PSI ETH zürich

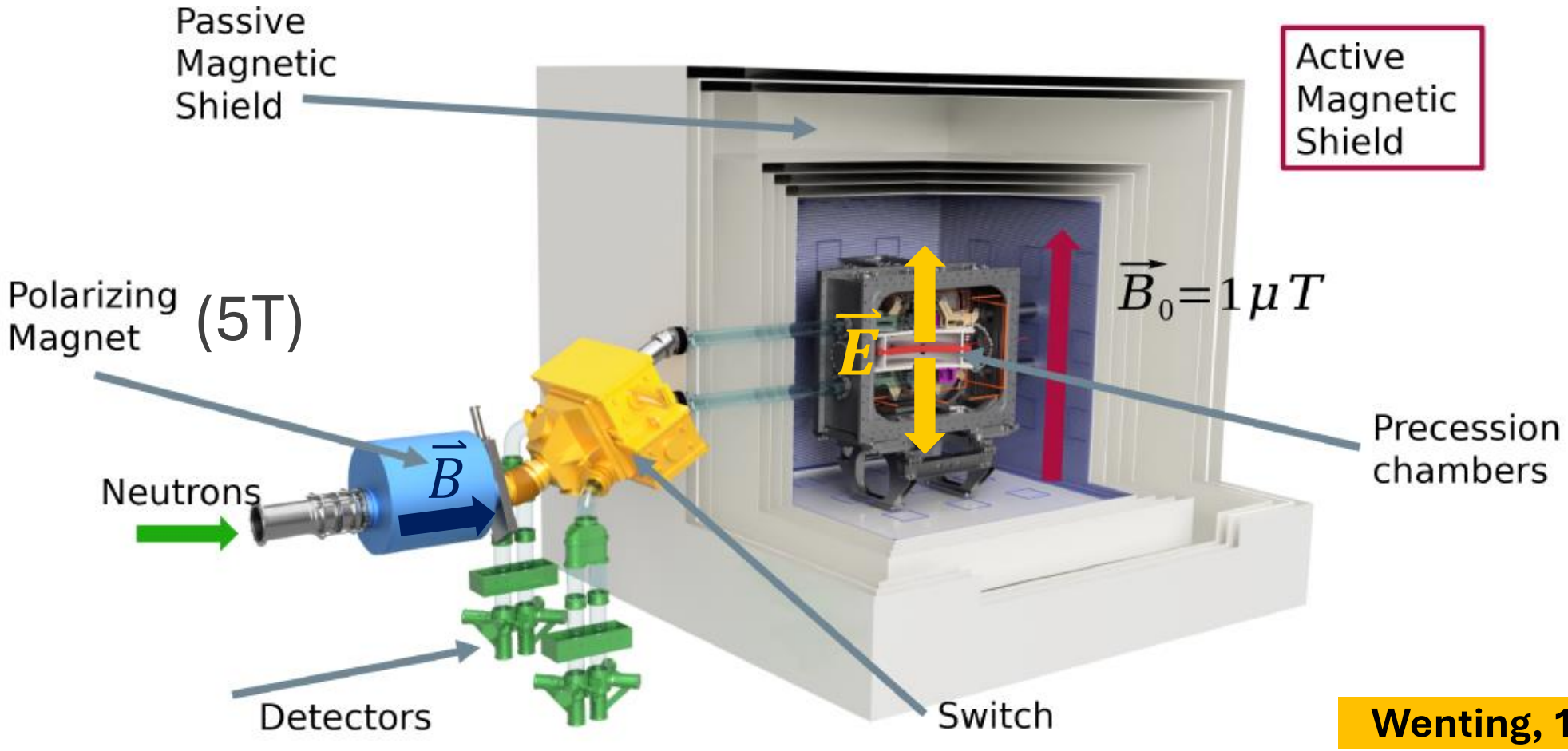
An efficient spin transport system for ultracold neutrons in the n2EDM experiment

