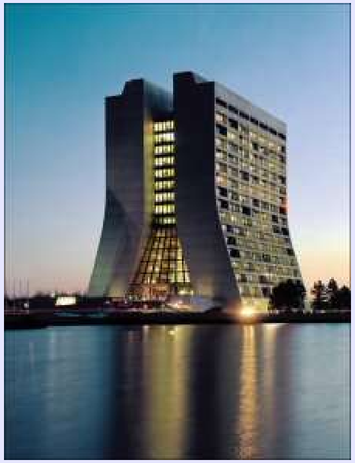

DiBoson Physics: WW, WZ

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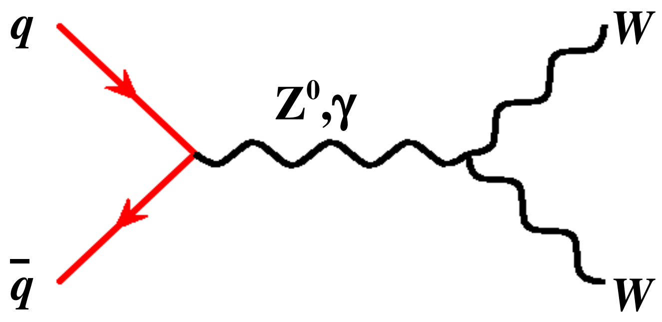
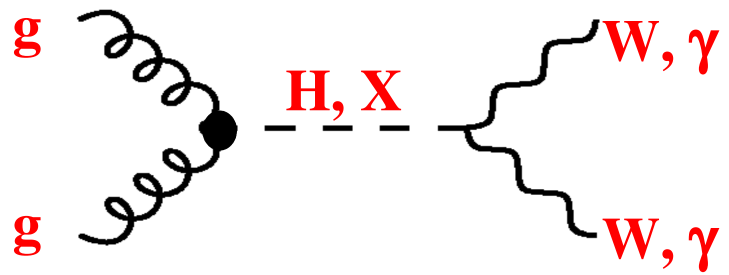
Oxford University,
NBI

March 14, 2006

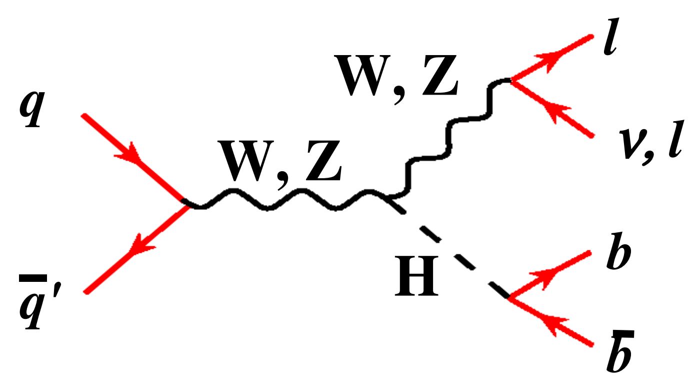
Motivations for the diboson final state



- SM tests of the triple gauge vertex.
- Lower statistics than LEP but higher ŝ.

