



*May 26, 2021*

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# Update on SiD ECal MAPS Simulations

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# Introduction



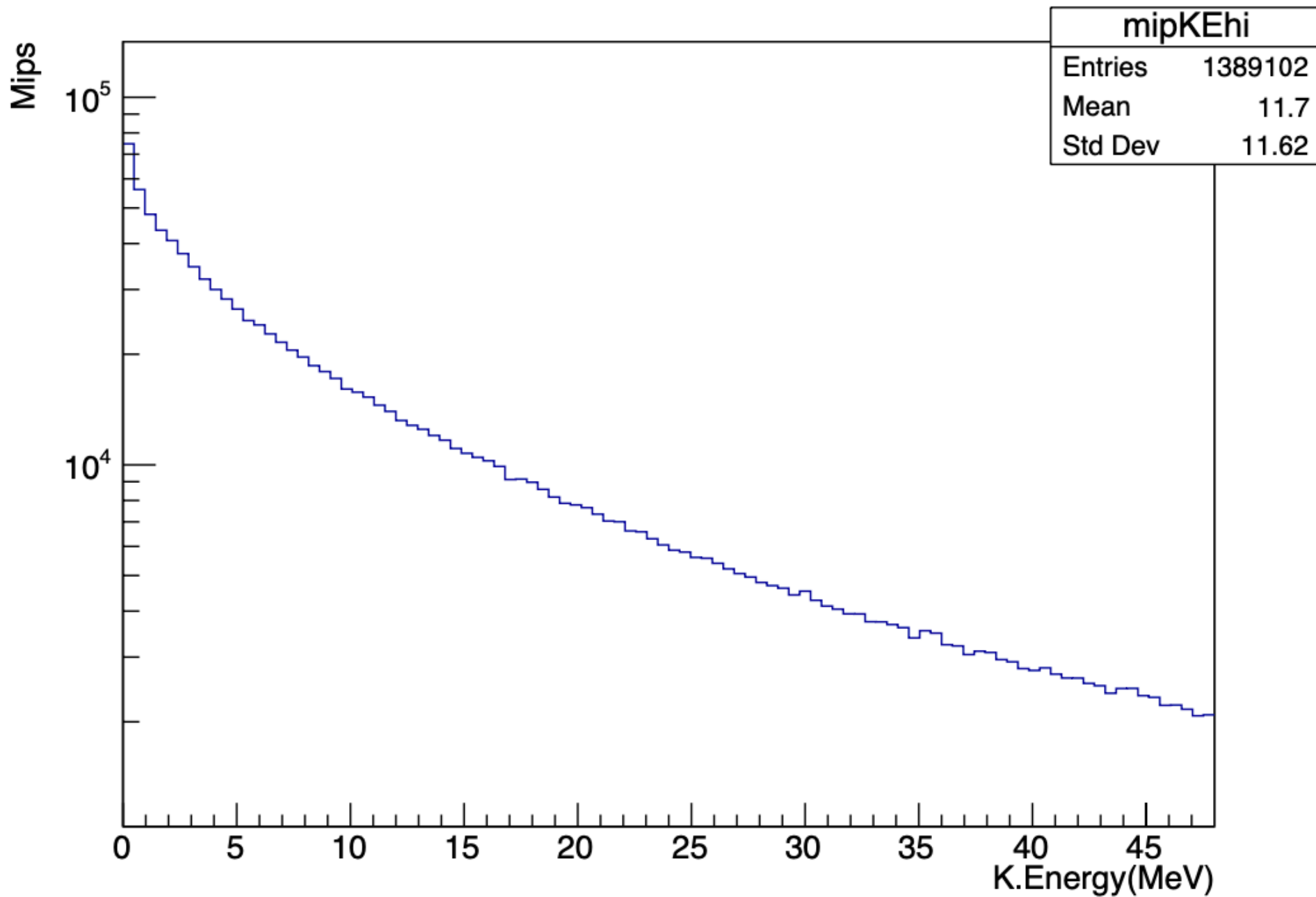
- ❖ 1. Threshold dependence of resolution.
  - ❖ mip and pixel hit.
- ❖ 2. Continued studies - single silicon layer within tungsten calorimeter.
  - ❖ mips / hits / clusters
- ❖ 3. Distribution of hits on 5 mm reticle

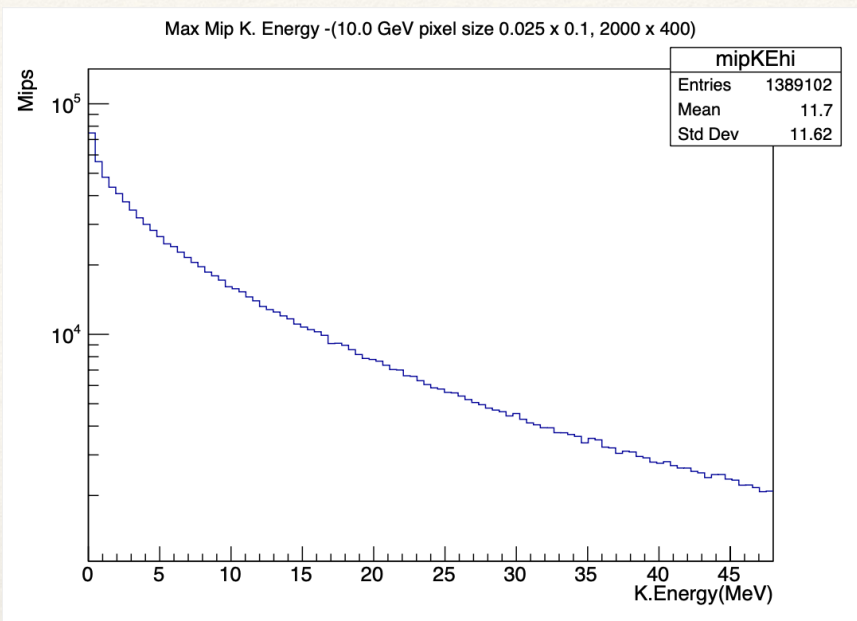
# 1. Threshold dependence of resolutions



- ❖ What is resolution vs. mip threshold? (0.1 MeV  $\rightarrow$  30 MeV)
- ❖ What is resolution vs. pixel threshold? (1 keV  $\rightarrow$  10 keV)  
(270 e's  $\rightarrow$  2700 e's)

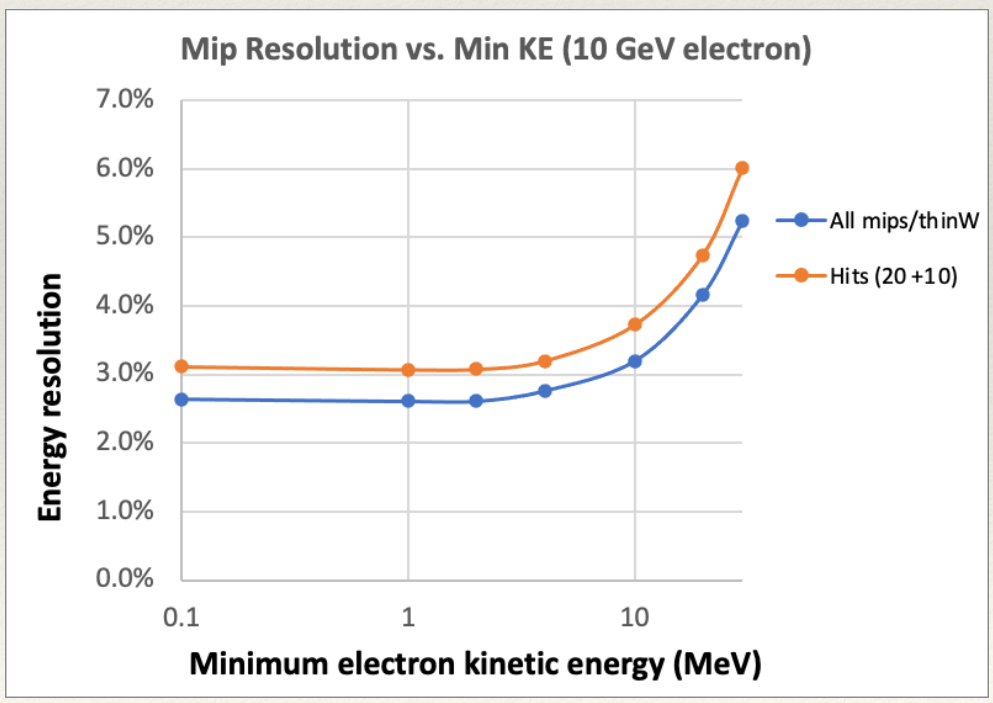
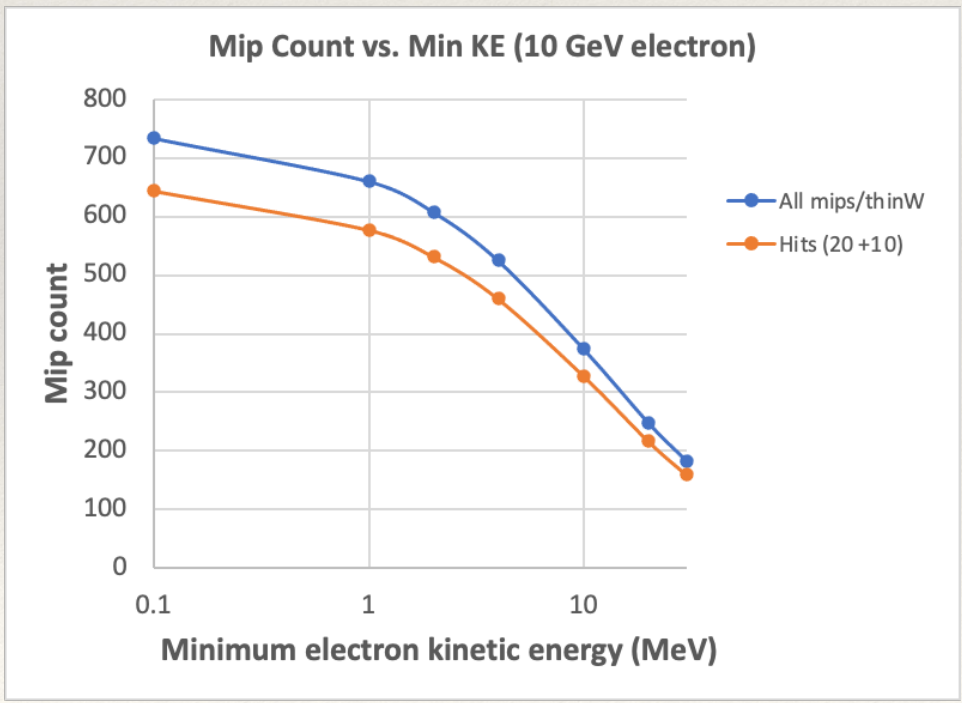
Max Mip K. Energy -(10.0 GeV pixel size 0.025 x 0.1, 2000 x 400)

