Study of H+jet, H□ □□ at the Tevatron in Run 2

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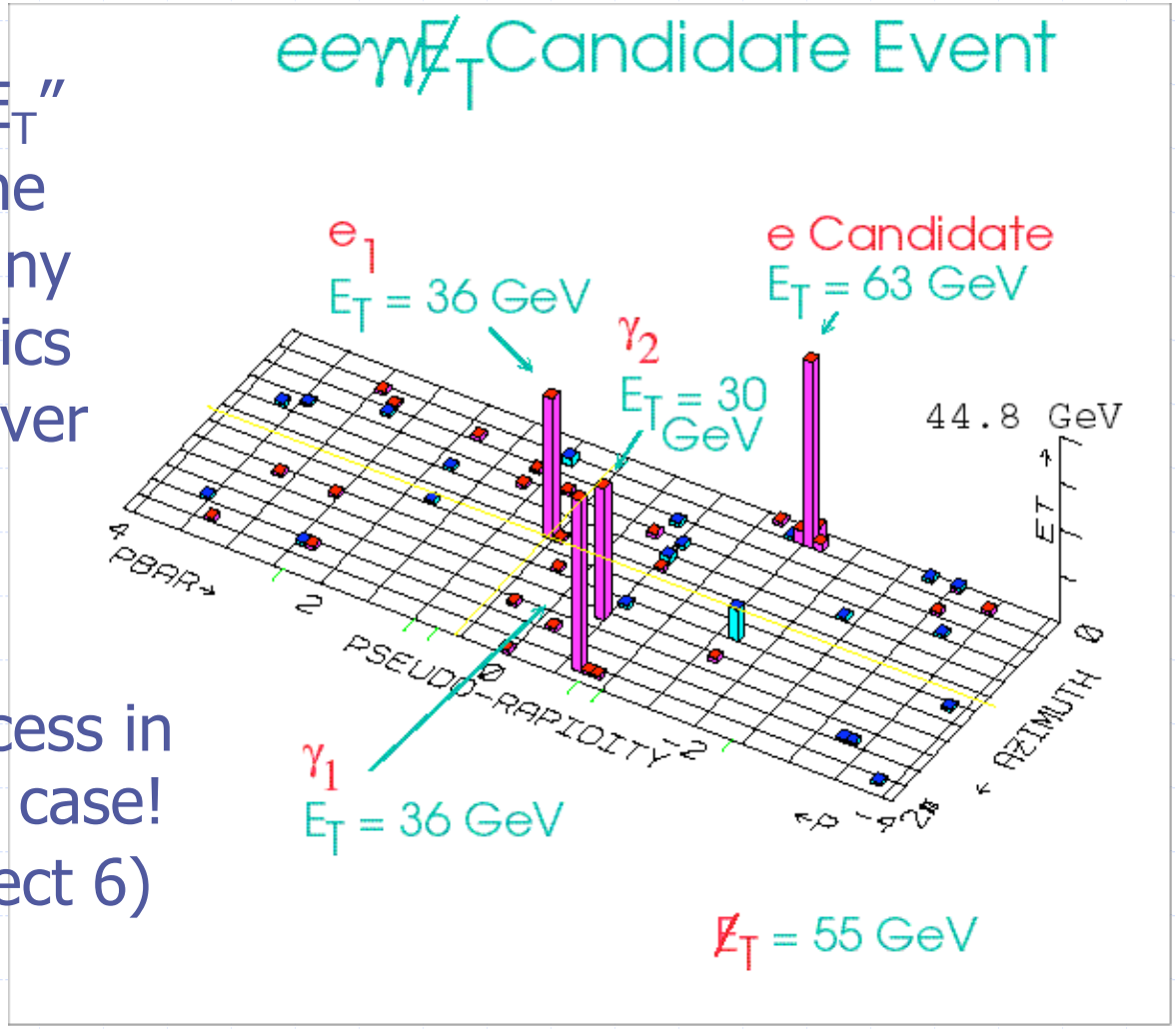
Appetizer: a trio of strange events

"ee□□ + missing E_T" event: possibly the strangest event any high energy physics experiment has ever recorded…

