

NUISANCE HEPDATA

MC Tools Workshop 2024

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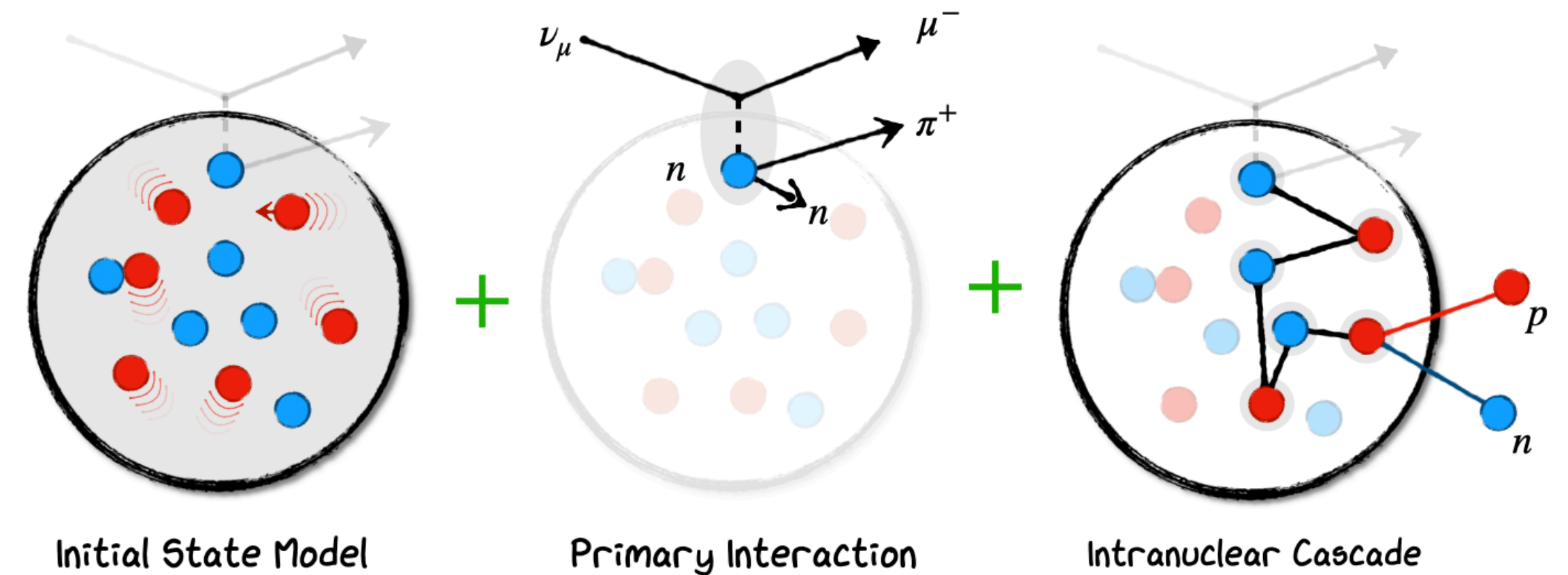
C. Wilkinson



S. Dolan



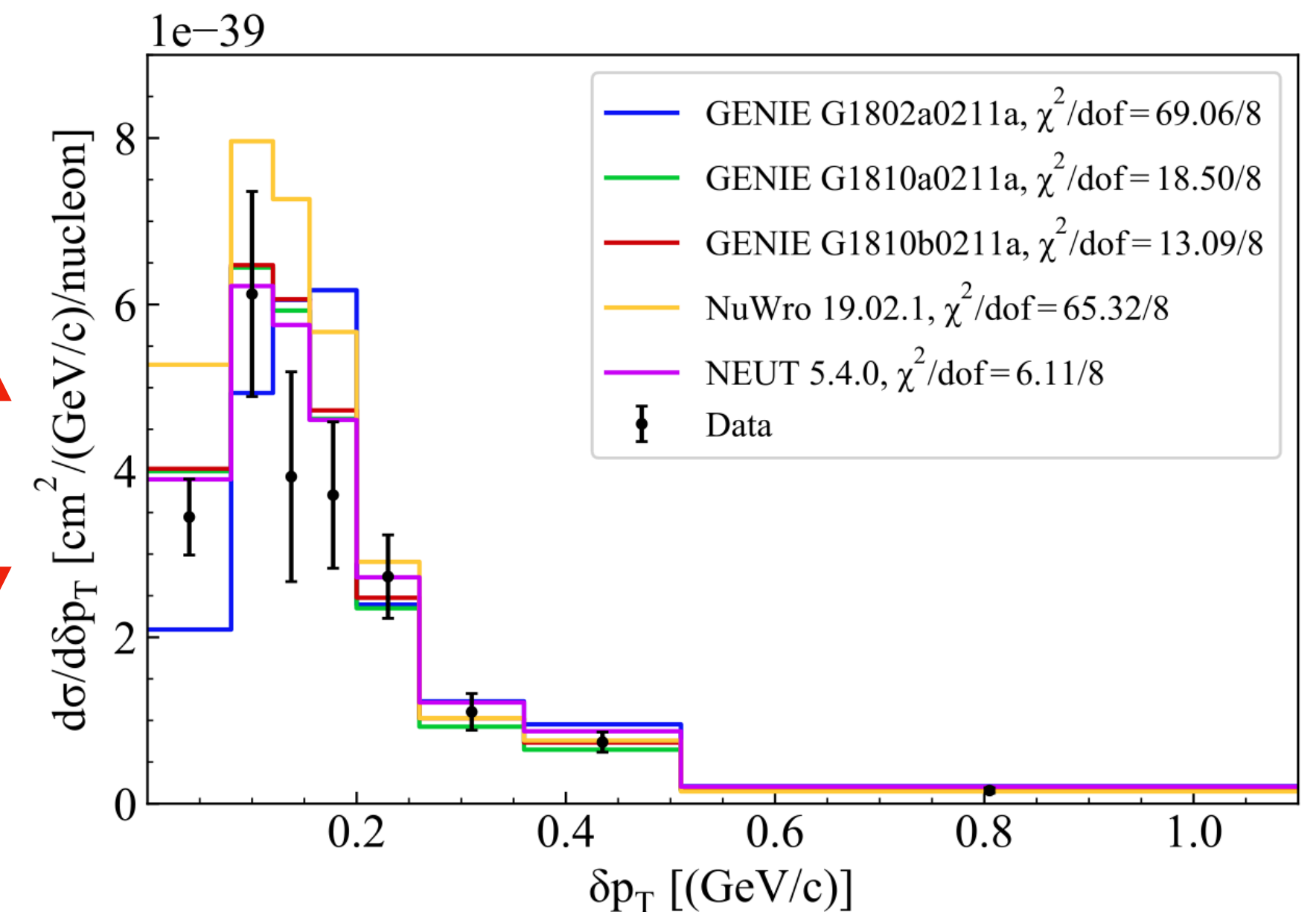
- ◆ Neutrino community relies on interaction generators to bridge the gap between inclusive theoretical models and exclusive final state topology predictions.
- ◆ Five possible generators used in the community : GENIE, NEUT, NuWro, GiBUU, ACHILLES
- ◆ **The challenge:** Major tensions in the global dataset, no neutrino interaction generator model gets good agreement.



