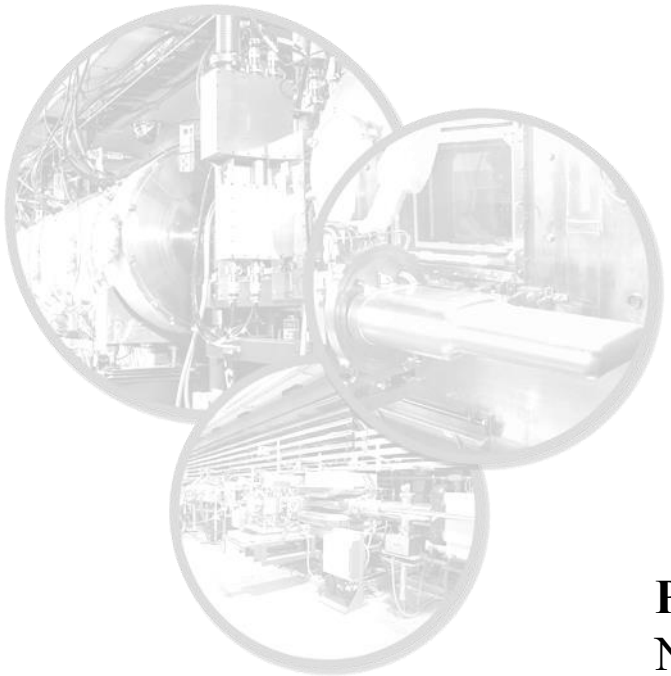
DEVELOPMENT OF HELIUM VESSEL WELDING PROCESS FOR SNS PPU CAVITIES

IPAC21

May 24-28, 2021



P. Dhakal, K. Macha, J. Fisher, K. Davis, P. Owen, K. Wilson, N. Haque, M. Wiseman, and E. F. Daly

Jefferson Lab

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

U.S. DEPARTMENT OF ENERGY | Office of Science

JSA

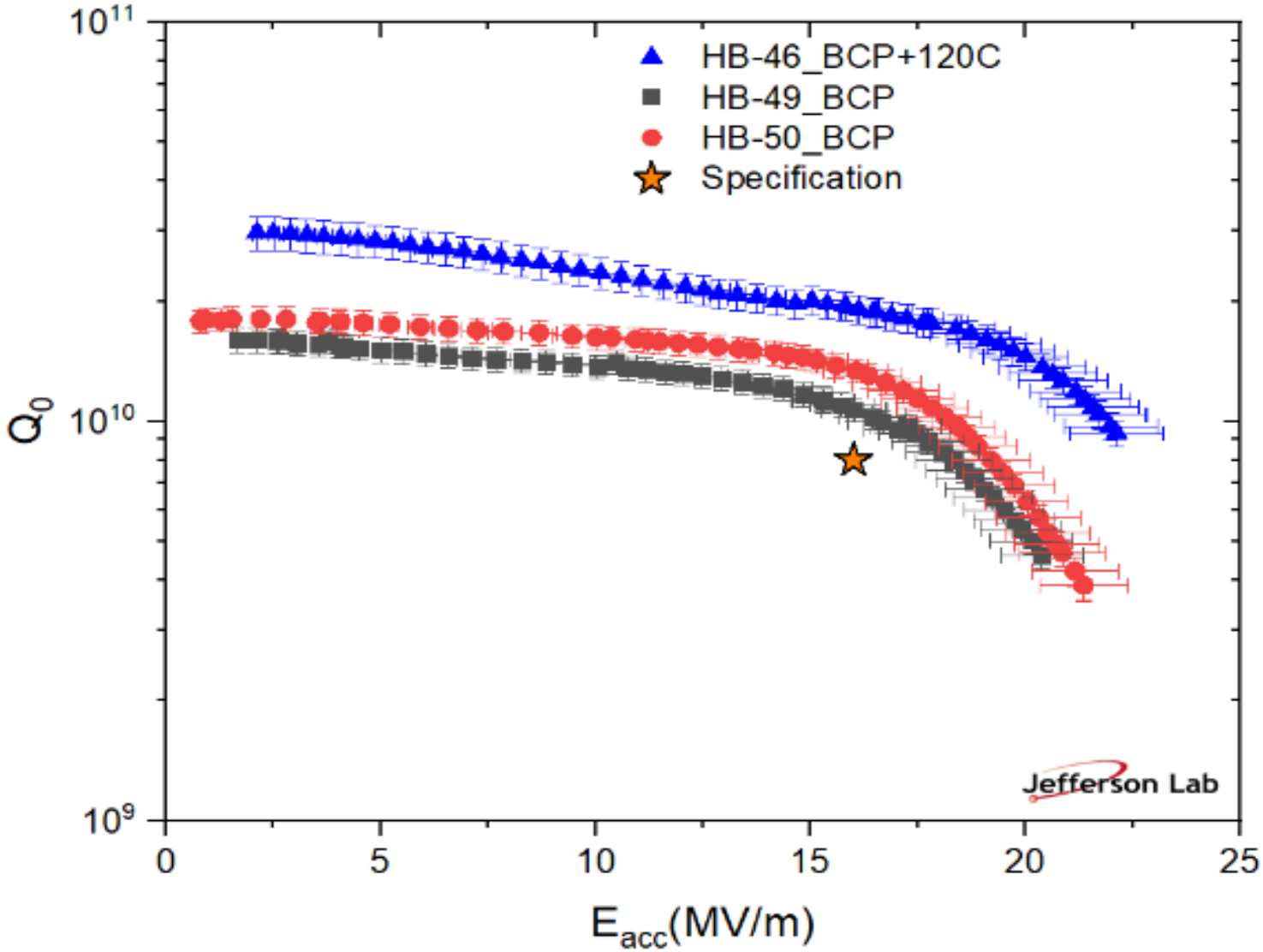
Abstract

The Spallation Neutron Source Proton Power Upgrade (SNSPPU) cavities are produced by Research Instrument with all the cavity processing done at vendor sites with final chemistry applied to the cavity to be electropolishing. Cavities are delivered to Jefferson Lab, ready to be tested. One of the tasks to be completed before the arrival of production ready PPU cavities is to develop a robust helium vessel welding protocol. We have successfully developed the process and applied to three six cell HB cavities. Here, we present the summary of RF results, welding process development and post helium vessel RF results.

Introduction

- One of the task to be completed before baseline qualifications of production ready PPU cavities is to develop the robust helium vessel welding protocol.
- Jefferson Lab received three six cell HB cavities with earlier design to develop the helium vessel welding protocol.
- All three cavities were processed at Jefferson Lab and vertical RF tests at 2.1K were done.
- Typical processing steps includes the 600 °C heat treatment for hydrogen degassing for 10 hours flowed by ~ 30 μm buffer chemical polishing in JLab's closed chemistry system.
- The cavities were tuned to field flatness better than 90%. The cavities received first 2 pass HPR, pre-assembly and additional 2 pass HPR before the final assembly to test stand.
- Cavity HB-046 was subjected to additional low temperature baking at 120 °C for 24 hours before the vertical test.
- The cavities were tuned to ~804 MHz at room temperature for fundamental mode with all pass band frequency being measured. The field profile measurements were recorded with the field flatness of > 90%.

