# Neutrinos Originating from the Fermilab Muon Campus Delivery Ring During the g-2 Experiment

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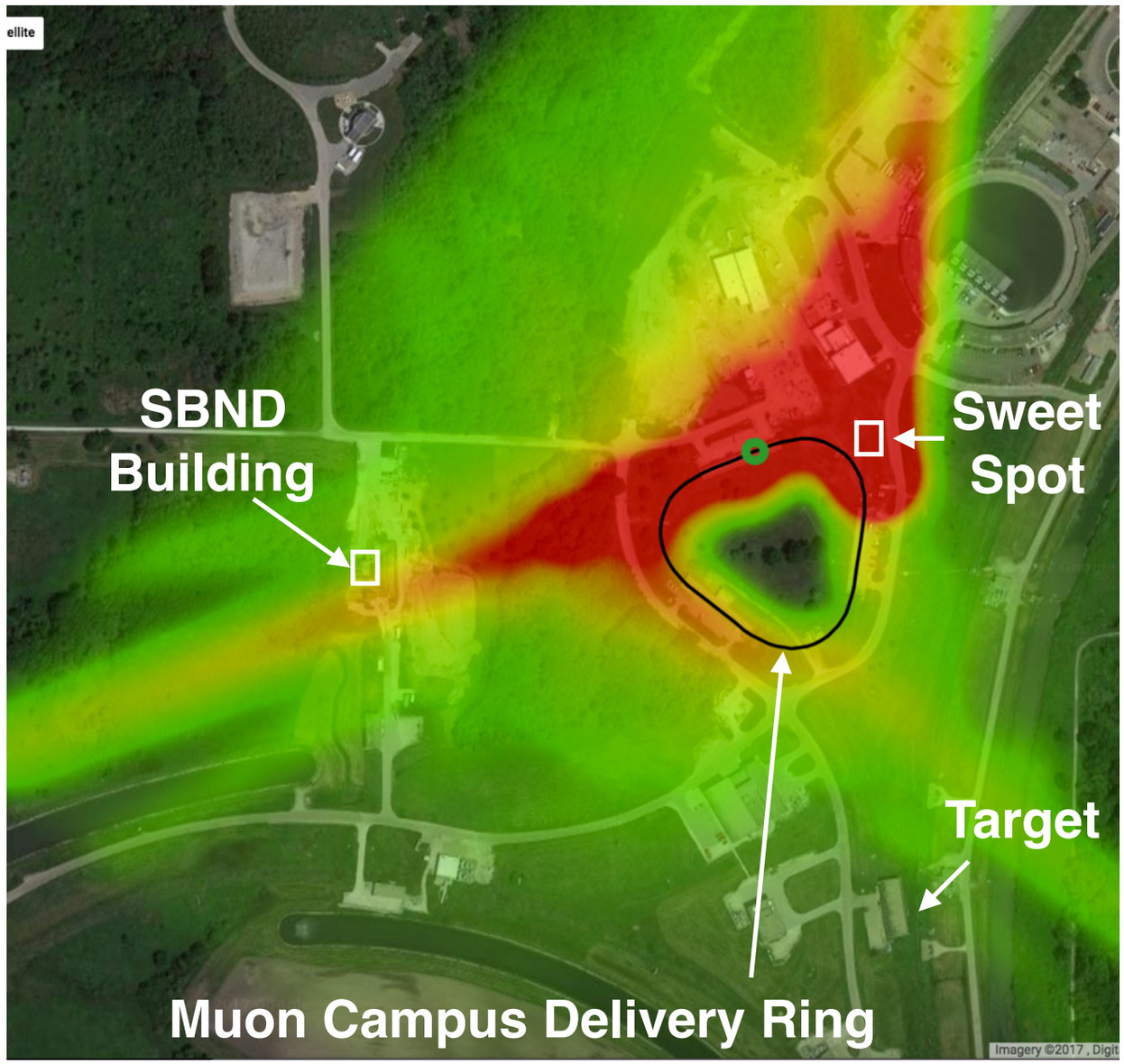
# Overview

- The Delivery Ring accepts charged pions of a given energy from the old PBar source

- These pions travel around the Delivery Ring and decay into muons before being passed into g-2 storage ring

- We have studied the neutrinos that originate from this process at a variety of locations around the lab

