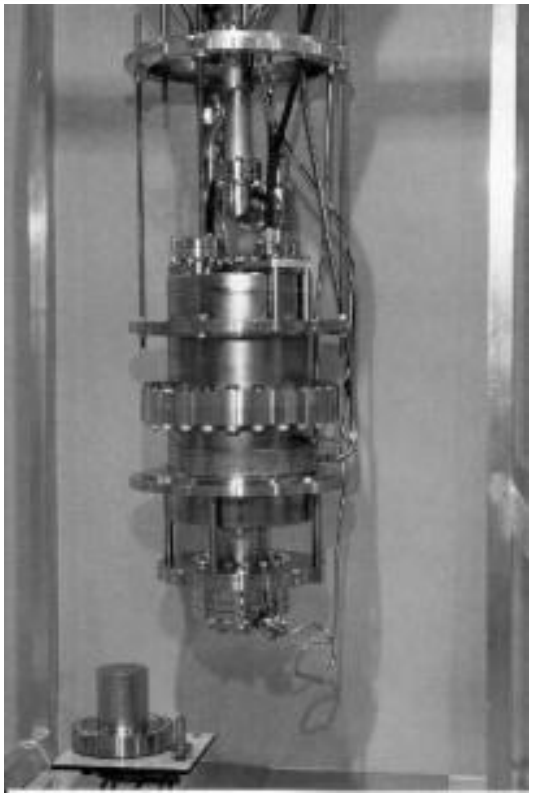
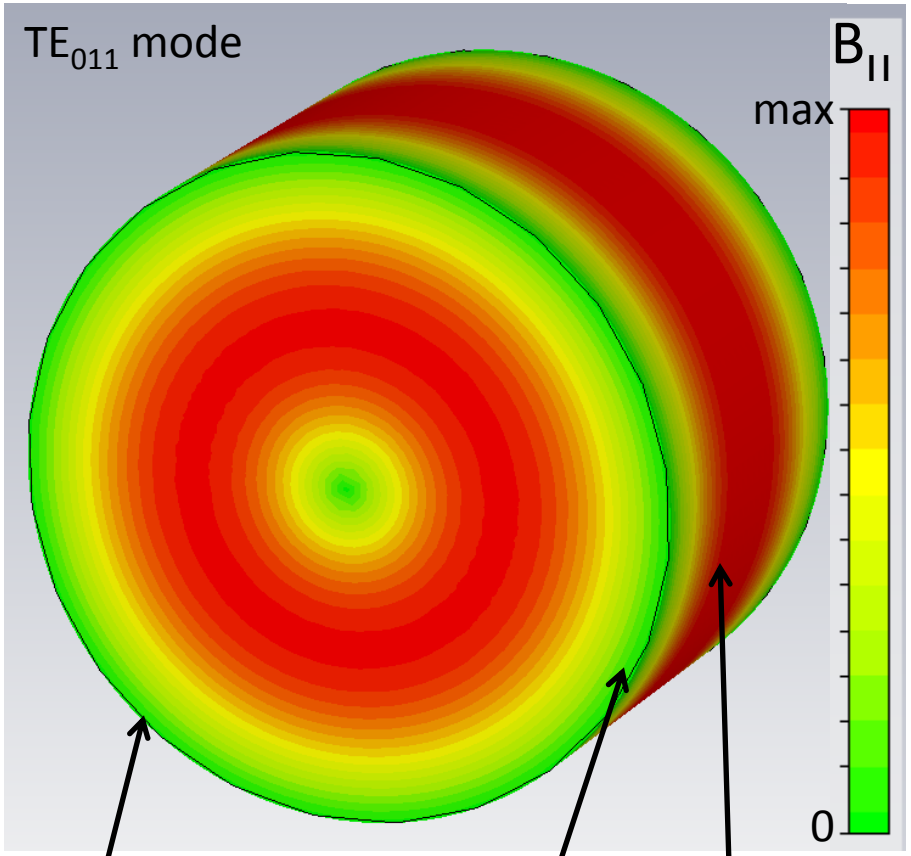
Review of RF Sample Test Equipment and Results



Work supported by the German Doctoral Students program of the Federal Ministry of Education and Research (BMBF)
Acknowledgements: Wolfgang Weingarten and everybody from CERN BE/RF and TE/CRG
Carsten Welsch (University of Liverpool, Cockcroft Institute, Daresbury)
Ernst Haebel (CERN)

- Small samples can be exposed to RF using a pill box cavity with demountable endplate

- Three possible techniques
  - Replacement
  - Thermometry
  - **Calorimetric**



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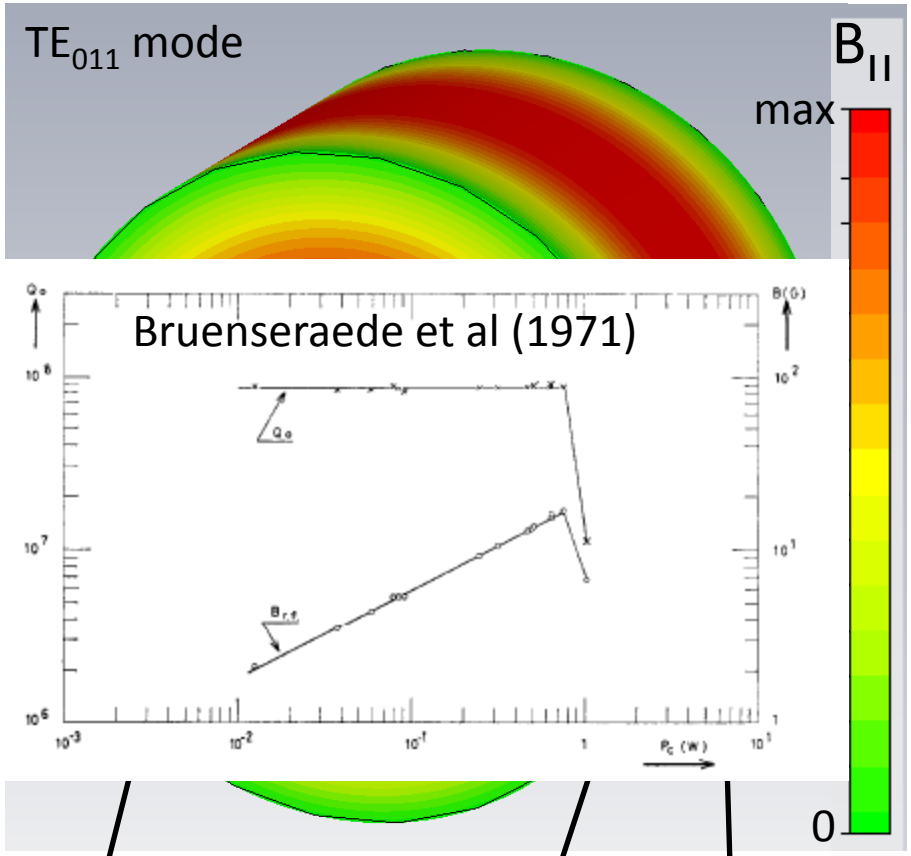

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- Small samples can be exposed to RF using a pill box cavity with demountable endplate

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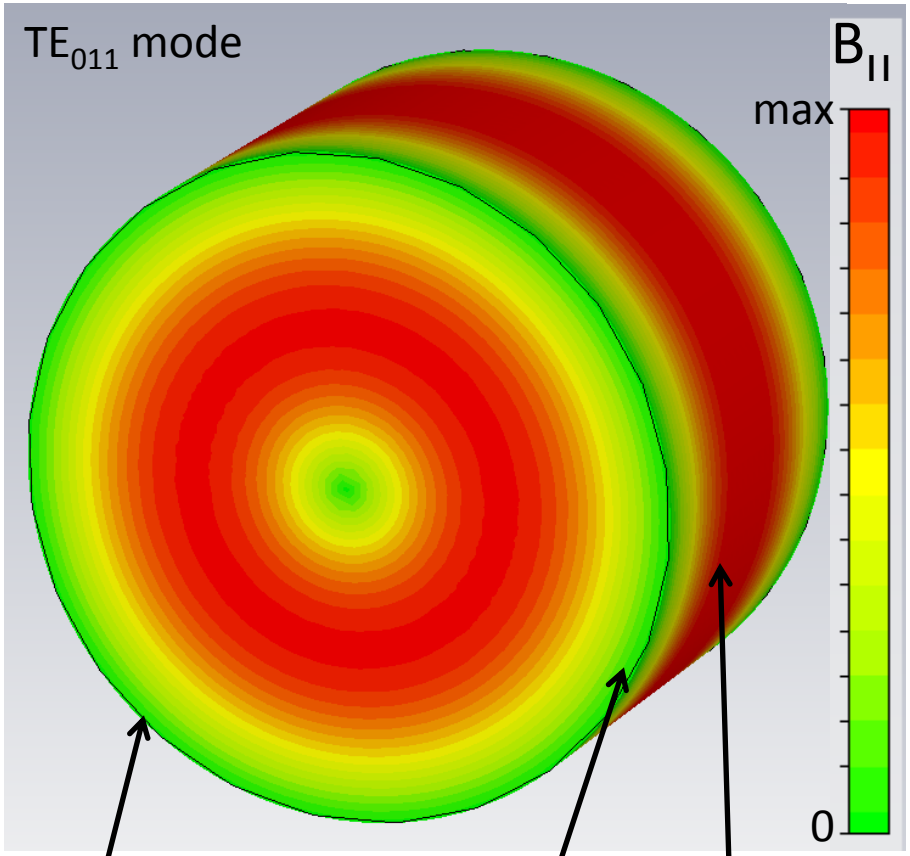
THPO050



