TGC Limits and Search for New Resonances in WZ Production at CMS

Keti Kaadze

Kansas State University

On behalf of CMS collaboration

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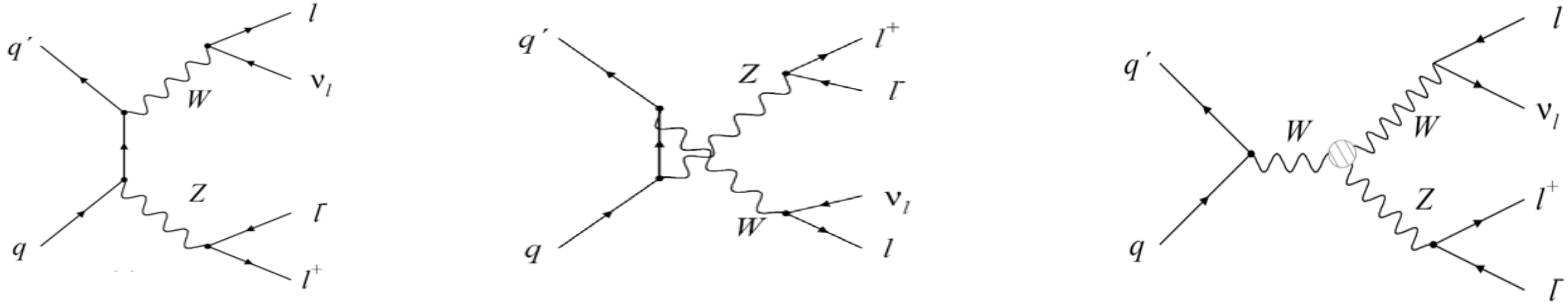
WZ production

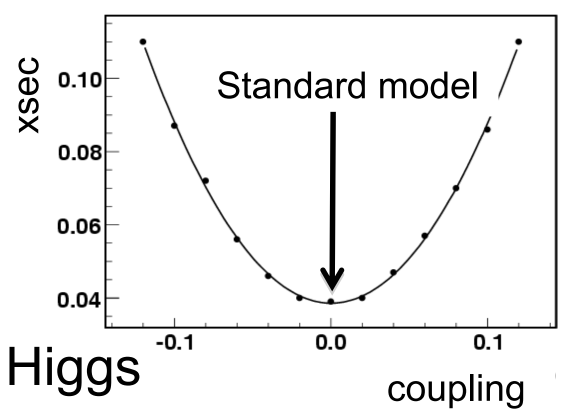
- Three diagrams describe WZ production at tree level:



- Important measurements with WZ
  - Cross section measurement
    - Important for Higgs and other searches
  - Measuring WWZ coupling
- Search for new physics
  - Limits on anomalous couplings
    - Increase of cross section
    - Enhanced p_T spectra
  - Search for a resonant production
    - Technicolor, W', fermiophobic charged Higgs

Generalized lagrangian is parameterized by 7 couplings. To be measured:

$\Delta g^Z_1 = g^Z_1 - 1$; $\Delta\kappa_Z = \kappa_Z - 1$; λ_Z

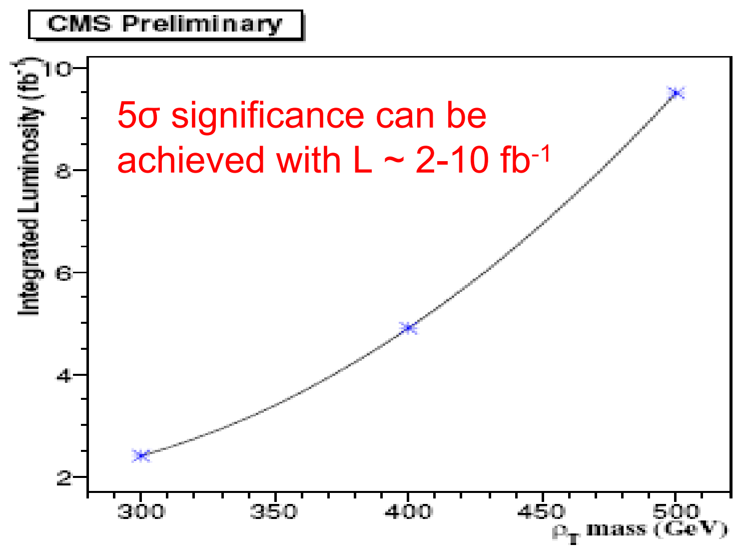


Towards new physics

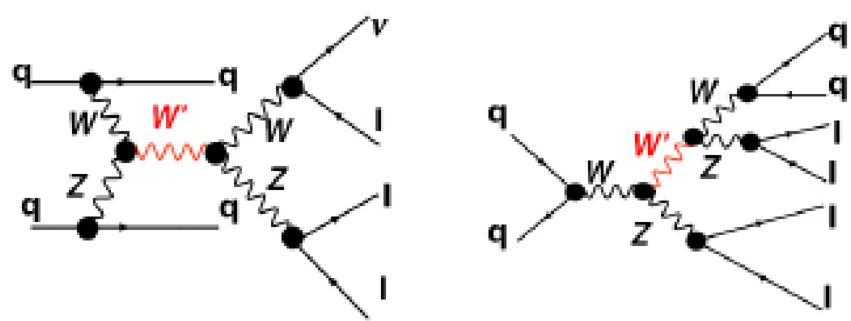
- Technicolor (TC) – explaining EWSB
  - "walking" gauge coupling
  - Avoid FCNC interactions
  - Low-scale TC < 250 GeV
  - Mass of ρ_{TC}, ω_{TC} < 0.5 TeV

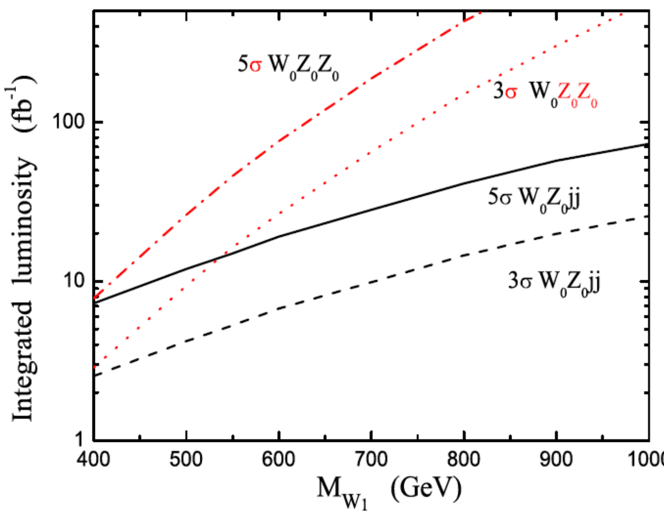
$\rho_{TC}/a_{TC} \rightarrow W^{\pm}+Z \rightarrow l^{+}l^{-}l^{\pm}\nu$ – cleanest

$\rho_{TC}/a_{TC} \rightarrow W^{\pm}+\pi_{TC} \rightarrow l^{\pm}\nu\, bq$ – hard at LHC



- Minimal Higgsless Model
  - Predicts new gauge bosons W', Z'





Analysis strategy

$WZ \rightarrow$	$jjjj$	$jjl\nu$	$jjll$	$lll\nu$
Br frac. %	47.25	7.55	2.28	0.36

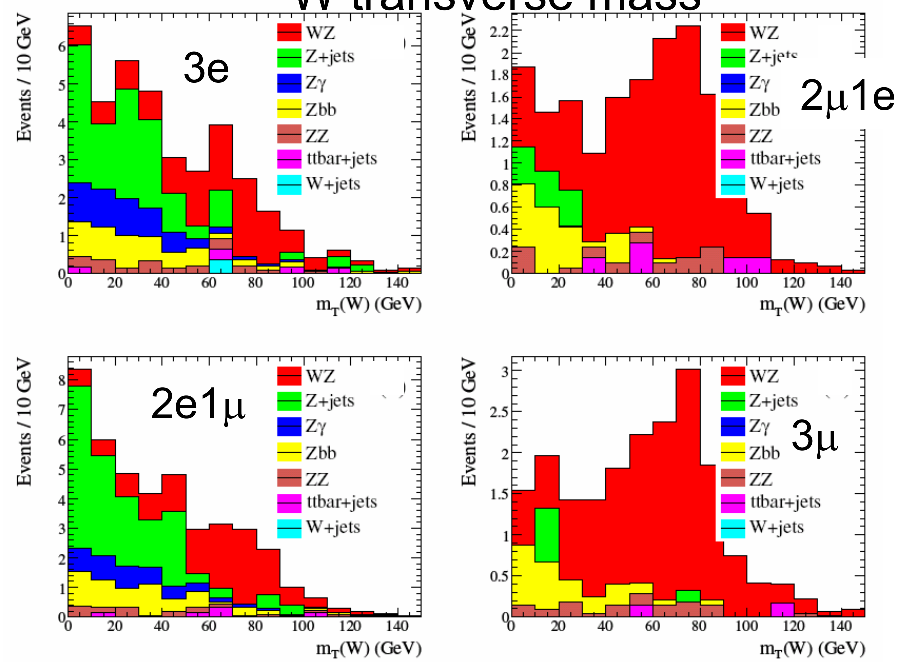
Fully leptonic channel is cleanest at LHC

