RF Surface Resistance Measurements on Planar Samples at STFC

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Outline

- **Continuing thin film optimisation studies with choke cavity**
- **Nb/Cu:**
  - HiPIMS
  - Study effect of substrate temperature during deposition
  - Samples from 2 Nb targets
  - Further analysis (MFP, RRR, T_c, surface analysis) in progress
- **Nb_3Sn/Cu:**
  - DCMS, HiPIMS
  - Effect of target power
- **NbTiN/Cu**
  - DCMS, HiPIMS

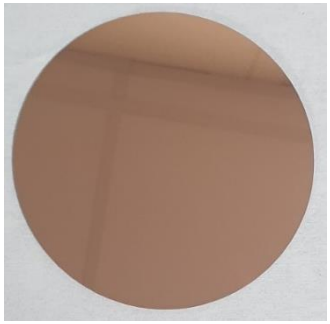
RF measurements of Nb samples

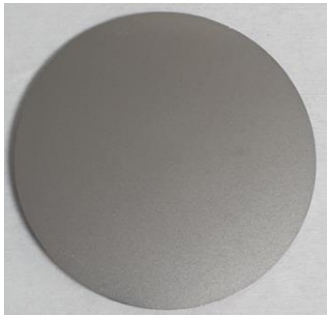
Sample preparation

- **Aim:** investigate effect of substrate heating
- **Substrate preparation:**
  - Diamond turned Cu disks – 10 cm diameter, 3 mm thick
  - Average roughness ~ 2-3 nm
- **Sample preparation:**
  - HiPIMS

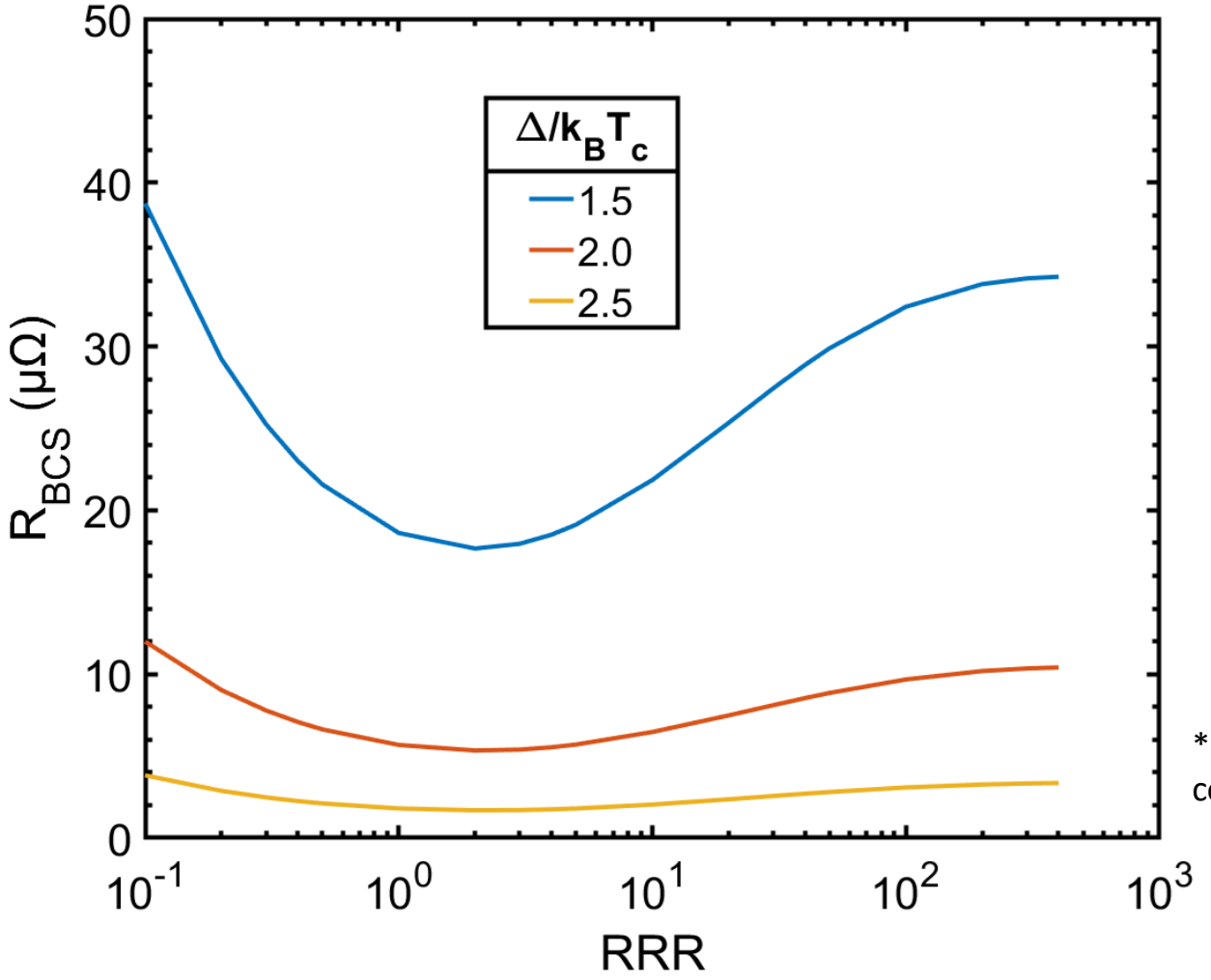
Parameter	Target 1	Target 2
Substrate heater current (A)	0, 10, 15, 23, 30, 35	0, 10, 15*, 23*, 28, 32 35
Substrate heater temperature (A)	RT to ~ 650 °C	RT to ~ 650 °C
Expected thickness (µm)	3	3

