Track-based alignment of the ATLAS-ALFA detectors

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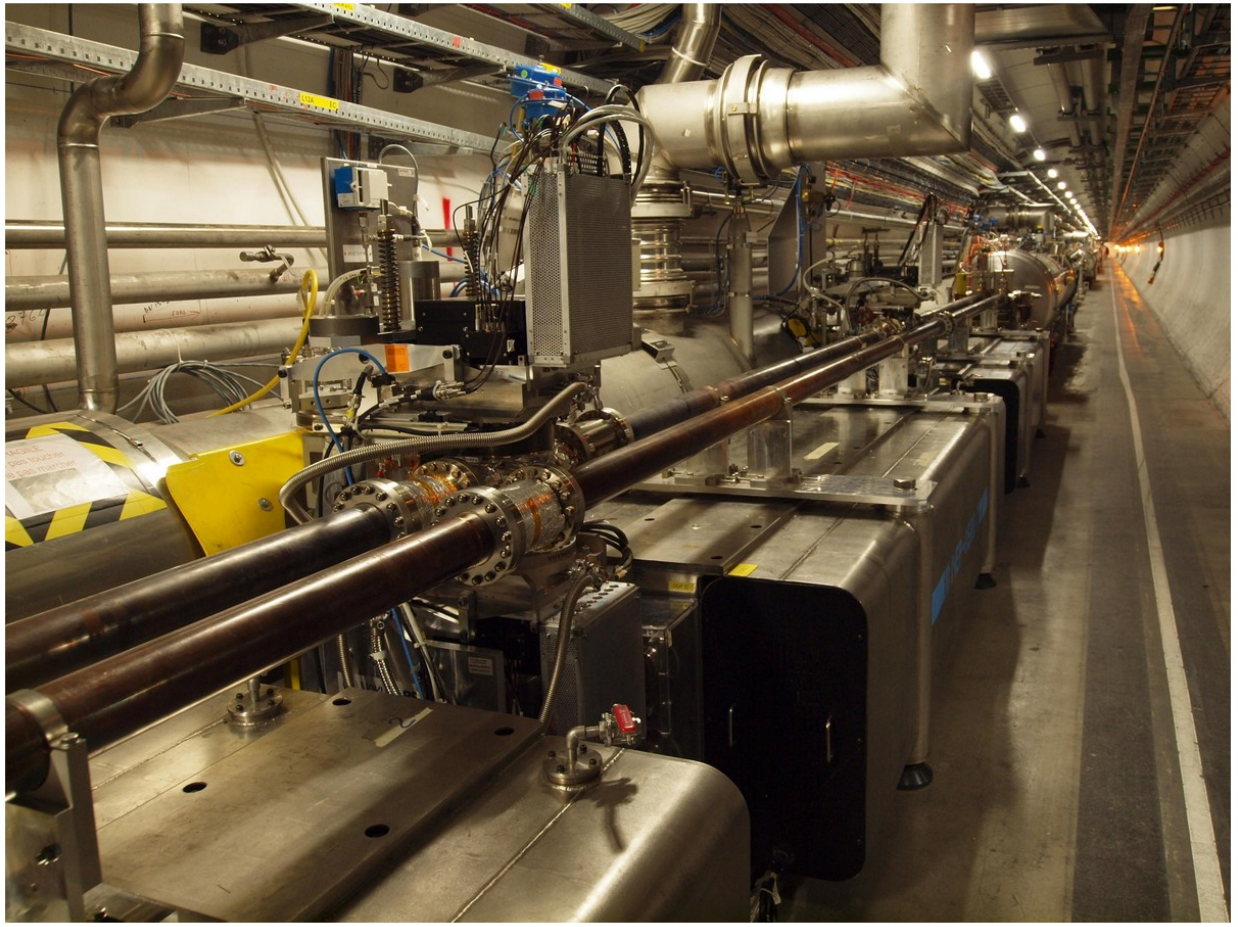
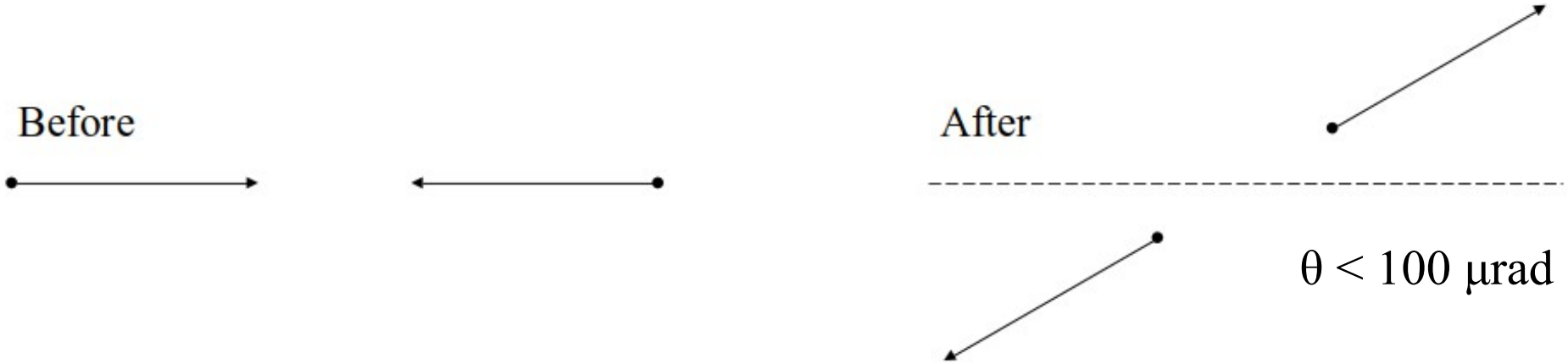


Outline:

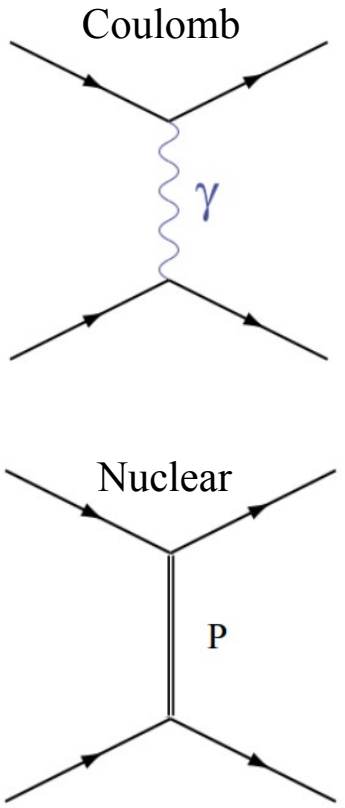
- Elastic proton-proton scattering
- ALFA detector
- Alignment

