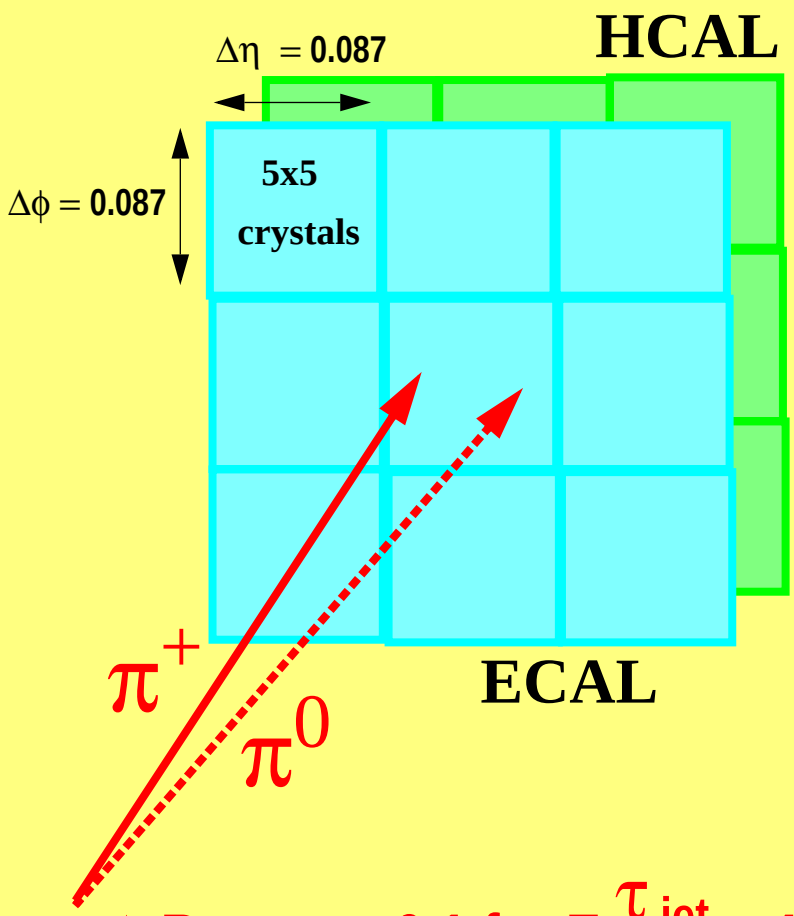
S. Lehti (HIP), S. Ilyin (MSU), A. Nikitenko (HIP)

Study of the light Higgs in qq->qqH, H->ττ (e/μ+τ jet, e+μ)

- estimates at low luminosity
- high luminosity aspects
  - triggering
  - false jets from pile-up
  - mass resolution degradation
  - soft (~20 GeV) jet reconstruction



Branching ratios of τ->hadrons

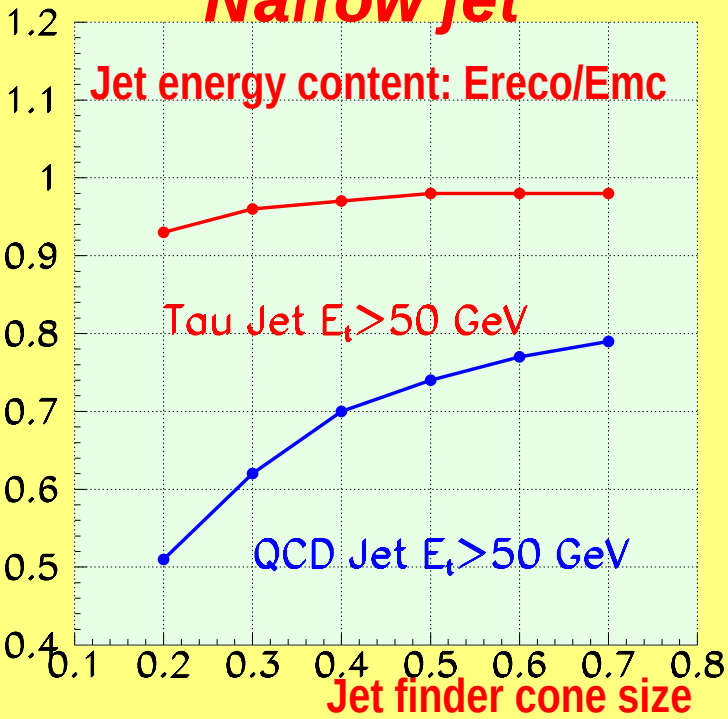
- Br(τ->hadr) = 0.65
- Br(1 pr + X /τ->hadr) = 0.78
- Br(1 pr + nπ^0 /τ->hadr) = 0.76

$\Delta R_{\pi^+\pi^0} < 0.1$ for $E_t^{\tau\ jet} > 40$ GeV

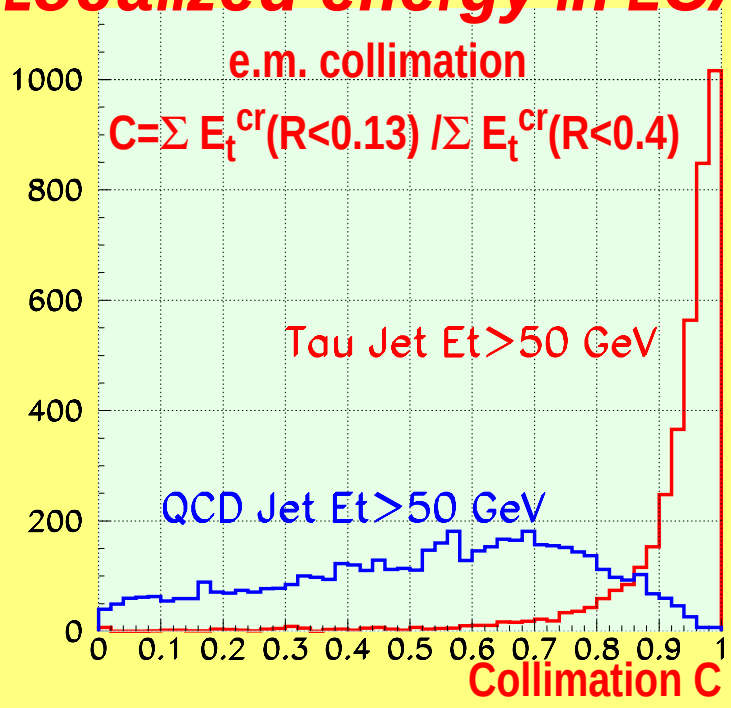
Off-line τ -jet identification at low luminosity for H-> $\tau\tau$ search

C A L O R I M E T R Y

Narrow jet



Localized energy in ECAL



T R A C K E R

One high Pt track matches Calo Jet

Physics Performance of τ -jet Selections

1. electromagnetic collimation: $C = \Sigma E_t^{cryst}(R<0.13) / \Sigma E_t^{cryst}(R<0.4) > r_{cut}$

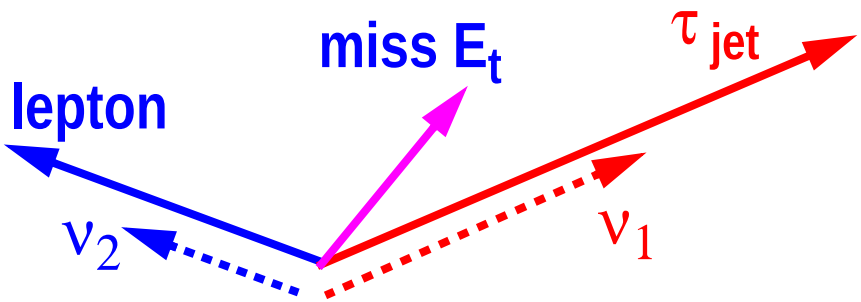
2. calorimeter (ecal+hcal) isolation : max $E_t^{ecal+hcal\ cell}(0.13<R<0.40) < E_t^{cut}$

3. one p_t^{hadr} > 10 GeV, no tracks p_t> 2 GeV in cone 0.4 around jet direction

	em.collimation	em. collimation, ecal+hcal isolation	em. collimation, ecal+hcalisolation, tracker selections
H->$\tau\tau$, M_H=140 GeV	52.1 %	43.0 %	32.0 %
W+jet background	4.1×10^{-2}	2.2×10^{-2}	1.9×10^{-3}
bb jets background	5.5×10^{-3}	2.5×10^{-3}	$< 0.9 \times 10^{-3}$

H->ττ mass reconstruction. Resolution at low luminosity

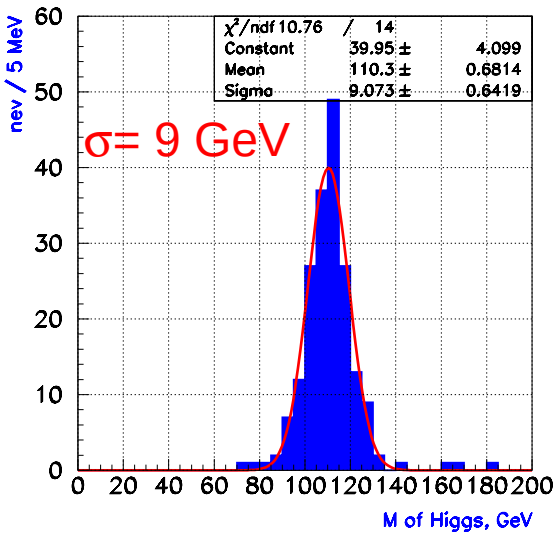
Reconstruction assumes m_τ=0 and uses missE$_t$ measurement



