.

Due to the time zone difference between the US and India, as well as the technical aspects to be covered, the review will be conducted in two sessions:

1. **Electromagnetic (EM) Design**
2. **Thermal and Mechanical Design (week of February 24, 2025, with details TBD)**

Details regarding the date, time, and agenda for the first session are shared below.

2. Review Agenda

Production SSR Conduction Cooled Solenoid Final Design Review-Session 1
- Agenda -

Location: Microsoft Teams

Date: 15 January 2025

Time: 8am -10am FNAL (7:30pm – 9:30pm BARC)

Indico Site: https://indico.fnal.gov/event/67459/
Access key:

Participants:

Miao Yu miaoyu@fnal.gov	FNAL	Role: Coordinator and Presenter
Ramesh Gupta gupta@bnl.gov	BNL	Role: Review Chair
Vladimir Kashikhin kash@fnal.gov	FNAL	Role: Reviewer
Vito Lombardo lombardo@fnal.gov	FNAL	Role: Reviewer
Steve Krave skrave@fnal.gov	FNAL	Role: Reviewer
Kumud Singh kumuds@barc.gov.in	BARC	Role: Presenter

Agenda details:

1. Test results from the Pre-series Magnet (Miao Yu)
2. Updated PRD and TRS (Miao Yu)
3. Electromagnetic Design and Quench Protection (Kumud Singh)

3. Review Charge Statement

The review committee is tasked with evaluating the SSR solenoid at the final design stage by addressing the following questions:

a) Does the final design, with respect to the electromagnetic aspects of the SSR solenoid, meet the specified requirements?
b) Are the predicted performance metrics and margins for all requirements adequate? Particular attention should be given to:
    a. Operational margin
    b. Manufacturing tolerance impact on performance
    c. Fringe field on the cavity surface
c) Is the final design of the SSR solenoid sufficiently protected in the event of a quench?
d) Is the quench detection mechanism satisfactory for all the coils?

4. Reference Documents

List of relevant documents referred to in the Review Charge Statement.

1	PIP-II Technical Review Plan – TC ED0008163
2	PIP-II SSR2 Cryomodule Functional Requirements Specification – TC ED0001829
3	Engineering Process Document Management ppSSR Solenoids – TC ED0001257

Table 1 - Document Deliverables for this review from the System Design Plan

	Document Title	Status (preliminary, final, released)	Comments
1	PIP-II Magnets Physics Requirement Document (PRD), TC ED0010226 Rev. A	Final	
2	PIP-II Production SSR Focusing Lens Technical Requirements Specification (TRS), TC ED0013800 Rev. A	Final	
3	Test results from the Pre-series Magnet	Final	

4	PIP-II SSR Production Solenoid EM Design Report	Final	