Angular dependency of flux expulsion

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TTC/ARIES topical workshop on flux trapping and magnetic shielding

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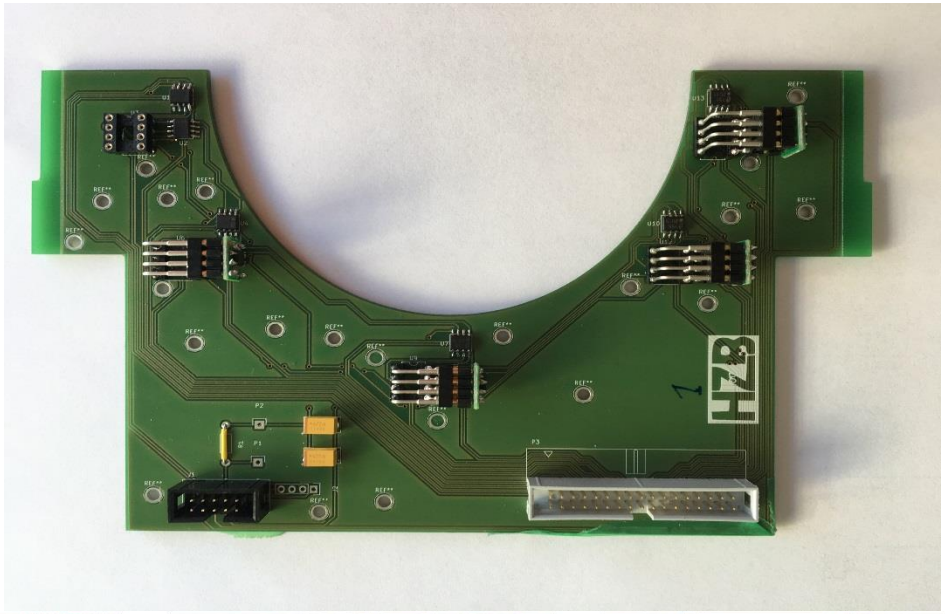
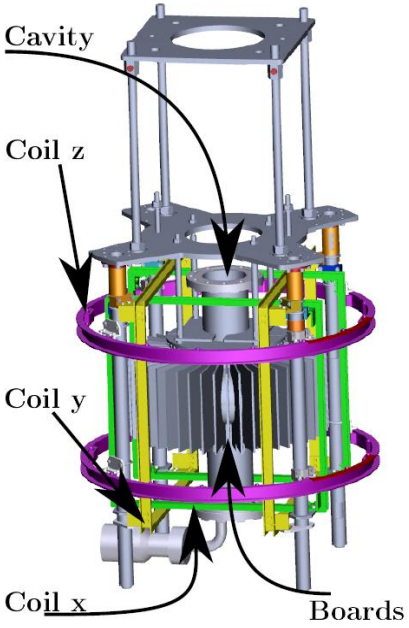
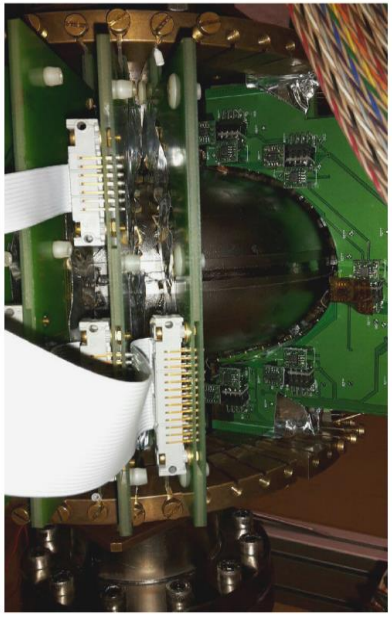
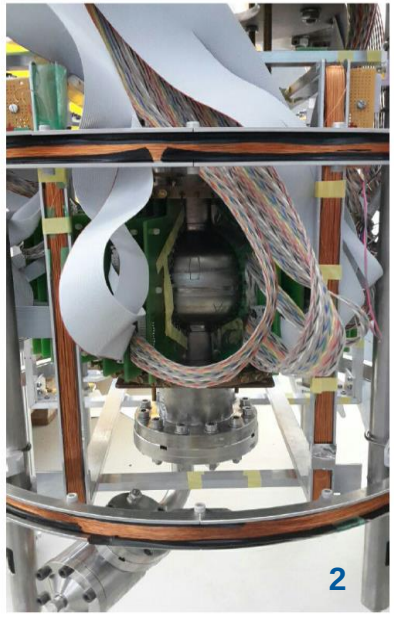
Mapping setup:

- 3 sensors in one group (r, z, φ)
- 5 groups on one card (rz plane)
- 4 cards around cavity (φ)
- T mapping (from DESY)
- Data acquisition hardware: 2 ms for complete cavity map
- Helmholtz coils for x, y, z

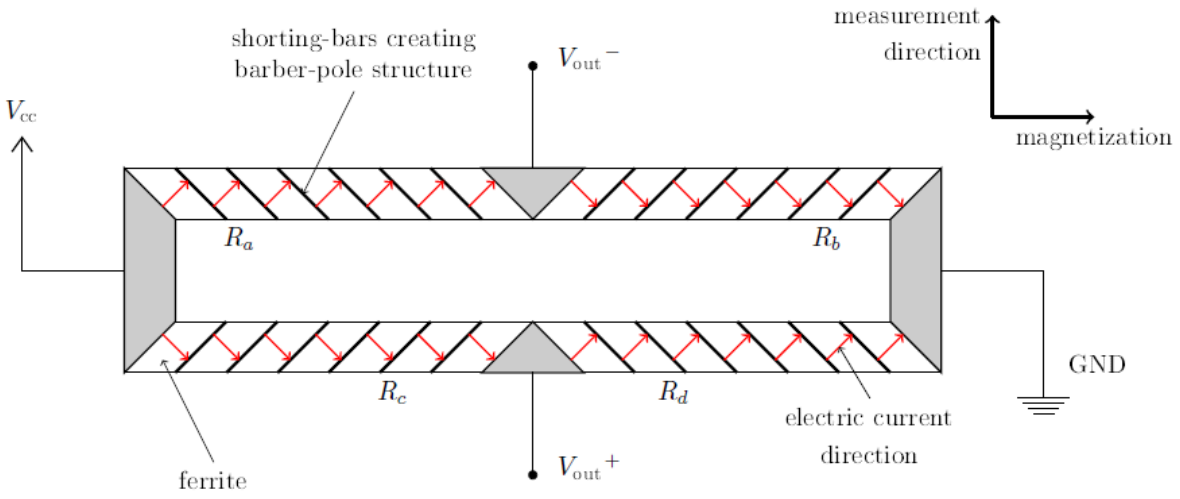




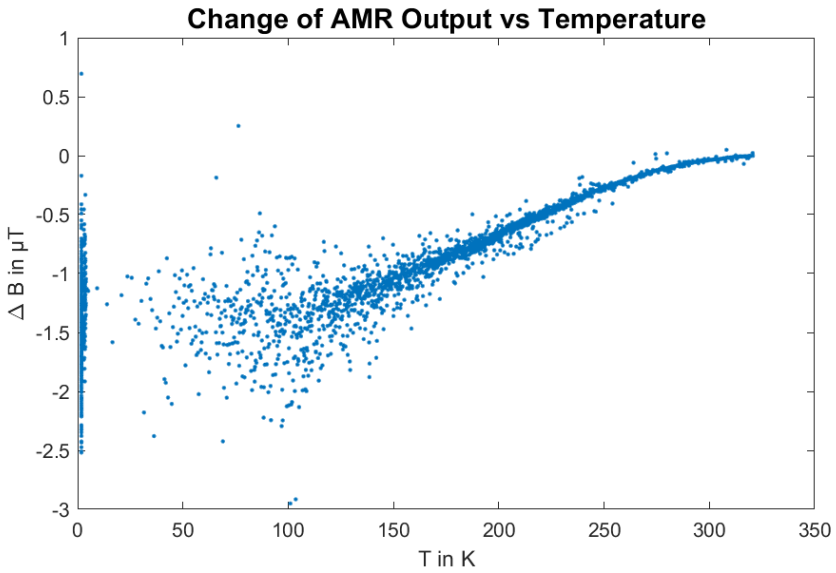




- Wheatstone bridge with four AMR elements
- Set magnetization in each element
- Magnetization coil to reset and flip magnetization 180°



