HELMHOLTZ ZENTRUM BERLIN
für Materialien und Energie

Experience With A Single, Non-Linear Injection Kicker Magnet

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ESLS XVIII, Elettra, 25 November 2010

Outline

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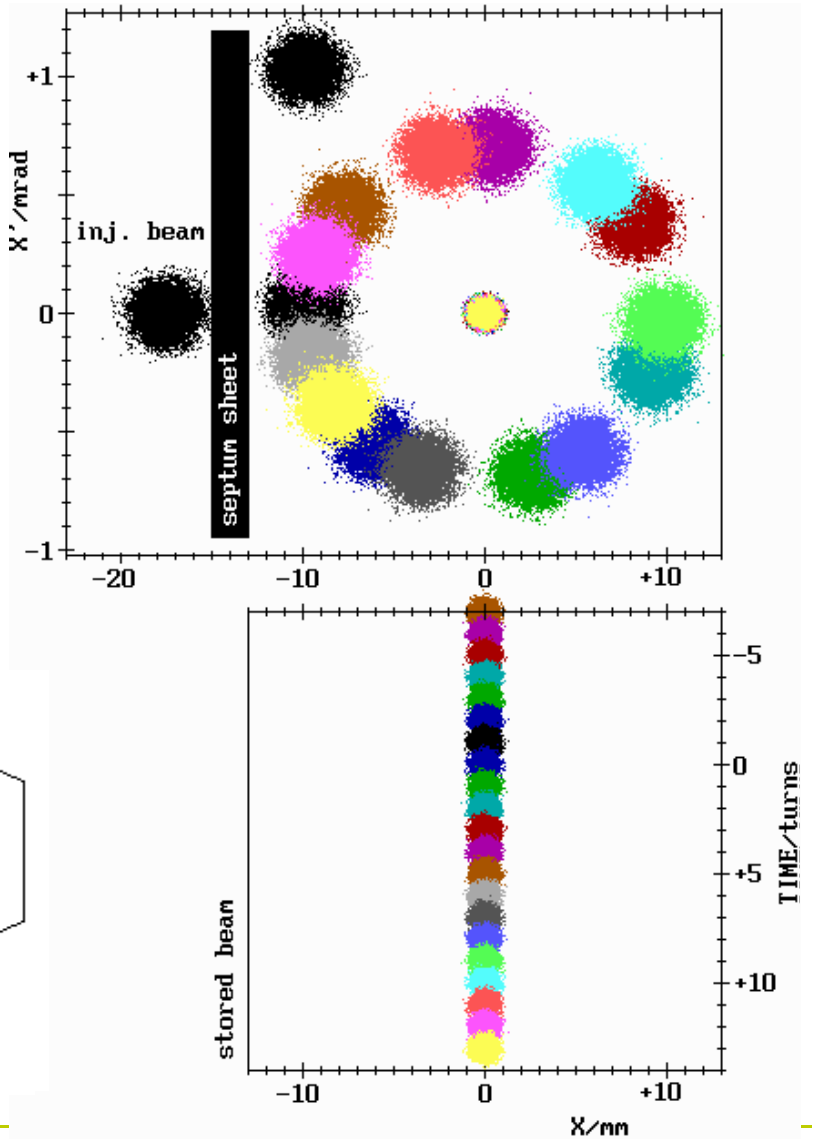
- Introduction – Single Kicker Magnet Injection and Accumulation
- In-Vacuum Kicker Magnet – Design and Construction
- Field Measurements
- Results of Beam Tests
  - Thermal and Vacuum Problems
  - Beam Dynamics Issues
  - Injection Efficiency
  - Positional Stability of Stored Beam
- What Went Wrong?
- Summary and What to Do Next

Single Kicker Injection and Accumulation

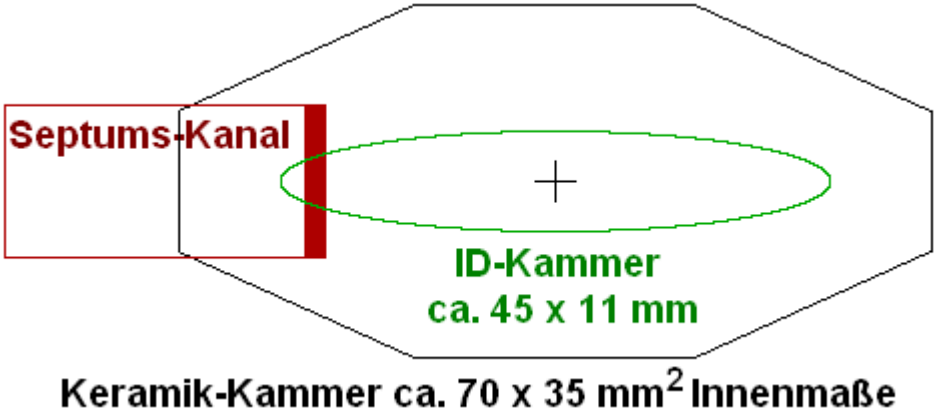
Kentaro Harada's idea:
use a single (non-linear) kick

~40° phase advance septum - kick
only injected beam is kicked
on-axis field = 0

kick strength ~1 mrad @ x=10mm



Only a dream?



