DUNE-PRISM Gaussian Fluxes

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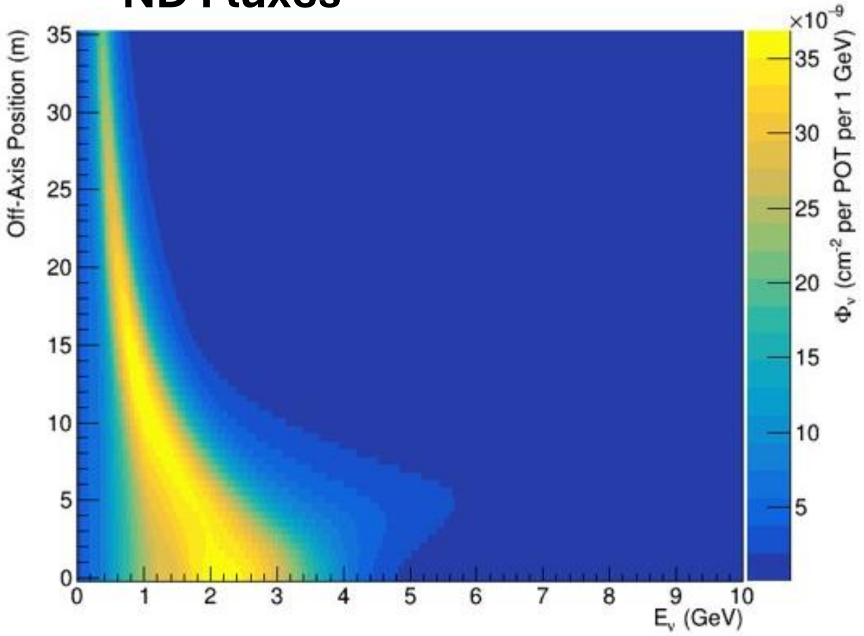
Matching a Gaussian Target

- Match the ND ν_μ fluxes to a narrow gaussian shape
- Just solving a **linear algebra problem** with the flux
- Mathematically, this is $\mathbf{N}c = F$ – we solve for c!

ND Fluxes



some vector, c

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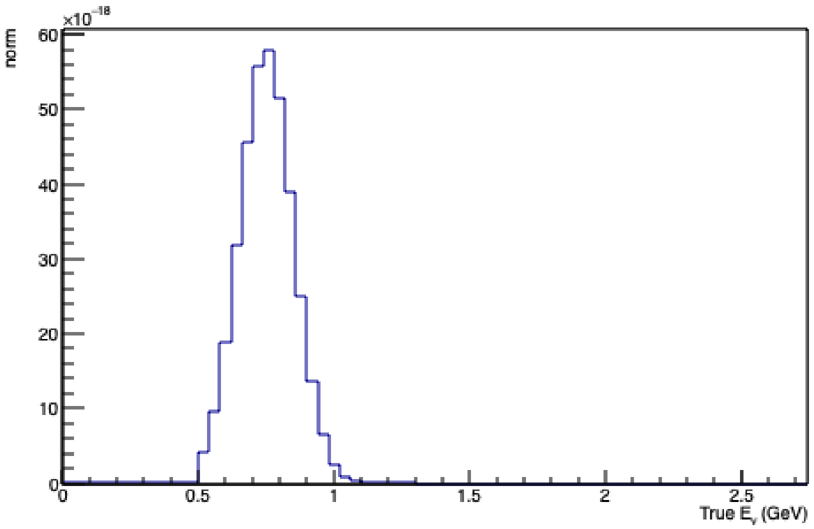
Gaussian Target Shape