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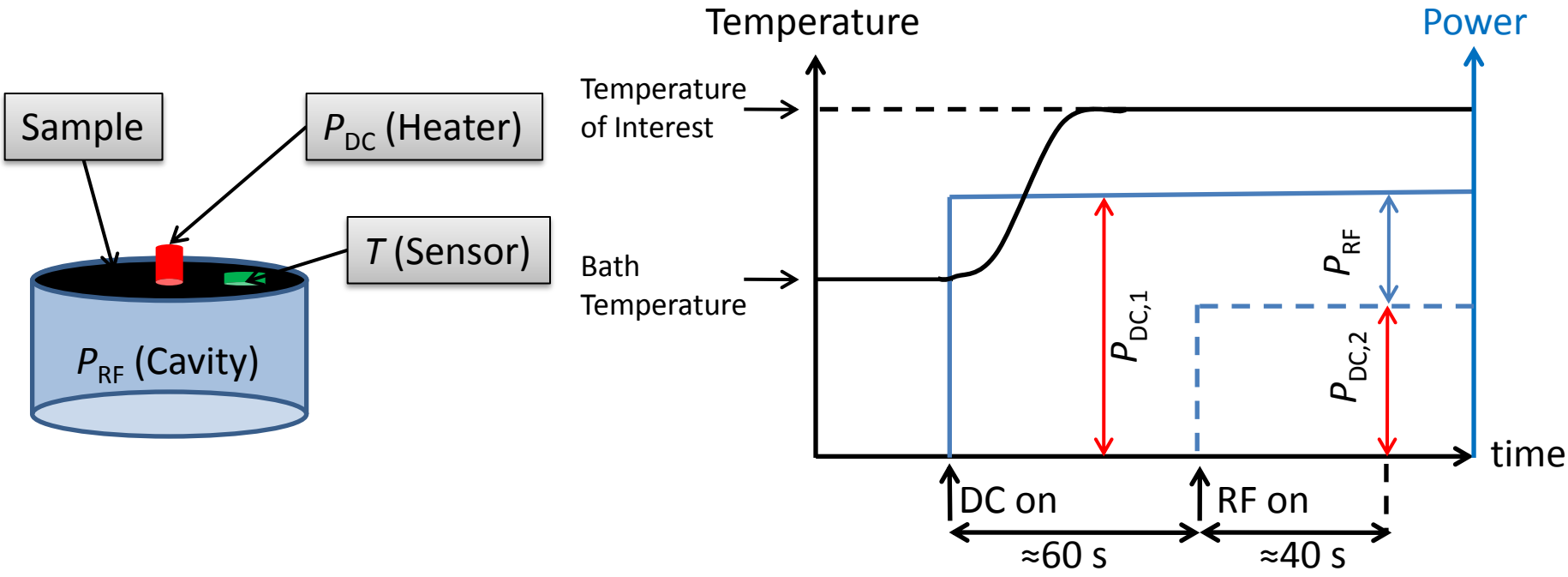

$$P_{RF} = P_{DC,1} - P_{DC,2} \approx 1/2\, R_{Surface} \int_{Sample} H^2 dS$$

$$R_{Surface} = \frac{2(P_{DC,1} - P_{DC,2})}{\int_{Sample} H^2 dS}$$

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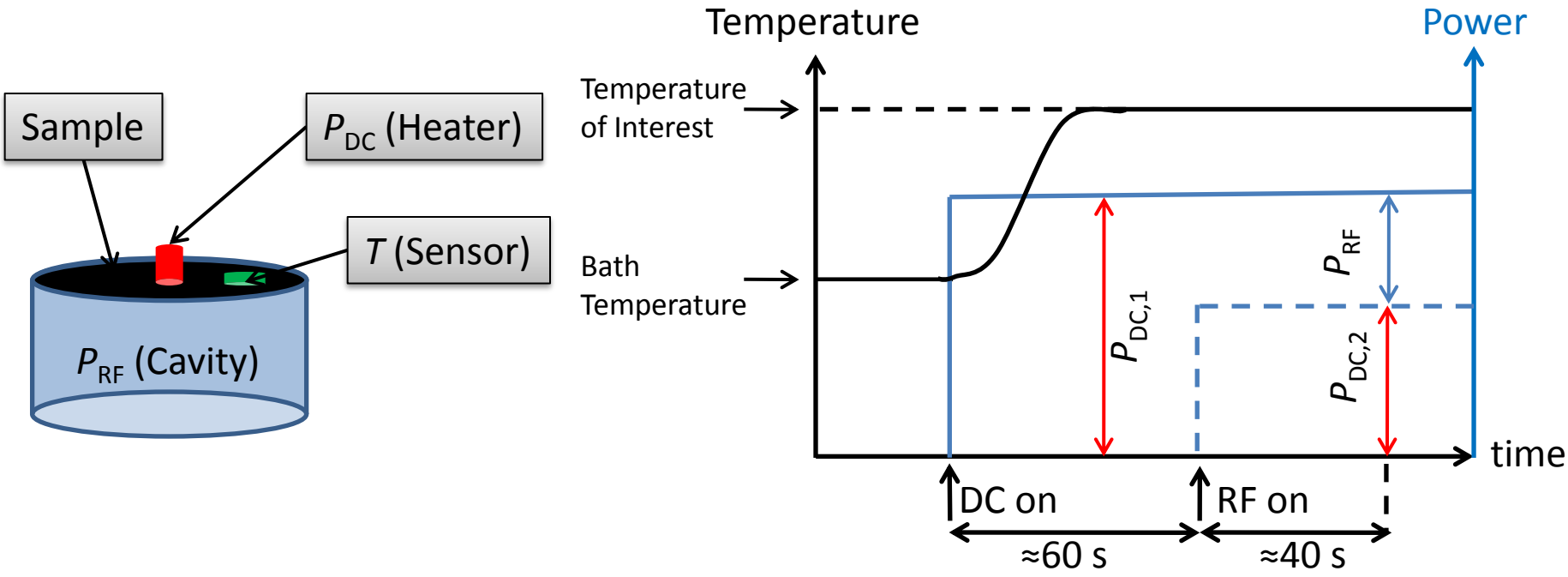

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Direct Measurement

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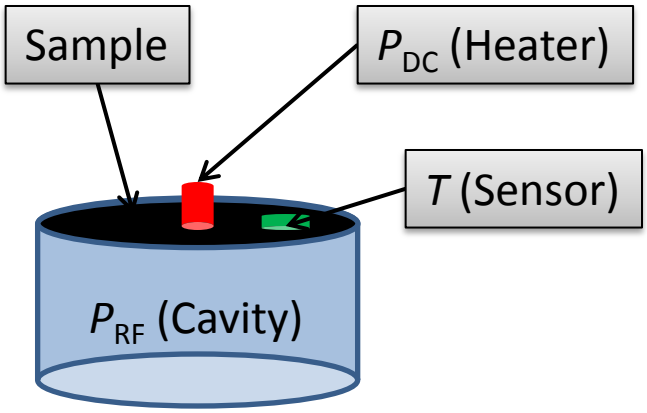

