Luminosity Monitor Session

Helmholtz Institute Mainz

Luminosity Fit and Influence of Beam Parameters

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11. September 2012

Luminosity

The Model

$$N(p) = L \cdot (\sigma(p) \cdot \epsilon(p)) \otimes Res$$

- N: measured number of events
- p: phase space variables
- σ: cross section
- ϵ: detection efficiency (without smearing)
- Res: resolution function of detector
- L: luminosity (fit param.)

Influence of the Beam Parameters

Categories

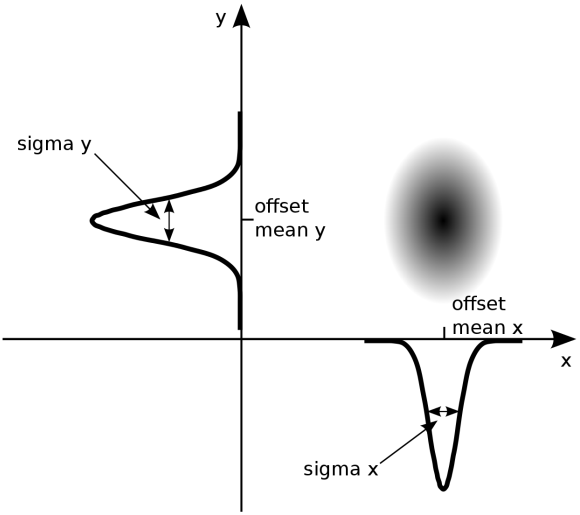
beam offset

- displacement of the IP (here only in x and y)
- beam offset is a pure acceptance effect $\rightarrow$ can be completely corrected by acceptance correction
- note: beam offset is equivalent to displacement of detector vertical to beam axis

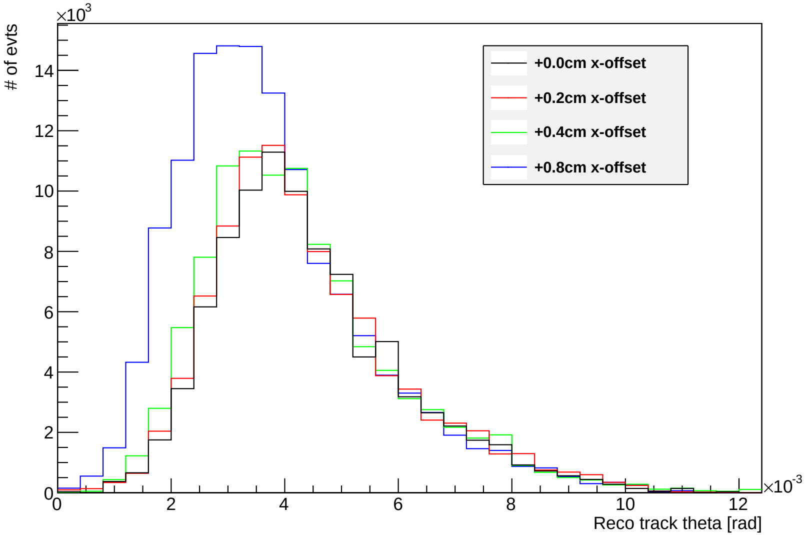
oblique beam

- $\bar{p}$ enter with an angle w.r.t. z-axis
- angle modifies true distribution (MC truth) but also the acceptance
- problem: cannot be measured directly
- basic model needs modification
- note: beam divergence is just an additional angular resolution

