Wγ and Zγ Production and Extraction of Trilinear Gauge Couplings at CDF in Run 2

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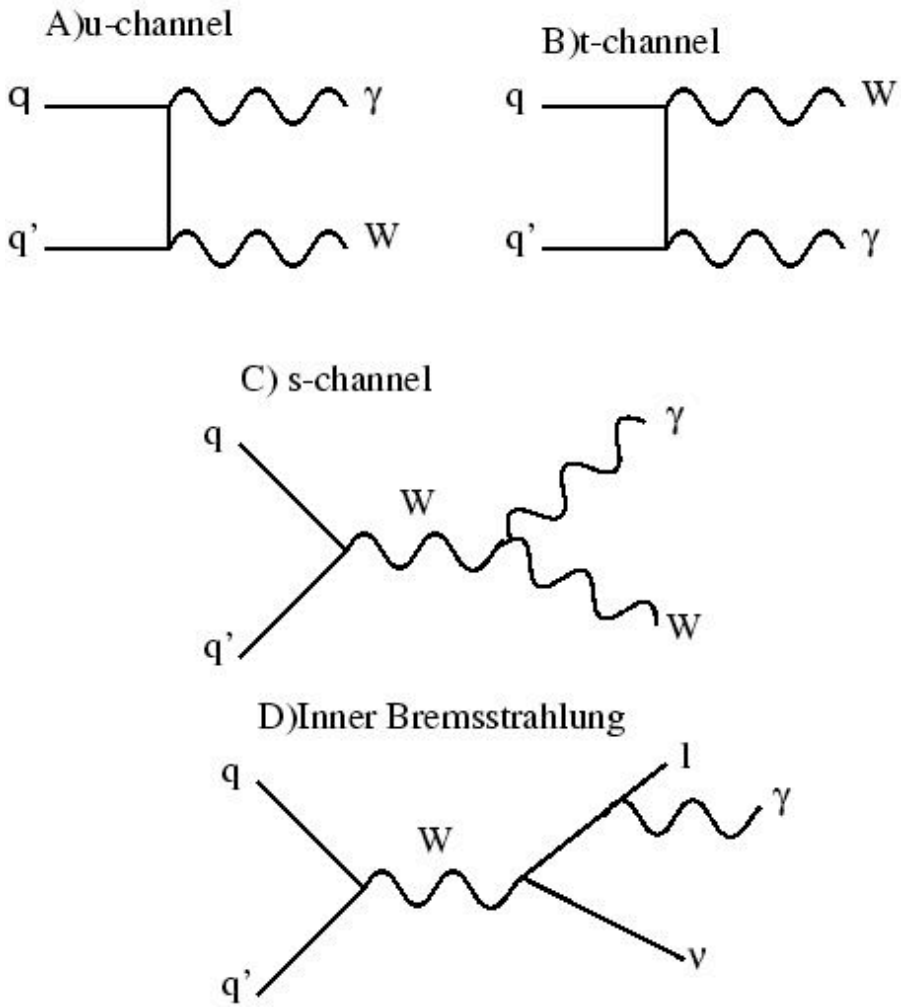
Outline of Talk

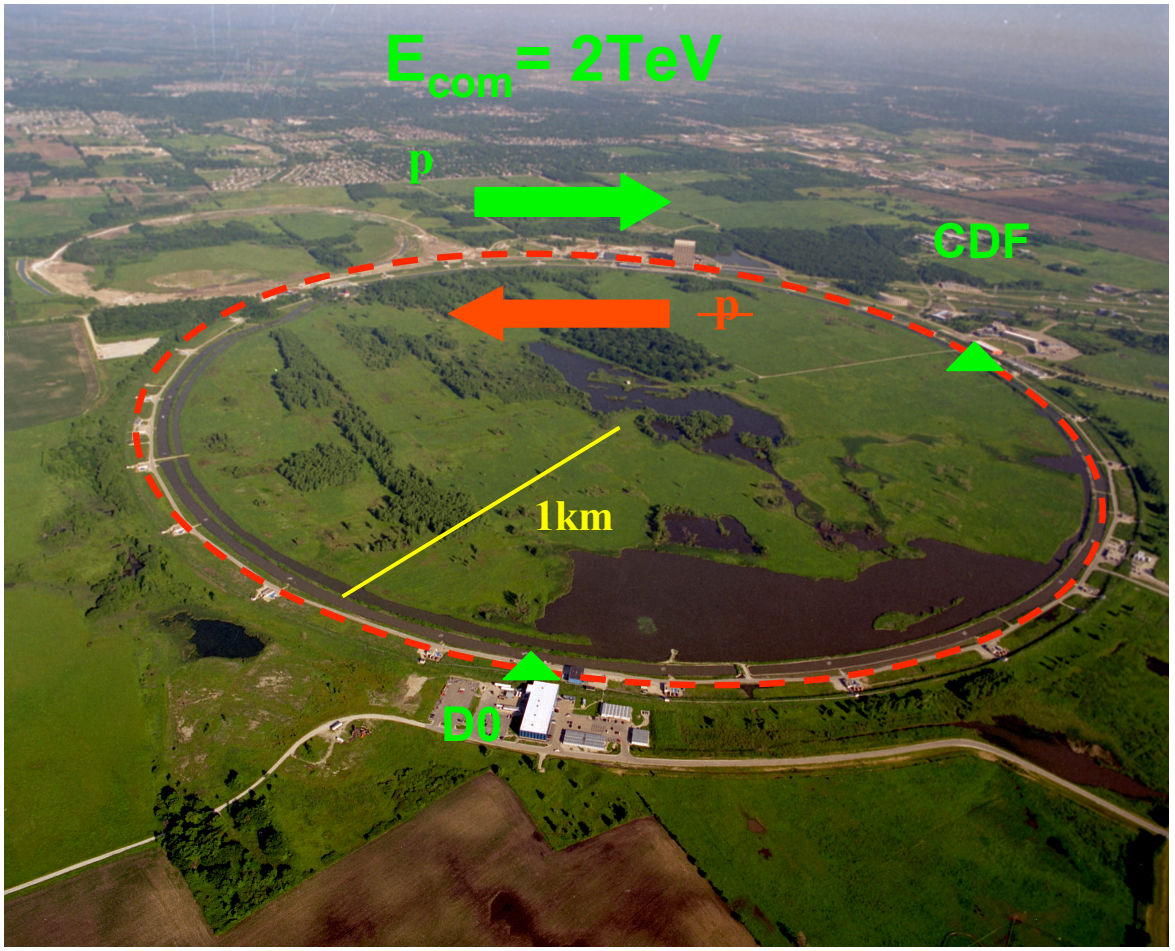
- Why $W\gamma$ and $Z\gamma$?
- Why the Tevatron?
- Major Background
- Cross-Section
- Kinematic distributions
- Triple Gauge Couplings

Why is W/Zγ interesting?

