Role of the calorimeter in LUXE

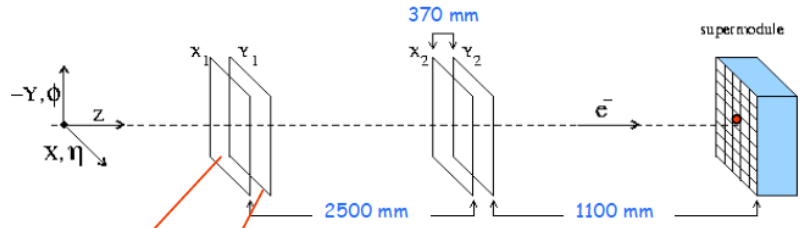
- Calibration ➔ determine in situ E(x)
- Reconstruct positron spectra for all multiplicities (needs calibration)

Calibration challenges: in situ E(x) – requires measuring total Edep, translating into GeV from beam-test measurements, and reconstructing of the enetry point of the position from its shower development
Main issues:

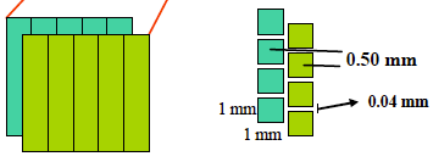
- Non-projective geometry: pads left and right of the shower axis (original path of the positron) have different signals for the same “input”
- How to take it into account for a universal calibration? What is the best way to correlate Edep with true energy?
  - Ignore angle of incidents (Shan’s results for linearity & resolution)
  - Apply angular correction pad-position dependent (Shan’s results for linearity & resolution)
  - ➢ Can we learn something by studying
- How to reconstruct the position of the positron from the shower development
  - center of “gravity” with weights = Edep
  - center of gravity with weights = W0 + log (Edep/Etotdep)
  - or maybe ANN for best weights determination?

Precision on 'true' impact position

- A hodoscope system determines the e-trajectory (and impact point on crystal)



Per plane: 2 staggered layers with 1 mm wide strips

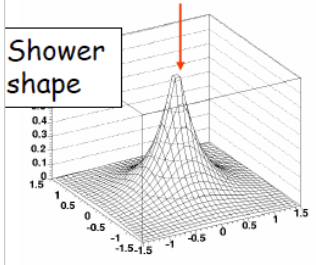


Per orientation 4 points:

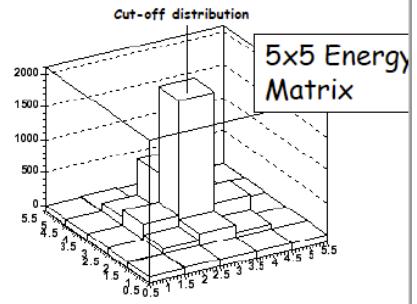
$\sigma(x) = \sigma(y) = 145\ \mu m$

Incident electron

Shower shape



Crystal size 2.2 x 2.4 cm



Impact on crystal centre: 82% in central crystal and 96% in a 3x3 matrix (use 3x3)

General Idea: $\langle x \rangle = \frac{\sum_i w_i \cdot x_i}{\sum_i w_i}$

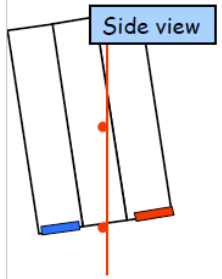
- The position of the crystal (η_i, φ_i) or (x,y)
- Two methods using different weights: $w_i = E_i$ or $w_i = w_0 + \log\left(\frac{E_i}{\sum_j E_j}\right)$

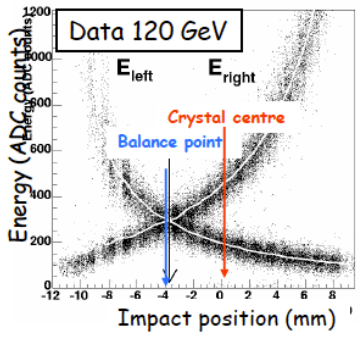
Defining THE position of the crystal:

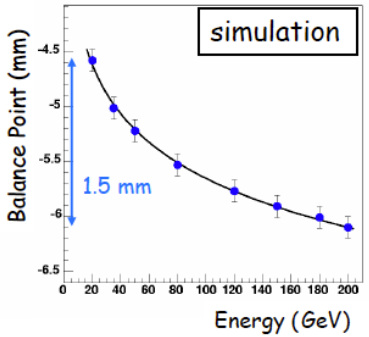
- Crystals are off-pointing and tilted by in η and φ
- Depth of shower maximum is energy dependent

