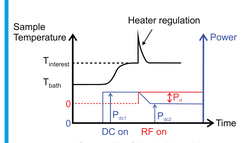
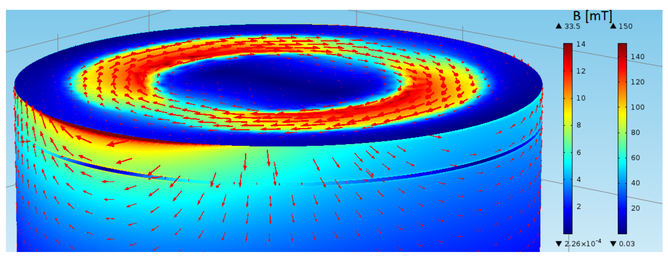
S. Keckert, R. Kleindienst, J. Knobloch, O. Kugeler
Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Germany

DESIGN AND FIRST MEASUREMENTS OF AN ALTERNATIVE CALORIMETRY CHAMBER FOR THE HZB QUADRUPOLE RESONATOR

The **Quadrupole Resonator (QPR)**
- → Dedicated system for the RF characterization of sc samples
- → Calorimetric measurement of surface resistance R_S using an RF-DC compensation technique
- → Large parameter space of RF field, temperature, frequency and ambient magnetic field quickly accessible
  - B_{Sample} up to 120 mT
  - T up to T > T_c (Nb)
  - f = 433, 866, 1300 MHz

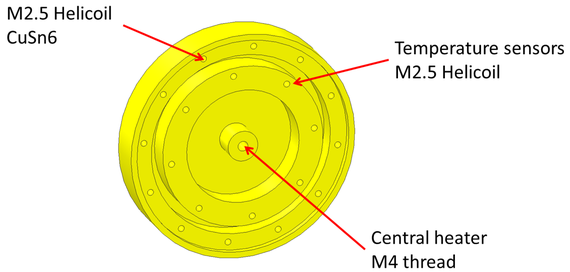


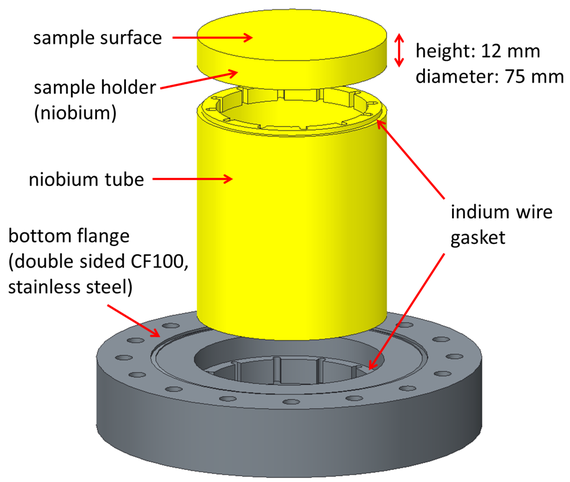
[S. Aull, SRF 2013]



Color plot: Magnetic field and surface currents on the surface of the calorimetry chamber. The simulation is normalized to 150 mT peak field on the sample surface.
Vertical distance gap ↔ sample surface: 5 mm

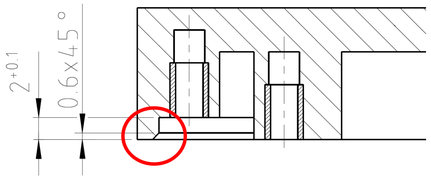
Motivation: Demountable design
- → Thin sample holder to be coated w/ sc thin films for material research
- → Exchangeability between QPRs at HZB and CERN
- → Quick and easy sample changes, no electron beam weld required



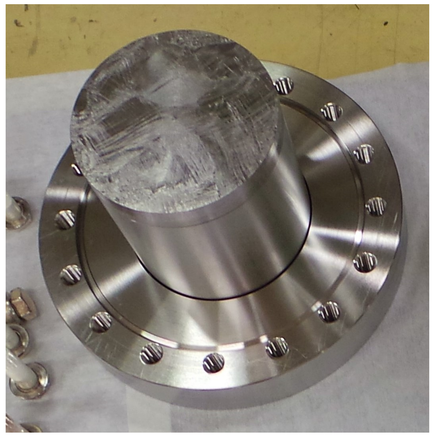


Exploded view of the alternative calorimetry chamber.

