Jets and $\not\!\!E_T$ at HLT: Status and Plans

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Introduction

- Status of the HLT JetMET Filters
- Verification of the Jet Reconstruction Algorithms
- Jet Reconstruction Timing Studies
- A Preliminary Look at L1 GCT Emulator Output
- Commissioning Triggers for JetMET
- Upcoming Plans

HLT JetMet Trigger Menu

from PTDR vol. II for $\mathcal{L} = 2 \times 10^{33}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$

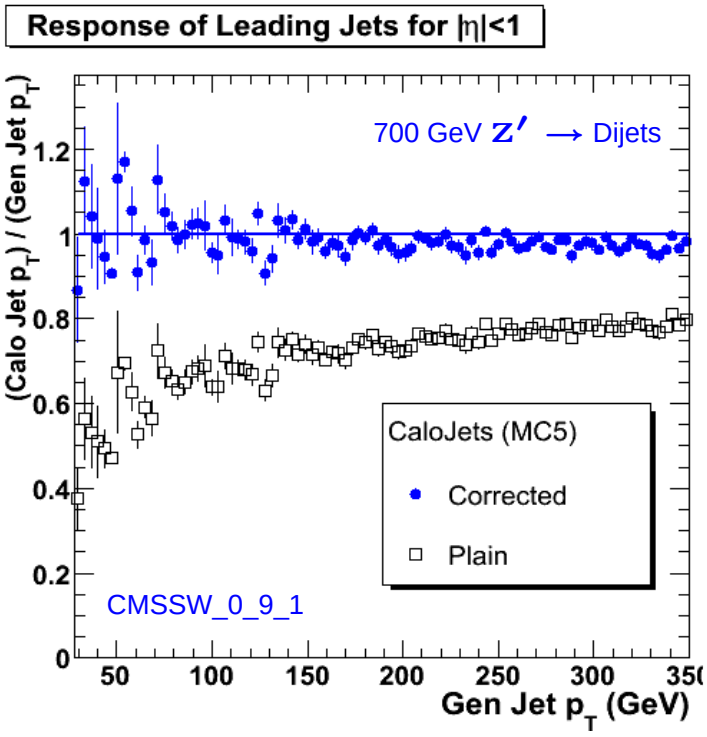
Trigger	Level-1 Prescale	HLT Threshold (GeV)	HLT Rate (Hz)	CMSSW availability
SINGLE-JET	1	400	4.8 ± 0.0	✓
DOUBLE-JET	1	350	3.9 ± 0.0	✓
TRIPLE-JET	1	195	1.1 ± 0.0	✓
QUADRUPLE-JET	1	80	8.9 ± 0.2	✓
$\not\!\!E_T$	1	91	2.5 ± 0.2	✓
jet + $\not\!\!E_T$	1	180,80	3.2 ± 0.1	✓
acoplanar 2 jets	1	200,200	0.2 ± 0.0	✓
acoplanar jets + $\not\!\!E_T$	1	100,80	0.1 ± 0.0	✓
2 jets + $\not\!\!E_T$	1	155,80	1.6 ± 0.0	✓
3 jets + $\not\!\!E_T$	1	85,80	0.9 ± 0.0	✓
4 jets + $\not\!\!E_T$	1	35,80	1.7 ± 0.0	✓
H_T + $\not\!\!E_T$	1	350,80	5.6 ± 0.2	X
H_T + e	1	350,20	0.4 ± 0.1	X
SINGLE-JET	10	250	5.2 ± 0.0	✓
SINGLE-JET	10^3	120	1.6 ± 0.0	✓
SINGLE-JET	10^5	60	0.4 ± 0.0	✓

H_T still needs a producer in CMSSW. It should be available shortly.

Let us know asap if you do not see your favorite jet or $\not\!\!E_T$ filter.

