Progress with RF Characterisation facility at STFC

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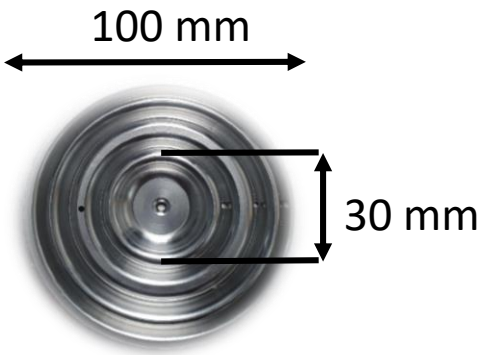
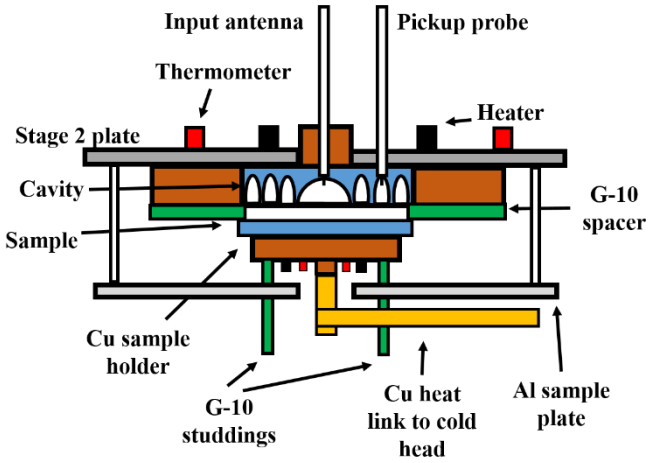
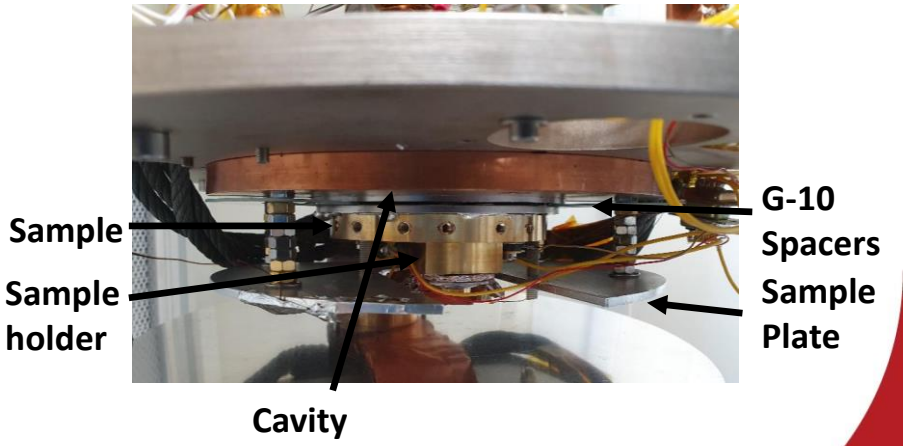
Facility Reminder

- Measurements of R_S with RF-DC compensation using Nb choke cavity (3 choke or 2 choke)
- Aim to test planar samples **90 - 130 mm** diameter **(100 mm is ideal size)** with **2 day turnaround** between tests
- So far allows R_s measurements of
  - **f_0 = 7.8 GHz**
  - **T_S = 4 to 10 K**
  - **RF Power up to 1 W**
  - **$B_{s,pk} \leq$ 1 mT**





