HZB Helmholtz Zentrum Berlin

Mitigation of parasitic losses in the QPR enabling direct measurements of low R_{res}

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14.01.2022

6th SMART meeting

CONCLUSION

- **Very successful subproject thanks to…**
  - → active discussions
  - → regular informal discussions
  - → short distances
  - ➔ enabled by the SMART collaboration

- **Biased QPR measurements due to parasitic losses**
  - → Understood with the help of numerical simulations
  - → Mitigated by applying Nb on stainless coating
  - → Experimentally proven and verified
  - ➔ Joint publication in AIP Advances

AIP Advances ARTICLE scitation.org/journal/adv

Mitigation of parasitic losses in the quadrupole resonator enabling direct measurements of low residual resistances of SRF samples

Cite as: AIP Advances 11, 125326 (2021); doi: 10.1063/5.0076715
Submitted: 27 October 2021 • Accepted: 3 December 2021 •
Published Online: 27 December 2021

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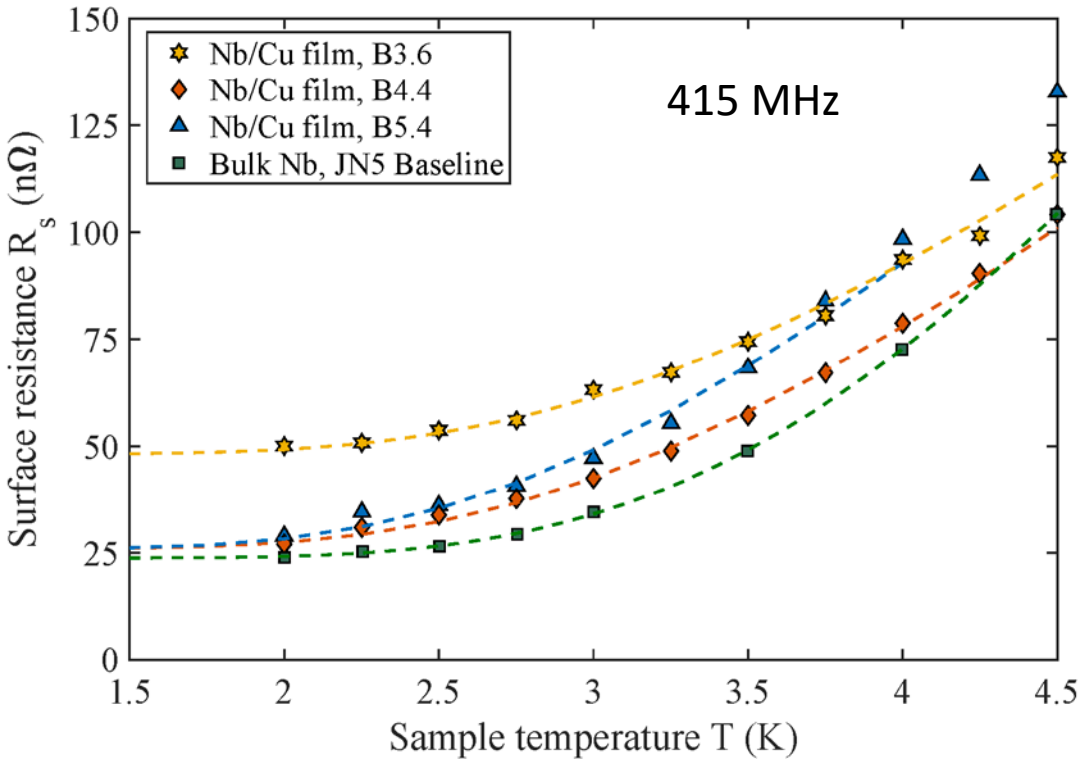
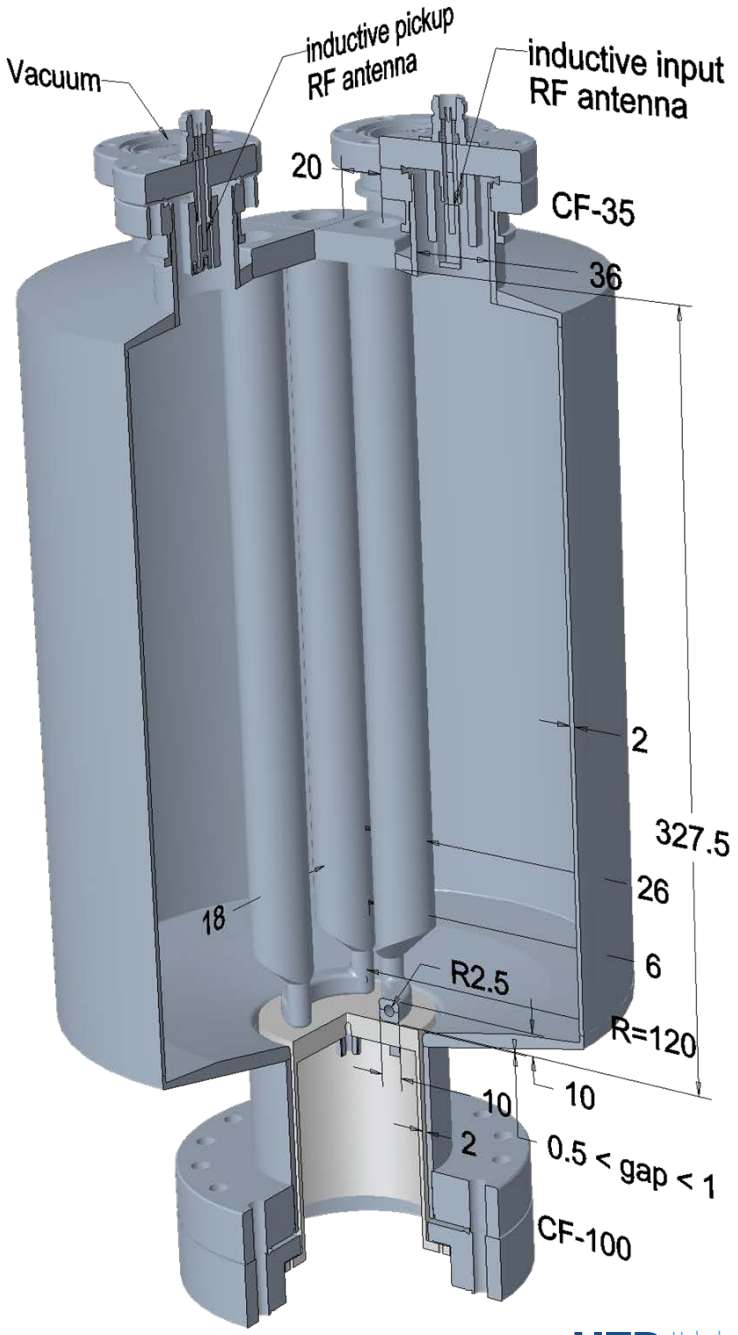
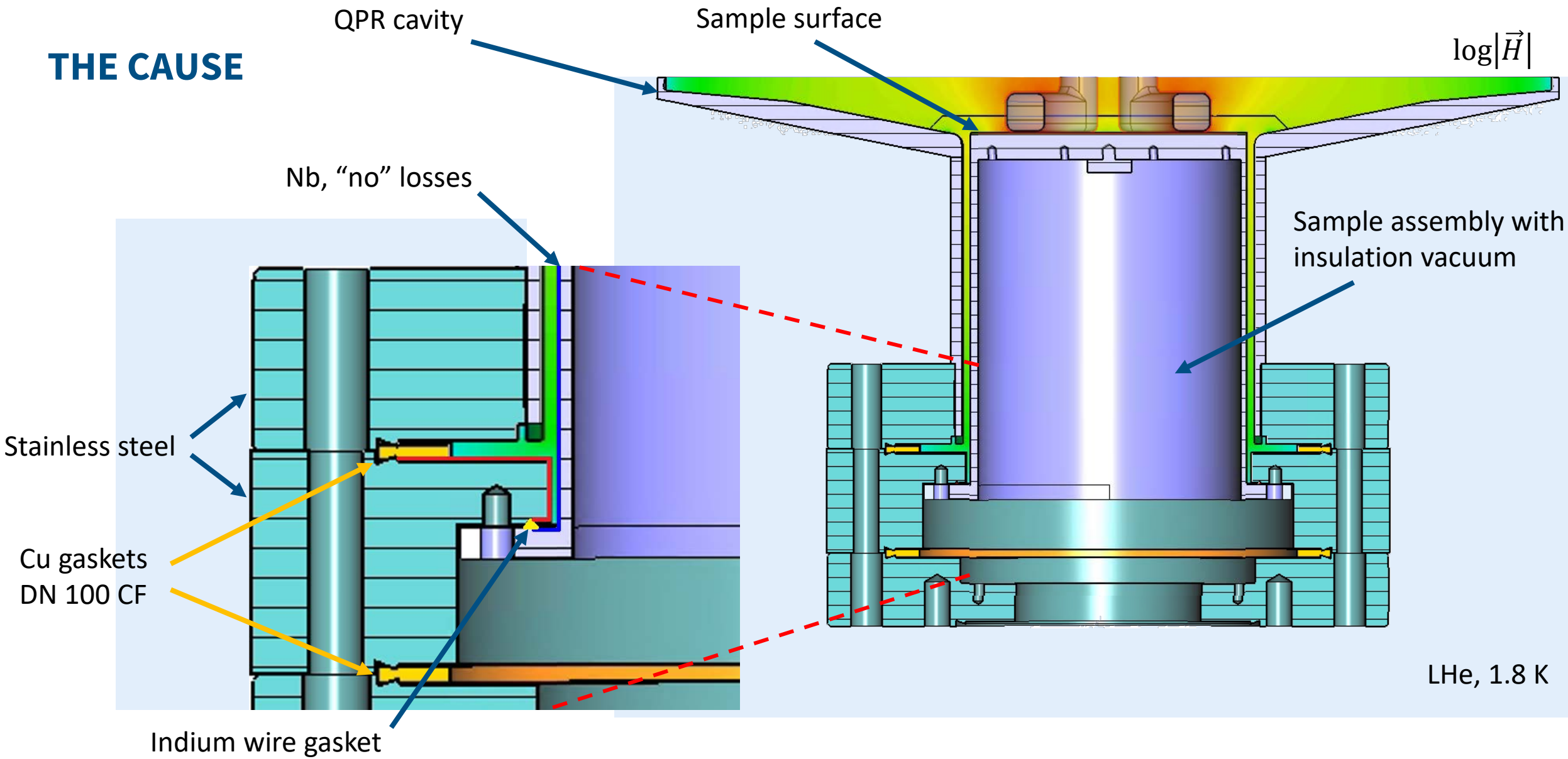
STARTING SITUATION