Gian Luca Caratsch

for the n2EDM collaboration

SPS Conference, Zürich, 11 September 2024

UCN depolarization during transport



Wenting, 14:30

Neutron depolarization during transport

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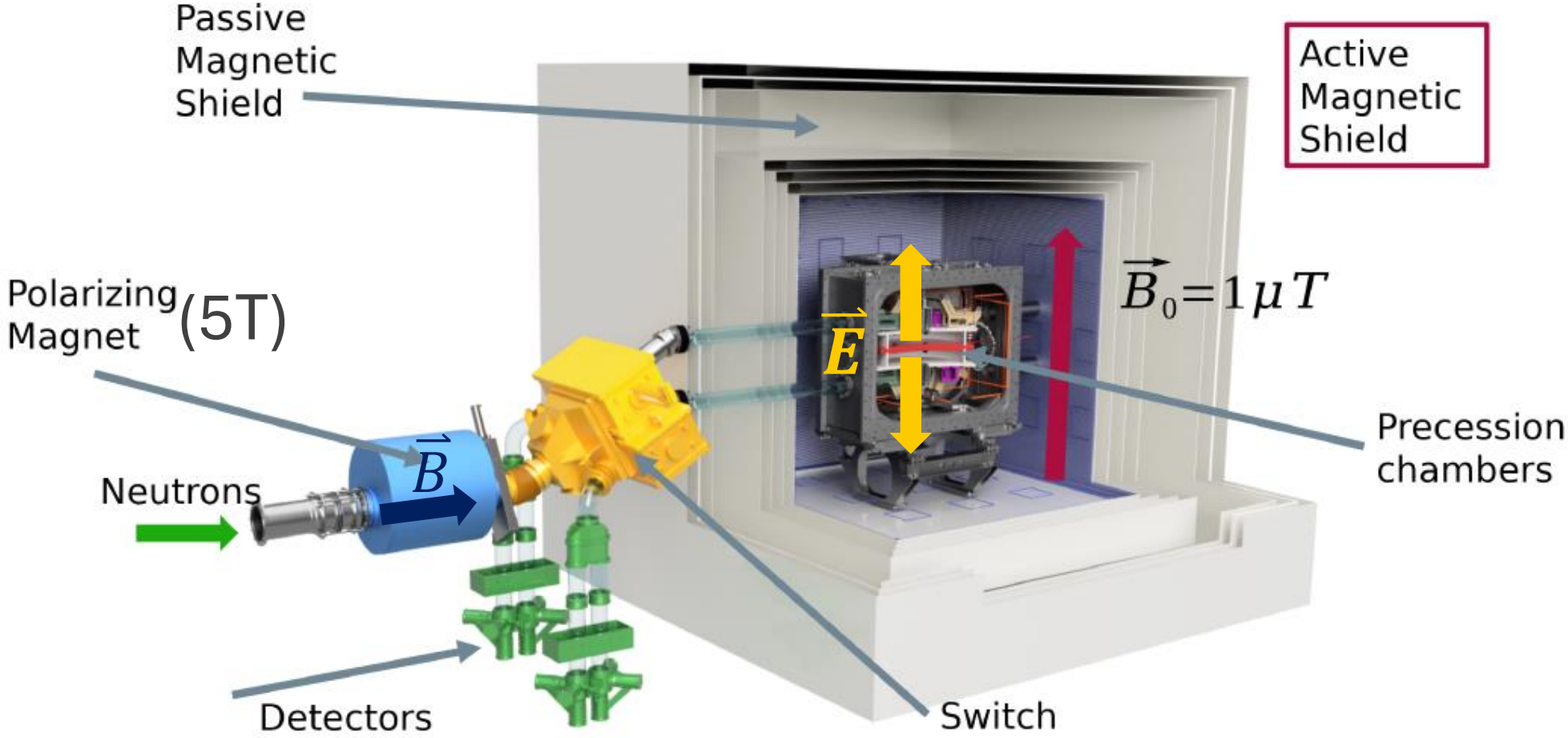
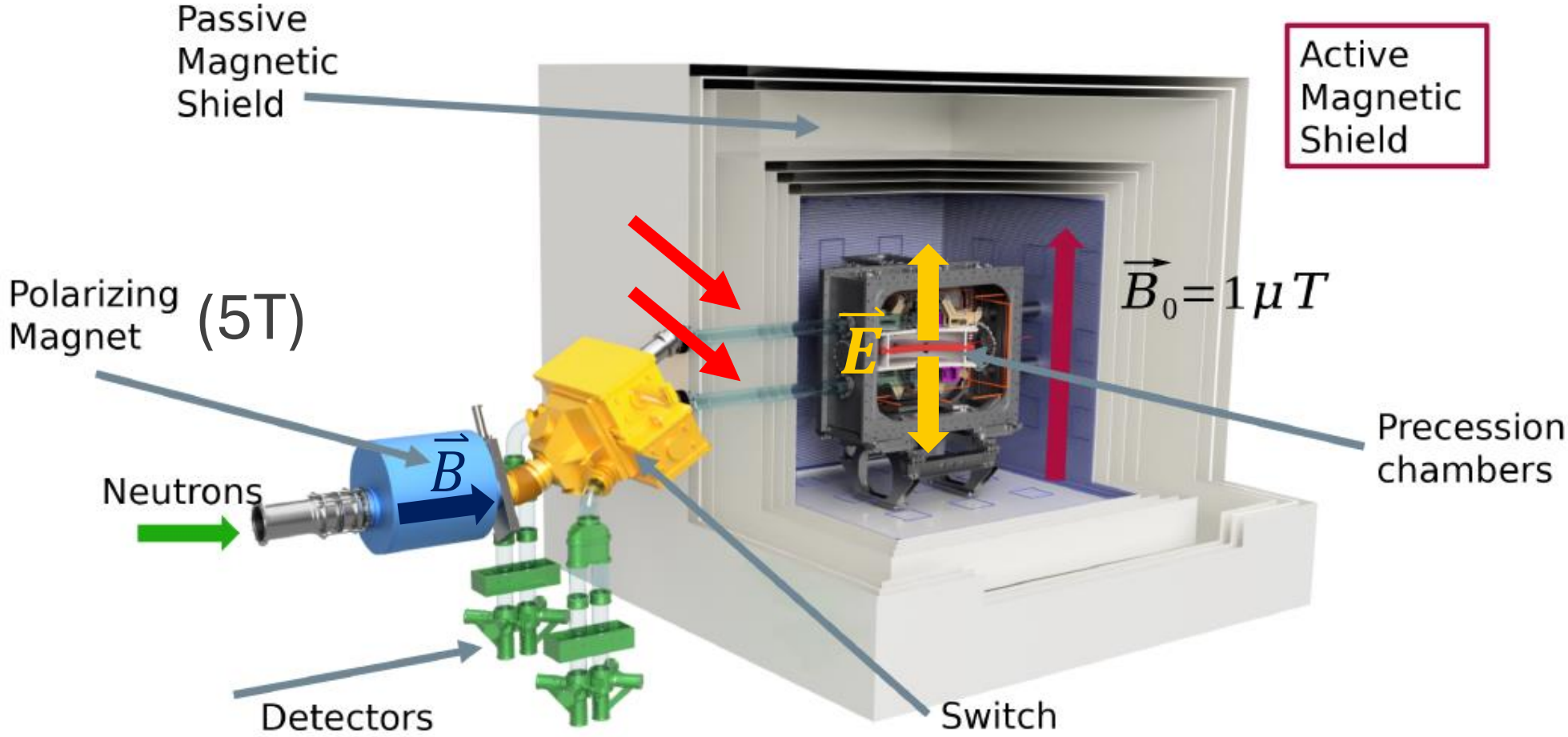


