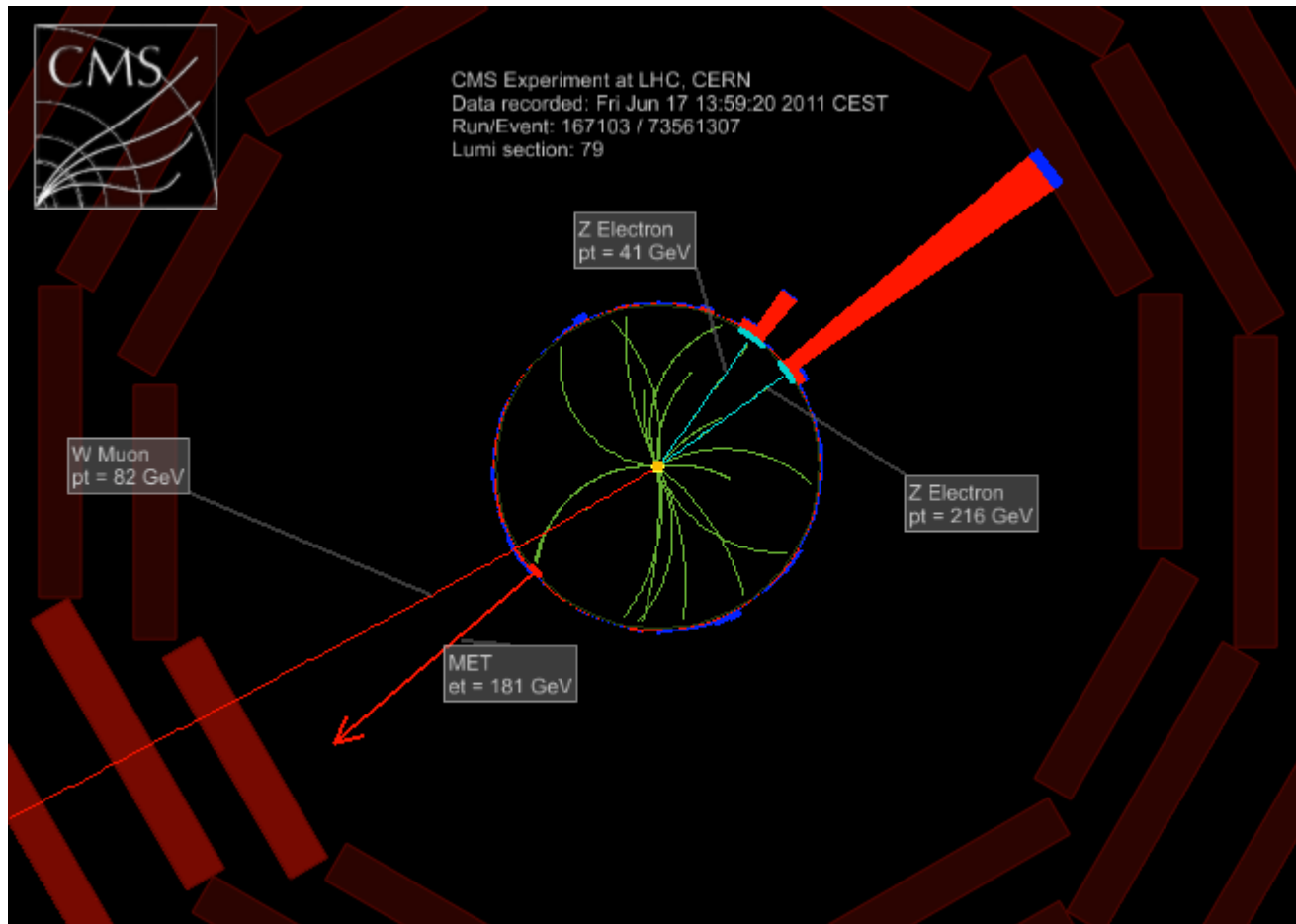


Search for Exotic WZ Resonances in CMS with 4.98 fb^{-1} at 7 TeV

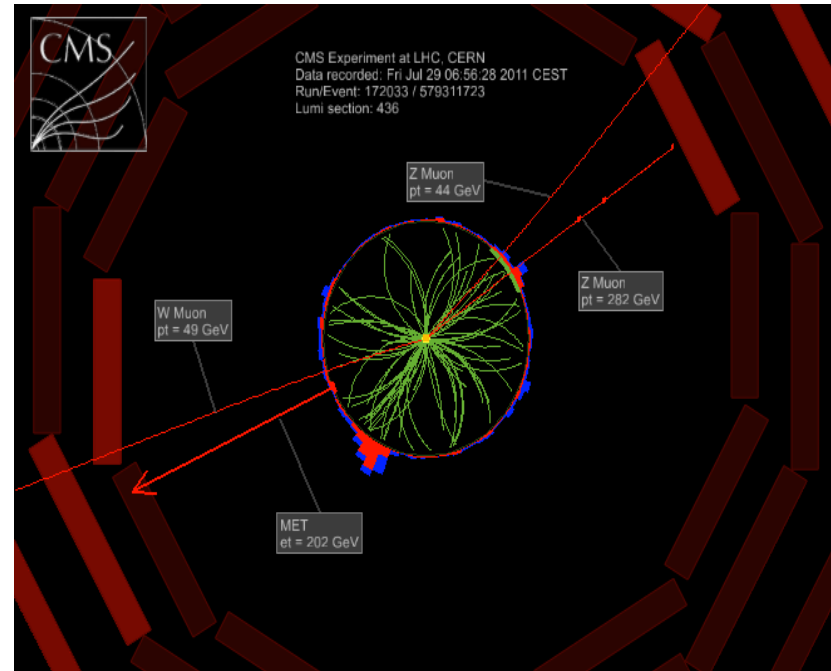
Cory Fantasia - Boston University



USLUO - 2012.10.20

WZ Resonances

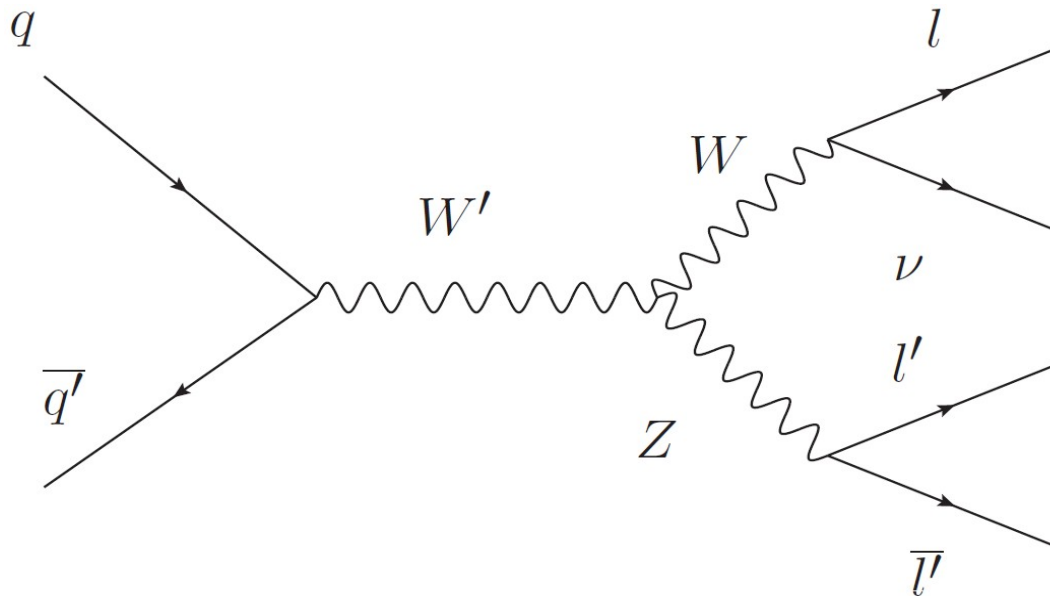
- New WZ Resonances predicted by many extensions of the SM
 - Sequential Standard Model (SSM): W'
 - Technicolor: ρ_{TC}
