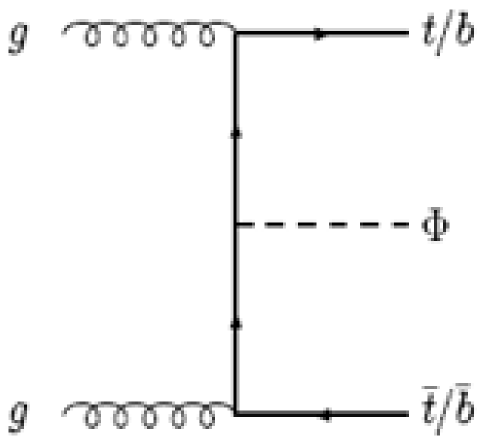
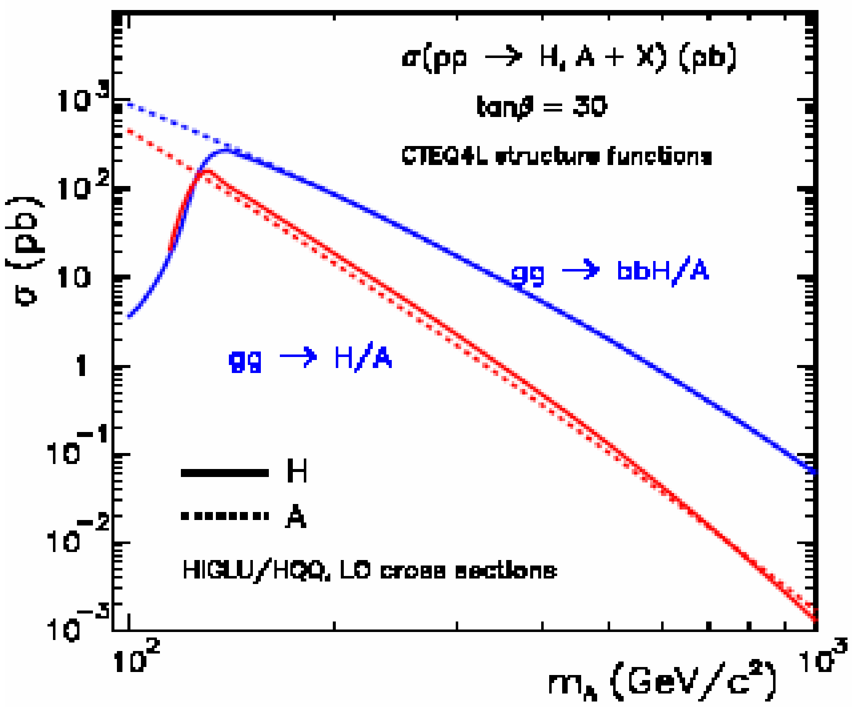
Search for MSSM
A/H $\rightarrow$ 2τ $\rightarrow$ 2 jets at CMS.

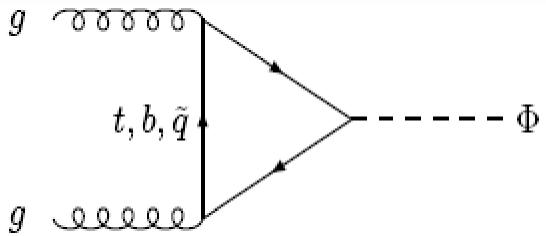
Event selection

- $M_H \approx M_A$
- CMS Physics TDR focused on production associated with b quarks gg →bbH - using b tagging in analysis.



