Re-Entrant Cavity Progress

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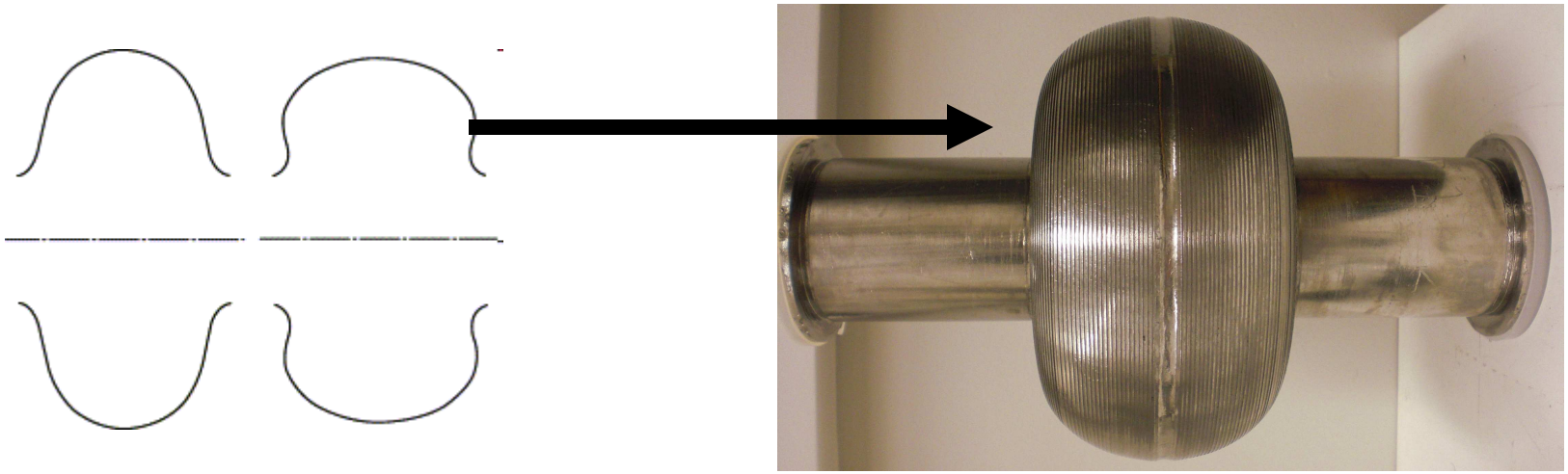
Outline

- What are reentrant cavities and why are they important.
- Experimental Results and Progress
- Summary and Future Plans

Reentrant Cavities

- For a fixed accelerating gradient the peak surface magnetic field of an accelerating cavity may be decreased at the expense of increasing the peak surface electric field. (V. Shemelin, H. Padamsee, and R.L. Geng, Nucl. Instrum. Meth. A, Vol 496, Issue 1, Pg. 1-7).
- This is useful because the maximum achievable magnetic field is a fundamental limit while the maximum achievable electric field is not. You pay the price in field emission.



