Forward Spectrometer Update

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Finding the Compton edge

- Electron signal measured at LANEX screen in gamma spectrometer used to reconstruct the incident photon spectrum
- The error in reconstruction affected by noise and the estimation of the monochromatic response weights
- This, in principle, will lead to an error in the determination of the Compton edge
- The edge is found by locating the **minimum** in the response to an FIR filter - First Derivative Of a Gaussian (FDOG) used here

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Deconvolution and Response to Filter

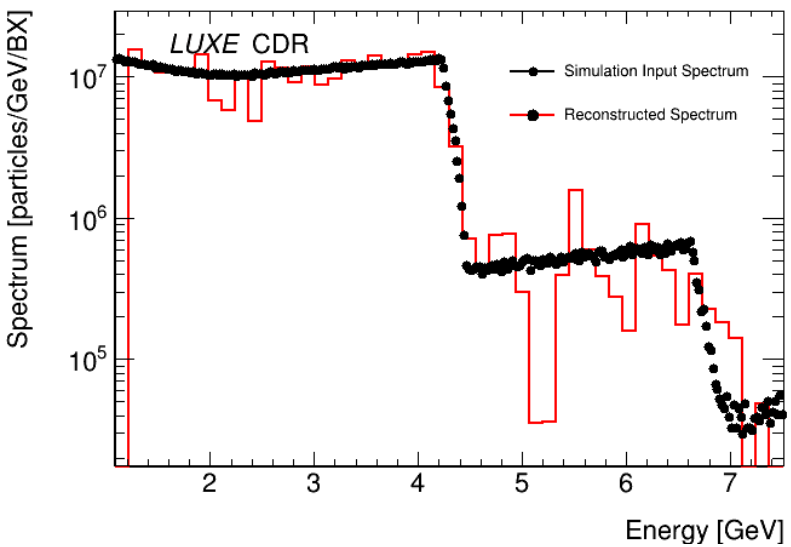

Figure: Comparison of the deconvolved spectrum (red) with the original input photon spectrum (black). First order Compton edge clearly visible at 4.2 GeV.

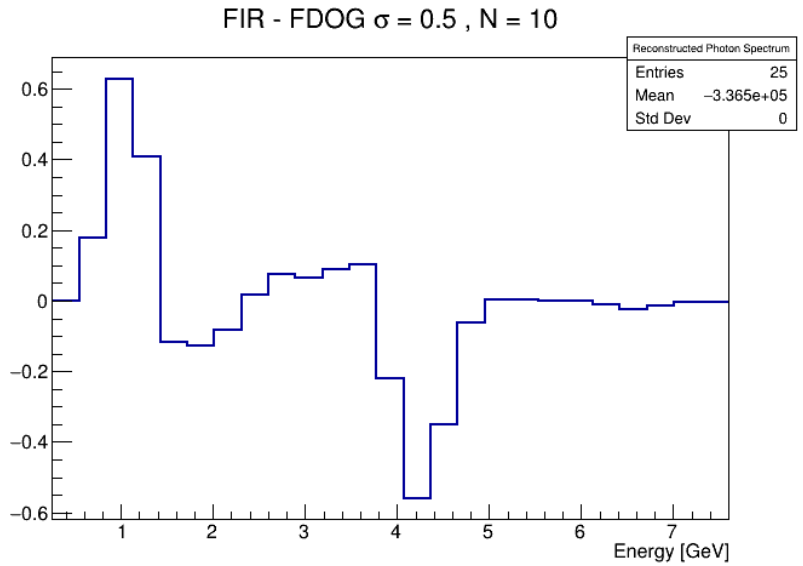

Figure: Response of the deconvoved spectrum to the FDOG filter with $N = 10$ windows and $\sigma = 0.5$. The minimum value of this function locates the first order Compton edge.

Uncertainty in Edge Finding

- "Least squares-esque" approach taken, similar to Ruth's but with added step of deconvolution
- For each discrete point in the electron signal, there is an associated error in measurement
- At each point, a random scaling, $\lambda \in [-1, 1]$, multiplies the error and adds it to the 'true' electron signal value
- This perturbed signal is then deconvolved and passed through the FIR filter and the location of the edge is determined
- For a large sample, this should give a Gaussian distribution with mean equal to the edge value and RMS its statistical error

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Results of Uncertainty Determination I

