

Use, maintenance and extensions of EvtGen in LHCb

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Use of EvtGen

- EvtGen is used since 2004 to produce all simulation data samples for physics analysis studies in LHCb.
- Simulates decays of all hadrons produced by pp collisions (generated by Pythia)
- Several event types:
 - Minimum bias,
 - Inclusive B or D events,
 - Signal B, D, J/ψ or τ , without and with CP violation.
- EvtGen(LHCb) is used as a regular package of the LHCb software to allow people to develop decay models more easily (ie the source code is in our CVS repository). This implies that the source has to be maintained to follow compiler, architecture changes in LHCb.
- EvtGenLHC is a build of the last production version of the EvtGen package in the LHCb CVS repository.

Modifications to EvtGen (1)

- The main modification is to be able to generate incoherent B mixing.
- Starting from EvtGen version alpha-00-11-07 (December 2003).
- Only extend to B^0 what was already inside EvtGen for B_s^0 mixing (ie B mixing treated as a $B \rightarrow \bar{B}$ decay)

```
//Will include effects of mixing here
//added by Lange Jan4,2000
static EvtId BS0=EvtPDL::getId("B_s0");
static EvtId BSB=EvtPDL::getId("anti-B_s0");
static EvtId B0 =EvtPDL::getId("B0");
static EvtId B0B=EvtPDL::getId("anti-B0");
.....
insertDaugPtr(0,scalar_part);
```

Modifications to EvtGen (2)

- Possibility to generate CP violation in signal simulation samples at pp collisions.
- Idea suggested by Anders Ryd and David Lange at the EvtGen workshop at CERN in 2003: treat the « tag » of the B as a random variable and allow it to « flip ».
- Rewrite the function « otherB » called by all models implementing CP violation, anything else is unchanged.
- But it is the interface outside EvtGen (the steering algorithm used to generate events) which allows in the end to generate CP violation and which ensures the correct integrated CP asymmetry.
- It is very difficult/impossible to generate correctly CP violation for incoherent B production in a generic way. This is why we generate CP violation only for specific signal samples, not for generic samples, and why this part is probably not useful outside LHCb.

Modifications to EvtGen (3)

- The other changes to EvtGen are only technical changes:
 - Changes to EvtPythia (interface to Pythia) to follow the evolution of Pythia, such as adaptation to Pythia 6.4 needed in Pythia.F.
 - Changes to follow gcc compiler changes, for 64 bit platforms, and to be able to compile with Windows compiler.
 - Some memory leaks in destructors reported by valgrind.
 - Recently all compilation warnings had to be removed to allow nightly builds.

Development of new models

- Some new decay models have been developed in LHCb:
 - $B_s \rightarrow J/\psi \phi$ (Correct time dependant angular distributions, G. Raven, T. Du Pree, NIKHEF)
 - $\Lambda_b \rightarrow \Lambda \omega/\rho$ (Taking into account ω/ρ mixing, E. Conte, Clermont-Ferrand)
 - $B \rightarrow D K$ (γ angle in D Dalitz plot)
 - $B \rightarrow K^* \mu \mu$ (Under development, W. Reece, Imperial College, would like to use GSL functions to perform precise numerical integrations: add extra dependance to EvtGen)

Maintenance of DECAY.DEC

- The main decay file, DECAY.DEC, is maintained to follow PDG updates of branching fractions, and also to integrate requests of analysis working group asking to increase/decrease some of the branching fractions.
- The resulting file is of course available outside LHCb, and comments are welcome for corrections.
- But to my opinion, impossible to envisage to maintain a « LHC » DECAY.DEC file, because of the complexity to accomodate too many requests.

Conclusions - Future of EvtGen in LHCb

- LHCb uses heavily EvtGen: we have in LHCb to port it to new compilers/platforms and to maintain the main decay file.
- We are very interested in being able to use the latest developments of EvtGen in LHCb, since the version we use is now quite old.
- Interface to Pythia6 will have to be changed to an interface to Pythia8 in the near future.