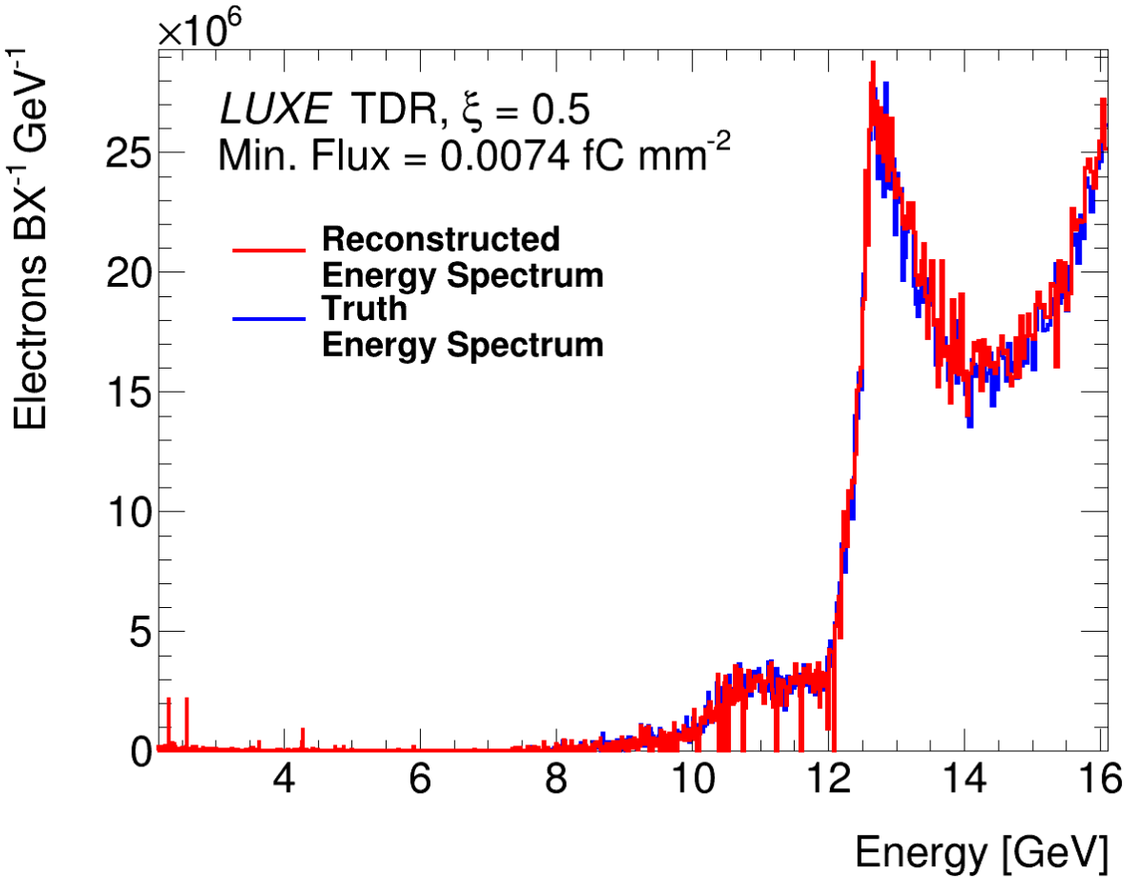
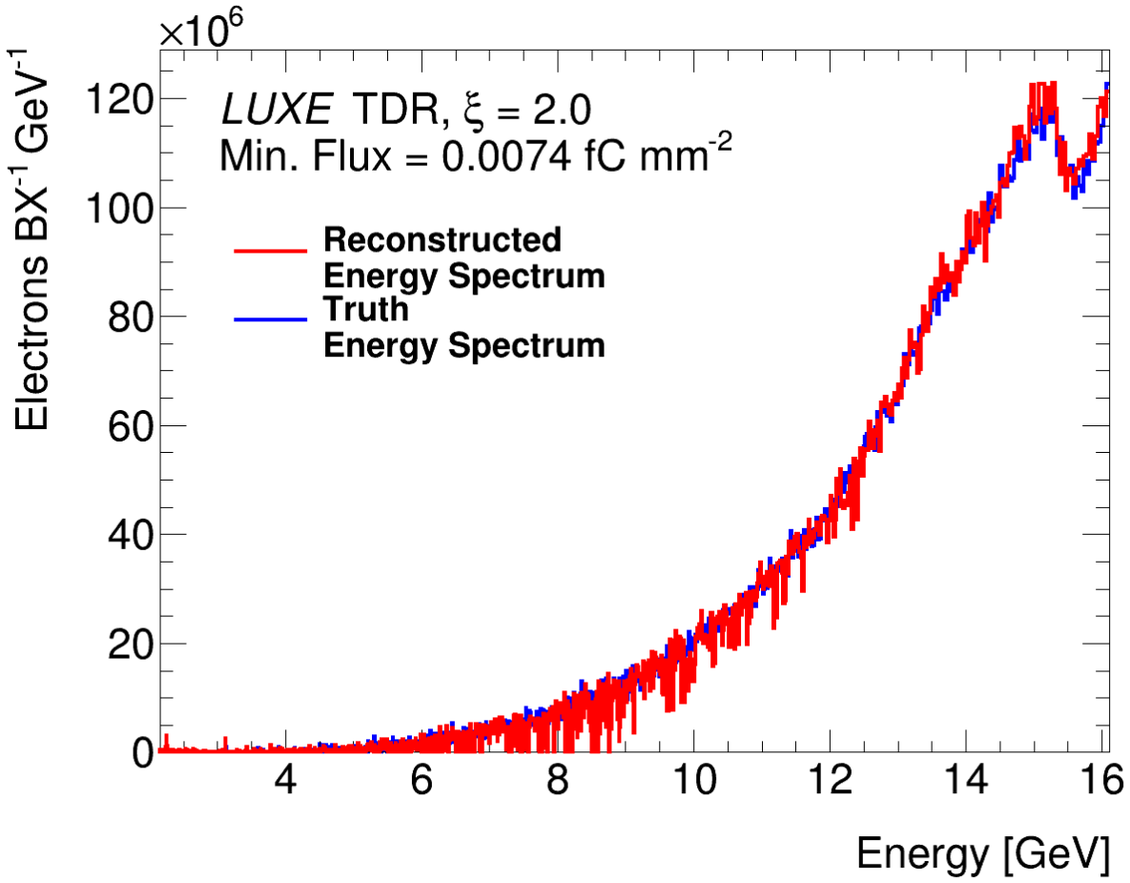
Finite Impulse Response Filters

First we may ask ourselves if using the filters is well-motivated!

To do this, look at a naïve analysis of choosing maximum bin of energy as the Compton edge in scint. Reconstruction.

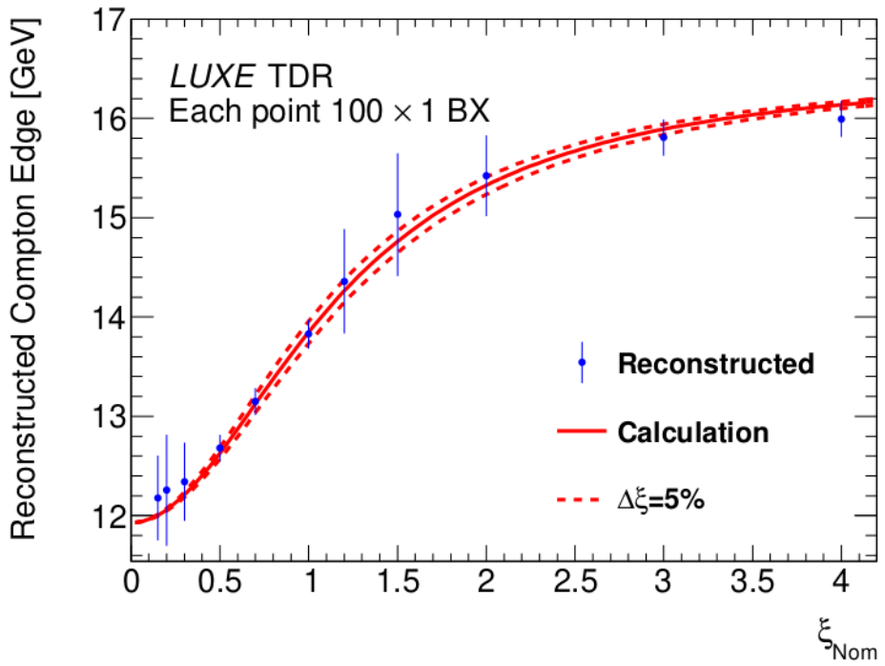
Showing here reconstructions for only one BX statistics w/ noise emulation



