

Simulation Results for Spin Filtering Experiments at COSY

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Task: Geometry optimization for experimental setup of spin filtering experiment.

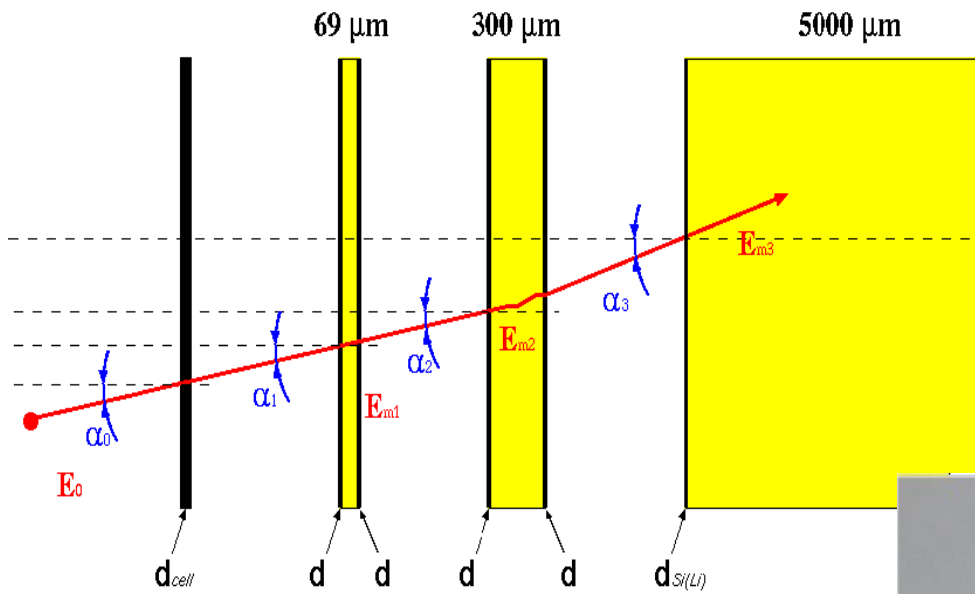
Tool: GEANT3 package.

Simulation was performed for two different Silicon Tracking Telescope (STT) configurations:

- (i) **ANKE** like and
- (ii) **HERMES** like.

Target cell: 10 μm thickness (Teflon) with 10x10 mm² cross-section and 400 mm length.