- Probes EW boson self-coupling: direct consequence of non-abelian nature of SM
- Sensitive to coupling of gauge bosons to each other.
  - Limits on Triple Gauge couplings
- NEW PHYSICS, e.g. composite W or Z modifies coupling

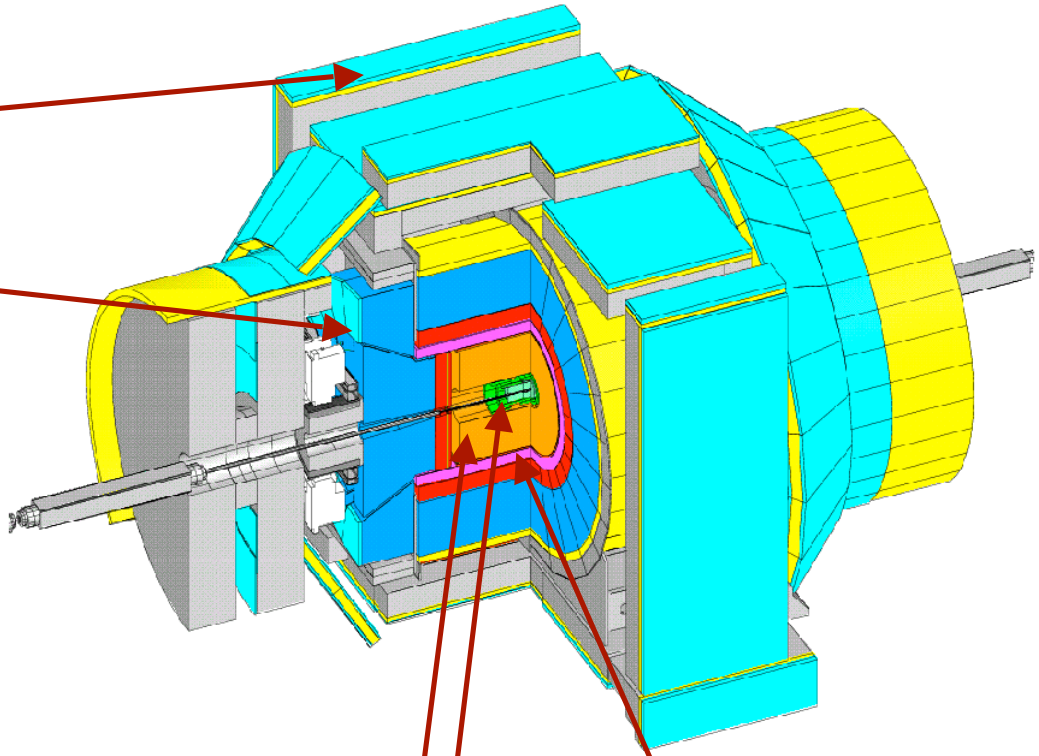


CDF and the Tevatron

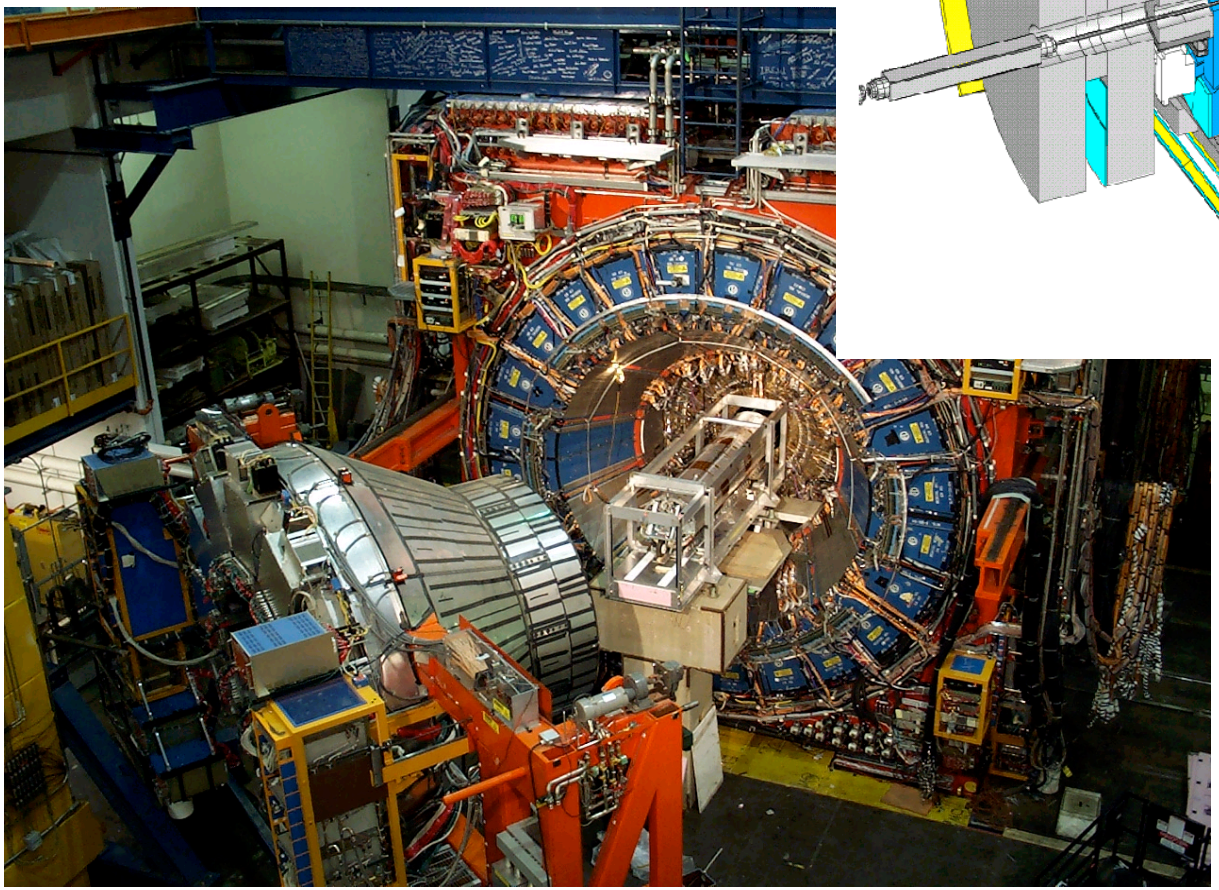


Fermilab, Chicago

- Muon Chambers
- Calorimeters

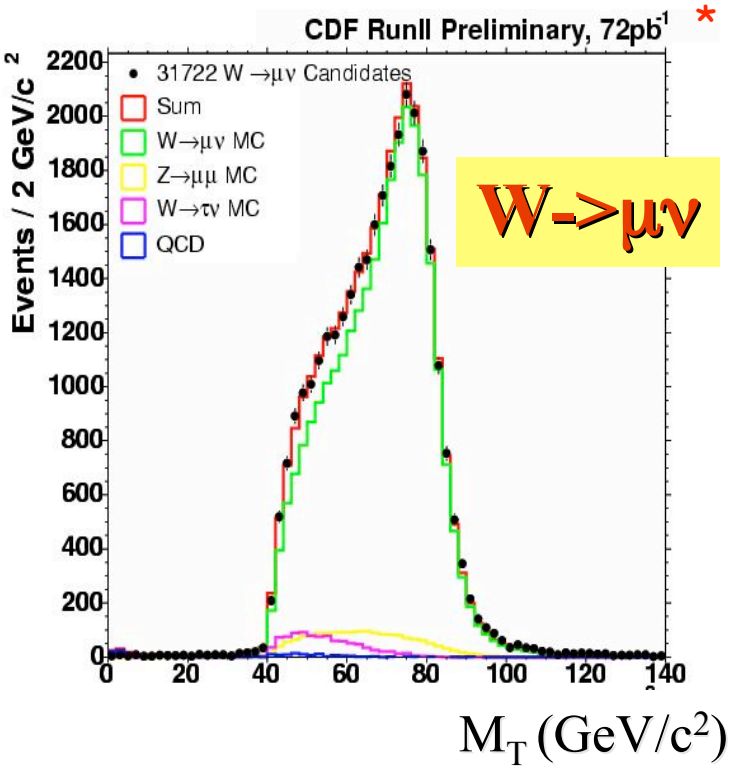


