



Alistair Gemmell
a.gemmell@physics.gla.ac.uk

Introduction

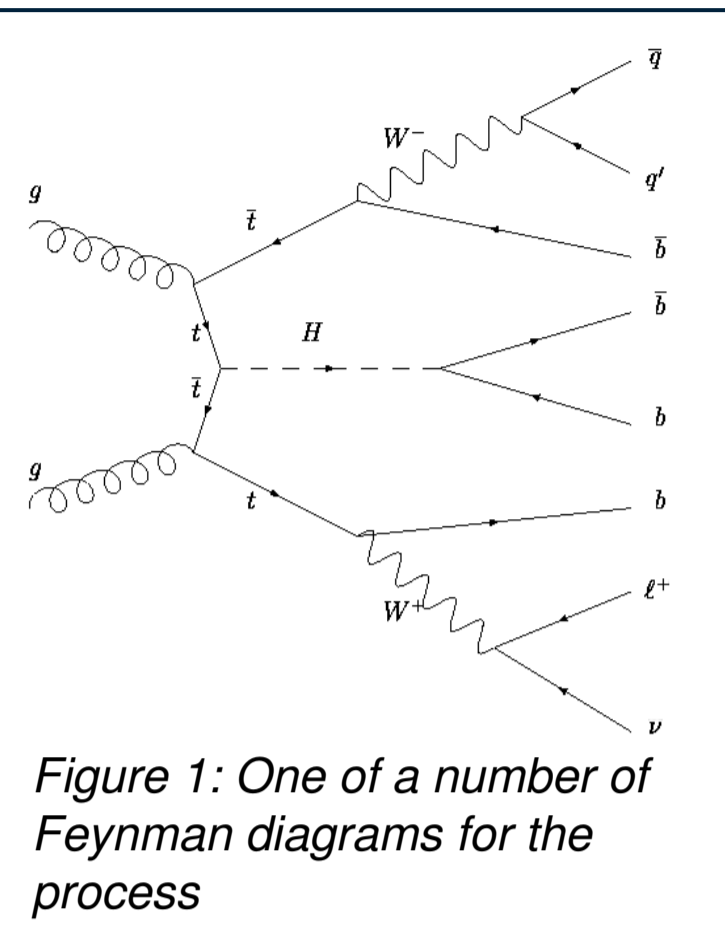


Figure 1: One of a number of Feynman diagrams for the process

Monte Carlo (MC) generators are used to simulate processes expected to occur at the LHC. I am comparing how Sherpa 1.1.3 and Pythia 6.403 differ in their predictions of the $ttH(H \rightarrow bb)$ process. Unlike Pythia, Sherpa takes into account spin correlations and colour flow between quarks, and so it is expected to be able to better model this process.

The process simulated was $ttH(H \rightarrow bb)$. One of the W s then decayed hadronically, the other decayed leptonically – as shown in Fig. 1. The centre of mass energy in the simulation was 14 TeV.

Results:

1. b quark properties

The b quarks produced by Sherpa consistently had a lower p_T , and the b coming from the Higgs also had a consistently greater $\Delta\Phi(b,b)$ separation than Pythia – although there was an anomalous peak at low $\Delta\Phi$, which is under investigation.

