EvtGen Workshop
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Status of EvtGen in ATLAS

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on behalf of ATLAS MC generators group

Outline

- EvtGen usage in ATLAS MC
- Implemented version and updates
- Interface to ATLAS SW framework
- Issues when using together with other generators
- Summary

EvtGen Usage in ATLAS

- Exclusive B-decays simulation
  - Models of decays not included in standard generators (e.g. rare B-decays)
  - Models where spin correlations, mixing or CPV are needed
- Inclusive B-decays
  - B-tagging studies (small difference w.r.t. Pythia observed)
- Decay all particles in the event
  - **Pythia/Herwig** used only for hard interaction, **EvtGen** decays the particles
  - Used for production of di-jet with D* in the final state
- But more requests from individual users and groups are coming

Implemented Version

- **EvtGen** installed in ATLAS SW sice 2003, using copy of LHCb version **alpha-00-10-22**
  - Current version **alpha-00-10-28**: added few models, fixed collision of Pythia model with Pythia inside ATLAS SW
    - Note: the new version number does not correspond to upstream, but only to the ATLAS specific updates
  - Decay and particle data tables for inclusive running based on versions of BaBar and CDF as of summer 2005
  - Source unchanged since 2006, only minor changes/fixes to the interface
- ATLAS updates:
  - $B_s \to J/\psi(\mu^+\mu^-)\ \phi(K^+K^-)$ - model accounting weak phases to get mixing and CPV through interference
  - $\Lambda_b \to \Lambda(p,\pi)\ J/\psi(\mu^+\mu^-)$ - polarization studies, describing spin configurations
  - **Jscont** model - routine to generated $e^+e^- \to$ qqbar using **JetSet**
  - $\Lambda_b \to \Lambda(p,\pi)\ \mu^+\mu^-$ - semileptonic rare decay
  - All changes either found to be implemented (or have alternative) in newer upstream EvtGen, or were added during 2009 merging campaign

Issue with Sharing Pythia6 Common Blocks

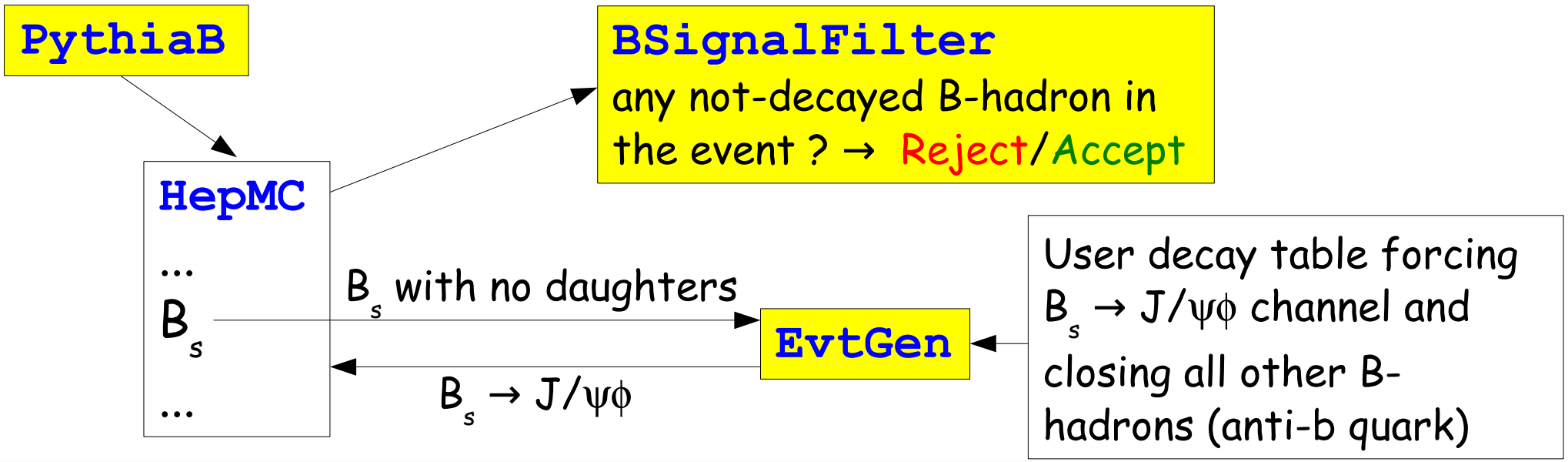
- **EvtGen** calls back **Pythia/JetSet** to simulate generic decays
  - **EvtGen** needs specific **Pythia** configuration
    - Decay tables, showering of qqbar or gg pair or ggg triplet, B-oscillations, minimum remaining energy stopping fragmentation
  - Clashes with **Pythia6** configuration within ATLAS SW when **Pythia6** is used as the primary generator → changes from **EvtGen** propagates to subsequent **Pythia** event generation
- Symptoms:
  - Undecayed partons in the event records
  - **Pythia** error messages due to switching to old method of tracking color connections
- Possible fixes (both implemented in the ATLAS **EvtGen** version):
  - Backup the **Pythia** parameters before **EvtGen** **Pythia** model is used and restore the values afterward → requires to initialize **Pythia** parameters in **EvtGen** in each event → slowdown by ~ 30%)
  - Use build-in **Pythia/JetSet** with renamed common blocks

