Varied Horn Current Studies

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Motivation

- NC events mimic lower energy events as the outgoing neutrino carries a significant energy
- CC events deposit much closer to the full incoming neutrino energy
- Highest energy particles not affected (as much) by focusing horns, so horn focusing raises proportion of CC events at lower energy
- Data from multiple configurations provides solvable system of equations for decomposition
- Method worked for MINOS, where neutrino beam was on axis

Method

- Total events written for two configurations, a and b:

$$\begin{array}{rcccccc} N^a_{Tot} & = & N^a_{NC} & + & N^a_{\nu_\mu} & + & N^a_{\nu_e} \\ N^b_{Tot} & = & r_{NC} N^a_{NC} & + & r_{\nu_\mu} N^a_{\nu_\mu} & + & r_{\nu_e} N^a_{\nu_e} \end{array}$$

- Ratios $r_x \equiv N^b_x / N^a_x$ are calculated from MC, since modeling errors cancel to first order
- Also assume MC models ν_e beam component correctly

$$N^a_{NC} = \frac{r_{\nu_\mu} N^a - N^b + (r_{\nu_e} - r_{\nu_\mu}) N^a_{\nu_e}}{r_{\nu_\mu} - r_{NC}}$$

$$N^a_{\nu_\mu} = \frac{r_{NC} N^a - N^b + (r_{\nu_e} - r_{NC}) N^a_{\nu_e}}{r_{NC} - r_{\nu_\mu}}$$

- Requires different ratios of events, enough statistics in both configurations

Statistics

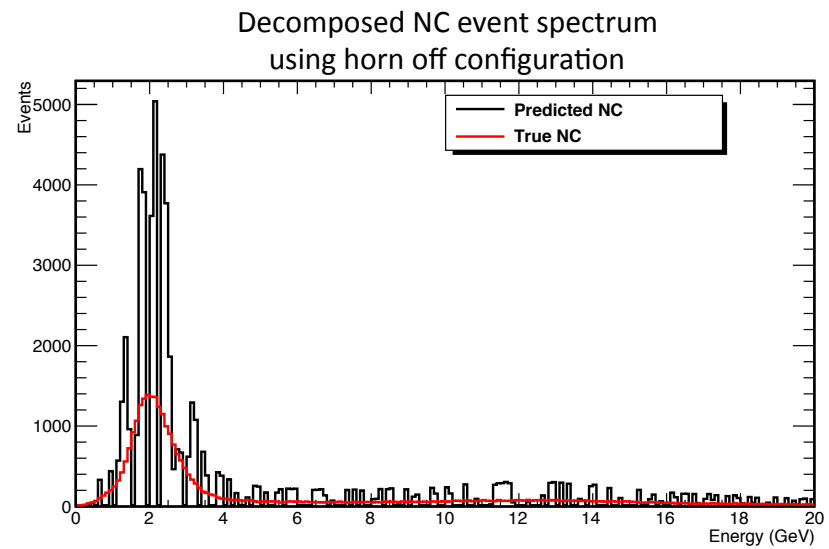
- For horn on/off, studies were performed on sim files with 1000 events per file
- r parameters generated from 1000 horn on, 100 horn off files, decompositions were performed with 97 horn on, 31 horn off files (different files from r parameter calculations)
- For intermediate horn currents, studies were performed with flux files
- ~435M POT were used to generate r parameters (both configurations), ~45M POT were used for decompositions
- ALL studies used ONLY truth information
- File names and locations are listed in the back up slides

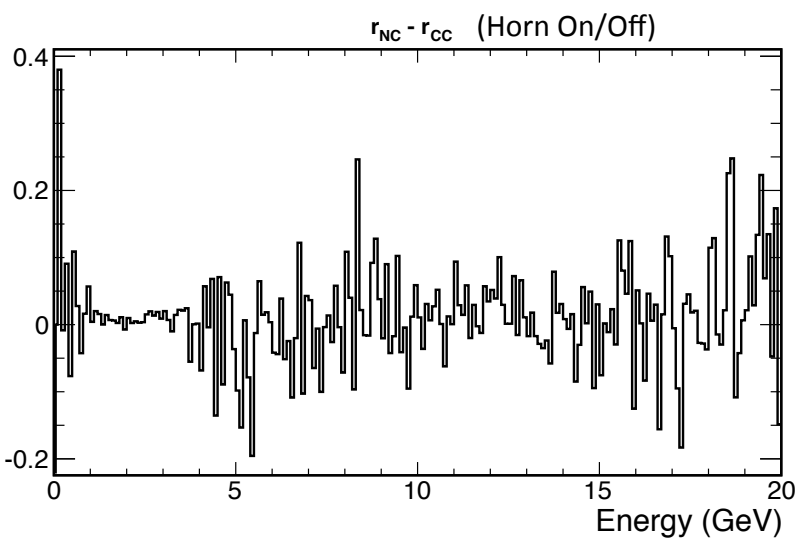
Enough Statistics?

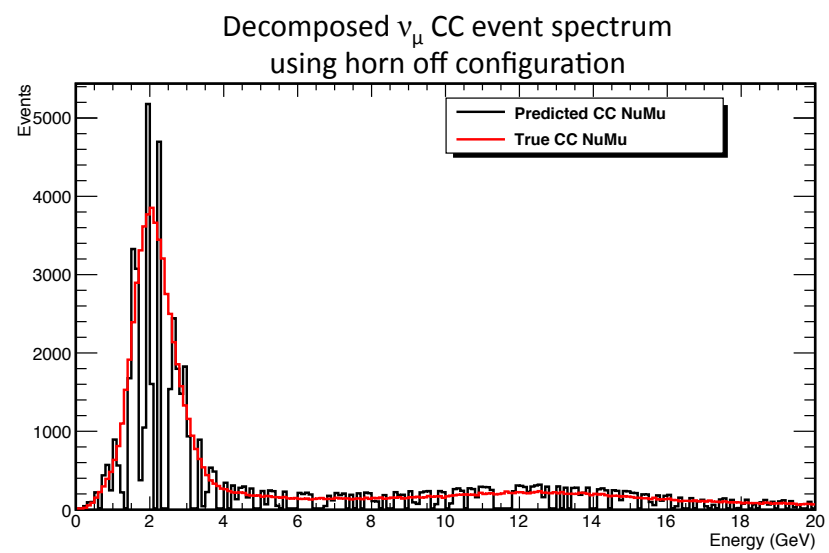
- Spoiler: the decompositions look terrible
- All plots were checked, and enough statistics were used to generate reasonable smooth event distributions, including for all relevant ν_e plots
- The decomposition denominator, or $r_{\nu\mu} - r_{\nu NC}$, is close to 0 because the two r parameters do stay very similar
- Consequently, the decomposition spectra were noisy (from dividing by ~0), negative bins were set to 0, and bins above the total event rate were set to the total event rate (per bin)

Horn On/Off

- Configuration "a," normal condition, 200 kA
- Configuration "b," horn off, 0 kA