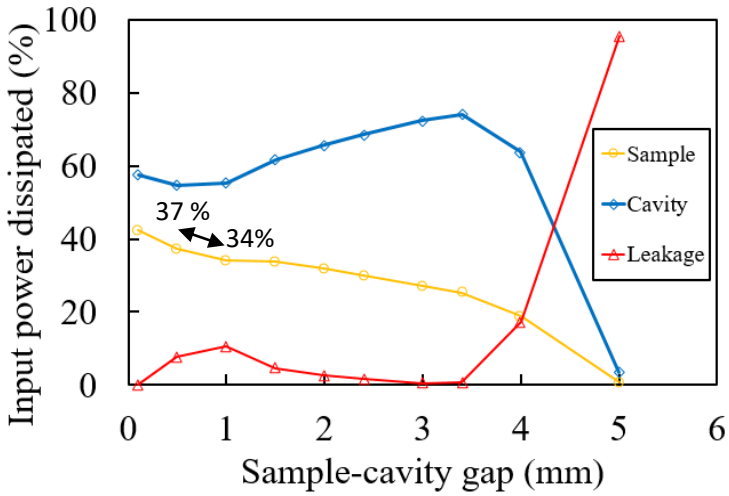


Facility Upgrades – 2 Choke Cavity & Sample-Cavity Gap

- **Cavities:**
  - Studying difference in performance between 2 and 3 choke cavities – both cavities haven't received full treatment
    - CST
    - Experimentally (effect of polishing, heat treatment…)
  - At 5 K:
    - R_S (2 choke) ~ 600 µΩ,
    - R_S (3 choke) ~ 120 µΩ
  - 2 choke cavity sent to IJCLab for full treatment
- **Sample-Cavity Gap Optimisation:**
  - Wish to maximize % of RF power dissipated on sample
  - Highest power dissipation on the sample for a gap of 0.5 mm.
  - Significant leakage through gap > 4 mm
  - **Sample measurements can still happen even if choke fails or cavity quality is poor**

3 choke cavity currently being used

2 choke cavity at IJCLab for treatment



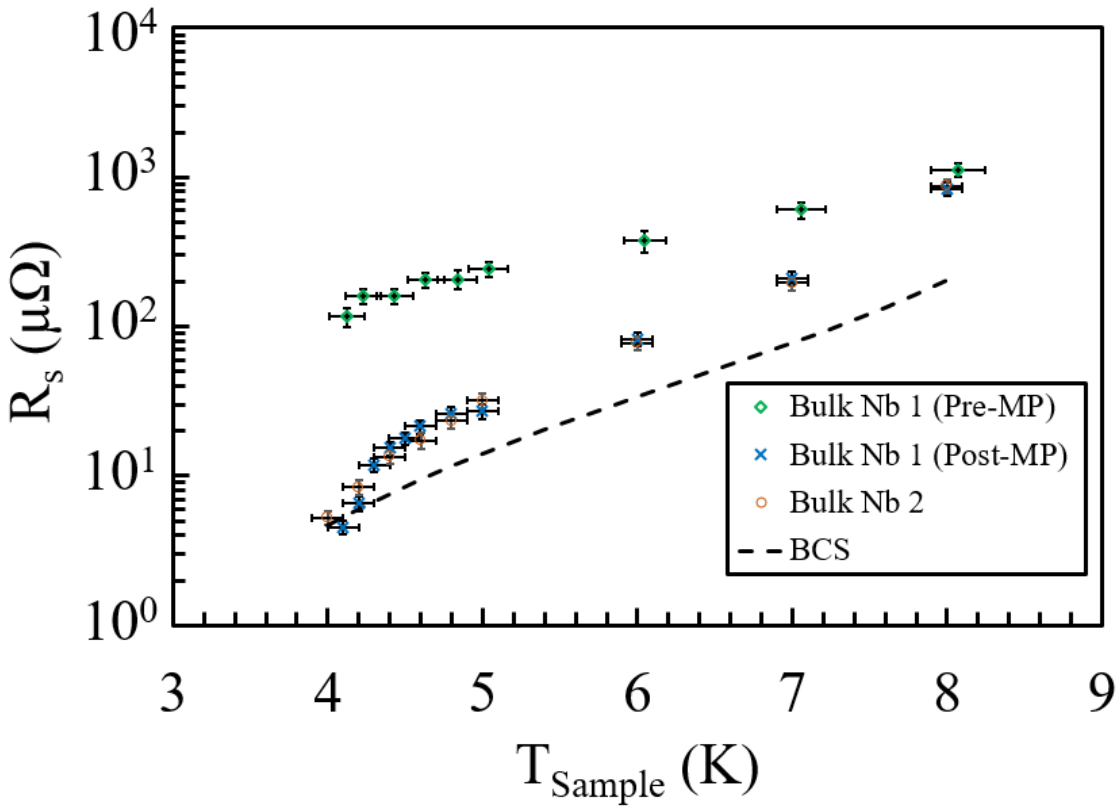
Facility Upgrades - RF Bunker

- Potential to increase B_{peak} (overlap with QPR):