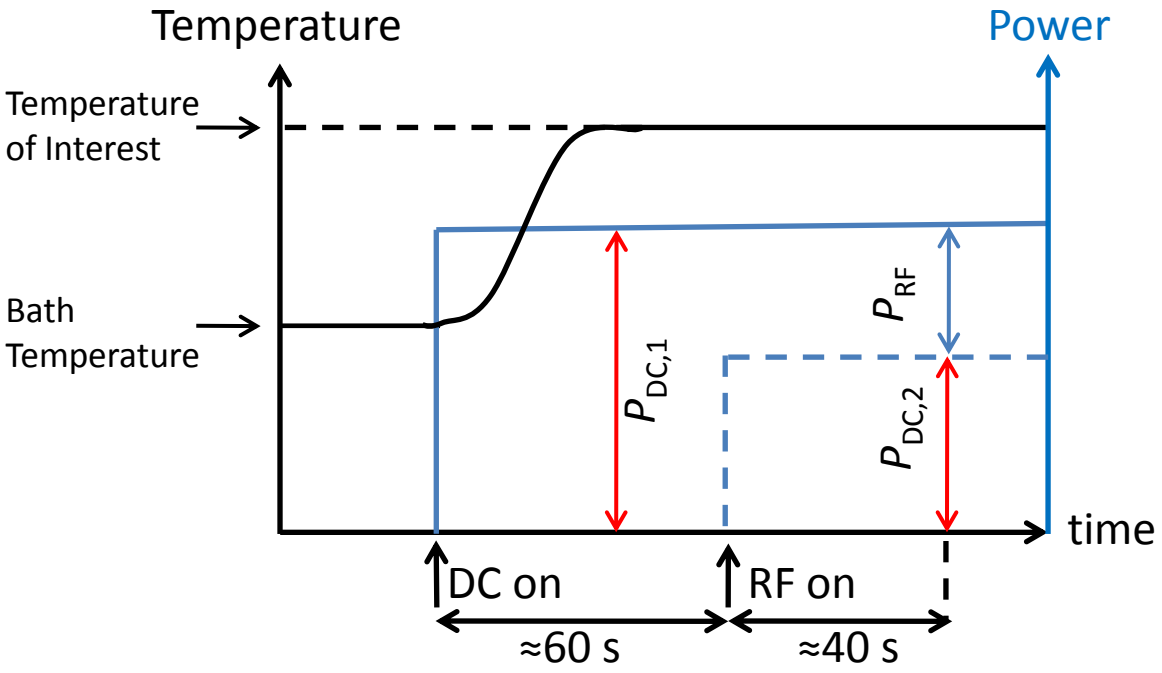

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Direct Measurement

- Measurement of transmitted power P_t
- $P_t = c\int H^2 ds$, c from computer code

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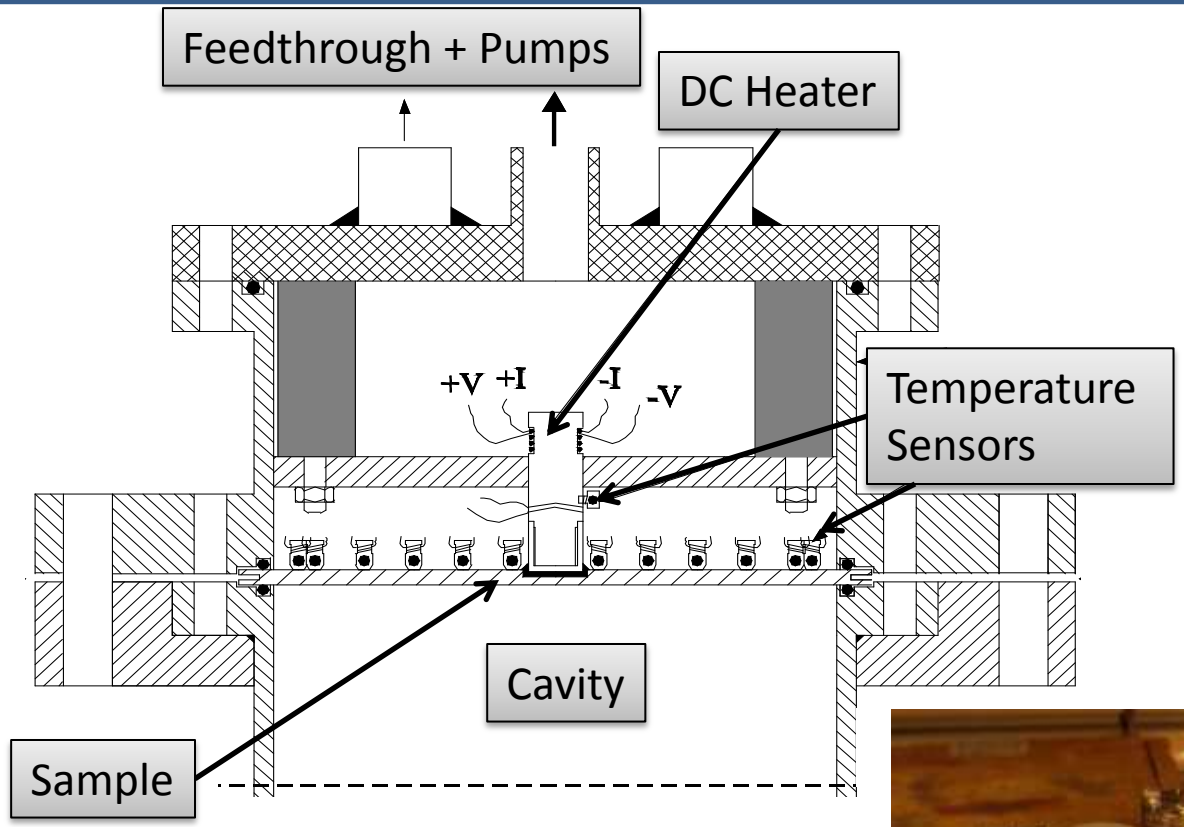
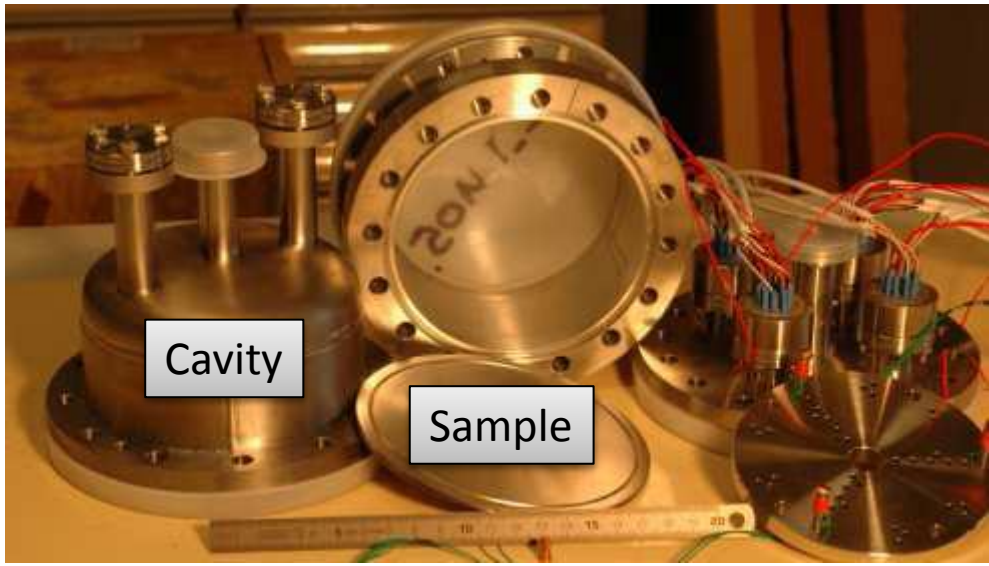
2. TE_{011}/TE_{012} Cavity from CEA Saclay and IPN Orsay[1,2]



- TE_{011} (4 GHz) TE_{012} (5.6 GHz)
- Developed from CEA Saclay/IPN Orsay[1]
- Modified cavity recently comissioned[2]



[1] M. Fouaidy, P. Bosland et al. - EPAC 2002, Paris, France
[2] G. Martinet et al. – SRF 2009, Berlin, Germany