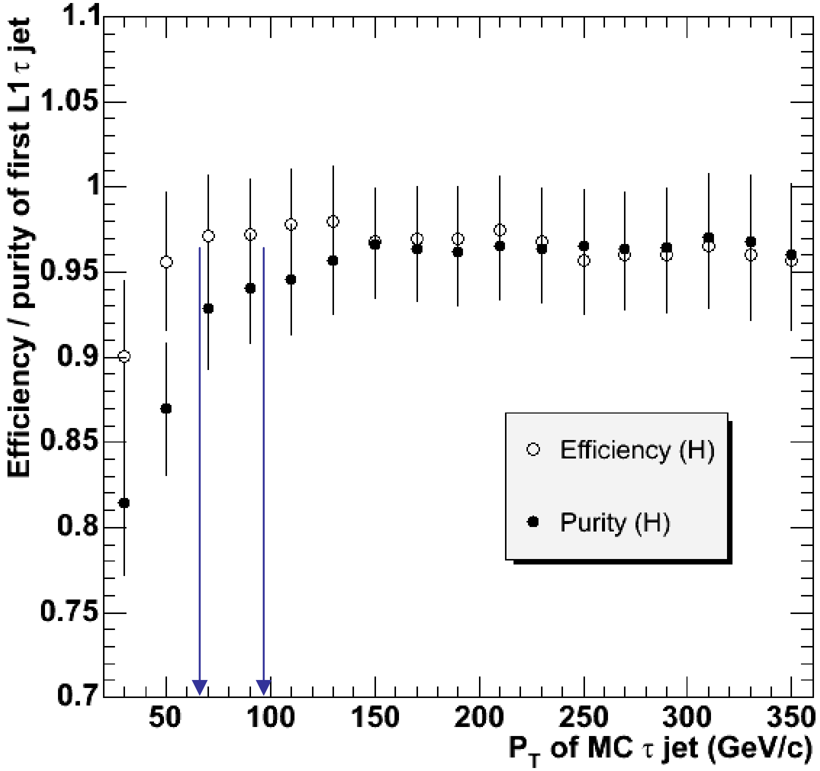


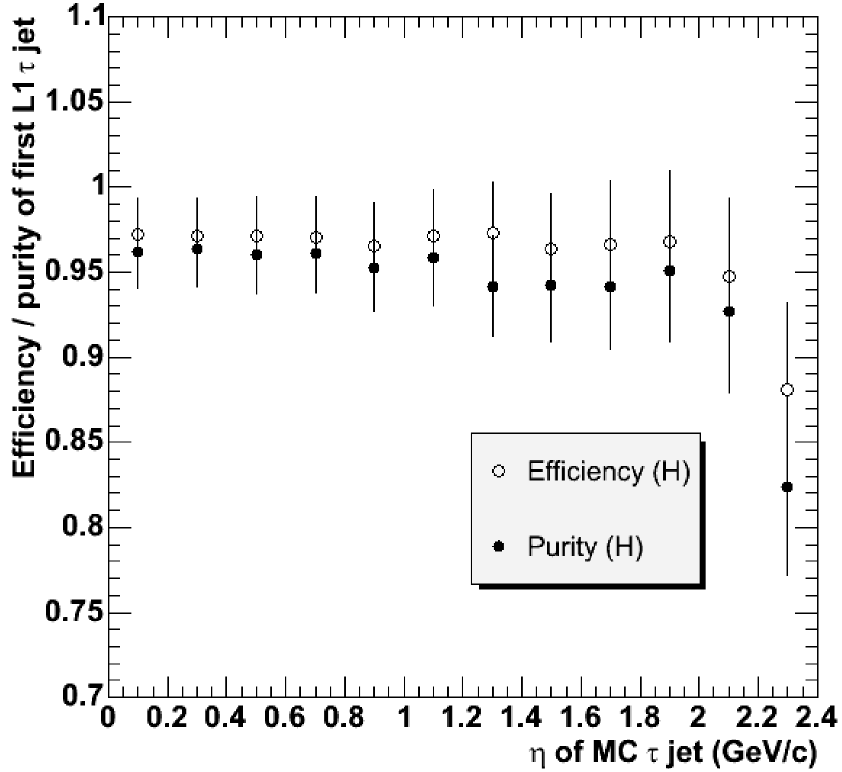
- Now try with MET - bring in additional production mechanism. gg→H.
- May be important at low masses.



L1 τ trigger

- Single or double τ triggering.
- τ jet defined as narrow, isolated standard jet.
- Single τ E_T threshold 93 GeV.
- Double τ E_T threshold 66 GeV.





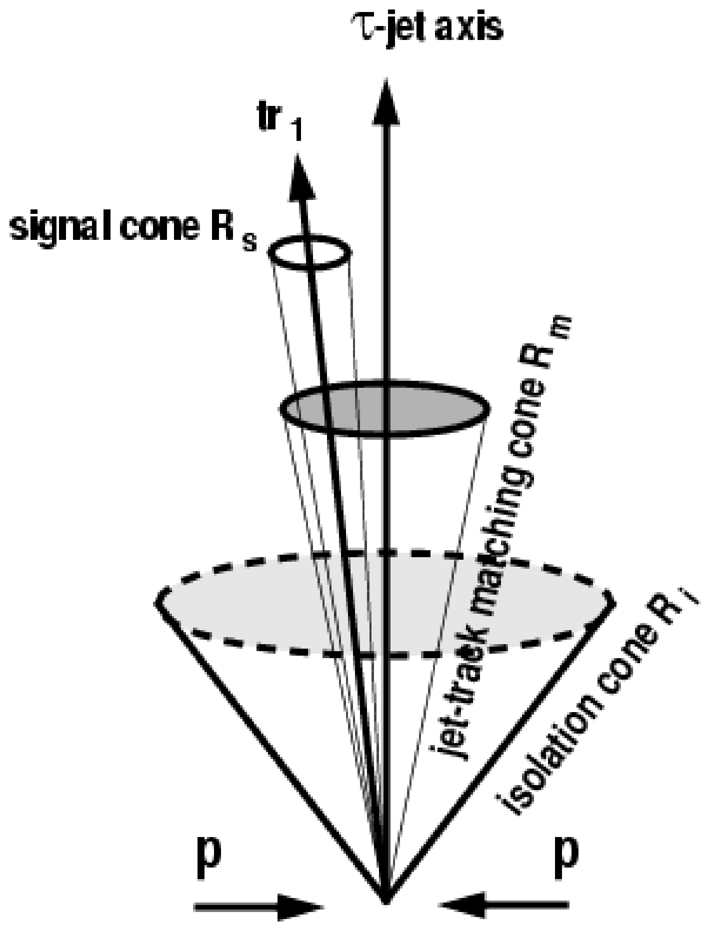
Puritiy defined as $\Delta R(L1 - MC) < 0.4$.

