

# Study of WZ + Heavy Flavor Production in the Fully Leptonic Channel



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## Abstract

A measurement of WZ produced with an associated heavy flavor jet is performed using  $140 \text{ fb}^{-1}$  of proton-proton collision data at  $\sqrt{s} = 13 \text{ TeV}$  from the ATLAS experiment at the LHC. The measurement is performed in the fully leptonic decay mode,  $WZ \rightarrow \ell\nu\ell\ell$ . Events are separated into inclusive 1-jet and 2-jet categories, and regions formed based on pseudo-continuous b-tag spectrum of the associated jets are fit to data.

## Introduction

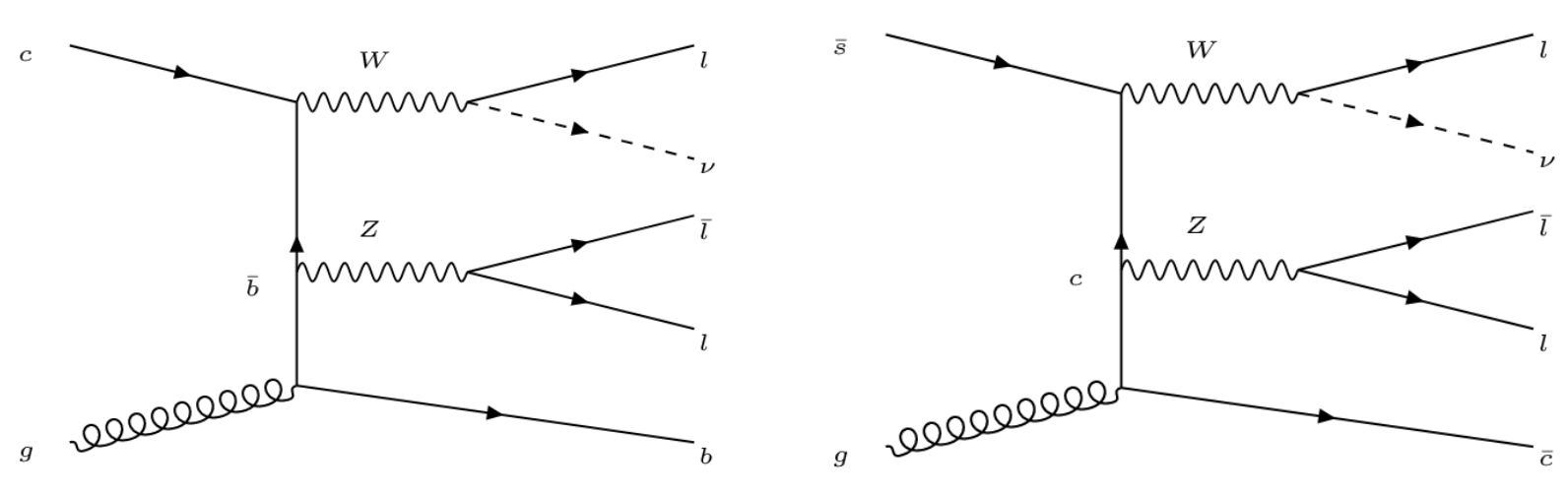


Figure 1: WZ + b and WZ + c production

- Many major analyses include WZ + b as a background, motivating a measurement of this process, which is difficult to simulate accurately
- The continuous b-tagging spectrum of the jets is used to separate out WZ + b from WZ + light, forming regions which are fit to data.
- Currently blinded to data, showing MC only Asimov fits

