Diboson Physics at CMS

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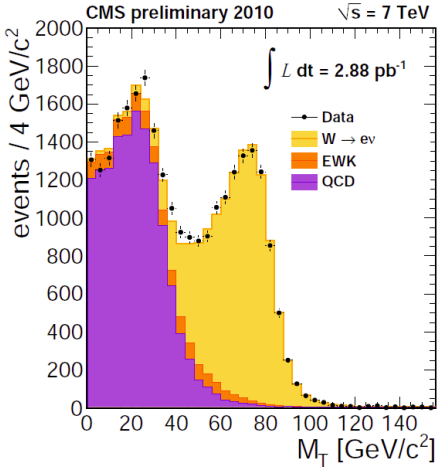
On a behalf of CMS collaboration

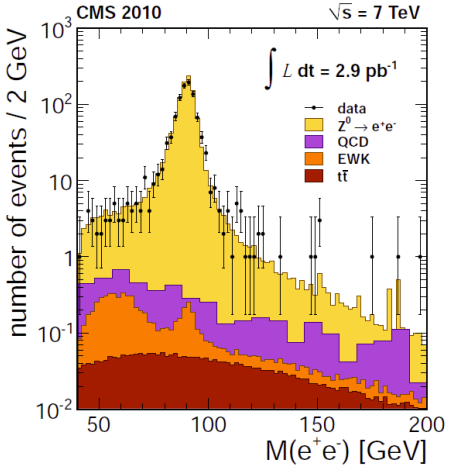
Diboson physics

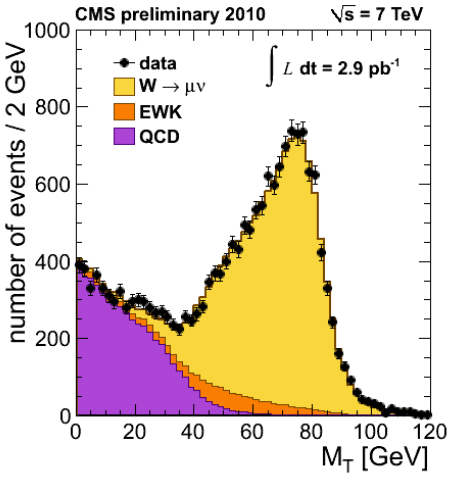
- The measurement of vector boson pair production provides very important tests of electroweak interactions at high energy
  - Many new physics models predict final states with multiple bosons
  - Important background to Higgs searches
- A number of important measurements and searches
  - Cross sections
    - $W\gamma$, $Z\gamma$, WW, WZ, ZZ
  - Search for resonant production
  - Anomalous Trilinear Gauge couplings - passage to physics beyond the standard model physics

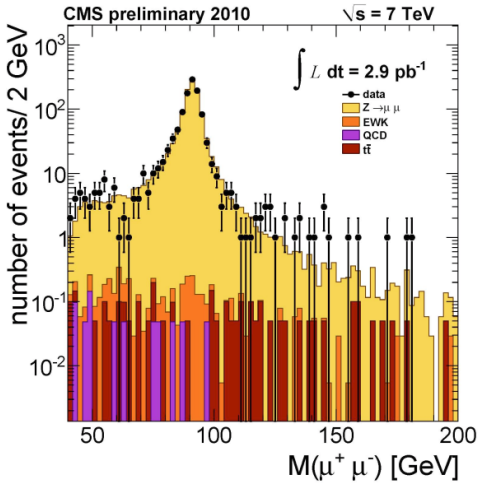
Leptons at CMS

- Bosons with leptonic final states including charged leptons
  - Small branching fraction but very clean signature
- Finely segmented calorimeters, tracker and Muon solenoid
  - Resolution and momentum energy scale is well understood for Electrons, Muons
- Identified “standard candles”: Z and W bosons
  - Excellent agreement with standard model expectation



