New shape dependent clustering algorithm

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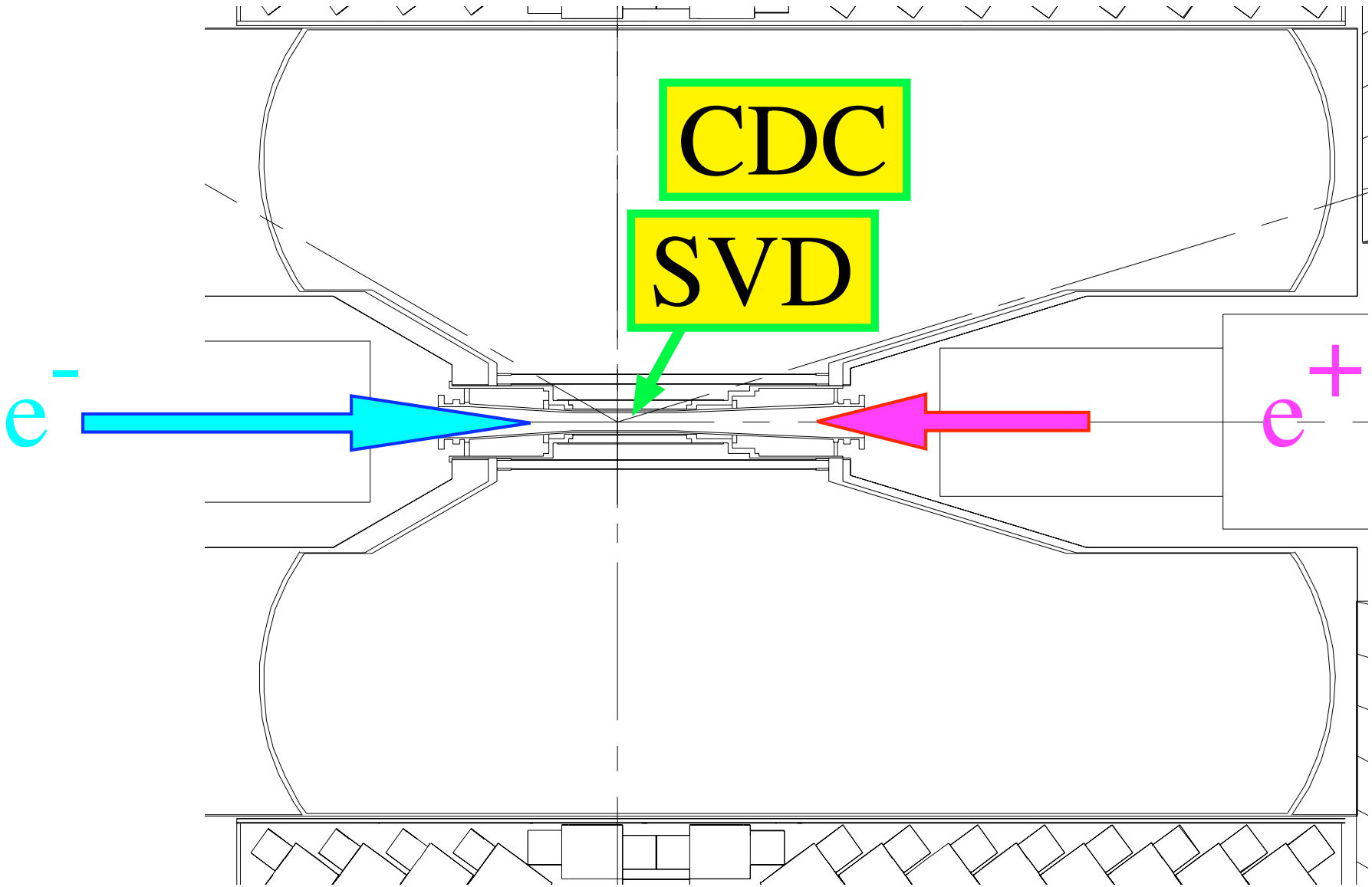
Introduction

Drift chamber and vertex detector

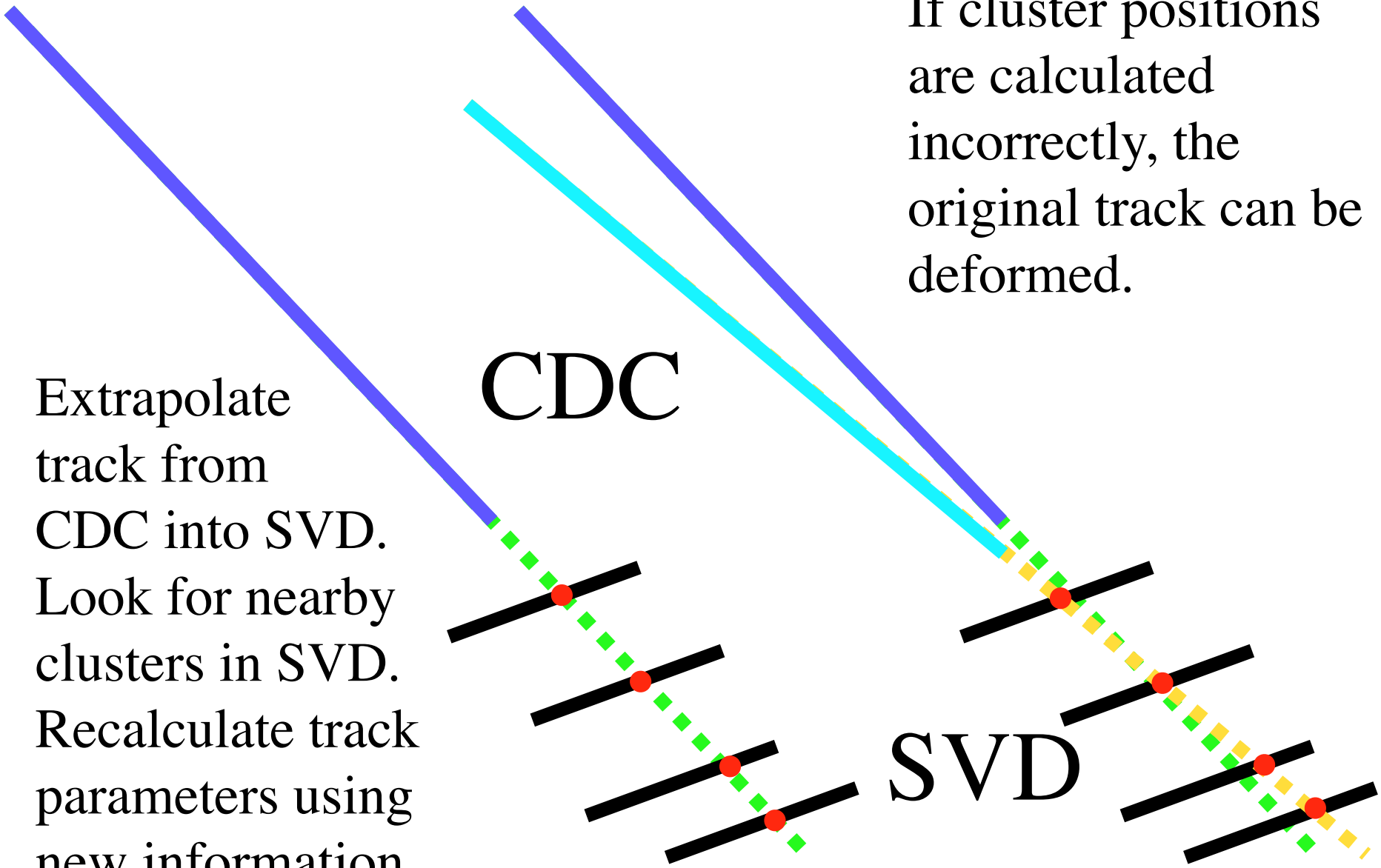


Tracking is performed in the multiwire chamber (CDC). Silicon vertex detector (SVD) is situated inside this tracking chamber. Outer detectors are used for calorimetry and particle species identification.

Tracking

If cluster positions are calculated incorrectly, the original track can be deformed.

