



Cornell Laboratory for
Accelerator-based Sciences and Education (CLASSE)



Locating Quenches With Second Sound

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Accelerator-based Sciences
and Education (CLASSE)

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14th International Conference on RF Superconductivity





- Superfluid Helium
- Second Sound Quench-Spot Location
- What is going on now
- Summary

Collaborators:

Don Hartill

Eric Smith

Nick Szabo

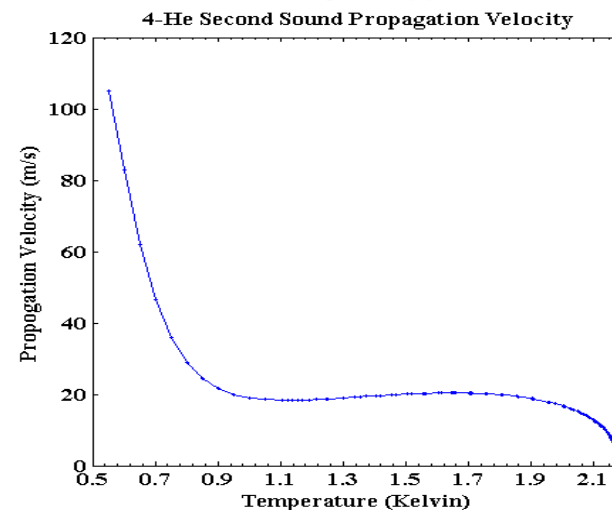
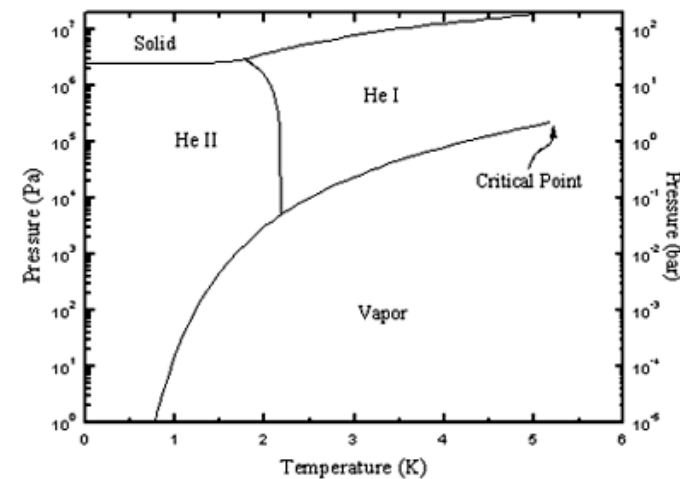
Hasan Padamsee

