



Physics Opportunities with the MESA Facility



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University of York
July 7th, 2026



Half day workshop at the University of York last week

- Anchored around a keynote talk on the upcoming MESA facility from Patrick Achenbach, JGU Mainz
- Additional talks highlighting outputs from existing UK-Mainz collaborations and detector technologies developed by the York group
- Roughly 20 participants, mostly from York, but some external participation via Zoom





Johannes Gutenberg University Mainz



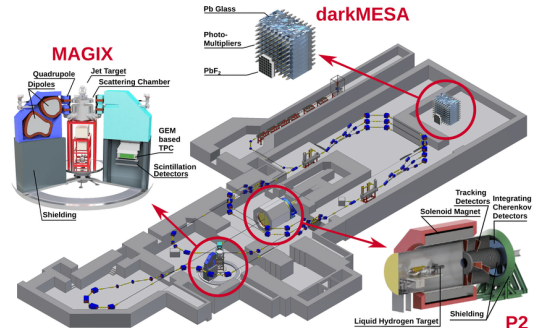
- Re-established from a predecessor institution in 1946
- Member of the U15, the German equivalent of the Russell Group
- Institut für Kernphysik has hosted a variety of accelerator facilities over many decades





Mainz Energy-Recovering Superconducting Accelerator

- New accelerator facility
- Independent of existing MAMI facility
- Double sided multi turn Energy-Recovery Linac (ERL)
- Beam energies from 20 MeV to 155 MeV
- Three experimental stations: P2, DarkMESA and MAGIX





Mainz Energy-Recovering Superconducting Accelerator

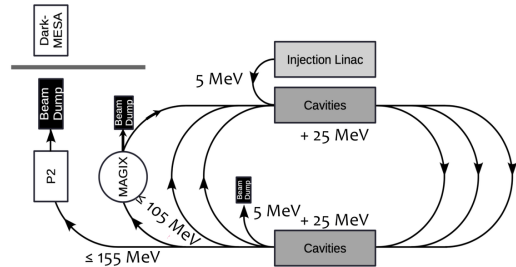
Two operating modes

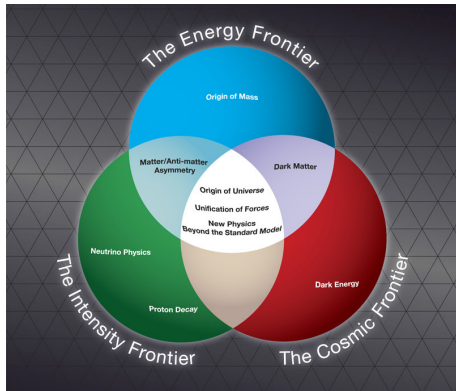
■ Energy Recovery Mode

- $E_o = 20 \text{ MeV to } 105 \text{ MeV}$
- Unpolarised beam currents up to 1 mA

