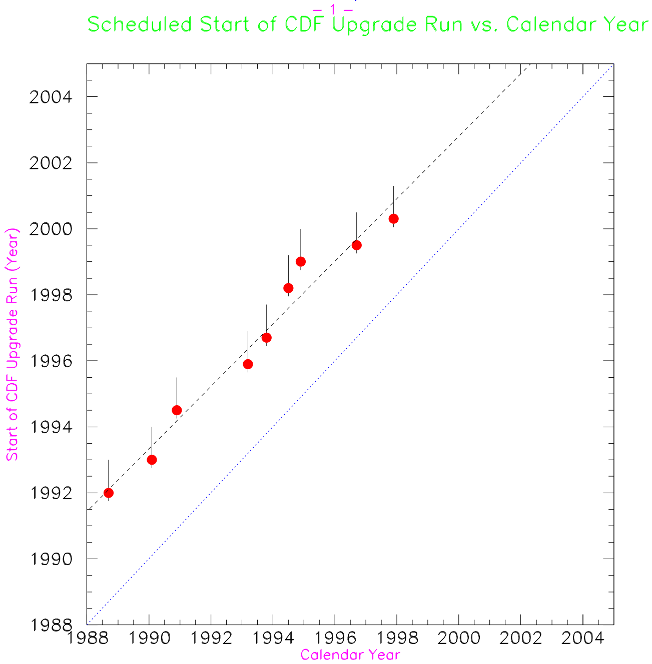
Signature-based Searches, High-Pt Leptons,Top Physics, Some UC Group Interests and Contributions-

Henry Frisch

University of Chicago

A Little Background (helpful for understanding our current situation-errors and opinions are my own.).

We (UC) set the schedule for hardware construction and installation based on the official Fermilab schedule for Run II A; the commissioning of the trigger is always very labor intensive for us. The L1 calorimeter trigger system was installed in Oct. 99; along with trigger commissioning we could then turn attention to other issues. Final schedule showed start of Run IIA as March 1, 2001, and the end of IIA with $\int \mathcal{L} dt = 2.0\ \mathrm{fb}^{-1}$ as Mar. 1, 2003 (<14 weeks from now).



Present situation:

Delivered:	$0.1295\ \mathrm{fb}^{-1}$
Recorded	$0.0904\ \mathrm{fb}^{-1}$
Good Run except SVX	$0.0521\ \mathrm{fb}^{-1}$
Good Run require SVX	$0.0395\ \mathrm{fb}^{-1}$

Two Scenarios for Our Future

Scenario A (US Physics Lucks Out) New Physics is large cross section, e.g. either strongly (QCD) produced or quite light and EWK. Examples: light $\tilde{t}$ squark, relatively light photino as $\chi 2$, etc.

