SPS EXTRACTION KICKER MAGNET – THERMAL ANALYSIS

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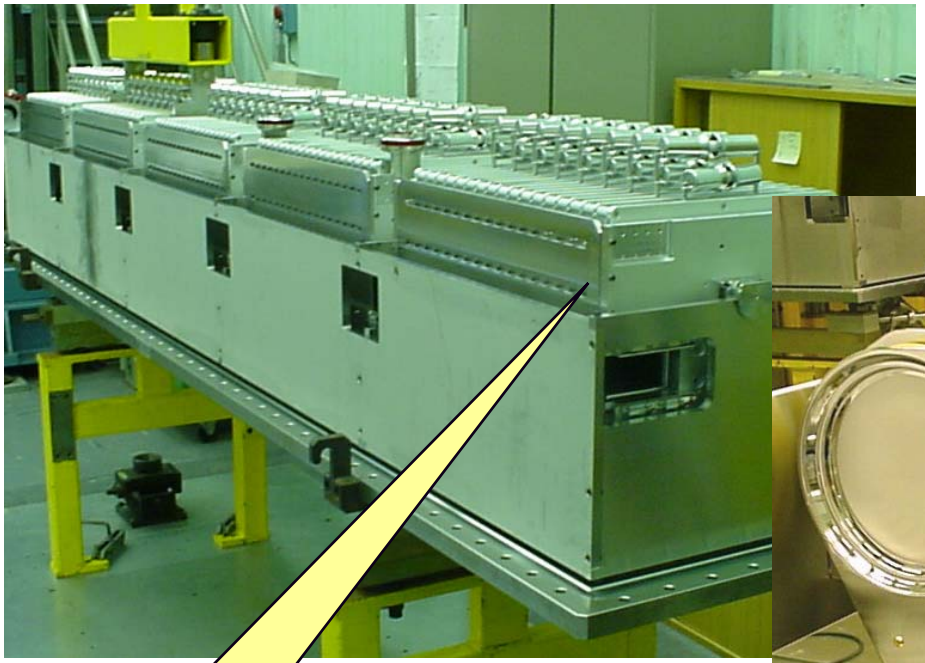
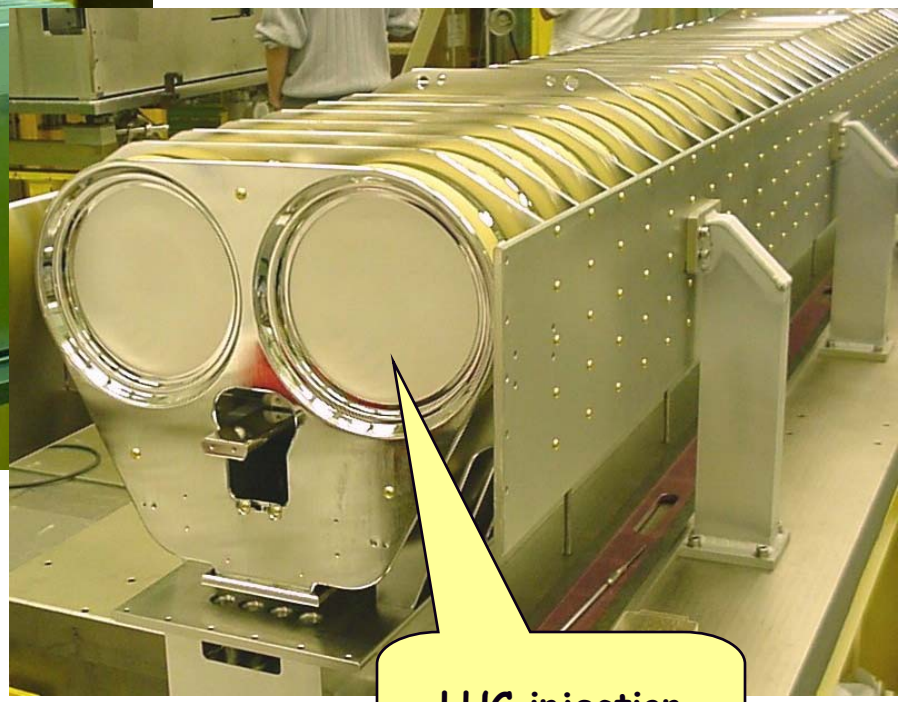
Presentation content

1. What are kicker magnets ?
2. MKE extraction kicker magnet
3. Why do the magnets heat up? and why do they need to be cooled?
4. MKE design and thermal analysis
5. Machine data
6. Conclusions

