Estimate of the W+jets in single-top analyses by a fraction fitting method

M. Alhroob
D. Bartsch, E. Nuncio

Physikalisches Institut
Rheinische Friedrich-Wilhelms-Universität Bonn

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- In order to understand the single-top channel, W+jets and $t\bar{t}$ backgrounds have to be well measured
- There are different methods to measure the W+jets such as Z+jets to W+jets ratio, likelihood, matrix method
- Fraction fitting is a robust method to measure the W+jets cross-section
- This cross section is a data driven estimate for the W+jets background in single-top measurement

Data sets

Monte Carlo samples

mc08 Monte Carlo samples (10 TeV)

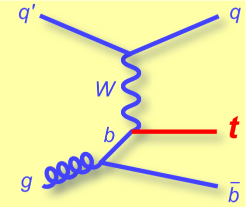
$t\bar{t}$, W+jets, Z+jets, single top, WW, WZ, ZZ, W$b\bar{b}$

Simulated Data sample

The method was tested on the Mixing exercise sample user.RichardHawkings.0108175.topmix.Muon.AOD.v5 (Muon stream) with integrated Luminosity 168.24 pb^{-1}

Following the CSC cuts

Preselection



- $\not\!\!E_T$ >20 GeV
- One and only isolated lepton with high P_T
  - $P_T > 30$ GeV
  - et_cone20 < 6 GeV
  - $|\eta| < 2.5$
- A veto on the second isolated lepton $P_T > 10$ GeV
- $N\bar{o}$ jets ≤ 4 with $P_T > 15$ GeV, $|\eta| < 5$
- $N\bar{o}$ jets ≥ 2 with $P_T > 30$ GeV, $|\eta| < 5$
- At least 1 b-jet with $P_T > 30$ GeV, $|\eta| < 2.5$(Jet_W >3.95)

t-channel selection

- At least 1 b-jet with $P_T > 50$ GeV
- The hardest light jet has to be in the forward region $|\eta|$ >2.5

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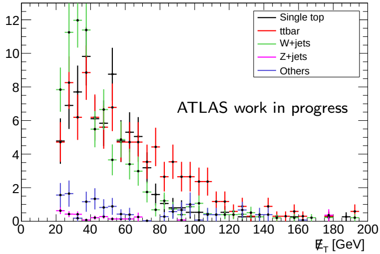
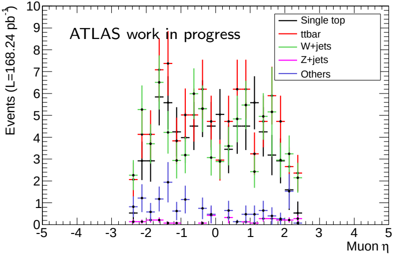
Comparision with CSC

	This analysis (10 TeV) $\epsilon\,(\%)$	CSC numbers (14 TeV) $\epsilon\,(\%)$
Preselection	4.7	4.1
b Jet P_T	3.3	2.9
light Jet η	1.1	0.9
S/B	0.40	0.37

- Reasonable agreement with the CSC with a little differences due to the different CME





- The dominant backgrounds are the W+jets and $t\bar{t}$
- It is very difficult to separate background from the signal
- the background has to be measured in the signal region

Fraction fitting method

Fraction Fitting method used to estimate the W+jets background

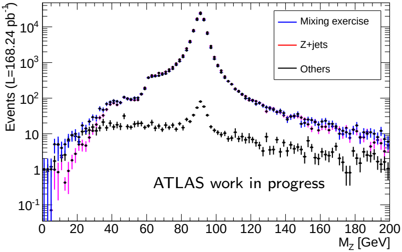
ROOT TFractionFitter class

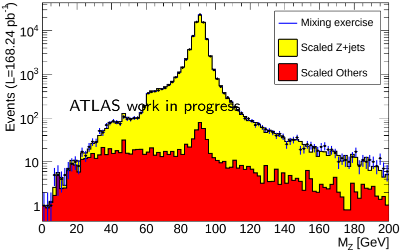
- A technique of fitting templates of various sources to data in order to extract constituent fractions

$$\alpha_1 M_1 + \alpha_2 M_2 + ... + \alpha_N M_N = Data$$

- Taking into account both data and Monte Carlo statistical uncertainties
- see *http://arxiv.org/abs/0803.2711*
- ROOT TFractionFitter class was used for the study

