The Heavy-Flavor Production Fraction Reweighting Procedure in ATLAS

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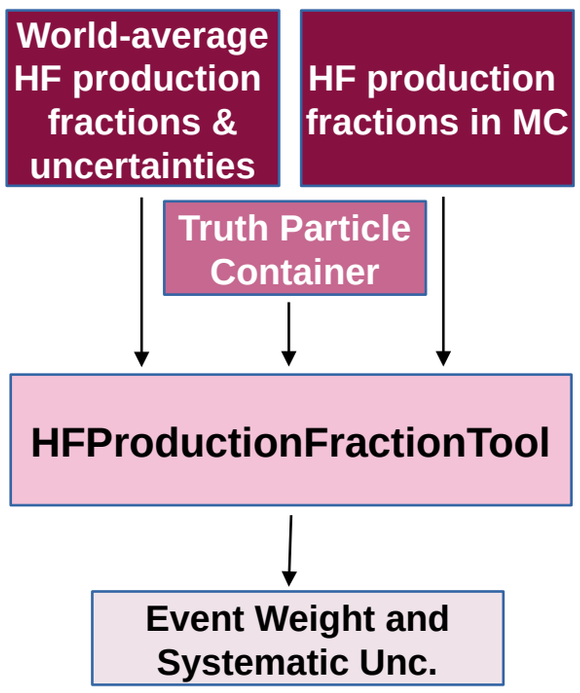
on behalf of the ATLAS Collaboration



Motivation

Flavor tagging is one of the key experimental techniques in ATLAS. The c- and b-tagging efficiencies vary among the different MC shower simulations, affecting the modeling uncertainties associated with flavor tagging. A dominant cause is the different heavy-flavor production fractions among the MC shower generators. A new analysis tool, the **HFProductionFractionTool**, is introduced, with a purpose to reweight the production fractions in MC to the common world-average values.

Tool description

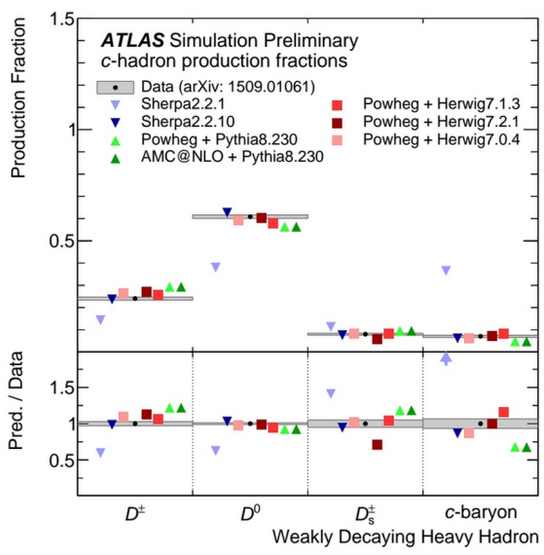
Selection of truth heavy-flavor hadron → Specification of event weight

$$w = \prod_{HF \in V_{fid.}} \frac{f^{Data}(HF)}{f^{MC}(HF)}$$

← World-average HF production fraction
← HF production fraction in MC

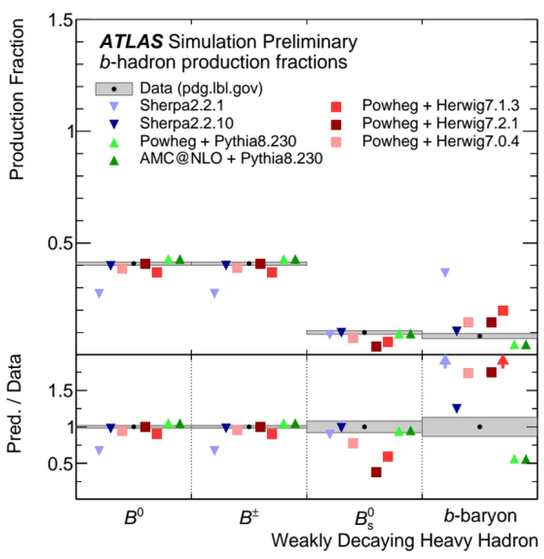
In addition to the nominal event weight the tool provides five event weight variations which are summed in quadrature to derive the final uncertainty.

Heavy-flavor production fractions



The HF production fractions in the simulated samples are calculated by counting the fraction of final state hadrons from c- and b-quarks

- Exclude c-hadrons from b-hadron decays
- Kinematic cuts: $|\eta(\mathrm{HF})|<2.5$ & $p_T(\mathrm{HF})>5\mathrm{GeV}$