 - Little Higgs
 - Extra Dimensions
- Some of these offer alternatives to the SM mechanism of EWSB
- Clean signature
 - 3 leptons + E_T^{Miss}
 - Able to reconstruct Z boson mass
 - Form W boson from remaining lepton and E_T^{Miss}
 - Search for bump in WZ mass distribution



$$WZ \rightarrow l^\pm \nu l'^+ l'^- \quad (l, l' = e, \mu)$$

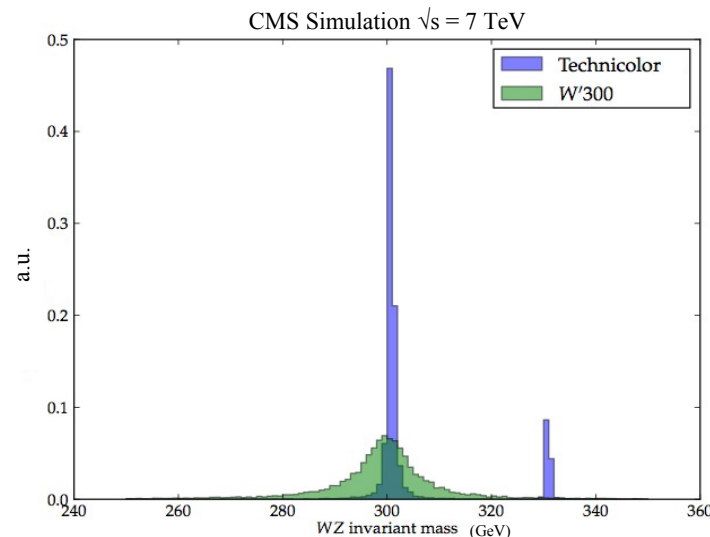
SSM W'

