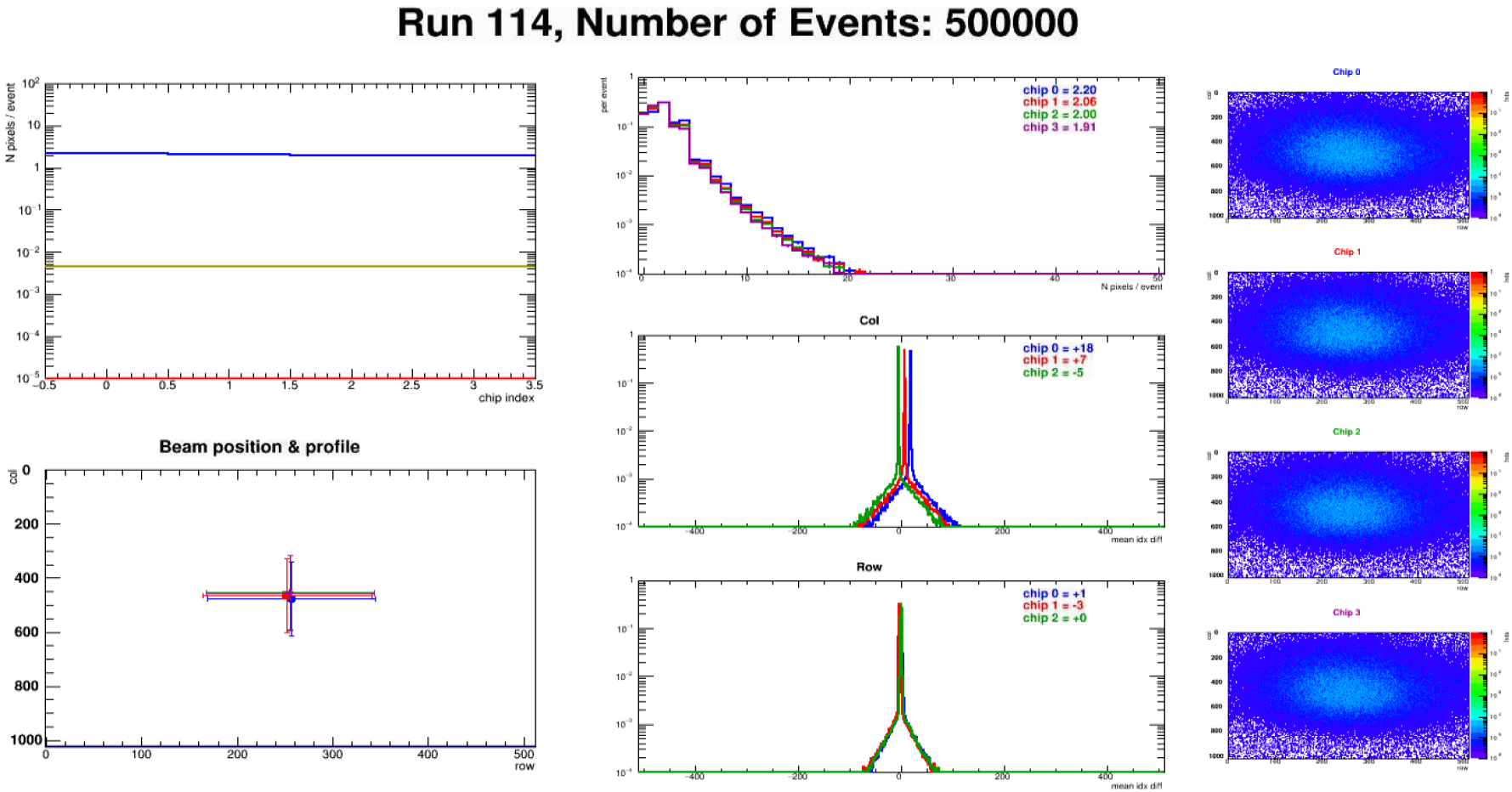
Analysis of the 2018 MVTX testbeam data – efficiencies