Generator Factorisation

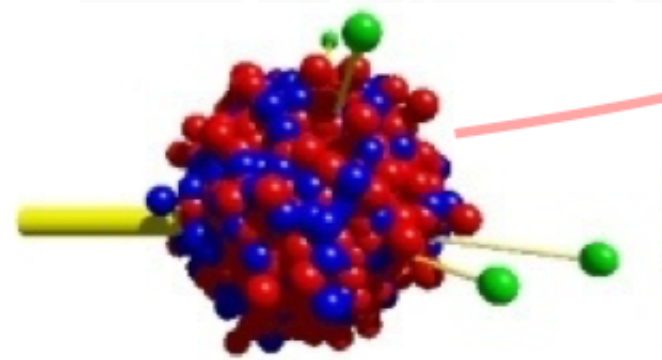
Huge model differences in some regions of phase space

T2K Transverse Mom. Comparisons TENSIONS2019



NUISANCE

- ◆ Developed the NUISANCE framework as a neutrino focussed tuning tool to standardise comparing generators to data (neutrino equivalent of RIVET in collider community).
- ◆ V1 T2K external data fitter (2014). V2 community release (2017).
- ◆ Open source tool for comparing/fitting neutrino generators.

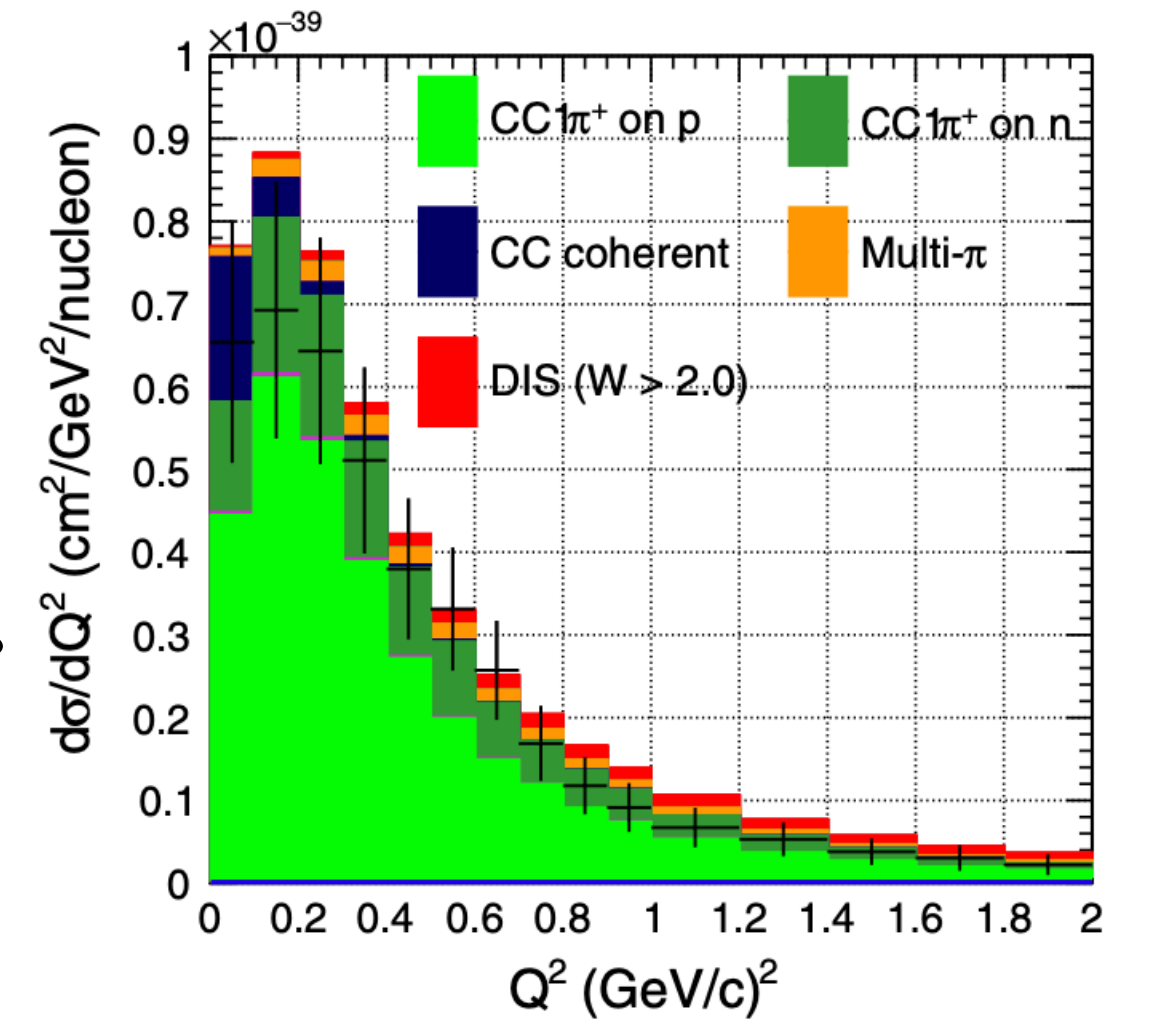
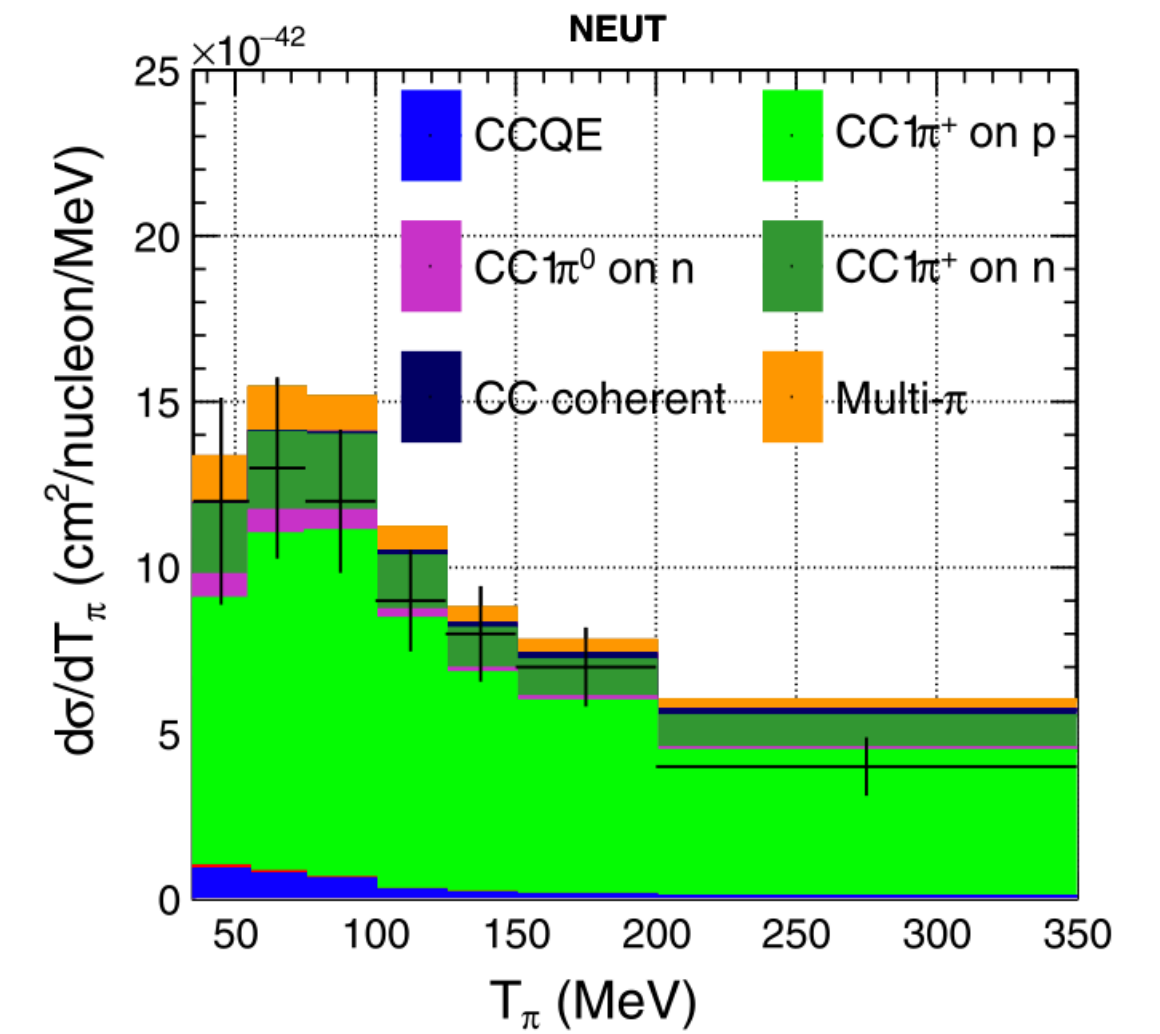