Matching a Gaussian Target

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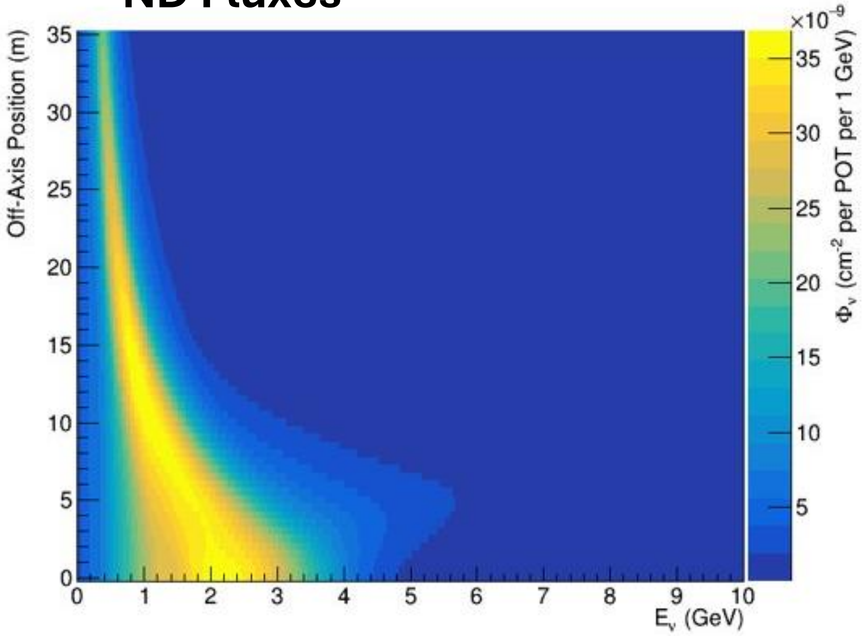
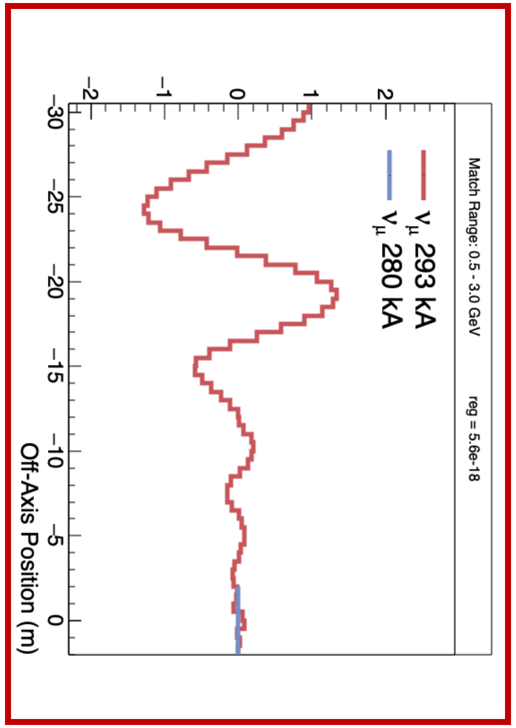
ND Fluxes





