Effect of temperature gradients during cooling of SRF cavity on flux expulsion

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Fermilab

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Based on paper:

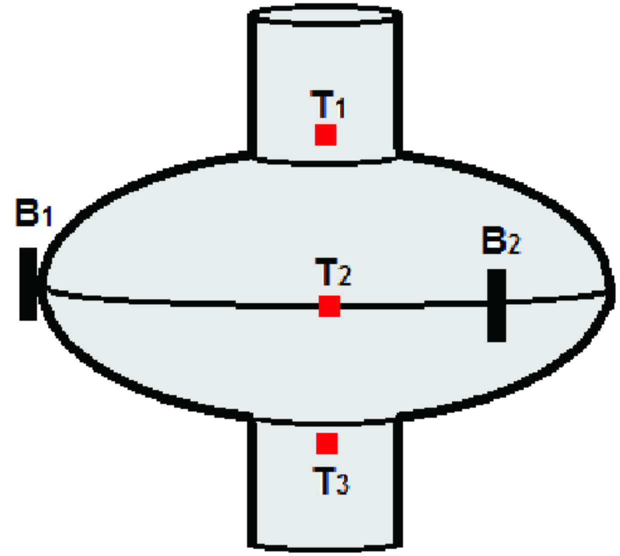
"Ultra-high quality factors in superconducting niobium cavities in ambient magnetic fields up to 190 mG,"

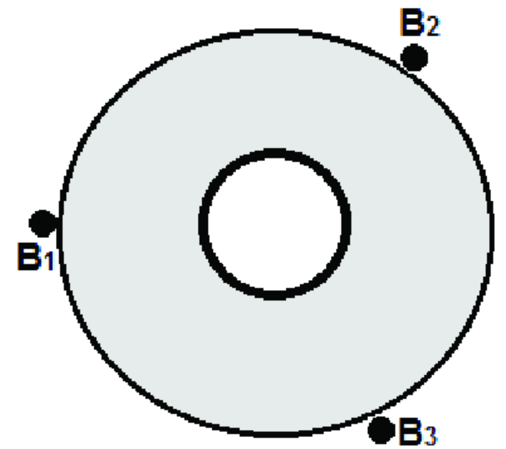
A. Romanenko, A. Grassellino, A. C. Crawford, D. A. Sergatskov, and O.Melnychuk

will be published in *Appl. Phys. Lett.* 105, (2014).

More recent data and comments are added.

Experimental setup





$B = (B_1 + B_2 + B_3)/3$

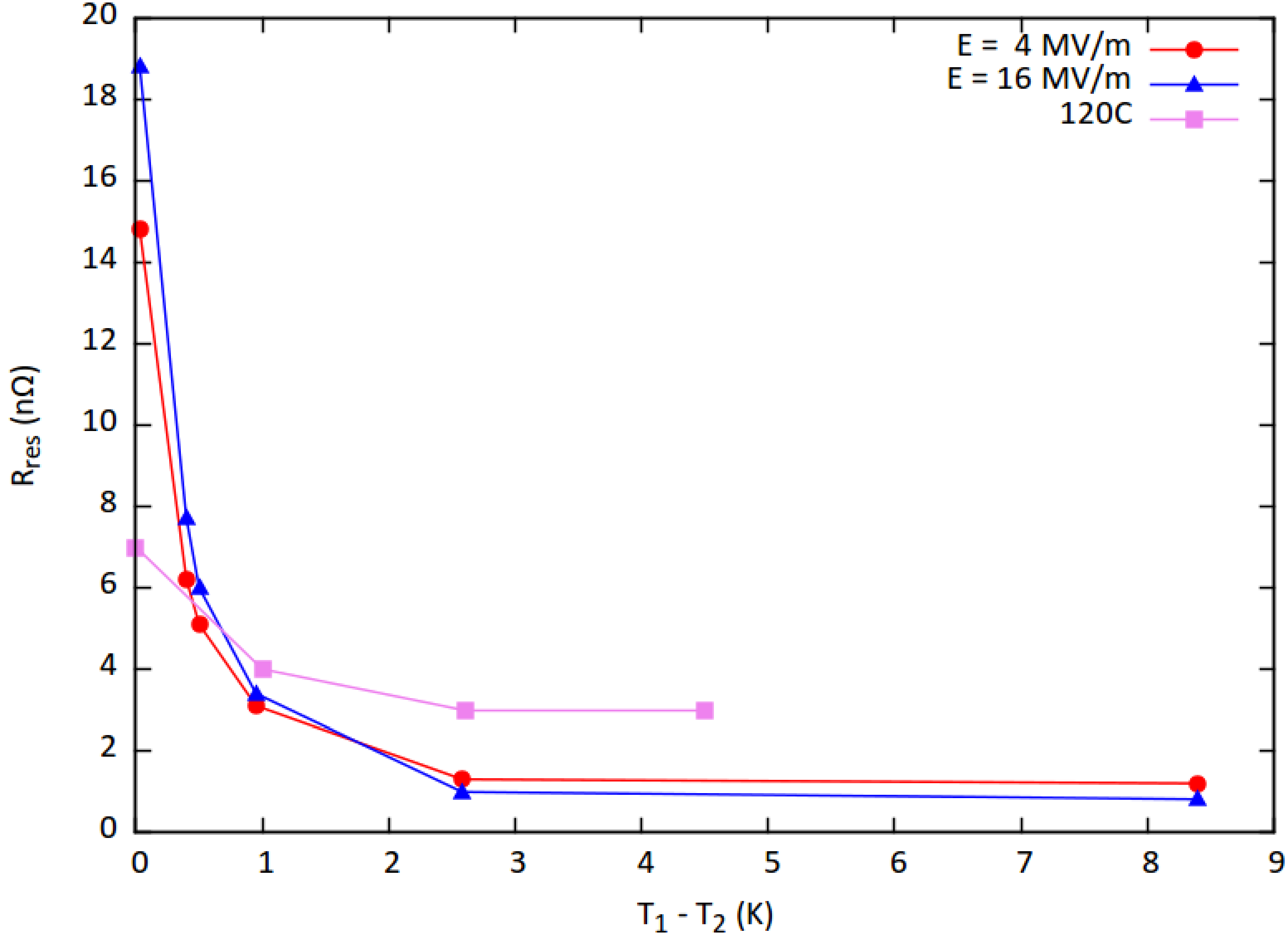
te1aes011 (N_2 doped),
te1aes014 (EP+120℃ baked)