Neutrino
Generator Events



> 300 ν - A
Standardised
Comparisons

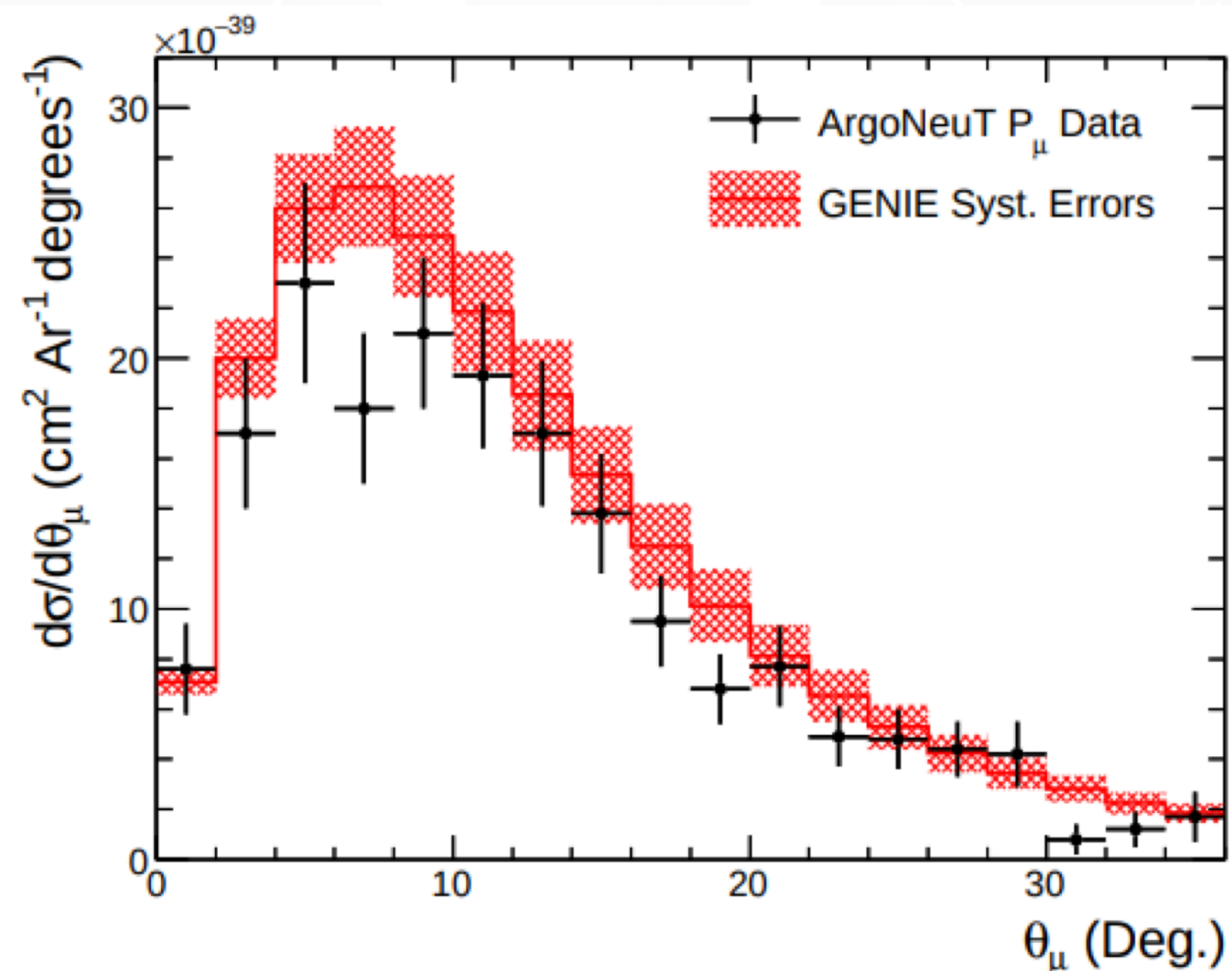
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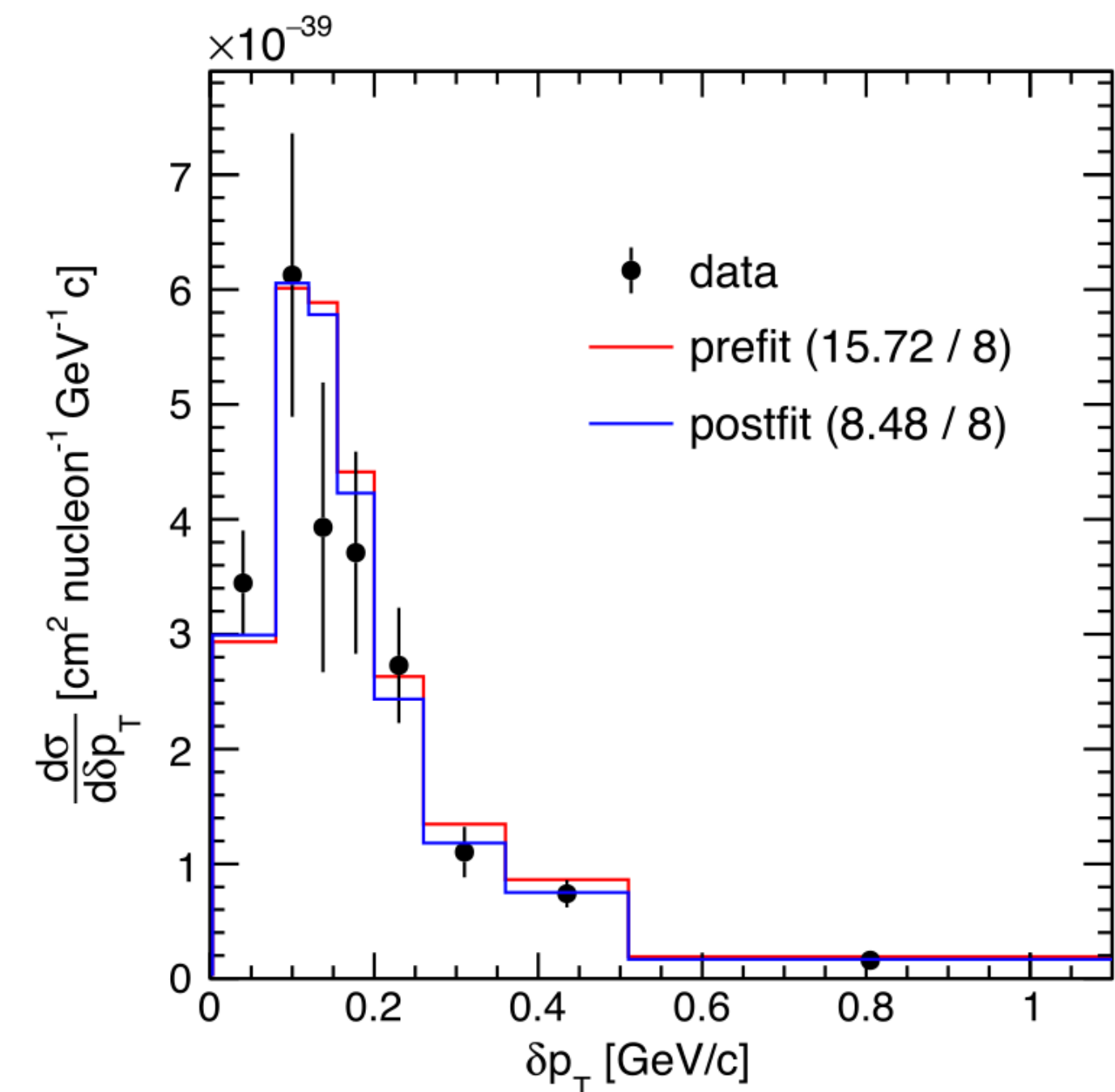
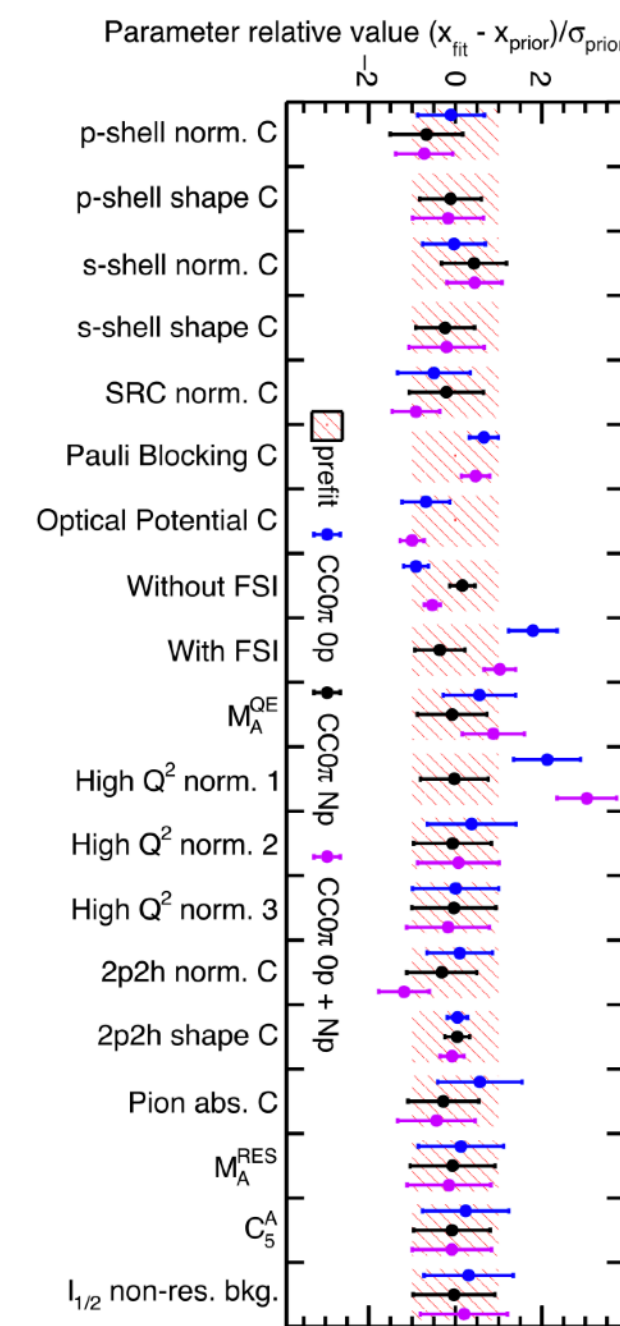
Pion Modelling in NEUT : Comparisons and Challenges of Modern Neutrino Scattering Experiments.

NUISANCE Analyses

- ◆ Original interface written aimed at flux averaged total cross-section neutrino experiments.
