Cryogenic RF performances of Nb_3Sn films on copper

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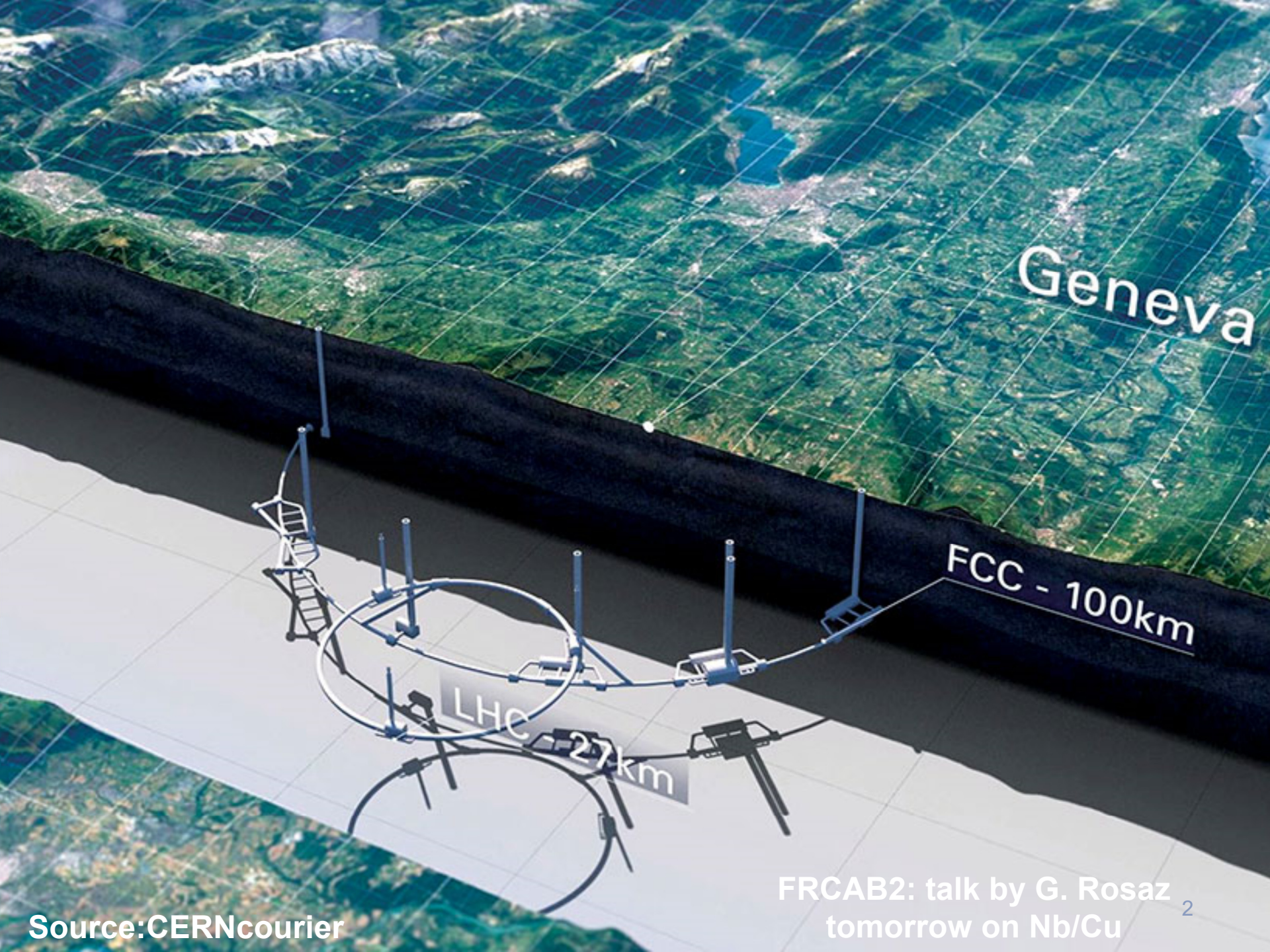
On behalf of FCC RF & WP 3

SRF conference
Dresden 2019



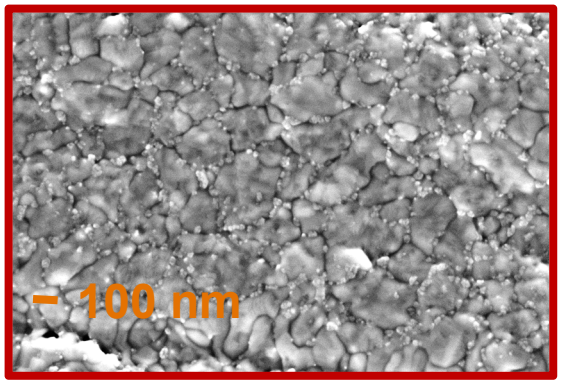
Source:CERNcourier

FRCAB2: talk by G. Rosaz tomorrow on Nb/Cu


Beyond
Source: lapiumablog.com

Two coating procedures by magnetron sputtering

reacted after coating



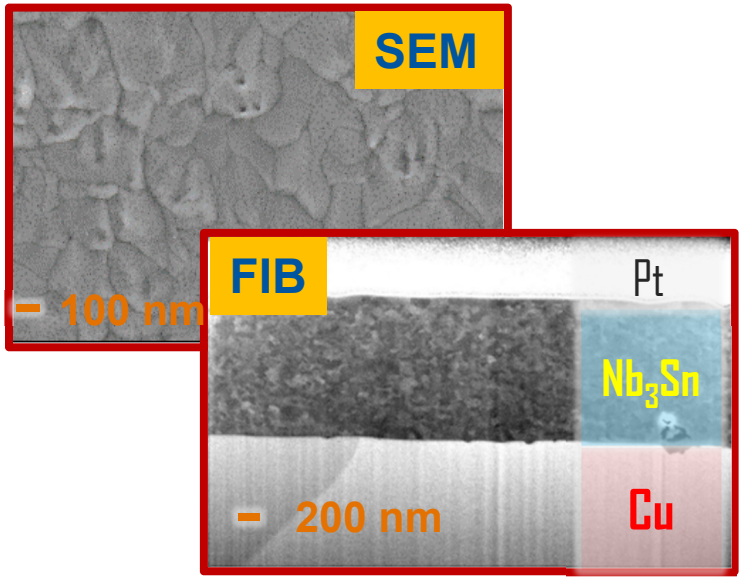
Main coating parameters:

Coating gas: *Ar* or *Kr*

Coating pressures:
$3x10^{-4}$ *mbar* … $5x10^{-2}$ *mbar*

Composition:
Sn 20 At% to 27 At%

reacted during coating



Compulsory Annealing

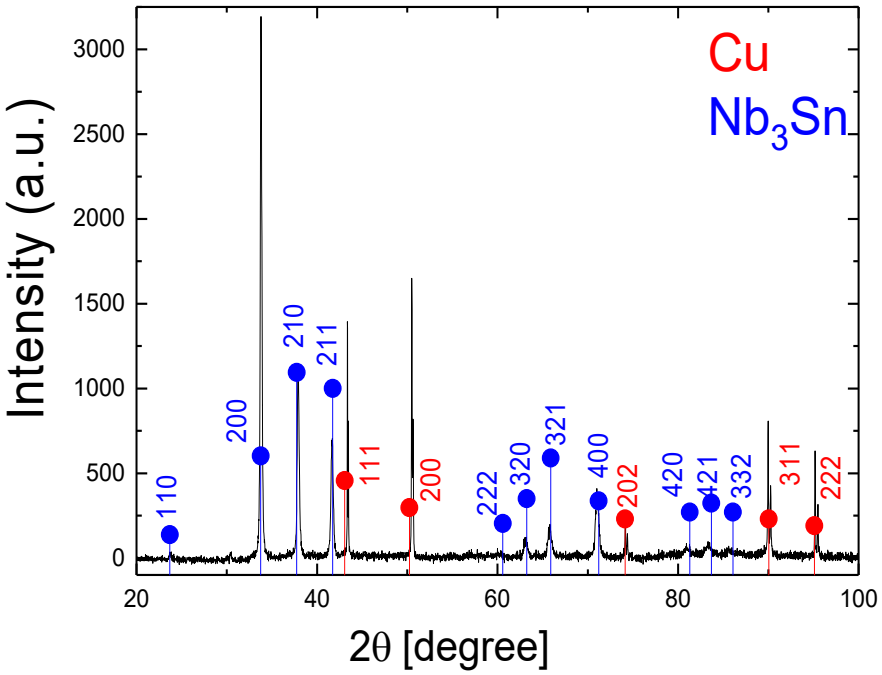
Annealing temperatures	600 - 800°C
Annealing time	24 h… 72 h

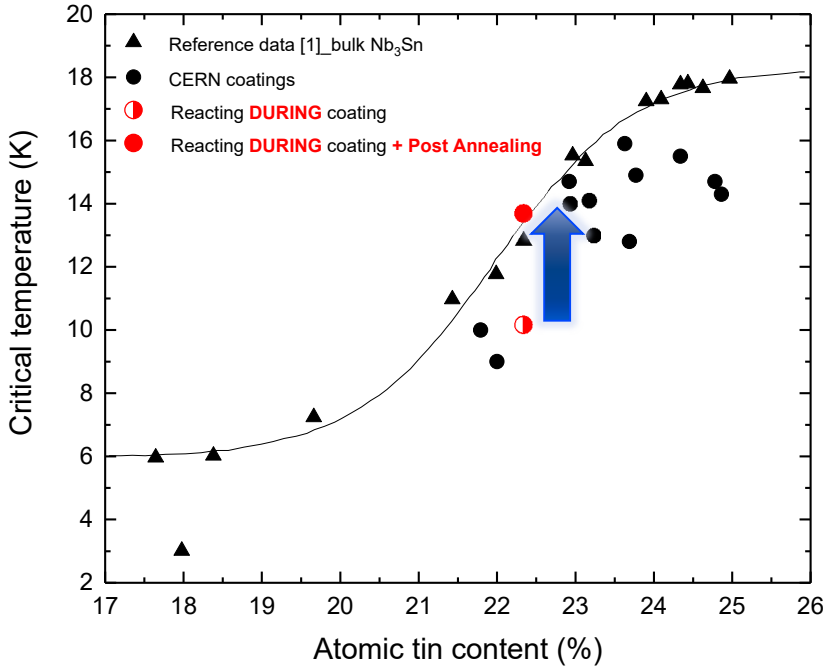
Alternative Annealing

Coating temperatures	600 - 735°C
Alternative Additional Annealing	24 h… 72 h

For more details see: E. A. Ilyina, *et al. Supercond. Sci. Technol.*, **32** *(2019)*

