Effect of HO in MET resolution in 2012 data

- Look on
  - /MET/Run2012A-ProbmptReco-v1/RECO
  - /HT/Run2012A-ProbmptReco-v1/RECO
  - /Jet/Run2012A-ProbmptReco-v1/RECO
  - Cert_190456-194074_8TeV_PromptReco_Collision12_JSON.txt
  - CMSSW_5_2_3
    - Different than Default reconstruction of CMSW_5_2_3_patch1
- Used old noise filter (HBHENoiseFilter, ecalDeadCellTPFilter, eeNoiseFilter)
- No correction on Jet/MET, after inclusion of HO, one need to recalculate everything again.

- Preselected events with
  - No noisy Readout Module
  - Atleast one jets with Pt>50 GeV and |\(\eta\)|<1.2 (but later on use 0.9)
  - Atleast one HO tower with Energy >5.0 GeV, irrespective of any jet in that direction or not.
PF Jet/MET reconstruction

- Use standard PFAlgorithm, where HO are included, but thresholds of HO are not optimised yet.
- Use different thresholds for seed tower and different for Ring-0 and Ring-1 (in GeV)

<table>
<thead>
<tr>
<th>Seed Ring-0</th>
<th>Other Ring-0</th>
<th>Seed Ring-1</th>
<th>Other Ring-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>1.0</td>
<td>2.0</td>
<td>2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>2.0</td>
<td>5.0</td>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td>5.0</td>
<td>10.0</td>
<td>10.0</td>
<td>20.0</td>
</tr>
<tr>
<td>10.0</td>
<td>20.0</td>
<td>20.0</td>
<td>40.0</td>
</tr>
<tr>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>30.0</td>
<td>30.0</td>
<td>30.0</td>
<td>30.0</td>
</tr>
<tr>
<td>40.0</td>
<td>40.0</td>
<td>40.0</td>
<td>40.0</td>
</tr>
</tbody>
</table>
Calo Jet/MET reconstruction

- One can not use standard algorithms, which included all HO towers in MET
- Modify reconstruction code with a bias.
  - Use only HO towers, which are behind ($|\Delta R|<0.5$) a jets of $p_T>50$ GeV
- Use different thresholds for Ring-0 and Ring-1 (in GeV), need to find out how to put different threshold for Seed towers and others for clustering

<table>
<thead>
<tr>
<th>Ring-0</th>
<th>Ring-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td>10.0</td>
<td>20.0</td>
</tr>
<tr>
<td>15.0</td>
<td>25.0</td>
</tr>
<tr>
<td>20.0</td>
<td>30.0</td>
</tr>
<tr>
<td>30.0</td>
<td>40.0</td>
</tr>
<tr>
<td>40.0</td>
<td>50.0</td>
</tr>
</tbody>
</table>
Noisy Readout Module

- Looked for number of channels with different energy threshold in a readout module (RM), there are 18 towers in each RM in Ring±1

Remove events if any of these RM has more than 8 towers with E>2 GeV

<table>
<thead>
<tr>
<th>Ring+1</th>
<th>2-4</th>
<th>8-10</th>
<th>26-28</th>
<th>38-40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring−1</td>
<td>23-25</td>
<td>41-43</td>
<td>50-52</td>
<td>62-64</td>
</tr>
</tbody>
</table>
HO mean and pedestal (using /MET sample)

<table>
<thead>
<tr>
<th>$i_\eta$</th>
<th>$i_\phi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-9$</td>
<td>48</td>
</tr>
<tr>
<td>$-7$</td>
<td>15</td>
</tr>
<tr>
<td>$-5$</td>
<td>24</td>
</tr>
<tr>
<td>$-3$</td>
<td>7</td>
</tr>
<tr>
<td>$-2$</td>
<td>3, 60</td>
</tr>
<tr>
<td>1</td>
<td>29</td>
</tr>
<tr>
<td>3</td>
<td>51</td>
</tr>
<tr>
<td>5</td>
<td>9, 20</td>
</tr>
<tr>
<td>7</td>
<td>46, 60</td>
</tr>
<tr>
<td>8</td>
<td>2, 3, 4, 6, 66</td>
</tr>
<tr>
<td>9</td>
<td>27</td>
</tr>
<tr>
<td>10</td>
<td>2, 3, 8, 9</td>
</tr>
</tbody>
</table>

- Remove noisy channels (based on earlier /Jet sample)
- This table which was made using /Jet sample previously does not match with this MET sample!!
Pedestal in /HT and /Jet dataset

They are not same. Related with jet/trigger.
Timing information

- Consider only $[-10 \text{ to } 12], [-8 \text{ to } 12]$ for Ring-0 and Ring±1 respectively
HO Signal vs time in Ring-0

- Peak is in ~6ns
Survived events with different MET threshold
(PFMET with only Ring-0 towers)

- With at least one PFJet with Pt>50 GeV and |\eta|<0.9

- Upto about 140 GeV, there are reduction of high MET events after inclusion of HO.
- Seed threshold 10 GeV looks optimum choice for this
- MET upto 140 is dominated by shower leakage, beyond that those are noise in ECAL/HCAL, which are uncorrelated with HO?
Survived events with different MET threshold
(PFMET with Ring-0 and Ring±1 towers)

- Upto about 140 GeV, there are reduction of high MET events after inclusion of HO.
- MET upto 140 is this is better than only Ring-0 towers, but beyond that inclusion of HO towers deteriorates the MET performance much faster than only Ring-0 case!
Survived events with different MET threshold
\( (\text{tcMET with Ring-0 and Ring} \pm 1 \text{ towers}) \)

