



CWP: Simulation Session

V. Daniel Elvira (Fermilab), John Harvey (CERN) for the simulation working group



Guidelines

1. Each WG should write and agree on the text for a charge for the WG. The charge should specify three things:
 - The scope - what is covered by the WG, and possibly what is not covered
 - The challenges (see below)
 - Questions the working group should answer during the CWP process
2. A plan describing how the WG will work over the next 6 months to complete its charge. Things that could be relevant for the plan include:
 - specific input to collect - whitepapers, presentations or dedicated discussion sessions (What? From whom?)
 - meetings of various types, including possibly Vidyo meetings, dedicated topical workshops or sessions at other pre-existing meetings/workshops/conferences, etc. (When? Who will organize them?)

Tried to identify areas of potential collaboration across experiments and projects



Format

Presentations by experiments/projects - food for thought

- CMS, Fermilab's neutrino and muon experiments, Geant4, GeantV - also present were members of ATLAS, ALICE, ILC

Discussion and writing of google document with scope, challenges, and plan - summarized here

People who either participated in the afternoon discussion or modified the google doc a posteriori:

Federico Carminati, Daniel Elvira, Makoto Asai, Andrea Dotti, Sandro Wenzel, Frank Gaede, Mike Hildreth, Taylor Childers, Joe Boudreau, Riccardo Maria Bianchi, K. Genser



Scope

- Full and Fast simulation applications of HEP experiments (detectors, beam lines):

MC truth, geometry, particle propagation in materials and fields, physics modeling, pileup, digitization, analysis/monitoring tools

- Software and physics support, training

(Outside scope: generators, event visualization, propagation/manipulation of beams through accelerator lattice (i.e. LHC), space or medical applications)



Scope - detail

- Handling of MC truth information
- Geometry description software tools (DDL, interface to CAD), geometry description
- Navigation, error transport (GEANE)
- Explore random number generator options - fast, guarantee reproducibility in the world of parallel computing
- Modeling of pileup
- Readout modeling (digitization)
- Physics models of particle interaction with matter, decay tables, evaluation of systematic uncertainties associated to physics models
- Physics validation (unit tests, thin target experiments, test beam experiments, in-situ)



Scope - detail

- Generic detector-independent Fast Sim framework
- Fast Sim tuning to Full Sim, test beam, experiment data
- Modeling of neutrino beams from proton-target
- Neutrino-nucleus interaction (GENIE)* and interface with nucleus de-excitation and hadronic shower (Geant4)
- Low energy neutrons, modeling of shielding
- Computing performance monitoring (profiling, instrumentation code to measure in what functions, what particles, what energy ranges the time is spent)
- Software training and support

* Some overlap with generators group



Challenges

1. Improving computing performance

- Geometry library optimization/vectorization (i.e. VecGeom)
- Explore options to reduce digitization time (vectorization?)
- Continue work to exploit benefits of vectorization, SIMD, data locality in modern architectures (CPU, GPU, coprocessors)
 - Develop prototype application for complex experiment and demonstrate 2-5X CPU gain
- Continue tests of simulation applications in HPC



Challenges

2. Improving physics accuracy

- Improve, re-implement physics models
- Validate physics models for LAr
- Extend hadronic physics for the FCC energy frontier
- Improve Full-Fast Sim agreement to expand Fast Sim use
- Shower library development

3. Pileup handling (I/O and local bandwidth issues)

4. Find areas of commonality across experiments for Fast Sim, Geometry tools, ..., etc



CWP contribution Plan

Hold series of meetings every month or so devoted to 1 or 2 topics - recruit and invite experts

First step (meeting):

- Decide on plots to benchmark current computing performance of complex experiments (where time is spent - what functions, what particles, what energy ranges)

Ideas for subsequent meetings:

- Fast Sim options, including ML for tuning
- Improving hadronic physics
- Code improvement/optimization campaigns

Recruit contributors in theme areas - for CWP writing