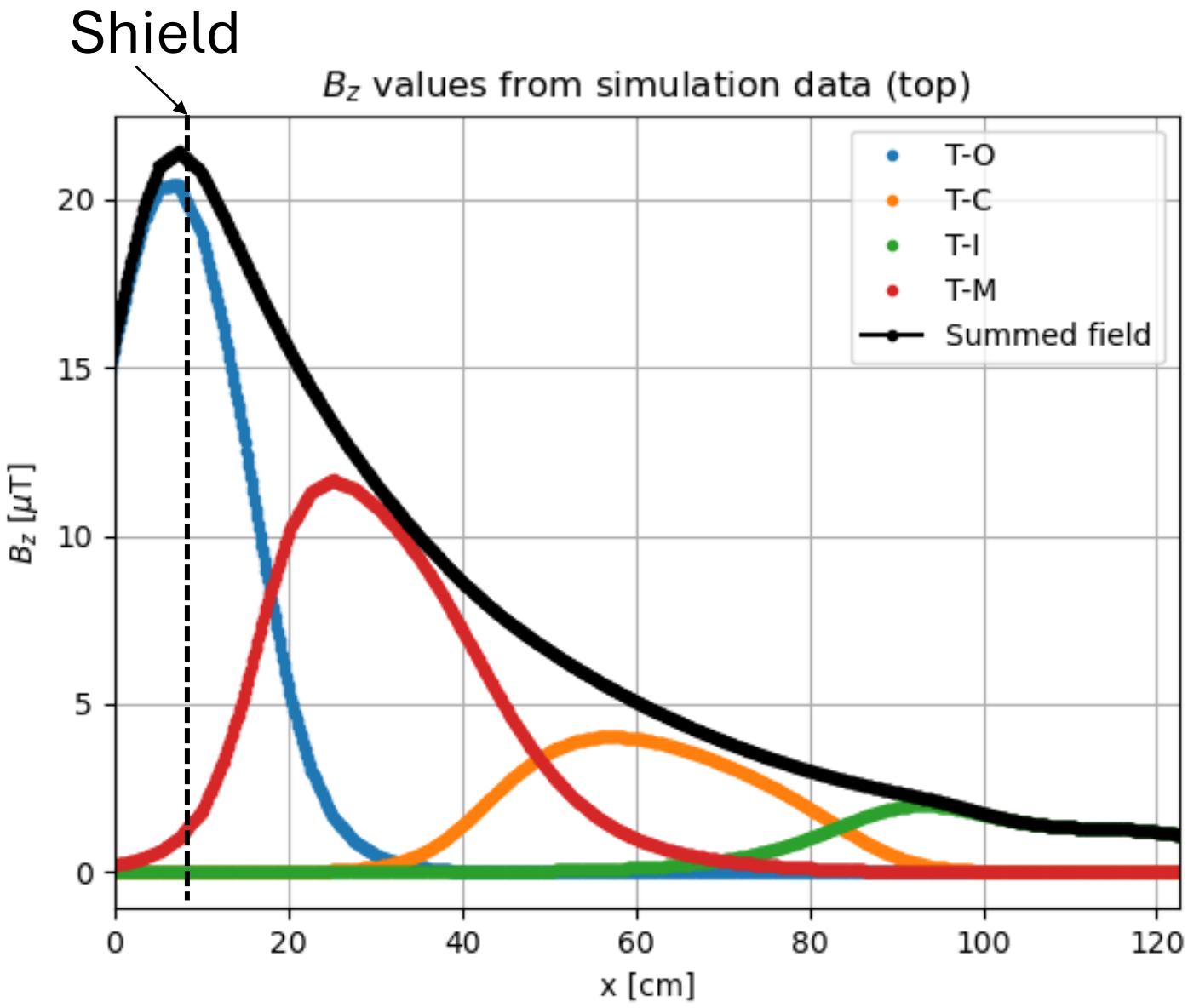
$$k = \frac{\omega_{\mathrm{Larmor}}}{\omega_{\mathrm{turning}}} >> 1$$

