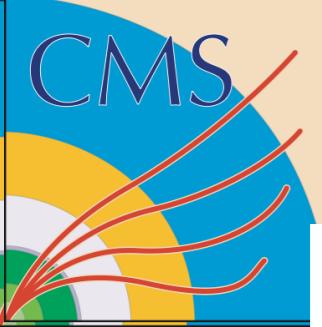


WW SS Vector Boson Scattering at the HL-LHC

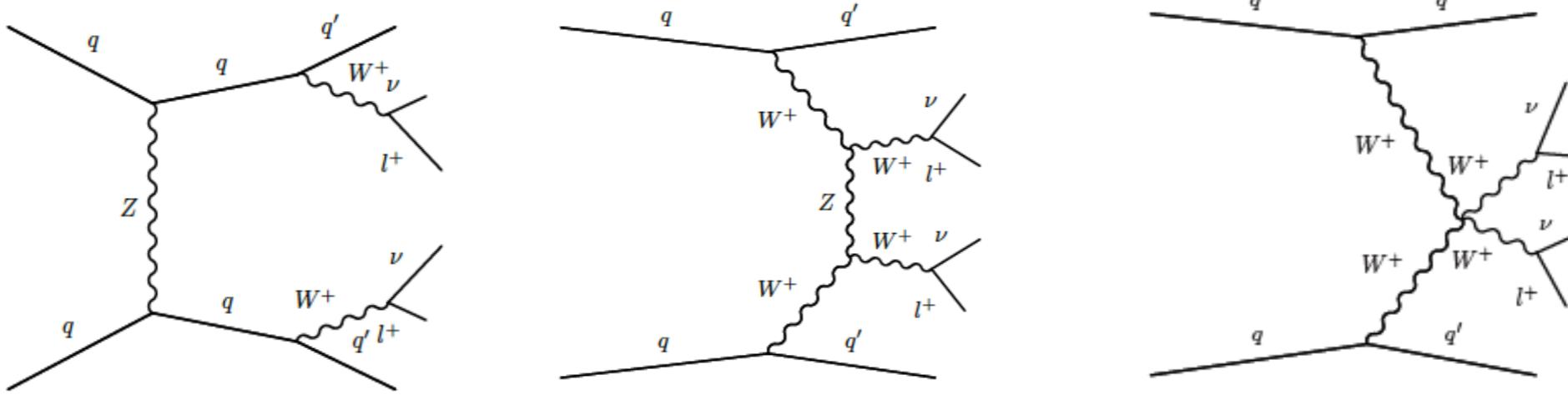
**Sandhya Jain, Gobinda Majumder, Kajari Mazumdar,
Sarvesh Uplap***

TIFR, Mumbai, India

Alexander Savin
University of Wisconsin-Madison



Introduction



Observation of Electroweak Production of Same-Sign W Boson Pairs in the Two Jet and Two Same-Sign Lepton Final State in Proton-Proton Collisions at $\sqrt{s} = 13$ TeV

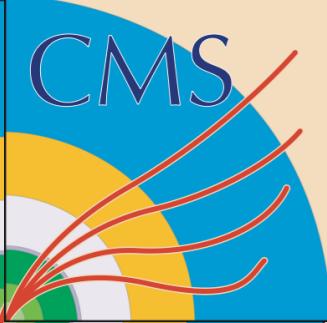
A. M. Sirunyan *et al.* (CMS Collaboration)
Phys. Rev. Lett. **120**, 081801 – Published 22 February 2018

Observed significance of 5.5 std deviations with 35.9fb⁻¹ of integrated luminosity at 13TeV

Fiducial cross section = 3.83 ± 0.66 (stat) ± 0.35 (syst) fb.
Predicted theoretical cross section at LO = 4.25 ± 0.27 fb,
In agreement with the measurement