} the characteristic position is energy dependent

As an example: the balance point in X

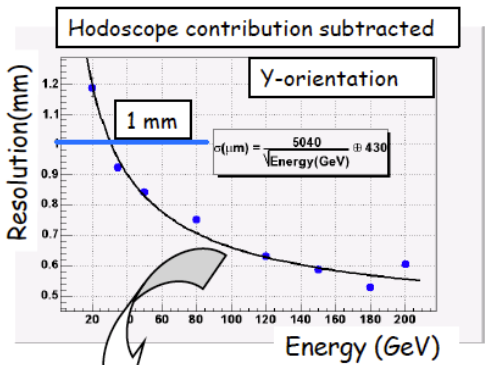






Impact Position Resolution versus energy (x, y)

- Resolution on impact position using the logarithmic weighting method:

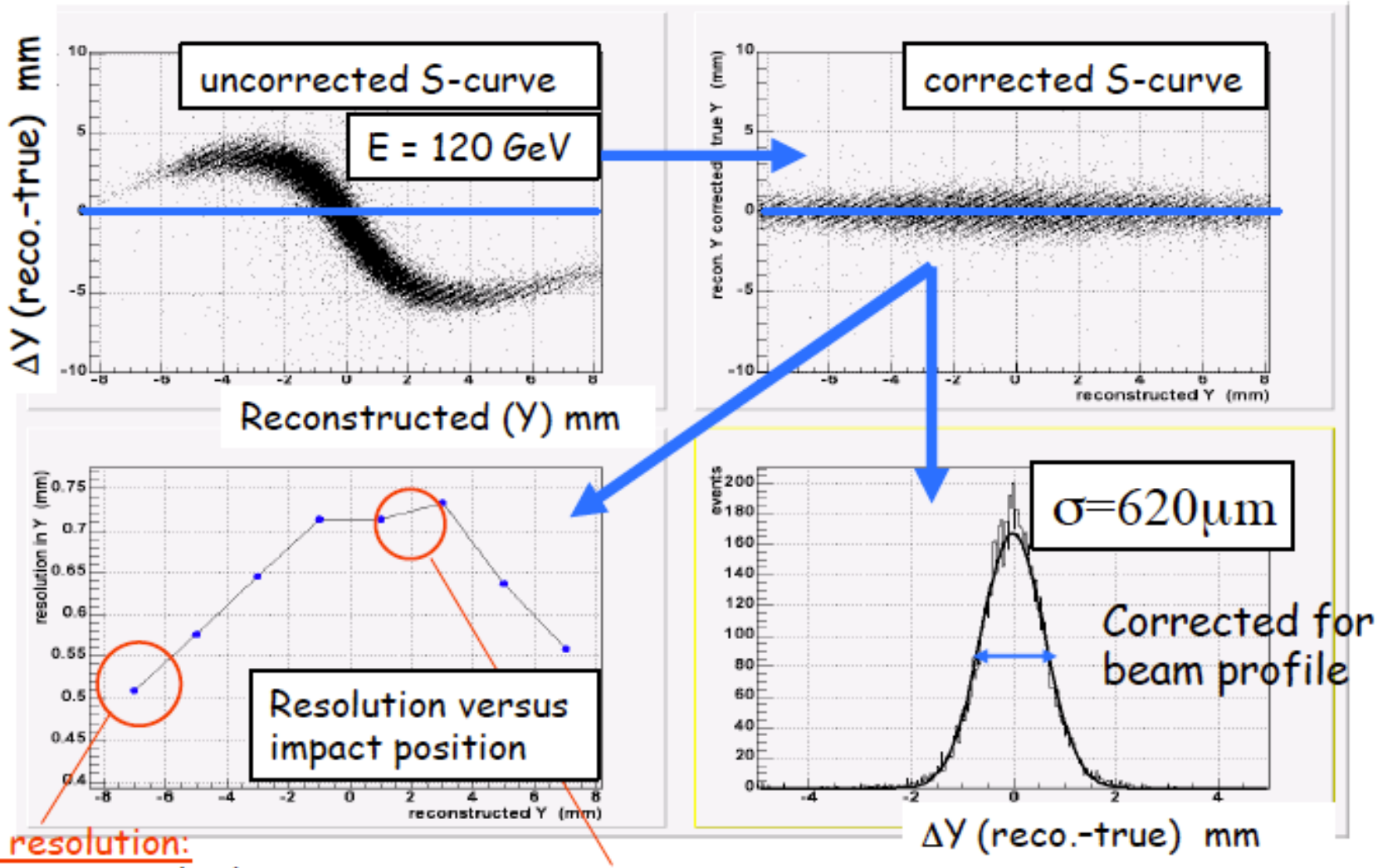


$\sigma_Y(\mu m) = \frac{5040}{\sqrt{E}} \oplus 430$

- Resolution in X slightly worse:
  - Different staggering of crystals
  - Different crystal dimensions
    10% larger in X than in Y
  - Different (effective) angle of incidence