- Solenoid
- Tracking
- silicon



W selection

- 1 high Et lepton
- Large missing Et
- $30<M_T<120$ GeV/c^2
- +...



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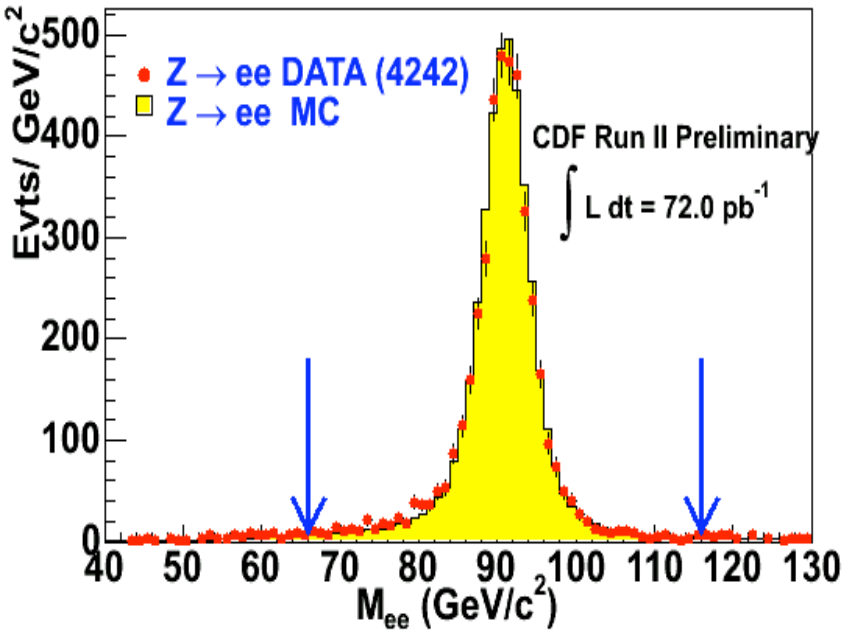

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Z Selection

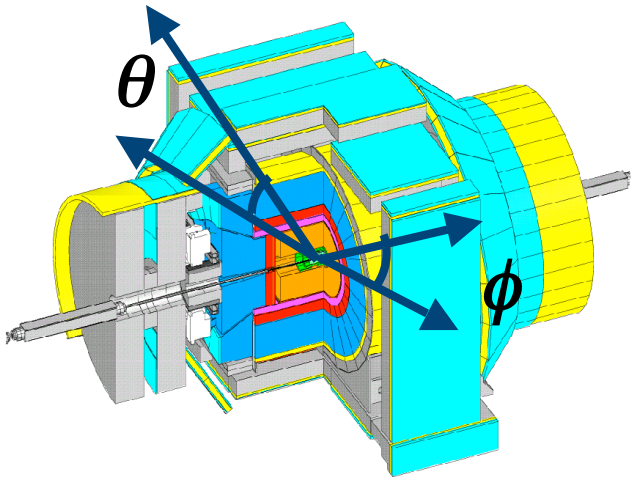
- 2 high Et lepton
- $40<M_{INV}$ GeV/c^2
- +...

*(Presented at Moriond 2004)

