

KOALA at GSI Cave C

Heinrich Leithoff

Johannes Gutenberg Universität Mainz

BTTB 2026 Mainz

April 13, 2026



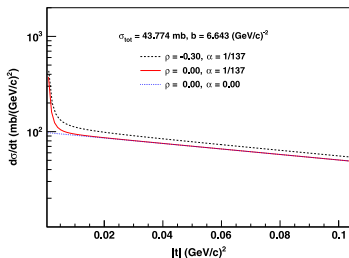
Elastic pp-scattering

Coulomb part:

- well understood
- differential cross section calculated with high precision
- dominant at very small $|t|$

Hadronic part:

- dominant at larger $|t|$
 - description by data driven models
- ⇒ large model uncertainties due to limited data



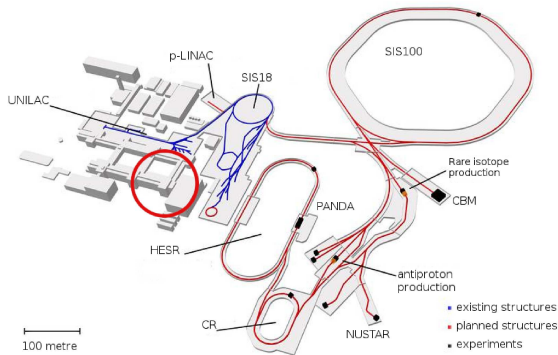
Hu, Q. et al. *Simulation of proton-proton elastic scattering for the KOALA recoil detector*. Nuclear Instruments and Methods in Physics

Research A, 898: 133–138, 2018

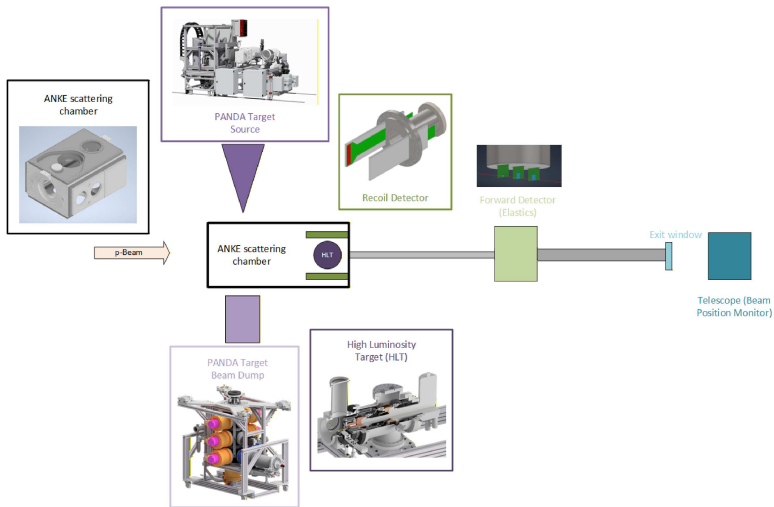
$$\frac{d\sigma_{total}}{dt} = \frac{d\sigma_{Coulomb}}{dt} + \frac{d\sigma_{Had}}{dt} + \frac{d\sigma_{interf}}{dt}$$

GSI Cave C

- SIS18 extraction beam
- up to 4.5 GeV for protons
- $\sim 1 \times 10^9$ p per cycle
- energy definition $\sim 10^{-3}$

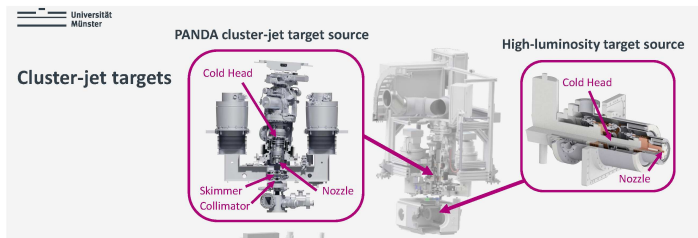


KOALA Experiment general setup



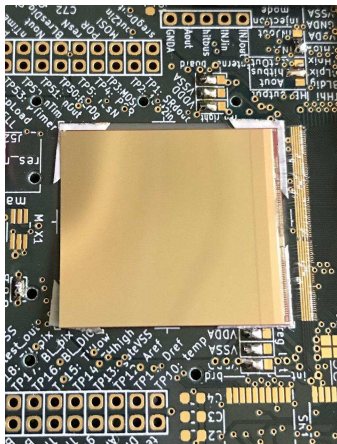
Target specifications

Target parameter	PANDA cluster-jet target	High luminosity target
Target thickness at IP	$\sim 1 \times 10^{16}$ at/cm ²	$\sim 1 \times 10^{18}$ at/cm ²
Dimensions at IP	(1.0×3.6) mm ²	Ø7.0 mm
Vacuum conditions at IP	1×10^{-7} mbar	1×10^{-2} mbar
Distance nozzle to IP	550 mm	40 mm



