PIP-II
Project Director Report
August 2022

PROJECT HIGHLIGHTS

- UKRI-STFC delegation visits Fermilab, PIP-II
- pHB650 cryomodule achieves important milestone
- Ongoing LLRF work at STC
- More ASPIRE student updates

UPCOMING EVENTS

5–9 Sept.	Fermilab Director, PIP-II leadership visit to India

UKRI-STFC delegation visits Fermilab, PIP-II

Fermilab hosted the British Consul General in Chicago and a delegation from the United Kingdom Research and Innovation (UKRI) and the Science and Technology Facilities Council (STFC) — including Mark Thomson, executive chair of STFC — on Aug. 24, 2022, to meet new laboratory director, Lia Merminga, and to learn about our facilities, science programs and capabilities. The visit included an overview of Fermilab–UK collaboration in neutrino, accelerator and quantum programs. The delegation toured various facilities including the assembly of PIP-II high-beta 650 MHz cryomodule.

Fermilab hosted the British Consul General in Chicago and a delegation from United Kingdom Research and Innovation and the Science and Technology Facilities Council on Aug. 24, 2022. Photo credit: Ryan Postel

Prototype HB650 cryomodule achieves important milestone

The high beta 650 MHz (HB650) cryomodules occupy the final accelerating section in the PIP-II accelerator. These are the longest and heaviest amongst PIP-II cryomodules, and the majority of these in production will undergo overseas transport after assembly by PIP-II's international Partner in UK. Having implemented feedback from previous projects like LCLS-II, ESS, and the PIP-II prototype Single Spoke Resonator Type 1 (SSR1) cryomodule, a prototype of the HB650 cryomodule is currently being assembled at Fermilab. Lessons from this prototype HB650 cryomodule will feed into the design and assembly of PIP-II's future pre-production and production cryomodules.

The HB650 cryomodule contains six β=0.92 cavities. These are integrated into a string of cavities with couplers and intermediate components in an ISO 4 cleanroom. After, outside the cleanroom, the string is integrated with additional components, like instrumentation, frequency tuners, magnetic shields, etc. The SSR and 650 cryomodules employ a novel room-temperature strongback on the bottom, and the string and the remaining cryomodule cold mass are built over it. The lowering and mating of the string with the strong back is a critical step in the cryomodule assembly process — as these are manufactured and assembled independently up to this stage — and influence mechanical stability, vacuum integrity and ability to align the cavities. This lowering and mating of the prototype HB650 string with the strongback was successfully completed in August 2022, achieving another important milestone in the HB650 program.

This prototype HB650 cryomodule will now undergo a very critical final alignment of the string on the strongback, which impacts the particle beam that passes through these cavities in the accelerator. Next, the cold mass will be built over this assembly and inserted into a vacuum vessel. After some additional assembly, the cryomodule will be complete. Validation of the design and assembly processes is obtained through (1) a cold RF test of the cryomodule where the cavities will be at 2 K, (2) an overseas transportation test of this cryomodule by transporting it to and from our Partner in UK and (3) a repeat cold RF test of the cryomodule. The cryomodule is validated once the requirements for alignment, heat loads, vacuum, etc. are met.

The prototype HB650 cryomodule during assembly, after achieving an important milestone of the string being lowered and mated to the strongback. Photo credit: Charles Grimm

Construction of the PIP-II access road is underway. Photo credit: Steve Dixon

Ongoing LLRF work at the Spoke Test Cryostat

Following the most recent low-beta 650 MHz (LB650) cavity test at the Spoke Test Cryostat (STC), the low-level radiofrequency team was afforded an opportunity for dedicated study time — a rare occurrence. Difficulties were initially encountered using the Fermilab-built Low Level RF (LLRF) controller running in Generator Driven Resonance mode operation due to large Lorentz Force Detuning effects and problems with Fast (Piezo) tuning feedback. Ponderomotive instabilities, suspected but previously undetected, appear to be the source of the inability to drive cavities stably on resonance in this mode. Recently, a controller based on the design for LCLS-II at SLAC (and the planned controller for PIP-II) has been installed and is being placed into service at STC. Early results at low gradient are encouraging, but further calibration steps are needed before reaching full gradient operation.

Dedicated study time on various subsystems, such as LLRF, are important for validating and finalizing PIP-II designs. This is but one example and underscores the ongoing collaborative nature of work across the entire PIP-II project as well as with the project's partners.

ASPIRE students make progress

Accelerator Science Program to Increase Representation in Engineering, or ASPIRE, is a Fermilab fellowship providing immersive learning experiences to undergraduate and graduate engineering students who are historically and contemporarily underrepresented in accelerator engineering fields. The 2022 cohort is participating in the design, development and construction of PIP-II; here are updates from three of this year's six ASPIRE fellows:

Victor Rodriguez is working on the design of the CDS Access Platform, a 150m-long structure to be installed in the PIP-II tunnel to allow for personnel and equipment access to the interfaces connecting the linac's cryomodules with the Cryogenic Distribution System. This design requires careful interfacing with the complex geometry of the Cryomodule Distribution System itself, as well as consideration of the ergonomic aspects of the linac's installation and maintenance.

Luis Bravo is conducting a load flow and arc flash analysis of the PIP-II project's linac complex process power using the electrical network modeling and simulation software tool ETAP. This analysis will help to identify potential areas of concern within the current design of the linac complex process power system and determine ways to mitigate them and establish appropriate safety protocols. Luis will continue this work throughout the school year and eventually do the same analysis for other projects at the lab.

Monika Sadowski is working with the PIP-II Mechanical Fluids group to prepare procurement readiness packages for several fluid system construction projects. This work includes creating engineering notes for the various fluid systems, updating P&ID drawings using AutoCad Plant 3D, creating purchase requisitions and applying fluid mechanics theory to solve complex fluid system problems.