NUISANCE

Neutrino Generator Comparison and Tuning

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Introduction

- NUISANCE is an open source neutrino event generator tuning framework [1], supporting the NEUT, NuWro, GENIE, and GiBUU generators [2-5]

nuisance.hepforge.org

Generator Comparisons

- Generator files are converted to common format
- Likelihoods, tunings, signal definitions, dependent variables handled consistently between generators

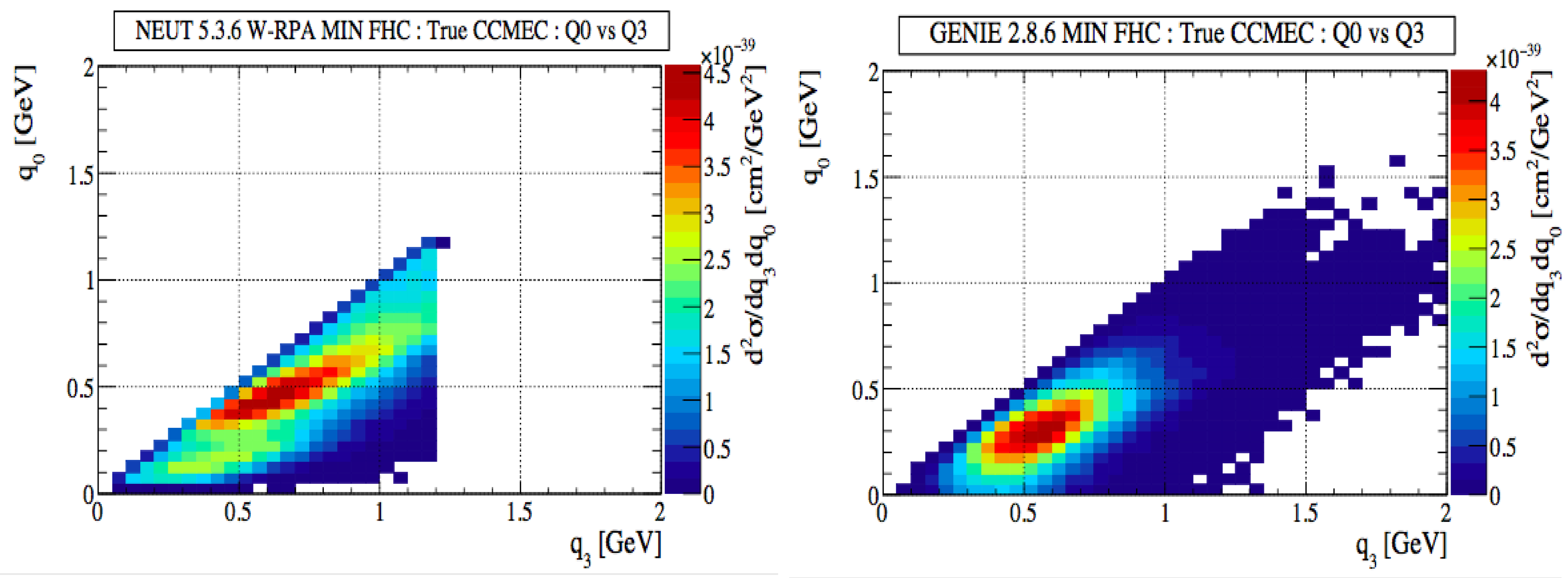

Figure 1. Comparison of NEUT Nieves 2p2h (left) and GENIE Empirical MEC (right) models in true energy transfer (q_0) and momentum transfer (q_3)

- Can make "flat trees" for all generators to investigate interesting distributions for analysers

Data/MC Comparisons

- More than 200 datasets included for multiple scattering targets, energy ranges and final states
- Likelihoods automatically calculated allows evaluation of different model effectiveness

