Cs magnetometer based current source for n2EDM

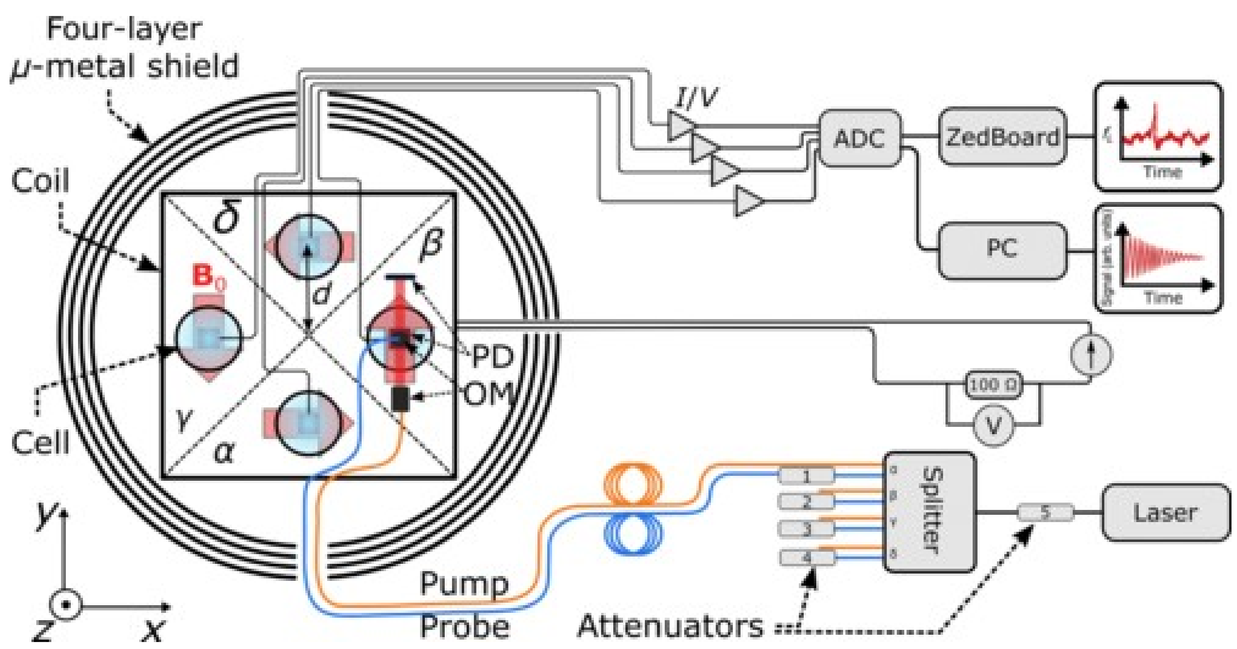
Ren Li[1], Judith Vankeirsbilck[1], Reza Tavakoli-Dinani[1], Nathal Severijns[1]
[1] Instituut voor Kern- en Stralingsfysica, University of Leuven
(on behalf of the nEDM collaboration)

A cesium magnetometer (CsM) based electric current source was developed at KU Leuven with $5*10^{-9}$ stability at 20 mA for 70 min. It could be used either to provide a feedback-stabilized current or for monitoring the evolution of the B_0-field and then performing an offline correction. It will service for n2EDM project helping to realize the goal of 10^{-27} e.cm level [1].

Mechanism

I → B: $B = (\mu_0 I)/(2\pi r)$

External B_{ext} and its spatial gradient must be considered when performing precise B measurement.



