LHCP2018 · Bologna, 4-9 June 2018

Measurements of the W/Z production with (heavy flavour) jets in ATLAS

W/Z+jets allows to test perturbative QCD and to perform high precision measurements, comparable with theoretical predictions. The W/Z production with ***heavy flavour-jets*** (HF-jets) is a benchmark for understanding the proton structure and the gluon splitting. Moreover it constitutes a large background for Higgs and new physics searches with high jet multiplicity final states.

W+jets @ 8 TeV

Differential cross sections for W(→eν)+jets and W^+/W^- cross section ratios are measured with L = 20.2 fb⁻¹.

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Dominant backgrounds:

- **multijet** for W+≥1,2,3 jets (8-16%)
- **top** for W+≥4,5,6 jets (16-36%). For W+≥7 jets, top is larger than signal (43%), even vetoing b-jets.

W^+/W^- well described by all predictions.
W+≥1jet: offset between **LO ALPGEN+PY** and **LO ALPGEN+HERWING** due to Matrix Element calculations and/or incorrect u/d ratio in the LO PDF.

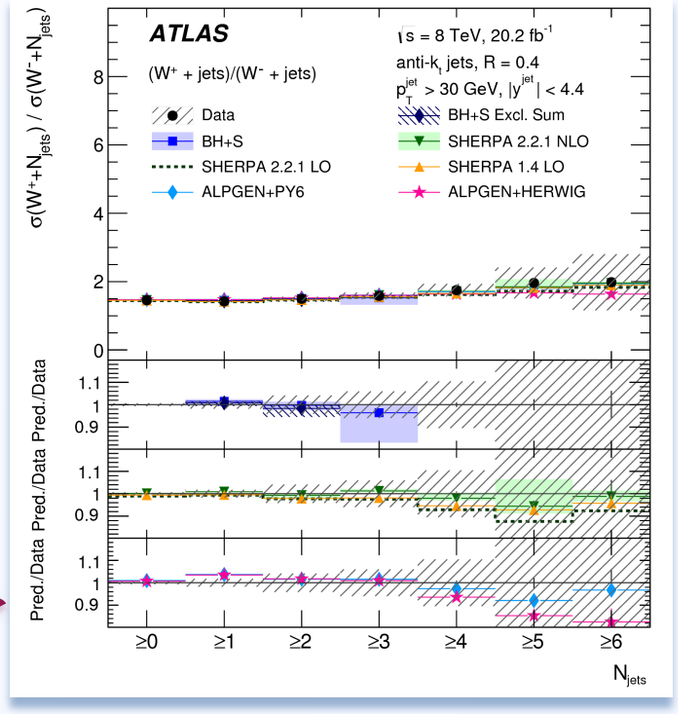

Fig.1: Measured W^+/W^- cross section ratio for the different inclusive N_{jets}.

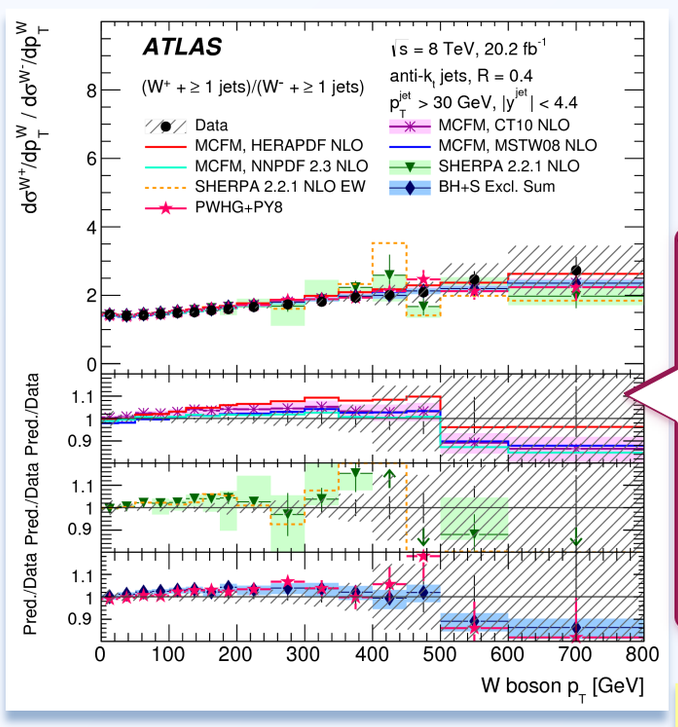

Fig.2: Measured W^+/W^- cross section ratio as a function of W p_T for W+≥1jet.

