A Temperature Mapping System for Coaxial Superconducting Radio Frequency Resonators

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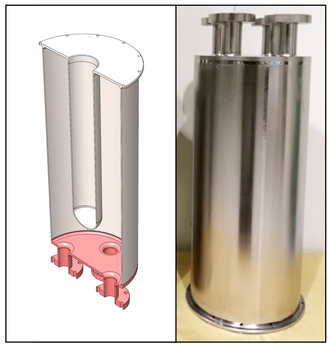
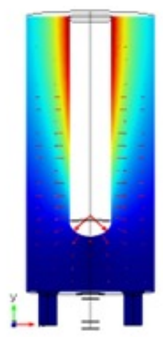
Overview

In the field of superconducting radio frequency (SRF) cavity research, quality factor is an important measure of how well a treatment to a SRF cavity has worked. Consisting of an array of evenly spaced thermometers positioned on the quarter wave resonator cavity wall, a temperature mapping (T-map) system can detect small increases in temperature. The T-mapping system aims to identify hotspots, which degrade the quality factor and result in the loss of the cavity's superconducting capacities.



Quarter wave resonator

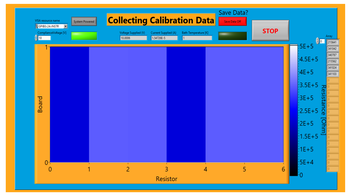


Magnetic field of quarter wave resonator

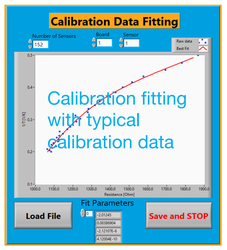
Introduction

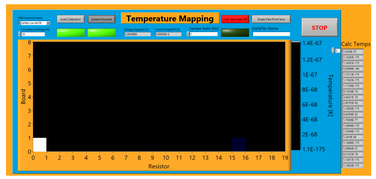
SRF cavities accelerate a particle beam. To maintain superconductivity, SRF cavities are surrounded by liquid helium. If the radio frequency field is too high, the cavity will heat up too much in certain sections that will become normal conducting – this is called a quench. The aim of the T-mapping system is to identify hot spots – areas where there are more than the expected amount of losses, which lower the quality factor and could lead to an early quench. Through measuring the surface temperature, we can identify hotspots and use the t-map to detect the location where quench happens.

Data Processing

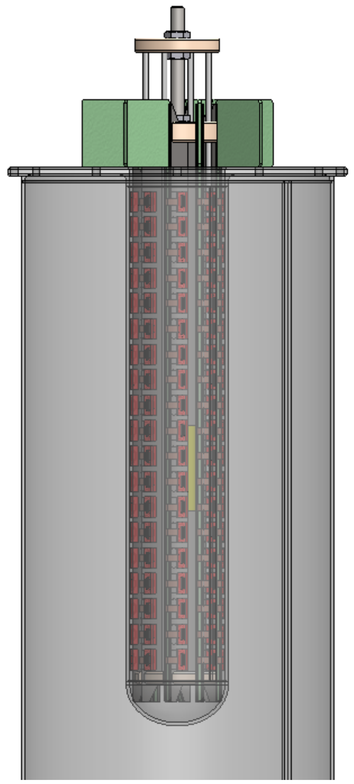


Calibration data from a sample data set

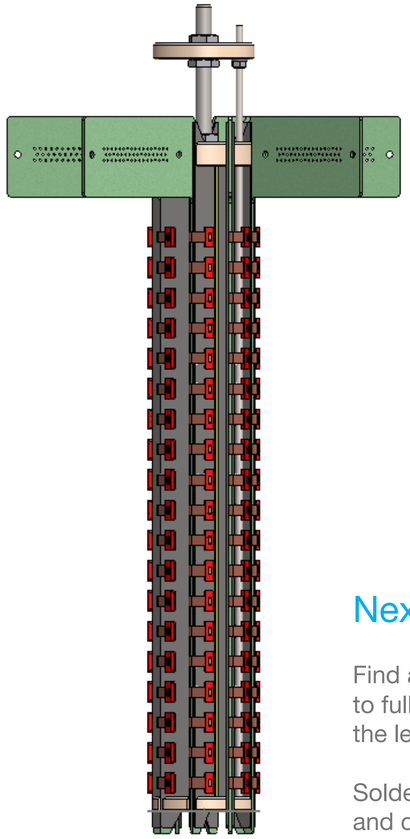




Temperature mapping from sample data



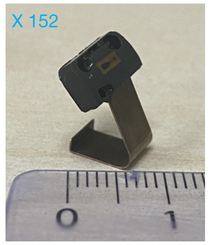
T-map in quarter wave resonator



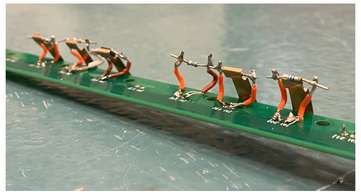
Assembled T-map

Assembly

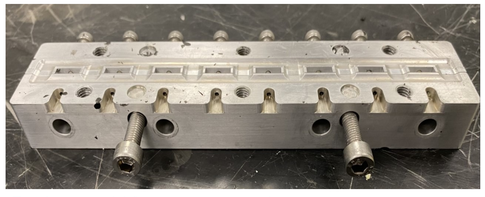
Board with resistors



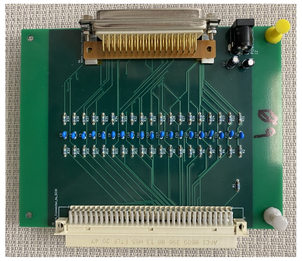
Spring with resistor and spacer



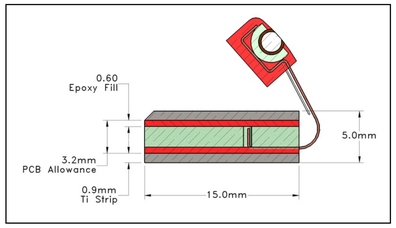
Prototype of sensors on board



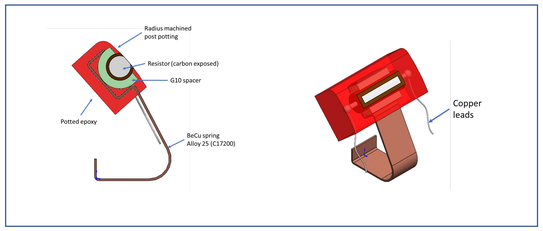
Potting mould for sensor encasing



Signal processing board



PCB sandwiched between Ti sheets for mechanical stability.



Proposed spring design

Next Steps

Find a method that will allow epoxy to fully form around spring and keep the leads on.

Solder on the leads to 152 sensors and cast in epoxy. Solder the epoxied springs to cold boards and test.

Discovery, accelerated