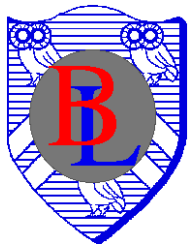
Prospects for study of Anomalous WWγ couplings and the Radiation Amplitude Zero in Wγ Events at the Tevatron



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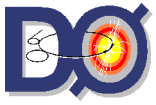
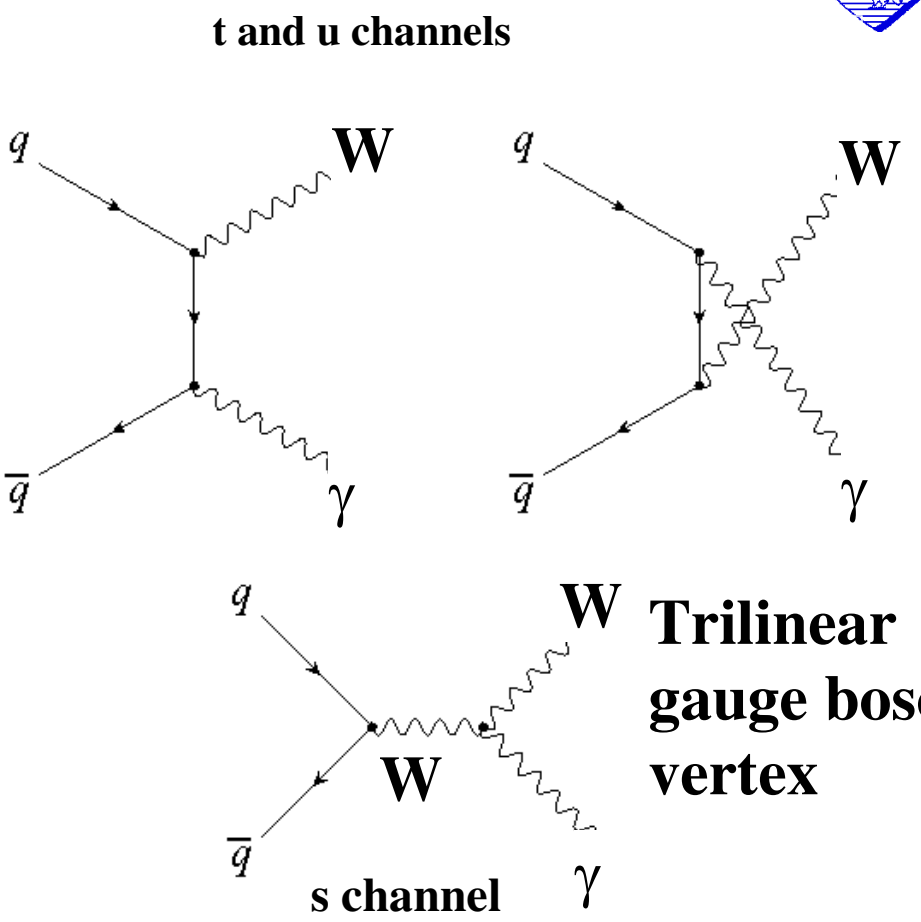


$W\gamma$ What is it?

- Standard model coupling of W boson to the photon. There are very specific predictions made on the strength of these couplings.
- At DØ we are interested in all final state leptons, but for the purpose of this analysis we are interested in the decays W->$\mu\nu$ and W->eν. The event signature is:
  - high P_T electron or muon
  - photon
  - missing E_T carried by the neutrino.



