New ANL/FNAL SRF Cavity Processing and Testing Facilities - Part 1

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Outline

• ANL/FNAL SRF collaboration history
• Overview of collaboratively developed processing facilities
  ▫ Processing recipe
  ▫ Processing tools
• FNAL facility use of SCSPF
  ▫ Cavity types
  ▫ Throughput
• Planned use and need for expanded facilities
  ▫ SSR dedicated HPR cleanroom facility
  ▫ Production and R&D plans
• Mike Kelly—Part 2
ANL/FNAL SRF Collaboration History

• Began in CY 2002---Executive interest letters
• Leadership of Ken Shepard (ANL/Phy Div) and Helen Edwards (FNAL/Accel Div)
  ▫ ANL desired expanded and improved facilities over G150
  ▫ FNAL wanted to support 3.9 GHz CKM and 3rd Harmonic program—no existing chemical facilities at FNAL or supporting safety program
• FNAL began processing 3.9 GHz cavities in G150 in 2003
ANL/FNAL Collaboration History

• Superconducting Cavity Surface Processing Facility (ANL/FNAL SCSPF) development – Chemistry rooms 2003-2004, Cleanrooms 2005
• ILC Cold Technology Decision Jan. 1, 2005
• FNAL BCP System (later replaced) 2005-2006
• ANL/FNAL EP Tool for 1.3 GHz elliptical cavities 2006-2007
• FNAL cleanroom hardware (HPR tool, etc.) 2007-2008
• Full 1.3 GHz EP/HPR/Assembly work Jan 2009
• ANL EP Tool for QWR/650 MHz 2011-2012
Current Status of Collaboration

• SCSPF mutually operated and funded by ANL/FNAL.
• Technicians from FNAL are in permanent residence at SCSPF to perform all CR work. ANL—chemistry.
• Mutually agreed upon operating schedule manages facility and personnel resources.
• Diverse cavity processing program (FNAL and ANL push many types of resonators).
• Production and R&D cavity processing occur simultaneously.
• Test-bed for technology transfer to industry.
### General SRF Cavity Processing Recipe

<table>
<thead>
<tr>
<th>Step</th>
<th>Purpose</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection (RF, Optical, Mech.)</td>
<td>QA/QC</td>
<td>FNAL IB4/ICB</td>
</tr>
<tr>
<td>Bulk Chemistry (EP/BCP)</td>
<td>Damage layer removal</td>
<td>SCSPF Chem Rooms</td>
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<tr>
<td>Post Chemistry Cleaning</td>
<td>Prep. for H2g Degas Bake</td>
<td>SCSPF Cleanrooms</td>
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<tr>
<td>High Temp. bake (600C, 800C)</td>
<td>H2g Degas</td>
<td>FNAL IB4/MP9</td>
</tr>
<tr>
<td>RF tuning</td>
<td>Field flatness and/or Freq. adj.</td>
<td>FNAL IB4</td>
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<tr>
<td>Light Chemistry (EP/BCP)</td>
<td>Final surface prep before VT</td>
<td>SCSPF Chem Rooms</td>
</tr>
<tr>
<td>Post Chemistry Cleaning</td>
<td>Prep. for HPR</td>
<td>SCSPF Cleanrooms</td>
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<tr>
<td>HPR and Assembly</td>
<td>Surface cleaning and assembly</td>
<td>SCSPF Cleanrooms</td>
</tr>
<tr>
<td>Slow Evacuation and leak check</td>
<td>Final VTS prep.</td>
<td>SCSPF Cleanrooms</td>
</tr>
<tr>
<td>VTS Testing</td>
<td>Performance test/qualification</td>
<td>FNAL IB1</td>
</tr>
<tr>
<td>Prep for cavity dressing</td>
<td>Prep for installing helium vessel</td>
<td>SCSPF Cleanrooms</td>
</tr>
<tr>
<td>Horizontal/CM Test Prep/HPR</td>
<td>Prep for installation into CM</td>
<td>SCSPF Cleanrooms</td>
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FNAL Use and Operations in SCSPF

1.3 GHz Cavity Electropolishing, 325 MHz BCP

650 MHz Cavity Electropolishing

SSR Cavity Rinsing

Bldg. 208 Rm B101
FNAL Elliptical Cavity Processing at ANL

- Ten 3.9 GHz 9-cell 3rd Harmonic cavities
  - BCP processed in G150 (CR work done at FNAL)
  - Developed 4 cavity CM at FNAL for DESY FLASH
  - Traded 4-cavity CM for TESLA 8-cavity 1.3 GHz CM kit
1.3 GHz TESLA/ILC/XFEL Cavities

