Some Thoughts on L1 Change for Jet/MET Trigger

Motivation & Goal

Wish List

Froward tagging jet trigger

MET trigger

Motivation & Goal

Motivation:

- **Today's L1 table for pure Jet/MET trigger is good for mass scale above 300-400GeV. But Higgs study and other physics studies need to cover 100-200 GeV region, too, at 10E34.**

Goal:

- **Lower Jet/MET threshold!**
  - E.g. Jet > 30GeV, MET > 100GeV
- **Strategy:**
  - Combine Jet/MET with other L1 objects.
  - Sharpen the turn-on curve.
  - Avoid problems associated with lower Et jets.

A Wish List

Jets:

- **Sliding 12x12 window seamlessly up tp eta 5.**
  - **Trigger on forward tagging jet.**
- **Et scale correction on 12x12 jets.**
  - **To fix calorimeter non linearity.**
    - (Et,eta) dependent.
- **Simple test on jet shape.**
  - **To remove fake jet due to pile-up**
    - look for core of jet, e.g. Et(max-tower)>10 GeV
- **Simpe test on j-j, j-l correlation.**
  - **Trigger on forward tagging jet.**
    - Eta-correlation, e.g. | Eta2- Eta1 | > 4.0

MET:

- **$Ex' = Ex + \Sigma(\Delta(Et(jet)))$, $Ey' = Ex + \Sigma(\Delta(Et(jet)))$**
  - **to fix calorimeter non linearity**

Trigger on Forward Tagging Jets @ 10E34

HE-HF boundary

Low Et jets (pile-up, energy scale)

jet-jet, jet-lepton correlation

Today's L1 Jet Trigger Table

Trigger Type	Trigger E_T Cutoff (GeV)	95% Efficiency Threshold (GeV)	90% Efficiency Threshold (GeV)	Incremental Rate (kHz)
Sum E_T	400			0.3
Missing E_T	80		200	0.9
Electron	27	35	33	5.3
Dielectron	14	22	20	1.3
Single jet	100	155	142	1.0
Dijet	60	106	100	0.7
Trijet	30	70	65	1.3
Quadjet	20	52	49	1.0
Jet + Electron	50 & 14			0.3
Cumulative Rate (kHz)	12.1			

Table 1: E_T cutoffs, 95% and 90% efficiency turn-on thresholds and incremental rate are shown for a variety of triggers at $\mathcal{L} = 10^{34}$ cm^{-2} s^{-1}.

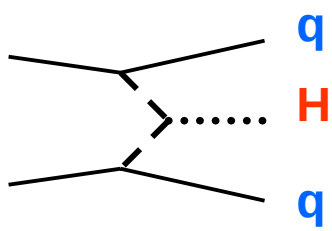
Pure Jets trigger good for mass scale above 300-400GeV

but,

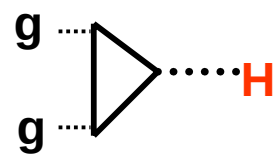
Higgs study (and others) need to cover 100-200GeV region, too.

=> lower jet Et threshold and combine with other objects at L1

qqH(135)



WWH



ffH

Need to study both!

and also to cover decay modes as many as possible!

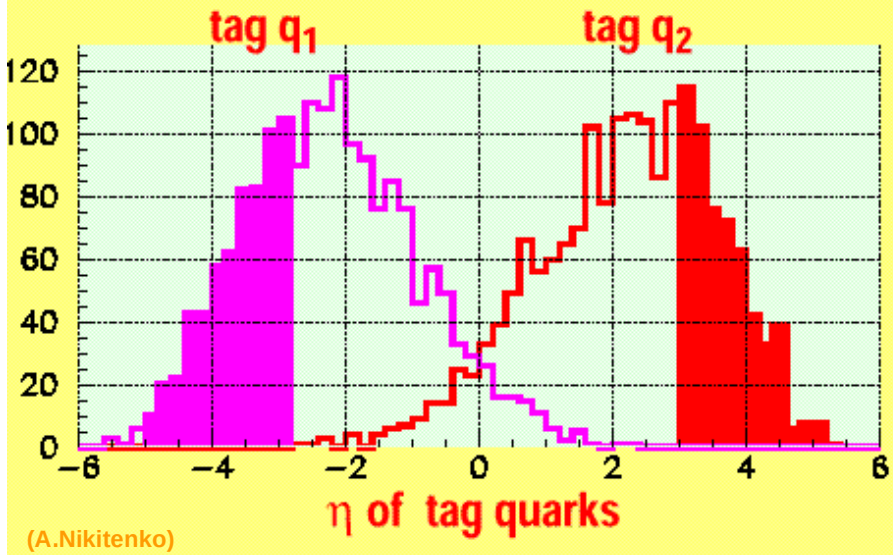
qqH (135GeV)
- **-> tau -> e/mu +X**
- **-> tau -> jet + X'**

