

LBL Meeting

First look at DUNE FD VD production

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Overview

- Summary of new FD VD CAF's
- First look at efficiency of FD VD
- First look at efficiency of FD VD using MaCh3

FD VD

- Small scale validation of DUNE FD Vertical Drift Production
- Using 700,000 events
- Nu_mu sample:

cafmaker_dunevd10kt_1x8x6_3view_30deg_runreco-nuenergy_geov3__prodgenie_nu_dunevd10kt_1x8x6_3view_30deg/fardet-vd_mc_list-merge_physics_cafmaker_dunevd10kt_1x8x6_3view_30deg_runreco-nuenergy_geov3_root-tuple_merged_skip000000_lim000060_final_20241024T024241

- Nu_e switch sample:

cafmaker_dunevd10kt_1x8x6_3view_30deg_runreconuenergy_geov3__prodgenie_nu_numu2nue_nue2nutau_dunevd10kt_1x8x6_3view_30deg/fardet-vd_mc_list_nu_numu2nue_nue2nutau_physics_cafmaker_dunevd10kt_1x8x6_3view_30deg_runreco-nuenergy_geov3_root-tuple_merged_skip000000_lim000073_final_20241031T172350

- Plans to scale up and use whole production in near future

Calculating Efficiency

"What proportion of MC events have been correctly reconstructed?"

$$\text{Efficiency}_{\nu_{\mu}} = \frac{N_{\text{Events}}(\nu_{\mu}^{\text{MC}} \cap \nu_{\mu}^{\text{Reco}})}{N_{\text{Events}}(\nu_{\mu}^{\text{MC}})} = \frac{\text{N.o of reconstructed } \nu_{\mu} \text{ events with a CVN} > 0.5}{\text{N.o of MC. } \nu_{\mu} \text{ events}}$$

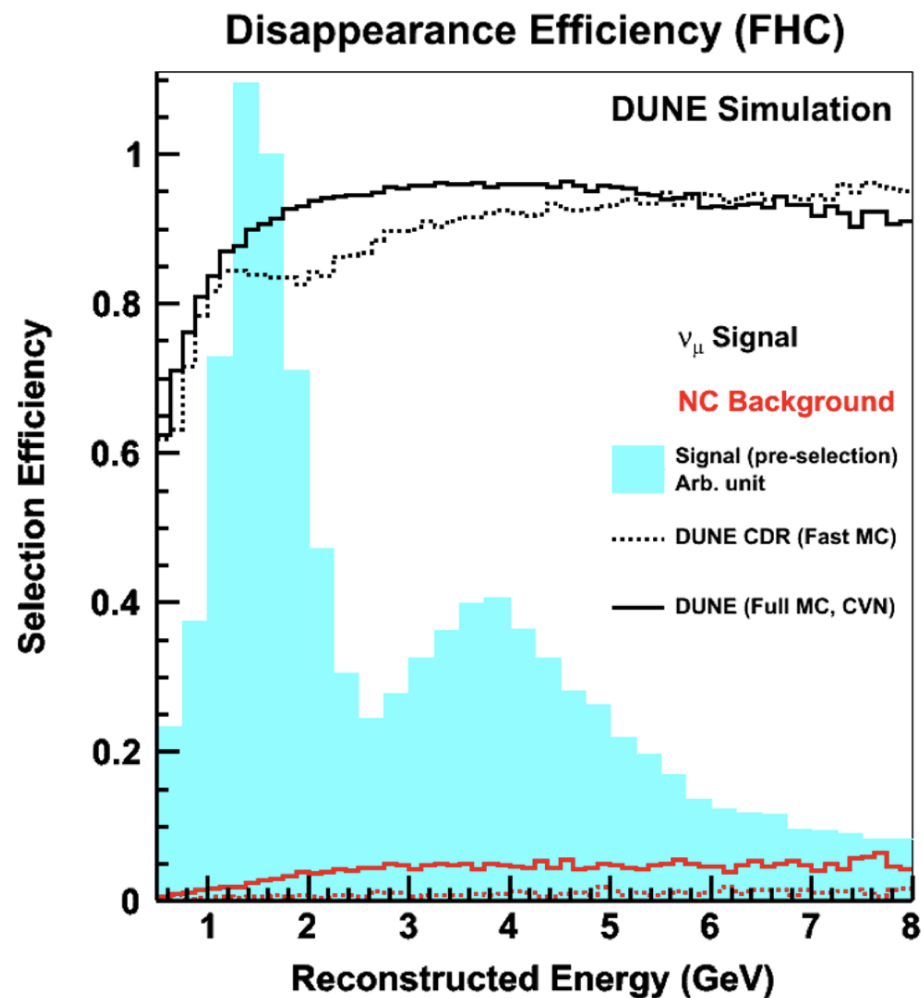
Same definition for ν_e , but for CVN score > 0.85

CVN score = Probability assigned in reconstruction that the event has been categorised correctly

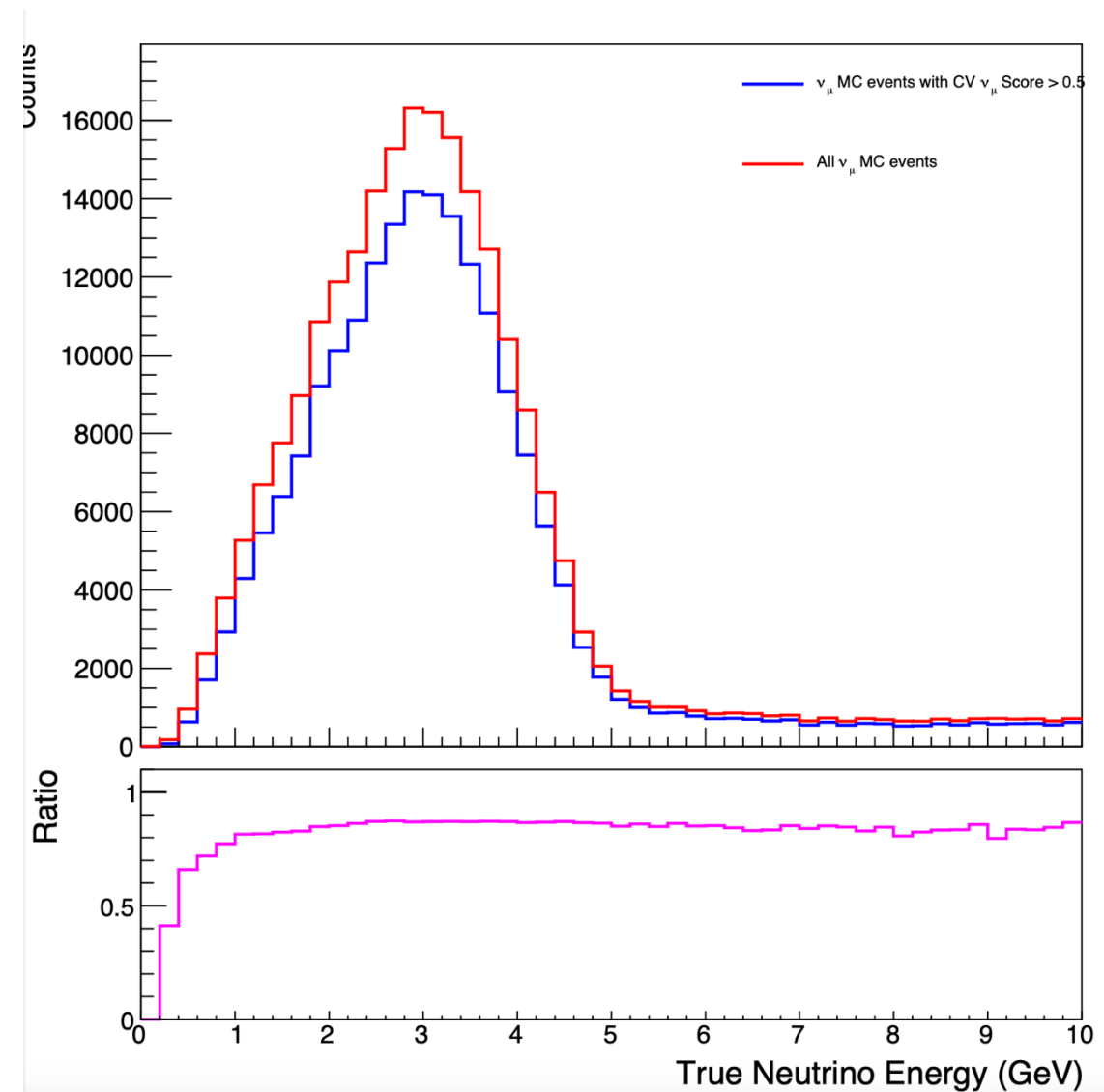
ν_μ Energy

PhysRevD.102.092003,

Neutrino interaction classification with a convolutional neural network in the DUNE far detector