Normal Operation mode not applicable in cryogenic use



- Unpredictable behavior => no calibration possible
- Absolut calibration down to 2 µT

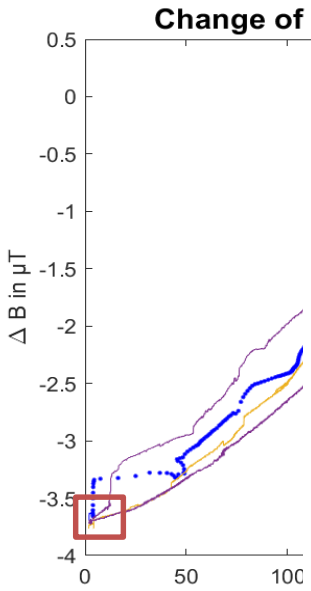
Calibration Setup

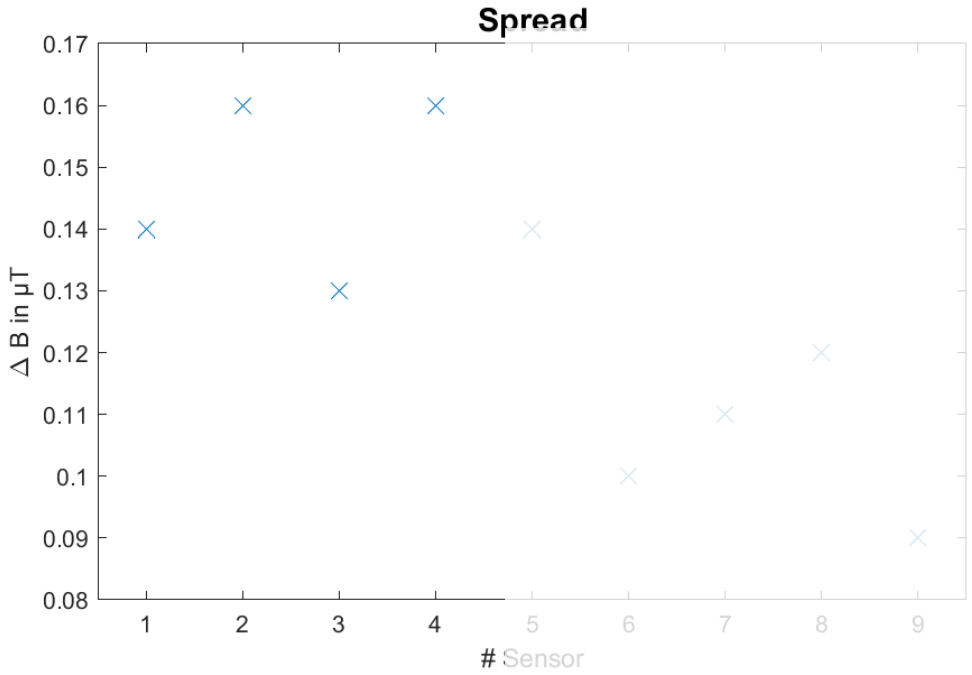
PRELIMANARY

- Setup to investigate reproducibility of change in Output vs Temperature curve

Cycle Test-Board from room temperature to 2 K with help from DESY

PRELIMANARY





- T shows s
  Sensor ter
  - ➢ Differe
    to different curves
- Smooth curves => calibration possible

=> Absolut calibration down to 0.2 µT (Relative calibration up to 0.02 µT)

