Update on resolution studies for EEEMCal

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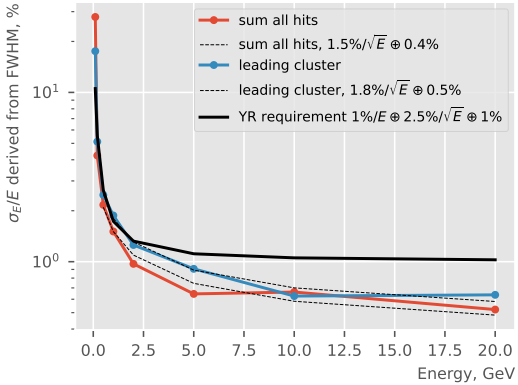
Today's topic

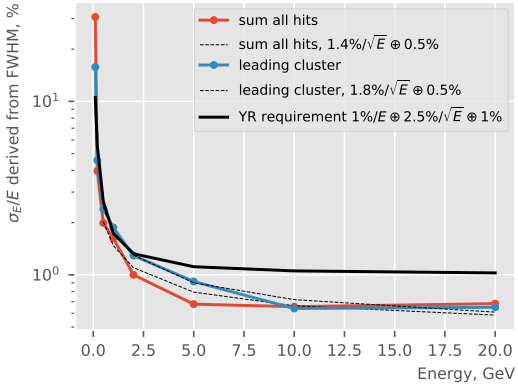
Study of `https://github.com/eic/EICrecon/pull/1064`

`-PEEMC:EcalEndcapNRawHits:readoutType=simple`



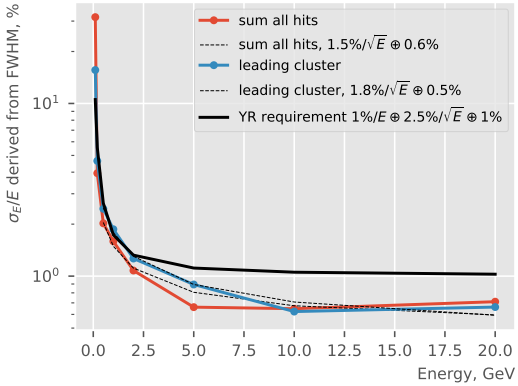
No extra smearing, no photon counting modelled

```
-PEEMC:EcalEndcapNRawHits:readoutType=poisson_photon
```



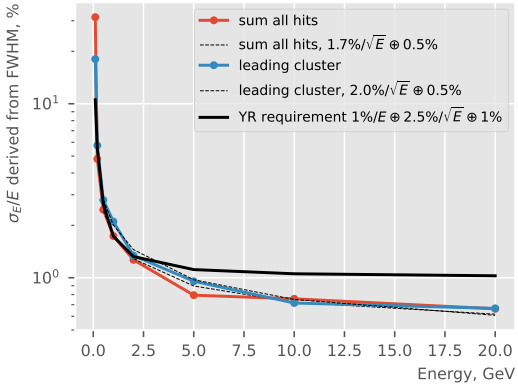
Nominal 17 pe/MeV

```
-PEEMC:EcalEndcapNRawHits:readoutType=poisson_photon
-PEEMC:EcalEndcapNRawHits:photonDetectionEfficiency=0.02
```



Test with 6 pe/MeV

```
-PEEMC:EcalEndcapNRawHits:readoutType=simple
-PEEMC:EcalEndcapNRawHits:energyResolutions=0.007669649888473705,0,0
```



$$0.007669649888473705 = \frac{1}{\sqrt{17000 pe/GeV}}$$, i.e. additional $0.76\%/\sqrt{E}$ smearing introduced

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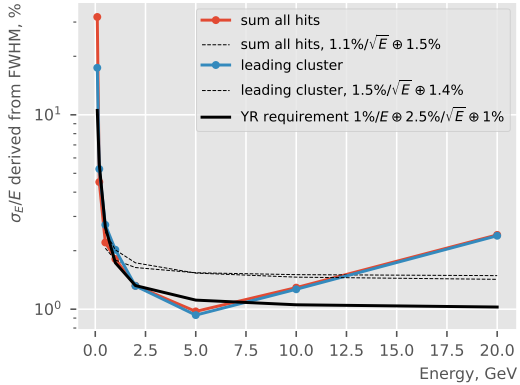
`-PEEMC:EcalEndcapNRawHits:readoutType=sipm`



(S14160-6015PS - 159565 pixels, 6x6 mm) × 4 sensors, totally receiving 17 pe/MeV (based on Artur's original study)

$\frac{17000*20}{4*159565} \approx 0.53$, indded, we are supposed to be in the saturation

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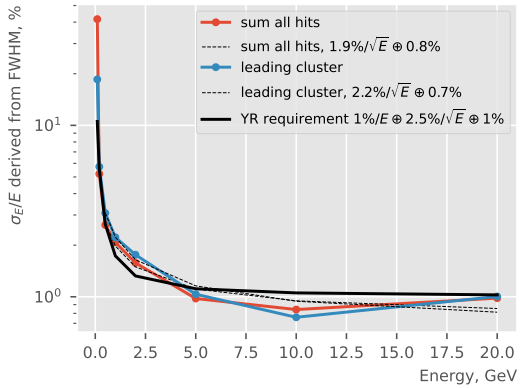
```
-PEEMC:EcalEndcapNRawHits:readoutType=sipm
-PEEMC:EcalEndcapNRawHits:photonDetectionEfficiency=0.02
```



