J. Völker, A. Frahm, S. Keckert, J. Knobloch,
A. N. Matveenko, A. Neumann, H. Plötz, Y. Tamashevich,
Helmholtz-Zentrum Berlin, Germany

HZB Helmholtz Zentrum Berlin
SeaLab bERLinPro

A Superconducting Magnetic Shield for SRF Modules With Strong Magnetic Field Sources

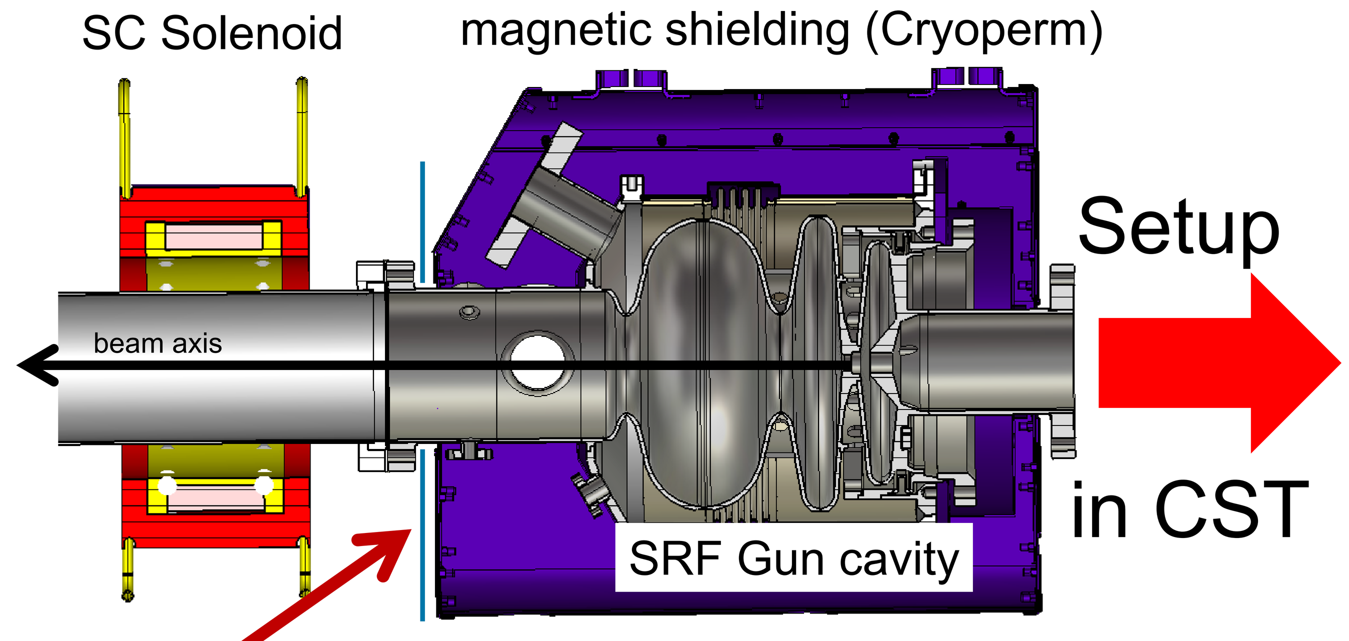
ABSTRACT

- Magnetic fields are a big issue for SRF cavities, especially in areas with strong electromagnets or ferromagnetic materials
- **Mu shields (metal alloys with high magnetic permeability like Cryoperm)** are reroute the external magnetic flux
- typically designed for weak magnetic fields (Earth's magnetic field)

-> BUT: next to strong magnetic field sources like **superconducting (SC) solenoids**, they can be **easily saturated**
-> degradation of the shielding efficiency and permanent magnetization

