$WW \rightarrow l\nu jj$ STATUS REPORT

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Overview

- Overview of the note
- structure of the analysis
- Control Regions
- Inclusive Selection
- fit and systematics
- Exclusive Selection
- Conclusions

The aim is to prepare a note assessing the first evidence of the semileptonic WW at ATLAS using 5 fb^{-1} of data (2011), $\sqrt{s} = 7$ TeV. The considered channels are the electron and muon channels.

Overview of the note

Draft version 0.0

ATLAS NOTE

June 3, 2012

Evidence of the di-boson WW+WZ production in $\sqrt{s} = 7$ TeV proton-proton collisions with the ATLAS detector in the semileptonic decay channel

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- going for a CONF note and possibly a pubblication
- goal: to have the note ready by the end of July
- first draft of the note on CDS (link)

Points in the note (I)

Contents

Points in the note (II)

Selections

preselection:

- lepton with $p_T > 25$ GeV and central η
- $\not{E}_T > 25$ GeV, $M_T(W) > 40$ GeV
- jets with $p_T > 25$ GeV, central η
- quality checks on leptons and jets, second lepton veto, overlap removal
- other cuts to improve signal shape and significance

inclusive selection:

- $\Delta\eta_{jj} < 1.5$
- $\Delta R_{jj} > 0.7$
- $|\Delta\phi_{jj}| < 2.7$
- b-jet veto

tight selection:

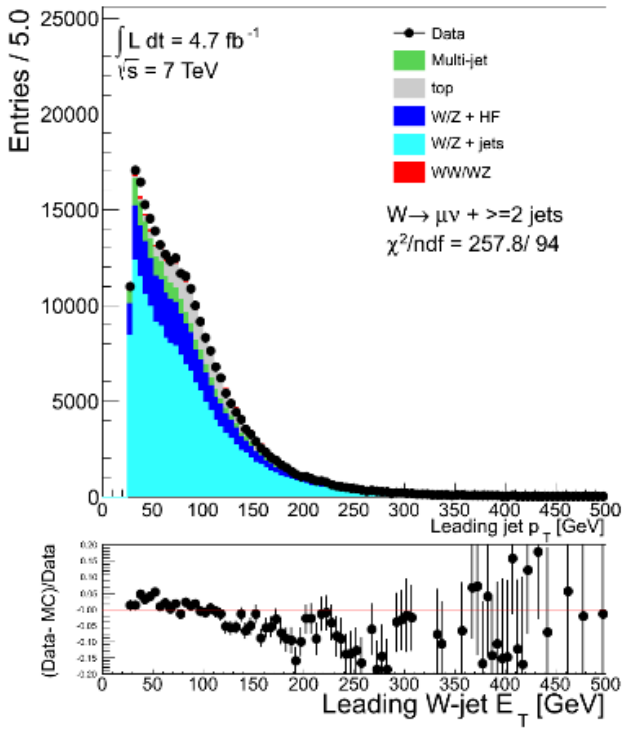
- $p_T(jj) > 80$ GeV
- $p_T(WW) < 35$ GeV
- $\Delta R_{jj} > 0.7$
- b-jet veto

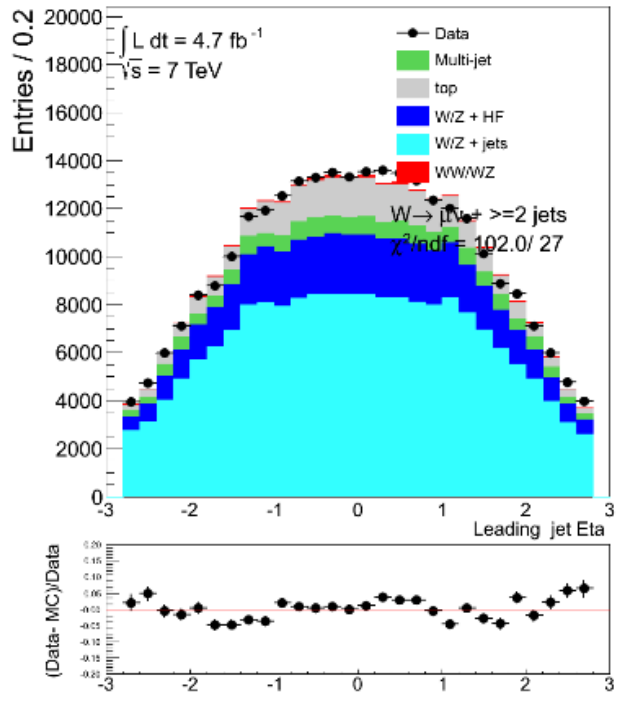
Control Regions:

- sidebands
  - preselection
  - 60 GeV $< M_{jj} <$ 110 GeV
- $Z + \text{jets}$
  - two opposite-sign leptons in the preselection (instead of $\not{E}_T$ and M_T cuts)
  - 66 GeV $< M_{ll} <$ 116 GeV
- $t\bar{t}$
  - preselection
  - at least 3 jets, at least 1 btagged and 2 non bjets

CR: sidebands (I)

Region to check the description: events in the dijet region consistent with the W mass are excluded; no btag veto applied.

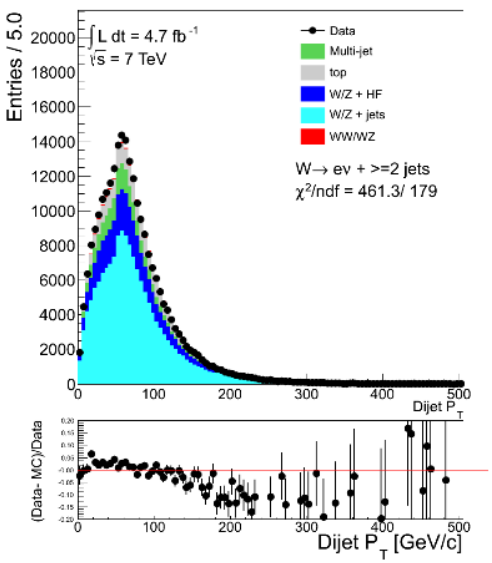


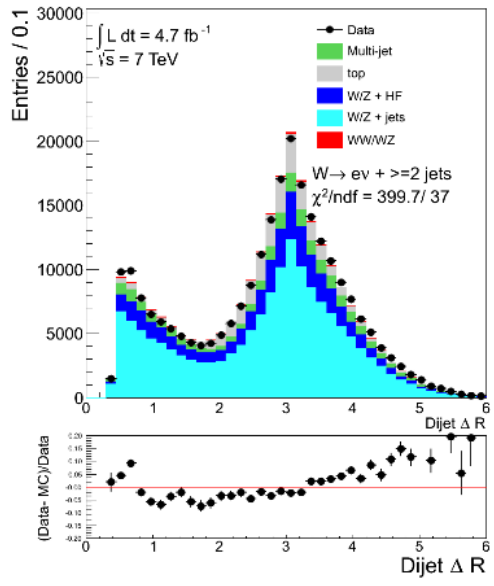


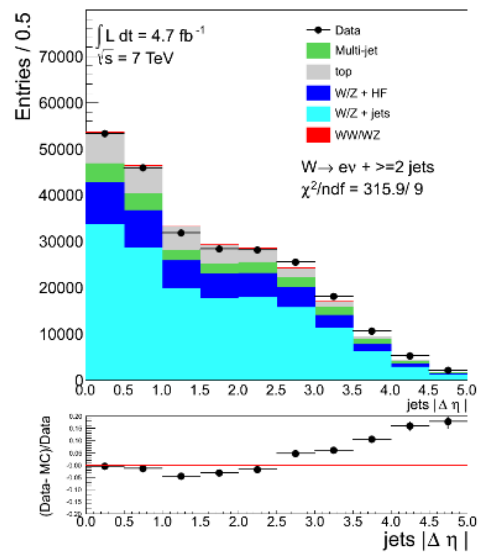
CR: sidebands (II)

Major mis-modelings:

- dijet p_T
- dijet ΔR
- dijet $\Delta\eta$

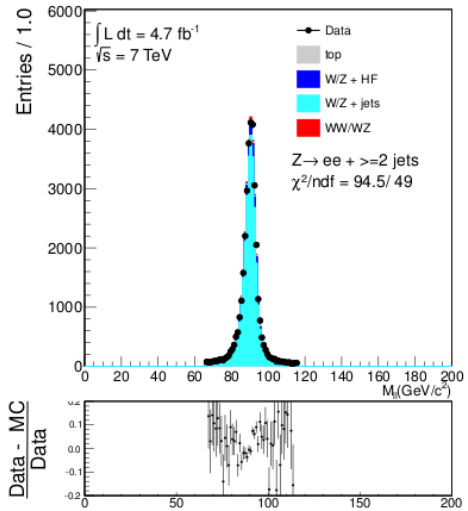


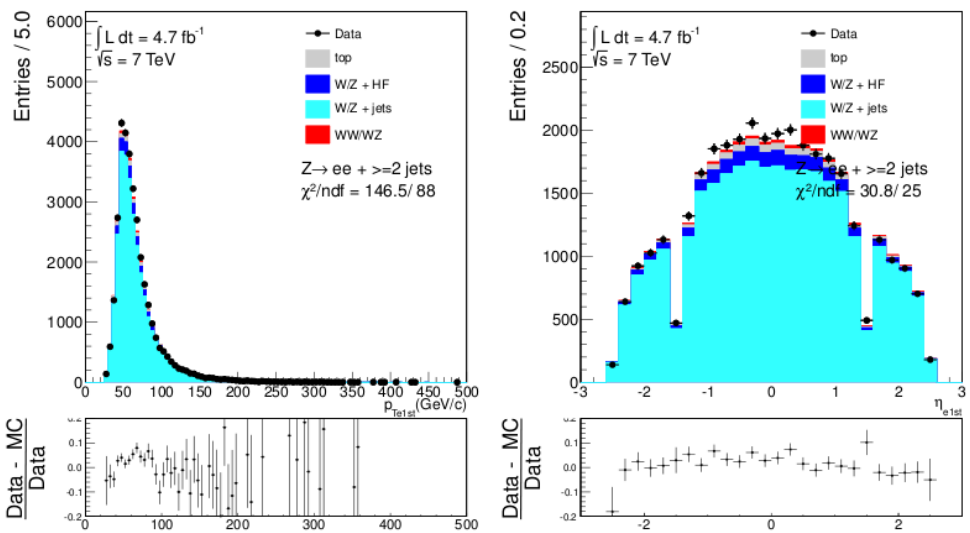




CR: Z + *jets* (I)

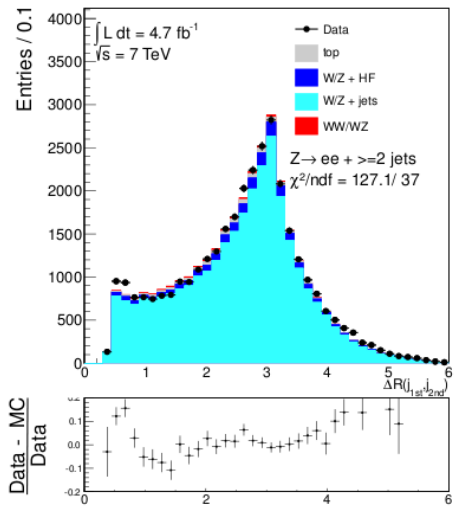
$Z + \text{jets}$: similar to $W + \text{jets}$, but almost multijet free. The selection follows that of the $Z + \text{jets}$ measurement.

