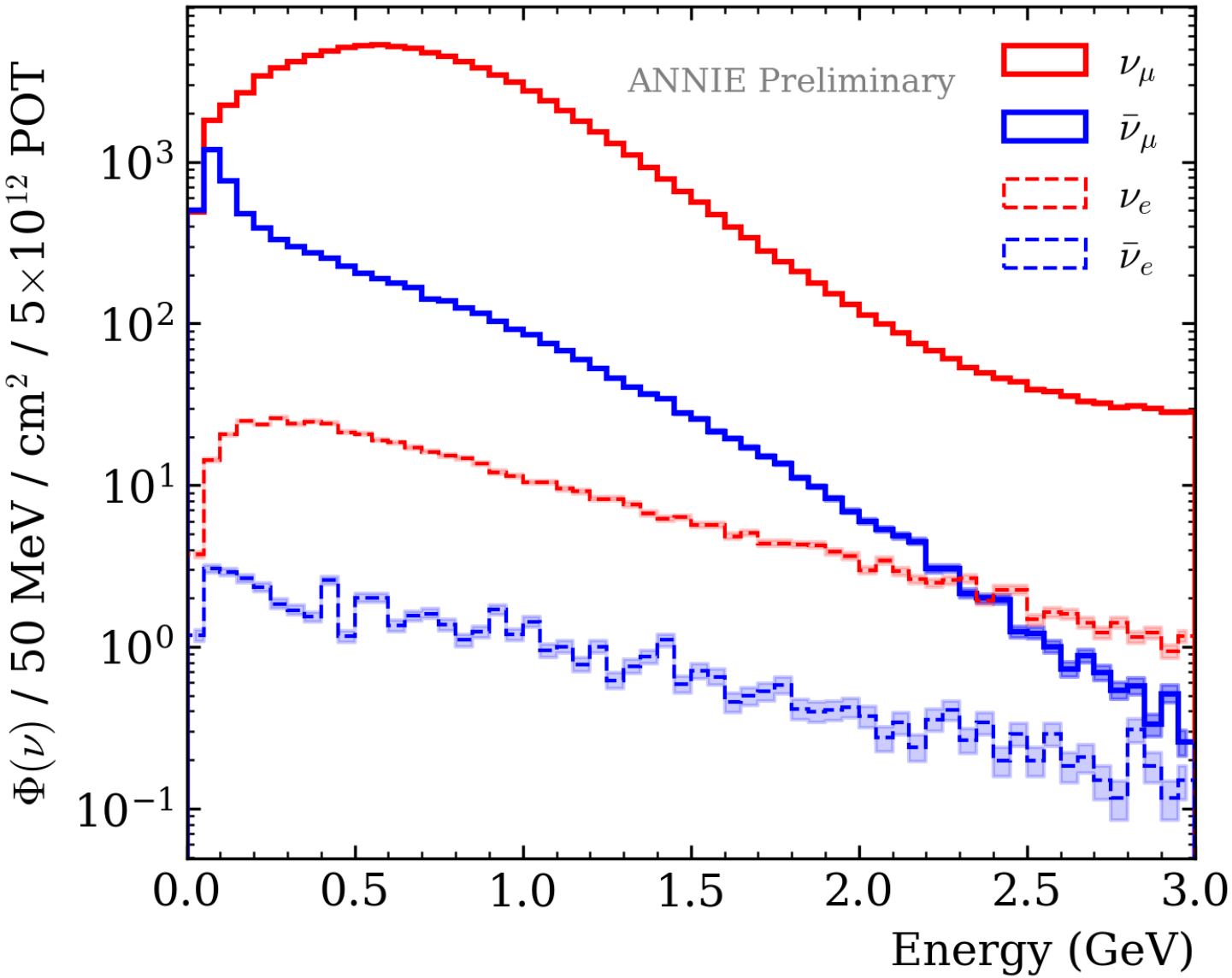
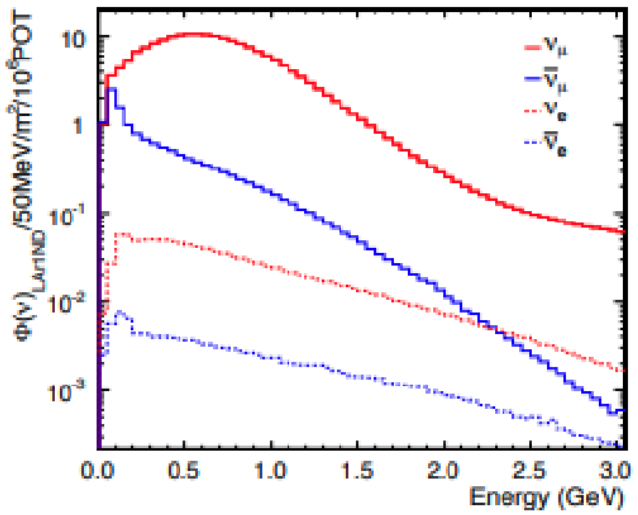
ANNIE Flux Histograms


