TECHNISCHE UNIVERSITÄT DRESDEN

ATLAS EXPERIMENT

Institut für Kern- und Teilchenphysik, Professur für experimentelle Teilchenphysik

Measurement of WW and WZ production cross section at 8 TeV and limits on anomalous triple gauge couplings with the ATLAS detector

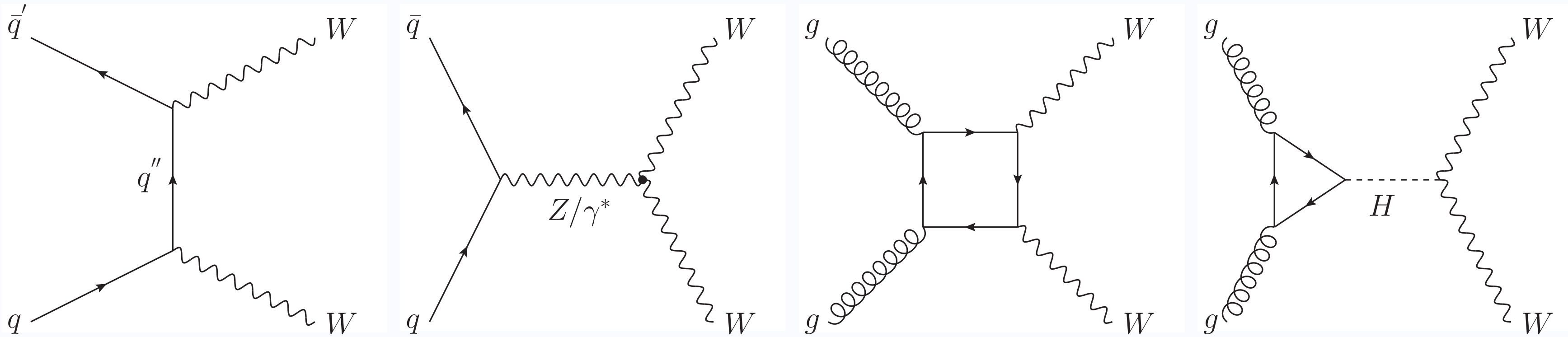
Felix Socher
on behalf of the ATLAS collaboration

DIS16
DESY, HAMBURG 11-15 APRIL 2016

Hamburg,
12.04.2016

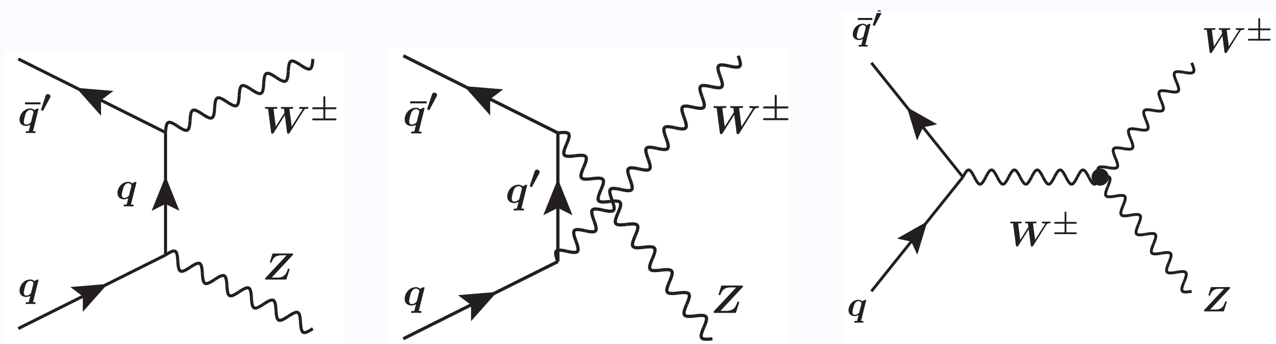
DRESDEN concept

WW Production

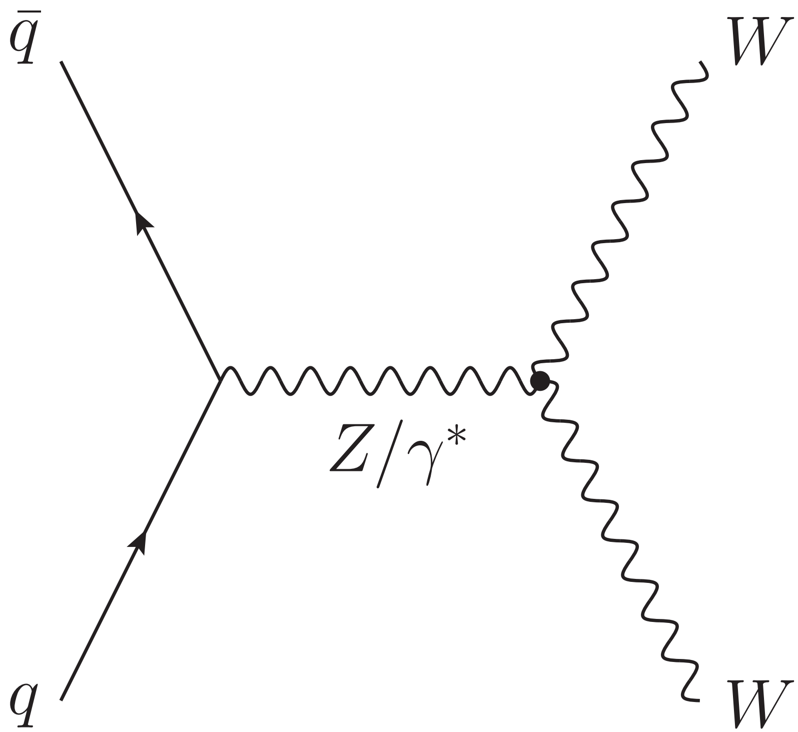


(a) t- channel (b) s- channel (TGC vertex) (c) gluon fusion (d) Higgs boson production

WZ Production

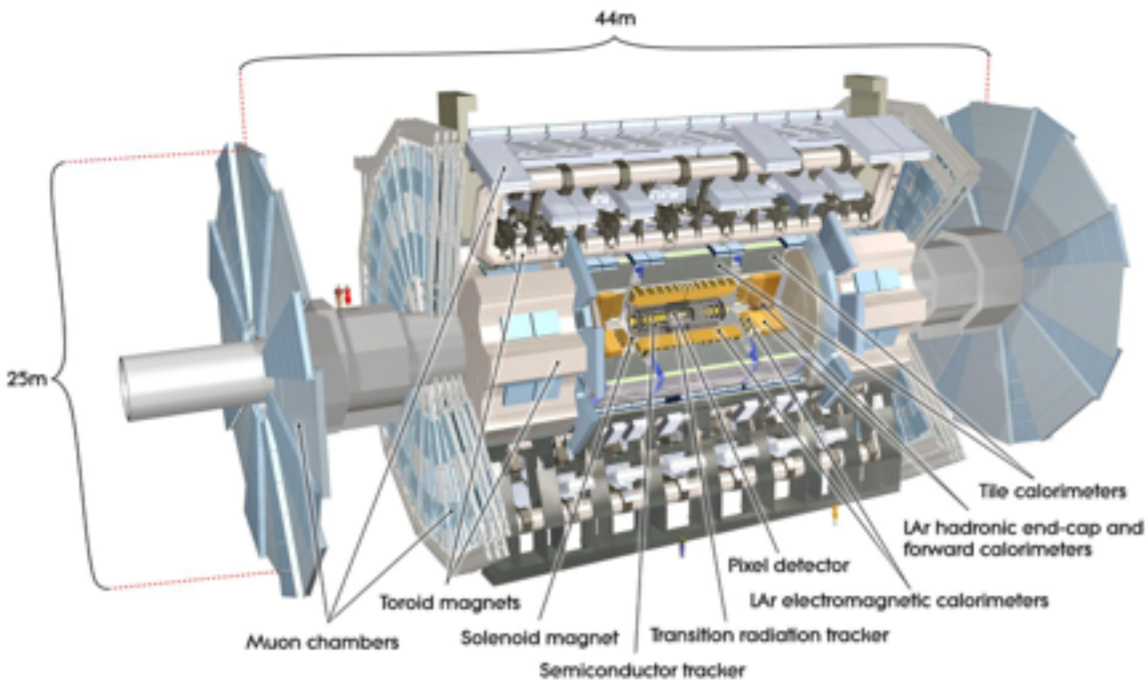


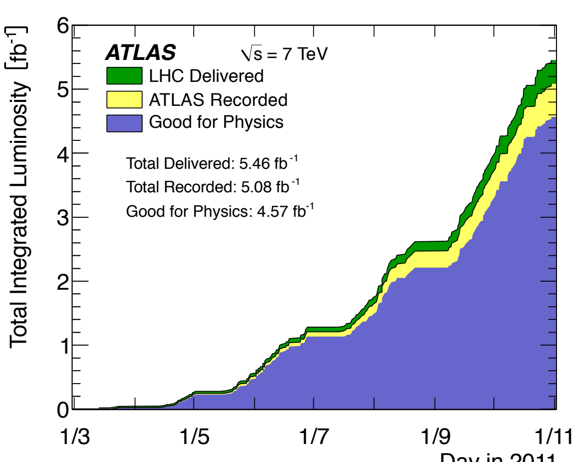
Introduction - Why study WW and WZ?

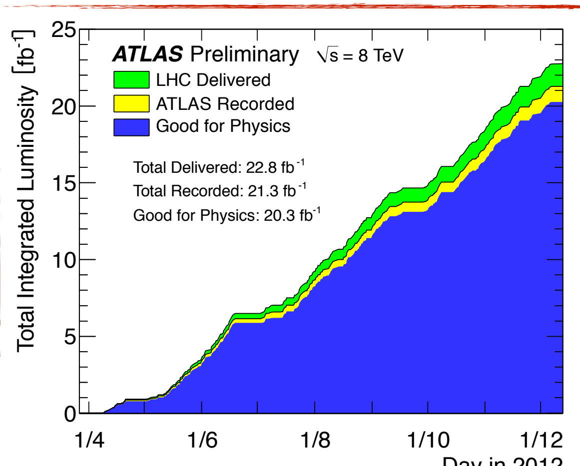


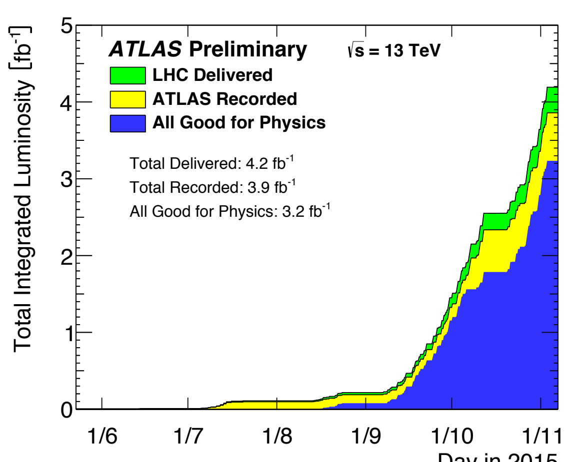
- test of the electroweak gauge sector
- test of perturbative QCD
- search for new physics via anomalous triple gauge couplings
- background for e.g. H → WW

