Available on CMS information server **CMS IN 2000/000**

CMS Internal Note

The content of this note is intended for CMS internal use and distribution only

14 March 2000

Missing transverse energy high level trigger plans

P. Hidas

RMKI, Budapest, Hungary

S. Kunori

University of Maryland, USA

Abstract

Former Level 1 works are reproduced, also new studies are performed in comparison with previous CMS and ATLAS results.

1 Introduction

2 Previous Level 1 studies

2.1 CMS studies

[1] and [2] were performed without pile-up addition that makes it hard to compare the trigger rate with our results.

2.2 ATLAS studies

[3] shows the importance of pile-up in the emerging of fake missing transverse energy. They used $p_t > 5GeV/c$ "mini-jet" and also `PYTHIA` minimum bias events. For pile-up they assumed 20 deep inelastic events per bunch crossing and an overlap of 3 bunches only. They found that the intime pile-up significantly increases the missing transverse energy, while the non intime pile-up is rather negligible. The recent CMS assumption is an overlap of 9 bunches and this can lead to a further increase of the fake missing energy that can have also an important contribution to the trigger background.

[4] states the the largest contribution to the missing energy resolution comes from the addition of trigger tower noiese, but this effect can be reduced by an appropriate threshold cut on the trigger tower energies.

3 The software and events used for this analysis

`ORCA_3_0_5` and the ntuple maker of the JetMET Physics Group were used to produce ntuples from simulated events of the CMS experiment. The data were taken from the Pass7Oct99 segment of the CMS Objectivity database. These events contain intime pile-up only (17.3 minimum bias pile-up events on the average).

For the trigger rate study jet background events (QCD mini-jets) were taken from several p_t bins (see Tab. 1). There contribution was normalized to their relative cross section.

Table 1: QCD two-jet event samples used to calculate the missing E_t background trigger rate

p_t	σ_i	$f_{i,0}$	$f_{i,80}$	$f_{i,80}$	Number of events		
		initial	L1 region	tower		$E_t > 80GeV$	
(GeV/c)	(mbarn)	(kHz)	(kHz)	(kHz)	initial	L1 region	tower
15-20	1.54	12200	19.5	14.6	5000	8	6
20-30	0.657	5940	11.9	3.59	26440	53	16
30-50	0.162	1580	5.38	1.54	18480	63	18
50-80	$2.26 \cdot 10^{-2}$	225	2.31	0.502	11220	115	25
80-120	$3.14 \cdot 10^{-3}$	31.4	0.976	0.307	4500	140	44
120-170	$5.46 \cdot 10^{-4}$	5.46	0.365	0.153	3998	267	112
170-230	$1.09 \cdot 10^{-4}$	1.09	0.138	0.059	1280	162	69

The method to calculate the rates is the following. The bunch crossing rate is $40MHz$, the ratio of filled bunches in the LHC ring is $2835/3564$, so the average total bunch crossing rate is $f_0 = 31.82MHz$. Consider say the $15GeV/c < p_t < 20GeV/c$ channel, the partial cross section of which is $\sigma_i = 1.54mb$. The expected value of the number of events in one bunch crossing is at $L = 10^7 mb^{-1}Hz$ high luminosity :

$$< n_i >= L\sigma_i / f_0 = 0.484$$

Assuming Poisson-distribution this is the parameter of the distribution, so the probability having $n > 0$ events in the bunch crossing :

$$P_i = 1 - e^{-<n_i>} = 0.384$$

and finally the partial trigger rate

$$f_{i,0} = f_0 P_i = 12.2MHz$$

Comparing the contributions of different p_t bins in Tab. 1 one can state that the lower p_t bins dominate even above the nominal Level 1 $80 GeV$ missing transverse energy cut. This indicates, that we need a study of $p_t < 15 GeV/c$ events or more preferably a minimum bias study. This study should include a full pile-up, intime pile-up only comparison too.

4 The reproduction of the first level trigger

4.1 Trigger rate

Fig. 1 and Fig. 2 show the missing E_t cumulative trigger rate calculated from first level trigger tower regions on a logarithmic and linear scale repectively. Fig. 3 and Fig. 4 show the ditribution over the $80 GeV$ first level cutoff.

