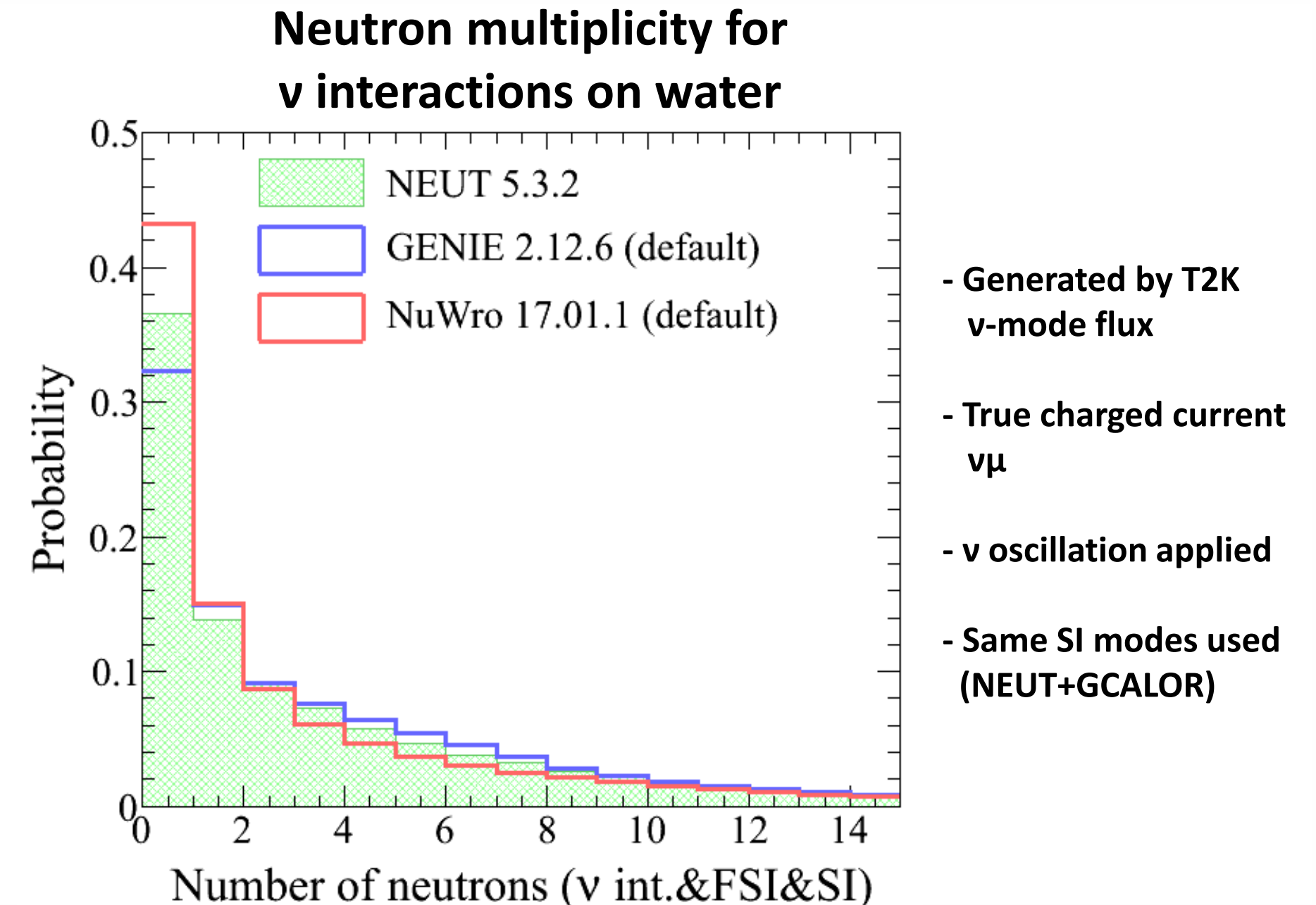


Study of neutrons produced in neutrino interactions with a water target at T2K



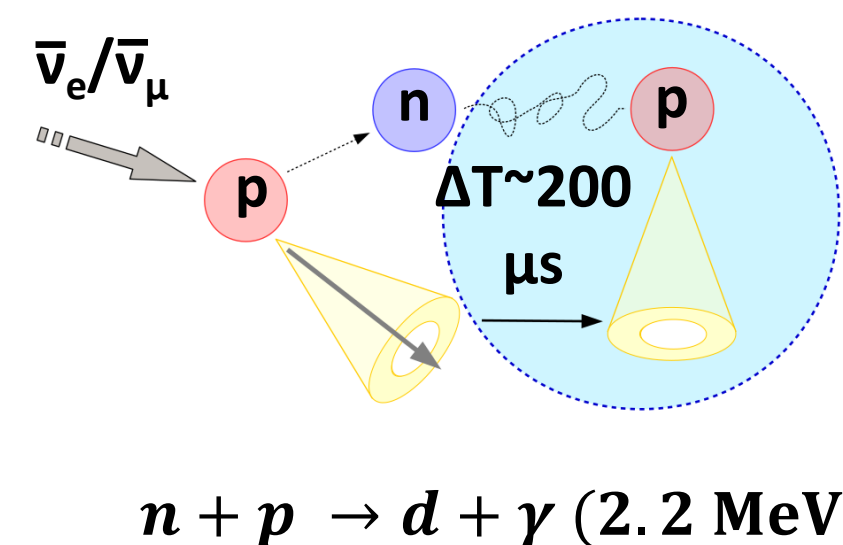
Neutron multiplicities for ν interactions on water

- The **multiplicities** are expected to be useful for future precise ν oscillation analyses and have been used for proton decay searches.
- However, the multiplicities have **large uncertainties** originating from
 - **ν -nucleon interactions** in nuclear medium
 - **hadronic-final state interactions** in nucleus (FSI)
 - **secondary interactions** in detector medium (SI)
- Studying the multiplicities would be **valuable** for these analyses and understanding of ν interactions with nuclei.



