Optimisation Study Of CEPC ECAL

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Optimisation Study Of CEPC ECAL

- Measurement Performance Of CEPC ECAL

- Saturation Effect To The CEPC ECAL's Measurement

Calorimeter Model

- The calorimeter is Si-W sandwiching design and it is high granularity sampling type.

```
SiCalLayerStructure Si:0.5;(Cu:0.5,W:0,Cu:0.5,PCB:1.2,Si:0.5,Air:0.5)*240

SiCalZeroThickReset 1.4*240
SiCalInnerRadius  3000
SiCalBarrelHalfZ  8000
SiCalEndcapEta1   4
SiCalEndcapEta2   4
SiCalBuildBarrel   1
SiCalXCellSize    10
SiCalYCellSize    10
SiCalEndcapOuterR  6120
```

The geometry of ECAL could be changed by tuning the relevant parameter, then we can take the experiment under different situation. In order to study the performance of calorimeter only, we did not take other parts of detector into consideration, like vetex, tracker, magnet, muon detector and so on.On the other hand, we take gama sample as our EM events.

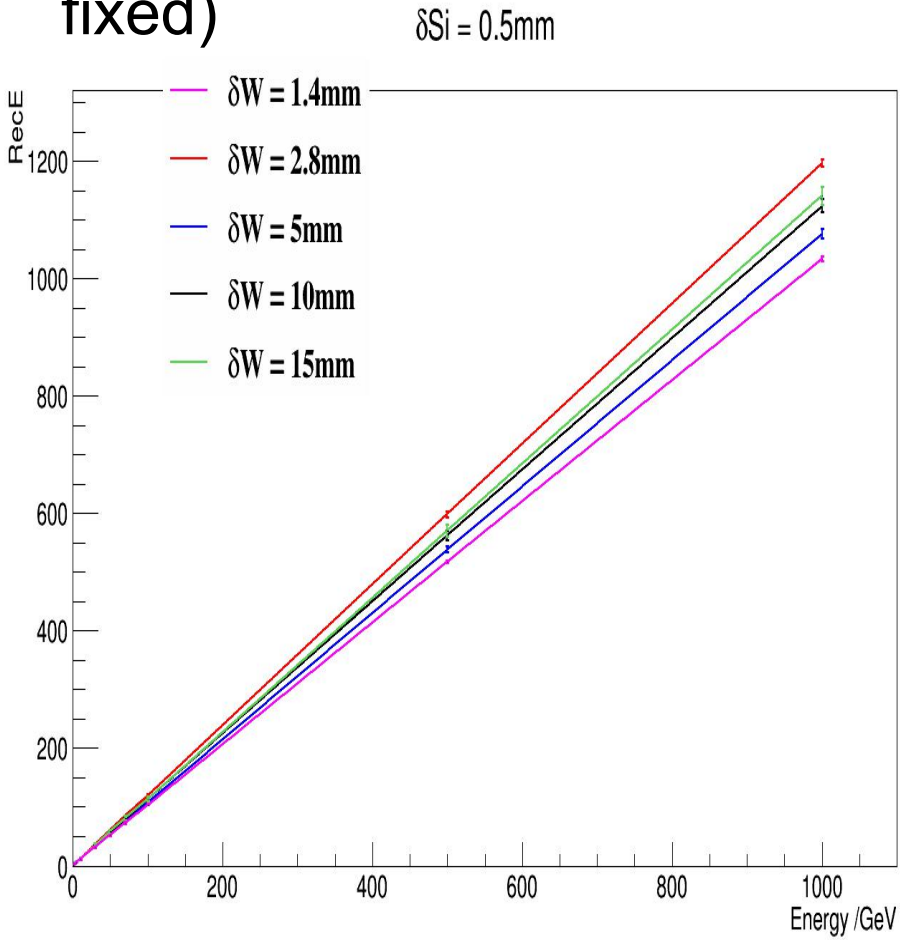
Energy Measurement

- Linearity and resolution are important indexes of energy measurement, according to our physical aim and after considering the practical limit, we can get good performance.

