Matter and the Universe

Offline Software for the Luminosity Detector

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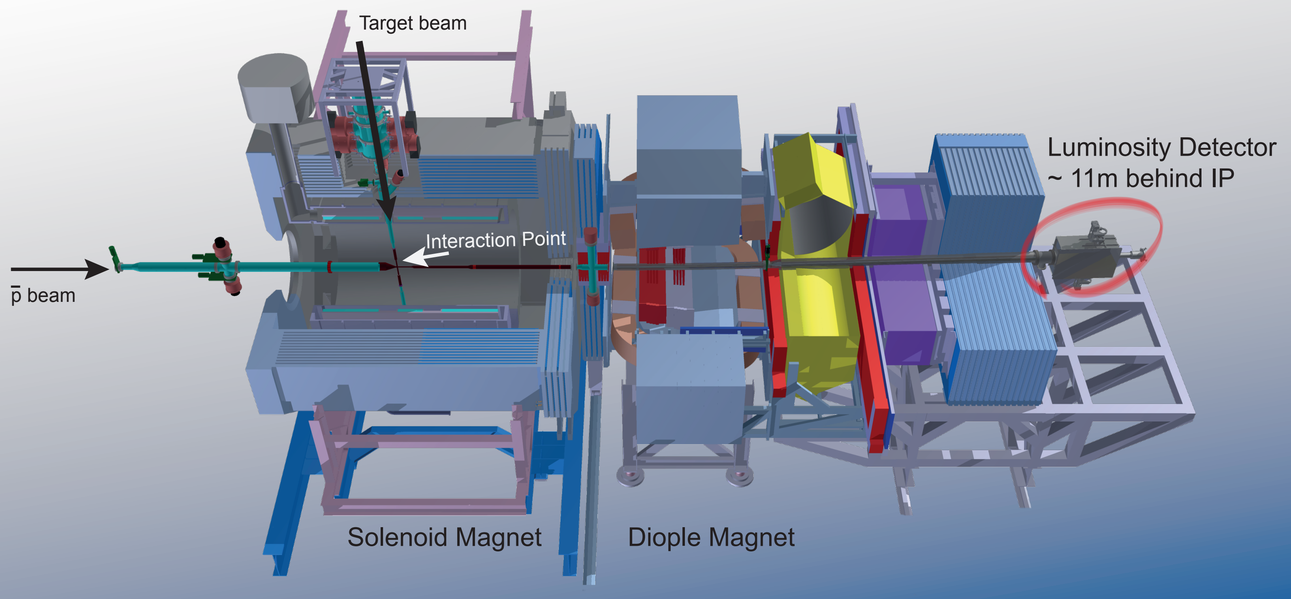


The High Energy Storage Ring (HESR) at the FAIR accelerator facility in Darmstadt will provide anti-protons in the momentum range of 1.5-15 GeV/c. The PANDA spectrometer is build around the interaction point of a crossing material beam with the stored anti-proton beam. The magnet setup consists of a combination of a super conducting solenoid and a normal conducting dipole magnet, bending the non interacting anti-proton beam by 40 mrad.

To calculate from a measurement the absolute crosssection, precise knowledge of the luminosity is required which is determined within PANDA by the Luminosity Detector.

Measuring the Luminosity

$$N(t) = L \cdot \sigma(t)$$

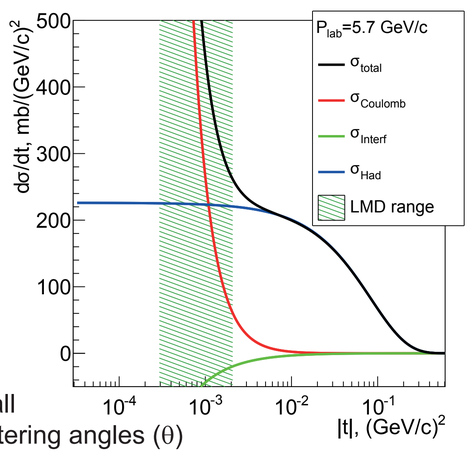
Number of events connected with Luminosity and cross section

Elastic pp scattering events as reference channel

Coulomb part
exact calculations from QED

Hadronic part
known from measurements and applied models to it

➔ Less model dependence at small 4 momentum transfers (t) / scattering angles (θ)