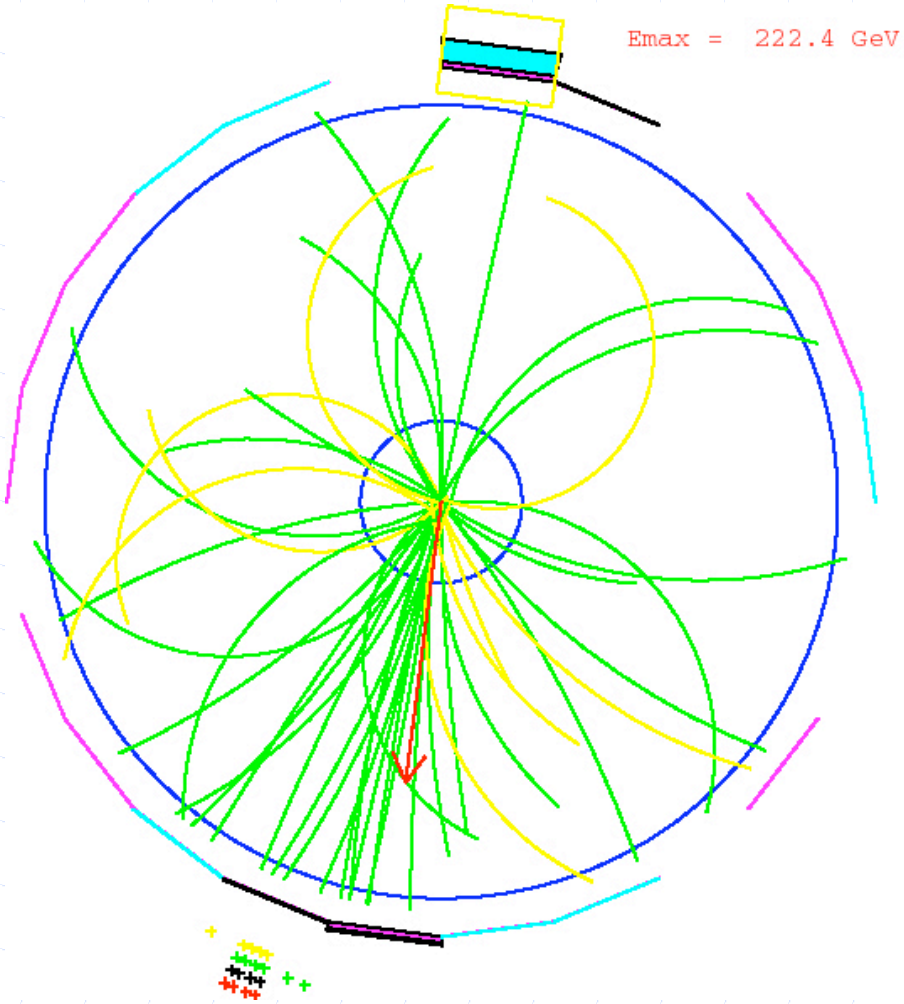
Studied related channels; see excess in l+ □ + missing ET case! (observe 16, expect 6)



"The Whopper" - high-E_T tau?

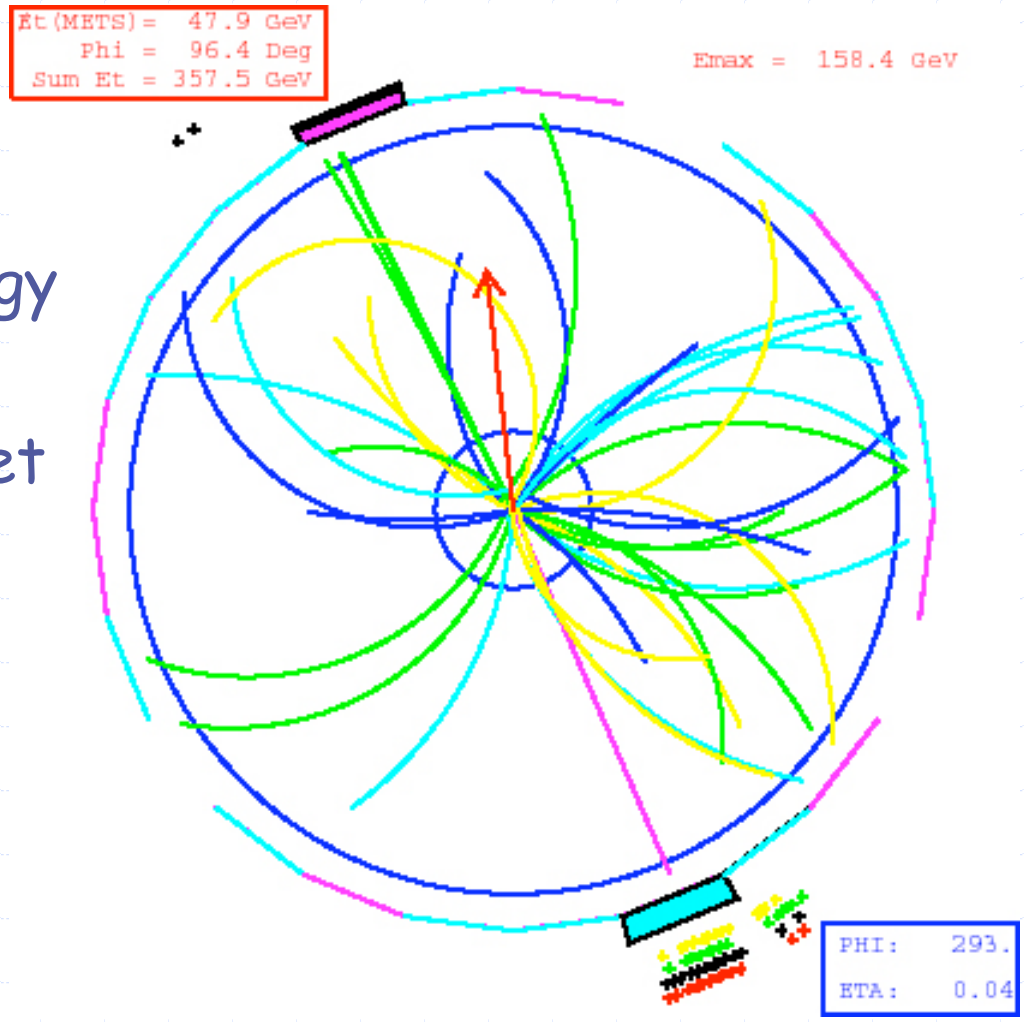
A 222-GeV transverse energy tau candidate…

We expect about 0.5 of these from QCD dijet, with one jet faking a tau.