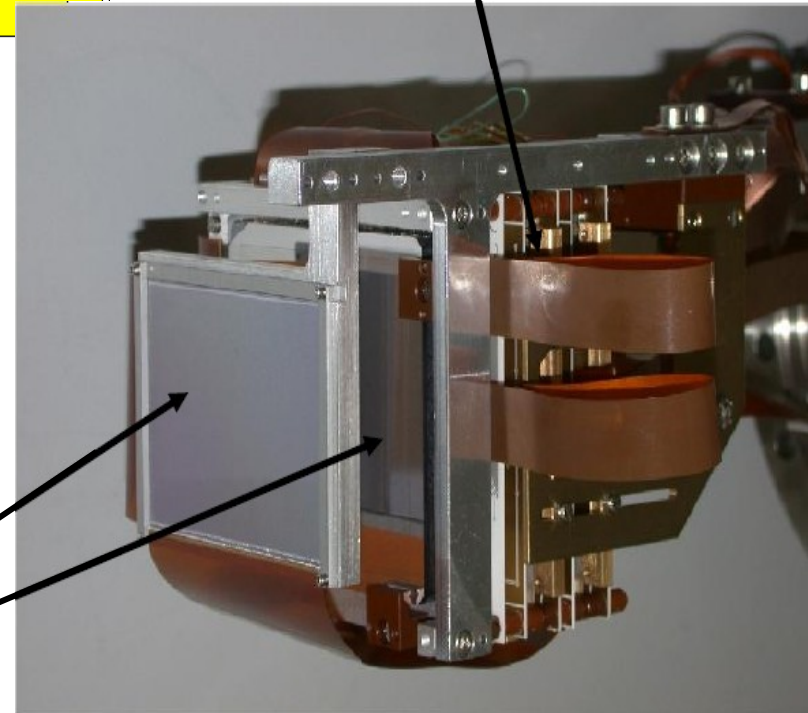
ANKE STT



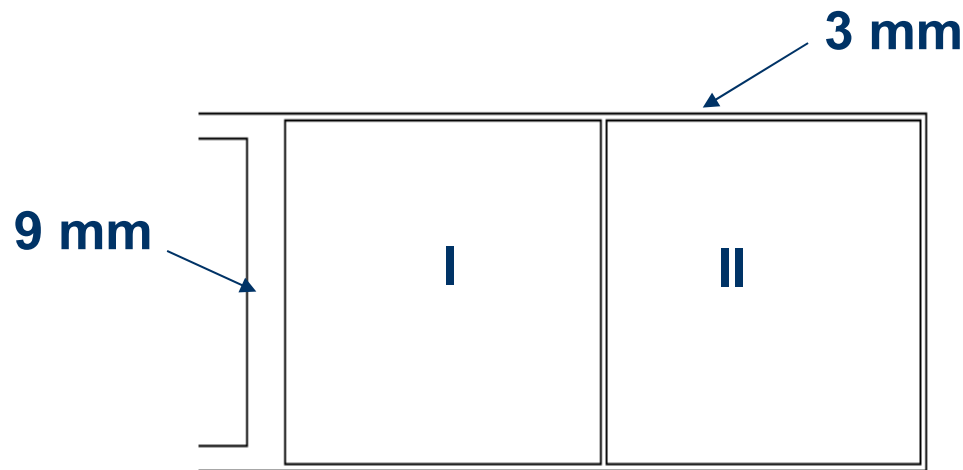
preamplifier electronics

Layer dimensions: $64 \times 64\ \text{mm}^2$

double sided
Silicon Detectors



Sketch of the HERMES silicon modules



3 mm wide aluminum-nitride ceramic support structure hosting two silicon modules.

