Thermometry in support of ILC R&D program

G. Ciovati
Jefferson Lab

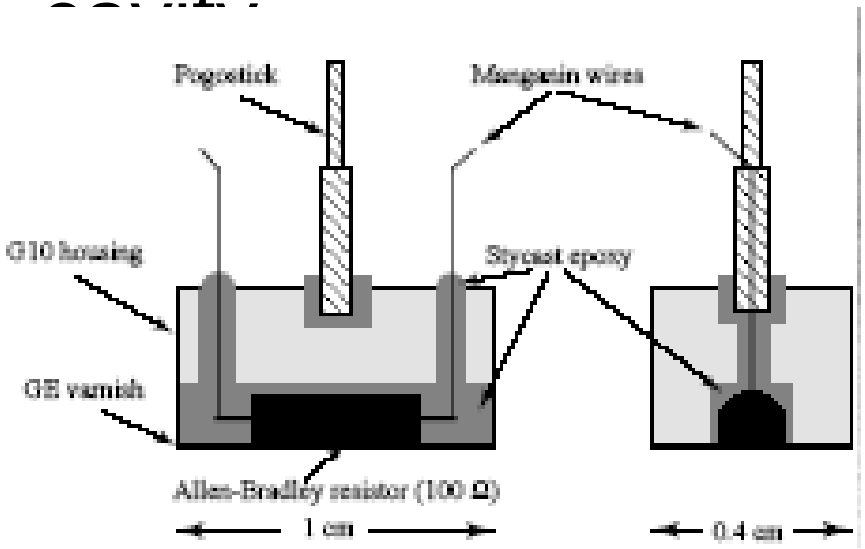
SCRF Meeting, FermiLab, April 21st-25th 2008

Motivation (1)

- From "Replan for SCRF" L. Lilje, M. Ross, March 08: "…Still, a significant variability in the maximum gradient exists. An improved understanding on quench locations in multi-cells is needed. *This is the highest priority activity for 2008.*", "…Diagnostic tools especially high-resolution temperature mapping systems are essential. Support for the development of temperature mapping systems is essential…"
- **JLab completed a 2-cell temperature mapping system for ILC 9-cell cavities in Jan. 08 funded by FermiLab. The system was commissioned on a fine-grain 9-cell cavity built at JLab**

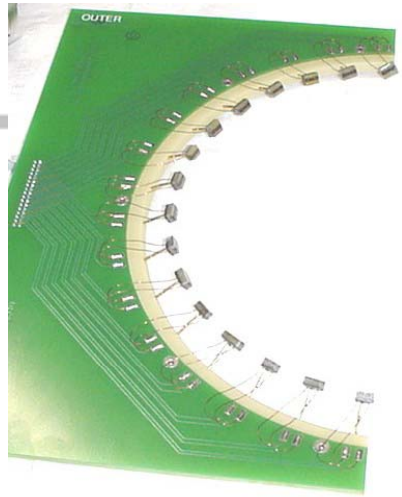
ILC 2-cell system

- 320 Cornell style RTDs which can be mounted on <u>any</u> two cells of an ILC 9-cell cavity

