INGRID MC
Neutrino Efficiency

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Contents

- Neutrino energy spectrum
  - Flux into modules
  - Interact in modules
  - Observed int modules
- Efficiency of neutrino observation

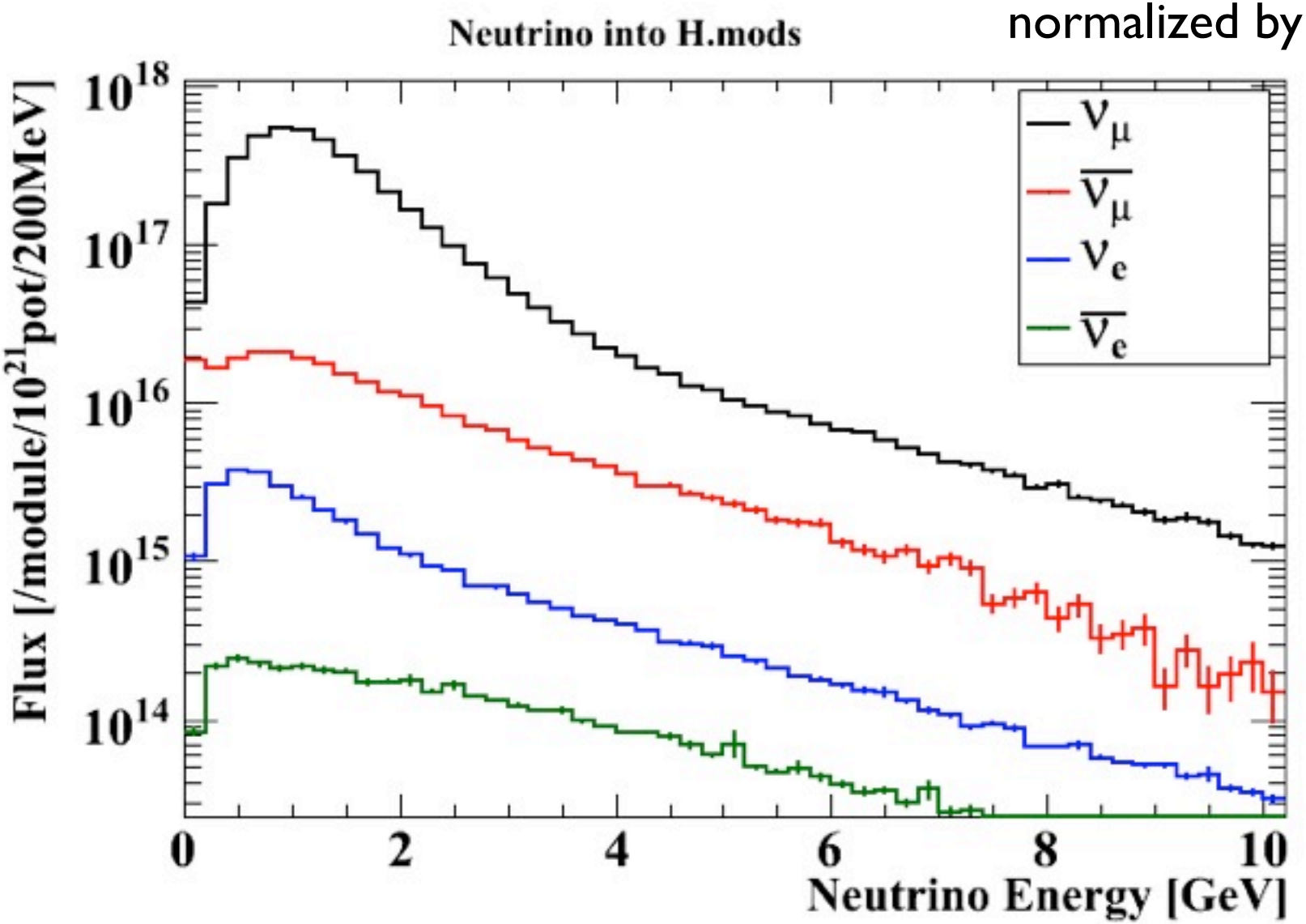
MC

- Jnubeam 10ab
- NEUT
- INGRID Detector MC (GEANT4, non nd280 package)
  - Use MC statistics : numu(2.41E18pot), numubar(6.64E19pot), nue(2.42e20pot), nuebar(2.90E21pot)
  - not including MPPC noise, hit efficiency.
  - not including beam-related background sample (rock muon, neutron, gamma).
- Consider about only horizontal in this study.
- Analysis method of MC data is same as one of INGRID beam data.

Neutrino energy (Flux)

