Making Precision Measurements at Hadron Colliders-II

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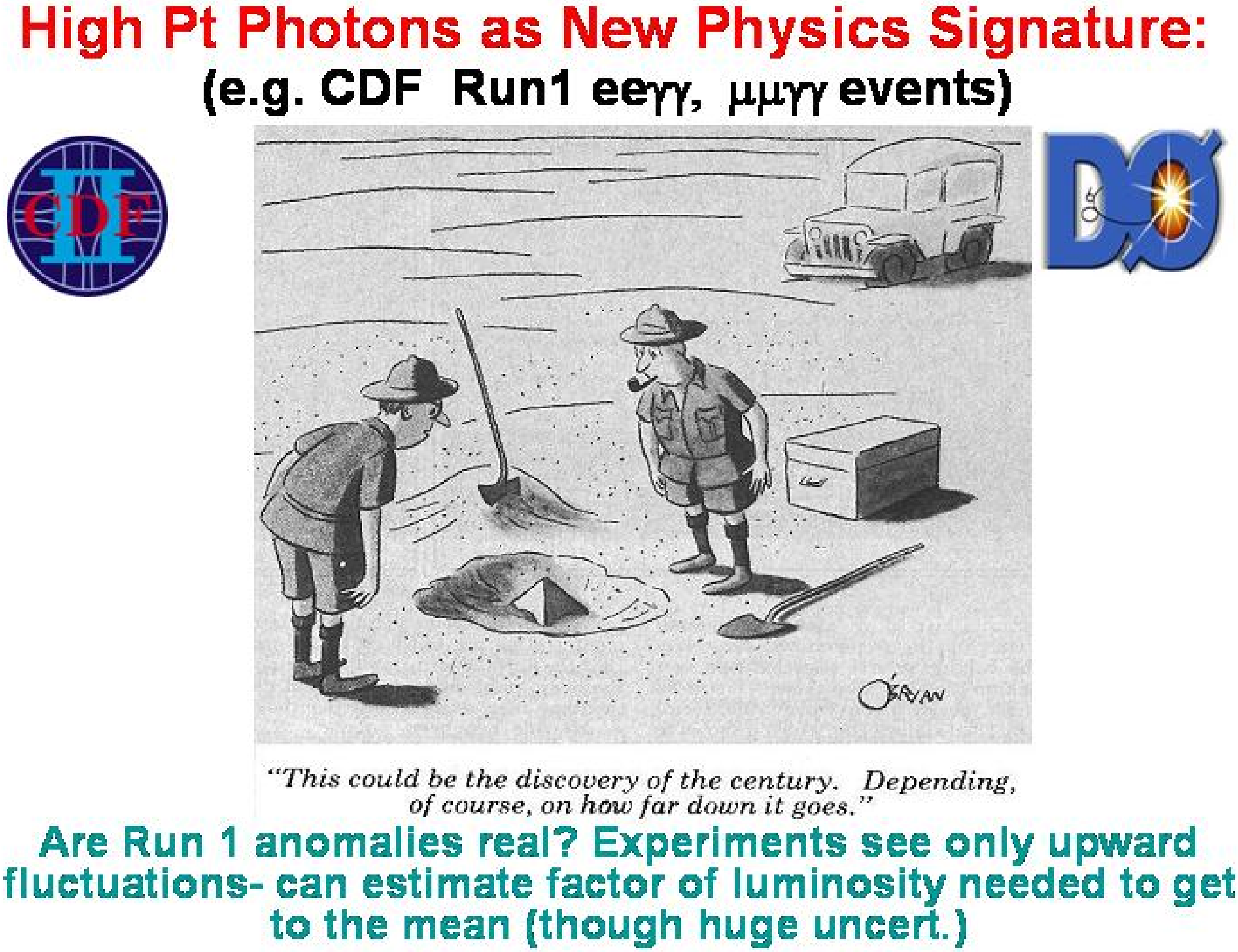
Contents

1 Lecture II: Searching for Physics Beyond the SM, and Some Challenges for the Audience

In this lecture I will continue the theme of making precision measurements at hadron colliders. Like Lecture I, this will not be a review of searches– I will instead emphasize the problems that high statistics will bring- first at the Tevatron, and then (in spades) at the LHC.

Many of these problems are theoretical- in almost all cases we need precise Standard Model predictions in order to find new things (exceptions being new bumps- e.g. a Z-prime, KK excitations of the Z, etc.)

Our hope at the Tevatron is, of course, that we find something new before the LHC. We had hints of new things in Run I:



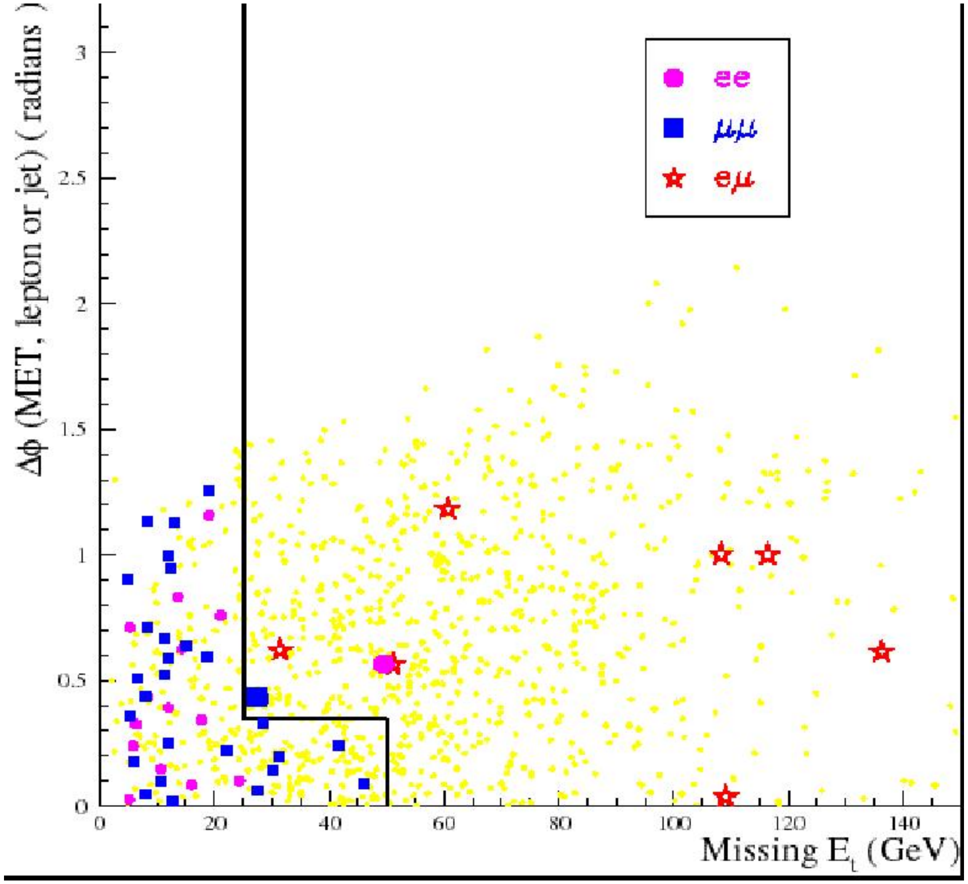
High Pt Photons as New Physics Signature:

(e.g. CDF Run1 $ee\gamma\gamma$, $\mu\mu\gamma\gamma$ events)

"*This could be the discovery of the century. Depending, of course, on how far down it goes.*"

Are Run 1 anomalies real? Experiments see only upward fluctuations- can estimate factor of luminosity needed to get to the mean (though huge uncert.)

Figure 1:



The Run-1 Dilepton events in the $\not\!\!E_t - \Delta\Phi$ plane. The yellow dots are SM expectations for $t\bar{t}$.

Some Run I oddities (none significant):

1. The top dilepton sample looked odd (too many e-mu events, e-mu close in phi, a few events with kinematics that didn't fit the top mass, and the 'tri-lepton' event.)
2. Top mass in dileptons was consistently lower than in lepton+jets.
3. Resolutions on top mass seemed too good- we got lucky?
4. The $ee\gamma\gamma\not\!\!E_t$ event and the 2.8σ excess in $\ell + \gamma + \not\!\!E_t$.
5. High-Pt $Z + \gamma$ event, and then $W + 2\gamma$ event at start of Run II.

1.1 Strategies: Signature-Based vs Model-Directed, Blind vs A Priori vs Myopic, etc.

None of the above effects was significant statistically- but made one want more data. We now have 10-times the data, and are scheduled for a factor of 4-10 beyond that. What to do? There are two major kinds of direct searches, and in each three kinds of strategies have been followed (all this categorization is arguable):

1. Model-Directed: Optimize sensitivity for point or points in 'theory' parameter space

2. Signature-Based: Look broadly under lamp-posts in attractive neighborhoods

Avoiding biases is important (see next slide)- two solid strategies:

1. A Priori- use the same cuts as published in Run I, or in the 1st 1/3rd of the data; then run on rest of data without changing anything (a propos for signature-based searches).
2. Blind- this is heavily used now-very useful and appropriate in some cases (e.g. precision measurements: W mass, B lifetimes and masses, and classic well-defined searches: $B \to \mu\mu$,...

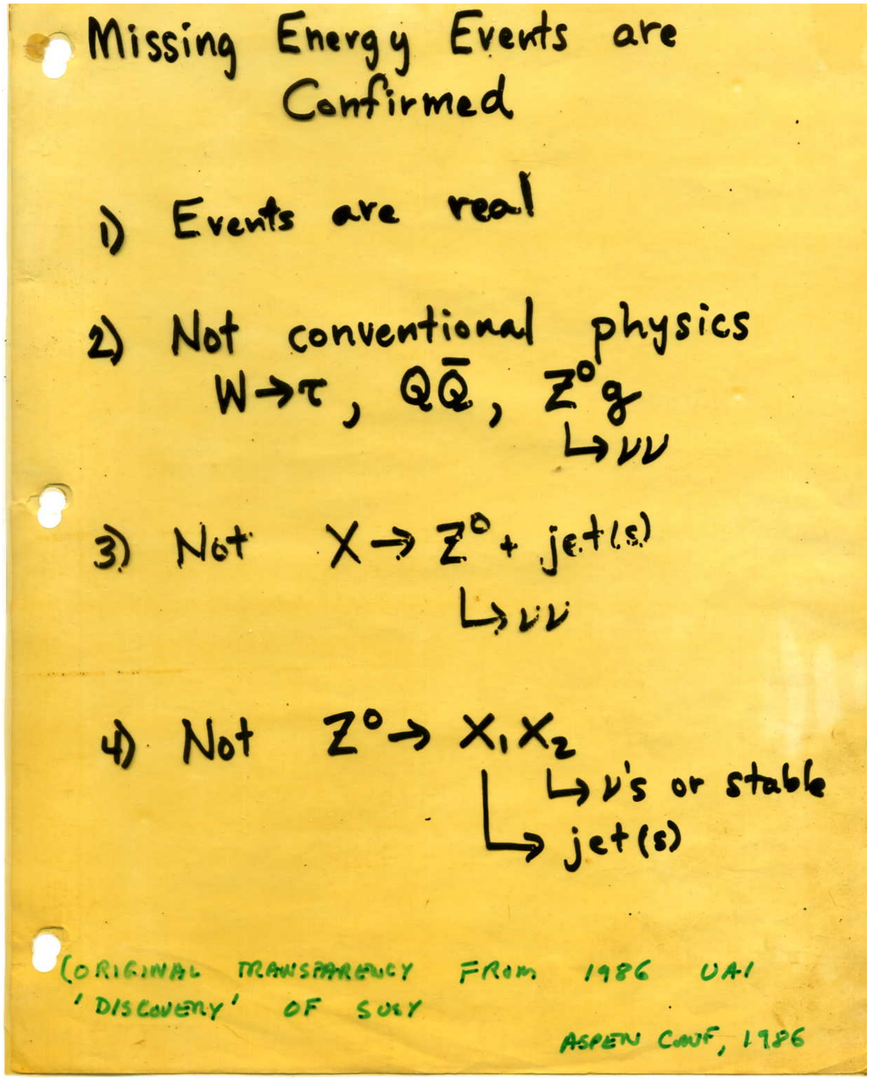
A brief anecdote about a blind analysis around 1900:

There was a controversy over 2 conflicting measurements of a line in the solar spectrum. The famous spectroscopist at Princeton asked his machinist to rule a grating at a non-standard (blind!) lines/inch, and to put the value in a sealed envelope. The Prof. then measured the line in terms of an unknown dispersion, wrote a Phys Rev with an accompanying letter that said 'under separate cover you will receive the grating spacing from my machinist, Mr. Smith; take this number, multiply it by my number, put it in the blank space in the paper, and publish it'. Now, that's blind.

2 Theoretical Motivation and Experimental Caution

Much as in the search for the W and Z, there is a defining energy scale for new physics beyond the SM. In the case of the W, Fermi's 'Standard Model' (i.e. 'effective field theory') of a 4-fermion interaction predicted that $\nu_e + e^- \rightarrow \nu_e + e^-$ scattering violated S-wave unitarity at a c.m. energy $\overset{=}{\sim} 300$ GeV (see Commins and Bucksbaum, Chapter 1.6, e.g.). For the SM, it's more complicated (see, e.g. Gunion et al. in the Higgs Hunter's Guide), but the conclusion is the same- there must be something new at the TeV scale.

We experimentalists are consequently primed to find something new at the Tevatron and/or LHC. New means comparing data to precise predictions of the SM. Figure 2 shows what can happen when eagerness combines with insufficiently understood SM predictions.