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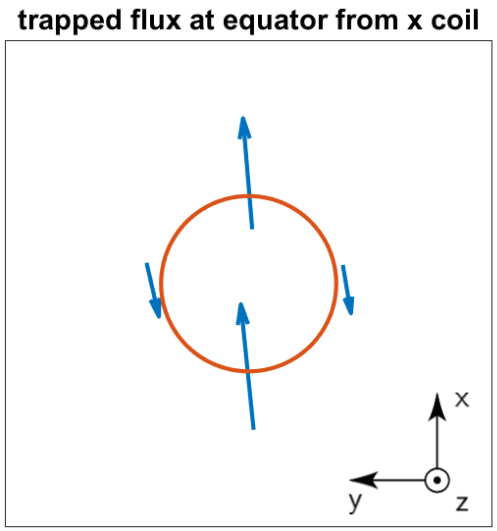
PRELIMANARY

1. Cycle with only Background: Q_0 = 3.1E+10

2. Cycle with 10 µT in X: Q0 = 6.1E+9

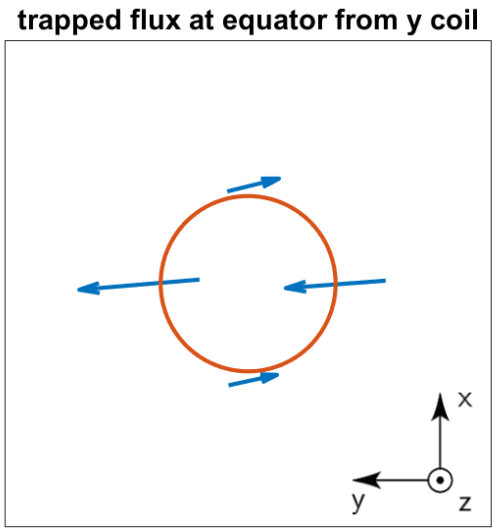
Top view



- Trapped magnetic field minus the background from 1st cycle
- Maximal trapped flux: 3.9 µT

3. Cycle with 10 µT in Y: Q0 = 6.3E+9

Top view



- Trapped magnetic field minus the background from 1st cycle
- Maximal trapped flux: 3.8 µT

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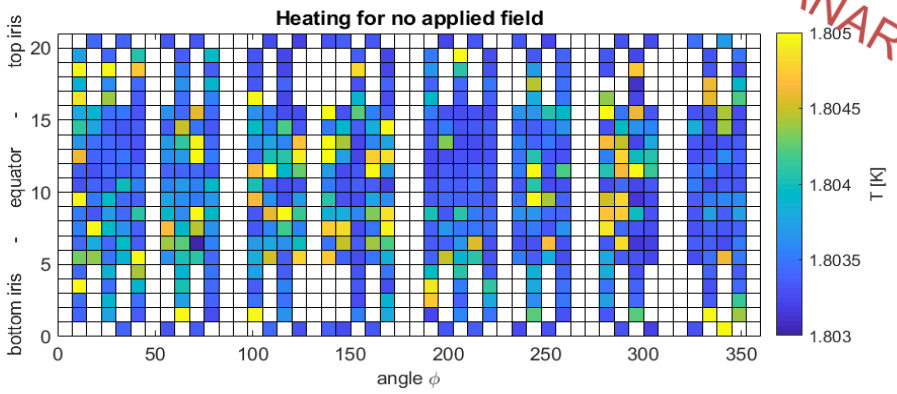
PRELIMANARY

