Electron neutrinos in the T2K near detector
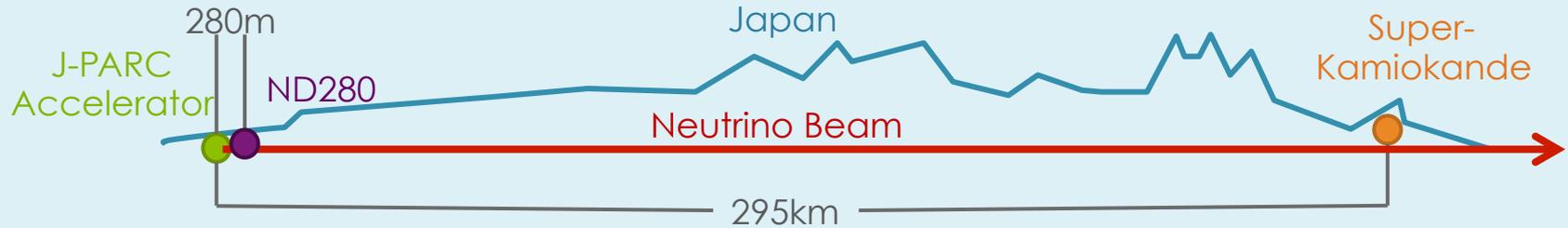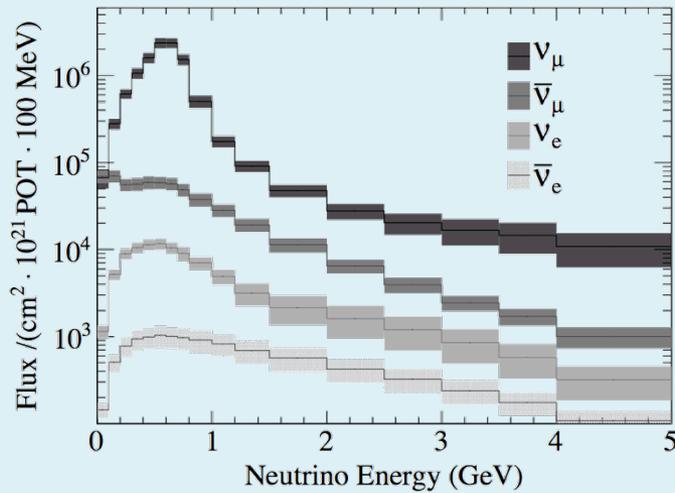
Ben Smith
Imperial College London
IOP HEPP and APP meeting – 09/04/2013

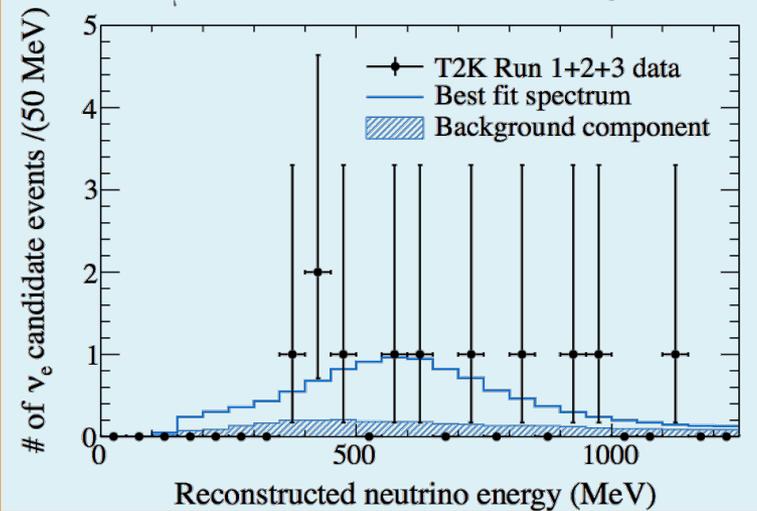# T2K

280m

J-PARC
Accelerator

ND280

Japan

Super-
Kamiokande

Neutrino Beam

295km

Start with high purity ν_μ beam

Phys. Rev. D 87, 012001

ν_μ can oscillate to ν_e

arxiv/1304.0841

Why measure ν_e at ND280?