Kicker magnets

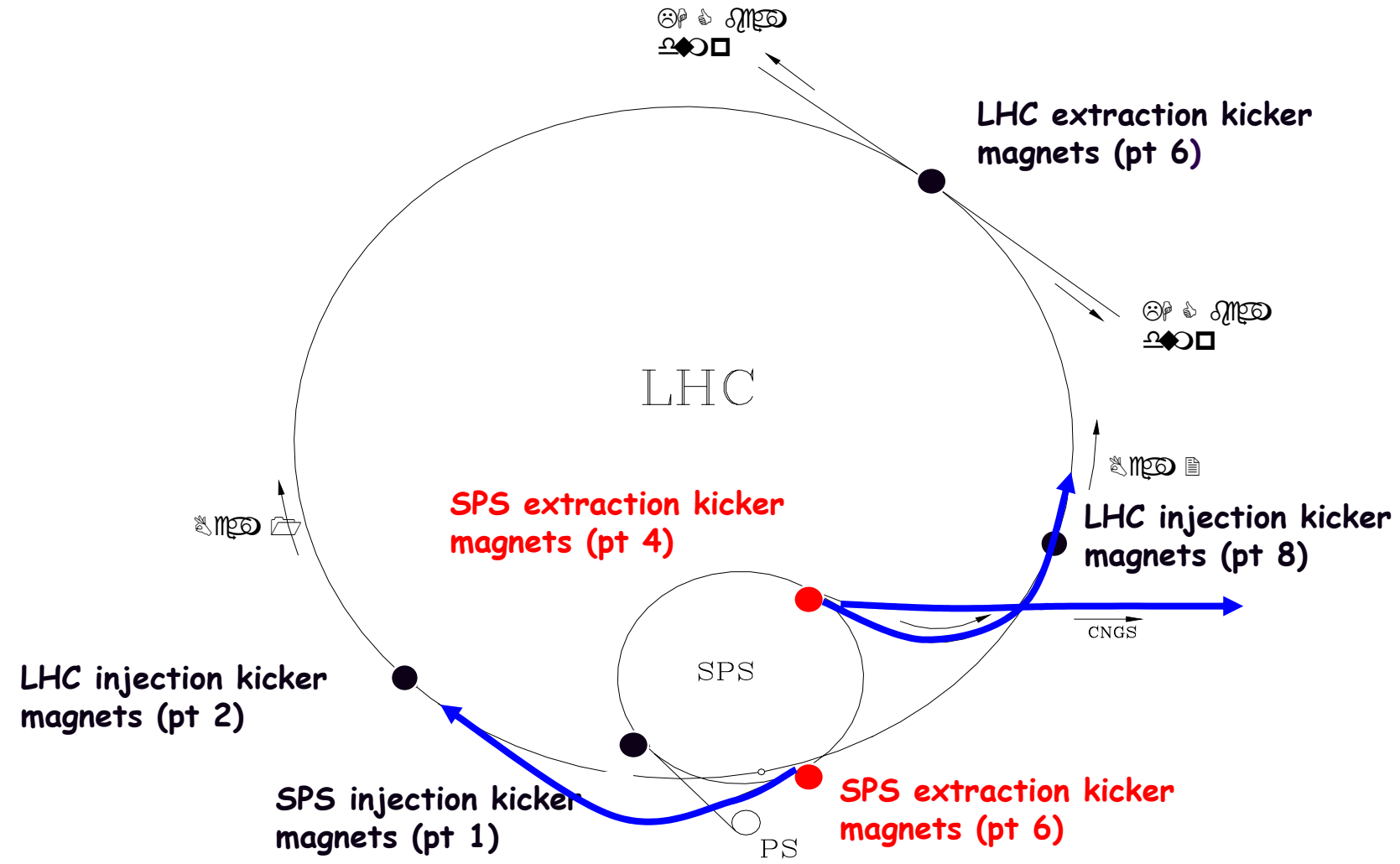


SPS injection kicker magnet

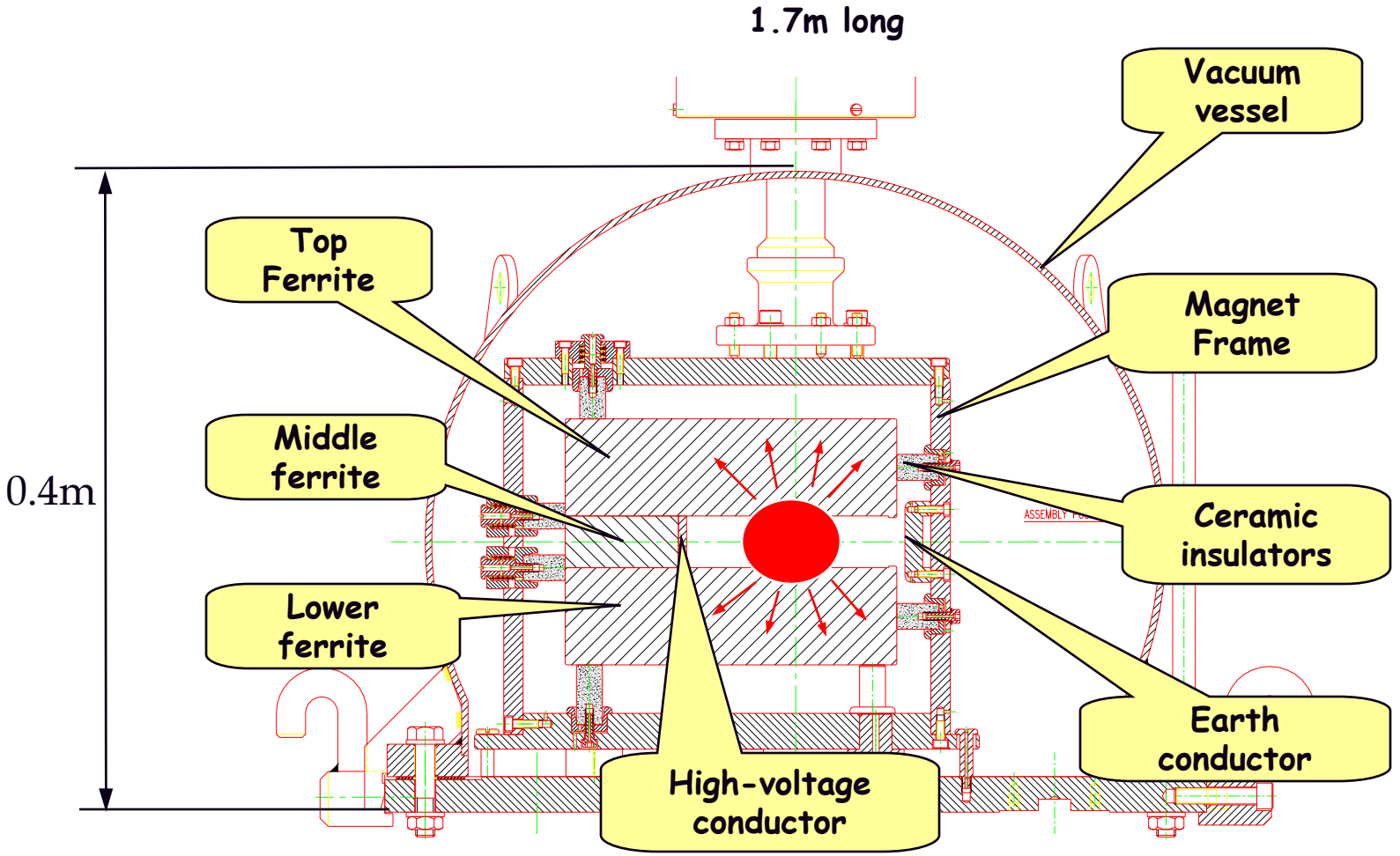


LHC injection kicker magnet

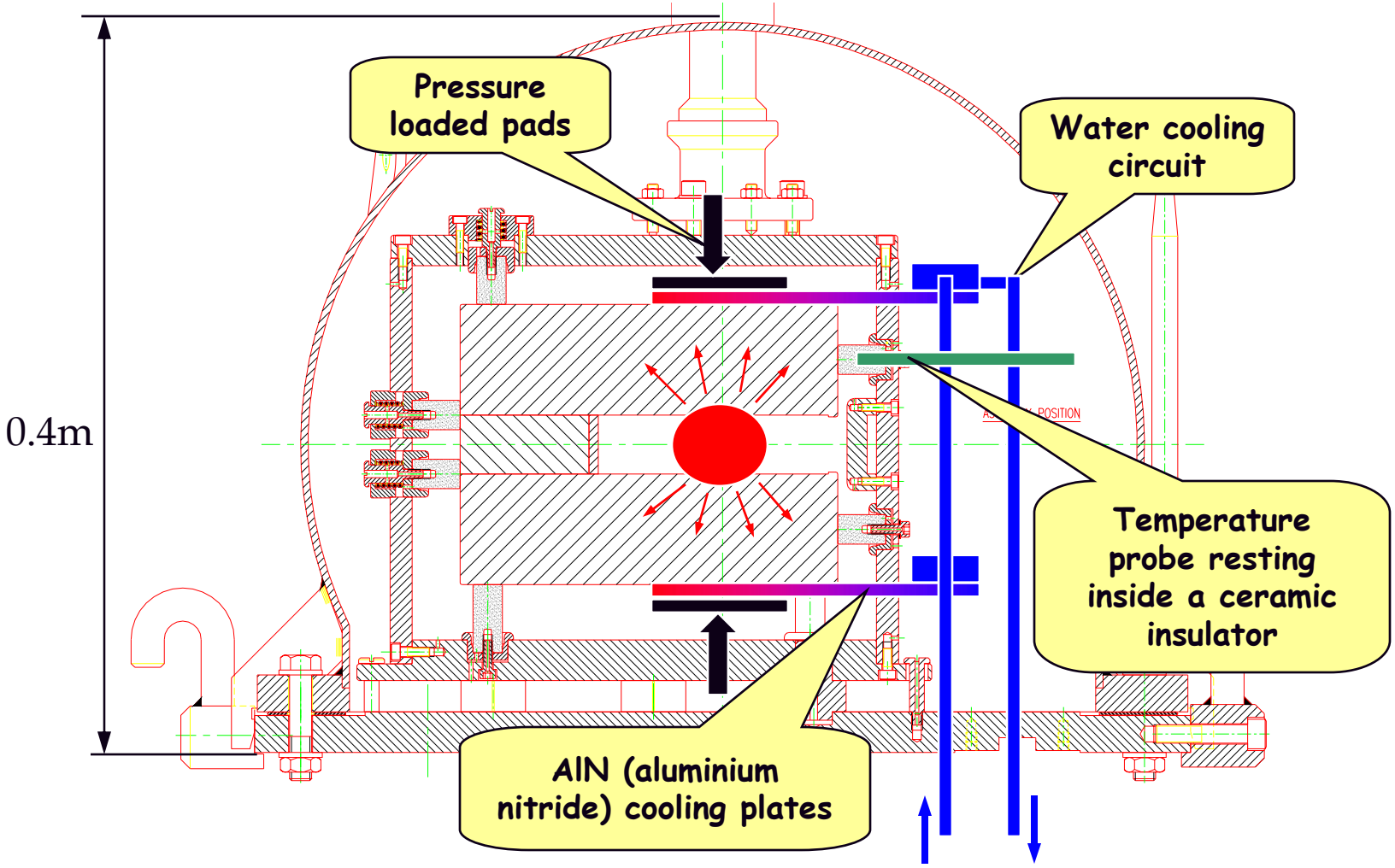
Where are kicker magnets



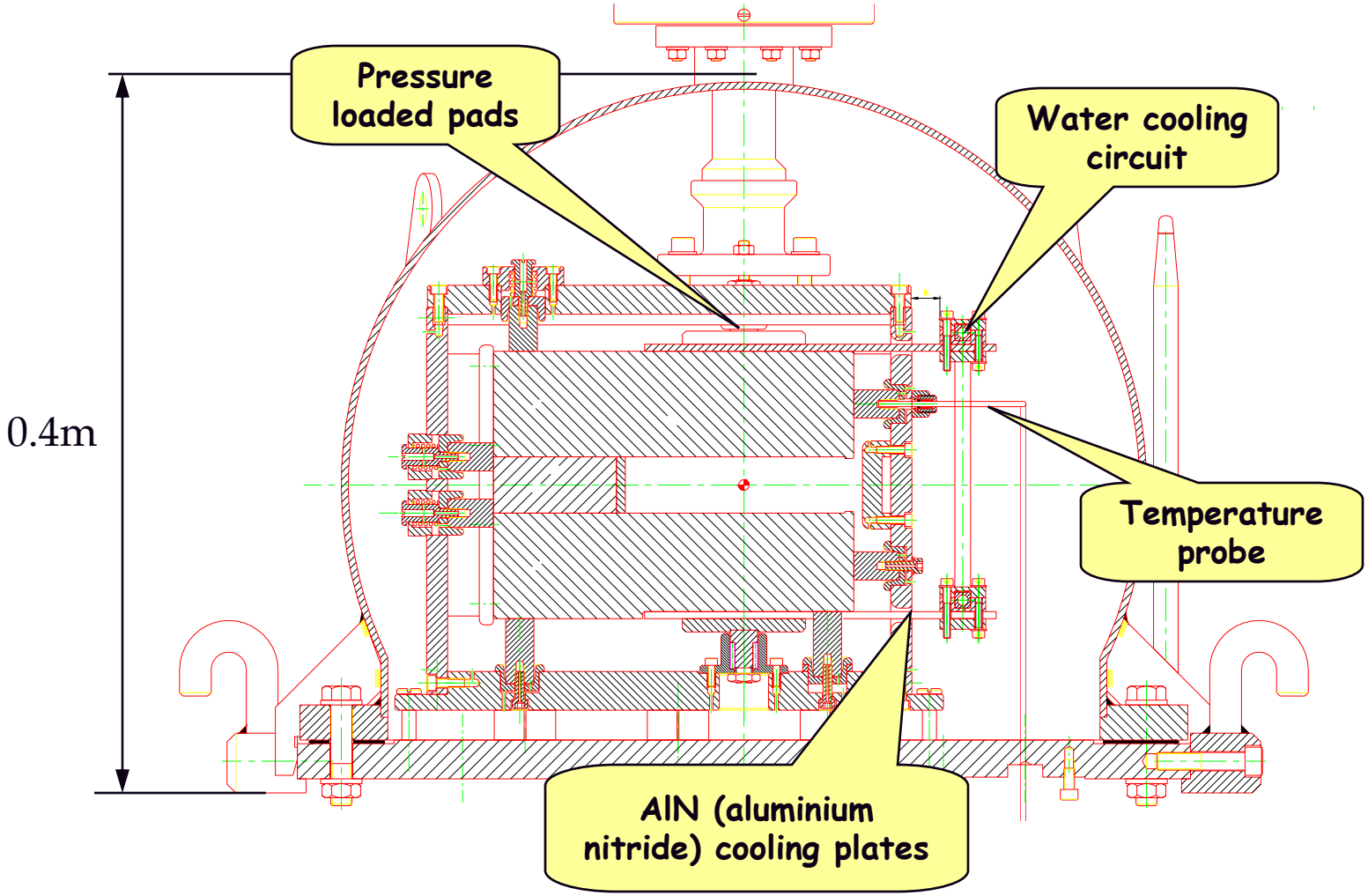
Original magnet design



