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Ongoing Activities for the Fortran Interface

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Reminders

- The theory community is producing a rich spectrum of models for the different neutrino interactions, including charged current quasi-elastic, resonance, deep inelastic, meson change current, coherent, neutral current…
- Some available theoretical models are not available in the event generators
- Having common interface between event generators will allow neutrino experiments to fully benefit from recent theoretical advances in a timely manner
- Common interface means the neutrino community would be able to plug the model immediately into any of the available event generator (GENIE, NuWro, NEUT and GIBUU)
- The community might need different interfaces to accommodate the different calculations available

Several Models available

Table 1: Summary of responders to the neutrino interaction modeling survey

Authors	Processes
Saori Pastore et al. [35]	QE and MEC
Gil Paz et al.[37]	QE
Artur Ankowski et al.[38]	QE
Alessandro Lovato et al.[39]-[42]	Elastic scattering, low energy transition, QE
Luis Alvarez et al.[43]-[49]	QE, (coherent) pion, eta production and photon emission
Noemi Rocco et al.[32]-[34]	QE, MEC, 1 and 2 pion production
Raul Jimenez et al.[50]-[51]	QE
Minoo Kabirnezhad. et al.[52]-[53]	Single pion production
Natalie Jachowicz et al. [54]-[62]	Elastic scattering, low-energy excitations, QE, MEC, SRC and single pion production
Toru Sato et al.[63]	Meson(pion,kaon,eta,2pi) production for nucleon in nucleon resonance region
Huma Haider et al.[64]	Deep Inelastic Scattering
Juan Nieves et al. [65]-[90]	QE+SpectralFunctions+RPA+2p2h+pion production (Delta, chiral background, some other N*)
Maria Barbaro et. al. [91]	Quasi-elastic scattering, two-nucleon emission (2p2h), pion production, higher resonances, deep inelastic scattering, both CC and NC processes.

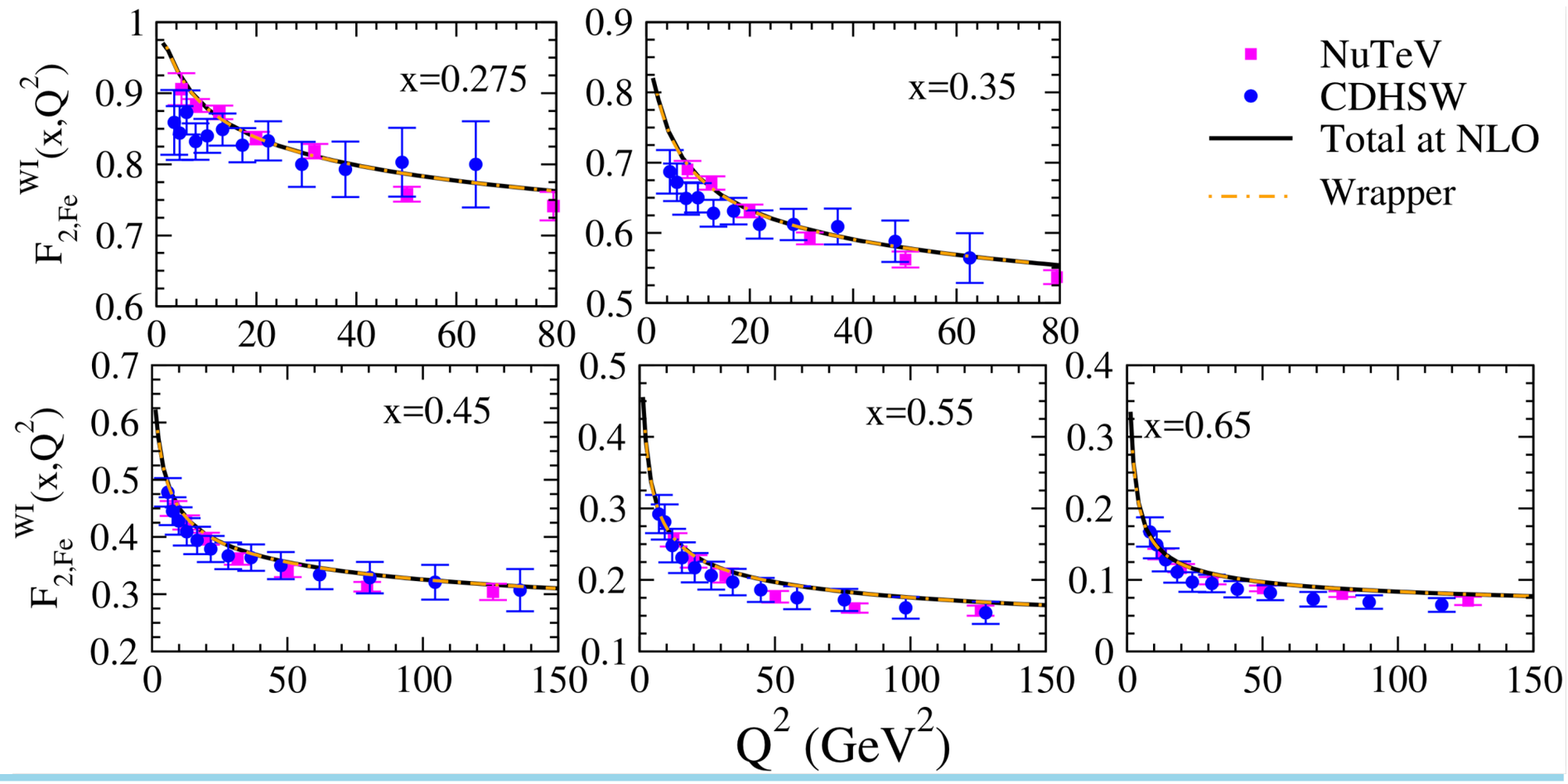
- Full report is available at: https://indico.fnal.gov/event/24164/sessions/7454/attachments/127928/154529/Survey.pdf
- Some models are not included in the different event generators and experiments analysis chain