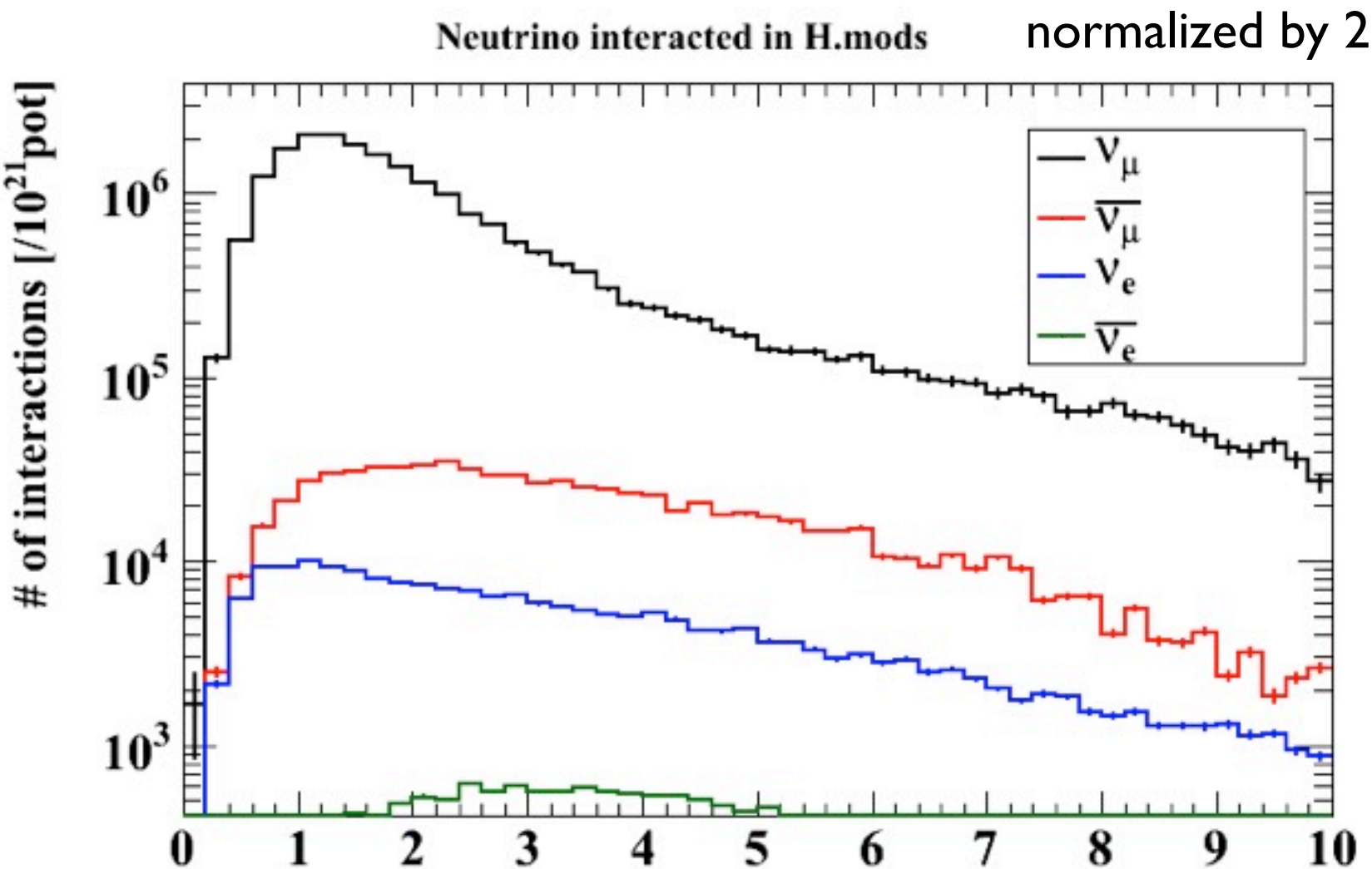
Jnubeam output

normalized by 21pot

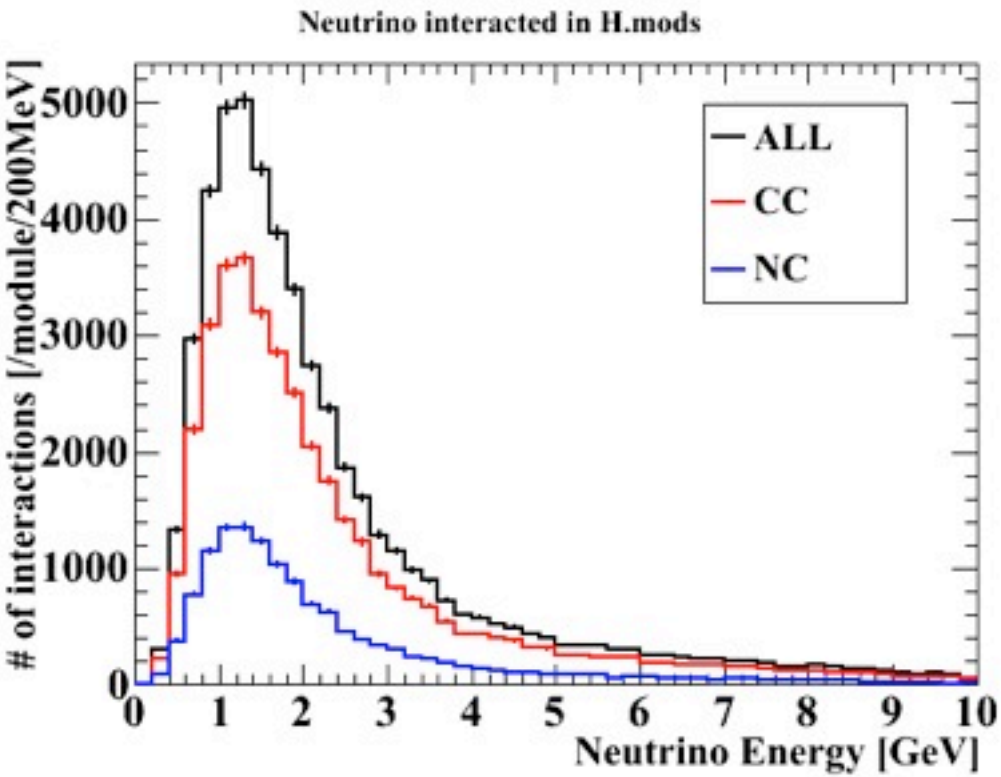


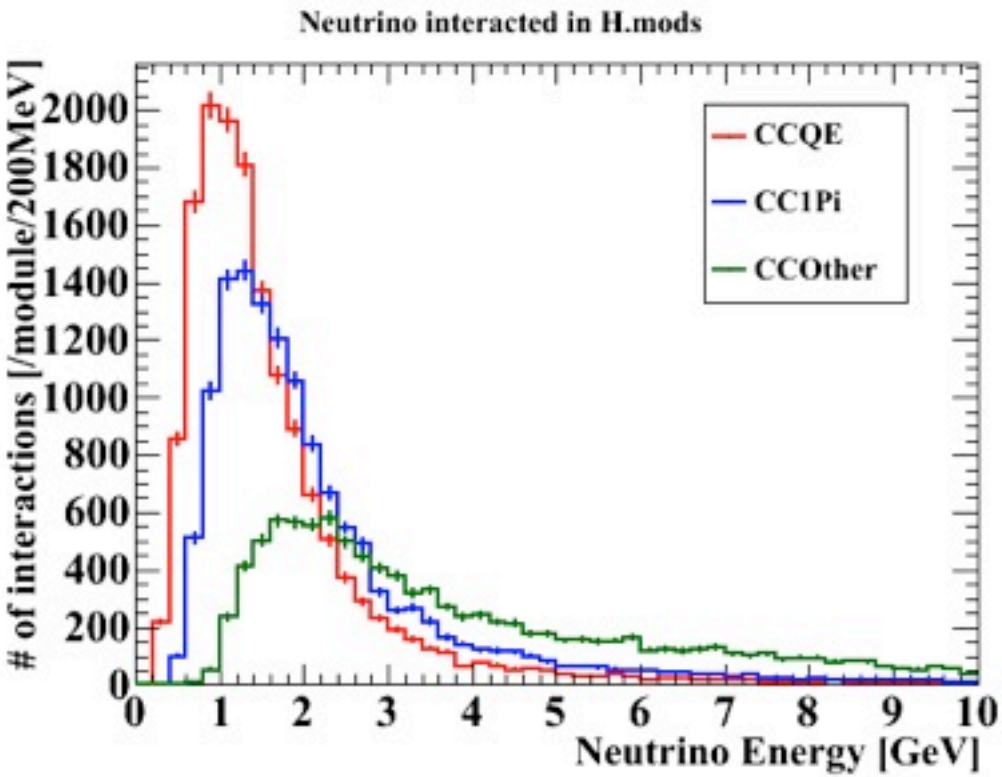
Neutrino energy (interacted, after NEUT)

Output after NEUT



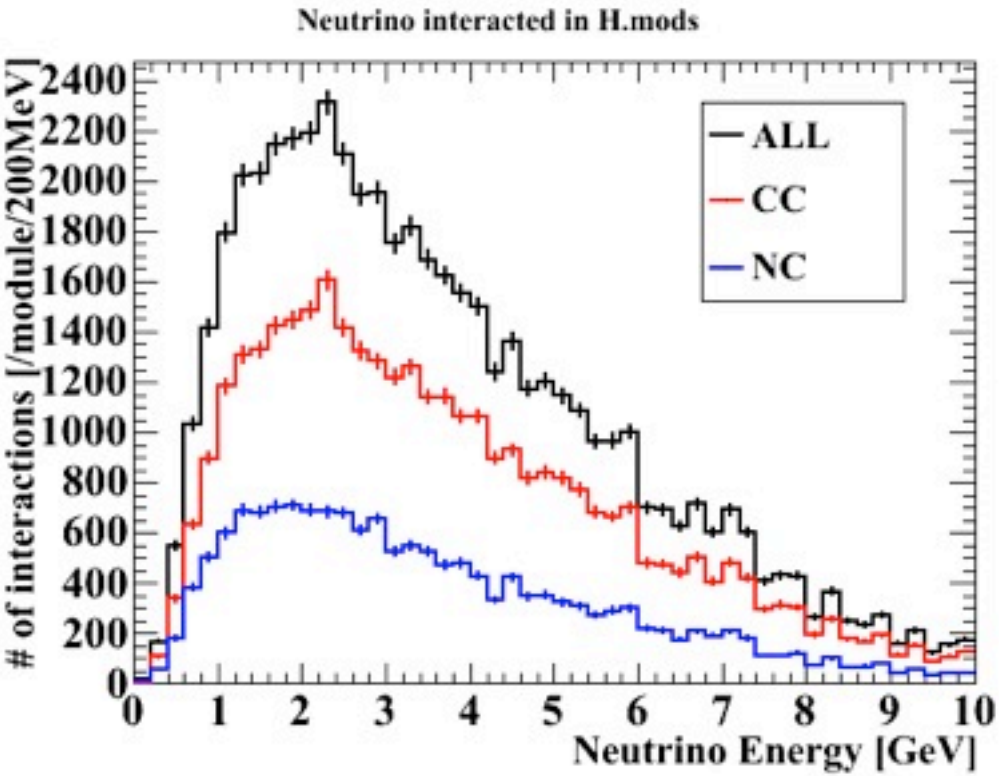
Neutrino energy
(at each interaction mode)

