EvtGen in ATLAS

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EvtGen applications in ATLAS

- EvtGen is used by many groups not only B-physics group: b-jets, sources of leptons, di-leptons for physics and performance studies, leptons are isolated or in jets.

- EvtGen is combined with various Generator packages, Pythia, Herwig, POWHEG, Jimmy

- Exclusive decays: usually 1 channel per generation sample:
  - e.g. Bs→ J/ψφ   exclusive decay of one type of B-hadron produced other Generator.
- Semi-inclusive decays
  - Type 1 bb-J/ψX: all B-hadrons produced in bb decay semi-inclusively J/ψ.
    - not yet used, but highly desired, tuning update needed
  - Type 2 a Hadron produced in HF production (t,b,c) in decay cascades, decayed in certain decay channel(s)
    - e.g jet-jet production followed by D* Filter   and EvtGen to decay D* into exclusive channel (DstarP2D0PiP_D02Kpi.DEC)

- Inclusive decays
  - e.g. Pythia jet-production combined with HF Filter (filtering B, D hadrons) followed by decay in EvtGen, inclusive.dec, inclusive.pdt to decay all B, D hadrons
  - e.g. Pythia bb (or cc) production, hadronization, followed by EvtGen,inclusive.dec, followed by Lepton Filter
  - same for PowHeG (Frixione, Nason, Ridolfi NLO HF production) followed by showering of Pythia
  - same for Herwig bb or cc

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EvtGen & Particle properties

- ATLAS uses PartPropSvc tool to define consistently particle properties that are stored in Table / HepPDT-2.06.01/ data/

- HepPDT is used in MC production, decays, G4 simulation and Physics analysis. EvtGen: decay package - needs consistency with Generators that produce particles (Pythia, Herwig)

- Table Builder: external/ HepPDT-2.06.01/ src/ HepPDT/ addEvtGenParticles.cc - each Generator can add properties to HepPDT table

```
     HepPDT::TableBuilder&) {
161
162   bool (*pF)  (std::istream &,
163               HepPDT::TableBuilder &);
165   if (typ == "PDG") {
166     pF = &HepPDT::addPDGParticles;
167   } else if (typ == "PYTHIA") {
168     pF = &HepPDT::addPythiaParticles;
169   } else if (typ == "EVTGEN") {
170     pF = &HepPDT::addEvtGenParticles;
171   } else if (typ == "HERWIG") {
172     pF = &HepPDT::addHerwigParticles;
```

- Tools in place, however need regular updates

- Some B-hadron properties updating with new measurements. Simulations to be useful must follow newest data.

- Problem 1 consistency between newly measured data and other particle properties, in some cases, e.g. B masses cannot be changed easily due to consistency with other masses (excited states)

- Problem 2 ATLAS big collaboration cannot change big productions (HepPDF) just because of some (from point of other studies) unimportant changes.

- For B-physics: samples dedicated to certain decay are easiest to update.

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Two EvtGen implementations in ATLAS

- EvtGen installed in ATLAS SW using copy of LHCb version alpha-00-10-22

- [EvtInclusiveDecay.h](#) typically used by Inclusive applications see slide 1

- [EvtDecay.h](#) typically used by exclusive applications

- Models coded by ATLAS

    Bplus_Kplus_mu6mu4.DEC
     Bplus_Kplus_star_K0s_pi_mu6mu4.DEC
     Bs2Jpsiphi.DEC
    MYDECAY_Lb2Lll.DEC
     MYDECAY_antiLb2Lll.DEC
     LbJpsiL.DEC
    bTosllAli.py

    Other packages EvyGen use:
     StopPytWeakBdecays.py
     pdt.table
     inclusive.dec
     inclusive.pdt

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EvtGen and dedicated measurements

- EvtGen-specific tools to be applied/validated in 2011 analysis

  - helicity calculus
  - operations with complex amplitudes allowing simulation of interferences, e.g. CPV
  - to be used in Bd J/ψK0*, Bs J/ψφ, ΛbJ/ψ Λ and validated vrt respective measurement results

- Other applications in 2011 analysis

  - bb-J/ψX to be updated: fBu/fBd/fBs/fbBar, branching fractions
  - to be used/validated in B-average lifetime measurement using J/ψX
  - to be used as a reliable background simulation in dedicated B measurements
  - bb-X cc-X decay tables: important for b-jets in many ATLAS physics measurements

- HF Production tuning urgent

  - The above has to be associated with implementing new QCD data production results into Pythia/Herwig, POWHEP and other production simulation tools.

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Summary

- EvtGen tools in ATLAS allow all needed functionalities: work with other packages, tools for updating Particle properties, options for inclusive and exclusive applications.

- Issues of updating: updating is slower than needed by dedicated B-physics tasks, mainly due to big productions of other groups, and due to consistency of particle properties updates with the rest of ATLAS physics. Sensitive topic is b-jets - their multiplicities must be checked if EvtGen was used for generation and if the decay tables changed.

- On the other side exclusive B-decay samples can be updated - are independent.

- Updating EvtGen decay tables and validation of models vrt data of high interest. Tunings of production models in generators to be done urgently.

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