High rate electron beam tests with MuPix8 sensors at MAMI

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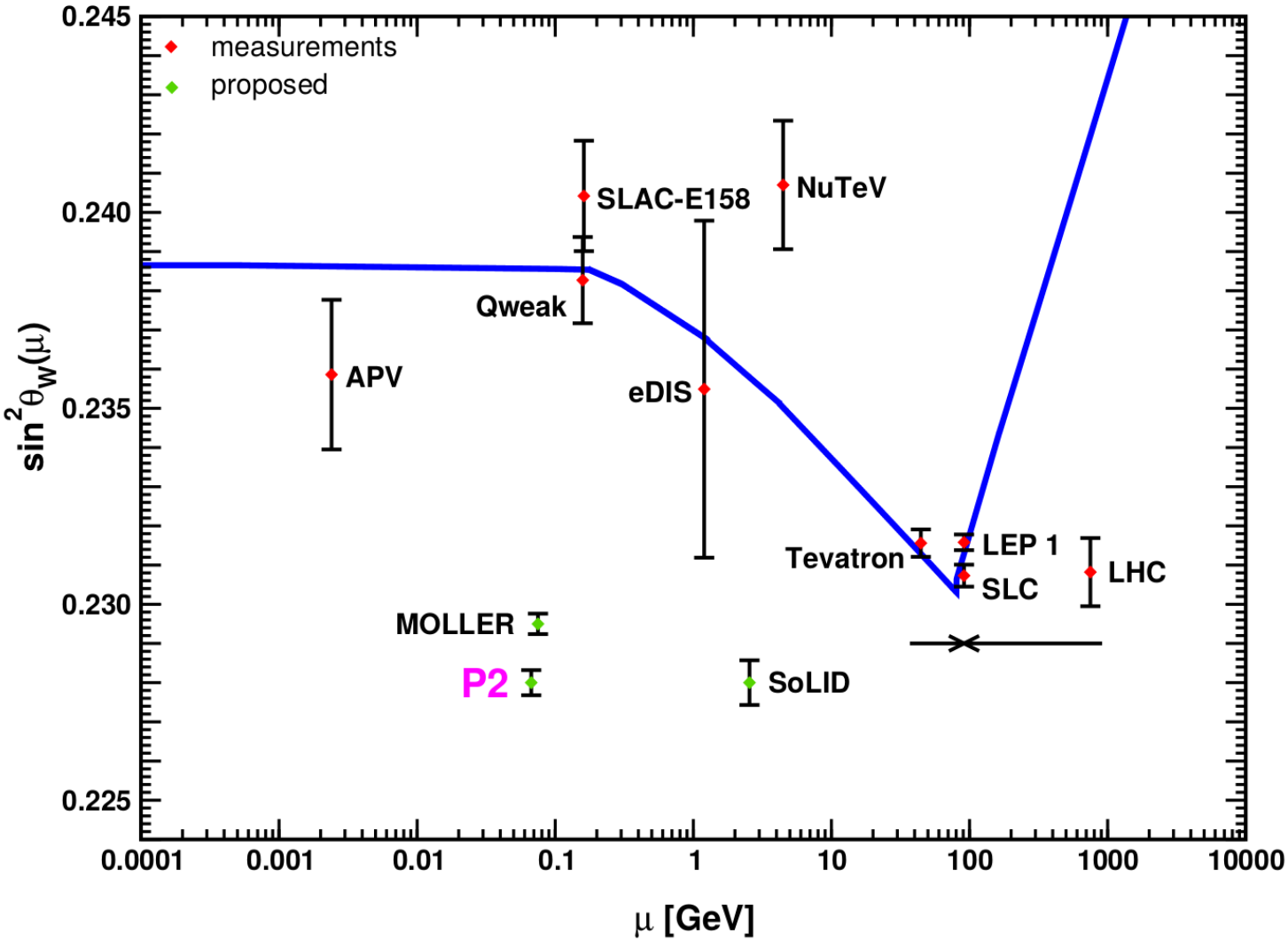
Outline

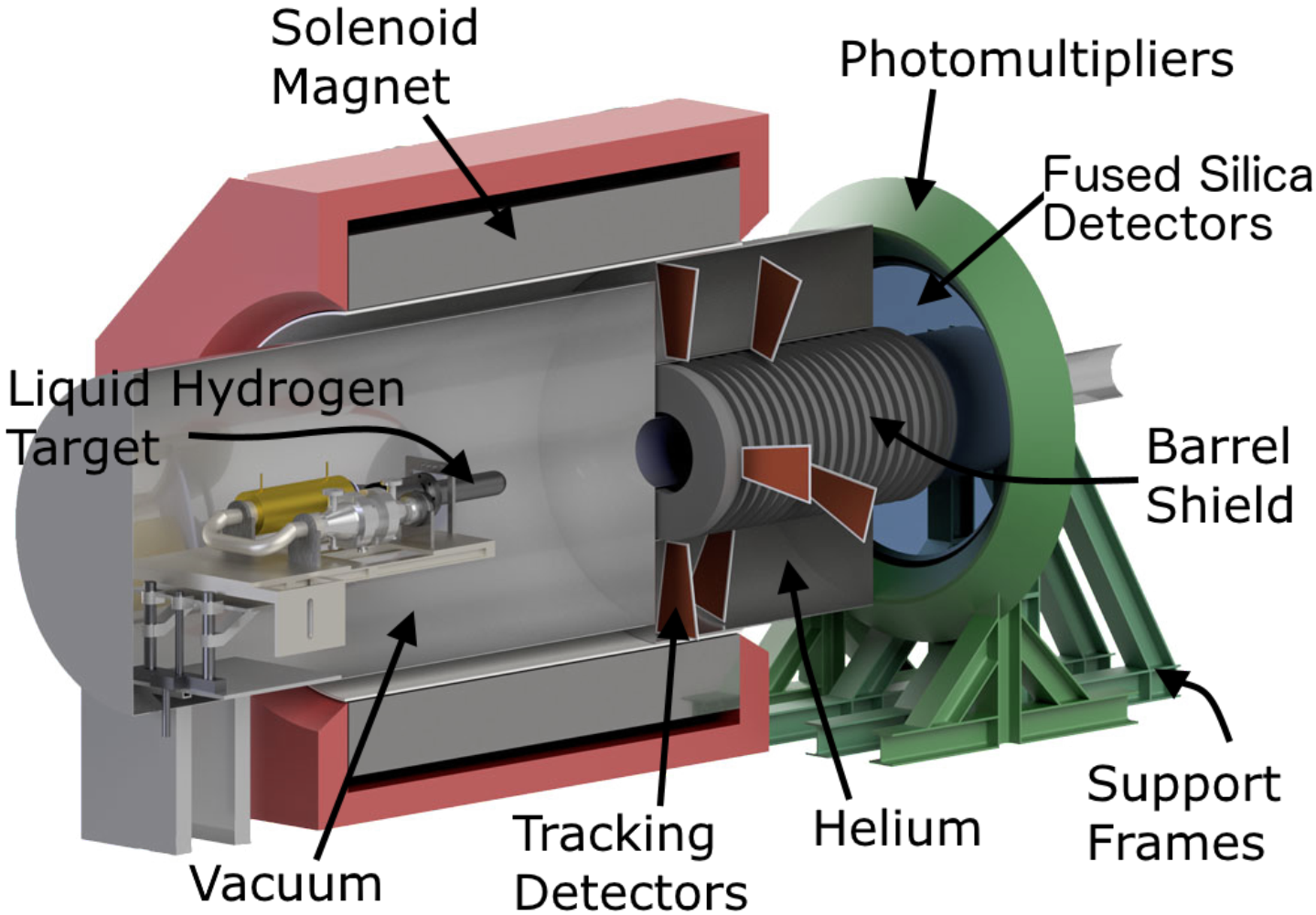
- The P2 experiment
- MuPix sensor for the P2 tracking detector
- MuPix8 high rate testbeam at MAMI