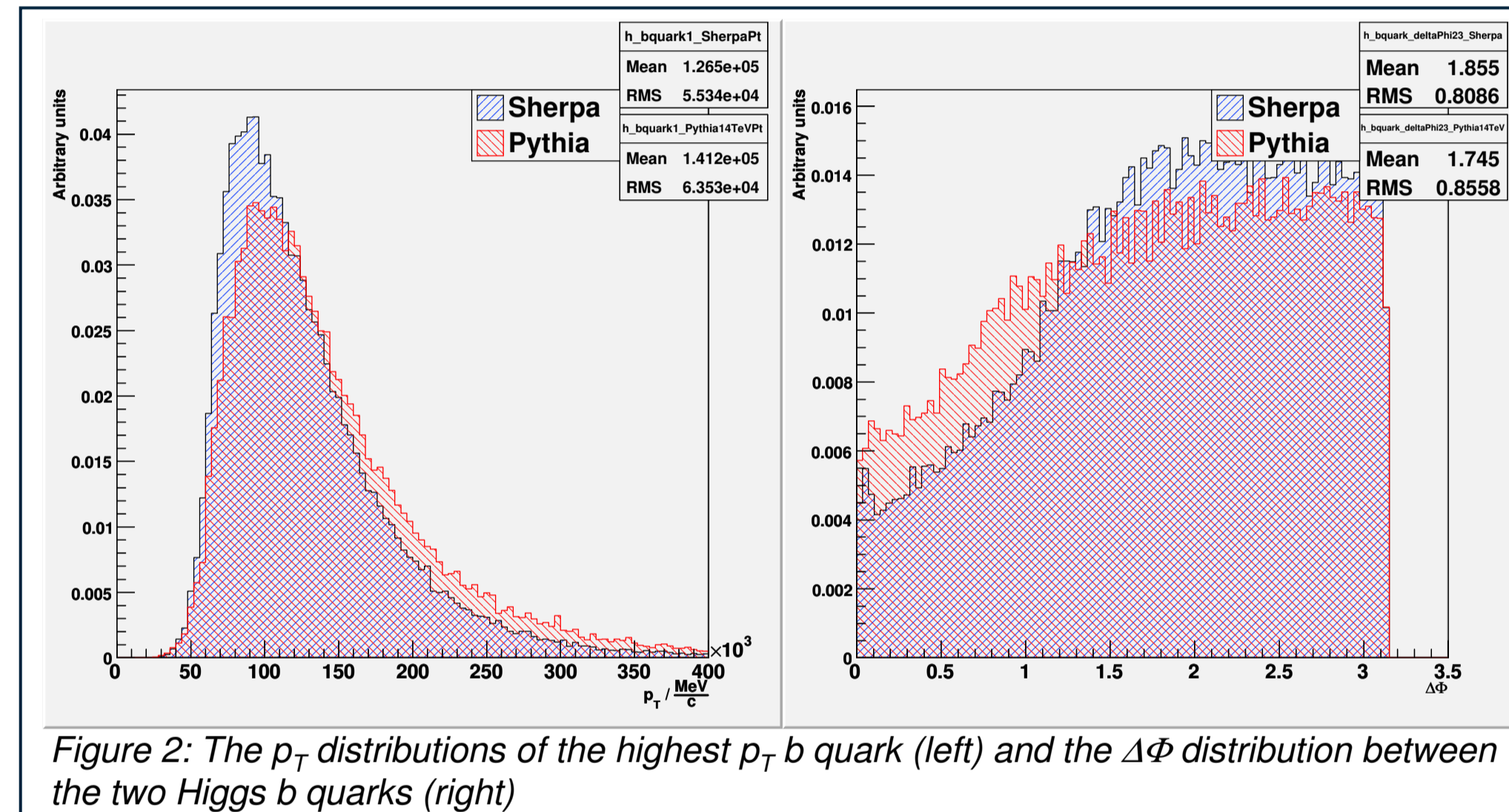


Figure 2: The p_T distributions of the highest p_T b quark (left) and the $\Delta\Phi$ distribution between the two Higgs b quarks (right)