A15 phase with Tc as bulk





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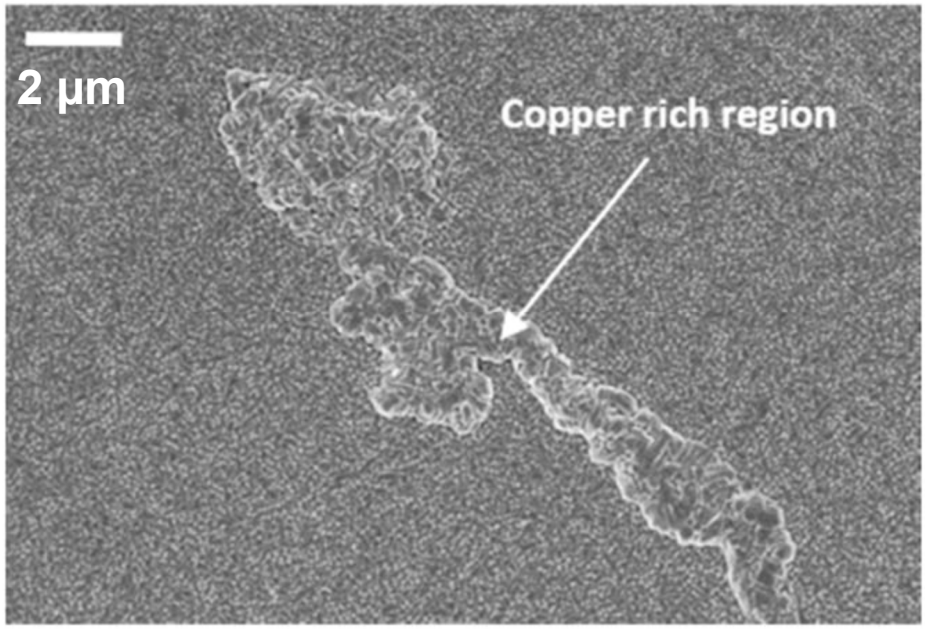
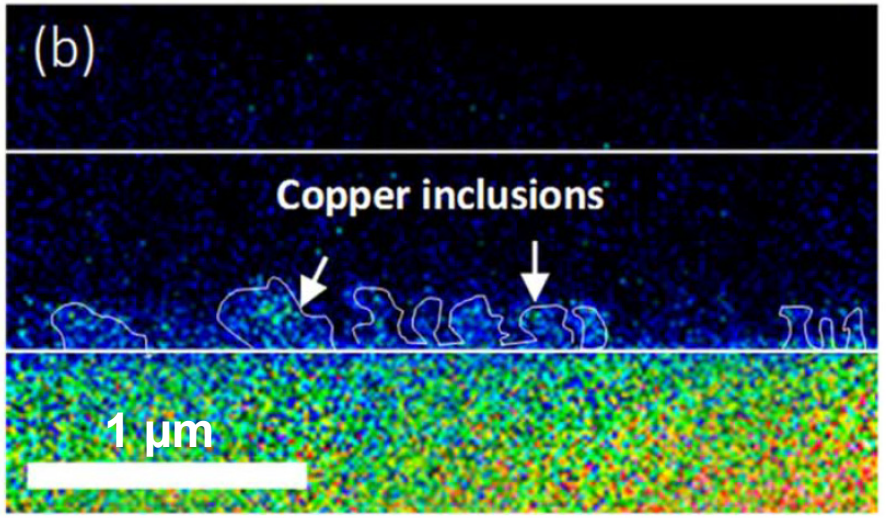
For more details see:
E. A. Ilyina, *et al. Supercond. Sci. Technol.*, **32** *(2019)*

[1] A. Godeke, *Supercond. Sci. Technol.*, **19** *(2006)*

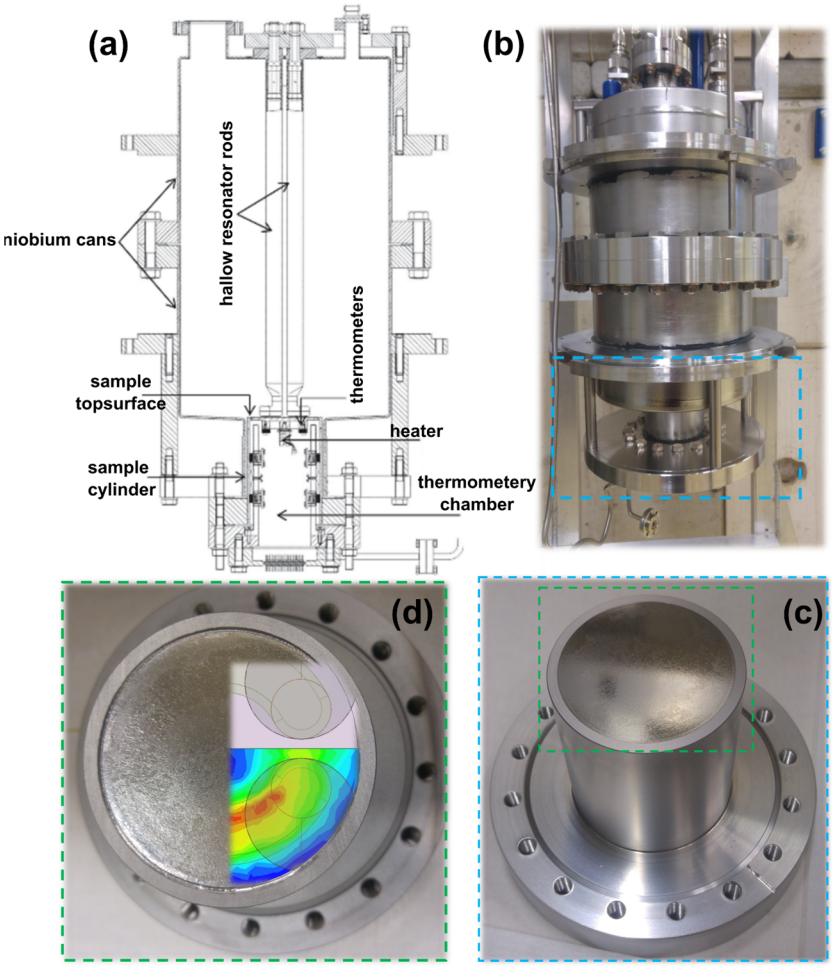
Intermediate layer to stop Cu inclusions





For more details see:
E. A. Ilyina, *et al. Supercond. Sci. Technol.*, **32** *(2019)*

RF performances characterized via the quadrupole resonator



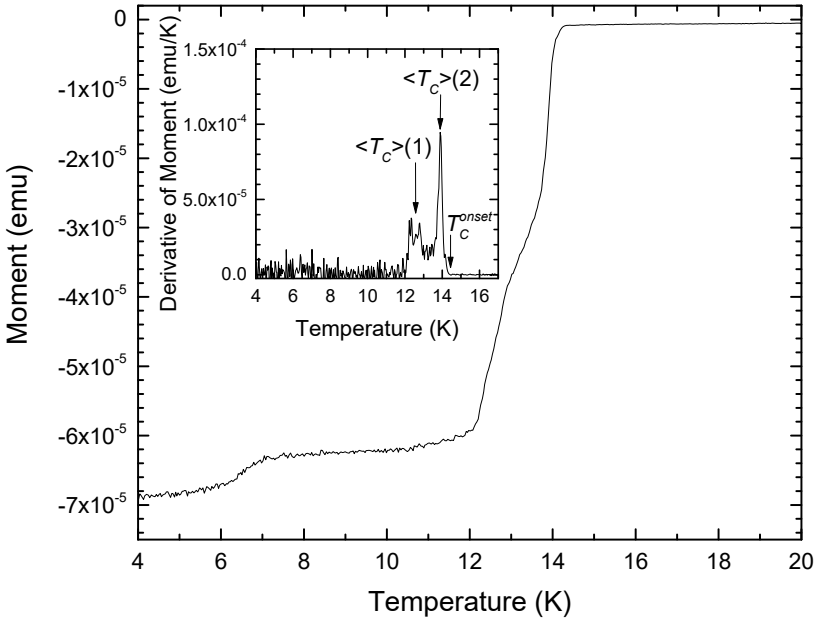
Multiple frequency operation:
400, 800 and 1200 MHz

