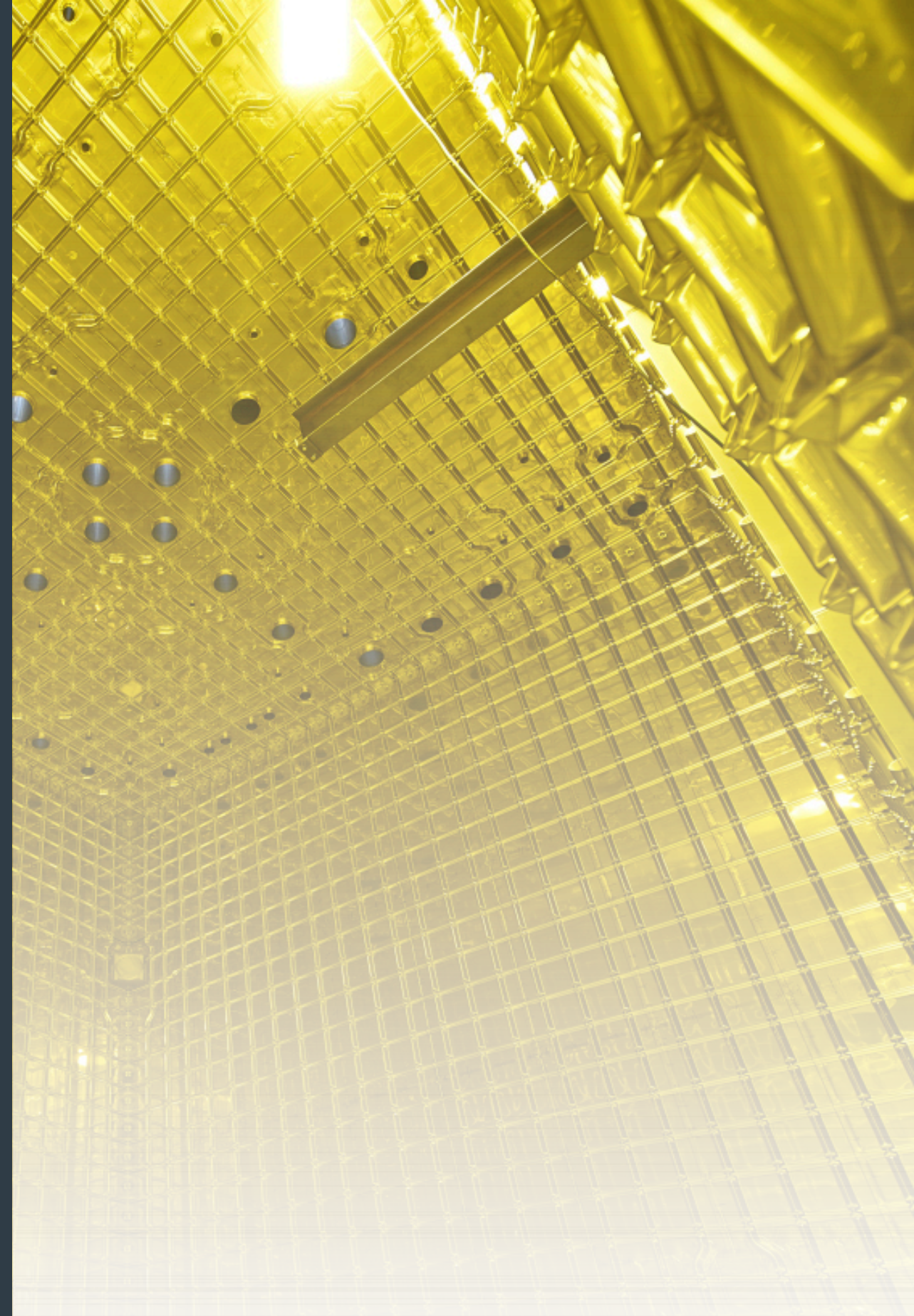


IMPROVING THE MODELLING OF NEUTRINO ENERGY BIAS

April 24

CALLUM COX



SYSTEMATIC UNCERTAINTIES

Systemic Parameters are defined as:

Neutrino Flux ' $\Phi(E_\nu)$ '

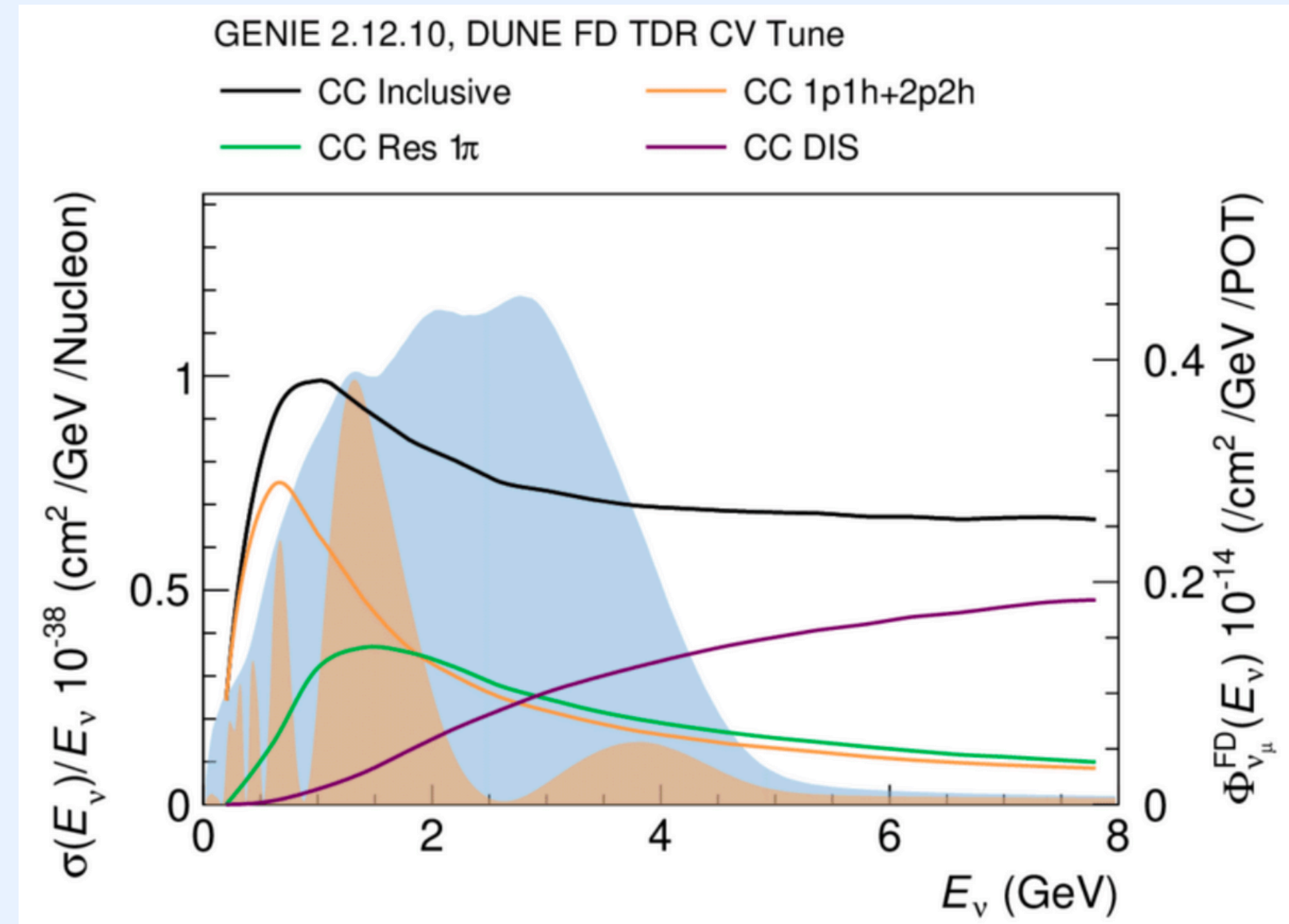
Cross Section ' $\sigma(E_\nu)$ '

Detector Efficiency ' $\epsilon(E_\nu)$ '

All are functions of neutrino energy - and therefore dependant upon how accurate our energy reconstruction is.

