'Understanding Objects' and their limitations

Example- electro-magnetic (em) cluster

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

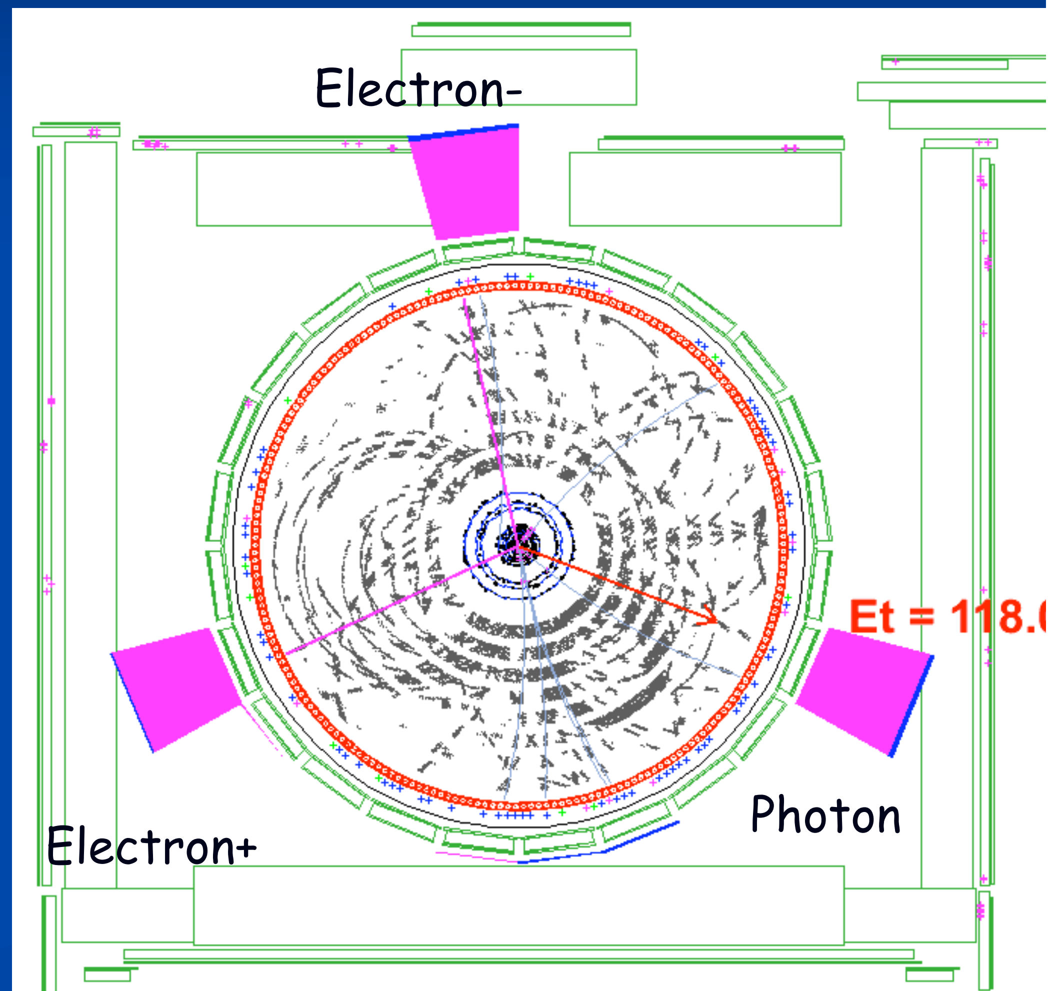
E/p < 2: Electron

E/p> 2: Jet

P <1: Photon

Where p is from track, E is from cal

E/p measures bremstrahlung fraction



Recent 'typical' zoo event (only an example)

THINGS WE CAN'T TRIGGER ON

1. Large s-hat 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=vXB and come from the beamline
6. Electrons with had energy, photons with had energy
7. Tracks out of time