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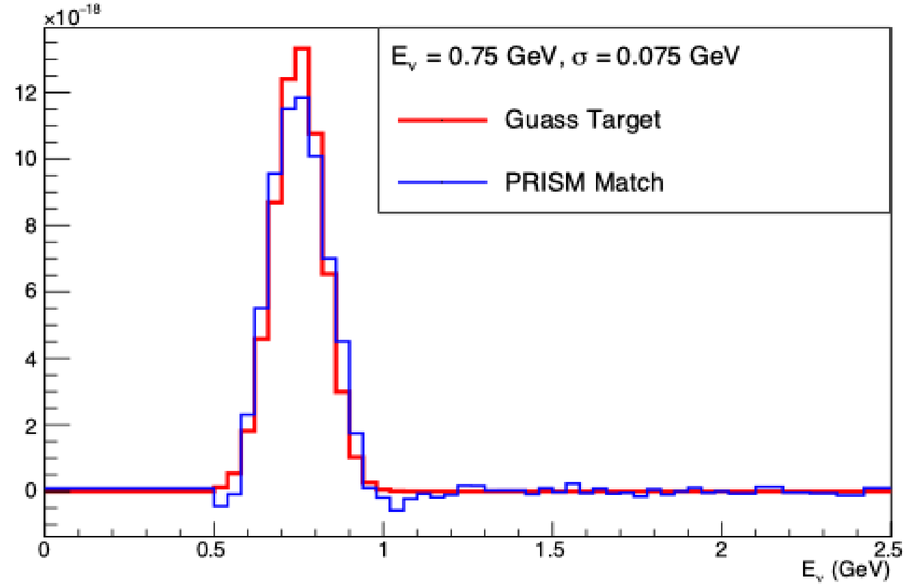
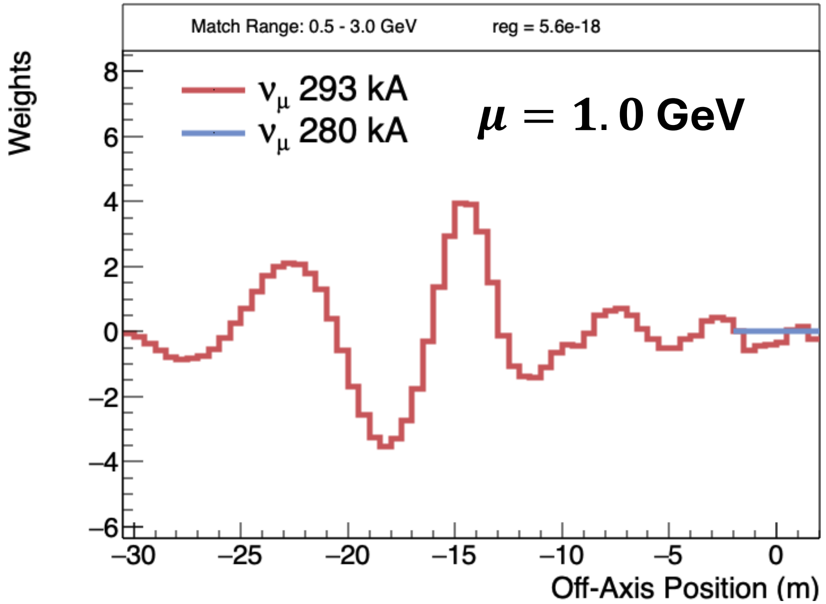
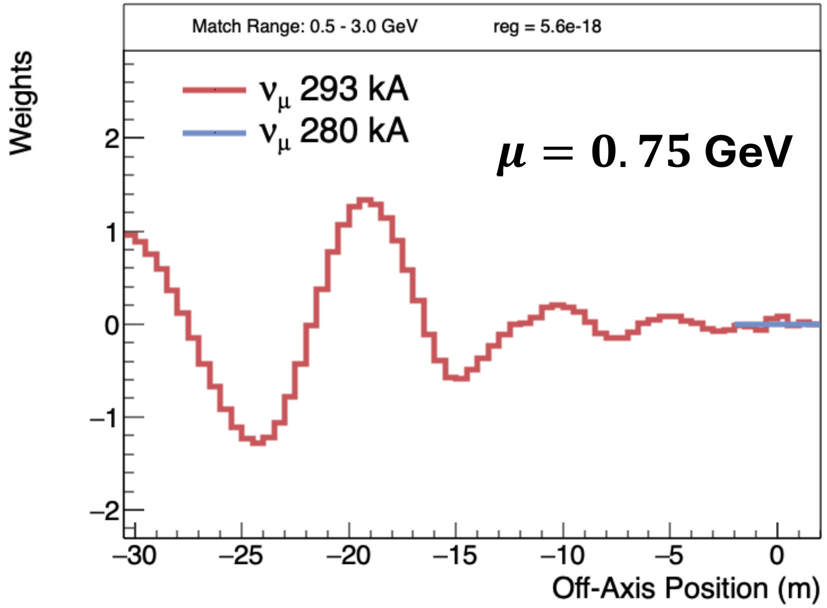
Gaussian Target Shape