Z+jet background scaling factor





	Scaling factor
Z+jets	0.910 $\pm$ 0.004
Others	0.997 $\pm$ 0.112
χ^2/dof	44.57/98

- The χ^2/dof is small because the correlation between the top-mixing data and MC

- The method was tested by spliting the MC to 2 statistically independent samples getting $\chi^2/dof \approx 1$

The scaling factor of Z+jets (0.91) will be used later

Following the CSC cuts
(without last 3 cuts)

Preselection

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t-channel selection

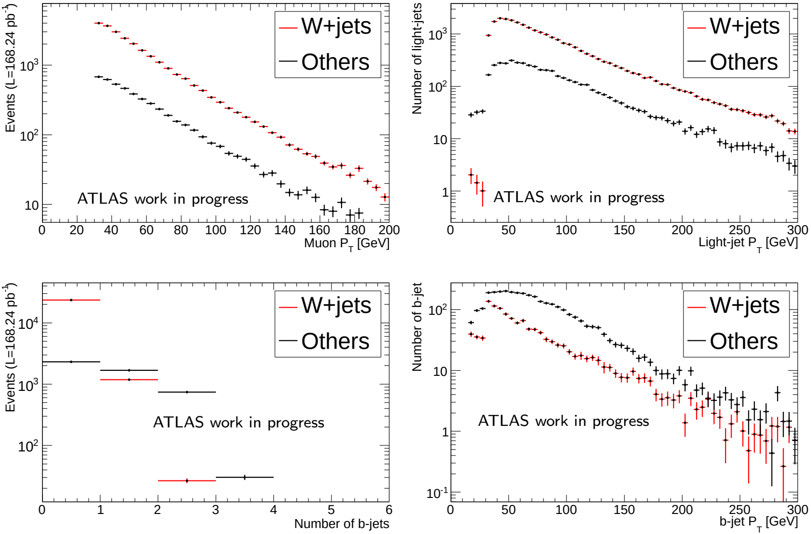
- At least 1 b-jet with $P_T > 50$ GeV
- The hardest light jet has to be in the forward region $|\eta| > 2.5$

W+jets sample considered as signal now

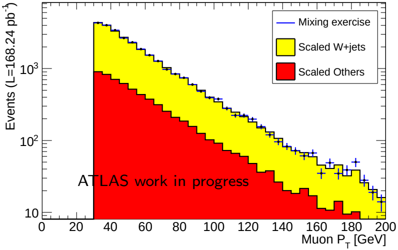
- Z+jets, single top, $t\bar{t}$, WW, WZ, ZZ, $Wb\bar{b}$ samples are added together to form others (background)
- Z+jets background is scaled by a factor of 0.91