Dominant systematic uncertainties on W^+/W^- from jet energy scale (0.3-17%) and multijet (1.2-27%).

W^+/W^- vs W p_T not well described by **NLO SHERPA** and **NLO BLACKHAT+SHERPA**.
NLO MCFM prediction is shown for **CT10**, **HERAPDF**, **MSTW08** and **NNPDF2.3** NLO PDF sets.
For $200<p_T^W<400$ GeV all PDFs predict two times larger with respect to data.

The results can be used to constrain PDFs.

Z+jets @ 13 TeV

Differential cross sections for Z+jets (up to 7) are measured with L = 3.16 fb⁻¹.

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	Z→e⁻e⁺ (%) ≥1 (7) jets	Z→μ⁻μ⁺ (%) ≥1 (7) jets
Signal	**97.6 (81.2)**	**97.5 (84.6)**
Top	**1.2 (11.6)**	**1.1 (7.7)**
Others	1.4 (7.5)	1.5 (7.9)

Tab.1: Fraction of signal and background events in the final selection.

$d\sigma/dp_T$ well modelled by most predictions. **LO MG5_aMC+PY8 CKKWL** models a too hard jet p_T spectrum for $p_T^{jet}>200$ GeV.

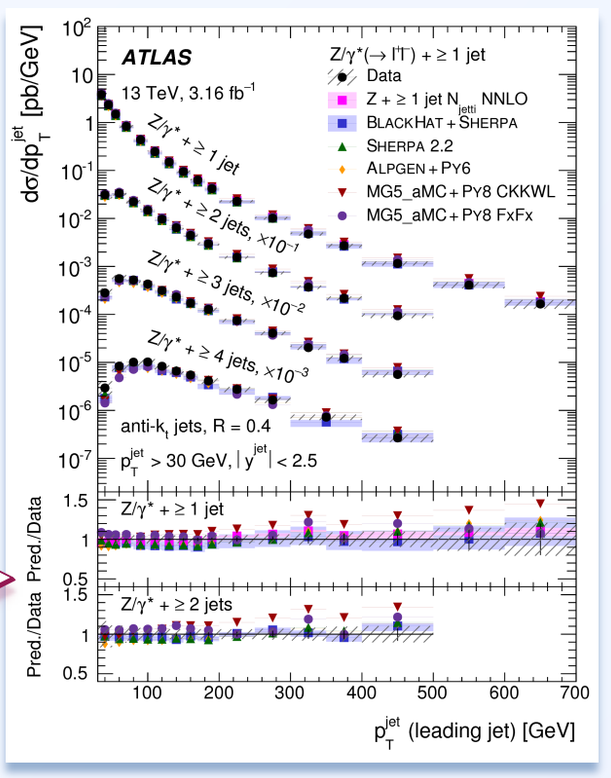

Fig.3: Measured cross section as a function of the leading p_T^{jet} for Z+≥1,2,3,4 jets.