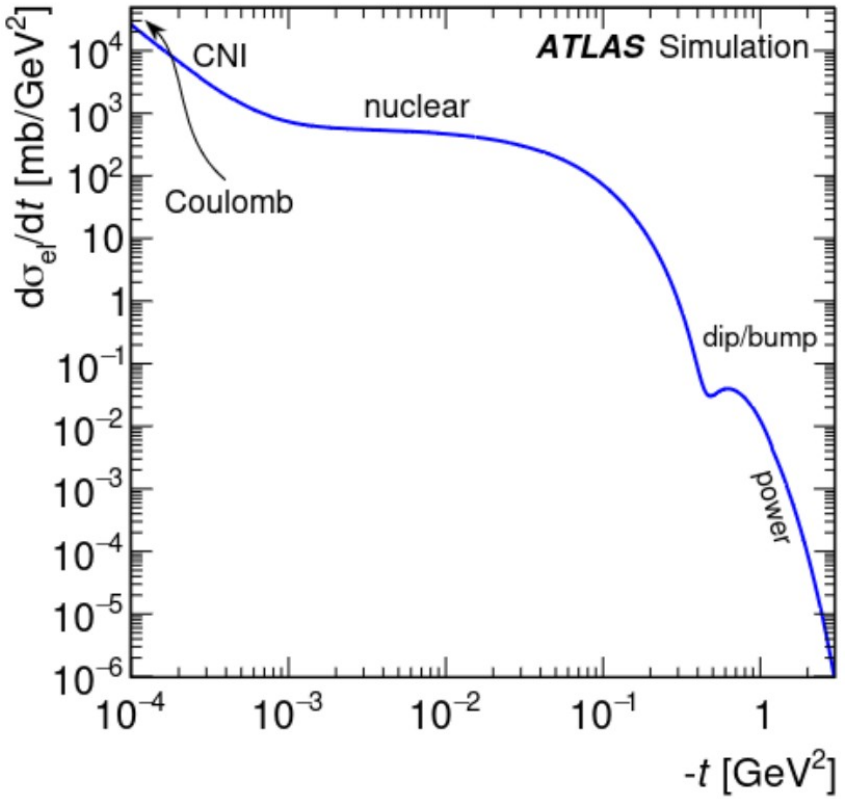
Elastic pp scattering, pp → pp



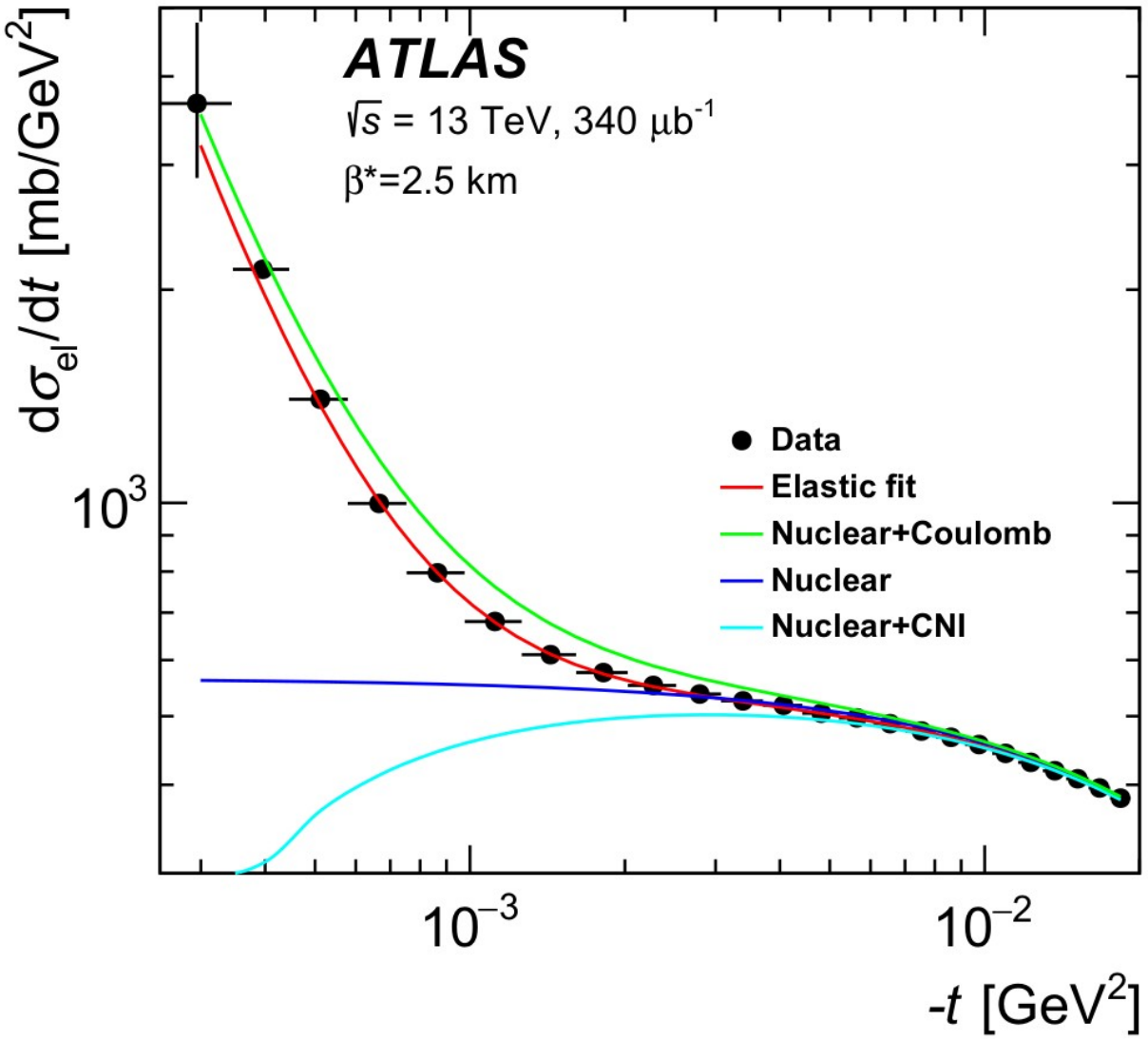
Energy and momentum conservation

- Two kinematic degrees of freedom: φ, θ
- φ – trivial (uniform)
- $t \approx -p^2\theta^2 = -p_T^2$
- Low |t| ≈ large distance, high |t| ≈ small distance





Differential cross section



$$\frac{\mathrm{d}\sigma_{\mathrm{el}}}{\mathrm{d}t} = \left|F_C(t)e^{i\alpha\phi(t)} + F_N(t)\right|^2$$

$$= \left|-\frac{2\sqrt{\pi}\alpha G^2(t)}{|t|}e^{i\alpha\phi(t)} + (\rho+i)\,\frac{\sigma_{\mathrm{tot}}}{4\sqrt{\pi}}e^{-\Omega(t)/2}\right|^2$$