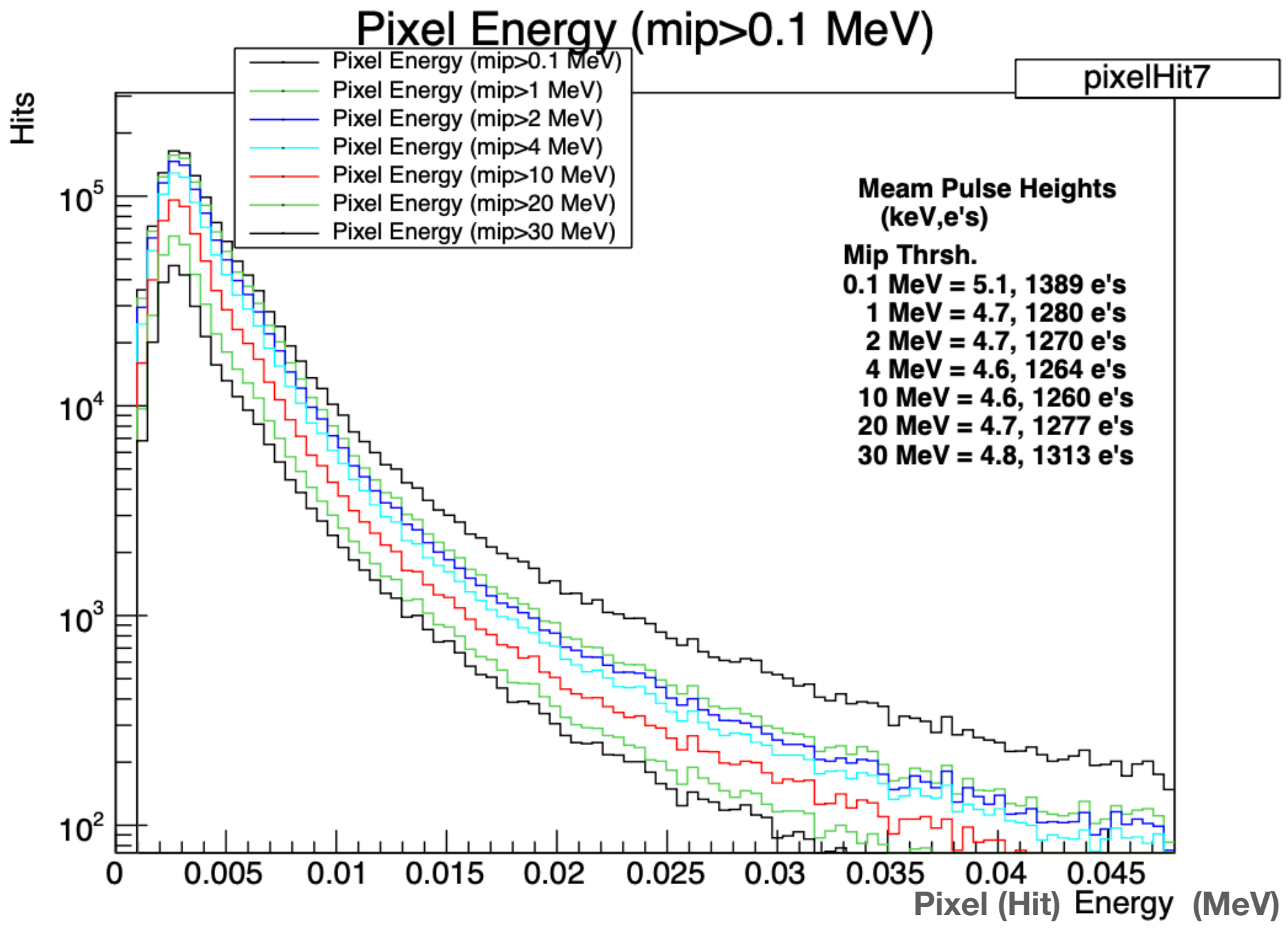


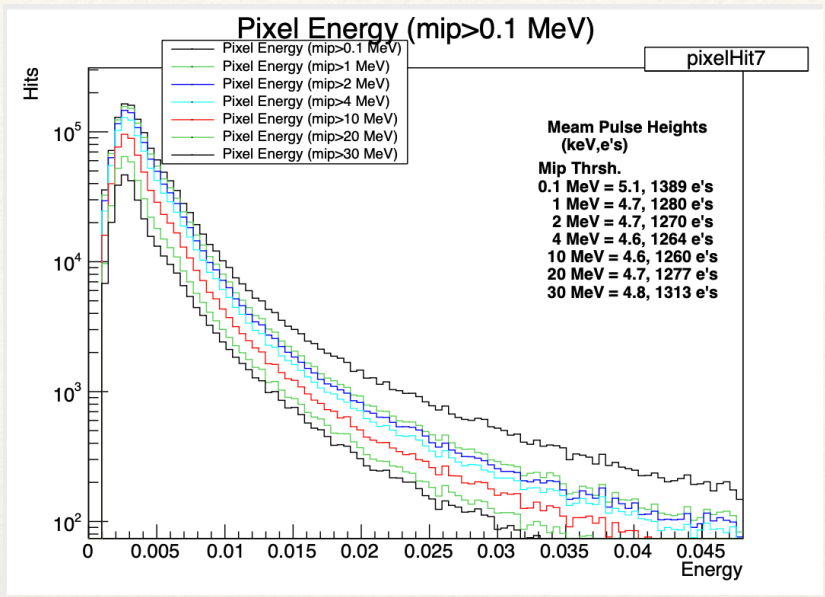


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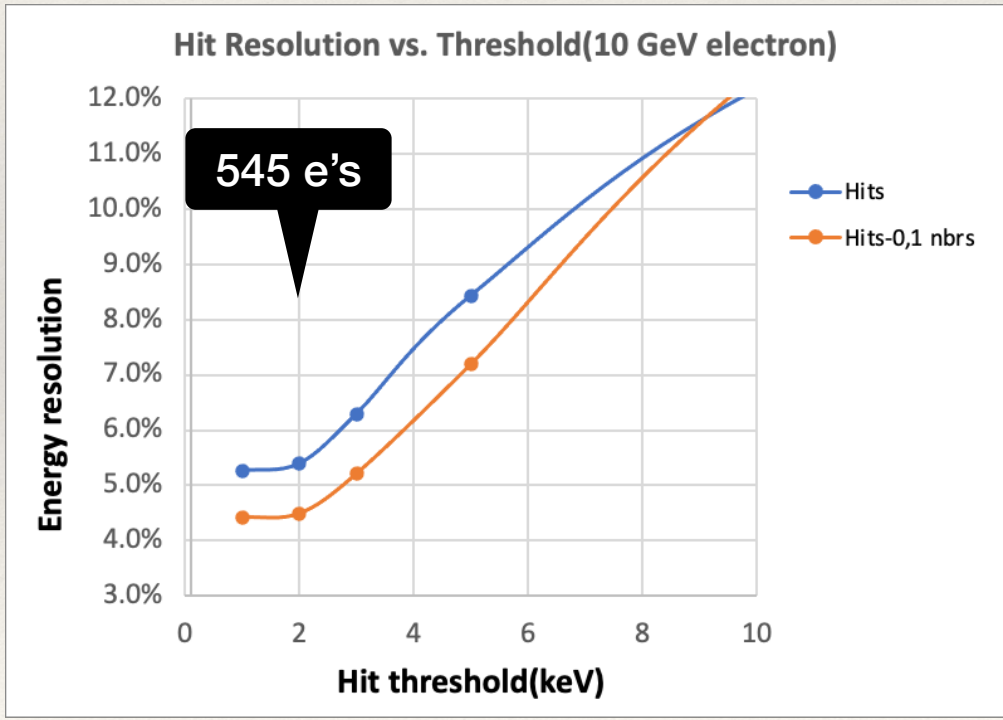
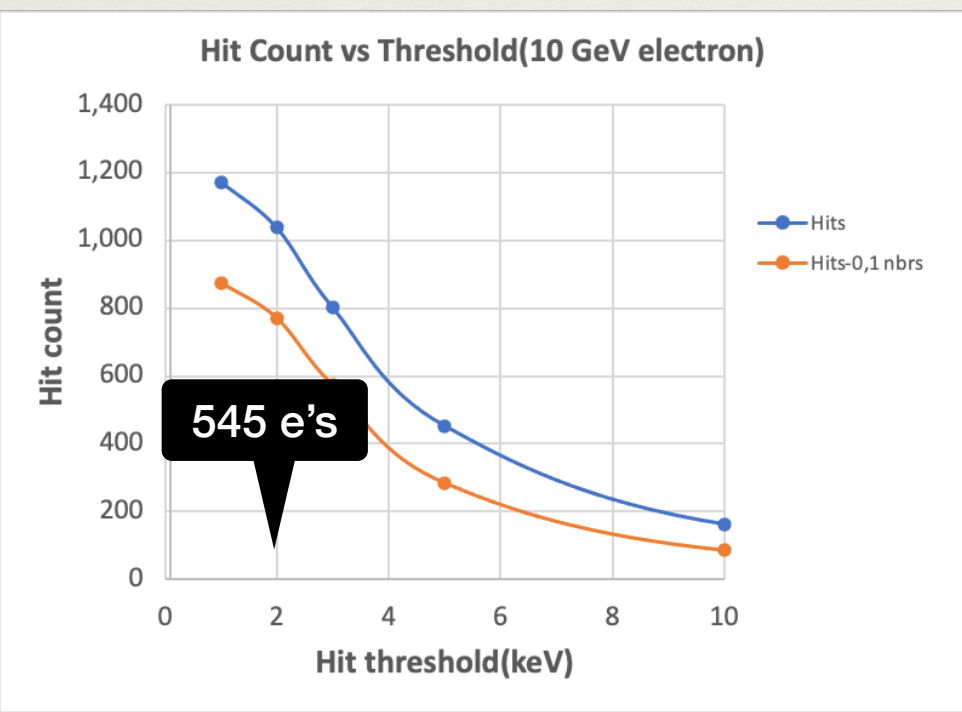
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# 1. Threshold dependence of resolutions



- ❖ What is resolution vs. mip threshold? (0.1 MeV  $\rightarrow$  30 MeV)
  - ❖ Degradation begins at 3 MeV and doubles at 30 MeV.
- ❖ What is resolution vs. pixel threshold? (1 keV  $\rightarrow$  10 keV)  
(270 e's  $\rightarrow$  2700 e's)
  - ❖ Degradation begins at 2 keV and doubles at 7-8 keV.  
(1900 e's - 2180 e's)



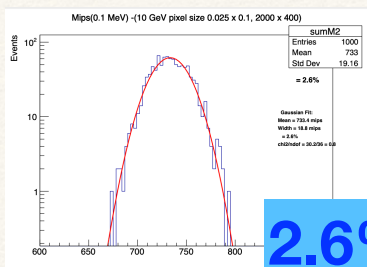
## 2. Mip, hit, cluster studies



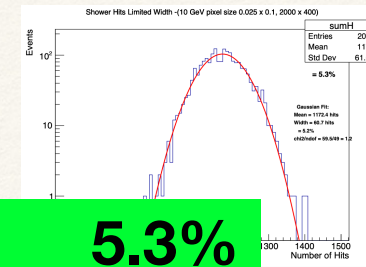
- ❖ Weighting clusters by average mip multiplicity for cluster size.
- ❖ Cluster shape studies.
  - ❖ Average mip dependence on  $y$ ,  $z$ , total sizes.
- ❖ Analysis of contributions to resolution.
  - ❖ Clusters with mips.
  - ❖ Clusters w/o mips - size =1
  - ❖ Clusters w/o mips - size >2



# 10 GeV electrons

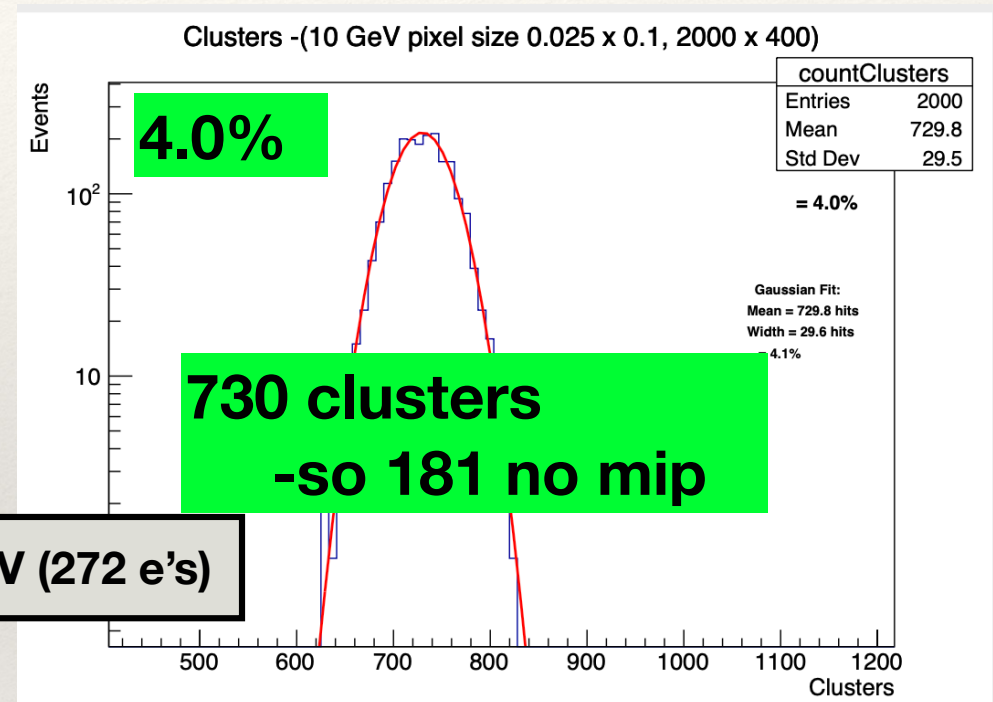
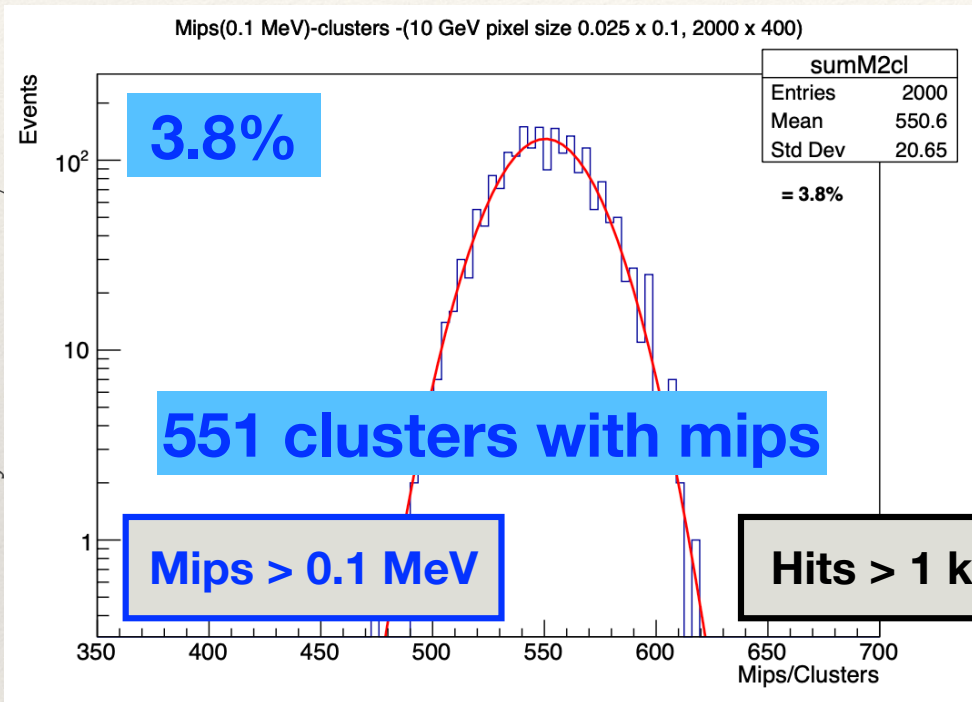


