Estimating tanβ in gg->bbH_{SUSY}, H_{SUSY}->ττ

In MSSM H/A couplings to down type fermions enhanced at large tanβ

large branching fraction to ττ
large production cross section in association with b-quarks

Final states lepton+lepton (12.4%),
lepton+jet (45.6%),
jet+jet (42.0%)

Searches in these channels can be combined

Cross section proportional to $\tan^2\beta$

$$\sigma = \tan^2\beta * x$$

Uncertainty on $\tan\beta$ measurement

Theoretical error assumed for cross section: $dx/x \sim 30\%$ for 2b tagging

$dx/x \sim 30\%$ for 1b tagging

Luminosity error $dL/L \sim 5\%$

$$\Delta\tan\beta/\tan\beta = 1/2 * \mathrm{sqrt}((N_S + N_B)/N_S^2 + (\Delta L/L)^2 + (\Delta x/x)^2)$$

Hadronic final states H_{SUSY}->ττ->jet jet

Main backgrounds Z,γ*-> ττ,

multijet production with jets faking τ's (QCD)

tt,Wtb

W+jet events with W->τν

Tau jet : narrow shape and low multiplicity - can be exploited to reduce QCD,W+jet

Good E_T^{miss} measurement necessary for efficient Higgs mass reconstruction

b tagging gives strong rejection against QCD di-jet and Z,γ* backgrounds

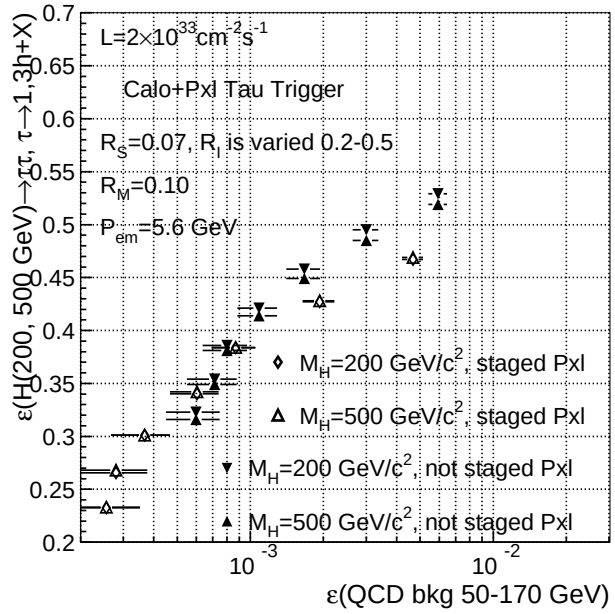
Efficient hadronic τ trigger needed for extending the channel for low masses (~200GeV)

τ trigger

Level-1 calorimetric selection (ECAL+HCAL)
Level-2 ECAL isolation
Level-3 tracking isolation

Designed to enhance the efficiency to trigger hadronically decaying τ's at low E_T (τ from low mass Higgs bosons)

