Triple Gauge Bosons at ATLAS

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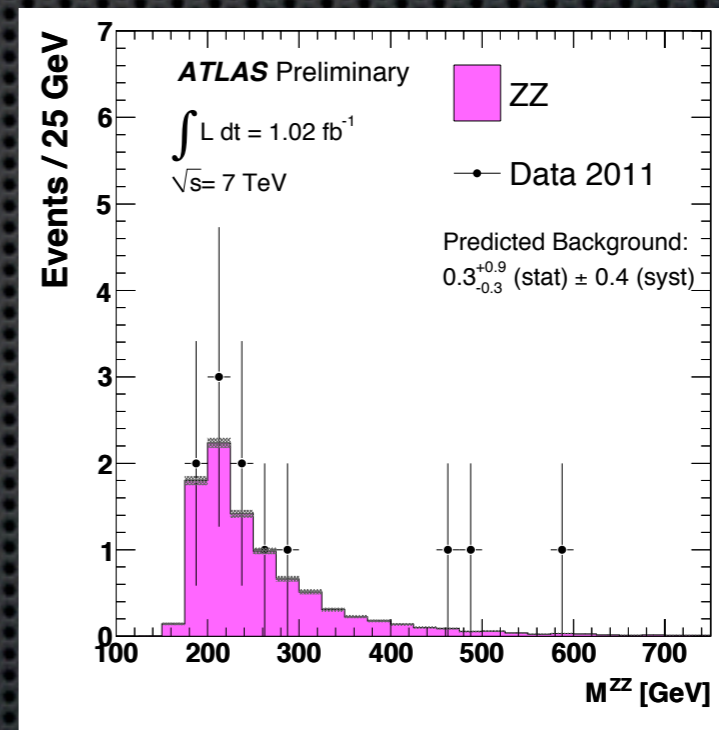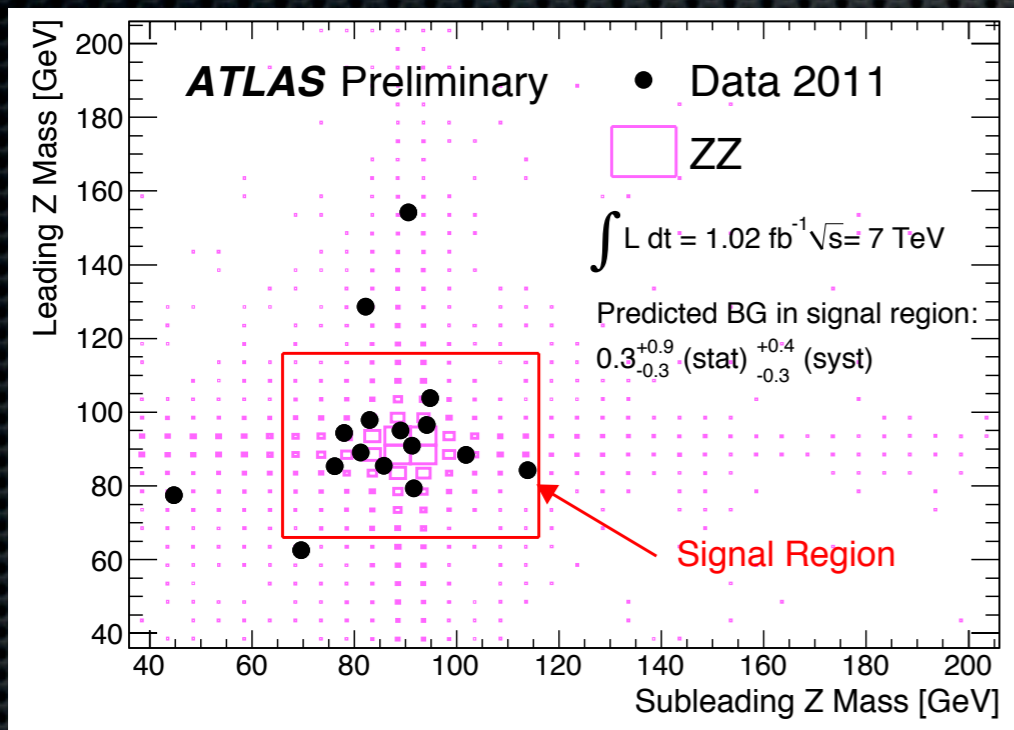
LPCC, CERN 2011

October 13, 2011

- **Luminosity: 1 fb^{-1}**
- **Cut based analysis**
  - **Main backgrounds: Z+jets** (3%)