- Current best limit come from W' decays to leptons
- Exclude W' masses < 2.85 TeV @ 95% C.L. [CMS, CERN-PH-EP-2012-103]
 - Assumes SM as benchmark and that $W' \rightarrow WZ$ is suppressed
- $W' \rightarrow WZ$ search is complementary to this search
 - Important for fermiophobic W' models, etc
 - Previous published limits from D0 [D0, Phys. Rev. Lett. 104, 061801 (2010)]
 - Excludes W' masses between 188 GeV and 520 GeV for SSM $W' \rightarrow WZ$



Technicolor

- A theory of dynamical breaking of electroweak symmetry
 - Introduces new strong dynamics *a la* QCD
- Technicolor problems with the S parameter can be naturally suppressed if the lightest ρ_{TC} and its axial vector partner, a_{TC} , are nearly degenerate
 - Phenomenology set forth in the “Technicolor Strawman Model” TCSM
 - Lightest ρ_{TC} and ω_{TC} lie below 1 TeV and they decay to γ, W, Z, π_{TC}
 - Channels have distinctive signatures since they are very narrow : $\Gamma < 5$ GeV

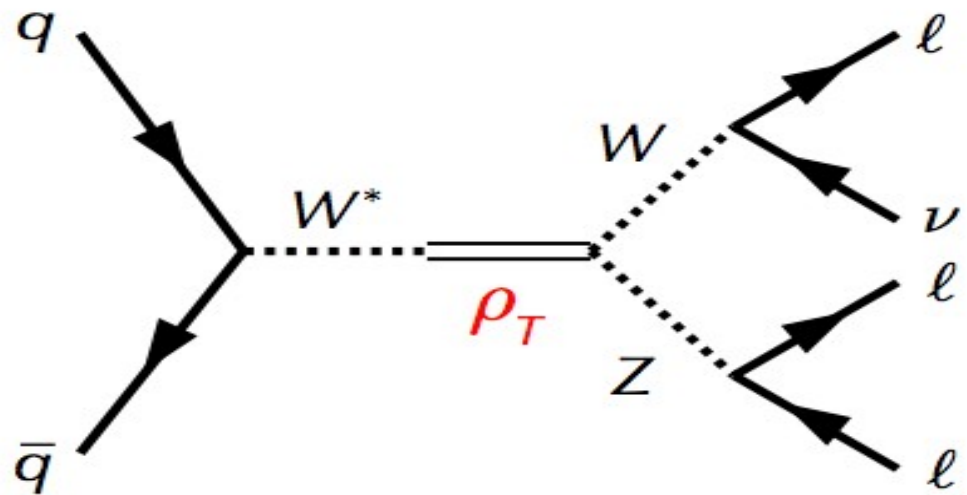


ρ_{TC} much narrower
than W' at
generator level

ρ_{TC} and a_{TC} merge
and are
indistinguishable
after
reconstruction

Technicolor

- Relationship of $M(\pi_{TC})$, $M(\rho_{TC})$ significantly affects $BR(\rho_{TC} \rightarrow WZ)$
 - If $M(\rho_{TC}) > 2 M(\pi_{TC})$, WZ BR reduced $\sim 10x$
 - WZ BR $\sim 100\%$ if $M(\rho_{TC}) < M(\pi_{TC}) + M(W)$
 - $M(\pi_{TC}) = \frac{3}{4} M(\rho_{TC}) - 25 \text{ GeV}$
- Theoretically motivated by work with TC proponents
- Current published exclusion limit: 408 GeV
 - [D0, Phys. Rev. Lett. 104, 061801 (2010)]
 - For $M(\rho_{TC}) < M(\pi_{TC}) + M(W)$