Cornell SRF Group



Relevant Properties of Liquid Helium

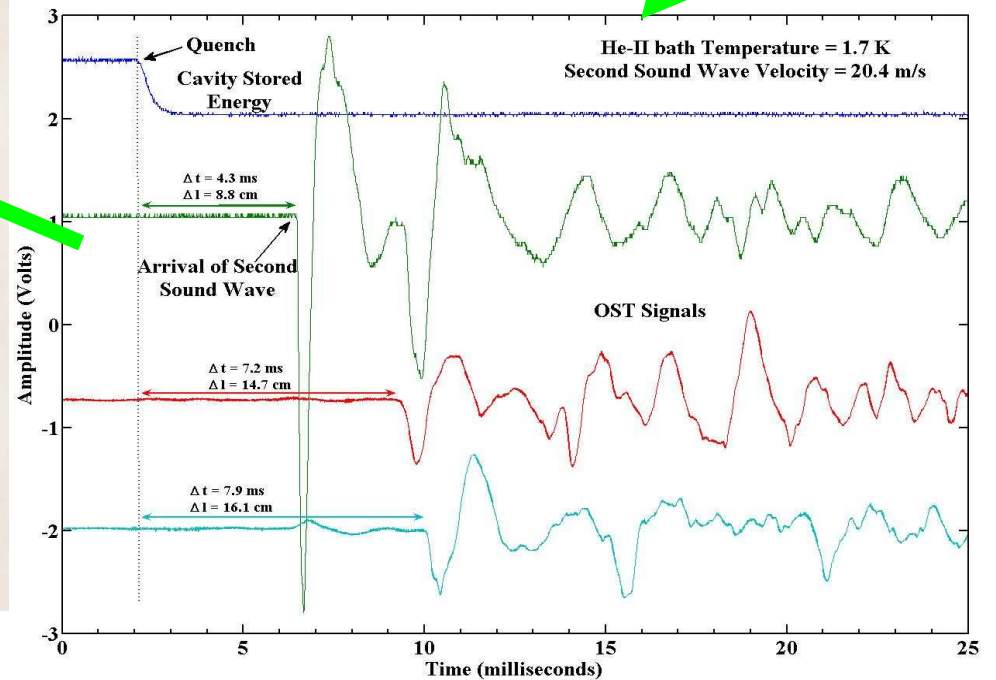
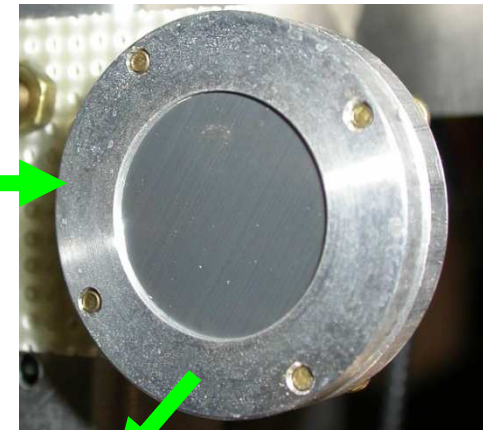
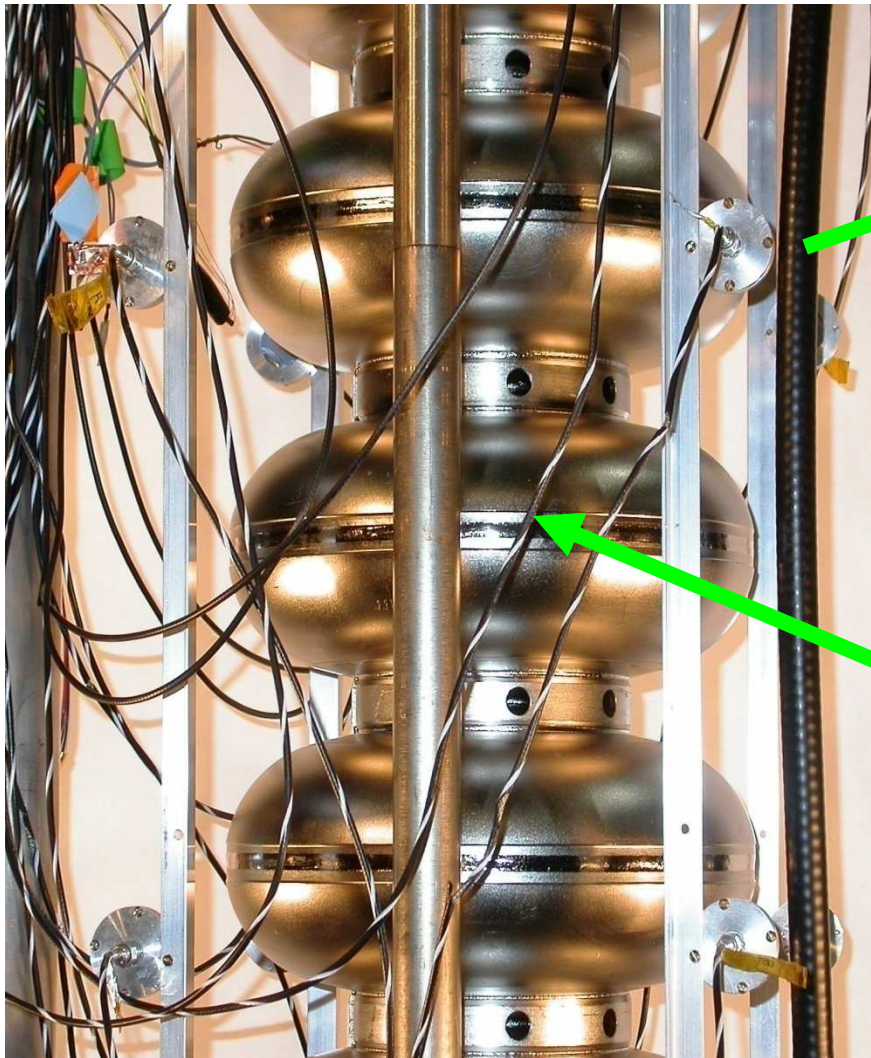
- **Wave Propagation in LHe**
 - Normal P- ρ wave = 1st Sound, with velocity = ~ 220 m/s
 - Below the lambda point a T-S wave can propagate = 2nd Sound, with velocity = ~ 20 m/s
 - Superfluid ρ -T wave = 4th Sound, with velocity = ~ 200 m/s
- The detector response time can be around 0.1 msec or less which implies a spatial uncertainty of 2 to 4 mm if the start time and the propagation time (initiation of cavity RF field collapse) can be determined to the same timing uncertainty, we are not there yet!