* In progress



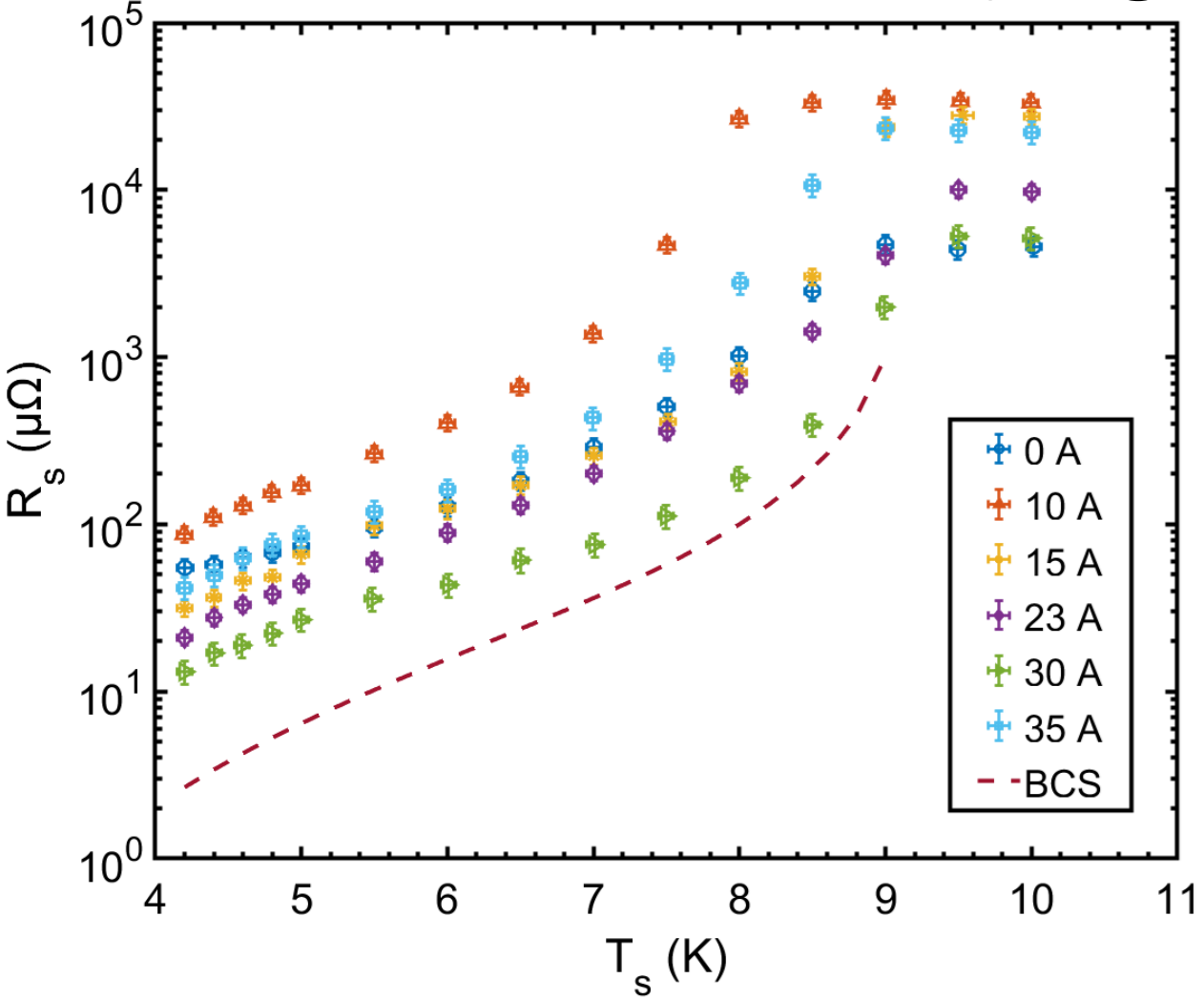


Optimising Nb/Cu surface resistance



