Progress Report A01: Electron scattering on superfluid helium-4

J. Birkhan, A. D'Alessio, U. Friman-Gayer, M. Hilcker,
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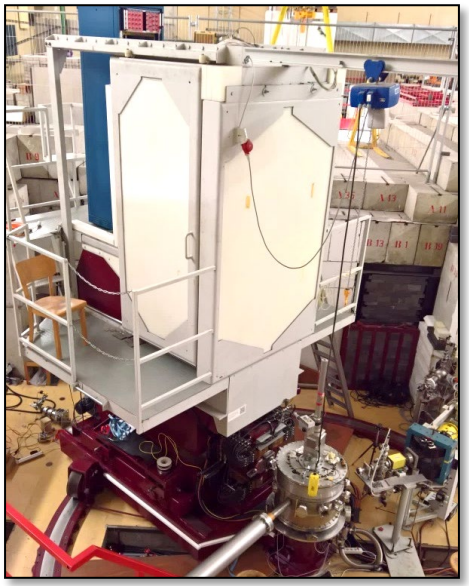
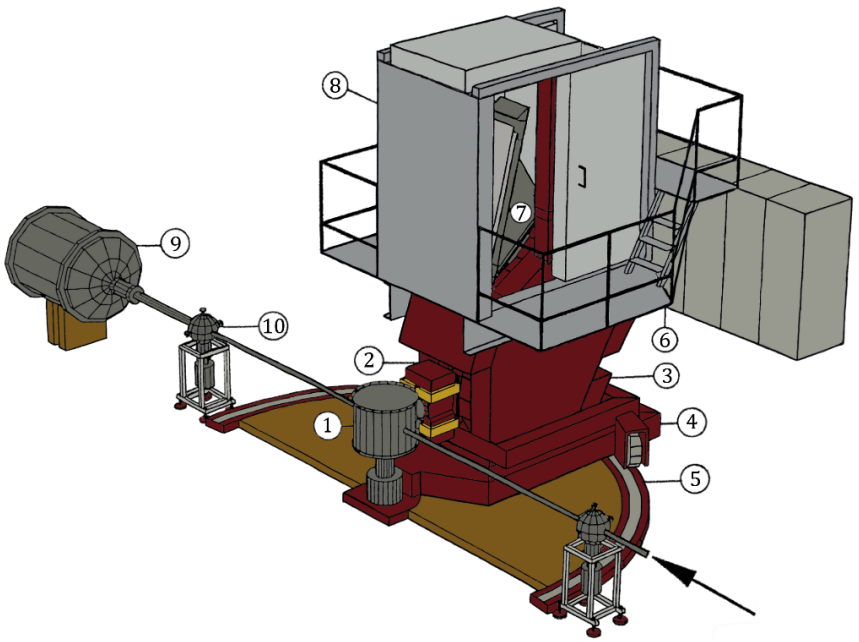


Project Goal:

- Measurement of monopole transition form factor of 0_2^+-state at 20.21 MeV and longitudinal response function of ^{4}He
- Measurement @ QCLAM
- Usage of sLHe-target

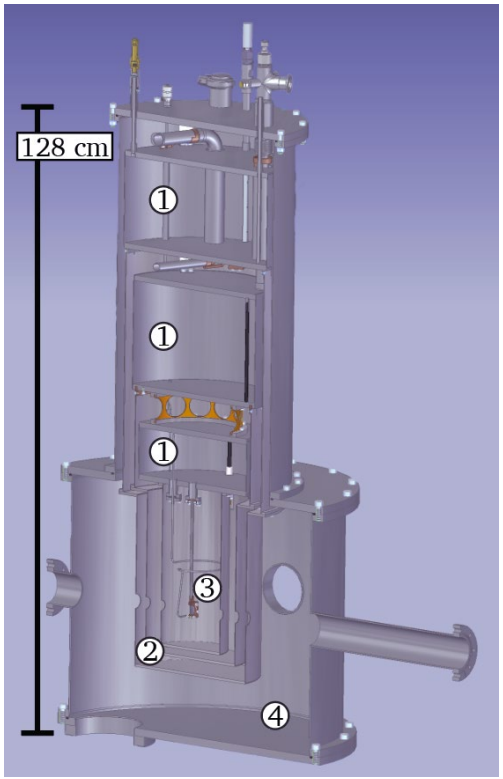
QCLAM spectrometer

- Magnetic spectrometer for (e,e’) and (e,e’x) experiments
- Scattering angles: 25° - 155° and 180°
- Large acceptance (momentum and solid angle)
- Relative energy resolution: 3 x 10^{-4}