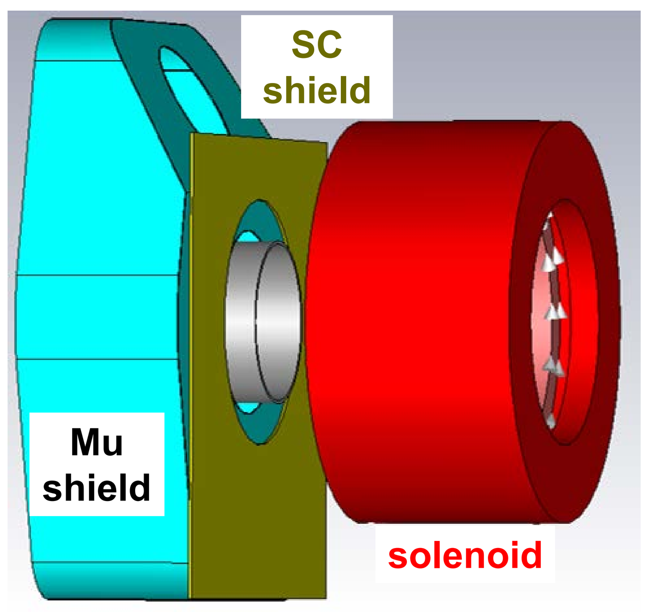
-> we designed an **SC magnetic shield** placed between the solenoid and the cavity shield to protect the latter during solenoid magnet operation

INTRODUCTION AND CALCULATION

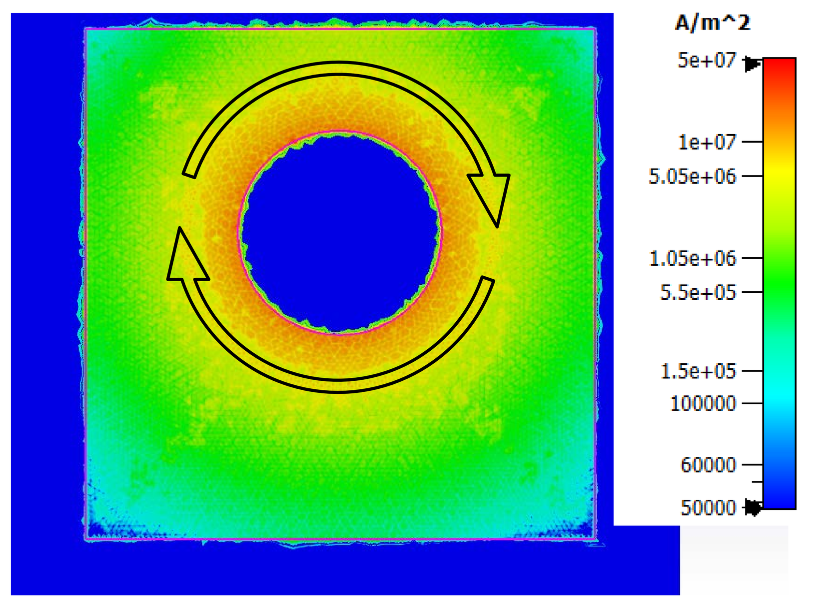


SC Shield should as close as possible to the Mu Shield

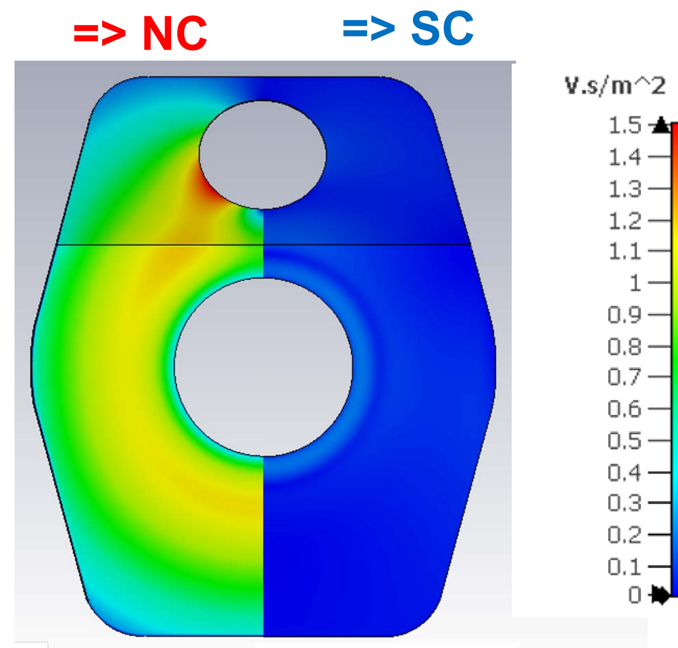
LF solver:



eddy currents in the SC Shield

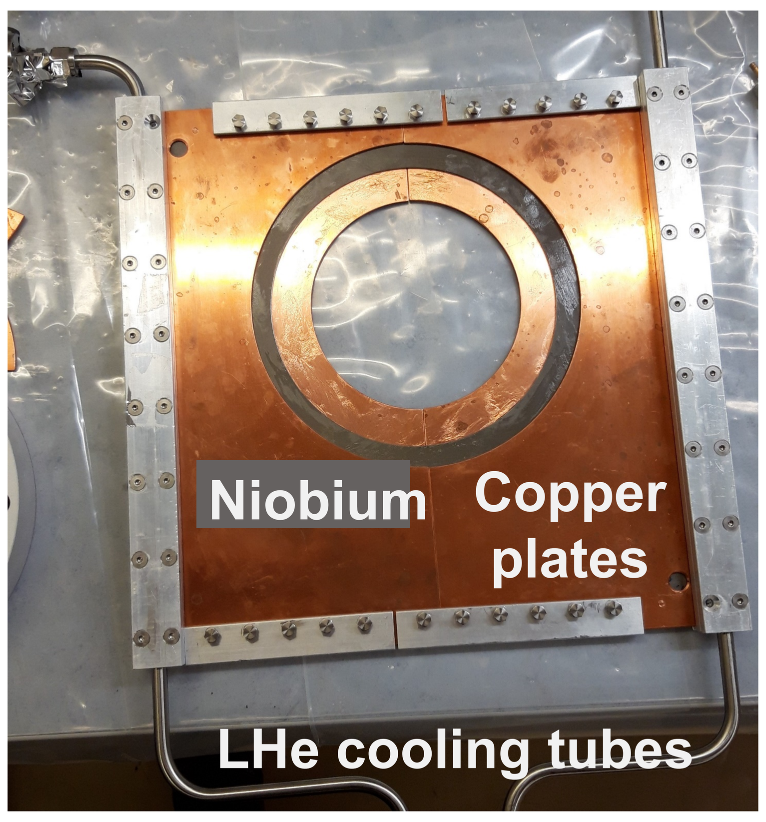


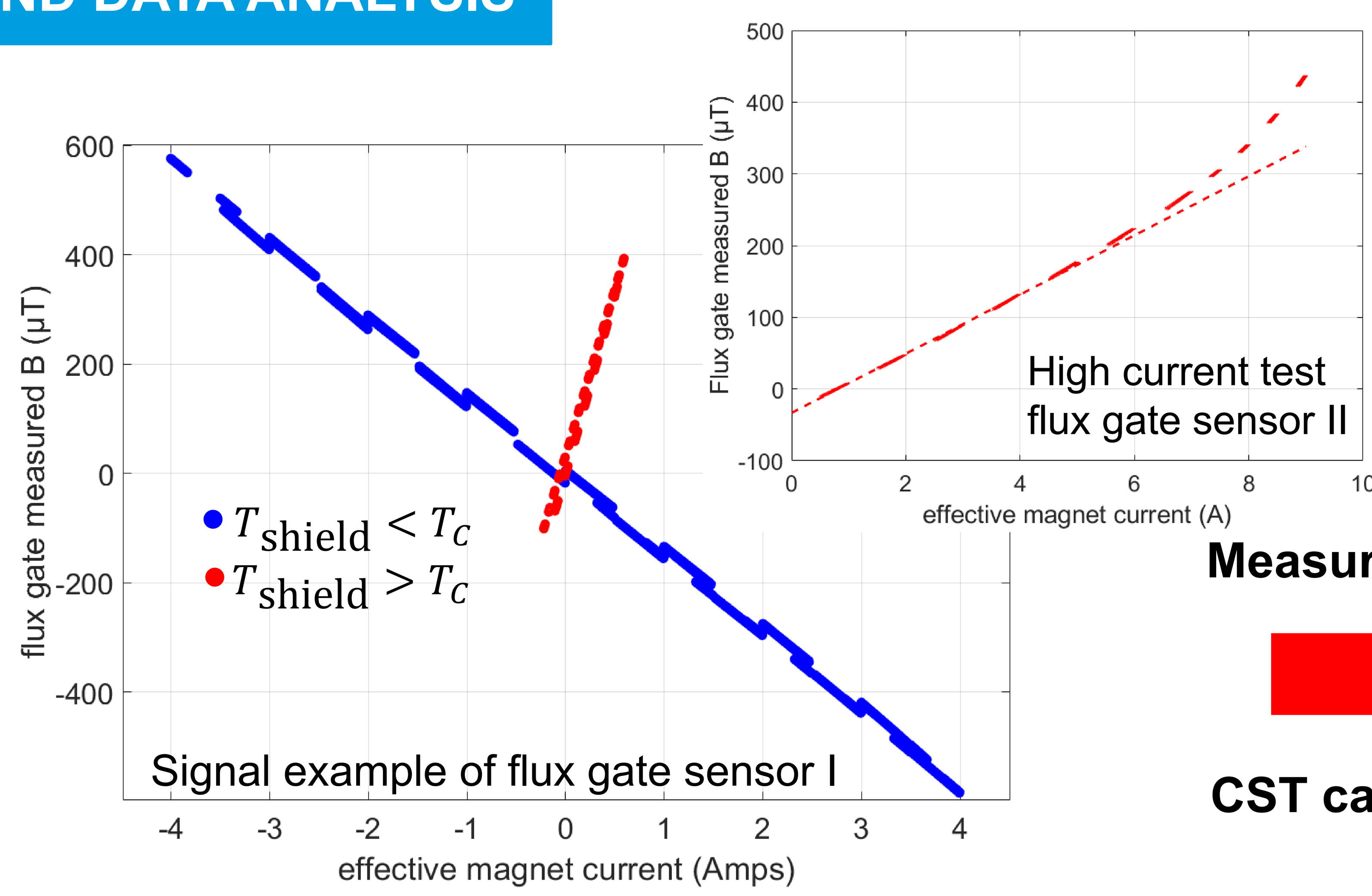
SC Shield => NC