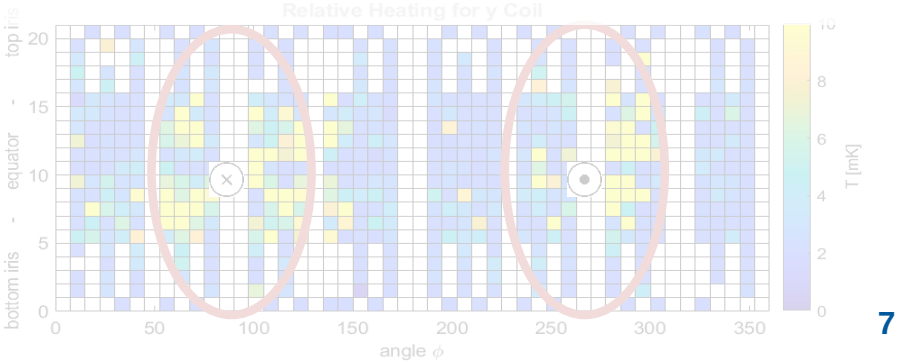
Moving Hotspots for different fields

Without Coil



Coil in X direction

Coil in Y direction

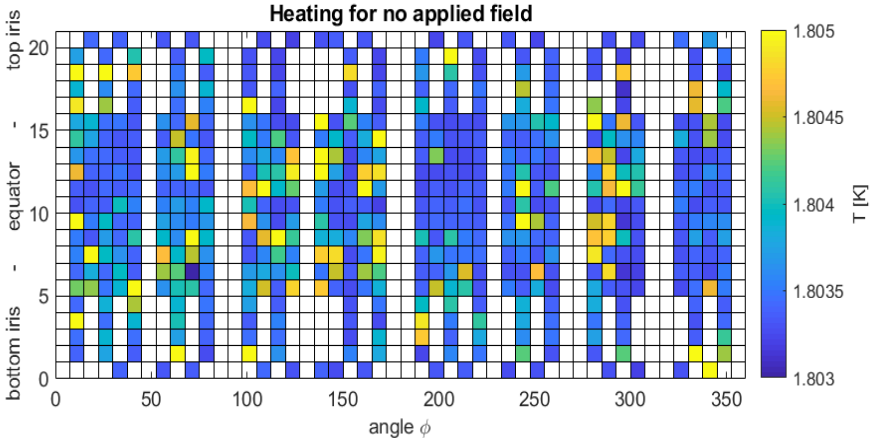


T MAPS FOR DIFFERENT APPLIED FIELDS

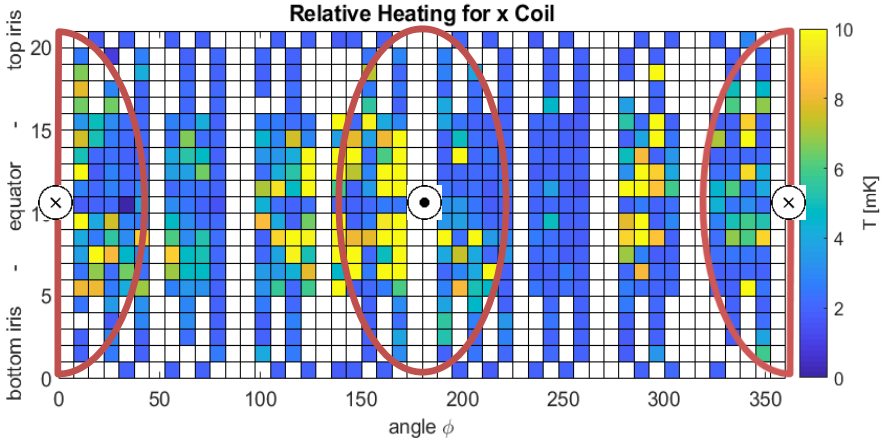
PRELIMANARY

Hotspot also moves when polar angle is changed

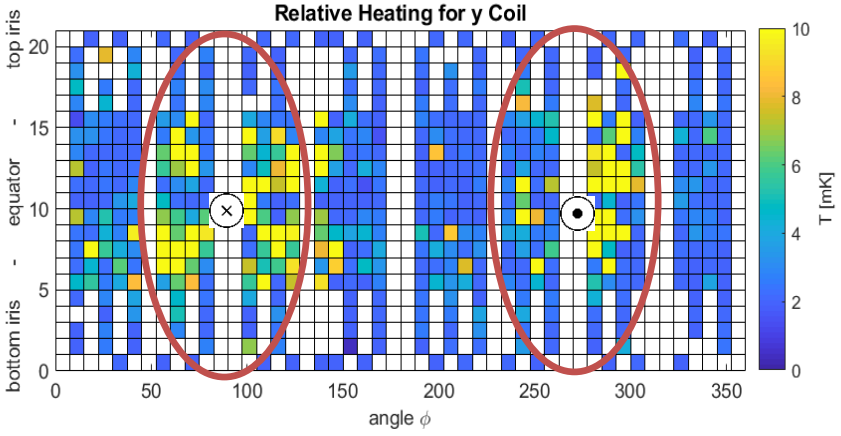
Without Coil; Q_0 = 3.1E+10



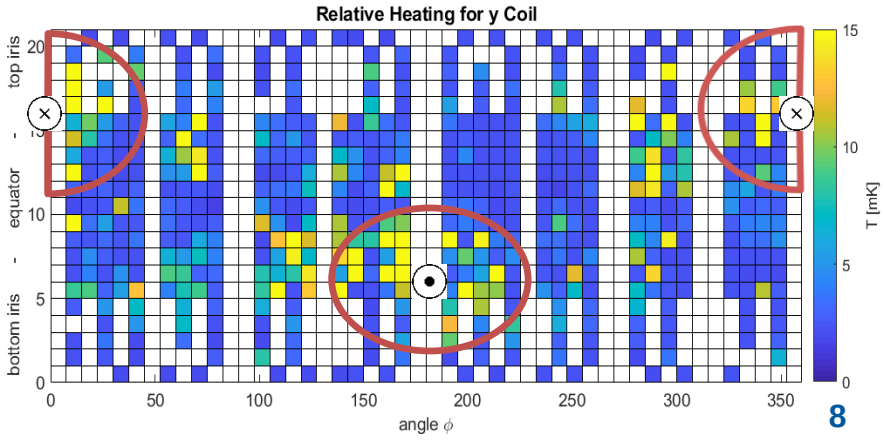
Coil in X direction; Q_0 = 6.1E+9