Russel J. Donnelly and Carlo F. Barenghi, "The Observed Properties of Liquid Helium at the Saturated Vapor Pressure." J. of Phys. Chem. Ref. Data, vol. 7, Issue 6, Pg. 1217 (1998).



Second Sound Quench-Spot Location

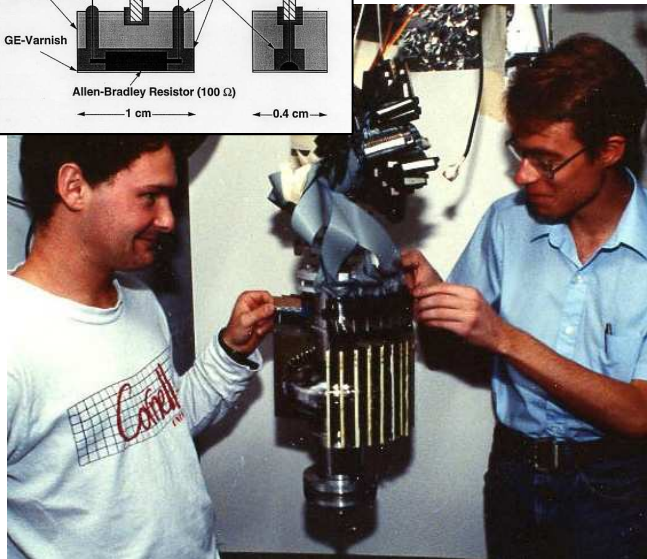
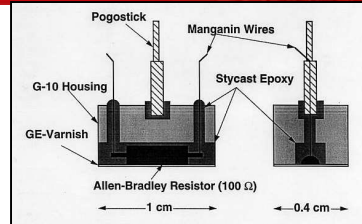