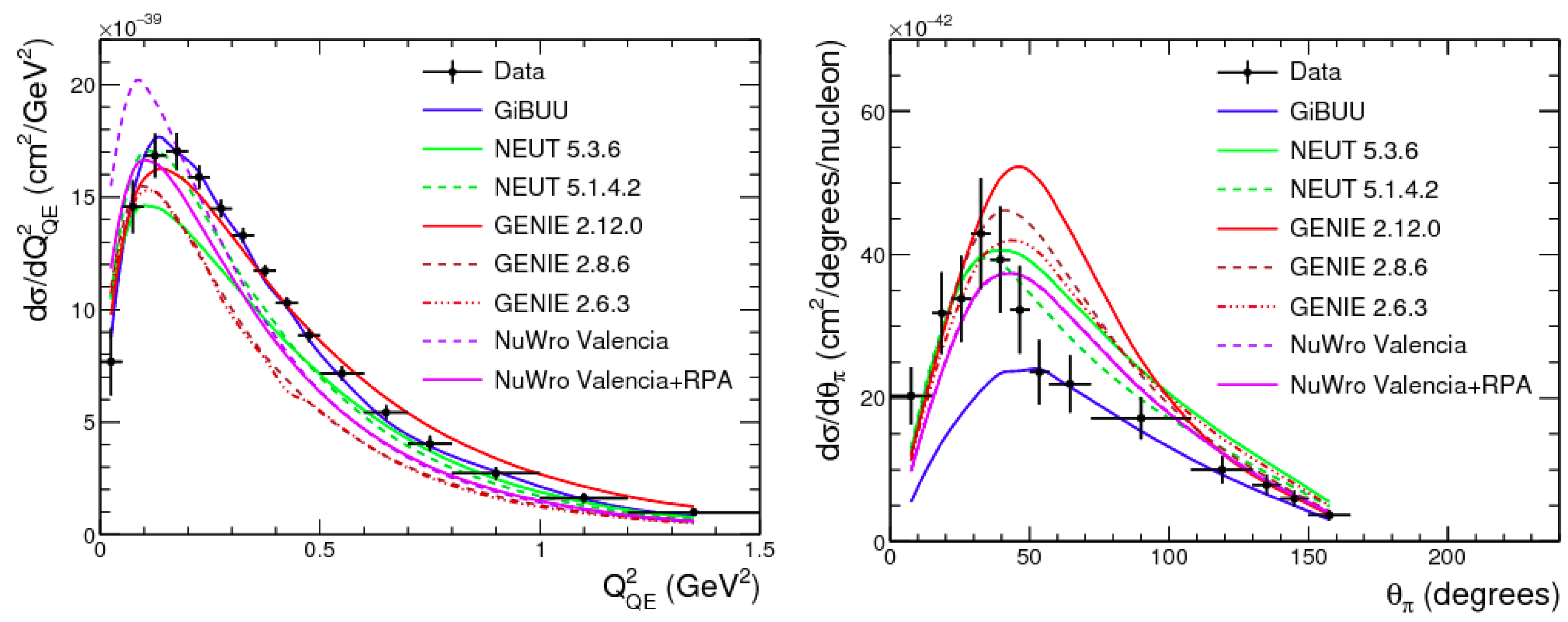

Figure 2. (left) Comparisons of different MC predictions to MiniBooNE -CH_2 CCQE data [6] (right) Comparisons of the same models to MINERvA -CH CC data [7]

Model Tuning

- Interface with ROOT minimiser and error estimators
- Enables tuning of generator model parameters