Introduction - ATLAS







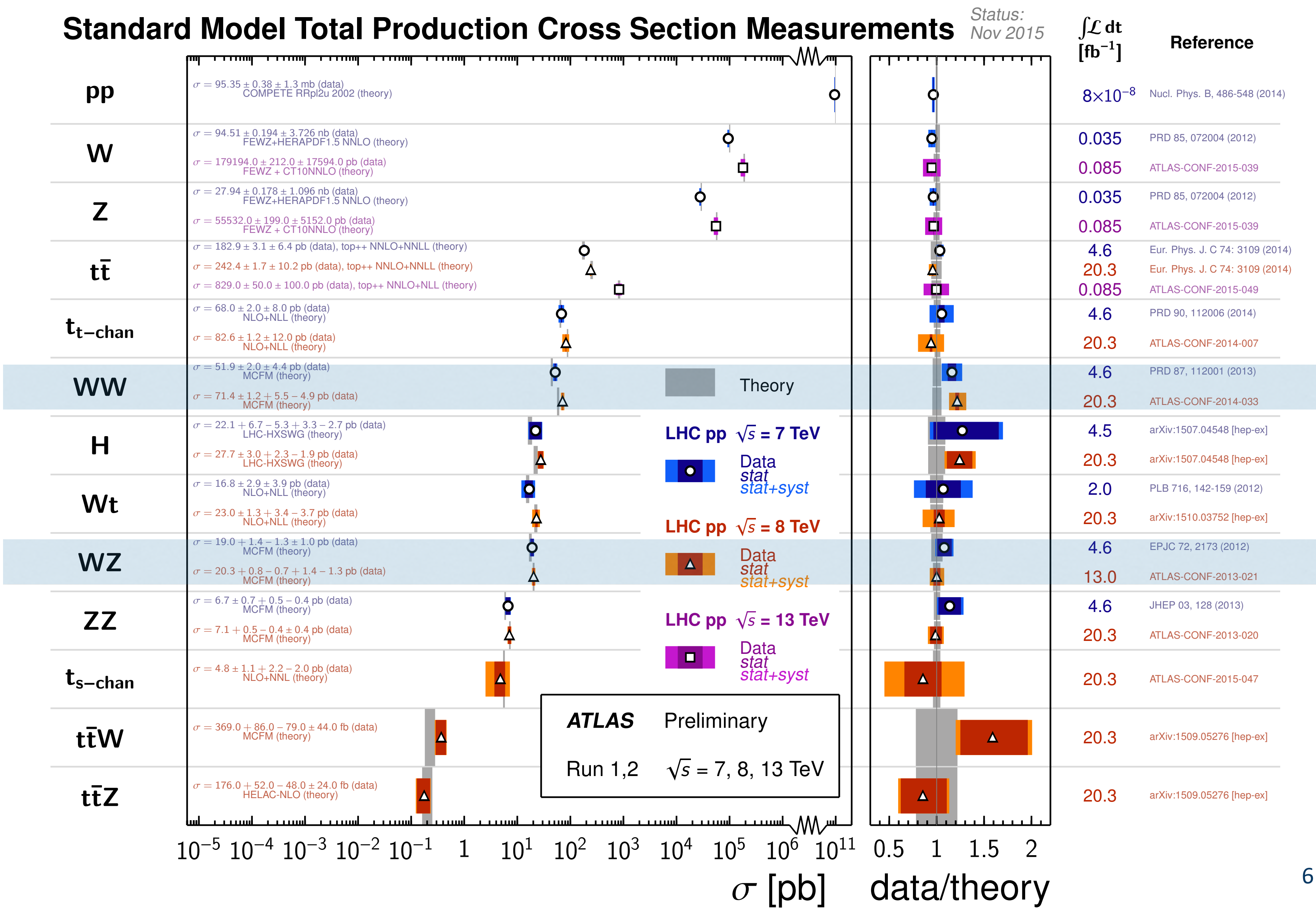


Introduction - Available Papers

	inclusive xsec	diff. cross sections	used variable for aTGCs
WZ → lllv @ 8 TeV arxiv:1603.02151v1 submitted to PRD	yes	$p_{\mathrm{T}}^{\mathrm{Z}}, p_{\mathrm{T}}^{\mathrm{W}}, M_{\mathrm{T}}^{\mathrm{WZ}}, p_{\mathrm{T}}^{\nu}, \lvert y_{\mathrm{Z}} - y_{\mathrm{W}} \rvert, N_{\mathrm{Jets}}, m_{\mathrm{jj}}$	$M_{\mathrm{T}}^{\mathrm{WZ}}$
WW → lvlv @ 8 TeV arxiv:1603.01702v1 submitted to JHEP	yes	$p_{\mathrm{T}}^{\mathrm{lead}},\ p_{\mathrm{T,ll}},\ m_{\mathrm{ll}},\ \Delta\Phi_{\mathrm{ll}},\ \lvert y_{\mathrm{ll}} \rvert,\ \lvert \cos(\theta^*) \rvert$	$p_{\mathrm{T}}^{\mathrm{lead}}$
WW+WZ → lvjj @ 7 TeV JHEP01(2015)049	yes	-	$p_{\mathrm{T}}^{\mathrm{jj}}$

- fully leptonic final states offer clean signatures but have low statistics
- final states with jets have higher statistics → complementary
- of course always stay tuned for new results

Introduction - Standard Model Overview

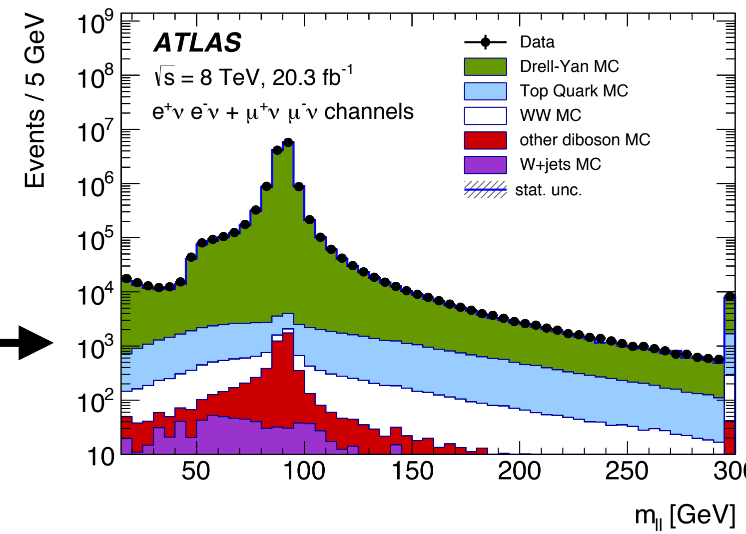


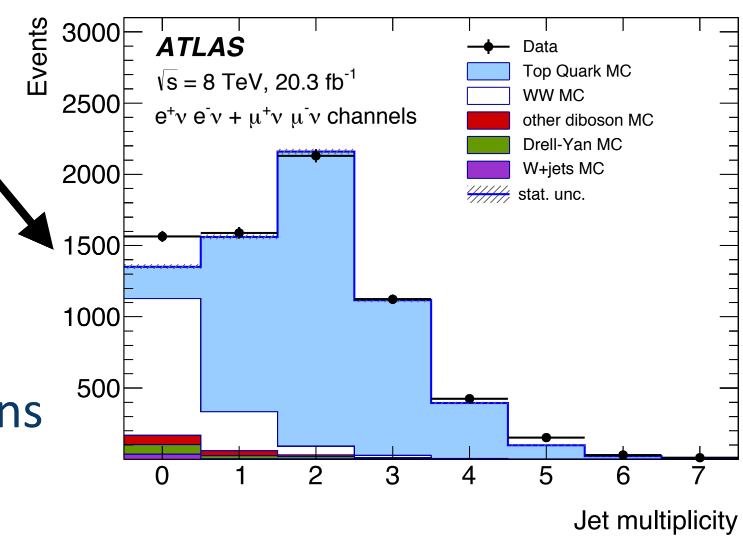
WW → *lνlν* @ 8 TeV

arxiv:1603.01702v1

WW - Selection Strategy

	$e\mu$	$ee/\mu\mu$
p_T^ℓ (leading/sub-leading)	> 25 / 20 GeV	
$\lvert\eta^\ell\rvert$	$\lvert\eta^\mu\rvert < 2.4$ and $\lvert\eta^e\rvert < 2.47$, excluding $1.37 < \lvert\eta^e\rvert < 1.52$	
Number of additional leptons with $p_T > 7$ GeV	0	0
$m_{\ell\ell}$	> 10 GeV	> 15 GeV
$\lvert m_Z - m_{\ell\ell}\rvert$	—	> 15 GeV
$E_{T,\,Rel}^{miss}$	> 15 GeV	> 45 GeV
p_T^{miss}	> 20 GeV	> 45 GeV
$\Delta\phi(\boldsymbol{E}_T^{miss}, \boldsymbol{p}_T^{miss})$	< 0.6	< 0.3
Number of jets with $p_T > 25$ GeV, $\lvert\eta\rvert < 4.5$	0	0





- highlighting shows mainly affected background
- large backgrounds but well suppressible
- jet veto introduces new theoretical complications

WW - Yields and Cross Section Determination

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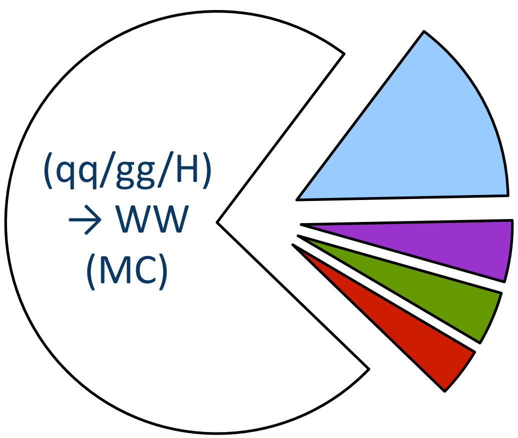
	eµ	ee	µµ
Data	5067	594	820
tot exp.	4420 ± 320	507 ± 40	820 ± 65
WW signal	3240 ± 280	346 ± 33	613 ± 60
tot bkg.	1180 ± 150	161 ± 23	205 ± 26

$$\sigma_{\mathrm{fid}}^{\ell\ell'}(WW) = \frac{N_{\mathrm{data}} - N_{\mathrm{bkg}}}{C_{WW} \times \mathcal{L}}$$

efficiency corrects for detector effects

$$\sigma_{\mathrm{tot}}(pp \to WW) = \frac{\sigma_{\mathrm{fid}}^{\ell\ell'}(pp \to WW)}{A_{WW} \times \mathcal{B}^2(W \to \ell\nu)}$$

extrapolation to total phase space determined via MC



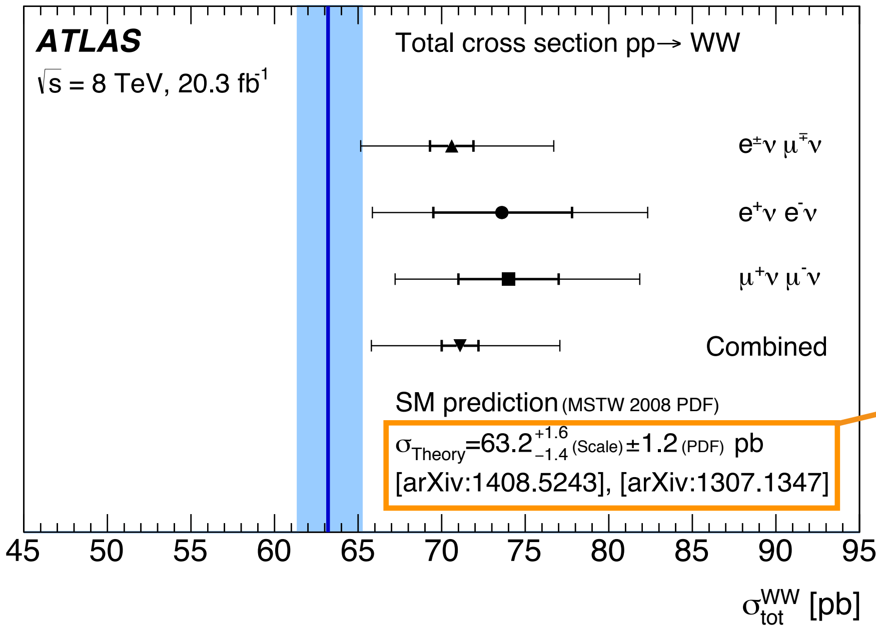
Top Quark (shape from MC, normalisation from data via control region)

W+Jets (completely data driven, also contains multi jet contribution)

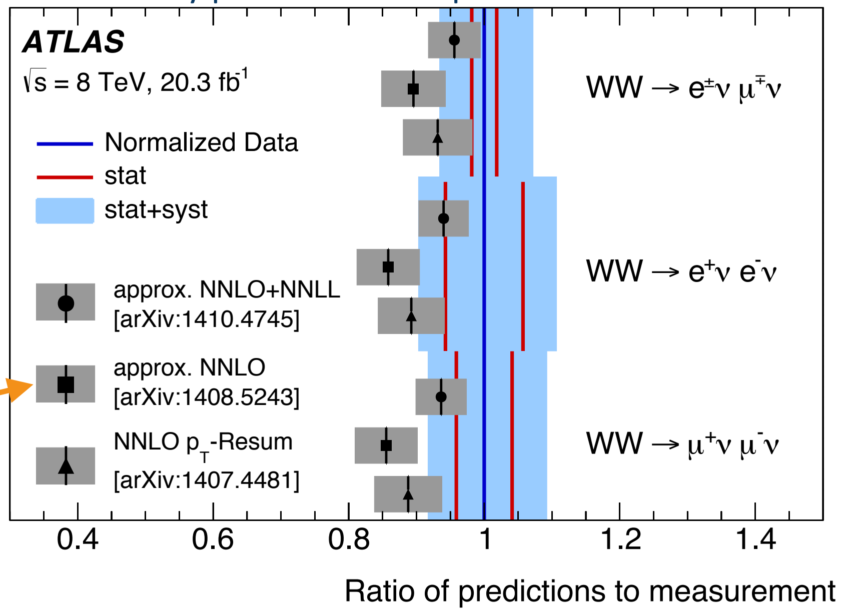
Drell-Yan (shape from MC, normalisation from data via control region)