τ tagging methods

- Useful τ properties:
  - 65% hadronic decays.
  - Narrow jets with 1,3,5 charged particles + neutrals.
- 2 main tagging methods
  - Calorimeter and tracker isolation.
- ECAL isolation:
  - Localized / isolated ECAL deposit.

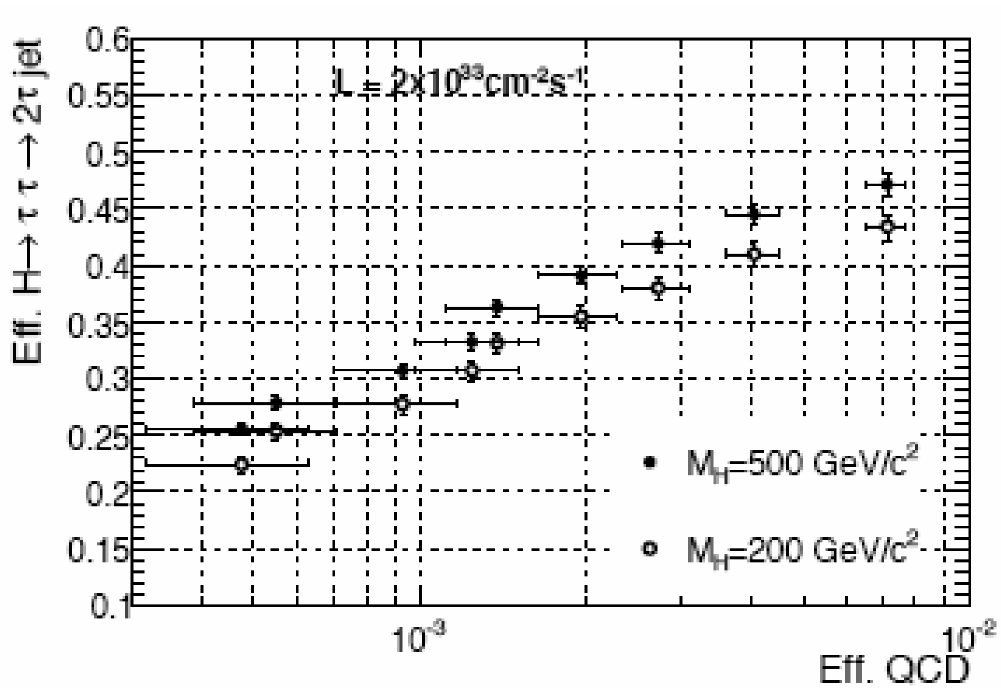
$$P_{isol} = \sum_{\Delta R<0.4} E_T - \sum_{\Delta R<0.13} E_T$$

- Tracker isolation:
  - 1,3,5 charged particles in signal cone.
  - 0 charged particles in isolation cone.



HLT τ tagging

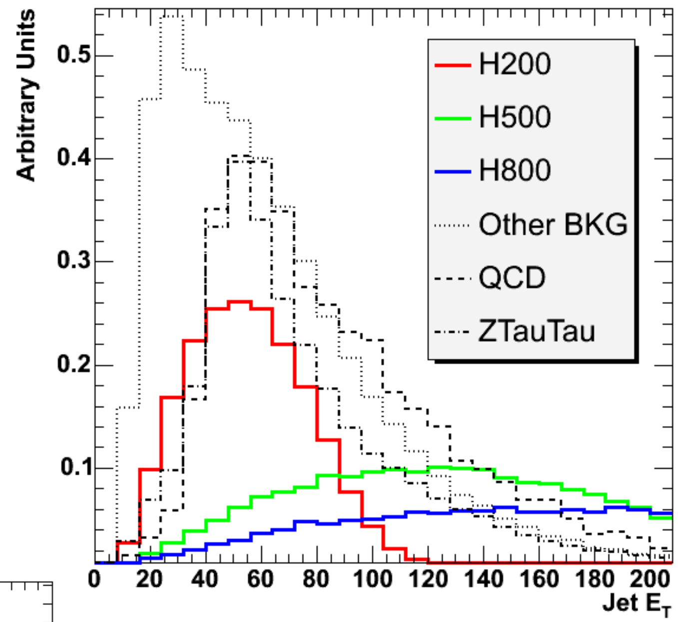
- Combine both methods:
  - First perform ECAL isolation $P_{isol} < 5$ GeV.
  - Tracker isolation using only Pixels (inner tracker layers). No E_T jet threshold.
- Signal $\varepsilon \sim 0.3$ QCD background $\varepsilon \sim 10^{-3}$.