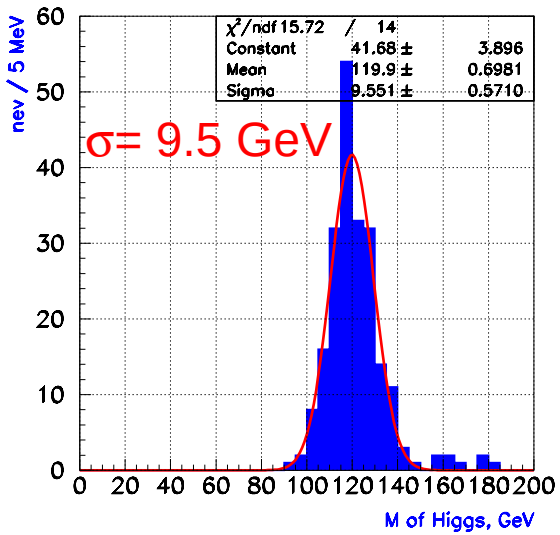
$$E_{\nu 1}\, x_1 + E_{\nu 2}\, x_2 = \text{missE}_t^{\,x}$$

$$E_{\nu 1}\, y_1 + E_{\nu 2}\, y_2 = \text{missE}_t^{\,y}$$

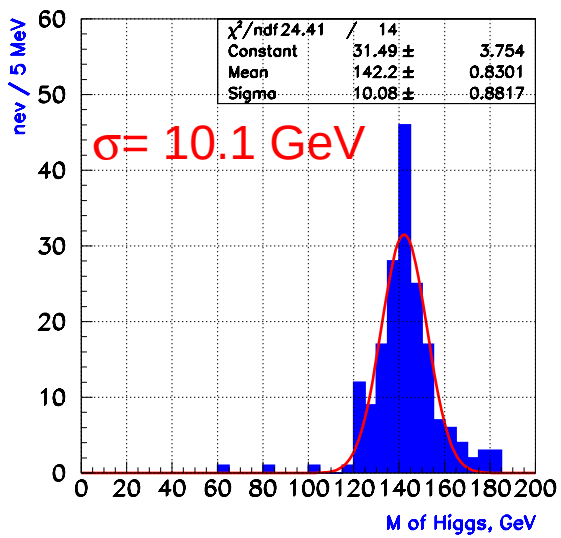
110 GeV



120 GeV

