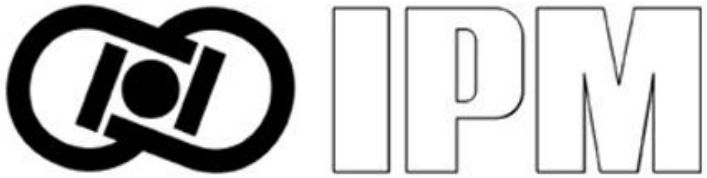
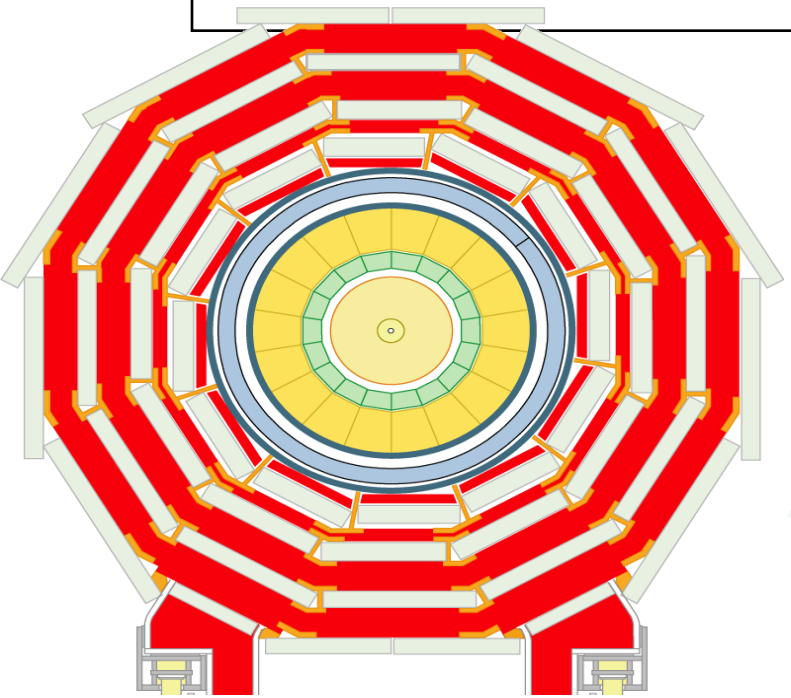


EW @ CMS

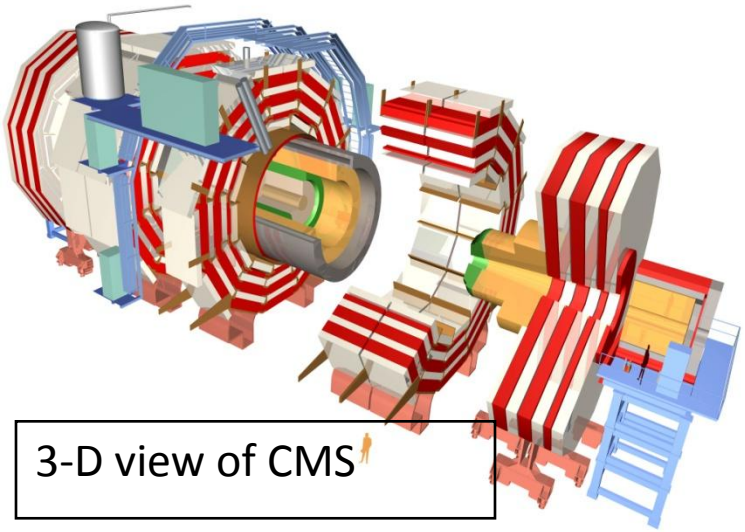
Saeid Paktinat Mehdiabadi
School of Particles and Accelerators, IPM

One Day Workshop on New Results at the CMS Experiment with Emphasis on the Higgs Boson, 27 December 2012

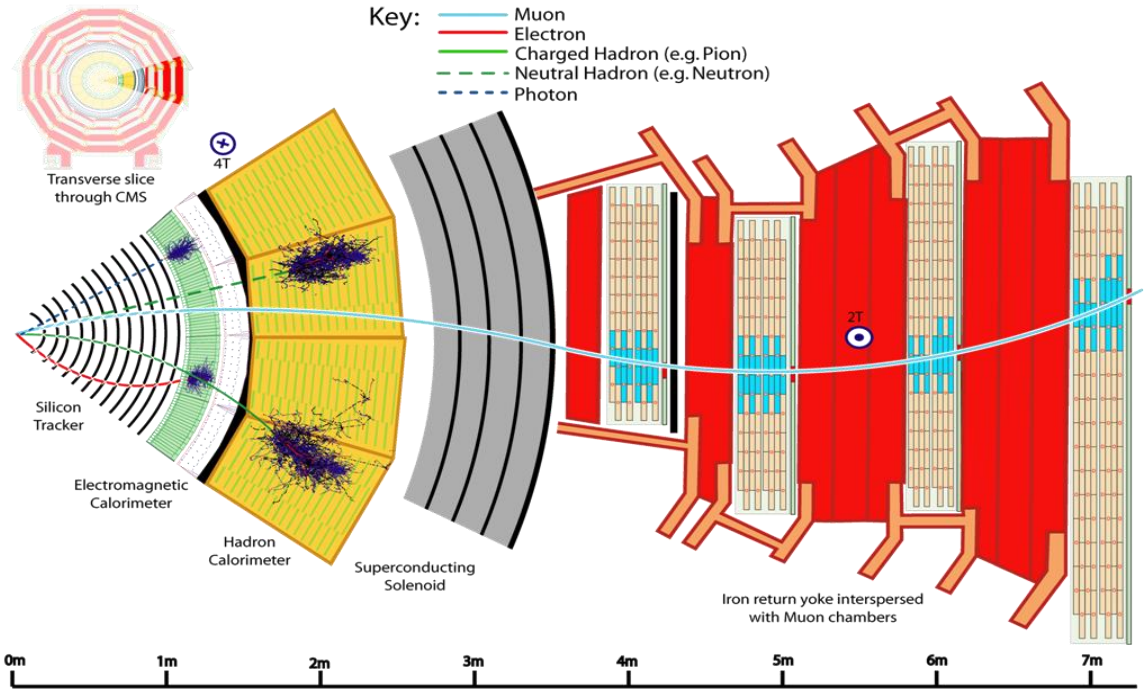
The “CMS” detector for LHC



- Each color shows a different layer
- This is the view along the beam direction



3-D view of CMS



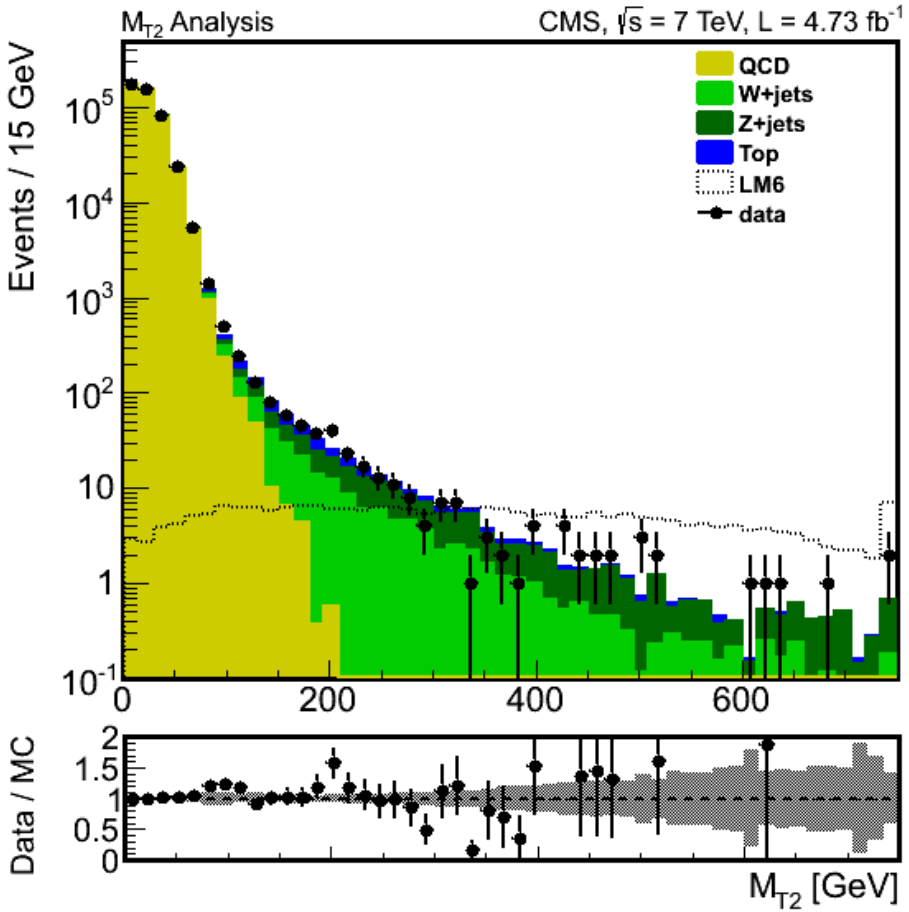
Why Electroweak @ CMS?

W and Z production at hadron colliders:

- Test of the Standard Model predictions at TeV scale
- Performance measurements of the detectors calibration
- Unique test and contribution to the Parton Density Distribution (PDF)
- Precision test of pQCD and input to event generators
- Better understanding of background to Higgs and new physics searches

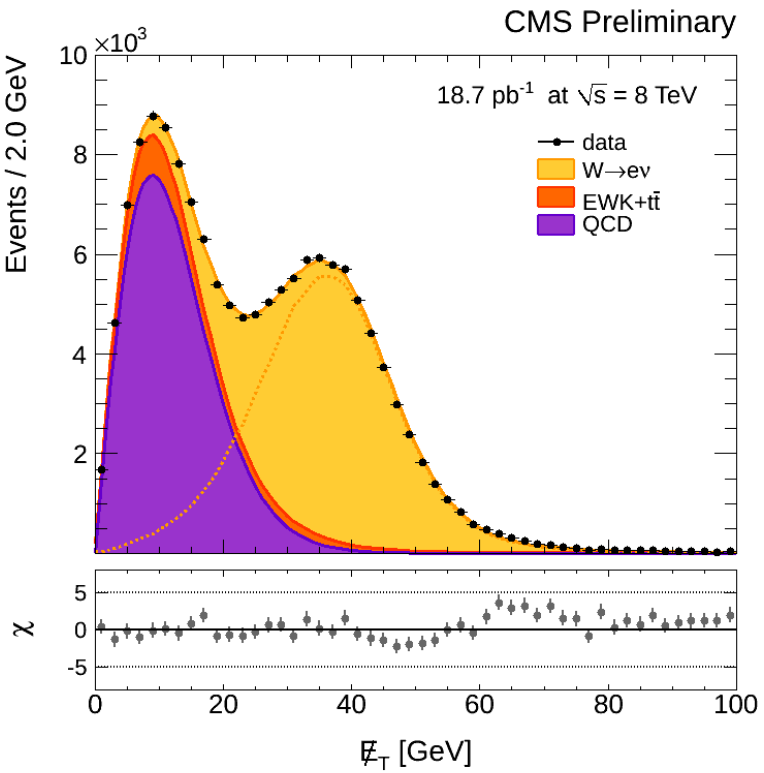
Why EW @ CMS?

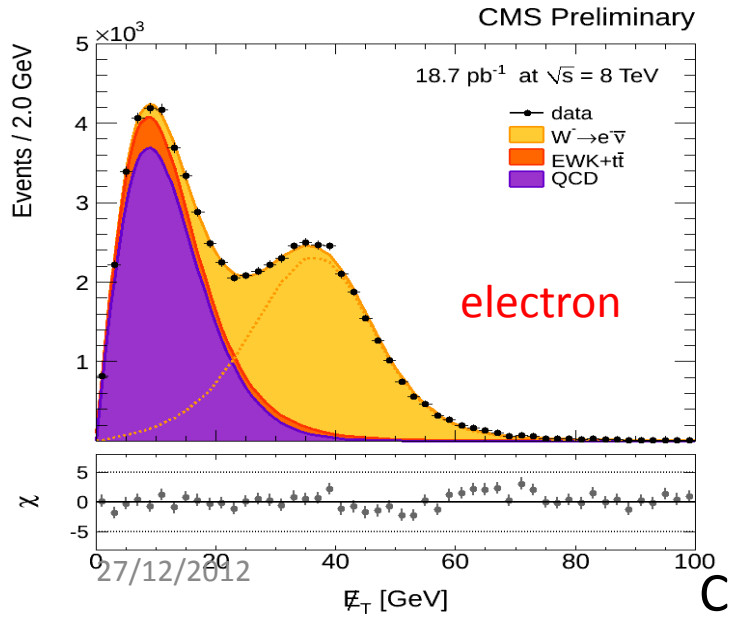
- Search for squarks and gluinos in jets + MET.
- Invisible Z is estimated with γ+jets and Z(→μμ)+jets.
- WW and ZZ are the main channels to look for Higgs.

