Imperial College London

Calculating the Beam Position at the Ecal for DESY Run 230101 (Independent of Tracking)

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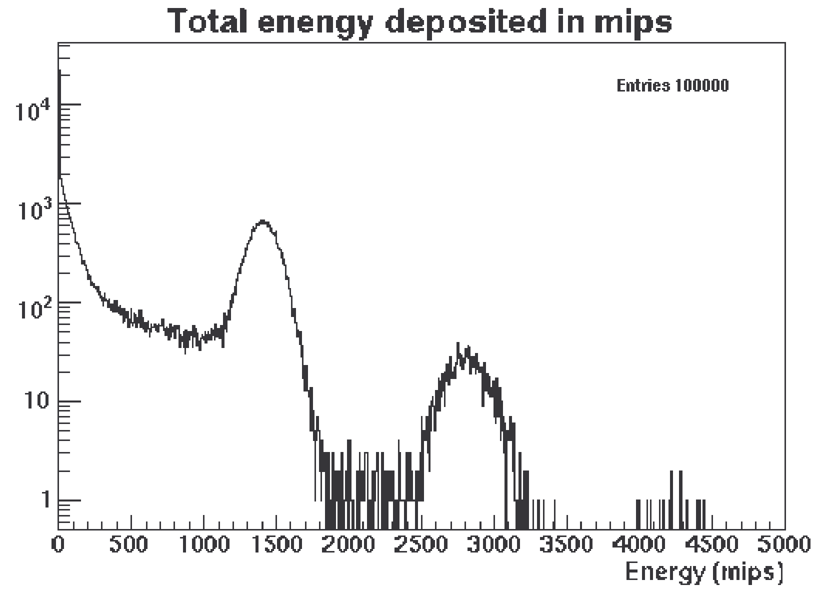
Outline

- 3-fold motivation:
- Use Ecal calculated beam position as a cross-check for the track calculated position
- Need beam placement better than tracking resolution (0.4-0.5 mm) otherwise subject to biases
- My study into Ecal position/angle resolution produces similar distributions, so will adapt this technique to correct these fits

Outline of Method

- Method is to compare S-curve of barycentred Ecal hits, per event, with a Gaussian cdf (cumulative distribution function—related to *erf(x)).*
- Can then correct barycentre per event and iterate the procedure with the aim of converging to true mean beam position and RMS

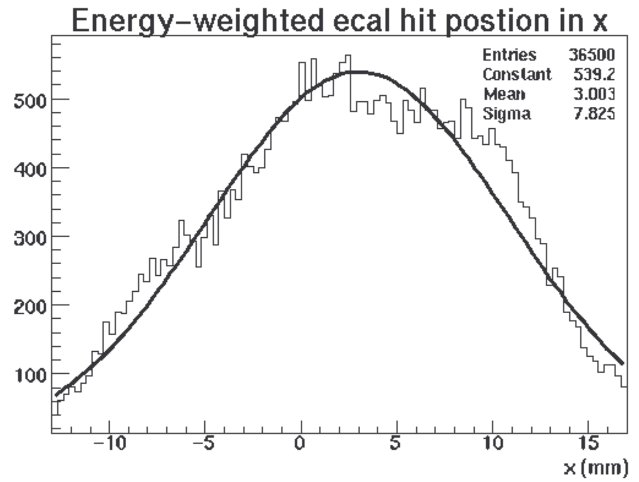
Initial Distributions

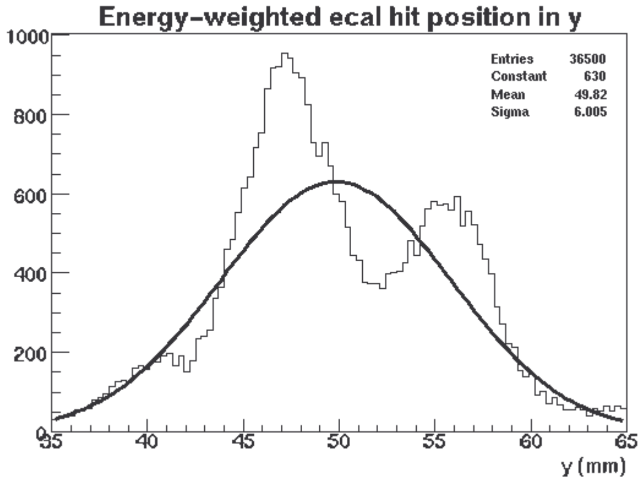


- Threshold cut at 0.5 mips
- Use the range 900-1700 mips & weight hit energy by tungsten thickness
- The distribution is now in agreement with George’s