Predicted number of events
at Super-K (for $\sin^2 2\theta_{13} = 0.1$)

Total	10.71
ν_e oscillation signal	7.79
ν_e background	1.56
Other background	1.37
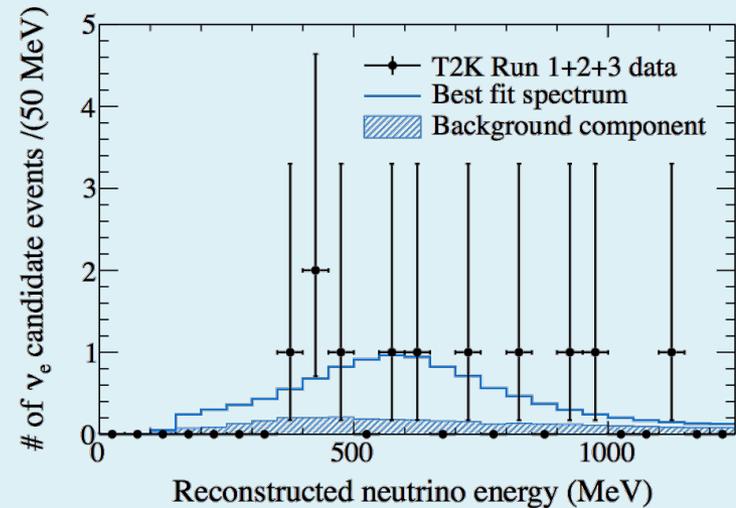
- Intrinsic ν_e in the beam are largest background in $\nu_\mu \to \nu_e$ measurement

- ND280 can measure the unoscillated ν_e spectrum and constrain the ν_e background prediction

ND280

- FGDs (scintillator and water layers) are active interaction targets

- TPCs (gas) give excellent particle ID using dE/dx

- ECals (scintillator and lead layers) aid particle ID

- All in 0.2T magnetic field

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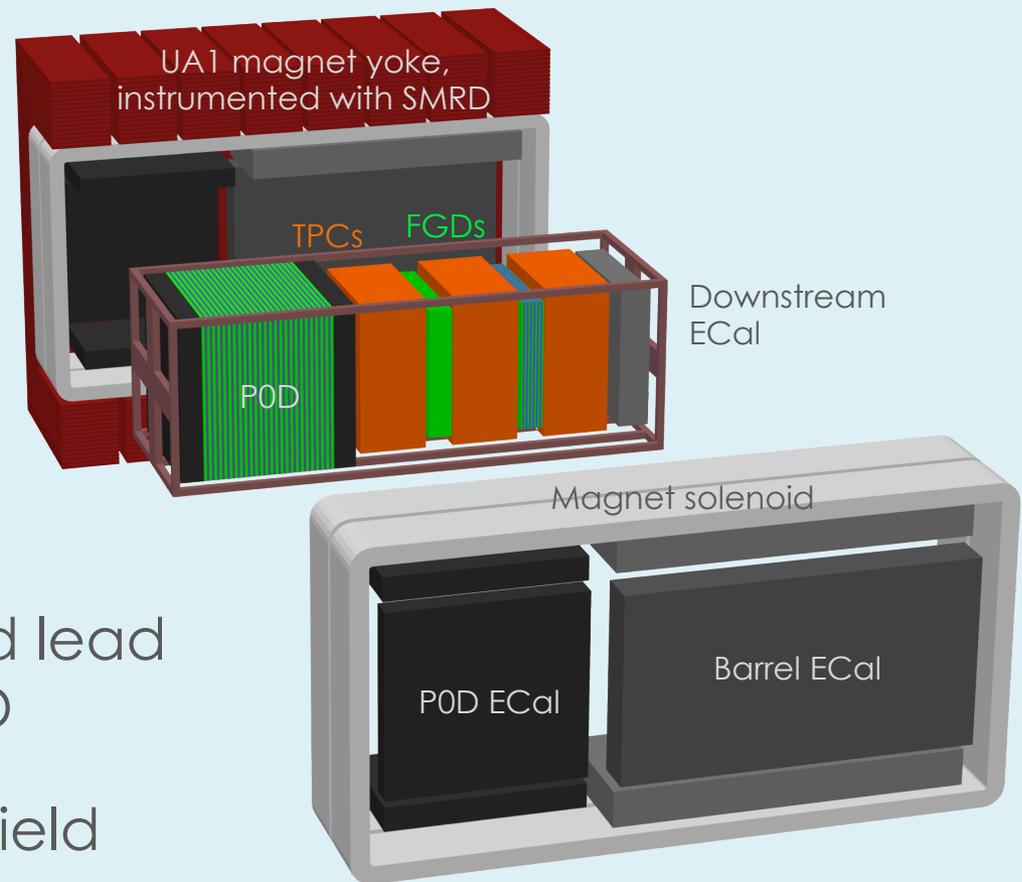
ν_e signal

