LHCP POSTER SESSION – BOLOGNA, JUNE 2018

Search for resonant WZ production in the fully leptonic final state in proton-proton collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector

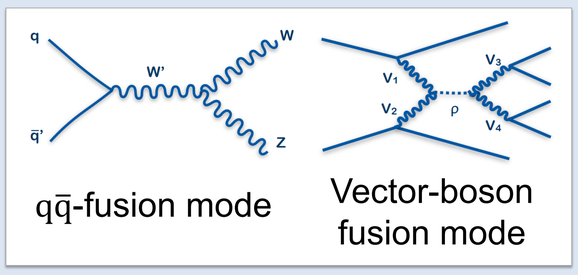
Reference:

ATLAS-EXOT-2016-11

Motivation

- Search for resonant WZ production in the fully leptonic final state ($lvll$, where $l = e, \mu$) in exclusive $\mathrm{q\bar{q}}$ and VBF production modes
- Diboson vector and scalar resonances predicted by models like Composite Higgs models, Grand Unified Theories, theories with extra dimensions etc.
- Study two benchmark models:
  - Vector: Heavy Vector Triplets (HVT): *W'* [D. Pappadopulo et al., JHEP 09 (2014) 060]
  - Scalar: Georgi-Machacek (GM) Higgs Triplet Model: $\mathrm{H}_5^{\pm}$ [H. Georgi and M. Machacek, Nucl. Phys. B 262, (1985) 463]

Production modes



$\mathrm{q\bar{q}}$-fusion mode | Vector-boson fusion mode

Signature

- 3 high p_{T} charged leptons
- Missing transverse energy
- VBF-category:
  - Two jets with large η separation and high invariant mass
- $\mathrm{q\bar{q}}$-category:
  - Fails VBF selection

Dominant systematics

- The effect of systematic uncertainties on the extracted limit of the signal-strength parameter μ
- Largest impact on sensitivity:
  - Statistical uncertainties on data
  - Uncertainties related to *WZ* background modelling

Source	$\Delta\mu/\mu$ [%]	
	$q\bar{q}$ Category $m(W')$ = 800 GeV	VBF Category $m(H_5^{\pm})$ = 450 GeV
WZ modelling : Scale, PDF	5	11
WZ modelling : Parton Shower	10	6
MC statistical uncertainty	7	8
Electron identification	4	2
Muon identification	3	3
Jet uncertainty	1	8
Missing transverse momentum	2	1
Fakes	1	5
Total systematic uncertainty	17	21
Statistical uncertainty	53	52

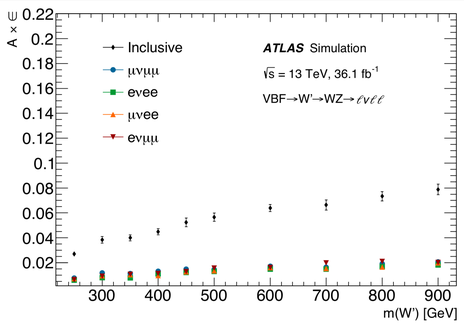
Object and event selection

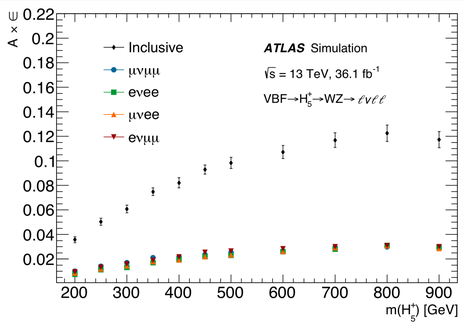
- Single lepton trigger
- 3 high p_{T}>25 GeV isolated leptons
- 4th lepton veto (p_{T}>7 GeV) to reduce *ZZ* background
- *Z* selection:
  - Pair of same flavour, opposite sign leptons
  - Consistent with Z boson mass in a $\pm$20 GeV window
- *W* selection
  - Third lepton
  - MET > 25 GeV

