High rate electron beam tests with MuPix8 sensors at MAMI

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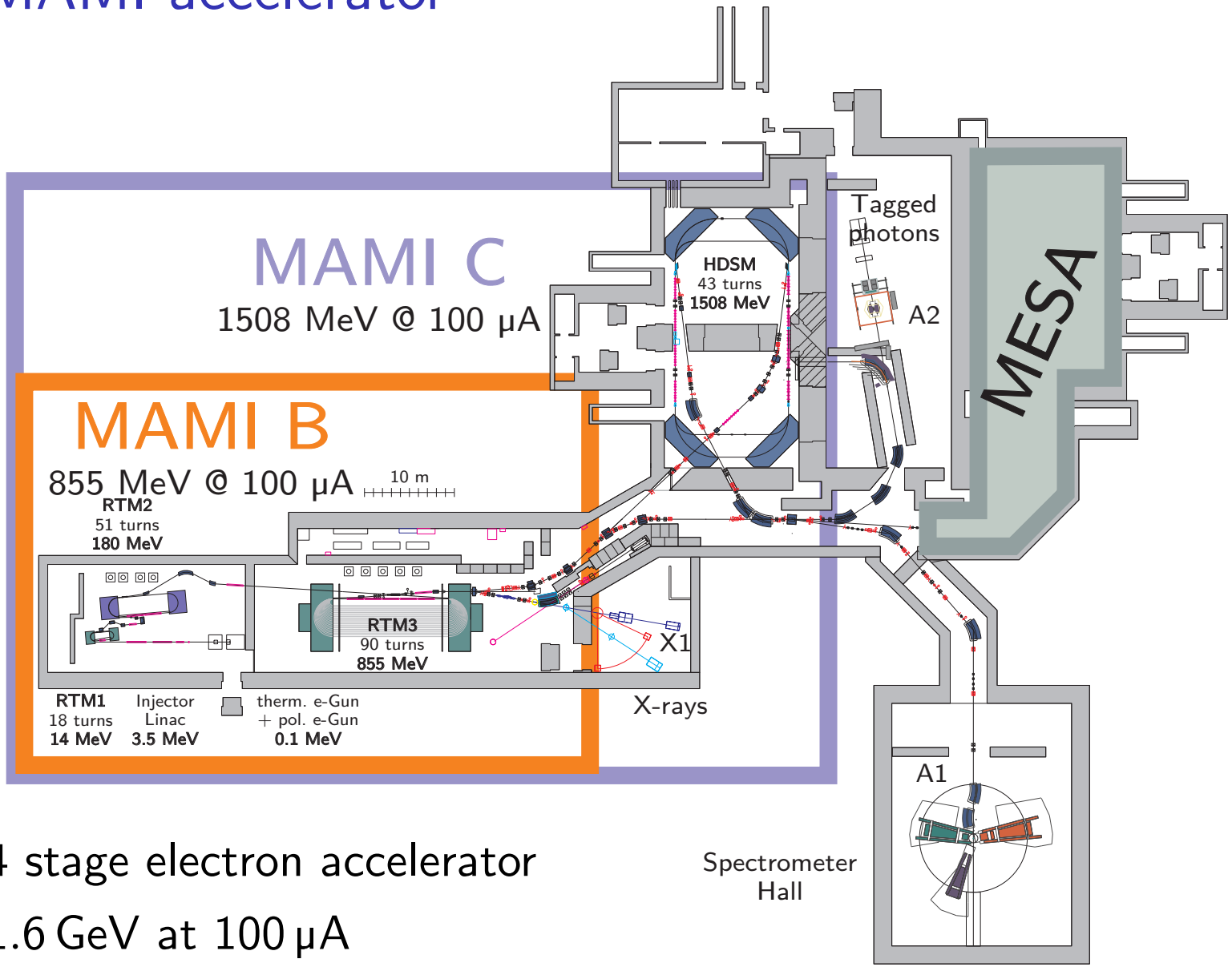
Outline

- Mainz Microtron (MAMI) accelerator
- MAMI testbeam locations
- MuPix8 high rate testbeam at MAMI

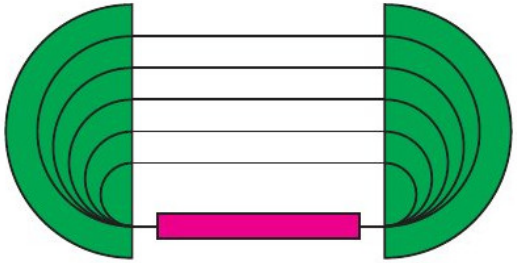
The MAMI accelerator



- 4 stage electron accelerator
- 1.6 GeV at 100 µA
- 82 % polarization (max. 20 µA)

Accelerator stages 1-3 - MAMI-B

- Linear injector
- 3 stage racetrack microtrons
- Energies[MeV]: 14, 180, 855



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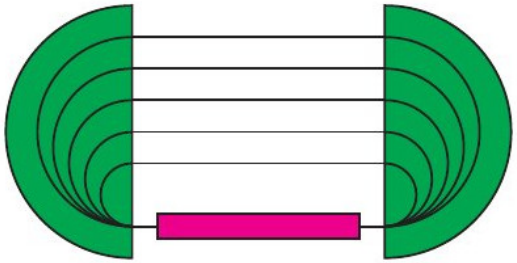
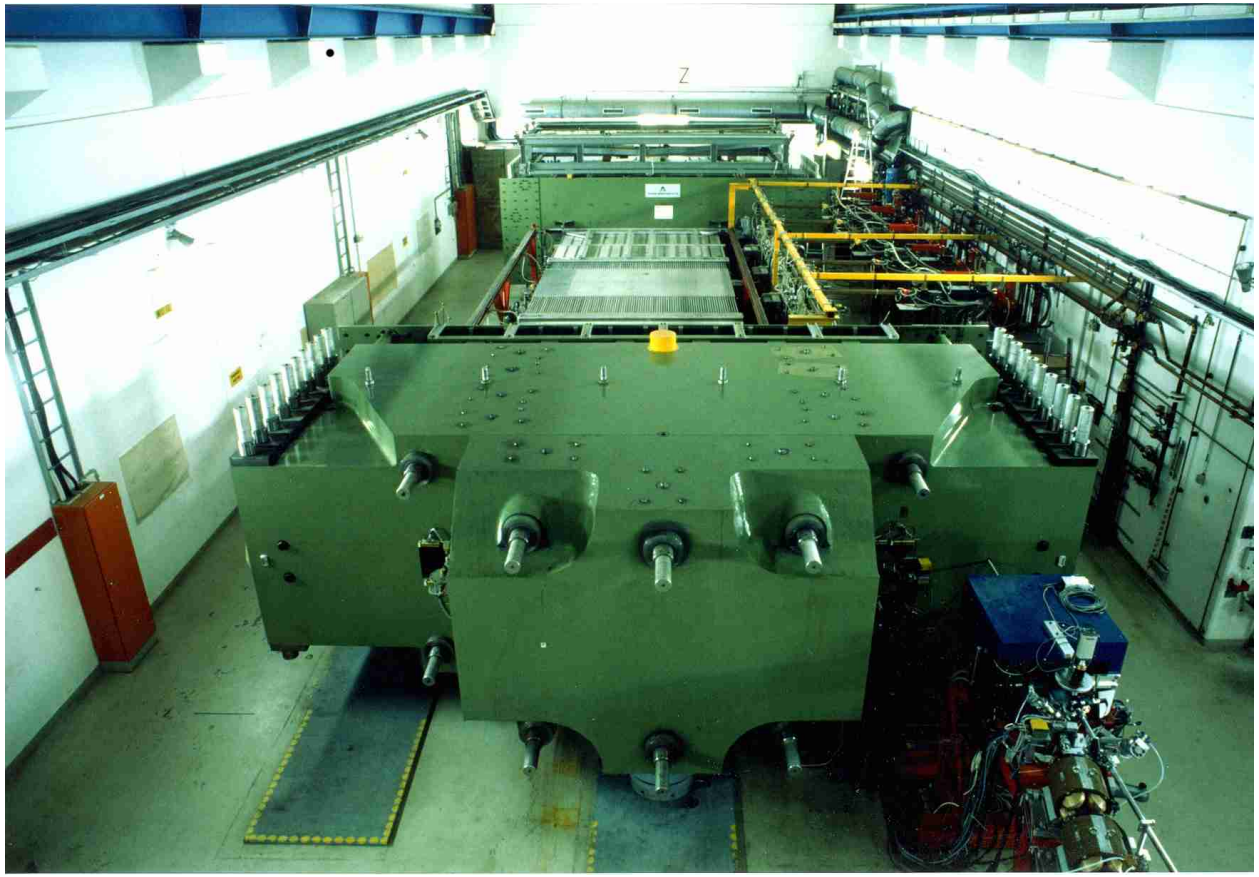
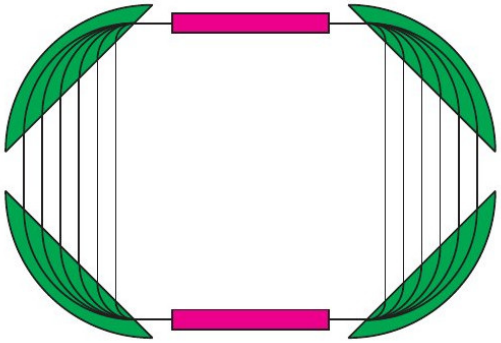
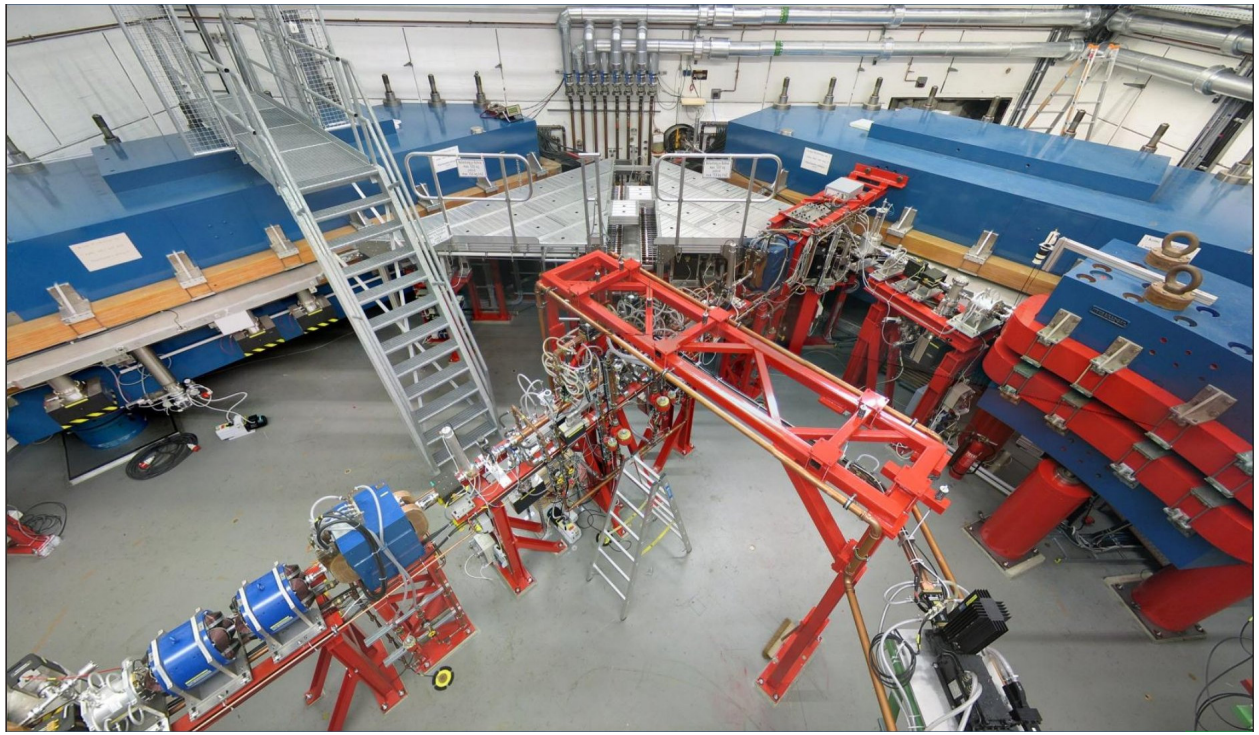