- ◆ Have required extensions to the analysis methodology in NUISANCE as new experiments move to novel unfolding/detector smearing approaches.
- ◆ Recently many measurements implemented into NUISANCE by experiments themselves, similar user model to RIVET analyses.



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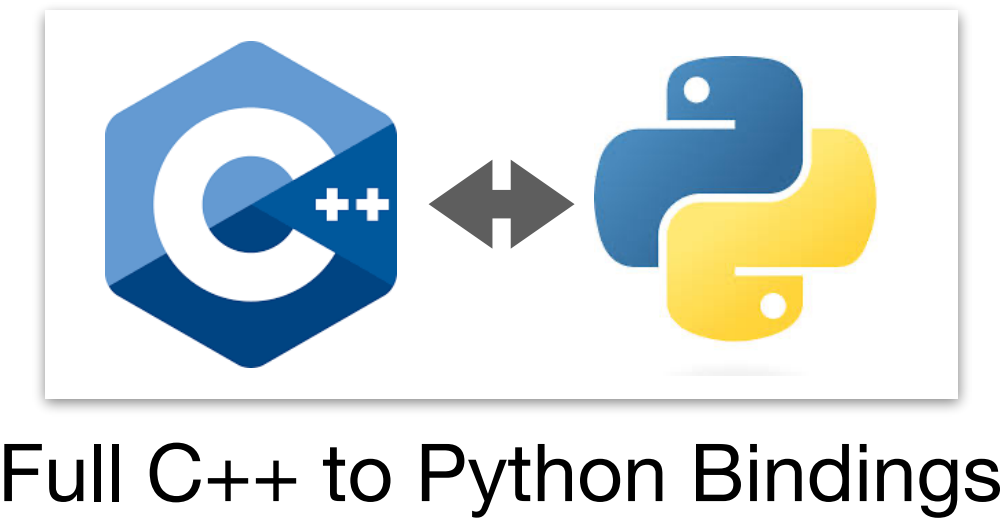