Dimensions of each module are 10x10 cm².

Event generator

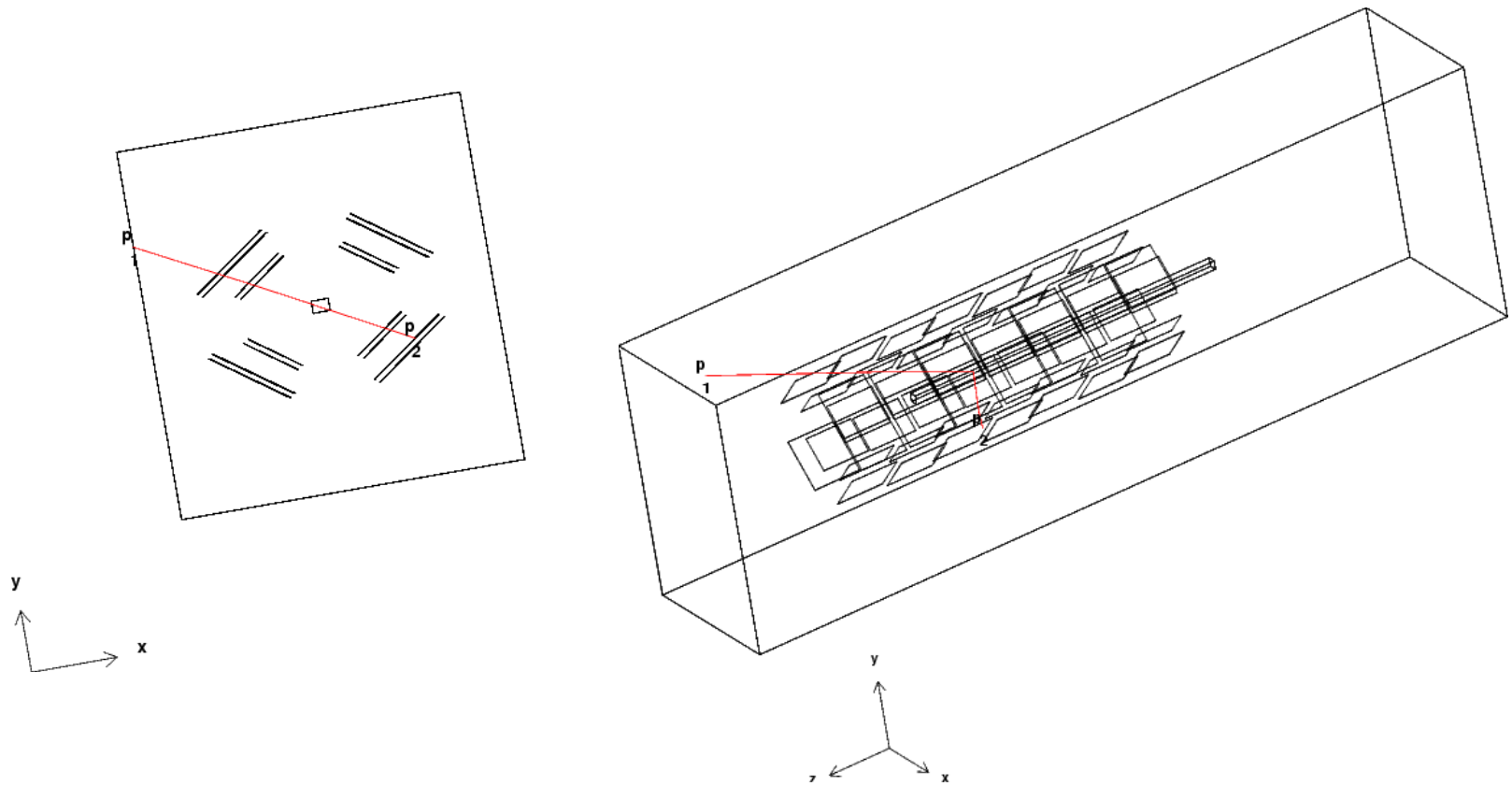
5×10^5 pp elastic events at $T_p = 45$ MeV was generated according SAID differential cross section form in range $\theta_{\text{CM}} = (12 - 168)$ degree.