W/Z +γ

- W+…
- Central Photon: Et>7GeV
- ΔR(l,γ)>0.7

- Z+…
- Central Photon: Et>7GeV
- ΔR(closest l,γ)>0.7



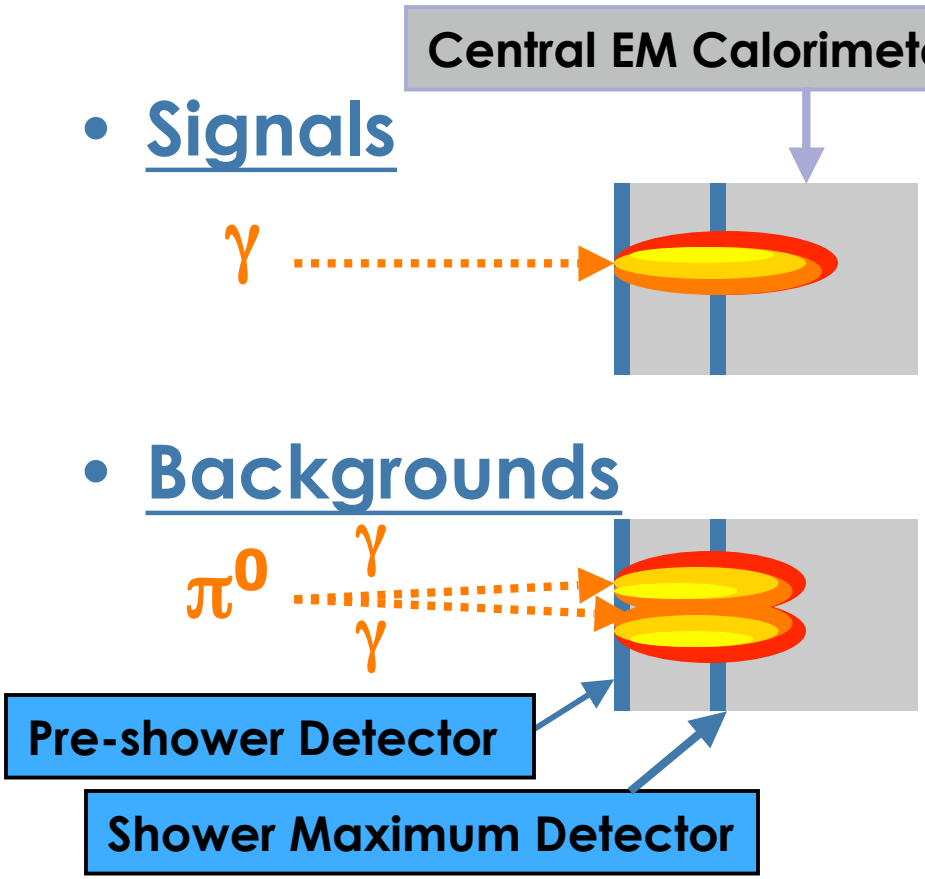
- We use η, the pseudo-rapidity:

$$\eta = -\log(\tan(\theta/2))$$

- We define ΔR, the distance between the (closest) lepton and the γ

$$\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$$

Identification of Photon Signals at CDF



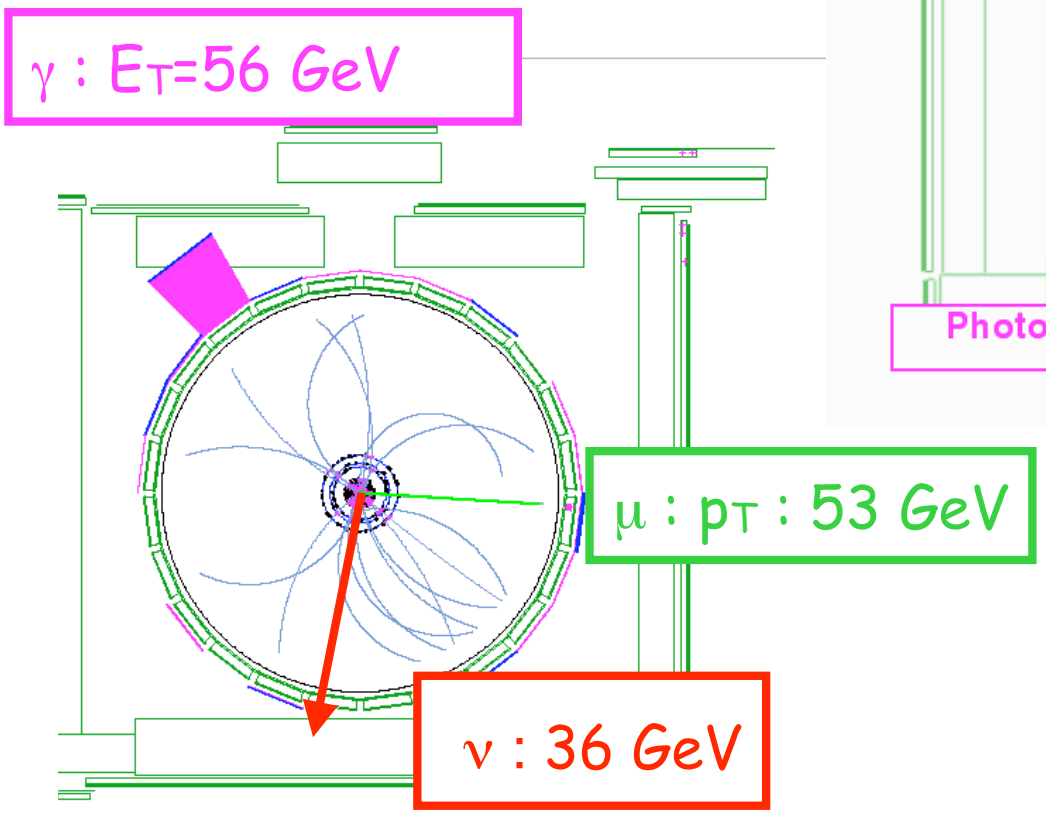
- EM calorimeter deposit with no track
  - γ or π^0 ?
- Techniques for determination of photon signals:
- EM Shower Width (shape)
  - Using Shower Max Detector
- Probability of Conversion in Solenoid
  - Using Pre-radiator hits