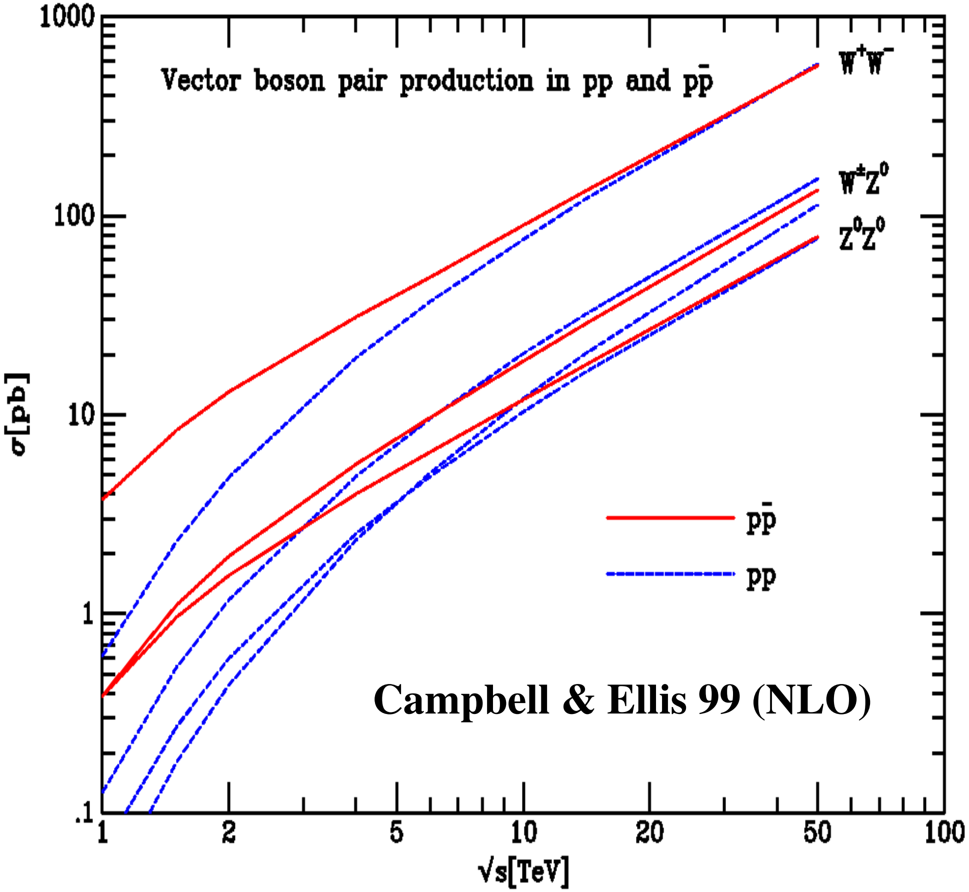


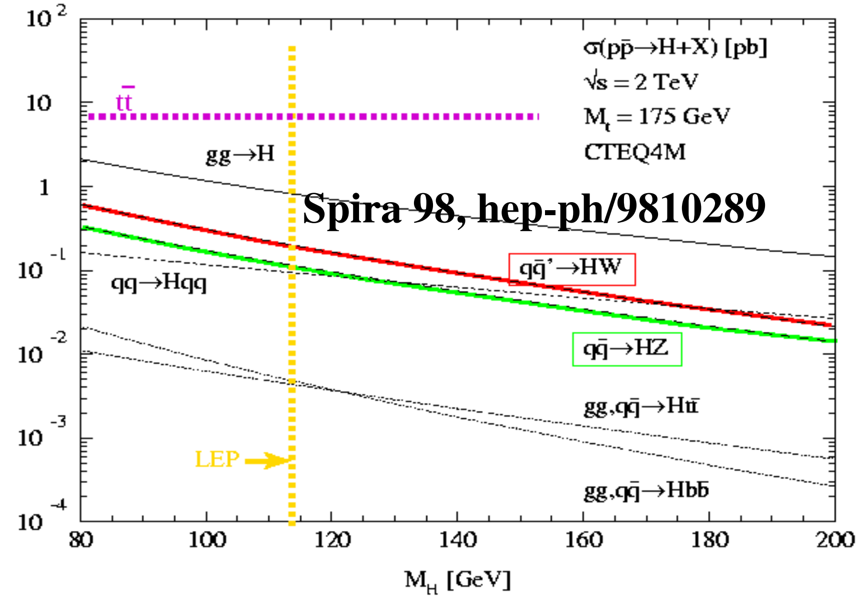
- Searches for heavy resonances. Note however that di-boson scattering is small compared to LHC.

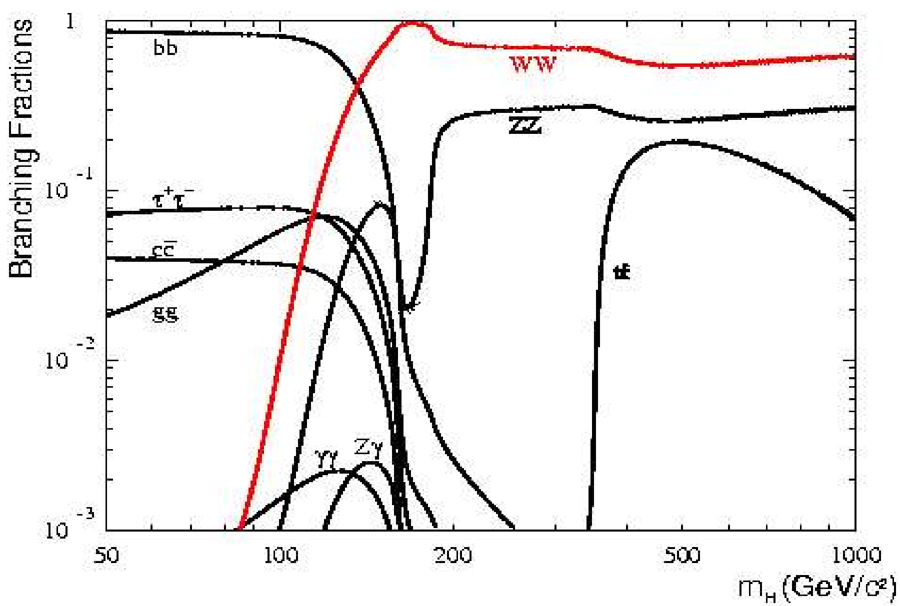


- Searches for light higgs.

Di-boson theoretical predictions







Di-boson signatures

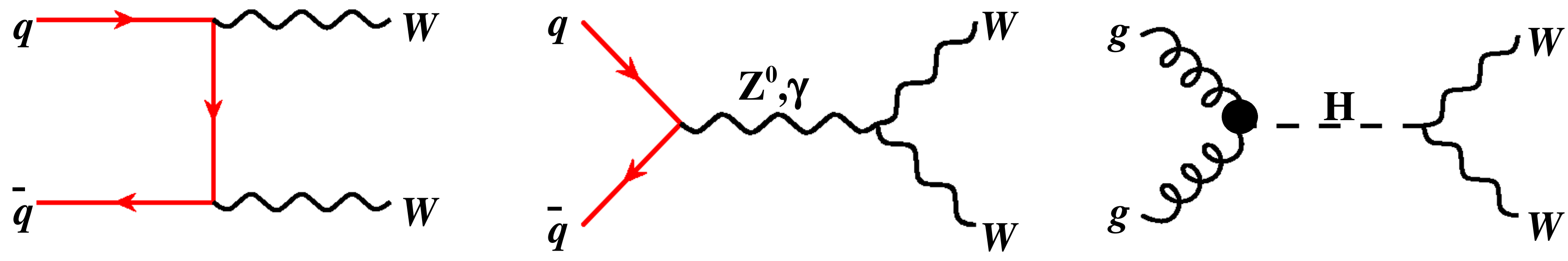
Ordered in mass/cross-section:

- $\gamma\gamma$
- $W\gamma$, $Z\gamma$
- WW, WZ, ZZ
- WH, ZH

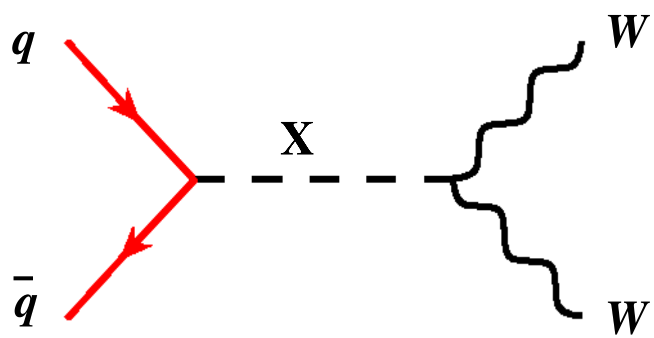
I only have new results on these!

WW in hadron collisions

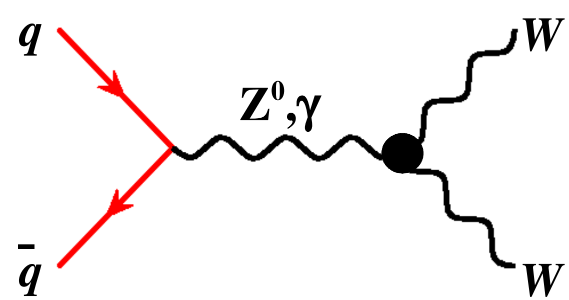
SM:



Resonance searches:

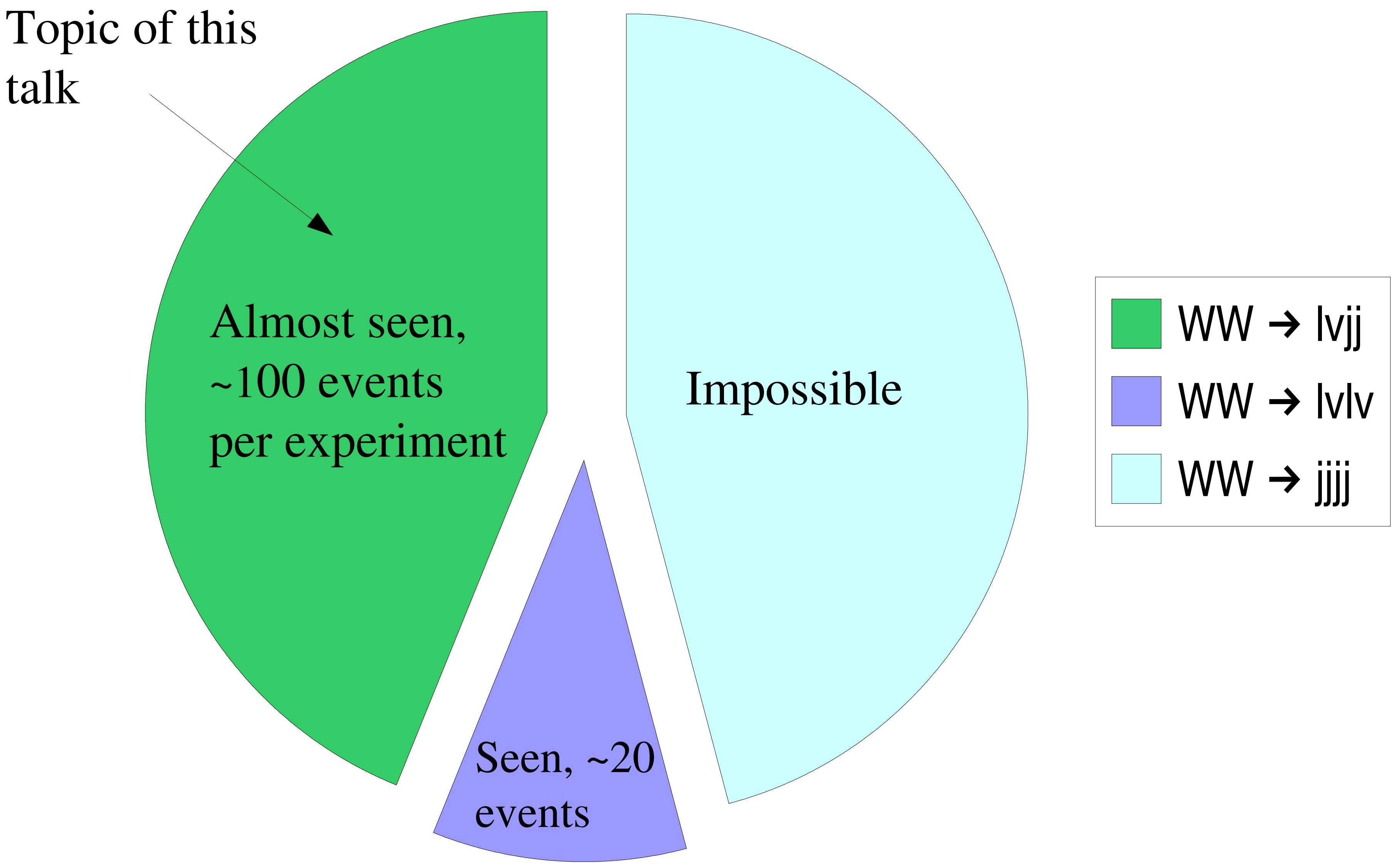


Anomalous couplings:



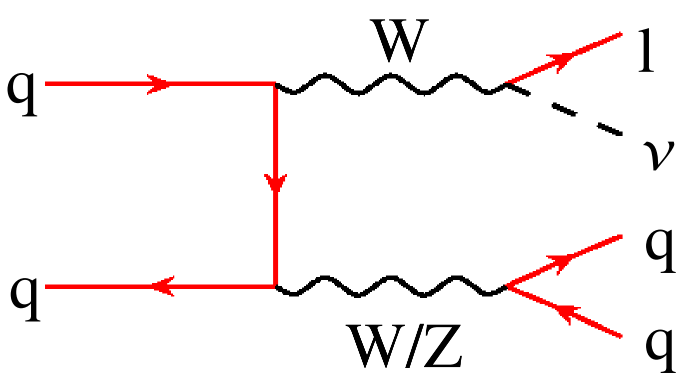
- First seen during Run I: $\sigma(WW) = 10.2^{+6.3}_{-5.1} \pm 1.6$ pb
- The signature important as signal but also as background to other searches.

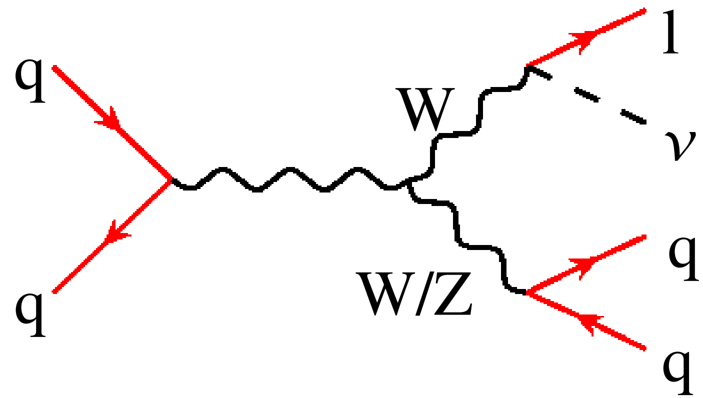
WW@Tevatron

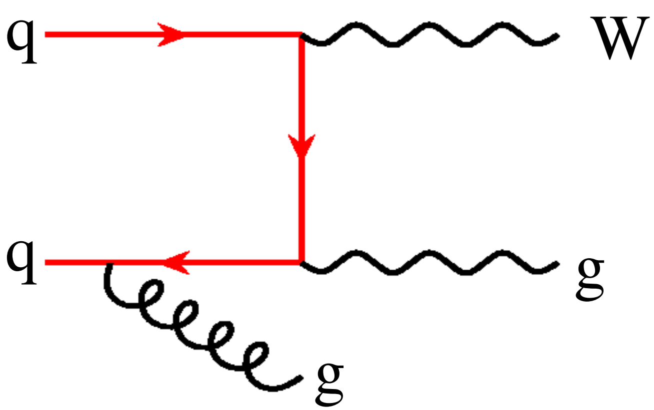


Topic of this talk
Almost seen, ~100 events per experiment
Impossible
Seen, ~20 events
WW → lvjj
WW → lvlv
WW → jjjj