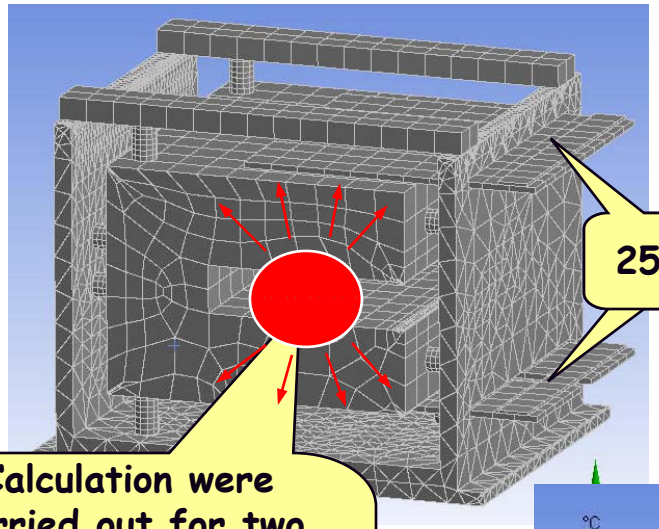
Cooling design principal



Cooling design



FEA model using Design-Space

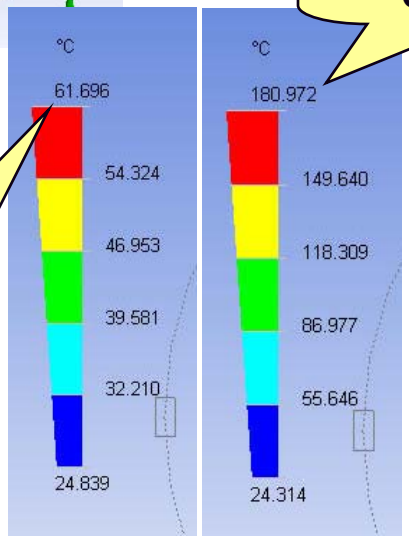


Model definition

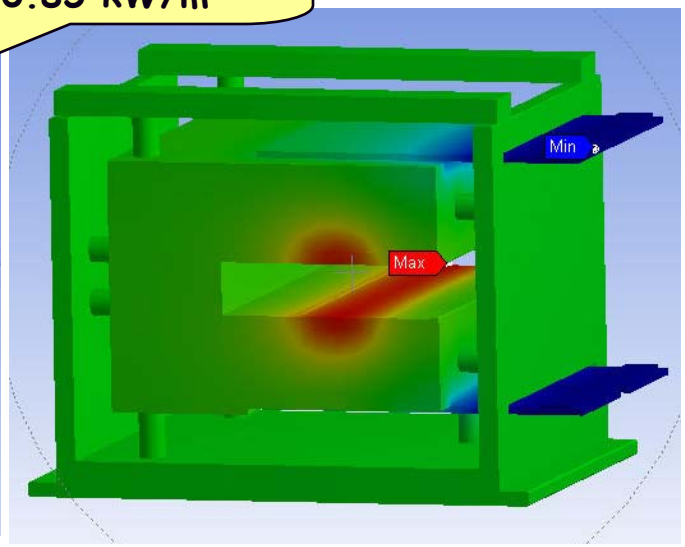
- magnet length: 0.23m (1/7th of the real length)
- Surface contacts are considered perfect