DOI: [10.1103/PhysRevD.109.072006](https://doi.org/10.1103/PhysRevD.109.072006)

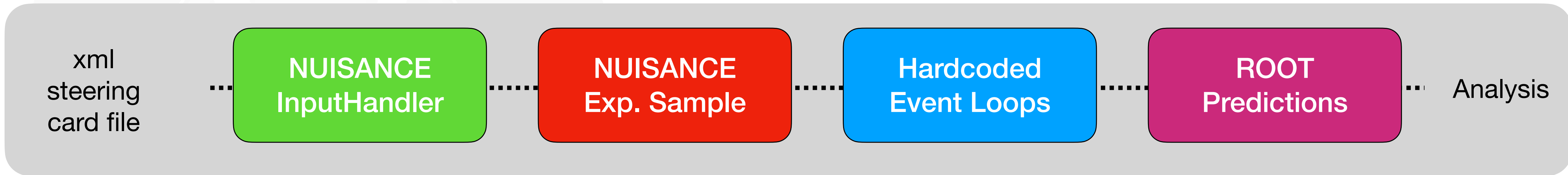
PROTOTYPING EFFORTS : nuisance3



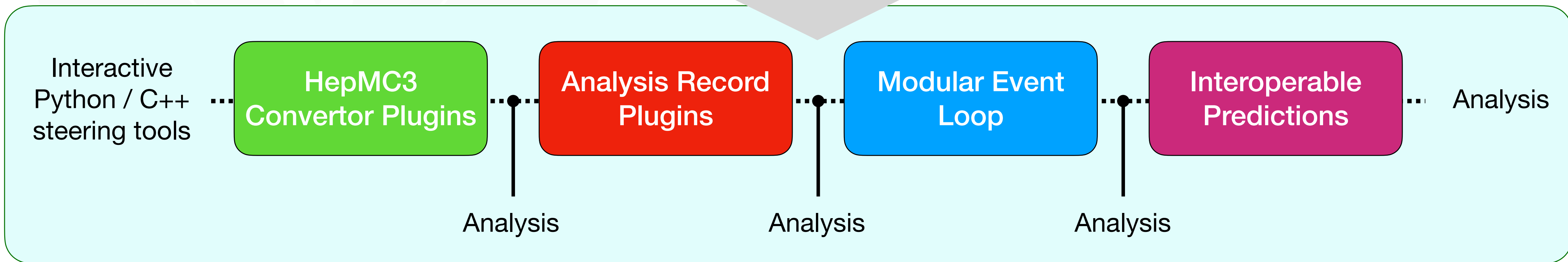
- ◆ Exploring how the structure of NUISANCE could be rewritten to make it more accessible.
- ◆ Move away from prior monolith structure to modular interfaces.
- ◆ Enable external processing/tuning libraries to interface at different stages in the analysis chain through C++ or python.



V2

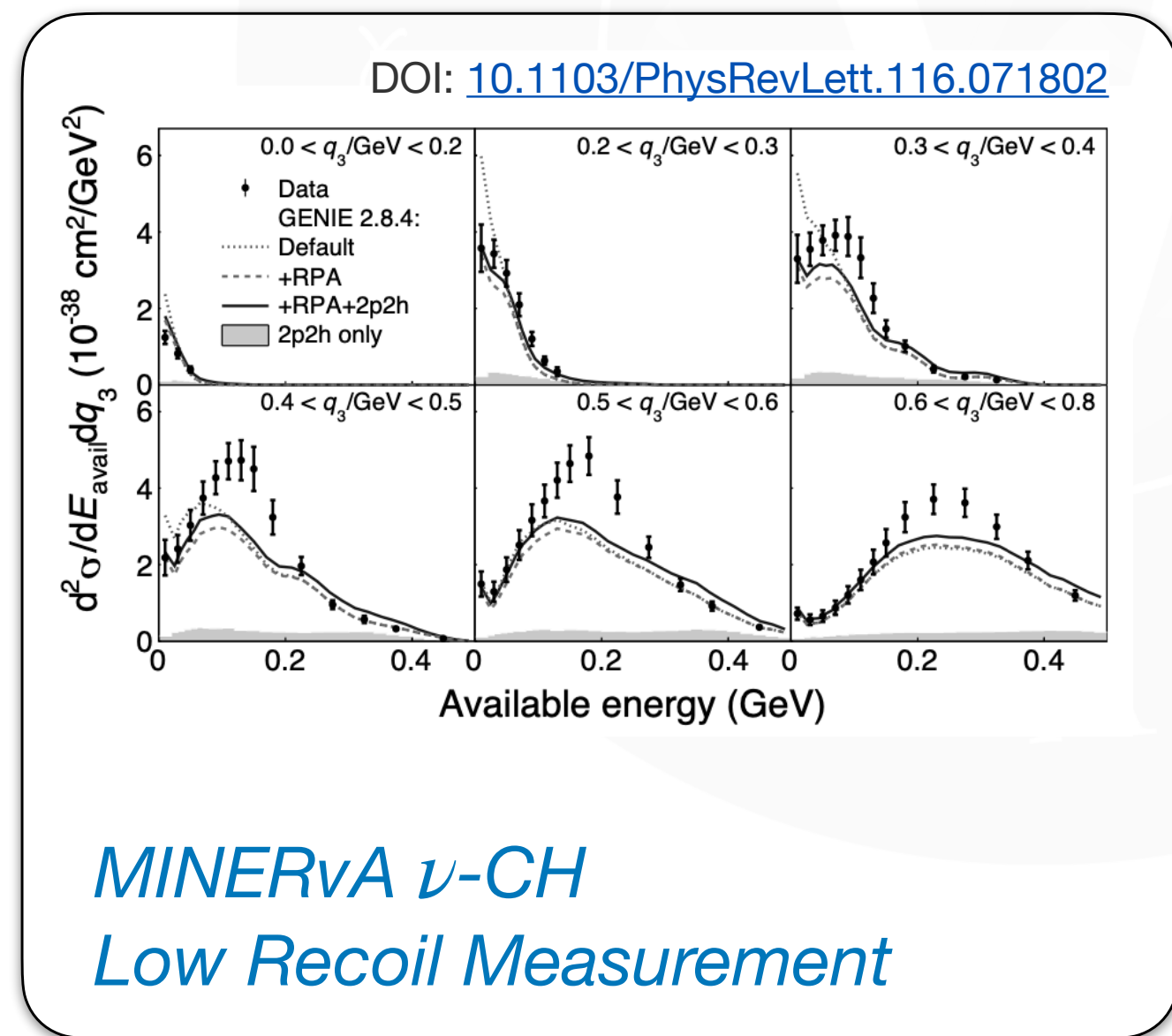


V3-Prototype





- ◆ **ProSelecta** : a modular NuHepMC event analysis tool that supports JIT compiling of analysis functions.
- ◆ Automatic loading of HepMC3 extensions makes development slightly easier but real strength is the ability to prototype analysis data releases and signal selections.
- ◆ Directly compare many different experimental projection approaches kept in a single file loaded at runtime.