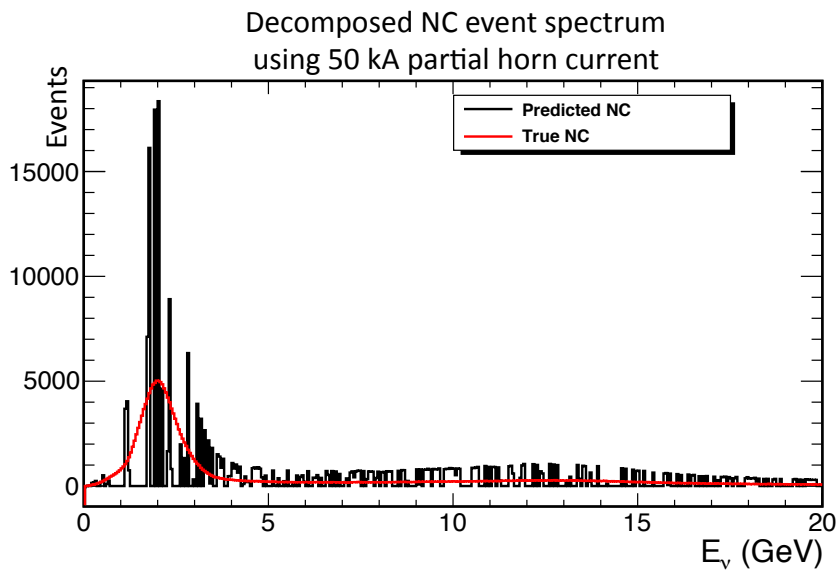


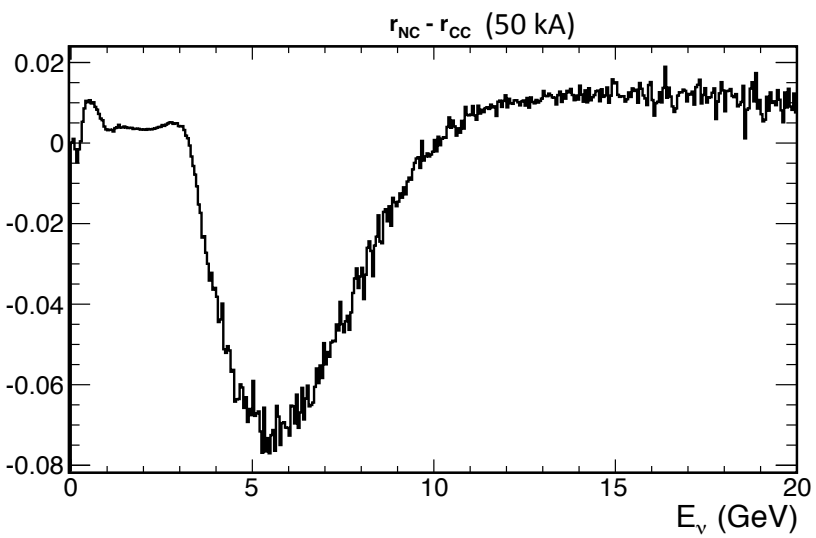


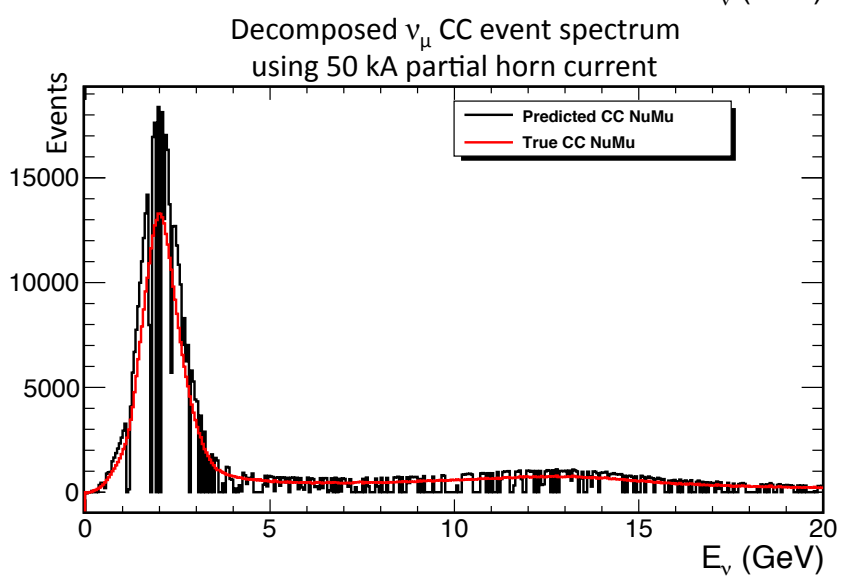


200 kA vs 50 kA

- Configuration "a," normal condition, 200 kA
- Configuration "b," partial horn current, 50 kA