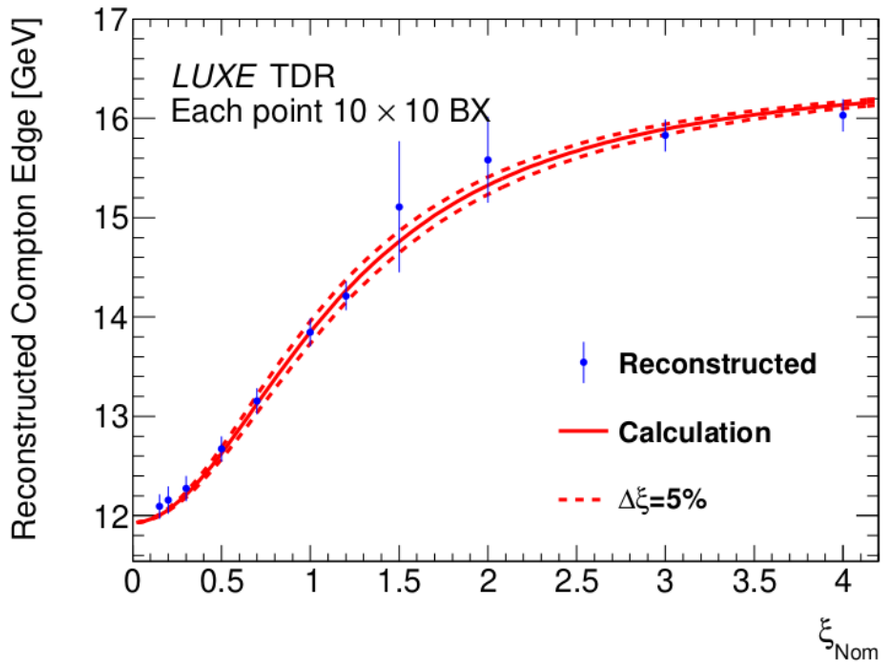


Finite Impulse Response Filters

Wanted to look at a naïve analysis of choosing maximum bin in scint. reconstruction



(a)



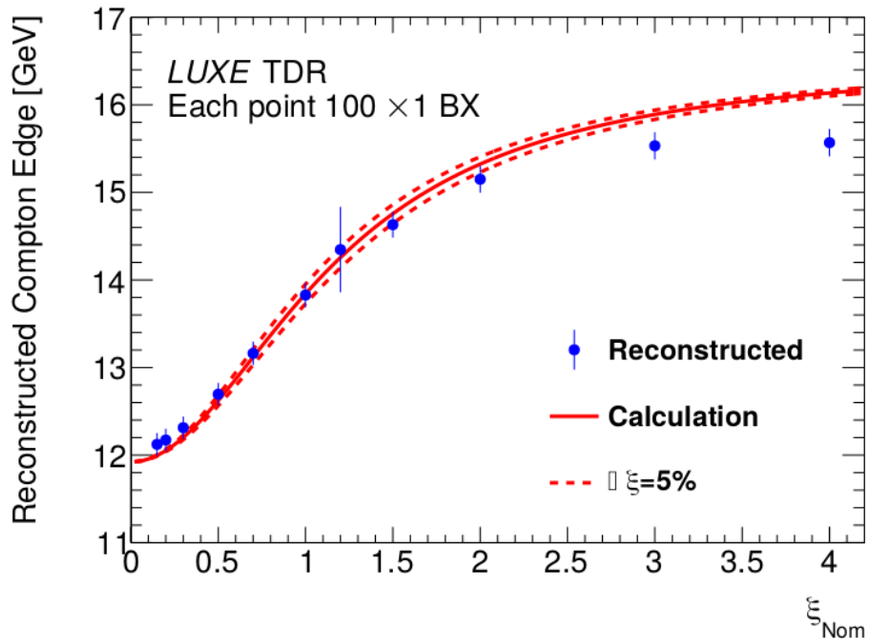
(b)

Figure 16: **(a)** The reconstructed Compton edges, with 100 single-bunch-crossing simulations for each point in ξ. The reconstruction is performed with the energy of the center of the maximum bin in the reconstructed energy spectra. **(b)** Shows a similar analysis, instead for the spectra of 10 accumulated bunch-crossings, with each point showing the mean of ten of these analyses.

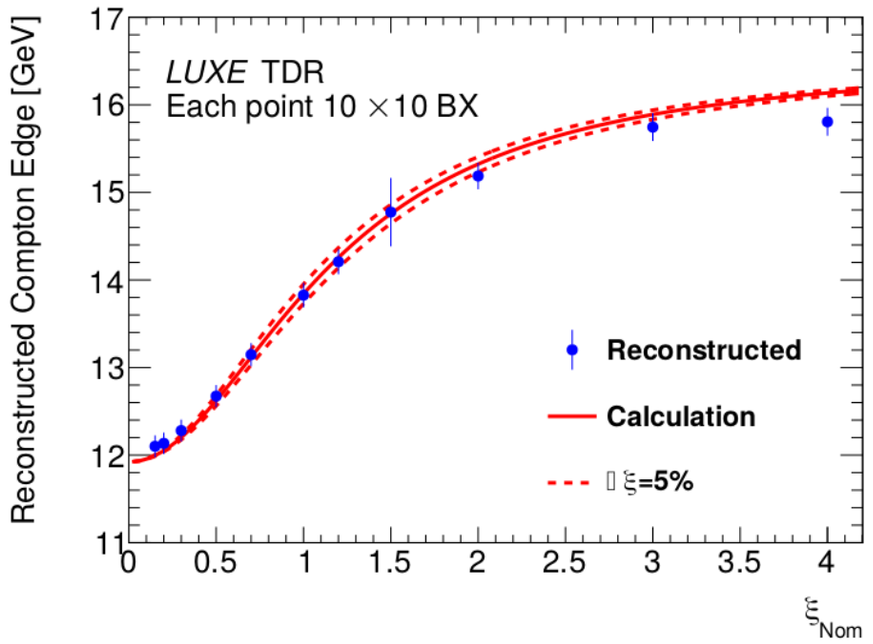
Finite Impulse Response Filters

We can compare the use of filters now; the reconstructed edges lower in energy in particular look better / more stable in identification

At xi = 3.0, 4.0, there is a systematic which actually takes us further from the expectation → do not use filter above xi=2.0



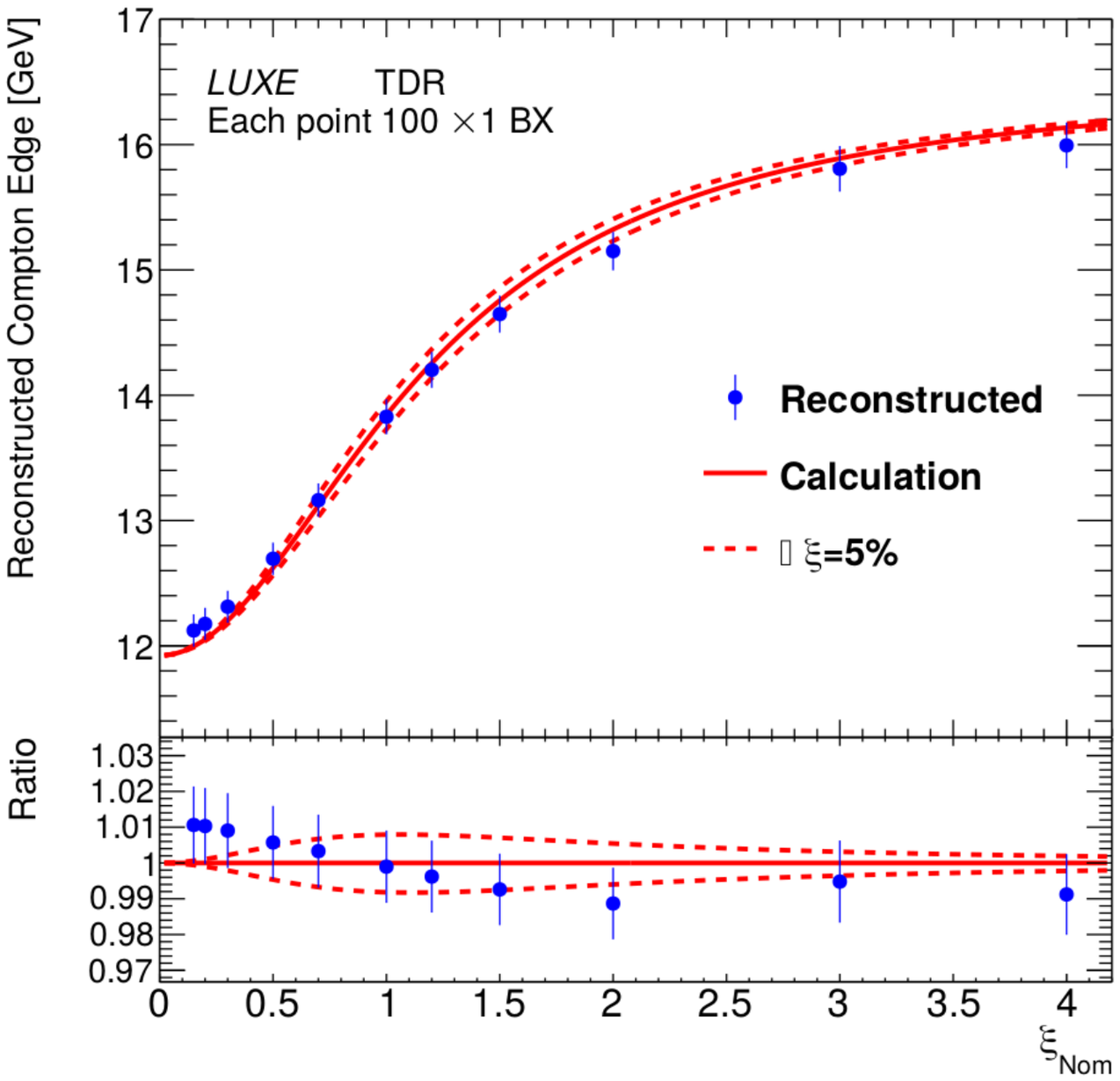
(a)



(b)

Figure 18: **(a)** The reconstructed ξ_{max} values for 100 single-bunch-crossing reconstructed spectra for each point in ξ. The reconstruction here is performed with the Finite-Impulse-Response technique. This is compared to the theoretical ideal alongside upper and lower bounds for $\pm 5\%$. **(b)** Shows a similar analysis, instead for the spectra of 10 accumulated bunch-crossings, with each point showing the mean of ten of these 10×10BX spectra.

