Measurements at HoBiCaT : Heating HOM loop couplers in CW mode

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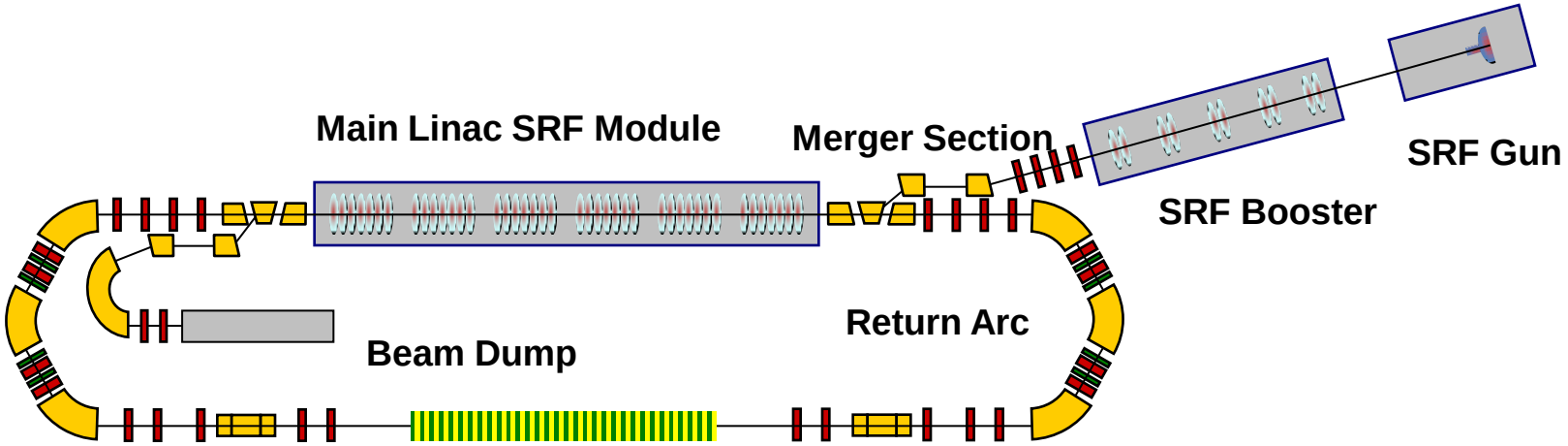
HZB Helmholtz Zentrum Berlin

B*ERL*inPro approved on 10/08/2010 !!



B*ERL*inPro, a 100 MeV ERL to demonstrate high currents and low emittance for future light source applications

Measurements on TESLA HOM loops in CW operation at HoBiCaT

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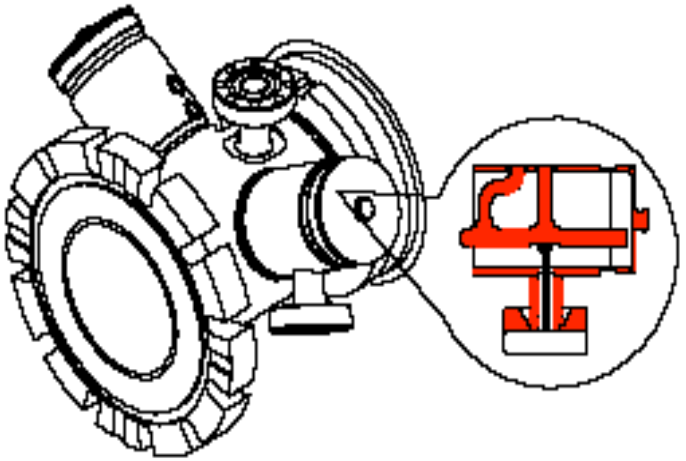
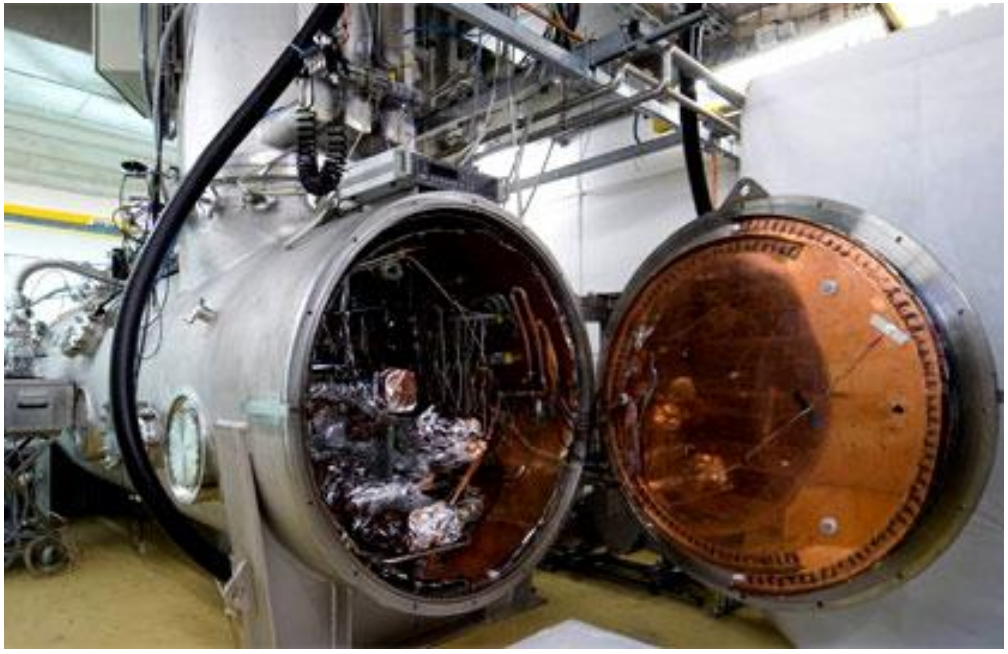