Possible L1:
- **e(22) + 1 jet(90?)**
- **e(22) + 3 jets (30)**

>> Study done by S.Lehti(HIP),S.Ilyin(MSU), A.Nikitenko(HIP) <<

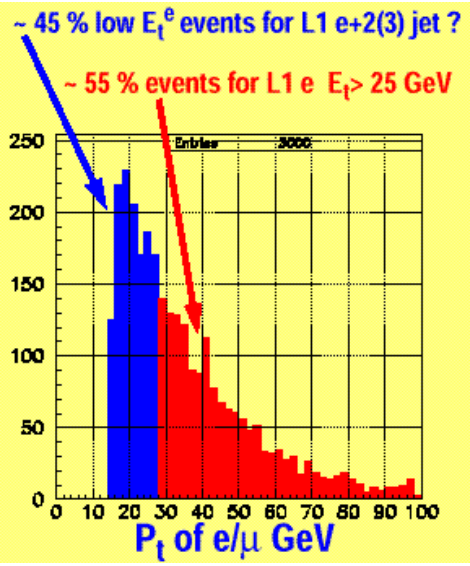
Eta Coverage

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

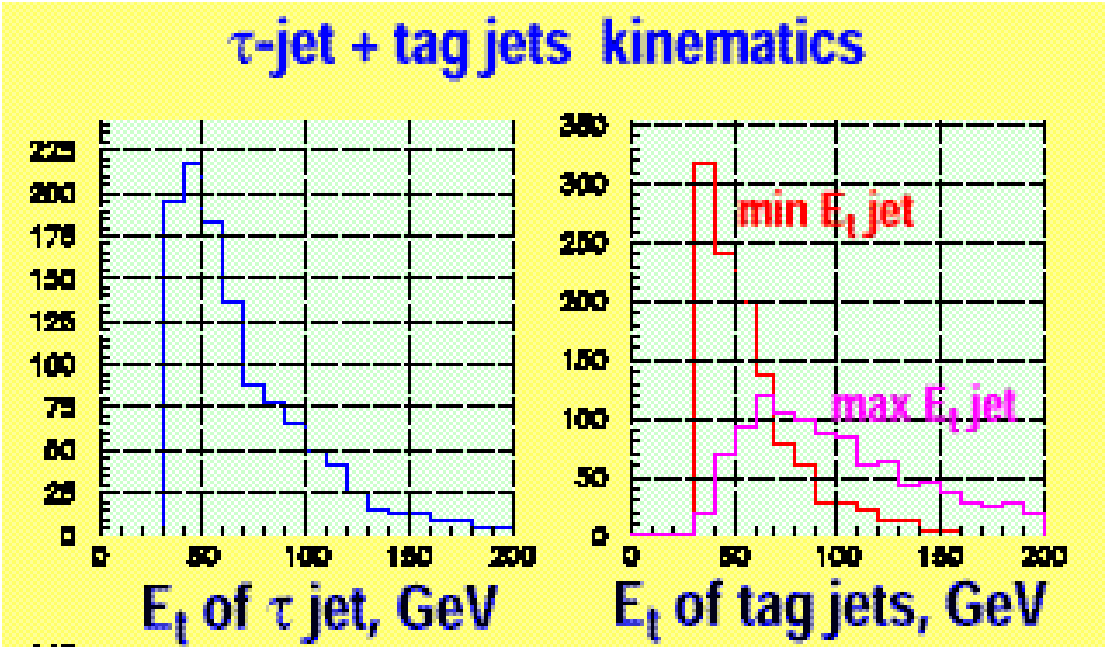


=> Need to cover both HE and HF region.

1 lepton + 3 jets



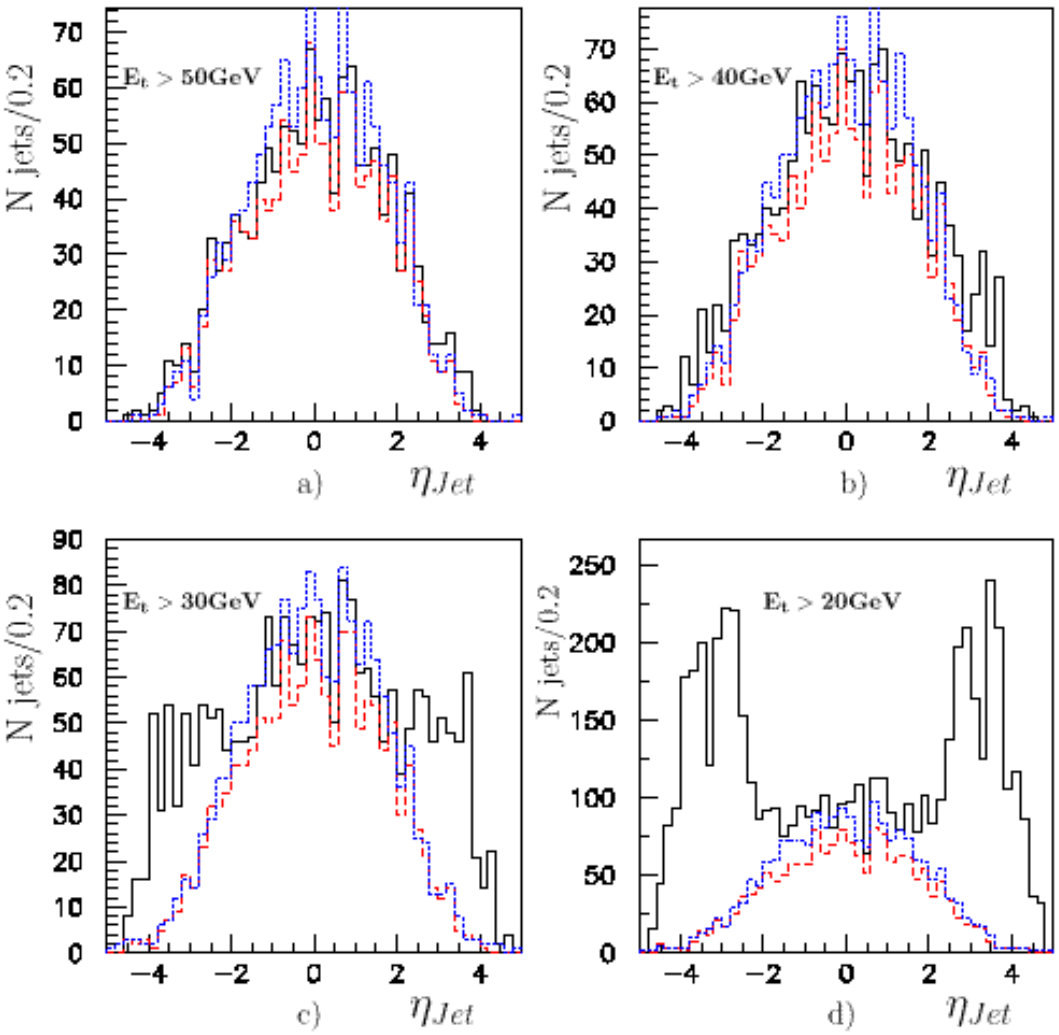
=>Lepton (>15GeV)



=> 3 jets (>30GeV)

(A.Nikitenko)