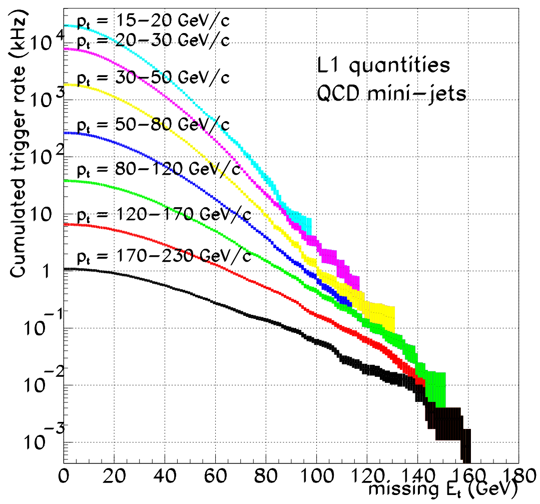

Figure 1: The missing E_t cumulative trigger rate of QCD background events (mini-jets) is shown as a function of the E_t cutoff on a logarithmic scale.

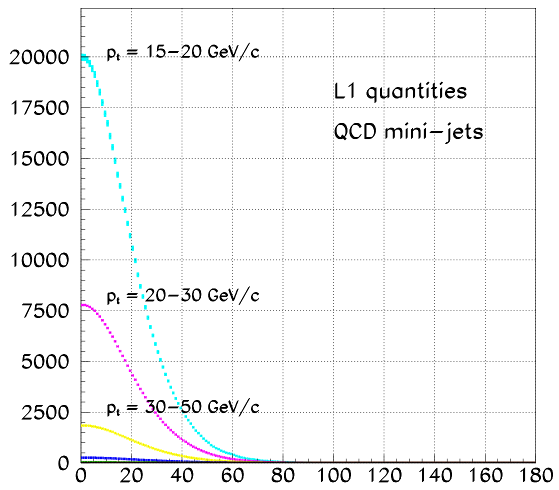

Figure 2: The same on a linear scale. The missing E_t is calculated from first level trigger tower regions

Fig. 5 and Fig. 6 show the missing E_t cumulative trigger rate calculated from trigger towers on a logarithmic and linear scale repectively. Fig. 7 and Fig. 8 show the ditribution over the $80 GeV$ first level cutoff. even above $80 GeV$.

The linear trigger rate plots enhance the dominance of lower p_t bins even above $80 GeV$. Using trigger towers than first level trigger tower regions significantly lowers the fake missing transverse energy background, though it is still

4.1.1 Effect of pile-up

4.1.2 Effect of electronics noise

Acknowledgements

We wish to thank to the Hungarian Scientific Research Fund (OTKA) for its financial support (contract no. T029264)

References

[1] **CMS TN/95-111**, S.Dasu et al., *"CMS Missing Transverse Energy Trigger Studies"*.

[2] **CMS Note 1998/027**, S.Dasu et al., *"CMS Level-1 Calorimeter Trigger Detailed Simulation"*.

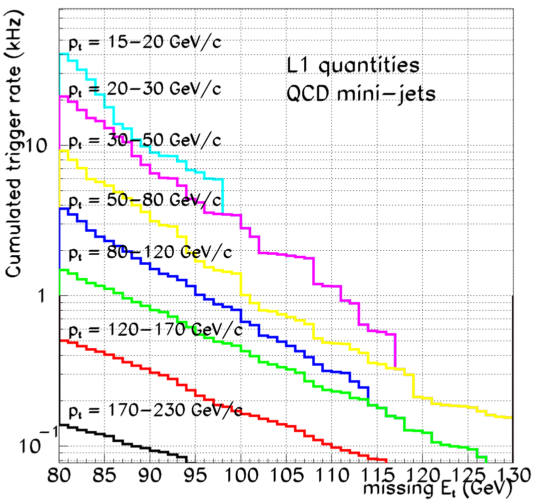

Figure 3: The missing E_t cumulative trigger rate of QCD background events (mini-jets) is shown as a function of the E_t cutoff above the first level nominal 80 GeV cut on a logarithmic scale.