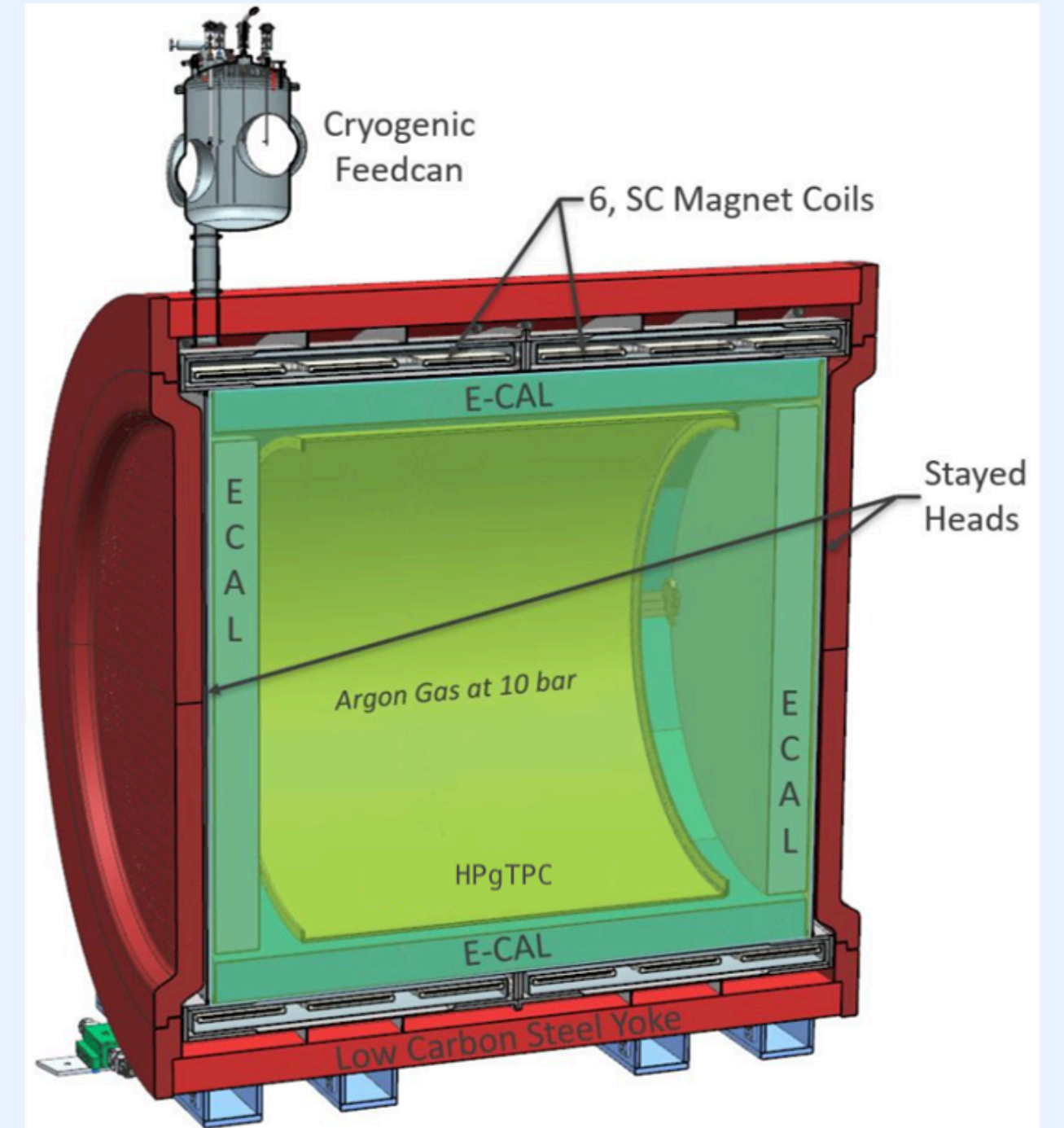
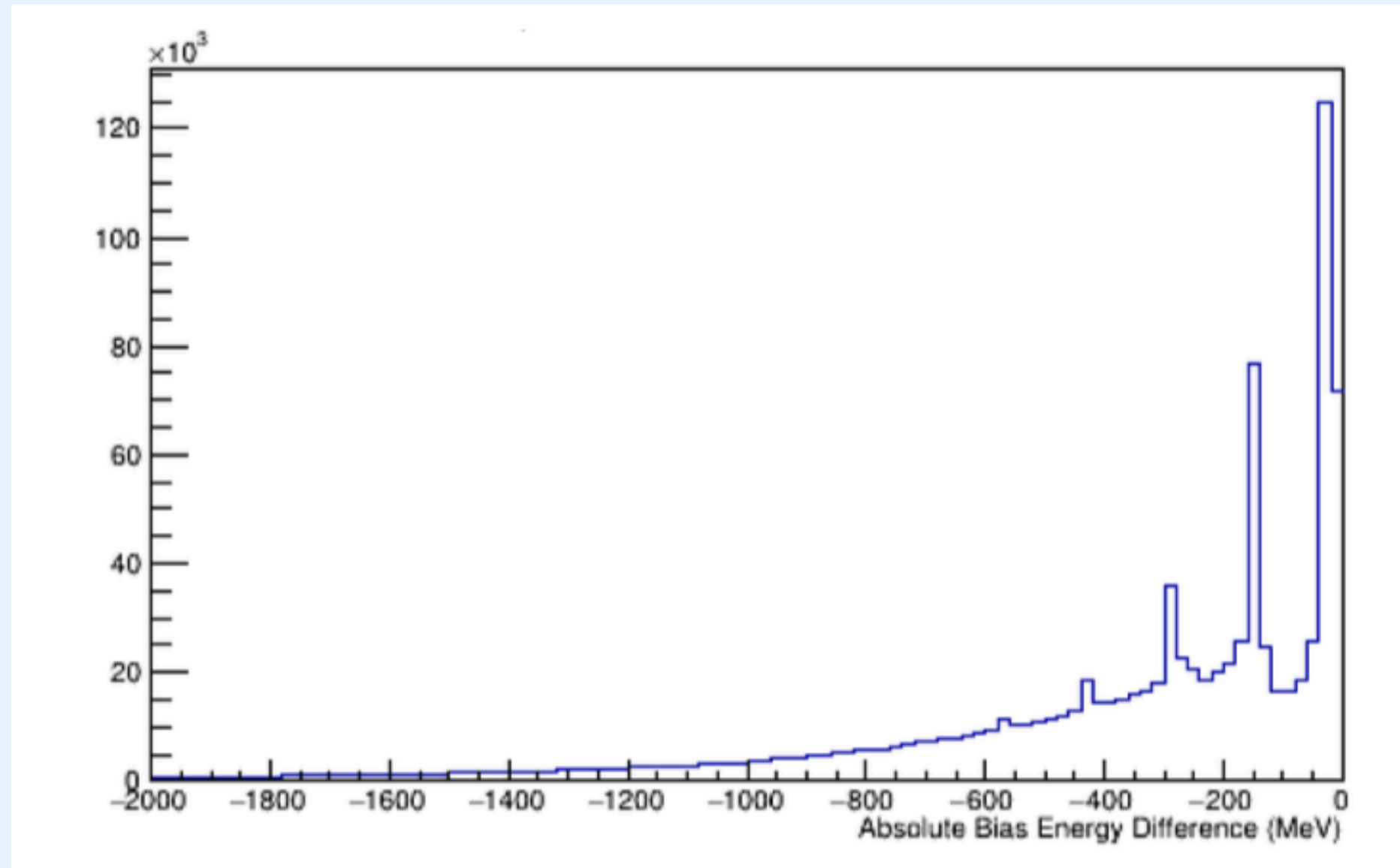
The worse our reconstruction is, the greater our systematic uncertainties, the primary uncertainty for DUNE.

So improving our neutrino energy reconstruction reduces the delimiting uncertainties of DUNE.



WHAT GOES INTO OUR MODEL

$$E_{\nu} + E_{nucleon} = E_{\ell} + \sum E_{had},$$
$$E_{\nu, recon} = E_{\ell} + \sum E_{had}; \quad E_{had, total} \approx E_{p,K} + E_{\ell} + E_{\gamma} + E_{\pi^{\pm}, K} + E_{\pi^0}$$