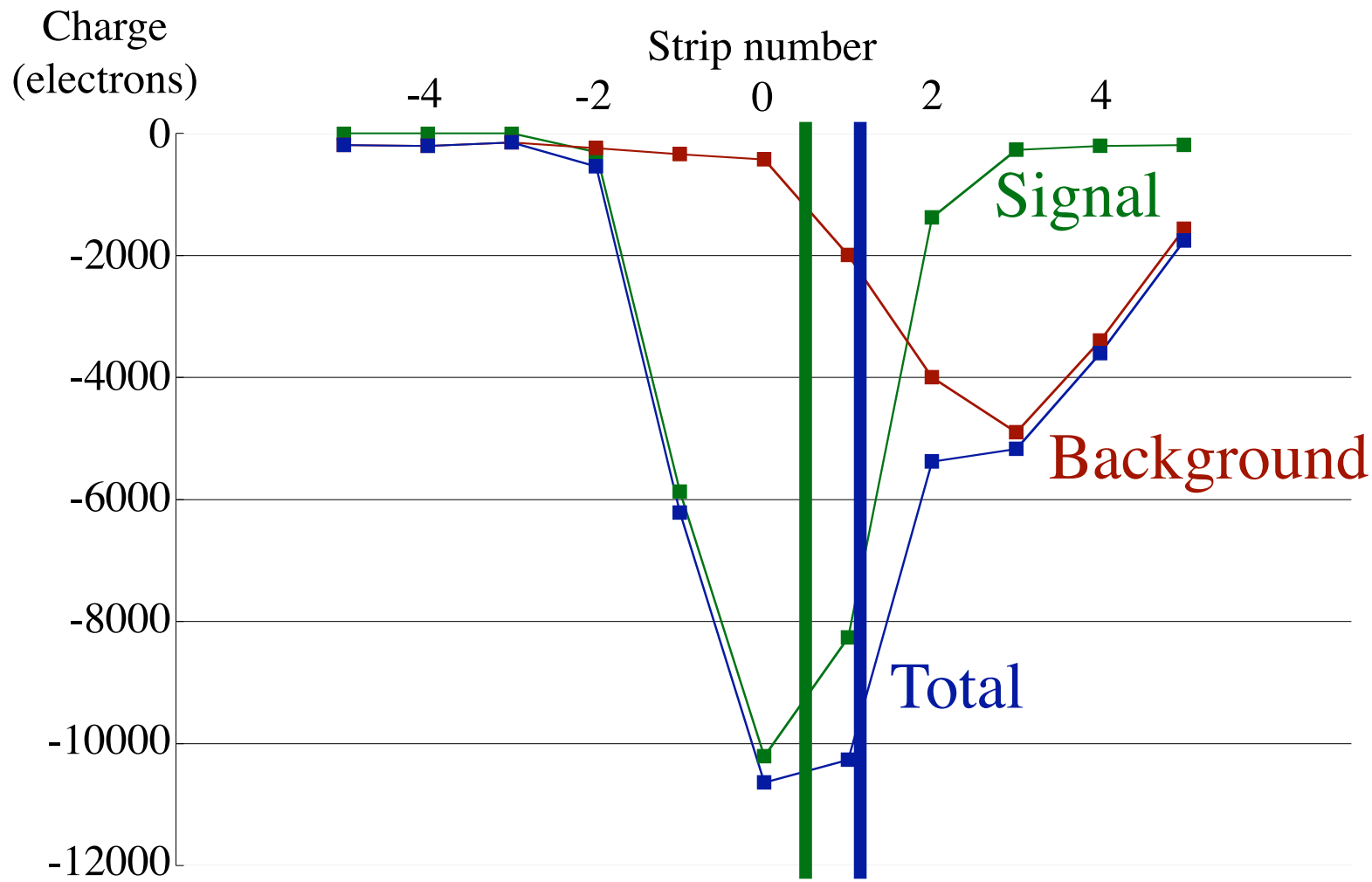
1. Extrapolate track from CDC into SVD.
2. Look for nearby clusters in SVD.
3. Recalculate track parameters using new information from SVD.



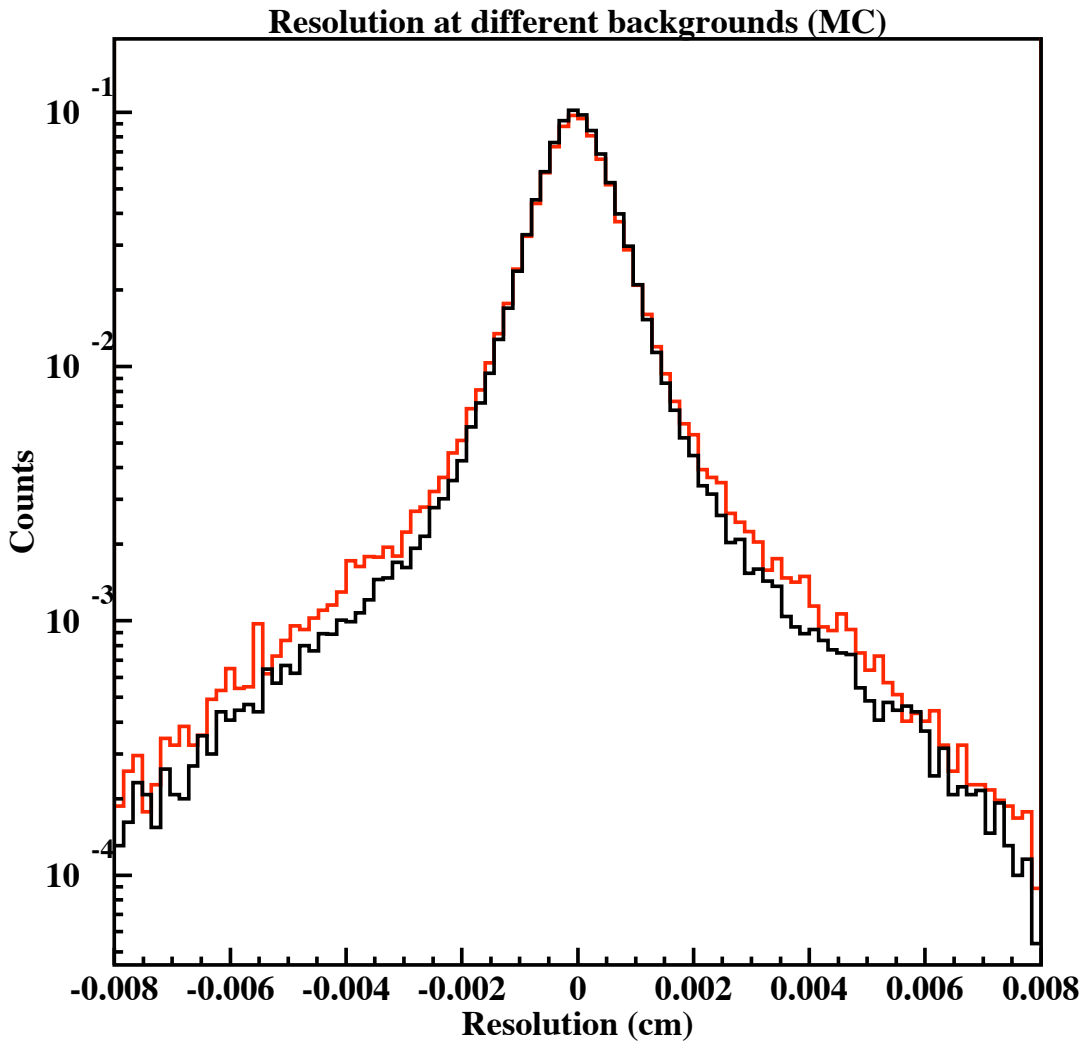
Cause of tracking degredation

1. Incorrect cluster used in tracking.

2. Cluster position is calculated incorrectly due to merging of true hit with background hit.



Merged clusters



normal background (x1)
higher background (x3)

Under higher background the some clusters are significantly deformed because of merging with the background.

Position of merged clusters can not be calculated correctly and results in degradation of SVD clustering resolution.