2. Light quark and lepton properties

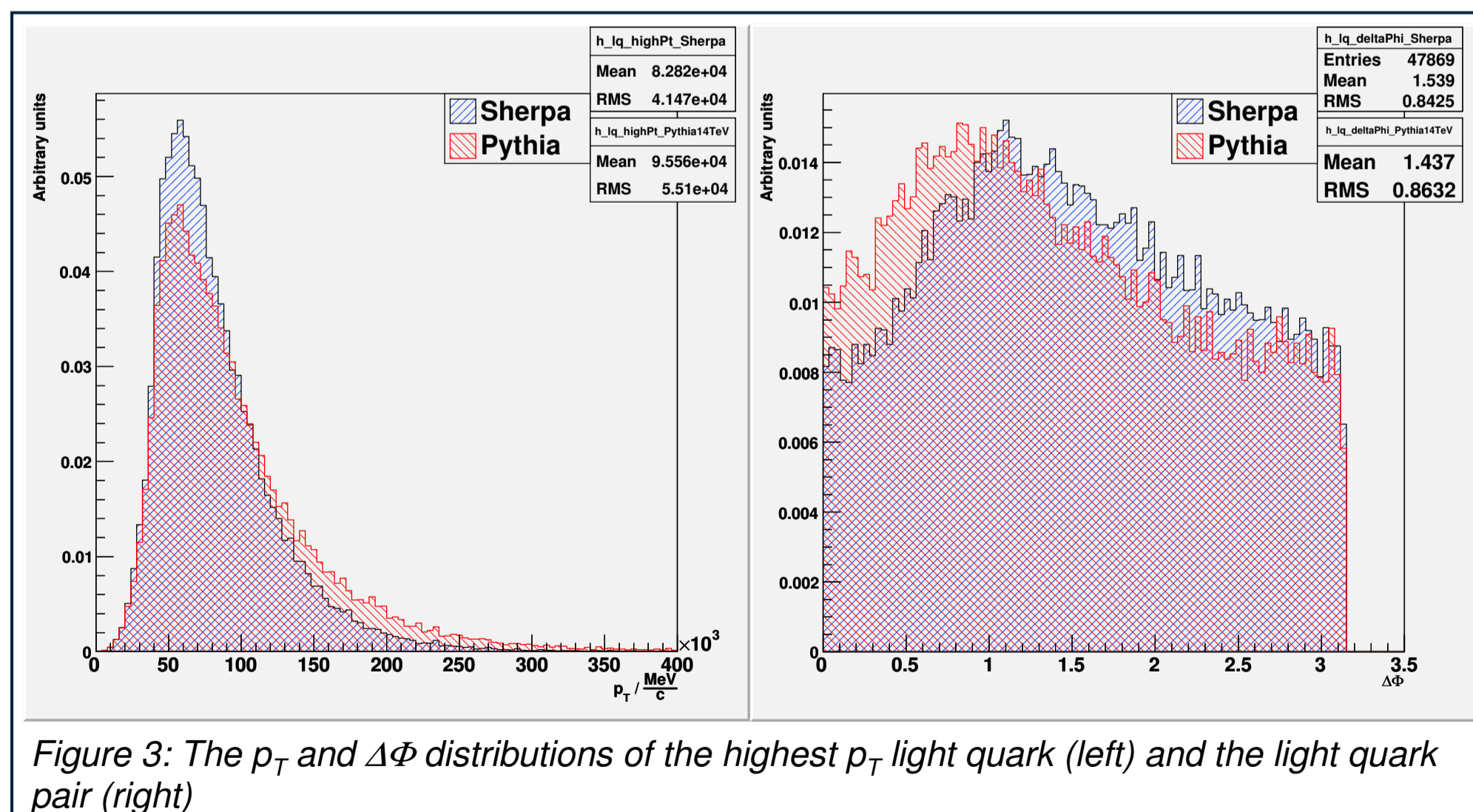


Figure 3: The p_T and $\Delta\Phi$ distributions of the highest p_T light quark (left) and the light quark pair (right)

Light quarks from the W decay are seen to have a greater $\Delta\Phi(q,q)$ and smaller p_T when generated in Sherpa. Leptons are also observed to have a greater $\Delta\Phi(l,\nu)$ in Sherpa, though the difference is less pronounced, and the p_T distributions are broadly similar.

3. W properties

Pythia suggests that both hadronically and leptonically decaying W s have broadly similar distributions – however, Sherpa simulated a lower p_T distribution for the hadronic W – the reasons for this are not understood.