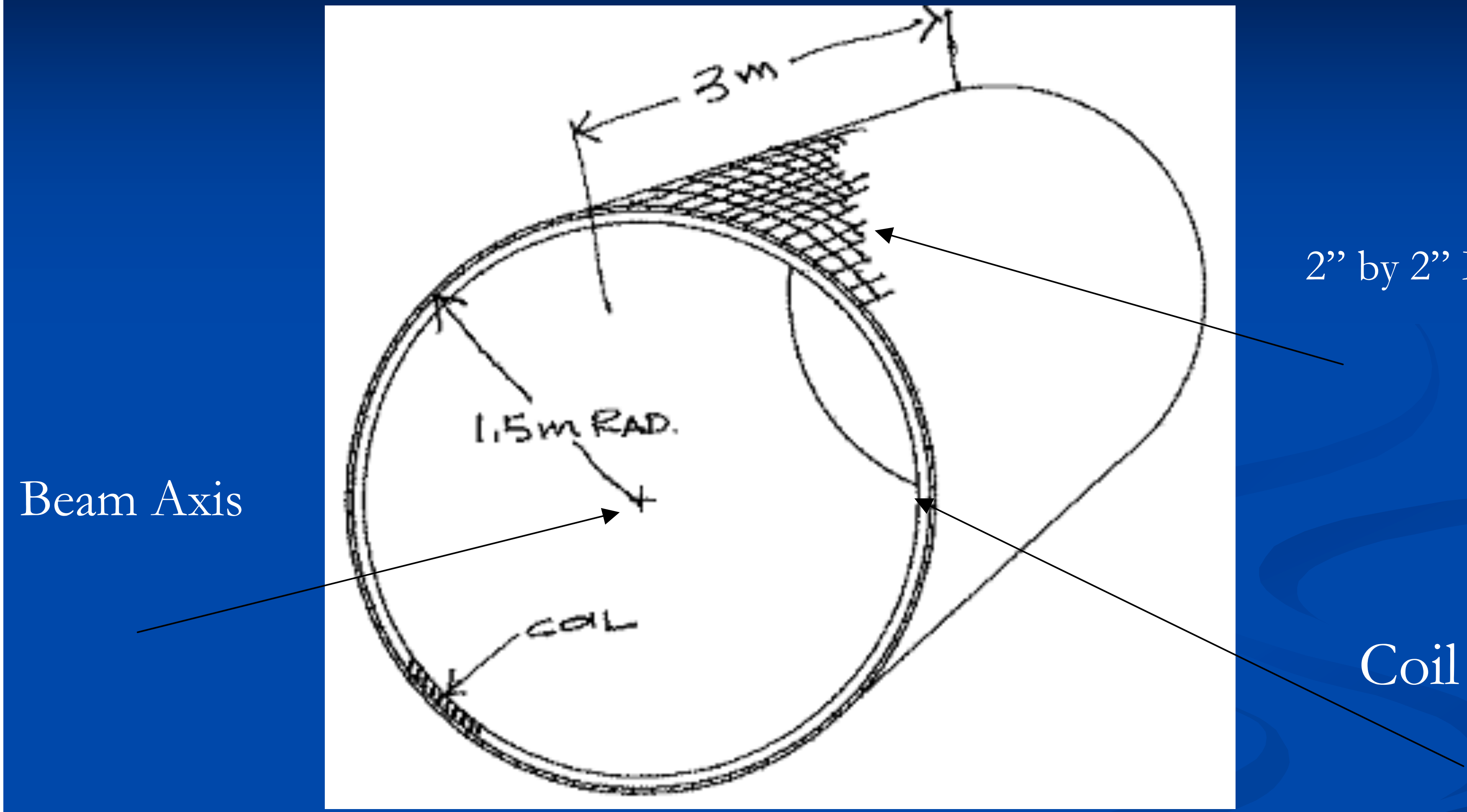
THINGS UNLIKELY TO END UP IN A DATASTREAM (CDF)