Diboson (taken from MC)

WW - Cross Section Results



Note: theory prediction extrapolated via NLO MC



in fiducial phase space

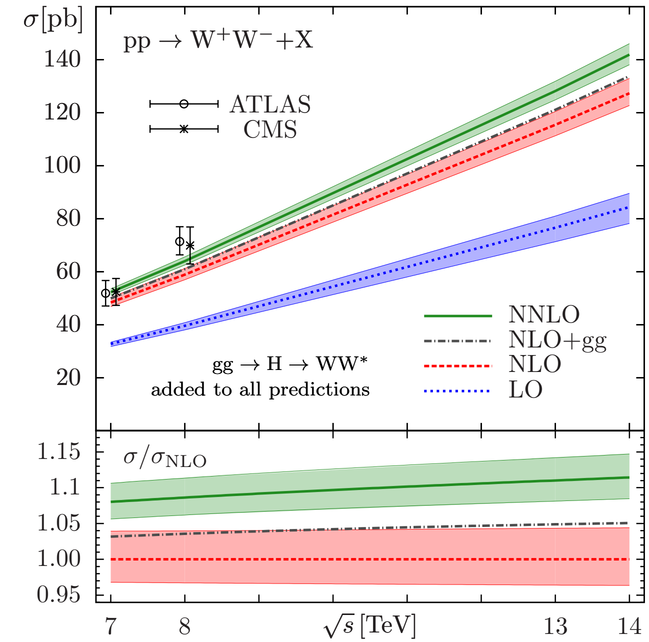
- driving uncertainties: jet measurement, luminosity, pileup, W+jets/multijet bkg, and top bkg

- slight discrepancy between data and theory seen at NNLO
- caused by theoretical complications due to jet veto

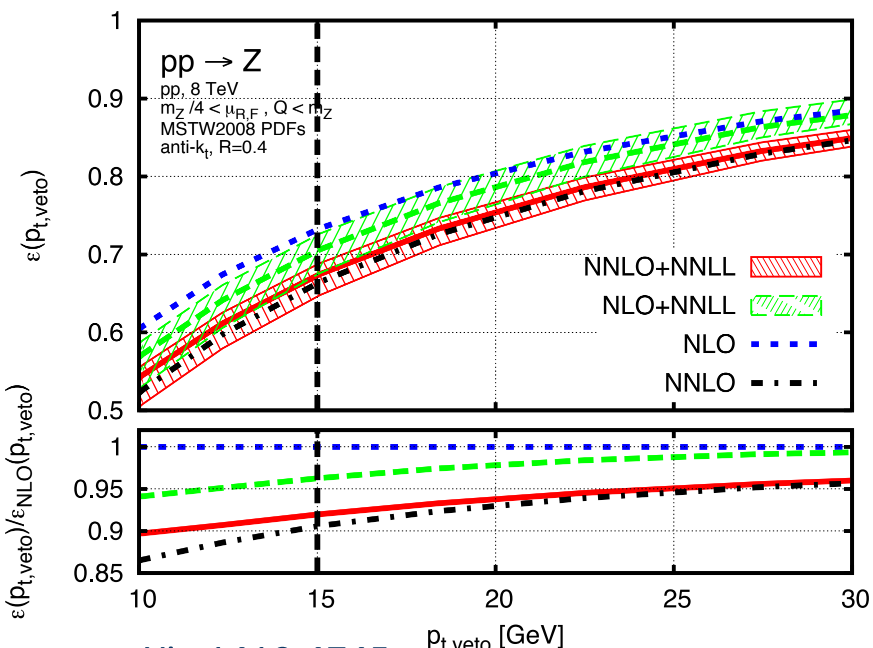
WW - Discussion on Cross Section Results

- total phase space predictions rising with higher order
- theory uncertainties not covering higher orders
- extrapolation from fiducial to total phase space done with PowHeg (NLO MC) -> discussed in arXiv:1410.4745

- two effects:
  - veto efficiency overestimated by PowHeg (~ -7-8%)
  - treatment of the hardest emission (~ -3%)



arXiv:1408:5243

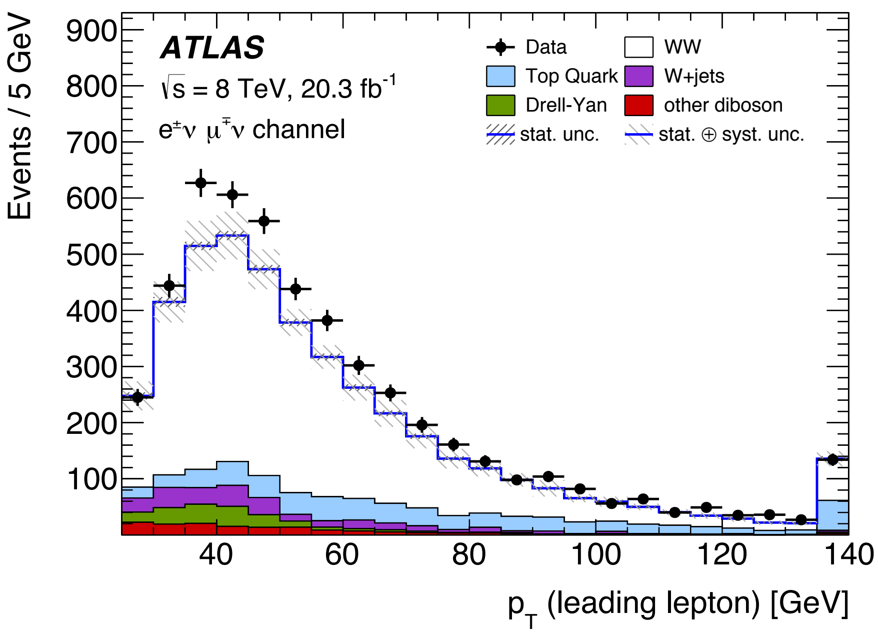


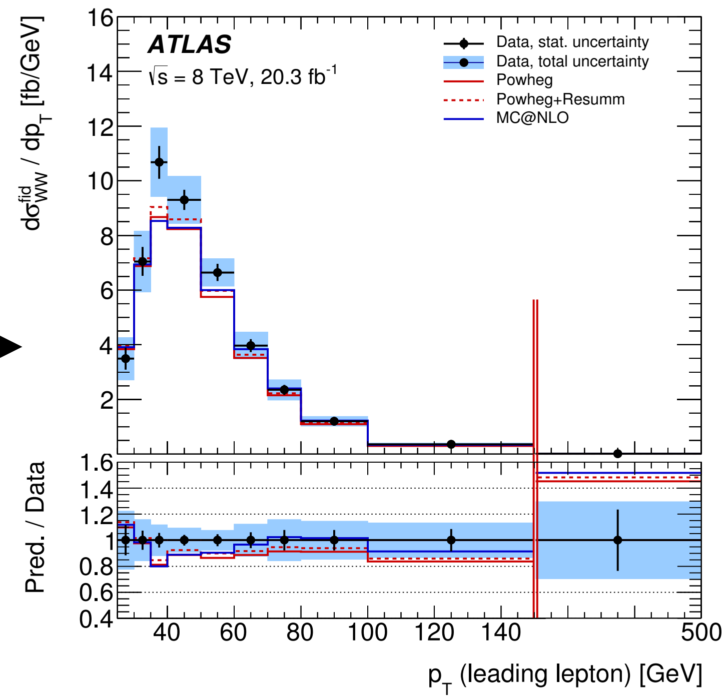
arXiv:1410:4745

- higher extrapolation factor obtained at NLO leads to higher measured cross section

WW - differential distributions

- only measured in the eμ channel (cleaner, more statistics)
- unfolding done via Bayesian Iterative unfolding (3 iterations)
- shapes seem to be described relatively well
- prediction normalised to NNLO but using NLO extrapolation





WZ → *lllv* @ 8 TeV

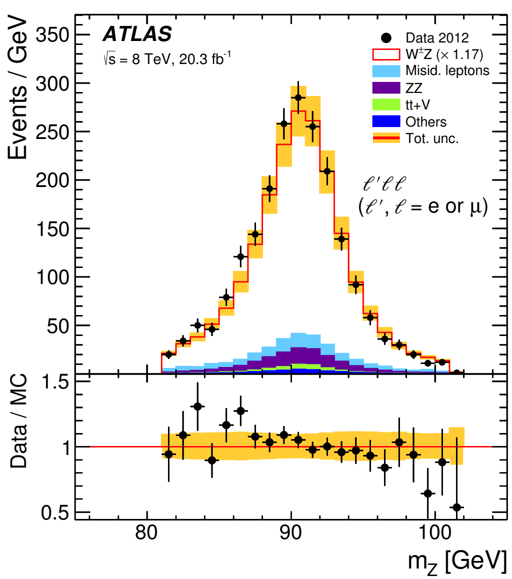
arxiv:1603.02151v1

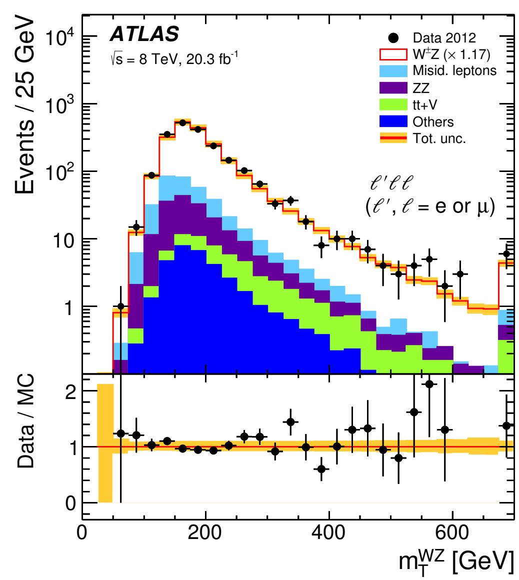
WZ - Selection Strategy

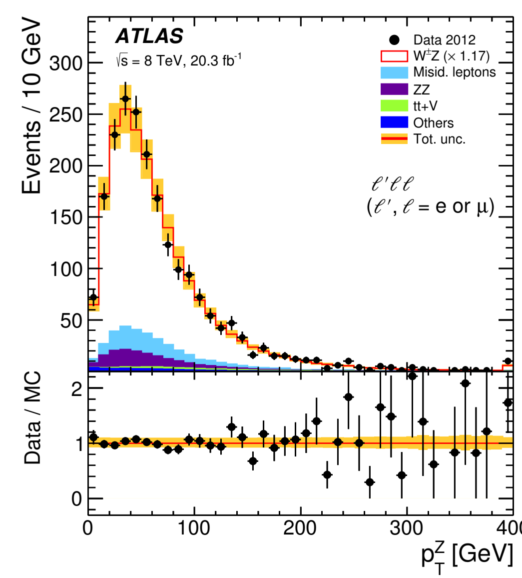
Variable	Requirement
p_{T}^{lZ}, p_{T}^{lW} $\lvert\eta^{l}\rvert$	> 15 GeV, > 20 GeV $\mu :< 2.4$, $e :< 2.47$
Number of leptons with $p_{\mathrm{T}} > 15$ GeV Number of additional leptons with $p_{\mathrm{T}} > 7$ GeV $\lvert m_{\mathrm{Z}} - m_{\mathrm{Z}}^{\mathrm{PDG}}\rvert$ $m_{\mathrm{T}}^{\mathrm{W}}$	$= 3$ 0 < 10 GeV > 30 GeV

- assignment of leptons via finding the best Z candidate
- tight requirements on lepton associated with W to suppress Z+jets