Darren McGlinchey

P-25
Los Alamos National Laboratory

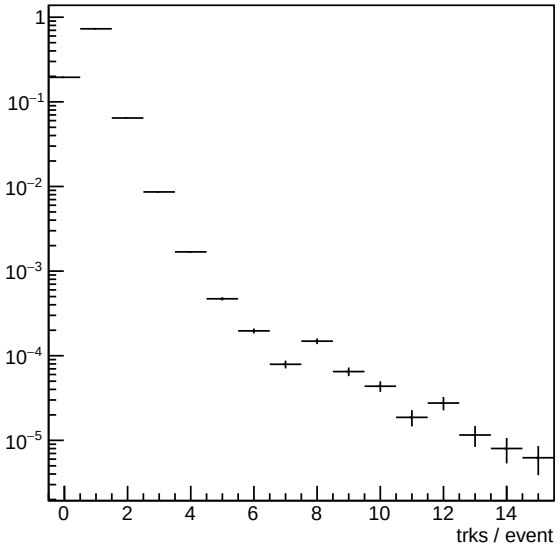
April 5, 2018

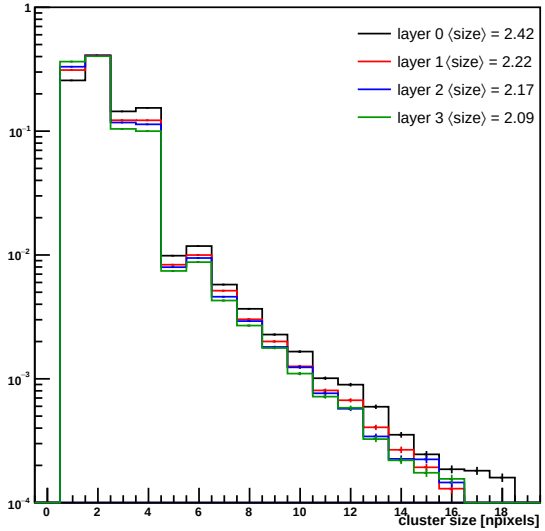
Overview

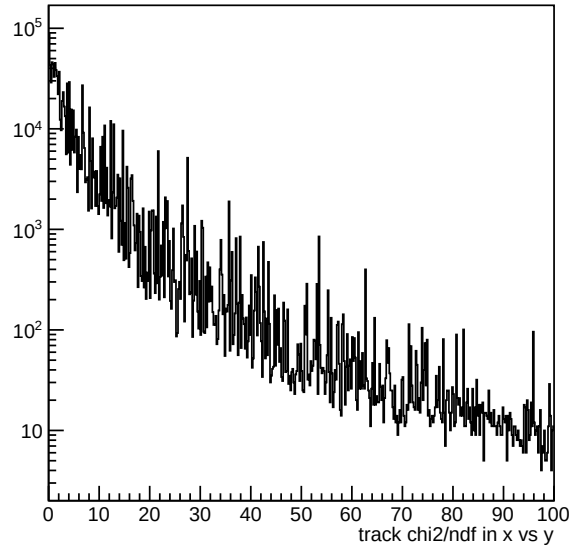


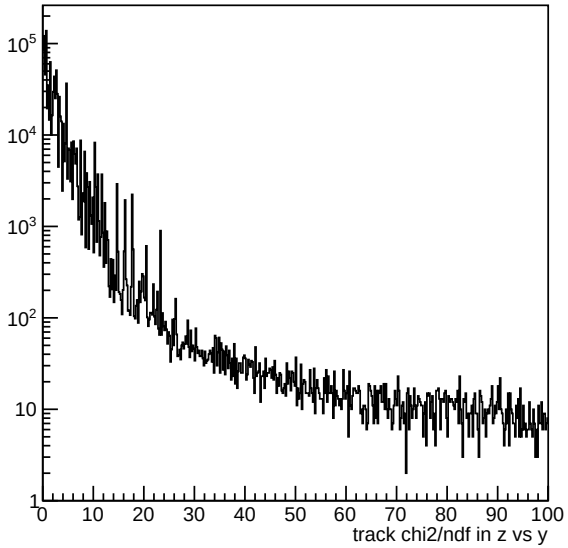
- Start with run 114 – 120 GeV protons
- highest statistics
- After shifting positions based on beam center and after masking hot pixels