WW/WZ → lνjj







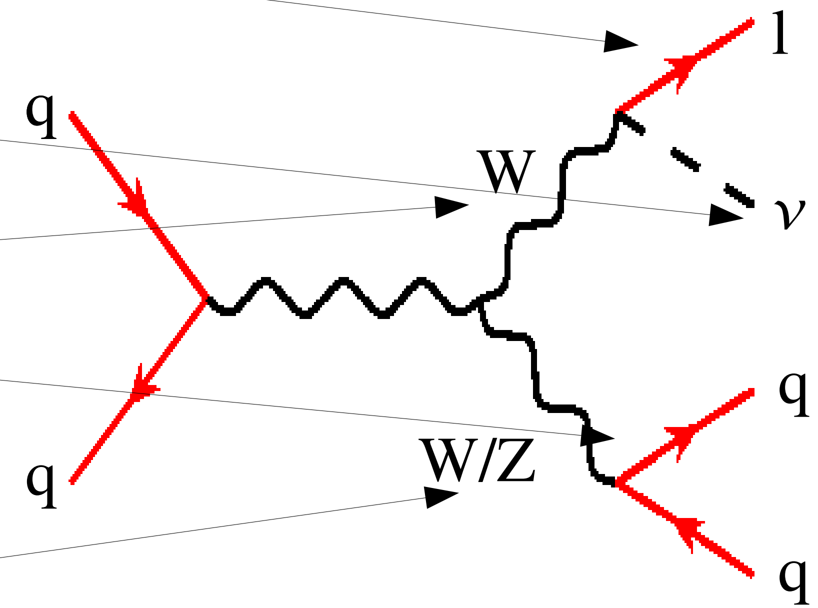
☆ W + 2 jets has O(100) diagrams.

+ Much higher yield than lνlν.
- Low jet-jet mass resolution and large jet energy scale uncertainty.
- Gluon/jet tagging very limited.

→ Challenging!

WW/WZ → lνjj event selection

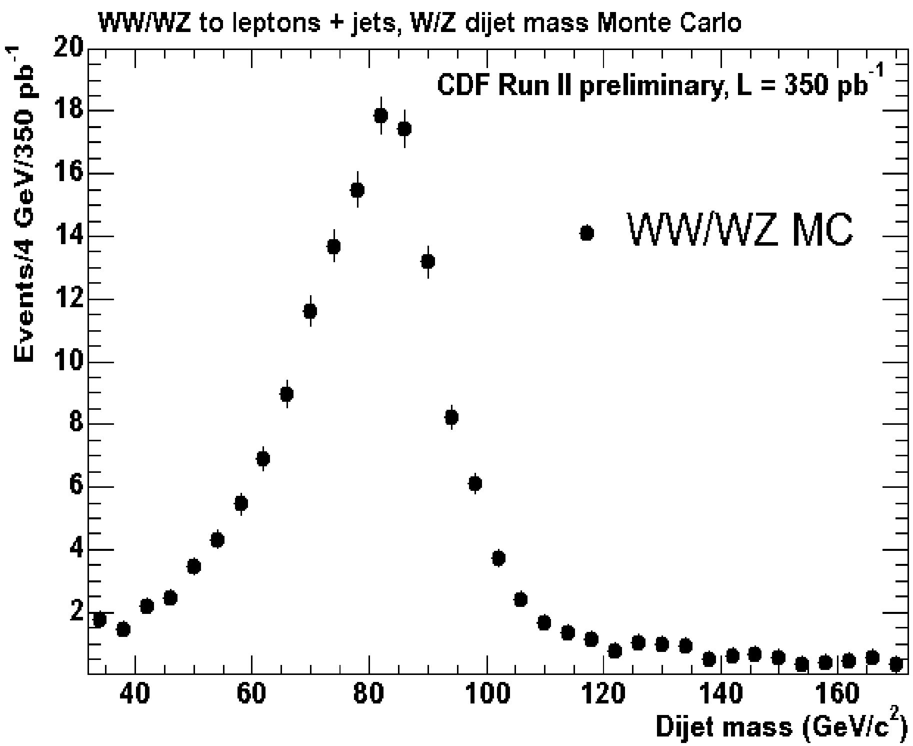
- Trigger on the charged lepton. 350/pb of electron and muon data.
- Require missing transverse energy.
- Get a sample of inclusive W.
- Look for at least two jets and form the invariant mass.
- Fit the expected W/Z and background shape to data to extract the diboson fraction.

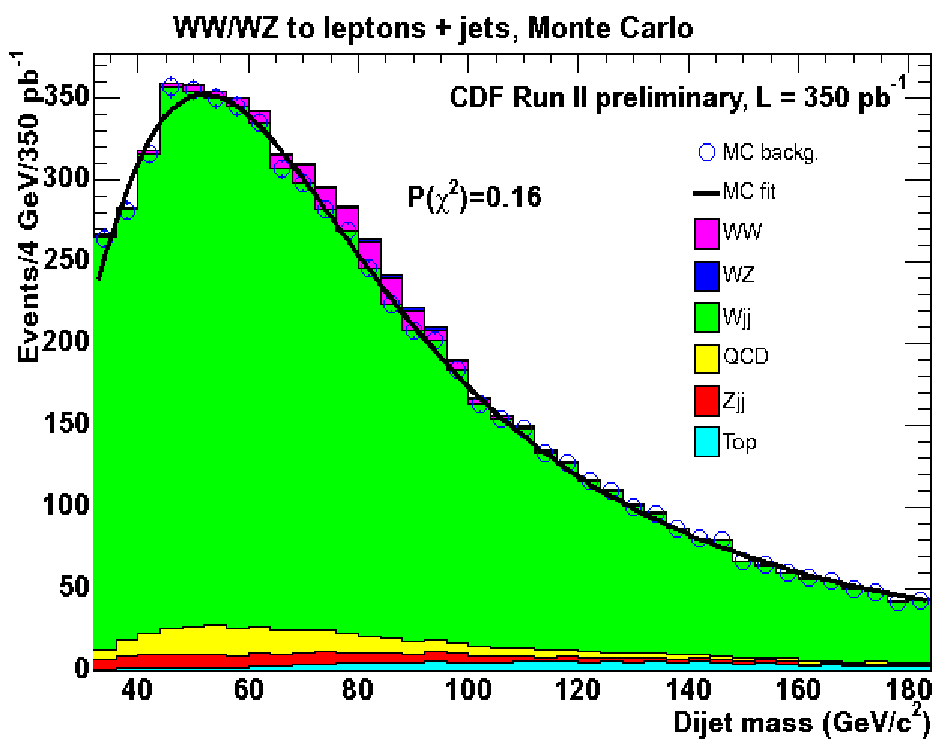


WW/WZ → lνjj expectations

- Lepton $E_T > 25$ GeV, $|\eta| < 1$
- $\not{E}_T > 25$ GeV.
- At least 2 jets $E_T > 15$ GeV
- Dijet mass 32-184 GeV

Process	Uncert.(%)	Electrons	Muons	Total
WW	15	79.9	62.1	142
WZ	15	11.3	6.9	18.2
W+jets	20	3537	2724	6261
Fixed backg.	20-40	438	354	792





WW/WZ → lνjj systematics

Large systematics:

- W + 2jets cross-section ~20% uncertainty (~3*signal!).
- LO W + 2jets sensitive to renormalization scale.
- Jet energy scale.