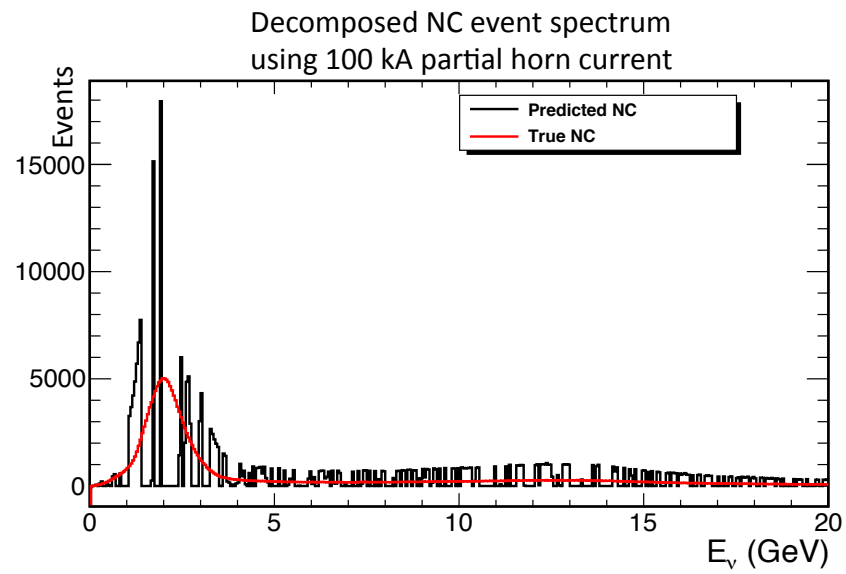


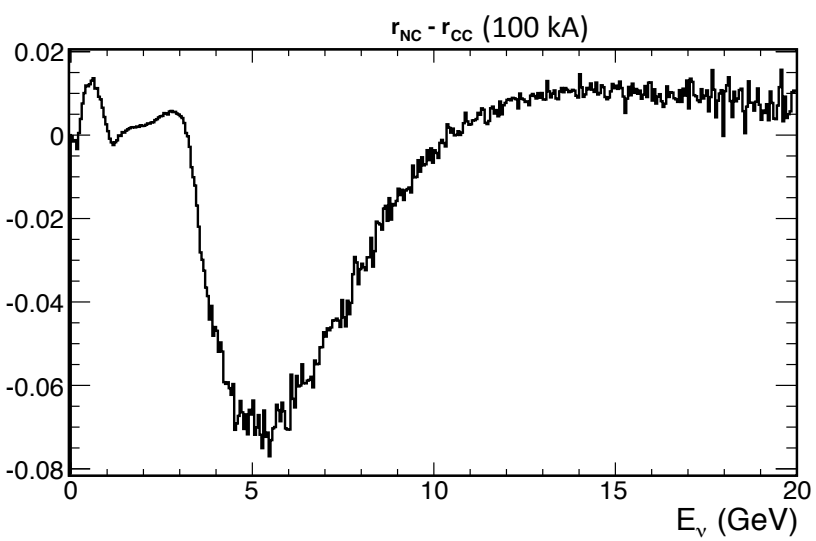


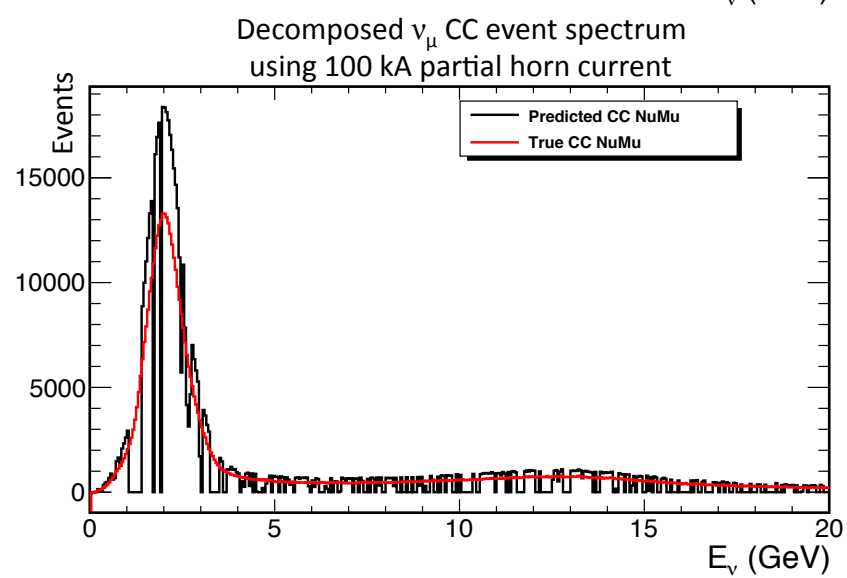


200 kA vs 100 kA

- Configuration "a," normal condition, 200 kA
- Configuration "b," partial horn current, 100 kA

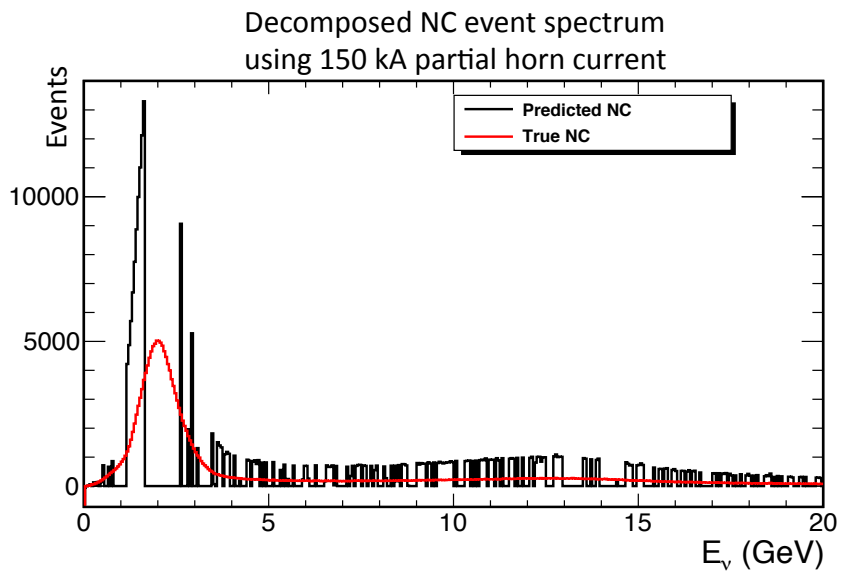


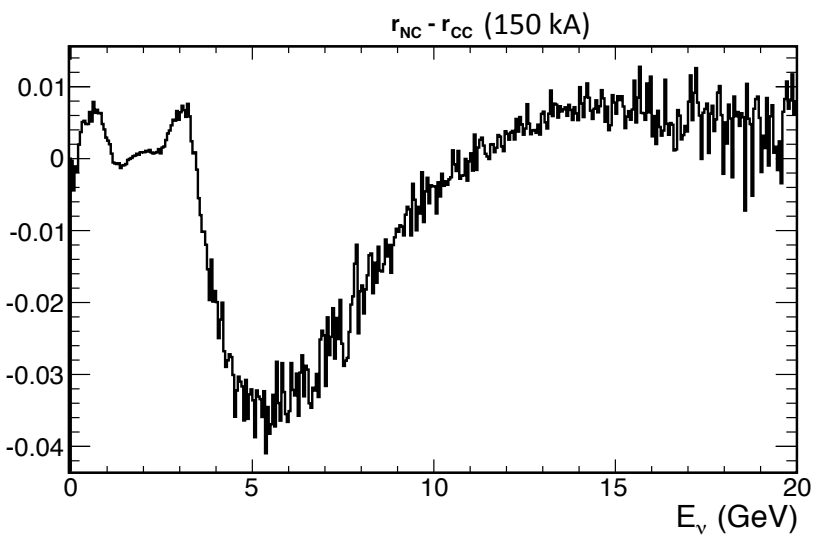


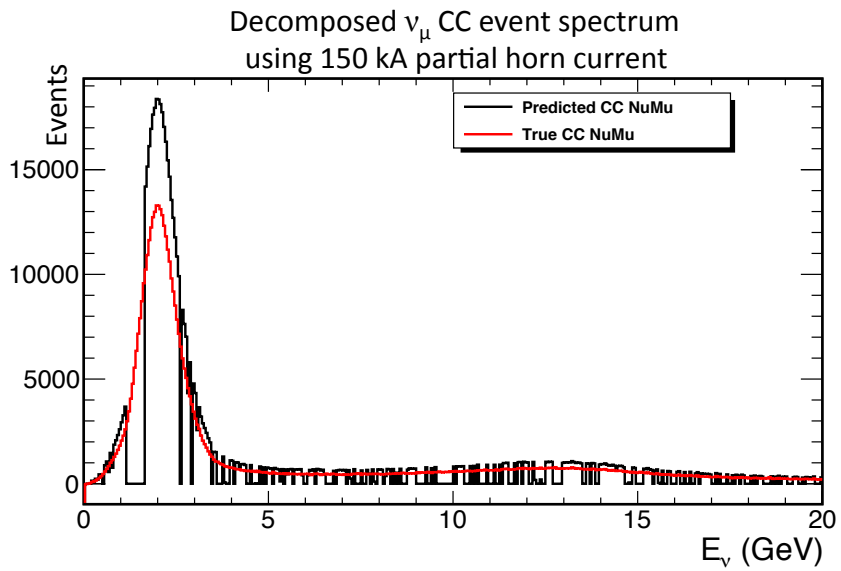


200 kA vs 150 kA

- Configuration "a," normal condition, 200 kA
- Configuration "b," partial horn current, 150 kA







Conclusions

- Enough statistics were used for what could have been a decomposition proof of concept
- The event rate ratios remained similar regardless of horn current
- As a result, I am forced to conclude that a varied horn current decomposition is unviable for NOνA, regardless of how many statistics other experiments may lobby for