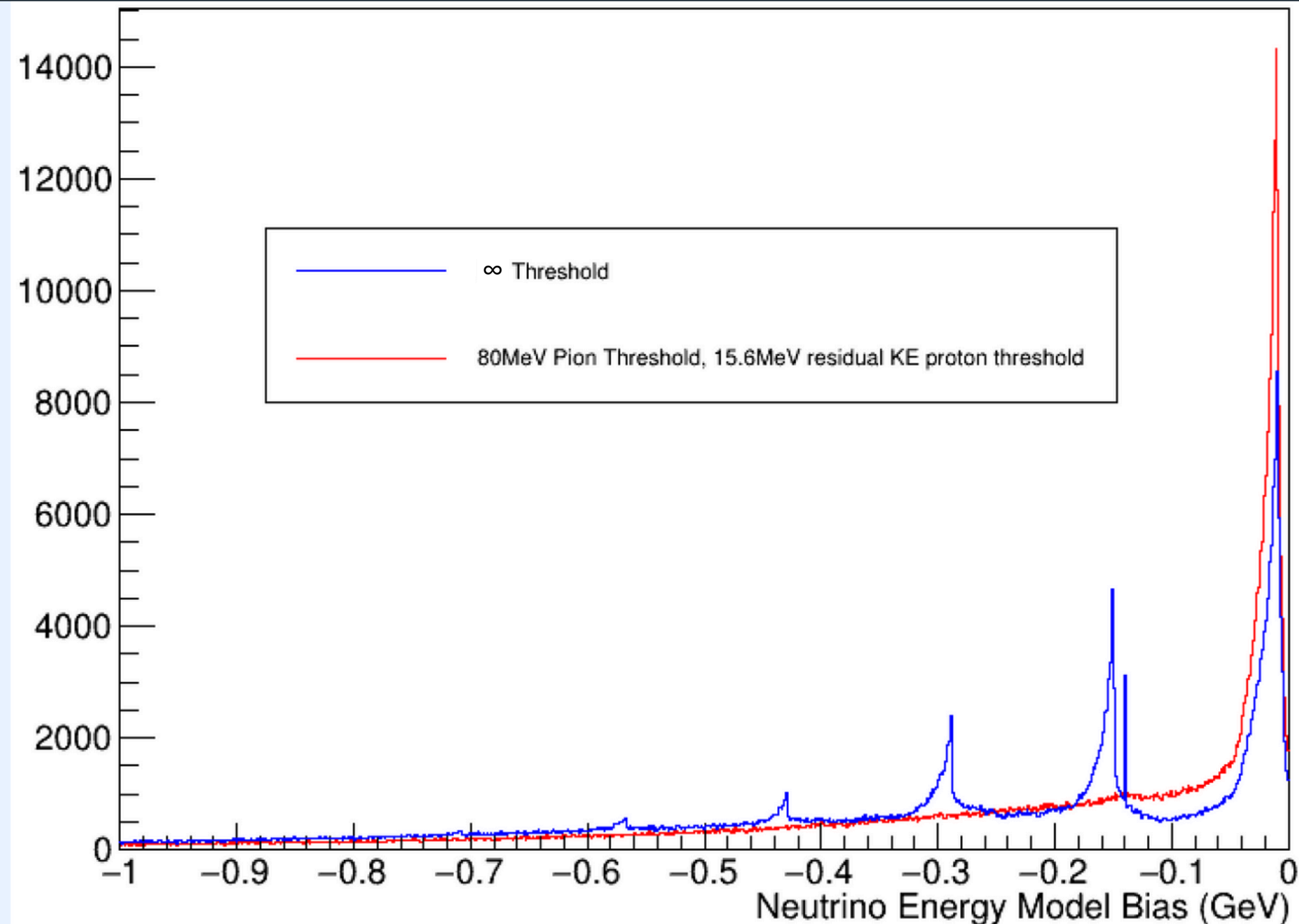
TRACKING THRESHOLDS

Introducing the thresholds improves the model. Applying 90% efficiency thresholds for the charged pion momentum (80MeV) and residual kinetic energy of protons (15.6MeV).

One cut introduced is charged-current events only.

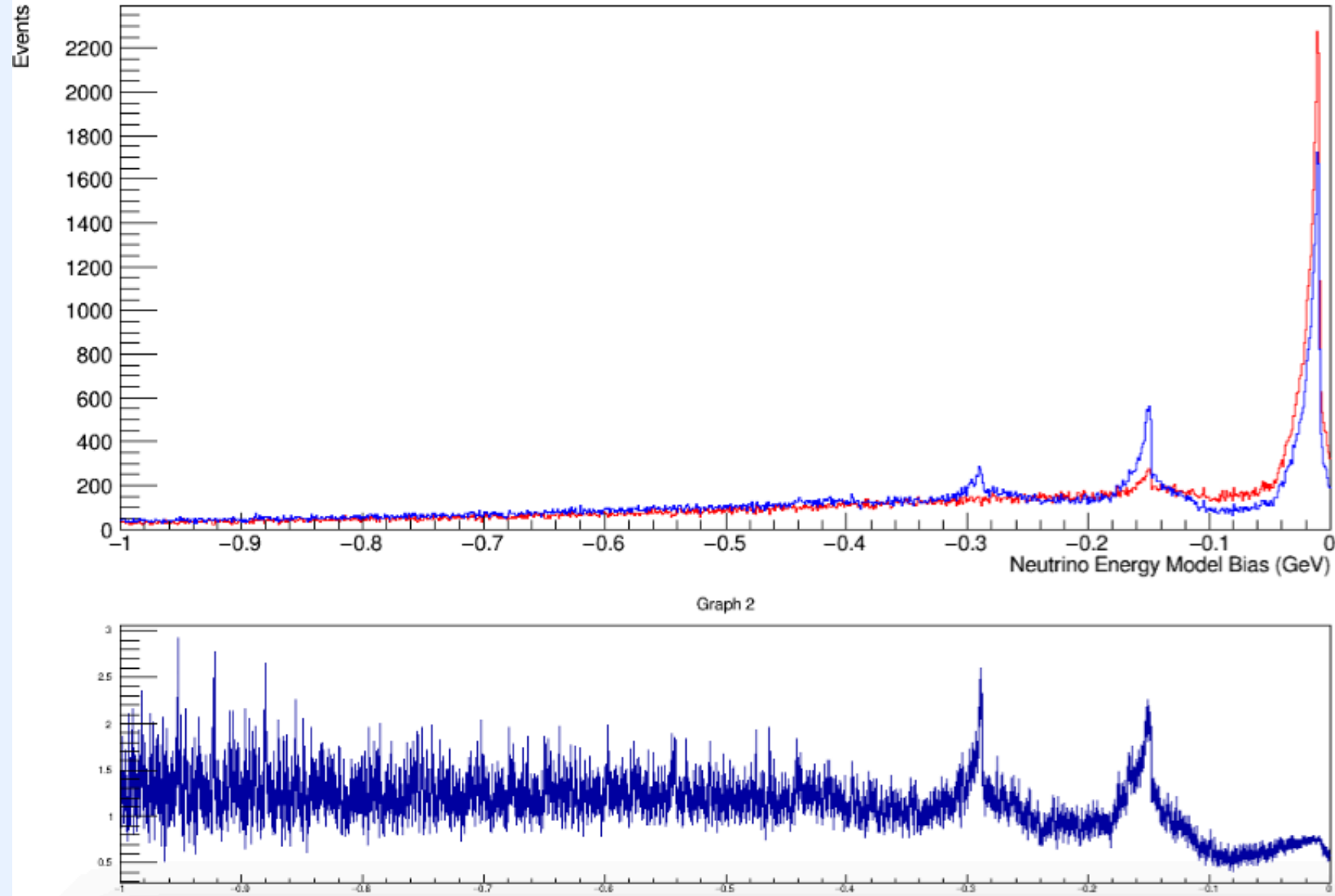
Residual kinetic energy of protons threshold causes a very minor increase to the background.

Pion peaks almost entirely eliminated - only primary offset peak remains due to charged-pion removal energies unaccounted for.