M. Knirsch, Dissertation, TH Darmstadt D17 (1991)

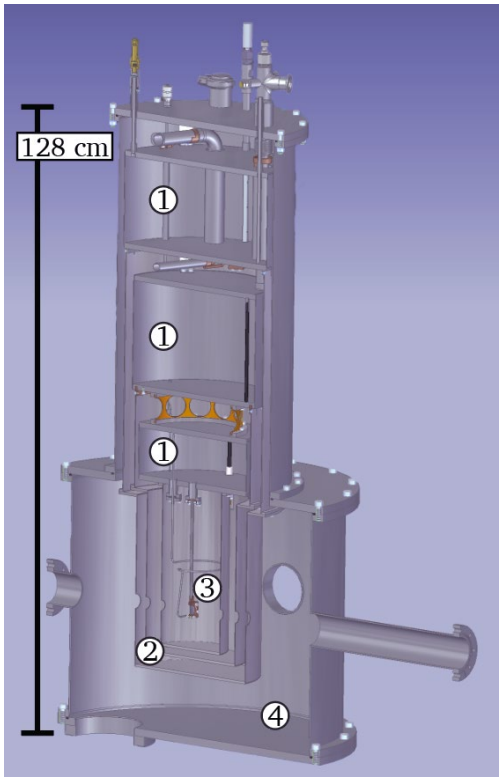
Target and cryostat system

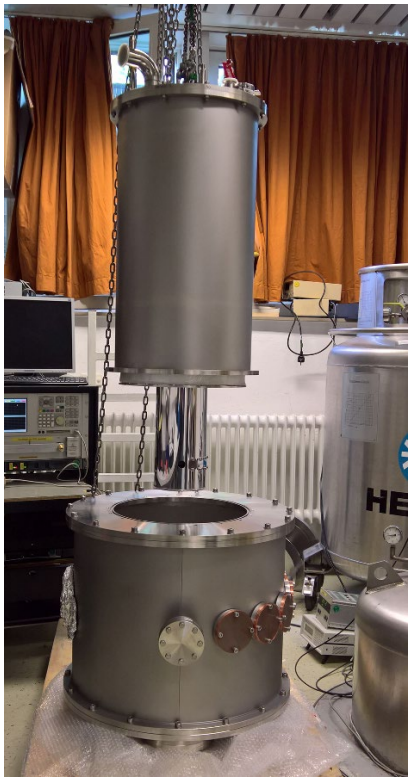


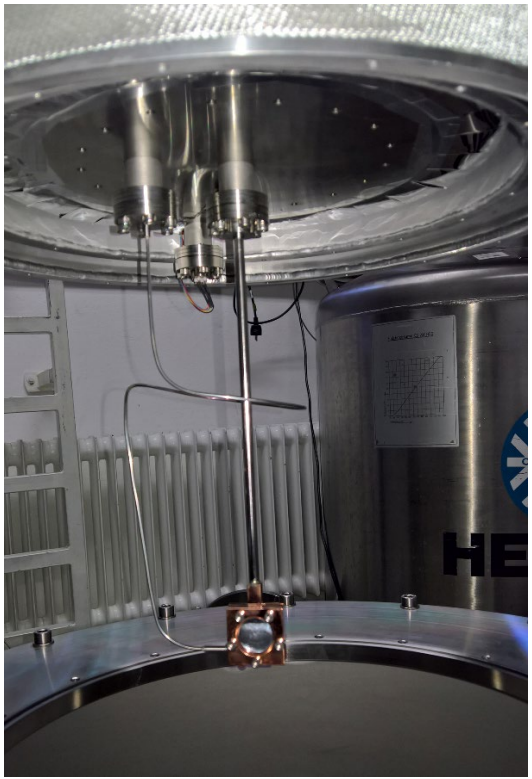
M. Hilcker et al., NIM-A 957, 163418 (2020)