- Look for electrons from ν_e charged current reactions

- Reactions can be quasielastic or non-quasielastic

CCQE e⁻ ν_e nucleus

CCnonQE e⁻ ν_e nucleus
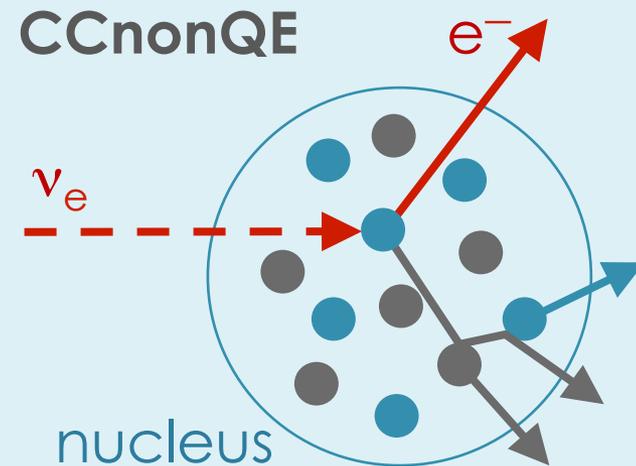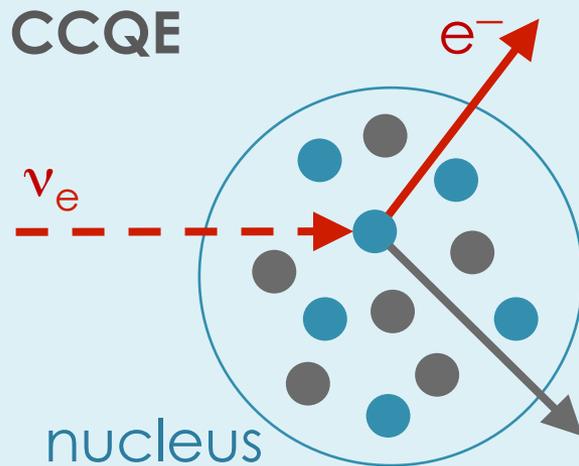
- Try to avoid non-electrons, and electrons from muon decay and photon conversions

