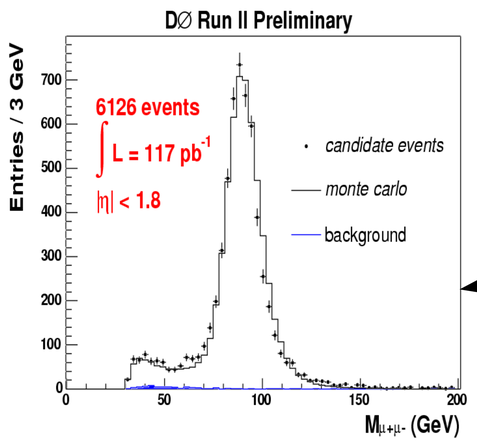
Electroweak Physics at DØ

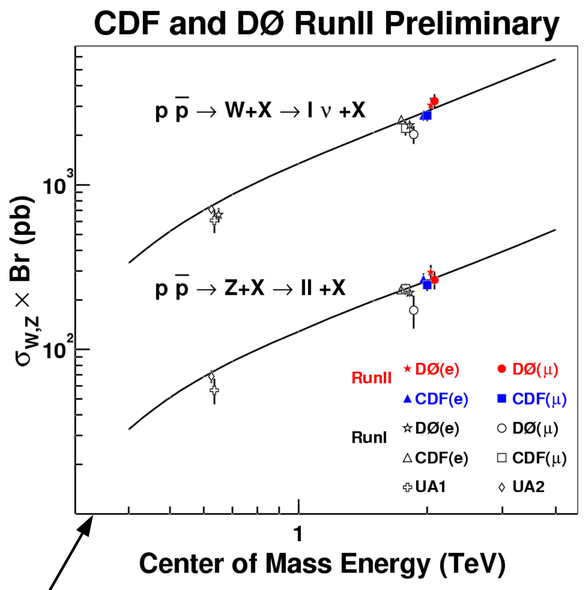
Andrew Askew

W and Z Cross sections:

Why study W and Z Cross sections?
W and Z events are important for hadron collider experiments. Not only are the cross sections tests of the theoretical predictions, W and Z decays serve as benchmarks for measuring detector and algorithm performance. Z events are important for calibrating the electron energy scale, while W events can be used to help understand the missing transverse energy resolution. Both are important steps in understanding the detector for precision measurements such as the W mass.

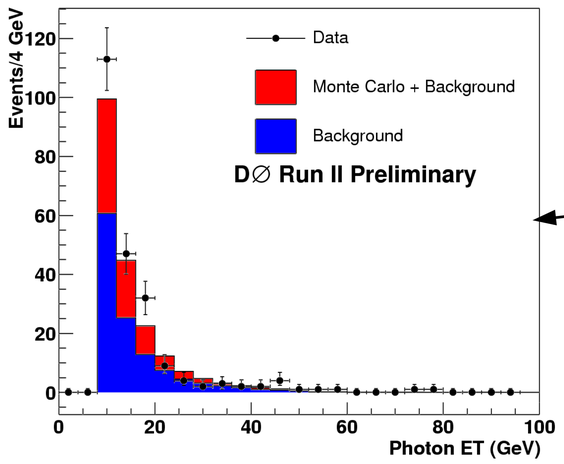


Z->μμ invariant mass using momentum information from central track.



Summary plot of Tevatron W and Z cross section results from Summer 2003.

W+γ

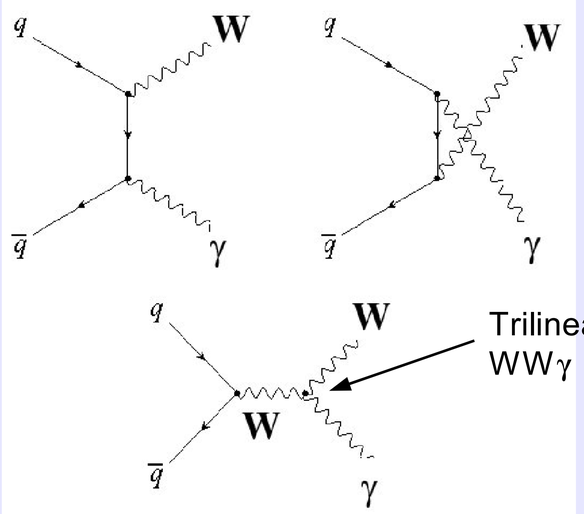


Combined Photon E_T spectrum from both Electron and Muon channels.