	Number of events
W+jets	24748
Others	4770
S(W+jets)/B(Others)	5

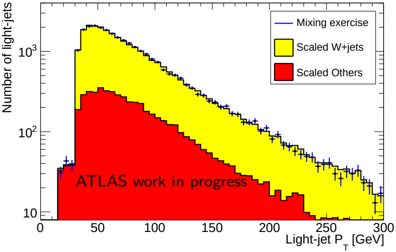
Input distributions



One dimensional fraction fit

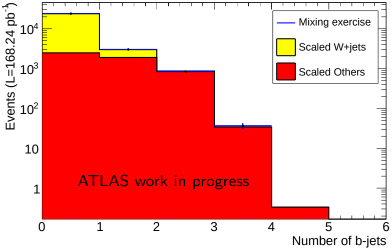


	Scaling factor
W+jets	0.87 ± 0.05
Others	1.37 ± 0.28
χ^2/dof	$17.27/31$

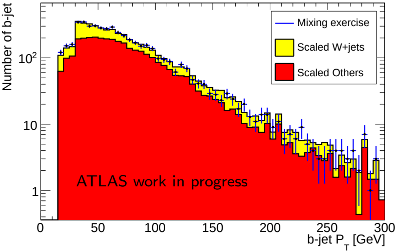


	Scaling factor
W+jets	0.91 ± 0.03
Others	1.16 ± 0.14
χ^2/dof	$20.20/55$

One dimensional fraction fit

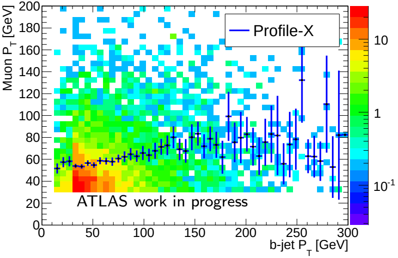


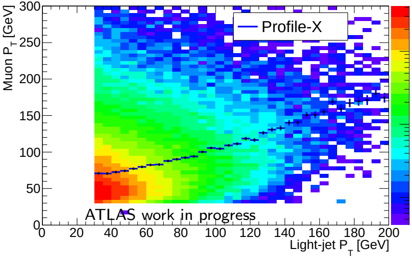
	Scaling factor
W+jets	0.91 ± 0.01
Others	1.14 ± 0.04
χ^2/dof	$1.08/3$

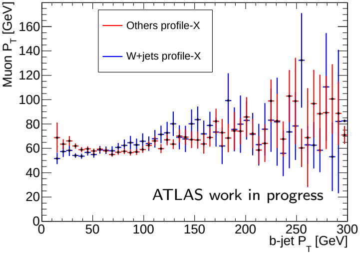


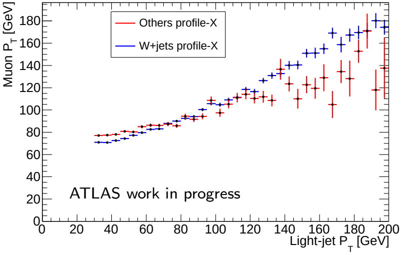
	Scaling factor
W+jets	1.18 ± 0.23
Others	1.03 ± 0.09
χ^2/dof	$17.79/55$

Correlations









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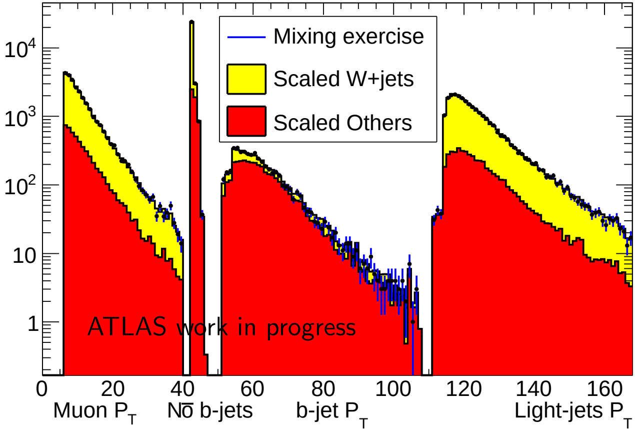
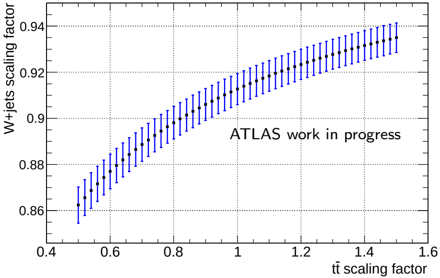
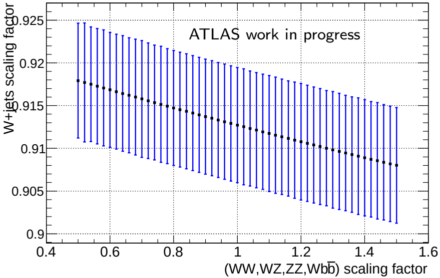


	W+jets scaling
W+jets	0.912 ± 0.007
Others	1.132 ± 0.024
χ^2/dof	$57.78/153$

Systematics





- Combining MC samples introduces new systematic errors
- This error significantly smaller than the statistical error without MC combination
- Varying the SM $t\bar{t}$ fraction by $\pm 20\%$ the W+jets scaling factor varies by $\pm 1.6\%$
- Varying the SM $WW, WZ, ZZ, Wb\bar{b}$ fraction by $\pm 20\%$ the W+jets scaling factor varies by 0.2%

Summary

- Fraction fitting method can be used to measure the W+jets and Z+jets backgrounds
- Variables with higher correlation were not used
- current badly understood variables like $\not{E}_T$ were not used
- Results for mixing exercise
  - Z+jets scaling factor is 0.91 $\pm$ 0.01
  - W+jets scaling factor is 0.91 $\pm$ 0.02
  - W+jets scaling factor Systematic errors from combining MC samples $\approx$2 %