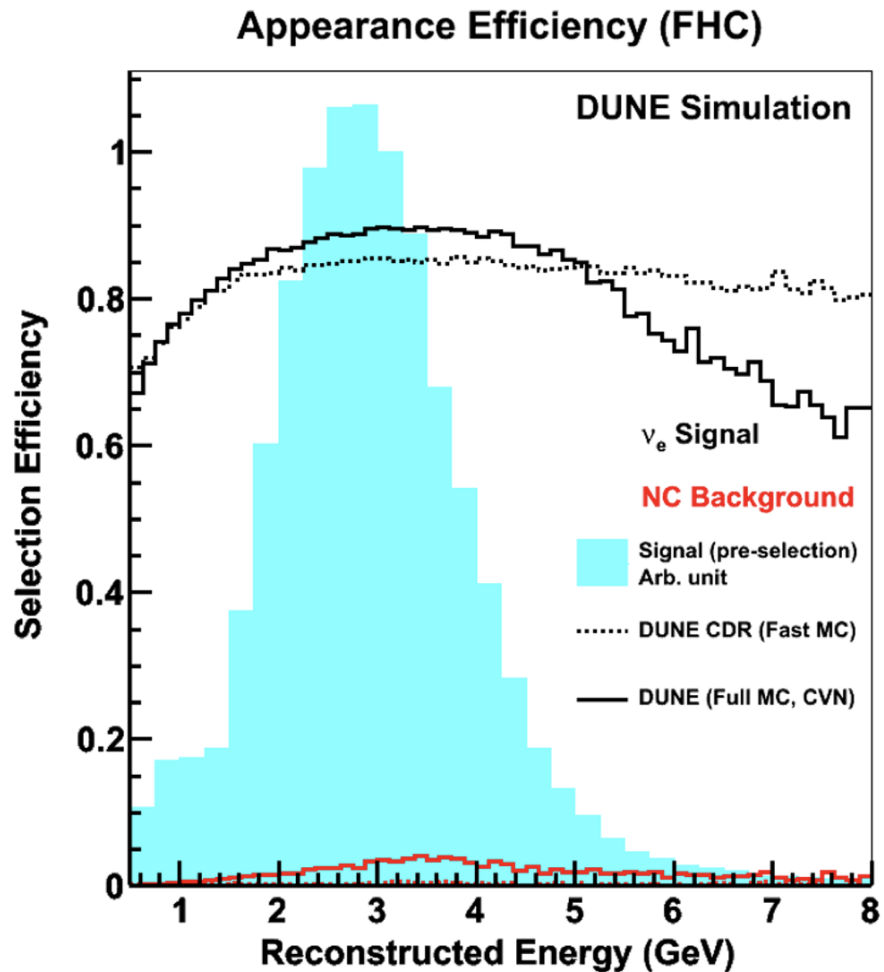


First Look

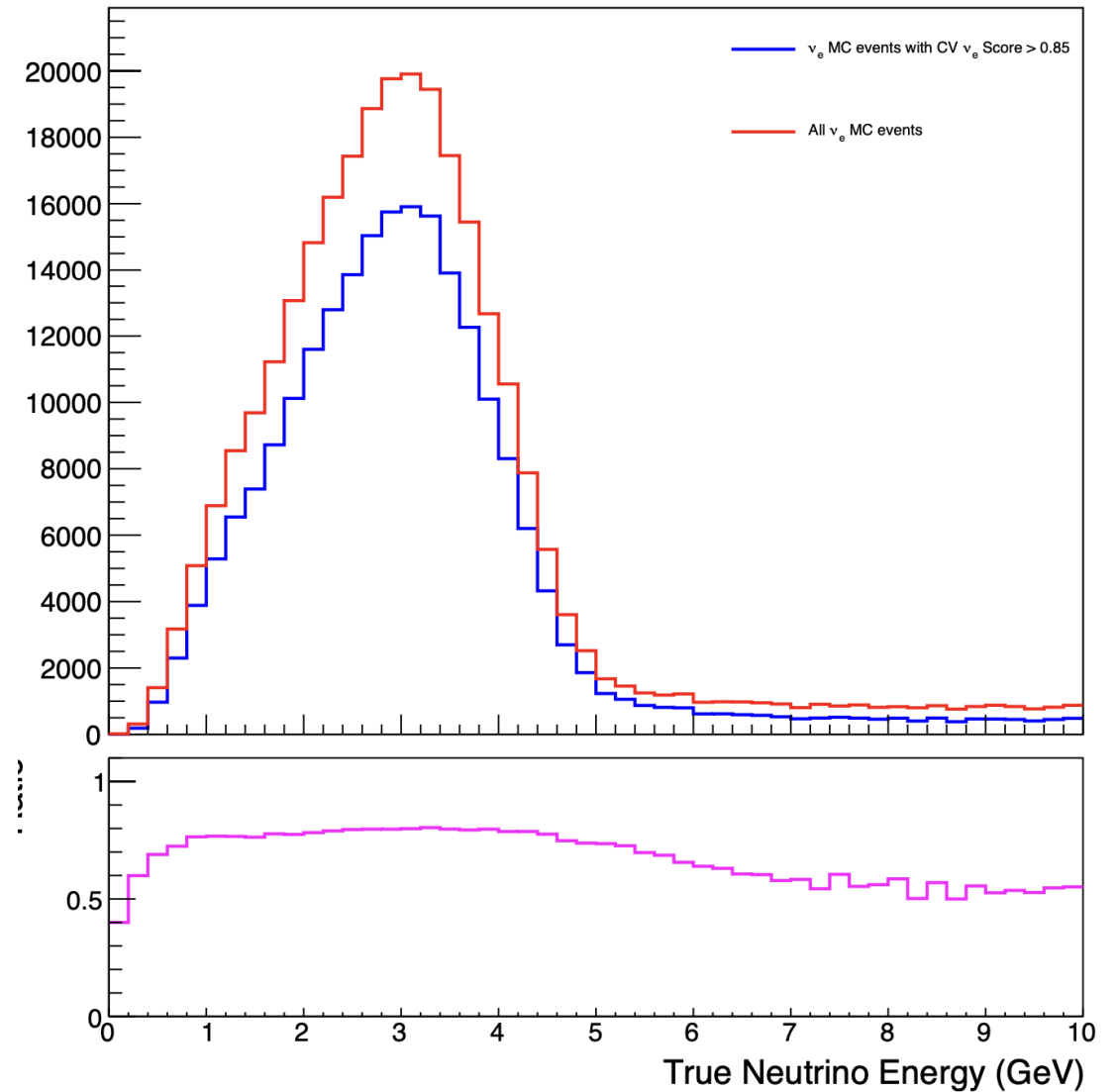


ν_e Energy

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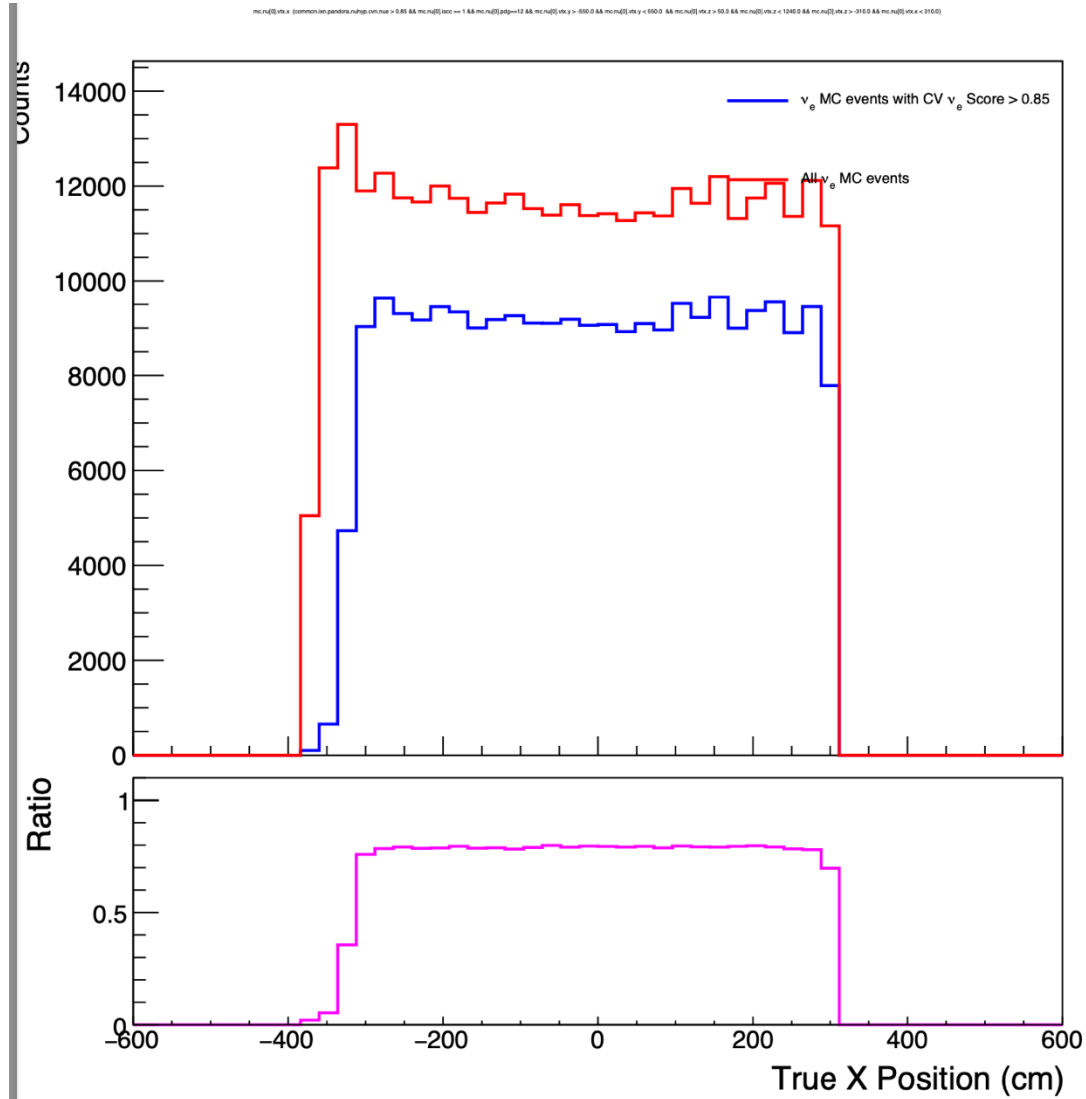