Finite Impulse Response Filters

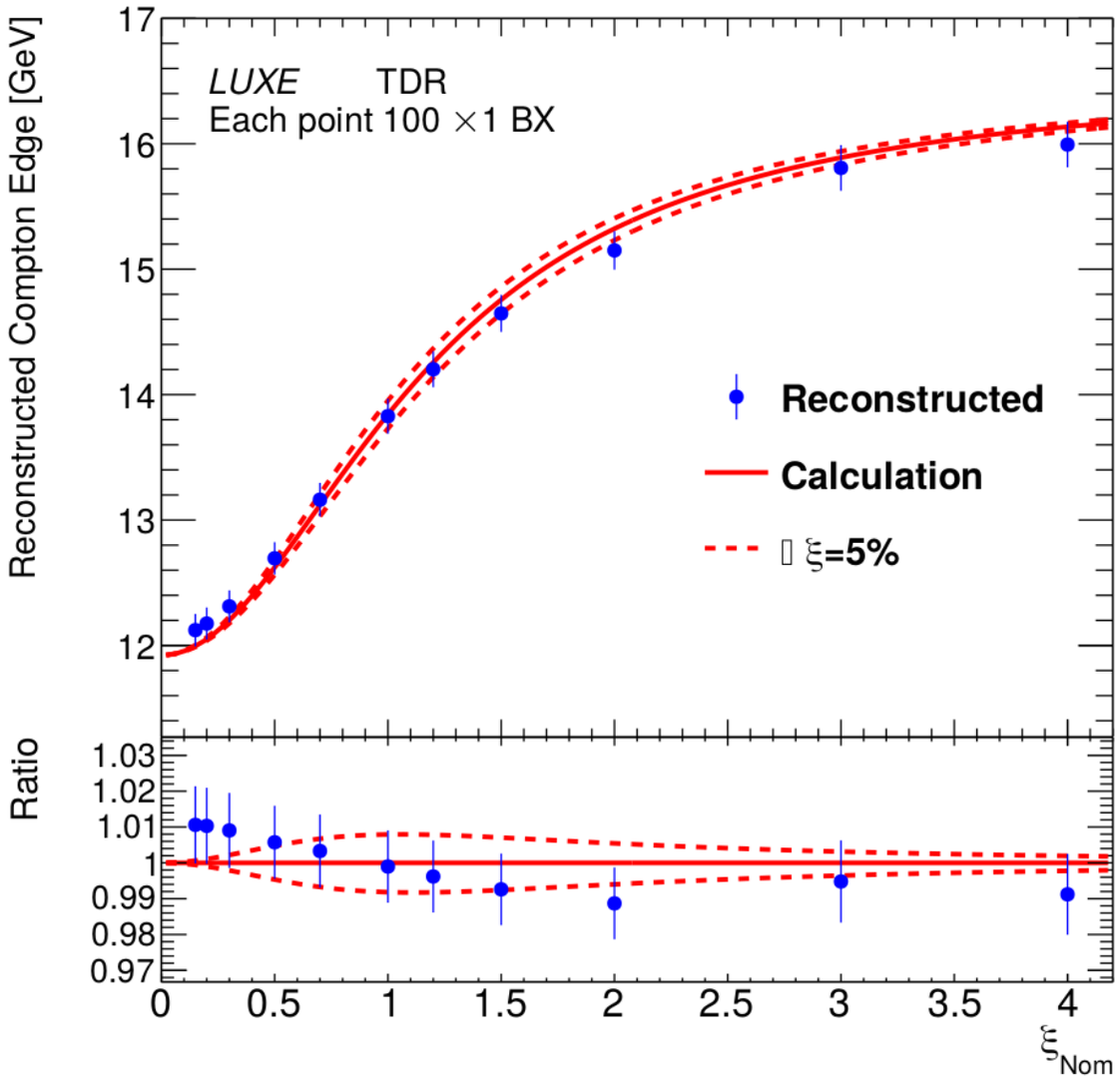


← We then settle on the optimised parameters

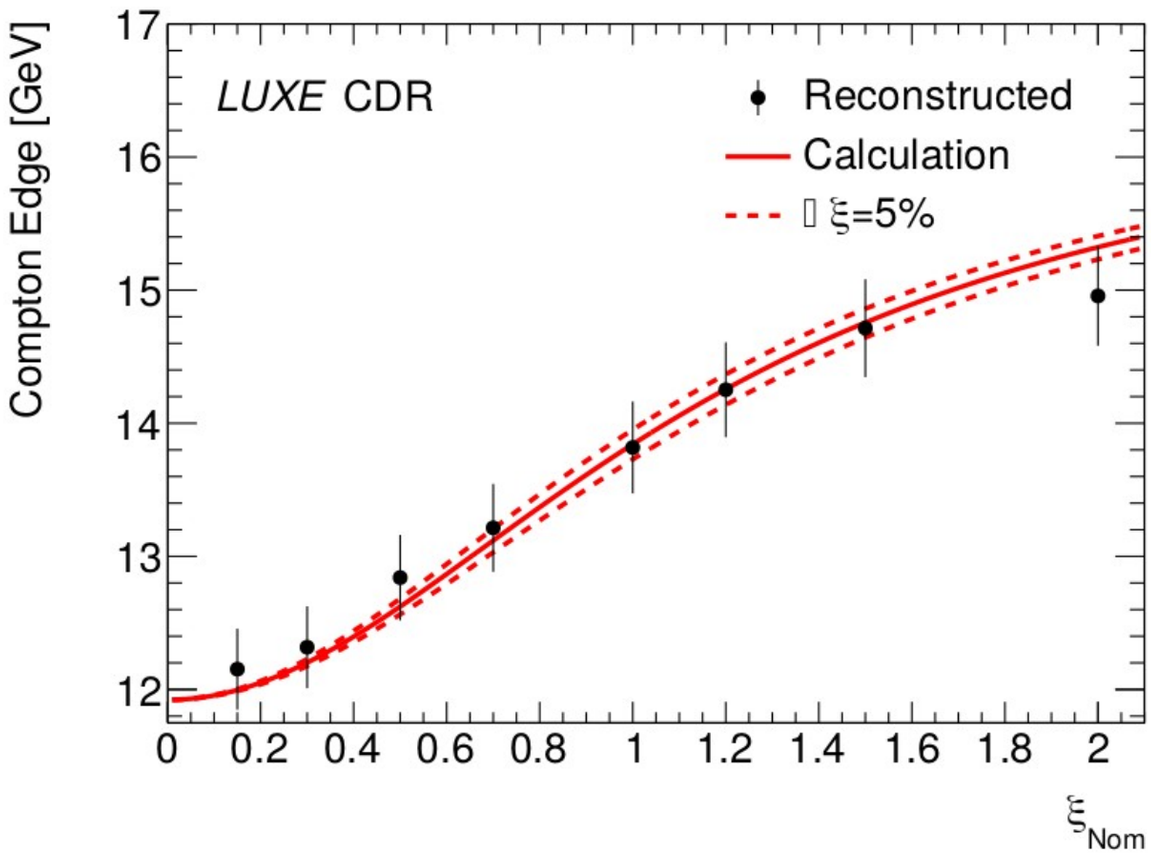
Errors are dominated by systematics which we set to +/- 1%