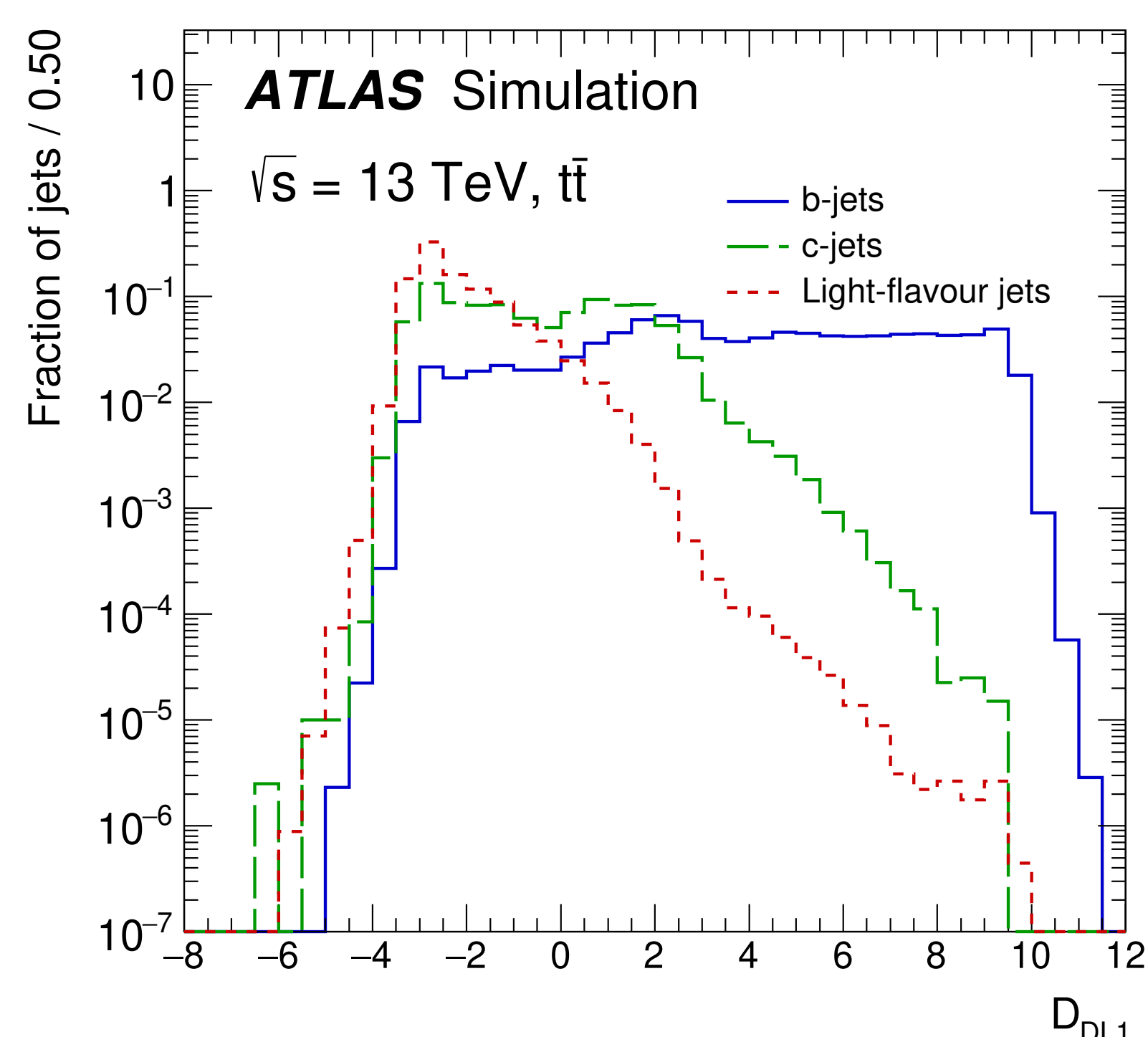


Figure 2: Distribution of DL1r score for b, charm, and light jets

## Event Preselection

- Exactly three, tight, isolated leptons with  $p_T > 20 \text{ GeV}$ ,  $|\eta| < 2.47$
- $M_{l+l-}$  of a pair of oppositely charged, same flavor leptons within 10 GeV of 91.2 GeV
- Require 1-2 jets, with  $p_T > 25 \text{ GeV}$ ,  $|\eta| < 2.5$
- $E_{miss}^T > 20 \text{ GeV}$
- Data/MC Yields after preselection has been applied are shown in figure 1