P2 experiment

- Weak mixing angle to 0.14 % precision
- Asymmetry in elastic electron proton scattering

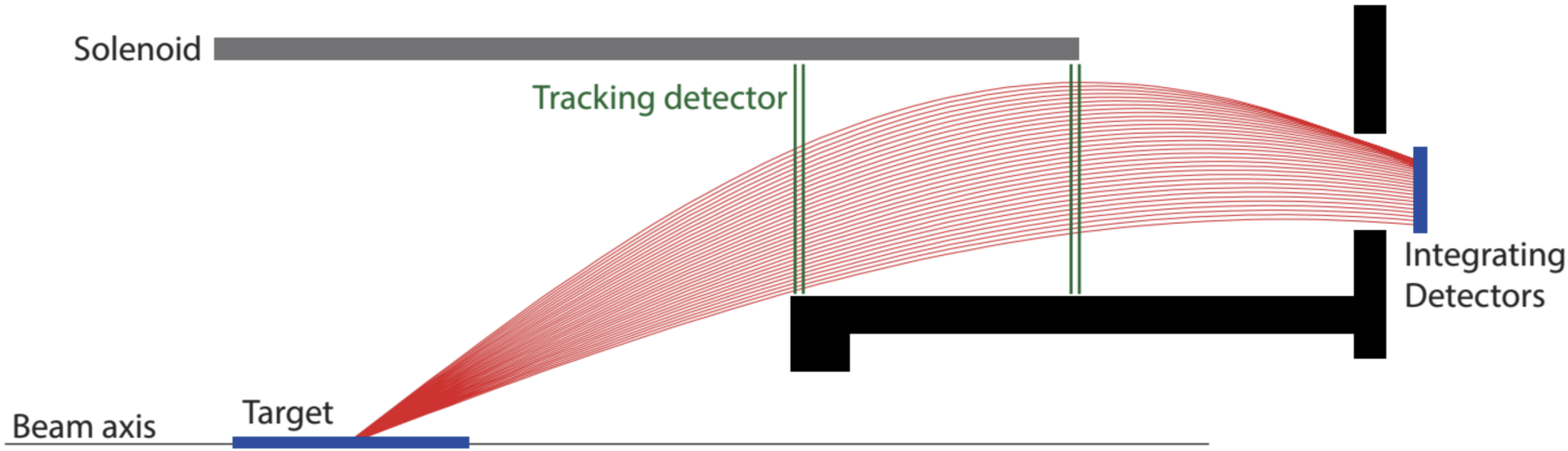


P2 experiment - detector



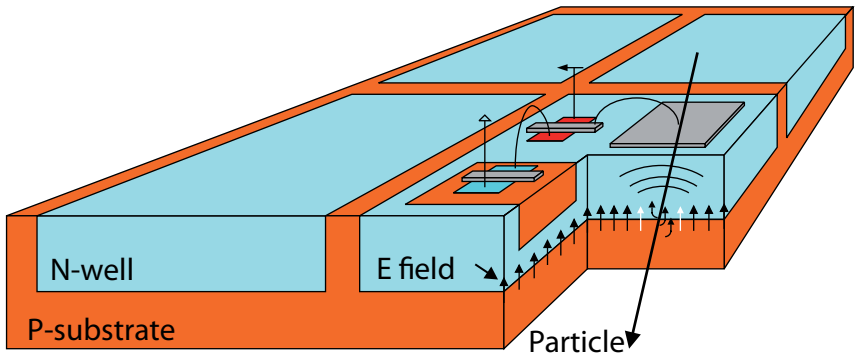
- polarized electron beam, E = 155 MeV
- max. event rate: 10^{11} Hz

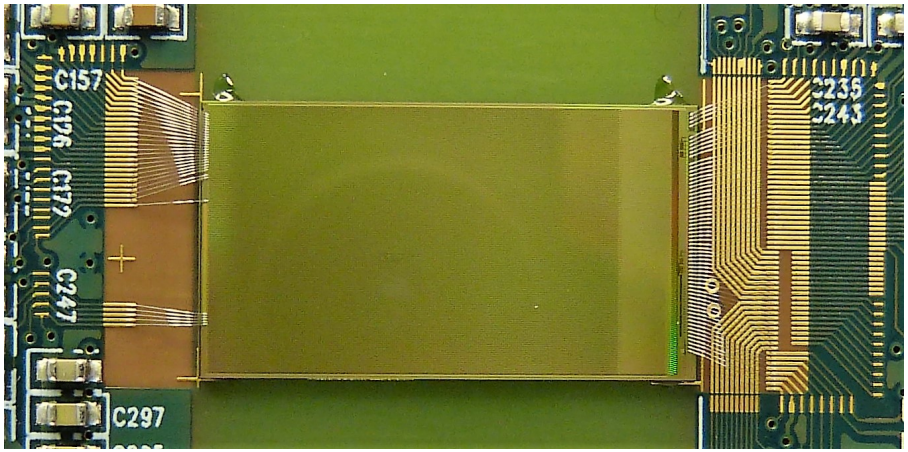
P2 experiment - spectrometer and tracking system



- 0.6 T solenoid magnet
- Inhomogeneous field in tracking system
- Measure the average Q^2
- T 67.5 for more P2 tracking

