Simulation Studies for the KOALA Experiment

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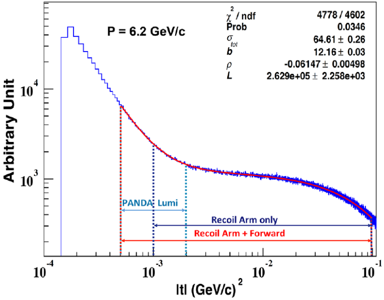
Luminosity Determination

- Largest uncertainty from model function of the differential cross section
- Coulomb part calculated from QED
- Hadronic part parametrized with σ_{tot}, ρ and b
- Data missing for $\overline{\text{P}}$ANDA energy range
- KOALA will measure over a large range of momentum transfer t to determine the cross section parameters precisely

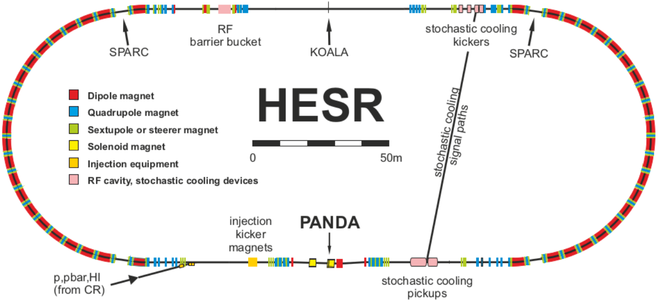


Eur. Phys. J. A. 50 (2014)

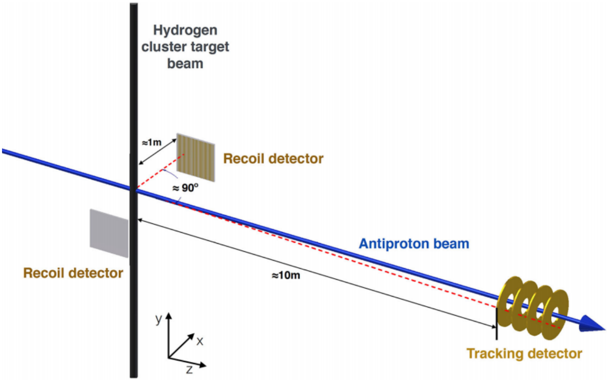
KOALA

- @COSY
- P_{beam}=(1.5-3.6) GeV/c
- pp elastic scattering

- @HESR
- P_{beam}=(1.5-15) GeV/c
- $\bar{p}p$ elastic scattering



http://www.panda-physik.de/



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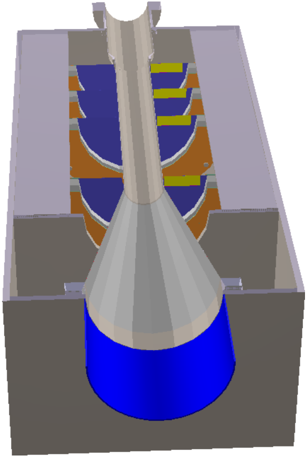
- Forward scattered proton measurement by Lumi prototype
- Backwards scattered proton measurement by KOALA

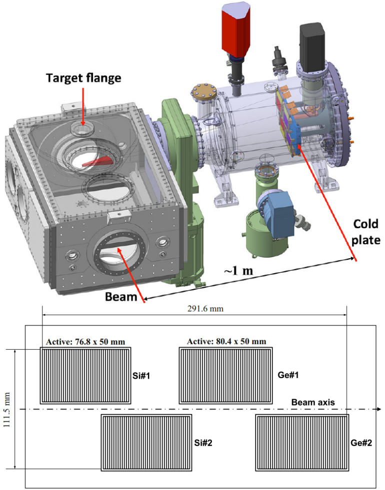
Prototype of Luminosity Detector

- MC model
- One set of pixel sensors per plane
- Distance from IP: 401 cm at COSY
- No magnetic field



KOALA Detector

- 90° angle to the beam direction
- One layer of two germanium and two silicon strip detectors
- Distance from beam-axis: 101 cm at COSY and 70-120 cm at HESR
- Covers recoil angles between 0° and 19°
- Energy measurement by completely stopping recoil particles



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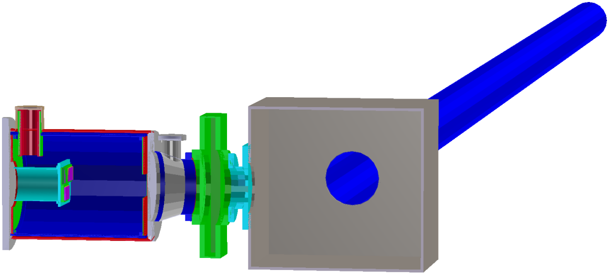
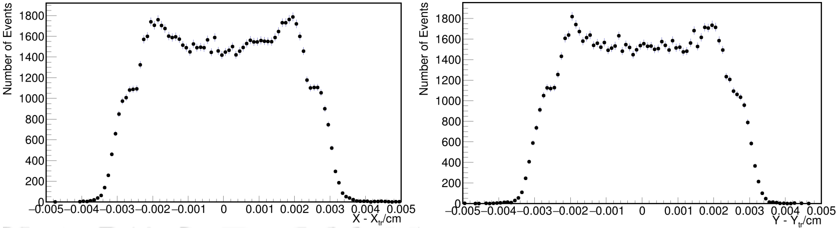
Geometry implementation in MC simulation



KOALA & Lumi prototype included

- All materials included to take into account scattering effects with the walls

- Currently all particles passing the sensors are reconstructed
- At least one hit per plane