High-E_T di-tau event

Two extraordinarily high transverse energy tau candidates…not accounted for by dijet fakes or Drell Yan signal…what is it?



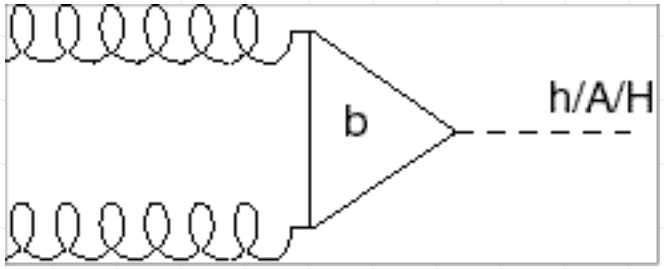
Taus in CDF

Taus have been used (and will be used) in many analyses in Run 1 and Run 2 in CDF:

- W → τν, rate and FB charge asymmetry
- top → charged Higgs search
- top → W → τν
- 3rd generation leptoquark search
- SUSY at high tanβ
- MSSM Higgs

MSSM Higgs search using tau pairs

- gg Hj jj may add sensitivity in MSSM Higgs search at Tevatron: cross section $\tan^2$



 want to cross check result using PGS simulation and optimistic selection

 study Higgs signal and Z+jet background only

PGS simulation

- Run 2 SUSY/Higgs workshop: needed simple simulation of generic collider detector
- Easy interface to PYTHIA, ISAJET, …
- Use for rough estimates of signal, background
  - ⇒ fast turnaround for prototype analyses
  - ⇒ accurate to about 20%

What PGS does/does not do

Does simulate

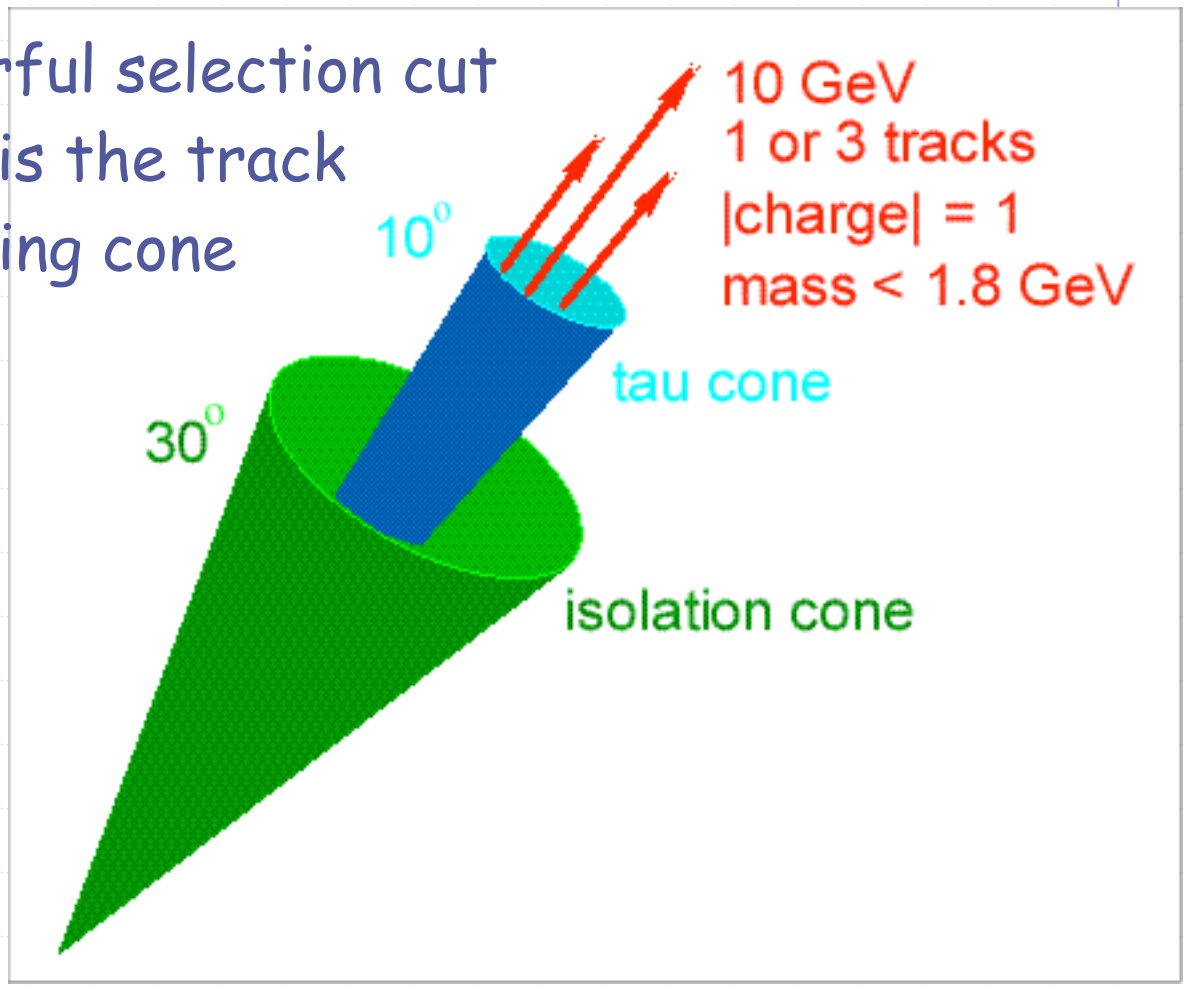
- ✓ tracking (inc. resolution)
- ✓ calorimetry (ind. particles)
- ✓ trigger info
- ✓ physics objects (□,e,mu,…)