Aim

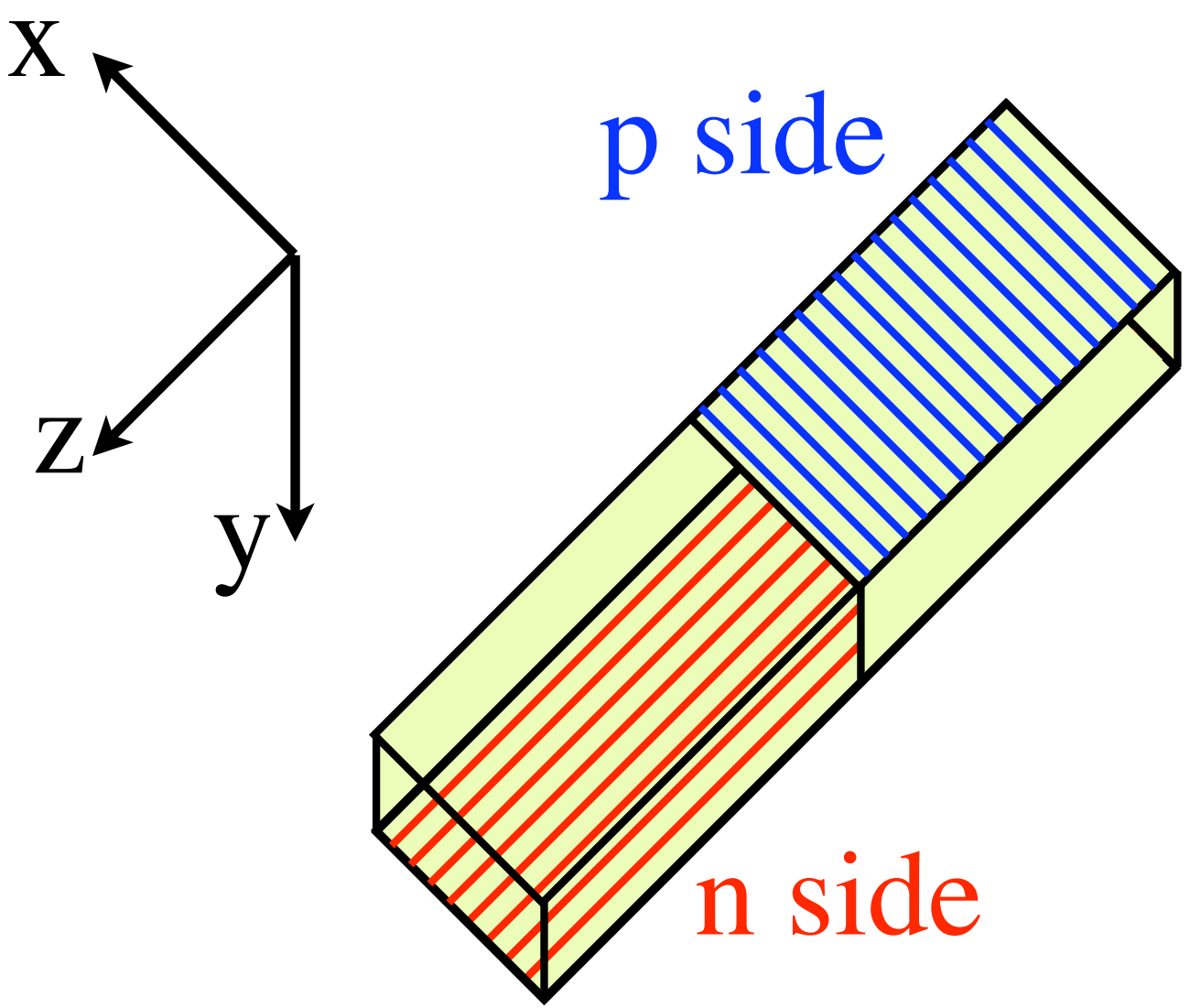
In the future, higher background will result in a degradation of clustering resolution.

Aim:
1. Determine behaviour of cluster shape.

2. Create a new clustering algorithm that takes differences in cluster shape into account.

Inter-strip Charge sharing

Local DSSD coordinates



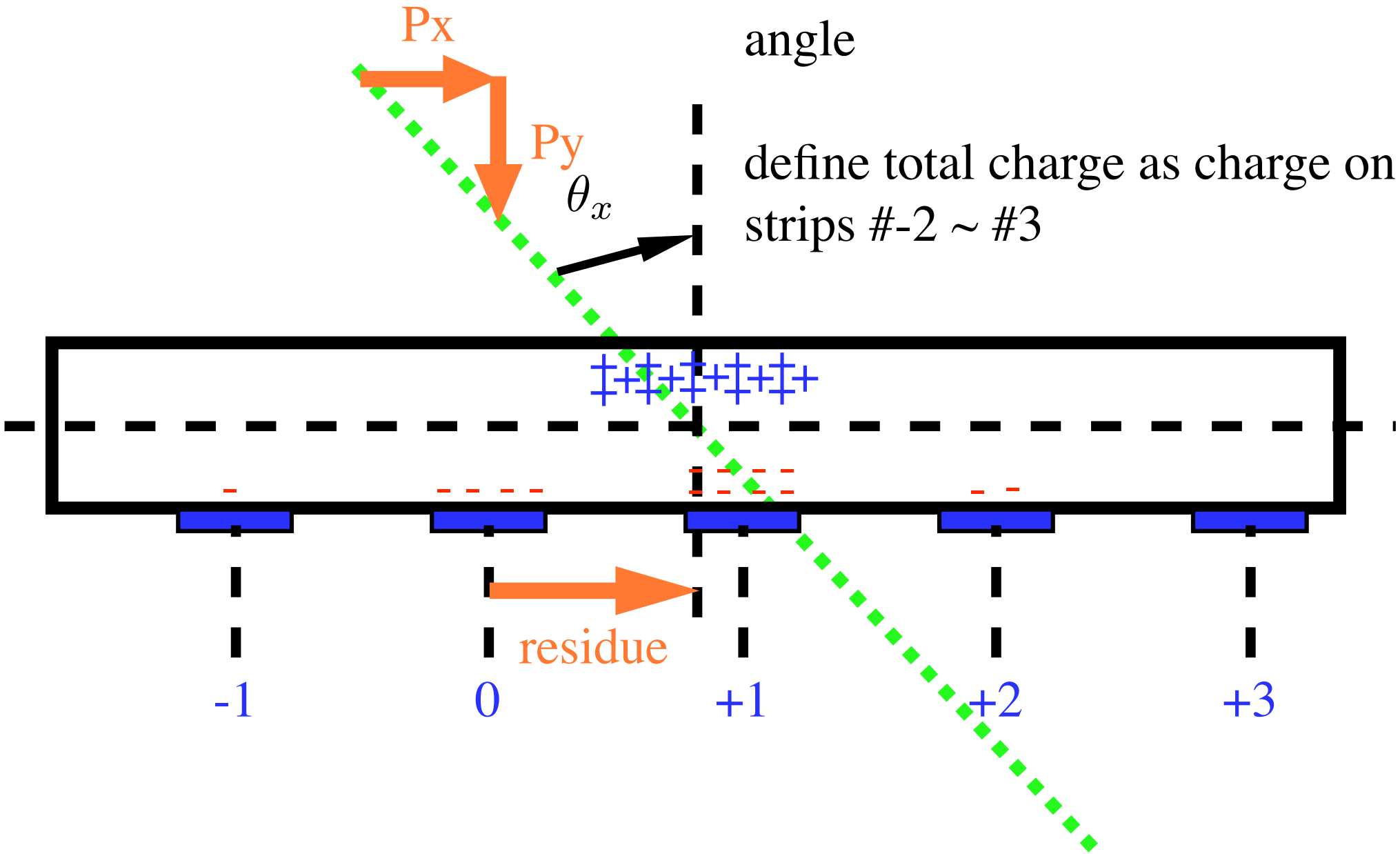
Latitudinal (p-side) and longitudinal (n-side) readout strips. Strips on each side are parallel. P-side and n-side readout wires are orthogonal.

