Event Generator LOI:

CompF2: Theoretical Calculations and Simulation

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Background

- LOIs are promises to do work
- Computing related outlook:
  - Not: What theoretical calculations are needed
  - But: How will we do the numerical work
- Casting a wide net to gather community input
  - e.g. CMS/ATLAS, LHCb, DUNE, EIC, FASER, ...
  - Individual, more-focused LOIs might appear
- We believe one unified LOI is also important
  - Common problems
  - Solutions in sub-domains might be relevant to others

Expand upon and update the HEP Software Foundation report, which was focused on ATLAS and CMS for the HL-LHC. https://arxiv.org/abs/2004.13687

Out of the many issues that we have described, we have identified the following five as the main priorities on which the WG should focus:

1. *Gain a more detailed understanding of the current CPU costs by accounting and profiling.*
2. *Survey generator codes to understand the best way to move to GPUs and vectorized code, and prototype the port of the software to GPUs using data- parallel paradigms.*
3. *Support efforts to optimize phase space sampling and integration algorithms, including the use of Machine Learning techniques such as neural networks.*
4. *Promote research on how to reduce the cost associated with negative weight events, using new theoretical or experimental approaches.*
5. *Promote collaboration, training, funding and career opportunities in the generator area.*

Example topics not addressed:

LHCb concerns (probably more general):

1. rare processes and decays:
    a. what is the biasing, reweighting strategy needed to address either B physics or BSM search needs?
    b. Is the current infrastructure adequate? What new algorithms are needed?
    c. How can GPUs fit into the discussion.
2. low-pT physics (mini-bias and/or underlying event structure):
    a. how to address uncertainties per event.
    b. How to incorporate efficiently into matching/merging schemes.
    c. How to generate efficiently -- is parallelization possible, etc.

EIC

1. polarization (in process, in shower, in hadronization)

Some input on Neutrino Event Generators

1. How to incorporate theorists calculations into event generators, SM and BSM:
2. Are there theory (quantum computing or lattice) calculations to help parametrize low Q^2 hadronization. Modeling low-momentum baryons knocked out of the nucleus may also require attention.
3. Are HPCs needed for any aspects of neutrino event generation (or the production of flux files)?
4. Are HPCs needed for fitting interaction models to experimental data? Oscillation parameter fits frequently require large computing resources.
5. Do we need a community-wide agreement on parameterization of systematic uncertainties in neutrino-interaction generators?
6. How do we ensure long-term support for generator codes for use by experiments and future readers of our publications/consumers of our results?
7. Are there issues that need to be addressed in generating rare events, without also generating large numbers of non-rare events?
8. Can generator physics code be extracted and re-used, for example to compute matrix elements for event analysis?
9. Use of community tools (such as HepMC3, Rivet, Professor, etc.)

Sociology

How do we build the teams we need to complete computing tasks?

- Is the SciDAC model useful here?
- How much domain specific knowledge does a contributor need?

Career paths, incentives?

- How do we educate and retain the computing experts we need?
- Why choose computing over “pure” physics?

LOI Discussion tomorrow

https://indico.cern.ch/event/949161/

< 1 hour (promise)

Please voice your opinions

Also, email the “coordinators”