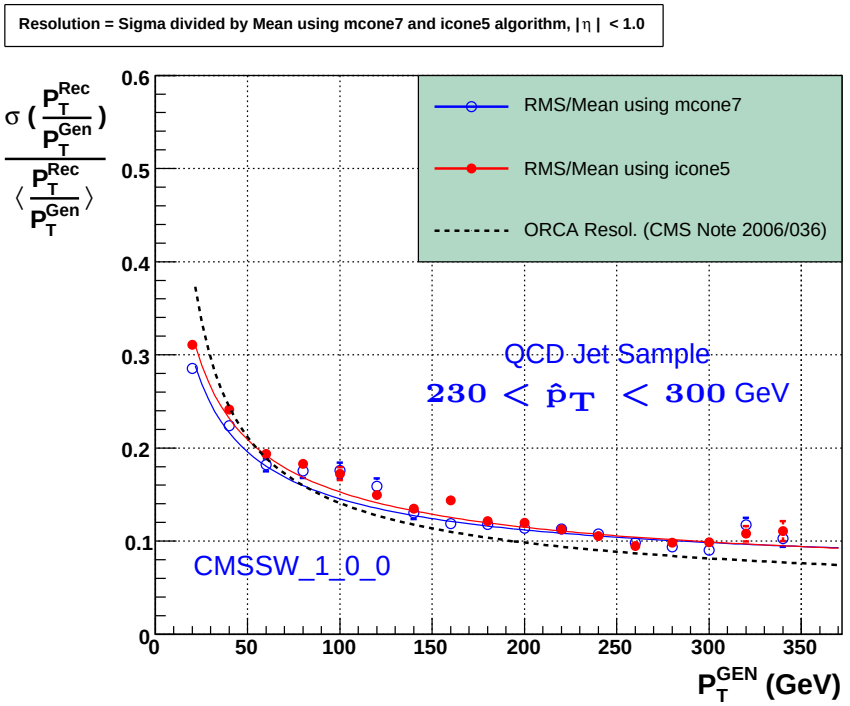
Jet Reconstruction Studies

Rob Harris



Jet Response

Agata Smoron

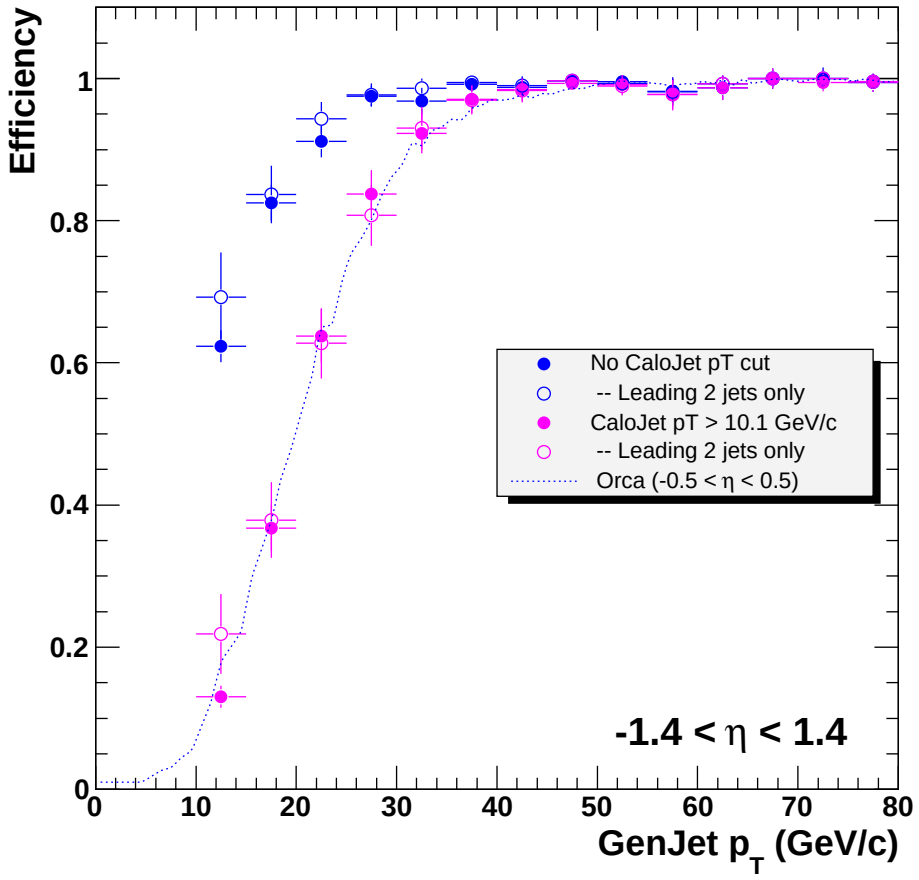


Jet Resolution

Jet Reconstruction Studies (cont.)

- $\Delta R^{gen-calo} < 0.3$ matching criteria.
- Previous studies from ORCA (CMS Note AN2006/036) found that the jet finding efficiency was 50% at E_T^{Gen} = 20 GeV for E_T^{Rec} = 10.1 GeV and CaloTower $E_T > 0.5$ GeV for jet finding.

