Sherpa in ATLAS: Weak Boson Processes

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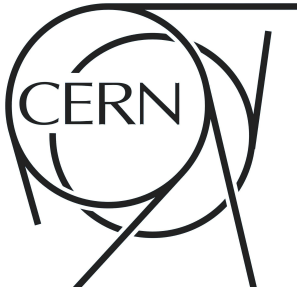
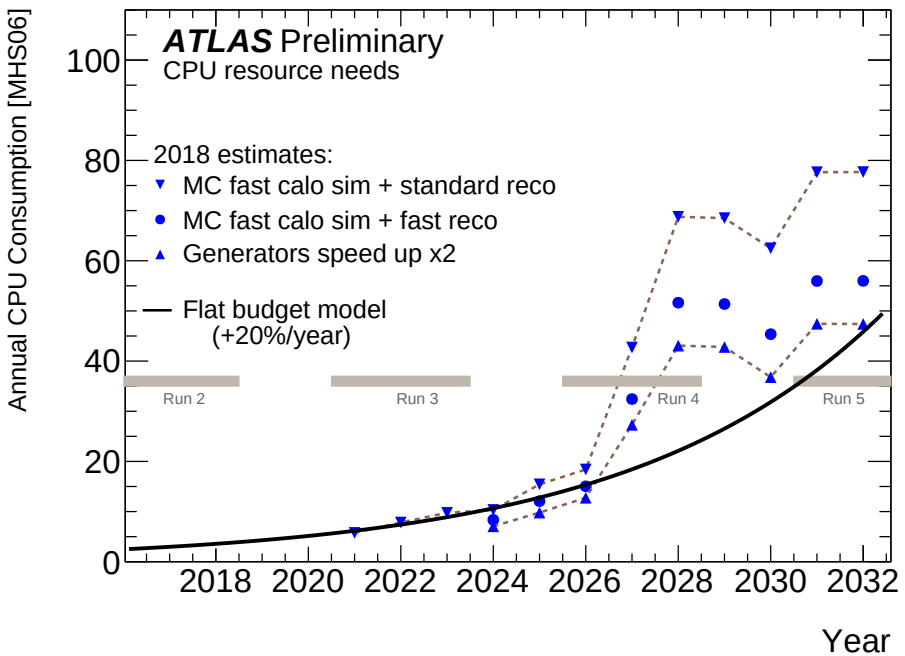
Sherpa developer meeting

