Search for the semileptonic WW/WZ decay in proton-proton collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector using 2011 data

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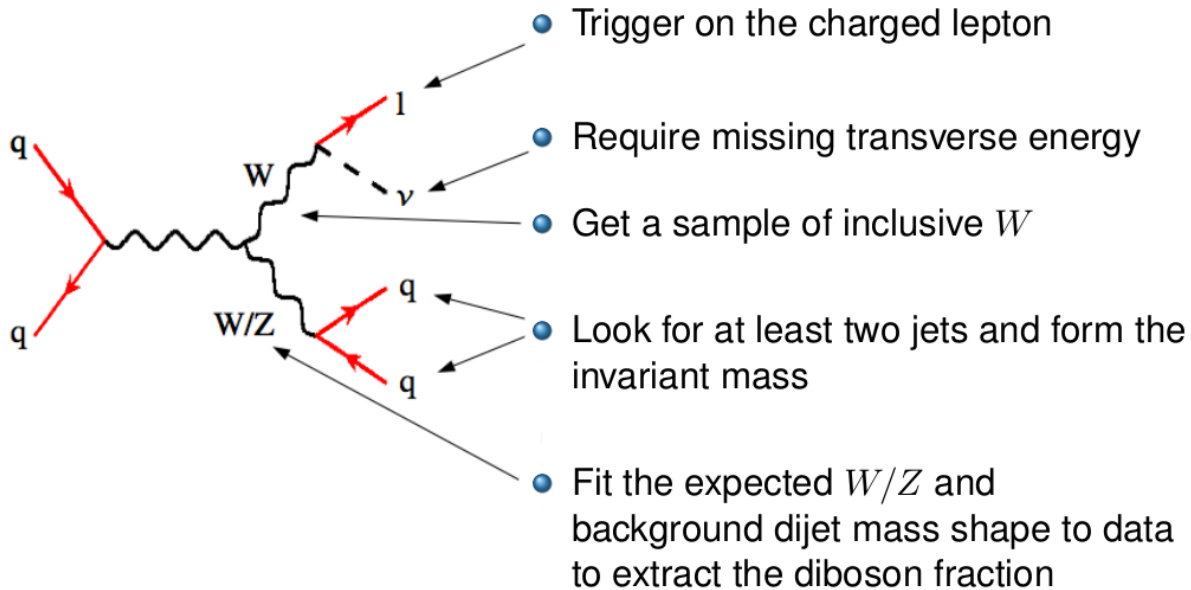
Introduction

challenging final state:

- W+jets is dominant
- $S/B < 1\%$



Analysis selection

leptonic W

muon channel:

- trigger: lowest unprescaled μ
- 1 muon with $p_T > 25$ GeV
- veto on second lepton
- track and calo isolation
- vertex pointing: $d_0/\sigma(d_0) < 3$

electron channel:

- trigger: lowest unprescaled e
- 1 electron with $p_T > 25$ GeV
- veto on second lepton
- track and calo isolation
- vertex pointing: $d_0/\sigma(d_0) < 10$

