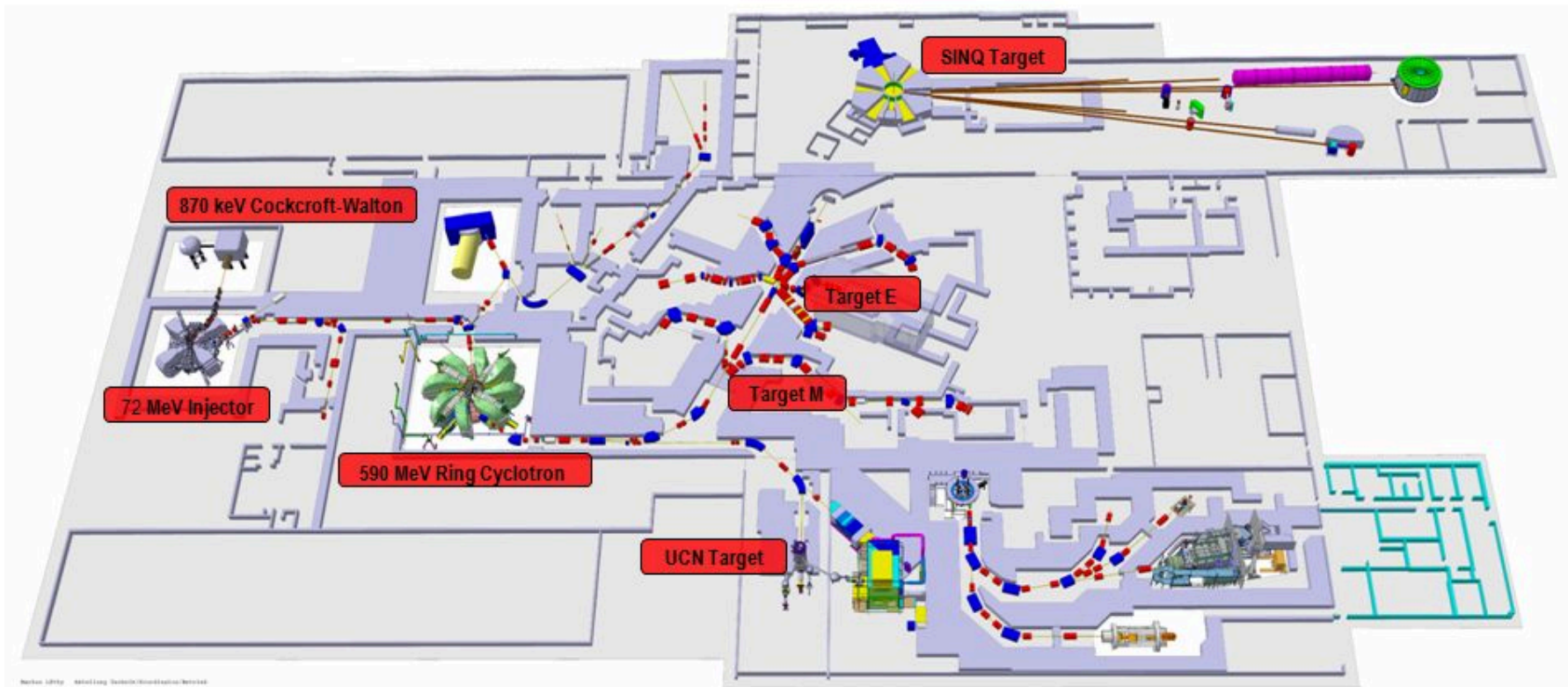


External magnetic fields - mapping, monitoring and shielding

Michał Rawlik on behalf of the nEDM@PSI collaboration

nEDM PSI site overview



SULTAN + EDIPO

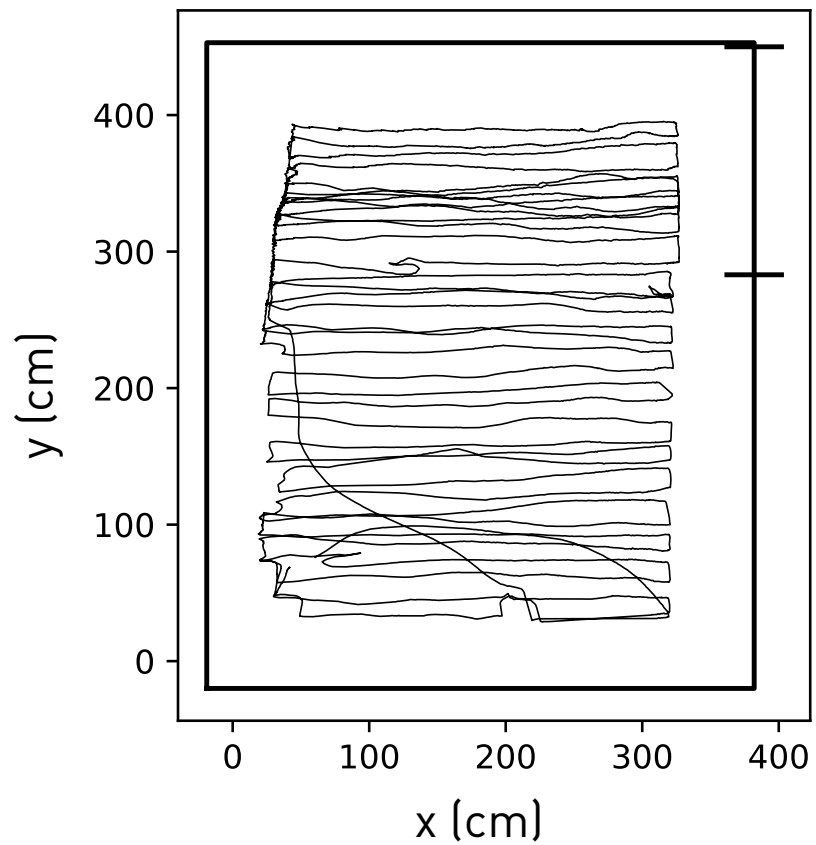
Large-Scale mapper



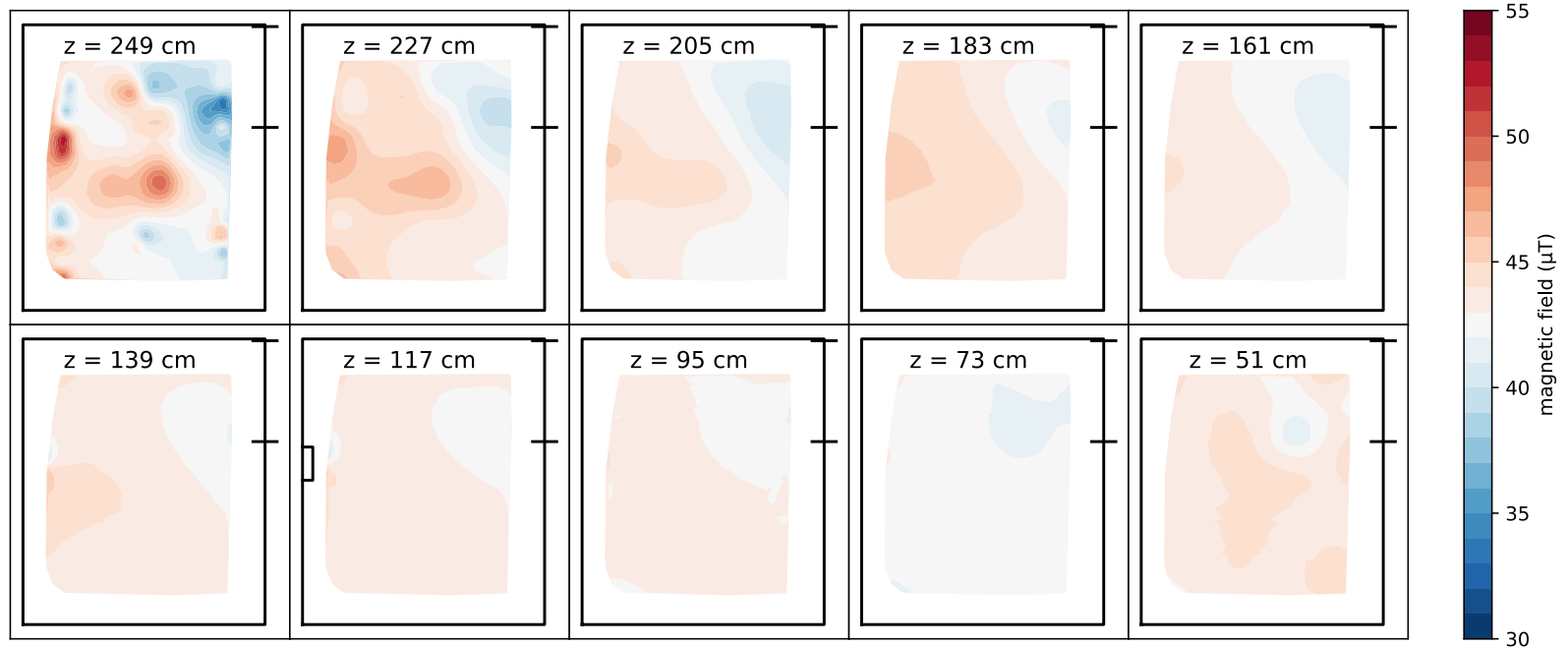
Large-Scale mapper



Position measurement

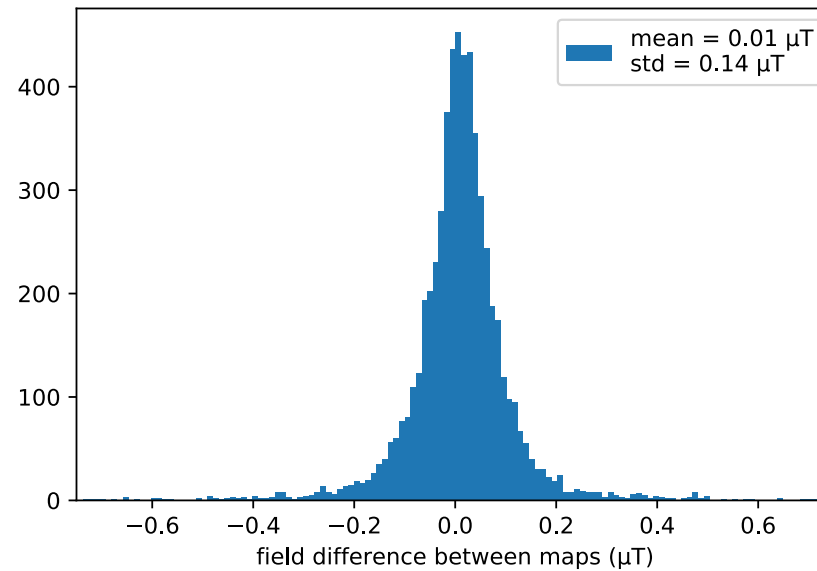


Magnitude of the magnetic field (horizontal slices)



