Pileup offset correction update

Revised EM and HAD energy fractions and progress towards accounting for the full offset

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Pile-up offset jet-energy correction

Introduction and aims of the offset correction

We have been investigating contributions to jet energy not associated to the primary interaction but which can be corrected for in an average way using the size and location of a jet.

- This is an investigative study, first and foremost
- Both CDF and DZero calorimeters saw such an effect
- However, ours are different calorimeters, in a different environment, used in different ways

The burden of proof is on us to claim that this effect is either significant enough to merit a correction or negligible enough (on an average basis) to approach it with a jet-by-jet correction.

$$\mathcal{O}(\eta, N_{PV}, \mathcal{L}) = E_{ZB}(\eta, \mathcal{L}) + E_{PU}(\eta, N_{PV}, \mathcal{L})$$

Today's focus:

EM and HAD tower energies

Revised tower *EM* and *HAD* distributions

Offset correction

Measured tower and jet energy offsets

Corrected jet energy offset with standard towers

Corrected jet energy offset with topo-towers

Conclusions

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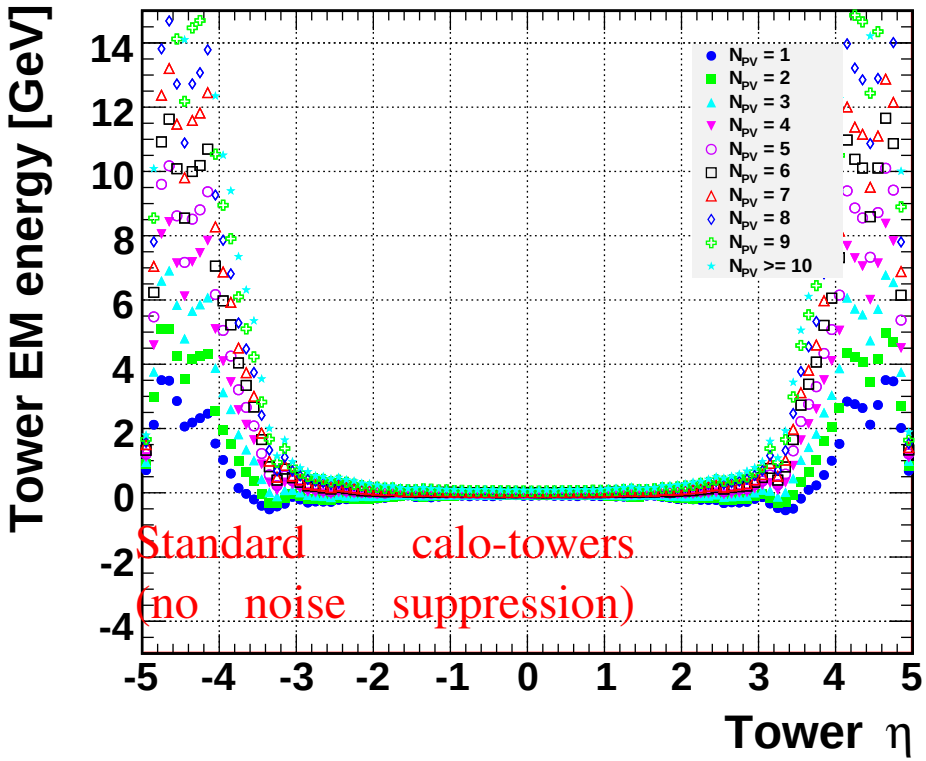
Tower energy distributions

Calo-towers in minimum bias events

Reminder and update

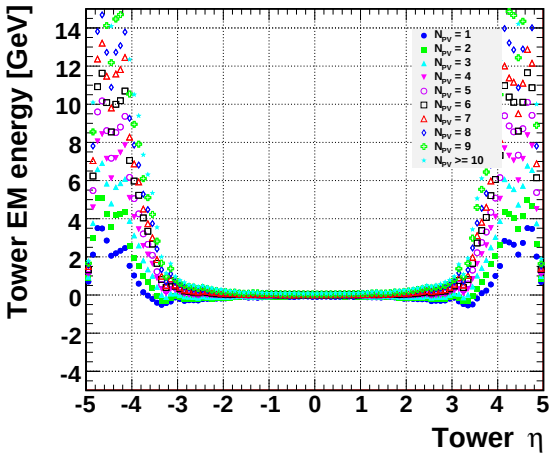
At the end of last year, we began looking at the breakdown of the energy deposition in *EM* and *HAD* separately. We saw some strange distributions, but they turned out to be due to neglecting the cell weights in the tower when calculating the *EM* and *HAD* energy components. Today we'll have an updated look at those distributions.



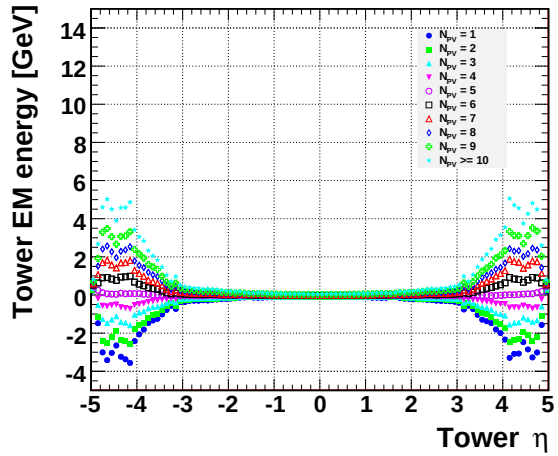
Today's talk will elaborate on *HAD* and *EM* energies for these events

EM: *PreSamplerB*, *PreSamplerE*, *EMB*$(1-3)$, *EME*$(1-3)$, *FCAL0*
HAD : Everything else

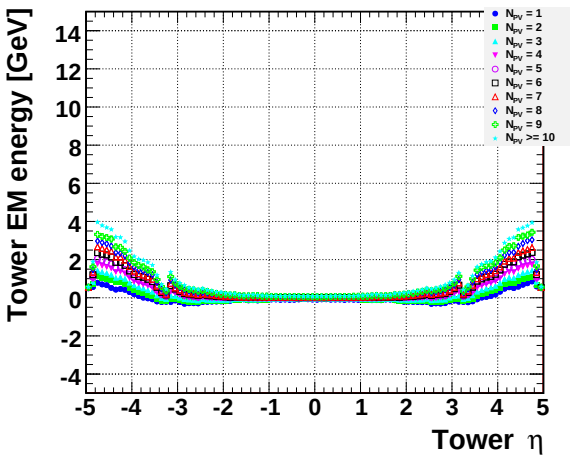
MB tower EM energy distributions vs. η



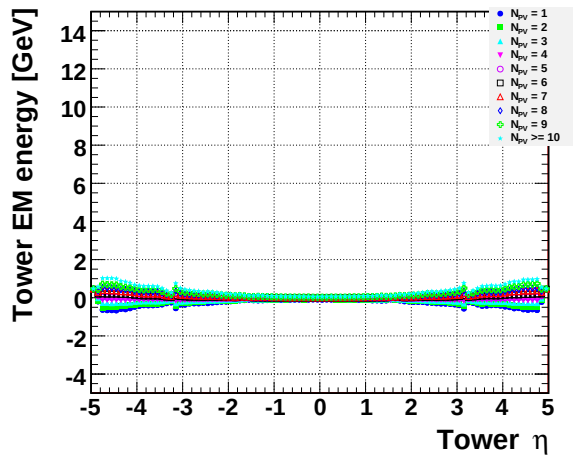
Before: $1 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 75ns