→ **Surprisingly high and similar residual resistance**

THE CAUSE

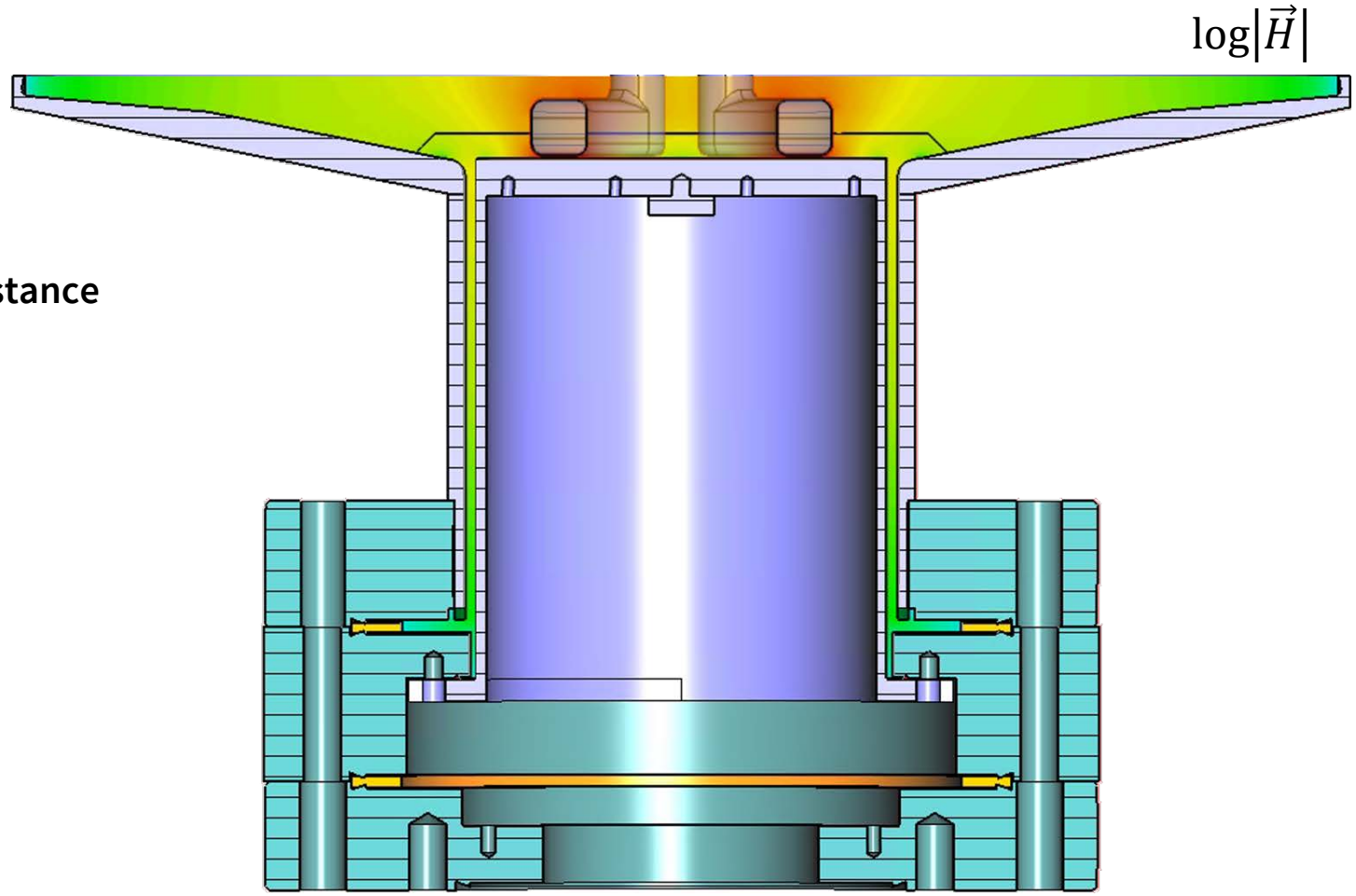

QPR cavity
Sample surface
$\log|\vec{H}|$
Nb, “no” losses
Sample assembly with insulation vacuum
Stainless steel
Cu gaskets DN 100 CF
Indium wire gasket
LHe, 1.8 K

THE CAUSE

- **Calorimetric measurement of the RF surface resistance**

  Integral of all losses on the sample assembly
  (weighted with the thermal distribution)

- **non-zero RF magnetic field in the coaxial gap**



THE CAUSE

- **Calorimetric measurement of the RF surface resistance**

  Integral of all losses on the sample assembly
  (weighted with thermal distribution)