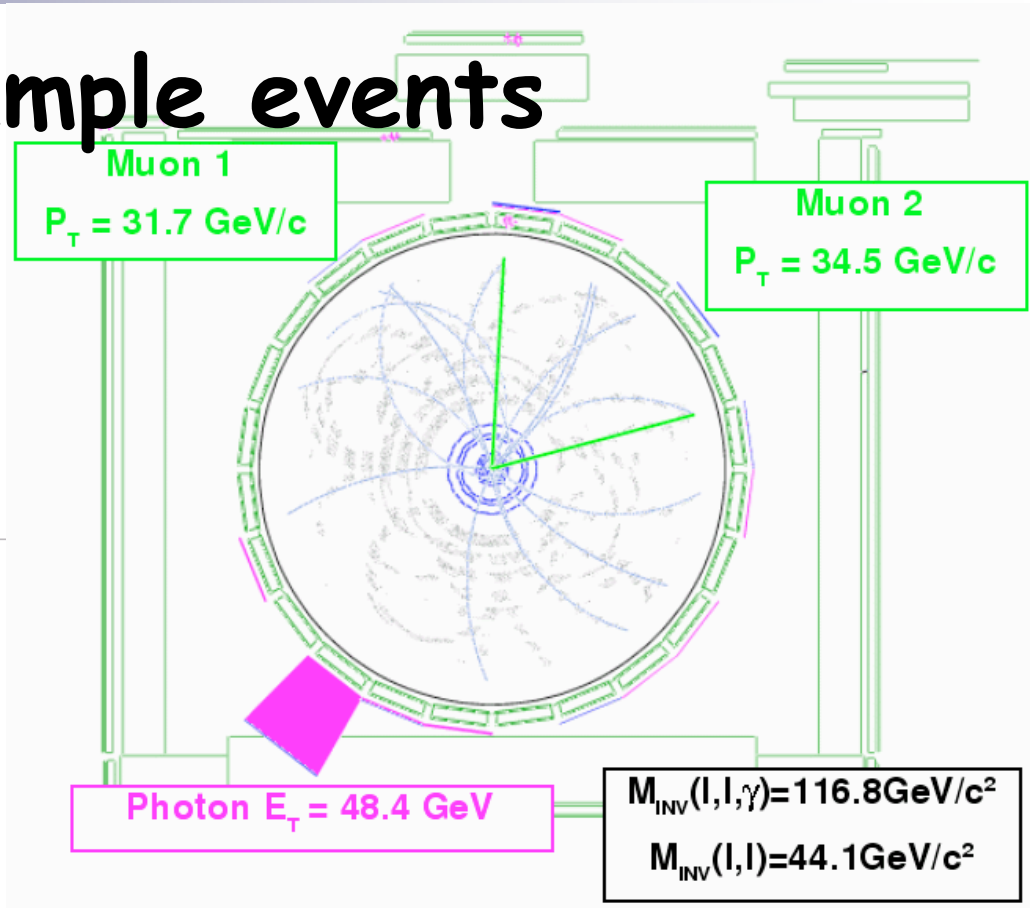
Photon candidates: Isolated electromagnetic showers in the calorimeter, with no charged tracks pointing at the calorimeter cluster