Keramik-Kammer ca. 70 x 35 mm^2 Innenmaße

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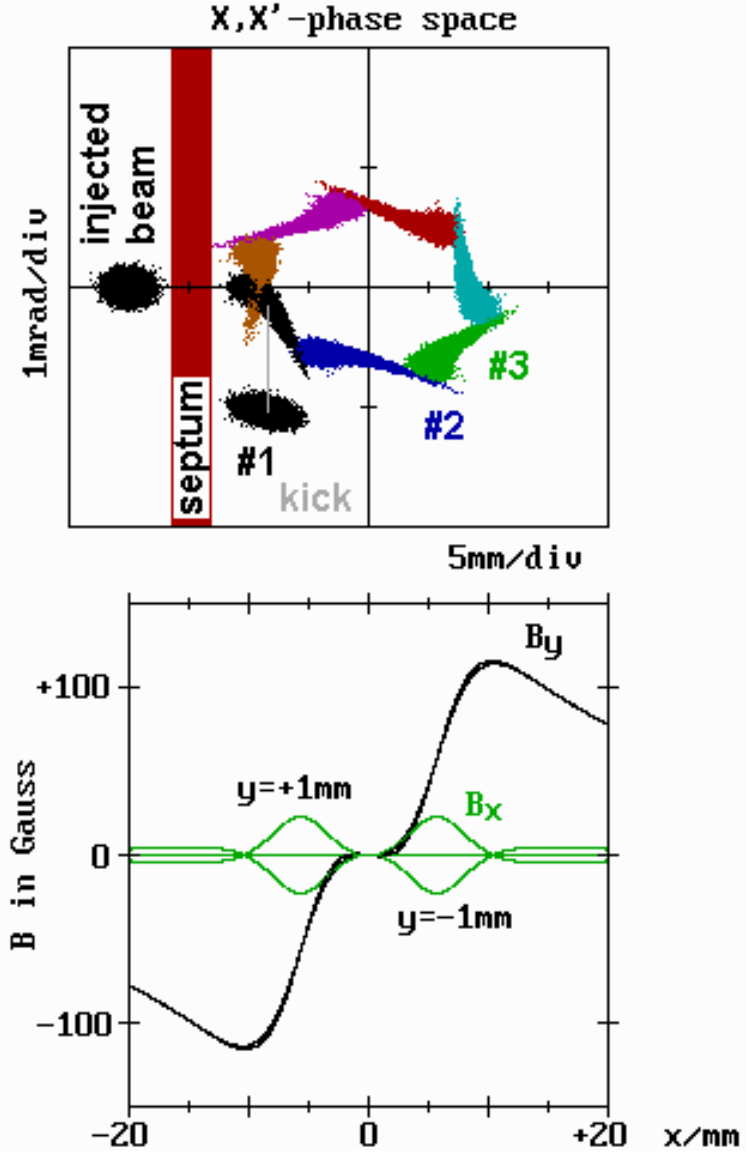
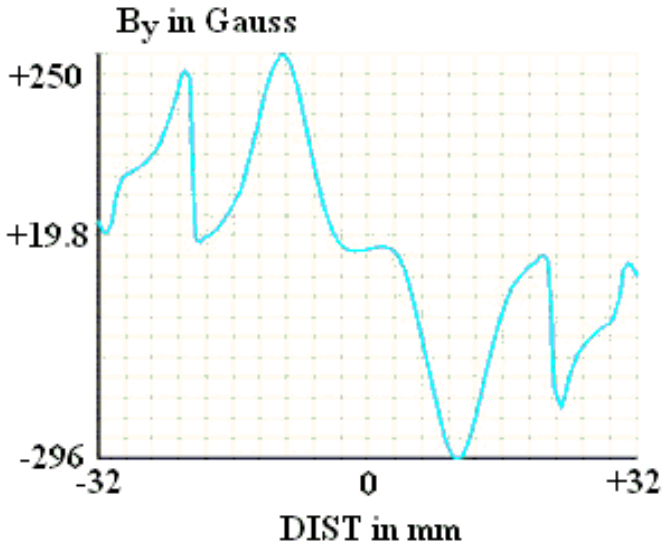
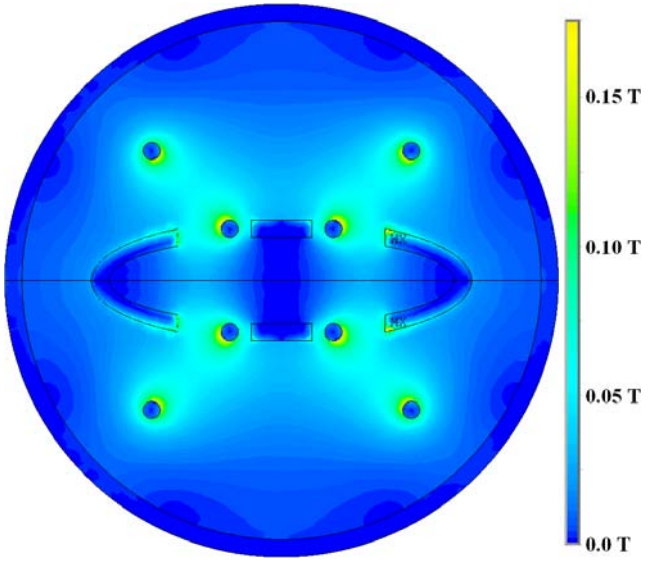
Injection and Accumulation Process





EPAC'08



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Final In-Vacuum Kicker Magnet

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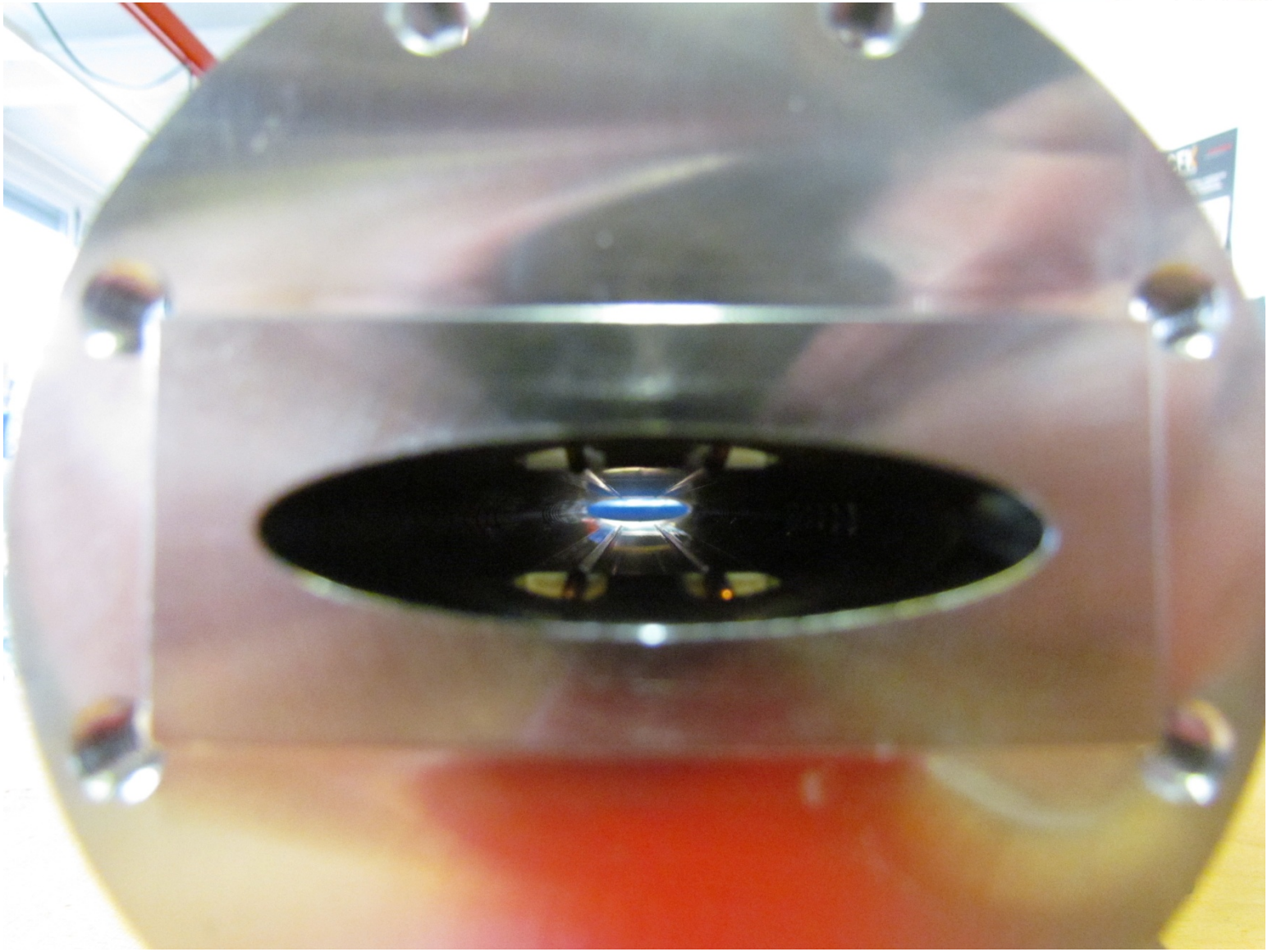