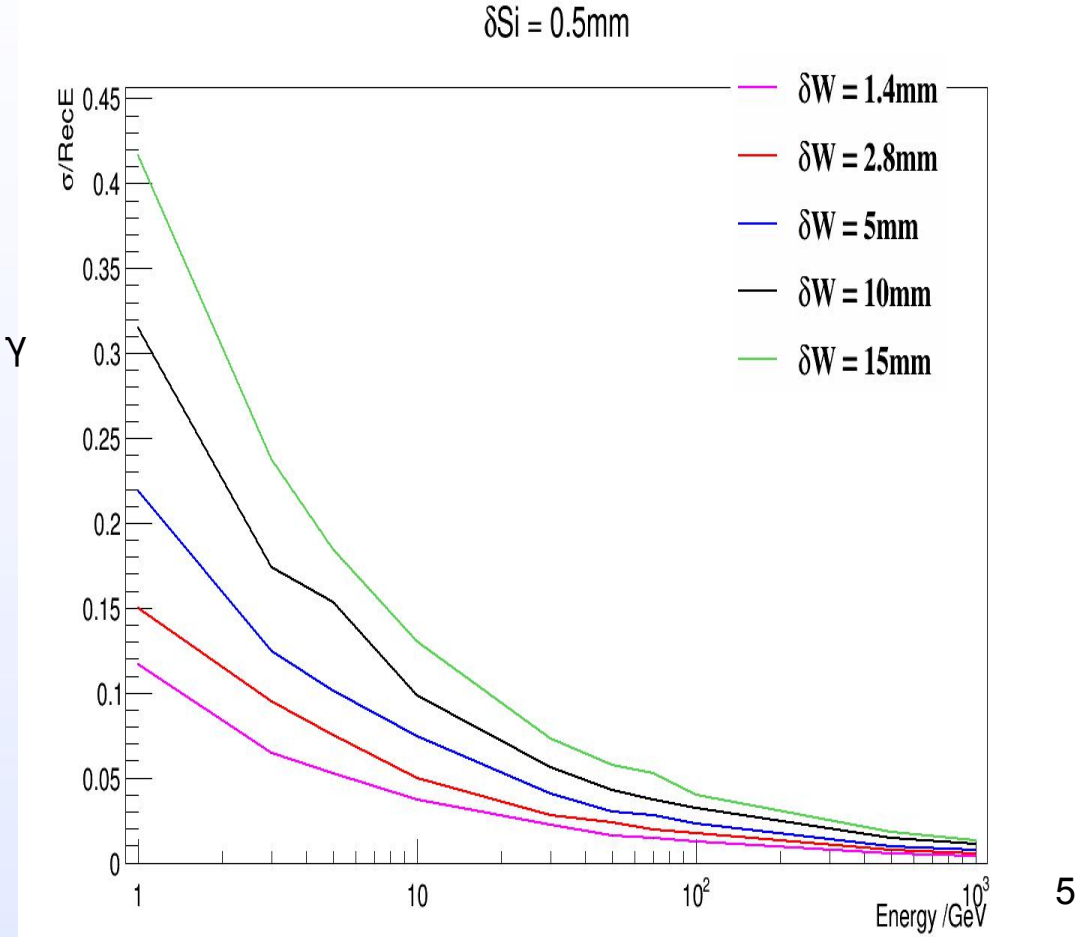
- Energy Measurement vs Calorimeter Geometry. In Si-W calorimeter, Si as sensor while W as absorber, PCB record the “Hit” and read them out, then we calibrate the signal we get for it is sampling calorimeter. The thickness of material and layer number are all make contribution to the mearsurement performance.

Energy Measurement

- Energy Measurement under different Si-W thickness(make the Si thickness fixed)