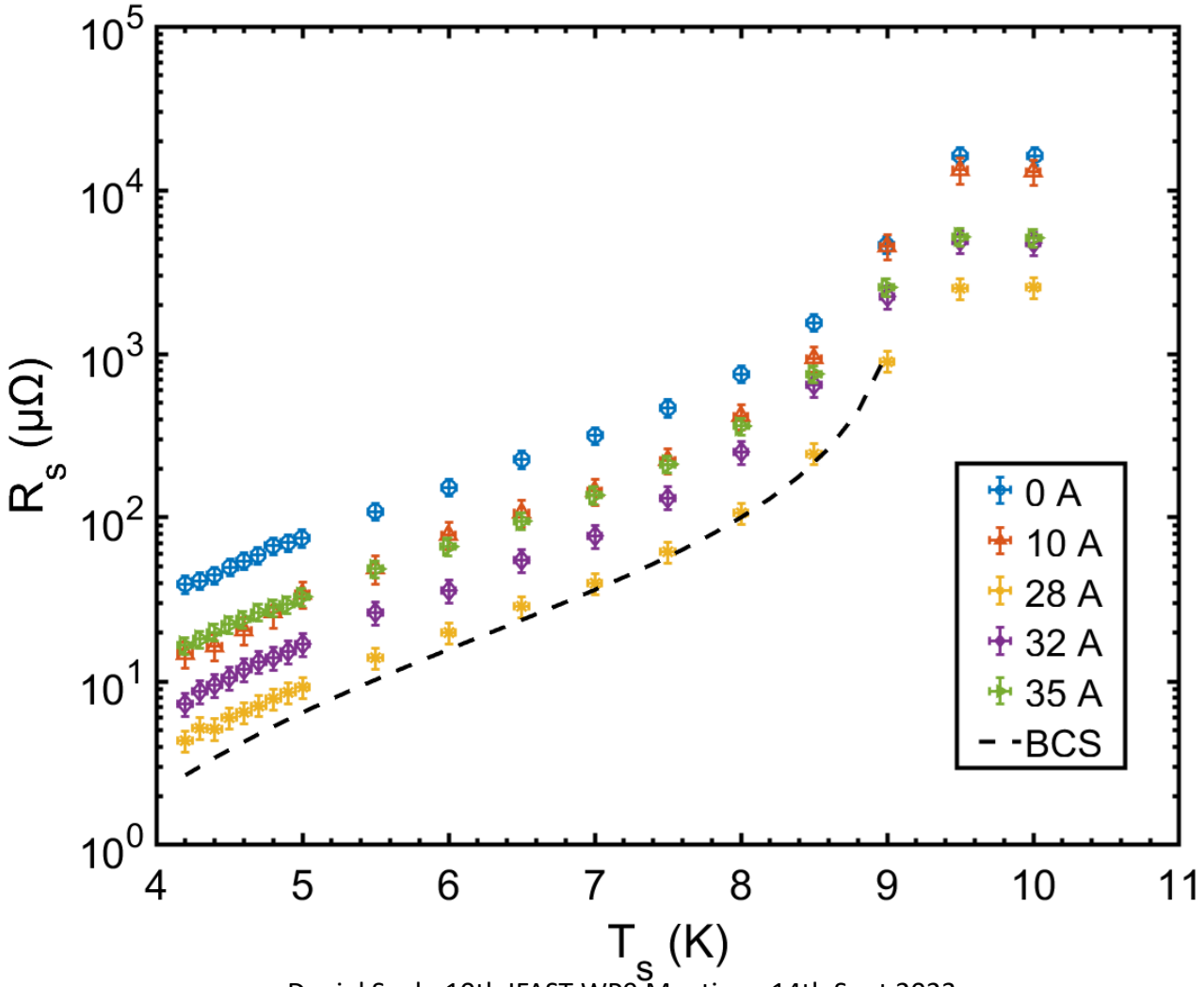
*BCS from SRIMP code

Nb/Cu: surface resistance (target 1)