HV-MAPS - MuPix sensor prototype



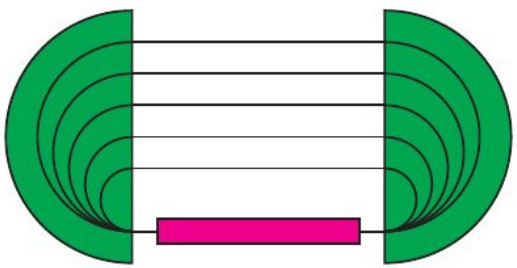


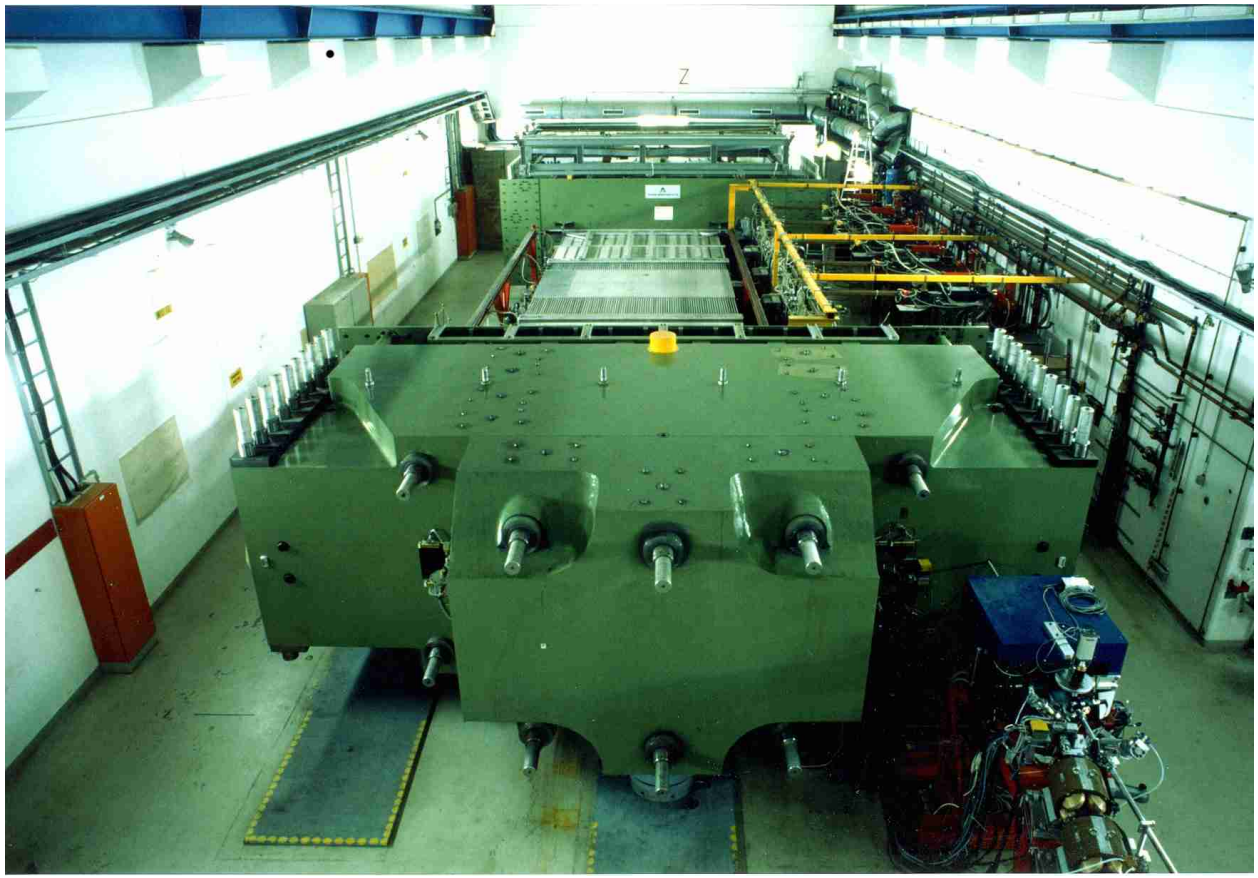
- 180 nm HV-CMOS technology
- Reverse biased up to 90 V
- Readout logic on chip
- Thinnable down to 50 µm
- T 27.1, T 27.1, T 27.1

- MuPix8
- Pixel size: $80 \times 81\,\mu m^2$
- Sensor size: $2 \times 1\,cm^2$
- Used in Mu3e, P2
- T 51.4