**2.6%**  
 ↘  
**3.8%**



**5.3%**  
 ↘  
**4.0%**

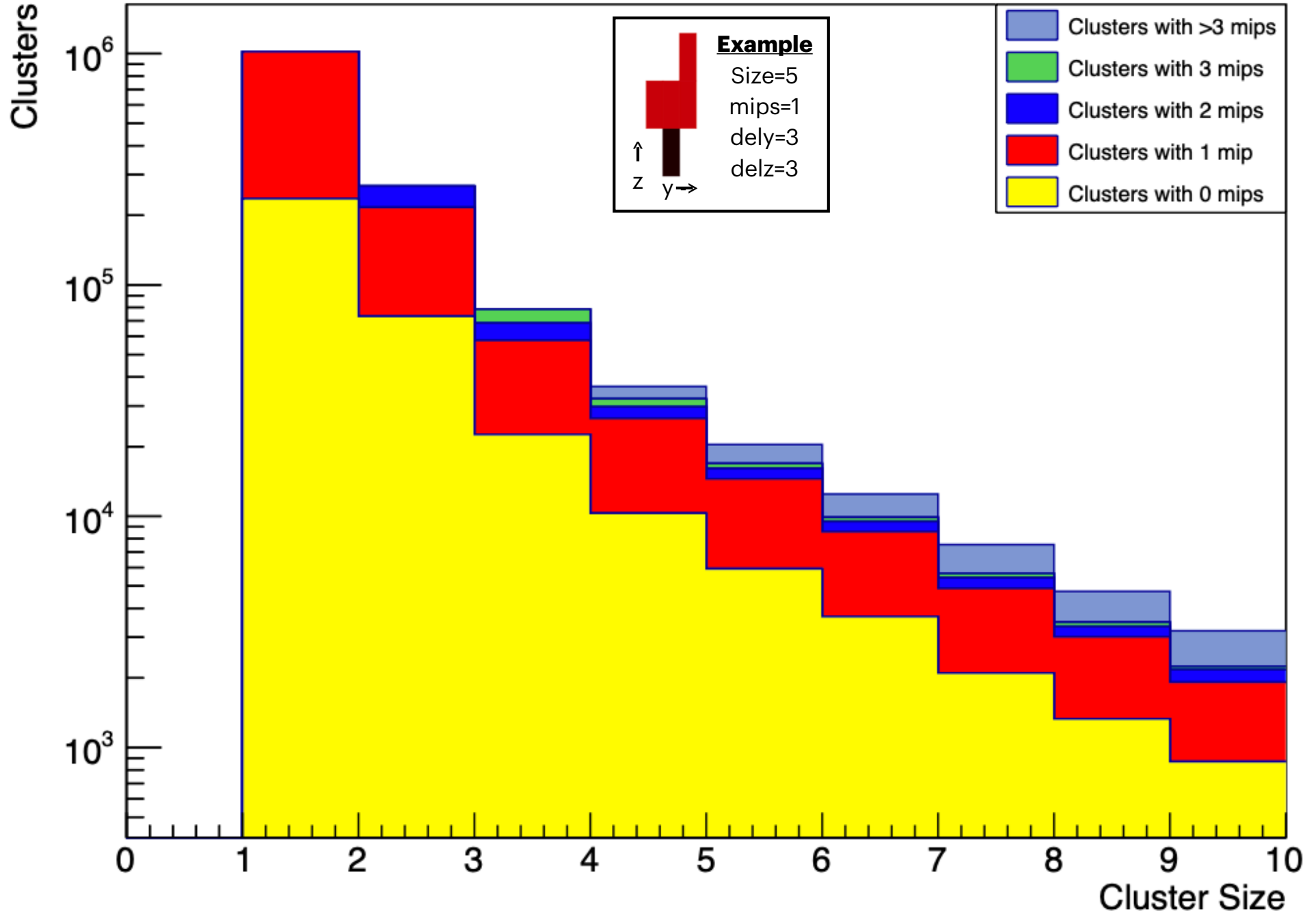
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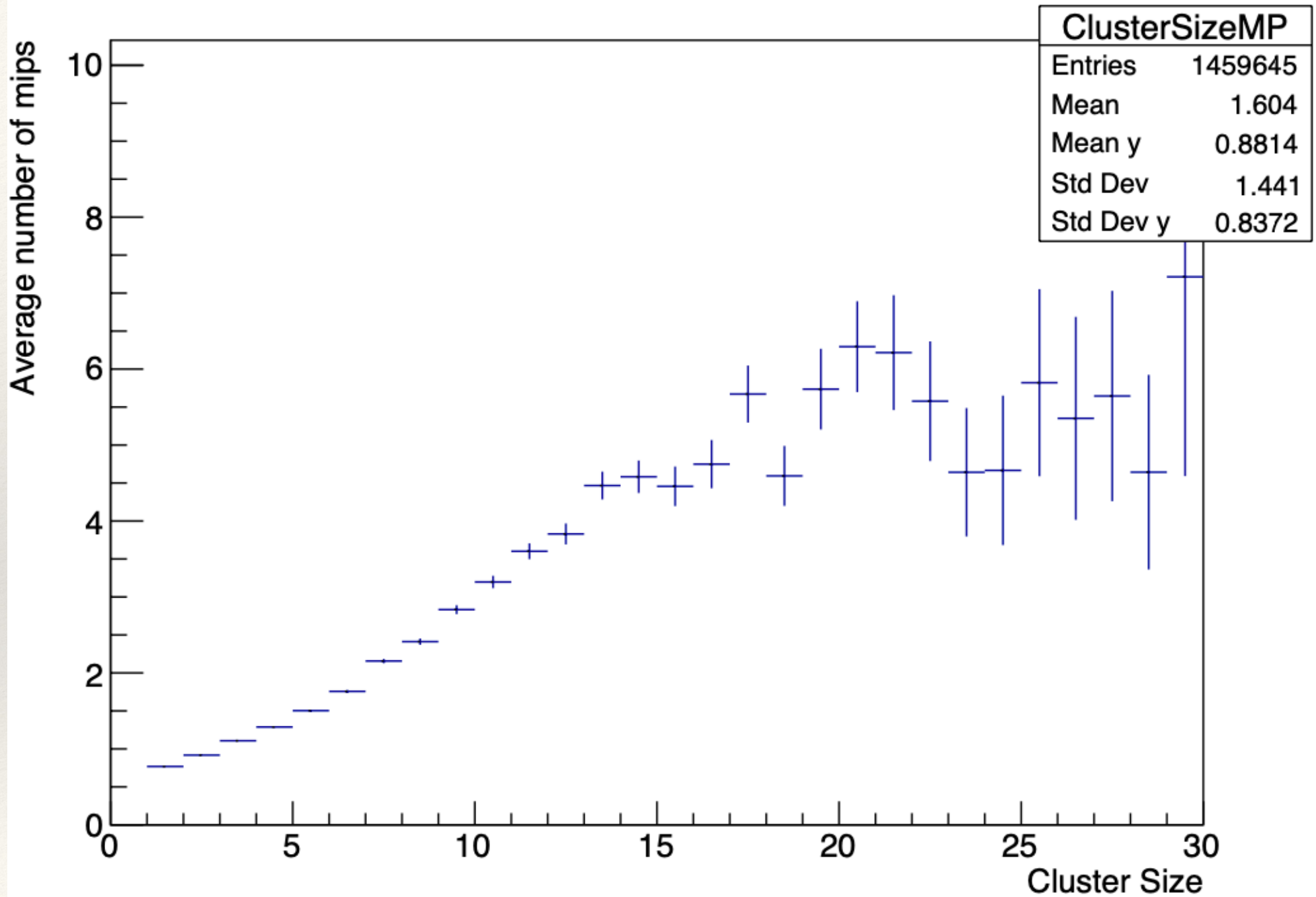
**Simple cluster algorithm**

**But both depend on my simple cluster algorithm.  
 Can we do better?**

# Cluster Size for Mip Counts



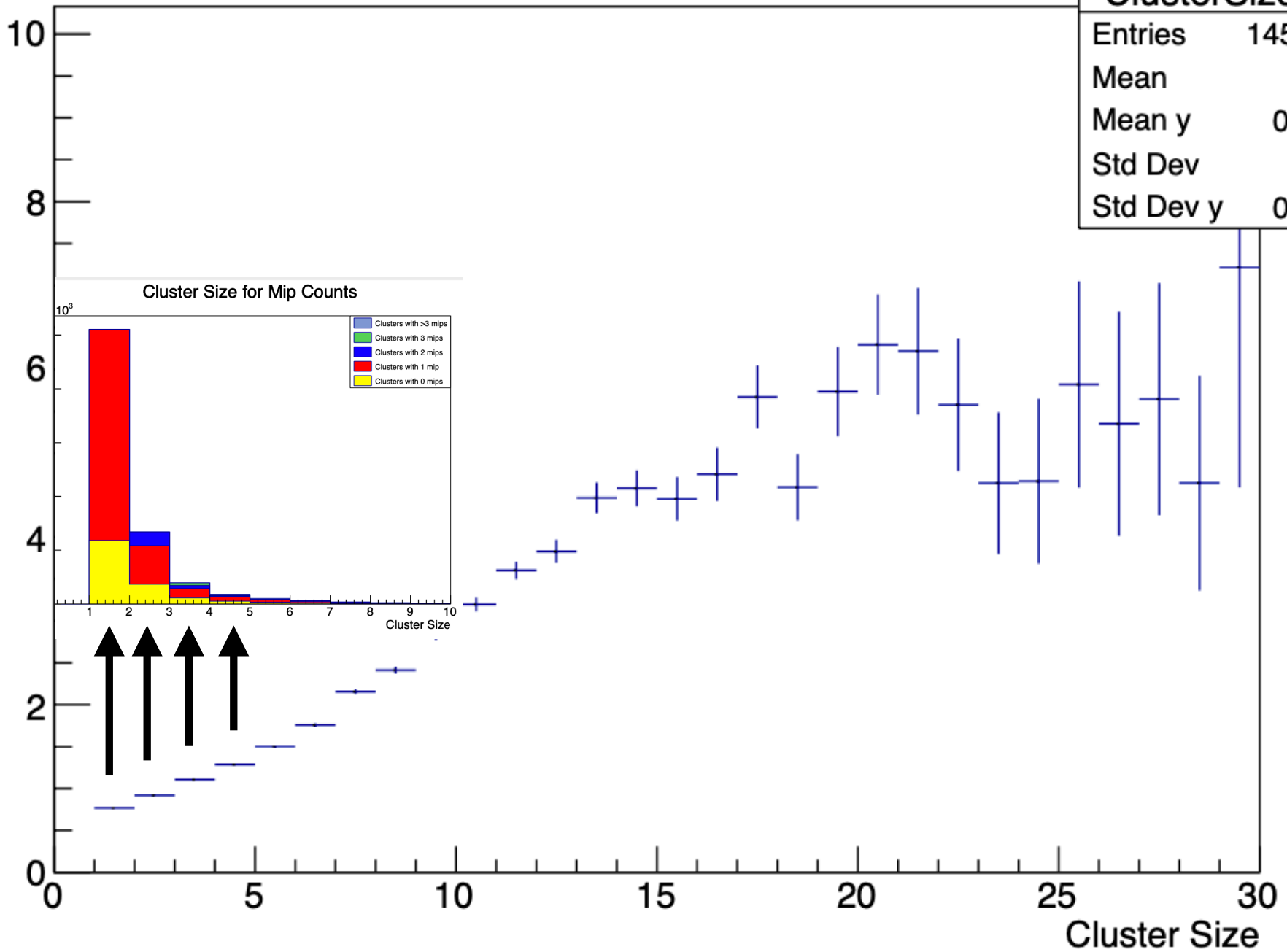
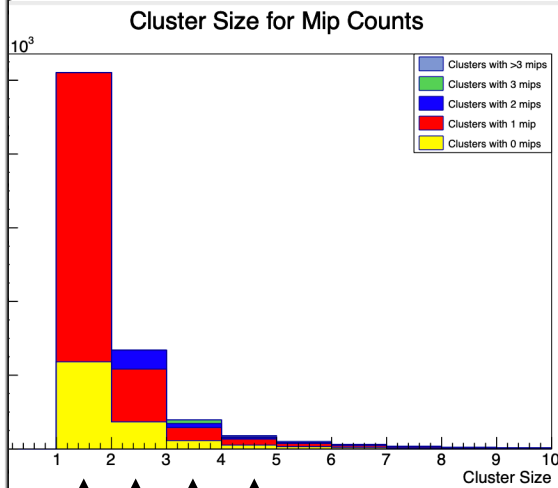
Average mips vs. Cluster Size -(10 GeV pixel size 0.025 x 0.1, 2000 x 400)



Average mips vs. Cluster Size -(10 GeV pixel size 0.025 x 0.1, 2000 x 400)

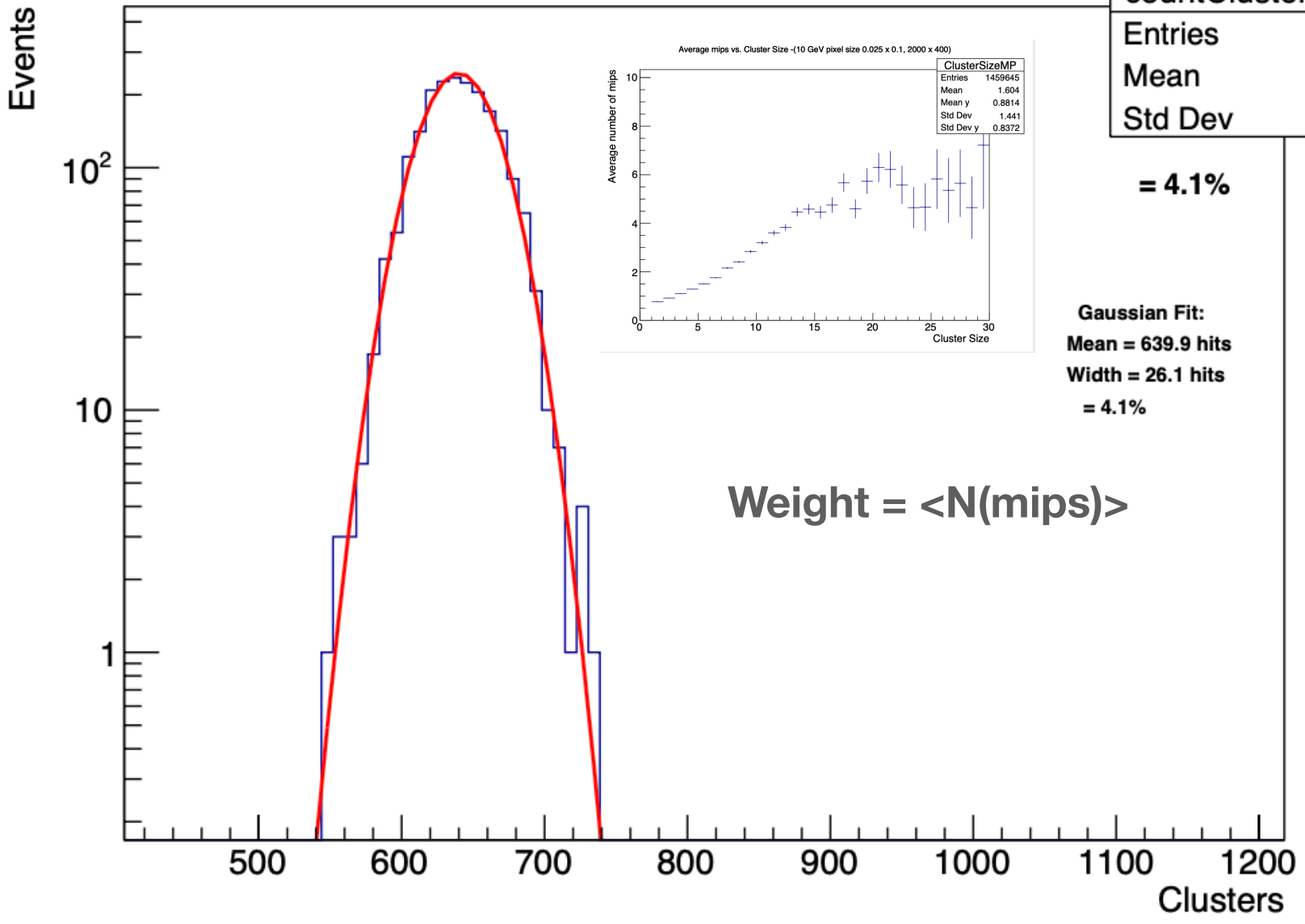
Average number of mips

ClusterSizeMP	
Entries	1459645
Mean	1.604
Mean y	0.8814
Std Dev	1.441
Std Dev y	0.8372