Before: $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

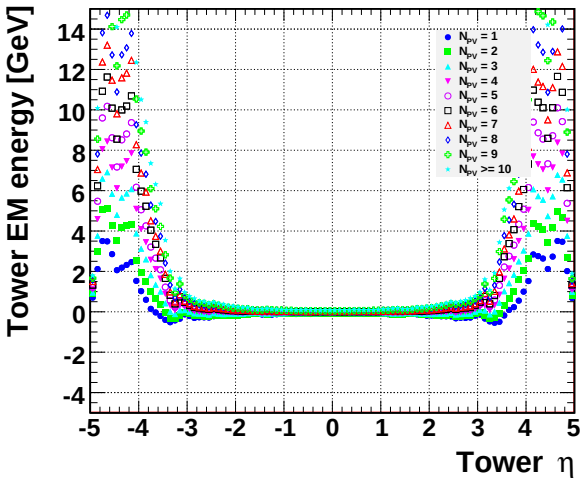


Updated: $1 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 75ns



Updated: $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

MB tower EM energy distributions vs. η



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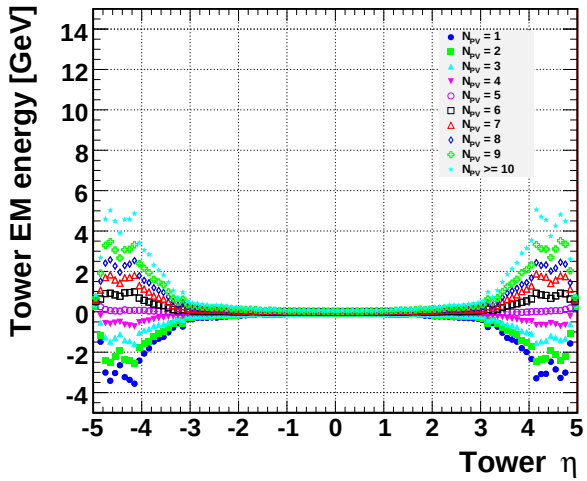
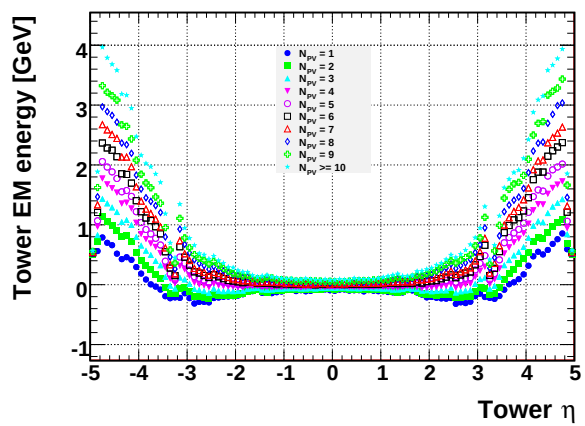
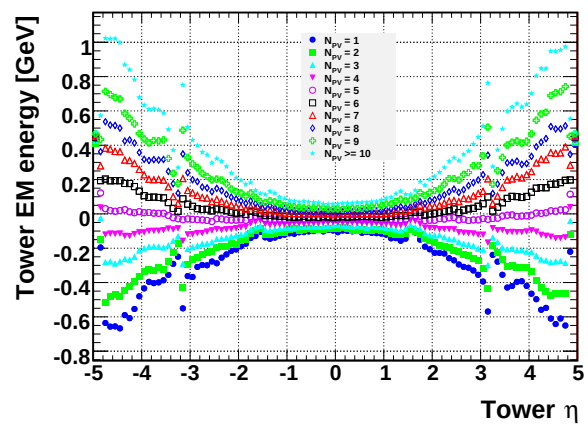


Before: $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns



Updated: $1 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 75ns



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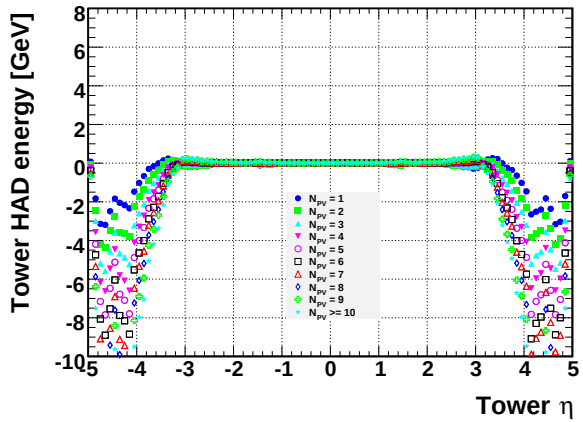
MB tower HAD energy distributions vs. η



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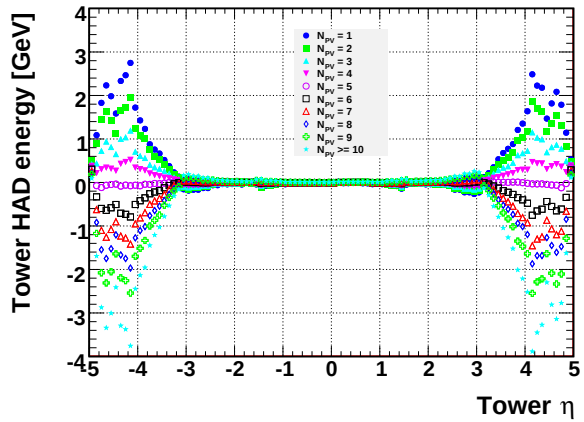