Missing Energy Events are Confirmed

1) Events are real

2) Not conventional physics
$W \rightarrow \tau$, $Q\bar{Q}$, $Z^0 g$
$\hookrightarrow \nu\nu$

3) Not $X \rightarrow Z^0 +$ jet(s)
$\hookrightarrow \nu\nu$

4) Not $Z^0 \rightarrow X_1 X_2$
$\hookrightarrow \nu$'s or stable
$\hookrightarrow$ jet(s)

(ORIGINAL TRANSPARENCY FROM 1986 UA1
'DISCOVERY' OF SUSY
ASPEN CONF, 1986

Figure 2: An example of why the careful calculation of SM predictions is so crucial: the announcement of the 'discovery' of SUSY at the 1986 Aspen Conference. The right explanation (S. Ellis) turned out to be a cocktail of SM processes, in particular W+jets and Z+jets.

2.1 Lepton+Gamma+X: The $\ell\gamma\not\!\!E_t$ and $\ell\ell\gamma$ Signatures

One of the anomalies of Run I was the famous $ee\gamma\gamma\not\!\!E_t$ event. This spawned the advent of ‘signature-based’ searches at the Tevatron. In particular there were two follow-ups: $\gamma\gamma{+}X$ (Toback) and $\ell\gamma{+}X$ (Berryhill). The $\ell\gamma + X$ search resulted in a 2.7σ excess over SM expectations.

The analysis is being repeated with exactly the same kinematic cuts so this time it is a priori- (i.e. not self-selected to be interesting).

$ee\gamma\gamma\not{E}_T$ Candidate Event

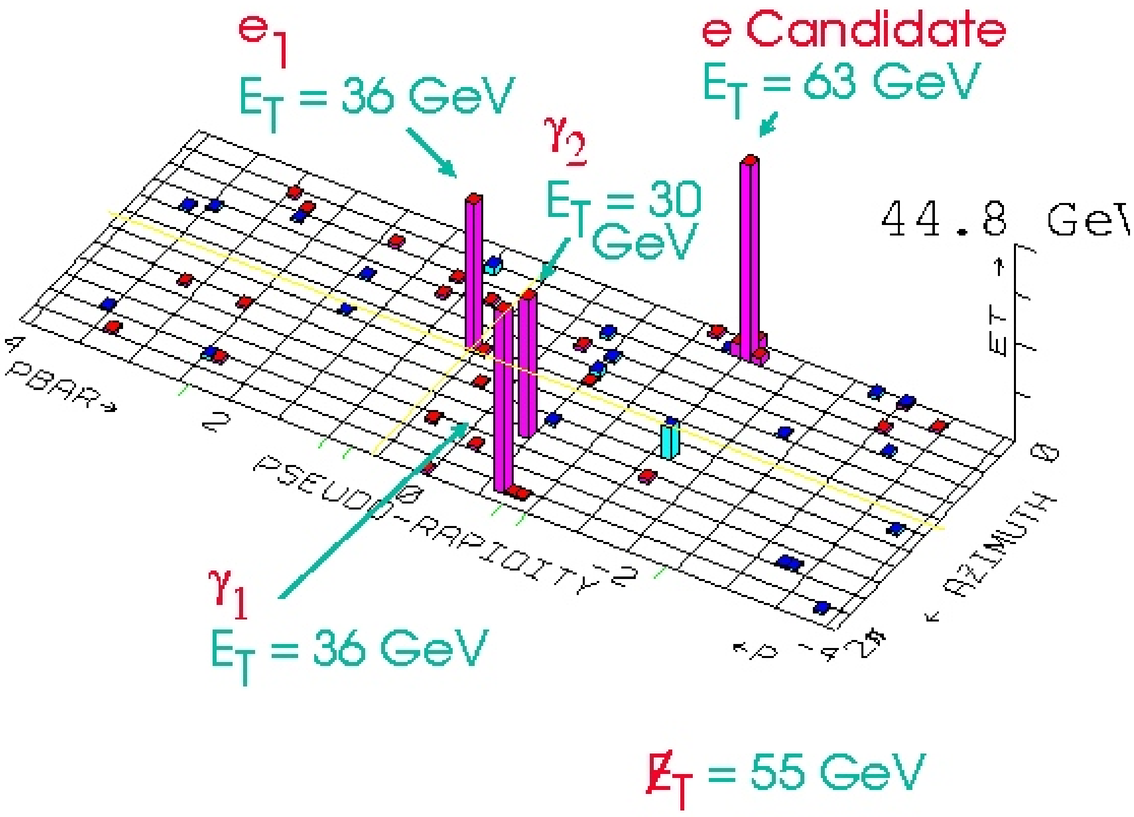
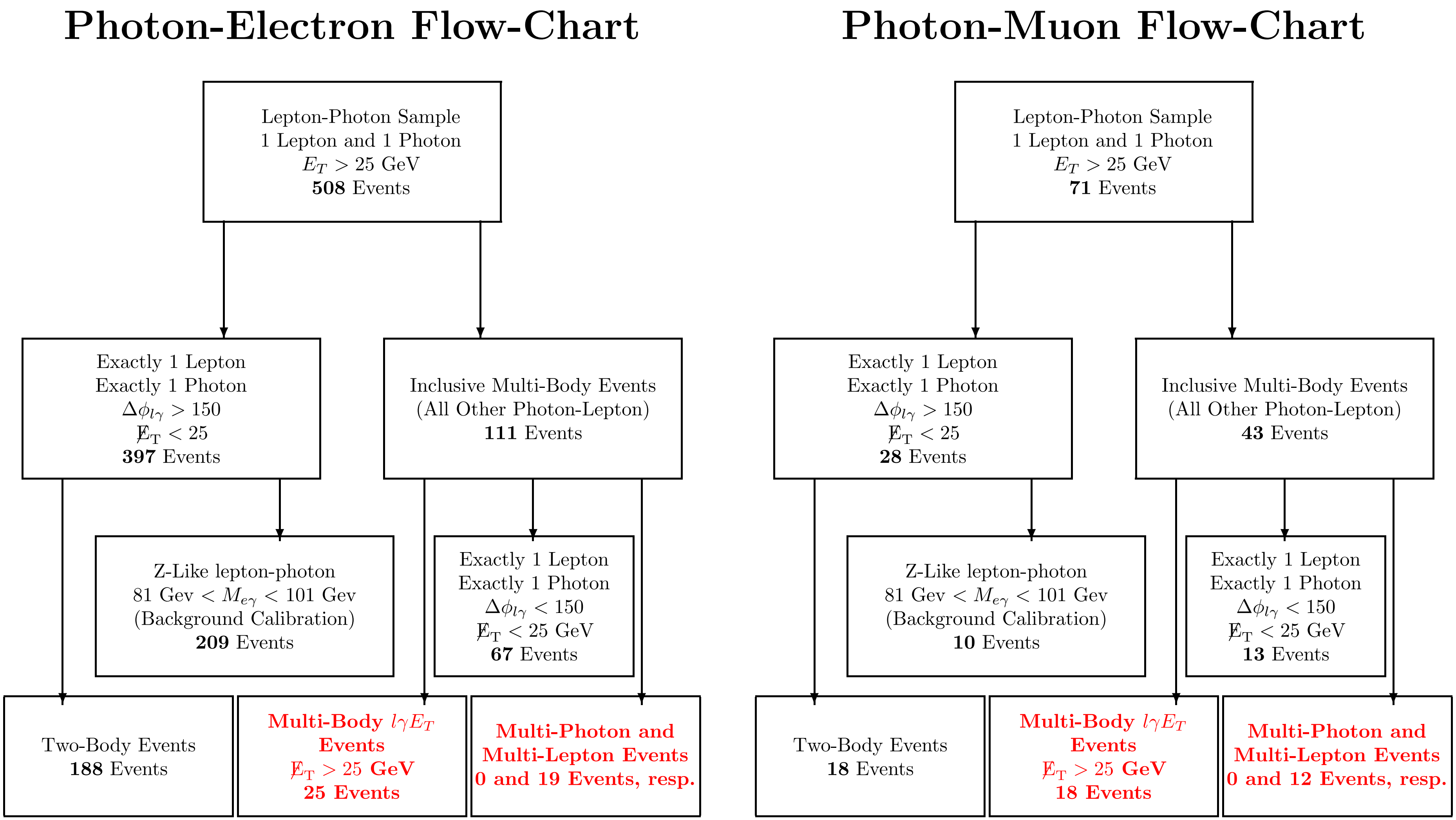


Figure 3:



Photon-Electron Flow-Chart

Lepton-Photon Sample
1 Lepton and 1 Photon
$E_T > 25$ GeV
508 Events

Exactly 1 Lepton
Exactly 1 Photon
$\Delta\phi_{l\gamma} > 150$
$\not\!E_{\mathrm{T}} < 25$
397 Events

Inclusive Multi-Body Events
(All Other Photon-Lepton)
111 Events

Z-Like lepton-photon
81 Gev $< M_{e\gamma} <$ 101 Gev
(Background Calibration)
209 Events

Exactly 1 Lepton
Exactly 1 Photon
$\Delta\phi_{l\gamma} < 150$
$\not\!E_{\mathrm{T}} < 25$ GeV
67 Events

Two-Body Events
188 Events

Multi-Body $l\gamma E_T$
Events
$\not\!E_{\mathrm{T}} > 25$ GeV
25 Events

Multi-Photon and
Multi-Lepton Events
0 and 19 Events, resp.

Photon-Muon Flow-Chart

Lepton-Photon Sample
1 Lepton and 1 Photon
$E_T > 25$ GeV
71 Events

Exactly 1 Lepton
Exactly 1 Photon
$\Delta\phi_{l\gamma} > 150$
$\not\!E_{\mathrm{T}} < 25$
28 Events

Inclusive Multi-Body Events
(All Other Photon-Lepton)
43 Events

Z-Like lepton-photon
81 Gev $< M_{e\gamma} <$ 101 Gev
(Background Calibration)
10 Events

Exactly 1 Lepton
Exactly 1 Photon
$\Delta\phi_{l\gamma} < 150$
$\not\!E_{\mathrm{T}} < 25$ GeV
13 Events

Two-Body Events
18 Events

Multi-Body $l\gamma E_T$
Events
$\not\!E_{\mathrm{T}} > 25$ GeV
18 Events

Multi-Photon and
Multi-Lepton Events
0 and 12 Events, resp.

Figure 4: Left: The flow of the $\ell + \gamma + X$ signature based search in electrons. Right:The flow in muons.

Lepton+Photon+$\not\!\!E_{\mathrm{T}}$ Predicted Events

SM Source	$e\gamma\not\!\!E_{\mathrm{T}}$	$\mu\gamma\not\!\!E_{\mathrm{T}}$	$(e+\mu)\gamma\not\!\!E_{\mathrm{T}}$
$W^{\pm}\gamma$	11.9 ± 2.0	9.0 ± 1.4	20.9 ± 2.8
$Z^0/\gamma+\gamma$	1.2 ± 0.3	4.2 ± 0.7	5.4 ± 1.0
$W^{\pm}\gamma\gamma, Z^0/\gamma+\gamma\gamma$	0.14 ± 0.02	0.18 ± 0.02	0.32 ± 0.04
$(W^{\pm}\gamma$ or $W^{\pm}) \rightarrow \tau\gamma$	0.7 ± 0.2	0.3 ± 0.1	1.0 ± 0.2
Jet faking γ	2.8 ± 2.8	1.6 ± 1.6	4.4 ± 4.4
$Z^0/\gamma \rightarrow e^+e^-, e \rightarrow \gamma$	2.5 ± 0.2	-	2.5 ± 0.2
Jets faking $\ell+\not\!\!E_{\mathrm{T}}$	0.6 ± 0.1	< 0.1	0.6 ± 0.1
Total SM Prediction	**19.8 ± 3.2**	**15.3 ± 2.2**	**35.1 ± 5.3**
Observed in Data	**25**	**18**	**43**

Multi-Lepton+Photon Predicted Events

SM Source	$ee\gamma$	$\mu\mu\gamma$	$ll\gamma$
$Z^0/\gamma+\gamma$	12.5 ± 2.3	7.3 ± 1.7	19.8 ± 4.0
$Z^0/\gamma+\gamma\gamma$	0.24 ± 0.03	0.12 ± 0.02	0.36 ± 0.04
$Z^0/\gamma+$ Jet faking γ	0.3 ± 0.3	0.2 ± 0.2	0.5 ± 0.5
Jets faking $\ell+\not\!\!E_{\mathrm{T}}$	0.5 ± 0.1	< 0.1	0.5 ± 0.1
Total SM Prediction	**13.6 ± 2.3**	**7.6 ± 1.7**	**21.2 ± 4.0**
Observed in Data	**19**	**12**	**31**

Figure 5:

CDF Run II results on the 2 signatures $\ell\gamma \not\!\!E_t + X$ and $\ell\ell\gamma + X$. This is a repeat of the Run I search- the $ee\gamma\gamma \not\!\!E_t$ event would show up in both, and so would an excess in $\ell\gamma \not\!\!E_t$.