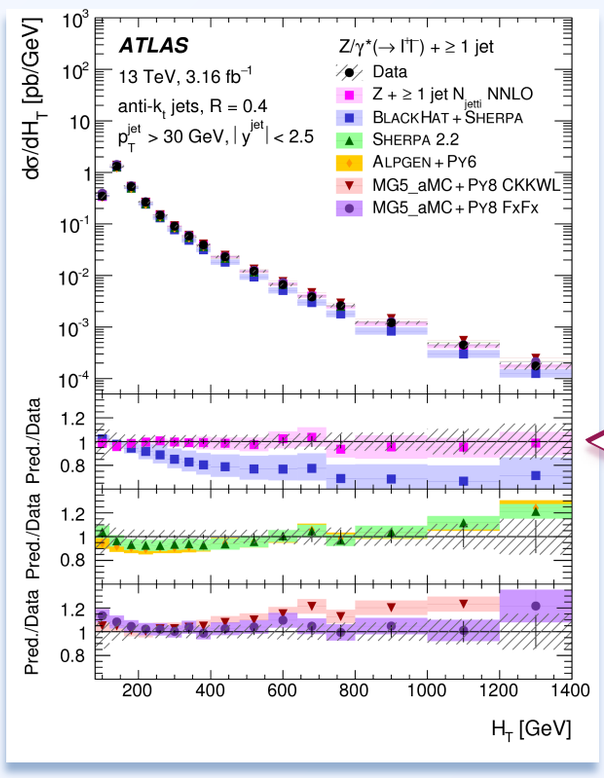

Fig.4: Measured cross section as a function of H_T for inclusive Z+≥ 1 jet.

$d\sigma/dH_T$ well described by **NLO SHERPA 2.2**, **LO ALPGEN+PY6** and **NLO MG5_aMC+PY8 FXFX**.
NLO BLACKHAT+SHERPA underestimates the cross sections for $H_T>300$ GeV (missing contributions for higher jet multiplicities).
Significant improvement is obtained with **NNLO Z+≥1 jet N_{jetti}**.

Uncertainties:

- **jet energy scale and resolution** (8-25%)
- **PDF** and **QCD scale** variations (1-5%).

H_T = scalar sum of the p_T of final state objects

Simulations for Z/W+HF-jets @ 13 TeV

Two schemes used in the HF-jets production: 4FNS and **5FNS**, the latter considering b-quarks in the initial state.

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$d\sigma/dp_T$ of the leading b-jet very different among the generators. **5FNS LO MG5_aMC+PY8 CKKWL** models a too hard jet p_T spectrum.

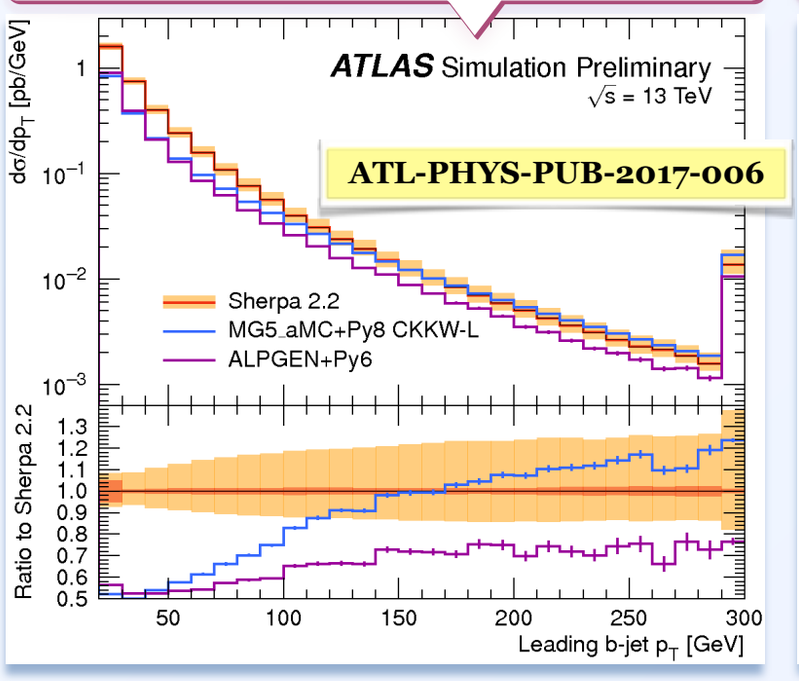

Fig.5: Predictions for differential cross section as a function of leading b-jet p_T for W+1 b-jet at 13 TeV.

Similar description for $d\sigma/d\Delta R_{bb}$ by **5FNS NLO SHERPA 2.2** and **LO MG5_aMC+P CKKWL**. **LO 4FNS ALPGEN+Py6** shows a different shape at low ΔR_{bb}.