**Neutrino Flux**

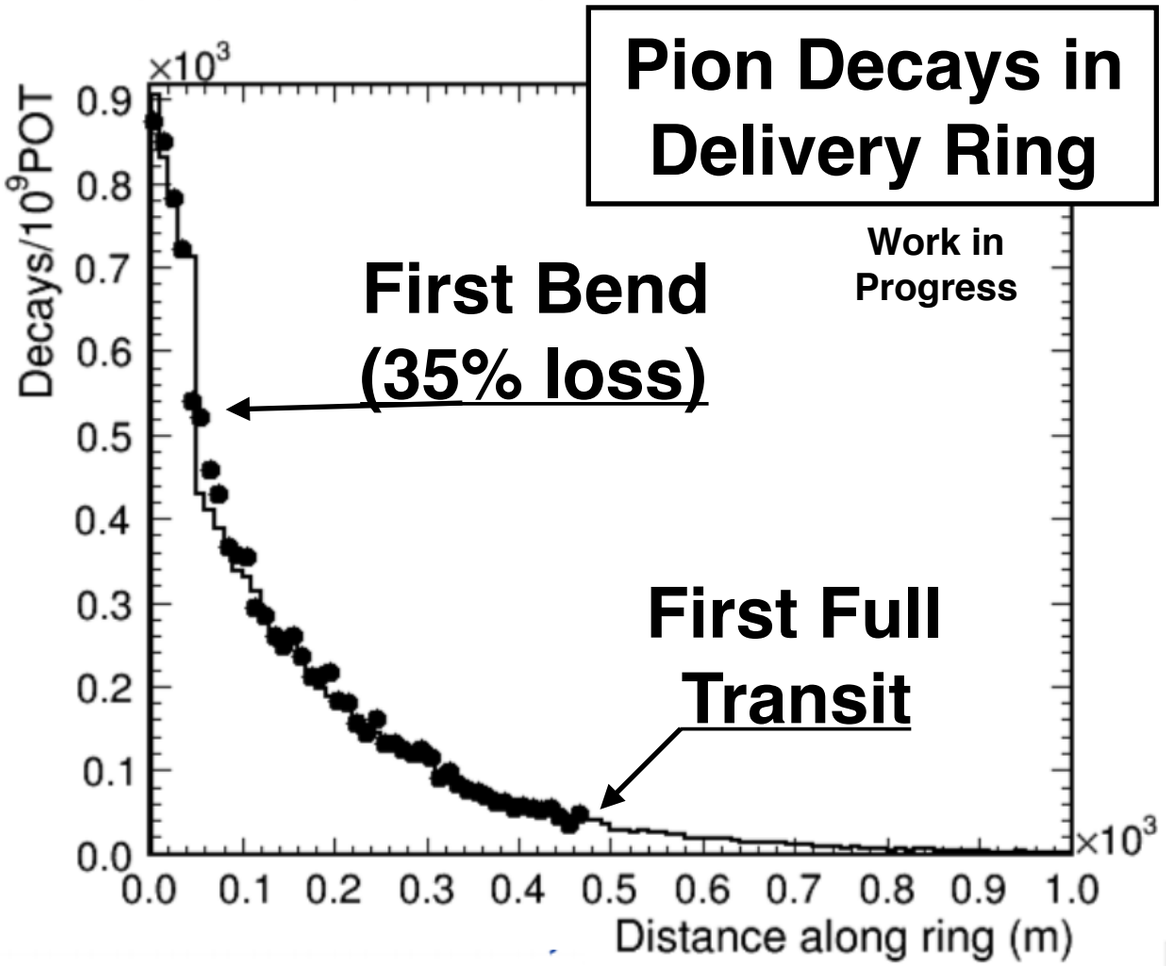


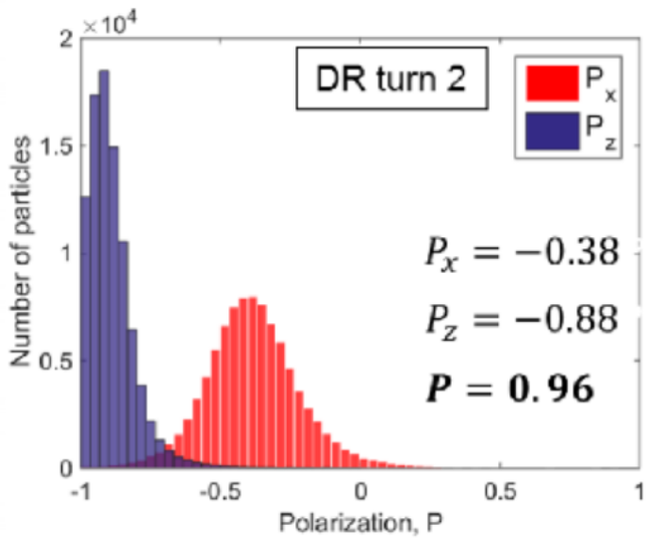
# Beam Modeling

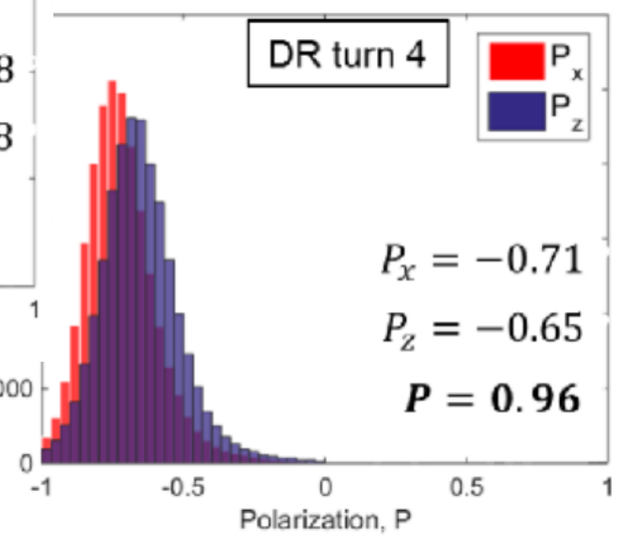
- 1e7 positively charged pions enter the Delivery Ring per 1e12 POT beam spill from the Recycler

- We track the pions and muons as they create neutrinos and study the energy, timing, and flavor of these neutrinos

- Using a fast Monte Carlo based on the Delivery Ring survey data and taking into account the pion momentum spread and the muon polarization we can model the flux