4 hit tracks – Run 114

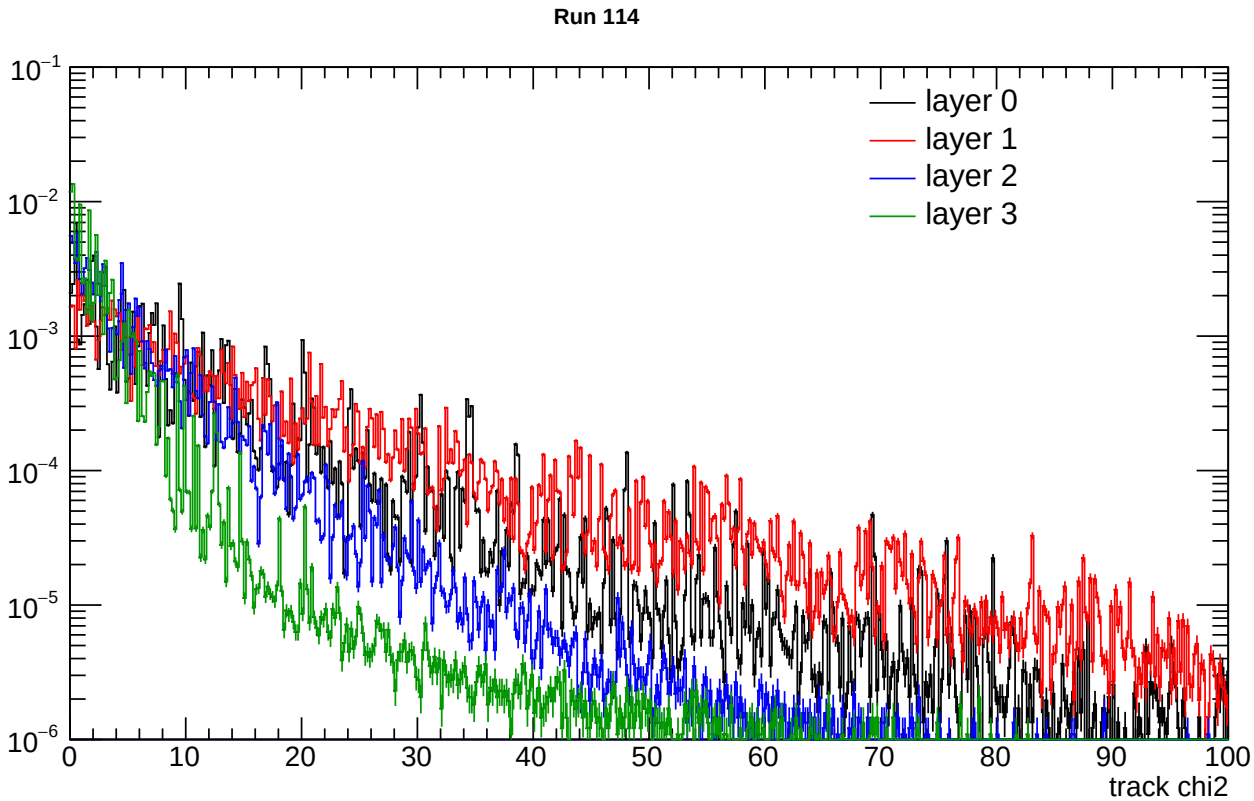






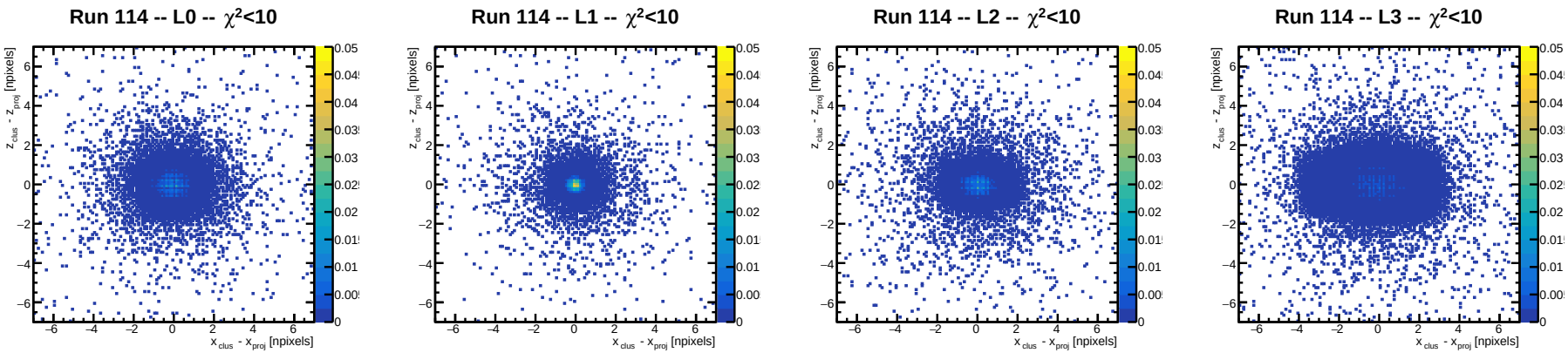


Procedure – tracking



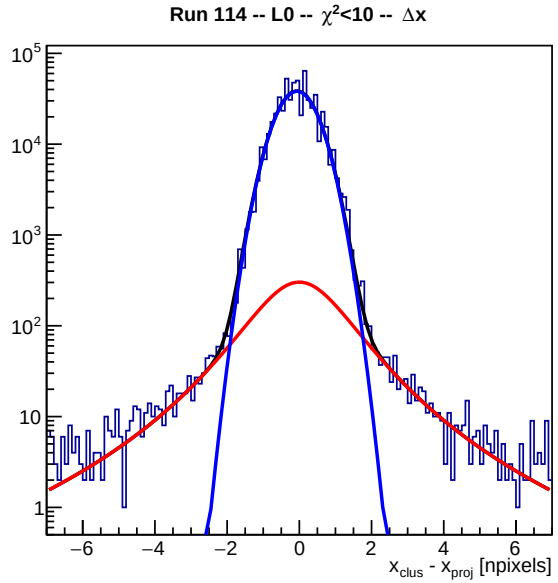
- In order to calculate the cluster finding efficiency in layer X, start by making tracks using clusters in the 3 other layers
- Require that there is only 1 track candidate in the event