- **non-zero RF magnetic field in the coaxial gap**

- **Very low thermal conductivity of stainless steel at cryogenic temperatures**

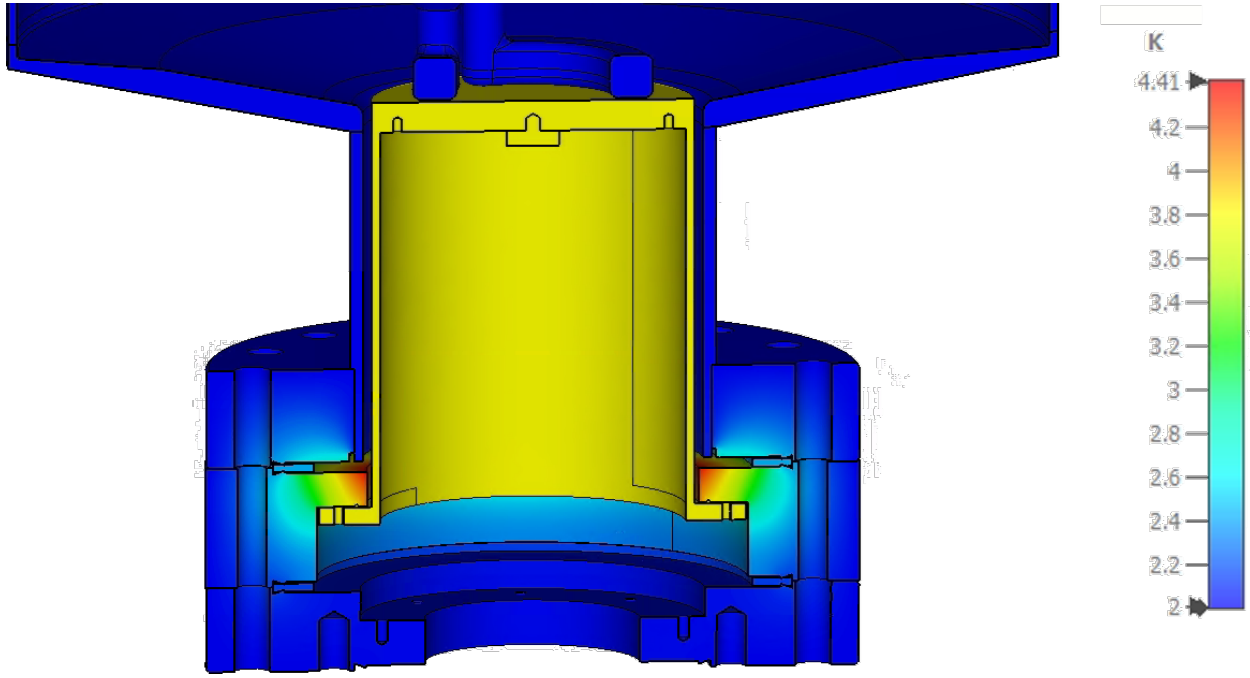


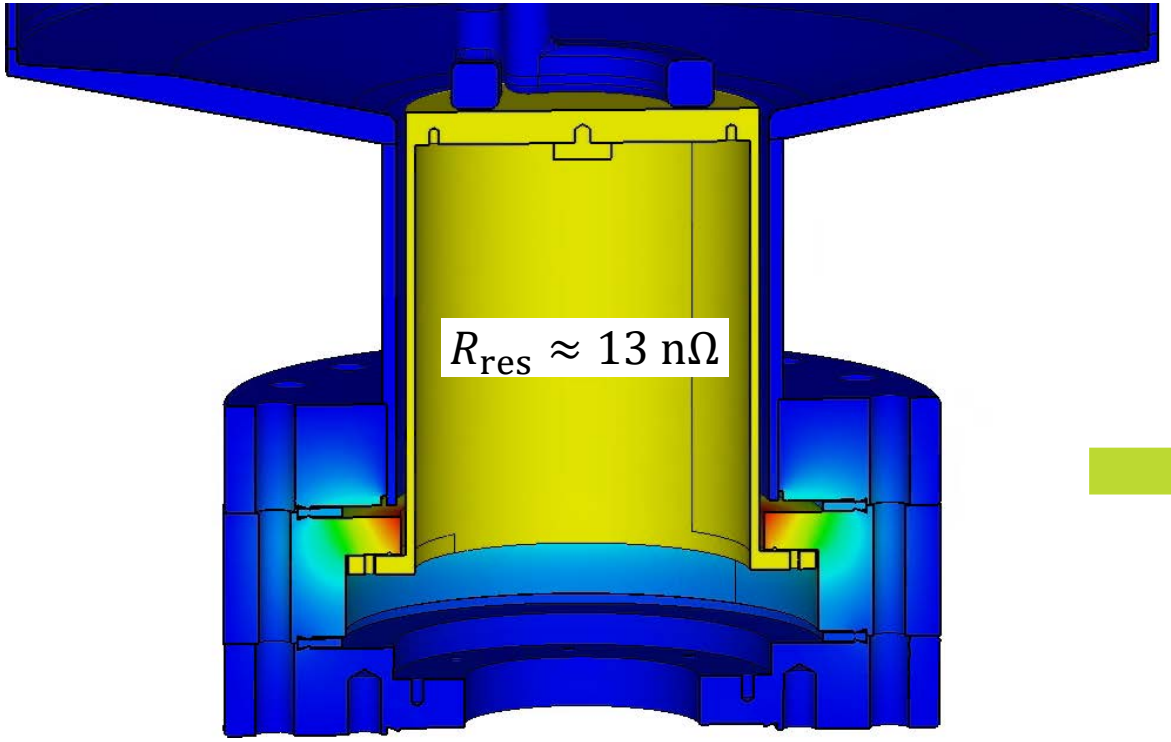
TABLE I. Sample temperature, effective power, and parasitic surface resistance for the first three quadrupole modes of the QPR resulting from the finite conductivity of the applied materials.

	Q_1			Q_2			Q_3		
B (mT)	T (K)	P (mW)	R_S (nΩ)	T (K)	P (mW)	R_S (nΩ)	T (K)	P (mW)	R_S (nΩ)
5	2.008	0.067	12.6	2.015	0.129	26.0	2.032	0.282	63.1
10	2.030	0.266	12.6	2.058	0.515	26.0	2.124	1.127	63.0
20	2.117	1.062	12.6	2.219	2.050	25.9	2.446	4.449	62.1
50	2.621	6.527	12.4	3.059	12.84	25.9	3.879	30.08	67.3
100	3.803	28.17	13.4	4.801	58.56	29.5	6.513	131.6	73.6