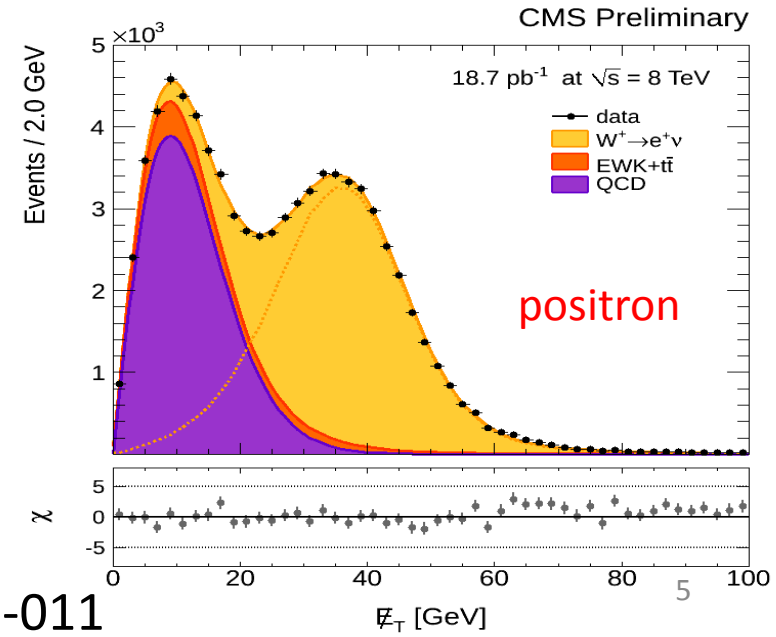


W/Z Production Cross Sections

- Clean standard candle
- Two high-pT isolated leptons
- Small background O(1%)
- Results systematically limited



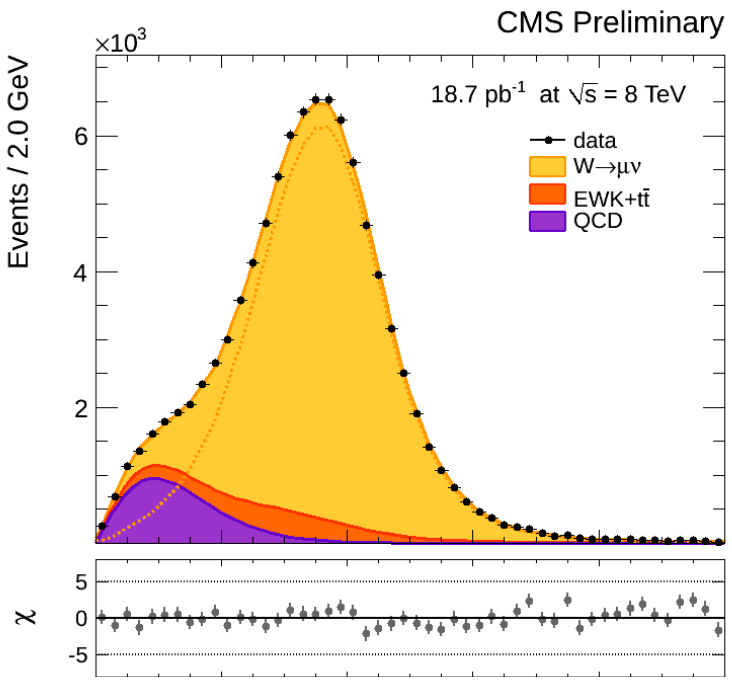


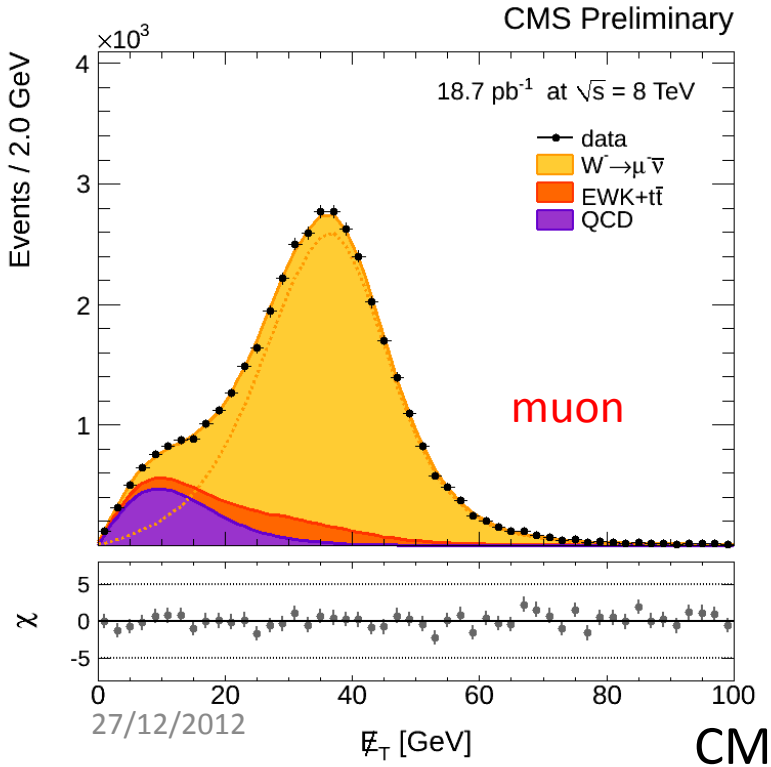


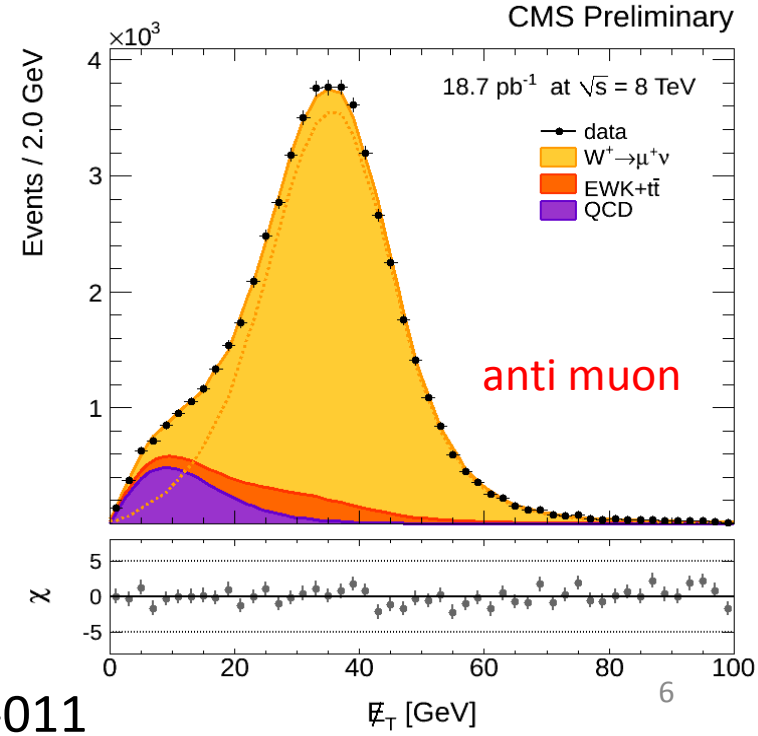
CMS-PAS-SMP-12-011

Muonic channel

- Much less bkg!

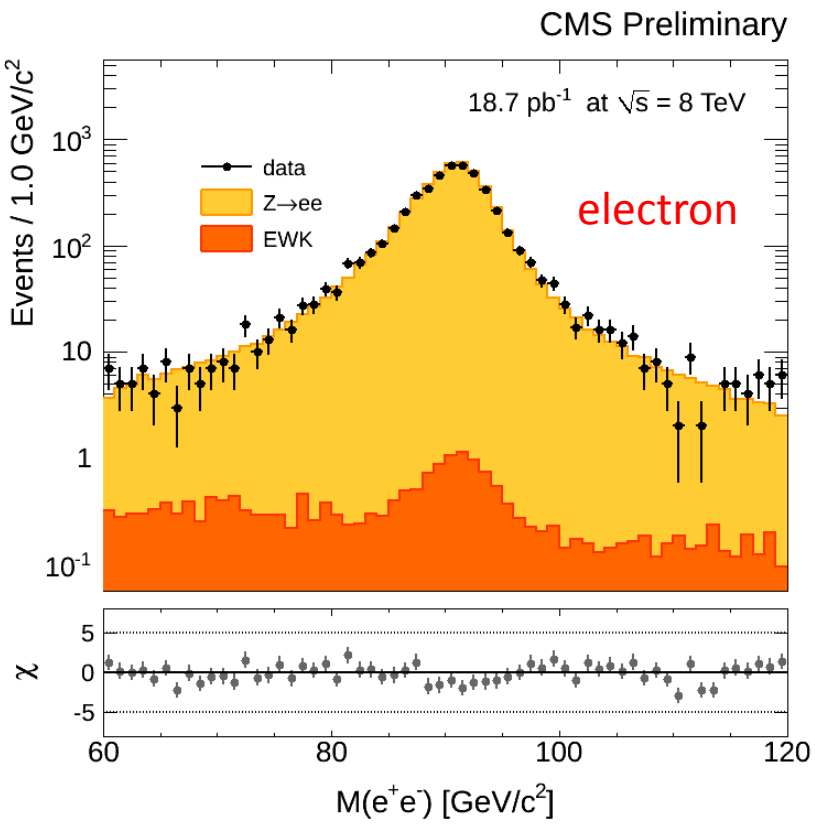


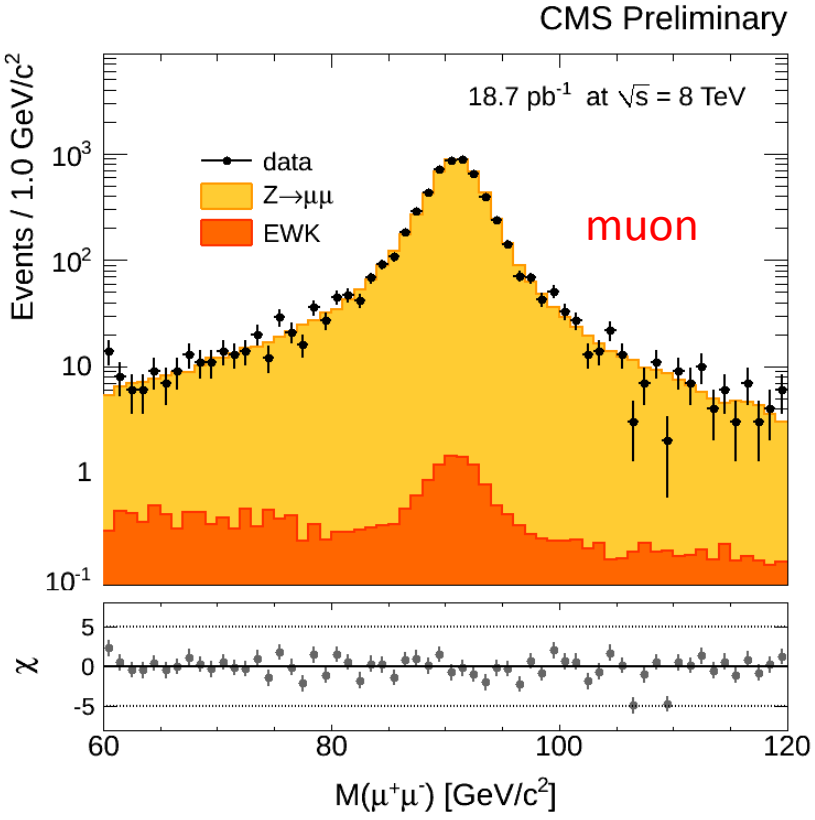




CMS-PAS-SMP-12-011

Z Production



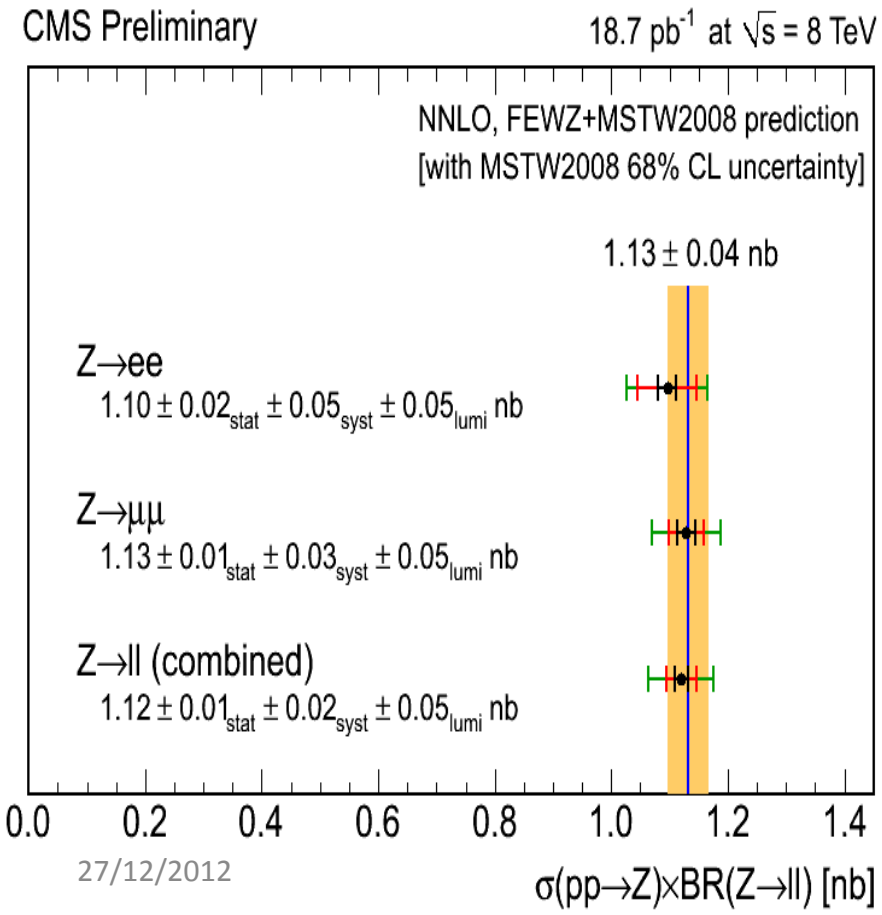


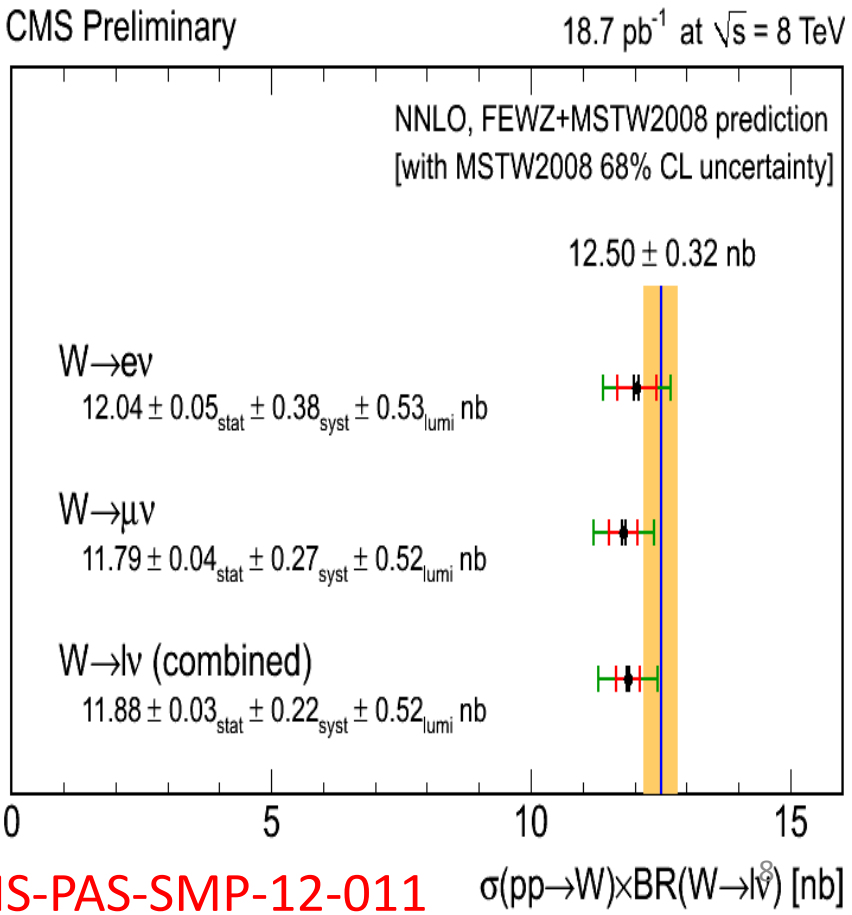
CMS-PAS-SMP-12-011

W/Z Production Cross Section

$$\frac{d\sigma}{dx} = \frac{(N_{data} - N_{bkg})}{\varepsilon \times L \times \Delta x}$$

