Study of WZ production at DØ

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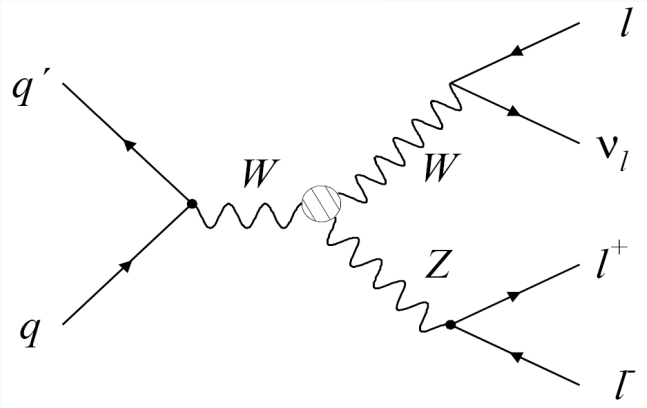
For DØ collaboration

Motivation

- Measure cross section,

  triple gauge couplings

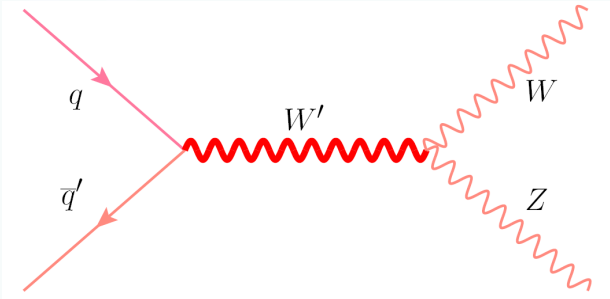


- Explore physics beyond the SM
  - The sequential heavy gauge bosons
  - Search for Technicolor resonances
  - ED based Higgsless model, little higgs model
  - Background to Higgs searches

Particles we searched for...

- Sequential heave W-like boson, so-called W'

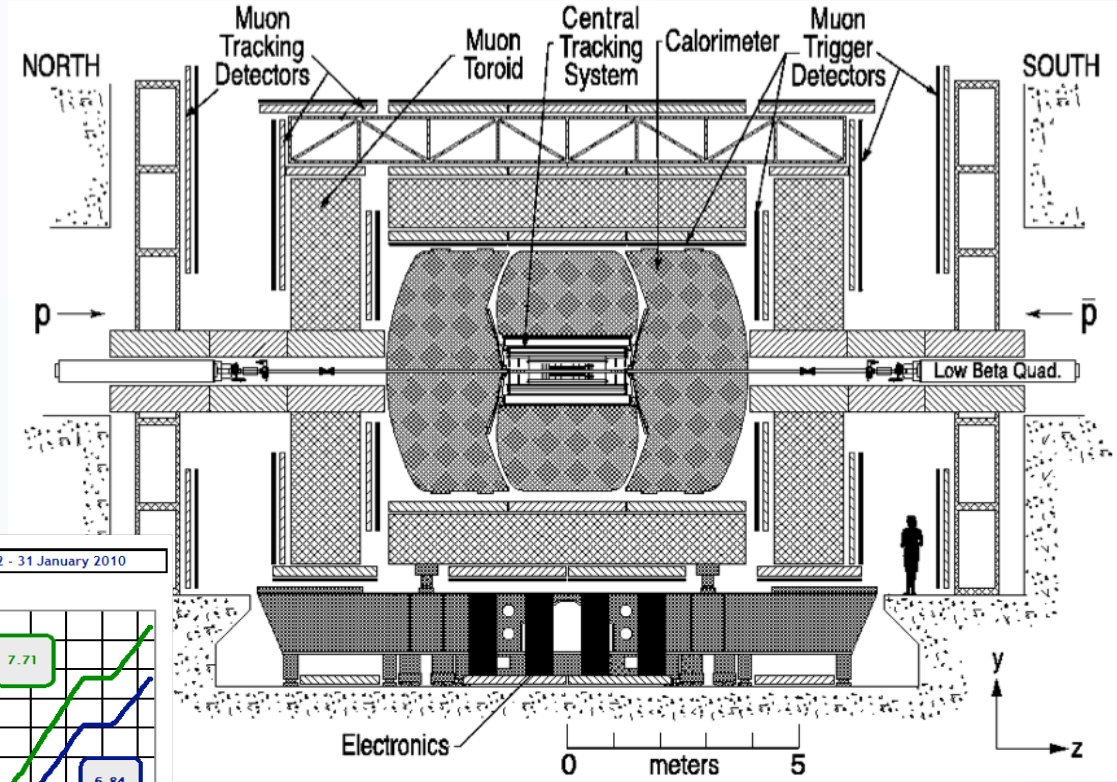
$$\Gamma_{W'}(M_{W'}) = \frac{4}{3}\frac{M_{W'}}{M_W}\Gamma_W$$

