

PIP-II

Project Director Report



October 2022



PROJECT HIGHLIGHTS

- LB650 new record test
- Successful transportation test to STFC UKRI
- 650 MHz high-power RF commissioning at PIP2IT
- First cold testing of SSR2 cavity

UPCOMING EVENTS

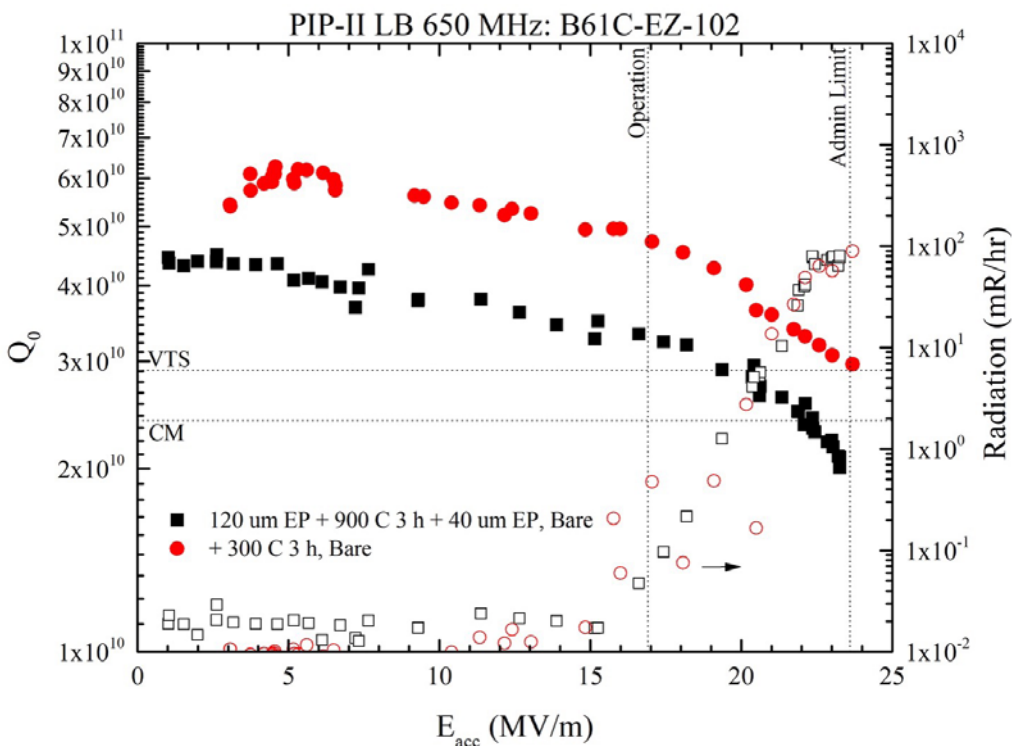
16 November | P2PEB#13

LB650 new record test

A processing recipe optimization program is currently in progress for the 650 MHz $\beta=0.61$ (LB650) cavities. A LB650 cavity, B61C-EZ-102, was previously bulk electropolished, heat treated at 900 °C for 3 hours in high vacuum to degas hydrogen, tested in a vertical test stand, and then heat treated at 300 °C for 3 hours in a high vacuum. This last step is also referred to as the mid-T

bake in the SRF community and is anticipated to increase the quality factor (Q_0) while minimizing the impact on the accelerating gradient (E_{acc}) of the cavity.

As illustrated in the figure, the results from the test of -102 after the mid-T bake (red circles) are compared to the pre-mid-T bake test (black squares).



The results agree with the trends seen in the community, with an approximate 45% increase in Q_0 at the operating gradient of 16.9 MV/m. While both recipes have resulted in the Q_0 meeting specifications, the mid-T bake provides an opportunity for significant increase in margin for Q_0 during operation. The optimization program shall continue with three additional cavities and a couple of other recipes. A final decision on the recipe will culminate in a processing Final Design Review.

Successful transportation test to STFC UKRI

The latest test of the cryomodule transportation system was a trip from Fermilab to PIP-II partners in the UK. The voyage started on Sept. 23 at Fermilab's Industrial Center Building where the dummy load was installed and secured inside the transportation frame. The system was also instrumented with sensors to capture shocks observed during the test.

The entire trip consisted of a drive to O'Hare International Airport, a flight on a cargo plane to Luxembourg, then a drive from Luxembourg to the UK — including a trip through the Channel Tunnel. The frame reached our partners at STFC UKRI's Daresbury Laboratory on Oct. 3. There, the team removed the panels and dummy load from the frame and examined the sensors, bumpers, springs, and other hardware. After checking all components, the transport system was reassembled, loaded onto the truck, and sent on its way back to Fermilab on Oct. 5. It arrived back in Batavia on Oct. 11.