- Only conduction is used for heat transport.
- Calculations are steady state

Calculation were carried out for two different power values:

1 – 0.2 kW/m
2 – 0.85 kW/m



~ 180°C for 0.85 kW/m

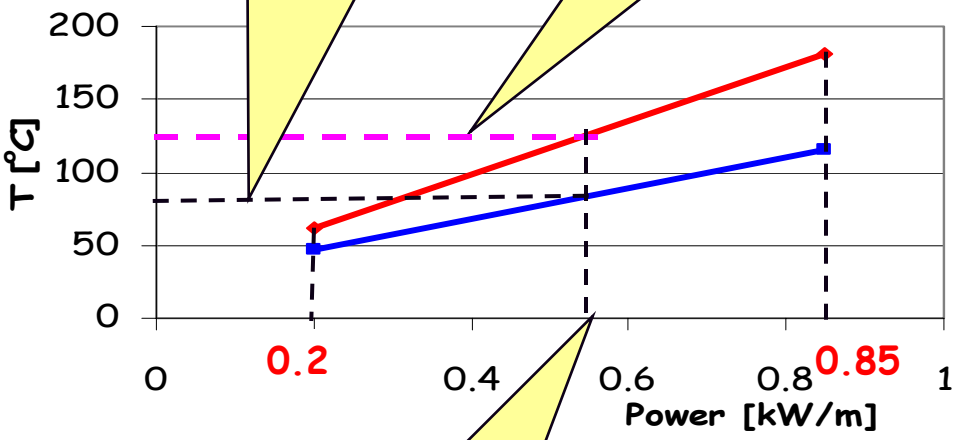


Highest temperature is ~ 61°C for 0.2 kW/m

FEA results and analysis

85°C around the Temperature probe area

125°C Ferrite Curie temperature

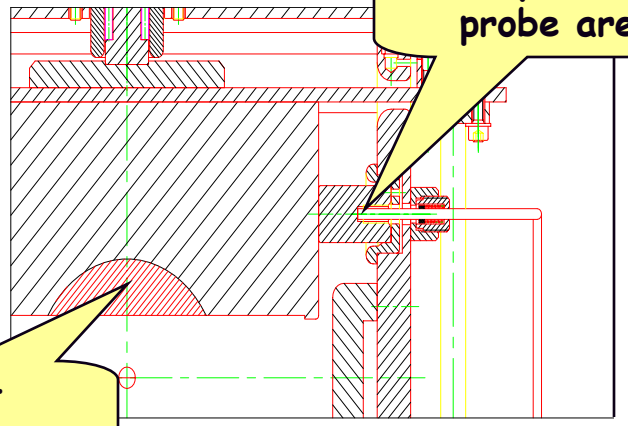


Highest temperature

Temperature probe area

Curves are given for the two power input values: 0.2kW/m and 0.85kW/m and assuming a linear relation between power and temperatures.