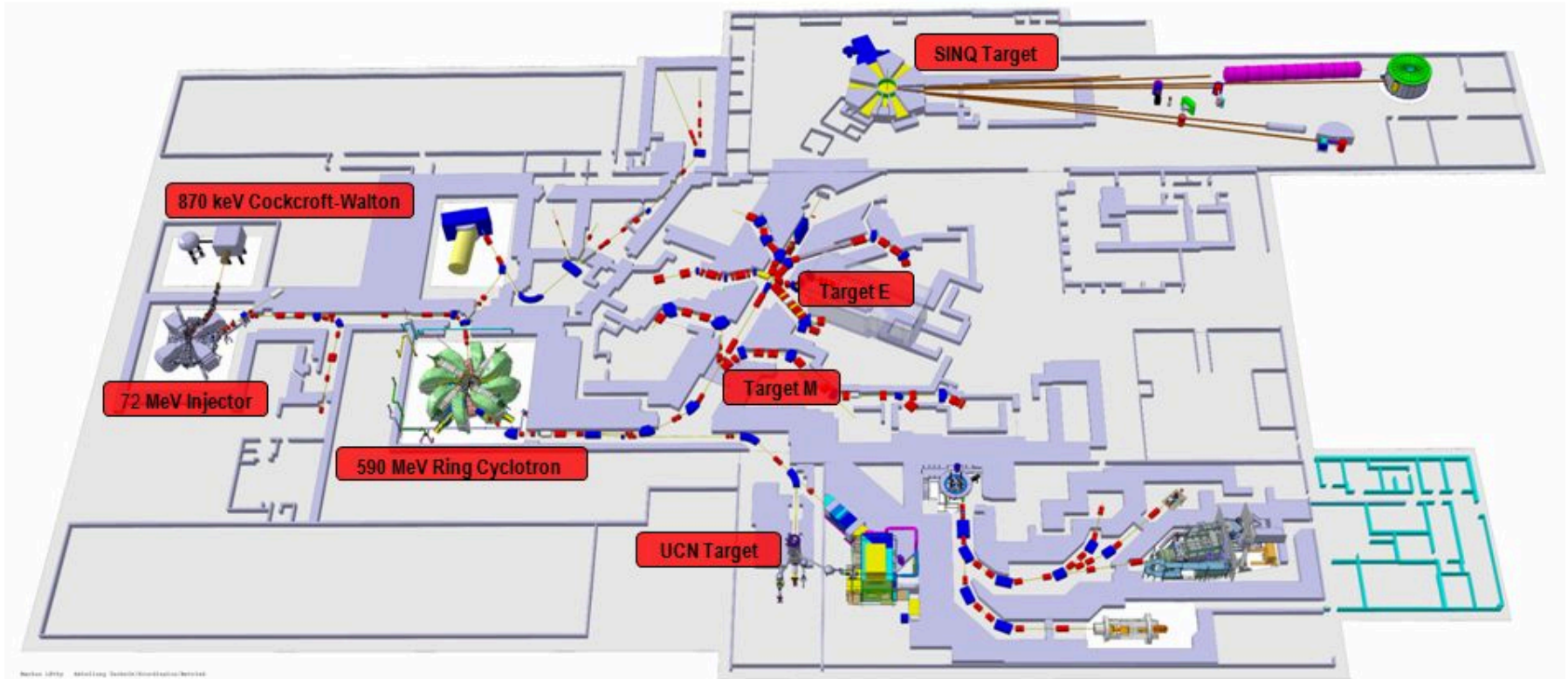
Reproducibility of the maps

vector field



Many thanks to Tizian Blüntschi and Avraam Chatzimichailidis

nEDM PSI site overview

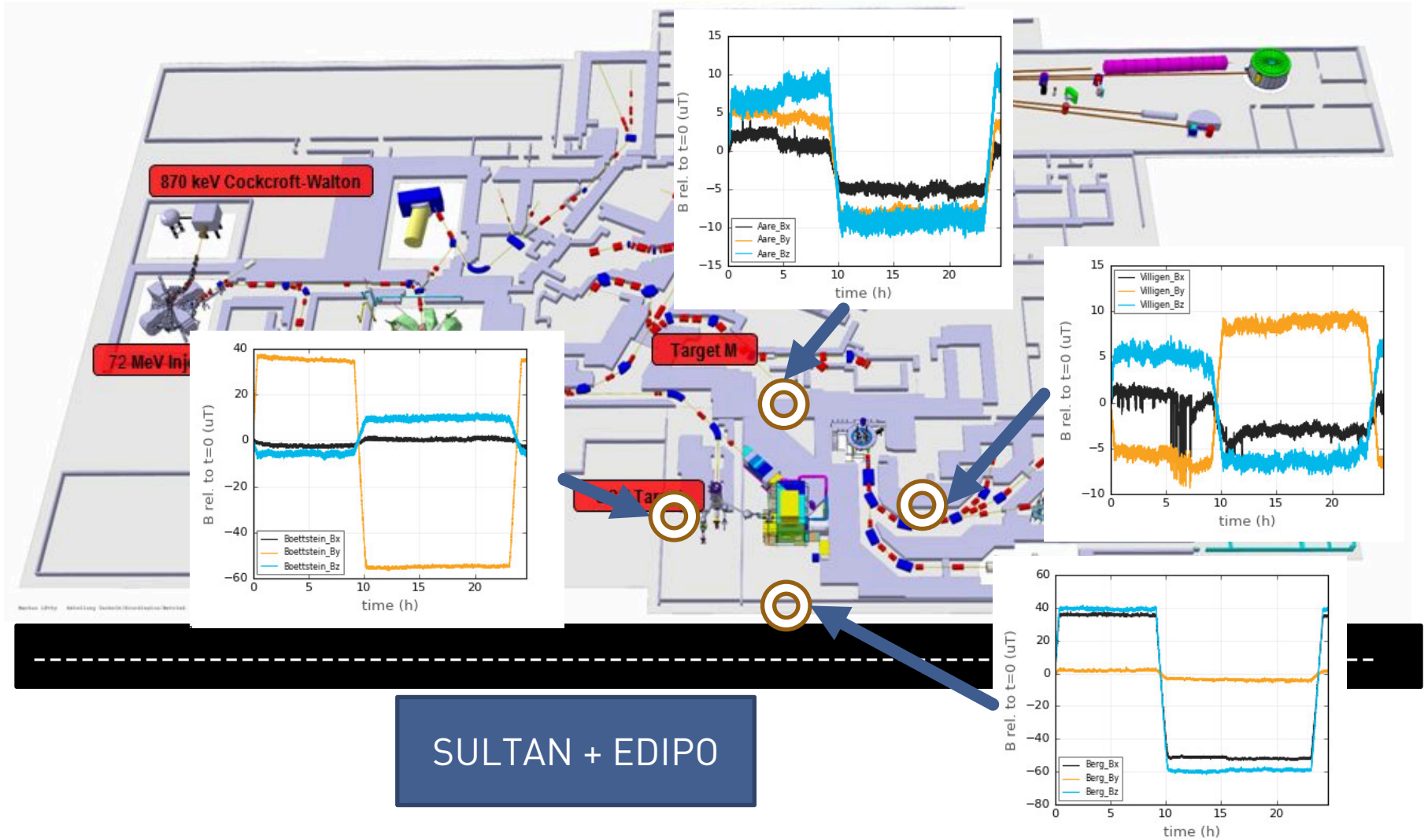


SULTAN + EDIPO

A "remote magnetometer"



SULTAN ramp seen by remote magnetometers



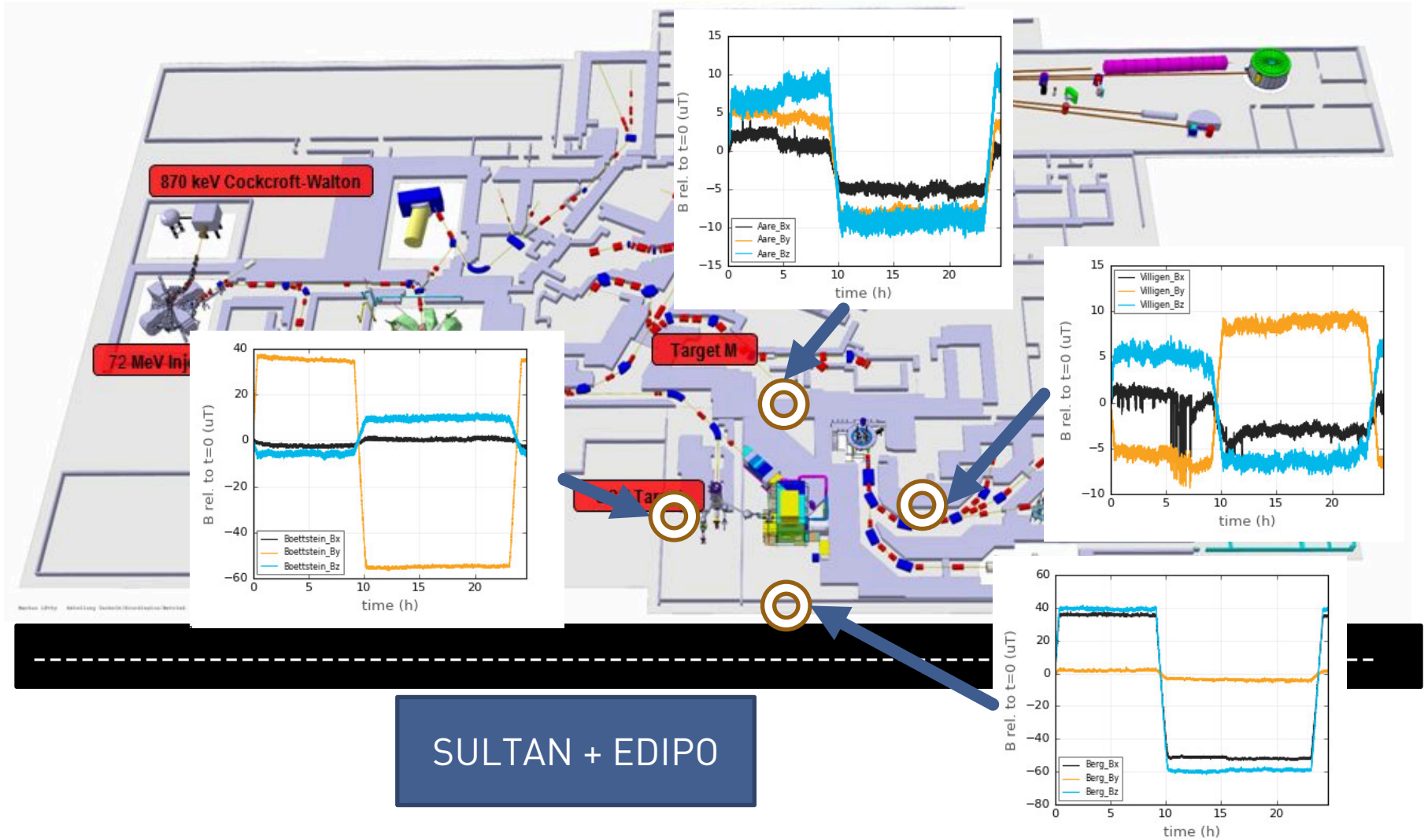
SULTAN + EDIPO

Gradient determination

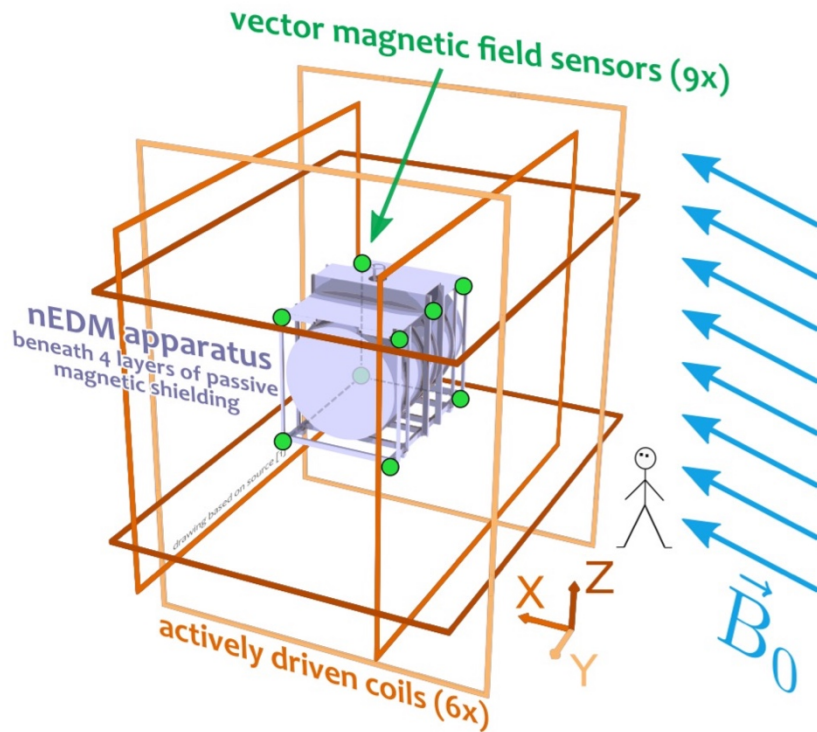


Many thanks to Daria Cegietka and Gianluca Janka

SULTAN ramp seen by remote magnetometers

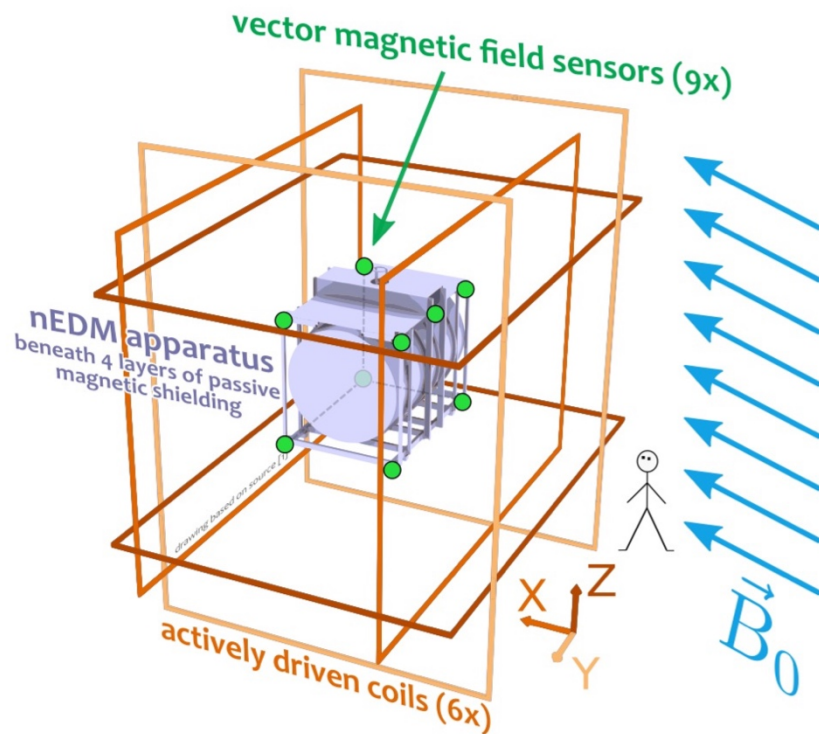


Surrounding Field Compensation (SFC) – nEDM



thanks to Beatrice for the image
(and for the SFC)