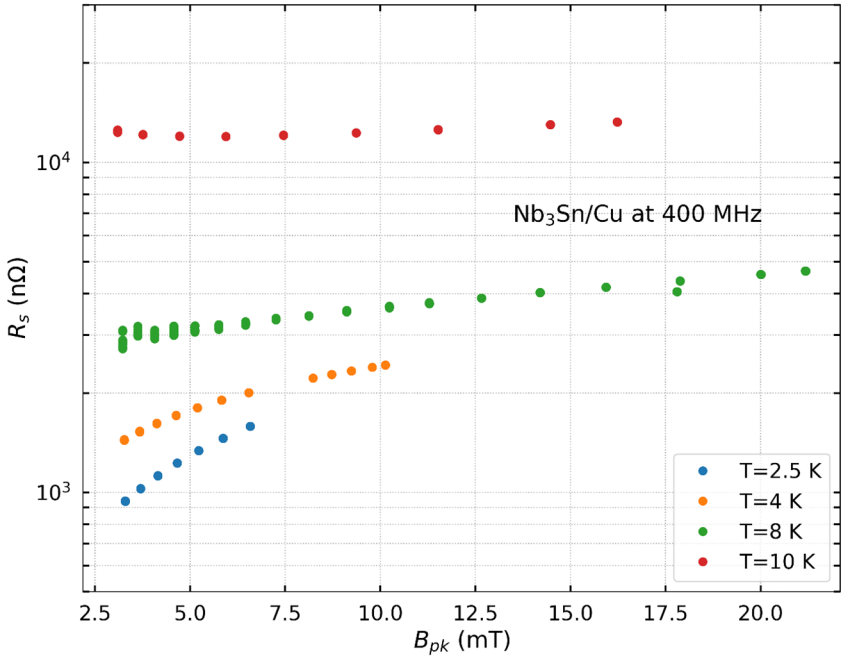
Calorimetric technique

$$R_s = \frac{2\mu_0^2(P_{DC1} - P_{DC2})}{\int_{sample} |\overrightarrow{B}|^2 dS}$$

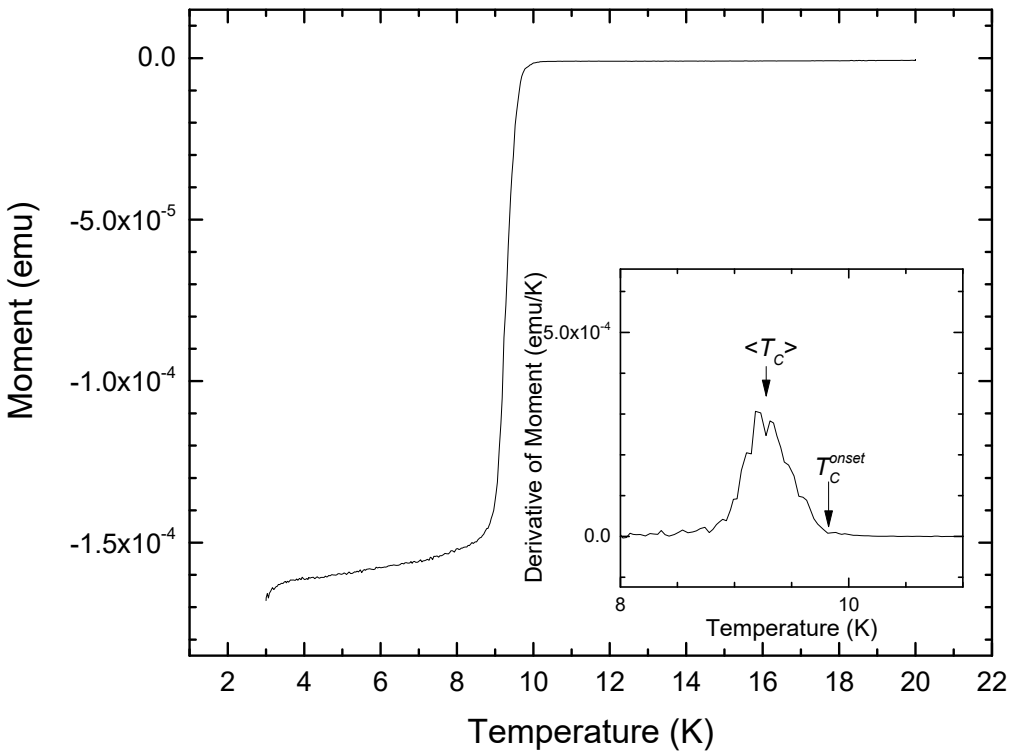
Flat samples for RF characterization

Cu / ***Nb*** / Nb_3Sn (~ **1.5 – 1.7** µm)
$P_{coating} = 7 \cdot 10^{-3}$ mbar (**Kr**)
$T_{coating}$ = 680°C (real lower)
$T_{annealing}$ = 72 hours @ 670°C (real lower)





Flat samples for RF characterization

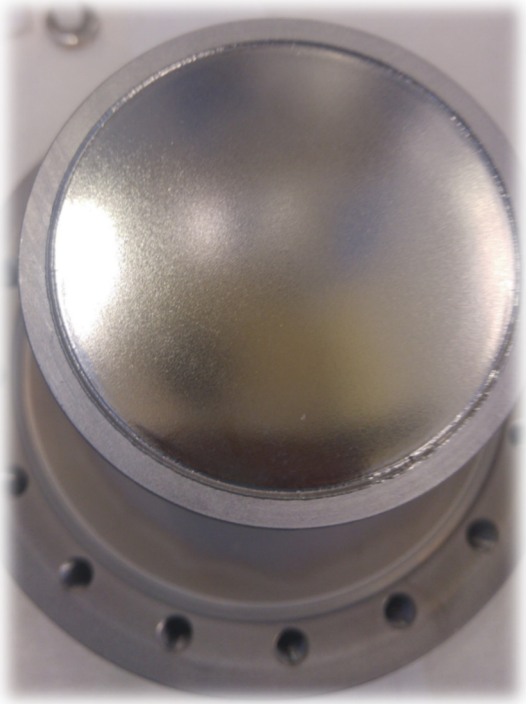


Cu / ***Ta*** / Nb_3Sn (~ **1.7 – 1.8** µm)