Initial Cavity RF Test Results

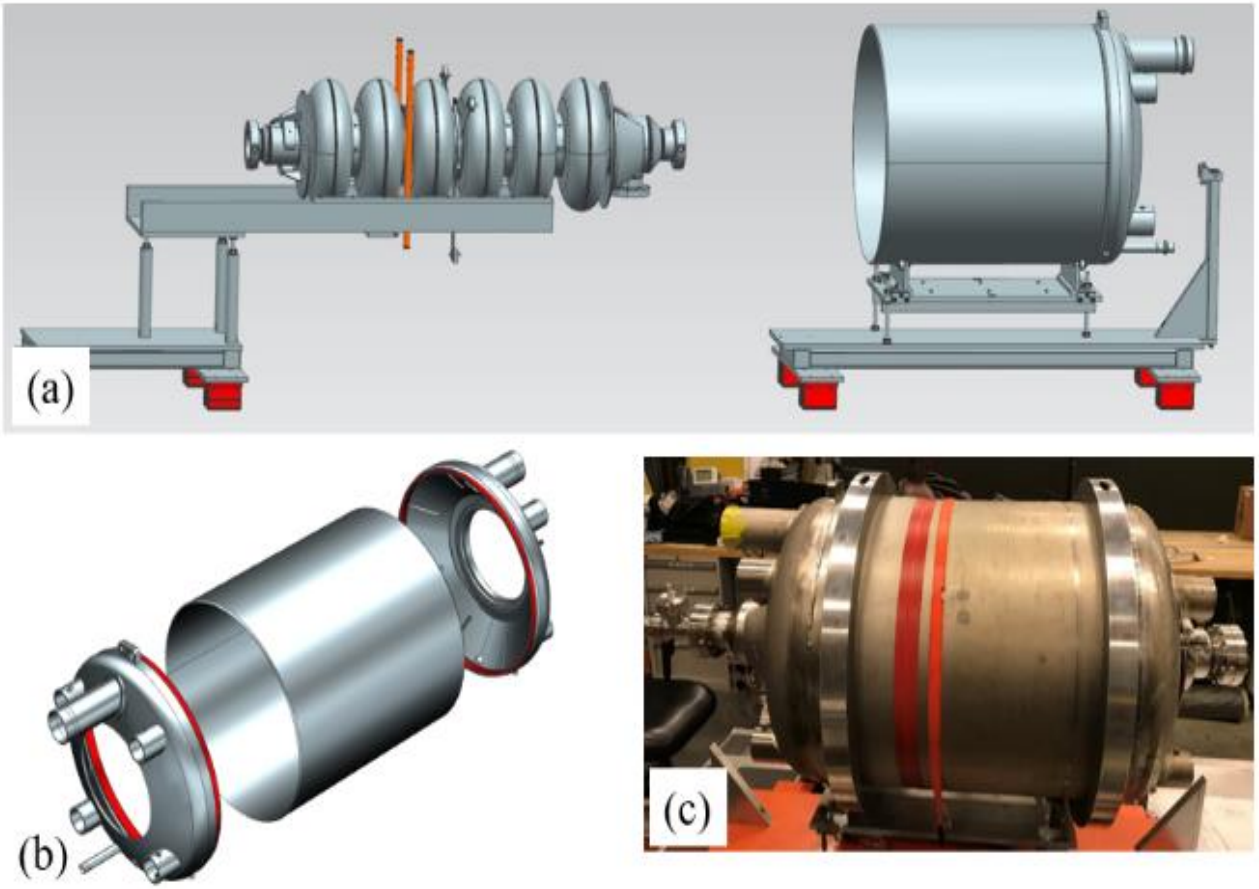


HV Welding Development

Goal: Develop robust HV welding process development without compromising RF performance.

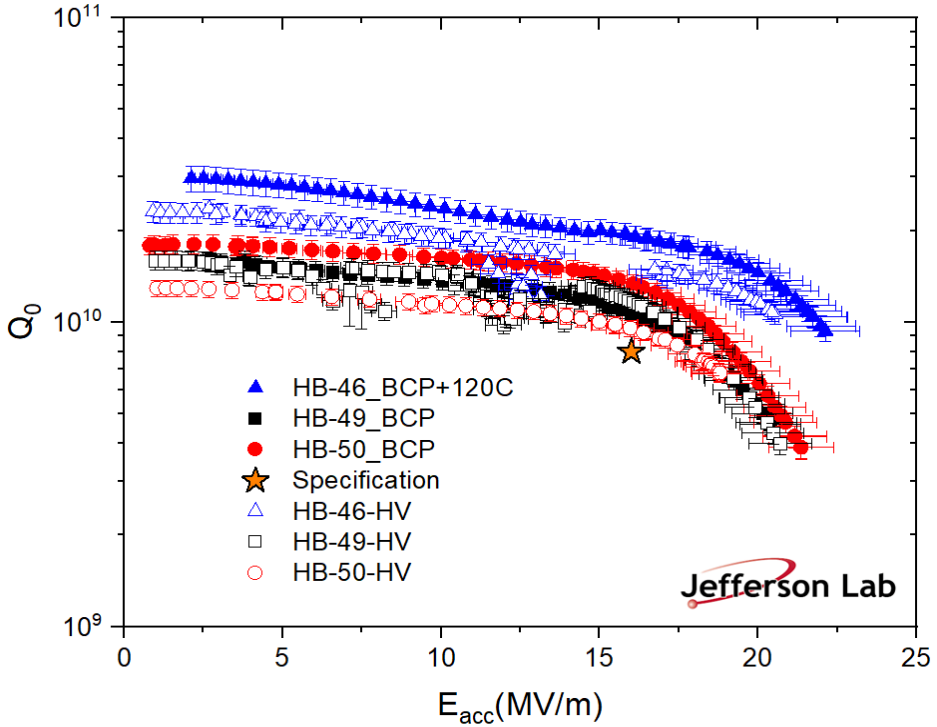
- Development of HV welding procedure with cavity under vacuum
- Potential issue we may encounter is frequency shift and field profile
- Continuous monitoring fundamental mode during welding. Can't check FF during welding process.
- RF test after HV welding followed by leak/pressure check.
- Check RF performance before and after HV Check FF after RF test