- $\not{E}_T > 25$ GeV
- $M_T(W) > 40$ GeV

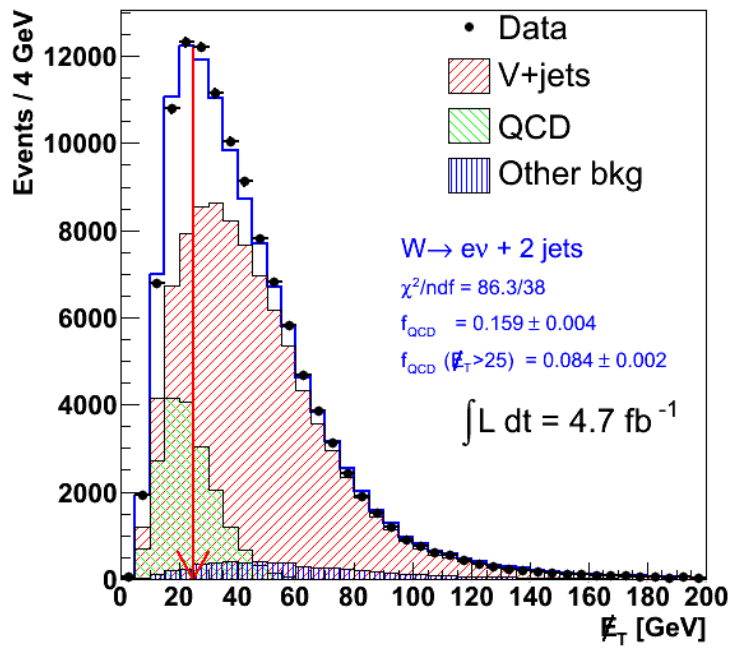
hadronic W/Z

- jet cleaning and overlap removal
- at least 2 good jets with $p_T > 25$ GeV and $|\eta| < 2.8$
- $|JVF| > 0.75$ if $|\eta| < 2.5$
- $\Delta\phi(\not{E}_T, j_{lead}) > 0.8$: further reduction of multijet background
- $|\eta_{jet}| < 2$: avoid mis-modeling in forward jets in boson+jets
- $\Delta R(j_1, j_2) > 0.7$: avoid mis-modeling due to a generator level cut
- $|\Delta\eta(j_1, j_2)| < 1.5$: improve S/B
- $|\Delta\phi(j_1, j_2)| < 2.7$: increase S/B

QCD data-driven estimate

QCD contribution is extracted using a data-driven method because it is very difficult to model the multijet background

- already used in W+jets measurement
- enrich data samples with QCD:
  - invert isolation cuts in muon data
  - loose selection cuts in electron data
- fit the $\not\!\!E_T$ distributions with MC
- extracted parameteres:
  - QCD normalization
  - W+jets, Z+jets scale factors
- QCD fraction in e channel: $\sim 8\%$
- QCD fraction in μ channel: $\sim 6\%$

