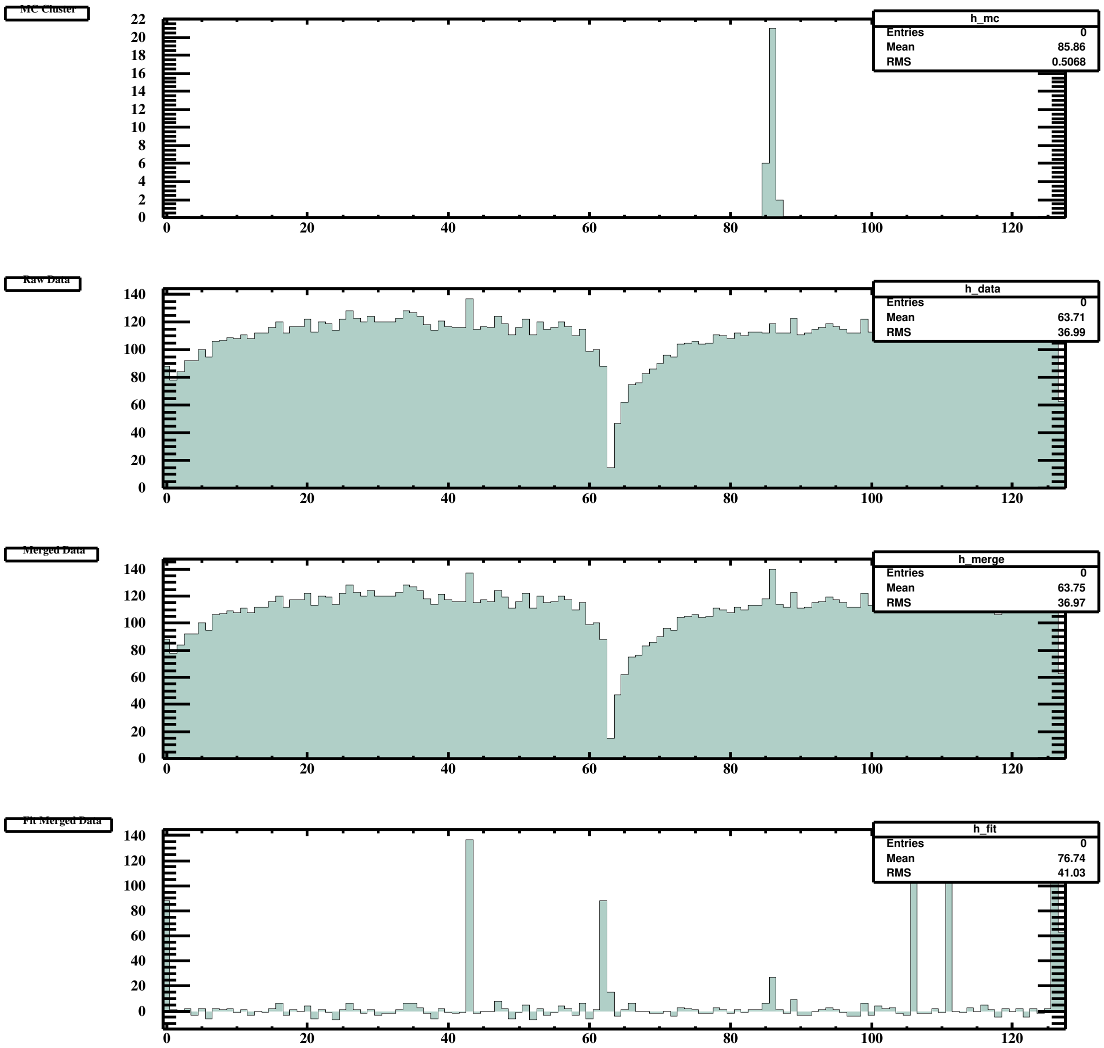
L00: Some studies using event merging

- Method
- Cluster Quality Cuts
- Global Efficiency and Resolution
- Position dependent biases

Method

- Simulated single particle passage through random sensor
- Merge this with raw physics data (run 153271)
- Fit merged data, look for cluster at intersection



Signal vs. Generic Cluster Comparison

- There are an average of 6 clusters per sensor
- Most are not physics
- Need to determine how to get good purity

