EvtGen in FCCSW with EDM4hep

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Introduction

- Use of EvtGen important in heavy flavour studies
- Use Pythia to generate $e^+e^- \to Z^0 \to b\bar{b}$ and to hadronise in order to make B-hadrons
- EvtGen used to decay the hadrons produced
  - DECAY.DEC used in general to decay all of the products, **but**
  - User can request a specific exclusive decay chain for a particle produced e.g. $B^\mp \to (D^0 \to K^\mp \pi^\pm)\pi^\mp$
- Clement has been working to include EvtGen in FCCSW and with output in EDM4hep format
  - I have been helping to validate the output

Command to run

```
fccrun PythiaDelphes_config_IDEAtrkCov.py

--Filename ee_Z_bbbar.cmd

--doEvtGenDecays true

--UserDecayFile user_decay.dec

--EvtGenDecayFile DECAY.DEC

--EvtGenParticleDataFile evt.pdl

-n 10000
```

Example use-case: $B^{\mp} \to (D^0 \to K^{\mp}\pi^{\pm})\pi^{\mp}$, Bu2D0Pi.dec

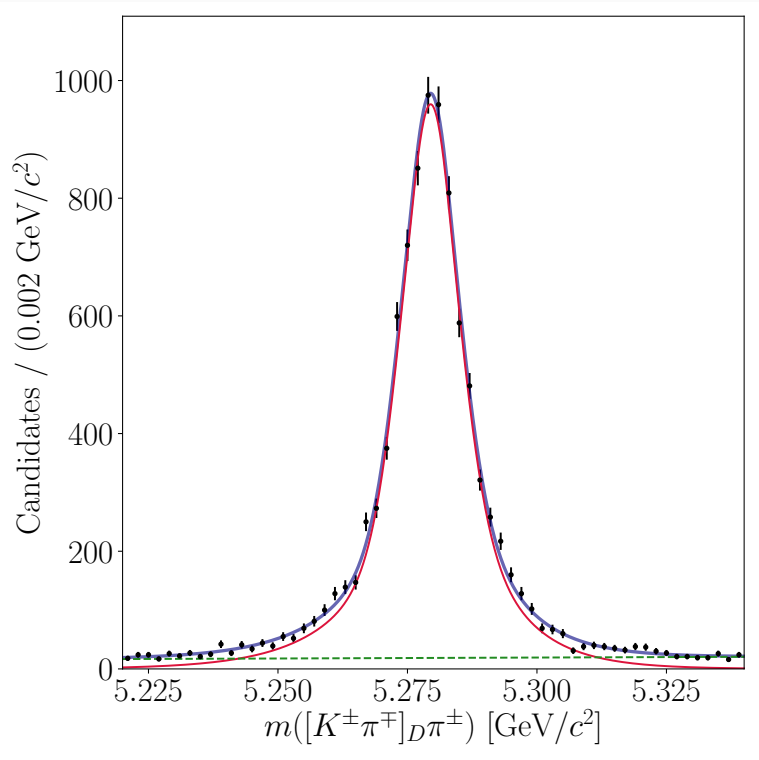
```
Alias      MyD0     D0
Alias      Myanti-D0    anti-D0
ChargeConj   MyD0     Myanti-D0

Decay B+
    1.000    Myanti-D0    pi+ PHSP;
Enddecay
CDecay B-

Decay Myanti-D0
    1.000    K+   pi- PHSP;
Enddecay
CDecay MyD0

End
```

Expected yield in test run

- Generated 10k $Z^0 \to b\bar{b}$ with exclusive ***Bu2D0Pi.dec***, so have 20k b-quarks
- 43% of q-quarks hadronise to $B^{\pm}$, so expect $\sim 8,600$ $B^{\pm}$ in total
- Using ***ReconstructedParticles*** to build the D^0 and $B^{\pm}$ candidates, so some loss expected due to track cuts in Delphes
- Fit $m(D^0\pi)$ in exclusive sample and compare yield to expectation
  - Include an exponential background component for combinatorial in the fit
  - **No additional cuts applied apart from ± 30 MeV $m(D^0)$ window**

$m(D^0\pi)$ fit result

- $N(B^{\mp} \to D^0\pi^{\mp}) = 8835 \pm 120$
- Yield well aligned with expectation for this exclusive sample
- $\sigma = 5.5 \pm 0.2$ MeV
  - Modelling peak with a sum of two Crystal Ball functions due to visible tails (both share the same σ)



Summary

- EvtGen functional within FCCSW generation using EDM4hep
- Exclusive sample of $B^{\pm} \to D^0\pi^{\mp}$ decays analysed in *awkward array* has the expected yield
- Core width of mass peak is good (σ = 5.5 MeV) but some tails are visible
- Purity is good (90%) even with no extra cuts applied apart from loose $m(D^0)$ window
- Will begin generating several exclusive modes next for dedicated performance studies