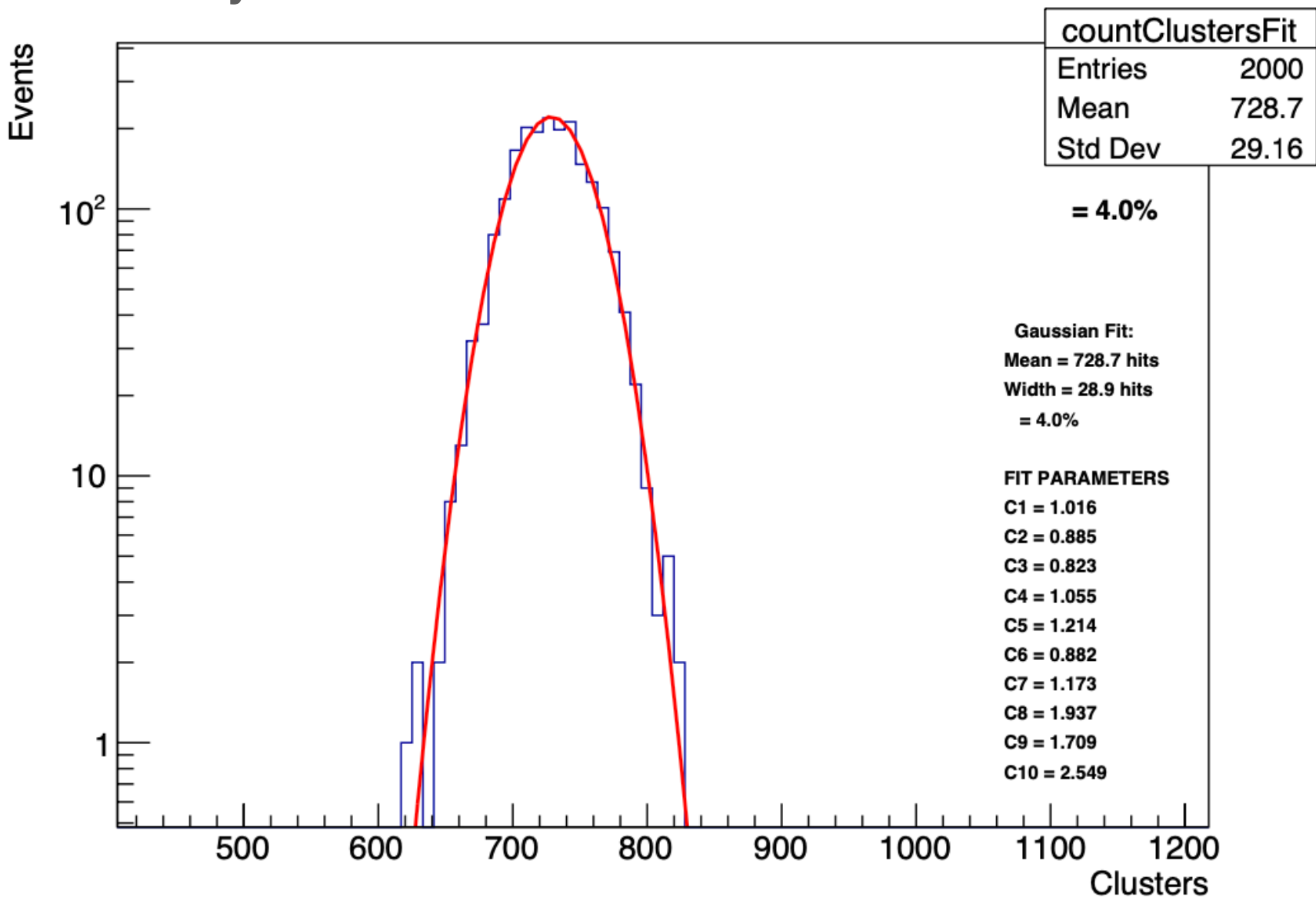


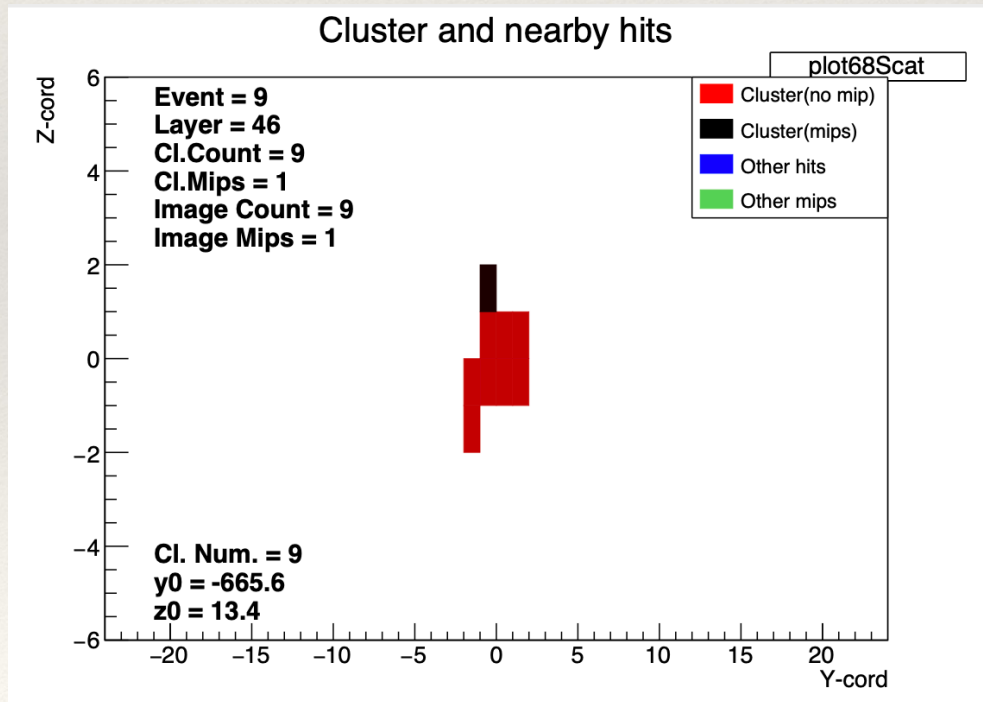
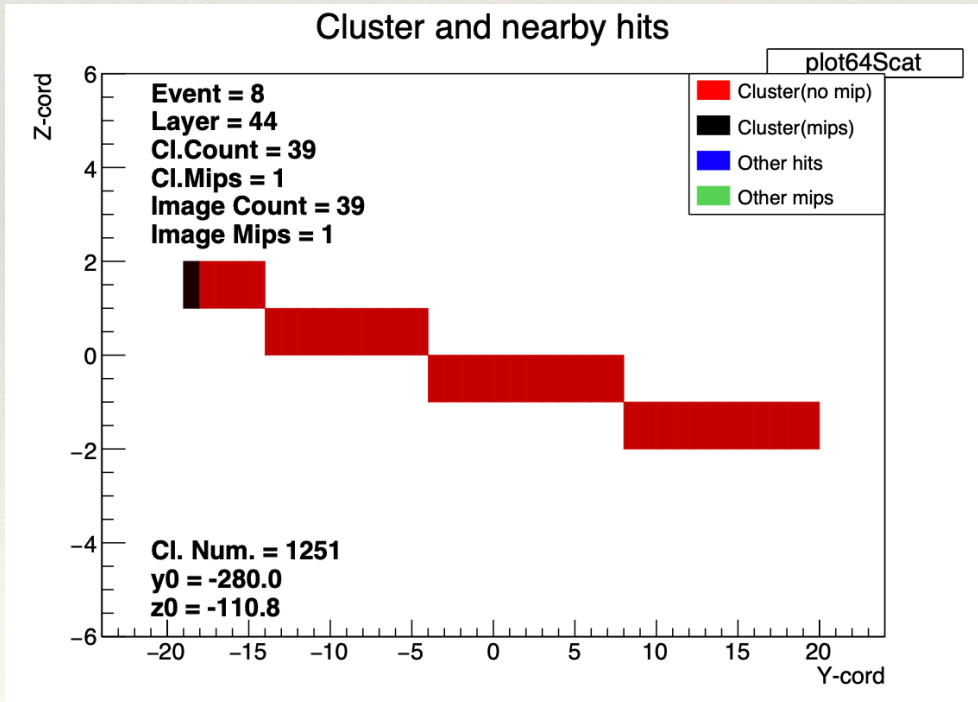
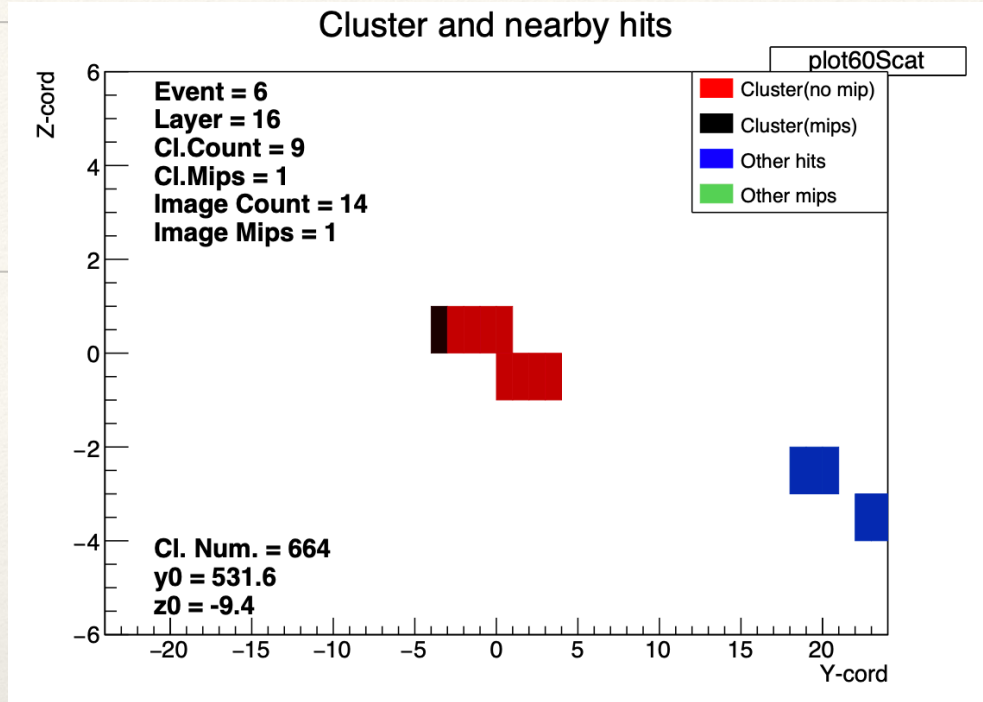
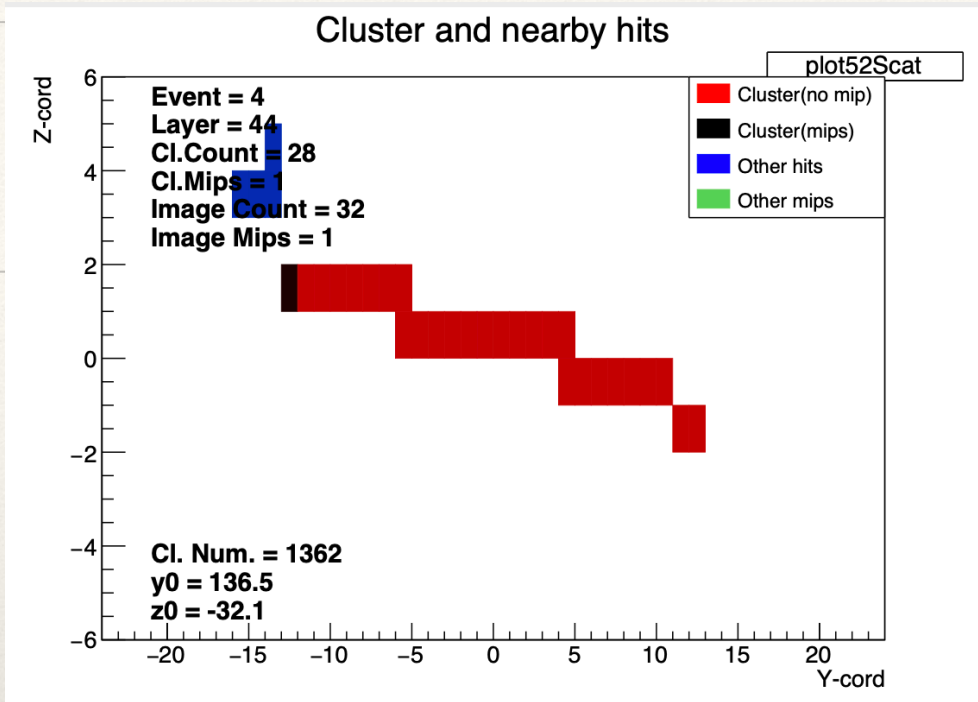