Feedback algorithm



dim 27, readouts of all sensors

dim 27x9, proportionality constants – encodes geometry

dim 6, currents in the coils

dim 27, the external field

dim 27, the no-field goal

$$\vec{B} = M \vec{I} + \vec{B}_0 \stackrel{!}{=} \vec{0}$$

$$\vec{I}_{n+1} = \vec{I}_n - M^i \vec{B}_n$$

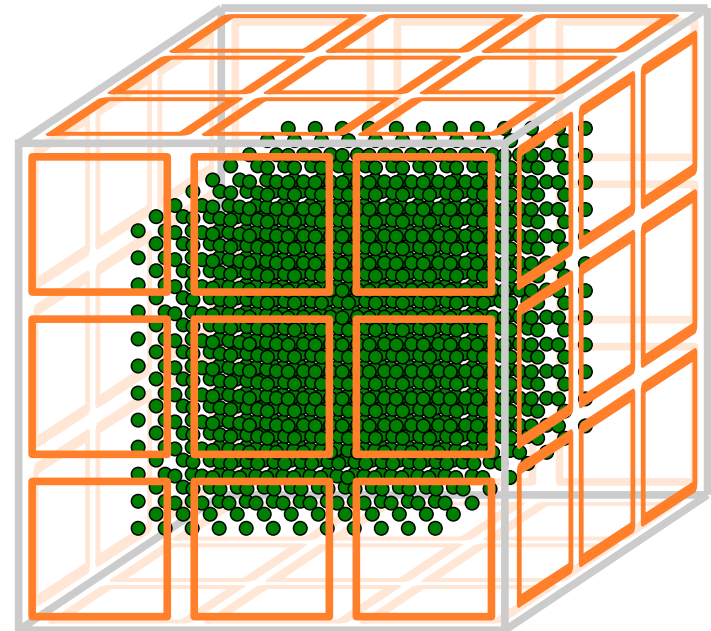
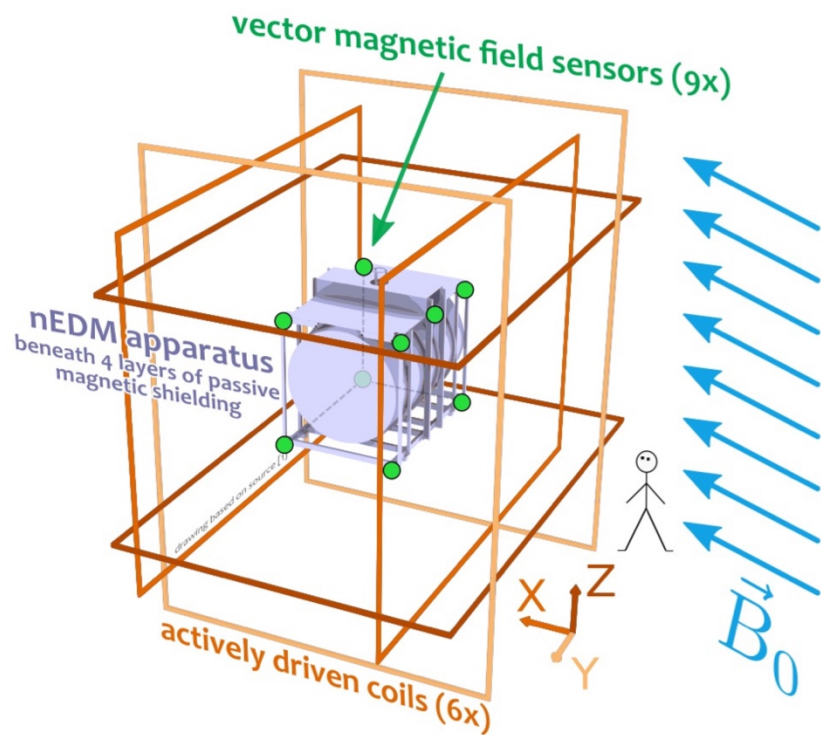
next currents

currents now

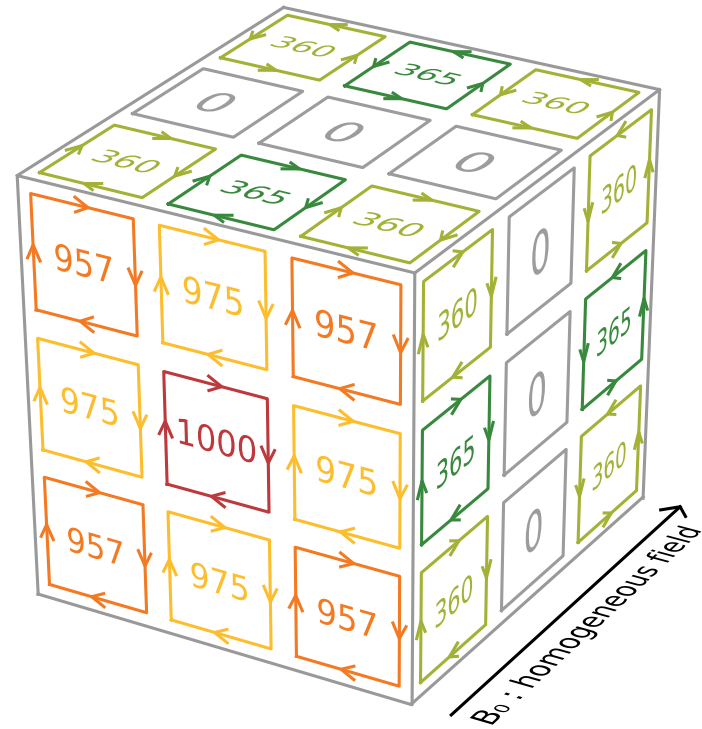
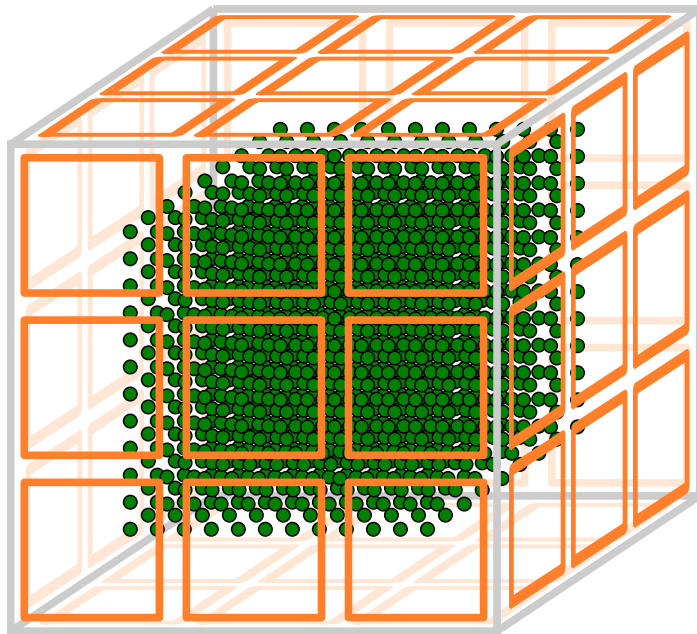
readouts now

Moore-Penrose pseudoinverse of M

Coil design “SFC style”

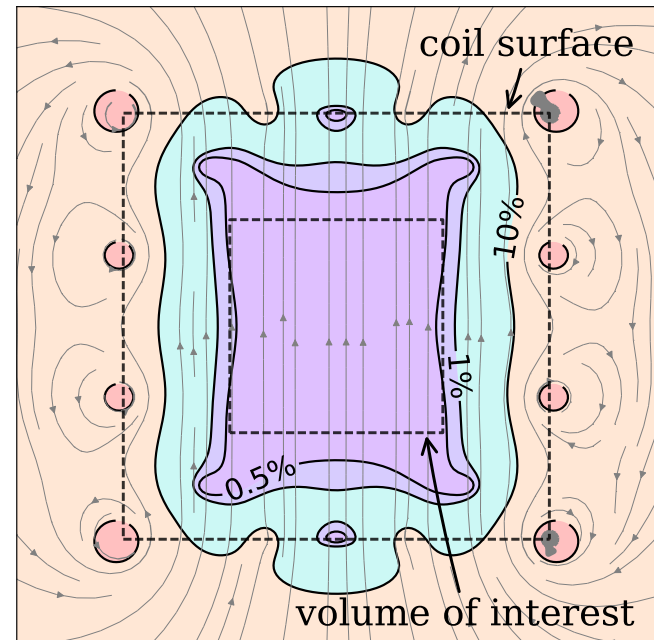
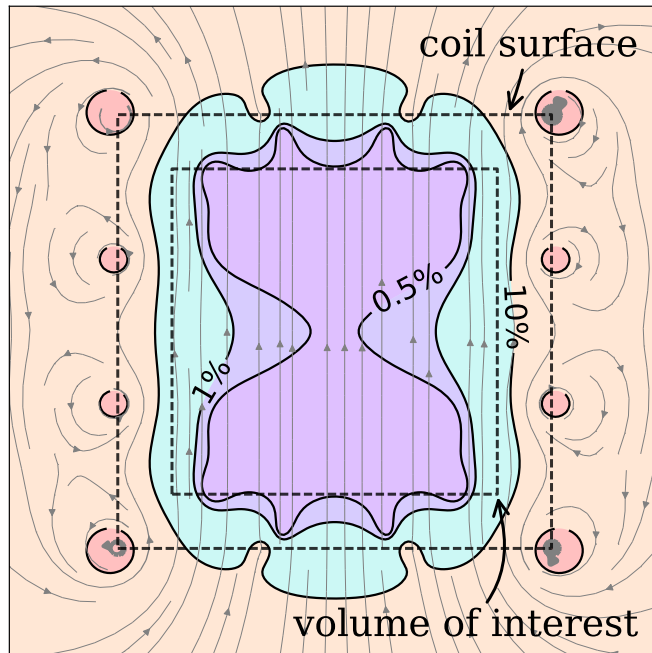


Least squares \rightarrow currents in “tiles”