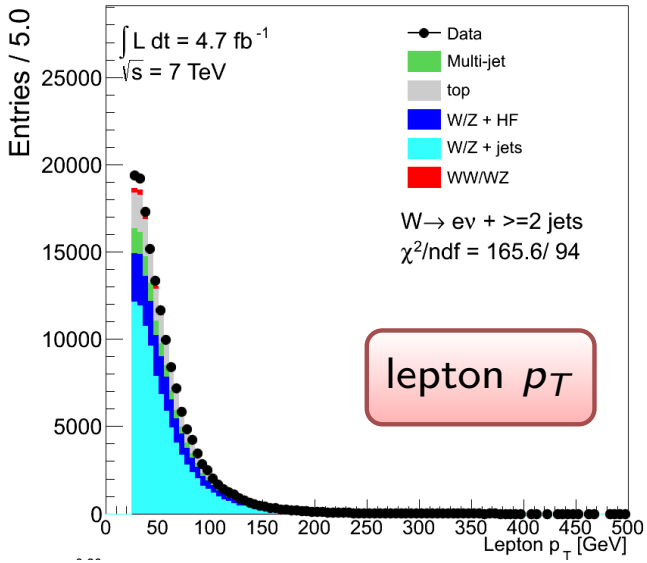


Background estimation

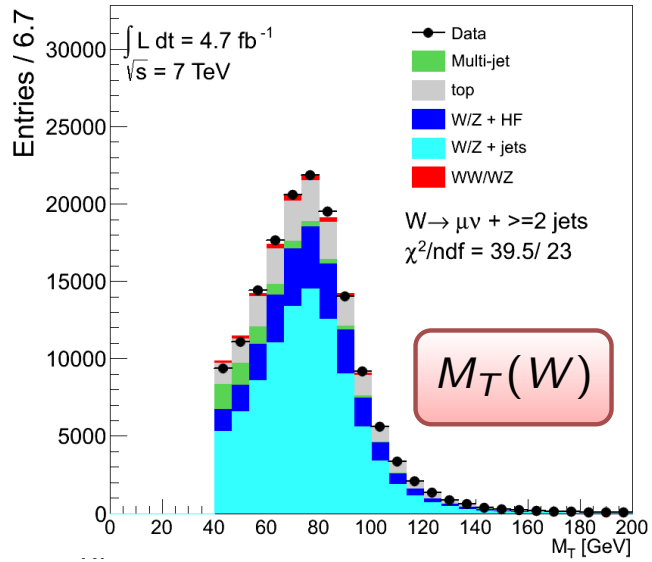
- normalization: cross sections at NLO or LO+k-factors
- expected shapes: W/Z + jets, W/Z + HF, top and single-top, WW/WZ
- QCD: data driven

Process	Generator	cross-section σ (pb) ($\times$ BR)
Inclusive $W \to \ell\nu$	ALPGEN	10.5×10^3 [**?**]
Inclusive $Z/\gamma^* \to \ell\ell$ ($M_{\ell\ell} > 40$ GeV)	ALPGEN	10.7×10^2 [?]
Inclusive $Z/\gamma^* \to \ell\ell$ ($10 < M_{\ell\ell} < 40$ GeV)	ALPGEN	3.9×10^3 [**?**]
$t\bar{t}$	MC@NLO	166.8
Single top Wt	MC@NLO	15.6
Single top s-channel	MC@NLO	0.47
Single top t-channel	MC@NLO	6.65
WW	HERWIG	45.0
WZ	HERWIG	18.0
ZZ	HERWIG	5.96
$\gamma W \to \ell\nu(\ell = e,\mu,\tau)$	PYTHIA,MADGRAPH	135.4
Wbb	ALPGEN	723.0
Zbb	ALPGEN	25.8
Wcc	ALPGEN	256.9
Wc	ALPGEN	914.4