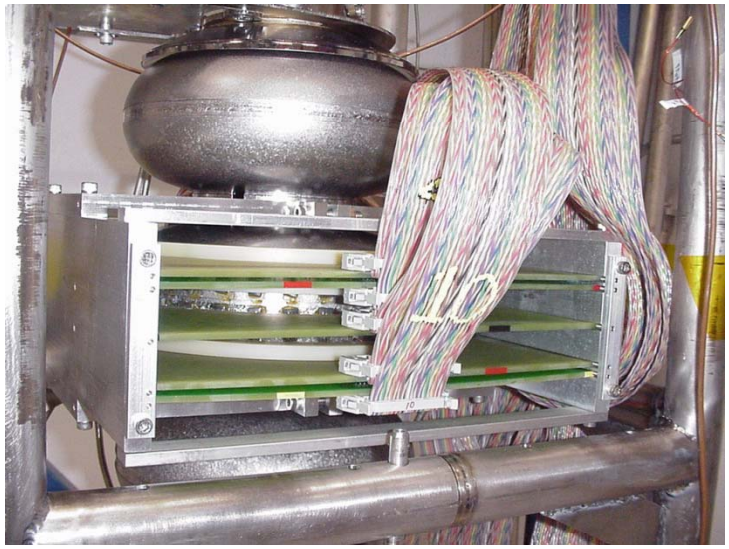


- Well-proven, well characterized sensors
- sensitivity ~ 1 mK at 2 K

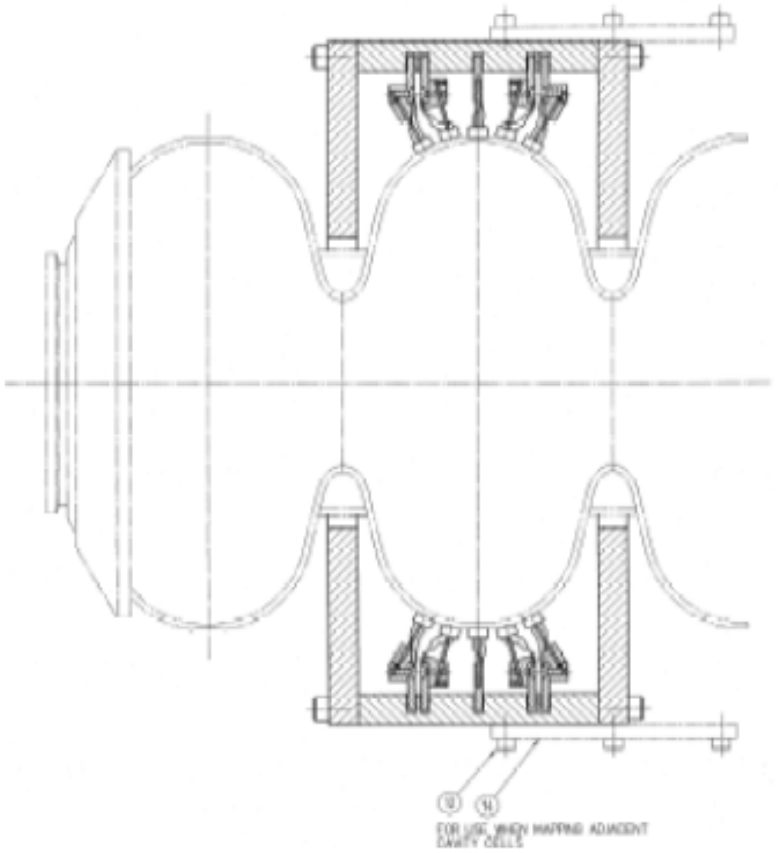
G. Ciovati et al., “A 2-Cell Temperature Mapping System for ILC Cavities”, JLab Tech Note 08-012 (2008)



Thermometers are mounted on PCB boards which cover half of circumference



Aluminum frame holds boards into position



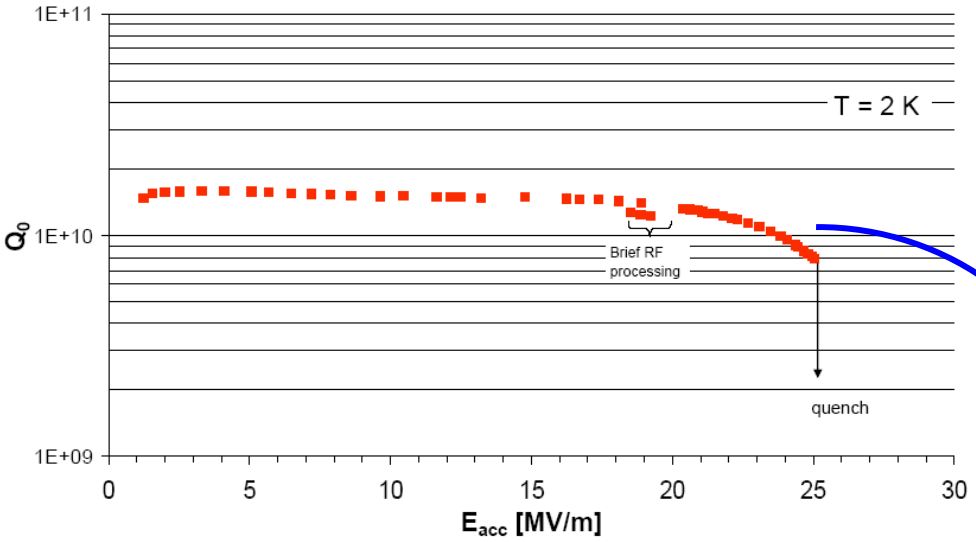
Thermometers cover a region ~ 4 cm on each side of the equator weld

T-map system mounted on cells # 2 and # 8

National Instruments SCXI data acquisition system and Labview software, shared with 1-cell thermometry system