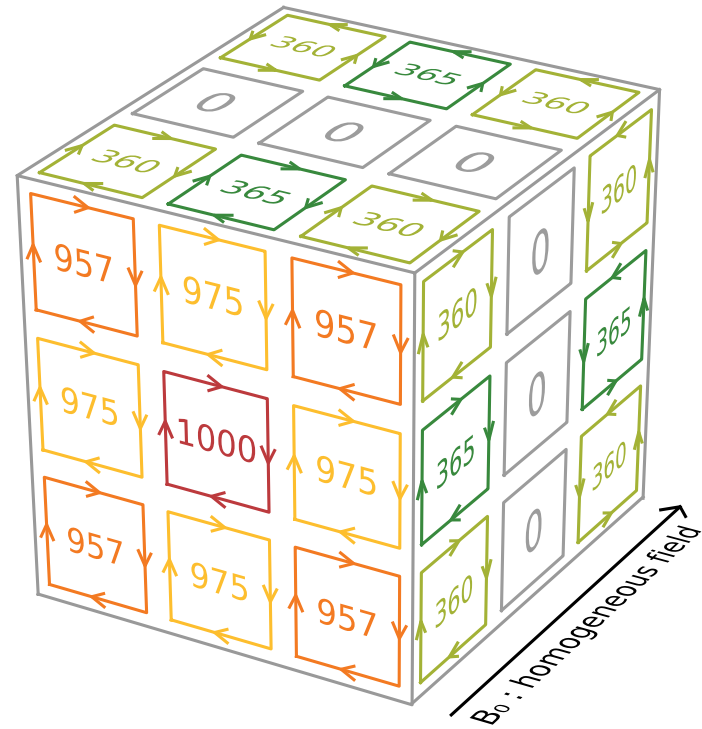
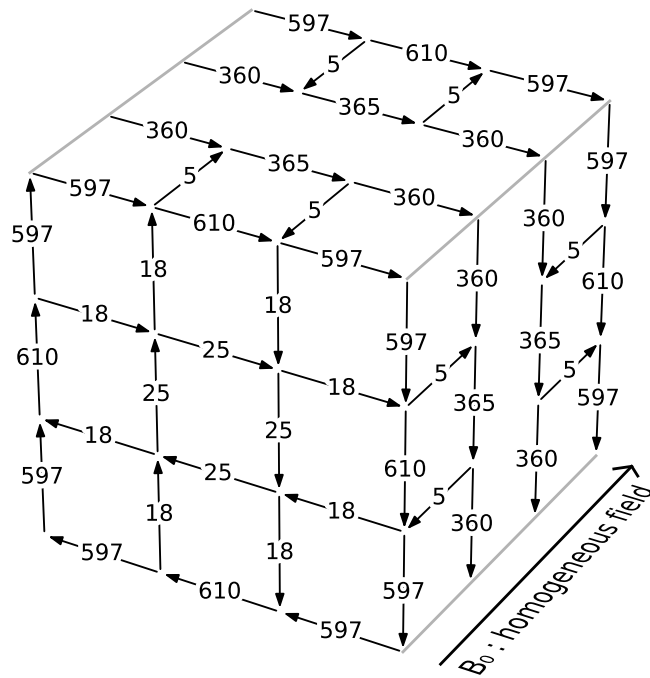


$$\vec{B} = M \vec{I} + \vec{B}_0 \stackrel{!}{=} \text{homogeneous along } x$$

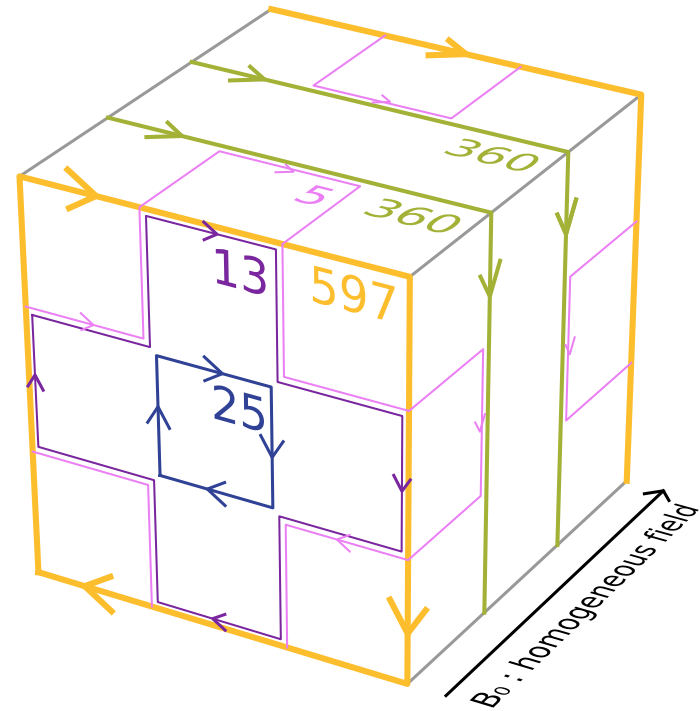
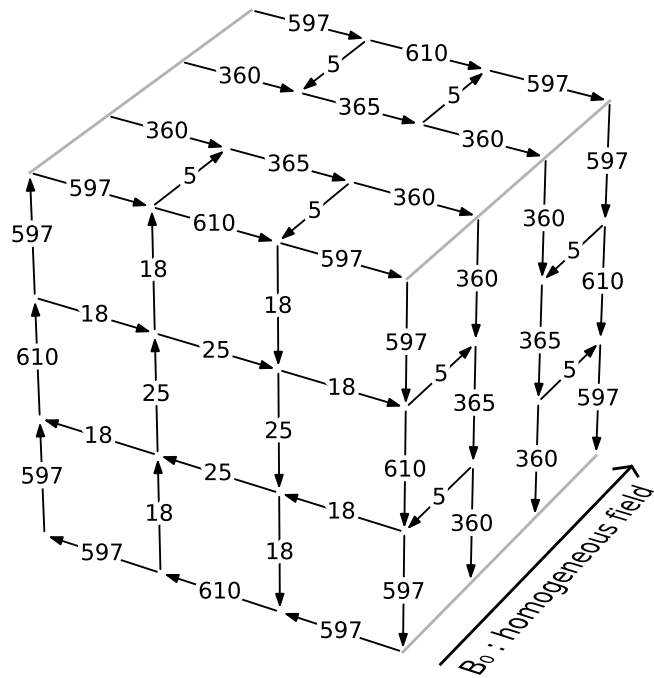
Active Magnetic Field shielding



edge currents ← currents in “tiles”



edge currents \rightarrow simplified coils



github.com/rawlik/Coils.jl

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Add topics

35 commits 1 branch 0 releases 1 contributor BSD-3-Clause

Branch: master New pull request Create new file Upload files Find file Clone or download

Michał Rawlik Fix the histogram fix. Latest commit 95c673a a day ago

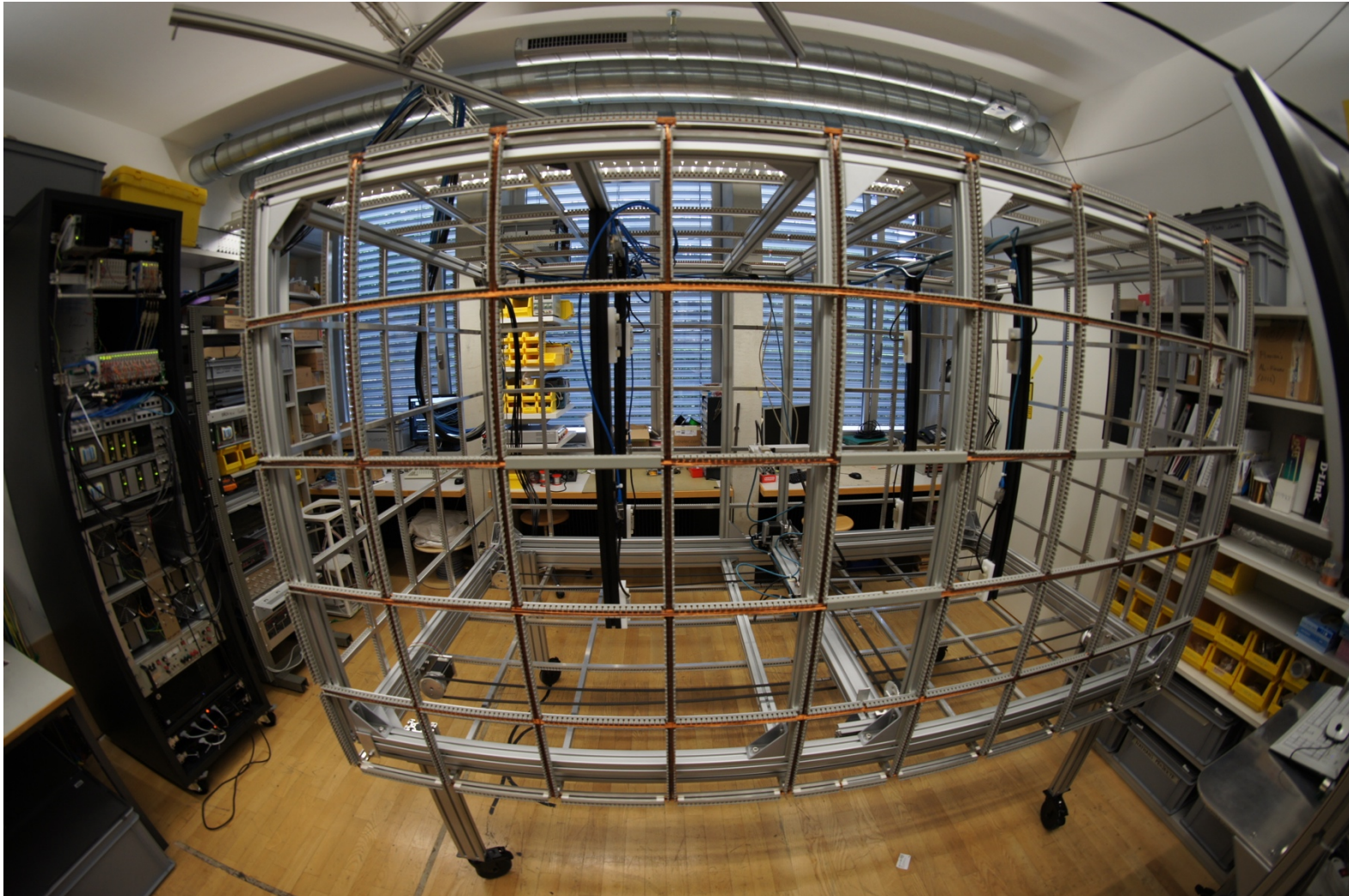
.gitignore	Add an image to the README.	22 days ago
.travis.yml	Add a travis test.	a month ago
Coils.jl	Relax the tolerance when adding the edges automatically.	a month ago
CoilsPlot.jl	Fix the histogram fix.	a day ago
LICENSE	Initial commit	a month ago
README.md	Add an image to the README.	22 days ago
arrow3d.py	Add existing code.	2 months ago
example.ipynb	Fix typos in the example.	22 days ago
screenshot.png	Add an image to the README.	22 days ago
test.jl	Remove pySFC dependency from test.jl.	a month ago