Reconstruction Method 1: Linear weighting

$w_i = E_i$



est resolution:
lose to crystal edge

Worst resolution: max. energy fraction in central crystal

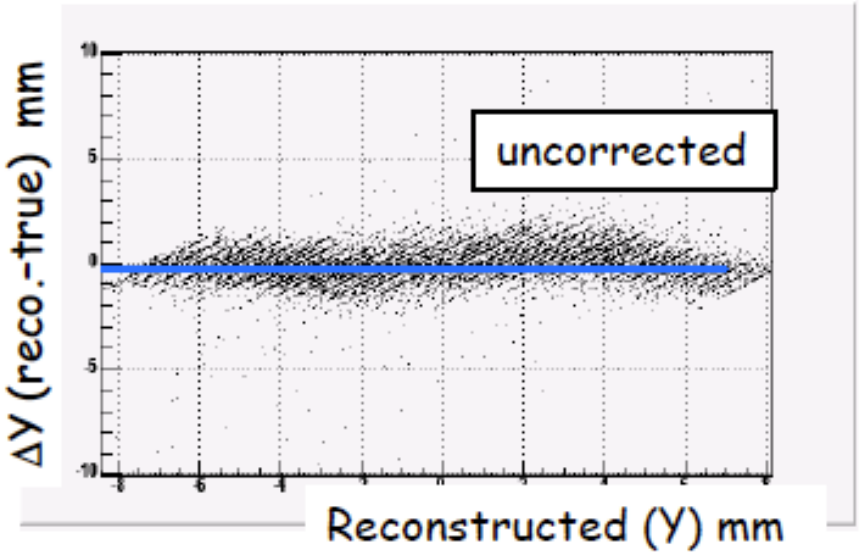
- Requires a correction that is f(E,η,φ)

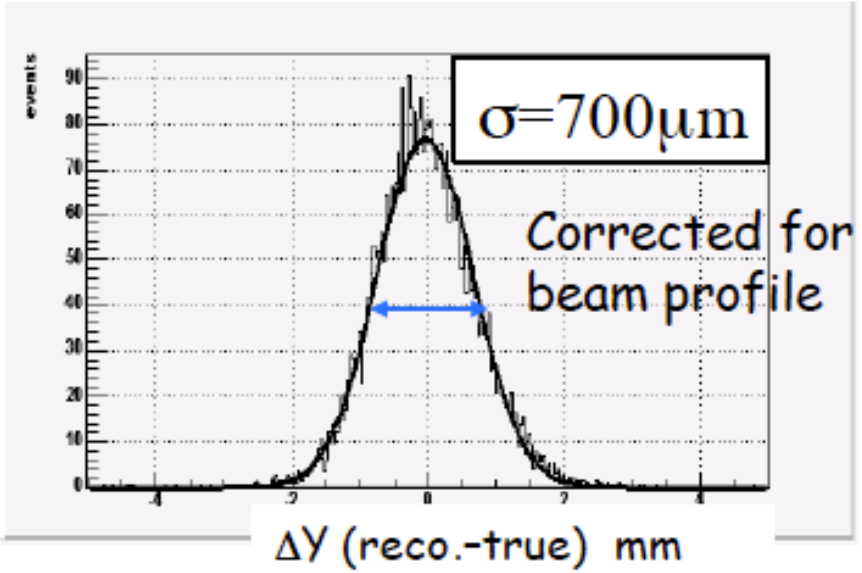
Reconstruction Method 2: Logarithmic weighting

$$w_i = w_0 + \log\left(\frac{E_i}{\sum_j E_j}\right)$$ (all weights should be ≥ 0.)

Minimal (relative) crystal energy included in computation

Optimal W_0 = 3.80 (min. crystal energy is 2.24% of the energy contained in the 3x3 matrix





- Resolution is now more flat over the crystal surface
- no correction needed that is f(E,η,φ)