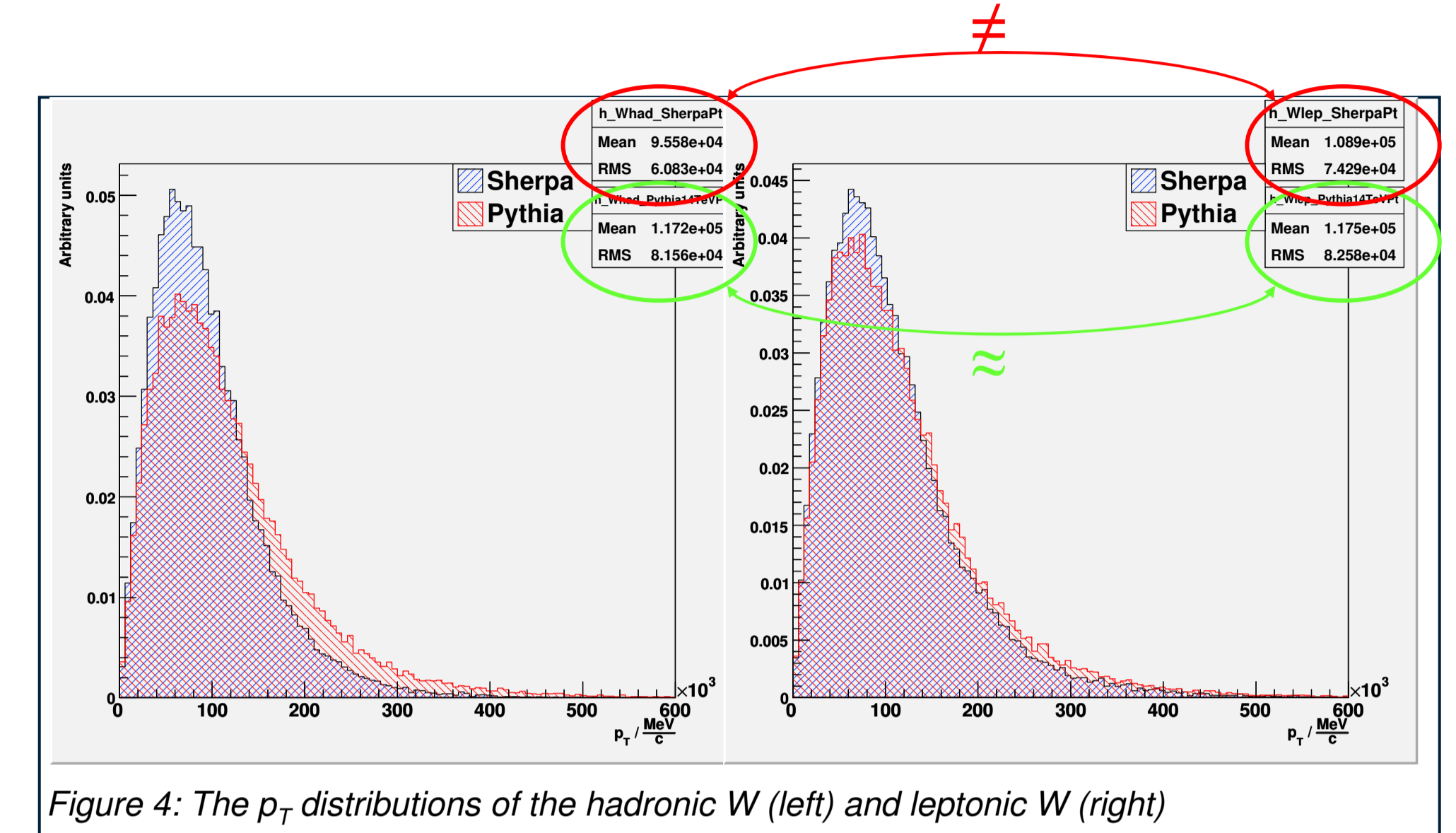


Figure 4: The p_T distributions of the hadronic W (left) and leptonic W (right)

4. Cross-section properties

The LO cross-section given in the CSC note is 100 fb [1] (k -factor 1.2). Pythia calculates a cross-section of 101.6 fb, whereas Sherpa predicts a cross-section of 49.8 fb. However, in contact with the Sherpa authors, a simulation on a beta version of Sherpa 1.2.0 calculated a cross-section of 82.9 fb – much closer to the CSC value.

| Energy /TeV | Generator | | | |
|-------------|---------------|---------------------------------|---------------|---------------------------------|
| | Sherpa | | Pythia | |
| | σ / fb | $\frac{\sigma}{\sigma_{14TeV}}$ | σ / fb | $\frac{\sigma}{\sigma_{14TeV}}$ |
| 14 | 24.9 | 1.00 | 50.8 | 1.00 |
| 10 | 10.6 | 0.43 | 21.6 | 0.43 |
| 7 | 4.0 | 0.16 | | |
| 4 | 0.7 | 0.03 | | |

It was also investigated how the cross-section from each generator scaled with energy – it was found that Sherpa and Pythia's cross-sections both scaled in the same manner.