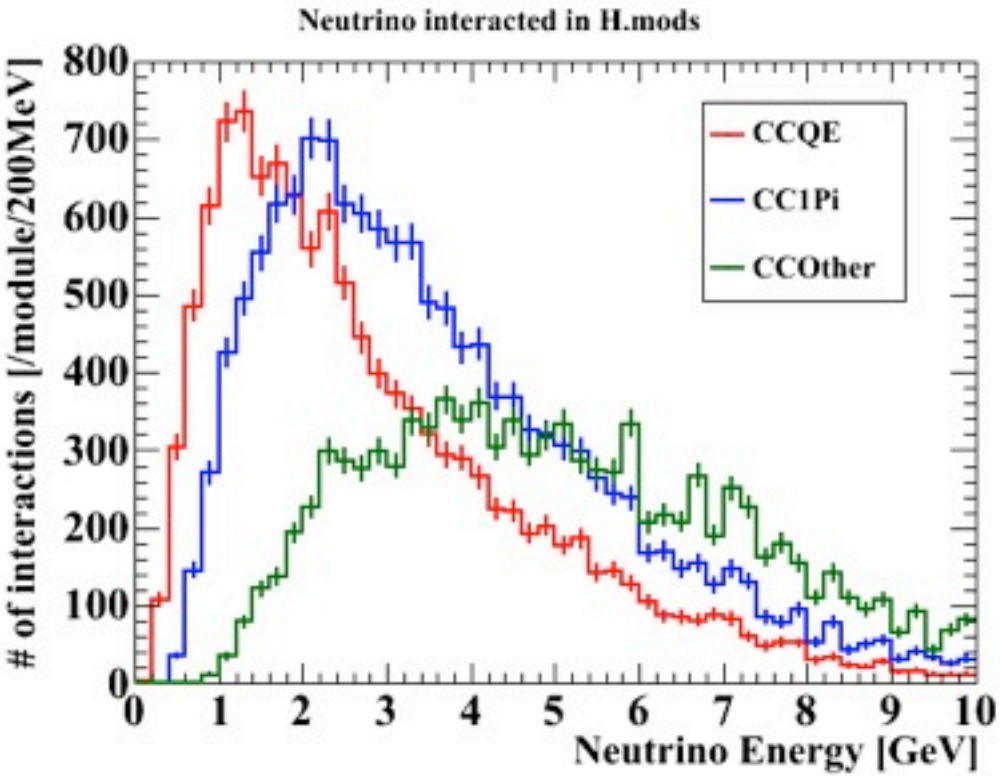




only numu
at horizontal modules

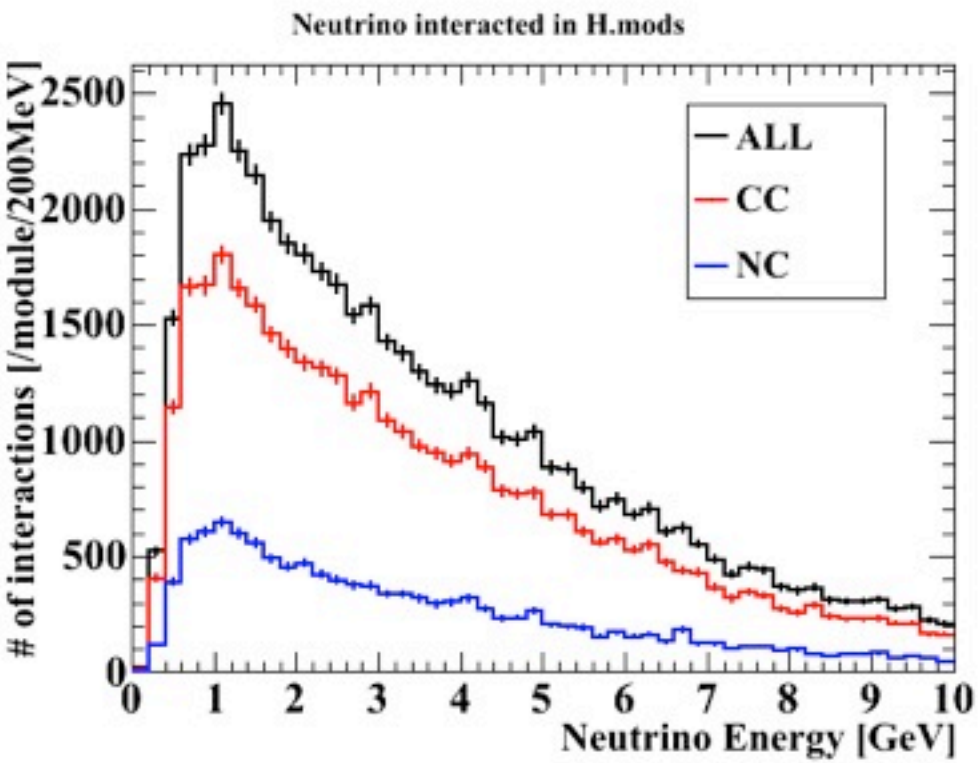
Neutrino energy
(at each interaction mode)

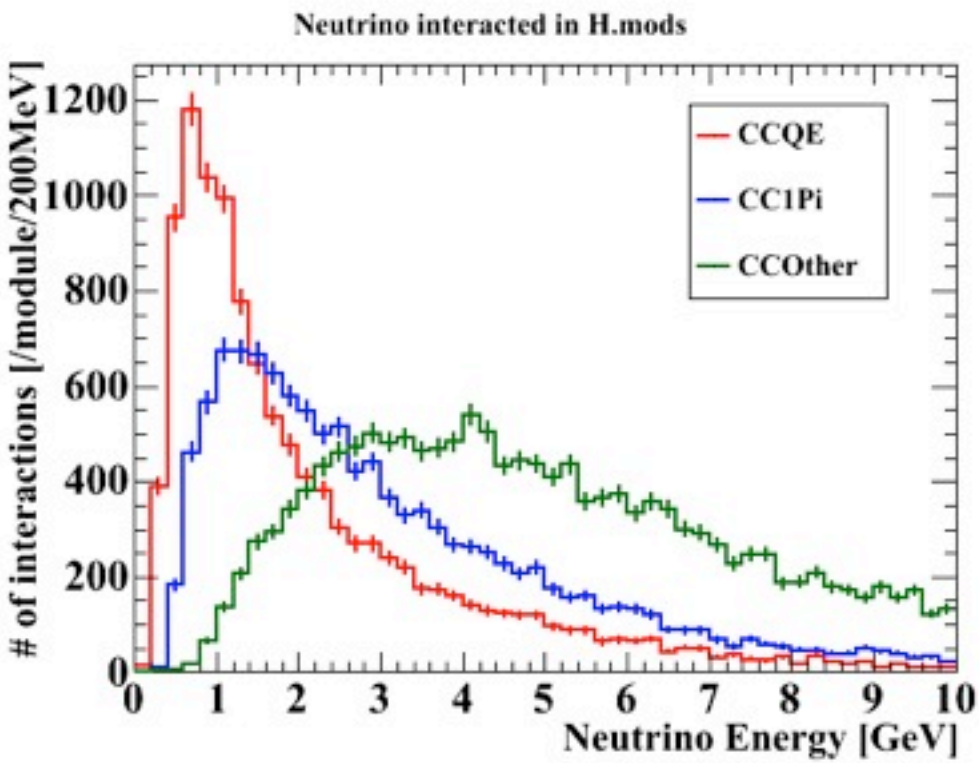




only numubar
at horizontal modules

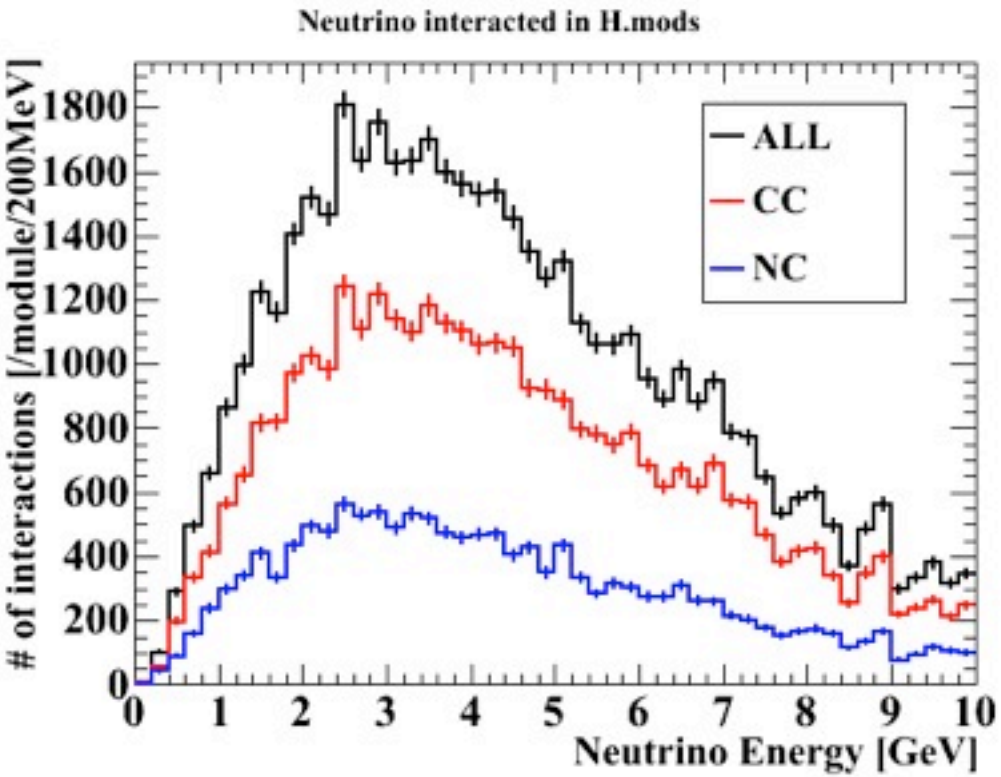
Neutrino energy
(at each interaction mode)

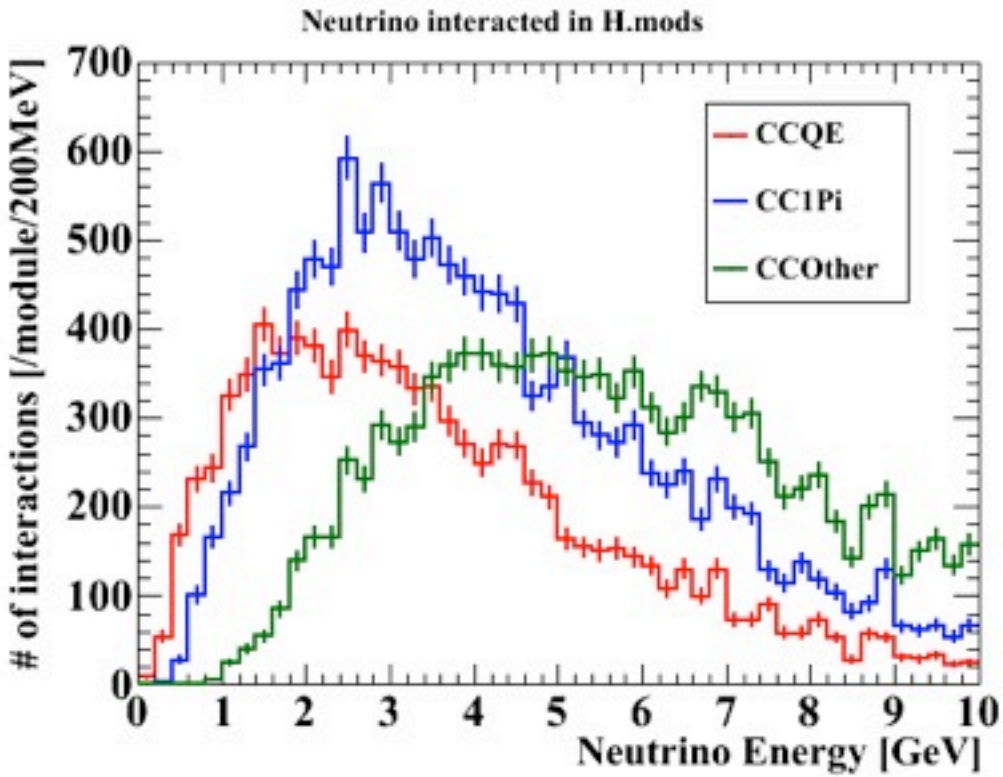




only nue
at horizontal modules

Neutrino energy
(at each interaction mode)