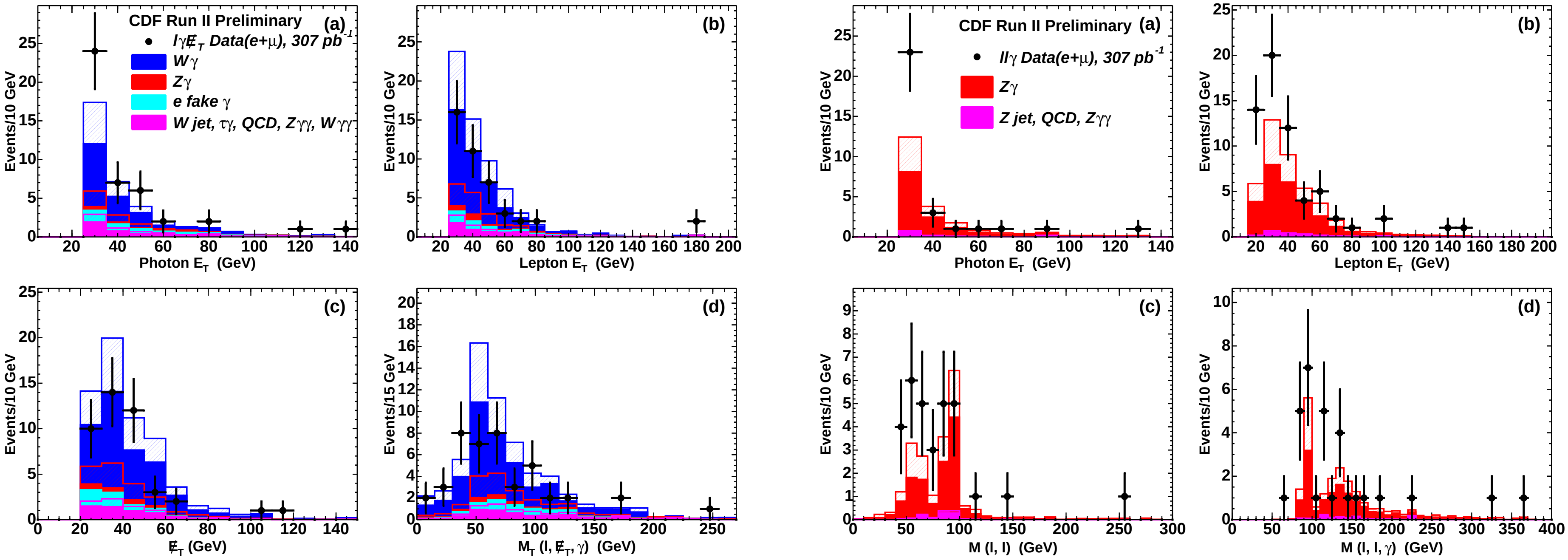


Figure 6:

Look at $\not\!\!E_t$ in the signature of $\ell\ell\gamma + X$:

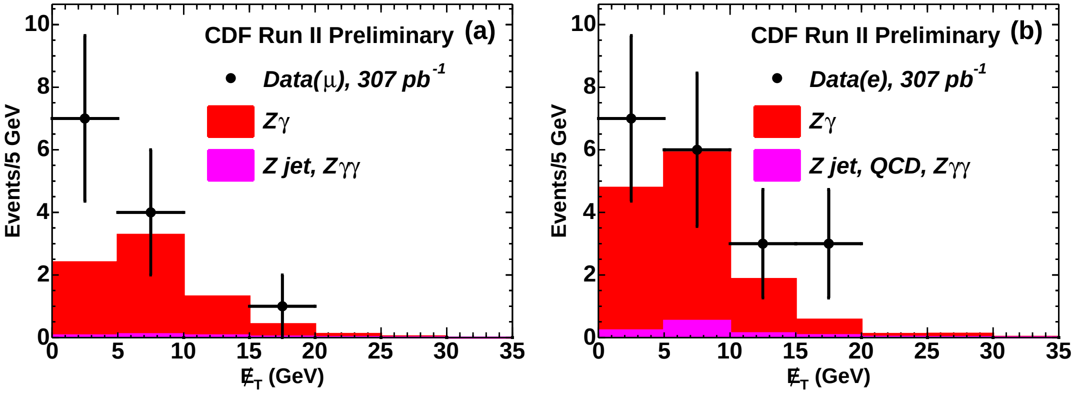
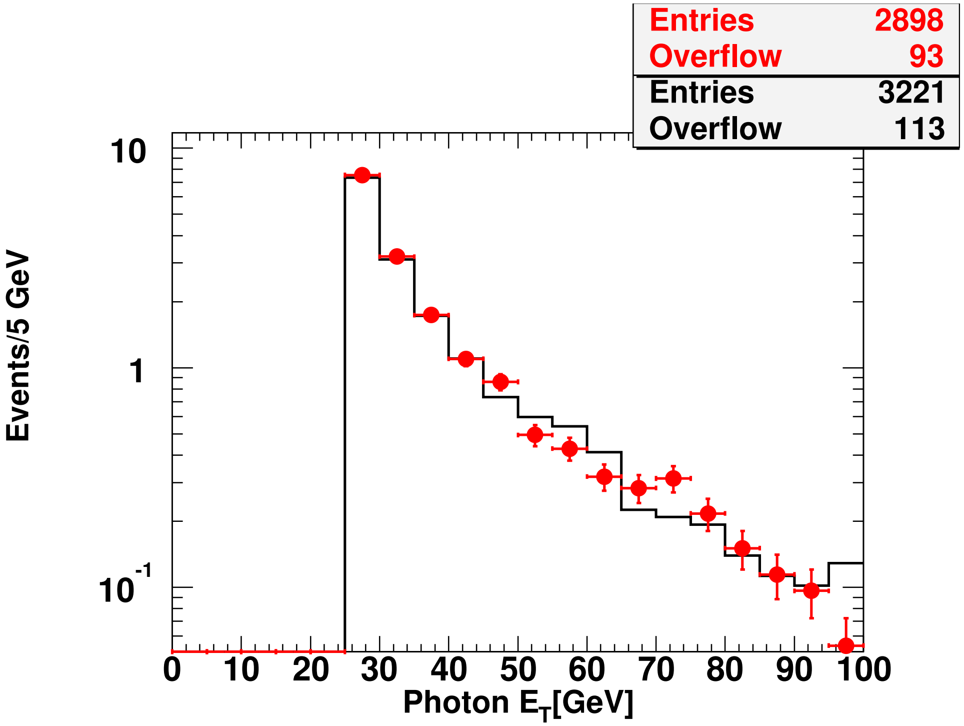


Figure 7:

No more $\ell\ell\gamma\gamma\not\!\!E_t$ events with > 3 times the data (305 pb^{-1}/86 pb^{-1}) and higher energy (30% increase in $t\bar{t}$ crossection, e.g.). Have another factor of 3 in data ready.



Comparison of the E_T spectrum of isolated photons in Drell-Yan+γ from MadGraph (red) and Baur (black) MC generators. There was disagreement *after* fragmentation and ISR with Pythia-now understood.

However, this has proved another educational example of MC predictions being the limiting factor in speed and sensitivity. We do not have a control sample- depend on SM predictions, largely $W\gamma$ and $Z\gamma$. Have 2 MC generators- MadGraph and a program from UliBaur. They agree beautifully.

However after running them through Pythia they disagreed by 15% in yield, including a different identification efficiency for muons (!). Problems were in the interface (diagnosed by Loginov and Tsuno) for *both*- the Les Houches accord format is not precisely defined. Lessons:

1. The MC generators can be ok (both were) and you still can get it wrong.
2. Always use 2 MC's- you may find both samples are flawed.
3. CDF has lost huge amounts of time to the generator interfacing- needs re-examination by the theoretical community.

Problem coming up- do not yet have the SM event generators with integrated higher-order QED and QCD at a precision comparable to the statistics we will have. We can normalize to data at low E_T^γ, but we need the next step up in prediction sophistication.

2.2 Inclusive High Pt W's and Z's: A Weak Boson Signature

Idea: Many models of new physics- Extra Dimensions, Z-primes, Excited Top, $t' \rightarrow Wb$, SUSY, Right-handed Quarks naturally give a signature of a high-Pt EWK boson- W, Z, or photon. Natural in strong production of pairs- if decays, decays weakly. E.g. top

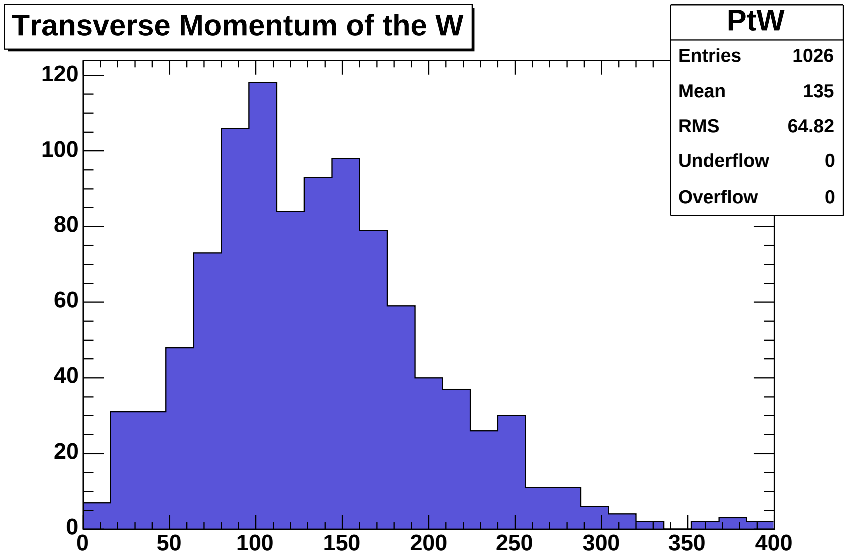


Figure 8: The p_T spectrum for Z's from the decay of a 300 GeV right-handed singlet down quark $Q\bar{Q} \rightarrow uWdZ$ in the Bjorken-Pakvasa-Tuan model.

Select on dilepton mass $66 < m_{\ell\ell} < 106$ and then compare $\mathrm{p_T}$ spectrum with expectations:

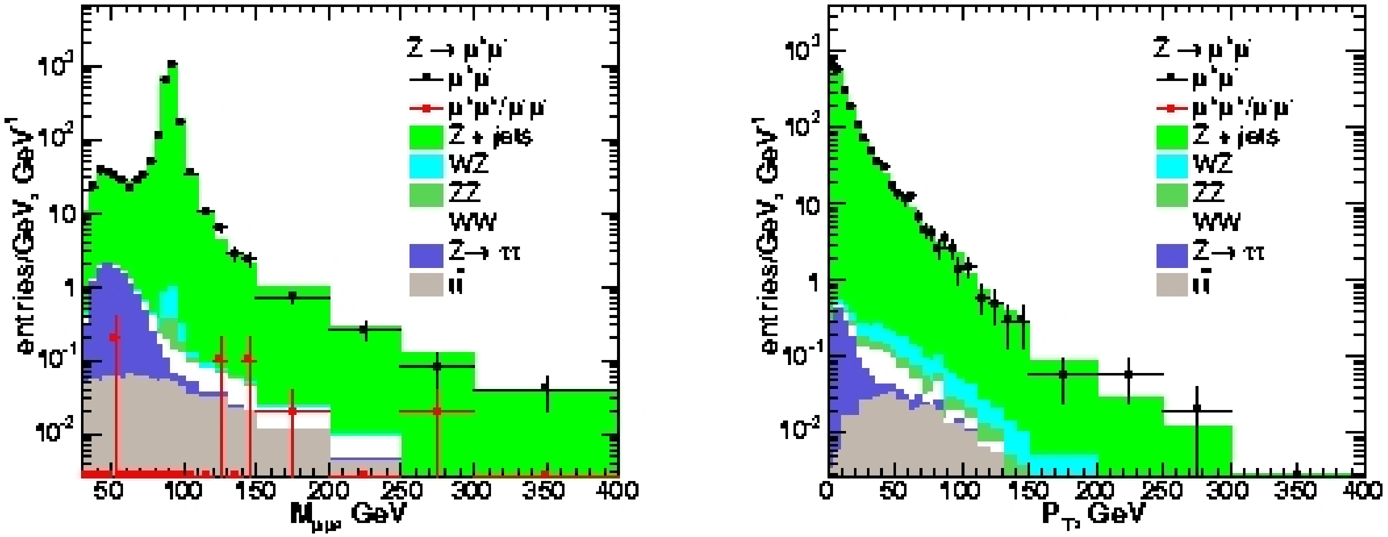


Figure 9: The inclusive search for high-¶$_T$ Z+X production (CDF). The cuts are frozen on the first 0.3 fb^{-1}: the rest will then be a priori.

However the inclusive Z+X is dominated by SM Z+jets- we cannot yet predict this at the level needed.