Statistics
Systematics
Luminosity





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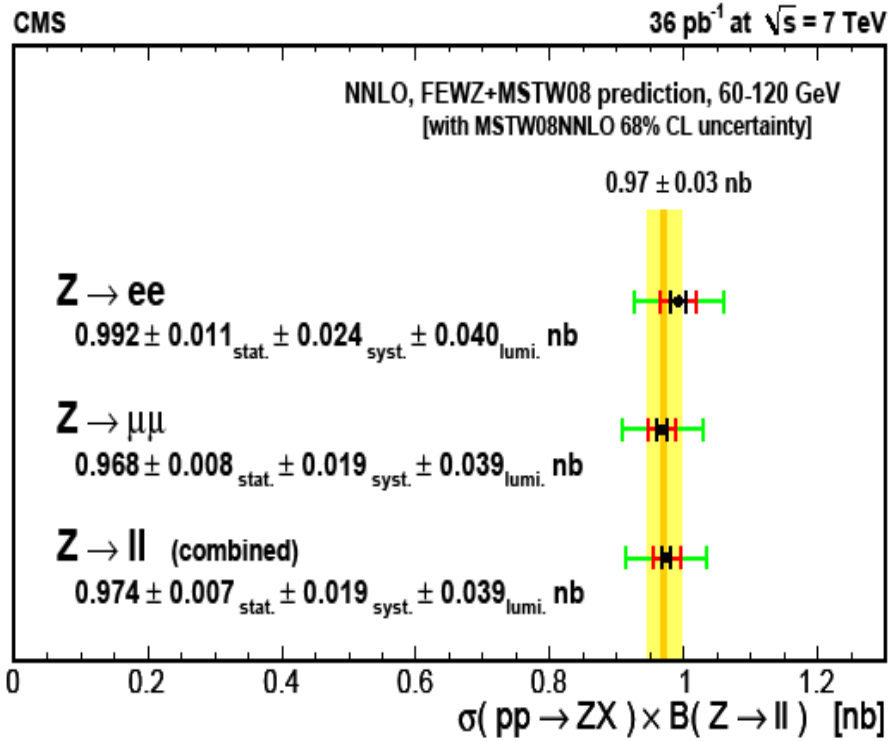
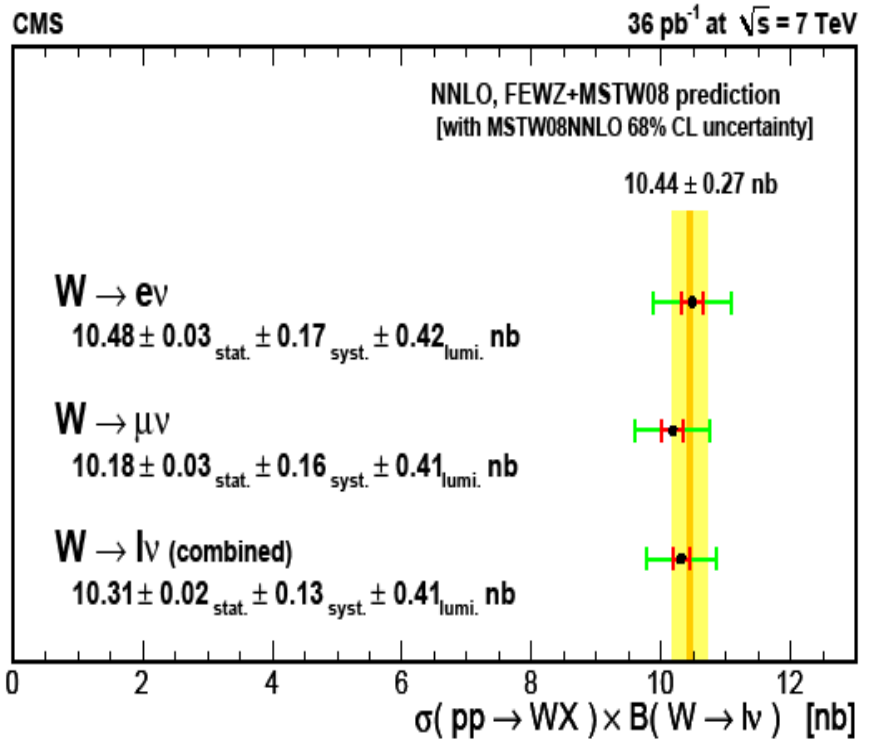
W/Z Production Cross Section @ 7 TeV

A small fraction of the data is used for this meaurement.

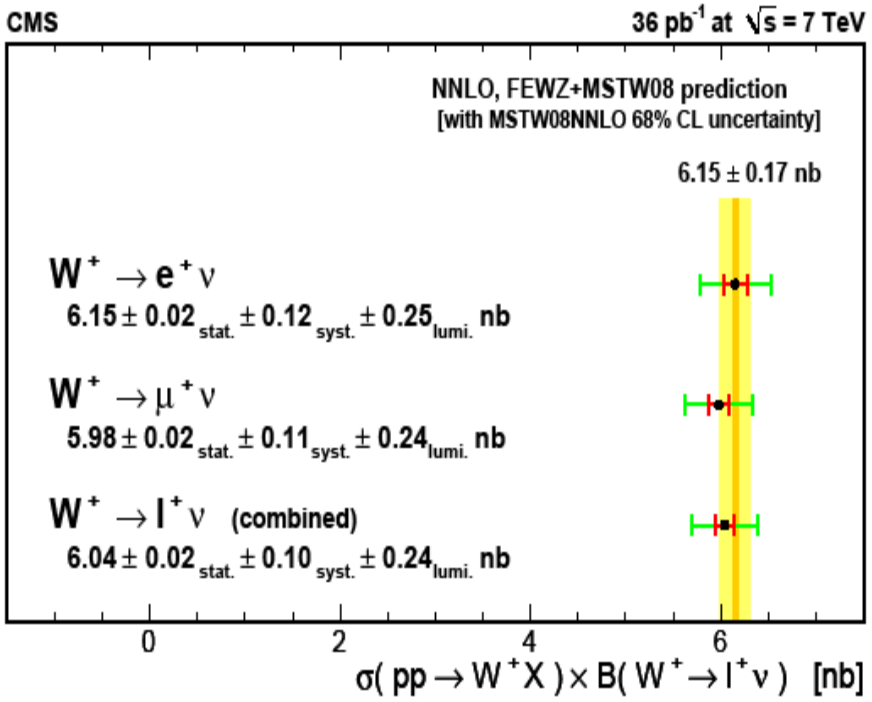


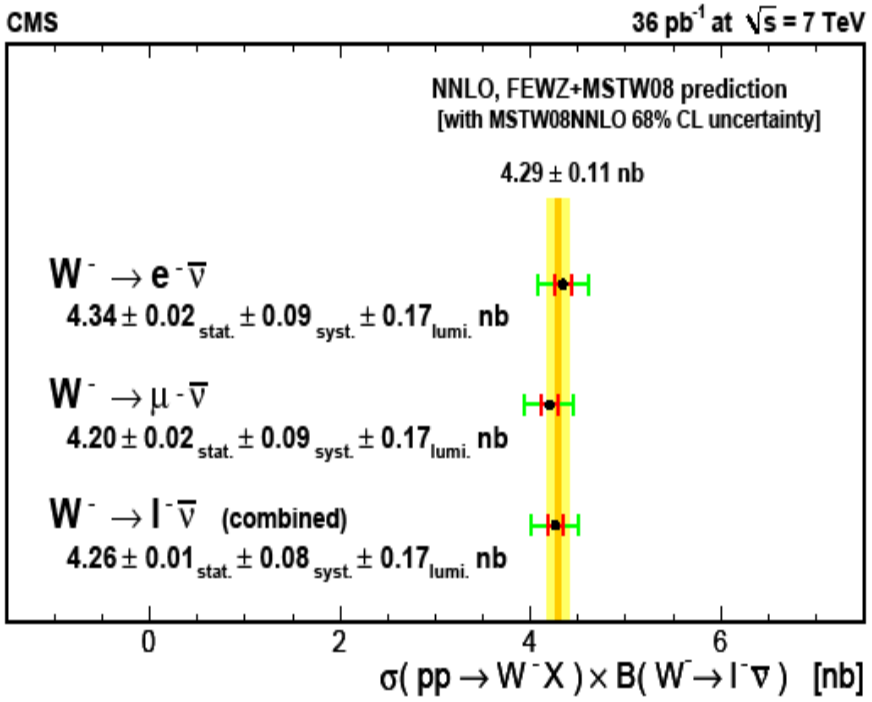


CMS-PAS-EWK-10-005

Positive vs Negative

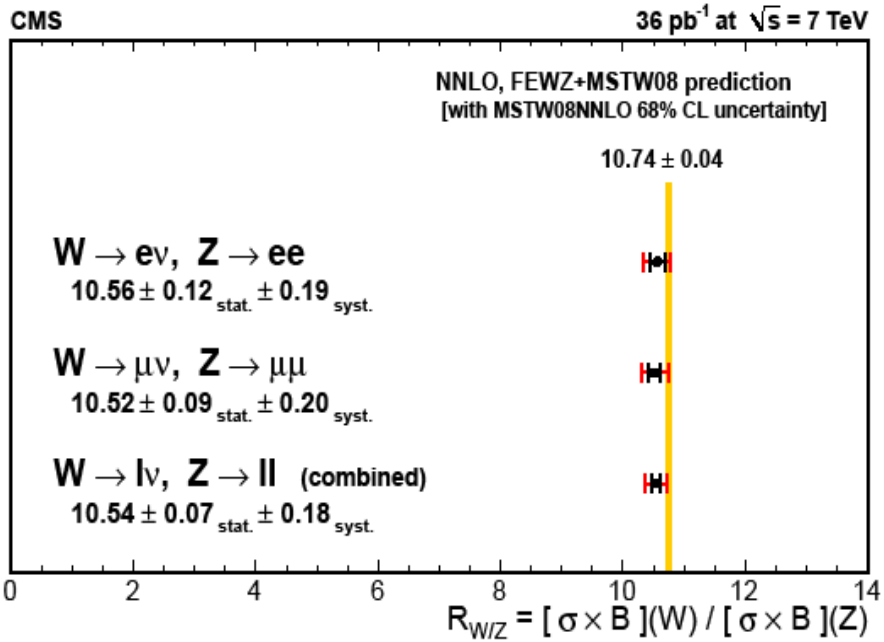
- Measurements are consistent with the predictions.
- No room for the new physics yet!