Back Ups

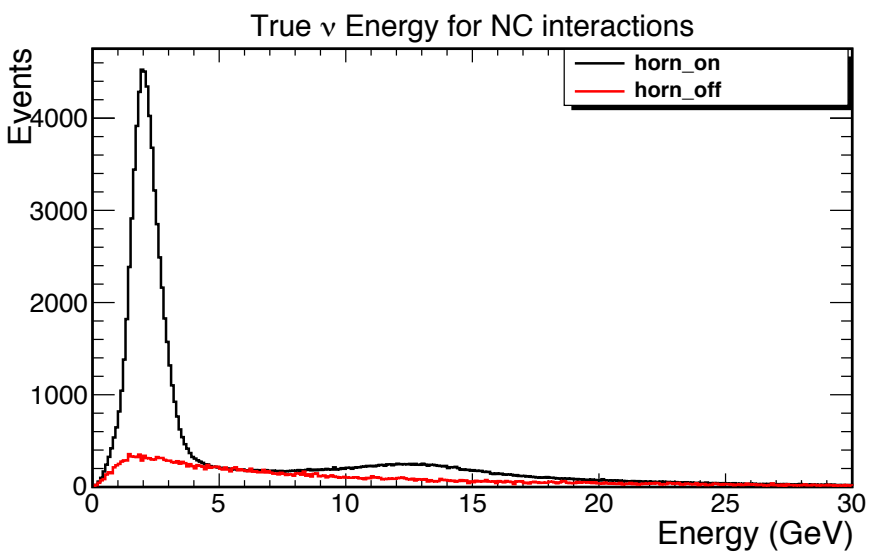
Files Used

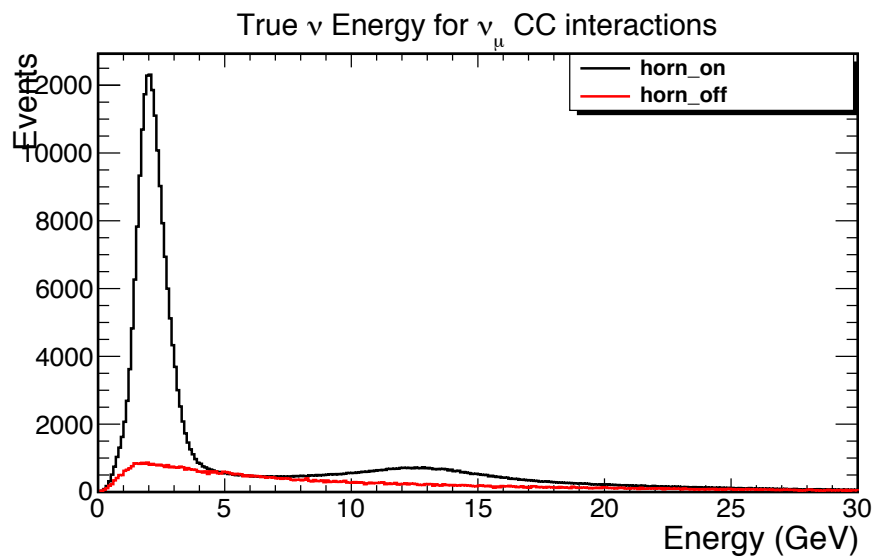
- Horn on/off:
  - /nova/data/mc/S12-12-12/genie/nd/nd_r0000001_s00_S12-12-12_v1_genie_1000_fhc_20121129_181943.sim.reco.root
  - /nova/ana/users/rschroet/genie/nd/nd_r0000001_s27_S12-11-16_v1_genie_1000_fhc_0hc_20130522_152509.sim.daq.root
- Only MC Truth information was accessed, so the results were unaffected by the difference between daq and reco files

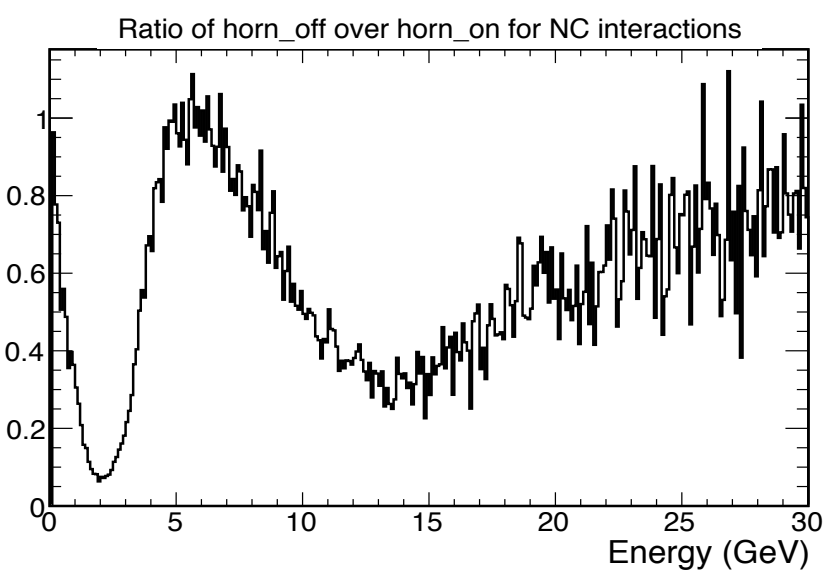
Files Used

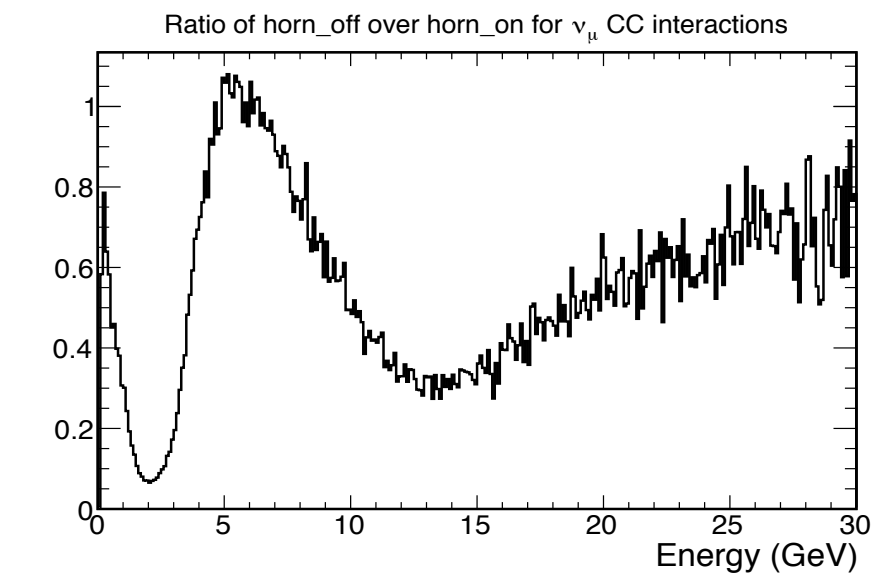
- Intermediate horn currents
  - /nova/ana/users/gkafka/NovaBeamMat/Horn_FHC/novabeammat_flugg_20101117_ndfd_fhc_*.root
  - /nova/ana/users/gkafka/NovaBeamMat/Horn_050i/novabeammat_flugg_ndfd_050i_*.root
  - /nova/ana/users/gkafka/NovaBeamMat/Horn_100i/novabeammat_flugg_ndfd_100i_*.root
  - /nova/ana/users/gkafka/NovaBeamMat/Horn_150i/novabeammat_flugg_ndfd_150i_*.root
- Files based on FLUGG using FLUKA 2008

Horn On/Off

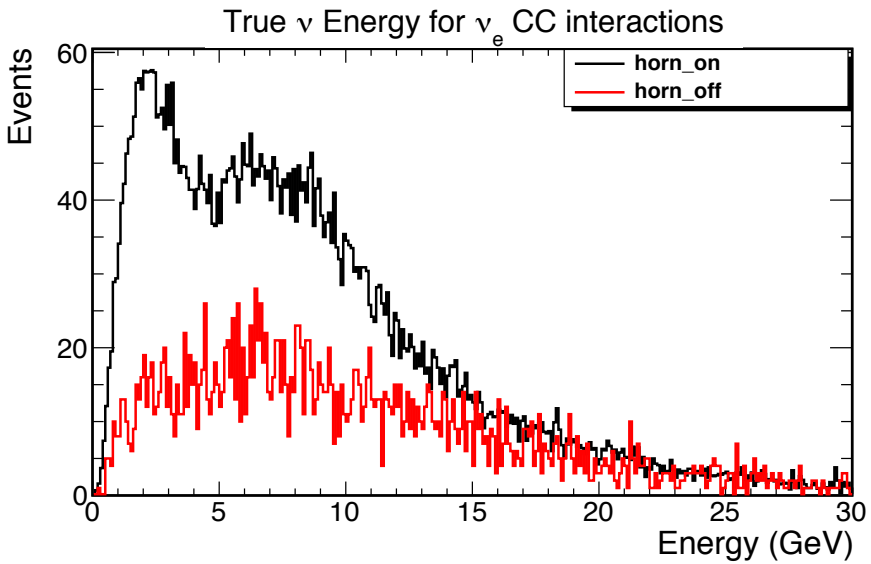

True ν Energy for NC interactions
horn_on
horn_off
Events
Energy (GeV)