- WZ scaled to data in plots for illustration purposes



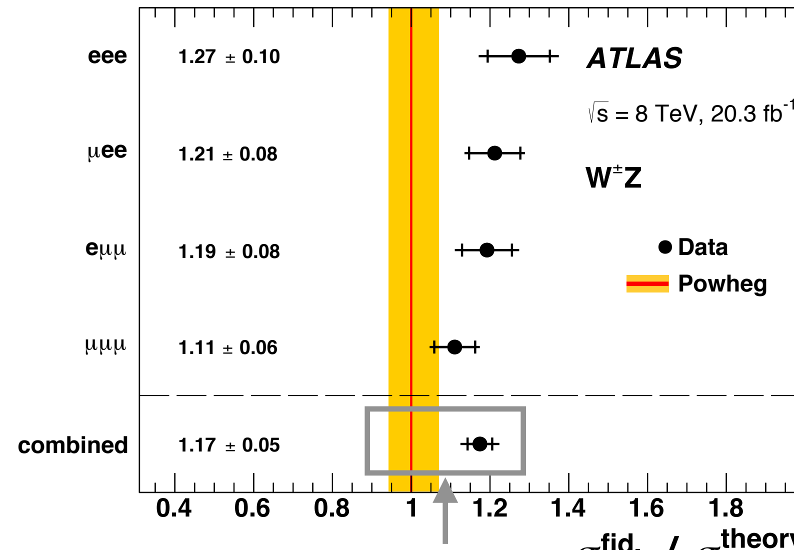




WZ - Yields and Cross Section Results

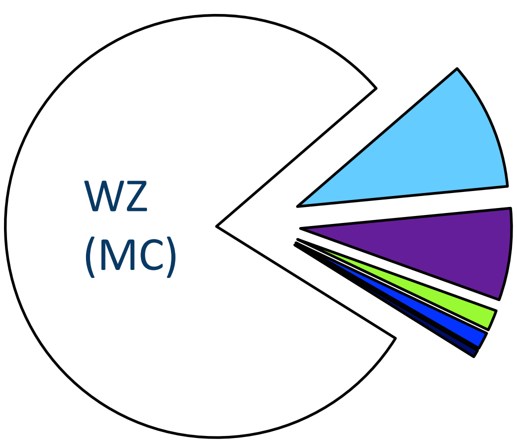
	eee	μee	eμμ	μμμ
Data	406	483	539	663
tot exp.	337 ± 2	411 ± 2	469 ± 2	608 ± 4
WZ signal	256 ± 1	337 ± 1	367 ± 1	496 ± 2
tot bkg.	81 ± 2	74 ± 2	102 ± 2	112 ± 3

Main uncertainties: lepton identification, luminosity, misid. leptons background



tension with MCFM (NLO)

NNLO results will be available soon and may remedy this



misid. Leptons (completely data driven, estimates simultaneously top and W/Z+Jets contributions)

ZZ (shape from MC, normalisation from data)

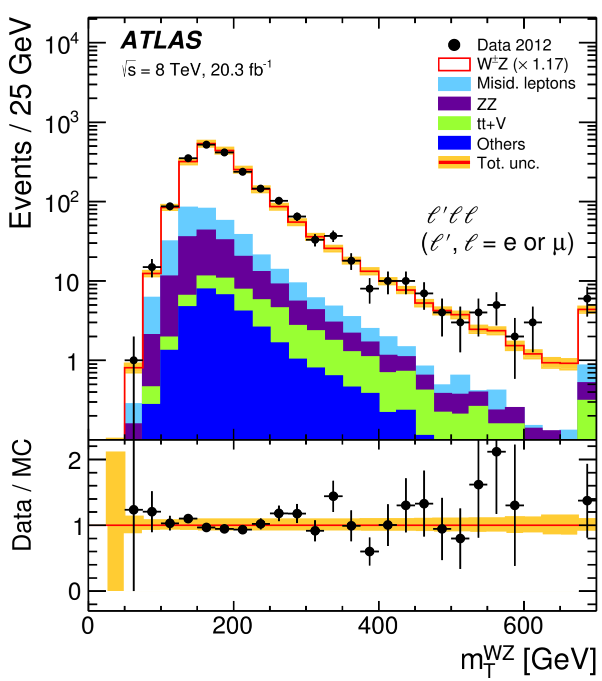
Top+V (taken from MC)

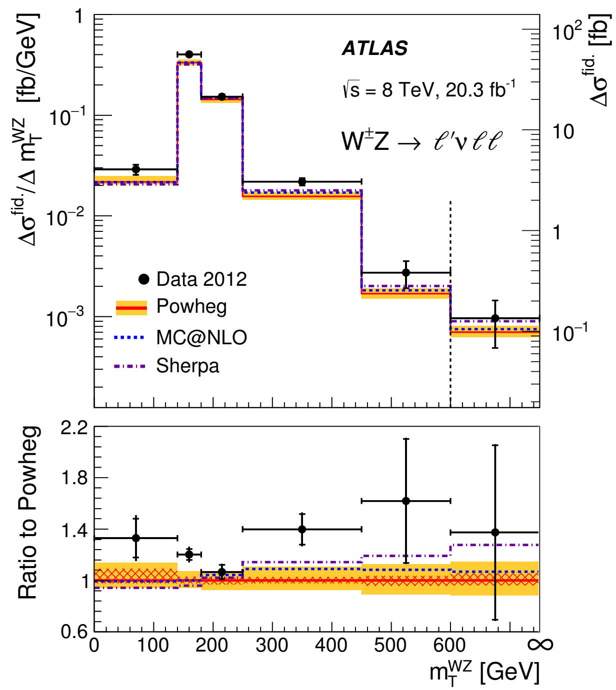
tZ (taken from MC)

others (multiple parton scattering and VVV taken from MC)

WZ - Differential Distributions

- measured across all channels
- unfolding done via Bayesian Iterative unfolding (3 iterations)
- shapes seem to be described relatively well
- factor of 1.17 on PowHeg prediction has been removed on the right





aTGCs

aTGCs - Swift Introduction

- aTGCs offer a general approach to new physics
- new operators affecting triple gauge vertices added
- coupling strengths of operators model new physics effects
- several parameterisations possible
- here only CP conserving operators considered

$$\mathcal{L} = ig_{WWV}\left[g_1^V(W^+_{\mu\nu}W^{-\mu} - W^{+\mu}W^-_{\mu\nu})V^\nu + k^V W^+_\mu W^-_\nu V^{\mu\nu} + \frac{\lambda^V}{m_W^2}W^{+\nu}_\mu W^{-\rho}_\nu V^\mu_\rho\right]$$

Effective Field Theory:

$$\mathcal{O}_{WWW} = \frac{c_{WWW}}{\Lambda^2}\mathrm{Tr}[W_{\mu\nu}W^{\nu\rho}W^\mu_\rho]$$

$$\mathcal{O}_W = \frac{c_W}{\Lambda^2}\left(D_\mu\Phi\right)^\dagger W^{\mu\nu}\left(D_\nu\Phi\right)$$

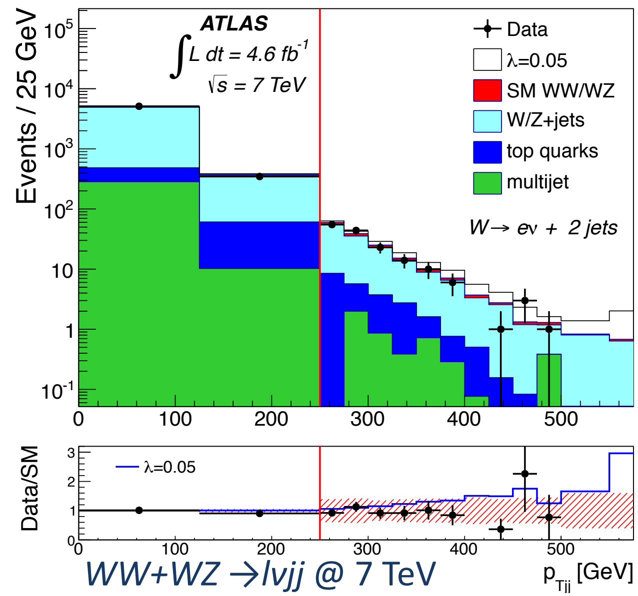
$$\mathcal{O}_B = \frac{c_B}{\Lambda^2}\left(D_\mu\Phi\right) B^{\mu\nu}\left(D_\nu\Phi\right)$$

- conversions between parameterisations exist, e.g. LEP Scenario:

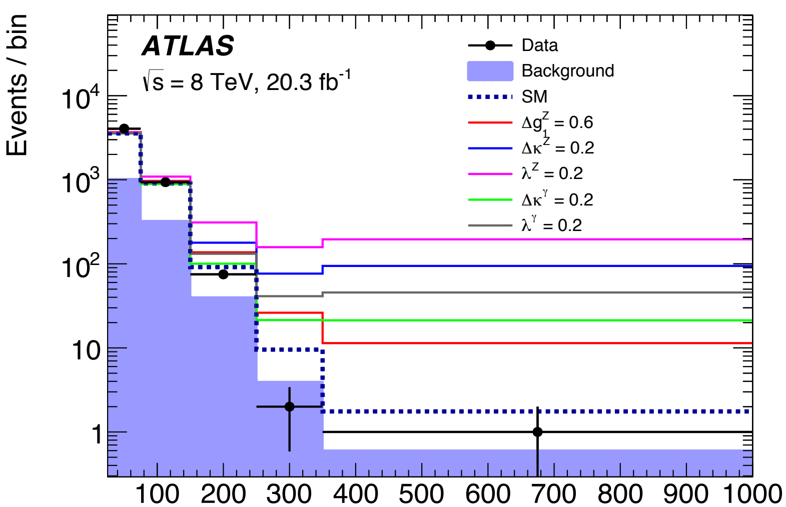
$$\frac{c_W}{\Lambda^2} = \frac{2}{m_Z^2}\Delta g_1^Z \qquad \frac{c_B}{\Lambda^2} = \frac{2}{m_W^2}\Delta\kappa_\gamma - \frac{2}{m_Z^2}\Delta g_1^Z \qquad \frac{c_{WWW}}{\Lambda^2} = \frac{2}{3g^2 m_W^2}\lambda$$

aTGCs - Discriminating Variables

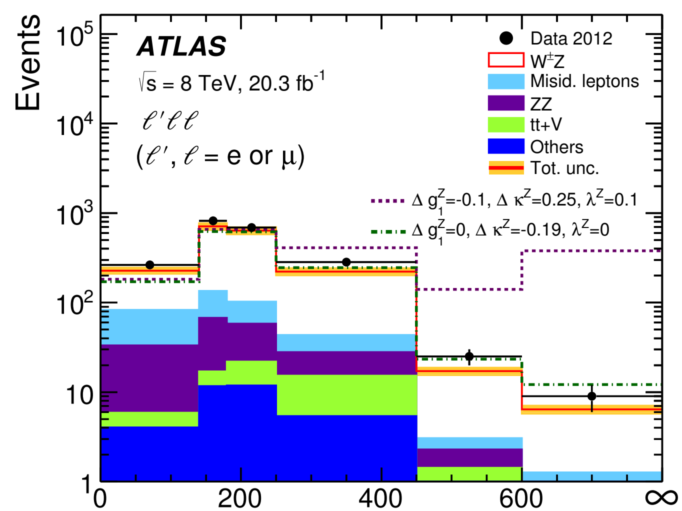
- aTGCs tend to enhance yields in tails
- restricted by fit on sensitive variables
- theory corrections (EW, QCD) applied
- binning optimised towards sensitivity



WW+WZ →lvjj @ 7 TeV



WW → lνlν @ 8TeV



WZ → lllν @ 8 TeV

aTGCs - Results

aTGC Limits	C_{WWW}/Λ^2 [TeV^{-2}]	C_B/Λ^2 [TeV^{-2}]	C_W/Λ^2 [TeV^{-2}]
WZ → lllv @ 8 TeV arxiv:1603.02151v1 submitted to PRD	exp: [-3.9, 3.8] obs: [-3.9, 4.0]	exp: [-270, 180] obs: [-320, 210]	exp: [-3.7, 7.6] obs: [-4.3, 6.8]
WW → lvlv @ 8 TeV arxiv:1603.01702v1 submitted to JHEP	exp: [-7.6, 7.4] obs: [-4.6, 4.6]	exp: [-35.8, 38.4] obs: [-20.9, 26.3]	exp: [-12,6, 14.3] obs: [-5.9, 10.5]
WW+WZ → lvjj @ 7 TeV JHEP01(2015)049	exp: [-11.6, 11.5] obs: [-9.5, 9.6]	exp: [-73, 39] obs: [-64, 69]	exp: [-17,21] obs: [-13, 18]