Coil in Y direction; Q_0 = 6.3E+9

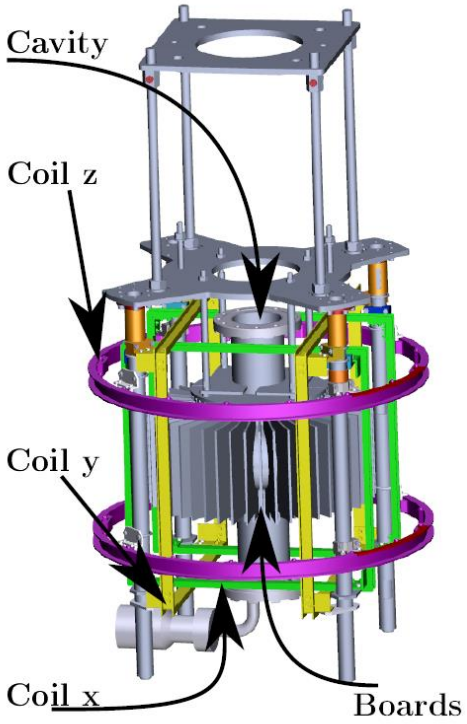


B_X=B_Z; Q_0 = 5.3E+9



Summary

- Absolut calibration of AMR sensors up to 0.2 µT (at 2K)
- Relative Calibration 0,02 µT (at 2K)
- Hotspots move according to trapped flux measured with AMR
- Mapping system reveals significantly changing trapped flux configurations while quality factor is similar
- BT mapping useful to see local magnetic field and heating
- Details: https://aip.scitation.org/doi/10.1063/1.5030509