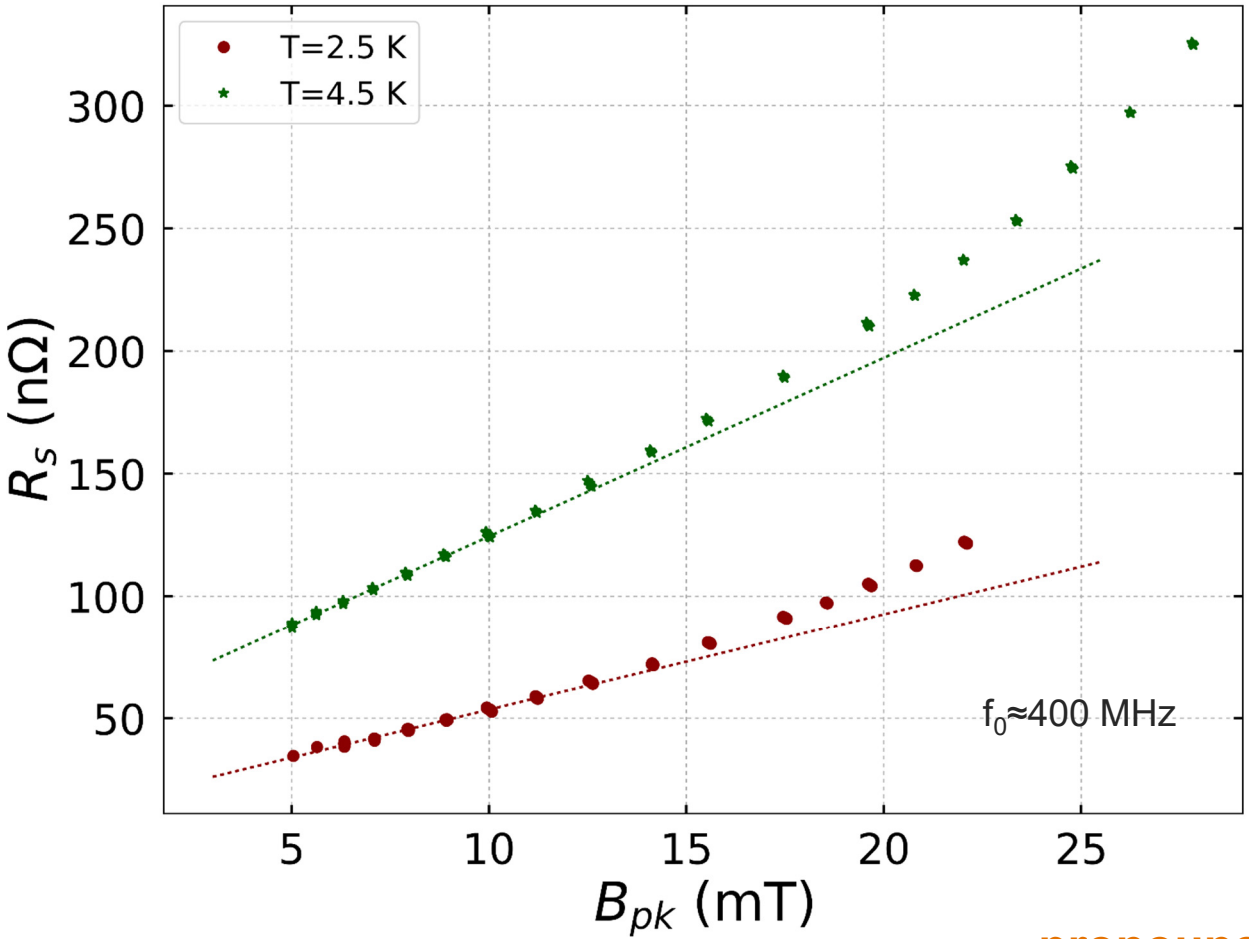
$P_{coating}$ = $5x10^{-3}$ mbar (**Ar**)