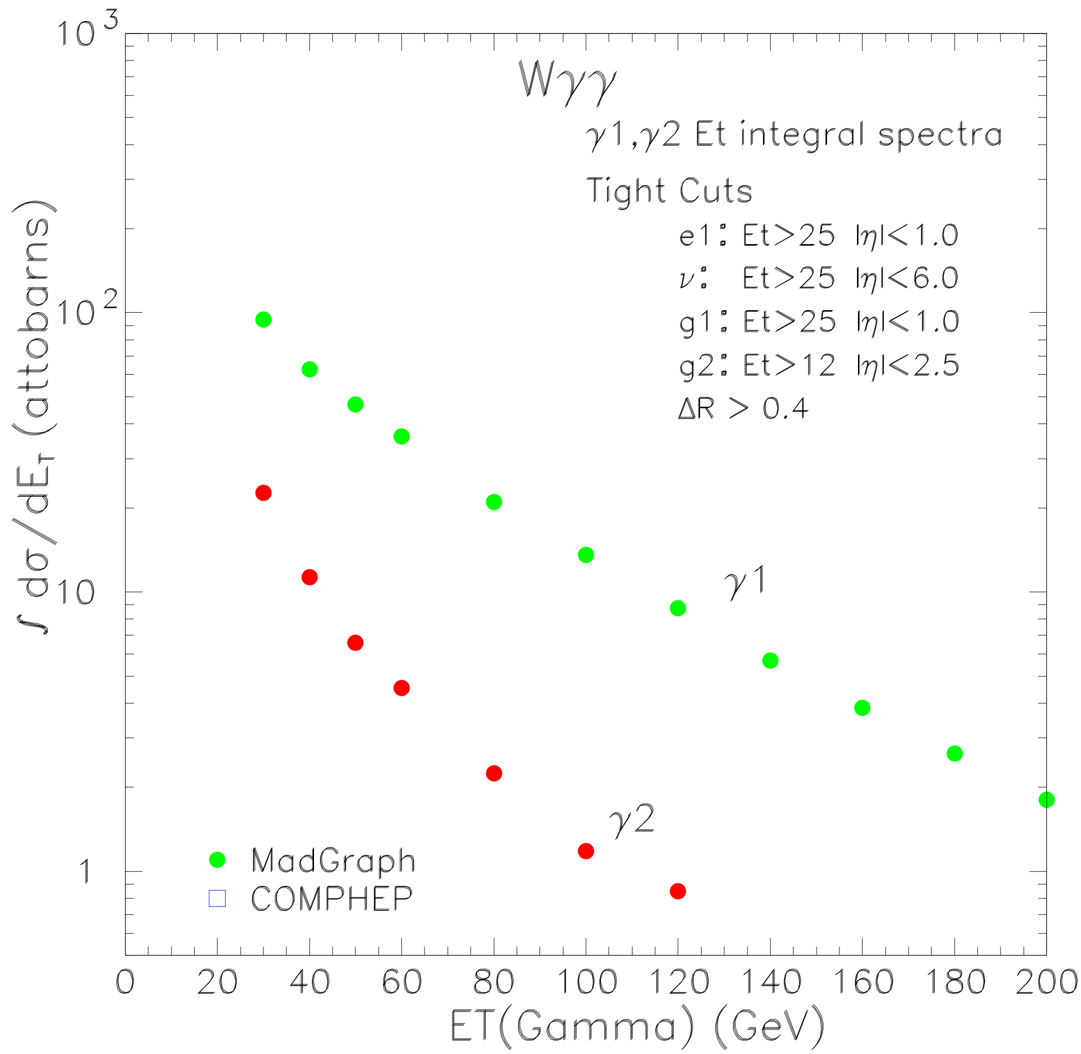
Scenario B (CM Moves to Europe) Lightest new particle masses are heavy ($> 400 - 500$ GeV)- have to get to sensitivity (luminosity) of SM Higgs.

If Scenario B, we really have to put our heads together to understand how to keep the best young people coming into the field, to keep the ability and resources to teach them how to innovate, design, and build detectors, etc. We are not doing enough already - university infrastructure is fading rapidly.

I've bet on Scenario A based on Run I results- work fulltime on CDF, with no LHC/NLC involvement- big decision, based on Run I UC analyses:

1. Multiple rare events with high-Et photons ($ee\gamma\gamma \not{E}_t, \mu\mu\gamma\gamma jj$) and/or W's or Z's.
2. Dilepton events that don't look like top

Example of a Run II event with high Et photons- first, expectations (MadGraph-new tool!):



Note- it took a better part of a year in Run I to get the predictions for one photon (not two!) for Jeff Berryhill's thesis- a quantum leap in the power of MC tools for SM predictions for Run II! Thanks to Tim Stelzer, Lev Dudko, Edward Boos, John Campbell, Keith Ellis, Michelangelo Mangano, et al.- major change!

High-E_T photons cont. Ray Culbertson, Beate Heinemann, Petra Merkel, Dave Toback,HF:

Beate found a two-photon event- looks like a high pt W:

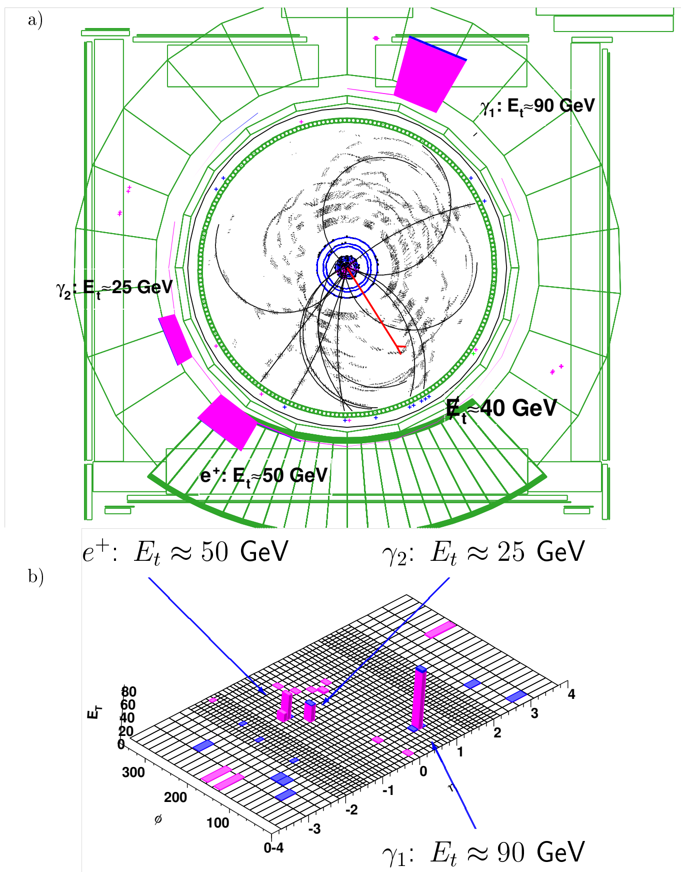
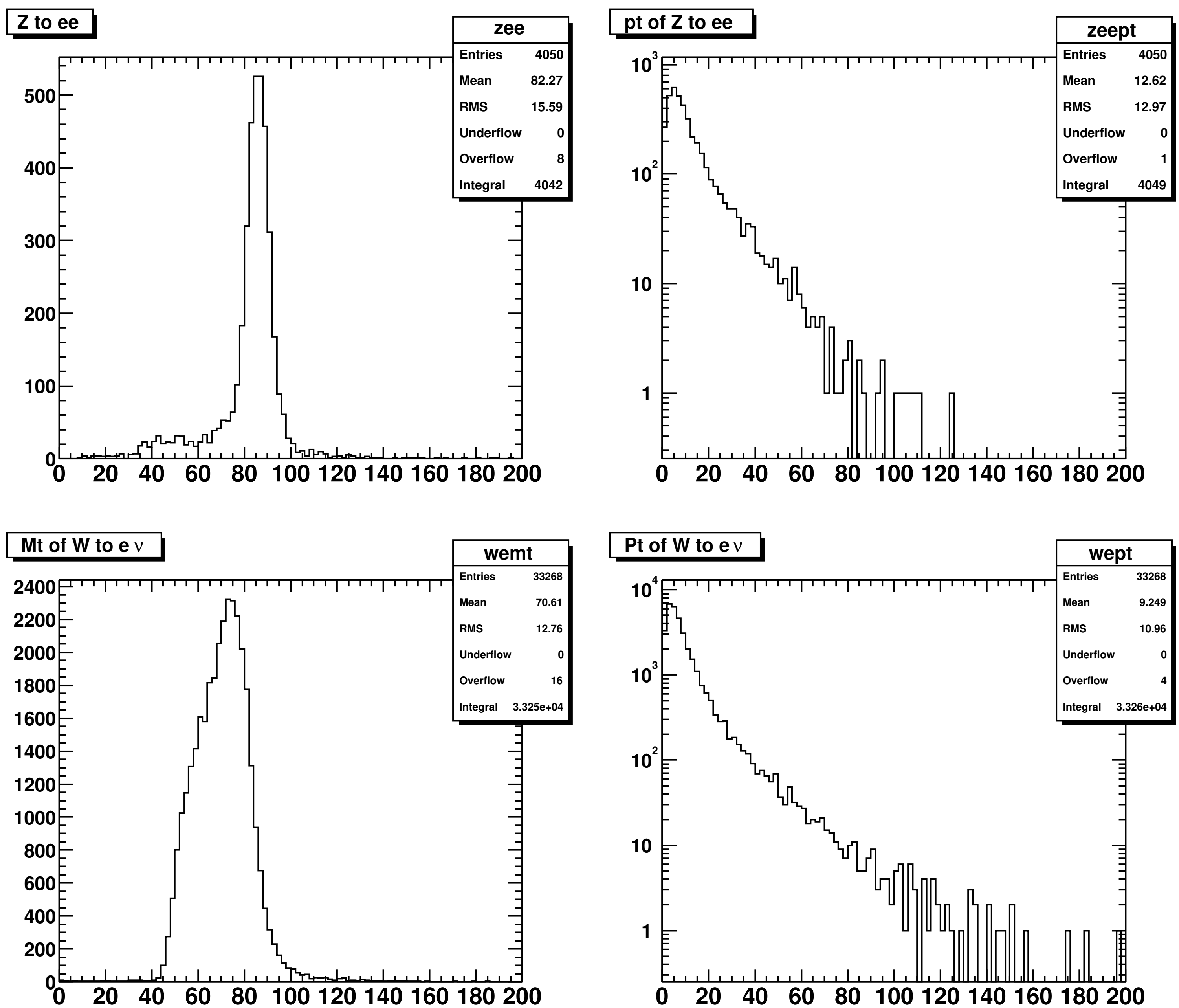


