

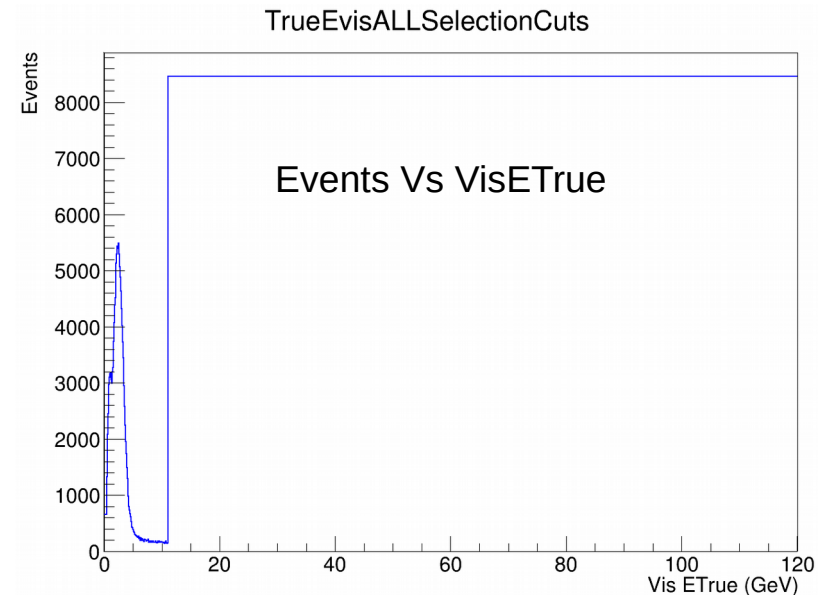
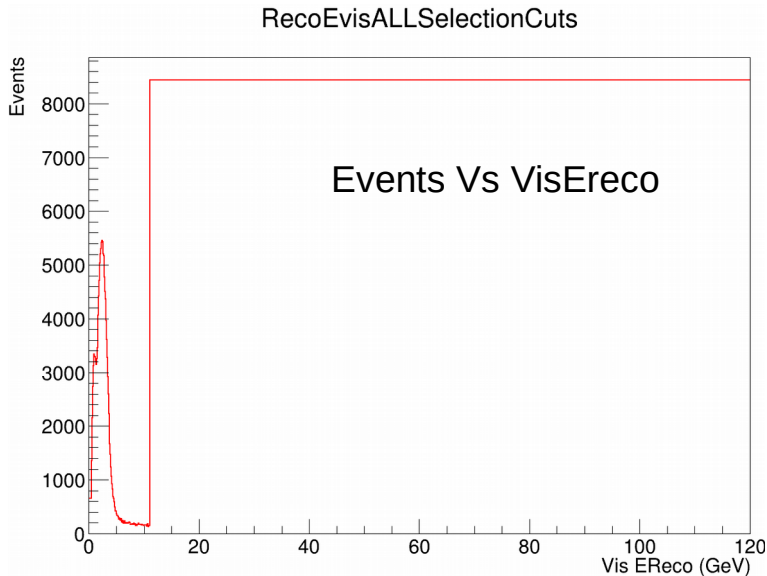
Improving RISM prediction – Unfolding procedure revised

Setup Overview

- Improve Etrue unfolding first by using a small script (1 CAF file)
 - Plot Erec forward folding vs ErecCAF → cross check everything works fine
 - Plot EtrueUnfold Vs EtrueCAF → optimize regularization parameter
- Implement the changes within PRISM analysis → compare to previous results
- Still some things left to be improved BUT getting there :)

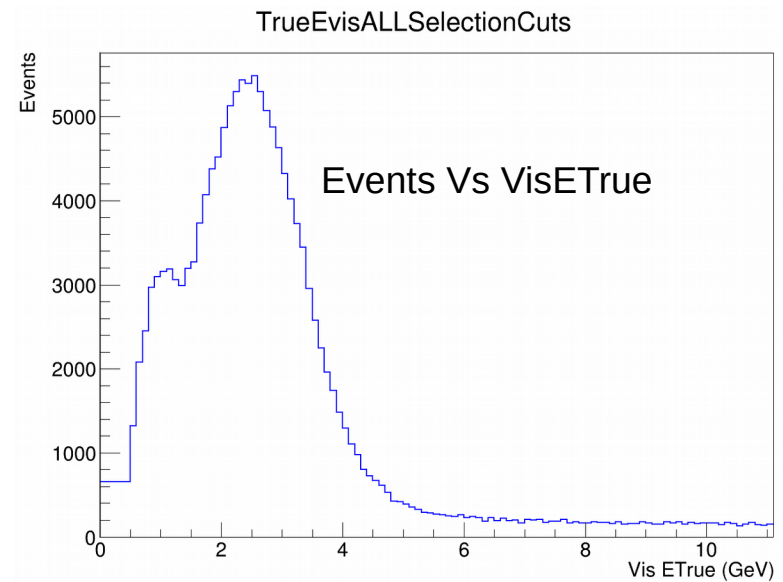
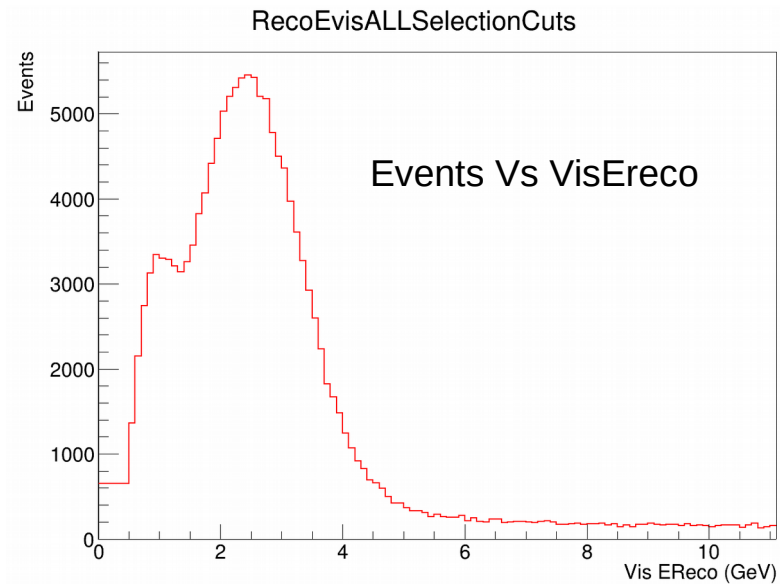
CAF file distributions