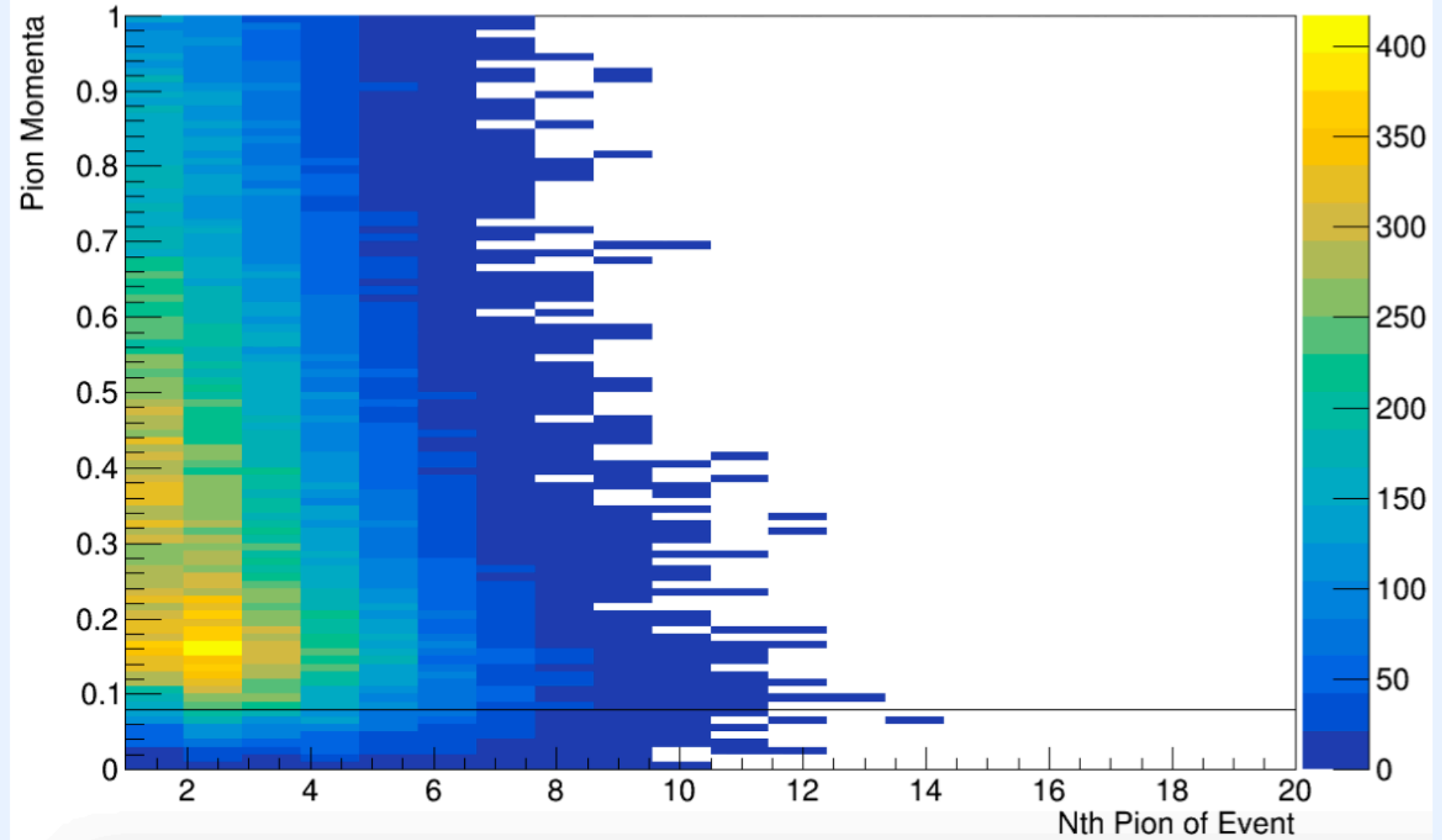


ND GAr JUSTIFICATION

Pion Thresholds/Proton Thresholds - LAr Threshold Comp



Nth Pion Energy



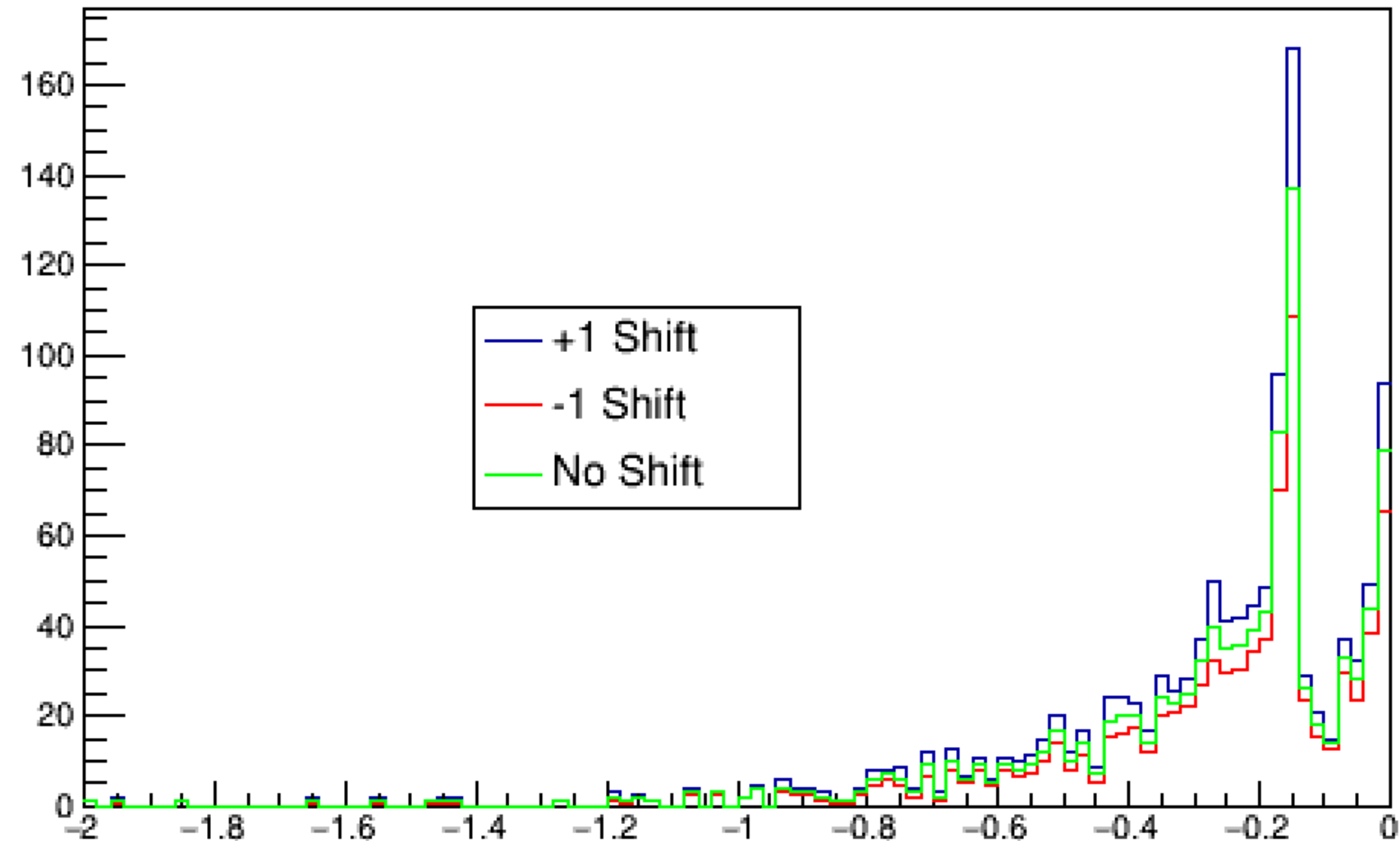
CROSS SECTION DIALS

Producing dials for our models allows for tweaking of cross section uncertainties.