Double τ trigger for H->ττ->jj tau1 E_T > 93GeV
tau2 E_T > 66GeV

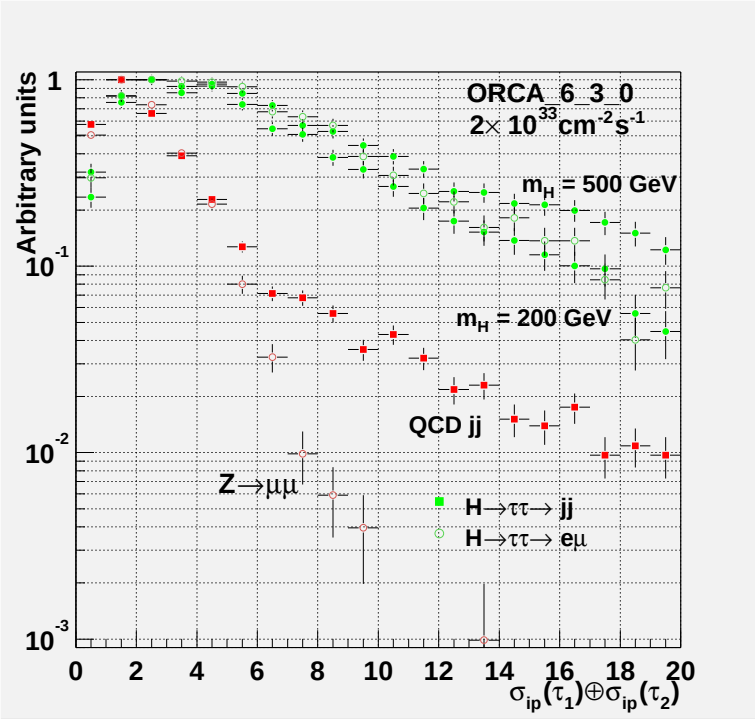


High Level Trigger (Level-2 + Level-3)
starts with the reconstruction of a jet centered at the Level- 1 τ jet
EM isolation calculated for jets, isol. < threshold are retained as τ candidates

Tracks are searched for in a cone around the jet. Accurate track p_T measurement not needed -> fast tracking algorithm exploiting only pixel data used.(2nd approach: full tracker)

Complete HLT selection for ττ : ECAL selection for the 1st jet, Pixel selection for both calorimeter jets.

τ tagging with impact parameter



$c\tau \sim 90\ \mu m$ for tau's

ip < 0.5mm to suppress K,Λ,b

combined variable $\sigma_{ip}(\tau_1) \oplus \sigma_{ip}(\tau_2)$

$\sigma_{ip} > 5$ to suppress the QCD backgr

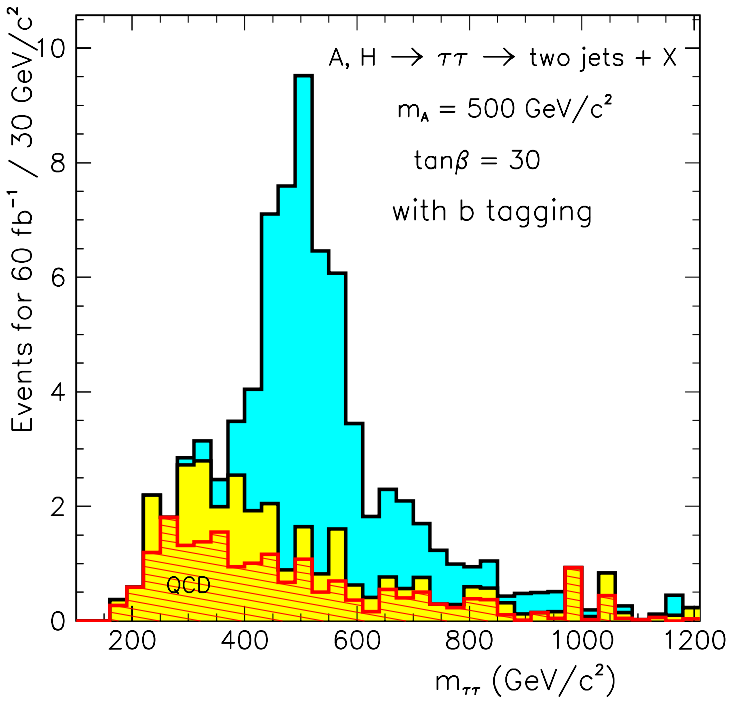
charge correlation between the two tau's
-> backgr suppression factor 2

leading track pT > 20 GeV, efficiency for signal ~60%, backgr suppressed by factor 9 (including charge corr)

track p_T cut normally 40 GeV

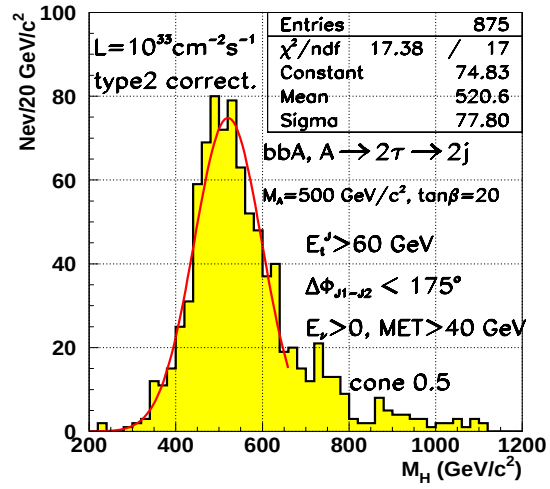
mass reconstruction

The two neutrinos assumed to be emitted close to the directions of τ jets
Precise E_T^{miss} measurement needed: E_T^{miss} projected onto the directions of the τ jets



mass resolution proportional to E_T^{miss} resolution and to $1/\sin(\Delta\phi_{jj})$
No reconstruction possible for back-to-back jet configuration ($\Delta\phi_{jj} \sim 180^o$)