T2K

ν_e selection

- Select highest momentum negative track in an event

- Require track to start in FGD, as FGDs are interaction targets

- Track dE/dx is electron-like in TPC

- Track shape is electron-like in ECal, if ECal is used

- Apply photon and upstream activity vetoes

- Separate into CCQE and CCnonQE topologies

TPCs FGDs

Downstream ECal

Barrel ECal
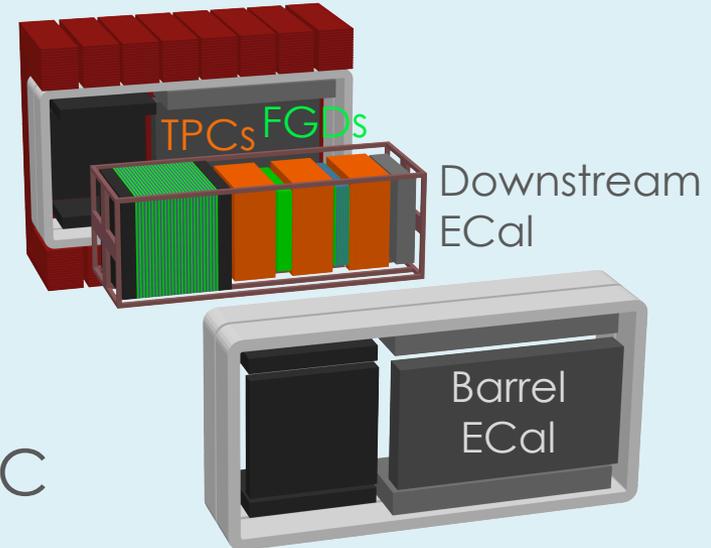
Particle ID improvements

- PID cuts re-optimised for purity × efficiency of cut

- Examples of new cuts shown below

Barrel ECal PID

DsECal EM Energy
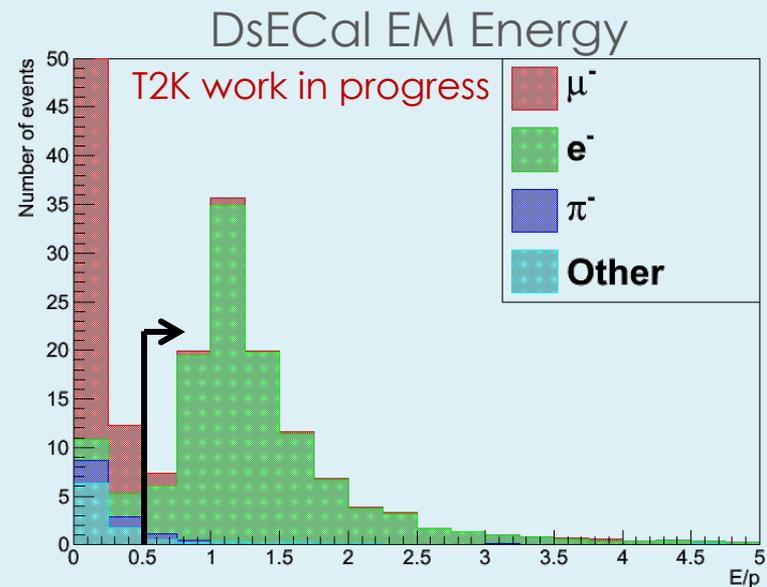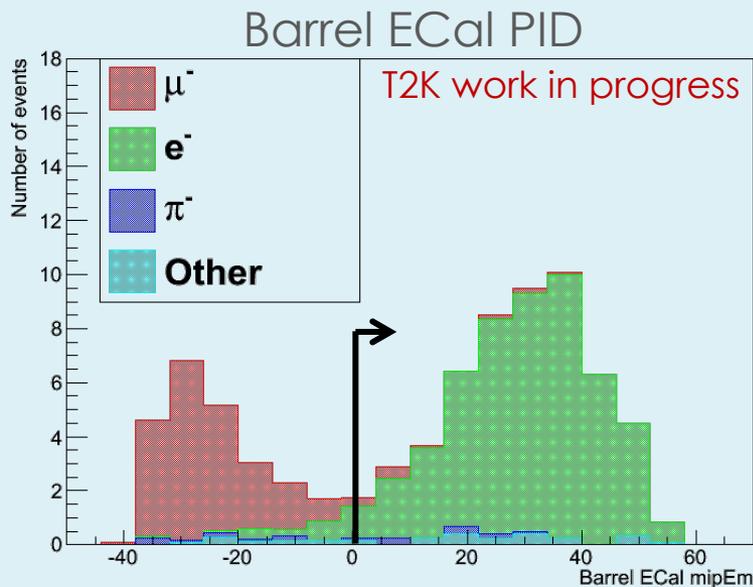
Beam MC from FLUKA2008 and GEANT3; ND280 MC from NEUT v5.1.4.2 and Geant4