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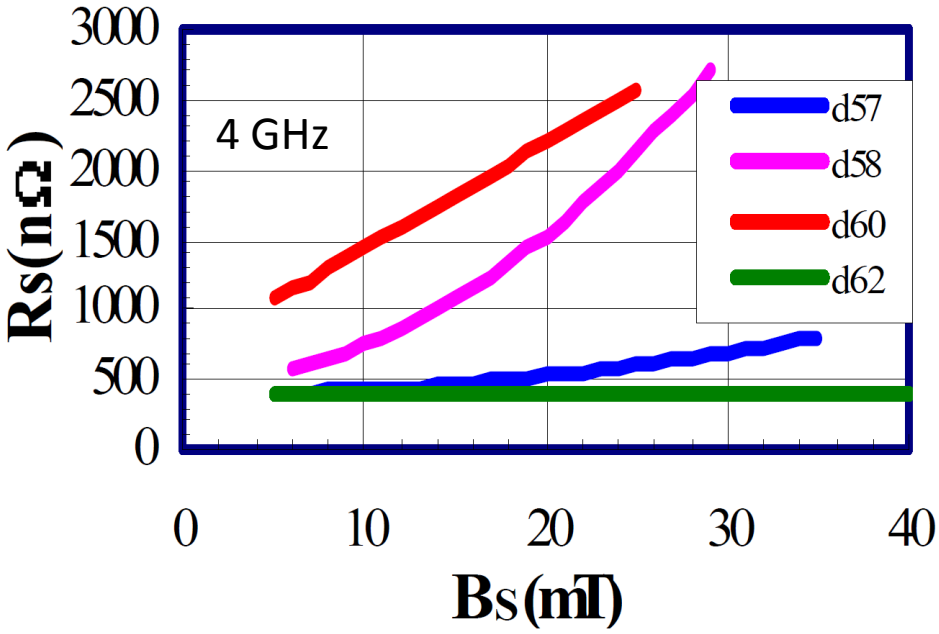
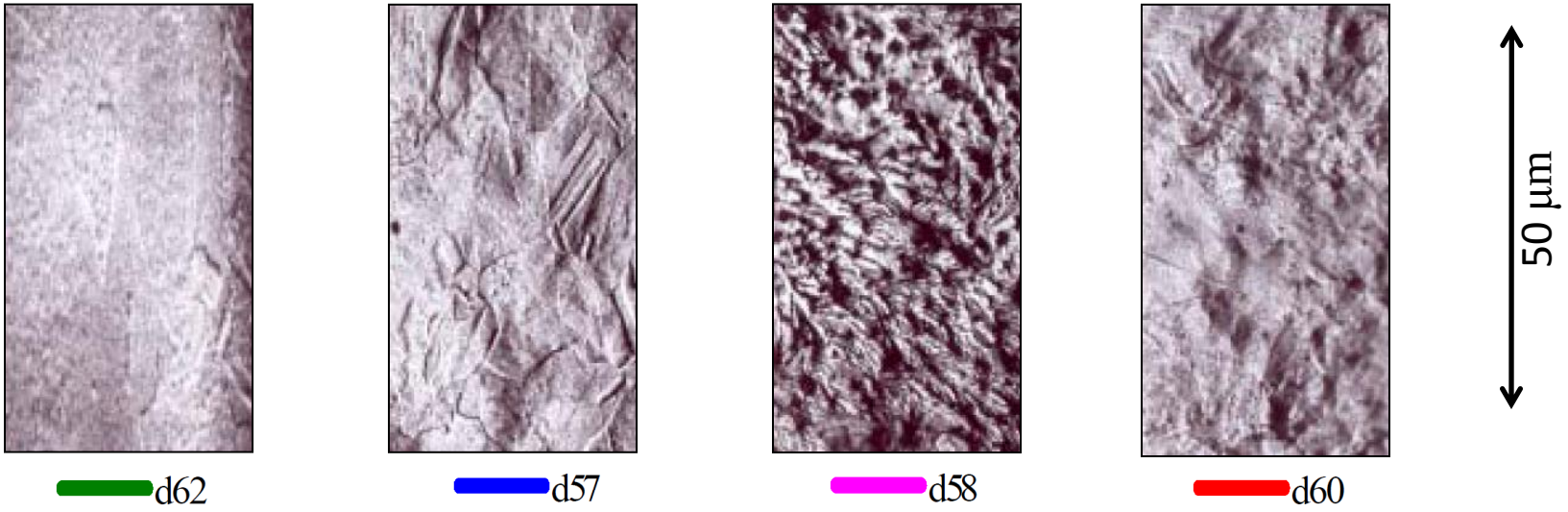


- Systematic sample studies
- Correlation with surface properties
- Nb film residual surface resistance increases with the substrate roughness



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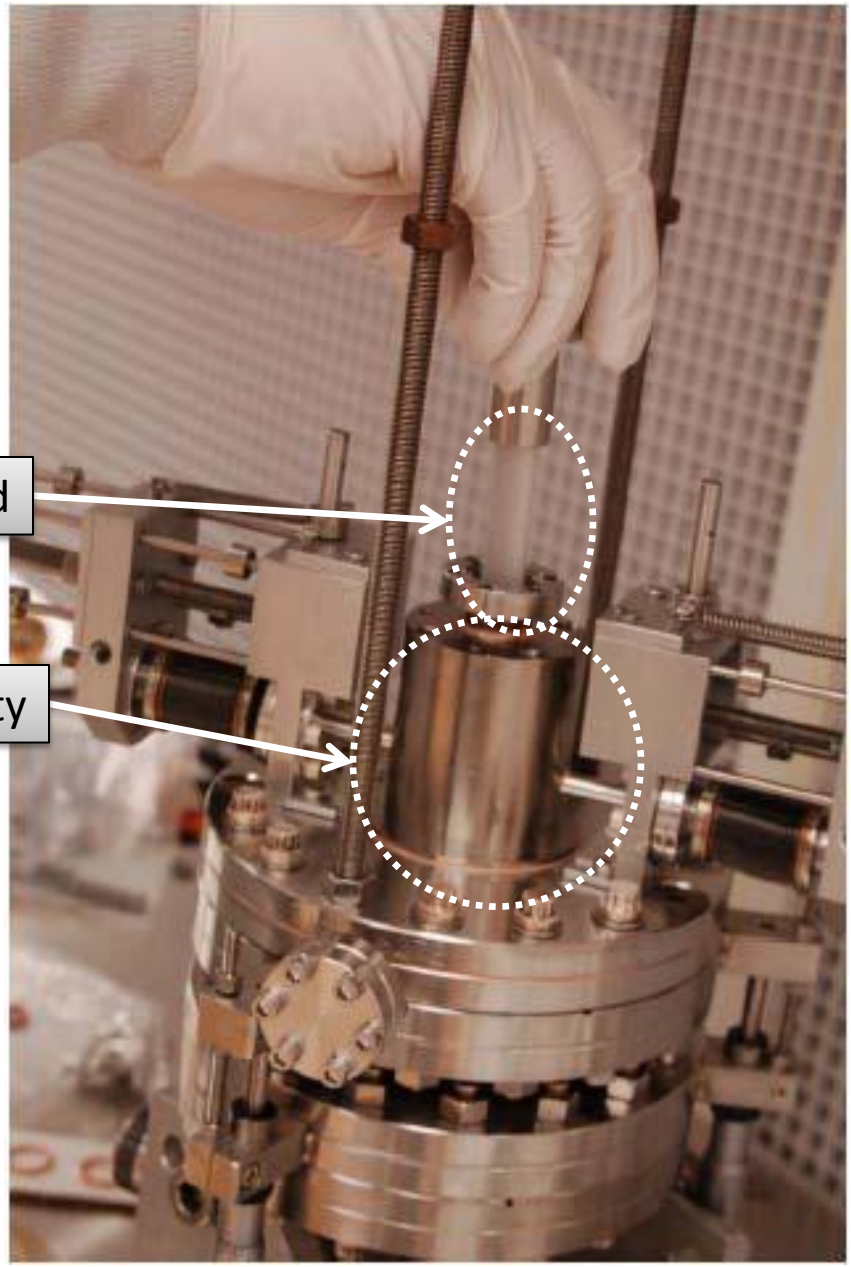
[1] M. Fouaidy, P. Bosland et al. - EPAC 2002, Paris, France

3. Sapphire loaded cavity at JLAB[3,4]

- Sapphire rod attached inside the cavity lowers resonance frequency
- 7.5 GHz for 5 cm sample diameter



[3] L. Phillips et al. – SRF 2005, Ithaca, United States
[4] B. Xiao et al. – Rev. Sci. Instrum. 82, 056114 (2011)

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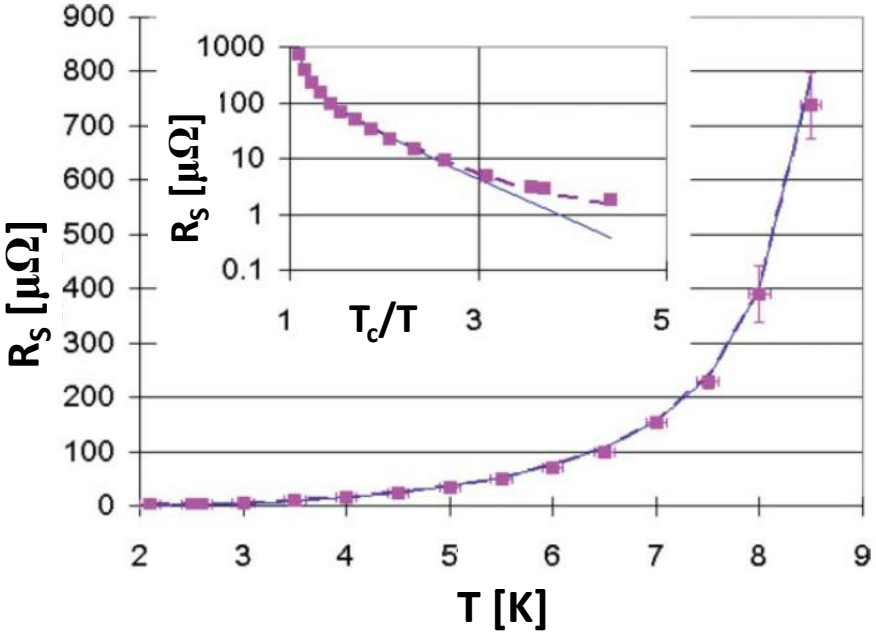