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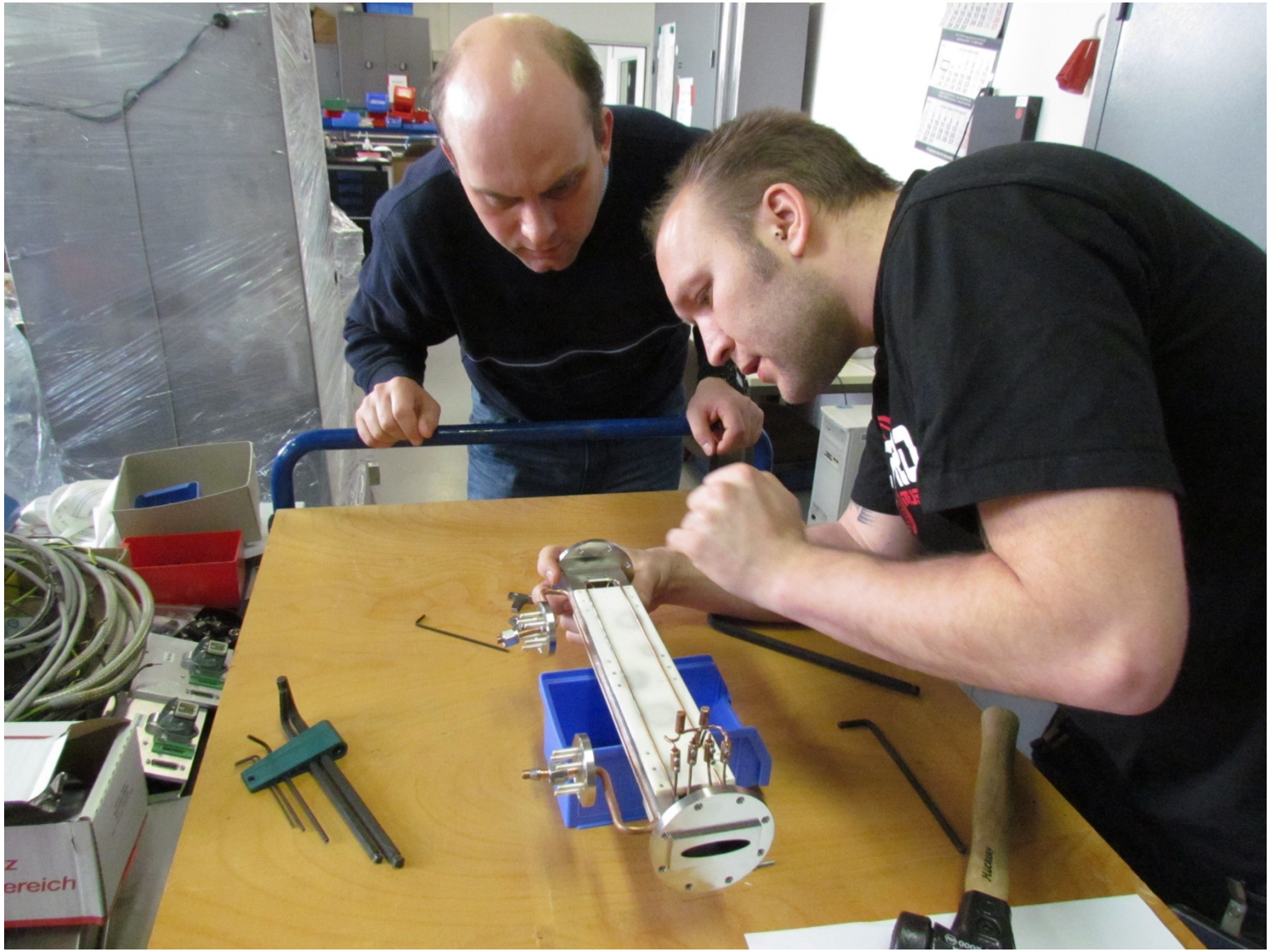
Heart of the Kicker



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O. Dressler, M. Dirsat

Details of the Kickermagnet

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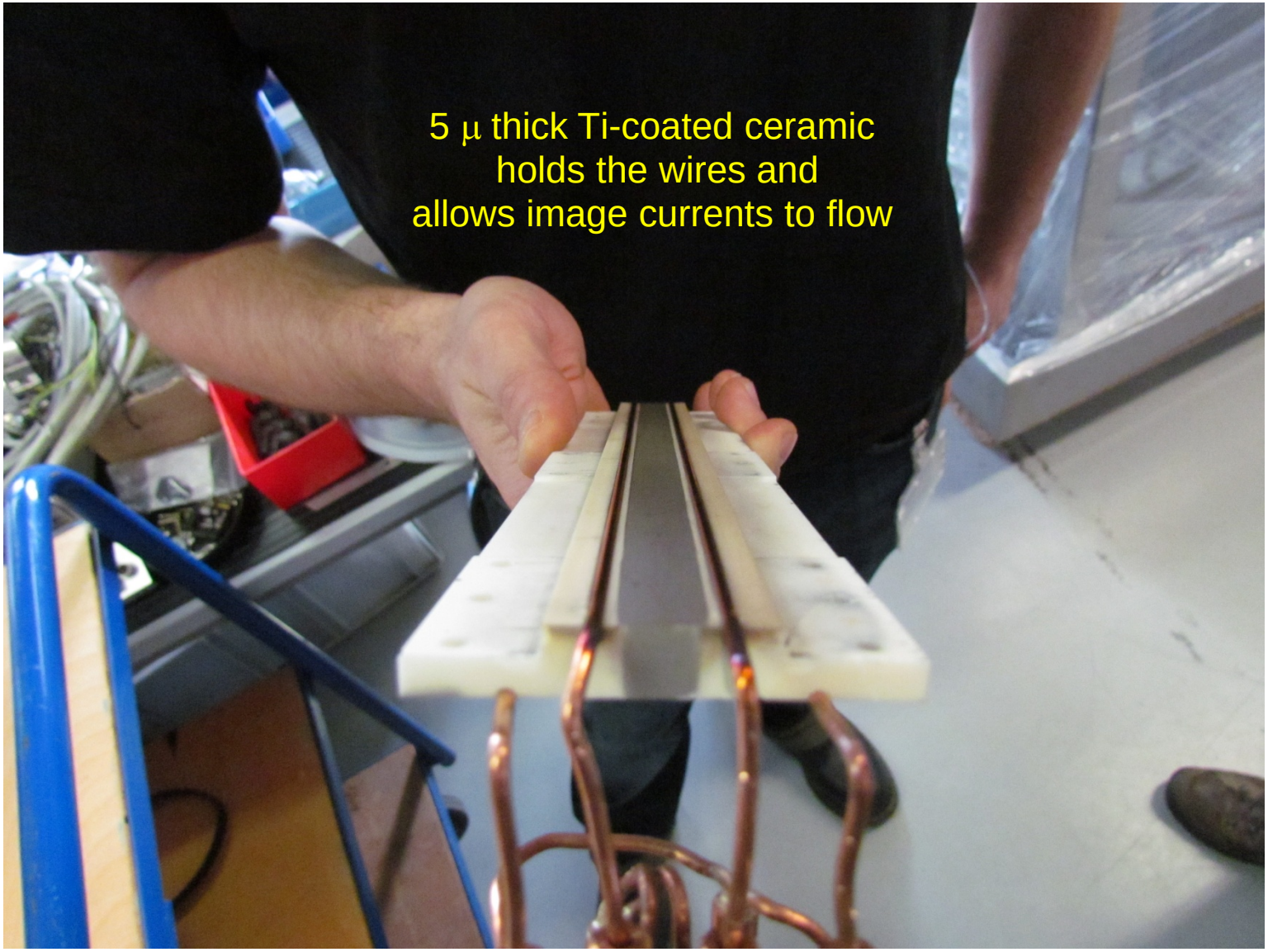