# Weighted by cluster size -(10 GeV pixel size 0.025 x 0.1, 2000 x 400)

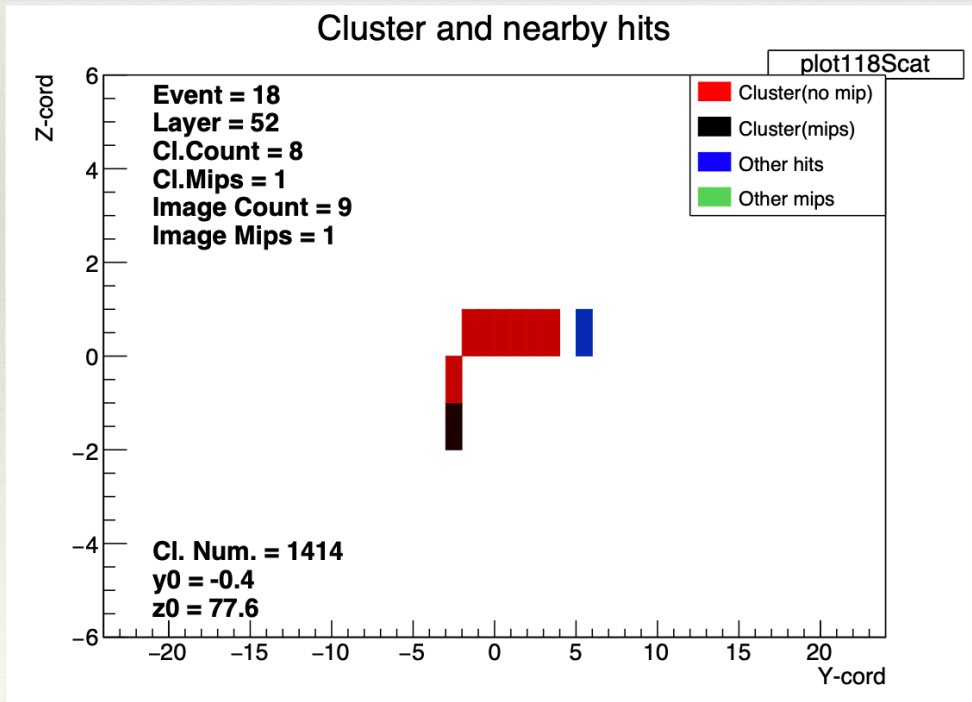
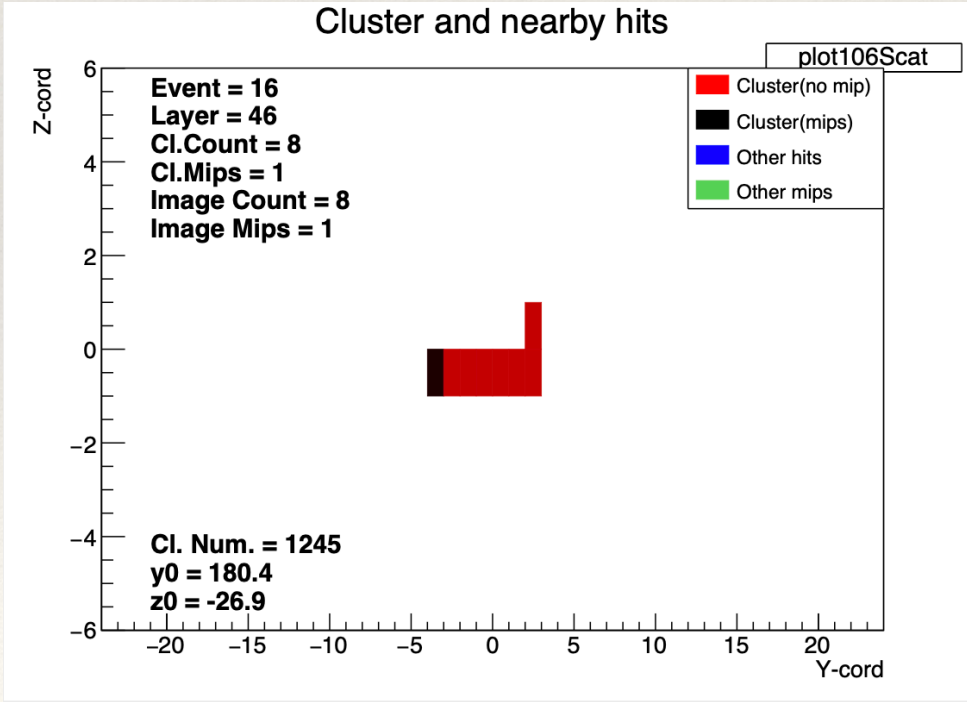
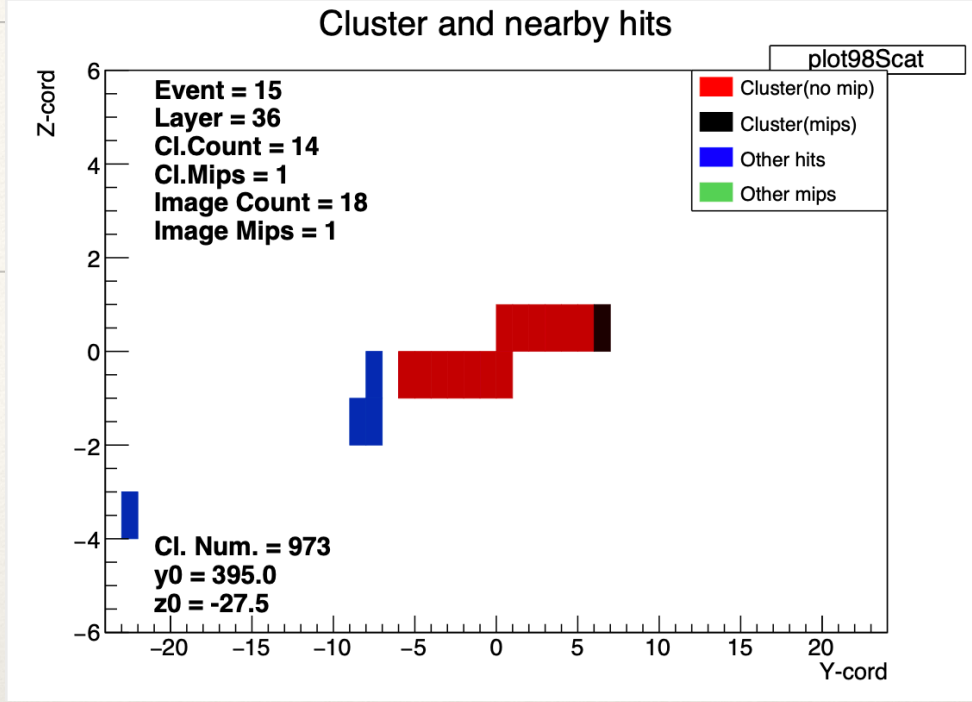
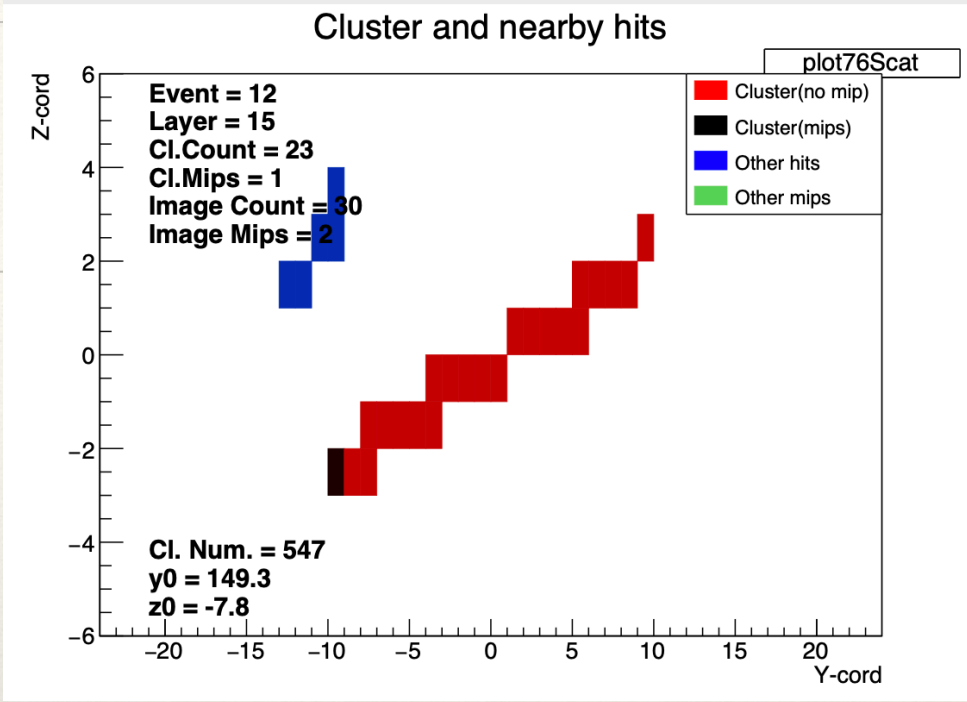


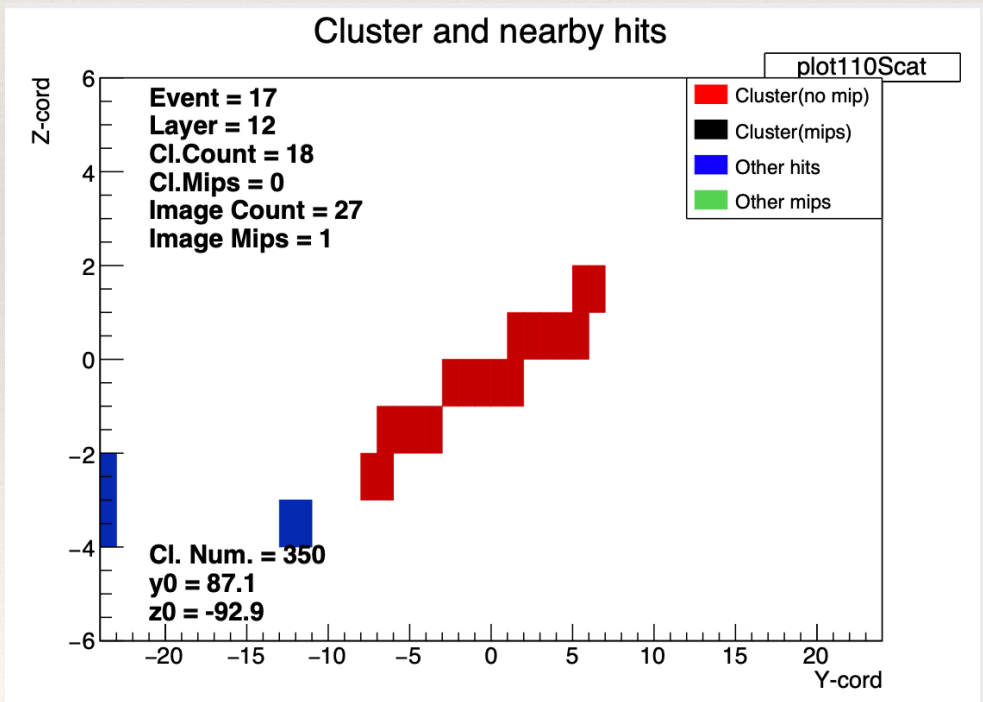
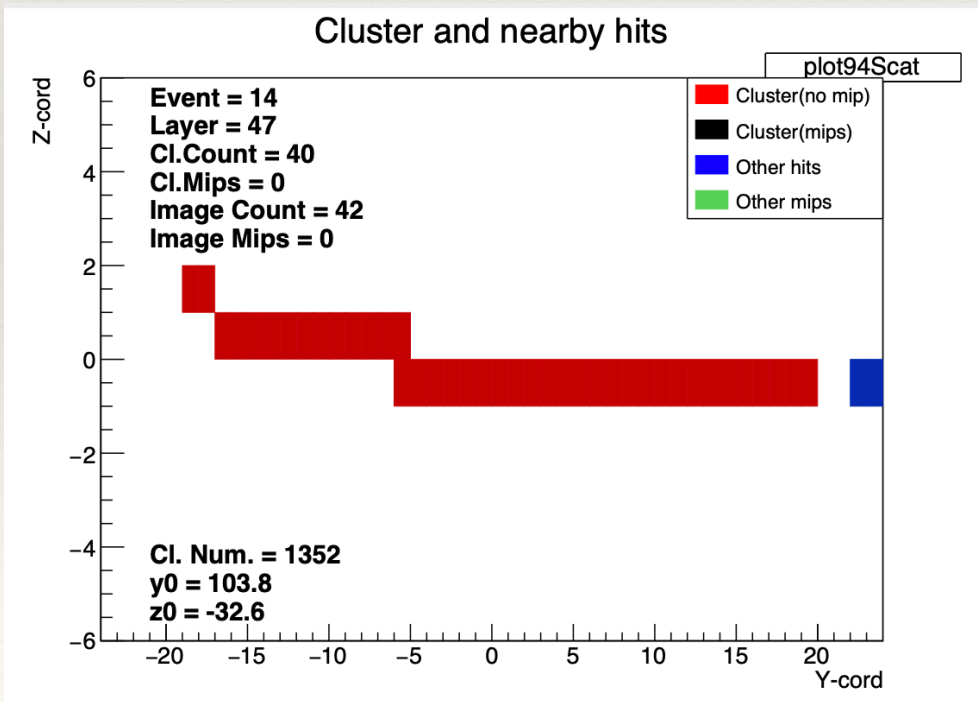
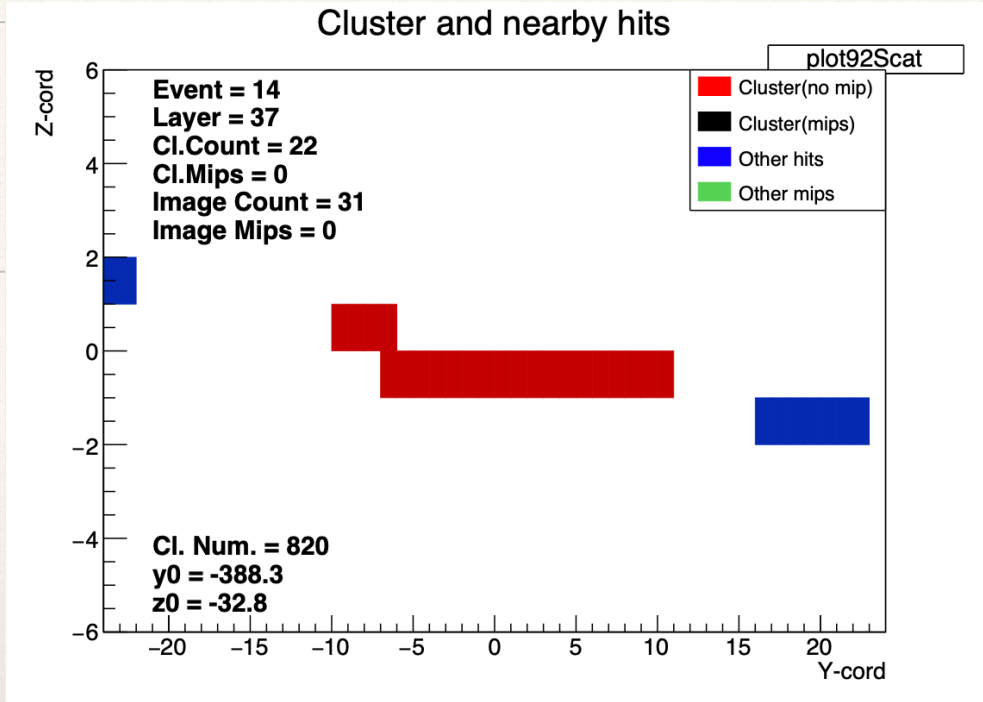
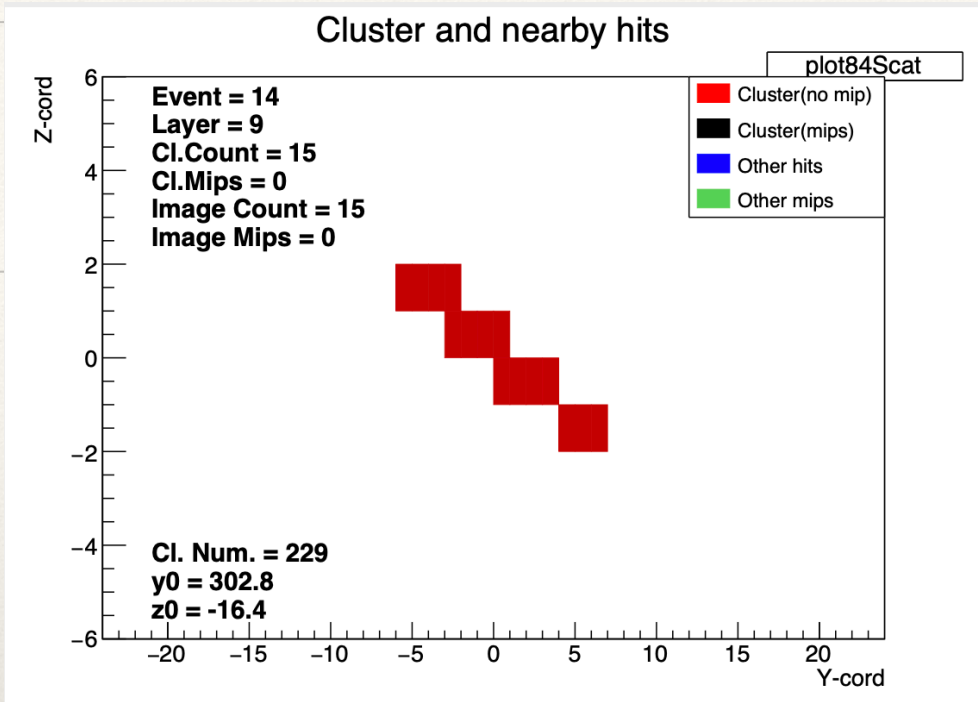
### Fit by cluster size -(10 GeV pixel size 0.025 x 0.1, 2000 x 400)



