



Gold Coating Processes for 2.6 GHz SRF Cavities

Sadie Seddon-Stettler



CLASSE
Cornell Laboratory for Accelerator-based Sciences & Education



July 9, 2026

Outline

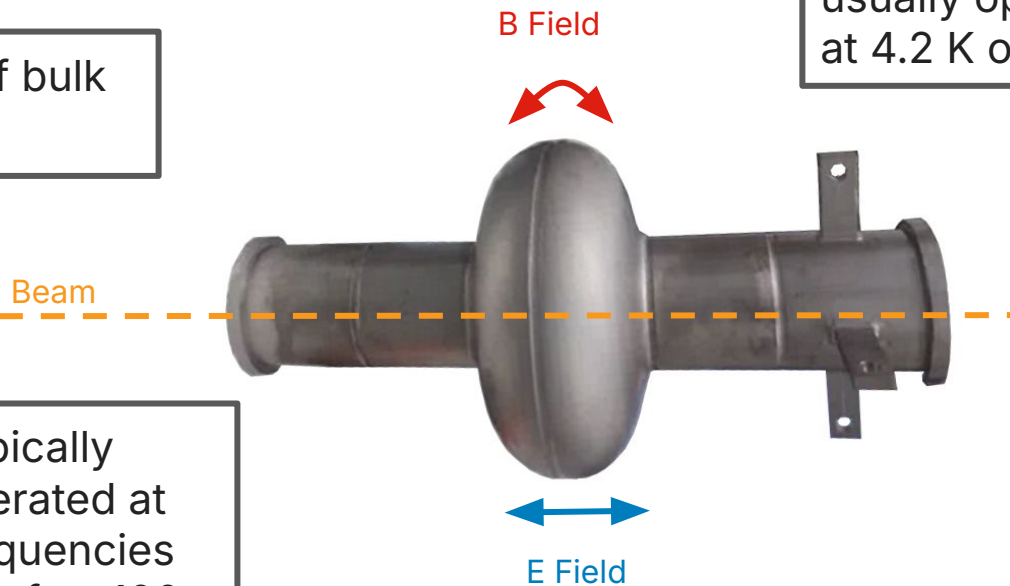
1. Introduction to SRF Cavities
2. Surface Optimization
3. Gold Coating Processes
4. First Cavity Results
5. Current Sample Work
6. Next Steps



Niobium SRF Cavities

Made of bulk niobium

Superconducting below 9.2 K,
usually operated at 4.2 K or 2 K



Typically operated at frequencies of a few 100 MHz to a few GHz

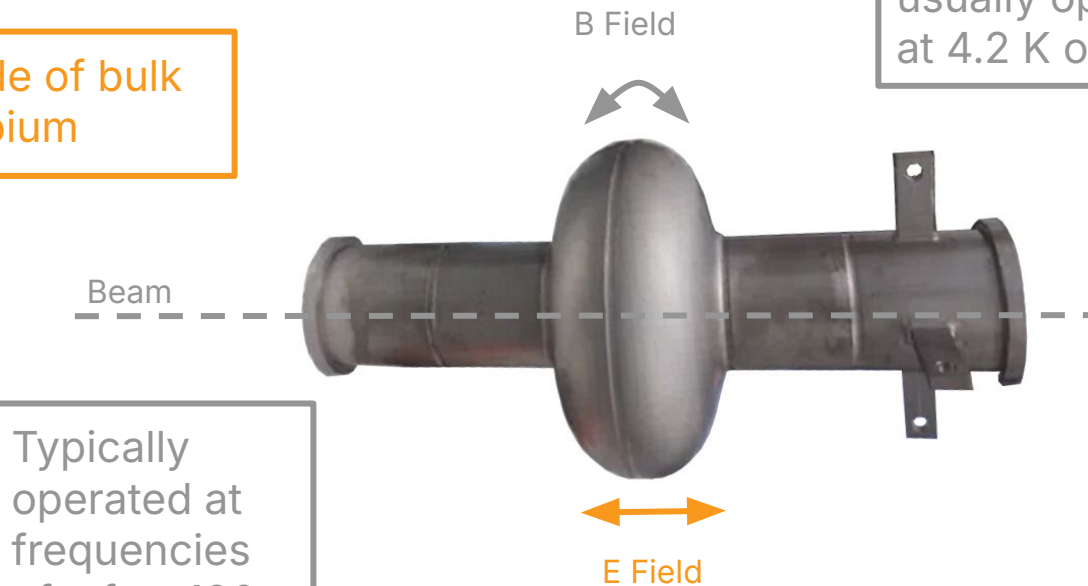
Useful for accelerators, quantum computers, many others