Definition of “incident angle” and “residual”

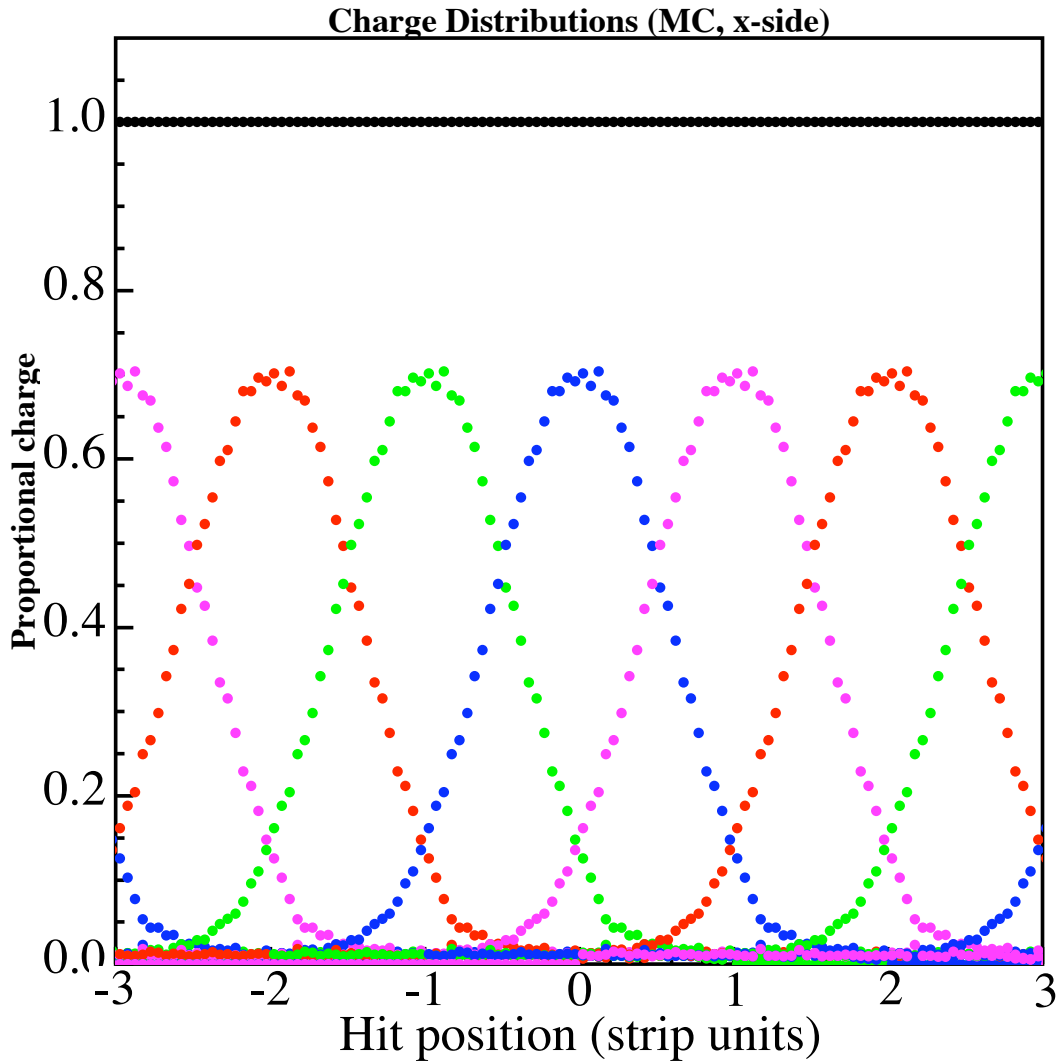
Extrapolate from CDC to SVD :

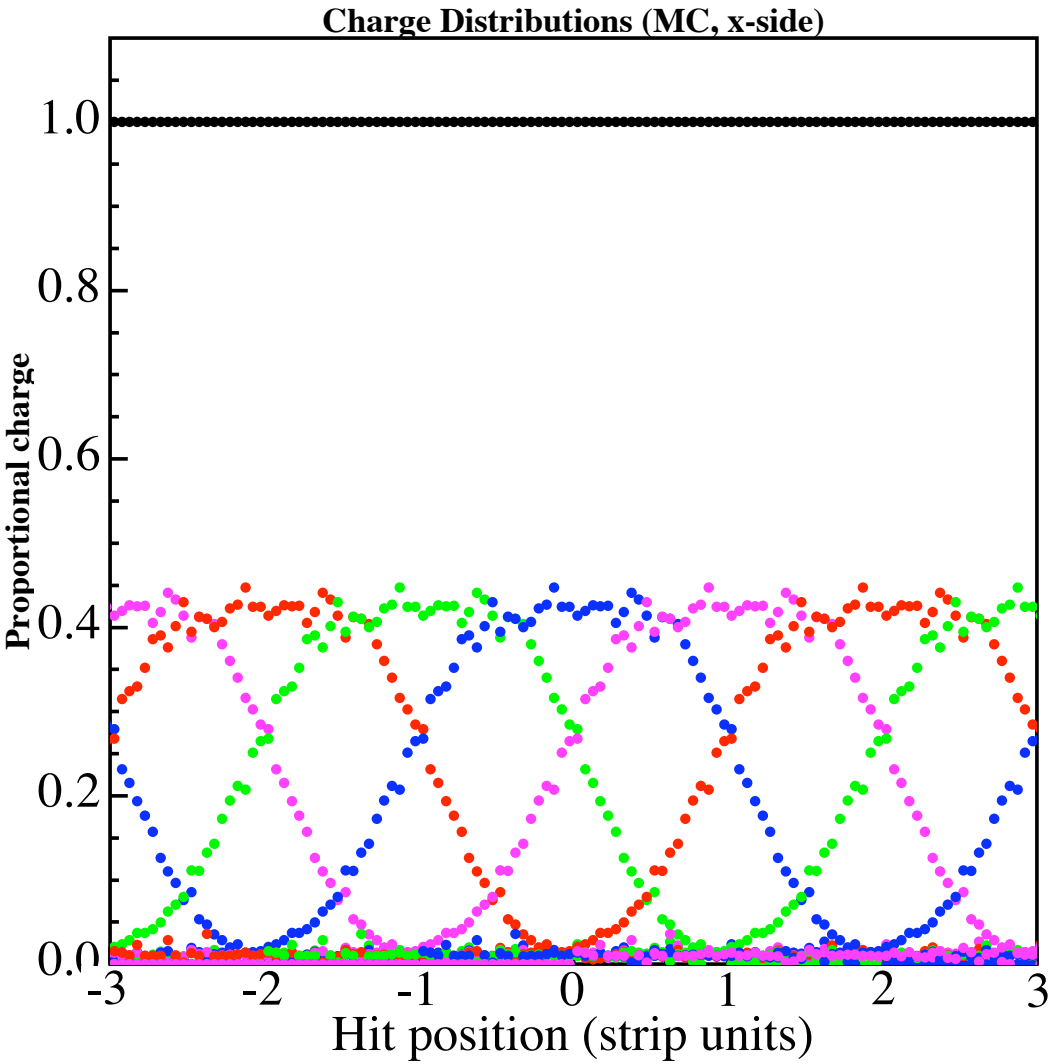
charge sharing behavior depends on residual as well as incident angle

define total charge as charge on strips #-2 ~ #3



charge sharing distributions (MC)





