Binning optimisation for unfolded data spectra

Applications for the inclusive jet cross section

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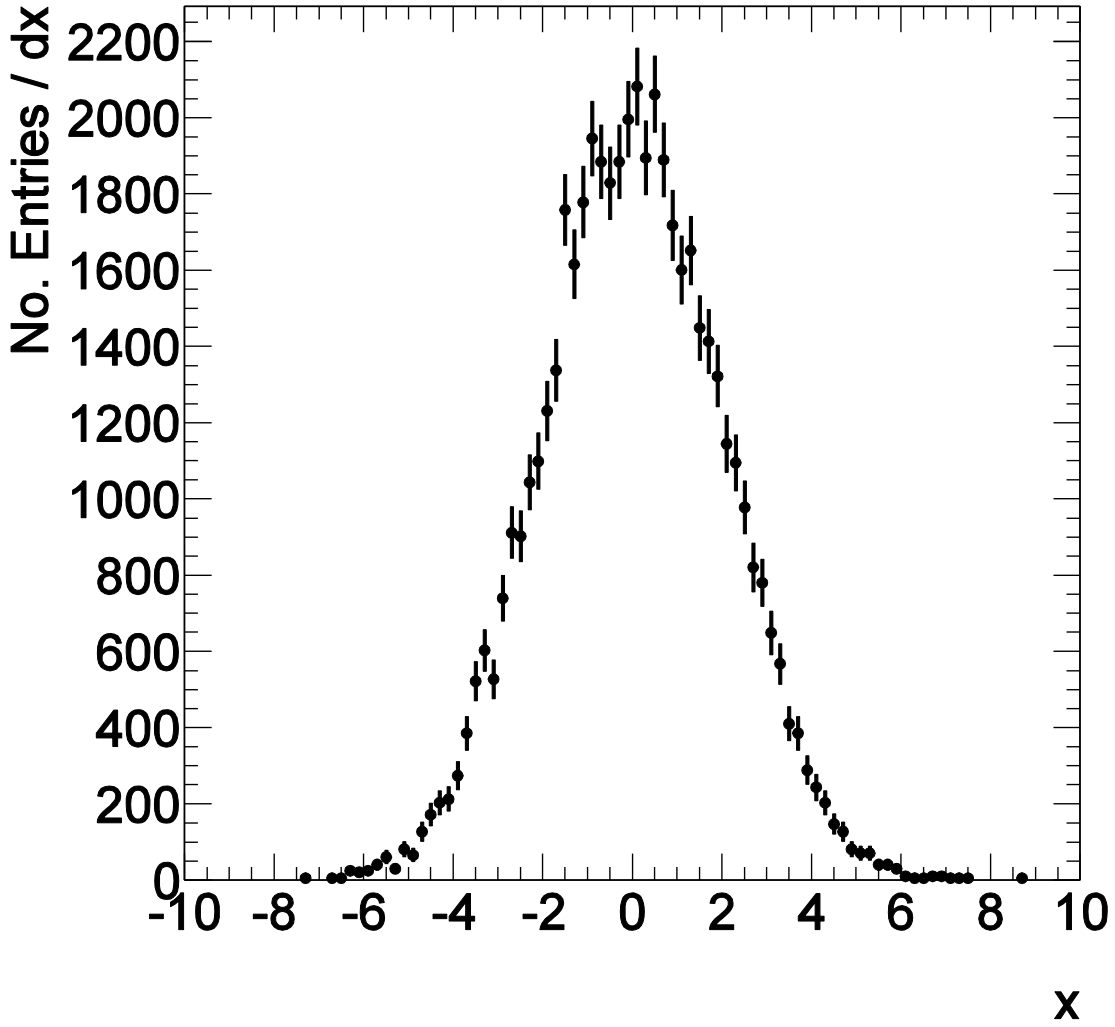
Aim:

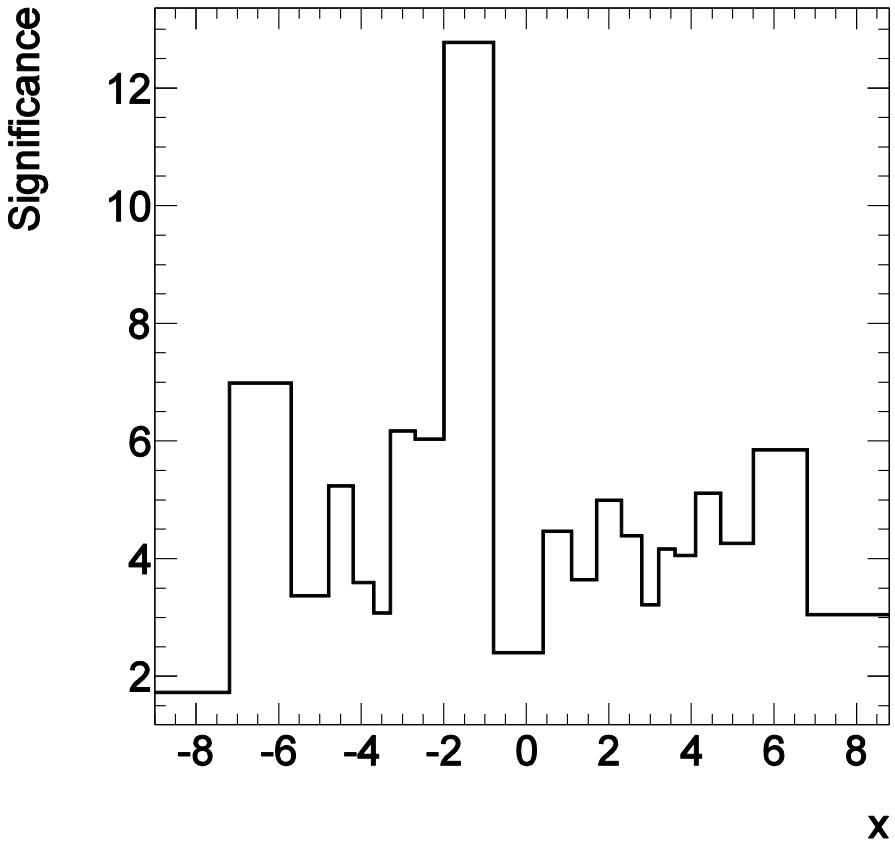
- Implement and test a newly devised method for optimising the binning of unfolded data spectra, specifically focused on inclusive jet cross-sections from the ATLAS experiment.
- Explore and study the effects of this binning optimisation.