HV Welding Development

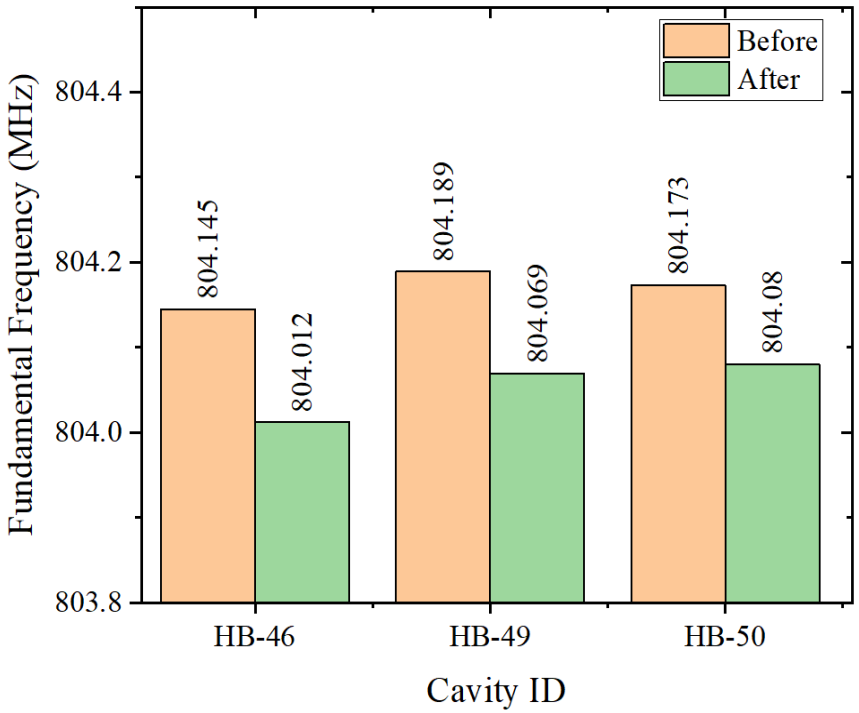


(a) The schematic of the He vessel welding fixture with cavity on rail, (b) schematic of helium vessel and (b) the cavity after completed welding.

Post HV RF Test Results



Summary of RF test before and after HV welding at 2.1 K.



The fundamental frequency before and after the HV welding.

Summary of developmental cavity performances

Cavity ID	Status	E_{max} (MV/m)	Q_0 at E_{max}	Q_0 at 16 MV/m	Limitation	Field flatness (%)
HB-46	Bare	22	9.3×10^{9}	2.1×10^{10}	Quench	95
HB-46	HV	20.54	1.1×10^{10}	1.9×10^{10}	Quench	91
HB-49	Bare	20.3	4.6×10^{9}	1.1×10^{10}	RF Power	96
HB-49	HV	20.7	4×10^{9}	1.2×10^{10}	Admin	93
HB-50	Bare	21.3	4×10^{9}	1.3×10^{10}	RF Power	95
HB-50	HV	18.8	6.8×10^{9}	9.6×10^{9}	MP/Quench	95

Summary

Prior to the work start on the production cavities, three high beta cavities were successfully processed at Jefferson Lab with all cavities exceeding the PPU specification in accelerating gradient and quality factor. The helium vessel welding process was developed for the production cavities without any significant change in the RF performance. The developed process is currently being applied to the production cavities.

P. Dhakal

dhakal@jlab.org

Questions?

Authored by Jefferson Science Associates, LLC under U.S. DOE Contract No. DE-AC05-06OR23177.