- 6 scattering angles: 55° - 155°
- Vacuum chamber
- 3 cryo-tanks (LN, LHe @4.2 K, sLHe @1.8 K)
- 3-stage heat shielding
- Target thickness: 3.78 mm ≙ 54.9 $\frac{\mathrm{mg}}{\mathrm{cm}^2}$
- Aluminum windows: 2 x 0.20 mm ≙ 108 $\frac{\mathrm{mg}}{\mathrm{cm}^2}$
- Monitoring system for temperature and liquid levels

Target and cryostat system







M. Hilcker et al., NIM-A 957, 163418 (2020)

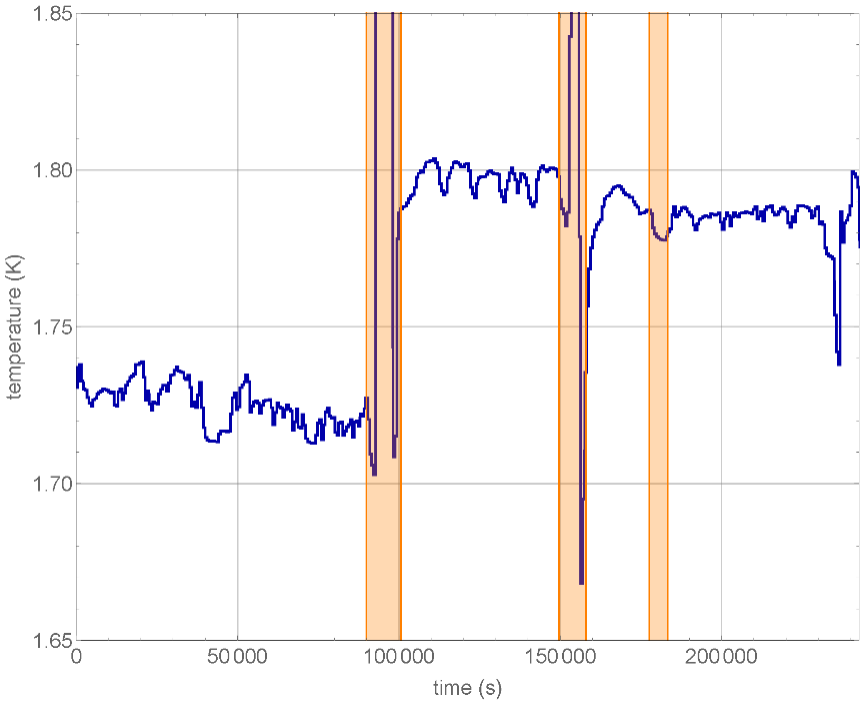
Commissioning experiment

- Measurement at 42,5 MeV and 75°
- Momentum transfer 0,047 fm^{-2}
- Temperature stability ± 0,1 K

  → Fluctuation of helium density below 0,1%
- Problems with beam positioning

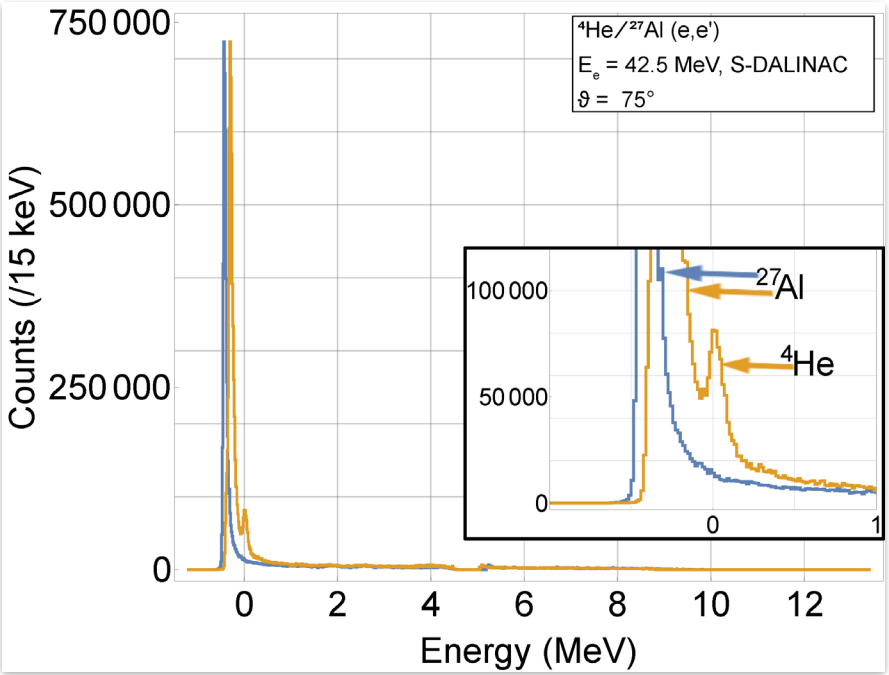
  → new steerer system
- High count rates