## Fit Procedure

- MC predictions are fit to the full Run-2 dataset,  $140 \text{ fb}^{-1}$  of  $\sqrt{s} = 13 \text{ TeV}$  data
- Truth jets are binned based on the b-jet efficiency working points of the DL1r algorithm - 85%, 77%, 70% and 60%
- Events meeting the highest working point are further separated into a signal like region and a tZ CR based on an MVA
- The WZ events are separated by truth flavor into three templates, which are fit to data

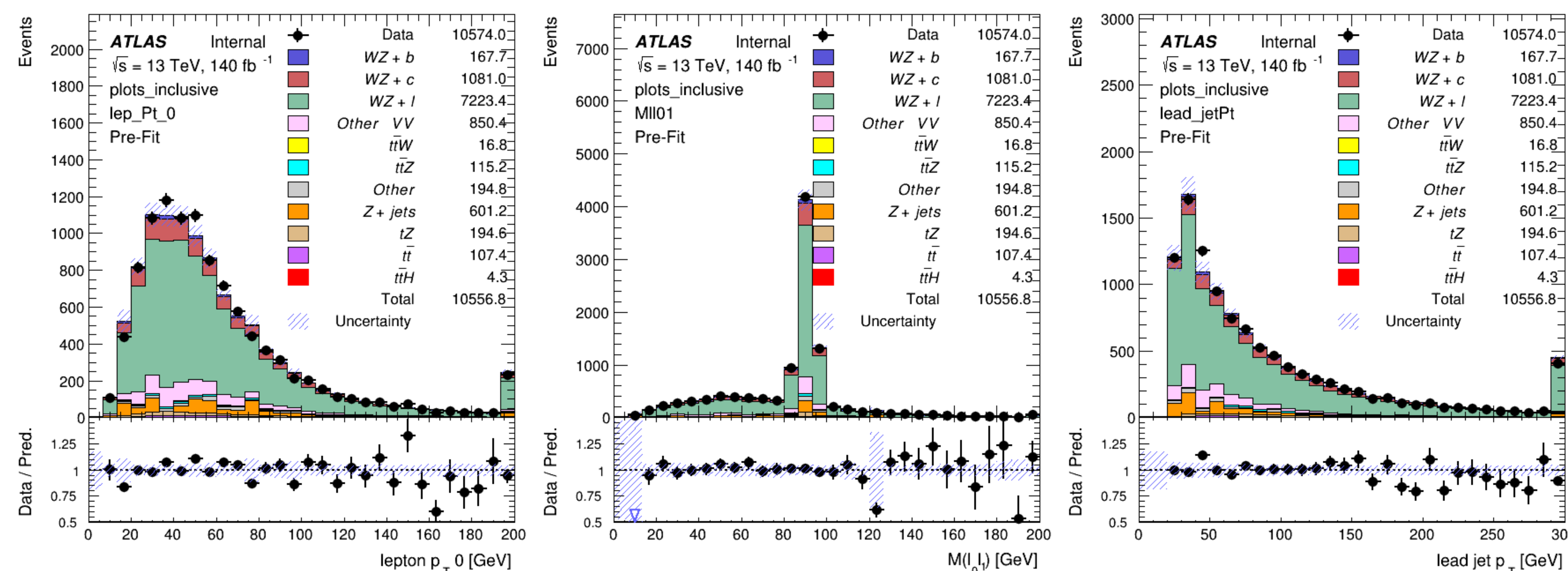


Figure 3: Distribution of (left) the  $p_T$  of the opposite sign lepton, (center) the invariant mass of a lepton pair, and (right) the  $p_T$  of the leading jet.