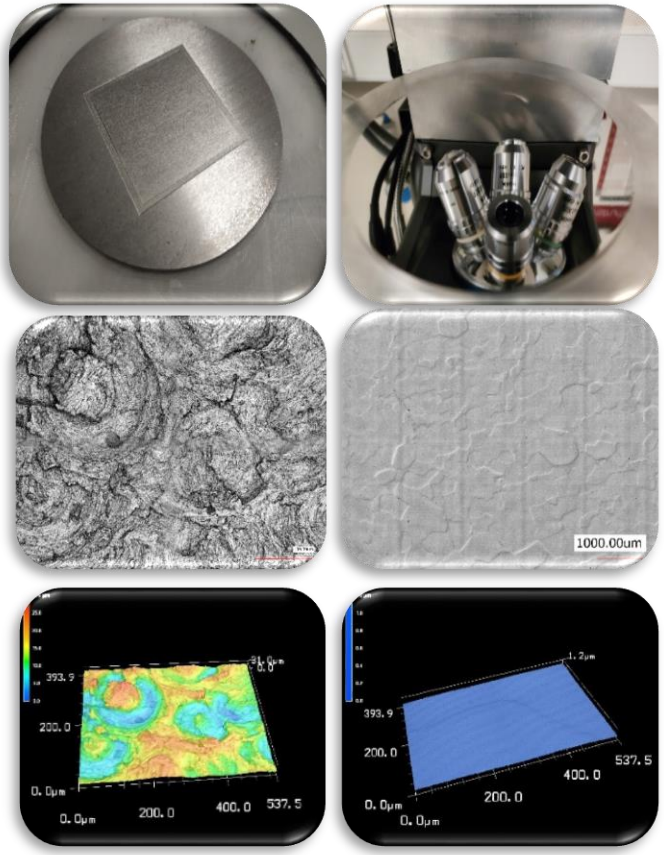
	Q	$P_{cav,\ max}$ (W)	B_{peak} (mT)
Present state	7×10^5	0.3	1.1
With PLL	3×10^6	0.3	1.7
Improve cavity Q	6×10^6	0.3	3.6
Increase CW Power	6×10^6	1	8.1
Increase CW Power	6×10^6	1.5	9.9
Pulsed power (e.g. 30% duty)	6×10^6	5	18

- Higher fields difficult at our frequency & Qs
- A new bunker would allow for present RF power safety limits to be exceeded