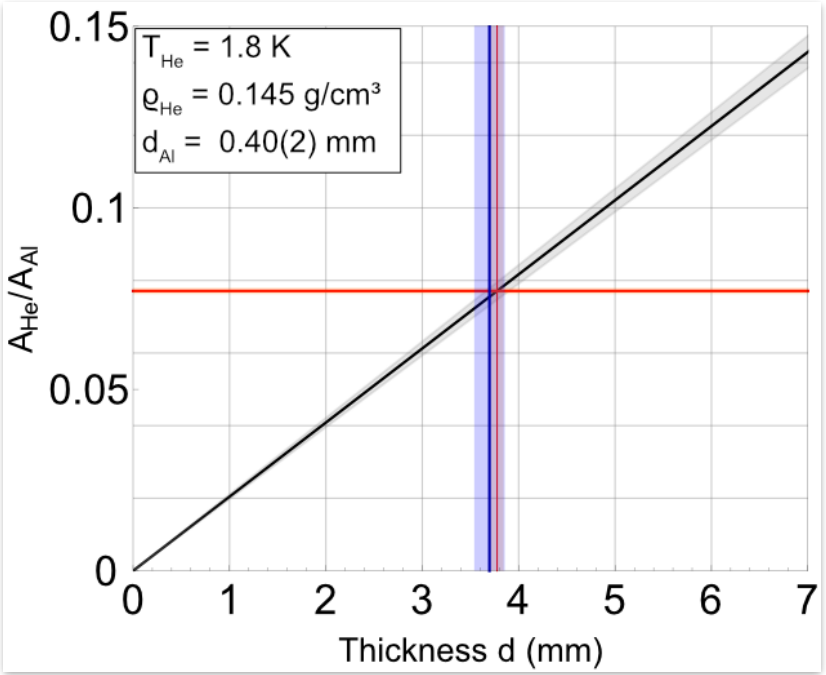
  → new target cell with thinner windows