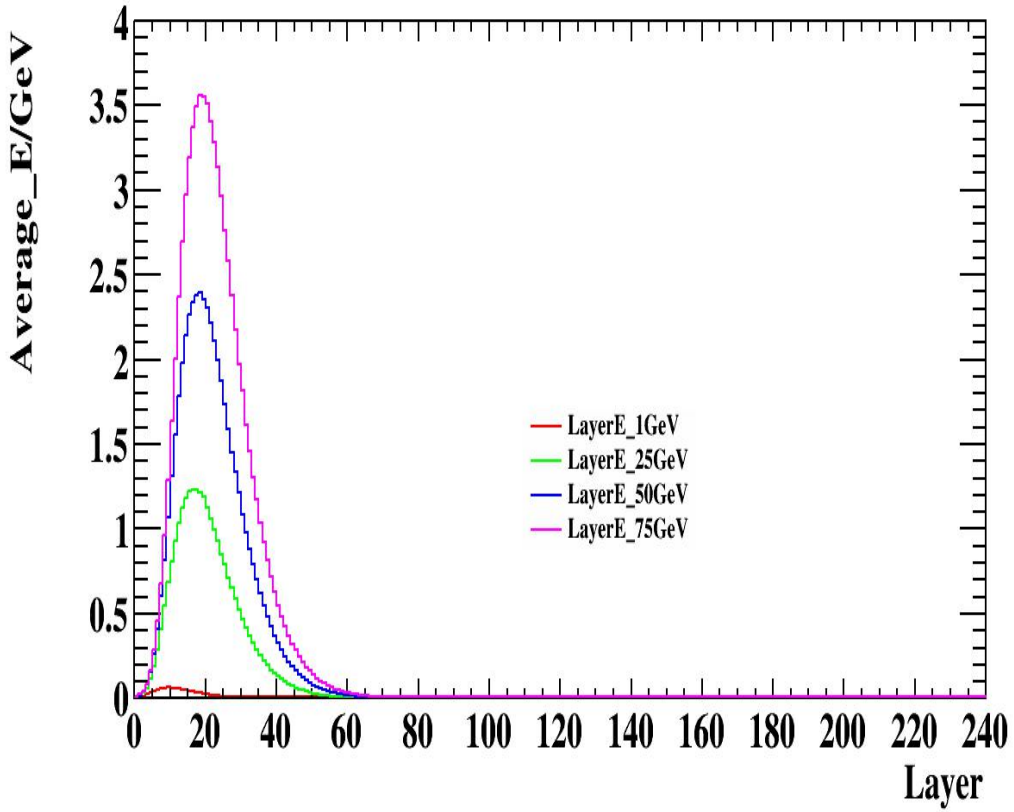


sample： γ

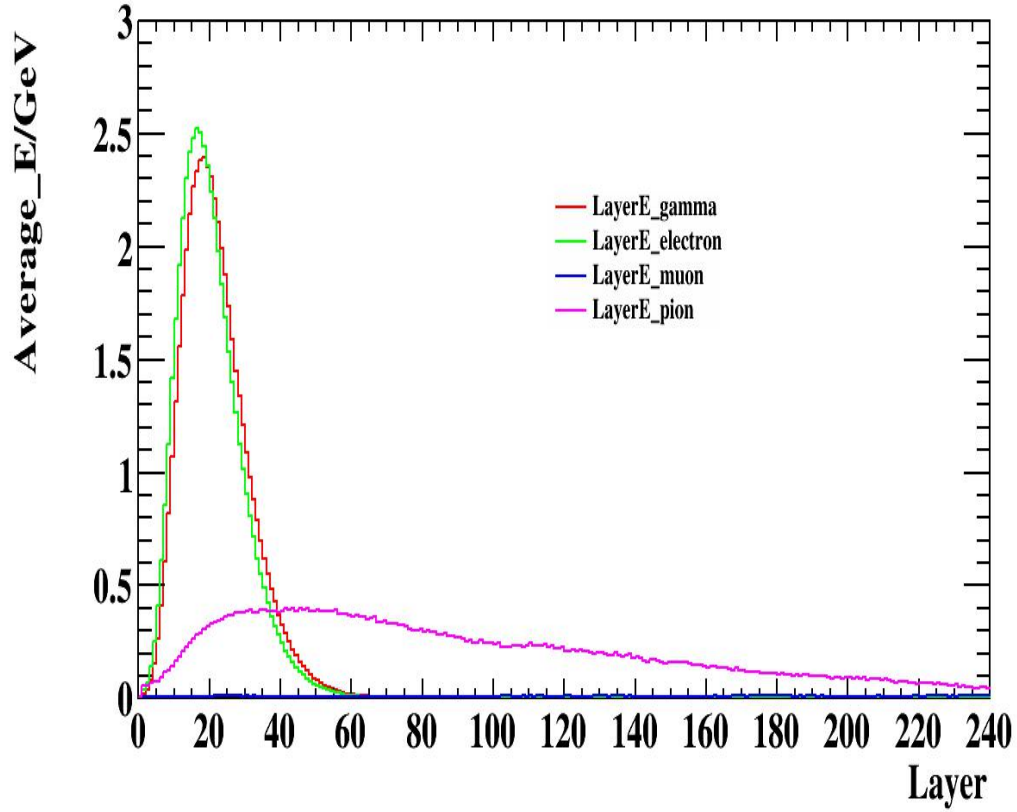


Energy Measurement

- Deposited energy distribution under different incident energy and different particles.



50GeV



Position Measurement

- Calorimeter could measure particle's momentum and incident position by recording all Hits' position.

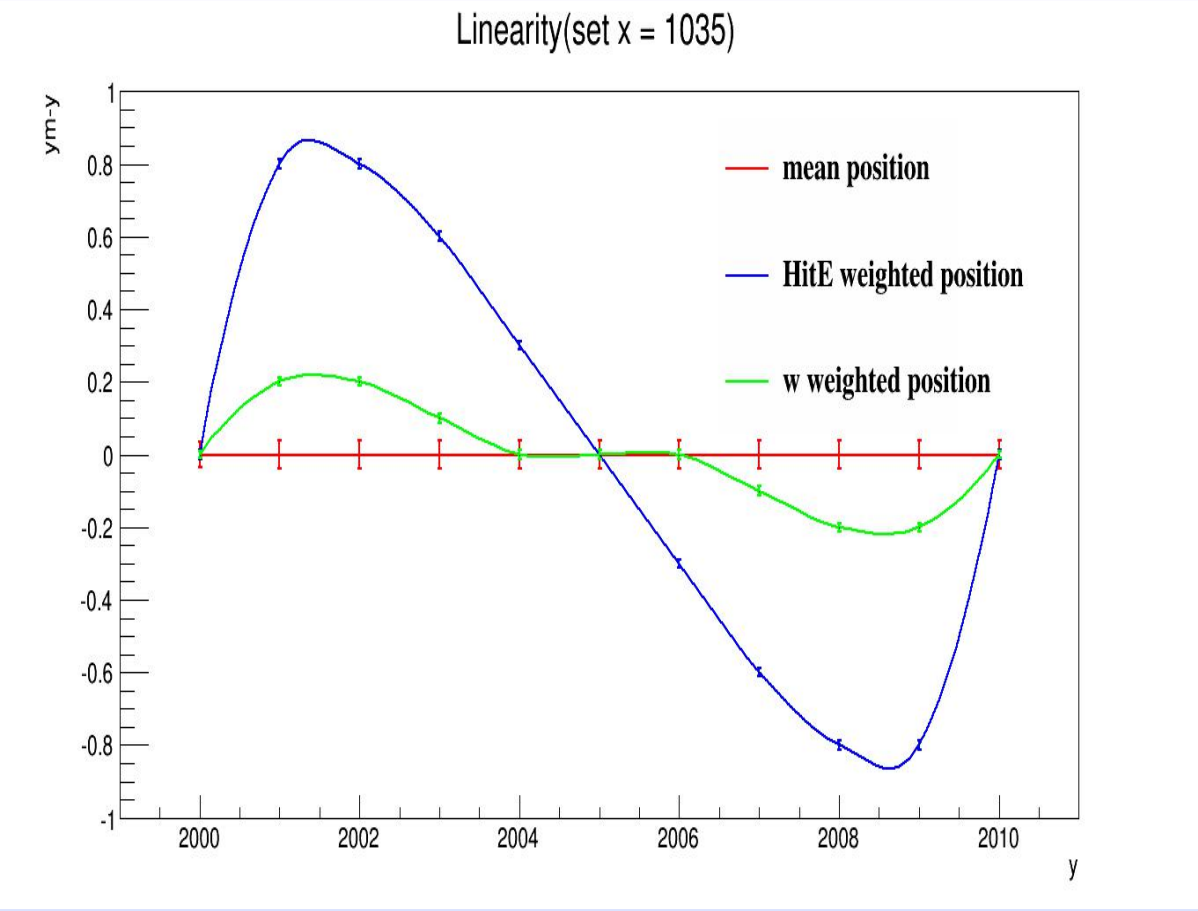
- Method: we shoot the gama to the gap and measure it using all gathered Hits' information.