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



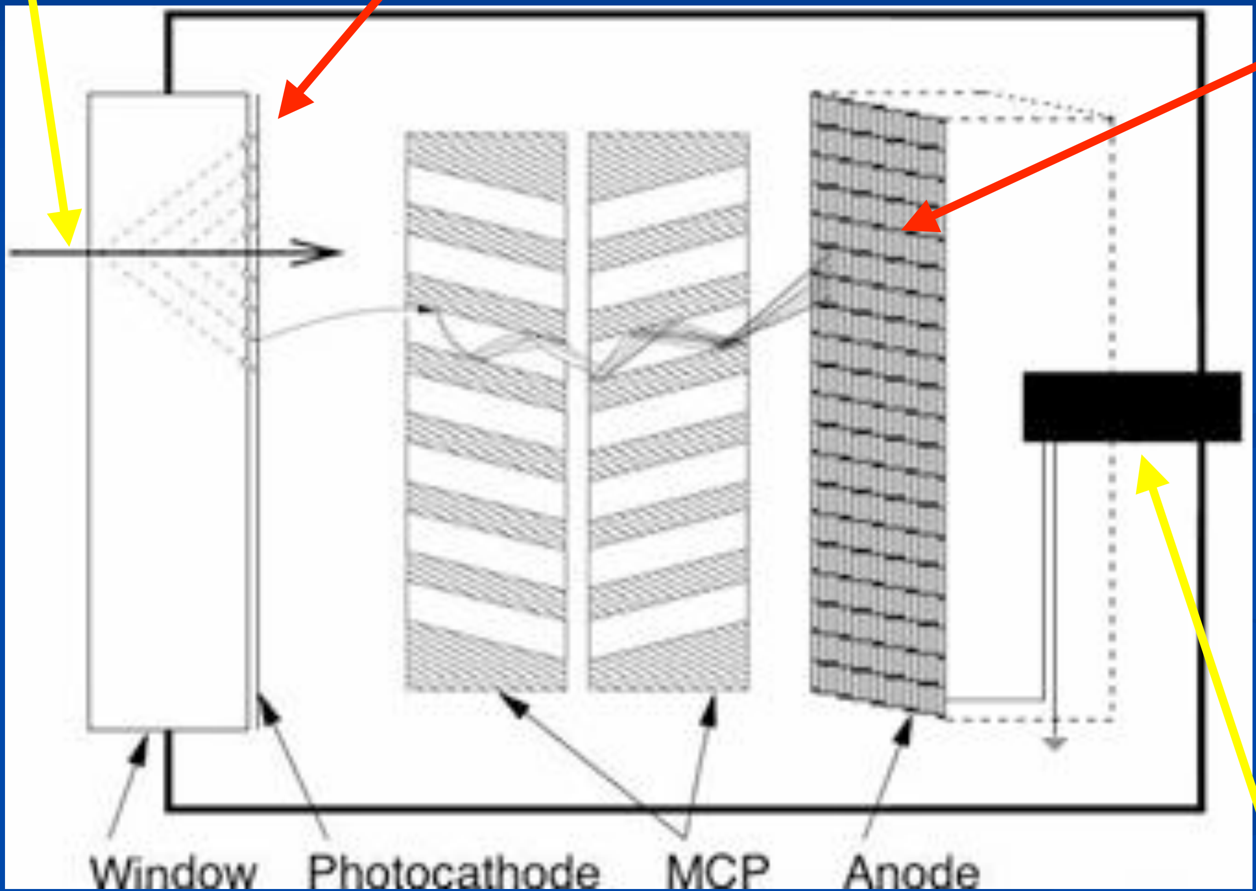
"r" is expensive- need a thin segmented detector