ATLAS Preliminary   ● Data 2011   ☐ ZZ

$\int$ L dt = 1.02 fb^{-1} $\sqrt{s}$= 7 Te

Predicted BG in signal region:
$0.3^{+0.9}_{-0.3}$ (stat) $^{+0.4}_{-0.3}$ (syst)

Signal Region

Leading Z Mass [GeV] / Subleading Z Mass

ATLAS Preliminary   ☐ ZZ

$\int$ L dt = 1.02 fb^{-1}
$\sqrt{s}$= 7 TeV   — Data 2011

Predicted Background:
$0.3^{+0.9}_{-0.3}$ (stat) ± 0.4 (syst)

Events / 25 GeV / M^{ZZ} [GeV]

ATLAS Prelimina

$\int$ L dt = 1.02 fb^{-1}
$\sqrt{s}$= 7 TeV

Events / 20 GeV

	$N_{observed}$	N_{bkg}	σ_{total} (pb)	$\sigma_{theory(NLO)}$ (pb)
ZZ	12	$0.3^{+1.0}_{-0.4}$	$8.4\ ^{+2.7}_{-2.3}\ ^{+0.4}_{-0.7}\ \pm 0.3$	$6.5\ ^{+0.3}_{-0.2}$
$\sigma_{fiducial}$ (pb)		19^{+6}_{-5} (stat) $^{+1}_{-2}$ (syst) ± 1 (lum) fb		
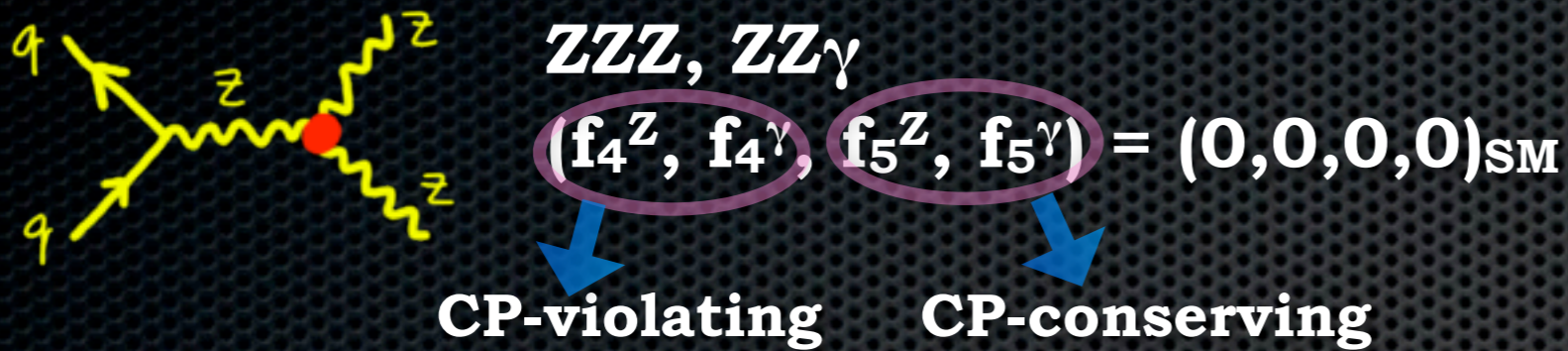
ZZZ, ZZγ

$(f_4^Z, f_4^\gamma, f_5^Z, f_5^\gamma) = (0,0,0,0)_{SM}$

CP-violating   CP-conserving

- **Limit obtained using total number of observed events**
  - **Small statistics for differential measurement**
  - **95% CL with a maximum profile likelihood fit**
- **Dependency on couplings simulated with SHERPA**
  - **Re-weighted using LO ME (Baur)**
  - **Account for effects on acceptance and efficiency**
- **Limits for each coupling assumes other couplings at SM value**
- **Form factors:**