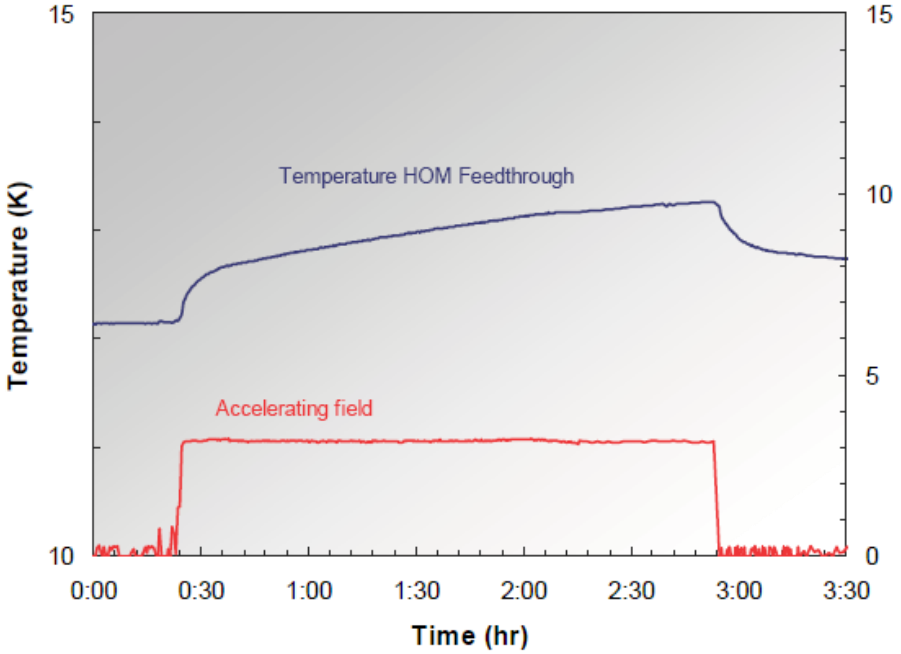
Horizontal tests at the the HoBiCaT testfacility operating TESLA cavities in CW mode

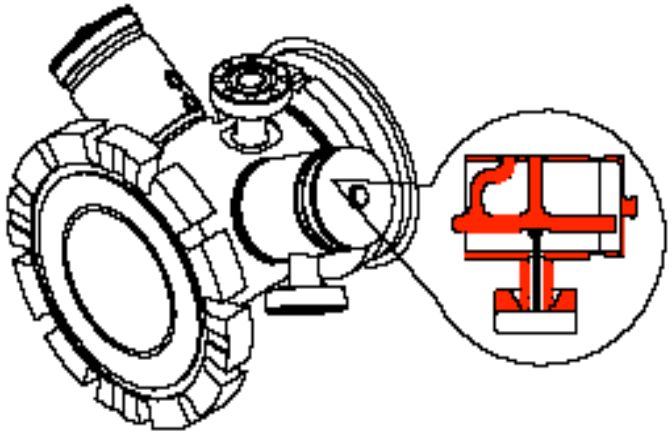


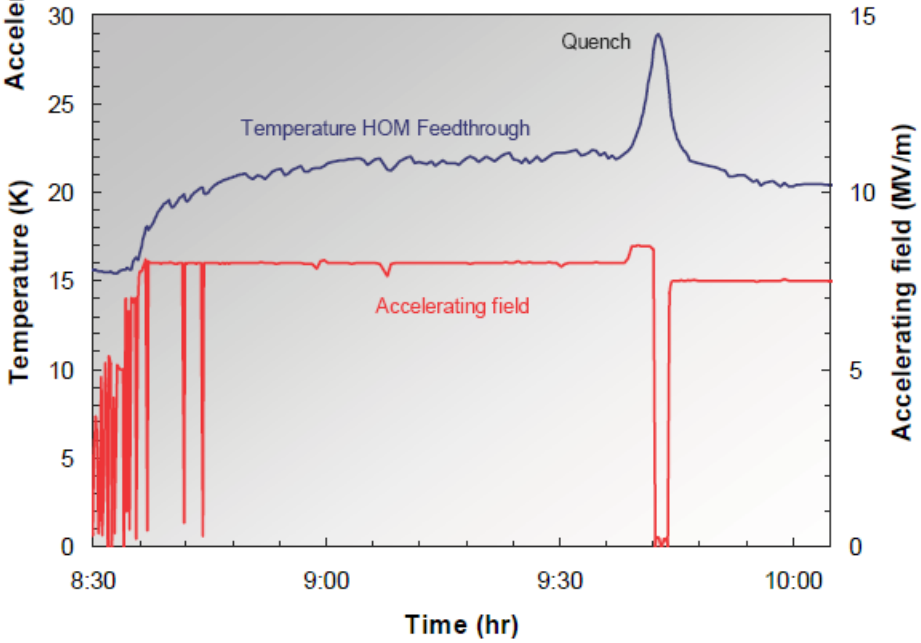
Test of thermal behavior of TESLA type HOM loop couplers

Heating HOM loop couplers in CW mode

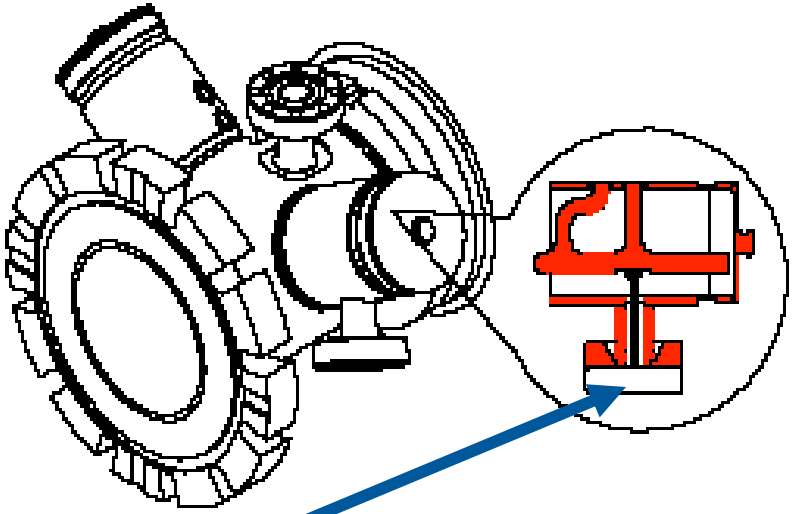
Heating at the HOM Pickup on CW mode







Heating at the HOM Pickup



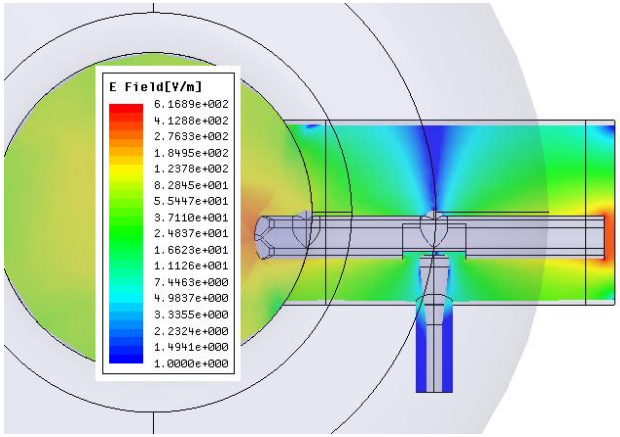
HOM pickups have been problematic for CW