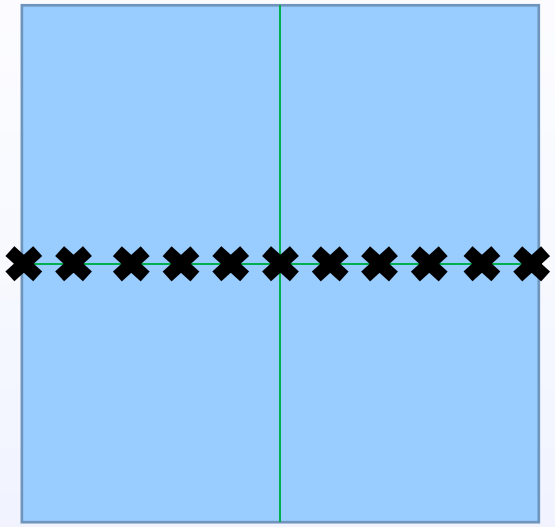
  Everage position：$\langle Posx \rangle = 1/NHit^* \Sigma\, pos(x)$

  Everage position with energy weight：$\langle Posx \rangle = 1/E^* \Sigma\, HitE^*pos(x)$

Position Measurement

- Inside bias of a calorimeter unit in position measurement.

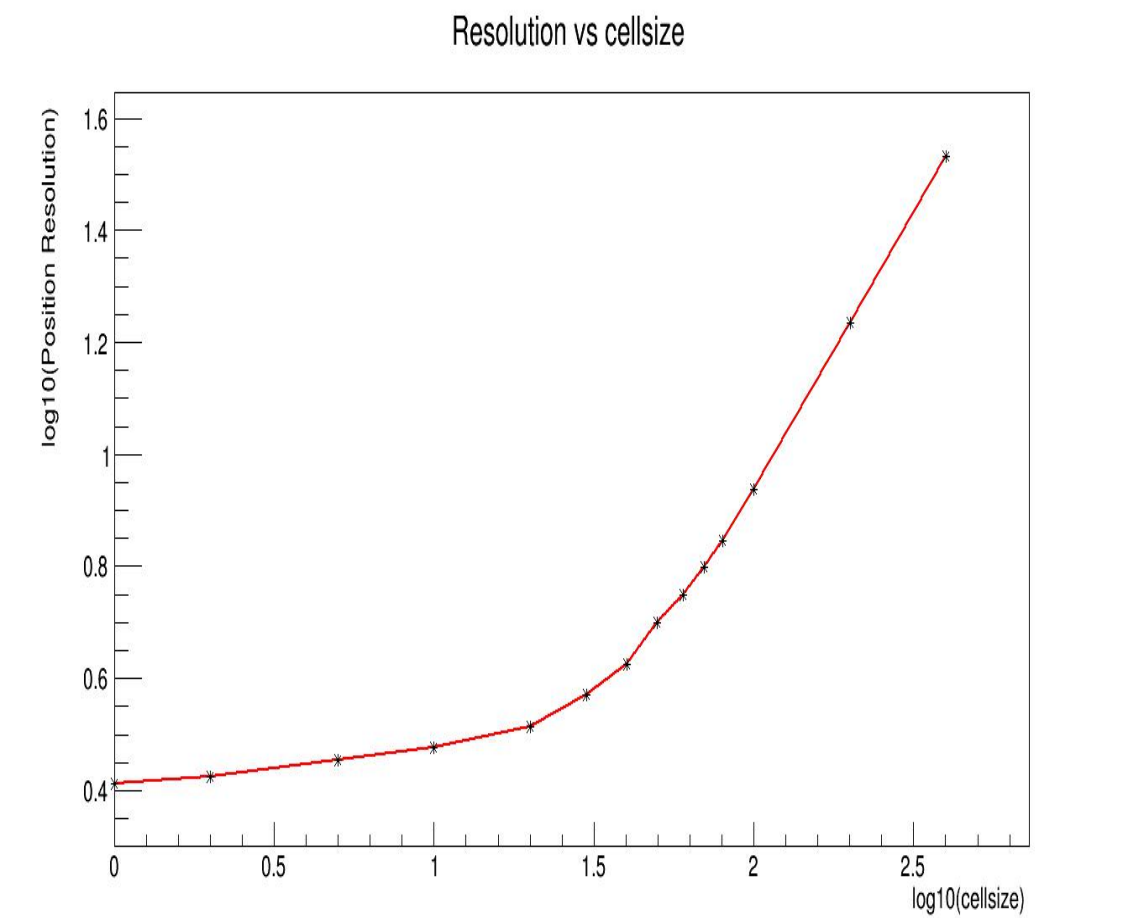




the cross denote incident position

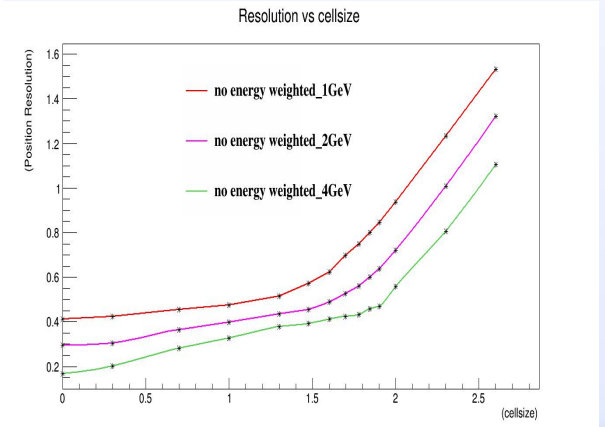
Position Measurement

- Cell size vs Position Measurement Resolution.