- VBF category:
  - Use of jet vertex tagger to mitigate pile-up contamination
  - B-jet veto
- Event selection:
  - $\mathrm{q\bar{q}}$: $p_{\mathrm{T}}^{Z}/m_{WZ}$>0.35 and $p_{\mathrm{T}}^{W}/m_{WZ}$>0.35
  - VBF: 2 jets with $m_{jj} > 500$ GeV and $\Delta\eta_{jj} > 3.5$
- Reconstruct invariant *WZ* mass using MET, the third lepton and known *W* mass

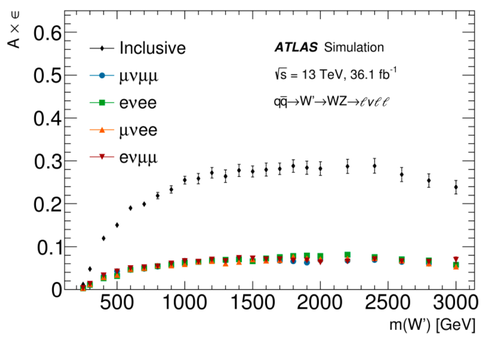
Acceptance x Efficiency

VBF-category





$\mathrm{q\bar{q}}$-category

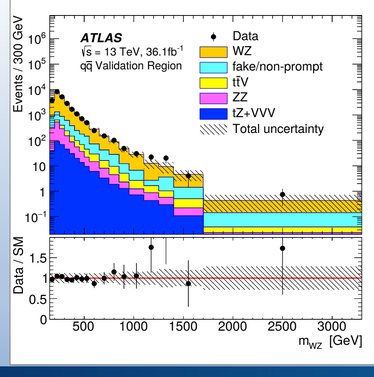


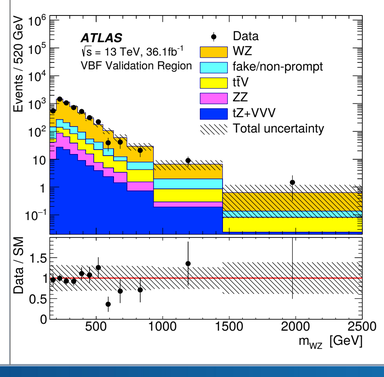
Background estimation

- Dominant background: Standard Model production of *WZ*
  - Normalization and shape are estimated from Monte Carlo (MC)
  - Other smaller background estimated with MC
    - ttbar+V, *ZZ*, tZ, VVV, *WZ*+bj
- Events from backgrounds (*Z*+jets, *Z*, *W*, ttbar, single top or *WW*) where jets are misidentified as leptons (*fake/non-prompt* leptons) are estimated by a data-driven method using a global matrix method

Validation regions

- Invert qq and VBF selection cuts
  - $\mathrm{q\bar{q}}$: $p_{\mathrm{T}}^{Z}/m_{WZ}$<0.35 and $p_{\mathrm{T}}^{W}/m_{WZ}$<0.35
  - VBF: $100 < m_{jj} < 500$ GeV and $\Delta\eta_{jj} < 3.5$
- Good agreement in both categories



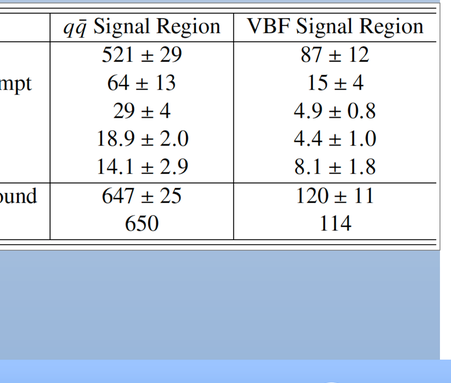


Results

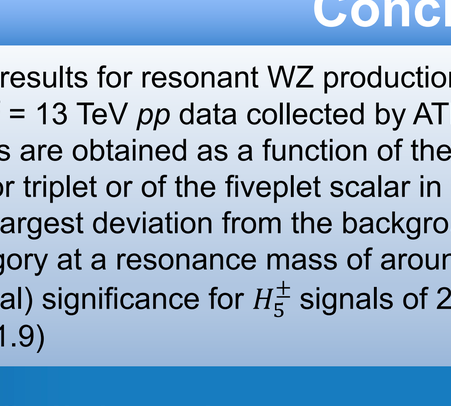
- Limit obtained using a binned likelihood function built from a sum of Poisson probabilities of the background distribution and a hypothetical signal
- Fit is performed separately for VBF- and $\mathrm{q\bar{q}}$-categories