Impact of particle ID improvements

- 3.5 percentage point increase in purity

- 1.5 percentage point increase in efficiency

Selection purity

Selection efficiency

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T2K
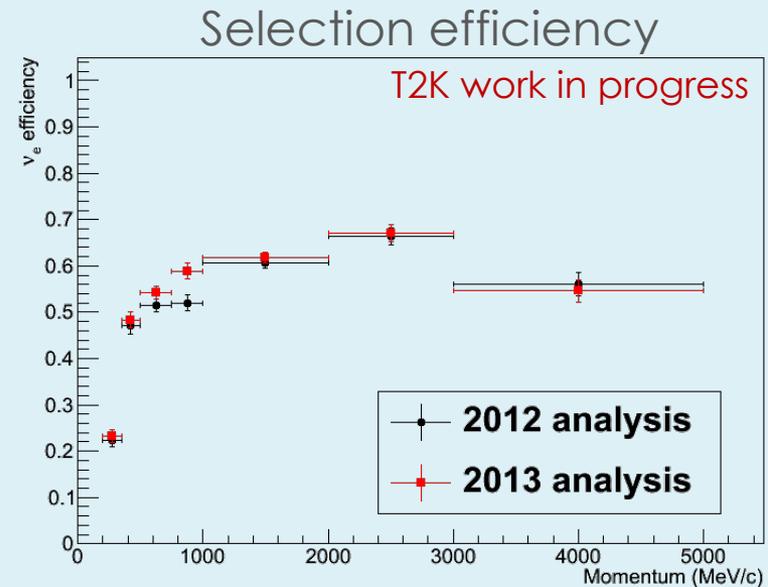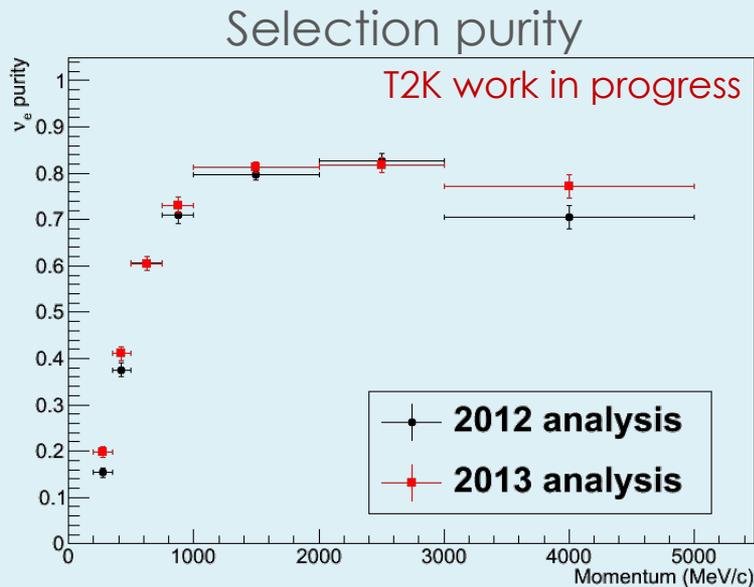
Final selections

