

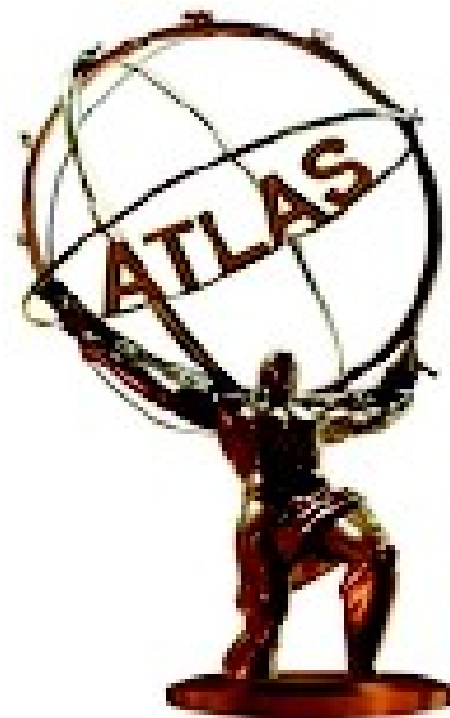
Status of EvtGen in ATLAS



Pavel Řezníček
IPNP, Charles University in Prague



James Catmore, Mária Smižanská
University of Lancaster



Outline

- Code used in ATLAS
- Changes made w.r.t picked up LHCb version
- Athena interfaces to EvtGen
- EvtGenLHC with ATLAS software
- Summary

EvtGen in ATLAS

- EvtGen installed in Athena since 2003 (copy of LHCb version **alpha-00-10-22**)
 - currently **alpha-00-10-28**: few new models, fix for collision of Pythia usage in Athena and EvtGen - see next slides
 - located at */afs/cern.ch/atlas/offline/external* area
- Two Athena interfaces to combine EvtGen with event generators in Athena (using events stored in HepMC)
 - 1) for B-hadron decays only
 - **exclusive** - models for (rare) decays not included in standard generators, or models where spin correlations, mixing or CPV are needed
 - **inclusive** - e.g. for b-tagging studies
 - 2) for all decays available in EvtGen
 - use Pythia for just the hard interaction, let EvtGen decay the particles
 - Athena packages *Generators/EvtGen_i* and *External/EvtGen*
- Source code unchanged since release 11.5.0 (2006), only minor changes/fixes to the interfaces

Modifications to EvtGen

Models added w.r.t. the LHCb version:

- $B_s \rightarrow J/\psi(\mu^+\mu^-) \phi(K^+K^-)$
 - model accounting weak phases to get mixing and CPV through interference
- $\Lambda_b \rightarrow \Lambda(p, \pi) J/\psi(\mu^+\mu^-)$
 - Λ_b polarization studies, model describing complicated spin configurations
- **JetSet** model
 - use JetSet 7.4 to decay particles
 - renamed common-blocks \rightarrow independent from Pythia in Athena
- **Jscont** model
 - routine to generate $e^+e^- \rightarrow q\bar{q}$ using JetSet
- $\Lambda_b \rightarrow \Lambda(p, \pi) \mu^+\mu^-$
 - semileptonic rare decay in b-baryon sector
- Models validated w.r.t. to independent MC generators (if possible)

Modifications to EvtGen (2)