UCN depolarization during transport



$$k = \frac{\omega_{\text{Larmor}}}{\omega_{\text{turning}}} >> 1$$

Required magnetic field

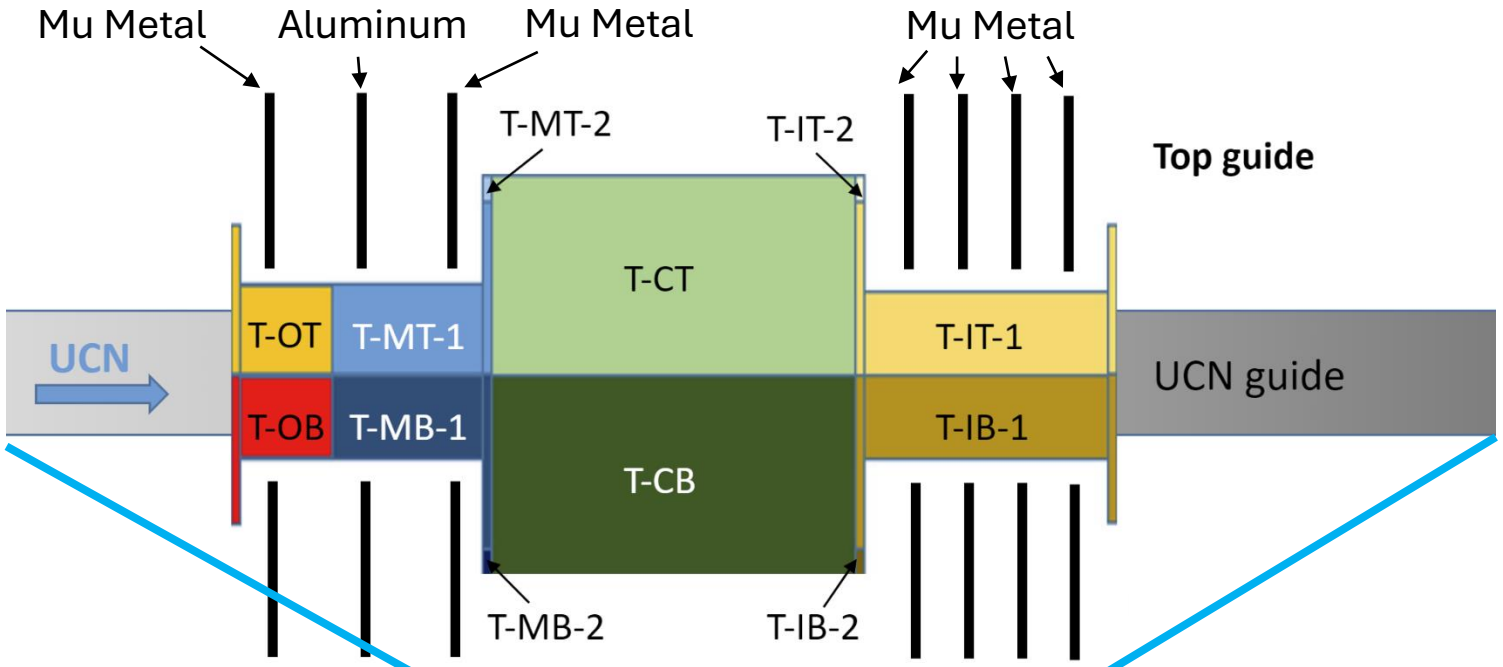


Field of the top STC

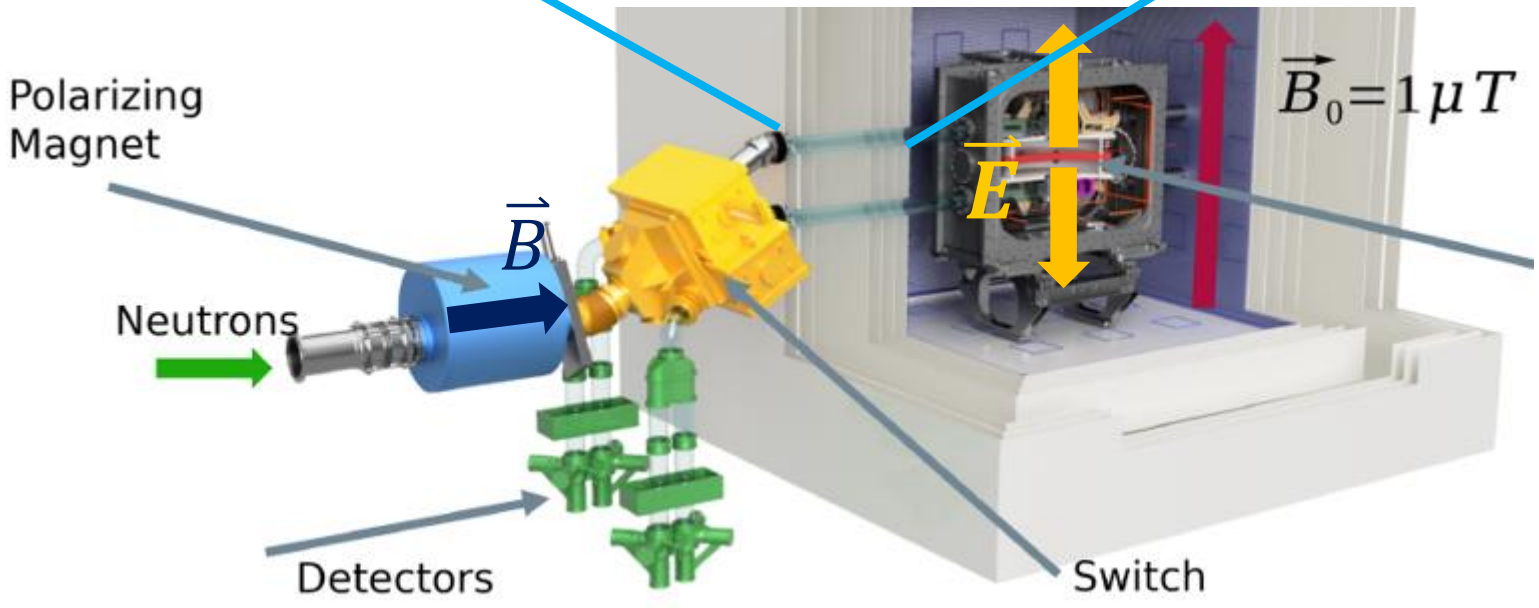
Data from a COMSOL simulation

The spin transport coils (STC)

