**Luminosity Determination**

### pp elastic scattering

- Coulomb part: can be calculated from QED
- Hadronic part: measurement + models
- Measurement at small momentum transfer → small scattering angle \(\theta\) (3-8 mrad)

### Luminosity Extraction

Reconstructed data with model fit

\[
N = L \cdot \sigma \cdot \epsilon \cdot \Delta \theta
\]

- \(N\): number of events
- \(L\): cross section
- \(\epsilon\): efficiency
- \(\Delta \theta\): resolution
- \(L\): luminosity

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**PANDA@FAIR Experiment**

- A fixed target experiment with antiproton beam (momentum range: 1.5 to 15 GeV/c)
- Physics program:
  - Hadron Spectroscopy
  - Hadrons in Matter
  - Nucleon Structure
  - Hypernuclei

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**Luminosity Detector (LMD)**

- Measurement at small \(\theta\)
- Position ~ 11 m downstream from IP
- 4 detector planes with 10 modules each
- Placed inside vacuum to minimize multiple scattering of \(\pi\)

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**Track Reconstruction**

- Track Search
- Track Fit
- Track Search
- Track Fit
- Back Propagation to Interaction Point
- Nucleon Structure
- Fast track-based software alignment procedure
- Based on a non-iterative least squares fitting method
- Utilizes a C++ implementation of the "matrix-crushing" algorithm Miliepede

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**Back Propagation to Interaction Point**

- Recalculation of track parameters through the dipole and solenoid magnetic field
- Resolution after back propagation decreases with decreasing momentum due to multiple scattering

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**Time Consumption**

- Fastest process → Back Propagation
- Slowest process → Track Following

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**Expected Mechanical Accuracy**

- \(\Delta_{\text{LMD}} \approx 200 \mu m, \Delta_{\text{rel}} \approx 3 \text{ mrad}\)
- Resolution before alignment
  - \(\Delta_{\text{before}} \approx 200 \mu m\)
  - \(\Delta_{\text{rel}} \approx 3 \text{ mrad}\)
- Resolution after alignment
  - \(\Delta_{\text{after}} \approx 100 \mu m\)
  - \(\Delta_{\text{rel}} \approx 1 \text{ mrad}\)