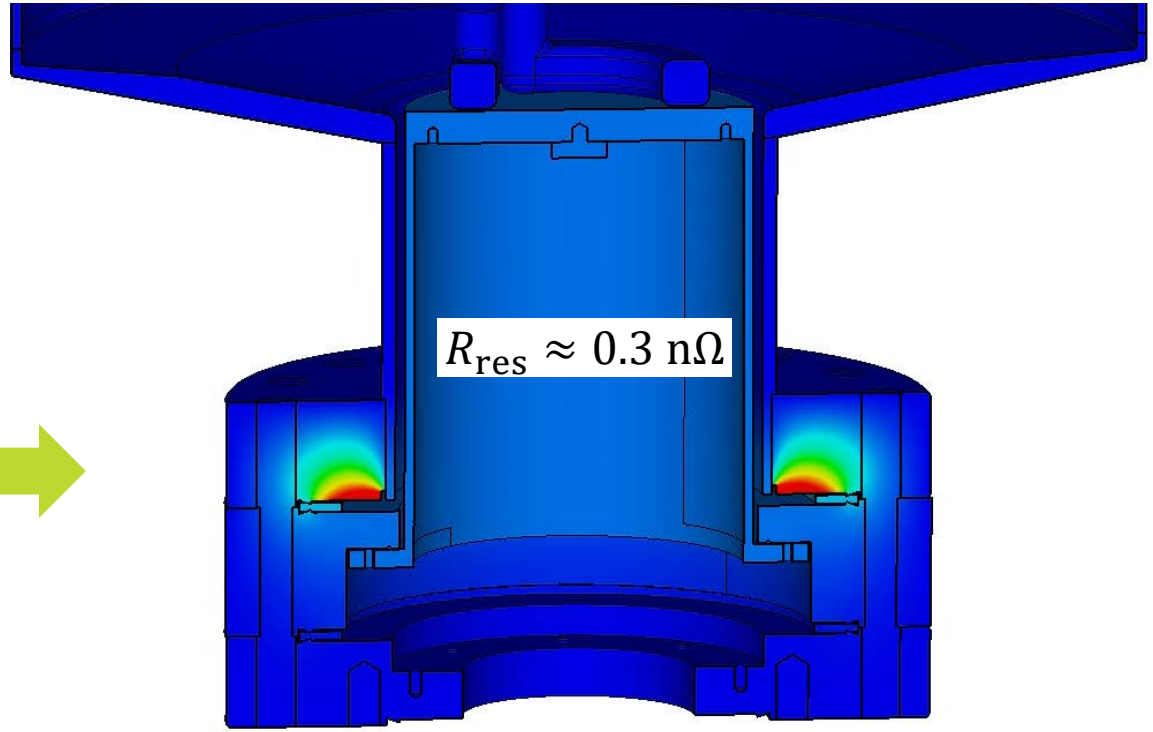
THE SOLUTION

➔ **We have to „switch off“ losses on the sample adapter flange**