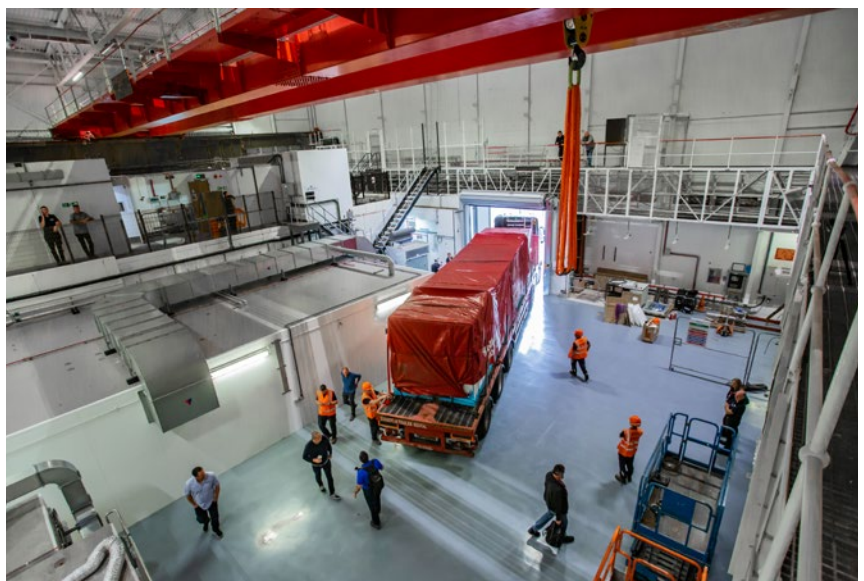
The test was performed using procedures, techniques, and oversight that were as realistic as possible. From the isolation system and vibration instrumentation to handling, logistics, and customs, the test closely mimicked what the real cryomodules will go through during transportation. All aspects of the transportation system were deemed validated by this test.



Loading the trailer for the departure from Fermilab. Credit: Adam Wixson



The frame is loaded onto the cargo plane at O'Hare International Airport. Credit: Brian Hartsell



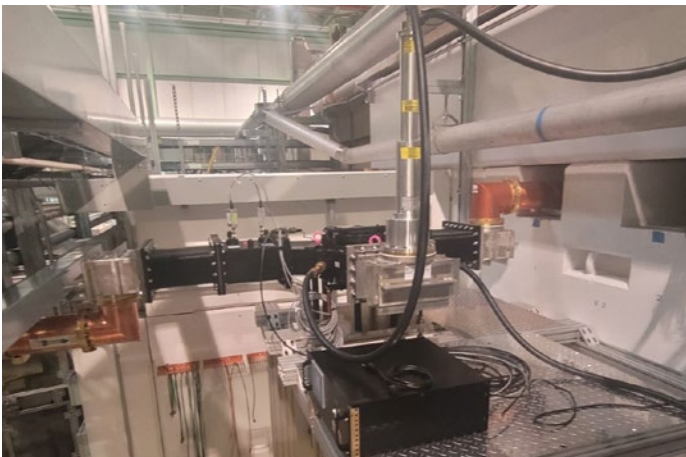
The truck backs into the facility at Daresbury Lab. Credit: Mitchell Kane

650 MHz high-power RF commissioning at PIP2IT

Commissioning of the 650 MHz high-power radiofrequency (RF) system at PIP2IT has begun. 40 kW of continuous wave RF power was run from the prototype amplifier, built and delivered by Raja Ramanna Centre for Advanced Technology in India, through the circulator and into the tunnel to a water-cooled dummy load within feet of its final connection: the superconducting RF cavities comprising the pHB650 cryomodule. The cryomodule is expected to arrive at PIP2IT in the coming weeks. Operational readiness clearance, RF leak checking, and performance verification occurred in the last week of October, and the results met expectations. This is the first 650 MHz

test configuration at PIP2IT. The prototype HB650 cryomodule's six cavities will be sequentially powered during cold testing of this cryomodule.

Previous tests of the amplifier and circulator have been done independently; this test allowed for the first measurements of the integrated system's overall performance, including insertion loss and basic RF parameters. Further integrated testing is foreseen prior to cold testing of pHB650, with the amplifier being driven by the low-level RF drive system. This achievement brings PIP2IT even closer to readiness for the first testing of a 650 MHz cryomodule.



40 kW, 650 MHz RF distribution system, including circulator, external to the PIP2IT cave. Credit: Victor Grzelak

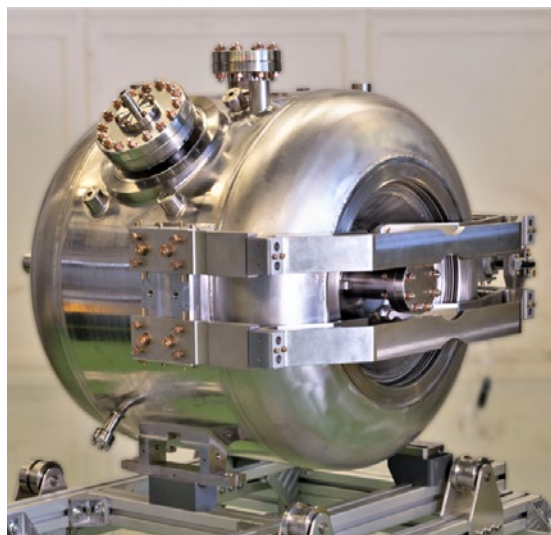


40 kW, 650 MHz Solid State Amplifier (two cabinets) in the CMTF building. Credit: Victor Grzelak

First cold testing of SSR2 cavity

The first pre-production SSR2 cavity, S2-ZA-001, was prepared and dressed with the frequency tuner for cold testing at IJCLab. The cavity was successfully cooled down to 2K, demonstrating very sound structural performance. The frequency was found in the expected range, and subsequently tuned to the nominal frequency of 325 MHz. The coarse- and fine-tuning performance were successfully verified through the use of electromechanical motor and piezos installed on the double-lever frequency tuner. The sensitivity of the cavity to helium pressure fluctuations was measured within project requirements ($df/dp < 20\text{Hz/Torr}$). However, the cavity did not reach the specified nominal accelerating gradient of 11.4 MV/m because of high radiation due to field emission. The setup of the HPR

wand and nozzles was identified as the root cause of field emission. Changes were implemented to improve the rinsing of all inner niobium surfaces based on the results of numerical simulations.



Credits: Dominique Longieras, David Longuevergne (IJCLab)