The vertex z-coordinate distribution inside cell has a triangle form, x and y was distributed uniformly inside ellipse with $r_x(z)$ and $r_y(z)$:

$$r_i(z) = \sqrt{(\epsilon_i \cdot \text{Beta}_i(z))}, \quad \text{Beta}_i(z) = \text{Beta}_i(0) / (1 + z^2 / \text{Beta}_i(0)^2)$$

where $i = x, y$ and Beta function after cooling at cell center are equal to $\text{Beta}_x(0) = 0.46$ m and $\text{Beta}_y(0) = 0.499$ m and emittance $\epsilon_x = \epsilon_y = 3 \pi$ mm mrad (numbers from Archil Garishvili).

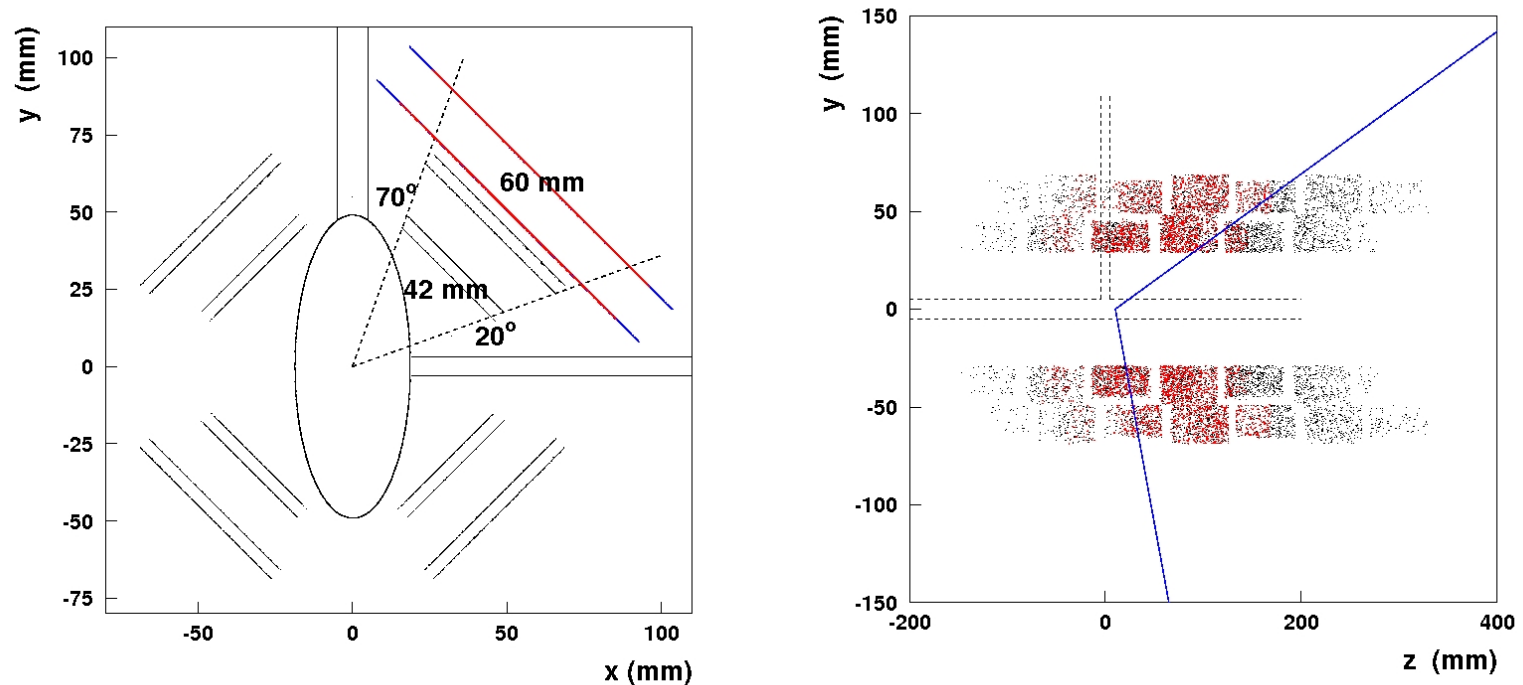
Schematic view from GEANT



XY- plane

3D- plane

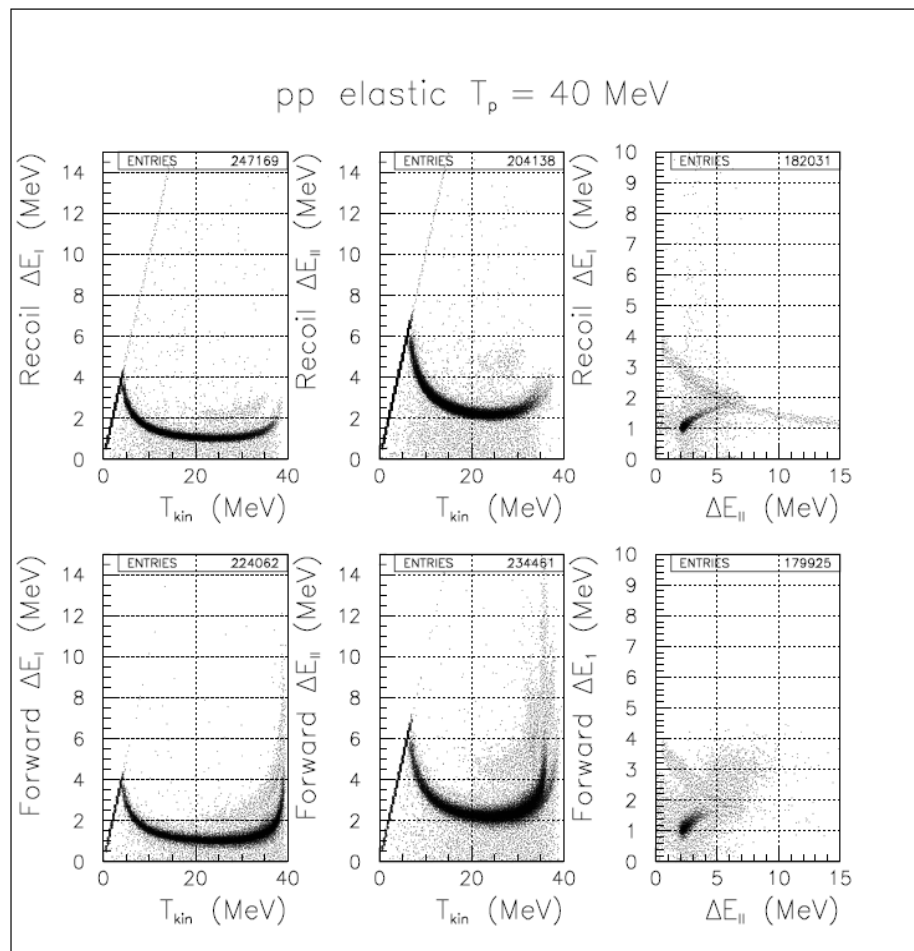
ANKE like detector (reconstructed hit distribution)



I layer (active area): $42 \times 60 \text{ mm}^2$ and $150 \text{ }\mu\text{m}$ thickness,
 II layer (active area): $60 \times 60 \text{ mm}^2$ and $300 \text{ }\mu\text{m}$ thickness.
 Distances: $d_{\perp} = 42$ (48) mm and $d_{\parallel} = 62$ (68) mm.
 Azimuthal coverage: 55%.
 Gaps between layers in z direction: 5 mm.