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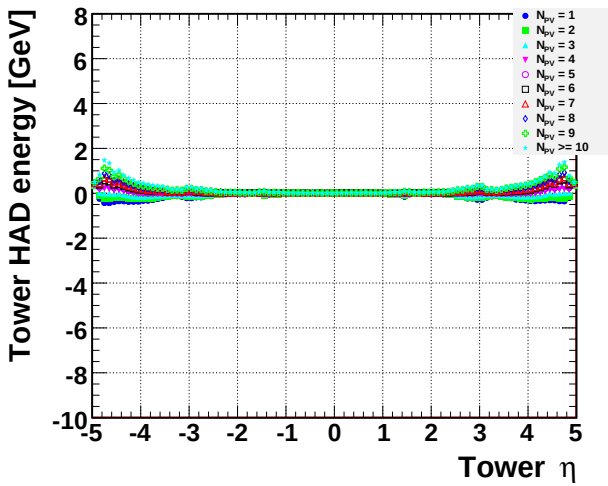
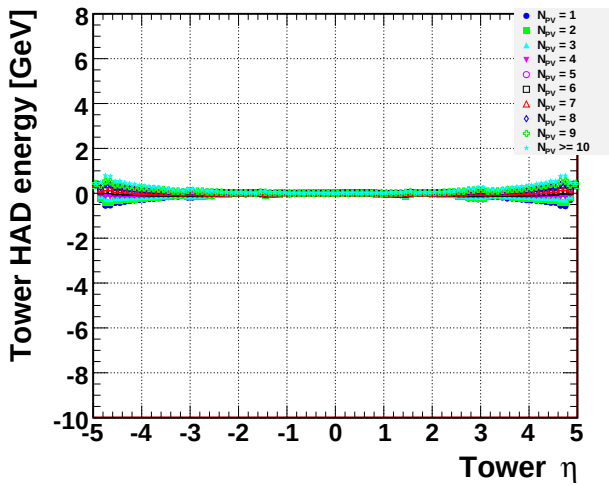
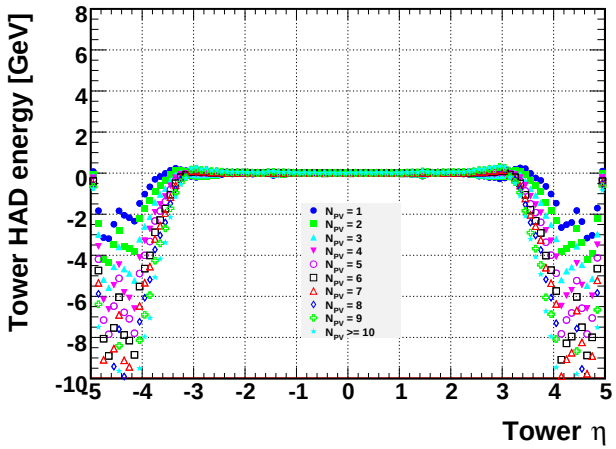


Updated: $1 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 75ns

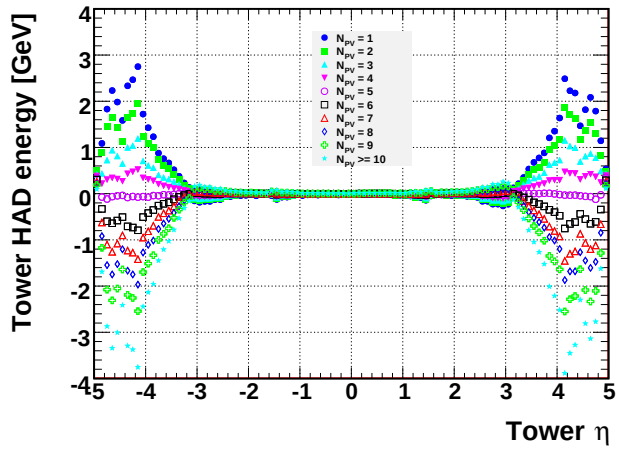


Updated: $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

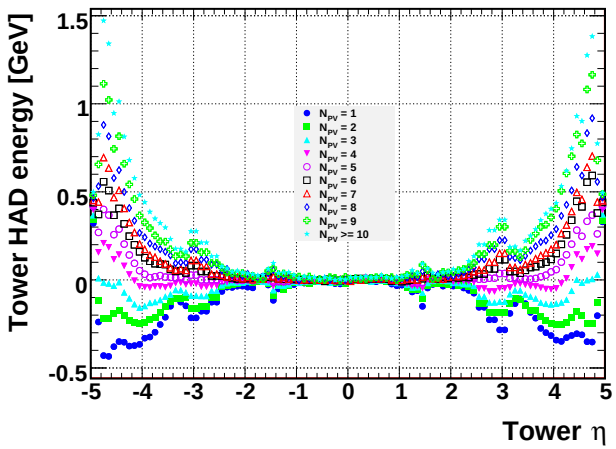
MB tower HAD energy distributions vs. η



Before: $1 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 75ns



Before: $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns



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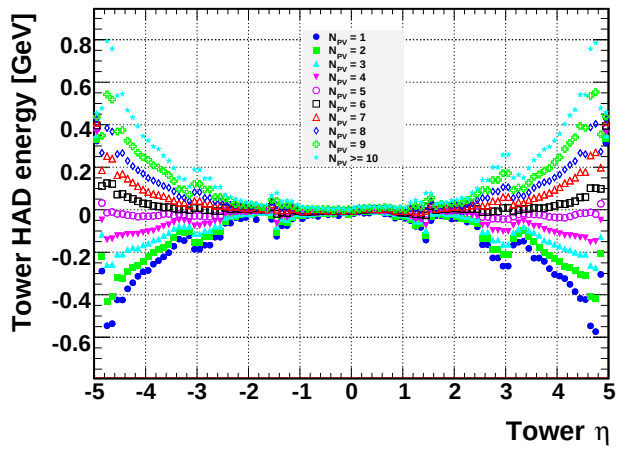