Still a systematic offset effect? Downward slope from 0.15 to 2.0

Finite Impulse Response Filters

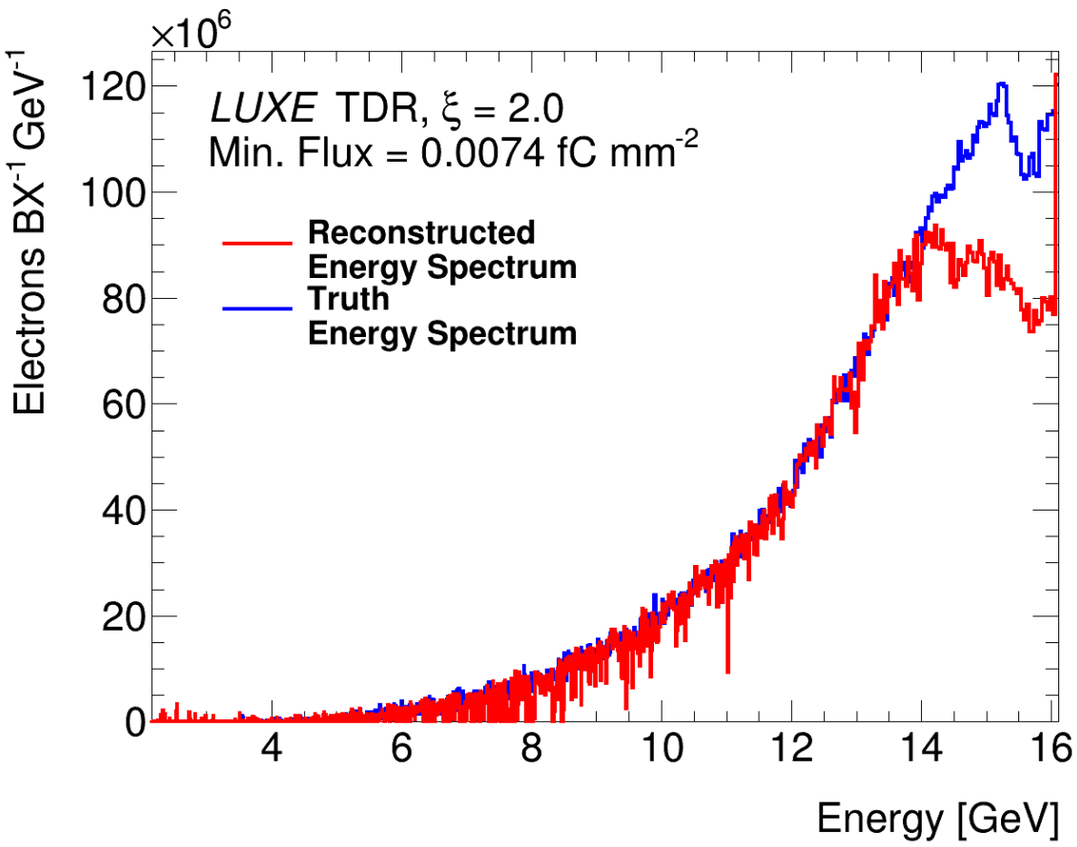


Scint Screen & Camera system, TDR



Cherenkov Detector, CDR

Problem!



I've been working on simulations with the finest binning in images yet, and this has resulted in the largest levels of flux we've yet seen…

Exchanging 1mm² for (0.2x0.2)mm²
→ ~ factor 3 increase maximum flux

The maximum flux for some of the spectrum at particular xi is above (~factor 2 greater) the dynamic range expected for our system…

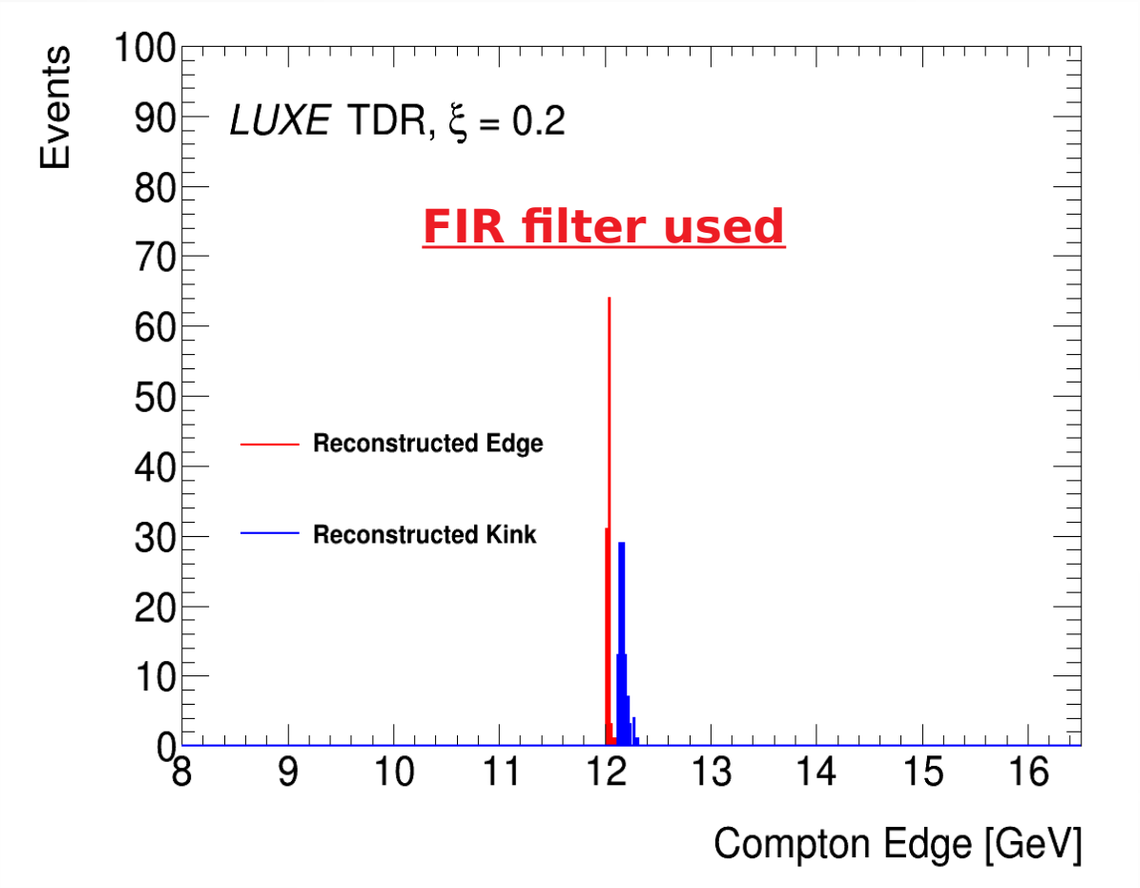
It's possible to decrease the exposure time to decrease signal levels, but I don't like this solution because as we go lower temporal jitter becomes more problematic

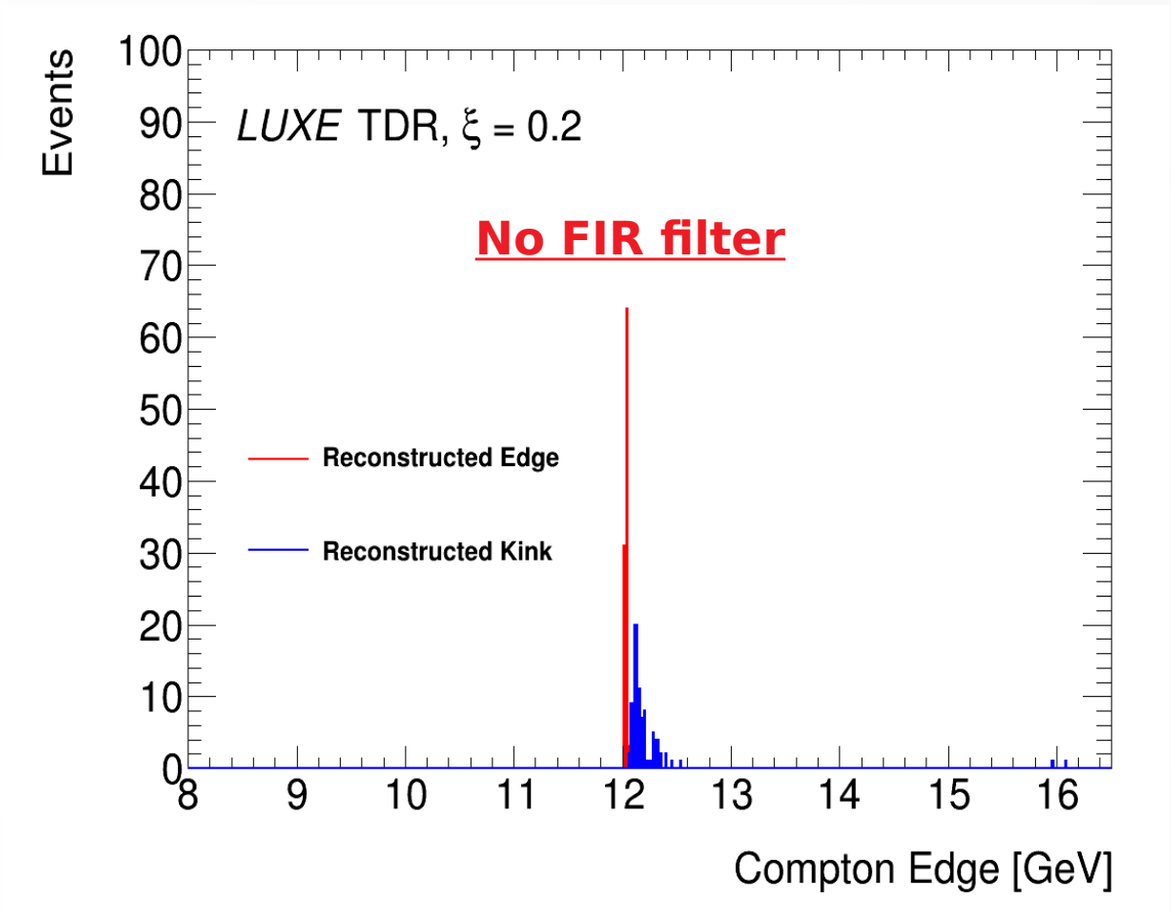
Changing aperture is possible but not precise