0 < angle < 5

sum
strip# = -2,+2
strip# = -1,+3
strip# = 0,4
strip# = -3+2

20 < angle < 25

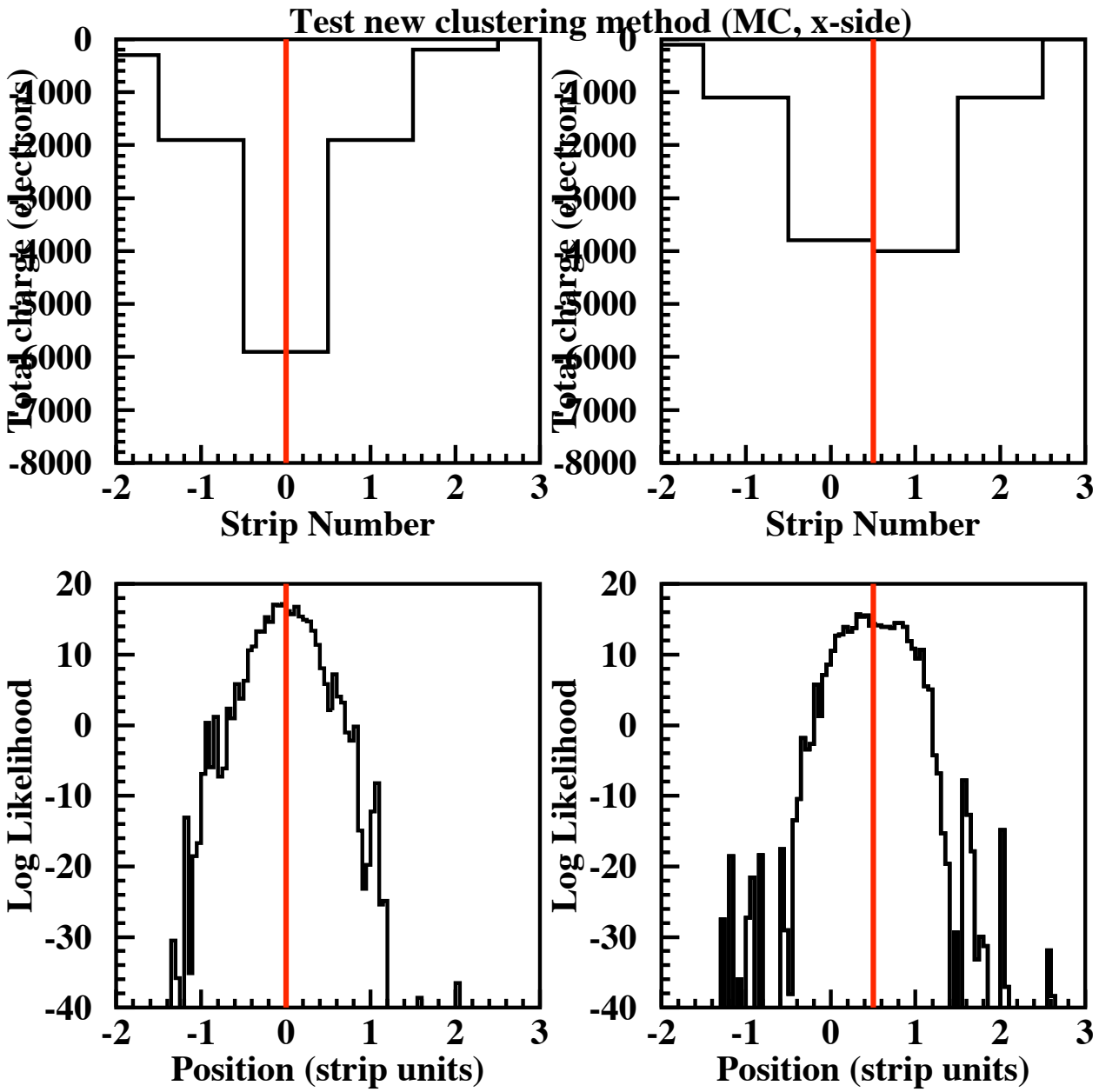
Interaction point resolution

Clear differences in the charge sharing behavior (cluster shape) can be seen for different residuals and incident angles.

Shallower incident angles produce wider clusters.

New Clustering Algorithm

new clustering method test

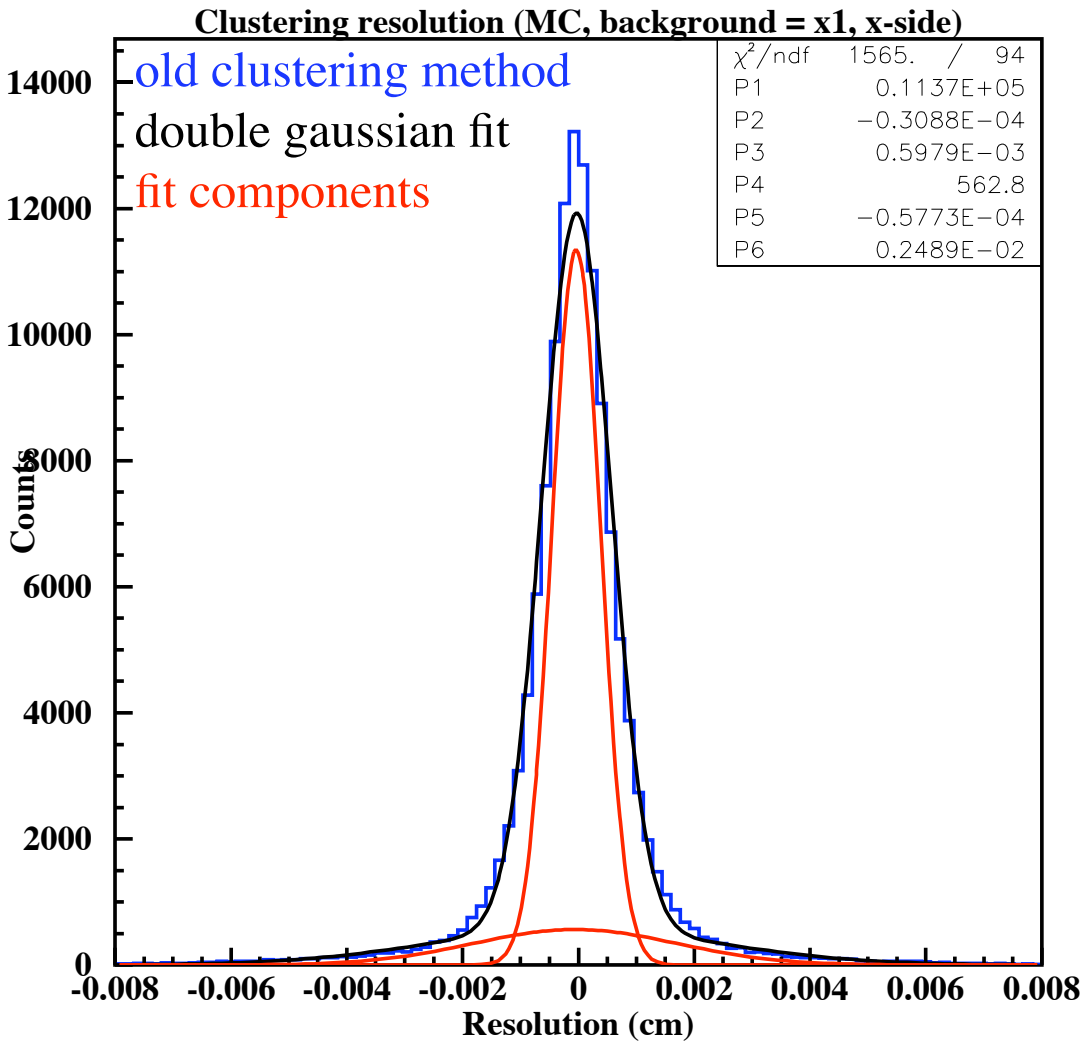


The new clustering algorithm was run on ideal clusters produced from the values in the charge distributions.

The resulting likelihood functions are peaked very close to the expected residual positions (red lines).

Results

Clustering position resolution 2



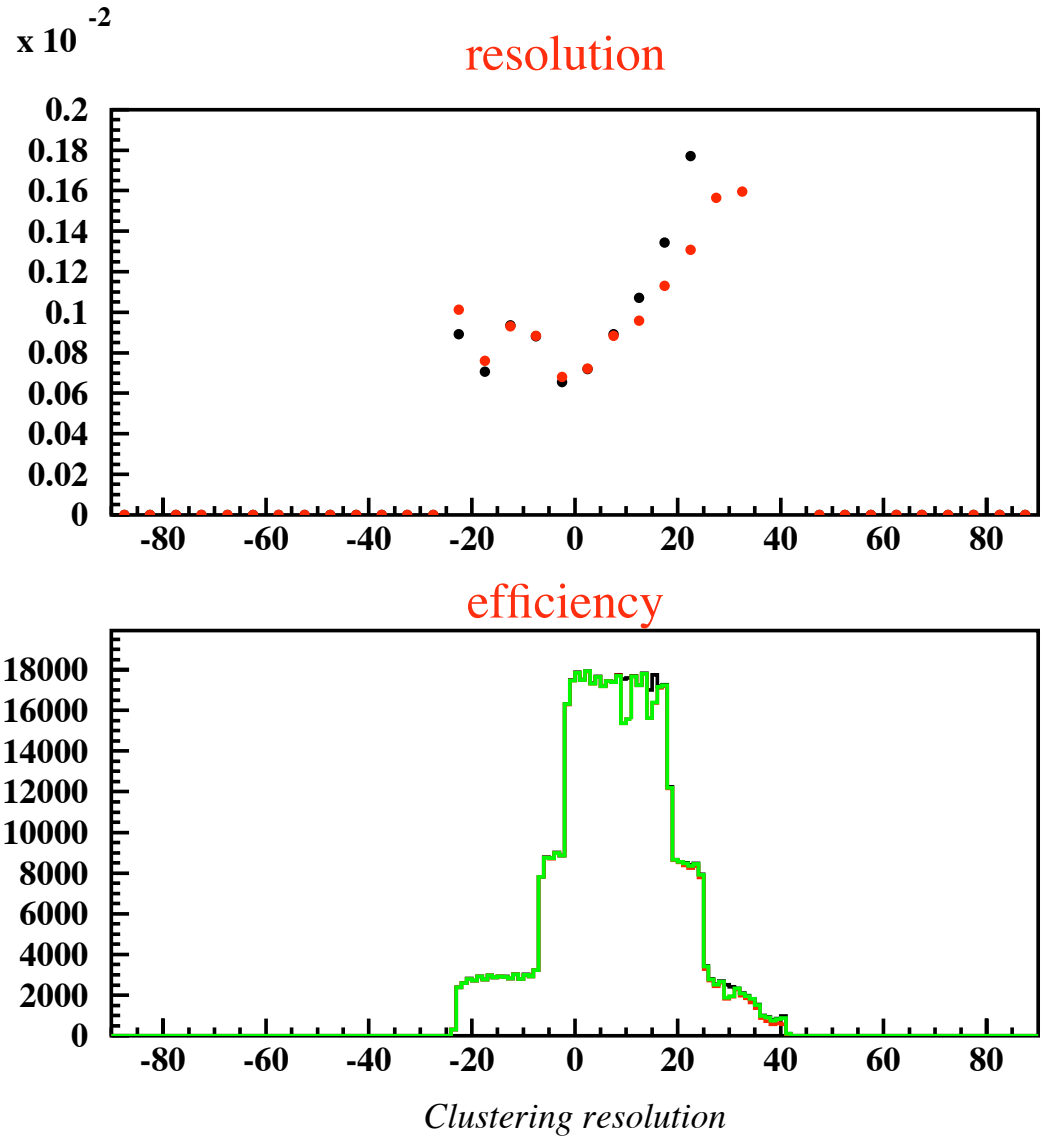
The distributions are fitted with a double gaussian function, the two components of which express the peak and the wider tail respectively.