One of Hardest Problems is precise predictions of W,Z+Njets

L. Beitler from datasets with CKKW matching made by Steve Mrenna– see S. Mrenna and P. Richardson, hep-ph/0312274

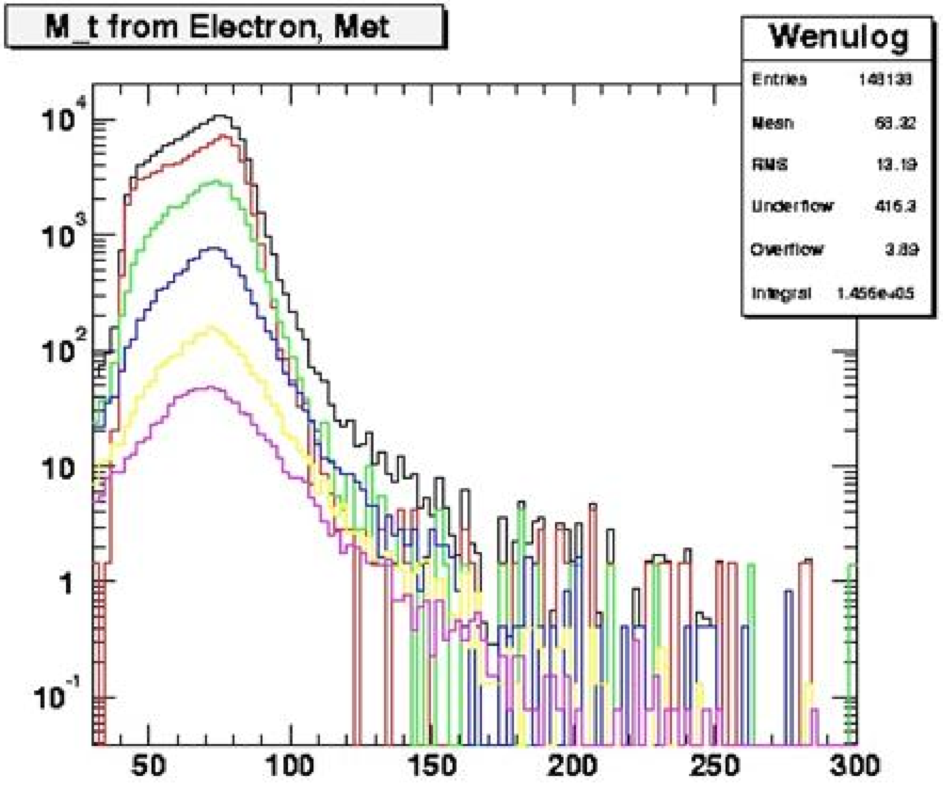
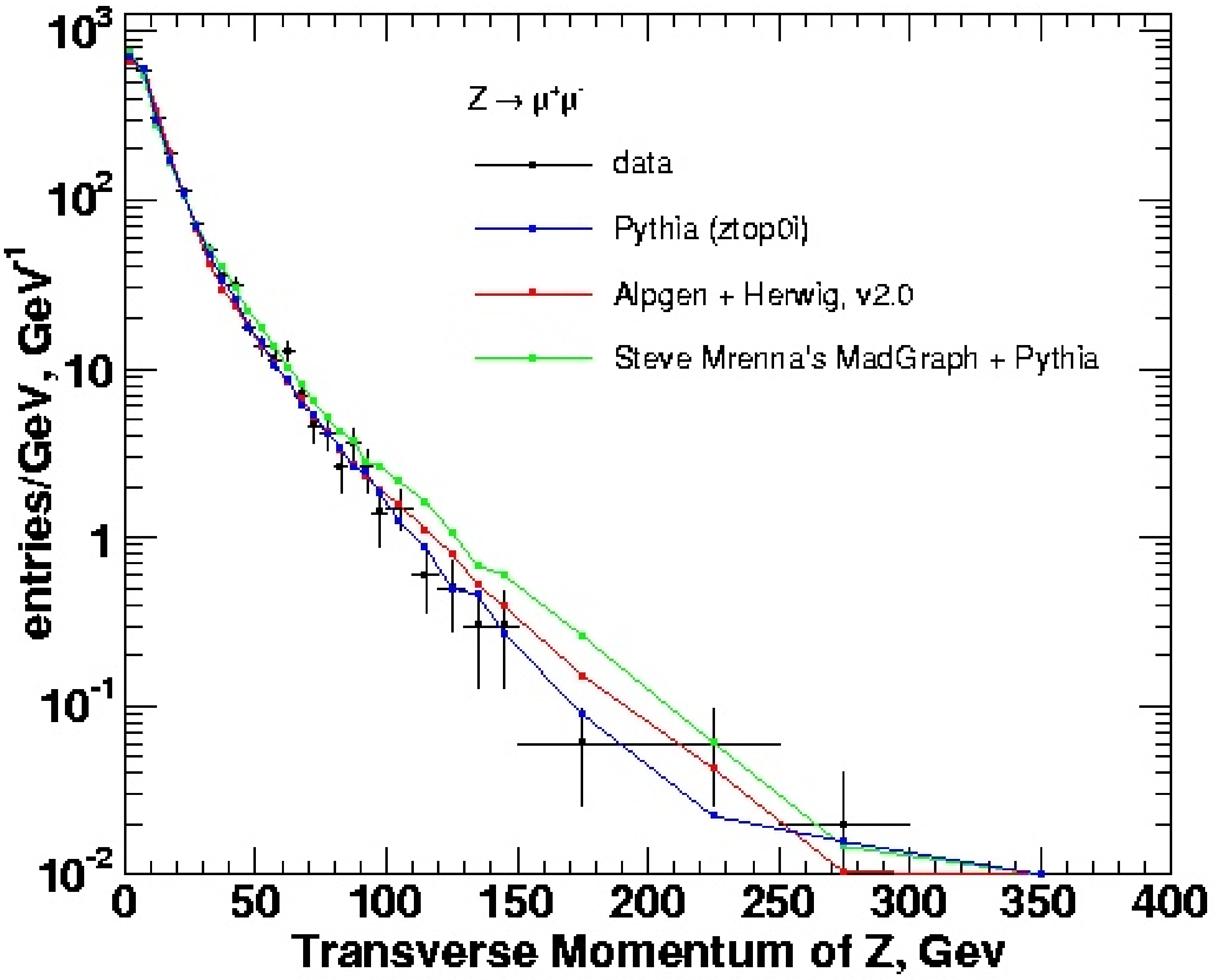
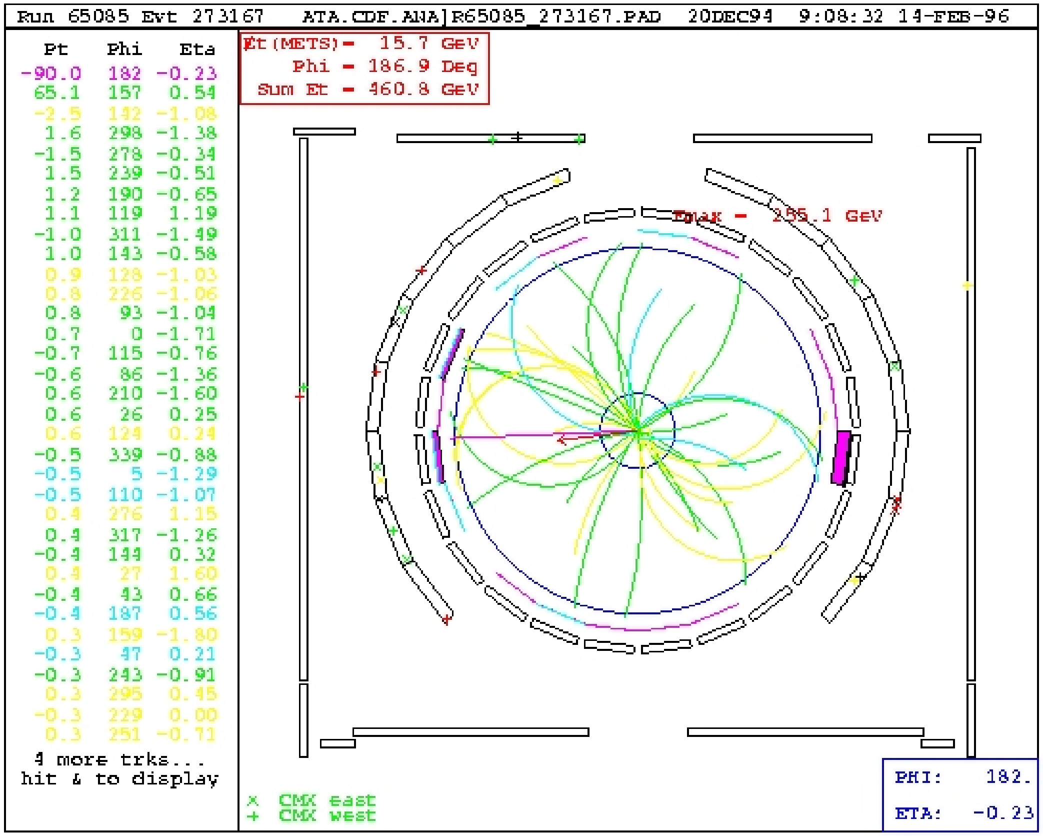


Figure 3: Logarithmic plot of transverse mass for $W \to e\bar{\nu}_e$ monte carlo events.

Inclusive high p_T Z production and 3 monte-carlo predictions, showing that we cannot yet a priori test the data against the SM.



To increase sensitivity, add objects to the signature- subsignatures of Z+Njets, $Z+\gamma$, $Z+\ell$,... For example: we saw a Z with 200 GeV Pt balanced by a photon with 200 GeV Pt in Run I (100 pb^{-1}):



Run 65085 Evt 273167 ATA.CDF.ANA]R65085_273167.PAD 20DEC94 9:08:32 14-FEB-96

Pt	Phi	Eta
-90.0	182	-0.23
65.1	157	0.54
-2.5	142	-1.08
1.6	298	-1.38
-1.5	278	-0.34
1.5	239	-0.51
1.2	190	-0.65
1.1	119	1.19
-1.0	311	-1.49
1.0	143	-0.58
0.9	128	-1.03
0.8	226	-1.06
0.8	93	-1.04
0.7	0	-1.71
-0.7	115	-0.76
-0.6	86	-1.36
0.6	210	-1.60
0.6	26	0.25
0.6	124	0.24
-0.5	339	-0.88
-0.5	5	-1.29
-0.5	110	-1.07
0.4	276	1.15
0.4	317	-1.26
-0.4	144	0.32
0.4	27	1.60
-0.4	43	0.66
-0.4	187	0.56
0.3	159	-1.80
-0.3	47	0.21
-0.3	243	-0.91
0.3	295	0.45
-0.3	229	0.00
0.3	251	-0.71