- Pick-up „sees“ a small part of the accelerating field

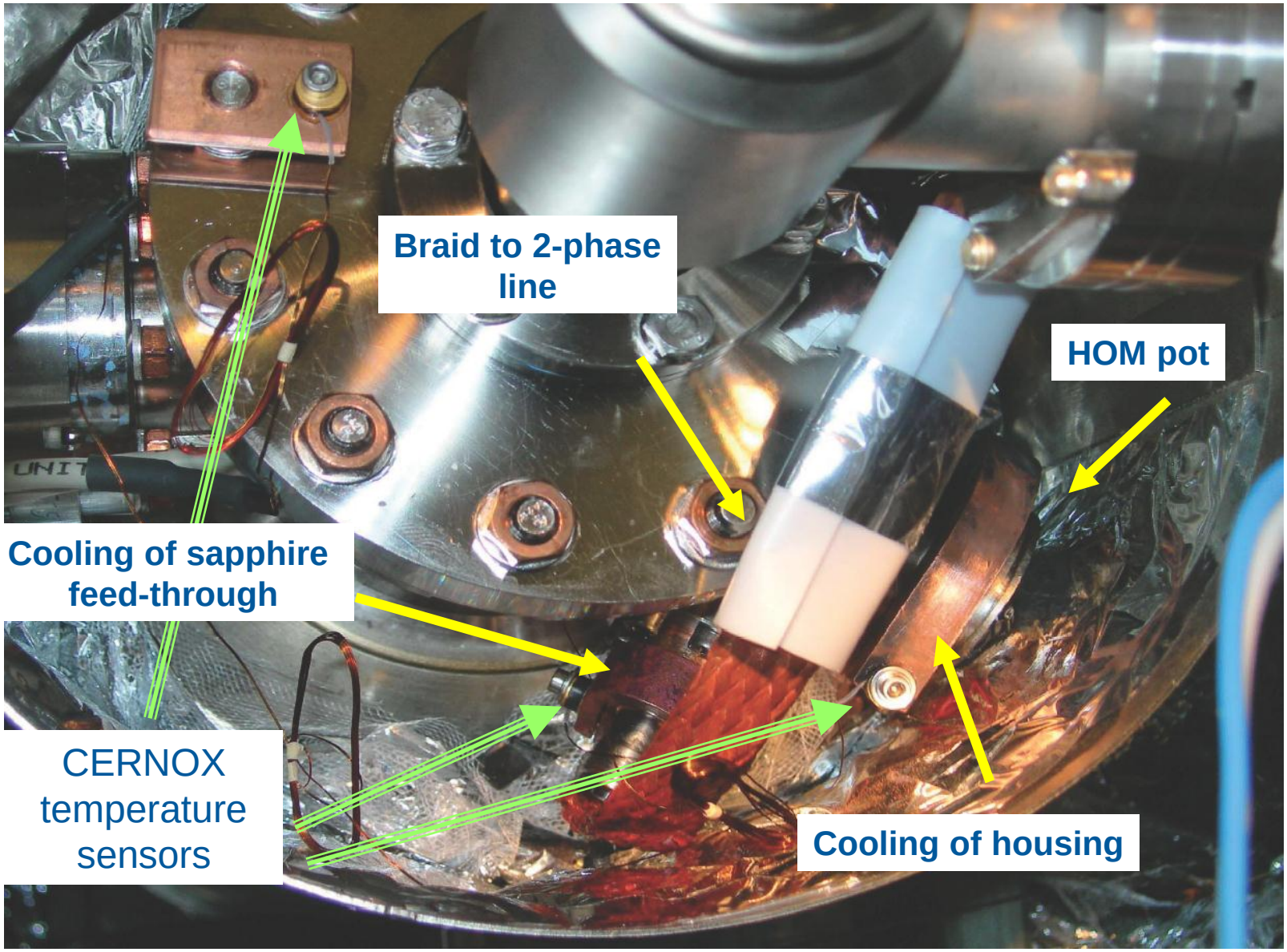
→The tip heats up a little (<< 1 W)

- But: The tip is cooled only via the ceramic of the feed-through

→A thermal bottleneck may cause thermal runaway



Mesurement setup



Improved HOM pickups

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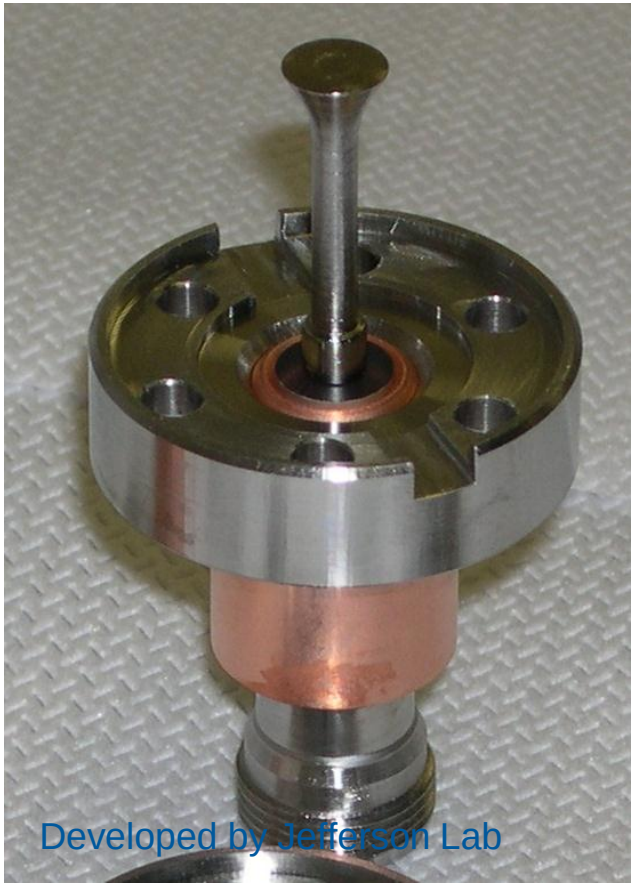
Improved cooling through