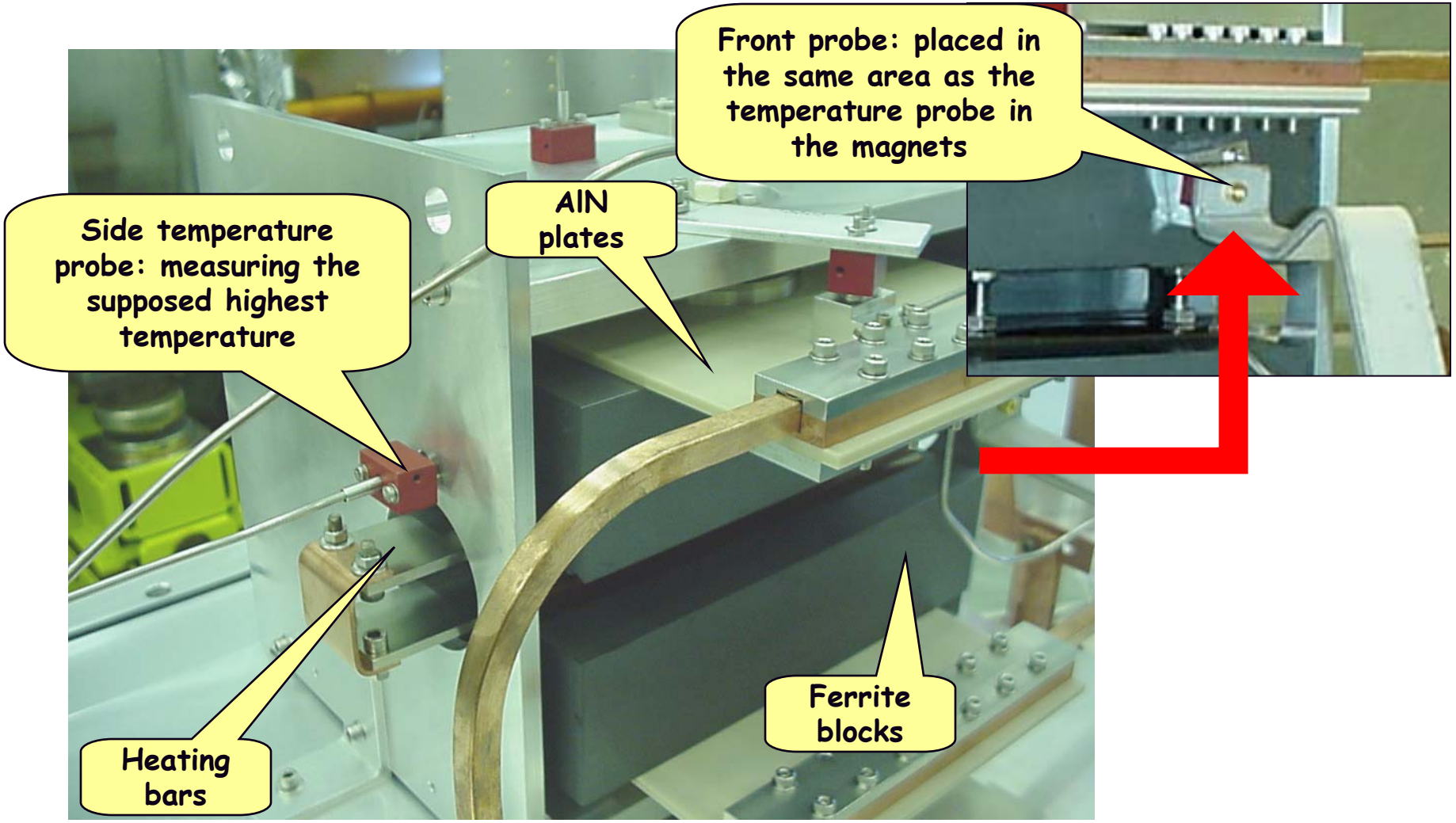
0.55kW/m
power for which the Curie temperature would be reached