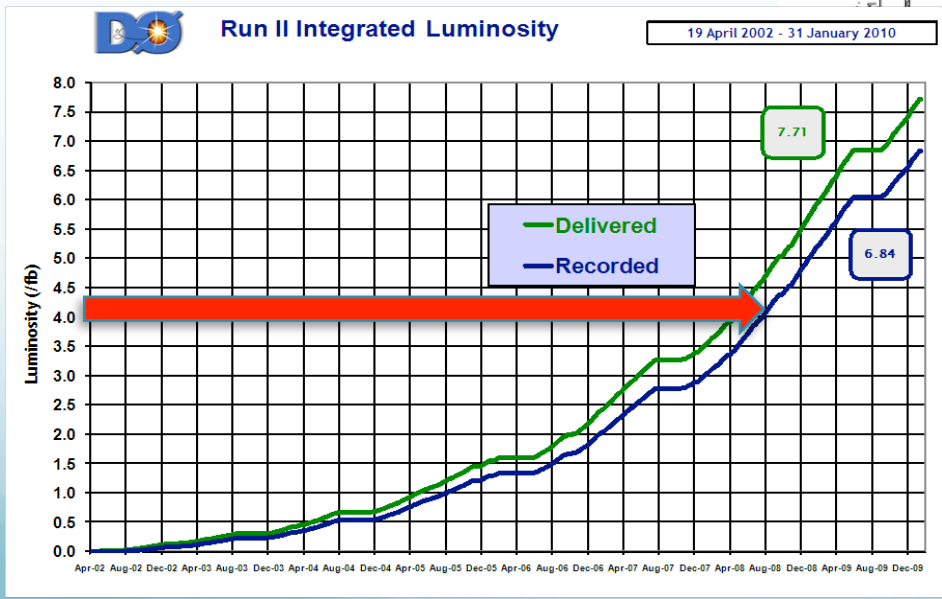


- Within low scale TC
  - Light techni-particles have masses < 500 GeV
  - Mostly decay with at least one gauge boson
    $\rho^{\pm}_T/a^{\pm}_T \rightarrow W^{\pm}\pi_T$; $\rho^{\pm}_T/a^{\pm}_T \rightarrow W^{\pm}Z$; $\omega_T/\rho^0_T \rightarrow \gamma\pi_T$;
  - Very distinct signature, narrow resonances

D0 detector

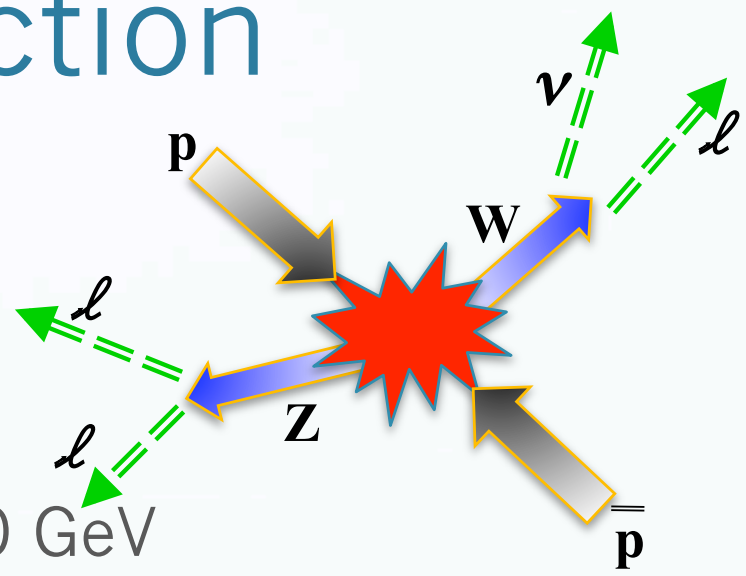
- Tracking
- 2T solenoid
- Calorimeters
- Muon system