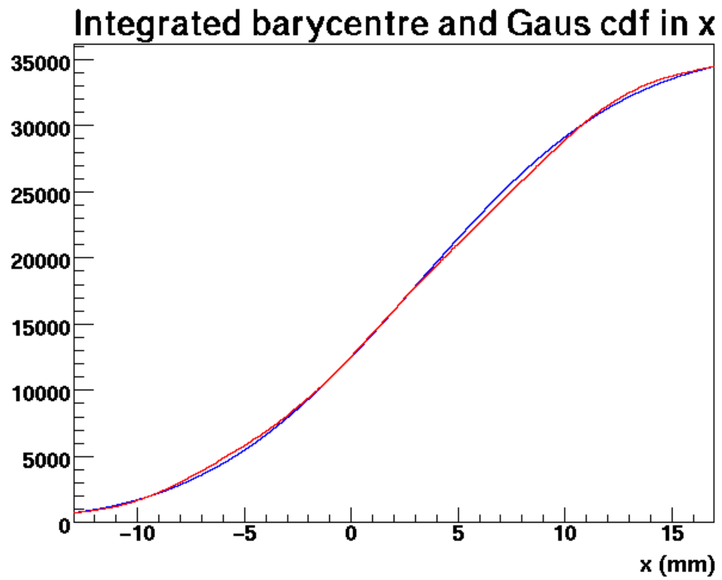
Barycentre distributions

- Cut tails off of barycentre distributions to concentrate on peaks—cut on about 2σ
- Get initial values for mean and sigma of the distributions





Method



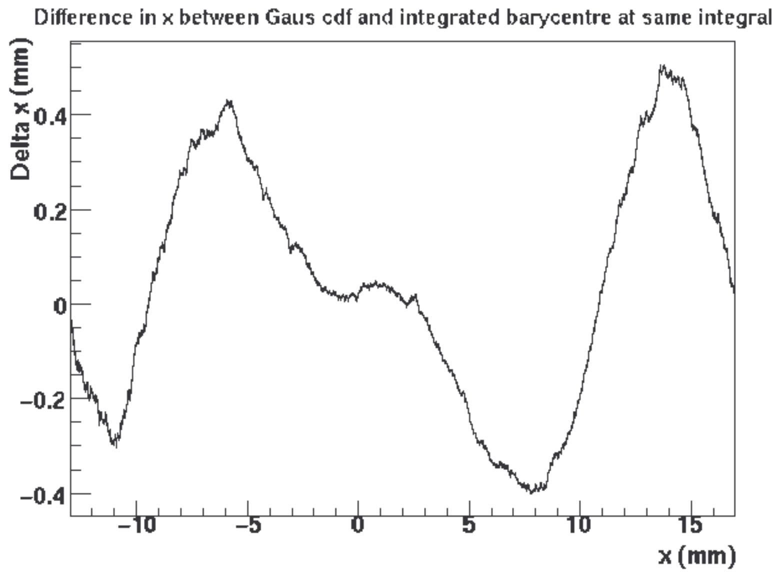
Blue = Gaus cdf

Red = Integrated barycentre

- Assume true beam position is Gaussian at Ecal
- Blue curve is the integrated value of a gaussian from -infinity to x (scaled to number of events in run)
- Red curve is the equivalent for barycentre of Ecal hit distribution
- Expect red curve to wiggle in and out of blue curve due to discrete Ecal hit points (staggering in x is a complication)
- For a given vertical-axis value, can look at difference between Gaus cdf and integrated barycentre…

