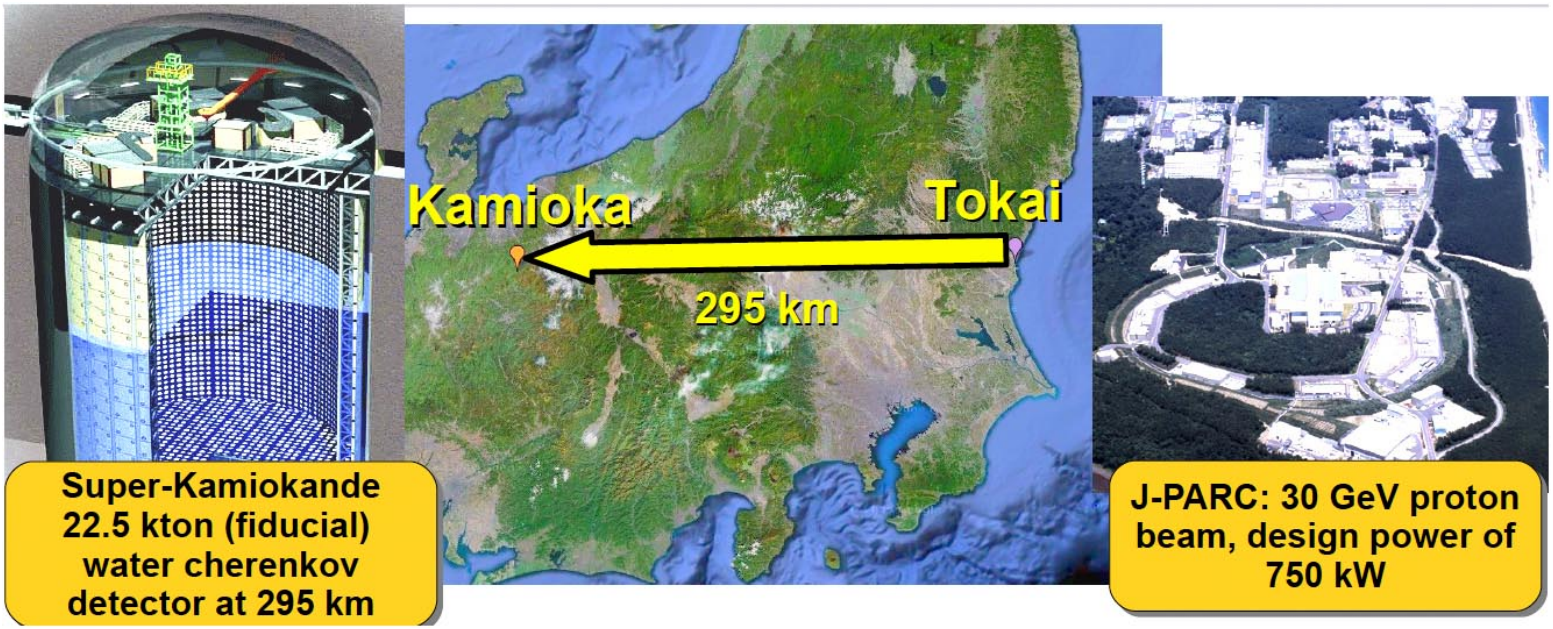
LPNHE Neutrino group

Initiated by François Vannucci in 1982

- 1984-88: ν decays and oscillations:
  PS191 (CERN) and E816 (Brookhaven)
- 1990-2000: $\nu_\mu \rightarrow \nu_\tau$ NOMAD (CERN)
- 1997: $\nu_\mu \rightarrow \nu_e$ I216 (CERN)
- 2000-2008: hadro-production HARP (CERN)
- 2006-today: new generation $\nu_\mu \rightarrow \nu_e$ and hadro-production experiments
  T2K and NA61 (Tokai, Japan and CERN)
- Future: LBNO (Long Baseline Neutrino Oscillations between CERN and Finland)