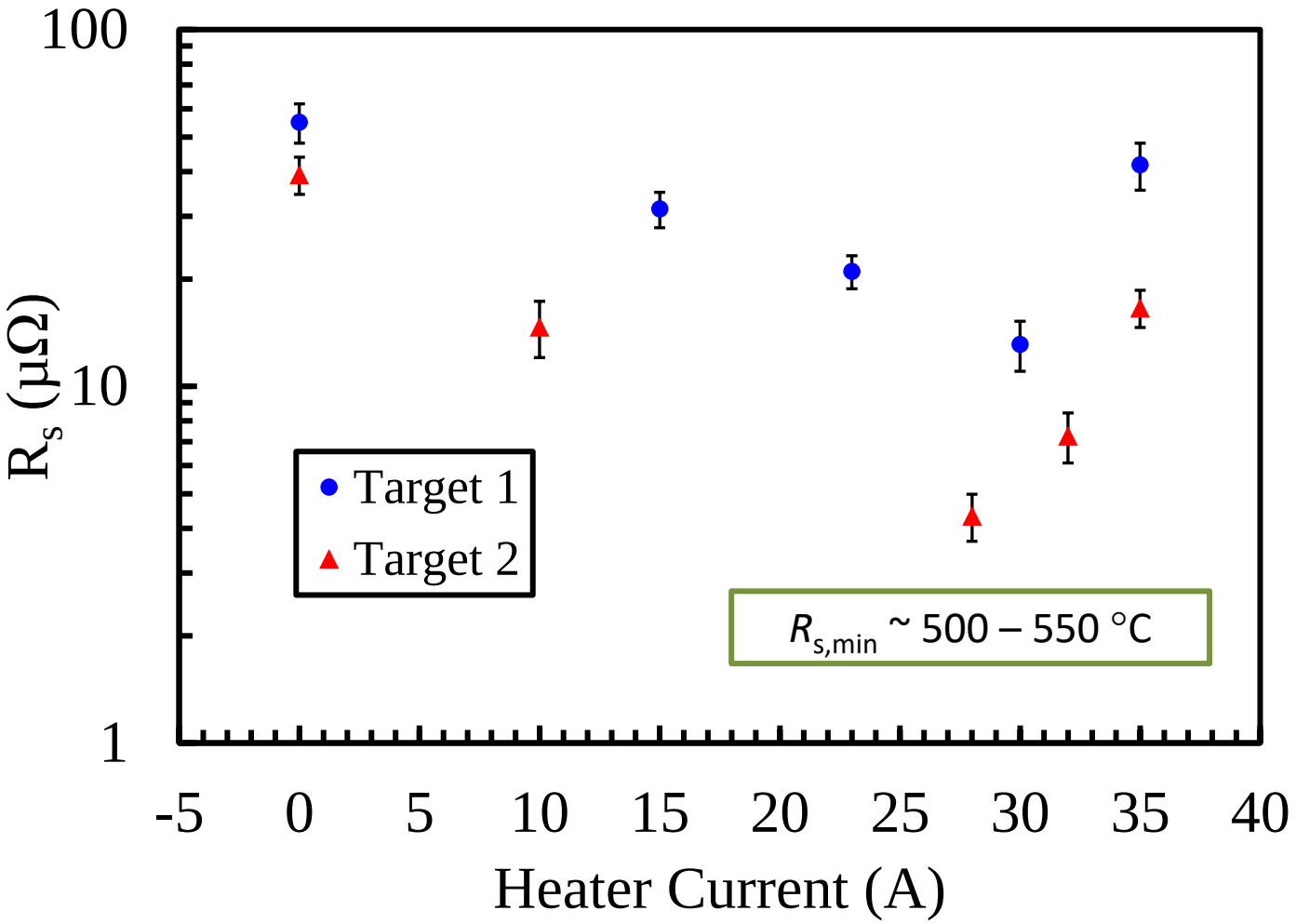
*BCS from SRIMP code

Nb/Cu: surface resistance (target 2)