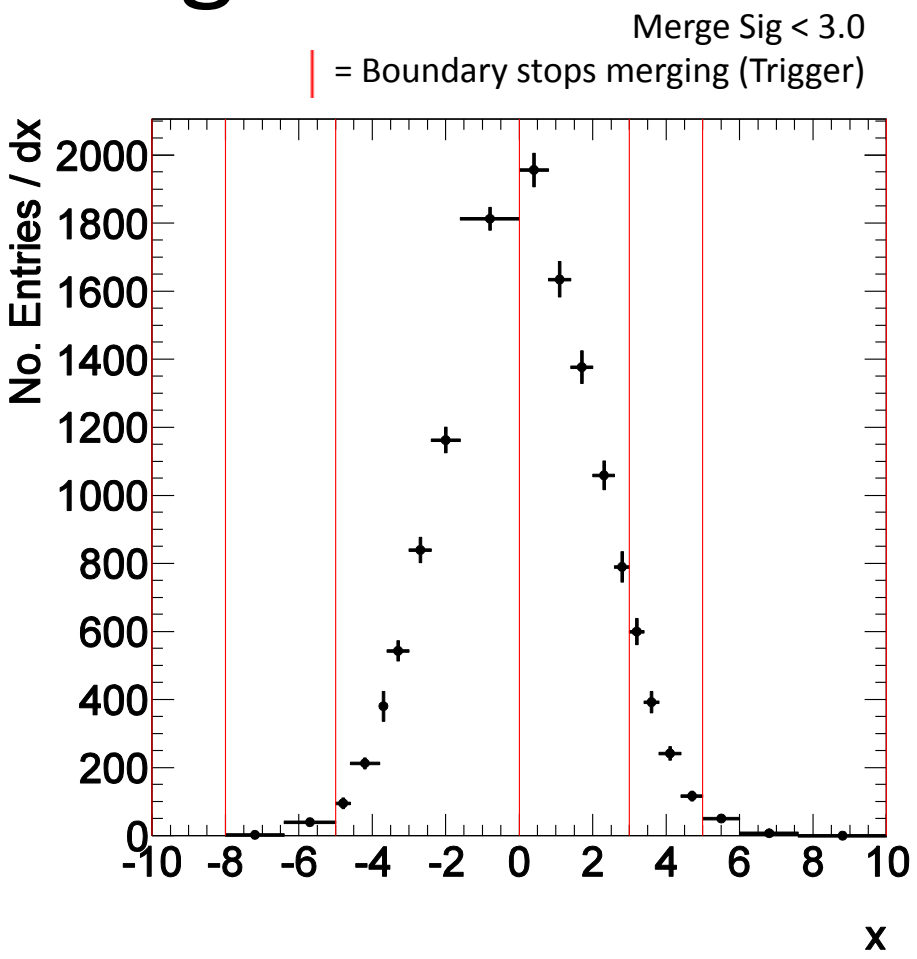
Normalised Gaussian* Plot



* Entries are randomly generated (100 bins).

Rebinning





Significance of slope = magnitude / error

(Final 78th Iteration)

Covariance Matrix

$$cov(X_i, X_j) = \langle (X_i - \bar{X}_i)(X_j - \bar{X}_j) \rangle$$

0.773104	3.04969	13.0517	3.10553	0.0231037
3.04969	501.559	1722.82	409.93	3.04969
13.0517	1722.82	7796.8	1754.36	13.0517
3.10553	409.93	1754.36	518.247	3.10553
0.0231037	3.04969	13.0517	3.10553	0.773104

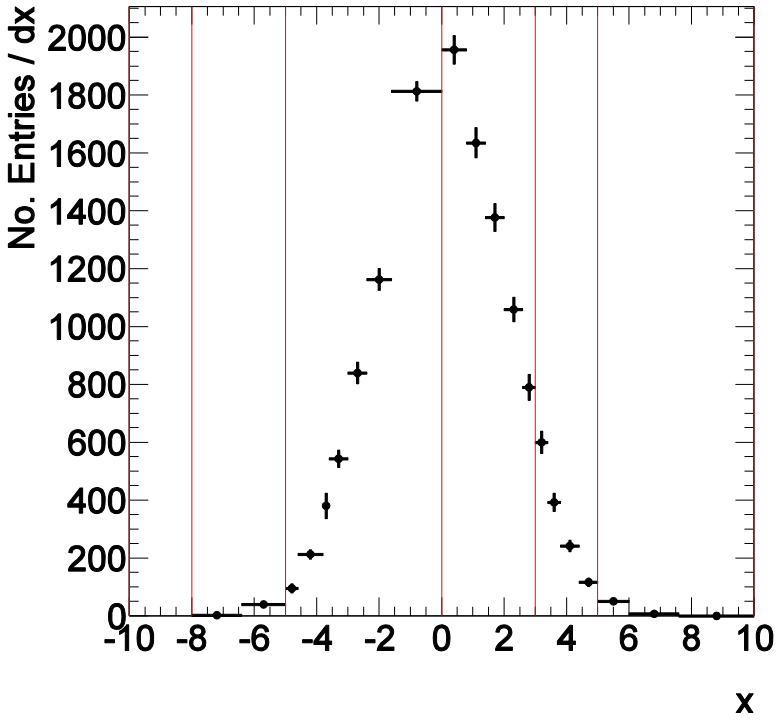
0.773104	8.05069	3.10553	0.0231037
8.05069	2936	1082.15	8.05069
3.10553	1082.15	518.247	3.10553
0.0231037	8.05069	3.10553	0.773104