Figure 1: a) Global radial view, b) global calorimeter lego plot.

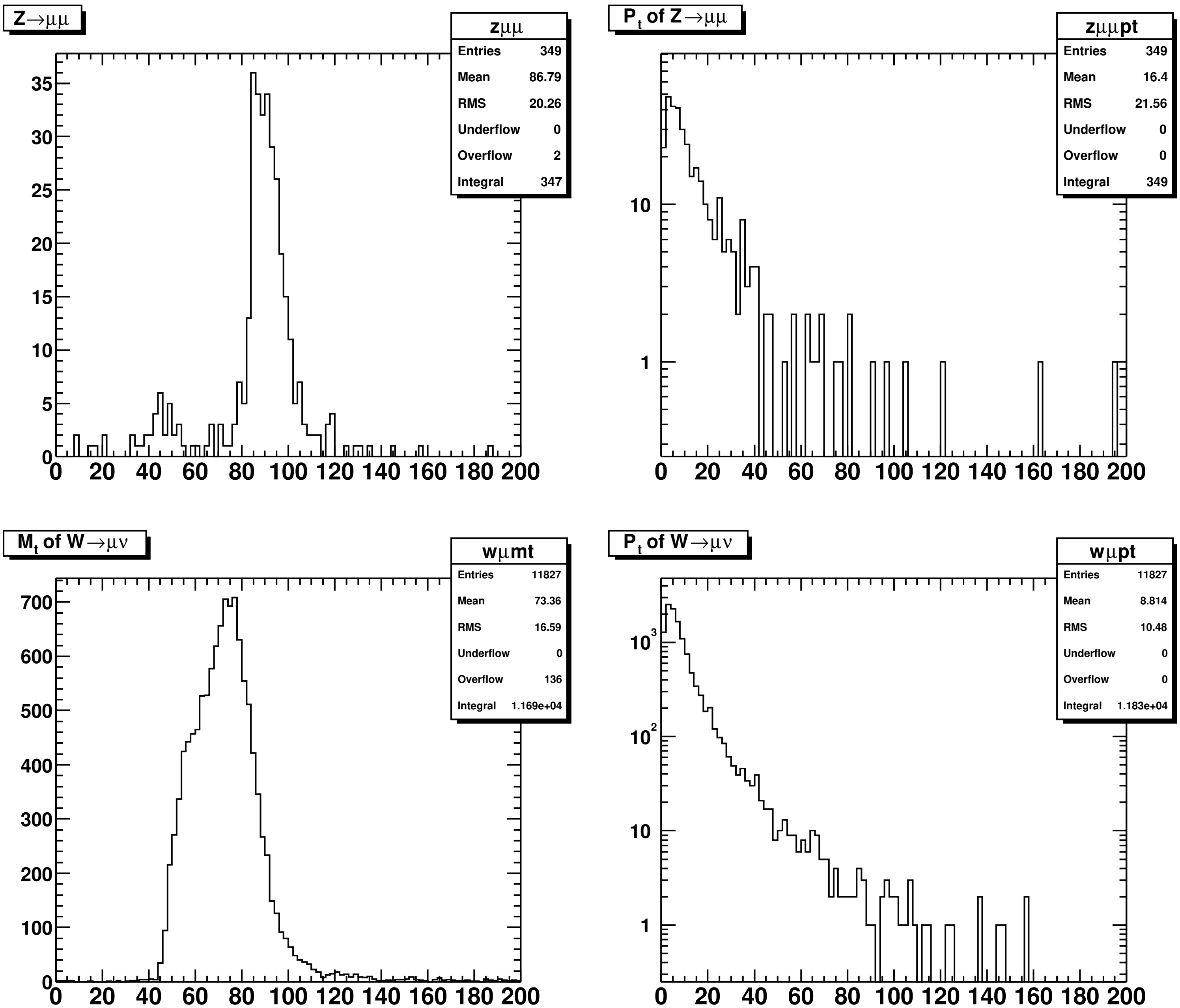
Run II Exotics Analyses/Searches Underway:

1. Gamma-met (Peter Onyisi, undergrad- Run I PRL)
2. High-Et W, Z, Z asymm (Abe DeBenedetti, undergrad- Sr. thesis)
3. Top to tau decays+tau impact parameter (Matt Reece, undergrad)
4. Gamma-lepton+X (HF, Collin Wolfe-1st yr grad)
5. Top dileptons (Collin Wolfe, UnKi Yang, HF)
6. Precision measurements of W/Z ratios (Erin Collins- 1st yr grad)
7. VISTA- broad look across exclusive channels (Bruce Knuteson)

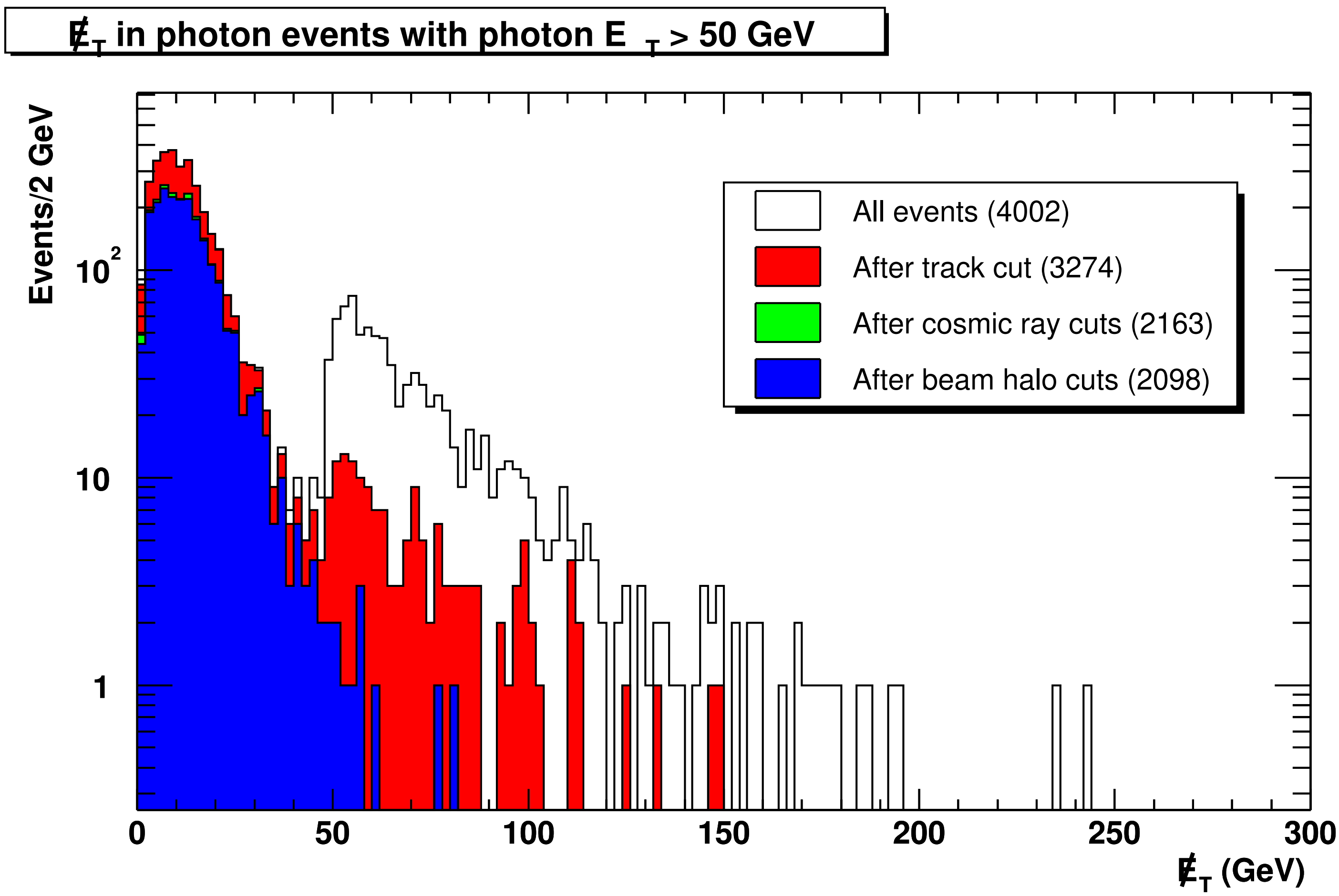
From Abe DeBenedetti's analysis- W and Z form the control samples for high Et gauge bosons and leptons. Electrons:



From Abe DeBenedetti's analysis- W and Z control samples for muons:

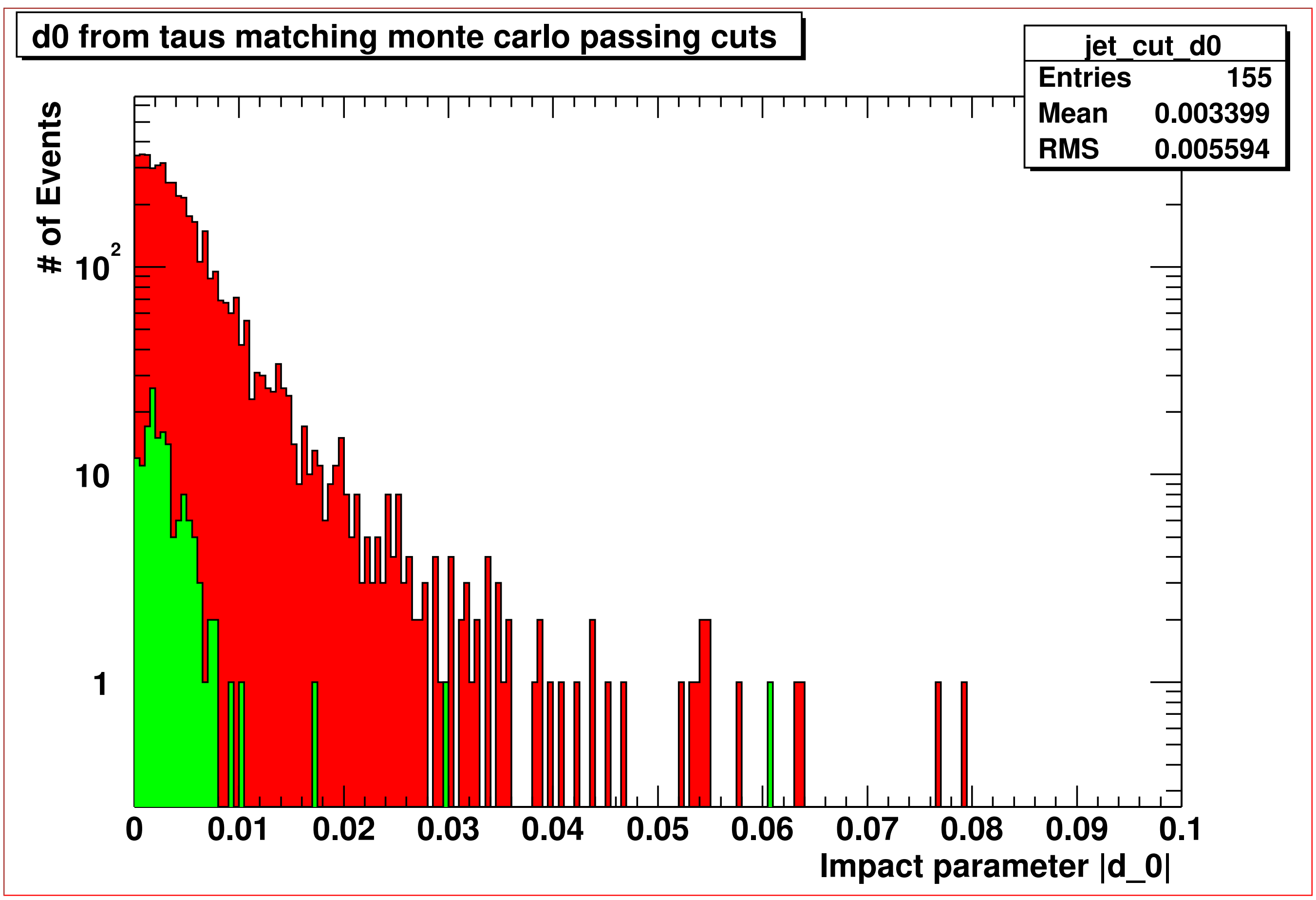


From Peter Onyisi's Run II Analysis (his PRL, which set limits on extra dimensions better than any single LEP experiment in some cases, was just accepted in PRL (!)):

