

#### **RFD Cavity Processing Update**

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TTC meeting, Riken Nishina Center – June 28th 2018

### Outline

- Processing and testing bare RFD cavities
- Upgrades from LARP to AUP processing
- Test results
- Summary



### **Fabrication and Testing Plan**

- Bare cavities procurement in industry
- Processing/Testing in laboratories (ANL and FNAL)
- Centralized management at Fermilab (Issue PO's, Perform QC)



(ANL+FNAL)



(Industry)

#### **Bare Cavities Processing and Testing Plan**

- Buffered chemical polishing based SRF cavity processing plan
  - Long history for complex geometries not suitable to electropolishing
- Standard SRF Cavity Cleanroom and Heat Treatment Techniques adapted to RFD geometry



HL-LHC

### **Upgraded BCP tool at ANL I**

- RFD cavities BCP has been performed at Jlab in a static, set-up.
- New rotational BCP tool has been developed at ANL and RFD-LARP-001 cavity has been processed.
  - Allows more uniform removal
  - Better acid circulation and drainage

![](_page_4_Figure_5.jpeg)

![](_page_4_Picture_6.jpeg)

Rotational BCP tool for RFD cavity at ANL

## **Upgraded BCP tool at ANL II**

- In addition the BCP tool can tilt the cavity for better acid evacuation or improved rinsing right after BCP procedure.
- Cavity temperature is kept under control using chilling water on the outside of the cavity
- First rotational BCP performed in April 2018

![](_page_5_Picture_4.jpeg)

![](_page_5_Picture_5.jpeg)

![](_page_5_Picture_6.jpeg)

Horizontal position of the BCP tool

Vertical position of the BCP tool

Rinsing position after BCP

![](_page_5_Picture_10.jpeg)

## **Upgraded BCP tool at ANL III**

- Material removal has been compared between the two BCP procedure: AVG removal is 48 microns for ANL, 40 microns for Jlab.
- Uniform removal confirms better process compared to BCP prformed on static RFD: Standard deviation in etch data drops to 1/3 going from static to rotating cavity BCP.

![](_page_6_Picture_3.jpeg)

Location	ANL BCP 48 µm	JLAB BCP 40 µm
HHOM	46.1	22.5
VHOM	55.0	58.6
FPC	48.6	28.4
BODY	44.5	25.1
POLE (left)	51.8	26.2
POLE (right)	51.3	28.7
MAX	66	213.7
MIN	25.4	8.5

![](_page_6_Figure_5.jpeg)

![](_page_6_Figure_6.jpeg)

# **Upgraded BCP tool at ANL IV**

- Visual inspection after light rotational BCP showed the inner surface has a uniform matte looking.
- No signs of long and big bubble traces: slow rotation is preventing big bubbles formation in the acid mixture!
- No signs of chemisty residue: succesful evacuation and rinsing

![](_page_7_Picture_4.jpeg)

### **RFD cavities HPR at ANL I**

- Use of a high pressure rinse set-up using multiple ports → combination of hand-HPR and automated procedure
  - ANL automatic tool has been upgraded to allow automated beam ports HPR
  - HHOM, VHOM FPC and PU ports are rinsed by hand.

![](_page_8_Picture_4.jpeg)

#### **RFD cavities HPR at ANL II**

![](_page_9_Figure_1.jpeg)

#### **RFD-LARP-001 VTS at FNAL I**

- Results of 1<sup>st</sup> test confirm Jlab results
- Q<sub>0</sub> was consistently higher than 1E10 up to quench.
- Cavity quenched at 4.7 MV of V<sub>t</sub> exceeding the requirements of 4.1 MV.

![](_page_10_Figure_4.jpeg)

![](_page_10_Picture_5.jpeg)

### **RFD-LARP-001 VTS at FNAL II**

- Results of 2<sup>nd</sup> test at FNAL, <u>after light BCP at ANL</u>, were affected by Field Emission.
- Q<sub>0</sub> at low field, up to 2 MV, above 1E10 validates the BCP procedure at ANL.
- Cavity quenched at 3.5 MV with consistent field emission, not meeting the required value of  $Q_0$ =3.9E9 at V<sub>t</sub> =4.1 MV.
- HPR procedure has been modified to reduce FE.

![](_page_11_Figure_5.jpeg)

![](_page_11_Picture_6.jpeg)

### **RFD-LARP-001 VTS at FNAL III**

- HPR procedure has been modified to reduce FE: <u>No radiation</u>.
- 3rd test after HPR at ANL showed improved FE but still low V<sub>t</sub> at quench, consistent with previous test.
- Optical inspection shows overall good surface except for some unusual pitting in the electrode areas (not responsible for quench).
- Quench location (not accessible with camera) detected with 2<sup>nd</sup> sound and thermal sensors (possible local defect, investigation ongoing...)

![](_page_12_Picture_5.jpeg)

## Summary

- RFD cavities have been successfully processed and tested at Jlab in the past throughout LARP.
- Jlab results have been confirmed at FNAL.
- Rotational BCP of RFD cavity has been performed at ANL.
- HPR procedure has been optimized, lowest field emission detected on RFD cavity.
- Despite early quench of the cavity processed, optical, visual inspection and thickness measurements validate the rotational BCP procedure.

![](_page_13_Picture_6.jpeg)