$T_{coating}$ = 750 °C

$T_{annealing}$ = 24 hours @ 750 °C

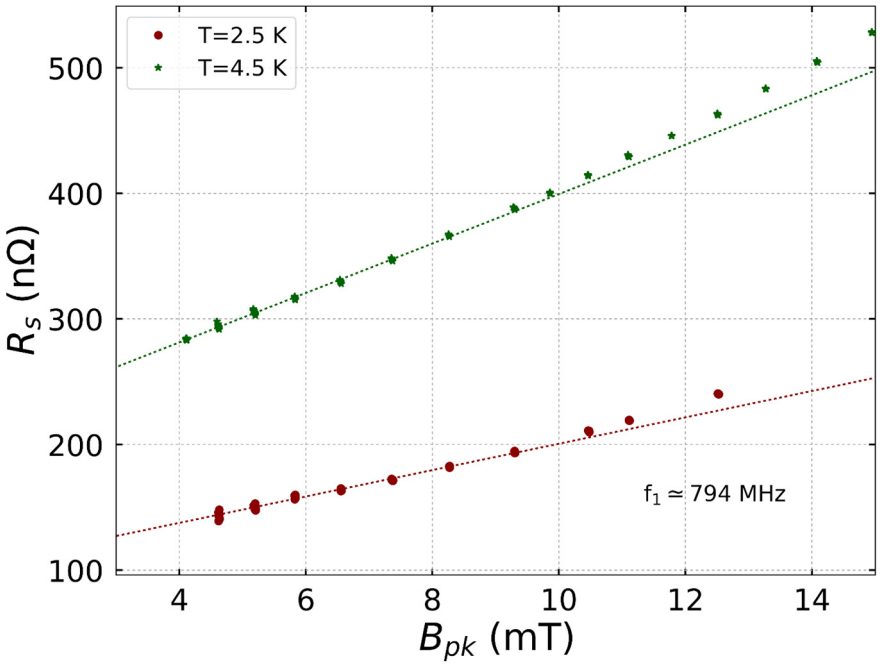


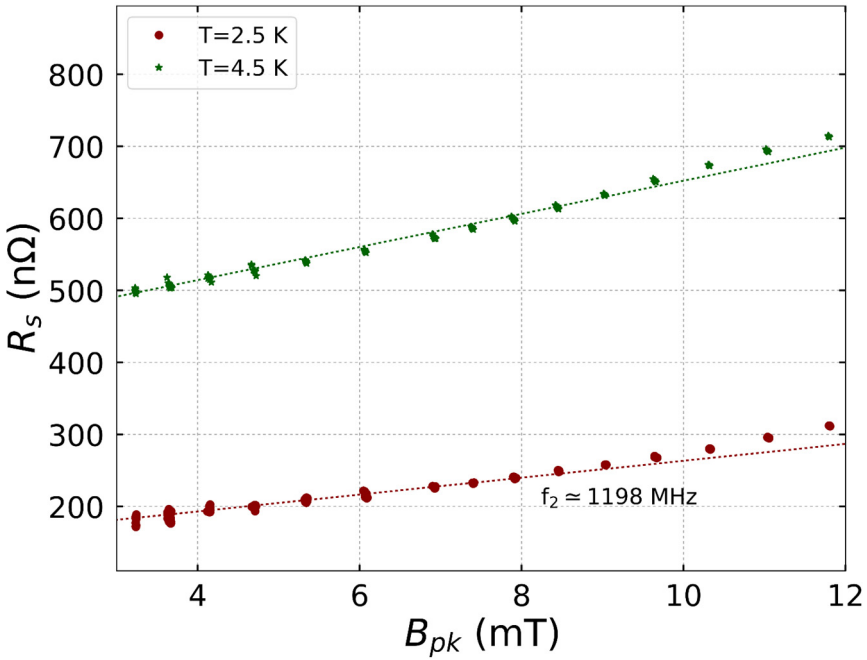
Promising RF results



pronounced “Q-slope”

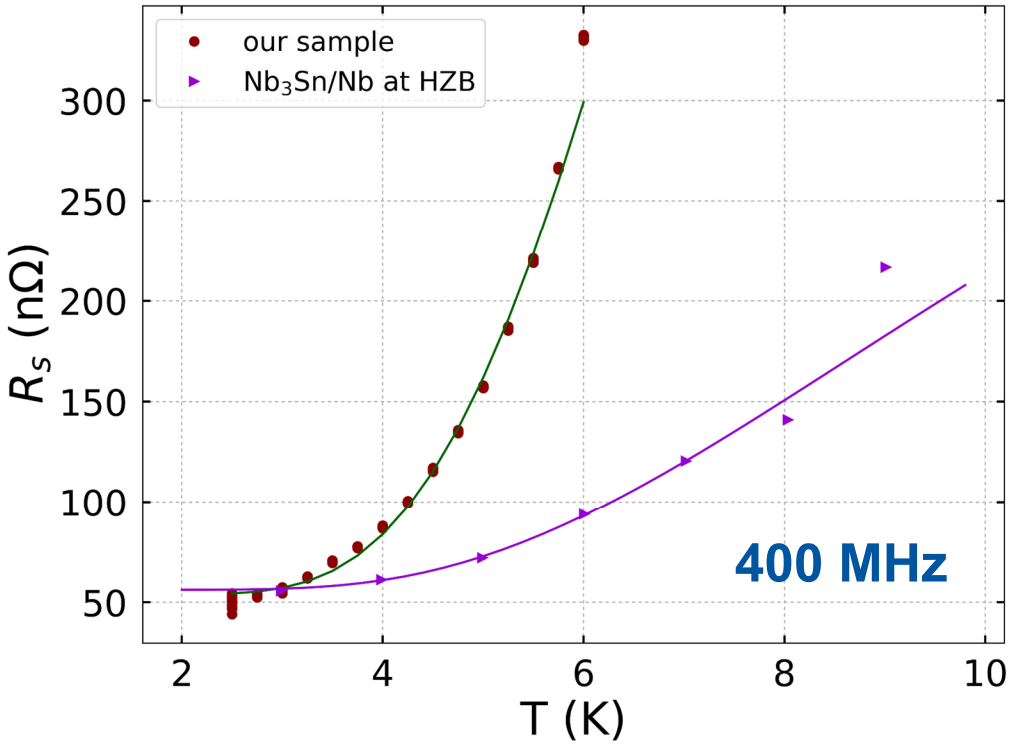
Pronounced Q-slope





The slope increases with both temperature and frequency

Aiming at larger mean free path



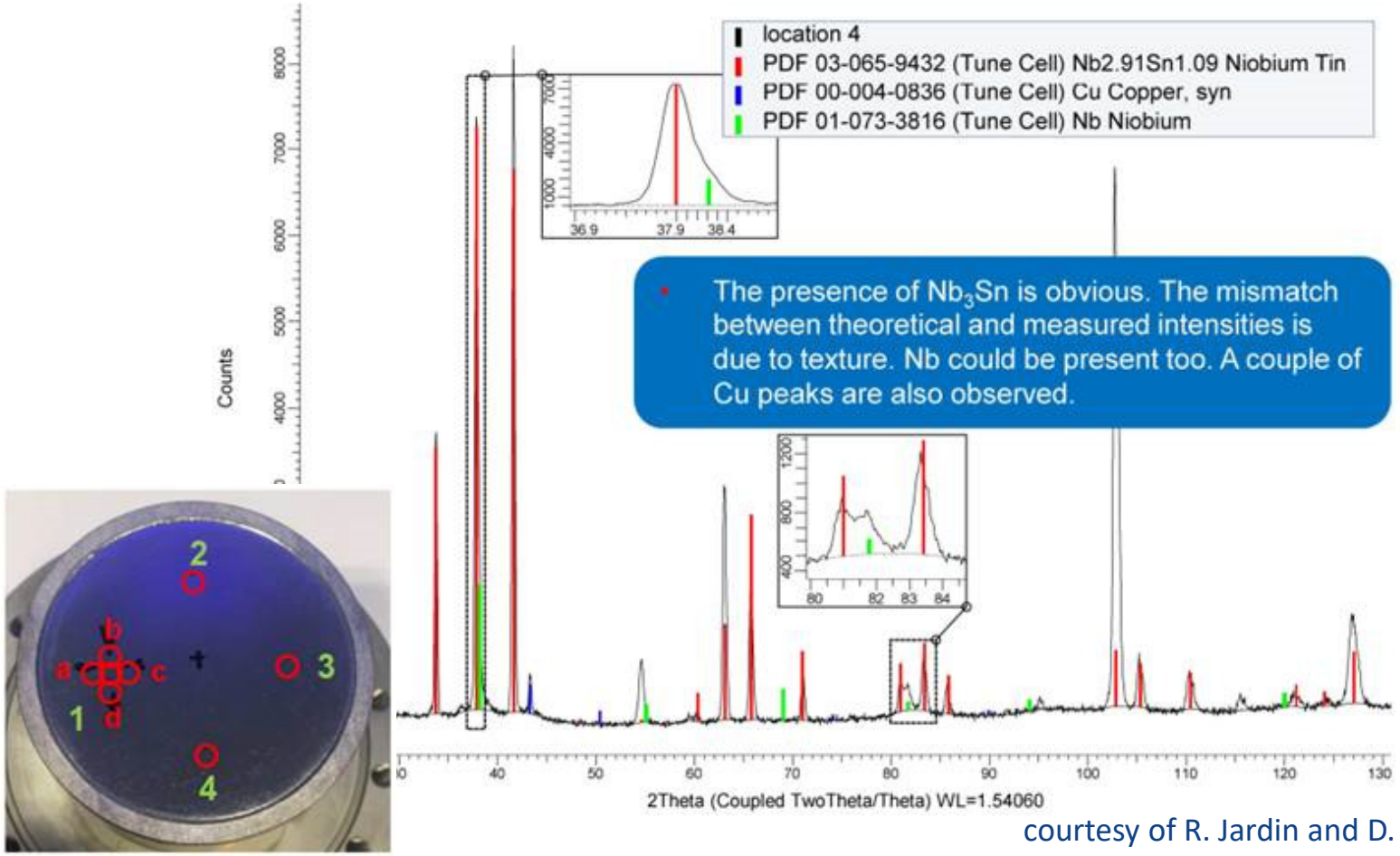
$$R_s(T) = \frac{A}{T}\exp\left(-\frac{\Delta_0}{T}\right) + R_{res}$$