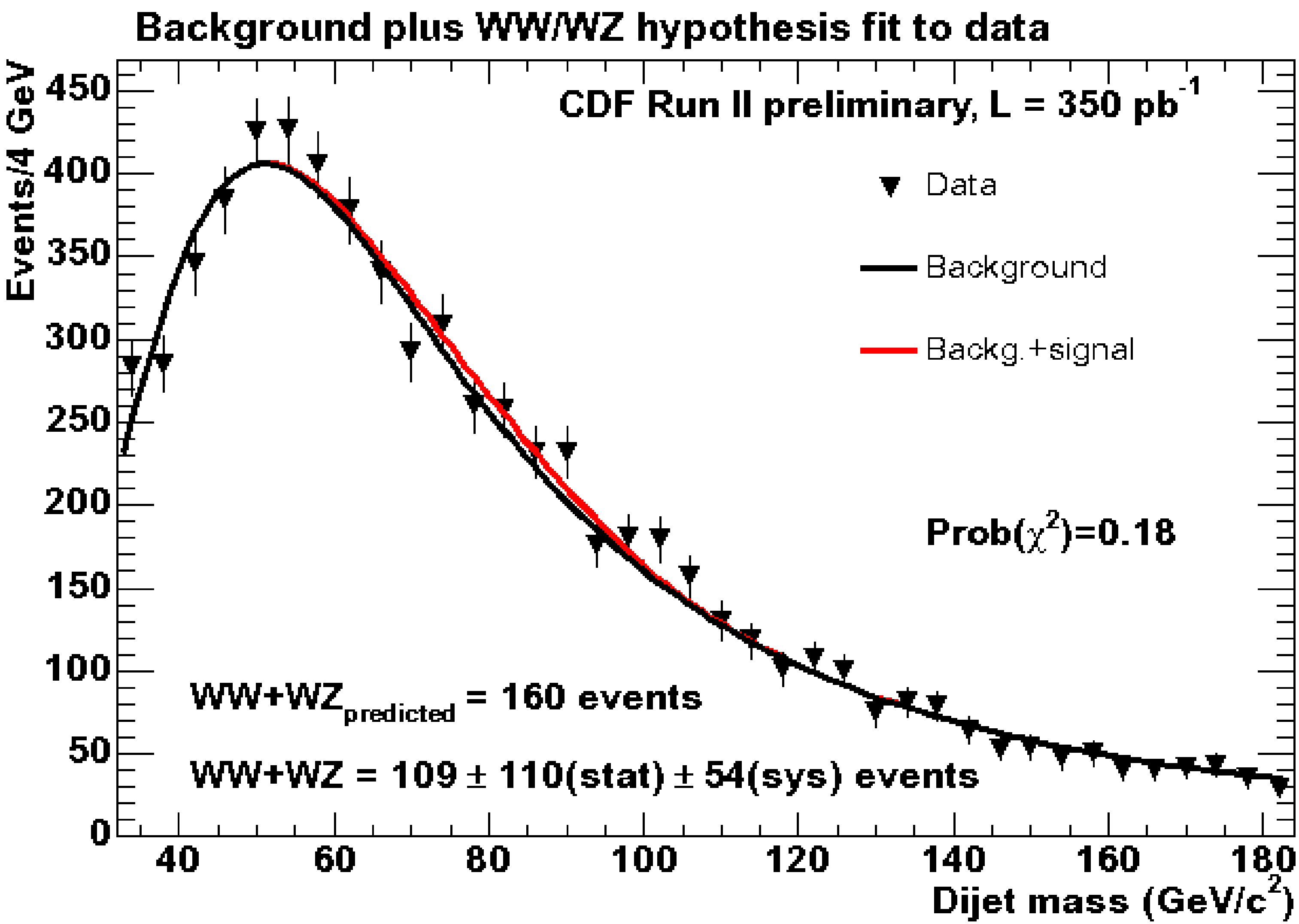
Several methods evaluated for optimal performance, this is what we finally use in the measurement:

- Fit signal and background shape to data.
- Vary MC and cross-check with data sideband.

Source	3-par fit(%)
Events statistics	69
Jet resolution	19
Jet energy scale	16
Non-W	16
ISR/FSR	10
Signal shape	10
Q^2 uncertainty	8
Luminosity	6
Leptonic W	3

WW/WZ → lνjj cross-section

- Fit signal and background di-jet mass shape to data.



WW/WZ → lνjj cross-section

- Expected events for SM cross-section σ(WW+WZ)=16 pb:

  WW+WZ events = 160 ± 113(stat) ± 34(sys)