README.md

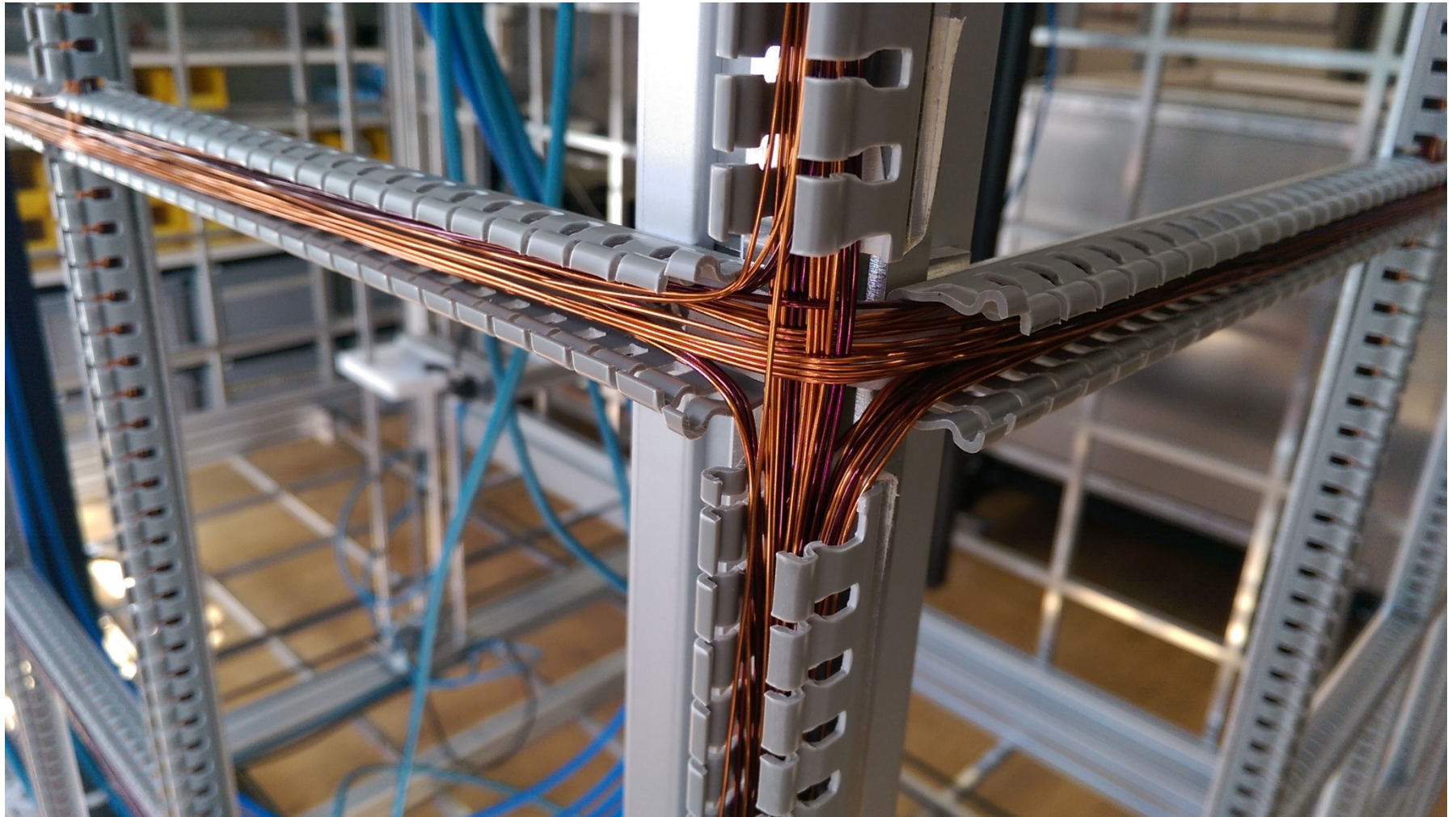
Coils.jl

build passing

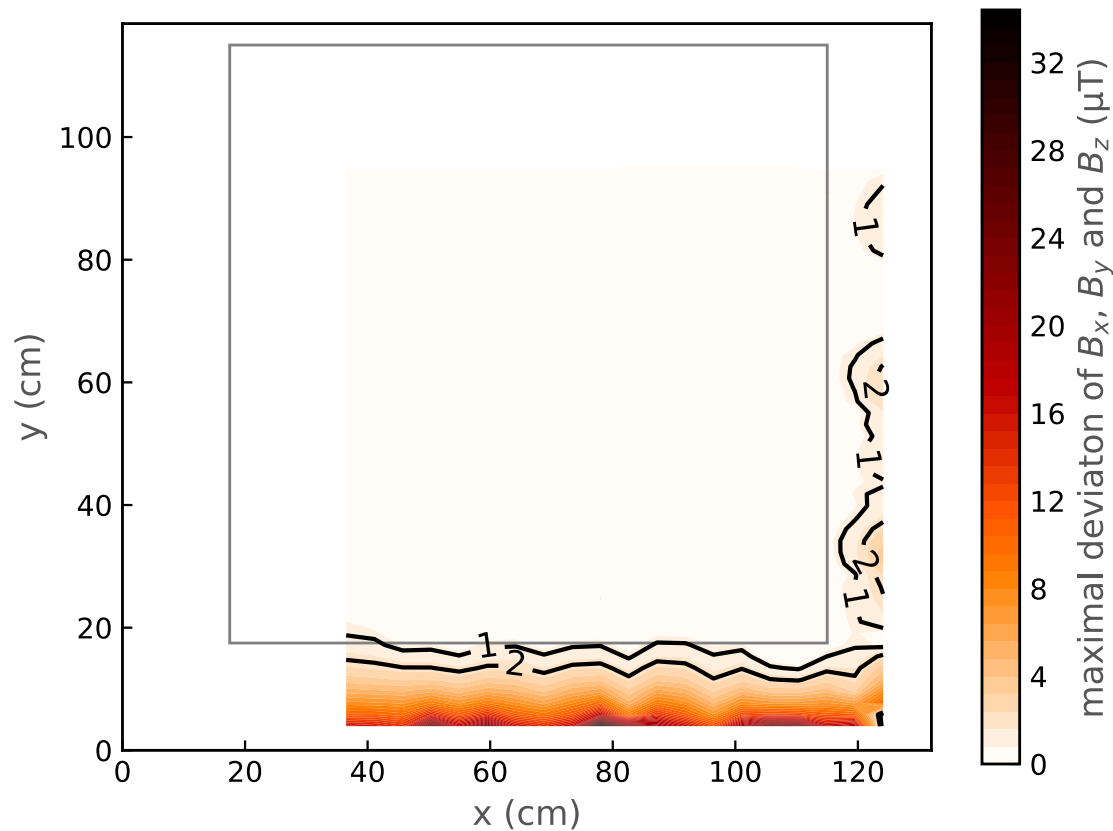
Prototype at ETH



Prototype at ETH

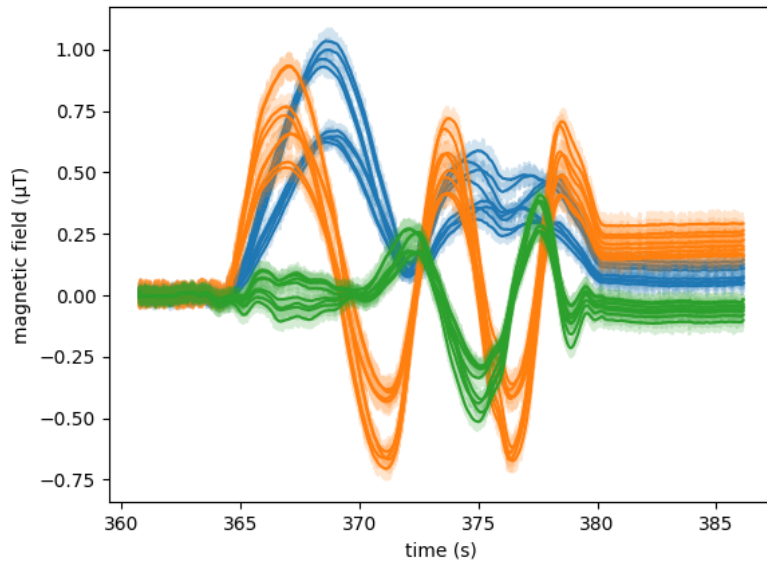


A measured map of a homogeneous field ($50\mu\text{T}$ along x)