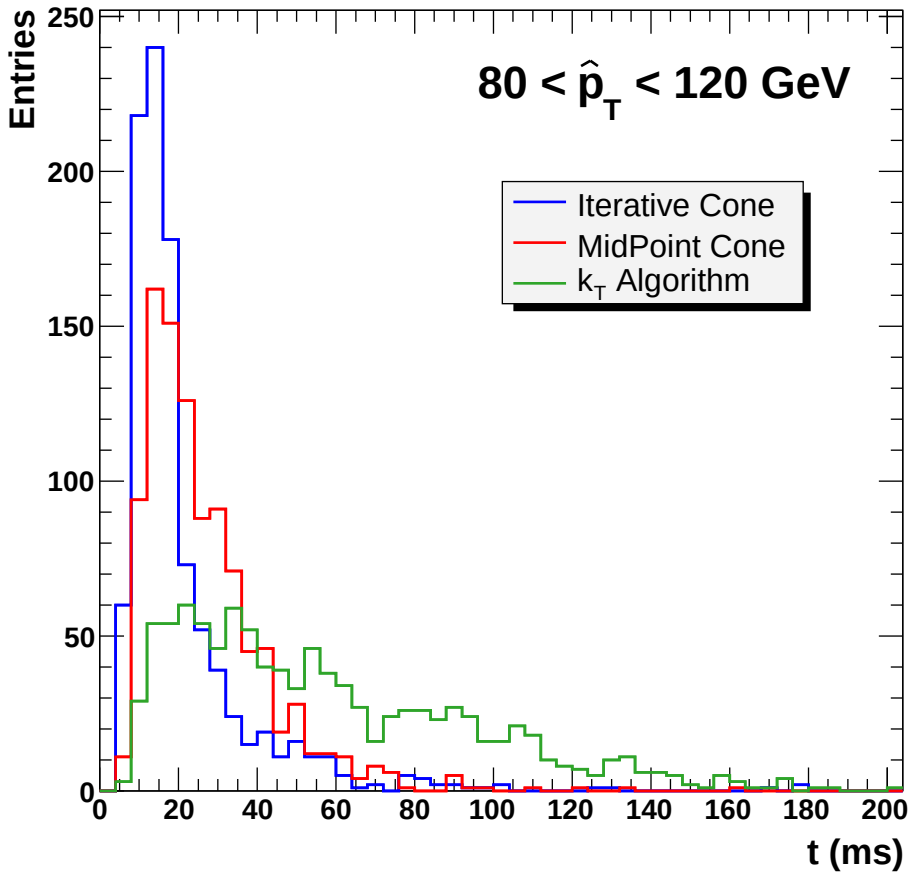
Iterative-cone jets with $\Delta R < 0.5$



Jet Finding Efficiency

Jet Timing Studies

- Using `CMSSW_1_0_1` for reconstruction.
- Timing measurements were made using CMSSW's `Timer` module and the UNIX `times` system function.
- Times shown here were obtained with a 2.67 GHz Pentium 4 processor.



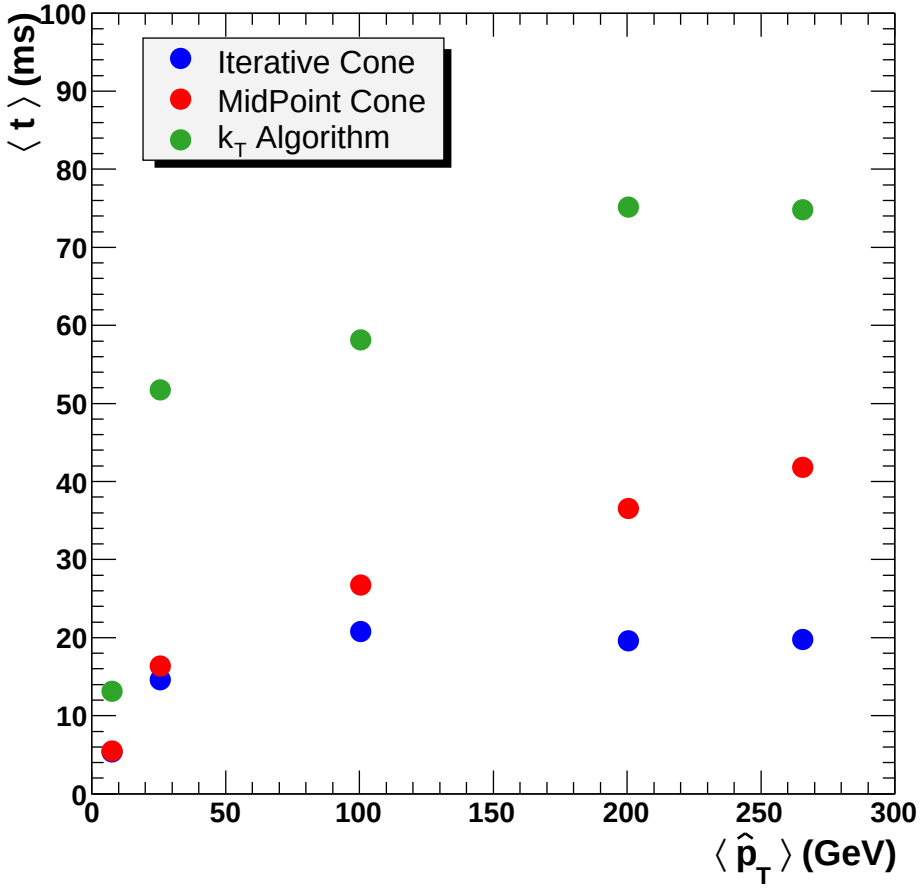
Jet Producer

Note: CMS currently uses an old implementation of the k_T jet algorithm. A much faster implementation is available.

Jet Timing Studies (cont.)