cell size and shower size dominate the resolution in different area

we can take second derivatives as valid size of EM shower



Study Of Saturation

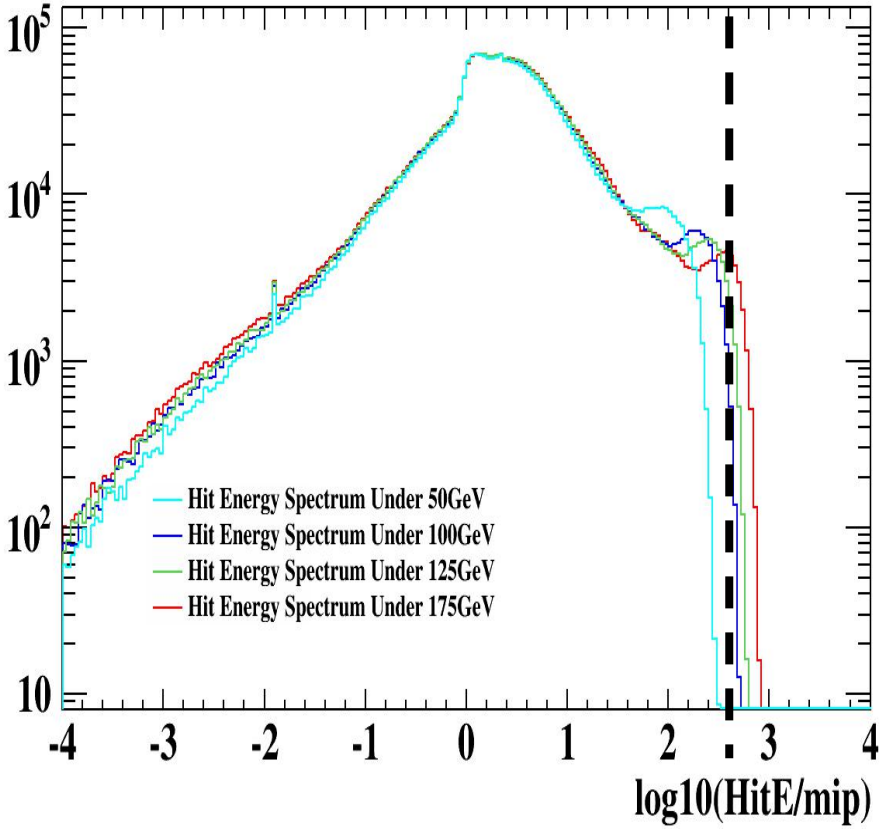
- Digital readout saturation practically exists, Energy measurement and Position measurement will be influenced by the saturation.

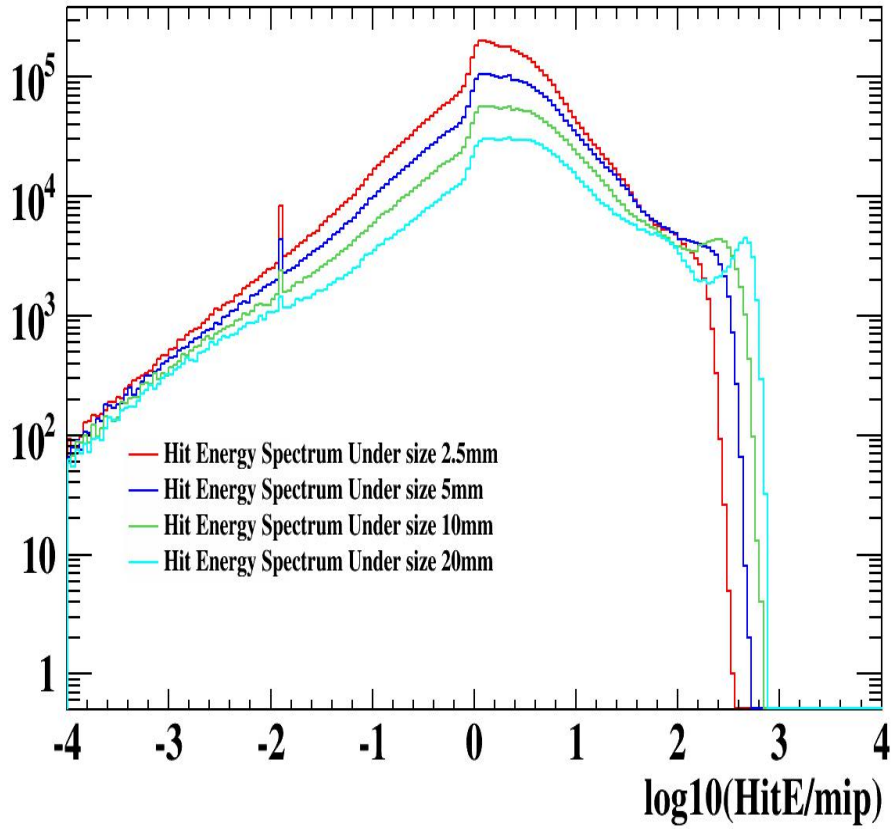
- On one hand, We should take its effect into consideration; On the other hand, we must control our cost by adding the appropriate saturation.Our target is to study the performance and give saturation advice.

- Method: we set the Hit energy as a certain threshold energy when their energy are higher than the threshold.