M. Hilcker et al., NIM-A 957, 163418 (2020)

Measured spectrum

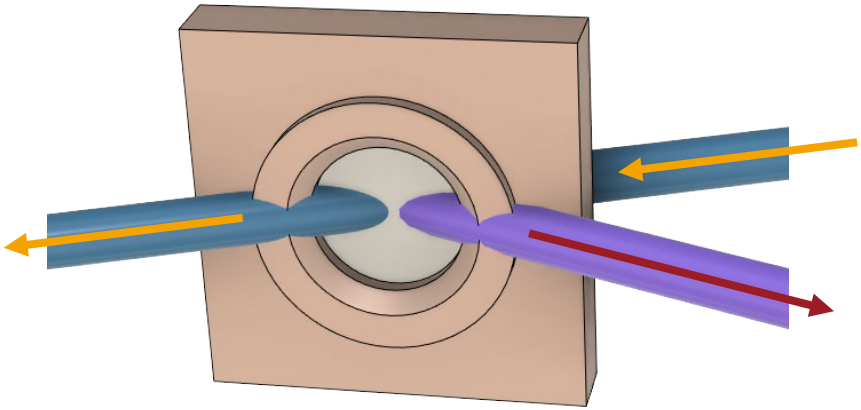




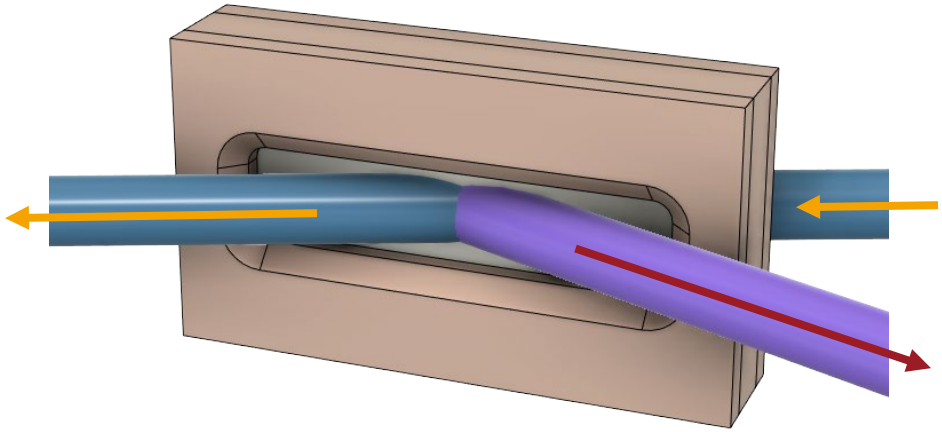
M. Hilcker et al., NIM-A 957, 163418 (2020)

New target cell

- Aluminum windows
- Thickness: 0.2 mm
- Window size: Ø 20 mm

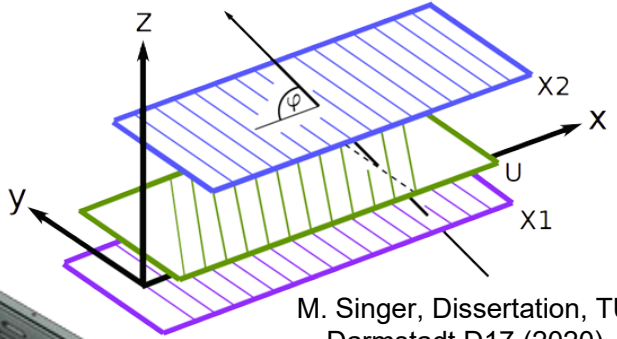


- Aluminum windows
- Thickness: 0.15 mm
- Window size: 44 mm x 10 mm

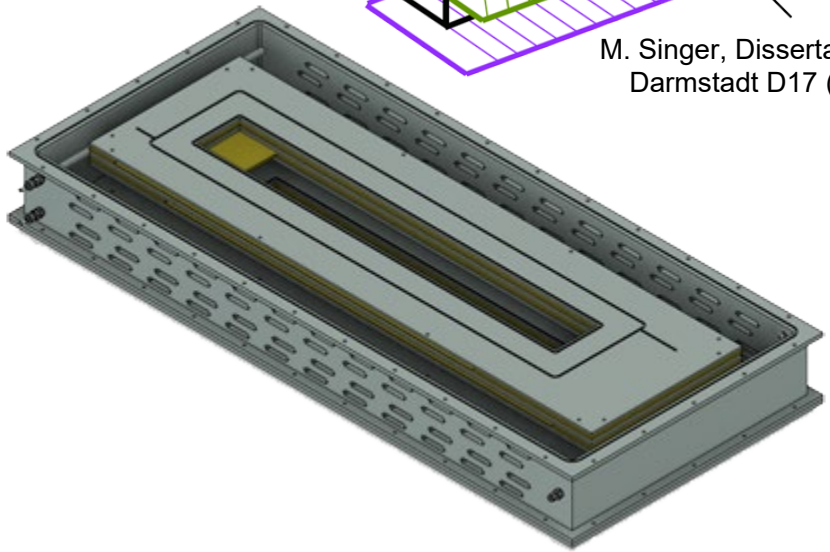


New drift chamber

- Single closed Casing
  → easier to handle
  → less oxygen
- 4 wire layers
  → additional information for track reconstruction
- More wires per layer
  → higher resolution and efficiency