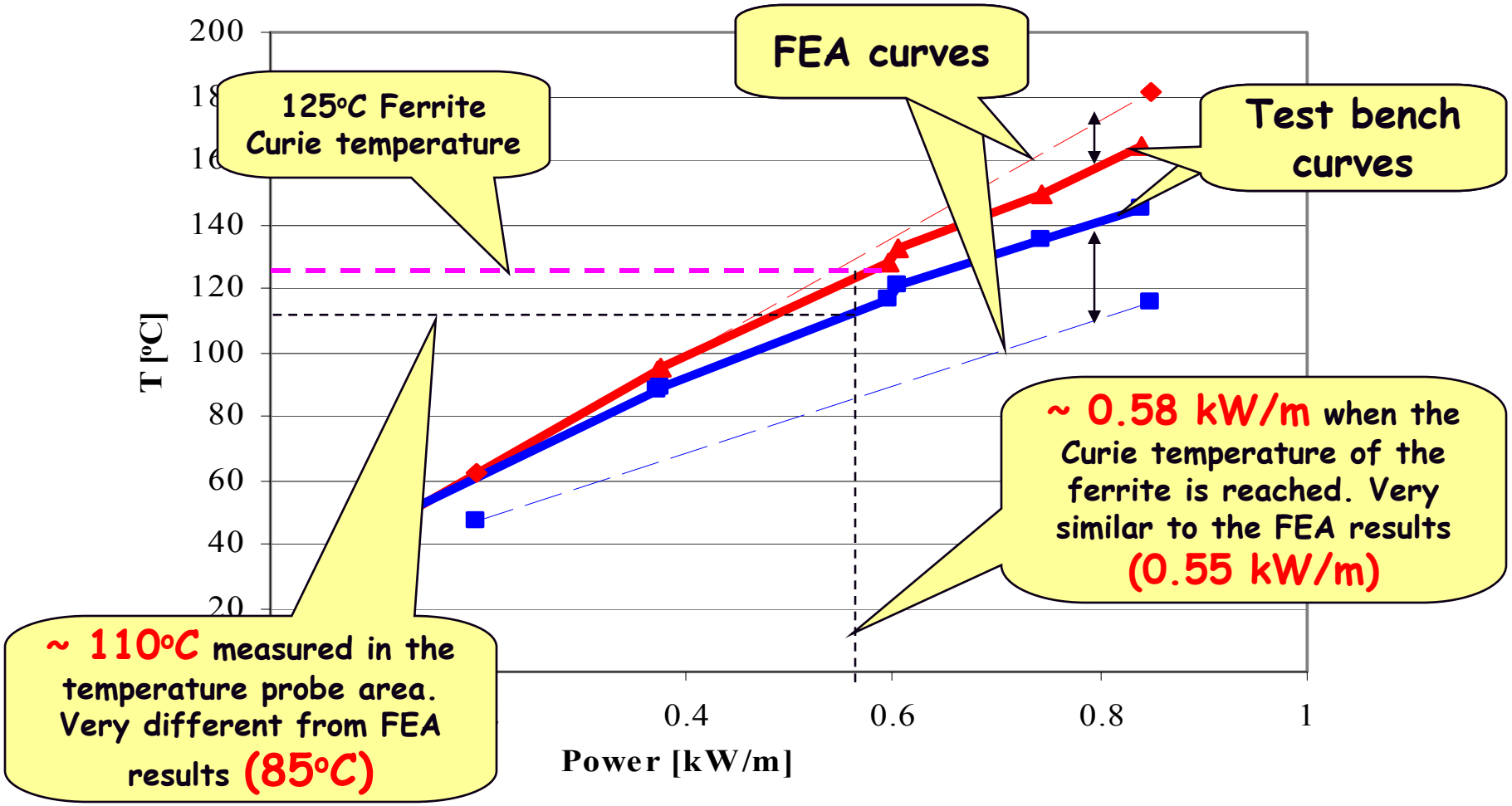
Temperature probe area

Highest temperature

Thermal analysis "test bench"