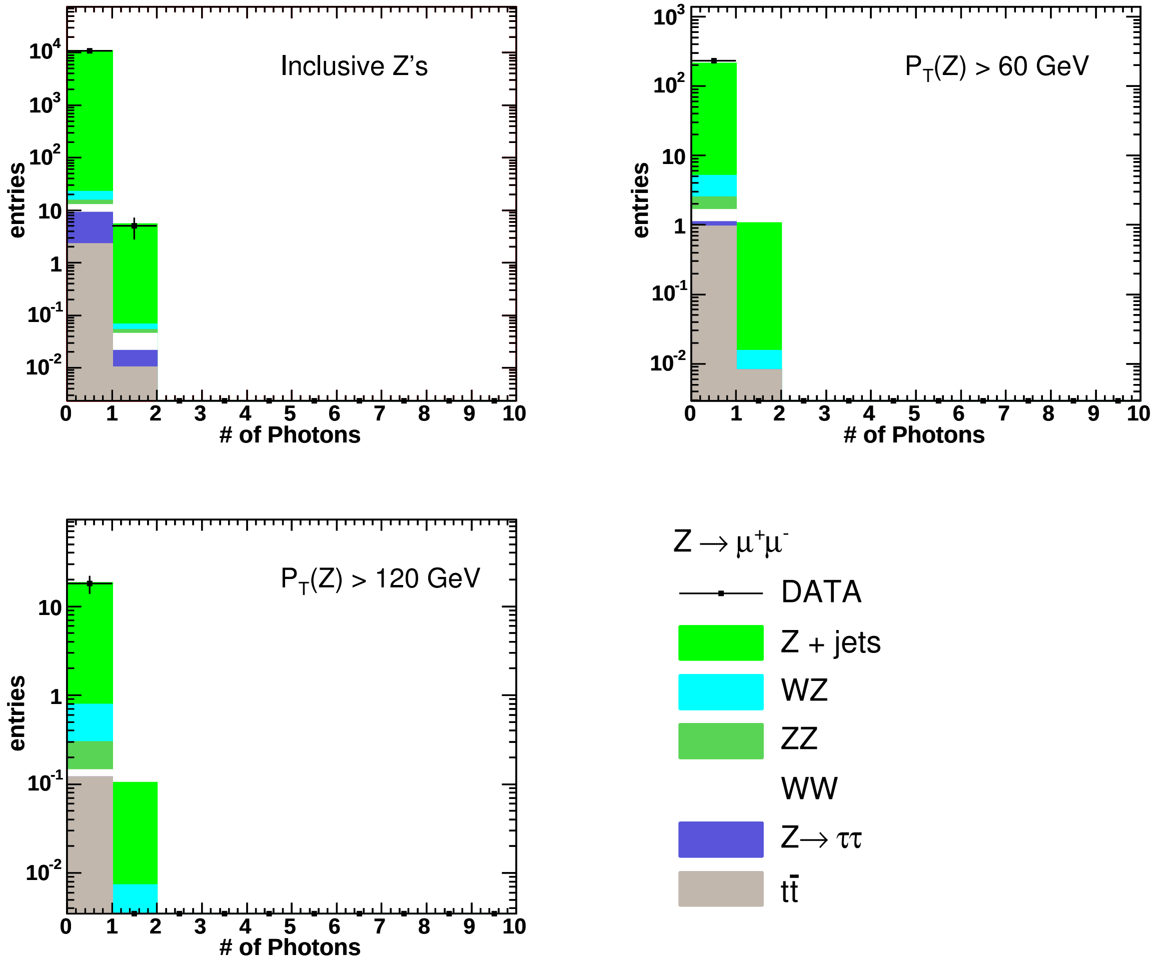
4 more trks...
hit & to display

$\not{E}$t (METS) - 15.7 GeV
Phi - 186.9 Deg
Sum Et - 460.8 GeV

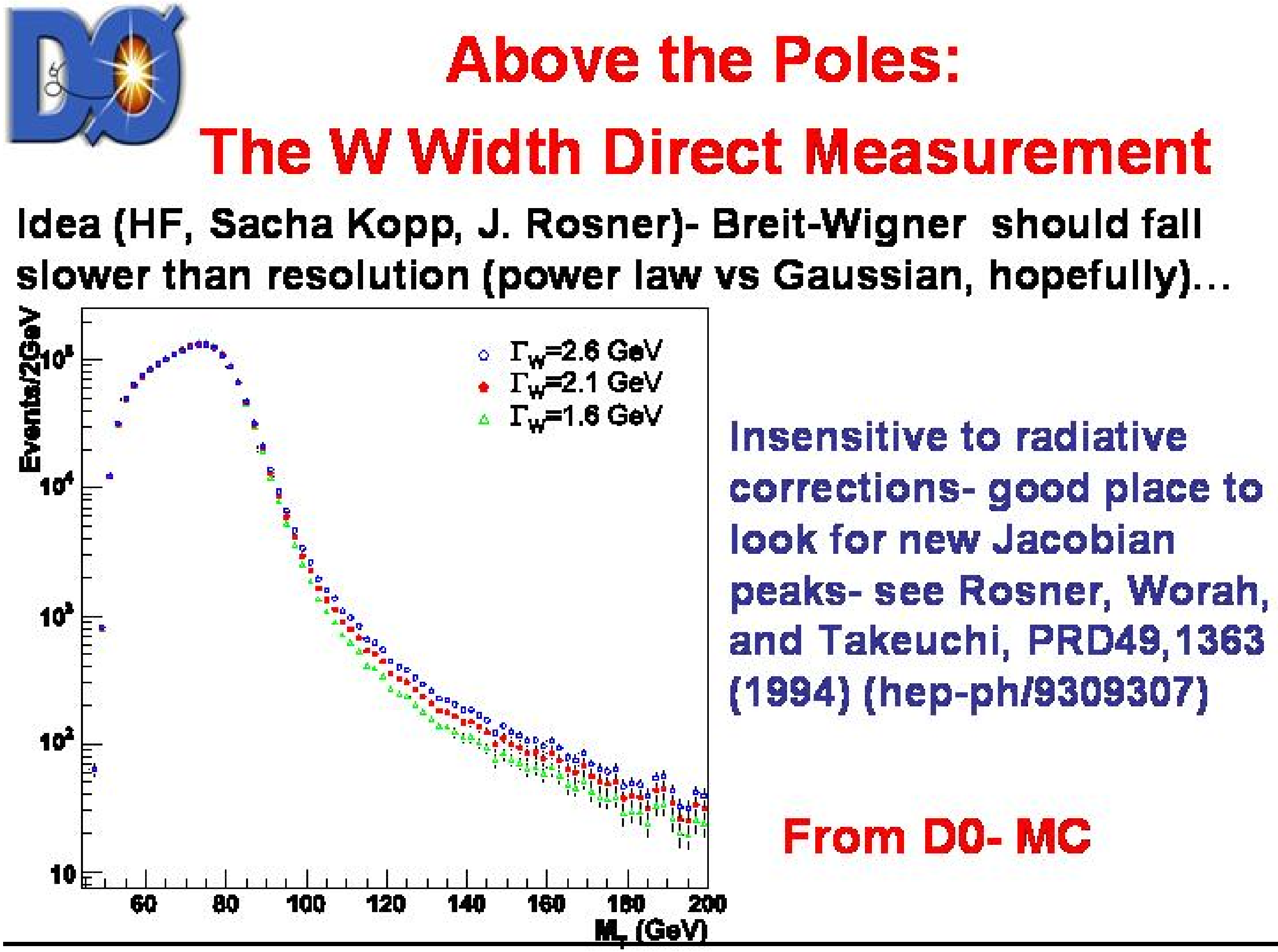
PHI: 182.
ETA: -0.23

Figure 10:

Now in Run II- Ask for a photon in addition to a high p_T: Z+N(photons) This is in 300 pb^{-1}now- soon 1000. Compare to LO+ISR SM expectations



2.3 The Tail of the W: Above the Pole- Wprimes



Above the Poles:

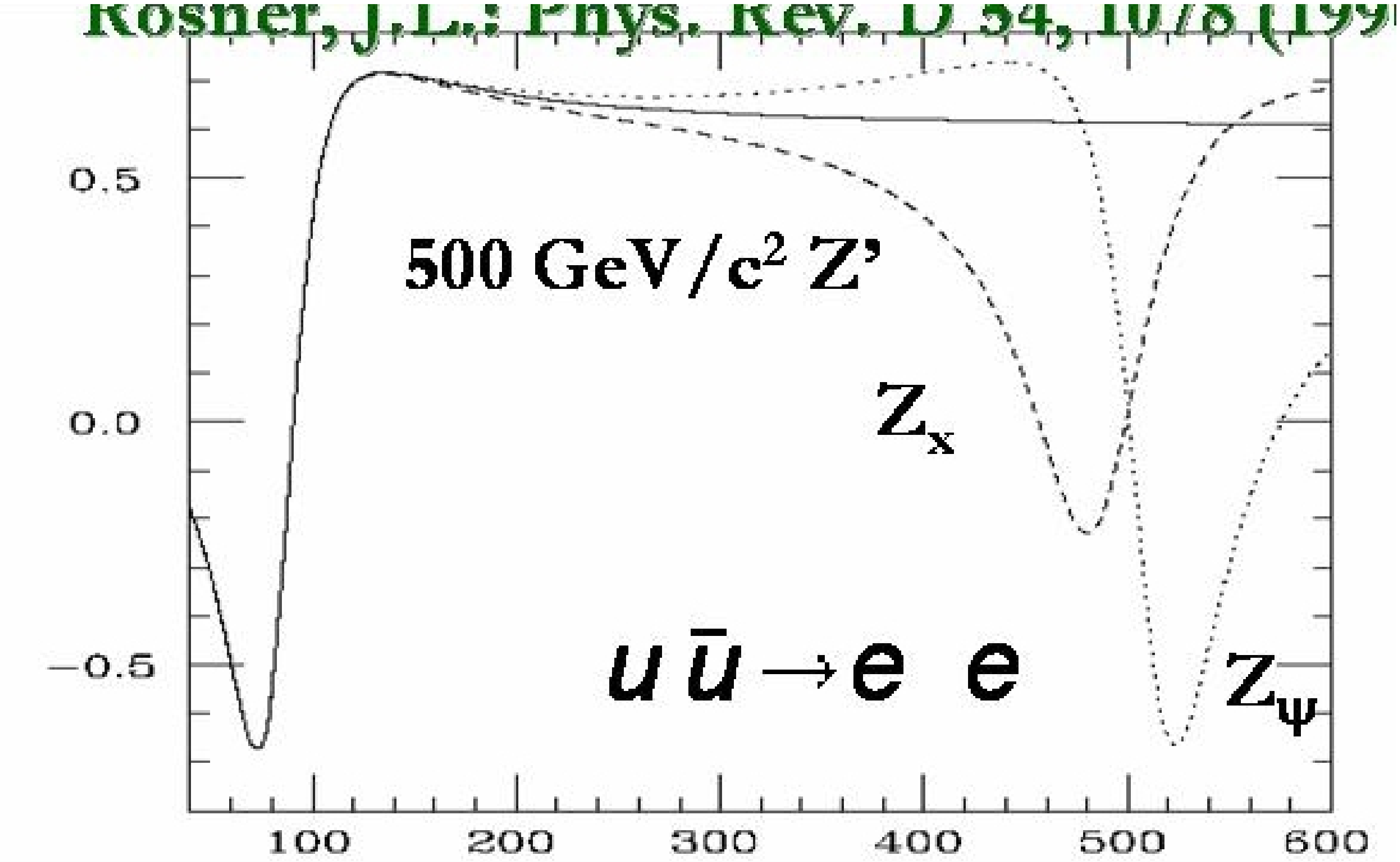
The W Width Direct Measurement

Idea (HF, Sacha Kopp, J. Rosner)- Breit-Wigner should fall slower than resolution (power law vs Gaussian, hopefully)...

Insensitive to radiative corrections- good place to look for new Jacobian peaks- see Rosner, Worah, and Takeuchi, PRD49,1363 (1994) (hep-ph/9309307)

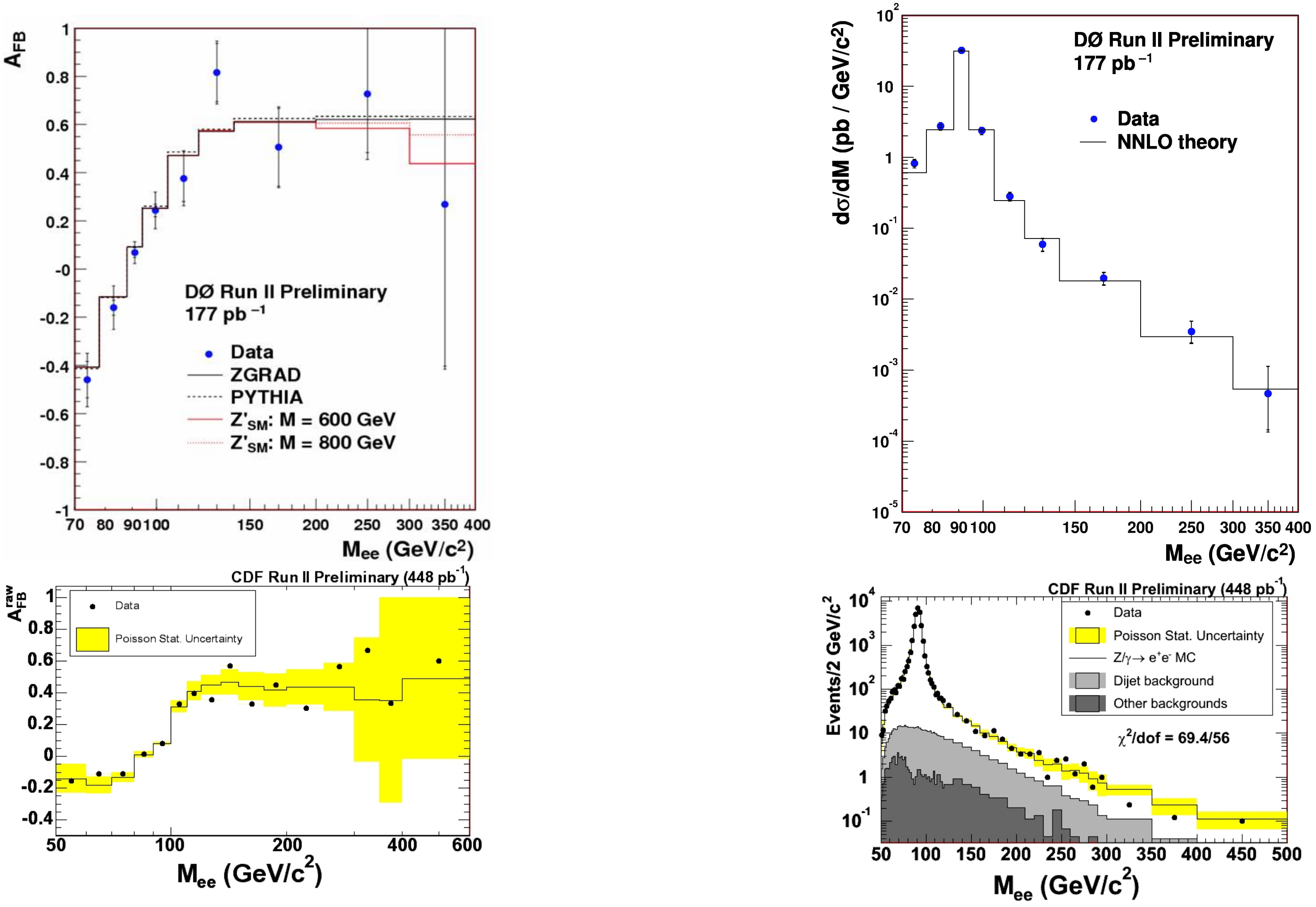
From D0- MC

2.4 An Indirect Search: Asymmetries above the Pole (CDF+D0)



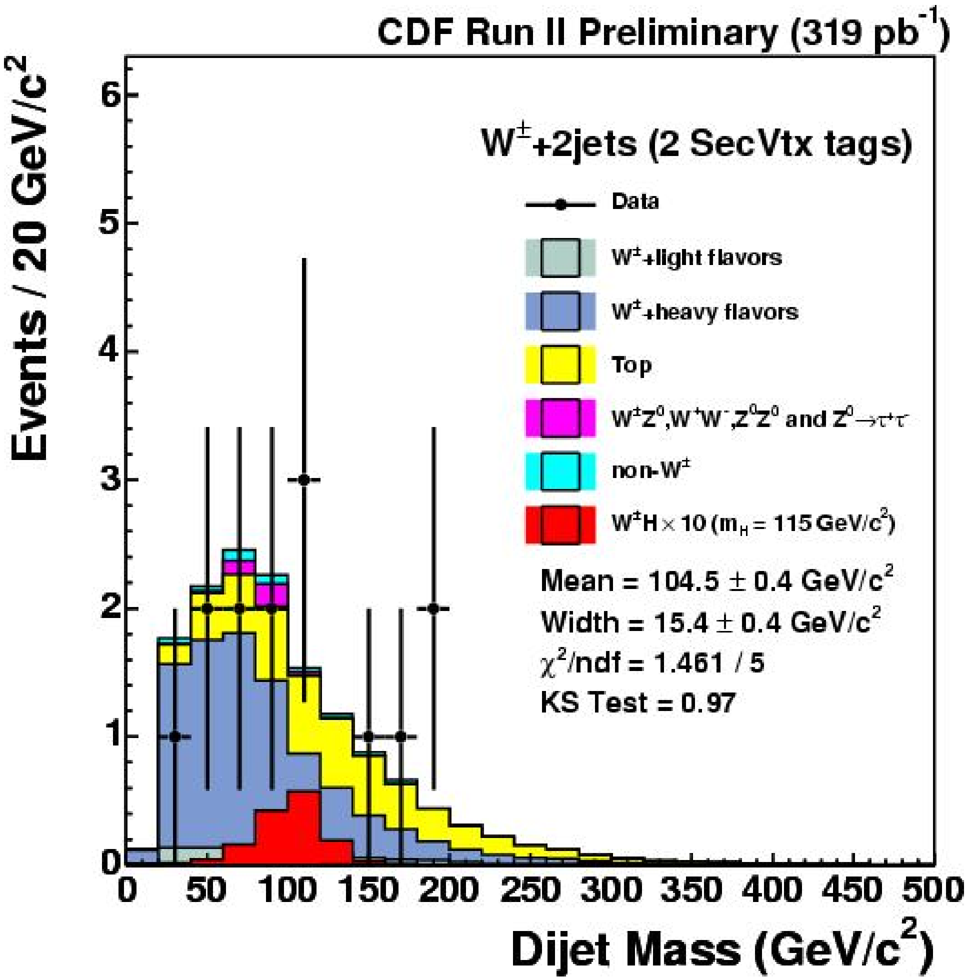
Note change in phase as you cross the pole.