Bulk Nb Samples



Bulk Nb 1

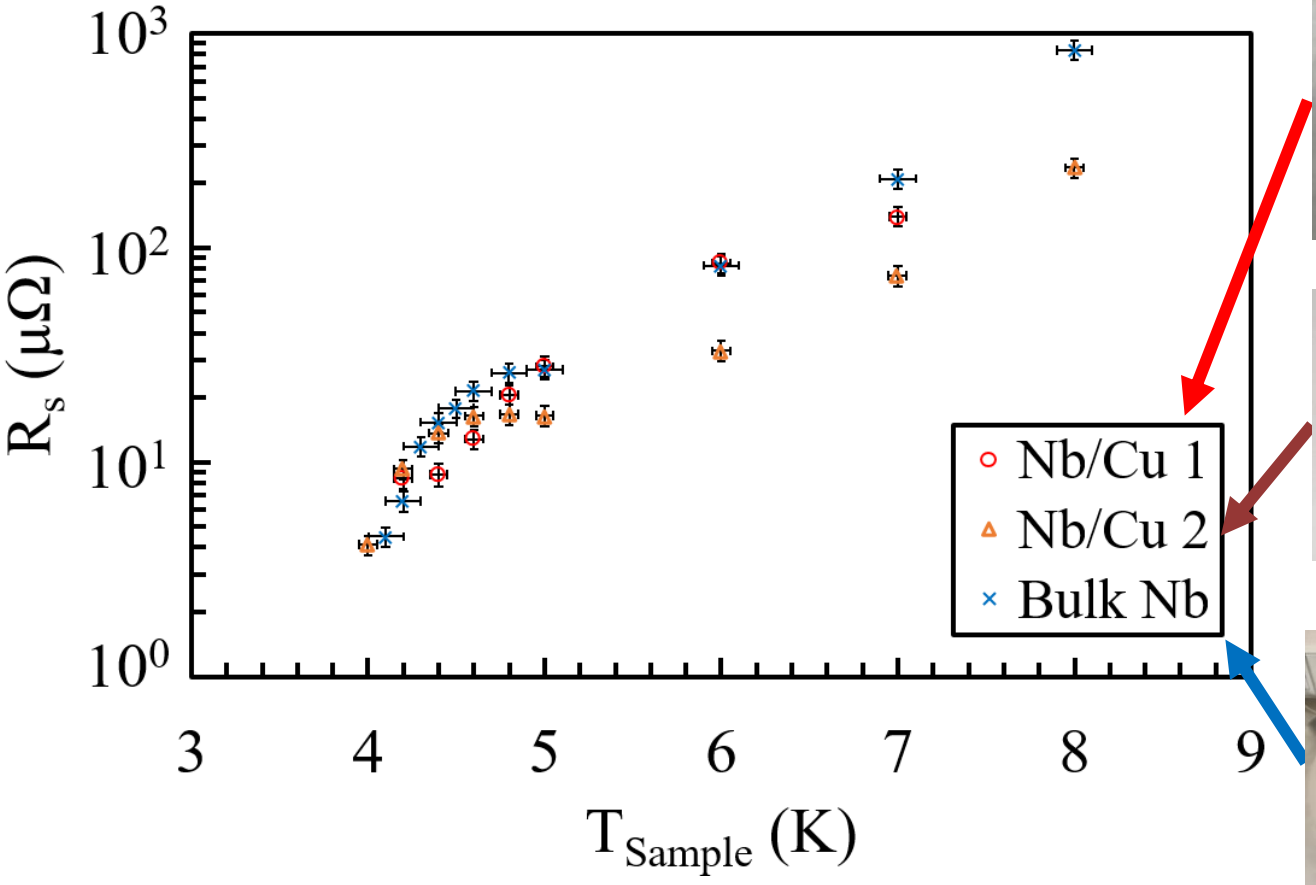


Pre-MP *Post-MP*

Courtesy of O. Hryhorenko (IJCLab)

Nb on Cu Samples

- **High impulse magnetron sputtering (HiPIMS)**
- 130 mm diameter **diamond turned Cu** disks.