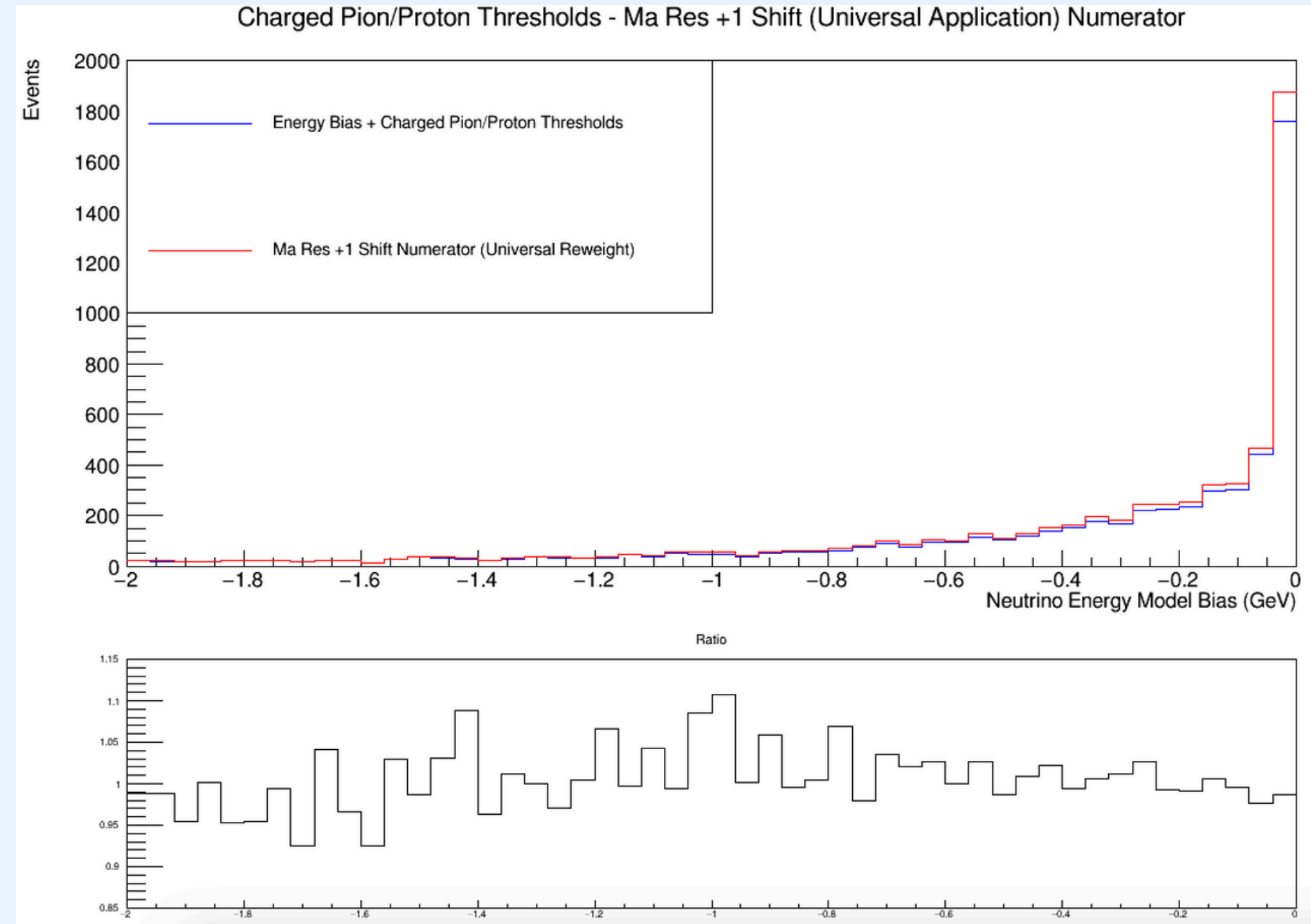
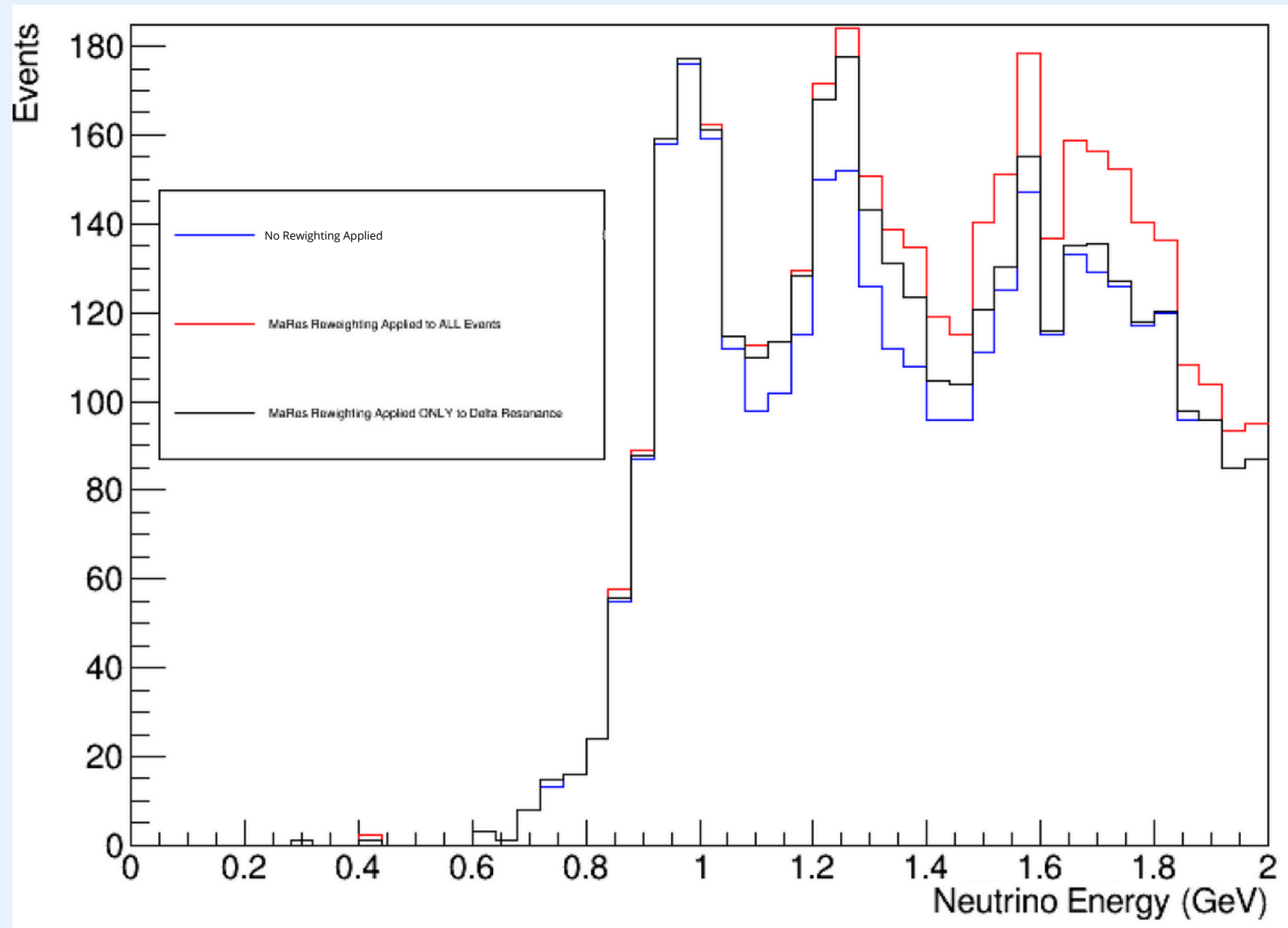
The graph on the right shows a +1, 0 (central value) and -1 sigma shift of the MaCCRes Genie dial.

This works by applying a reweight to a given event - default, each event contributes a '1' to a histogram bin. Tweaking the dial, if a reweight is applicable, will increase or decrease this value of 1.

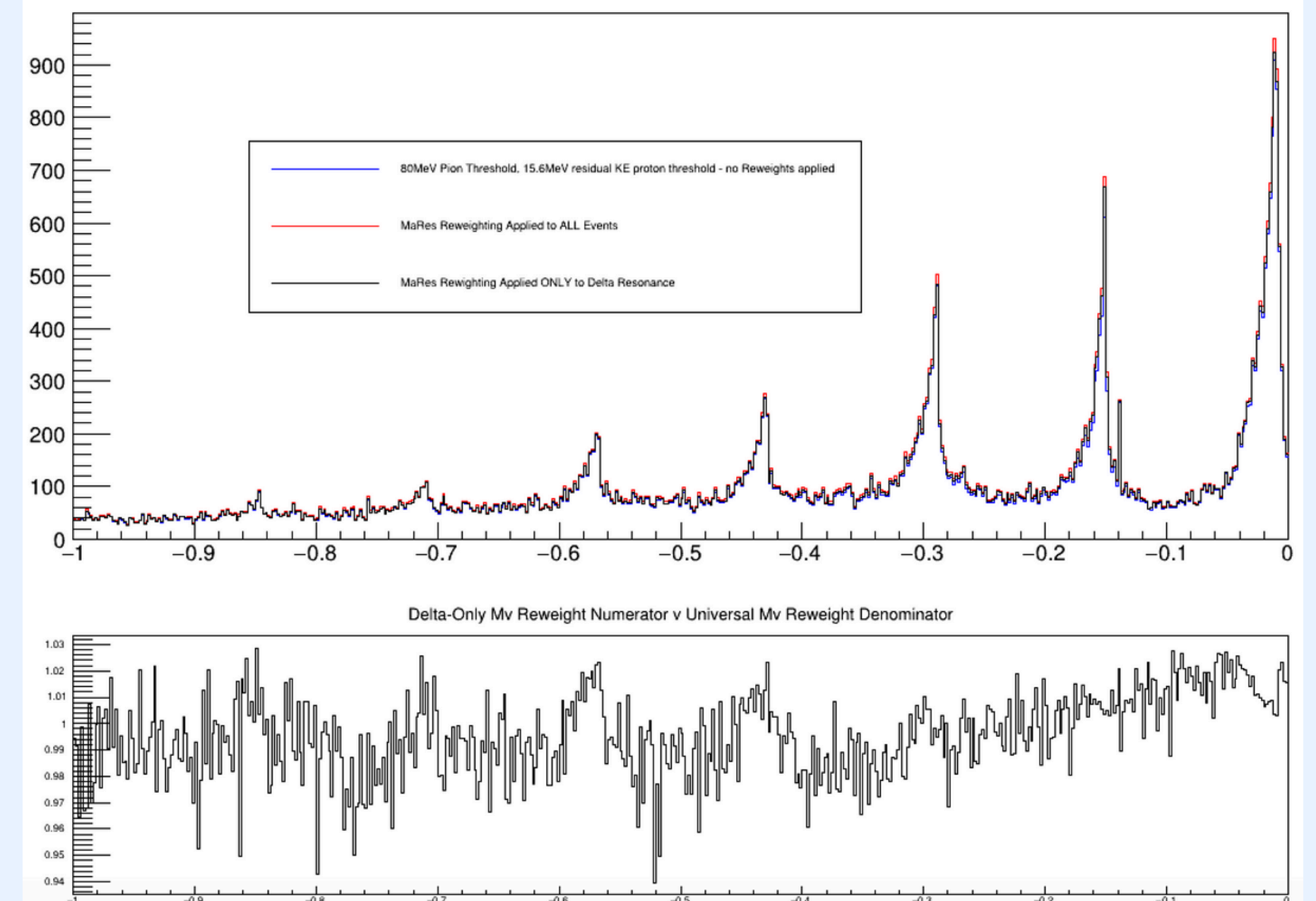
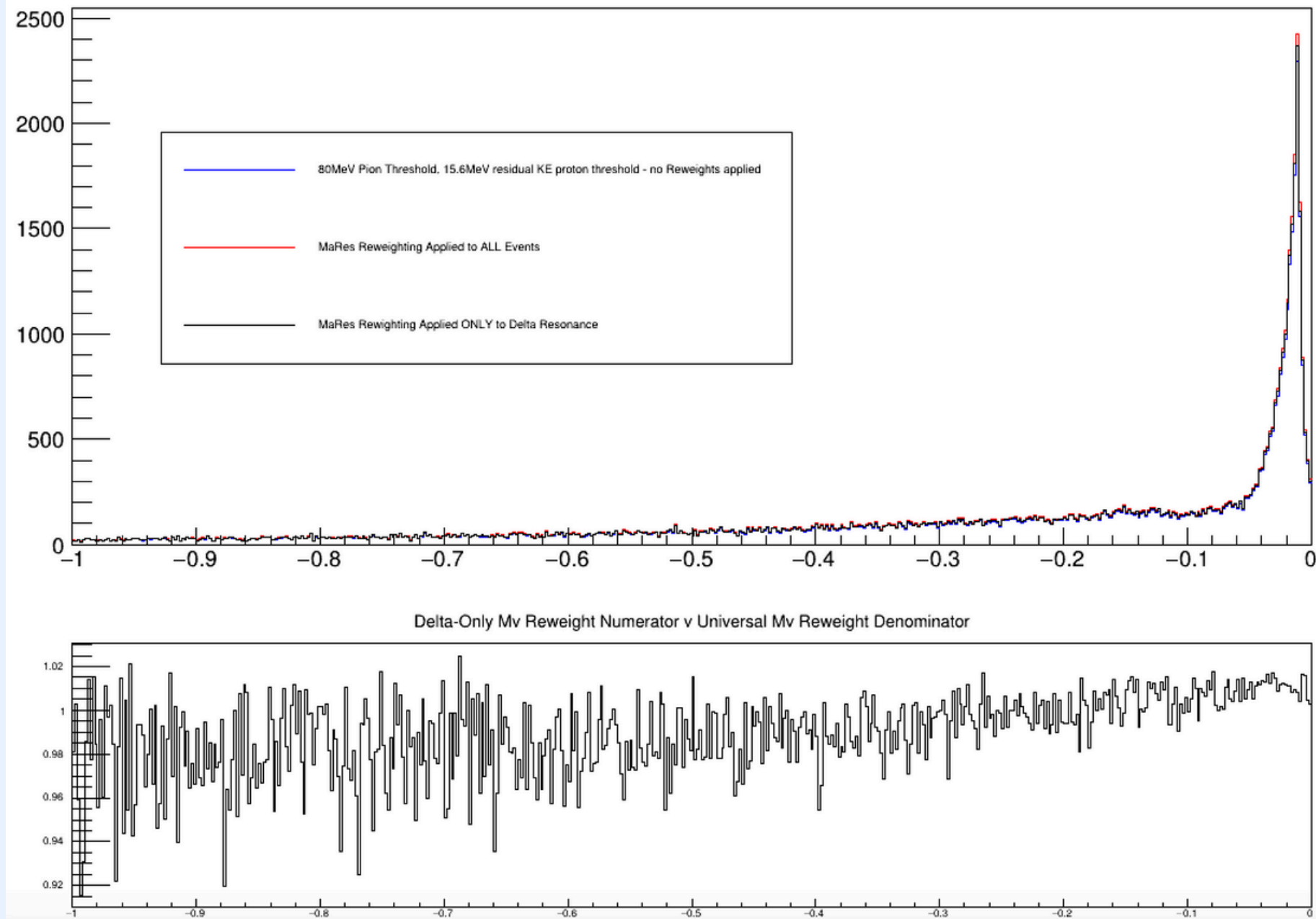
Ma Res Shift