4.1 fb^{-1} is used in this search

Event selection



- Four signatures:
  - e/μ + neutrino
- Well identified, isolated,

  high energetic leptons – p_T >20 GeV
- Invariant mass constraint on Z boson candidate
  - $80 < M_{ee} < 102$ GeV and $70 < M_{\mu\mu} < 110$ GeV
- $\Delta R(l^Z, l^W) = \sqrt{(\Delta\varphi^2+\Delta\eta^2)} > 1.2$
- Missing transverse energy > 30 GeV

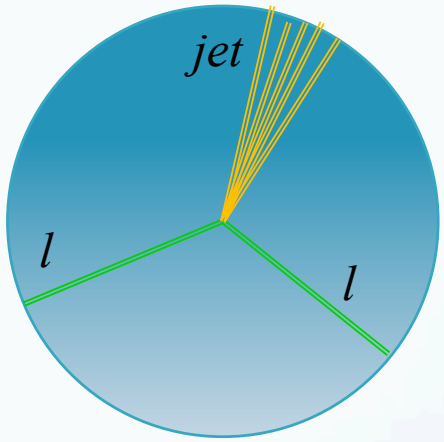
Backgrounds

- Processes with at least three genuine leptons
  - WZ and ZZ production – estimated from MC simulation
- Instrumental backgrounds due to wrongly identification of a jet, photon from processes
  - Z+jets, Zγ – estimated using data-driven methods
  - ttbar – estimated from MC simulation and found to be negligible

Z+jets

- Genuine Z candidate and misidentified jet
- Measure the misidentification ratio

  in multijet events from data

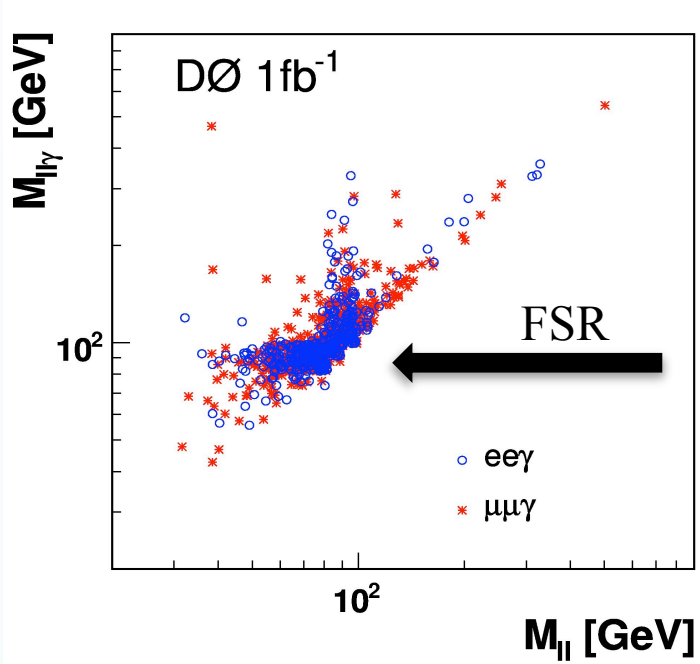


$$fr = \frac{dN/dp_T(\text{"true"})}{dN/dp_T(\text{"false"})}$$

- For each signature Z+"false" lepton sample is selected from data
  - p_T spectrum of "false" lepton is folded by *fr*

Zγ

- Background for WZ→llεν
  - Due to track mismatch or photon conversion
- Measure photon to electron misidentification rate in data $f_{\gamma\to e}$
  - Use Z(μμ)γ final state radiation

