JLab SRF ILC Activities and Plans

ILC SCRF Meeting, @ Fermilab, April 21st-25th 2008

JLab FY09 high-gradient plan

JLab Philosophy toward achieving ILC GDE Objectives:

Pursue maximal scientific understanding and lead process improvement and risk reduction based on knowledge. Design tasks to answer specific high priority technical questions.

We identify three broad goals that together address this higher level challenge.

Goal 1: Understand the causes of cavity performance variability at the high gradient limit.

Goal 2: Optimize the standard processes for reliable performance.

Goal 3: Pursue alternative concepts to the baseline which address cost and technical risk.

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Goal 1: Understand the causes of cavity performance variability at the high-gradient limit.

- Identify the nature and location of the limiting quench site in every cavity by T-mapping and visual inspection and by sacrificial analysis of single-cell cavities.
- Quantify the first-pass and second-pass 9-cell yield using the best effort "standard process" (S0 goal).
- Continue the fight to eradicate field emission in 9-cells.
- Deliver qualified cavities for the S1 cryomodule goal.
- Exchange cavities between regions for cross calibration of methods.

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Goal 2: Optimize the standard processes for reliable performance.

- Working with small samples, continue contamination studies, quantitative topographical characterization with all candidate materials, and fundamental EP process characterization with attractive parameter sets.
- Based on what is learned from cavity defect characterization and systematic sample analysis, perform targeted trials to improve the process using flat samples and single-cell cavities.
- Develop improved and “lean” processes based on sound understanding of the fundamental requirements for high gradient and eliminate no-value-added process steps. Aim for scalable industrializable integrated cavity processing system.

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Goal 3: Pursue alternative concepts to the baseline which address cost and technical risk.

- Based on JLab's unique experience with cryomodule design, assembly, and operation and a wide range of structures, contribute to cryomodule and component value engineering studies.
- Evaluate alternative materials such as the direct-from-ingot "large grain" Nb, alternative structures such as superstructures and superconducting joints, seamless cavities and alternative cell shapes (low loss, ICHIRO etc.).
- Continue to qualify new sources of candidate niobium materials.

JLab FY09 high-gradient tasks

1. Robust 9-cell program with at least 30 "standard EP cycles" with T-mapping on a new batch of cavities (~$1M). *Emphasis is on maximum learning.* Address specific S0 yield goals plus understanding of quench variability. Identify location and nature of limiting quench on all tests. Visual inspection* on all cavities. Provide qualified cavities for S1.
2. Additional 9-cell tests (4 x BCP large grain, 4 x Cornell flash-EP cavities etc.).
3. Single-cell program: 25 cycles with T-maps. Bridge between small samples & 9-cells.
   - Q-slope / quench characterization / visual inspection / evaluate guided repair methods / sacrificial surface analysis.
   - Comparison of LG vs. fine grain, EP vs. BCP (continuation of existing program).
   - Particulate studies related to JLab EP (e.g. cavity exposed to real EP solution, witness samples in active polishing region and full utilization of FE viewer).
   - Alternative material removal methods (e.g. barrel polishing, BEP, VEP).
4. Active cooling upgrade for EP system to address temperature variability.
5. Flat sample R&D *with university and industry partners:* Surface Roughness, contamination control, EP characterization, hydrodynamic modeling, baking studies, material studies, origins of losses, defect identification and characterization, etc.
6. Next generation "advanced integrated cavity processing development" studies (ICP).
7. 2 new 9-cell "plug compatible" large grain cavities fabricated at JLab.
8. Value engineering (e.g.: Superconducting joint, Nb seamless cavities, 1.3 GHz high-power windows).
9. Management, coordination and travel.

*home built or Kyoto type.