Updated: $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

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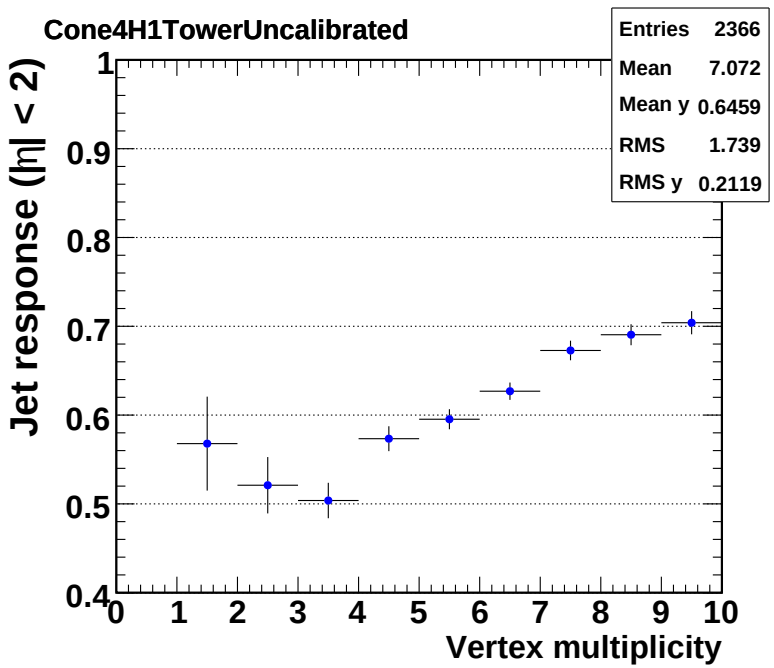
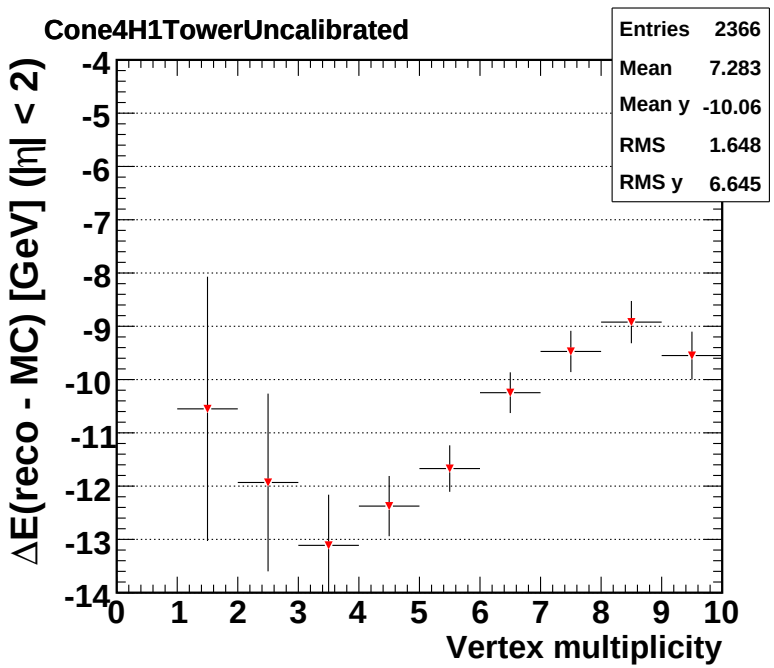
Back to the offset correction...

Now that we have the EM and HAD energy distributions sorted out ..

- Can we account for the shifts in response as a function of in-time pile-up?

Looking at the tower energy offset and response for central jets at EM-scale



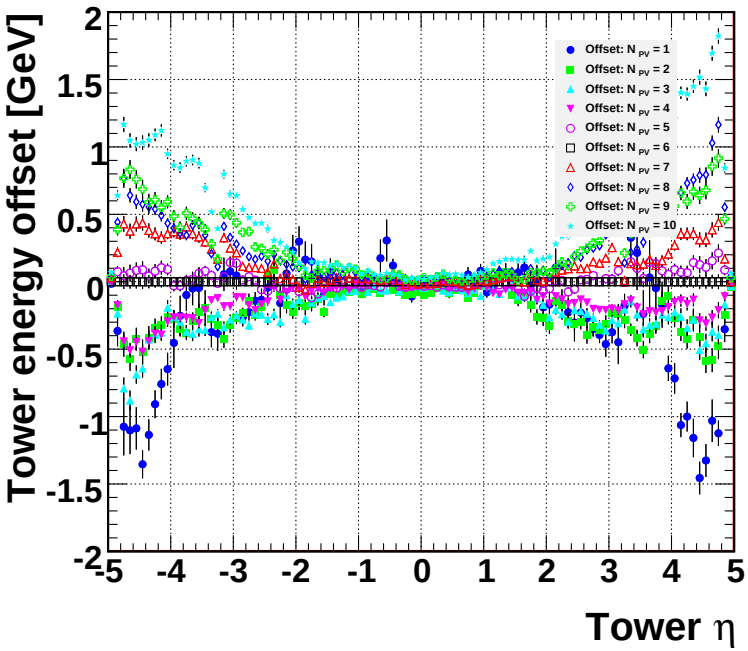


Calo-towers: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

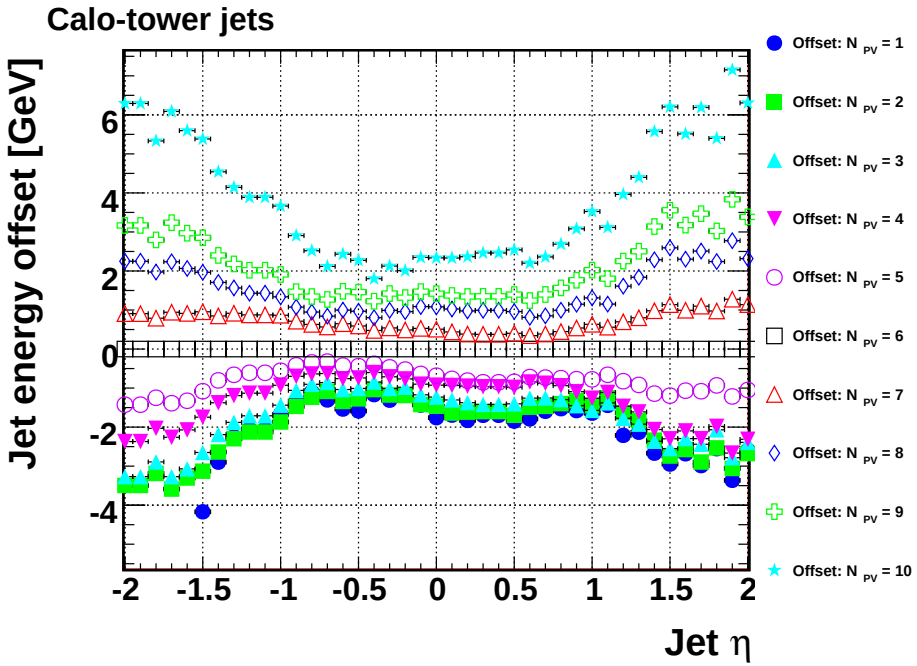
Calo-tower jets: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

Tower and jet energy offset (w.r.t. $\langle N_{PV} \rangle$) vs. η

Calo-towers in J2 events



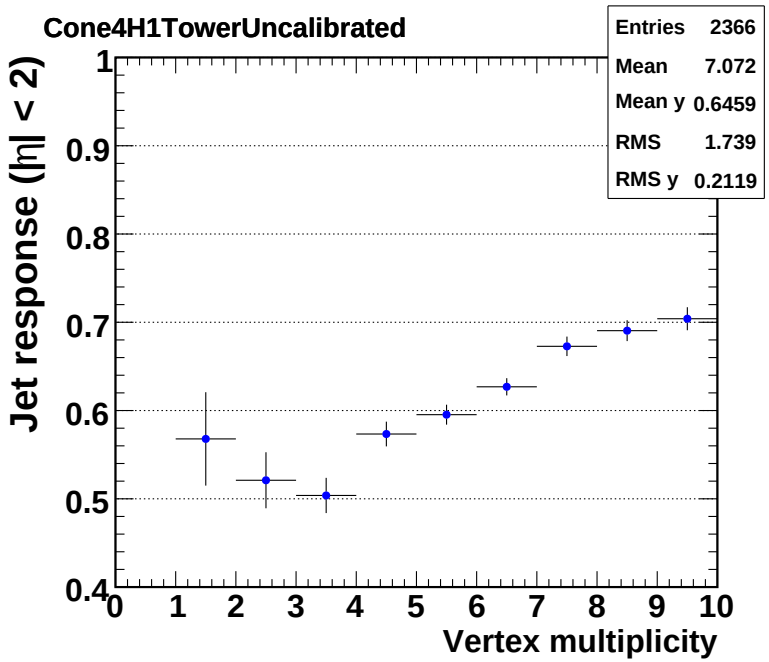
Calo-towers: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns