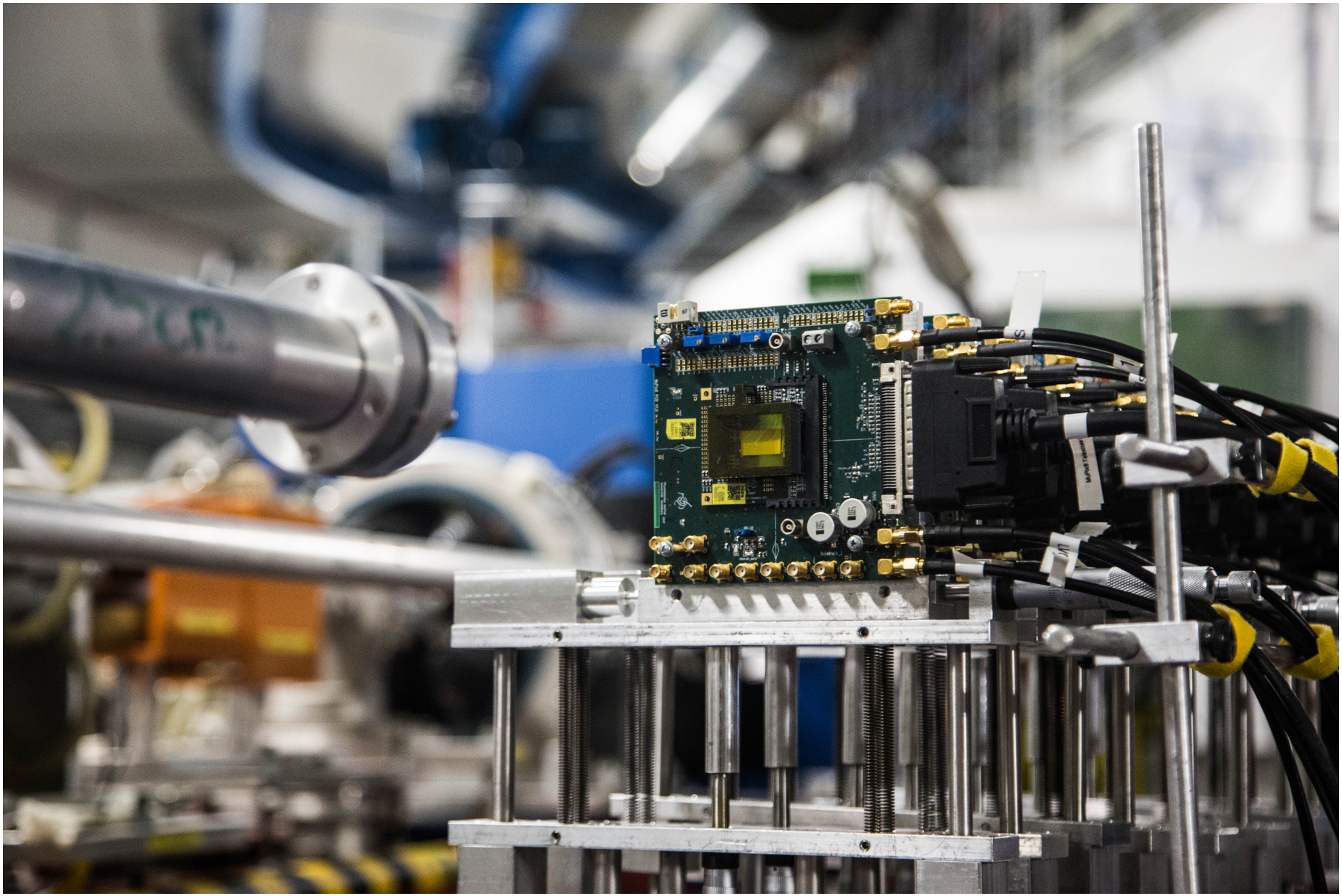
Mainzer Microtron - MAMI accelerator

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

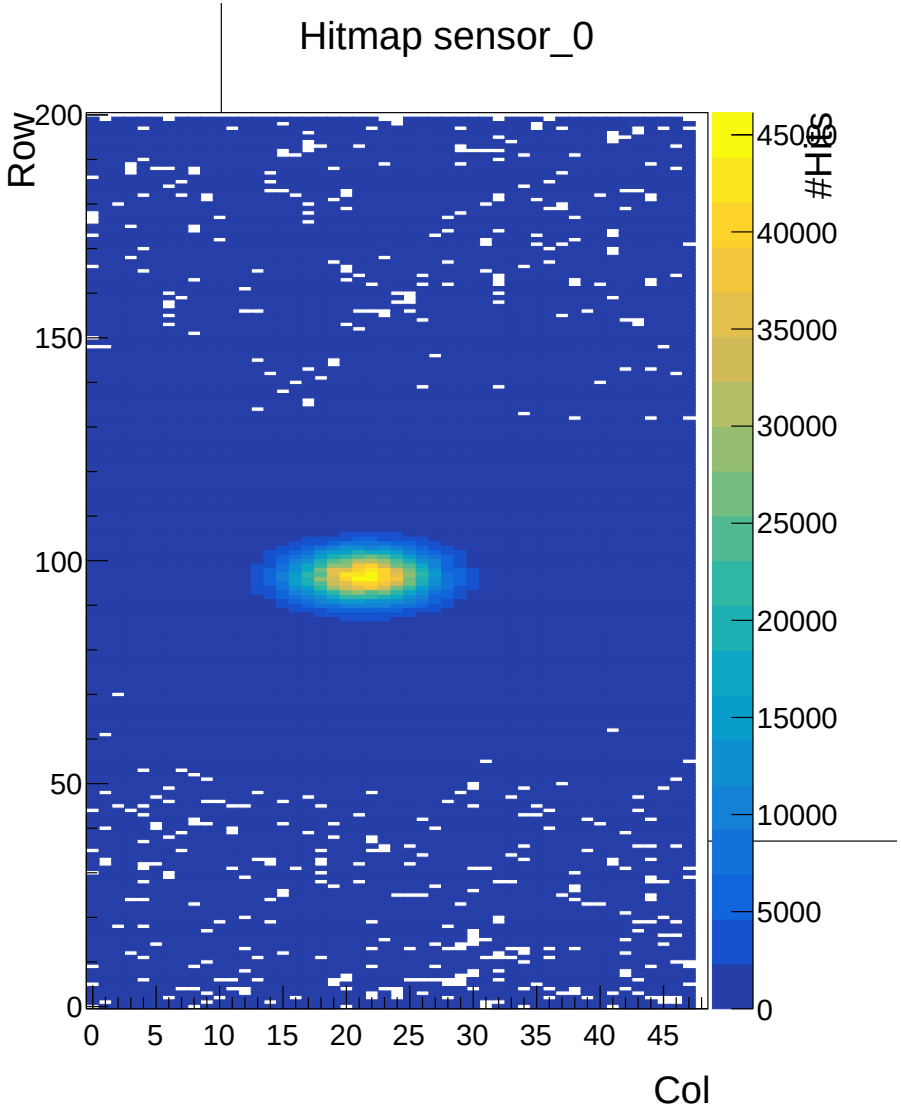




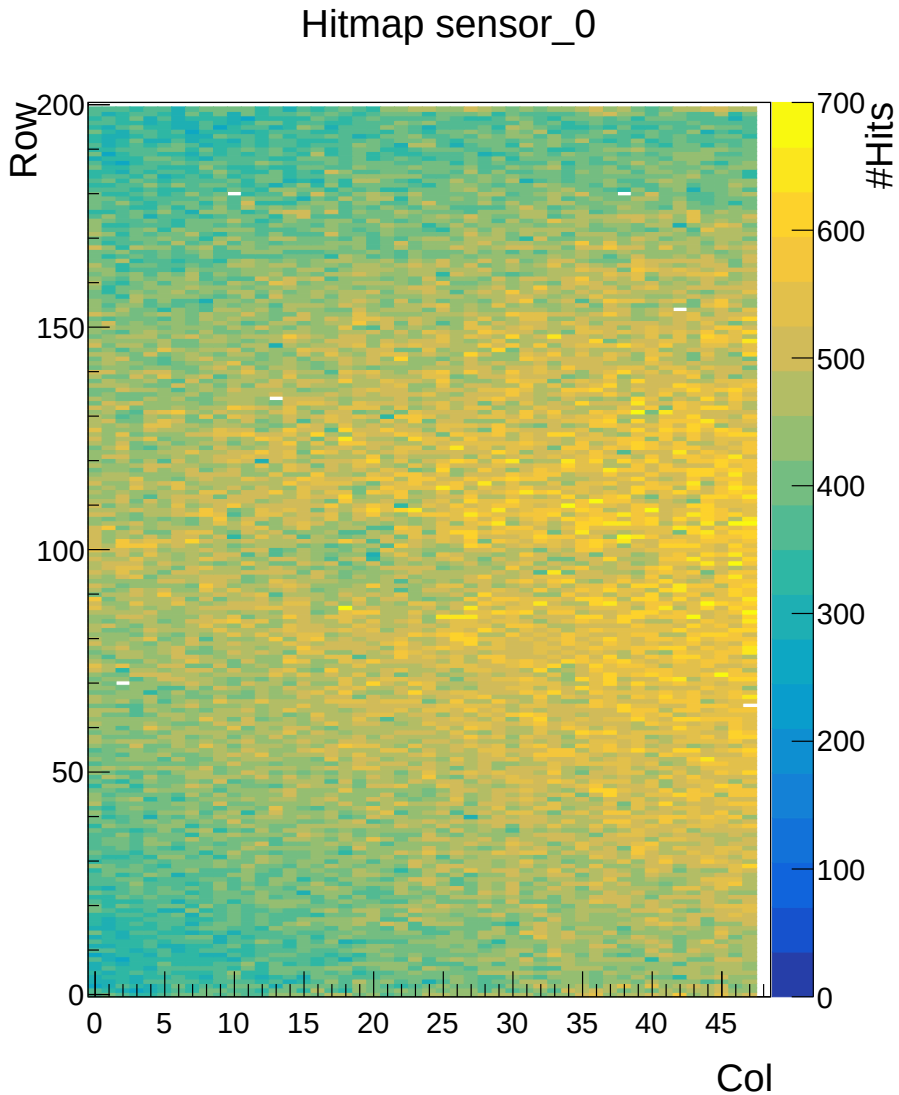
X1 high rate electron testbeam