Residuals for 10^5 reconstruced hit in the first plane

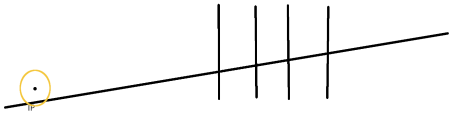
- Hits on pixels detected as if in center
- Form of residuals is caused by pixel geometry

Reconstruction of track candidates

- All possible 4 hit combinations of an event will be checked with one hit in each plane
- Broken line fit via Track Finding to determine the track parameters
- In case of two tracks the one with best χ^2-value is taken

"Backpropagation"

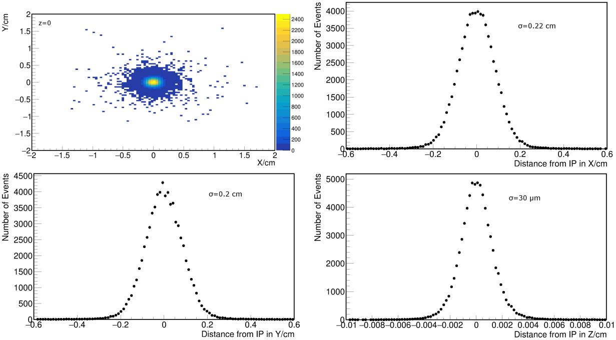
- No magnetic field
- Particles move in straight lines
- Hit position in the first plane and the components of the momentum are used for backpropagation



Point of closest approach to the IP determined

- Required distance of closest approach < 2 cm

After backpropagation to IP

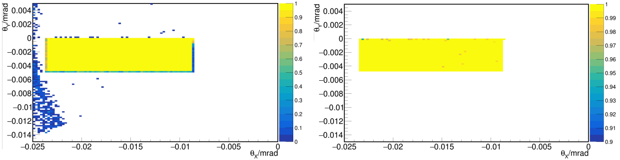


Projected position of the reconstructed particle in the z=0-plane and the residuals for the point of closest approach

- The narrow peak along the z-axis is caused by the large momentum in the beam direction

Efficiency determination - 1 hit efficiency

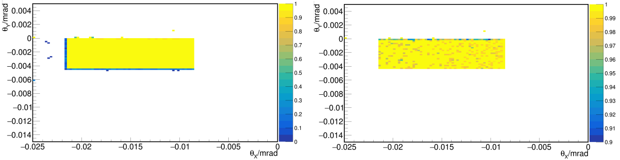
- Determined by dividing remaining events by those from the previous step

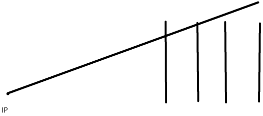


$\varepsilon = \frac{\#(\text{1 hit in 1st plane})}{\#(\text{generated events})}$ with generated direction plotted

- The hits outside of the sensor are caused by particles hitting the beam pipe and the nonactive parts of the detector
- The low efficiency at the edges of the sensor are a result of binning effects

Efficiency determination - 4 hit efficiency

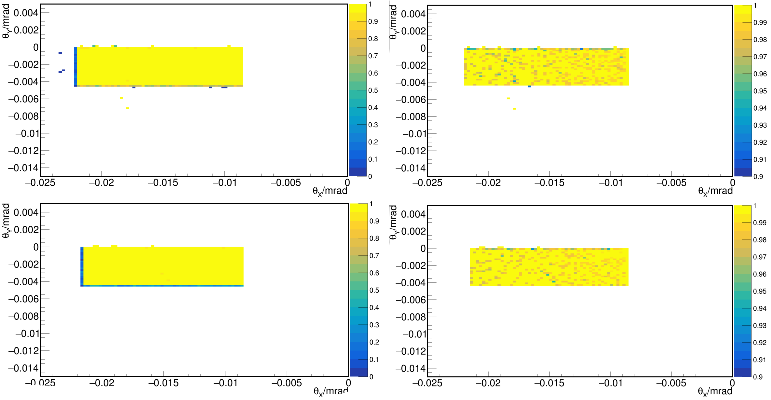




$$\varepsilon = \frac{\#(4 \text{ hits })}{\#(1 \text{ hit in 1st plane})}$$ with generated direction plotted

- Particles hitting the edges of the first layer will miss the other layers

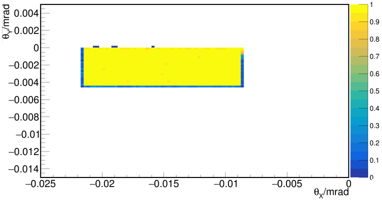
Efficiency determination - Track reconstruction -Track finding and filtering

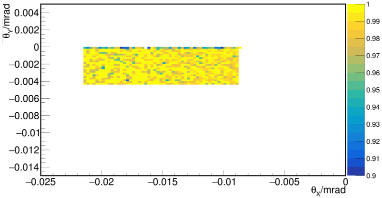


$$\varepsilon = \frac{\#(\text{Tracks})}{\#(4 \text{ hits})}$$ with generated direction plotted (top)

$$\varepsilon = \frac{\#(\text{Tracks at IP})}{\#(\text{Tracks})}$$ with generated direction plotted (bottom)

Efficiency determination - Total efficiency





$$\varepsilon = \frac{\#(\text{Tracks at IP})}{\#(\text{generated tracks})}$$

- Total efficiency in the sensor area $\varepsilon > 0.94\%$ @3.2 GeV/c
- Similar to prior studies with LMD

Summary & Outlook

- Modelling of the KOALA detector
- Successful modelling and track reconstruction in the Luminosity Detector prototype
- Efficiency $\varepsilon > 0.94\%$

Next steps:

- Efficiency check for KOALA
- Implementation of energy measurement of KOALA
- Reconstruction efficiency of elastic pp events