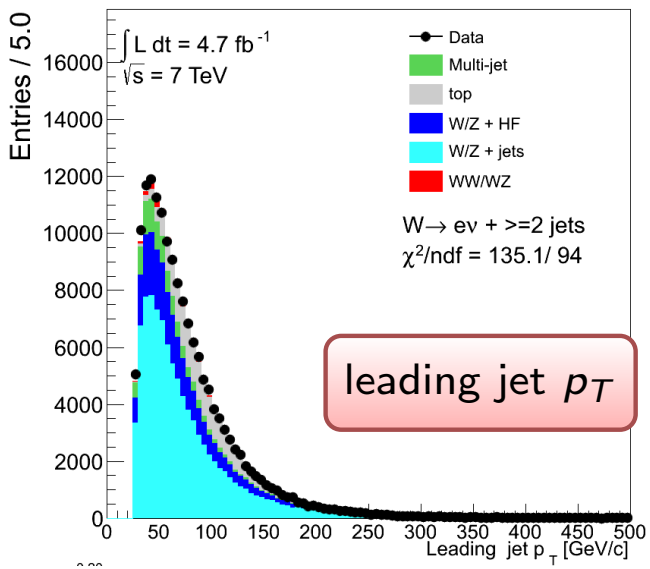
Data/MC agreement



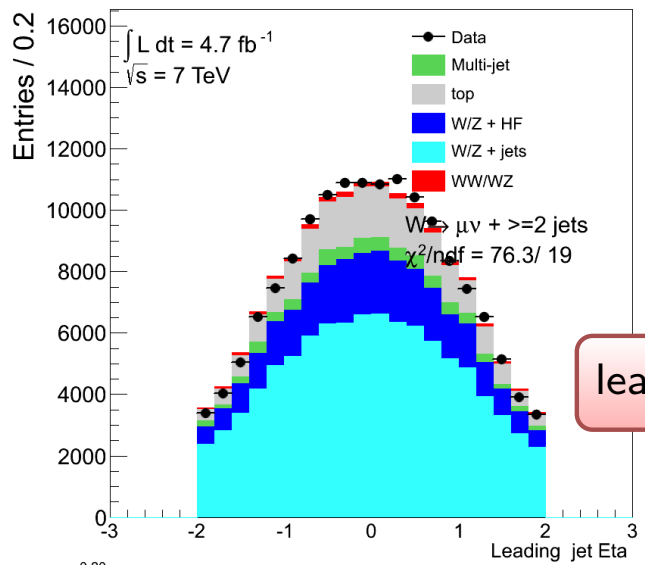
lepton p_T



$M_T(W)$



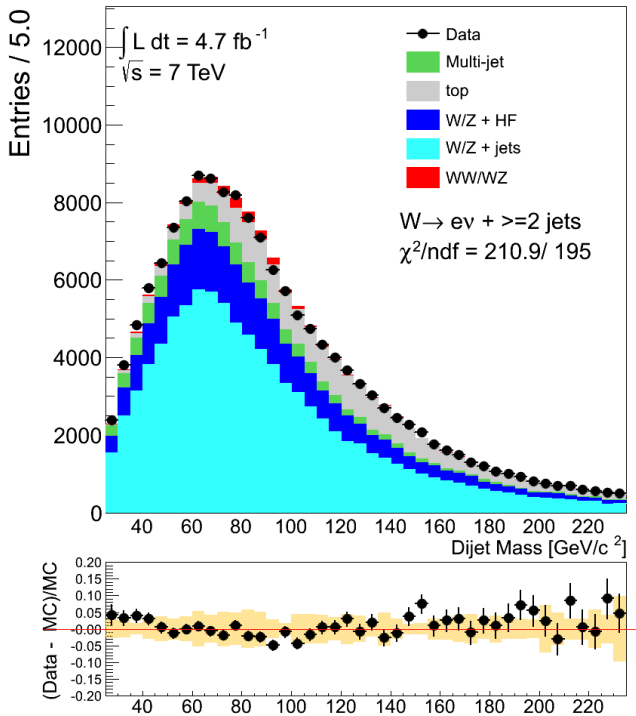
leading jet p_T

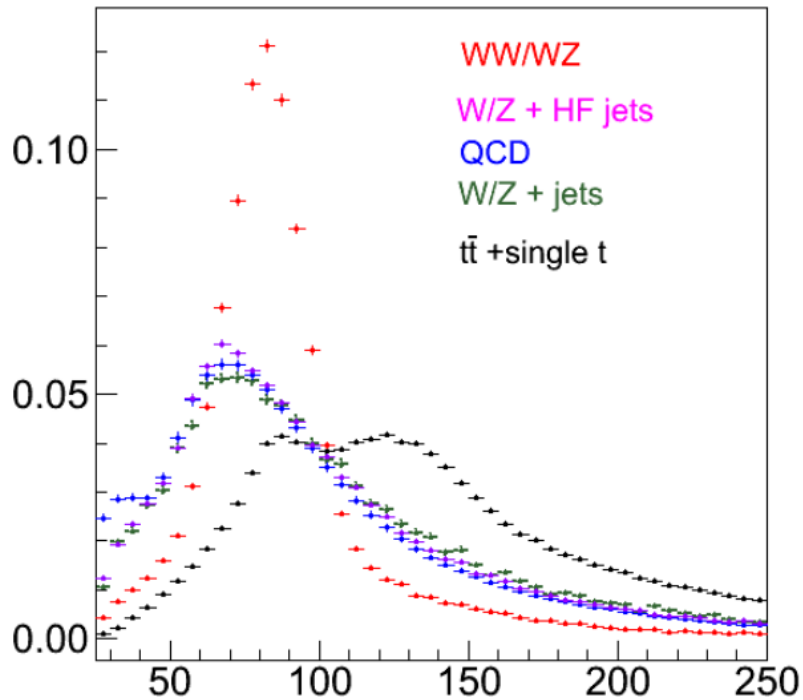


leading jet η

Dijet distributions

M_{jj} distribution and normalized templates:

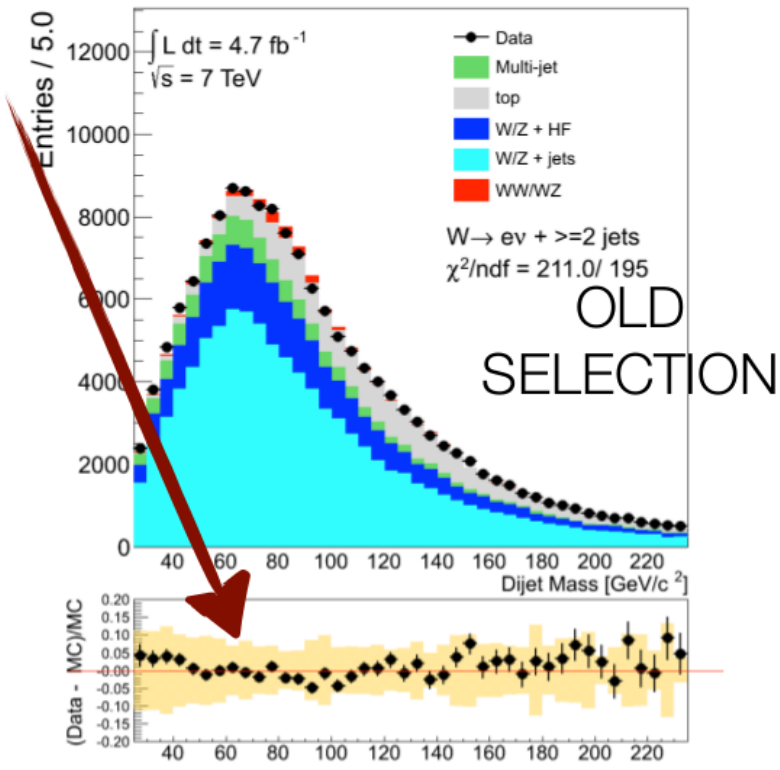


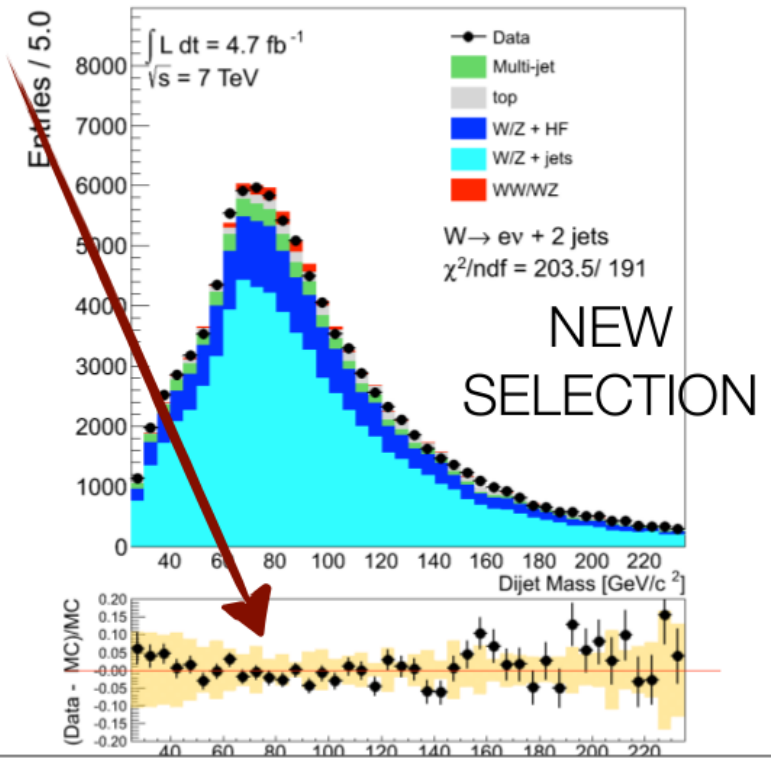


- selection efficiency: $\epsilon \sim 1.1\%$, S/B ratio: 2.6%
- templates are used for a fit method to extract WW/WZ σ
- binned maximum likelihood fit to M_{jj} distributions
- systematic uncertainties and background normalizations treated as nuisance parameters; JES and QCD estimated with toy experiments

New selection

- $\not{E}_T > 30$ GeV: QCD 20% smaller
