Snowmass on the Mississippi a.k.a CSS 2013

(Nu4) **Neutrino Interactions**
subgroup conveners: Jorge Morfin (FNAL), Rex Tayloe (Indiana)

Charge

The neutrino scattering subgroup will explore neutrino-nucleus scattering physics with the goal of improving our understanding of both the weak interaction with nuclear matter and the effect of neutrino scattering systematics on neutrino oscillation analyses.
In order to achieve these goals, we will concentrate on these major topics:

- determination of the neutrino flux by measuring event rates of well-known (calculable) processes,
- measurement of the energy-dependent effective neutrino-nucleus cross section for various nuclei over a spectrum of energies,
- using a range of contemporary neutrino generator models, reproduction of the A- and E- dependence of these effective cross sections will be studied to understand the interplay of the neutrino nucleon (within a nucleus) cross section with nuclear effects and the incoming neutrino energy spectrum.
- from this same study with a range of neutrino generator models, an estimate of the systematics in the measurement of neutrino oscillation parameters due to neutrino-nucleus scattering unknowns will be produced.

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Outline:
Motivation:
Better understand ν-quark/nucleon/nucleus interactions over range of energies/targets
- to aid/improve ν oscillations searches/measurements
- interesting nuclear/particle/IF/CF physics

Challenges:
- new/improved data of last 10 years has shown some gaps
- broad-band beams, nuclear targets, quark/nucleon/nuclear DOF

Requires:
- New experiments (or dedicated efforts within experiments)
- Improved theory/phenomenology efforts

- ~20 whitepapers received
- Summarized nicely here at this meeting in 4 sessions. Thanks to speakers!
- Much overlap with other subgroups, 2 joint sessions.

Topics:

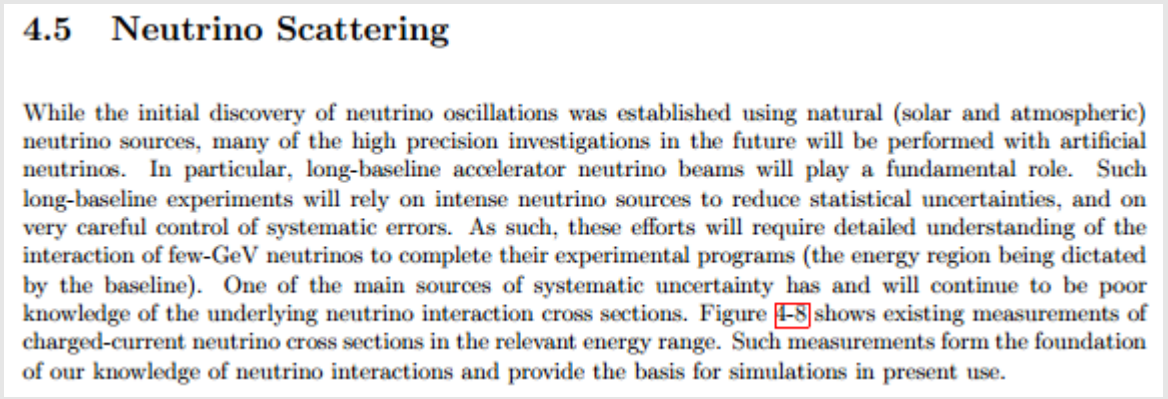
(with relevance to oscillations)

- beyond impulse approximation: 2N/MEC in nucleus
- E_ν reconstruction with nuclear targets and oscillations
- event generators and models
- near detectors experience, requirements, improvements
- “better” beams: narrow-band, muon-factory, pi-DAR, etc

(and other interesting physics)

- astrophysical-, supernovae- relevant processes
- ν nucleus coherent elastic (CENNS) scattering for beyond-SM, dark matter, nuclear physics
- UHE ν N cross sections (nu6)

- Have a very good document to build upon...



4.5 Neutrino Scattering

While the initial discovery of neutrino oscillations was established using natural (solar and atmospheric) neutrino sources, many of the high precision investigations in the future will be performed with artificial neutrinos. In particular, long-baseline accelerator neutrino beams will play a fundamental role. Such long-baseline experiments will rely on intense neutrino sources to reduce statistical uncertainties, and on very careful control of systematic errors. As such, these efforts will require detailed understanding of the interaction of few-GeV neutrinos to complete their experimental programs (the energy region being dictated by the baseline). One of the main sources of systematic uncertainty has and will continue to be poor knowledge of the underlying neutrino interaction cross sections. Figure 4-8 shows existing measurements of charged-current neutrino cross sections in the relevant energy range. Such measurements form the foundation of our knowledge of neutrino interactions and provide the basis for simulations in present use.

- please help with suggestions/input/etc.. !