



LCG Generator Services Meeting
CERN
9 May 2006

LUND UNIVERSITY

The User–Author Interaction: A PYTHIA Case Study

Torbjörn Sjöstrand

CERN/PH and

Department of Theoretical Physics, Lund University

Personal Situation

When in Lund:

- ~ 30% teaching + “administration”
- ~ 40% research with graduate and master’s students whereof ~ 10% direct PYTHIA development
- ~ 30% PYTHIA support, whereof
 - ~ 20% “useless” correspondence
 - ~ 5% “useful” correspondence
 - ~ 5% own initiatives \implies webpage, manual, . . .

so

- “Useless” correspondence blocks many useful developments
- Need to go to CERN to have any time at all for “coding”

PYTHIA coauthors: Stephen Mrenna and Peter Skands

- contribute and support code for several specific areas
- handle much user interaction at Fermilab
- but also have their own agendas
- and do not know all parts of PYTHIA

What Correspondence?

- Physics issues
 - Relevant issues well worth discussing
 - Requests to comment on draft articles
 - It is in the manual, but requires you to combine two places
 - References to it are in the manual
 - It is in the manual
 - You should know this, or else ask your thesis advisor
- Programming issues
 - Code contributions
 - Bug reports, with their solution
 - Bug reports, with standalone program showing problem
 - Bug reports, plausible
 - Bug reports, half-baked
 - Bug reports, irreproducible
 - Bug reports, attention-grabbing
 - Bug reports: installation, Fortran, . . .

From Whom?

- LHC: ATLAS, CMS, some LHC-B, almost no ALICE
- Tevatron: could be worse (thanks, Steve & Peter!)
- HERA: H1, ZEUS, HERMES
- LEP: hardly any more, but used to dominate
- LC: some
- fixed target: COMPASS, NOMAD, ...
- RHIC: mainly pp, charm production
- B factories: almost nothing
- cosmic rays: a few
- JLAB: sorry, guys
- theorists: LHC Olympics, ...
- ...

General comment: right now is not the most intense time, was more when LEP was running, will become more again??

Some Recent Examples

True bugs:

- > 69 external processes.
- `gg \rightarrow H` cross sections runs haywire when replacing Higgs decay channels using SLHA.
- `CLOSE` statement might be executed even if file not opened.
- Real arguments replaced by complex ones in recent FeynHiggs.

Unresolved bugs:

- New PYTHIA showering option sometimes fails for AcerMC $t\bar{t}$ events.
- Why are some normal PYTHIA decays absent when I use HIJING?

False bugs:

- R -hadron mass and kinematics is not quite right.
A: Because CMS commands overwrote Peterson ϵ_b variable.
- Charm events does not give the expected number of muons.
A: Because of the way the ATLFAST muon filter is working.

- The $qg \rightarrow q\gamma$ process does not give same cross section for central jet and forward γ as the opposite!
A: No, because of different q/g PDF's and u -channel pole.
- The longitudinal W fraction in top decay is 0.68 and ought to have been 0.70.
A: b can radiate, so $b + \text{lepton}$ invariant mass bad measure.
- I get strange high-momentum particles when using my “afterburner” on PYTHIA events!
A: Gluons with negative energy were inserted, such that a string system had mass $\equiv 0$.
- The neutral energy fraction in e^+e^- at 150 GeV is wrong!
A: ISR of photons.
- There are no $Z^* \rightarrow A^0 H^0$ decays.
A: Because you set all A^0 decay widths 0 (instead of switching off decay)

Physics questions:

- What are colour reconnection effects on the top mass?

- Why does efficiency (for my cuts) change by ISR (for Z, graviton)?
- How understand central jet veto in Higgs events?
- How reliable are predictions for isolated pions?
- Is the crossing angle at LHC taken into account?

Not quite in the manual:

- How change slope in elastic scattering?

In the manual:

- How do I generate b events?
- How can one subdivide PYTHIA heavy flavour production mechanisms?
- What means “Advisory warning: maximum violated ...”?
- Why is an off-shell γ^*/Z always called a Z (code 23)?
- Why do resonance shapes tend to have a long tail to small masses?
- Why are PYENT Z^0 decay events not same as PYEEVT ones?
- How do I interface my HH code (from Baur) to PYTHIA?

Basic knowledge:

- Why does PYTHIA not accept my main program?
A: Fortran has special meaning for columns 1-6

Official Recommendation

PYTHIA webpage, link to “Debugging”:

Debugging

Clearly, a program the size of PYTHIA can never be guaranteed bug free. Therefore we welcome input from users who suspect improper behaviour. Such input has been very helpful to us.

However users often combine PYTHIA with a batch of other libraries in their studies, and then problems originally attributed to PYTHIA in the end may turn out to be located somewhere else. This is especially true currently, when a lot of LHC software is in a rather preliminary stage of development. Much time then is lost in unsuccessful attempts to reproduce purported PYTHIA bugs. Furthermore, the use of external libraries makes it impossible to receive a bug-demonstrating main program and run it locally. Therefore, if you want your complaints to be taken seriously,

do confirm that your bugs also occur if you run PYTHIA in a completely standalone mode. To be specific:

- Make sure you use a **clean** copy of PYTHIA, not one that has been subject to "local modifications" by parties unknown. Also make sure it is a **recent** one — you may have encountered a true bug, but one already solved in the current version. If uncertain, pick up a new copy directly from the PYTHIA webpage.
- Create a cleanly compiled PYTHIA code. Typically this is as simple as
`f77 -c pythia6xxx.f`
where `xxx` is the current subversion number. Compiling in some library mode may have its advantages, but is unnecessary here and may e.g. lead to PYDATA not being linked.
- Write a **simple standalone main program** that demonstrates the claimed bug. Feel free to use some of the simpler main programs given on these webpages as templates.
- Link and run the program, typically with
`f77 main.f pythia6xxx.o`
`a.out > output`

- Now systematically **peel away all irrelevant code** in the main program, so that only code really needed to reproduce and document the bug remains. Where explanations in the code would be helpful, do add comments in English.
- **Send** the main program, with a description what is the problem and whatever guesses you may have about a probable cause.

Important note for CMS members:

Internal policy demands that all hypothetical PYTHIA bugs should be discussed internally, and be reproducible with a standalone PYTHIA version, before the PYTHIA authors are contacted. Send a message to cms-generator@cern.ch or directly to either of [Filip Moortgat](#) and [Sergey Slabospitsky](#).

Important note for ATLAS members:

Internal policy demands that all hypothetical PYTHIA bugs should be discussed internally, and be reproducible with a standalone PYTHIA version, before the PYTHIA authors are contacted. Use the [Savannah bug reporting system](#), or mail directly to either of [Ian Hinchliffe](#) and [Borut Kersevan](#).

Recommendations

- Inform MC authors when new contact persons are appointed, and which internal bug-tracking policies exist.
⇒ Allows to post info on PYTHIA “Debugging” page.
- Filter/study bug reports within collaborations.
- When you suspect a bug, follow the instructions on the web.
If it does not go away, then
provide simple standalone main program running with current PYTHIA.
- Encourage physics discussions to take place within physics working groups, between students and their advisors, and with local theorists.
There are a lot of people feeling lost!
- When LHC gets running, do not expect efficient help if MC authors are on the “not to know” list (cf. LEP).