Generating the signal

Use Cherenkov light - fast

Incoming rel. particle

Custom Anode with Equal-Time Transmission Lines + Capacitative. Return



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

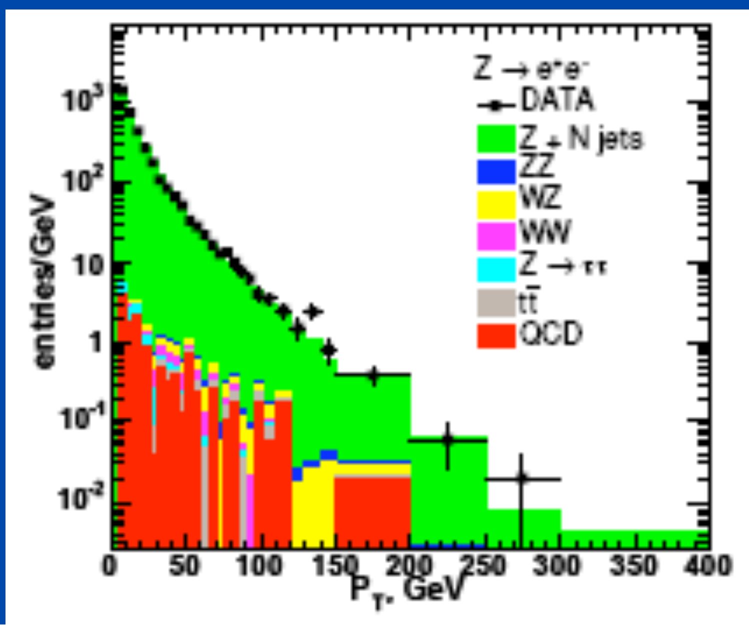
5 Observed and Expected events in each P_T-category

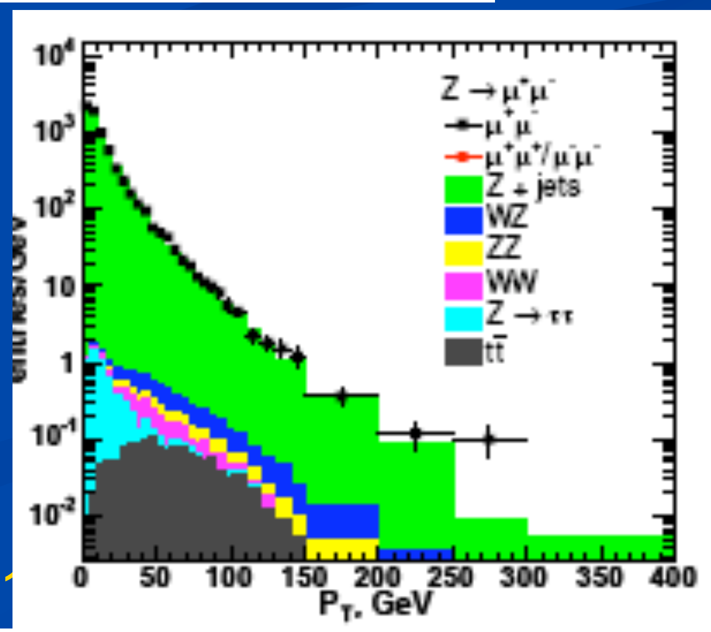
Z + X	Inclusive	$P_T(Z) > 60$ GeV	$P_T(Z) > 120$ GeV
$Z \to e^+e^-$	25079	587	70
$Z \to \mu^+\mu^-$	34222	721	74