Low Et Jets and Pile-up



Reco with pile-up

Reco w/o pile-up

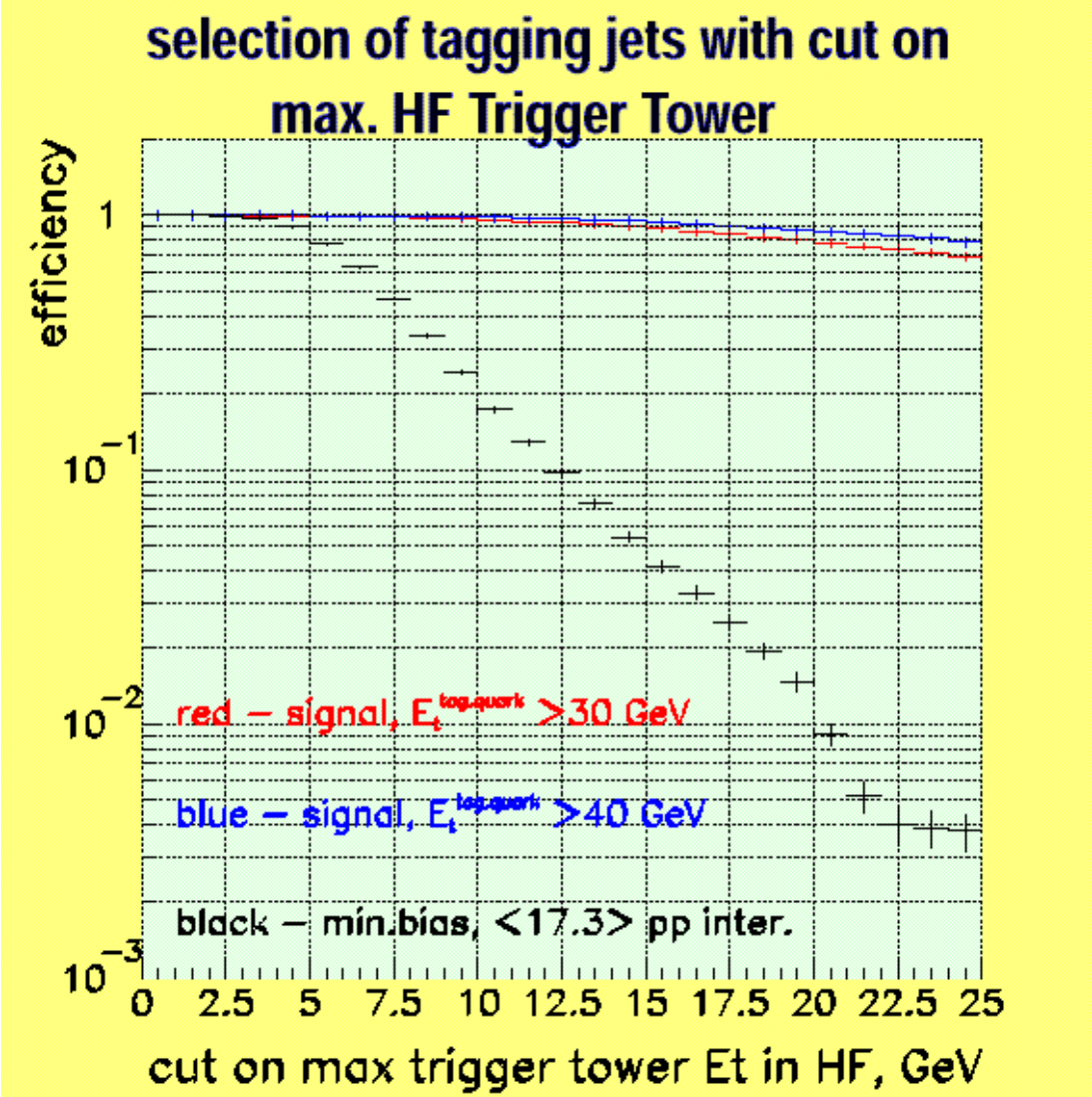
Generated

(R<0.7)

Fake jets < 40GeV

(A.Krokhotine)

Shape of Jets



(A.Nikitenko)

Shape:

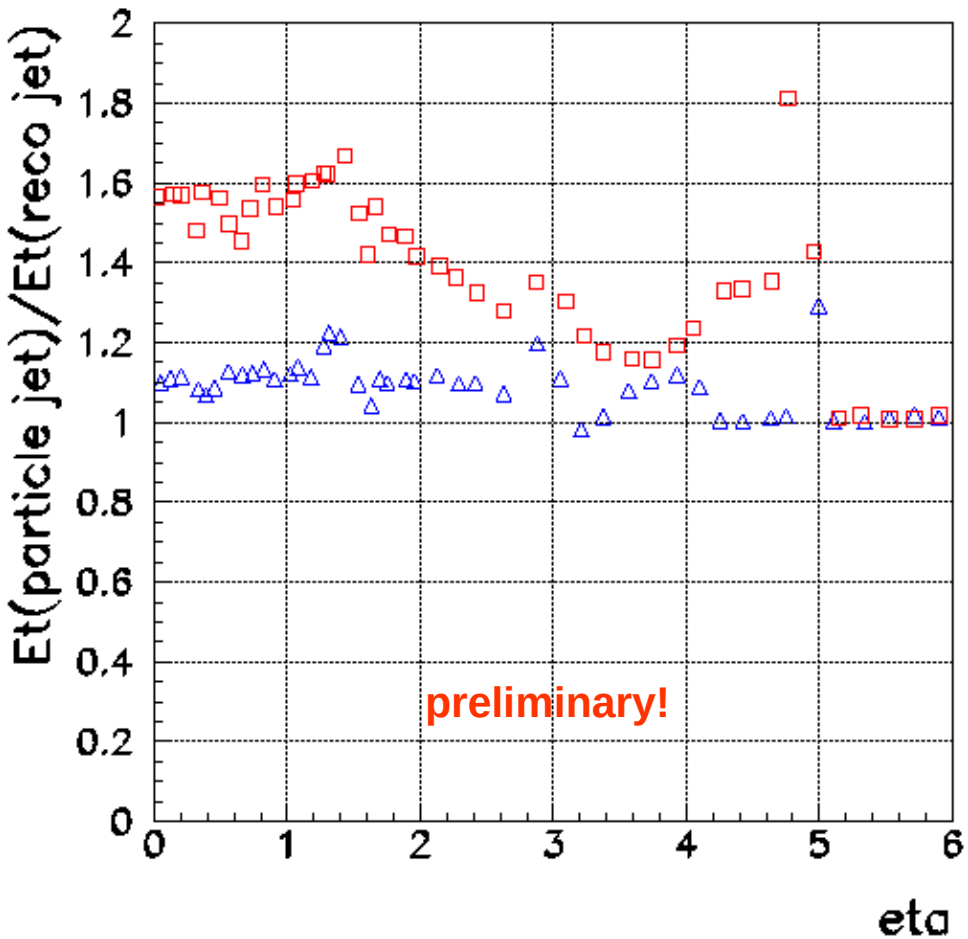
Flat = Fake Jets (due to pile-up)