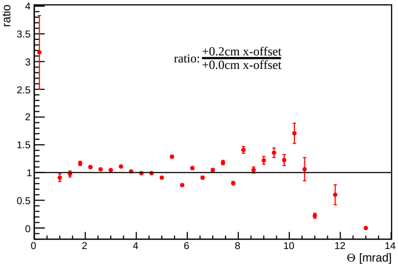
Beam Offset Parametrization

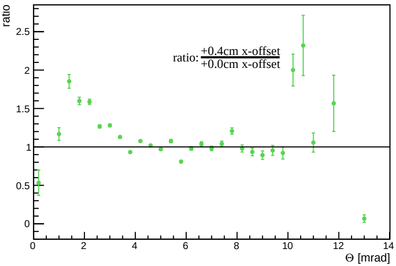


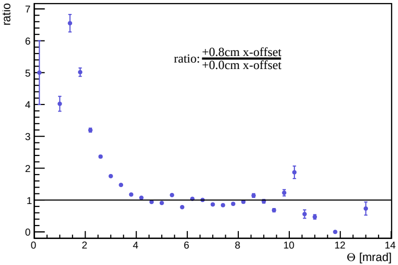
Reconstruction with Beam Offset



Reconstruction with beam offset contd.



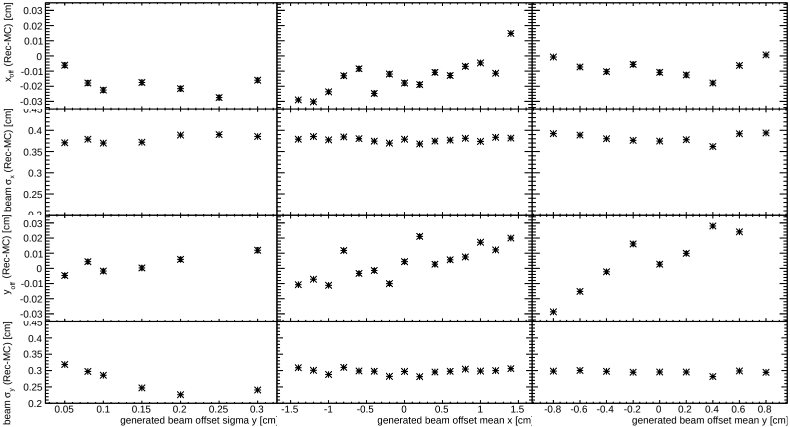




Beam Offset Conclusion

- precise determination of beam offset required for good acceptance description
- how precise can our detector measure the beam offset?

BEAM OFFSET DEPENDENCIES: RESULTS



x_{off} = 0.00 cm	x_{off} was variated	x_{off} = 0.40 cm
y_{off} = 0.00 cm	y_{off} = 0.00 cm	y_{off} was variated
beam σ_x = 0.08 cm	beam σ_x = 0.08 cm	beam σ_x = 0.08 cm
beam σ_y was variated	beam σ_y = 0.08 cm	beam σ_y = 0.08 cm

Beam Parameter Dependencies

Conclusions

- $x-$ and $y-$offset can be measured upto $300\mu m$ precision
- σ_x and σ_y differences have constant offset from zero $\rightarrow$ detector resolution

Outlook

- include smearing in z (however influence will be minor)
- additionally tilt the beam

The Luminosity Fit in Practice

ROOT

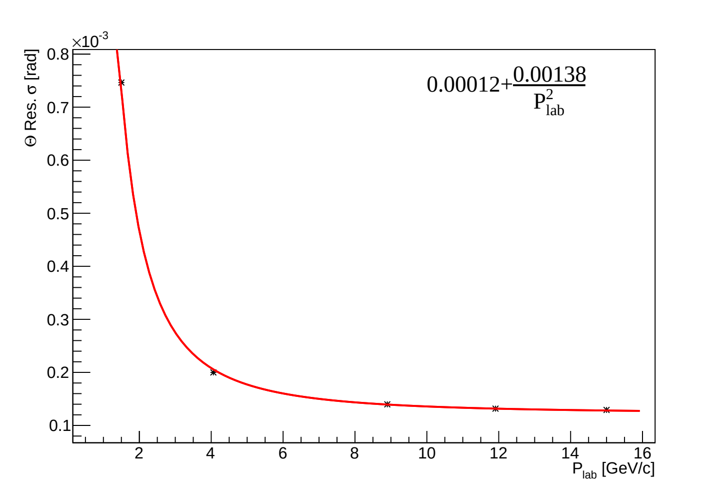
- Pro: user has full control over procedure
- Con: most implementations have to be written by user
- currently: complete in 1D