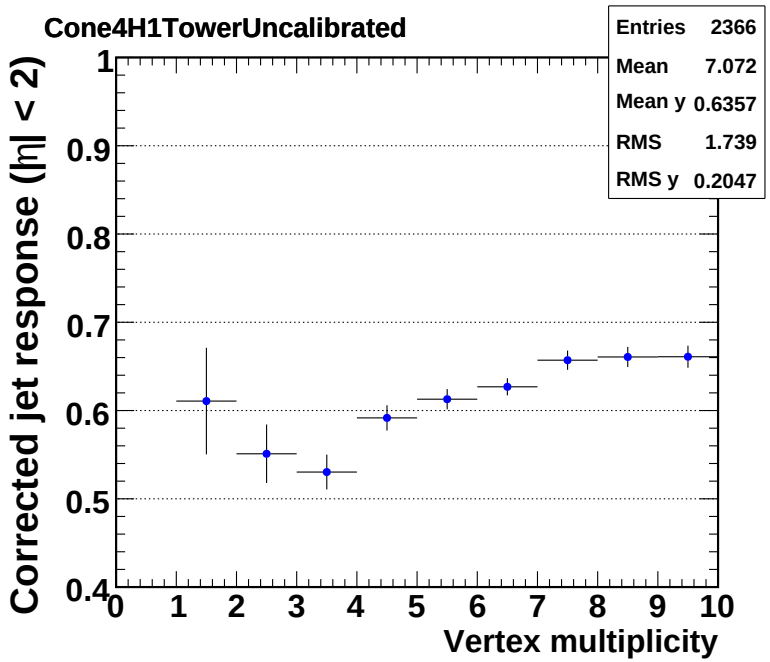
Cone $R = 0.4$ tower jets: $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

Jet energy offset vs. η

Calo-towers in J2 events



Un-corrected jets: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

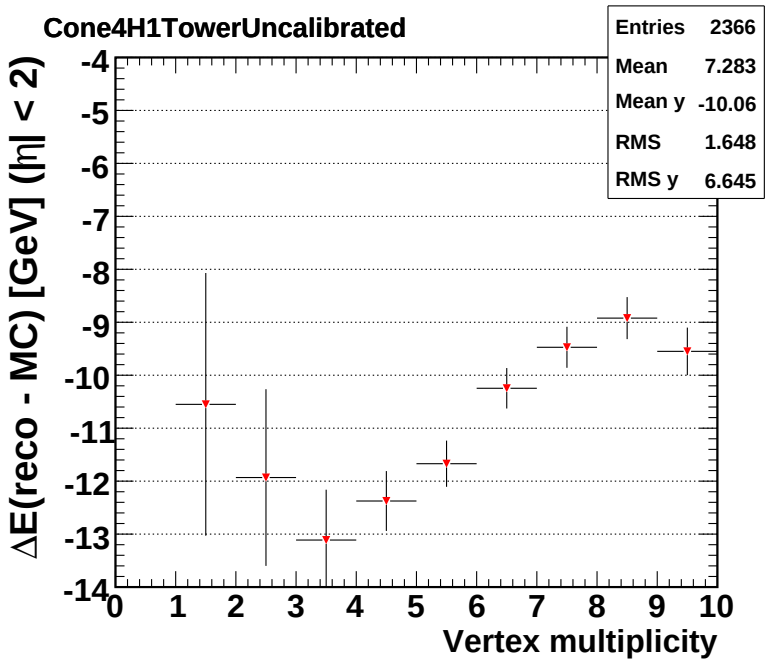


Corrected jets: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

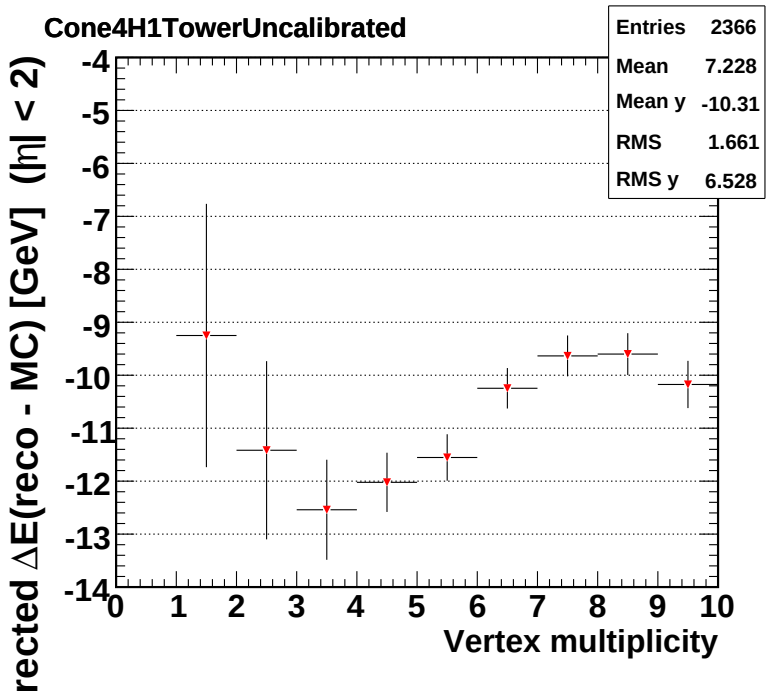
- Reduced the overall response increase from 35-40% to 15-20% (from lowest to highest response)
- *High multiplicity events seem stable!*
- Do I have a good measurement of the tower energies? (need more events, esp. low N_{PV})