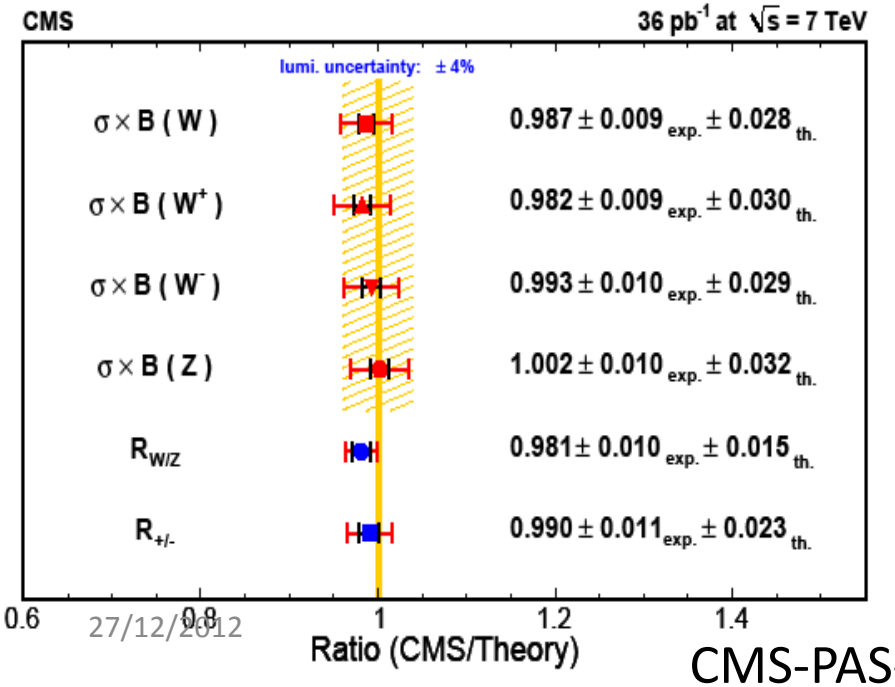


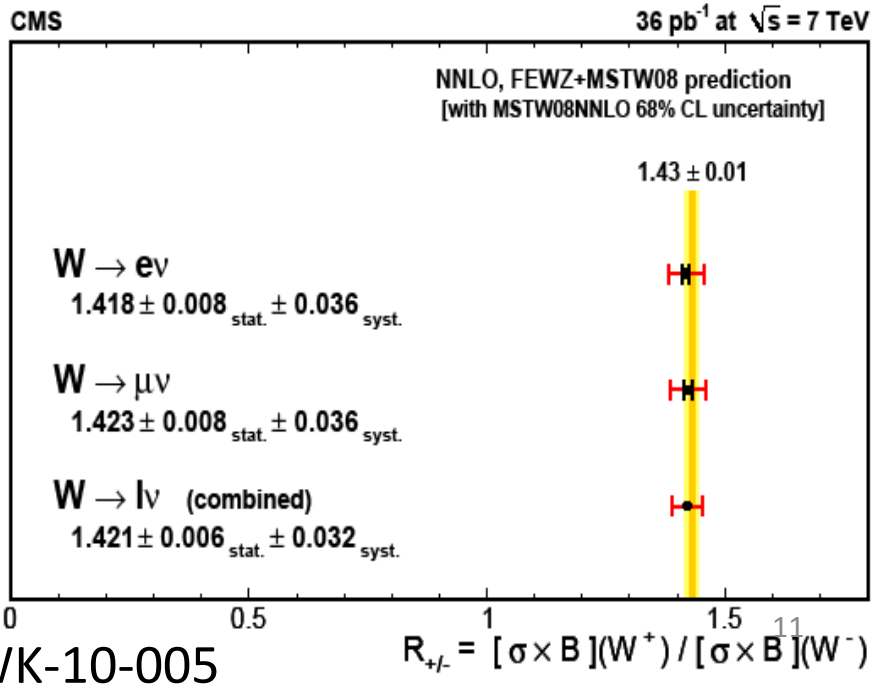


CMS-PAS-EWK-10-005

More Comparisons

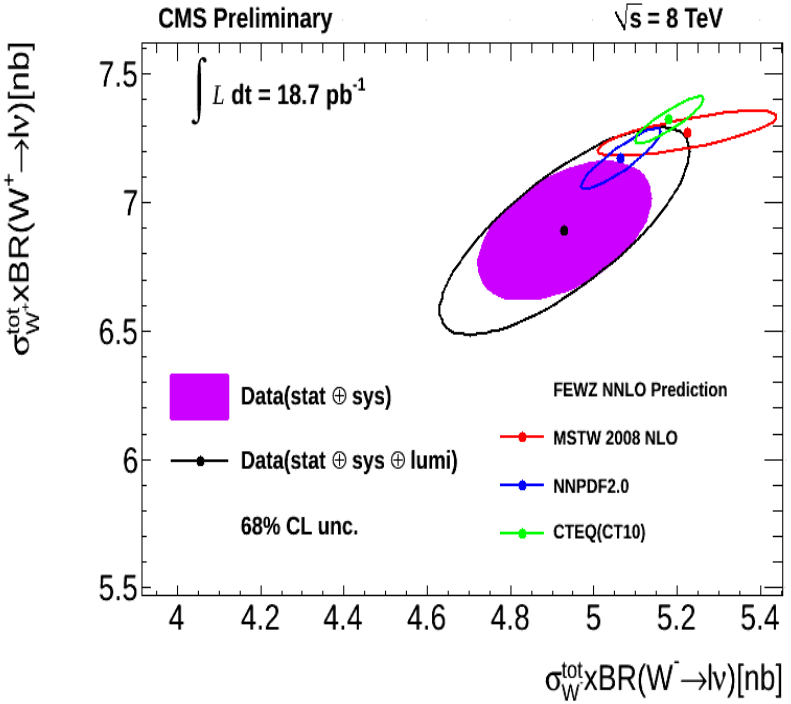


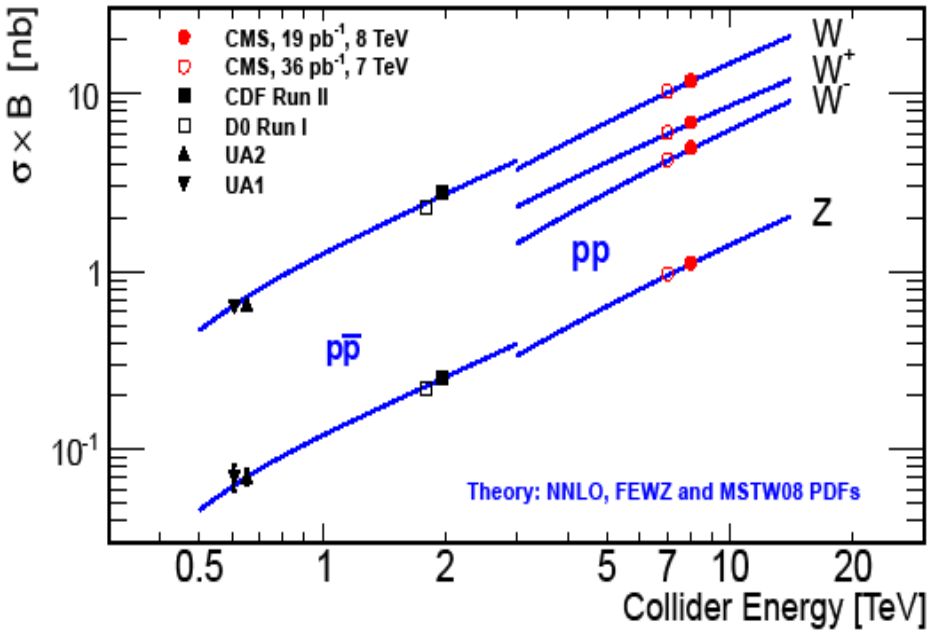


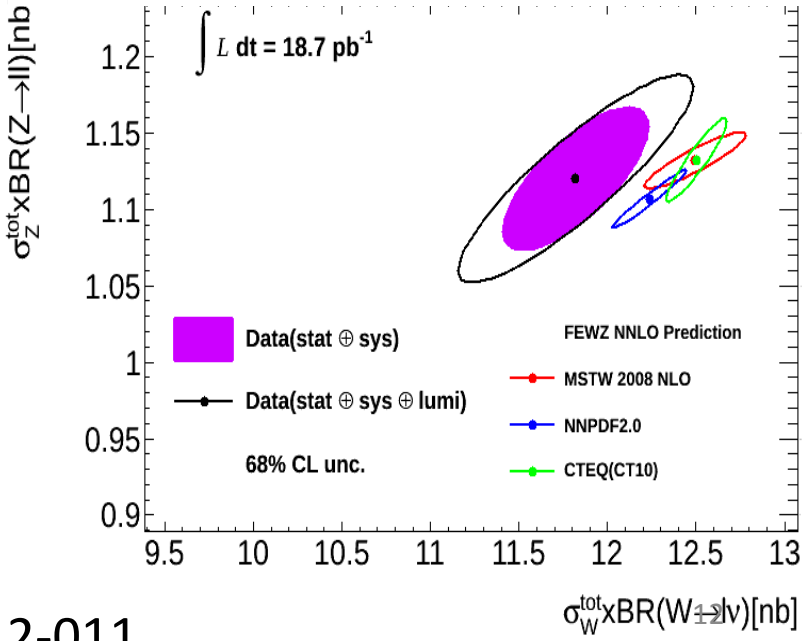


CMS-PAS-EWK-10-005

Measurement vs MC Prediction







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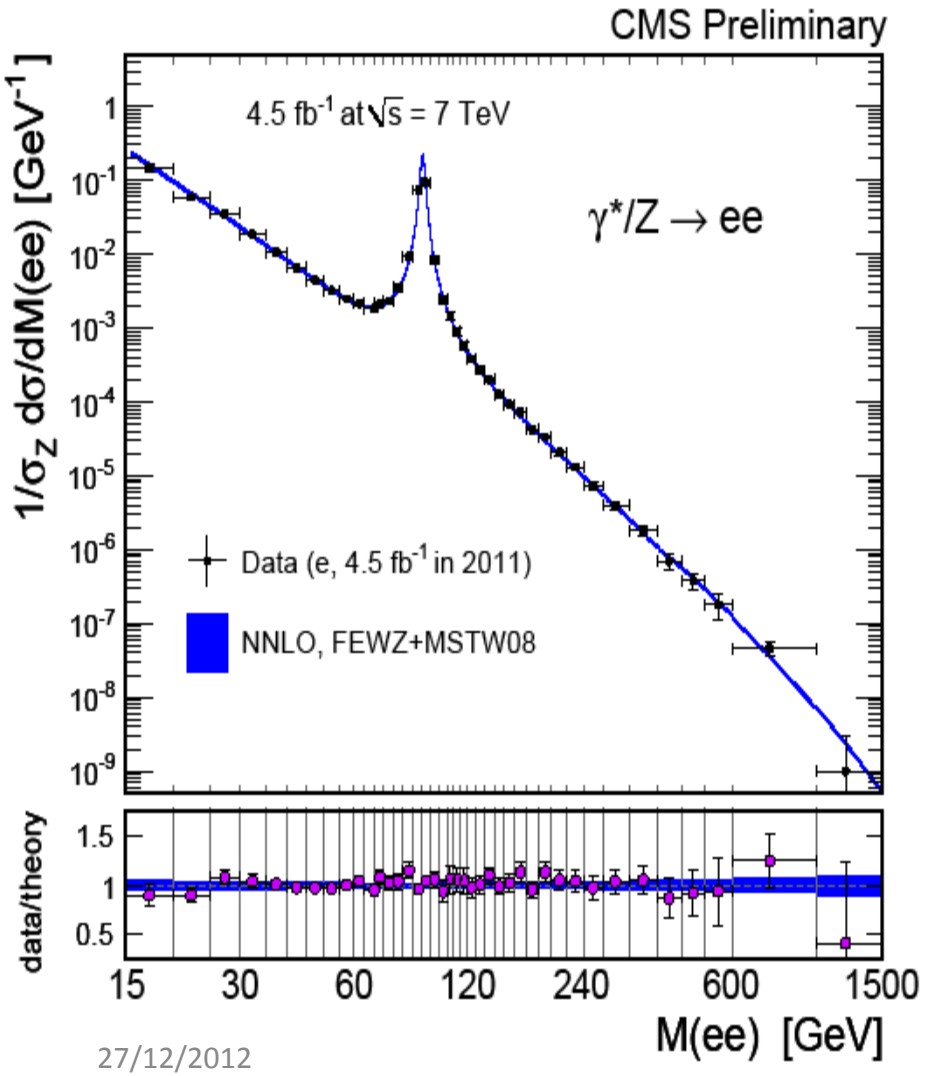
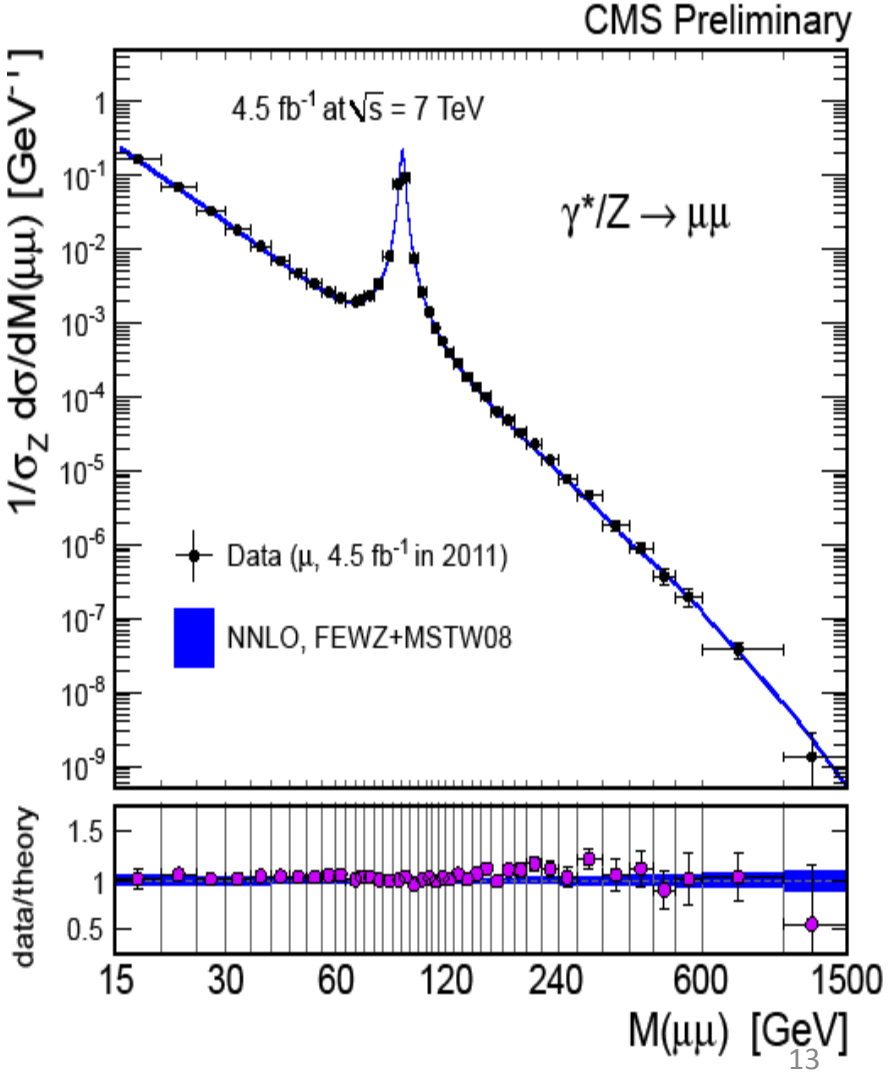
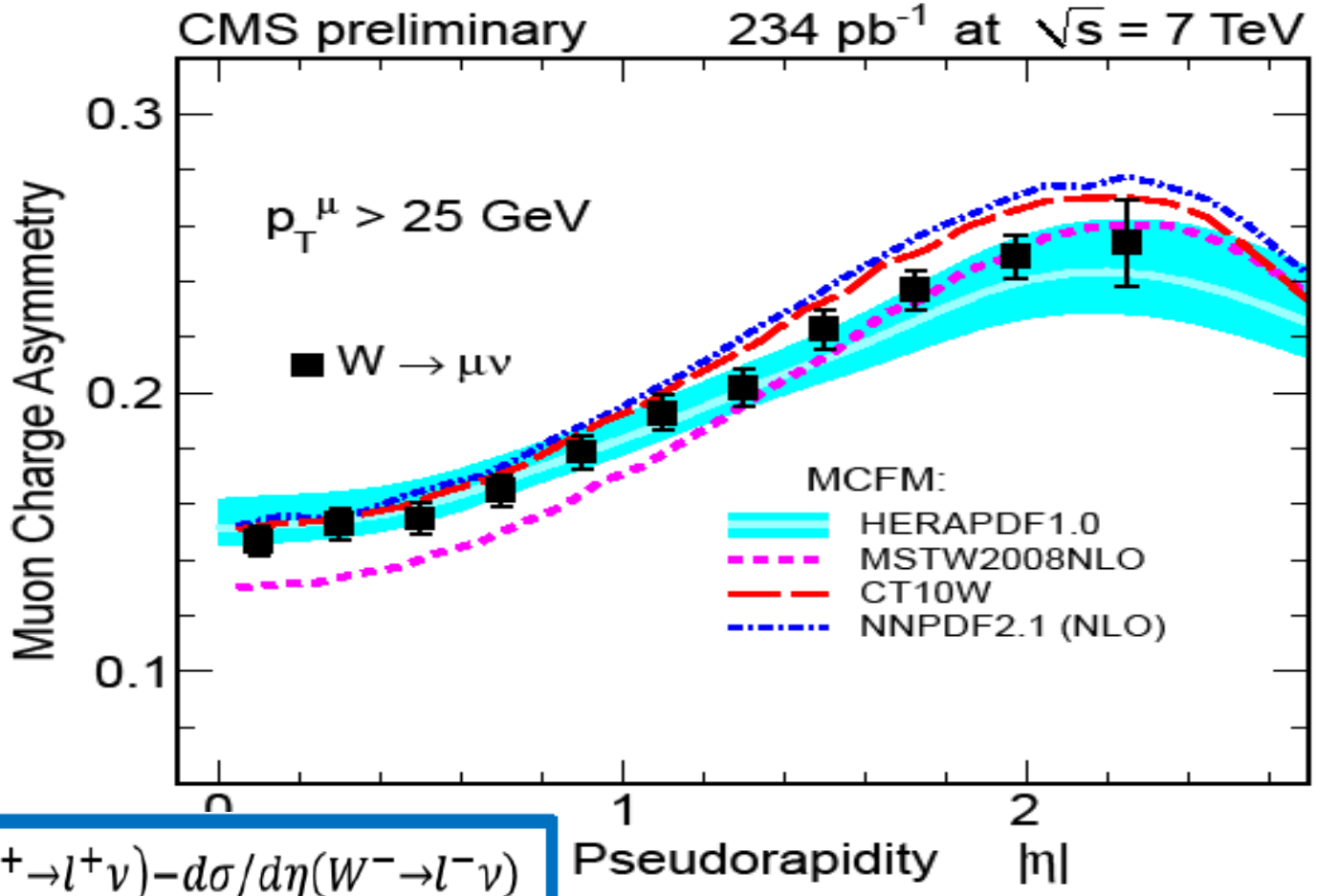
Differential Cross Section