- Events with ALL Reco cuts → ‘data’ like → at this point no efficiency applied → only trying to translate from Ereco to Etrue using the info from CAF file
- Use equal bin widths between 0.5 – 11 GeV
 - 1 bin 0-0.5 GeV and 1 bin 11-120GeV



CAF file distributions

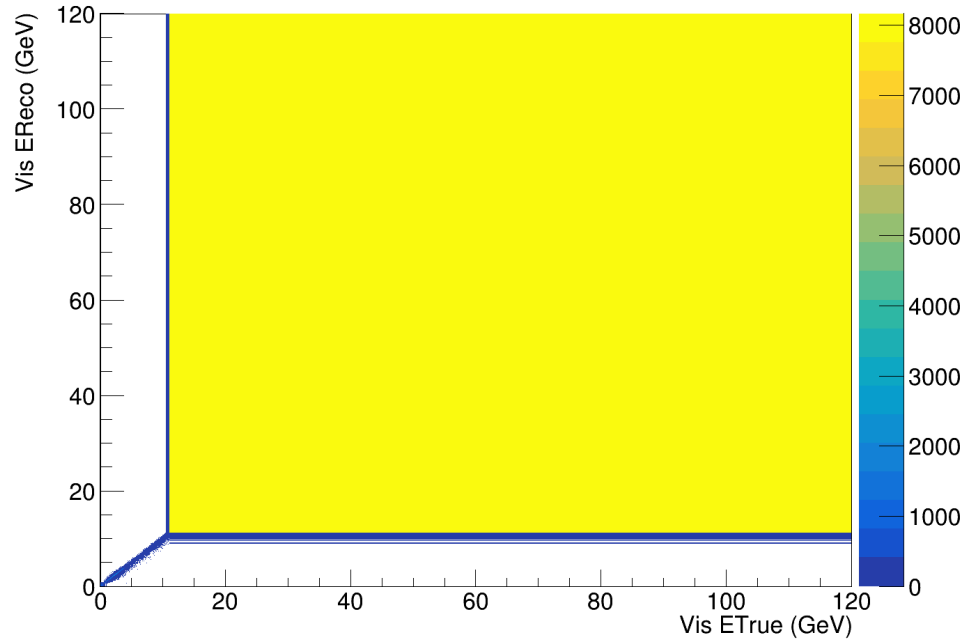
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CAF file smearing matrix

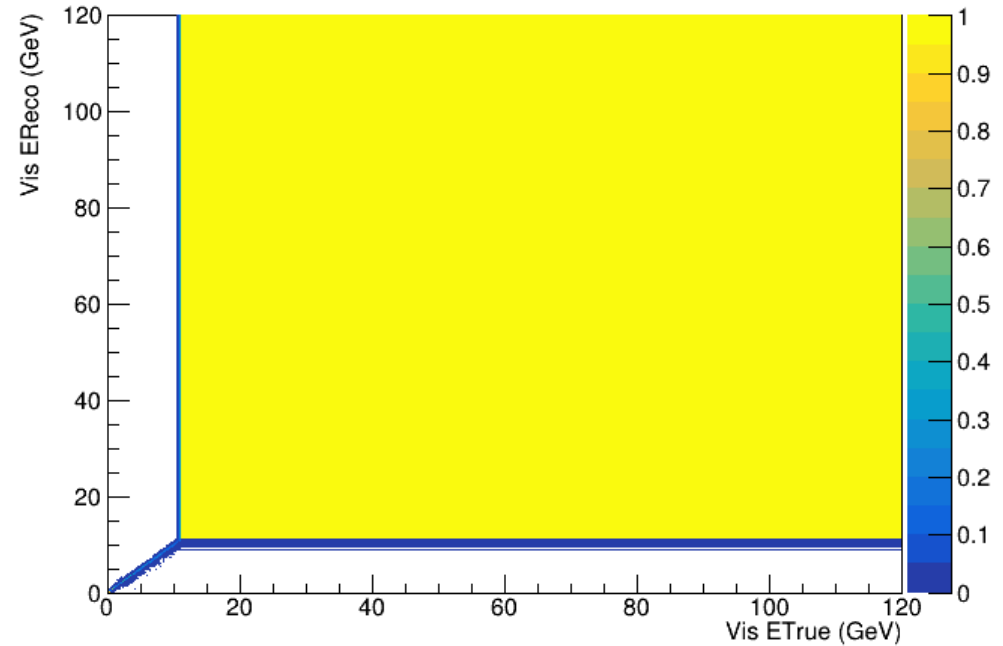
- Only want to reproduce the signal-like distributions (no efficiency involved at this stage)