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

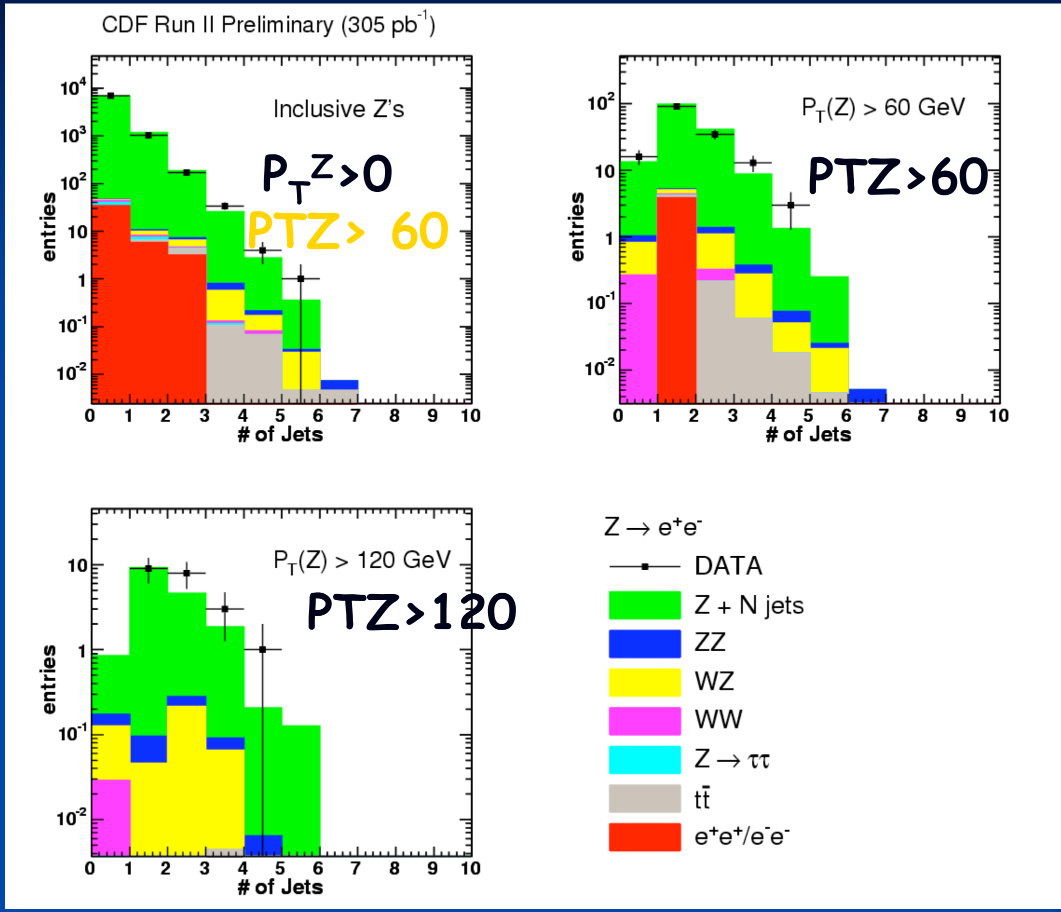
Z + X	Inclusive	$P_T(Z) > 60$ GeV	$P_T(Z) > 120$ GeV
$Z \to e^+e^-$	25079	500	53.7
$Z \to \mu^+\mu^-$	34222	650	61.8

Table 2: Number of Z + X events expected in each category.





Signature-Based High Pt Z+X Searches



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

Signature-Based High Pt Z+X+Y

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

One Object

X	Observed	Expected
Lepton	3	1.6
Photon	14	12.4
Missing Energy	97	85.4
Ht	45	36

Z+X+anything

Two Objects

X+Y	Observed	Expected
Lepton+Photon	0	0.001
Lepton+Missing Energy	0	0.8
Lepton+Ht	0	0.14
Photon+Missing Energy	0	0.19
Photon+Ht	0	0.28
Missing Energy+Ht	6	3.5

Z+X+Y+anything

Communicating results of searches to Theorists

Proposal (R. Culbertson et al, Searches for new physics in events with a photon and b-quark jet at CDF. Phys.Rev.D65:052006,2002. hep-ex/0106012)- Appendix A:

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…

True Acceptnce | Ratios to True (ABC)