r-ϕ view of example events

Muon Channel

- Track with P_T>20 GeV
- Associated muon stub

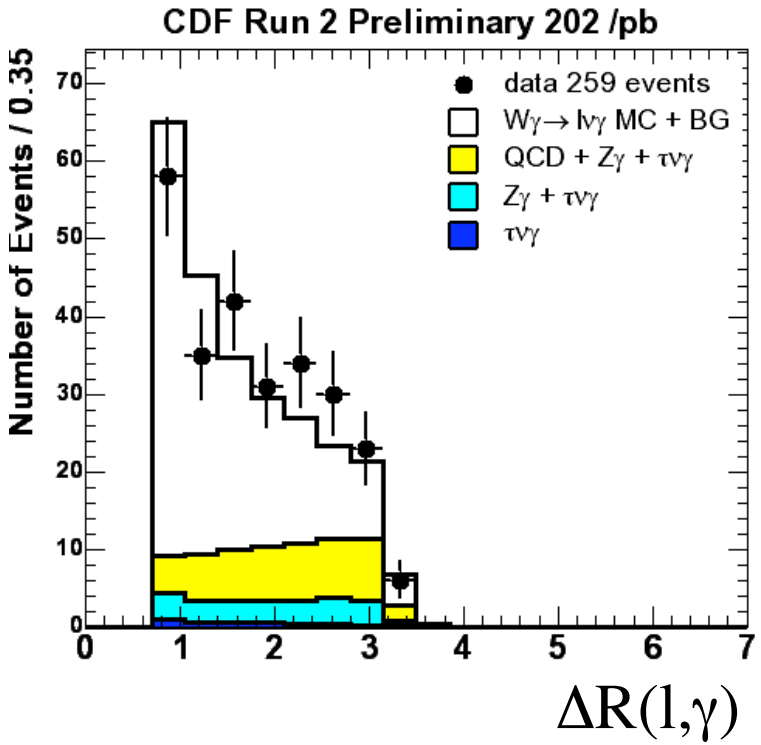


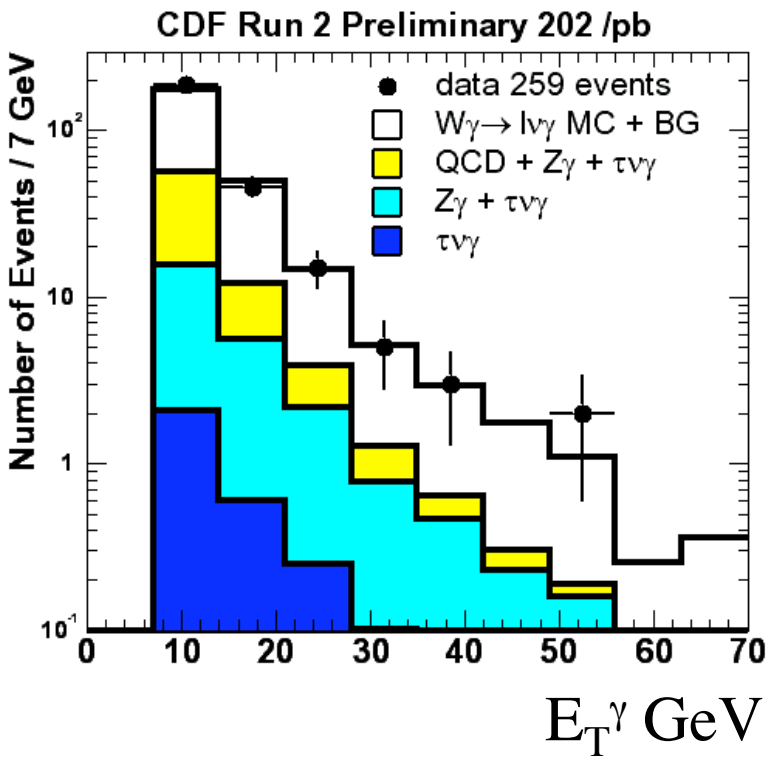


Electron Channel

- E_T>25 GeV
- EM calorimeter signal and associated track

Wγ Kinematic Distributions



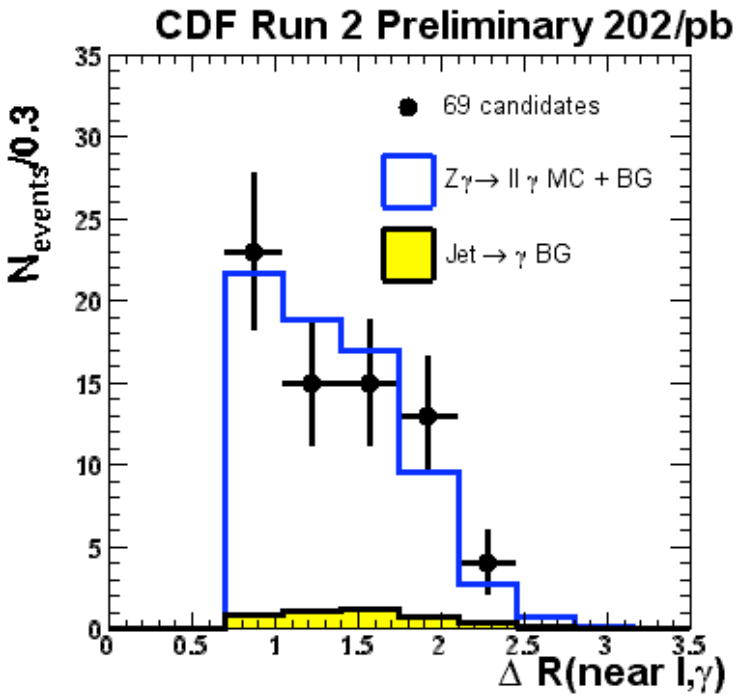


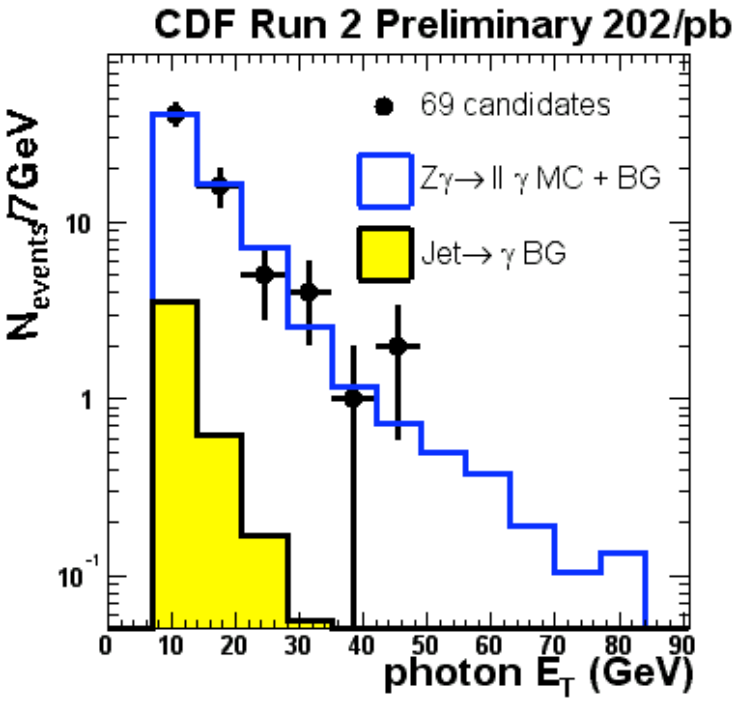
*Preliminary Results, 200pb^{-1}
(Presented at Moriond 2004)

$\sigma(W^{\pm}\gamma)*BR(W->l\nu)=19.7+-1.7(stat)+-2.0+-1.2$ pb

SM: 19.3+-1.3 pb

Zγ Kinematic Distributions





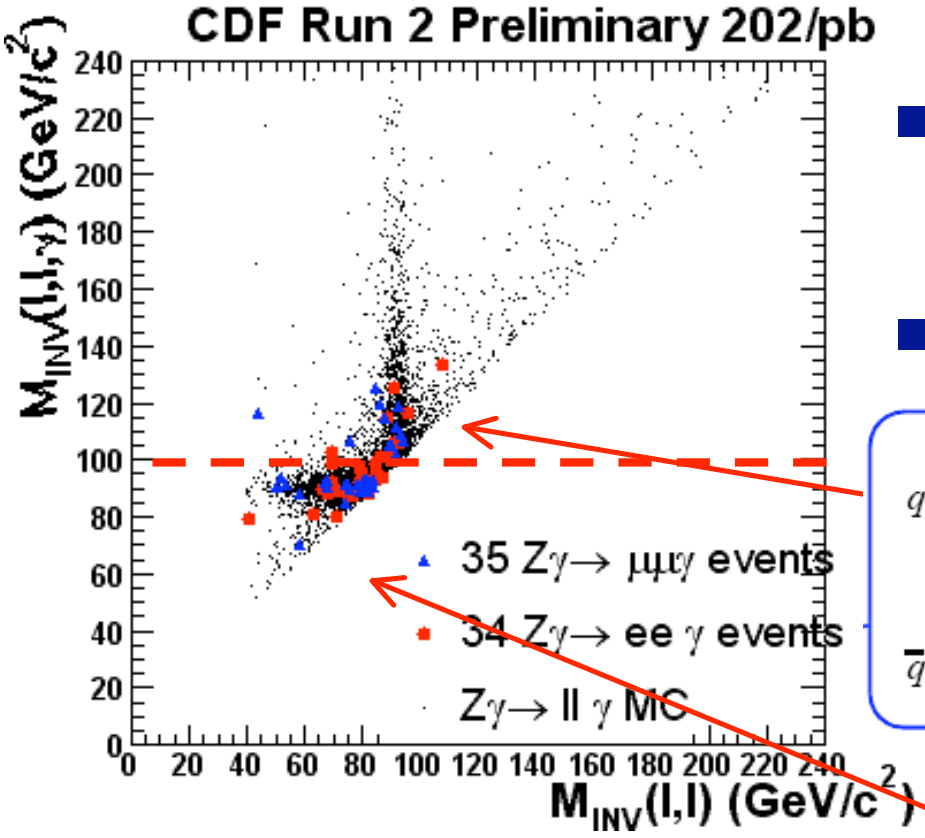
*Preliminary Results, 200pb^{-1}
(Presented at Moriond 2004)

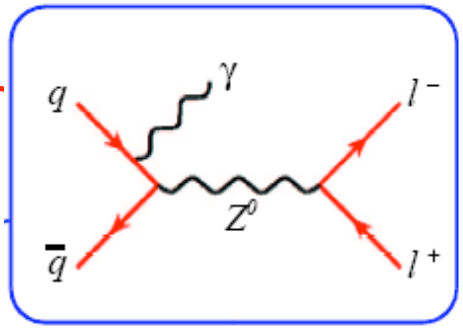
$\sigma(Z\gamma)*BR(Z\to l^+l^-)= 5.3+-0.6(stat)+-0.3(sys)+-0.3(lumi)$ pb *