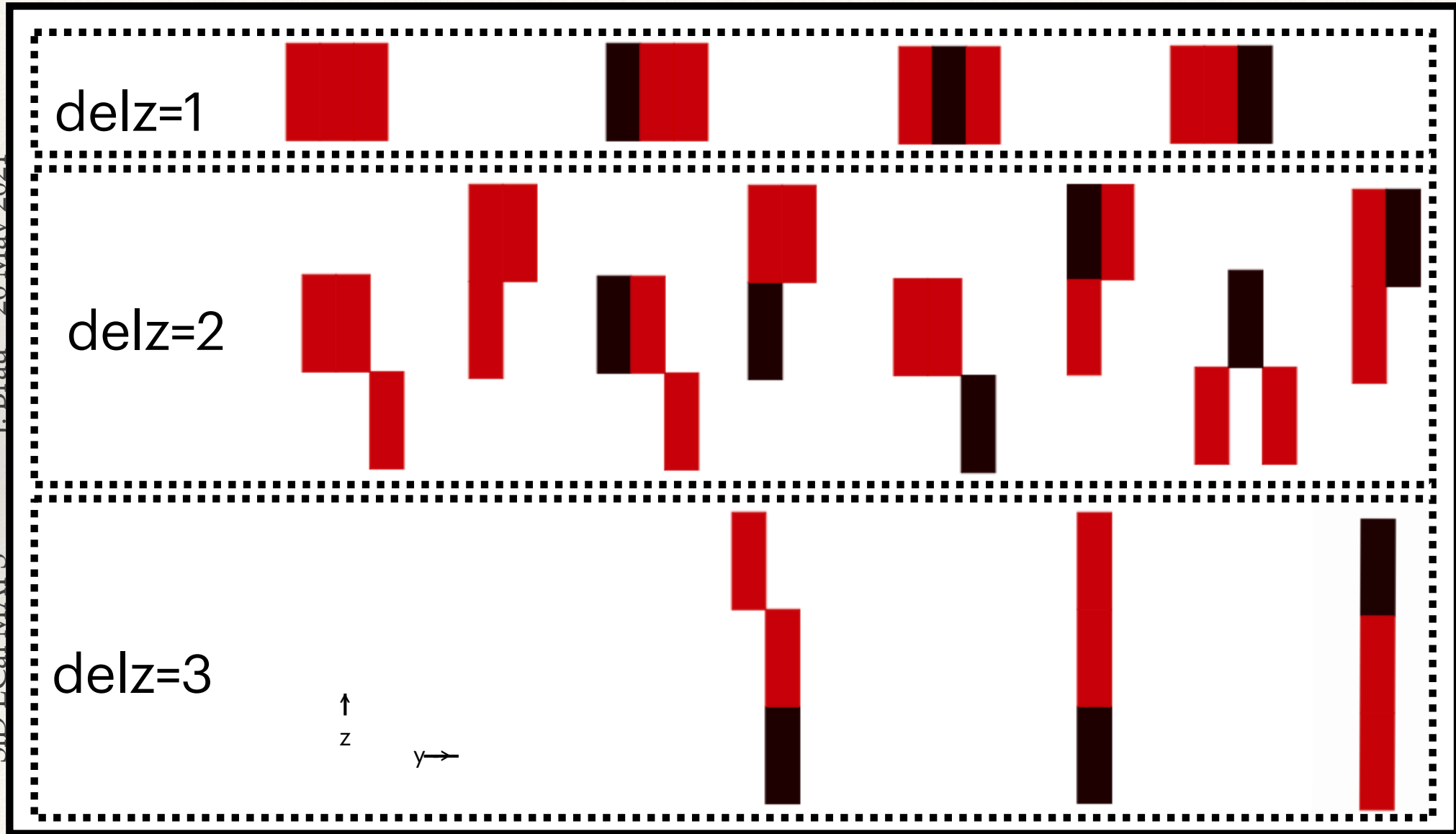




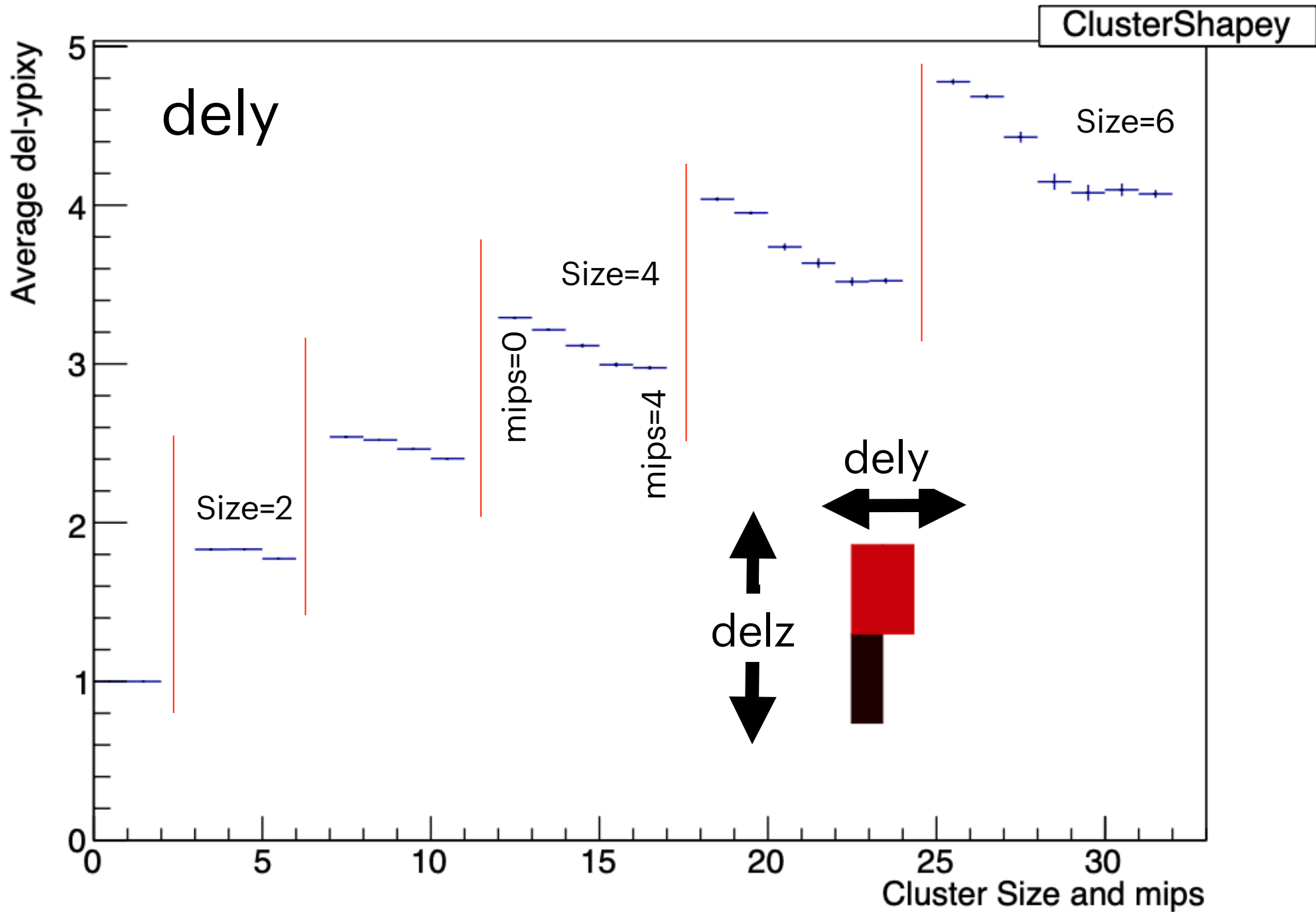




# Cluster Shape (Size = 3)

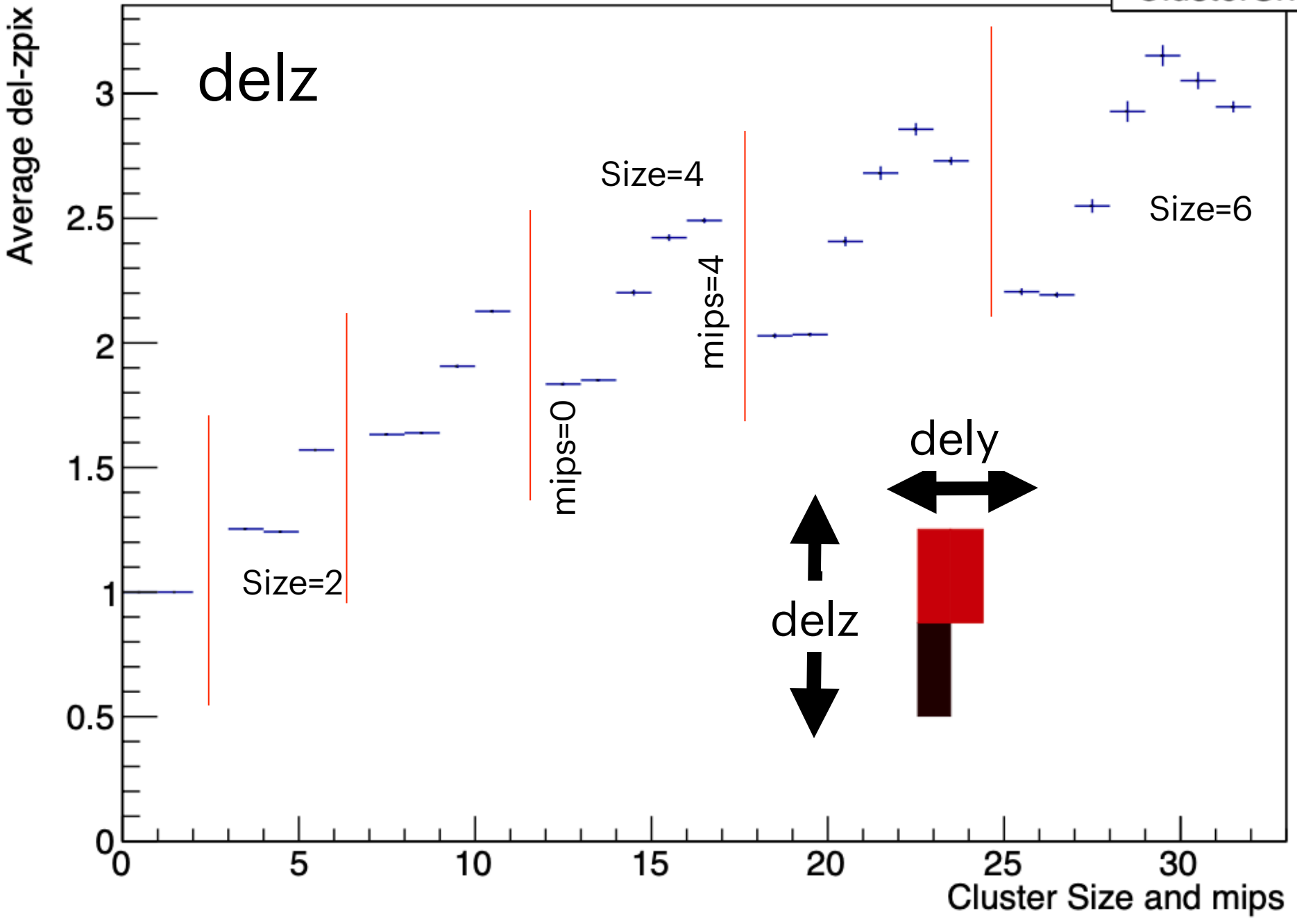


Average del-ypix vs. Cluster Size and mips -(10 GeV pixel size 0.025 x 0.1, 2000 x 400)



Average del-zpix vs. Cluster Size and mips -(10 GeV pixel size 0.025 x 0.1, 2000 x 400)

ClusterShapez

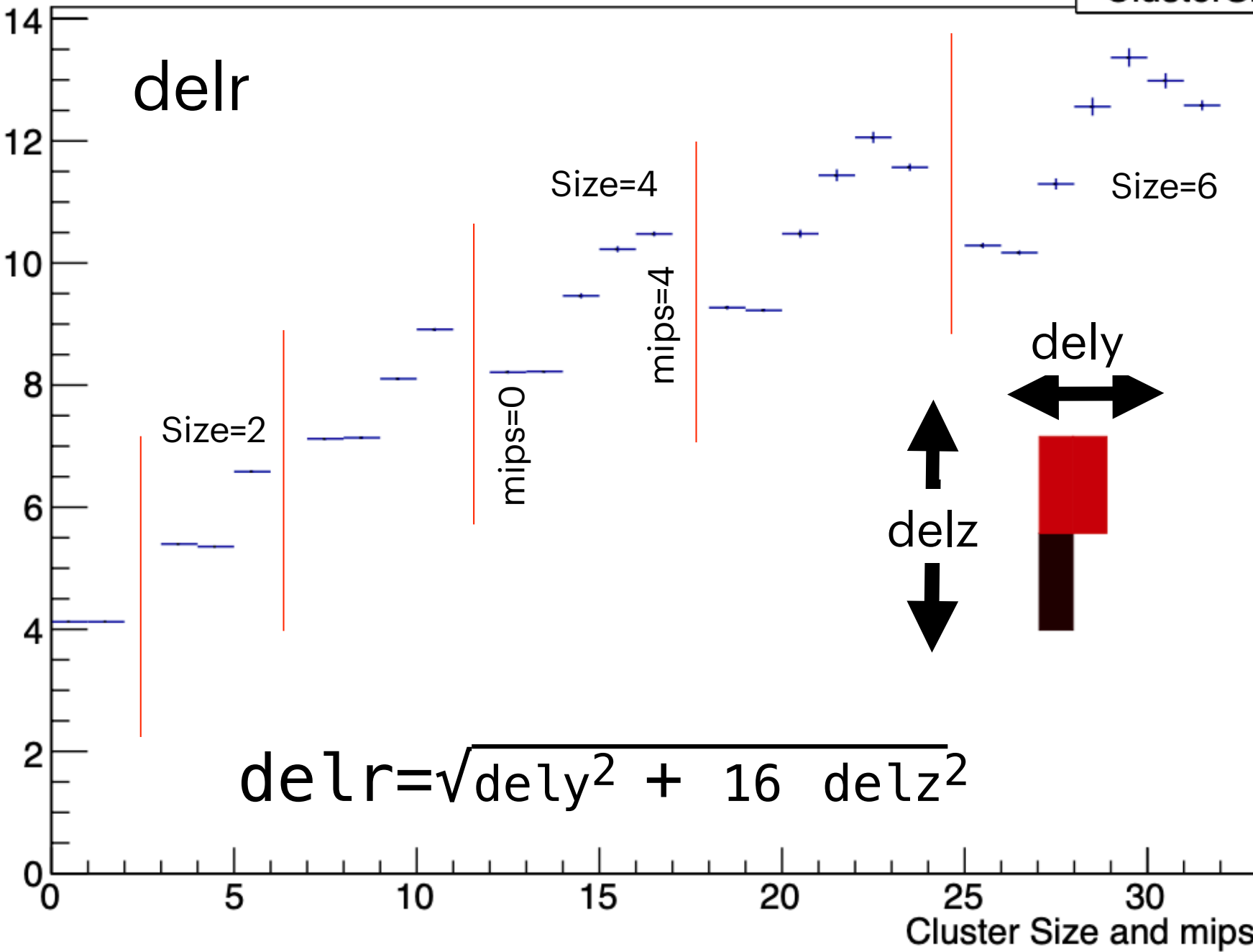


Average del-rpix vs. Cluster Size and mips -(10 GeV pixel size 0.025 x 0.1, 2000 x 400)