The two variances are combined as follows to yield a RMS value that represents the combined distribution.

$$f(x) = A_1 \exp(\frac{-x^2}{\sigma_1^2}) + A_2 \exp(\frac{-x^2}{\sigma_2^2})$$

$$\sigma^2_{\text{comb}} = \sigma_1^2 \left(\frac{A_1\sigma_1}{A_1\sigma_1 + A_2\sigma_2} \right) + \sigma_2^2 \left(\frac{A_2\sigma_2}{A_1\sigma_1 + A_2\sigma_2} \right)$$

Resolution, old vs. new (r/phi)



Clustering resolution

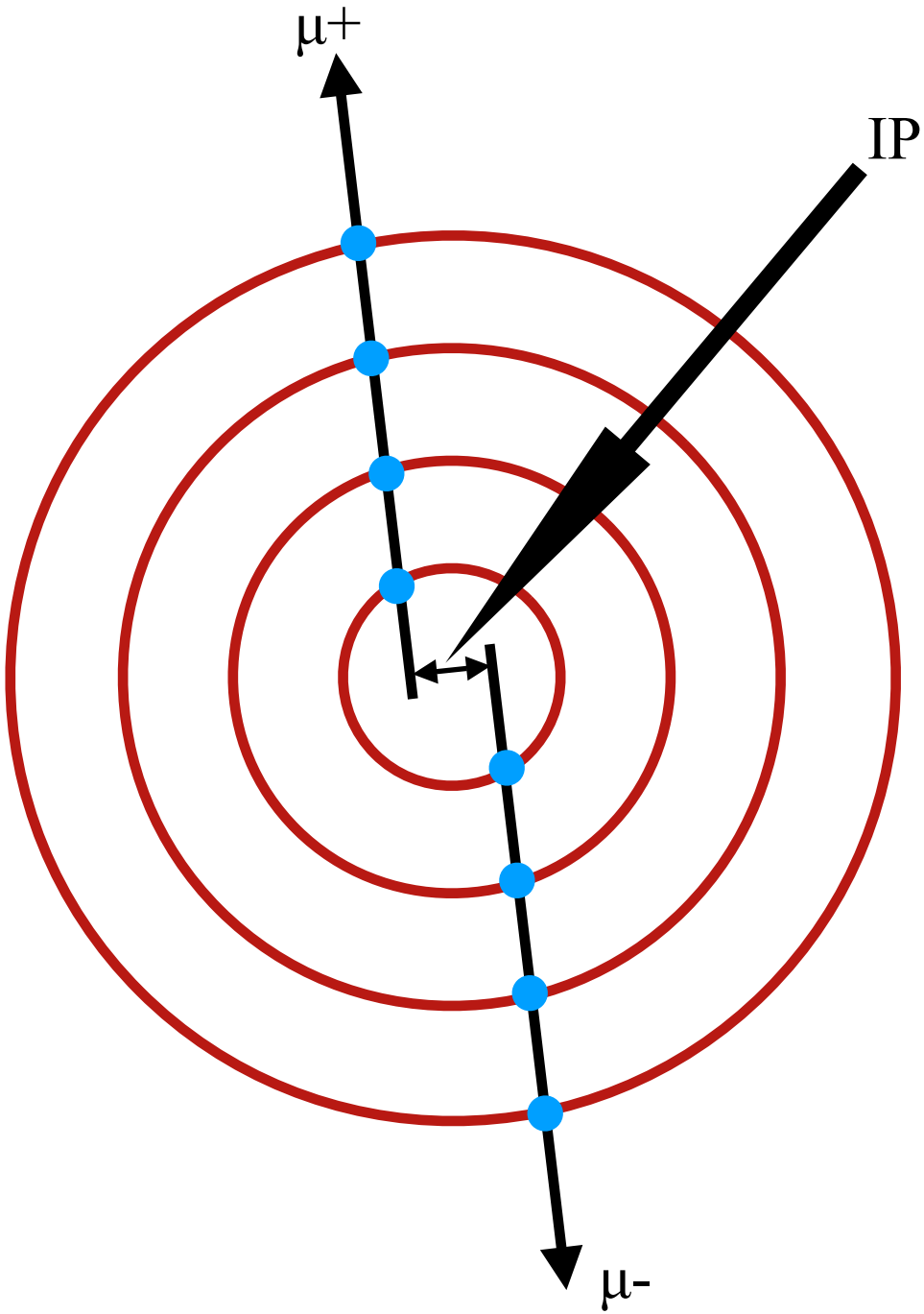
X : local incident angle
Y (top) : RMS
Y(bottom) : number of counts.

Similar or better resolution. Better efficiency with new method.

Same true for z side.

Use this new clustering method in tracking to check overall resolution.

Interaction point resolution

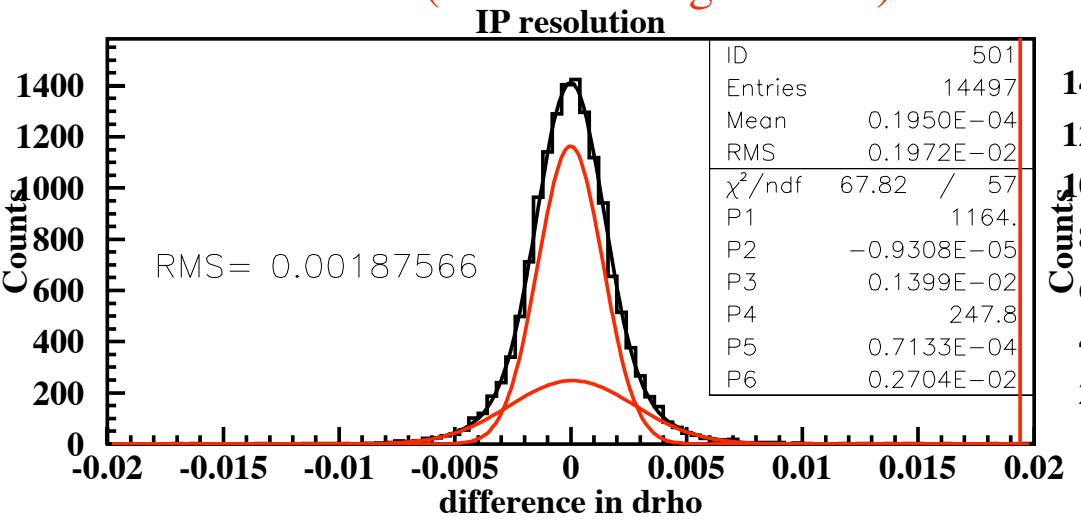


Use this new clustering method in tracking to check overall resolution.