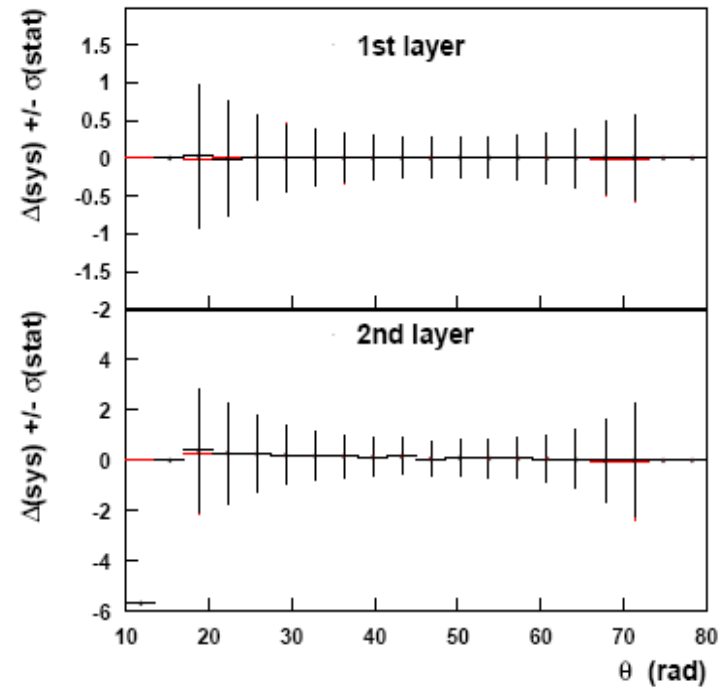
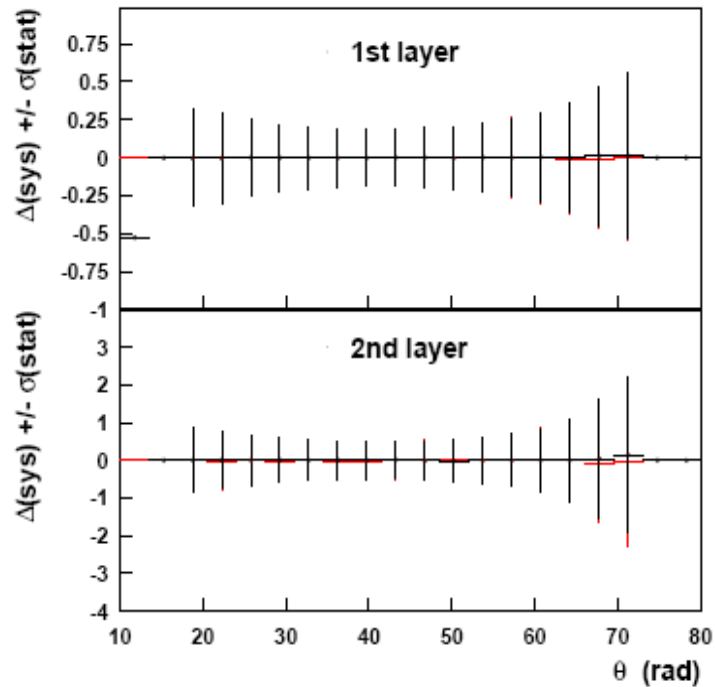
Detector performance :

- Energy deposit vs T_p for I and II layers;
- Energy loss in I vs Energy loss in II layers .