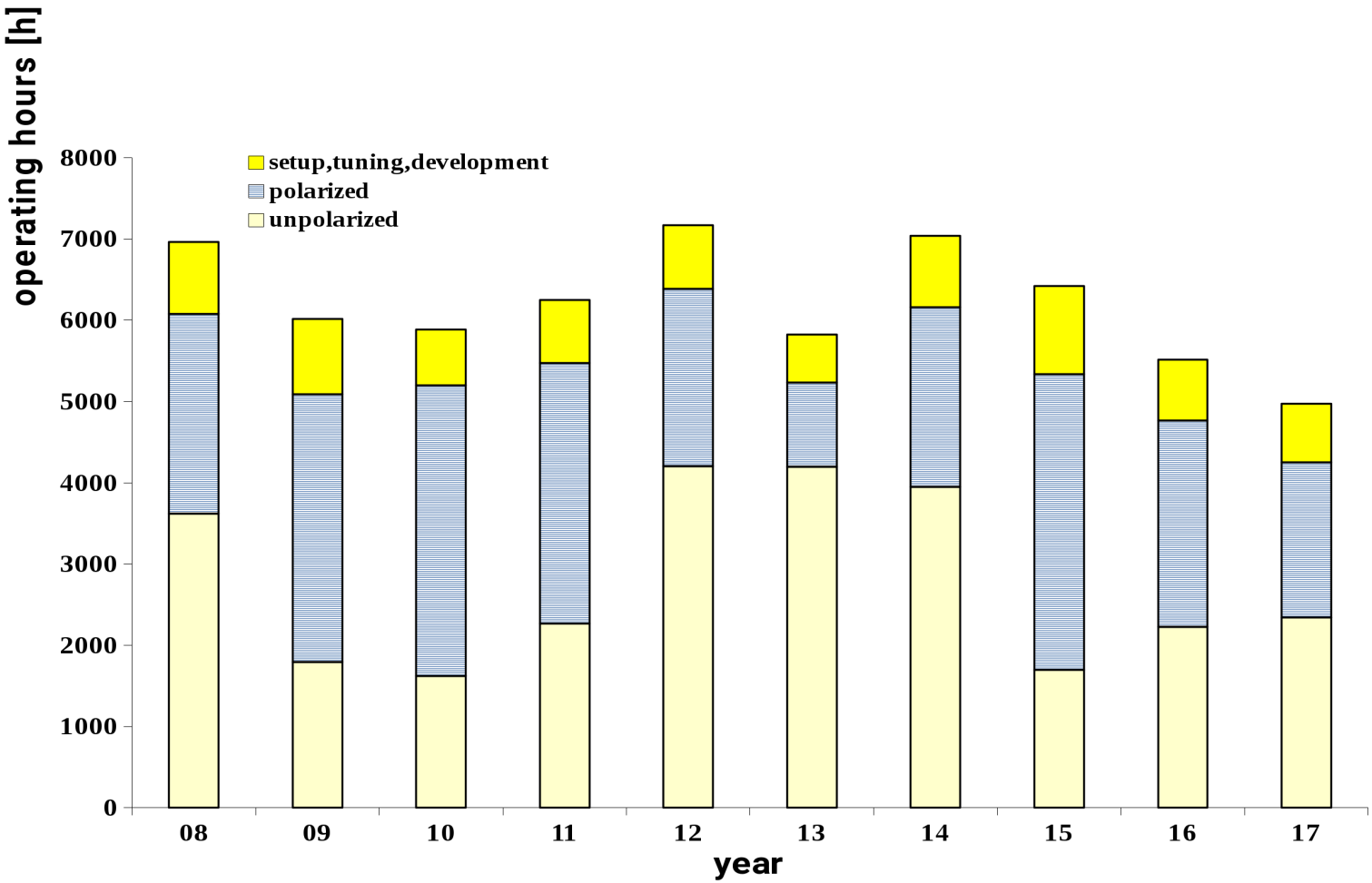
Accelerator stage 4 - MAMI-C

- Harmonic double-sided microtron
- Output energy: 1.6 GeV



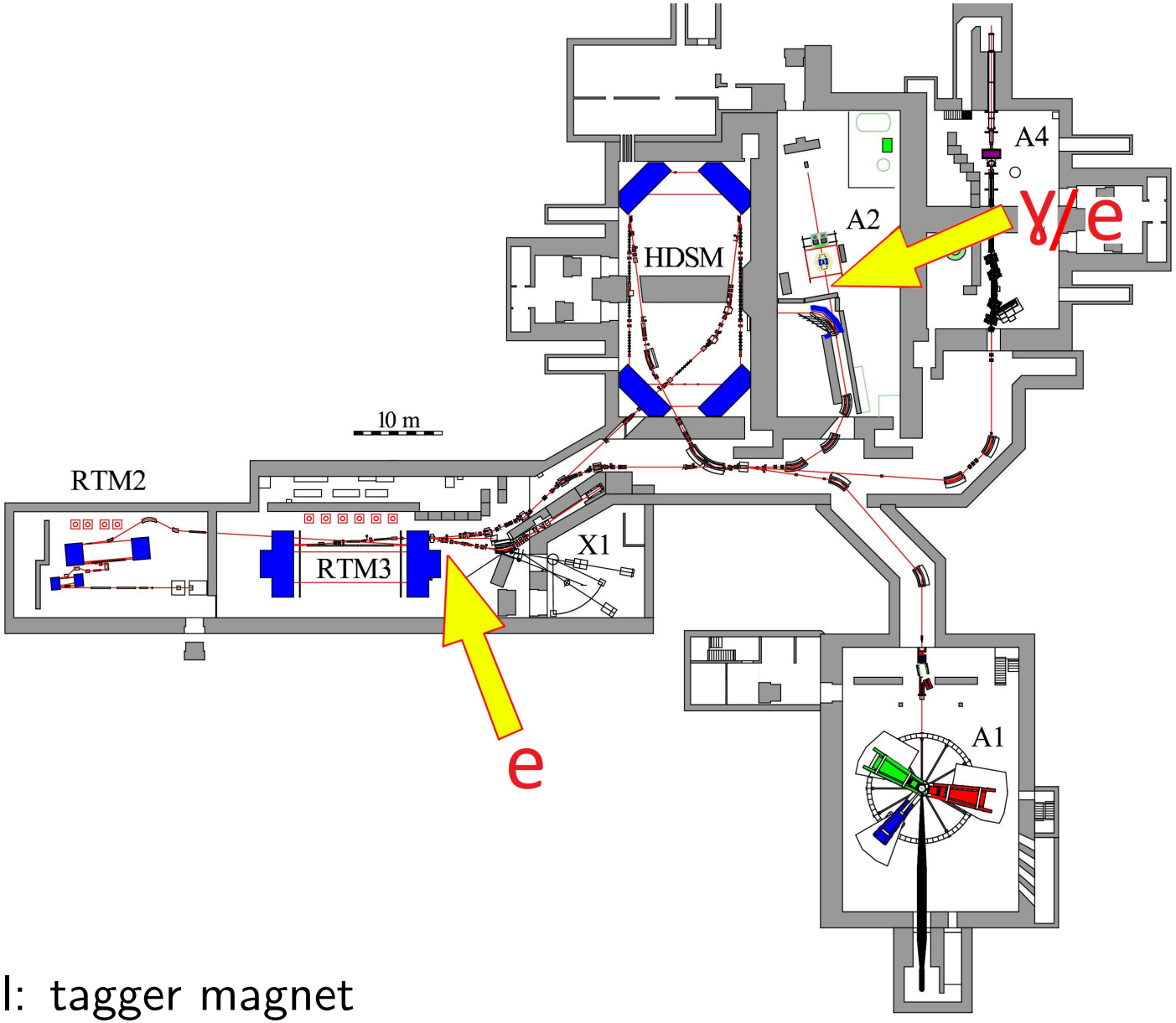


MAMI operation



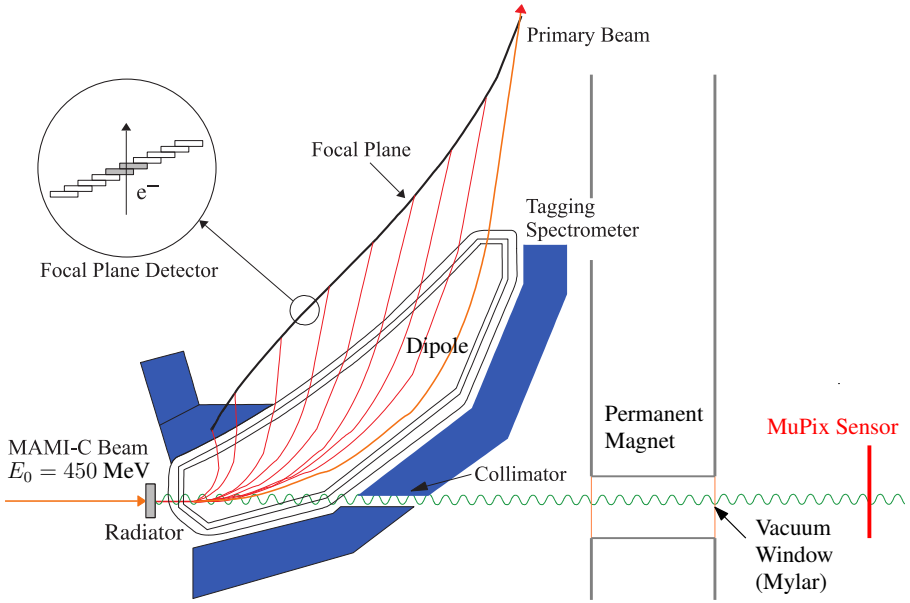
- Up to 70 % duty cycle
- December 2017 missing ($\approx$ 150 h unpolarized)