- Timing comparisons for several different Monte Carlo samples.

$$0 < \hat{p}_T < 15 \text{ GeV}$$
$$20 < \hat{p}_T < 30 \text{ GeV}$$
$$80 < \hat{p}_T < 120 \text{ GeV}$$
$$170 < \hat{p}_T < 230 \text{ GeV}$$
$$230 < \hat{p}_T < 300 \text{ GeV}$$



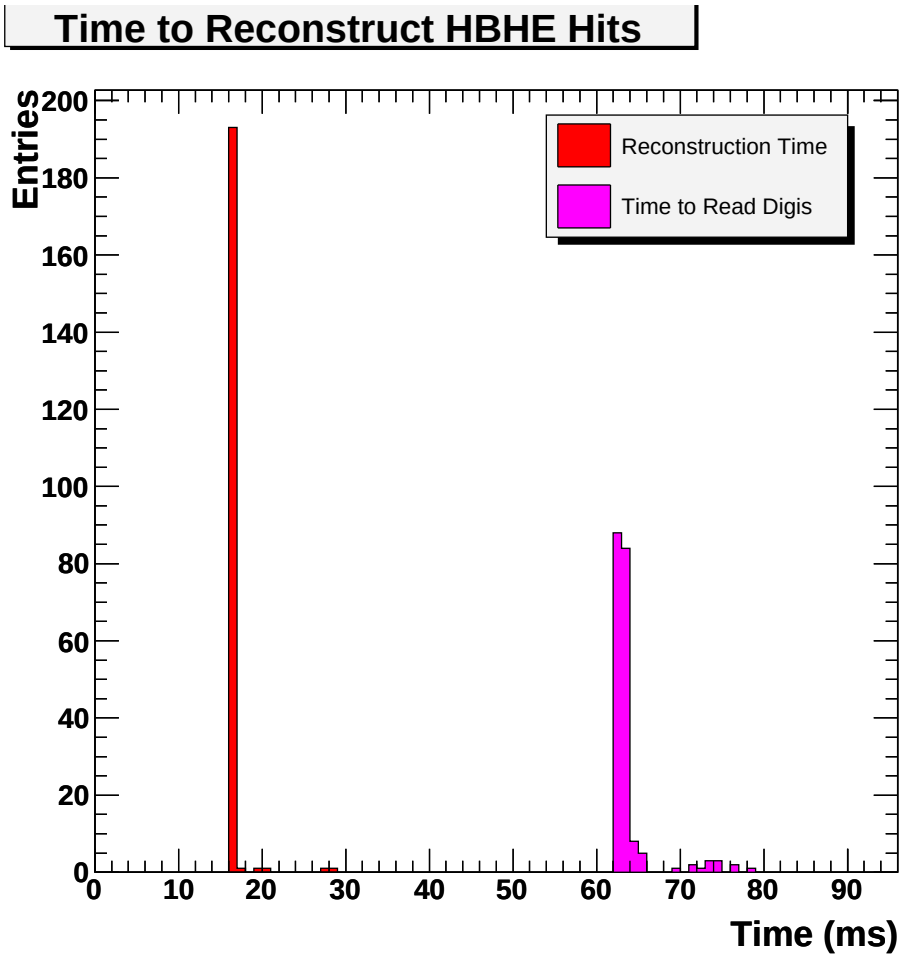
Jet Producer

Jet Timing Studies (cont.)

- Timing for the jet producers reflects only last element in the reconstruction chain:
  Unpacking $\Rightarrow$ HCAL and ECAL hits $\Rightarrow$ CaloTowers $\Rightarrow$ Jets
- Data unpacking time covered in an earlier talk by David Lange.
- `Timer` module reports back total processing time. Need to be careful to factor out the collection reading time (e.g. DIGIS for hit reconstruction), as that time will not be relevant for the overall online processing time.

HCAL Hit Reconstruction

- Using CMSSW_1_1_0 for reconstruction.
- Studies performed with a 2.4 GHz Intel Xeon processor.
- HBHE DIGIS read in from existing rootfile. Reading time should not be considered as part of the online processing time.
- No zero suppression. All HBHE DIGIS read (5184 channels $\times$ 10 time frames).