- Above shows the chi2 distribution for the 3 hit tracks using all layers except X

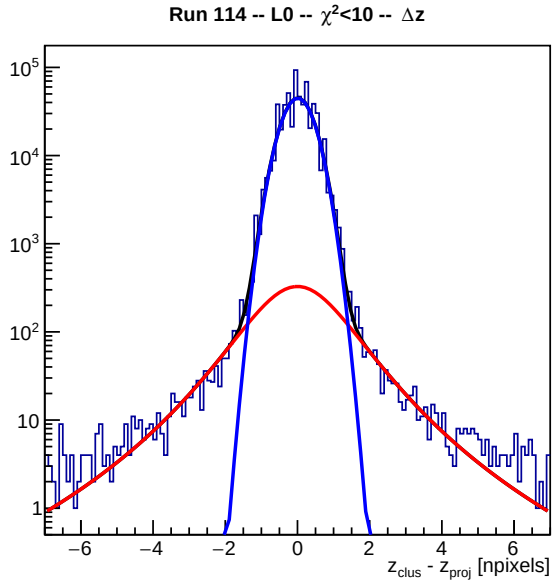
Procedure – residuals



- Look at the residuals (cluster - projected) for all clusters in the layer of interest
- As a test, we can look at the residuals as a function of the track chi2
- As a test, I'll try 3 methods for calculating the cluster finding efficiency