First Look

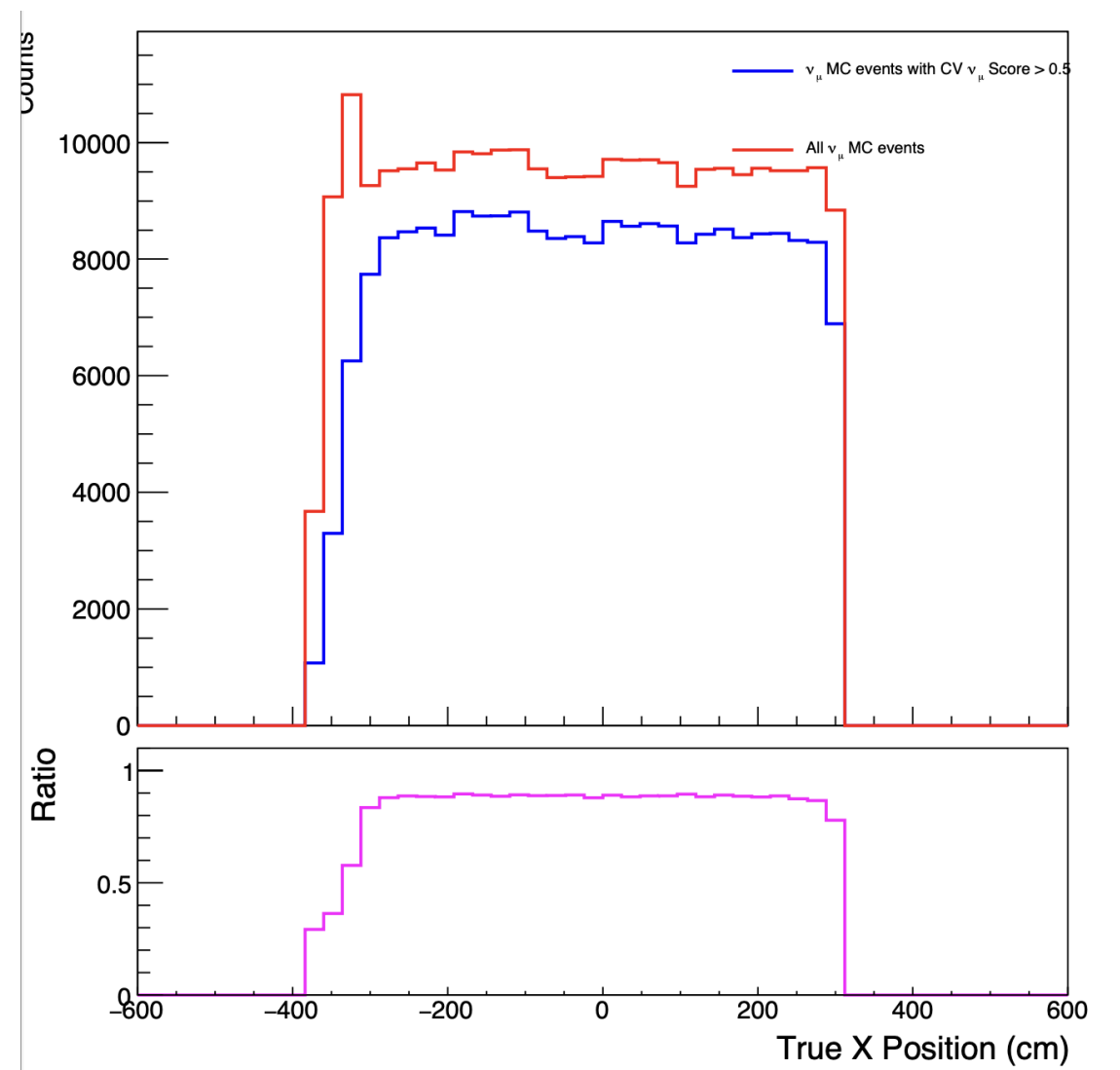


X vertex Efficiency

nu_e

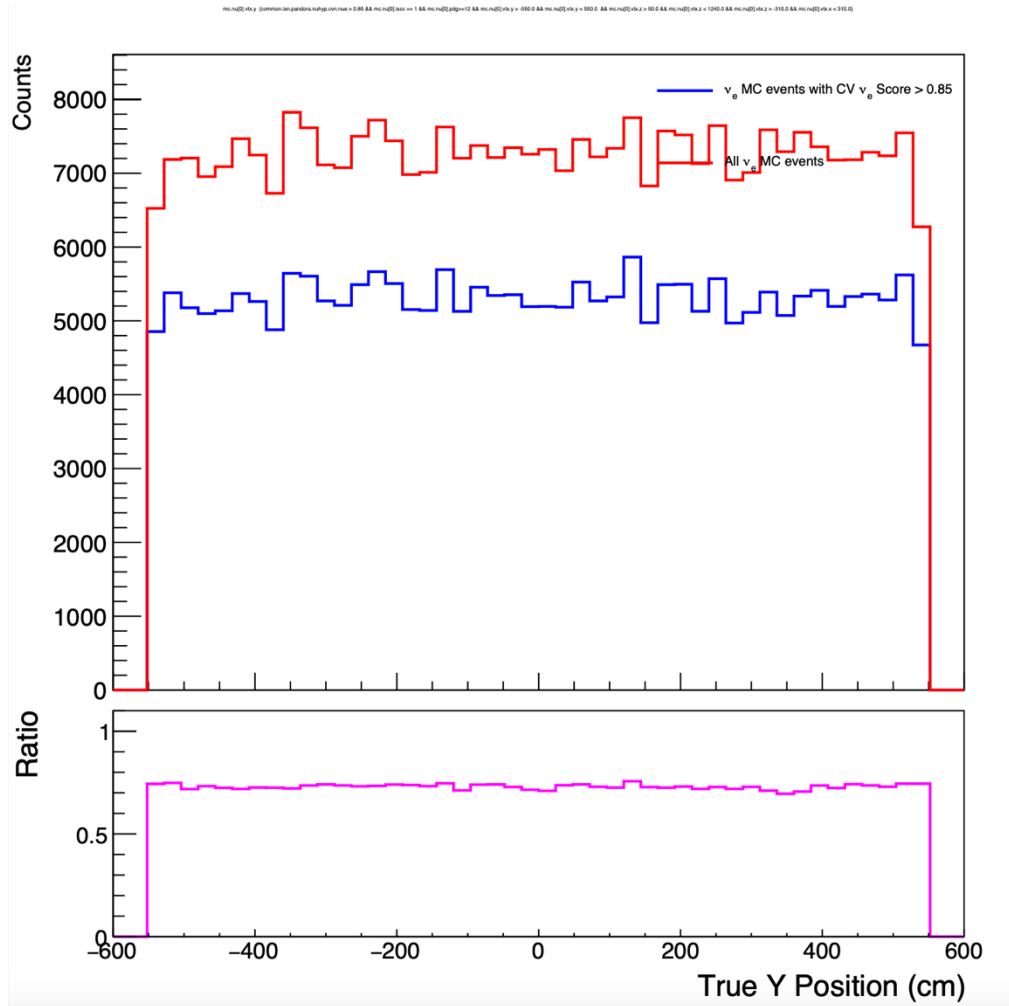


nu_mu

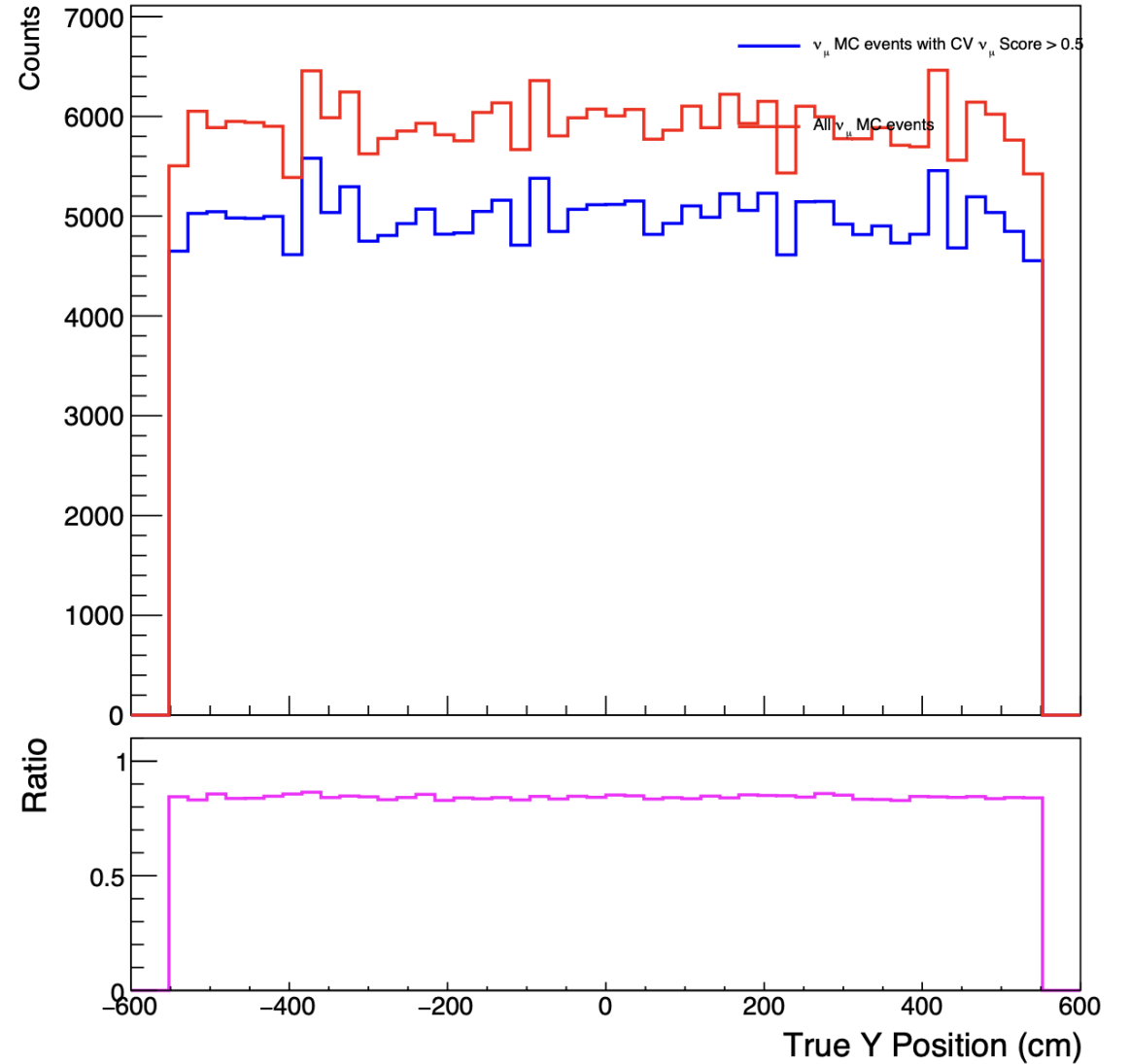