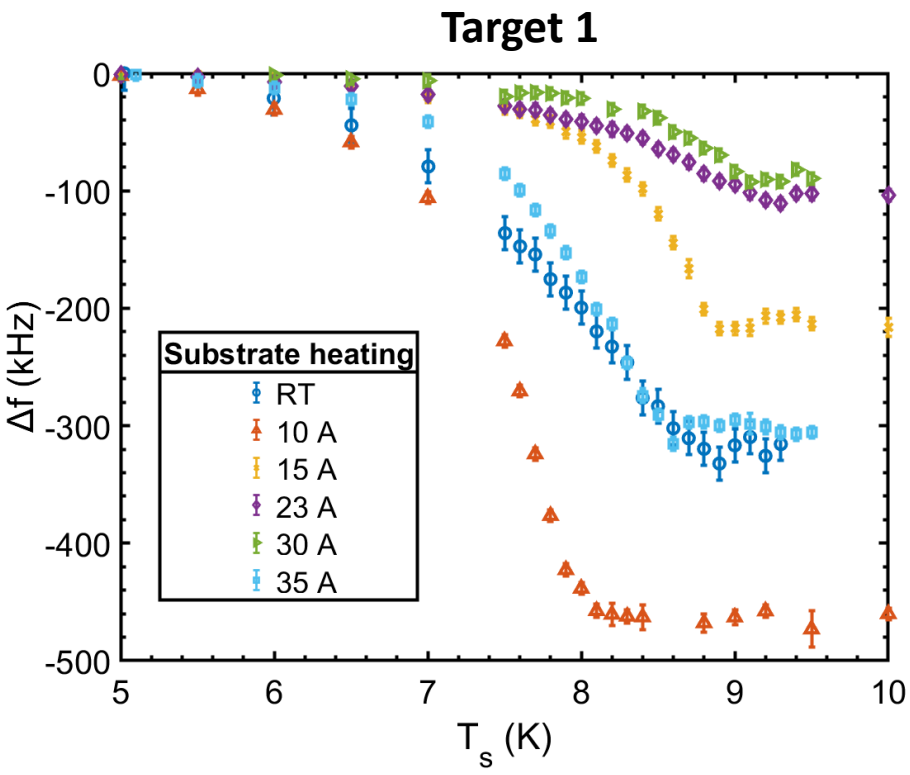


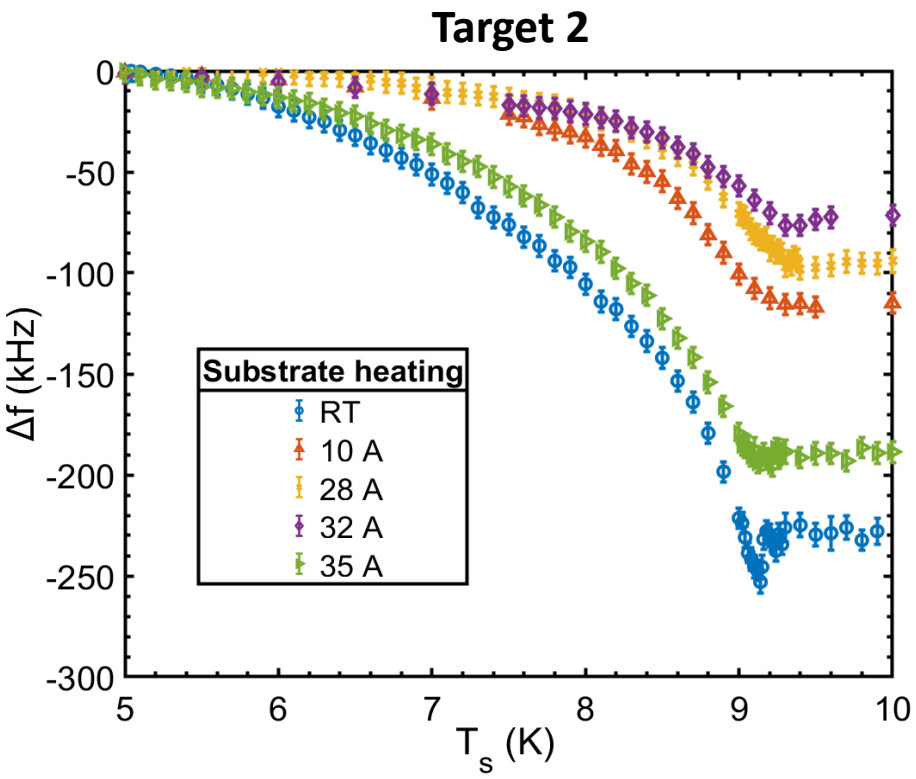
*BCS from SRIMP code

Nb/Cu: surface resistance at 4.2 K



Nb/Cu: frequency shift





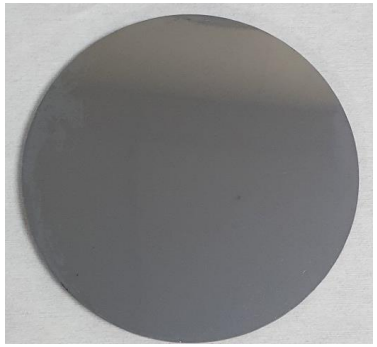
- Variation in T_c due to Cu contamination
- T_c as expected for all samples