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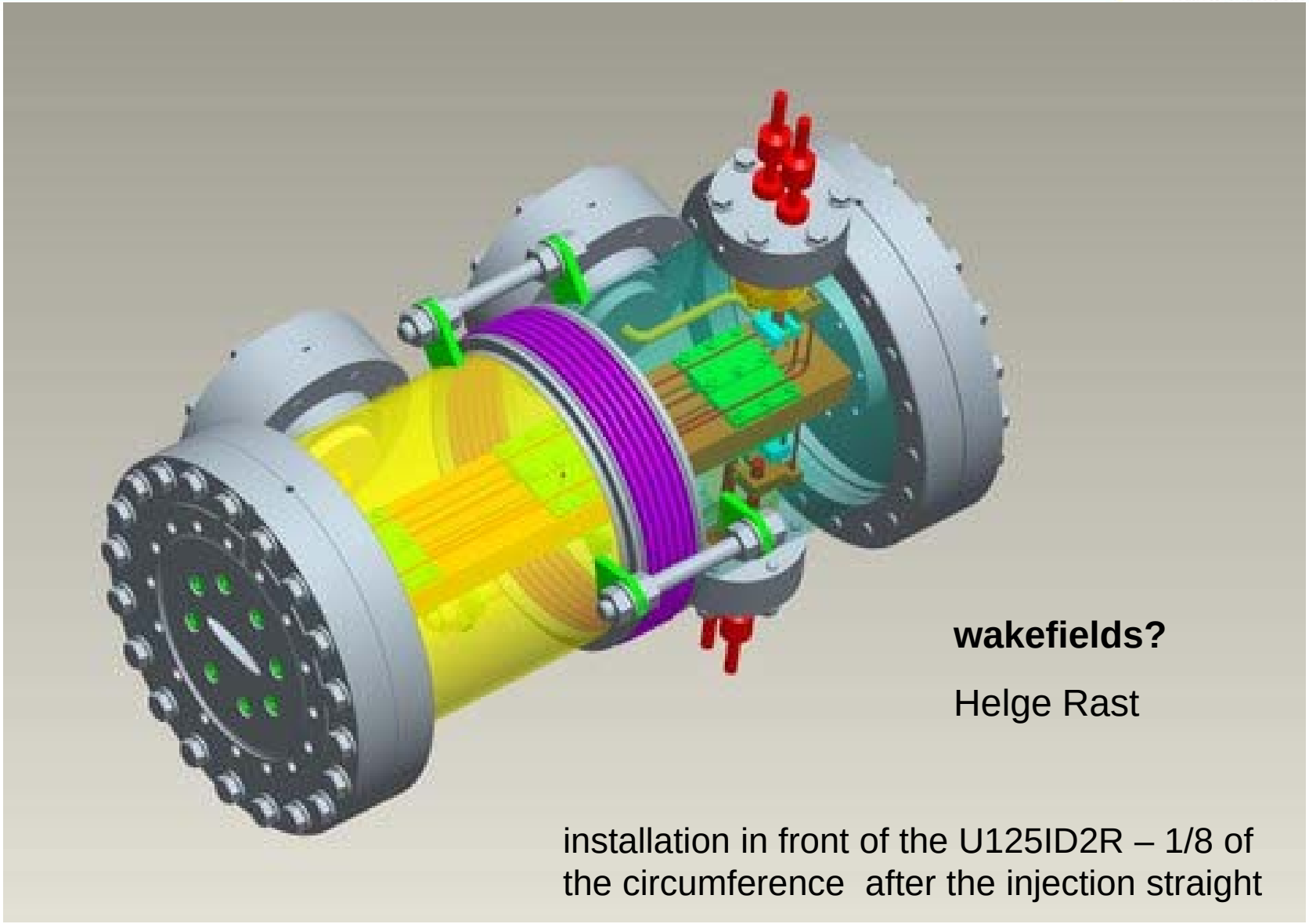
View of the Kicker Tank



wakefields?

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installation in front of the U125ID2R – 1/8 of the circumference after the injection straight

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M. Dirsat, V. Dürr

Pulsed PS for the Prototype Kicker

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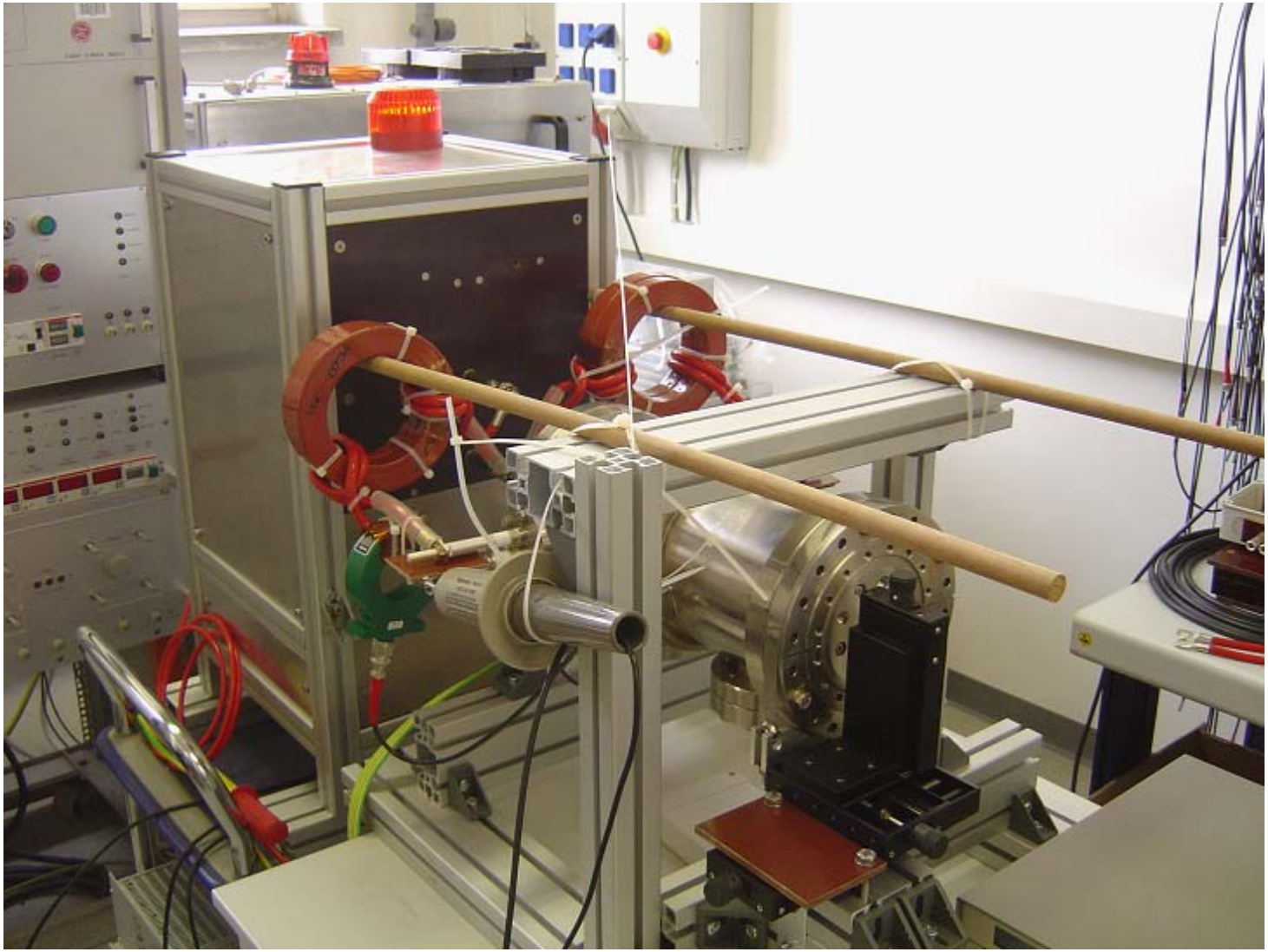

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Prototype Field Measurements

