

# EvtGen in ATLAS

## Outline:

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- **ATLAS EvtGen B-physics group requirements**
- **ATLAS EvtGen other groups requirements**
- **EvtGen in ATHENA**
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# ATLAS EvtGen users: General requirements

- ATLAS does all B-decays at Event Generator level ( Pythia, Herwig, EvtGen, etc), no need to do it at detector simulation level (Geant). Dominant part of B and Charm hadrons decay inside beam pipe radius=2.4cm – fraction beyond this point is negligible.
- Only decays K0s, Lambda are done in Geant.
- In case of K0s and Lambda from exclusive B-decays we first decay in Event Generator a full decay chain for instance  $B \rightarrow J/\psi(\mu\mu) K_s^0(p\pi)$  and apply acceptance cuts. Events are written into output files, which can be used as input into fast (detector) simulations – Atfast or full detector simulations ( Geant).
- In case of Geant K0s or Lambda decay is removed from event chain and K0s and Lambda is given a chance to interact with detector. If not then the weak decay of K0s or Lambda is generated in Geant again.

→ No need to call EvtGen from Geant in ATLAS  
→ For K0, Lambda special treatment (to preserve correct angular information given by EvtGen at a new decay point).

# ATLAS EvtGen B-physics group requirements

## Exclusive decays:

- **Strong B-decays:**  $\Sigma b$ , etc – production polarization must be defined in spin operator ( by hand – no model for b-production yet) and correctly treated to get polarization of secondary B-baryons – otherwise all baryon weak decays angular distributions incorrect.
- **Elmg B-decays** – EvtPhotos, ok.
- **Weak decays EvtGen provides:**
  - ✓ **Default decay models for all decays** – are they all consistent?
  - ✓ **Tools for user to accommodate own model:**
    - ✓ **Complex amplitudes** – interference effects – strong and weak phases differences, CP violation, interference between resonances in final states.
  - ✓ **General algorithm for angular distribution in cascade decays** – using spin-density matrix – ok, can be used also for strong/elmg decays.

→ **Need to complete baryons, polarizations and strong decays however tools in EvtGen exist – ok**

→ **EvtGen OK for individual exclusive channels, however a problem is with inclusive samples generator – see next.**

# ATLAS EvtGen B-physics group requirements

## Semi-Inclusive samples:

- **Semi-leptonic decays:** EvtGen has several models for semi-leptonic decays however problem with multiplicities of the rest. Pythia has a model similar to fragmentation.
- **bb->J/ψX** very bad condition in Pythia (EvtGen) – experimental data missing on multiplicities, need some model on fragmentation

→ **For all types of inclusive decays: EvtGen should provide decays of all species even if it calls Pythia(Jetset) for higher-multiplicity decays.**  
→ **bb->J/ψX data on X-multiplicities and other X properties are needed: can CDF and D0 supply??**

# ATLAS EvtGen other groups requirements

- QCD b-production based on combining exclusive B-decays with semi-leptonic ,  $bb \rightarrow J/\psi X$  and b-jets.
- Top, SUSY, Higgs – use b-jets and semi-leptonic samples
- What is needed of b-jets: multiplicities, pT distributions,
- correct number of  $K_0$ ,  $\Lambda_0$  contained in b-jet.
- These properties are treated in PYTHIA – with more or less success. There is no need that EvtGen duplicates this.
- Currently part of decays are in EvtGen – rest in Pythia(Jetset) – must check if b-jets and semi-leptonic general properties are OK this way.

# EvtGen in ATHENA

- EvtGen has been implemented in ATHENA – similar as in Gaudi (LHCb)
- Events are first converted from HEPEVT to HepMc then communicated to EvtGen and back to HepMC.
- More details in J.Catmore presentation Friday.
- ATLAS plan to keep close with LHCb – however will not follow LHCb in B-decays from Geant.
- In correspondence with previous B-generation ATLAS provides user a possibility of generation of only one exclusive channel per one run.
- ATLAS use a concept of repeated hadronization (for timing reasons). This is preserved also in case of using EvtGen.
- We will keep both possibilities Pythia or EvtGen user can choose.

# Conclusions:

- **Technically we can provide EvtGen as a default B-decay tool for all ATLAS groups however all of them (except for B-group) are interested in inclusive samples and need more general properties.**
- **These properties are treated in PYTHIA – with more or less success. There is no need that EvtGen duplicates this.**
- **EvtGen –makes part of decays in Pythia(Jetset) – must check if b-jets and semi-leptonic general properties are OK this way.**
- **We will keep both Pythia and EvtGen modes opened and recommend Pythia for inclusive samples generation until b-jet general properties are checked for EvtGen.**
- **ATLAS plan to go close with LHCb – however do not follow LHCb in B-decays from Geant.**
- **Different types of data are expected from BaBar, Belle about exclusive decays, however we need CDF, D0 to describe inclusive samples.**