$W\gamma$ Parametrized Lagrangian

$$L_{WW\gamma}/g_{WW\gamma} = g_\gamma^1 \left(W^\dagger_{\mu\nu} W^\mu A^\nu - W^\dagger_\mu A_\nu W^{\mu\nu} \right)$$

$$+ \kappa_\gamma W^\dagger_\mu W_\nu F^{\mu\nu} + \frac{\lambda_\gamma}{M_W^2} W^\dagger_{\lambda\mu} W^\mu_\nu F^{\nu\lambda}$$

λ=0, in SM

Standard Model:
κ=1, g_γ=1

$$\mu_W = \frac{e}{2M_W}(1+\kappa+\lambda)$$

Magnetic dipole moment of W

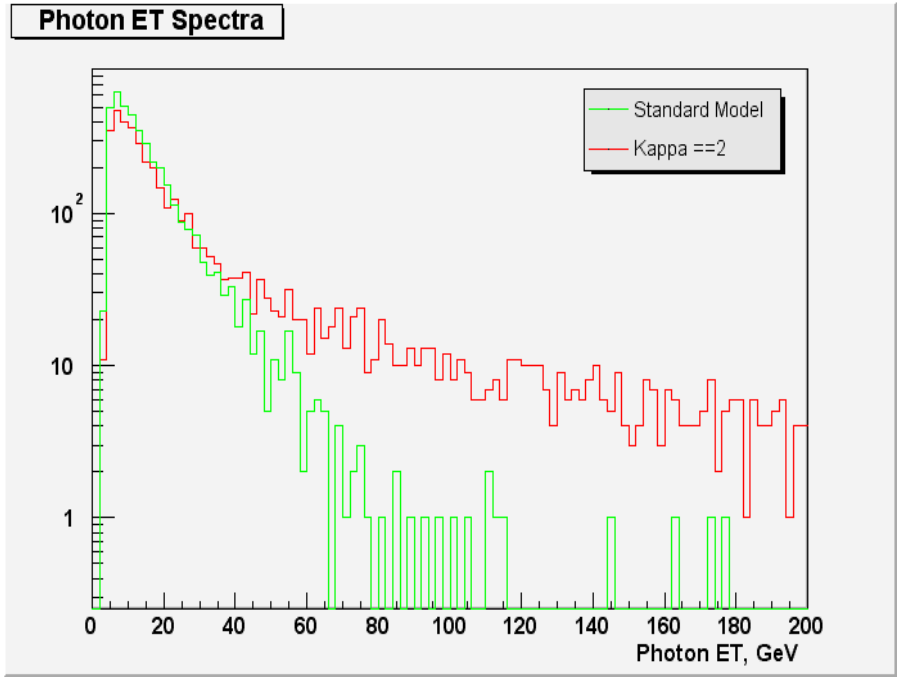
$$Q_W = \frac{-e}{M_W^2}(\kappa-\lambda)$$

Electric quadrupole moment of W

$W\gamma$ How do we test this?

- Extra coupling between the W and the photon leads to an excess of events, especially visible at high E_T. Lower energy dominated by bremstrahlung
- Can measure or set limits on couplings by measuring E_T spectrum
- Dominant background is W+jets, where the jet fakes a photon.

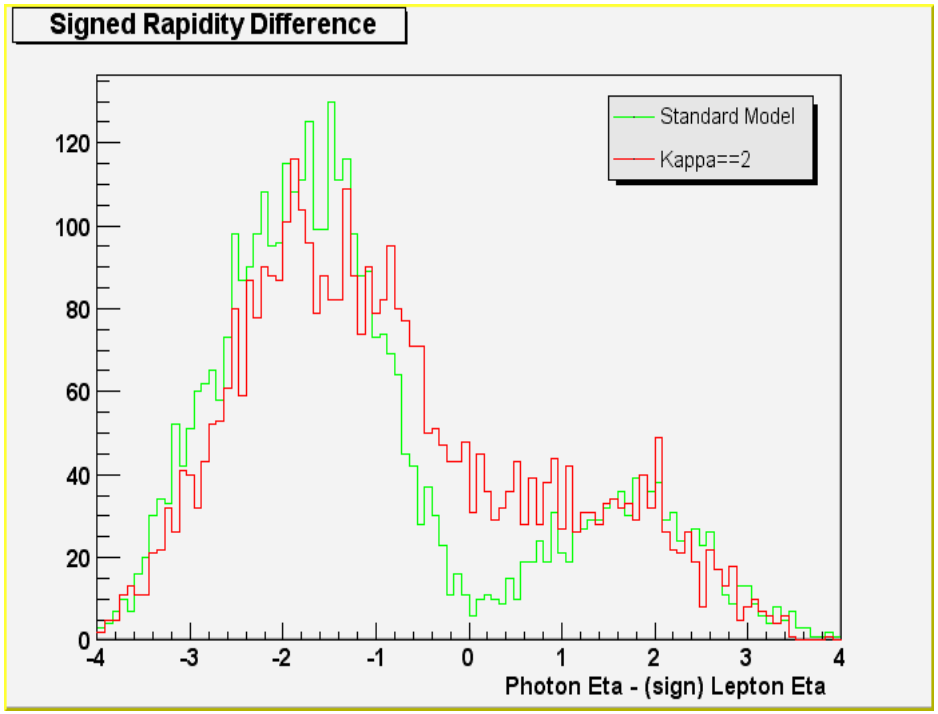
Baur MC using parametrized detector simulation for Photon E_T spectra