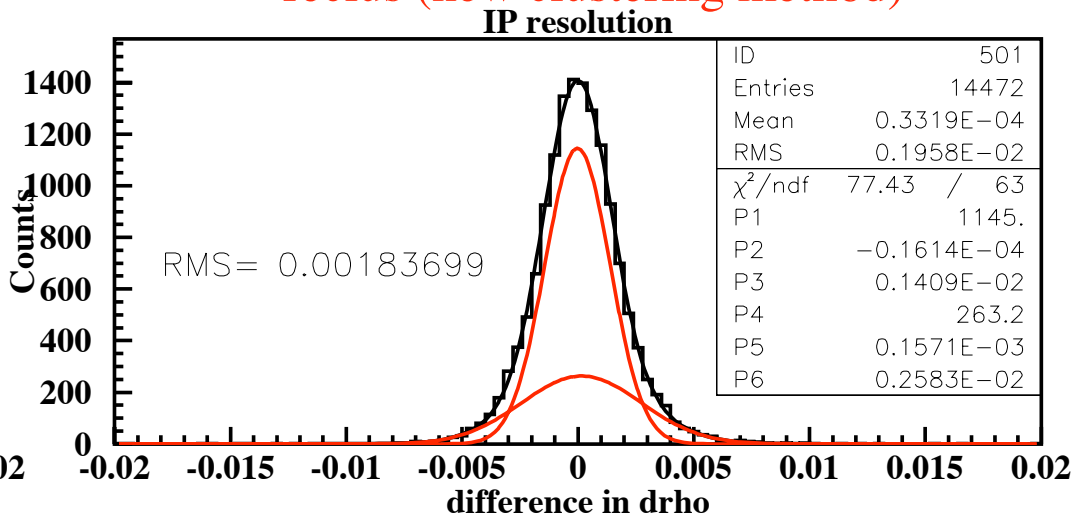
Check distance between mu+ and mu- tracks at the interaction point.

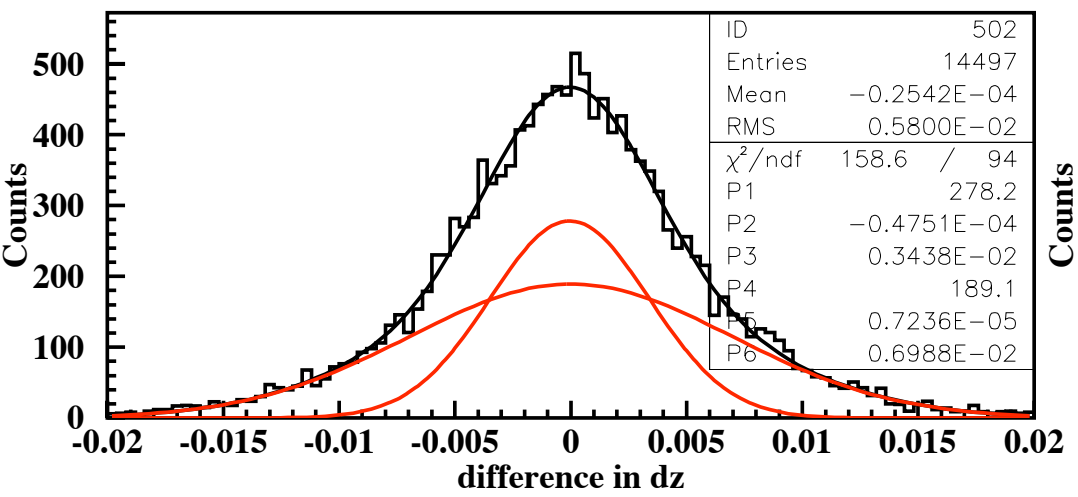
IP resolution - MC - resolution

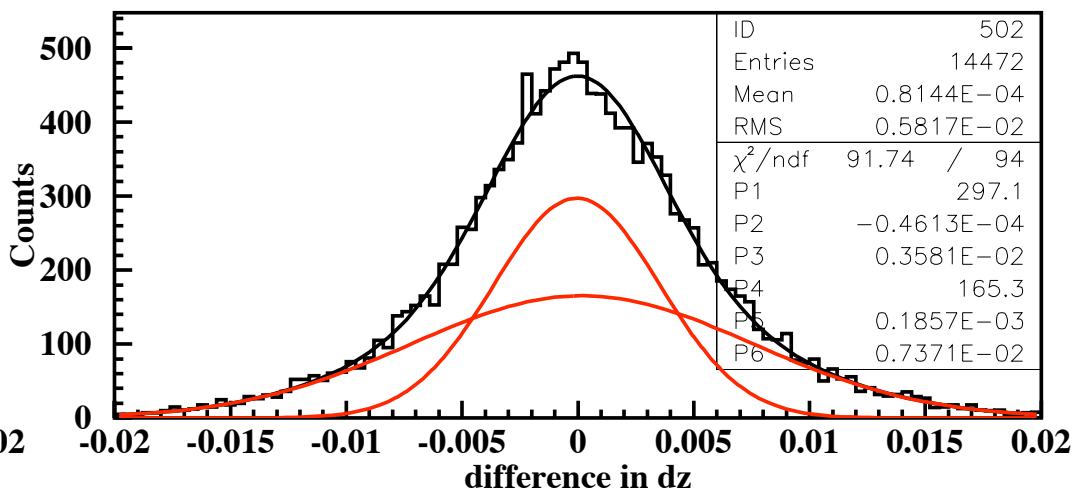
recsvd (old clustering method)



reclus (new clustering method)



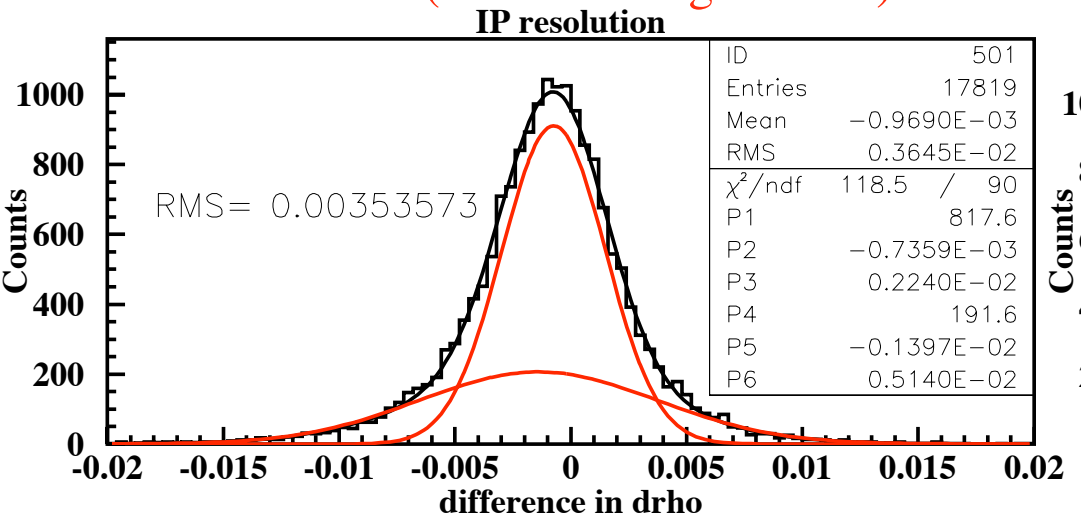


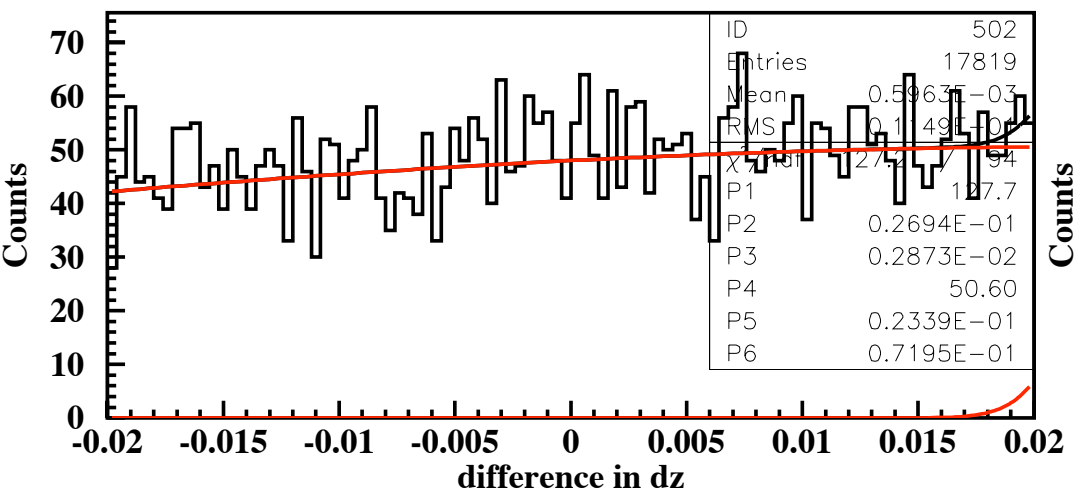


Small reduction in RMS, sigma of peak and tail components of double gaussian fit, and weighted mean of double gaussian fit.