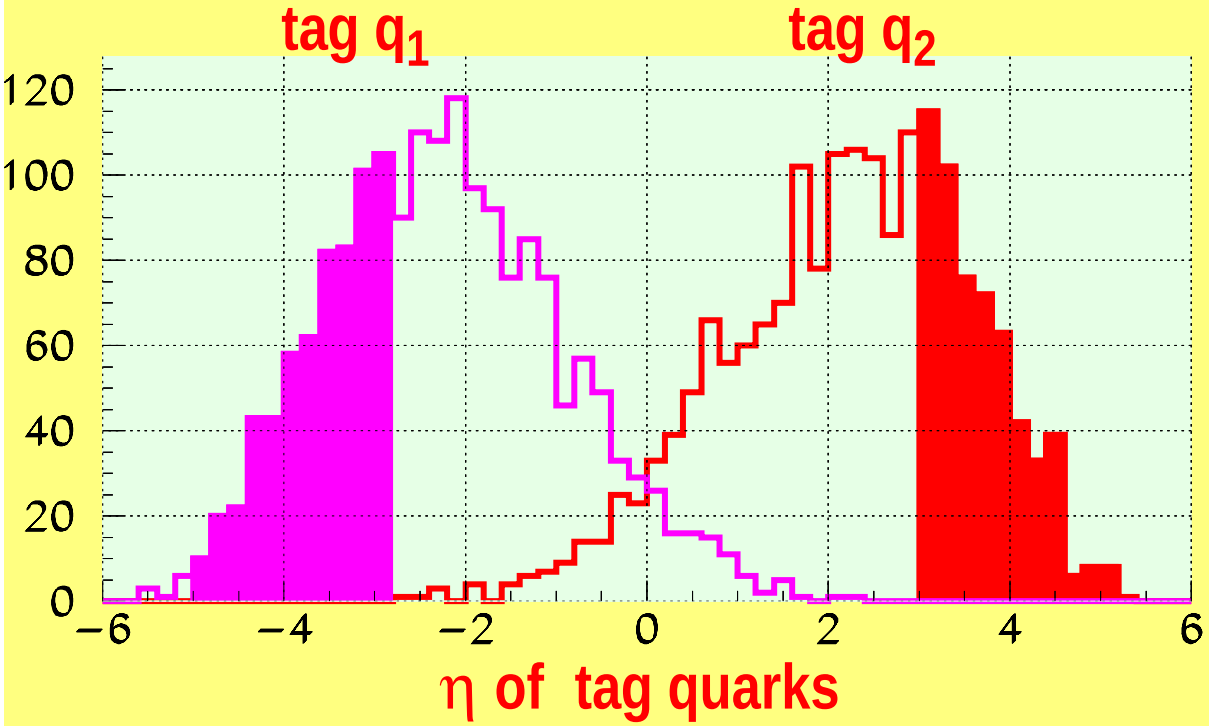


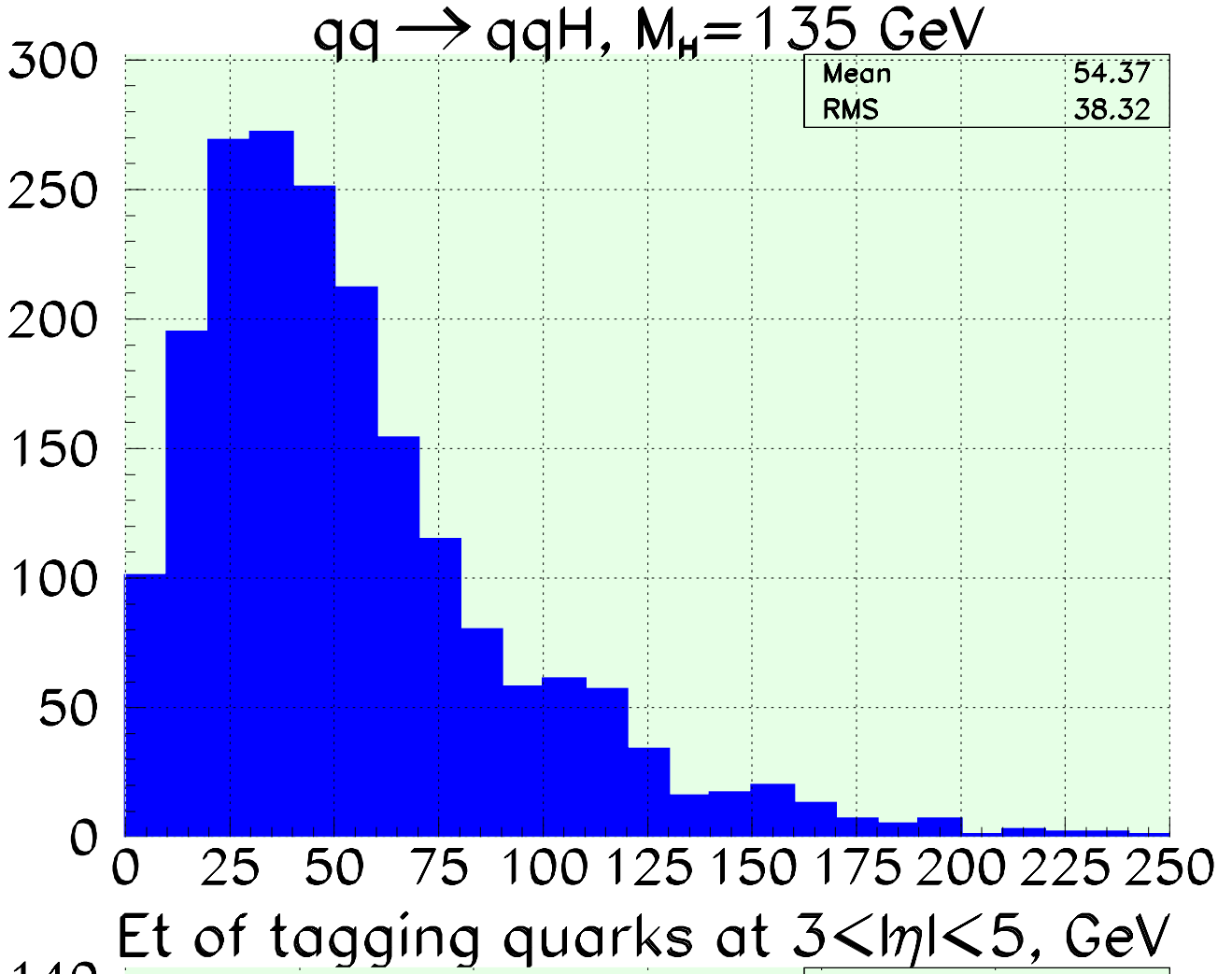
140 GeV

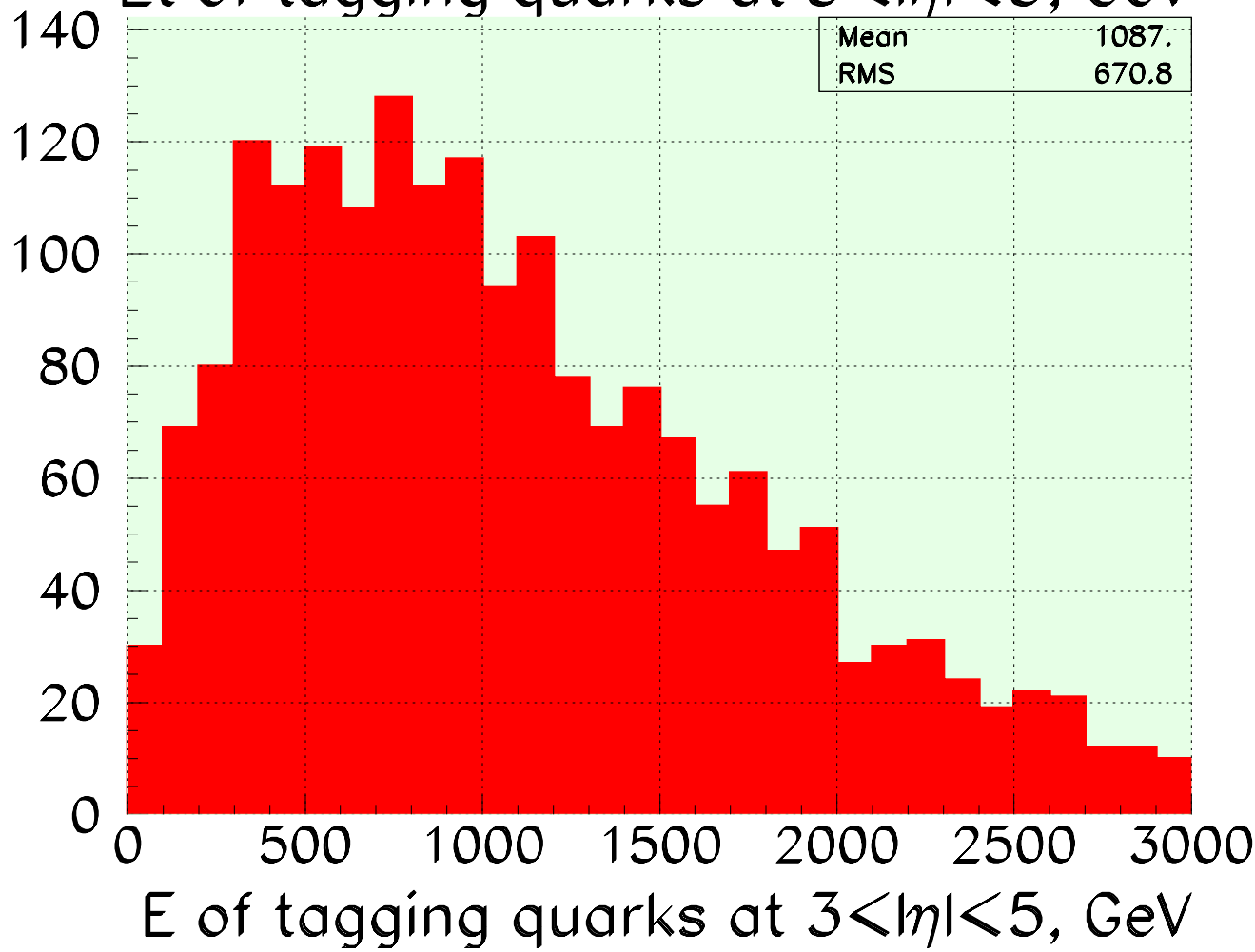


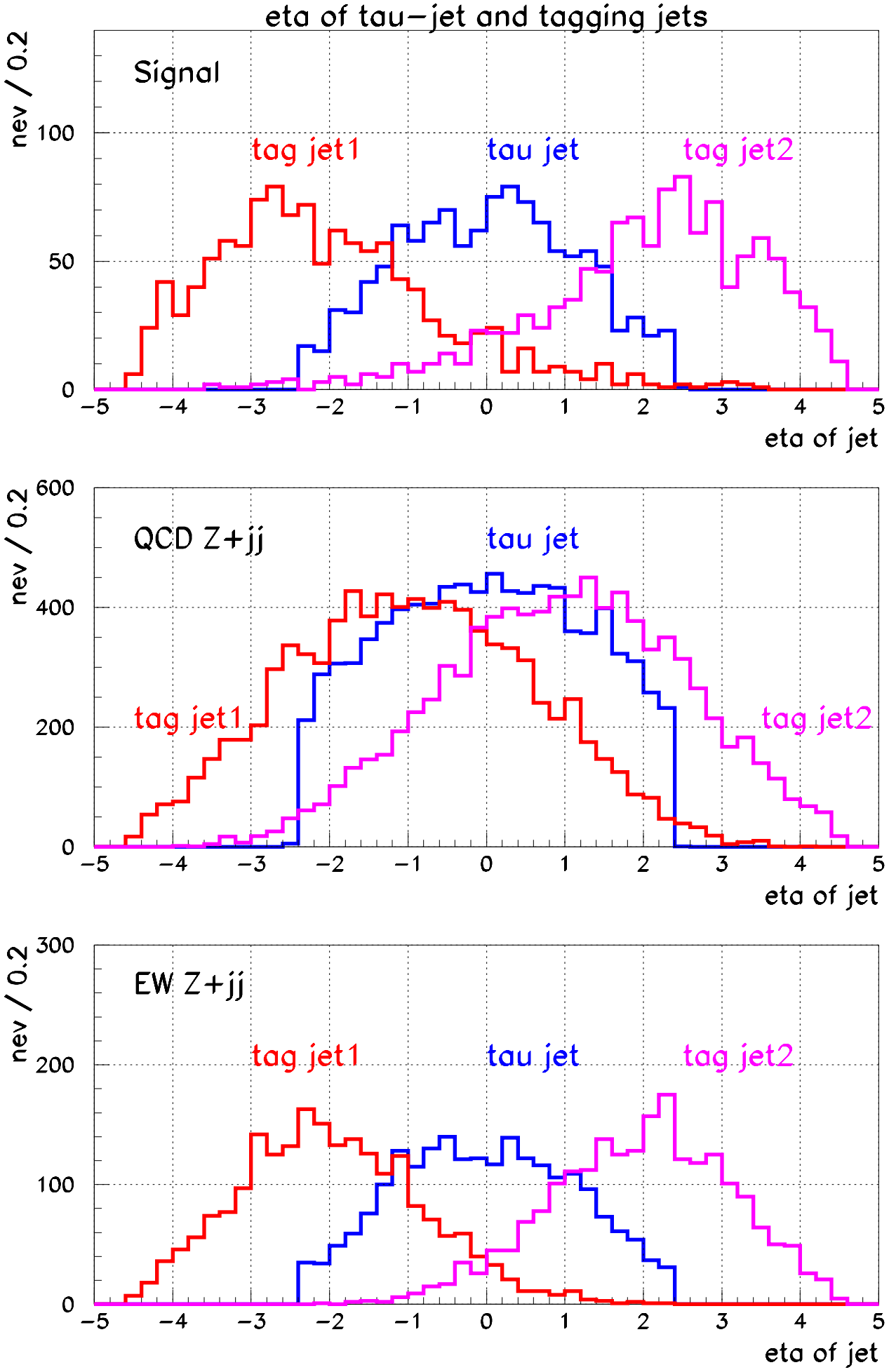
HF acceptance for tagging quarks from qq->qqH, H -> $\tau\tau$. M_H = 135 GeV