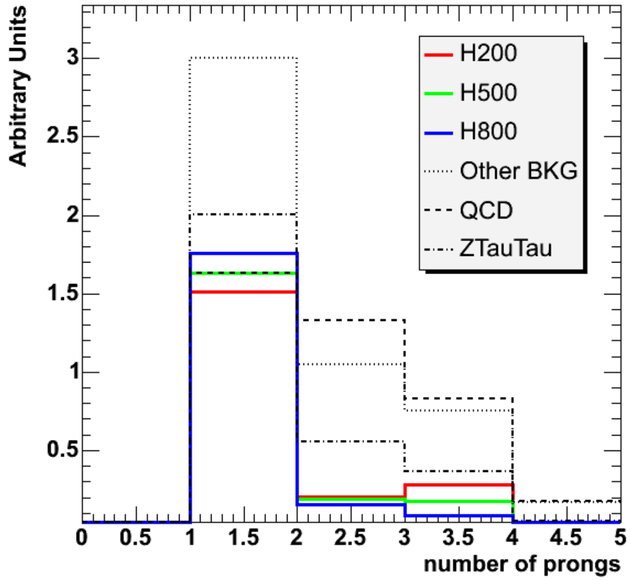


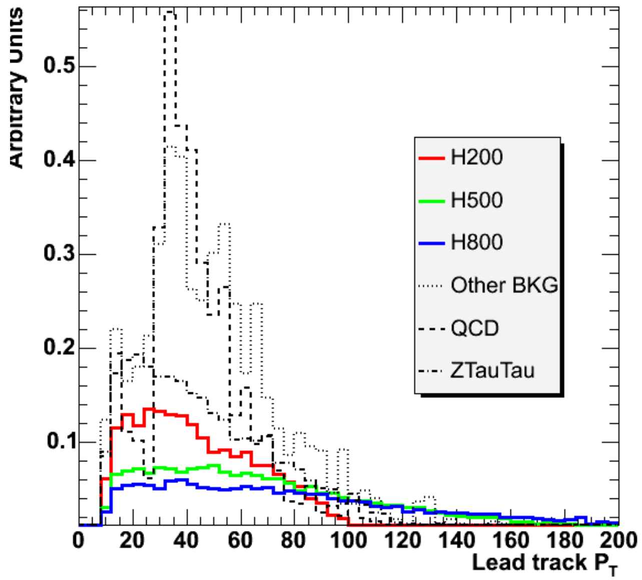
CMS Physics TDR - volume I

Offline selection cuts

- 2 τ jets E_T > 60 GeV.
- Lead track P_T > 35 GeV.
- 1 prong τ decay.
- τ charge correlation.