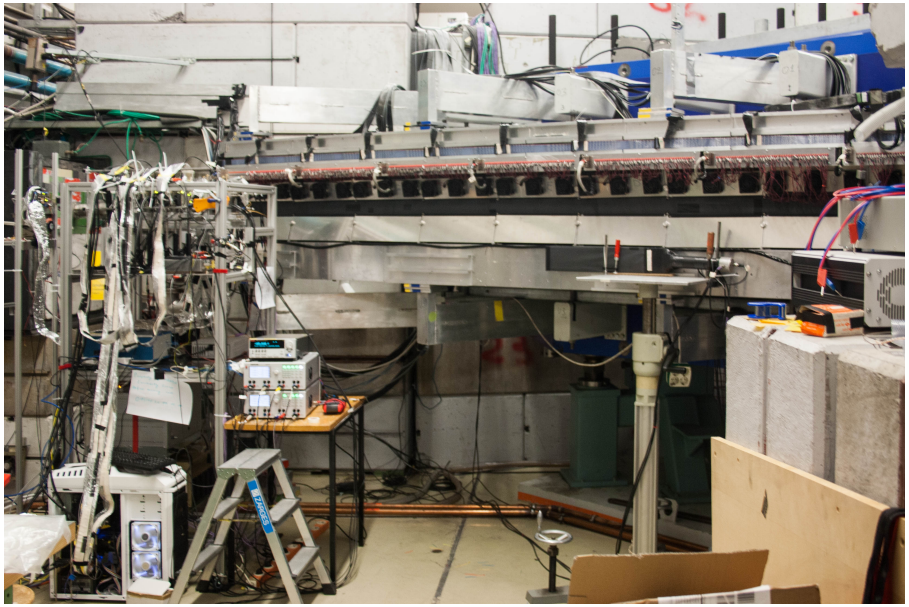
Testbeam locations



- A2 hall: tagger magnet
- X1: behind RTM 3

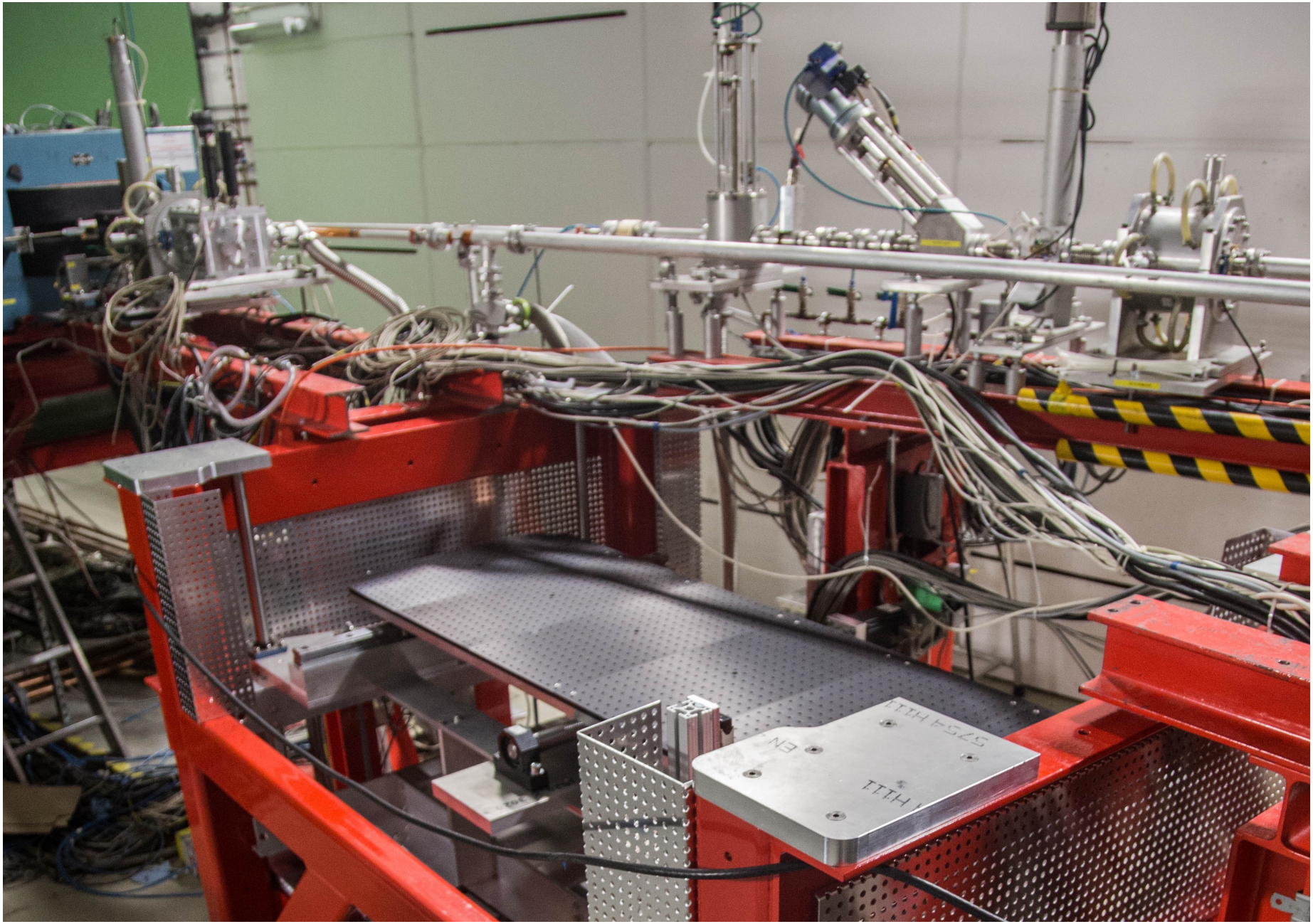
Testbeam locations - A2



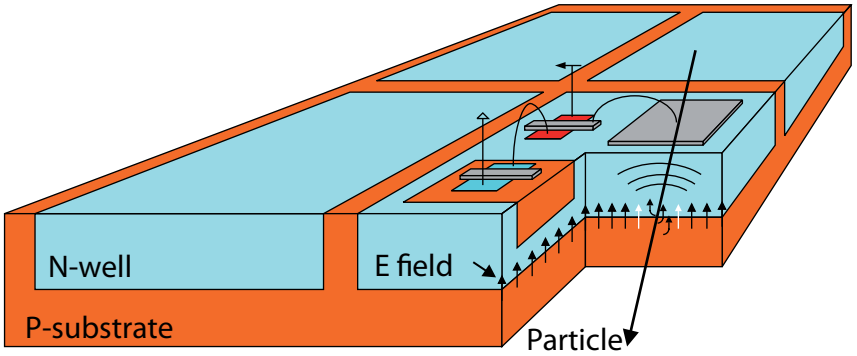


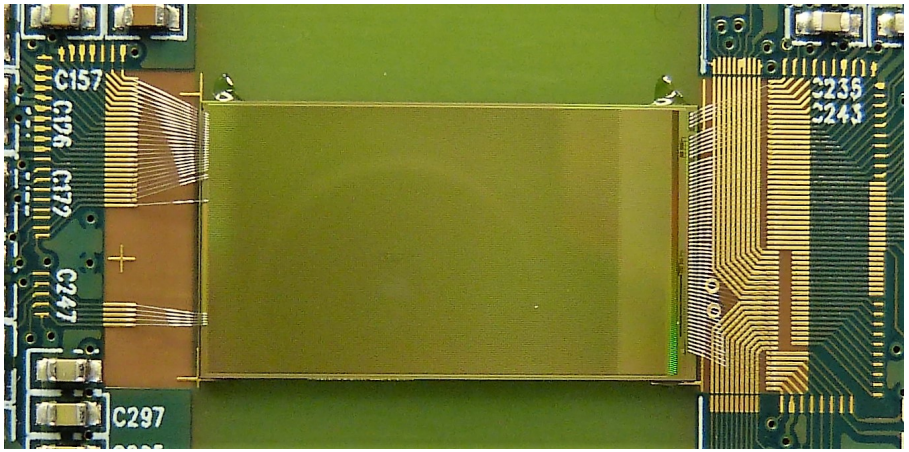
- Glasgow photon tagging spectrometer
- tagged photon beam (5 - 93% of beam energy)

