



Report on Pythia and Neutrino Generators

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Pythia: SM
Neutrino Generators: Robert Hatcher, SM

1



Think of it as a particle physics version of pop radio's “top 40” countdown: INSPIRE, a database of particle-physics publications, has released its annual list of most-cited articles.

Topping the charts in 2012 are articles about the Higgs boson, which made up about 20 percent of the list.

But *the most-cited publication of 2012 is a 583-page manual about PYTHIA*, a program for simulating particle collisions and their byproducts.

Researchers at Lund University in Sweden and Fermilab in the United States published the manual in 2006. The PYTHIA manual, which was cited in an estimated 1225 scientific articles in 2012, also ranked very high in INSPIRE's top-cited lists for 2011 and 2010.



The Pythia Project

- Software that simulates particle collision events
 - Pythia6 (Fortran, legacy)
 - Pythia8 (C++)
 - Vincia (Pythia8 plugin)
- User support and documentation
- Integration into experimental frameworks
- Basic theoretical and phenomenological research

Pythia Collaborators



- Stephen Mrenna (Fermilab, Scientist II)
- Torbjorn Sjostrand (Lund, Professor)
 - main developer
 - graduate students
- Peter Skands (CERN, 5-year position)
 - main Vincia developer
 - MCnet students (European funding program)
- 2 other post-docs (part-time)

Why “most” citations?



- Design
 - Fits easily into computing workflows
 - Easy to configure
 - Easy to modify and extend
- Integration
 - I server as primary generator expert on CMS and solve problems
 - We listen to ATLAS and CMS requests
- Teamwork
 - All collaborators do important work

6



Pythia Milestones

- 2012: Most HEP Citations
- Summer 2013
 - Freezing of Fortran Pythia
- Fall 2013
 - Pythia 8.200 release, with physics and coding updates
- ~Fall 2013
 - Vincia for LHC collisions



Pythia Outlook

- Transition experiments into Pythia8
 - **not** computing: this requires “physics” inputs, tunes, which **we** must catalyze
 - Threading? Multicore?
- Vincia
 - Plugin to Pythia8 that keeps us state-of-the-art
 - Adding more accurate theory calculations for higher accuracy
 - Requires theoretical work **and** coding



Neutrino Generators

- Neutrino experiments are a major part of the labs/communities future
- Pythia-like software important for design and analysis
- GENIE: “universal” neutrino-generator framework
 - Robert Hatcher is the local expert on experimental integration
 - “the community” is concerned about development
- We are charged to evaluate GENIE and determine how CD can contribute



Potential Contributions

- Expertise on generator framework
- Implementation of physics models
 - Coding
 - Known deficiencies in neutrino cross sections
 - Alternative models for rescattering and nucleon treatment
 - Validation
- Tuning of parameters on data



neutrino-nucleus generators - present and future

June 9-11, 2013

PITTSburgh Particle physics, Astrophysics and Cosmology Center
Department of Physics and Astronomy
Dietrich School of Arts and Sciences
University of Pittsburgh

The purpose of the workshop is get experimenters, theorists, and phenomenologists together to discuss existing neutrino-nucleus event generators and future needs. These codes are at the core of all Monte Carlo simulations; existing detector groups depend on their success for understanding analysis. With the new era of liquid Argon detectors well underway, this is an excellent time for this unique mix of people to plan the future.

Organizers : Steve Dytman (Pitt, dytman@pitt.edu), Donna Naples (Pitt, dnaples@pitt.edu), Hugh Gallagher (Tufts, hugh.gallagher@tufts.edu), Jorge Morfin (Fermilab, morfin@fnal.gov), Sam Zeller (Fermilab, gzeller@fnal.gov).

Administrator : Cindy Cercone (cmc138@pitt.edu).



Generator Manpower Outlook

- SM allocation is 20% Pythia, 30% LPC, 50% CMS service and research
 - Pythia success is related to CMS component
 - No clear boundaries between fixing bugs in Pythia for CMS and doing Pythia development
- Pythia is a research tool and must be under constant development (Vincia)
- Currently no room for IF (neutrino) generator support