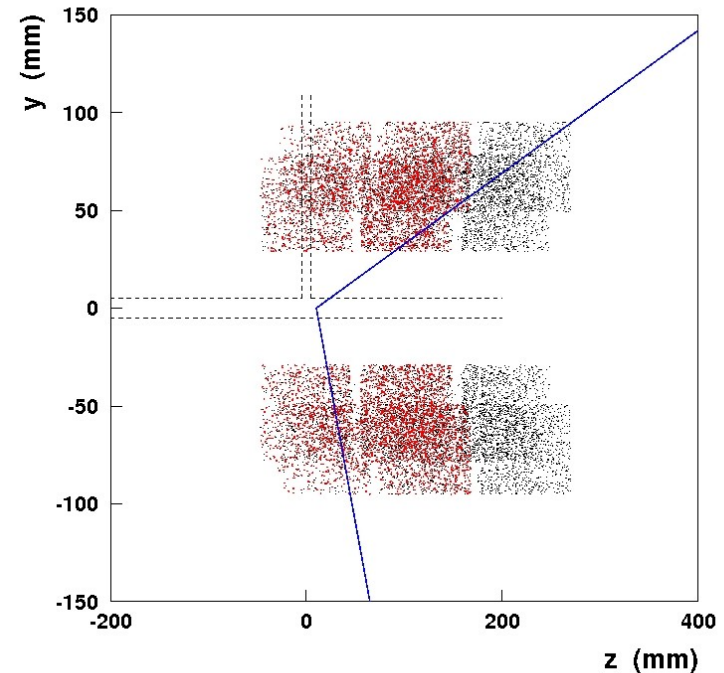
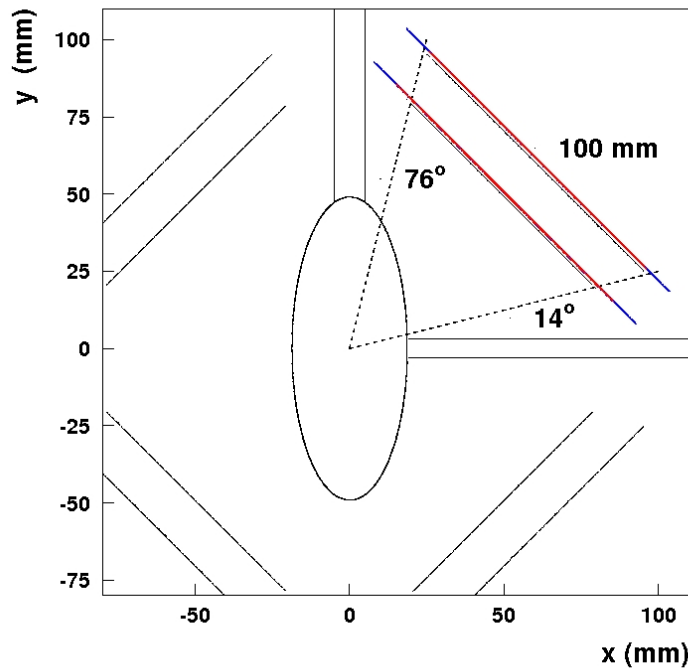
Detector performance:

- Multiple scattering effects.



Hit residuals for transverse (left) and longitudinal (right) coordinates.

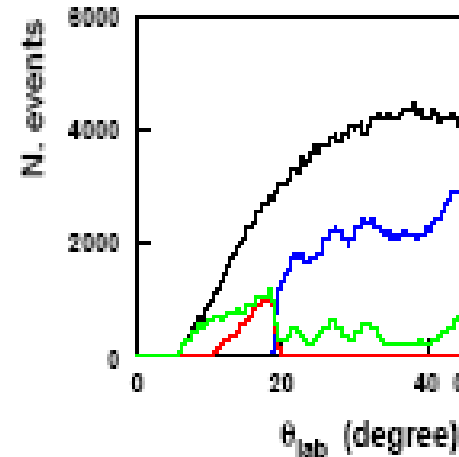
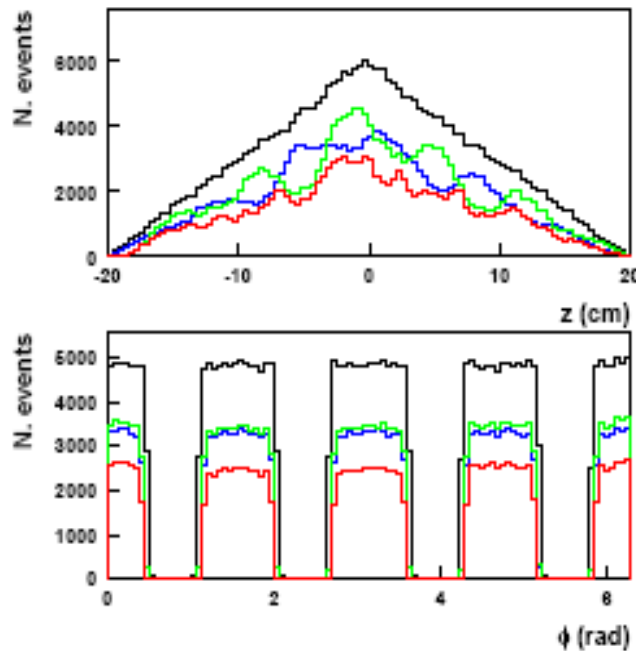
HERMES like detector (reconstructed hit distribution)



Layers active area: $97 \times 97 \text{ mm}^2$ and $300 \text{ }\mu\text{m}$ thickness.
 Distances: $d_{\perp} = 70 \text{ mm}$ and $d_{\parallel} = 85 \text{ mm}$. Azimuthally coverage 69%.
 Gaps between layers in z direction: 5 mm.