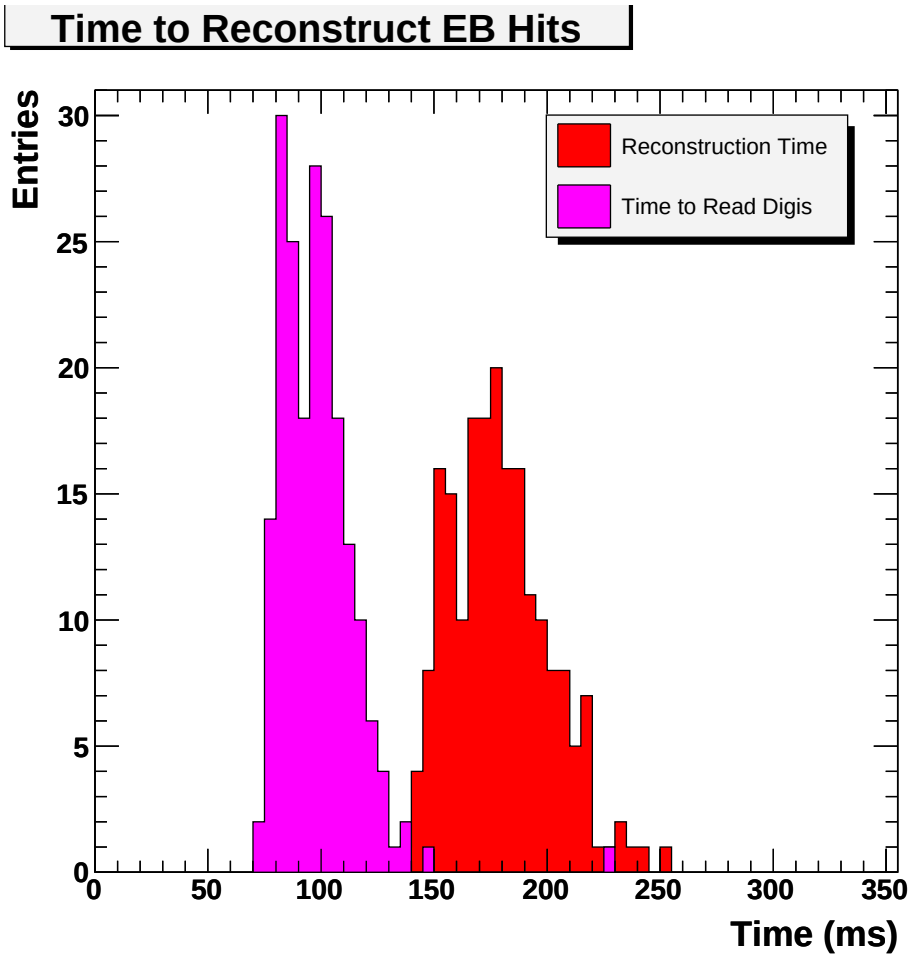


QCD MC Sample – $50 < \hat{p}_T < 80$ GeV

ECAL Hit Reconstruction

- Using CMSSW_1_1_0 for reconstruction.
- Studies performed with a 2.4 GHz Intel Xeon processor.
- EB DIGIS read in from existing rootfile. Reading time should not be considered as part of the online processing time.
- DIGIS are zero suppressed. Avg. 3162 channels / 61200 read.
- Reconstruction time dominated by module: `EcalWeightUncalibRecHitProducer`

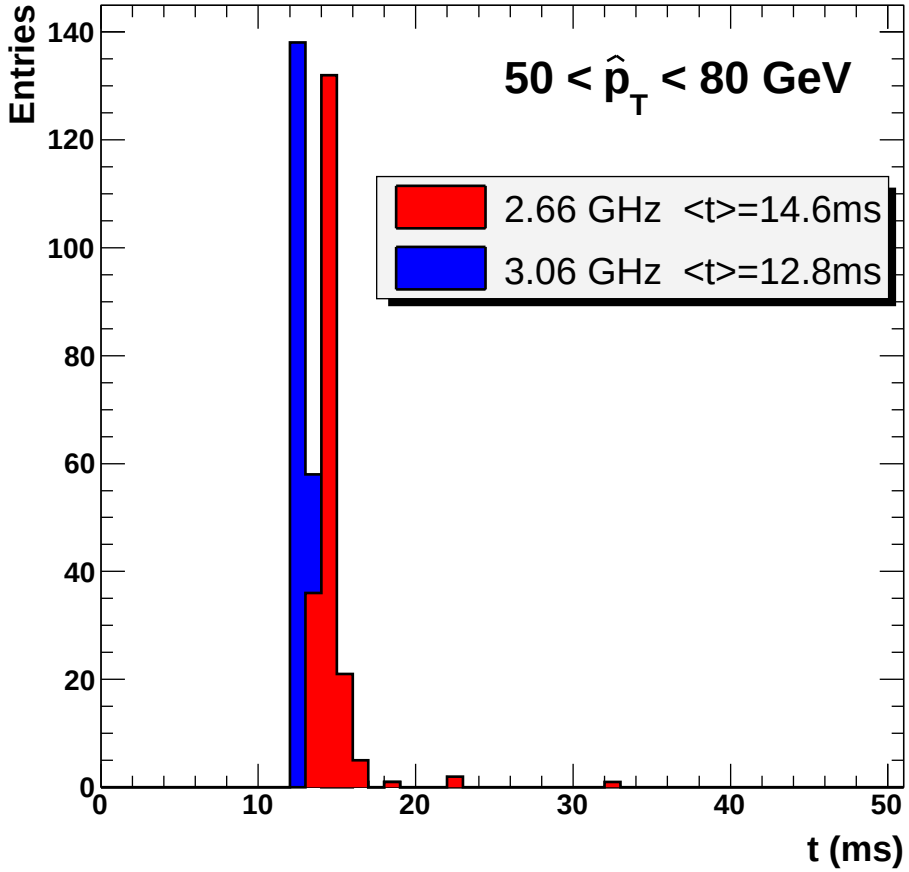
QCD MC Sample – $50 < \hat{p}_T < 80$ GeV



The difference in reading time between the HCAL and ECAL DIGIS is not understood at the moment.

CaloTower Reconstruction

- Using CMSSW_1_1_0 for reconstruction.
- Reconstruction times shown for 2.66 and 3.06 GHz Intel processors. After scaling for processor speed, the distributions are in good agreement.
- Time to fetch ECAL and HCAL hit collections is not included.