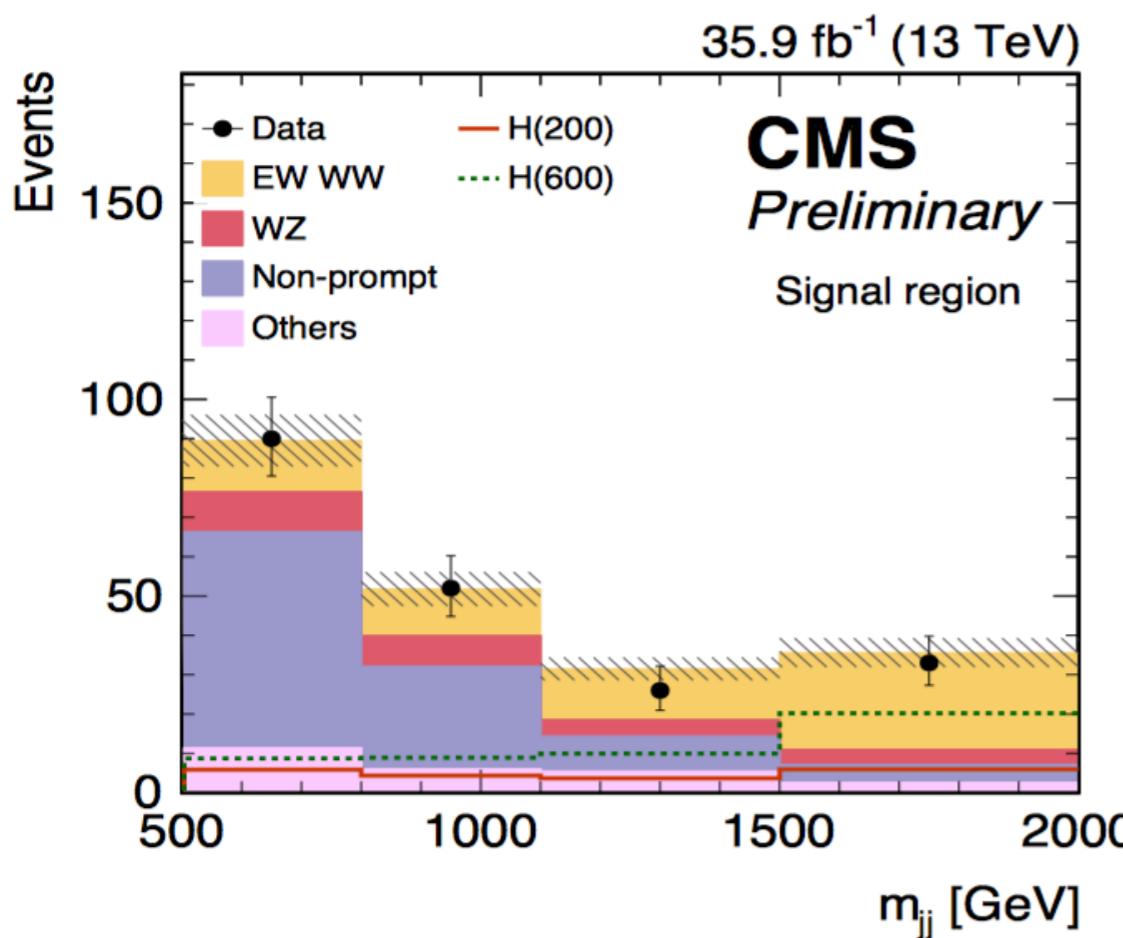
SMP-14-008 →

Prospects for the study of vector boson scattering in same sign WW and WZ interactions at the HL-LHC with the upgraded CMS detector



Published 13 TeV results

Fully leptonic decays to muons and electrons, at least two jets with high m_{jj}



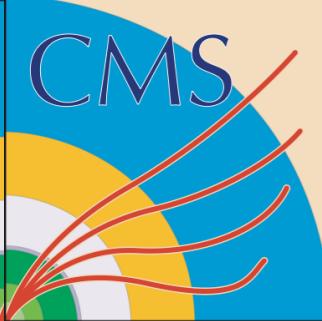
Main backgrounds from $t\bar{t}$ and WZ ,
signal dominates the high di-jet mass
range

