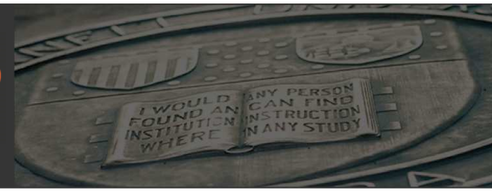
Cornell University
Laboratory for Elementary-Particle Physics

Fiona Wohlfarth
SUNY Adirondack
Sam Posen
Matthias Liepe

SRCCS 2013



Summer Research for Community College Students – 2013

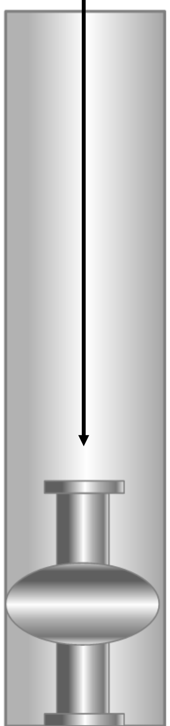
Nb_3Sn Program for Superconducting Cavities

Why Nb_3Sn?

Currently Niobium is used in modern accelerators and is reaching its fundamental limit. Nb alone has a high quality factor (Q_o); Nb_3Sn has a higher critical temperature (~18 K, where as Nb has a T_c of ~9 K)-- so it has an *even higher* Q_o. Nb_3Sn performs just as well, if not better, at the natural boiling point of liquid helium (4 K) as opposed to Nb cooled to 2 K. Also, Nb_3Sn has a higher superheating field, which allows for higher accelerating gradients.

Coating the Cavity

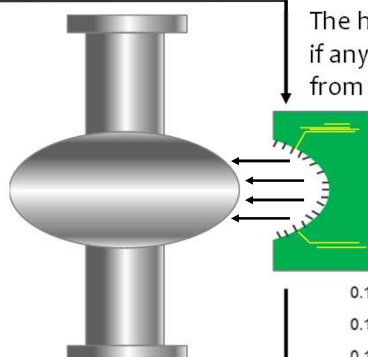
After loading samples of tin and placing the standard niobium cavity within the furnace, it is placed under vacuum and heated up to 1300 °C so that tin vapors coat the interior of the cavity.

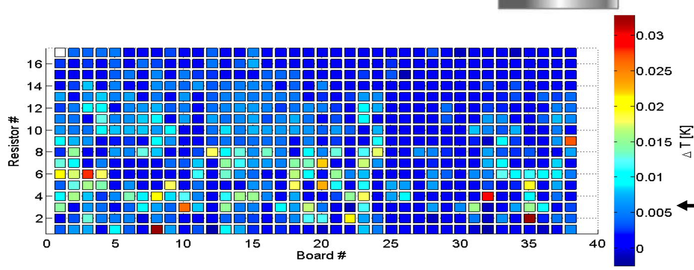


Temperature Mapping

Once coated, the cavity is submerged in liquid helium and Q_o as a function of the accelerating field is found.

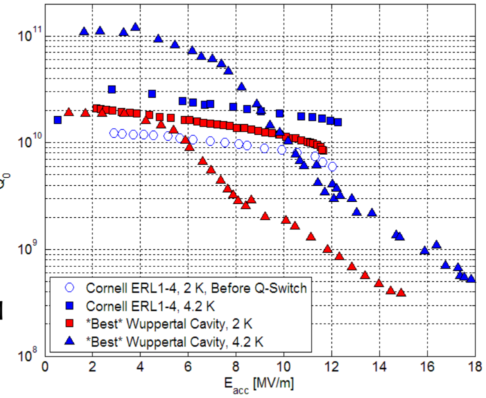
38 boards each holding 17 resistors are placed on the cavity-- the 646 resistors give a full temperature profile of the cavity during operation.





Result

The cavity tested in July 2013 marked a breakthrough for the Nb_3Sn program-- it outperformed previous cavities of its type, which were produced by other labs in the 1980s. This allows for multiple new applications within the field!

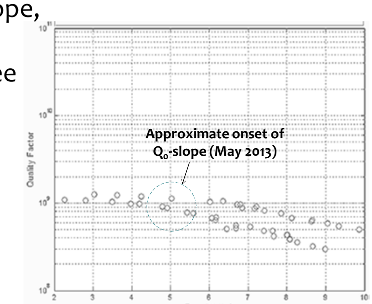


Data Analysis

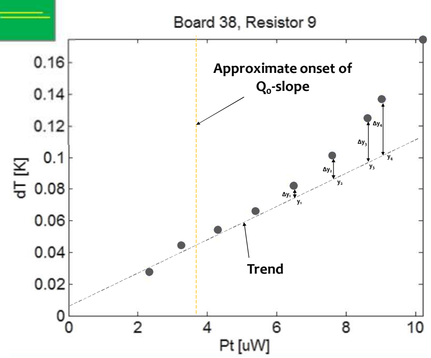
In the case of Wuppertal's Cavity, it was thought that the reason for the Q_o-slope was strictly a fundamental occurrence. This breakthrough test shows that the reason for the degradation is in fact *not* fundamental!

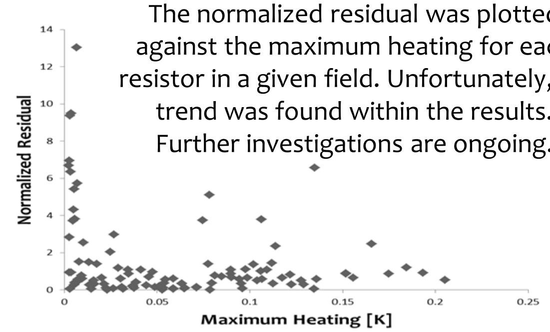
The first cavity manufactured at Cornell also showed a similar result to Wuppertal. In an attempt to try to further understand the Q_o-slope, the ΔT data was examined.

The heating before and during the Q_o-slope was compared to see if any trends could be found. The deviation of the other points from the trend was measured, providing the normalized residual.



$$NR = \frac{\Delta y_1}{y_1} + \frac{\Delta y_2}{y_2} + \frac{\Delta y_3}{y_3} + \cdots + \frac{\Delta y_n}{y_n}$$





The normalized residual was plotted against the maximum heating for each resistor in a given field. Unfortunately, no trend was found within the results. Further investigations are ongoing.

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