Discussion: How can/should the various FSI effects be factorized ?

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Preamble

- Monte Carlo generators adopt factorization/impulse approximation approach in modeling ν-nucleus interactions
- Any scattering is described as a two-step process
  - initial interaction (at this stage event weight/probability and lepton kinematics are determined)
  - hadron rescatterings (cascade or hadronic transport models called FSI - final state interactions)
  - justification 1: de Broglie wave of virtual boson $\rightarrow$ at momentum transfer above 200 MeV/c only $\sim$ 1 fm distance is seen
  - justification 2: electron inclusive cross section computations based on the factorization assumption work well
  - a quality of modeling final state hadrons is becoming a concern.
- How critical is inherent limitation of factorization scheme for ν oscillation experiments?
- How to have good (not too conservative) estimate of uncertainties?

Nuclear effects

There are three distinct ways in which nuclear effects enter computations in the factorization picture

- description of a target nucleon: Fermi gas, spectral function (Omar Benhar approach), effective potential (GiBUU), ...
- description of hadrons arising from the initial interaction: plane wave impulse approximation (Fermi gas), distorted plane wave impulse approximation (Ghent group), spectral function (Valencia group), "folding approach" (Omar Benhar), ...
- final state interactions: intranuclear cascade (MCs), hadron transport (GiBUU).

Theorist perspective

- Monte Carlo's treatment of initial interaction and FSI is typically not consistent
  - different nuclear physics models for initial nucleon, hadrons after primary interaction and FSI.
- Should we worry about that?
  - theoretical consistency should allow for a reduction of systematic uncertainties parameters
  - a lot of work must be done to achieve this goal, though.

Experimentalist perspective

- What is a required precision in general, and for particular predictions?
- Do we have/need a plan to explore fully information from electron- (and also pion- and nucleon-) scattering experiments?

Separating hard scattering and FSI in generators

- The physics of ISI and FSI doesn't factorise (nuclear potentials, consistency between nuclear models, etc)
- But it would be handy if they did (lightweight generators, more straightforward comparisons, systematics calculation, etc)
- How could this separation be implemented in each generator?
    - All generators already have FSI implemented in an independent way (standalone routine within themselves)
        - **Kevin's simple model:** generator have a common event format and one can mix and match (with caution!)
        - **Costa's onion** (Option 2b): GENIE is used for everything that is not physics models, and physics models and generator frameworks could be changed
        - Discuss!
- Need a standard event format or (translator between formats) for plug and play
    - info about ISI, (info on FSI?), local positions, nuclear model used, and ??