Fermilab

Vertical Test Stand (VTS)

Camille M. Ginsburg
Fermilab
• 40 cavity tests in Oct’07-Apr’09, where “test” = cavity cryogenic thermal cycle
  – 9-cell & single-cell 1.3 GHz elliptical cavities, and 325 MHz SSR1 HINS cavities
  – instrumentation development, variable coupler, thermometry, cavity vacuum pump system, cavity vendor development, ANL/FNAL CPF commissioning
  – Throughput of up to 48 tests/yr projected; achieved short-term under ideal conditions
  – work done in collaboration with JLab, Cornell, ANL
• All recent consecutive ANL/FNAL process/assembly/tests of 1-cell cavities show no field emission, except
  – Test 7 TE1ACC002 handled with new pumping station
  – Test 14 FE appeared only after 120 C baking
• We are satisfied with complete cavity cycle for 1-cell cavities
1-cell cavity tests at VTS

- Single-cell work done in strong collaboration with Cornell U./ANL
- New cavity vendors AES and Niowave-Roark, and qualified vendor Accel (now Research Instruments)
- Single-cell ANL/FNAL cavities have excellent performance at VTS
9-cell cavity tests at VTS

VTS tests for: instrumentation development, cavity vendor development, ANL/FNAL cavity processing facility commissioning

FNAL 9-cell tests done in strong collaboration with JLab/ANL
- Most FNAL-tested cavities processed at JLab and tested without modification
- Few FNAL tests of ANL processed/assembled cavities

35 MV/m
Understanding Cavity Limitations

- Correlation Fast Thermometry -> optical inspection
- FNAL provided thermometry information and cavity used for development of KEK/Kyoto inspection system
• TE1AES004 has huge pit (Ø ~1mm) at edge of weld seam; nevertheless, 39 MV/m

- HPR and reassembly only
FNAL Test/Inspection/Thermometry

Good performance limited by quench. Found oxidized stripe going from beampipe into cell.

1-cell diode thermometry system located quench.
VTS Diagnostic Instrumentation

• Fast Thermometry
  – Well established and useful

• Variable Coupler
  – Several system tests
  – Works well
  – FE to be overcome

• Diode Thermometry
  – 1-cell prototype working
  – 9-cell version in progress

• Second Sound
  – Cornell system implementation planned
VCTF Upgrade Cavity Requirements

- Cavities to accommodate
  - ILC/SRF R&D
    - 9-cell and 1-cell elliptical ILC cavities
  - HINS/Project X
    - SSR1
    - SSR2
    - TSR
    - 9-cell elliptical cavities
  - Do not fit in VTS1

- Conclusion
  - VTS1 is sufficient to support FY09, FY10 test plans
  - VTS2 with larger diameter operational by ~Dec. 2010 to support increased throughput and SSR2, TSR as needed
  - VTS3 needed by ~Sep. 2011

- Our Plan: New design with Indian Institutions for VTS2&3
  - Build VTS2 in U.S. Industry
  - Build VTS3 slightly later in Indian Industry with same design
## Americas Cavity Inventory

### Tesla-shape nine-cell cavities

<table>
<thead>
<tr>
<th>Description</th>
<th>No. Cavities</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES 1-4</td>
<td>4</td>
<td>tested</td>
</tr>
<tr>
<td>AES 5-10</td>
<td>6</td>
<td>received; testing in progress</td>
</tr>
<tr>
<td>AES 11-16</td>
<td>6</td>
<td>due Oct 2009</td>
</tr>
<tr>
<td>Accel 6-9</td>
<td>4</td>
<td>tested</td>
</tr>
<tr>
<td>Accel 10-17</td>
<td>8</td>
<td>received Mar 2008; testing in progress</td>
</tr>
<tr>
<td>Accel 18-29</td>
<td>12</td>
<td>due May 2009</td>
</tr>
<tr>
<td>Jiab fine-grain 1-2</td>
<td>2</td>
<td>fabrication complete; testing in progress</td>
</tr>
<tr>
<td>Niowave-Roark 1-6</td>
<td>6</td>
<td>due Oct 2009</td>
</tr>
<tr>
<td>Stimulus Procurement</td>
<td>40</td>
<td>still in the planning stages; assume first cavities ~April 2010</td>
</tr>
</tbody>
</table>

**Total** 88

**Already Received** 24

### Tesla-shape single-cell cavities

<table>
<thead>
<tr>
<th>Description</th>
<th>No. Cavities</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES 1-6</td>
<td>6</td>
<td>tested at Cornell; further testing in progress</td>
</tr>
<tr>
<td>Accel 1-6</td>
<td>6</td>
<td>received Dec 2008; testing in progress</td>
</tr>
<tr>
<td>Niowave-Roark 1-6</td>
<td>6</td>
<td>tested at Cornell; further testing in progress</td>
</tr>
<tr>
<td>PAVAC</td>
<td>4</td>
<td>requisition in progress</td>
</tr>
</tbody>
</table>