T2K: Tokai to Kamioka



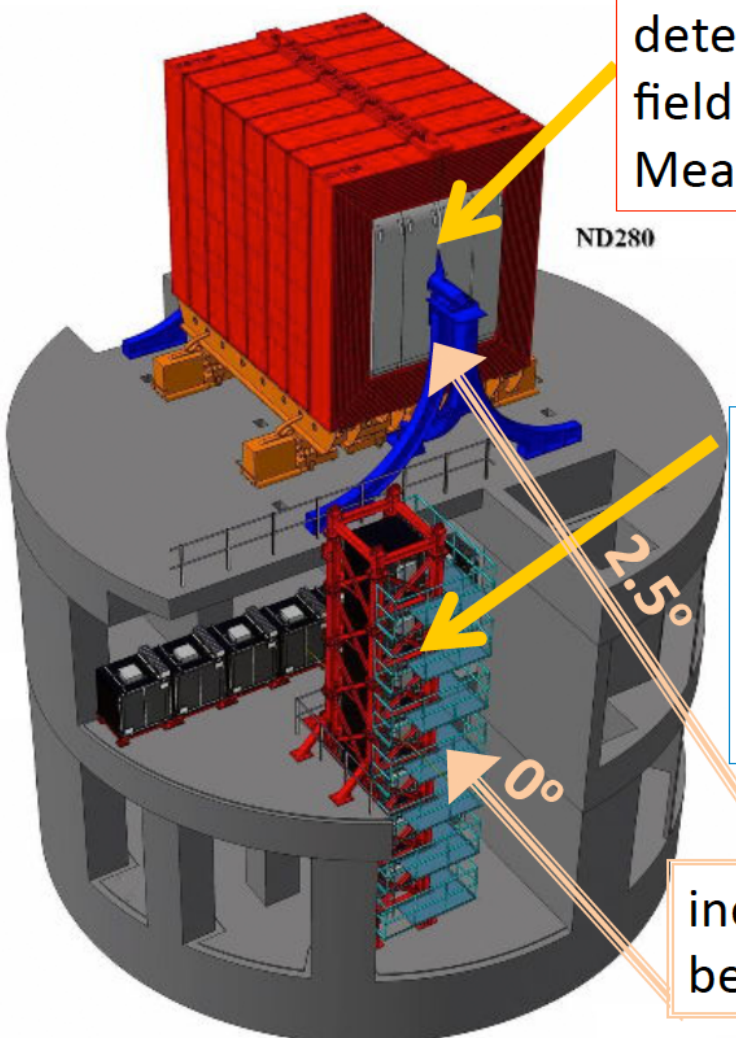
Primary goals of the experiment:

- Search for ν_e appearence:

$$P(\nu_\mu \rightarrow \nu_e) \approx sin^2\theta_{23} sin^2 2\theta_{13} sin^2 \frac{\Delta m^2_{32} L}{4E_\nu}$$

- Precise measurement of ν_μ disappearence

Near Detector Complex at 280m



Off-Axis (ND280) suite of fine grained detectors/tracker inside a 0.2 T magnetic field (UA1/NOMAD magnet)

Measure:

- CC ν_μ events (normalization, spectrum)
- NC π^0, CC ν_e events (backgrounds)
- Neutrino interaction properties

On-axis (INGRID)

- 14 + 2 iron scintillator tracking detectors (each unit $\approx$ 10 ton)