Method

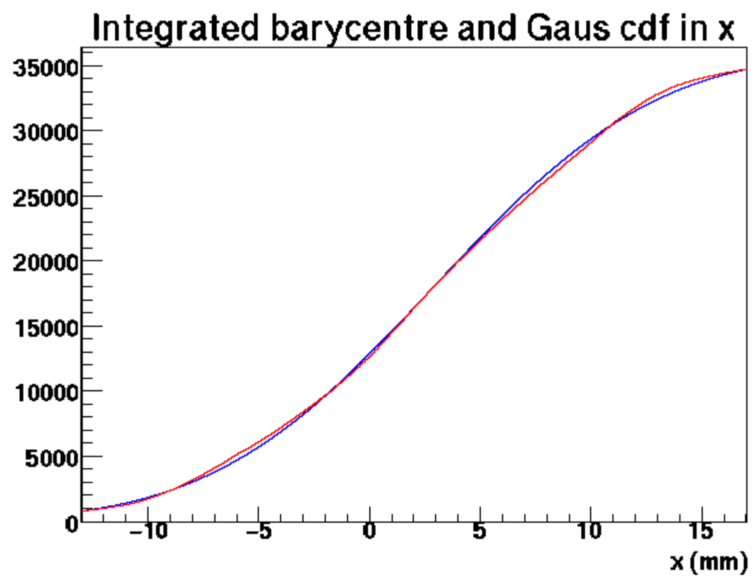
- Expect the wiggle to give something which looks like a sine curve
- Can then parametrise this curve and re-process run with barycentre correction in order to smooth out peaks into expected Gaussian
- Can then fit a Gaussian to barycentre distribution as before and use new parameter values
- Iterate until convergence