γ - β pair

$$B_\gamma \approx i\lambda_\gamma - (B_{ext,0} - r*(\partial B_{ext}/\partial x))$$

$$B_\beta \approx i\lambda_\beta + (B_{ext,0} + r*(\partial B_{ext}/\partial x))$$

α - δ pair

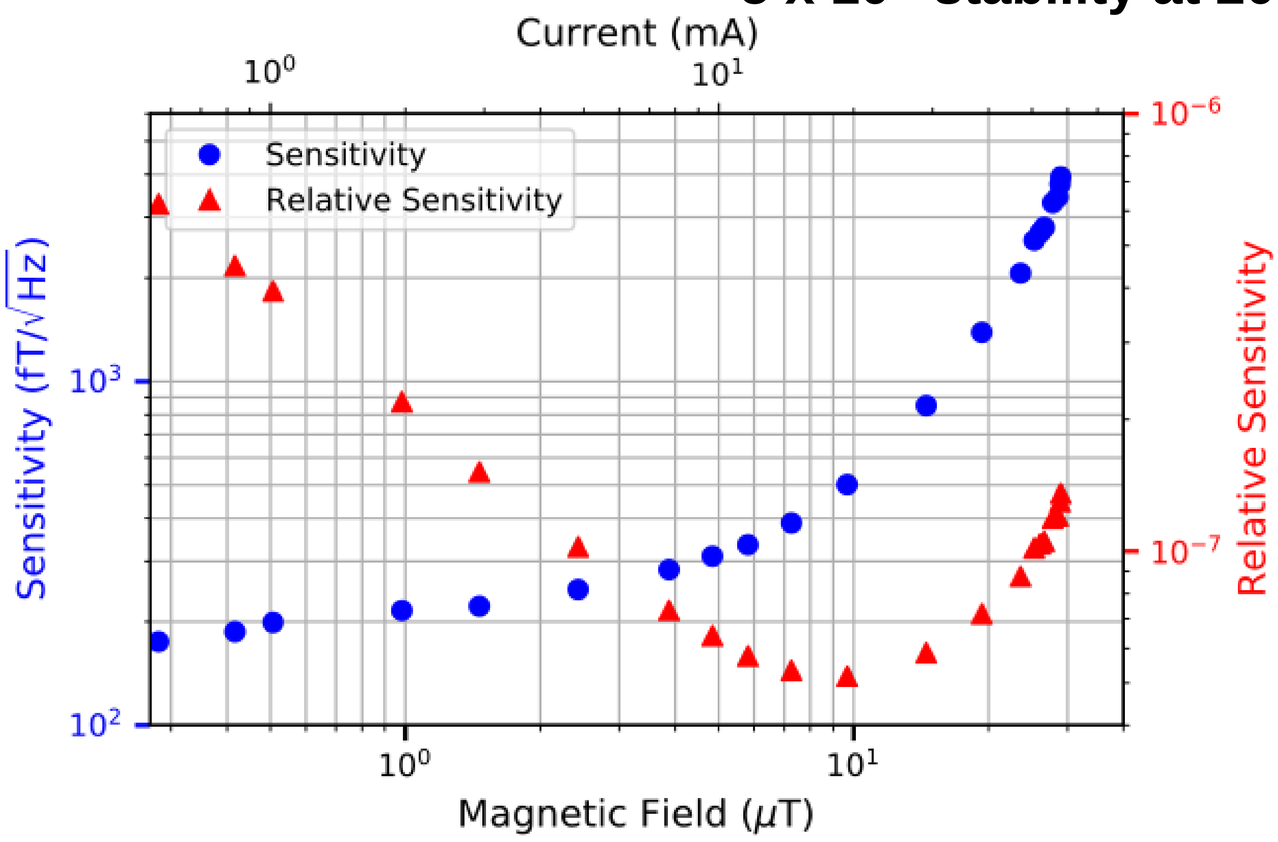
$$B_\alpha \approx i\lambda_\alpha + (B_{ext,0} - r*(\partial B_{ext}/\partial y))$$