Performance measurement:
Quality factor, usually $\sim 10^{10}$

Niobium SRF Cavities

Made of bulk niobium

Superconducting below 9.2 K,
usually operated at 4.2 K or 2 K



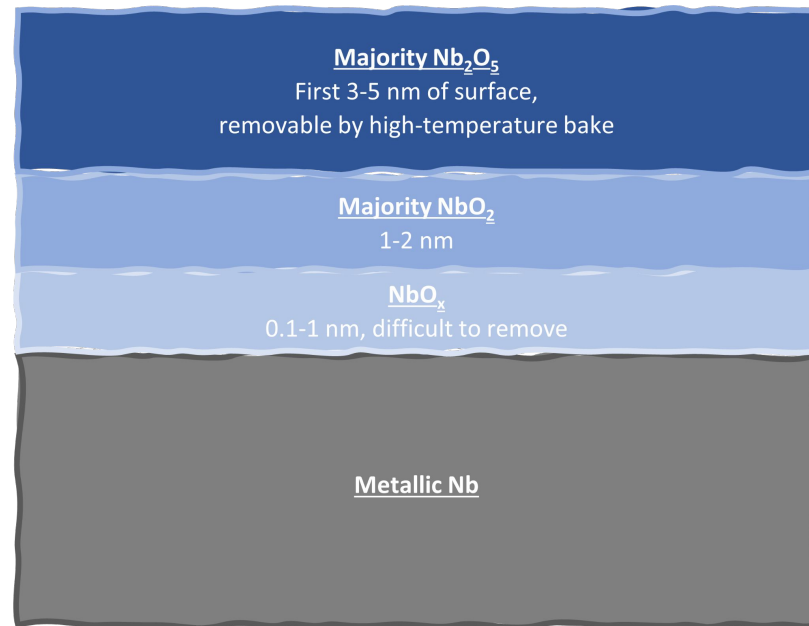
Typically operated at frequencies of a few 100 MHz to a few GHz

Useful for accelerators, quantum computers, many others

Performance measurement:
Quality factor, usually $\sim 10^{10}$

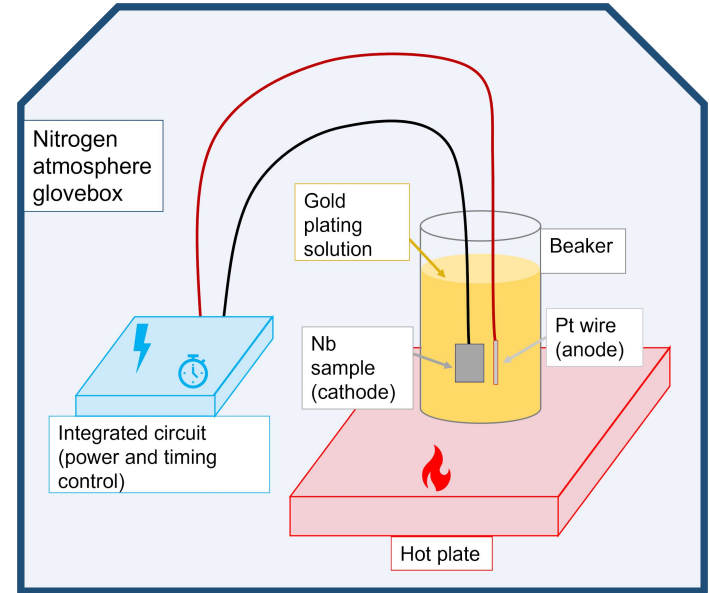
Niobium Oxide

- When exposed to atmosphere, Nb forms a **complex, multi-phased oxide**
- RF interaction is strongest in the first 40 nm of the Nb surface → **5-10 nm of oxide is significant**
- Can impact SRF cavity performance for accelerators and quantum applications:
 - Conductive properties of lower phases can introduce **conductive losses at high energies**
 - Dielectric properties of upper phases can introduce **dielectric losses at low energies**



Non-Oxidizing Capping Layers

- Remove oxide (chemically or thermally)
- Before oxide can reform, deposit a thin film of a non-oxidizing metal
- Film can be normal conducting if sufficiently thin