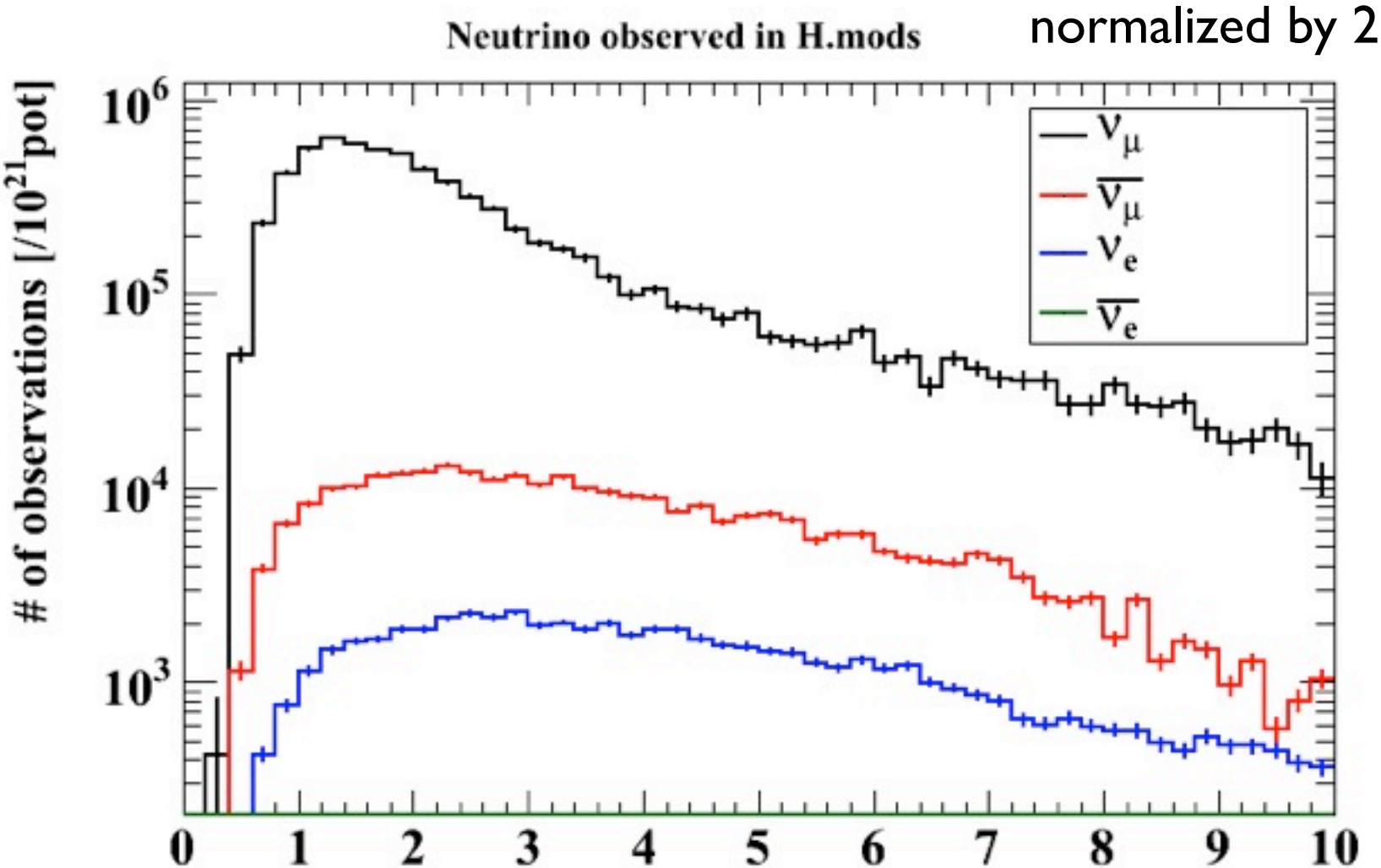


only nuebar
at horizontal modules

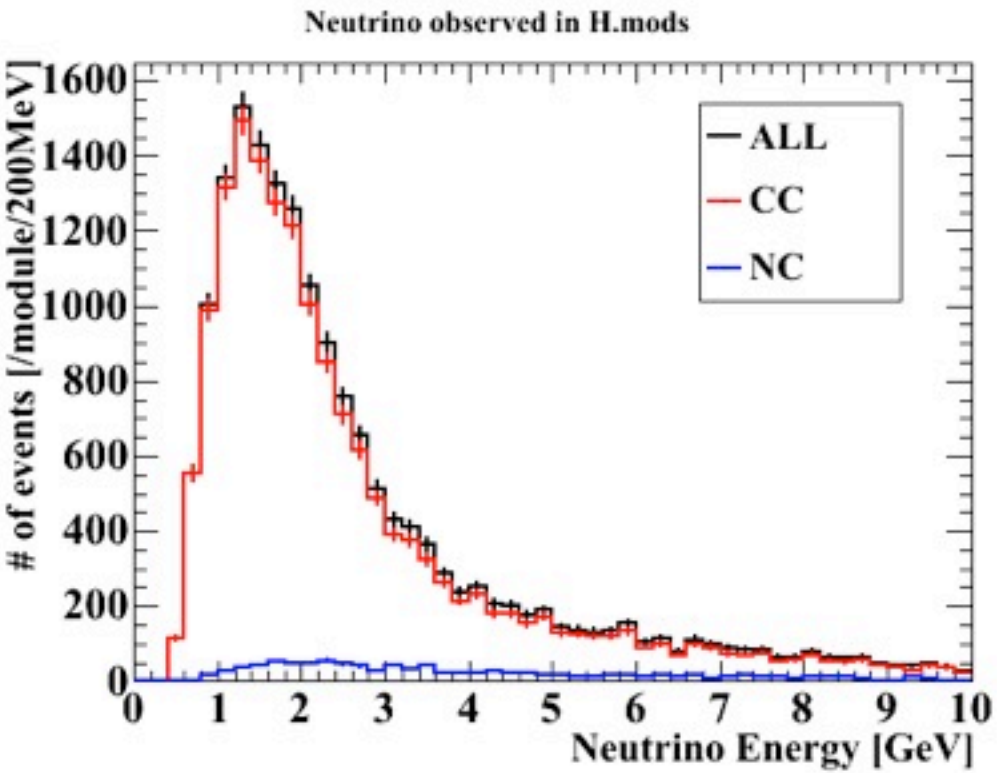
Neutrino energy
(observed in modules)

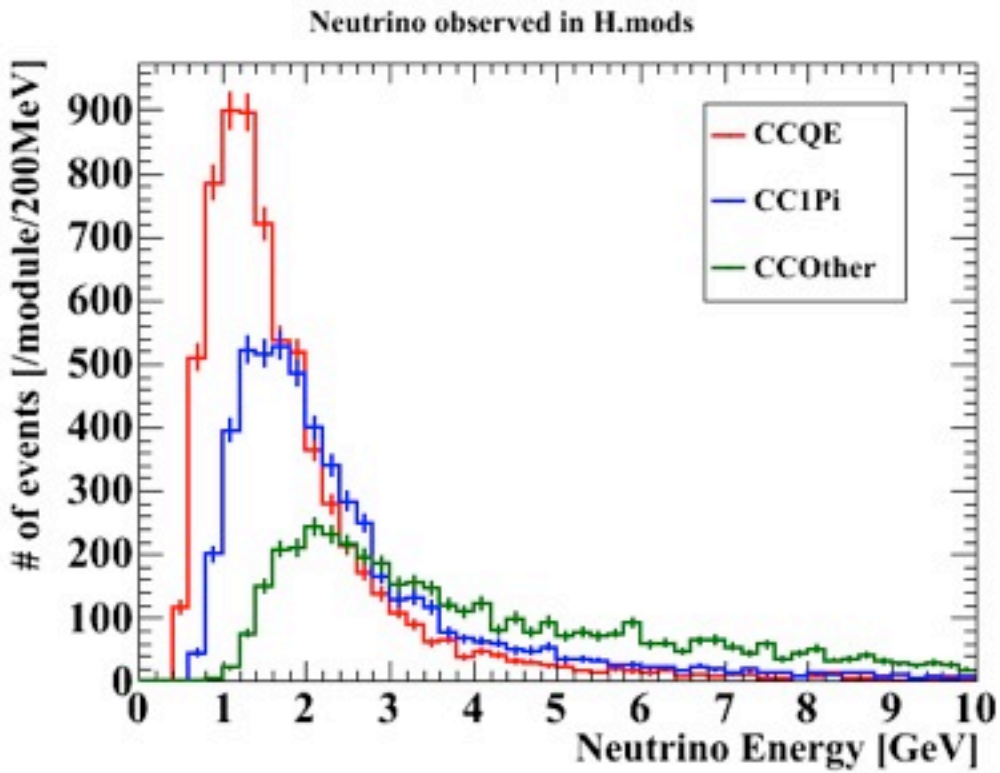
After Detector MC and neutrino event selection