Reentrant Cavity Experimental Results

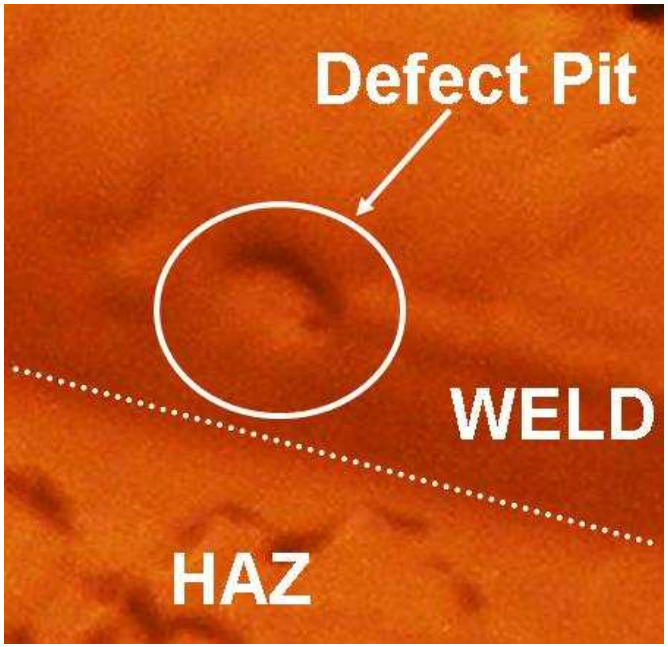
- Early (KEK & Cornell) single-cell reentrant cavity test results were excellent. (See R.L. Geng et al, PAC2005 ROAC009, Pg. 653) The cavities reached peak surface magnetic fields comparable to the upper critical field of Niobium.
- The success of the Cornell/KEK reentrant single cell cavity tests (E_{acc} > 50 MV/m) led to the development and fabrication of multi-cell reentrant cavity geometries and to the investigation of the behavior of Niobium resonators at the superheating field
  - Multi-Cell Reentrant Cavity Development
    - Higher E_{acc} for a fixed H_{pk}
    - A cavity geometry which is more forgiving of surface heating
  - Single Cell Reentrant Cavity Tests
    - Explore the behavior of Niobium at the superheating field
    - Prototyping new even more efficient reentrant geometries

Multi-Cell Reentrant Cavity Development

- Cornell and Advanced Energy Systems collaborated on the development, fabrication, and testing of two multi-cell reentrant cavities.
  - A 9-Cell Cavity
  - A 3-Cell Cavity
- This collaboration helps AES develop their cavity fabrication techniques. We provided feedback on the cavity defects which limited RF performance, allowing for AES to improve techniques and QA.

Vendor Collaboration

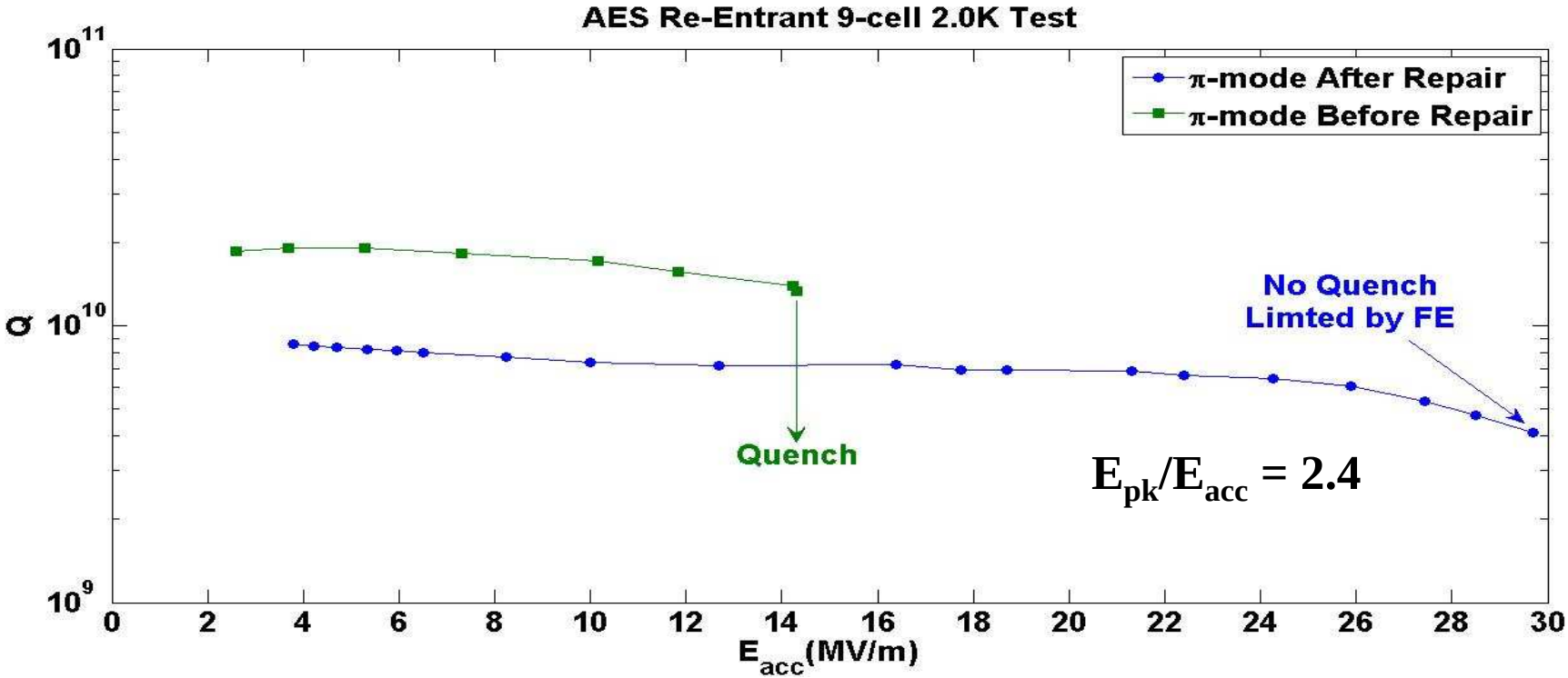
- The 9-cell cavity fabricated by AES was defect limited to 15 MV/m
- We located the defect (incomplete consumption of weld undercut) with second sound quench location
- We repaired the pit-defect with tumbling to remove 80 μm of material from the cavity interior surface
- The cavity performance improved remarkably!



