

LuminosityFit

The PANDA Luminosity Determination Software

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Luminosity Measurement via Elastic Scattering

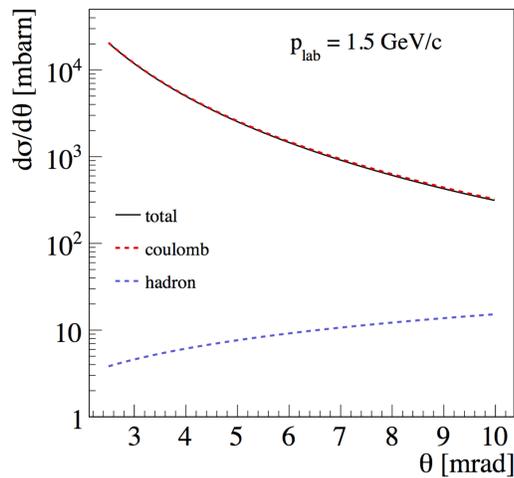
$$\frac{dN(t)}{dt} = L \cdot \frac{d\sigma(t)}{dt}$$

N: measured angular distribution
 σ : cross section (theory)
t: four-momentum transfer

↪ Luminosity L relates measurement and theory
↪ known cross section enables luminosity determination

@PANDA: antiproton-proton elastic scattering cross section

$$\frac{d\sigma_{el}}{dt} = \frac{1}{16\pi} |f_{had} + f_{coul} e^{i\delta(t)}|^2 = \frac{\sigma_{coul}}{dt} + \frac{d\sigma_{had}}{dt} + \frac{d\sigma_{int}}{dt}$$



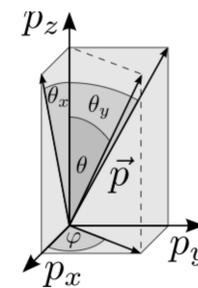
Main Idea:

modification of cross section for direct comparison with measured angular distribution

base transformation

↪ effectively handle accelerator beam tilts

$$\frac{dN(\theta_x, \theta_y)}{d\theta_x d\theta_y} = L \cdot \frac{d\sigma(\theta_x, \theta_y; \theta_x^{tilt}, \theta_y^{tilt})}{d\theta_x d\theta_y}$$