normalized by 21pot



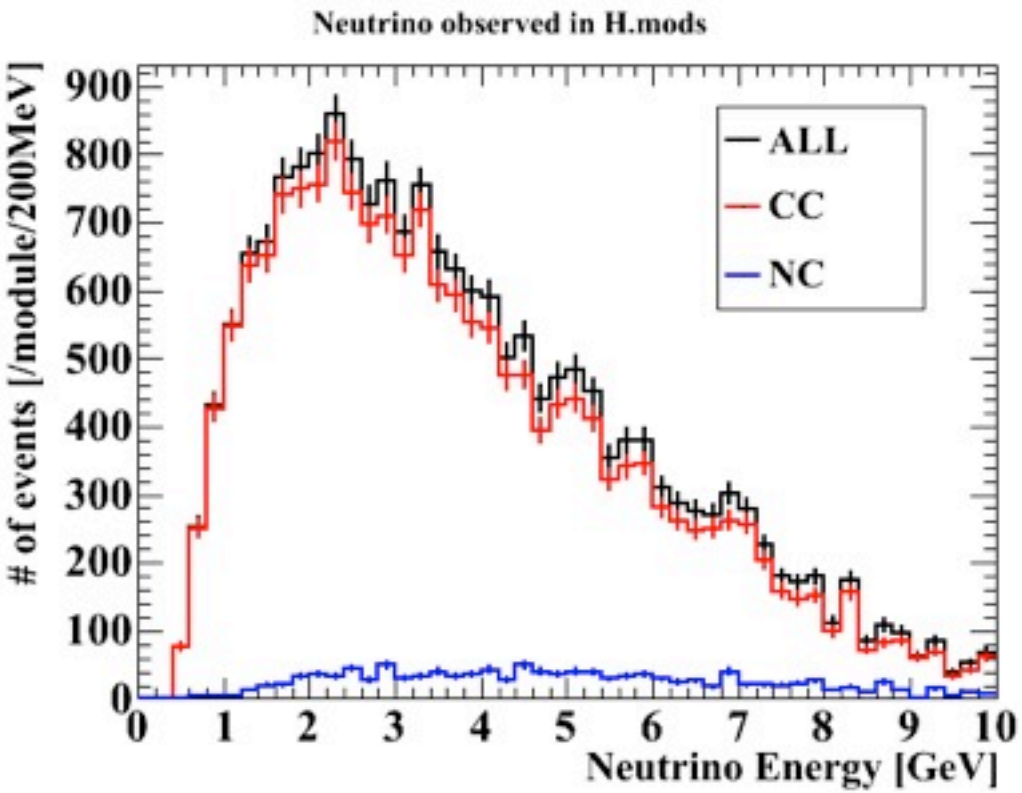
Neutrino energy
(at each interaction mode)

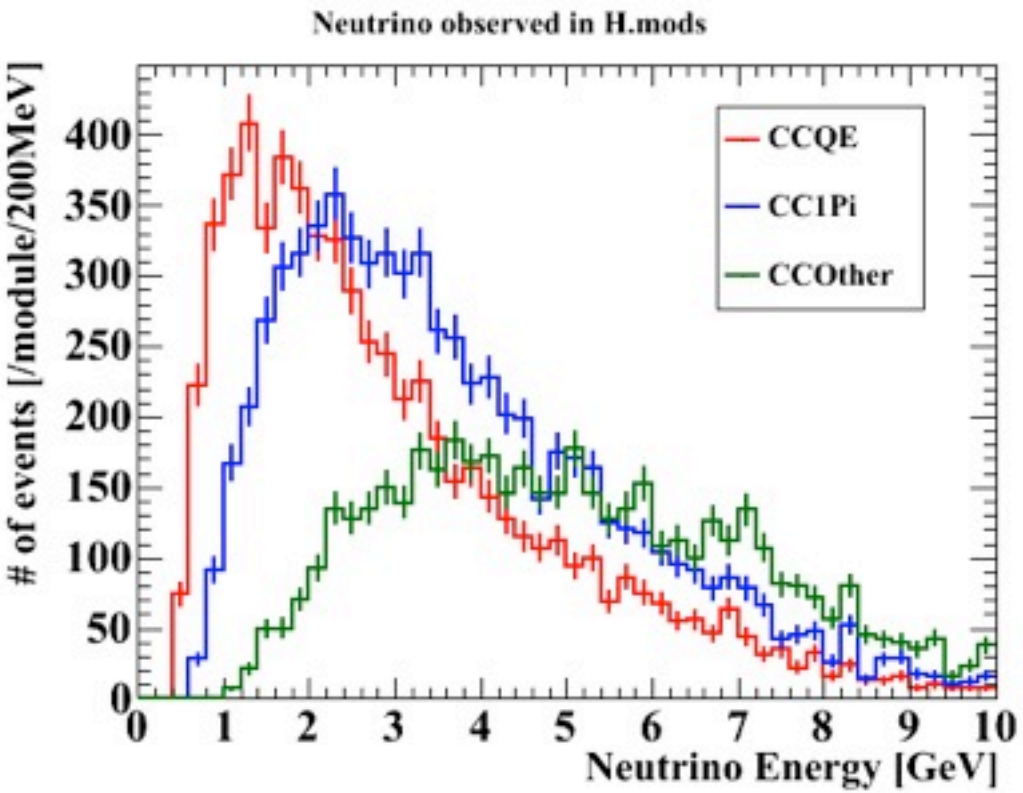




only numu
at horizontal modules
statistics ~ 2.41E18 pot

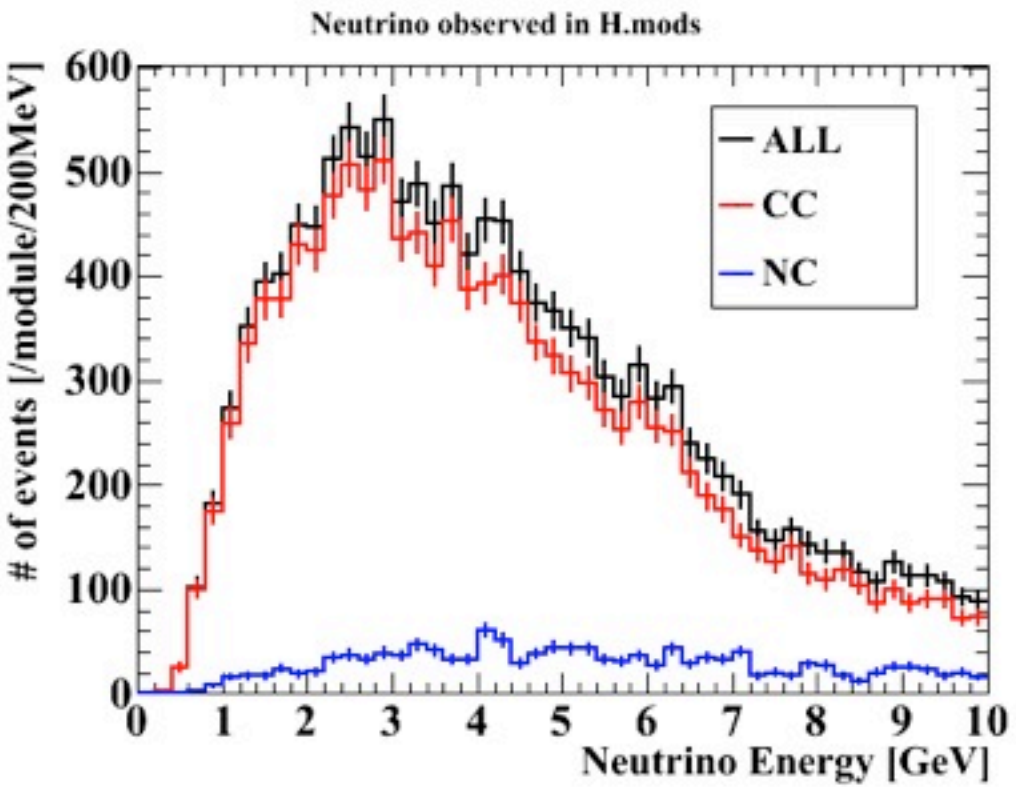
Neutrino energy
(at each interaction mode)