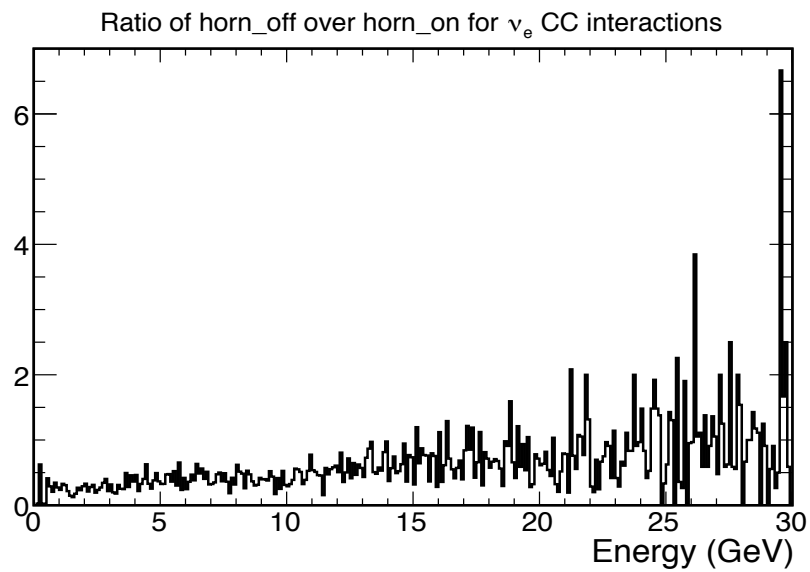

True ν Energy for ν_μ CC interactions
horn_on
horn_off
Events
Energy (GeV)


Ratio of horn_off over horn_on for NC interactions
Energy (GeV)

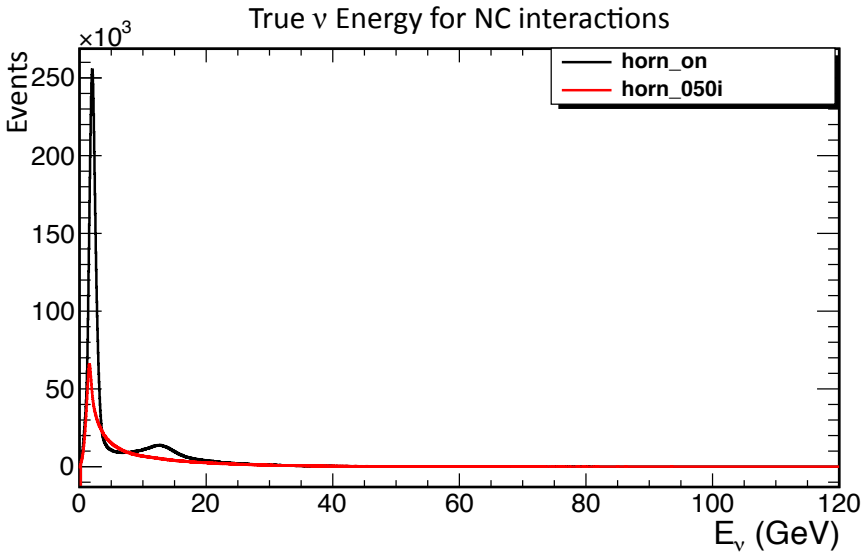

Ratio of horn_off over horn_on for ν_μ CC interactions
Energy (GeV)

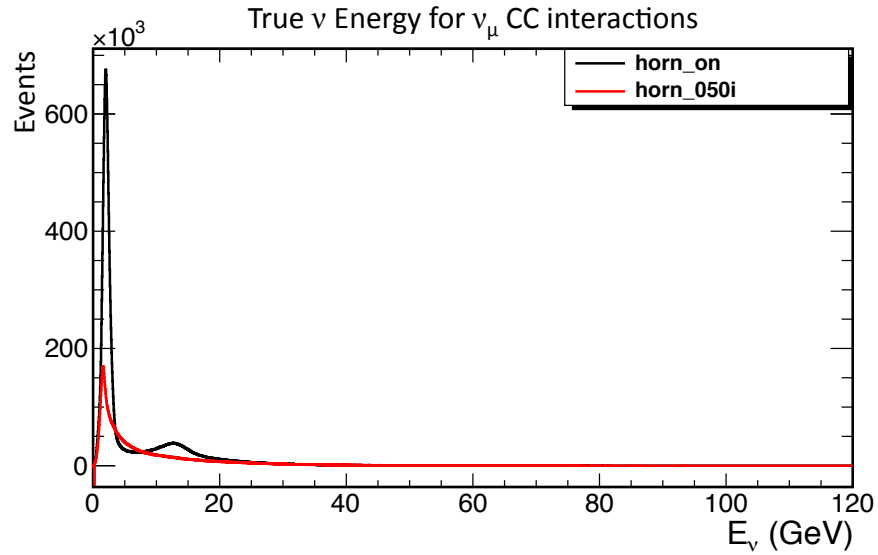
Horn On/Off

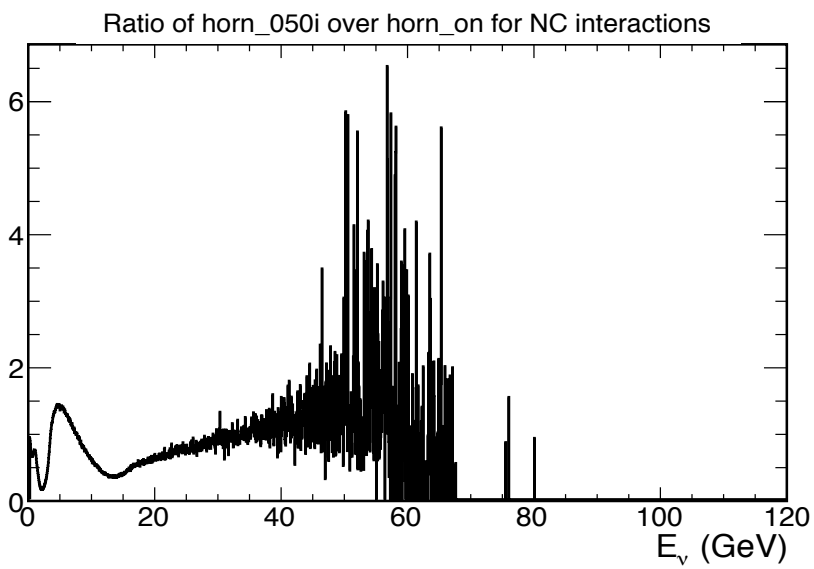

True ν Energy for ν_e CC interactions
Events
horn_on
horn_off
Energy (GeV)