Procedure – fitting

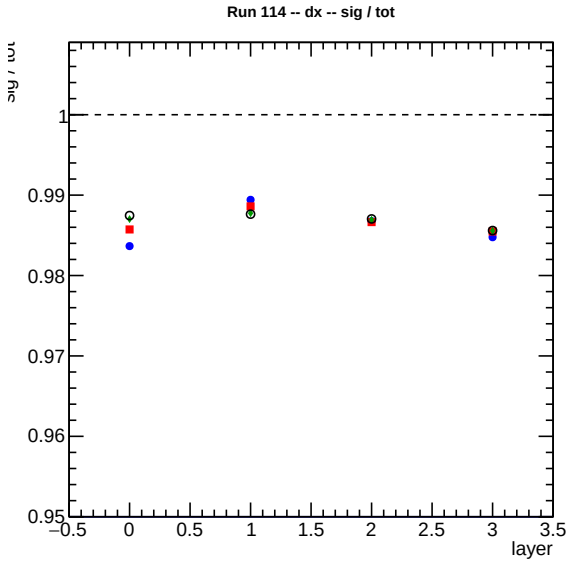


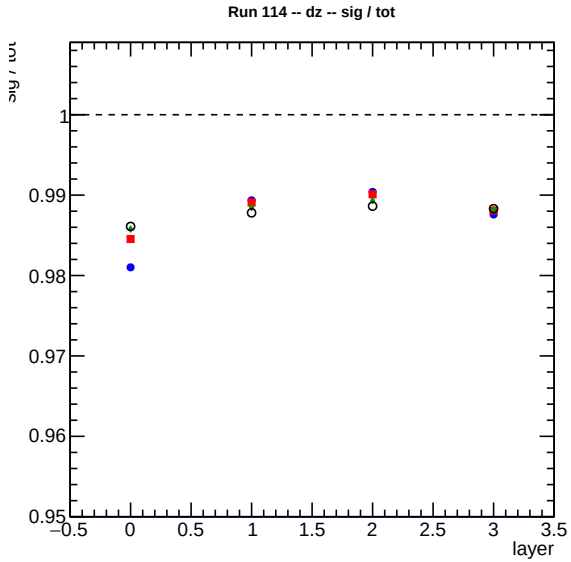


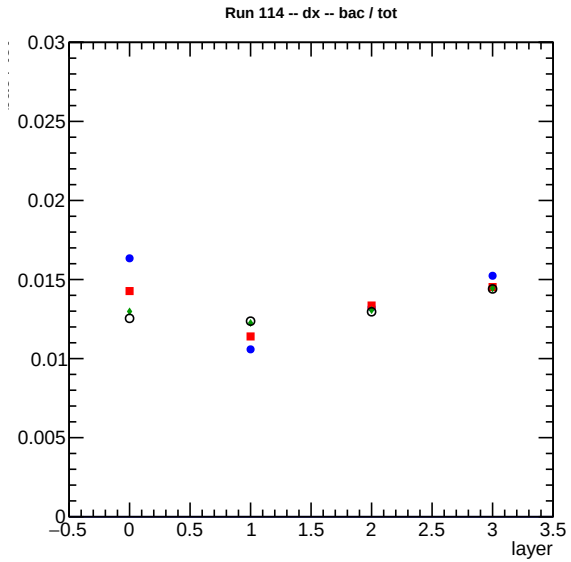
- Figure shows example residual distributions
- Distributions show strong gaussian peak, but the wide tail
- Try fitting with Guassian (signal?) + Student's T distribution (background?) – describes the distribution well
- The fitting is done independently in dx and dz, but they should give consistent results
- tail could be from:
  - noise clusters
  - random clusters from additional particle not associated with track
  - real cluster, but for "bad" tracks

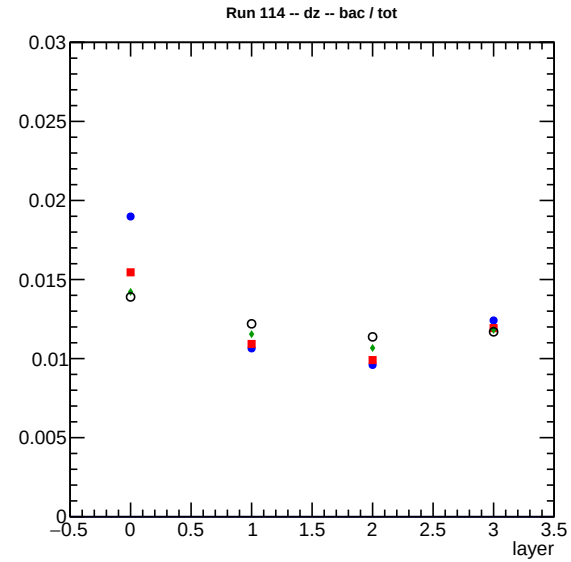
fitting

- After fitting with the two components, calculate fraction of the distribution that is “signal” (gaussian) and fraction that is “background” (student’s T)
- Get consistent fractions between dx & dz
- $\approx$ 1.5% of the distribution comes from the “background”