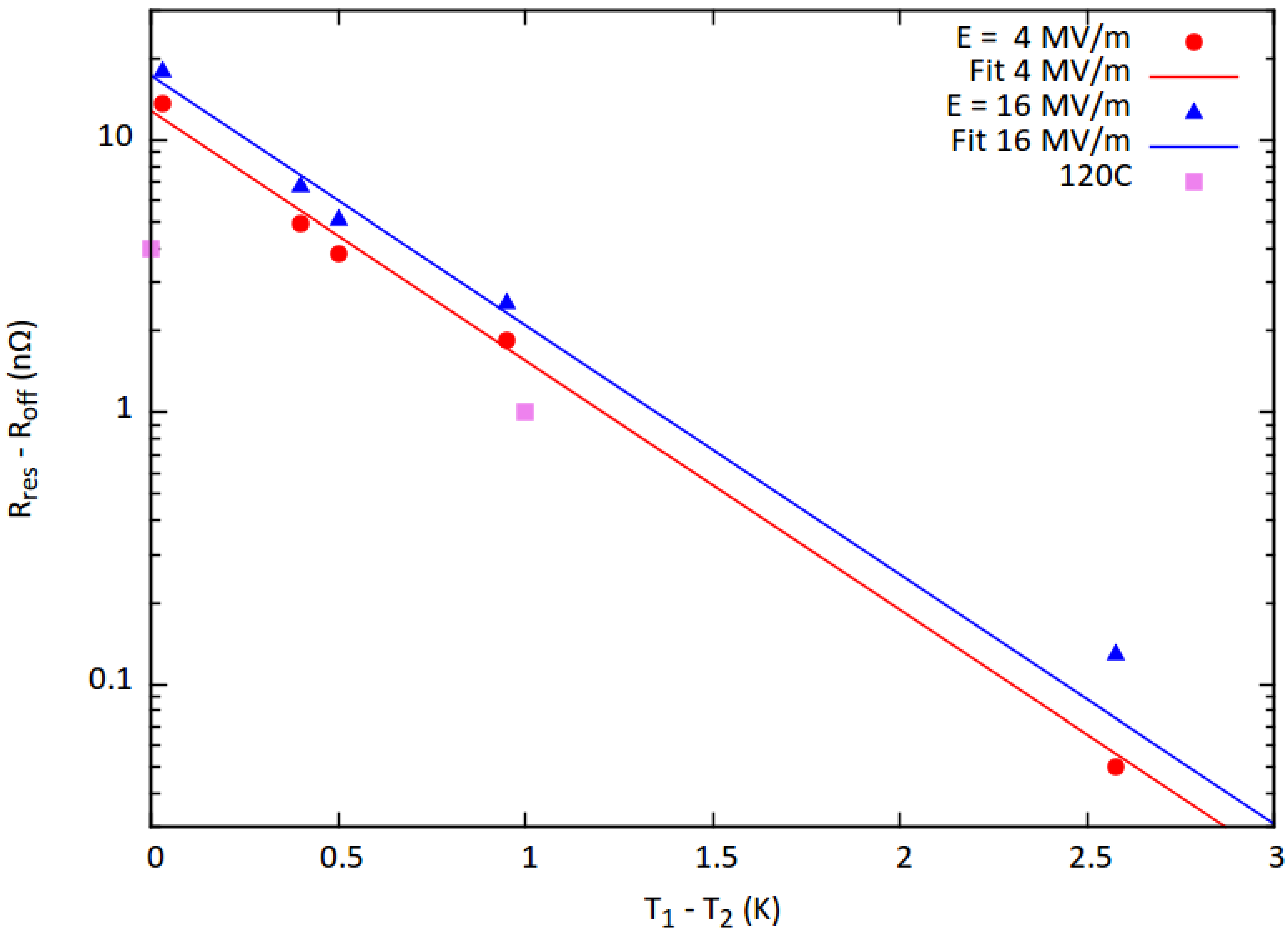
$\Delta T = (T_1 - T_2)$ @ $T_2 = T_c$

The measurement plan

1) Fix the ambient field to 10 mGauss and vary the cooling procedure (the starting T and the rate through transition).
2) Using the cooling with the best expulsion, try different magnetic fields.