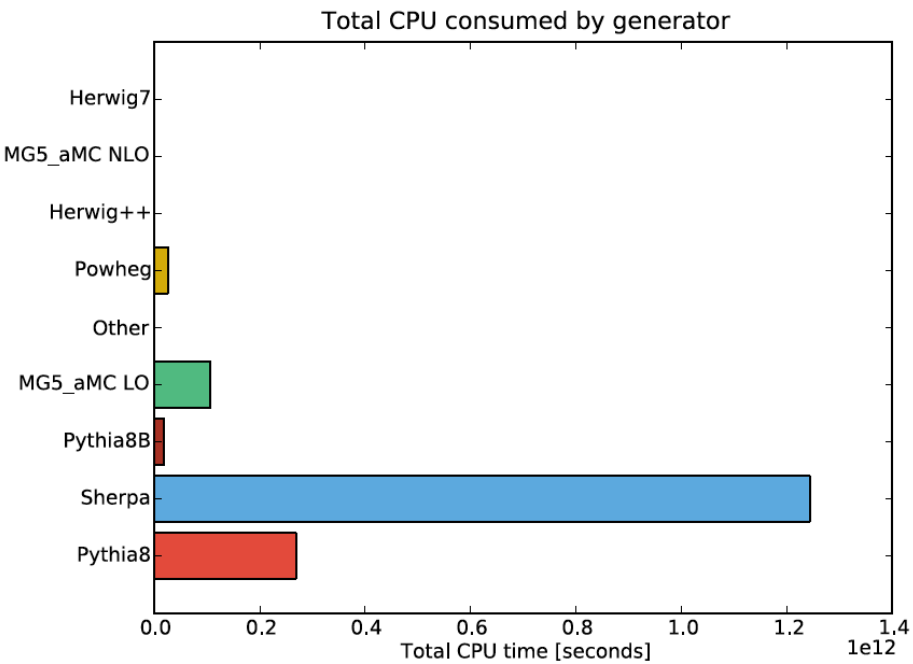
08 January 2020



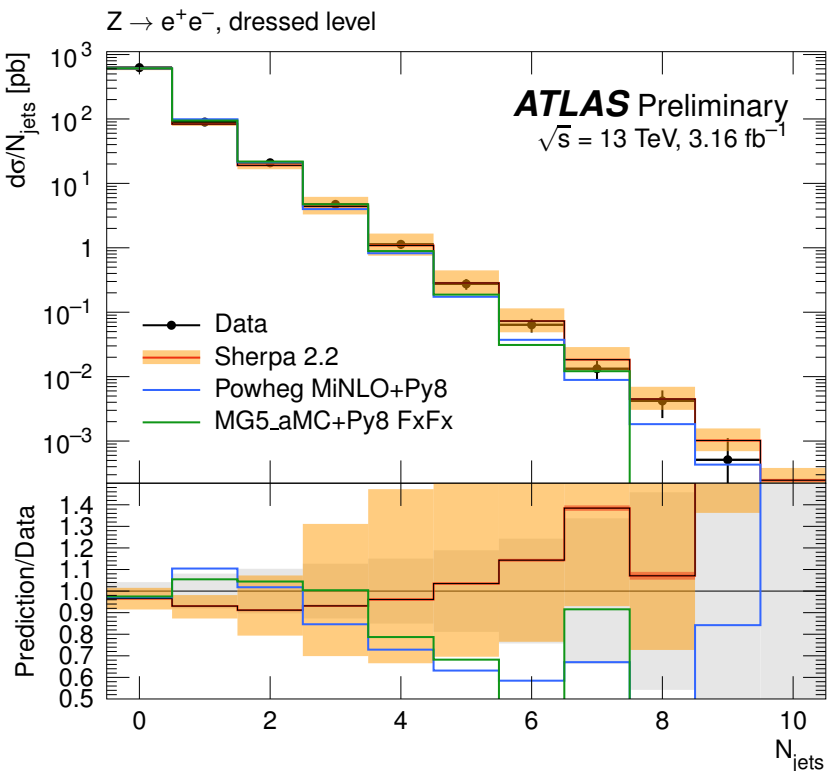
The elephant in the room

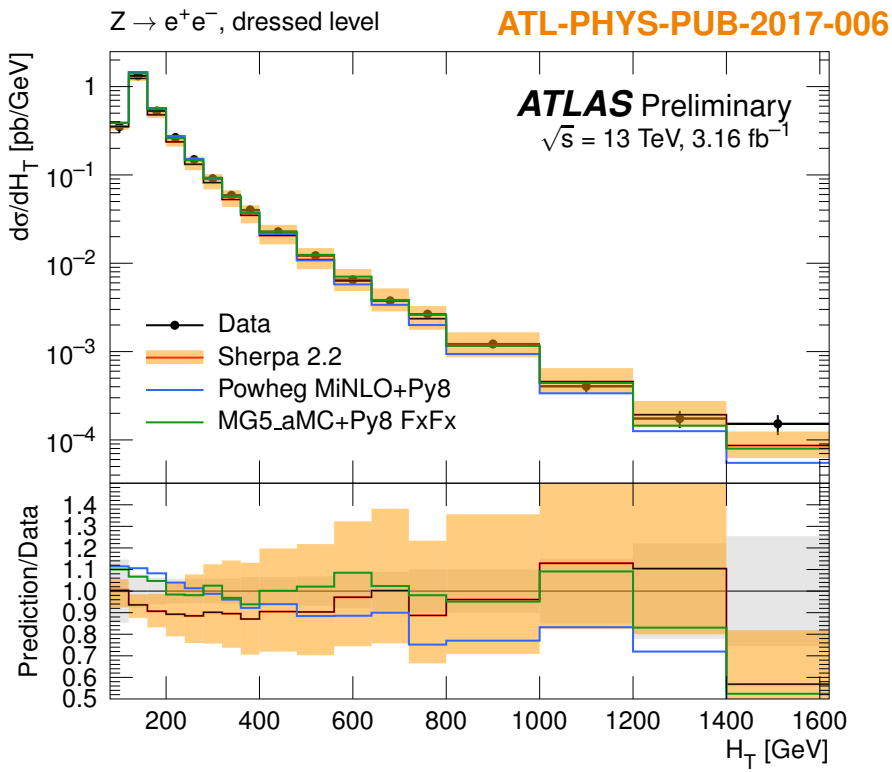
- MC generation is becoming the bottleneck for the experiments
- this needs attention now to avoid measurements being limited by MC statistics