- leading jet $p_T > 30$ GeV: kill $t\bar{t}$
- no $\Delta\phi$ cut, $N_{jet} = 2$: smaller effect of JES on signal region

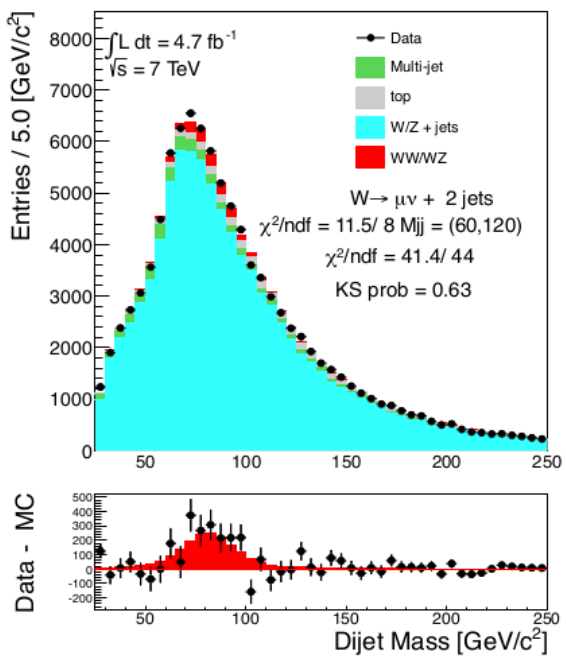


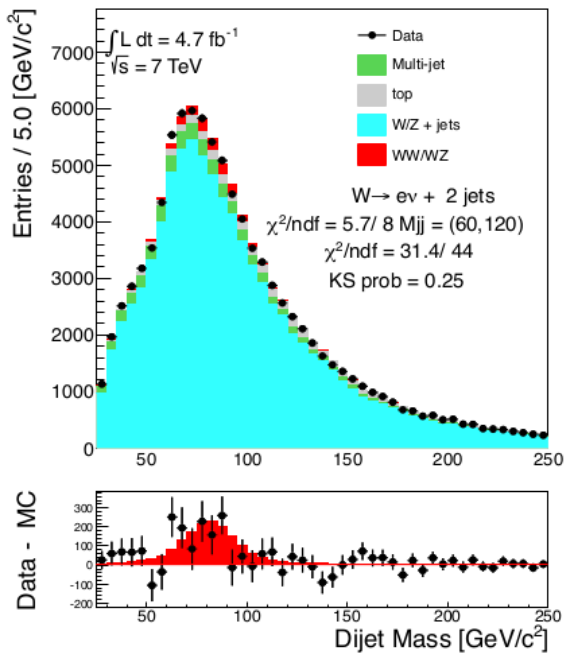


Fit setup

- likelihood fit to templates
- W/Z + jets: uncertainty on normalization of 20%
- $t\bar{t}$: 10% uncertainty on normalization
- WW/WZ left free
- QCD: 30% uncertainty on normalization
- systematics described as nuisance parameters

Fit after new selection:

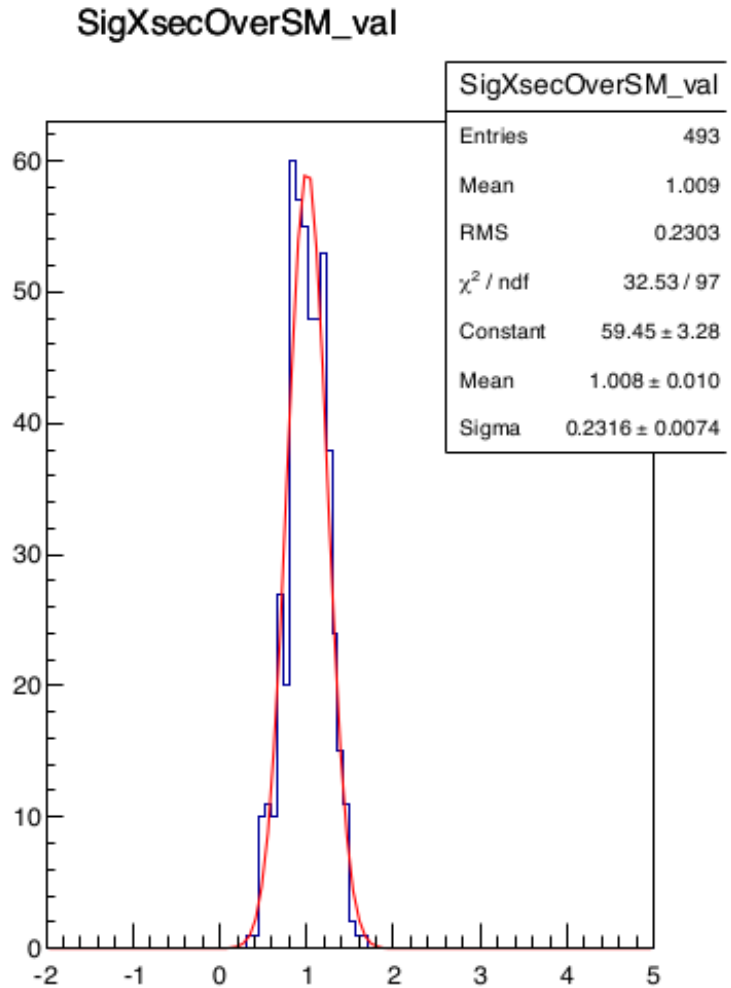




signal $\frac{\sigma_{signal}}{\sigma_{SM}} = 1.13 \pm 0.26.$

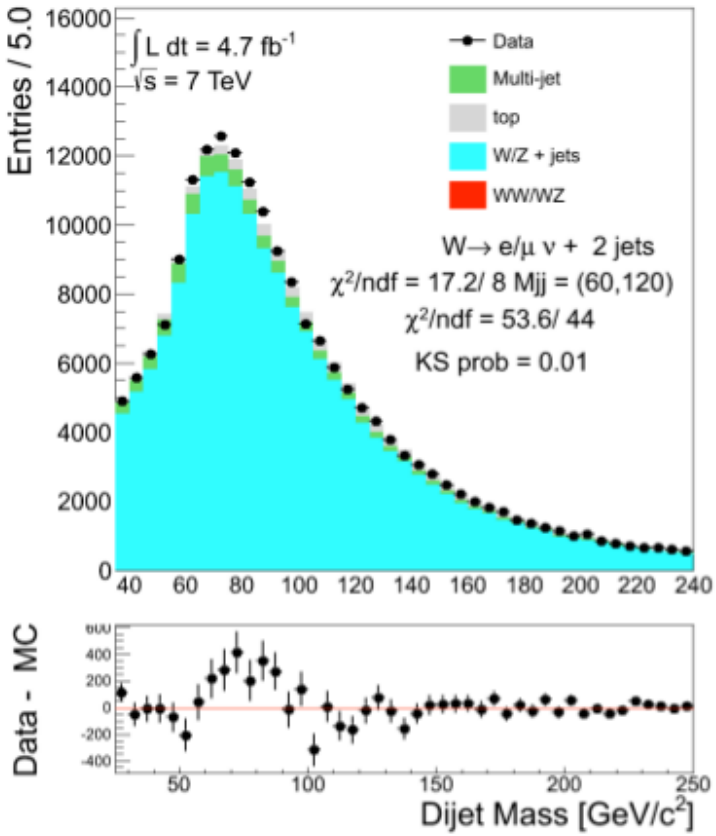
JES and QCD estimation

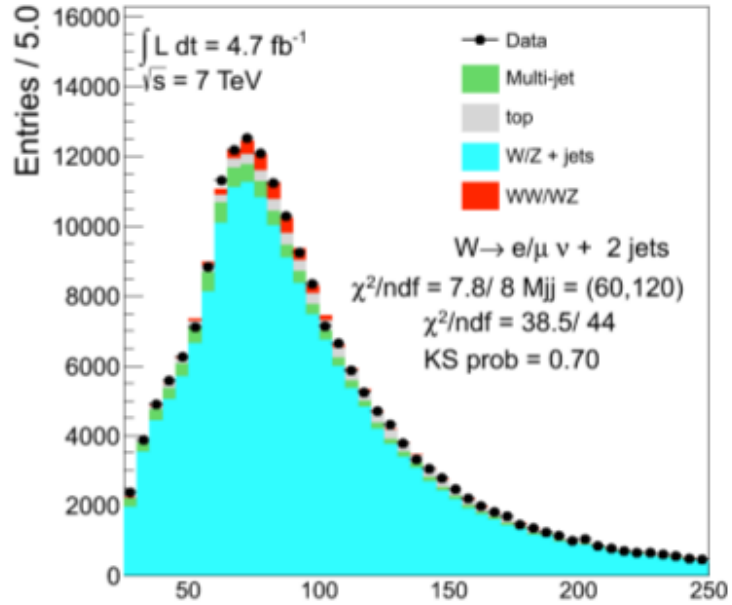
- JER, W+jets, $t\bar{t}$: nuisance parameters
- JES and QCD are obtained without profiling
- toy experiments after profiling to estimate JES and QCD