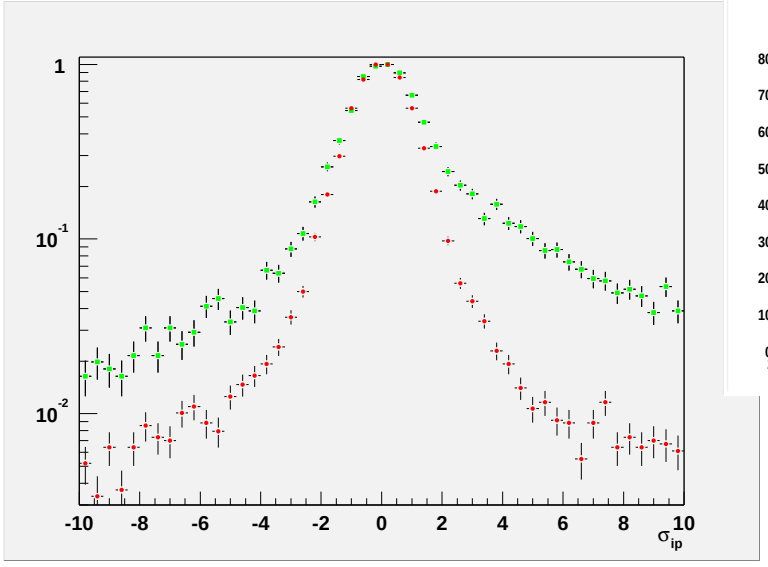
Mass resolution can be improved by $\Delta\phi_{jj}$ cut

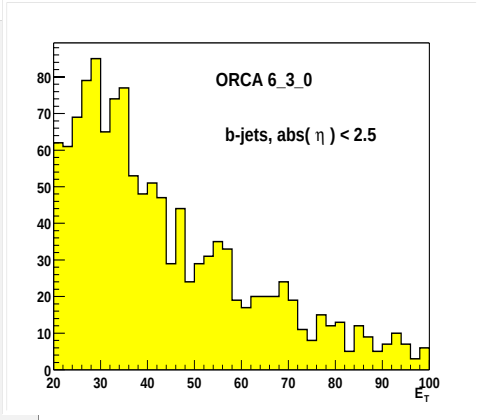


b tagging

b jets in bbH soft and distributed over wide rapidity range
Efficiency to find two reconstructed jets (E_T > 20GeV) matching with the two b quarks low, ~ 5%
Efficiency to find at least one jet matching with a b is ~ 36%
--> b tagging efficiencies low even with perfect ip measurement
Tagging method: counting significant tracks with p_T > 1 GeV, σ_{ip} > 2 (signed)

One tagged b jet per event required - veto on the second jet suppresses tt background





ORCA results for events with two tau's + jet (1b tagging)

Tagging efficiency

eff/event ~ 31% (=eff/jet)

Number of signal and background events

Fast simulation: CMSJET(parametrized from full simulations)

Cuts: Preselection, tau trigger + off line tau selection

- τ impact parameter
- $\Delta\phi_{jj} < 178^o$
- Mass reconstruction
- Tagged b jet
- second jet veto
- m_H window

Events for 60 fb^{-1}

	N_S	N_B	signif
m_A=200GeV $\tan\beta$=20	38.8	18.8	5.1
m_A=500GeV $\tan\beta$=25	39.4	33.6	4.6
m_A=500GeV $\tan\beta$=30	56.7	33.6	6.0

1b tagging, theoretical error assumed 30%

1b tagging, m_A = 500 GeV, $\tan\beta$ = 30

$\Delta\tan b/\tan b$ = 17%

→ 1b tagging, m_A = 500 GeV, $\tan\beta$ = 25

$\Delta\tan b/\tan b$ = 19%

2b tagging, theoretical error assumed 30%

→ 2b tagging, m_A = 500 GeV, $\tan\beta$ = 25

$\Delta\tan b/\tan b$ = 27%

	N_S	N_B	
m_A=500GeV $\tan\beta$=25	14	22	2.3

tt background can be further suppressed by m_T cut but some tt background always survives