T_{max} = 4.4 K



T_{max} = 2.5 K

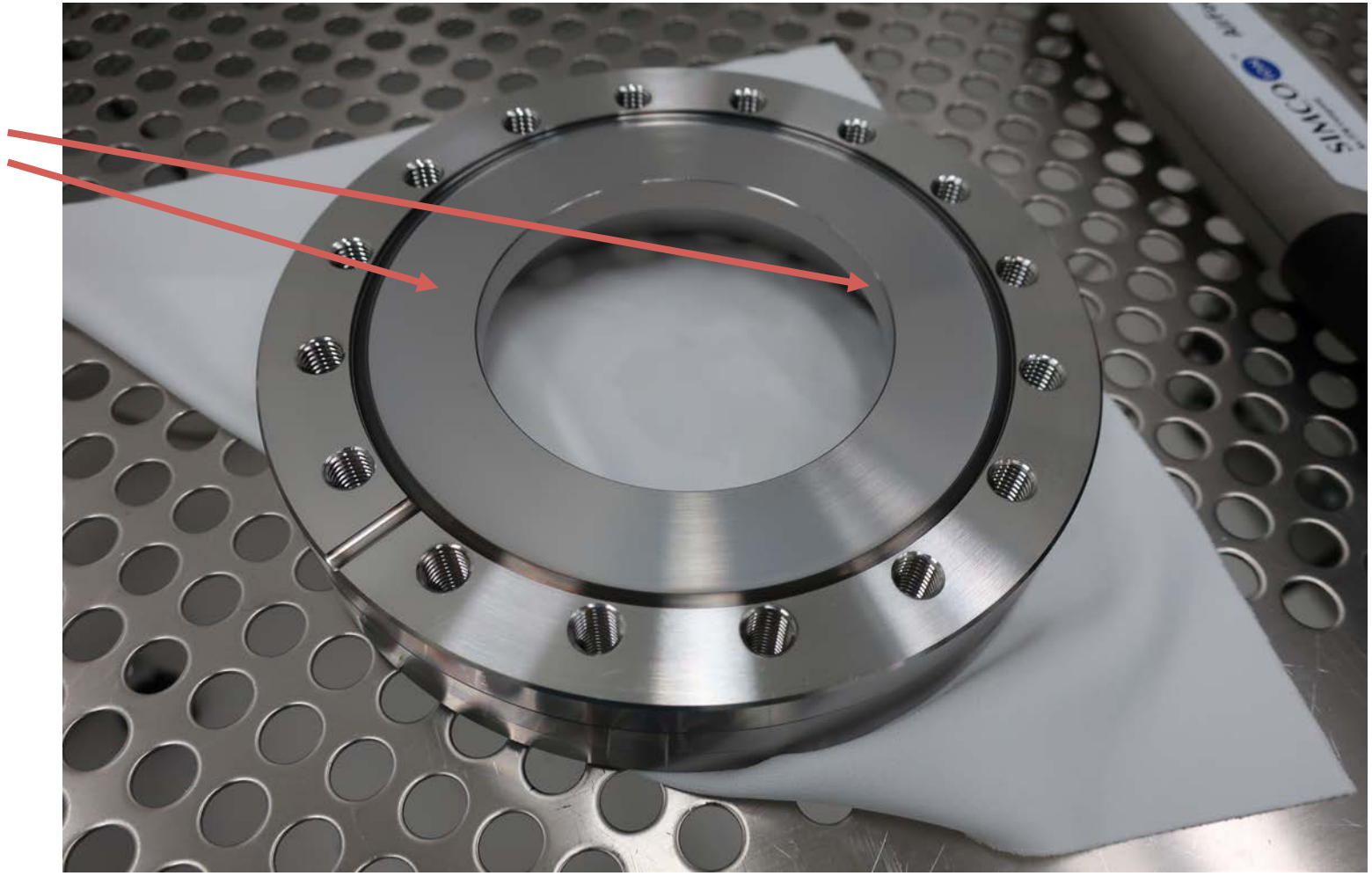


Same RF field, different color scale!

