Needs for global fits

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Soapboxing

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Global fits

A fit of model/generator parameters to published datasets from one or more experiments, producing best-fit values and uncertainties

Global fits: who and why?

T2K/NEUT

- Input to oscillation analysis
- C and O most important targets. Energies 100s of MeV to handful of GeV
- Near detectors
- Global fit is just input to next stage
- Factorizes into CCQE, single pion, FSI parts

GENIE

- Universal generator
- Need all channels, all energies, all targets
- Considering νA, eA, πA

Shooting for the moon


- Nucleon-level data, plus nuclear data on a range of targets, plus FSI measurements (pion scattering, photoproduction)
- All as absolute cross sections, with full errors separated by type, along with intra- and inter-experiment correlations.

A pipe dream: new nucleon-level measurements
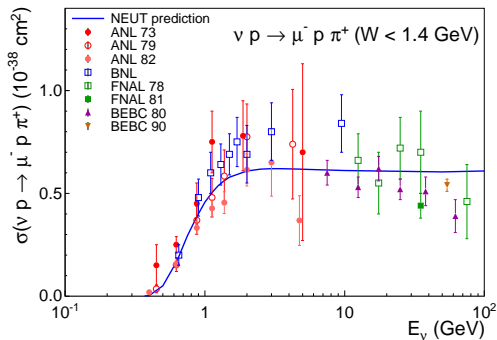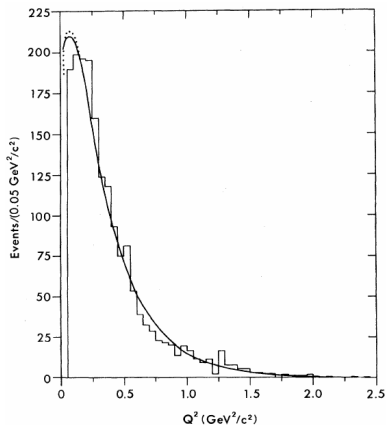
- ▶ CCQE fairly well understood (but overall norm?)
- ▶ Single π not great. What can we do?
    - ▶ Oscillation expts only need cross section on nuclei, arguably...
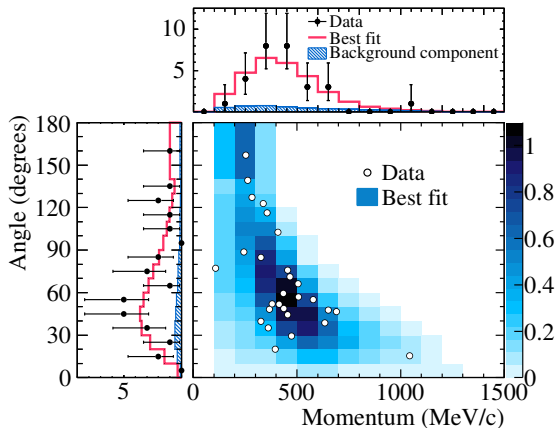
Getting the most out of what we have
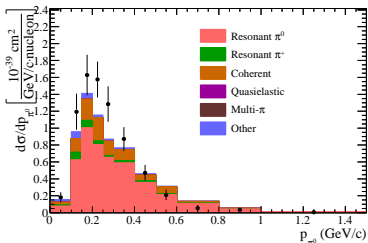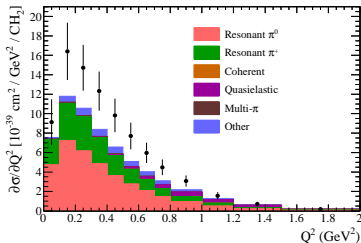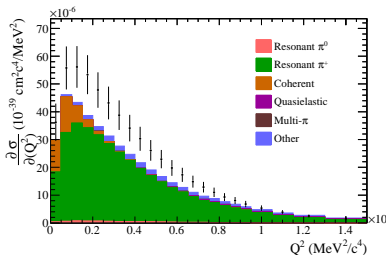
- Taking data sets together, e.g. single pion sets from MiniBooNE
- Looking at all available distributions
- Exactly what are we measuring?