- This analysis require 300-400 pb^{-1} of integrated luminosity to claim a discovery (for $\sqrt{\hat{s}}$ =14 TeV)
  - Earlier measurement of Z and W boson production is very useful
- Development of a well-controlled data-driven background estimation methods is crucial
- There are number of background processes to $WZ \rightarrow lll\nu$: Z+jet (largest), $Z\gamma$, ZZ, W+jet, $t\bar{t}$+jet
  - We must have reliable and efficient lepton ID to reduce background!

Event selection (eee, eeμ, e$\mu\mu$, $\mu\mu\mu$):

- Trigger based electrons or muons
- Three leptons satisfying lepton ID
  - Loose selection for l from Z decay
  - Tight selection for l from W decay
- Z mass constraint
- W transverse mass cut
- Event rejected if there is more than one Z boson candidates

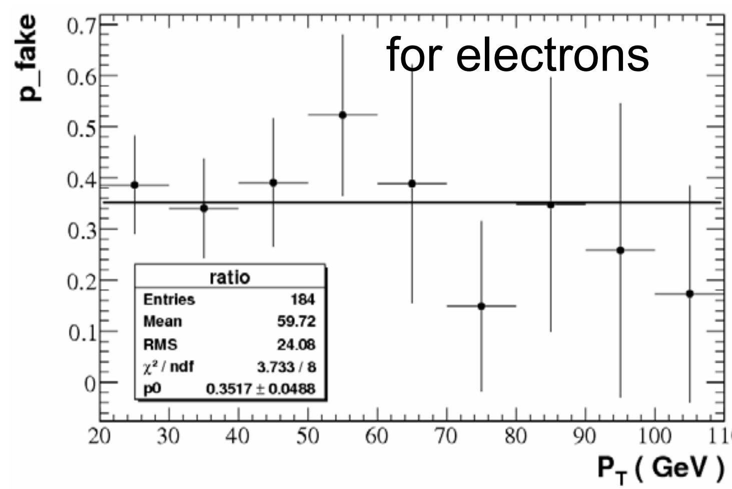
W transverse mass



Background estimation

Separate backgrounds

- Physics: ZZ, Zγ estimated from MC
- Instrumental without genuine Z boson: W+jet, $t\bar{t}$+jet is relatively small(6% of signal sample) and is determined from MC. Can be estimated from side-bands with real data
- Instrumental with genuine Z boson: Z+jet, Z+$b\bar{b}$ using data-driven matrix method



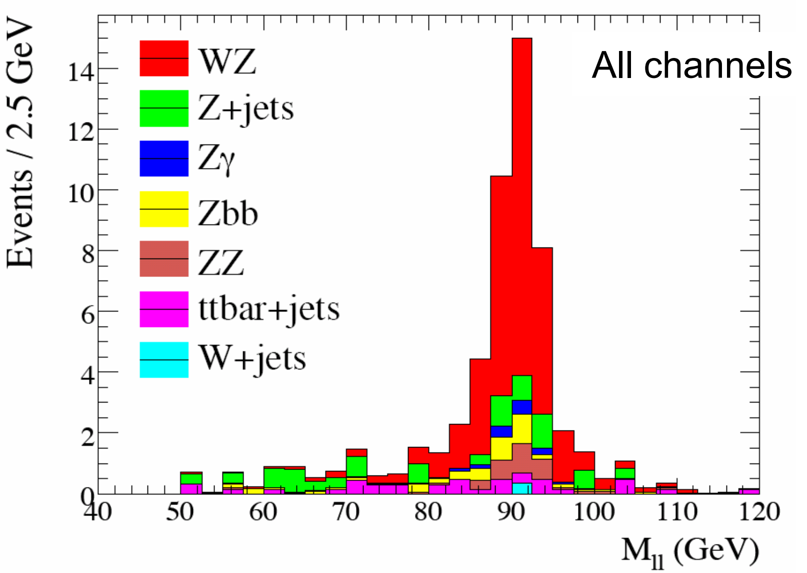
$$\begin{cases} N_{loose} = N_l + N_j \\ N_{tight} = \varepsilon_{tight} N_l + p_{fake} N_j \end{cases}$$