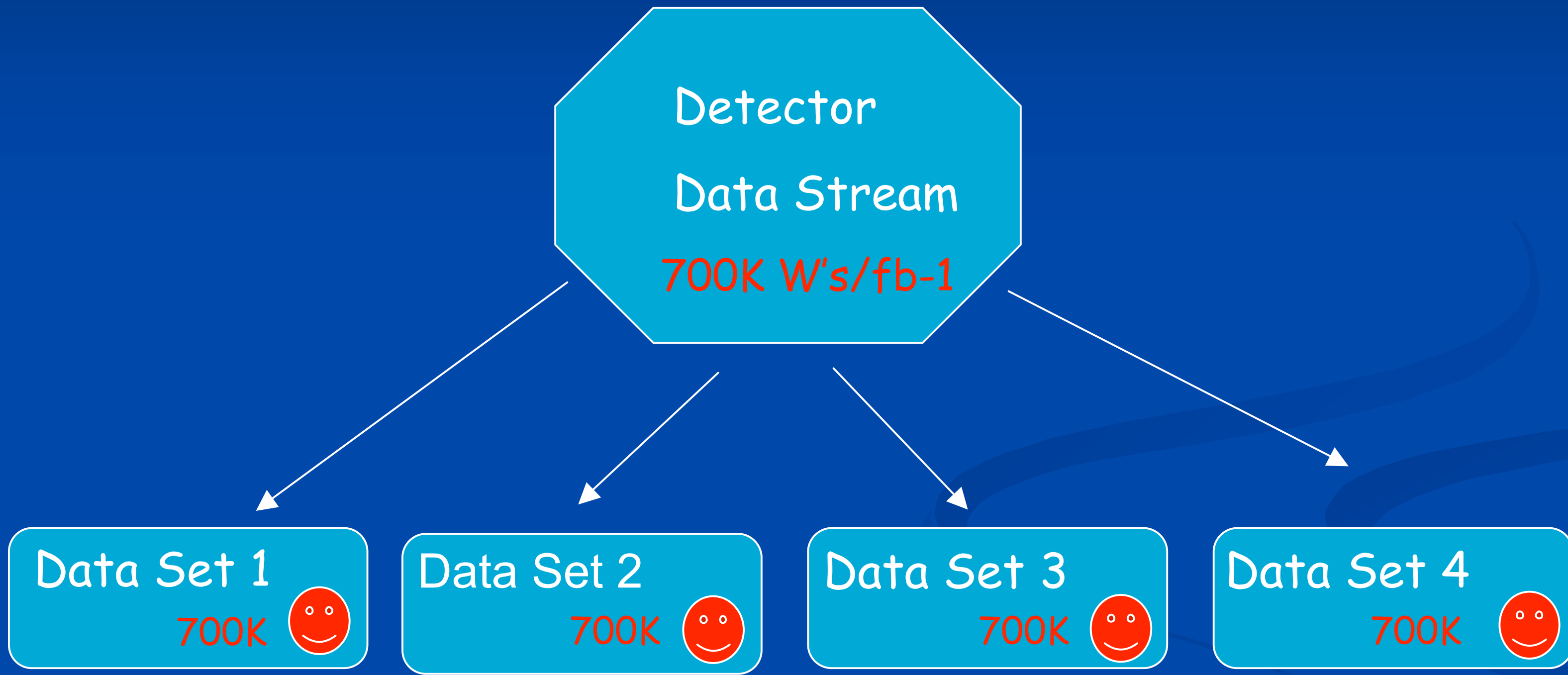
Model	M_s	BR(%)	A	$A \cdot \epsilon$	R_{obj}	R_{WW}	R_{SMW}
GMSB $M_s = M_{\tilde{\chi}_1^\pm}$	130	3	65.0	27.50	2.79	3.03	1.07
	147	20	49.8	7.45	0.91	1.00	0.70
	170	23	51.7	8.35	0.97	1.00	0.87
	186	18	54.7	11.44	1.26	1.22	1.11
$\tilde{\chi}_2^0 \to \gamma\tilde{\chi}_1^0$ $\tilde{q}$, $\tilde{g}$ production $M_s = M_{\tilde{b}}$	185	30	17.0	1.97	0.91	0.68	0.48
	210	30	22.0	2.98	1.04	0.73	0.90
	235	30	24.0	3.23	1.01	0.68	0.90
	260	30	24.5	2.69	0.82	0.52	0.75
	285	30	19.7	2.16	0.84	0.48	0.72
$\tilde{\chi}_2^0 \to \gamma\tilde{\chi}_1^0$ $\tilde{q}$, $\tilde{g}$ production $M_s = M_{\tilde{\chi}_2^\pm}$	110	100	13.5	0.93	0.54	0.54	0.59
	130	100	12.6	1.41	0.88	0.80	0.87
	140	100	14.8	1.29	0.68	0.60	0.66
	150	100	13.7	1.34	0.77	0.65	0.78
	170	100	11.5	1.27	0.85	0.68	0.65

TABLE XIX. The results of comparing the methods of calculating $A\epsilon$ using the model-independent methods and the rigorously-derived $A\epsilon$. Each row is a variation of a model of supersymmetry as indicated by the label in the first column and the mass of a supersymmetric particle listed in column two (GeV). The column labeled A is the acceptance of the model in % and the next column is the rigorously-derived $A\epsilon$. The columns labeled with R are the ratios of the rigorously-derived $A\epsilon$ to $A\epsilon$ found using the model-independent method indicated.

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…)