Systematic Errors

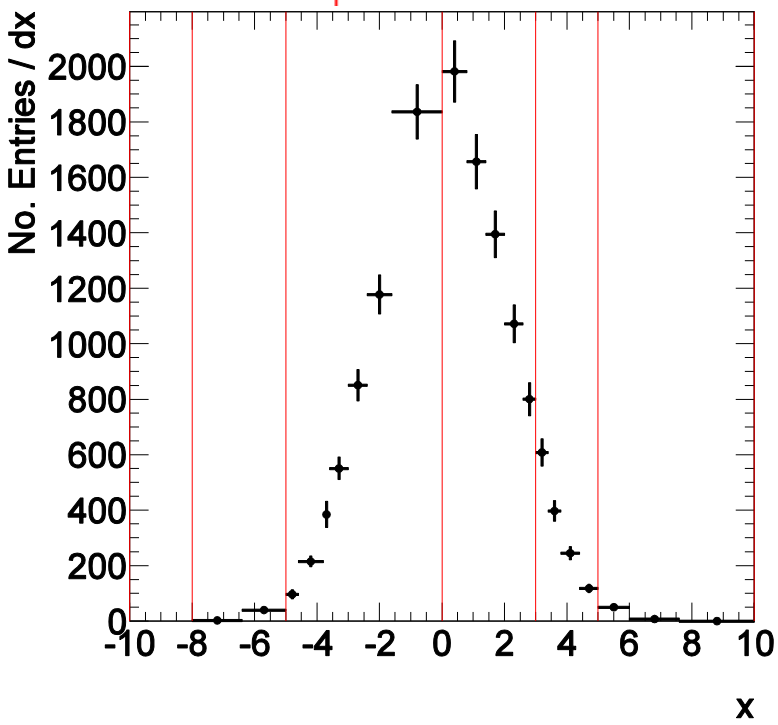
$$corr(X_i, X_j) = \frac{cov(X_i, X_j)}{\sigma_{X_j}\sigma_{X_j}} = \frac{\langle (X_i - \bar{X}_i)(X_j - \bar{X}_j) \rangle}{\sqrt{\langle (X_i - \bar{X}_i) \rangle \langle (X_j - \bar{X}_j) \rangle}}$$

Merge Sig < 3.0

= Boundary stops merging (Trigger)