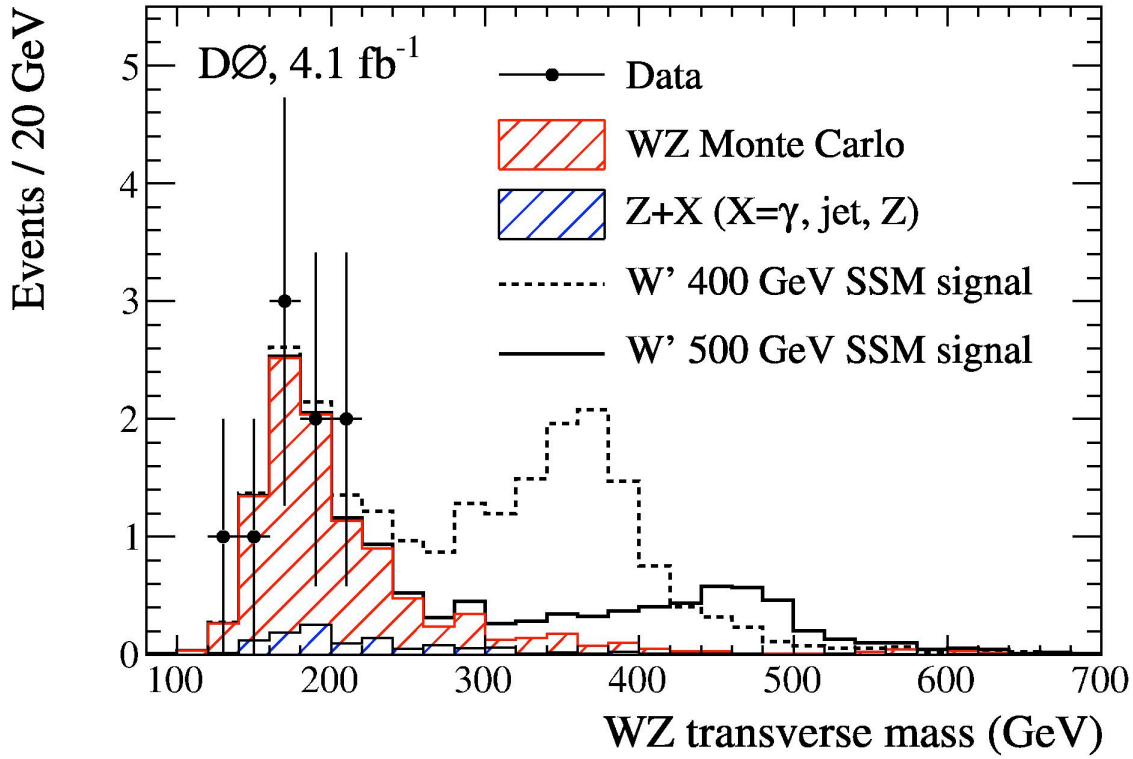


- Photon p_T distribution is multiplied by p_T dependent γ→e misidentification rate

$$N_{Z\gamma} = \sigma_{ll\gamma} \times L_{data} \times Accep \times \varepsilon_{selection} \times f_{\gamma\to e}$$

Event yields

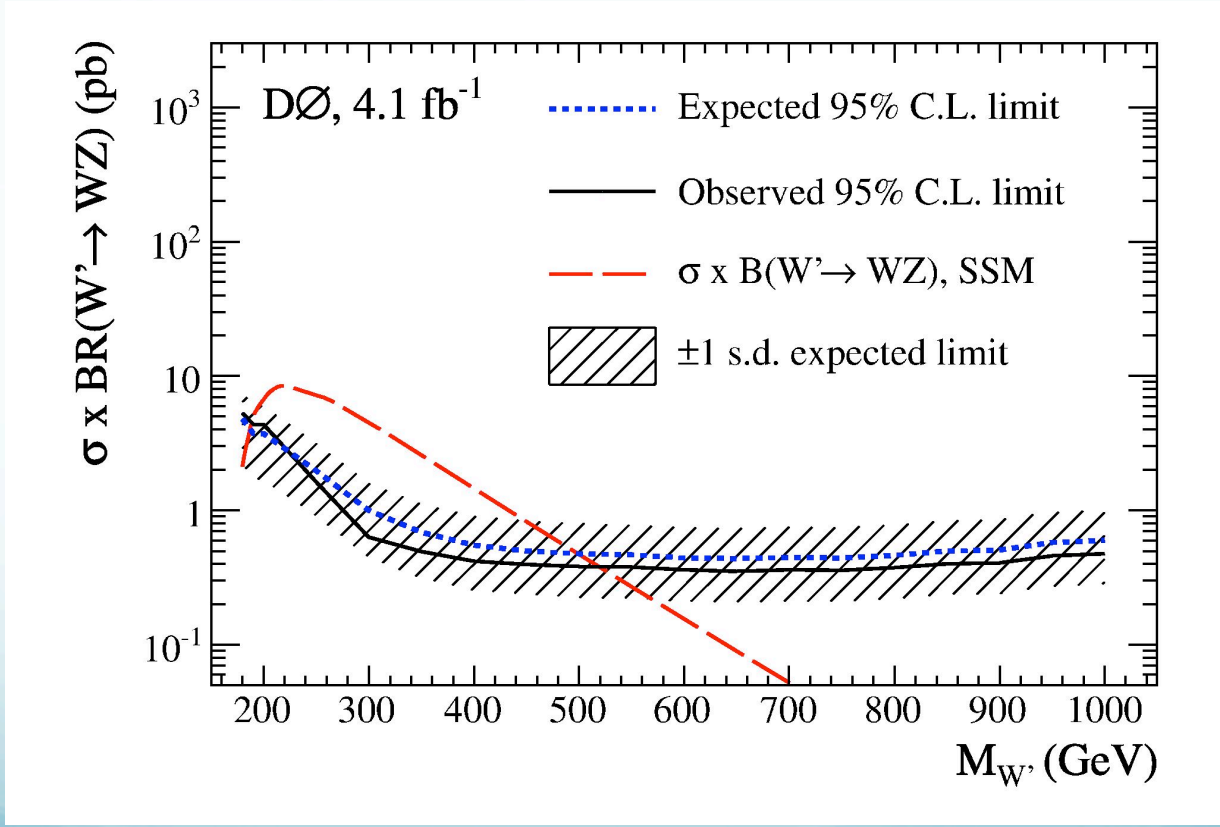
Source	Events
W' (500 GeV)	**4.4 ± 1.1**
WZ	9.0 ± 1.5
ZZ	1.0 ± 0.2
Z+jets	0.2 ± 0.1
Zg	0.1 ± 0.1
Total bkg.	**10.2 ± 1.6**
Observed	**9**