! **Pythia** parameters can also be changed via **DECAY.DEC** file → user have to take care of possible clashes with **Pythia** configuration in ATLAS SW

EvtGen Interface to ATLAS SW

Interface dedicated to B-decays:

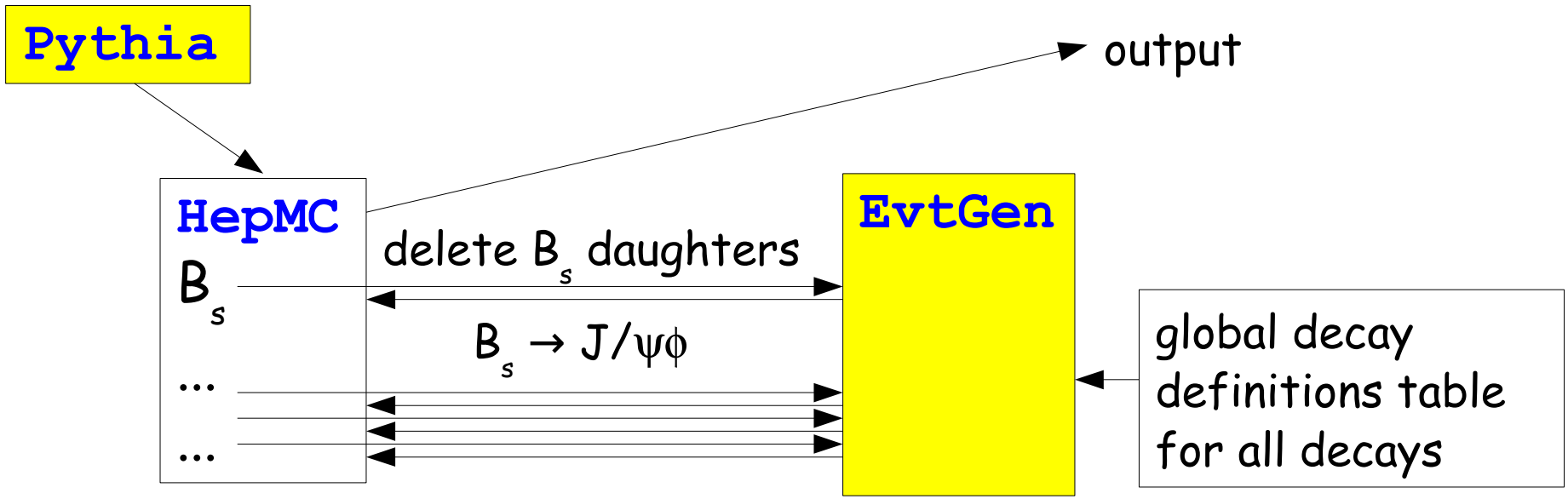
- B-decays closed in preceding generator (**PythiaB**)
- The interface algorithm **EvtGen_i/EvtDecay** searches for not-decayed B-hadrons and lets them decay using **EvtGen** tables, results written back to **HepMC** (ATLAS event record format)
- Forcing a decay channel: all other B-decays denied in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



EvtGen Interface to ATLAS SW

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 and would work with this interface, but complicated for configuration
- Allows to be switched also to mode for B-decays only