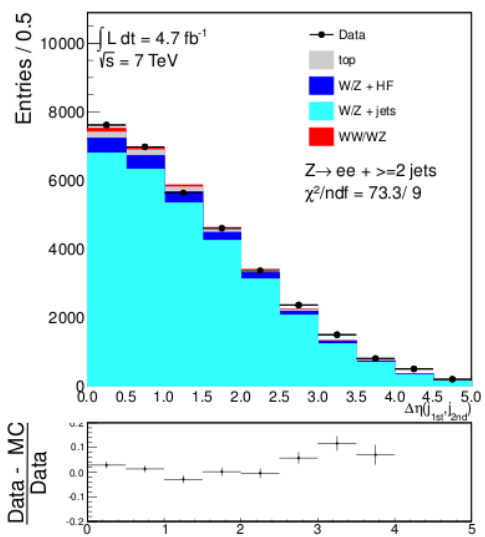


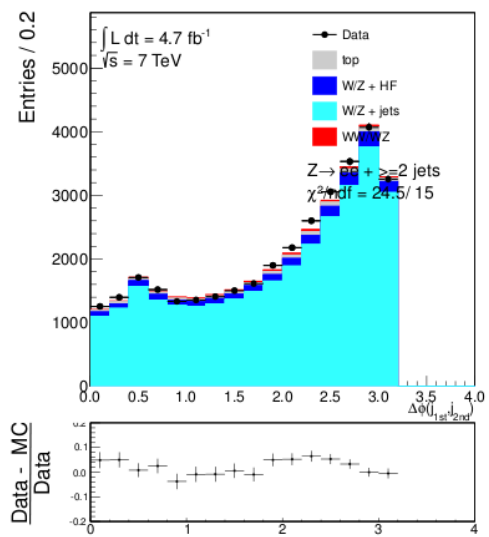


CR: Z + *jets* (II)

This control region checks whether the mis-modeling is due to problems in the W + jets samples or not:

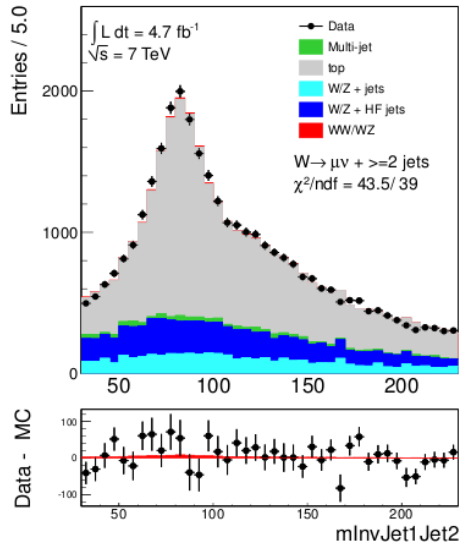


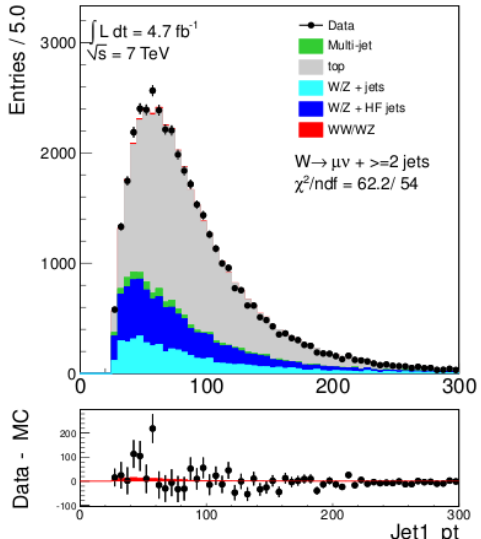


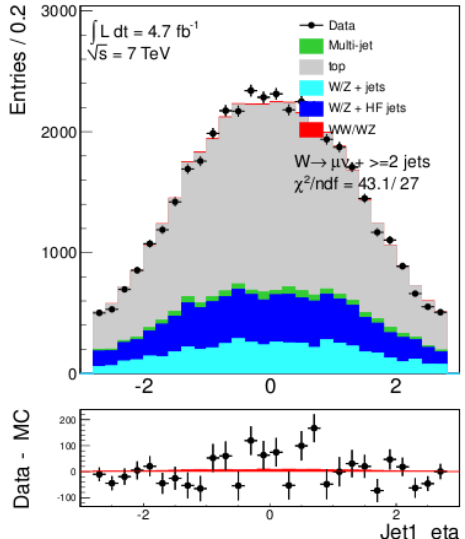


CR: $t\bar{t}$

$t\bar{t}$ is sensible to the jet energy scale: the presence of the W peak in this selection is an indication of how well JES and JER are described in MC.