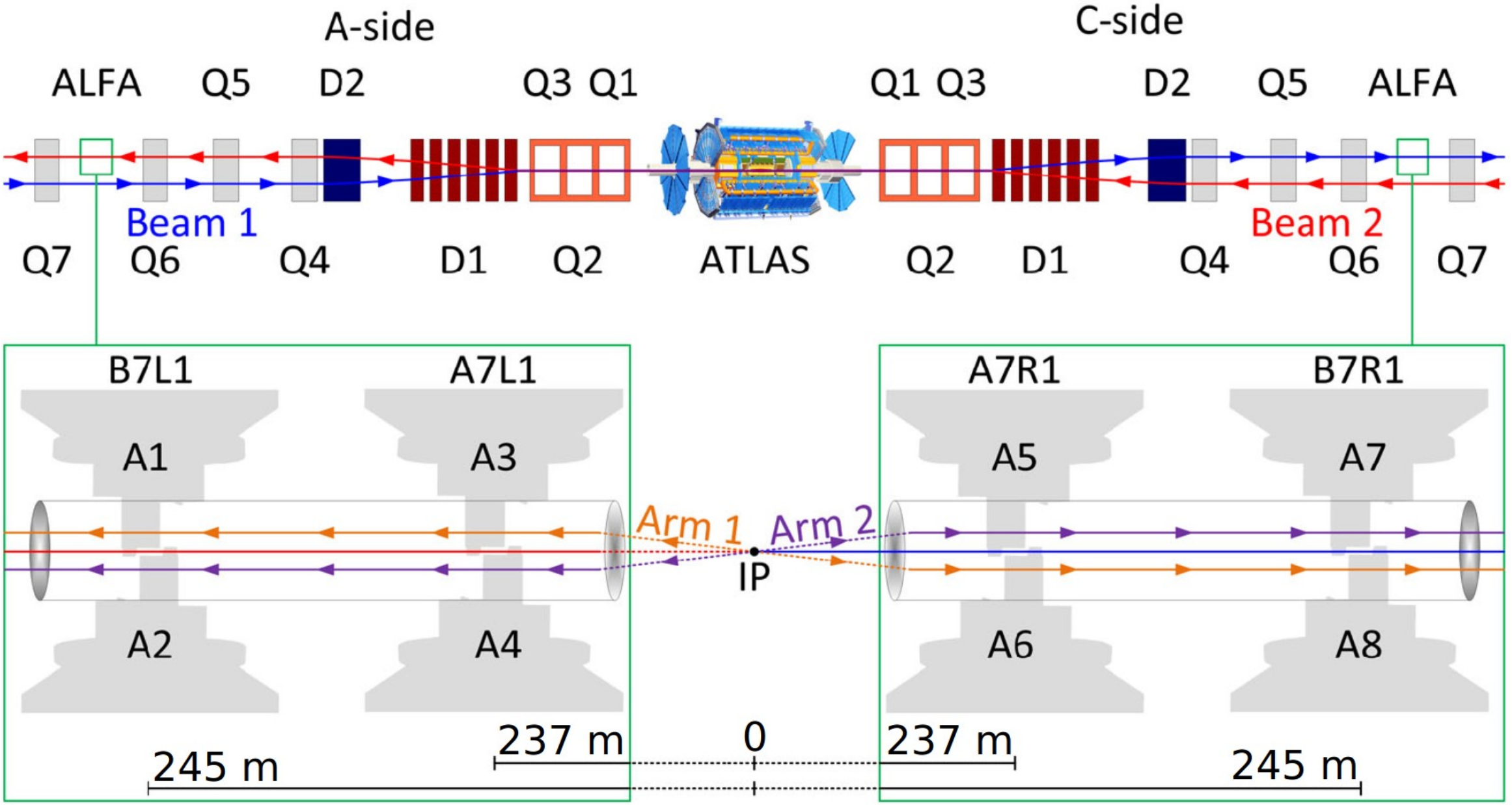
$$= \frac{4\pi\alpha^2 G^4(t)}{|t|^2}$$

$$- \sigma_{\mathrm{tot}}\frac{\alpha G^2(t)}{|t|}\left[\rho\cos(\alpha\phi(t)) + \sin(\alpha\phi(t))\right]e^{-\Omega(t)/2}$$

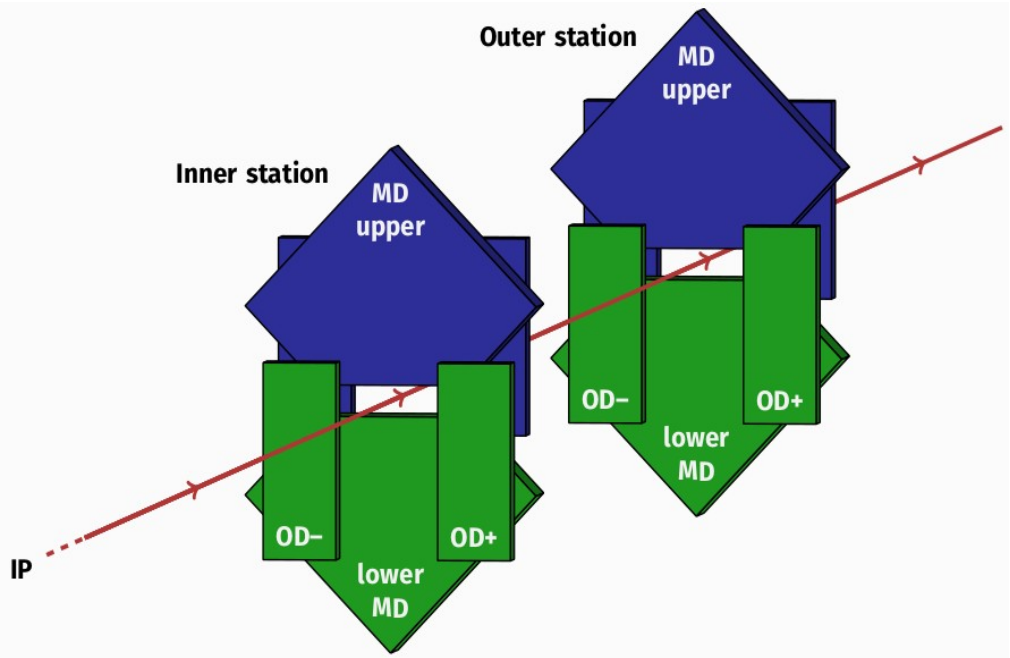
$$+ \sigma_{\mathrm{tot}}^2\frac{(\rho^2+1)}{16\pi}e^{-\Omega(t)},$$