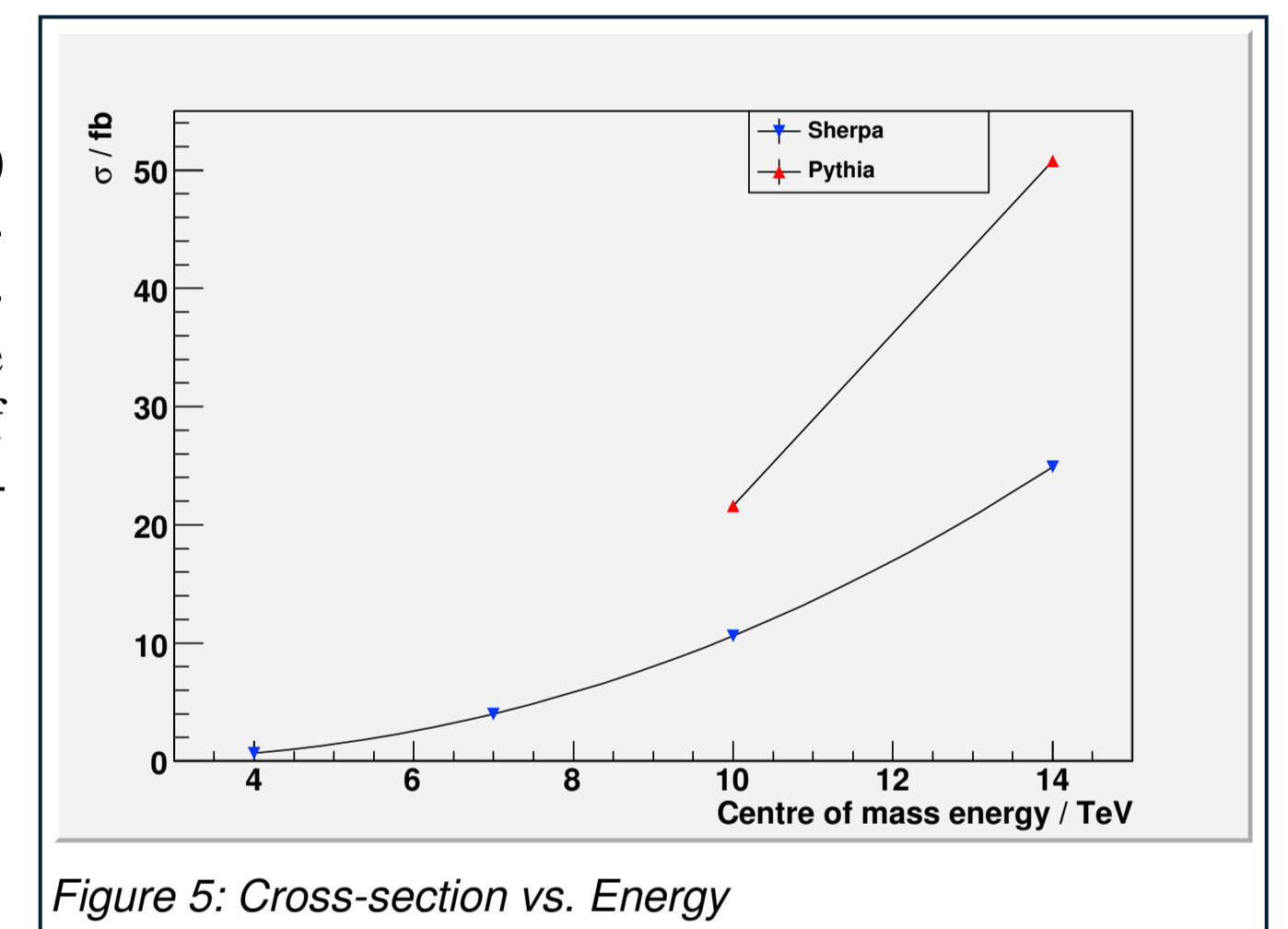


Figure 5: Cross-section vs. Energy

[1] The ATLAS Collaboration, CERN-OPEN-2008-020

Discussion:

Sherpa's predictions suggest a decrease in p_T for all particles concerned as well as increased separation between certain pairs. The cross-section produced by Sherpa 1.1.3 is also not in agreement with the CSC note, though it does scale correctly with energy, and the beta version of Sherpa 1.2.0 appears to correct this problem.