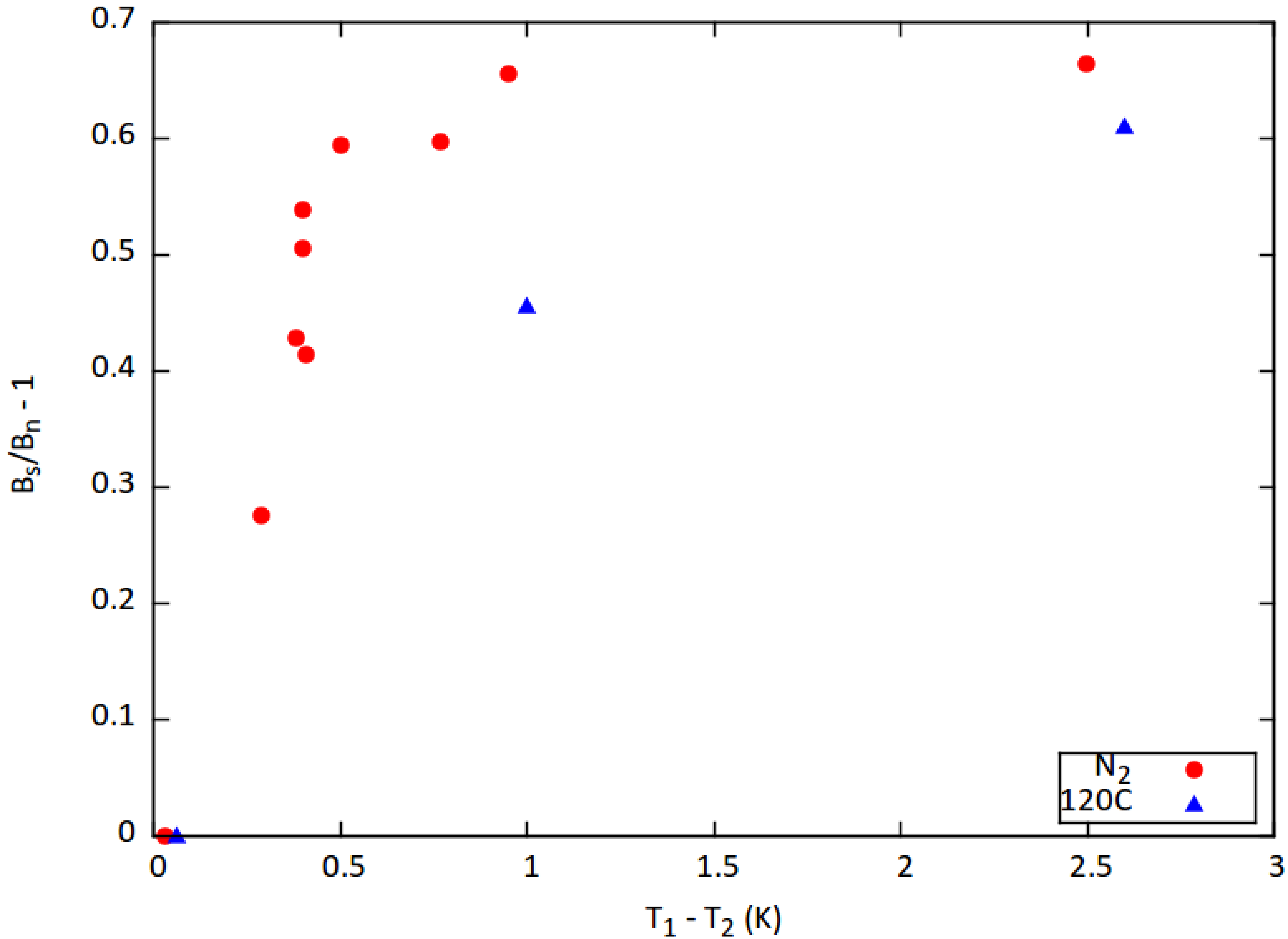
Residual resistance as function of ΔT