ClusterShaper

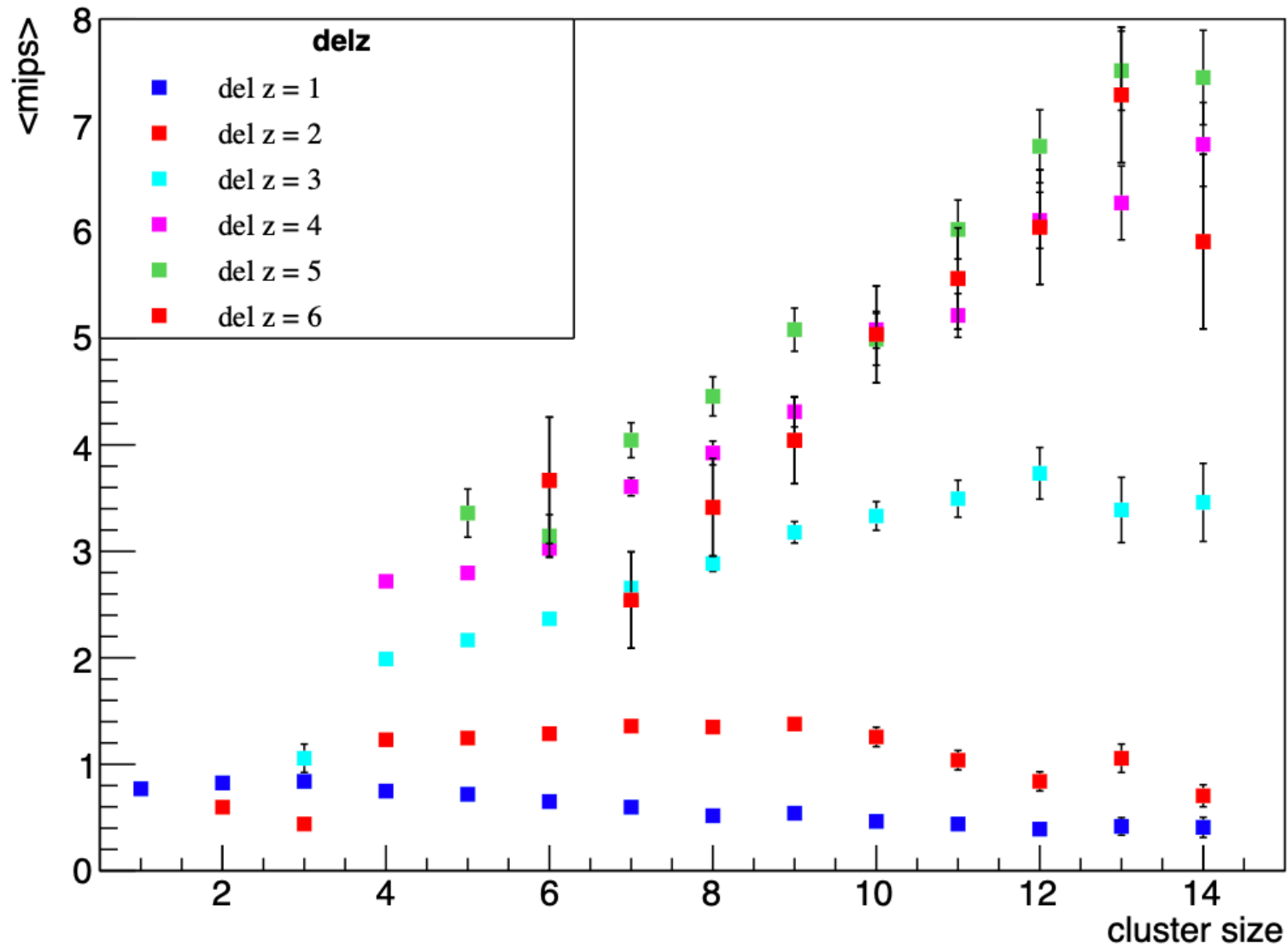
Average del-rpix

delr

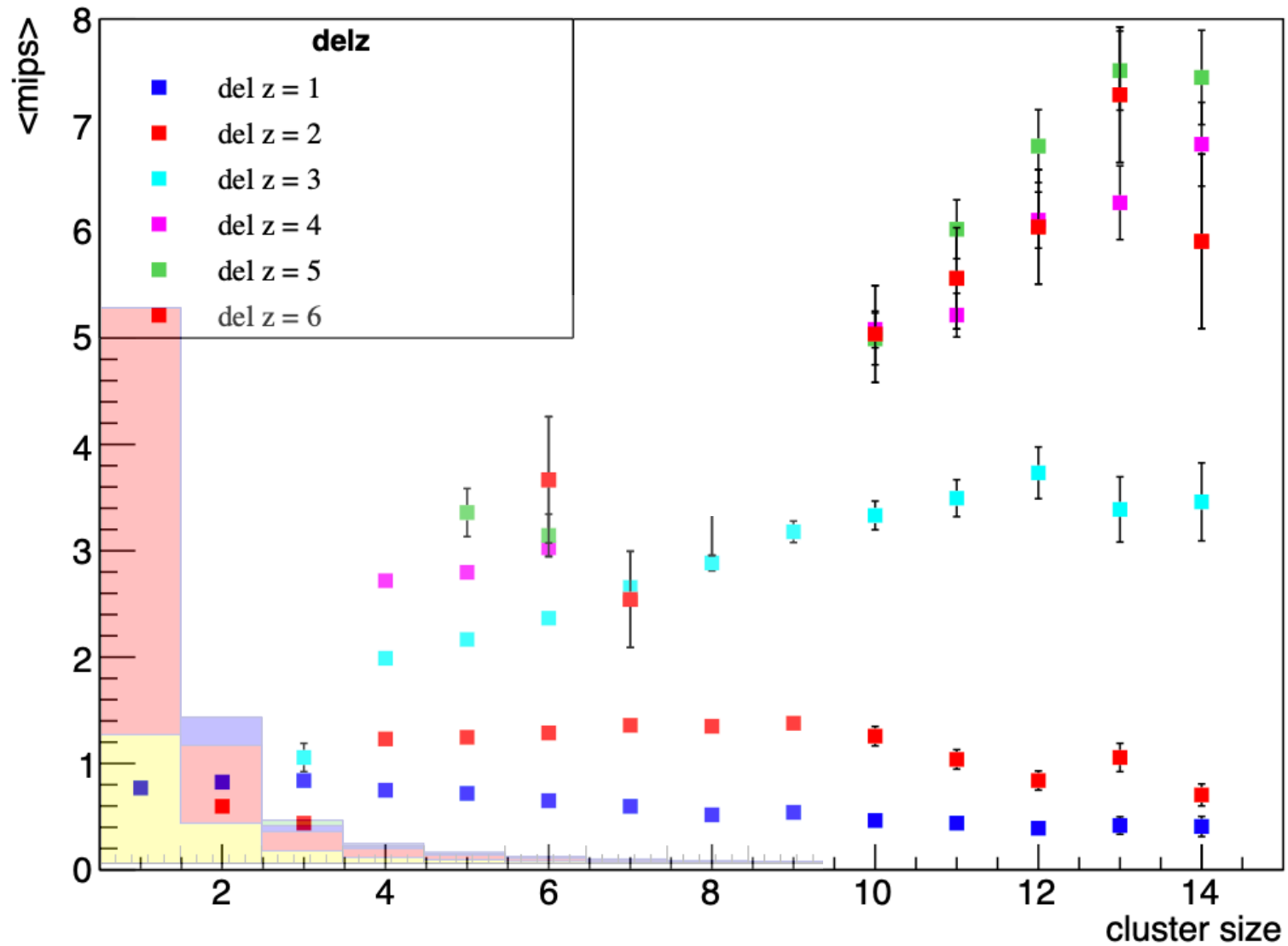


Cluster Size and mips

## Average mips vs. cluster size (for delz)

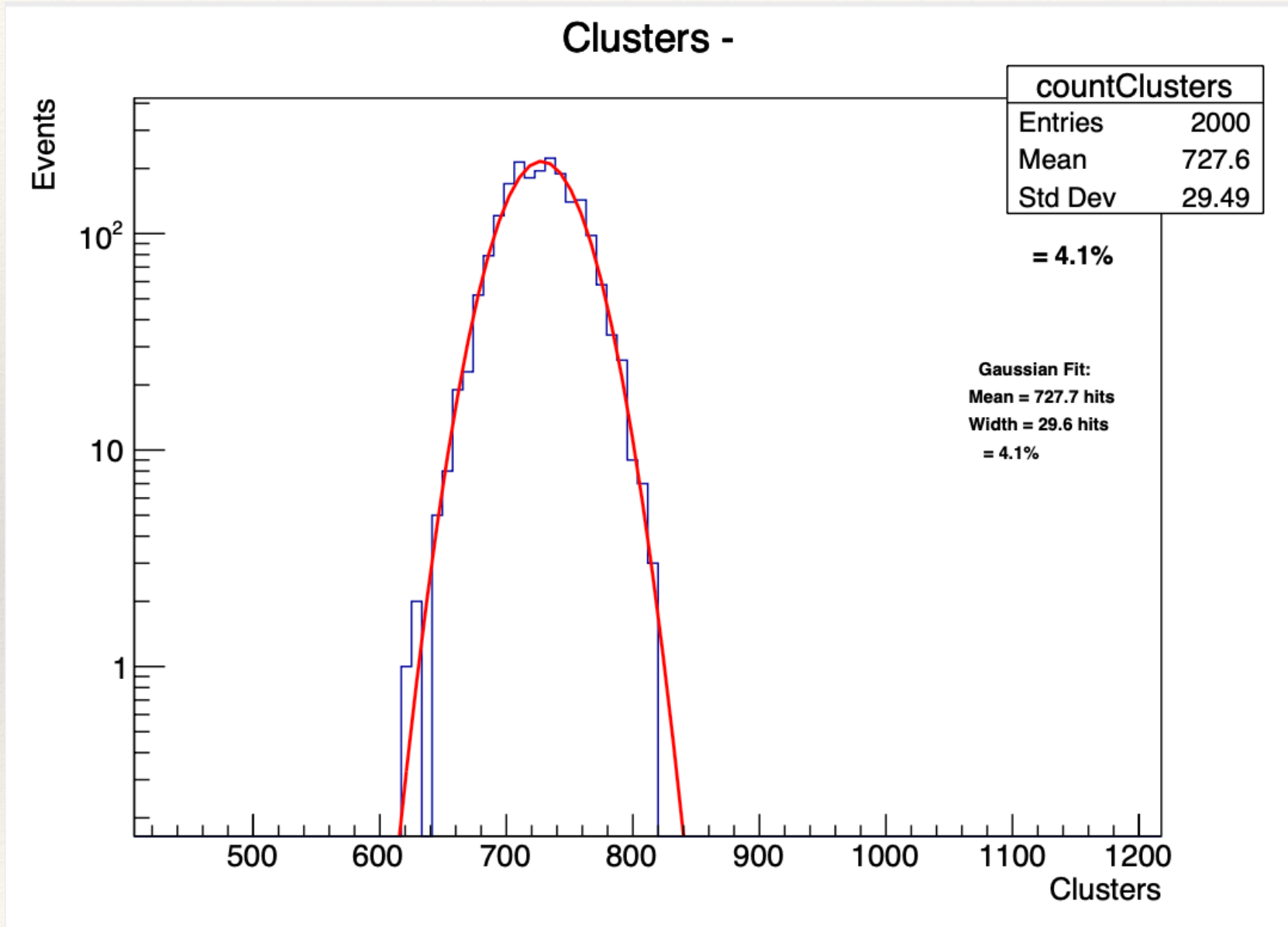


# Average mips vs. cluster size (for delz)

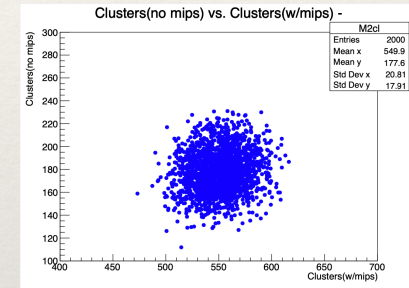
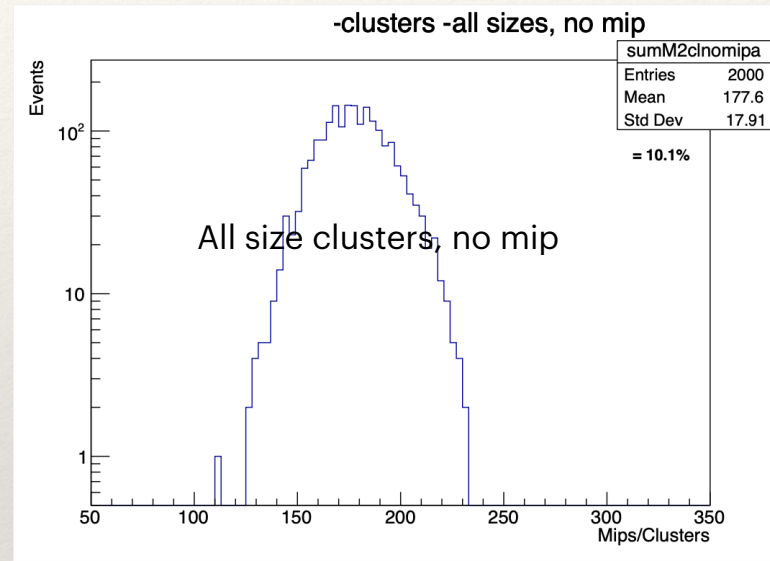
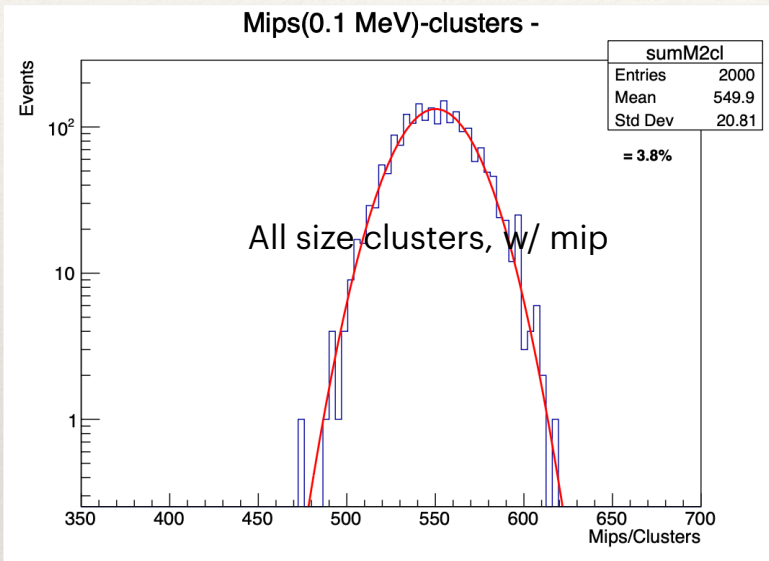
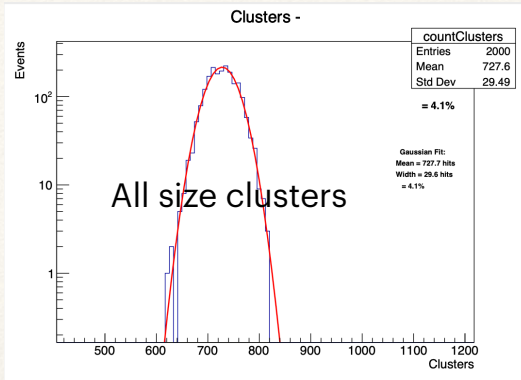