X1 high rate electron testbeam - observations

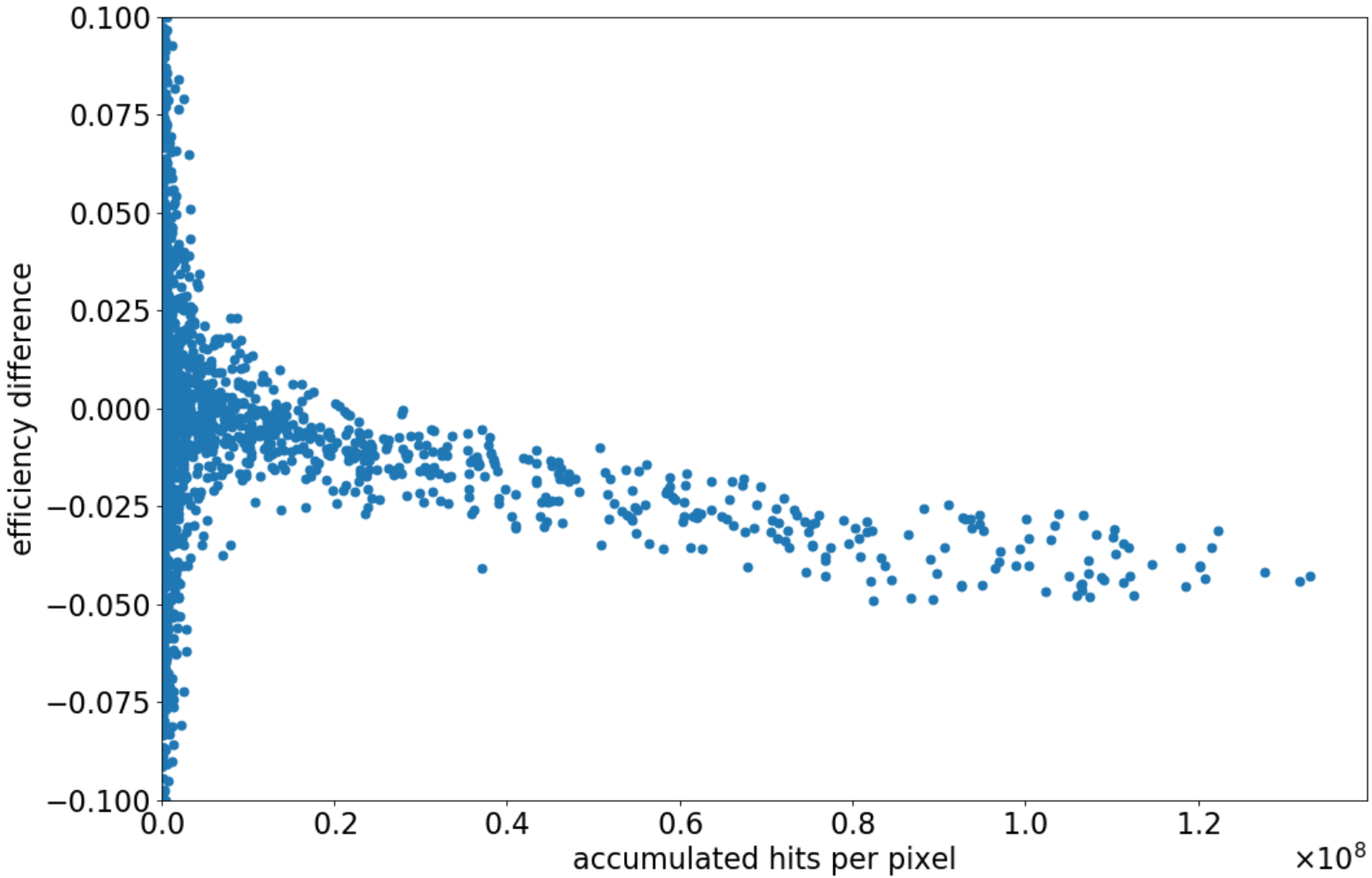


hitmap during testbeam run



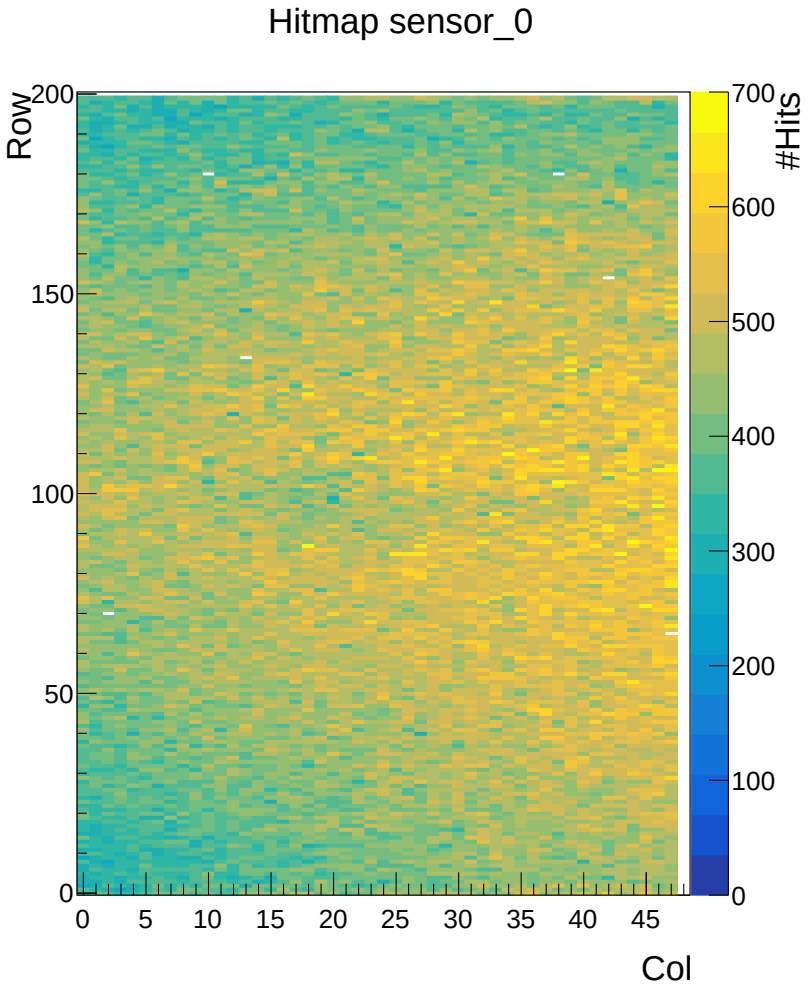
hitmap after the testbeam

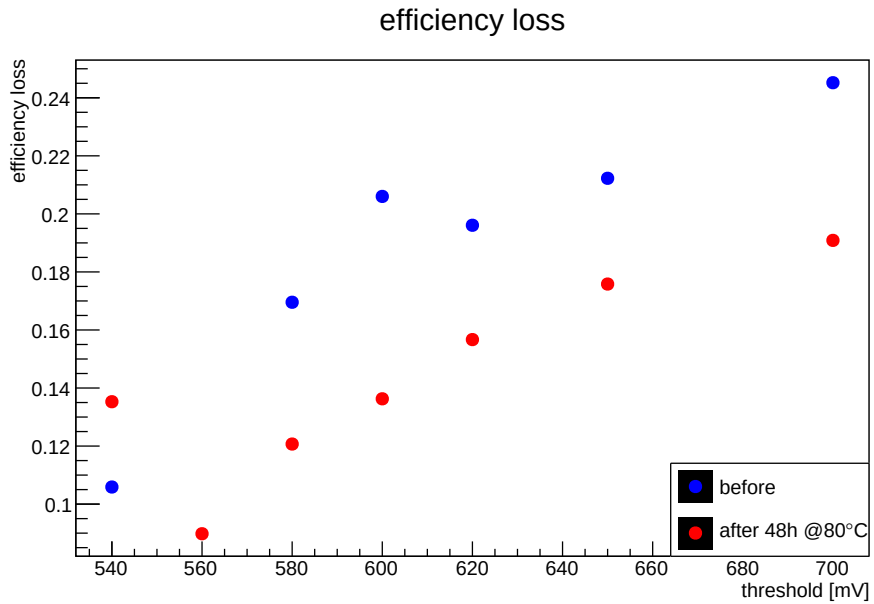
X1 high rate electron testbeam - efficiency analysis