RF measurements of Nb_3Sn samples

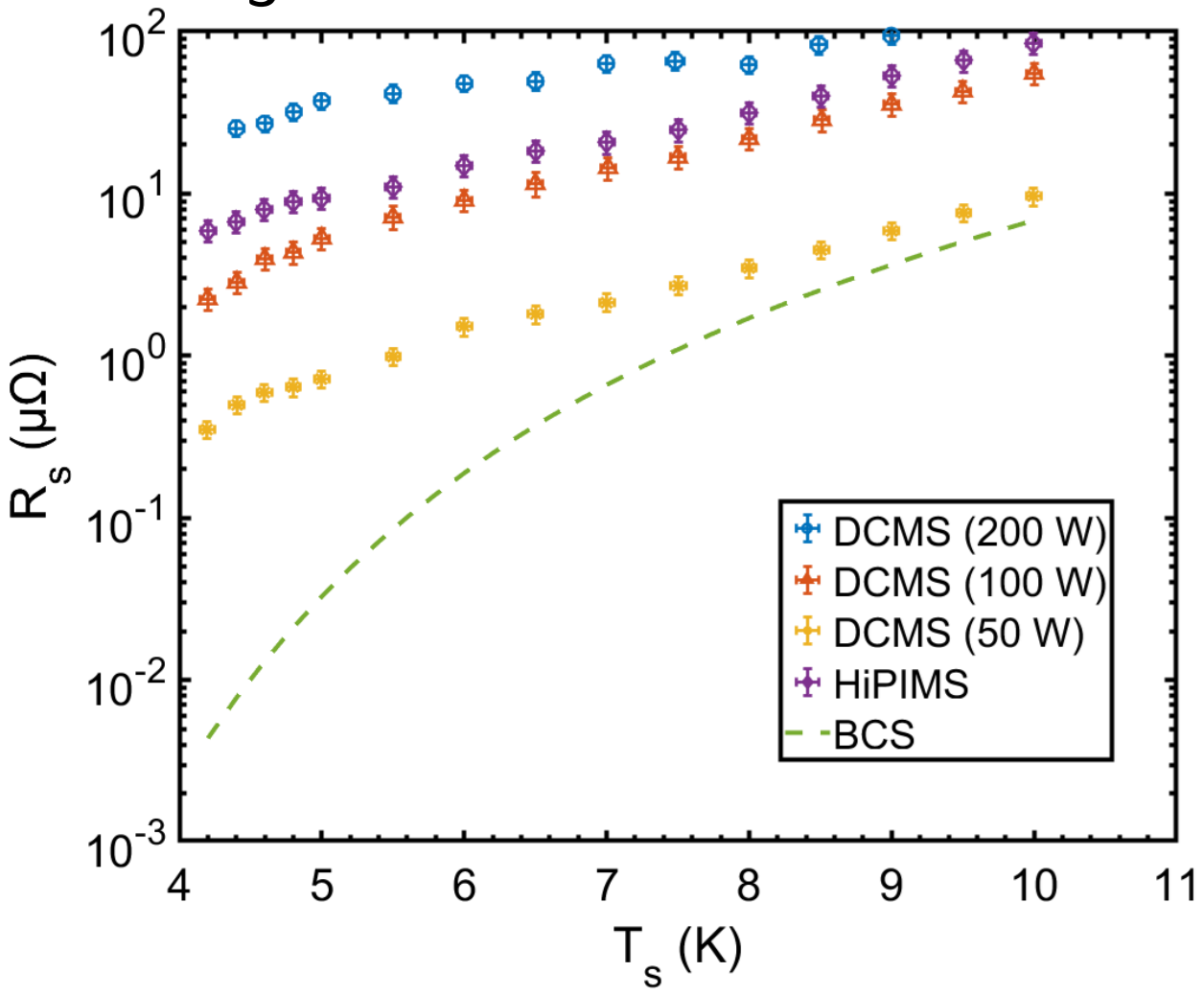
Sample preparation

- **Aim:** investigate effect of target power/deposition method
- **Substrate preparation:**
  - Diamond turned Cu disks – 10 cm diameter, 3 mm thick
  - Average roughness ~ 2-3 nm
- **Sample preparation:**
  - 3 DCMS, 1 HiPIMS

Parameter	DCMS	HiPIMS
Substrate heater current (A)	35 (~ 650 °C)	35 (~ 650 °C)
Target power (W)	200, 100, 50	100
Expected thickness (µm)	2.6	2.6



Nb_3Sn: surface resistance



T_c ~ 16.5 – 17 K from frequency shift

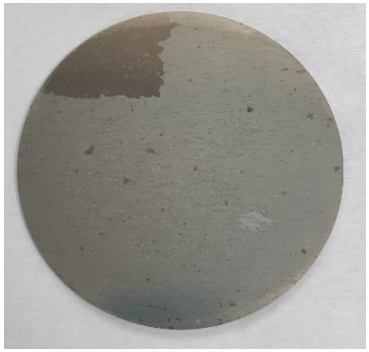
*BCS from SRIMP code (Parameters from: A-M Valente-Feliciano, *Superconducting RF materials other than bulk niobium: a review)*