The ATLAS flagship setup: vector boson + jets



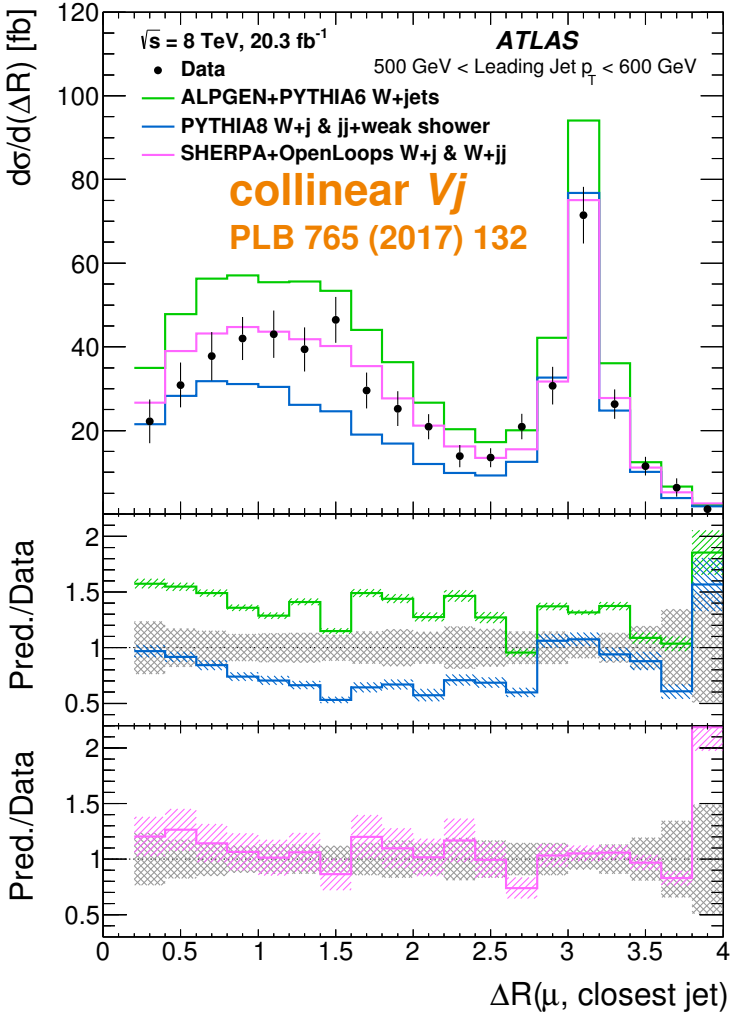


- the 'current' 2.2.1 baseline sample is for $V + 0, 1, 2j$@NLO+$3, 4j$@LO
- $\mathcal{O}(3.2)$ billion unweighted events
- sliced in $\max[H_T, p_T^V]$ and filtered according to heavy-flavour content

Negative weights are expensive

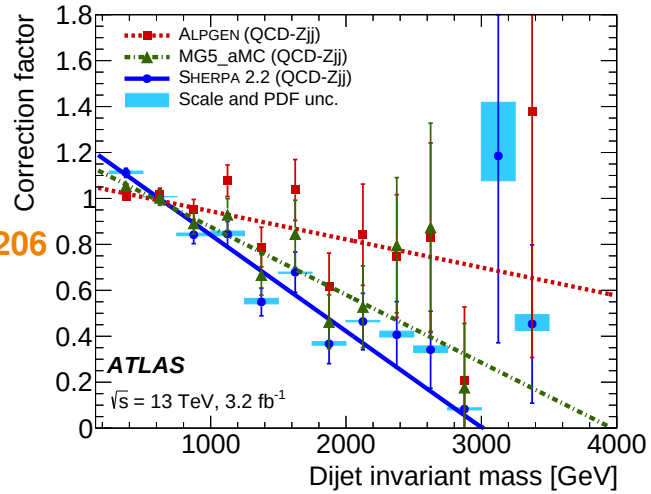
- In the 2.2.1 setup, negative weight fraction (NWF) about 30 % for $70 < p_{\mathrm{T}}^{V} < 140$, 15–20 % above/below that slice and < 10 % above 250 GeV
  - NWF$=$ 10 % implies statistical error becomes factor 1.25 larger
    - need factor 1.5 as many events
  - NWF$=$ 20 % implies statistical error becomes factor 1.7 larger
    - need factor 2.8 as many events
  - NWF$=$ 30 % implies statistical error becomes factor 2.5 larger
    - need factor 6.3 as many events
  - NWF$=$ 40 % implies statistical error becomes factor 5 larger
    - need factor 25 as many events
- new setup with in preparation where NWF improved inclusively from 18 % down to 9 %
  - huge saving!