CCQE selection

True interaction	Purity (%)
ν_e CCQE	55.1
ν_e CCnonQE	15.4
Other	29.5

CCnonQE selection

True interaction	Purity (%)
ν_e CCQE	14.0
ν_e CCnonQE	56.1
Other	29.9

Constraining the flux

ND280 ν_e measurements and uncertainties

Neutrino interaction model and uncertainties
See P. Sinclair

ND280 ν_μ measurements and uncertainties
See T. Duboyski

Joint fit for near detector flux and cross-section parameters

Flux prediction, including CERN NA61 hadron production data

Extrapolate to predict far detector rates
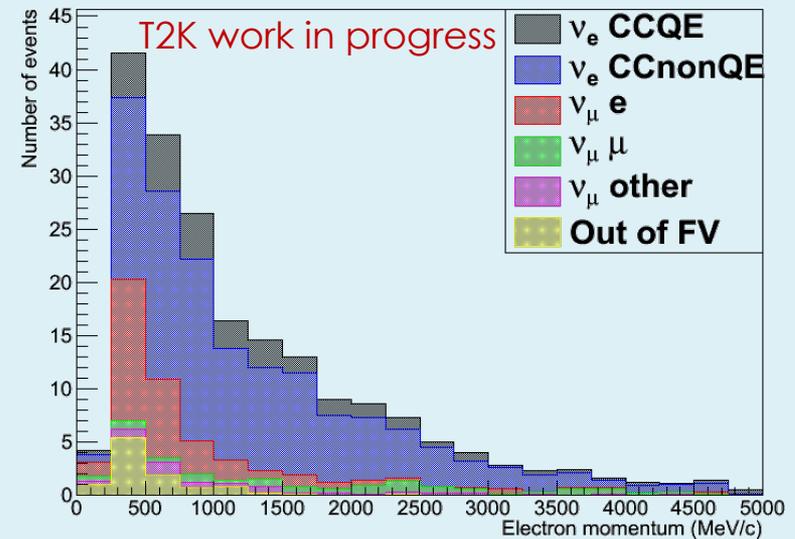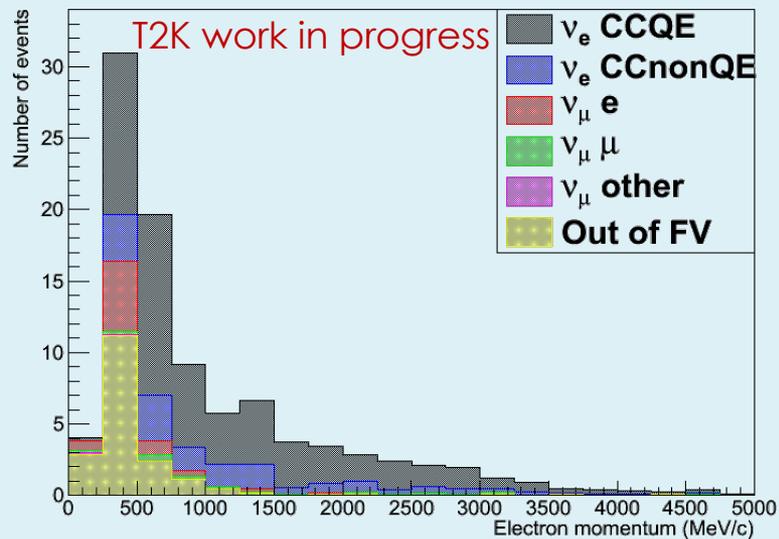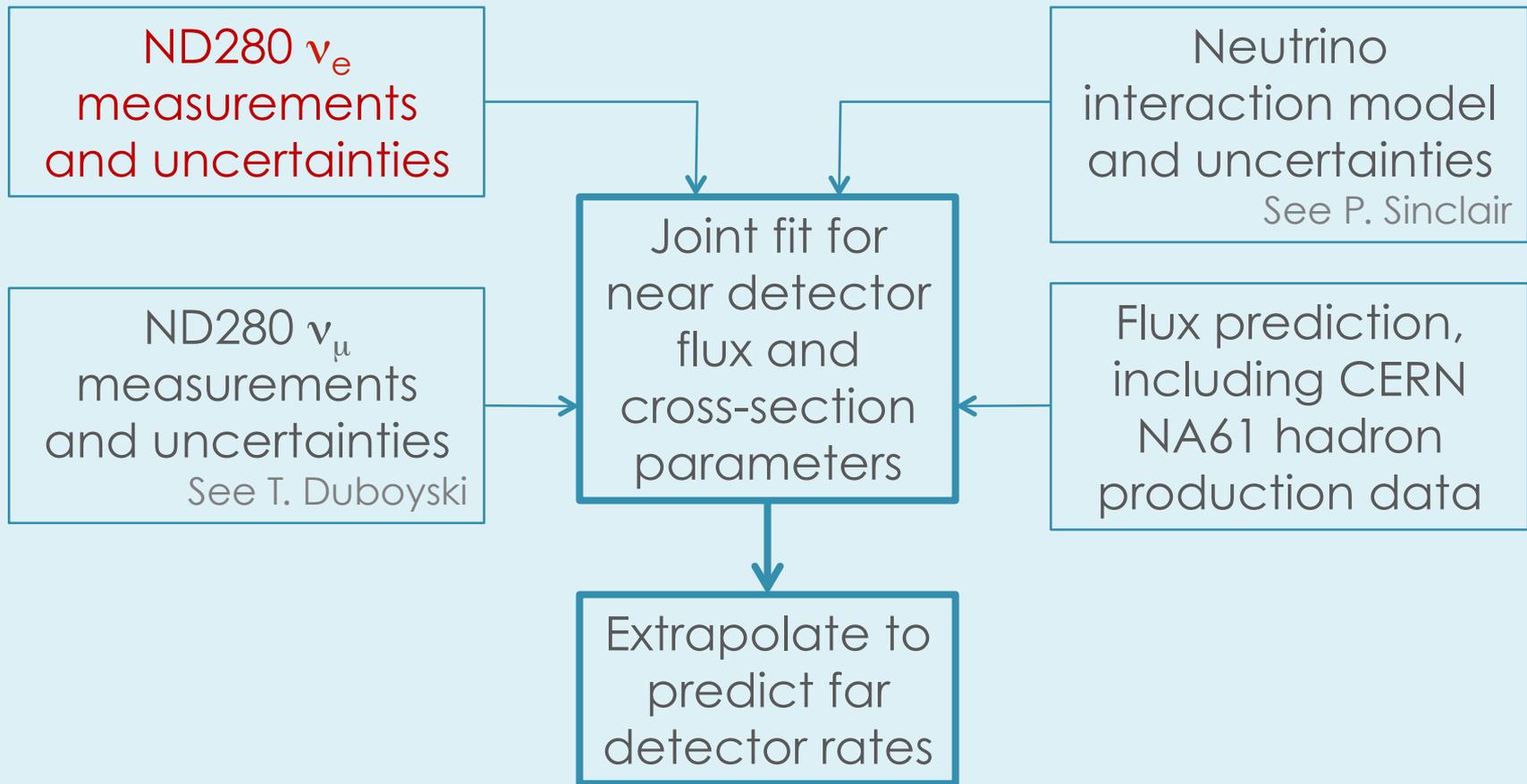
Summary

- Biggest background in T2K's $\nu_\mu \rightarrow \nu_e$ measurement is from intrinsic ν_e in the beam

- ND280 near detector can measure unoscillated ν_e spectrum to constrain far detector ν_e prediction

- I have increased the purity and efficiency of the ND280 ν_e event selection by improving the particle identification

- The new selection will be used to constrain the T2K flux and cross-section parameters in the 2013 oscillation analyses