**Total** 22

**Already Received** 18

- Expect to increase cavity inventory substantially
VCTF Upgrade

- Increase cavity test throughput
  - Current throughput estimate: 48 cavity tests/year
  - Increase throughput to >200 cavity tests/year by Oct 2011
- Planned upgrades
  - Improve cryogenic system reliability
  - Reduce interference with magnet test program
  - Two more cryostats and staging area

Very similar to Feb.2007 plan
Present IB1 Configuration

**Disadvantages**
- Shared VCTF/MTF Vacuum Pumping
- Limited suction pressure control
- High He contamination risk from sub atmospheric operations
- Undersized Gas Storage capacity relative to LHe inventory
- Shared VCTF/VMTF 10-ton crane bridge

**Consequences**
- Unable to support high cavity test throughput
- Excessive interference with magnet testing

- Gas Storage (3 x 30,000 Gallon Tanks)
- Refrigerator Compressors
- Partial Purifiers (~ 50 g/s)
- Refrigerator Cold Box
- LHe Dewar (10,000 Liters)
- VCTF/MTF Kinney Pumps (6 g/s@23Torr)
- VCTF (1 Test Stand)
- MTF (5 Test Stands)
- Gas Storage
- Limited suction pressure control
- High He contamination risk from sub atmospheric operations
- Shared vacuum pumping
- 10-ton Crane Bridge
- Shared 10-ton crane bridge
- Undersized GHe storage relative to LHe inventory
### Upgraded IB1 Configuration

**Advantages**
- Independent VCTF/MTF Vacuum Pumping
- Adequate suction pressure control
- Minimize He contamination risk from sub atmospheric operations
- Matched GHe capacity with LHe inventory
- Independent VCTF/VMTF 10-ton crane bridge

**Consequences**
- Can support high cavity test throughput
  - >250 “standard” cavity test cycles/year, three cryostats, two cavities per cryostat
- Low interference with magnet testing
VTS/IB1 FY09 Plans

- Plan to obligate funds in FY09 for VTS Upgrades (VTS2&3 plus cryogenic infrastructure upgrade) using ARRA + SRF funding
- Prepare space for new cryogenic equipment – ready FY09
- Procure two purifiers, cryogenic piping & instrum, 1,500 KVA Transformer - FY09
- IB1 civil construction for upgrades: two larger diameter pits plus trenches, dedicated 10-ton crane bridge
  - Place POs before end of FY09, civil construction summer FY09
  - Very disruptive to cavity and magnet test programs (~ 6 weeks IB1 downtime)
  - Fermilab internal (FESS/TD Support) activity for civil construction started
- Complete design of full VTS cavity staging area – FY09
- Design VTS2&3 cryostats as part of FNAL-Indian Inst. collaboration
  - As similar as possible to VTS1 to minimize design effort/time: major changes include larger diameter & length, higher capacity J-T heat exchanger
  - Includes top plates, magnetic & radiation shields, cryostat internal cryogenic piping and instrumentation
  - Preliminary Design Review in May 2009
- Procure VTS2 – FY09
Projected VTS Cavity Throughput

- Assumes sufficient staff available
- Satisfies projected need shown in detail in A. Rowe’s talk
Milestones

- **VTS2&3 civil construction**
  - July/August 2009

- **VTS 2 cryostat**
  - preliminary design review May 2009
  - fabrication & delivery in FY10
  - installation in FY10-FY11
  - commissioned in FY11

- **Cryogenic system upgrades**
  - procurement completed by end of FY09
  - commissioned in FY11

- **VTS 3 cryostat**
  - fabrication & delivery in FY10-FY11
  - installation in FY11
  - commissioned in FY11
ARRA and Other Funding

- **ARRA**
  - VTS2 Cryostat
  - IB1 Purifiers
  - IB1 Transformer

- **SRF Program**
  - 10-ton crane bridge
  - IB1 Building modifications
  - VTS2&3 civil construction

- **Indian Institutions Collaboration (in-kind contribution)**
  - VTS3 cryostat
Conclusions

• Progress/accomplishments in past two years
  – Vendor qualification
  – Instrumentation development
  – 1-cell cavity qualification (including processing)
  – Throughput goal has been met short term under ideal conditions

• Plan for next two to three years
  – Substantially higher throughput: +2 cryostats, cryo system upgrades
  – ARRA funds to speed up these improvements

• Collaboration with other national labs and universities
  – DESY: TTF cryostat operational experience, radiation shielding data
  – JLab: RF/DAQ system, cavity processing and qualification (9-cells)
  – Cornell: cavity processing and qualification (1-cells)
  – KEK: vendor qualification with thermometry & cavity optical inspection
  – Indian Institutions: design and procurement of VTS2&3

• Technical Milestones
  – for VTS1 have been met
  – for VTS2&3 expected within 2-3 years