Signal regions

VBF-category



$\mathrm{q\bar{q}}$-category

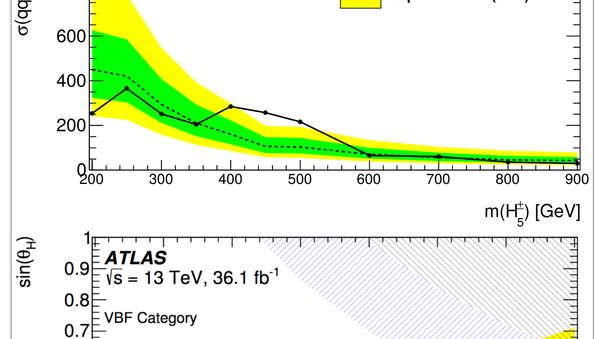


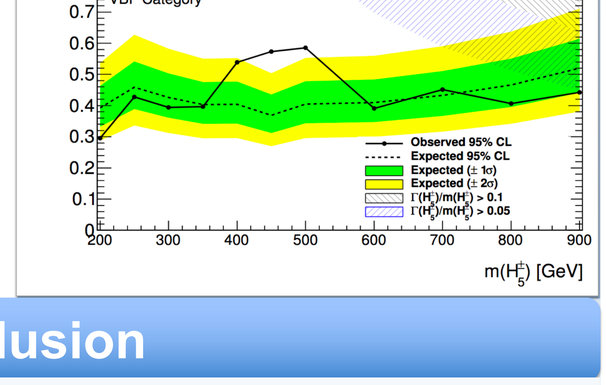
Post-fit yields in signal regions obtained with background-only fit

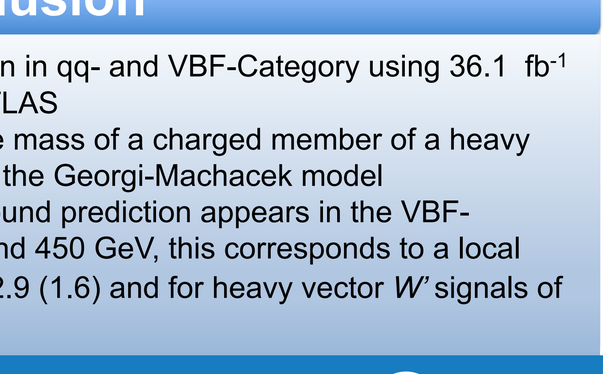
	$q\bar{q}$ Signal Region	VBF Signal Region
WZ	521 ± 29	87 ± 12
Fake/non-prompt	64 ± 13	15 ± 4
$t\bar{t}V$	29 ± 4	4.9 ± 0.8
ZZ	18.9 ± 2.0	4.4 ± 1.0
$tZ + VVV$	14.1 ± 2.9	8.1 ± 1.8
Total Background	647 ± 25	120 ± 11
Observed	650	114

Upper limits on $\sigma\times\mathcal{B}$ as well as on $\sin\theta_H$ parameter of the GM model

- Regions where Γ/m>5% are shaded







Conclusion

- First results for resonant WZ production in qq- and VBF-Category using 36.1 fb^{-1} of $\sqrt{s}$ = 13 TeV *pp* data collected by ATLAS
- Limits are obtained as a function of the mass of a charged member of a heavy vector triplet or of the fiveplet scalar in the Georgi-Machacek model
- The largest deviation from the background prediction appears in the VBF-category at a resonance mass of around 450 GeV, this corresponds to a local (global) significance for $H_5^{\pm}$ signals of 2.9 (1.6) and for heavy vector *W'* signals of 3.1 (1.9)

Benjamin Freund, Université de Montréal, on behalf of the ATLAS Collaboration

Université de Montréal

ATLAS EXPERIMENT