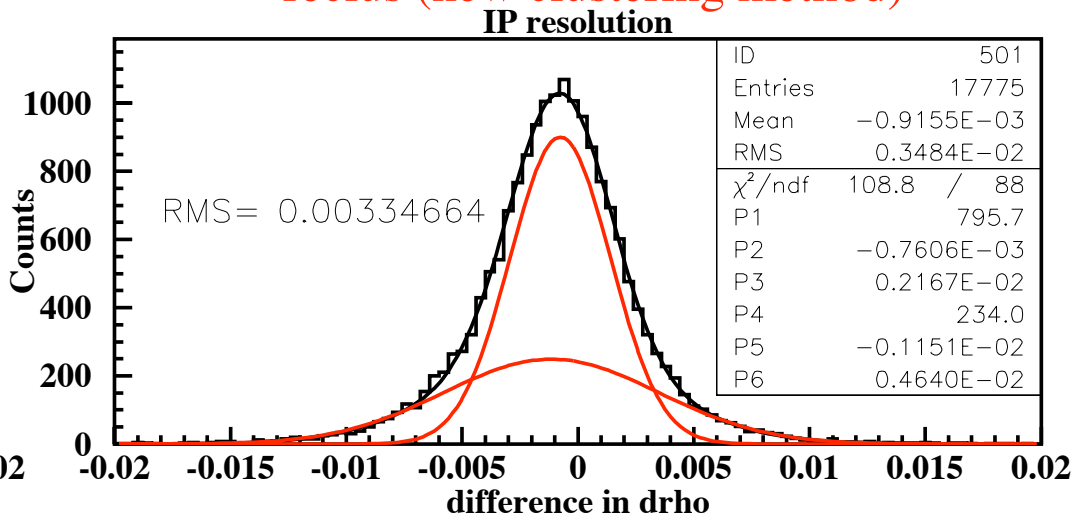
IP resolution - data (Exp 37) - resolution

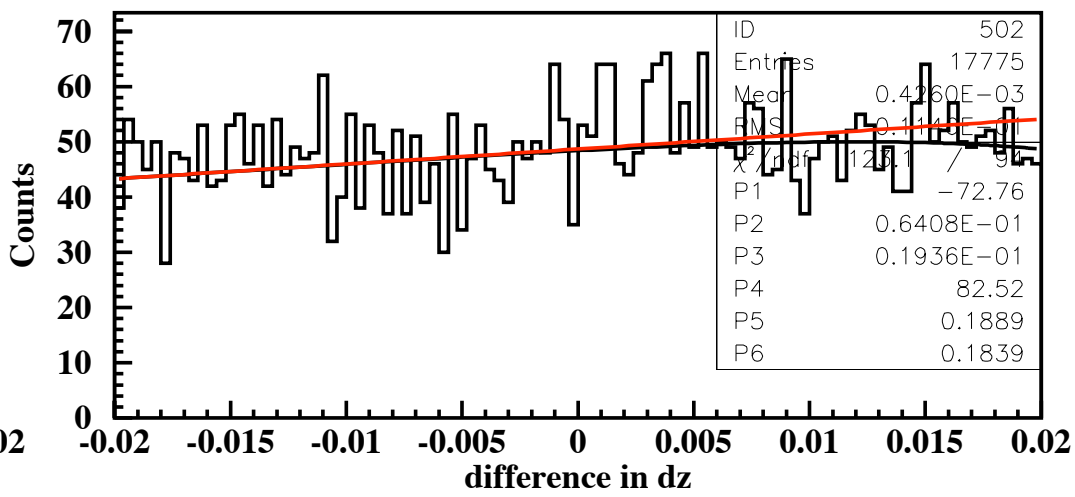
recsvd (old clustering method)





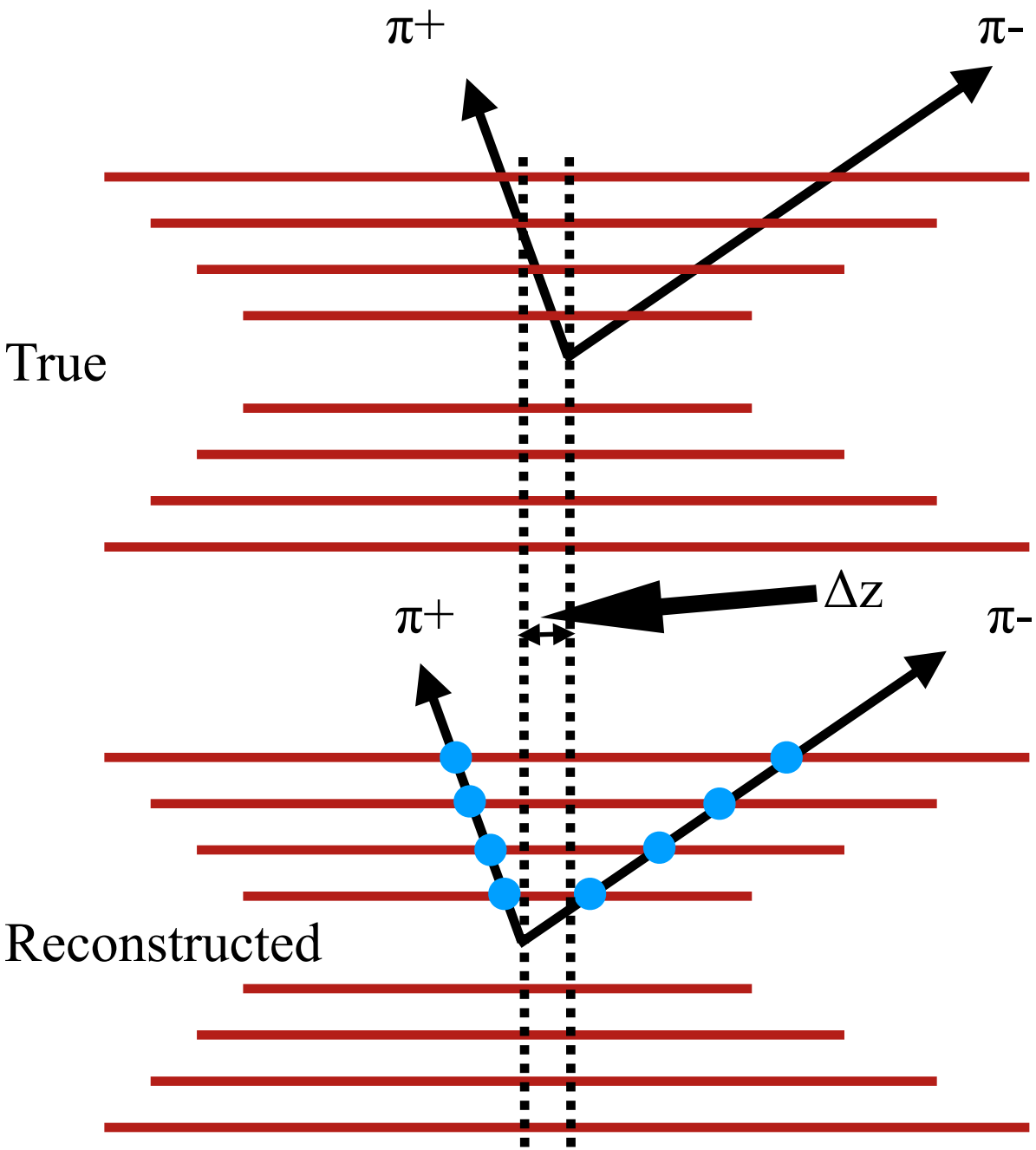
reclus (new clustering method)





Small reduction in RMS, sigma of peak and tail components of double gaussian fit, and weighted mean of double gaussian fit.

resolution for hadronic CP events



Final goal : to test new method on hadronic B decays, and check reconstructed Δz.

Use MC simulation

Y(4S) -> BB

B -> π +π-

B -> generic

Summary

1. Charge distribution depends on incident angle and residual. Shallower incident angles have wider spread.

2. Based on these differences, a new clustering algorithm was created to find cluster positions based on the maximum likelihood method.

Clustering resolution is similar for old and new method for MC.

IP resolution is better for dimuon events for both MC and data.

Currently working on checking resolution using hadronic events.