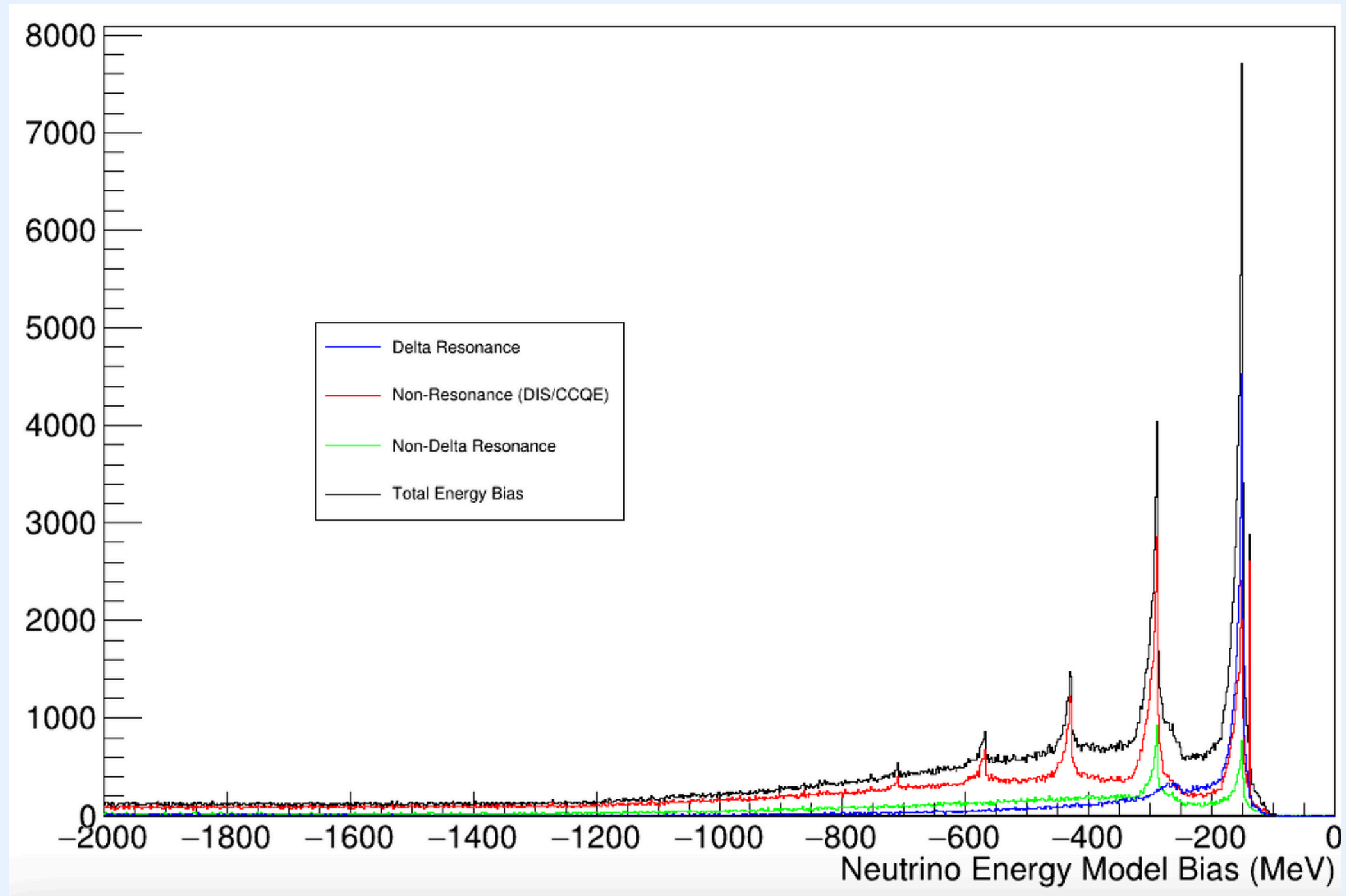
VARIATION BETWEEN REWEIGHTS



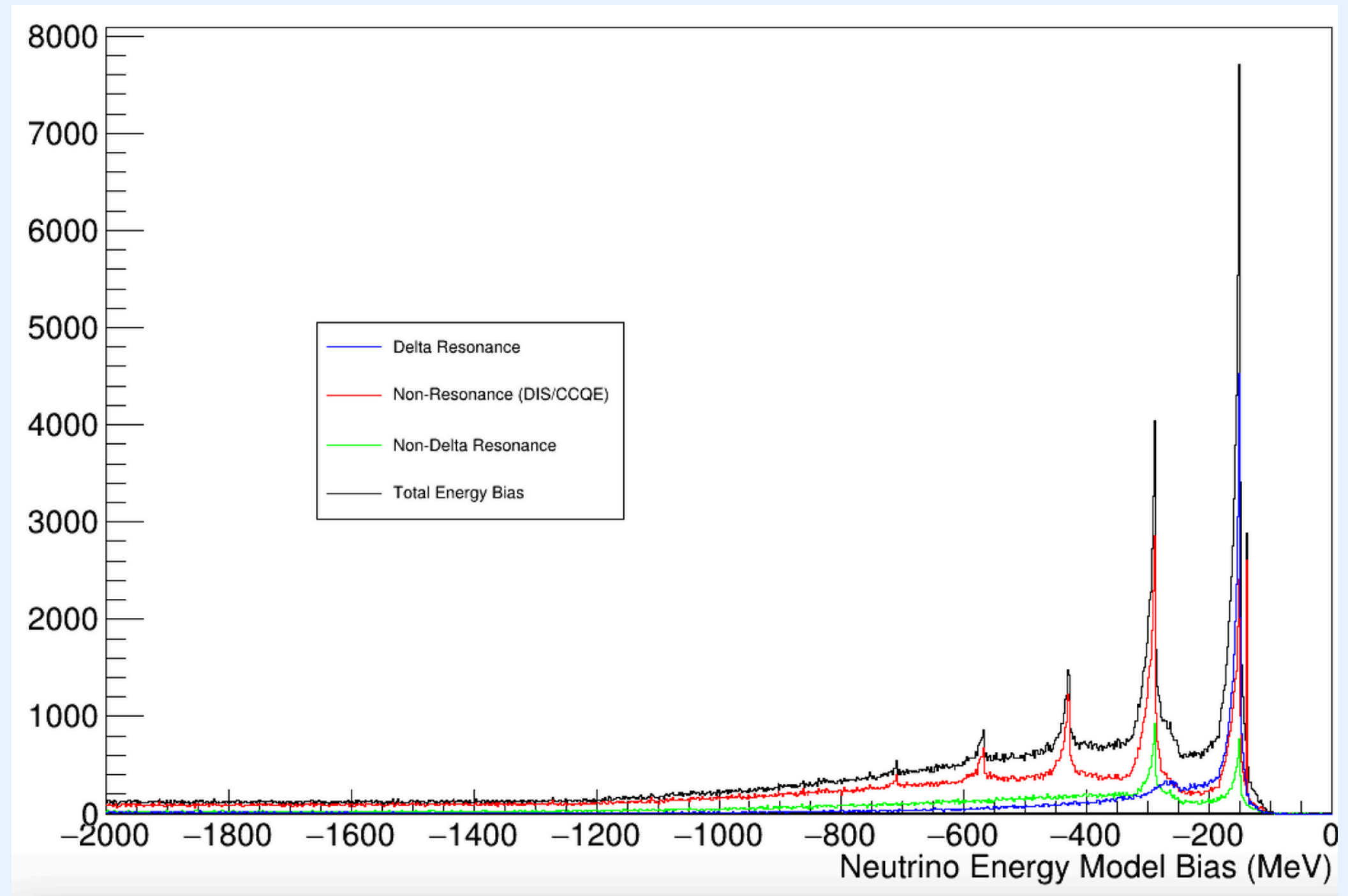
MvCC RESONANT DIAL COMPARISONS



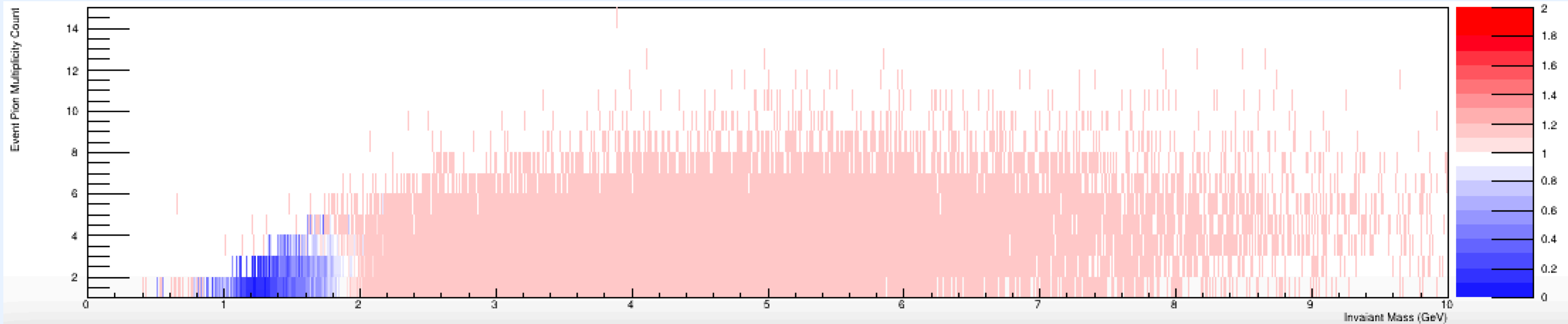
IMPORTANT CONTEXT



IMPORTANT CONTEXT