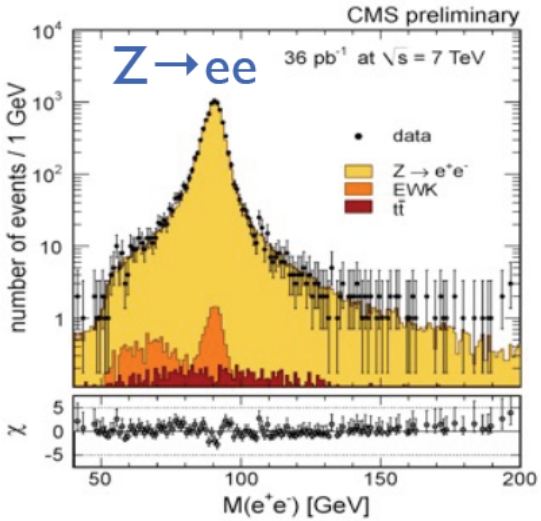


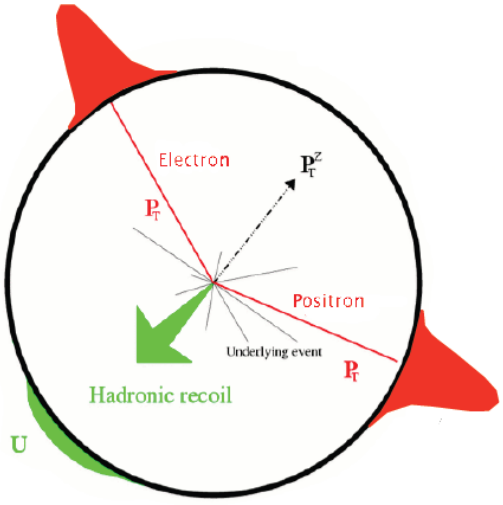


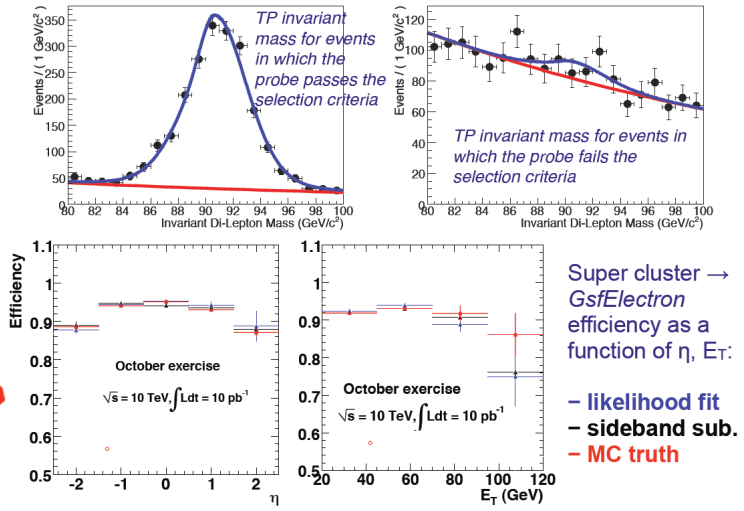


Lepton efficiencies: Tag and Probe

- Using Standard candle processes Z->ll
  - Very clean experimental signature
  - Two high-pT leptons in the final state provide sufficient discrimination against backgrounds
- Redundant number of leptons allows measuring efficiency as a function of various kinematic parameters such as p_T, pseudorapidity
- Allows correcting for differences in efficiencies between true leptons in data and Monte Carlo simulation