Measure ν-beam direction and profile with 1mrad precision on daily basis

incoming neutrino beam

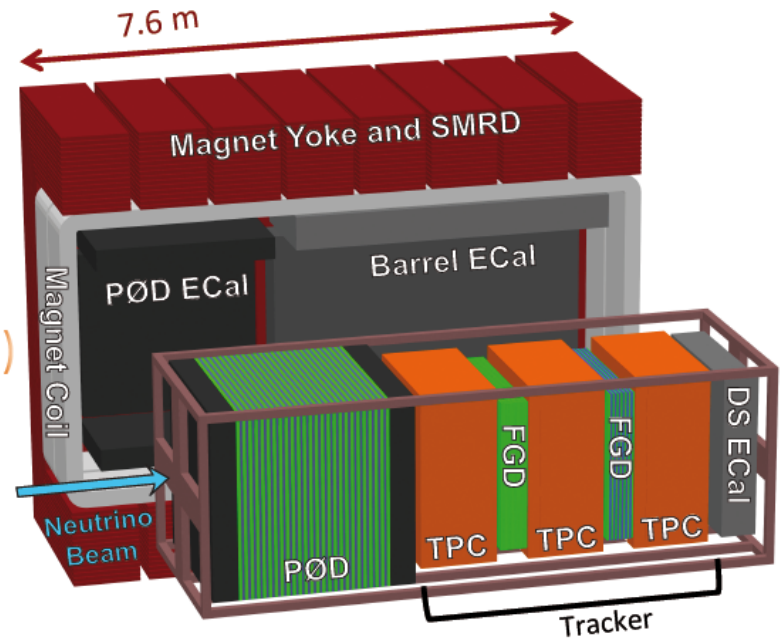
11

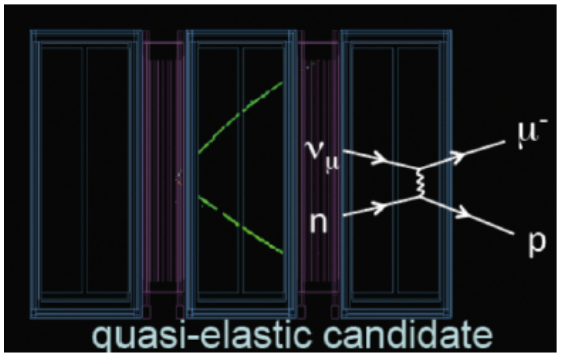
Off-axis near detector: ND280

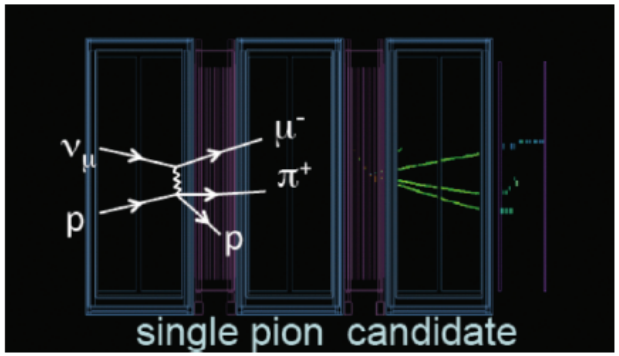
Tracker Section

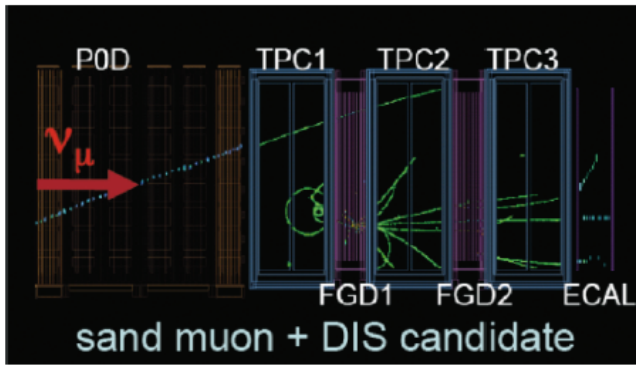
Fine Grained Detectors (FGD)
- Scintillator target mass
- Vertex reconstruction

Time Projection Chambers (TPC)
- Momentum reconstruction
- Particle identification









Far Detector: SK-IV

SK IV:

50kt Water Cherenkov detector (Fiducial : 22.5kt)

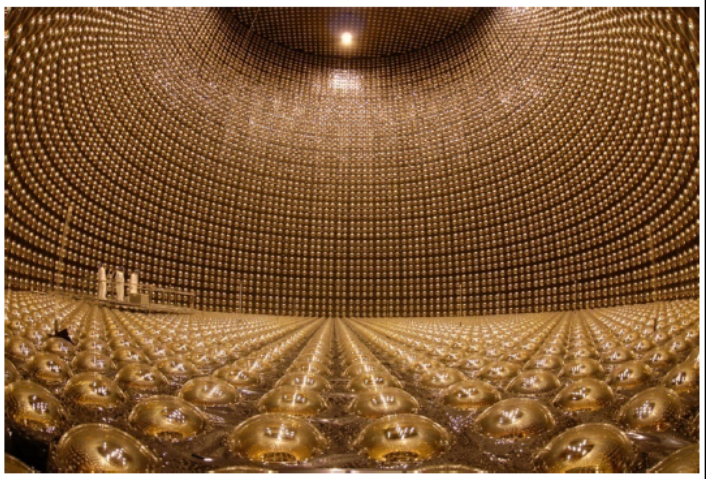
Since July 2006 SK is back to 40% Photo coverage

Electronics & online DAQ upgrade in Sept. 2008

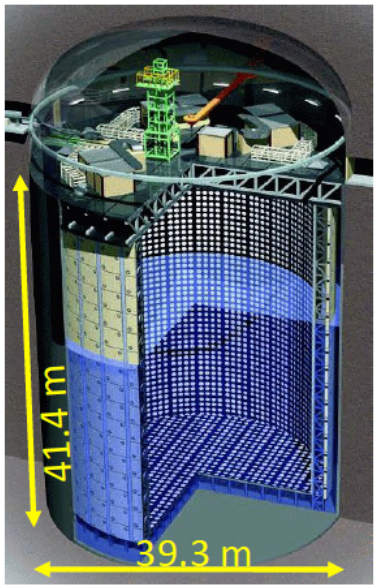
- high-speed & dead-time-less DAQ
- wider dynamic range