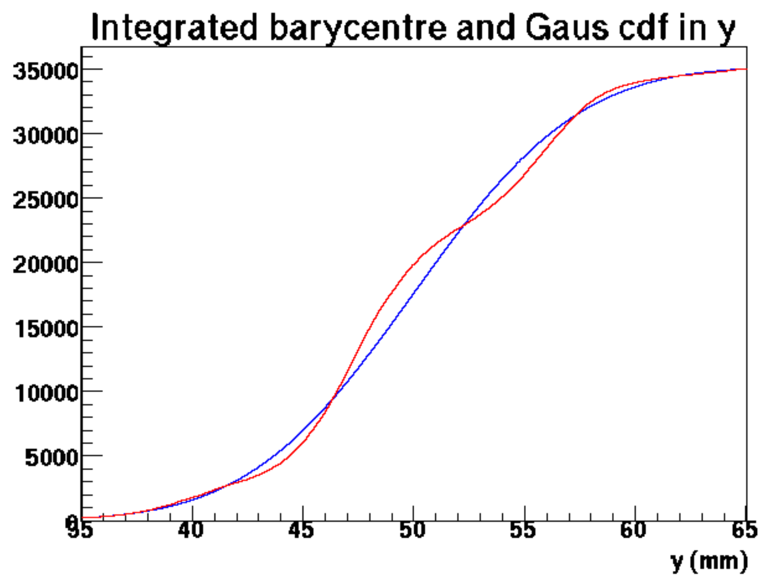


$$position \pm = A \sin(2\pi / period\ (position - offset))$$

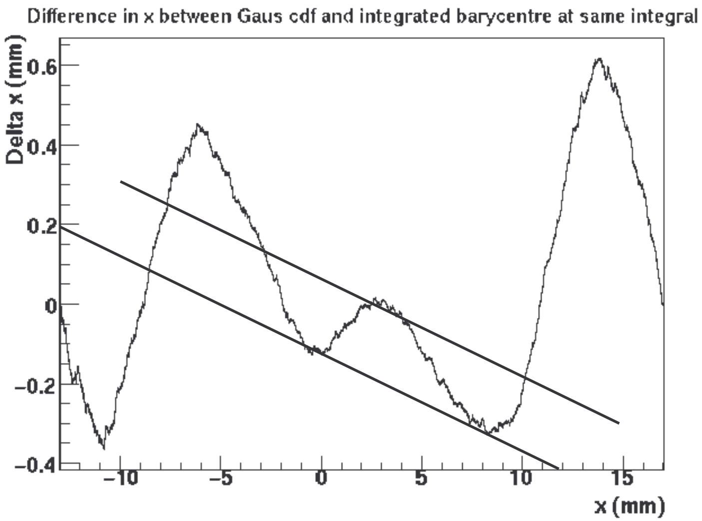
Results

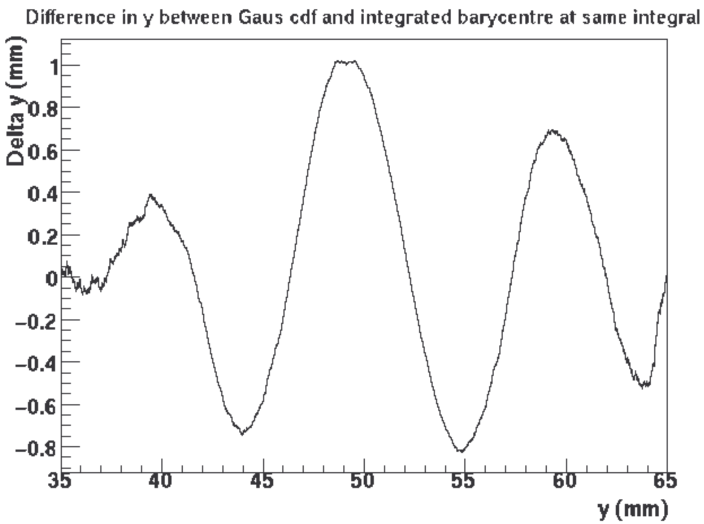
- After a few iterations both x and y can be seen to fit the blue curve well
- This means the mean and sigma of the Gaussian are close to correct





Results

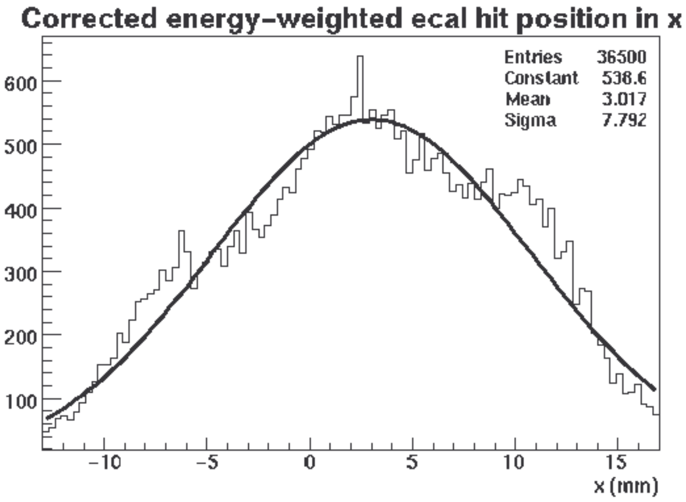


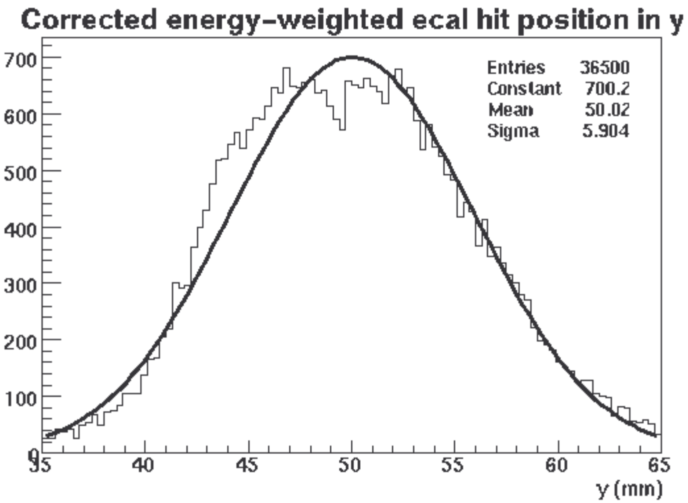


- These distributions are very sensitive to changes in the Gaussian parameters
- Staggering in x makes measurement of the amplitude tricky—parallel lines show ~0.15mm (see later)
- y is easier—0.9 mm is a good estimate
- Can also calculate offset and period