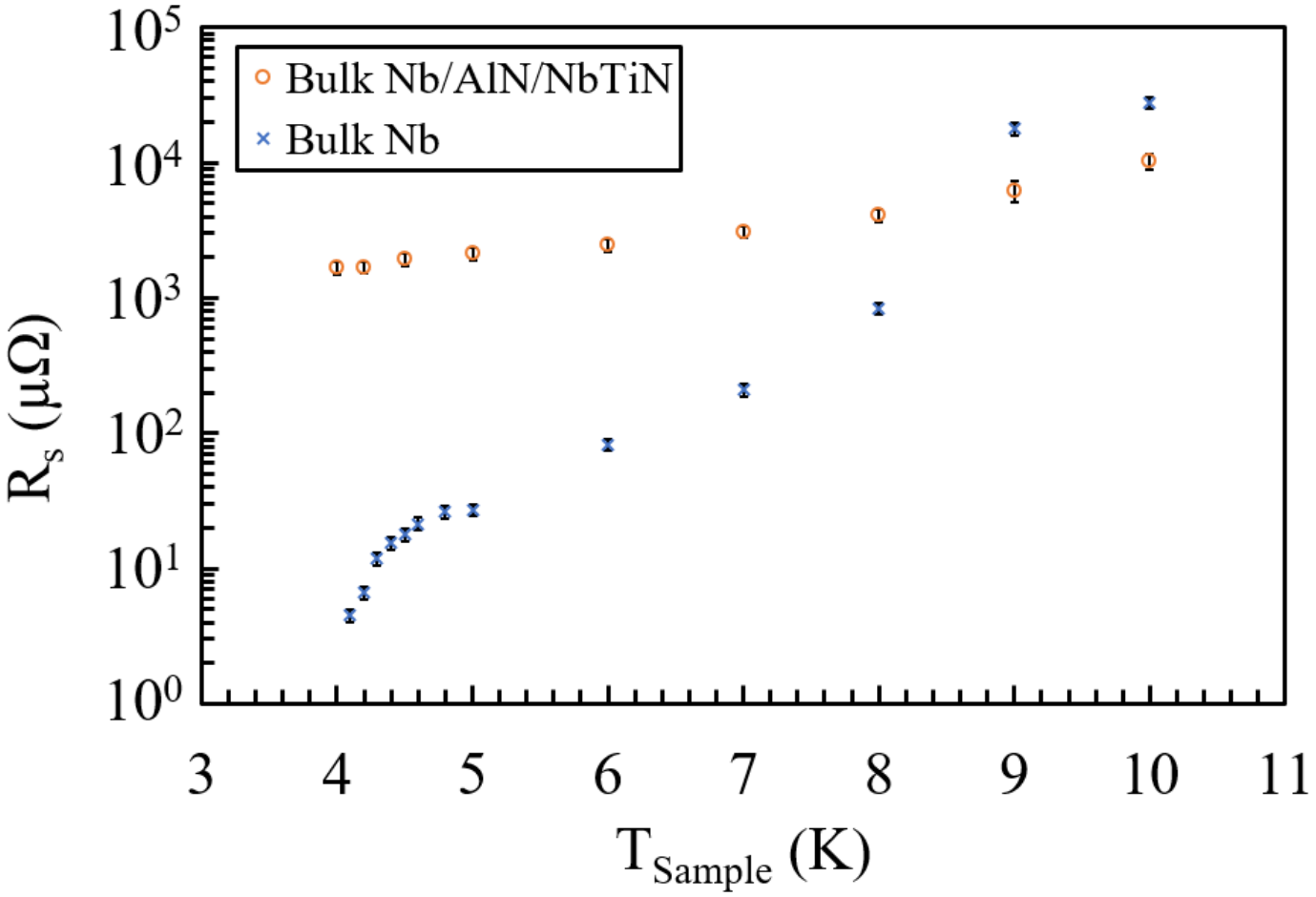


~ 500 °C

~ 330 °C

Bulk Nb 1 annealed at ~ 600 °C

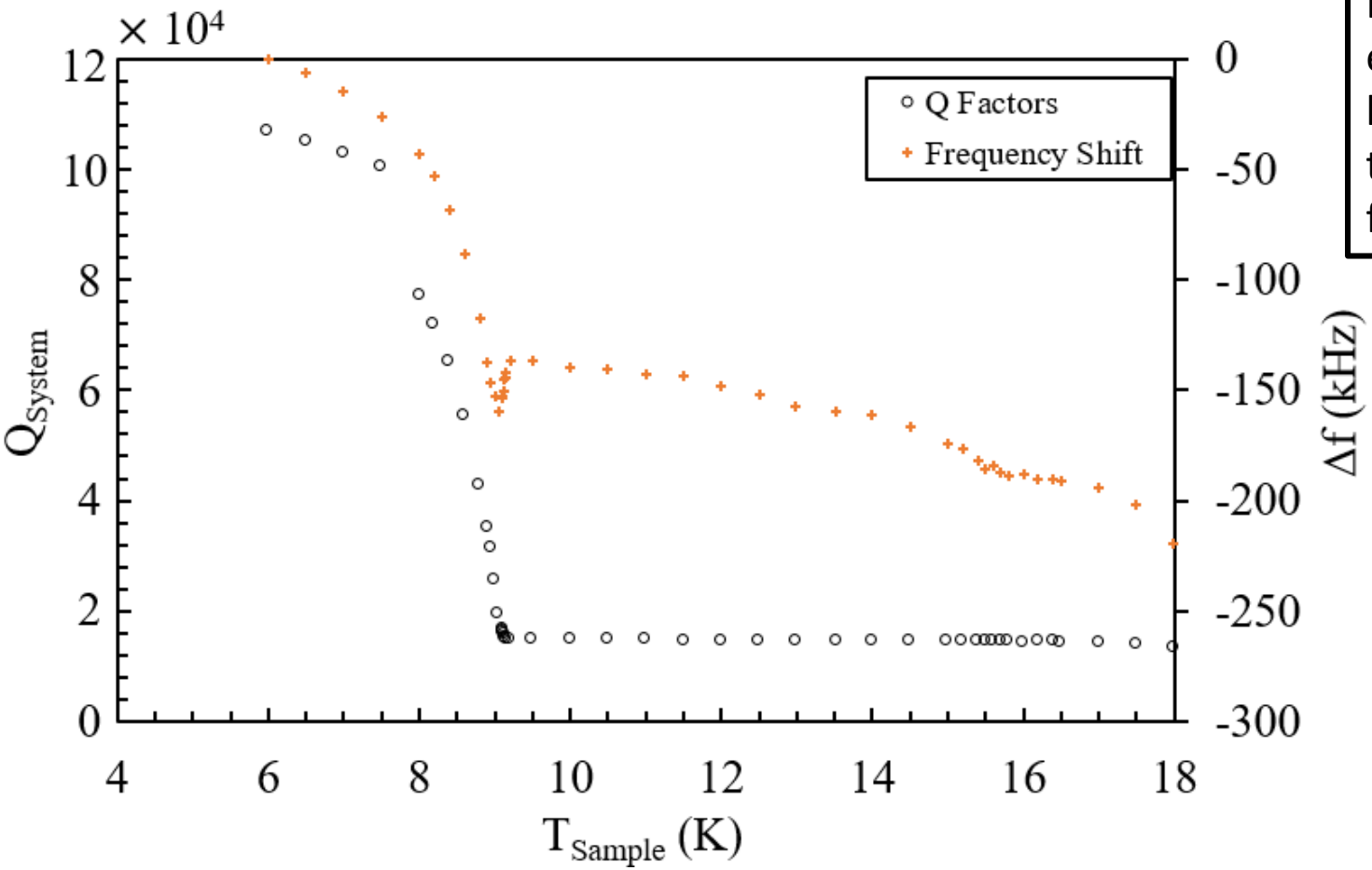
Nb/AlN/NbTiN Multilayers



Thicknesses:
- MP Bulk Nb 3 mm