ANNIE Preliminary
ν_μ
$\bar{\nu}_\mu$
ν_e
$\bar{\nu}_e$
$\Phi(\nu)$ / 50 MeV / cm^2 / 5×10^{12} POT
10^3
10^2
10^1
10^0
10^{-1}
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Energy (GeV)

Description

- Neutrino BNB flux predictions for ANNIE
- We typically share the MiniBooNE flux prediction plot when showing ANNIE talks, this can serve as the actual flux prediction at ANNIE's location on the beamline
- Histograms created using the gsimple base flux files (central-value flux)
  - /pnfs/annie/persistent/flux/annie_gsimple/gsimple_may2006_baseline_root/
- Style to match SBND plot commonly shared (see right)
- Flux prediction is for the entire water detector
- Units are given per cm^2, per 50 MeV bin, per spill POT (5e12 POT)
- Statistical errors for each bin, flavor provided
- More info on the flux breakdown in a couple of slides

From SBND



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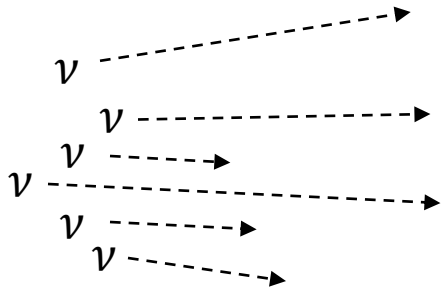
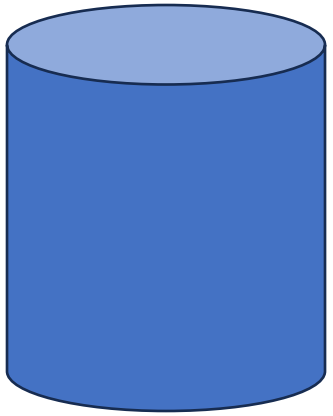
Details

- Samples
  - All 5000 gsimple base flux files used (flux central-value)
  - ~215 million total neutrinos produced upstream the detector (corresponding to ~5e9 POT), kinematics and flavor determined from simulating hadronic interactions & decays in the beam line
- Neutrinos propagated from ray origin to detector, only use energy and flavor of neutrino rays that pass through water tank volume (r=1.524m, half height=1.98m)

Ray origin
upstream detector





ANNIE tank geometry

Details

- From gsimple files we have:
  - Total POT used to create neutrinos in file
  - Neutrino 4-momentum
  - Neutrino ray origin
  - Weights (= 1)

1. Step neutrinos from origin to front of the detector using truth 4-momentum
2. Iterate neutrino propagation, accept / reject neutrinos that pass through detector volume
3. Record neutrino energy + flavor of accepted neutrinos
4. Calculate total flux using detector cross-sectional area and total POT

Flux Histogram details

- **ANNIE_FLUX_full_detector.root** contains the flux histograms per POT, and thus are more useful for various analyses
- The statistics on the following page are based on this

Details

Script can be found here: https://github.com/S81D/FluxHist/tree/main

Based on James Minock's scripts

Full Detector volume selected: 1.524m radius, 1.98m half-height

*** Summary of Neutrino Ray Propagation ***

Corresponding POT	Total neutrinos produced	Neutrinos hitting FV	Fraction passing (%)
5.000058e+09	215373573	12685506	5.89