- Sapphire feed-throughs to cool the inner conductor
- Good thermal anchoring to 1.8 K (2-phase line)



Tests in collaboration with DESY and JLAB

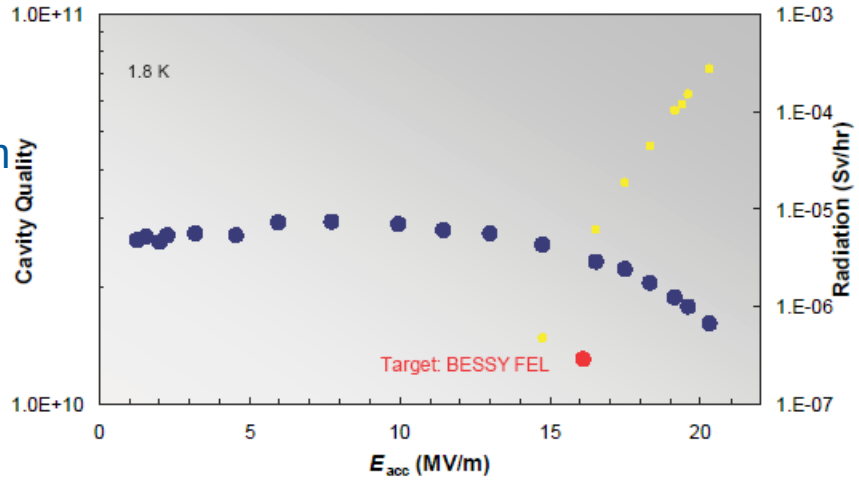
CW Measurements with DESY S33

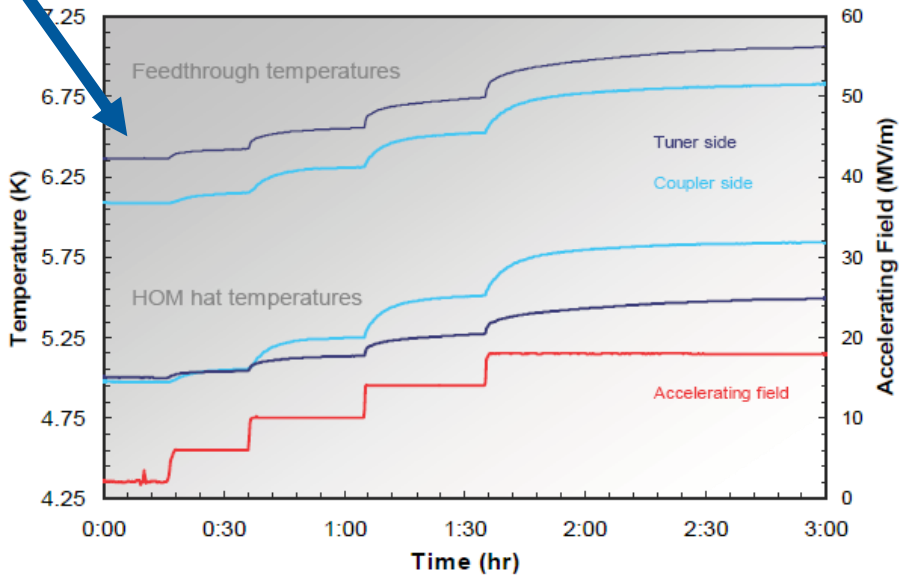
Measurement of Q v. E, DESY S33

- 20 MV/m reached
- Limited by quench caused by liquid helium instability (boiling, chimney to 2phase line to small)
- HOM pick-ups did not quench
- However, it still takes roughly an hour or more to reach thermal equilibrium
- Relatively high „zero field“ temperature

Question:

- Effect of pick-up cables (RG223 ca. 3 meters long)
- Do we need the thermal anchor?