Jet energy offset vs. η

Calo-towers in J2 events



Un-corrected jets: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns



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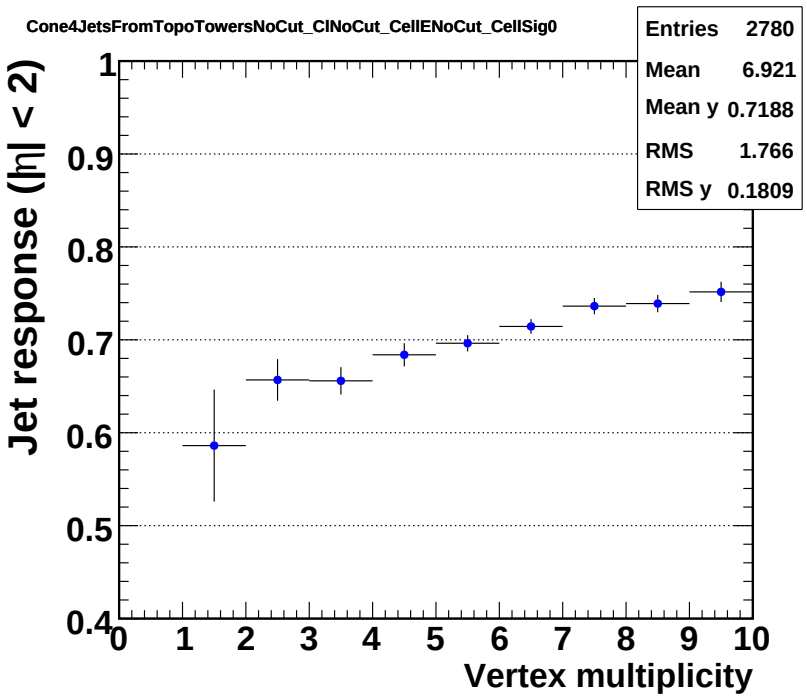
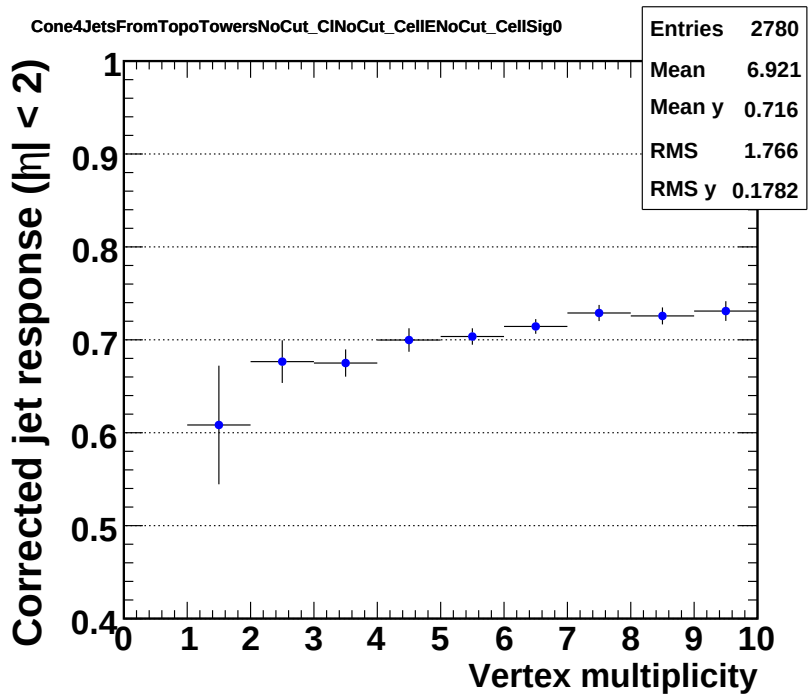
Jet energy offset vs. η

Topo-towers in J2 events



Un-corrected jets: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

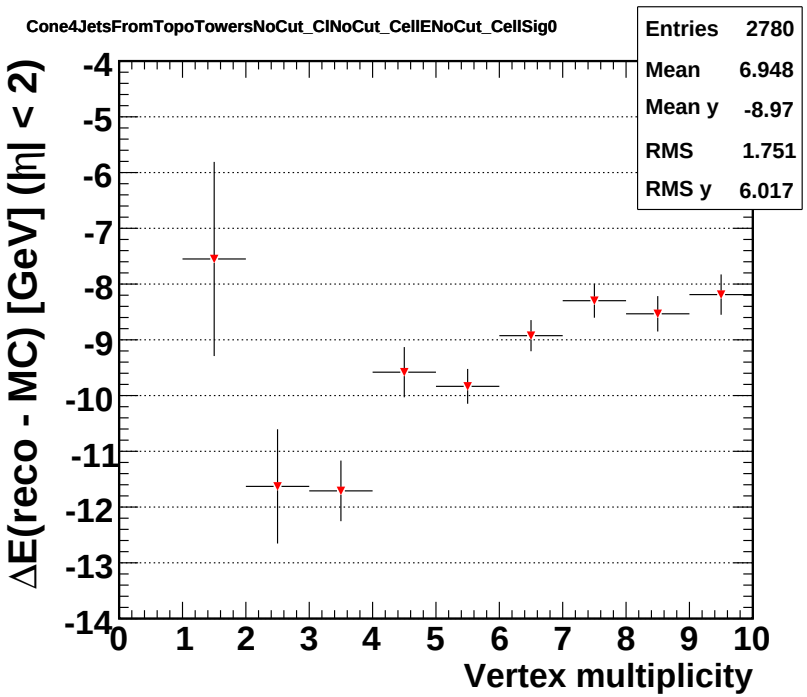


Corrected jets: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

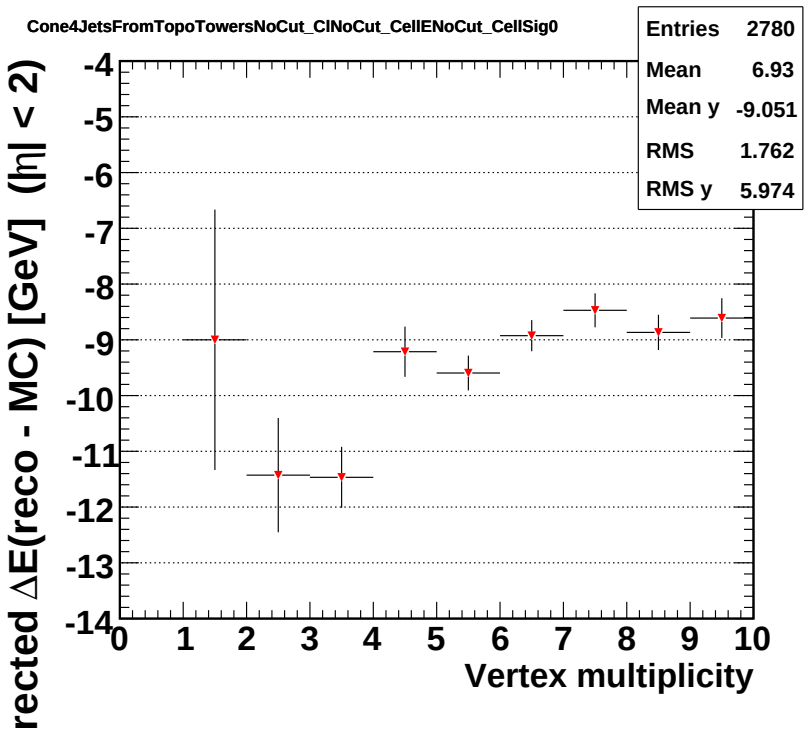
- Reduced overall effect for towers with noise suppression
- ***Very little offset after correction!***