*** Flux Breakdown by Flavor ***

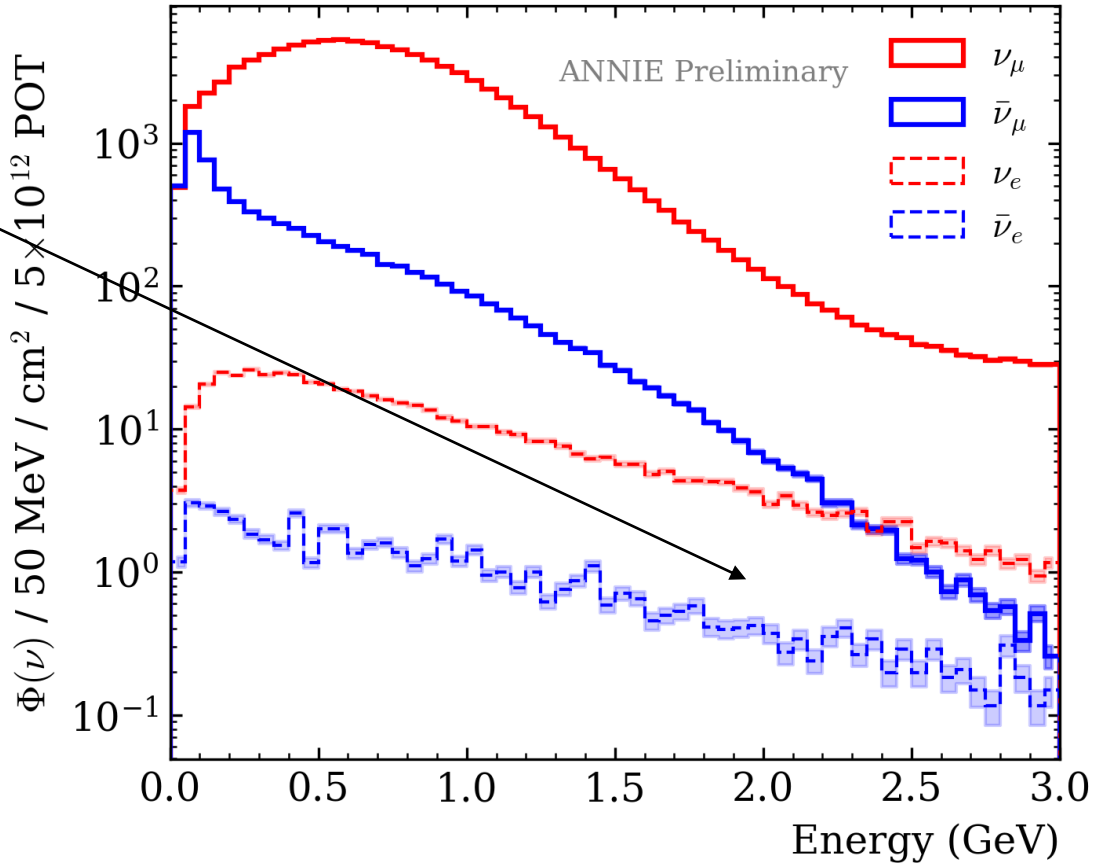
Flavor	Fraction (%)	⟨E⟩ [MeV]	Median E [MeV]	Fluence [cm^2/POT]
ν_μ	92.88	725.35	649.30	1.952333e-08
$\bar{\nu}_\mu$	6.55	421.05	266.16	1.375943e-09
ν_e	0.52	893.16	669.63	1.089707e-10
$\bar{\nu}_e$	0.05	918.50	705.09	1.126077e-11

*** Total Neutrino vs Antineutrino Flux Breakdown ***

Type	⟨E⟩ [MeV]	Median E [MeV]	Fluence [cm^2/POT]
Neutrino	726.28	649.37	1.963231e-08
Antineutrino	425.08	268.69	1.387204e-09

Sidenote

- Seemingly poor stats for nu e bar
- Despite 200 million neutrinos produced, only ~6% pass through detector volume
- nu e bar is only 0.05% of this flux → ~6000 total nu e bar in flux files
- ANNIE detector is small compared to world volume which the neutrino ray origins span, thus the low statistics



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