Testbeam locations - X1



HV-MAPS - MuPix sensor prototype

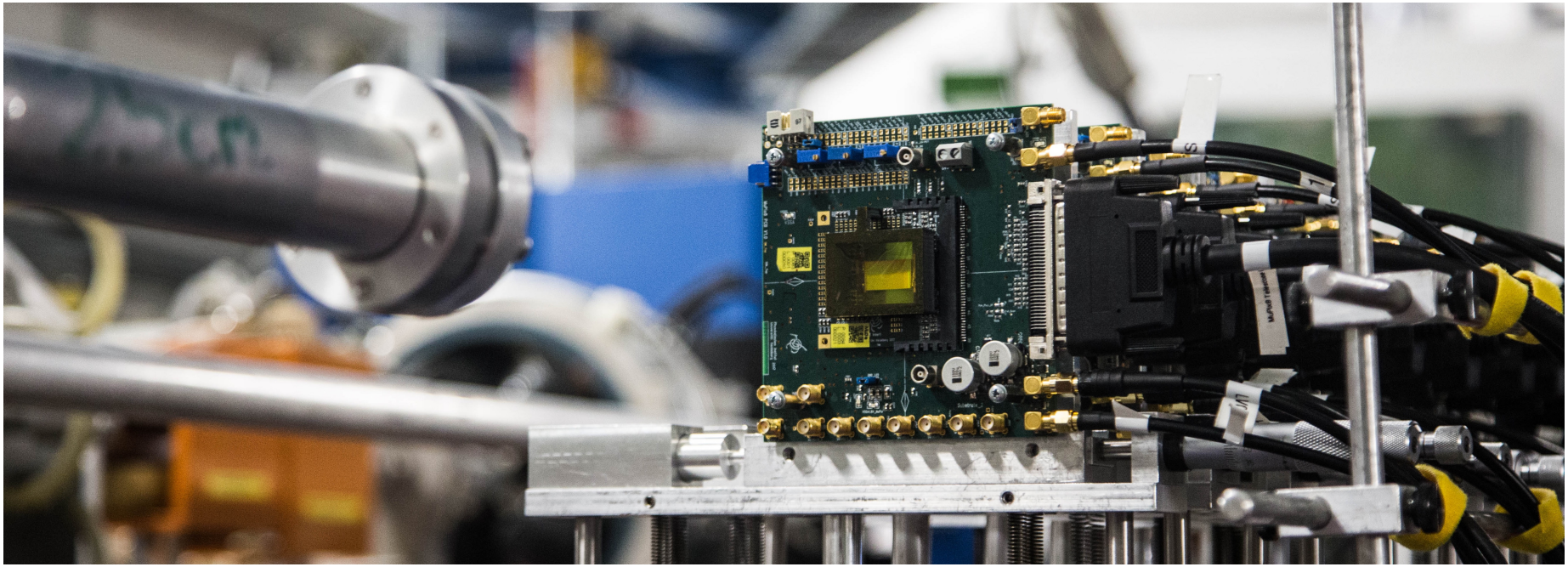




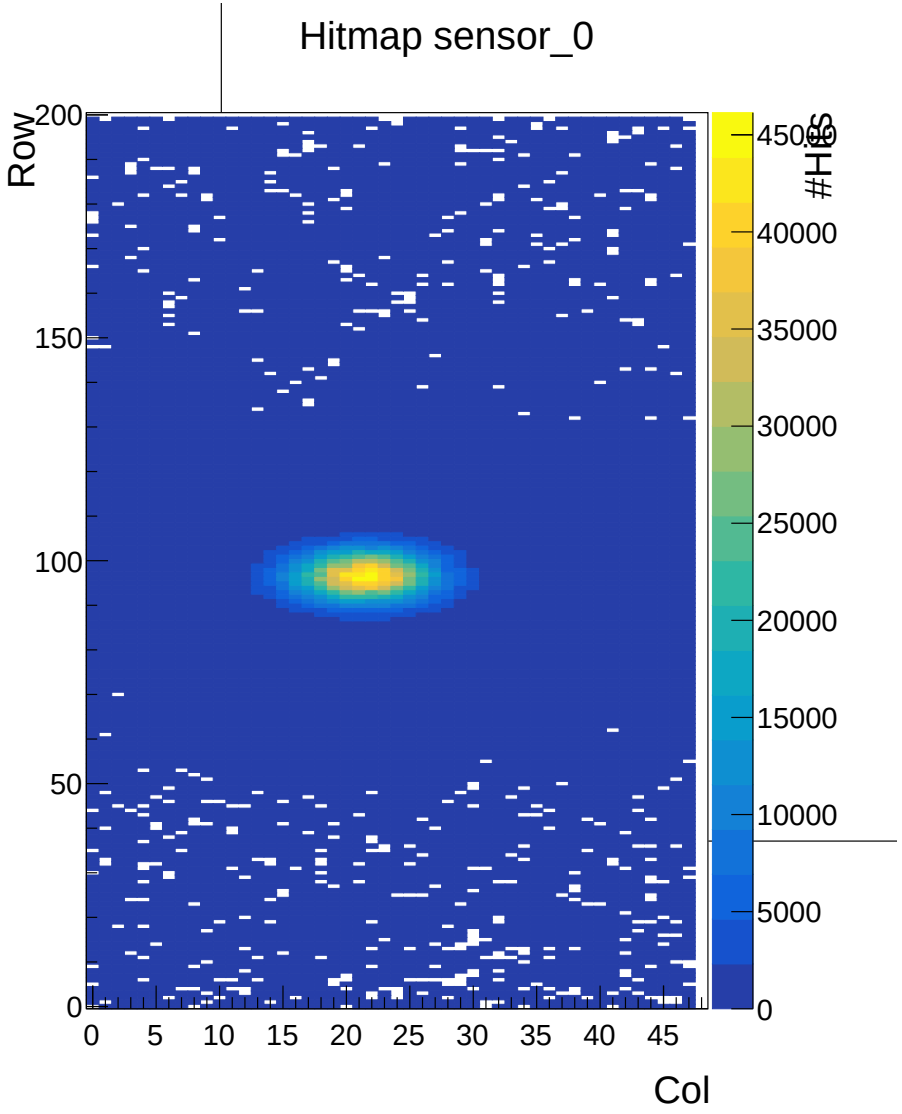
- 180 nm HV-CMOS technology
- Reverse biased up to 90 V
- Readout logic on chip
- Thinnable down to 50 µm
- MuPix8
- Pixel size: $80 \times 81\,\mu m^2$
- Sensor size: $2 \times 1\,cm^2$
- Used in Mu3e, P2

X1 high rate electron testbeam

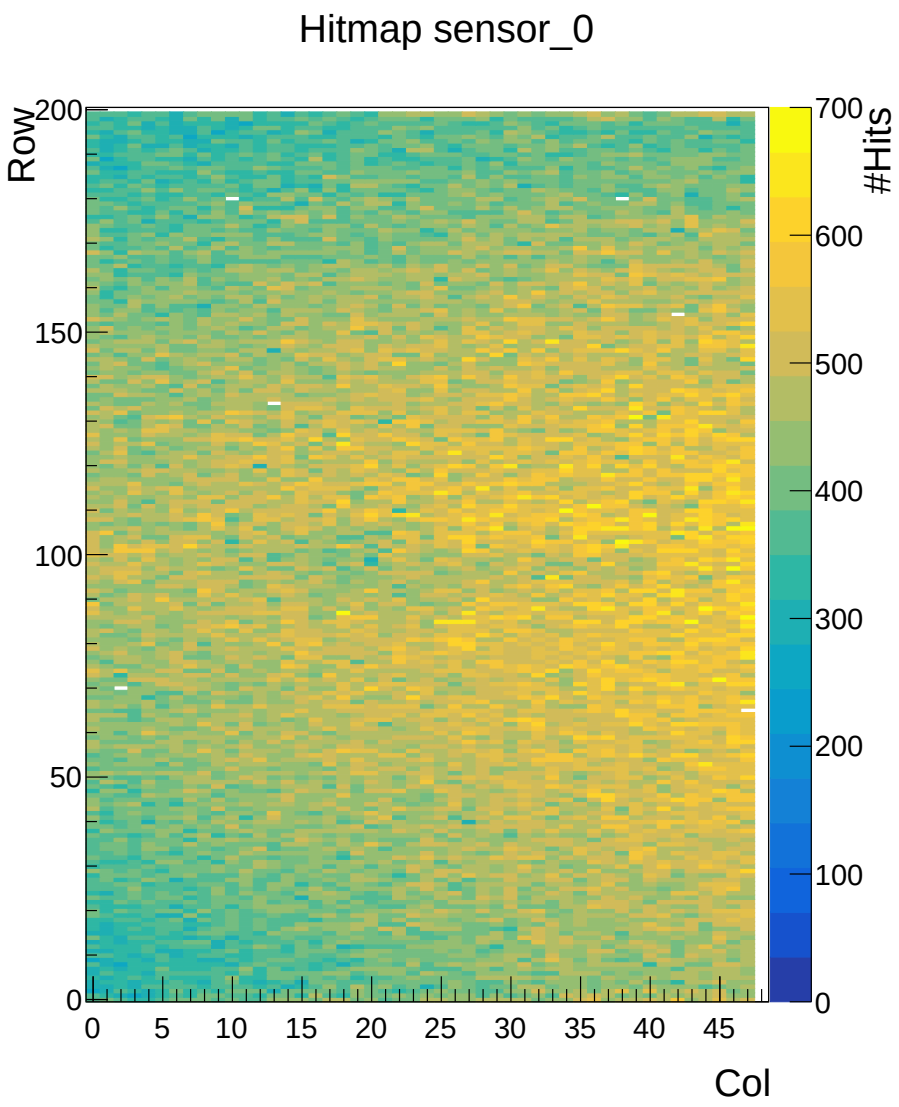
- 8 layer MuPix8 telescope (compare L.Huth: The MuPix8 telescope)
- Mu3e front-end readout board
- max. 10 MHz electron beam at 855 MeV