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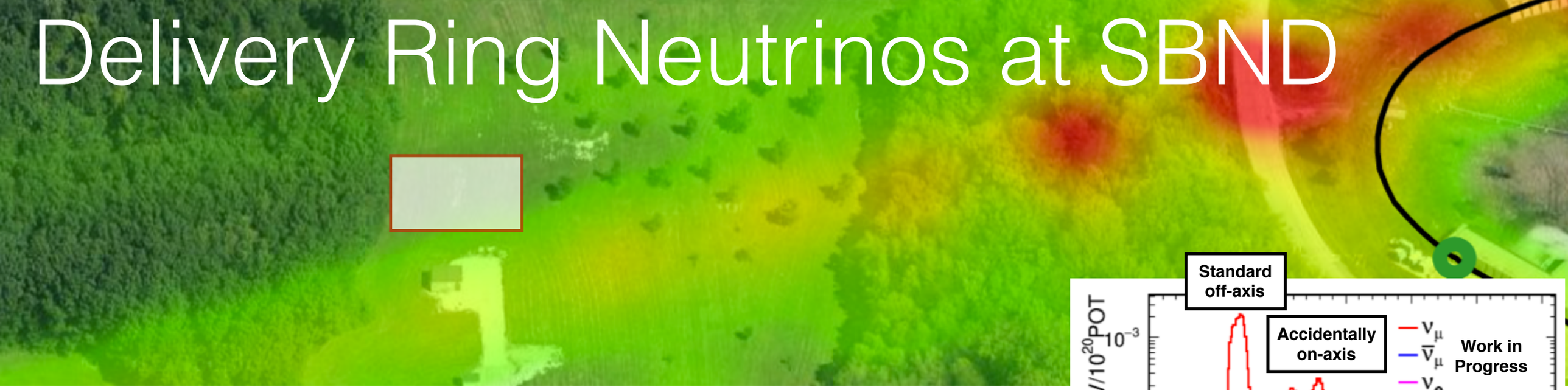
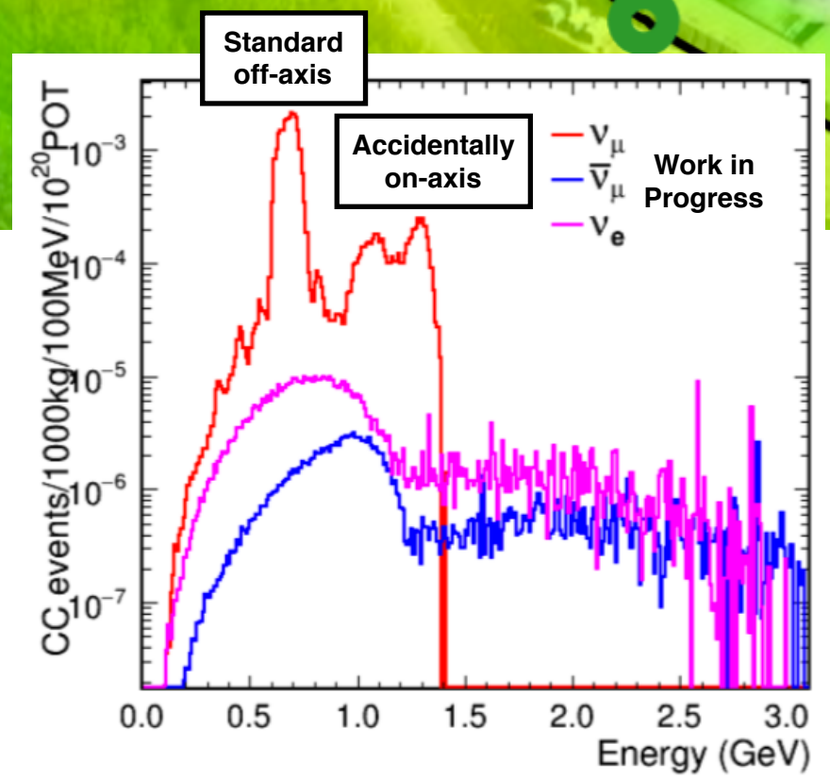
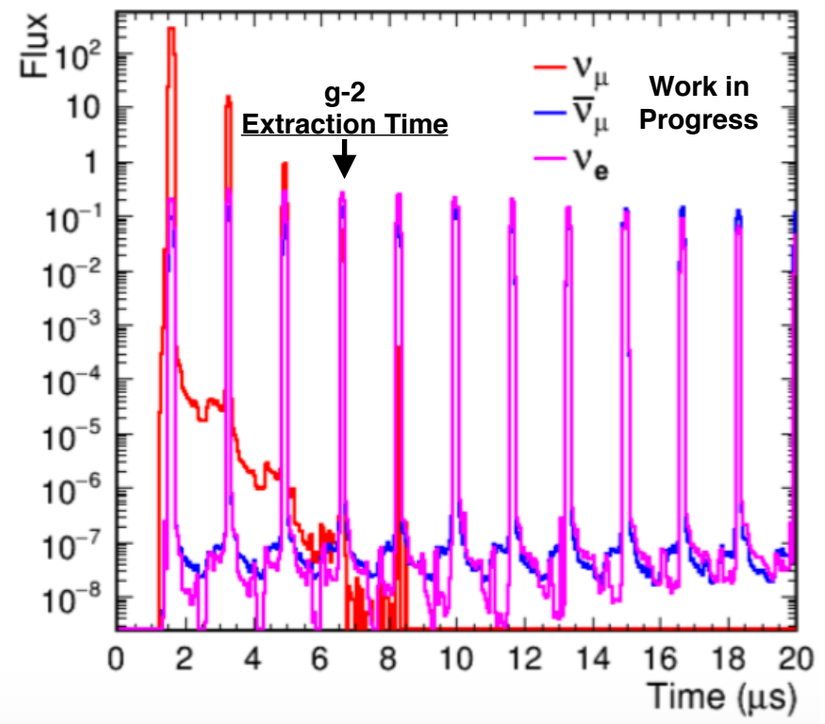
# Delivery Ring Neutrinos at SBND






- The SBND sits off-axis (~52 mrad) from the main straight section (Straight 10) which drives the overall flux normalization down and shifts the neutrino energy lower

- The early time flux is dominated by muon neutrinos while the late time flux sees electron neutrinos and muon antineutrinos originating from the muon decays

- Over the course of g-2 we will expect to see roughly 3.5 $\nu_\mu$ charged current interactions in SBND