Interfacing Theory with Event Generators

- Different approaches have been discussed and have started
  - Table approach: Theorists provide the model in a standard format, for example a differential cross section in some combination of variables
  - Hard-scatter events: This strategy is based on an interface developed by Collider Physics community,
  - Interface using lepton and hadronic tensors: Theorists would provide both tensors, recalculated and presented in a standard format or provide the code that computes these
  - Fortran interface: develop a uniform computer code format that allows the theorists to implement cross section calculation directly into the event generator, for example a Fortran wrapper that attaches an event generator (C++) to theory code (Fortran)

Fortran Interface

- Some models are written in Fortran, another interface could be a Fortran wrapper that attaches an event generator to theory code
- An example was presented at the workshop, a Fortran wrapper that takes the structure functions F1, F2 and F3, using the deep inelastic interaction calculation from Huma Haider
- Validation: Fortran original calculation (black) and GENIE wrapper (dashed yellow)



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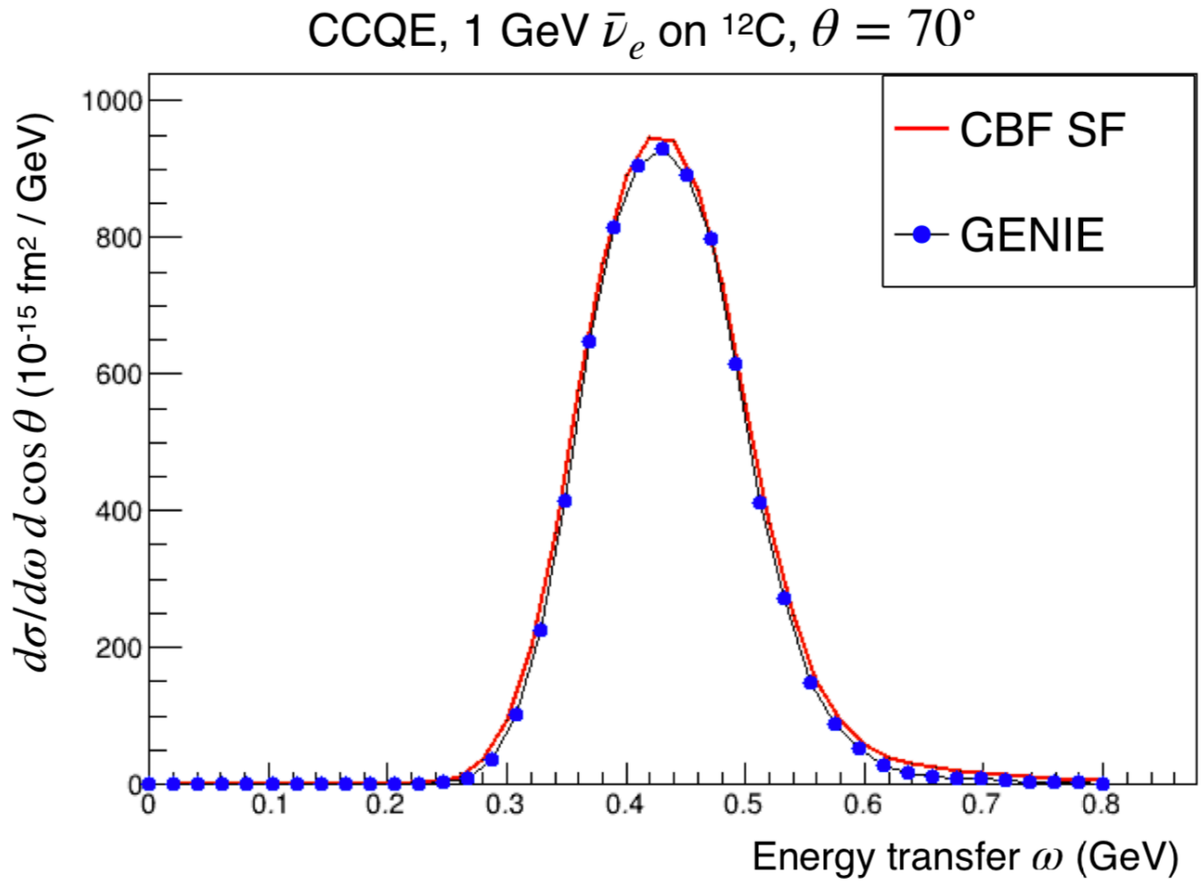
Spectral Function in GENIE

- Spectral function has been included in GENIE using the table approach and a translation of the code from Fortran to C++ for QE electron and neutrino scattering.
- QE neutrino scattering is in validation stage
- Spectral function is available for more process including MEC and RES
- We would like to have a Fortran interface to have rapid access to other available models written in Fortran



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Summer project: "test drive" of a Fortran-based interface

- We have a summer student (Syrian Truong) working with us to write a wrapper for the electron scattering QE and validate it with the existing code
- The goal is to create a working real-world example that can be used to clarify issues related to a general "theory API"
  - Passing 4-momenta, physics parameters, etc. between GENIE and an external theory code
  - Event generation and integration of total cross sections
- Implementation will be kept as general as possible to (hopefully) allow re-use of the new GENIE code for other processes. Some examples:
  - Select final-state kinematics via phase space generation rather than the "traditional" GENIE approach of throwing specific variables (Q^2, W, etc.)
  - Similarly, use MC integration to get the total cross section instead of a custom numerical integrator for each interaction mode
  - (Longer-term) Define a flexible data structure for passing model parameters between GENIE and an external code for runtime configuration / reweighting