SC Shield => SC



Max~1.5T Max~0.14T

EXPERIMENTAL SETUP AND DATA ANALYSIS



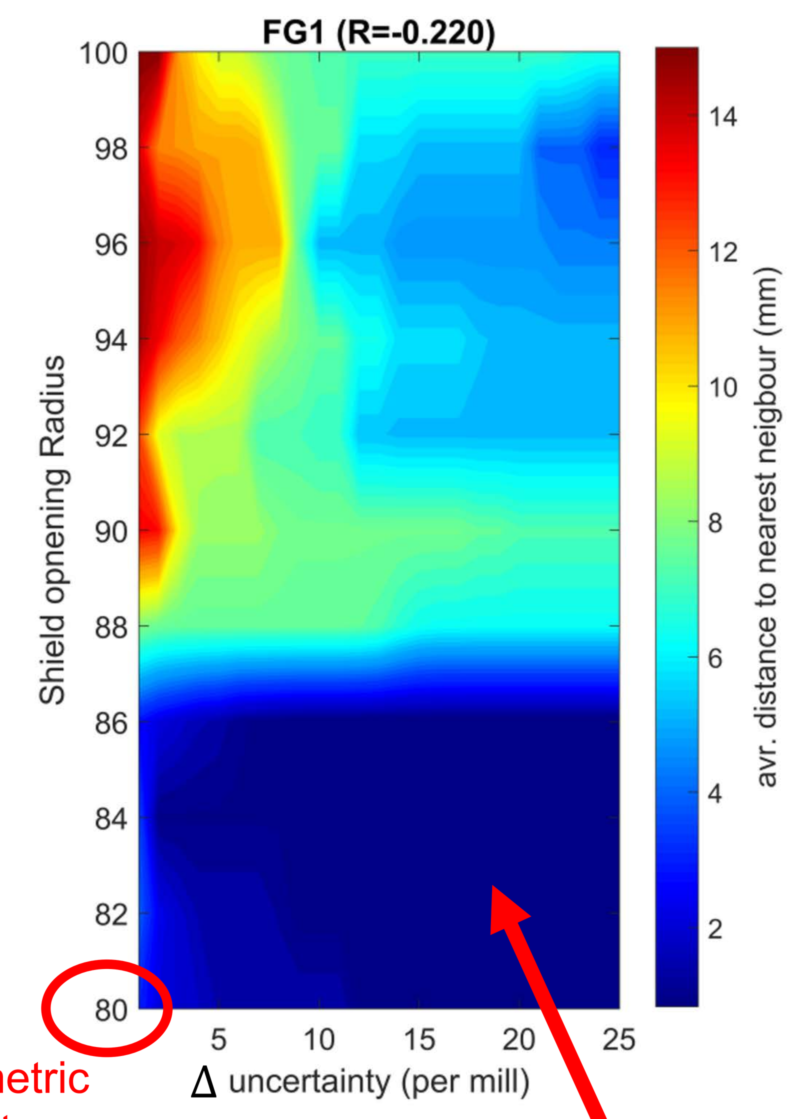


Measured results

vs.

