Polarization Measurement

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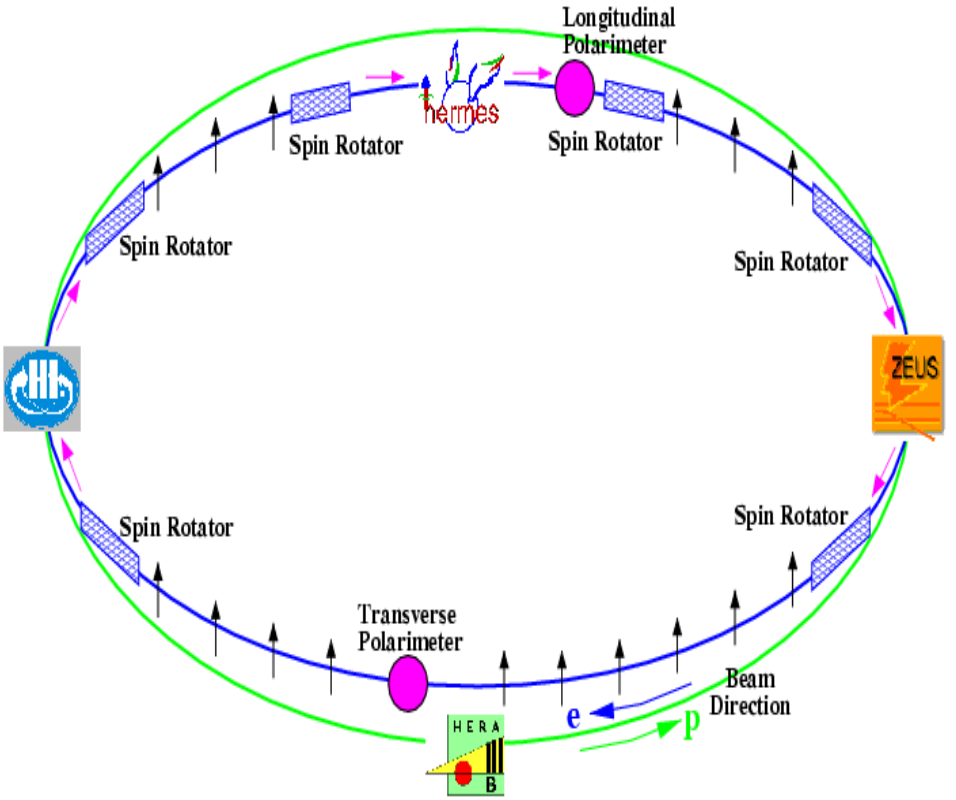
for the POL2000 Group

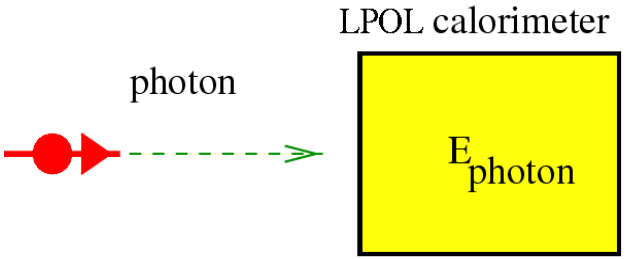
Outline:

- Status of LPOL and TPOL
- TPOL:
  - beam line simulation
  - beam spot & IP finding
  - bremsstrahlung
  - parametrisation of data



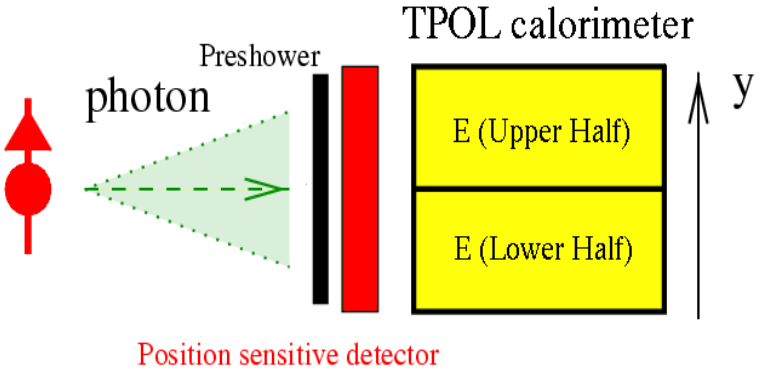
Polarisation Measurement

LPOL,LPOL Cavity
- measure longitudinal polarisation from energy asymmetry



TPOL
- measures transverse polarisation from spacial asymmetry

$$\eta = (E_{up} - E_{down})/(E_{up} + E_{down})$$



Status of longitudinal polarisation measurement

The dominant systematic error source is the error of the analysing power:

- determined from test-beam data,
- cross-checked with data taken with a sampling calorimeter

The crystal of the calorimeter have been replaced

- extra source of the systematic error

Source	$\Delta P/P$ (%)
Analyzing power	1.2
- response function	(0.9)
- single to multi photon extrapolation	(0.8)
Long term stability	0.5
Gain mismatch	0.3
Laser light polarization	0.2
Pockels cell misalignment	0.4
Electron beam / laser beam interaction region	0.8
Total HERA I error	1.6
Extra uncertainty for new calorimeter	≤ 1.2
Total HERA II error	2.0

Total systematic error 2%

Using the HERA Polarisation Measurements-Recommendations for Summer 2007 Conferences - POL2000-2007-001

Polarisation Measurement

Polarisation measurement using spatial asymmetry of energy asymmetry η , switching laser between left and right

polarisation given by "shift of means"

$$AP(focus) = \frac{<\eta_L> - <\eta_R>}{\Delta S_3 P_y}$$

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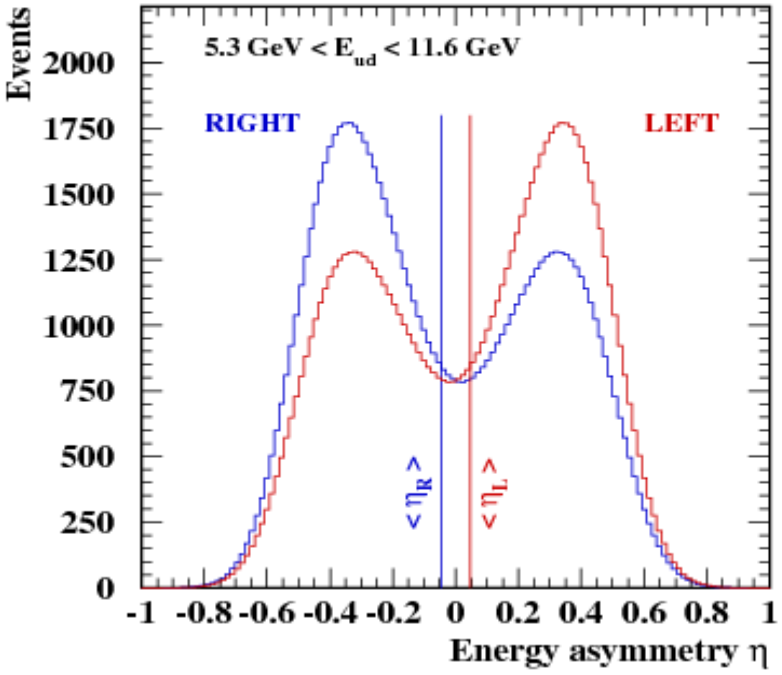


Analysing power dependants on beam divergence and IP distance

Status of the transverse polarisation measurement

The main sources of systematic error:

- analysing power
- focus correction
- interaction point

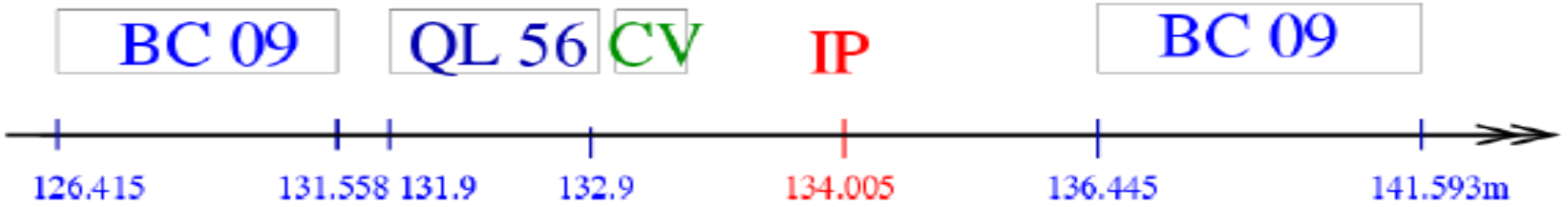
Source	Name	$\Delta P/P(\%)$
Electronic noise		< 0.1
Calorimeter calibration		< 0.1
Background subtraction		< 0.1
Light polarization	$\Delta P_{\mathrm{lin}}/P$	0.1
Focus correction	$\Delta P_{\mathrm{focus}}/P$	1.0
Compton beam centering	$\Delta P_{\mathrm{table}}/P$	0.4
Interaction region	$\Delta P_{\mathrm{IR}}/P$	0.3
Interaction point	$\Delta P_{\mathrm{IP}}/P$	2.1
Absolute scale	$\Delta P_{\mathrm{scale}}/P$	1.7
Total	$\Delta P/P$	2.9