- Difference of per pixel efficiencies
- Dependence on accumulated hits

X1 high rate electron testbeam - laboratory measurements

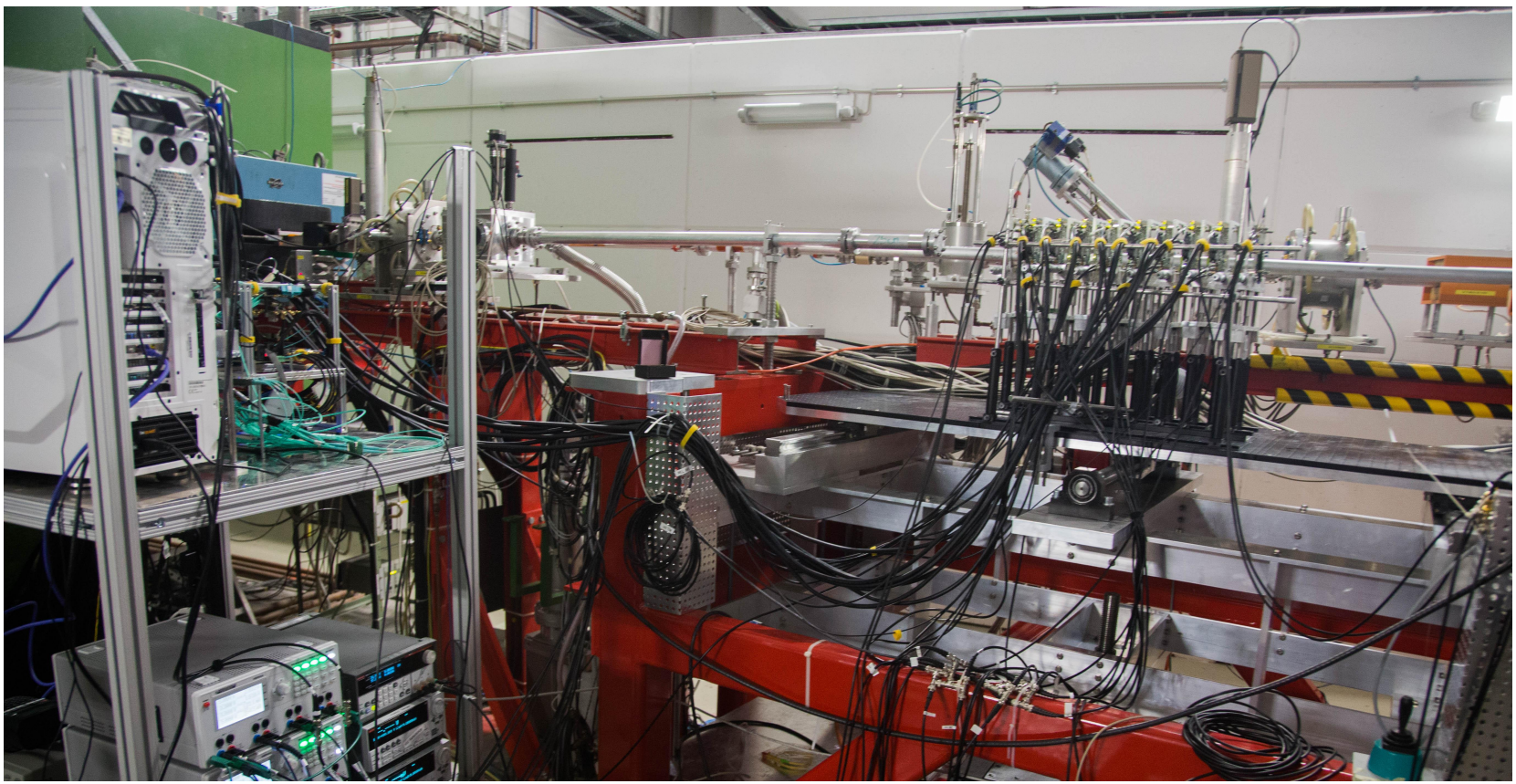




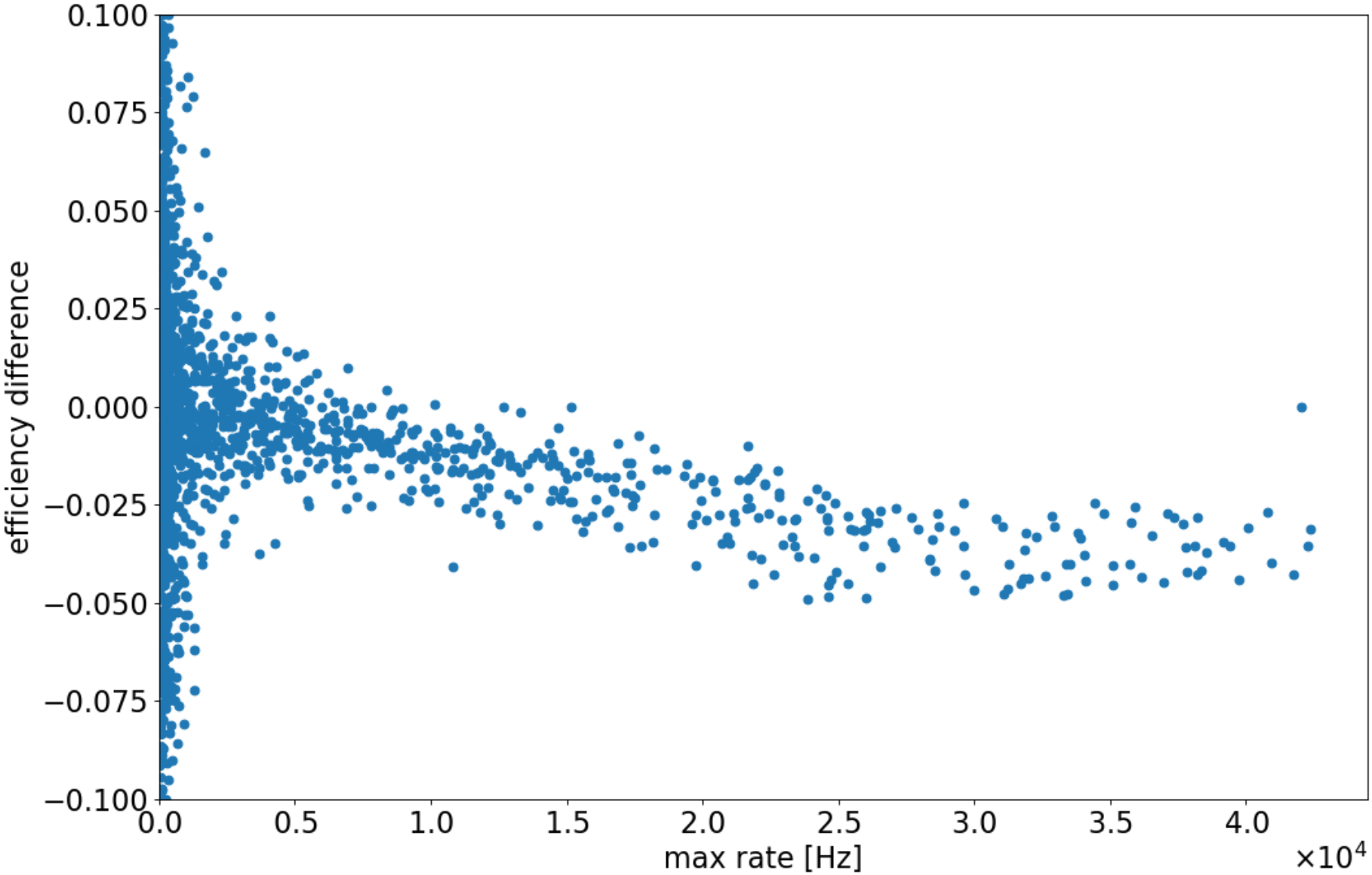
- Efficiency loss measured with Sr90 source