SOFT INELASTIC SCATTERING



FUTURE TASKS

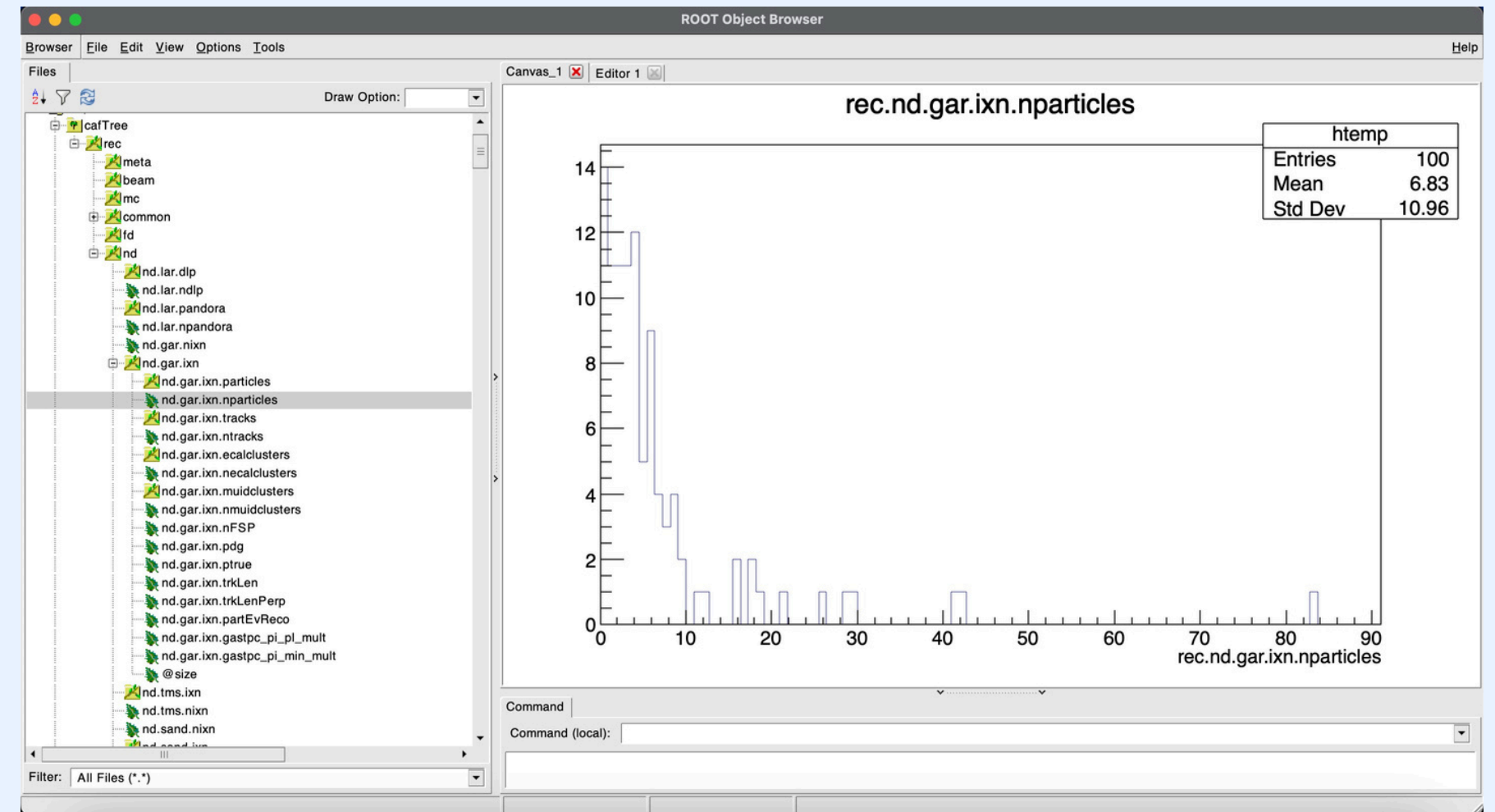
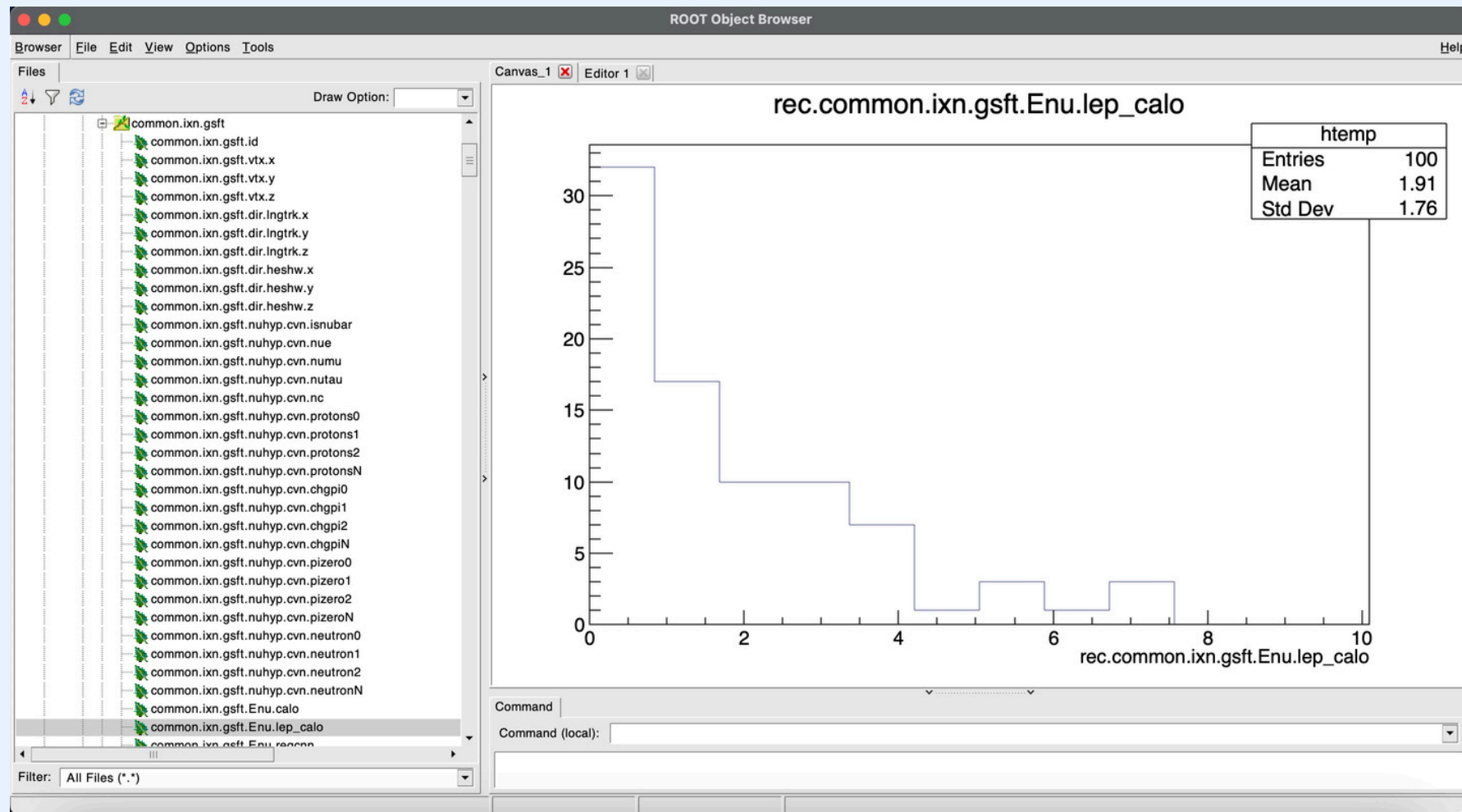
Pion Multiplicity Dials? Do they exist - if so, what effect does it have? If not, how to go about producing them.