Y vertex Efficiency

nu_e

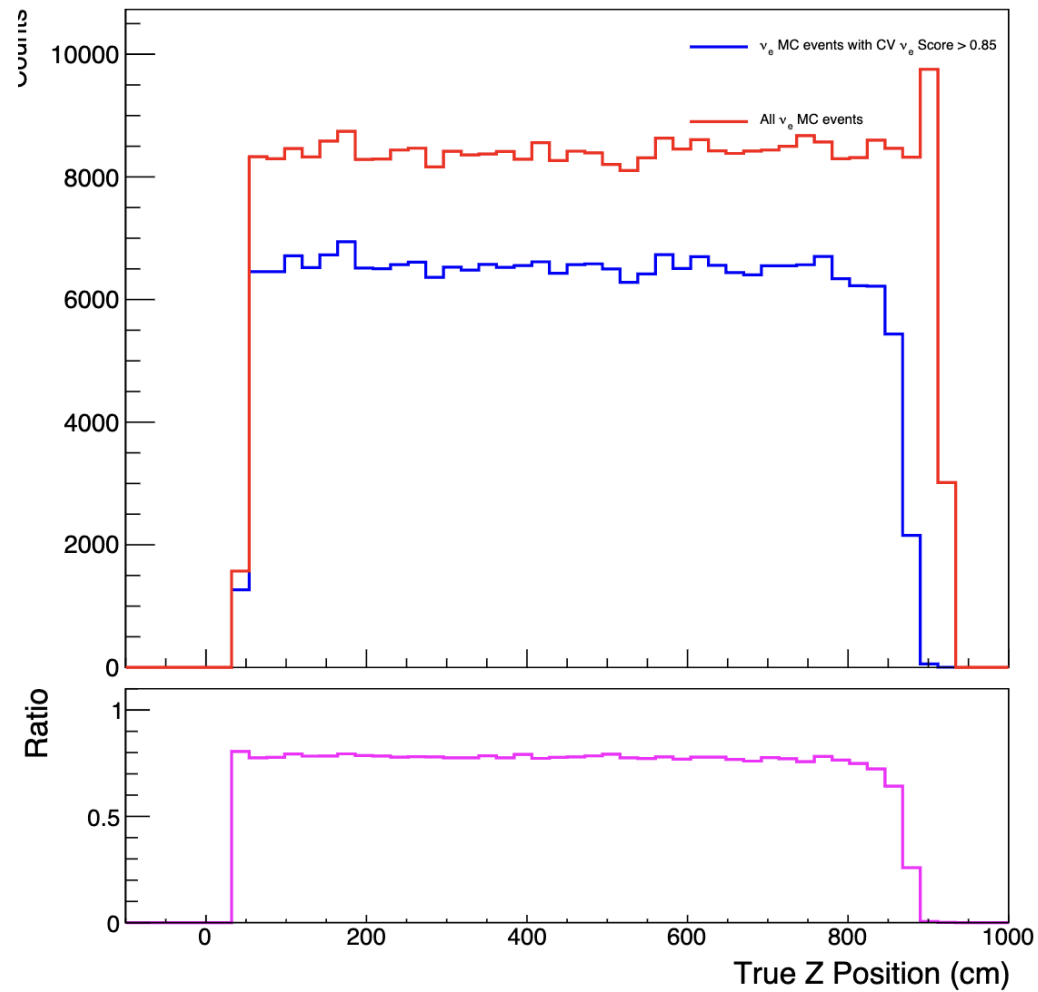


nu_mu

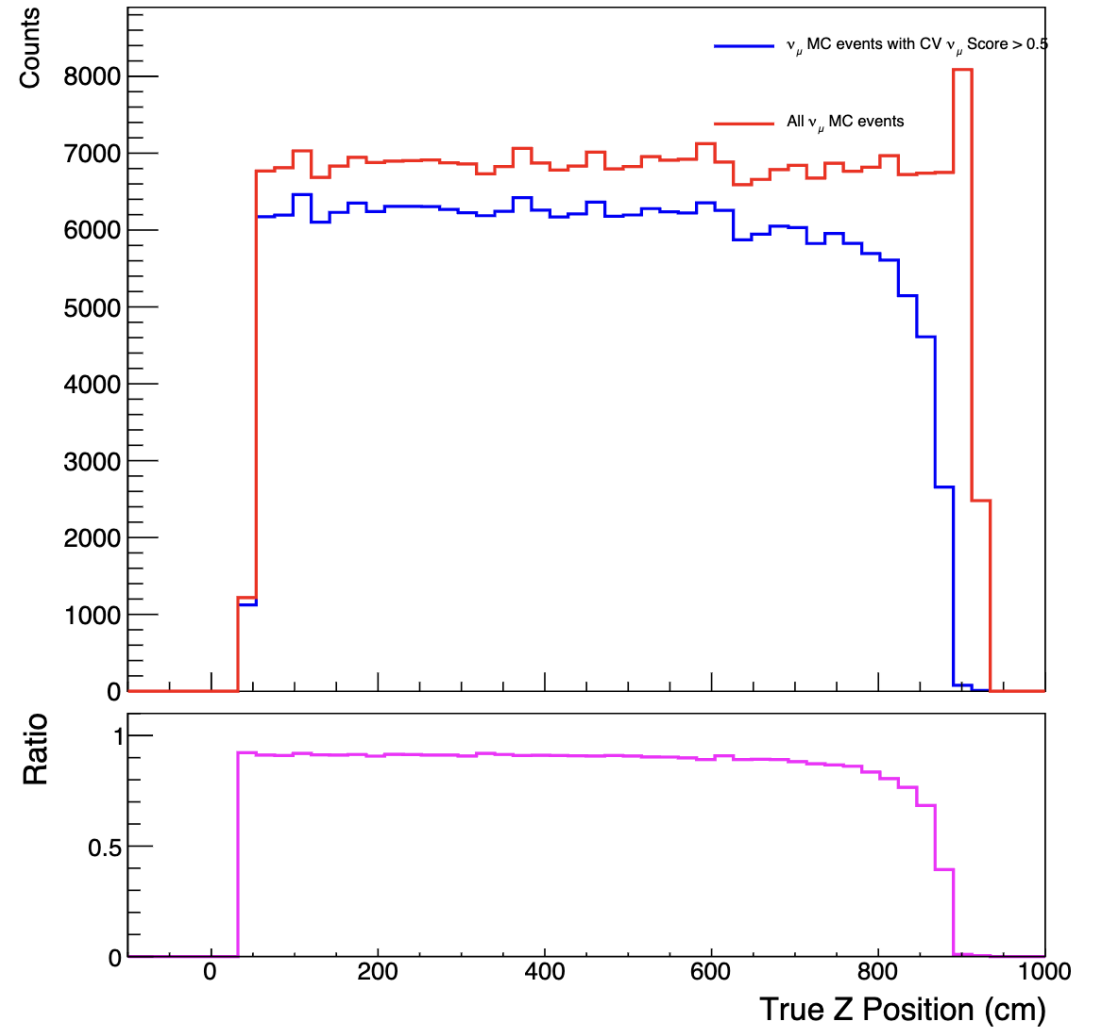


Z vertex Efficiency

nu_e



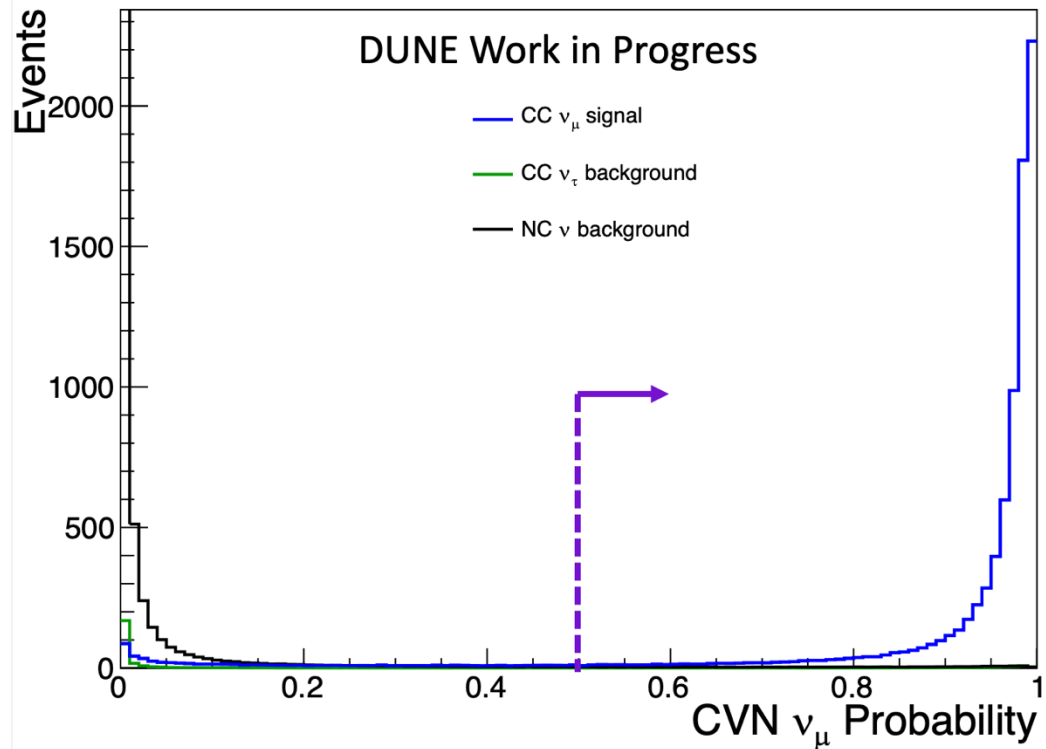