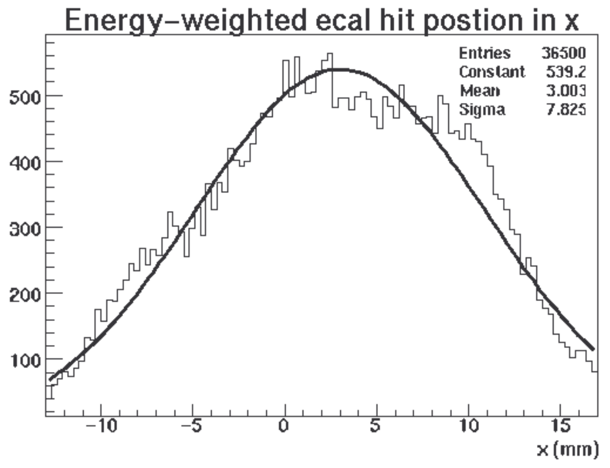
Results

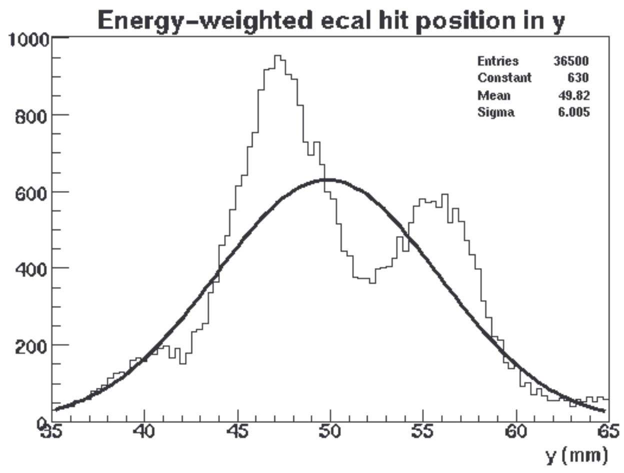
- Reprocessing gives converged results
- Correction can be seen to be very effective in y, not so much in x (see next slide)
- Final values in x:
  - Mean = 3.0mm
  - Sigma = 7.8mm
- In y:
  - Mean = 50.0mm
  - Sigma = 5.9mm