$$f_i^V = f_{i0}^V/(1 + \hat{s}/\Lambda^2)^n$$

n=3

  - Λ = 2 TeV ==> ensures unitarity
  - $\Lambda = \infty$

- **Comparison with other measurements**
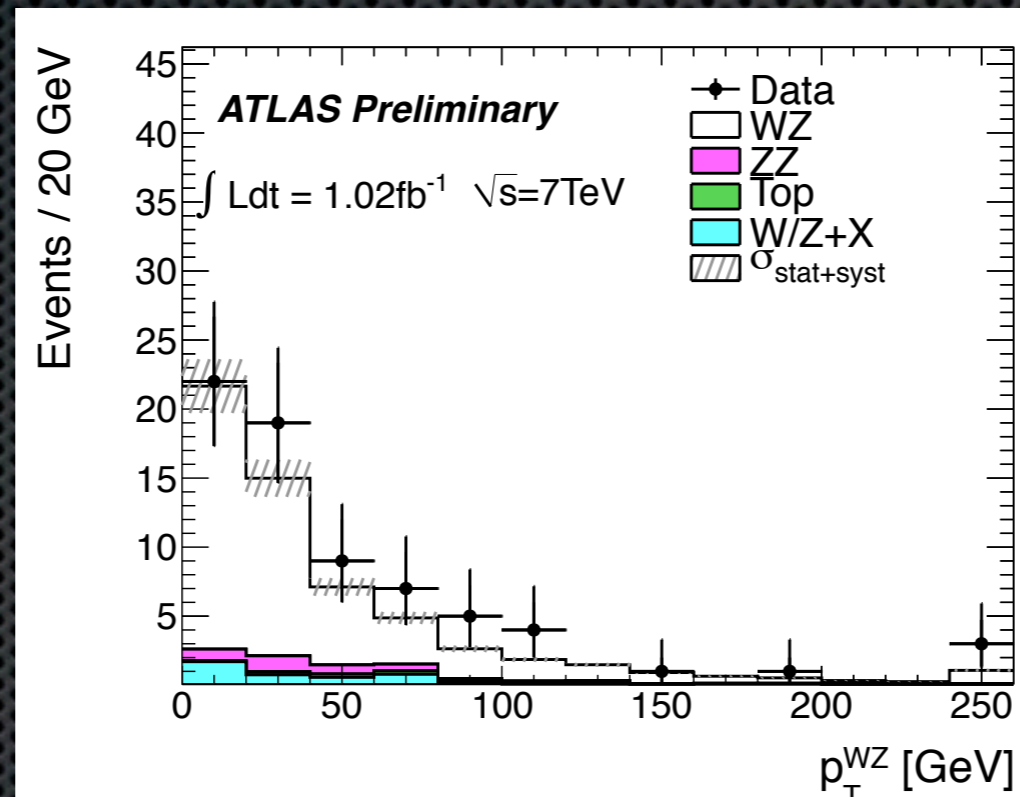 - **LEP: No form factor**
  - **Tevatron: $\Lambda = 1.2$ TeV**
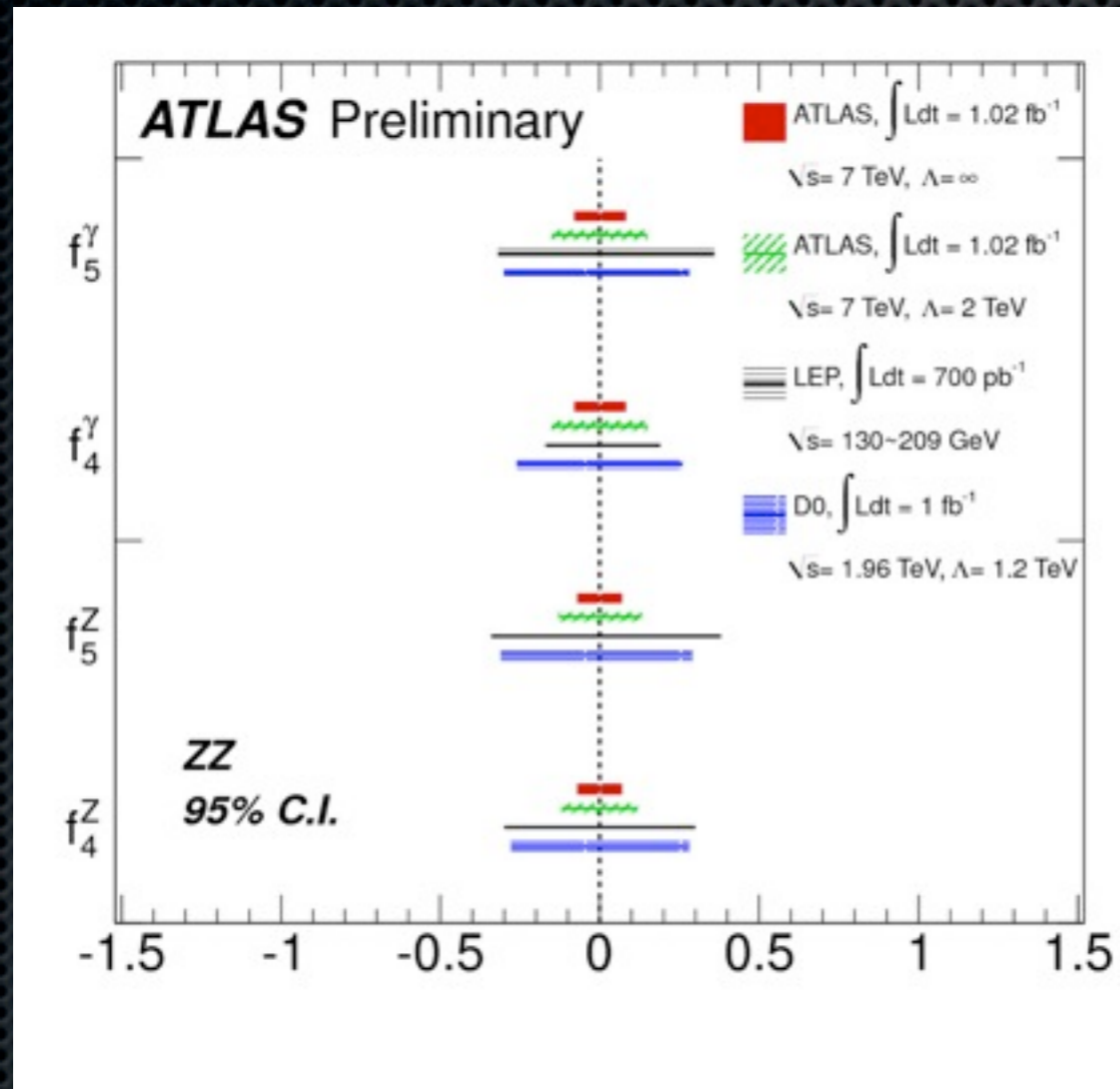
Limits strongly limited by statistical uncertainties