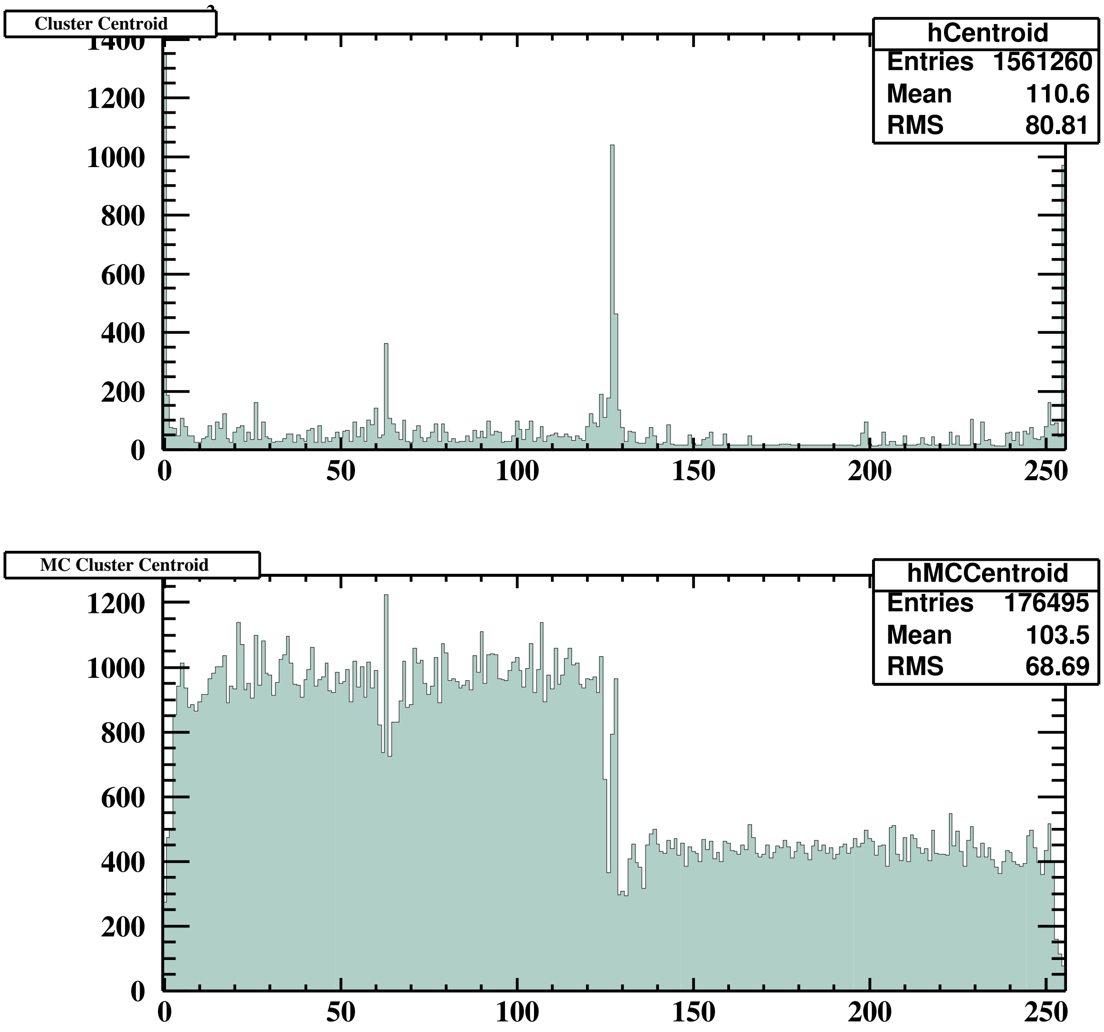


Figure 1: Location of generic and signal strips. *Top:* Generic *Bottom:* signal

Signal vs. Generic Cluster Comparison

- Bad strip flags and bad neighbor flags
- Do not use either

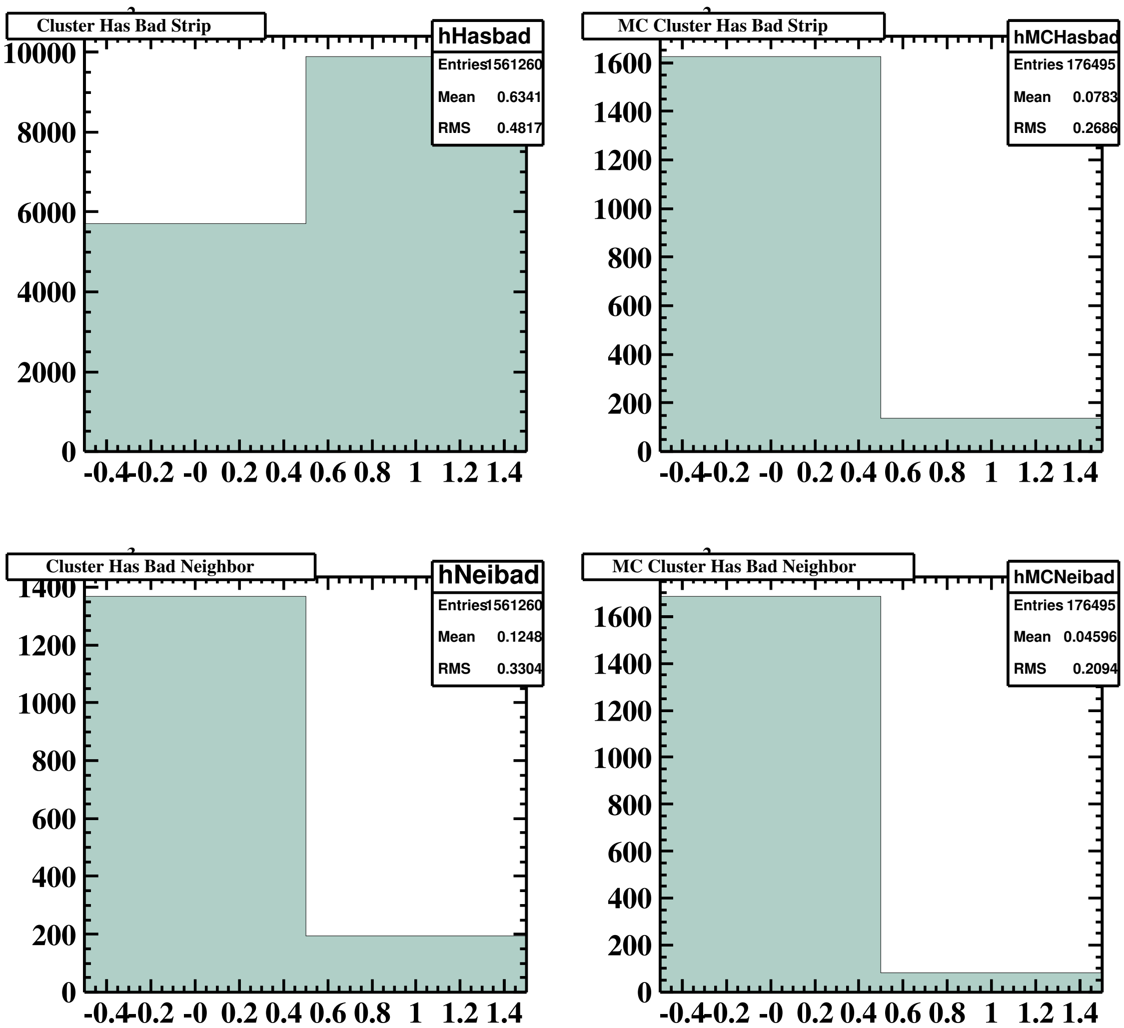


Figure 2: Flags for generic and signal strips.
Top: Bad *Bottom:* Neighbor bad *Left:* Generic *Right:* Signal

Signal vs. Generic Cluster Comparison

- Cluster charge and size
- Cuts: $N_{strip} < 5$ and $Q_{total} < 100$

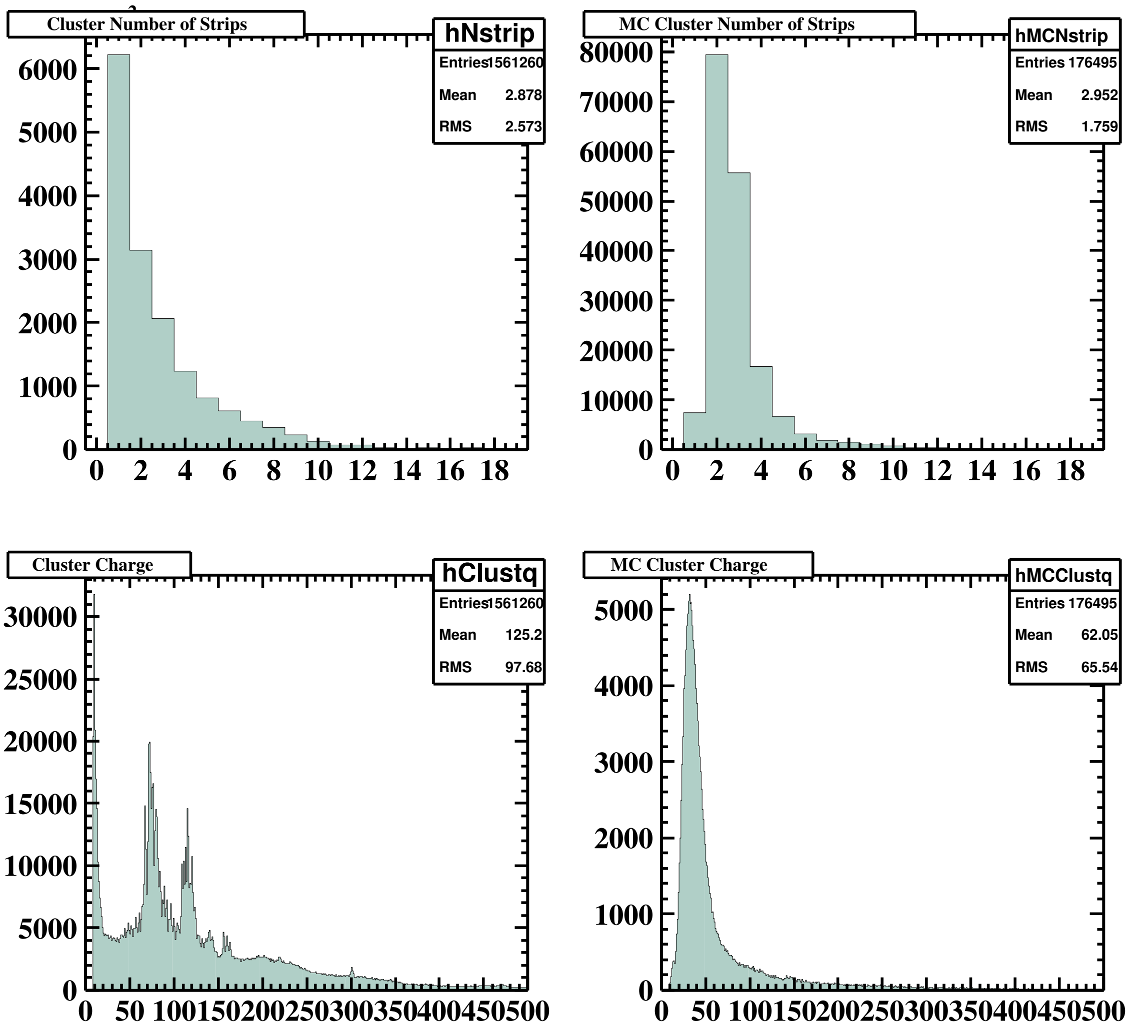


Figure 3: Cluster charge and number of strips
Top: N_{strip} *Bottom:* Q_{total} *Left:* Generic *Right:* Signal

Signal vs. Generic Cluster Comparison

- Other quantities that differ: Strip with Maximum charge and its noise.
- Cuts: $Q_{maxstrip} < 50$ and $Noise_{maxstrip} < 3.5$