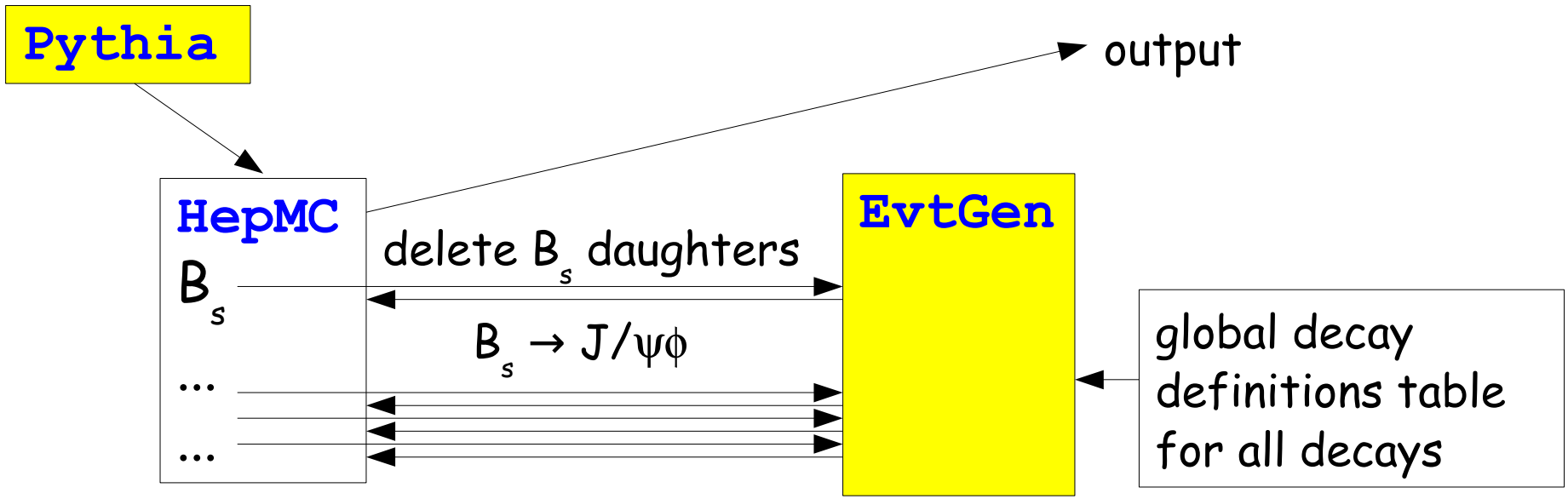


EvtGen Interface to ATLAS SW

Interface dedicated to inclusive mode:

- Preceding generator configured
- The interface algorithm **EvtGen** particles that can be decayed by and lets them decay by **EvtGen**.
  - Closing the decays at the preceding interface, but complicated for confi
- Allows to be switched also to mo

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



Miscellaneous

- Inconsistent particle definitions:
  - Particle masses evolve, some PDG codes have changed
  - Tables between **EvtGen** and other generators not synchronized
    - Particle properties in **DECAY.DEC** needs to be regularly updated or some ATLAS particle-properties service should be used to by the interface to update the mass in run-time
    - PDG codes presently translated before and back after **EvtGen** does the job
- Potential pitfalls
  - Double counting of processes (e.g. photon emission, B mixing)
  - How to avoid user configuration errors ?
- Tau decays
  - Interface **Tauola** in **EvtGen** and use it for all tau decays ?

Conclusions

- **EvtGen** presently used not too intensively in ATLAS (mainly by B-physics group for exclusive B-decays), but interests from individual users is growing
  - B-physics to produce inclusive MC samples for background studies
  - b-tagging group to use **EvtGen** to understand systematic uncertainties on calibration of the b-tagging efficiency (e.g. sensitivity to b-decay modeling)
- ATLAS uses quite old **EvtGen** version, which would need to be updated especially for inclusive use of **EvtGen**
- All ATLAS-specific updates already included during 2009 merging campaign. Migration to new **EvtGen** version should be straightforward, although detailed validation will be needed.
- Main issues when including **EvtGen** in ATLAS SW:
  - Problems of clashing **Pythia** configuration in **EvtGen** and **Pythia** used as primary generator
  - Particle properties not synchronized between **EvtGen** and other generators in ATLAS

Backup