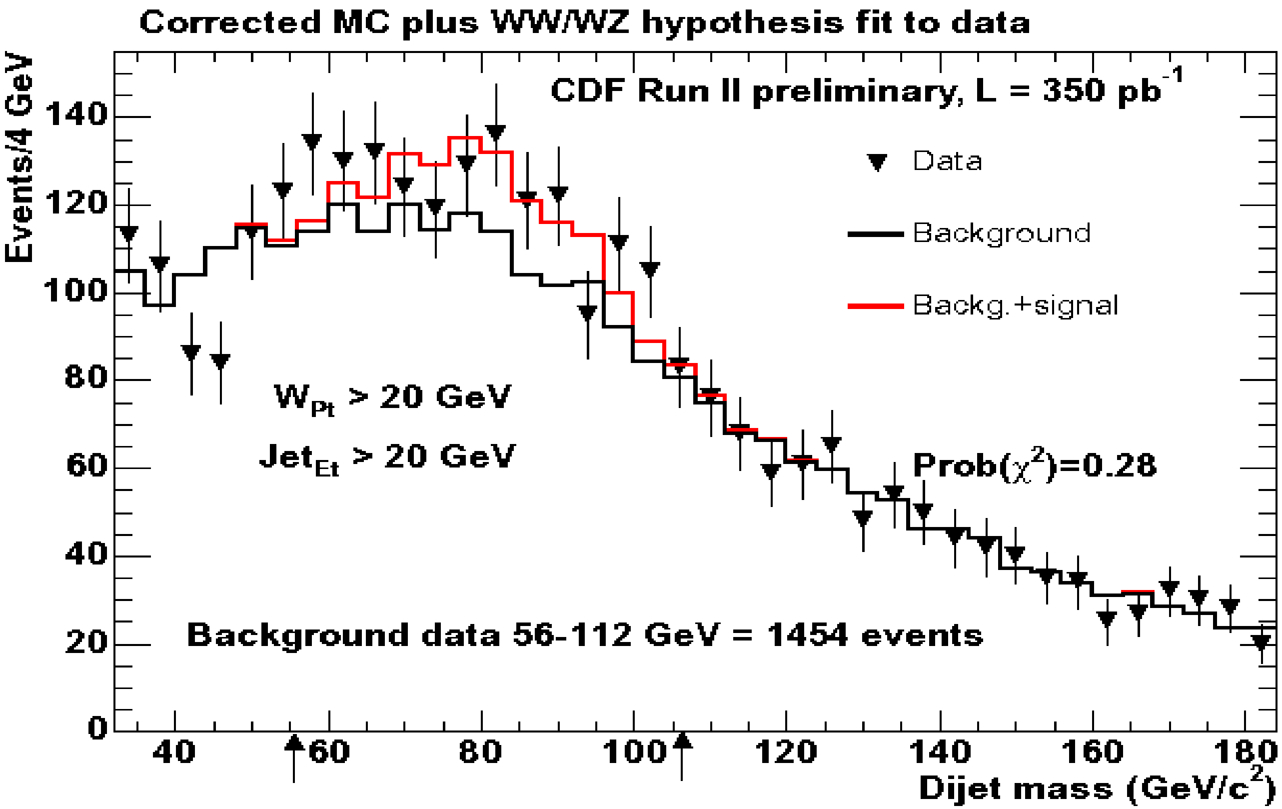
- Measured from 350/pb of data:

  WW+WZ events = 109 ± 110(stat) ± 34(sys)

σ(WW+WZ) < 36 pb (95% C.L.)

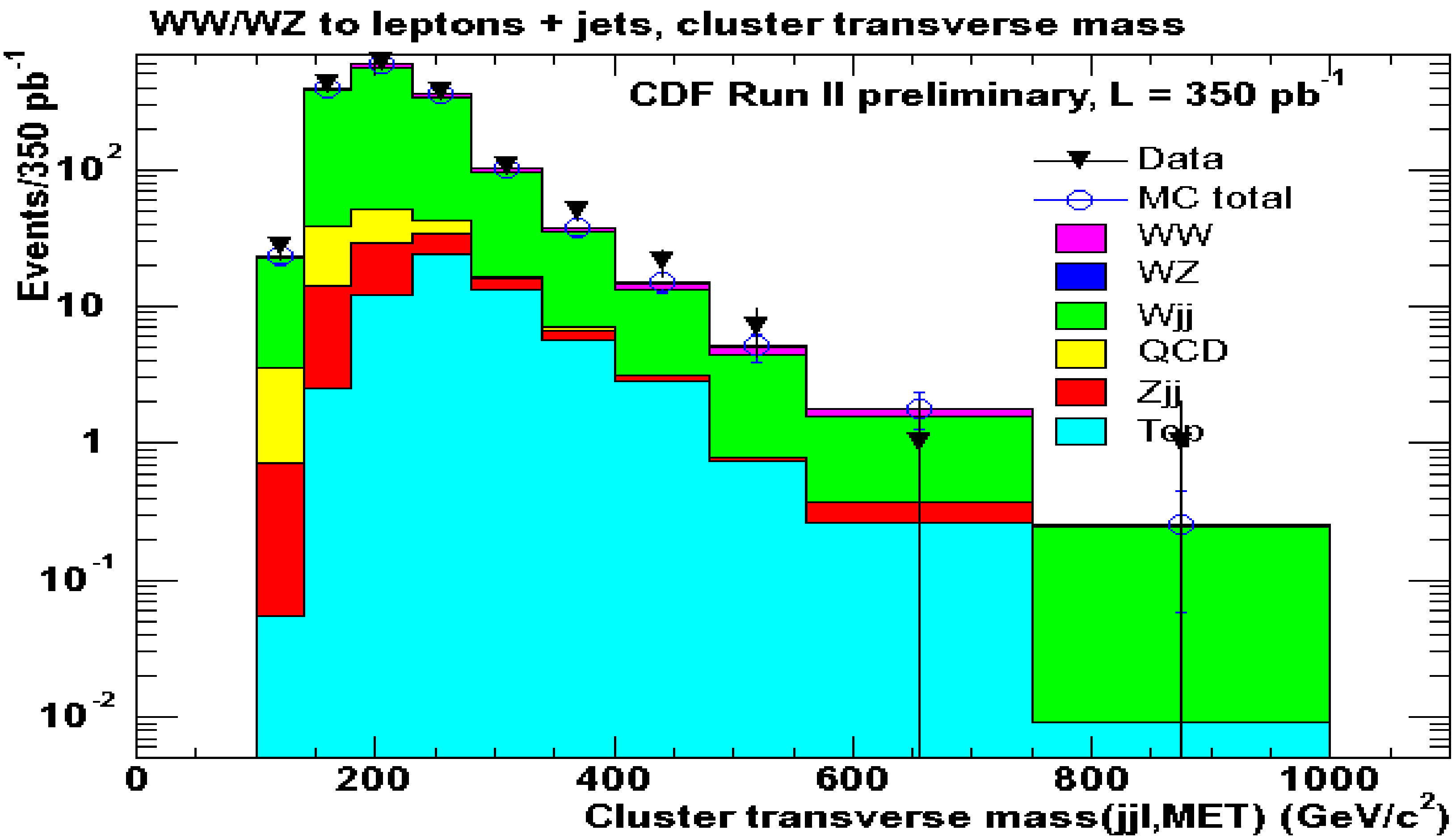
WW/WZ → lνjj anomalous couplings

- Most sensitivity in the high energy tail.
- Increase jet Et > 20 GeV and W Pt > 20 GeV.
- Fit for the background in the region 32-184 GeV.
- Then test a AC hypothesis in the dijet signal region 56-112 GeV using the most sensitive kinematic distribution.