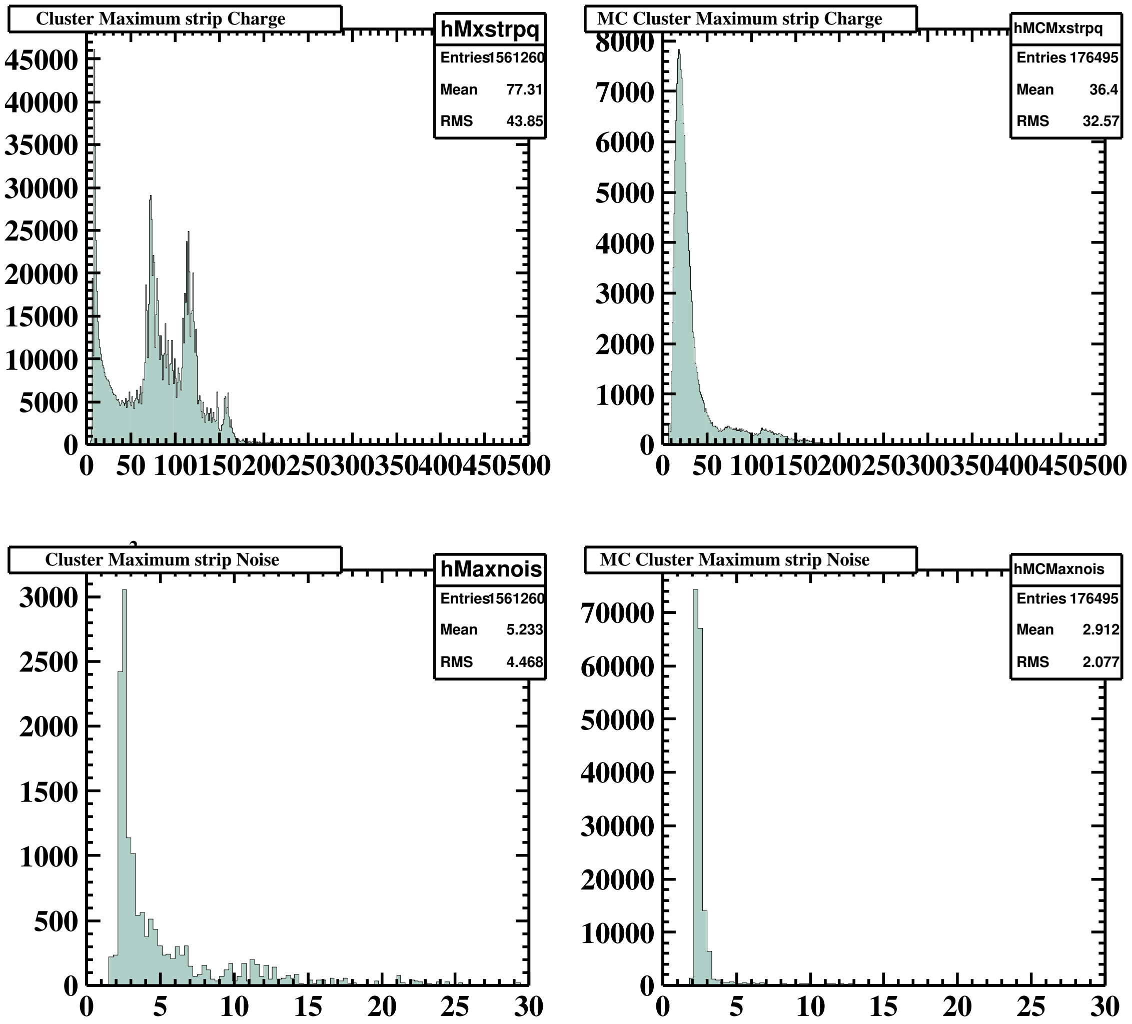


Figure 4: Max strip charge and noise
Top: $Q_{maxstrip}$ *Bottom:* $Noise_{maxstrip}$ *Left:* Generic *Right:* Signal

Summary of cluster quality cuts

Cut (cumulative)	**Efficiency (%)**
No bad strip	84.3
No Bad neighbor	82.8
$N_{strip} < 5$	76.4
$Q_{total} < 100$	70.1
$Q_{maxstrip} < 50$	69.8
$Noise_{maxstrip} < 3.5$	69.8

So how do these cuts perform?

- Look at both charge resolution and position resolution as a function of these cuts. (Note that "noisy" is a historical cut $Noise_{anystrip} < 30$)
- First granularity of each of 108 chips average:

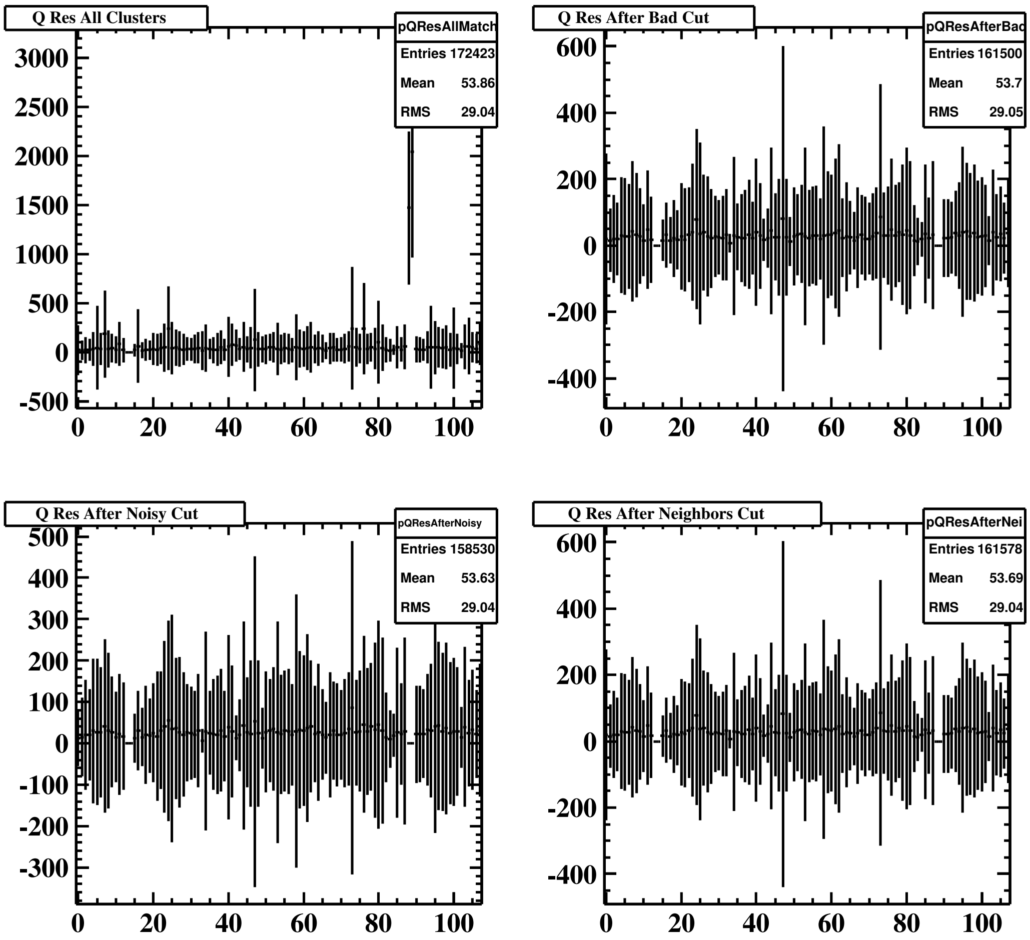


Figure 5: Charge resolution ($Q_{fit} - Q_{MC_{cluster}}$) after successive cuts
TopLeft: All *TopRight:* After Bad
BottomLeft: After Noisy *BottomRight:* After Neighbors

Charge Resolution (cont.)

- Charge reconstructed is around 2.5 ± 5 ADC counts from ideally clustered MC
- (Upward bias due to presence of physics?)

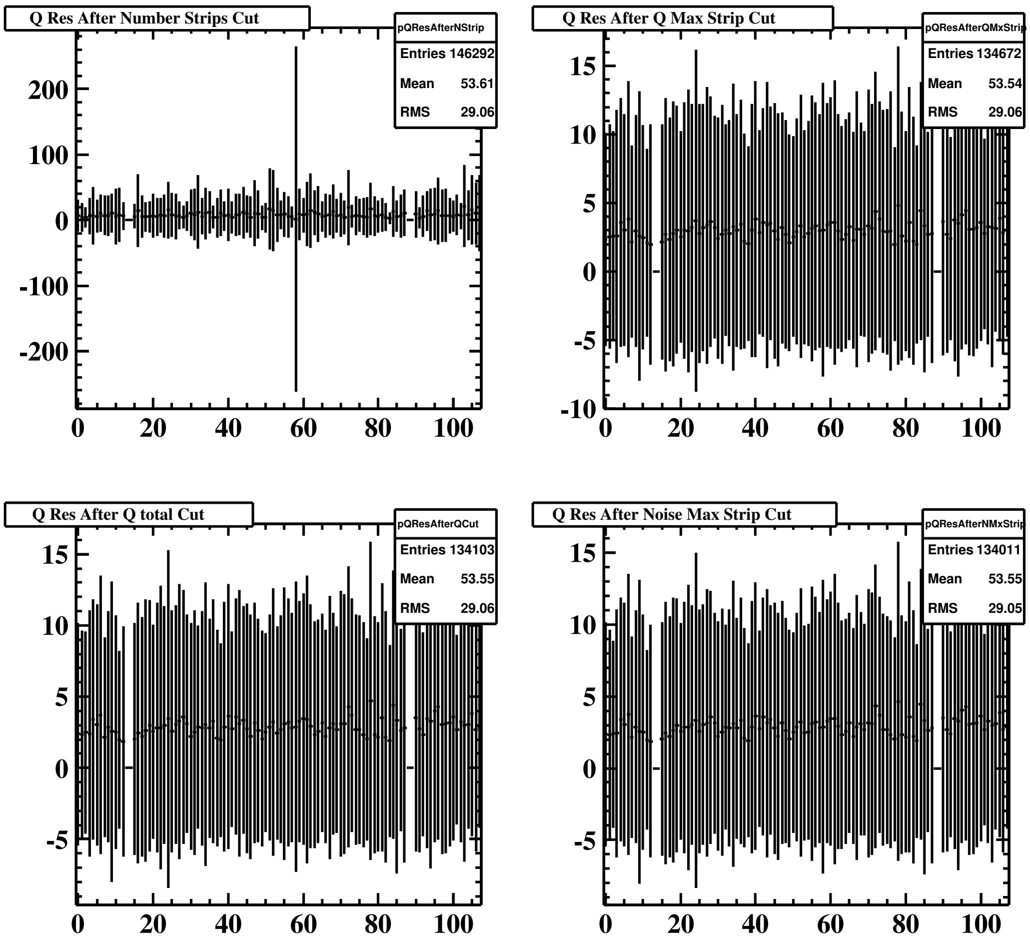


Figure 6: Charge resolution $(Q_{fit} - Q_{MCcluster})$ after successive cuts
TopLeft: After N_{strip} *TopRight:* After Q_{total}
BottomLeft: After $Q_{maxstrip}$ *BottomRight:* After $Noise_{maxstrip}$