$W\gamma$ The Radiation Amplitude Zero

- The three Standard Model diagrams I've shown interfere with each other.
- The interference between these diagrams causes an angular zero in the spin and color averaged matrix element.
- If anomalous couplings exist, this angular zero is filled in. QCD backgrounds also fill in the zero.
- Never before observed.

Baur MC, using parametrized detector simulation.

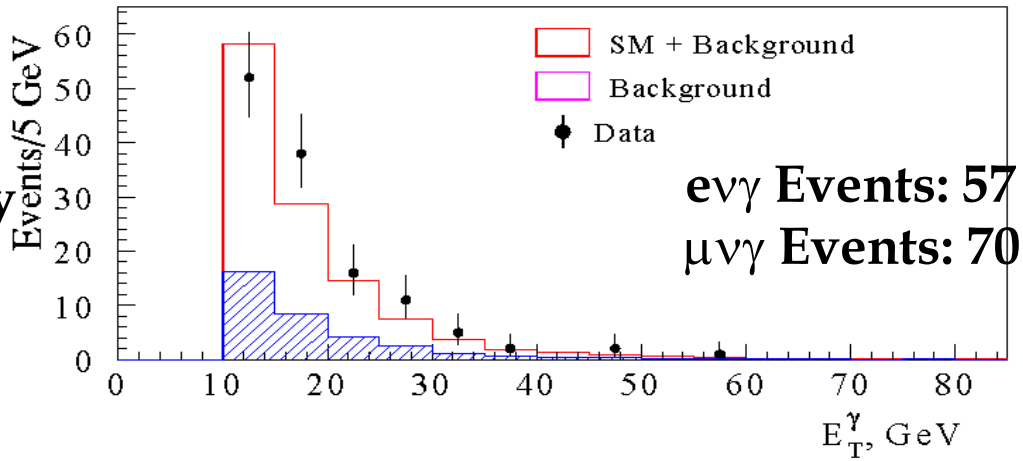


$W\gamma$ $W\gamma$ Results at DØ from Run I Data

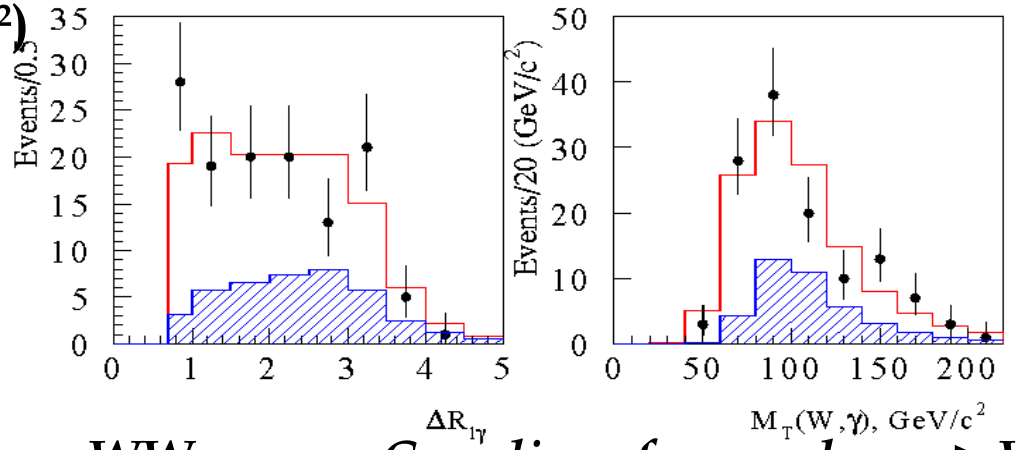
Selection criteria:

High E_T electron 25 GeV
(or muon 15 GeV)
Missing Transverse Energy
>25 (15) GeV
M_T(l,n)>40 (30) GeV/c^2

Photon E_T > 10 GeV
dR(l,γ) >0.7 ($dR^2 = d\eta^2 + d\phi^2$)



e$\nu\gamma$ Events: 57
$\mu\nu\gamma$ Events: 70



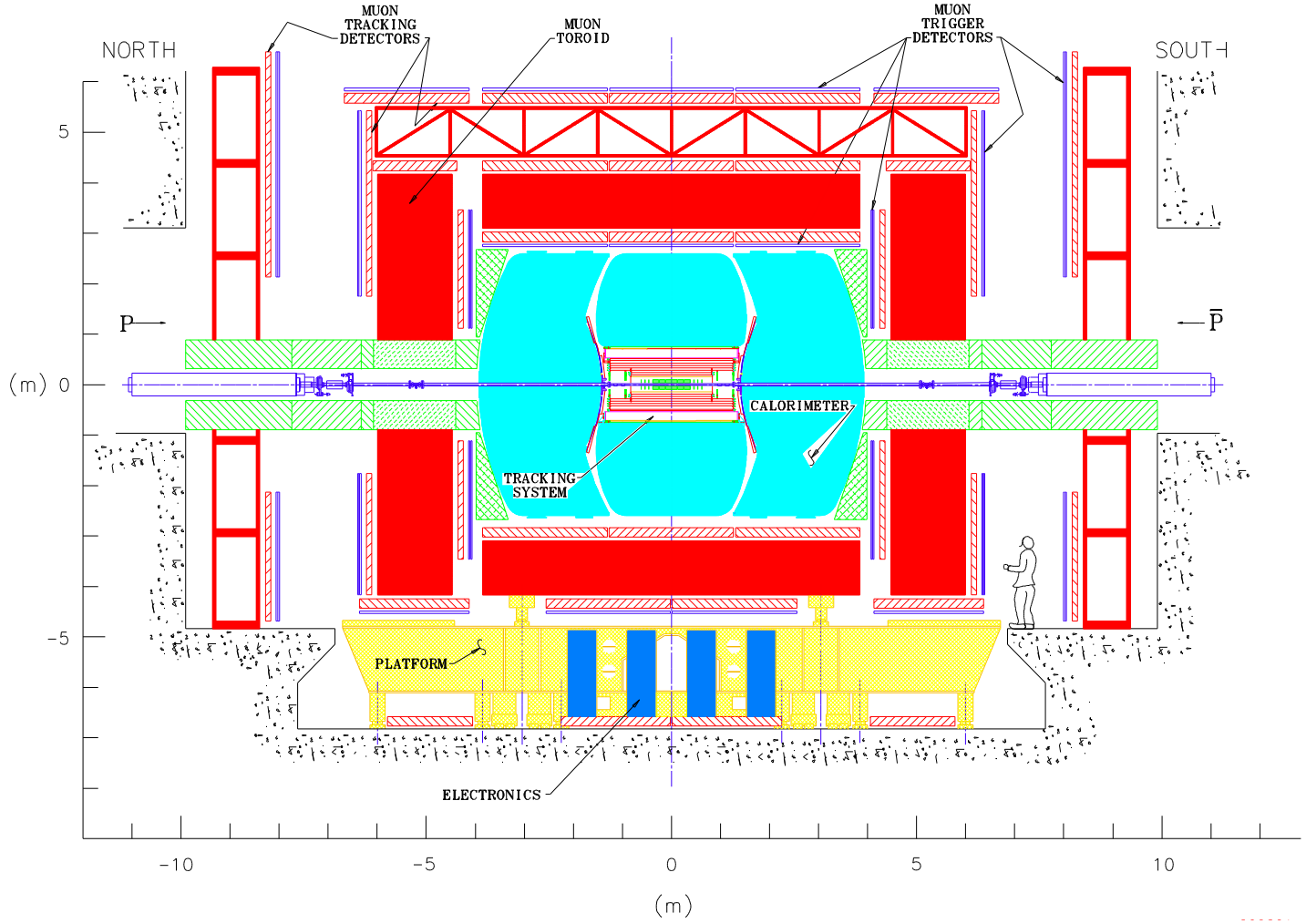
-.93<Δκ<.94;λ=0
–.31<λ<.29;Δκ=0

Limits on Anomalous WWgamma Couplings from ppbar --> W gamma+X Events at sqrt s = 1.8 TeV. **Phys. Rev. Lett. 78, 3634 (1997)**

$W\gamma$ DØ Upgrade:

- Magnetic Tracking: Silicon microstrip tracker surrounded by sixteen layers of scintillating fiber tracker.
