Investigation of the Surface Resistance of Niobium Between 325 MHz and 1300 MHz Using a Coaxial Half Wave Cavity

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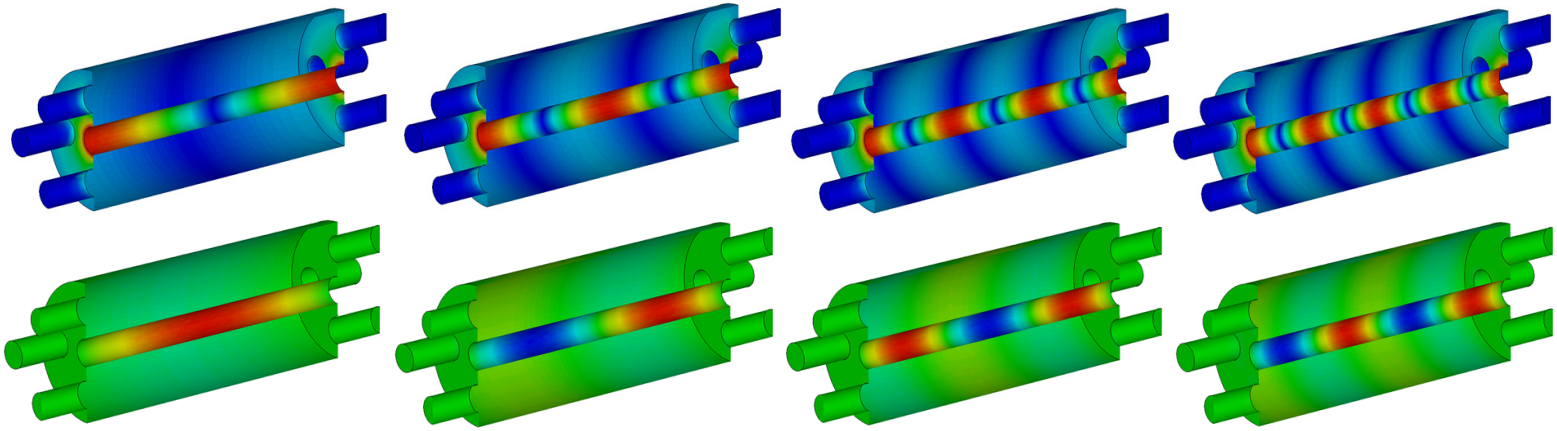
Introduction

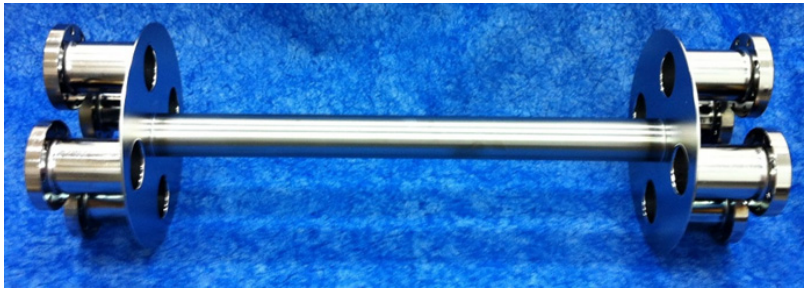
- Understanding of the surface resistance of superconductors (Niobium) requires systemic approach with well controlled parameters. Extracting frequency dependence is the best approach to understand the physics.

- So far, different cavities of different frequencies were tested but this method does not provide identical surface condition.

- Using TEM modes of half wave coaxial cavity we collect experimental data and develop/test theories.