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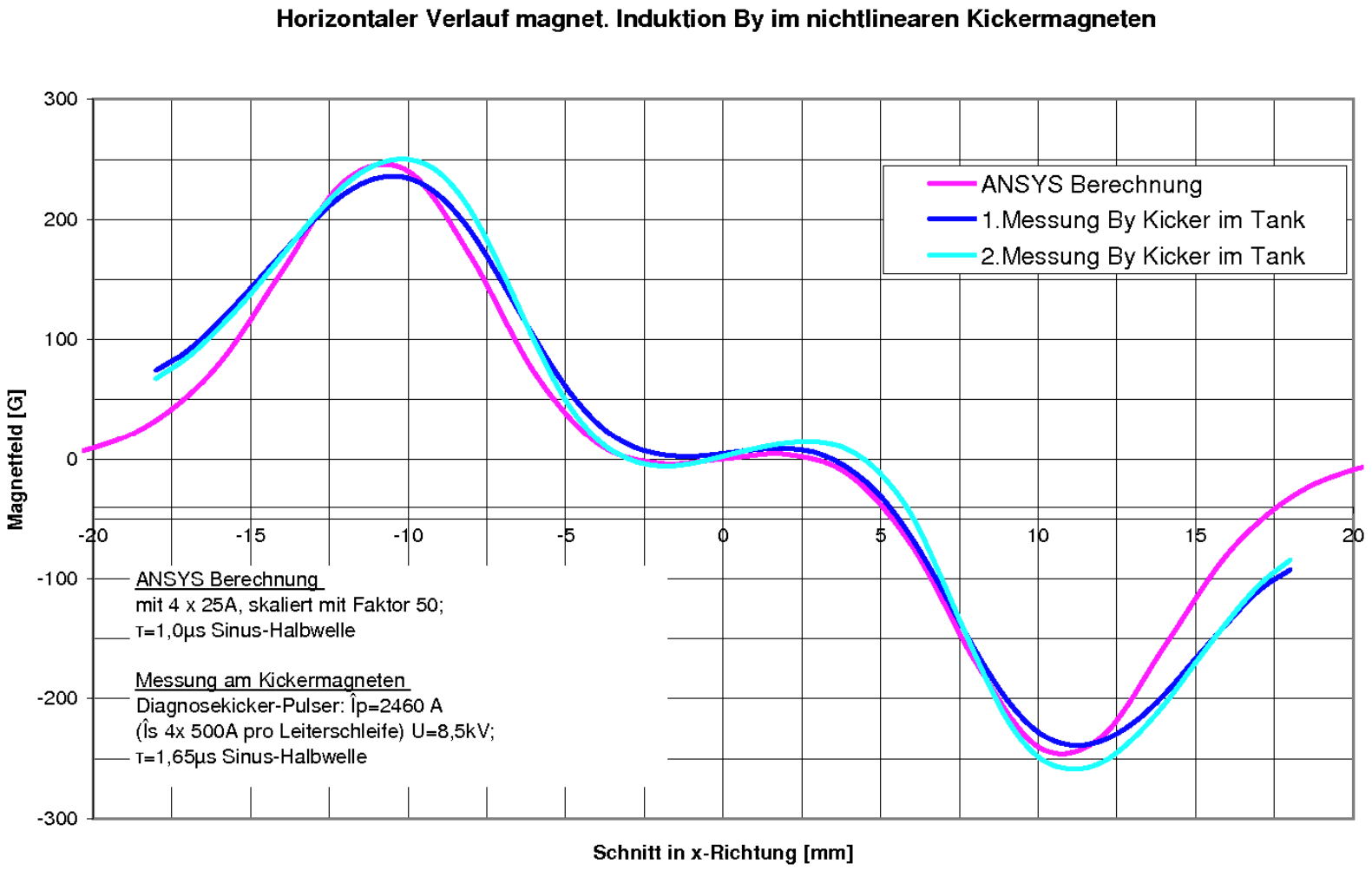
good agreement with calculations - fine adjustments desirable
maximum slightly too far off-center, pulsed power supply is okay



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Performance in the Storage Ring

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Thermal and Vacuum Problems: Temperature at the outside of the kicker tank increased within 20-30 min to 60°C with I_{mb}=300 mA or I_{sb}=15 mA, along with severe vacuum degradation

Beam Dynamics Issues: Except for vacuum related beam blow-up no coupled bunch instability was observed, measured loss factor

Injection Efficiency: was as good as with the 4 kicker injection bump, stored beam was far more stable

After the tests the kicker had to be removed

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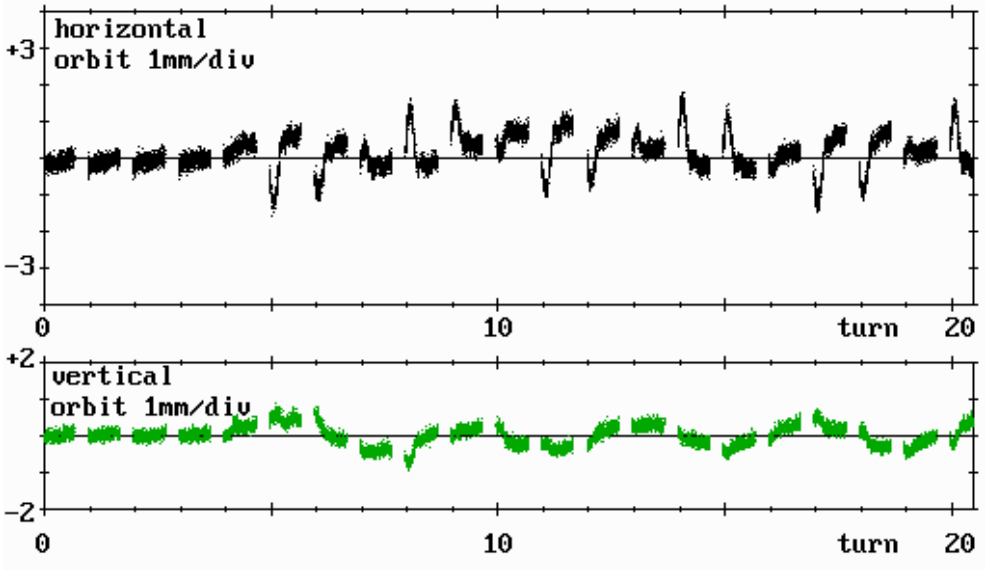
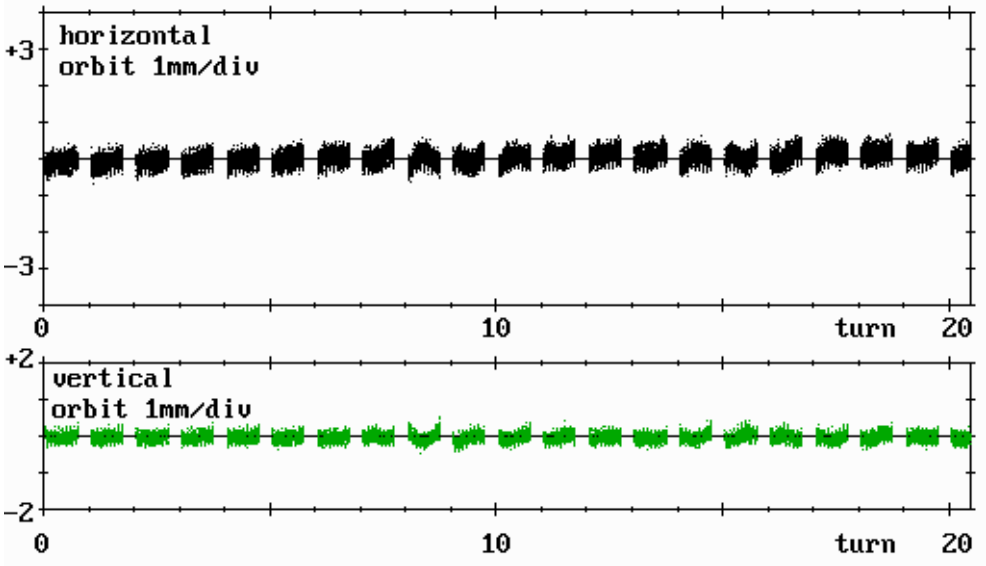
Injection Studies