Second Sound Quench-Spot Location

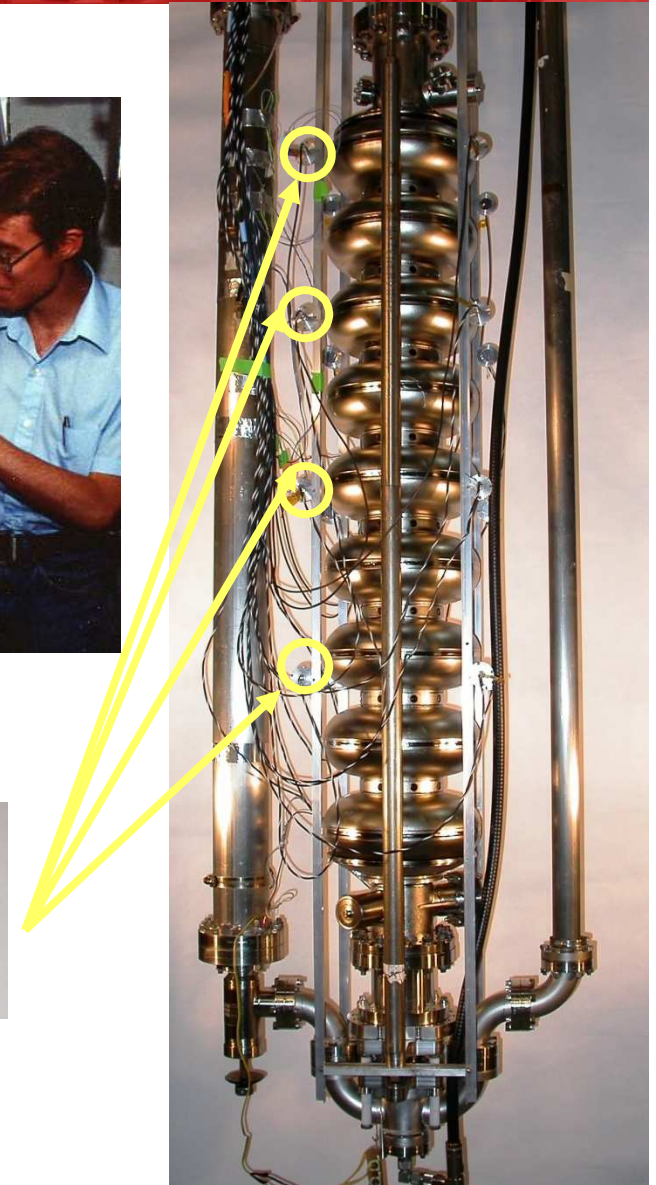
- **Thermometry**

- Full temperature map of the cavity at various field levels
- Required for a detailed understanding of the cavity performance
- Requires thousands of transducers



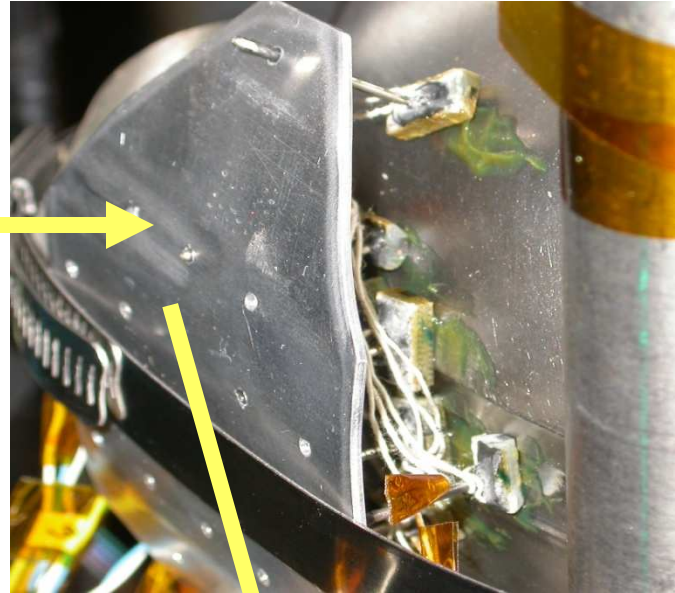
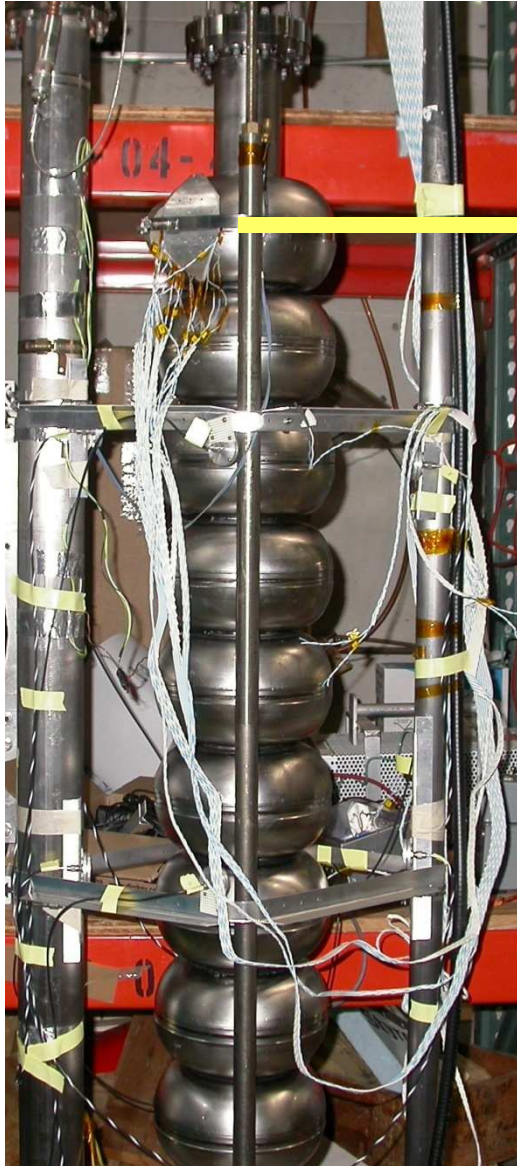
- **Second Sound**