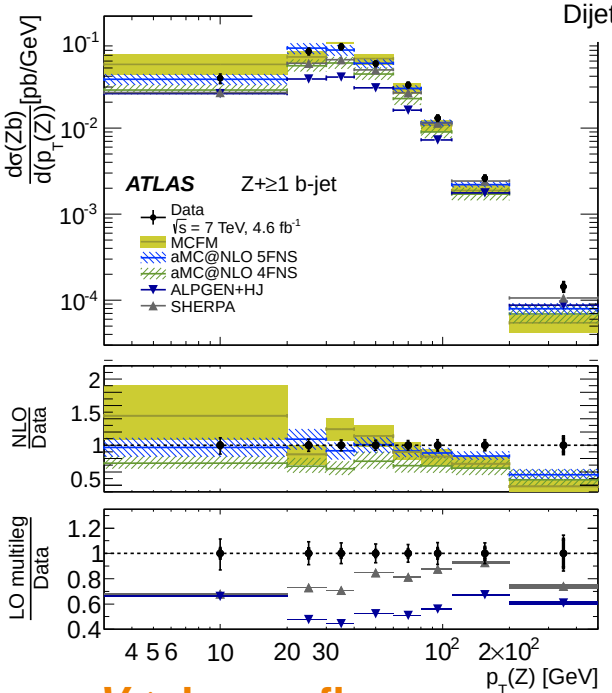
Known mismodelling



collinear *Vj*
PLB 765 (2017) 132

large m_{jj}
PLB 775 (2017) 206

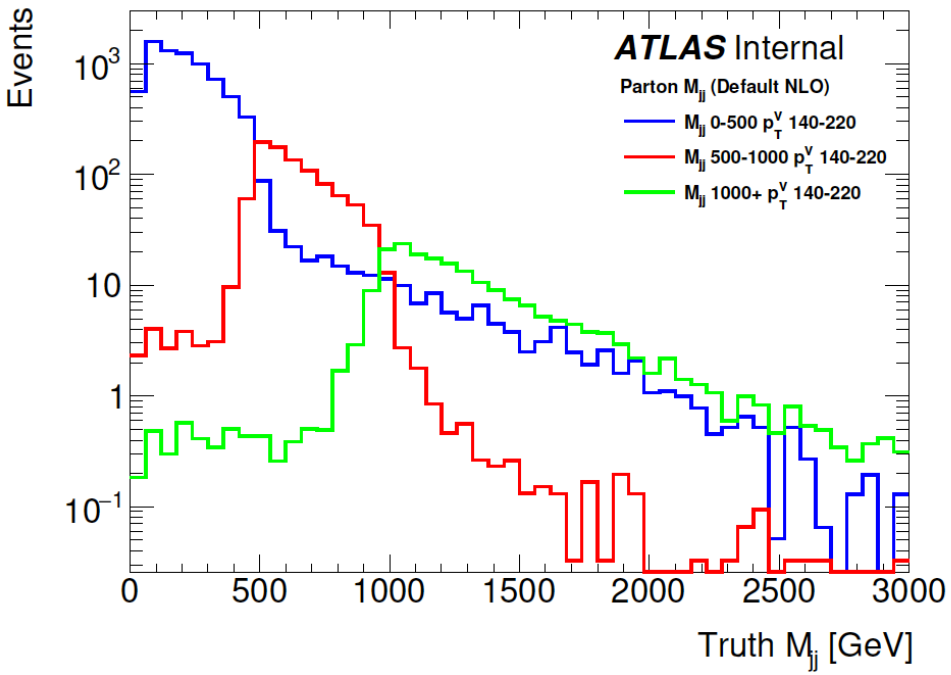


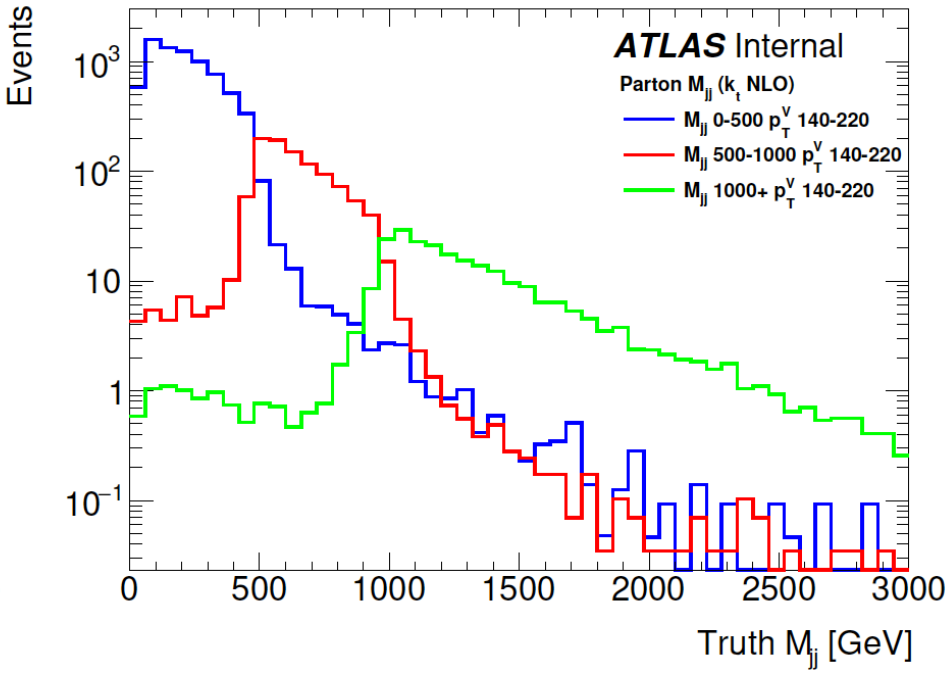


***V*+ heavy flavour**
JHEP 10 (2014) 141