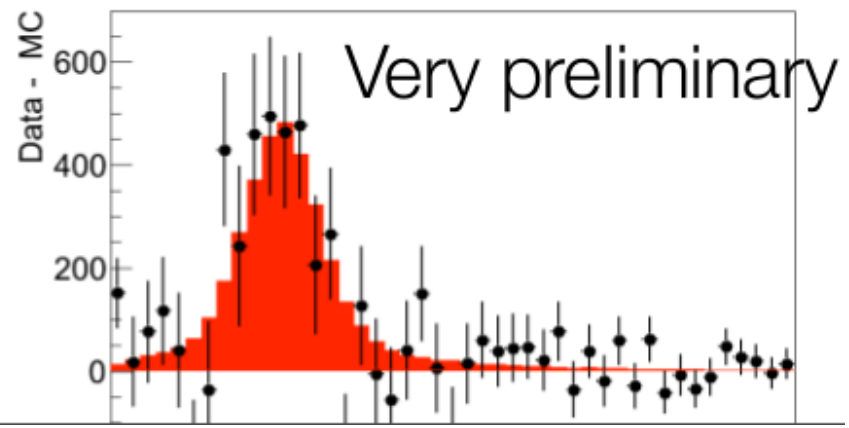


Sum of electron and muon channels

Fixing the signal to 0







Next steps

- go for the internal note with the analysis as it is -HCP?-
- move analysis on grid
- control each step of the analysis
- try other tools (quark-gluon tagging)
- try different cuts
- apply cuts to isolate the diboson peak with 2012 data