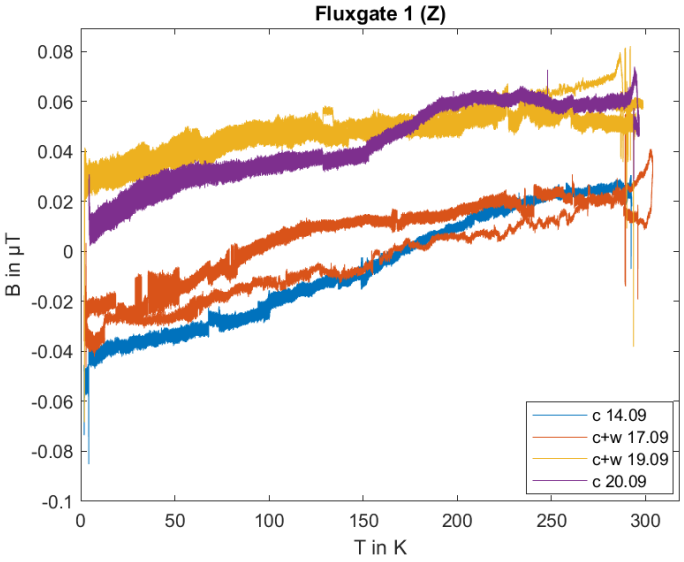


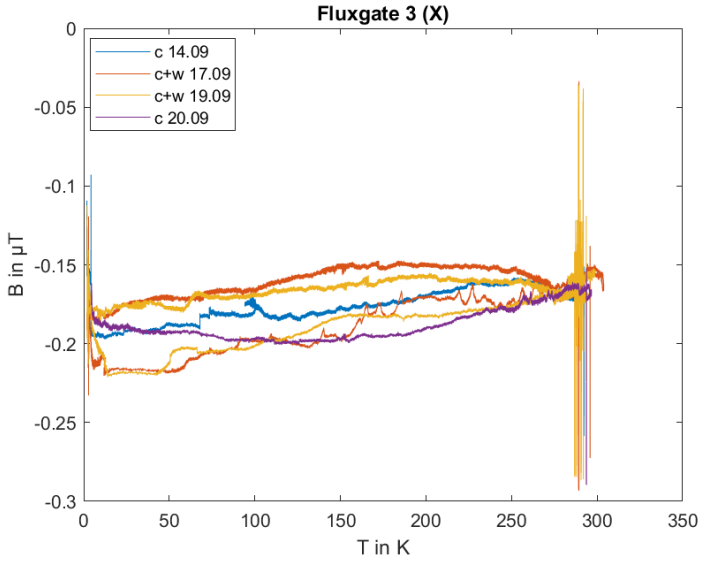
Outlook

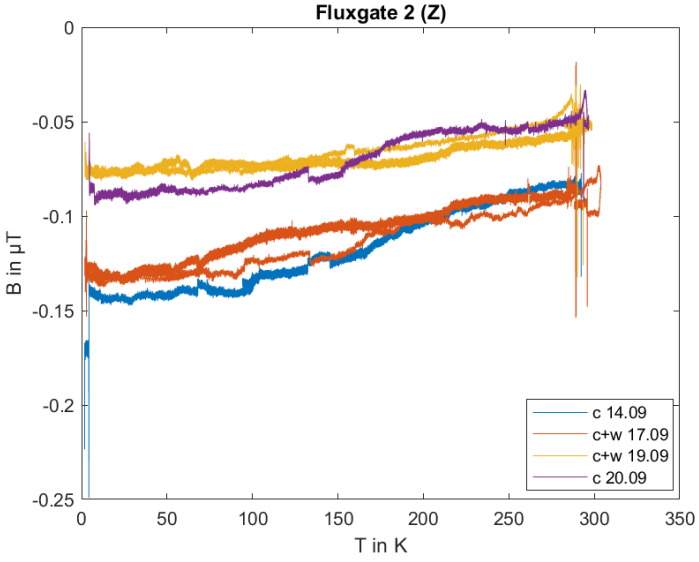
- Use absolute calibration
- Analyze data from polar angle scan

THANK YOU FOR YOUR ATTENTION!

I would like to thank the colleagues from DESY for their help with the calibration by giving us time at their cryostat


Fluxgate 1 (Z)
B in µT
T in K
c 14.09
c+w 17.09
c+w 19.09
c 20.09


Fluxgate 3 (X)
B in µT
T in K
c 14.09
c+w 17.09
c+w 19.09
c 20.09


Fluxgate 2 (Z)
B in µT
T in K
c 14.09
c+w 17.09
c+w 19.09
c 20.09