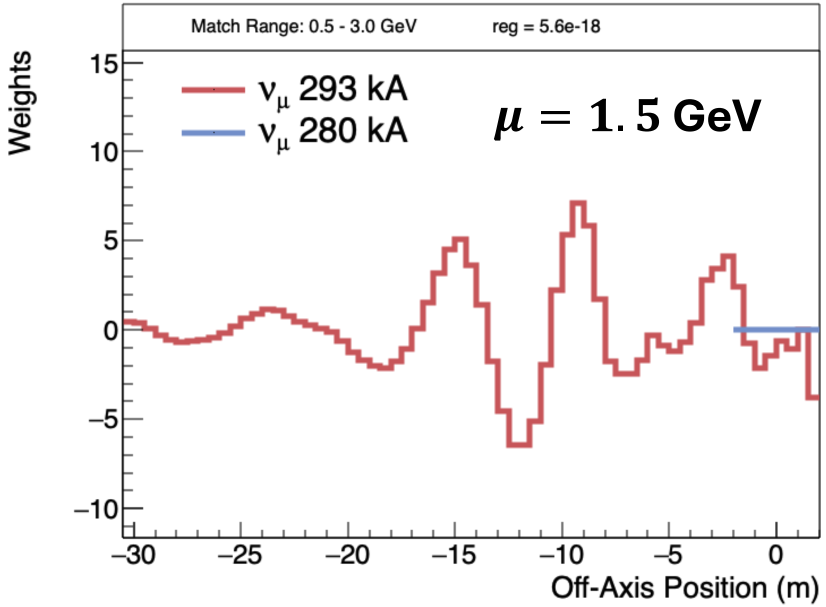


Matching a Gaussian Target

- Low energy mean – higher coefficients at far off axis position
- High energy mean – larger coefficients at more on-axis positions