Case study: k_t merging for $Z \to \nu\nu$

Ben Rosser

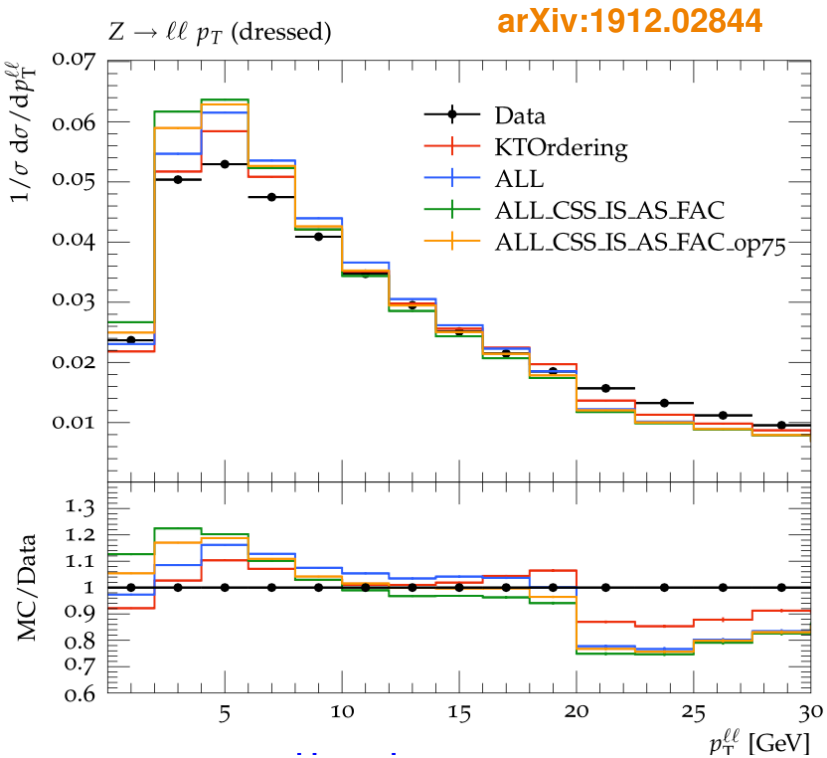




➜ Switching the ME+PS merging criterion to use k_t algorithm found to improve slicing by adding high-η partons to the matrix element