- Requires a few transducers (e.g. 8)
- Simple
- Fast
- Accurate
- Only locates the quench-spot
- Convenient for the rapid testing/repair of cavities

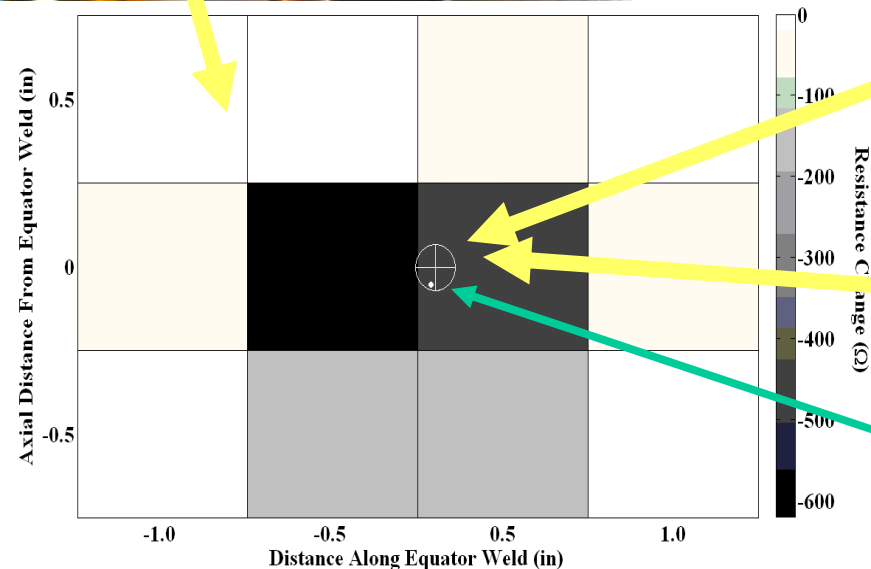




Second Sound Quench-Spot Location