- AlN ~ 10 nm
- NbTiN ~ 180 nm

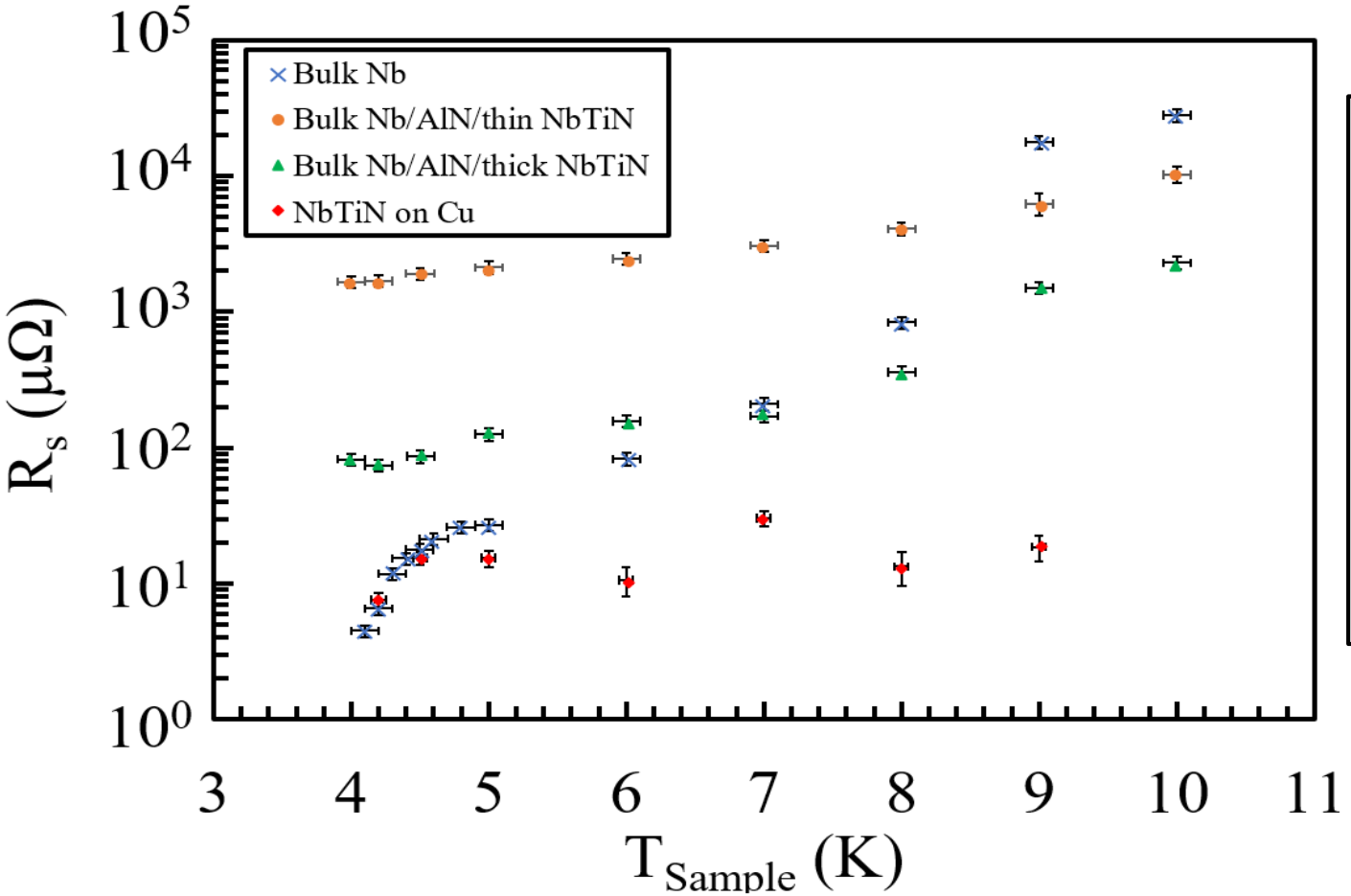
Deposition temperature: 600-650 °C

Nb/AlN/NbTiN Multilayers



Possibility to estimate T_c whilst keeping cavity temperature fixed

