

Working Status & A Short Introduction to Neutrino Event Generators

Son Cao

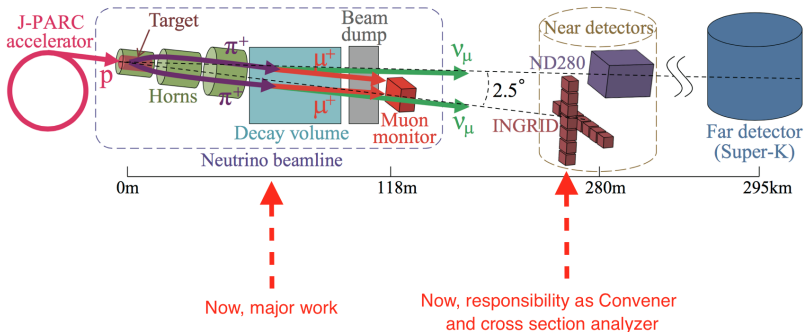
KEK

December 22, 2017



Works at T2K

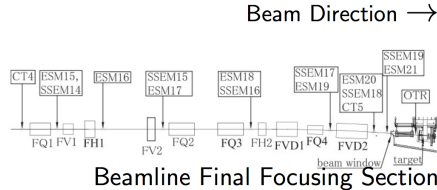
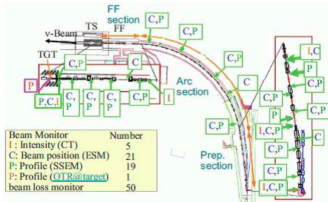
Main goal: precision measurement of neutrino oscillations



Also have performed neutrino oscillation analysis when proposing T2K-II (extend T2K run until 2026)



T2K beamline monitors & my responsibility



- Beam monitors are essential for protecting beamline equipment and understanding proton beam parameters for flux MC
- 5 CTs (Current Transformers) – monitor beam intensity
- 50 BLMs (Beam Loss Monitors) ◀ - - - BLM expert, monitor, R&D
- 21 ESMs (Electrostatic Monitors) – monitor beam position
- 19 SSEMs (Segmented Secondary Emission Monitors) – non-continuously monitor beam profile ◀ - - - R&D
- 1 OTR (Optical Transition Radiation) Monitor – continuously monitors beam at target
- 1 MUMON (Muon Monitor) – monitors secondary muon beam

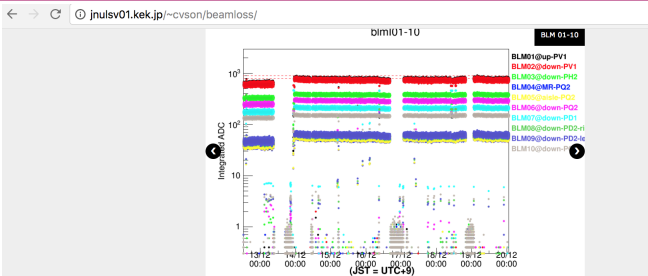
Working status: Neutrino beam operation



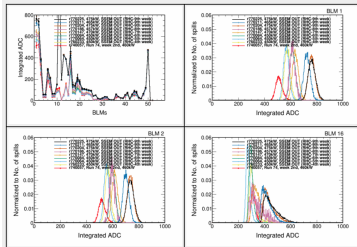
- ▶ T2K neutrino beam has just finished 2017 running (started from Oct. 20th 2017, end Dec. 21st 2017)
 - ▶ Overall stable. No major issue in the neutrino beam line.
 - ▶ The beam power is about 475kW in the last week of run.
 - ▶ Next run may start from March. 22nd 2018
- ▶ My responsibilities
 - ▶ Operate & monitor BLMs, including data processing & report typically every two times per week
 - ▶ Overall responsible for INGRID operation as conveners, take care of detectors & reports sometimes as shifter
 - ▶ Some days take responsibility as the NU operation leaders
 - ▶ Responsibility to release the final beam data for this run.
 - ▶ Also utilize valuable beam time for the BIF monitor R&D



Working status: BLM operation & data processing

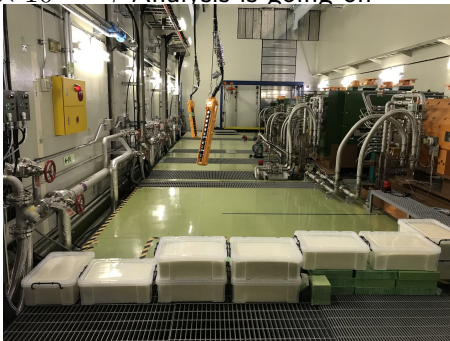


Compare multiple runs (SSEM-OUT)