RooFit

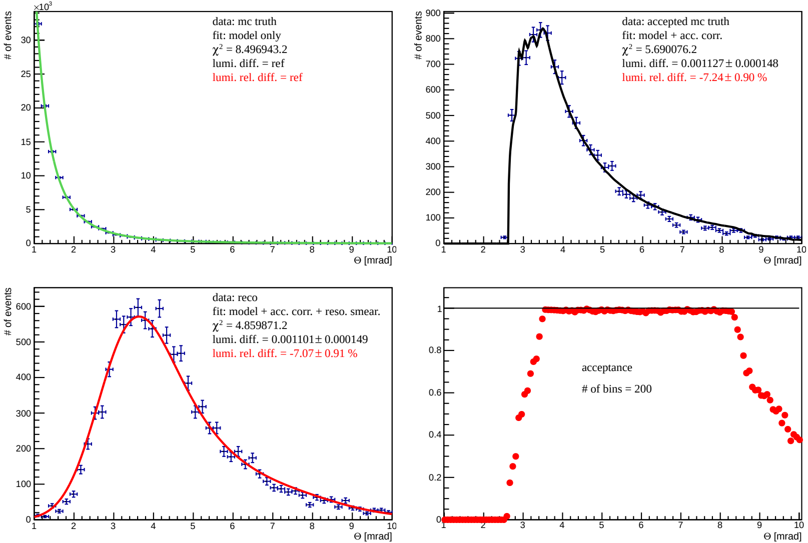
- Pro: many nice features for model description (convolution and background modelling)
- Cons: normalization difficulties and only very limited extension possibility
- currently: not properly working yet

Parametrization of θ Resolution

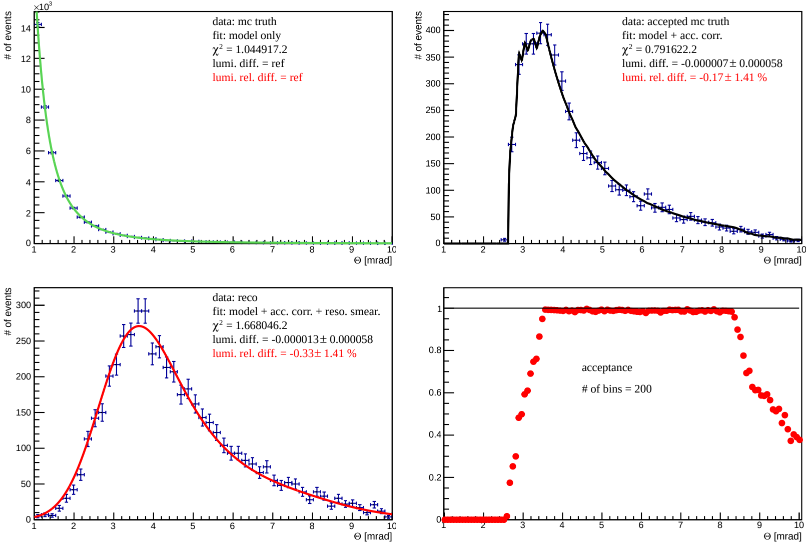
Major Dependence: P_{lab}



RESULT: DPM DATA + FIT AT $P_{lab} = 1.5GeV$



Result: Toy MC Data + Fit at $P_{lab} = 1.5GeV$



Conclusion

- fit results look promising apart from model discrepancy to DPM generator
- luminosity fit is on the verge of its first release
- However: many more things that need to be implemented
  - influence of the beam
  - include inelastic component
  - etc.

End

Thanks for Your Attention!