CMS-PAS-EWK-11-007

Muon Charge Asymmetry

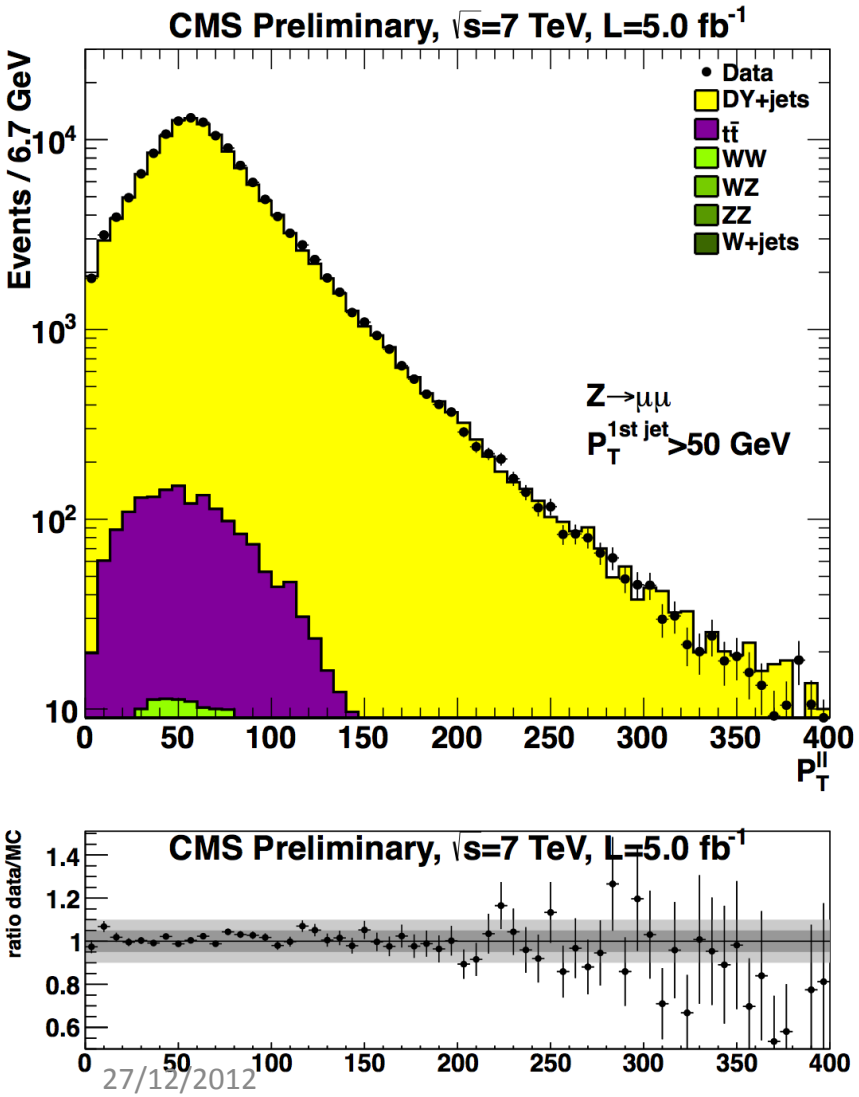


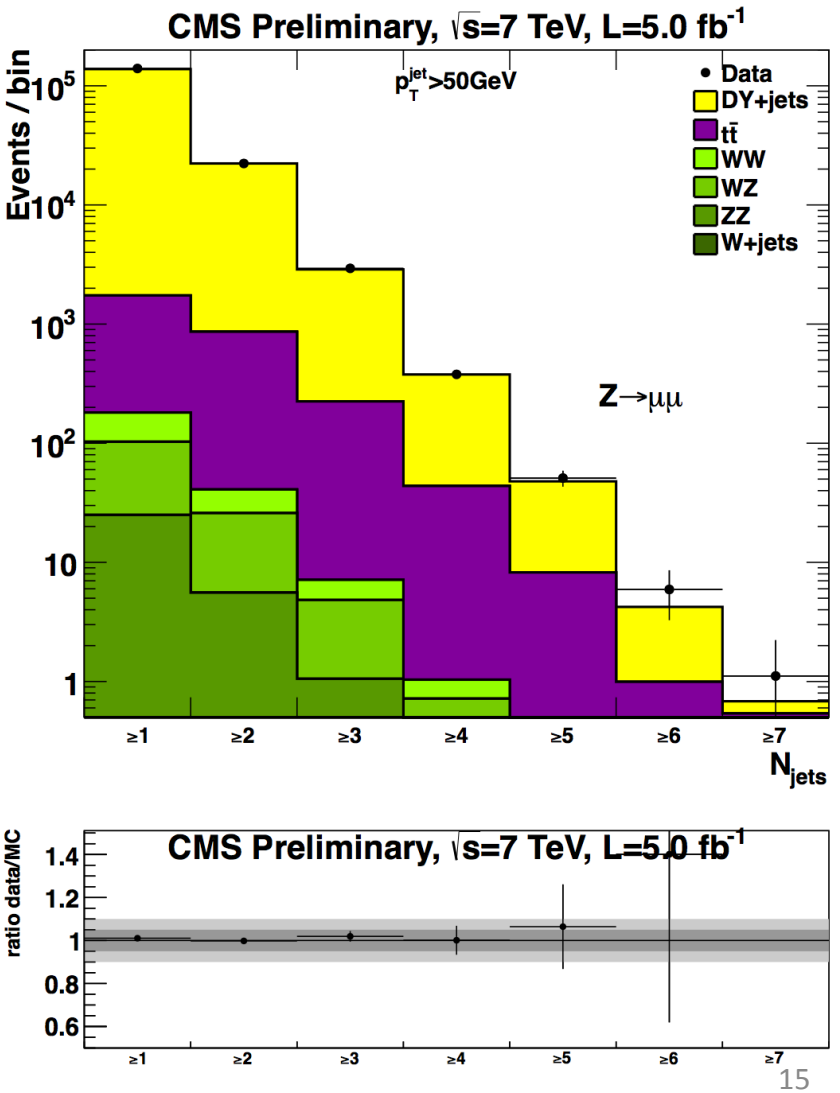
$$A(\eta)=\frac{d\sigma/d\eta(W^+\to l^+\nu)-d\sigma/d\eta(W^-\to l^-\nu)}{d\sigma/d\eta(W^+\to l^+\nu)+d\sigma/d\eta(W^-\to l^-\nu)}$$

CMS-PAS-EWK-10-005

Z-Pt, Jet Multiplicity

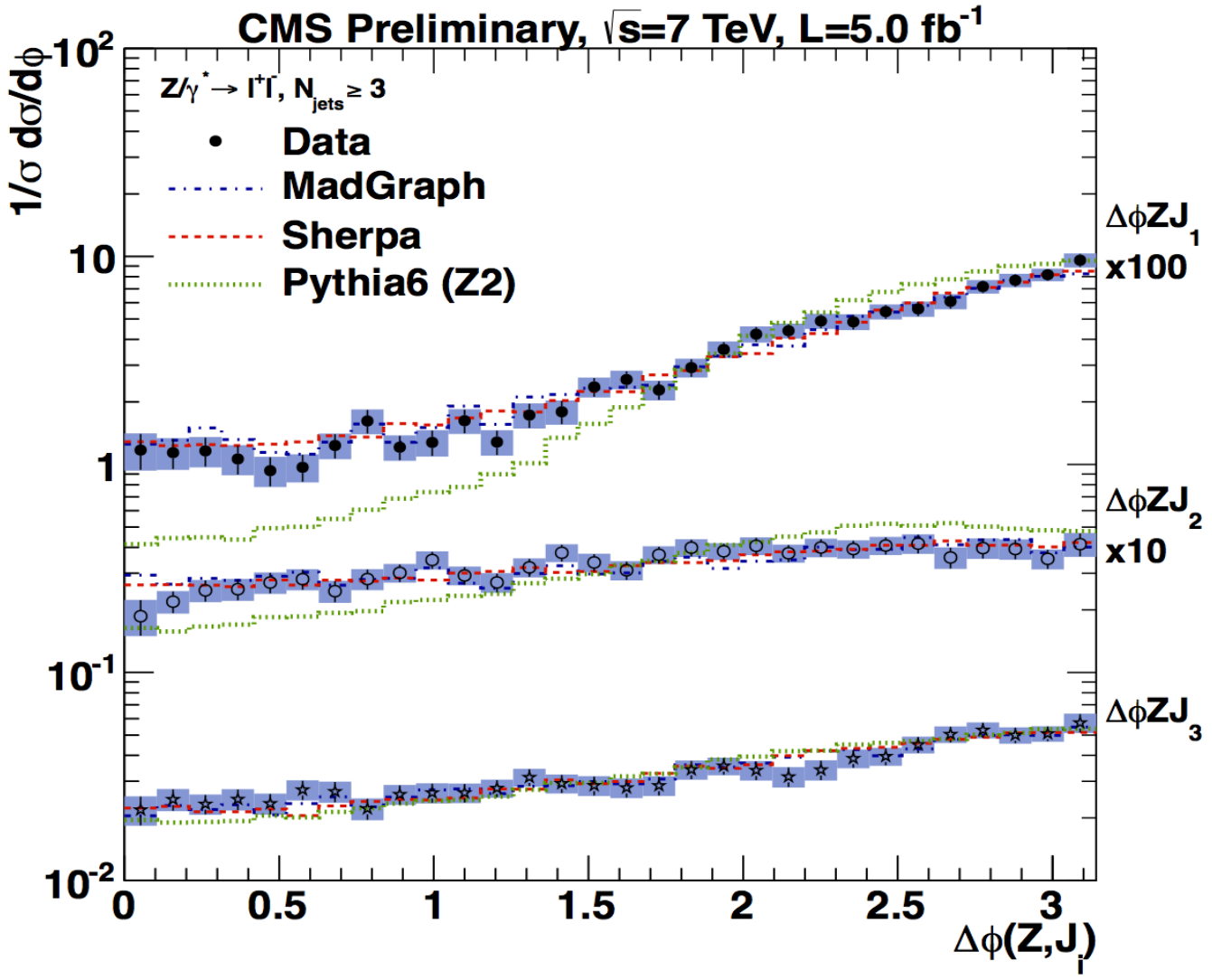
Good prediction even in extreme conditions