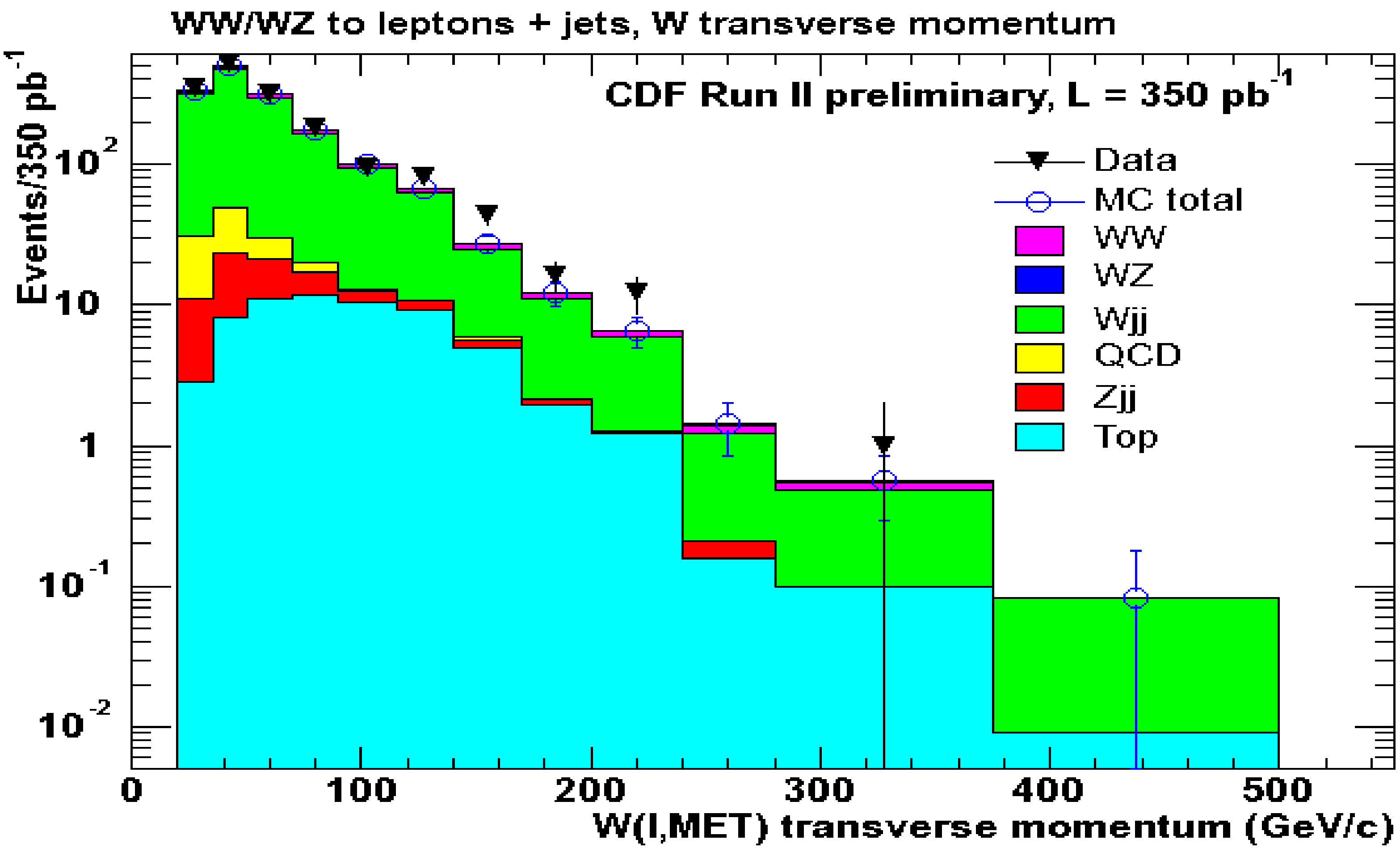
Cluster transverse mass

$$\mathrm{CTM}^2(\mathrm{ljj}, \not{E}_T) = ((m_{\mathrm{ljj}}^2 + |p_{T_\mathrm{l}} + p_{T_{\mathrm{j}1}} + p_{T_{\mathrm{j}2}}|^2)^{1/2} + \not{E}_T)^2 + -|p_{T_\mathrm{l}} + p_{T_{\mathrm{j}1}} + p_{T_{\mathrm{j}2}} + \not{E}_T|^2.$$



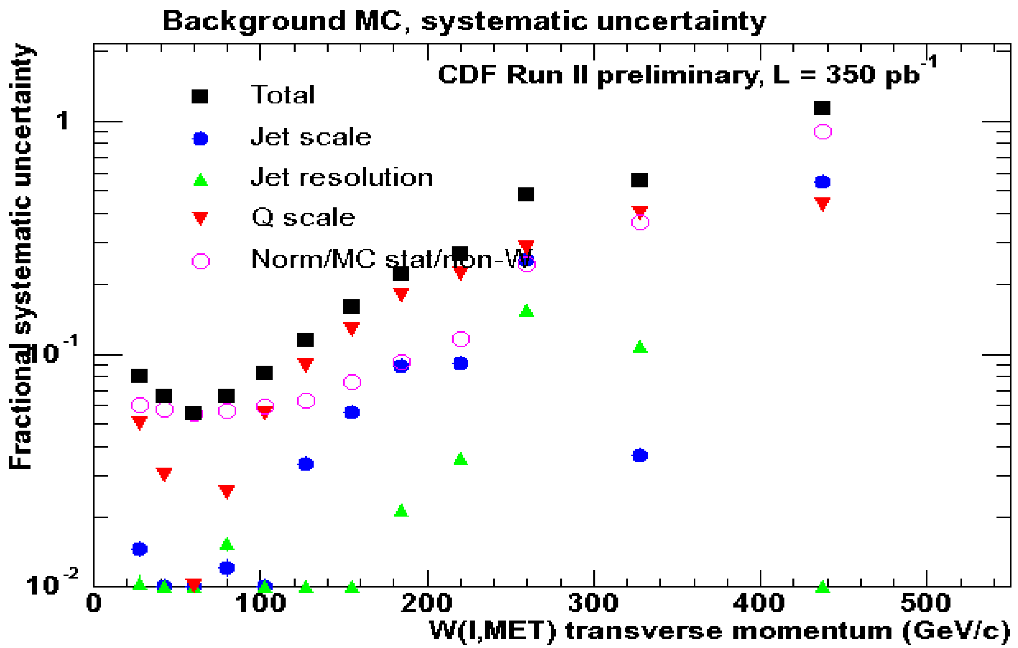
- CTM peaks at correct ŝ.
- Mass resolution ~ 15%.
- Sensitive to resonances: X -> W + Y