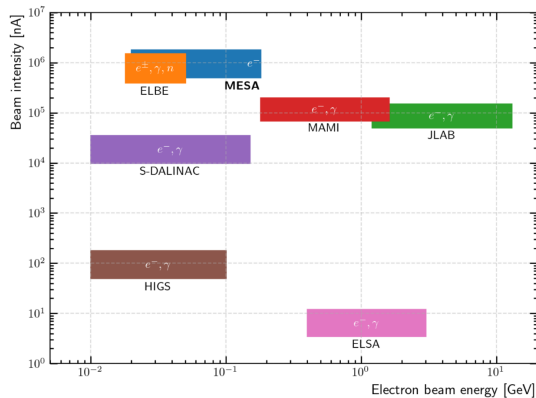
■ Extracted Beam Mode

- E_o up to 155 MeV
- Polarised currents up to $150 \mu\text{A}$



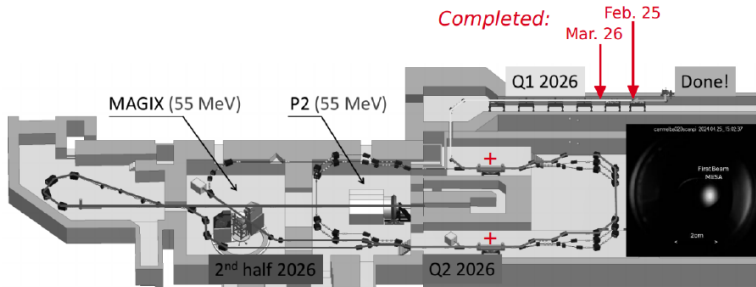


US DOE Office of Science

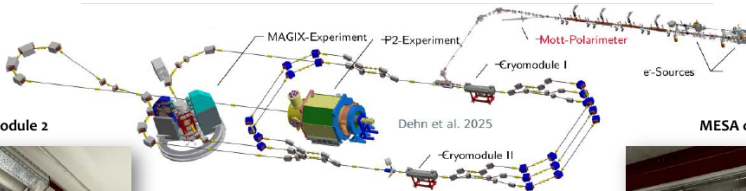




MESA Schedule



- First beam planned in June 2027, 55 MeV, unpolarised, $1\mu\text{A}$
- First beam to MAGIX September 2027
- First beam to P2 in November 2027



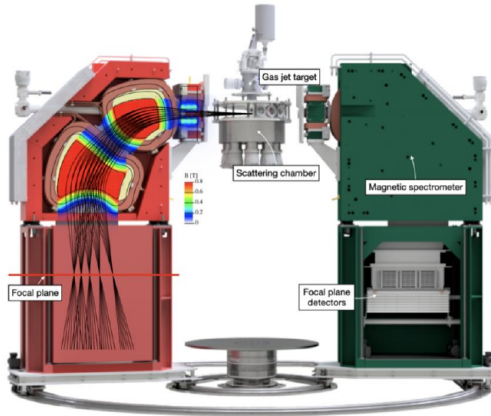
MESA cryomodule 2



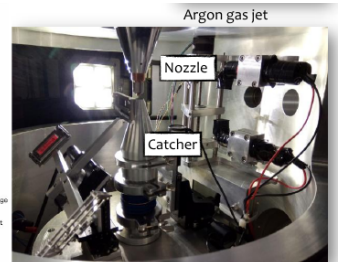
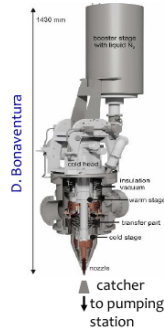
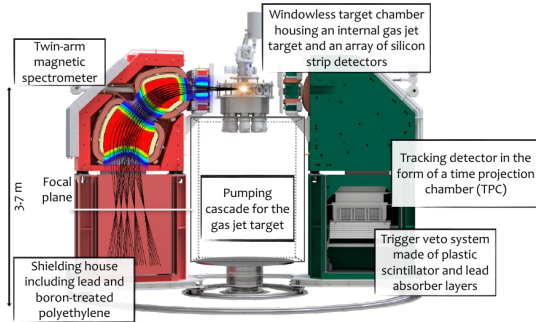
MESA cryomodule 1



Mainz Gas Internal eXperiment

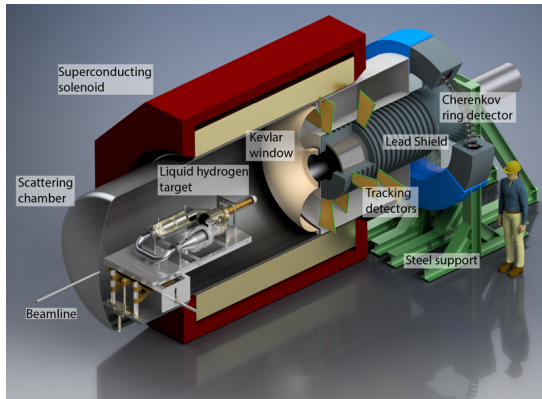


- High-intensity electron scattering experiment
- Novel windowless gas jet target
- Competitive luminosities at low target thickness
- Twin magnetic spectrometers with focal plane detectors
- Low momentum particles measured with high accuracy

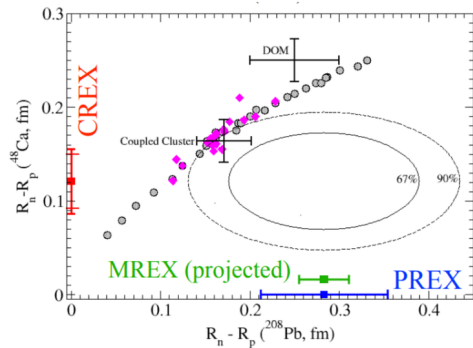
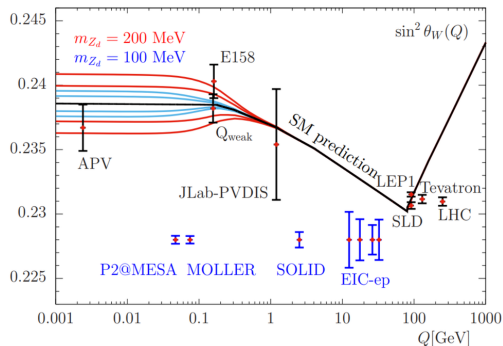