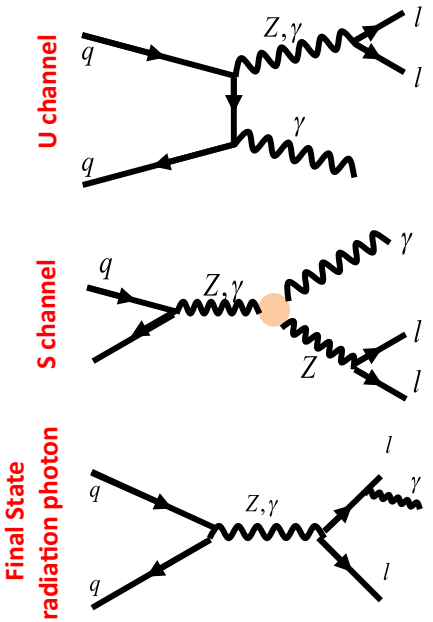


Super cluster → *GsfElectron* efficiency as a function of η, E_T:

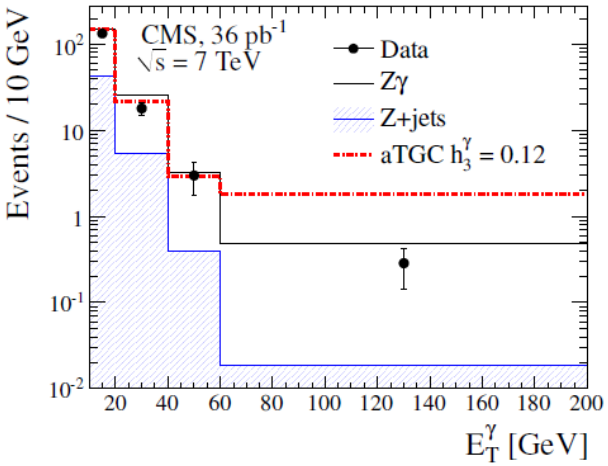
- likelihood fit
- sideband sub.
- MC truth

Wγ and Zγ

- Important background to searches:
  - $\rho_T/\omega_T/a_T$, e*/μ*, monophoton, SUSY, H→γγ
- Major backgrounds to Vγ production:
  - Major background W/Z + jets are determined from data:
    - Build shower shape deposition templates for true photon in Monte Carlo and photon candidates coming from a jet in data, later one has wider spread in pseudo rapidity
    - Fit photon shower shape distribution in data with templates and extract background contribution from the fit
- Cross section measured in phase space:
  - Wγ: $E_T^{\gamma} > 10$ GeV, $\Delta R(l,\gamma) > 0.7$
  - Zγ: same as Wγ plus $M_{ll} > 50$ GeV