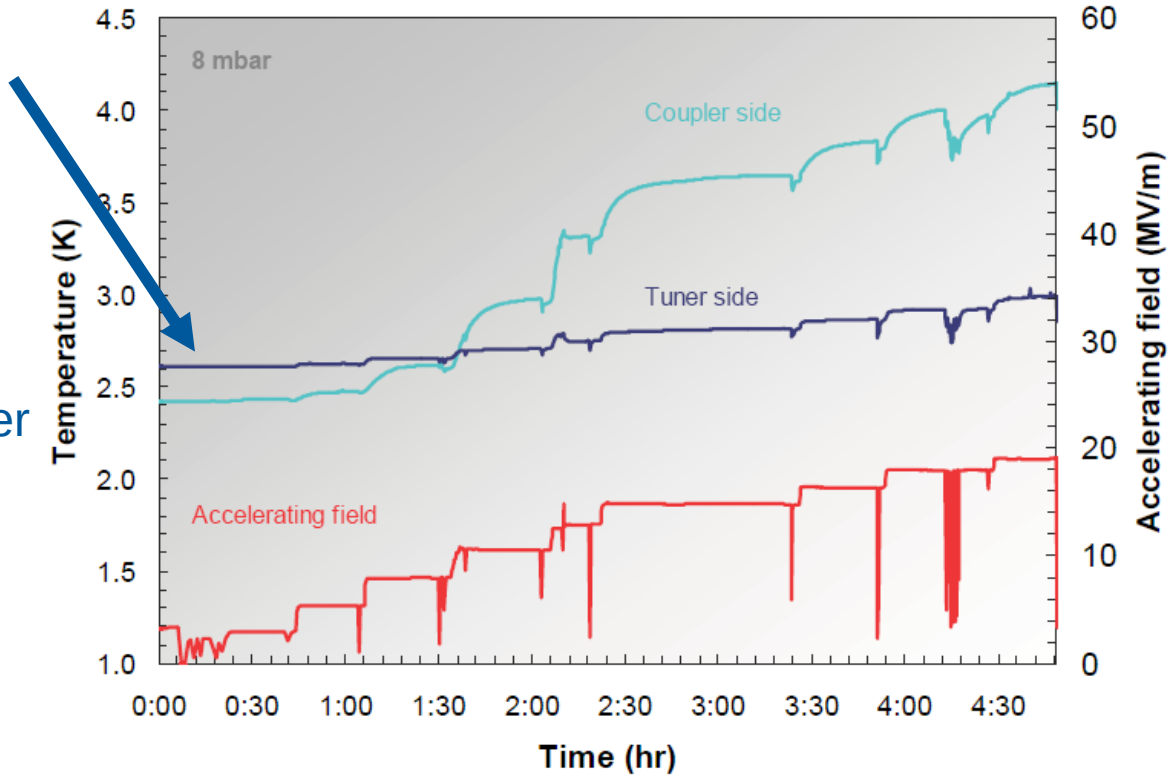




Effect of the HOM Pickup cables

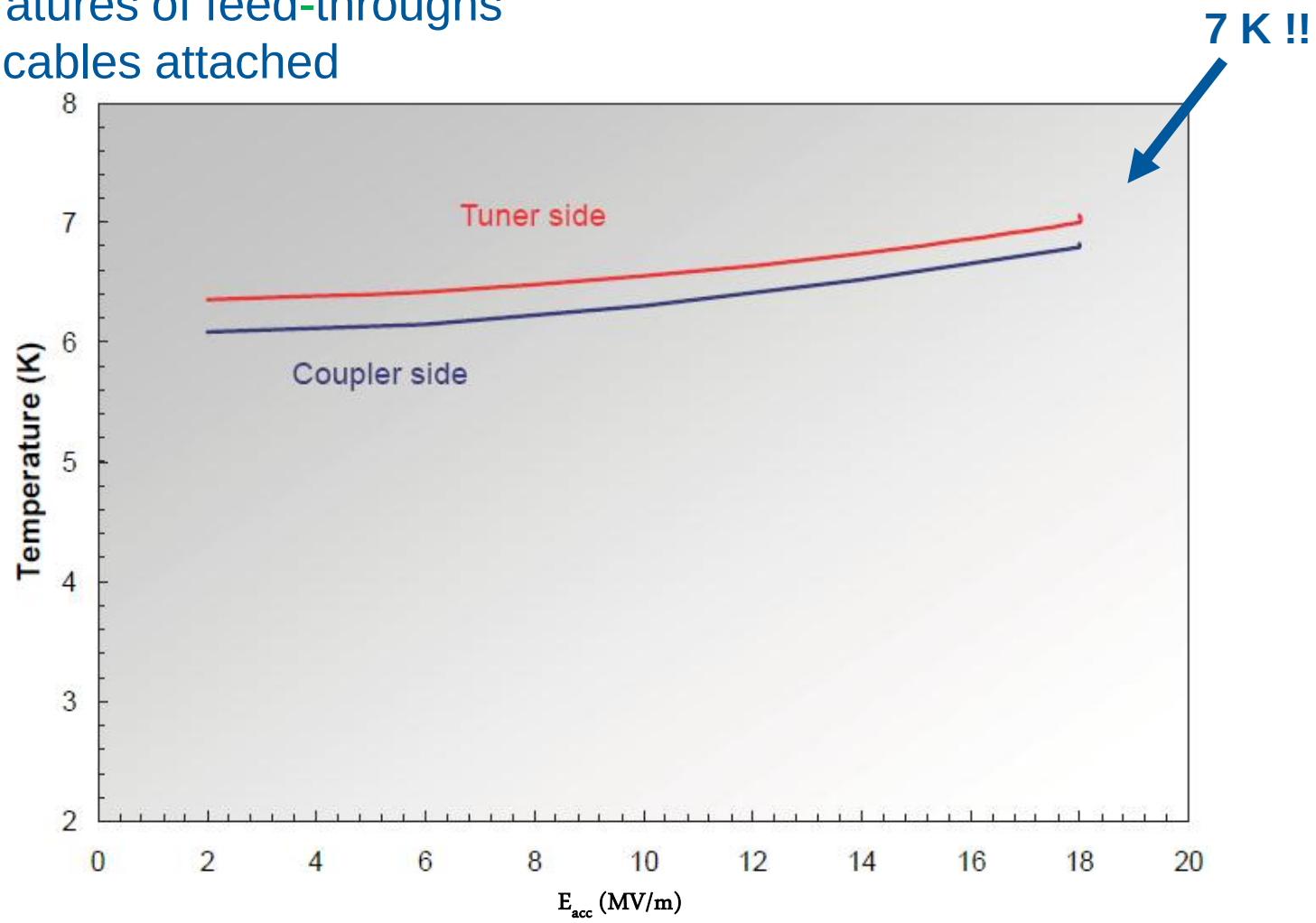
Disconnected HOM Pick-up cables

- Zero-field temperatures drop significantly (nearly 4 K)
- Temperature rise on tuner side negligible & time constant short
- Higher time constant and temperature rise on coupler side.