CAF Smearing Matrix M_{ND}



Normalize
Efficiency (E_{true}) = 1

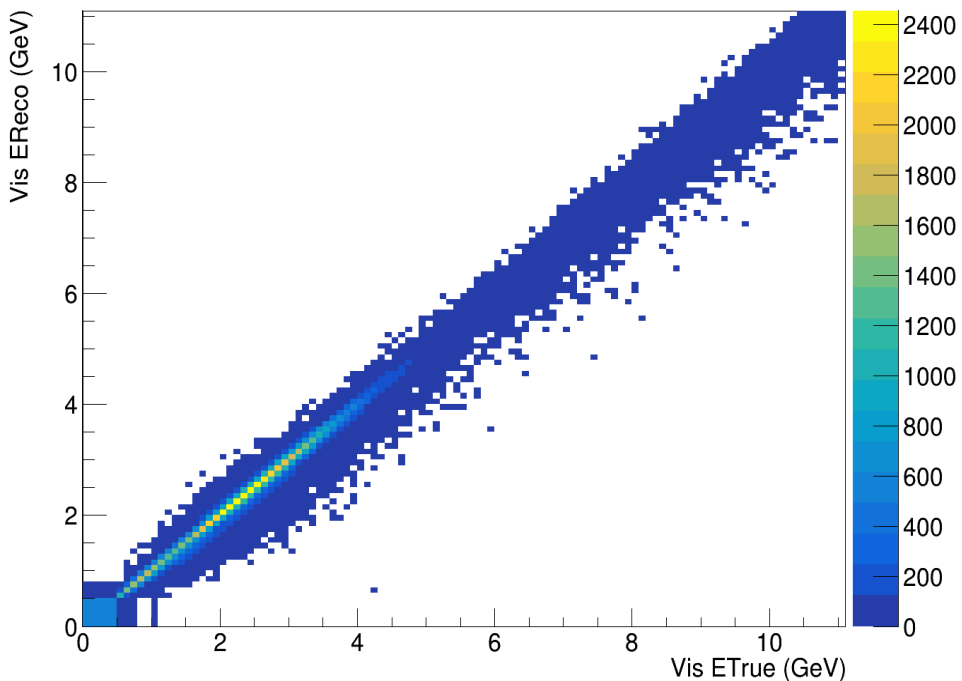
Smearing Matrix M_{ND}
Normalized to efficiency



CAF file smearing matrix

- Only want to reproduce the signal-like distributions (no efficiency involved at this stage)

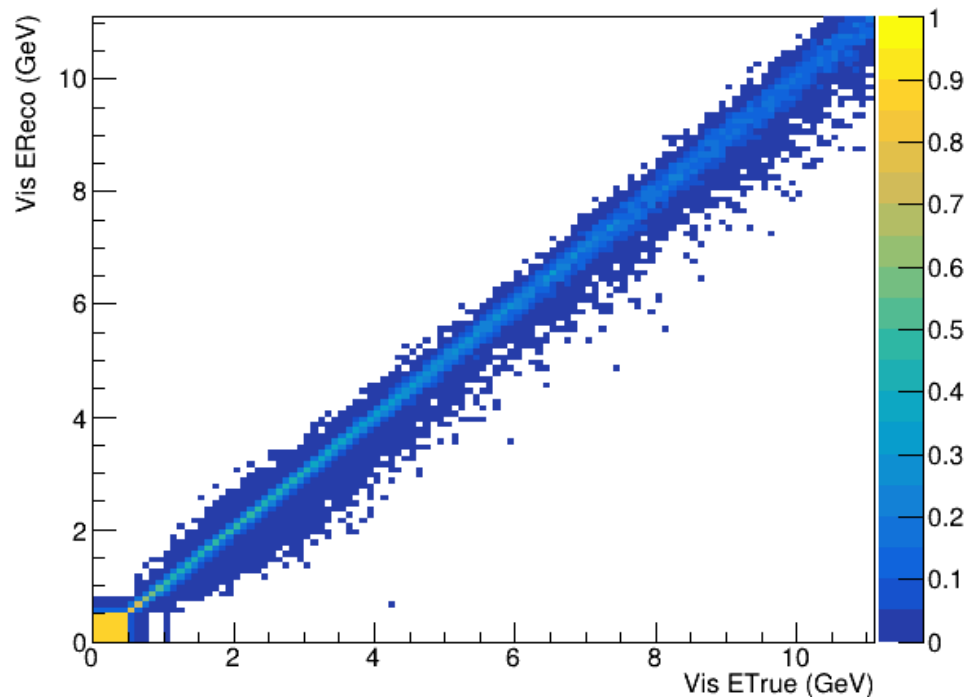
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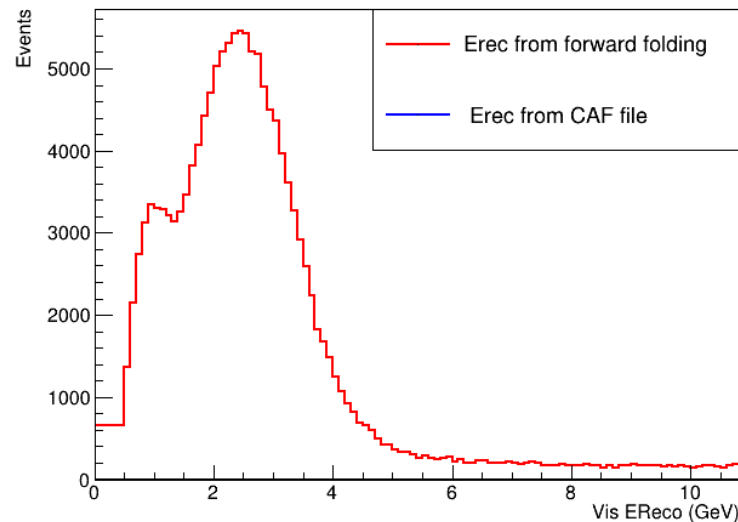
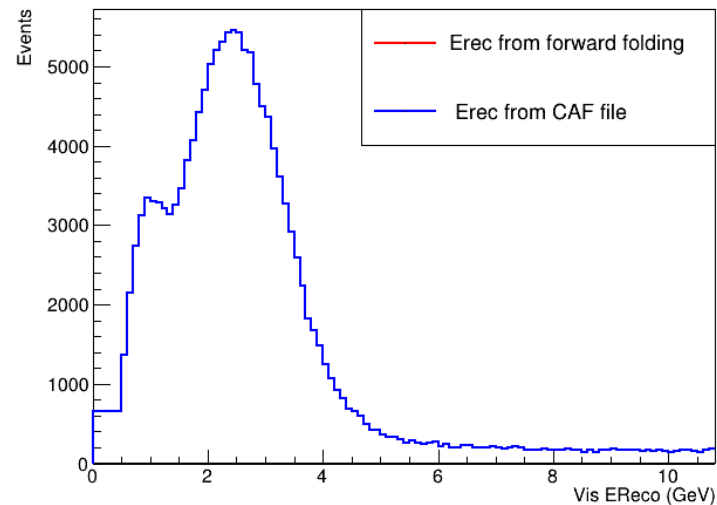
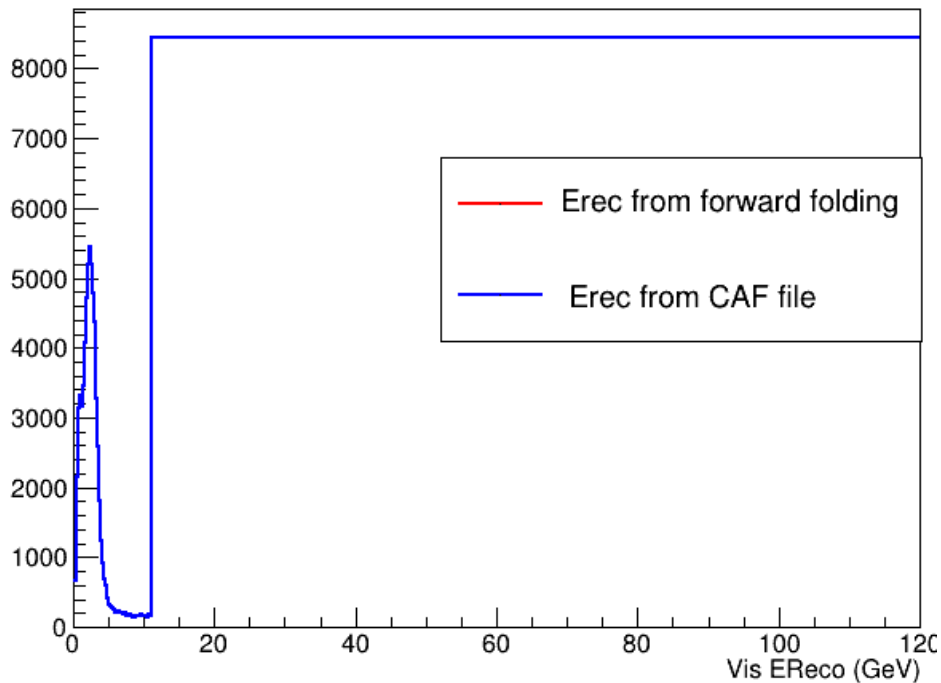
Smearing Matrix M_{ND}
Normalized to efficiency