Does not simulate

- ✗ magnetic deflection
- ✗ multiple interactions
- ✗ z-vertex effects
- ✗ actual detector geometry

Tau ID in CDF

Most powerful selection cut for tau ID is the track isolation using cone around tau direction:



- Also cut on cluster width, mass (inc. □°)

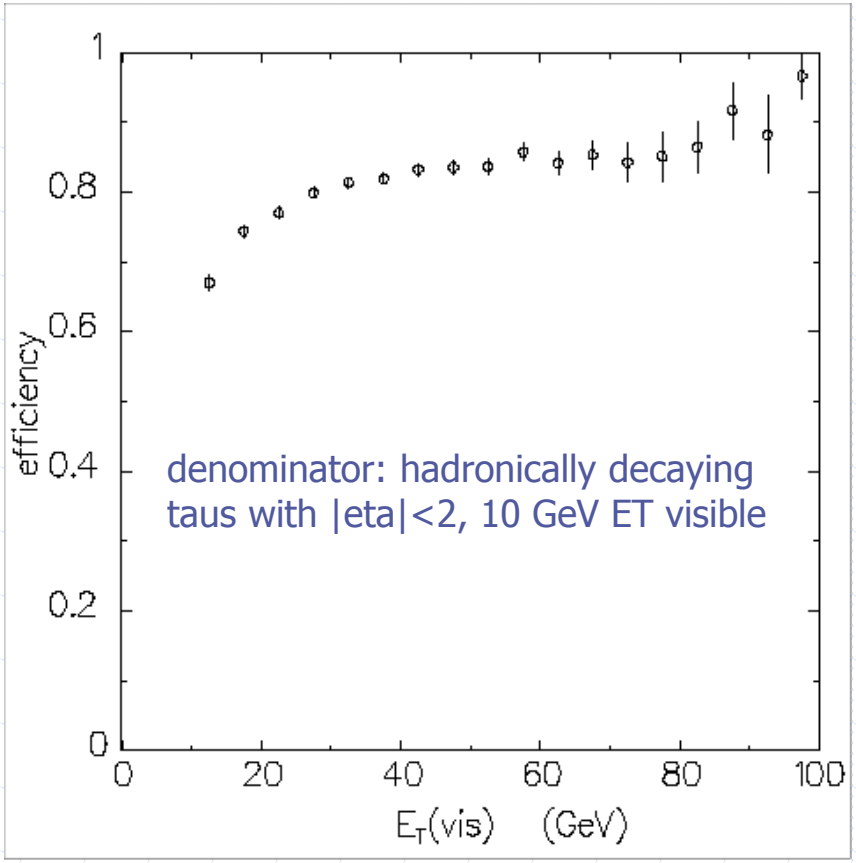
~70% efficiency

jet fake rate ~ 0.5%

Tau selection and efficiency in PGS

Tau identification cuts

- calorimeter cluster
- 1 or 3 tracks in 10^o cone
- 0 tracks in 10-30^o cone
- |charge|=1
- $E_{cal}/E_{trk}(1-E_{em}/E_{had})>1/4$
- track $p_T > 5$ GeV
- (no mass cut yet)