Test with 6 pe/MeV, Looks like issue was with saturation

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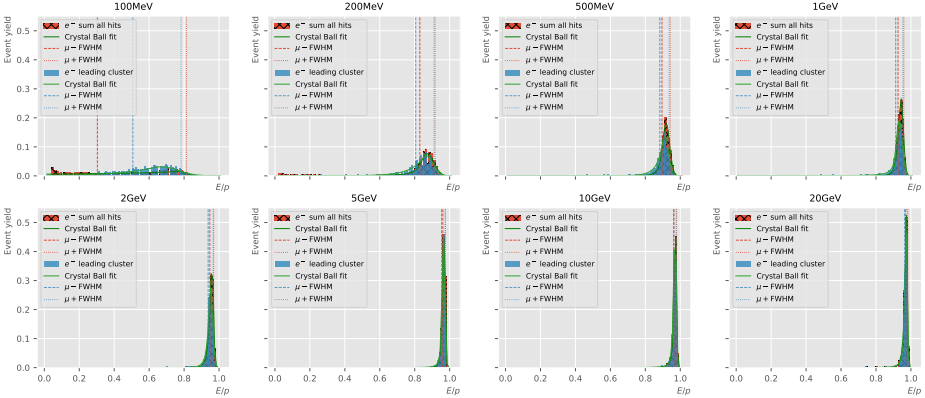
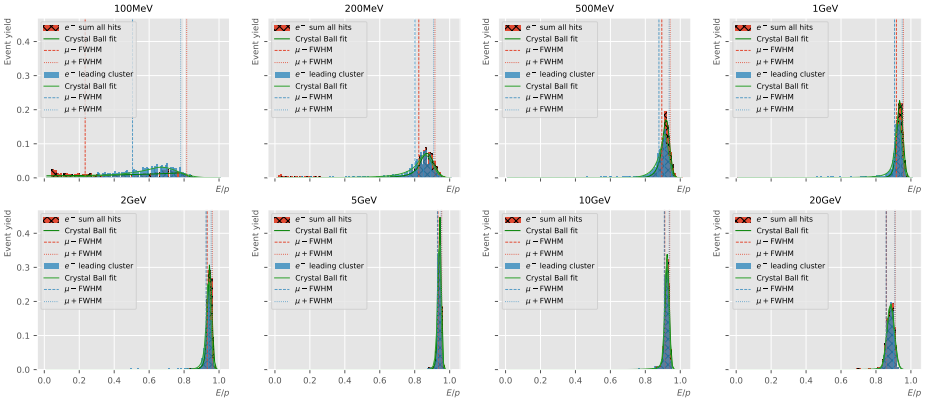
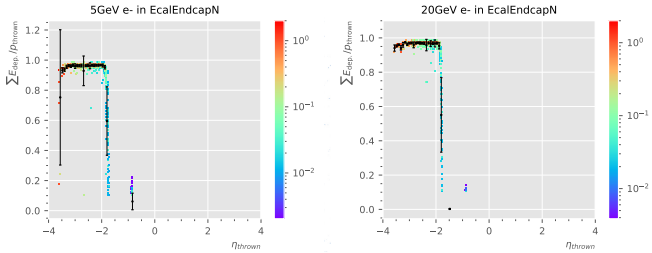
-PEEMC:EcalEndcapNRawHits:readoutType=simple



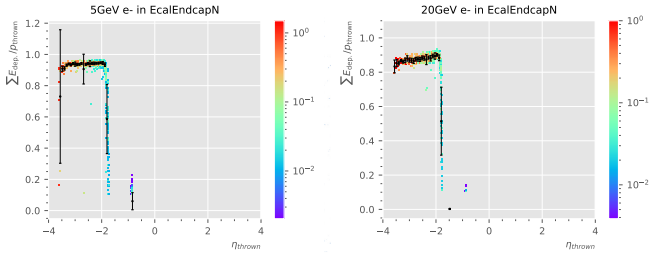
-PEEMC:EcalEndcapNRawHits:readoutType=sipm



-PEEMC:EcalEndcapNRawHits:readoutType=simple



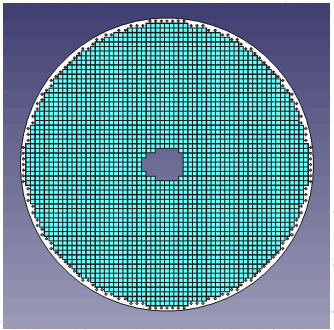
-PEEMC:EcalEndcapNRawHits:readoutType=sipm

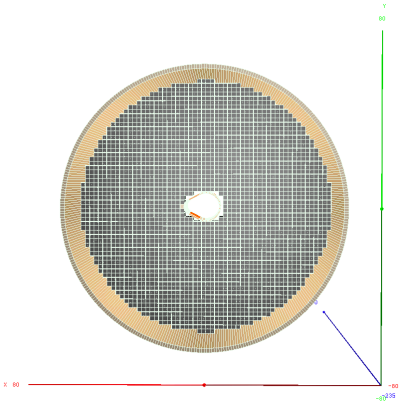


Some η-dependence at 20 GeV

Conclusions

- An inconsistency between "`poisson_photon`" configuration and a naive $1/\sqrt{N_{pe}}$ smearing
- SiPM simulation shows saturation effect, and poor high-E resolution may require a non-linear per-cell energy calibration to reduce





Left: CAD model provided by Carlos, Right: DD4hep WIP