A sensitive way to search for new U(1)'s or any other s-channel object that would interfere with the Z and photon above the pole is to measure the F-B asymmetry vs $\sqrt{s}$. Intrinsically Precise-



The FB asymmetry (left) and Mass spectrum in e^+e^- pairs for DØ (top) and CDF (bottom)

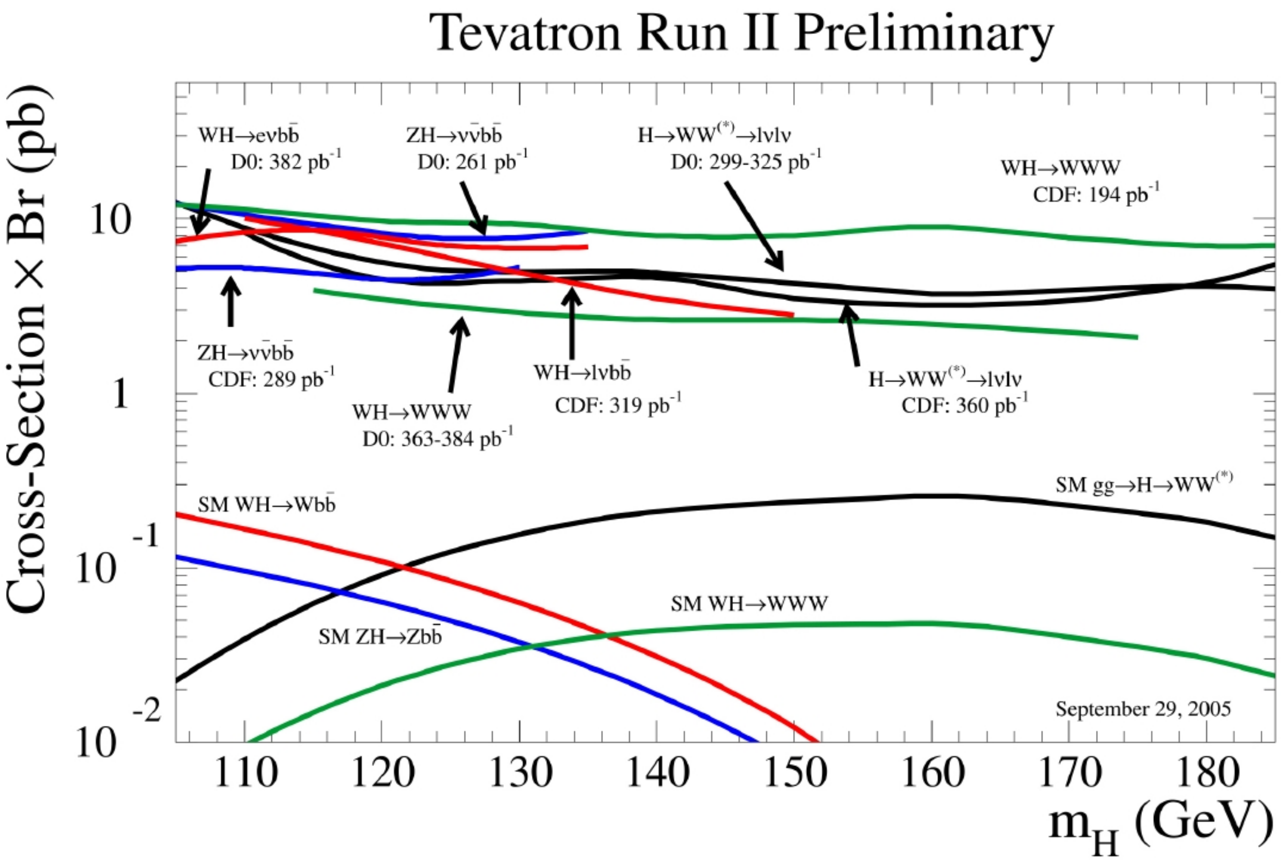
3 Direct Search for the Higgs



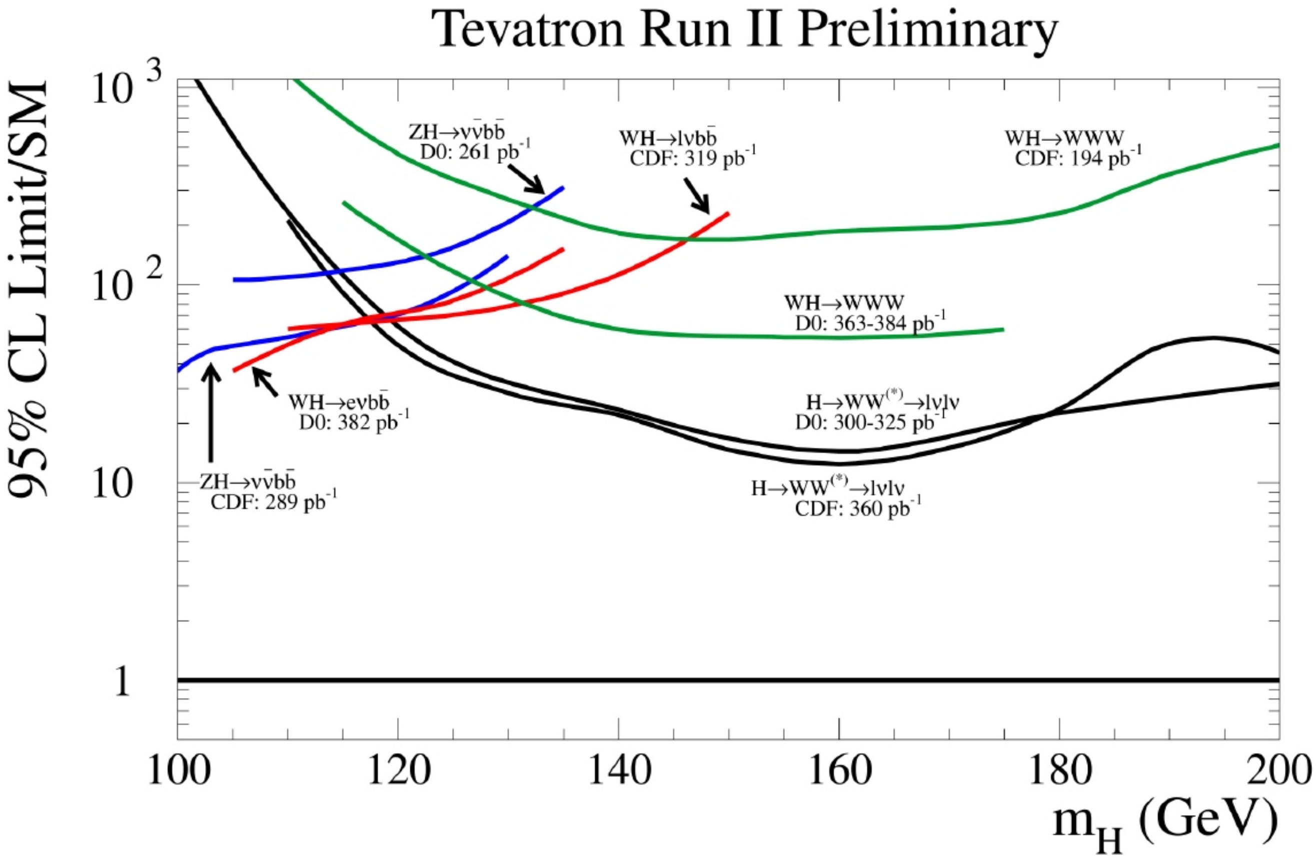
CDF WH channel with 319 pb^{-1}

We saw in Lecture I that the EWK precision data favor a light Higgs (too light, even). Although it's not a precision measurement (my title), take several slides to summarize the current status of direct Higgs searches. Take one channel from one experiment as an example.

The cross-section limits from direct searches for the Higgs as of Sept., 05 from CDF and D0



The ratio of cross-section limits from direct searches to SM predictions for the Higgs as of Sept 05, from CDF and D0.



4 Precision Measurements in B Physics

This is an enormous topic, and one in which I'm not expert. There are many new results in the works. Dan Krop will talk on B-physics results from DØ and William Wester will talk on B_c measurements from CDF (and can answer detailed questions). I will limit myself to some (possibly contrarian) thoughts on precision, illustrated by several specific results from CDF that are not in William's talk.

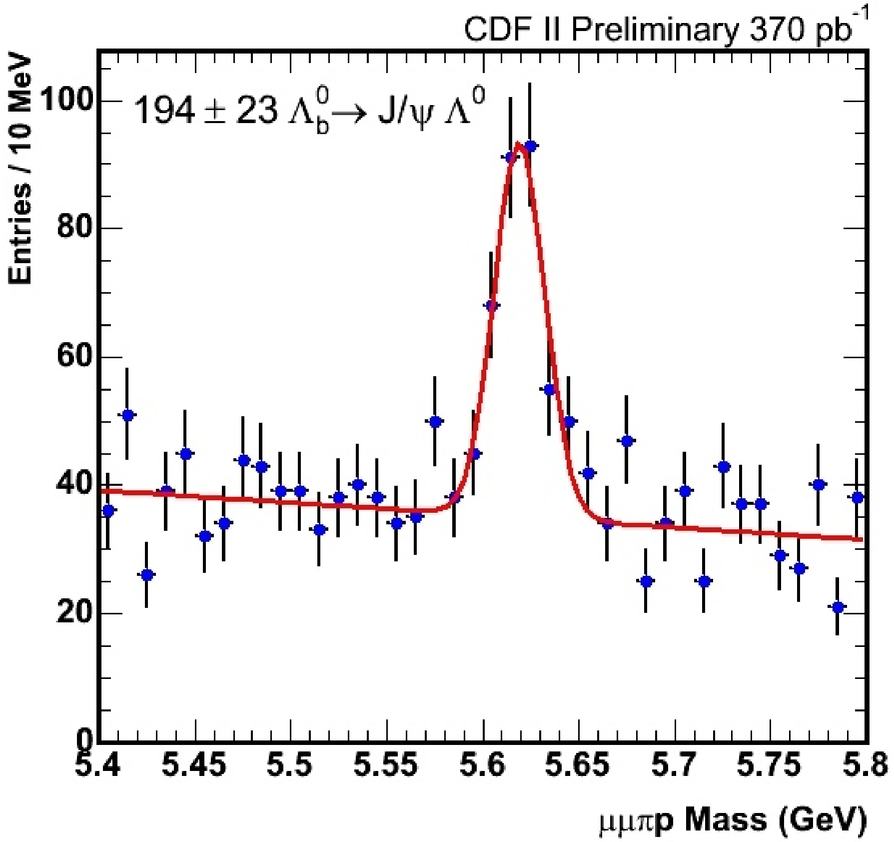
The measurements of masses, lifetimes, and mixing are inherently precision measurements. They differ from the other standard-bearing precision measurements at a hadron collider, the top mass, the W mass, W and Z and top cross-sections, W and Z decay asymmetries, etc., in that they are usually entirely tracking-based, rather than depending on the calorimeters. Precision thus depends on different quantities: alignment, resolution, tracking and trigger efficiencies, and tracking trigger biases. While difficult, these have fewer degrees-of-freedom (i.e. are less complex) than the calorimeter response to jets and the underlying event (for $\not{E}_t$) in top decay, to pick an example. Consequently with much beautiful hard work these measurements are often limited by statistics.