RF measurements of NbTiN samples

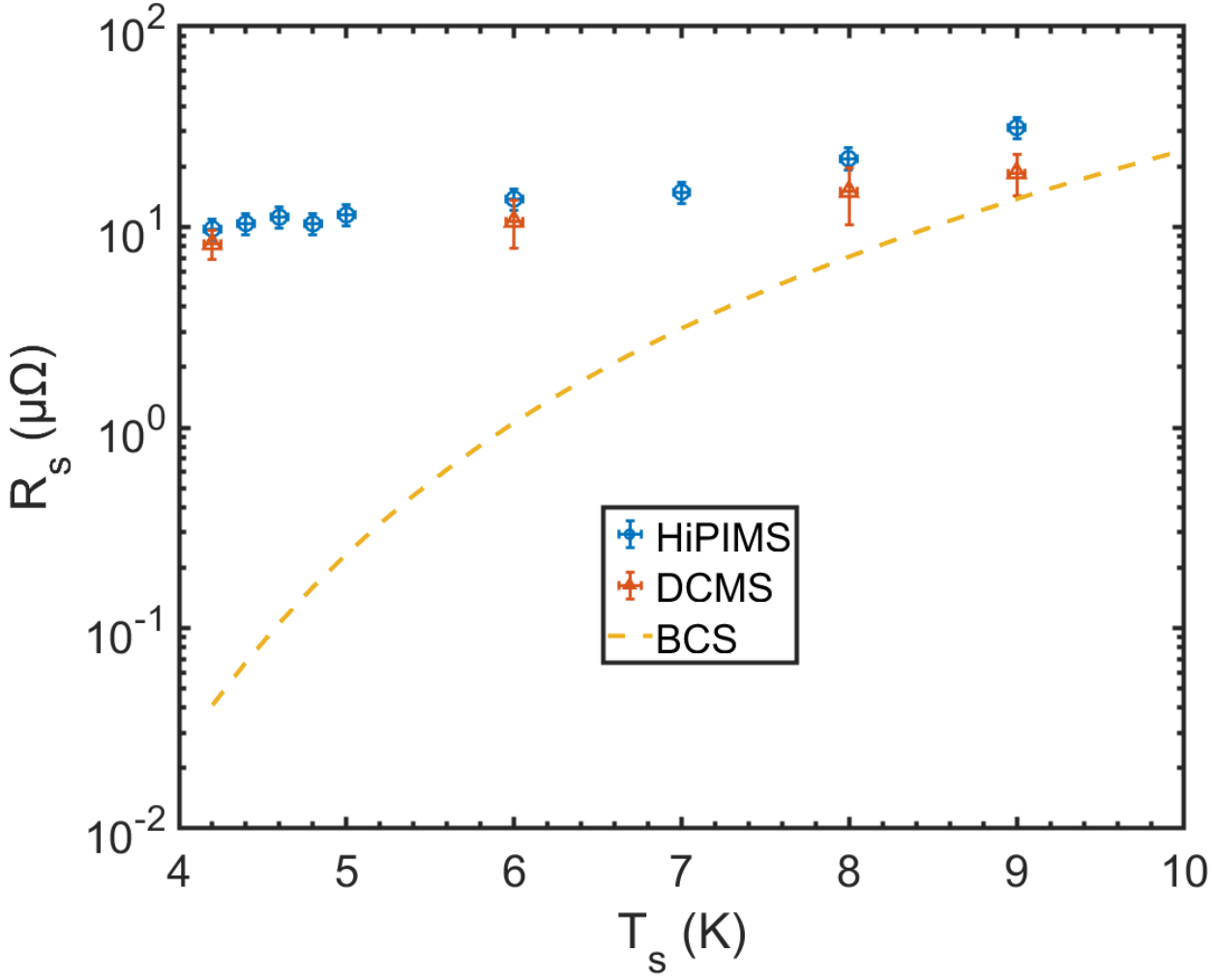
Sample preparation

- **Substrate preparation:**
  - Diamond turned Cu disk – 10 cm diameter, 3 mm thick
  - Average roughness ~ 2-3 nm
- **Sample preparation:**
  - 1 DCMS, 1 HiPIMS

Parameter	DCMS	HiPIMS
Substrate heater current (A)	35 (~ 650 °C)	35 (~ 650 °C)
Target power (W)	300	300
Expected thickness (µm)	0.8	0.8