Taking data sets together: example

MiniBooNE CC1π^+ MiniBooNE CC1π^0
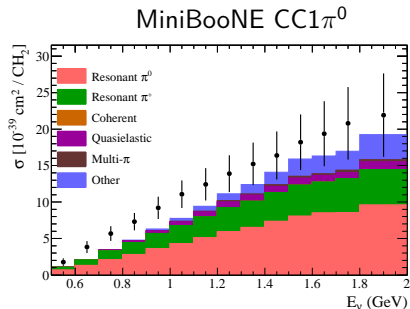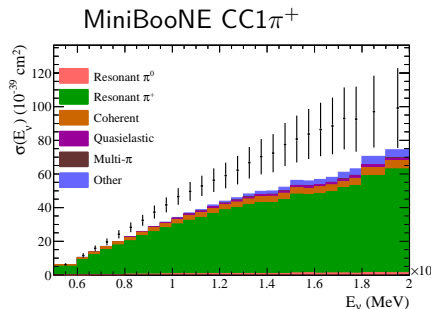
- There's more going on here than just the flux!

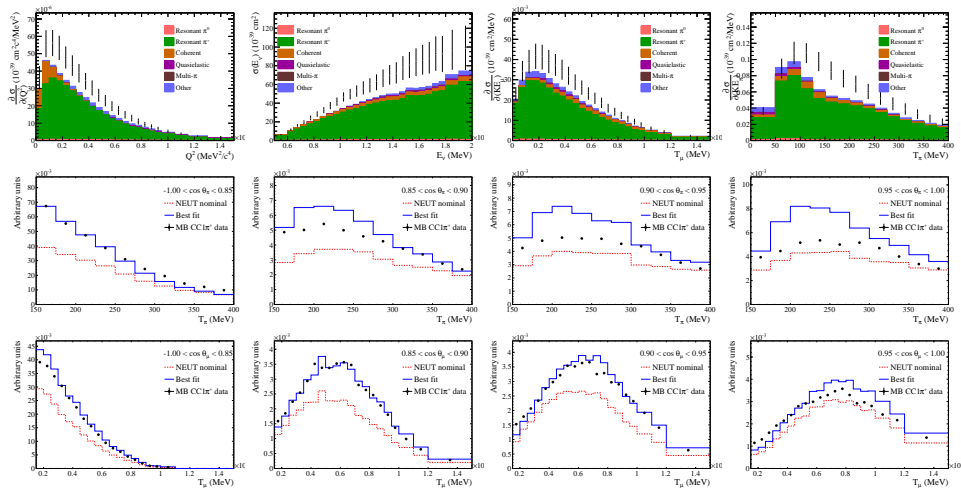# But the total cross section isn't enough!

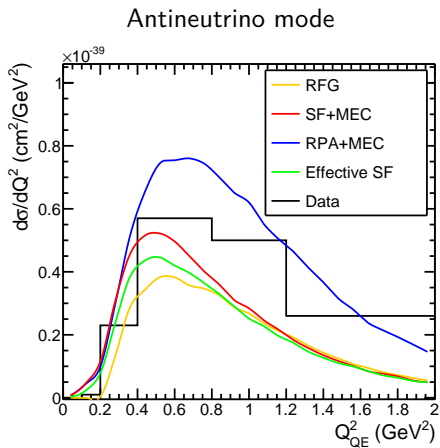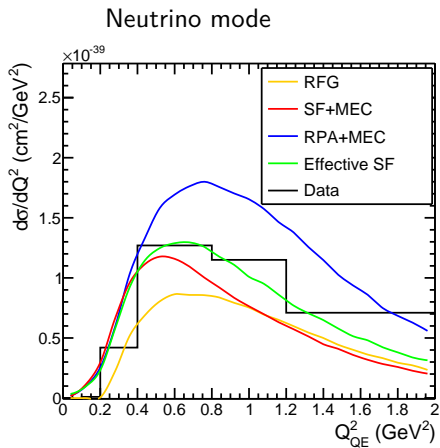T2K ν_e appearance, PRL 112, 061802 (2014)

▶ Oscillation experiments are emphatically *not* rate-only
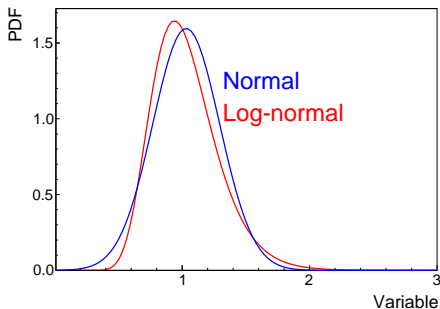
Publish all the available distributions

MiniBooNE CC1π^+

Exactly what *are* we measuring, again?