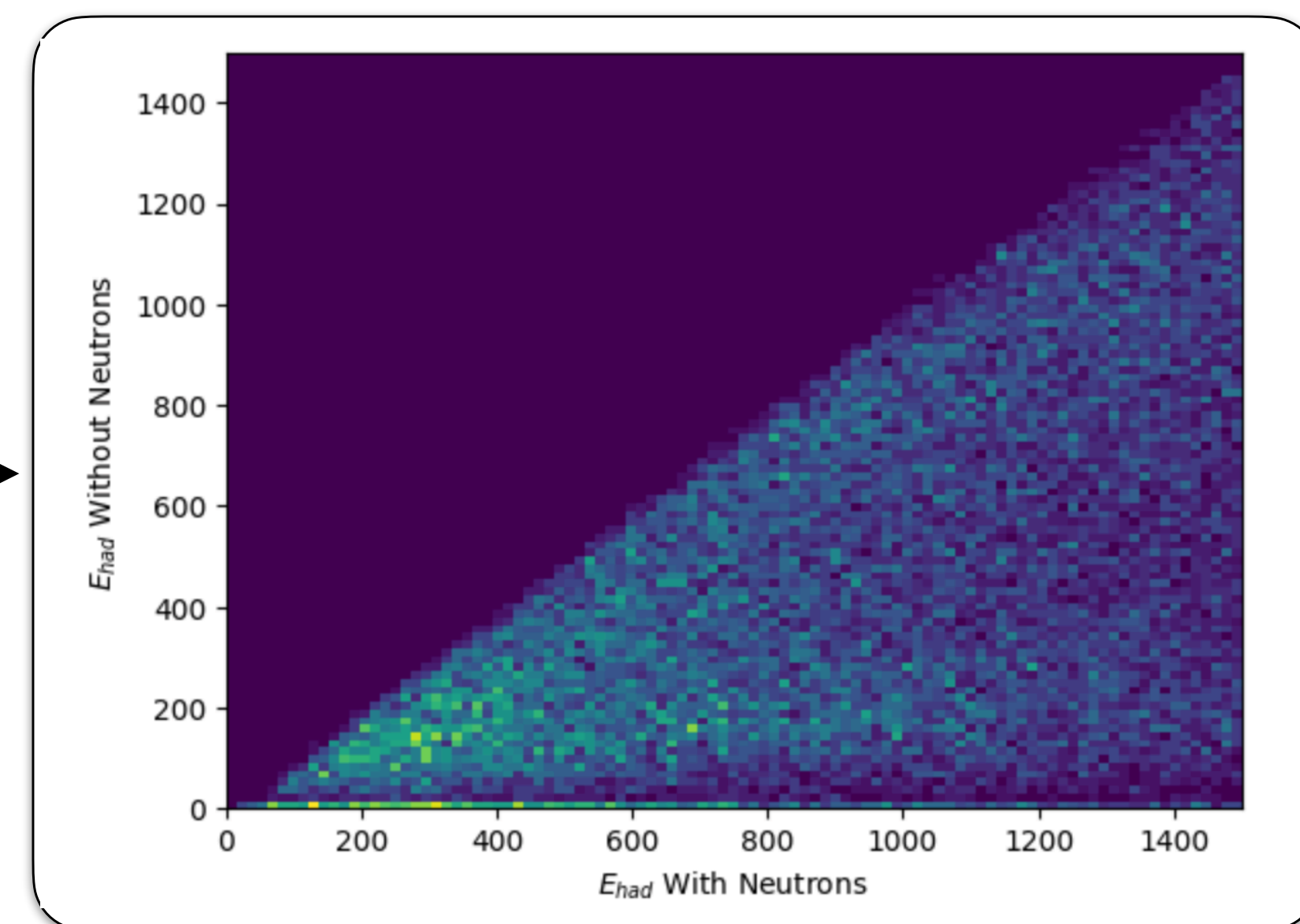
```
// MINERvA CC-inclusive Signal Definition
int MINERvA_CCINC_CCEavq3_Filter(ev) {
  auto nu = ps::sel::Beam(ev, ps::pdg::kNuMu);
  if (!nu) return false;

  auto mu = ps::sel::OutPartHM(ev, ps::pdg::kMuon);
  if (!mu) return false;

  double cosangle = ps::proj::event::CosLep(ev);
  if (cosangle) < 0.93969262078) return false;

  if (ps::proj::event::ELep(ev) < 1.5 * ps::GeV)
    return false;

  return true;
}
```



DATA PLUGINS : HEPDATA ν -A Scattering

- ◆ Exploring the use of HEPDATA as a standard data release format for adoption by the neutrino community.
- ◆ YAML based data release with associated correlation matrices, supporting flux info.
- ◆ Additional information beyond the data tables is needed to reliably preserve the original analysis.
 - ◆ Historically most of the effort has been in the “Reanalysis Processor” stage.
- ◆ nuisance3 setup to automatically parse HEPDATA snippets using ProSelecta, fully dynamic processing of comparisons.