- Sensor after 48h at 80 °C
- No further improvement (72h at 90 °C)

Summary

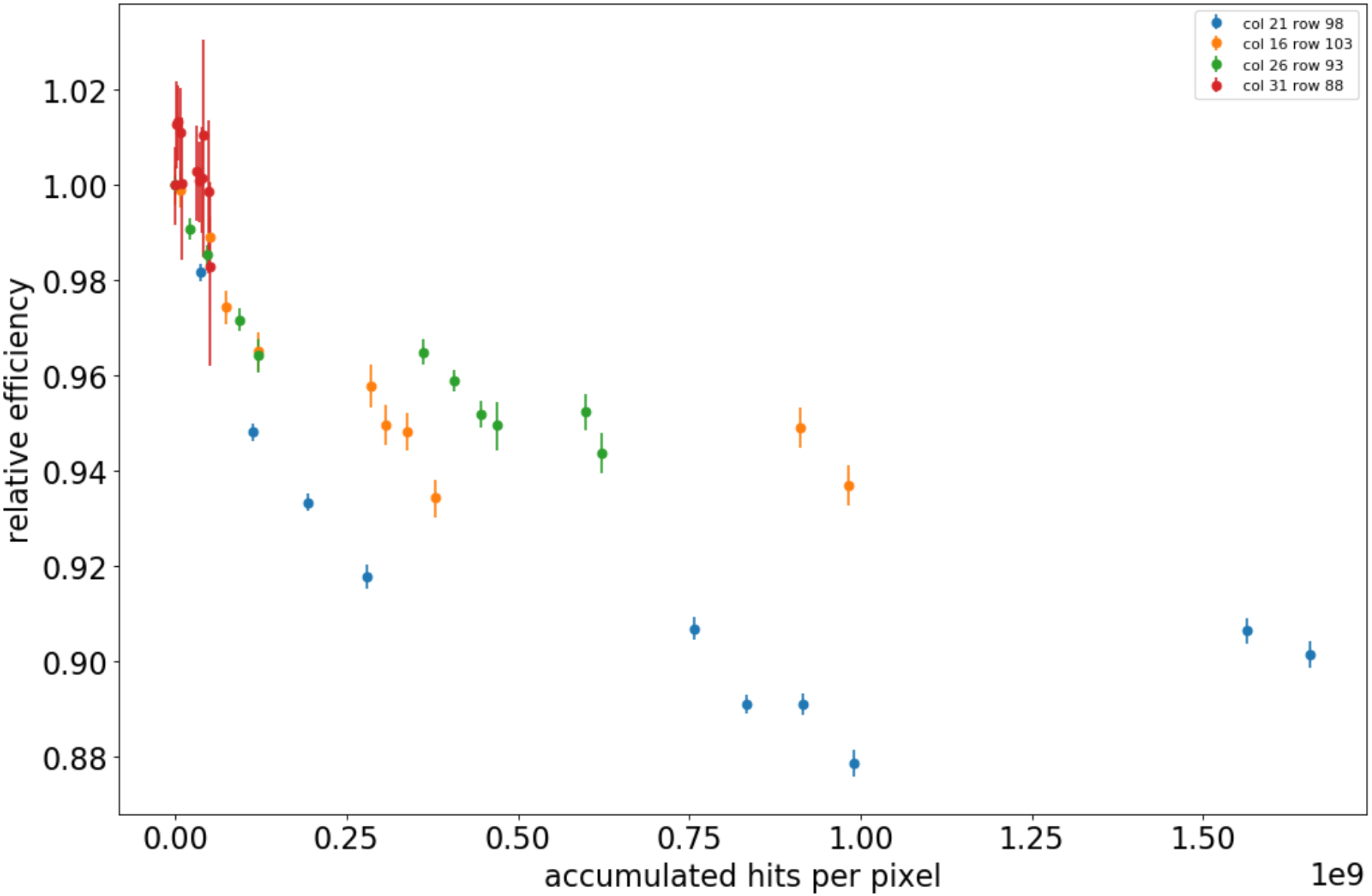
- P2 aims to measure weak mixing angle
- MuPix sensor used for P2 tracking detector
- MuPix8 shows rate dependent efficiency loss
- Further testbeams planned