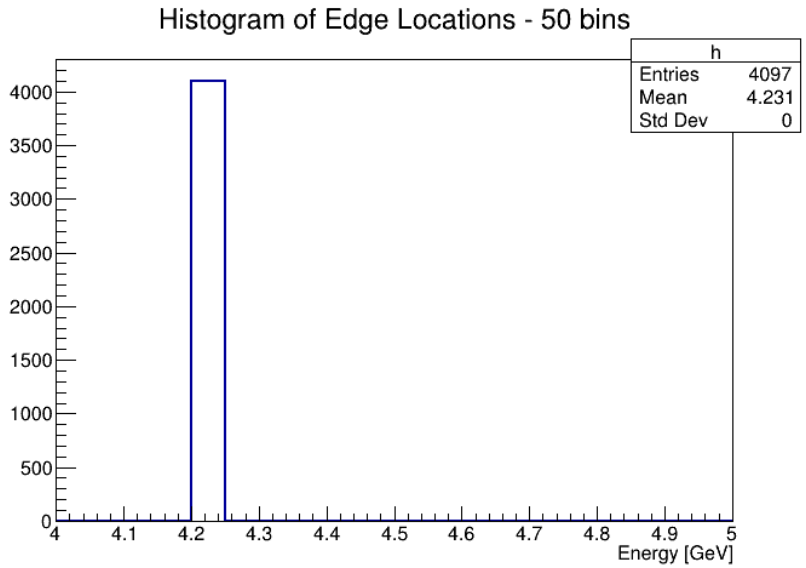

Figure: Histogram of edge locations of 4097 random perturbations to electron signal before deconvolution. 50 bins were used in the deconvolution process.

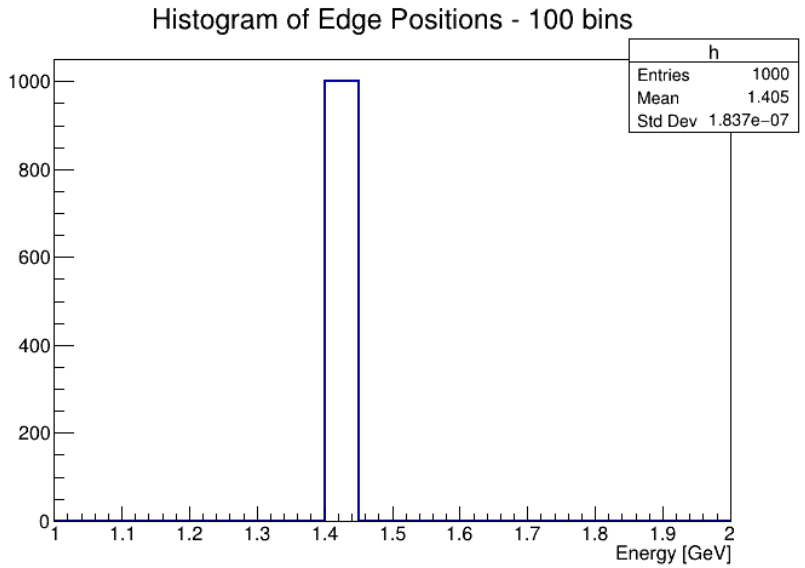

Figure: Histogram of edge locations of 1000 random perturbations to electron signal before deconvolution. 100 bins were used in the deconvolution process.

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Results of Uncertainty Determination II