Reconstructed energy from forward folding

$$E_{\text{rec}}^{\text{FF}} = M_{\text{ND}} * E_{\text{true}}^{\text{CAF}}$$

RecoEvisALLSelectionCuts



- Perfect Erec reproduction → cross check OK :)

True energy - unfolding

- Tikhonov regularization:
 - minimize $\|M_{ND} E_{true} - E_{rec}\|^2 + \|\Gamma E_{true}\|^2$
 - Γ – regularization matrix

$$\Gamma = \tau_{unf.} \begin{pmatrix} 1 & -2 & 1 & 0 & \dots & 0 & 0 & 0 \\ 0 & 1 & -2 & 1 & \dots & 0 & 0 & 0 \\ 0 & 0 & 1 & -2 & \dots & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & \dots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & \dots & 1 & -2 & 1 \\ 0 & 0 & 0 & 0 & \dots & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \dots & 0 & 0 & 0 \end{pmatrix}$$

↓
regularization
parameter

- this form of the matrix is corresponding to a regularization of the second derivative: approx. by $(x_{i+1} - x_i) - (x_i - x_{i-1})$.

$$L_{i,i} = 1, L_{i,i+1} = -2, L_{i,i+2} = 1.$$

$$\Gamma = \tau_{unf.} \begin{pmatrix} -1 & 1 & 0 & 0 & \dots & 0 & 0 \\ 0 & -1 & 1 & 0 & \dots & 0 & 0 \\ 0 & 0 & -1 & 1 & \dots & 0 & 0 \\ \cdot & \cdot & \cdot & \cdot & \dots & \cdot & 0 \\ \cdot & \cdot & \cdot & \cdot & \dots & \cdot & 0 \\ \cdot & \cdot & \cdot & \cdot & \dots & \cdot & 0 \\ 0 & 0 & 0 & 0 & \dots & -1 & 1 \\ 0 & 0 & 0 & 0 & \dots & 0 & 0 \end{pmatrix}$$