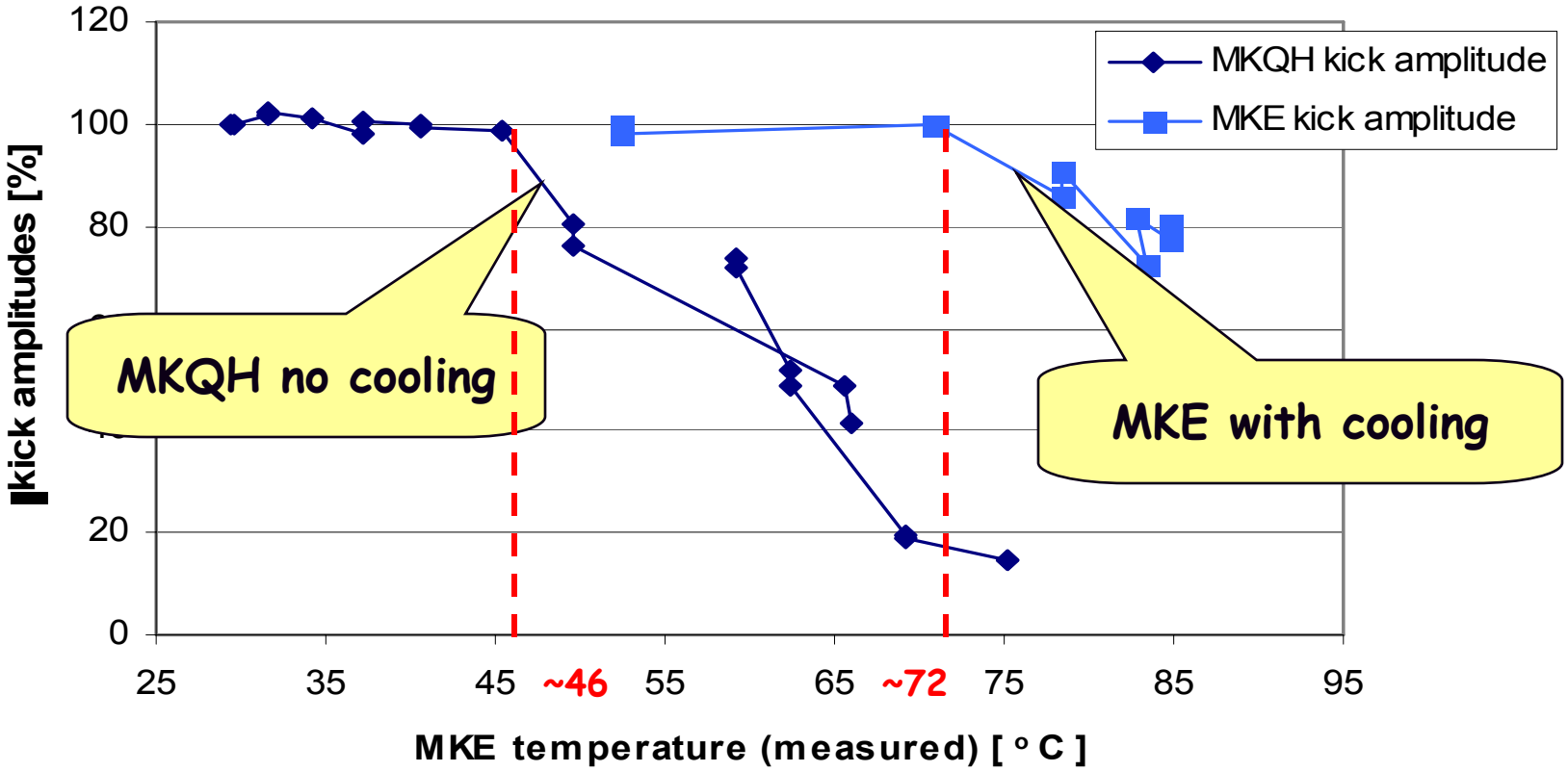


FEA / "test bench" comparison



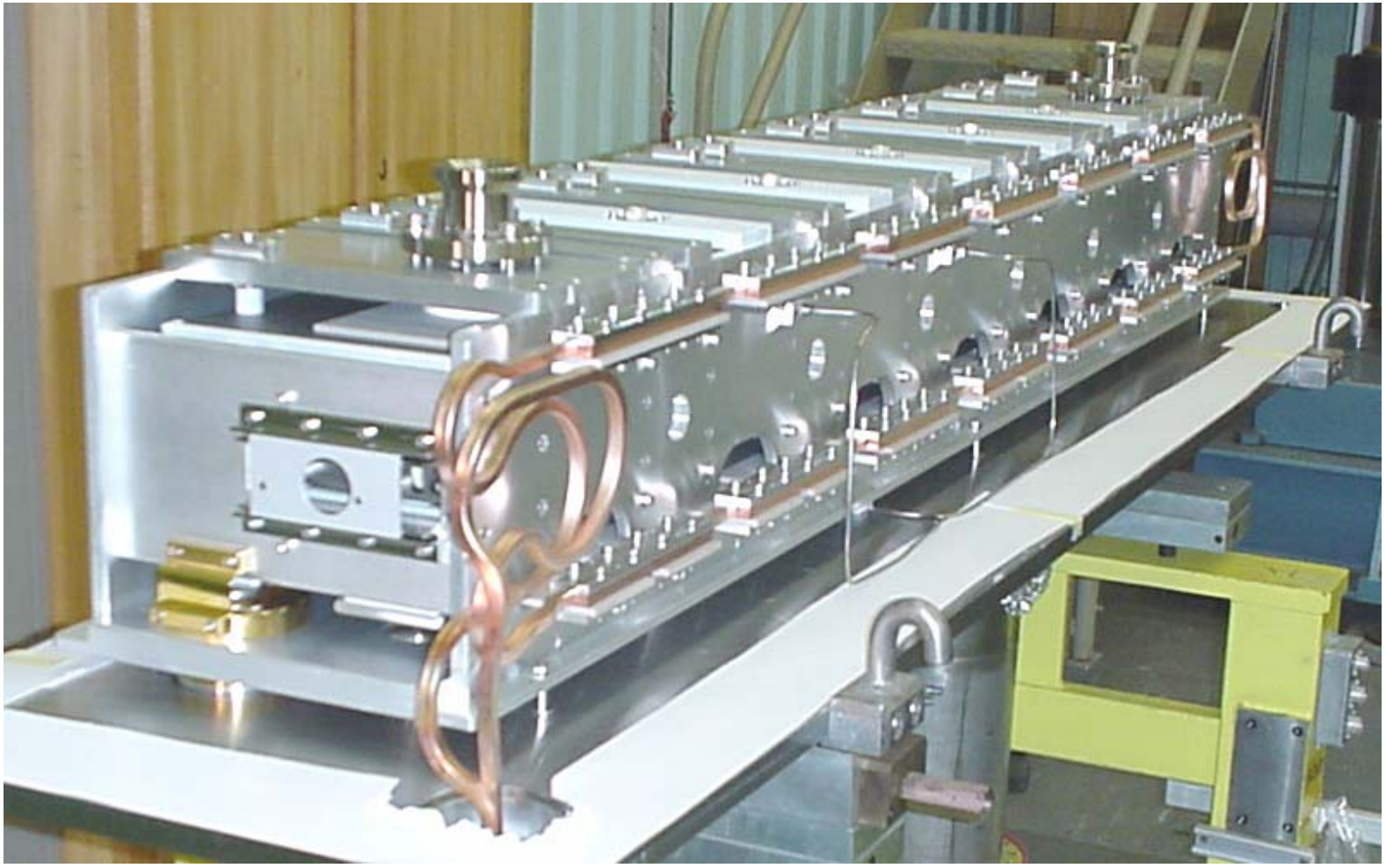
SPS machine measurements

The MKQH magnet is a shorter version of the MKE magnet, it has NO cooling system implemented and NO temperature probe.



With the cooling , the magnets will function with a power increased by a factor of 2 according to what it was in the past.

Cooled MKE magnet



Conclusions

- The FEA calculations and the measurements made on the test bench agree within 5% for the highest temperature.
- Resulting from our thermal analysis, the Cooling design would limit the beam power to 0.55kW/m and this is considered sufficient to extract the beams towards the LHC and the CNGS target.

  The magnets were built with the presented cooling design and were installed in the SPS in the beginning of 2003.
- Machine data agrees with FEA calculations
- Nevertheless, the differences in temperature between the lab test bench and the FEA calculations, around the temperature probe area, are still unexplained today. And would require further analysis.

I would like to thank:

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