Core = Real Jets

Cut on max. HF trigger tower Et.

=> Can L1 do like this?

Energy Scale



Calculated by

- **<Et>~35GeV, Z->jj**
- **<Et>~360GeV, Z'(1TeV)**

=> (Et,eta) dependent correction on 12x12 jets

Jet-Jet, Jet-Lepton Correlation

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	
$\lvert\eta_{j\,max}-\eta_{j\,max}\rvert > 4.4$	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			

y

* 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, $|\eta|$ < 5, M_Z>80 GeV, $M_{J,J}$>500 GeV

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

=> Can L1 do like this?

(A.Nikitenko)

Summary (Jets)

Today's L1 table - made for discovery!

- add jets+leptons, jets+met, etc. for more detailed study of lower mass scale physics.

Jet Trigger

- 12x12 window is close to offline, cone R<0.6.
- Low Et trigger is troublesome.
- Can L1 do the following?
  - Sliding 12x12 window seamlessly up to eta 5.
  - Et scale correction on 12x12 jets, (Et,eta)-dependent.
  - Simple test on jet shape.
  - Simple test on j-j, j-l correlation.
    - (Et,eta,phi) is available only four highest jets. Is it enough to test 'correlation' in multi jet events?

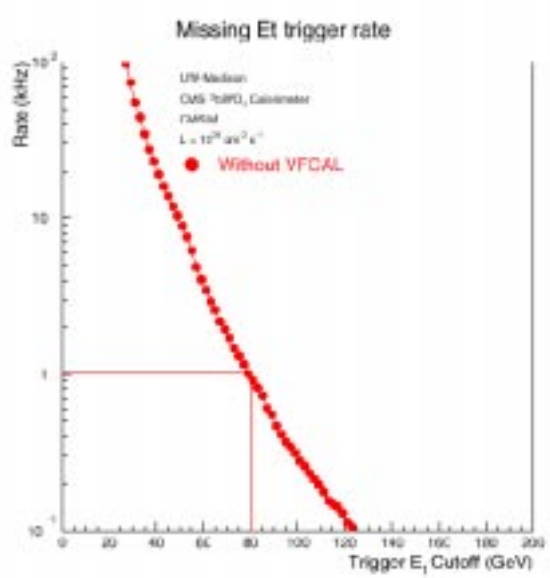
MET Perfomance

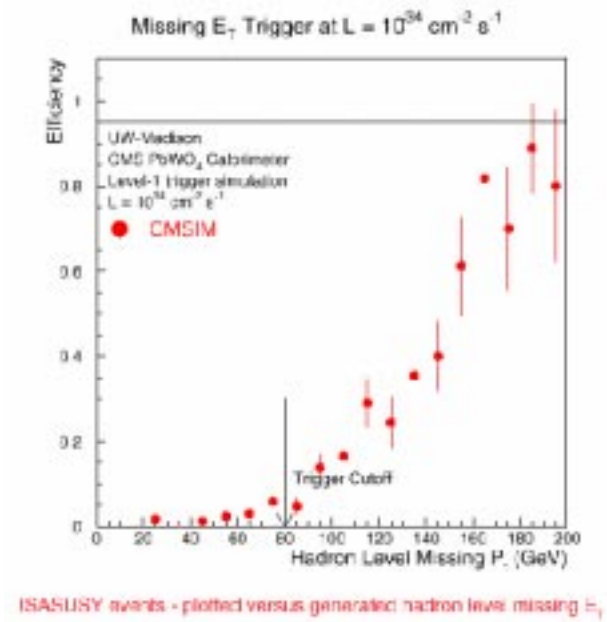
Resolution

Rates

Today's L1 MET Trigger Table @10E34

Efficient at 200 GeV (with 80 GeV threshold)





