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**

**n + p → d + γ (2.2 MeV)**

**Generated by T2K ν-mode flux**

- True charged current νμ
- ν oscillation applied
- Same SI modes used (NEUT+GCALOR)

**νe/νμ**

- **NEUT 5.3.2**
- GENIE 2.12.6 (default)
- NuWro 17.01.1 (default)

**Number of neutrons (ν int.&FSI&SI)**

**Probability**

- Wednesday session
- Poster #198

**Presenter:** Ryosuke AKUTSU

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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 $\mu$) samples.
- Using the samples, neutrons associated with $\nu$ interactions on water can be studied in the $\nu$- 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

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

Presenter: Ryosuke AKUTSU