Switch, polarizer magnet

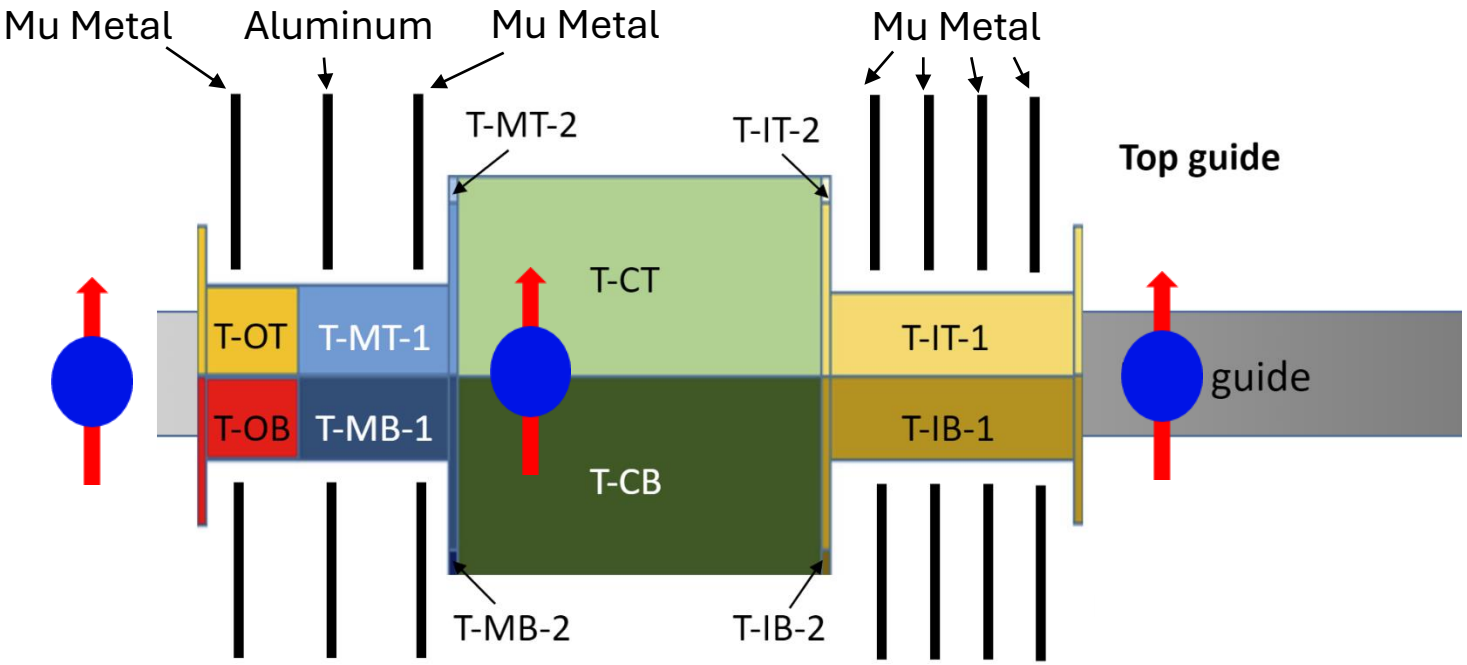


B0 coil, storage chambers



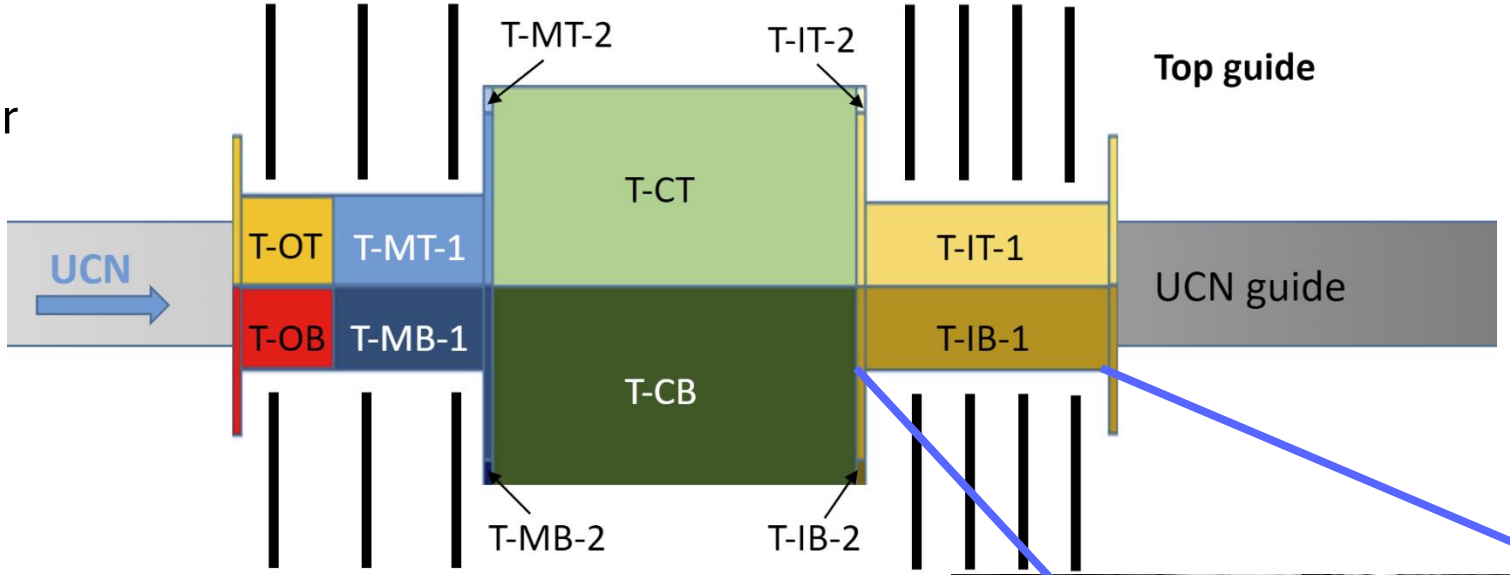
The spin transport coils (STC)