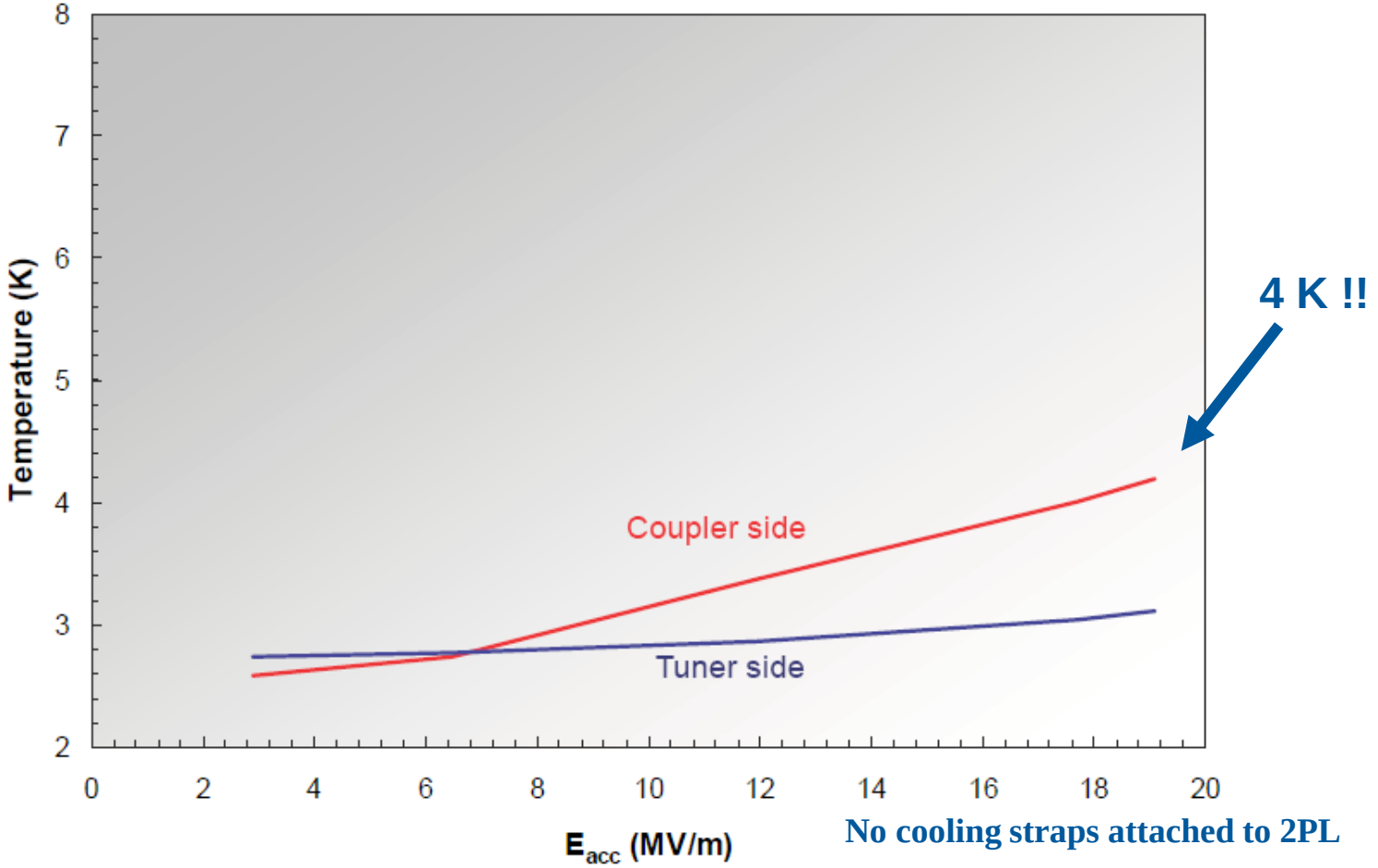
Effect of cables

Temperatures of feed-throughs
Pickup cables attached



Effect of cables

Temperatures of feed-throughs
Pick-up cables disconnected



Effect of the cooling straps

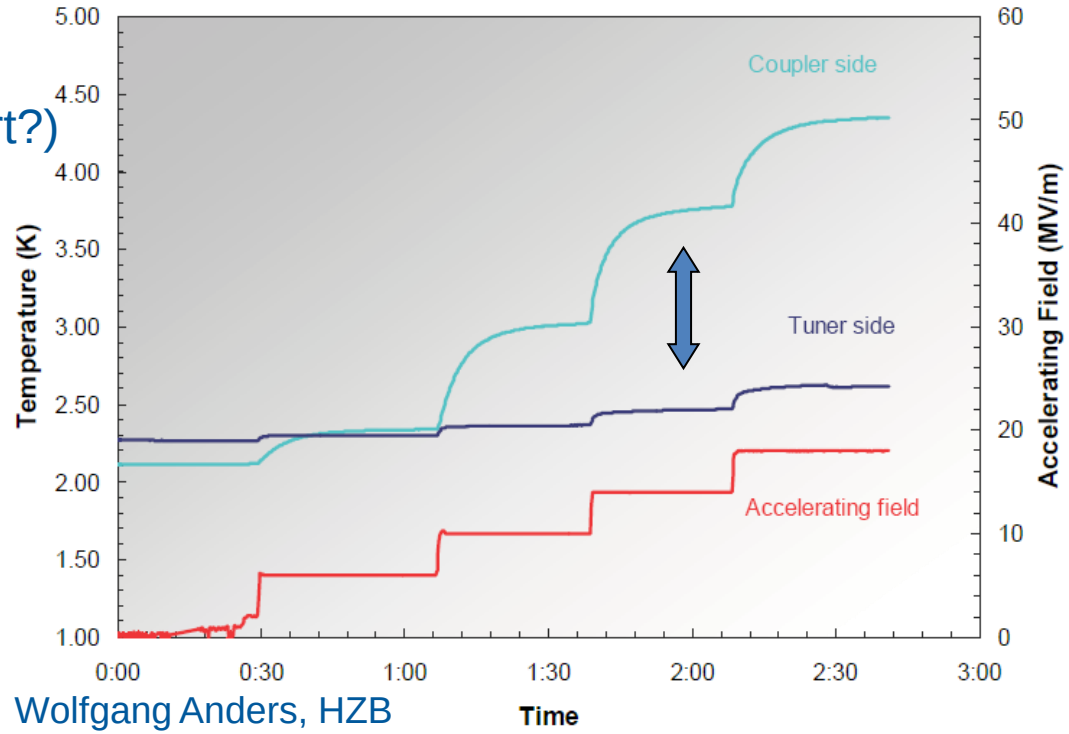
Cut connection to 2-phase line of the cooling straps to feed-through (no pick-up cables attached)