Saturation

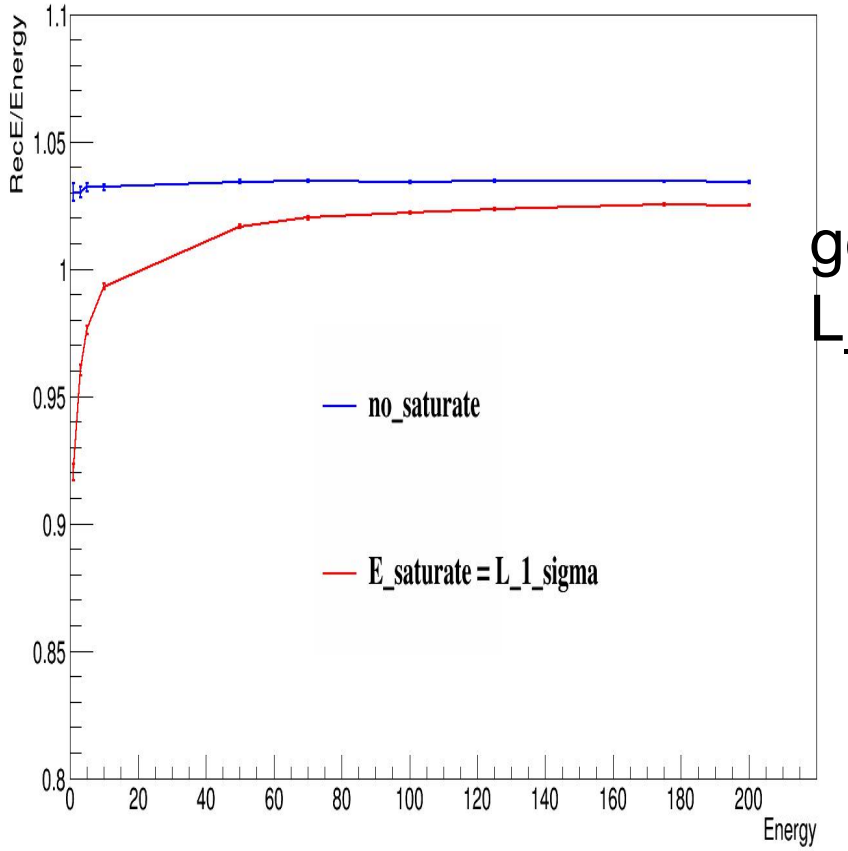
- Hit Spectrum in Different gama Energy and Different Cellsize



