Identify an em cluster as one of 3 objects: (CDF)

$E/p < 2$: Electron

$E/p > 2$: Jet

$P < 1$: Photon

Where $p$ is from track, $E$ is from cal

$E/p$ measures bremsstrahlung fraction

Recent 'typical' zoo event (only an example)
THINGS WE CAN’T TRIGGER ON

1. Large $s\hat{a}$ but all soft particles—e.g.:
   a. $<2$ isolated photons $<8$ (CDF)
   b. No jet $>100$ (CDF), or not 4 jets $>15$ + ET
   c. no isolated single lepton $>18$, no two leptons $>12$
   d. No high-Et isolated leptons (18)

2. Displaced vertices (CDF and D0 can)

3. Tracks that do not obey normal trajectory
   a. out of time b. not from vertex c. not vXb
THINGS WE CAN’T TRIGGER ON- Continued

4. Penetrating particles that change charge
5. Delayed decays
6. Very slow particles (beta < 0.3-?)
THINGS THAT WON’T SURVIVE PRODUCTION

1. Events with too high occupancy in tracking- no really high Et jets, photons
2. Events with too high occupancy in calorimeter (‘cookie-cutter jet algorithms vs PacMan)’
3. Events that overflow buffers- too many jets, too many hits, too large (“8% solution of CDF)’
4. Events with whole single subsystems lit up (no redundancy)
5. Tracks that don’t obey $F=\mathbf{v}\times\mathbf{B}$ and come from the beamline
6. Electrons with had energy, photons with had energy
7. Tracks out of time
THINGS UNLIKELY TO END UP IN A DATASTREAM (CDF)

1. ‘Photons’ with hadronic energy near them
2. ‘Electrons’ with hadronic energy near them
3. Muons with em energy (maybe ok)
4. Photons with another photon nearby
5. Events with too high occupancy in tracking
6. Events with too high occupancy in calorimeters
7. Tracks that don’t appear to come from the beamline
8. Objects that do not satisfy criteria for a SM object (!)
Ultra-precise Time of Flight?

- **Five functions for PSEC-TOF:**
  - 1. Measure v and p, get mass => follow quark flavor flow (e.g. kaons to D*, charm to b’s, … non-SM signatures like bcbar…)
  - 2. Slow heavy new particles-
  - 3. Particles that don’t have normal trajectories => time is off from expected
  - 4. Delayed decays
  - How well can we do? Don’t know. 5-6 ps achieved in small scale- 1-3 may be possible.
  - Associating photons with vertices
  - Note: 1 psec = 300 microns- almost getting to b-lifetimes
Geometry for a Collider Detector

“r” is expensive - need a thin segmented detector

Davis 11/17/07
Generating the signal

Use Cherenkov light - fast

A 2” x 2” MCP - actual thickness ~3/4”

e.g. Burle (Photonis) 85022-with mods per our work

Collect charge here - differential
Input to 200 GHz TDC chip
Signature-Based High Pt Z+X Searches

Look at a central Z +X, for Pt > 0, 60, 120 GeV, and at distributions...

Need SM predictions even for something as `simple' as this... (not easy-ask Rick)

5 Observed and Expected events in each $P_T$-category

<table>
<thead>
<tr>
<th>$Z + X$</th>
<th>Inclusive</th>
<th>$P_T(Z) &gt; 60$ GeV</th>
<th>$P_T(Z) &gt; 120$ GeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Z \rightarrow e^+e^-$</td>
<td>25079</td>
<td>587</td>
<td>70</td>
</tr>
<tr>
<td>$Z \rightarrow \mu^+\mu^-$</td>
<td>34222</td>
<td>721</td>
<td>74</td>
</tr>
</tbody>
</table>

Table 1: Number of Z + X events observed in each category.

<table>
<thead>
<tr>
<th>$Z + X$</th>
<th>Inclusive</th>
<th>$P_T(Z) &gt; 60$ GeV</th>
<th>$P_T(Z) &gt; 120$ GeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Z \rightarrow e^+e^-$</td>
<td>25079</td>
<td>500</td>
<td>53.7</td>
</tr>
<tr>
<td>$Z \rightarrow \mu^+\mu^-$</td>
<td>34222</td>
<td>650</td>
<td>61.8</td>
</tr>
</tbody>
</table>

Table 2: Number of Z + X events expected in each category.
Signature-Based High Pt Z+X Searches

$N_{\text{jets}}$ for $P_{TZ}>0$, $P_{TZ}>60$, and $P_{TZ}>120$ GeV Z's vs Pythia (Tune AW) - this channel is the control for Met+Jets at the LHC (excise leptons - replace with neutrinos).

Davis 11/17/07
Signature-Based High Pt Z+X+Y

Simple Counting Expt - ask for a Z + one object, or Z+ 2 objects

<table>
<thead>
<tr>
<th>One Object</th>
<th>X</th>
<th>Observed</th>
<th>Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lepton</td>
<td>3</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Photon</td>
<td>14</td>
<td>12.4</td>
<td></td>
</tr>
<tr>
<td>Missing Energy</td>
<td>97</td>
<td>85.4</td>
<td></td>
</tr>
<tr>
<td>Ht</td>
<td>45</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Two Objects</th>
<th>X+Y</th>
<th>Observed</th>
<th>Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lepton+Photon</td>
<td>0</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Lepton+Missing Energy</td>
<td>0</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Lepton+Ht</td>
<td>0</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Photon+Missing Energy</td>
<td>0</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>Photon+Ht</td>
<td>0</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Missing Energy+Ht</td>
<td>6</td>
<td>3.5</td>
<td></td>
</tr>
</tbody>
</table>

Z+X+anything    Z+X+Y+anything
Communicating results of searches to Theorists


3 Ways:

A. Object Efficiencies (give cuts and effic. for e, mu, jets,b’s. met,....
B. Standard Model Calibration Processes (quote Wγ, Zγ, Wγγ in lγmet,e.g.)
C. Public Monte Carlos (e.g. John Conway’s PGS)

Comparison of full MC with the 3 methods:

Conclusion- good enough for most applications, e.g. limits...

Case for gamma+b-quark+met+x (good technisig)
Tools: W and Z events as Imbedded Luminosity Markers

In measuring precise cross-sections much effort is spent on tiny effects in the numerator— the denominator is largely faith-based.

Imbed a small record (e.g. 12 words per W or Z in every dataset. Counting W’s and/or Z’s will validate lum (cross-section!) to 1-2 % (not just normalizing- book-keeping...