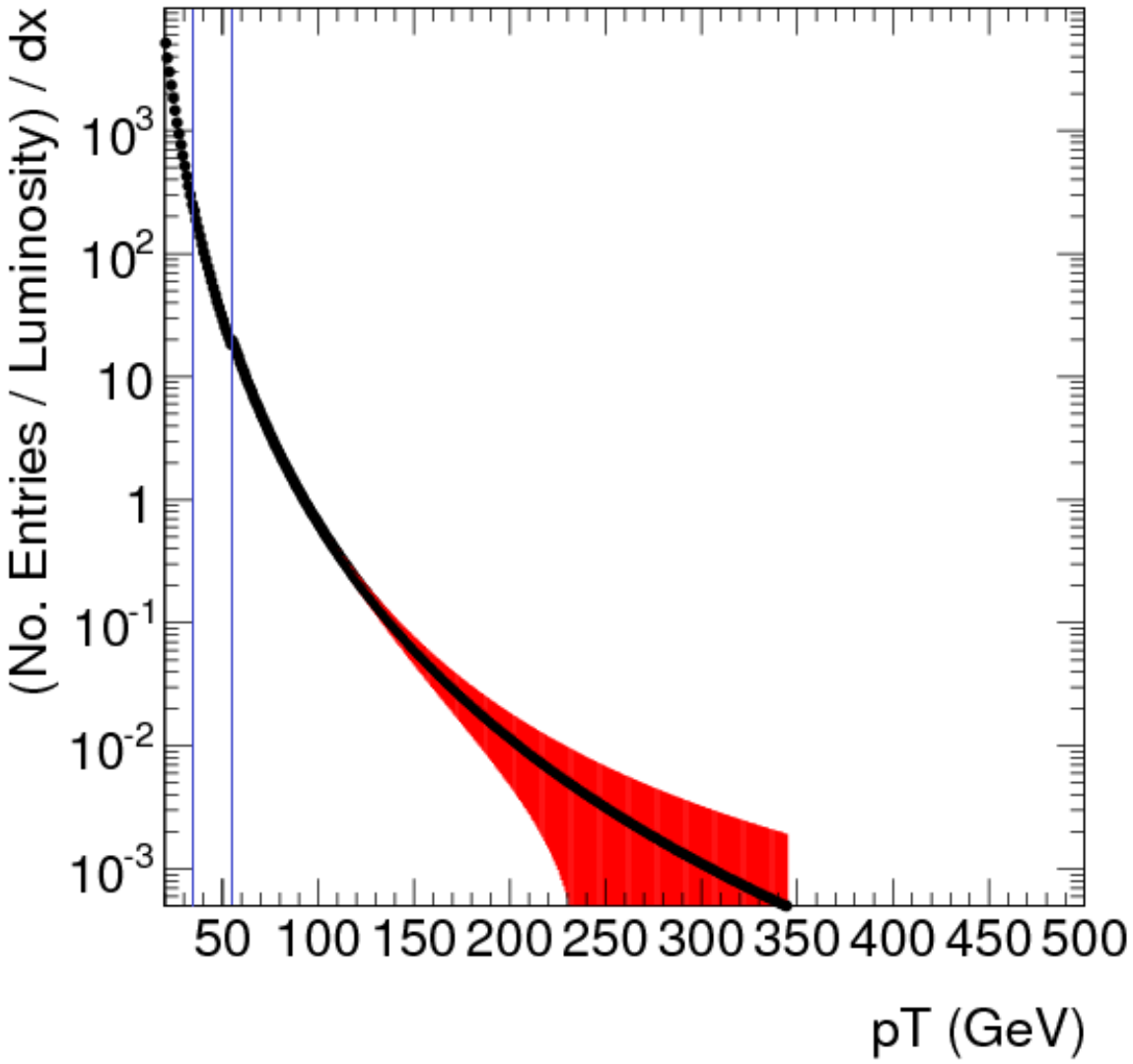


(No correlations: Final 78th iteration)



(5% correlations: Final 78th iteration)