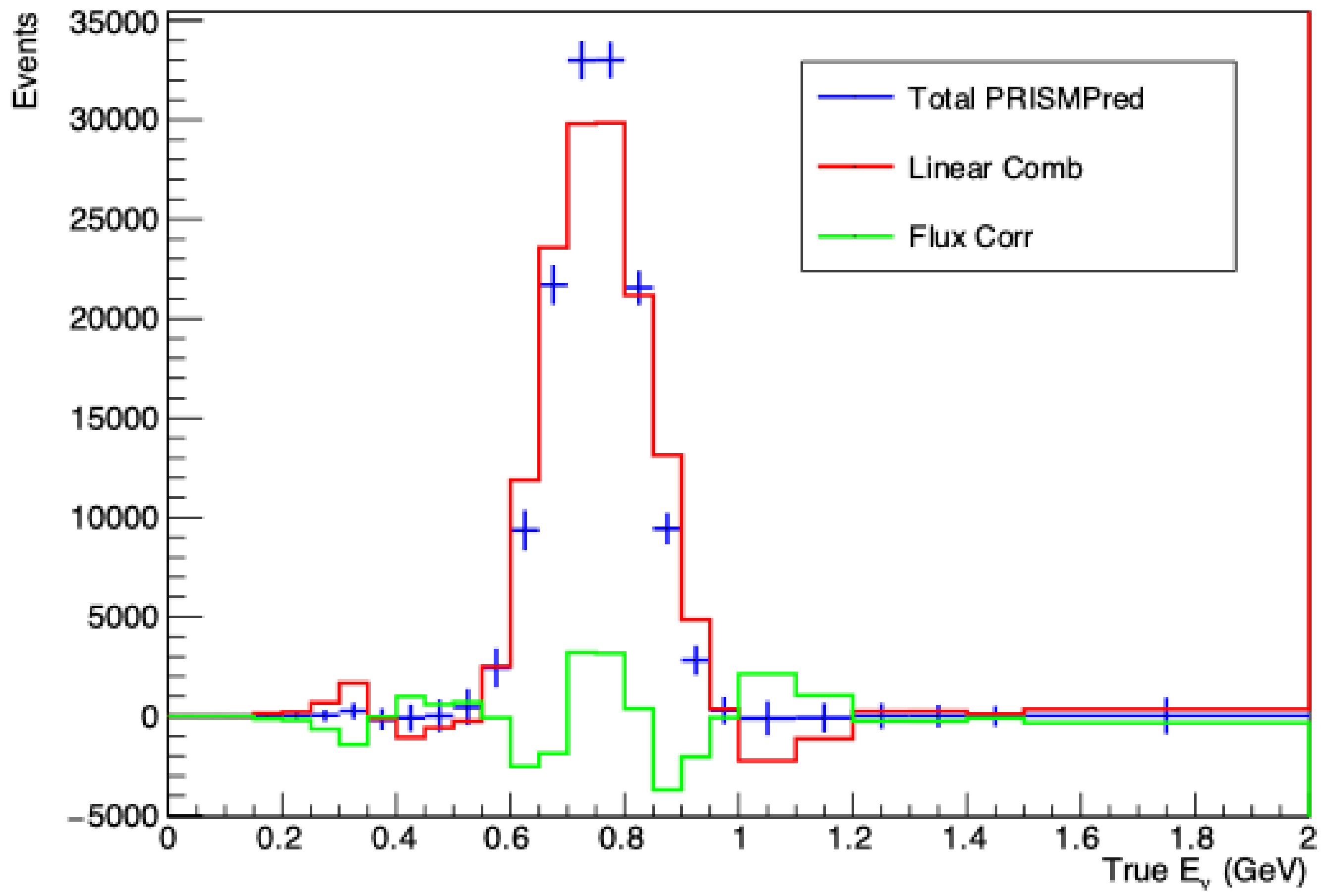






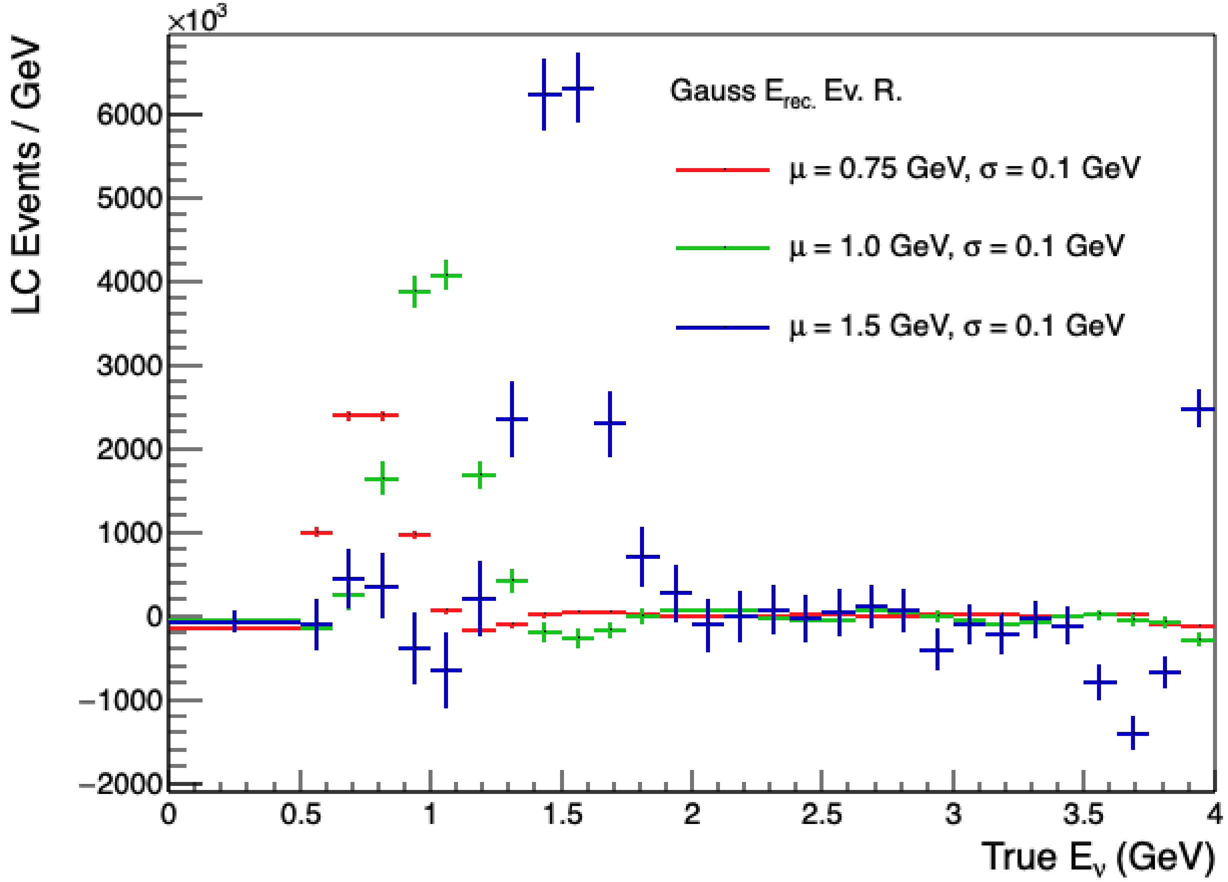
Flux Mismatch Correction

- Like in the oscillation analysis – the coefficient calculation is **not perfect**
- Correct with a **flux mismatch correction**
- Calculated by **weighting on-axis ND MC** by flux-mismatch **residual**
- Seems to **work okay**