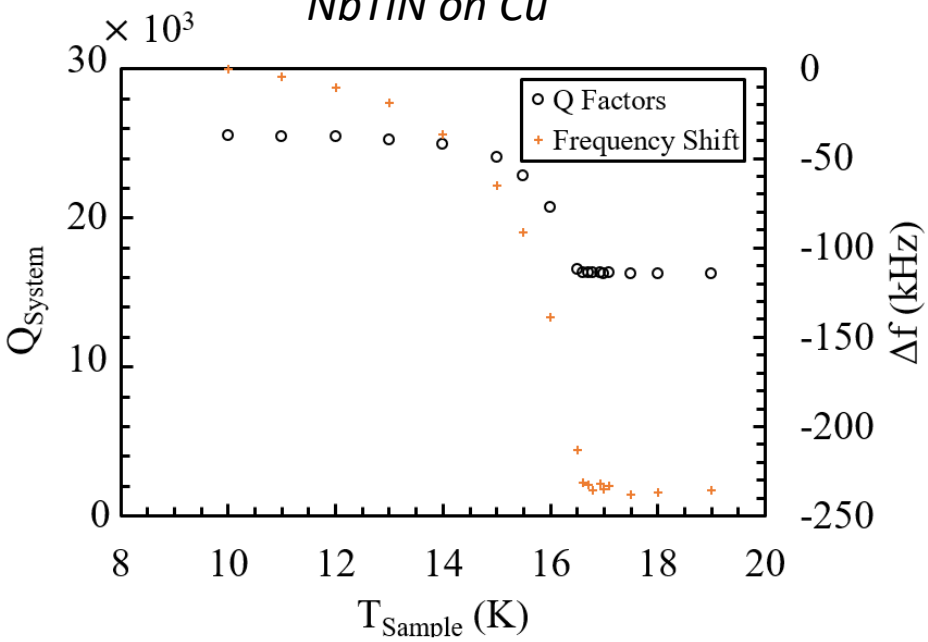
Nb/AlN/NbTiN Multilayers



- Additional ~ 620 nm NbTiN deposited → total = 800 nm NbTiN on existing layers
- Deposition temperature: 600-650 °C