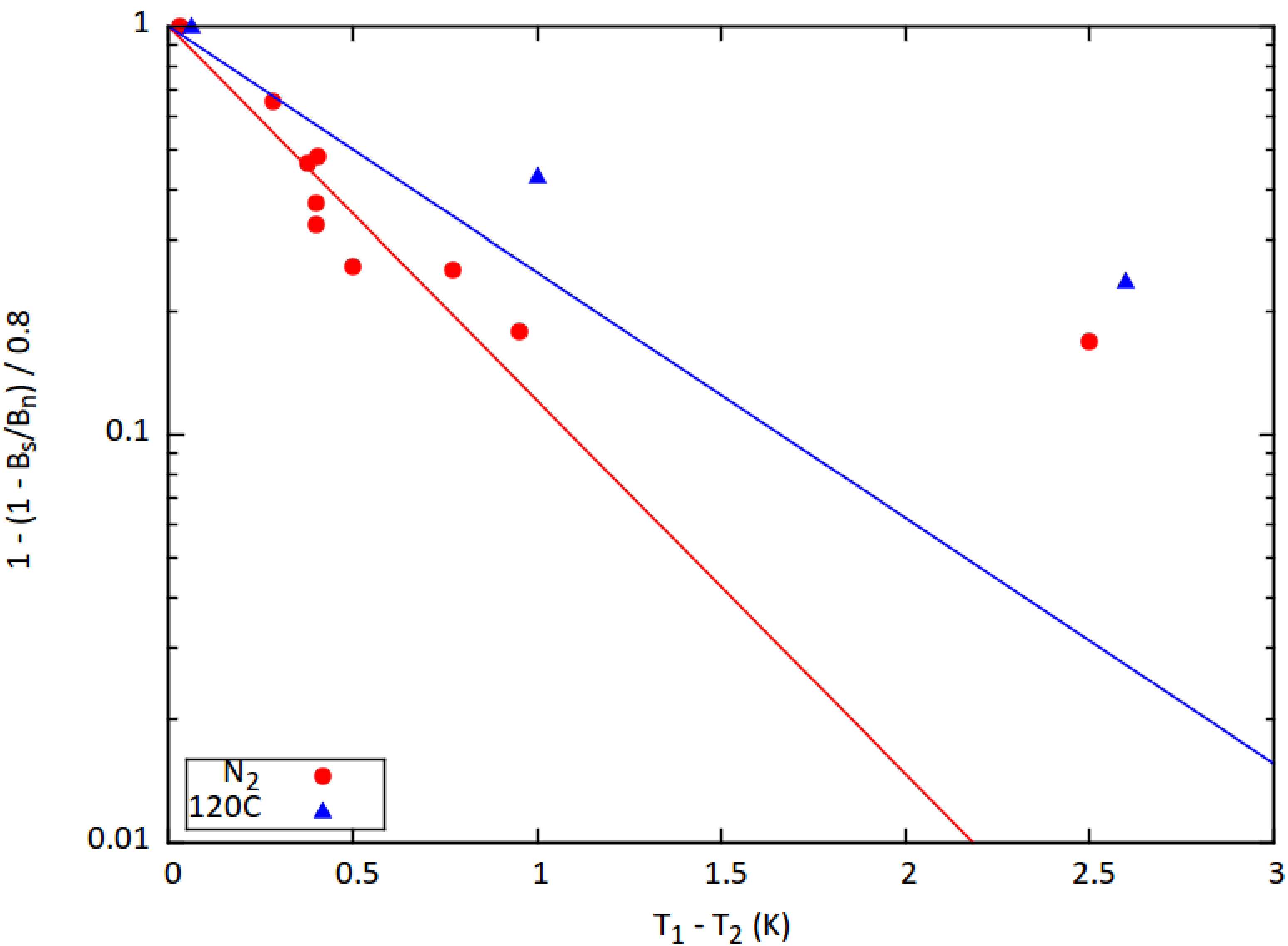




The exponent is 0.47K (0.72K for 120℃ baked cavity)