	our sample	HZB
$A(\xi_0, \lambda_L, l)$ [nΩK]	2.23x10^5	2.99x10^4
Δ_0 [K]	30.1	29.9
R_{res} [nΩ]	53.8	56.1

BCS parameter *A* is the major difference

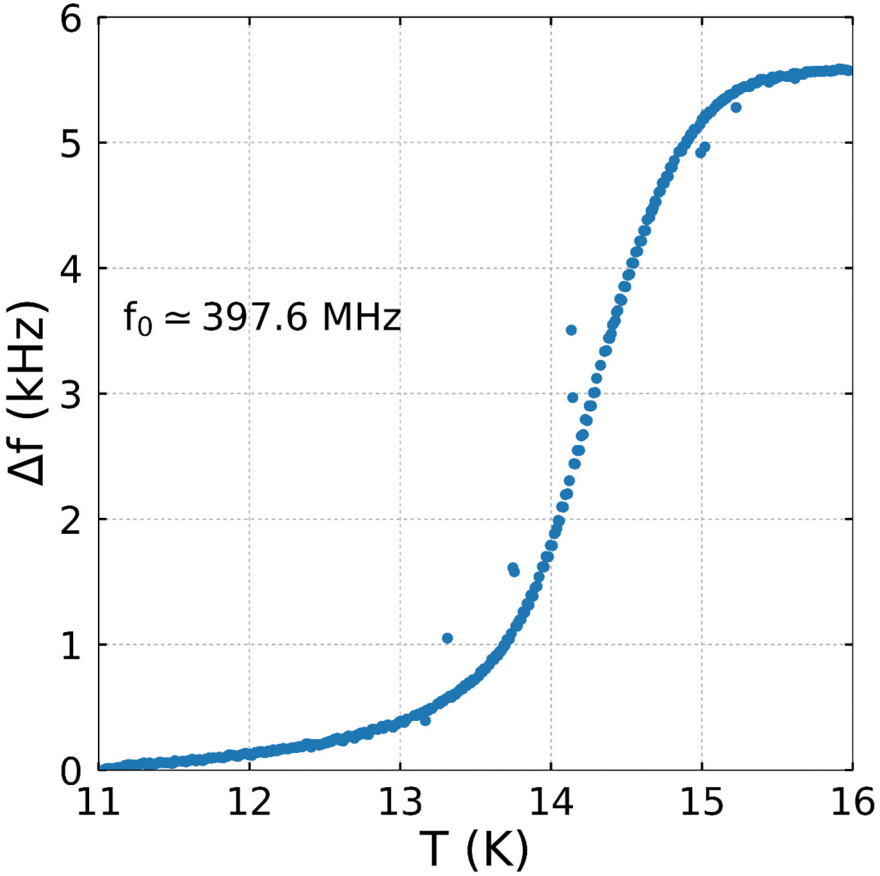
Nb_3Sn/Nb data taken from
S. Keckert et al., SRF2017

