



LUND  
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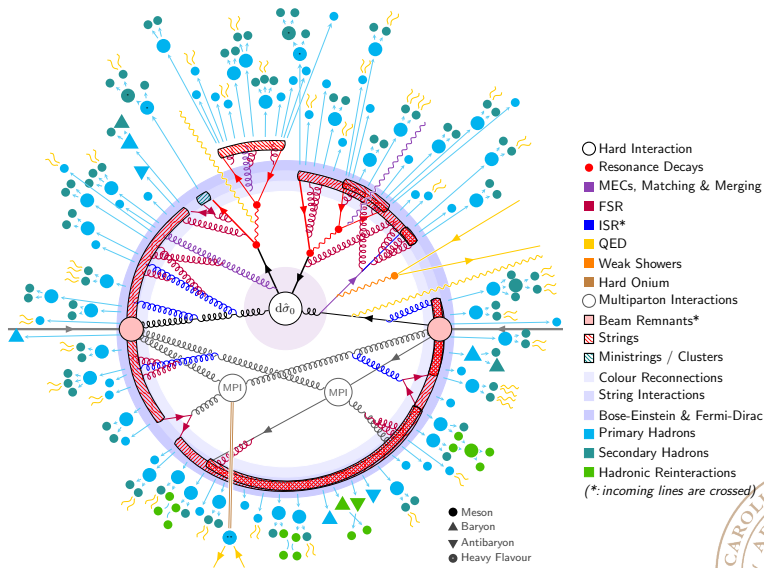
**PYTHIA8**

**a critical research infrastructure of national importance?**

Leif Lönnblad

Department of Physics  
Lund University

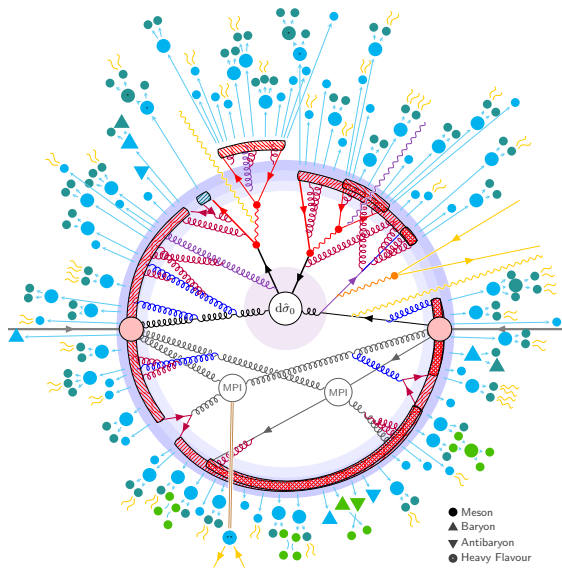
Uppsala, 2024-10-22



[arXiv:2203.11601, A comprehensive guide to the physics and usage of PYTHIA8]



## Encodes the whole (B)SM



- Hard Interaction
  - Resonance Decays
  - MECs, Matching & Merging
  - FSR
  - ISR\*
  - QED
  - Weak Showers
  - Hard Onium
  - Multiparton Interactions
  - Beam Remnants\*
  - Strings
  - Ministrings / Clusters
  - Colour Reconnections
  - String Interactions
  - Bose-Einstein & Fermi-Dirac
  - Primary Hadrons
  - Secondary Hadrons
  - Hadronic Reinteractions
- (\*: incoming lines are crossed)

[arXiv:2203.11601, A comprehensive guide to the physics and usage of PYTHIA8]



- ▶ The most used General Purpose Event generator in particle physics.
- ▶ How many users?
- ▶ 73% of all ATLAS papers refers to PYTHIA usage.  
(CMS: 72%, ALICE: 42%, LHCb: 75%)  
(HERWIG: 48%, SHERPA: 44%)
- ▶ Not only LHC. ALL collider experiments use PYTHIA, as well as several non-collider experiments.
- ▶ Many specialised simulation codes use PYTHIA
- ▶ Is it even conceivable to do collider experiments without PYTHIA?