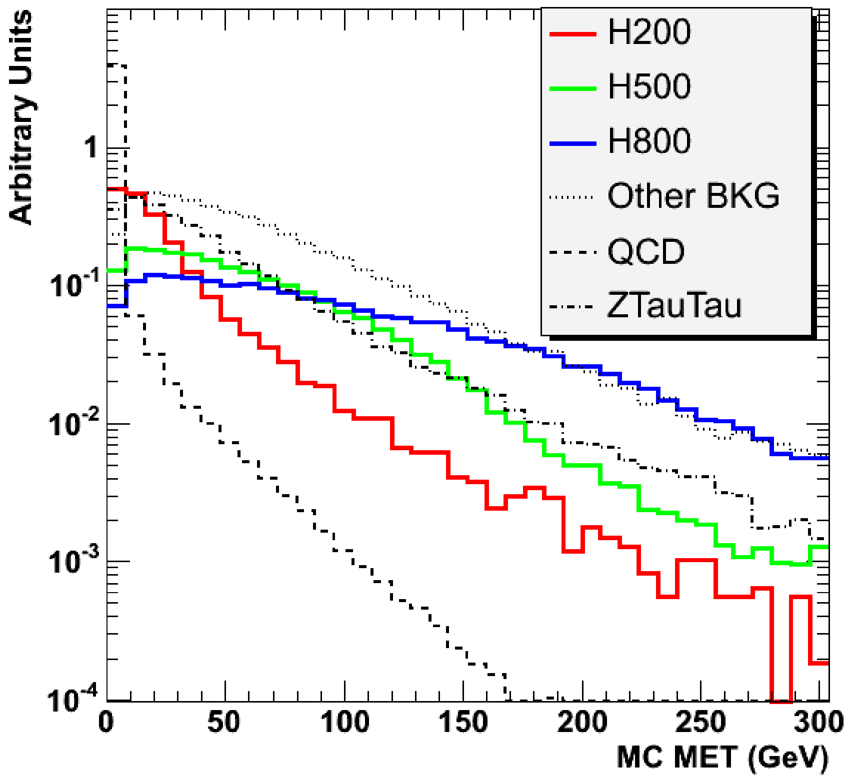


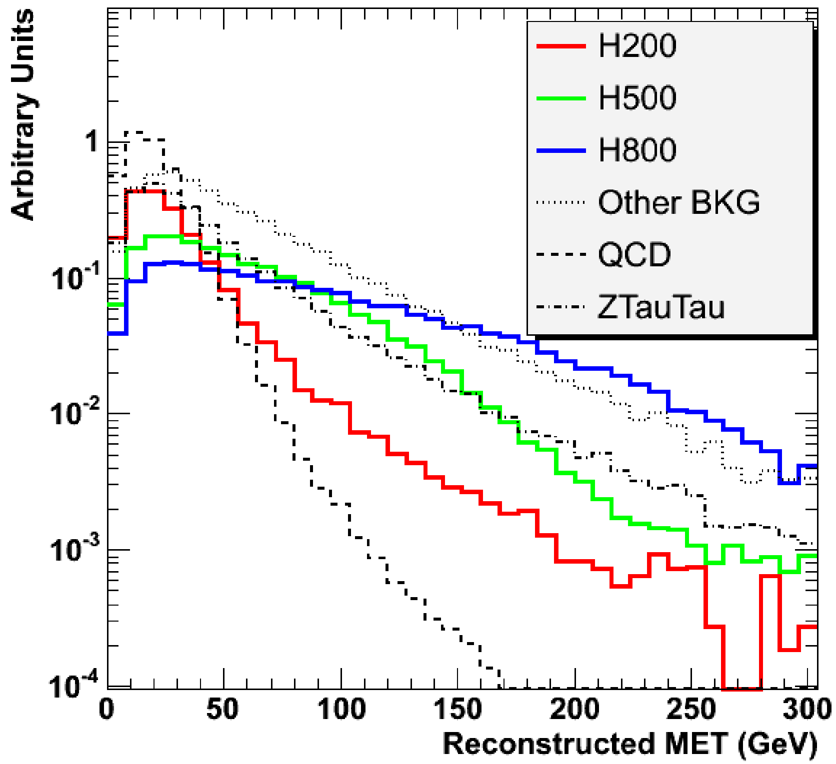




MET I

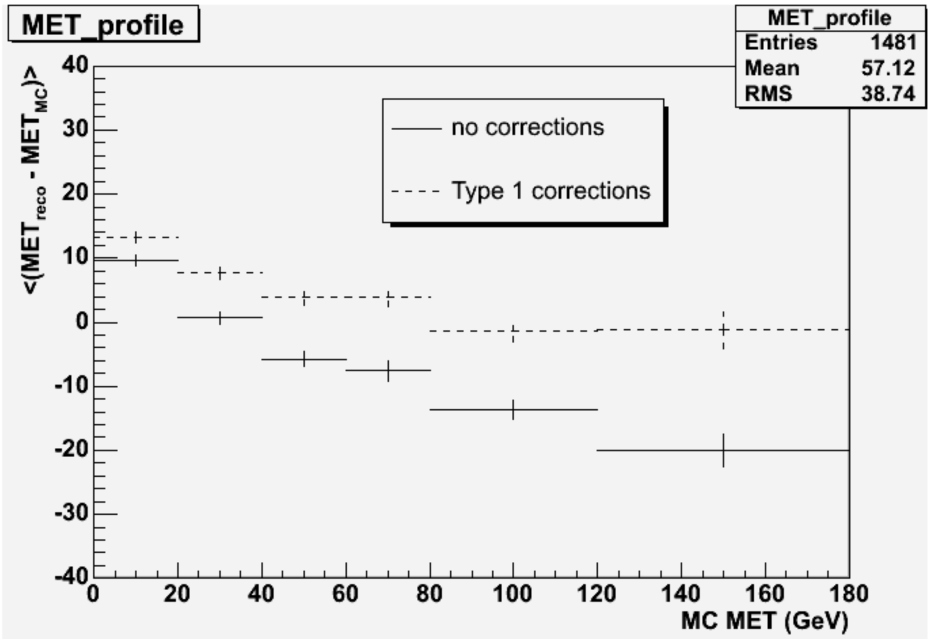
- Is MET a useful cut?
- What about MET resolution?