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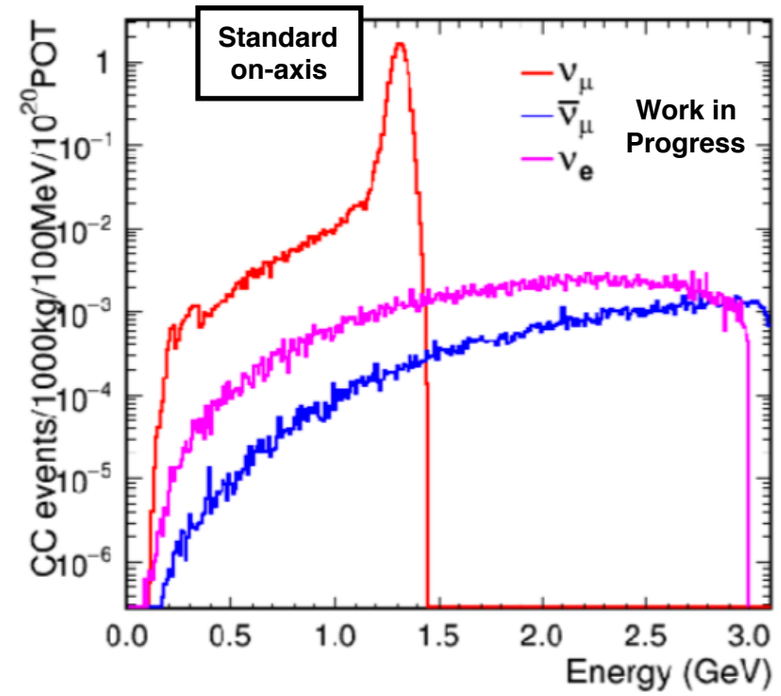
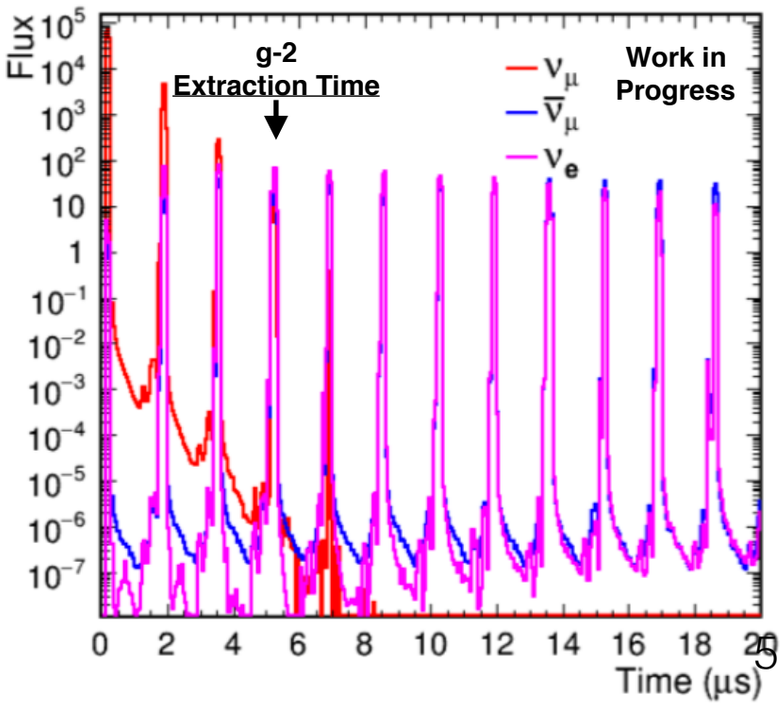
# Delivery Ring Neutrinos at a Sweet Spot


- We can instead select a location around the ring which maximizes our on-axis neutrino flux
  - This gives us a tightly peaked 1.3 GeV $\nu_\mu$ neutrino beam with a sub-percent contamination from other flavors




- This overall flux is limited by the total number of initial pions that enter the ring
  - 14 $\nu_\mu$ charged current interactions per ton per 1e20

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# Long Term Thoughts

- This facility offers us a unique source of muon neutrinos with a very narrow energy range
  - FWHM is around 100 MeV compared to 1 GeV for NUMI off-axis at NOvA

- If we can trigger on the first spill (width 120 ns) we can achieve an excellent duty factor with a new coming spill every 10 ms