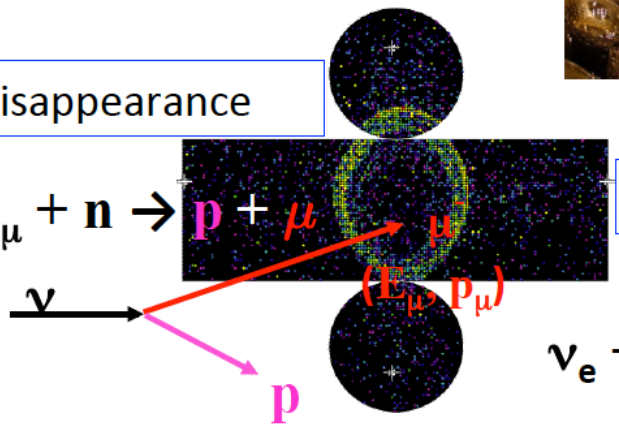
Good energy resolution (~ 10%)

Good e/μ separation



Measurement of ν_μ disappearance

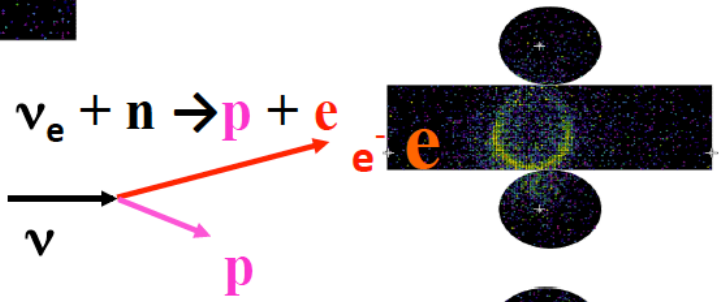




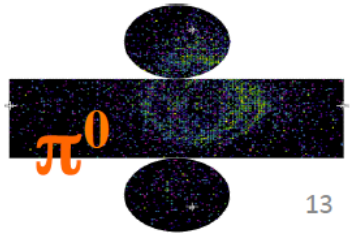
20' ID PMT×11,129

8' OD PMT×1885

Measurement of ν_e appearance



Background :



13

LPNHE contributions

Hardware: on the near detector (ND280)
TPC Data Concentrator Cards: electronics board for the TPC data acquisition
Magnet power supply: design installation and commissioning
(ongoing responsabilities: on-call experts for the TPC and Magnet during data taking; run coordination)

Analysis: within the T2K Analysis Strategy
Predict the event rates and distribution at Super-K as a function of θ_{13} and δ_{CP}

- Beam Monte-Carlo and neutrino interaction models provide the baseline prediction *(LPNHE via NA61)*
- Use the near detector measurements to normalize the ν_μ flux $\oplus$ cross section to data
- Use the near detector to verify the ν_e prediction *(LPNHE)*

Select ν_e events at Super-K
Compare observed ν_e distribution to prediction and fit to preferred θ_{13}

(ongoing responsabilities: convenor of the ND280 ν_e analysis; convenor of the T2K-NA61 group and of the T2K-beam group; convenor of the NA61 software and analysis groups)