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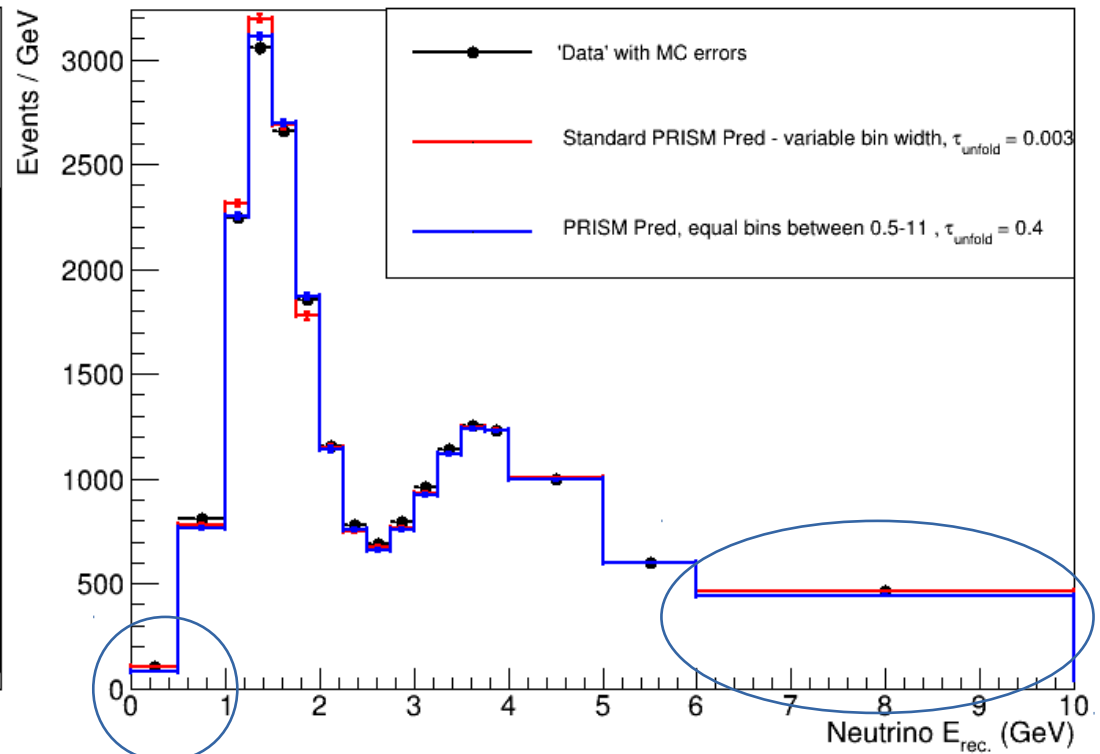
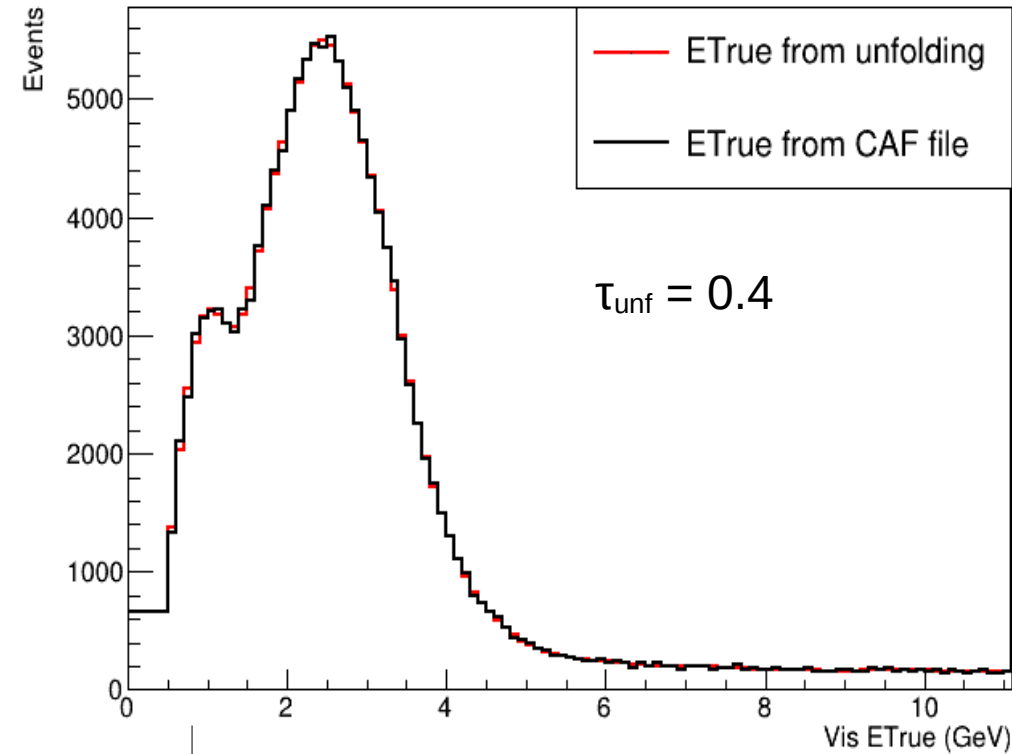
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- this form of the matrix is corresponding to a regularization of the second derivative: approx. by $x_{i+1} - x_i$.