Leptonic final states

Limited to mass range $m_A < 300$ GeV

ll and eμ studied

Main backgrounds from Z,g* -> ττ
tt
Wtb

bb and WW,WZ backgrounds small

lepton-lepton final state (any two leptons) suffer from Z->ll

Cuts to suppress the backgrounds

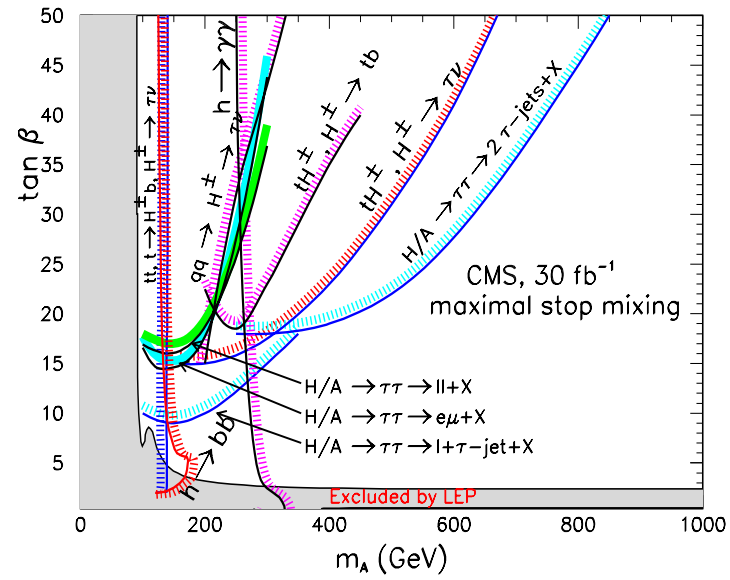
abs(eta) < 2.5, p_T(lepton) > 20GeV, isolation

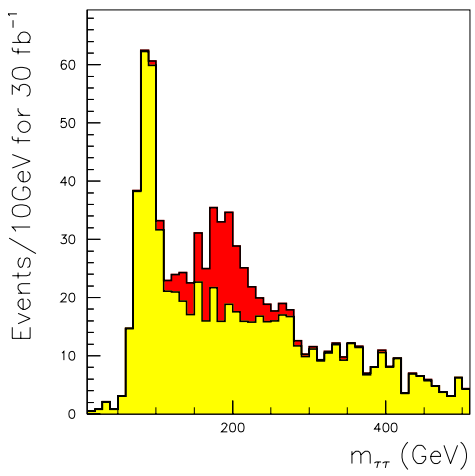
$\Delta\phi(l_1,l_2) < 175^o$

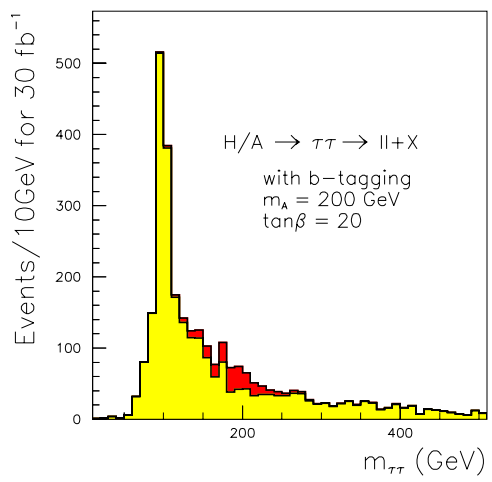
combined sip > 2.5

one jet, E_T > 20GeV

b-tagging







eμ :visible mass peak

ll : double statistics

Number of signal and background events for $3*10^4$ pb^{-1}

m_A = 140 GeV, tanβ = 14,Signal significance ~ 5

mass window 110 GeV < m_A < 160 GeV

1b-tagging !

eμ	ll
H/A : 68.8 events	H/A : 138 events
DY : 16.9	DY : 454
tt : 52.5	tt : 105
Wtb : 31.8	Wtb : 63.6
bb : 0.86	bb : 1.7
signif 5.3	signif 3.9
Δtanβ/tanβ ~ 18%	Δtanβ/tanβ ~ 20%