RF design simulations
- → Circumferential gap to be avoided
- → Four critical locations with surface currents perpendicular to the gap
- → 90 % damping if gap width < 2.5 mm
- → Height 12 mm: 150 mT on sample, 15 mT at gap, including magnetic field enhancement



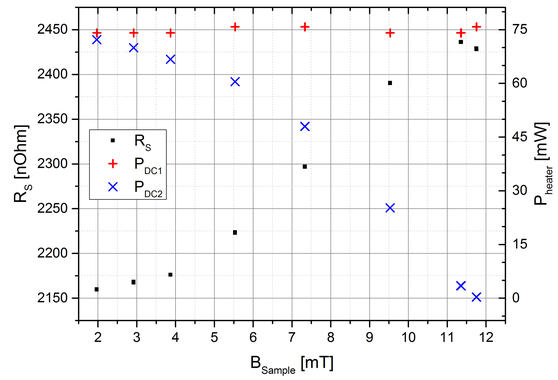
Implementation of the upper Indium gasket.



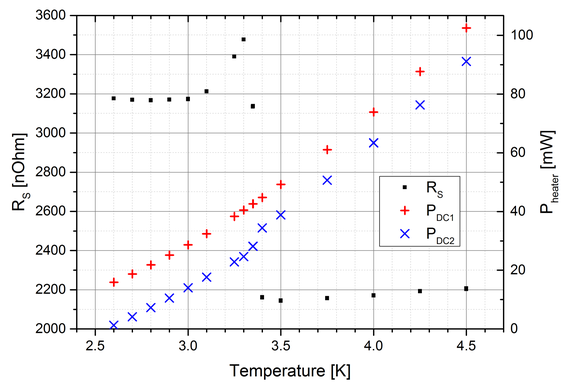
Surface roughness measurement
Stylus profilometry of typical and scratch-like structures
- → Stylus radius 2 µm (5 mg force)
- → Typical: periodic structures with height 2-3 µm peak-to-peak
- → Maximum height found: 11 µm

RF measurement with QPR at CERN
- → Unexpected high surface resistance
  Strong dependence on field strength and temperature
  Increase for T→ 3.3 K indicates RF losses at indium gasket
- → RRR ≥ 300, indicated by measurement of penetration depth and thermal conductivity

$$R_S = \frac{2\mu_0^2\,(P_{DC1} - P_{DC2})}{\int_{Sample}|B|^2 dS} = \frac{2\omega\mu_0^2\,c_{QPR}\,(P_{DC1} - P_{DC2})}{Q_t\,P_t}$$



R_S measured at constant temperature T_{Sample} = 4 K.



R_S measured at constant RF field B_{Sample} = 5 mT.

QPR CERN: E. Mahner et al., Rev. Sci. Instrum. 74, 3390 (2003).
S. Aull et al., „High Resolution Surface Resistance Studies", in Proc. SRF 2013, Paris, France.
QPR HZB: R. Kleindienst, O. Kugeler, J. Knobloch, "Development of an Optimized Quadrupole Resonator at HZB", in Proc. IPAC 2013, Paris, France.
R. Kleindienst et al., "Commissioning Results of the HZB Quadrupole Resonator", these proceedings, SRF 2015, Whistler, Canada.
S. Keckert, "Optimizing a Calorimetry Chamber for the RF Characterization of Superconductors", master thesis, University of Siegen, Germany, July 2015.

EuCARD-2 is co-funded by the partners and the European Commission under Capacities 7th Framework Programme, Grant Agreement 312453

This work is part of EuCARD-2, partly funded by the European Commission, GA 312453

Sebastian Keckert
sebastian.keckert@helmholtz-berlin.de
+49 30 8062-12922
www.helmholtz-berlin.de