Neutron detection at the T2K far detector

- **Neutrons** can be tagged by searching for **2.2MeV γ** signals.
- Employed **neural network** technique to **efficiently select** neutrons from backgrounds.
- A neutron calibration has been already done.



Current performance

- Tagging efficiency : **21.2%**
- Mis-tagging/ ν event : **0.018**

Work In Progress

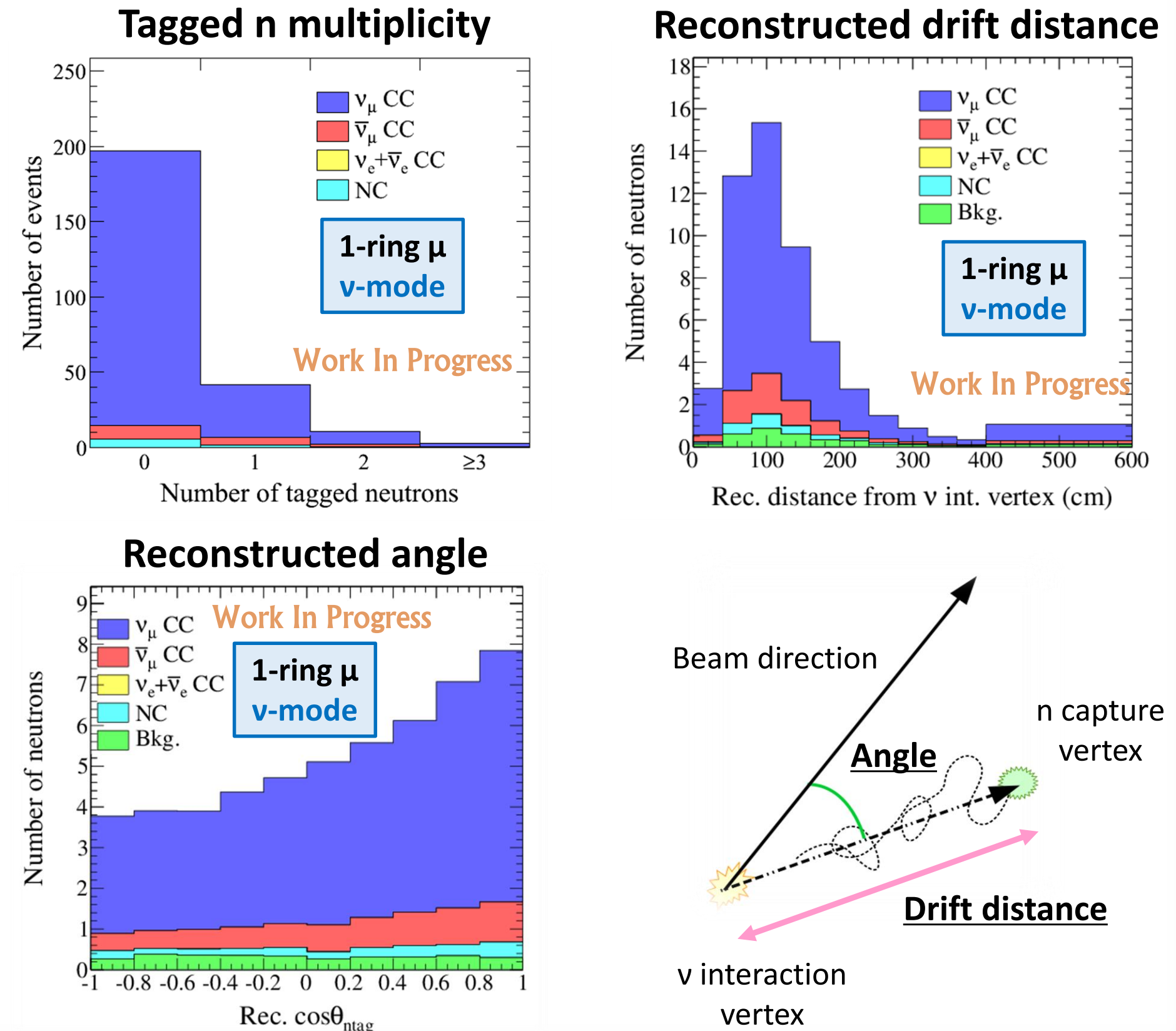
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Neutron studies at the T2K far detector

- In the far detector, Super Kamiokande, there are single-Cherenkov ring muon (**1-ring μ**) samples.
- Using the samples, neutrons associated with ν interactions on water can be studied in the ν - and $\bar{\nu}$ -mode beam, respectively.
- Two main goals of this study :
 - 1. measure “**mean neutron multiplicities in water**”
 - 2. compare the results with theoretical models
- The measurement can be done once several studies are completed such as :
 - Time varying effects on the neutron tagging
 - Estimation of model uncertainties associated with the neutron production processes in the MC predictions

Observables in this study (MC)



- **No measurement results** of neutron multiplicities in water have been **published yet**.
- **This study** aims to produce **the first measurement** of multiplicities in water.