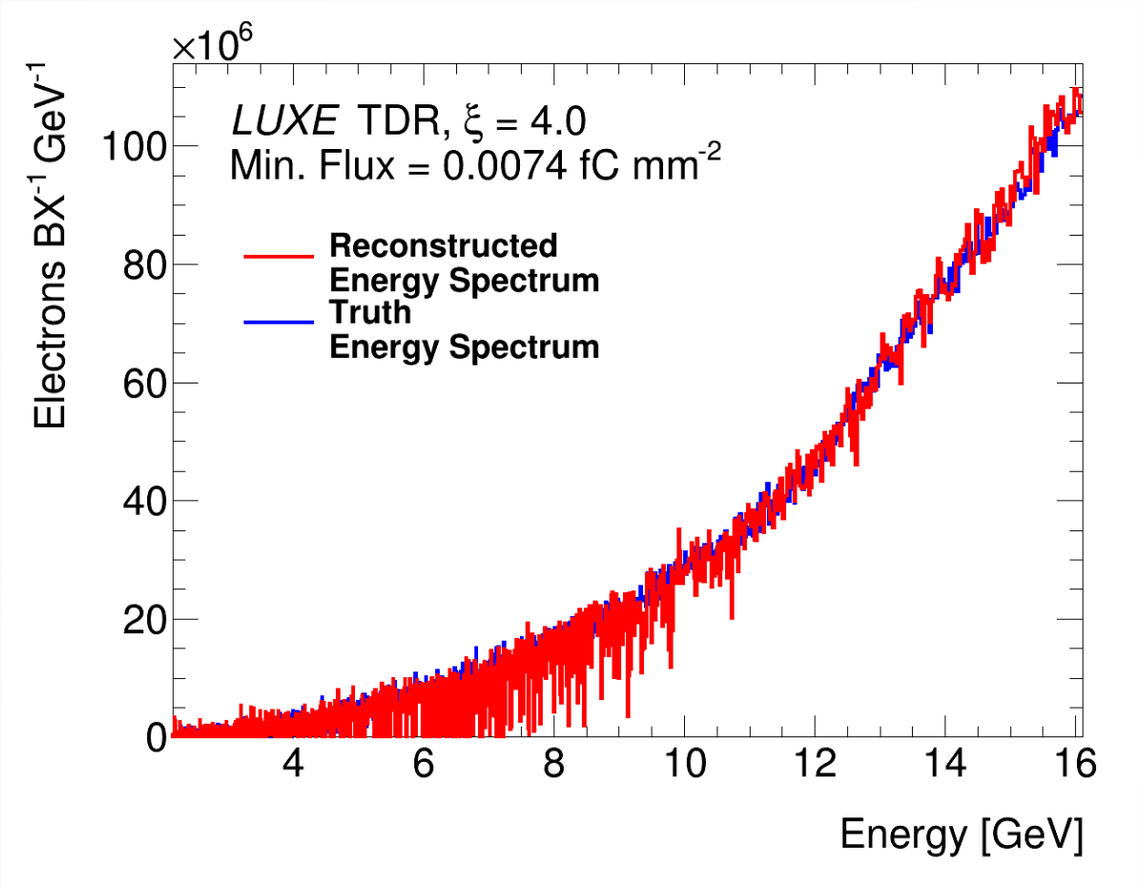
Instead we add the option of a neutral-density filter, reduces transmission of light for the 4K camera…

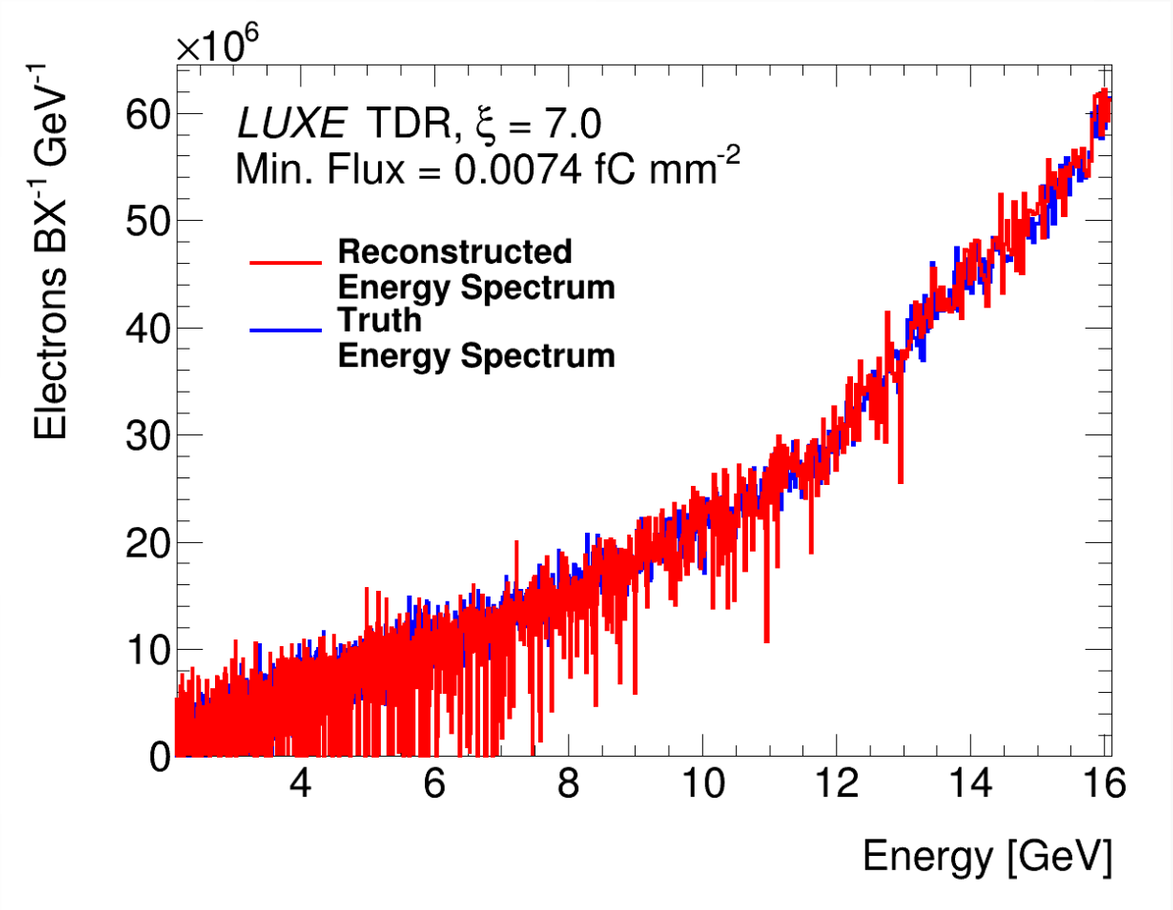
These filters were quickly added and costed in the technical note; the FIR analysis added to results