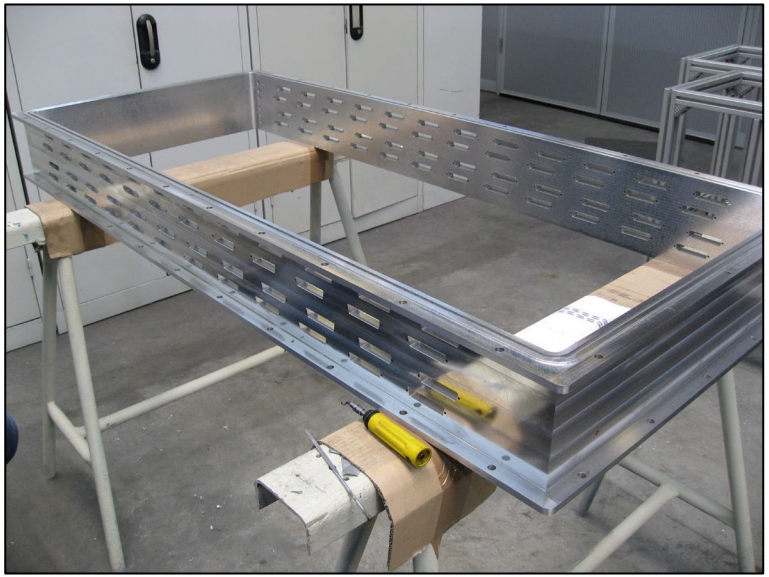


M. Singer, Dissertation, TU Darmstadt D17 (2020)



New drift chamber

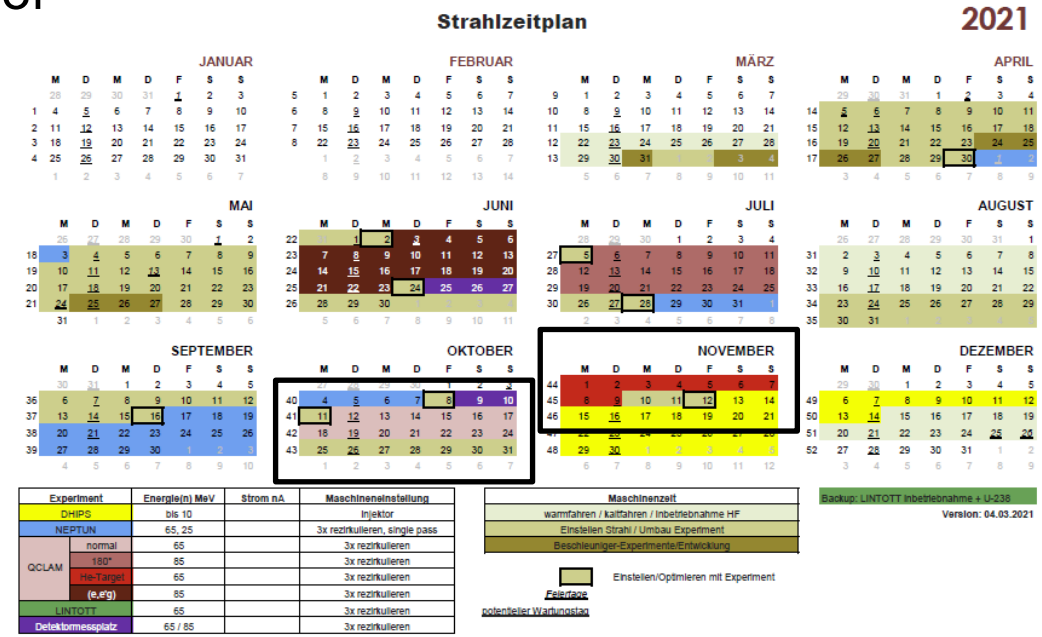
- Major parts are delivered
- Boards for preamplifiers are manufactured in-house by Mr. Bonnes
- Next: Soldering of the wires to the planes and assembling of the chamber in Frankfurt
- Commissioning experiment scheduled for October



J. Häuser, Kreß GmbH (2020)

Planned helium beamtime

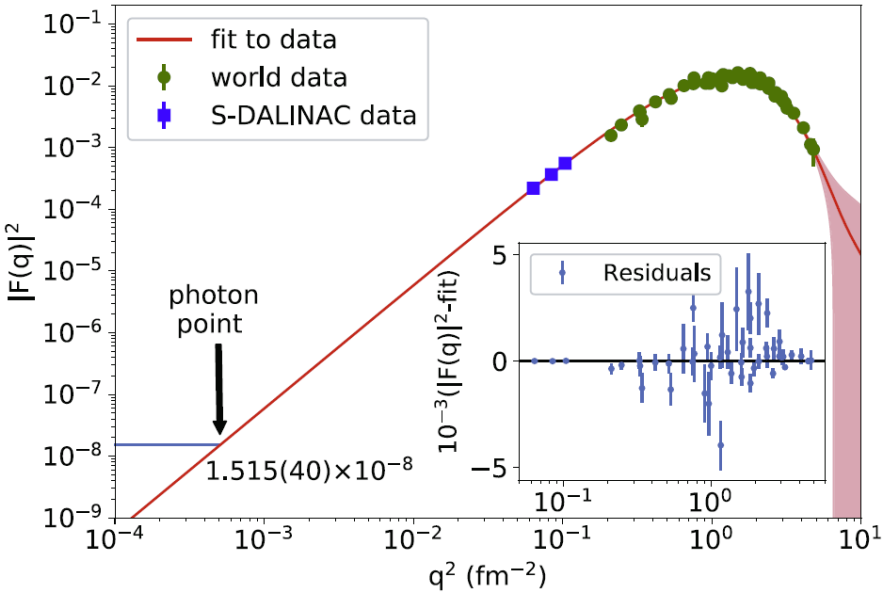
- Beamtime scheduled for begin of November
- 1 week preparation
- 9 days data taking
- Beam Energy: 65 MeV
- Scattering Angle: 95°
- Momentum transfer: 0.42 fm^{-1}