Successive Cut Performance for Efficiency

- Again, granularity of chip-by-chip

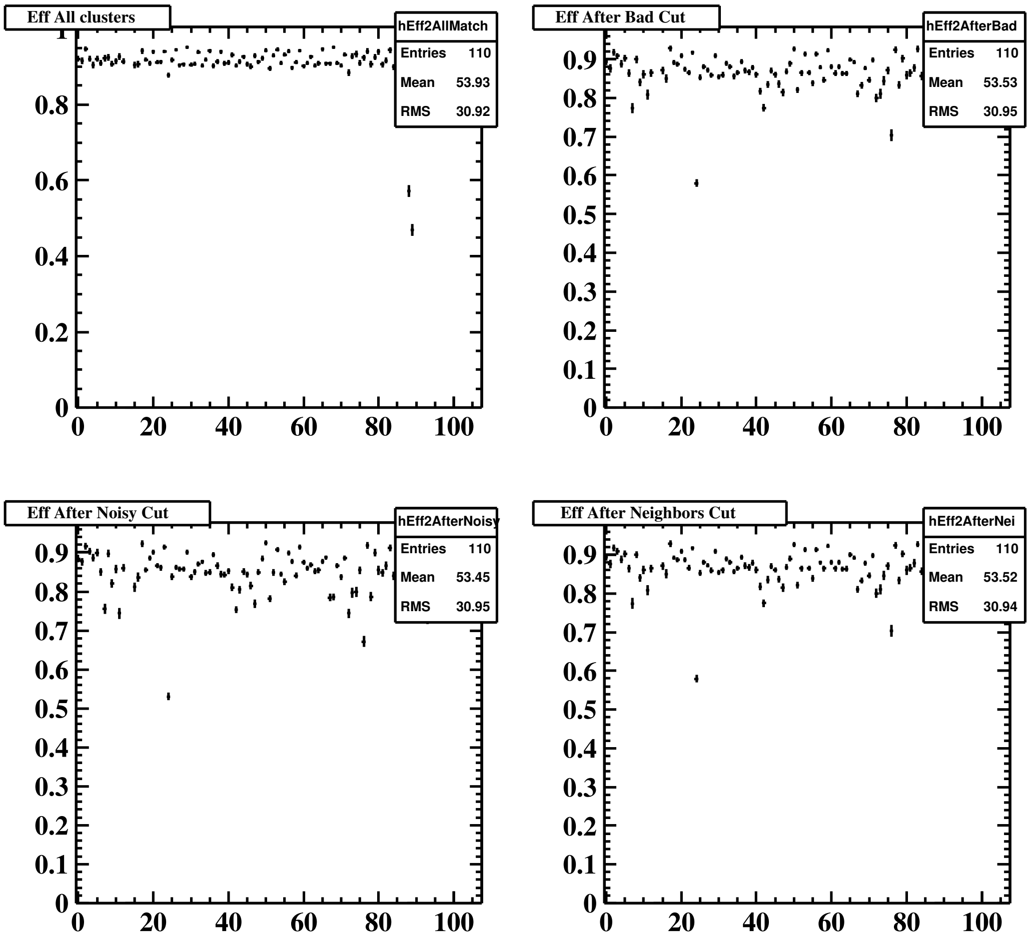


Figure 7: Efficiency by chip after successive cuts
TopLeft: All *TopRight:* After Bad
BottomLeft: After Noisy *BottomRight:* After Neighbors

Efficiency by chip (cont.)

- Efficiency is relatively stable across chips, 70 ± 10%.

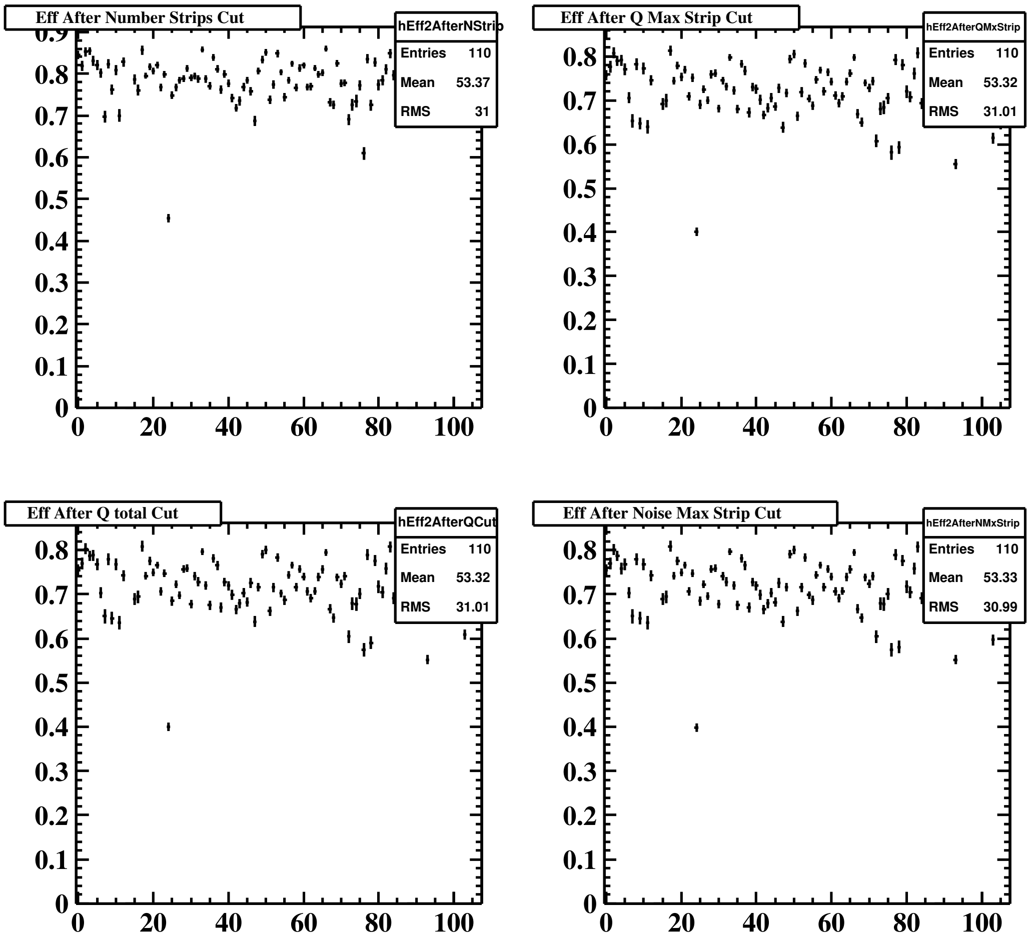


Figure 8: Efficiency by chip after successive cuts
TopLeft: After N_{strip} *TopRight:* After Q_{total}
BottomLeft: After $Q_{maxstrip}$ *BottomRight:* After $Noise_{maxstrip}$

Successive Cut Performance for Position Resolution

- The Y-axis is the profile of Geant minus fit reconstructed position
- Position units are *strips*!

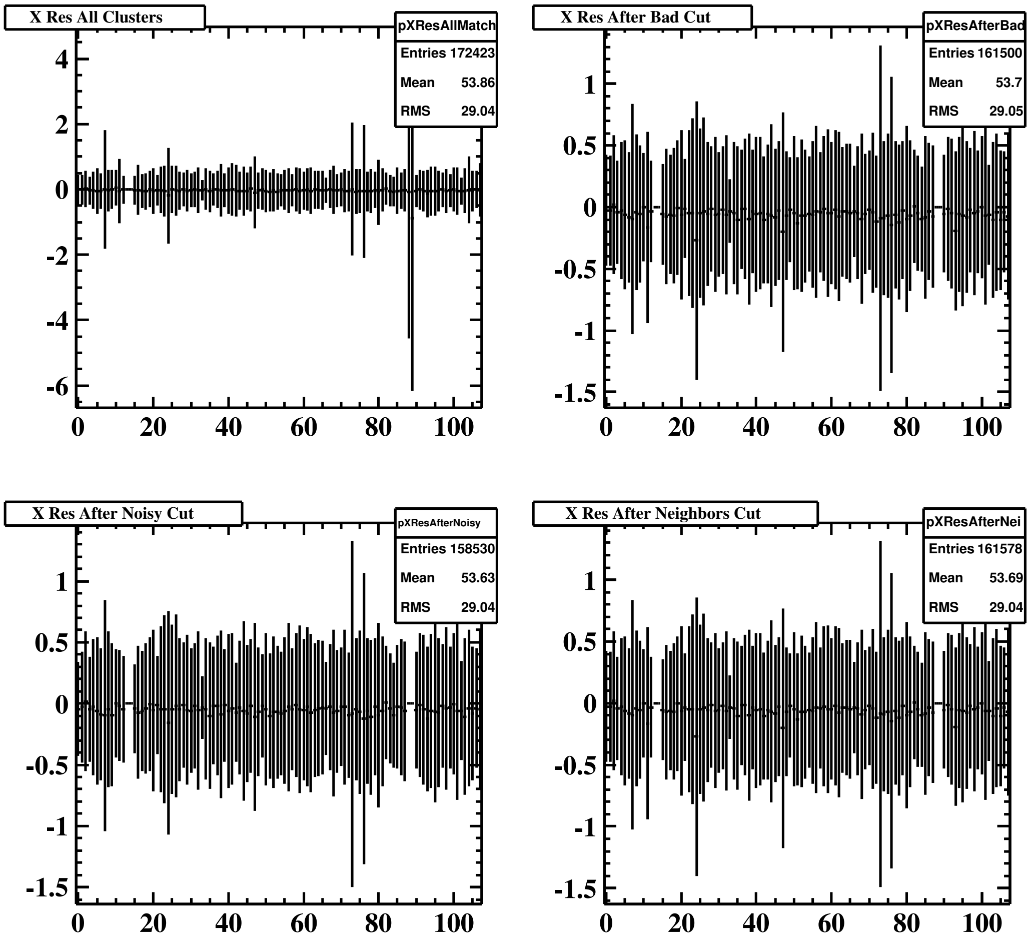


Figure 9: Position resolution by chip after successive cuts
TopLeft: All *TopRight:* After Bad
BottomLeft: After Noisy *BottomRight:* After Neighbors

Position Resolution by Chip (cont.)