Good for high mass object

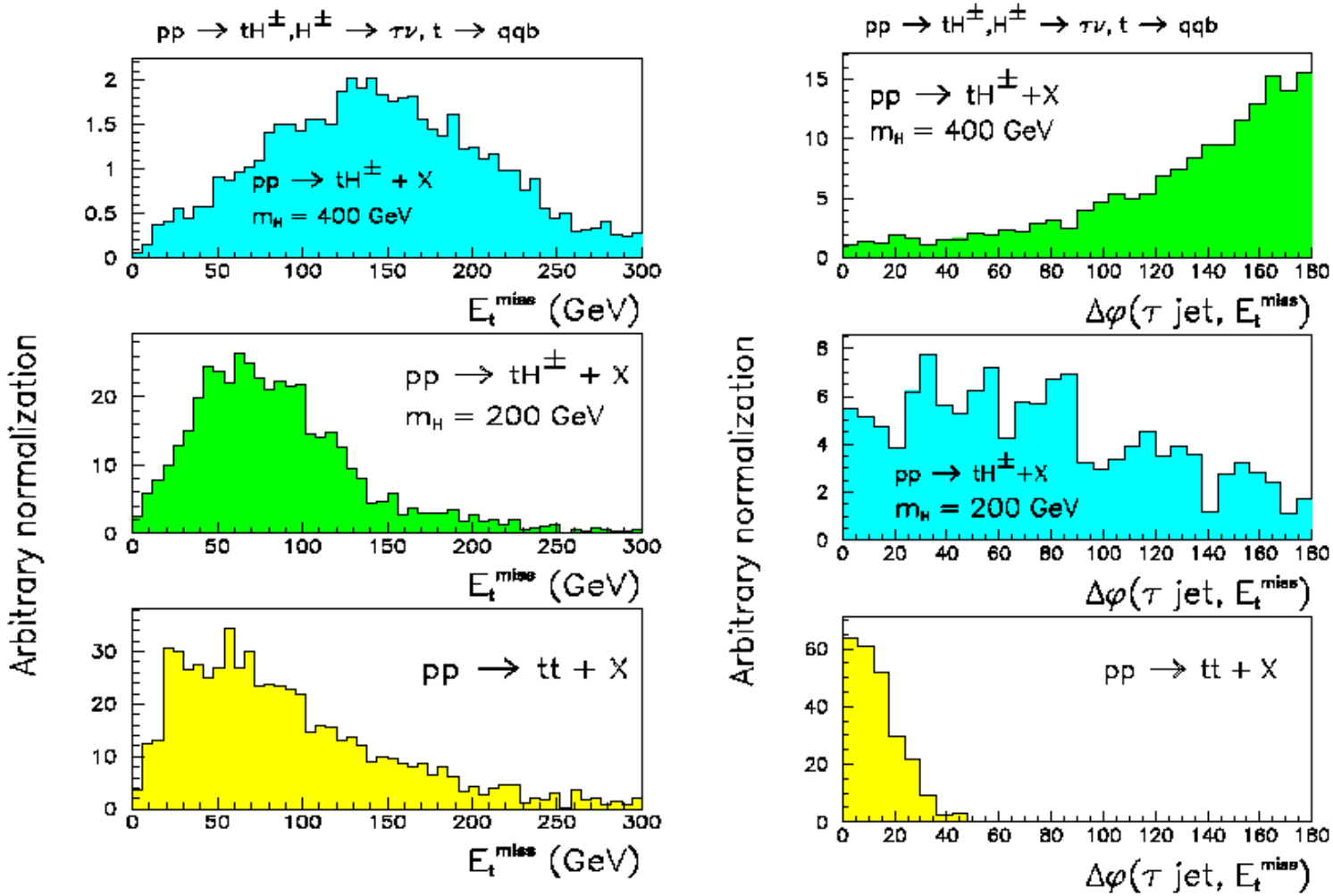
but

It will be nice, if we can sharpen the turn on curve and then lower the threshold.

>> need to understand the offline MET resolution.

MET in tH+

Reconstruction with CMSJET



(R.Kinnunen)

tH^+ : Selection & Signal

Event selection for tH^+, $H^+ \to \tau\nu$, $\tau \to h^+ + X$

1) τ selection:

jet, $E_t > 100$ GeV, $|\eta| < 2.5$ containing

one track with $r = p^h / E^{jet} > 0.8$, $\Delta R(\text{jet,track}) < 0.1$

2) $E_t^{miss} > 100$ GeV

3) W and top mass reconstruction from jets with $E_t > 20$ GeV

minimizing $\chi = (m_{jj} - m_W)^2 + (m_{jjj} - m_{top})^2$

4) W mass cut, $|m_{jj} - m_W| < 15$ GeV

5) top mass cut, $|m_{jjj} - m_{top}| < 20$ GeV

6) Tagging of the jet not assigned to W with $E_t > 30$ GeV, $|\eta| < 2.5$,

efficiencies from TDR (2 tracks, p_t>1, GeV, σ^{ip}> 2):