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# The PYTHIA8 Collaboration

Started out as a one-person (*i.e.* Torbjörn Sjöstrand) project.  
Today there is ~200k lines of code maintained and developed  
in a small collaboration:

J. Altmann (Monash), C. Bierlich (Lund), N. Cooke (Glasgow),  
N .Desai (Mumbai), I. Hellenius (Jyväskylä),  
P. Ilten (Cincinnati), L. Lönnblad (Lund), S. Mrenna(Fermilab),  
C. Preuss (Zürich), T. Sjöstrand (Lund), P. Skands (Monash)



- ▶ Code maintenance
- ▶ Code improvements
- ▶ CI/CD
- ▶ User support
- ▶ User requests
- ▶ ...



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## Phenomenology research and model development



Event generator developers are first and foremost ***Physicists***



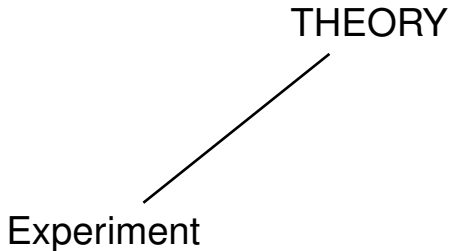
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## THEORY

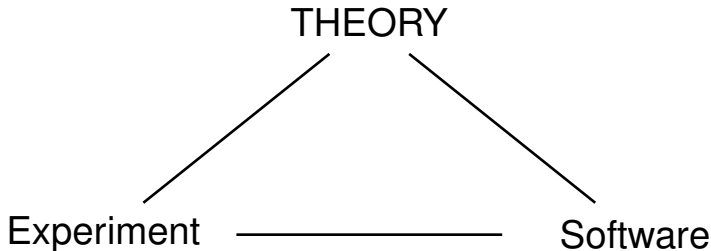




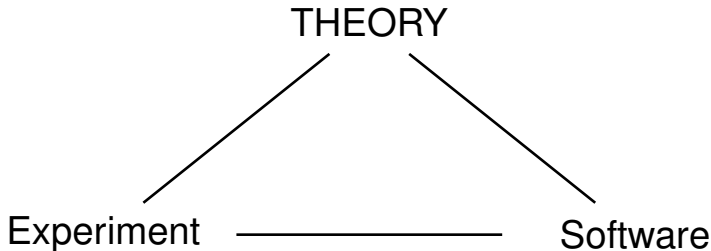
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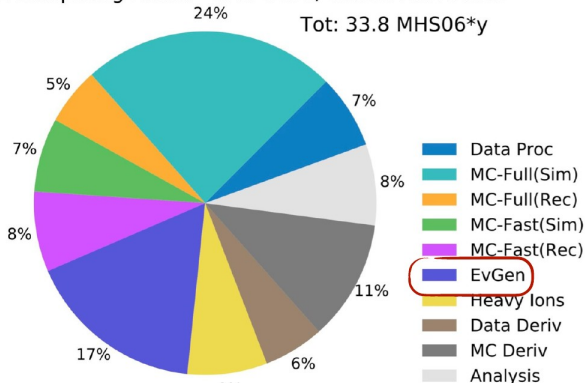
Academic career paths are tricky.  
(Two PYTHIA authors in Lund recently left for industry.)



### ATLAS Preliminary

2022 Computing Model - CPU: 2031, Conservative R&D

Tot: 33.8 MHS06\*y



[CERN-LHCC-2022-005](#)



# Funding

Everyone at CERN would agree that event generators in general and PYTHIA in particular belongs to the *critical infrastructure* necessary to do experiments.

And that they need to have stable, long-term support.

- ▶ Support for PYTHIA8 from CERN: ? MSEK/y
- ▶ Software licence fees from experiments: ? MSEK/y



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All funding for PYTHIA8 comes from individual, short-term research grants. (e.g. from VR)





# The future of PYTHIA

- ▶ Will PYTHIA continue to be supported and developed?
- ▶ Will PYTHIA still be a Swedish (Lund) project?



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- ▶ Comments?
- ▶ Suggestions?
- ▶ Questions?