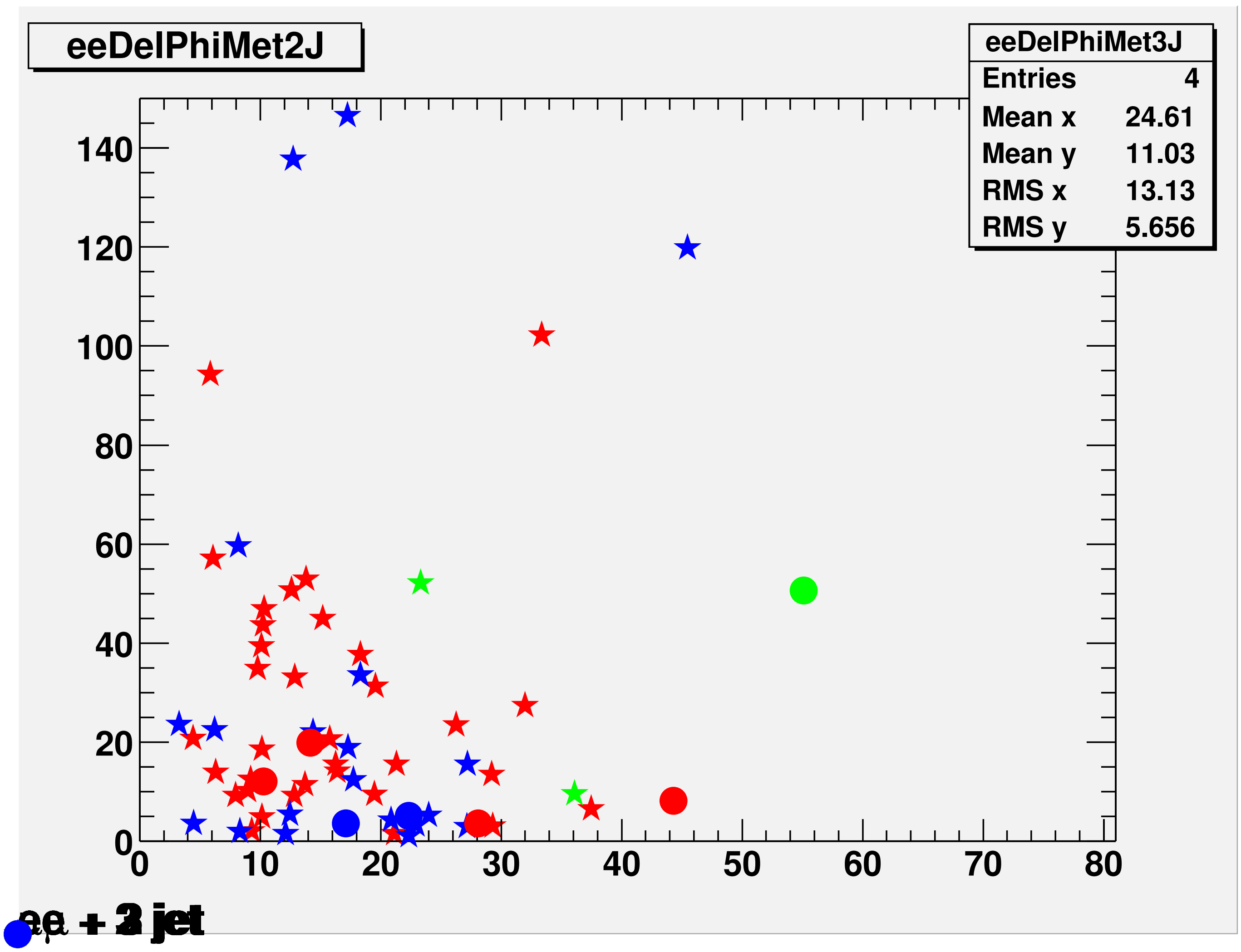


Note that Peter has managed to overcome the beam halo problem (Run II losses are very hard on photons- this is real progress).

From Matt Reece's top dilepton analysis with one lepton being a hadronically-decaying tau: This is a plot of the impact parameter from taus's (in red) and from light-quark jets from the W in top decay passing the tau selection cuts (in green).



From Collin Wolfe's top dilepton analysis: this is a (very preliminary- cum grano salis)- a plot of the missing Et vs the delta-phi between the missing Et and the nearest jet. Stars are 2 jet events, circles are 3-jet events. Green is e-mu, Red is ee, Blue is mu-mu.



Data from Feb 9 to Nov 9.

Some UC contributions to CDF analysis infrastructure (big emphasis on providing tools in a terribly corrosive software environment): (all with other institutions, but with at least some UC leadership):

1. Stream A (monitoring stream)/Express Line
2. Standard Ntuples
3. Good Run List etc.
4. Standard Lepton Cuts, lepton backgrounds (e.g. UnKi's muon DIF)
5. Lepton ID likelihoods (Bruce Knuteson)
6. Signature-based search methods
7. Bringing in modern generators for MC (COMPHEP, MadGraph,..)
8. Path to get generator datasets into CDF data handling (Sebastian Carron, Collin Wolfe, et alia)

