Study cavity wall material

- Conductivity theory predicts the anomalous skin effect
  - Copper is the simplest conductor to demonstrate the effect
  - How about Aluminum?
    - The prediction is made for the BCS theory and it is more complicated than Cu (e.g. anisotropy of the scattering of conducting electrons)
  - Presently, high-purity Aluminum is one of the most popular materials to make a quantum computer (QC)

- The test used a 11.442 GHz Al Cavity
- Purity: 99.999 %
- Critical temperature of Al: 1.2 K
- $Q = 3 \times 10^8$ in Super Conducting RF (SRF)
- $Q = 10^5$ in Normal Conducting RF (NRF)
- Dashed curve is a prediction
- Is Al better than Cu for ADMX?

M. Reagor et al., arXiv:1302.4408v2 (2013)
Work progress

• Made several high purity Aluminum cavities
  o 99.99% (4N), 99.999% (5N), and 99.9999% (6N)
  o Sumitomo Material provided a sample

• Collaborate with the QC group at U of Chicago
  o UC is interested in a high-Q SRF
    ▪ Observe a Q-factor for various SRF materials
    ▪ Utilize Fermilab SRF facility to prepare an SRF cavity
    ▪ Study a surface roughness vs a Q-factor
    ▪ First 4N Al cavity reaches $1.7 \times 10^8$ (Preliminary)
  o ADMX is interested in a high-Q NRF
    ▪ Measure the Q-factor of a high-purity Al cavity in a multi-Tesla magnetic field
    ▪ Find a fridge + a multi-tesla magnet

• Looking for more collaborator and funding support
  o Task is halted because of short money