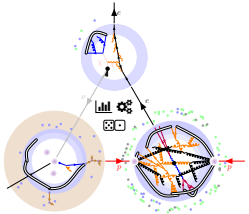
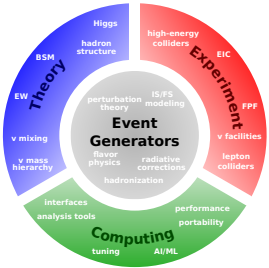
Event Generators for High-Energy Physics Experiments (arxiv:2203.11110)





- Effort lead by Fermilab Theory group: John Campbell, Tim Hobbs, Stefan Höche, Joshua Isaacson, and Steve Mrenna
- Other Fermilab Theory group members contributed as authors: Shirley Li, Pedro Machado, Noemi Rocco, and Mike Wagman
  - Also contributions from the major neutrino generator groups, NUISANCE authors, etc.
- First time bringing together the diverse communities of event generator developers to share resources and ideas
- Propose a collaboration addressing all experiments of interest to US particle physics, with a focus on cross-cutting aspects.
- Key point for neutrinos: The implementation of physics models with complete error budgets will be required to reach the precision goals of current and future experiments.

Theoretical tools for neutrino scattering (arxiv:2203.09030)

- Mike Wagman (FNAL theory) and Steven Gardiner (SCD) were among the co-leaders.
- Additionally, Tim Hobbs, Joshua Isaacson, Andreas Kronfeld, Shirley Li, and Noemi Rocco contributed as authors for this effort.
- Lattice QCD, nuclear effective theories, phenomenological models, and neutrino event generators
- Event generator section supplements longer, more technical material in arxiv:2203.11110
  - Organizational needs, experimental use cases

Process	Neutrino Energy Range	Example Final State
Coherent Elastic Scattering	$\lesssim 100$ MeV	$\nu + A$
Inelastic Scattering	$\lesssim 100$ MeV	$e + {}^{\mathrm{A}}(Z+1)^{*}(\rightarrow {}^{\mathrm{A}}(Z+1) + n\gamma)$
Quasi-Elastic Scattering	100MeV – 1 GeV	$l + p + X$
Meson-Exchange Currents	1 GeV	$l + 2N + X$
Resonance Production	1–3 GeV	$l + \Delta(\rightarrow N + \pi) + X$
Shallow Inelastic Scattering	3–5 GeV	$l + n\pi + X$
Deep Inelastic Scattering	$\gtrsim 5$ GeV	$l + n\pi + X$

Low-Energy Physics in Neutrino LArTPCs (arxiv:2203.00740)

- Steven Gardiner (SCD) was one of the editors, and Shirley Li (FNAL theory) was a primary contributor (apologies if I missed anyone else!)
- Scientific opportunities and challenges related to detection and reconstruction of low-energy ($\lesssim 100$ MeV) signatures in liquid argon time-projection chambers
- Relevance for this group: needs for interaction modeling & simulation (Sec. 4)
- Low-energy neutrino interactions and BSM signatures
  - Inelastic ν-A below 100 MeV especially difficult, not well supported in generators.
  - MARLEY is a dedicated tool, mostly used for CC ν_e-Ar
- MeV-scale activity associated with GeV neutrinos
  - Neutrino-induced neutrons, de-excitation γ-rays, etc.
  - Secondary interaction modeling in Geant4

NF06 (Neutrino Interactions) topical group report

- Conveners: Jonathan Asaadi, Baha Balantekin, Kendall Mahn, and Jason Newby
  - Contributions from many individuals and collaborations, including early career liaisons (Steven Gardiner, Tanaz Mohayai, Vishvas Pandey, and Jacob Zettlemoyer)
- Draft v1: `https://tinyurl.com/nf06-report-2021-v1`
- Spreadsheet for comments: `https://tinyurl.com/nf06-report-v1-feedback`
- Advocates for better supporting the kind of cross-cutting work we do in this group (theory/generators/experiment, high-energy and nuclear physics)