The Tracker

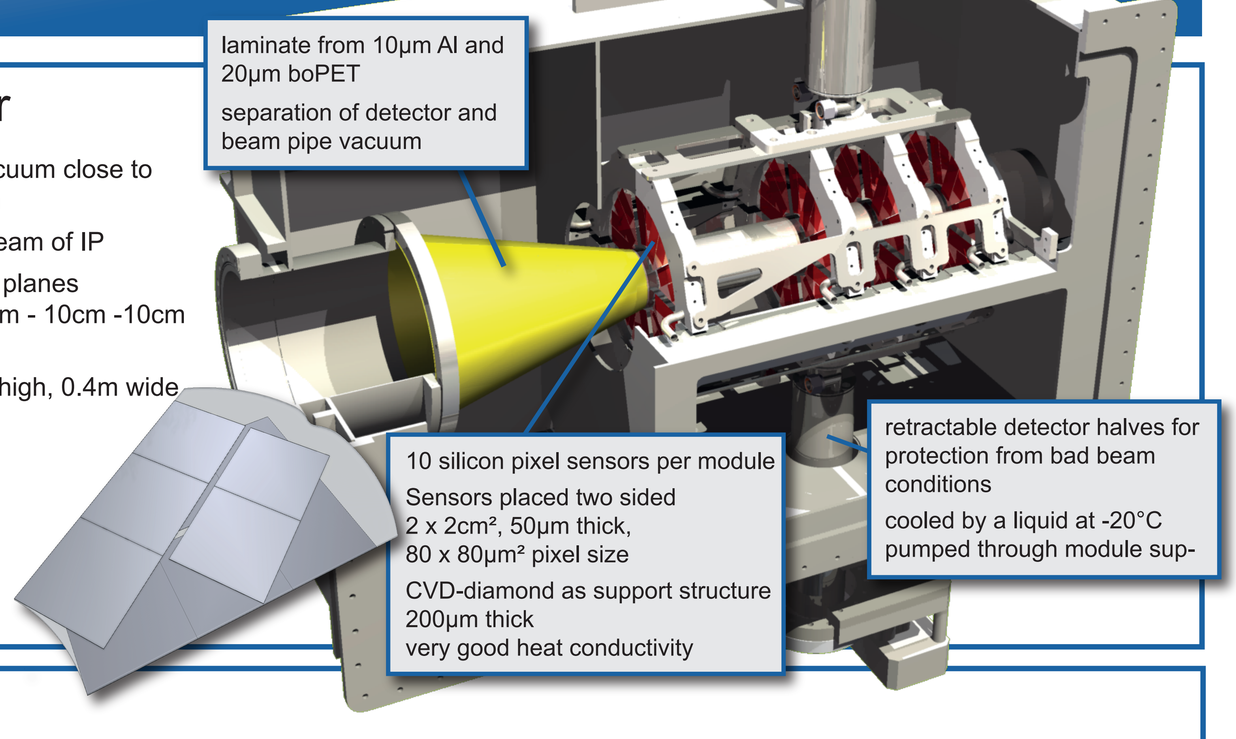
Measurement in vacuum close to circulating beam

About 11m downstream of IP

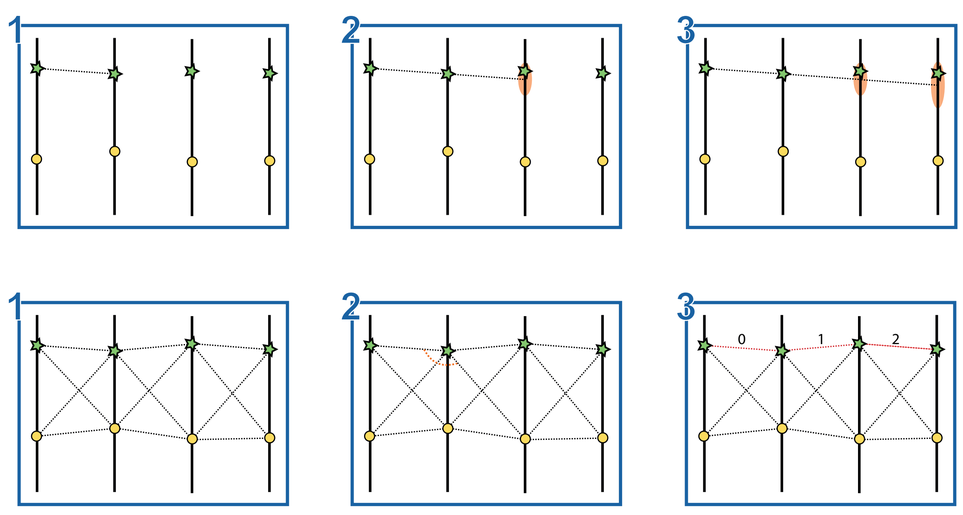
4 sensitive detector planes with gaps of 20cm - 10cm -10cm

Overall dimensions
~1m long, 1.5m high, 0.4m wide

Acceptance
$3 < \theta$ [mrad] < 9
full ϕ coverage



Track Search



Track Following

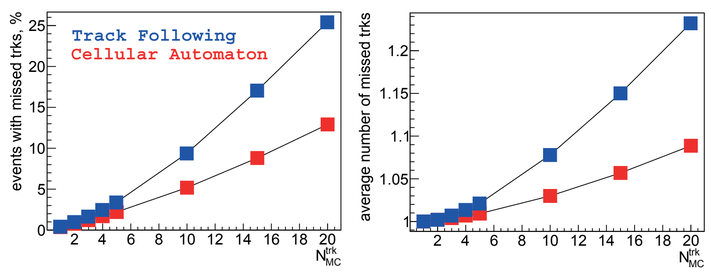
1. Build combinations between 1st and 2nd plane
2. Search additional hit on 3rd plane inside corridor
3. Search additional hit on the last plane in a wider corridor