- Almost Same results as seen in PFMET for MET<140 GeV.
- For low threshold it deteriorate much faster than PFMET with for higher MET

Noise cleaning and timing criteria do not change the scenario
HO signal vs Pt of Calo Jets

- Total HO signal while eta of Jets <0.34 (Ring-0) and >0.34 & <0.8 (Ring±1)

- Looks like signals in Rin-0 and Ring±1 are same. But, here it is as a function of Pt not P.
- There is no correlation beyond 400-500 GeV
HO signal for different Pt of CaloJets (|\eta|<0.34)

- Do not see much correlation of HO signal and Pt of jets
HO signal for different Pt of CaloJets ($0.34 < |\eta| < 0.80$)

Do not see much correlation of HO signal and Pt of jets
There is no correlation beyond 150-160 GeV
HO signal for different tcMET (only Ring-0)

- Do not see much correlation of HO signal and MET value
HO signal for different tcMET (both Ring-0 & ±1)

- Do not see much correlation of HO signal and MET value
2011B1 MET dataset
(tcMET with Ring-0 and Ring±1 towers)

Also used EcalAnomaloueEventFilter in 2011b1 data

- Only Ring-0
- Ring-0 + Ring±1

- Almost Same in 2012 data set.
- Did not yet port back PF algorithm in CMSSW_4_2_x

No HO noise cleaning and timing criteria
2011B1 MET Data: HO vs Jet Pt

Same as 2012 data
2011b1 vs 2012 MET Data: HO vs MET

Looks slightly better correlation (or illusion) in 2011b1 data below 300 GeV, but not sufficient to reduce higher MET tails.
Summary

• Looked on MET and HO in 2011/2012 data
• Ring-0 towers looks stable and can included in Jet/MET calculation
• There are some noisy channel in Ring±1, which are removed along with few noisy RM
• There is not much correlation of HO signal with very high MET (>150 GeV) or very High Jet (>500 GeV). Those are really High MET events?
• Difficult to make any conclusion using this data.
• Selecting events with two leading jets in opposite direction (|Δφ|>π/2) did not change the scenario

Need calibration before go for Jet resolution

• Same study was done with /HT and /Jet sample to see any bias in trigger, which are in backup slides, not much difference in behaviour except (plots are in backup)
  • HT sample: gain is only upto ~110 GeV (instead of ~140 GeV)
  • Jet sample: gain is upto ~170 GeV !!
• 2011 looks better correlation with HO signal and MET (but a small fraction of event). Details of 2011A data samples are also in backup
A biased view: Select events with

- Initial sample with tcMET>200 GeV

At 200 GeV, we have a large gain !!!!!!!!!!!!!!
A biased view: Select events with

- Initial sample with PFMET $> 200$ GeV

At 200 GeV, we have a large gain $!!!!!!!!!!!!!!!!!!!!!
Survived events with different MET threshold (PFMET with HT triggered events)

- With at least one PFjet with $P_T > 50$ GeV and $|\eta| < 0.9$

**Only Ring-0**

**Ring-0 + Ring±1**
Survived events with different MET threshold (tcMET with HT dataset)

Only Ring-0

Ring-0 + Ring±1
HO signal vs Pt of Calo Jets (HT dataset)

- Total HO signal while eta of Jets <0.34 (Ring-0) and >0.34 & <0.8 (Ring±1)

- Looks like more signal in Ring±1 in comparison with /MET dataset
- But, there is no correlation beyond 400-500 GeV (same as /MET dataset)
HO signal vs MET value (HT dataset)

- There is no correlation beyond 150-160 GeV
Survived events with different MET threshold
(PFMET with Jet triggered events)

• With at least one PFjet with \( P_t > 50 \) GeV and \( |\eta| < 0.9 \)

Only Ring-0

Ring-0 + Ring±1
Survived events with different MET threshold (tcMET with HT dataset)

Only Ring-0

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HO signal vs MET value (HT dataset)

- There is no correlation beyond 150-160 GeV
MET VS HO energy (2012A data)

MET dataset

HT dataset

Jet dataset
2011a May10 Data

**R0**

- Remaining events vs. MET threshold (GeV)
- Data points for different thresholds labeled:
  - 0.05
  - 0.1
  - 0.2
  - 0.5
  - 1.0
  - 2.0
  - 5.0
  - 10.0
  - 20.0
  - 30.0
  - 40.0

**R0+R1**

- Remaining events vs. MET threshold (GeV)
- Data points for different thresholds labeled:
  - 1.1
  - 1.2
  - 1.5
  - 1.10
  - 1.20
  - 1.30
  - 1.40

**Ratio**

- Ratio vs. MET threshold (GeV)
- Data points for different thresholds labeled:
  - 0.05
  - 0.1
  - 0.2
  - 0.5
  - 1.0
  - 1.2
  - 1.5
  - 1.10
  - 1.20
  - 1.30
  - 1.40
2011a V5 Data

Remaining events vs. MET threshold (GeV) for R0 and R0+R1.

Ratio vs. MET threshold (GeV) for different categories.

Categories include 0.05, 0.1, 0.2, 0.5, 1.0, 1.1, 1.2, 1.5, 1.10, 1.20, 1.30, 1.40.
2011a V6 Data

Remaining events vs. MET threshold (GeV)

- R0
- R0+R1

Ratio plots for different values (0.05, 0.1, 0.2, 0.5, 0.10, 0.20, 0.30, 0.40)

MET threshold (GeV) vs. Ratio
HO vs Jet in 2011A

May10

V4
HO vs Jet in 2011A

HO Energy (GeV)

Pt of Jet (GeV)

Ring-0

V5

Ring±1

V6

Ring-0

Ring±1