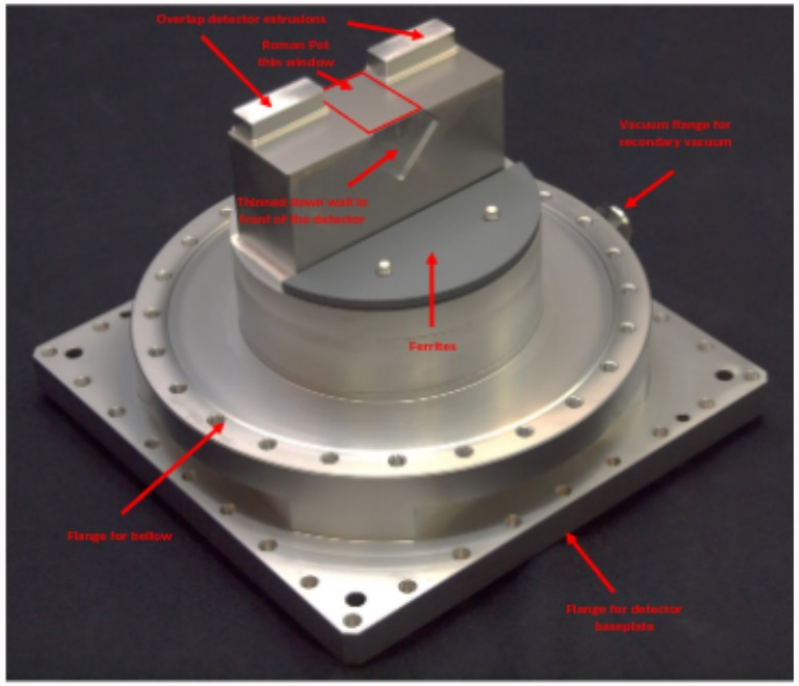
$$\rho \equiv \frac{\mathrm{Re}F_N(t=0)}{\mathrm{Im}F_N(t=0)} \qquad \sigma_{\mathrm{tot}} = 4\sqrt{\pi}\mathrm{Im}F_N(t\to 0)$$