Very good agreement with the SM background prediction

Limits on W'→WZ

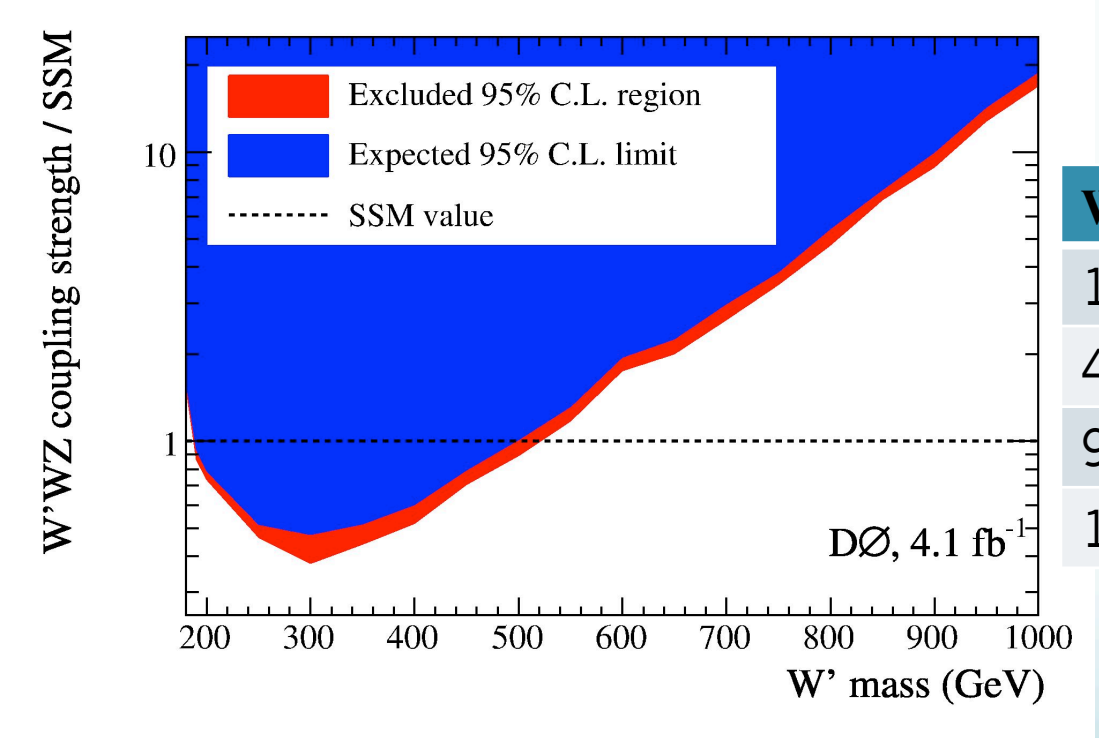
- We exclude sequential W'
  - 188 GeV < M(W') < 520 GeV (*obs.*)
  - 188 GeV < M(W') < 497 GeV (*exp.*)