Switch, polarizer magnet

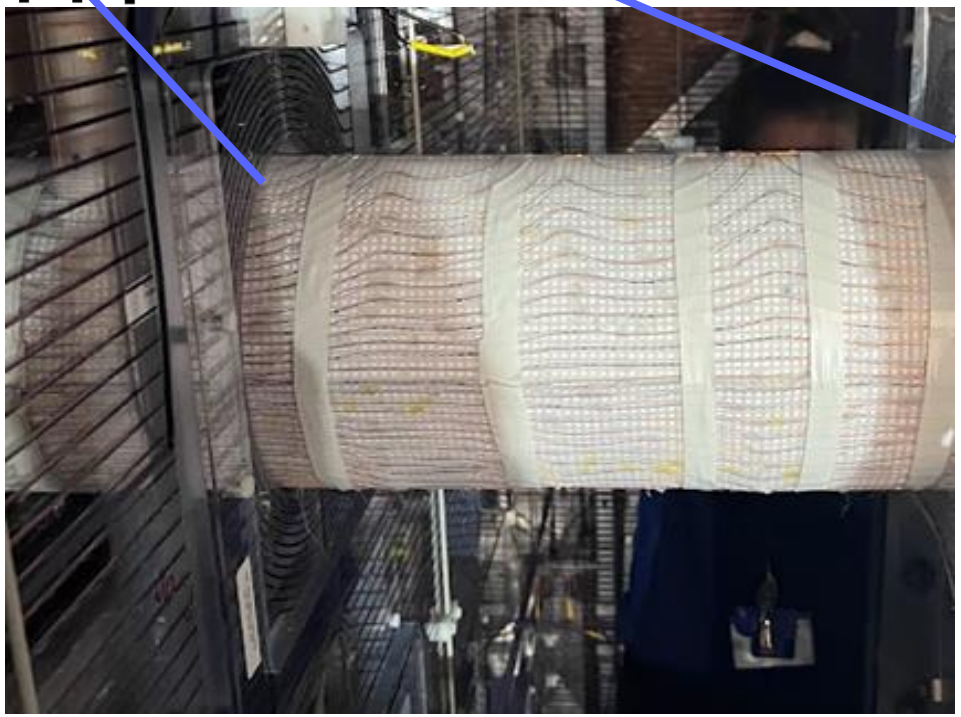


B0 coil, storage chambers

Switch, polarizer magnet



B0 coil, storage chambers



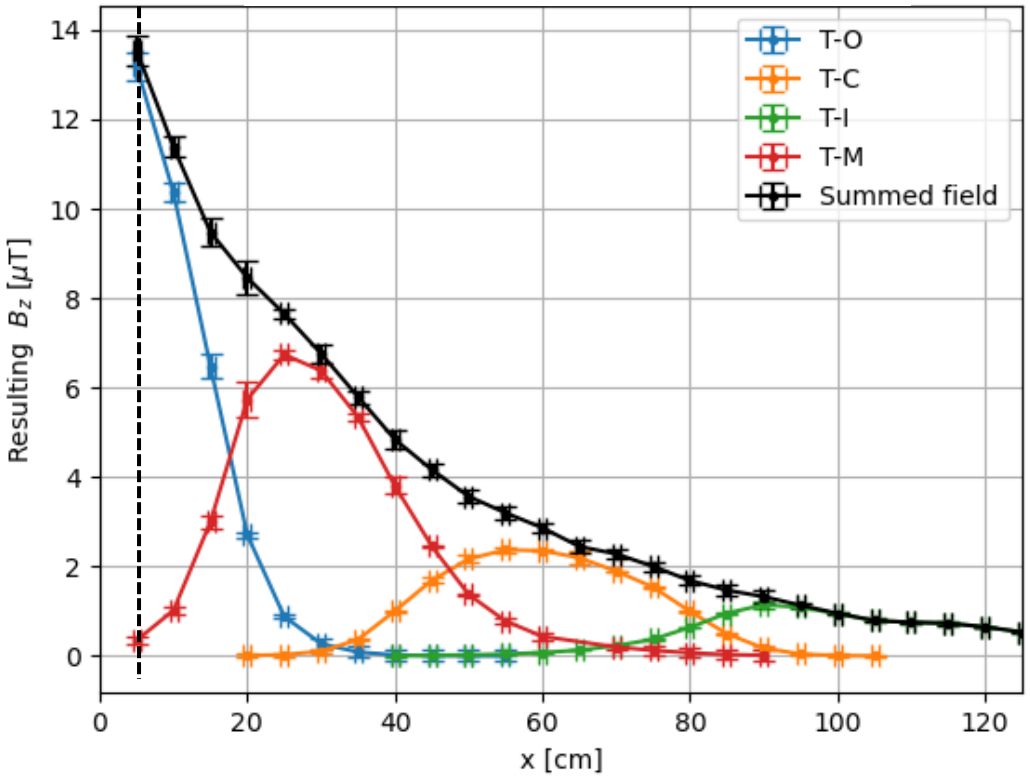
Design: C. Crawford, D. Bowles

Goal: preserve > 99% of the polarization

Analysis of magnetic field produced by the STC

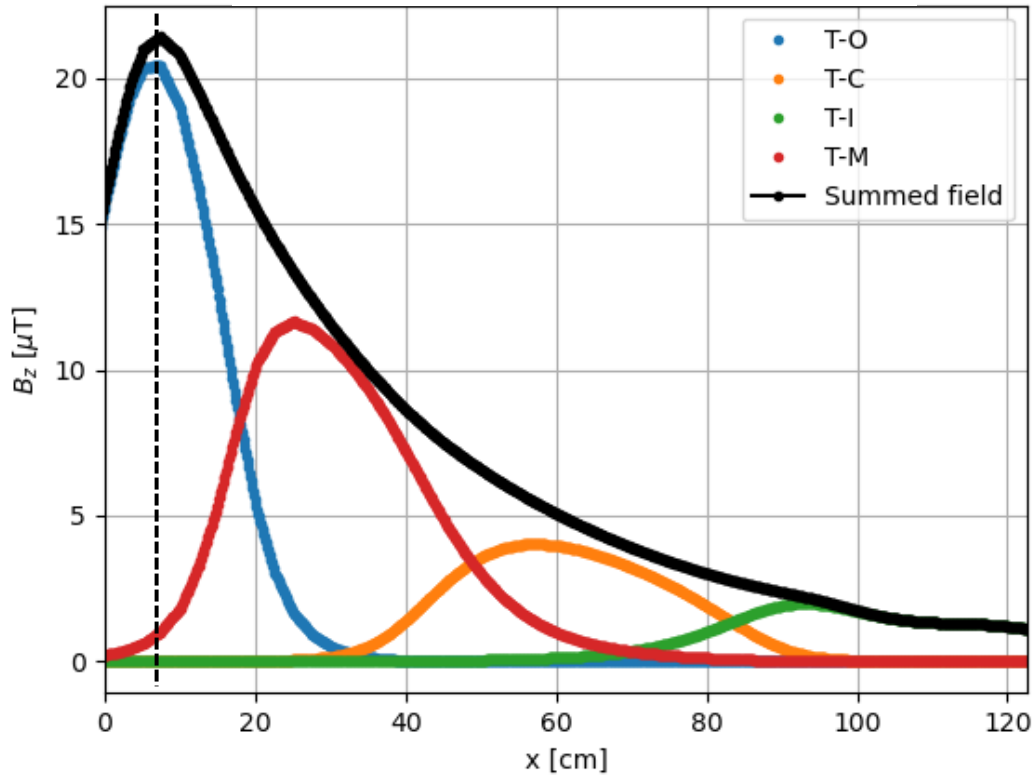
Shield

Measurement (Top)