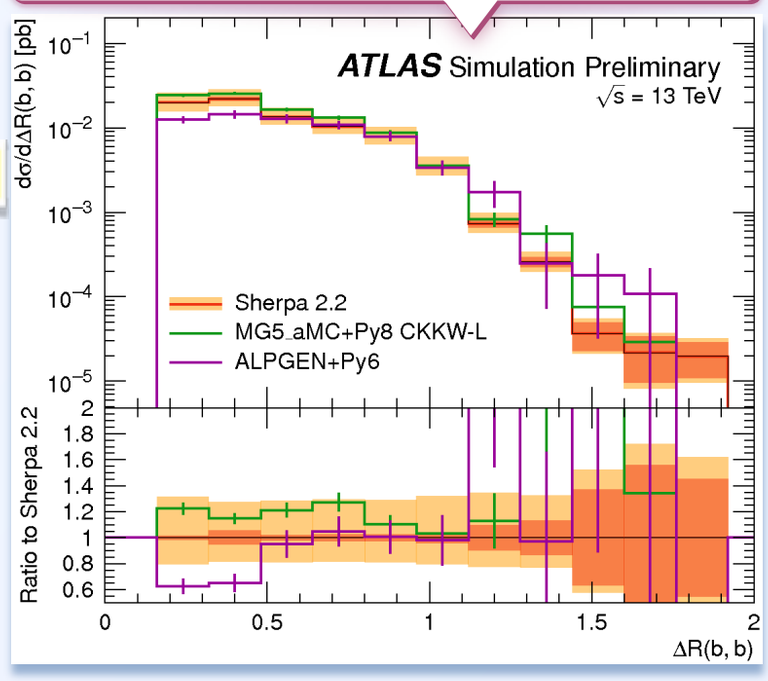

Fig.6: Predictions for differential cross section as a function of ΔR_{bb} for Z+≥ 2 b-jets at 13 TeV.

Difference between 4FNS and 5FNS can probe proton structure.

Interesting to see W/Z+HF-jets measurements at 13 TeV data.

ΔR_{bb} = angular separation between 2 b-jets

Discrepancy between data and all predictions in the low ΔR_{bb} range.

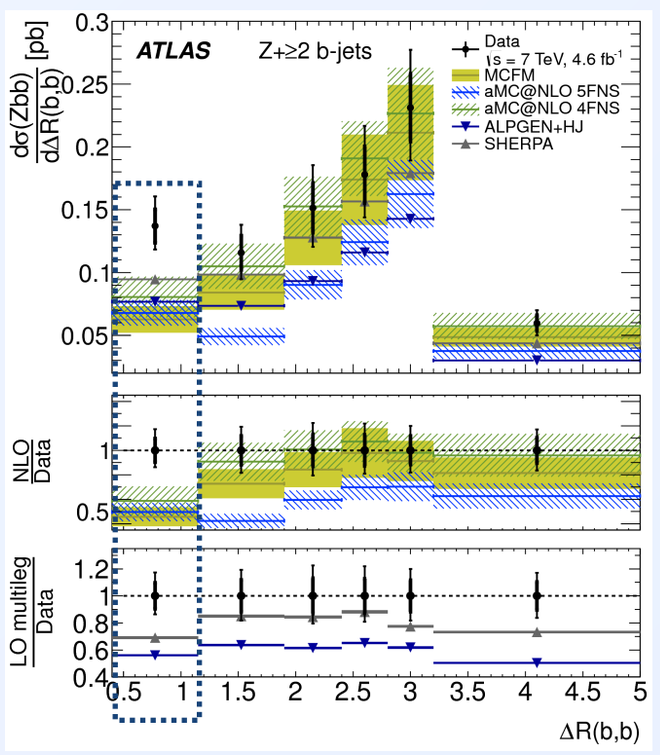

Fig.7: Measured differential cross section as a function of ΔR_{bb} for Z+≥ 2 b-jets at 7 TeV.

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