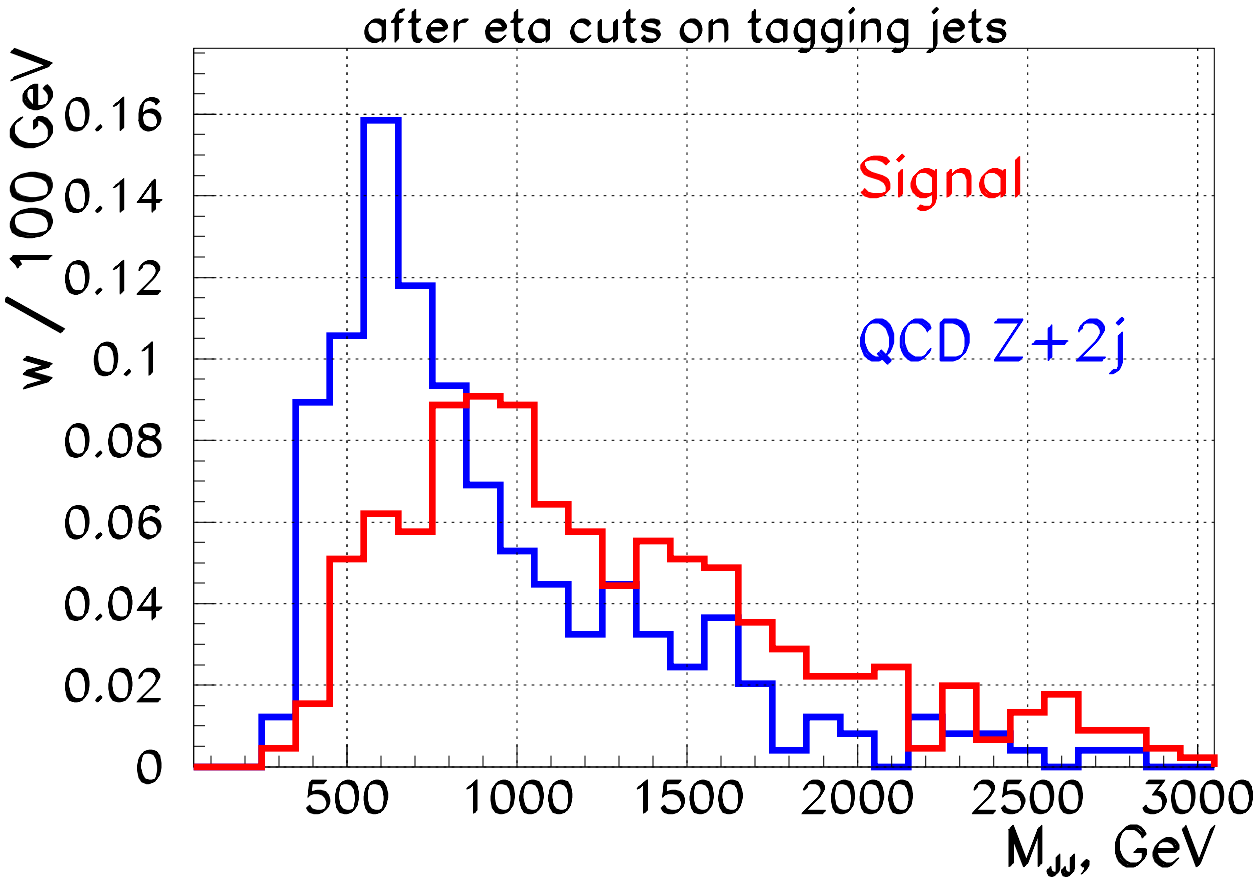
HF acceptance for tagging quarks of E_t^q > 30 GeV		
no q	1 q	2 q's
0.47	0.46	0.07

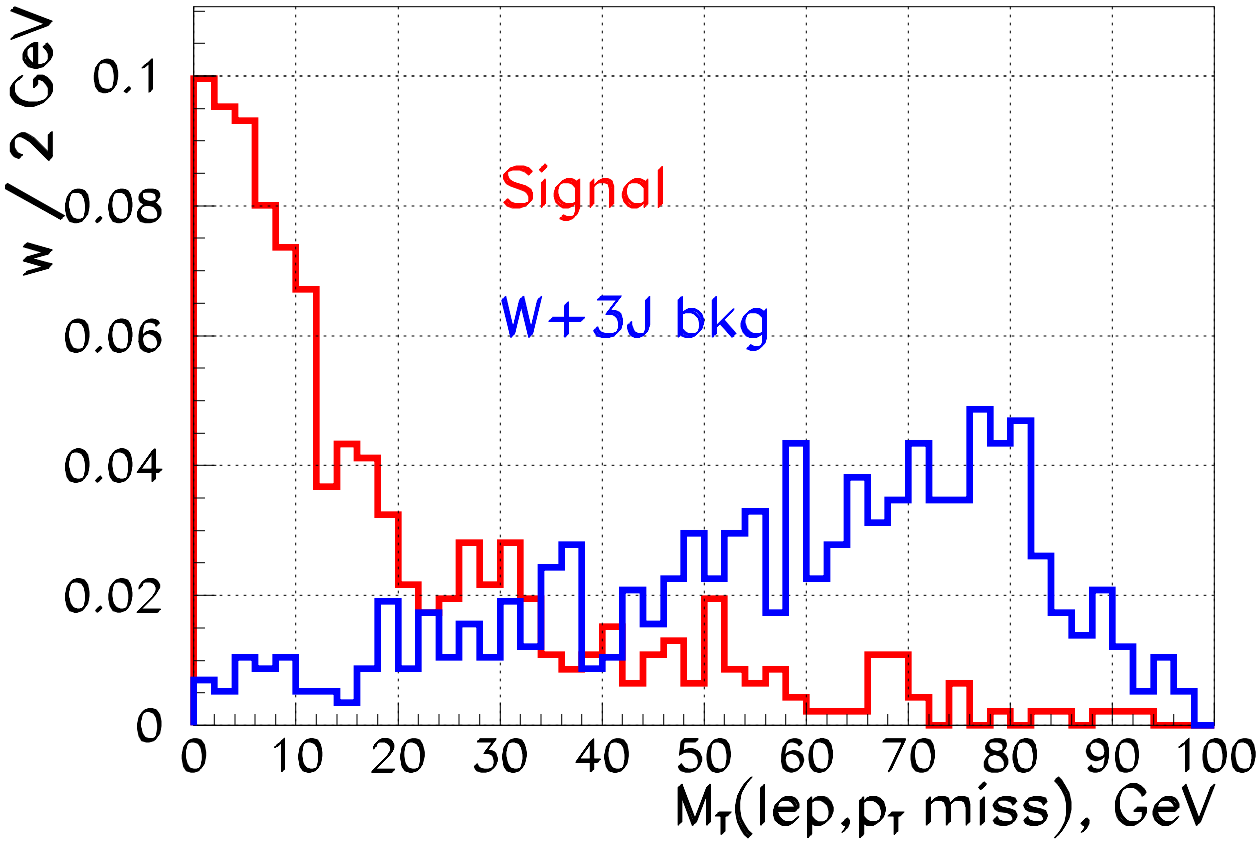


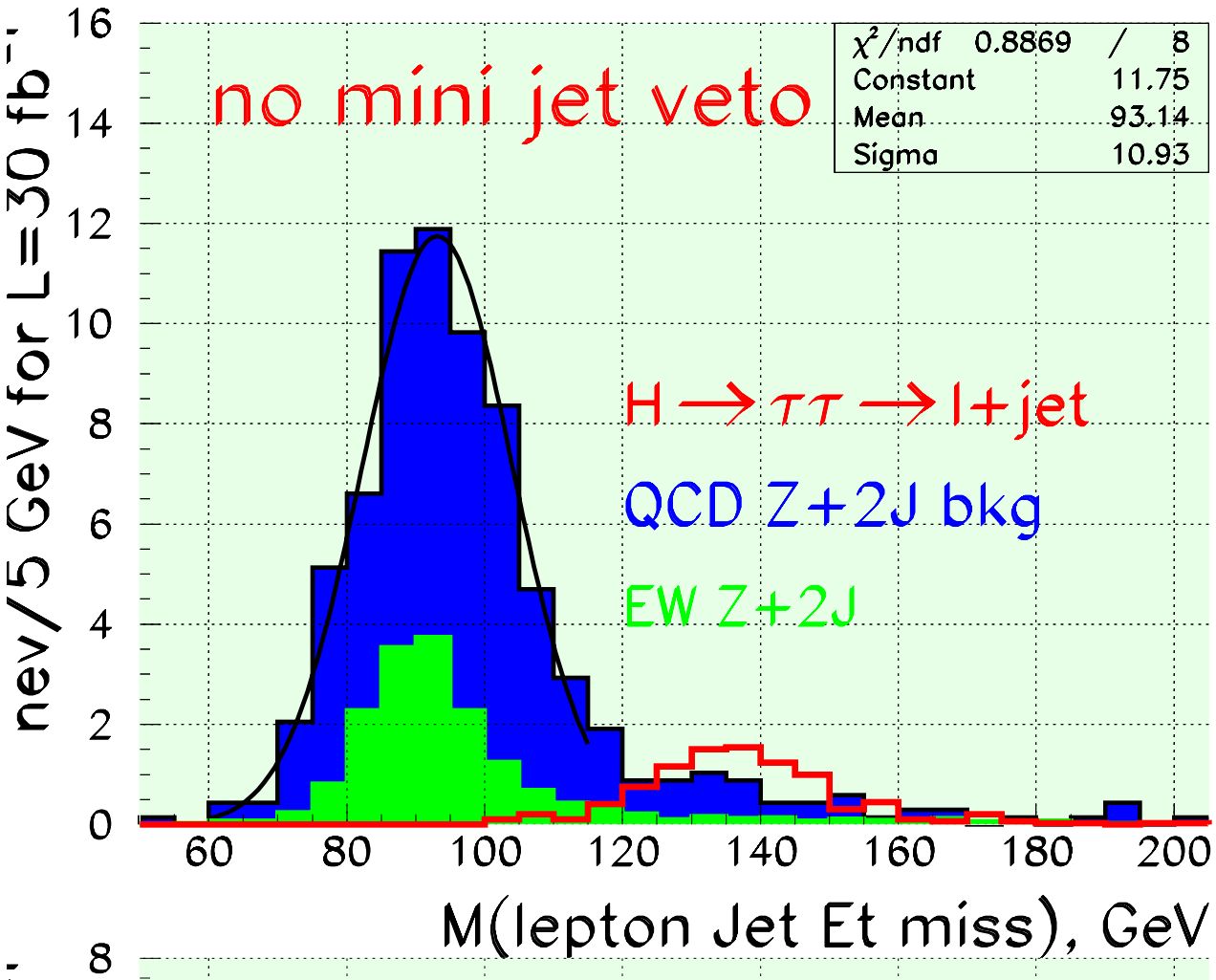

qq → qqH, M_H=135 GeV
Mean 54.37
RMS 38.32
300
250
200
150
100
50
0
0 25 50 75 100 125 150 175 200 225 250
Et of tagging quarks at 3<|η|<5, GeV