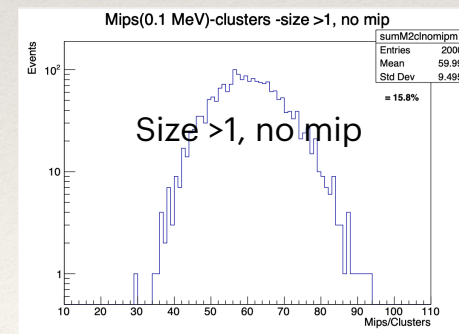
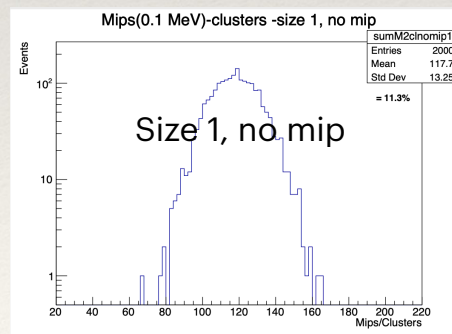
# Analysis: contributions to resolution



# Analysis: contributions to resolution



No correlation:  
Clusters w/mips  
Clusters - no mips



# Analysis: contributions to resolution

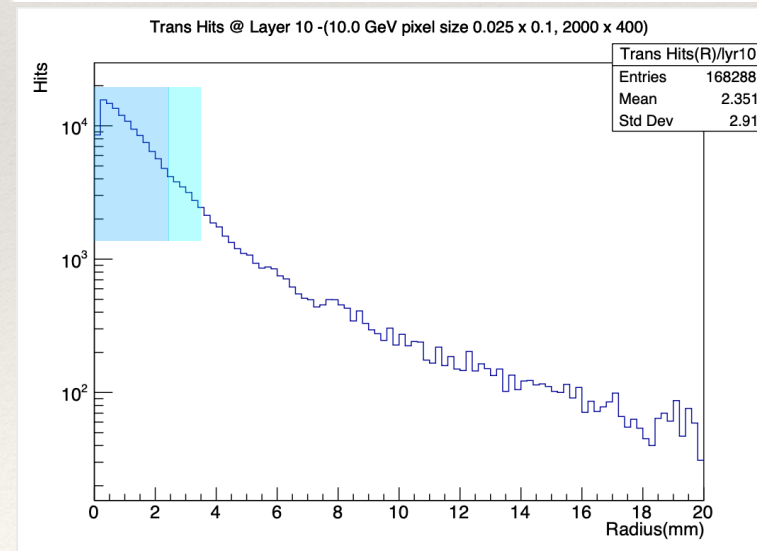
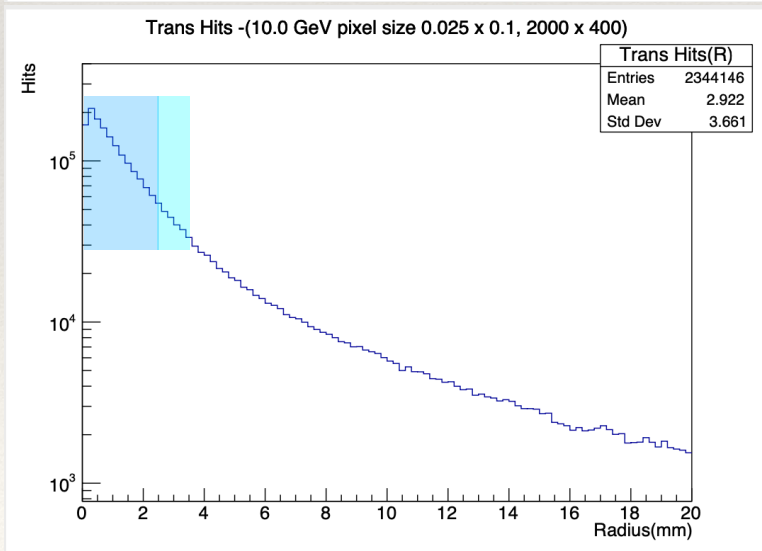
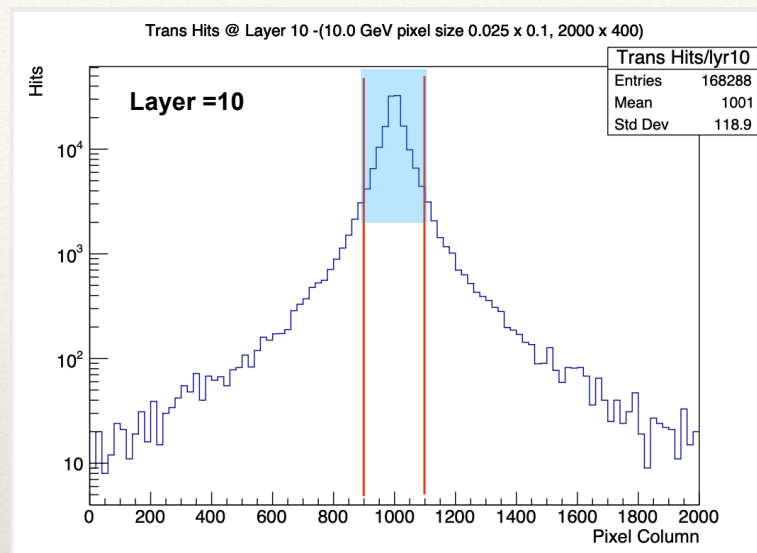
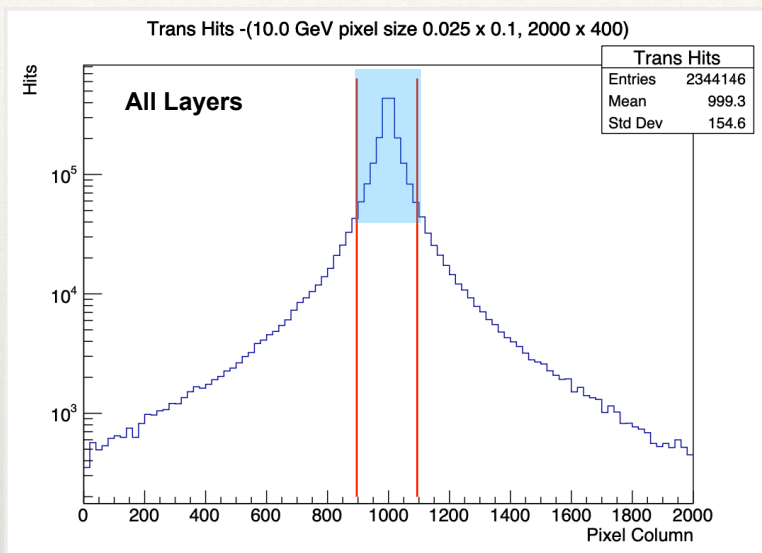
- ❖ Clusters =  $727.6 \pm 29.5 = 4.0\%$ .
- ❖ Clusters w/ mips =  $550 \pm 20.8 = 3.8\%$ .
- ❖ Clusters w/o mips
  - ❖ Size 1 clusters w/o mips =  $117.7 \pm 13.2$ .
  - ❖ Size > 1, no mips =  $60.0 \pm 9.5$ .
  - ❖ All sizes, no mip.  $177.6 \pm 17.9$
- ❖ Sum =  $728 \pm 26.0 = 3.6\%$ .

# 3. 5 mm reticle

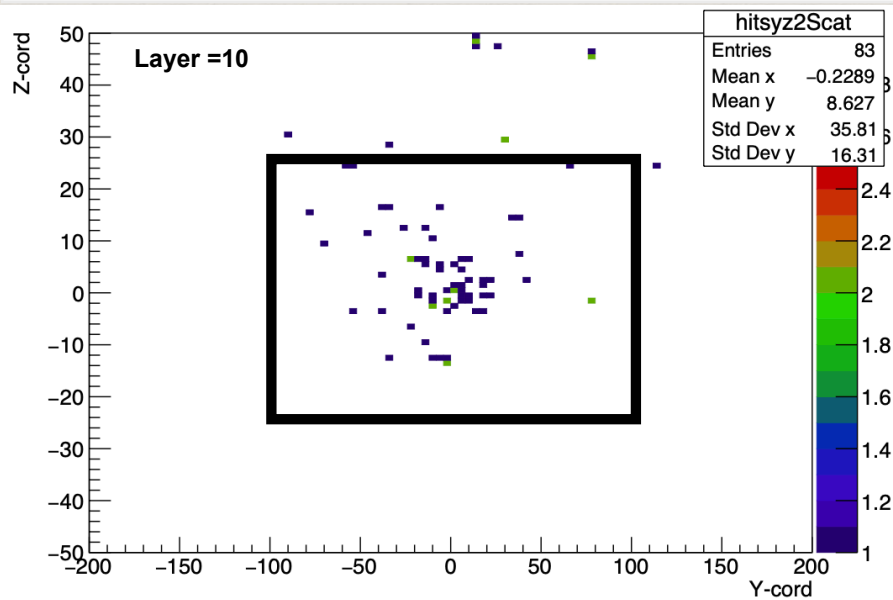
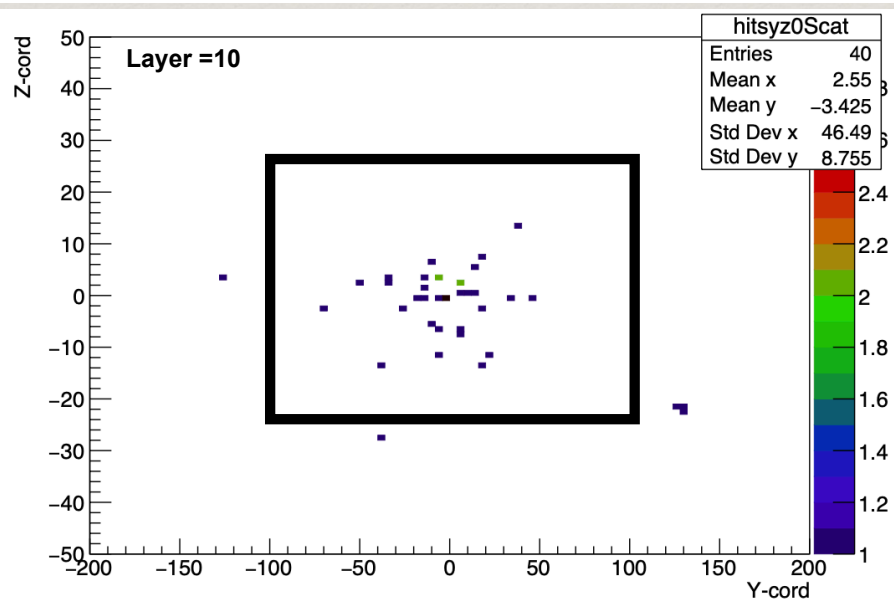
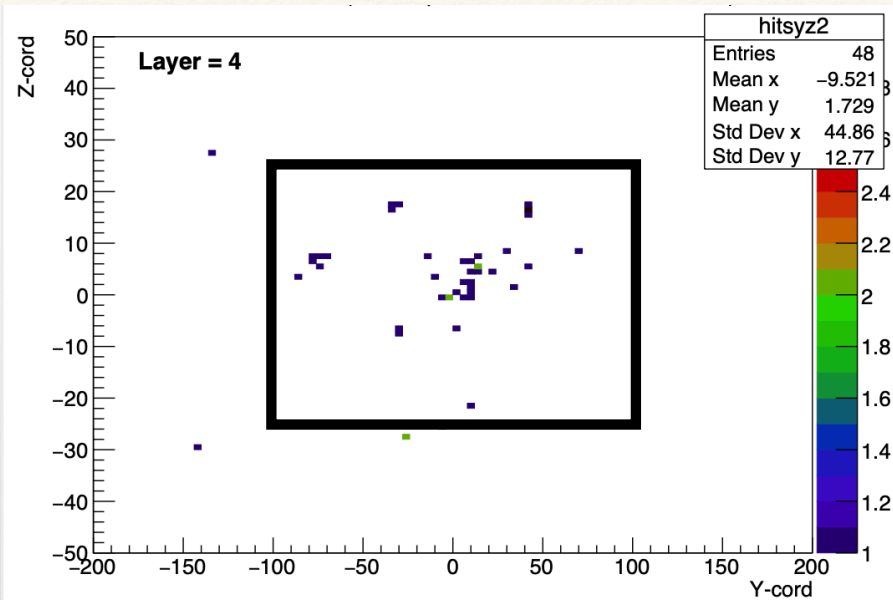
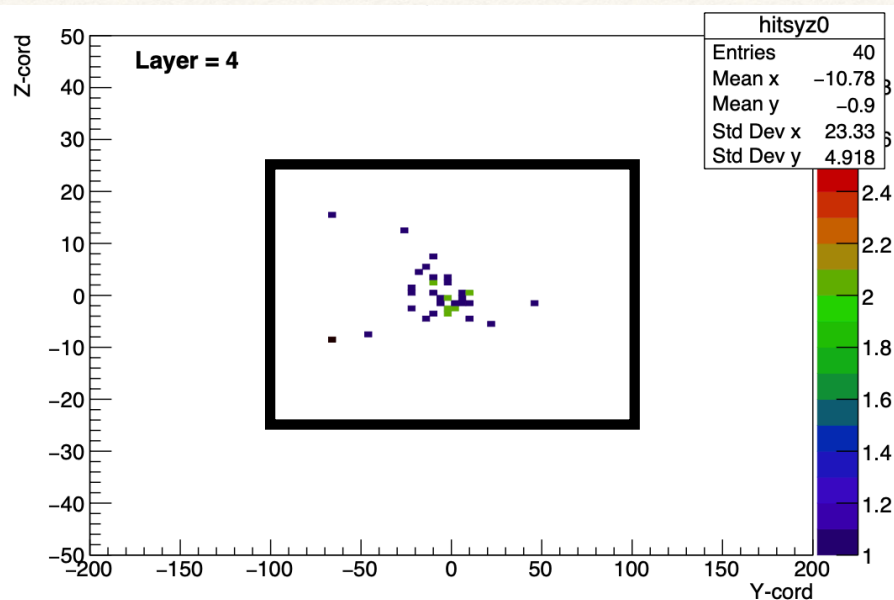


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SiD ECal MAPS



# 3. 5 mm reticle



# Summary



- ❖ Mip-based energy resolution begins to degrade at 3 MeV and doubles at 30 MeV.
- ❖ Pixel-hit resolution begins to degrade @ 2 keV & doubles at 7-8 keV. (1900 e's - 2180 e's).
- ❖ Cluster weighting gives very small improved resolution:
  - ❖ Next optimize for multiple factors (eg. mips / cluster vs. layer).
- ❖ Improve cluster algorithm?
  - ❖ Mip content correlated with cluster shapes.
- ❖ 5 mm reticle could detect good fraction of centered shower.