Coupling 95% CI	f_4^γ	f_4^Z	f_5^γ	f_5^Z
$\Lambda = 2$ TeV	$[-0.15, 0.15]$	$[-0.12, 0.12]$	$[-0.15, 0.15]$	$[-0.13, 0.13]$
$\Lambda = \infty$	$[-0.08, 0.08]$	$[-0.07, 0.07]$	$[-0.08, 0.08]$	$[-0.07, 0.07]$

- **Luminosity: 1 fb**
- **Cut based analys**
  - Select one Z eve
    - One lepton + missing E_T
  - Main backgrounds: Z+jets, ZZ, Top and W/Z+γ **(15%)**

ATLAS Preliminary
∫ Ldt = 1.02fb⁻¹ √s=7TeV

- Data
- WZ
- ZZ
- Top
- W/Z+X
- $\sigma_{stat+syst}$

p_T^{WZ} [GeV]

ATLAS Preliminary
∫ Ldt = 1.02fb⁻¹ √s=7TeV

- Data
- WZ
- ZZ
- Top
- W/Z+X
- $\sigma_{stat+syst}$

$p_T^{leading\ lepton}$ [G

	$N_{observed}$	N_{bkg}	$\sigma_{measured}$ (pb)		σ_{NLO} (pb)
WZ	71	$10.5^{+3.0}_{-2.2}$	$21.1^{+3.1}_{-2.8}\pm1.2^{+0.9}_{-0.8}$		$17.2^{+1.2}_{-0.8}$
		$\sigma_{fiducial}$ (pb)	118^{+18}_{-16} (stat) $^{+6}_{-6}$ (syst) ±5 (lum) fb		

WWZ

$(g_1^Z, k^Z, \lambda) = (1,1,0)_{SM}$

- **Limit obtained using total number of observed events**
  - **Small statistics for differential measurement**
  - **95% CI with a profile likelihood test**
- **Dependency on couplings modeled with MC@NLO v4.0**
  - **Possible to generate WZ events at any non-SM phase point**
  - **Account for effects on acceptance and efficiency**
- **Limits for each coupling assumes other couplings at SM value**
- **Form factors:**