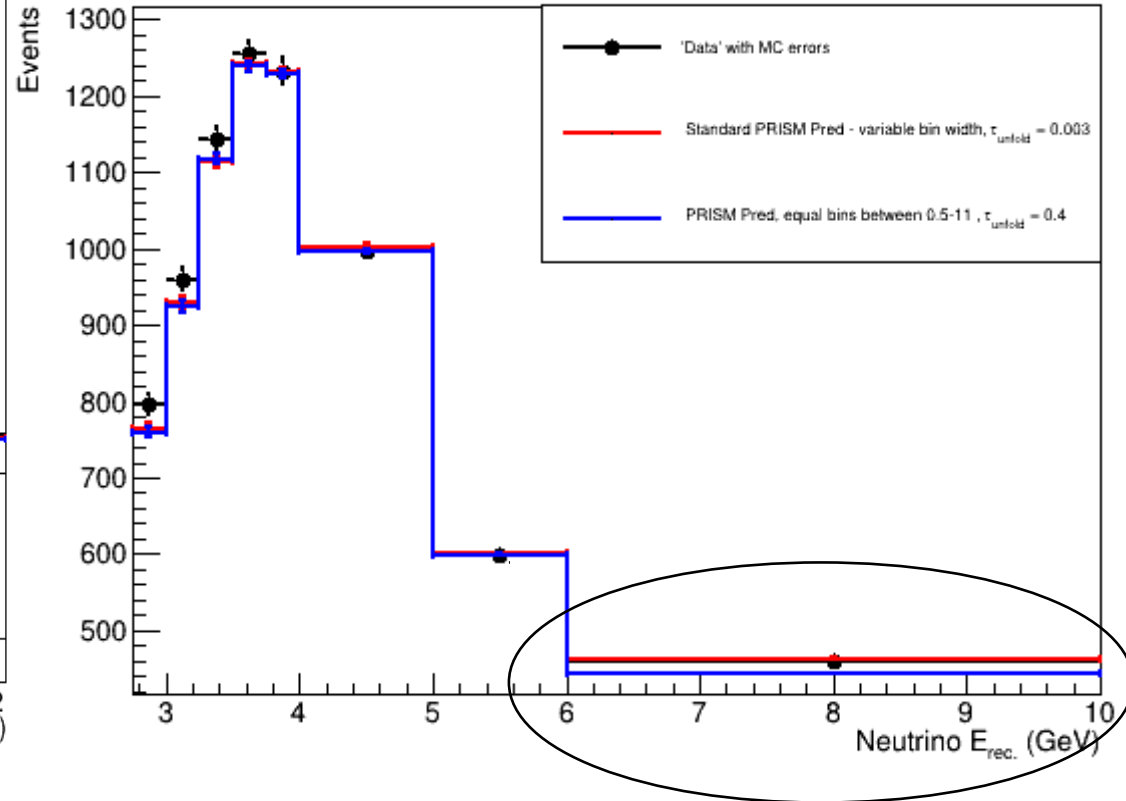
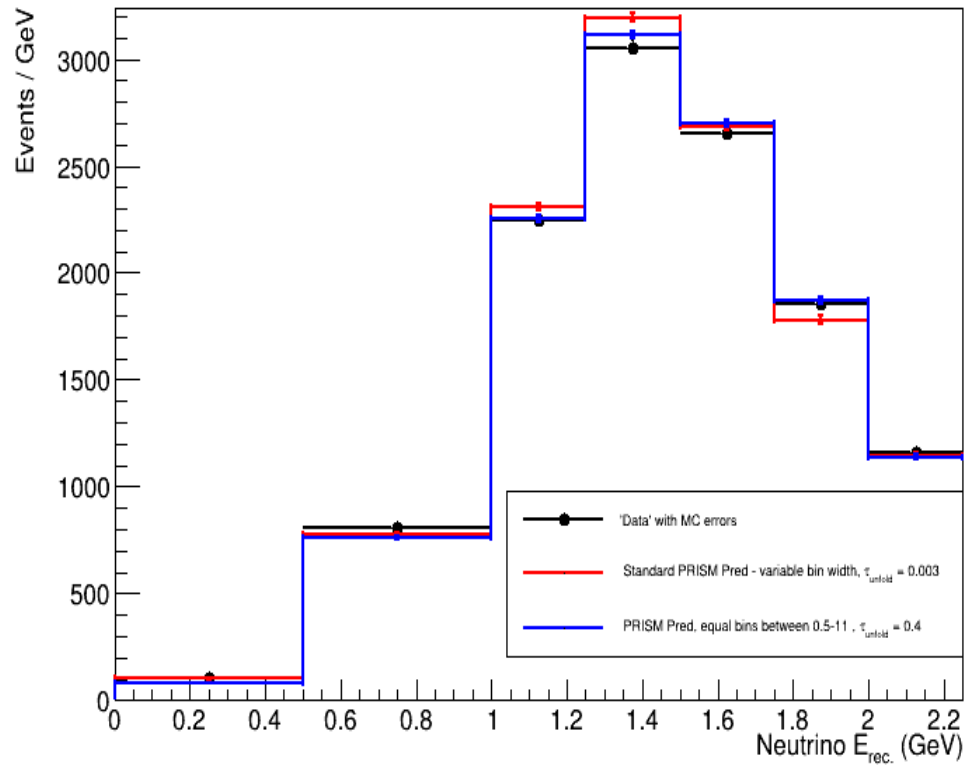
$$L_{i,i} = -1 \text{ and } L_{i,i+1} = 1$$