X1 high rate electron testbeam - observations

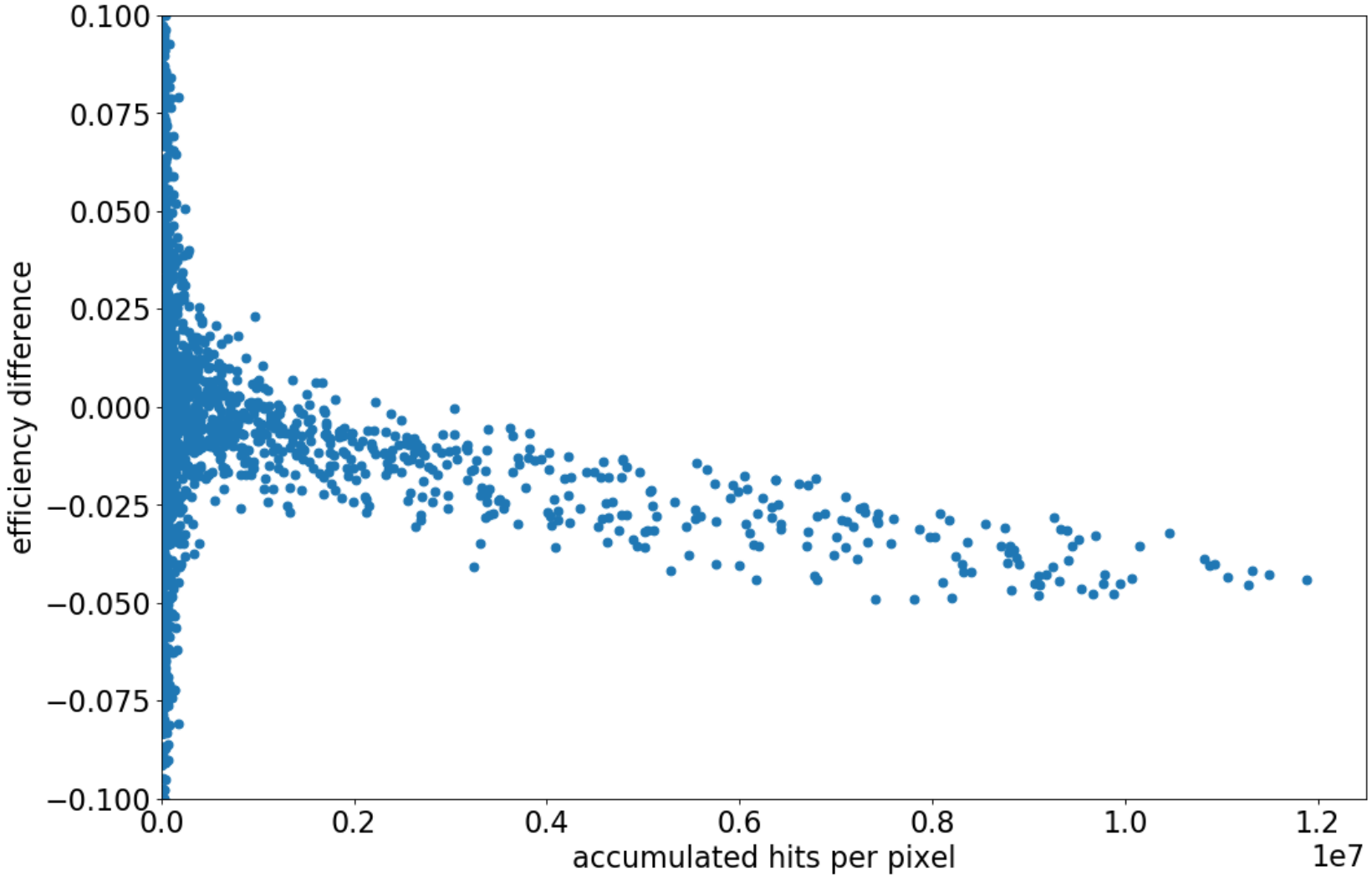


hitmap during testbeam run



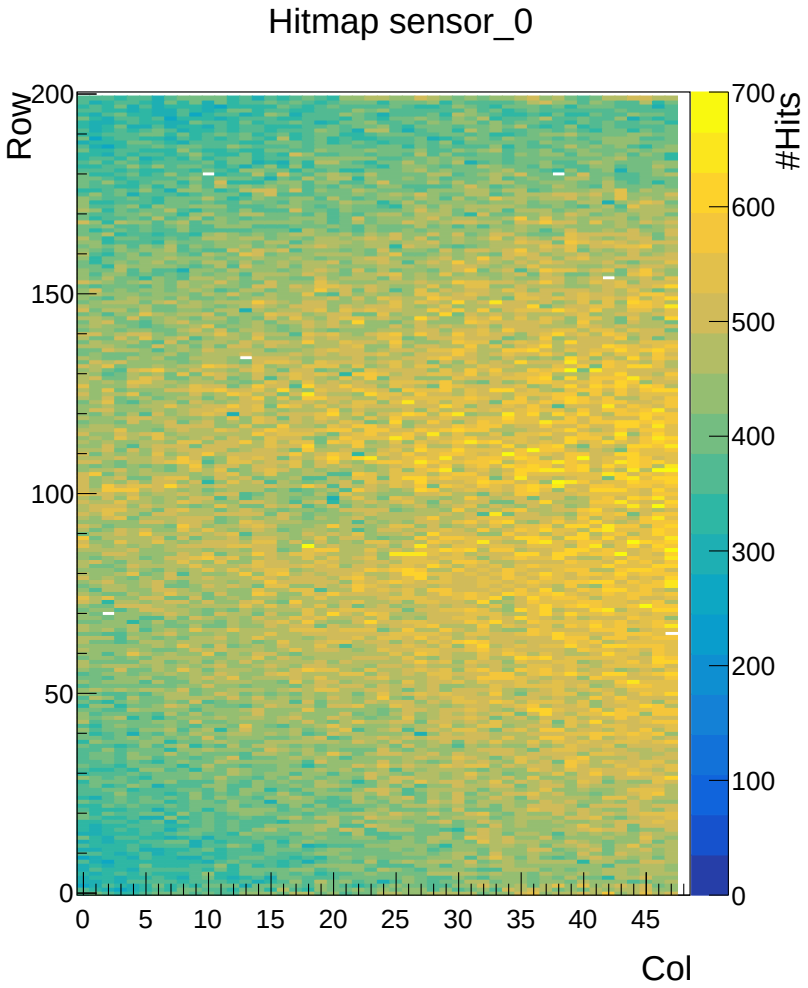
hitmap after the testbeam

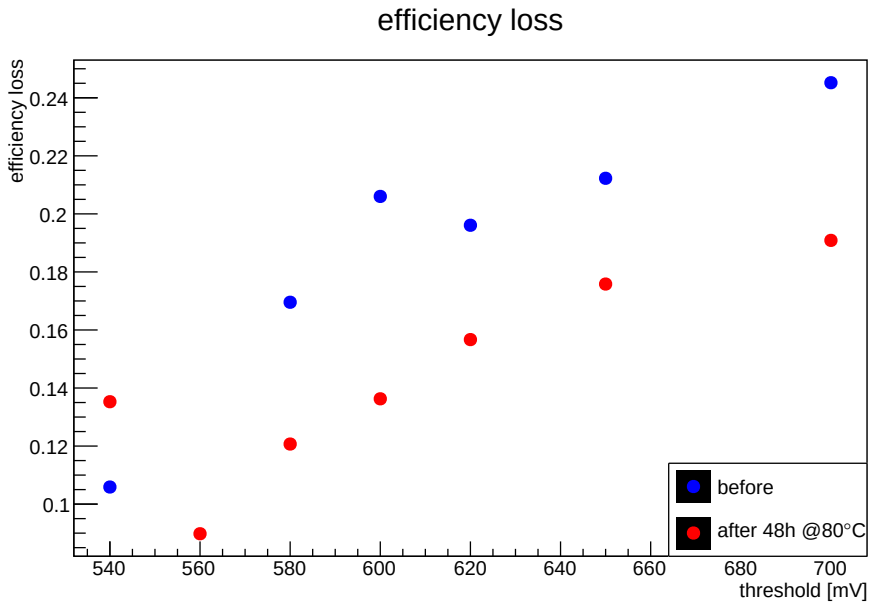
X1 high rate electron testbeam - efficiency analysis