- comparison of EFT parameters
- WZ less sensitive to C_B

aTGCs - Results

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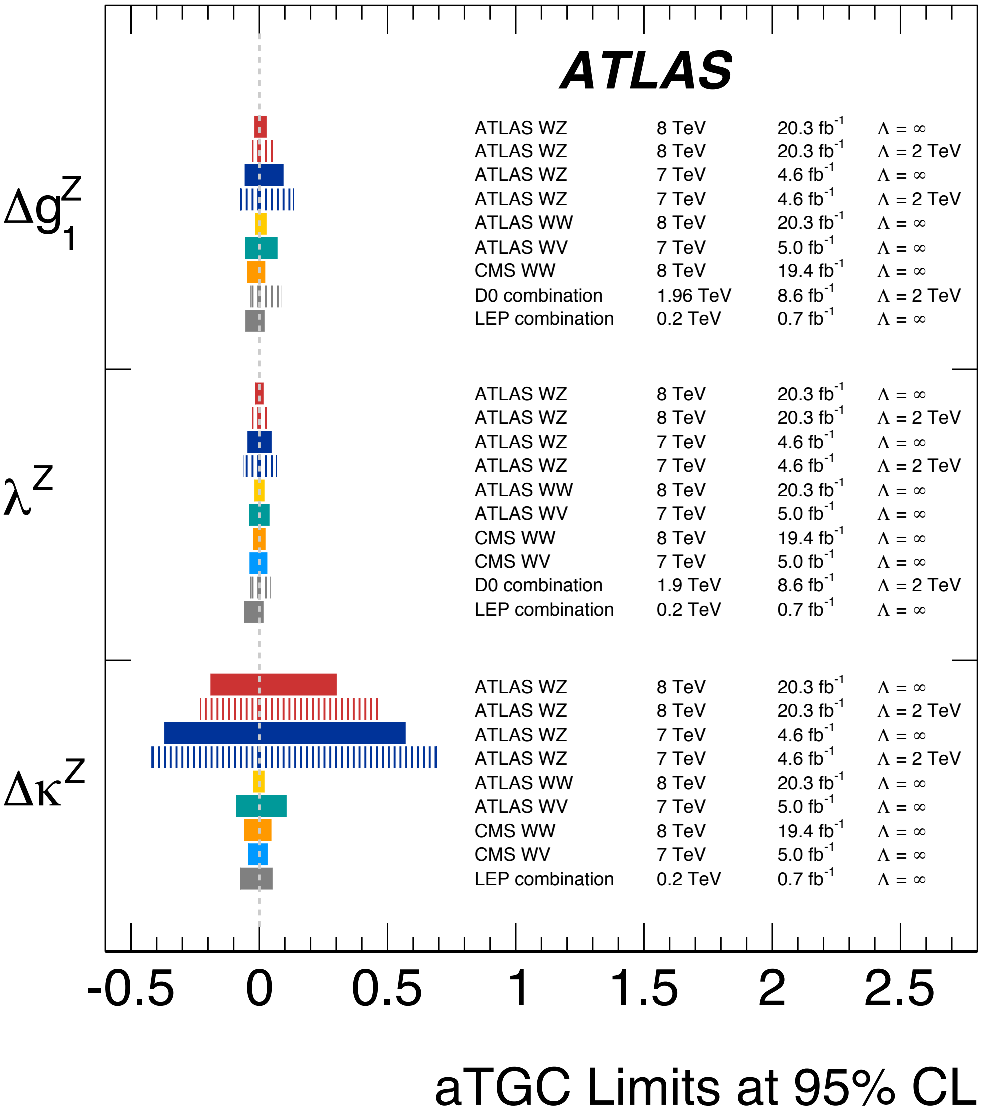

- aTGC limits in the LEP scenario
- LHC limits on par with LEP results
- WZ less sensitive to $\Delta\kappa^Z$

Summary

- diboson measurements provide an important test of the electroweak gauge sector
- new physics can be probed via measuring aTGCs

- available results:
  - inclusive cross sections for WW and WZ @ 8 TeV and WW+WZ @ 7 TeV
  - differential distributions for WW and WZ @ 8 TeV
  - constraints on aTGCs for WW and WZ @ 8 TeV and WW+WZ @ 7 TeV

- predictions agree well with theory at NNLO, agreement likely get better with improved calculations
- new data will provide complementary results -> stay tuned!

Thank you for your attention!

WW → lνlν @ 8 TeV

EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH (CERN)

CERN-PH-EP-2015-323
8th March 2016

Measurement of total and differential W^+W^- production cross sections in proton-proton collisions at $\sqrt{s}$ = 8 TeV with the ATLAS detector and limits on anomalous triple-gauge-boson couplings

The ATLAS Collaboration

Abstract

The production of W boson pairs in proton-proton collisions at $\sqrt{s}$ = 8 TeV is studied using data corresponding to 20.3 fb^{-1} of integrated luminosity collected by the ATLAS detector during 2012 at the CERN Large Hadron Collider. The W bosons are reconstructed using their leptonic decays into electrons or muons and neutrinos. Events with reconstructed jets are not included in the candidate event sample. A total of 6636 WW candidate events are observed. Measurements are performed in fiducial regions closely approximating the detector acceptance. The integrated measurement is corrected for all acceptance effects and for the W branching fractions to leptons in order to obtain the total WW production cross section, which is found to be 71.1±1.1(stat) $^{+5.7}_{-5.0}$(syst) ±1.4(lumi) pb. This agrees with the next-to-next-to-leading-order Standard Model prediction of 63.2$^{+1.6}_{-1.4}$(scale)±1.2(PDF) pb. Fiducial differential cross sections are measured as a function of each of six kinematic variables. The distribution of the transverse momentum of the leading lepton is used to set limits on anomalous triple-gauge-boson couplings.

- inclusive cross section measurement of WW prod.
- differential cross sections for selected variables
- limits on anomalous triple gauge couplings
- 20.3 ifb @ 8 TeV

WW - Yields and Cross Section Results

Final state	$e\mu$	ee	$\mu\mu$
Observed events	5067	594	975
Total expected events (Signal + background)	4420 ± 30 ± 320	507 ± 9 ± 39	820 ± 10 ± 65
WW signal (MC)	3240 ± 10 ± 280	346 ± 3 ± 33	613 ± 5 ± 60
Top quark (data-driven)	609 ± 18 ± 52	92 ± 7 ± 8	127 ± 9 ± 11
W+jets (data-driven)	250 ± 20 ± 140	14 ± 5 ± 14	6 ± 5 ± 12
Drell–Yan (data-driven)	175 ± 3 ± 18	28 ± 0 ± 13	33 ± 0 ± 17
Other dibosons (MC)	150 ± 4 ± 30	27 ± 1 ± 5	38 ± 1 ± 5
Total background	1180 ± 30 ± 150	161 ± 9 ± 21	205 ± 11 ± 24

Final state	Total cross section $pp \to WW$ [pb]
$e\mu$	$70.6 \pm 1.3(\text{stat})\ ^{+5.8}_{-5.1}(\text{syst})\ \pm 1.4(\text{lumi})$
ee	$73.6^{+4.2}_{-4.1}(\text{stat})\ ^{+7.5}_{-6.4}(\text{syst})\ \pm 1.5(\text{lumi})$
$\mu\mu$	$74.0 \pm 3.0(\text{stat})\ ^{+7.1}_{-5.9}(\text{syst})\ \pm 1.5(\text{lumi})$
Combined	$71.1 \pm 1.1(\text{stat})\ ^{+5.7}_{-5.0}(\text{syst})\ \pm 1.4(\text{lumi})$
$\sigma(\text{NNLO}_{\text{tot}})$ theory prediction [3]+[45]	$63.2^{+1.6}_{-1.4}(\text{scale}) \pm 1.2(\text{PDF})$

WW - Systematics

Sources of uncertainty	$e\mu$	ee	$\mu\mu$	Combined
Experimental uncertainties in fiducial and total cross sections [%]				
Integrated luminosity	±2.0	±2.0	±2.0	±2.0
Pile-up	±1.35	±2.00	±2.03	±1.48
Trigger	±0.43	±2.8	±3.0	±0.75
Electron energy scale	±0.42	±1.45	—	±0.43
Electron energy resolution	±0.04	±0.23	—	±0.05
Electron identification and reconstruction	±0.99	±2.19	—	±0.91
Electron isolation	±0.22	±0.47	—	±0.21
Muon momentum scale	±0.10	—	±0.39	±0.14
Muon momentum resolution (ID)	±0.56	—	±1.67	±0.67
Muon momentum resolution (MS)	±0.09	—	±0.21	±0.11
Muon identification and reconstruction	±0.41	—	±0.82	±0.43
Muon isolation	±0.59	—	±1.20	±0.62
Jet vertex fraction (JVF)	±0.22	±0.26	±0.24	±0.23
Jet energy scale	±4.1	±3.9	±4.4	±4.1
Jet energy resolution	±1.35	±1.30	±1.47	±1.35
$E_{\mathrm{T}}^{\mathrm{miss}}$ scale soft terms	±1.12	±2.07	±1.85	±1.28
$E_{\mathrm{T}}^{\mathrm{miss}}$ resolultion soft terms	±0.31	±0.38	±0.53	±0.35
$p_{\mathrm{T}}^{\mathrm{miss}}$ scale soft terms	±0.23	±0.38	±0.35	±0.25
$p_{\mathrm{T}}^{\mathrm{miss}}$ resolution soft terms	±0.13	±0.19	±0.14	±0.13
Background uncertainties in fiducial and total cross sections [%]				
Top-quark background	±1.35	±1.82	±1.42	±1.39
W+jets & multijet background	±3.6	±3.1	±2.0	±2.8
Drell–Yan background	±0.46	±3.00	±2.26	±0.86
MC statistics (top-quark, W+jets, Drell–Yan)	±0.61	±2.03	±1.39	±0.53
Other diboson cross sections	±0.70	±1.01	±0.55	±0.69
MC statistics (other diboson)	±0.10	±0.32	±0.18	±0.09