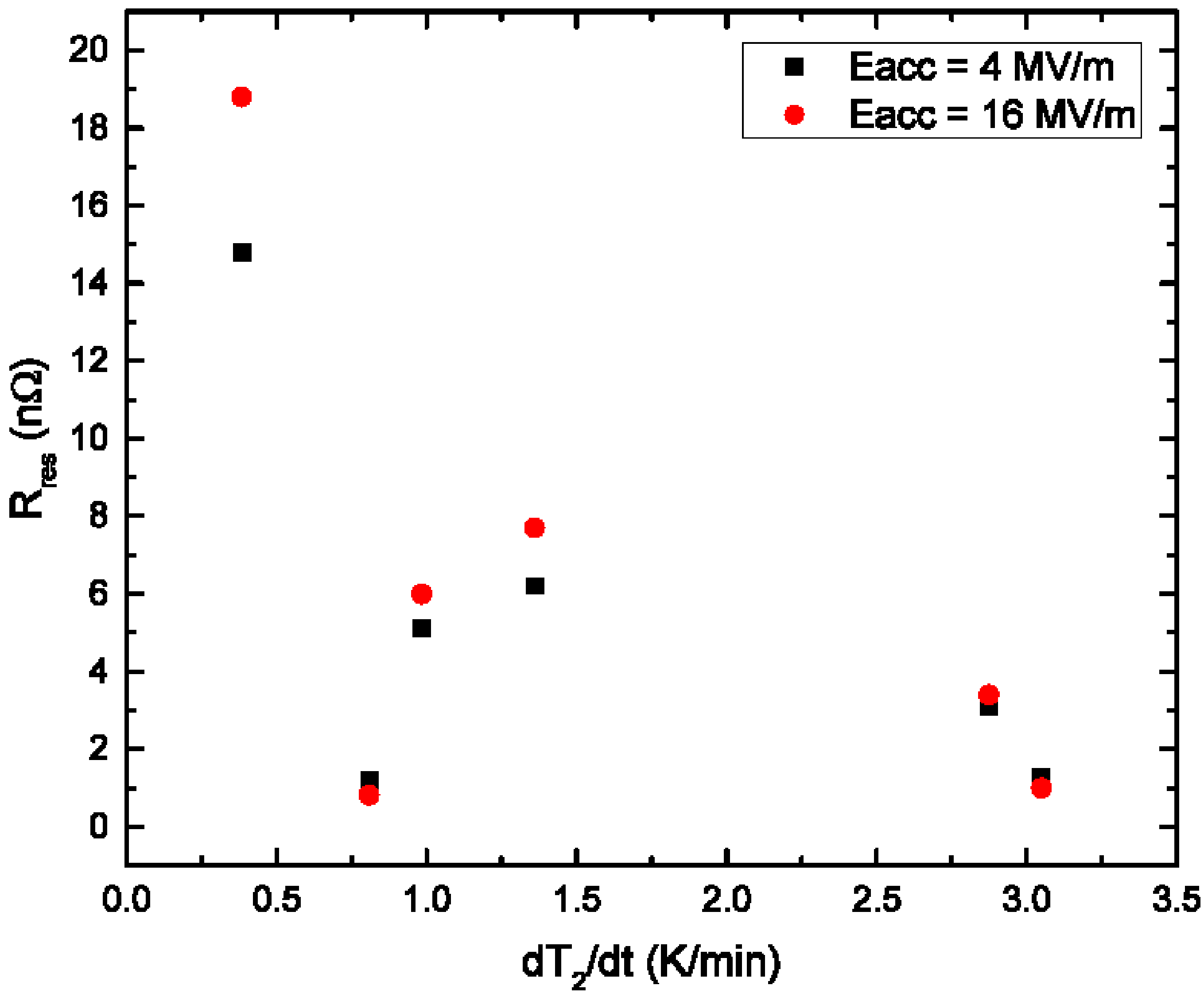
Flux expulsion as function of ΔT



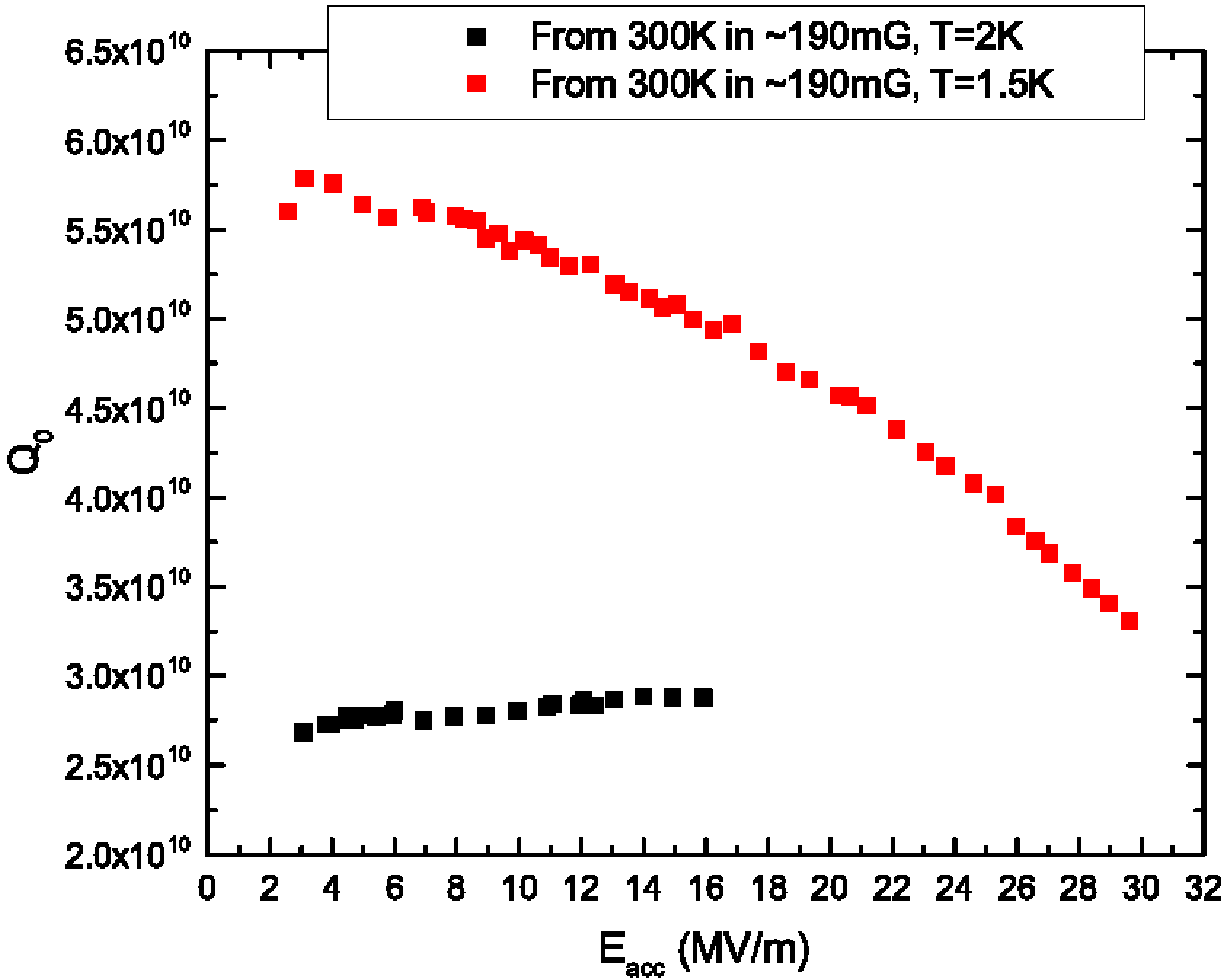


The lines are the exponents from the R_s vs ΔT plots.

No clear dependence on cooling rate



Record performance in 190 mGauss



Conclusions

- For the first time we demonstrate that by turning the cooling knob one can efficiently expel all flux. This was never even remotely thought of before.
- Temperature gradient appears to be the most important parameter. Cooling rate is just one of the nobs that produce temperature gradient.
- If efficient cooling could be achieved in CM, one can loosen shielding requirements significantly.