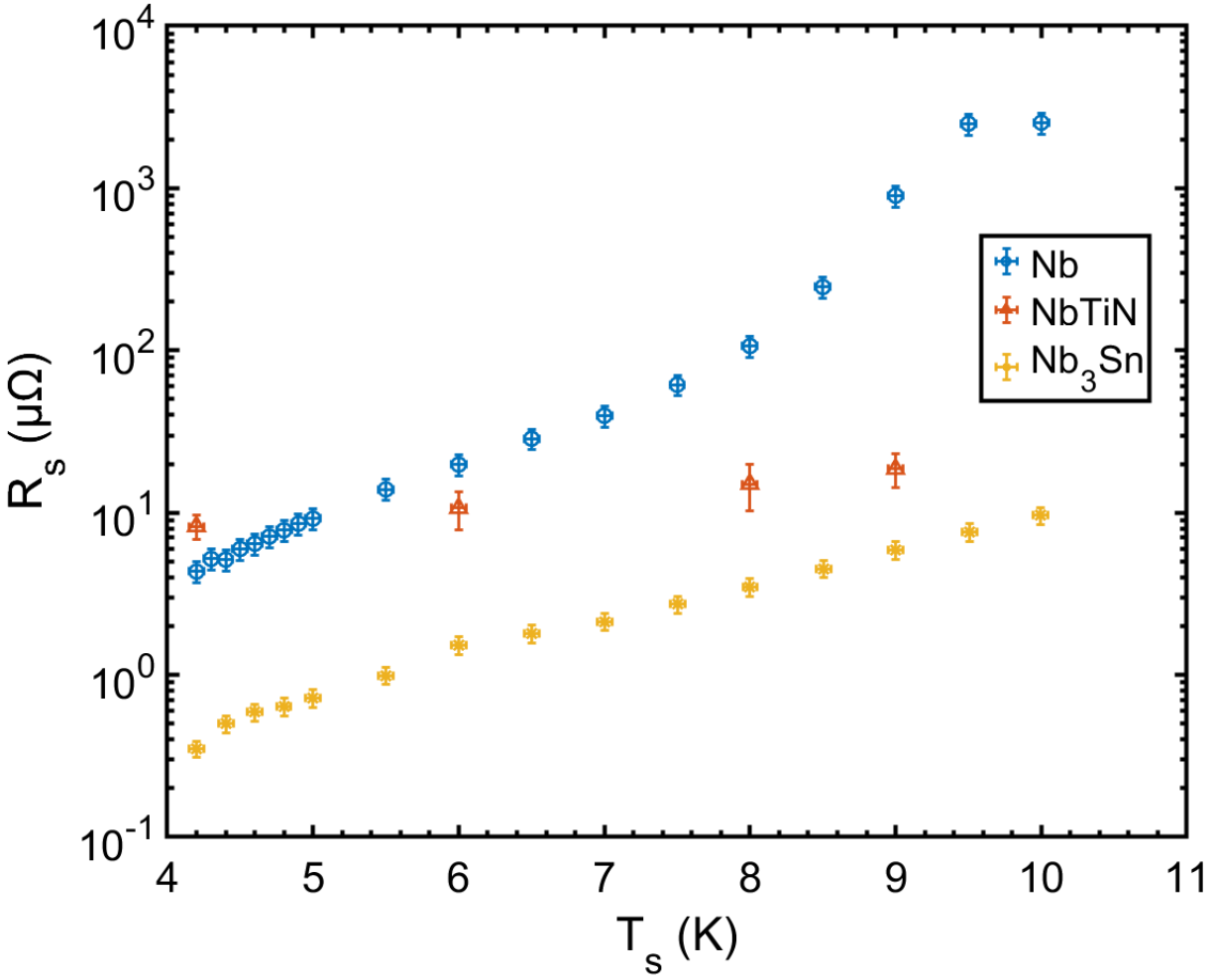


NbTiN: surface resistance



*BCS from SRIMP code (Parameters from: A-M Valente-Feliciano, *Superconducting RF materials other than bulk niobium: a review)*

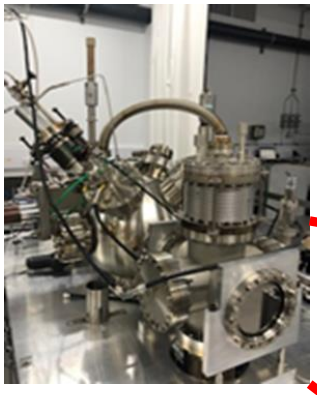
Nb, NbTiN, Nb_3Sn comparison



Next steps

From planar samples to real cavities

Aim: Flat samples → split cavities → 1.3 GHz cavities



3 sets of samples:

1. Nb coated planar samples
   - Low power RF test with choke cavity
   - High power RF test with QPR

2. Split cavity deposited with planar magnetron & planar target
   - RF test

3. Split cavity deposited with cylindrical magnetron & tubular target
   - RF test

Future plans

- **Complete Nb/Cu substrate temperature study**
  - Full substrate heater/temperature calibration
  - Surface analysis (STFC)
  - SC DC measurements (STFC & IEE?)
- **FLASH on Nb/Cu samples (HZDR):**
  - RT samples – can flash replace the need for high temperature depositions?
  - Best sample – can flash further improve the sample performance?
- **Nb/Cu on chemically treated Cu disks to compare with split cavity**
- **Continue Nb_3Sn, NbTiN, V_3Si single layer studies**
- **Multilayers:**
  - On Bulk Nb treated at INFN
  - On Nb/Cu deposited at DL
- **Facility upgrades to increase B-field**
  - IJCLab treated bulk Nb 2 choke cavity
  - TF on INFN treated Cu choke cavity
  - Test bunker

Acknowledgements

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Thank you for listening

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