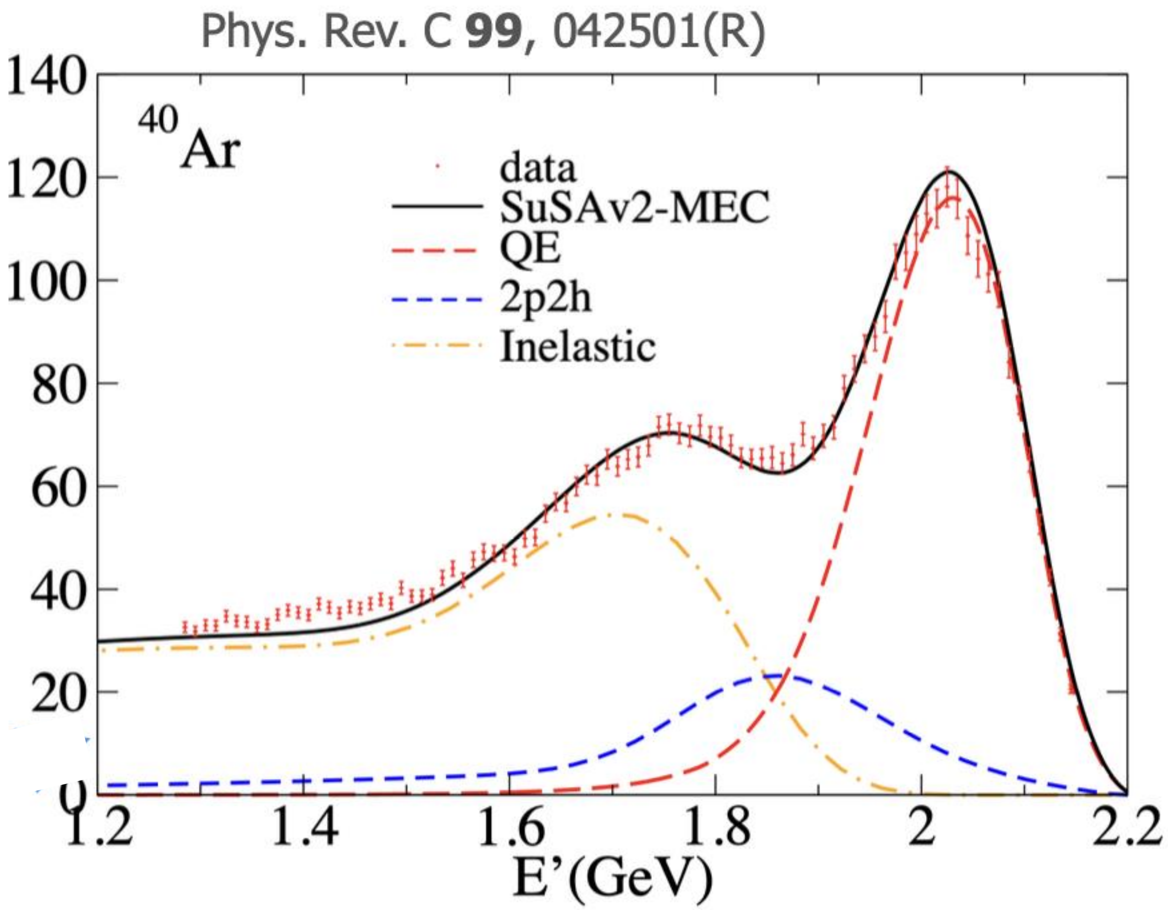
Removing Detector Effects

- In a cross section analysis probably want to **remove detector effects**
- Can **unfold ND data** and correct for **efficiencies** before linear combination
- Here shows unfolded gaussian fluxes for $E_\nu^{rec} \rightarrow E_\nu^{true}$



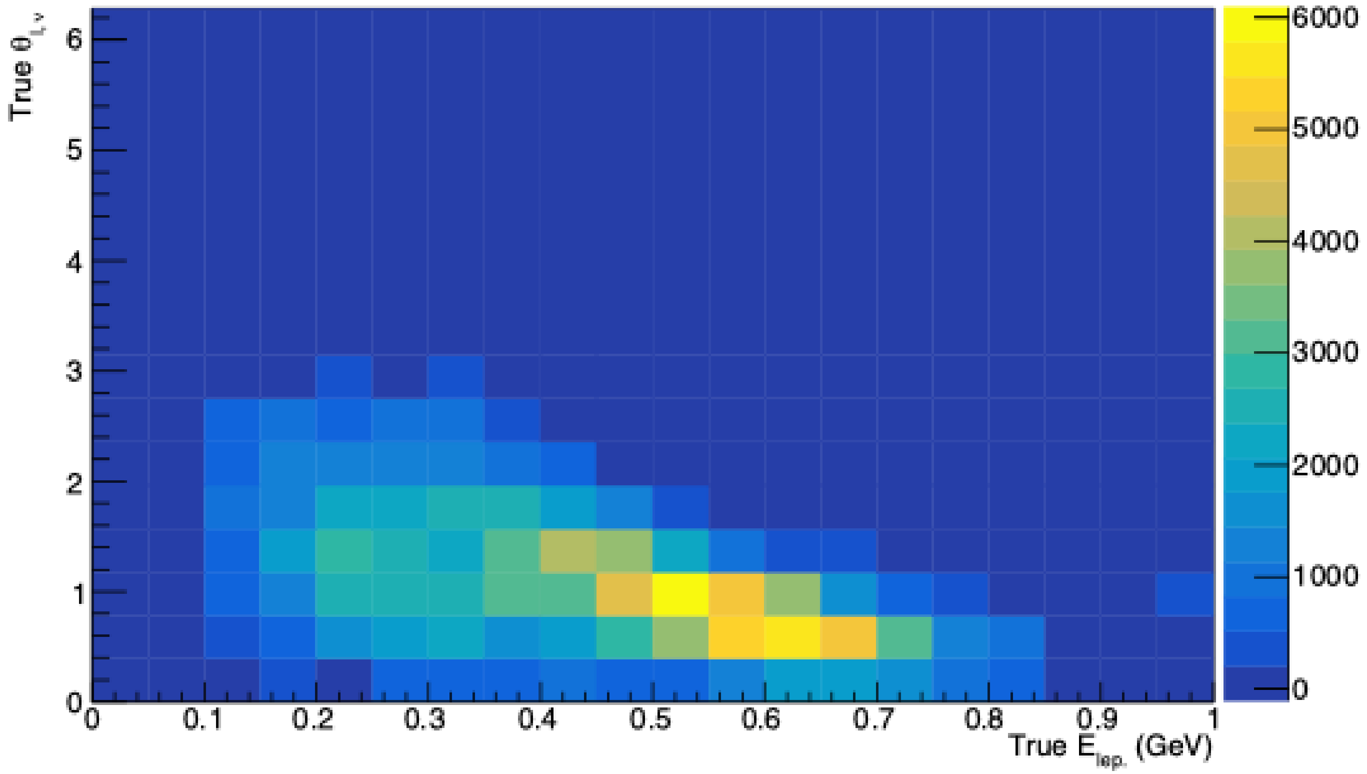
Different Analysis Axes

- Inspiration from **electron scattering** and see report by Amir Gruber
- Known **incoming electron energy**
- Measure outgoing scattered electron energy at specific **scattering angle**
- Enables **separation** of nuclear effects
- Gaussian neutrino flux gives a **pseudo-known** incoming **neutrino energy**
- Can measure outgoing lepton energy and angle from neutrino interaction