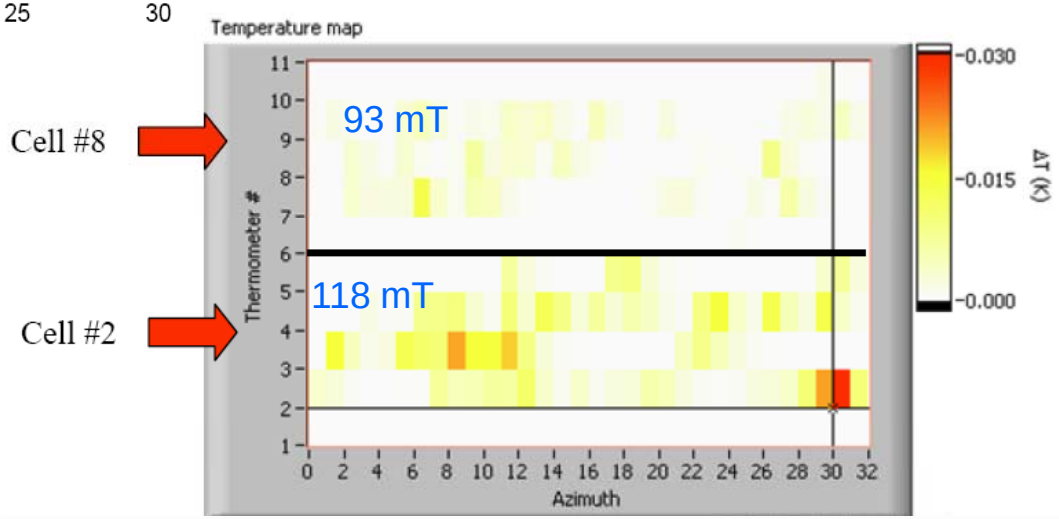
Commissioning results

We rely on RF measurements from TM_{010} passband modes to identify a pair of cells where thermal breakdown is more likely to occur

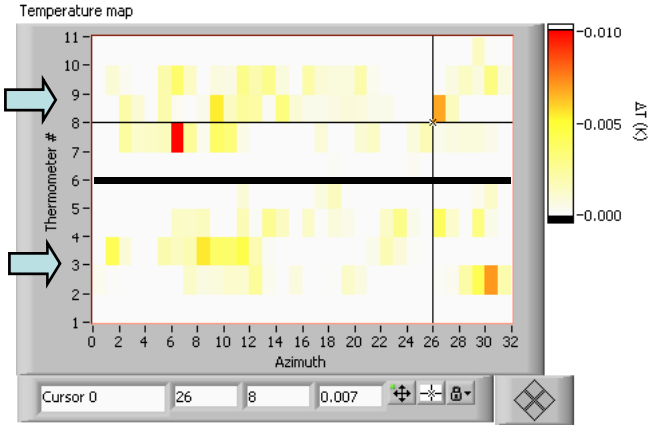


- Quench was not detected in neither cell.
- Some hot-spots were found on and near the weld of cell #2, contributing to Q-drop

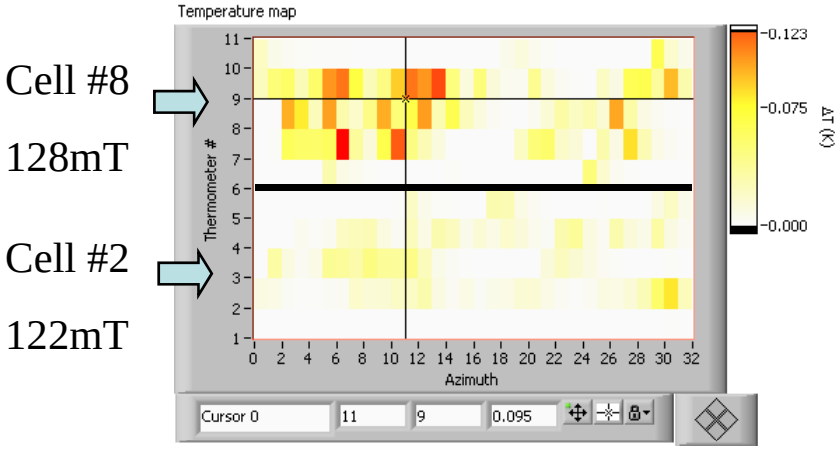
Non-uniform hot-spot distribution was noticed also from T-maps in other passband modes and made us suspect of field unflatness, confirmed after warm-up to RT (28% unflatness)