- Still cooling to HOM „pot“
- Behavior essentially unchanged

→ External cooling not required

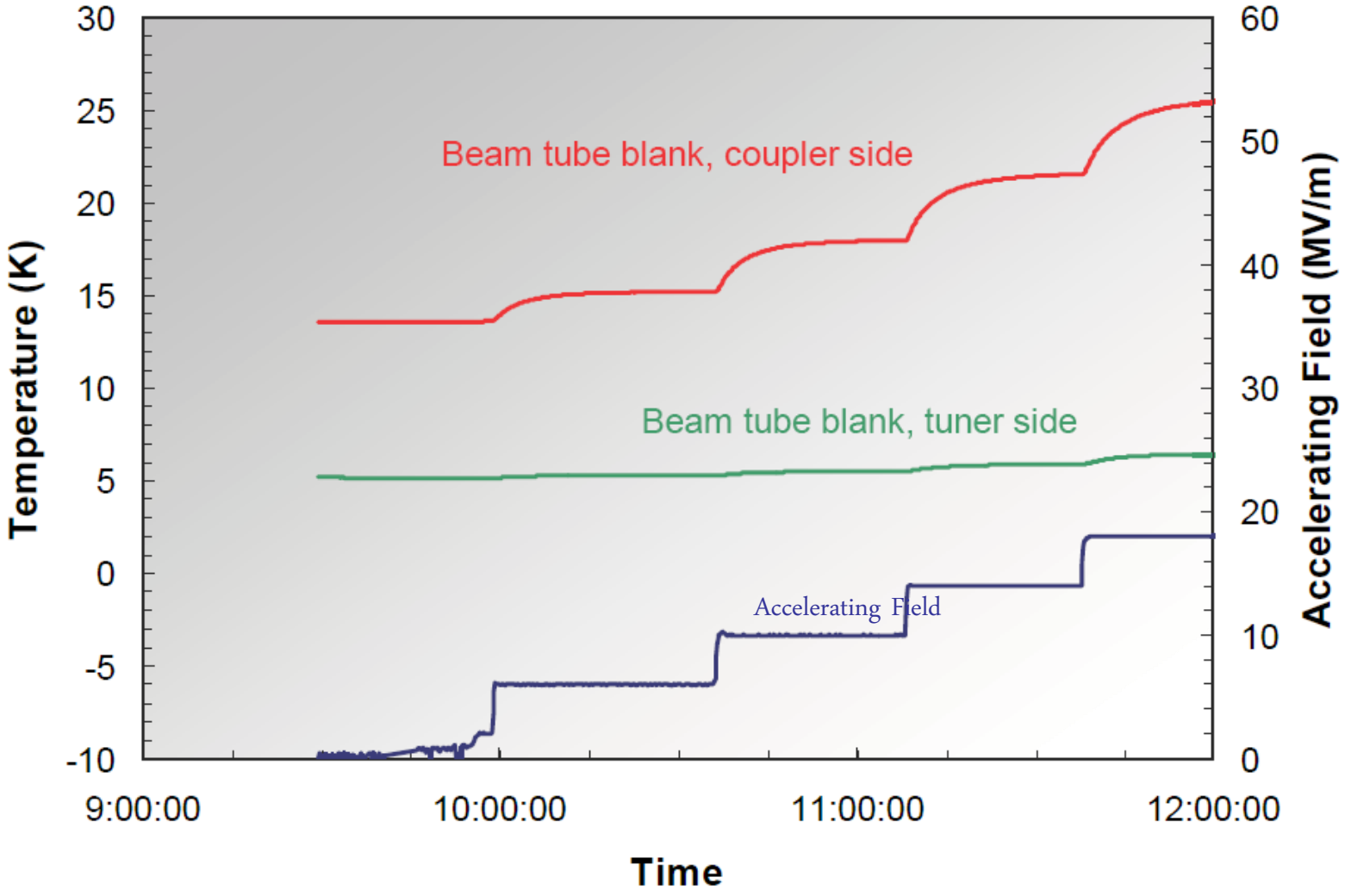
- However, should repeat without any straps altogether

- What causes heating on the coupler side? (vacuum pump port?)



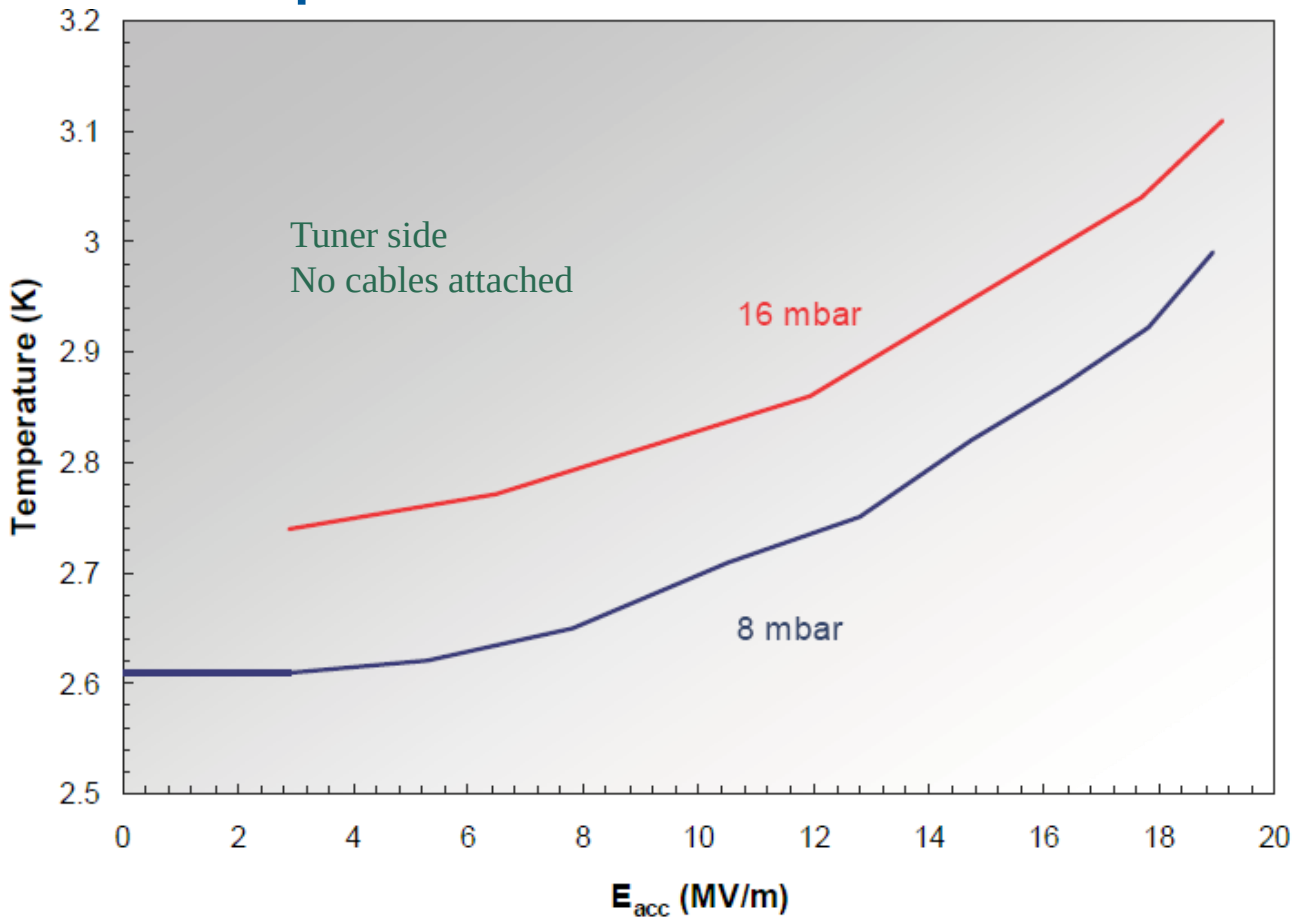
Asymmetry due to heat from pumping line?