## tZ BDT

- Primary background in the high b-tag region is tZ, introduces large uncertainty
- Lepton, jet kinematics, and reconstructed top mass are used as inputs to a BDT to distinguish WZ from tZ events
- Output score is used to form a tZ CR

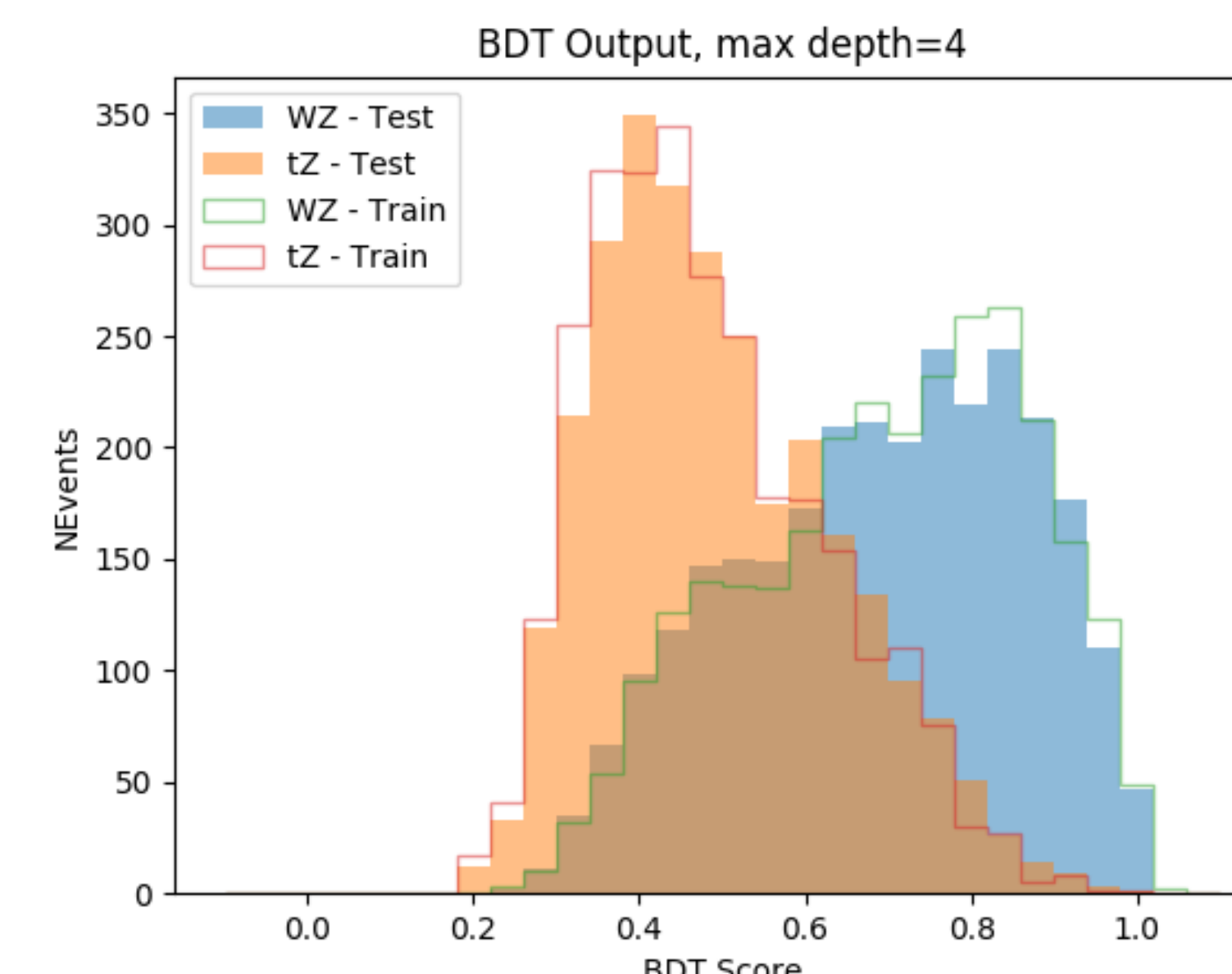


Figure 4: Output of the BDT for WZ and tZ events

## Results

- The yield in each region is summarized in figure 5
- The uncertainty on the measurement of WZ+b/c/light for each fit is shown in figure 1