Background Characteristics

- **Physics Background**

- SM Diboson

- **WZ**

- Same signature
- Softer non-peaking spectrum

- **ZZ**

- A missed lepton appears as
3 leptons + E_T^{Miss}
- Similar signature

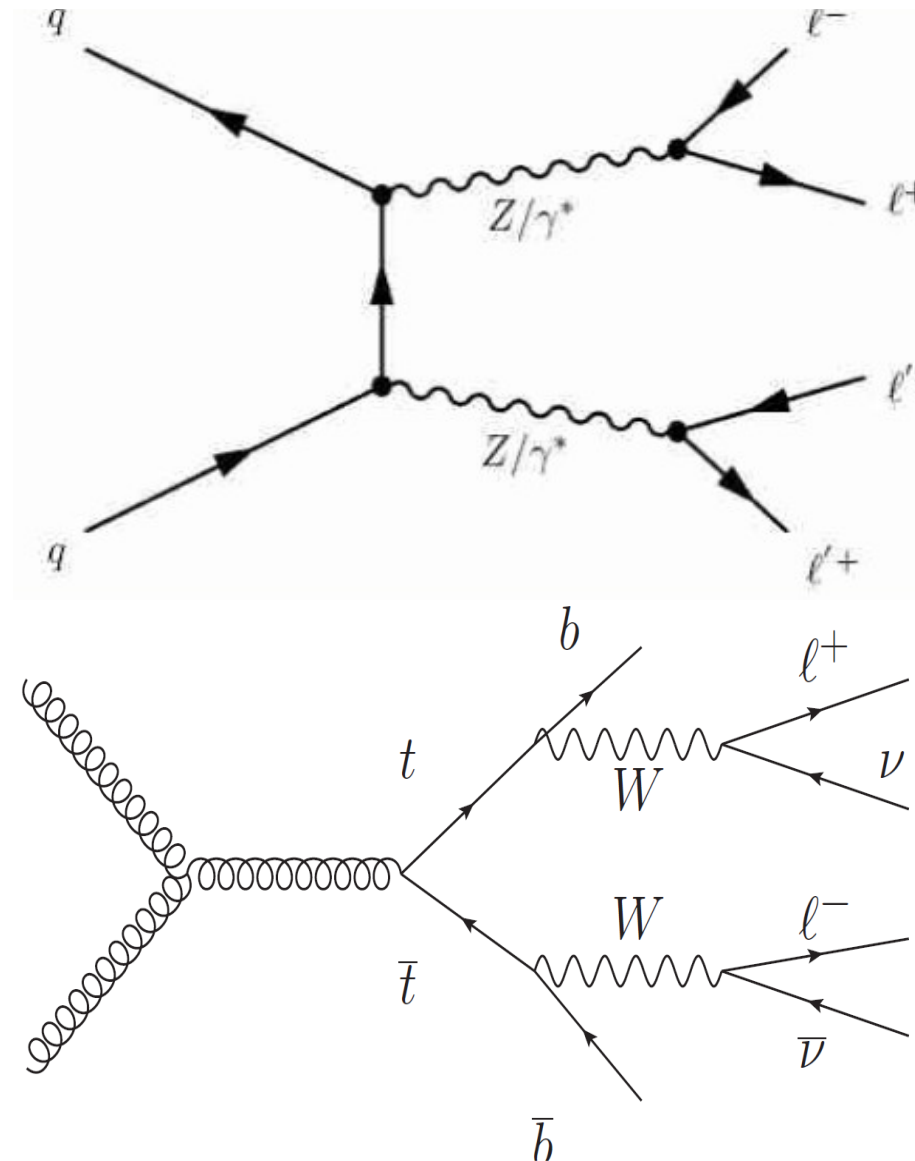
- **Instrumental Background**

- With a genuine Z boson

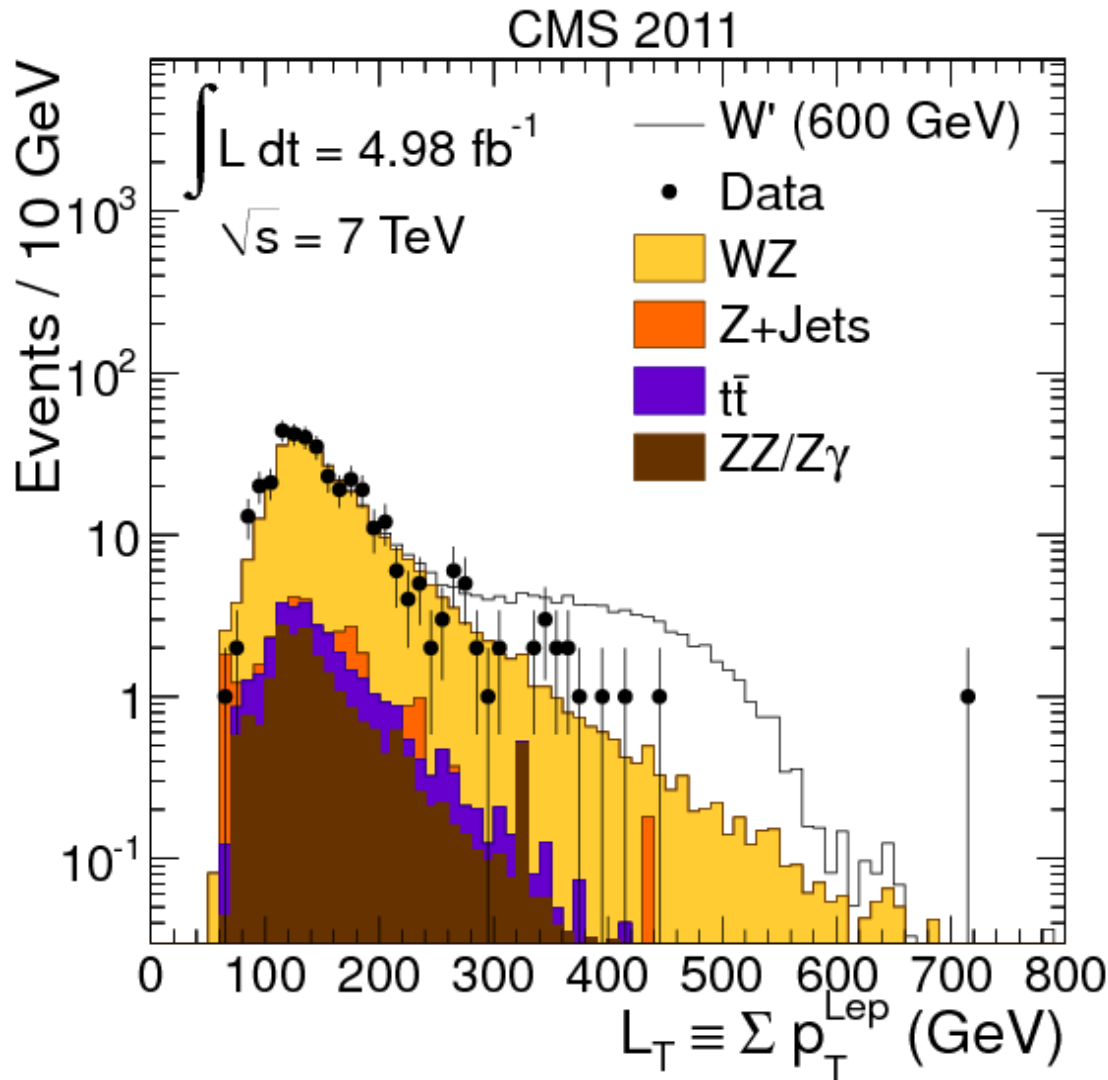
- **Z+jets, Z γ , ZQQ**

- Without a genuine Z boson

- **t \bar{t} , W+jets, W γ , WW, QCD**