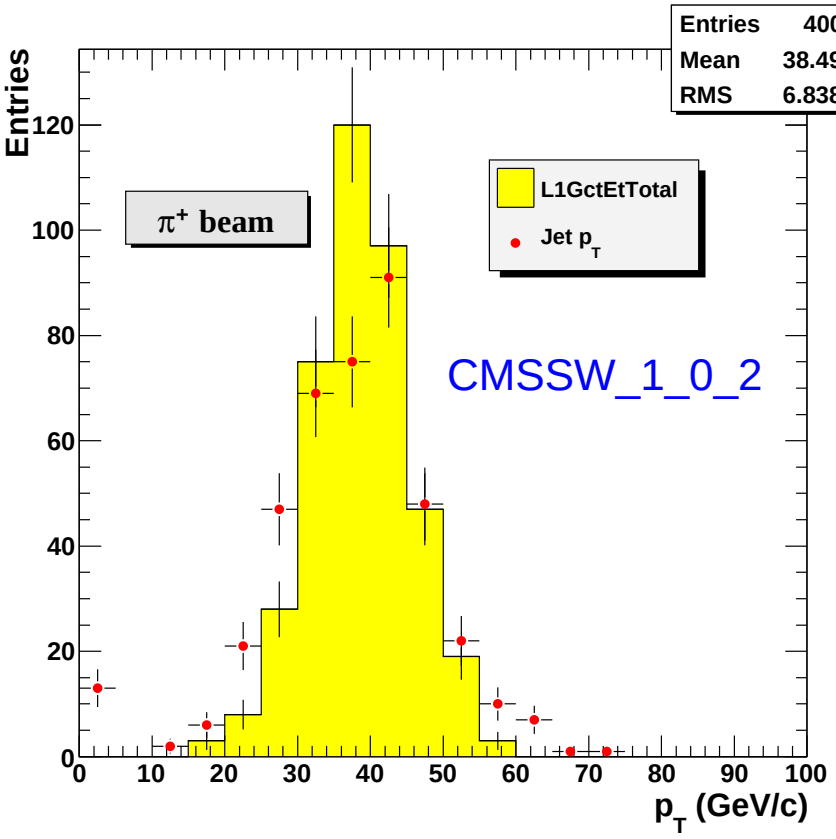
QCD MC Sample – $50 < \hat{p}_T < 80$ GeV

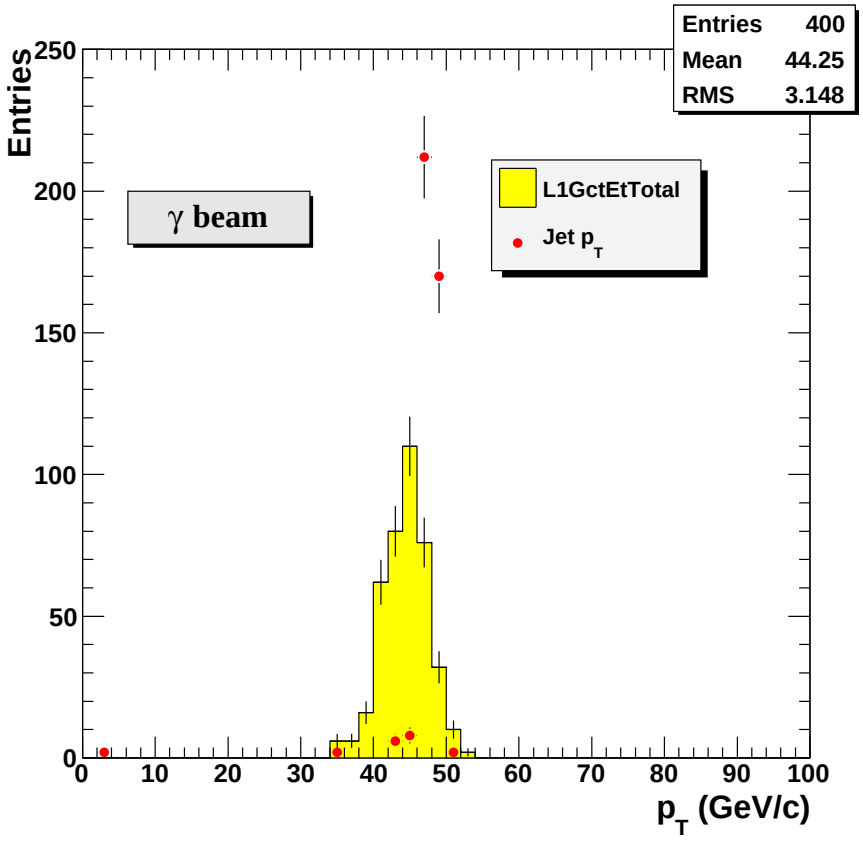
Level 1 Emulator Studies

- Introduction
- HLT JetMet Trigger Menu
- Jet Reconstruction Studies
- Timing Studies
- L1 Emulator
- Commissioning Triggers
- Upcoming Plans

50 GeV p_T particle gun MC

$-1.1 < \eta < 1.1, 0 < \phi < 2\pi$





L1 GCT output scaled by a factor of 3

Jets use midpoint cone algorithm with $R = 0.5$

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50 GeV $\mathbf{p_T}$ particle gun MC