Half Wave Coaxial Cavity





HW-Coax cavity before outer conductor weld

Base line surface treatment

- Heavy BCP
- Heat treatment 800C 2 hrs
- Light BCP
- No low temp bake

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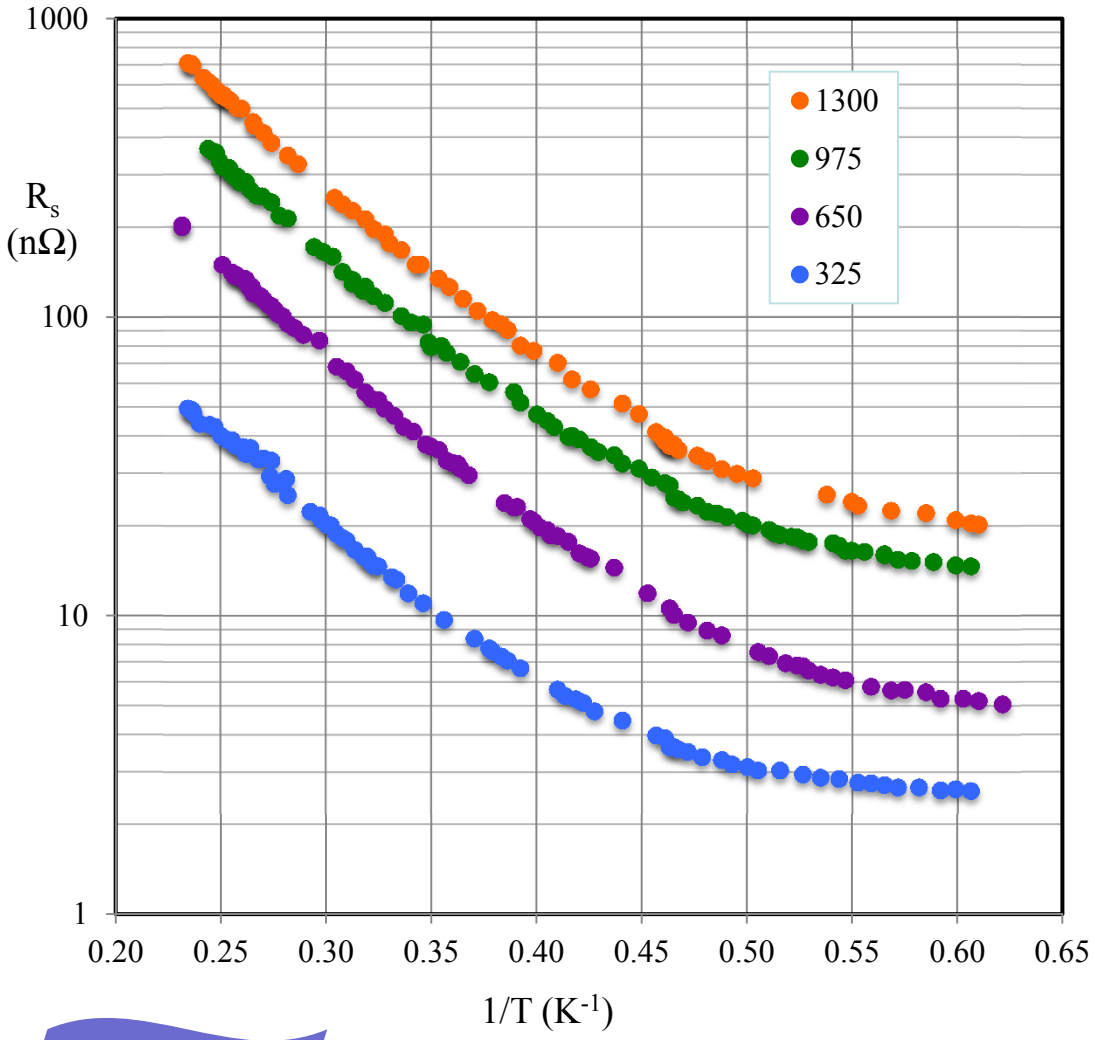
Baseline Test Results



Power measurement
➔ Q_0 calculated

$$Q_0 = \frac{\omega_r U}{P_{diss}} = \frac{\omega_r \int \mu_0 |\mathbf{H}|^2 \, dv}{\frac{1}{2}\int R_s |\mathbf{H}|^2 \, da} = \frac{G}{R_s}$$

$$R_s(T) = \frac{A(\omega)}{T}\exp\left[-\frac{\Delta}{kT}\right] + R_{res}$$

Mode (GHz)	A(ω)	R_res	D/k
0.3257	17082	2.5	18.7
0.6517	54526	4.7	18.1
0.9776	111895	13.6	18.0
1.303	212698	18.8	18.4