Backup - Max. rate

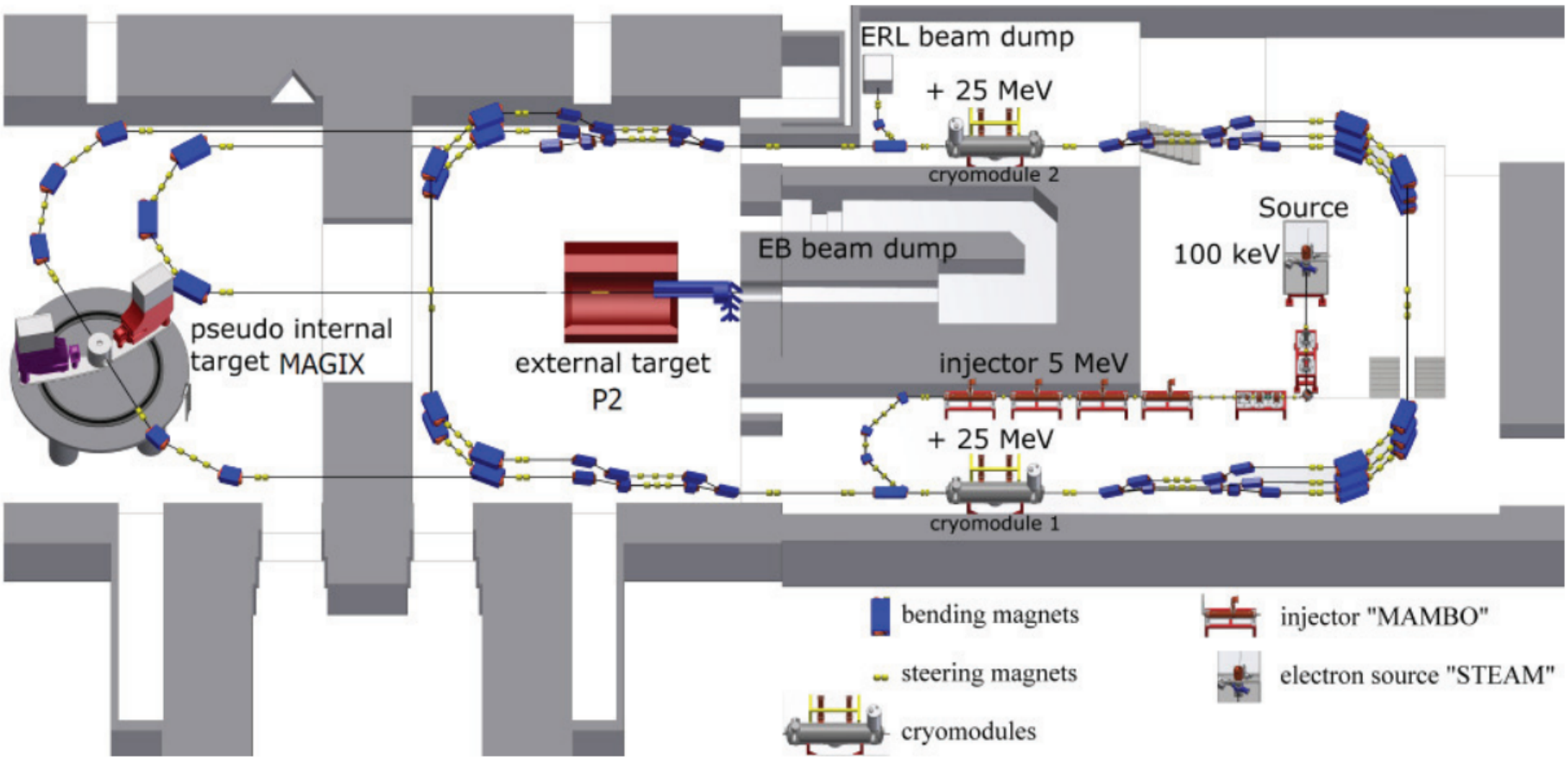


Backup - Pixel history

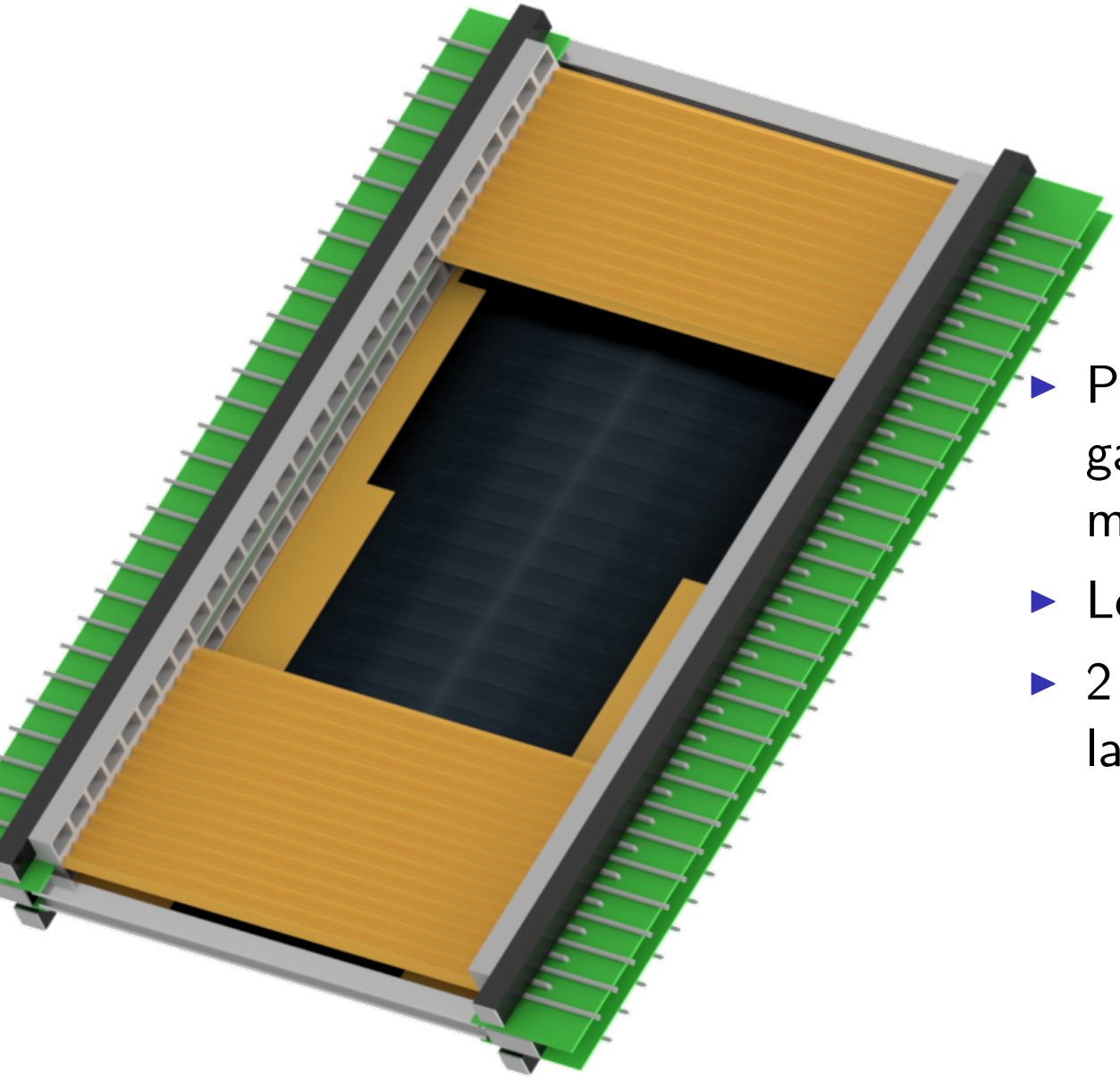


Backup - MESA

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



Backup - P2 tracking detector



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