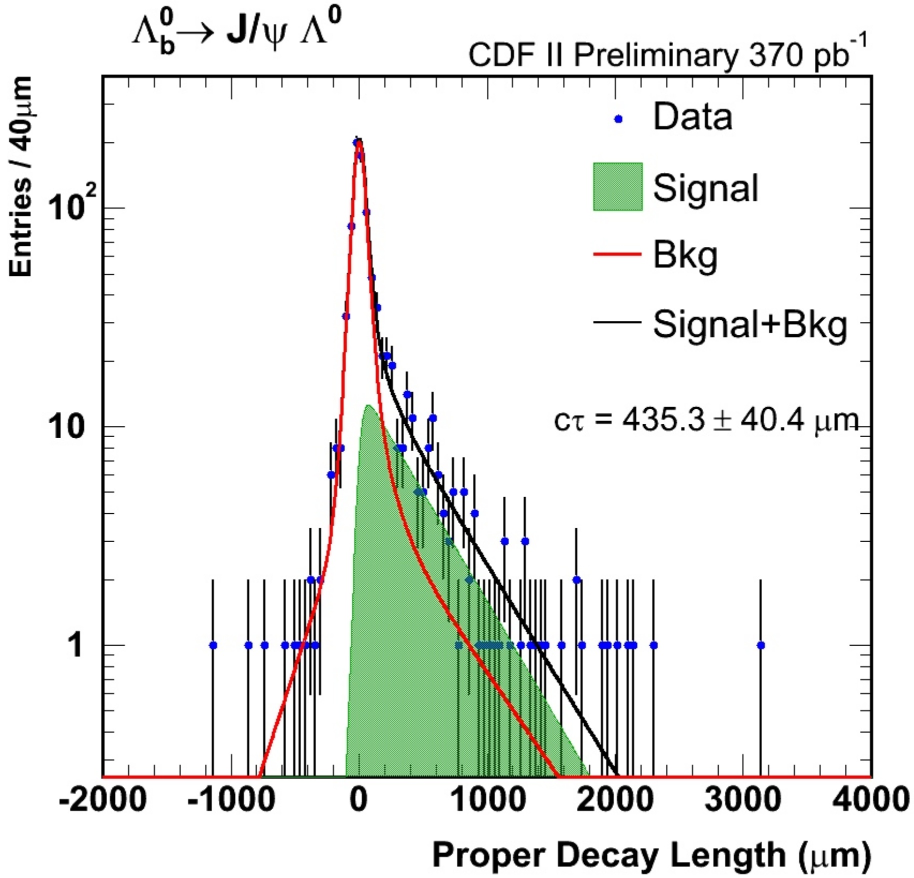
Precision Measurements in B Physics-II

The statistics limitation is not intrinsic: there are plenty of B's. The measured single-b cross-section at the Tevatron for $|y| < 1$ is 30 μb, so at 1.8E32 (present peak) Fermilab is making more than 5000 b's per second. Realistically one could expect more than 10^{10} per year produced.

This is the domain of LHCb and the late lamented BTeV. Can the big multi-purpose detectors improved their precision?

CDF measurement of the Λ_b lifetime:





Fully reconstructed $p\pi\mu\mu$ mass

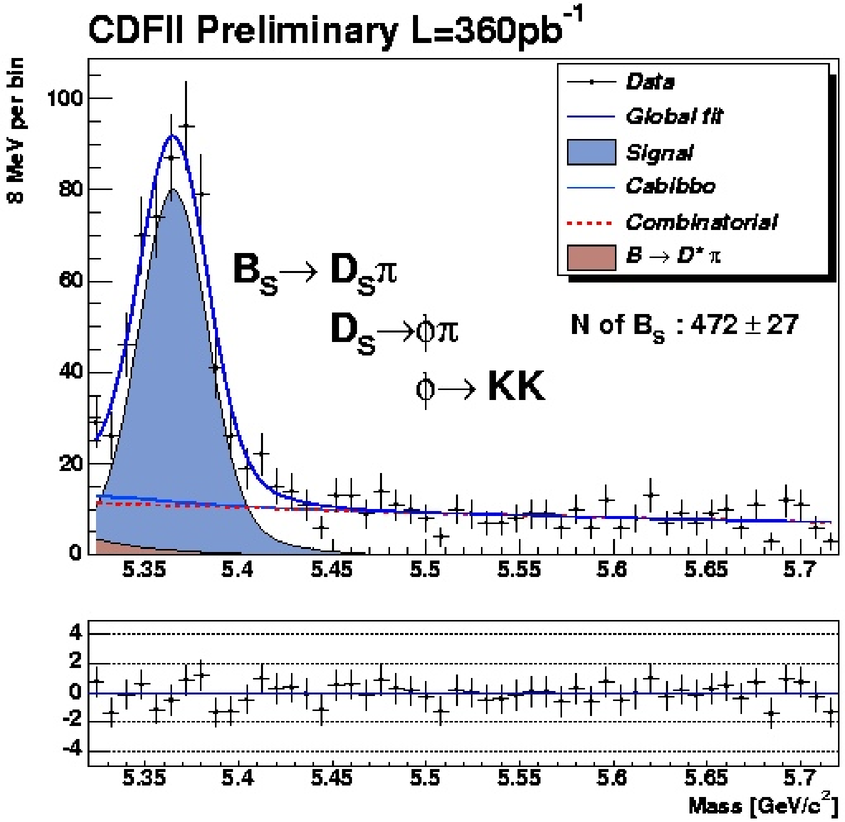
$\tau(\Lambda_b) = 1.45^{0.14}_{-0.13}$(stat)$\pm 0.02$(sys) psec

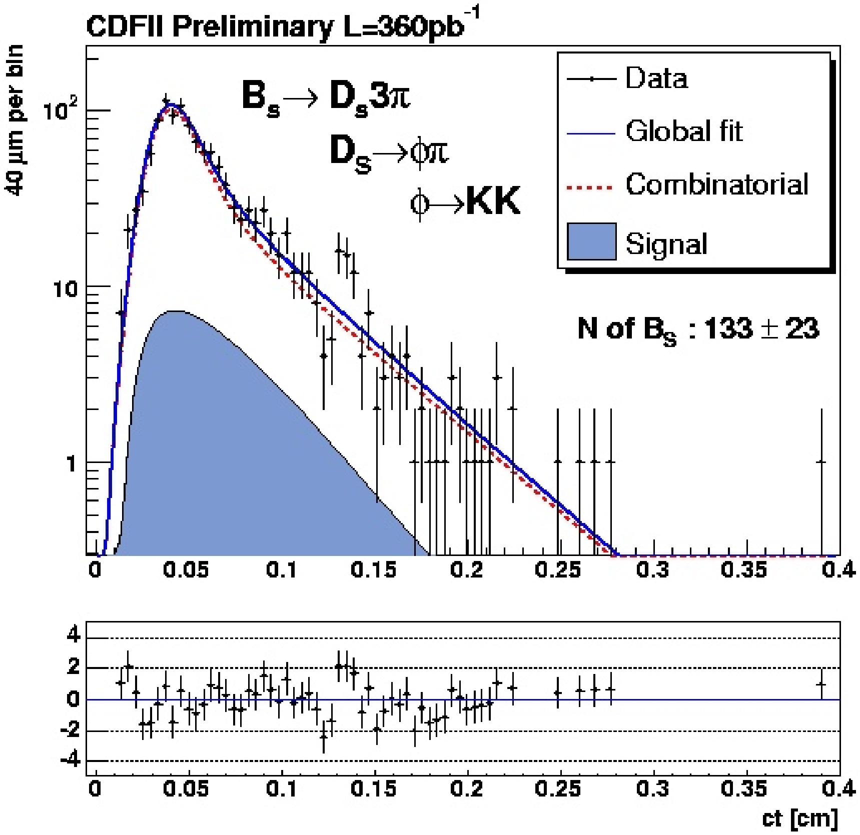
$\tau(\Lambda_b)/tau(B^0) = 0.944 \pm 0.089$ (CDF)

$\tau(\Lambda_b)/tau(B^0) = 0.803 \pm 0.047$ (world av summer 04)

$\tau(\Lambda_b)/tau(B^0) = 0.86 \pm 0.05$ (NLOQCD Gabbiani et al.)

CDF measurement of the B_s lifetime:





Fully reconstructed $p\pi\mu\mu$ mass

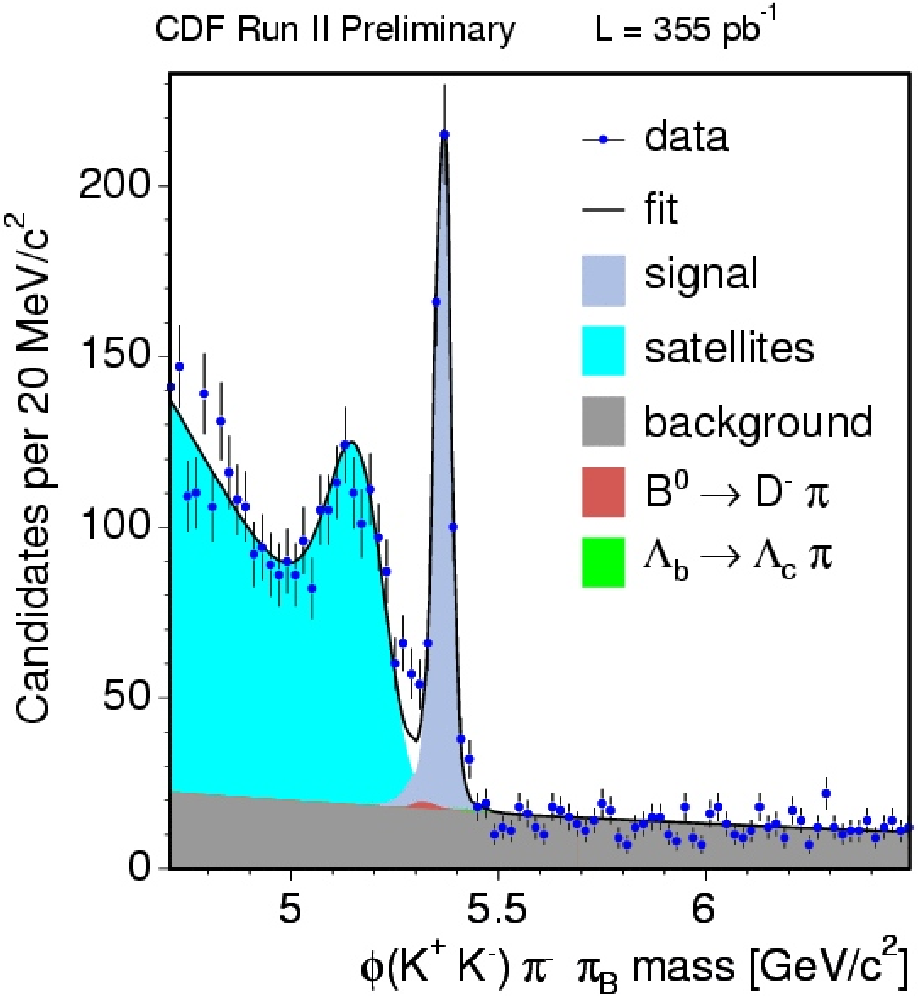
$$\tau(B_s) = 1.381 \pm 0.055(\text{stat})\pm^{0.052}_{0.046}(\text{sys})\ \text{ps}$$

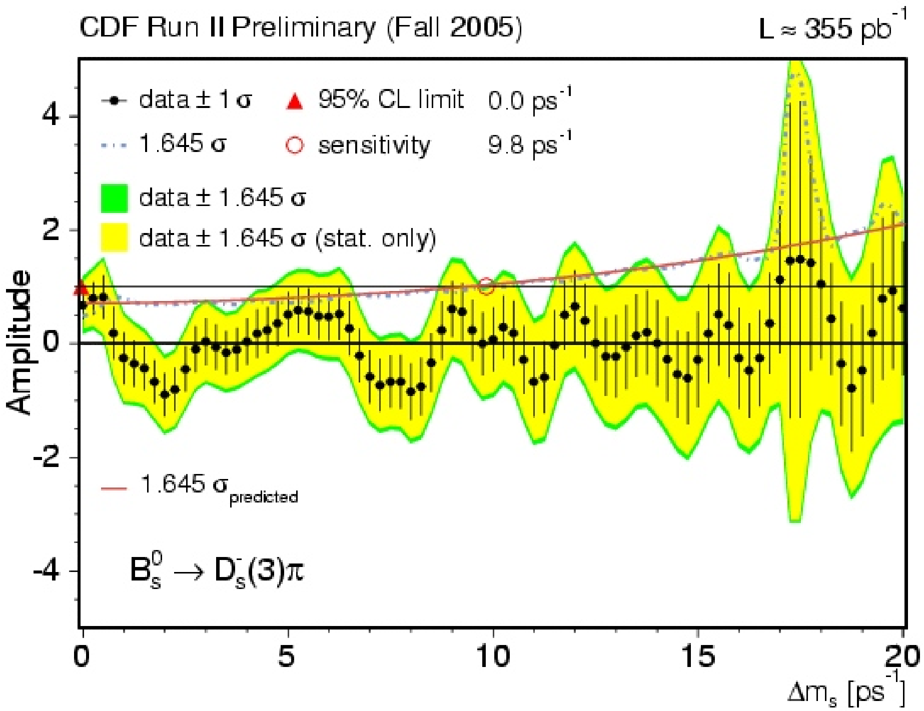
See Dan Krop's talk for the DØ number

CDF B_s Mixing:

$$\text{Prob } (B_s^0 \rightarrow B_s^0) = 1/2\Gamma e^{-\Gamma t}(1 + A cos(\Delta m_s t)$$

$$\text{Prob } (B_s^0 \rightarrow \bar{B}_s^0) = 1/2\Gamma e^{-\Gamma t}(1 - A cos(\Delta m_s t)$$





CDF: Exclusion (95%C.L.): $\Delta m_s \quad < 8.6$ ps^{-1}
(ask William about sensitivity projections)

5 Expert Topics: Challenges for Students

I will briefly touch on an (ideosynchratic) list of topics that I think lie ahead of us on the road to exploiting the higher precision inherent in our detectors.