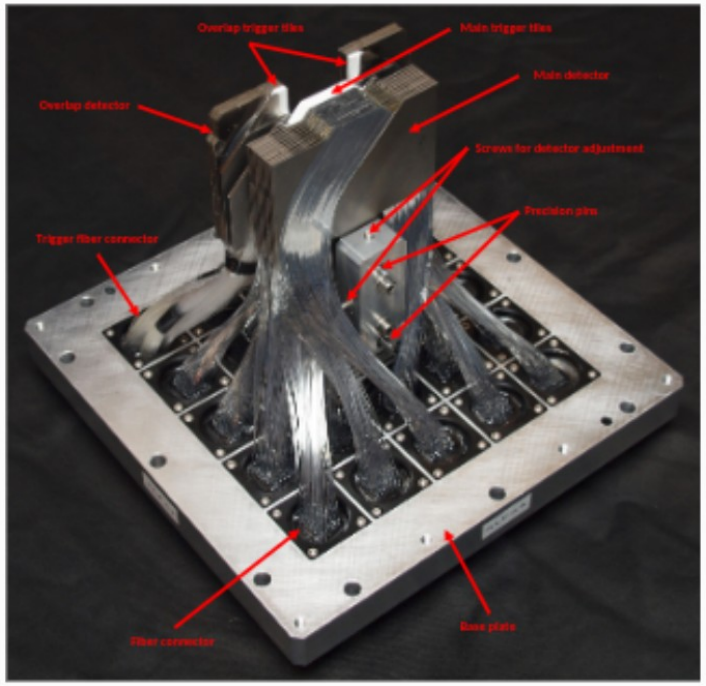
ALFA detector

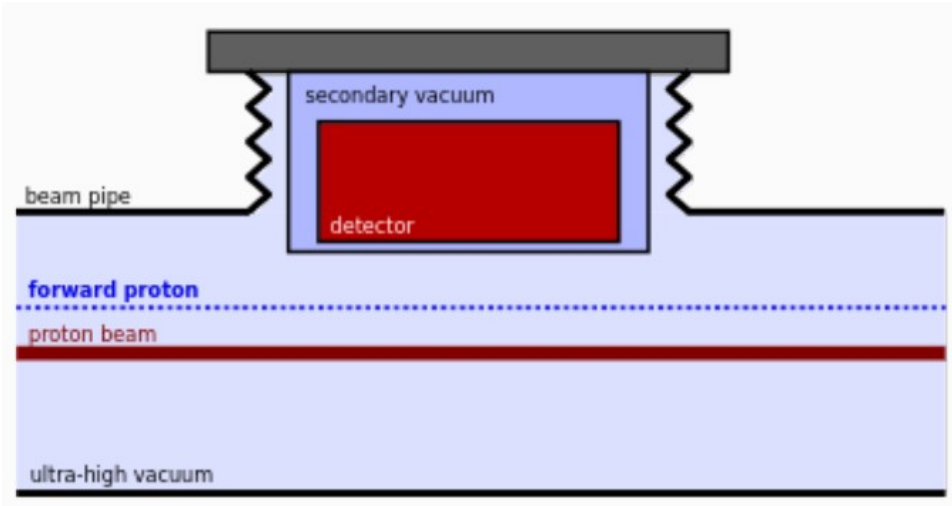


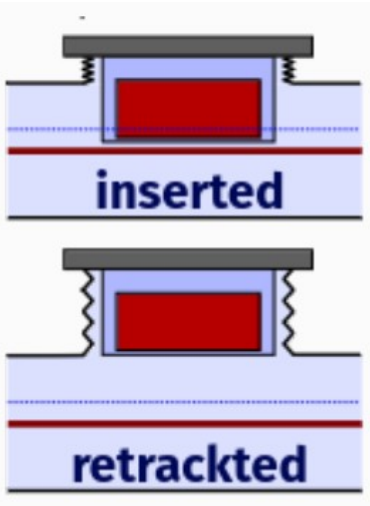
ALFA detector



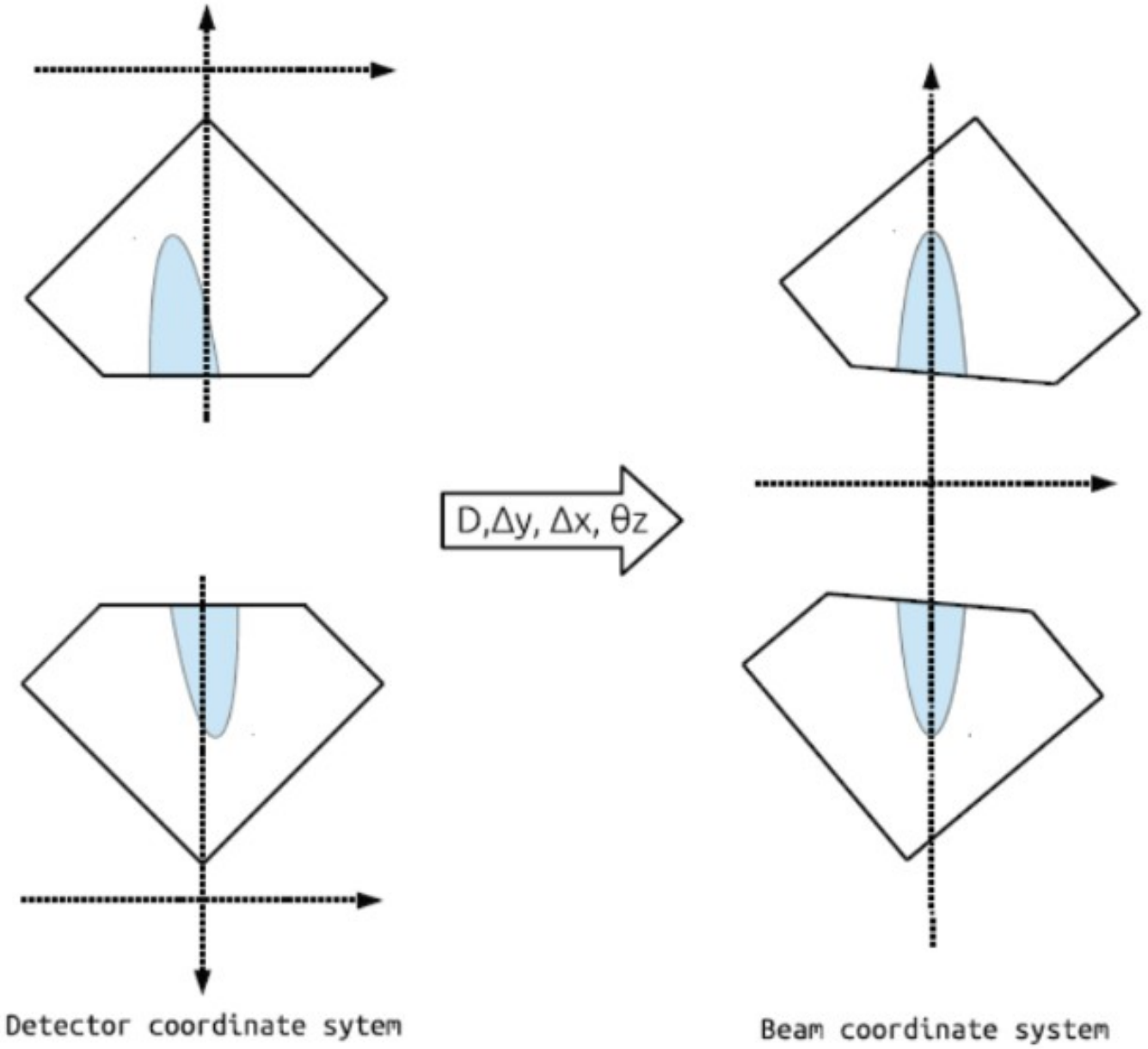








ALFA alignment parameters



D : Distance between upper and lower detectors

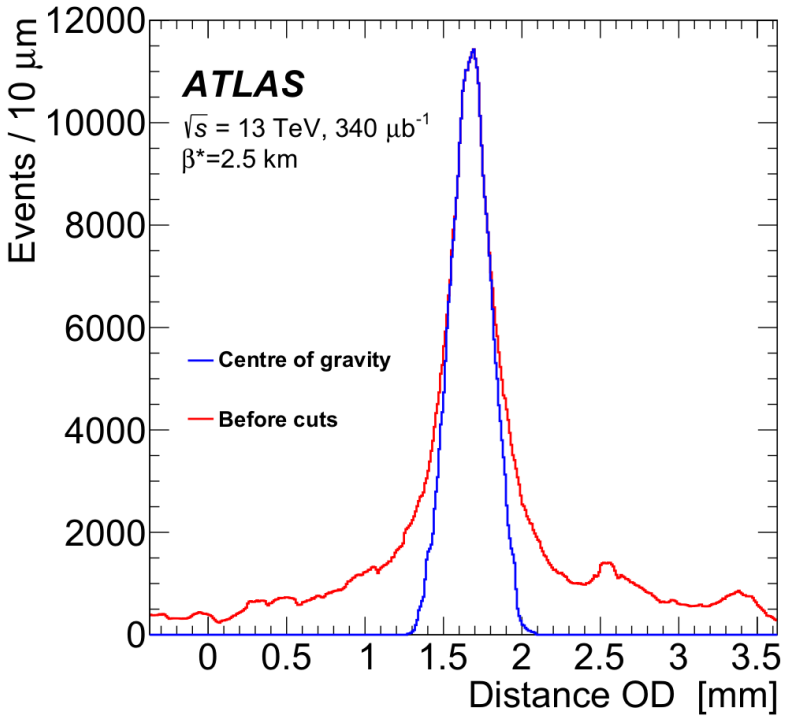
Δy : Vertical offset

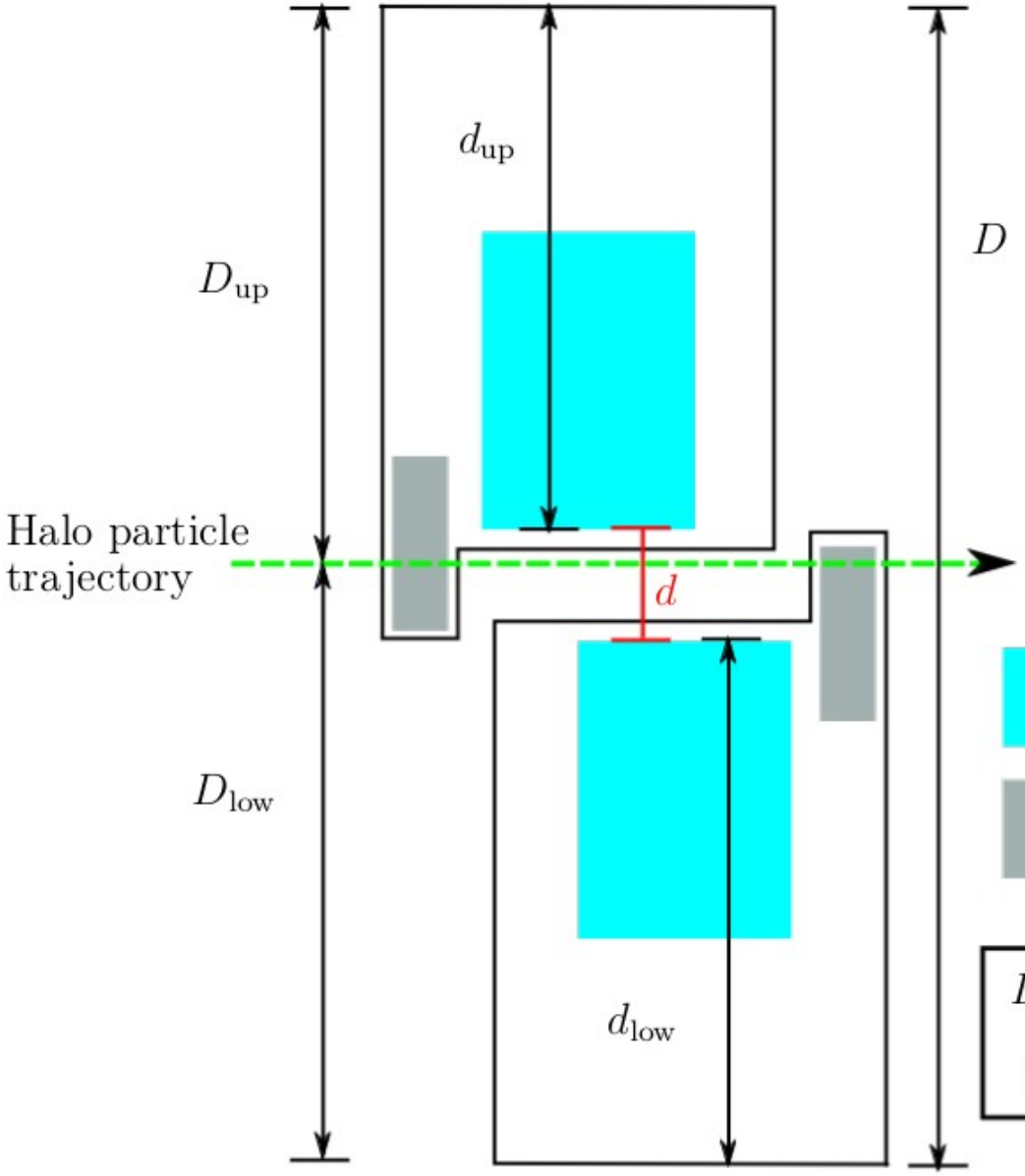
Δx : Horizontal offset