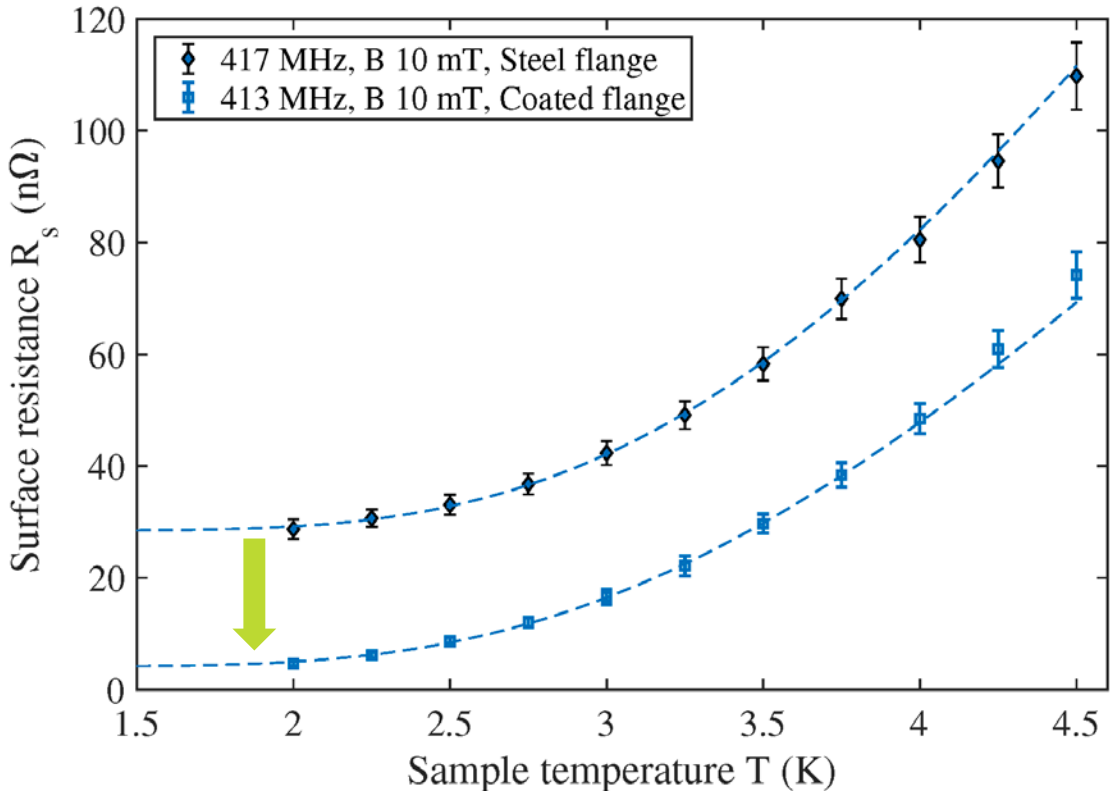
THE SOLUTION

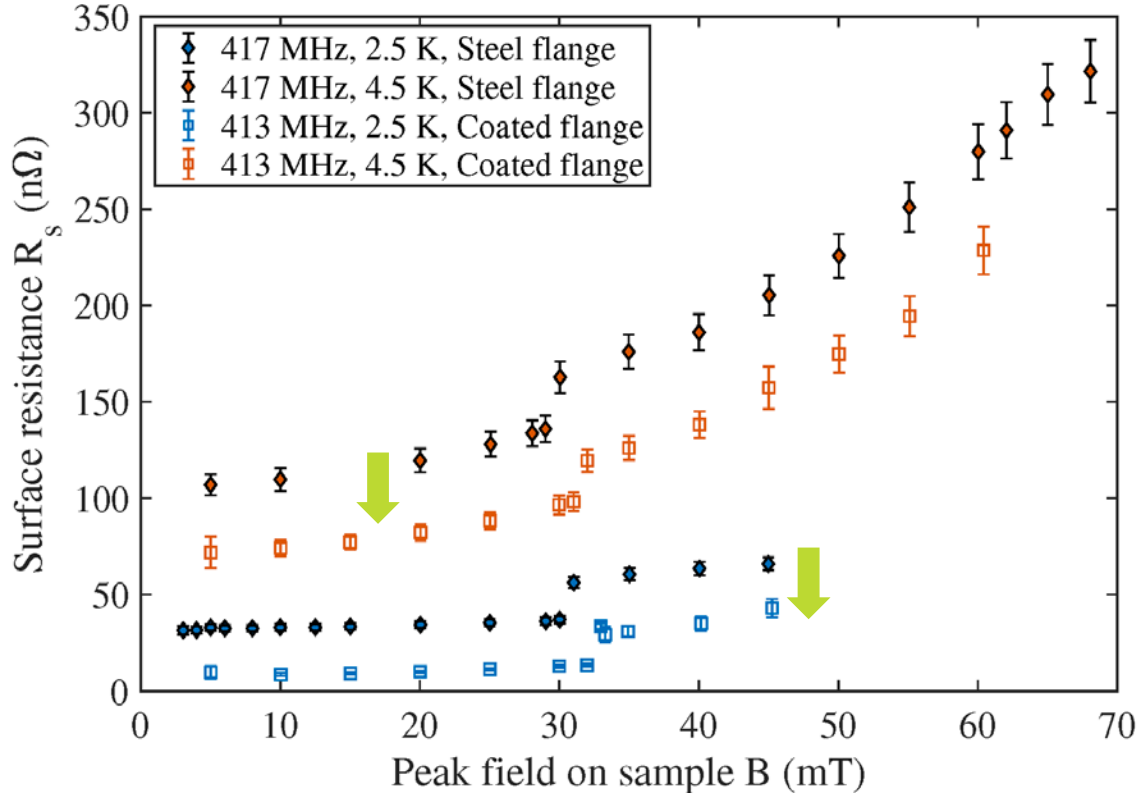
Thin film coating: Nb on stainless steel

- **RF exposed surfaces only**
- **few µm → full screening**
- **CF knife edge covered during coating**



THE IMPACT





Measured ΔR = 24 nΩ

ΔR is independent of RF field → bias of R_{res} only

OUTLOOK

- Optimization of covering masks ongoing
- 1st coating: Nb ‘remnants’ at bottom part of the flange
- 2nd coating: bottom part covered with additional mask

  → low adhesion at inner cylindrical surface due to resputtering