50% for b-jets, 1.3 % for non-b-jets

7) Central jet veto, $E_t^{jet} > 40$ GeV

8) Second top veto, $|m_{\tau\nu j} - m_{top}| > 130$ GeV

9) transverse mass reconstruction $m_T(\tau \text{ jet}, E_t^{miss})$

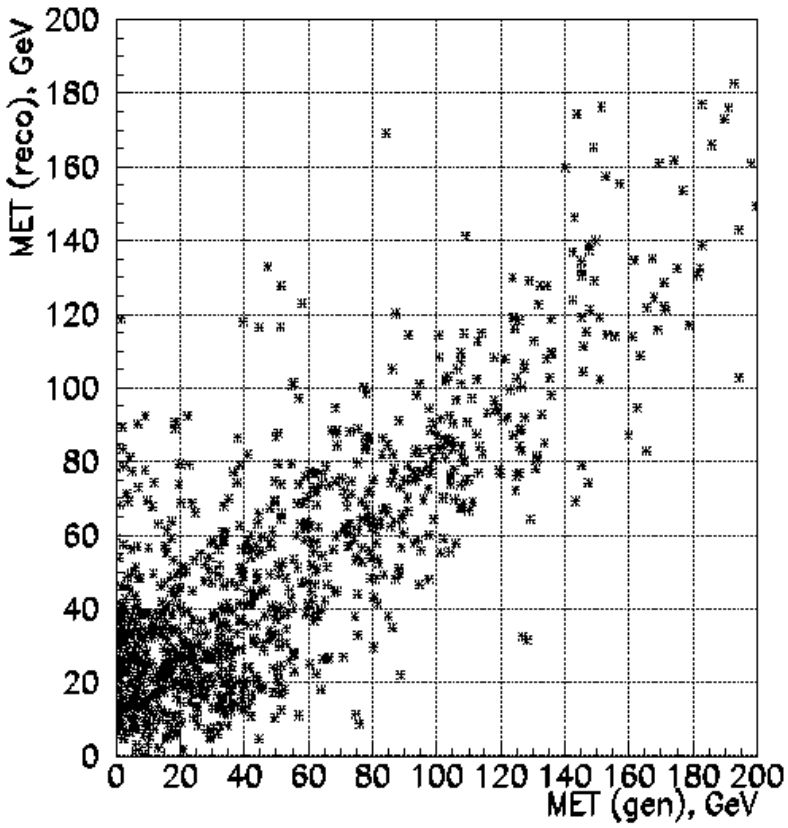
Events for 10^5 pb^{-1}

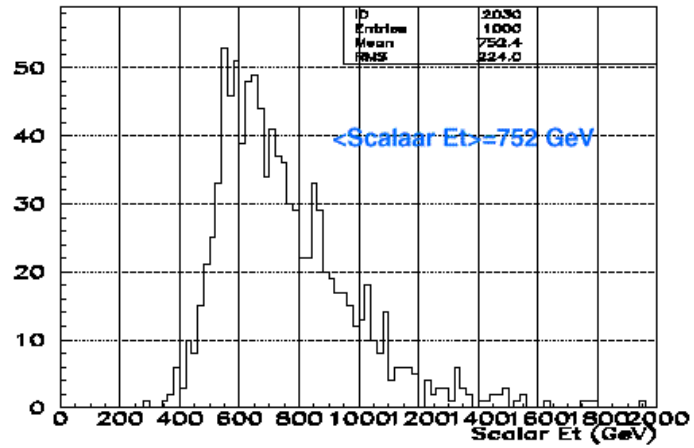
	Signal	Background tt, Wtb, W+jet
$m_T(\tau \text{ jet}, E_t^{miss}) > 100$ GeV		
$m_A = 400$ GeV, , $\tan\beta = 30$	68.5	25.6
$m_A = 200$ GeV, , $\tan\beta = 20$	41.1	25.6
$m_A = 600$ GeV, , $\tan\beta = 40$	33.5	25.6
$m_T(\tau \text{ jet}, E_t^{miss}) > 200$ GeV		
$m_A = 400$ GeV, , $\tan\beta = 30$	61.9	7.8
$m_A = 200$ GeV, , $\tan\beta = 20$	12.5	7.8
$m_A = 600$ GeV, , $\tan\beta = 40$	31.8	7.8
$m_T(\tau \text{ jet}, E_t^{miss}) > 100$ GeV, second top and jet veto		
$m_A = 400$ GeV, , $\tan\beta = 30$	37.8	4.2
$m_A = 200$ GeV, , $\tan\beta = 20$	18.2	4.2
$m_A = 600$ GeV, , $\tan\beta = 40$	17.9	4.2

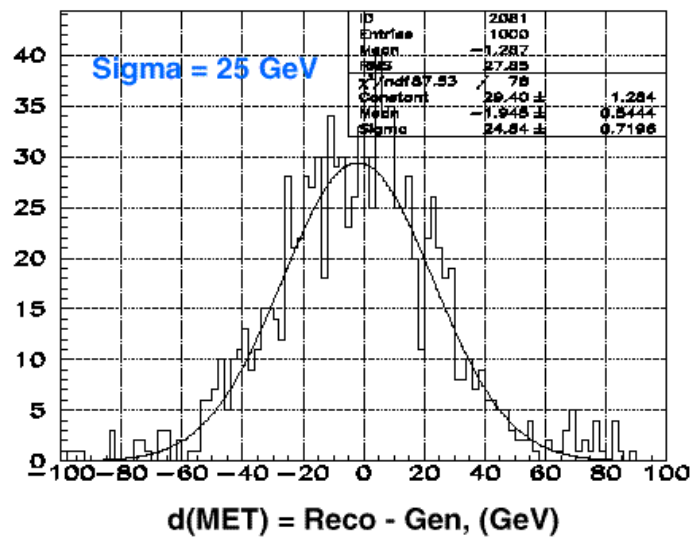
Assumed Trigger: 3 jets (Et>20GeV) plus tau-jet (Et>100GeV)