Data	201
Signal + total background	205 ± 13
Signal	66.9 ± 2.4
Total background	138 ± 13
Nonprompt	88 ± 13
WZ	25.1 ± 1.1
QCD WW	4.8 ± 0.4
$W\gamma$	8.3 ± 1.6
Triboson	5.8 ± 0.8
Wrong sign	5.2 ± 1.1

TABLE II. Observed and expected 95% C.L. limits on the coefficients for higher-order (dimension-8) operators in the effective field theory Lagrangian.

	Observed limits (TeV^{-4})	Expected limits (TeV^{-4})
f_{S0}/Λ^4	$[-7.7, 7.7]$	$[-7.0, 7.2]$
f_{S1}/Λ^4	$[-21.6, 21.8]$	$[-19.9, 20.2]$
f_{M0}/Λ^4	$[-6.0, 5.9]$	$[-5.6, 5.5]$
f_{M1}/Λ^4	$[-8.7, 9.1]$	$[-7.9, 8.5]$
f_{M6}/Λ^4	$[-11.9, 11.8]$	$[-11.1, 11.0]$
f_{M7}/Λ^4	$[-13.3, 12.9]$	$[-12.4, 11.8]$
f_{T0}/Λ^4	$[-0.62, 0.65]$	$[-0.58, 0.61]$
f_{T1}/Λ^4	$[-0.28, 0.31]$	$[-0.26, 0.29]$
f_{T2}/Λ^4	$[-0.89, 1.02]$	$[-0.80, 0.95]$