Systematics above 1% marked in blue

WW - variables as measured by the Detector

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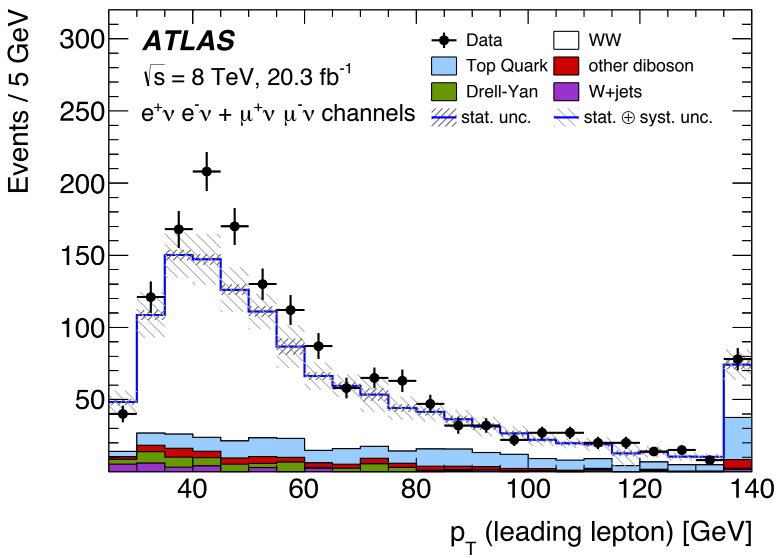
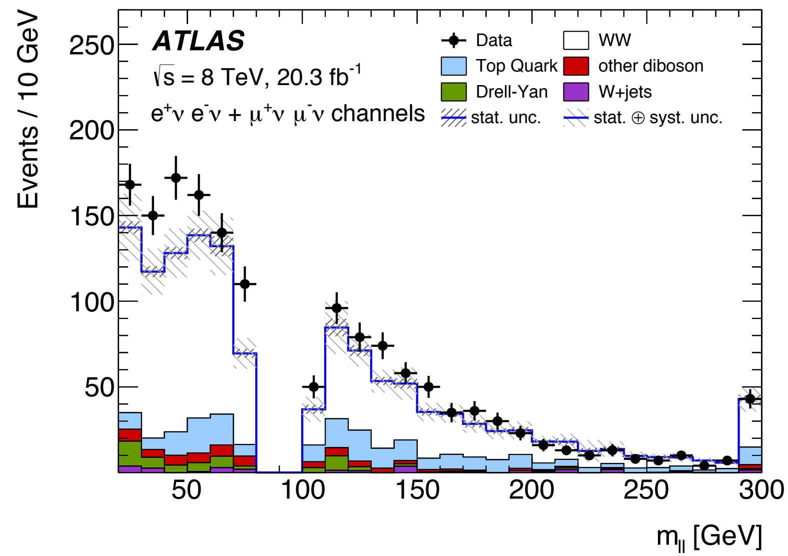
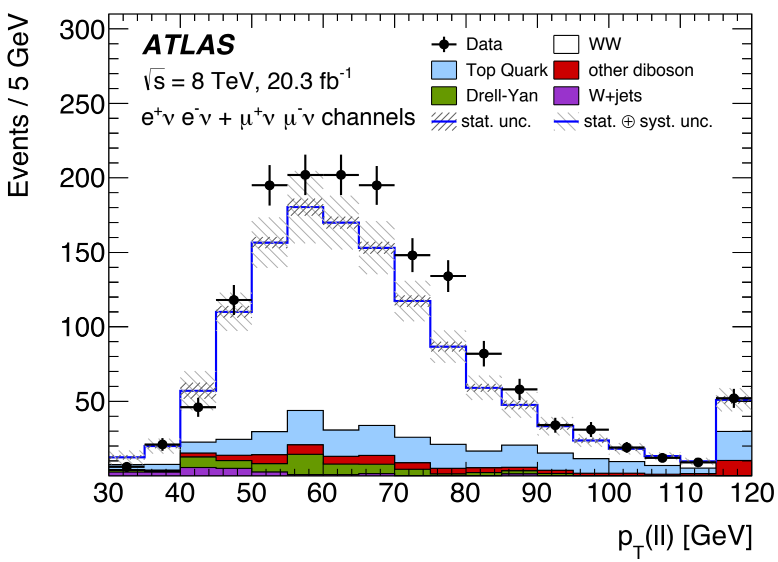
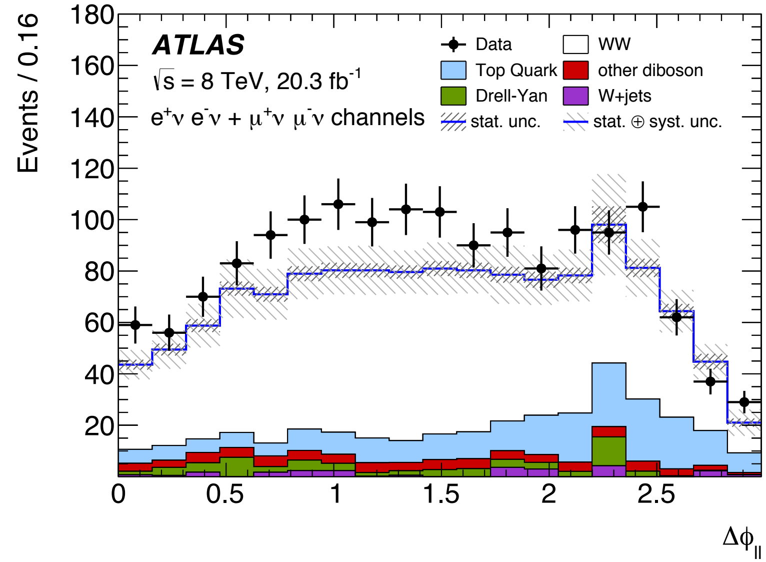
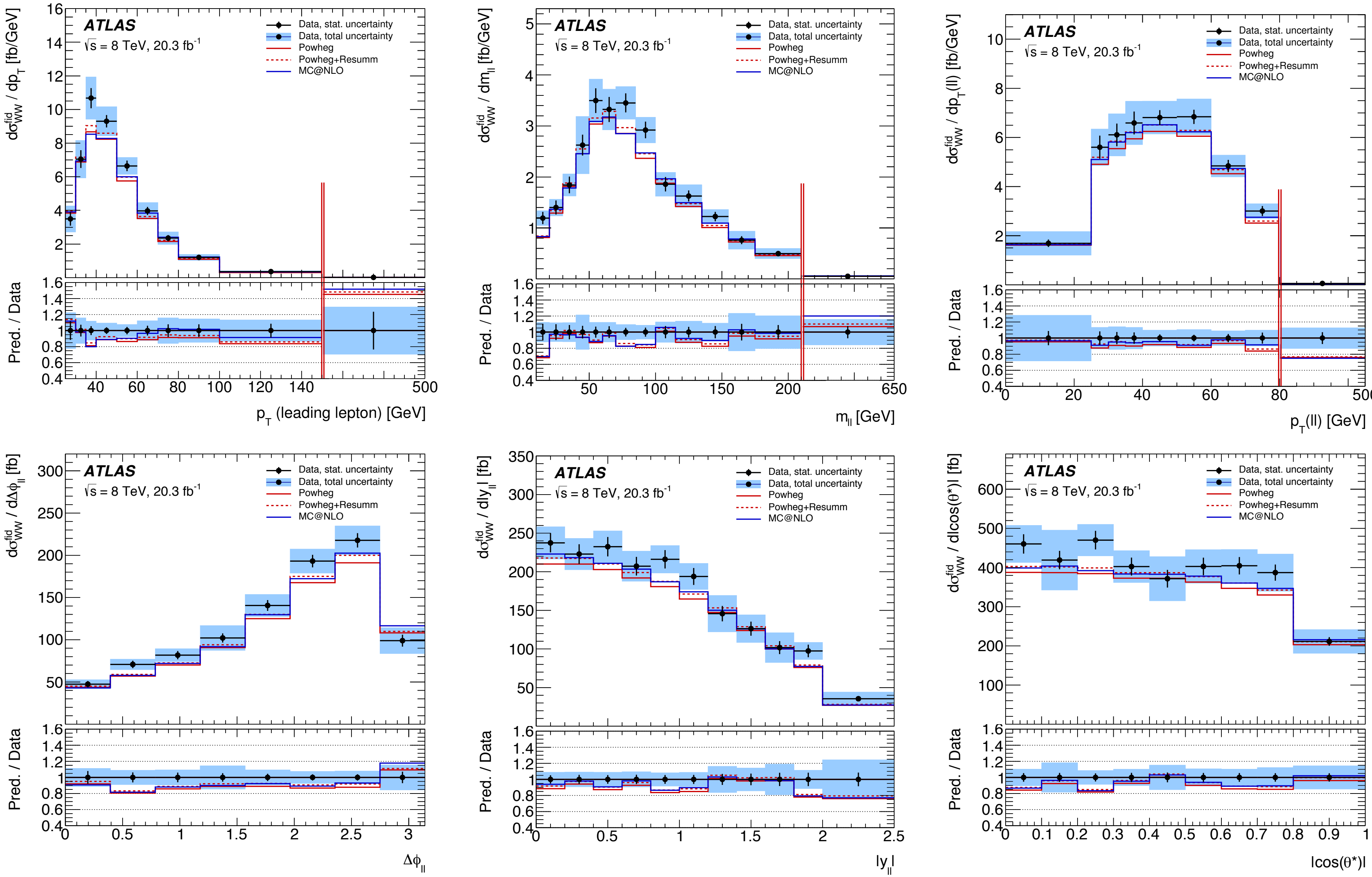




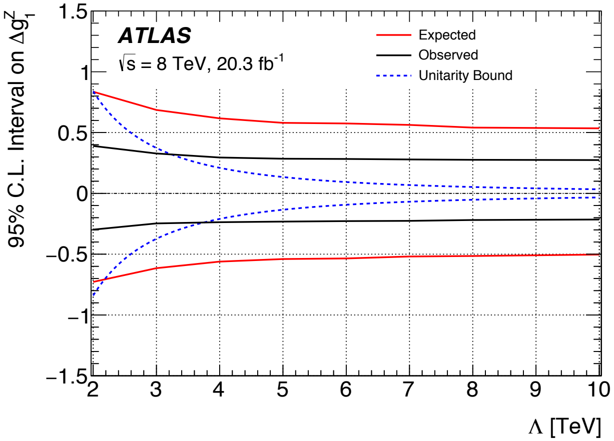


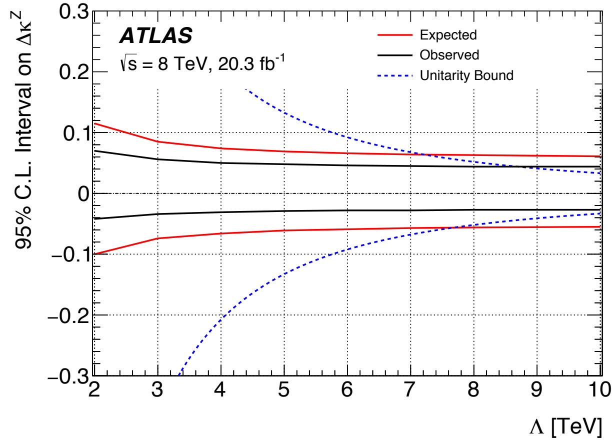


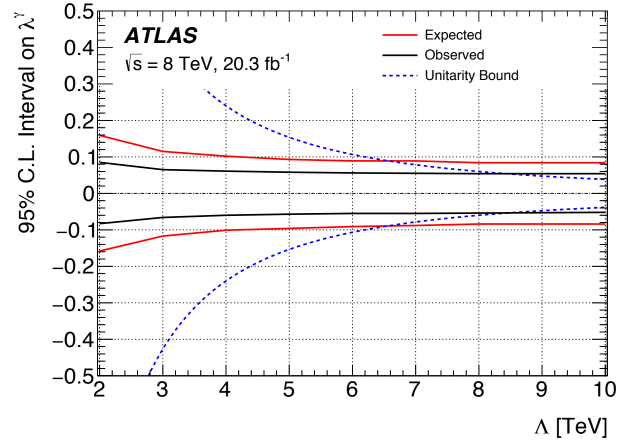
WW - Differential Distributions

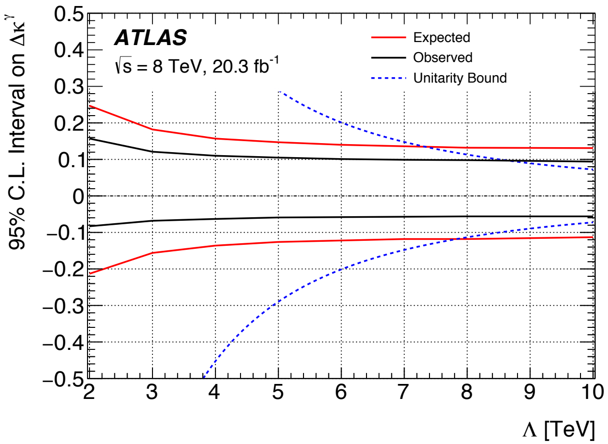


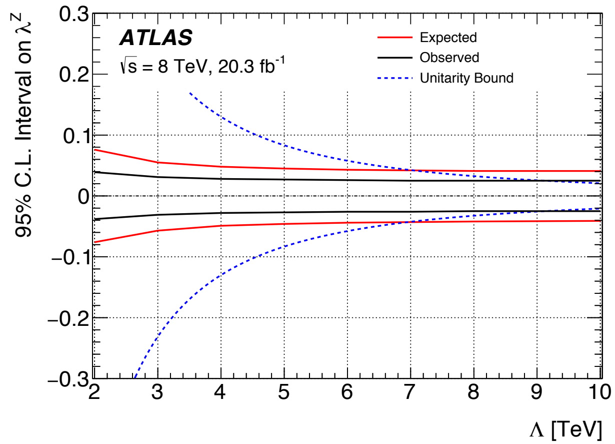
WW - aTGC results - No Constraints Model