To improve this errors is needed:

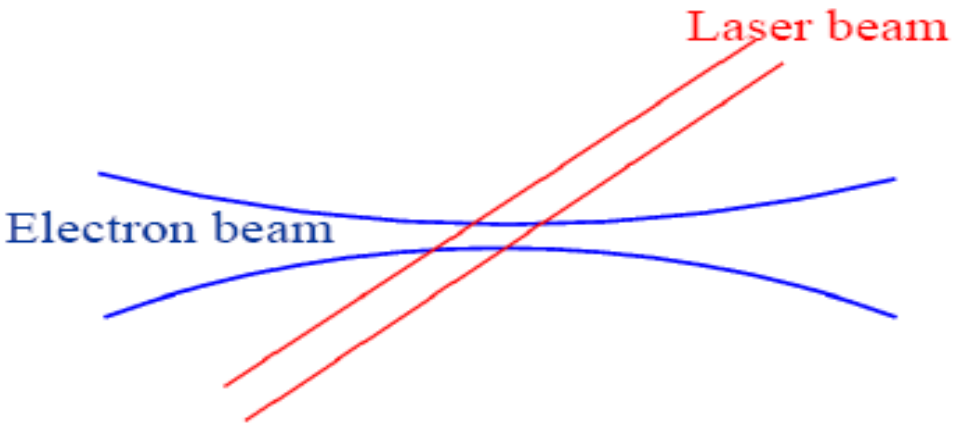
- detailed realistic simulation of magnetic beam line
- precise calorimeter response i.e. eta(y)
  - transformation and energy resolution for simulation

Using the HERA Polarisation Measurements-Recommendations for Summer 2007 Conferences - POL2000-2007-001

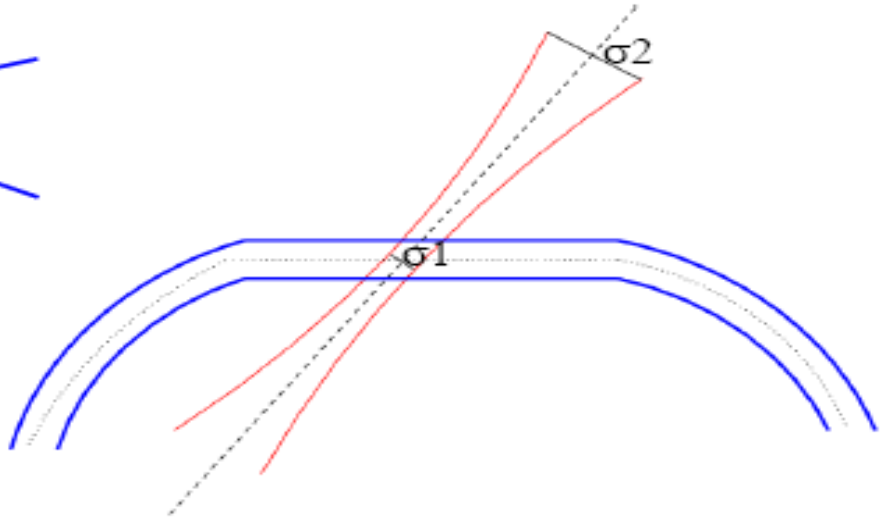
Beam Line Simulation



Previous version



New version



Electron Beam variables

The electron beam is described by:

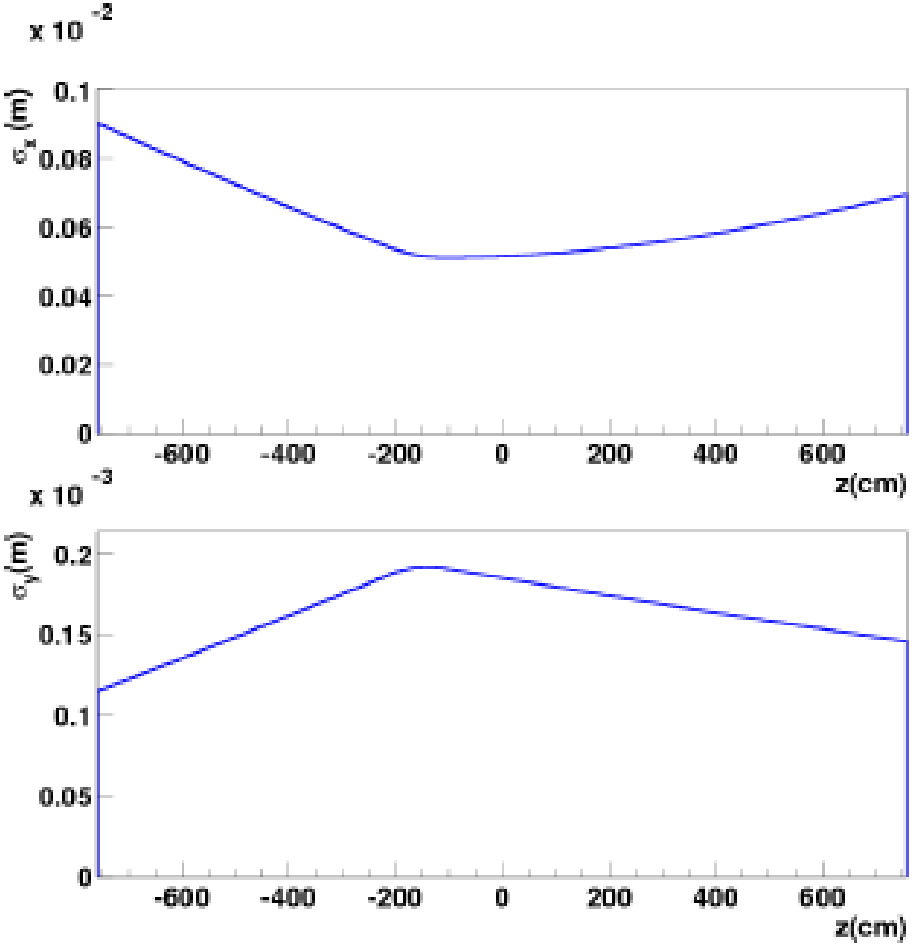
- transverse positions x,y and directions x',y' (approximately Gaussian distributions) with widths $\sigma_{e,x}$, $\sigma_{e,y}$, $\sigma_{e,x'}$, $\sigma_{e,y'}$,
- where: $\sigma_{e,y}(0) = \sqrt{\varepsilon_y \beta_y(0)}$,

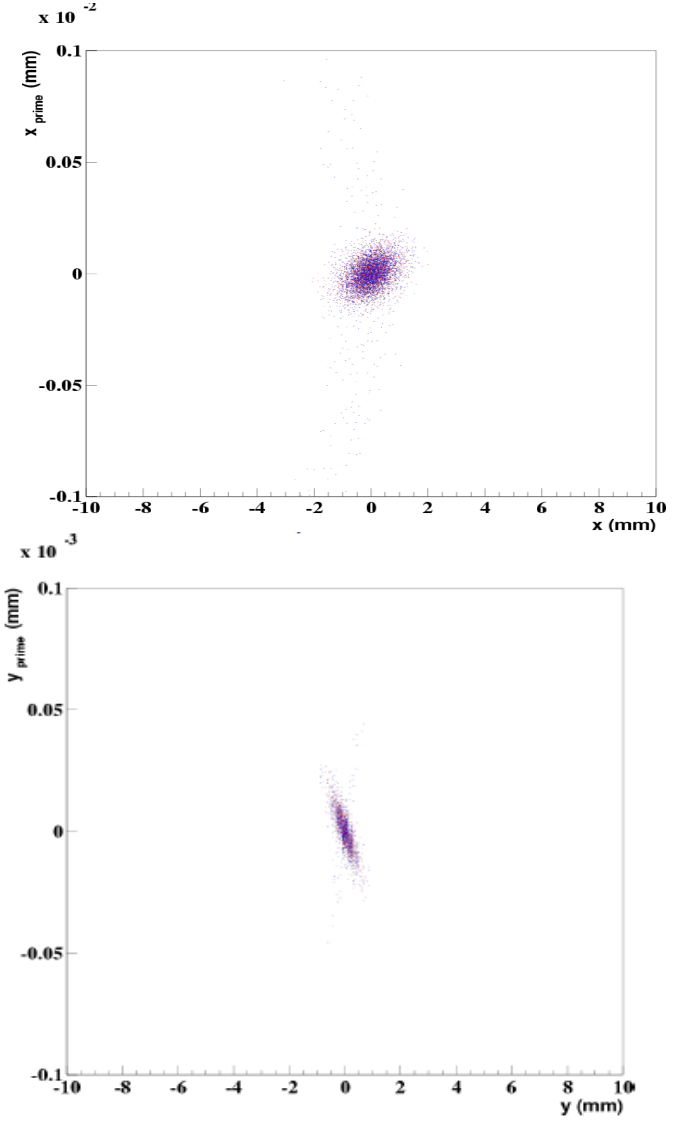
$$\sigma_{e,y'}(0) = \sqrt{\varepsilon_y \gamma_y(0)},$$