High Voltage Monolithic Active Pixel Sensors

- High Voltage Monolithic Active Pixel Sensors (HV-MAPS)
- Developed by Mu3e group in Heidelberg and KIT
- High bias voltage ($\sim 60\text{ V}$) for fast charge collection
- Pixel size $80\text{ }\mu\text{m} \times 80\text{ }\mu\text{m}$
- MuPix 11 size $20\text{ mm} \times 23\text{ mm}$
- Thinned down to $50\text{ }\mu\text{m}$
- Digital part on chip
- LVDS links for data transmission



MuPix 10

Beam position by MuPix telescope

- Telescope for MuPix sensor tests
- 4 layers
- currently upgraded to MuPix 11
- mechanics ready
- sensor boards ready
- common DAQ

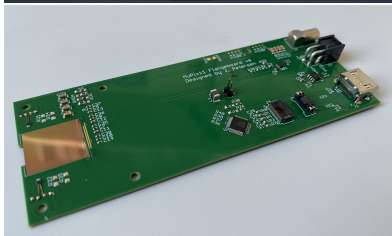
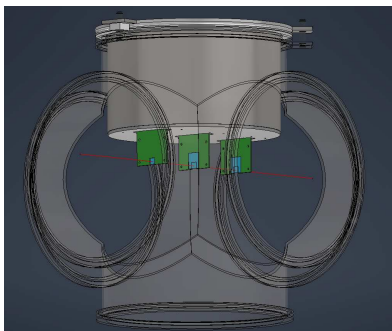


Test beam with HV-MAPS tracking station
(MuPix8)

Forward telescope concept

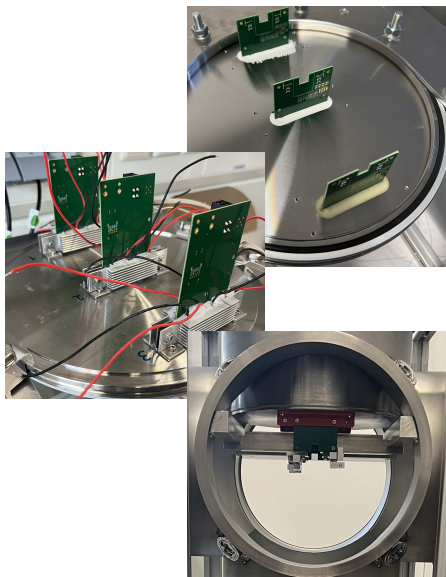
Originally designed as low material budget beam tracker, will measure the scattered protons

- based on standard components where possible
- 3 layers of HV-MAPS sensors bonded on PCBs
- PCBs glued into a flange as electrical feedthrough and thermal conductor
- air cooled
- direct connection to DAQ via LVDS



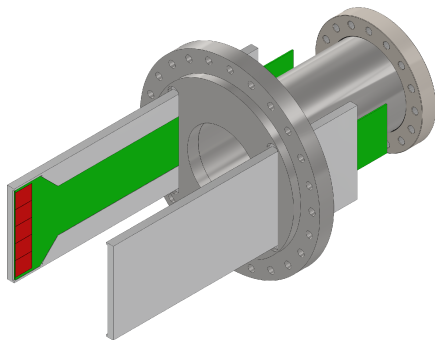
Forward telescope setup

- PCBs with cutout for low material budget
- sensor position measured
- cooling concept tested
- common DAQ still ongoing work
- sensor communication needed adjustment
- mechanical handling tested
- vacuum chamber ready
- vacuum tests successful

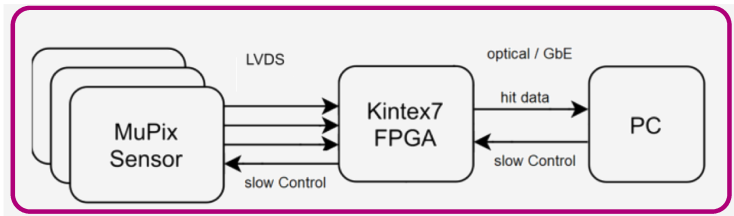


Recoil detector

- 10 HV-MAPS sensors bonded on a PCB
- position in vacuum close to IP (~ 65 mm)
- PCB glued in as electric feedthrough
- Aluminium backing as mechanical support and thermal conductor
- air cooling outside
- direct connection to common DAQ via LVDS



DAQ status



- based on Kintex7
- configuration and readout tested
- optimized for 40 MHz
- Aurora sync adapted
- currently ongoing work: scaling to planned sensor number

Summary & Outlook

Summary:

- targets ready and tested
- scattering chamber available & currently in adaptation
- beam position telescope ready, currently in upgrade
- forward telescope concept tested, construction in progress
- recoil detector in construction

Outlook:

- installation at GSI beginning 2027
- beam scheduled March 2027
- future beam time with larger forward telescope (PANDA Luminosity Detector)

Summary & Outlook

Summary:

- targets ready and tested
- scattering chamber available & currently in adaptation
- beam position telescope ready, currently in upgrade
- forward telescope concept tested, construction in progress
- recoil detector in construction

Outlook:

- installation at GSI beginning 2027
- beam scheduled March 2027
- future beam time with larger forward telescope (PANDA Luminosity Detector)

Thank You