ND LAr tracking efficiencies - whether through TDR estimations or theoretical justification

Particle IDing uncertainties and additional tracking efficiencies



ND GAr CAF STATUS



New `std::vector<SRInteraction>` in `sr.common.ixn` to store interactions reconstructed in GArSoft.

ND GAr CAF STATUS

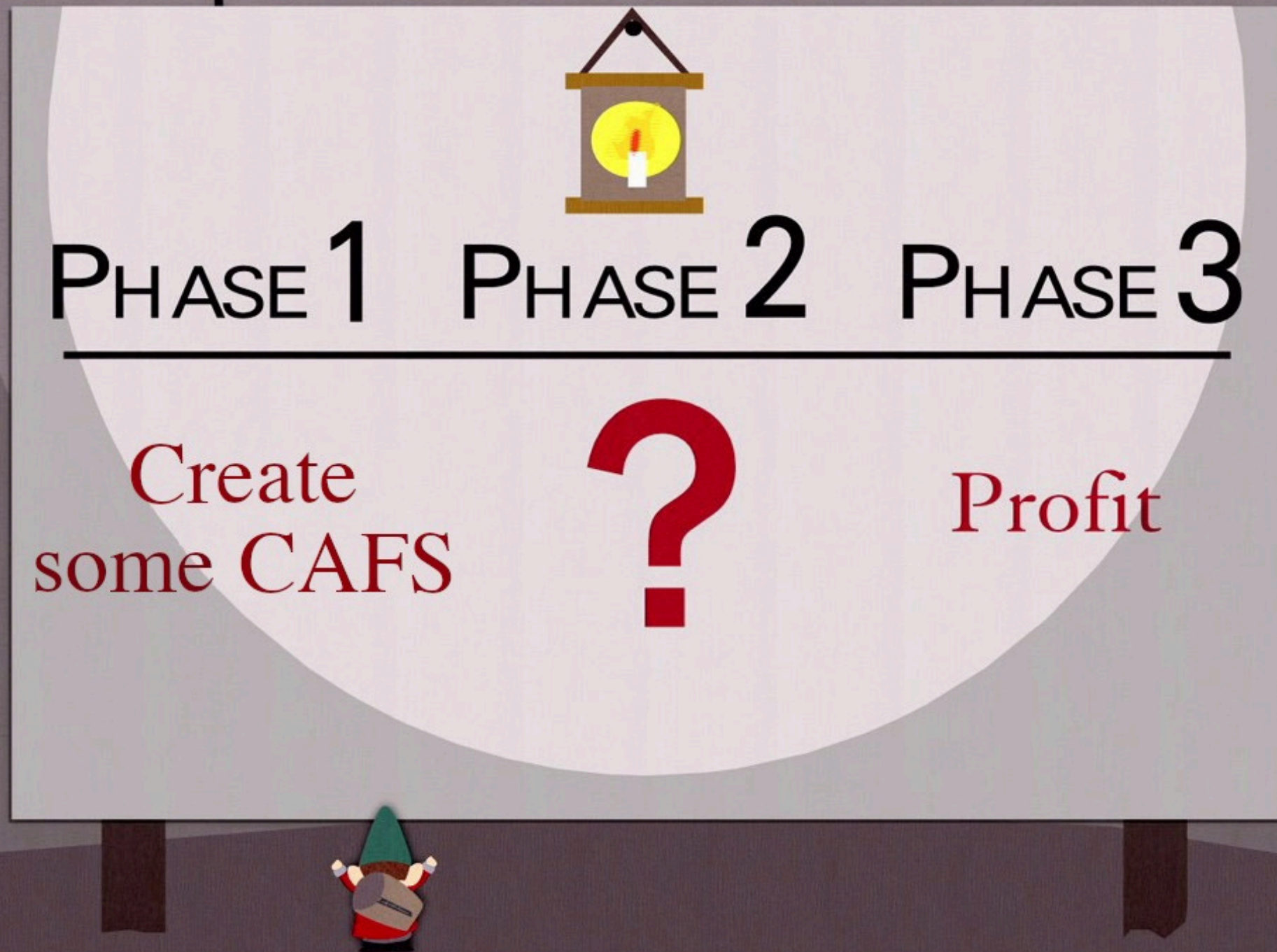
Relevant packages: GArSoft, duneanaobj, ND_CAFMAker.

Should we revert to the previous ROOT version?

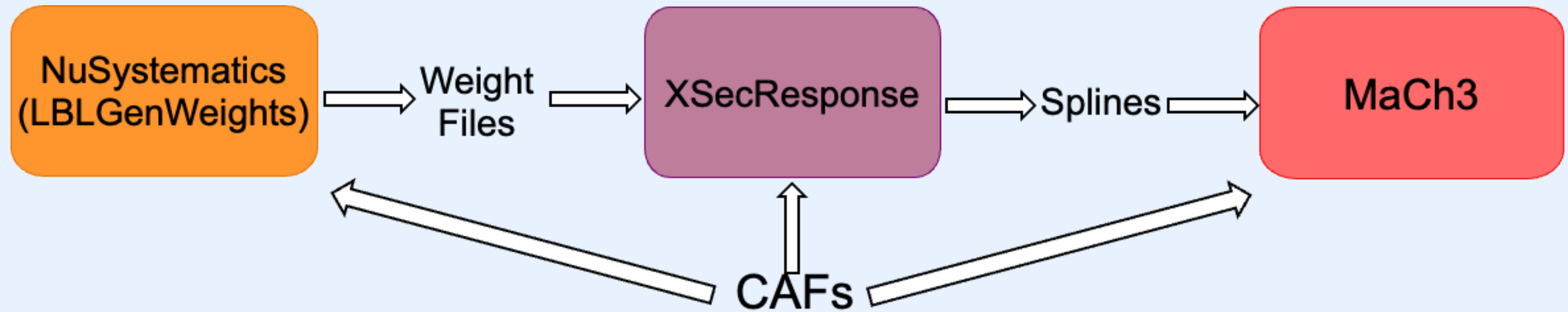
Does this affect someone else's code?

New GArSoft producer uses TMVA weight files. Where should these go?

Making flatCAFs doesn't work at the moment. Why? Do we need them?



CAF → MaCh3



Complete validations that pipeline is working and fix any remaining bugs

The MaCh3 refactor is complete for T2K branch. Need to get up to date with this in the DUNE branch and further validate

Refactor is intended to make things easier and more consistent between experiments for the core MaCh3 code

Get full CAF production into MaCh3 and include new dials