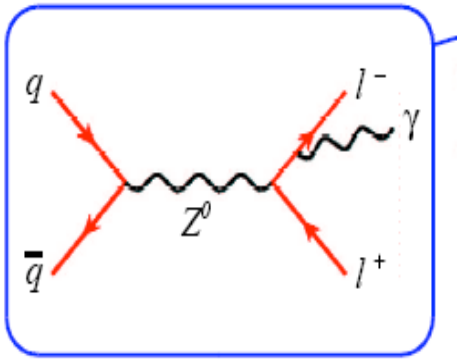
SM: 5.4+-0.4 pb

Separating processes: Zγ

- No s-channel diagram in SM
- Can suppress less interesting FSR diagram
- Require $M_{INV}(l,l,\gamma)$>100 GeV







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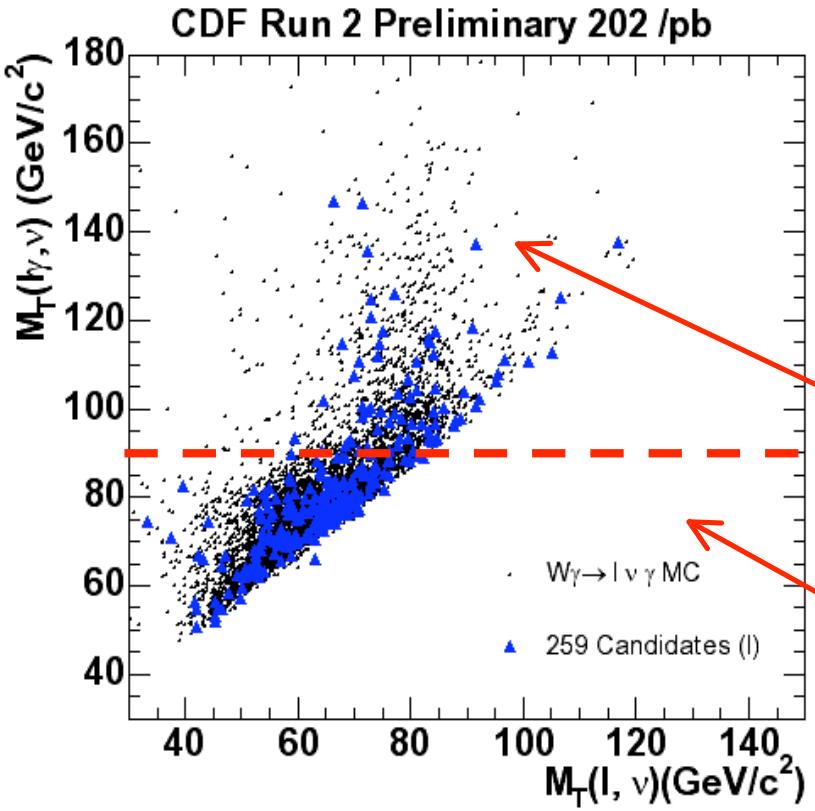
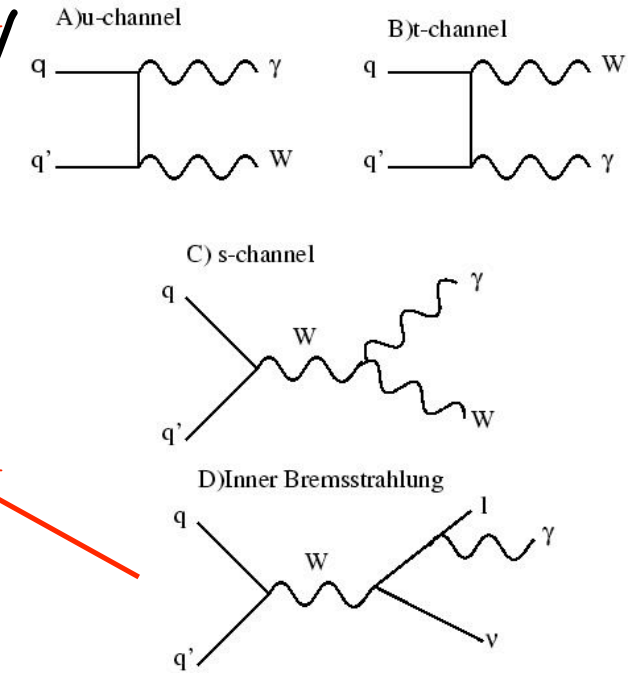
Separating processes: Wγ

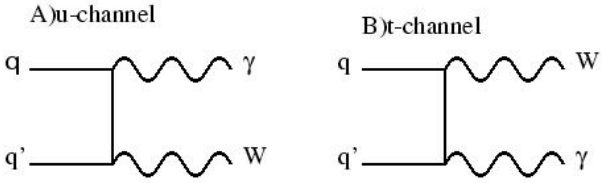


*Preliminary Results, 200pb^{-1}
(Presented at Moriond 2004)