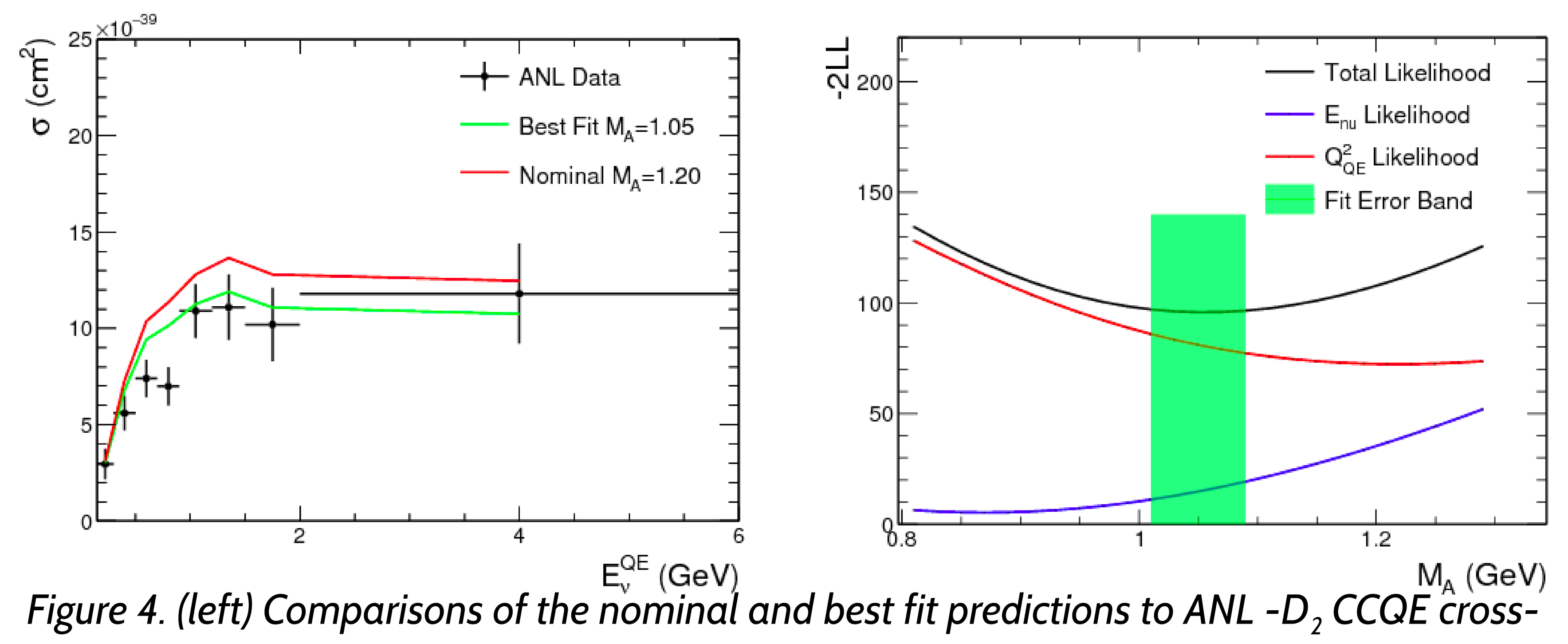

Figure 4. (left) Comparisons of the nominal and best fit predictions to ANL -D_2 CCQE cross-section data in NEUT [8] (right) Likelihood scan of the tuned minimum

Systematic Studies

- Error band routines included to understand how different model tunings cover global neutrino scattering data