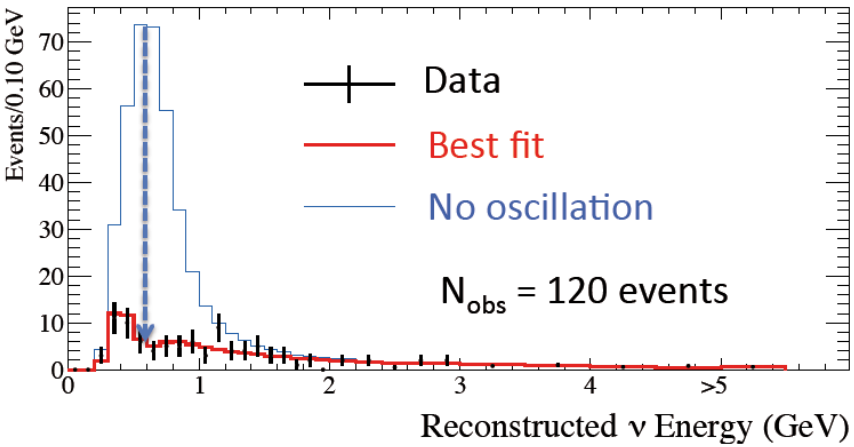
T2K main results

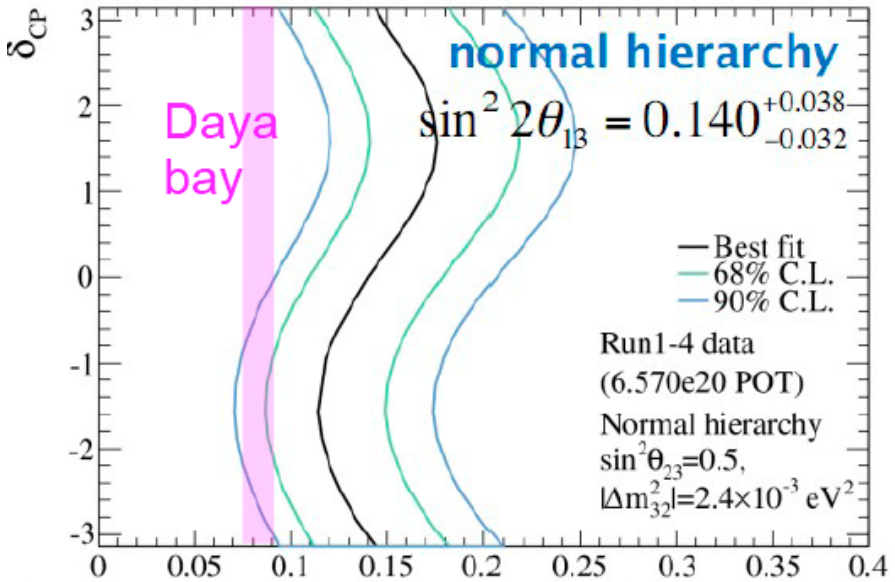
Selected T2K ν_e events in SK

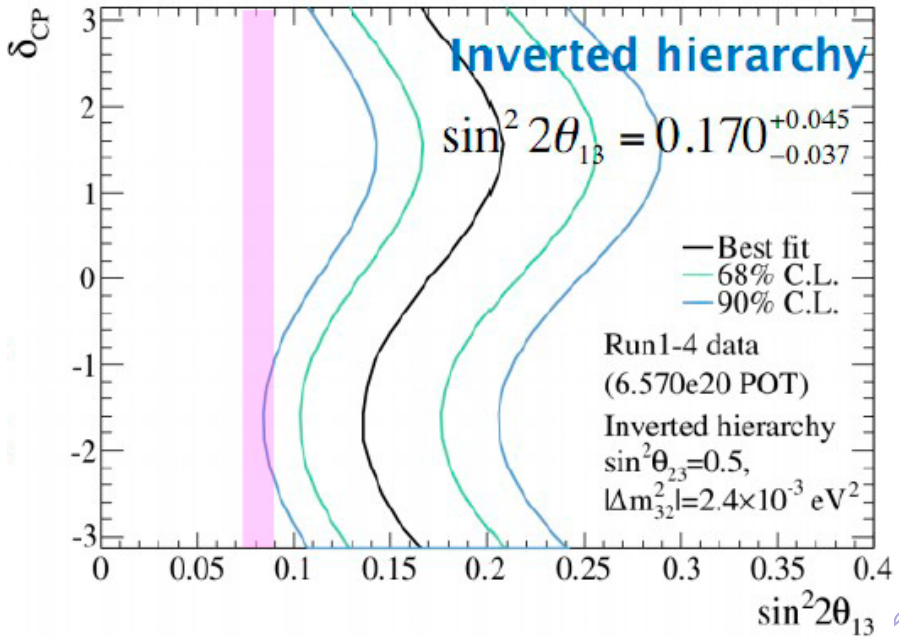
- Observed: 28 evts
- Expected ($\theta_{13} = 0$): 4.92 ± 0.55
- Significance: 7.3σ

T2K has first measured a non-zero θ_{13} angle in 2011 confirmed at Neutrino2012 with a 3.2σ measurement

T2K has also produced a first mea--surement of the ν_μ disappearence







Prospective

- the near future goal of T2K: accumulate 5×10^{20} POT in anti-neutrino mode by summer 2015: combined with NOνA and Daya Bay it could increase the sensitivity to δ_{CP}
- long term goal: desperately looking for *CP* violation in the neutrino sector: we will take part in the LBNO project with a first stage at building a big liquid argon prototype (6m x 6m x 6m active area double phase LAr detector) at CERN.