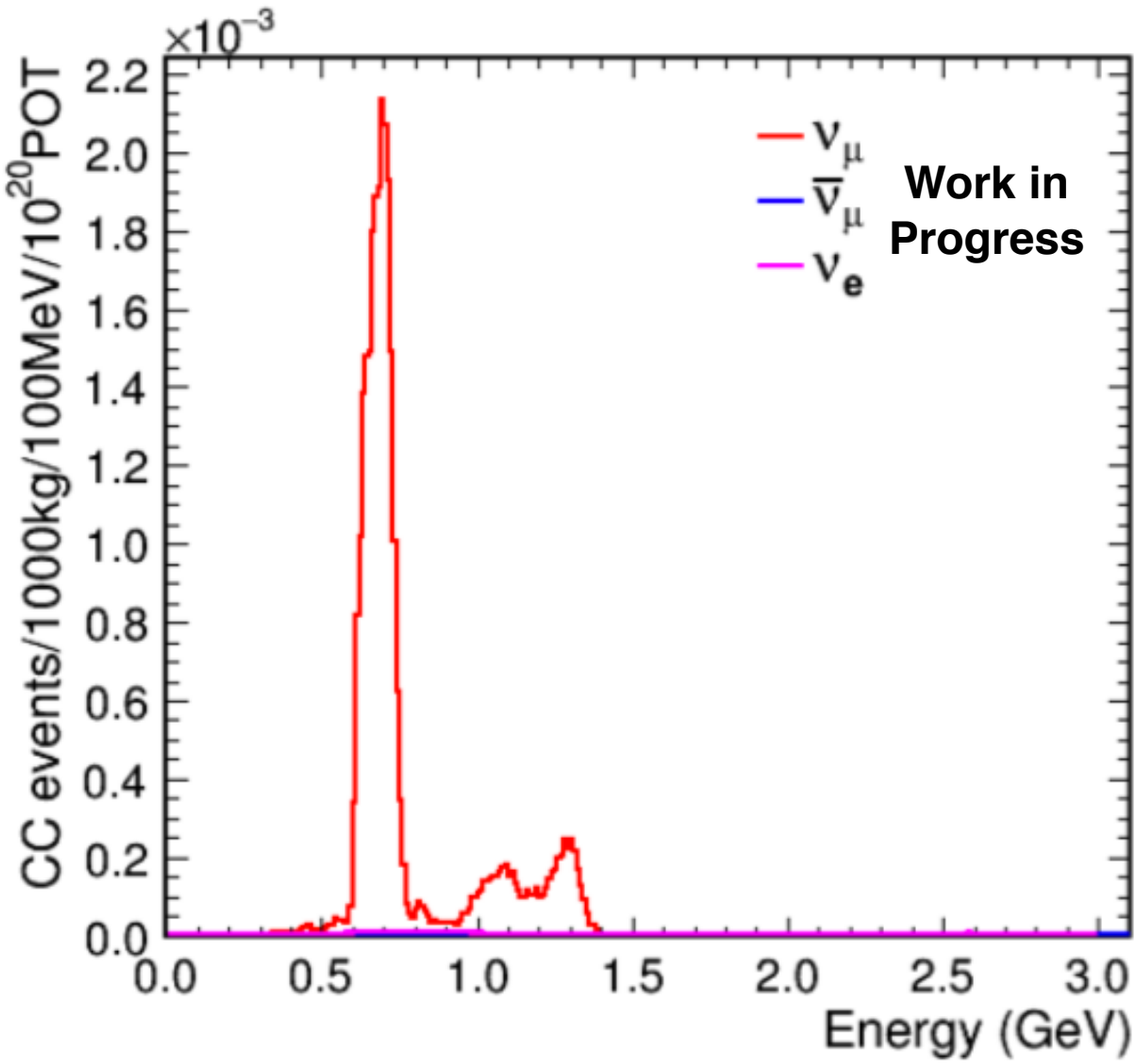
- The contemporary utility of this neutrino beam is reduced by the limited number of pions that enter the Delivery Ring per POT
  - A reasonable sized detector (~100 ton) exposed to the full g-2 proton allotment (1e20 POT) would see 1,400 CC $\nu_\mu$ interactions

- Increasing the overall pion yield into the Delivery Ring would directly increase the overall neutrino flux

# Backup

# CC Event Rates, Linear Scale

## Short-Baseline Near Detector




## Sweet Spot Detector