- The good news is no chip stands out
- Need to look closer at this; next will average over all strips

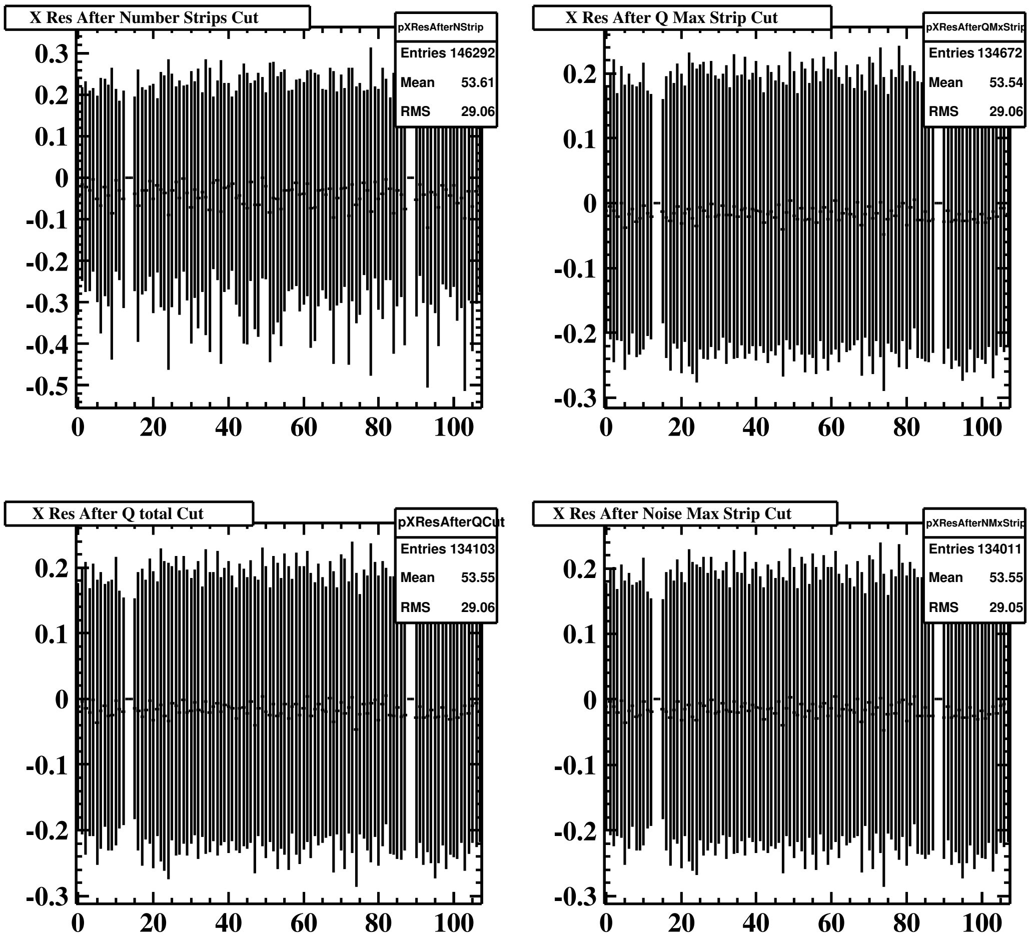


Figure 10: Position Resolution by chip after successive cuts
TopLeft: After N_{strip} *TopRight:* After Q_{total}
BottomLeft: After $Q_{maxstrip}$ *BottomRight:* After $Noise_{maxstrip}$

Successive Cut Performance for Position Resolution

- Now all strips are together in one resolution plot
- The X-axis Geant minus fit reconstructed position

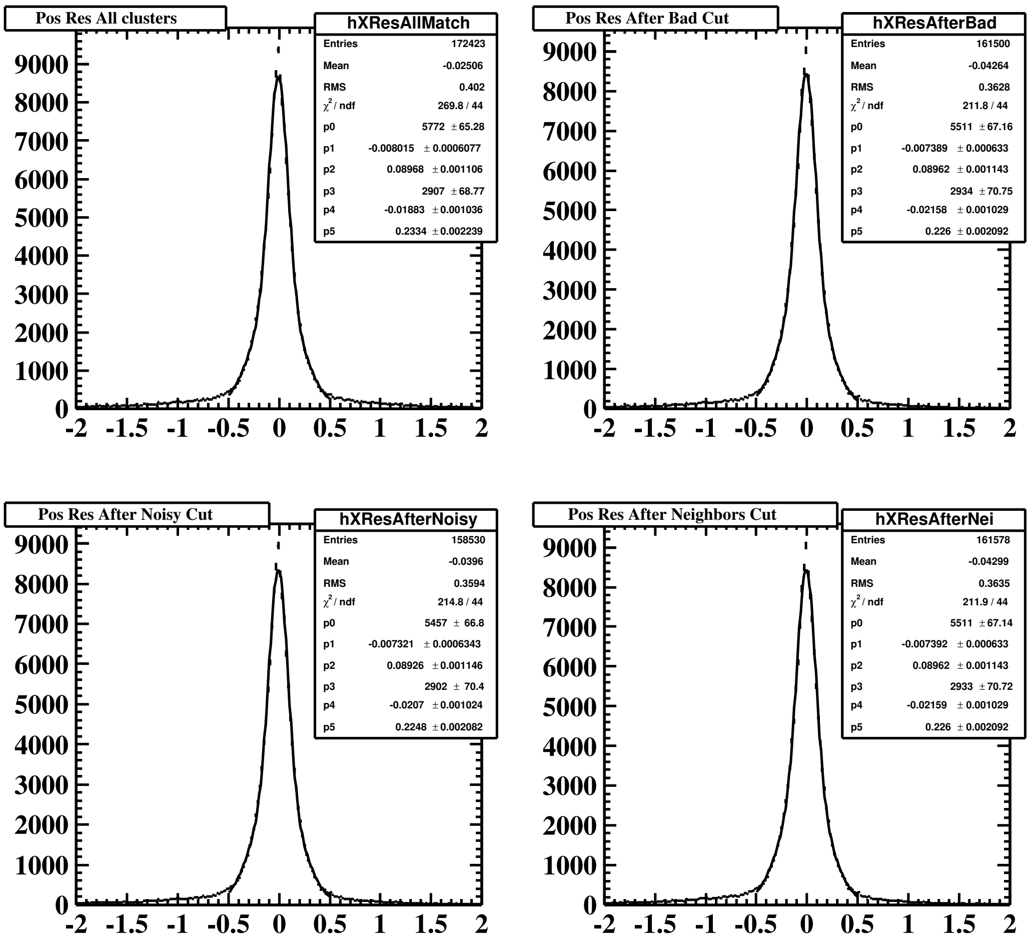


Figure 11: Position resolution after successive cuts
TopLeft: All *TopRight:* After Bad
BottomLeft: After Noisy *BottomRight:* After Neighbors

Position Resolution by Chip (cont.)

- So looking at the final result: fit shows $\sim 1\mu m$ shift, Two almost equal gaussians of 5 and 12 μm, and a small (per mil) slightly asymmetric tail.