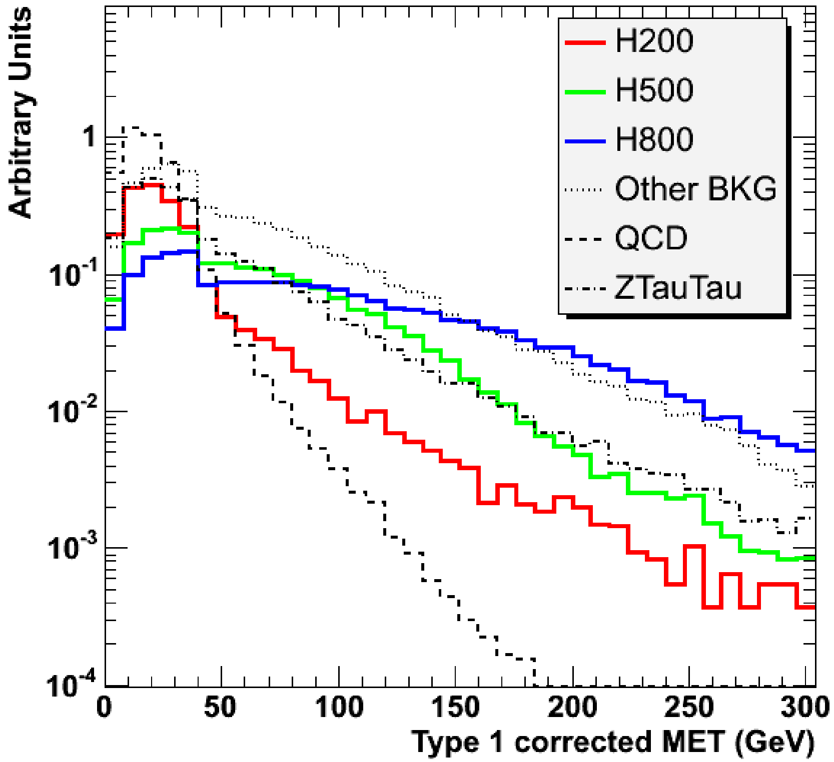




MET II

- Need to correct MET.
  - Replace ECAL + HCAL cluster energy with jet energy.
  - Jet energy calibrated for calorimeter response, magnetic field, particle showers and pile up.
- Set cut to 75 GeV.