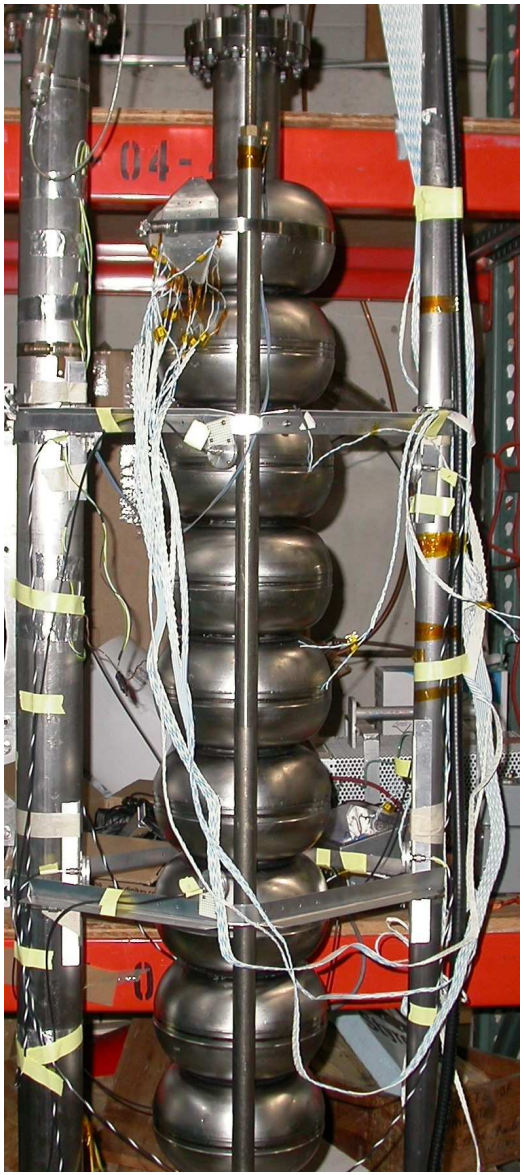
Tumbling media residue removed with HPR

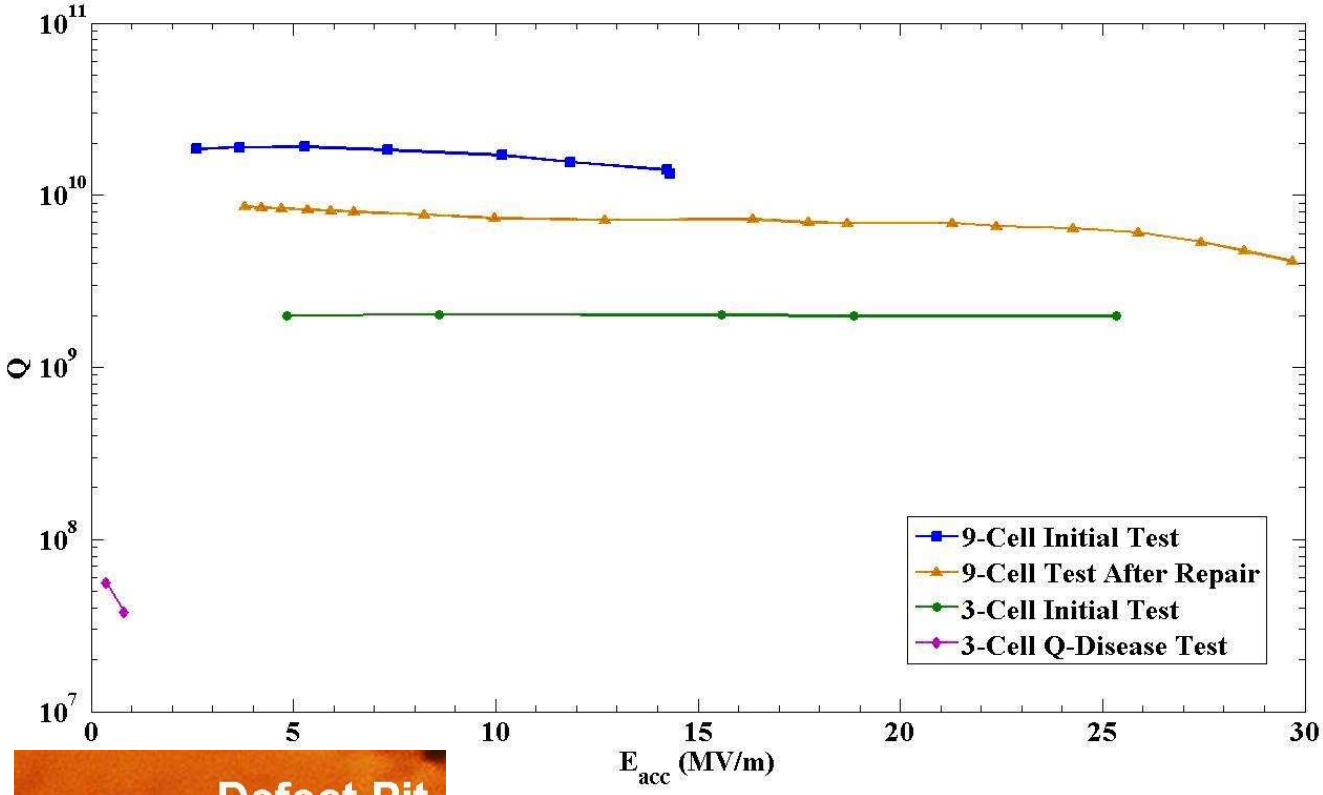
AES Fabricated 9-Cell Cavity Weld Pits Repaired

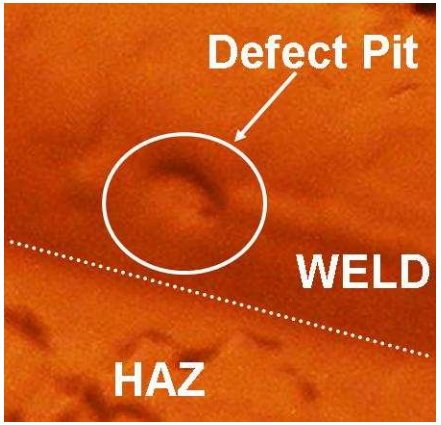
- **This cavity originally quenched at E_{acc} = 15 MV/m in the π-mode at a weld pit in the first cell, after tumbling and reprocessing the π-mode E_{acc} > 30MV/m. The measurement was limited by the available RF power the cavity did not quench.**
- **When excited in the 5π/9-mode peak fields of 89 MV/m and 1400 Oe were reached in the center cell. This corresponds to E_{acc} = 37 MV/m in the center cell.**
- **This test demonstrates that**
  - **Tumbling is an effective option to repair weld defects, e.g. pits.**
  - **Individual cells in cavities processed with VEP reach fields exceeding 35 MV/m.**