Example- table of SM samples I've generated at UC, and UnKi has pushed through simulation and production on the UC machines (working on getting the path through the farms to be easier- still not quite there).

Process	N Jets				
	0	1	2	3	4
$W^{\pm} \rightarrow e^{\pm}\nu$	•	•	•	•	•
$Z^0 \rightarrow e^+e^-$	•	•	•	•	•
$Z^0 \rightarrow \tau^+\tau^-$	•	•	•		
$W^{\pm} \rightarrow e^{\pm}\nu + b\bar{b}$	•				
$W^{\pm} \rightarrow e^{\pm}\nu + c\bar{c}$	•				
$Z^0 \rightarrow e^+e^- + b\bar{b}$	•				
$Z^0 \rightarrow e^+e^- + c\bar{c}$	•				
$Z^0 \rightarrow \tau^+\tau^- + b\bar{b}$	•				
$Z^0 \rightarrow \tau^+\tau^- + c\bar{c}$	•				
$WW \rightarrow e^+\nu e^-\nu$	•	•	•		
$WZ \rightarrow e^+\nu e^+e^-$	•				
$WW \rightarrow e^+\nu e^-\nu + b\bar{b}$	•				
$WZ \rightarrow e^+\nu e^+e^- + b\bar{b}$	•				
$t\bar{t} \rightarrow e^+e^-$	•				

Figure 1:

Conclusions

1. Detector is working pretty well- control samples starting to be in pretty good shape. Nice W and Z samples, ...
2. Have identified channels and cuts a priori- now have well-developed signature-based methods (had to develop these in Run I- long education process on all sides).
3. Have SM MC tools light-years beyond what we had in Run I
4. CDF is pulling together as a Collaboration- really fun.