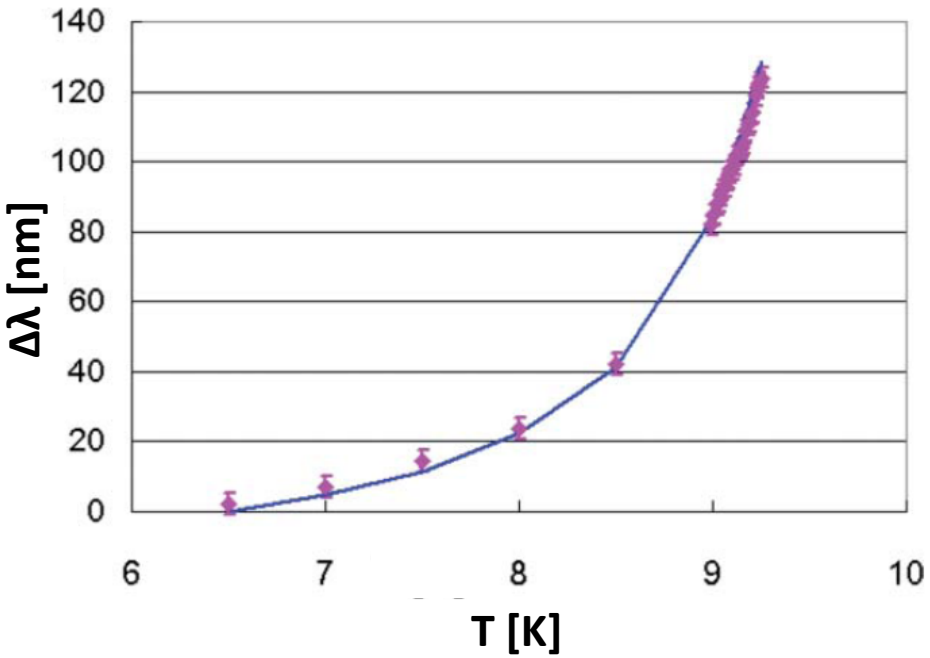

- Derive **material parameters** from surface impedance measurements
- Δ/kT_c=1.842, λ(0 K) =45.3 nm, London penetration depth=36.1 nm, coherence length=51.3 nm, mean free path=256 nm, R_{res}=1.54 μΩ for **Niobium Sample**

Results on MgB_2: THPO048

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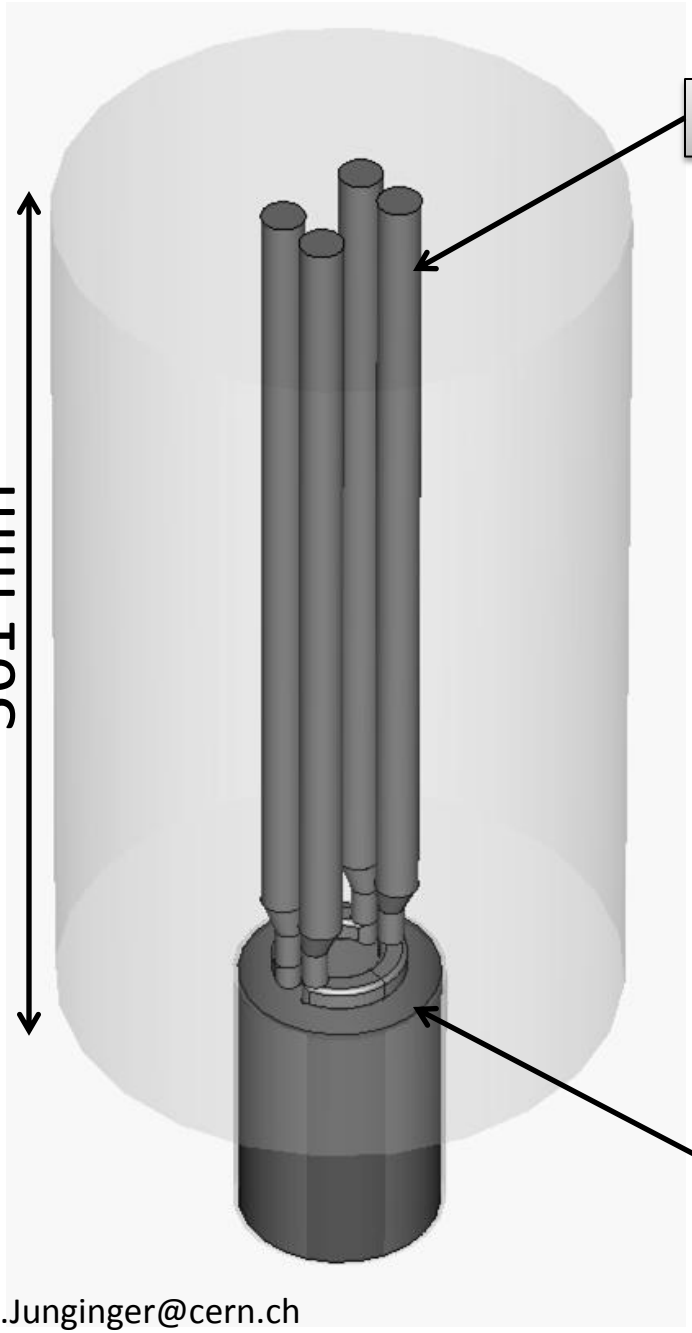
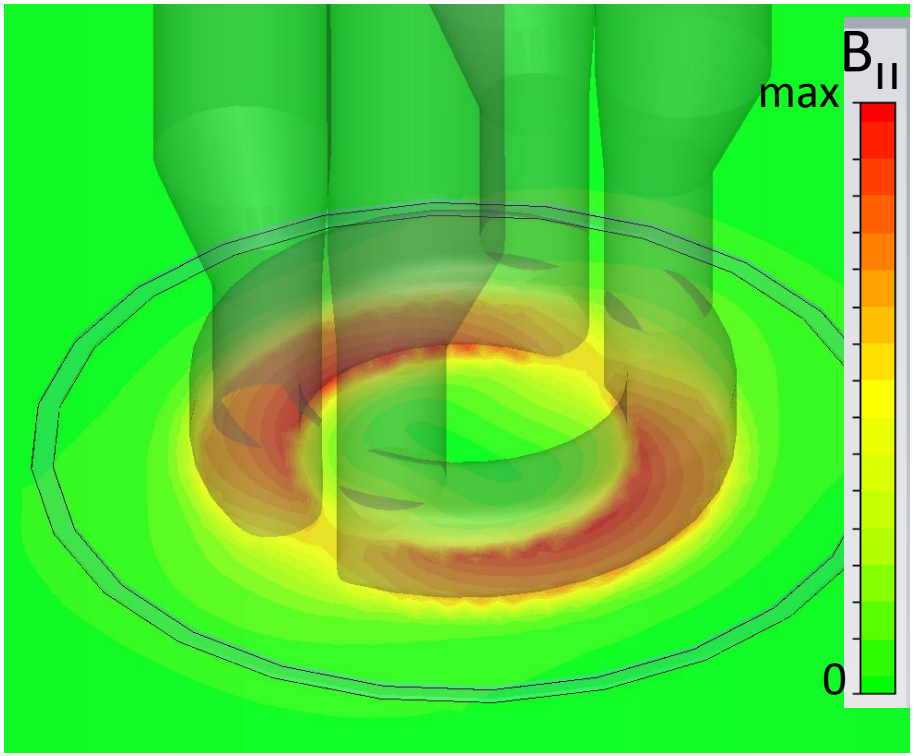
[4] B. Xiao et al. – Rev. Sci. Instrum. 82, 056114 (2011)





[5] E. Mahner et al. -Rev. Sci. Instrum., Vol. 74, No. 7, July 2003)
[6] T. Junginger et. al – SRF 2009, Berlin Germany