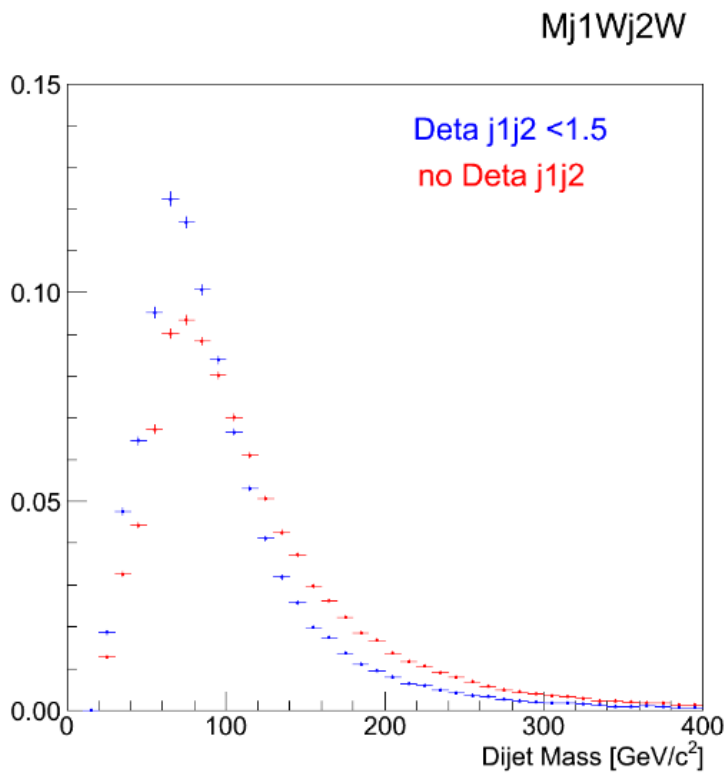


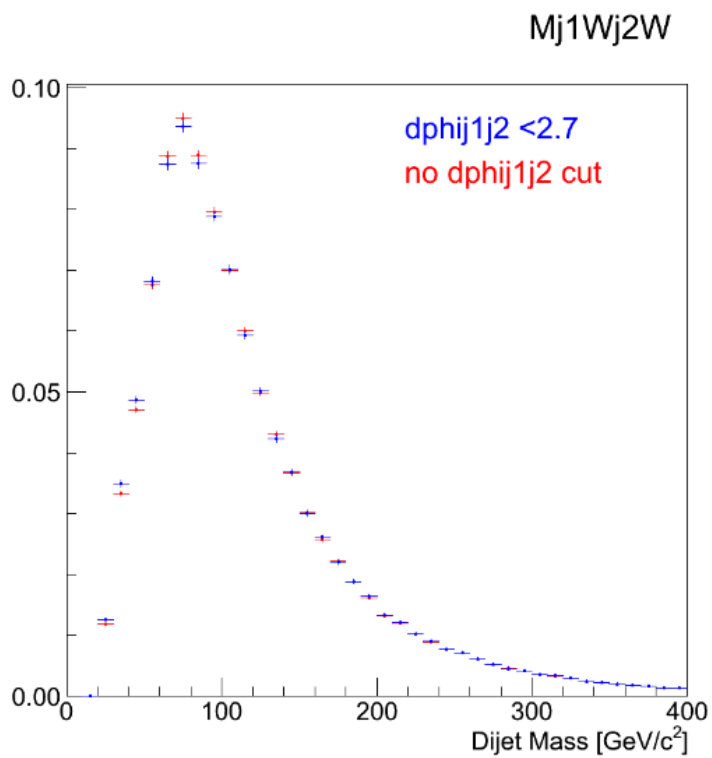


Inclusive selection

The nominal selection is called *inclusive*; it adds to the preselection the followings:

- $\Delta R_{j_1 j_2} > 0.7$ to avoid a mismodeling at low ΔR in Alpgen
- $|\eta_{jet}| < 2.0$: $W + \mathrm{jets}$ have mismodeling at higher η
- $\Delta\eta_{j_1 j_2} < 1.5$ and $|\Delta\phi_{j_1 j2}| < 2.7$ to improve S/B