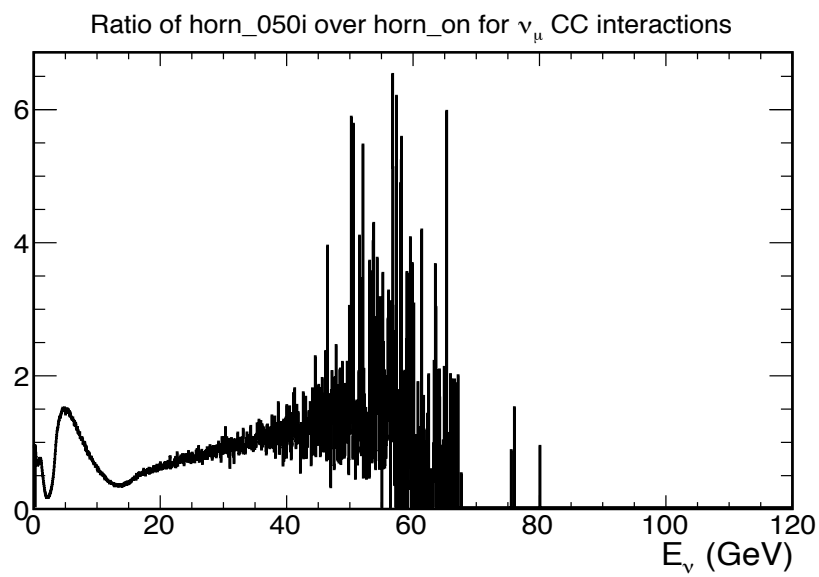

Ratio of horn_off over horn_on for ν_e CC interactions
Energy (GeV)