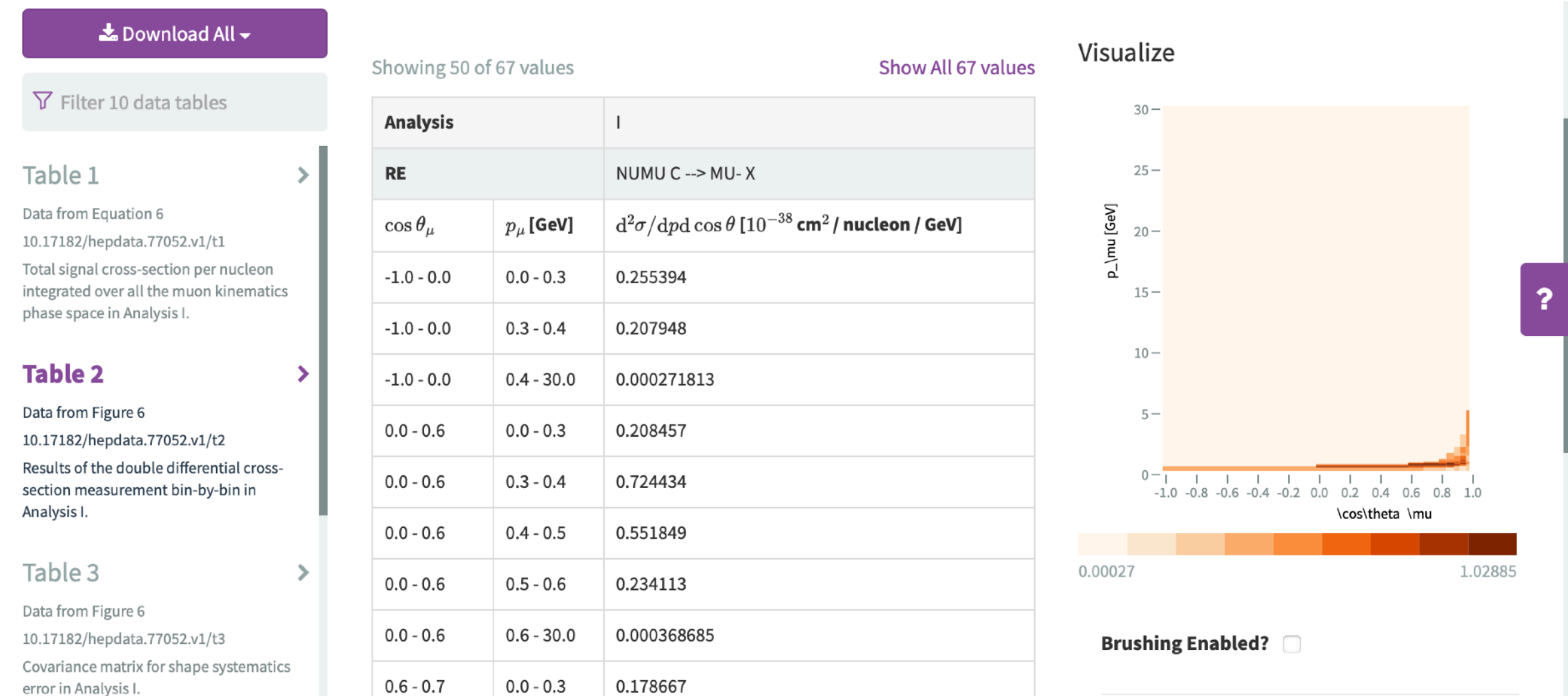


Measurement of double-differential muon neutrino charged-current interactions on C_8H_8 without pions in the final state using the **t2k** off-axis beam

The T2K collaboration Abe, Ko ; Andreopoulos, Costas ; Antonova, Maria ; *et al.*

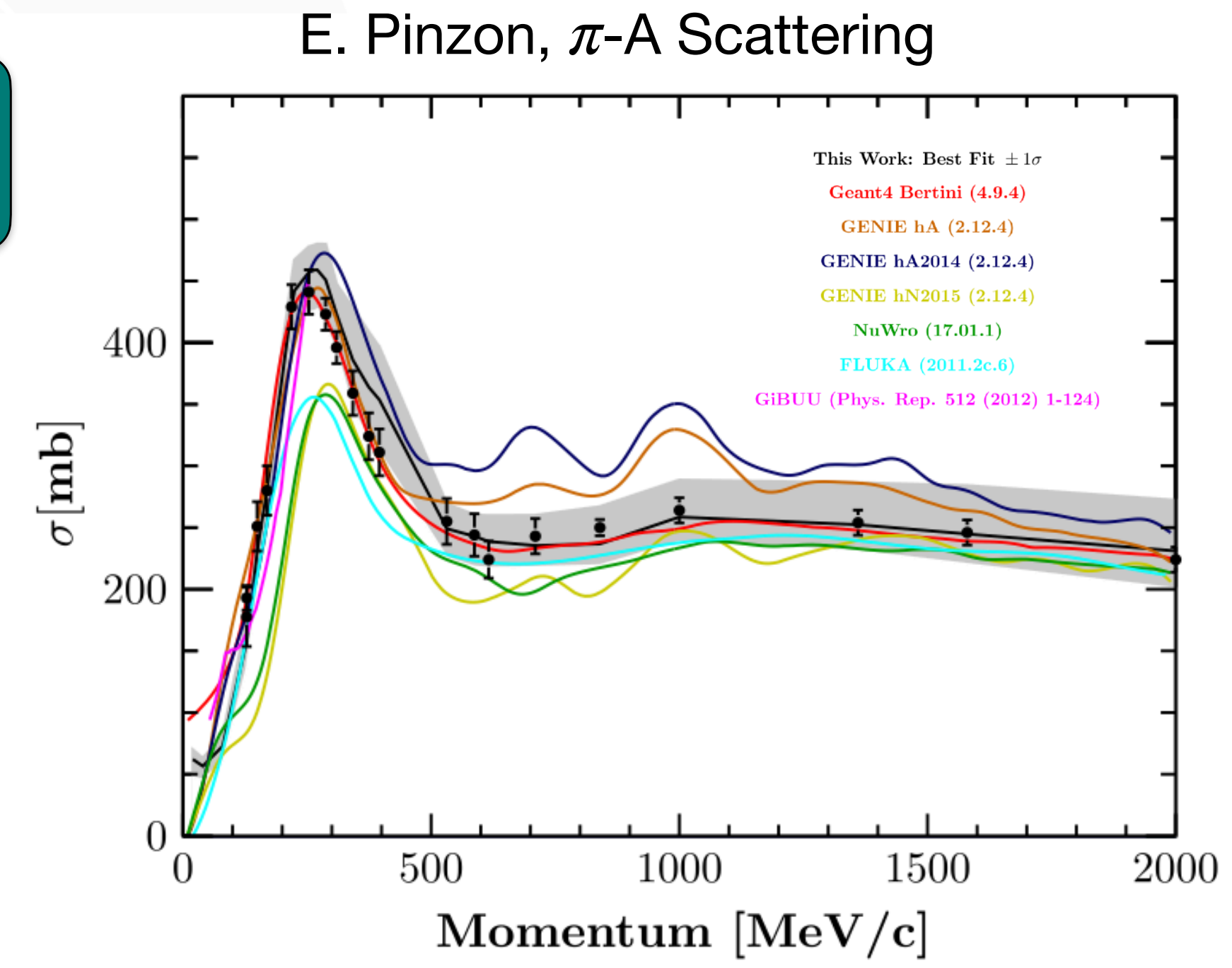
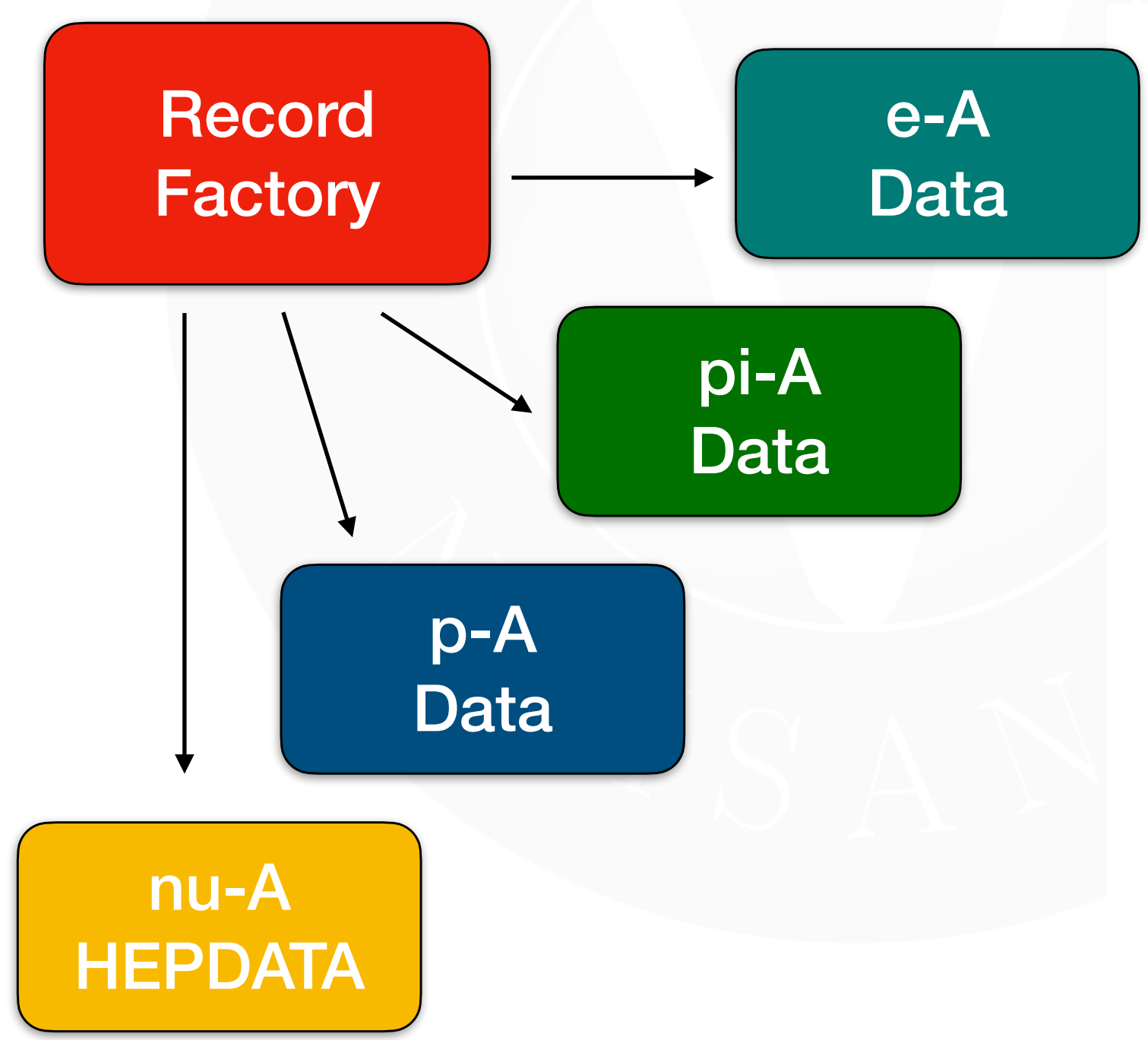
Phys.Rev.D 93 (2016) 112012, 2016.