Optional missing plane algorithm: only 3 hits required

Cellular Automaton

1. Build all combinations between hits (cells)
2. Search for neighbouring cells judged on bracking angles
3. Sort cells by number of neighbours

Optional missing plane algorithm extension: layer skipping allowed



Comparison of performances at 1.5GeV/c momentum

At low track multiplicities:
Similar amount of missed & ghost tracks

At high track multiplicities:
Cellular Automaton misses less tracks
Track Follower is faster

Track Fit

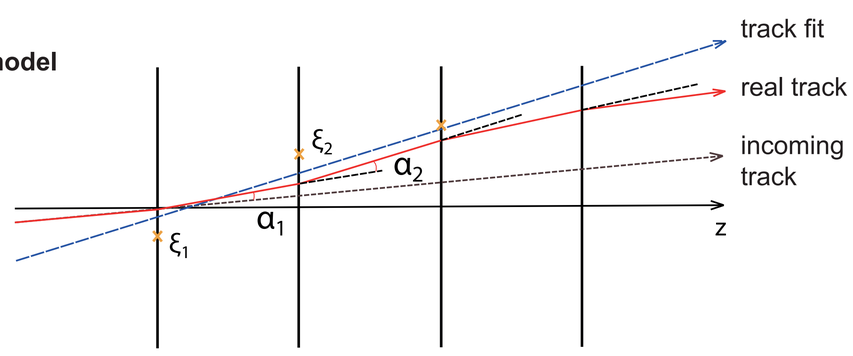
The least squares method with „broken lines“ track model

$$\chi^2 = \sum_{l=1}^{4} \left(\frac{(\xi_l^x - x_l)^2}{\sigma_x^2} + \frac{(\xi_l^y - y_l)^2}{\sigma_y^2} \right) + \sum_{J=1}^{4} \left(\frac{(\alpha_J^x)^2 + (\alpha_J^y)^2}{\sigma_s^2} \right)$$

ξ^x, ξ^y Hit coordinates with uncertainties σ_x, σ_y

x_l, y_l Coordinates of track on plane l

α_J^x, α_J^y Scattering angles on plane J



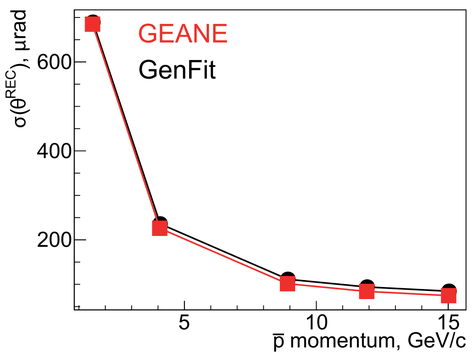
Test results from simulations at 1.5GeV/c momentum

Checking resolutions and pull distributions for track points (X,Y), momentum vectors (P), angles (Θ, ϕ)

Parameter	Resolution	Pull Mean	Pull σ
X	14.03 ± 0.02 µm	$-1.3 \cdot 10^{-3}$	0.96
Y	14.04 ± 0.02 µm	$2.3 \cdot 10^{-3}$	0.97
P_x	444 ± 2 keV	$6.5 \cdot 10^{-3}$	1.1
P_y	443 ± 2 keV	$3.9 \cdot 10^{-3}$	1.1
P_z	18 ± 0.1 keV	$-3.4 \cdot 10^{-3}$	1.1
θ	293 ± 1 µrad		
ϕ	6.21 ± 0.03 mrad		

Error estimation well under control

Back Propagation to Interaction Point



Testing GenFIT and GEANE

Back propagation through complex field structure reduces initial resolution

Worse resolution at low beam momenta due to increased multiple scattering

Comparible results but better propagation of errors by GEANE

Luminosity Fit

$$N = L \cdot (\sigma \cdot \epsilon) \otimes \Theta_{RES}$$

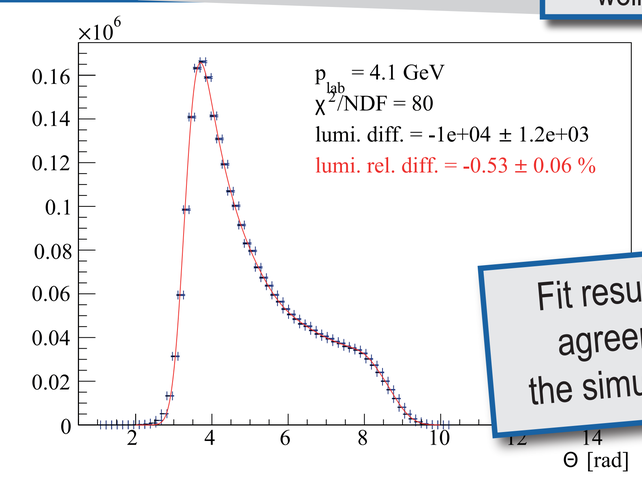
N Number of events

L Luminosity

σ Elastic cross section

ϵ Efficiency

Θ_{RES} Detector resolution



Fit results in good agreement with the simulated value!

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