200 kA vs 50 kA

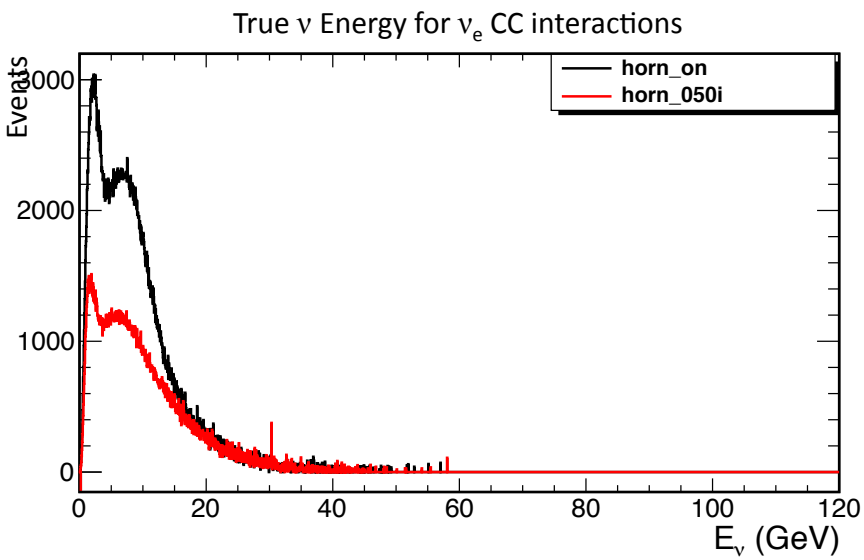


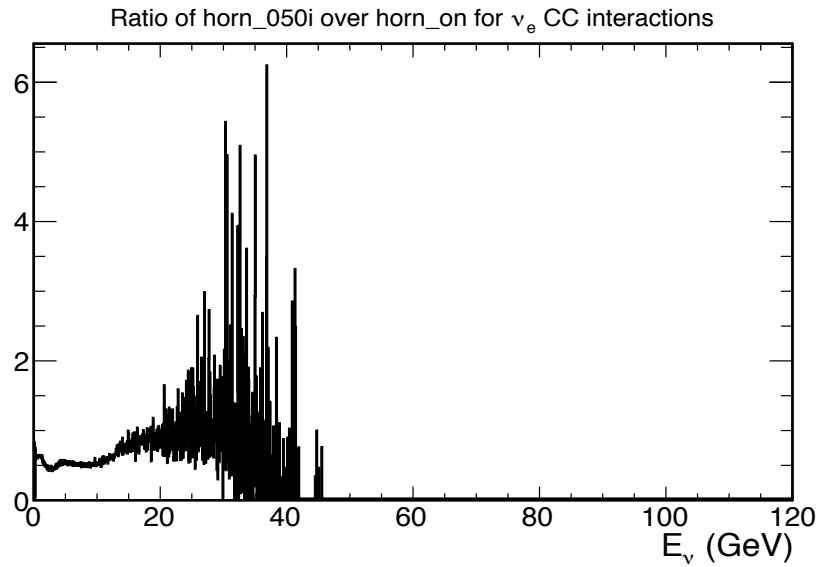




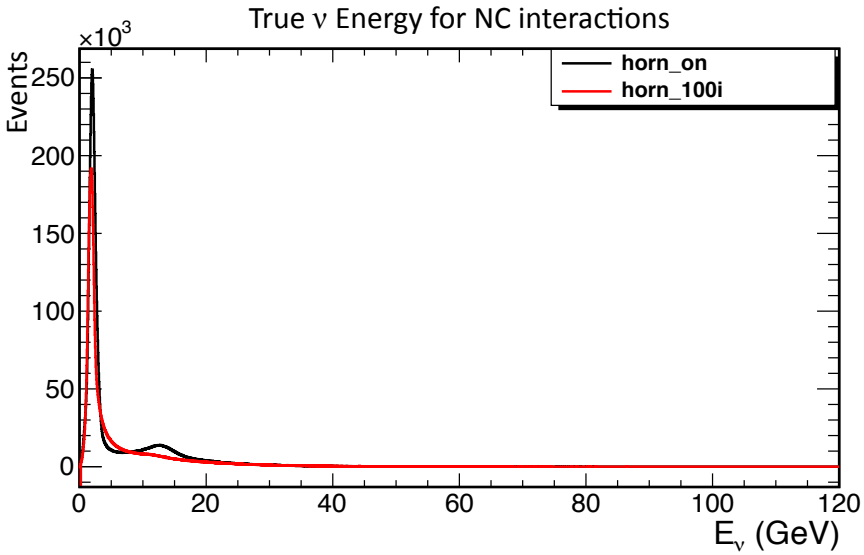


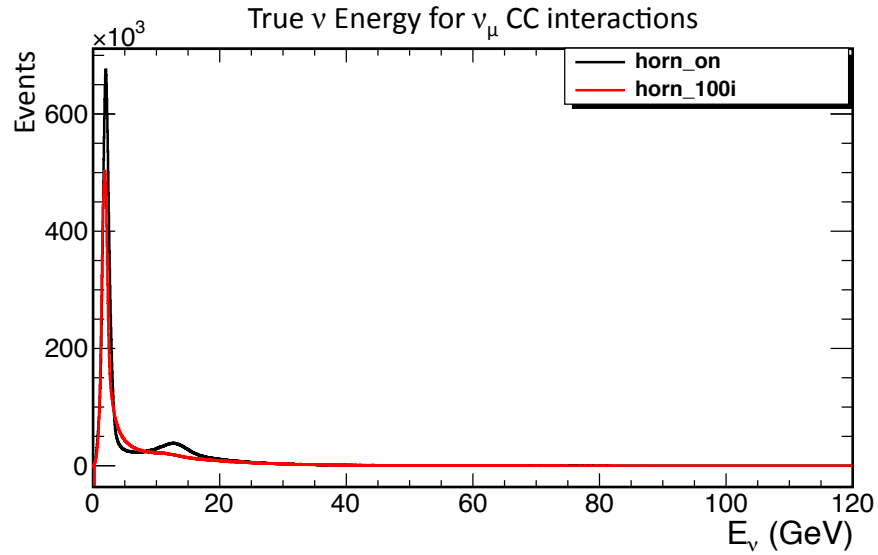
200 kA vs 50 kA

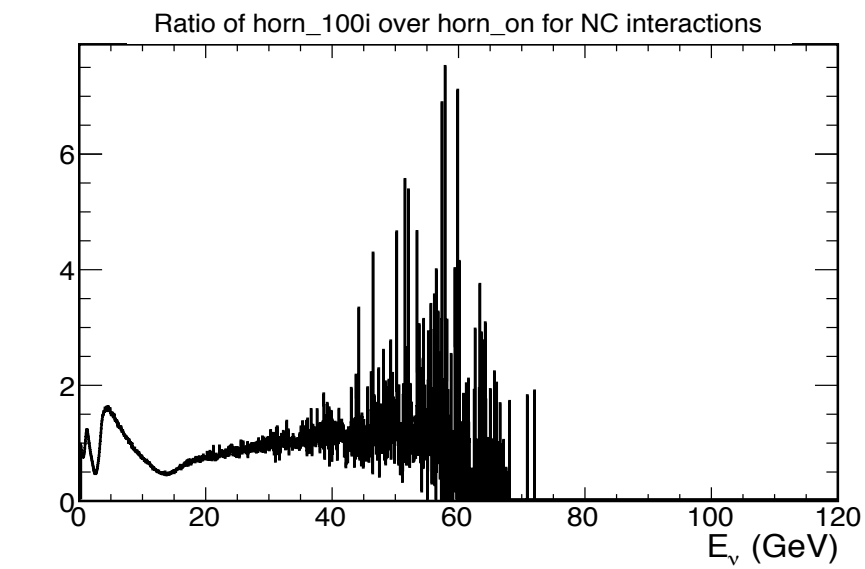


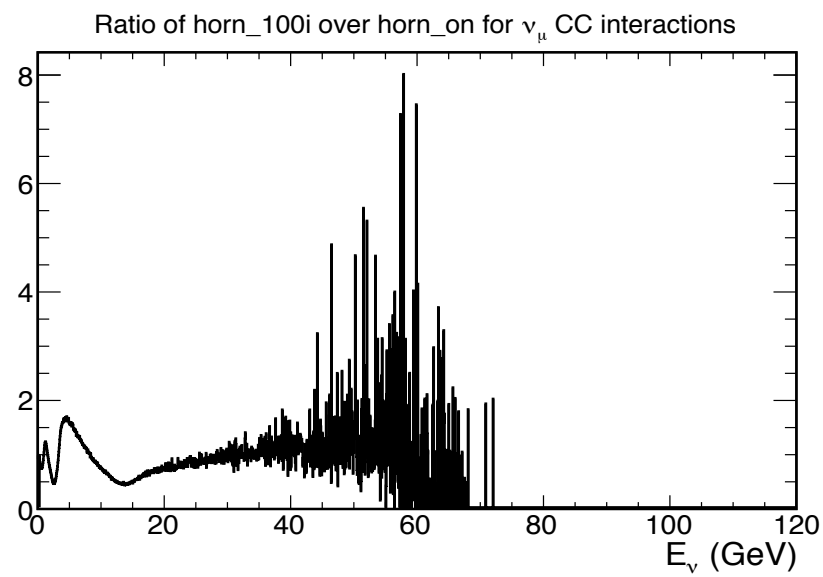


200 kA vs 100 kA









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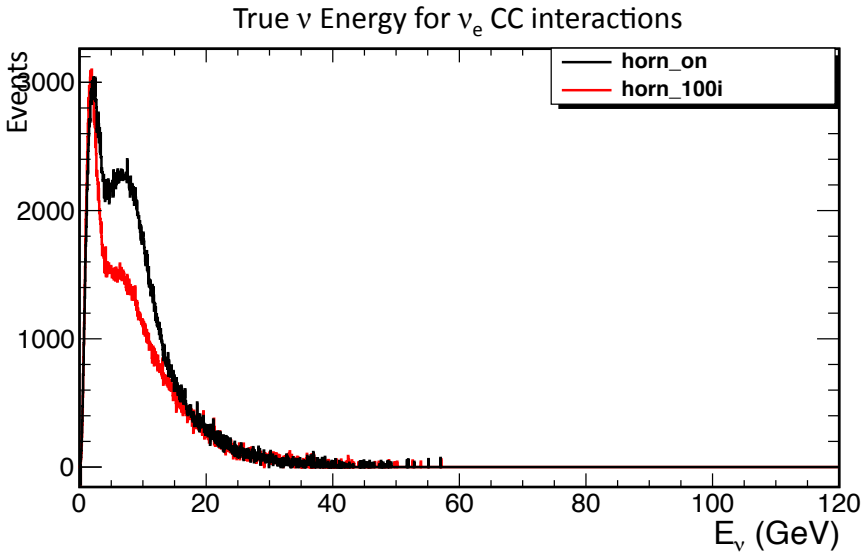
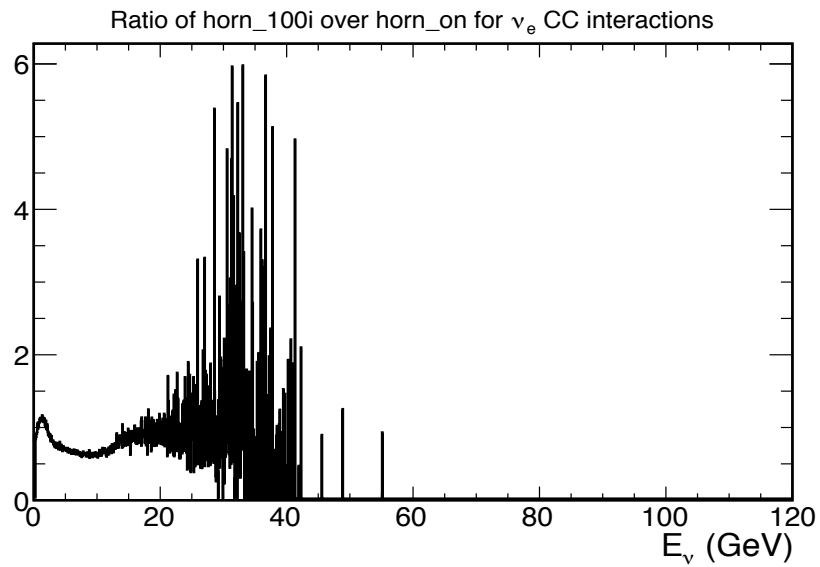
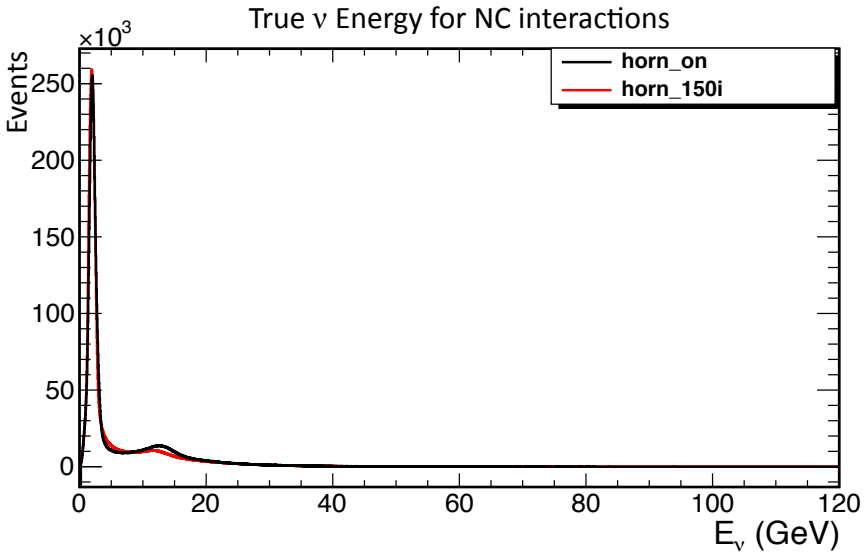
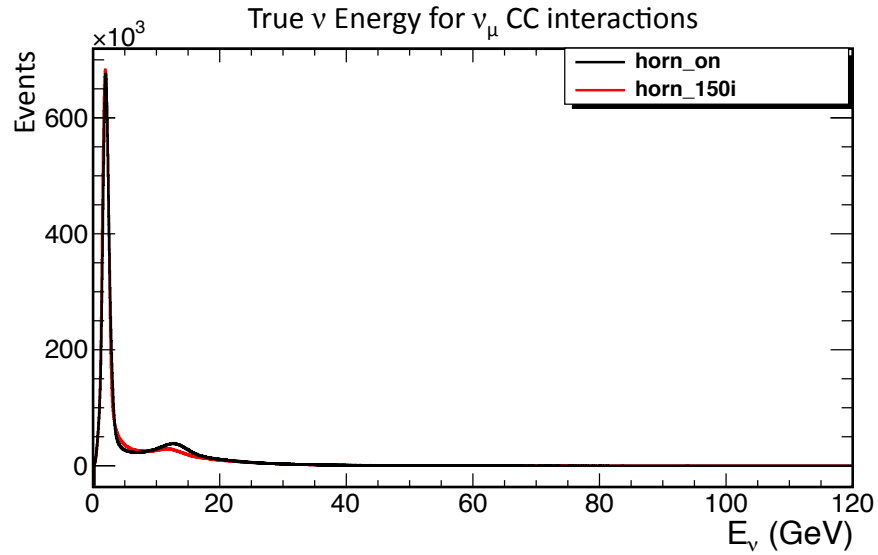
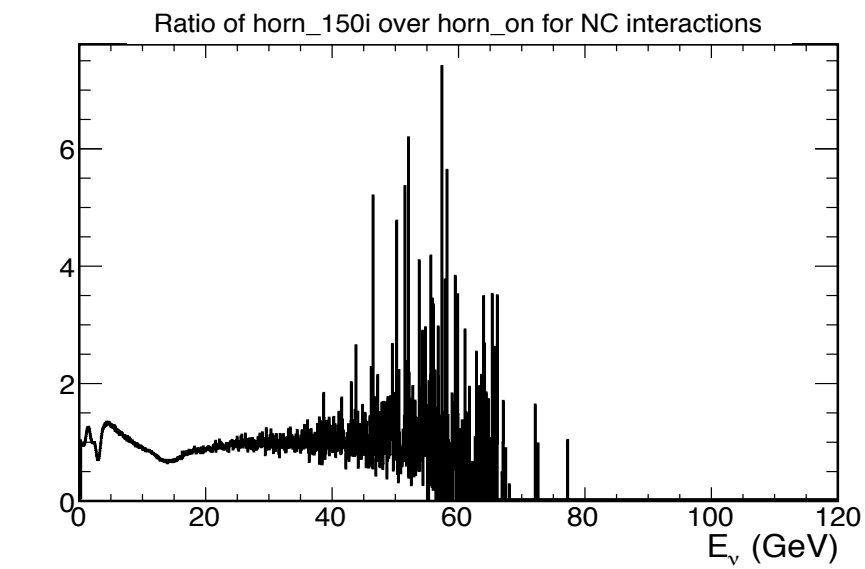