optimistic efficiency for taus…higher than Run 1

Event generation and selection

generation

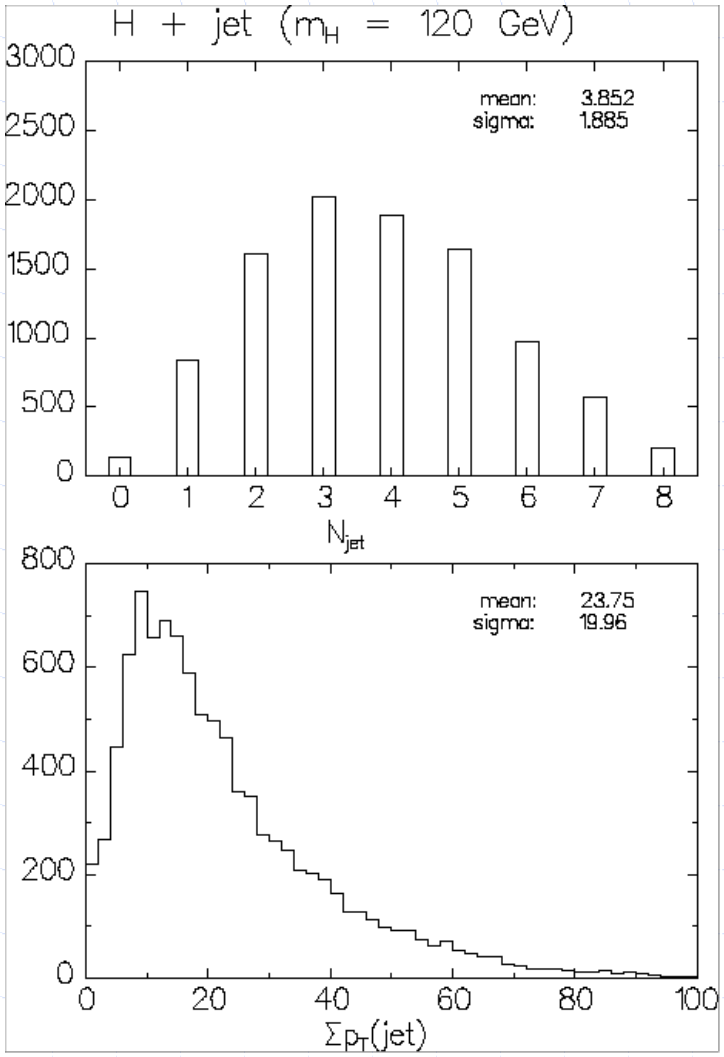
PYTHIA 6.2

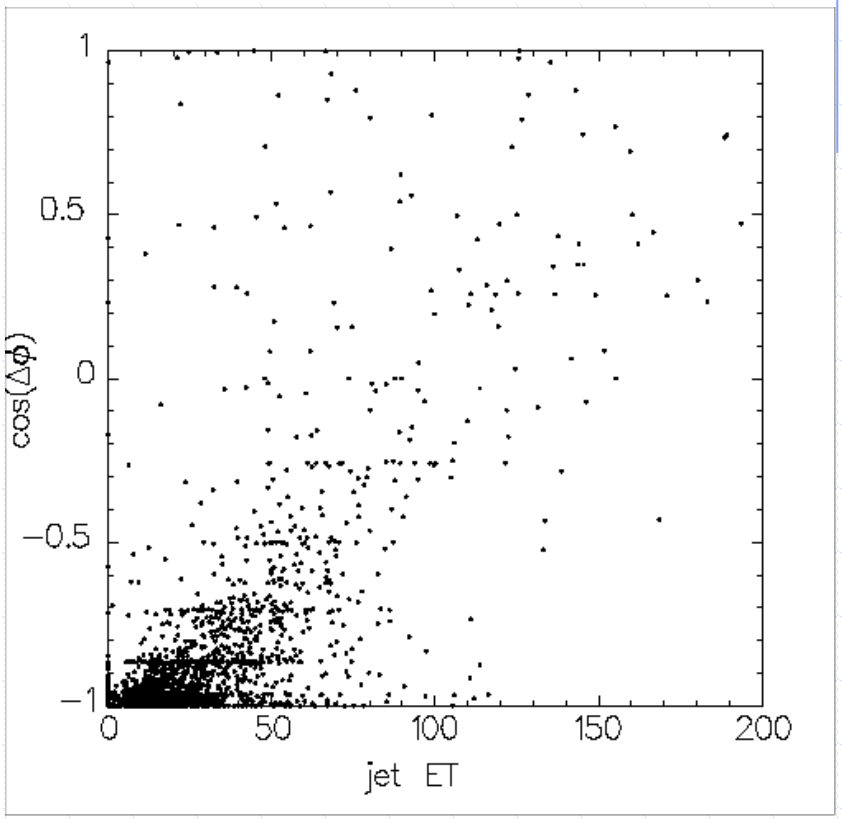
H+jet: processes 113, 185, 190
Z+jet: processes 15,30

selection

- e, mu, or tau: E_T > 15 GeV, |□|<2
- e, mu, or tau: E_T > 10 GeV, |□|<2
- jet E_T > 20 GeV