“Leptonic L_T ”



Good discriminator
between signal and
background

$$L_T \equiv \sum p_T^l$$

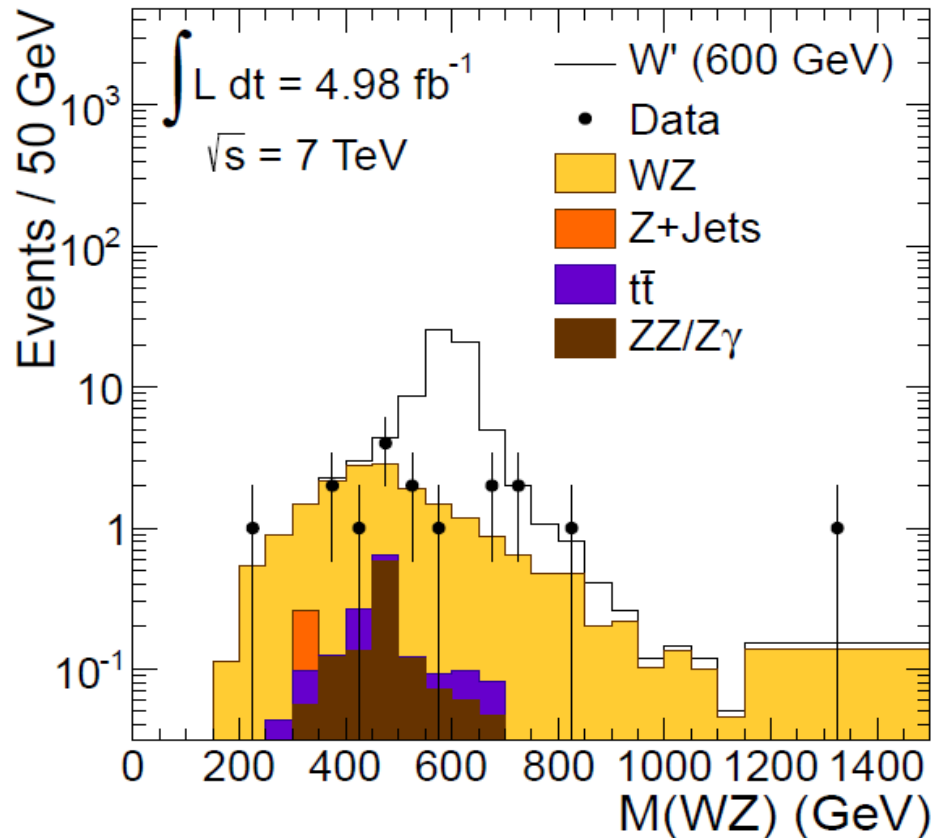
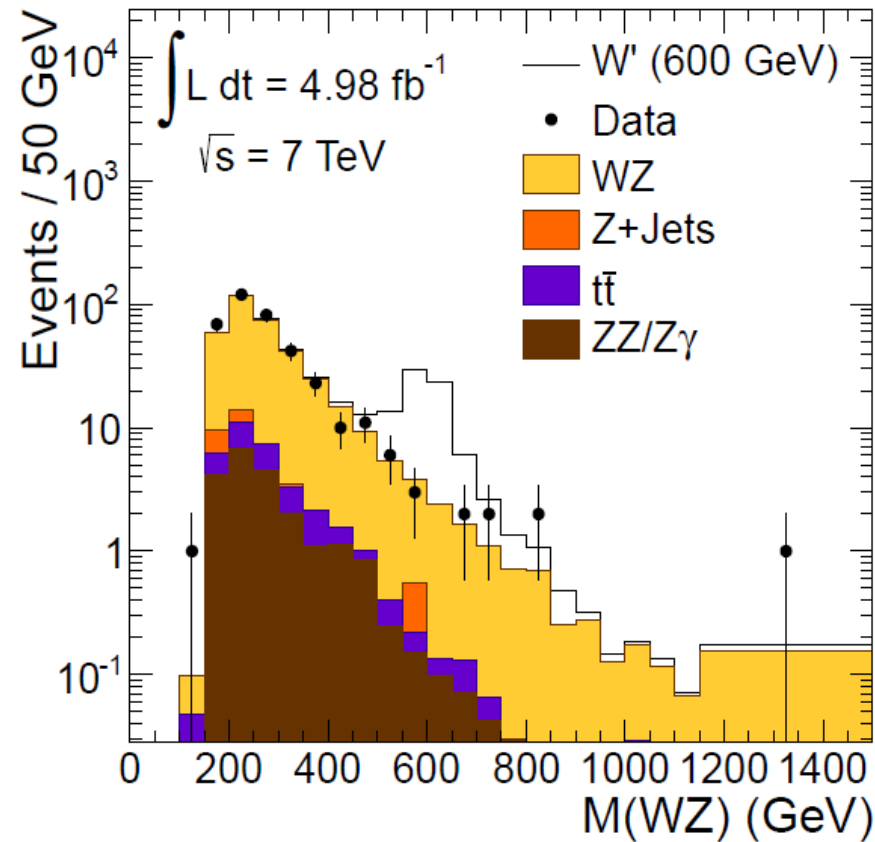
WZ Mass Before/After L_T Requirement