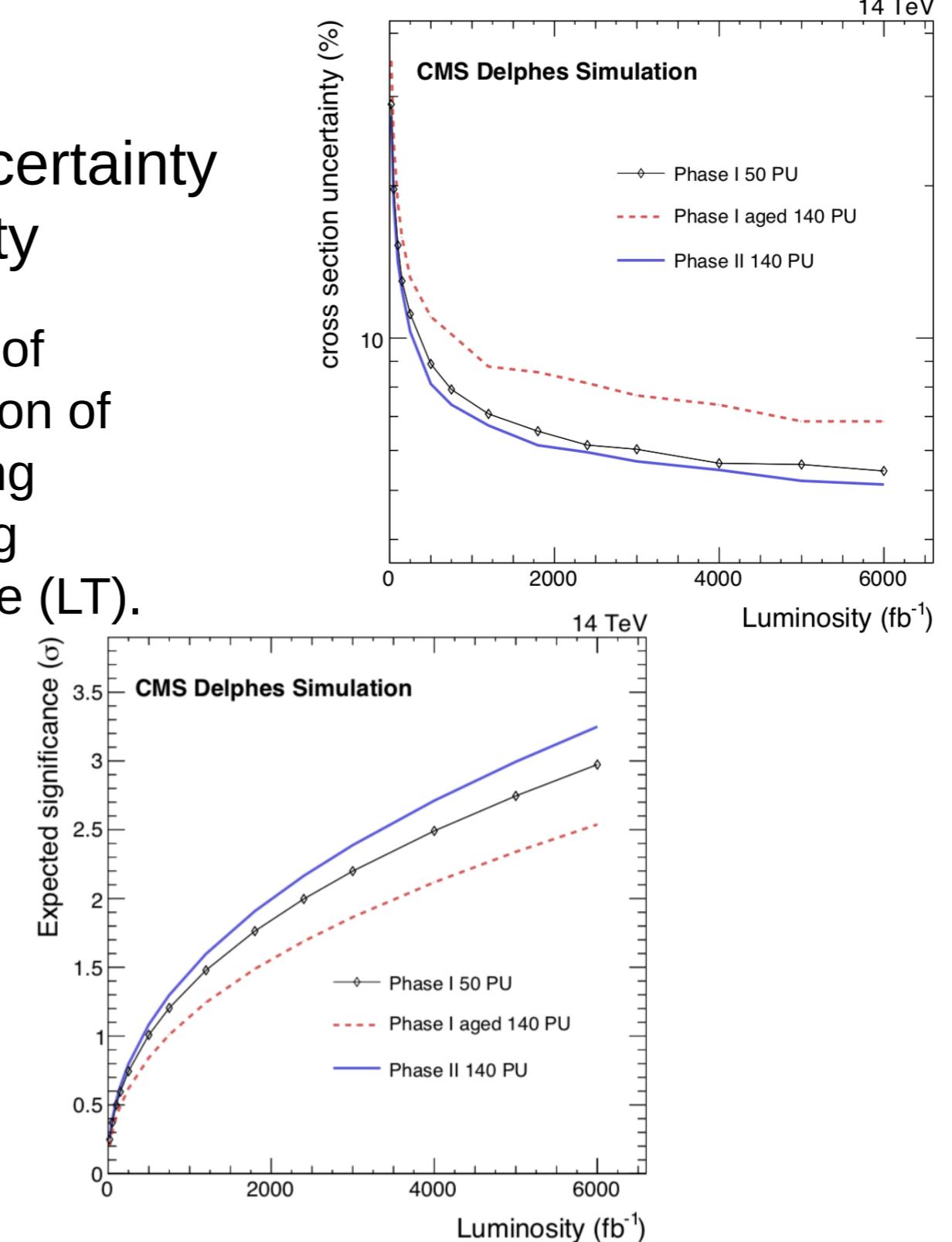
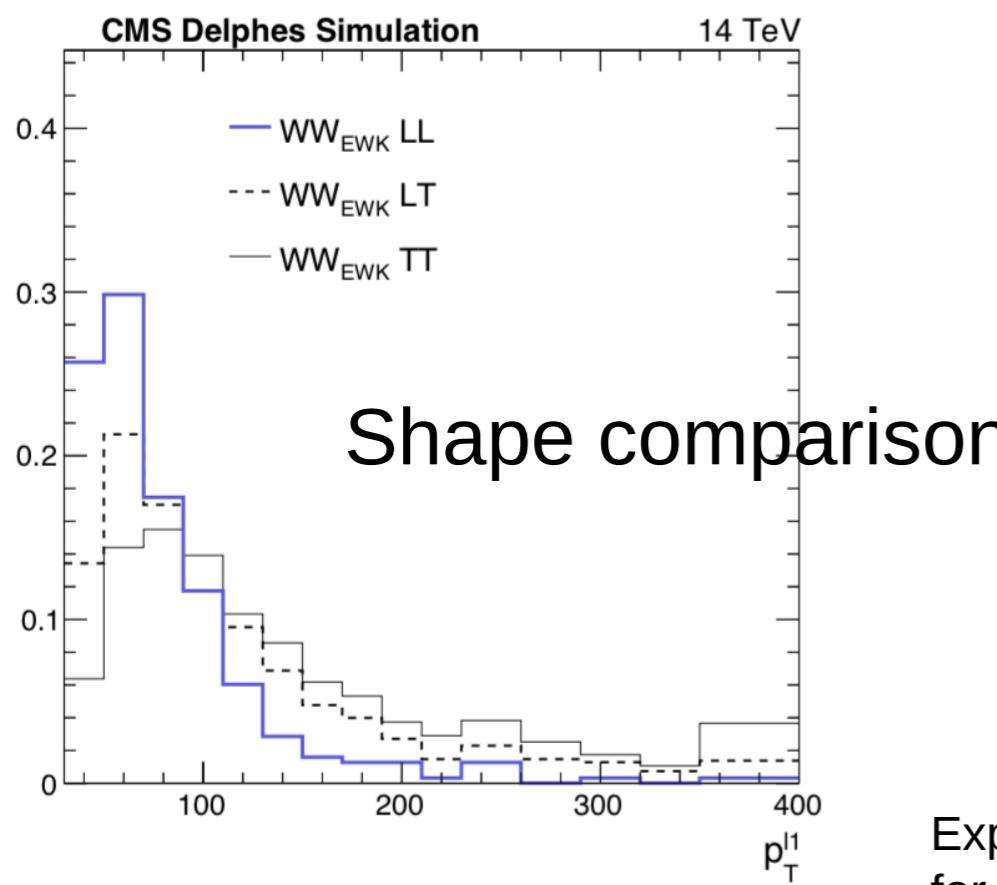
Limits on aQGC are set