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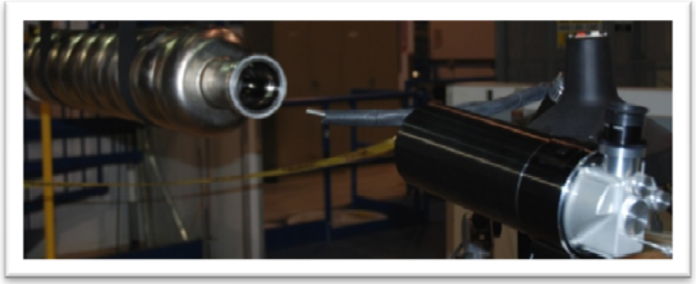
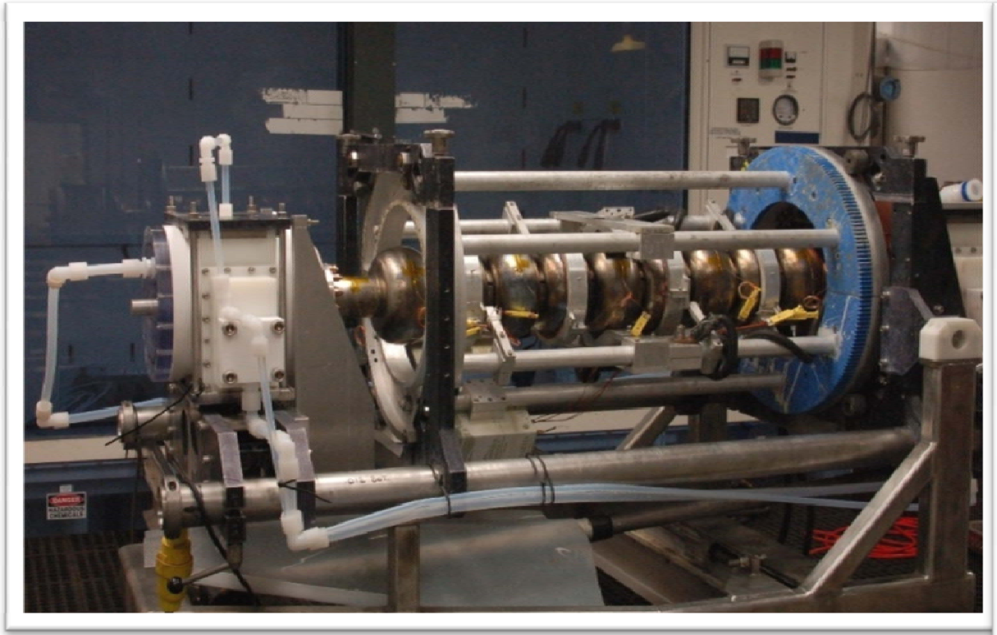
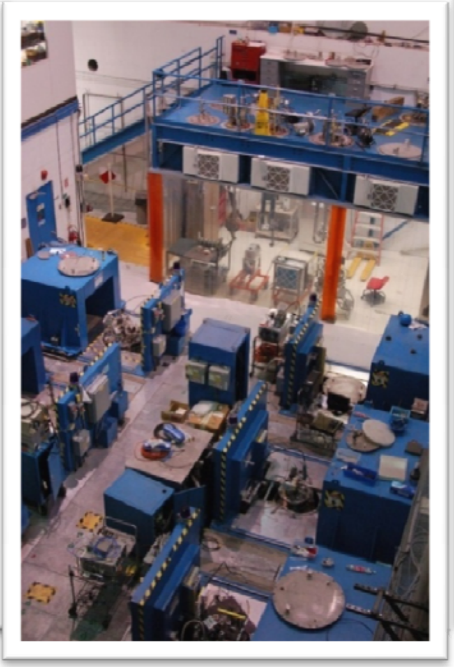


JLab assets to achieve Goal 1:

- Fully commissioned horizontal EP system
- Well-supported vertical test area (2735 tests to date)
- Experienced technical staff and proven infrastructure
- New 1300 MHz rf system
- Two-cell thermometry system for use on Tesla-style 9-cell cavities
- Developing optical inspection system – long-range microscope





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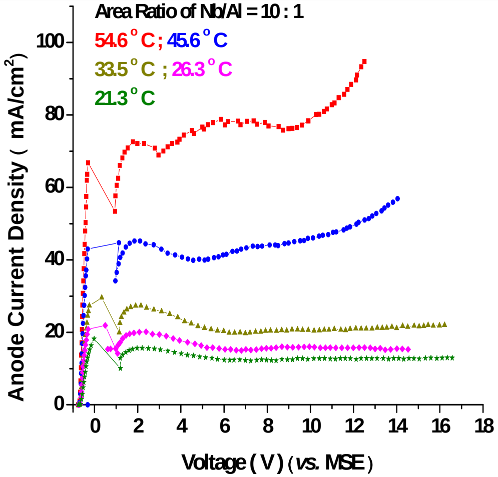
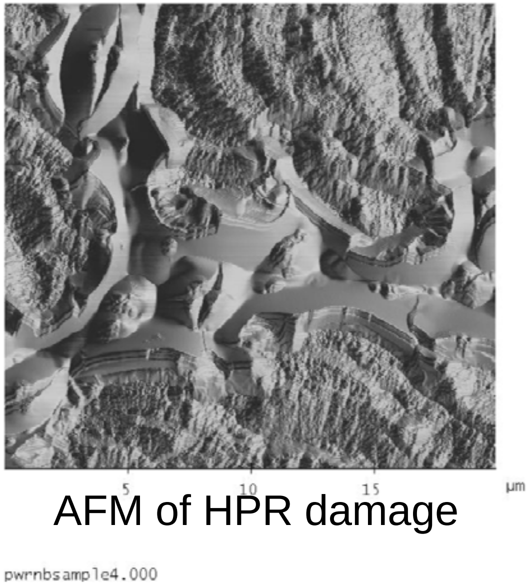
JLab assets to achieve Goal 2:

- Convenient fabrication and processing facilities for single-cell work.
- Single-cell premium thermometry system for detailed characterization and comparison studies. (Q-drop, quench studies)
- Instrumented electrochemical cell for EP process characterization via samples.
- In-house Scanning FE microscope, profilometer, AFM, SEM, and FE Viewer for sample characterization.
- Network with regional universities for materials characterization and grad students.
- Available non-production chemistry facility for process R&D in parallel with standard “production” work.
- Highly motivated and bright young scientists have joined the effort.