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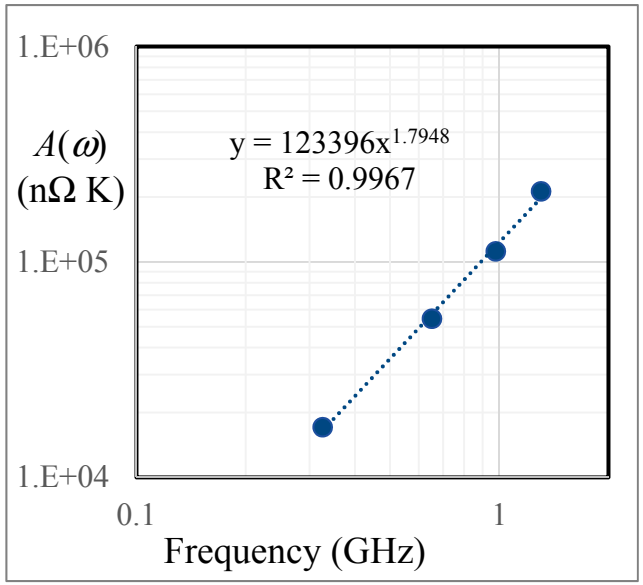
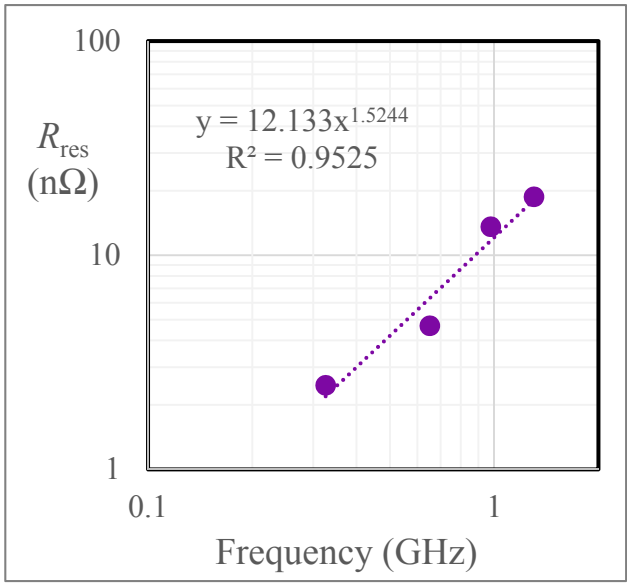
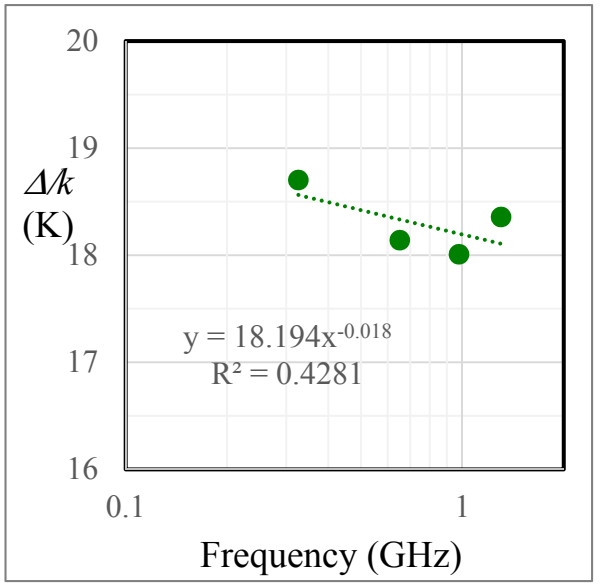
Baseline Test Results

$$R_s(T) = \frac{A(\omega)}{T}\exp\left[-\frac{\Delta}{kT}\right] + R_{\text{res}}$$







$$A(\omega) \propto \omega^{1.8}$$

$$R_{\text{res}} \propto \omega^{1.5}$$

$$\Delta / k \simeq 18.2\ \text{K}$$

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On-Going Work and Plans

- Influence of low temperature baking on $A(\omega)$, Δ/k, R_{res} , $R_s(H)$
  - Establish repeatable baseline
  - No baking, 6 hours, 6+6 hours, 6+6+12 hours, 6+6+12+24 hours
- Applying different surface treatment
  - Nitrogen infusion
  - Trapping of magnetic field
- Now building 2 new almost identical HW cavities
  - Entirely made of Nb to be able to go to high temperature
  - Nb_3Sn coating, High temperature heat treatment