5.1 B-jet Momentum Scale: Gamma-bjet Balancing

The response of the calorimeter to the b-quark jets from top decay is critical for the top mass; sharpening the resolution is also critical for discovering the Higgs. One source of b's of known momentum is $\mathrm{Z}^0 \rightarrow b\bar{b}$; even at the Tevatron this is very difficult as the rate of 2-jet production prohibits an unprescaled trigger threshold well below $M_Z/2$. At the LHC this will be hopeless, I predict. However the 'Compton' process gluonb $\rightarrow \gamma$b will give a photon opposite a b-jet. Figure 11 shows the flux of b-quarks versus x at $Q = 100$ GeV (CTEQ6.1M); one can see that at x=0.01 ($\mathrm{p_T} = 70$ GeV at the LHC) the b-quark flux is predicted to be only a factor of 3 lower than the gluon flux.

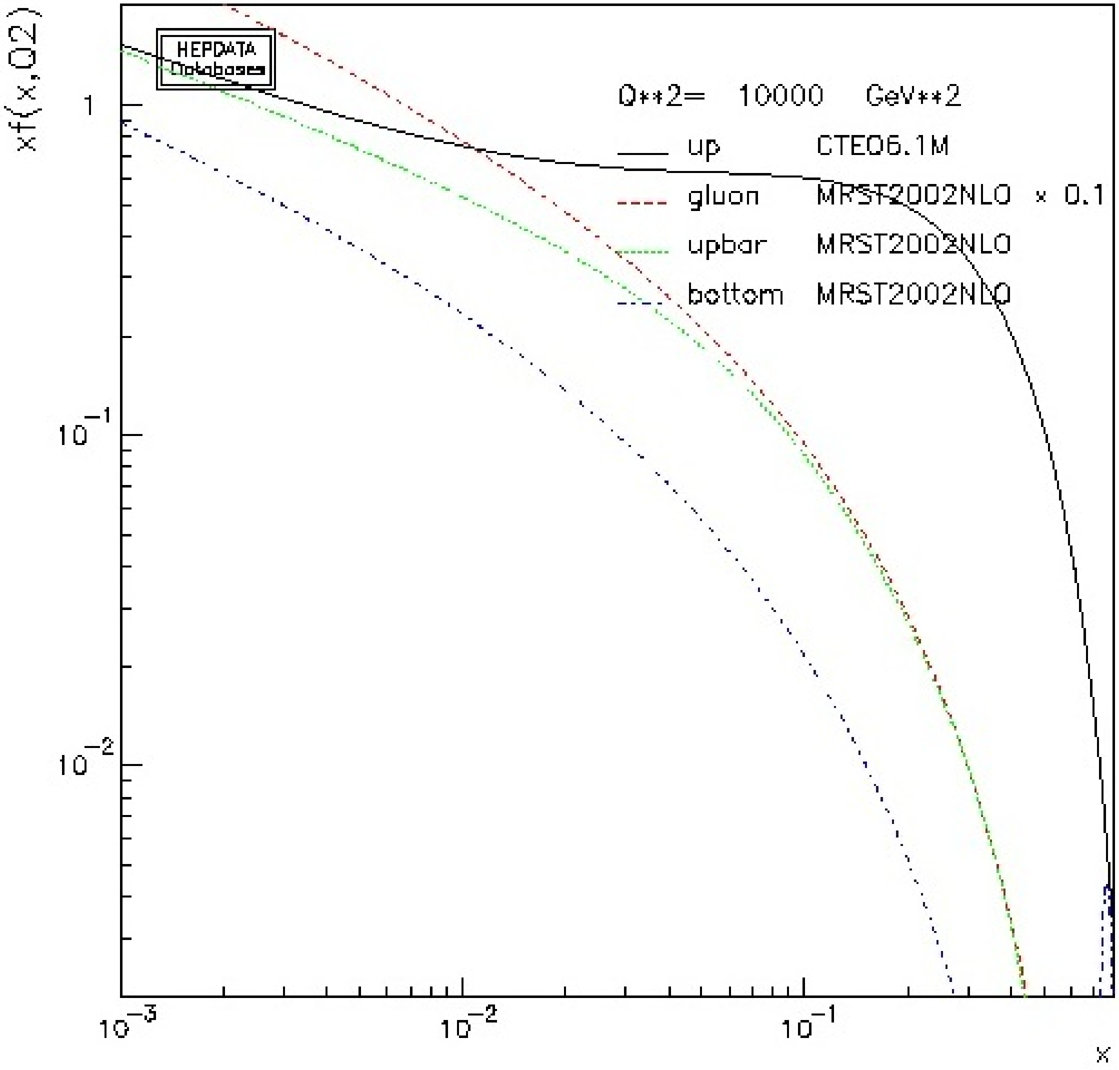
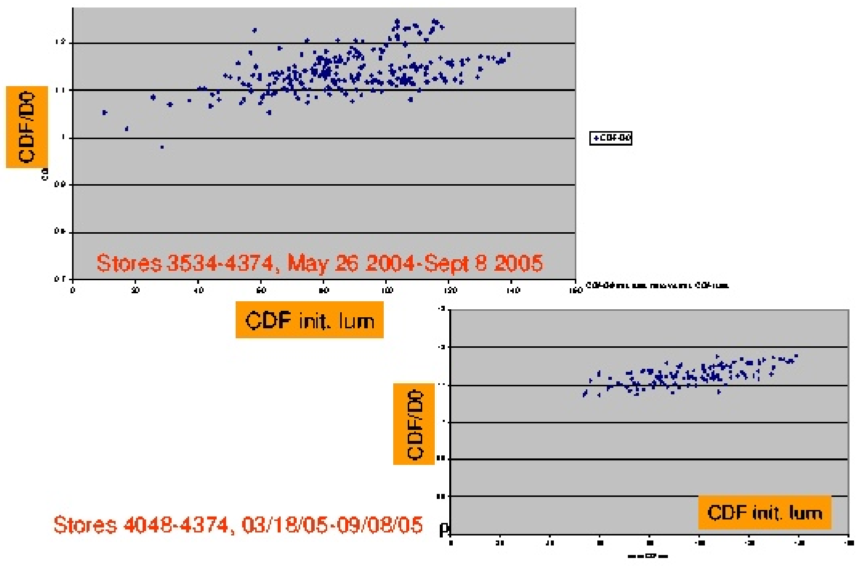


Figure 11: The PDF's at $Q = 100$ GeV (CTEQ6.1M) showing that the b-quark flux is only half that of the $\bar{u}$ flux (Plot from Joey Huston).

5.2 Rethinking Luminosity

To make precision measurements of cross-sections, we need both to measure the numerator and the denominator precisely, where the numerator is the number of events corrected for acceptance and efficiency, and the denominator is traditionally the proton-proton (antiproton) luminosity. However the denominator is harder to measure than the numerator. To improve the precision on some measurements, we should measure a ratio- e.g. at the Tevatron $\sigma top/\sigma W$.

CDF/D0 init. lum vs CDF init. lum



A secondary benefit would be in book-keeping- we could (should) keep each W or Z in every file (small record)- short-circuit the current nightmare of missing files and cockpit errors.

5.3 Changing the Paradigm: W/Z ratios, Color Singlet/Color Triplet Ratios, and Other New Precision Tests

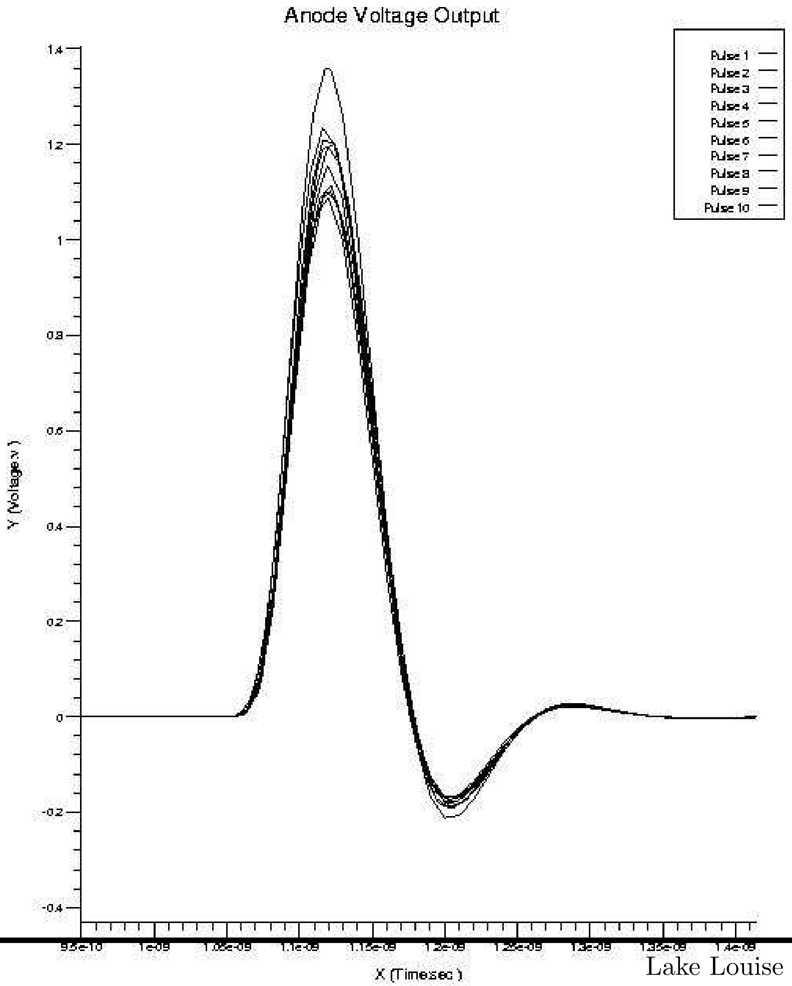
Are there quantities that we can measure more precisely than ones we traditionally have been using? One example (Abouzaid and HJF)- instead of searching in the W+N jets and Z+ N jets for new physics, search in the ratio (W+N)/(Z+N):

Event and W Properties		W/Z Ratio Method Reach	
N(Jets)	σ_W	σ_{new} 2 fb^{-1}	σ_{new} 15 fb^{-1}
0	1896 pb	20 pb (1.0%)	20 pb (1.0%)
1	370 pb	4.4 pb (1.2%)	3.7 pb (1.0%)
2	83 pb	1.5 pb (1.8%)	0.9 pb (1.1%)
3	15 pb	0.5 pb (3.5%)	240 fb (1.6%)
4	3.1 pb	230 fb (7.5%)	95 fb (2.9%)
5	650 fb	100 fb (16%)	40 fb (6%)
6	140 fb	50 fb (36%)	18 fb (13%)
7	28 fb	20 fb (78%)	8 fb (29%)
8	6 fb	——	4 fb (63%)

The cross section corresponding to a 1-sigma uncertainty in the W/Z ratio in 2 fb^{-1}, and in 15 fb^{-1}. The bins up through N=4 use the cross sections from CDF Run I; the N=5 and higher bins have been extrapolated, Using the dimuon channel one can gain approximately root-2 on these uncertainties.

5.4 Particle ID: Distinguishing $W \to c\bar{s}$ from $W \to u\bar{d}$, $b\bar{b}$ from b in Top Decays

We take it for granted that we can only identify hadrons (π, K, and p) up to a few GeV by dE/dx and by conventional TOF.



Based on simulations I believe that 1 psec resolution is possible, allowing particle ID to over 10 GeV in a detector the size of CDF. A Japanese group (Ohnema et al.) has recently achieved 5 ps resolution in TOF. This would have a big impact on precision measurements- for example, same-sign tagging in B_s mixing, identifying the b and $\bar{b}$ in the measurement of the top mass, and also separating $c\bar{s}$ from $u\bar{d}$ in top decays.

Summary

- The Tevatron is just moving into the domain where the W, Z, and top have enough statistics so that we are systematics dominated in many analyses.
- In addition, the statistics is such that the theoretical SM predictions are sensitive to QED as well as QCD higher-order corrections- a new regime. Challenge- to the theoretical community.
- Challenge- can we make systematics on top and W masses go down as $1/\sqrt{Luminosity}$?
- B_s mixing is not systematics dominated- it's a trigger problem. Challenge- can we accumulate the statistics for B_s mixing up to the inherent precision of the detector (trigger and DAQ question)?
- Watch the top mass, the W mass, B_s mixing, and for surprises.
- These detectors are remarkable precision instruments, and are presented with a wealth of measurements. We need not only to exploit them as they are but also to support those folks working on hardware who concentrate on further developing their precision.

6 Credits

Talks I have found very useful and/or taken plots from:

Florencia Canelli (UCLA), *QCD and the Importance of Hadron Calibration at the Tevatron*, Feb. 2005, Tev4LHC

Rick Field (Florida) *Jet Physics and the Underlying Event at the Tevatron*, XXXV Symposium on Multiparticle Dynamics, Kromericz, Czech Republic

Kenichi Hatakeyama (Rockefeller), *How to Calibrate Jet Energy Scale*, Coimbra, Portugal; Jan, 2006

Aurelio Juste (FNAL) Lepton-Photon, July, 2005

Cheng-Ju S. Lin, *Heavy Flavor Physics at the Tevatron*, Aspen Winter Conference, Feb. 2006

Fabio Maltoni (CERN, Louvain) *Theoretical Issues and Aims at the Tevatron and LHC*, HCP2005, Les Diableret, Switz., July 2005

Vaia Papadimitriou, *B_S, B_C and b-baryons*, XXXV Symposium on Multiparticle Dynamics, Kromericz, Czech Republic

Eric Varnes (Arizona), *Measurement of Top Quark Decay Properties at Run II of the Tevatron*, Top2006, Coimbra, Portugal; Jan, 2006

Evelyn Thompson (Penn) *Experimental Methods*, Top2006, Coimbra, Portugal;

Jan, 2006

Carlos Wagner (ANL,UC) EFI Presentation, February 2006

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