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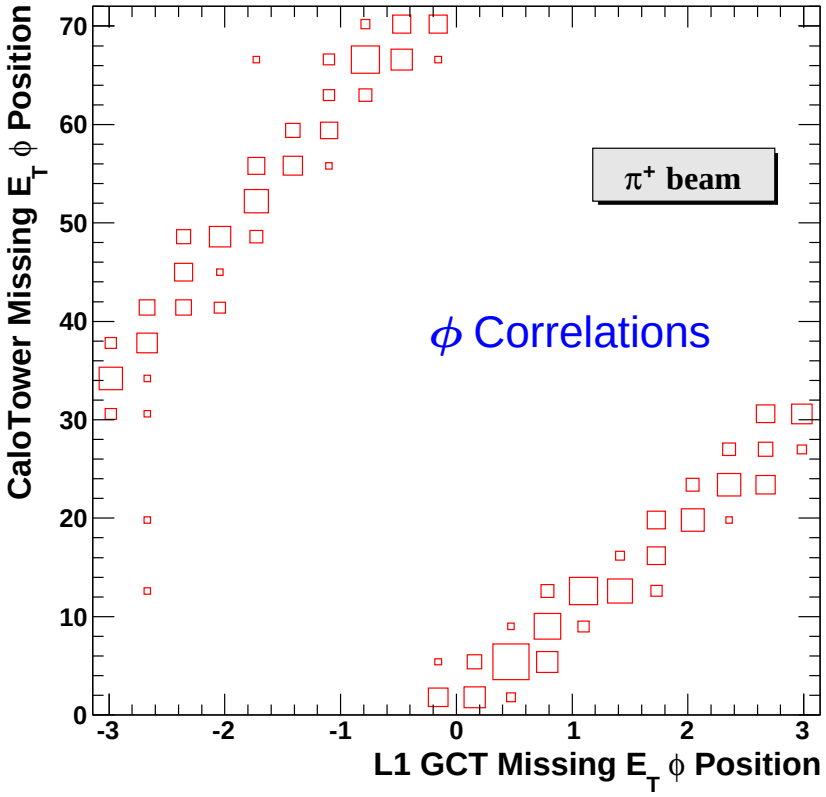
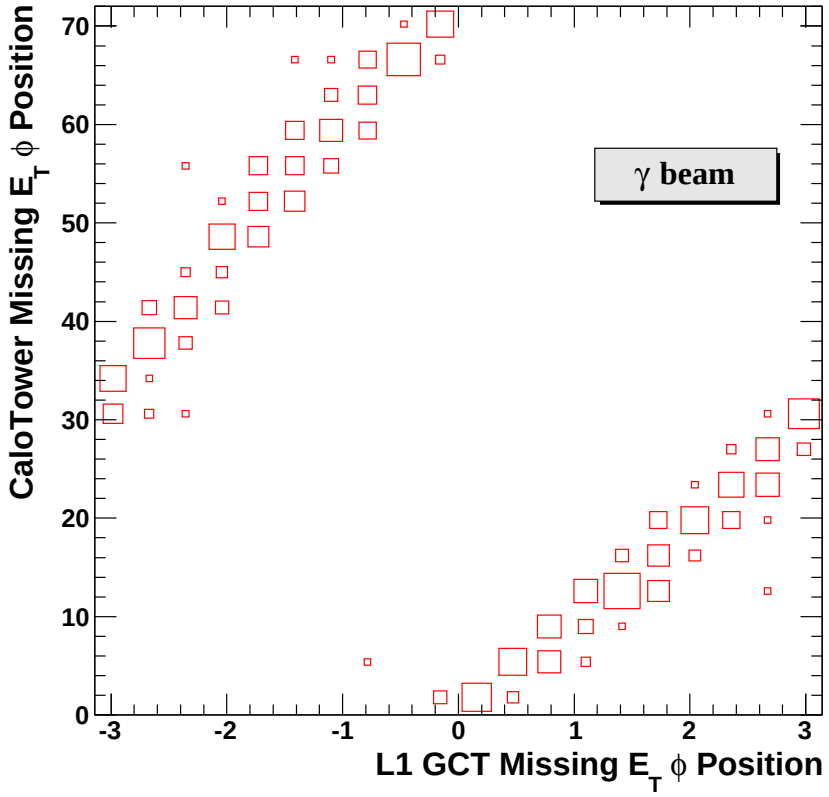
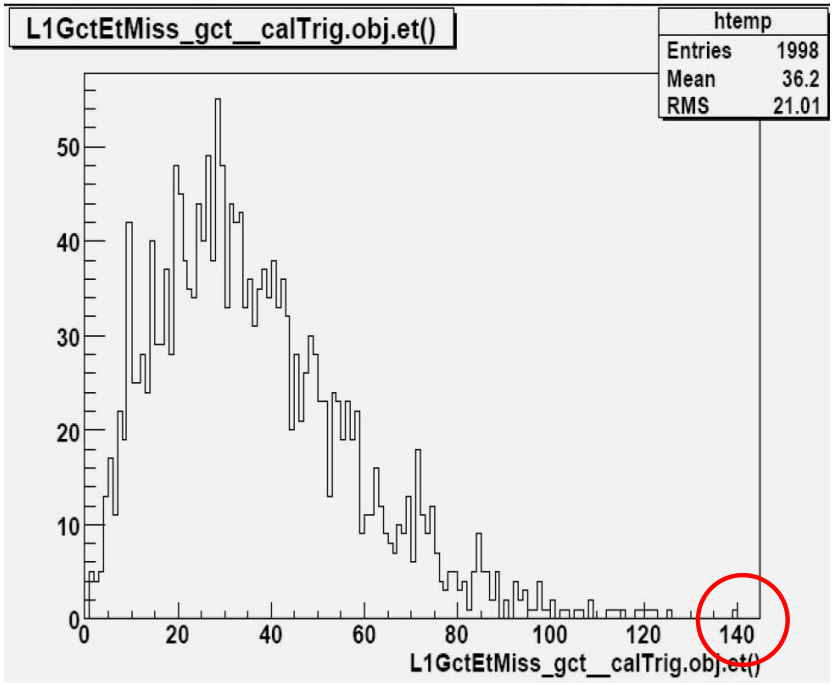