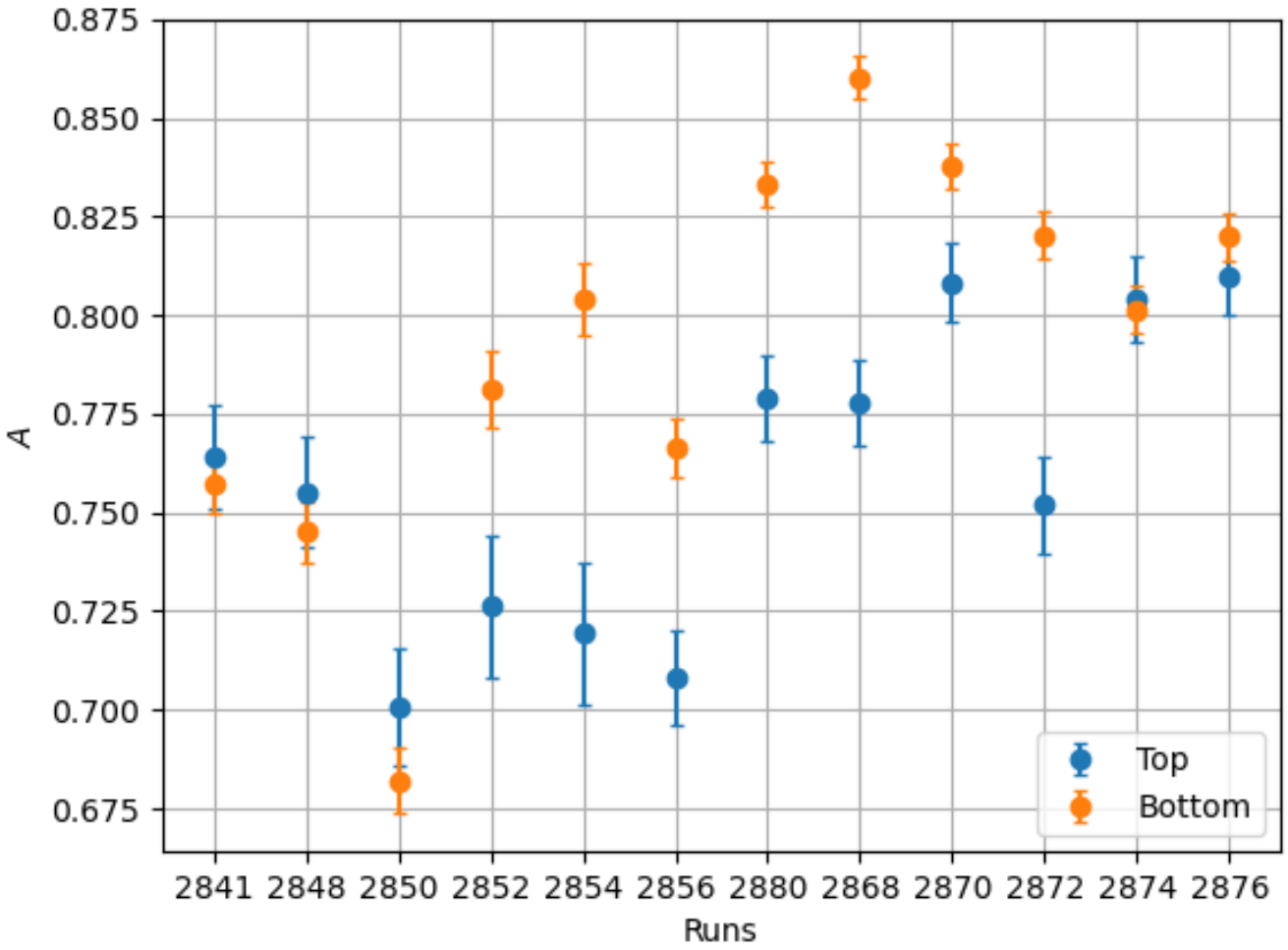


Shield

COMSOL Simulation (Top)



Verification of the STC using polarized neutrons



Asymmetry

$$A(t) = \frac{N_{\uparrow}(t) - N_{\downarrow}(t)}{N_{\uparrow}(t) + N_{\downarrow}(t)}$$

STC efficiency calculation

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$$A(t) = A_d \cdot \epsilon_{\mathrm{STC}}^2 \cdot (1 - D(t))$$

Direct shot into the detectors (without storage)

Depolarization in the chambers

STC efficiency calculation

PSI

$$A(t) = A_d \cdot \epsilon_{\mathrm{STC}}^2 \cdot (1 - D(t)) = A(0) \cdot e^{-t/T_1}$$

Direct shot into the detectors (without storage)

Depolarization in the chambers

Estimation of the STC efficiency

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Top

$A_d^t = 0.9188(2)$

$A_t(0) = 0.843(3)$

$\varepsilon_{STC}^t = 0.958(2)$

Bottom

$A_d^b = 0.8923(3)$

$A_b(0) = 0.861(3)$

$\varepsilon_{STC}^b = 0.982(2)$

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Thank you!

Gian Luca Caratsch
Zürich, 11 September 2024

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Backup slides

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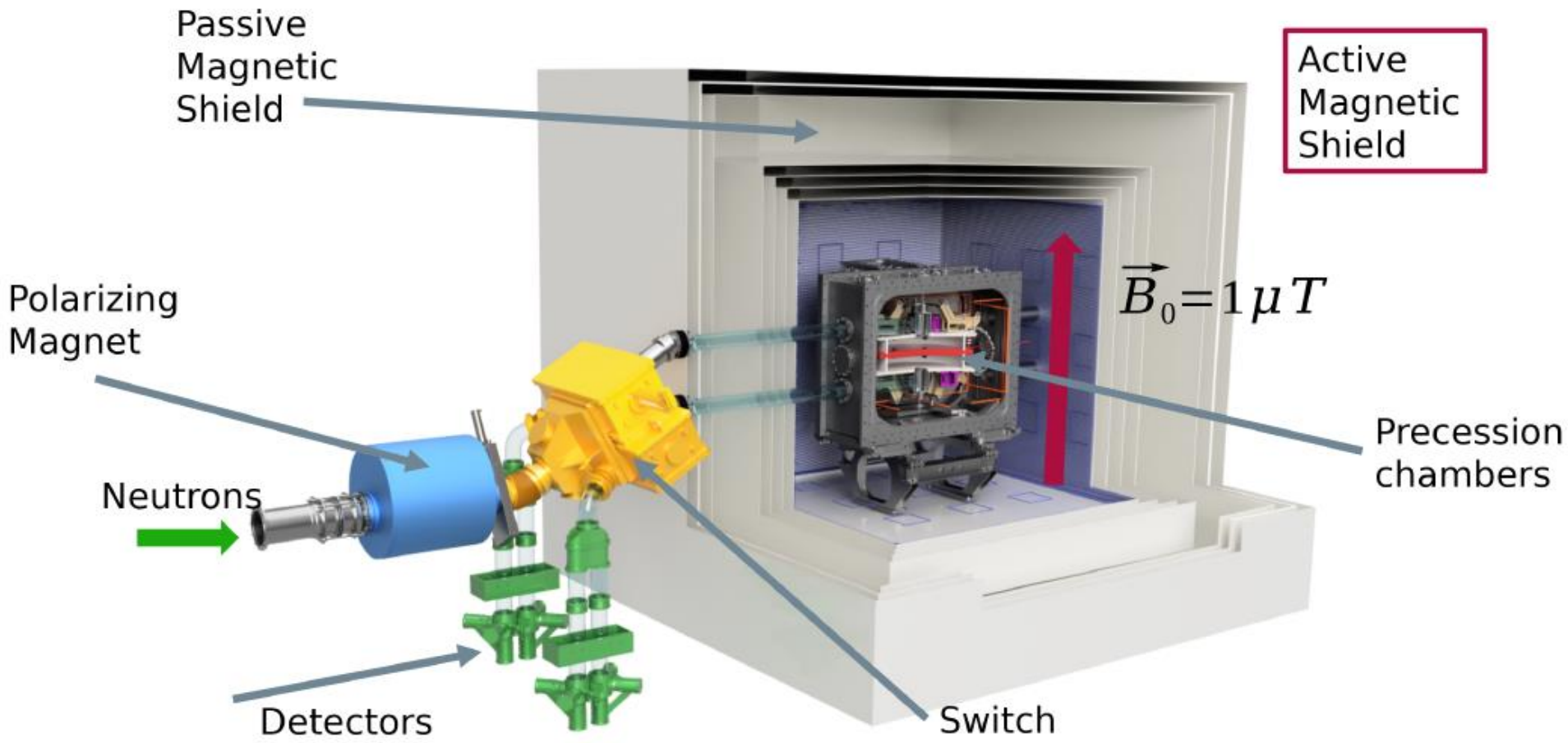
Zürich, 11 September 2024