Elastic Cross Section

$$\frac{d\sigma}{dt} = \frac{d\sigma_C}{dt} + \frac{d\sigma_{int}}{dt} + \frac{d\sigma_H}{dt}$$

with

$$\frac{d\sigma_C}{dt} = \frac{4\pi\alpha_{EM}^2 G^4(t)}{\beta^2 t^2}$$

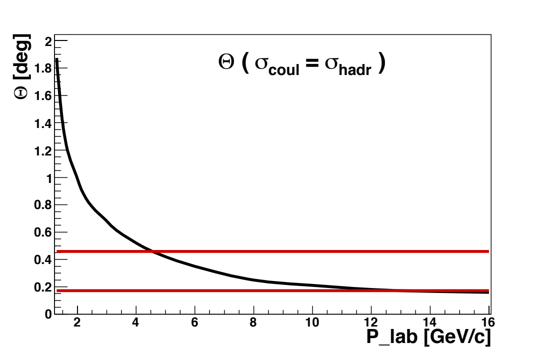
$$\frac{d\sigma_{int}}{dt} = \frac{\alpha_{EM}\sigma_{Total}}{\beta|t|} G^2(t) e^{\frac{1}{2}Bt} (\rho cos(\delta) + sin(\delta))$$

$$\frac{d\sigma_H}{dt} = A_1 \cdot \left[e^{t/2t_1} - A_2 \cdot e^{t/2t_2}\right]^2 + A_3 \cdot e^{t/t_2}$$

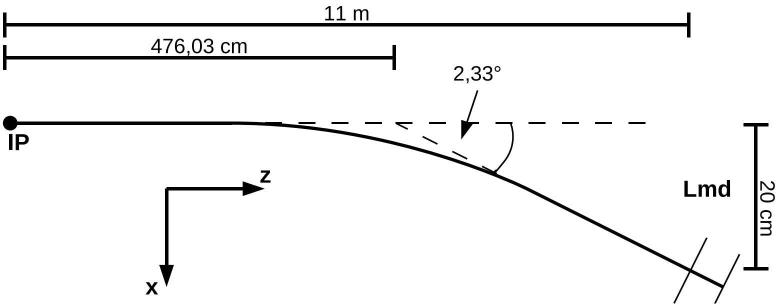
Luminosity Measurement Concept

$\bar{p}$-p Elastic Scattering

- process with good knowledge: Coulomb scattering
- minimal background at low momentum transfers
- note: for now inelastic background is neglected

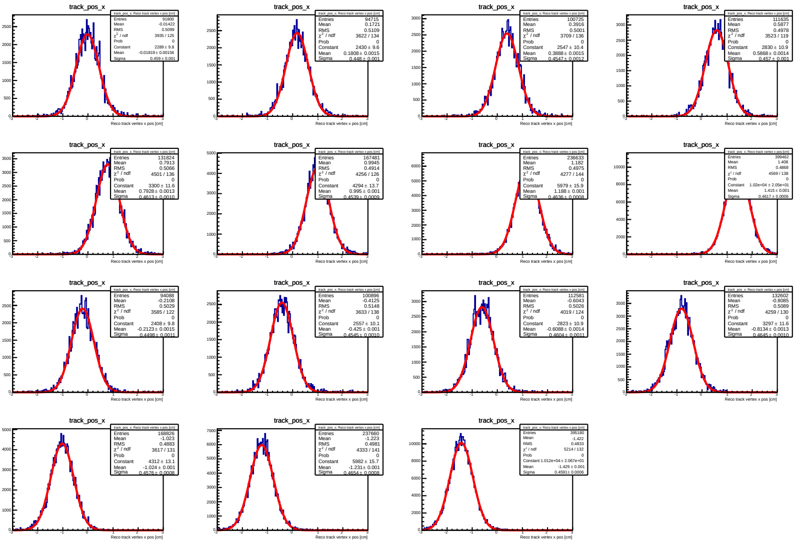


Detector Placement



⊙ here: $E_{beam} = 1.5\,\mathrm{GeV}$

Beam Offset Fit Example



Detector Resolution Smearing