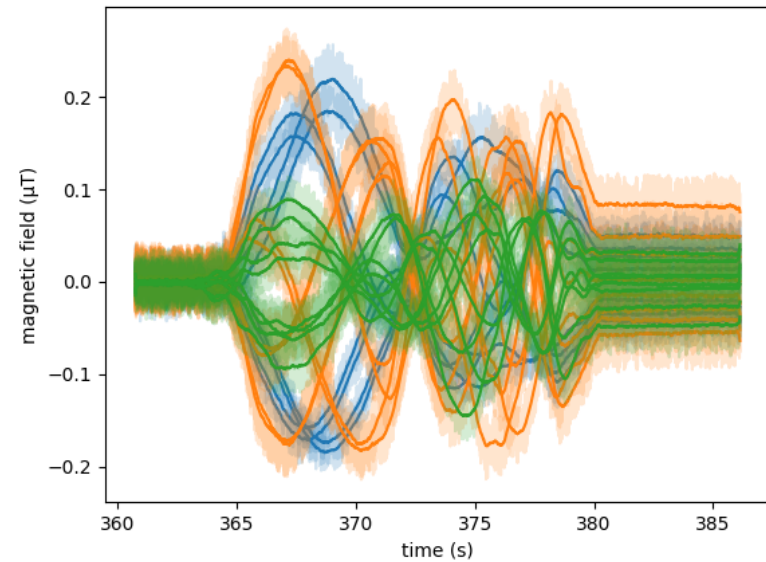


Compensating a dipole source 7.5m away

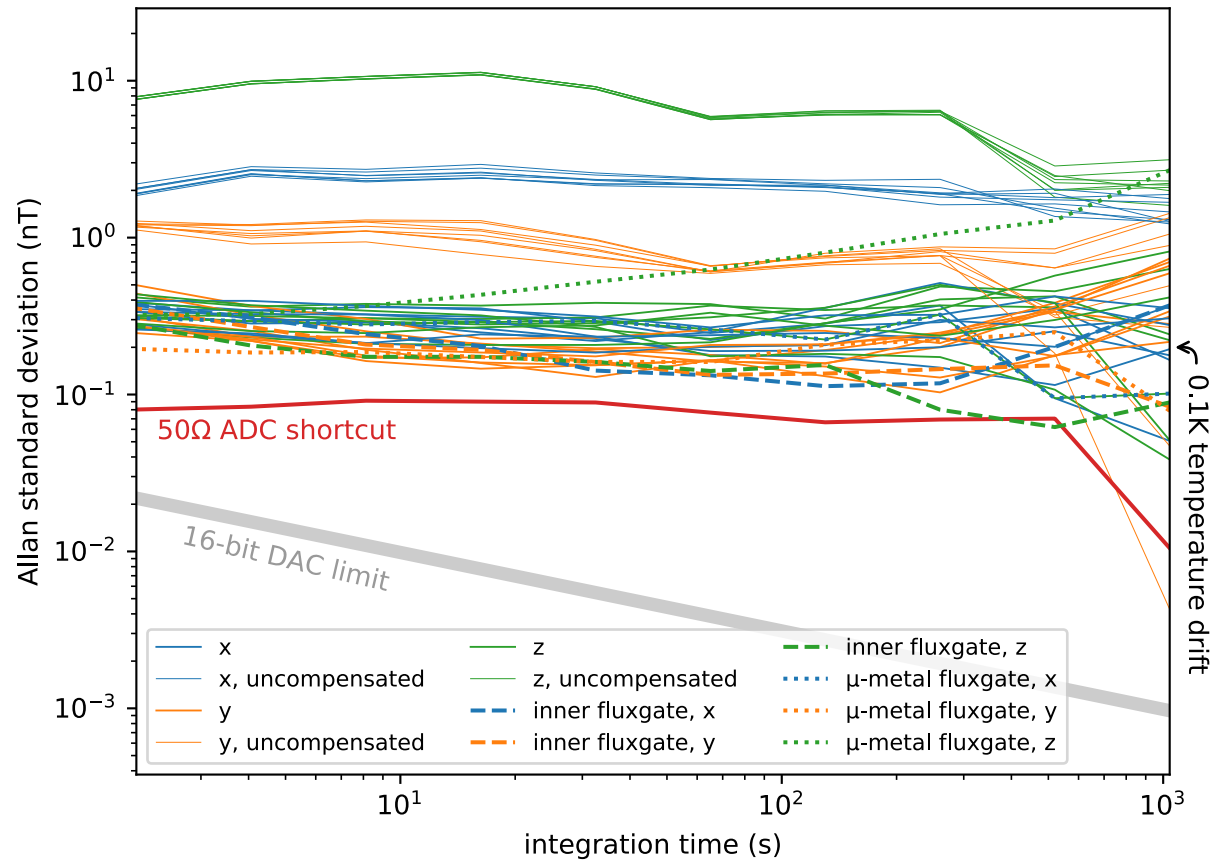
dipole source @ 7.5m



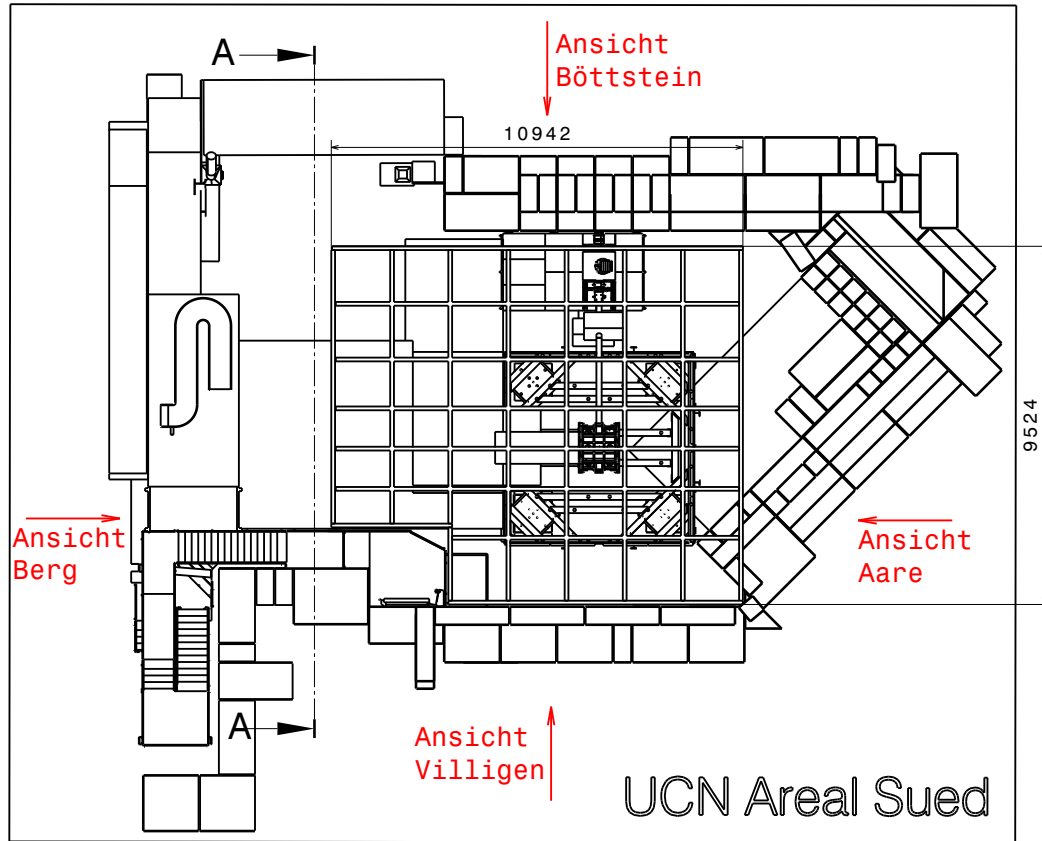
compensated field



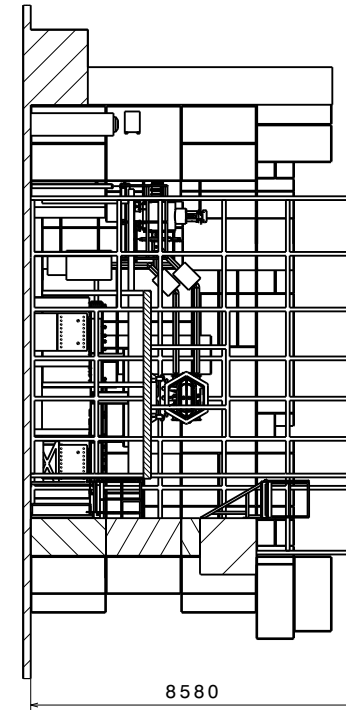
Field stability on a quiet weekend



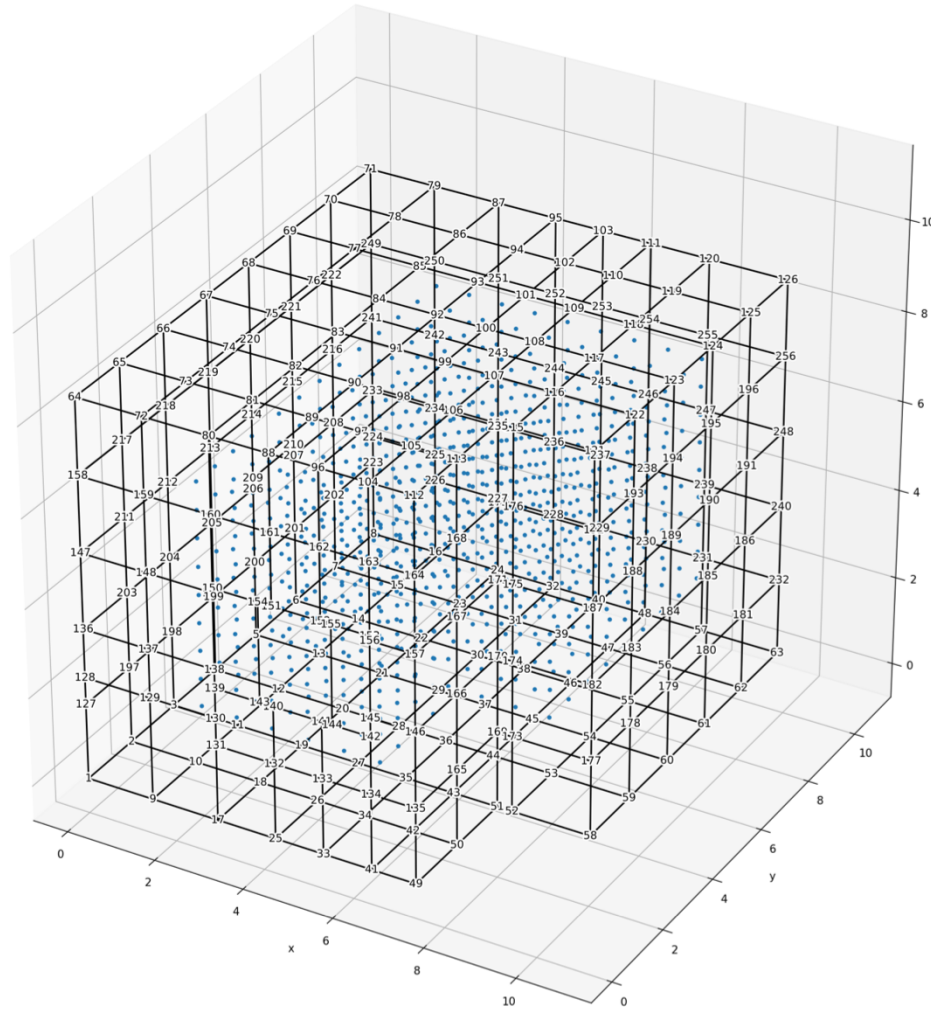
n2EDM SFC



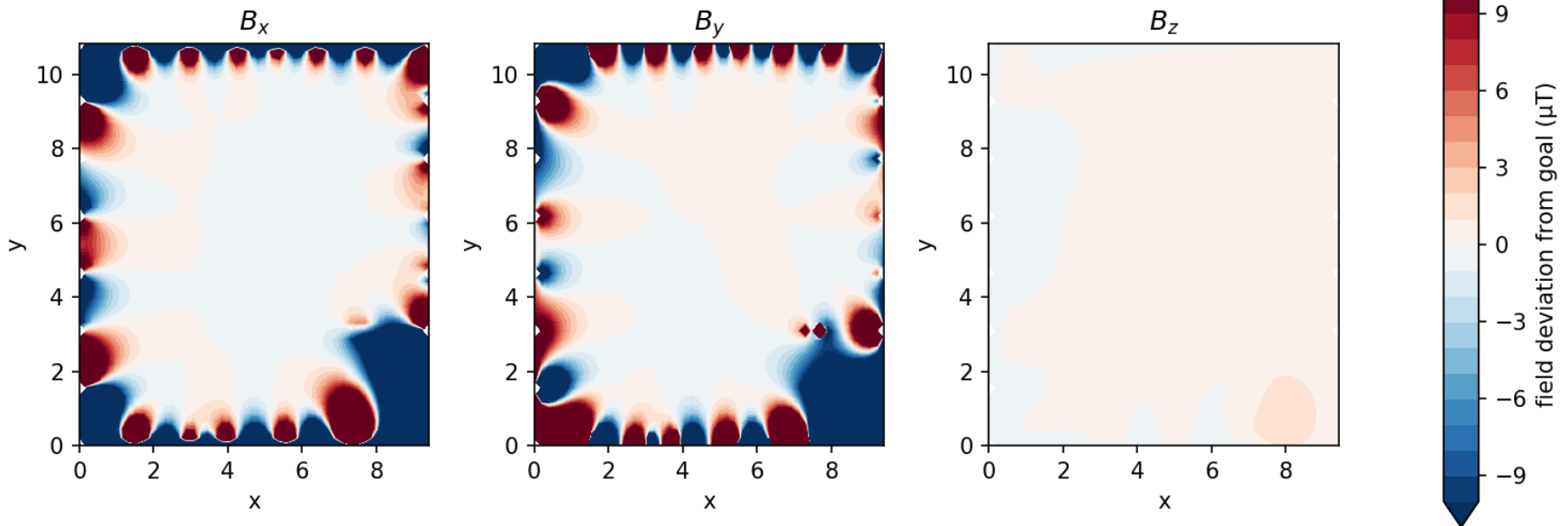
Schnitt A-A



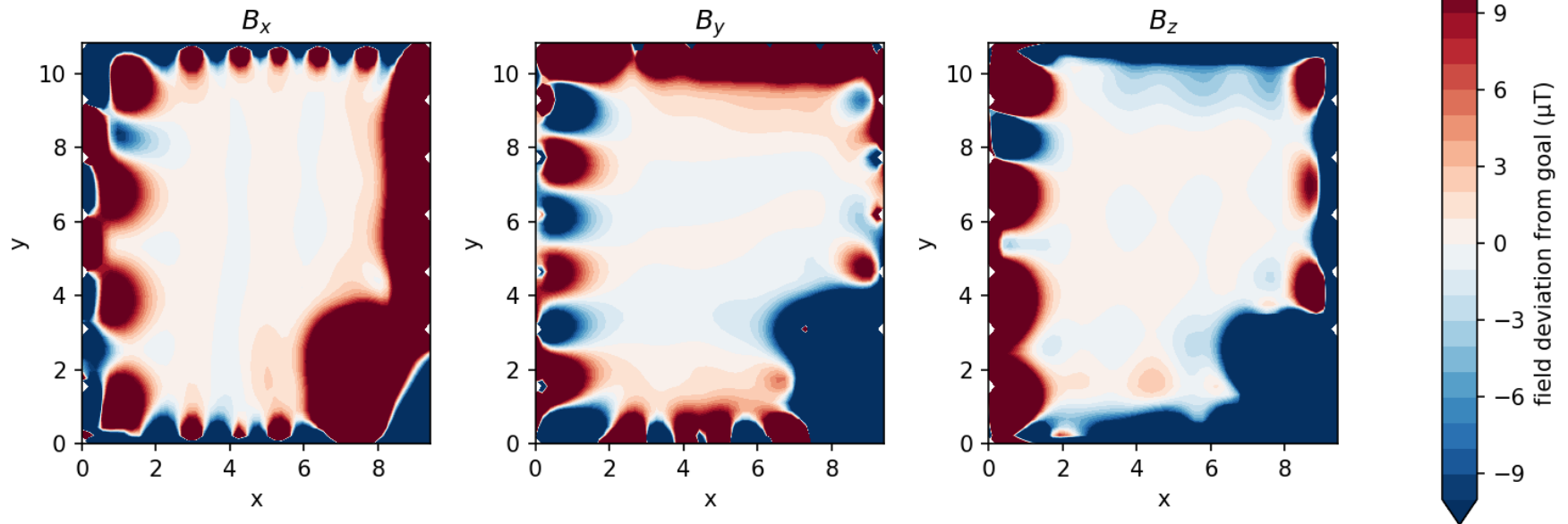
n2EDM SFC



homogeneous field along x



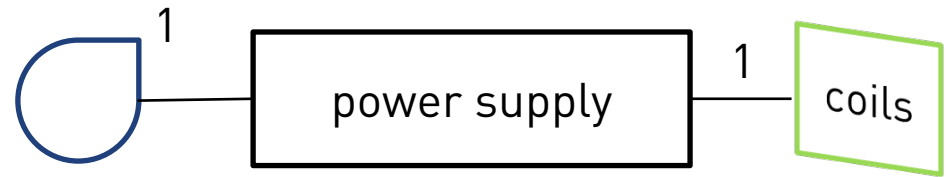
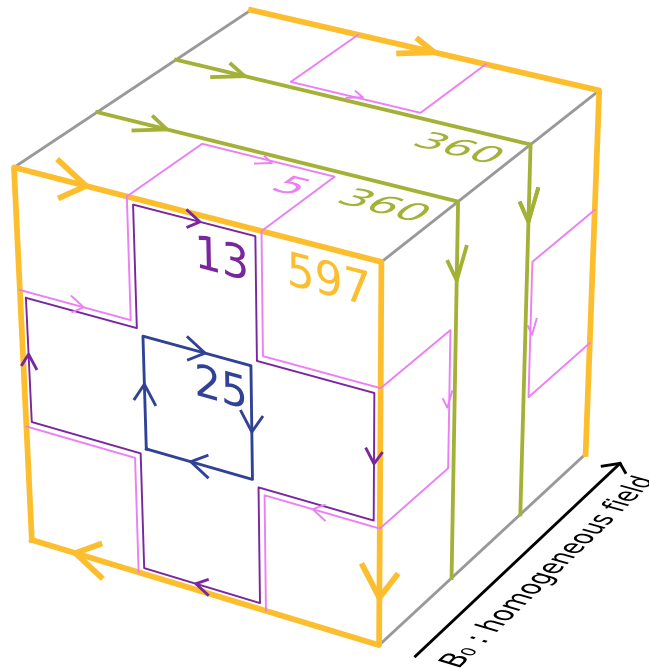
first order gradient



Thank you for your attention!