- difference of per pixel efficiencies
- dependence on accumulated hits

X1 high rate electron testbeam - laboratory measurements

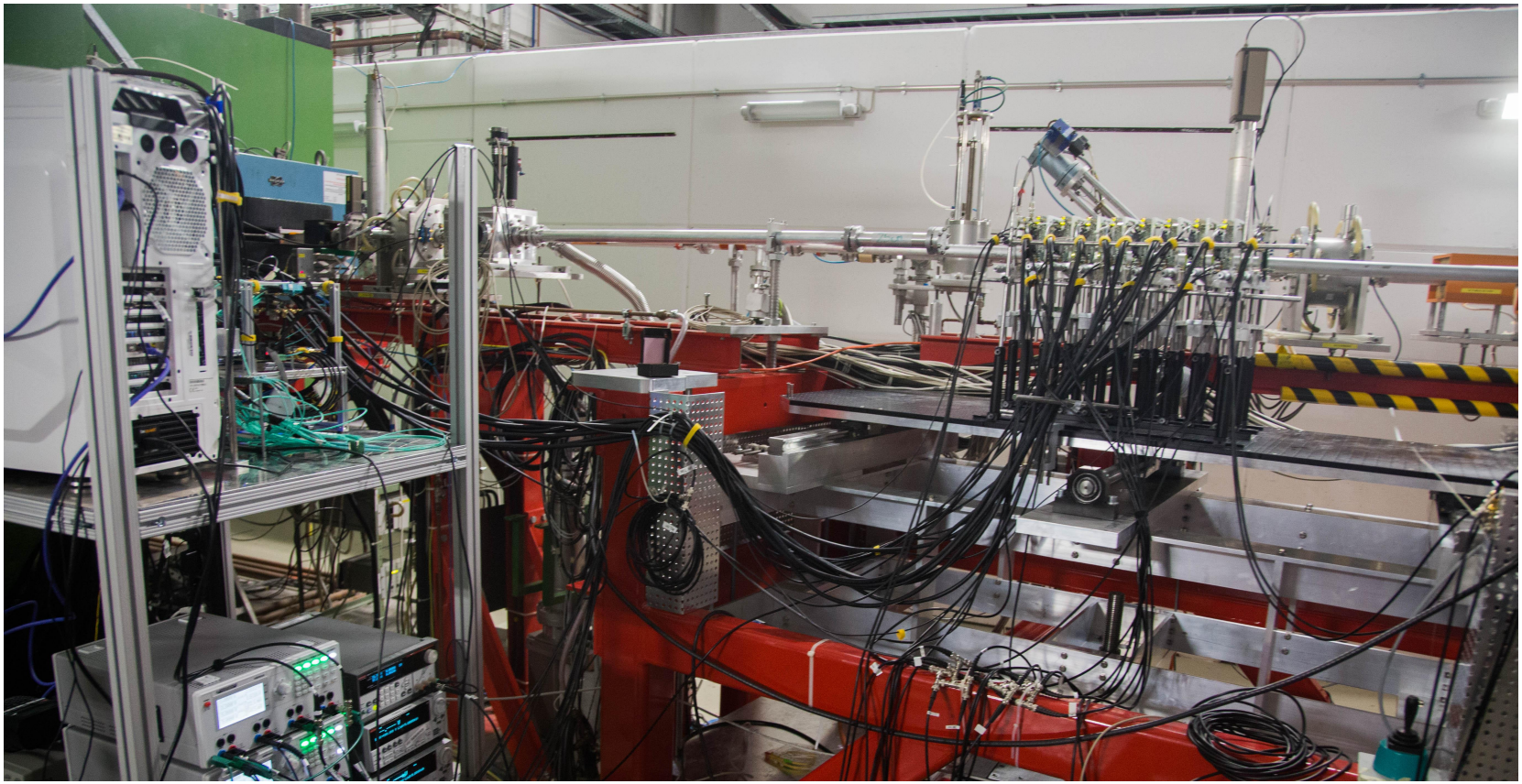




- efficiency loss measured with Sr90 source
- sensor after 48h at 80 °C
- no further improvement (72h at 90 °C)

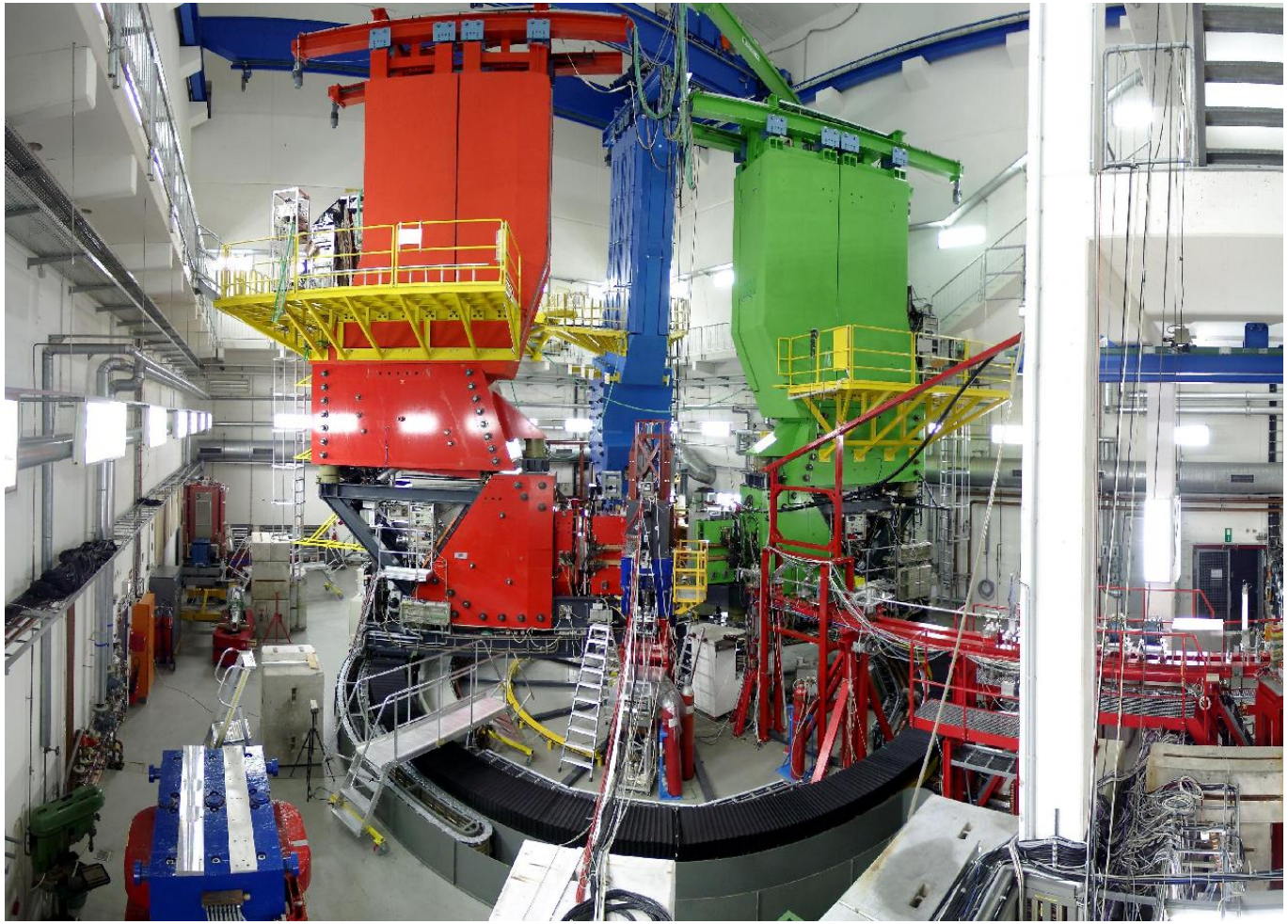
Summary

- MAMI provides polarized electron beam up to 1.6 GeV
- successfull MuPix8 telescope operation at high rates
- high local rates create degradation of MuPix8
- further testbeams and lab measurements planned



