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

Aaron Webb
University of Texas at Austin

Abstract

A measurement of WZ produced with an associated heavy flavor jet is performed using 140 fb^{-1} of proton-proton collision data at $\sqrt{s} = 13$ TeV from the ATLAS experiment at the LHC. The measurement is performed in the fully leptonic decay mode, $WZ \to l\nu ll$. Events are separated into inclusive 1-jet and 2-jet categories. The cross-section of WZ + b-jets is measured to be $X \pm X \pm X$, while the cross-section of WZ + charm is measured as X, with a correlation of X between the two processes. The QCD processes involved in the production of WZ + b-jet make it difficult to simulate accurately, introducing a large uncertainty for analyses that include it as a background. Motivated by its relevance to the $t\bar{t}H$ multilepton analysis, we perform a study of the fully leptonic decay mode of this channel. The pseudo-continuous b-tagging spectrum of the jets in a diboson enriched region is fit to data in order make a more accurate estimate of the contribution of WZ+b.

Introduction

- WZ + heavy flavor is a difficult process to simulate accurately, introducing a large uncertainty for analyses that include it as a background
- We aim to measure WZ + heavy flavor in the fully leptonic (3l) channel
- The continuous b-tagging spectrum of the jets is used
- This study is motivated by the $t\bar{t}H$ multilepton analysis, where the diboson cross-section is a leading nuisance parameter, largely from a 100% uncertainty assigned to WZ+b

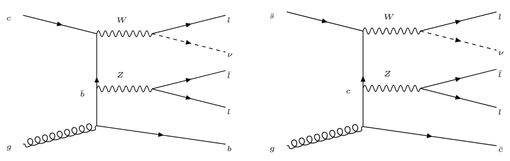

Figure 1: $WZ + b$ and $WZ + c$ production

Fitting Procedure

- MC predictions are fit to the full 2015 and 2016 dataset, 36.1 fb^{-1} of $\sqrt{s} = 13$ TeV data
- Truth jets are binned based on the b-jet efficiency working points of the MV2c10 algorithm
- The jets are separated by flavor into three templates, which are fit to data
- The fraction of each template is shifted to provide a best fit value, and the shape of the templates are allowed to vary within MCstat errors

Event Selection:

- Exactly three, tight, isolated leptons with $p_T > 20$ GeV, $|\eta| < 2.47$
- $M_{l^+l^-}$ of a pair of oppositely charged, same flavor leptons within 10 GeV of 91.2 GeV
- Require jet $p_T > 25$ GeV, $|\eta| < 2.5$

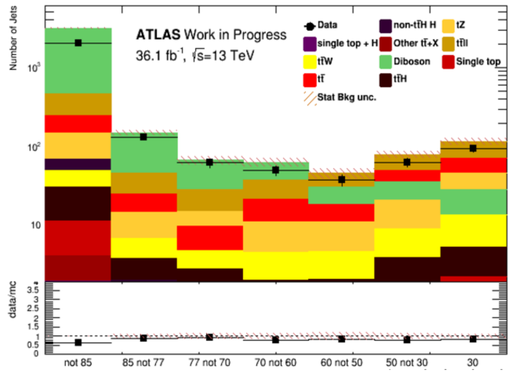

Figure 3: Continuous b-tagging spectrum of the diboson enriched region.

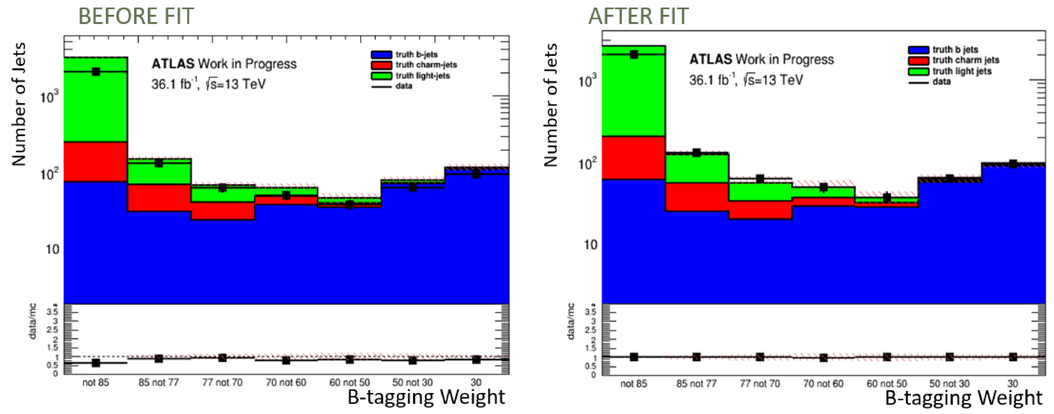

Figure 4: Continuous b-tagging spectrum based on MV2c10 working points by flavor, before and after fitting to data

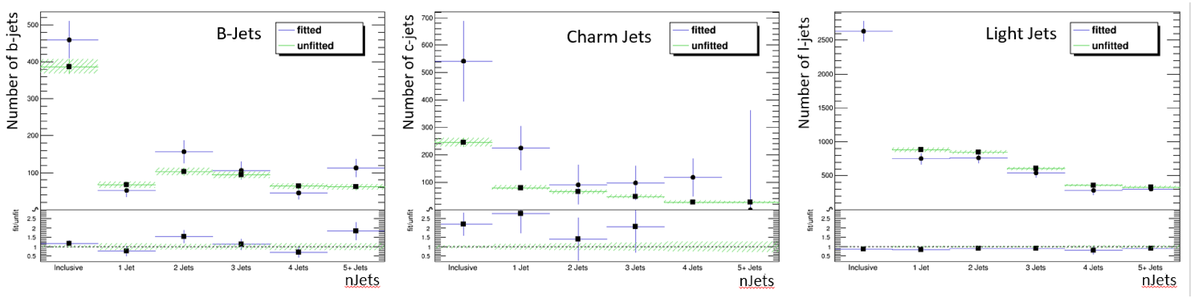

Figure 5: Number of jets by truth flavor as a function of nJets, before and after fit

Results

Flavor	Prefit/Postfit Yield
Truth b Jets	1.18±0.14
Truth c Jets	2.21±0.31
Truth light Jets	0.88±0.06

Figure 6: Ratio of pre-fit and post-fit yields of each jet flavor

Covariance Matrix:

Flavor	B-Jets	Charm-Jets	Light-Jets
B-Jets	1	0.37	-0.19
Charm-Jets	0.37	1	-0.76
Light-Jets	-0.19	-0.76	1

Figure 7: Matrix showing the covariance between the templates in the fit

- Good agreement is acheived between post-fit results and data.
- While a large shift in the charm jet contribution is observed, this is strongly correctly with the light jet contribution, as shown in figure 7.
- The best fit result shifts the b-jet contribution by around 20%, suggesting that WZ+b can be predicted with greater accuracy.

Future Work

- Apply systematic uncertainties
- Repeat the fit applying constraints on WZ+c and WZ+l based on recent calibration studies
- Make a measurement of WZ+b, and apply corresponding uncertainty to $t\bar{t}H$ analysis.