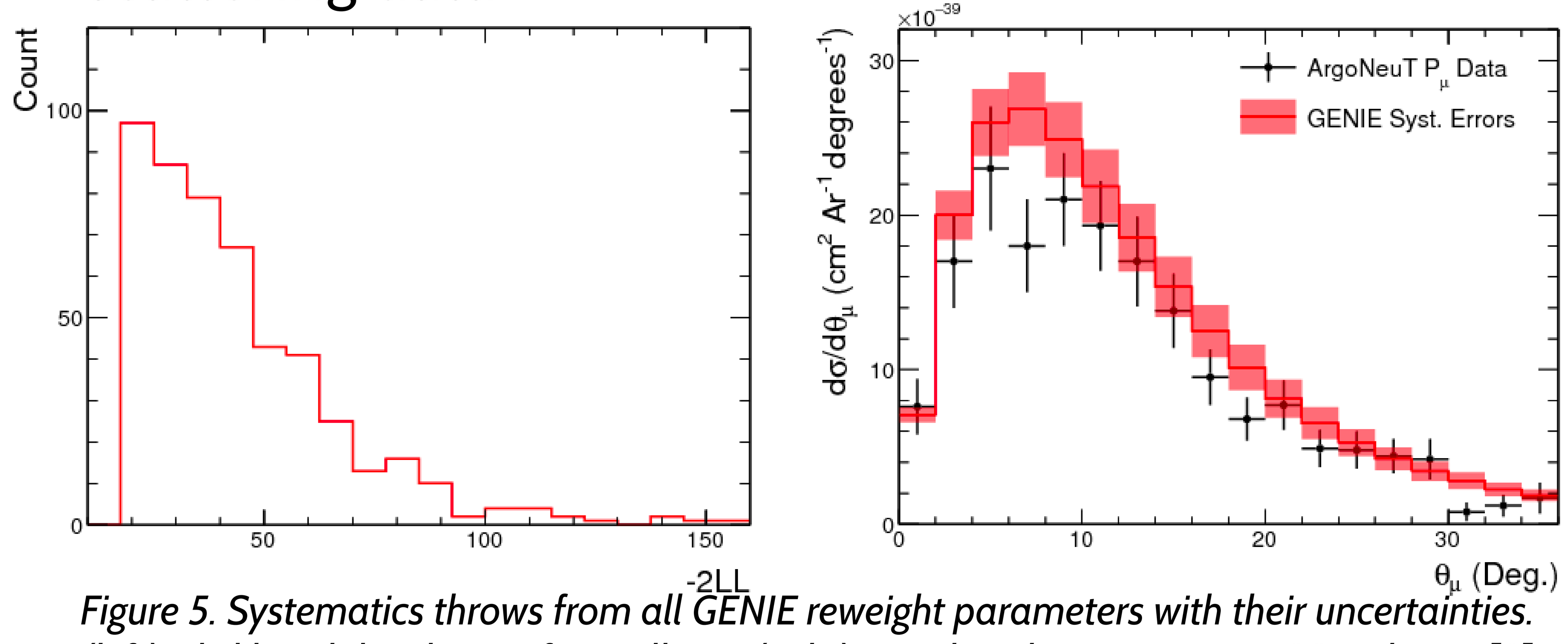

Figure 5. Systematics throws from all GENIE reweight parameters with their uncertainties. (left) Likelihood distribution from all toys (right) Error bands on ArgoNeuT CC-inclusive [9]

NUISANCE Validations

- Release NUISANCE Data/MC comparisons with latest generator models periodically on website