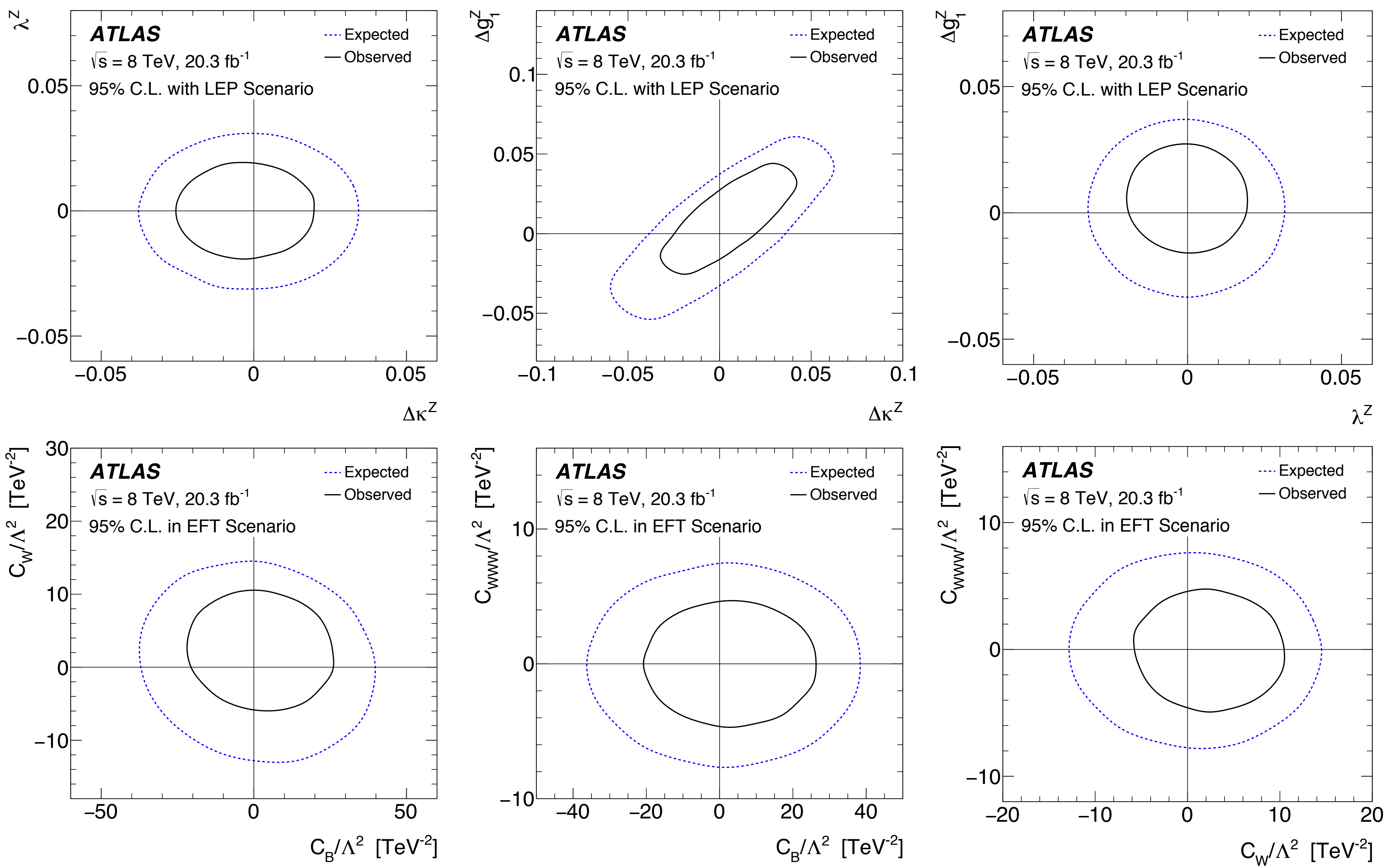








WW - aTGC results



Resources: Current Papers

EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH (CERN)

Submitted to: Phys. Rev. D.

CERN-EP-2016-017
March 8, 2016

Measurements of $W^{\pm}Z$ production cross sections in pp collisions at $\sqrt{s}$ = 8 TeV with the ATLAS detector and limits on anomalous gauge boson self-couplings

The ATLAS Collaboration

Abstract

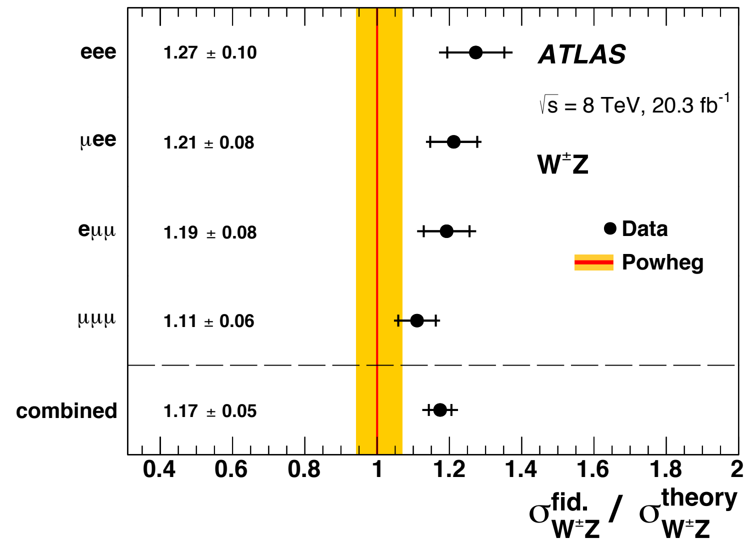
This paper presents measurements of $W^{\pm}Z$ production in pp collisions at a center-of-mass energy of 8 TeV. The gauge bosons are reconstructed using their leptonic decay modes into electrons and muons. The data were collected in 2012 by the ATLAS experiment at the Large Hadron Collider, and correspond to an integrated luminosity of 20.3 fb^{-1}. The measured inclusive cross section in the detector fiducial region is $\sigma_{W^{\pm}Z\to\ell'\nu\,\ell\ell}$ = 35.1 ± 0.9 (stat.) ± 0.8 (sys.) ± 0.8 (lumi.) fb, for one leptonic decay channel. In comparison, the next-to-leading-order Standard Model expectation is 30.0 ± 2.1 fb. Cross sections for $W^{+}Z$ and $W^{-}Z$ production and their ratio are presented as well as differential cross sections for several kinematic observables. Limits on anomalous triple gauge boson couplings are derived from the transverse mass spectrum of the $W^{\pm}Z$ system. From the analysis of events with a W and a Z boson associated with two or more forward jets an upper limit at 95% confidence level on the $W^{\pm}Z$ scattering cross section of 0.63 fb, for each leptonic decay channel, is established, while the Standard Model prediction at next-to-leading order is 0.13 fb. Limits on anomalous quartic gauge boson couplings are also extracted.

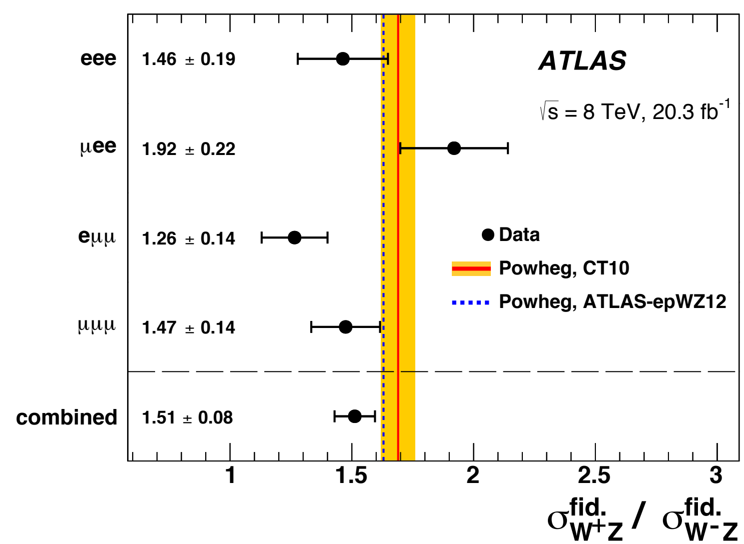
- inclusive cross section measurement of WZ prod.
- differential cross sections for selected variables
- limits on anomalous triple and quartic gauge couplings
- upper limits on electroweak WZjj production
- 20.3 ifb @ 8 TeV

WZ - Yields and Cross Section Results

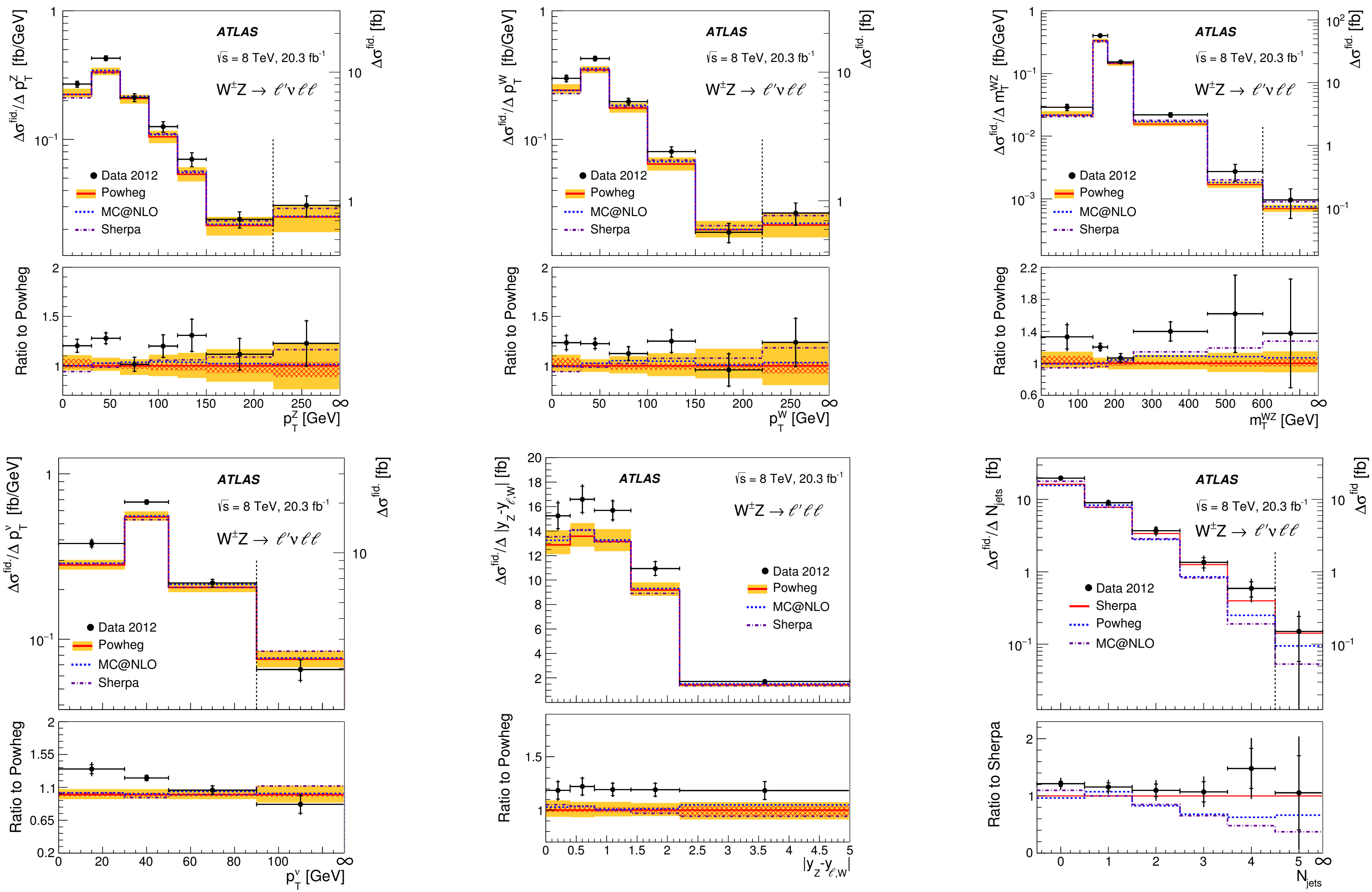
Channel	eee	μee	$e\mu\mu$	$\mu\mu\mu$	All
Data	406	483	539	663	2091
Total expected	336.7 ± 2.2	410.8 ± 2.4	469.1 ± 2.1	608.2 ± 3.5	1824.8 ± 7.0
WZ	255.7 ± 1.1	337.2 ± 1.0	367.0 ± 1.1	495.9 ± 2.3	1455.7 ± 5.5
Misid. leptons	43.7 ± 1.9	32.2 ± 2.1	50.2 ± 1.7	52.8 ± 2.6	178.9 ± 4.2
ZZ	25.9 ± 0.2	26.7 ± 0.3	36.1 ± 0.3	39.5 ± 0.3	128.2 ± 0.6
$t\bar{t} + V$	5.5 ± 0.2	6.7 ± 0.2	7.2 ± 0.3	9.1 ± 0.3	28.5 ± 0.5
tZ	4.2 ± 0.1	5.5 ± 0.2	6.0 ± 0.2	7.7 ± 0.2	23.3 ± 0.3
DPS	1.2 ± 0.1	1.9 ± 0.1	1.8 ± 0.1	2.3 ± 0.2	7.2 ± 0.3
VVV	0.5 ± 0.0	0.7 ± 0.0	0.8 ± 0.0	0.9 ± 0.0	3.0 ± 0.1

	eee	μee	$e\mu\mu$	$\mu\mu\mu$	combined
Source	Relative uncertainties [%]				
e energy scale	0.8	0.4	0.4	0.0	0.3
e id. efficiency	2.9	1.8	1.0	0.0	1.0
μ momentum scale	0.0	0.1	0.1	0.1	0.1
μ id. efficiency	0.0	0.7	1.3	2.0	1.4
$E_{\mathrm{T}}^{\mathrm{miss}}$ and jets	0.3	0.2	0.2	0.1	0.3
Trigger	0.1	0.1	0.2	0.3	0.2
Pileup	0.3	0.2	0.2	0.1	0.2
Misid. leptons background	2.9	0.9	3.1	0.9	1.3
ZZ background	0.6	0.5	0.6	0.5	0.5
Other backgrounds	0.7	0.7	0.7	0.7	0.7
Uncorrelated	0.7	0.6	0.5	0.5	0.3
Total systematics	4.5	2.6	3.7	2.5	2.4
Luminosity	2.2	2.2	2.2	2.2	2.2
Statistics	6.2	5.4	5.3	4.7	2.7
Total	8.0	6.3	6.8	5.7	4.2