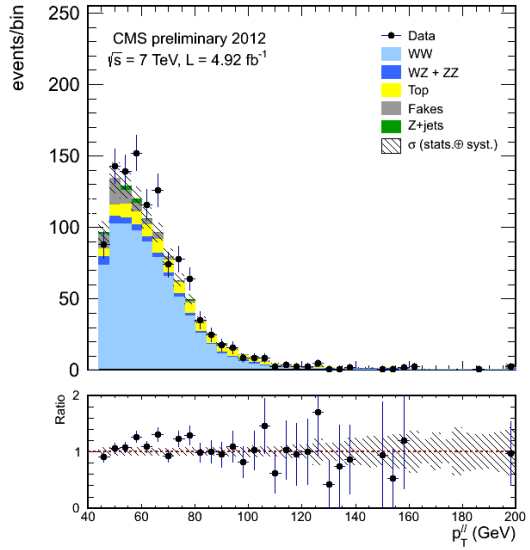


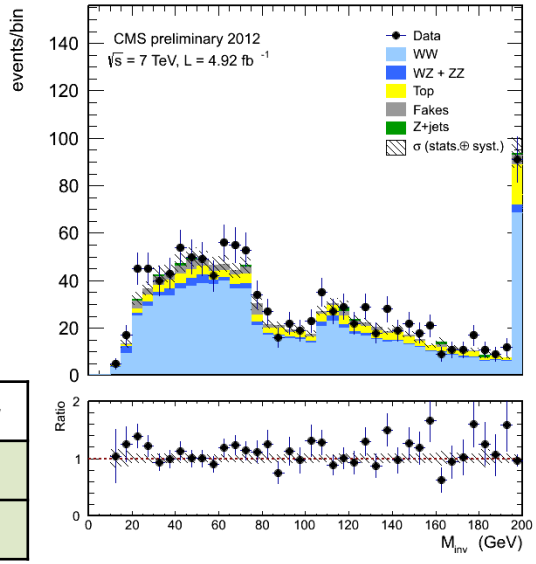
		Central	Statistical	Systematic	luminosity
Wγ	Measured	56.3 pb	5.0 pb	5.0 pb	2.3 pb
	Theoretical	49.4 pb	3.8 pb		
Zγ	Measured	9.4 pb	1.0 pb	0.6 pb	0.4 pb
	Theoretical	9.6 pb	0.4 pb		



WW production

- Important background to searches:
  - Higgs, Graviton G, Z'
- Major backgrounds to WW production:
  - Drell-Yan
    - Reject event with same flavor lepton in Z mass window
    - Missing transverse energy cut
  - ttbar, tW
    - Reject any event with at least one jet or B tagged
  - WZ, ZZ
    - Reject event with third lepton
  - W+jets and QCD
    - Using lepton isolation and identification algorithms in combination with data based approach to minimize background
    - Contributes largest systematic uncertainty
- Cross section measured in phase space:
  - 60 GeV < M_{ll} < 120 GeV

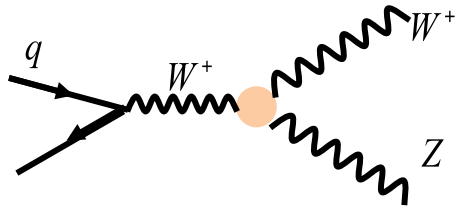


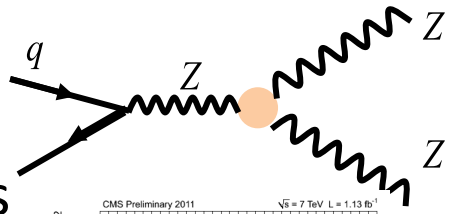


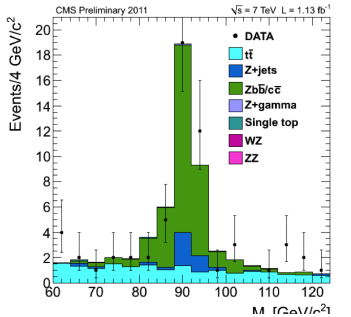
		Central	Statistical	Systematic	luminosity
W^+W^-	**Measured**	**52.4 *pb***	**2.0 *pb***	**4.5 *pb***	**1.2 *pb***
	Theoretical	**47.0 *pb***	**2.0 *pb***		

WZ and ZZ

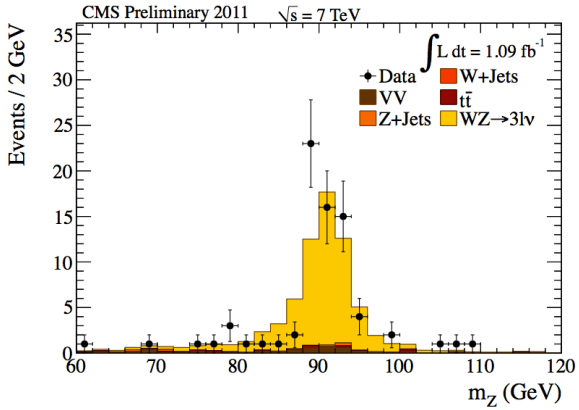
- Important background to searches:
  - Higgs, ρ_T, W*
- Major backgrounds to ZZ/WZ production:
  - Negligible contributions from other processes
- Cross section measured in phase space:
  - 60 GeV < $M_{ll\ (Z)}$ < 120 GeV



