

# README FILE

The T2K Collaboration

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## 1 Disclaimer

If this data is used, the following reference publication should always be quoted:

- K. Abe *et al.* [T2K Collaboration], “Measurement of the  $\nu_\mu$  charged current quasi-elastic cross-section on carbon with the T2K on-axis neutrino beam”, arXiv:1503.07452 [hep-ex].

It is your responsibility to ensure that this data is used correctly. The flux provided in this data release is also used for the inclusive  $\nu_\mu$  charged current cross section measurement with INGRID:

- K. Abe *et al.* [T2K Collaboration], “Measurement of the inclusive  $\nu_\mu$  charged current cross section on iron and hydrocarbon in the T2K on-axis neutrino beam ”, *Phys. Rev. D***90** (2014) 052010 [arXiv:1407.4256 [hep-ex]].

## 2 Introduction

The data release, explained in this file, is the data used to obtain the results presented in the paper. The data can be separated into two categories:

- Neutrino flux information (flux\_data\_release.root).
- Selection efficiency and nominal distribution information (efficiency\_data\_release.root).
- Systematic error covariance of the cross section results (error\_covariance\_data\_release.root).

## 3 Neutrino flux information

All the information in this section is contained in flux\_data\_release.root (ROOT file). The flux prediction is given for the Proton Module with the 250kA horn current. The unit is  $/\text{cm}^2/100\text{MeV}$  for  $10^{21}\text{POT}$ . This file contains:

- The muon neutrino flux at the location of the Proton Module (TH1F flux).
- The fractional covariance matrix of the muon neutrino flux uncertainty (TMatrixTSym<double> cov\_mat).

Details of the flux prediction is described in T2K flux prediction paper:

- K. Abe *et al.* [T2K Collaboration], “The T2K Neutrino Flux Prediction”, *Phys. Rev. D* **87** (2013) 012001 [arXiv:1211.0469 [hep-ex]].

The binning of the neutrino energy is as follows (43 bins):

0, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 30.0 (GeV). The binned fractional covariance matrix defined

$$V_{ij} = \frac{\delta\phi_i\delta\phi_j}{\phi_i\phi_j} \quad (1)$$

where  $i$  and  $j$  are the energy bins is given.

## 4 Selection efficiency and nominal distribution information

All the information in this section is contained in `efficiency_data_release.root` (ROOT file). This file contains:

- Neutrino energy distributions of CCQE, CC-nonQE and NC interactions in the Proton Module.
- Muon momentum–angle distributions of CCQE, CC-nonQE interactions in the Proton Module.
- Selection efficiencies for CCQE, CC-nonQE and NC interactions as a function of the neutrino energy.
- Selection efficiencies for CCQE, CC-nonQE interactions as a function of the muon momentum–angle.

They are contained in TH1F or TH2F histograms. The name of the histograms for the neutrino event distributions is “`dist_[A]_[B]`”, where [A] is “`enu`” or “`ptheta`” for the neutrino energy distributions or muon momentum–angle distributions, and [B] is “`ccqe`”, “`ccnonqe`” or “`nc`” for CCQE, CC-nonQE or NC interactions. The name of the histograms for the selection efficiencies is “`eff_[A]_[B]_[C]_[D]`”, where [A] and [B] are as stated above, [C] is “`1trk`” or “`2trk`” for the one-track or two-track sample, and [D] is “`he`” or “`le`” for the high energy or low energy sample. The neutrino event distributions are for  $10^{21}$ POT. The selection efficiency is defined as the number of selected events divided by the number of neutrino interactions in the fiducial volume of the Proton Module. The binning of the neutrino energy is the same as that for the neutrino flux information, and that of the muon momentum–angle is shown in Table 1.

Table 1: The binning definitions for the muon momentum and angle.

	Minimum edge	Maximum edge	Number of bins	Width of bin
Momentum	0	4 GeV/c	40	0.1 GeV/c
Angle	0	180 degrees	60	3 degrees

## 5 Systematic error covariance of the cross section results

All the information in this section is contained in `error_covariance_data_release.root` (ROOT file). This file contains the systematic error covariance matrices of the cross section results using various samples. The covariance matrices for the total systematic error and categorized systematic errors are included:

- Systematic error from the neutrino flux prediction (TMatrixTSym<double> `cov_flux`).
- Systematic error from the neutrino interaction model (TMatrixTSym<double> `cov_int`).
- Systematic error from the detector response (TMatrixTSym<double> `cov_det`).
- Total systematic error (TMatrixTSym<double> `cov_total`).

The definition of the covariance matrix is the same as Eq. 1. The definition of the rows and columns of the matrix is shown in Table 2.

Table 2: The definition of the rows and columns of the systematic error covariance matrix.

Row and column	Result
1	Result from the one-track high energy sample
2	Result from the two-track high energy sample
3	Result from the combined high energy sample
4	Result from the one-track low energy sample
5	Result from the two-track low energy sample
6	Result from the combined low energy sample