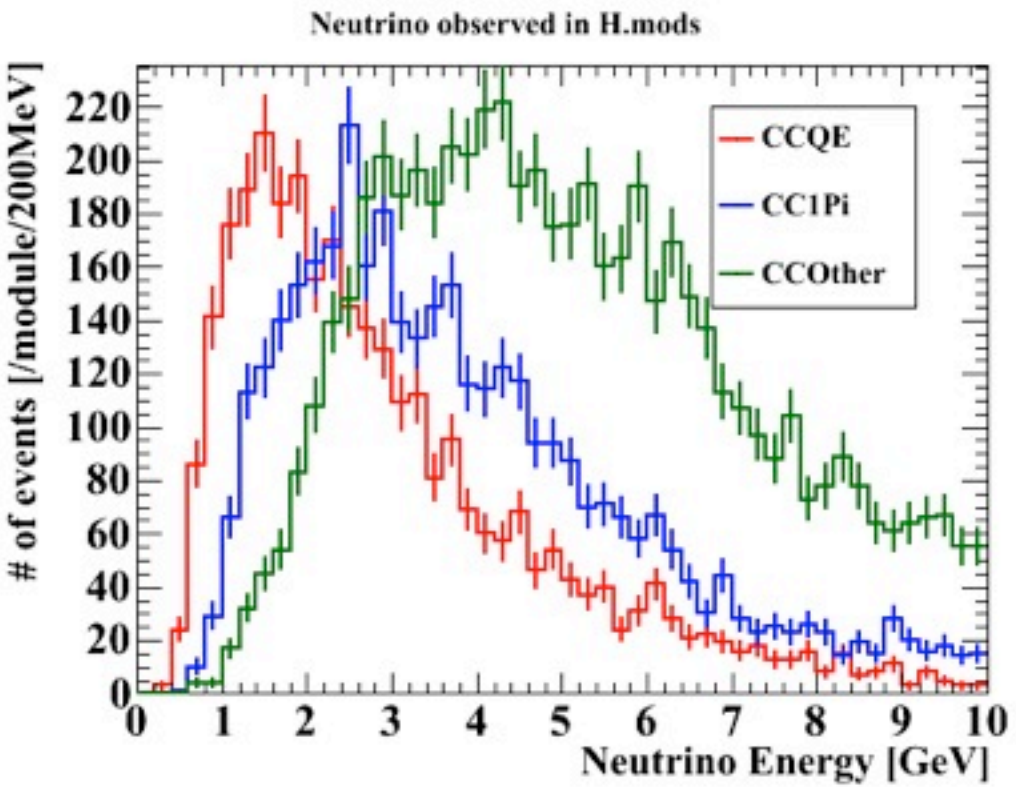




only numubar
at horizontal modules

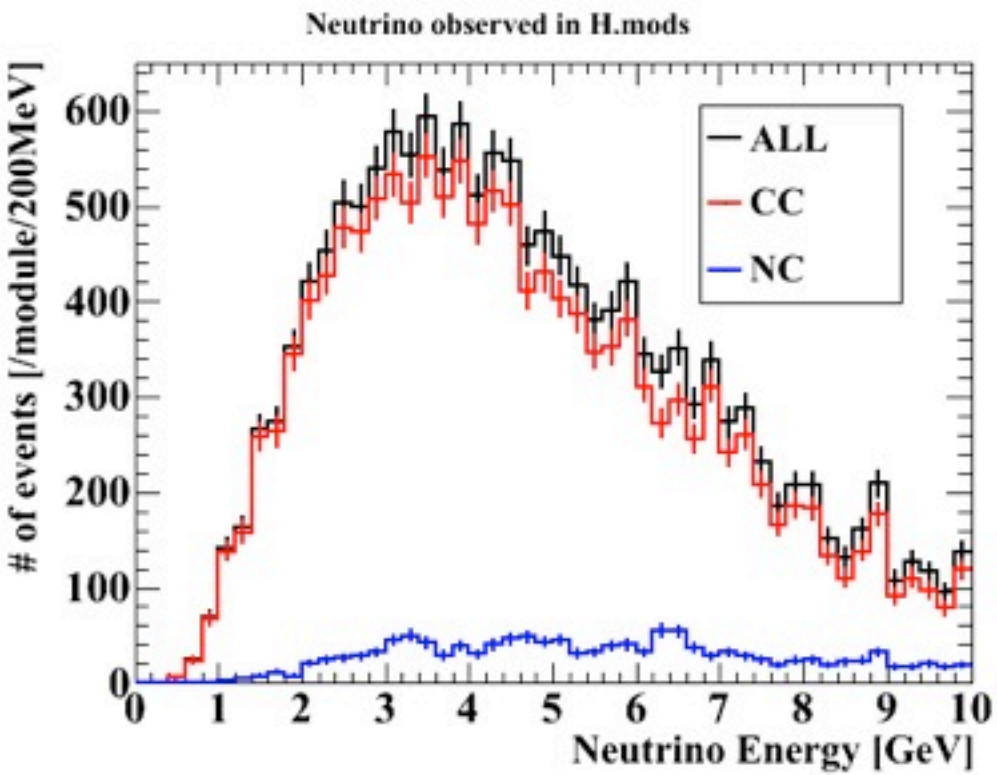
Neutrino energy
(at each interaction mode)

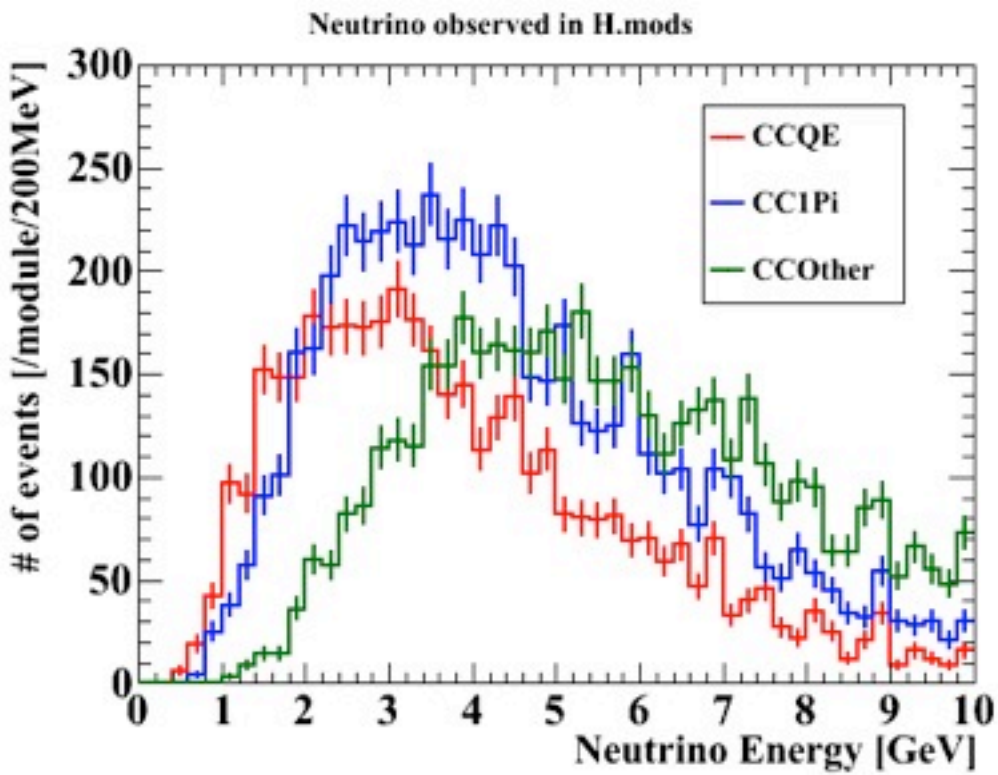




only nue
at horizontal modules

Neutrino energy
(at each interaction mode)