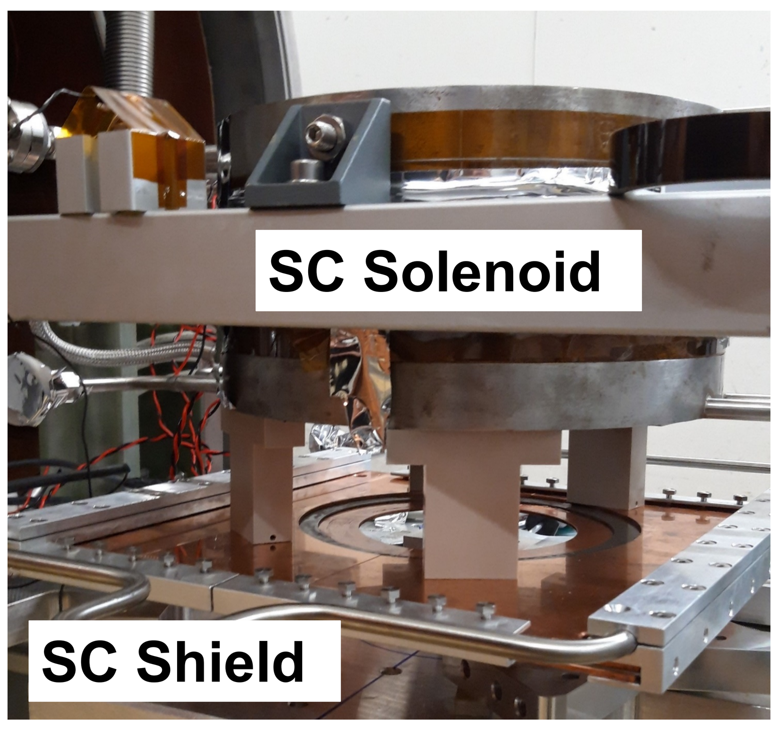
CST calculations

One example for flux gate #1:



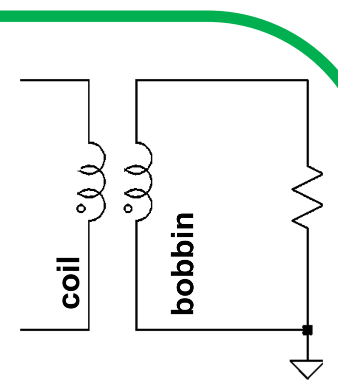
Geometric aperture

Small uncertainties, small coord. distances and correct geometry!



Shield and Solenoid were installed in HoBiCaT
-> measuring mag. field around shield (Hall sensors and flux gates) as function of shield temeprature and solenoid current

Analysis of the measurements:



-> signal correction of additional eddy currents in solenoid Cu bobbin (tranformer equation)

-> linear fit of all sensor data vs. eff. magnet current ($B_i = a_i \cdot I + b_i$) up to 4Amps

-> rel. field ratio $\boldsymbol{R} = a_{SC}/a_{NC}$ for each sensor (position)

-> comparison with CST simulation:
- find next to the sensor positions (in CST) coordinates with $|R_{CST} - R_{ex}| < \Delta$ (to be defned uncertainty)

-> a slight non-linearity above 7Amps (probably local quench @ inner shield aperture)

-> for almost all magnet sensors the CST results are in good agreement with the HoBiCaT measurements results

CONCLUSION

- A superconducting shield was developed and build to protect the sensitive Gun Mu shields
- An improved design of an SC shield were presented consisting of a single Niobium plate and LHe cooling
- Several test in HoBiCaT were performed under real conditions
- Measurements and CST calculations are in good agreement to each other
- CST model was additionally used to determine the shielding efficiency of the SC shield regarding the gun Mu shield
- the max. flux density will be reduced by about one order of magnitude

CORRESPONDING AUTHOR
Dr. Jens Völker
Helmholtz-Zentrum Berlin
jens.voelker@helmholtz-berlin.de