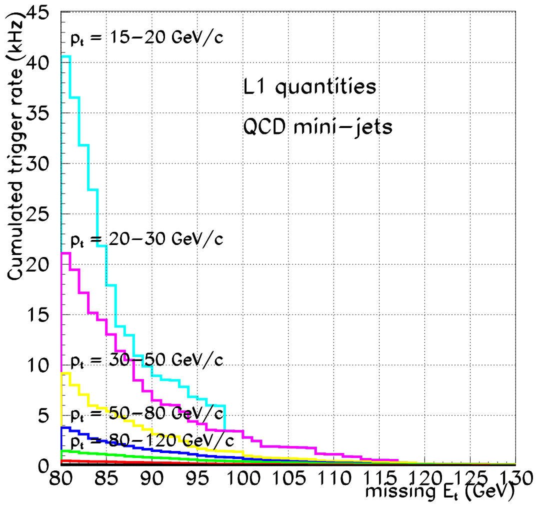

Figure 4: The same on a linear scale

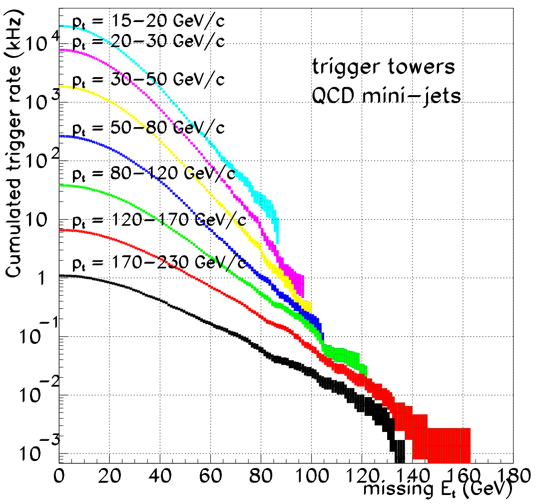

Figure 5: The missing E_t cumulative trigger rate of QCD background events (mini-jets) is shown as a function of the E_t cutoff on a logarithmic scale.

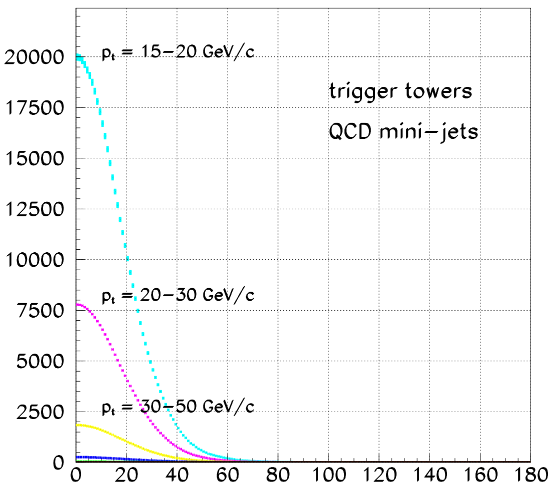

Figure 6: The same on a linear scale. The missing E_t is calculated from offline trigger towers

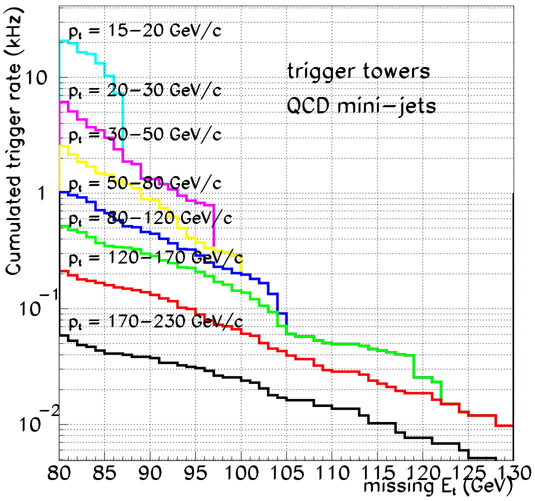

Figure 7: The missing E_t cumulative trigger rate of QCD background events (mini-jets) is shown as a function of the E_t cutoff above the first level nominal 80 GeV cut on a logarithmic scale.

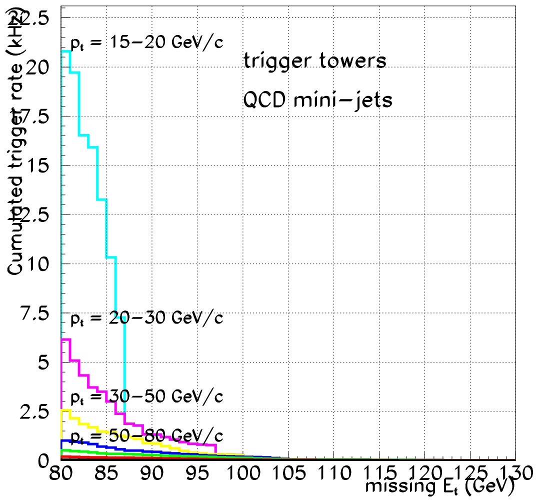

Figure 8: The same on a linear scale

[3] **ATLAS Internal Note LARG-NO-18**, I. Wingerter-Seez et al., *"Study of the effects of pile-up events on energy measurements for the LAr electromagnetic calorimeter"*.

[4] **CERN/LHCC 98-15**, ATLAS/Trigger Performance Group, *"ATLAS Trigger Performance Status Report"*.