Data release for the paper "First measurement of $\overline{\nu}_\mu$ and ν_μ charged-current inclusive interactions on water using a nuclear emulsion detector"

1. event.root: Event by event information of 86 water-target interactions. Variables shown in Table 1 are included.

Table 1: Variables contained in event.root

Branch name	
ntrk	The number of tracks contained in the event.
pid	Type of particle. 0: muon, 1: pion, 2: proton.
tanx	Track angle ($\tan\theta_x$) in x-z plane. z is the neutrino beam direction.
tany	Track angle ($\tan\theta_y$) in y-z plane. z is the neutrino beam direction.
dir	Direction of the particle. 1: forward, -1: backward.
momentum	Reconstructed momentum.
range	For proton, if it is fully contained in ECC and the momentum is reconstructed by range, 1 is assigned.

2. detector_efficiency.root: Detection efficiencies for each particle. Efficiencies from the detector acceptances are not included in muon_a and muon_b.

- muon_a: muon detection efficiency in Run-a period (Figure 6 in the paper)
- muon_b: muon detection efficiency in Run-b period (Figure 6 in the paper)
- muon_ingrid: two-dimensional muon detection efficiency: Selected events / Events in the INGRID acceptance
- muon_all: two-dimensional muon detection efficiency: Selected events / All CC events (Figure 8 in the paper)
- pion: two-dimensional pion detection efficiency (Figure 10 in the paper)
- proton: two-dimensional proton detection efficiency (Figure 10 in the paper)

3. momentum_resolution.root: Relation between true and reconstructed momentum.

- muon: muon momentum (Figure 7 in the paper)
- pion: pion momentum
- proton_mcs: proton momentum reconstructed by MCS
- proton_range: proton momentum reconstructed by range

4. syscov.root: Covariance matrices of systematic uncertainties. nuint_$*$ correspond to the systematic uncertainty from the neutrino interaction model, det_$*$ are the detector systematic uncertainties, and bkg_$*$ are the uncertainties of background estimation. Binning of each plot is

summarized in Table 2.

Table 2: Binning of each measurement

		Binning
∗_ntrk	Track multiplicity	[1, 2, 3, 4, 5, 10]
∗_npion	The number of pions	[0, 1, 2, 3, 4, 5, 10]
∗_nproton	The number of protons	[0, 1, 2, 3, 4, 5, 10]
∗_muon_angle	Muon angle	[0, 5, 10, 15, 20, 25, 30, 90] (deg)
∗_muon_momentum	Muon momentum	[0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0] (GeV)
∗_pion_angle	Pion angle	[0, 18, 36, 54, 72, 90, 108, 126, 144, 162, 180] (deg)
∗_proton_angle	Proton angle	[0, 18, 36, 54, 72, 90, 108, 126, 144, 162, 180] (deg)
∗_pion_momentum	Pion momentum	[0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6] (GeV/c)
∗_proton_momentum	Proton momentum	[0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6] (GeV/c)

5. flux.root: The neutrino flux and the covariance matrix of the flux error. The flux corresponds to the statistics of 10^{21} POT. The binning of the covariance matrix is [0.0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, 2.4, 2.6, 2.8, 3.0, 4.0, 6.0, 8.0, 10.0, 30.0 (GeV)].

- numubar: $\overline{\nu}_\mu$ component in anti-neutrino beam.
- numu: ν_μ component in anti-neutrino beam.
- flux_cov: The covariance matrix of the neutrino flux. Bin #1-20 correspond to ν_μ component in anti-neutrino beam and bin #21-40 correspond to $\overline{\nu}_\mu$ component in anti-neutrino beam.