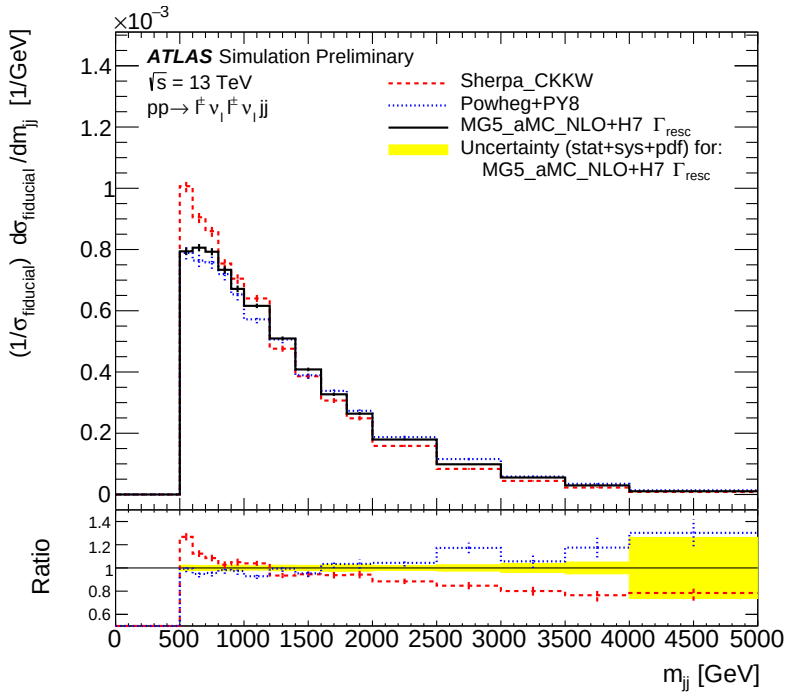
Case study: k_t merging for $Z \to \nu\nu$

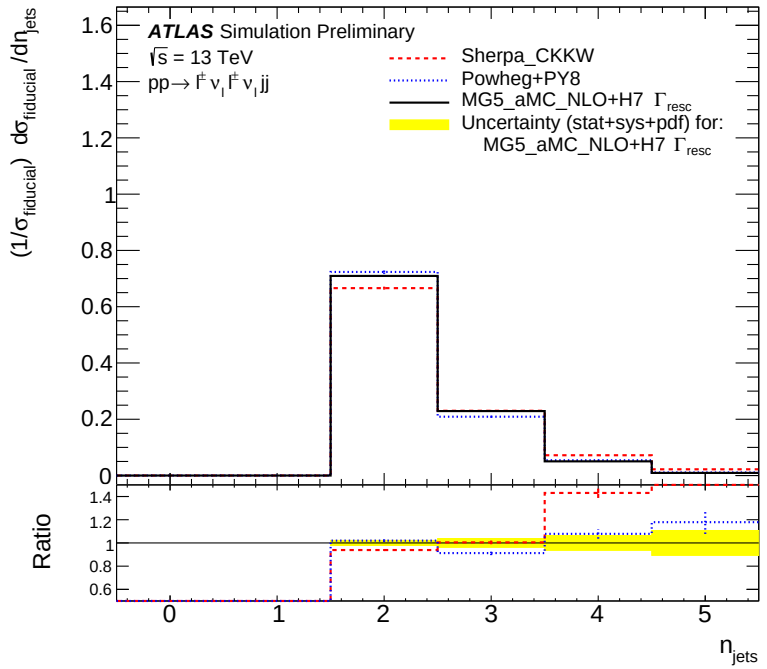
- Generation slower by factor 1.5-3 due to larger ME phase space
- sub-optimal step around merging scale