θz : Rotation around z axis

Distance measurement

A real example of distance distribution:





d: distance between two main detectors

Main detector

Overlap detector

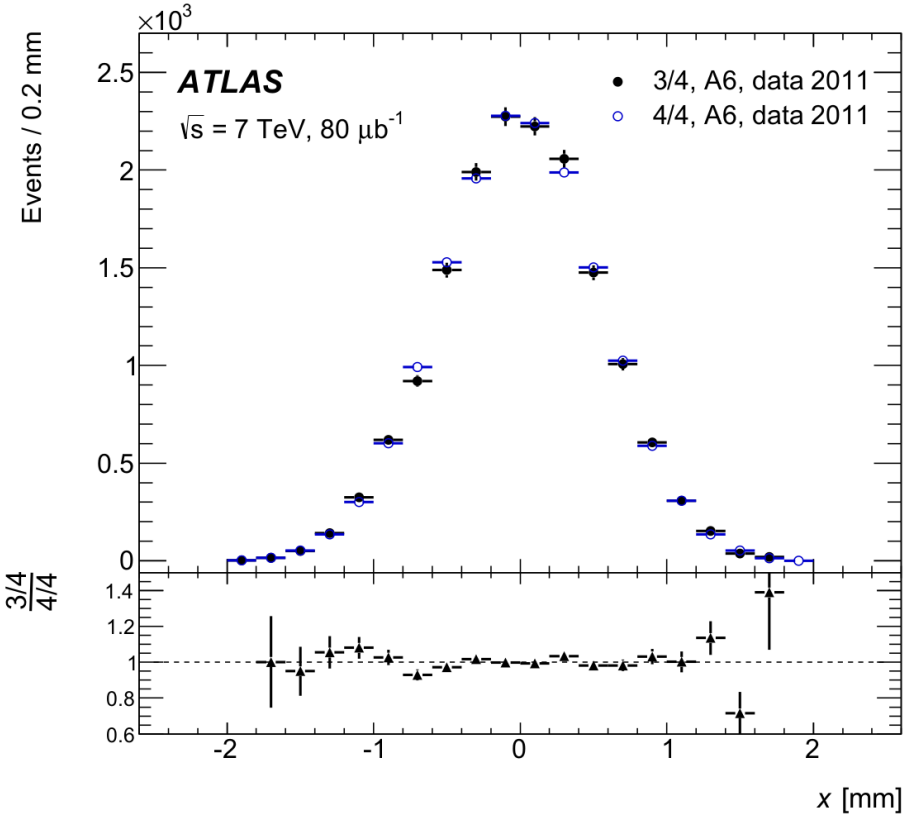
$$D = D_{up} + D_{low}$$

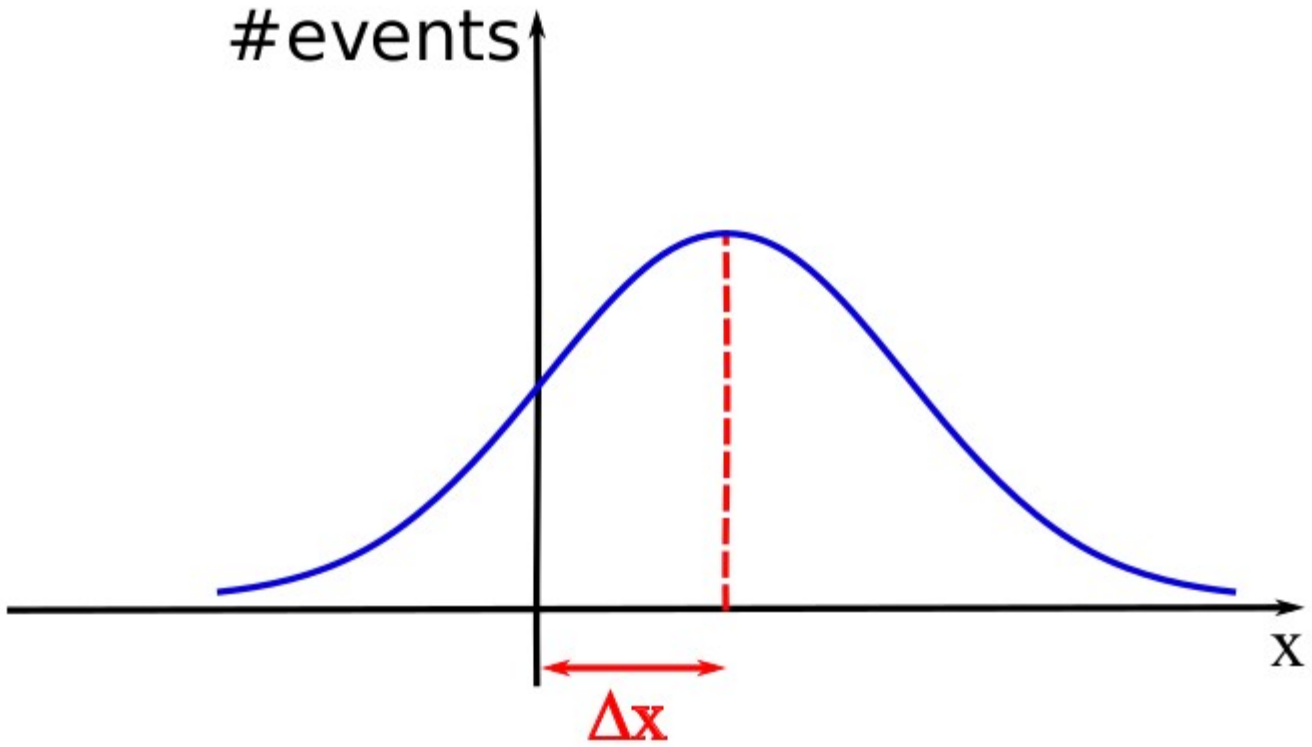
$$d = D - d_{up} - d_{low}$$

Horizontal alignment

Horizontal alignment, minimizes the mean value of the x-distribution of elastic protons for each detector.