β- amplitude function
α- twist function
$\gamma = \mathrm{sqrt}(1+\alpha^2)/\beta$
ε - emittance

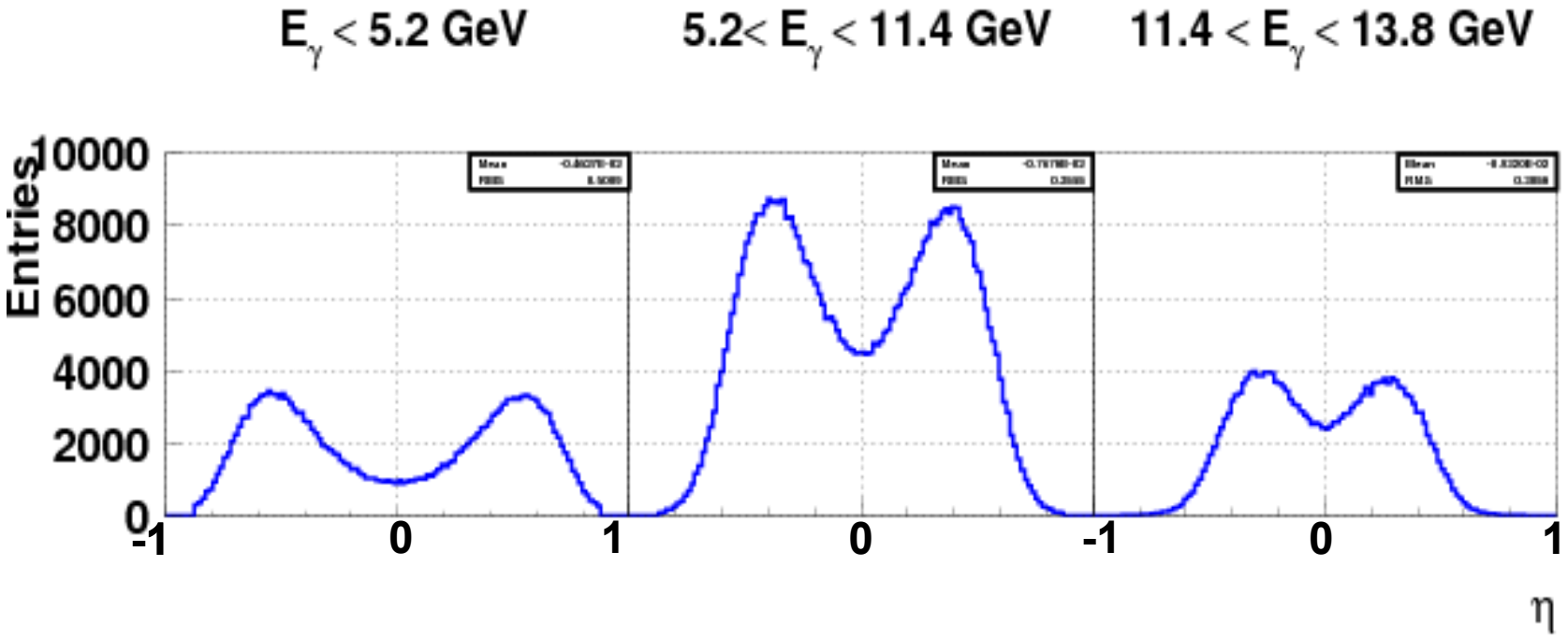
zoffset – position of the vertex according IP region
θ – crossing angle between laser and electron beam

Beam Line Simulation





IP and beam spot size



Previous:

1st bin calculation of IP

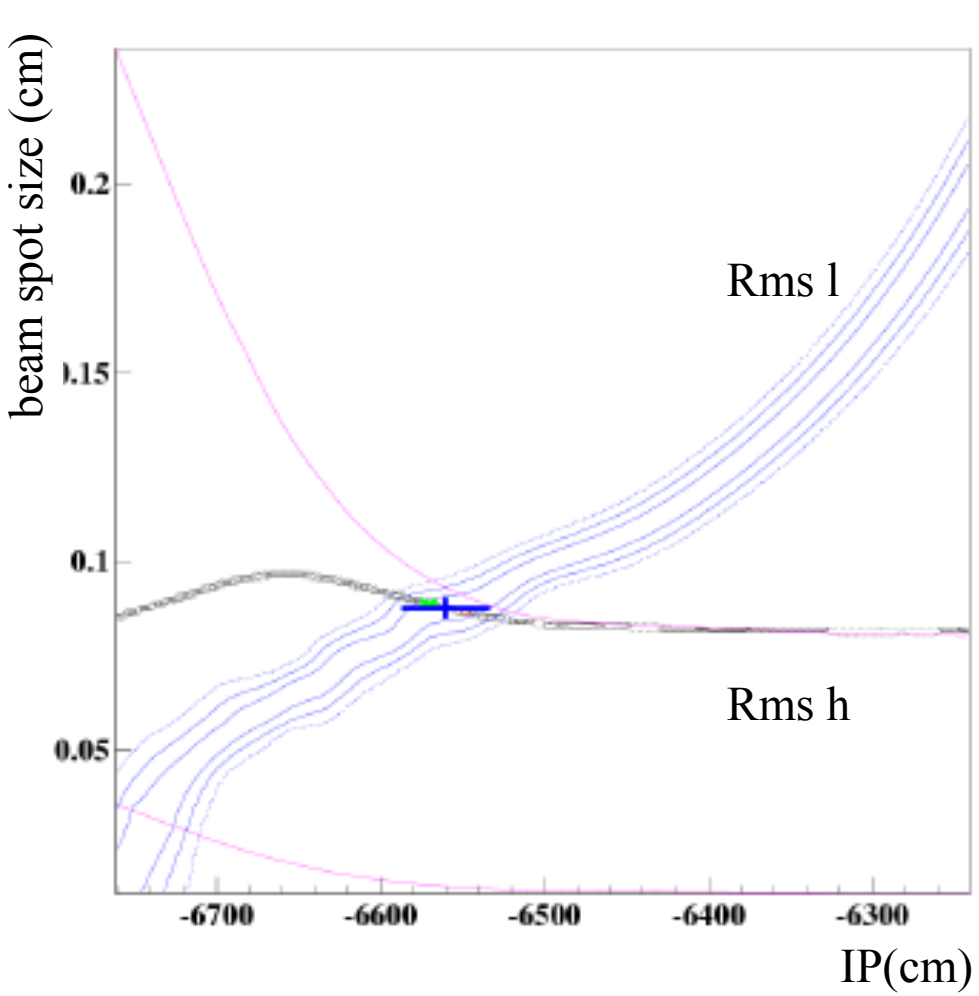
2nd bin calculation of Analasing Power

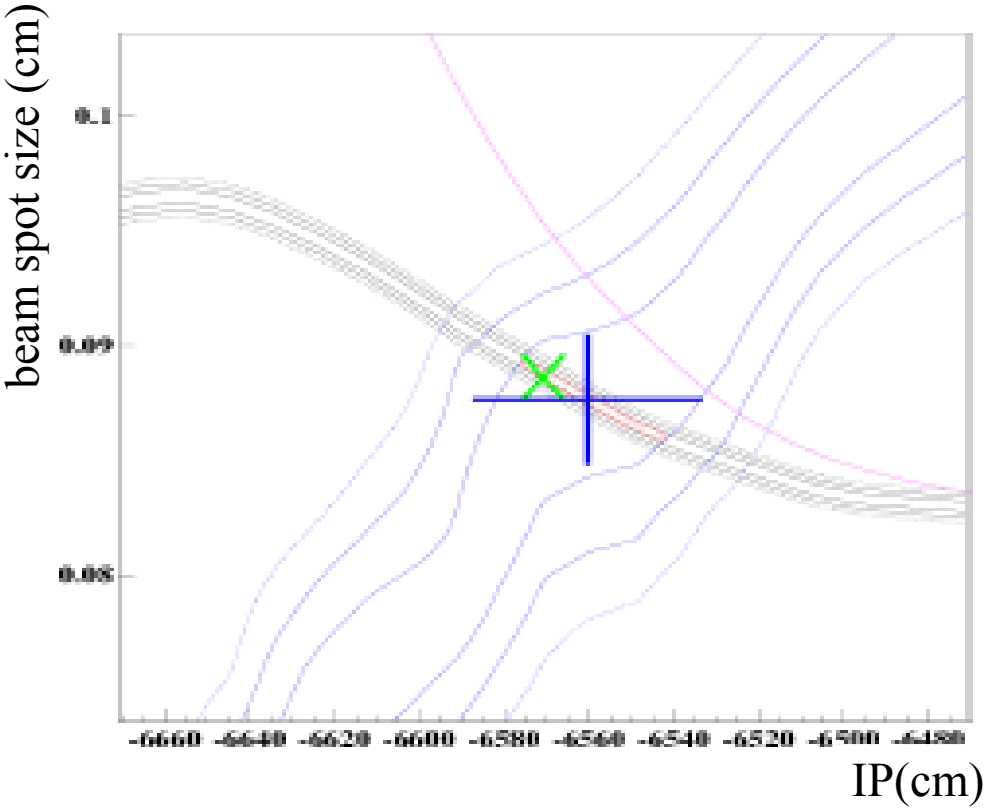
3rd bin calculation of focus correction

Now:

combined information from 1st and 3rd bin gives IP and beam spot size