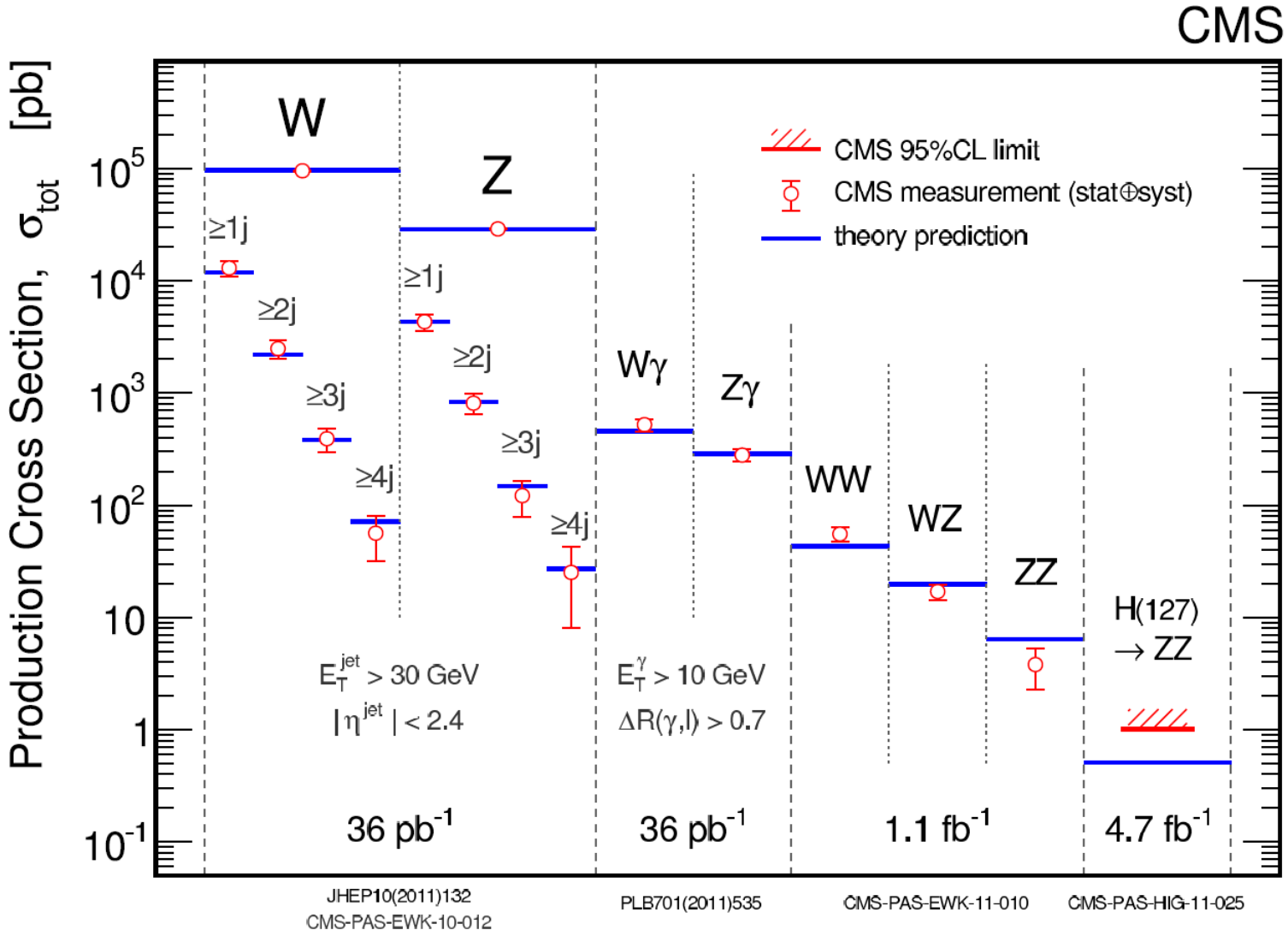




		Central	Statistical	Systematic	luminosity
WZ	Measured	17.0 *pb*	2.4 *pb*	1.1 *pb*	1.0 *pb*
	Theoretical	17.5 *pb*	0.6 *pb*		
ZZ	Measured	3.8 *pb*	1.5 *pb*	0.2 *pb*	0.2 *pb*
	Theoretical	6.4 *pb*	0.6		