True energy – unfolded distributions and PRISM Prediction



unfolding to true energy works quite well
within the mini-script and 1 CAF file

PRISM Prediction different binning – ZOOM in highest and lowest energies



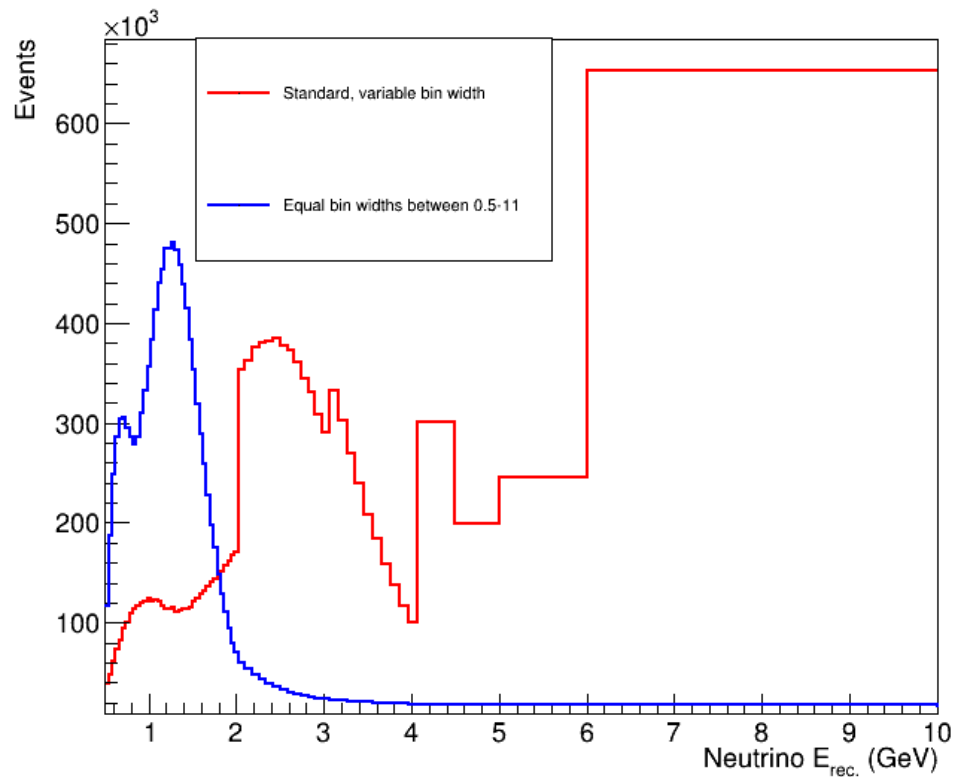
→ main problem still to be solved / understood regarding the highest energy bin..

Still TODO (but getting there..)

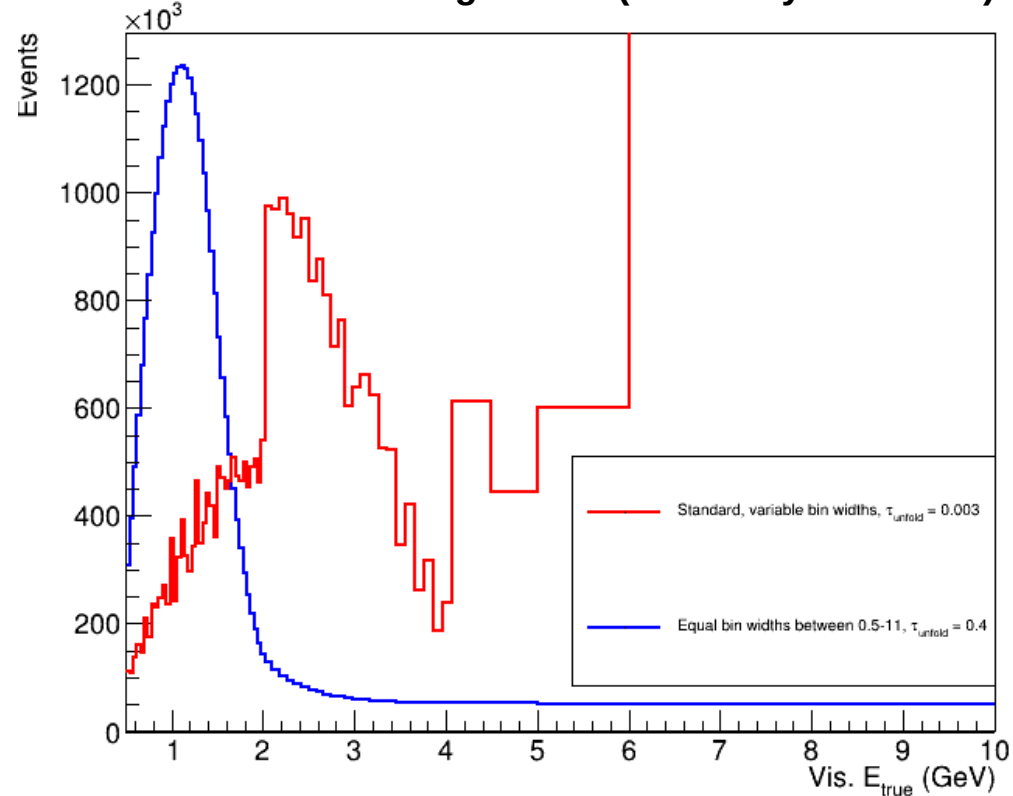
- try different binning (maybe more bins between 10-120 GeV, as well as maybe finer binning between 0 – 0.5)
- adapt unfolding procedure to bin content / bin width → solve any binning related problem
- still need to understand exactly the “block procedure” existent within PRISM analysis code, but should be done within the next week