A real example of x-distribution:

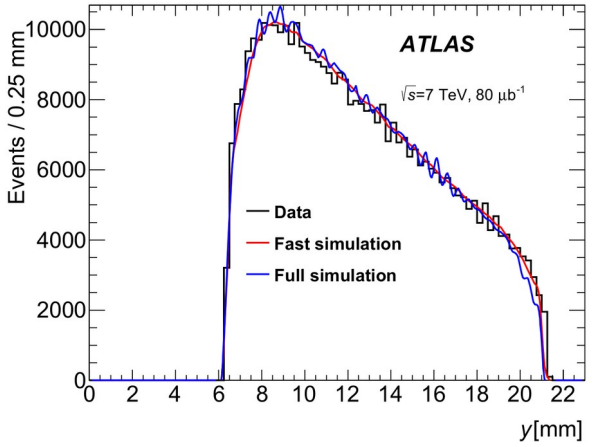


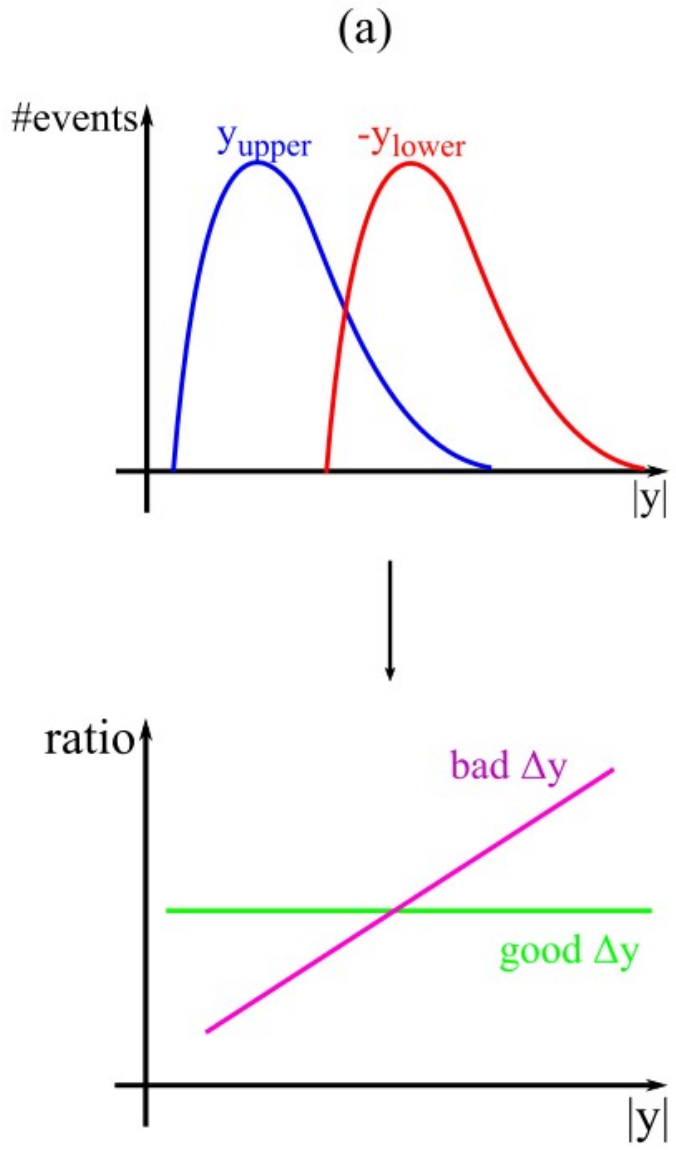


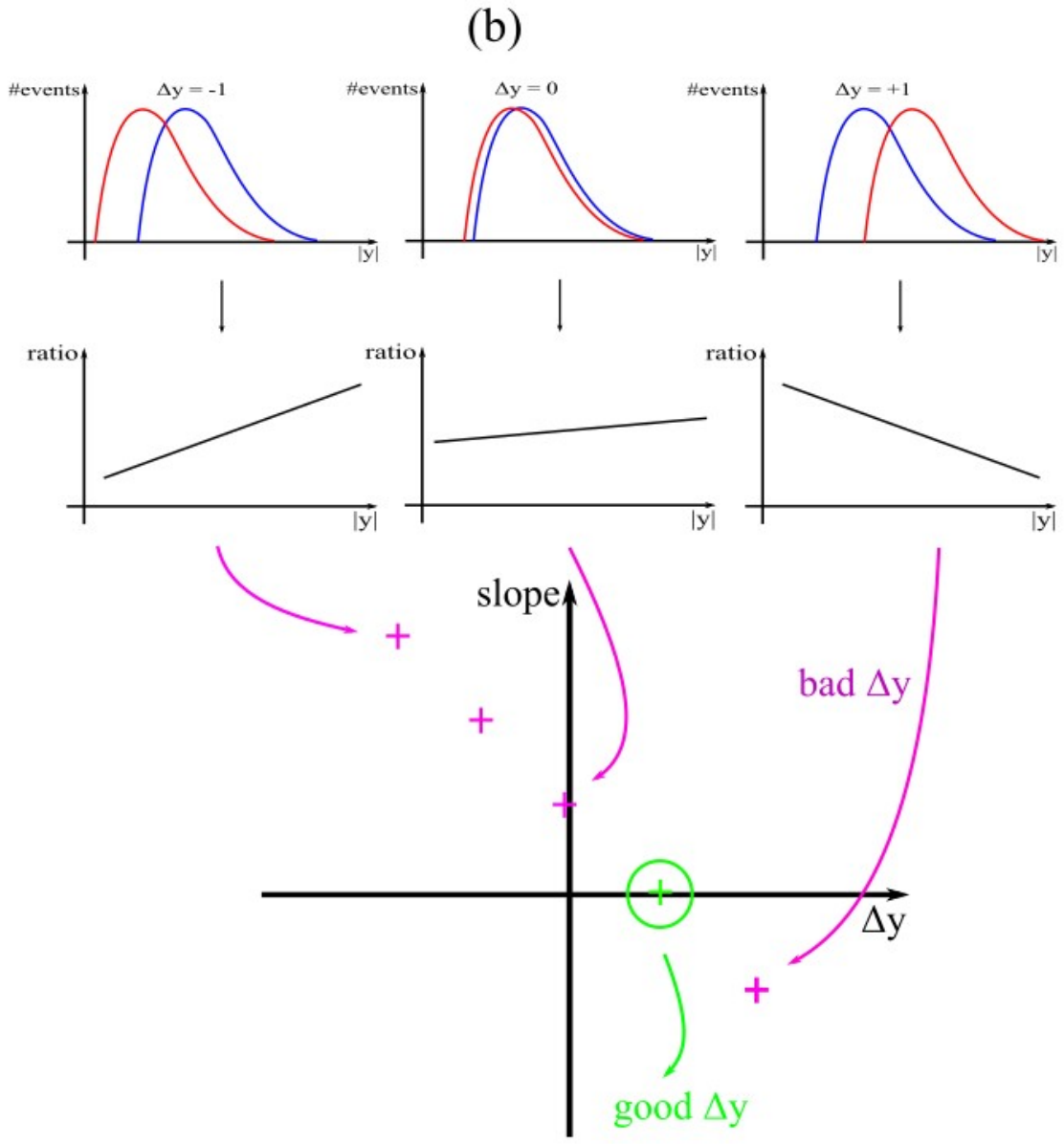
Vertical alignment

Vertical alignment, minimizes the root of the fitting line in the slope-shift plot for each station.

