

# Neutrino interaction studies in the near detector of the T2K experiment



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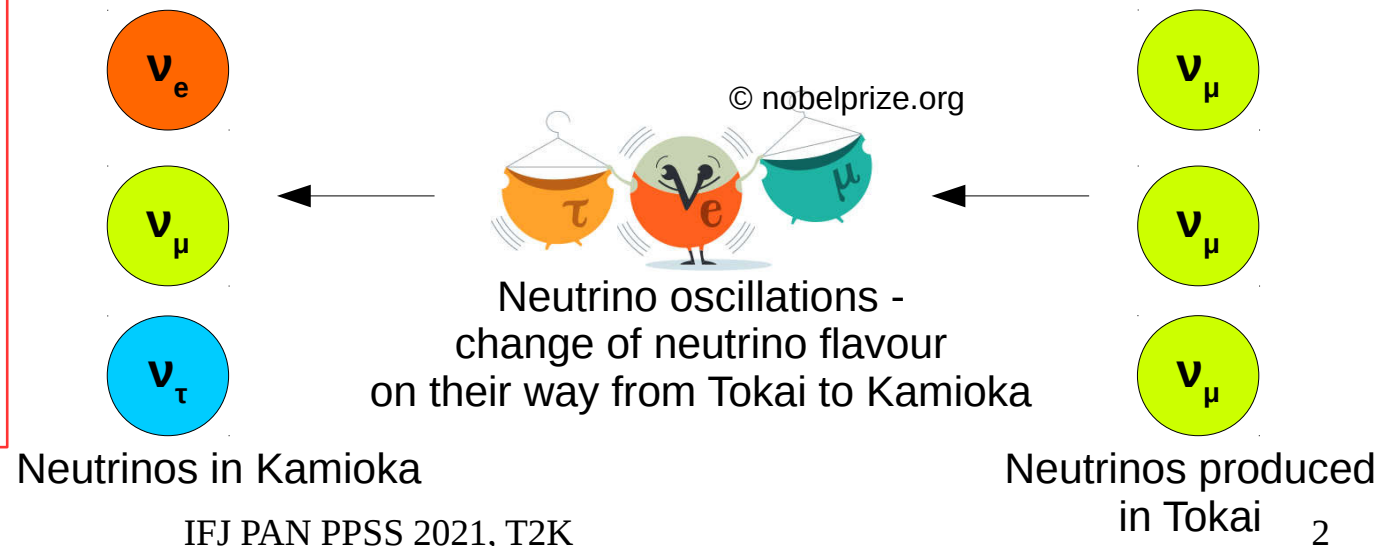
# T2K experiment

- T2K (Tokai to Kamioka) experiment
  - experiment studying neutrino oscillations (including matter-antimatter symmetry) and neutrino interactions
  - conducted in Japan by an international collaboration of ~60 institutions (including IFJ PAN)
  - currently heading forward the phase II of the experiment (2023-2027) and the Hyper-Kamiokande experiment (2027 – ...) – a successor of the T2K experiment



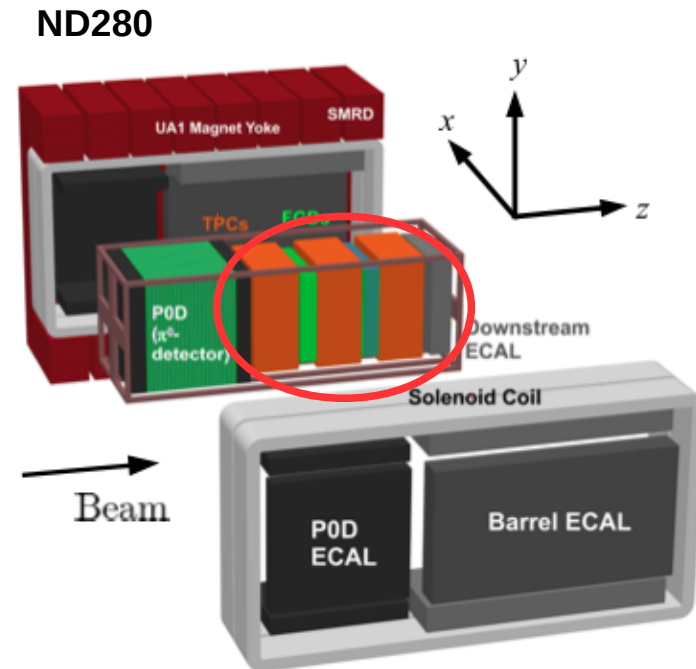
## More about T2K:

- [t2k-experiment.org](http://t2k-experiment.org) [en]
- [auger.ifj.edu.pl/eng/t2k.html](http://auger.ifj.edu.pl/eng/t2k.html) [en,pl]
- [en.wikipedia.org/wiki/T2K\\_experiment](http://en.wikipedia.org/wiki/T2K_experiment) [en,pl] (in 2020, the article was reviewed and extended by the T2K collaboration)



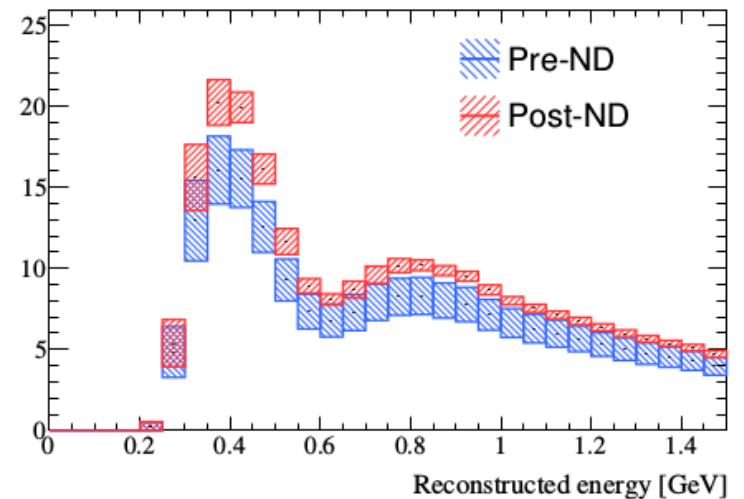
# ND280 near detector

- ND280 detector
  - 3 vertical time projection chambers
  - active material – plastic scintillator
  - passive material - water, iron, lead
  - magnetized
  - beam content before oscillations
  - neutrino cross-sections



- Current ND280 tracker:
  - 2 Fine Grained Detectors:
    - FGD1 – plastic scintillator only
    - FGD2 – scintillator interleaved with water layers
  - sandwiched between 3 TPCs
  - surrounded by ECal (Electromagnetic Calorimeter)

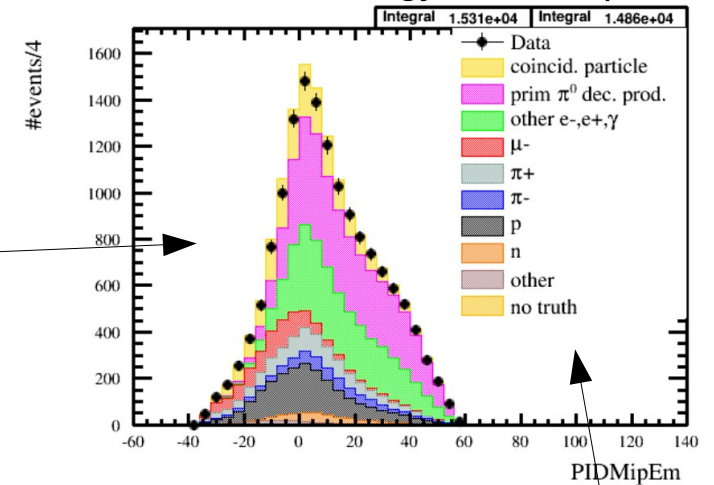
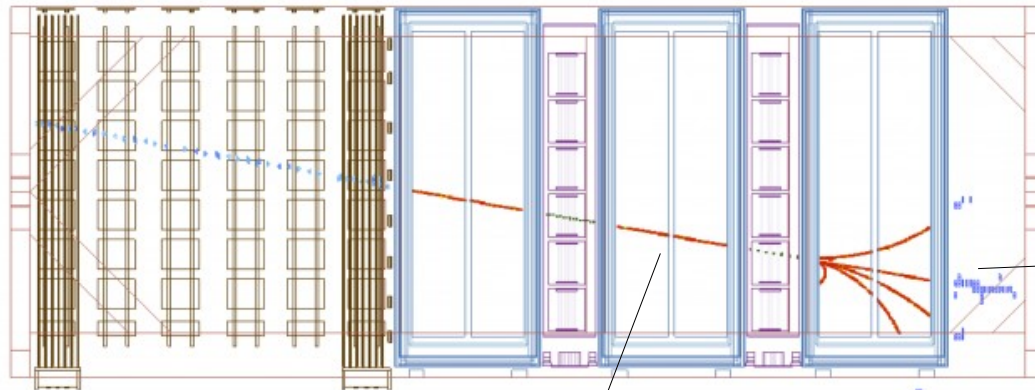
Total syst uncertainty on neutrino mode  $1R_{\mu}$  events