Offline MET Response

ttH(110) no min-bias overlap

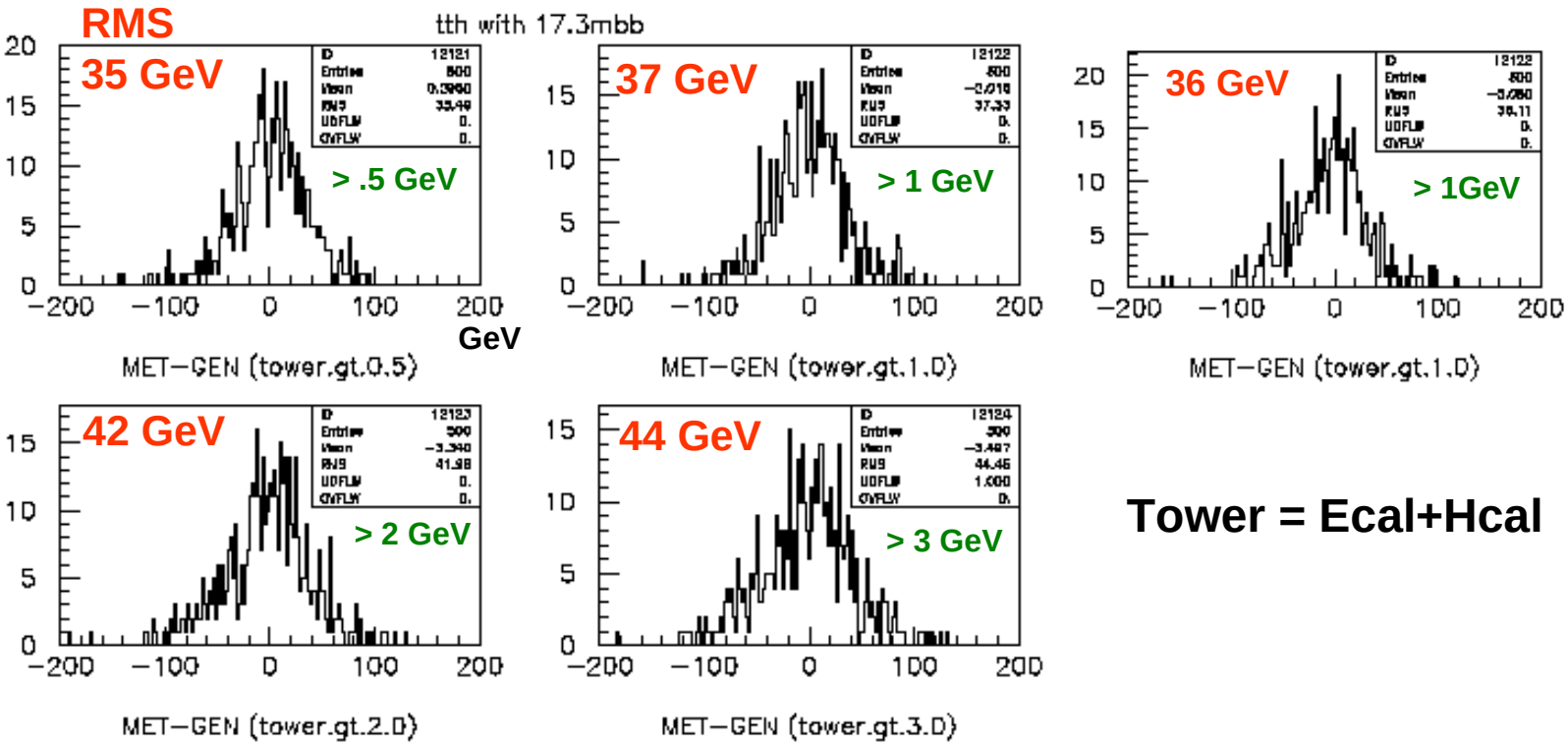






Pile-up and Tower Threshold

With 17.3 min-bias events **No min-bias**



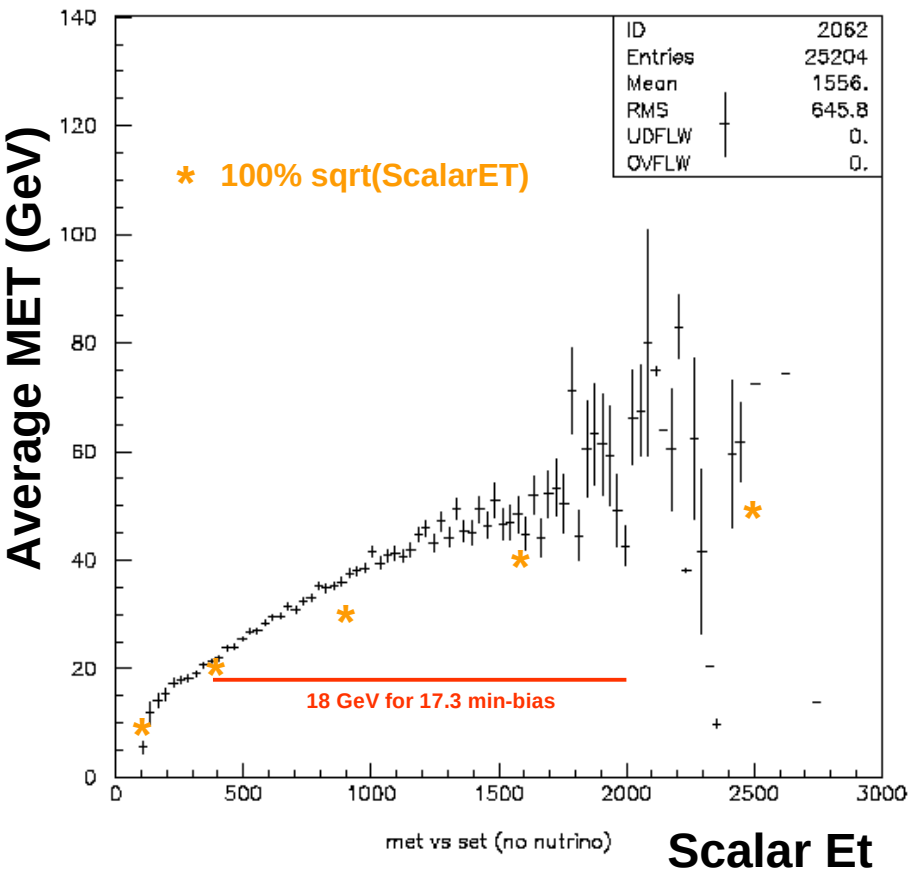
Tower = Ecal+Hcal

>> Not much pile-up effect with this resolution!
>> Resolution gets worse as threshold increase.

Offline MET Resolution

QCD Jets with no neutrino/muon

(no pile-up)



$Ex = \Sigma$ (Ex-tower)

$Ey = \Sigma$ (Ey-tower)

Any way to improve this?

e.g.

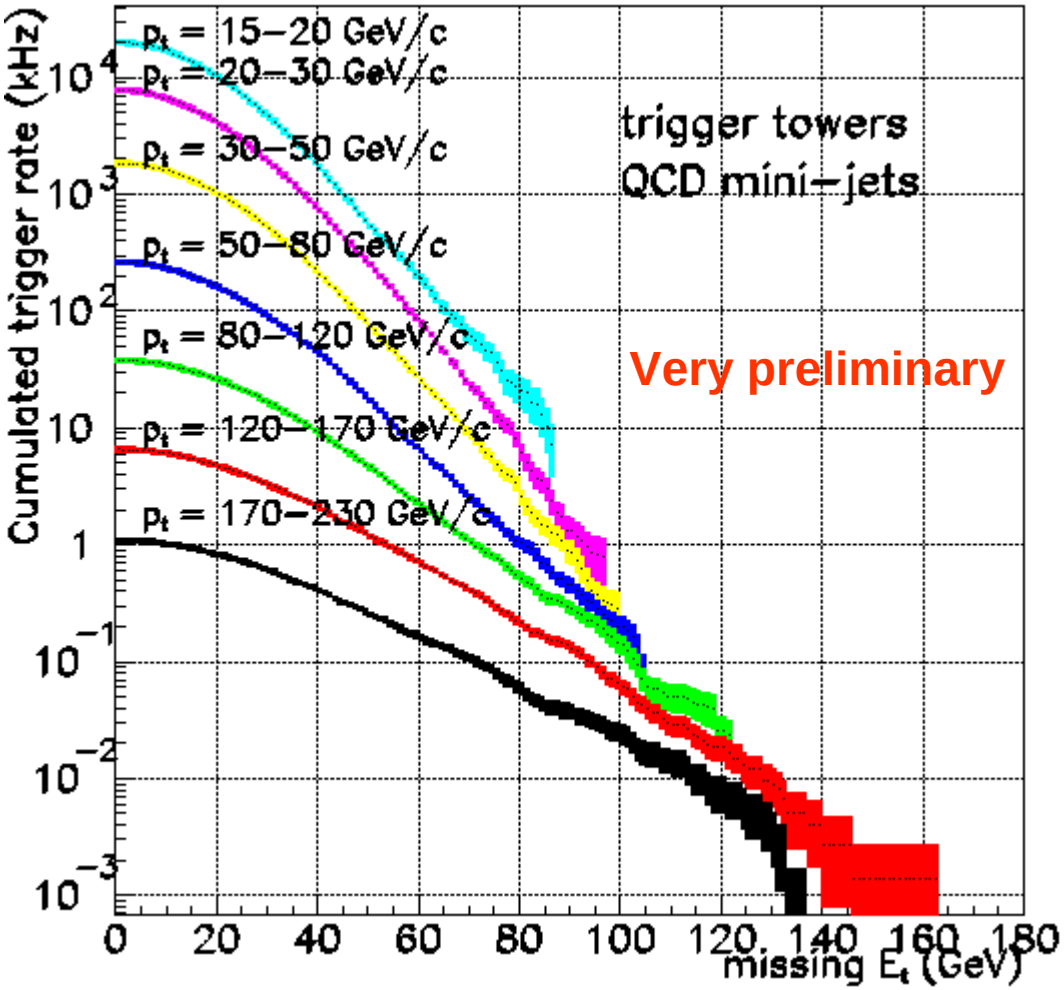
$Ex' = Ex + \Sigma\ (\Delta(Ex\text{-}jet))$