→ Once this is solved we can re-iterate over the flux systematics

ND 'data' we start with

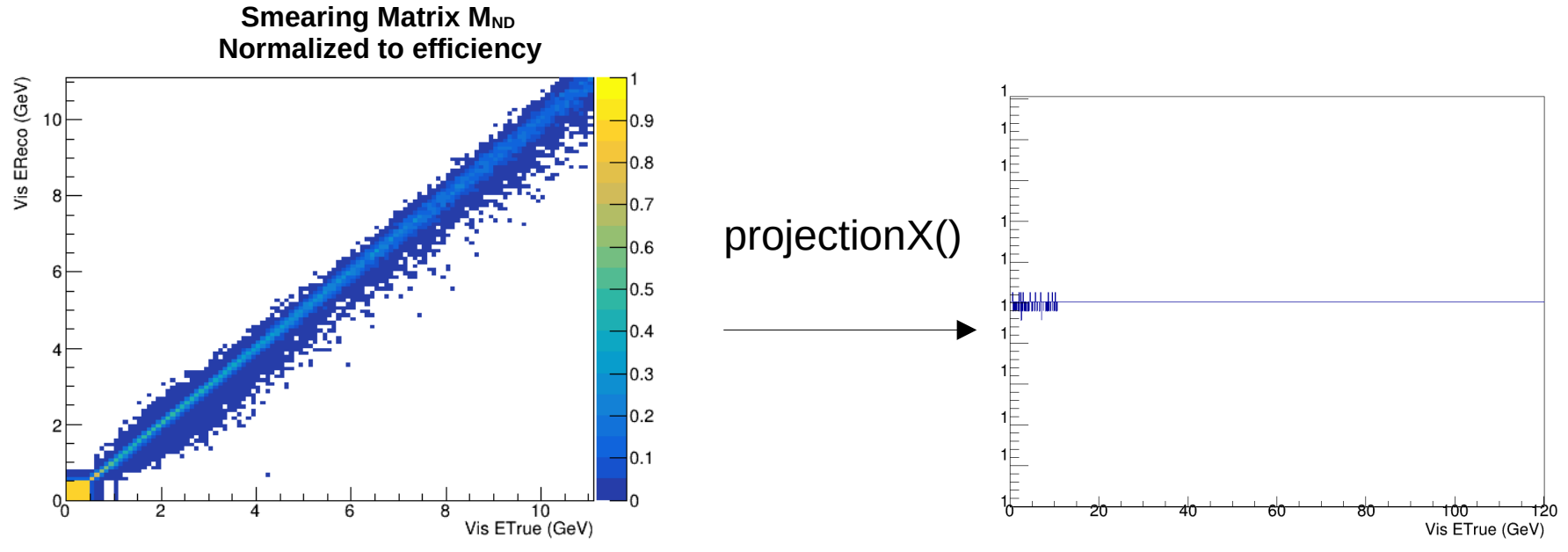


Unfolded ND signal-like (efficiency corrected)



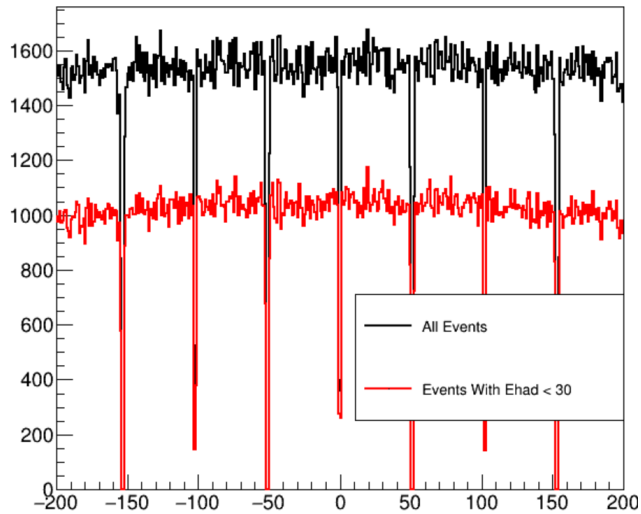
CAF file smearing matrix

- Only want to reproduce the signal-like distributions (no efficiency involved at this stage)
 - cross check normalization works properly

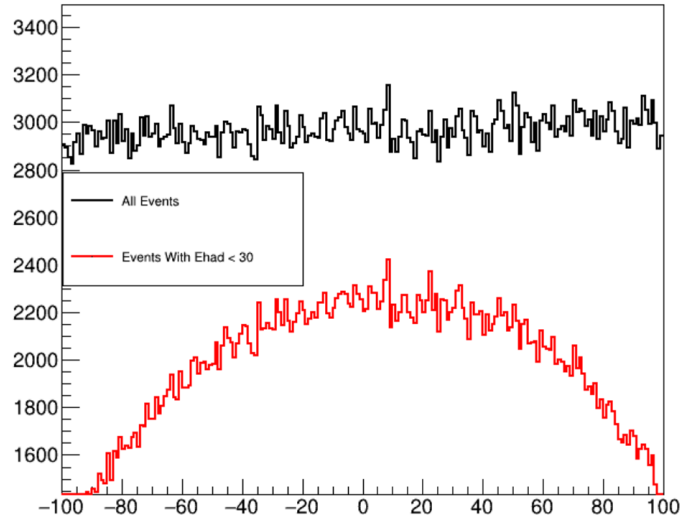


Meanwhile..

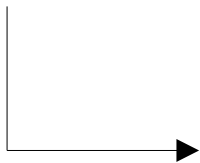
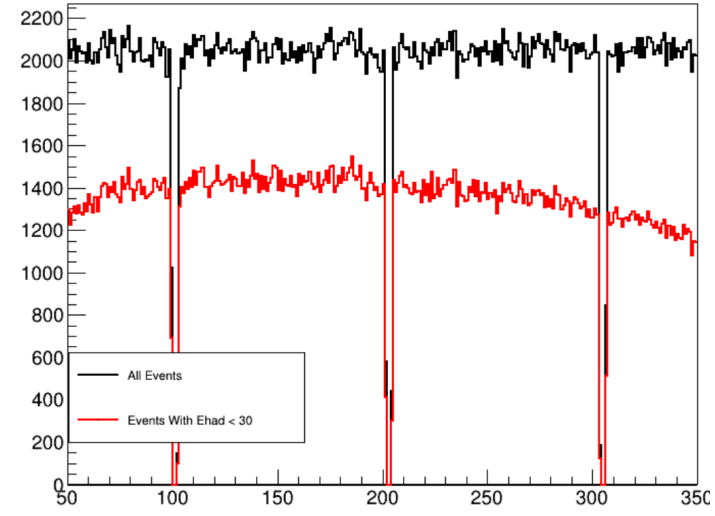
EventsInVtxX



EventsInVtxY



EventsInVtxZ



Why no edge effect in vtx X when veto cut is applied?