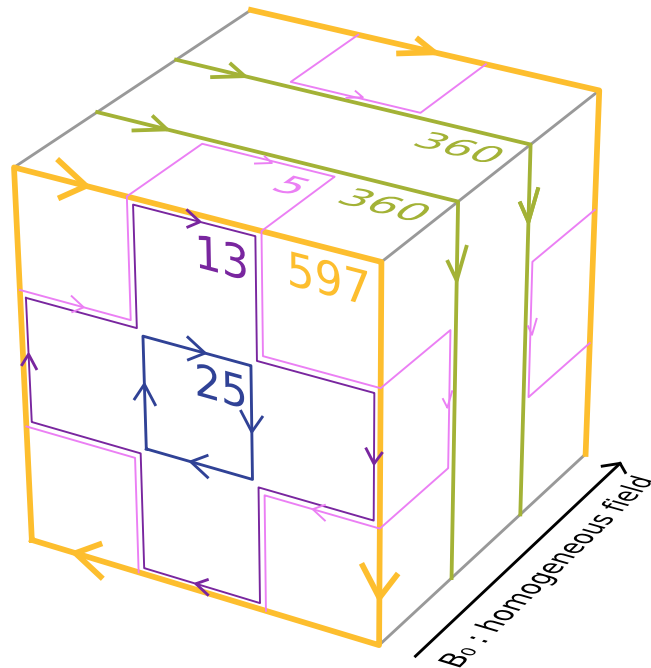


Division into windings



597 = 597 windings
 360 = 360 windings
 25 = 25 windings
 13 = 13 windings
 5 = 5 windings

Division into windings



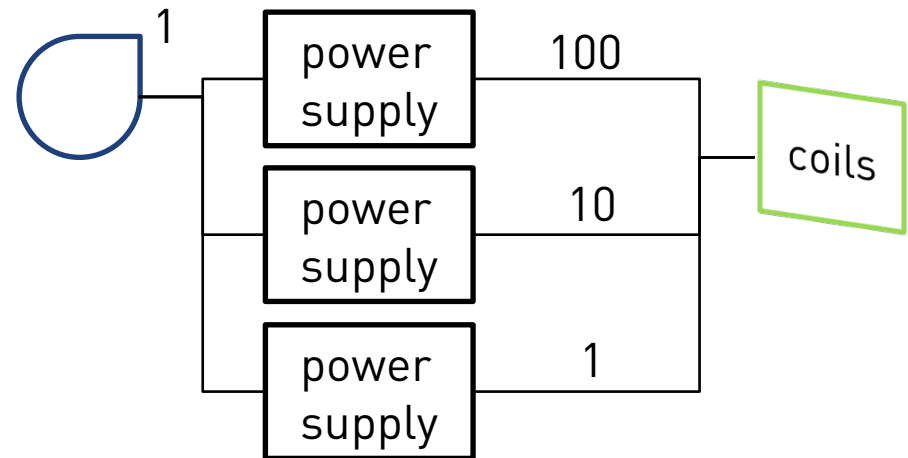
$$597 = 5 \times 100 + 9 \times 10 + 7 \times 1$$

$$360 = 3 \times 100 + 6 \times 10$$

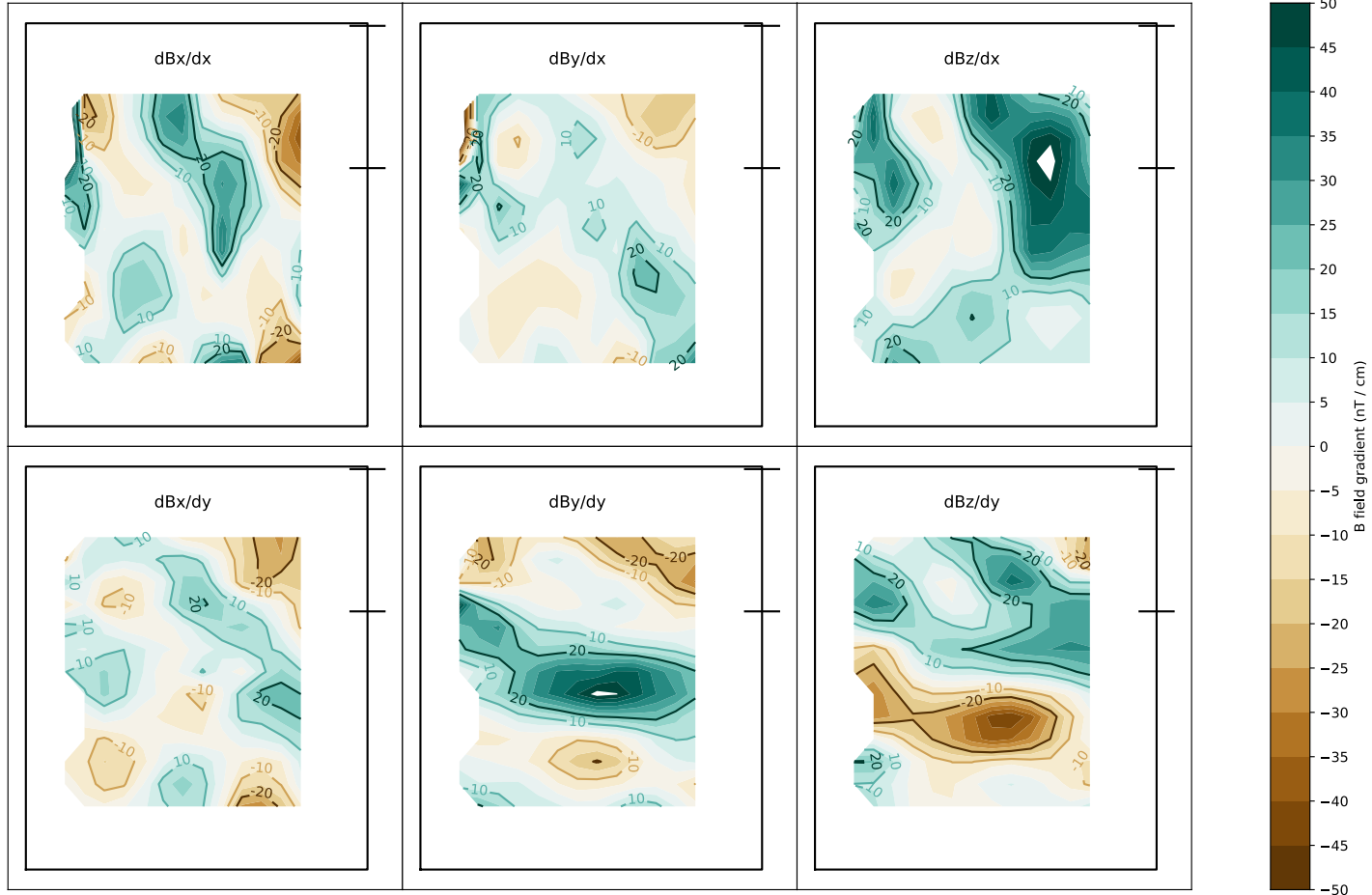
$$25 = 2 \times 10 + 5 \times 1$$

$$13 = 1 \times 10 + 3 \times 1$$

$$5 = 5 \times 1$$

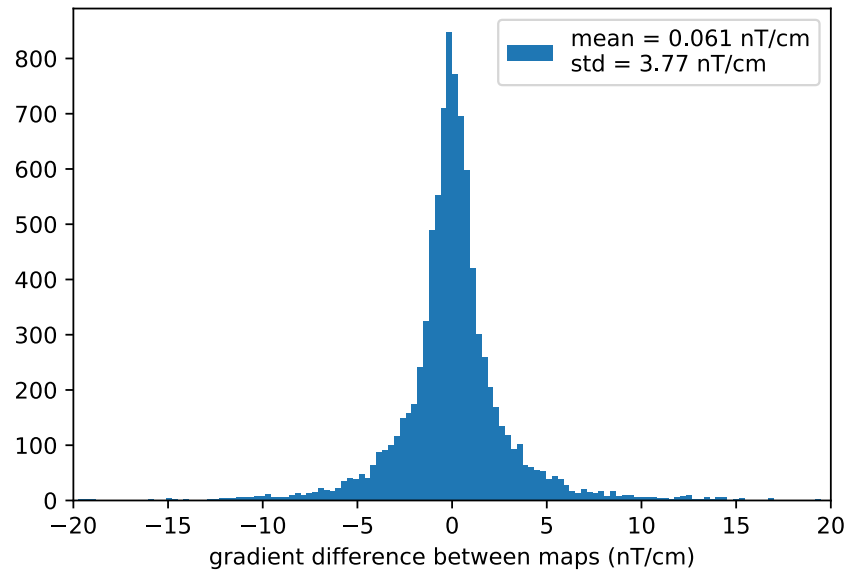


Gradient determination (one horizontal slice)

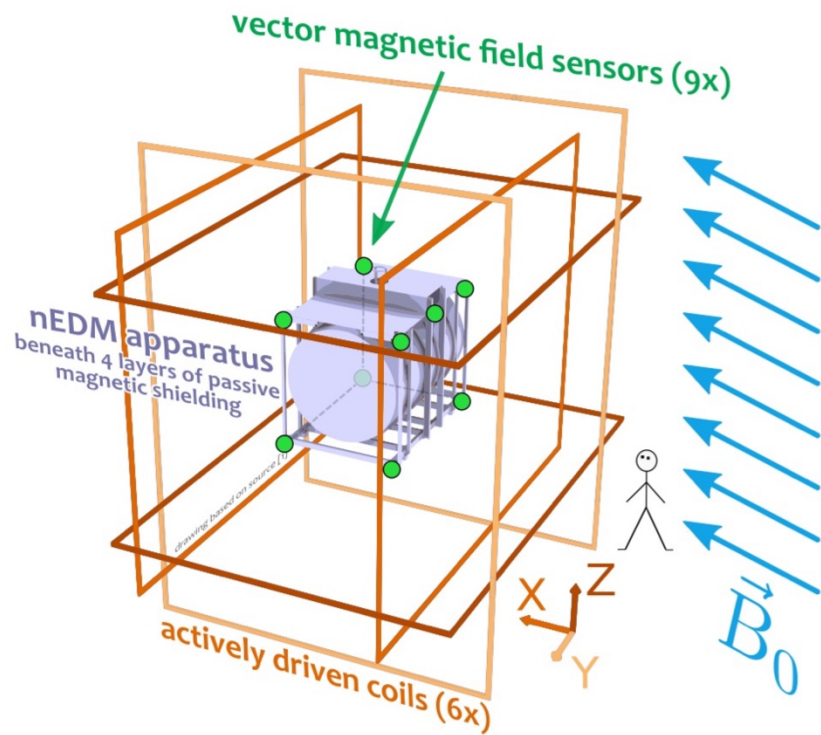


Gradient determination (reproducibility)