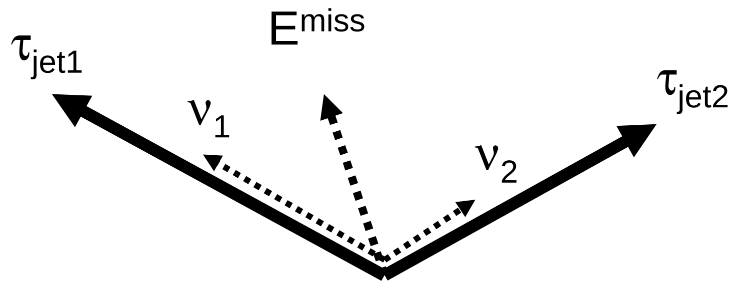




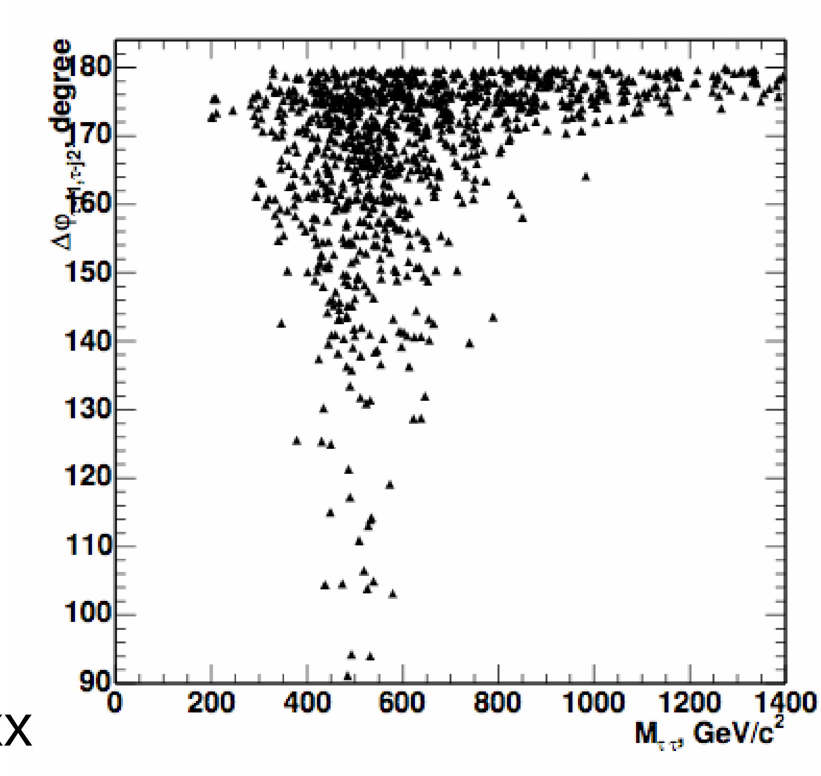
Higgs mass reconstruction

$M_H = [\, 2\, E\tau_1\, E\tau_2 \bullet (1 - \cos\theta_{\tau\tau})\,]^{1/2}$

With $E_\tau = E_{\tau\ jet} + E_\nu$

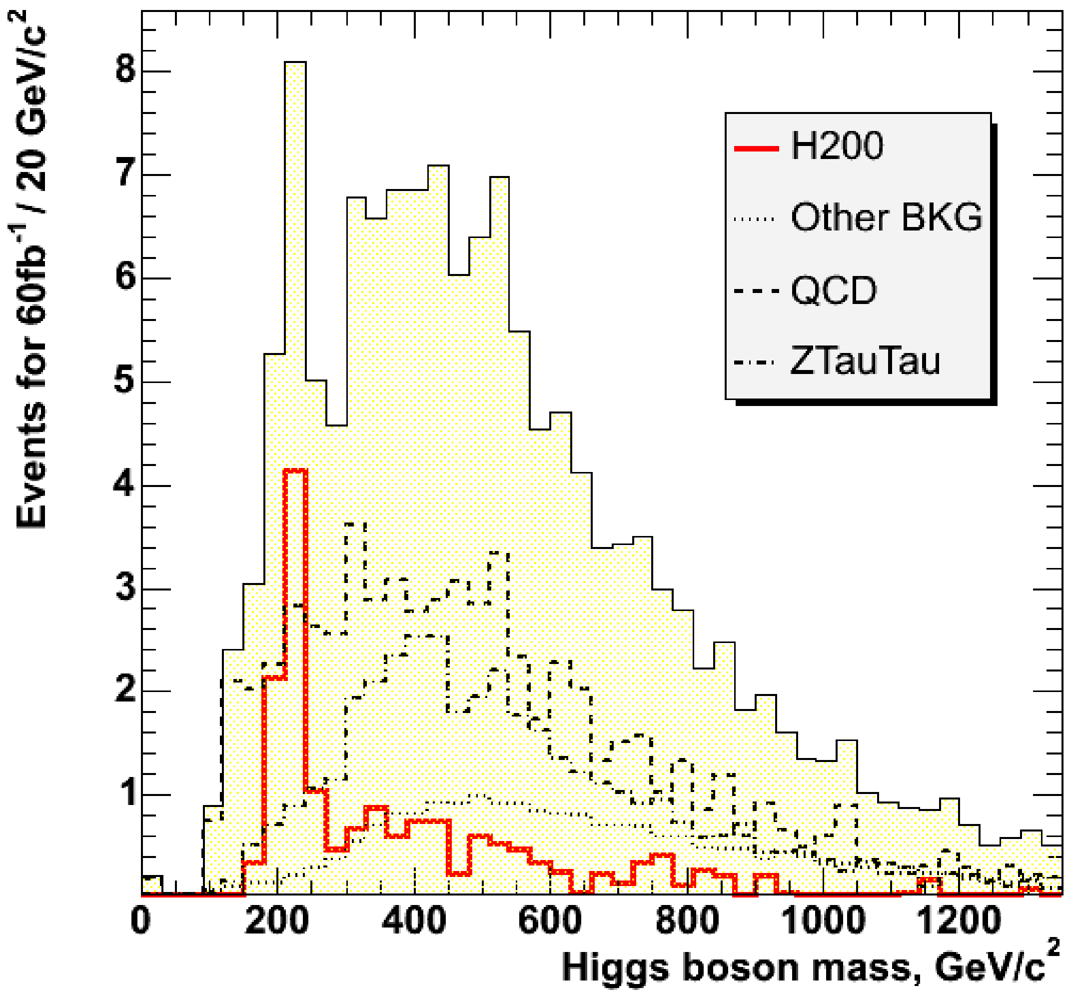


- Assume ν collinear with τ jet, $M_\tau << P_T$.
- Require $E_\nu > 0$. (< 0 from miss-measurement).
- Require non - back to back tau jets. $\phi < 175^o$



CMS NOTE 2006/xx

Higgs mass



Events for 60fb^{-1} / 20 GeV/c^2
8
7
6
5
4
3
2
1
0
200
400
600
800
1000
1200
Higgs boson mass, GeV/c^2
H200
Other BKG
QCD
ZTauTau