Jets versus tau-tau angle

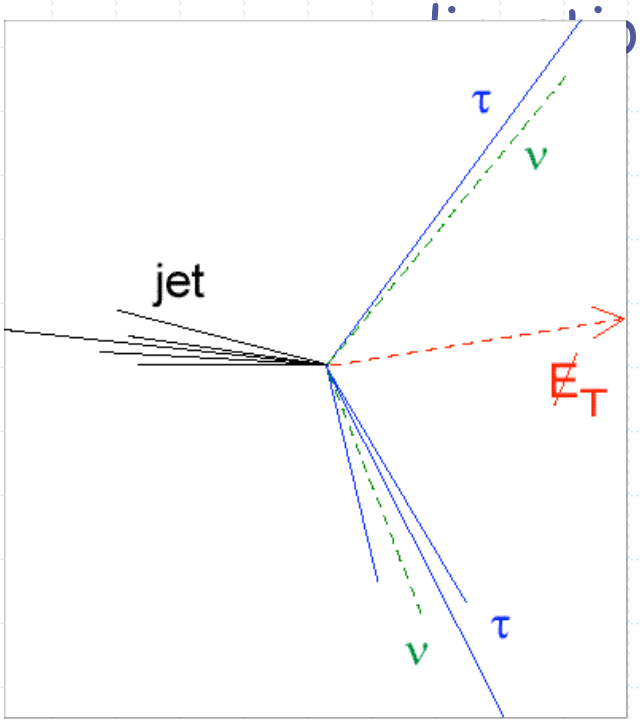


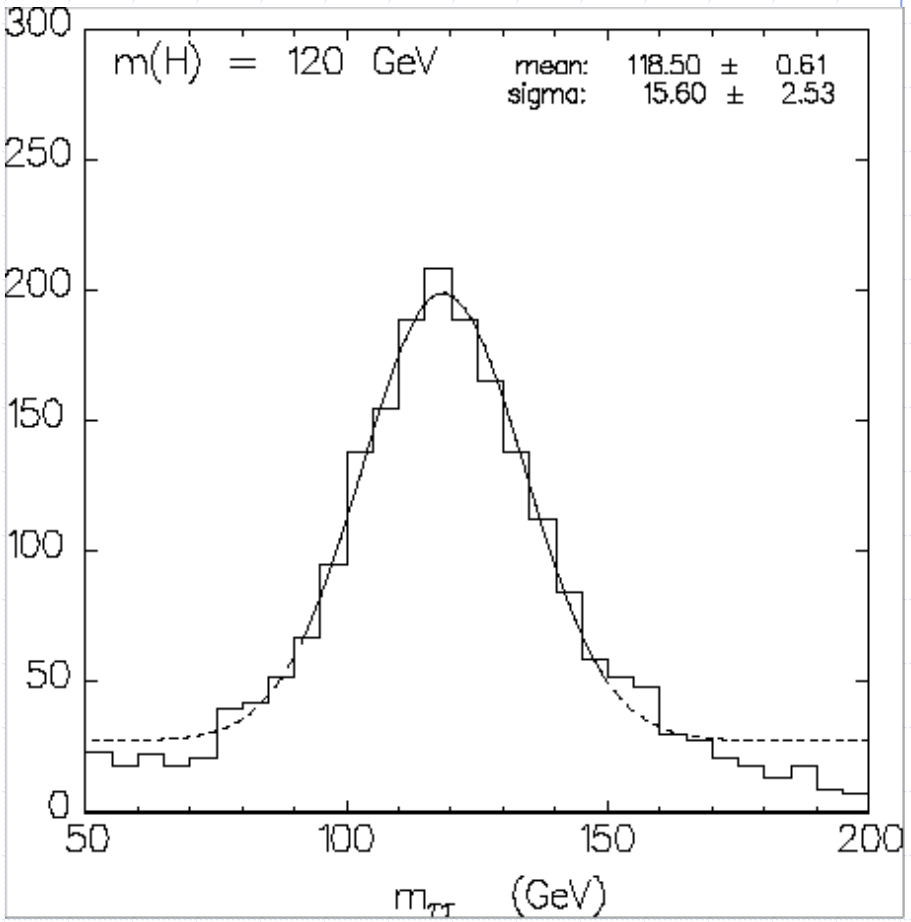


- cut on cos□□ rather than jet E_T to preserve efficiency?

Tau pair mass reconstruction

reconstruct tau pair mass by projecting missing E_T onto tau directions:



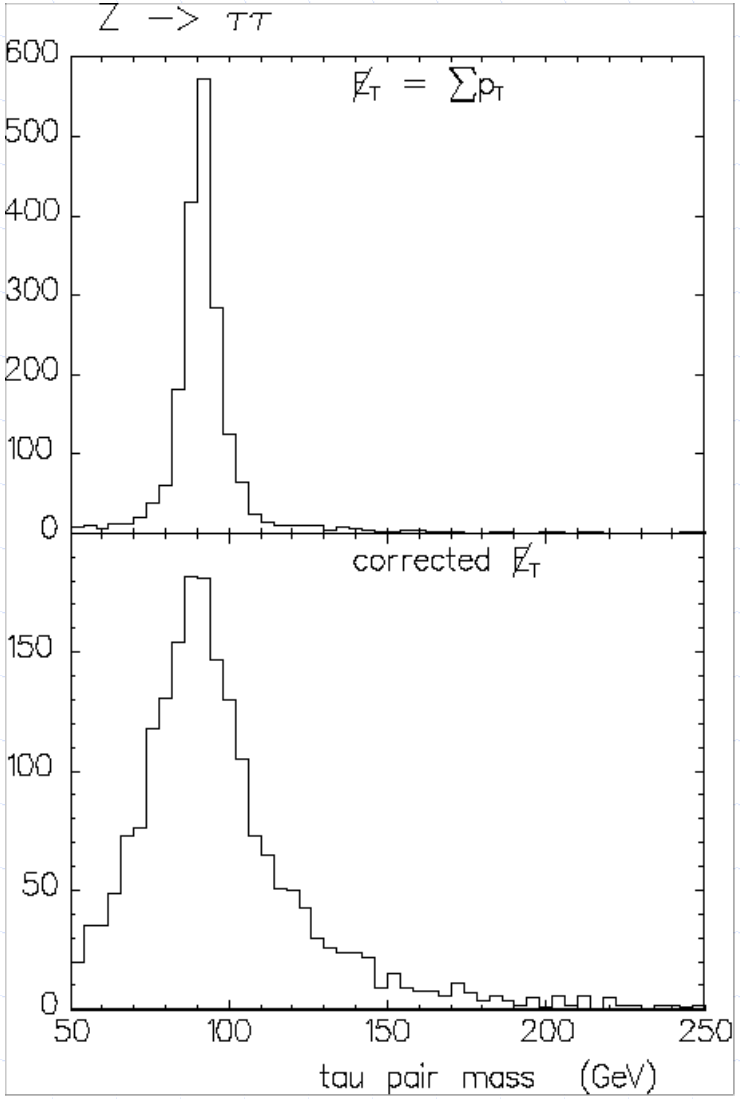


- sensitive to missing E_T resolution
- irreducible background from Z

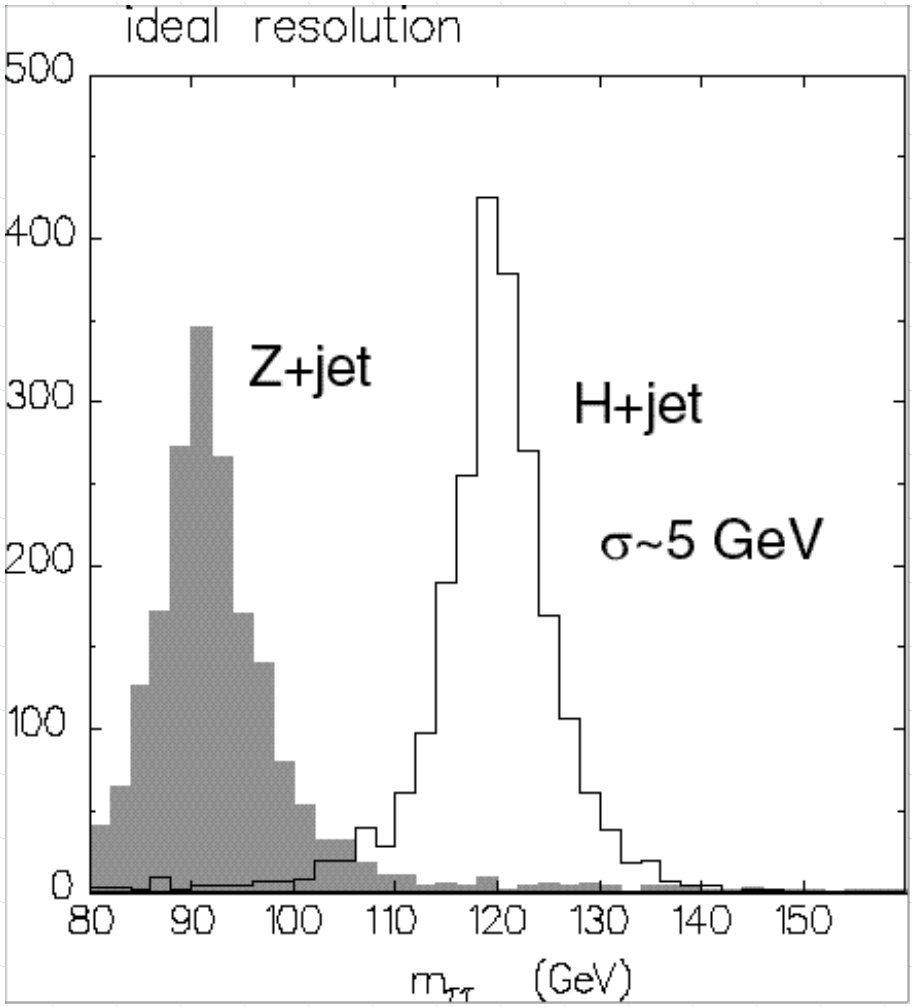
Ideal resolution for Z □ □

Get an idea of the ideal mass resolution by comparing tau pair mass determined using real missing E_T versus using "true" missing E_T from sum of tau decay neutrino p_T:

mass resolution determines the amount of Z and DY continuum leaking into signal region