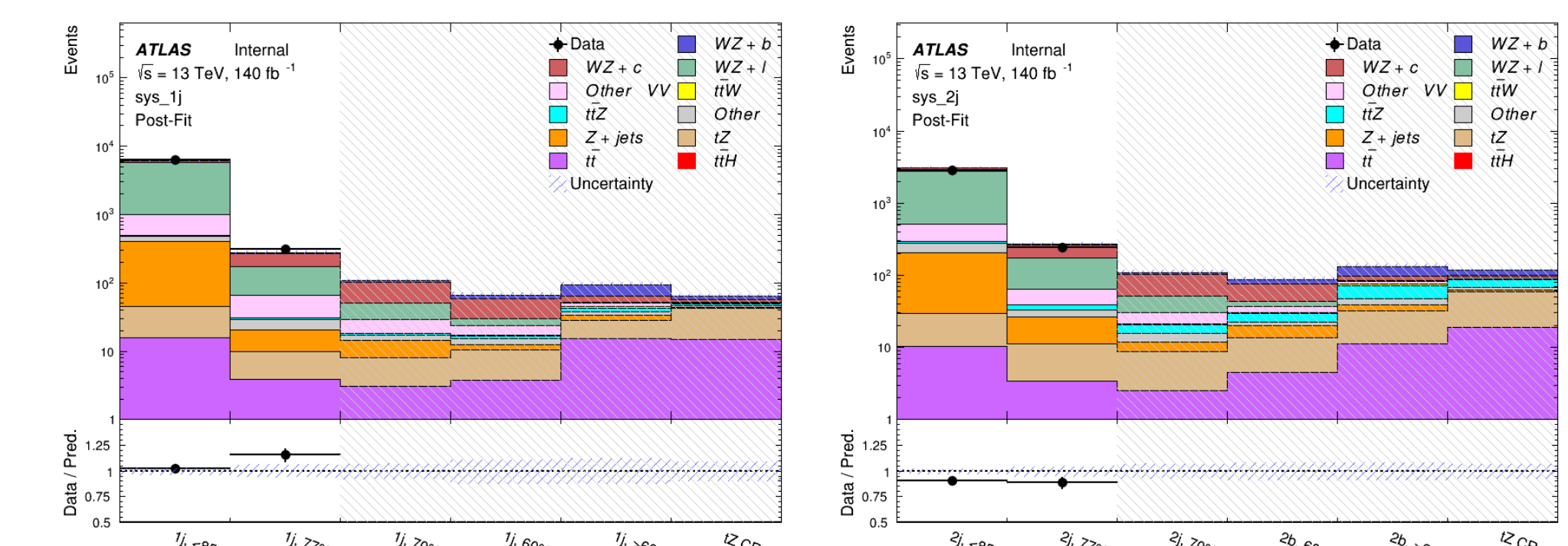


Figure 5: Summary of the fit regions for (left) 1-jet events and (right) 2-jet events.

1-jet Asimov Results:

$$\begin{aligned}\mu_{WZ+b} &= 1.00^{+0.54}_{-0.49} \\ \mu_{WZ+c} &= 1.00 \pm 0.21 \\ \mu_{WZ+l} &= 1.00 \pm 0.06\end{aligned}$$

2-jet Asimov Results:

$$\begin{aligned}\mu_{WZ+b} &= 1.00^{+0.51}_{-0.48} \\ \mu_{WZ+c} &= 1.00 \pm 0.24 \\ \mu_{WZ+l} &= 1.00 \pm 0.09\end{aligned}$$

- The impact of the systematic uncertainties on the value of WZ+b is shown in figure 1