Before

After

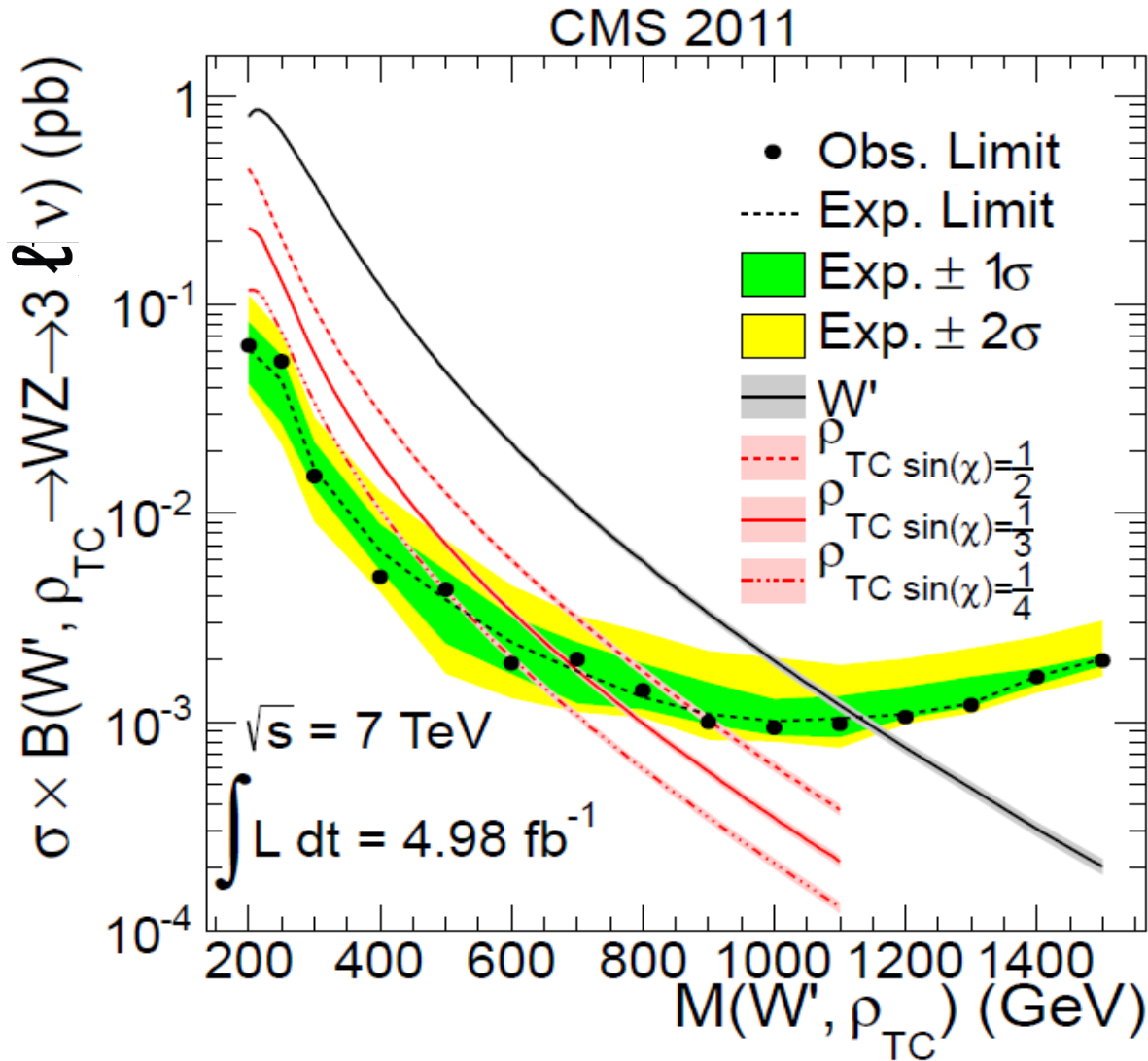
CMS 2011

CMS 2011



Good Data/MC Agreement

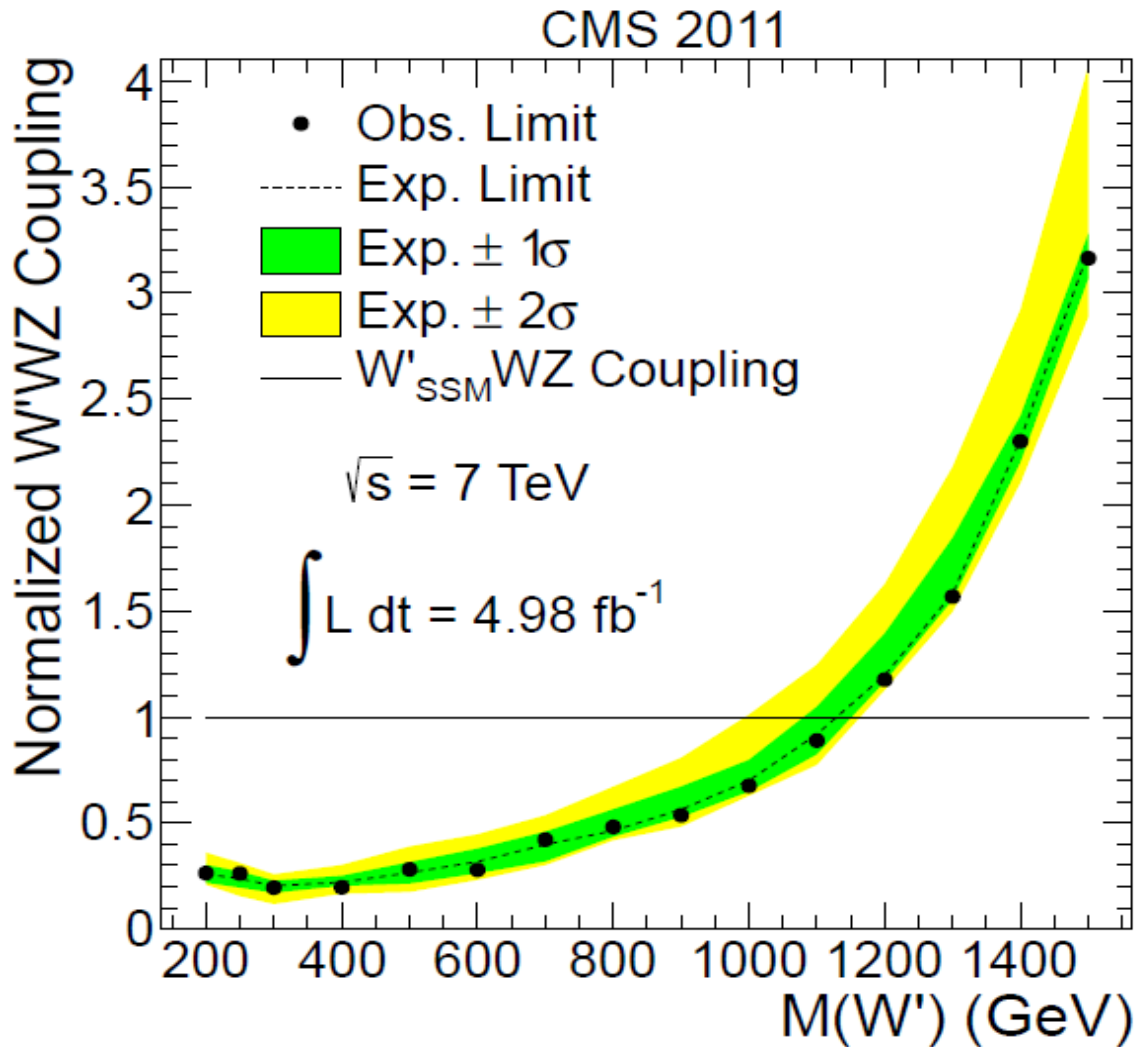
Exclusion Limit: W'