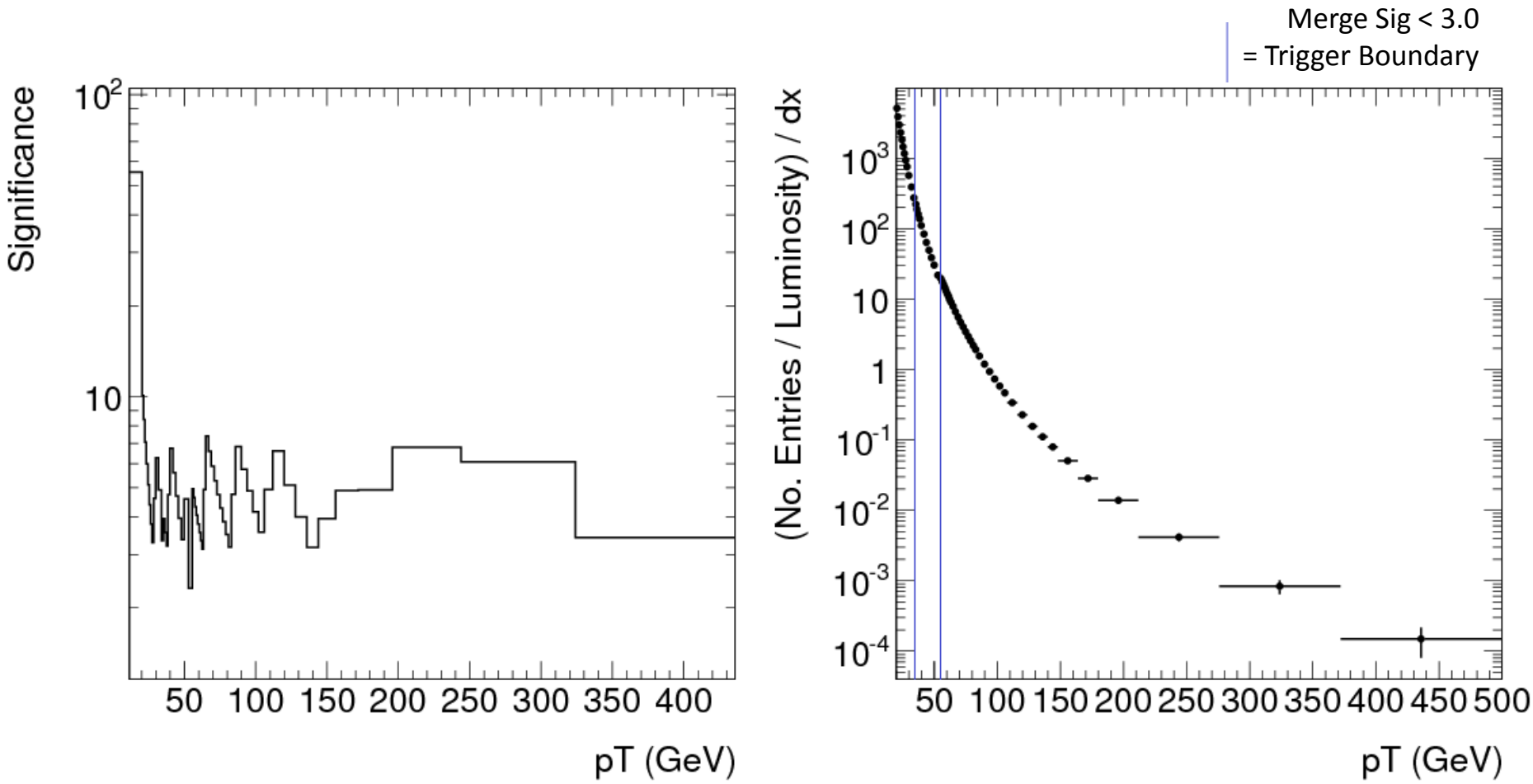
Steeply Falling Spectra



Merge Sig < 3.0
= Trigger Boundary

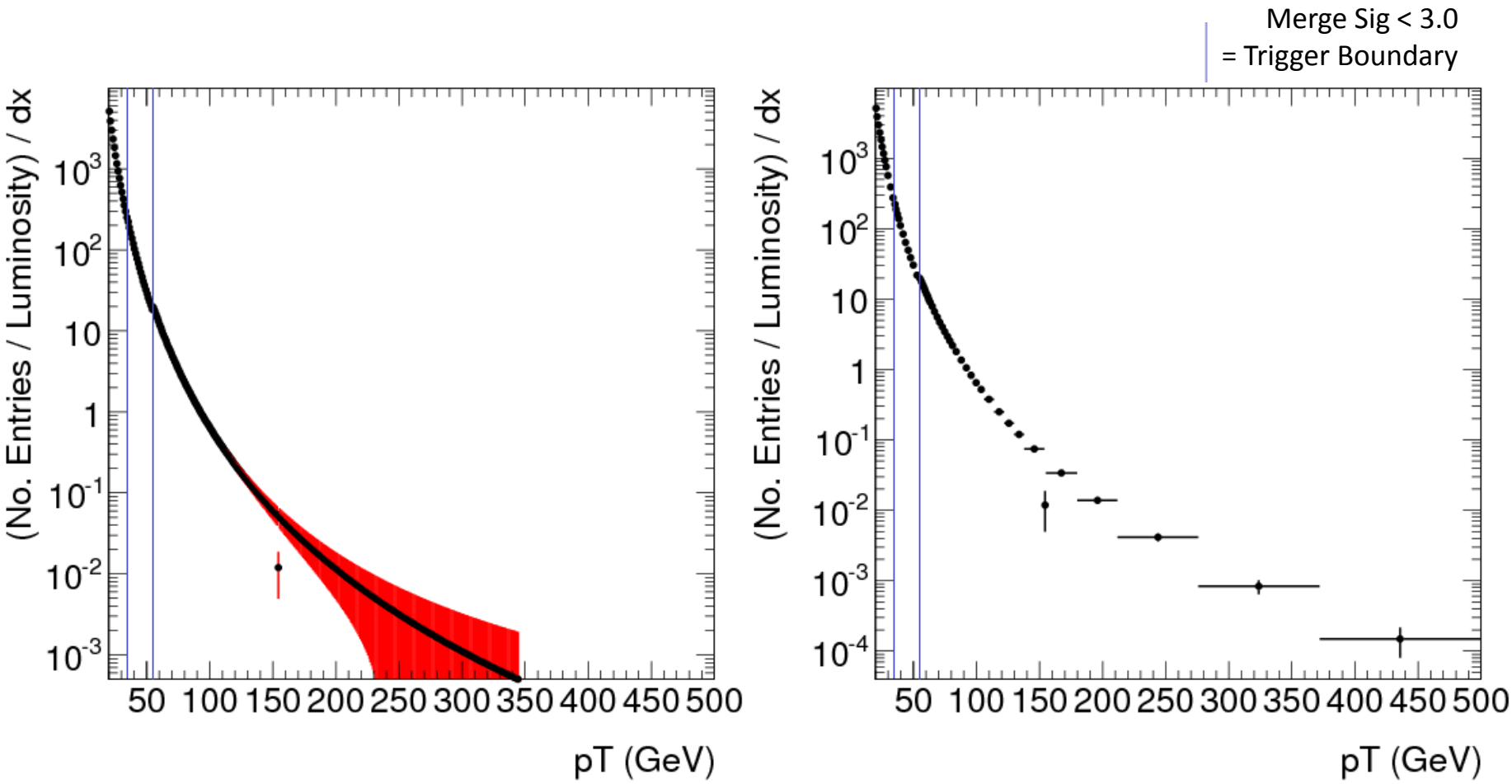
(500 initial bins)