Jet energy offset vs. η

Topo-towers in J2 events



Un-corrected jets: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns



Corrected jets: $J2$, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns

- Reduced overall effect for towers with noise suppression
- ***Very little offset after correction!***

Summary and outlook

Status of offset correction and observations

- We have now separated the energy contributions into *EM* and *HAD* separately (sensibly now)...but to no avail
- The offset correction can account for 50-55% of the total offset for standard calo-tower jets
- Jets from noise suppression show a reduced offset before correction
- They also seem to respond much better to the correction itself

Towards the initial jet-energy offset correction with data

- If we can measure the offset with data, we will be in a very good position to then apply jet-by-jet corrections
- Is the calo-tower "re-summation" (`TowerNoiseTool`) have un-desirable effects in events with pile-up? Is it thwarting our attempts at correcting for offset?
- Statistics for towers-in-jets in *MB* events is too small to say anything useful at the moment....need to understand spatial correlations (Giorgi Arabidze will help with this)

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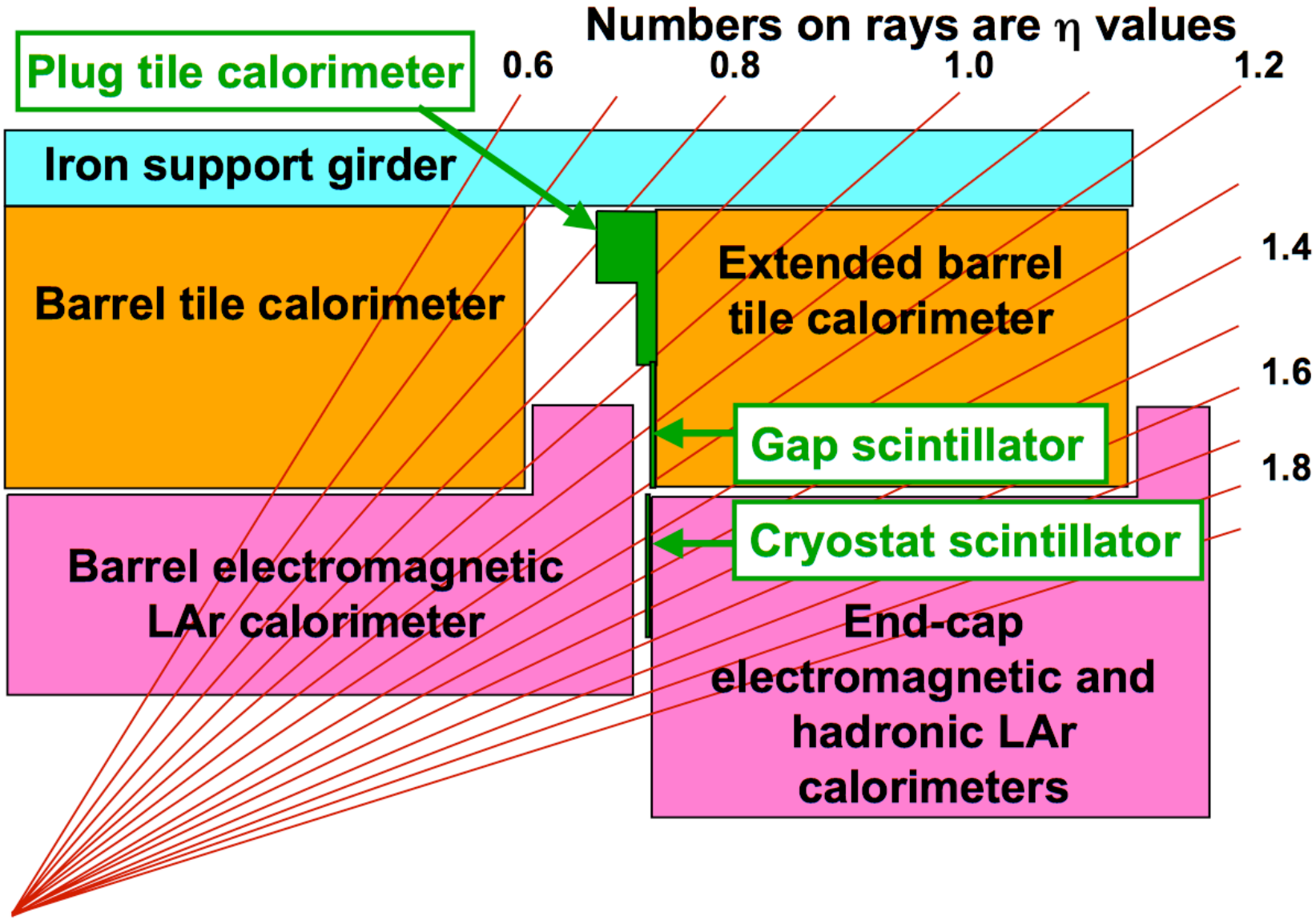
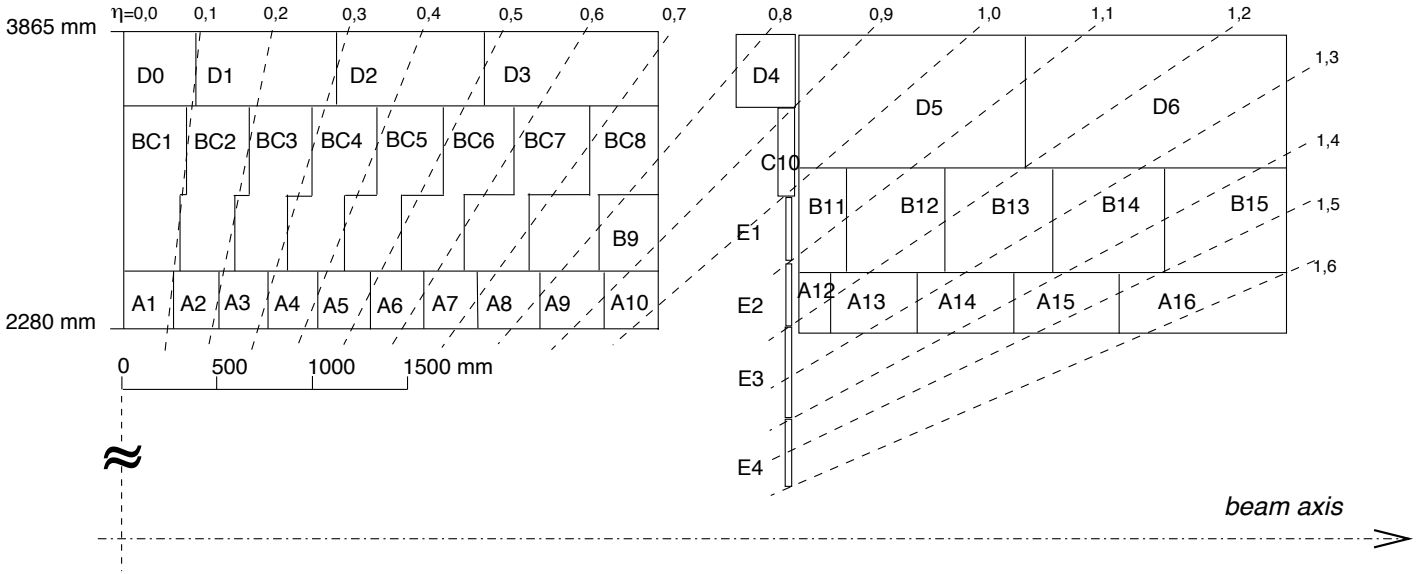
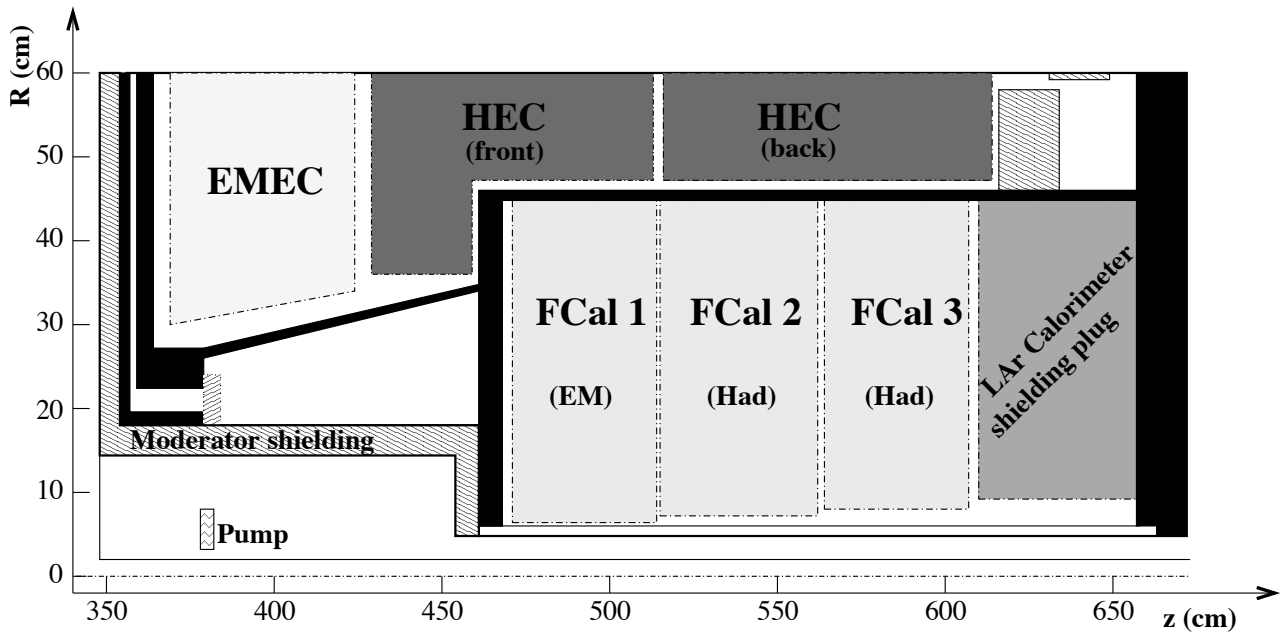
Additional material


