Simulation Studies for the KOALA Experiment

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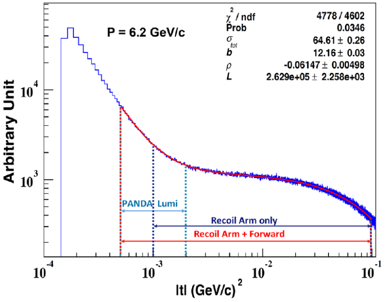
Luminosity Determination

- 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



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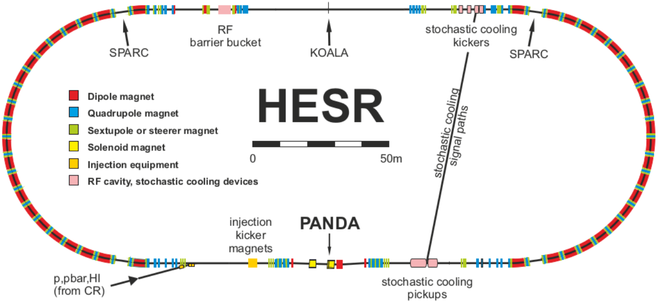
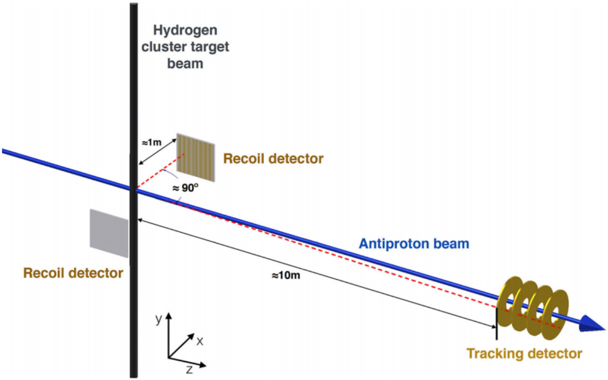
KOALA

- @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



KOALA



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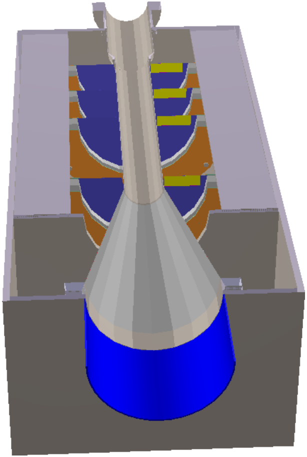
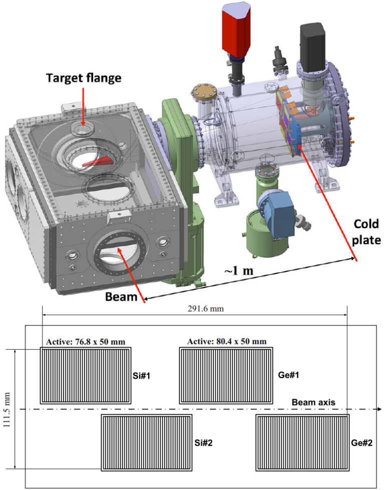
- Forward scattered proton measurement by Lumi prototype
- Backwards scattered proton measurement by KOALA

Prototype of Luminosity Detector

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



- 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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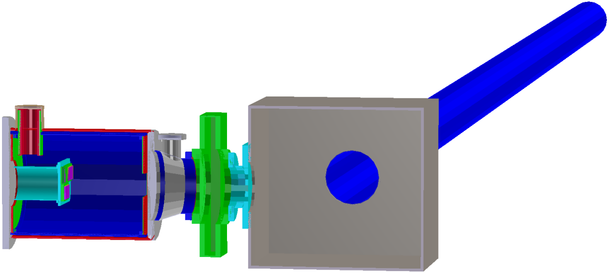
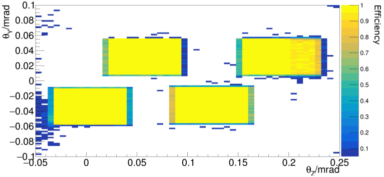
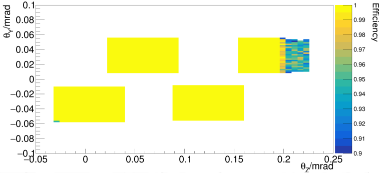
Previous Steps



- MC model of KOALA & Lumi prototype
- Hit reconstruction in center of pixel
- Tracks out of 4 hit combinations with one hit per plane
- Backpropagation: Determine point of closed approach to IP
- Reconstruction efficiency of $\varepsilon > 94$ % for Lumi prototype

KOALA detector reconstruction efficiency





$$\varepsilon = \frac{\#(\text{hits reconstructed})}{\#(\text{generated tracks})}$$

- Total efficiency in the sensor area $\varepsilon > 0.99\%$ @3.2 GeV/c
- Lower efficiency above $\theta_Z = 0.2$ mrad is an effect of the geometry
- All reconstructed hits are shown, no additional criteria used
- Result comparable to LMD

Finding coincidences

- Requires a reconstructed track from the Lumi prototype and a hit in the KOALA detector
- Deposited energy in KOALA detector needs to be > 600 keV
- At the moment no criteria for the time frame of an event set

Problems with the setup

- Half of KOALA detector can not be used to find coincidences
- Geometrical overlap only between Lumi prototype and KOALA detector with one set of sensors
- # of hits in KOALA detector highly dependent on initial momentum