Temperatures beam tubes

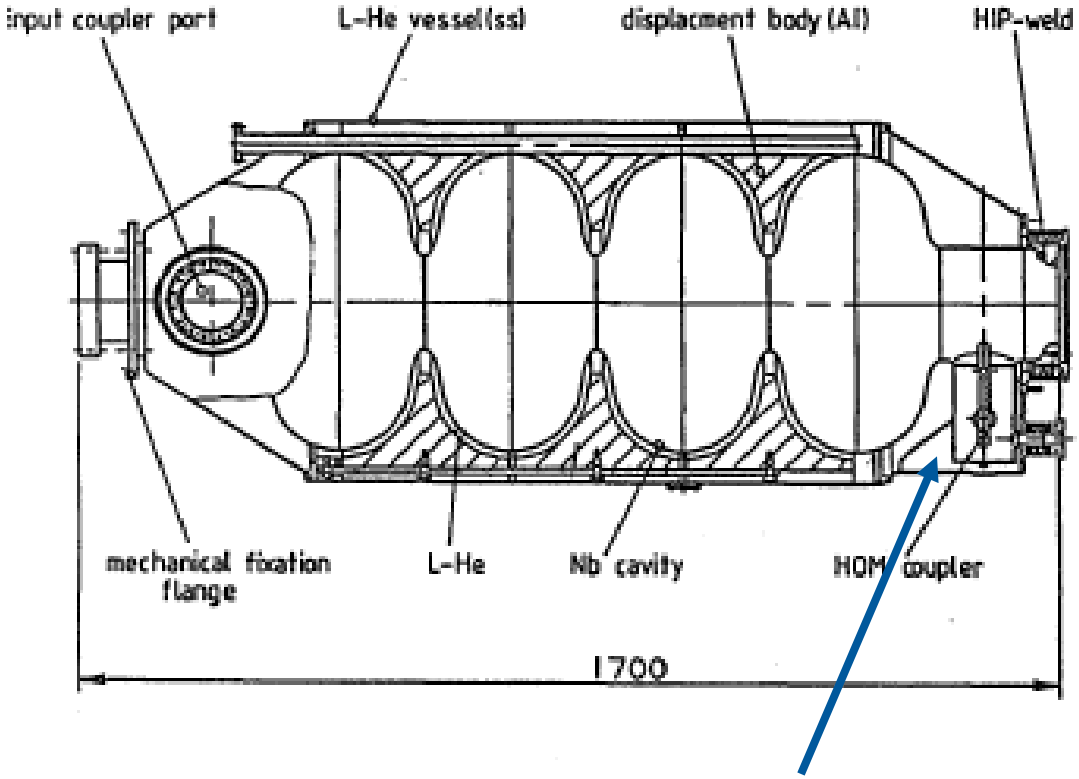


Effect of bath temperature

No difference in performance observed between 16 and 8 mbar



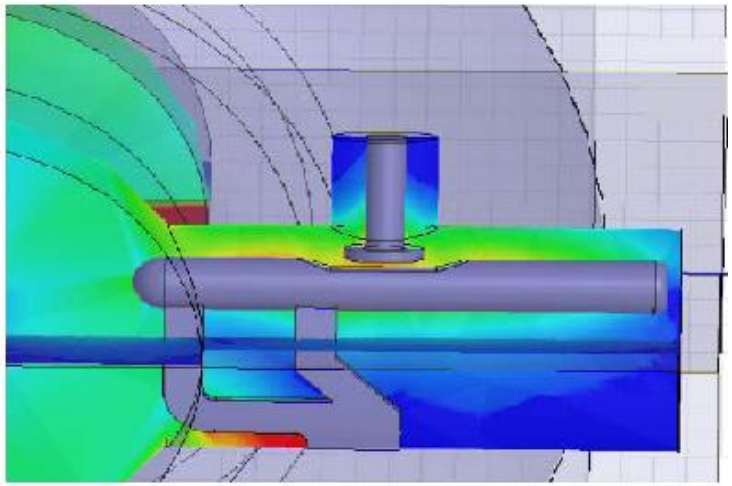
HOM cooling in the distant past….



HERA cavity (SRF1987), HOM coupler LHe cooled …

Loop coupler with double filter

TESLA HOM

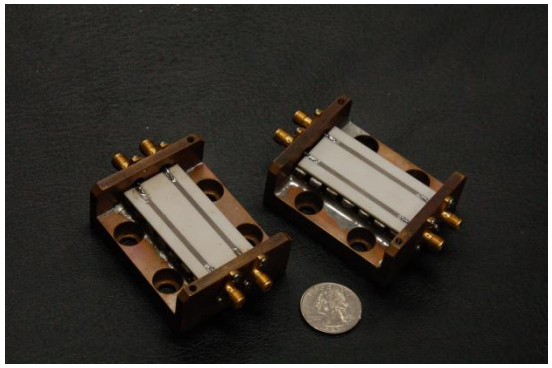


KEK HOM

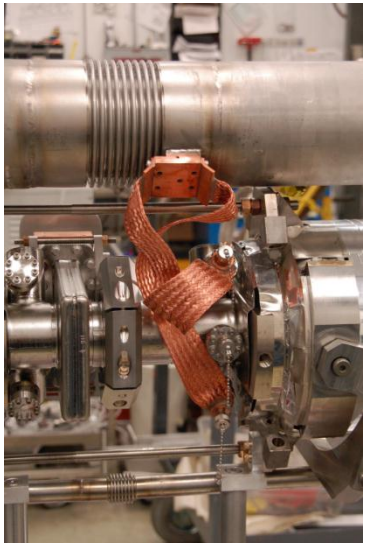
with double filter

Conclusions

- **Saphire feed-throughs are essential for CW mode**
- **Bath temperature plays no role**
- **Cooling by straps to 2PL is not required (up to 20 MV/m CW). Remains to be investigated if cooling can be removed altogether.**
- **Pick-up cables are a significant source of heat! These need a thermal anchor and/or low conductivity cables must be employed**
- **20 MV/m (and higher) CW operation should be easily realisable with saphire feed-throughs!**



Courtesy C. Reece, JLAB



Thermal anchoring of cables, CEBAF