Numbers on rays are η values
Plug tile calorimeter
0.6
0.8
1.0
1.2
Iron support girder
Barrel tile calorimeter
Extended barrel tile calorimeter
1.4
1.6
Gap scintillator
1.8
Cryostat scintillator
Barrel electromagnetic LAr calorimeter
End-cap electromagnetic and hadronic LAr calorimeters


η=0,0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1,0
1,1
1,2
1,3
1,4
1,5
1,6
3865 mm
2280 mm
D0
D1
D2
D3
D4
D5
D6
BC1
BC2
BC3
BC4
BC5
BC6
BC7
BC8
B9
C10
B11
B12
B13
B14
B15
E1
E2
E3
E4
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A12
A13
A14
A15
A16
0
500
1000
1500 mm
beam axis


R (cm)
60
50
40
30
20
10
0
EMEC
HEC
(front)
HEC
(back)
FCal 1
(EM)
FCal 2
(Had)
FCal 3
(Had)
LAr Calorimeter
shielding plug
Moderator shielding
Pump
350
400
450
500
550
600
650
z (cm)

Information related to LAr design for high luminosity

- Marco Delmastro's thesis:
  `http://cdsweb.cern.ch/record/953119/files/thesis-2003-033.pdf`
- LAr ECAL Team tutorial this summer.
  `http://indico.cern.ch/conferenceDisplay.py?confId=35889`
- *The* reference for LAr
  - "*Signal processing considerations for liquid ionization calorimeters in a high rate environment*"
  - NIM A: Volume 338, Issues 2-3, 15 January 1994, Pages 467-497
- Comparison between the estimated noise from `CaloNoiseTool` and the real noise from the pileup overlay with release 12
  - ATL-LARG-PUB-2007-011
- Wiki for calorimeter digitization:
  `https://twiki.cern.ch/twiki/bin/view/Atlas/CaloDigitization`
- Some related posts to the Pileup Hypernews Forum
  - `https://hypernews.cern.ch/HyperNews/Atlas/get/pileUp/61/3/1/2/1.html`
  - `https://hypernews.cern.ch/HyperNews/Atlas/get/pileUp/47/1/1.html`
  - `https://hypernews.cern.ch/HyperNews/Atlas/get/pileUp/46/1.html`

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Dataset information

- MB, $1 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 75ns
  - valid1.105001.pythia_minbias.digit.RDO.e357_s462_d137
  - http://gridui06.usatlas.bnl.gov:25880/server/pandamon/query?mode=dset&name=valid1.105001.pythia_minbias.digit.RDO.e357_s462_d137&grid=panda@tw,panda@us
- MB, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns
  - valid1.105001.pythia_minbias.digit.RDO.e357_s462_d140
  - http://gridui06.usatlas.bnl.gov:25880/server/pandamon/query?mode=dset&name=valid1.105001.pythia_minbias.digit.RDO.e357_s462_d140&grid=panda@us
- *J*2, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns
  - valid1.105011.J2_pythia_jetjet.digit.RDO.e344_s479_d137
  - http://gridui06.usatlas.bnl.gov:25880/server/pandamon/query?mode=dset&name=valid1.105011.J2_pythia_jetjet.digit.RDO.e344_s479_d137&grid=panda@us
- *J*2, $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$, 25ns
  - valid1.105011.J2_pythia_jetjet.digit.RDO.e344_s479_d140
  - http://gridui06.usatlas.bnl.gov:25880/server/pandamon/query?mode=dset&name=valid1.105011.J2_pythia_jetjet.digit.RDO.e344_s479_d140&grid=panda@us

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