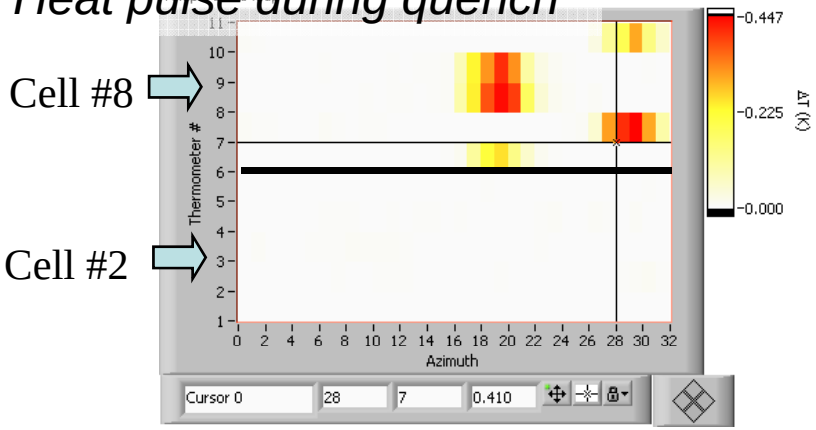
4π/9 mode



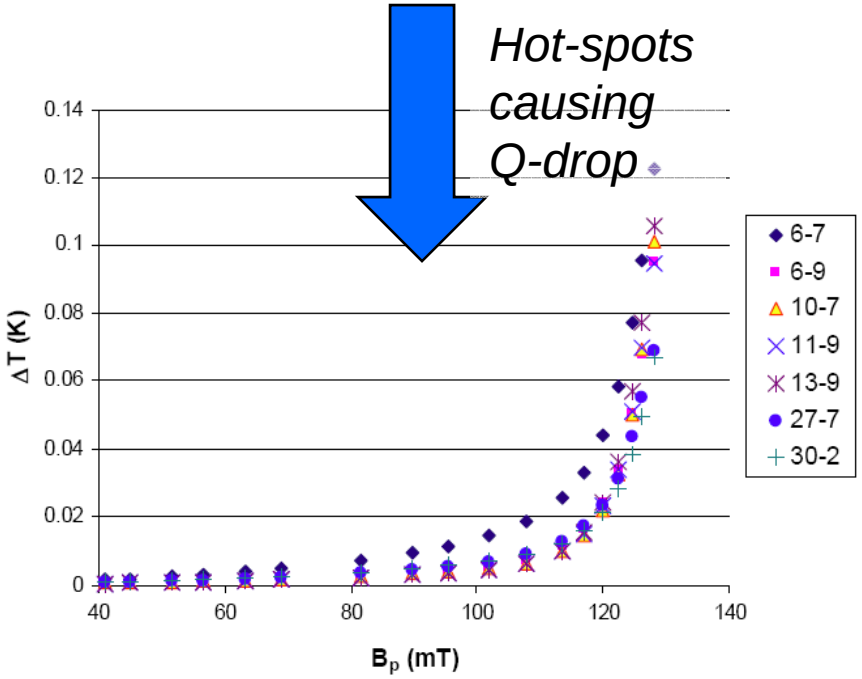
3π/9 mode



Heat pulse during quench



Hot-spots causing Q-drop



Conclusion and plan (1)

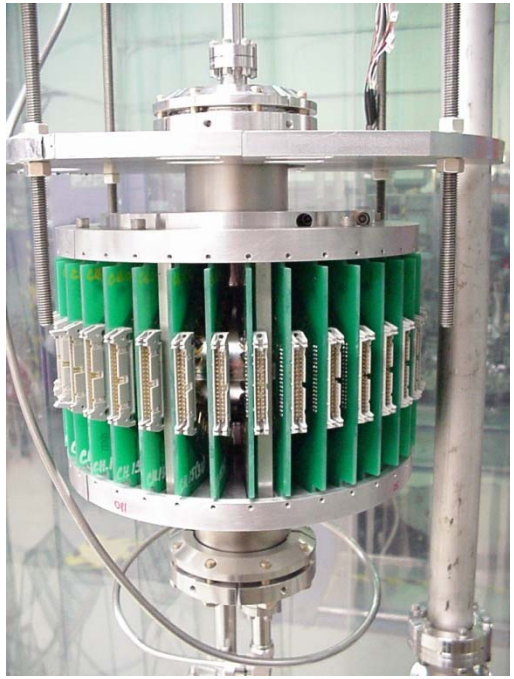
- A 2-cell thermometry system for ILC 9-cell cavity is available at JLab and will be used routinely in conjunction with optical inspection of hot-spots/defects to improve understanding of thermal breakdown, if funds will be available.

Motivation (2)

- From “Replan for SCRF” L. Lilje, M. Ross, March 08: “…Large grain material has been developed as a cost saving option…further development on the optimum preparation process needs to be done…”, “A study with T-mapping and optical inspection is needed on large-grain (or single-crystal) single-cells comparing the two surface treatments: EP and BCP”.

- **JLab has a single cell thermometry system which can be used for a comparative study between**
  - **Fine-grain Nb & EP**
  - **Large-grain Nb & BCP**
  - **Large-grain Nb & EP**

Single cell thermometry system



- 576 “Cornell style” RTDs, distributed over the surface of a 1.5 GHz Original CEBAF single cell cavity
- The system is being already **extensively used for Q-drop studies**

Conclusion and plan (2)

- If sufficient funding will be available, the single cell thermometry system at JLab can be used to
  - "calibrate" combination of T-mapping and optical inspection for quench studies
  - Comparative studies between large grain EP vs. BCP (once single cell EP system at JLab becomes available)