The n2EDM experiment



The n2EDM experiment: precession chambers

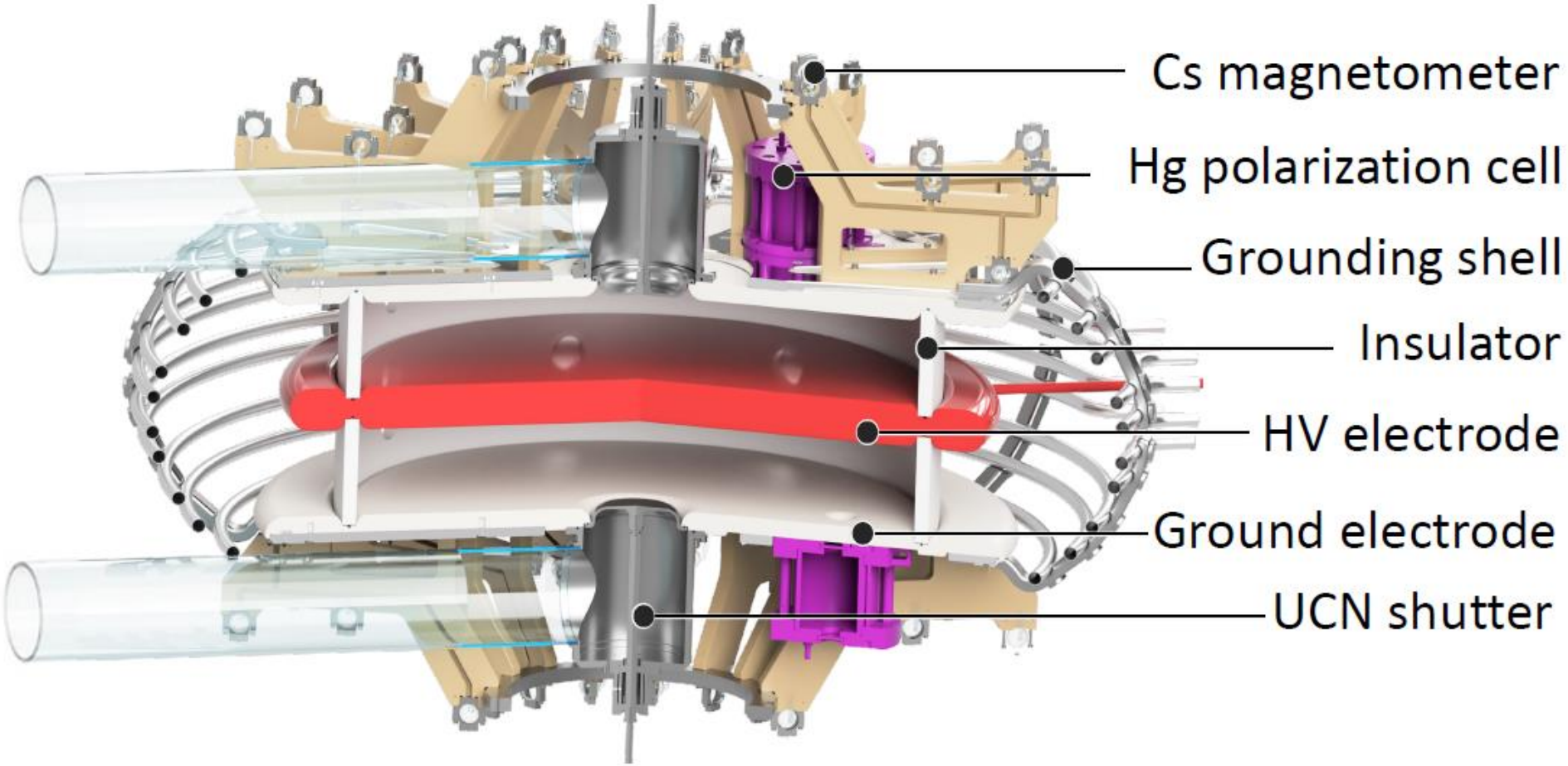
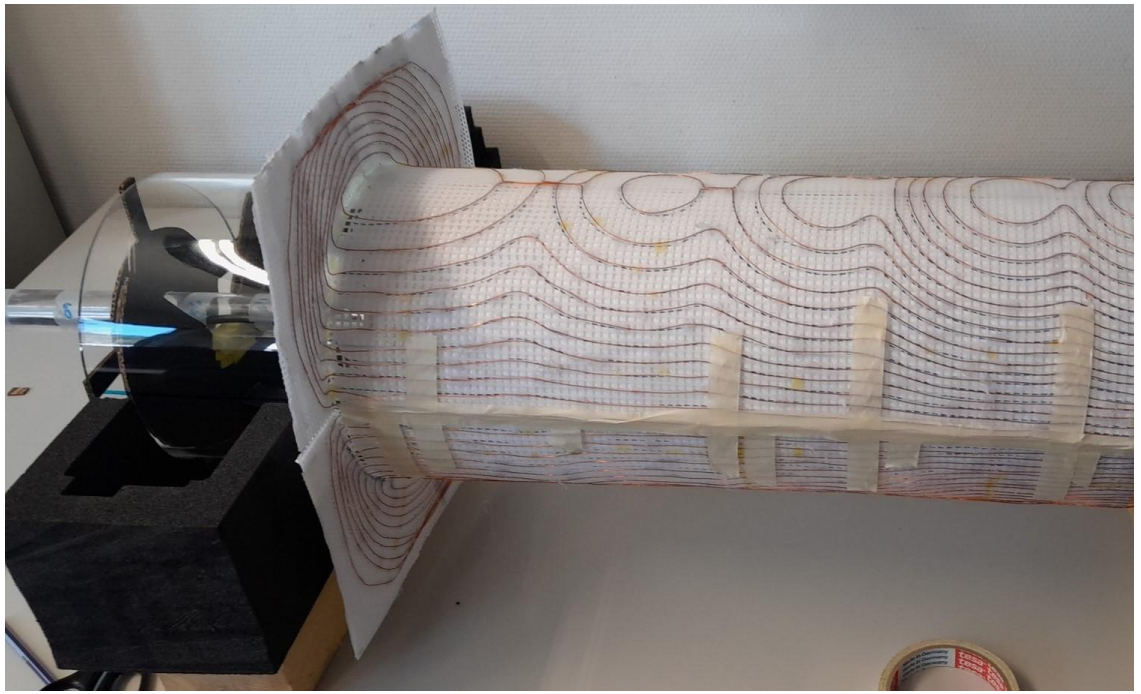


Table top setup to test the prototypes



Mag-13MCQ100, Bartington)

Estimation of the STC efficiency

Top

$A_d^t = 0.9188(2)$

$A_t(0) = 0.843(3)$

$T_1^t = 2689(259)$

$\varepsilon_{STC}^t = 0.958(2)$

Bottom

$A_d^b = 0.8923(3)$

$A_b(0) = 0.861(3)$

$T_1^b = 7184(1739)$

$\varepsilon_{STC}^b = 0.982(2)$