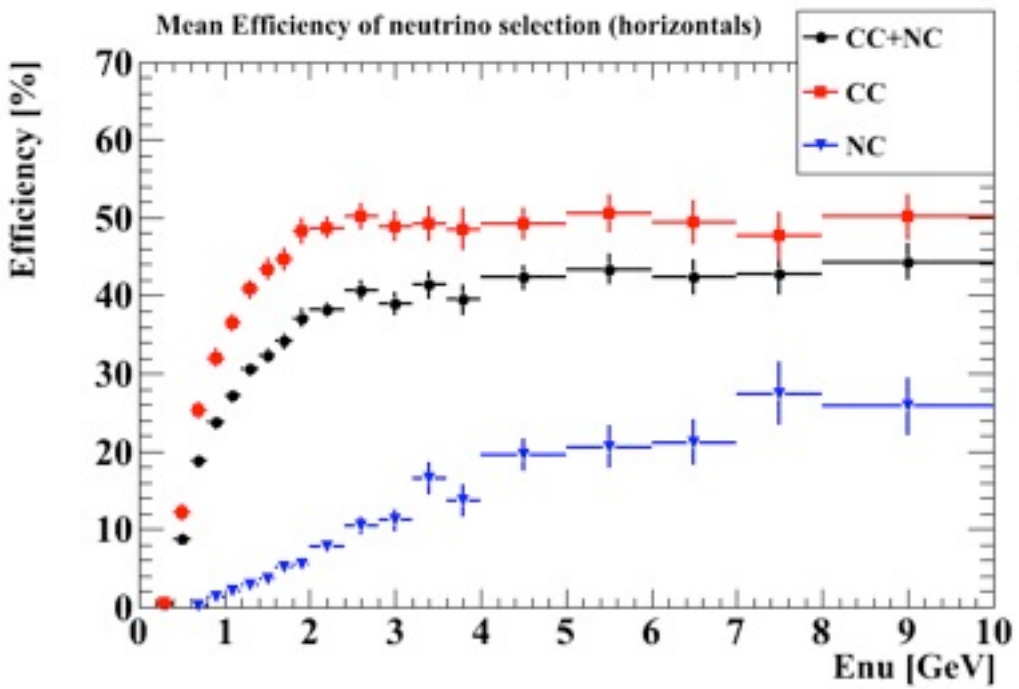
only nuebar
at horizontal modules

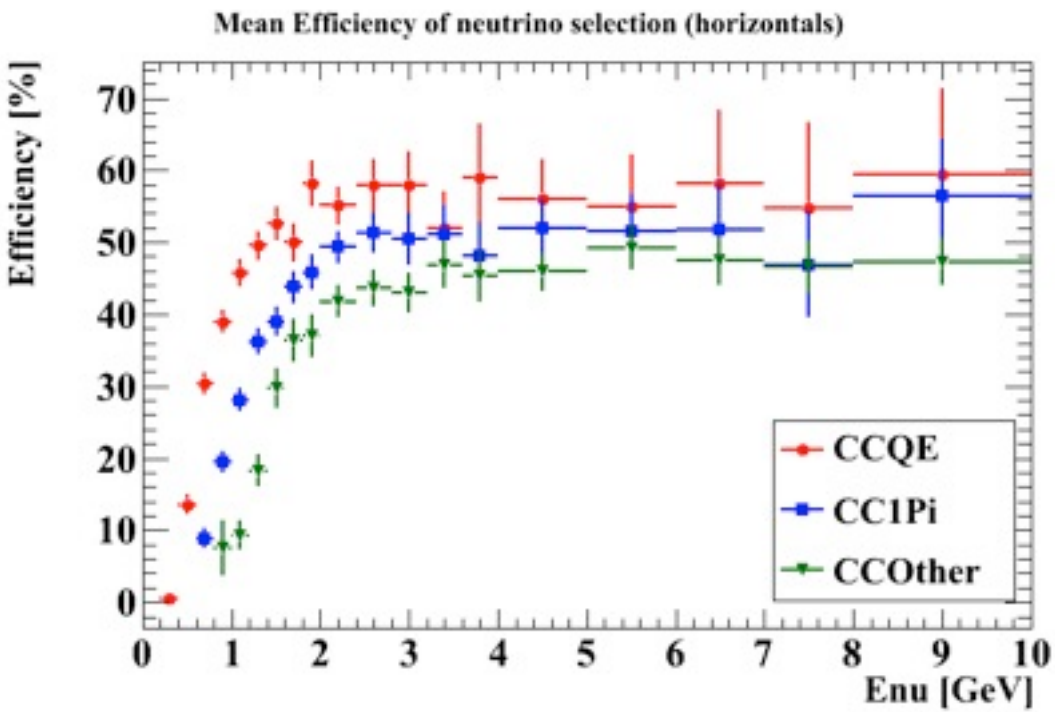
Neutrino selection efficiency as a function of neutrino energy

- Calculate neutrino selection efficiency for each interaction mode (CCQE, CC1Pi, CC other mode and NC).
- Use same efficiency curve for all modules.
  - The efficiency curves of modules are same within statistics error from MC study.

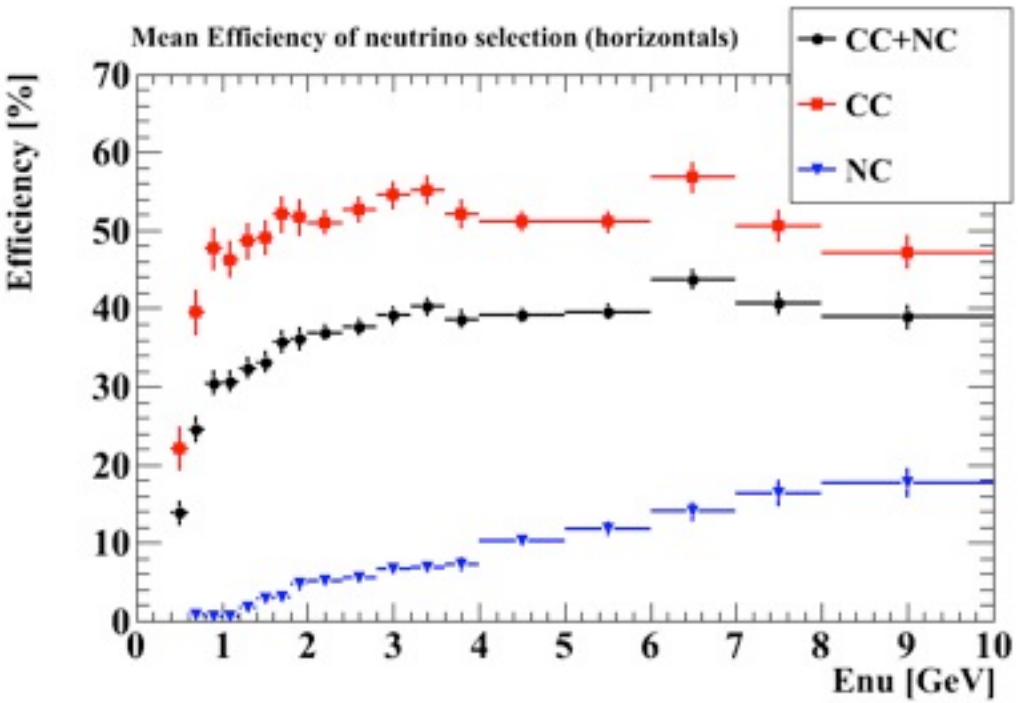
$$
\begin{aligned}
Efficiency(E) &= N_{obs}^{mode}(E)/N_{int}^{mode}(E) \times 100[\%] \\
N_{obs}^{mode} &= \#\ of\ events\ after\ neutrino\ event\ selection \\
N_{int}^{mode} &= \#\ of\ interactions\ in\ the\ modules
\end{aligned}
$$

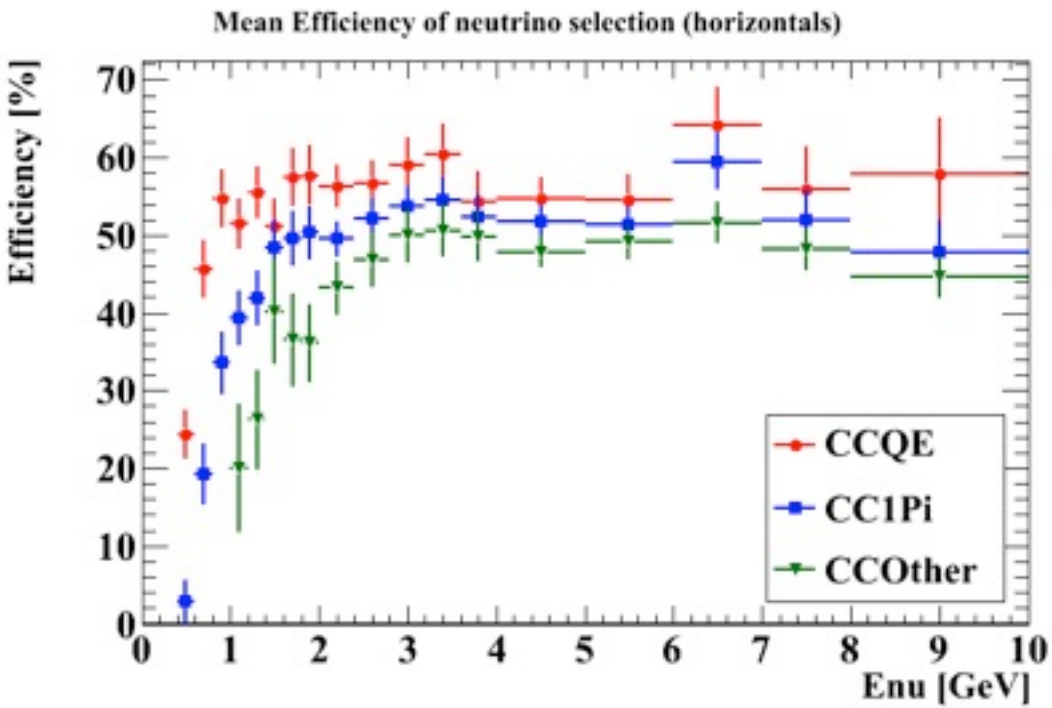
Efficiency (numu)



