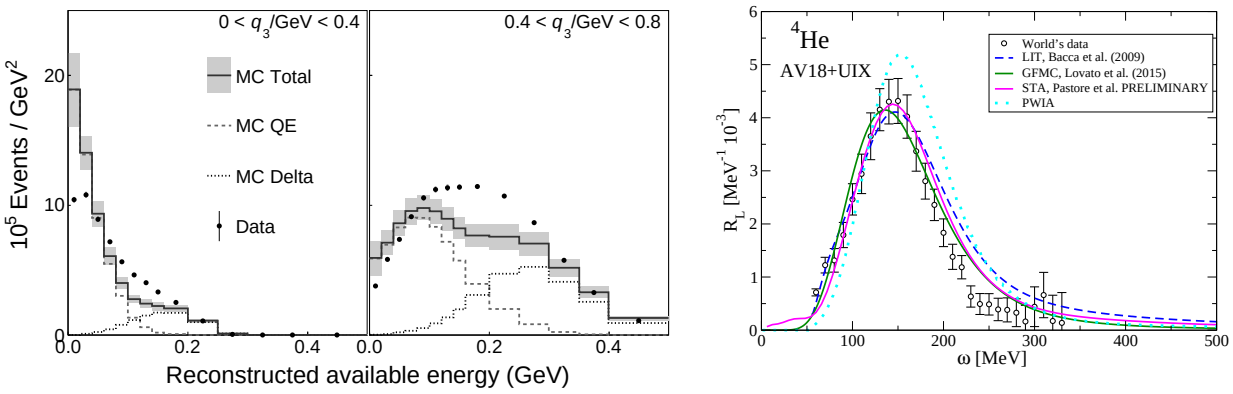

Figure 1: **Left**: Reconstructed available $E_{\rm avail}$ (dots) compared with GENIE simulations with QE process (dashed line), $\Delta(1232)$-resonance (dotted line), and the sum of the two plus unmodeled process (solid line). The lowest $E_{\rm avail}$ data is far below the simulation. Figure from PRL116(2016)071802. **Rigth**: ^{4}He Longitudinal Response at momentum transfer $q = 500$ MeV calculated in exact GFMC [1] (solid dark green), STA (solid magenta), LIT [2] (dashed blue), and Plane-Wave-Impulse Approximation (dotted cyan), to be compared with the experimental data (empty circles).

Interfacing Nuclear Theory with Experiments and Generators

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With this research plan I propose to utilize the Intensity Frontier Fellowship to efficiently and properly implement accurate neutrino-nucleus cross sections into neutrino generator codes. This will lead to improved neutrino energy reconstructions, which is crucial for the extraction of neutrino oscillation parameters. A close and active collaboration with GENIE developers and MINERνA experimentalists is essential. Therefore, I plan to utilize the fellowship to support short and extended stays at Fermi Lab during the period of October 15th 2017 - April 15th 2018. In order to emphasize the urgency and importance of this research plan, in the left panel of Fig. 1 it is shown a comparison between the reconstructed available energy and that calculated from GENIE. The discrepancy between dotted and solid lines is a clear indication that a more sophisticated implementation of nuclear models into the GENIE code is required.

At Los Alamos National Laboratory, we are developing the Short-Time Approximation (STA) that allows to evaluated electroweak cross sections for $A > 12$ nuclei without loosing the important dynamics that comes from two-body physics, which is crucial to explain availble experimental data. In the rigth panel of Fig. 1, I compare the STA calculation of the ^{4}He Longitudinal Response function at $q = 500$ MeV with the exact calculation carried out in Refs. [1–2]. The agreement between STA and exact calculations is excellent, for both Longitudinal and Tranverse Responses. We plan to have inclusive electromagnetic and CC cross sections off ^{4}He, comprehensive of contributions from two-body electroweak currents, by August 2017. I propose to use the Intensity Frontier Fellowship to support and facilitate a close collaboration with the GENIE developers (Dr Gabriel Perdue *et al.*) and MINERνA experimentalists (Dr Minerba Betancourt *et al.*) with the goal of addressing the pressing issue of how to properly implement the calculated neutrino-nucleus cross sections into the neutrino generator codes and compare precisely with experiments.

1. S. Bacca and S. Pastore, 'Electromagnetic reactions on light nuclei', J. Phys. G: Nucl. Part. Phys. **41**, 123002 (2014) and references therein.

2. A. Lovato, S. Gandolfi, J. Carlson, Steven C. Pieper, R. Schiavilla 'Electromagnetic and neutral-weak response functions of ^{4}He and ^{12}C' Phys. Rev. C 91, 062501 (2015).