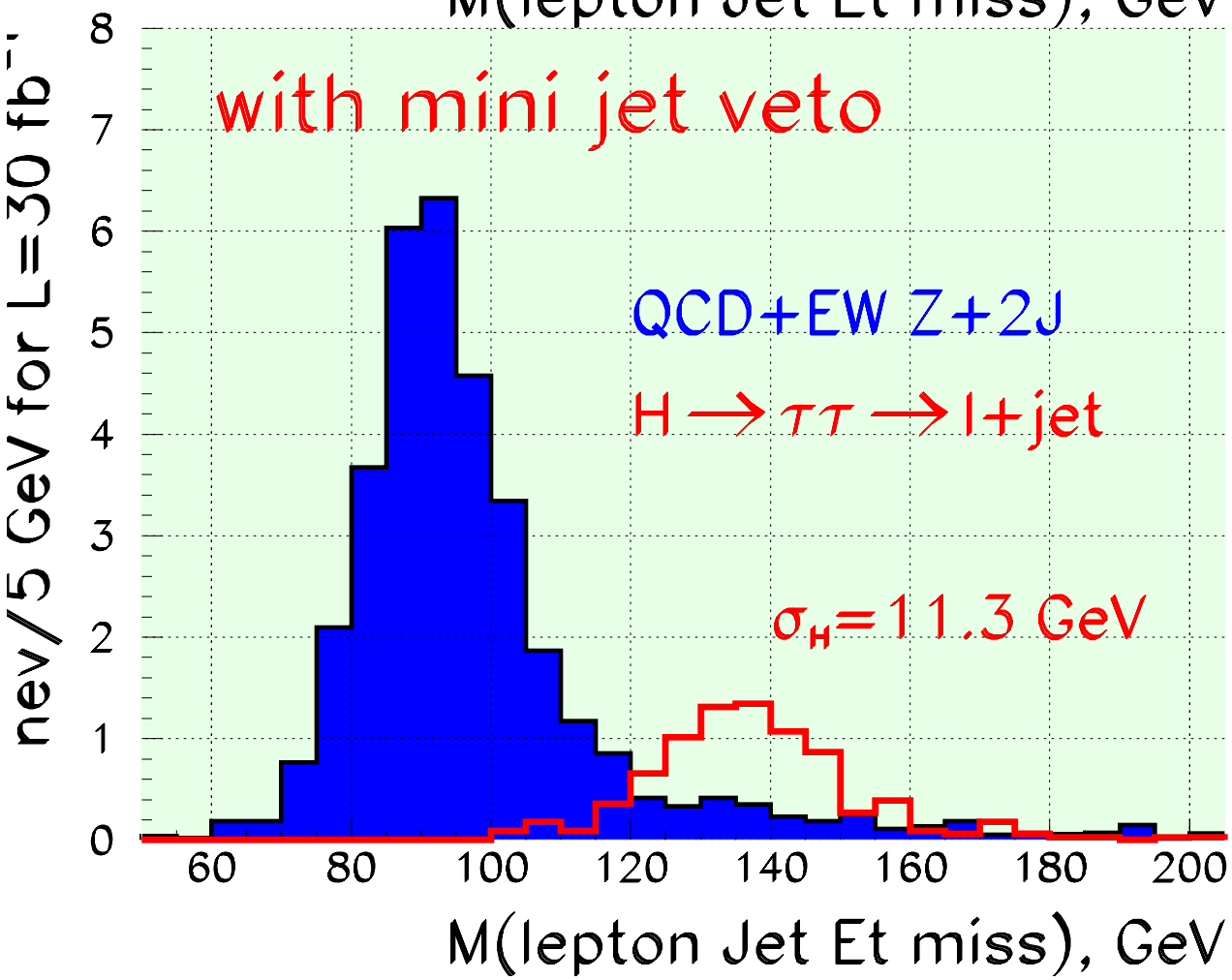

Mean 1087.
RMS 670.8
140
120
100
80
60
40
20
0
0 500 1000 1500 2000 2500 3000
E of tagging quarks at 3<|η|<5, GeV


eta of tau−jet and tagging jets
Signal
tag jet1
tau jet
tag jet2
nev / 0.2
eta of jet
QCD Z+jj
tau jet
tag jet1
tag jet2
nev / 0.2
eta of jet
EW Z+jj
tag jet1
tau jet
tag jet2
nev / 0.2
eta of jet


after eta cuts on tagging jets
w / 100 GeV
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Signal
QCD Z+2j
500
1000
1500
2000
2500
3000
M_{JJ}, GeV


w / 2 GeV
0.1
0.08
0.06
0.04
0.02
0
Signal
W+3J bkg
0
10
20
30
40
50
60
70
80
90
100
M_T(lep,p_T miss), GeV


no mini jet veto
χ^2/ndf 0.8869 / 8
Constant 11.75
Mean 93.14
Sigma 10.93
$H \rightarrow \tau\tau \rightarrow l+jet$
QCD Z+2J bkg
EW Z+2J
nev/5 GeV for L=30 fb^{-1}
M(lepton Jet Et miss), GeV


with mini jet veto
QCD+EW Z+2J
$H \rightarrow \tau\tau \rightarrow l+jet$
σ_H=11.3 GeV
nev/5 GeV for L=30 fb^{-1}
M(lepton Jet Et miss), GeV

y

data for M_H=135 GeV	H->ττ->lj	QCD Z+2j*	EW Z+2j**	W+3j*	bb+2j
cross-sect, pb	3.81	11130	10.4	24667	
br H,Z->ττ, W->(e+μ)ν	0.045	0.0336	0.0336	0.21	
p_t^l>15 GeV, |η|<2.4 $p_t^{\tau\text{-}j}$>30 GeV, |η|<2.4	0.275	0.06	0.20	0.616	
tracker lepton isolation	0.90	0.86	0.93	0.88	
calo lepton isolation	0.91	0.84	0.94	0.91	
>=3 jets, E_t>30 GeV, |η|<4.5	0.51	0.25	0.80	0.04	
τ-jet association(mc)	0.92	0.84	0.82	-	
$\eta_{j\,min}+0.7<\eta_{l,\tau\text{-}j}<\eta_{j\,max}-0.7$ $\eta_{j\,min}\,\eta_{j\,max} < 0$	0.57	0.08	0.55	0.20	
$\|\eta_{j\,max}-\eta_{j\,max}\| > 4.4$	0.70	0.33	0.51	0.48	
M_{JJ} > 1 TeV	0.59	0.32	0.71	0.34	
$m_t(l,p_t^{miss}) < 30$ GeV	0.77	0.83	0.84	0.16	
$0<x_{\tau l}<0.75$, $0<x_{\tau h}<1$	0.63	0.56	0.61	0.37	
M_H window 30 GeV	0.74	0.06	0.05	0.05	
P_{surv} mini jet veto by D.Z.	0.87	0.28	0.80	0.28	0.28
N event for 30 fb^{-1}	6.3+-0.4	1.26+-0.22	0.64+-0.03	0.14+-0.05	-
D.Z. estimates	6.2	1.1			

* qcd Z/W+J - pythia5.7, cteq4l, p_t>30 GeV

** EW Z+2J - generated by S.Ilyin with comhep, cteq4m, E_t^J>20 GeV, |η| < 5, M_Z>80 GeV, M_{JJ}>500 GeV

eff. of tau-id = 0.32, tau missidentification = 0.0019

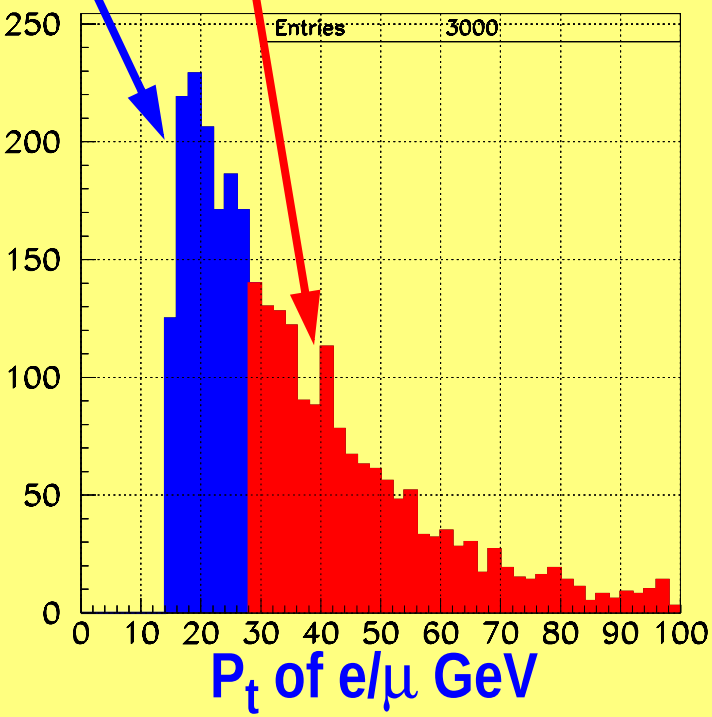
How to trigger on qq->qqH, H->ττ->e+τ-jet at L1 ?