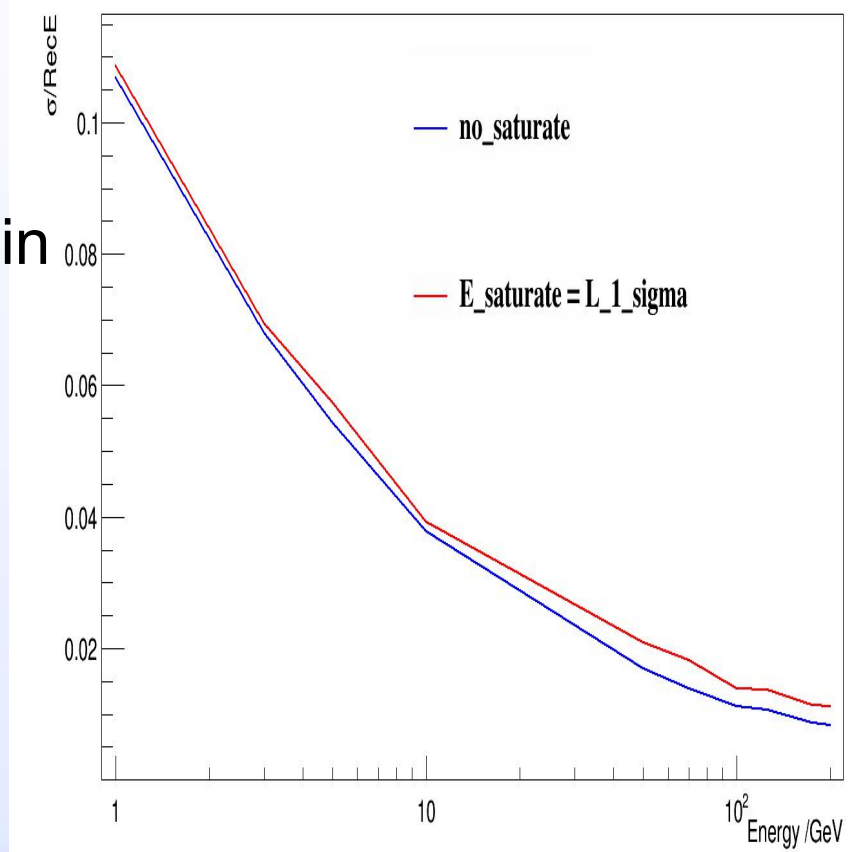


Saturation

- Energy Measurement under saturation

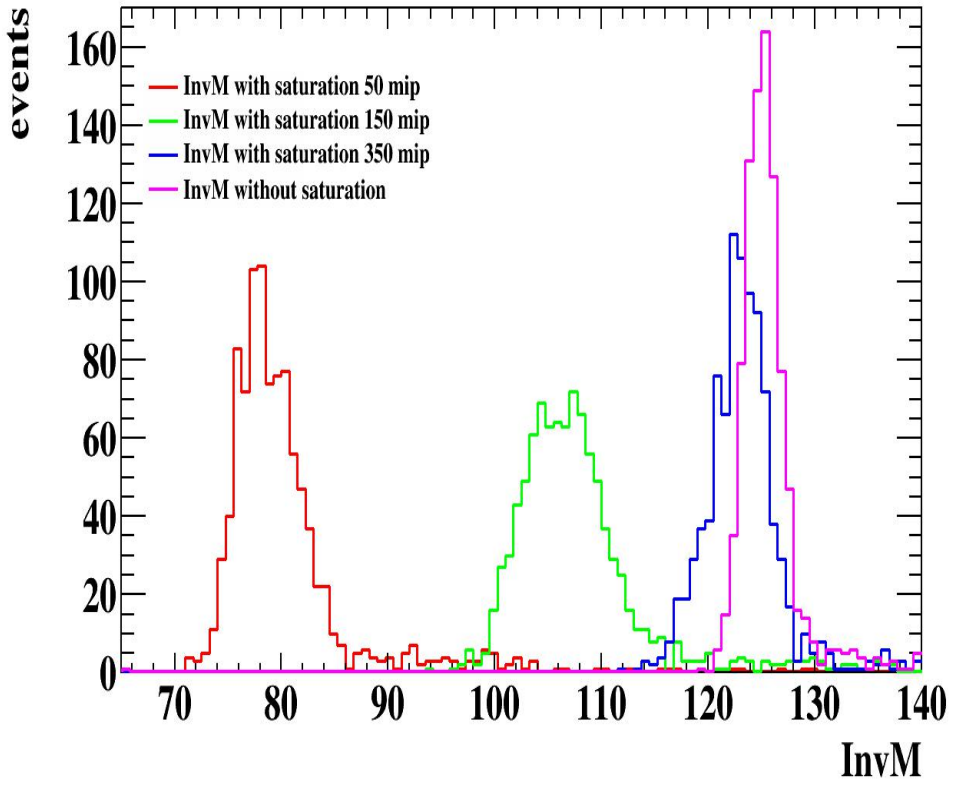


good performance in L_1σ saturation



Saturation

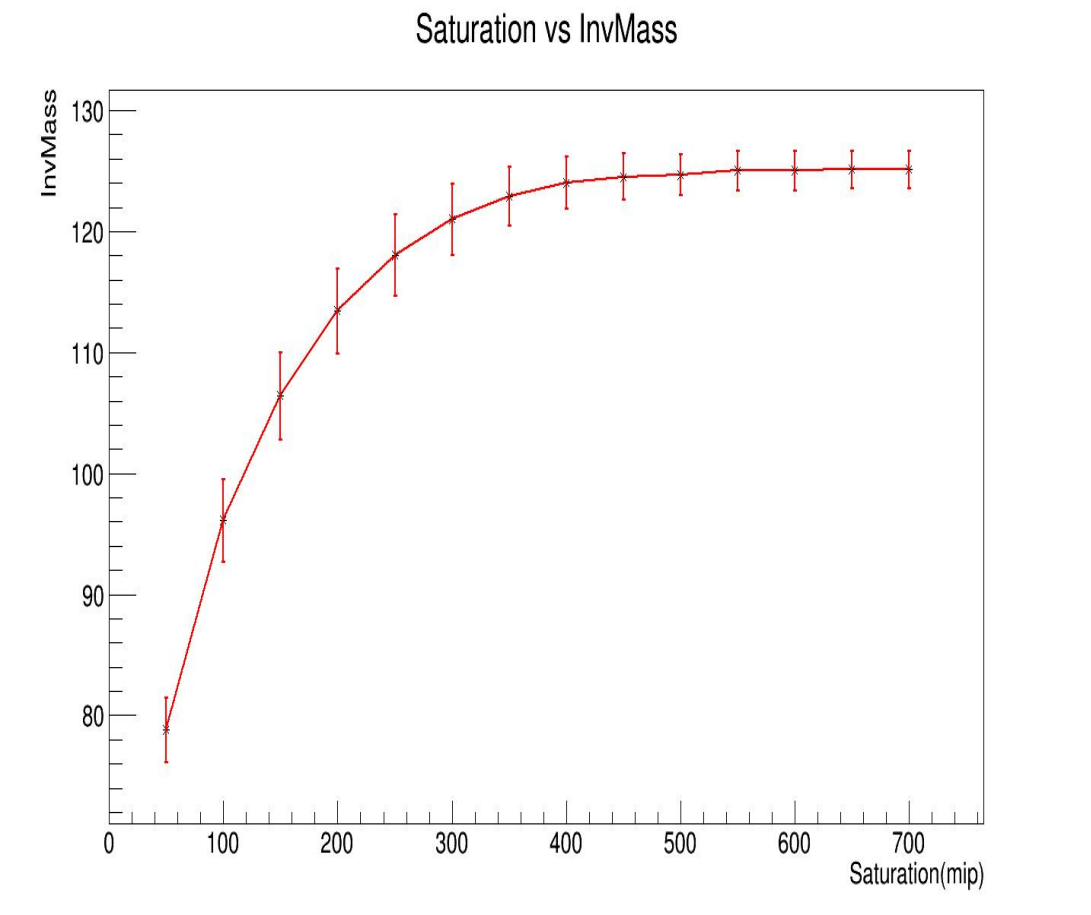
- Measure Higgs Invariant Mass Using H—>diphoton. And take saturation into consideration to see the influence.