nu_mu



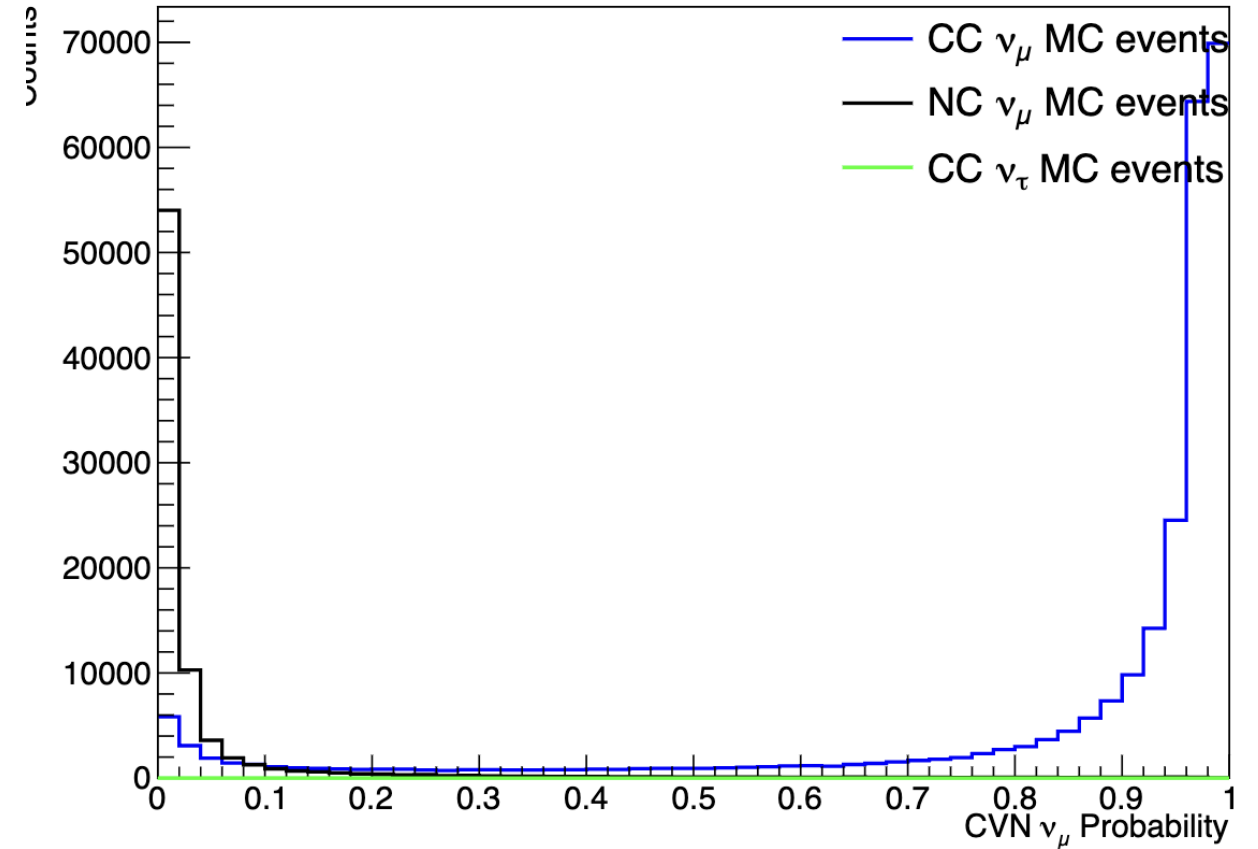
Selecting ν_μ

PhysRevD.102.092003,

Neutrino interaction classification with a convolutional neural network in the
DUNE far detector