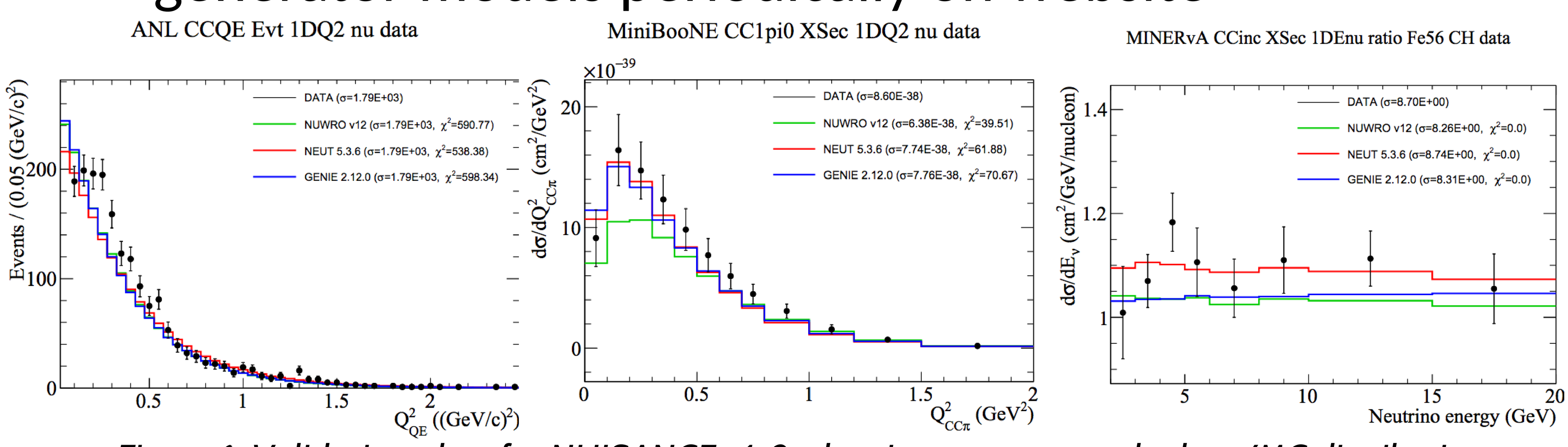

Figure 6. Validation plots for NUISANCE v1r0, showing some example data/MC distributions

NUISANCE Tuning Studies

- Release a set of bubble chamber tunings, constraining the neutrino-nucleon interaction cross-section
- Propagate these constraints to nuclear target data comparisons/fits and more inclusive channels