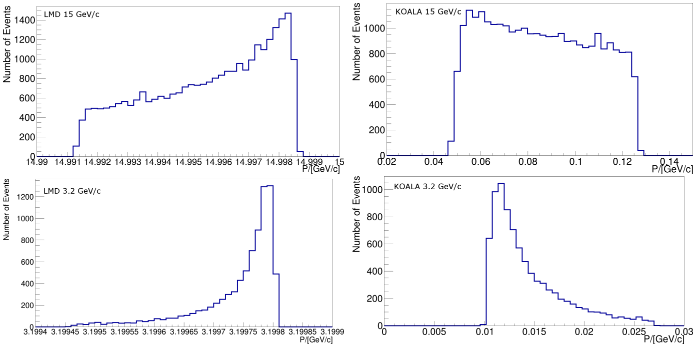
Momentum/[GeV/c]	Hits in Lumi	Coincidences
15	107153	8250
3.2	3425	342
1.5	1202	0

The influence of the momentum on the number of coincidences at 4 m distance between IP and Lumi

- Test with enlarged KOALA sensors show only secondary particles hit KAOLA at low momenta

Lumi prototype: momentum distributions (IP-LMD 11 m)

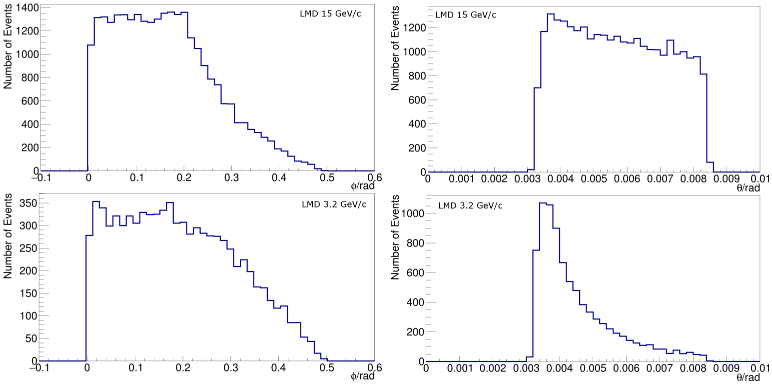
- Events with an initial momentum of 15 GeV/c and 3.2 GeV/c



Reconstructed events for Lumi prototype and KOALA detector with required hit in Lumi

Lumi prototype: ϕ and θ distributions (IP-LMD 11 m)

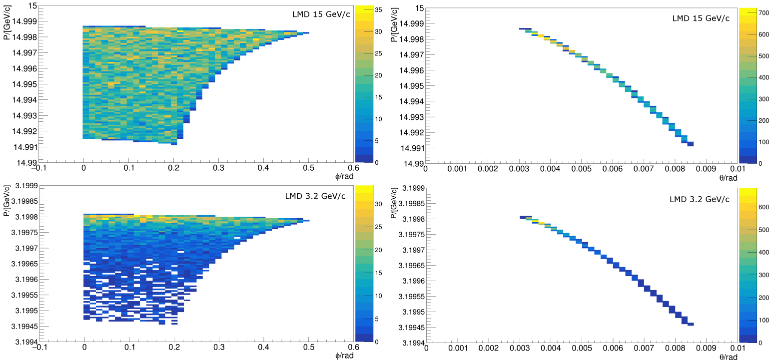
ϕ distributions $\qquad\qquad$ θ distributions



ϕ and θ for Lumi prototype at 15 GeV/c and 3.2 GeV/c

- Lower initial momentum causes smaller number of events for large θ
- Coulomb part in Lumi at lower beam momentum

Lumi prototype: ϕ and θ versus p (IP-LMD 11 m)



ϕ and θ plotted against the momentum

- For 3.2 GeV/c events are concentrated at high momenta
- Coulomb part in Lumi at lower beam momentum

Summary & Outlook

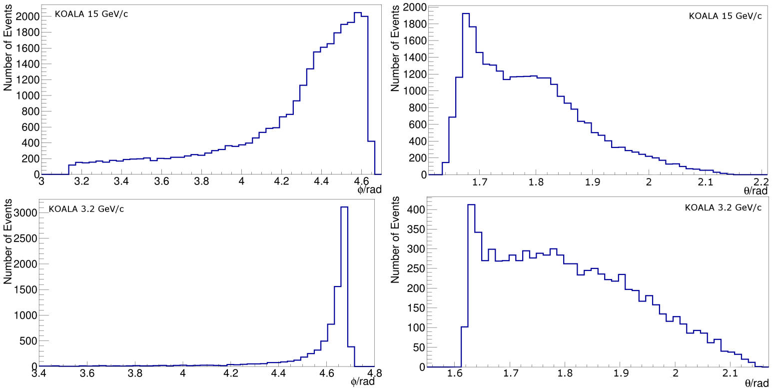
- Efficiency of the KOALA detector $\varepsilon > 0.99\%$
- Added energy measurement
- Coincidences for momenta $\geq$ 3.2 GeV/c @4 m distance between IP and Lumi
- Still some problems with implemented geometry
- Detailed checks ongoing

Next steps:

- Plotting the differences in θ and ϕ for 1.5 GeV/c and comparing it to the results for 3.2 GeV/c
- Determining solution for the geometry problem
- Reconstructing events for momenta $<$ 3,2 GeV/c
- Reconstruction efficiency of elastic pp events

KOALA detector: ϕ and θ distributions (IP-LMD 11 m)

ϕ distributions $\quad\quad$ θ distributions



- Lower initial momentum causes less events for small ϕ