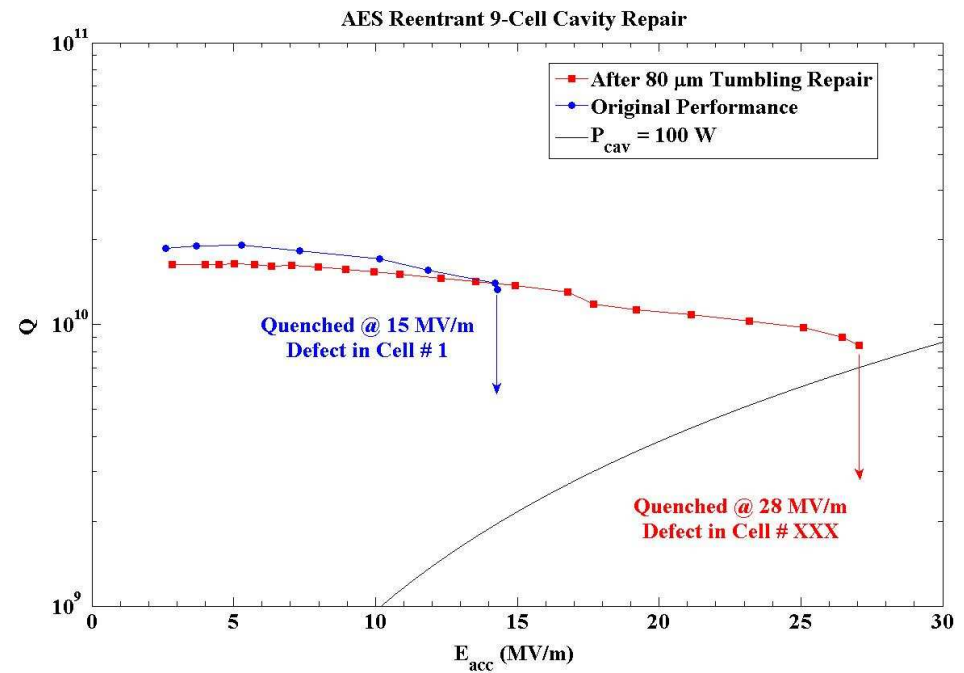
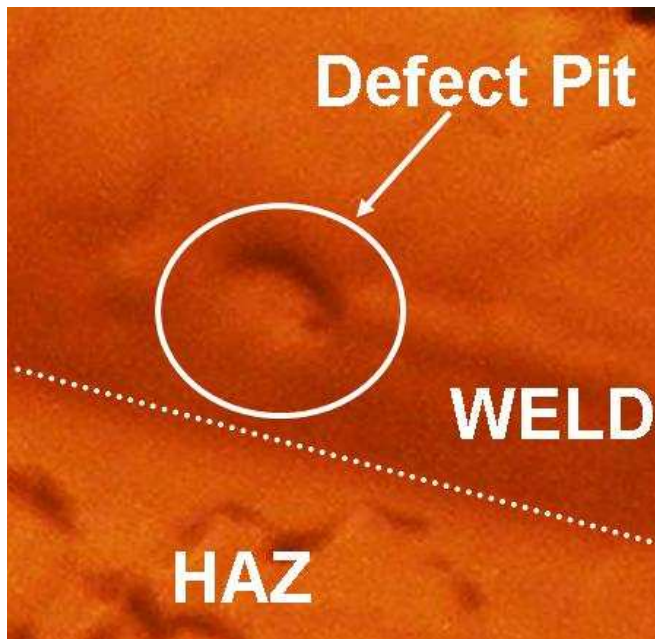
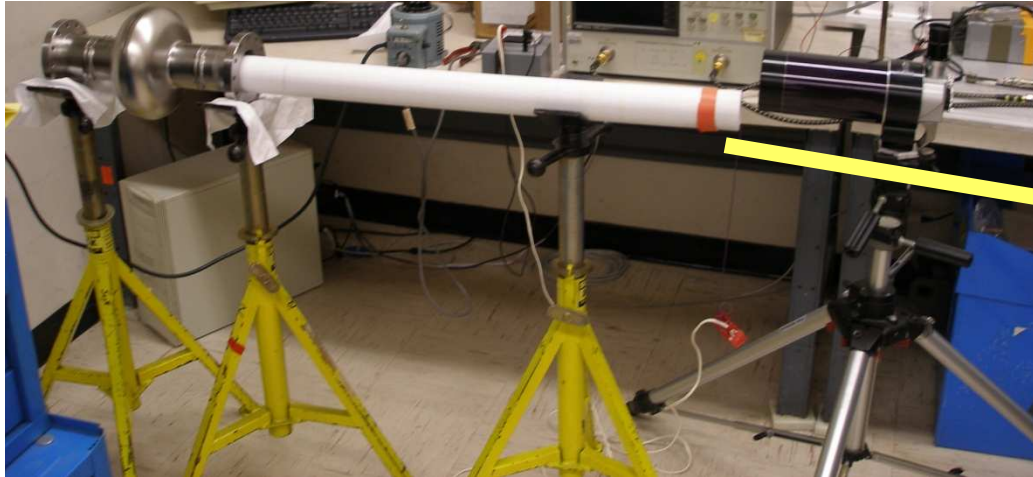
Comparison of fixed
thermometer heating,
2nd sound location and
Optical location. Defect
heating is about 50 mK
at 8 MV/m