W'WZ coupling

- Variation of coupling affects on σ(W') and Br(W'→WZ)

$$W^{'}WZ = \alpha \times WWZ(SM) \times \frac{M^2(W)}{M^2(W^{'})}$$



W'WZ	Obs. (GeV)	Exp. (GeV)
1 (SSM)	520	497
4	767	752
9	903	881
16	988	967

W' width studies

- SSM W' is predicted to be a narrow resonance

$$\Gamma_{W'}(M_{W'}) = \frac{4}{3}\frac{M_{W'}}{M_W}\Gamma_W$$

- Stronger W'WZ coupling results in increasing the width of the resonance

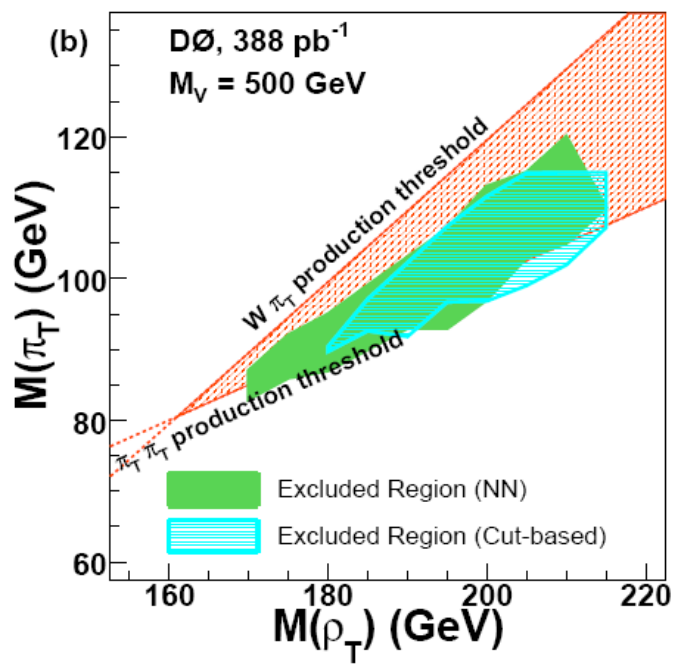
Width of 500 GeV signal for different coupling strength (α)

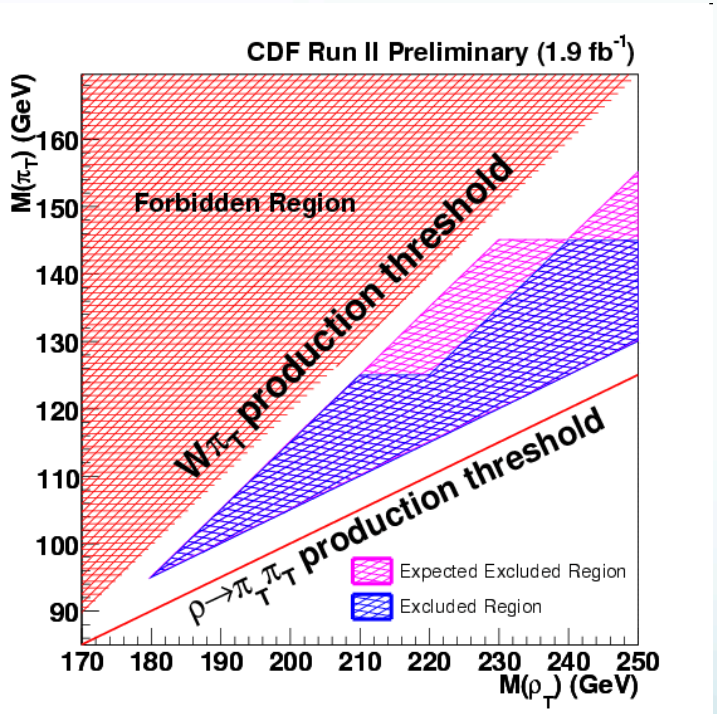
α =	1 (SSM)	2	4	10	20	30
Width (GeV)	17	18	22	45	130	271

- We studied and find limits stay within 1s.d. band for for W' resonances with width up to 25% of the mass

Technicolor

- Previous searches were done in $\rho_T / a_T \rightarrow W\pi_T \rightarrow l\nu bq$
  - Allowed only if $M(\pi_T) < M(\rho_T) - M(W)$