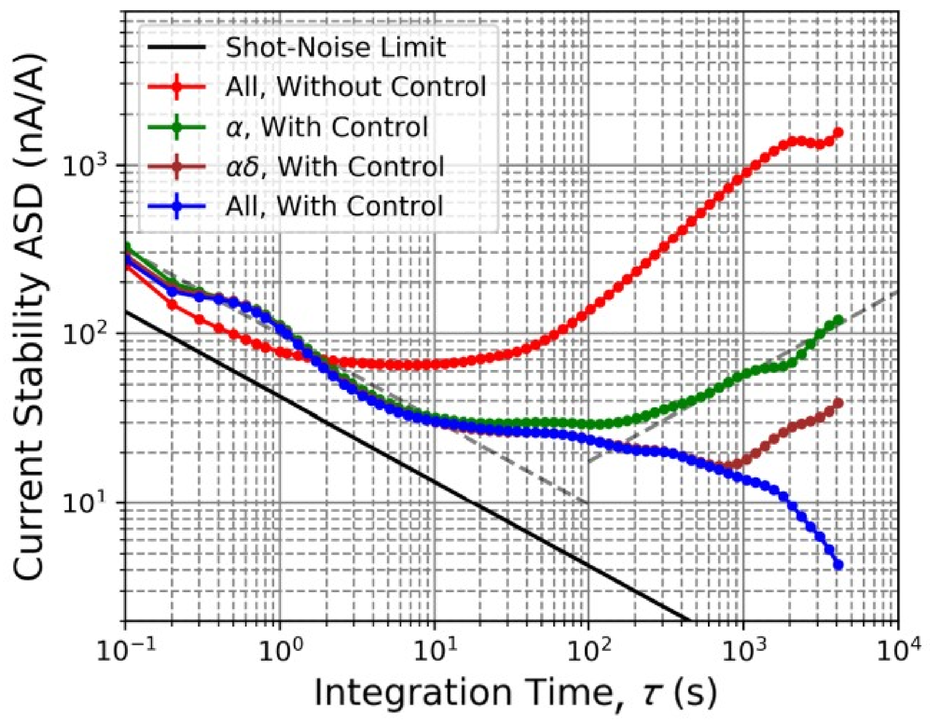
$$B_\delta \approx i\lambda_\delta - (B_{ext,0} + r*(\partial B_{ext}/\partial y))$$

λ_i: coil constant

Performance of current set-up

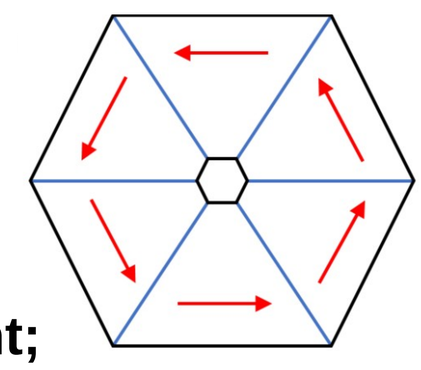
5 x 10^{-9} stability at 20 mA for 70 min

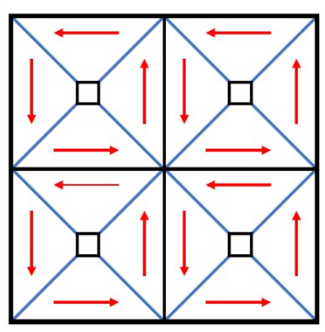


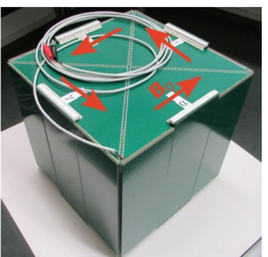


Following optimization

New coil: increasing number of CsM to enhance the precision of gradient;
Investigate the effect of temperature fluctuation;
Adding Twinleaf magnetometers;
New GPS clock;
New Cs laser system for stability of long time measurement;
New magnetometry laboratory at Leuven;







[1] N.J. Ayres et al., EUR. PHYS. J. C, (2021) 81:512
[2] P.A. Koss et al., PHYS. REV. APPLIED 16, 014011 (2021)

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