Inspire Record 1421157 DOI 10.17182/hepdata.77052

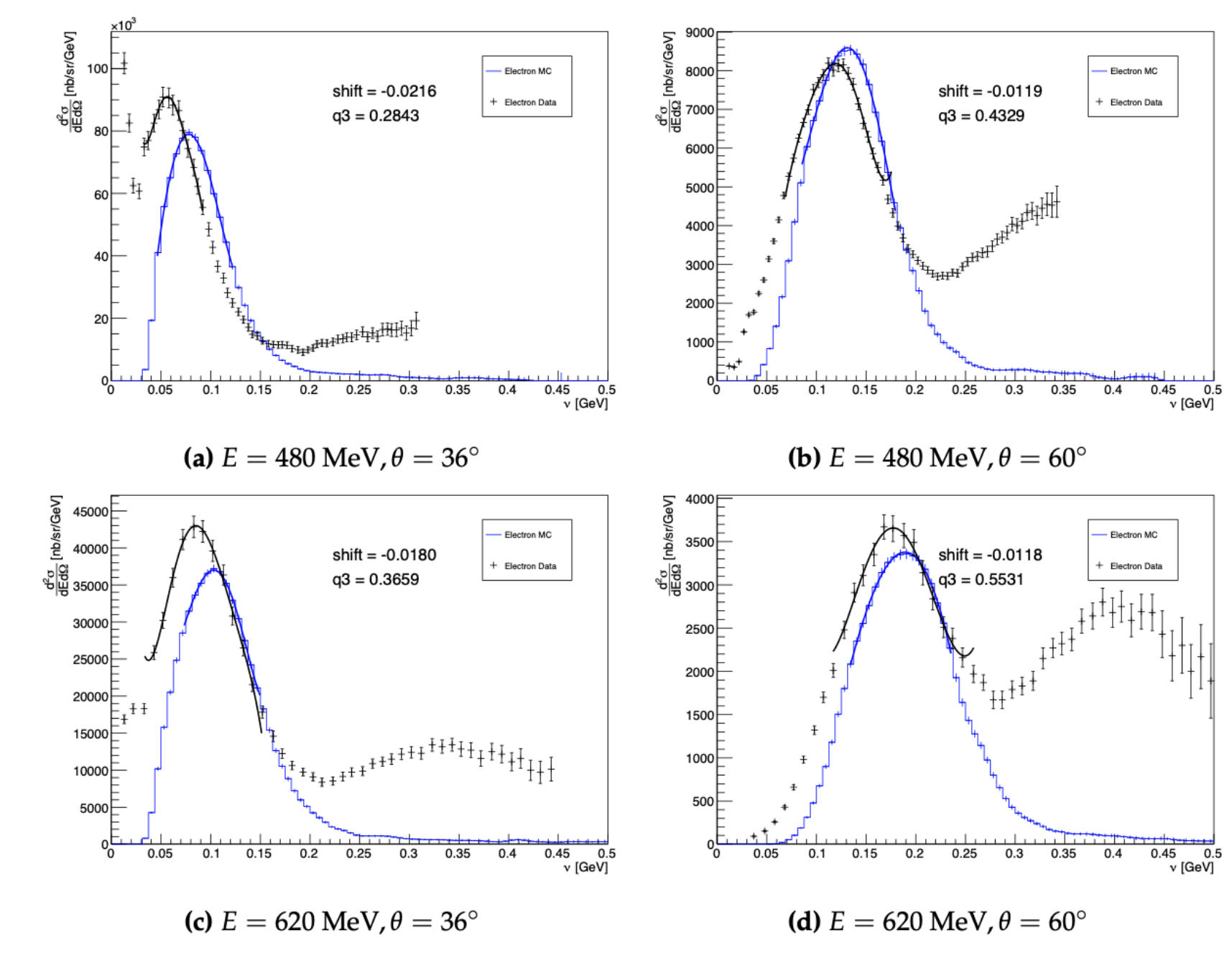


DATA PLUGINS : p -A/ π -A/ e -A Scattering

- ◆ Long term plan to combine neutrino HEPDATA global analyses with interfaces to existing pion and electron scattering data initiatives.
- ◆ Understanding correlations in nuclear models across multiple classes of data.



J. McElwee, e -A Scattering



CONCLUSIONS



- ◆ NUISANCE provides standardised generator tuning tools for the neutrino community.
- ◆ Looking at redeveloping core code structure to use module generator and analysis methods.
 - ◆ Moving away from monolithic comparison routines.
 - ◆ Exploring use of automated compilation of data release projection/signal operators.
 - ◆ Python steering code for interfacing to external tuning tools.
- ◆ Processes being considered based on feedback from experience in the neutrino community, but welcome thoughts, suggestions, and comments on lessons learnt in the collider community.

THANKS FOR LISTENING!