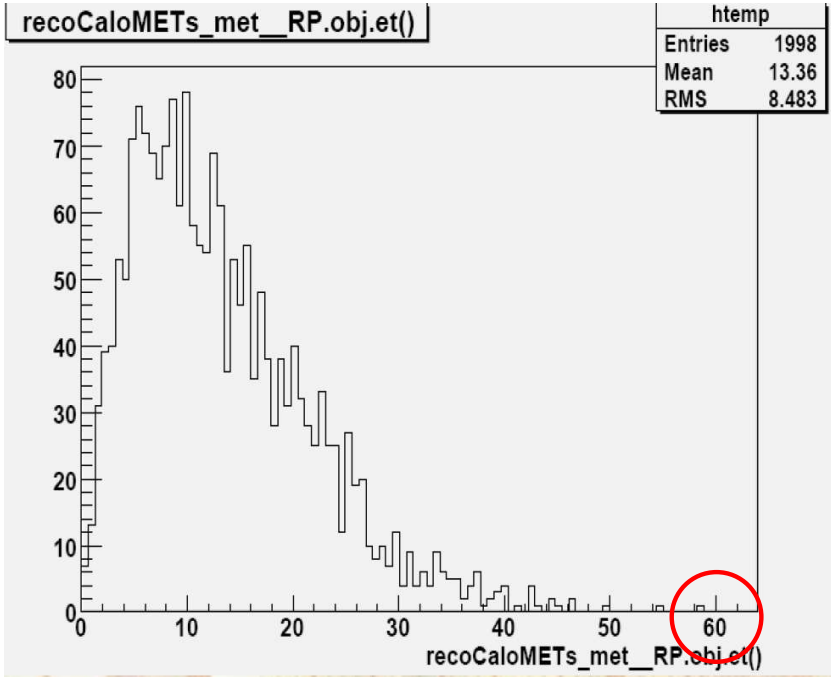


Level 1 Emulator Studies (cont.)

Greg Landsberg



$\not\!\!E_T$ from GCT



$\not\!\!E_T$ from CaloTowers

$\sqrt{s}$ = 900 GeV QCD sample: $80 < \hat{p}_T < 120$ GeV

L1 GCT output considerably higher than reconstructed output

Commissioning Triggers

See Chris Tully's talk at the Fall USCMS HCAL meeting for details.
http://indico.cern.ch/conferenceDisplay.py?confId=6825

- zero bias in crossings and in gaps
- minbias and single-tower triggers
- interspersed zero unsuppressed readout randomly distributed over different triggers – very low rate, first trigger following Nth BC0
- unprescaled jets (high E_T threshold)
  prescaled jets (lower E_T threshold)
- unprescaled dijet E_T trigger (high E_T threshold for dijet balance)
  prescaled dijet E_T trigger (low E_T threshold for dijet balance))
- unprescaled SumEt trigger (high E_T threshold to validate jet trigger)
  prescaled SumEt trigger (low E_T threshold to validate jet trigger)
- unprescaled MET + $\mathbf{H_T}$ and MET+SumET
  unprescaled MET (high threshold to detect anomalous behavior)
  prescaled MET (low thresholds to understand resolution)

Upcoming Plans

- $\mathbf{H_T}$ and missing $\mathbf{H_T}$ filters in CMSSW once the $\mathbf{H_T}$ producer is available.
- Use CSA06 HLT MC samples for high statistics studies.
- Continue with jet timing and efficiency studies.
- Continue to verify the level-1 emulator.
- Verify the HLT Jet and $\not\!\!E_T$ trigger rates reported in PTDRv2.
- Study cross-triggers (e.g. $\not\!\!E_T$ + leptons).
- Investigate the possibility of a Level-2 Jet / $\not\!\!E_T$ stage at HLT using Level-1 objects.
- Develop the Jet and $\not\!\!E_T$ trigger menu.