4-kicker injection bump optimized for small orbit perturbation

injection efficiency ~ 80 %



single, non-linear injection kicker – not fully optimized:

horizontal < 60 μ

vertical < 15 μ

injection efficiency ~80 % up to 300 mA

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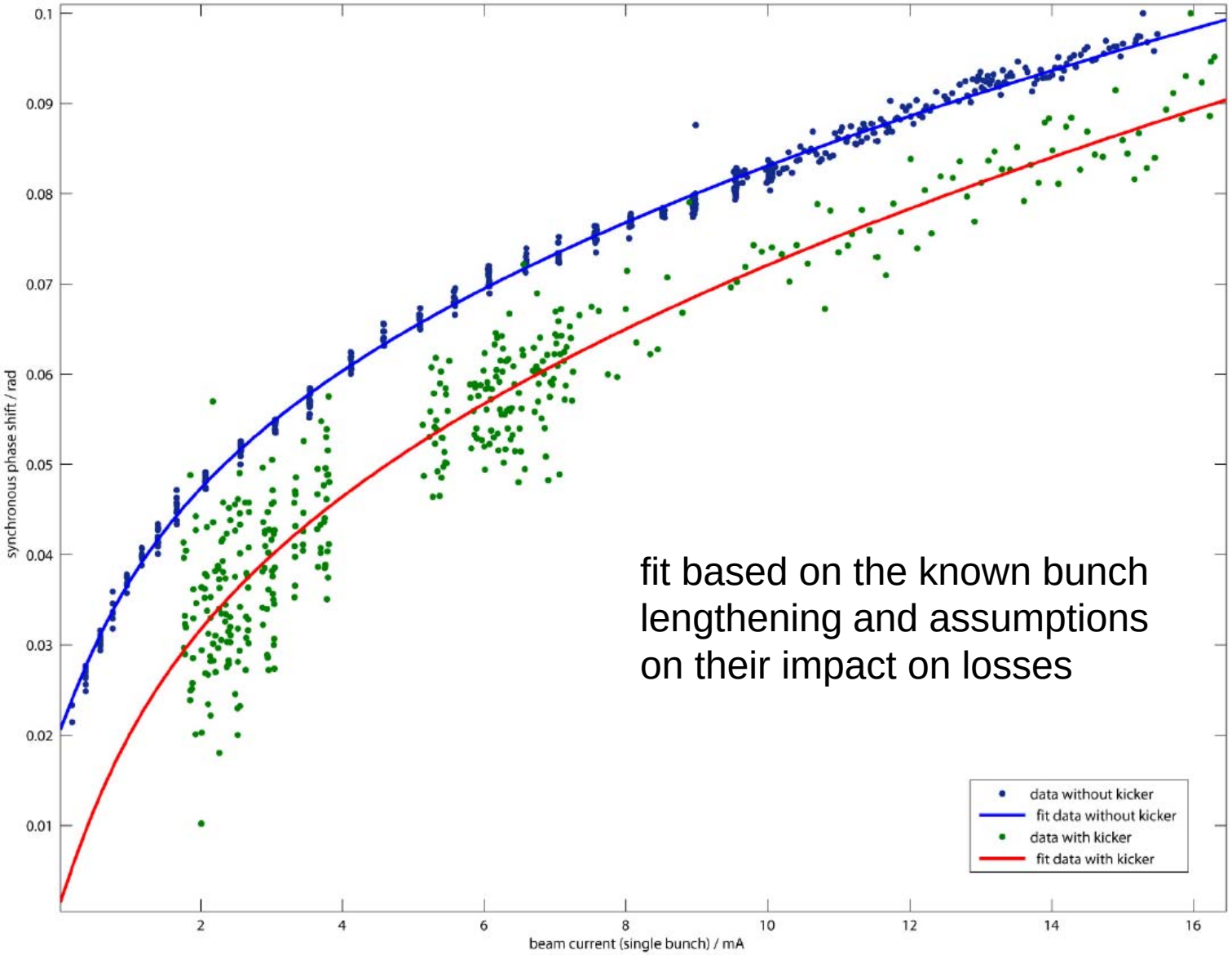
Lossfactor – Experimental Determination



fit based on the known bunch lengthening and assumptions on their impact on losses

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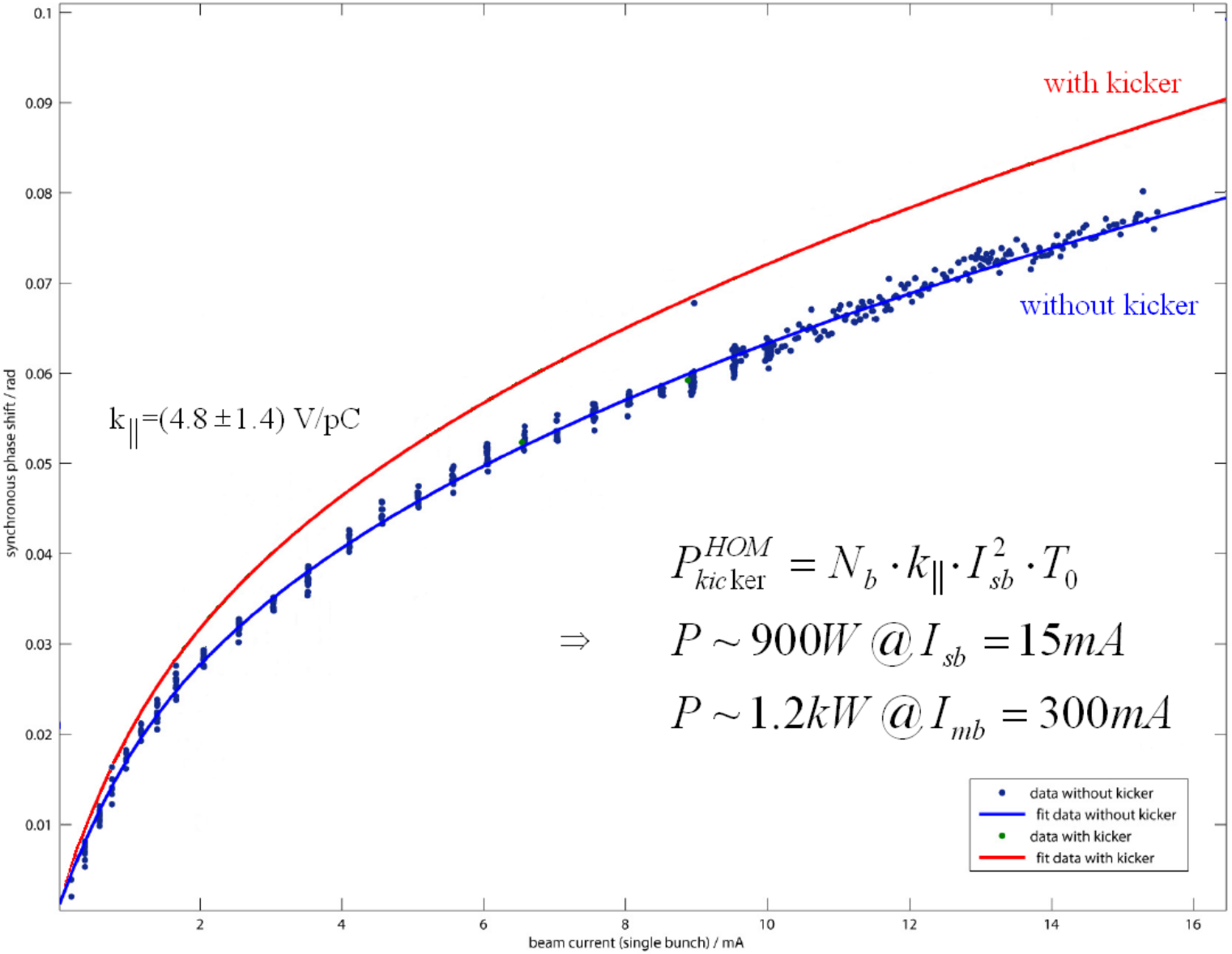
Lossfactor – Experimental Determination