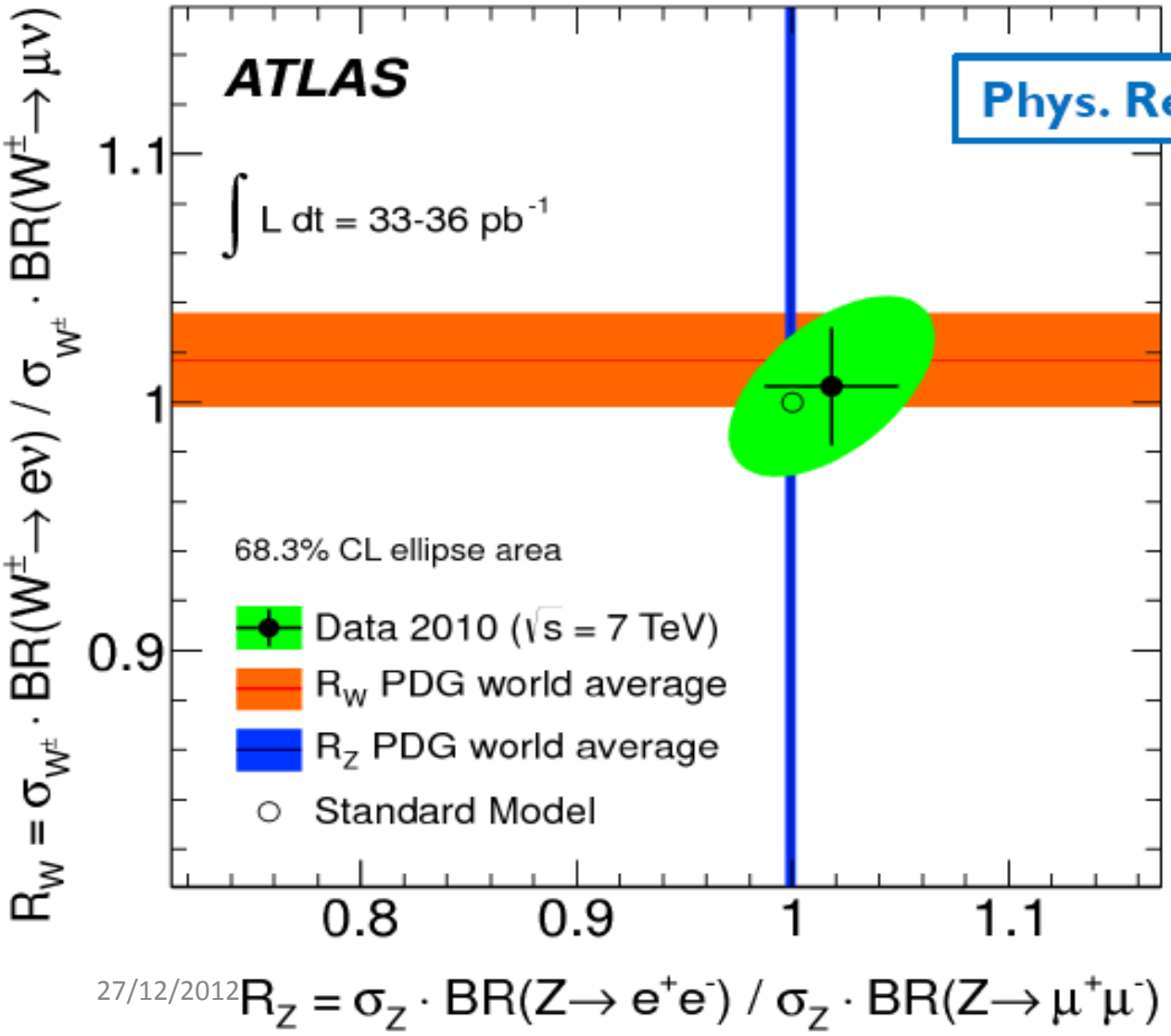
CMS-PAS-EWK-11-021

Different Event Generators



CMS-PAS-EWK-11-021

Lepton Universality



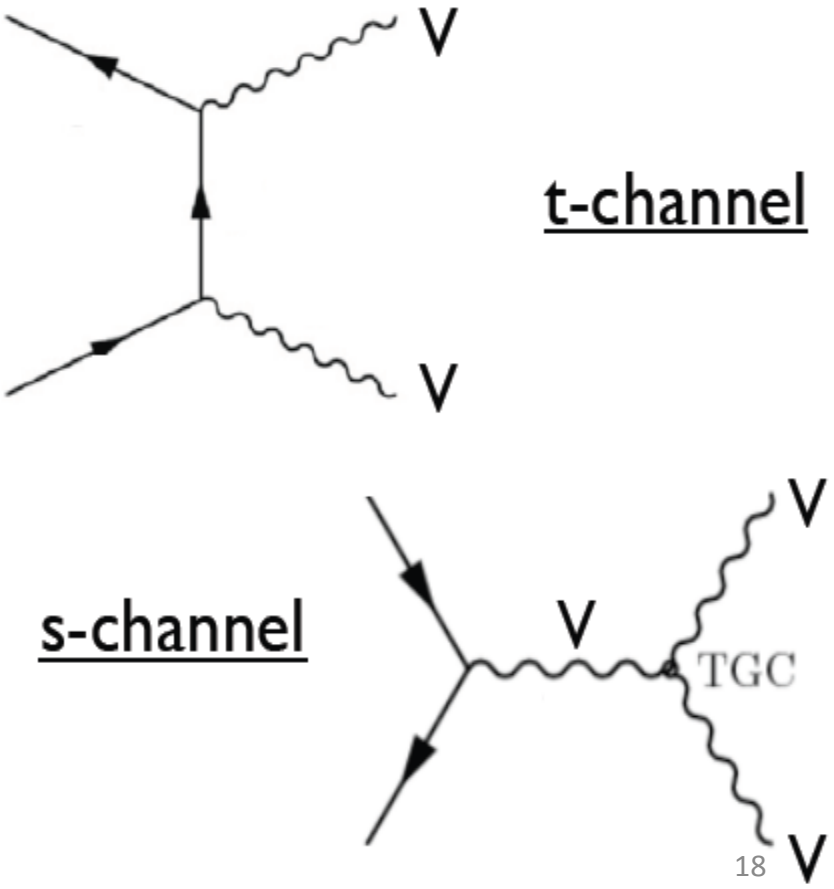
Phys. Rev. D85 (2012) 072004

G. P. Di Giovanni, HCP 2012

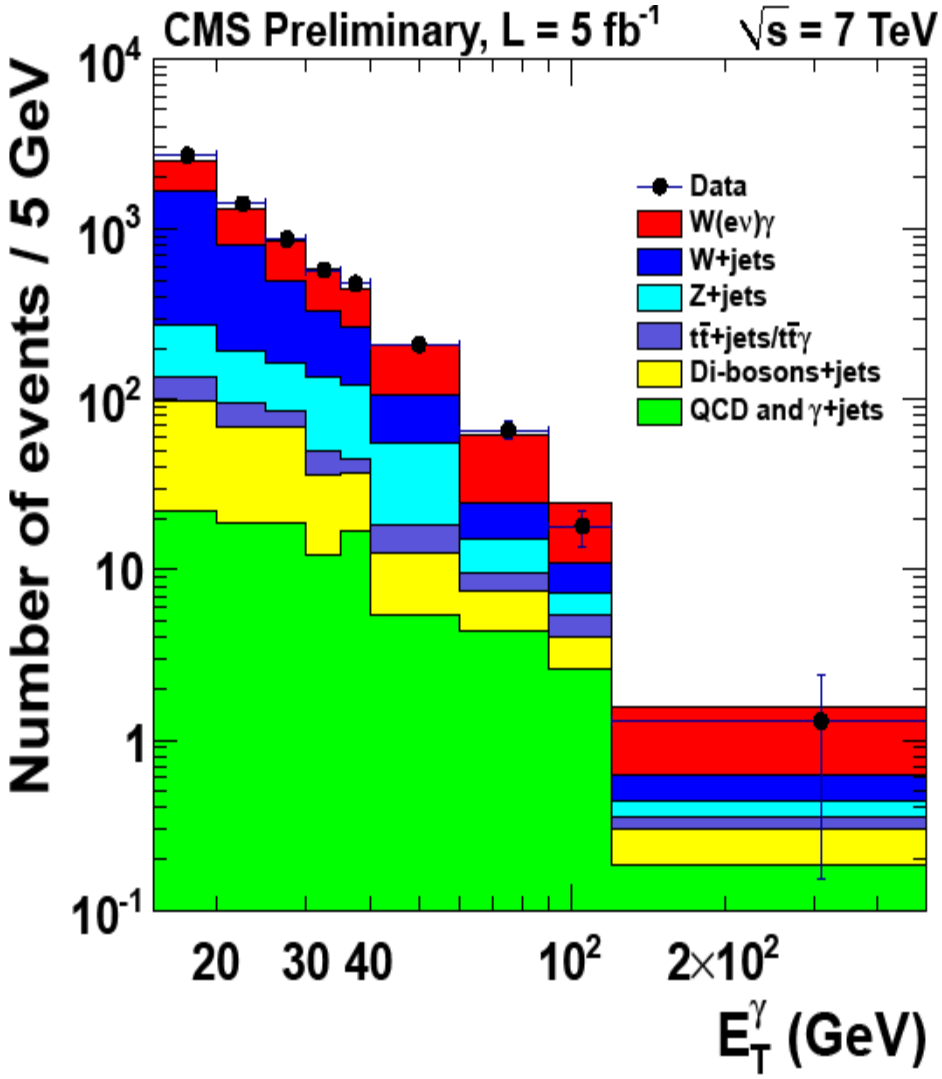
anomalous Triple Gauge Couplings

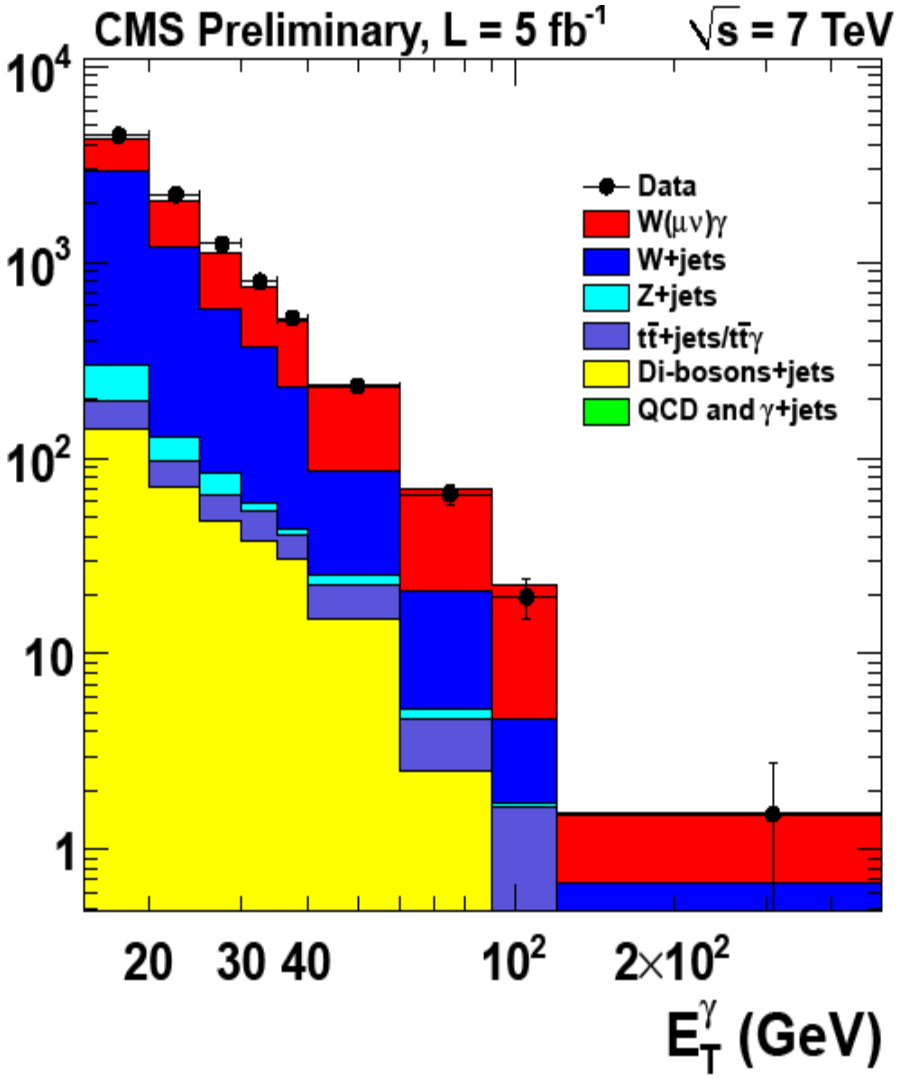
- Neutral TGC are not allowed in the standard model
- Observation of either

neutral TGC or deviations from the SM charged TGC would be an evidence of new physics