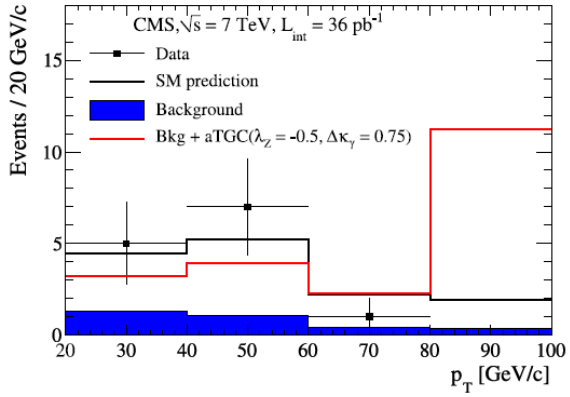


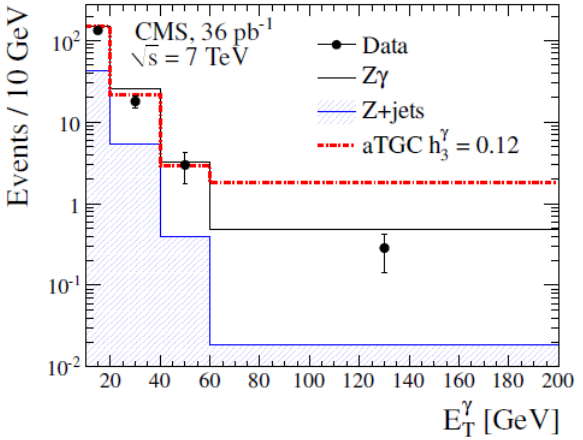
Summary plot for Diboson CS measurements



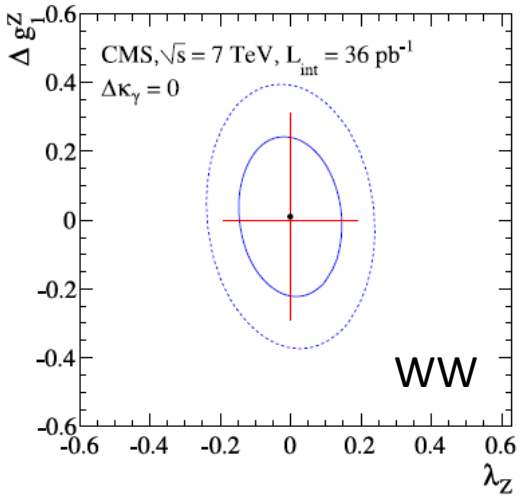
aTGC

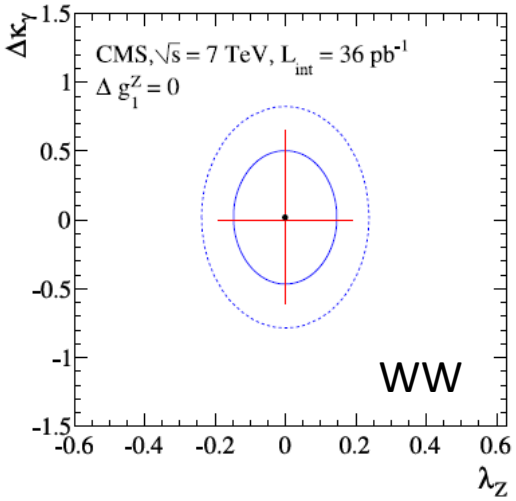
- Main contribution to production comes from t-channel quark exchange and partly final state radiation photons
- In the standard model s-channel contributes with triple gauge coupling
  - Allowed for WWγ and WWZ vertices
  - Not allowed for ZZZ, ZZγ or Zγγ vertices
- Theoretical independent approach using effective Lagrangian
  - Fits to log likelihood profile to get limits
- Select phase space with enhanced TGC contribution
  - E_T of photon in Wγ and Zγ
  - P_T leading lepton in WW
  - P_T of Z boson in WZ and ZZ