[S. Schlimme et al., NIM A 1013, 165668 (2021)]

Program of precision form factor and cross section measurements planned



- Elastic proton scattering experiment
- Seeking to determine the weak mixing angle, $\sin^2\theta_w$
- Measuring the parity violating asymmetry in elastic proton scattering
- Planned analyses to put limits on some Standard Model extensions, including effective quark coupling constants and dark photons



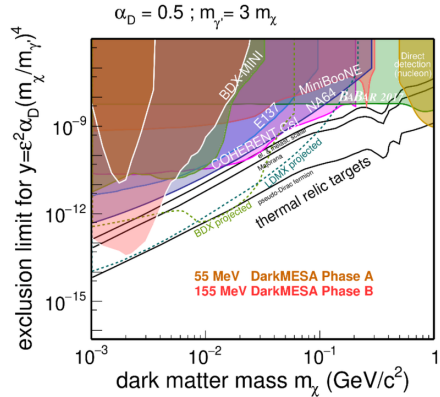
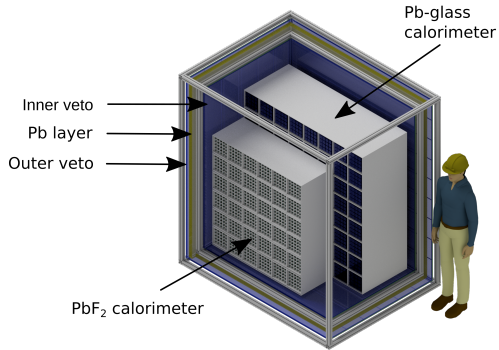
[PRL 129, 042501 \(2022\)](#)

[PRL 126, 172502 \(2021\)](#)



P2 Construction

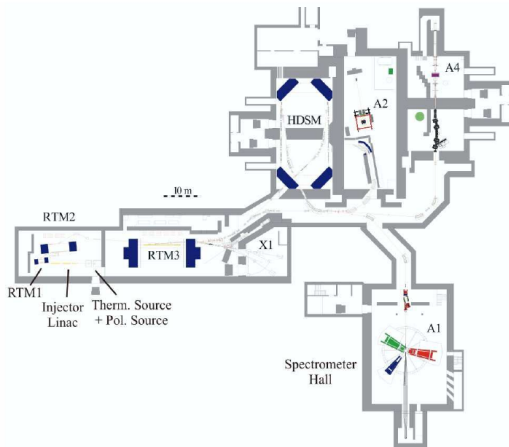




Stong legacy of UK-Mainz collaboration with the Mainzer Microtron (MAMI)

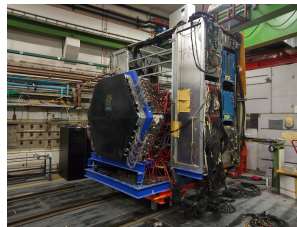
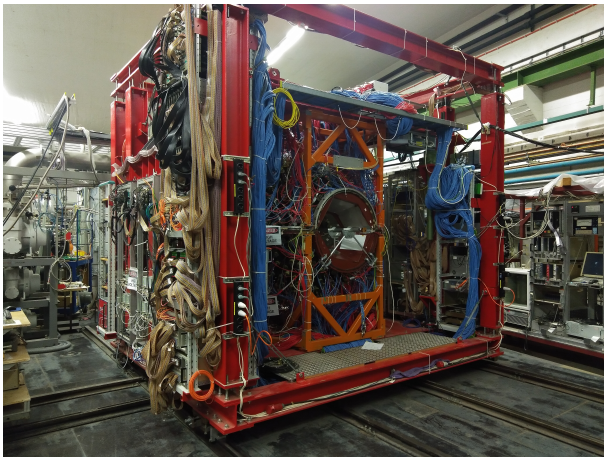
Two stage accelerator:

- Triple racetrack microtron (MAMI-B)
 - Electron energy from 180-883 MeV
- Harmonic Double-Sided Microtron (MAMI-C)
 - Electron energy up to 1604 MeV
- Currently two experimental halls, A1 and A2, and a test beam area, X1