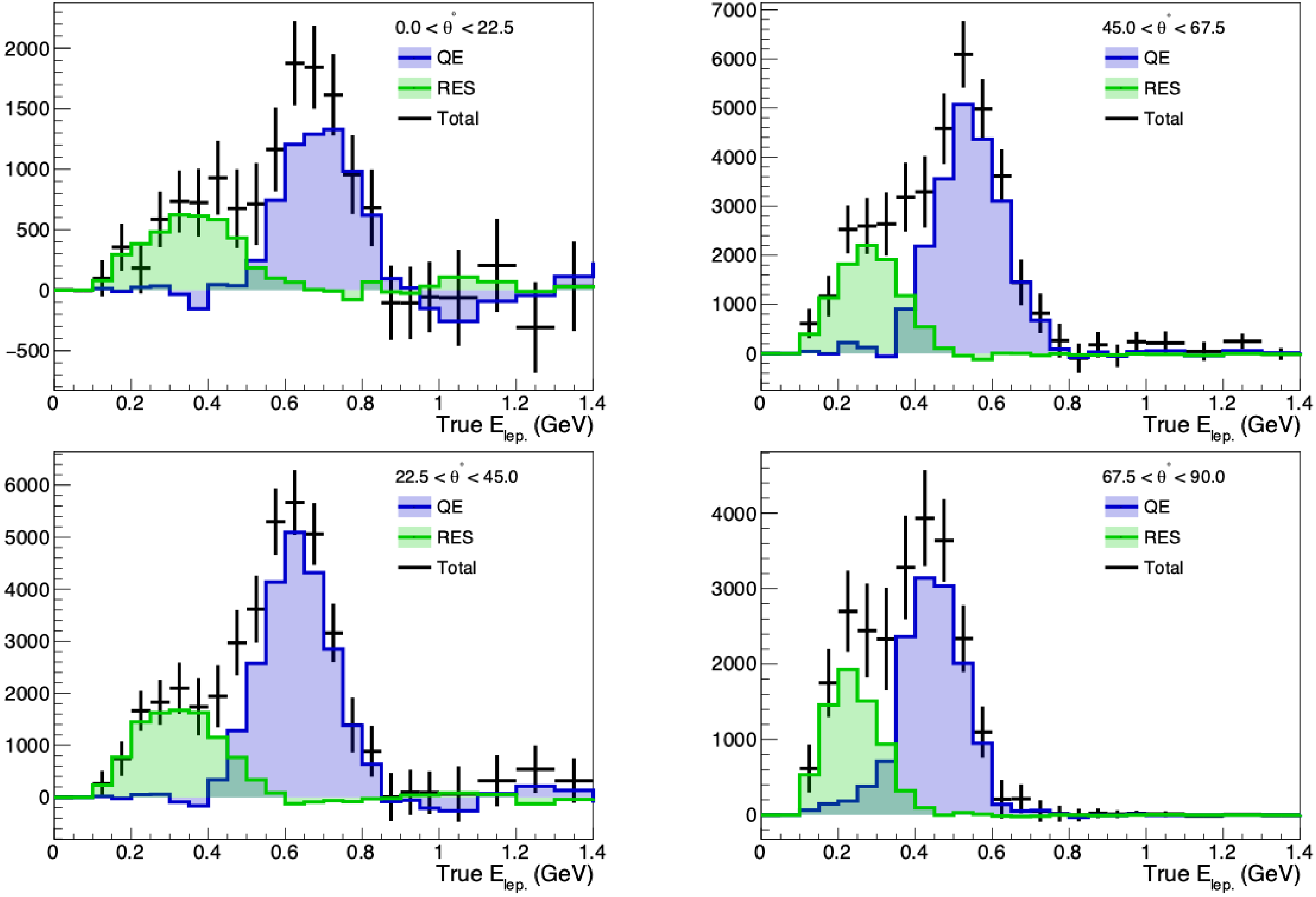
Different Analysis Axes

- Follow the **same procedure** for gaussian linear combination
- Analysis axis is now **Lep-NuTheta vs Elep**
- Look at **individual angular bins** – just like **electron scattering** experiments looking at a **single scattering angle**