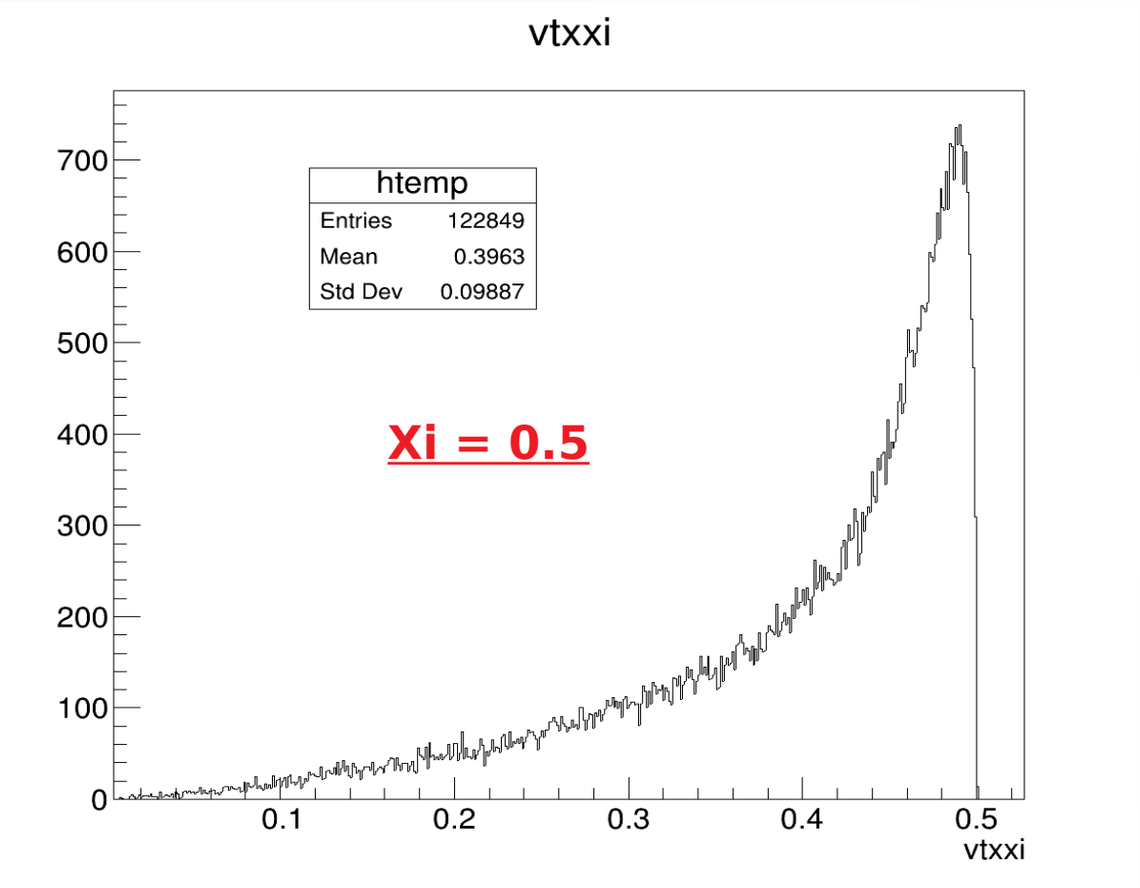
Backup

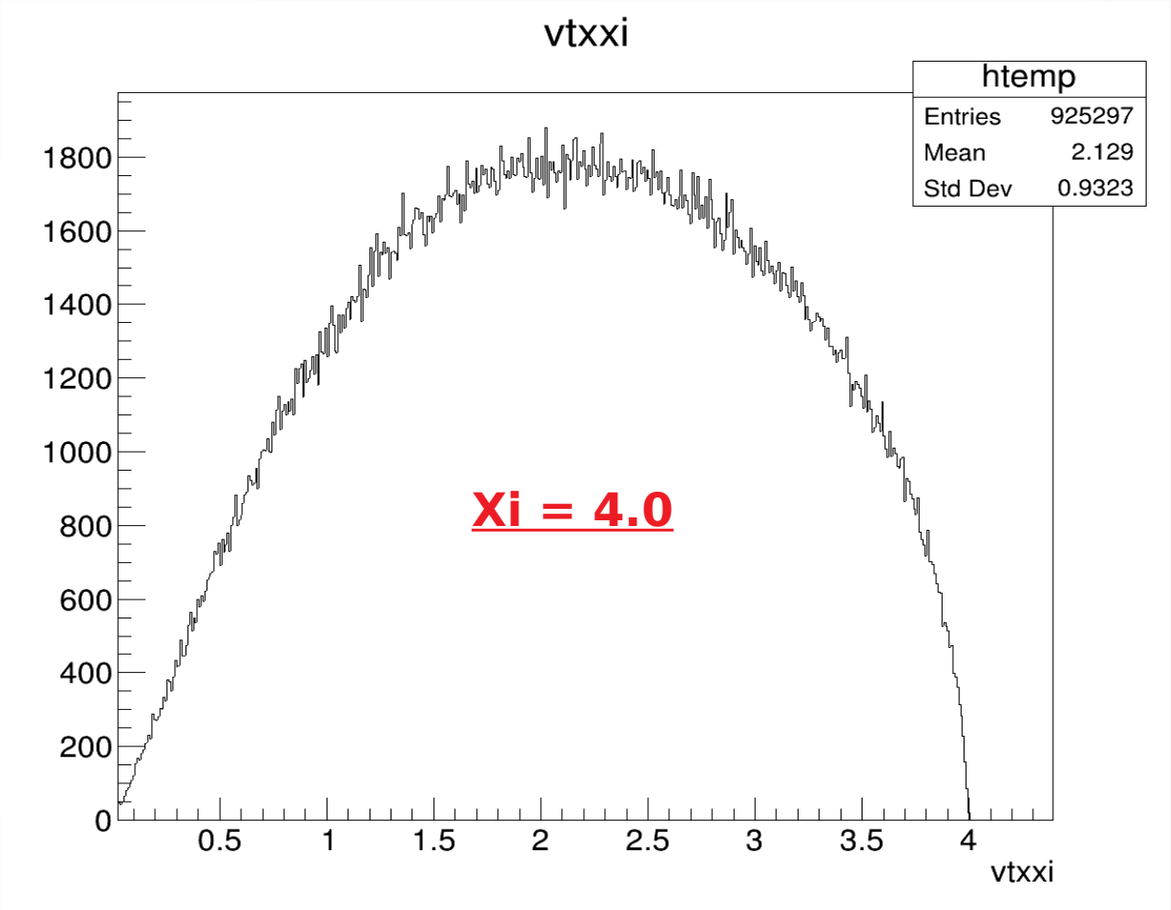

Events
100
90
80
70
60
50
40
30
20
10
0
LUXE TDR, ξ = 0.2
FIR filter used
Reconstructed Edge
Reconstructed Kink
8
9
10
11
12
13
14
15
16
Compton Edge [GeV]

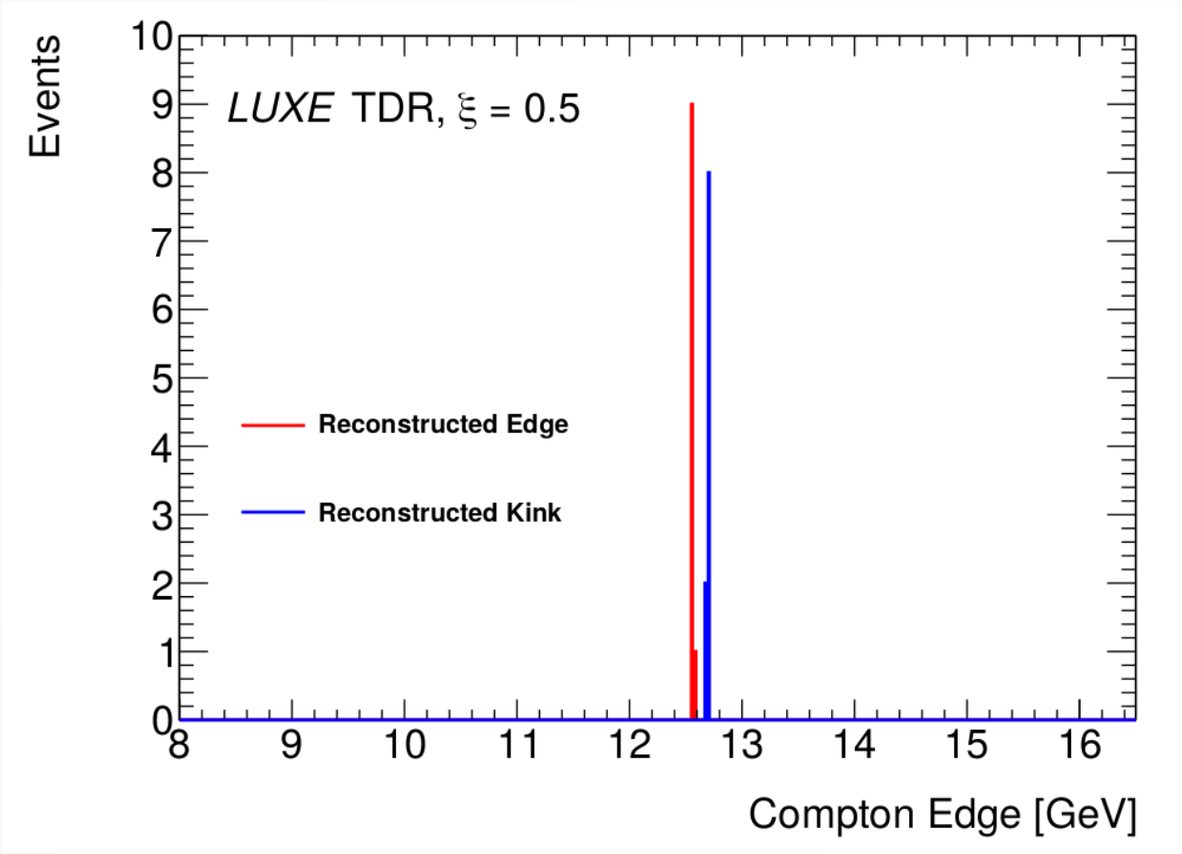

Events
100
90
80
70
60
50
40
30
20
10
0
LUXE TDR, ξ = 0.2
No FIR filter
Reconstructed Edge
Reconstructed Kink
8
9
10
11
12
13
14
15
16
Compton Edge [GeV]