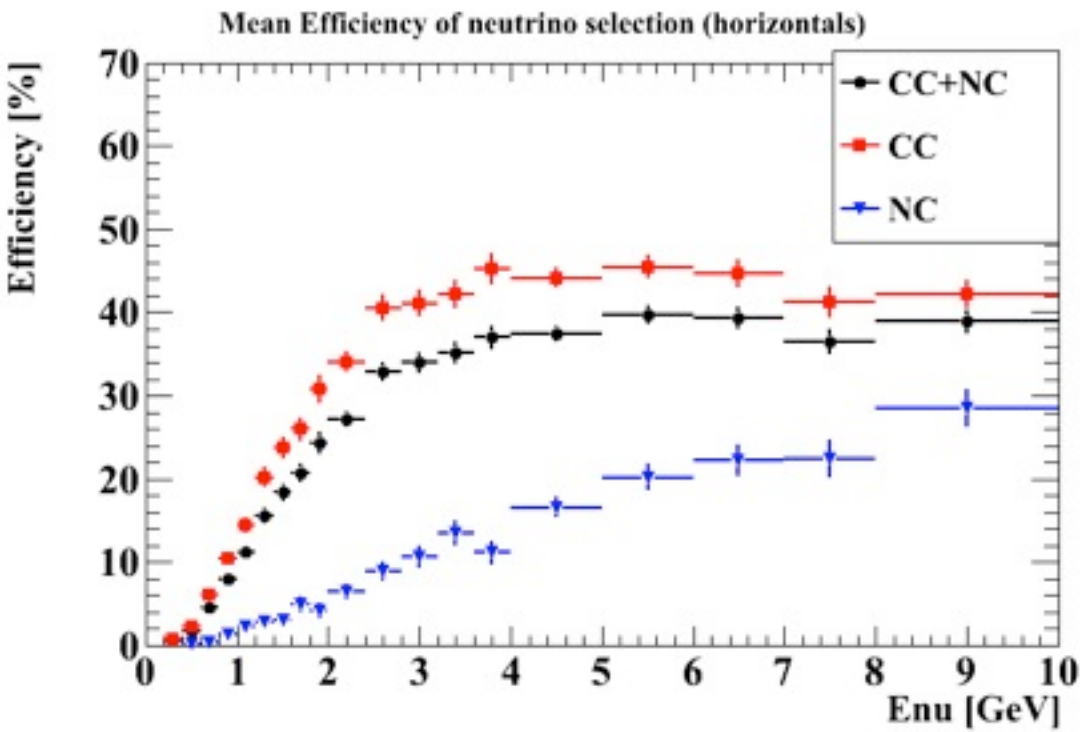


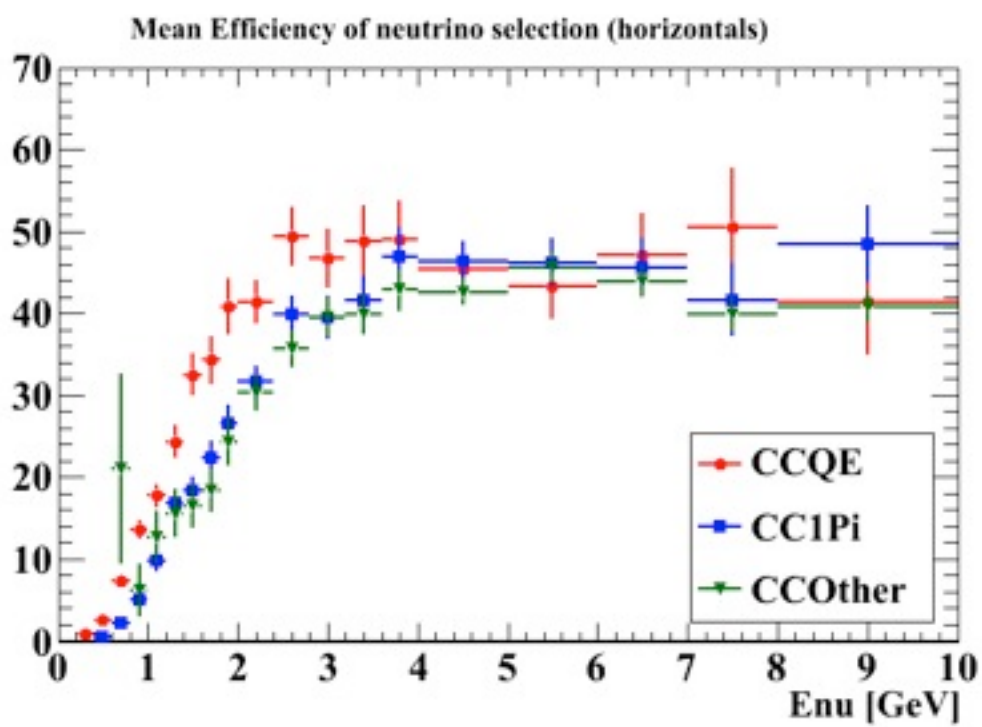
Efficiency (numubar)



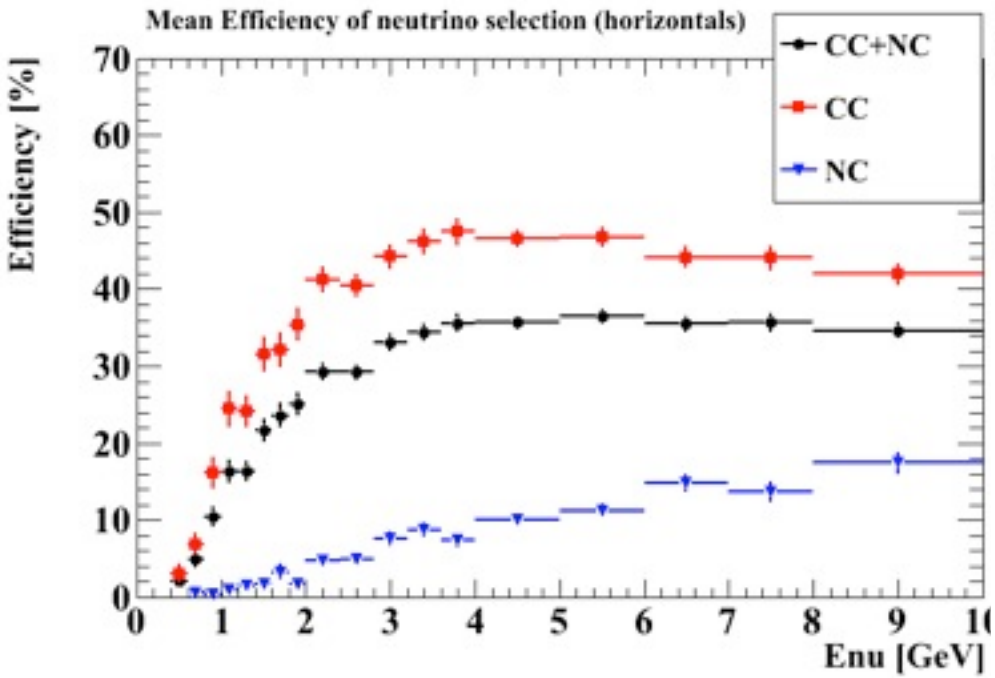


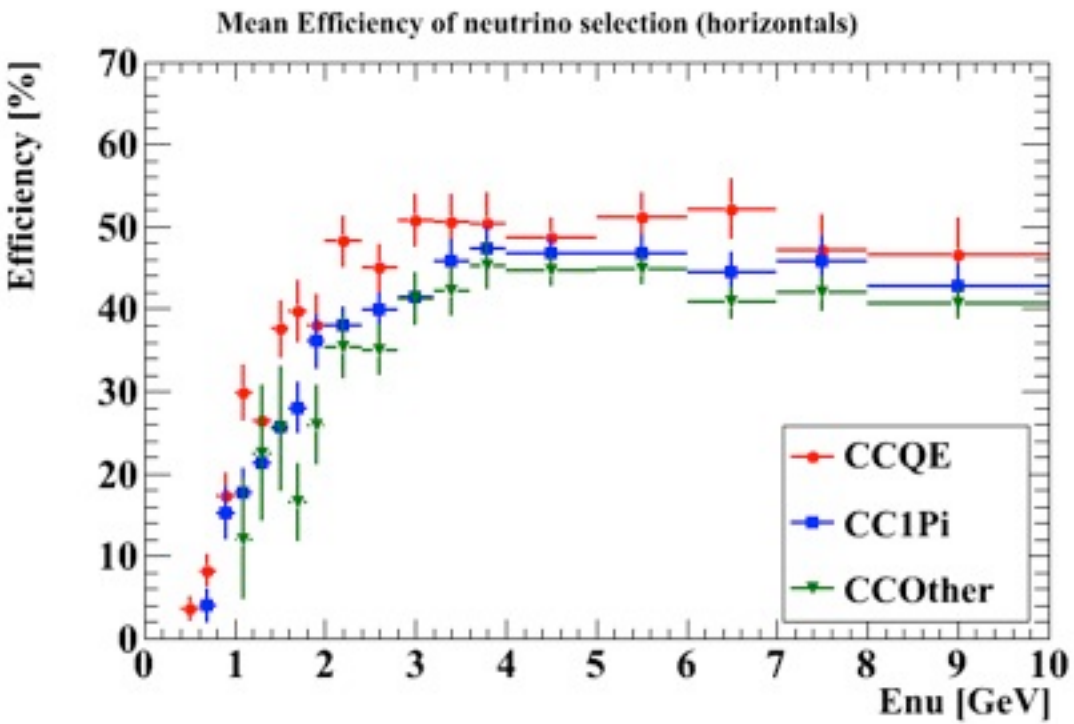
Efficiency (nue)





Efficiency (nuebar)





- Efficiency value table is below
  - http://www-he.scphys.kyoto-u.ac.jp/~akira.m/ingrid/MC/Ref/ingrid_eff_table_20100707.xls