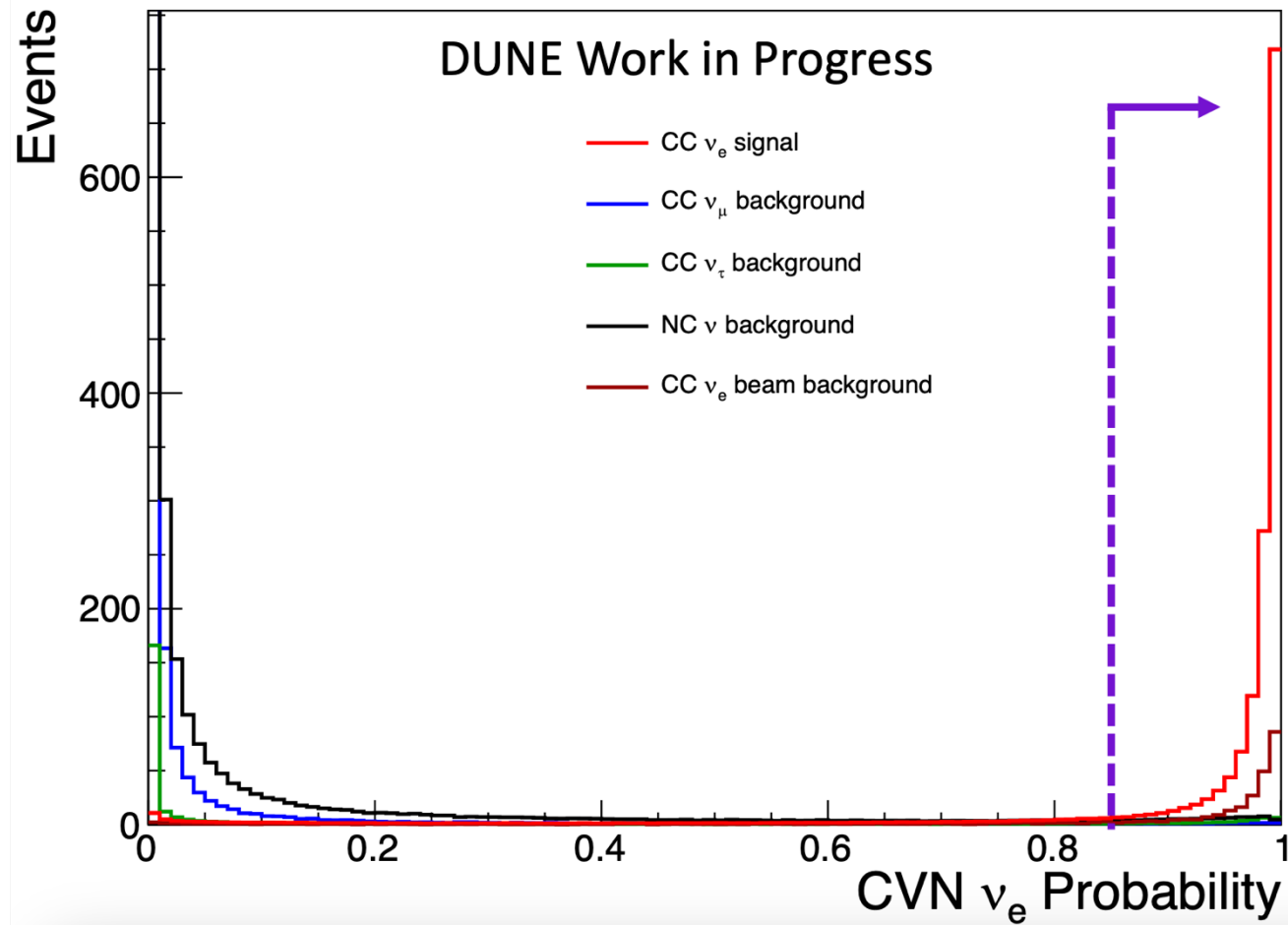
First Look



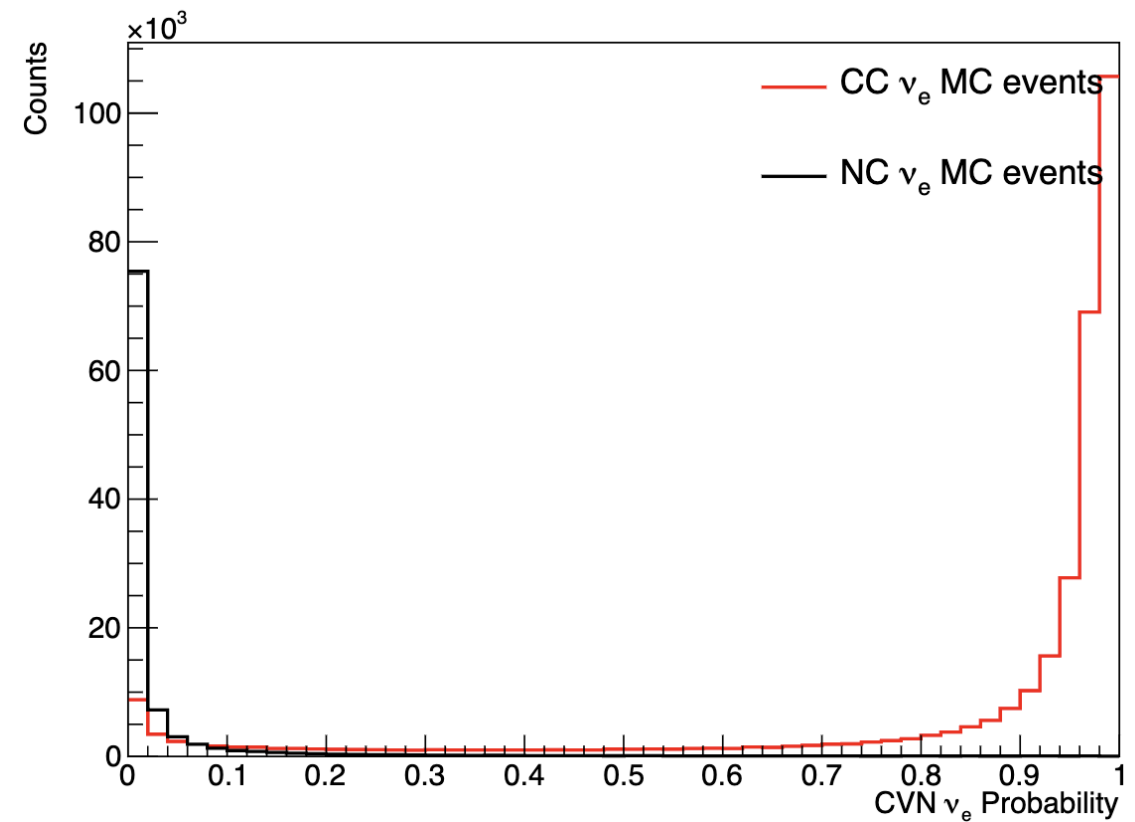
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