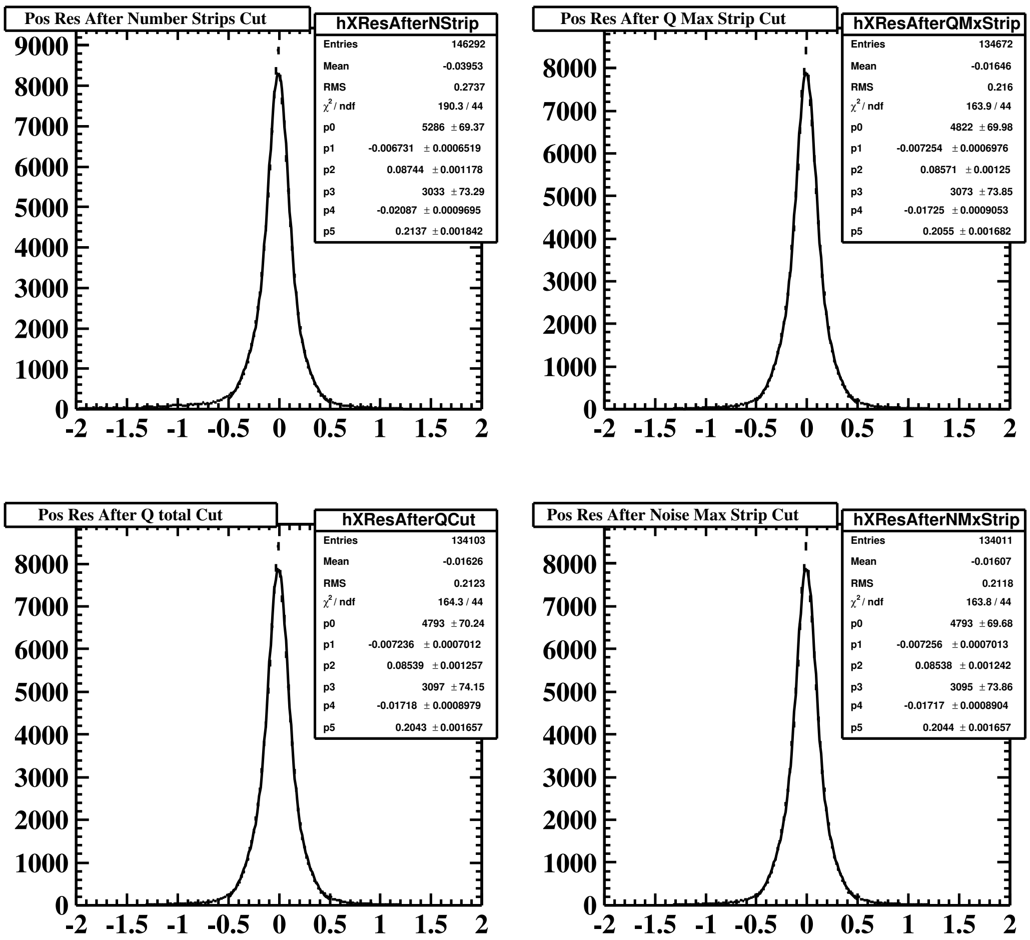


Figure 12: Position Resolution after successive cuts
TopLeft: After N_{strip} *TopRight:* After Q_{total}
BottomLeft: After $Q_{maxstrip}$ *BottomRight:* After $Noise_{maxstrip}$

Successive Cut Performance for Position Resolution

- Now all strips are together in one resolution plot
- The X-axis Geant minus fit reconstructed position
- Position units are *strips*!

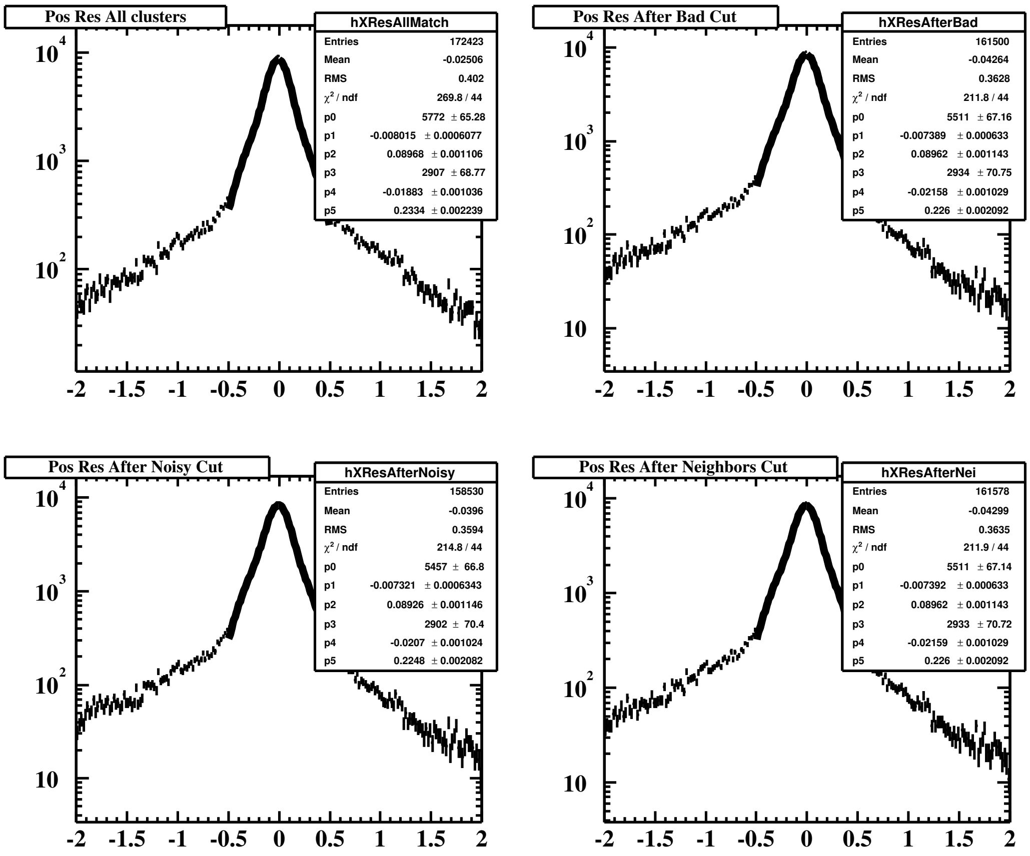


Figure 13: Position resolution after successive cuts
TopLeft: All *TopRight:* After Bad
BottomLeft: After Noisy *BottomRight:* After Neighbors

Position Resolution by Chip (cont.)

- So looking at the final result: fit shows $\sim 1 \mu m$ shift, Two almost equal gaussians of 5 and 12 μm, and a small ($< 1\%$) slightly asymmetric tail.

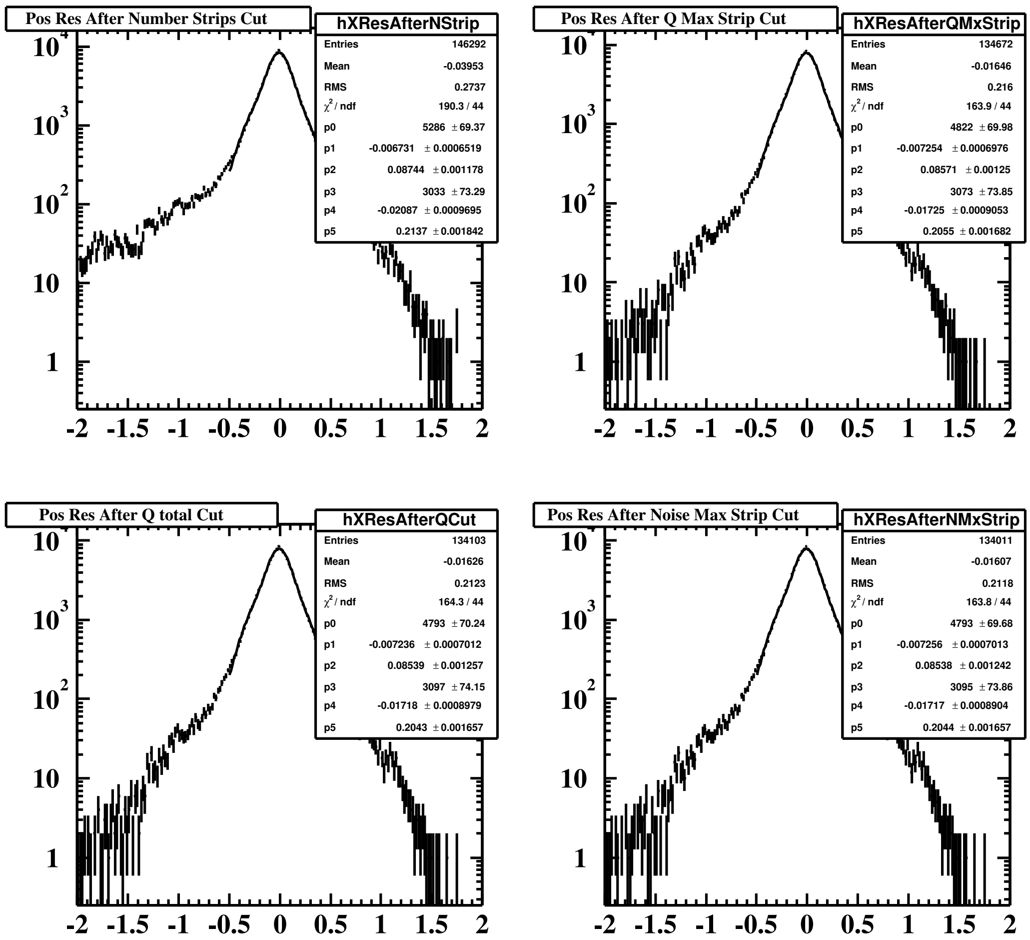


Figure 14: Position Resolution after successive cuts
TopLeft: After N_{strip} *TopRight:* After Q_{total}
BottomLeft: After $Q_{maxstrip}$ *BottomRight:* After $Noise_{maxstrip}$

Plot break

- So generally we have reasonable resolution in L00
- (After giving 30% effciciency up to some cuts to improve purity)
- On a chip-by-chip basis no significant biases.
- Still need to look for those tails.
- With large enough statistics, can measure a position resolution for each strip (13824 of them) and understand the outliers.
- I only have 680k events, but will show what that gives.