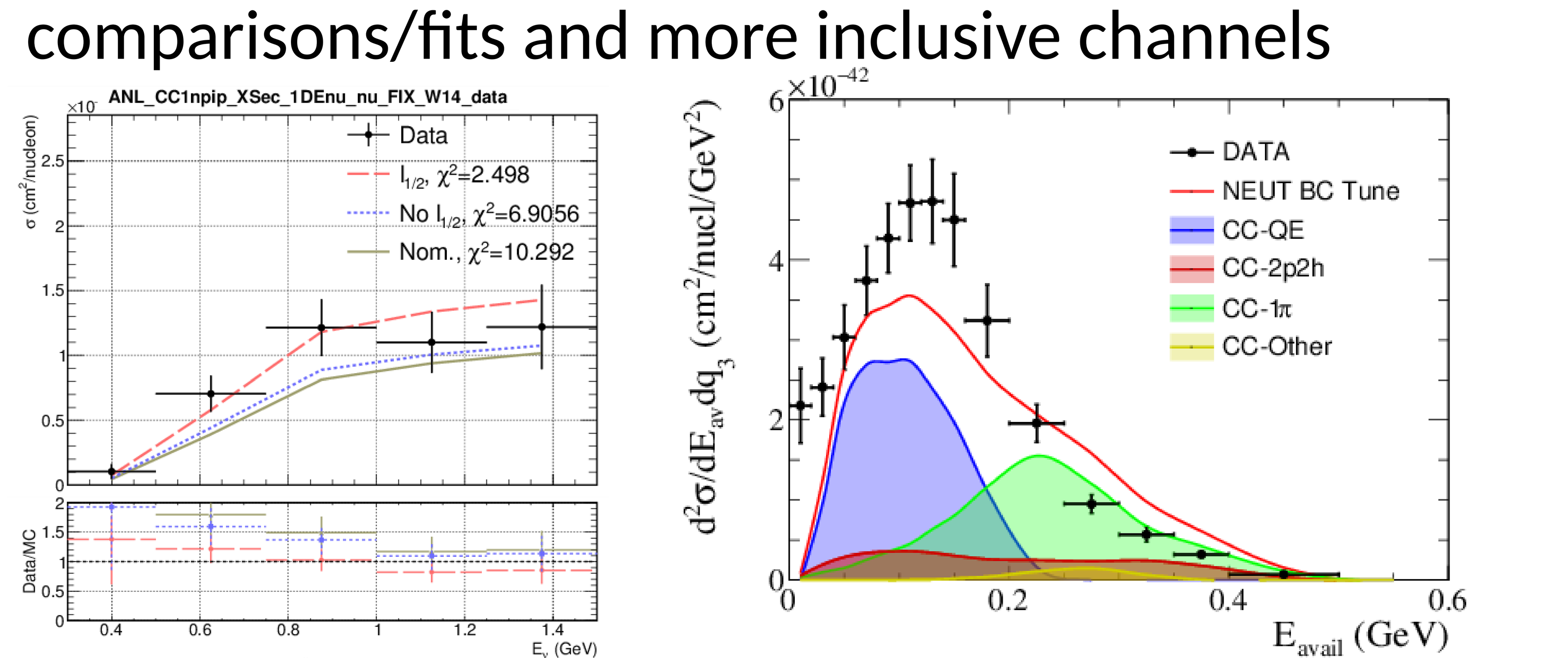

Figure 7. Tune of the single pion production model in NEUT to H_2/D_2 CC1π ANL W < 1.4 GeV chamber data [10], applying to MINERvA CC-inclusive data [11]

NUISANCE Electron Scattering

- Supports GENIE and NuWro electron scattering
- GiBUU and theory inputs are being included [12-14]

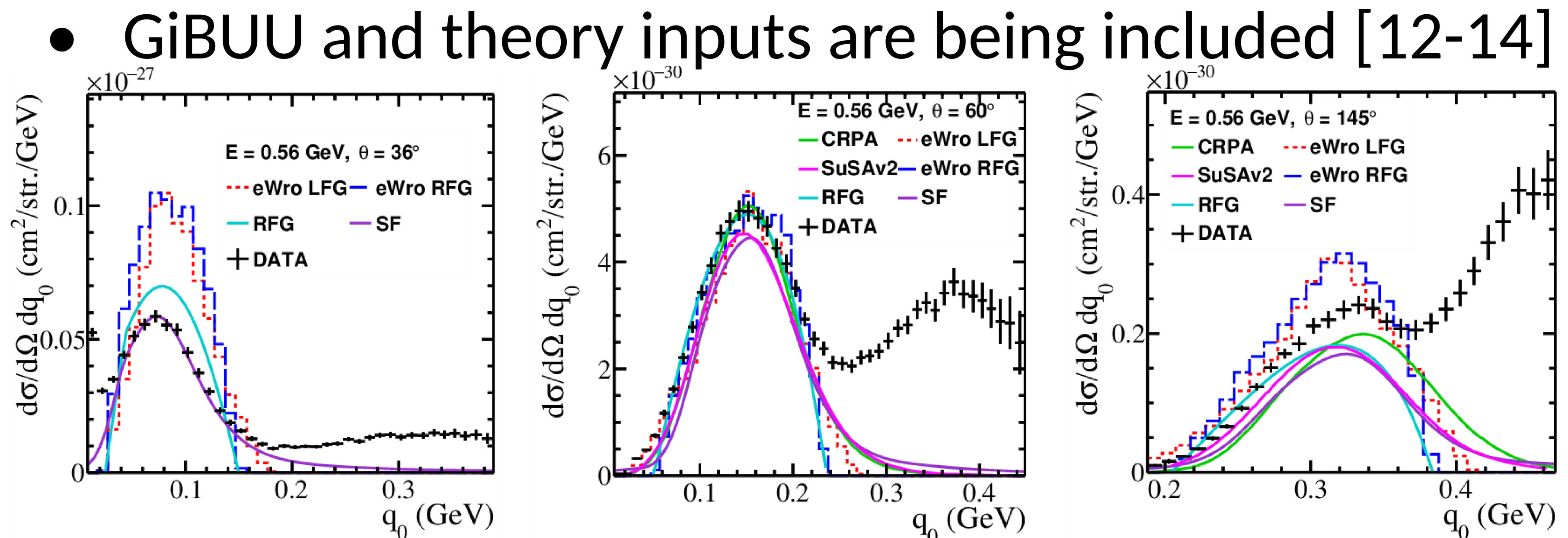

Figure 8. Preliminary electron scattering comparisons in NUISANCE, data from [15]

- Pion and photon induced production also considered

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