A real example of y-distribution:



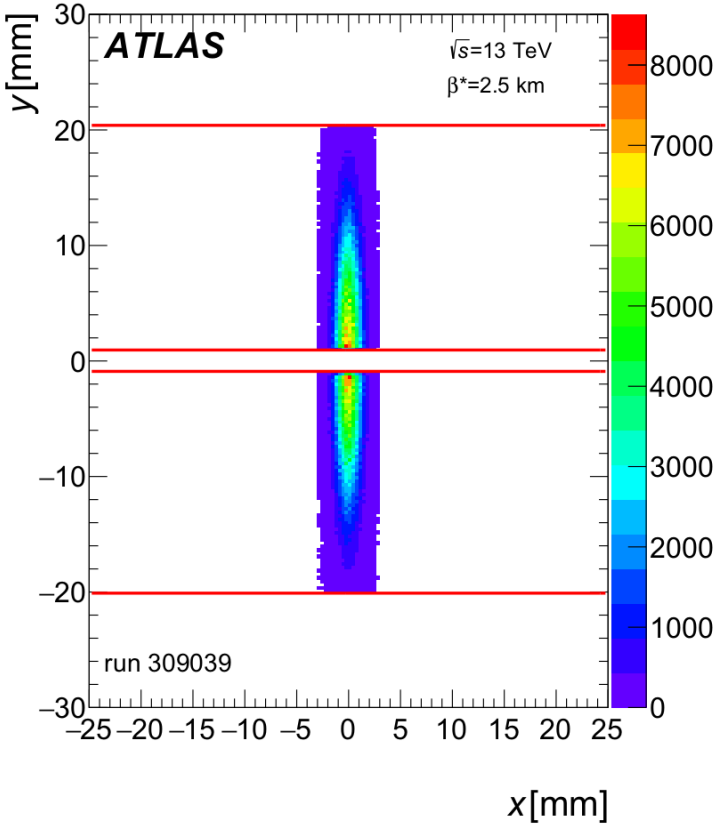


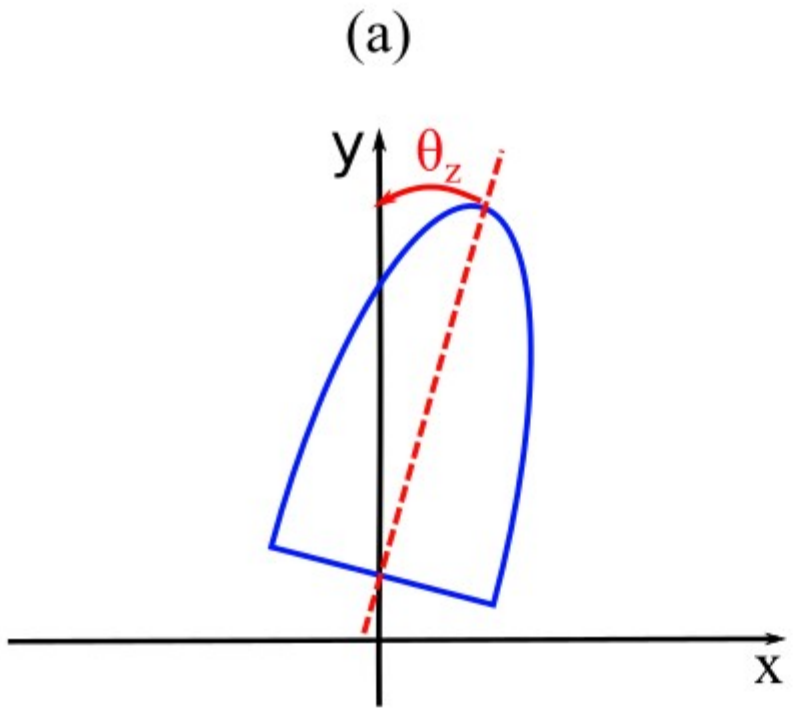


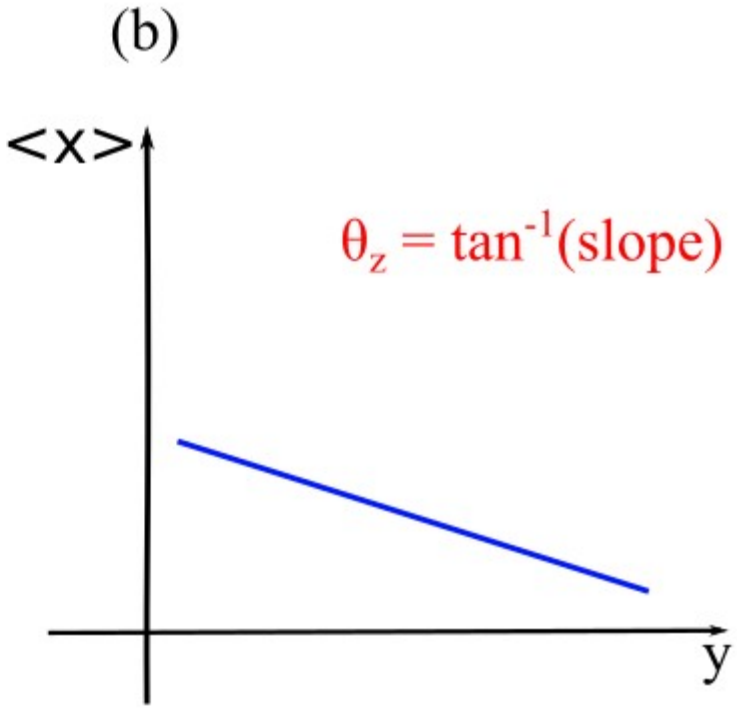
Rotational alignment

Rotational alignment, minimizes the rotation angle for each detector.

A real example of (x,y) distribution:







Summary

- The interesting physics behind elastic proton-proton collisions.
- The experimental set-up of the ATLAS-ALFA detector.
- The concepts of distance measurement, horizontal and vertical alignments, as well as rotational alignment.

Thank You
Shukria
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감사합니다
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Dankscheen
спасибо
Blagodaram
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Juspaxar
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