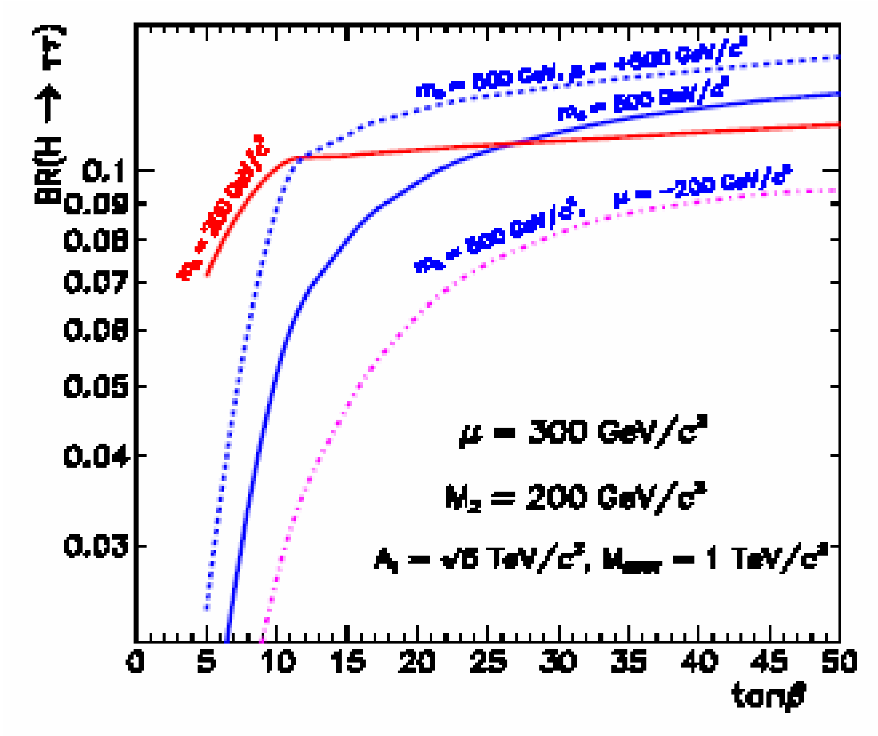
Conclusion and status

- Replacing b-tagging with a MET cut in this channel does give a detectable signal.
- Still to do:
  - Investigate higher mass regions.
  - Optimise cuts.
  - Compare this study with previous b-tagging ones.
  - Systematics etc…

Backup slides

Bkg. samples	σ Br, (fb)	L_{gen} (fb^{-1})	pyth. pres. ε_{kine}	Digi, DST
qcd, p_T = 50-80 GeV/c	2.08×10^{10}	0.020	2.44×10^{-4}	100K
qcd, p_T = 80-120 GeV/c	2.94×10^{9}	0.012	5.77×10^{-3}	200K
qcd, p_T = 120-170 GeV/c	5.03×10^{8}	0.009	4.19×10^{-2}	200K
qcd, p_T > 170 GeV/c	1.33×10^{8}	0.008	2.12×10^{-1}	1000K
tt, W->$\tau\nu$	5.76×10^{3}	285	4.88×10^{-2}	80K
Wt, W->$\tau\nu$	7.10×10^{2}	3053	1.38×10^{-2}	30K
W+j, W->$\tau\nu$	5.74×10^{5}	32	2.16×10^{-2}	400K
Z/γ*->$\tau\tau$, 80<$m_{\tau\tau}$< 130 GeV	1.57×10^{6}	4.3	1.90×10^{-2}	128K
Z/γ*->$\tau\tau$, 130<$m_{\tau\tau}$<300 GeV	1.24×10^{4}	59	9.53×10^{-2}	70K
Z/γ*->$\tau\tau$, $m_{\tau\tau}$ > 300 GeV	6.22×10^{2}	299	3.23×10^{-1}	60K
$\tau\tau$bb, 60<$m_{\tau\tau}$< 100 GeV	2.61×10^{4}	11	1	290K
$\tau\tau$bb, $m_{\tau\tau}$ > 100 GeV	1.05×10^{3}	95	1	100K

τ branching ratio



Cut table gg->bbH (200GeV)

Three group of cuts: GROUP1, GROUP2 and GROUP3.
GROUP2 and GROUP3 are not correlated cuts and applied independently after GROUP1.

GROUP1 cuts : L1 trigger plus L2 and off-line calo reconstruction + E_T cut	
L1 trigger	0.500
Two L2 calo jets exist with $\Delta R_{JJ} > 0.2$	0.981
E_T of each off-line calo τ-jet > 60 GeV	0. 208
GROUP2 cuts: τ-jet identification at HLT and off-line	
HLT Calo+Pxl trigger	0.334
two off-line τ-candidates	0.668
Cut on $p_T^{ltr} > 35$ GeV	0.595
Tracker isolation	0.868
Both 1 prong decays	0.534
Charge correlation	0.970

Cut table gg->bbH (200GeV)

GROUP3: the rest of the event + $M\tau\tau$ reco and mass window	
MET > 75 GeV	0.03
+ve E neutrinos	0.492
Df < 175^{o}	0.926
OVERALL	
GROUP 1	0.099
GROUP 2	0.060
GROUP 3	0.014
TOTAL	0.82×10^{-5}
Expected events fpr 60fb^{-1}	12.0

Cut table QCD > 170 GeV

GROUP1 cuts : L1 trigger plus L2 and off-line calo reconstruction + E_T cut	
L1 trigger	0.562
Two L2 calo jets exist with $\Delta R_{JJ} > 0.2$	0.967
E_T of each off-line calo τ-jet > 60 GeV	0.716
GROUP2 cuts: τ-jet identification at HLT and off-line	
HLT Calo+Pxl trigger	0.0007
two off-line τ-candidates	0.867
Cut on $p_T^{ltr} > 35$ GeV	0.730
Tracker isolation	0.240
Both 1 prong decays	0.050
Charge correlation	1 (only 2 events)

Cut table QCD > 170 GeV

GROUP3: the rest of the event + $M\tau\tau$ reco and mass window	
MET > 75 GeV	0.030
+ve E neutrinos	0.554
Df < 175^{o}	0.822
OVERALL	
GROUP 1	0.379
GROUP 2	5.36×10^{-6}
GROUP 3	0.016
TOTAL	3.3×10^{-8}
Expected events fpr 60fb^{-1}	50.4