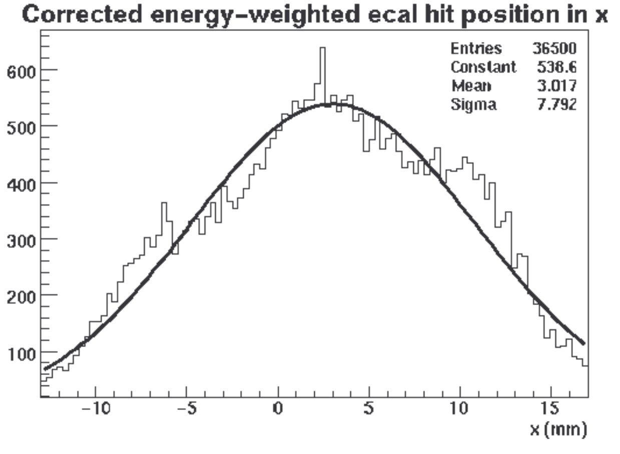


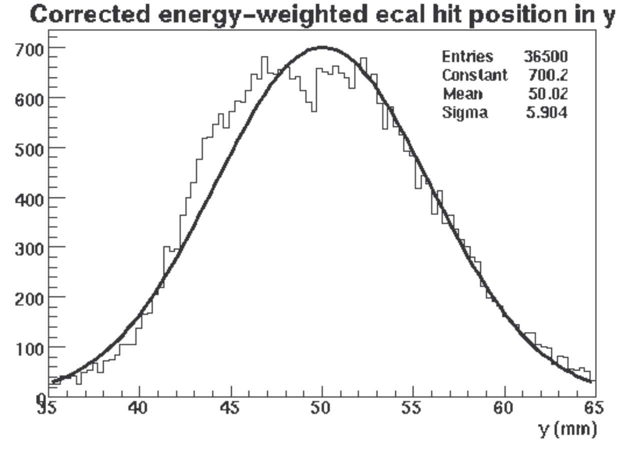


Comparison slide





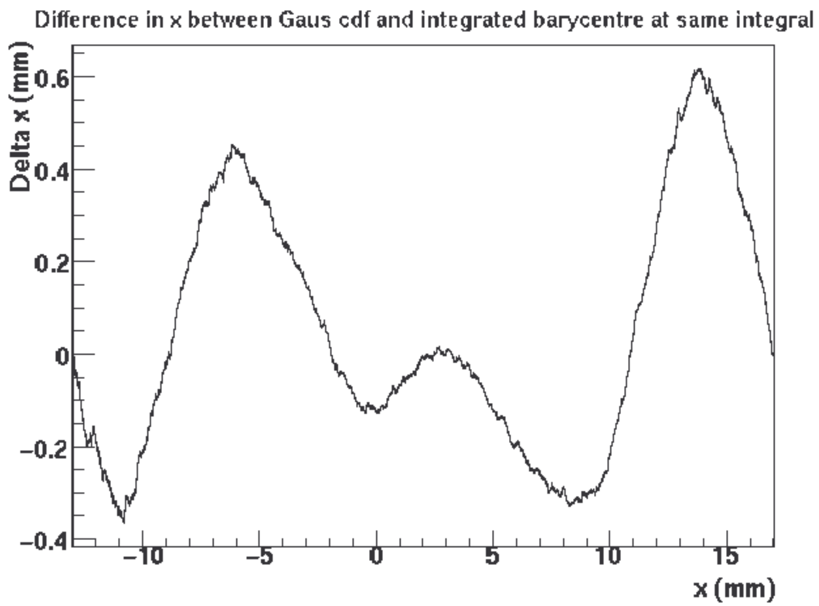


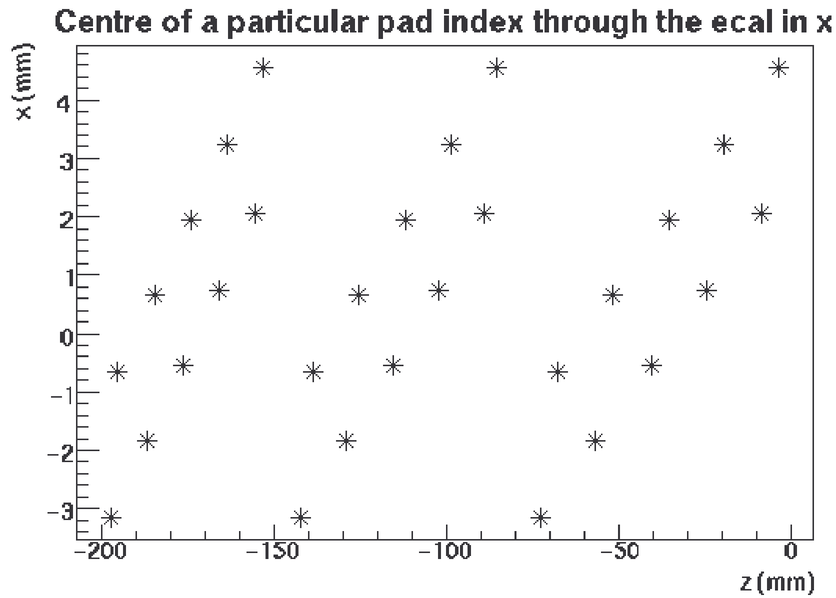


Above = before correction; Below=after correction

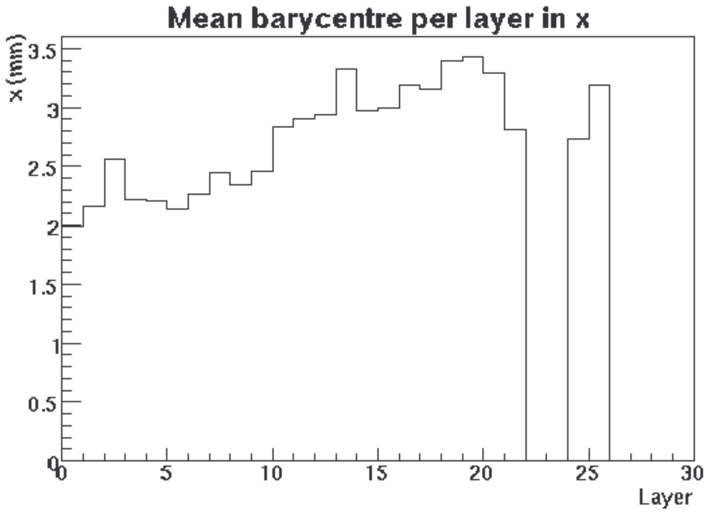
Problems in x

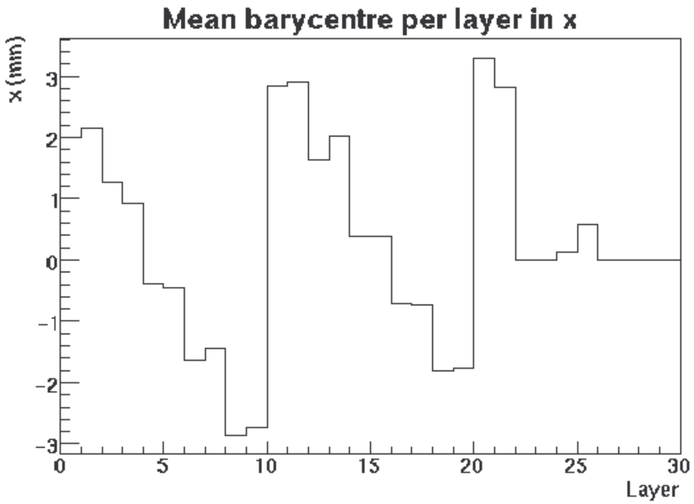
- Decided to separate x into odd/even layer as cross check
- Unexpected results led to the discovery that layer staggering in x is not as expected
- There is a shift between slabs as well as a stagger within slabs
- Not a valid way of deducing a sine parametrisation due to non-repeating pattern





Problems in x

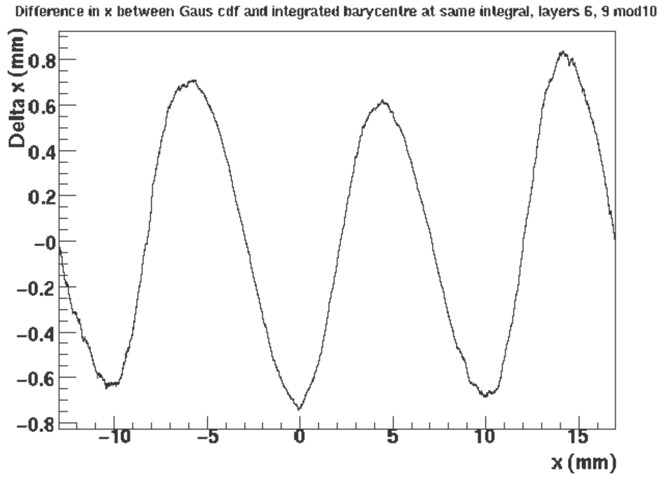


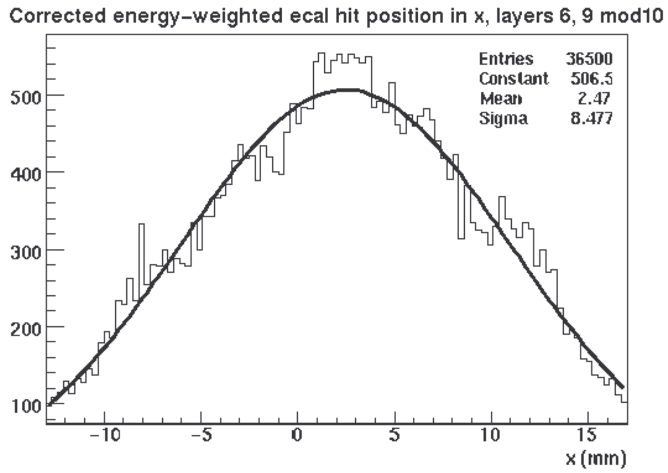


- To check that there was no mistake in the reco/database:
- Top histogram is mean barycentre per layer; bottom is shifted, to eliminate shifting between slabs
- Shift is clearly real
- Evidence of ~10mrad tilt in x also noticed

Problems in x

- Chose layers in x with little relative shift/stagger and applied the same method
- E.g. 6, 9, 16, 19, 26
- Gives excellent sine curves
- However, applying adjustment to barycentre distribution leads to different mean and RMS per layer set (here mean = 2.5mm, RMS = 8.5mm)
- Bias due to layer selection?





Summary

- Ecal-calculated beam position calculation works for y but not so well in x
- Non-repeating layer staggering causes problems
- Plan is now to use Monte Carlo fake layer to calculate correction directly
- That is, plot fake layer track minus barycentre as a function of barycentre
- Although this involves the MC, will hopefully give an idea of the shape of the correction in x
- Will adapt technique to Ecal position/angle resolution study