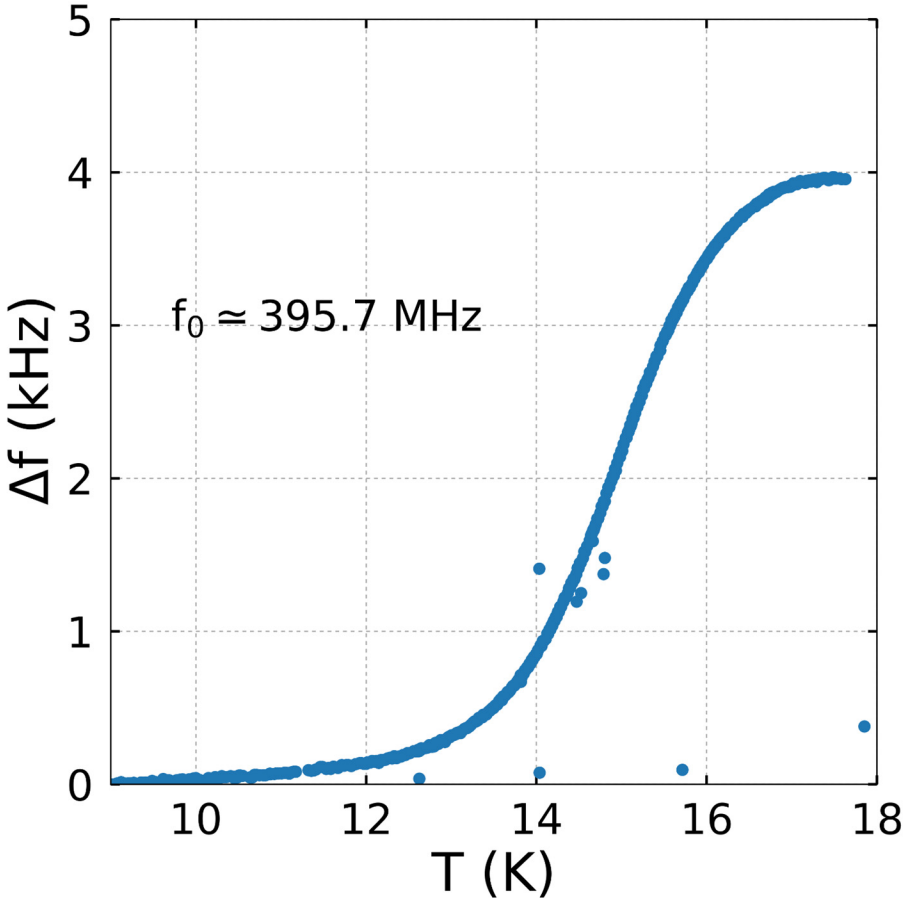
Post RF structural characterization



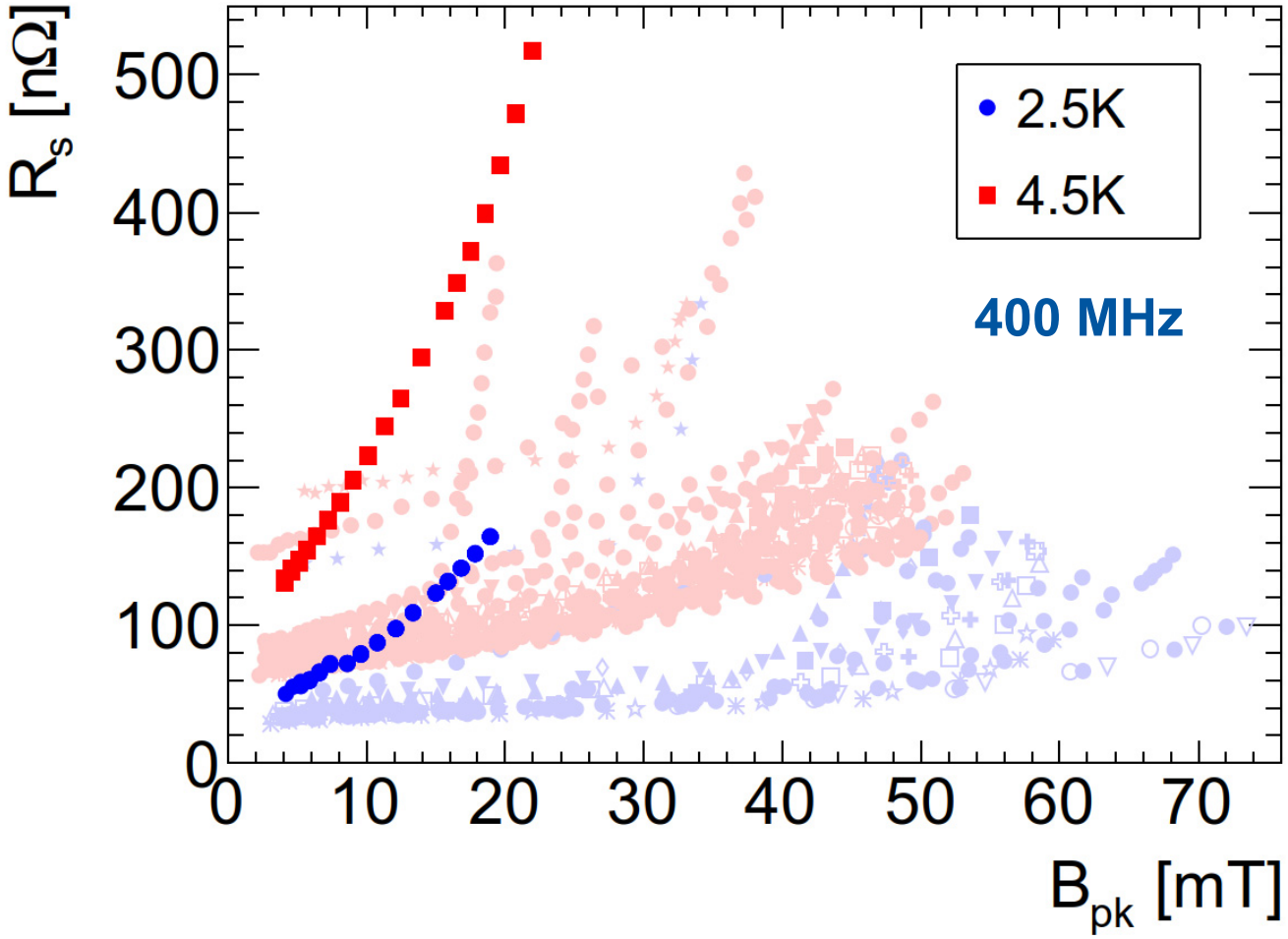
courtesy of R. Jardin and D. Cochet – Bruker

QPR samples with higher Tc



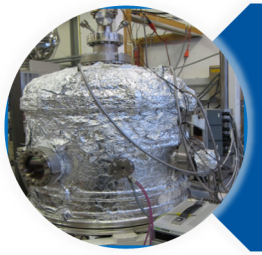


Comparing to Nb/Cu LHC cavities

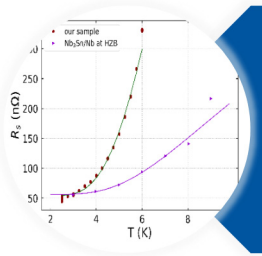


Not yet there but it is a very good starting point

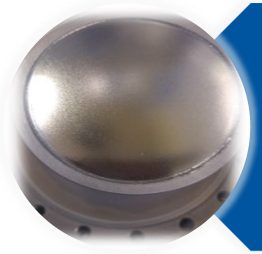
Conclusions and outlook



Good quality of the Nb_3Sn coatings



Low residual resistance



New samples are ready for RF tests

There are reasons to be optimistic