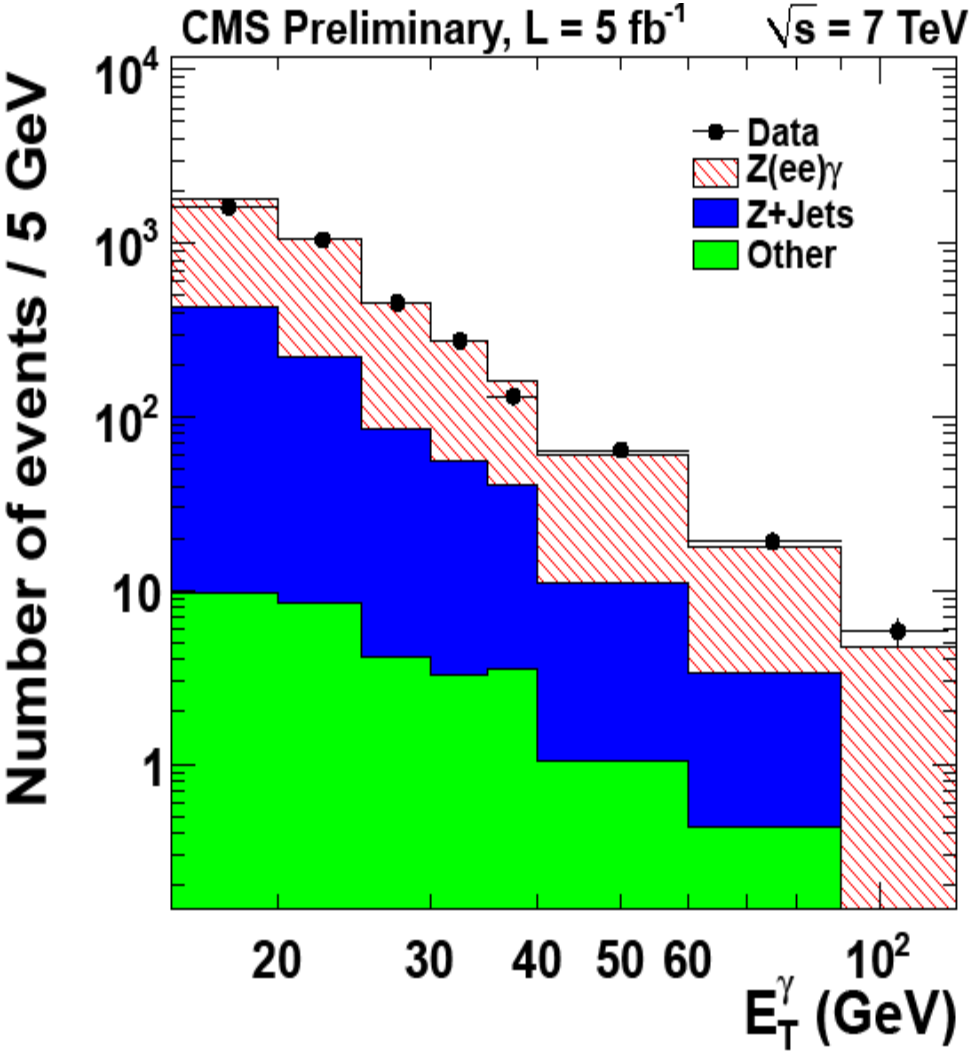
Wγ

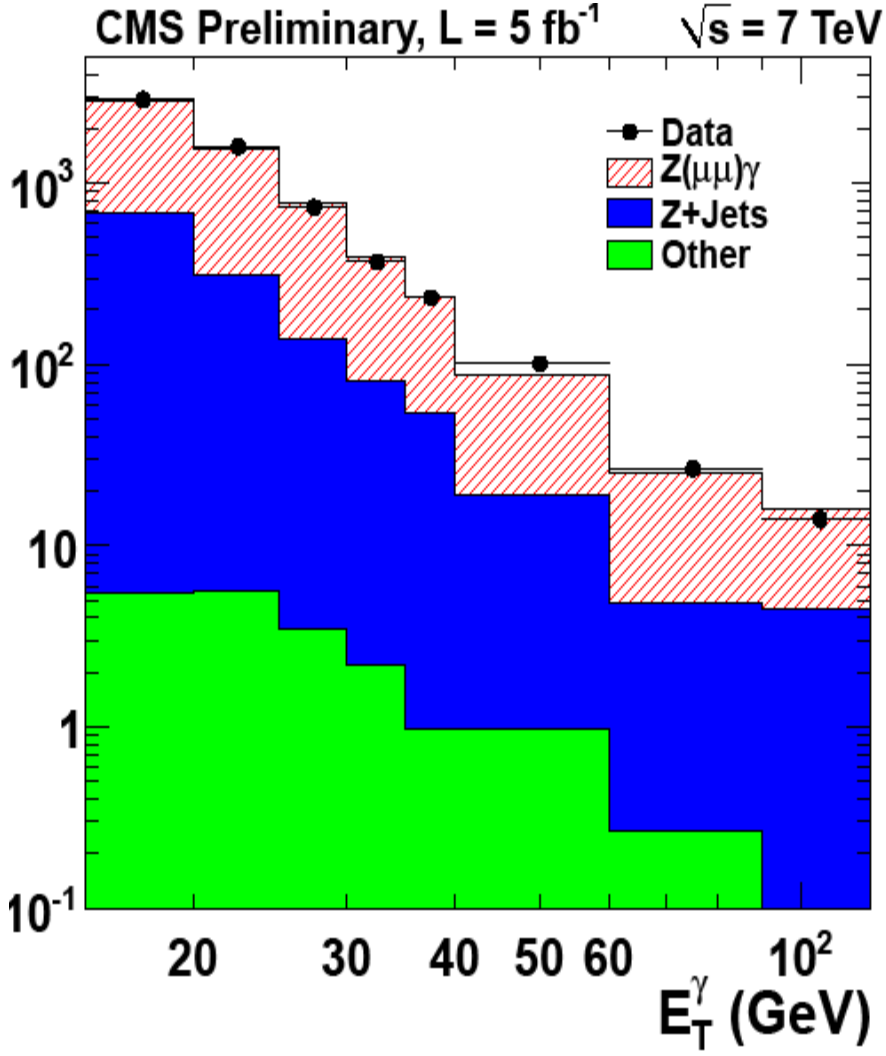




CMS-PAS-EWK-11-009

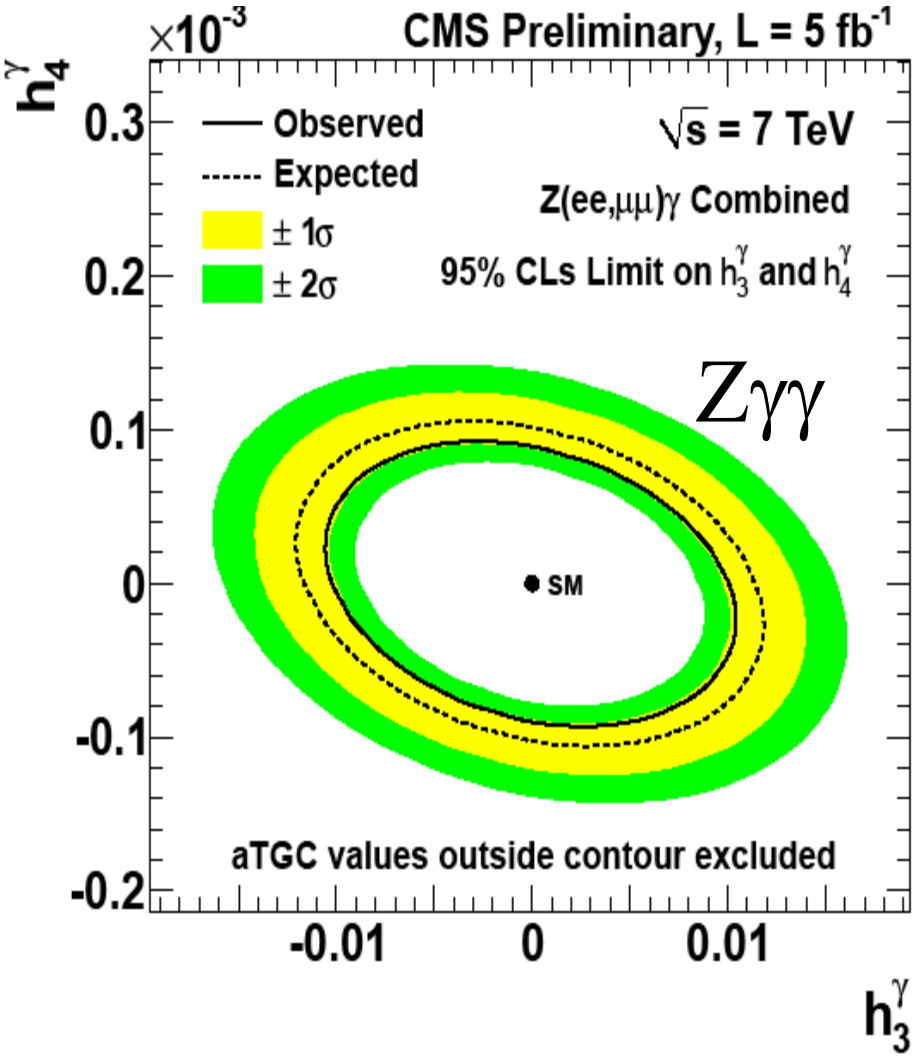
Zγ

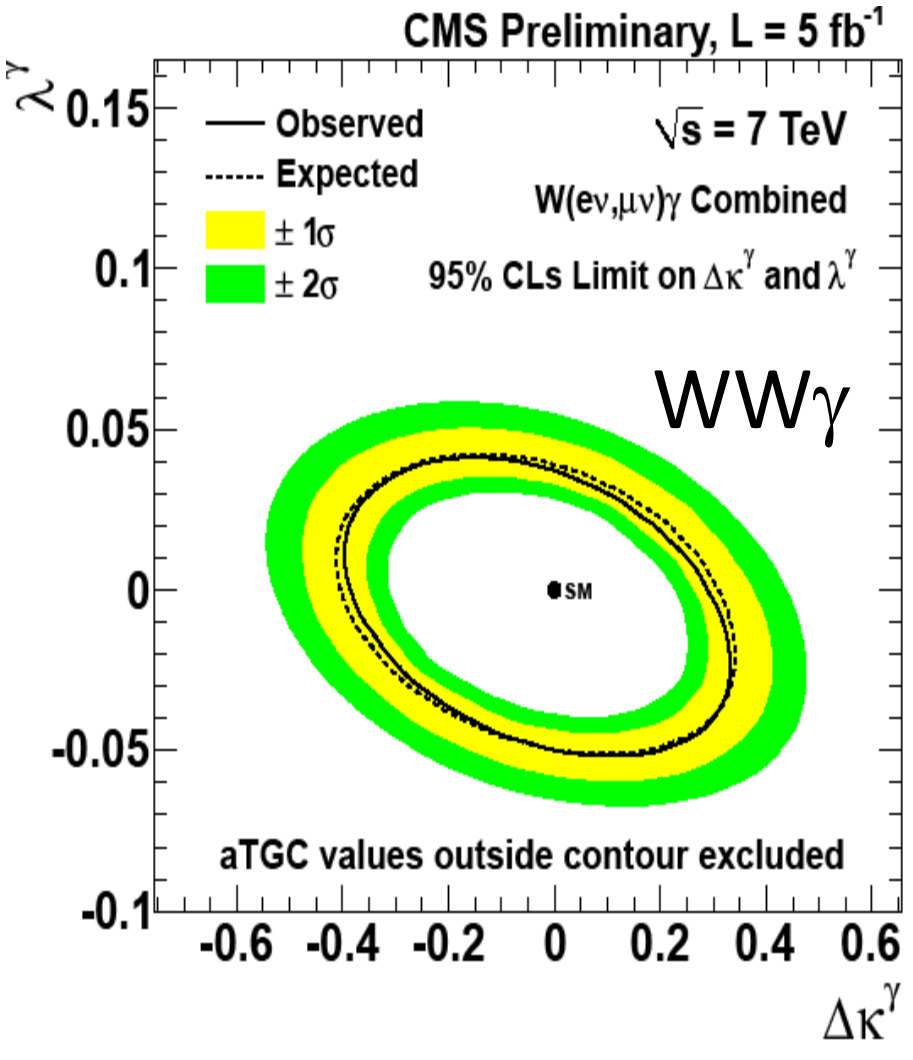




CMS-PAS-EWK-11-009

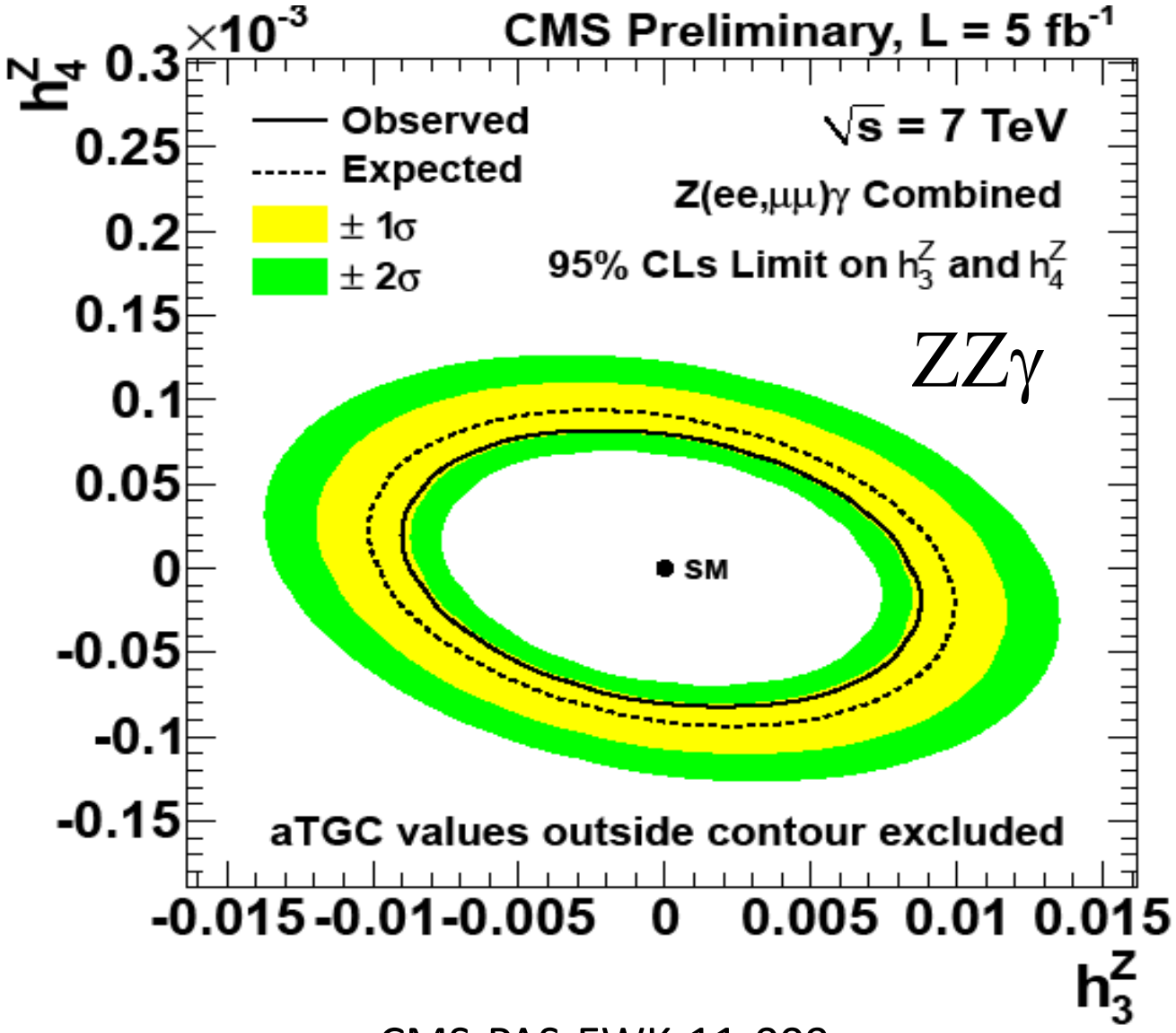
Constraints on New Physics





CMS-PAS-EWK-11-009

Constraints on New Physics

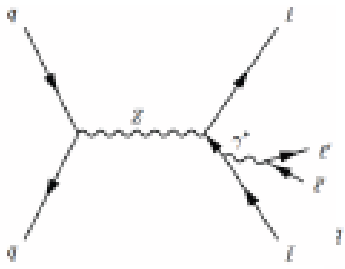


CMS-PAS-EWK-11-009

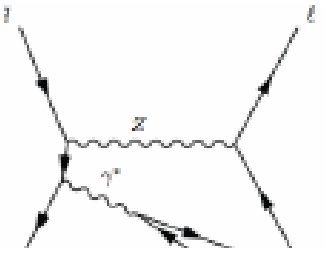
First observation of Z→4l in pp collisions