- ILC Gradient and CM Development, GDE Statistics
- Project X CM Development
- FNAL ASTA Program
- High Q, thin films, NbN, Heat Treatment, CBP, Coatings, etc. R&D
Project X Requirements
— new cavity processing
FNAL 325 MHz SSR Cavity Processing at ANL

Dressed SSR1 Renderings

SSR2 for RISP/ Project X

M. Merio, P. Berrutti
SCSPF SSR Processing

SSR1 BCP on 1.3 GHz EP Tool
(T. Reid, R. Murphy)

SSR1 Ultrasonic cleaning in B101
Bldg 203 Rm G150---1st HPR only—Horiz. orientation

G150 CR Ops
- Not Class 10
- Difficult cavity handling
- Low throughput
- Disconnected from SCSPF
- Requires 2nd HPR in B101
B101 SSR 2\textsuperscript{nd} HPR—Vert. orientation—ANL HPR Tool

HPR Water Draining
ANL/FNAL SCSPF Cumulative 1.3 GHz Throughput—through FY 2011

SCSPF Operating Months

- 1-cell Test Preps
- 9-cell Vertical Test Preps
- Horizontal Test Preps
- Cumulative Test Preps
- Cumulative EP
Production and R&D Plans

- PXIE CM – eight 325 MHz SSR1
  - Full BCP sequence
- ILC/ASTA CMs – twenty 1.3 GHz 9-cell cavities
  - Light EP through dressing
- RISP – two 325 MHz SSR2 (new cavity type)
  - Full BCP sequence
- Project X 650 MHz – six 1-cell, five 5-cell B=0.9
  - EP/BCP combination
- 1.3 GHz R&D – two cavities/week average
- Possible work for others – European Spallation Source, Next Generation Light Source
Case for SCSPF CR Facility Expansion

- Variety of cavities in FNAL program increasing.
- R&D expanding beyond high $E_{\text{accel}}$ to high Q for CW.
- Desire to maintain dedicated elliptical cavity cleanroom areas to improve work function.
- SSR$_1$ (PXIE, Project X), SSR$_2$ (RISP, Project X) work increasing substantially.
- Minimize overlap in cleanroom use---ANL CR multi-functional and subject to schedule squeeze.
- SSR processing improvements with facility designed around process requirements—multi-directional HPR tool, specialized assembly setup, for example.
Acknowledgements

FNAL
- C. Baker
- D. Bice
- R. Espinoza
- O. Pronitchev
- B. Stone

ANL
- S. Gerbick
- M. Kelly
- R. Murphy
- T. Reid
Backup slides
SSR Cavity Processing Recipe

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Notes</th>
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<tbody>
<tr>
<td>1.</td>
<td>Inspection – RF &amp; Optical</td>
<td></td>
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<tr>
<td>2.</td>
<td>Bulk BCP (flip at 60 um)</td>
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<tr>
<td>3.</td>
<td>HPR</td>
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<td>4.</td>
<td>600°C 10 hrs &lt; 5°C/min ramp rate</td>
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<tr>
<td>5.</td>
<td>RF Tuning</td>
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<td>6.</td>
<td>Light BCP</td>
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<td>7.</td>
<td>HPR</td>
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<td>8.</td>
<td>Assemble</td>
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<tr>
<td>9.</td>
<td>Evacuate + 120°C Bake 48 hrs</td>
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<td>10.</td>
<td>Vertical Test</td>
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<tr>
<td>11.</td>
<td>Helium Vessel Dressing</td>
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<tr>
<td>12.</td>
<td>HPR</td>
<td></td>
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<tr>
<td>13.</td>
<td>Assemble</td>
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<tr>
<td>14.</td>
<td>Evacuate + 120°C Bake 48 hrs</td>
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<tr>
<td>15.</td>
<td>Horizontal Test</td>
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</tr>
<tr>
<td>16.</td>
<td>Ready for String</td>
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Vacuum baking should improve VT multipactor processing time.
SSR Performance

![Graph showing SSR performance metrics including radiation, $Q_0$, $E_{acc}$, $E_{pk}$, and $B_{pk}$ over time.]
IB4 Facility Developments

- FNAL IB4 CPL 1.3 GHz Facility Operational