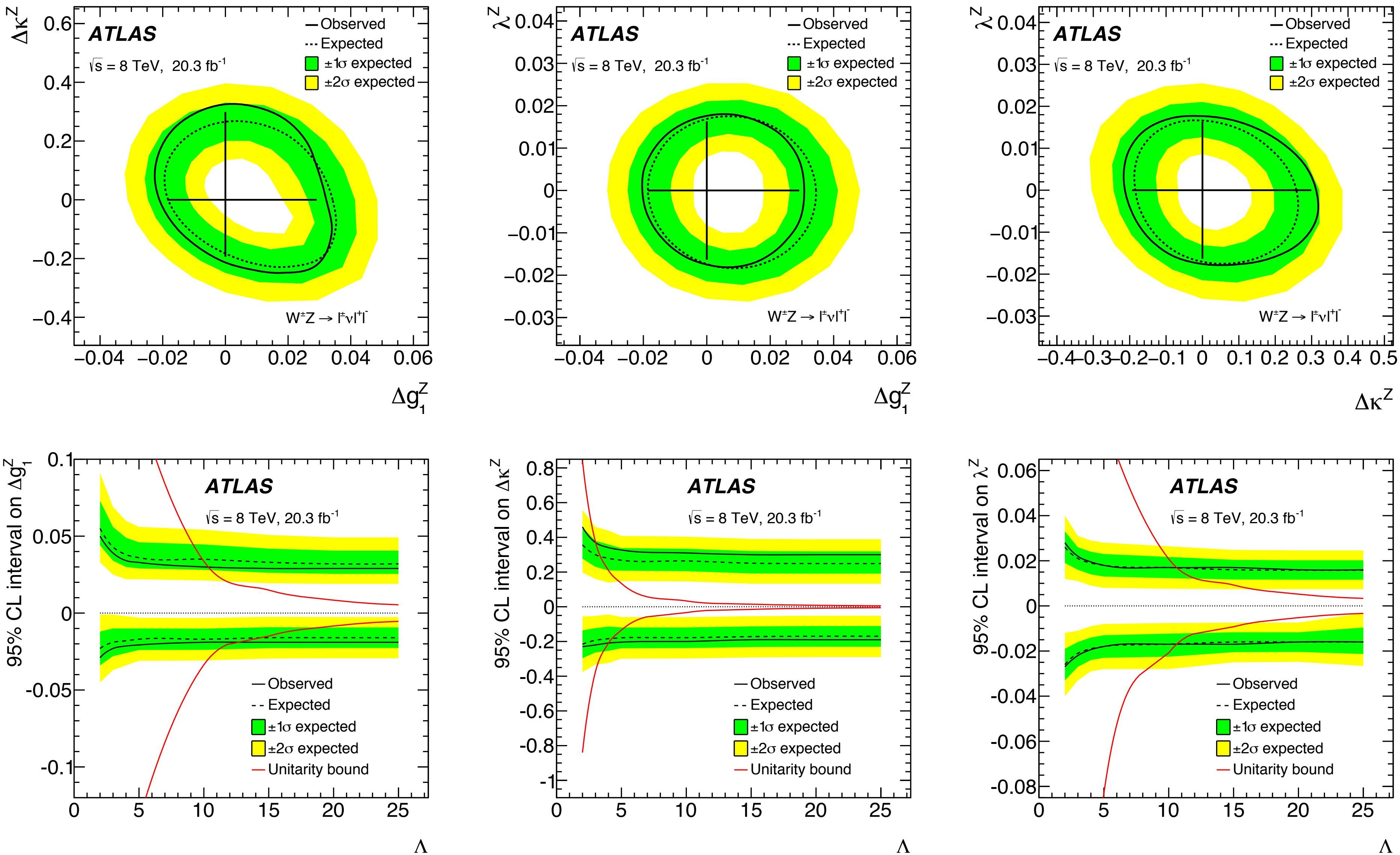


WZ - Differential Distributions



WZ - aTGC Limits

TECHNISCHE UNIVERSITÄT DRESDEN



Resources: Current Papers

TECHNISCHE UNIVERSITÄT DRESDEN

EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH (CERN)

CERN-PH-EP-2014-244

Submitted to: JHEP

Measurement of the $WW + WZ$ cross section and limits on anomalous triple gauge couplings using final states with one lepton, missing transverse momentum, and two jets with the ATLAS detector at $\sqrt{s} = 7$ TeV

The ATLAS Collaboration

Abstract

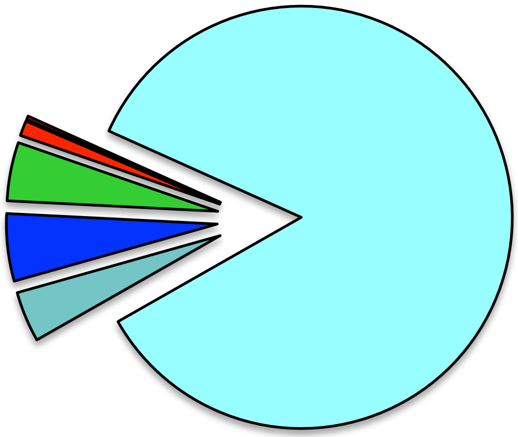
The production of a W boson decaying to $e\nu$ or $\mu\nu$ in association with a W or Z boson decaying to two jets is studied using $4.6\ \mathrm{fb}^{-1}$ of proton–proton collision data at $\sqrt{s} = 7$ TeV recorded with the ATLAS detector at the LHC. The combined $WW+WZ$ cross section is measured with a significance of 3.4σ and is found to be $68 \pm 7\,(\mathrm{stat.}) \pm 19\,(\mathrm{syst.})\ \mathrm{pb}$, in agreement with the Standard Model expectation of $61.1 \pm 2.2\ \mathrm{pb}$. The distribution of the transverse momentum of the dijet system is used to set limits on anomalous contributions to the triple gauge coupling vertices and on parameters of an effective-field-theory model.

- inclusive cross section measurement of WW+WZ prod.
- limits on anomalous triple gauge couplings
- 4.6 ifb @ 7 TeV

WW/WZ

Variable	Requirement
N_{Leptons} with $p_{\mathrm{T}} > 25$ GeV and $\|\eta\| < 2.5$	$= 1$
$E_{\mathrm{T}}^{\mathrm{miss}}$ [GeV]	> 30
$M_{\mathrm{T}}^{\mathrm{W}}$	40
$\|\Delta\phi(E_{\mathrm{T}}^{\mathrm{miss}}), j_1)\|$	> 0.8
N_{Jets} with $p_{\mathrm{T}} > 25$ GeV and $\|\eta\| < 2.8$	≤ 2
N_{Jets} with $p_{\mathrm{T}} > 25$ GeV and $\|\eta\| < 2.0$ and $p_{\mathrm{T}}^{\mathrm{leadjet}} > 30$ GeV	$= 2$
$\|\Delta\eta(j_1, j2)\|$	< 1.5
$\|\Delta R(j_1, j2)\|$ if $p_{\mathrm{T}}^{\mathrm{jj}} < 250$ GeV	> 0.7
m_{jj} [GeV]	$[25, 250]$

- highlights show mainly affected background
- main uncertainties:
  - W/Z Jets background
  - jet measurement
  - MC statistics



WW and WZ (shape taken from MC, cross section measured)

W+Jets and Z+Jets (shape from MC, normalisation fitted in cross section determination)

multi jet (completely data driven)

top (taken from MC, normalisation fitted in cross section determination)

WV Cross Section Results

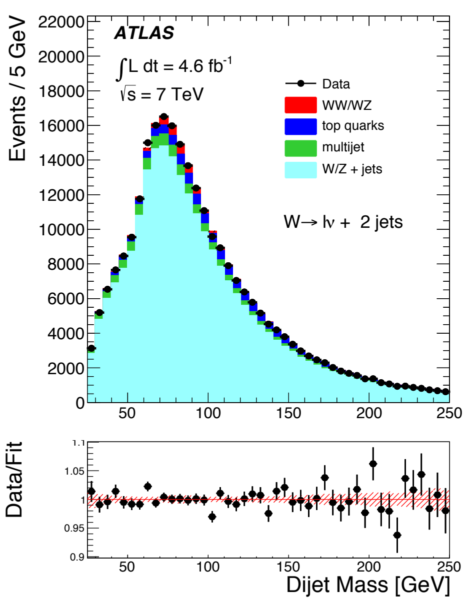
	e	μ
Data	127650	134846
tot exp.	128000 ± 17000	135000 ± 19000
WW signal	1435 ± 70	1603 ± 79
WZ signal	334 ± 23	370 ± 26
tot bkg.	126000 ± 17000	132000 ± 19000

Measured:

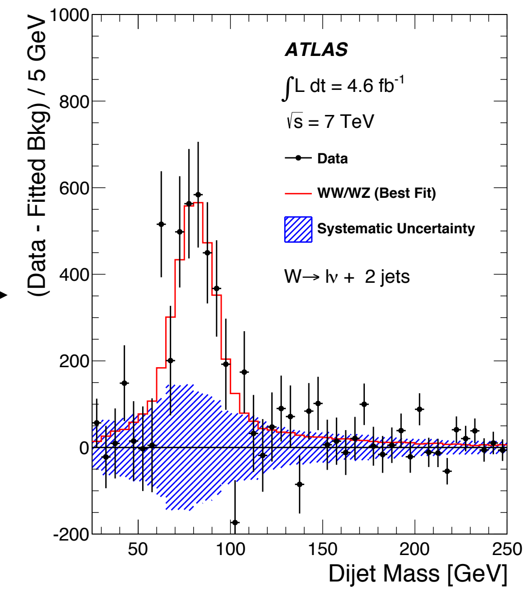
$$\sigma_{\mathrm{fid}} = 1.37 \pm 0.14(\mathrm{stat.}) \pm 0.37(\mathrm{syst.})\ \mathrm{pb}$$
$$\sigma_{\mathrm{tot}} = 68 \pm 7(\mathrm{stat.}) \pm 19(\mathrm{syst.})\ \mathrm{pb}$$

Prediction:

$$\sigma_{\mathrm{tot}} = 61.1 \pm 2.2\ \mathrm{pb}$$



Measurement done by fit on m_{jj} distribution



WW/WZ Yields

Signal processes	e	μ
WW	1435 ± 70	1603 ± 79
WZ	334 ± 23	370 ± 26
Background processes		
$W+$ jets	$(107 \pm 21) \times 10^3$	$(116 \pm 23) \times 10^3$
$Z+$ jets	$(55 \pm 11) \times 10^2$	$(46.3 \pm 9.3) \times 10^2$
$t\bar{t}$	$(47.2 \pm 7.1) \times 10^2$	$(47.2 \pm 7.1) \times 10^2$
Single-top	$(20.2 \pm 3.0) \times 10^2$	$(20.5 \pm 3.1) \times 10^2$
Multijet	$(67 \pm 10) \times 10^2$	$(50.5 \pm 7.6) \times 10^2$
ZZ	19.2 ± 3.8	21.1 ± 4.2
Total SM prediction	$(128 \pm 17) \times 10^3$	$(135 \pm 19) \times 10^3$
Total Data	127 650	134 846