Inclusive selection: numbers

Process	electron	muon
WW/WZ $\rightarrow$ lνjj	2140±261	2316 ± 276
W + jet	89617 ± 385	94270 ± 404
W/Z + HF	27082 ± 222	28201.6 ± 230
top	12516.2 ± 629	12449 ± 642
multi − jetQCD	12204 ± 110	8921 ± 94
Z + jet	8516.3 ± 201	6072 ± 206
Total SM prediction	152076 ± 846	152230 ± 390
Total Data	152318 ± 390	152417 ± 871

	Preselection	Inclusive selection
ϵ	38.4%	32%
S/B	0.9%	3.2%

The fitting procedure (I)

brief description:

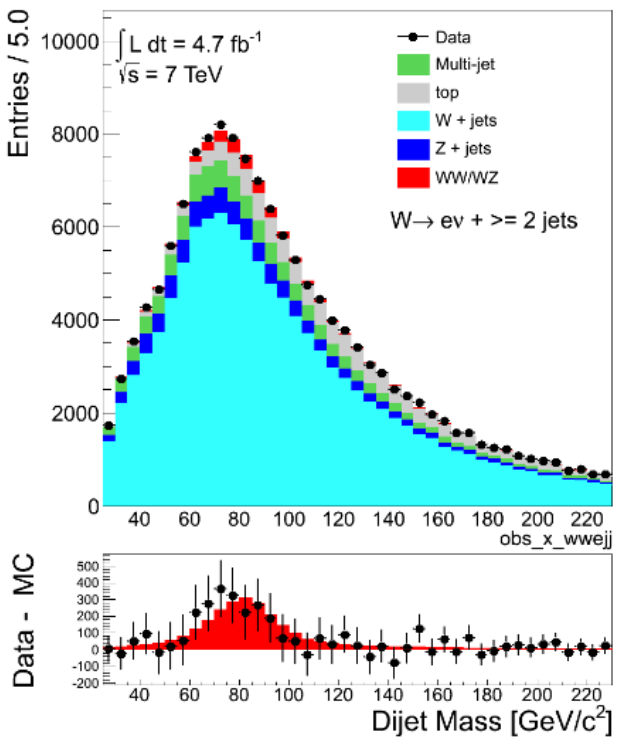
- based on binned maximum-likelihood method
- create histogram templates for signal, $W + \mathrm{jets}$, $Z + \mathrm{jets}$, top, QCD
- simultaneous fit of muon and electron channels
- systematics are constrined by using *nuisance parameters*
- fitting procedure has been validated: nuisance parameters and linearity
- fit is also used to estimate the expected significance (part of validation)

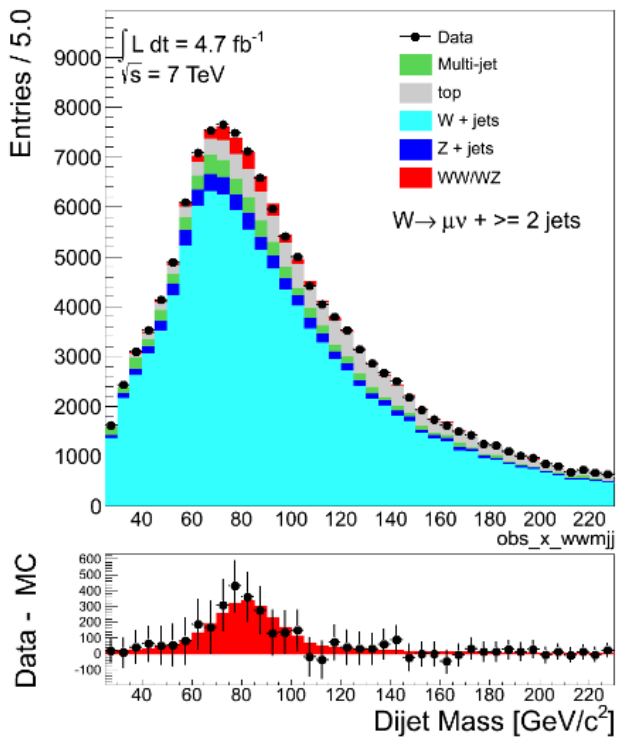
systematics included:

- main systematics:
  - JES and JER
  - modeling of the $W + \mathrm{jets}$ shape
  - bin-by-bin
- "minor" systematics:
  - multijet
  - normalization
  - uncertainties on top
- treated in the fitting procedure by means of nuisance parameters

The fitting procedure (II)

- test:
  - linearity
  - test shifting the JES up and down
- results:
  - expected significance: 5.4 σ (bin-by-bin not included)
  - $\sigma_{SM}/\sigma_{measured} = 1.2 \pm 0.23$

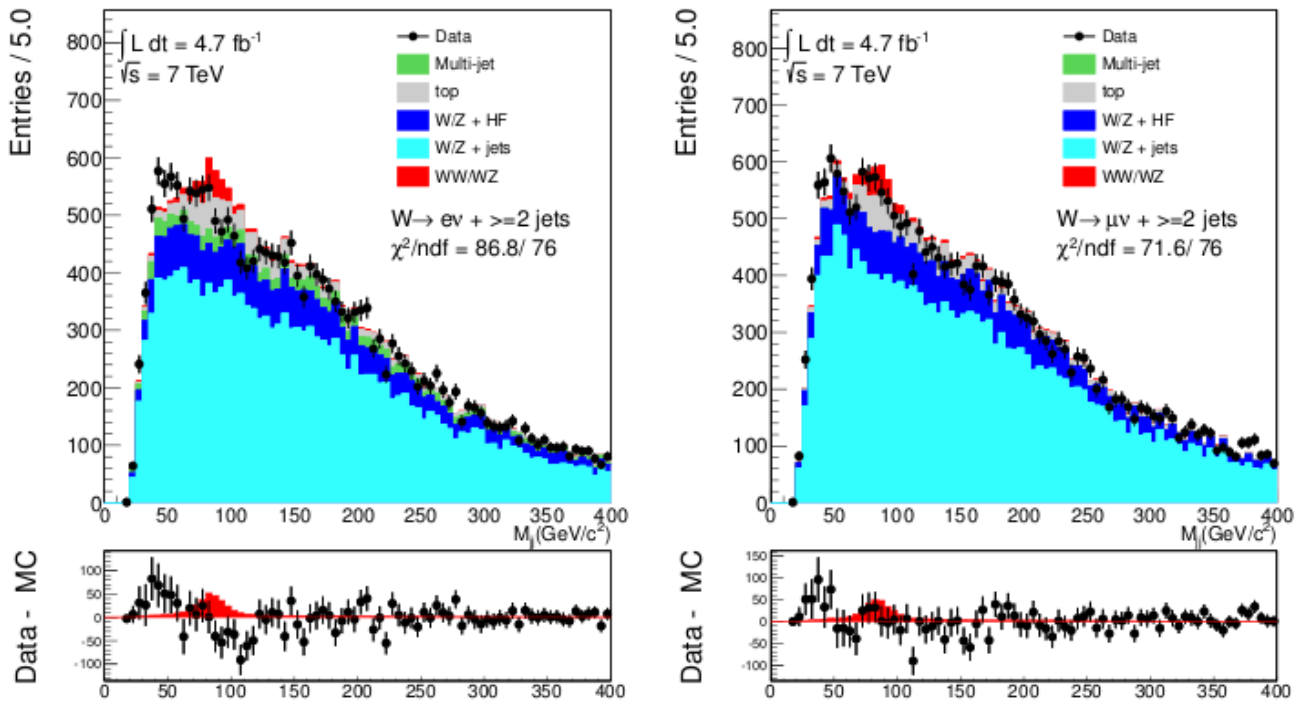




The errors in the plots are wrong, should be recalculated!

Exclusive Selection

A different selection is presented, the so called *exclusive selection*.
The idea here is to study a set of different cuts which allow to observe the diboson peak on a smoothly falling background: this is done by modifying the dijet background shape.



- improved S/B
- less sensitivity

Also plots with additional selections for data/MC improvement have been produced.