Precision measurement on ^{12}C

- Electron scattering measurement at Lintott spectrometer at S-DALINAC
- *Precision measurement of the E2 transition strength to the* 2_1^+ *state of* ^{12}C

A. D'Alessio, T. Mongelli, M. Arnold, S. Bassauer, J. Birkhan, I. Brandherm, M. Hilcker, T. Hüther, J. Isaak, L. Jürgensen, T. Klaus, M. Mathy, P. von Neumann-Cosel, N. Pietralla, V.Yu. Ponomarev, P.C. Ries, R. Roth, M. Singer, G. Steinhilber, K. Vobig and V. Werner



	$\lvert F(q)\rvert^2$	$B(E2; 2_1^+ \rightarrow 0_1^+)$
New	$1.515(40) \cdot 10^{-8}$	$7.63(19) e^2\,fm^4$
Old	$1.443(161) \cdot 10^{-8}$	$7.94(40) e^2\,fm^4$

A. D'Alessio et al., Phys. Rev. C **102**, 011302(R) (2020)

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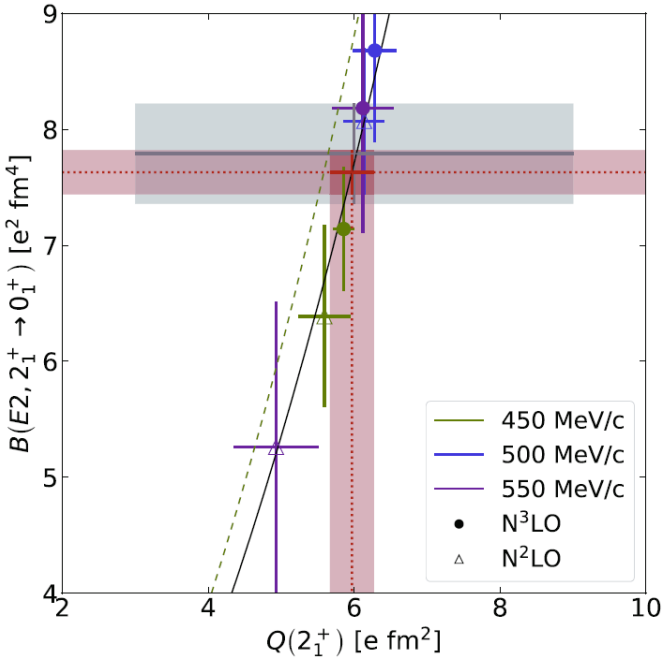


$$Q(2_1^+) = 5.97(30)\,\mathrm{e\,fm^2}$$

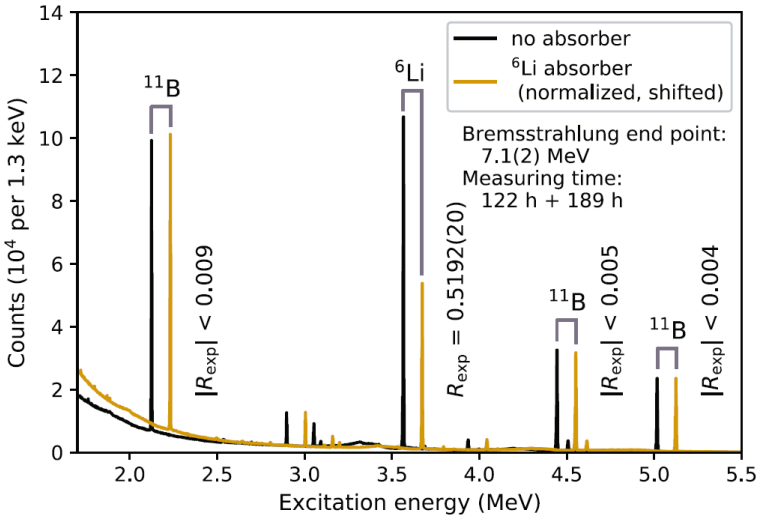
A. D'Alessio et al., Phys. Rev. C **102**, 011302(R) (2020)