$$\alpha(\hat{s}) = \frac{\alpha_0}{(1 + \hat{s}/\Lambda^2)^2}$$

  - $\Lambda = 3$ **TeV ==> ensures unitarity**

✿ Comparison with other measurements

✱ Tevatron: Λ = 2 TeV
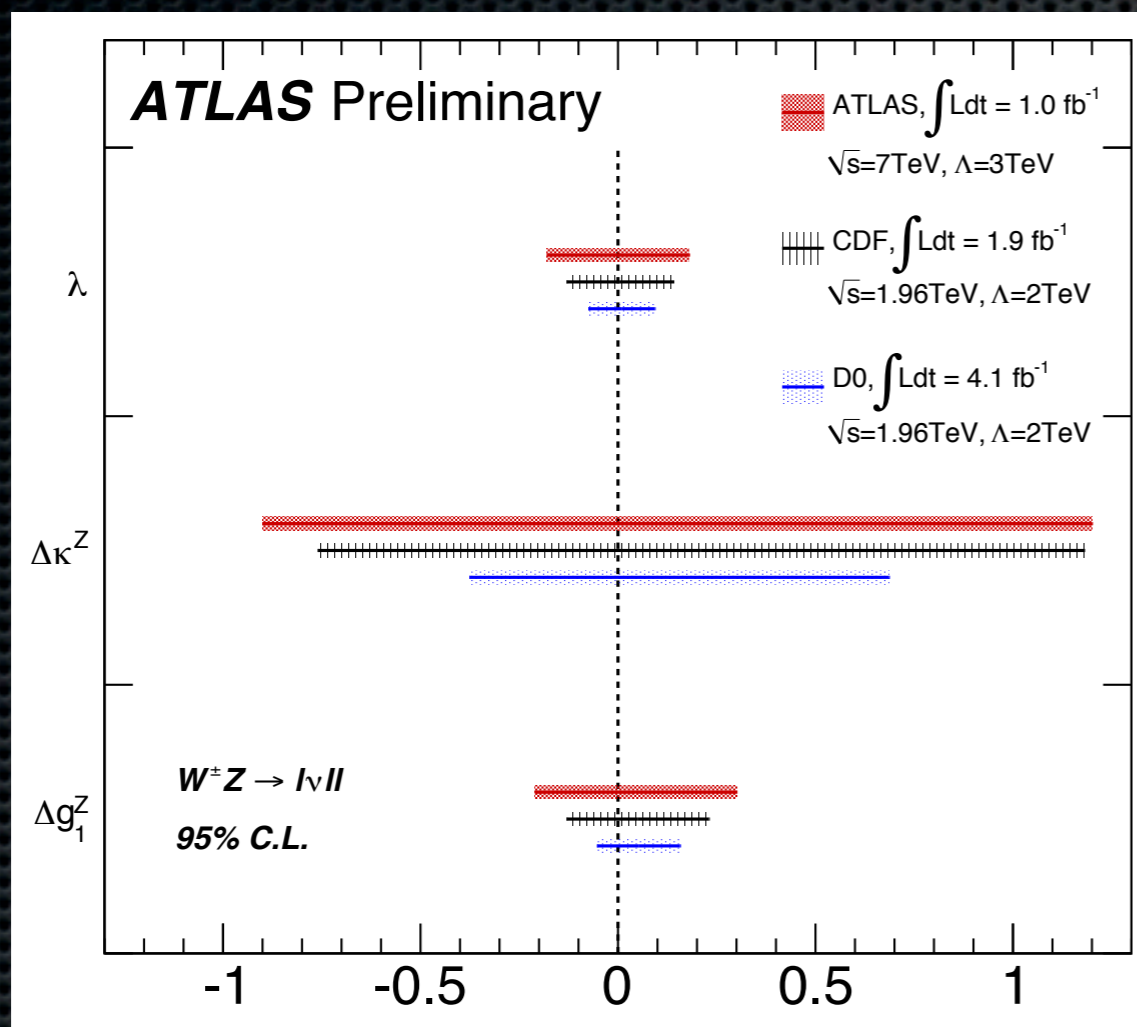
Results limited by statistical uncertainties

Anomalous Coupling	Limits of the 68% C.I.	Limits of the 95% C.I.
Δg_1^Z	$[-0.17, -0.05]$, $[0.13, 0.26]$	$[-0.21, 0.30]$
$\Delta \kappa^Z$	$[-0.8, -0.2]$, $[0.5, 1.0]$	$[-0.9, 1.2]$
λ	$[-0.15, -0.06]$, $[0.06, 0.15]$	$[-0.18, 0.18]$

Summary of Points

- **Measurements obtained with total of numbers of events observed**
  - **Significant improvements expected from larger integrated luminosity and differential kinematic quantities**
- **Form factors:**
  - **Use of no form factors ($\Lambda = \infty$):**
    - **Sensitivity depends on form factor**
    - **Allow for comparison/combination of results**
  - **So far, decided to use $\Lambda = \infty$ but also providing unitarity-preserving results**
- **Publish fiducial cross sections related to the TGC limit estimation**
  - **Quantify detector effects on TGC limits**
- **Limits on ONE coupling assume SM couplings in the other couplings**
  - **Should we do correlated limits? Which ones? (1D vs 2D)**
- **What constraint models should we use**
  - **HISZ, LEP?**
- **NLO-QCD+EW generators with TGCs**
  - **TGCs from EW-NLO is $\sim 10^{-3}$**