Work to be finished

11 Work to be finished

In this section we just list the items on which we are working and that will be finalized soon. None of these points will change the results of the analysis and will only give small corrections.

- Jet Vertex Fraction: efficiency and modeling
- Effect of ISR/FSR on signal template
- Moving the analysis cuts
- Z-vertex reweighing
- results with the exclusive selection

other important points:

- assess/check correct procedure for systematics and fit method
- mismodeling: why exclusive selection does not work as aspected?
- production of CR plots for jet $p_T > 25$ GeV
- comparison with other analysis to check results on CR
- waiting for EB

Conclusions

- the main issues in the analysis are done/on-going
- minor effects will be next step
- working for the note has been a very powerful and effective way to converge
- first steps with Shih-Chieh and John (mainly focalized on the fit method)

Back-up

Cut table

Requirement	Preselection	Inclusive selection	Tight selection	$t\bar{t}$ CR	m_{jj} sideband CR	Z CR
Muon p_T	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV
Muon $\|\eta\|$	< 2.4	< 2.4	< 2.4	< 2.4	< 2.4	< 2.4
Electron p_T	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV
Electron η exclude crack	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47	< 2.47
N of leptons	== 1	== 1	== 1	== 1	== 1	≥ 2
2nd lepton veto same flavor	yes	yes	yes	yes	yes	–
2nd lepton p_T	20 GeV	20 GeV	20 GeV	20 GeV	20 GeV	20 GeV
2nd lepton $\|\eta\|$	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5
Opposite charge	–	–	–	–	–	yes
Jet p_T	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV
Jet η	< 2.8	< 2	< 2	< 2.8	< 2.8	< 2.8
N of jets	≥ 2	≥ 2	≥ 2	≥ 3, 2 no b-tag	≥ 2	≥ 2
$\Delta\eta(j_1, j_2)$	–	< 1.5	–	–	–	–
$\Delta R(j_1, j_2)$	–	> 0.7	> 0.8	–	–	–
$\Delta\phi(j_1, j_2)$	–	< 2.7	–	–	–	–
$\Delta\phi(E_T^{miss}, j_1)$	> 0.8	> 0.8	–	> 0.8	> 0.8	> 0.8
b-jet veto	–	yes	yes	–	–	–
b-jet p_T						
N of b-jets	–	–	–	≥ 1	–	–
$\Delta R(\ell, j)$	> 0.5	> 0.5	> 0.5	> 0.5	> 0.5	> 0.5
E_T^{miss}	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV	> 25 GeV	–
m_T	> 40 GeV	> 40 GeV	> 40 GeV	> 40 GeV	> 40 GeV	–
$m_{\ell\ell}$	–	–	–	–	–	> 66 GeV < 116 GeV
m_{jj}	–	–	–	–	< 60 GeV > 110 GeV	–
$p_T(jj)$	–	–	> 80 GeV	–	–	–
$p_T(WW)$	–	–	< 35 GeV	–	–	–

Nuisance parameters in the fitting procedure

Source of Systematic	Type	uncertainty	Comments
W+jets cross-section	Norm.	40%	1 parameter affecting both channels
Z+jets cross-section	Norm.	40%	1 parameter affecting both channels
top cross-section	Norm.	5%	1 parameter affecting both channels
QCD rate	Norm.	30%	1 parameter affecting both channels
Electron efficiency	Norm.	2%	1 parameter affecting all of the components except for QCD in the electron channel
Muon efficiency	Norm.	2%	1 parameter affecting all of the components except for QCD in the muon channel
Luminosity	Norm.	3.7%	1 parameter affecting all of the components except for QCD in both channels
JES	Shape	N.A.	1 parameter affecting all of the components except for QCD in both channels
JER	Shape	N.A.	1 parameter affecting all of the components except for QCD in both channels
Pileup	Shape	N.A.	1 parameter affecting all of the components except for QCD in both channels
Clusters	Shape	N.A.	1 parameter affecting all of the components except for QCD in both channels
Bin-by-Bin Uncertainties	Bin-by-Bin	N.A.	82 parameters, 41 in each channel