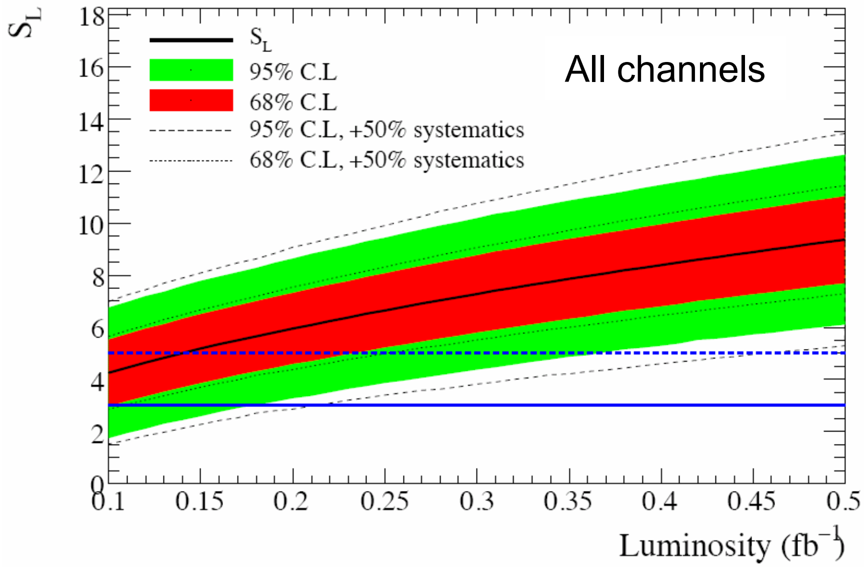
- Determine the efficiencies in data: Tag & Probe method (ε_{tight})
- Use W+jet sample to estimate p_{fake}

Signal extraction

- Estimated number of signal and background events are in perfect agreement with MC predictions

	3e	2e1μ	2μ1e	3μ
N - ZZ -Zγ - W+jets - $t\bar{t}$	11.1 ± 1.3	8.2 ± 0.9	12.1 ± 1.2	10.5 ± 0.8
$N^{genuine\ Z}$ (matrix method)	3.2 ± 1.7	0.6 ± 0.8	4.6 ± 2.0	0.6 ± 0.9
N^{WZ^0}	7.9 ± 2.1	7.6 ± 1.2	7.5 ± 2.3	10.0 ± 1.2
WZ^0 from MC	7.9	8.1	9.0	10.1





- 5σ significance can be achieved with L < 350 pb^{-1} all channels combined
- 3μ+MET signature is most sensitive due to low background level

Conclusion

- High energy range at LHC allows us to probe SM at energies never obtained before as well as increases sensitivity to new physics searches
- Di-boson physics studies are interesting

  and may provide an impact on our understanding of nature
- First measurements of WWZ coupling can be done with an early data. Any observation of anomalous couplings manifests new physics
- Stay tuned for the results from LHC ☺

References

- CMS Collaboration, “Study of the Process $pp \to WZ \to lll\upsilon$, http://cms-physics.web.cern.ch/cms-physics/public/EWK-08-003-pas.pdf

- K. Lane, S. Mrenna, “The Collider Phenomenology of Technihadrons in the Technicolor Straw Man Model”, Phys. Rev. D67, 115011 (2003) [hep-ph0210299]

- Alexander Belyaev et al., “Collider Phenomenology of Higgsless models”, arXiv:0711.1919v