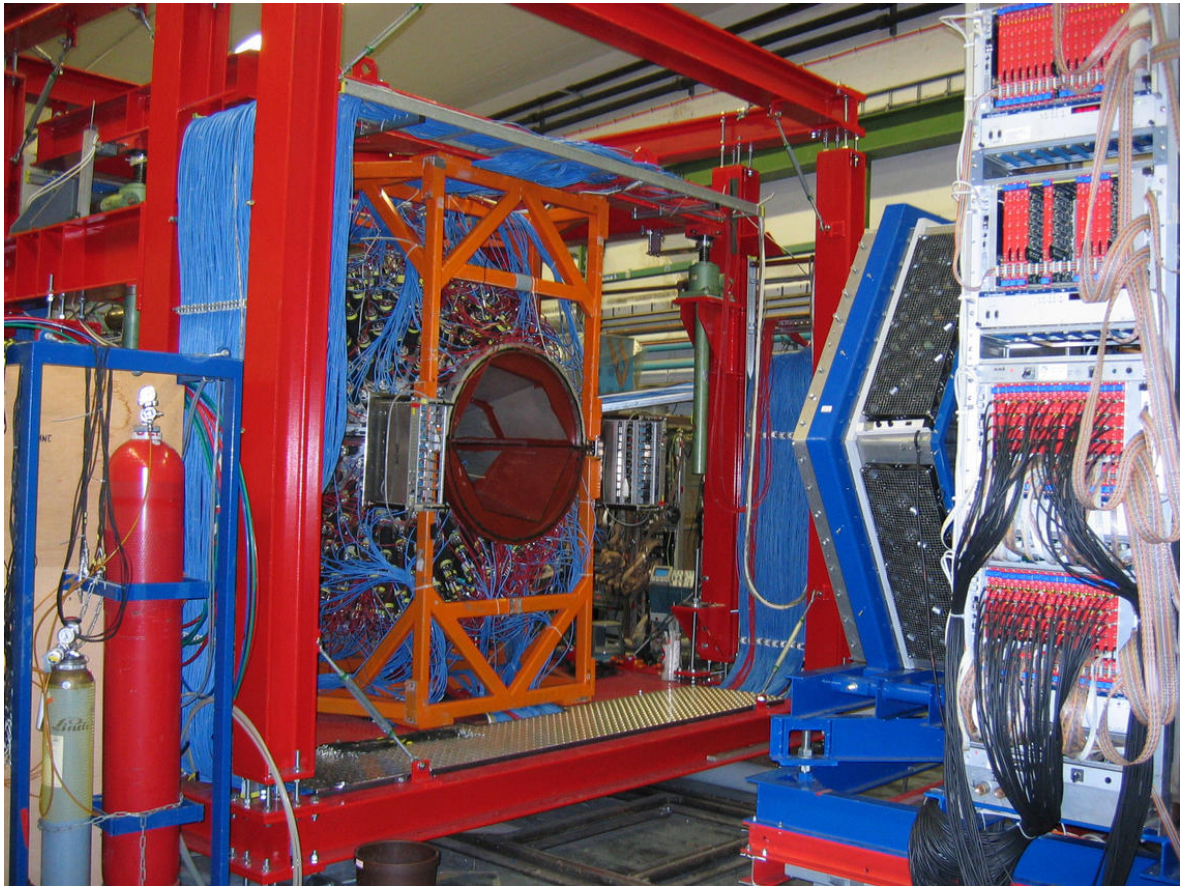
Backup - A1

- Electron scattering
- 3 rotatable spectrometers



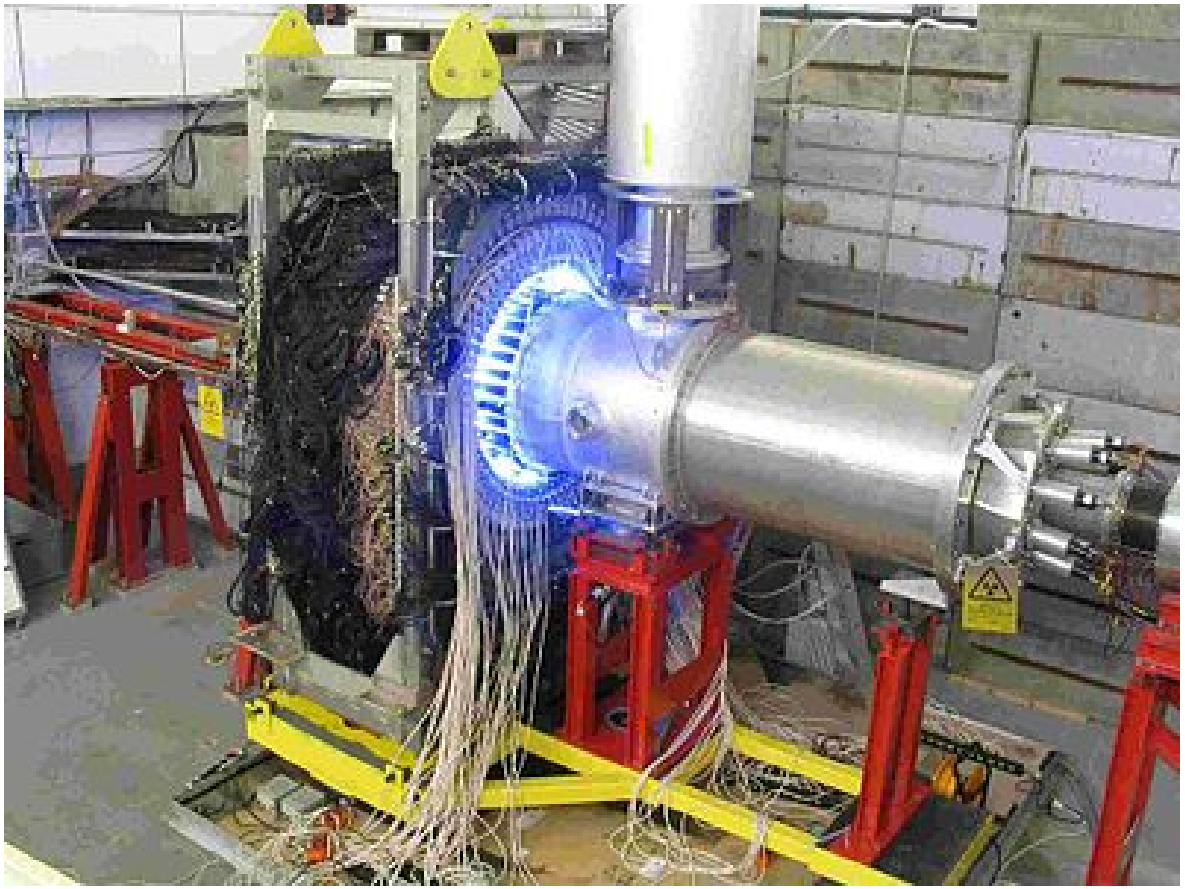
Backup - A2

- Photoproduction by Bremsstrahlung
- Beam electrons deflected and tagged by spectrometer
- Meson radiation of target nucleons



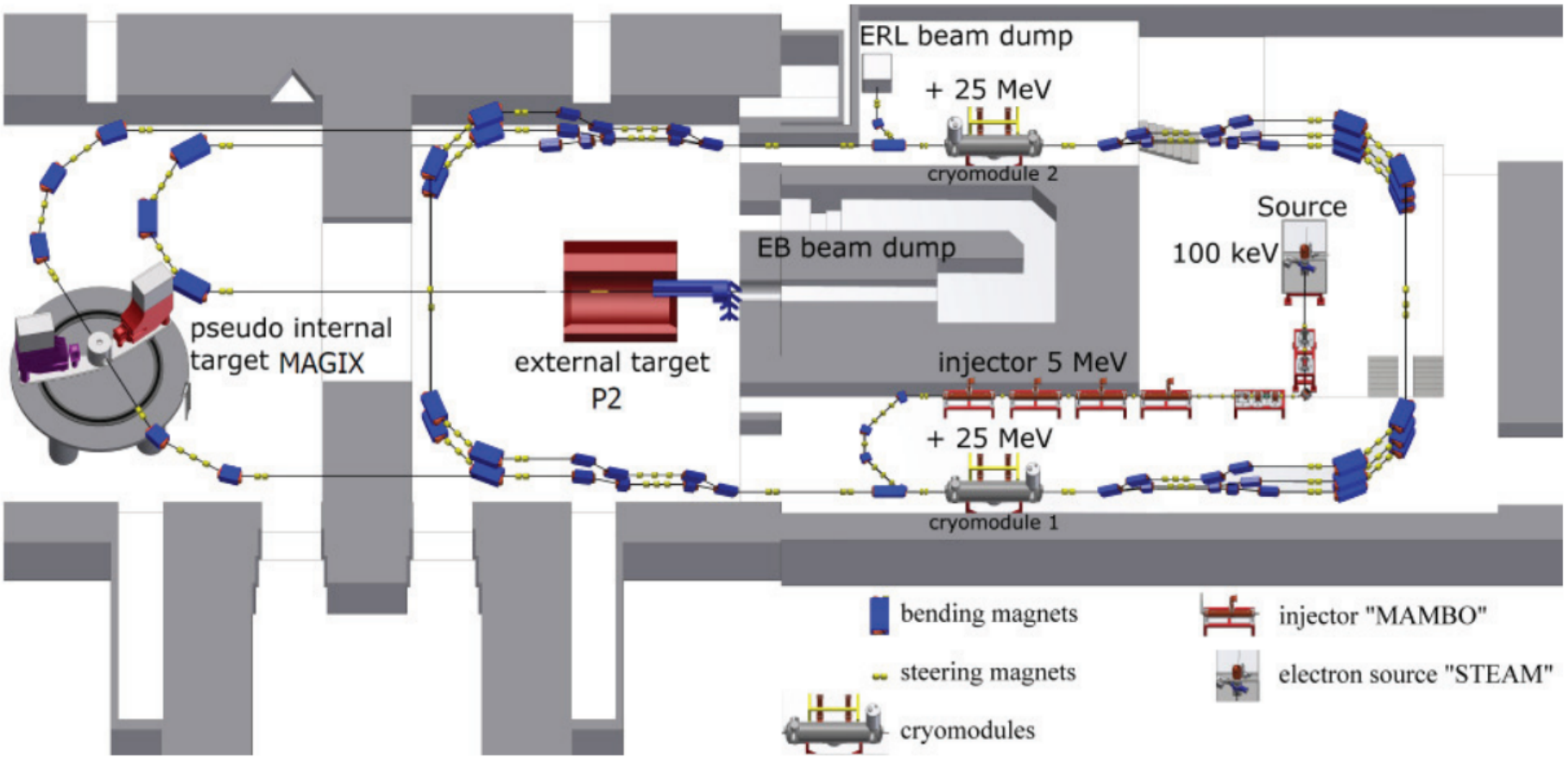
Backup - A4

- Elastic electron scattering
- Longitunally polarized electrons
- Unpolarized H_2 target
- Measure parity violating asymmetry