First Look



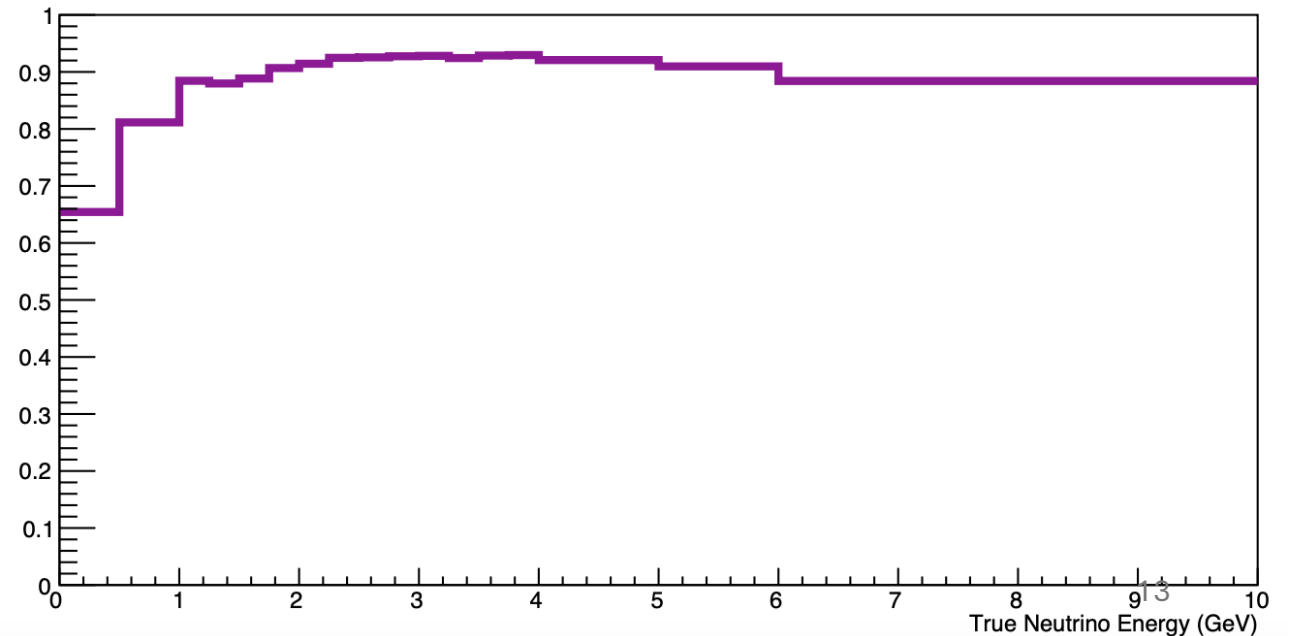
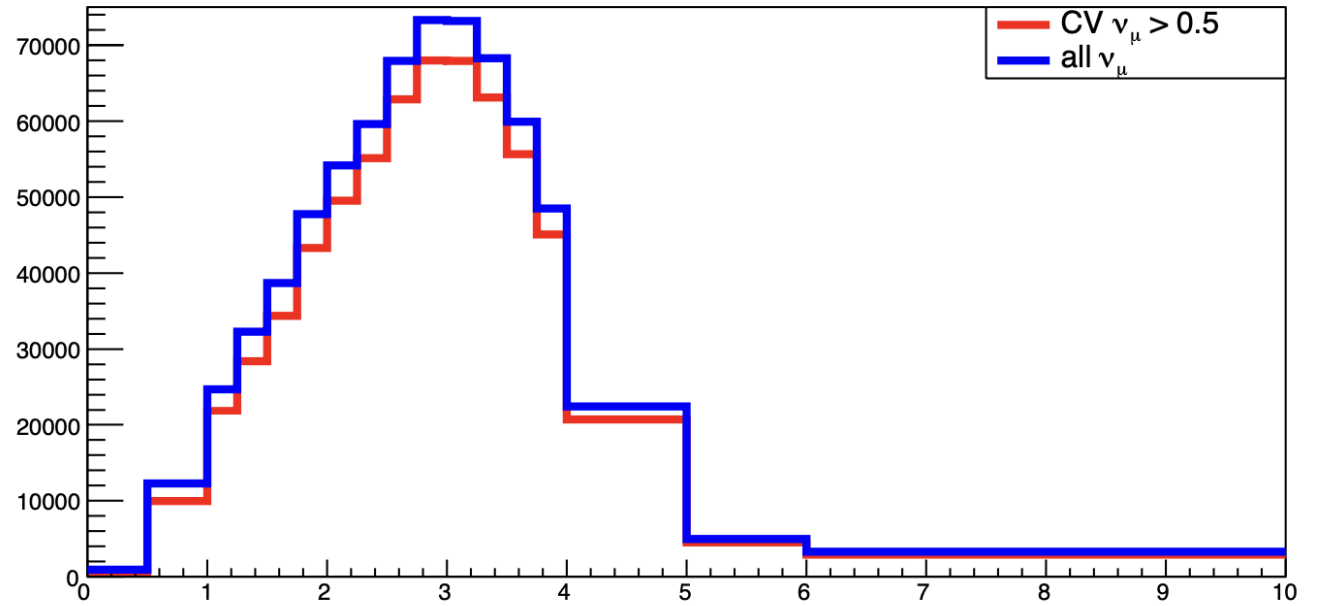
MaCh3 ν_μ Efficiency