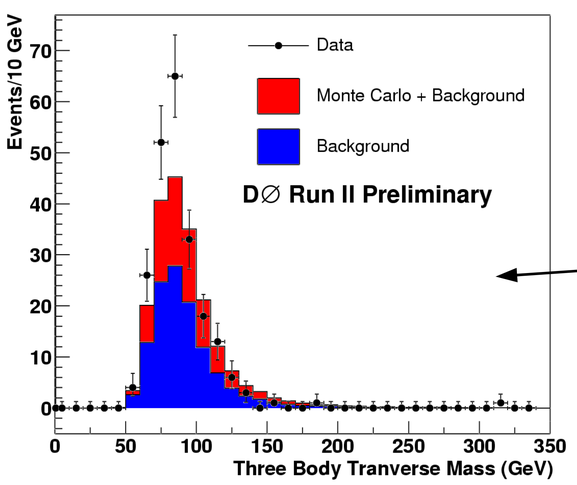
Electron $\mathcal{L}$: 162 pb^{-1}
Muon $\mathcal{L}$: 82 pb^{-1}

What is Wγ?

In the Standard Model, the electroweak force carriers are required to interact in a very specific way, i.e. through trilinear gauge boson vertices. Deviations in the cross section, and/or in the photon ET spectrum would be signs of new physics. Non-Standard Model couplings would lead to more events at high photon E_T. Therefore the photon spectrum will be used to set limits on the Wγ coupling as a test of the Standard Model.

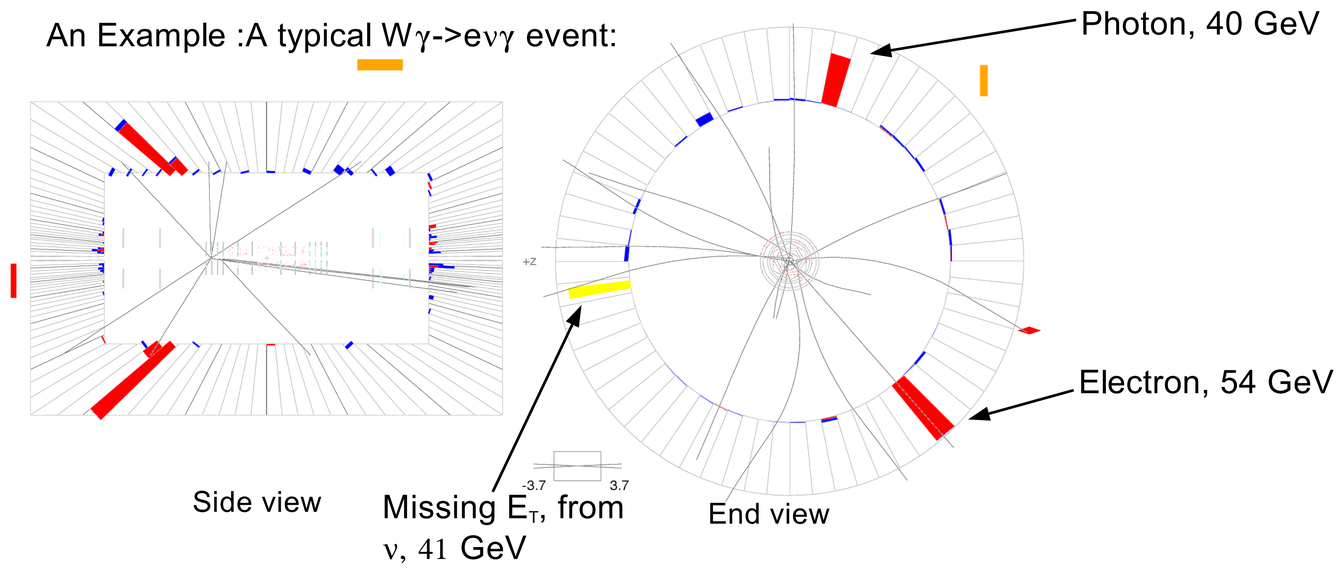


Standard Model diagrams for coupling of W boson to the photon.



Three Body (ℓ-γ-$\not{E}_T$) Transverse Mass:

An Example :A typical Wγ->eνγ event:



$\sigma_{W\gamma\to\ell\nu\gamma}$: 19.3 +/- 6.7 (stat. + sys.) +/- 1.3 (lumi.) pb, combined e and μ channels.
Standard Model Expected: 16.4 +/- 0.4 pb.

Top Physics at DØ

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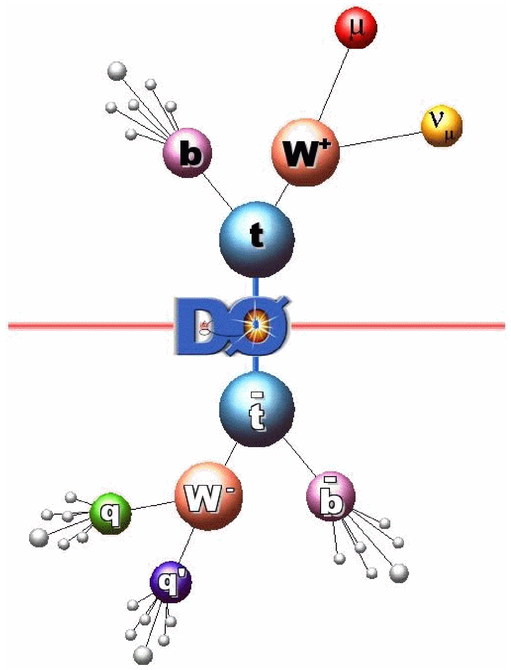
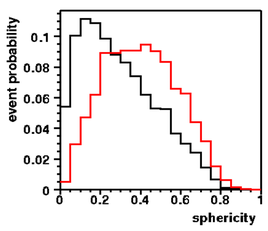