- Preshower systems to compensate for energy loss in solenoid, and provide better position resolution for EM objects.
- Brand new forward muon system.

$W\gamma$ DØ upgrade (view 1):

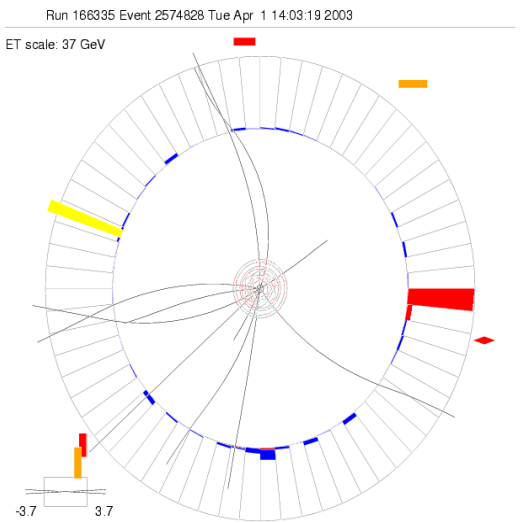


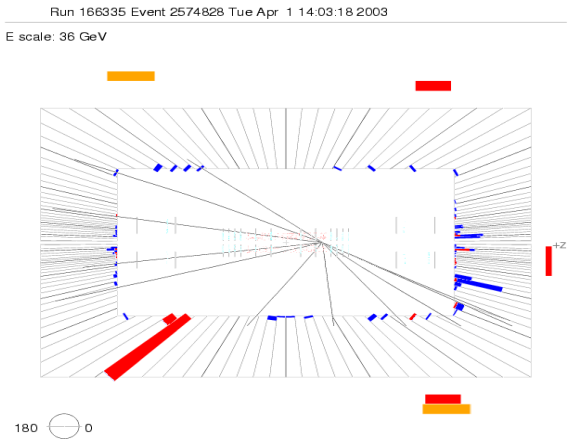
$W\gamma$ Expected Events

- Scaling from the Run I results, we should see on order 2600 events total (efficiencies already included, using full 2fb^-1).
- The above assumes Run I efficiencies. With improved lepton ID, we could do even better.
- Now we can tell the charge of the electron as well, helping with the RAZ.