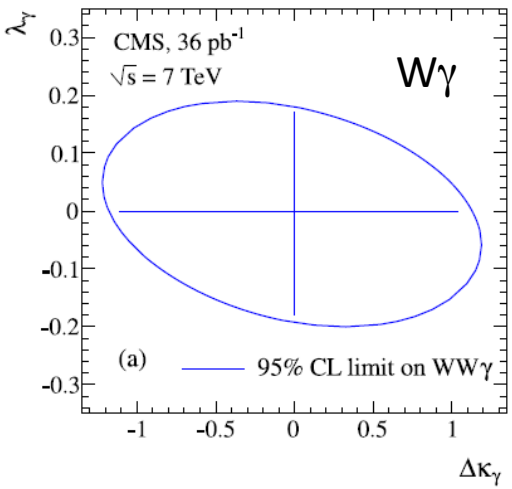


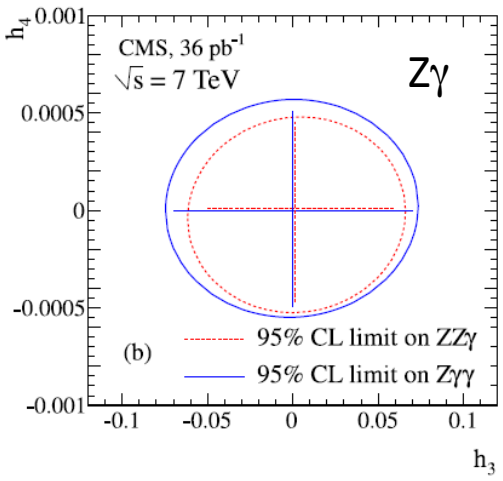


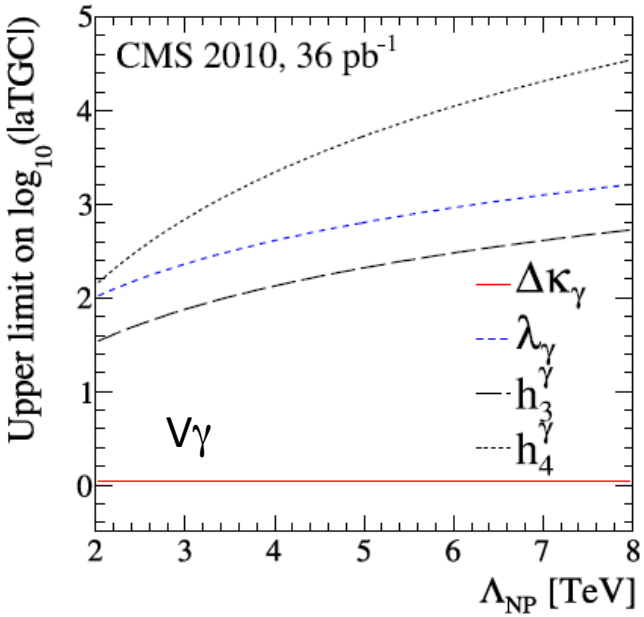
Current limits











WZ and ZZ limits coming soon

Summary

- Measured diboson cross sections on energy frontier
  - Good agreement with SM
  - Set the most stringent TGC limits
- Analysis with full statistics from 2011 data are coming up soon
  - Better measurements
  - Tighter limits or discovery