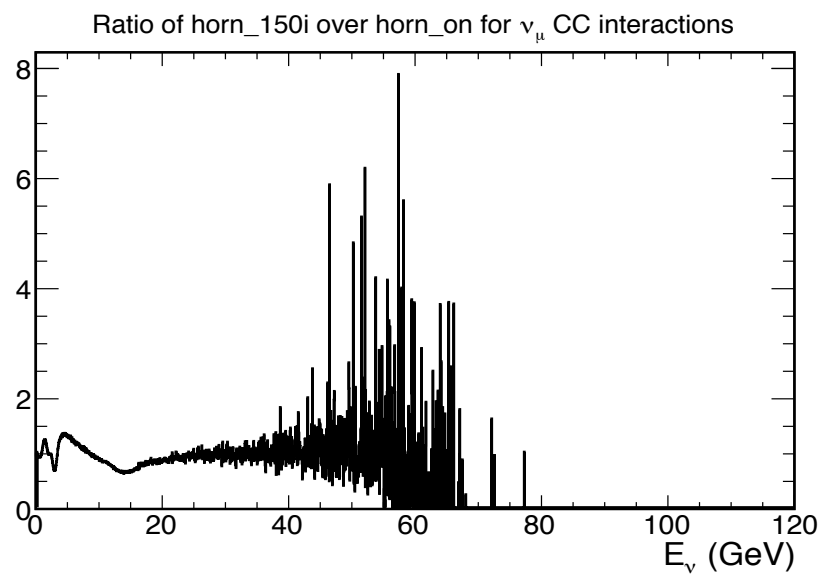
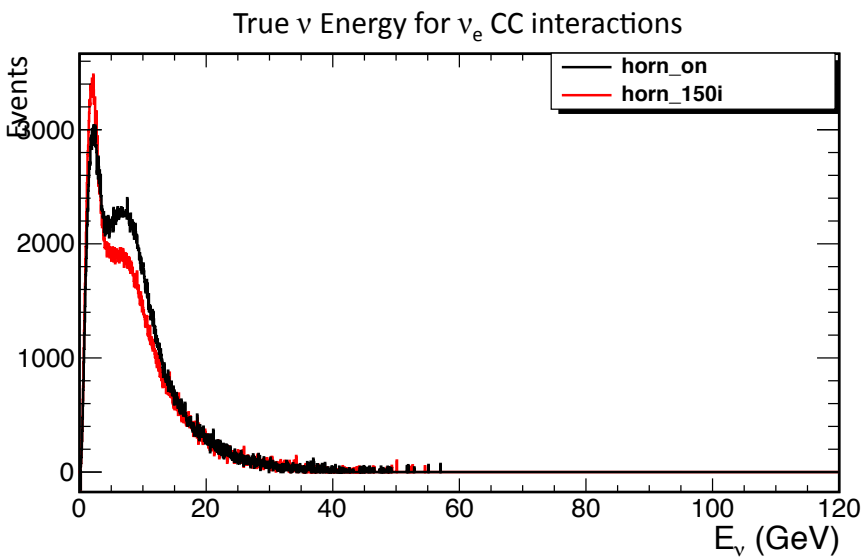
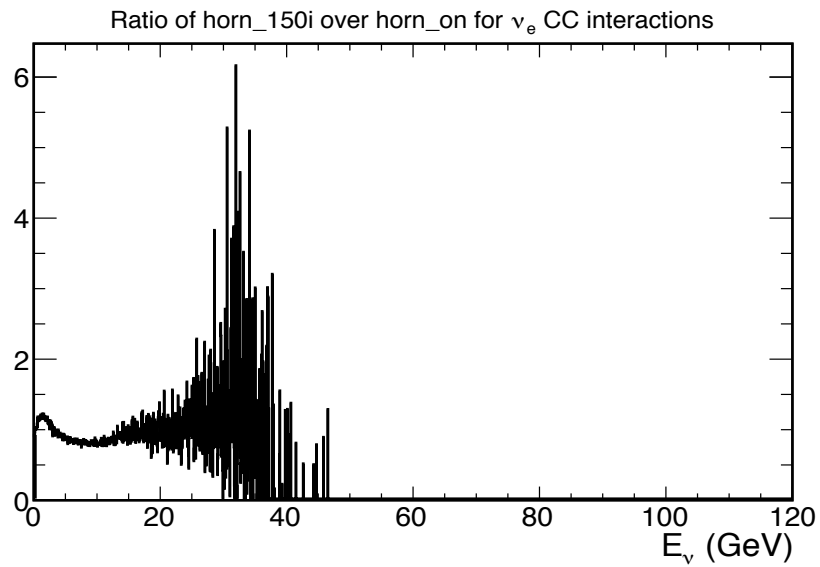


200 kA vs 150 kA





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