Example with cuts applied in config file

```
SampleName: "FHC_numu"  
SampleType: "BeamFD"  
POT: 1.3628319e+23  
SelectionCuts:  
- KinematicStr: "TrueXPos"  
  Bounds: [ -310.0, 310.0 ]  
- KinematicStr: "TrueYPos"  
  Bounds: [ -550.0, 550.0 ]  
- KinematicStr: "TrueZPos"  
  Bounds: [ 50.0, 1244.0 ]  
- KinematicStr: "CVNNumu"  
  Bounds: [ 0.5, 999 ]
```

Event Selection in SamplePDF

```
if (sr->mc.nu[0].pdg == 14 && sr->mc.nu[0].iscc == 1 ) {  
  duneobj->selected_numuCCevent_energy[entryi] = sr->mc.nu[0].E;  
  duneobj->selected_numuCCevent_vertexpos_x[entryi] = sr->mc.nu[0].vtx.x;  
  duneobj->selected_numuCCevent_vertexpos_y[entryi] = sr->mc.nu[0].vtx.y;  
  duneobj->selected_numuCCevent_vertexpos_z[entryi] = sr->mc.nu[0].vtx.z;  
}
```



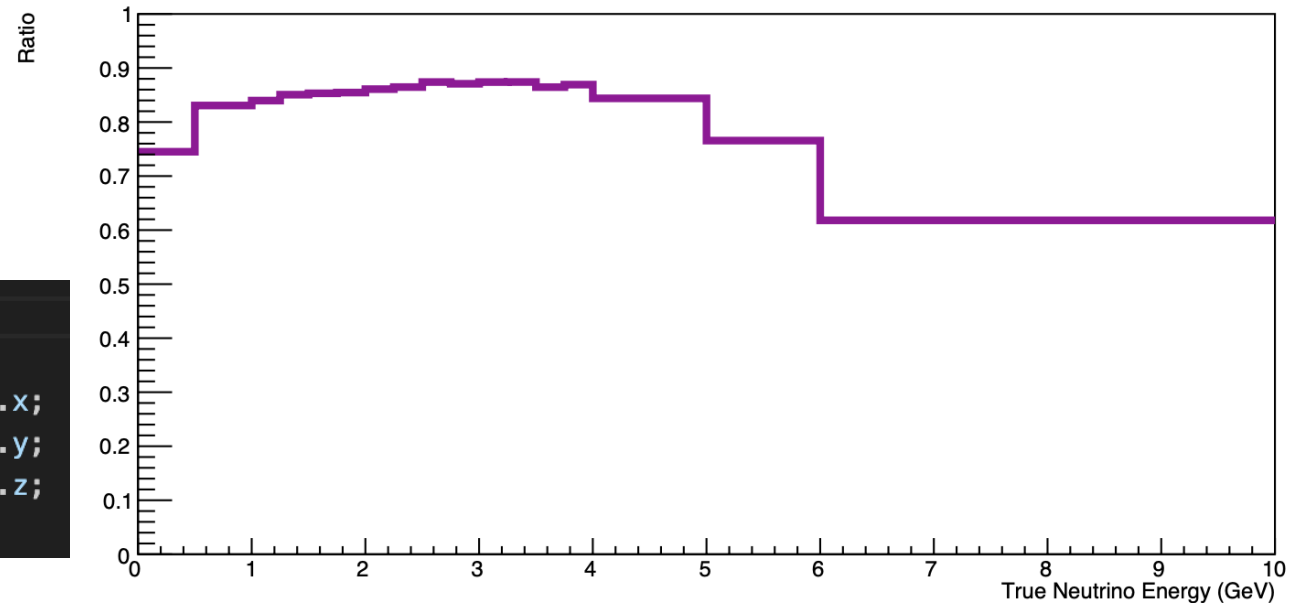
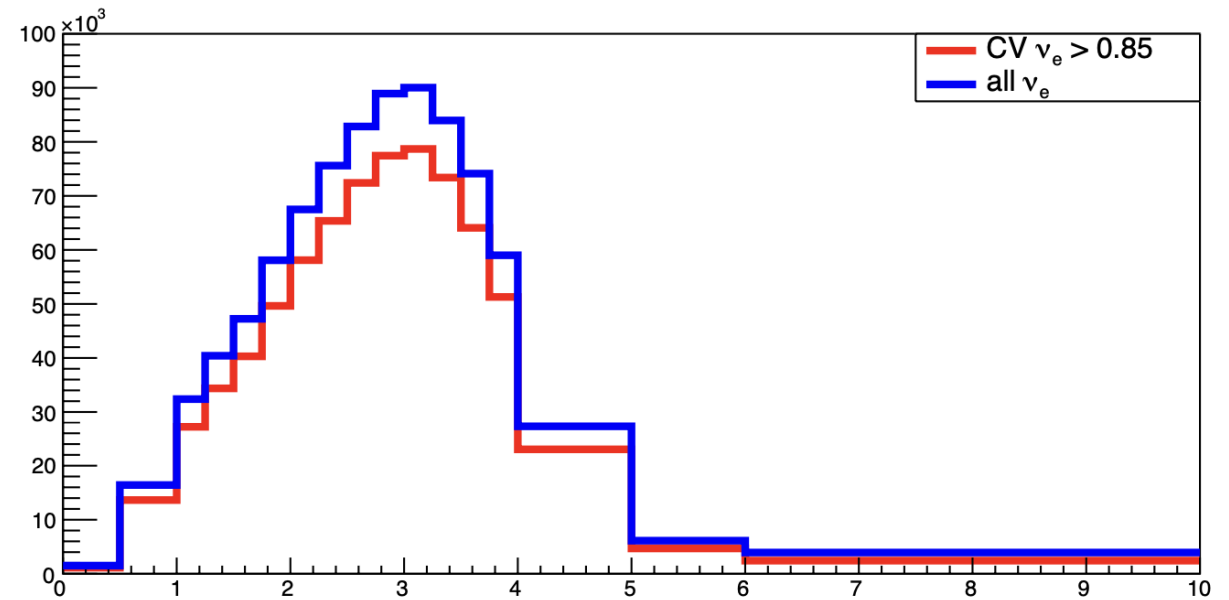
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  Bounds: [ -550.0, 550.0 ]  
- KinematicStr: "TrueZPos"  
  Bounds: [ 50.0, 1244.0 ]  
- KinematicStr: "CVNNue"  
  Bounds: [ 0.85, 999 ]
```

Event Selection in SamplePDF

```
if (sr->mc.nu[0].pdg == 12 && sr->mc.nu[0].iscc == 1 ) {  
  duneobj->selected_nueCCevent_energy[entryi] = sr->mc.nu[0].E;  
  duneobj->selected_nueCCevent_vertexpos_x[entryi] = sr->mc.nu[0].vtx.x;  
  duneobj->selected_nueCCevent_vertexpos_y[entryi] = sr->mc.nu[0].vtx.y;  
  duneobj->selected_nueCCevent_vertexpos_z[entryi] = sr->mc.nu[0].vtx.z;  
}
```



Summary

- Small scale first look at new DUNE FD VD Production
- Need to scale up to include more events
- Demonstrated the capabilities of MaCh3 for performing efficiency studies