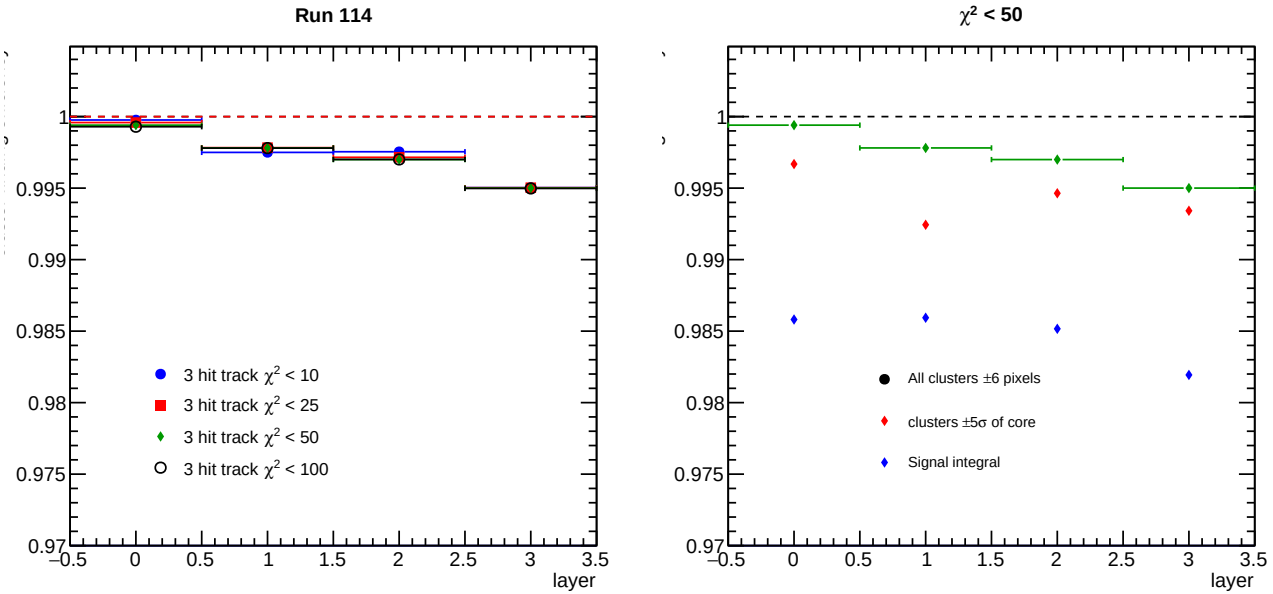








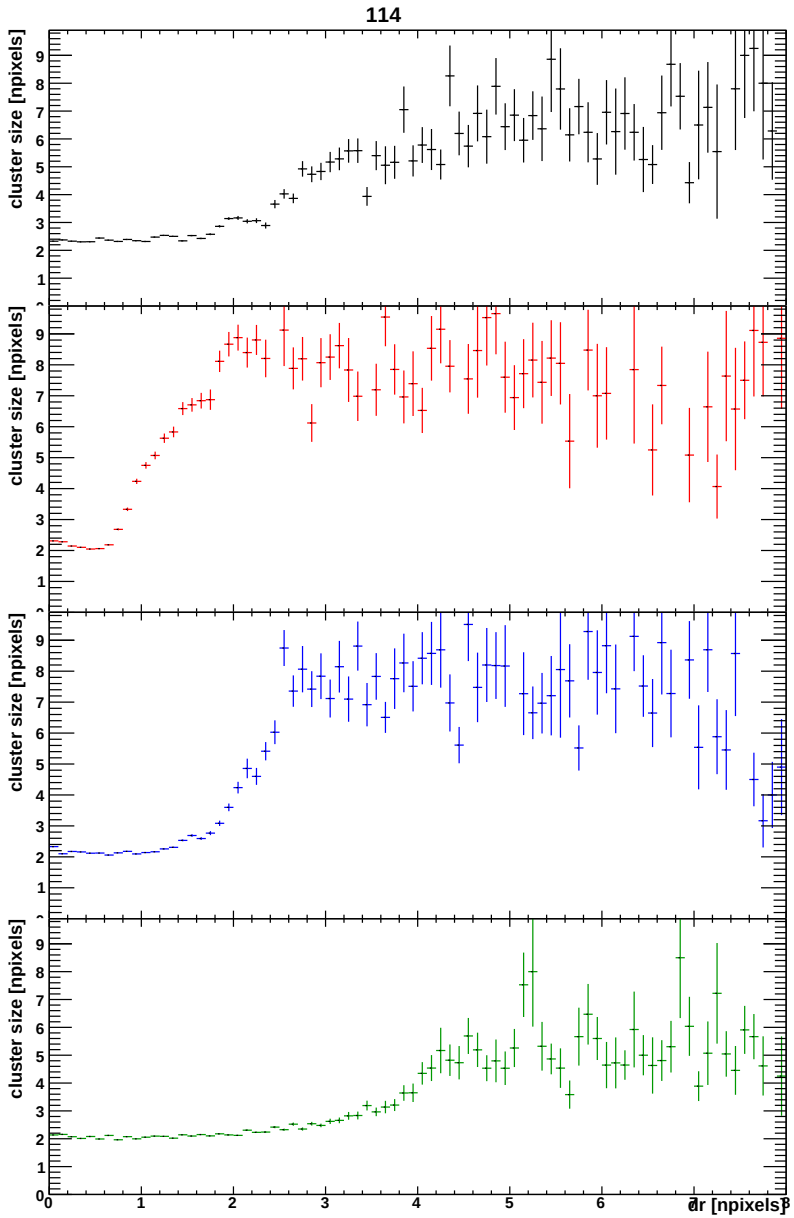
efficiency



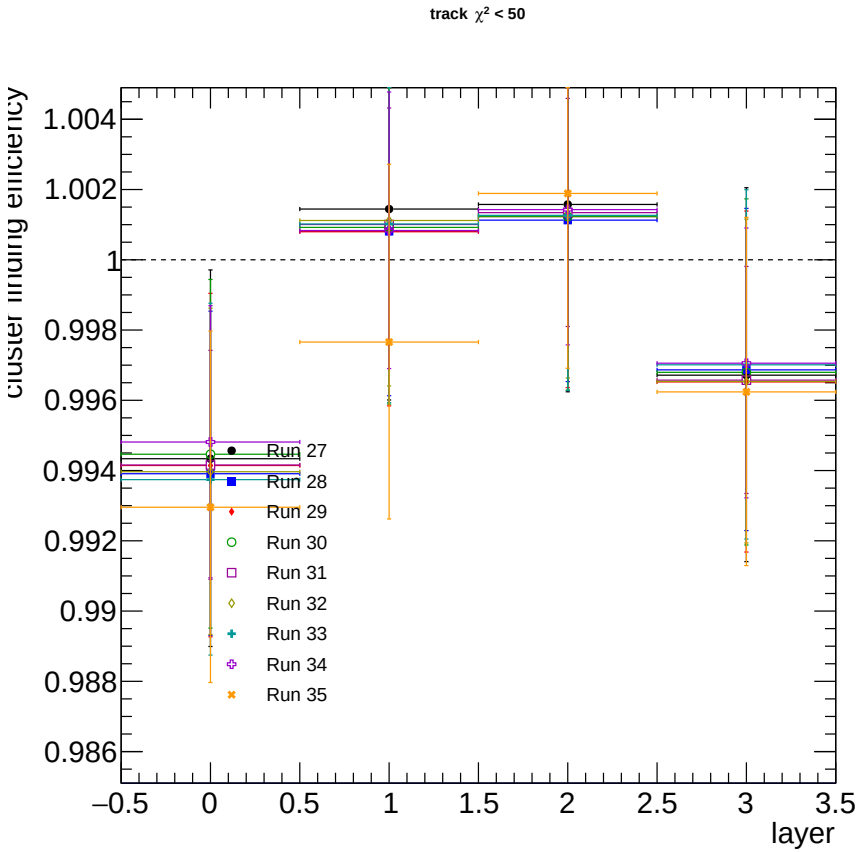
- denominator of efficiency is always total number of tracks (1 per event by construction)
- Calculate the numerator in 3 ways:
  - All clusters within ± 7 pixels of the projected position in both dx & dz (integral of the 2d distributions shown previously)
  - All clusters within $\pm 5\sigma$ of the gaussian mean in both dx & dz (red lines on the fit plots shown previously)
  - Integral of the “signal” distribution
- Check the efficiency as a function of the track chi2 using method 1 (Left)
- Show difference in efficiency for the different methods for a single chi2 cut (Right)

Cluster size

- Plotting the mean cluster size as a function of $dr = \sqrt{dx^2 + dz^2}$
- Error bars are the standard error on the mean
- See that the mean pixel size increases at some point.
- This is roughly where the “background” component begins to dominate
- So maybe the “background” is really just larger clusters with less precise centers
- But then, why the large clusters?