Neutrino mode

Antineutrino mode

NEUT predictions for MINERνA CCQE $\theta_\mu > 20°$. Plots courtesy Callum Wilkinson (see his poster)
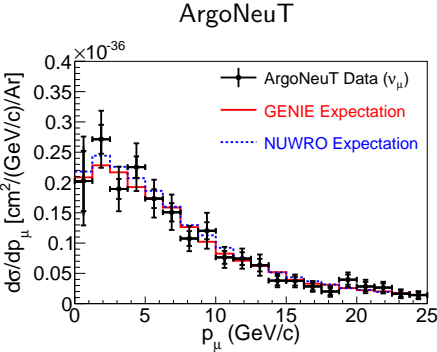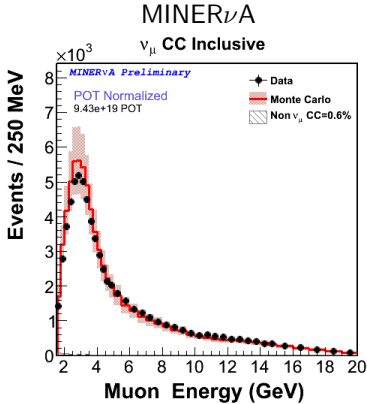
Correlations and assessing uncertainties

$$\chi^2 = (\mathbf{D} - \mathbf{M})^{\mathsf{T}} \mathbf{V}^{-1} (\mathbf{D} - \mathbf{M})$$
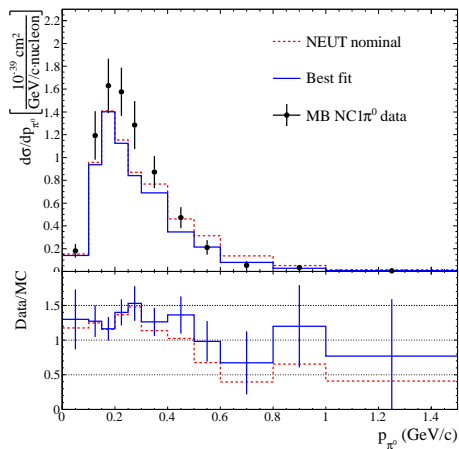
MiniBooNE NC$1\pi^0$, Phys. Rev. D81, 013005 (2010)

► "Peelle's Pertinent Puzzle"

# But wait, it gets better: inter-dataset correlations

arXiv:1404:4809

- Same flux in reality, but not in calculation, so don't do what I've done. . .
- (Fluxes are published, so it's fine)

Needs from theorists/generators

- What are the most interesting distributions to look at?
- Where are the parameters in models?

Where are the tunable parameters in (theoretical/empirical) models?

- Eg, in vector form factors, final state interactions, nuclear densities?
- Experimentalists not shy about inventing parameters...
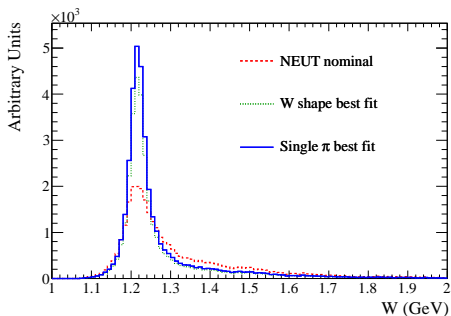
The infamous "W shape" parameter

Recap

- Global fits are hard
- We need:
    - As much information as possible from each measurement
    - Improved understanding of dealing with correlations
    - Clear descriptions of what's measured in each experiment