Controlled EP studies



AFM of HPR damage

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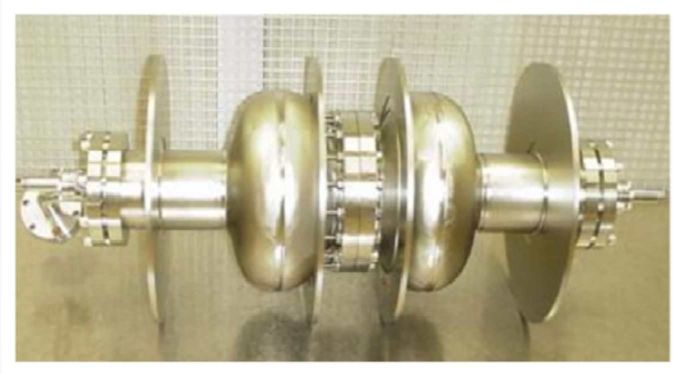
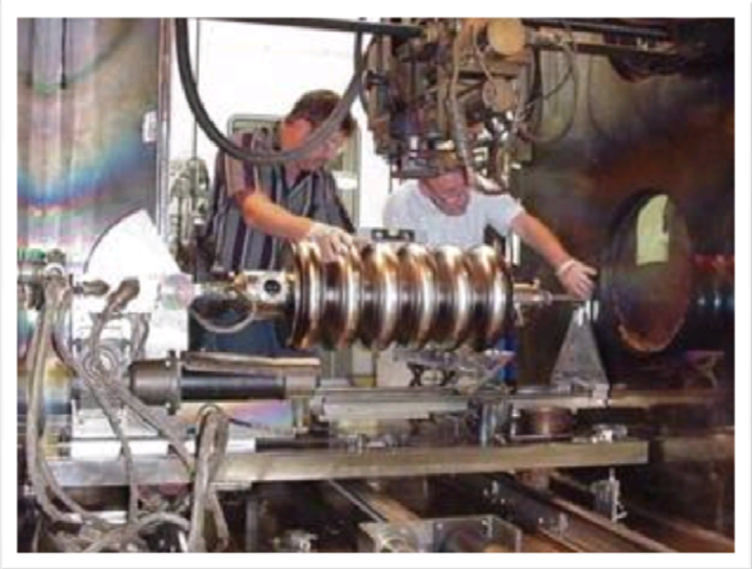
JLab assets to achieve Goal 3:

- Complete in-house cavity fabrication infrastructure.
  - EDM, CNC machining, presses, EBW, chemistry, furnaces
- Highly flexible rf structure development and testing infrastructure.
- Deep and broadly experienced technical staff experience.
  - (Kneisel & cavity fab staff)
- Highly interested in realizing any advantages of “large grain” Nb.
  - May have relevance to JLab’s 12 GeV Upgrade.
  - May enable ILC cost reduction.





JLab FY07 –FY08 ILC Progress

- While JLab is principally a Nuclear Physics research facility, with accelerator development focused on CW, high-current, SRF applications, we are eager to collaborate with colleagues to address common technical issues.

- The DOE also asks JLab to be an active contributor to all US Office of Science SRF applications that are in development.

- JLab has been making significant progress toward the ILC goals.

- We very much understand the need to make cost-efficient progress.

- A summary of ILC-related progress is maintained at: http://srf.jlab.org/JLabILCinfo/JLabILC.html

JLab 9-cell Cavity EP/VT supported by remainder of FY08 funded via FNAL

- AES4: max. E_{acc} 28 MV/m, FE limited, never reached quench limit yet. Plan for one more EP 20 um. First tune, HPR, VT.
- We expect to receive 4 (out of 8) new ACCEL built cavities from FNAL. *Ready*.
- Remainder of FY08 has high ratio of # of available new cavities to available EP/VT funding.
- We have potential for thermometry (2X 1-cell system) as well as RF surface inspection (Questar). FY08 offers opportunity for trial use. Aim for systematic development and use in FY09.
- Strategy of strength for remainder of FY08: maximize # of successful high gradient cavity to # of EP/VT cycles.
- Maximizing mutual benefits between US and Japan-US fund.

JLab FY09- ILC R&D

Goal 1: Understand the causes of cavity performance variability at the high gradient limit.

Goal 2: Optimize the standard processes for reliable performance.

Goal 3: Pursue alternative concepts to the baseline to address cost and technical risk.

In addition to the US DOE funds, we hope to be able to work with our KEK colleagues under the US-Japan Agreement, also pursuing the same three goals in complementary ways.

We are most grateful for support via this route in FY08; this sustained the ICHIRO cavity work during the US ILC work stoppage.