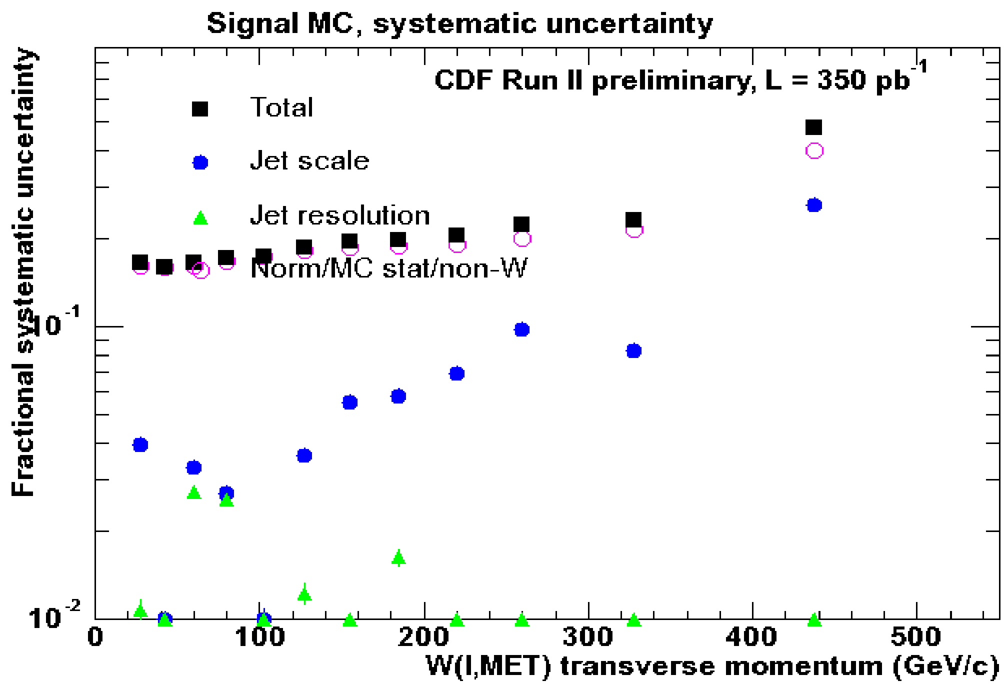
W transverse momentum



- ✯ Strongest observable found for anomalous couplings.
- ✯ Full spectrum fitted for the AC hypothesis and used for setting the limits.

Systematics, AC limits





Correlations among then systematics contributions are taken into account, in particular jet energy scale uncertainties.

Correlations are present both from bin to bin and between signal and background.

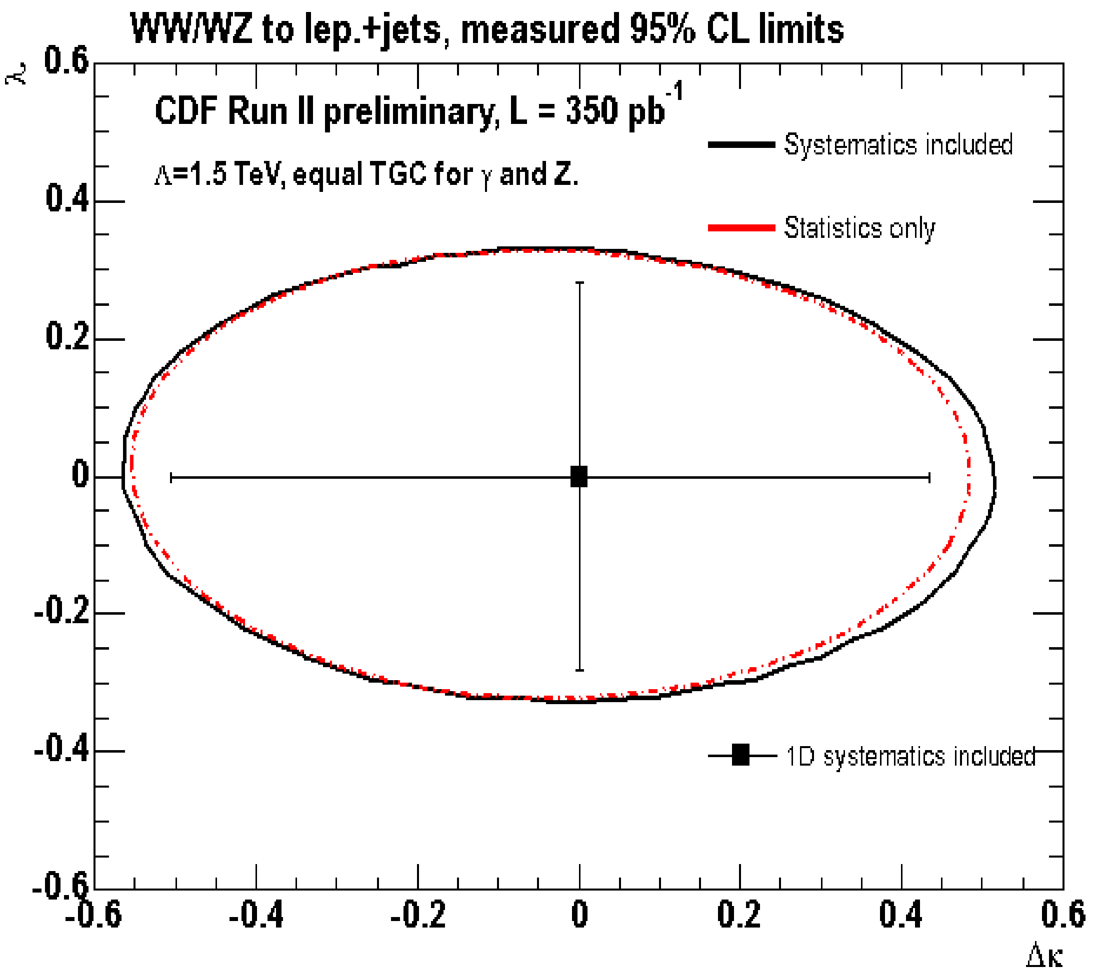
WW/WZ → lνjj ATGC limits

Measured 1D 95% C.L. limits:

$(\Delta\kappa,\lambda)$=([-0.51,0.44],[0.28,0.28])

Previous from Run I:

$(\Delta\kappa,\lambda)$=([-0.56,0.75],[0.42,0.44])



$$\mu_W=(e/2M_W)(2+\Delta\kappa+\lambda),$$
$$Q_W=-(e/M^2_W)(1+\Delta\kappa-\lambda)$$

Summary

- New limits are set on the processes WW+WZ to lepton, MET + jets at the Tevatron.

- With a SM expectation of 16 pb the limit on the total cross-section is set to < 36 pb (95% C.L.).

- 1D (95% C.L.) limits on the anomalous triple gauge couplings, assuming Lambda=1.5 TeV and equal Z and gamma couplings are set to

$$(\Delta\kappa,\lambda)=([-0.51,0.44],[-0.28,0.28])$$