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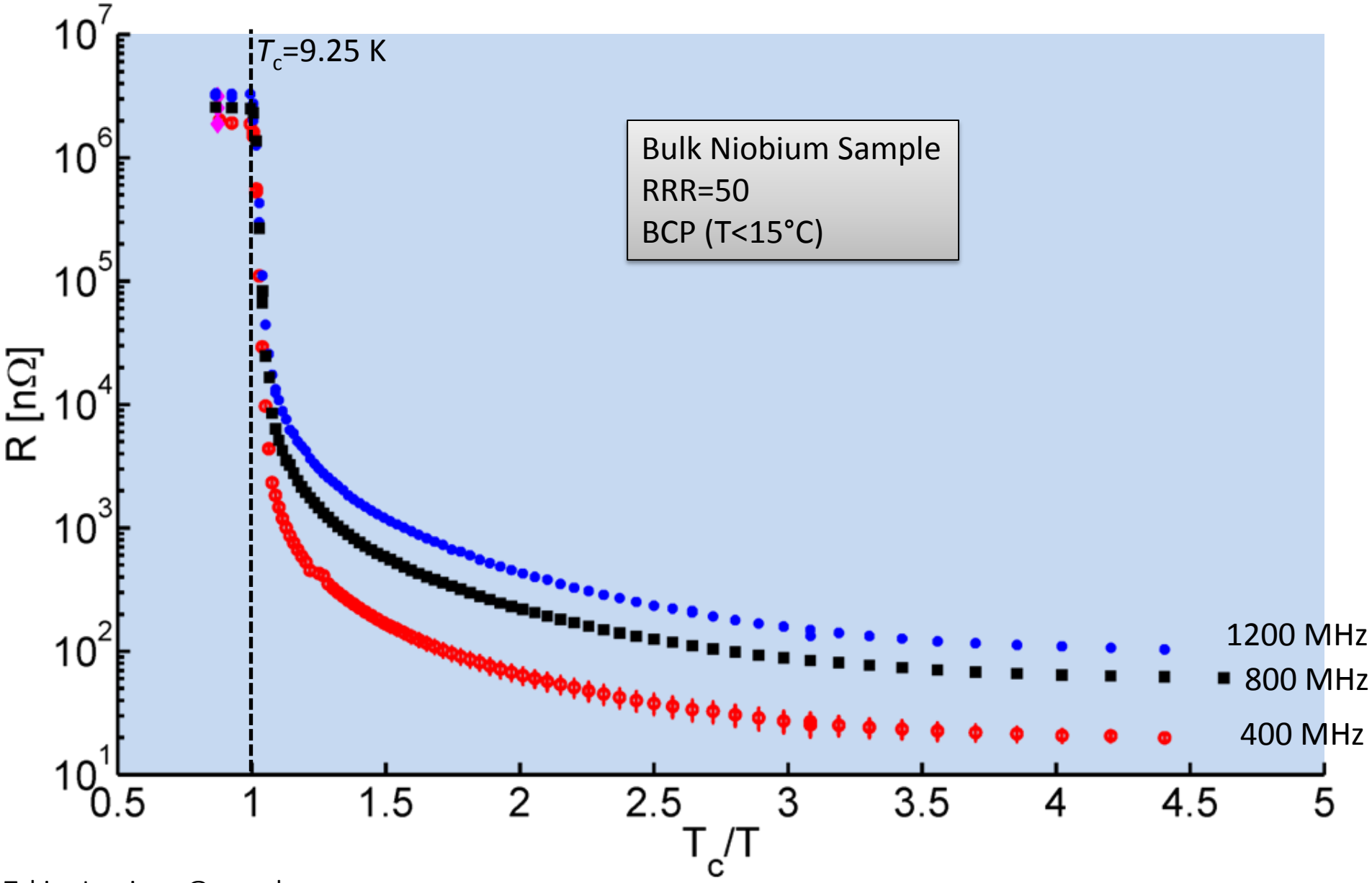

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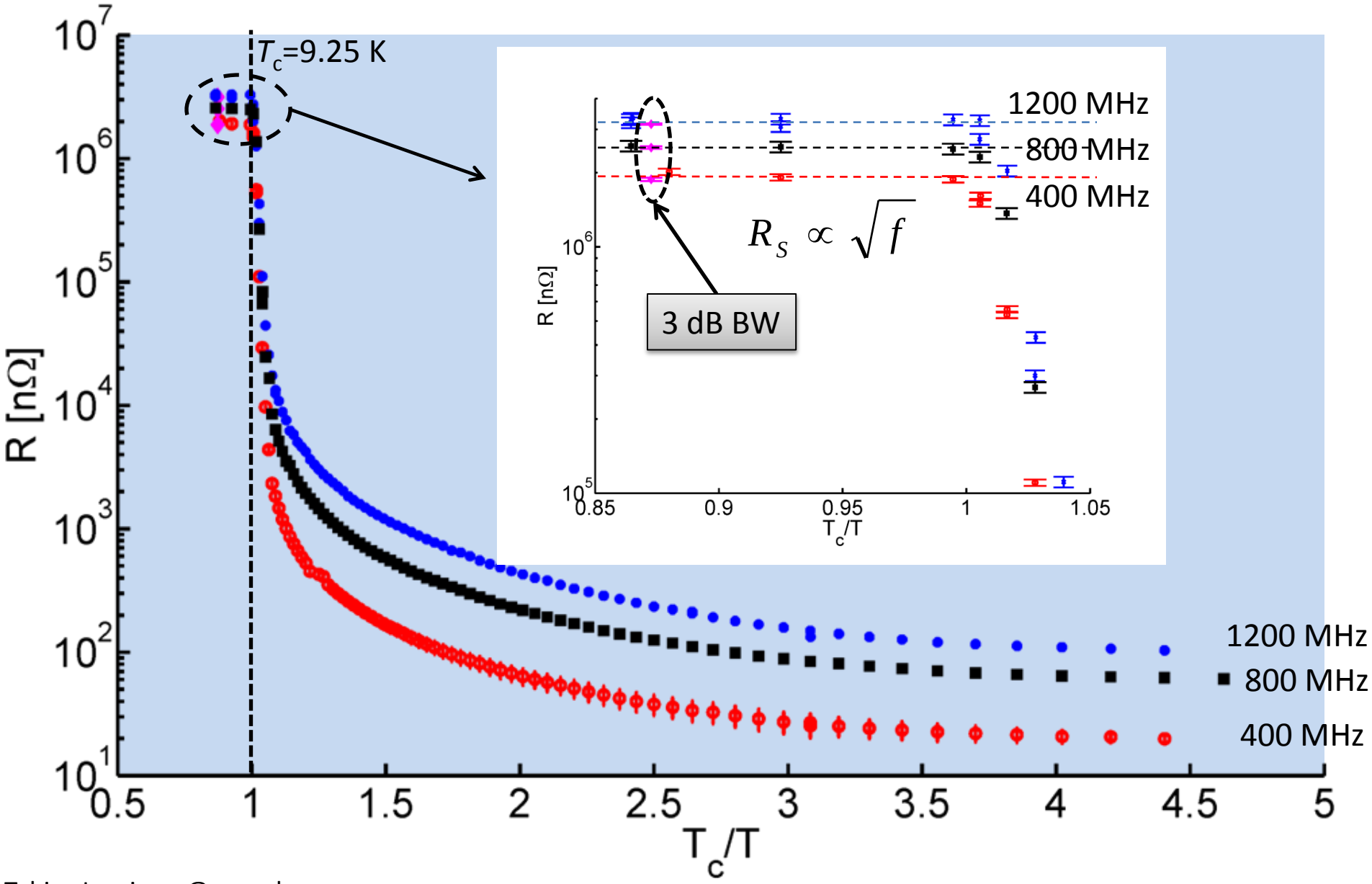