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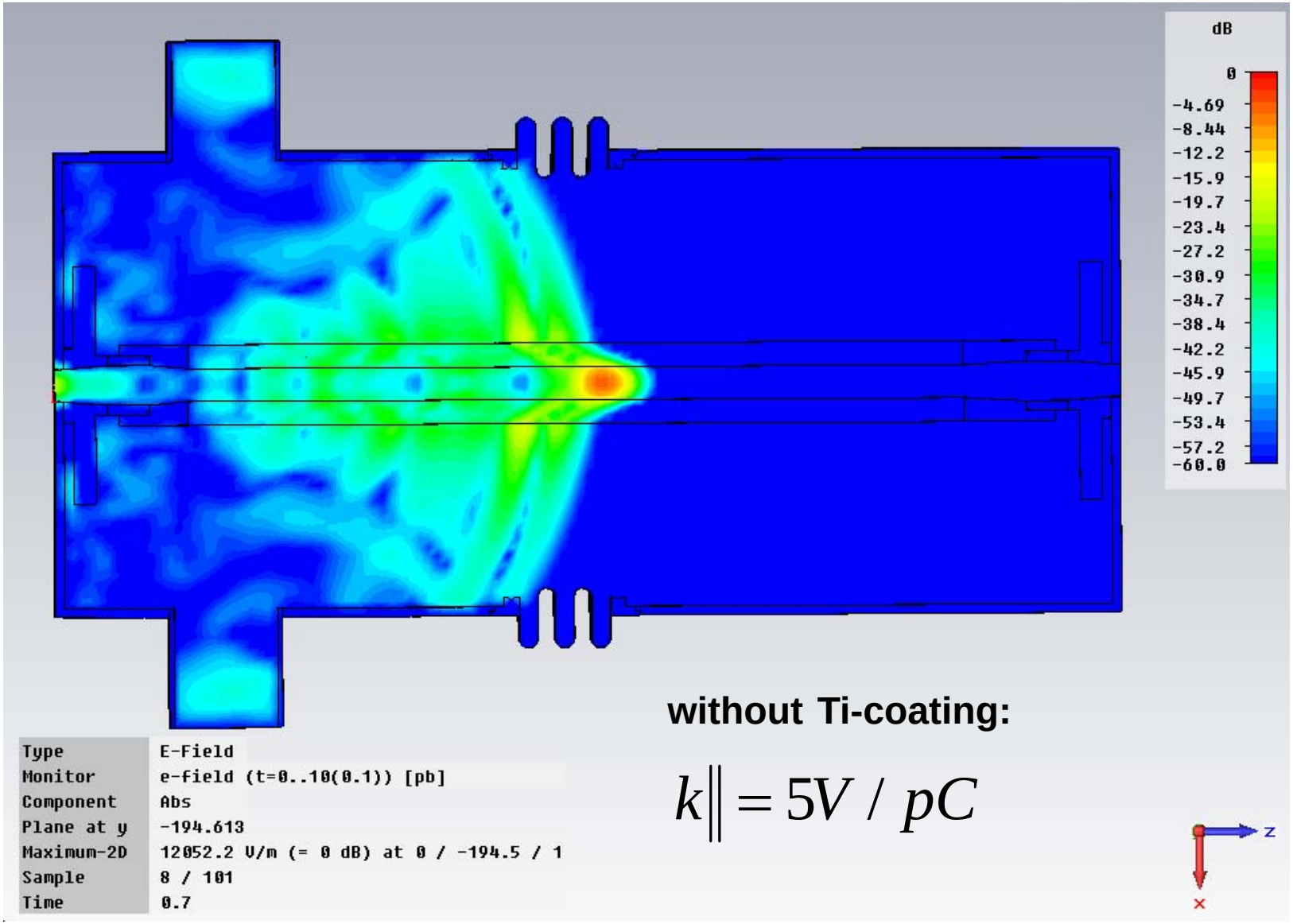
Lossfactor – MAFIA Calculation



The Desaster – After 1 Week of Operation

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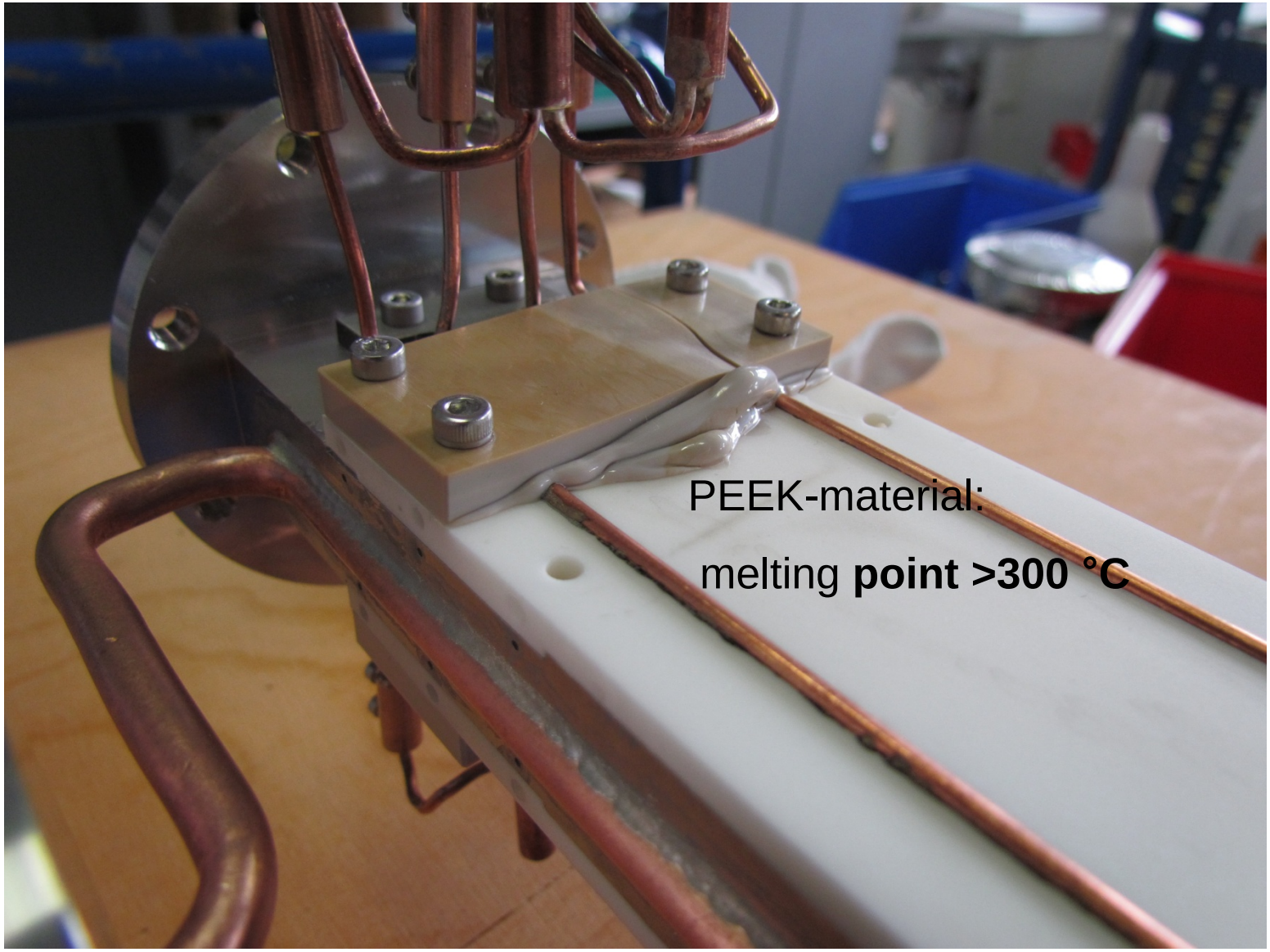