off-line cuts : $E_t^{e/\mu}$ > 15 GeV, $E_t^{\tau jet}$ > 30 GeV, $E_t^{tag.jets}$ > 30 GeV

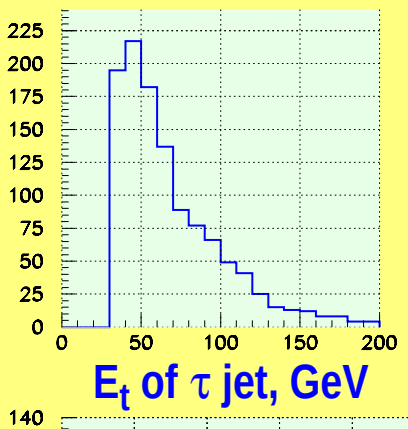
Lepton + 3 jets : kinematics for M_H=135 GeV

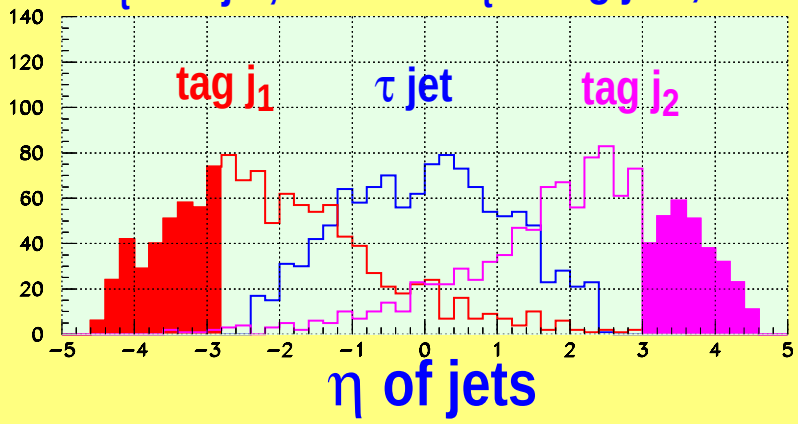
~ 45 % low E_t^e events for L1 e+2(3) jet ?

~ 55 % events for L1 e E_t> 25 GeV



τ-jet + tag jets kinematics



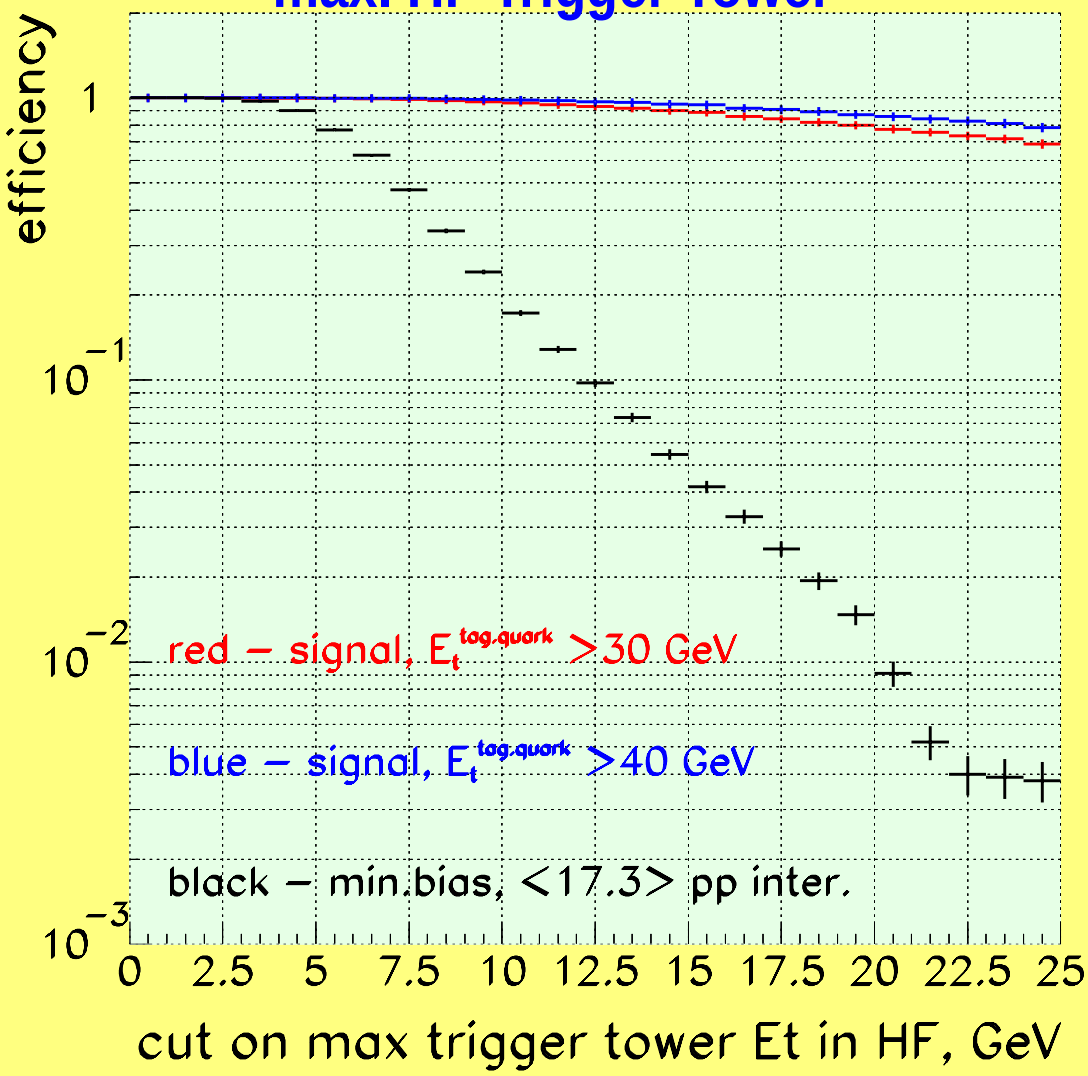


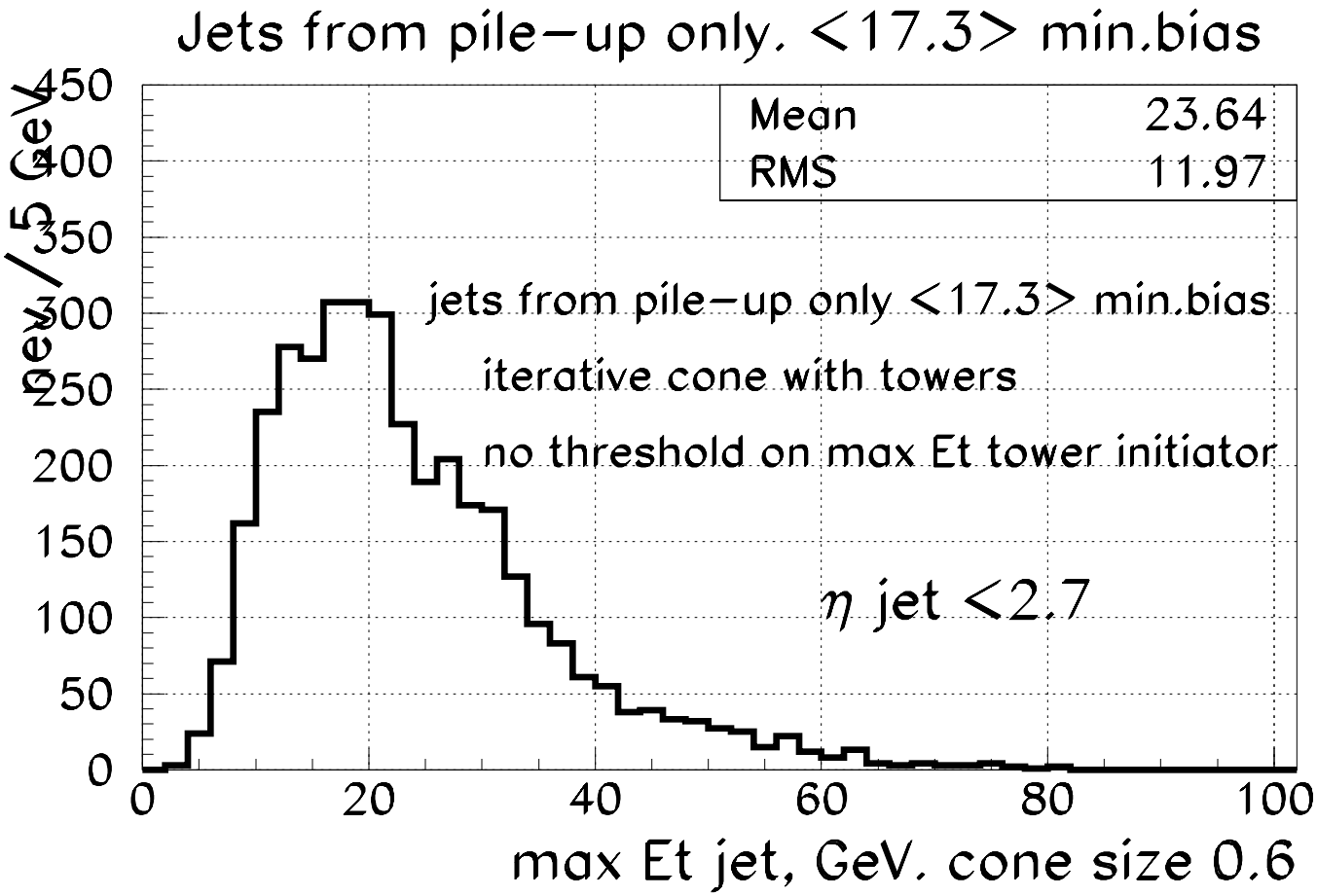
Recognition of tagging jets from qq->qqH, M_H=135 GeV in HF with HF Trigger Tower