$Ey' = Ey + \Sigma\ (\Delta(Ey\text{-}jet))$

If this works in offline, can we do this at L1?

(Need study for offline, first!)

Rates with Pile-up



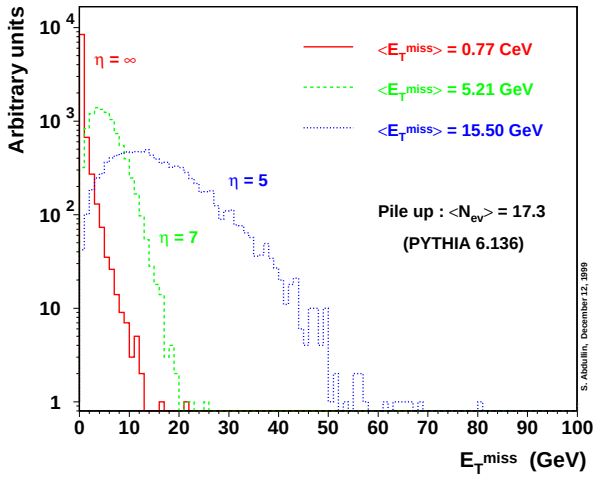
P.Hidas (cmsim+ORCA3)

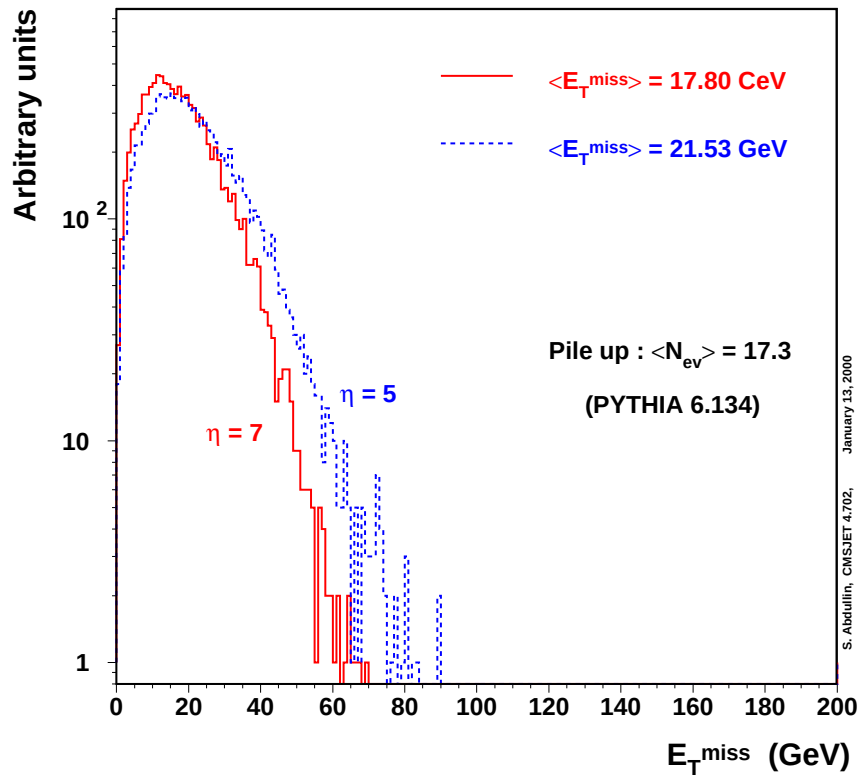
Huge rate below MET < 100 GeV due to min-bias at 10E34.

CMSJET Simulation

(by S.Abdullin)

Particle level E_T^{miss} calculation for various η coverage





MET (GeV)

eta	gen.	cmsjet res.	cmsjet all(*)
5	15.49	19.36	21.53
7	5.21	12.92	17.80

(all = res. & B-field & vtx smearing)

~ Equal contribution from eta 5-7, resolution and B-field
(15GeV) (12GeV) (9-12GeV)

Summary (MET)

Offline MET performance

- **probably worse than 100%sqrt(ScalarEt)**
- **need to look for improvement.**
  - **e.g. Ex'=Ex+Σ (Δ(Ex-jet)), Ey'=Ey+Σ (Δ(Ex-jet))**

L1 MET Trigger

- **Some questions!**
  - If offline finds a way to improve the MET resolution, can L1 follow?
  - How low MET can go?
  - Rate will be sensitive to noise and pile-up. How to control it?
- **Better to combine MET with other L1 objects for lower threshold with acceptable rates.**