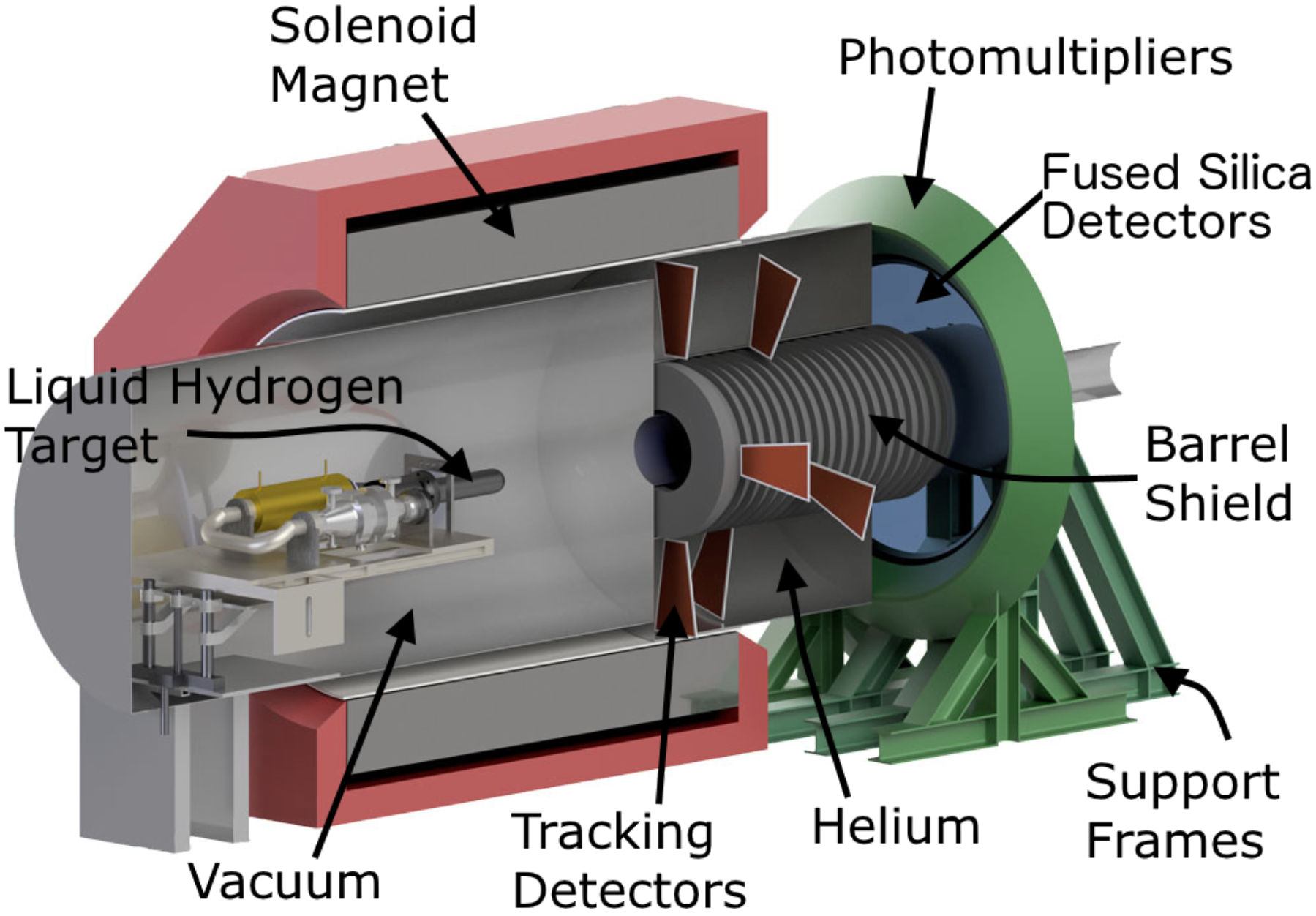


Backup - MESA

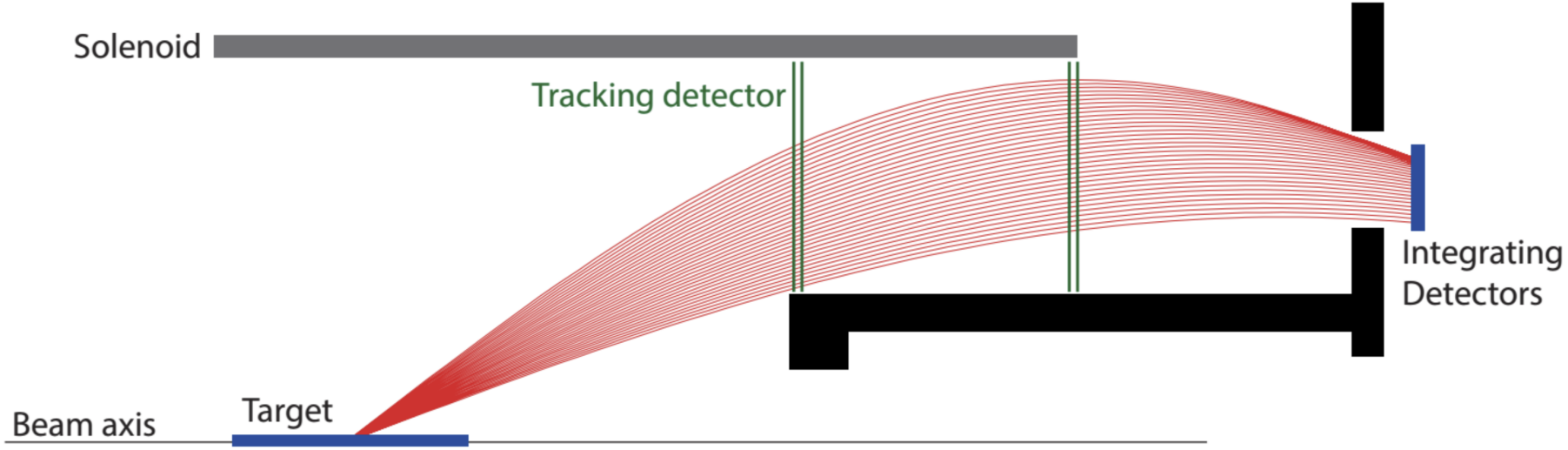
- Mainz Energy Recovering Superconducting Accelerator **(MESA)**
- 2 modes, up to 155 MeV, 85 % polarization



Backup - P2 experiment

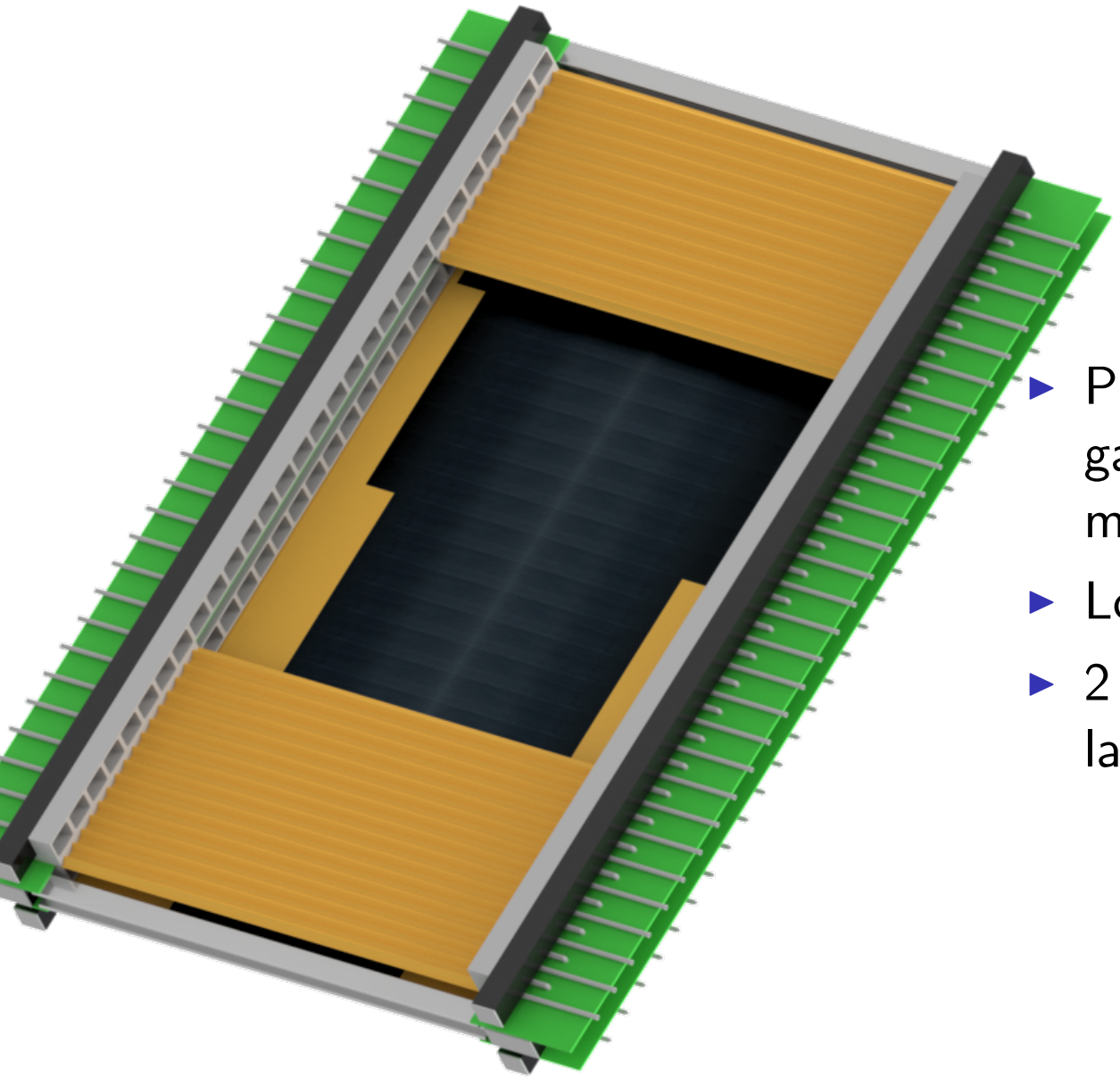


Backup - P2 spectrometer and tracking system



- 0.6 T solenoid magnet
- Inhomogenous field in tracking system
- Measure the average Q^2
- Validate acceptance, alignment
- Monitor beam and target conditions

Backup - P2 tracking detector



- Pixel sensors, electronics, gaseous helium cooling, mechanical support
- Low material budget
- 2×4 modules, double layers, 300 sensors per layer