Detector performance:

- Acceptance (ANKE case)



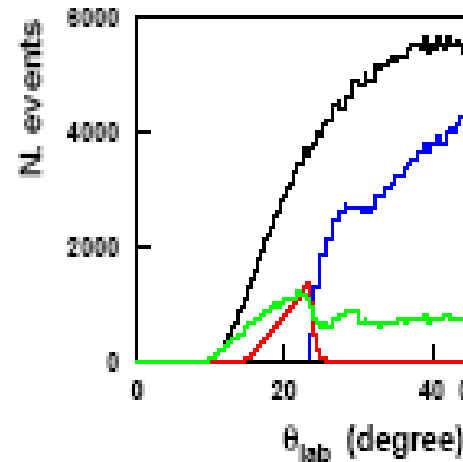
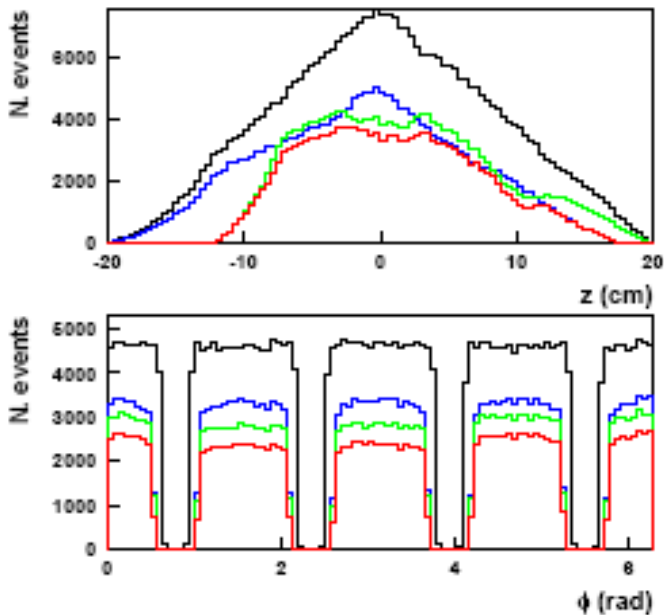
Black line – at least one hit in silicon.
 Green line – Recoil track reconstructed.
 Blue line – Forward track reconstructed.
 Red line – both tracks were reconstructed.

Black – at least one hit in silicon.
 Green – no reconstruction.
 Blue – full reconstruction.
 Red – Recoil stopped.

Tracks with < 20 degree are reconstructed by means of the energy information in I layer. **Full acceptance is 31%.** For **central part** it reduced to **22 %**.

Detector performance:

- Acceptance (HERMES case)



Black line – at least one hit in silicon.
 Green line – no reconstruction.
 Blue line – at least one reconstructed tracks.
 Red line – both track was reconstructed.

Black – at least one hit in silicon.
 Green – no reconstruction
 Blue - full reconstruction.
 Red - Recoil stopped.

Tracks with < 25 degree are reconstructed by means of the energy information in I layer. Full acceptance is 32%. For central part it reduced to 24 %.

Event rate estimations

We take a conservative estimate of the global efficiency (dead-time correction, trigger and reconstruction) of the order of 50 %.

With a sample of 500 k elastic events, acceptance of 22% and efficiency of 50%, the statistical error on the beam polarization determination is of the order of 0.4 %.

exp	σ_{el} [mb]	luminosity [cm ² s ⁻¹]	initial rate [Hz]	lifetime [sec]	fill integrated statistic
COSY	70	$1 \cdot 10^{29}$	770	1800	1 M

SUMMARY

- Fast simulation code exists based on pp elastic event generator (SAID).
- Comparison of ANKE vs HERMES configuration (4 modules) shows that HERMES like is preferable.
- Estimated count rate is 770 ev/s.
- Future work: pd elastic.