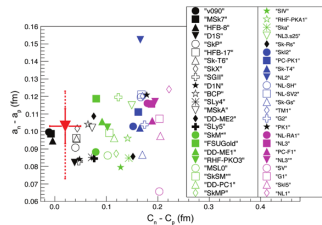
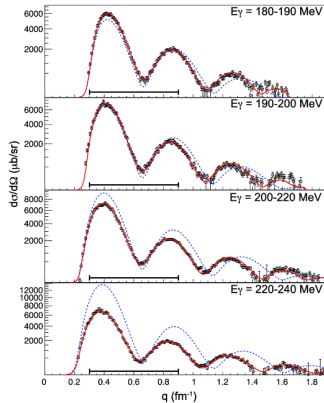


The Past - A2 and the Crystal Ball

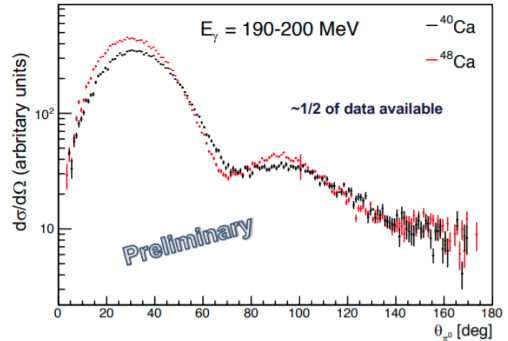
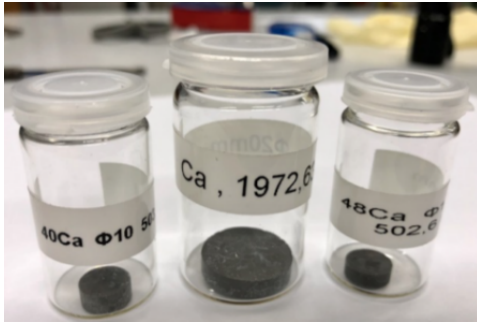




- A2 study of Lead-208, published in 2014
- Closed proton ($Z=82$) and neutron ($N=126$) shells means relatively well understood structure
- Neutron skin measured via coherent pion photoproduction
- Precision measurement discriminating between models



C. Tarbert, et. al., PRL 112, 242502 (2014)



Dedicated A2 measurements on two Calcium isotopes; ^{40}Ca and ^{48}Ca
Coherent π^0 and $2\pi^0$ production
Complimentarity with upcoming MESA experiments



York at MAMI: isotope production as a second output

Demonstrated the principle at MAMI, Mainz:

parasitic bremsstrahlung from MAMI was used to produce and assay ^{67}Cu from zinc targets, without making isotope production the primary experiment.



[APS Physics Focus](#)

FOCUS

Making Fresh Radionuclides with Leftover Gamma Rays

Accelerator infrastructure built for precision physics can also enable applied nuclear measurements.



Can we test a compact, removable converter--target station at MESA for electron driven medical isotope production?

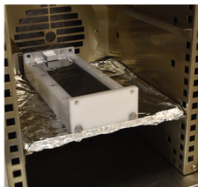
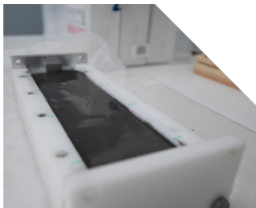
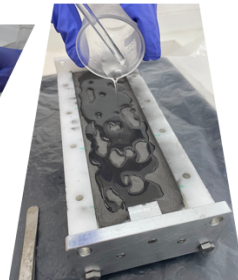
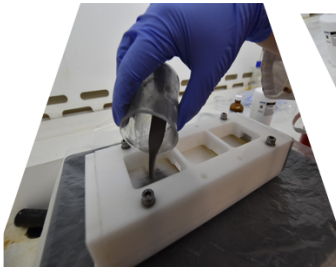
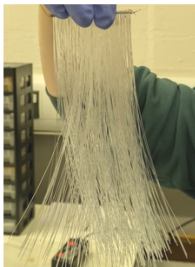


What York can bring

activation targets | HPGe assay | yield/cross section measurements | converter/target chamber

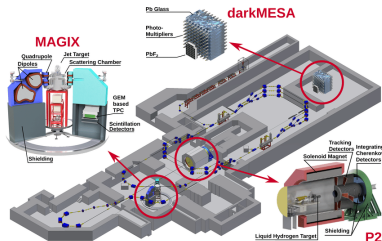


Tungsten-Fibre Calorimeters - A. Smith





A new accelerator facility will soon be operational in Mainz



- First beam expected next year
- A program of precision, high intensity, experiments planned
- Now they've built it, the Mainz groups are open to new ideas and collaborators to further leverage this facility