$W\gamma$ Run II selection:

- Muon channel:
  - Single Muon Trigger
  - PT, MET > 20 GeV
  - Photon ET>10 GeV
  - Transverse Mass > 50 GeV
  - Three body Mass > 90 GeV
  - $\Delta R(\mu,\gamma)>.7$
  - 19 candidates pass cuts



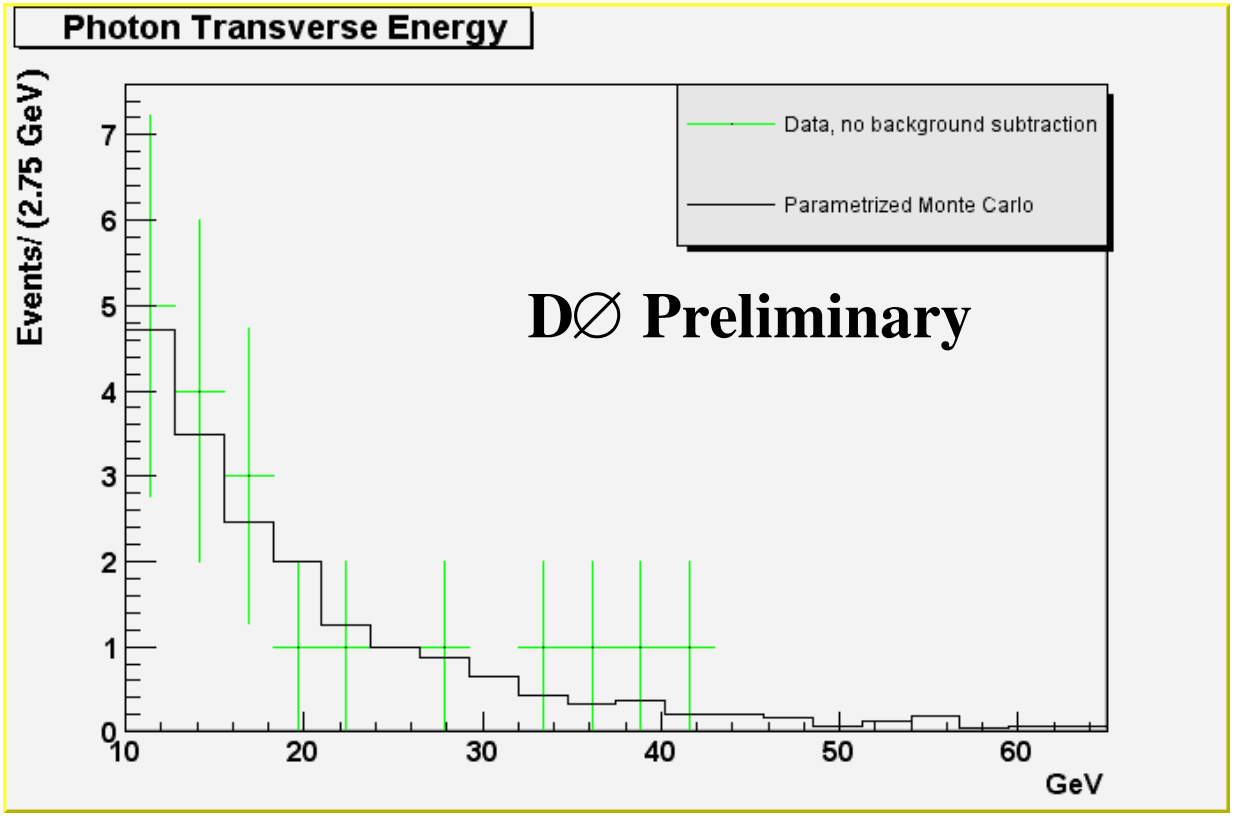


One of the candidate events passing these cuts.

$W\gamma$ Early work on background estimate:

- Find rate at which QCD jets fake photons.
  - Use jet trigger, require good jet object, match up trigger information.
  - Require low MET.
  - Examine 'other' side of event for photon candidate.
- Use W+jets to get the proper normalization, given this rate.
- Current estimate is approximately one event.

$W\gamma$ First look at Photon Et:



From muon channel only, based on 17pb^-1 of data.
No background subtraction.

$W\gamma$ Summary

- I've described $W\gamma$, anomalous couplings and the RAZ.
- I've shown the photon E_T spectrum for our first candidates.
- With the improved DØ detector, and greater statistics, the anomalous coupling limits will be improved and the Radiation Amplitude Zero observed.
- You'll be hearing from us soon.