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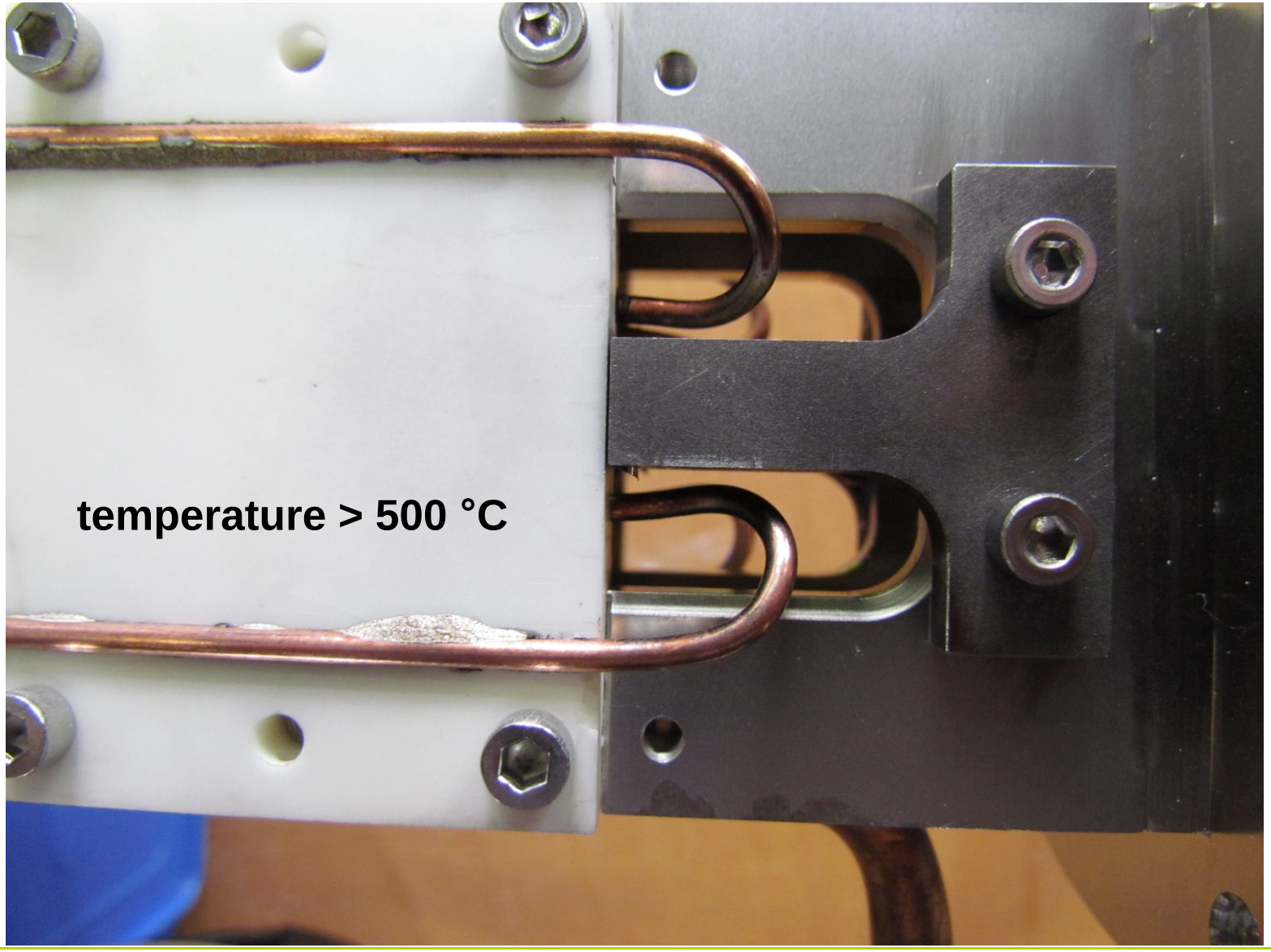

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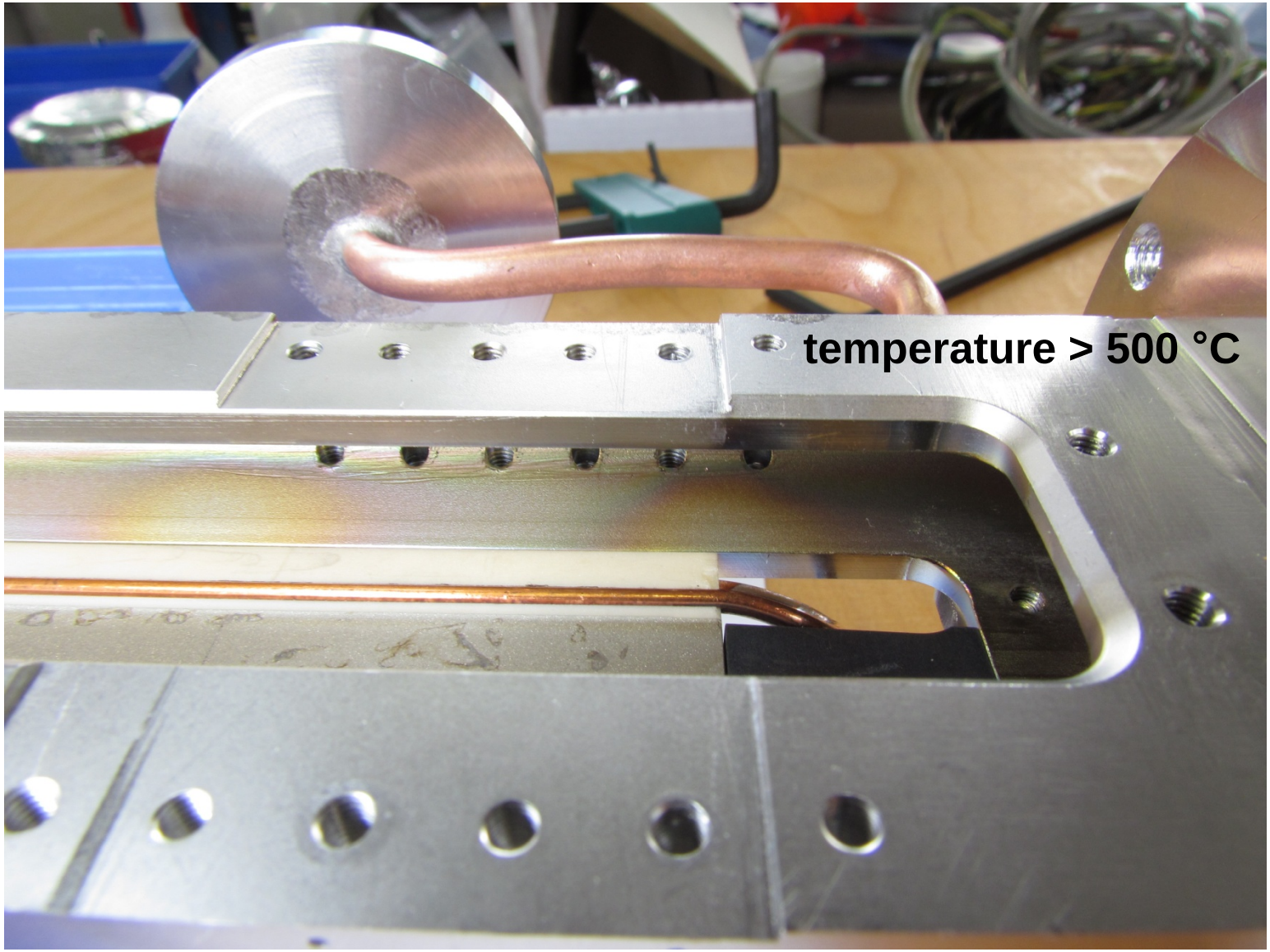

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Summary and What to Do Next

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Designed, built and tested in-vacuum injection kicker magnet

Worked fine for 20 min, we burnt our fingers: temperatures > 500°C

Agreement between lossfactor measurement and MAFIA calculation (without Ti-coating) could be accidental - ~1kW power looks reasonable – calculations needed

Next iteration: thicker coating, smaller holes for the wires, wires completely behind coating, rotating the kicker (exchange upstream and downstream ends), are we too close to the beam? …….

Why continue?

Only 1 weak instead of 4 strong injection kicker magnets/PS which never will perfectly close the bump – more space available for other components

Ideally, stored beam is not moved during injections – that's what we need for top-up operation

Why an in-vacuum design? Efficient injection into small acceptance rings and flat top allows efficient injection of larger beams