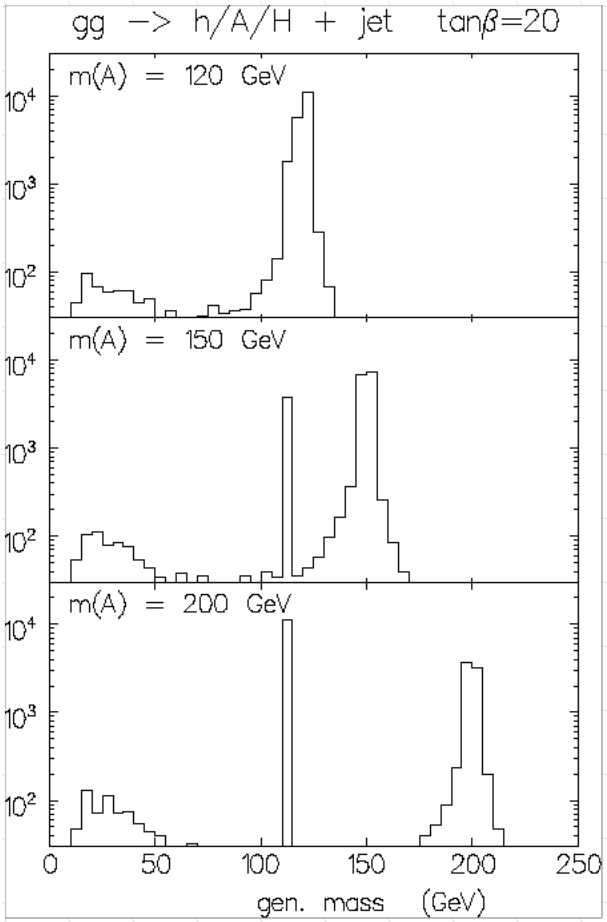
Comparison using ideal resolution



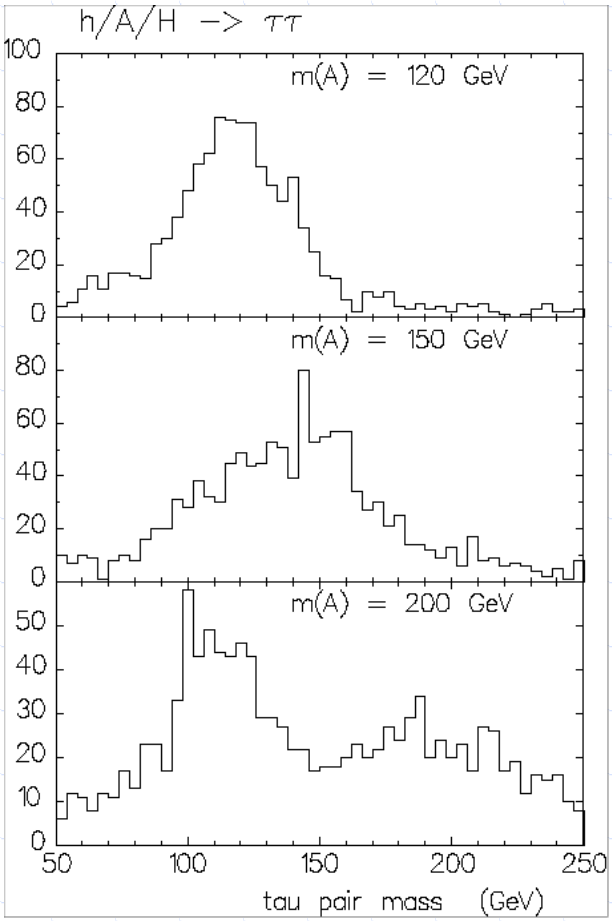
Here we use the true neutrino momenta rather than the missing E_T to reconstruct the tau pair mass; only detector resolution on the visible decay products is left

Realistic resolution

must generate all MSSM Higgses!



generated



reconstructed

Comparison of H+jet and Z+jet rates

	H+jet (*)	□□/Z+jet
cross section	1.6 x 24.0 fb	? x 148 pb
generated	10000	100000
e/□/□, E_T > 20 GeV	13195	25974
e/□/□, E_T > 15 GeV	4947	7003
jet E_T > 20 GeV	2445	2470
110 < $m_{□□}$ < 140 GeV	1001	299
events in 10 fb^{-1}	19	4440
(ideal resolution)	(40)	(1114)

(*) SM Higgs, 120 GeV mass

MSSM signal/background rates

tan□ = 20

m(A) =	120 GeV	150 GeV	200 GeV
cross section (fb)	351	113	37
mass range (GeV)	110-140	110-200	110-250
signal in 10 fb^{-1}	168	96	35
Z + jets in 10 fb^{-1}	4440	6321	6762

- even at moderately large tan beta, this looks difficult!

Conclusions (preliminary)

- Taus are very interesting for Run 2!
- The gg → H → ττ channel is enhanced at large tanβ and does not suffer huge QCD dijet background
- Can reconstruct ditau mass when tau pair is not back to back in azimuth - limited by missing E_T resolution
- This channel may not add much sensitivity, but more study is needed…