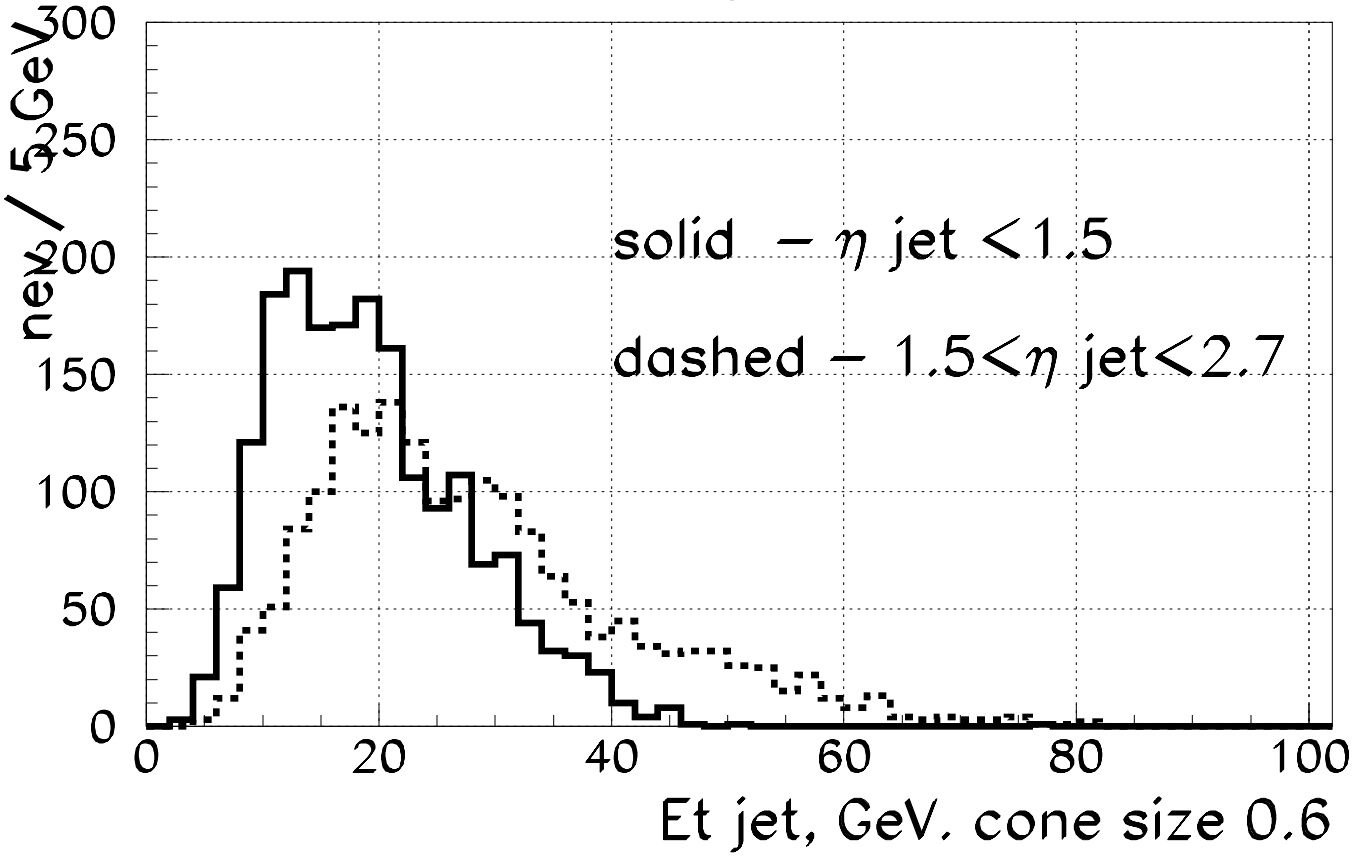
Trigger tower is taken as:

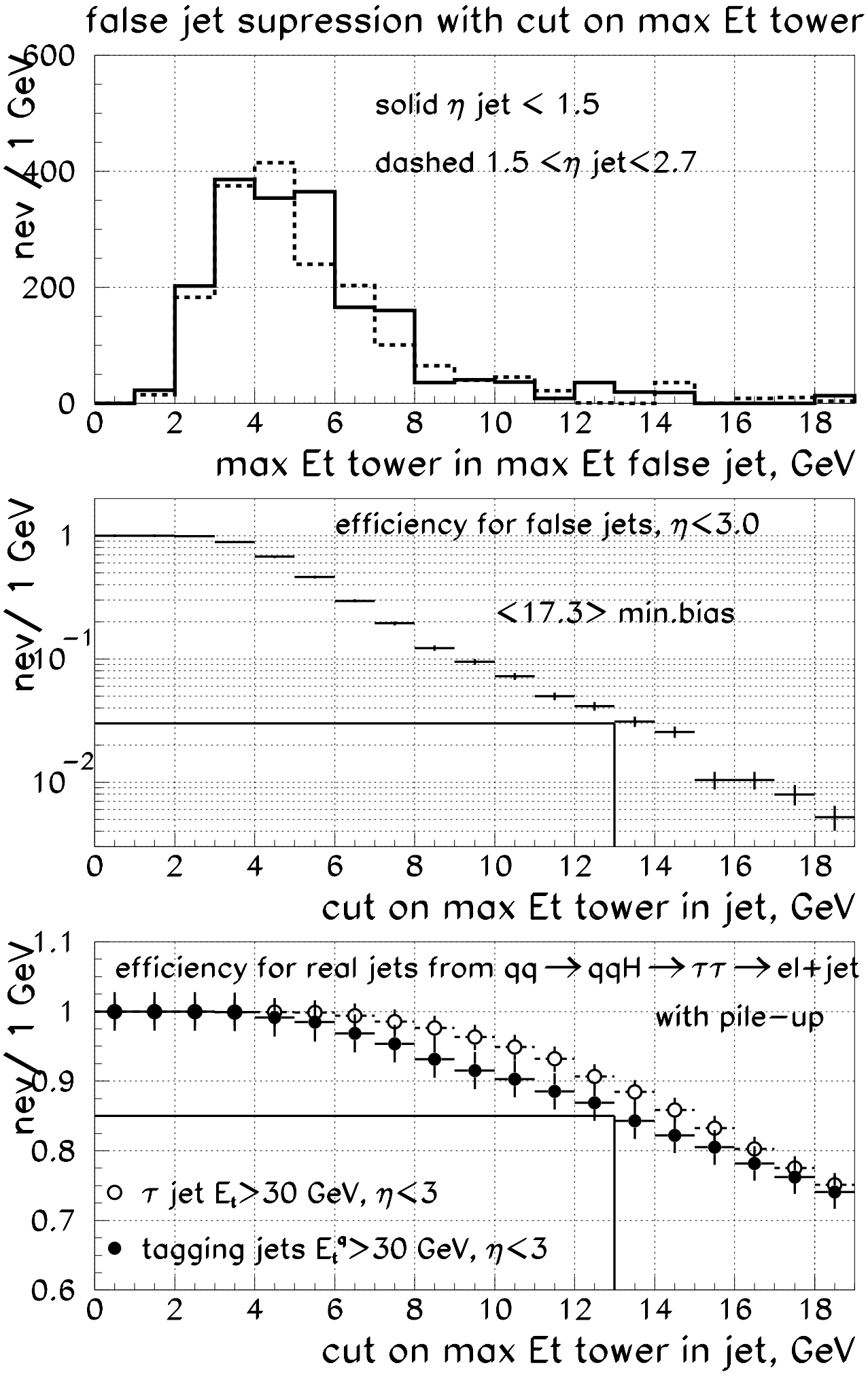
$\eta \times \varphi = 0.35 \times 0.35$ (2 x 2 HF towers)

selection of tagging jets with cut on max. HF Trigger Tower




Jets from pile−up only. <17.3> min.bias
Mean 23.64
RMS 11.97
jets from pile−up only <17.3> min.bias
iterative cone with towers
no threshold on max Et tower initiator
η jet <2.7
nev / 5 GeV
max Et jet, GeV. cone size 0.6