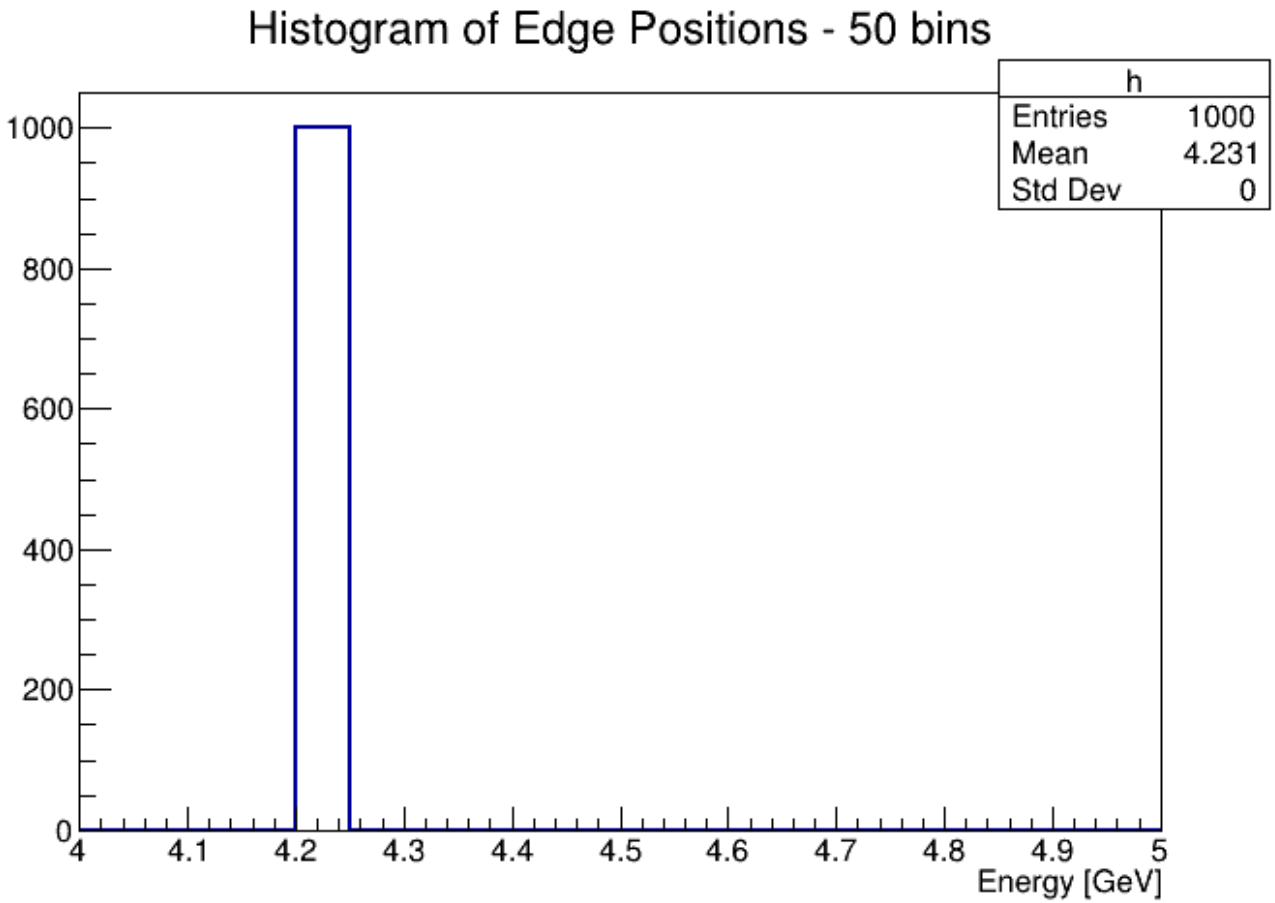

Figure: Histogram of edge locations of 1000 random perturbations to electron signal before deconvolution. 50 bins were used in the deconvolution process and errors in spectrum were amplified by a factor of 1000.

Summary

- Deconvolution and edge finding can predict the location of the first order Compton edge well but the uncertainty needs to be properly quantified
- A random signal perturbation approach taken as first steps to include effects of both deconvolution and application of FIR filter
- For a first attempt, this produces only a single value over 1000 samples, even for 1000 times the error in signal
- More careful approach in the error estimation may be needed

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Backup

Deconvolution with 150 Bins

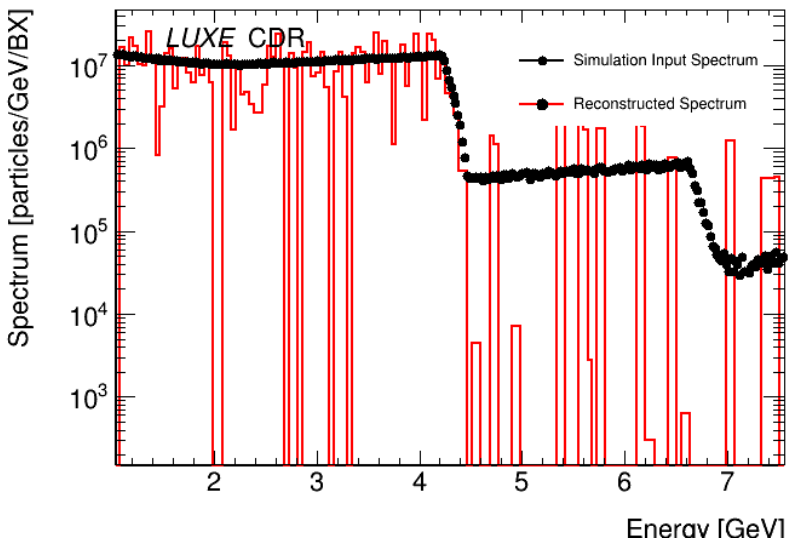

Figure: Deconvolved photon spectrum using 150 bins.

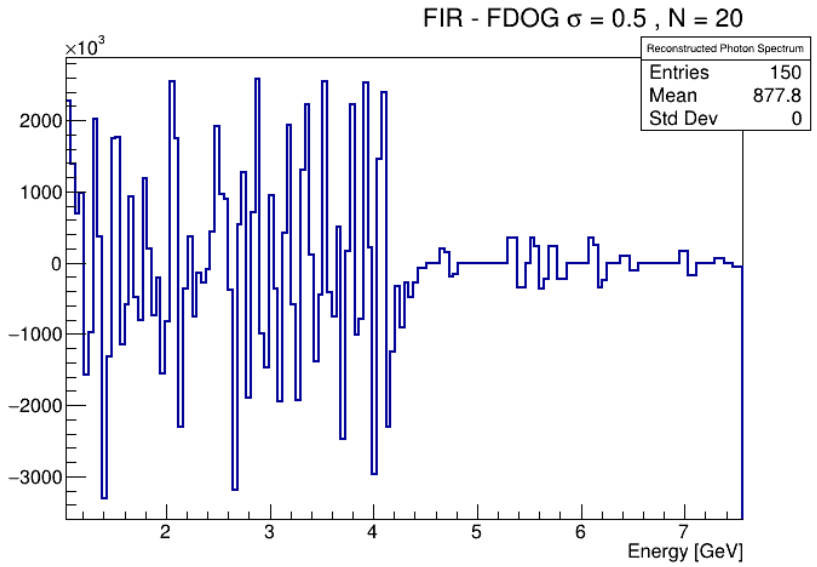

Figure: Response of deconvolved spectrum to FDOG FIR filter.