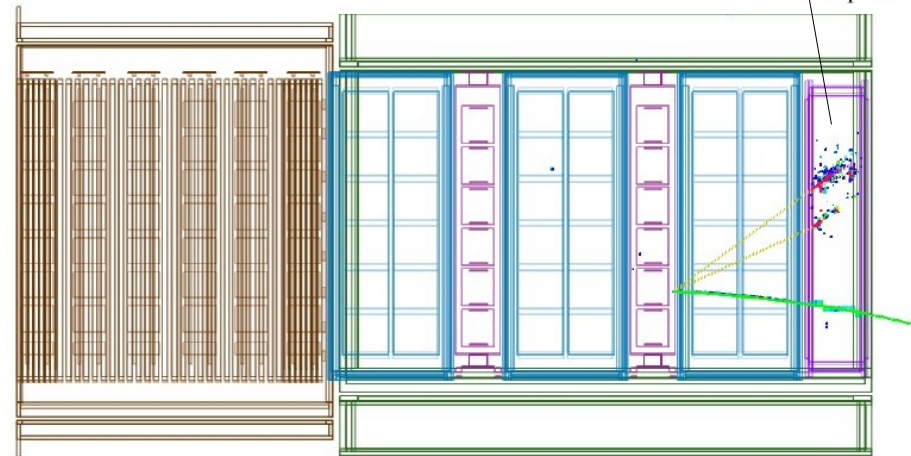
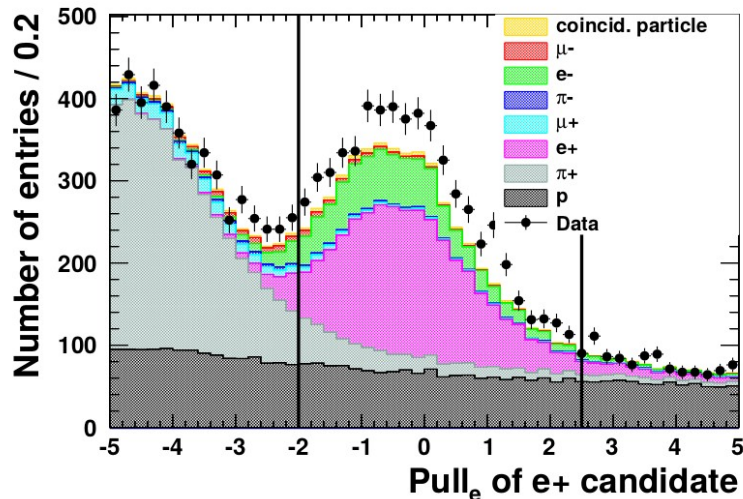
# Examples of neutrino interactions in the ND280 detector

© The T2K experiment

Particle identification in ECal based on energy blob shape



Particle identification in TPC based on dE/dx



# Overall practice plan

- Particle identification based on  $dE/dx$ , ECal information, etc.
- Selection of different charge current (CC, with muon in the final state) neutrino interaction types (quasi-elastic, resonant, etc.) based on identified particles, etc.
- Calculation of selection efficiency and purity as a function of momentum and angle of the selected particles, etc.
- Calculation of different kinematic variables related to selected neutrino interactions: neutrino energy, pion+proton invariant mass (resonance identification), etc.