Gauss:
$\mu = 0.75$ **GeV**
$\sigma = 0.075$ **GeV**

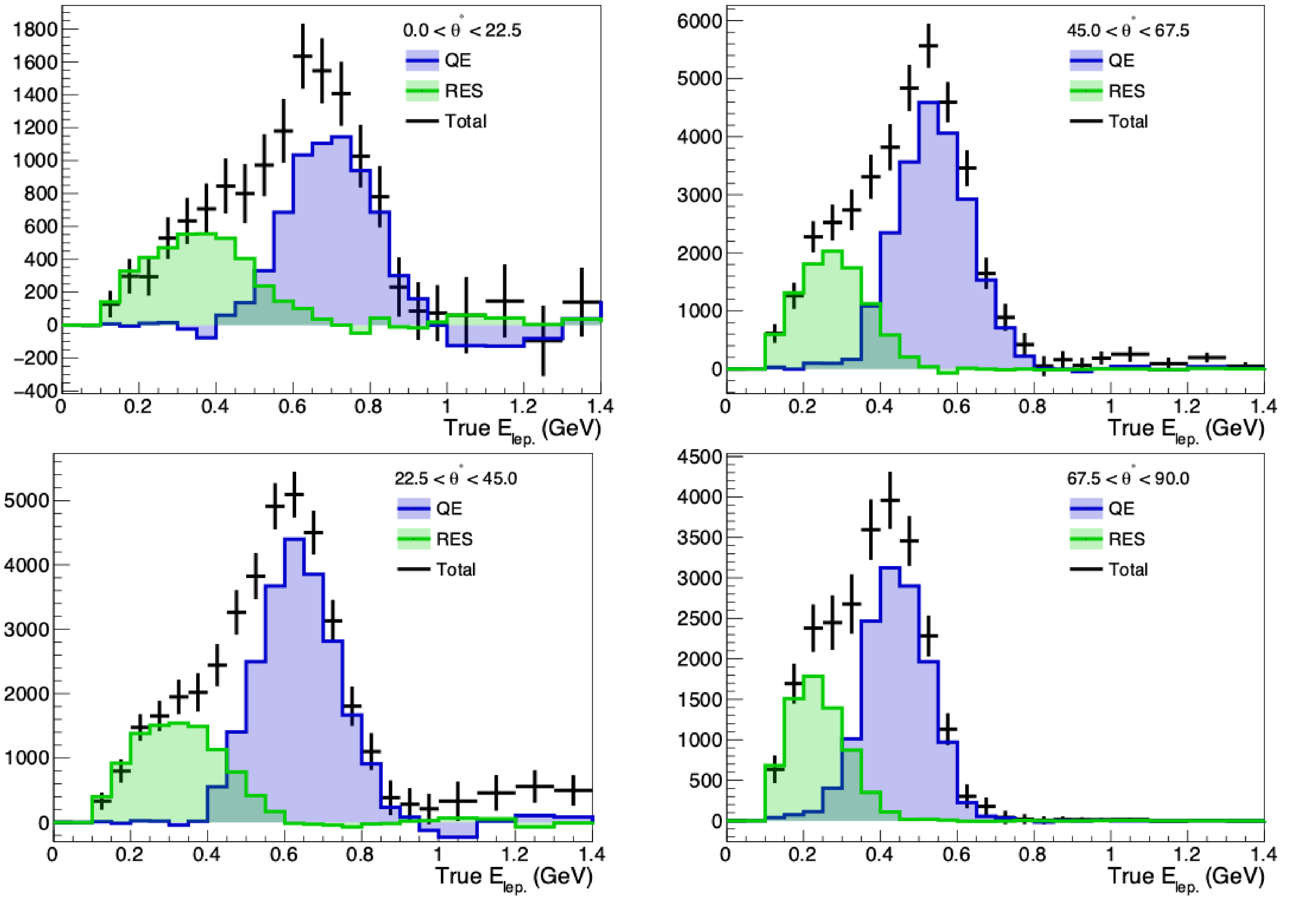
2 Years of ND data



Gauss:
$\mu = 0.75$ **GeV**
$\sigma = 0.1$ **GeV**

Slightly wider gaussian:

- Better control of **statistical errors**
- Weaker **separation** of QE and RES



Next Steps

- Main components are **working in CAFAna**
- Controlling **statistical uncertainties** is challenging but (I hope) manageable – more work needed
- Implementation of **all systematics** we should get for **free**
- Unfolding **detector effects** fine for 1D – need to get this working for **2D as well**
- Need to have a think of how to **demonstrate this is useful** in a simulated **cross section analysis**

Thanks for listening!