2nd Sound
Defect Location
3mm radius
circle around 2nd
sound result
Optically Located
Defect



Second Sound Quench-Spot Location

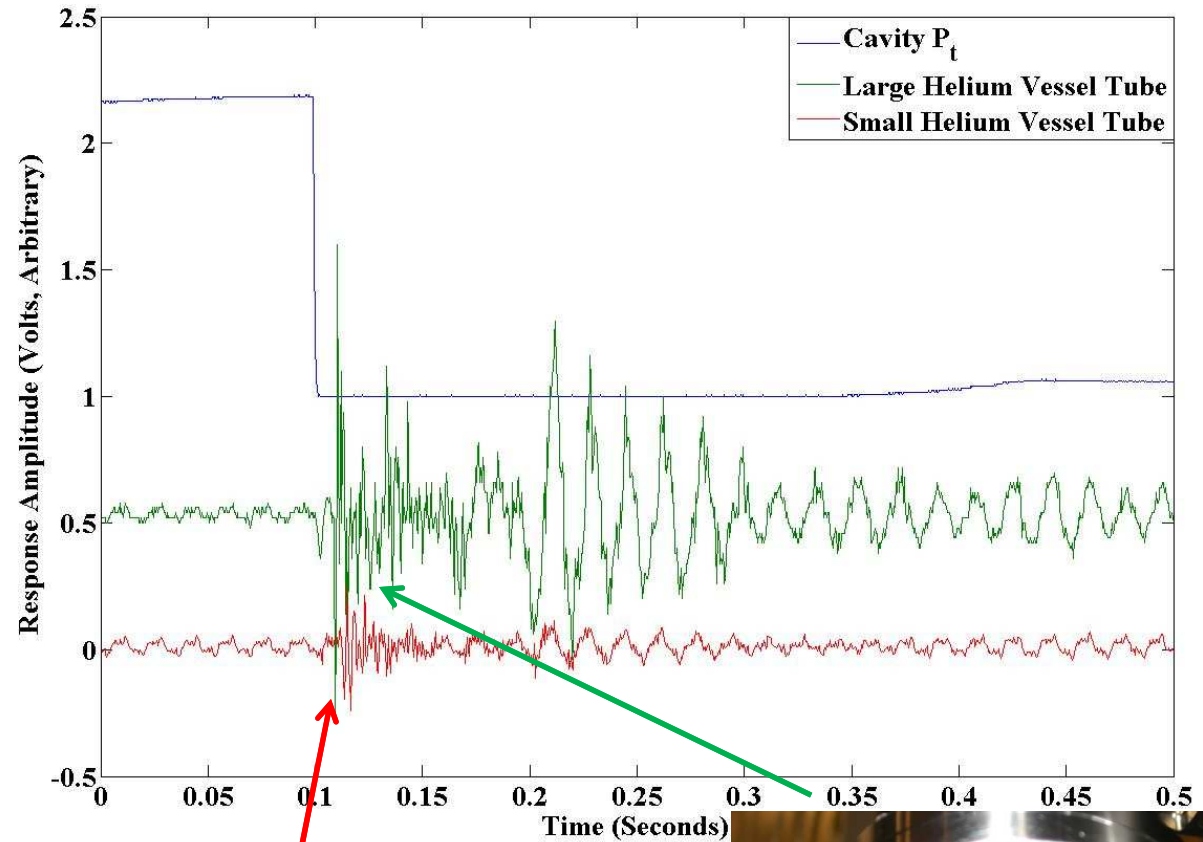




- Second sound quench location and signal convergence.
 - The signals to all of the OST transducers do not converge to 0.1 mm.
 - This currently looks to be caused by the thermal flux exceeding the maximum for superfluid helium, ~ 1.5 W/cm²
- Second sound quench location in a helium jacket



Quench Location and Helium Jackets





- 2nd sound quench location provides a simple, efficient, and reliable method of determining the location of quench-spots.
- 6-8 sensors per cavity test are employed versus thousands of resistors. This saves time, money, and frustration.
- The second sound quench-spot location technique would benefit any SRF institutions which wants to rapidly test/repair cavities.