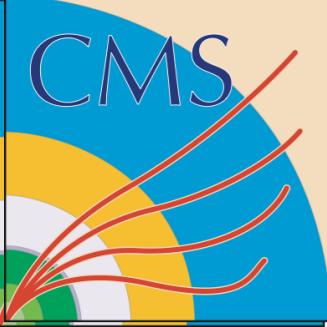
SMP-14-008 HL-LHC WW and WZ

Expected cross section uncertainty decrease with the luminosity

The total vector boson scattering is composed of three components, depending on the polarization of the final-state vector bosons: both of them being longitudinally polarized (LL), both of them being transversely polarized (TT), and the mixed case (LT).

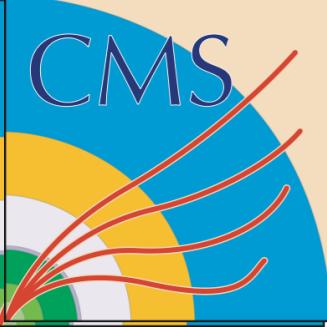


Expected discovery significance for the longitudinal vector boson scattering for the same-sign WW analysis as a function of the collected luminosity.

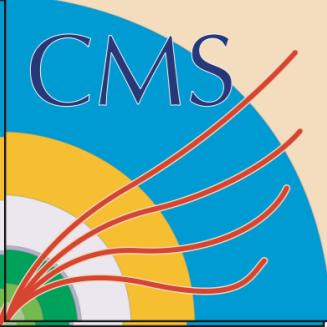


Ongoing 14 TeV analysis

New detector geometry
Optimization of object and event selections for
PU200
Systematics evaluation



Backup



13 TeV analysis: Event Selection

Event selection requirement are as follows:

1. Two jets with $pT > 30\text{ GeV}$ and $|\eta| < 5$ satisfying VBS criteria:

$$\begin{aligned} m(jj) &> 500\text{ GeV} \\ |\Delta\eta| &> 2.5 \end{aligned}$$

2. Two same sign isolated leptons with $pT > 25(20)\text{ GeV}$ and $|h| < 2.4$

3. Moderate missing transverse momenta ($> 40\text{ GeV}$)

4. Maximum zeppenfeld variable value for selected leptons < 0.75

5. Btag veto of jets

6. Minimum di-lepton mass $> 20\text{ GeV}$

7. Veto on third loose lepton ($pT > 10\text{ GeV}$)

8. Veto if di-lepton mass falls in Z mass region ($75\text{ GeV} - 105\text{ GeV}$)

9. Veto on identified hadronically-decaying τ lepton with $pT > 18\text{ GeV}$

Estimated signal and background yields after the selection at 35.9 fb^{-1}

	Data	201
Signal	66.9 ± 2.4	
Nonprompt(TTBar)	88 ± 13	
WZ	25.1 ± 1.1	
WW QCD	4.8 ± 0.4	
W γ	8.3 ± 1.6	
Triboson	5.8 ± 0.8	
Wrong Sign	5.2 ± 1.1	
Total Bkg	$; 138 \pm 13$	
Signal + Bkg	$: 205 \pm 13$	