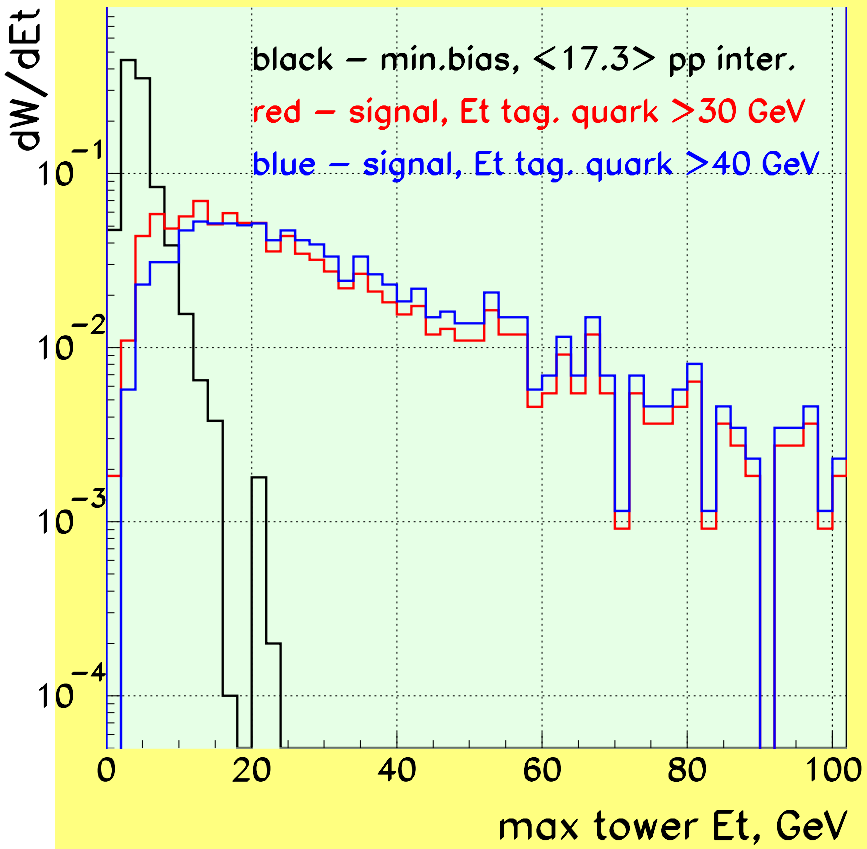

solid − η jet <1.5
dashed − 1.5<η jet<2.7
nev / 5 GeV
Et jet, GeV. cone size 0.6

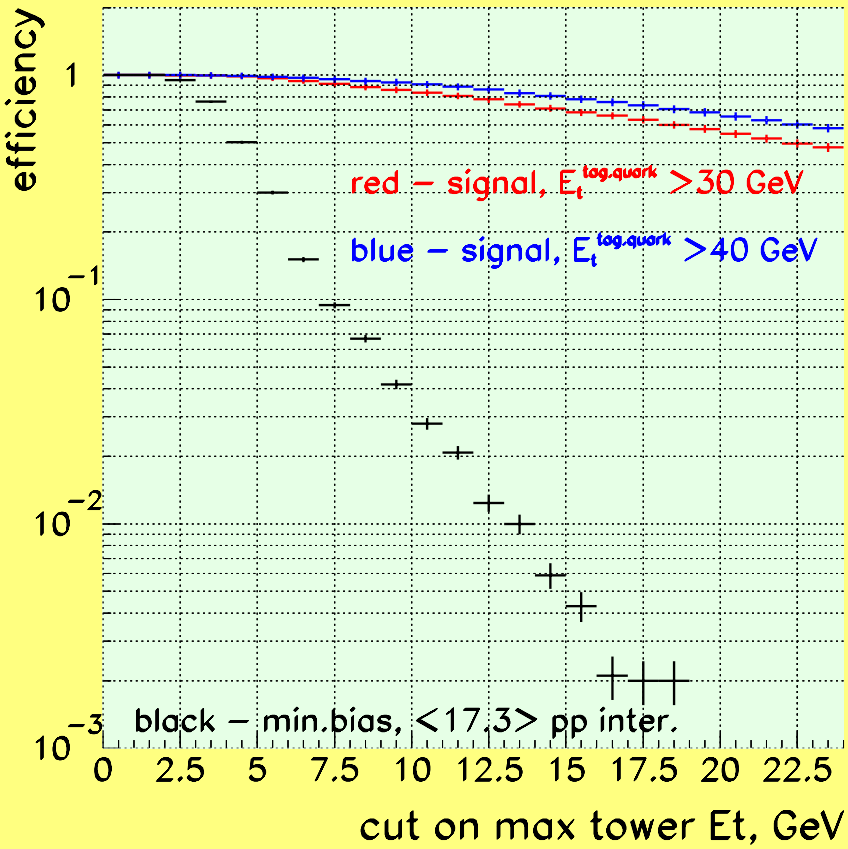

false jet supression with cut on max Et tower
solid η jet < 1.5
dashed 1.5 <η jet<2.7
nev / 1 GeV
max Et tower in max Et false jet, GeV
efficiency for false jets, η<3.0
<17.3> min.bias
nev/ 1 GeV
cut on max Et tower in jet, GeV
efficiency for real jets from qq → qqH → ττ → el+jet
with pile−up
τ jet E_t>30 GeV, η<3
tagging jets E_t^q>30 GeV, η<3
nev/ 1 GeV
cut on max Et tower in jet, GeV

Pattern recognition of tagging Jets from qq->qqH, M_H=135GeV

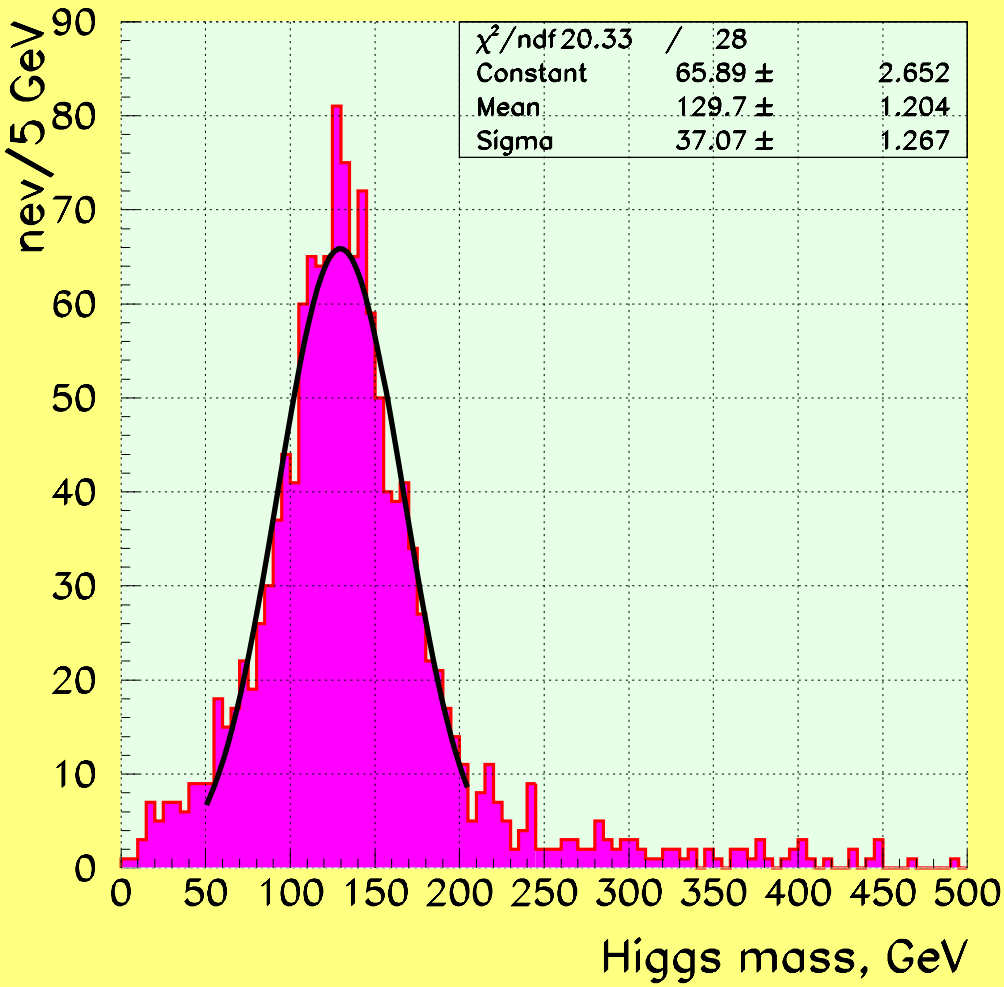
cross-check of previous studies (CMS Note 1998/015, CMS TN/95-099) with ORCA HLT data

Selection of tagging jets using cut on max. HF tower E_t





Higgs mass reconstruction for qq->qqH, H -> $\tau\tau$ -> e+jet, M_H=135 GeV

ORCA analysis. <17.3> min.bias superimposed

- missE$_t$ and τ-jet reconstructed with ecal+hcal towers
- iterative cone algo with cone size 0.6 (for 0.4 $\sigma/M = 32/125$)
- cut on digi 100 MeV for hcal and ebry and 150 MeV for efry
- no jet energy corrections. hcal calibration with pions