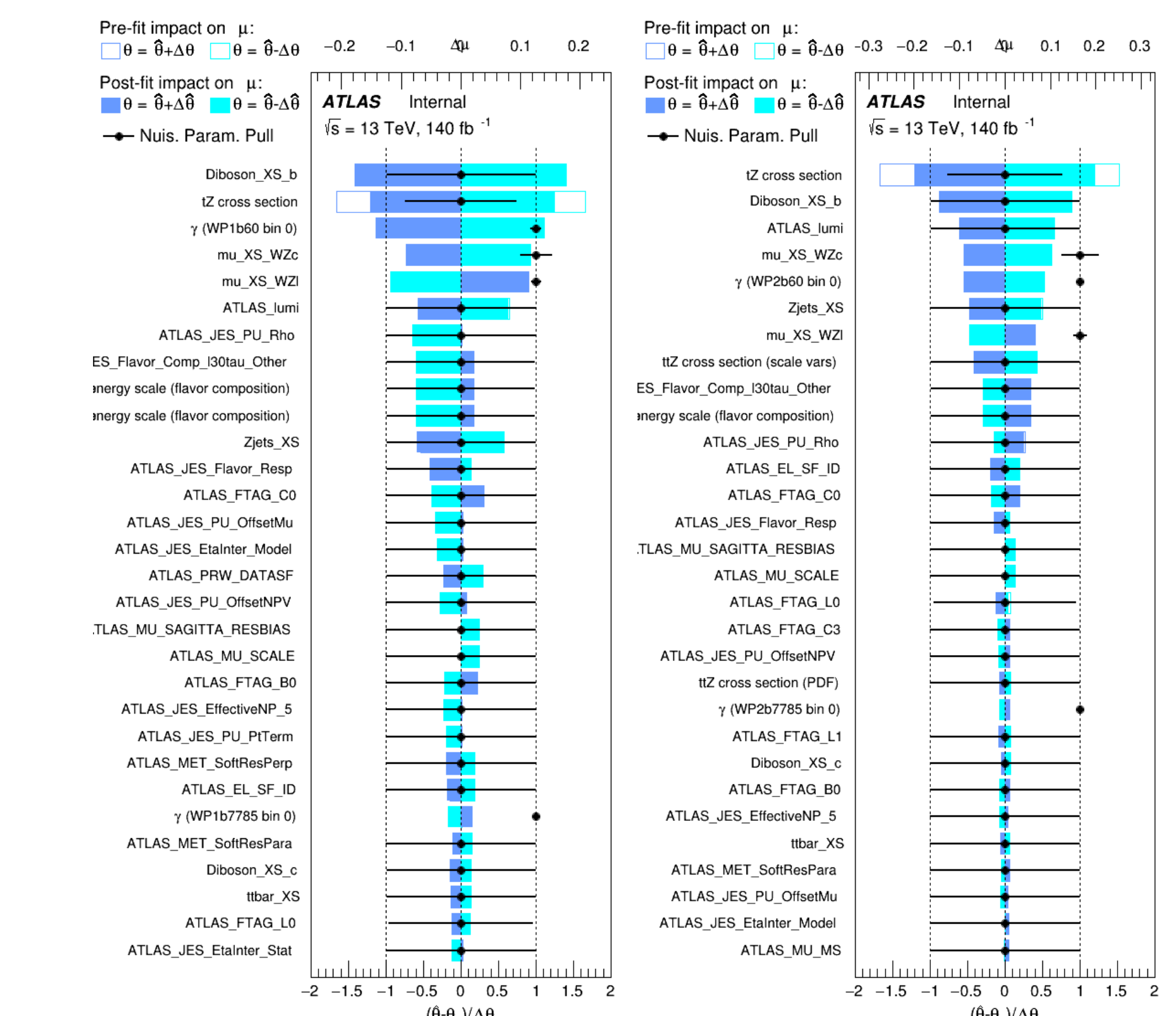


Figure 6: Ranking of the impact of nuisance parameters on (left) the 1-jet fit and (right) the 2-jet fit

## Conclusions

- Blinded fits show a measurement of WZ + heavy flavor can be made
- Draft of note can be found here: <https://cds.cern.ch/record/2684356/>