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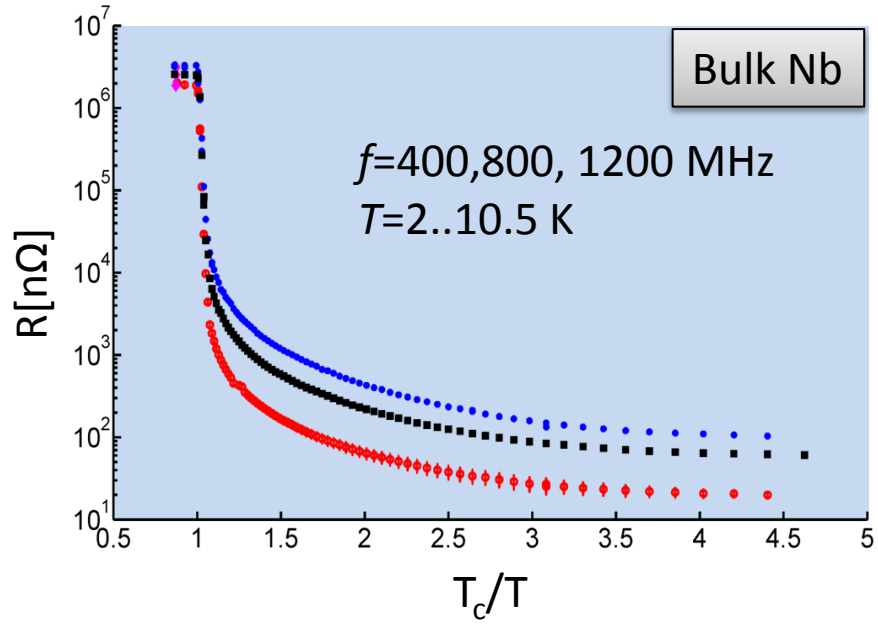
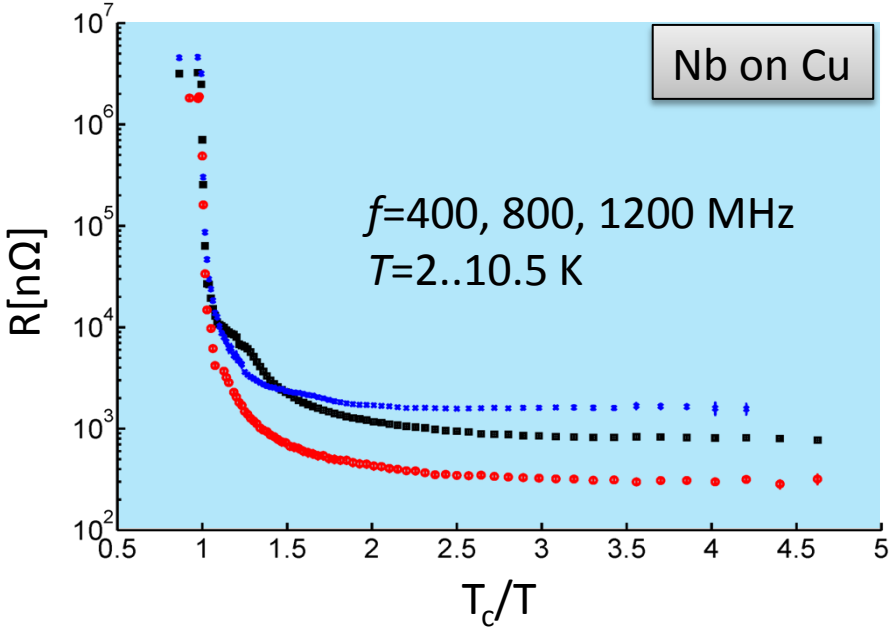
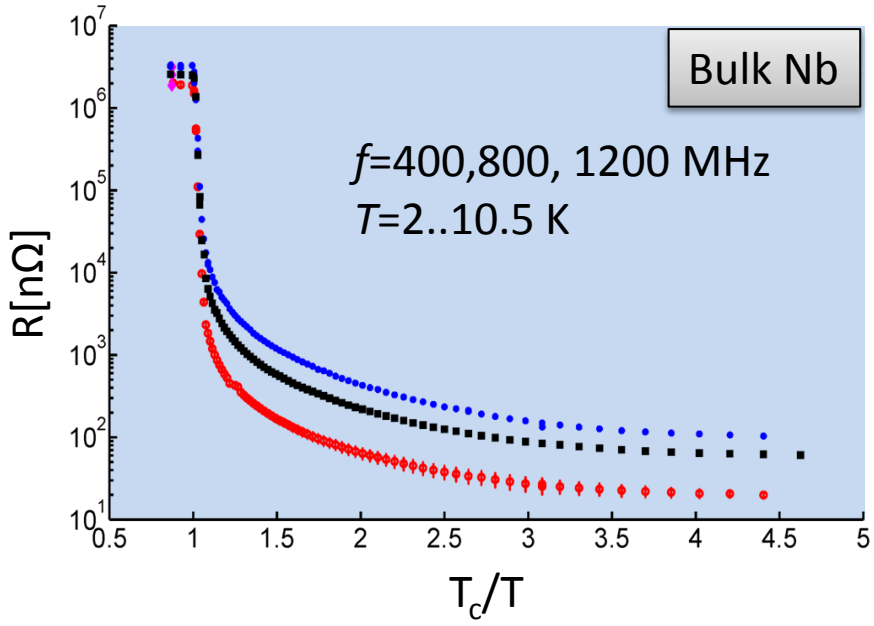
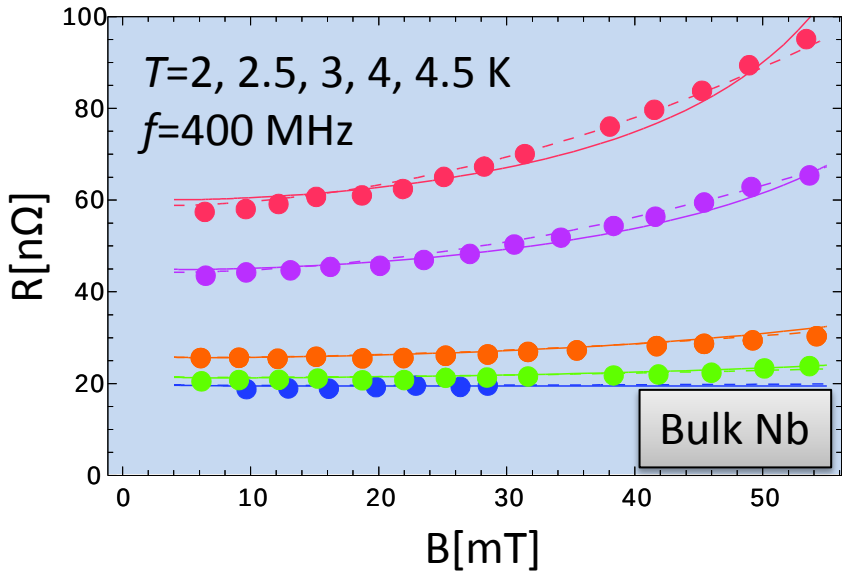
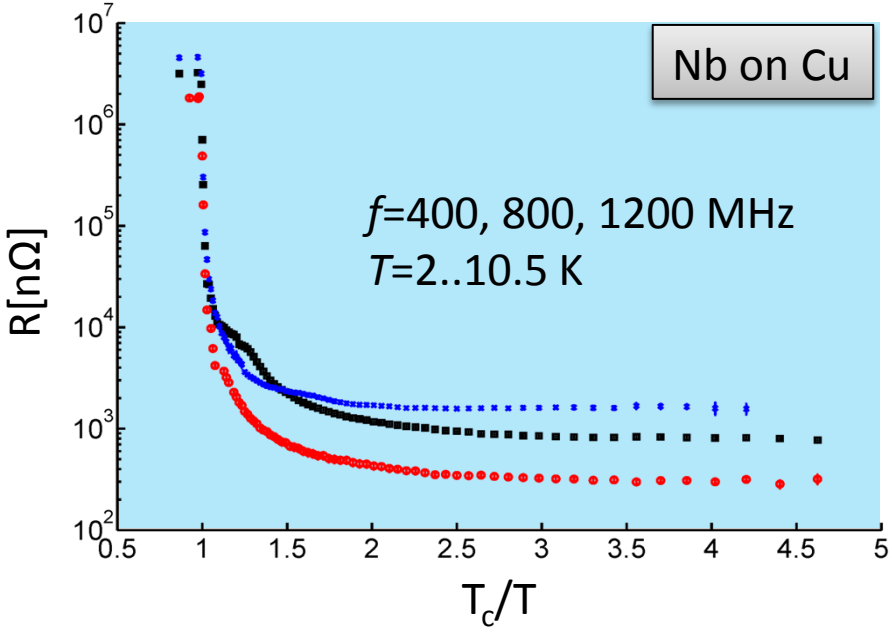
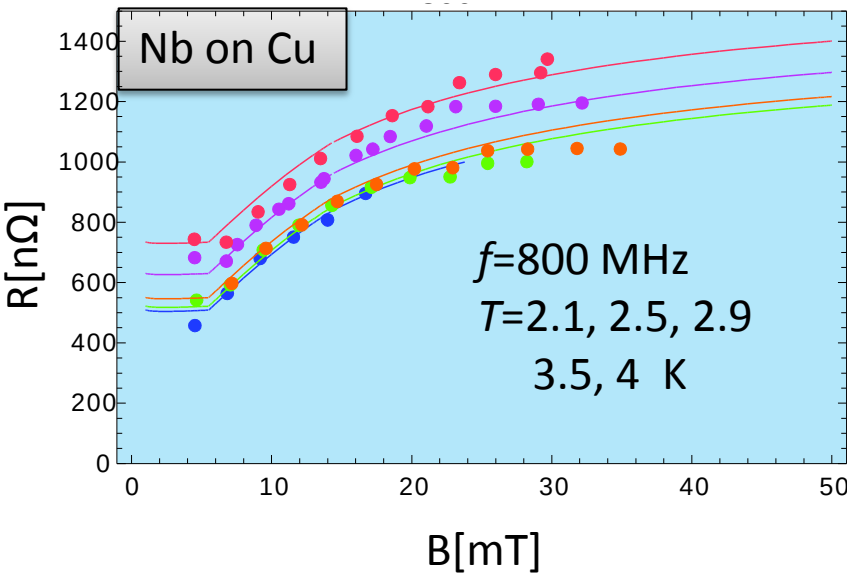