Strip by strip study

- Example: one of 108 chip profile histograms, 128 strips on X-axis.
- Lower right has mean position offset with error bars (look here for bias in position reconstruction)

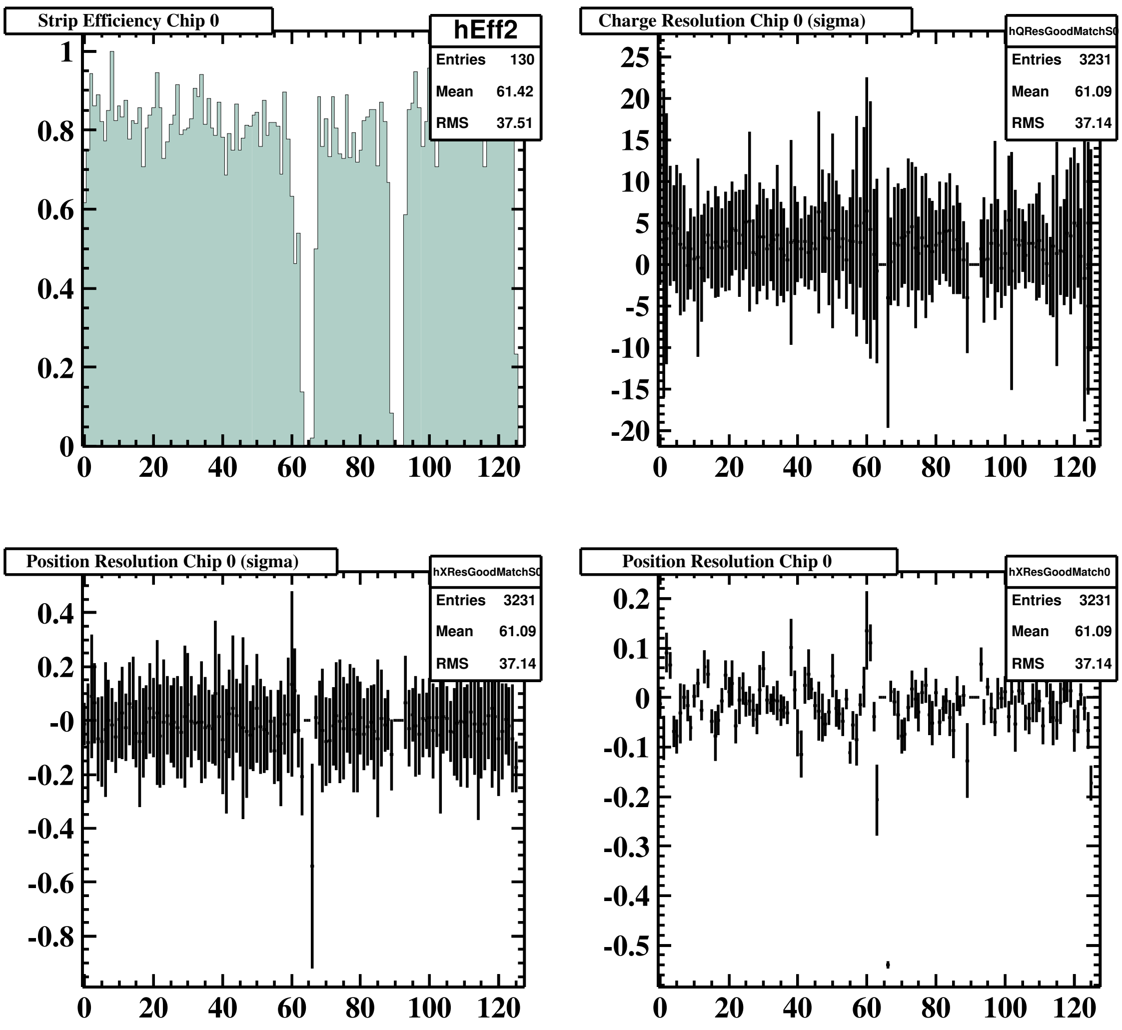
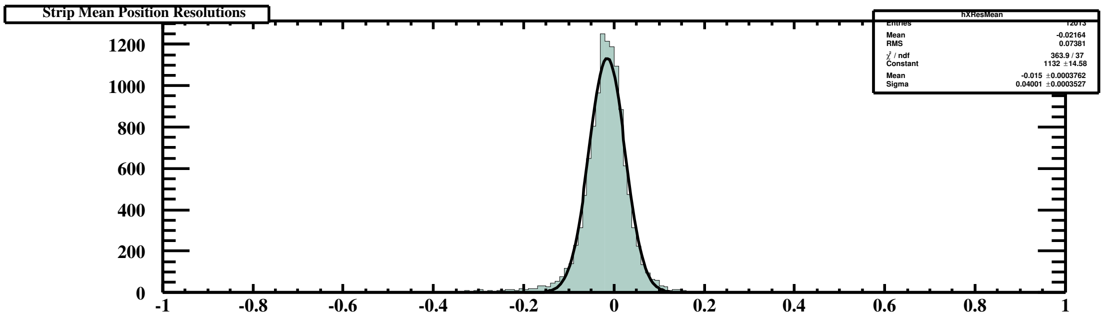
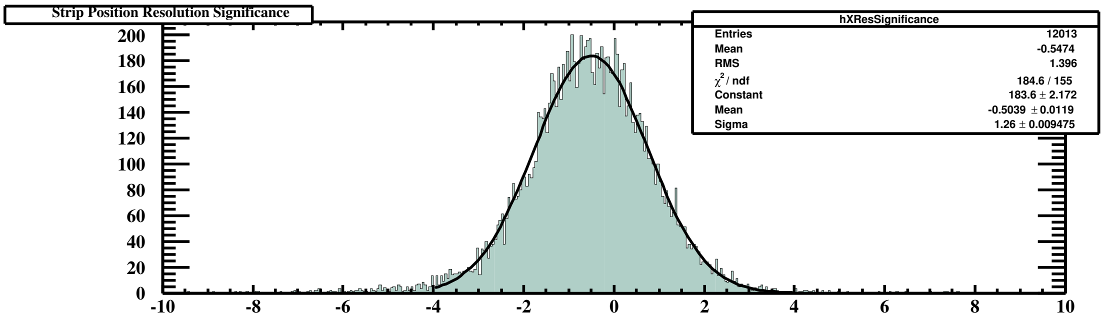


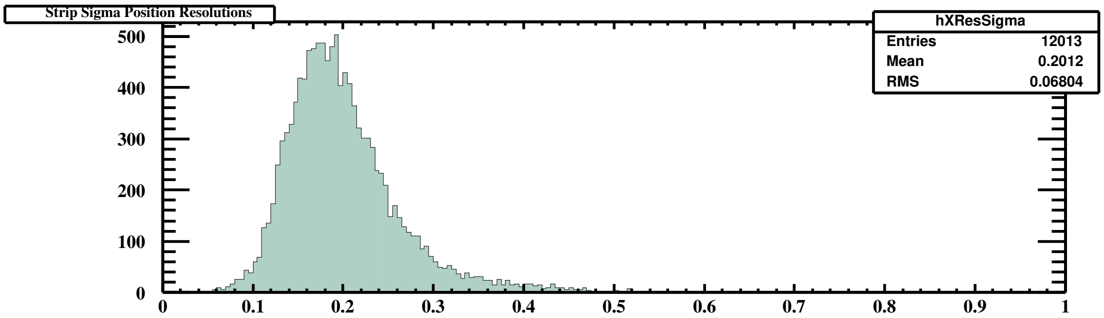
Figure 15: Note this chip has cable split in middle

Strip by strip study (cont)

- Projecting the 108 profile histograms
- Top: Means of reconstructed positions for each strip
  Middle: Significance of mean (measure of bias, sorta)
  Bottom: Sigmas of reconstructed positions (strip resolutions)