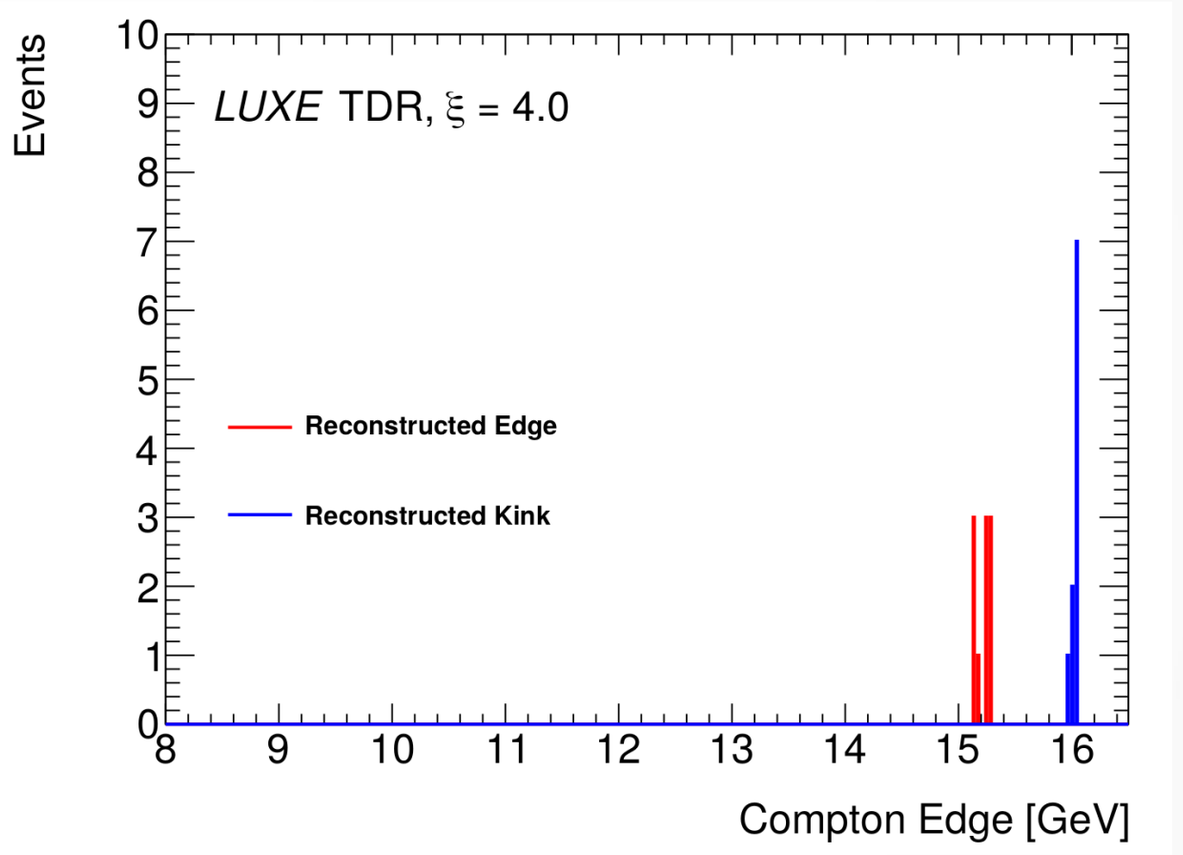

×10^6
Electrons BX^-1 GeV^-1
LUXE TDR, ξ = 4.0
Min. Flux = 0.0074 fC mm^-2
Reconstructed Energy Spectrum
Truth Energy Spectrum
Energy [GeV]


×10^6
Electrons BX^-1 GeV^-1
LUXE TDR, ξ = 7.0
Min. Flux = 0.0074 fC mm^-2
Reconstructed Energy Spectrum
Truth Energy Spectrum
Energy [GeV]


vtxxi
htemp
Entries 122849
Mean 0.3963
Std Dev 0.09887
Xi = 0.5
0
100
200
300
400
500
600
700
0.1
0.2
0.3
0.4
0.5
vtxxi

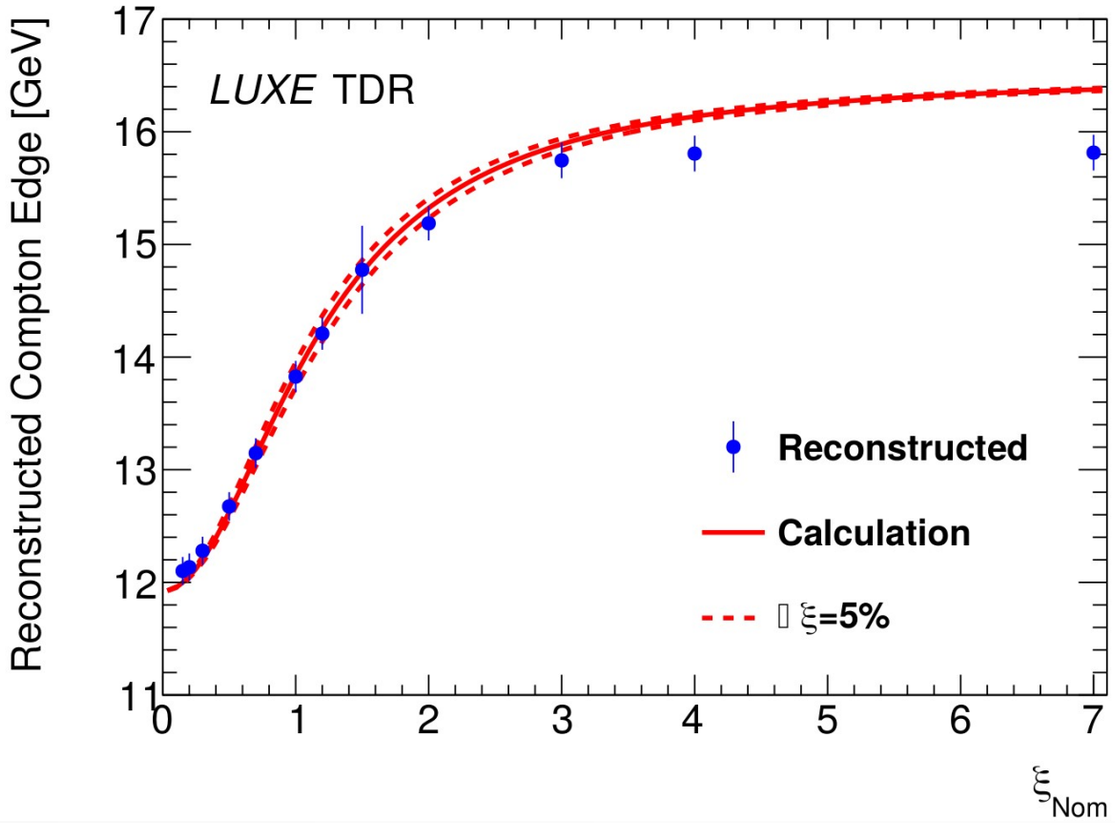

vtxxi
htemp
Entries 925297
Mean 2.129
Std Dev 0.9323
Xi = 4.0
0
200
400
600
800
1000
1200
1400
1600
1800
0.5
1
1.5
2
2.5
3
3.5
4
vtxxi

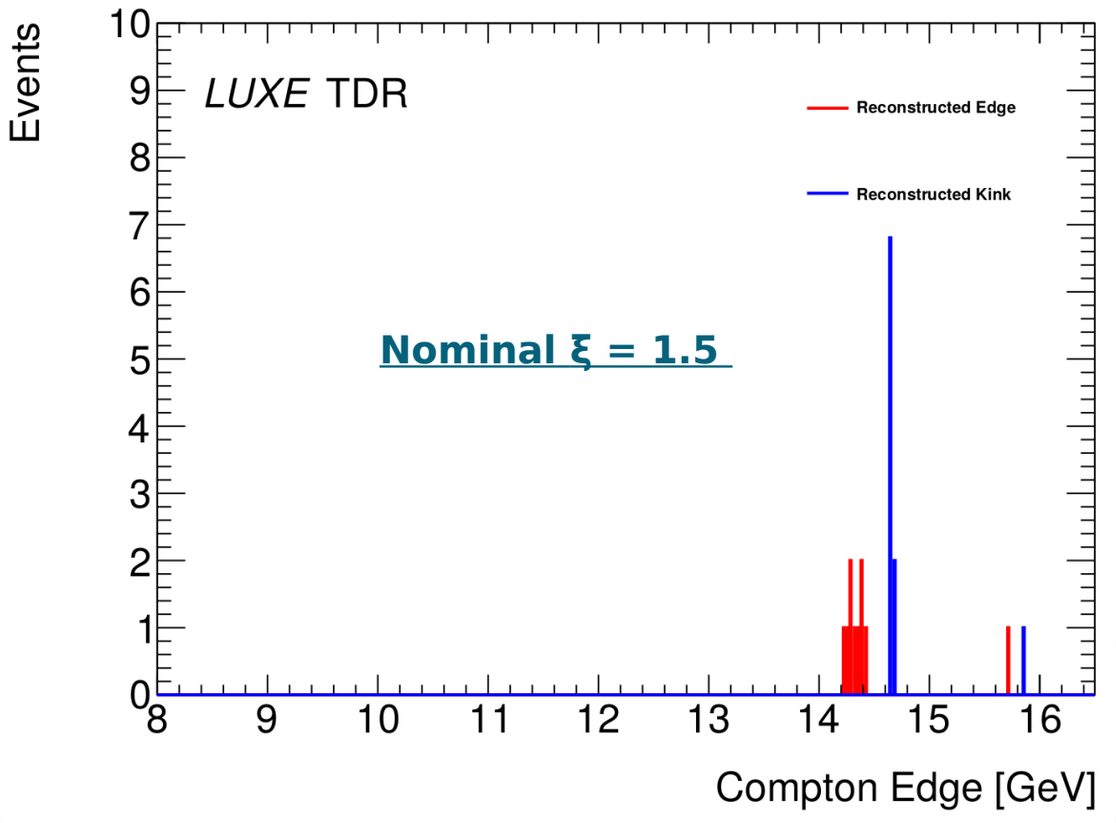

Events
LUXE TDR, ξ = 0.5
Reconstructed Edge
Reconstructed Kink
Compton Edge [GeV]


Events
LUXE TDR, ξ = 4.0
Reconstructed Edge
Reconstructed Kink
Compton Edge [GeV]