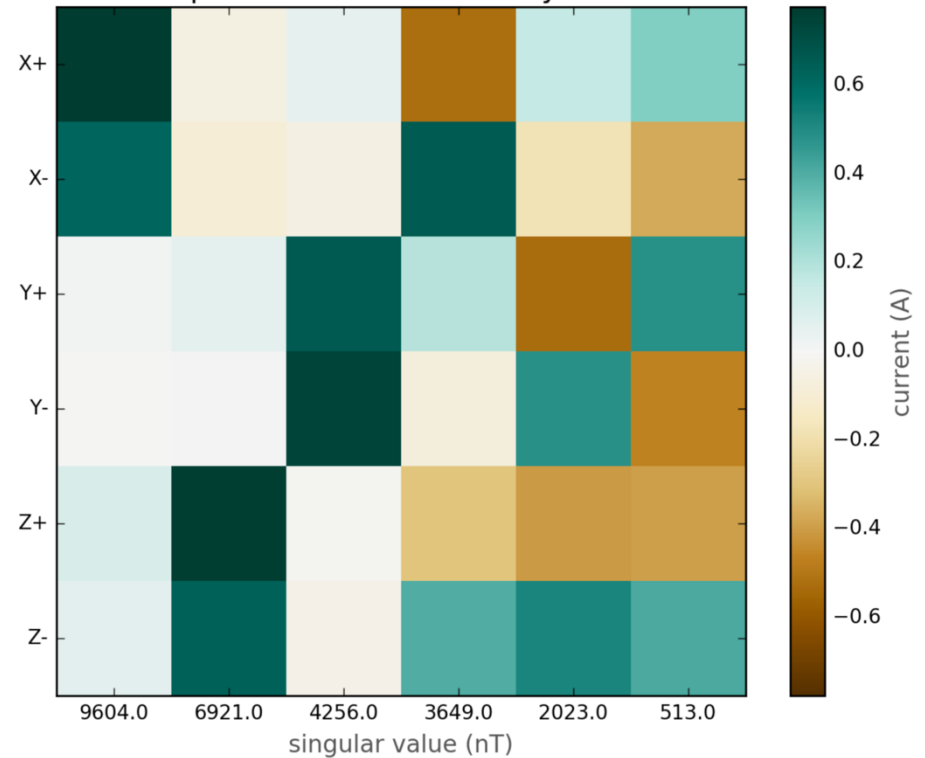
vector gradient



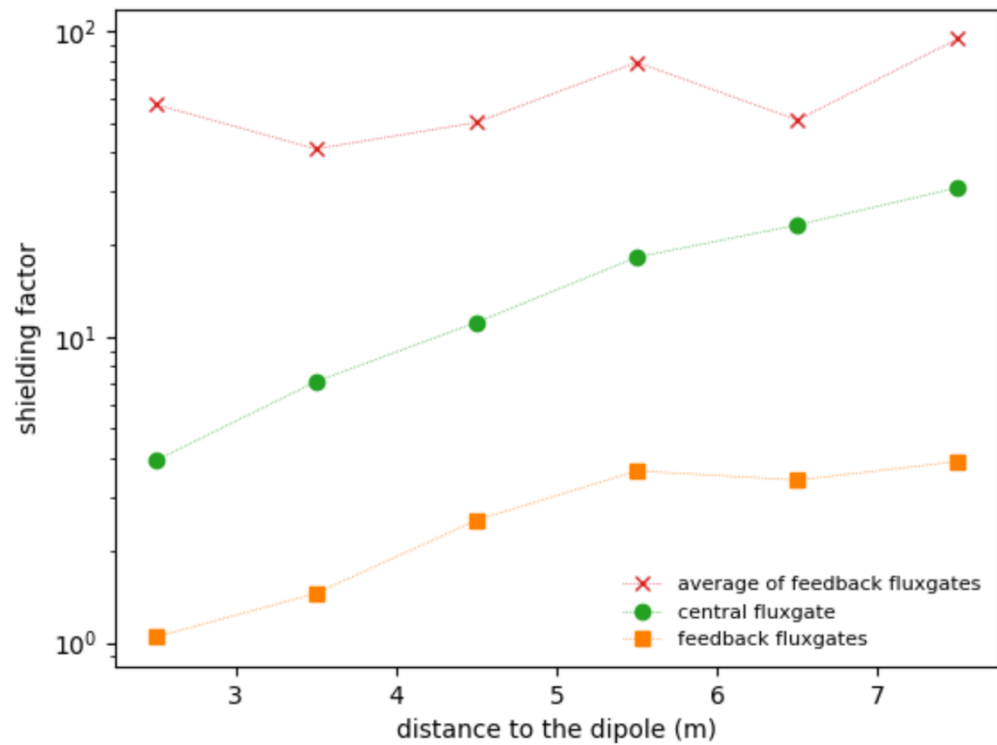
singular coils in an SFC



The coil-singular vectors of the nEDM SFC matrix
plotted on 2016-12-12 by MR



shielding a dipole with a homogeneous SFC



Prototype at ETH

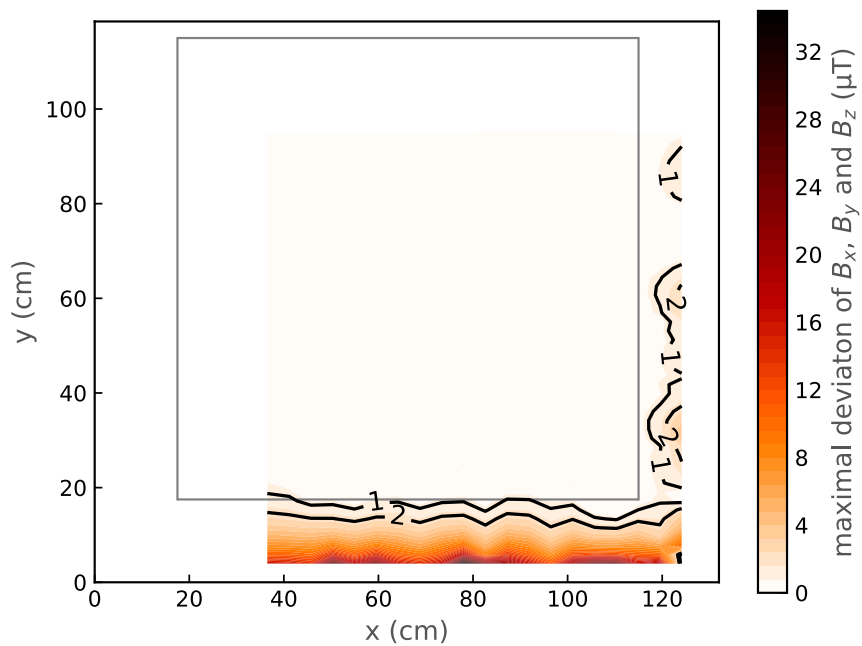


10m high mapping tower

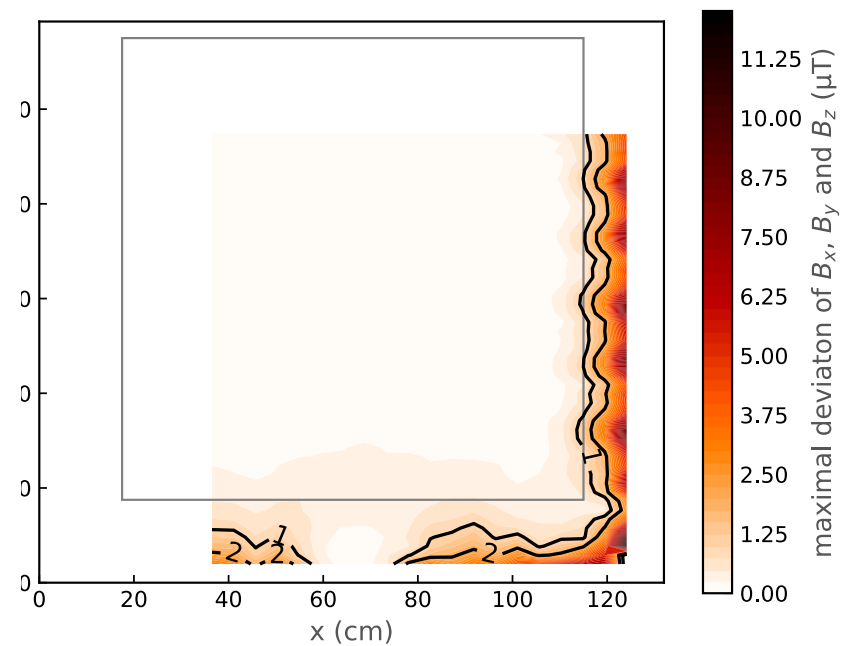


Maps of homogeneous fields

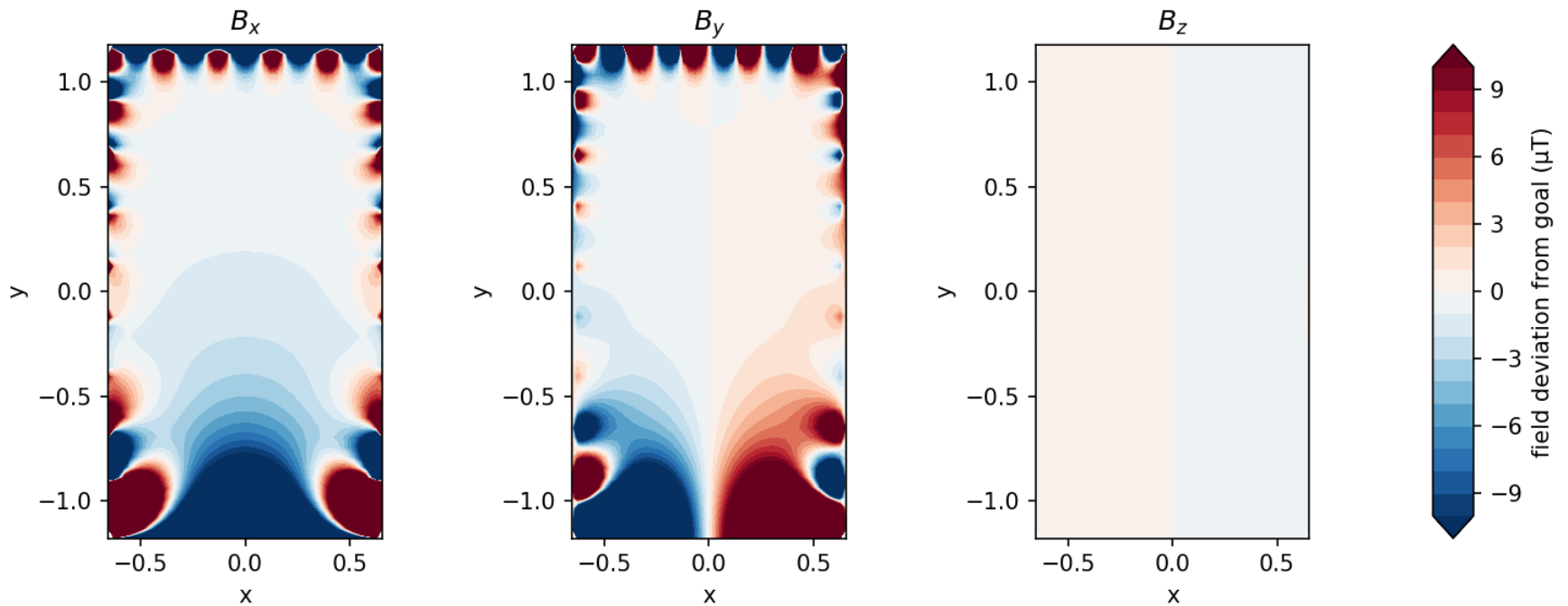
homogeneous along x: $50\mu\text{T}$



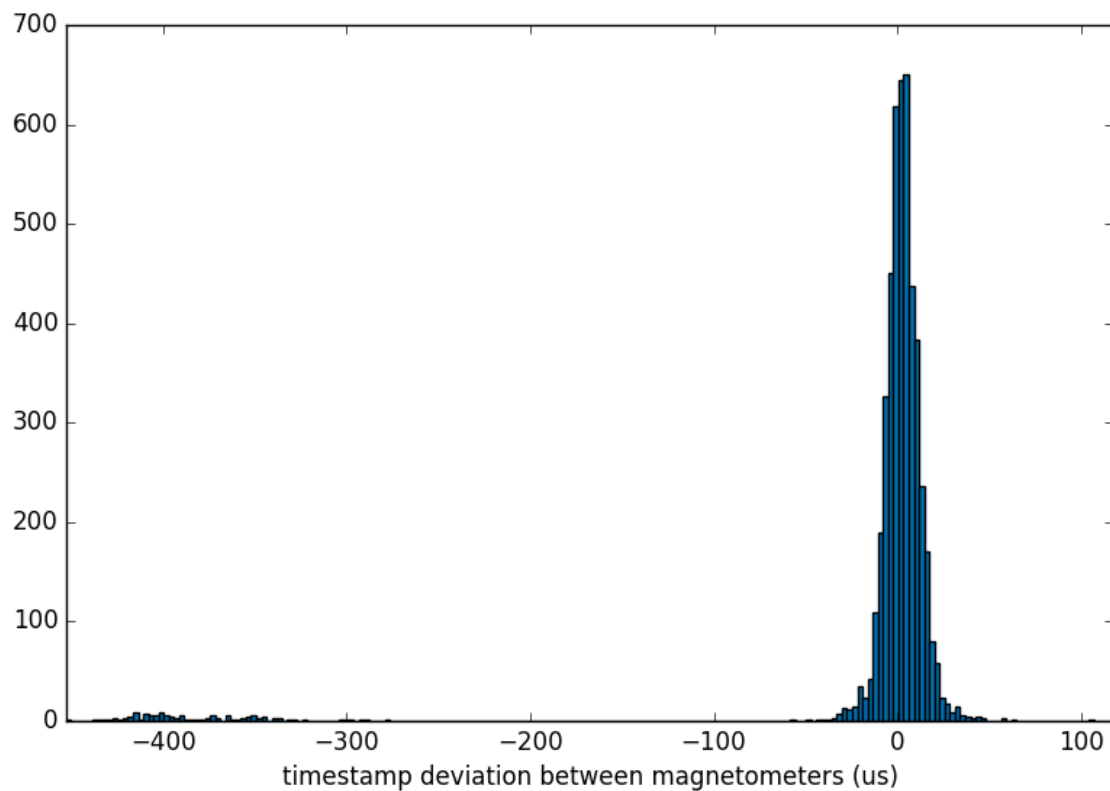
homogeneous along y: $50\mu\text{T}$



Open-end design, homogeneous field along x



Remote magnetometers timing



Remote Magnetometers