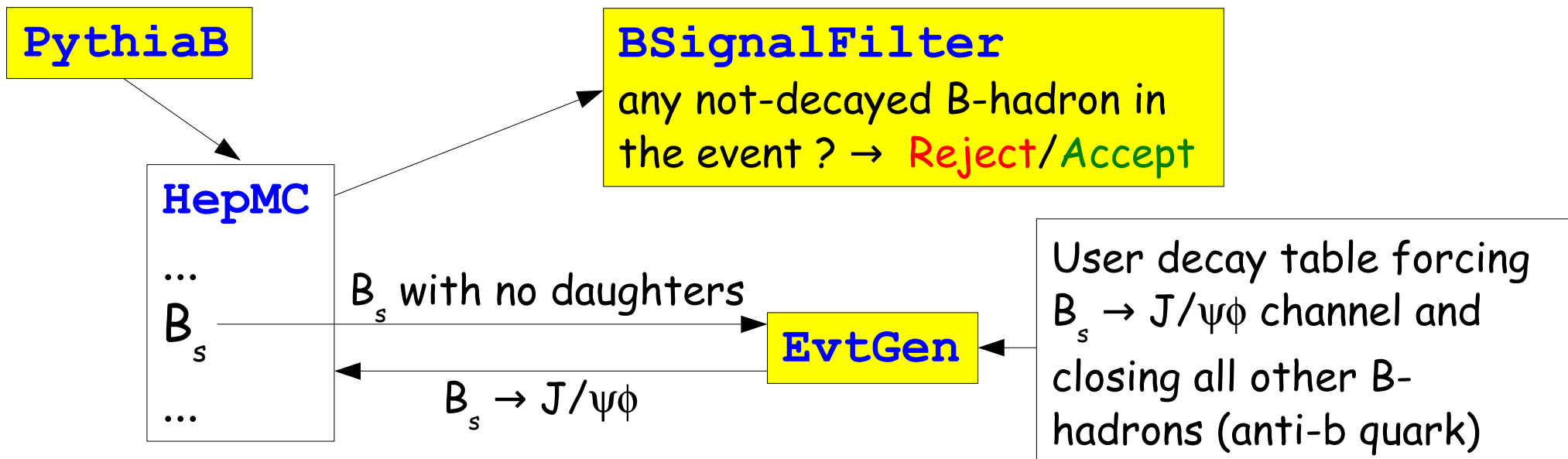
Collision of Pythia usage in Athena and EvtGen

- EvtGen model PYTHIA is changing some Pythia parameters (decay tables, showering of qq or gg pair or ggg triplet, B-oscillations, minimum remaining energy stopping fragmentation)
- **fortran code → EvtGen gets all Pythia settings from Athena and changes to Pythia in EvtGen propagates to all following events**
- **Symptoms:**
 - 1) undecayed partons in both HepMC and HepEvt records
 - 2) errors "(PYCTTR:) colour tag tracing failed" appeared
 - Pythia 6.3 introduced new method how to trace colour connections → switch back to old method in EvtGen, but restored for following Pythia production
- **Fix implemented:**
 - backup the Pythia parameters before EvtGen PYTHIA model is used and restore the values afterwards
 - force EvtGen to initialize its PYTHIA parameters not just on the first use (slowdown by ~30%)
- Pythia parameters can be also changed via DECAY.DEC file => user have to care of possible clashes with Pythia configuration in Athena

EvtGen Interface

Interface dedicated to B-decays:

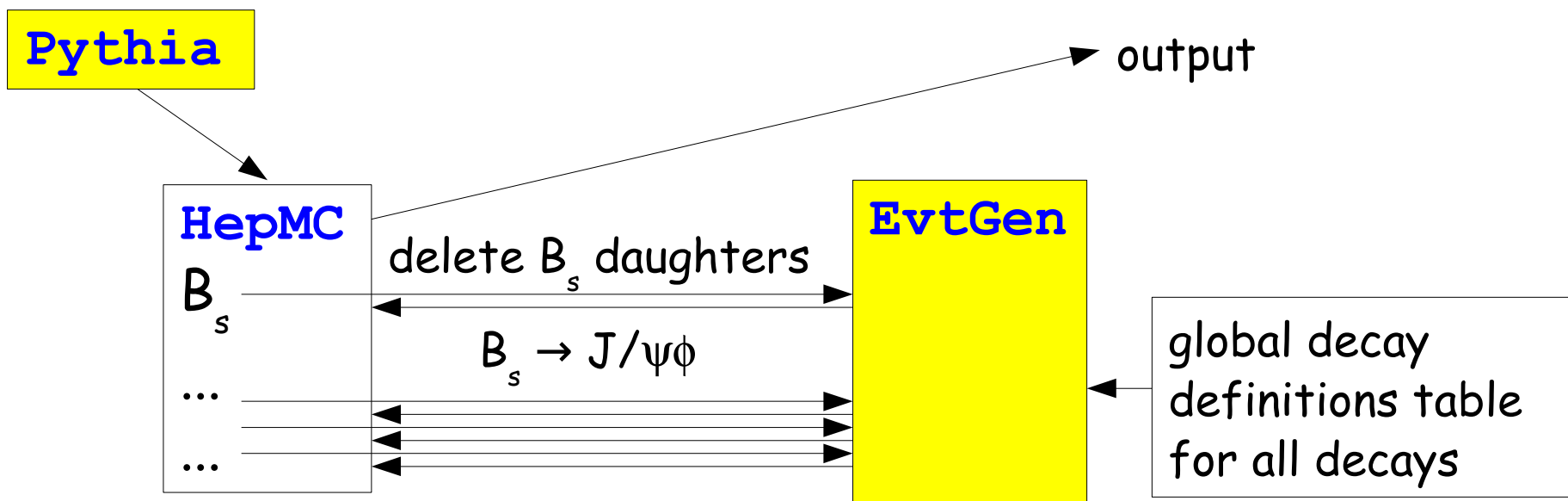
- B-decays closed in preceding generator (**PythiaB**)
- The interface algorithm **EvtGen_i/EvtDecay** searches for not-decayed B-hadrons and lets them decay using EvtGen tables, results written back to **HepMC**
- Forcing a decay channel: all other B-decays denied in EvtGen, then filtering out events containing not-decayed B-hadrons
- Allows to set initial Λ_b polarization (its spin density matrix)



EvtGen Interface (2)

Interface dedicated to inclusive mode:

- Preceding generator configured as if EvtGen was not used (all decays opened)
- The interface algorithm **EvtGen_i/EvtInclusiveDecay** searches for all particles that can be decayed by EvtGen, deletes their **HepMC** daughters tree and lets them decay by EvtGen. Results written back to **HepMC**.
 - closing the decays at the preceding generator could be faster, but complicated for configuration
- Allows to be switched also to mode for B-decays only
- Some PDG codes in EvtGen and Pythia differs → use translation table



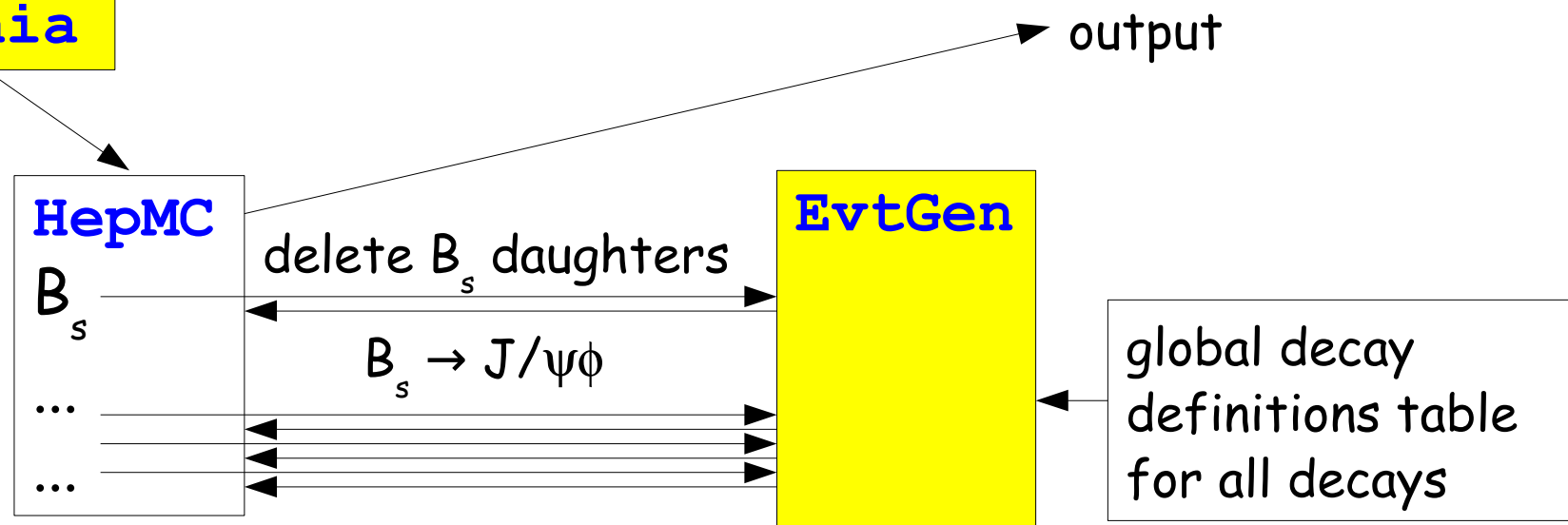
EvtGen Interface (2)