Gold Electrodeposition

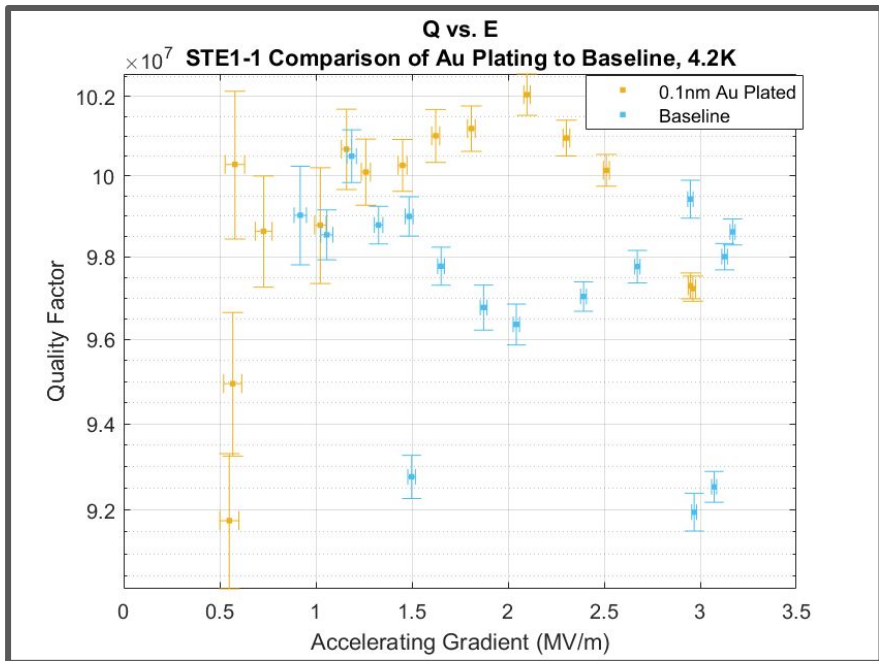
1. **Prepare cavity surface** with standard treatments (Buffered chemical polish → long electropolish → bake → short electropolish → high pressure rinse)
2. Move oxidized cavity into **inert-atmosphere glovebox**
3. Fill cavity with 1-2% hydrofluoric acid for 30 minutes to **remove oxide**
4. Empty cavity and rinse residual acid with methanol
5. Fill cavity with gold electroplating solution, place platinum wire in center of cavity, and **electroplate** with short bursts of low current
6. Empty cavity and remove from glovebox