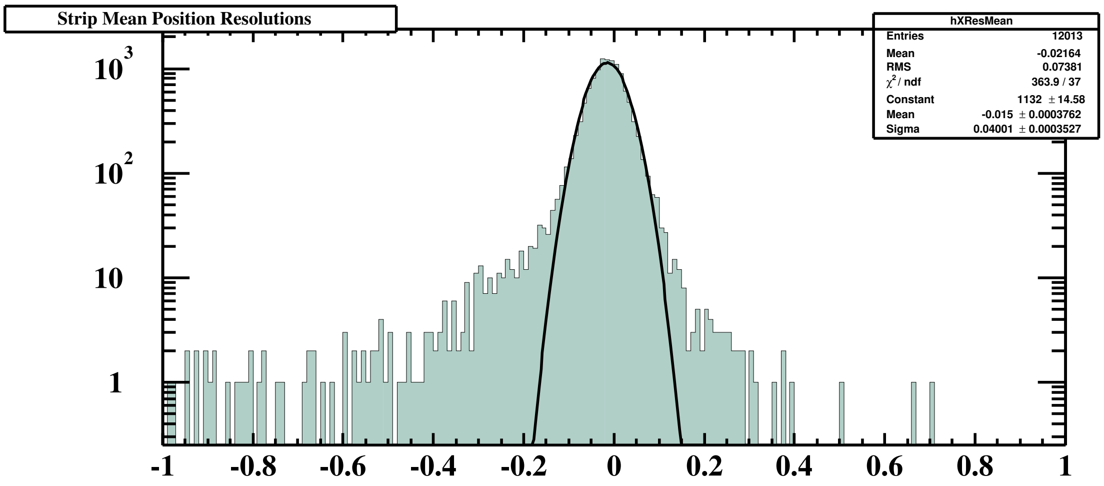


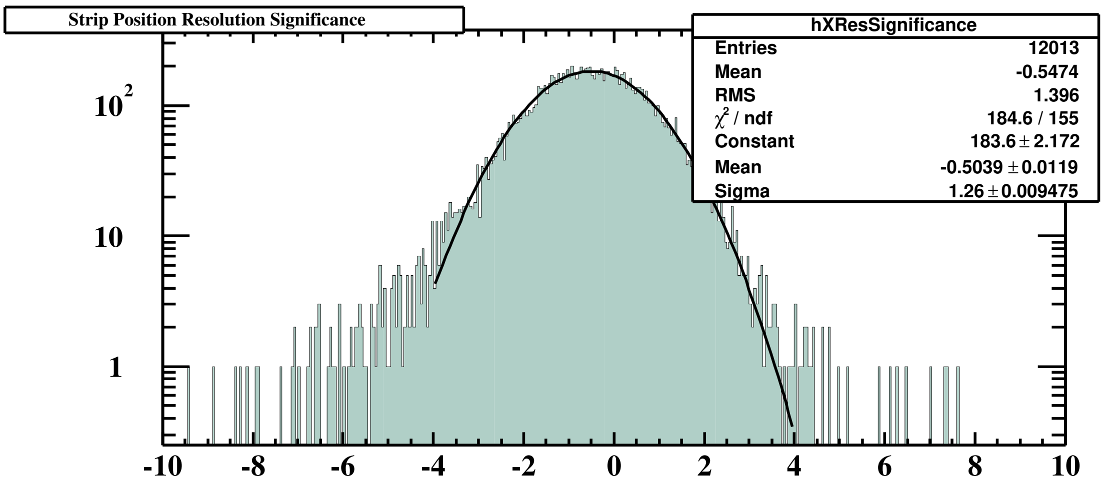




Strip by strip study (cont)

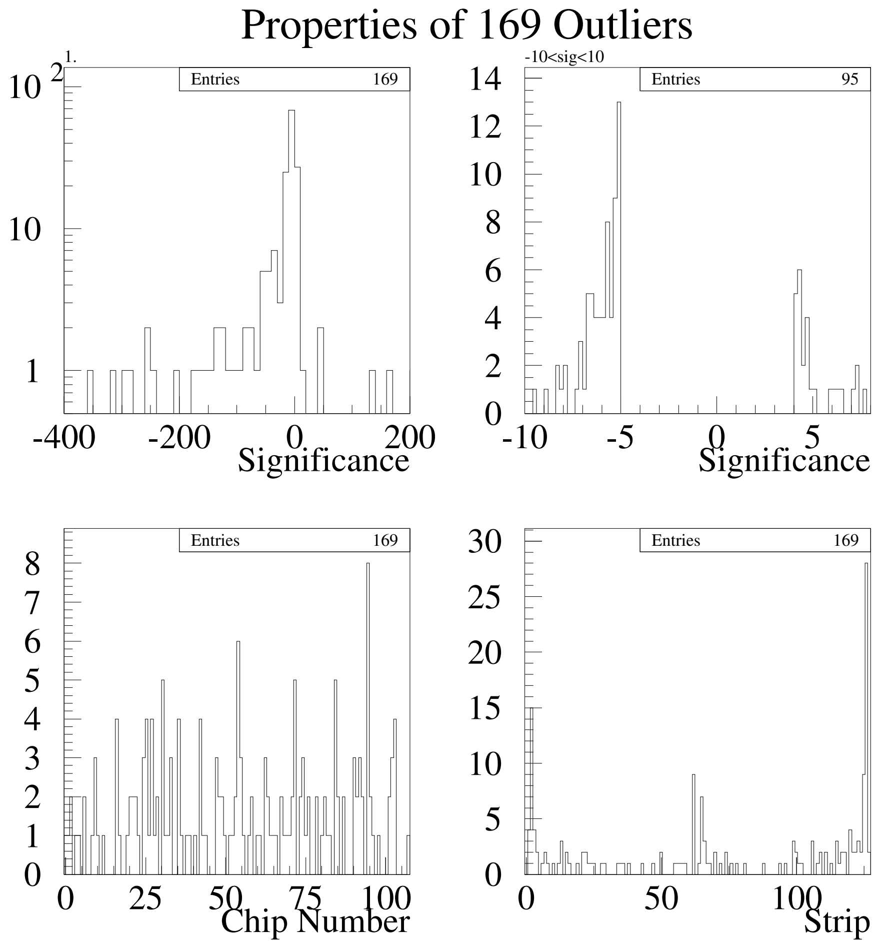
- Finally we can get the outliers by looking at the overly significant deviations from a mean of zero in position reconstruction.
- Top: Fit of means to gaussian
- Bottom: Fit of significance of means to gaussian. Shows around 170 outlier strips.





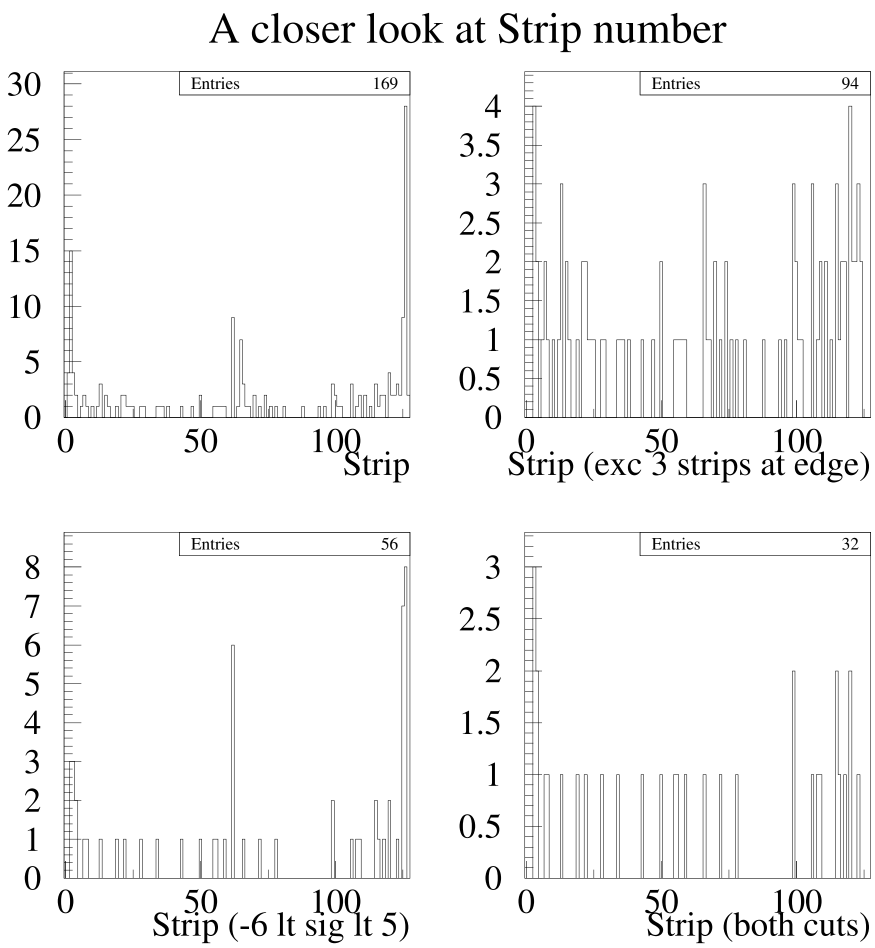
A closer look at the outliers

- The outliers are not concentrated in a single chip
- They are generally at the edges of cabling



A closer look at the outliers (cont.)

- Only 30 or so are in the middle
- Either way should mark these strips as bad
- $\longrightarrow$ small loss in efficiency



Conclusion

- We can use L00:
  - With quality cuts on clusters we can reconstruct physics in L00
  - Efficiency is low, ∼70%.
  - A few per mil strips may have a bad bias
  - The L00 shows a puzzling but acceptably small bias "to the left".
- Remaining to do:
  - Look at outliers to make sure there are no surprises
  - Major hits in efficiency come from bad strips and large total charge (N_{strip} and Q_{total})
    - Can we improve the calibration of "bad" strips?
    - Can we better optimize clustering and cluster splitting?