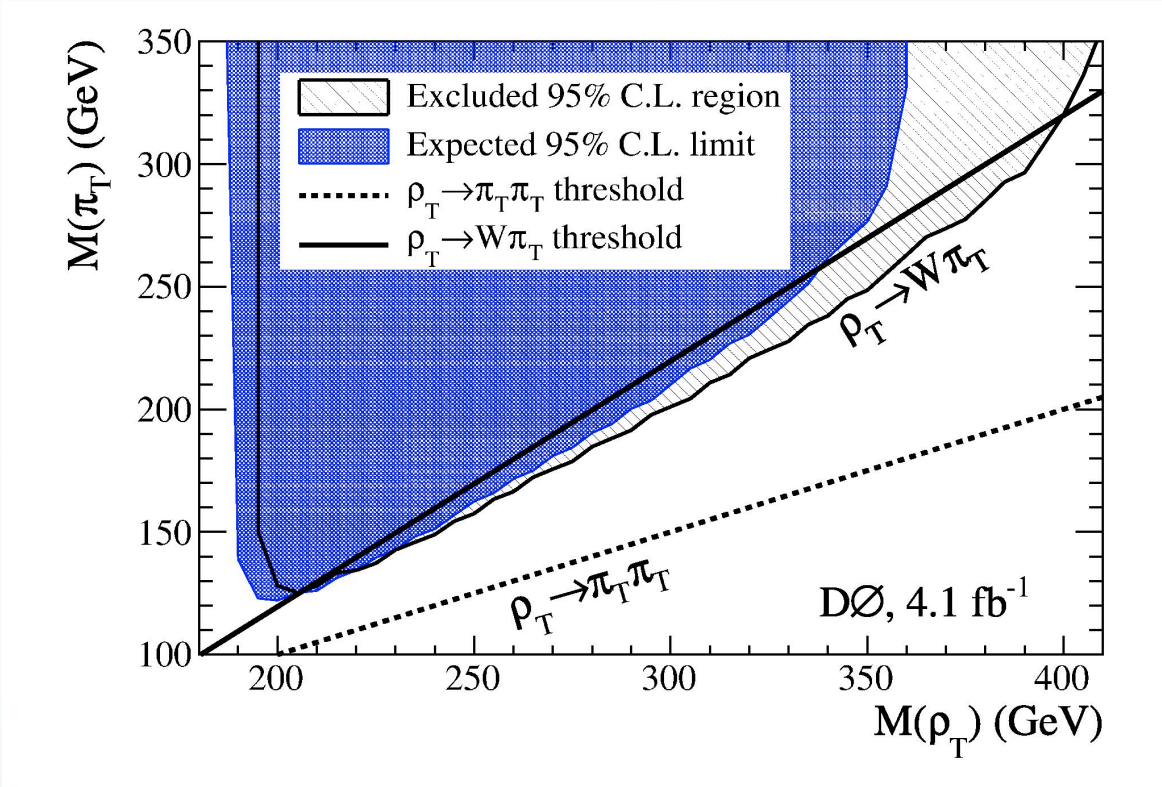


Previously excluded region is $M(\rho_T) < 220$ GeV (DØ)

Limits on $\rho_T \rightarrow WZ$

$M(\pi_T) > M(\rho_T) - M(W)$

→ decay to WZ is dominant



- We exclude
  - 208 GeV < $M(\rho_T)$ < 400 GeV at 95% C.L. (*obs.*)
  - 201 GeV < $M(\rho_T)$ < 339 GeV at 95% C.L. (*exp.*)

Conclusion

- The first search for a new resonance in WZ production is performed at the DØ experiment
  - SSM W' with masses 188-520 GeV is excluded
  - Set limits on W'WZ couplings predicted in different extensions of the SM
  - Excluded typical TC phase space for heavy techni-pions

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arXiv:0912.0715v3 [hep-ex]

BACKUP

W' Signal cross section & Br_{SSM}(W'->WZ)

W' Mass, GeV	$\sigma(W')$, pb	SSM $Br(W' \to WZ)$
180	780	0.003
190	704	0.007
200	635	0.011
250	379	0.019
300	226	0.020
350	135	0.019
400	80.7	0.018
450	48.2	0.017
500	28.8	0.016
550	17.2	0.016
600	10.3	0.015
650	6.13	0.015
700	3.66	0.014
750	2.19	0.014
800	1.31	0.014
850	0.78	0.014
900	0.466	0.013
950	0.278	0.013
1000	0.166	0.013