$M_{W'} < 1143 \text{ GeV}$
 Excluded @ 95% CL

Exclusions provided
 for several values of
 $\sin \chi$: a TC mixing
 angle

Limits on Coupling



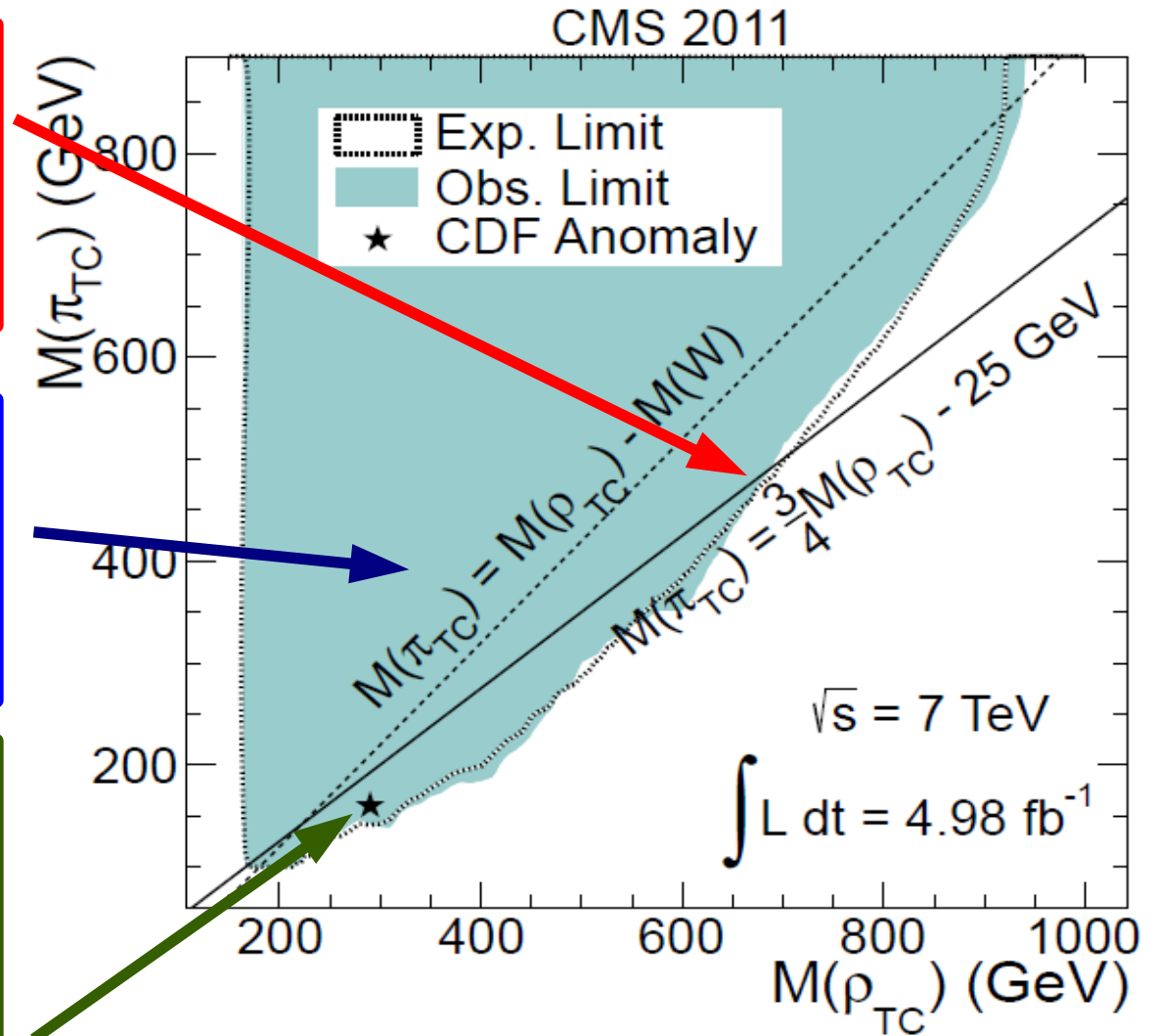
Reinterpret the data
as a limit on the
strength of the
coupling

2D TC Exclusion Plot

169-680 GeV
 excluded @ 95% CL
 $M(\pi_T) = \frac{3}{4}M(\rho_T) - 25 \text{ GeV}$

180-935 GeV
 excluded @ 95% CL
 $M(\rho_T) < M(\pi_T) + M(W)$

TC interpretation
 of CDF Bump
 excluded @ 95% CL
 for $\sin \chi = 1/3$



Results

- SSM W' excluded below 1143 GeV in $WZ \rightarrow 3lv$ channel
- ρ_{TC} excluded 169-680 GeV in $WZ \rightarrow 3lv$ channel
 - 180-935 GeV if $M(\rho_\tau) < M(\pi_\tau) + M(W)$
 - Exclude TC interpretation of CDF bump for $\sin \chi = 1/3$
- Strongest limit by CMS/LHC on W' and ρ_{TC} in this channel
 - Phys. Rev. Lett. 109, 141801 (2012)

Backup

- Atlas Results

- Used 1 fb^{-1}
- Excluded SSM W' @ 95% CL with masses below 760 GeV
- Excluded ρ_τ @ 95% CL with masses below 467 GeV if
 - $M(\rho_\tau) < M(\pi_\tau) + M(W)$
- Phys.Rev. D85 (2012) 112012