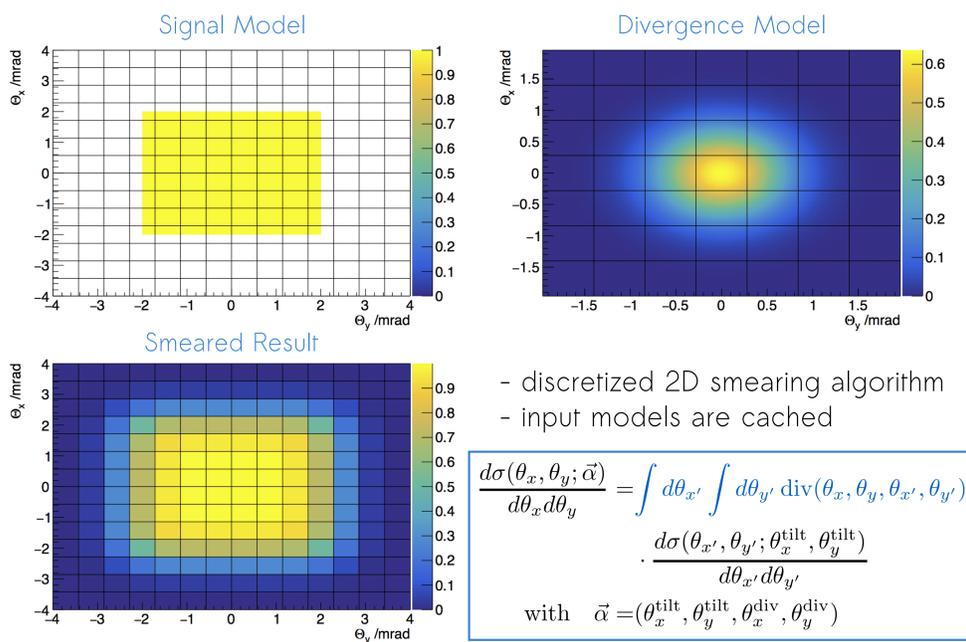


θ_x, θ_y : special angular coordinates of laboratory system

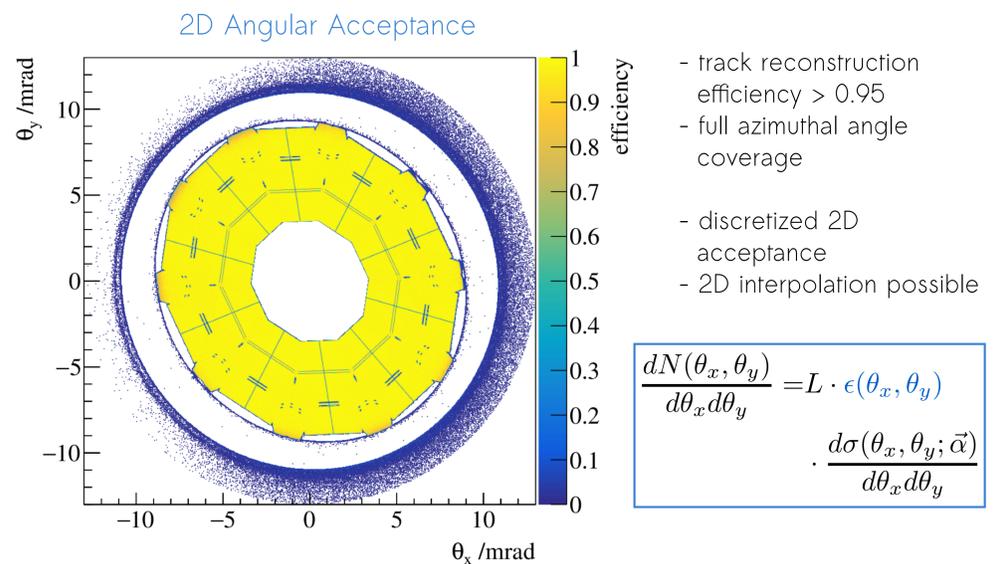
$\theta_x^{tilt}, \theta_y^{tilt}$: accelerator beam tilts

θ, ϕ : spherical coordinates

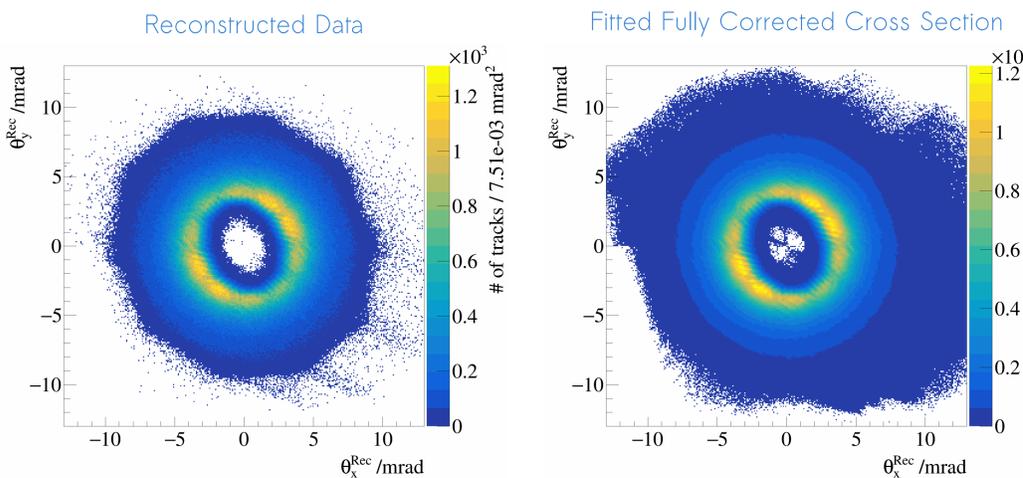
Beam Divergence Smearing



Detector Acceptance Correction



Detector Resolution Correction & Fit Results



$$\frac{dN(\theta_x^{rec}, \theta_y^{rec})}{d\theta_x^{rec} d\theta_y^{rec}} = L \cdot \int d\theta_x \int d\theta_y \text{Res}(\theta_x^{rec}, \theta_y^{rec}, \theta_x, \theta_y) \cdot \epsilon(\theta_x, \theta_y) \cdot \frac{d\sigma(\theta_x, \theta_y; \vec{\alpha})}{d\theta_x d\theta_y}$$

complicated corrections on cross section

↪ computation intensive

↪ optimized calculations

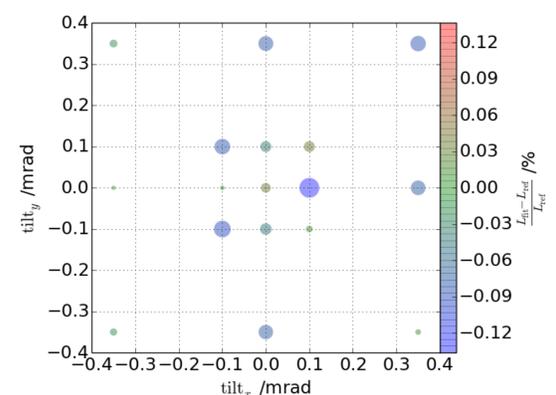
- data structure optimized
- cache optimized
- multithreaded...

additional effects (not shown):

- IP distribution
- IP displacements

↪ systematic uncertainties on luminosity on per mille level!

Luminosity Precision with Beam Tilt Variation



additional parameter extraction by fit:

- beam tilt
- beam divergence