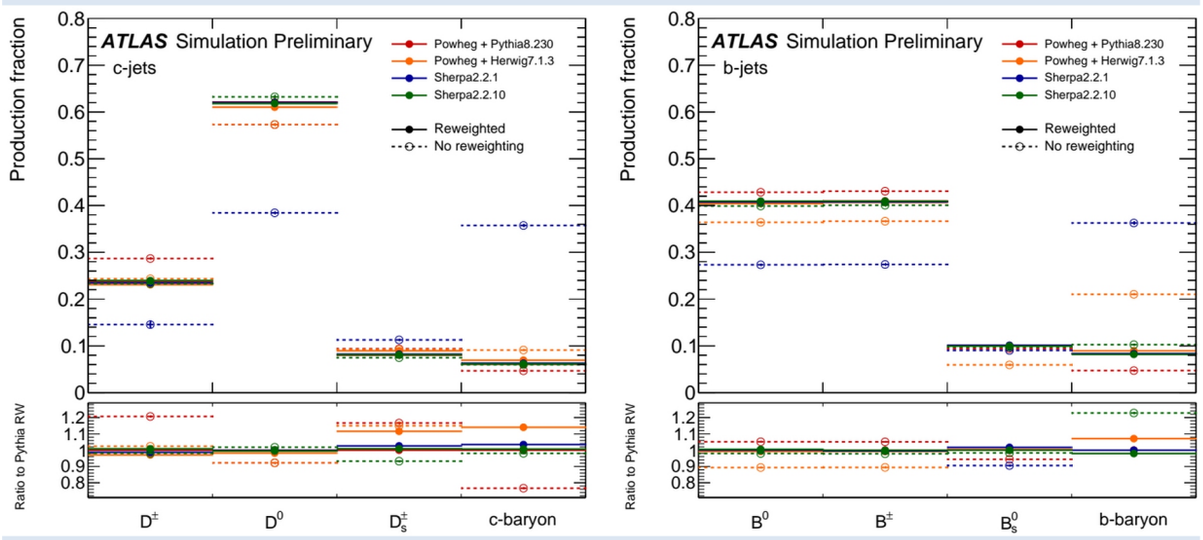
Systematic uncertainties

- Eigenvector variations of the measurements, using their correlation matrices

- A set of alternative HF production fractions for each eigenvector variation (three for c-hadrons and two for b-hadrons- equal B^0 and $B^{\pm}$ production fractions)

Validation

$t\bar{t}$ samples generated with different MC shower software

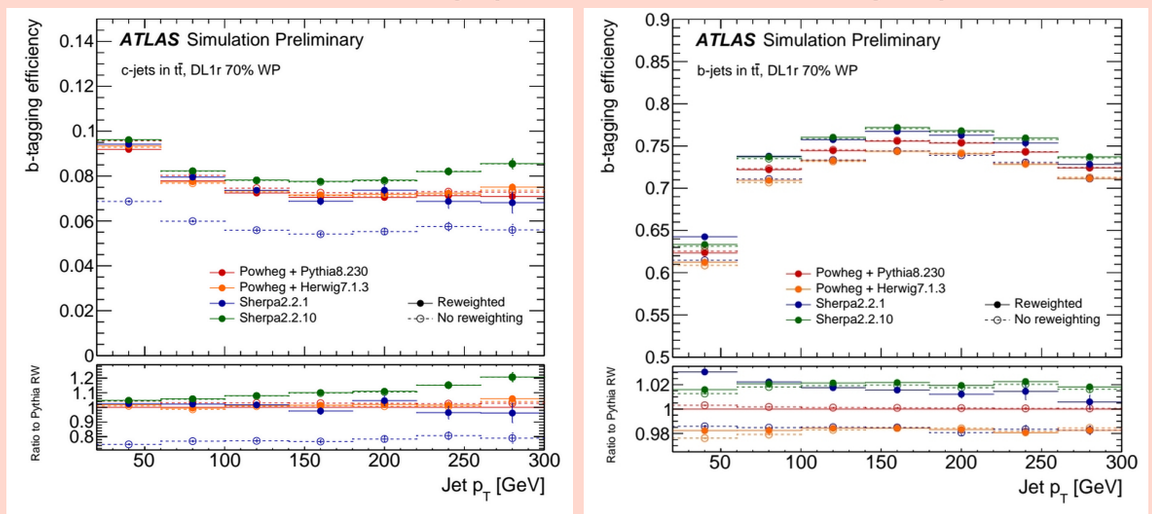


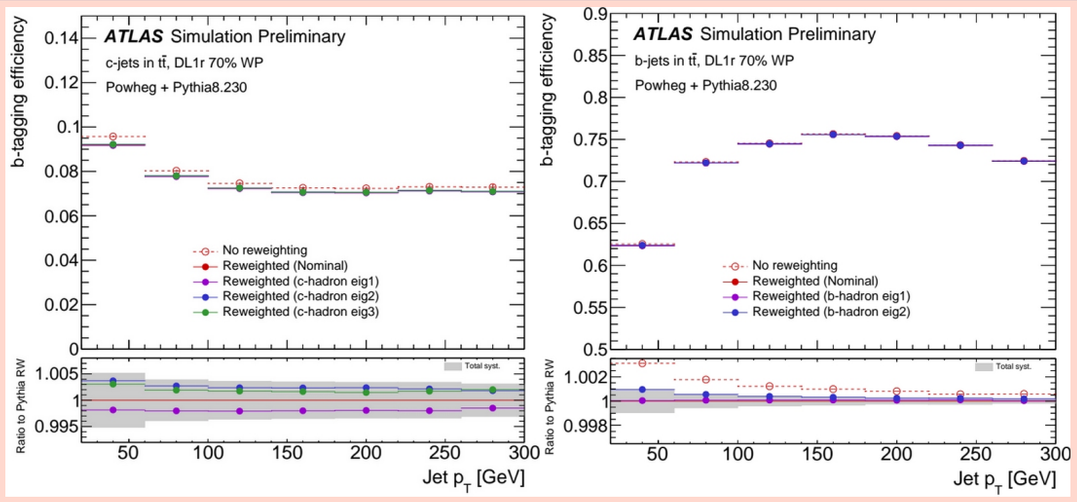
- The production fractions before the reweighting (dashed lines) show large difference between the MC shower generators
- Sherpa2.2.1 has the worst agreement, with a very large baryon fraction
- The reweighting is done independently of the jet selection, only using the content of the truth hadron collection in MC
- After the weight from the tool is applied any large disagreement between the samples is eliminated

Results

After reweighting:

- Sherpa2.2.1 matches other samples within about 2%
- Still some differences between MC shower generators (due to difference in branching ratios and fragmentation functions)
- Less than 1% uncertainty (smaller for b- than c-jets)





Usage of the tool:

- Directly by specialized analyses sensitive to heavy-flavor production fractions
- Part of the central heavy-flavor tagging calibration

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