- To suppress less interesting FSR diagram
- Require $M_T(l\gamma,\nu)$>90 GeV



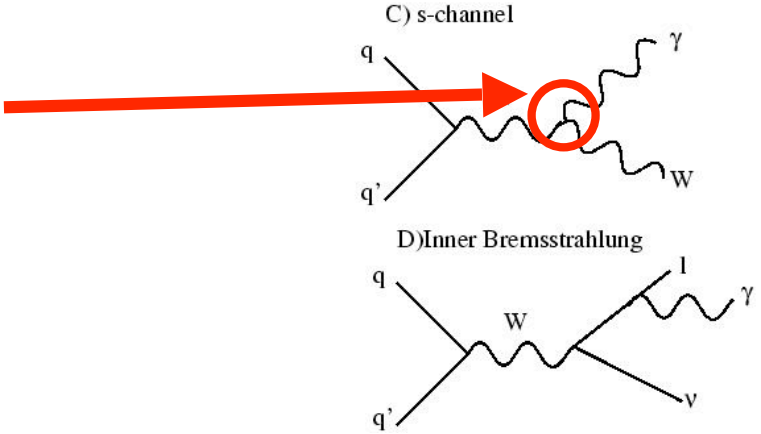
W/Z + γ: TGC

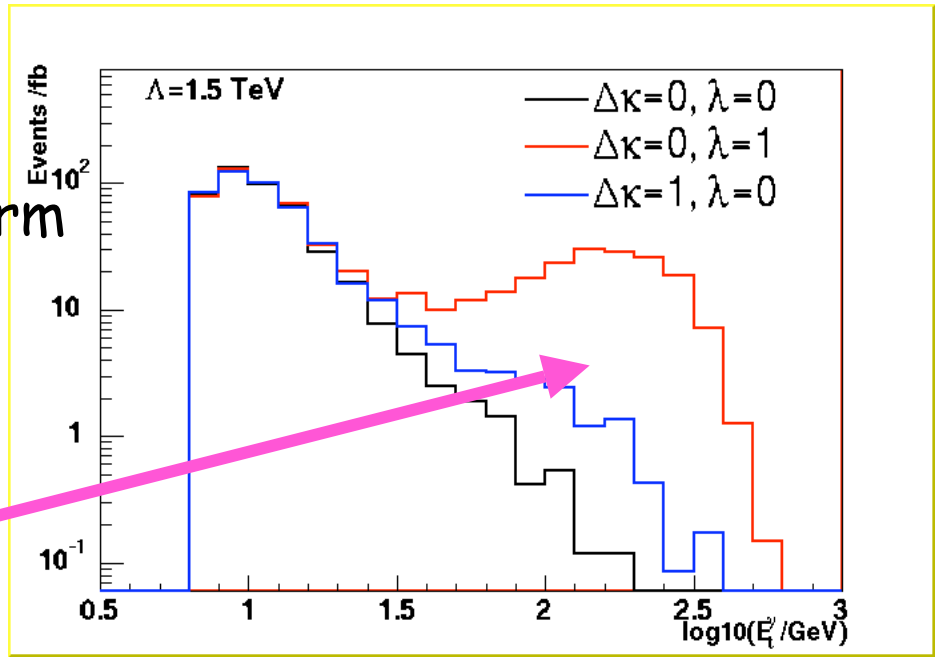


- Sensitive to coupling of gauge bosons to each other: WWγ vertex
- Z+γ don't couple to another in SM (diagram C non existent)
- Take Wγ as an example, introduce parameters Δκ and λ as deviations from SM
- Cross section rises with s, i.e. violates unitarity➔ introduce form factor Λ:

$$\sigma(s)=\Delta\kappa/[1+(s/\Lambda^2)]^n$$

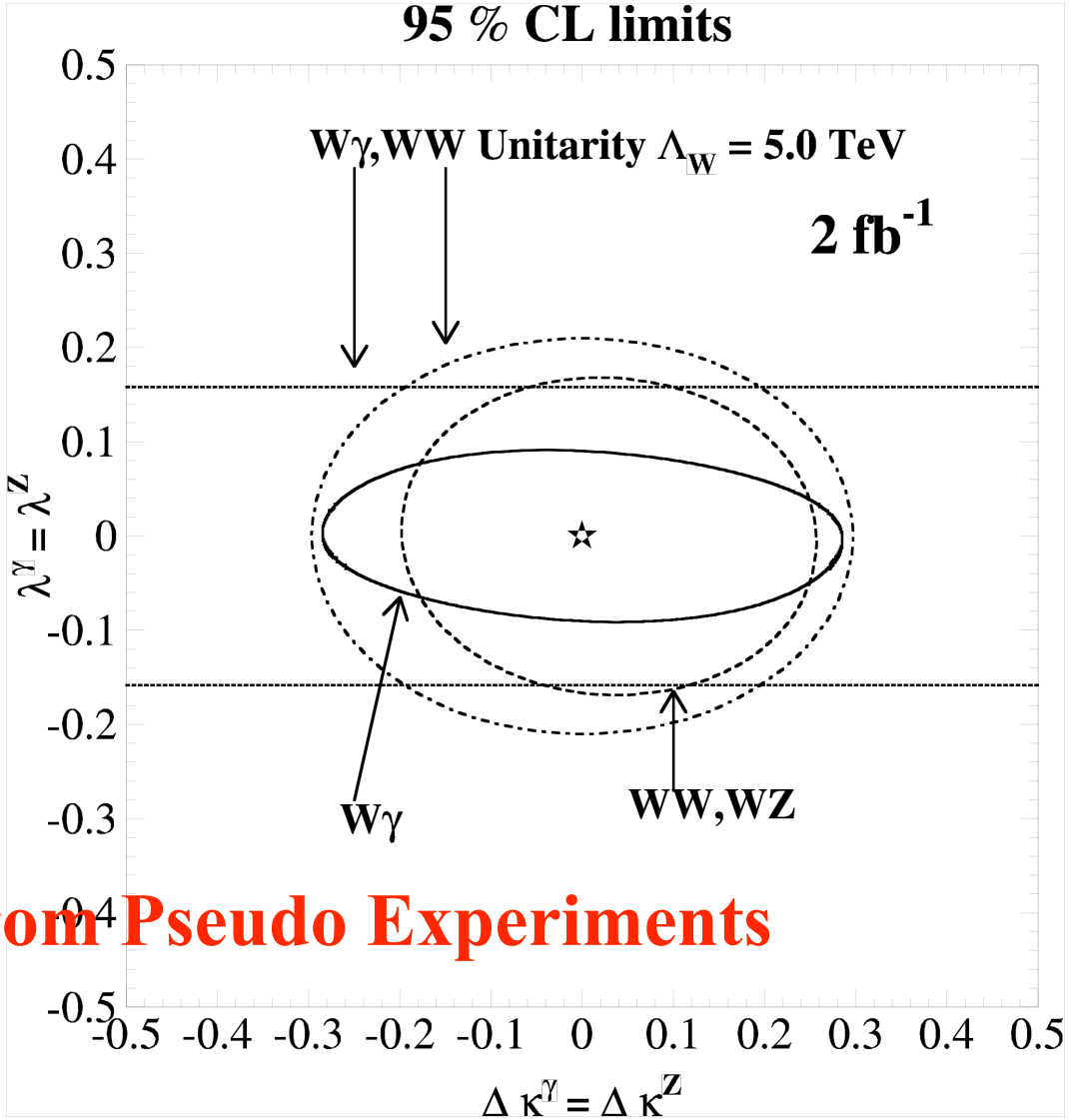
- Non-SM couplings cause harder photon Et spectrum





W/Z + Photon as Standard Model test

- Limits on $\Delta\kappa$ and λ:
  - Test SM at level of about 10(30)% in Run II
  - Similar precision achieved in measurements at LEP



CDF II: From Pseudo Experiments

Conclusions and Outlook

- Cross-section Measurements obtained with 200pb^{-1}: DONE
  - Wγ: 19.7+-1.7(stat)+-2.0(sys)+-1.2(lumi) pb
  - Zγ: 5.3+-0.6(stat)+-0.3(sys)+-0.3(lumi) pb
- First Limits on TGC to be completed soon.
- PRL to be published soon.
- THESIS!!! Soon.
- Work on PRD.