Processes involving a colour-singlet exchange

ATL-PHYS-PUB-2019-004

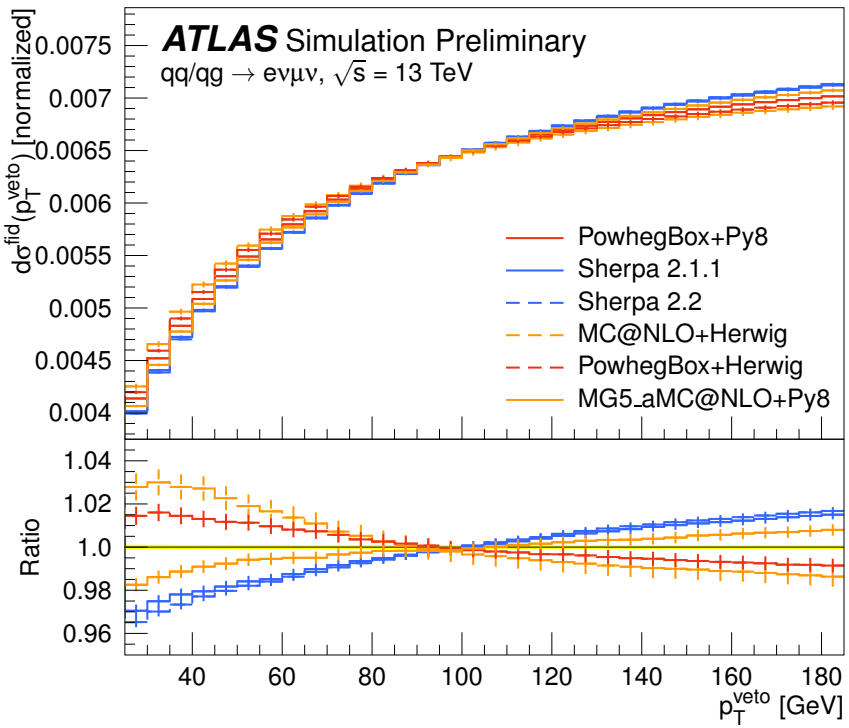


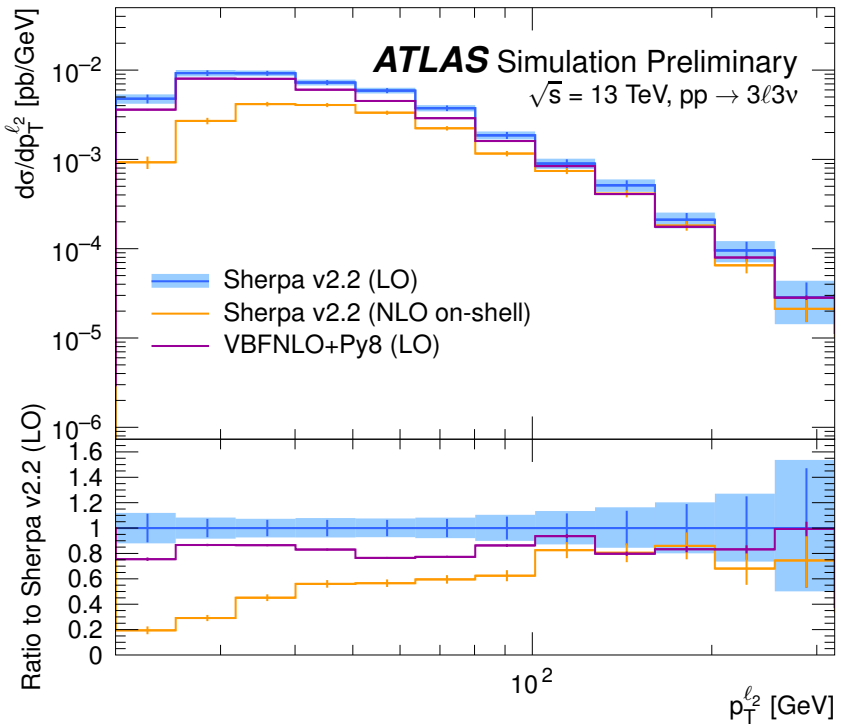


➜ renders these types of samples largely useless for VBF/VBS analyses

Multi-boson final states

ATL-PHYS-PUB-2017-005





- precision era for multi-V measurements only just begun
- gives rise to challening explosion of high-multiplicity final states

Electroweak input schemes

- momentum fraction of pions in $\tau \to \pi\nu$ (shown here for LO $Z \to \tau\tau$) depends on value of $\sin^2\theta_W$
- G_μ scheme preferred for $\mathrm{EW}_{\mathrm{virt}}$ corrections, but does not have $\sin^2\theta_W$ as input ➜ all correlations 'off'
- for V+jets could fix with a smart choice of input paramters that includes $\sin^2\theta_W$, but then what about WZ?