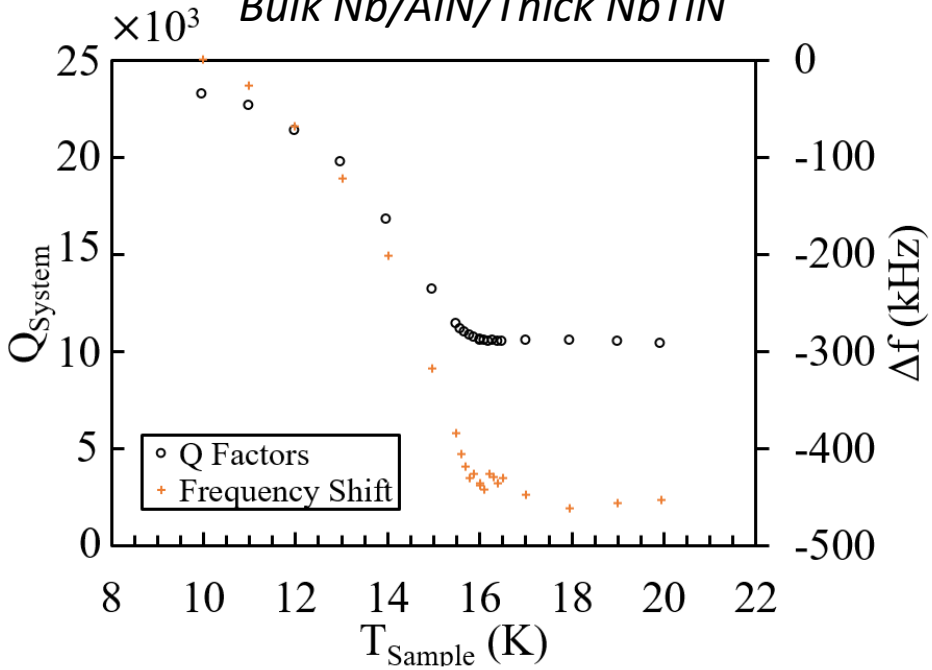
Nb/AlN/NbTiN Multilayers

NbTiN on Cu



T_c ~ 16.9 K

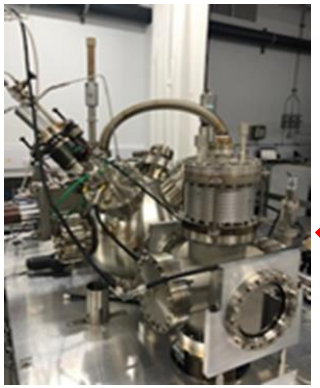
Bulk Nb/AlN/Thick NbTiN

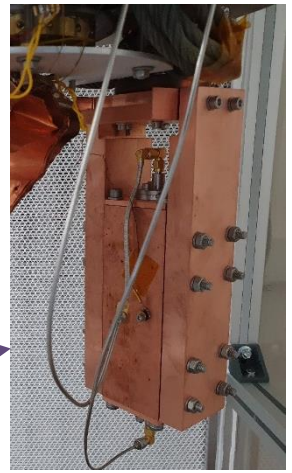


T_c ~ 16.1 K

From planar samples to real cavities

- **Aim:** Best performing flat samples → split cavities
- **3 sets of samples:**
  - Nb coated planar samples →
    - Tested with choke cavity
    - Up to 3 planar samples per week!
  - Split cavity deposited with planar magnetron & planar target
    - SRF test
  - Split cavity deposited with cylindrical magnetron & tubular target
    - SRF test





Future Plans

- Continuing RF testing of planar thin films:
  - Nb/AlN/NbTiN
  - Nb_3Sn
  - Nb
  - Etc
- Moving facility to an RF bunker early 2023 will allow for higher peak fields (overlapping with QPR)
- Will accept samples from IFAST partners on disks 90-130 mm diameter (up to 10 mm thickness)
  - We can provide unpolished or polished (will take longer) Cu
  - Contact: daniel.seal@cockcroft.ac.uk
- Any good samples could be given to Arturs for laser treatment at RTU
- Facility paper in progress

Thank you for listening

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