Oxide Passivation in Inert Atmosphere

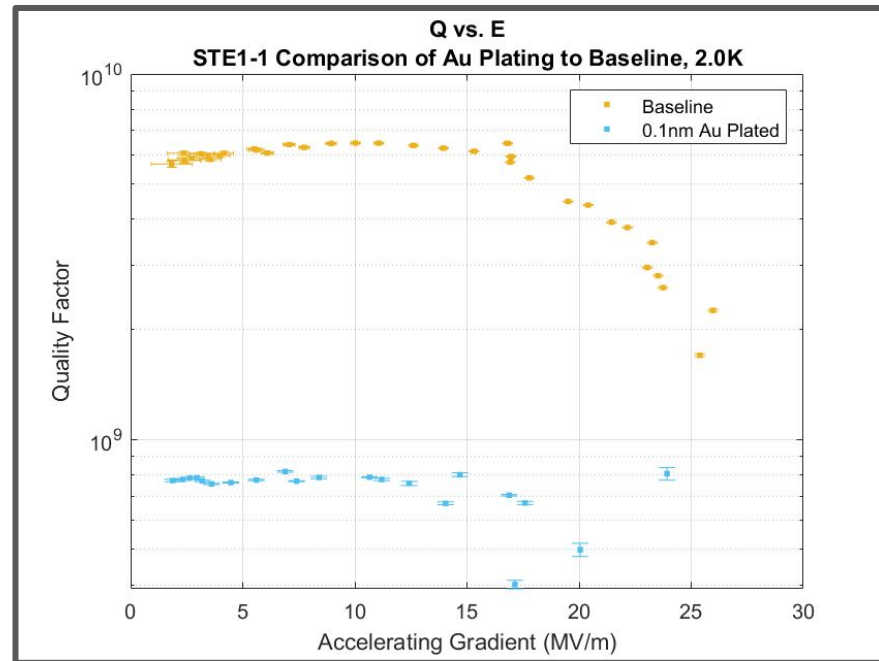


Q vs. E Results

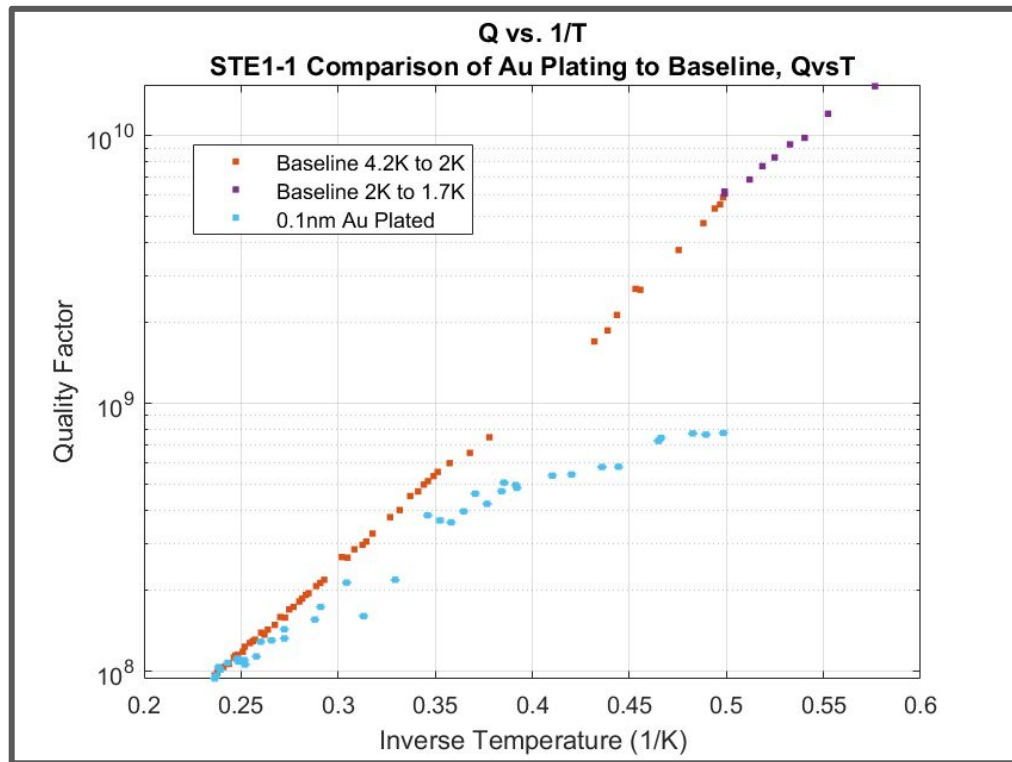
4.2 K



2.0 K

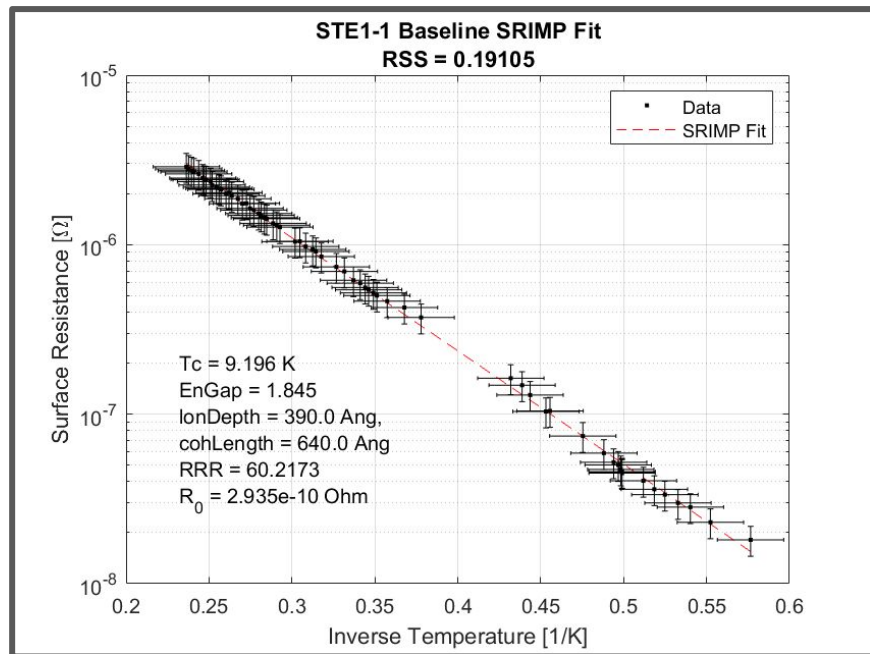


Q vs. 1/T Results

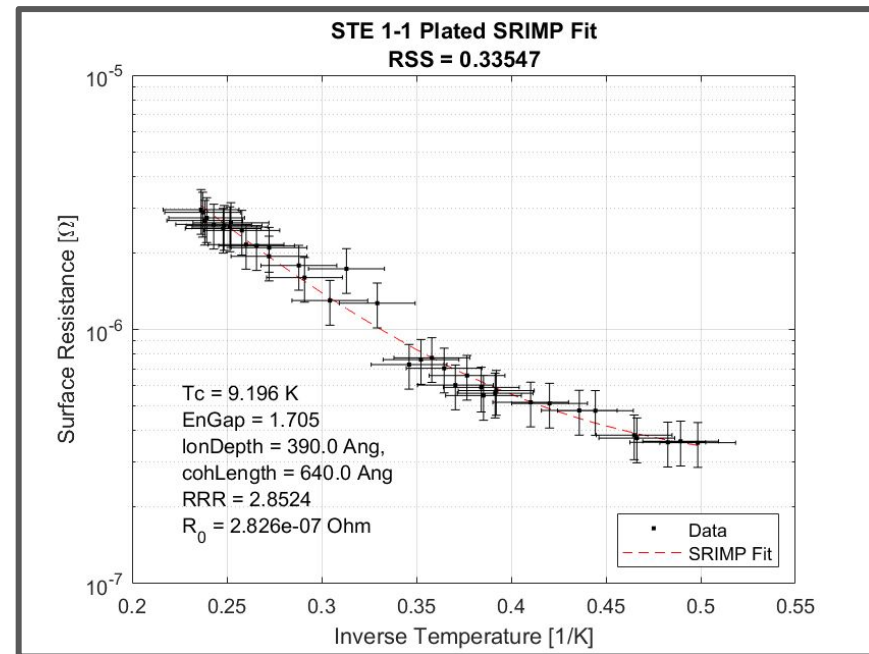


R vs. 1/T Results

Baseline



Plated



N.B. Surface resistance is inversely related to quality factor

In-House Sample Study

Chemical Oxide Removal

1. Full surface preparation
2. Baseline imaging
3. Move oxidized Nb into inert-atmosphere glovebox
4. Immerse in dilute HF to remove oxide
5. Electrochemically deposit thin Au layer
6. Remove from glovebox for repeat imaging

Thermal Oxide Removal

1. Full surface preparation
2. Baseline imaging
3. Electroplate oxidized Nb with thin Au layer
4. Bake in vacuum furnace to remove oxide
5. Repeat imaging

Current Status and Next Steps

Chemical Oxide Removal

1. ~~Full surface preparation~~
2. ~~Baseline imaging~~
3. ~~Move oxidized Nb into inert atmosphere glovebox~~
4. ~~Immerse in dilute HF to remove oxide~~
5. ~~Electrochemically deposit thin Au layer~~
6. ~~Remove from glovebox for repeat imaging~~

Thermal Oxide Removal

1. ~~Full surface preparation~~
2. ~~Baseline imaging~~
3. **Electroplate** oxidized Nb with thin Au layer
4. **Bake in vacuum furnace** to remove oxide
5. Repeat imaging

Current Status and Next Steps

Chemical Oxide Removal

1. ~~Full surface preparation~~
2. ~~Baseline imaging~~
3. ~~Move oxidized Nb into inert atmosphere glovebox~~
4. ~~Immerse in dilute HF to remove oxide~~
5. ~~Electrochemically deposit thin Au layer~~
6. ~~Remove from glovebox for repeat imaging~~

Thermal Oxide Removal

1. ~~Full surface preparation~~
2. ~~Baseline imaging~~
3. **Electroplate** oxidized Nb with thin Au layer
4. **Bake in vacuum furnace** to remove oxide
5. Repeat imaging

Winning Technique Will Be Applied to 2.6 GHz Cavity!



Thank You!

Sadie Seddon-Stettler



CLASSE
Cornell Laboratory for Accelerator-based Sciences & Education



July 9, 2026