Precision measurement on ^{6}Li

- Relative self-absorption measurement at DHIPS at S-DALINAC
- *Role of Chiral Two-Body Currents in ^{6}Li Magnetic Properties in Light of a New Precision Measurement with the Relative Self-Absorption Technique*

U. Friman-Gayer, C. Romig, T. Hüther, K. Able, S. Bacca, T. Beck, M. Berger, J. Birkhan, K. Hebeler, O.J. Hernandez, J. Isaak, S. König, N. Pietralla, P.C. Ries, J. Rohrer, R. Roth, D. Savran, M. Scheck, A. Schwenk, R. Seutin and V. Werner

	$\Gamma_{\gamma,0_1^+\to 1_1^+}$	$B(\mathrm{M1};0^+\to 1^+)$
New	$8.17^{+0.14}_{-0.13}(\mathrm{stat.})^{+0.10}_{-0.11}(\mathrm{syst.})\,\mathrm{eV}$	$15.61^{+0.27}_{-0.25}(\mathrm{stat.})^{+0.19}_{-0.21}(\mathrm{syst.})\,\mu_N^2$
Old	$8.19(17)\,\mathrm{eV}$	$15.65(32)\,\mu_N^2$



U. Friman-Gayer et al., Phys. Rev. Lett. **126**, 102501 (2021)

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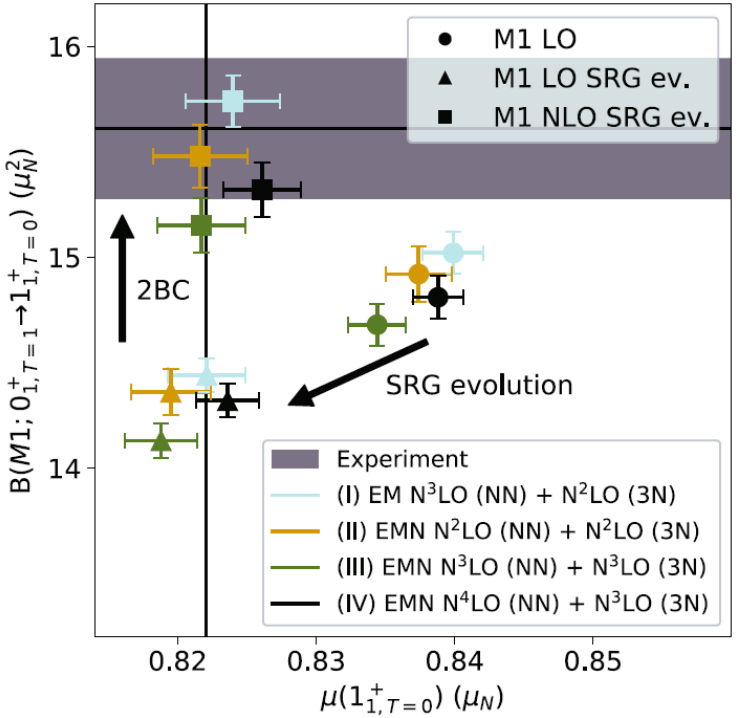

U. Friman-Gayer et al., Phys. Rev. Lett. **126**, 102501 (2021)

CRC schedule

- ^{12}C: $\mathrm{B(E2;}\ 2_1^+ \rightarrow\ 0_1^+)$ electron scattering done and published
- ^{6}Li: $\mathrm{B(M1;}\ 0^+ \rightarrow 1^+)$ relative self-absorption done and published
- sLHe target and cryostat system proved to be functional, target material works as expected
- Improvement of experimental setup: new target cell and new drift chambers
- Delay of 1 year compared to project plan
- First production measurement scheduled for November this year