- Standard candle for four lepton events in similar phase space to Higgs search
- Theoretical expectations
  - BR: 4.45×10^{-06}
  - Cross Section: 120 ± 4.92 fb

CMS arXiv:1210.3844



...FSR

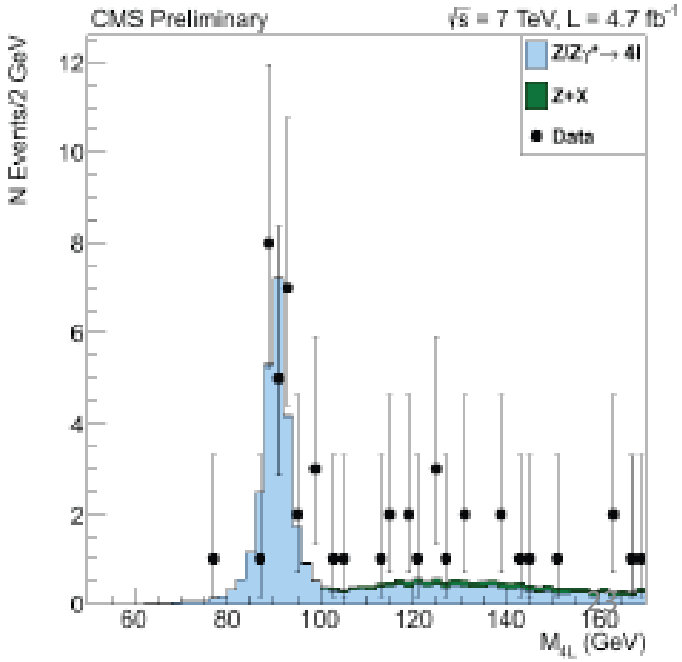


ISR...

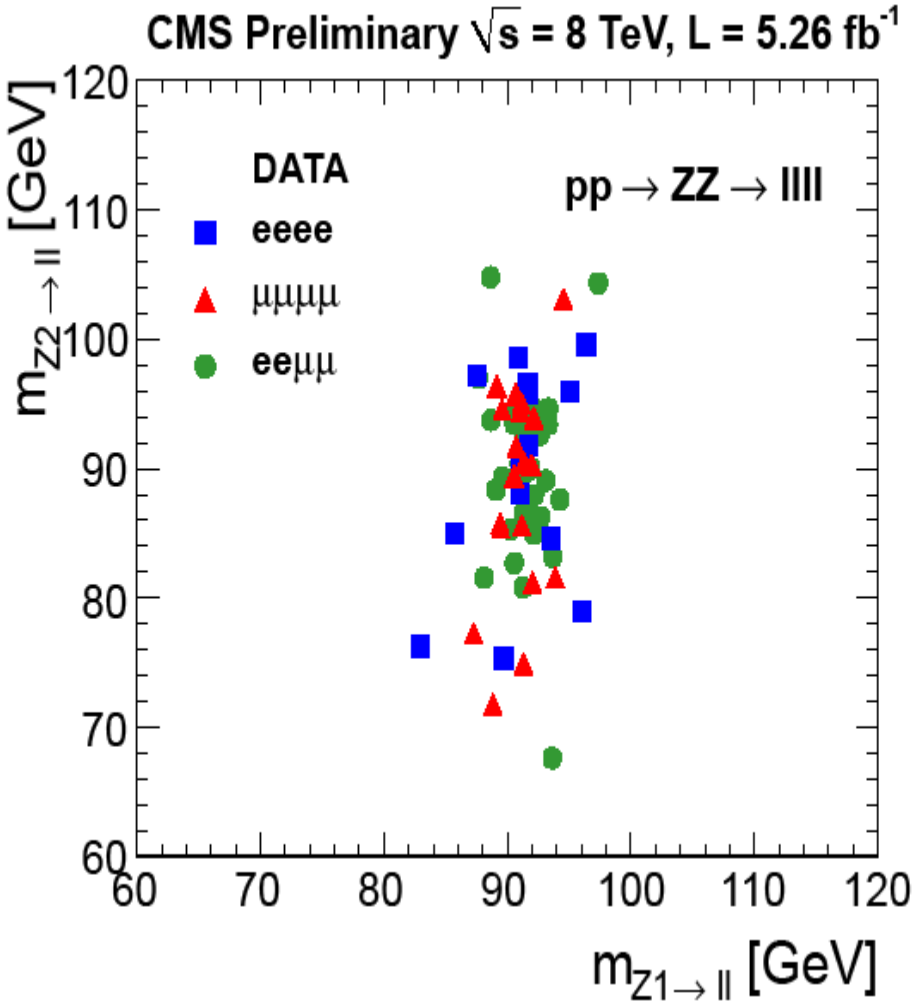
Final state channels	4e	4μ	2e2μ	4ℓ
Irreducible background ($pp \to Z\gamma^* \to 4\ell$)	0.07	0.25	0.14	0.46 ± 0.05
Other (reducible) backgrounds	0.01	0.01	0.05	0.07 ± 0.1
Expected signal ($pp \to Z \to 4\ell$)	3.8	13.6	12.0	29.4 ± 2.6
Total expected (simulation)	3.9	13.9	12.2	30.0 ± 2.6
Observed events	2	14	12	28
Yield from fit to the observed mass distribution	-	13.6 ± 3.8	11.5 ± 3.1	27.3 ± 5.4

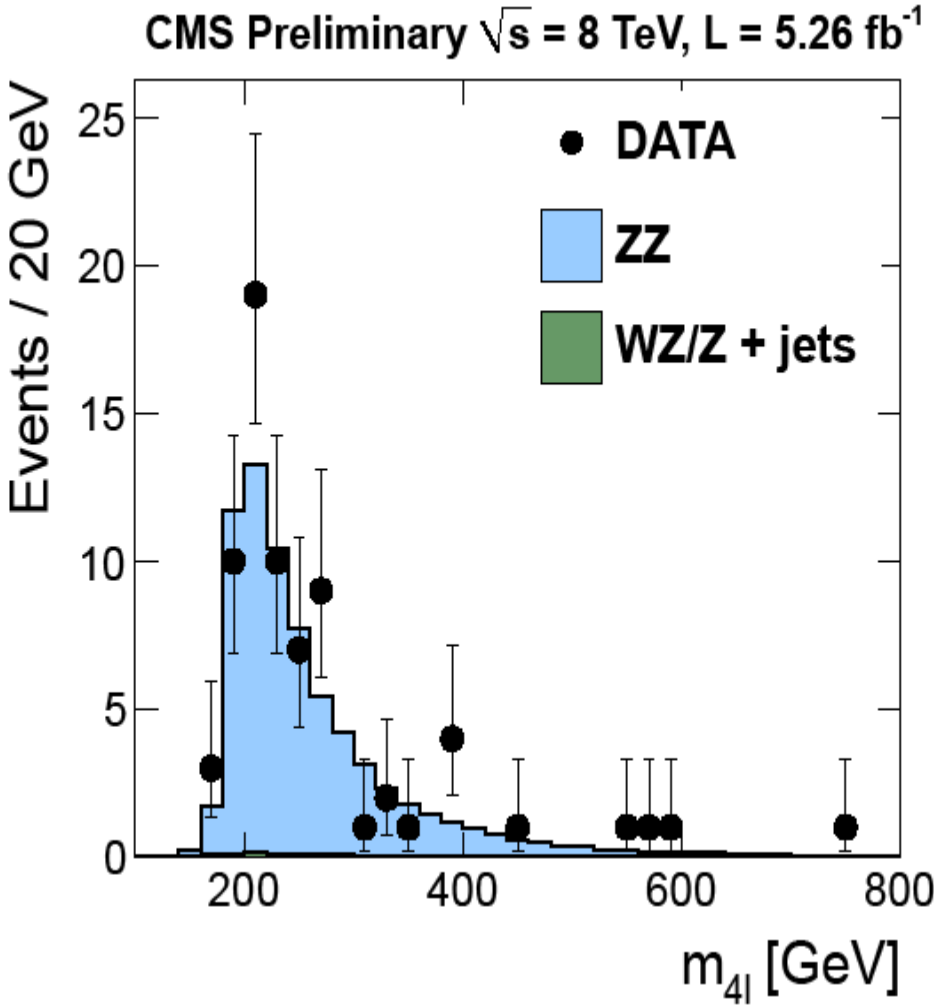
$$\sigma \times BR(Z \to 4\ell) = 125^{+26}_{-23}(\text{stat})^{+9}_{-6}(\text{syst})^{+7}_{-5}(\text{lumi})\ \text{fb},$$

$$BR(Z \to 4\ell) = 4.4^{+1.0}_{-0.8}(\text{stat}) \pm 0.2(\text{syst}) \times 10^{-6}.$$



ZZ @ 8 TeV





- CMS: σ_{ZZ} = 8.4 ± 1.0(stat.) ±0.7(sys.) ± 0.4(lumi.) pb
- SM: σ_{ZZ} = 7.7 ± 0.4 pb

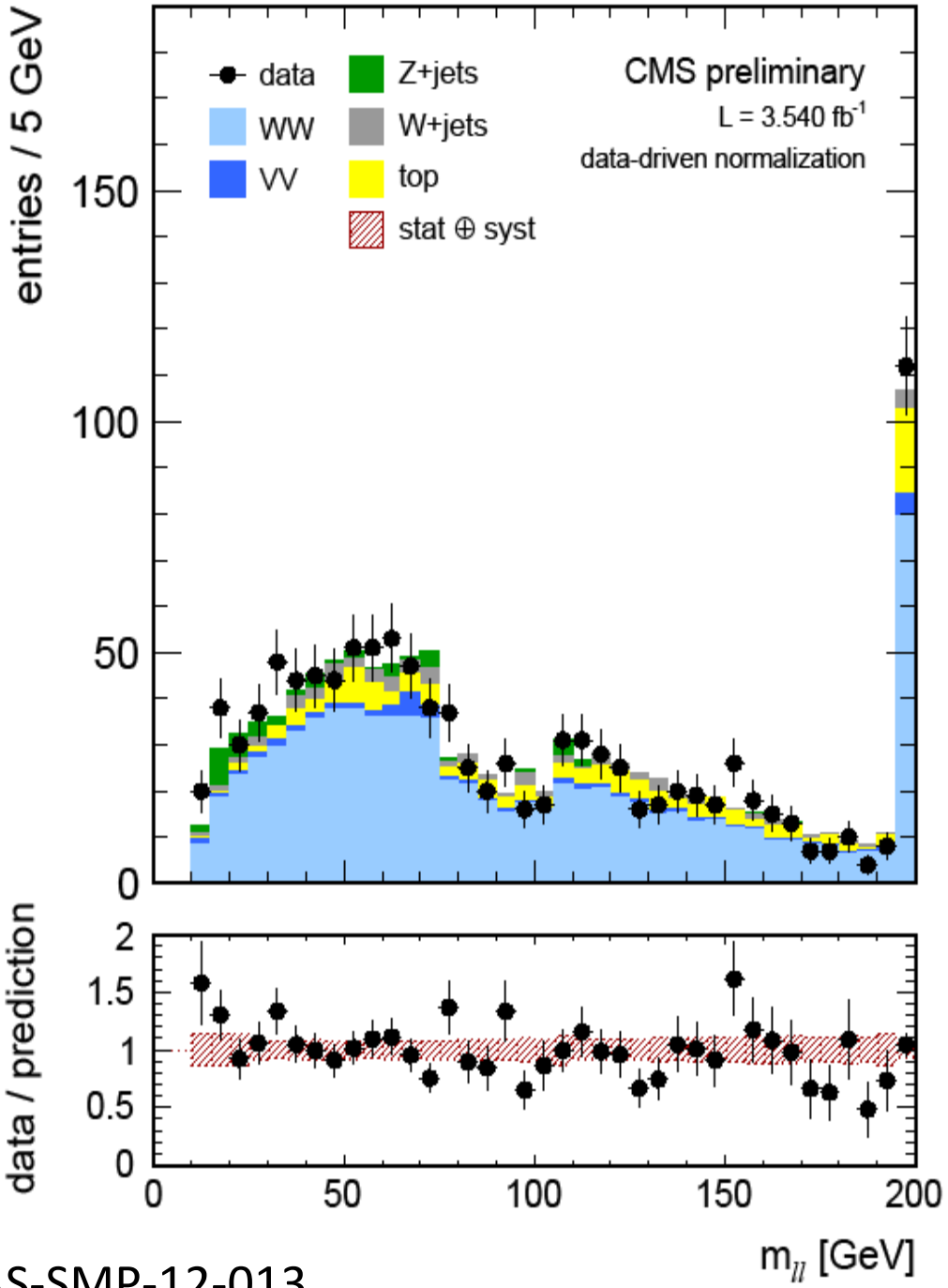
CMS-PAS-SMP-12-014

WW @ 8 TeV

CMS

- σ_{WW} = 69.9 ± 2.8 (stat.)
  ± 5.6 (syst.) ± 3.1 (lumi.)pb
  (systematically limited.)

- SM: 57.3 (+2.4/−1.6) pb



CMS-PAS-SMP-12-013

Conclusion

- Precise test of the Standard Model at TeV scale
- Significant contribution to PDFs
- Stable ground for new physics searches
- First W/Z measurement at 8 TeV: more results upcoming
- Results spanning several order of magnitudes
- General good level of agreement with NNLO theoretical calculations
- Starting to challenge NNLO predictions