Workshop Close-out

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Fermilab is hiring!

- Recently-formed **Event Generators Group** at Fermilab
  - Physics Simulation Department; Data Science, Simulation, and Learning Division; Computational Science and Artificial Intelligence Directorate
- We have an opening for a **postdoctoral researcher** to work on generator development and physics analysis in MicroBooNE and/or SBND
  - Opportunity to play a leading role in cross-section modeling for SBN
- Details here: https://inspirehep.net/jobs/2632750
- C++ coding skills essential. Prior generator experience helpful but not required.
- Please share the link with possible candidates. Steven G is happy to follow up via email with anyone interested (gardiner@fnal.gov)

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Focus areas from this workshop

- Theory interface (Wednesday afternoon)

- Common flux/geometry drivers (Thursday morning)

- Common event format (Thursday morning)

- Systematic uncertainties (Thursday afternoon)

- Data comparison tools (Friday)

Full agenda on Indico: https://indico.fnal.gov/event/57388/

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Theory interface

- Supporting a wide-ranging BSM program depends on this technical work
  - Key strength of Achilles effort
  - Standard nuclear physics (with tuning) needs to be consistent in BSM signal and SM background

- New efforts overcome some limitations of previous table-based approaches
  - Expose underlying theory for systematics evaluation, etc.
  - Precomputation (GENIE splines, etc.) can still play an important role

- "Injecting" pre-made events useful for experiments and theory studies
  - Desirable to allow participation without requiring full generator

- Fine details (e.g., simulating beam timing properly) can be important!

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Flux/geometry drivers

- Toy project from Josh is establishing a foundation for a general-purpose tool

- More effort will be needed in order to make this happen

- Recruitment for this may work differently than for, e.g., a common event format
  - Experiments may potentially opt for cheaper workarounds (Leo's talk for SBND)

- Questions about how best to make fluxes more friendly amongst generators and theorists

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Common event format

- Benefits are cross-cutting for all other topics considered in this workshop

- HepMC3 provides flexibility and well-supported tools for us to build upon

- The proposed NuHepMC standard gives some guidance for representing neutrino scattering physics within HepMC3 storage

- Further community feedback and generator buy-in will be needed

- Adoption and long-term support will be enabled by large experiments asking for this change

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Systematic uncertainties

- Theory guidance here is critical just as it is for the central-value prediction
  - What are the degrees of freedom that we should consider?
  - What is the size of the uncertainties?

- Experimental tuning is a fact of life, but it should be pursued carefully
  - Tuning and systematics appropriate for an oscillation analysis may be inadequate for other applications

- Data-driven constraints (near detector fits, sidebands, etc.) change which residual uncertainties are most important
  - Guidance here for theory efforts is valuable but takes work

- A trend towards greater transparency in reporting experimental strategies should continue

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Data comparison tools

- Experimental data sets relevant for us are growing in quantity and quality
  - Not just neutrinos, but electrons (e.g., e4v) and hadrons (e.g., ProtoDUNE)

- Establishing best practices and centralized storage (HepData?) for data releases will help to make these data maximally impactful
  - Optimization between correctness/completeness of results and ease of use is not a trivial problem (e.g., unfolding vs. ReMU-style comparisons)

- Difficulties in securing support for community tools are not unique to our subfield

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White Paper Plans (1)

- Goals:
  - Similar scope to white paper from 2020 workshop
  - List a set of action items to accomplish in a one to two year time span (aim to meet again to evaluate status as well)
  - Hope to maintain working groups after the workshop to work on action items
  - Notes from the workshop can be found at:
    - https://docs.google.com/document/d/1wFUCu4o1pkBsvsUW6iQRIQ81rbEjM7qo3Xm6yMnwg64/edit?usp=sharing
    - Is there interest in setting up a slack channel for future discussions and planning?

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White Paper Plans (2)

- Create working groups to focus on each topic

- Looking for volunteers to lead each topic:
  - Theory interface
  - Common flux/geometry drivers
  - Common event format
  - Systematic uncertainties
  - Data comparison tools

- Responsibilities would include:
  - Leading the writing of the given section of the white paper
  - Organizing meetings with other interested parties on establishing plans for future development

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