Interface dedicated to inclusive mode:

- Preceding generator configured to produce all tree
- The interface algorithm **EvtGen** identifies particles that can be decayed by EvtGen and lets them decay by EvtGen.
 - closing the decays at the preceding configuration
- Allows to be switched also to mode
- Some PDG codes in EvtGen and

Random numbers passed through standard Athena service **AtRndmGenSvc** (similarly as all the other generators)

Pythia



EvtGenLHC

Comparing **EvtGenLHC-9.1** version to currently used **alpha-00-10-28** at ATLAS

- slight enhancements (in dirac algebra, access to decays-table, particle properties)
- number of new models
 - FlatQ2, PVVCPLH, LambdaB2LambdaV, BtoDDalitzCPK, SVPCP, LambdaP_BarGamma, EvtSSD, LambdaB2LambdaV, LambdaP_BarGamma, PVVCPLH, SVPCP, SSD_DirectCP, BtoDDalitzCPK
- updates/fixes in some models
 - b2sX11Util, IncoherentMixing, Ddalitz, Pto3P, Btos11Ball(Ali,FF,Amp), Btos11VectorAmp, ISGW2, RelBreitWignerBarrierFact, PartWave, CBTo3piMPP, CBTo3piP00, BtoXs11, EvtSLN, Resonance2, PythiaF
 - some control? histogramming (in Bto3pi, BtoKpipi, Bto3piP00, Bto3piMPP)

However changes not dramatic to expect problems in migration

- Recompile within Athena OK (just trivial fixes to remove extra semicolons)
- But running leads to segfault when EvtGen launches Photos
- Need to test whether the problems with Pythia in Athena and in EvtGen still exist

Summary

- Present version of EvtGen in ATLAS is old → at least migration to EvtGenLHC is desirable
- After resolving starting technical problems, need to check whether fixes applied to the old version are still necessary
- Interfaces are in a good shape, usable with practically with any generator in Athena
- EvtGen is successfully used in MC8 production (semileptonic rare B-decays, $B_s \rightarrow J/\psi \phi$, $B_s \rightarrow J/\psi K^{*0}$)

Backup Slides

Possible Enhancements of the Interface

- Unification of the particle properties among generators and EvtGen (pointed by Juerg B.)
 - Pythia decay table is translated to `pdt.table` for EvtGen (or the other way)
 - on the fly (beginning of generator job)
 - a new `pdt.table` file is created with each new version of Pythia
 - or define a common table that is read by every generator ?
- Allow to decay only selected particles by EvtGen (generalized interface of B-hadron mode only)
 - when using forced decay assure that one and only one particle of the requested type is forced to the decay channel → write new interface to EvtGen that will be run e.g. after EvtGenInclusive
- To speed up generation when some final-state cuts are required:
 - allow to reuse multiple times the same parton configuration (repeatedHadronization feature in PythiaB)
 - allow to redo mutipltimes EvtGen decays at the same event

EvtGen Validation

- No core code change since 11.5.0, only minor fixes to the interface
- Rerunning EvtGen (inclusive mode) in every Athena release on a fixed dataset leads to identical results as expected
- Checking properties of e.g. B-particles daughters from combined PythiaB+EvtGen production shows consistent results