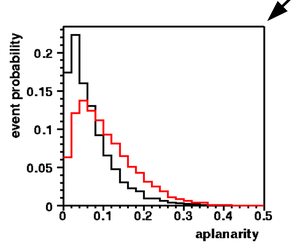
Lepton + Jets Top(-ological) Analysis:

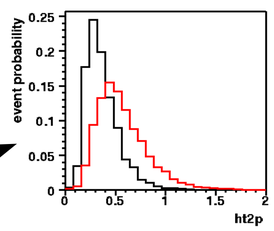
The majority of Top event decay to jets (t->Wb->jjb). Requiring one of the Ws in a top event to decay leptonically decreases the number of events, but vastly reduces the background from QCD multijet production. Even so, there are large backgrounds due to both physics processes (W+j), and instrumental background that further complicate matters. However by using the topology of the jets in the event, and combining the information in that topology into a likelihood, the top events may be extracted.

Sphericity: A measure of the magnitude of the momentum transverse to the event axis.

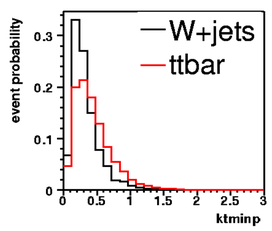


Aplanarity: A measure of the flatness of the event (how well the objects in the event fit into a plane).





Ht2p: A measure of how central the event is.



Ktminp: A measure of the minimum jet pT, relative to another.

What Information Should We Use?

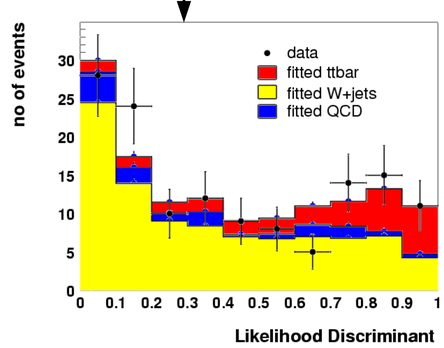
1.) Large separation between signal and background.
2.) Small sensitivity to systematics.
3.) Minimal correlation.

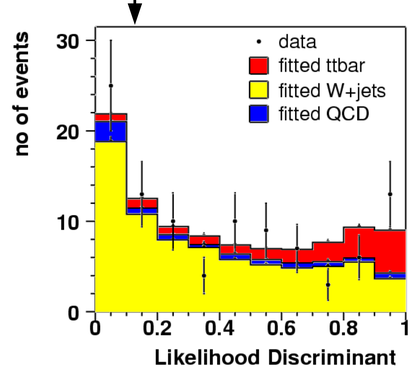
FEWER IS BETTER: All variables add noise as well, so the fewer used, the better. Therefore, only use the best!

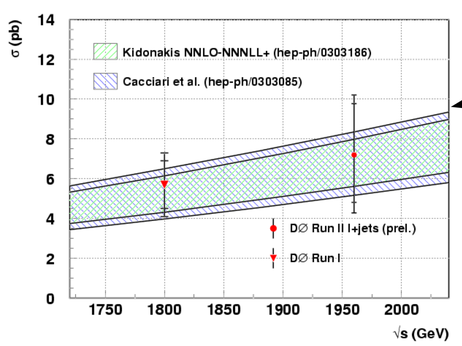
How should we use it?

In order to make use of all of the available information in the chosen quantites, a likelihood discriminant is constructed. Separate discriminant functions are formed for the electron and muon decays of the W. The number of $t\bar{t}$ events is then determined by a likelihood fit to the likelihood discriminant distribution in data by using templates for the $t\bar{t}$ signal and backgrounds (W+jets, QCD multijet).

Likelihood Discriminants for Muon+Jets and Electron+Jets







Run II Lepton + Jets analysis $t\bar{t}$ Cross section, as compared to the theoretical expectation, and the Run I measurement.

$$\sigma_{p\bar{p}\to t\bar{t}+x} = 7.20^{+2.58}_{-2.39}(\text{stat})^{+1.57}_{-1.68}\ (\text{syst}) +/- 0.47\ (\text{lumi})$$

Electron + jets $\mathcal{L}$: 141 pb^{-1}
Muon + jets $\mathcal{L}$: 144 pb^{-1}