- ▶ polyethylene shielding to reduce background from neutron
- ▶ Yesterday, turn off the vacuum pump to check if we see the signal. The pressure in the vacuum is about 1.3×10^{-5} , when it is off 8×10^{-5} → Analysis is going on





Working status: NEUT-related

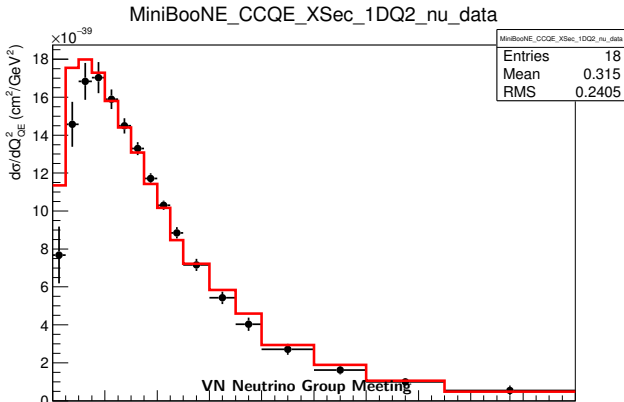
- ▶ Continue writing the technical note, or so-called NEUT manual
- ▶ Aim for the end of this year for first release but see too difficult.

31	Contents	
34	1 Introduction	3
35	1.1 Brief history of NEUT	3
36	1.2 Need of precise neutrino event generator	3
37	1.3 Procedure of the neutrino event generation	3
38	2 Neutrino-Nucleon Interaction Models	4
39	2.1 (Quasi-)elastic scattering	5
40	2.2 Single pion, photon, kaon and eta production	9
41	2.3 Deep Inelastic scattering	12
42	2.4 Two-body current contribution	13
43	2.5 Coherent pion production	18
44	3 Modeling Nuclear Effects and Final State Interactions	21
45	3.1 Nuclear effects	21
46	3.2 Final state interaction	21
47	3.2.1 Proton FSI	21
48	3.2.2 Pion FSI	22
49	4 Download and installation NEUT	22
50	4.1 Some useful application	22
51	5 Generating neutrino event samples	23
52	6 Integrate flux and detector geometry	23
53	7 Analyzing generated sample	23
54	7.1 Getting the particles informations	24
55	7.2 Normalize the distributions	24
56	7.2.1 Single interaction mode	24
57	7.2.2 Experimental flux	25
58	8 Events reweighting	25
59	9 Validation plots	26
60	10 Other generators	26
61	11 Summary	26
62	A Version history	27
63	A.1 NEUT 5.3.6	27
64	A.2 NEUT 5.4.0	27
65	A.3 NEUT 5.4.1	27



Working status: NEUT-related

- ▶ Successful install NUISANCE, a framework to compare neutrino event generators with experiment
 - ▶ Interface with NEUT, GENIE (which you know), also other generators
 - ▶ Almost important data for neutrino experiments included.



Other activities



- ▶ Report at ICRR annual review on behalf of T2K collaboration
<https://www.icrr.u-tokyo.ac.jp/indico/event/122/other-view?view=standard>
- ▶ Join neutrino workshop in Japan <https://kds.kek.jp/indico/event/25383/>

A short introduction to Neutrino Event Generator

NEXT MEETING

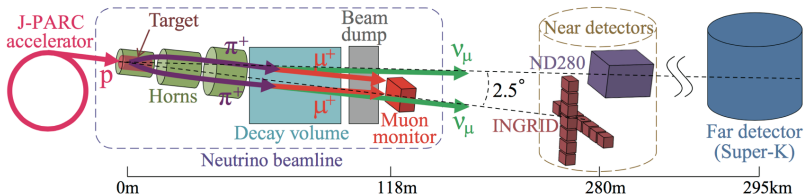
Backup





Introduction to T2K experiment

Main goal: precision measurement of neutrino oscillations



Achievements

- ✧ Discovery of $\nu_{\mu} \rightarrow \nu_e$
- ✧ Precision measurement of $\nu_{\mu} \rightarrow \nu_{\mu}$
- ✧ Precision measurement of $\bar{\nu}_{\mu} \rightarrow \bar{\nu}_{\mu}$
- ✧ 2sigma exclude CP invariance

Future goals

- ✧ Discovery of $\bar{\nu}_{\mu} \rightarrow \bar{\nu}_e$
- ✧ Explore CP violation
- ✧ Mass hierarchy constraint
- ✧ Some unknown...

→ World's leading results & more interesting results coming. Stay tuned!