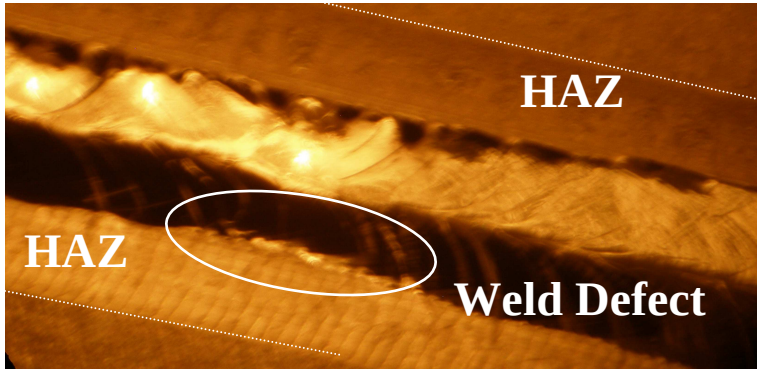


Multi-Cell Reentrant Cavity Development

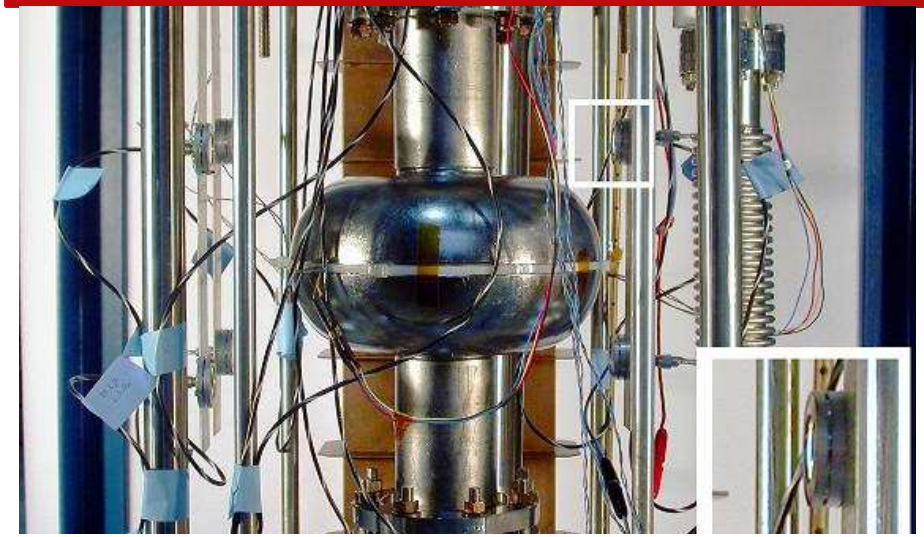


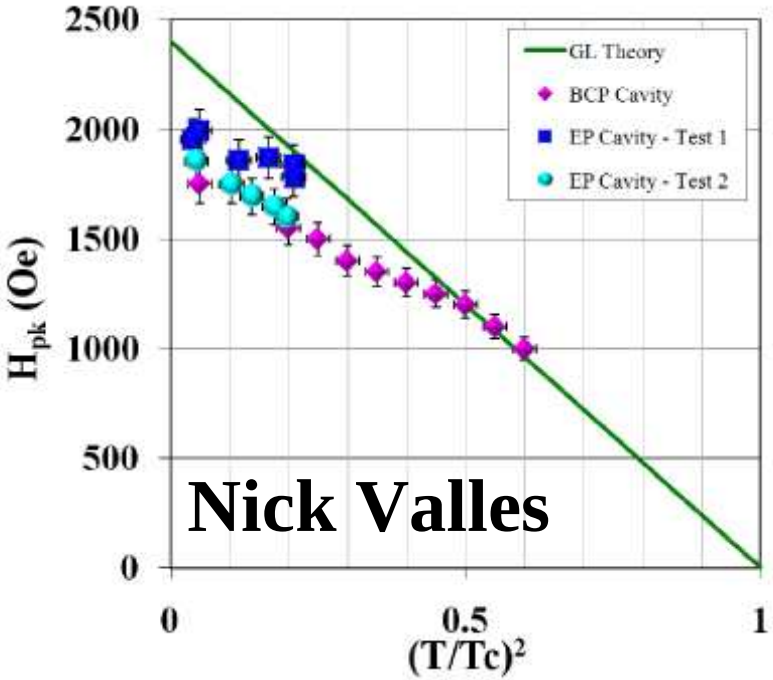


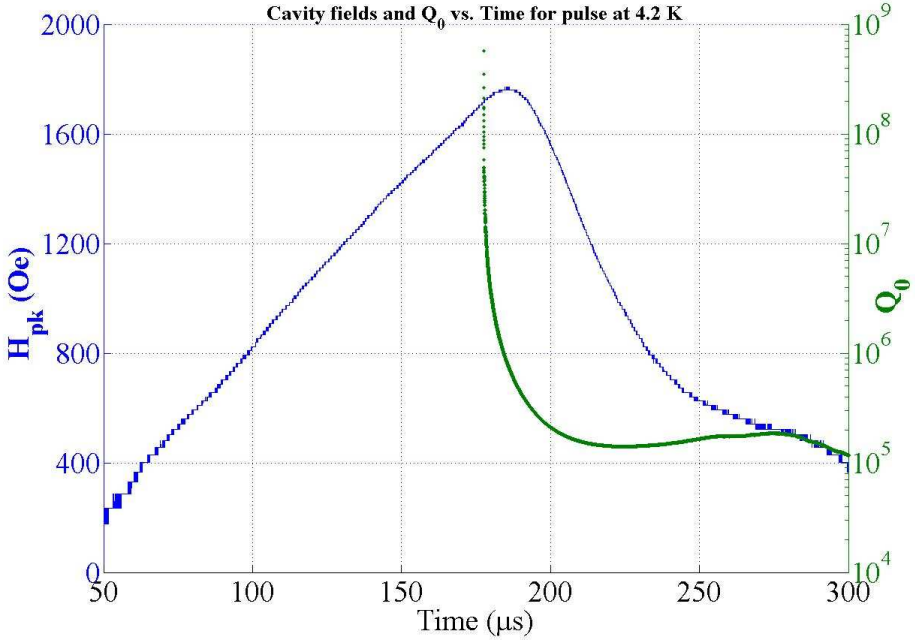


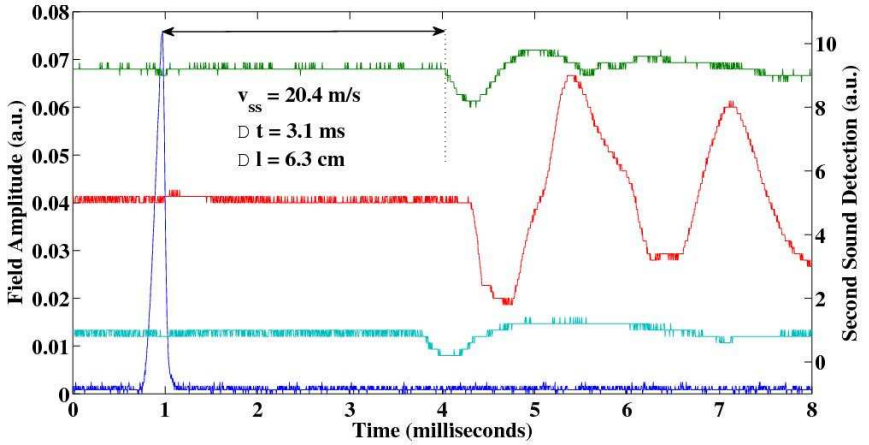


Single-Cell Reentrant Cavity Development









N.Valles et al SRF2009 TUPPO072

Summary & Future Plans

- Reentrant Cavities are being developed for accelerator applications (multi-cell) and being used for fundamental SRF research into the behavior of Niobium near the super heating field.
- R.L. Geng (JLAB) has degasses the reentrant 9-cell cavity and it is being prepared for testing.
- The reentrant cavity shape has been optimized and we plan on fabricating several new single and 9-cell prototypes for testing