IP simulation



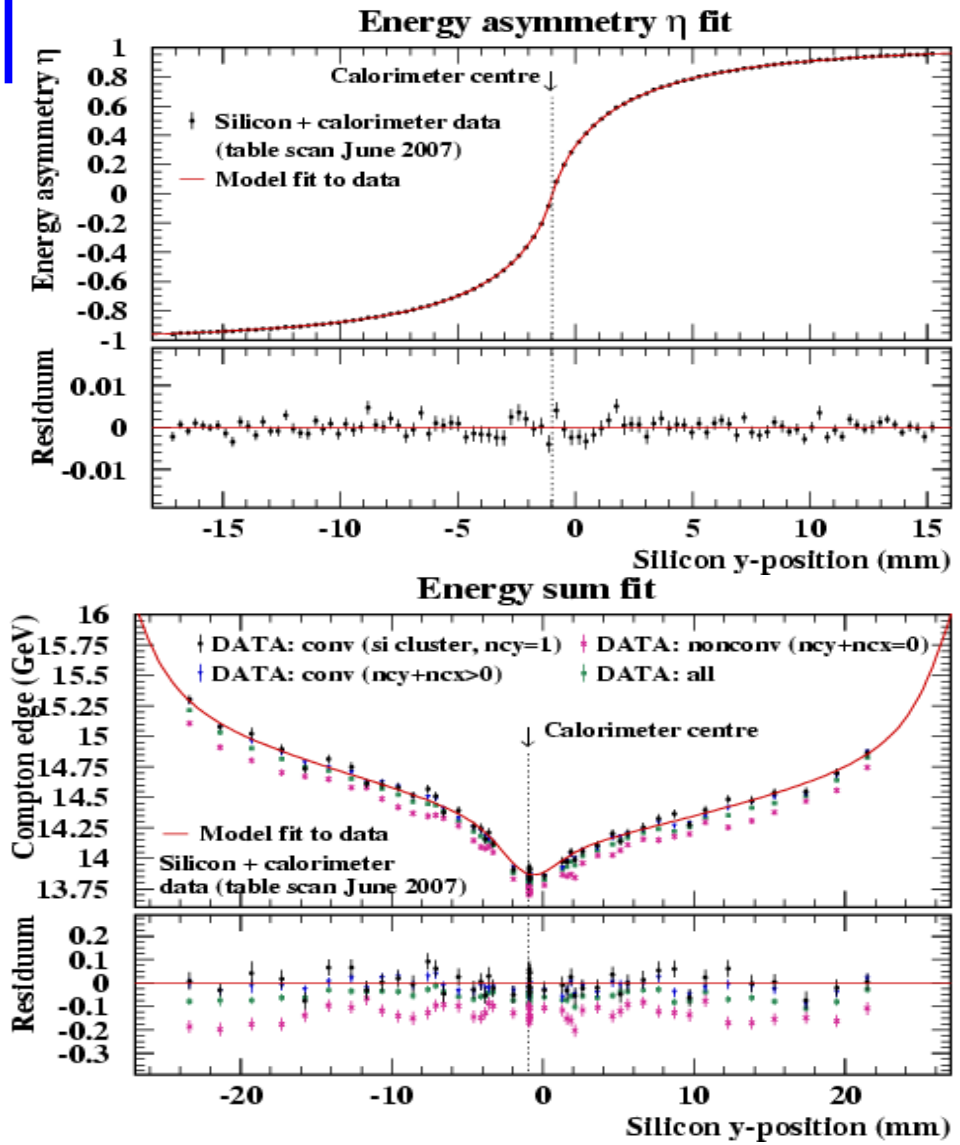


Generated IP and Beam Sport

Reconstructed IP and Beam Spot

IP and Beam spot size are reconstructed quite good

Parametrised Model



Parametries Model based on:

- measurement of the silicon data
- fit with analytical physical model using em shower description and detector effects

Reproduction of η(y) distribution important for calculation of AP

D.Barber et al. The HERA polarimeter and the first observation of electron spin polarization at HERA. Nucl. Instrum. Meth. A329(1993) 79

More dateils B.Sobloher TPOL Meeting 10th Febrary 2010

Bremsstrahlung Radiation at TPOL

Bremsstrahlung generator:

- imported into Geant by V. Andreev
- fully connected to beam line

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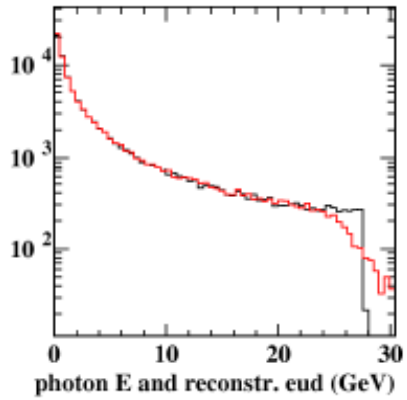

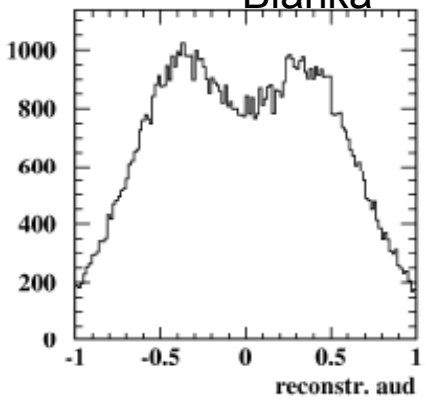

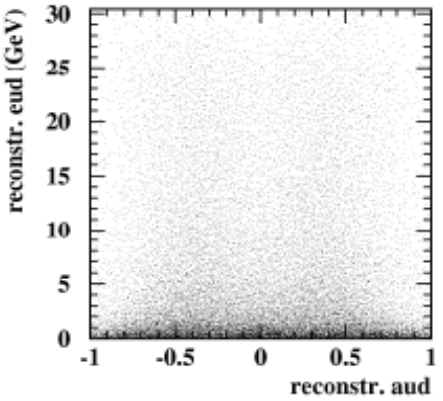

Bramsstrahlung from laser off

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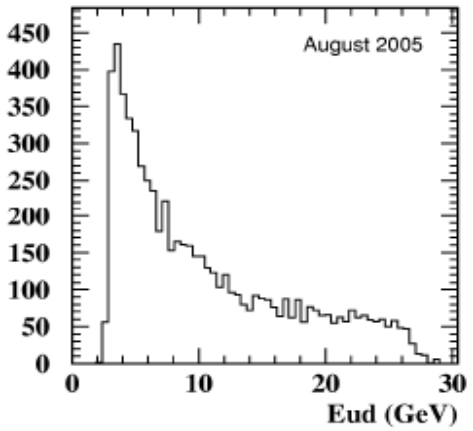

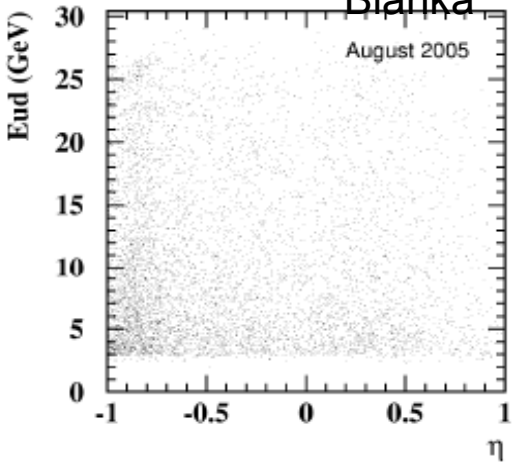

More details: Blanka Sobloher, POL2000 meeting, 30th September 2009

Done:

- Beam Line Simulation
- IP finding
- Geant 3 calorimeter simulation
- parametrised MC

To do:

- implement digitalisation model to MC
- parametrised MC has to be tunned to data
- replacement Geant by parametrised MC
- improve analysis including corrections