Rebinning



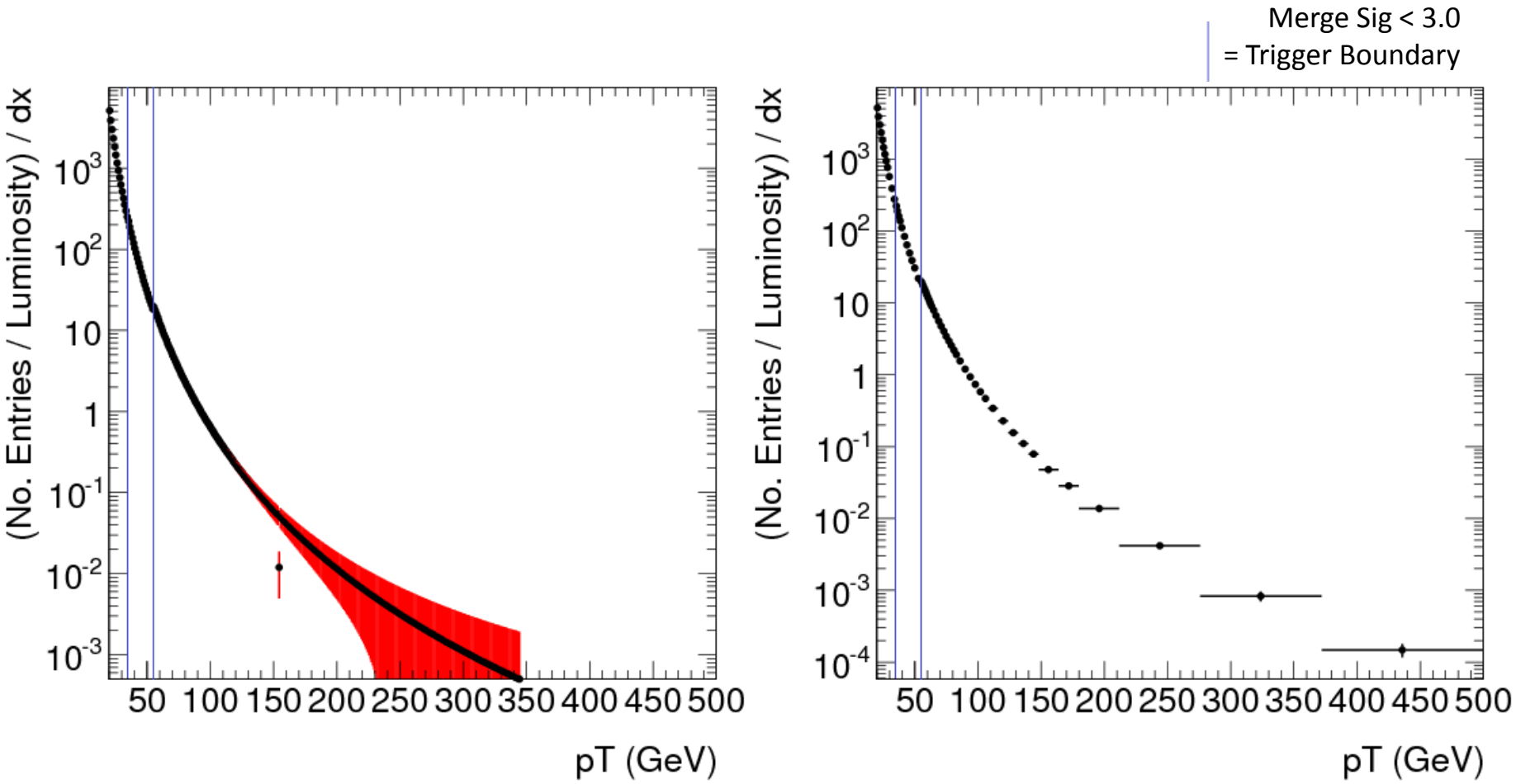
(Final 437th Iteration)

Outliers



(Final 438th Iteration)

Outliers (2) – Monte Carlo



(Final 437th Iteration)

Summary

- This method may be used on many shapes of data spectra.
- A (model independent) rebinning method may be useful for identifying outlying points in data.
- The use of Monte Carlo methods can avoid rebinning to enhance a false outlier.

Future Plans

- Test rebinning method on data spectra before and after unfolding – compare the results.
- Study the effect of changing the regularisation parameters for unfolding to give minimal bias and correlations.