Bulk Nb
f=400,800, 1200 MHz
T=2..10.5 K
R[nΩ]
T_c/T

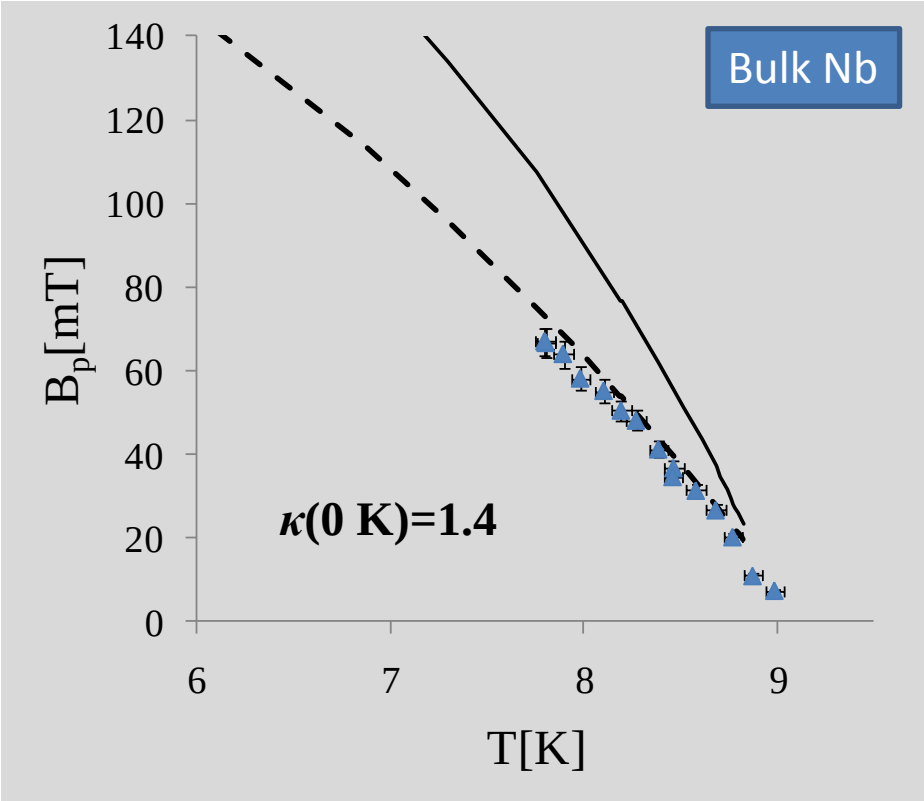

Nb on Cu
f=400, 800, 1200 MHz
T=2..10.5 K
R[nΩ]
T_c/T

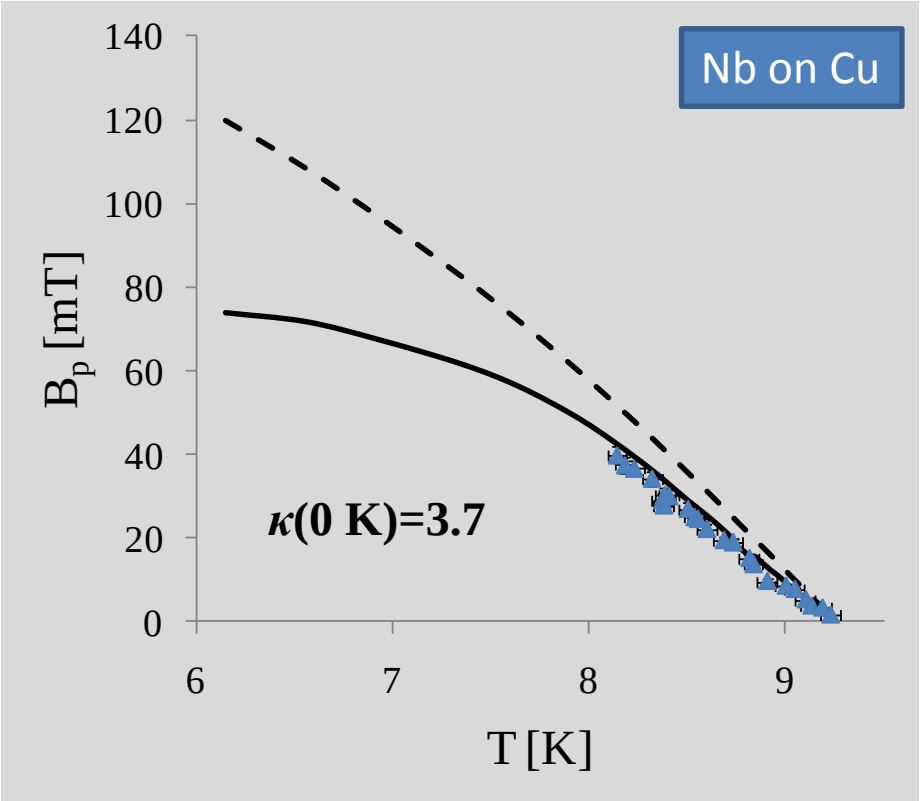

Bulk Nb
f=400,800, 1200 MHz
T=2..10.5 K
R[nΩ]
T_c/T


T=2, 2.5, 3, 4, 4.5 K
f=400 MHz
Bulk Nb
R[nΩ]
B[mT]


Nb on Cu
f=400, 800, 1200 MHz
T=2..10.5 K
R[nΩ]
T_c/T


Nb on Cu
f=800 MHz
T=2.1, 2.5, 2.9
3.5, 4 K
R[nΩ]
B[mT]





Solid Curve: Prediction from Vortex Line Nucleation Model
Dashed Curve: Prediction from Ginzburg Landau Model

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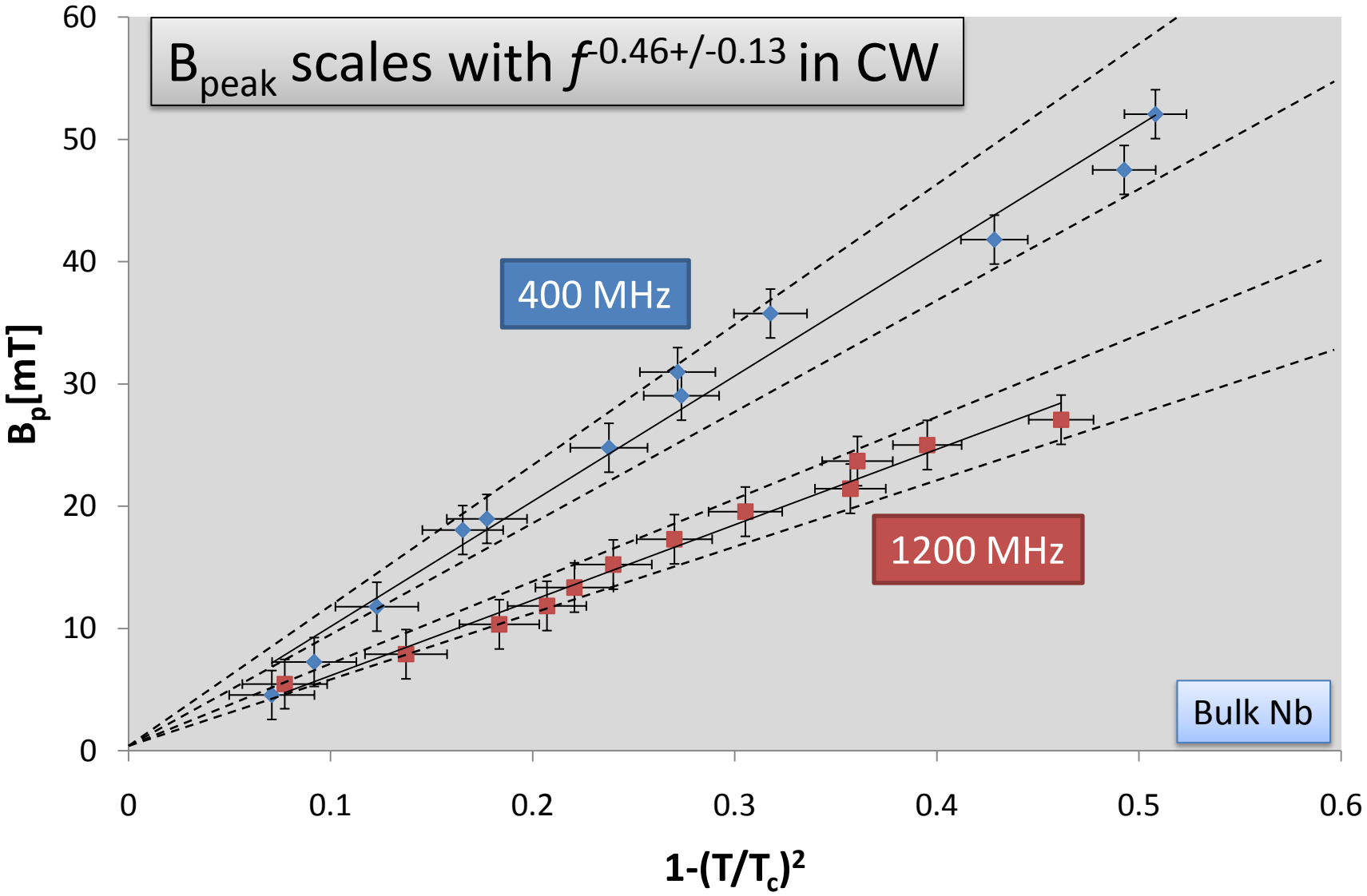

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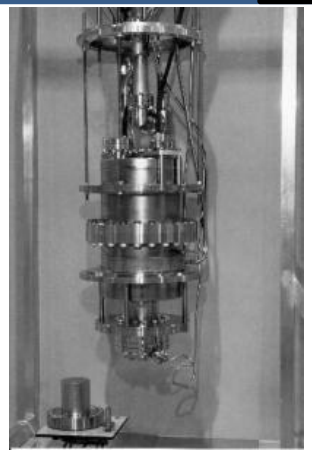
5. Comparison of the Different Devices



	$TE_{011/012}$ Cavity	Sapphire loaded	Quadrupole
f [GHz]	4/5.6	7.5	0.4/0.8/1.2
Sample diameter d [cm]	12	5	7.5
B_{max} [mT]	40	14 (Amplifier Power)	60 (Quench)
Resolution at 5 mT from minimal detectable heating [nΩ]	1.43[2]	1.2[4]	0.44

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[2] G. Martinet et al. – SRF 2009, Berlin, Germany
[4] B. Xiao et al. – Rev. Sci. Instrum. 82, 056104 (2011)