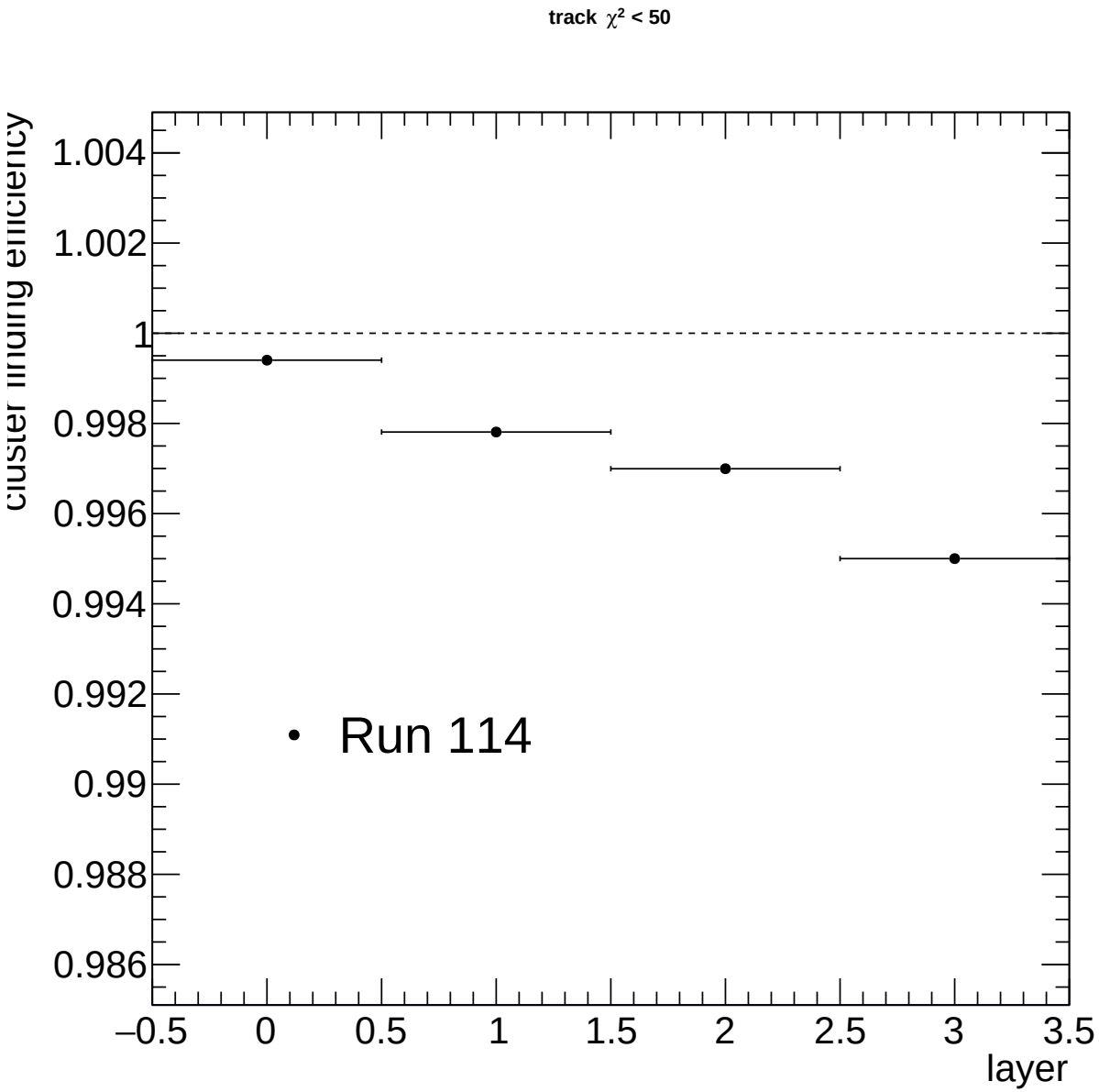
Trigger delay



- Using the 1st method (all clusters $\pm$6 pixels)
- All runs in trigger delay scan
- *errors assuming independent poisson – not true*
- No clear difference
- Trigger delay appears to uniformly effect all chips, need different method (ex. clusters / event);

Thank You!

Efficiency


track χ^2 < 50
cluster finding efficiency
1.004
1.002
1
0.998
0.996
0.994
0.992
0.99
0.988
0.986
–0.5
0
0.5
1
1.5
2
2.5
3
3.5
layer
Run 114

Cluster size

- Plotting the mean cluster size in each layer
- There are different curves for each track chi2 cut
- No dependence on the track chi2 cut
- No clear layer dependence either