Finite Impulse Response Filters

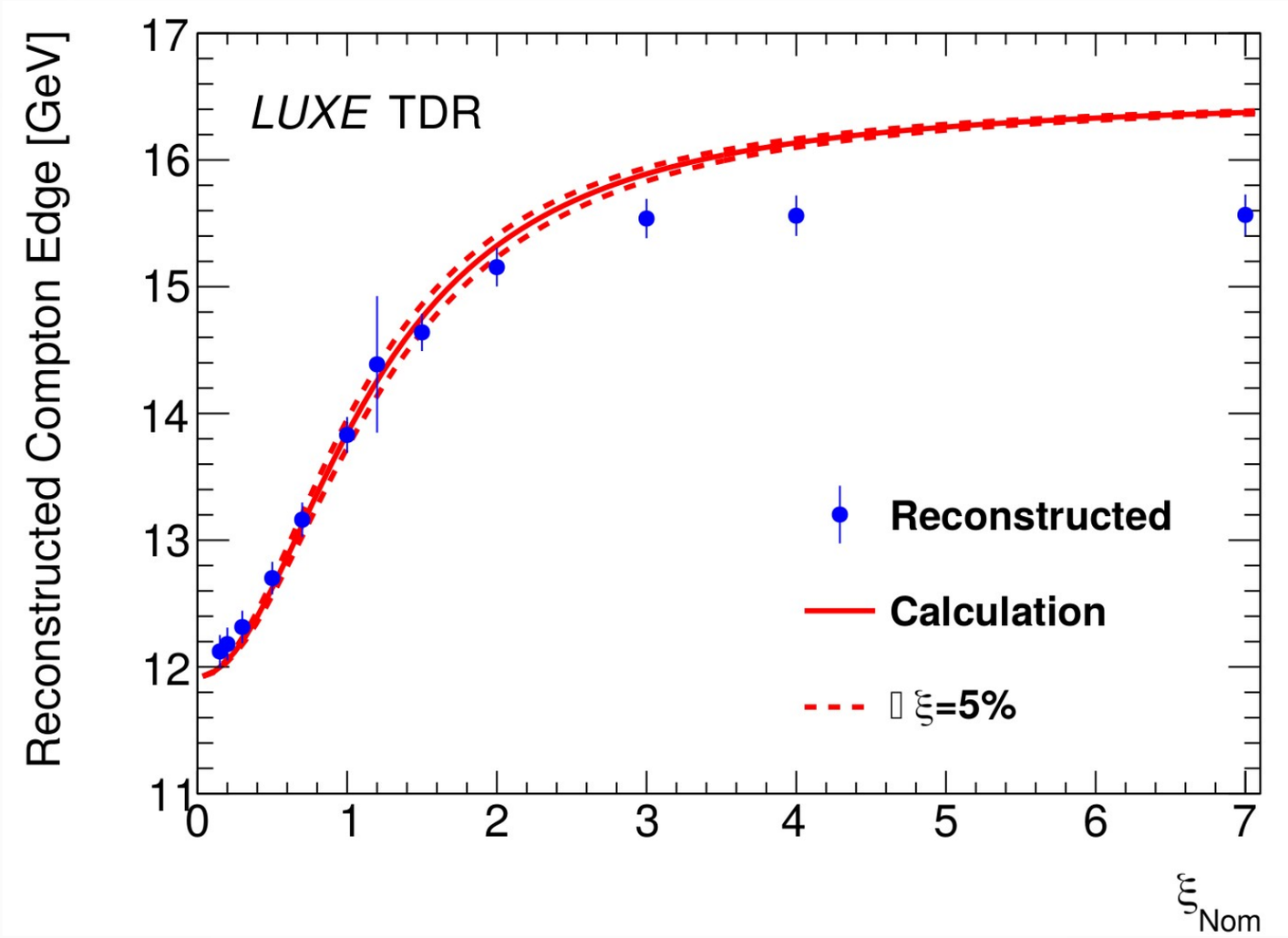
- Each of those points is applying the FIR filter to 10 instances of 10BX of statistics
- The errors are dependent on the std. Dev. Of the reconstructed edges for 10 different simulations (added in quadrature w/ 1% E error)
- Could maybe instead get the errors from a fit to the peak? Although there is no guarantee it follows a normal distribution





Finite Impulse Response Filters

Now looking at stats from only 1BX, because single-shot discrimination would be nice:



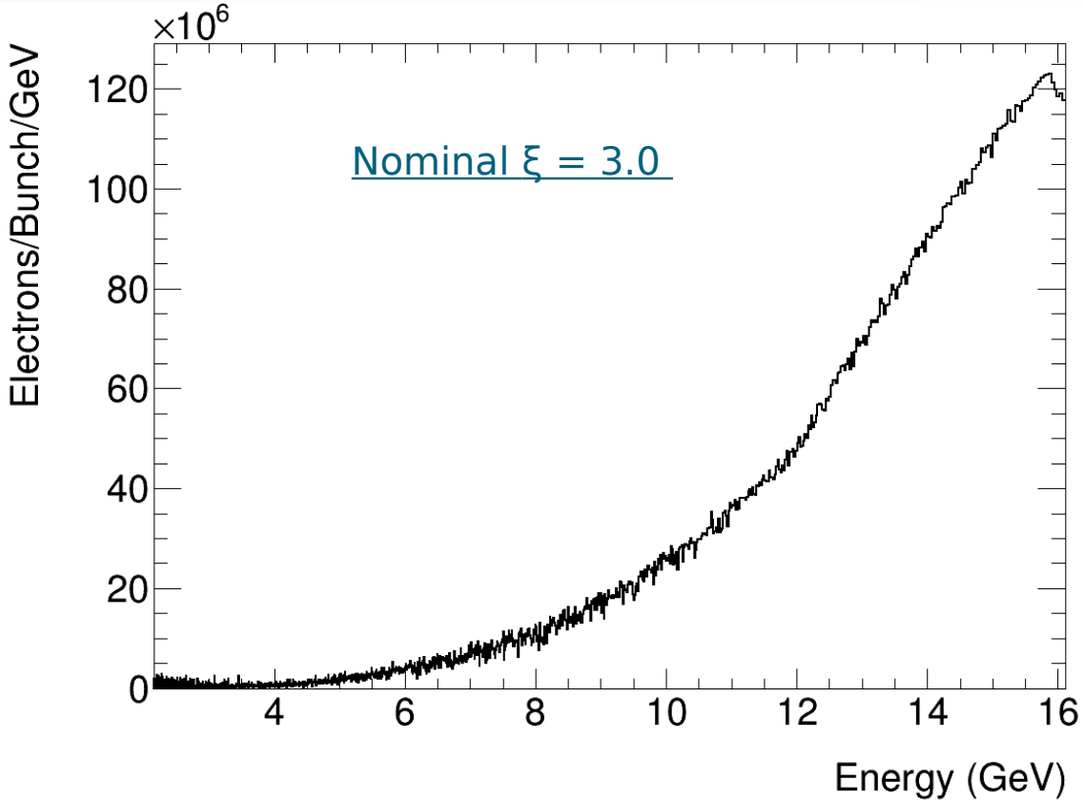
Finite Impulse Response Filters

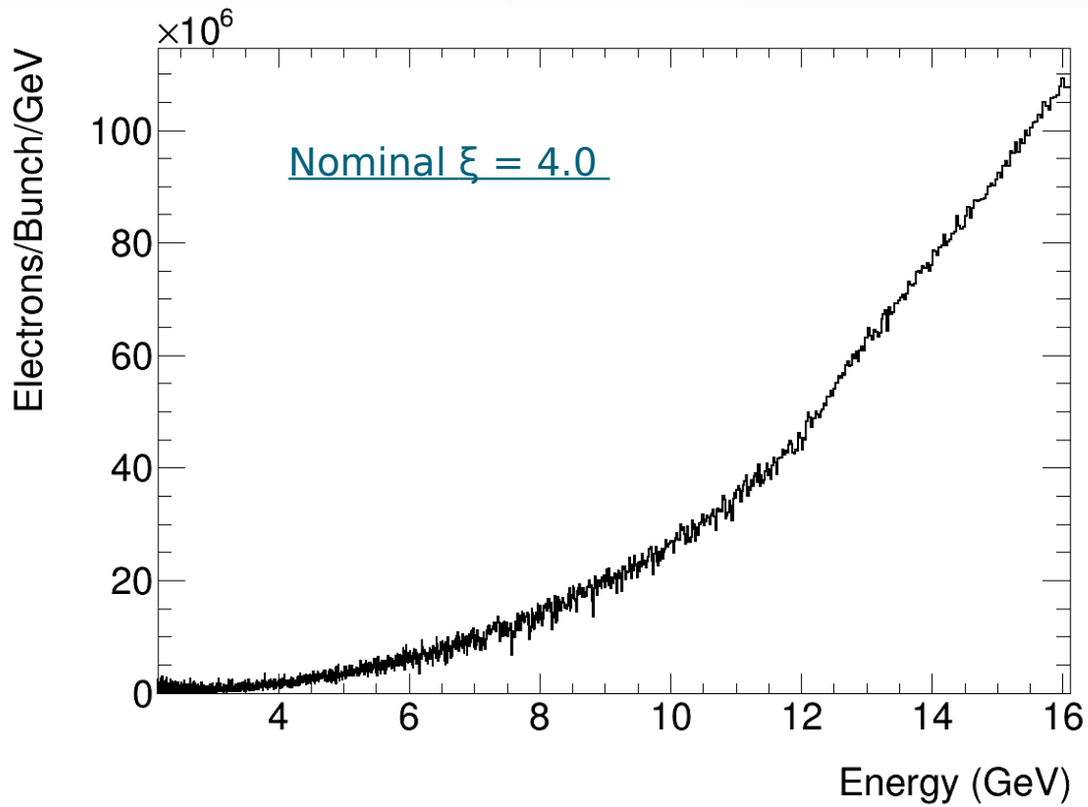
The improvement possible is a little limited, due to the edge escaping the acceptance of our screen

Looks like the edge is only within the very last bin… 200 microns wide

ξ = 7.0 is completely impossible, will remove this data point

I do wonder if using the filters is necessary compared to analysis by eye (or just choosing the maximum bin)





Finite Impulse Response Filters

The filter doesn't look all that much better than eye… but works best in the case of higher noise