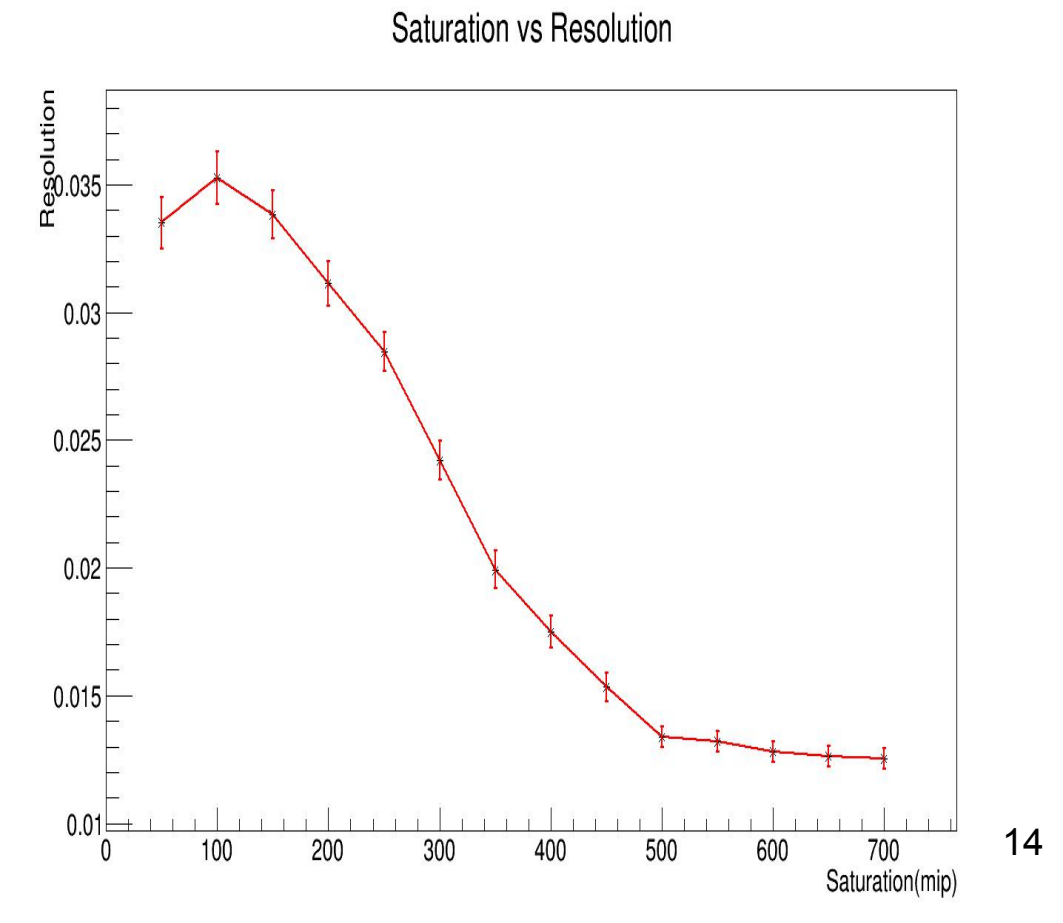


Higgs Invariant mass significantly varies under the saturation

Saturation

- Scan Different Saturation To Get Appropriate Value





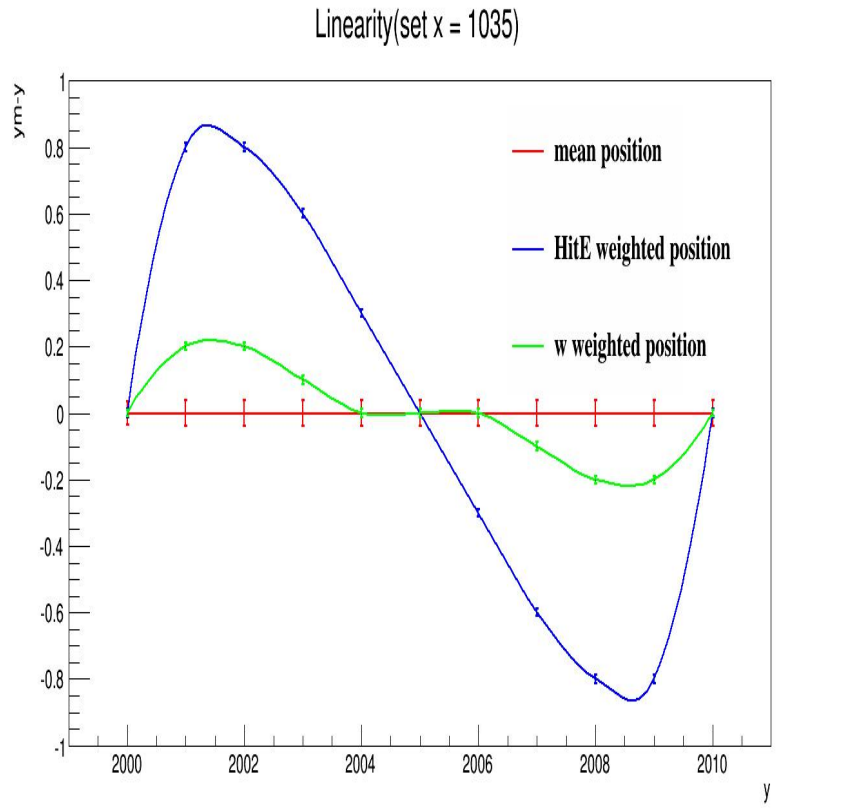
Summary

- The larger dSi / dW is, the better the energy measurement performance.
- For ECal, we don't need too many layers, the number needs to be optimised.
- If we set the Saturation at 500 mip, we can get good measurement performance. For safty, we can finally set Saturation at 1000 mip.

Thanks!

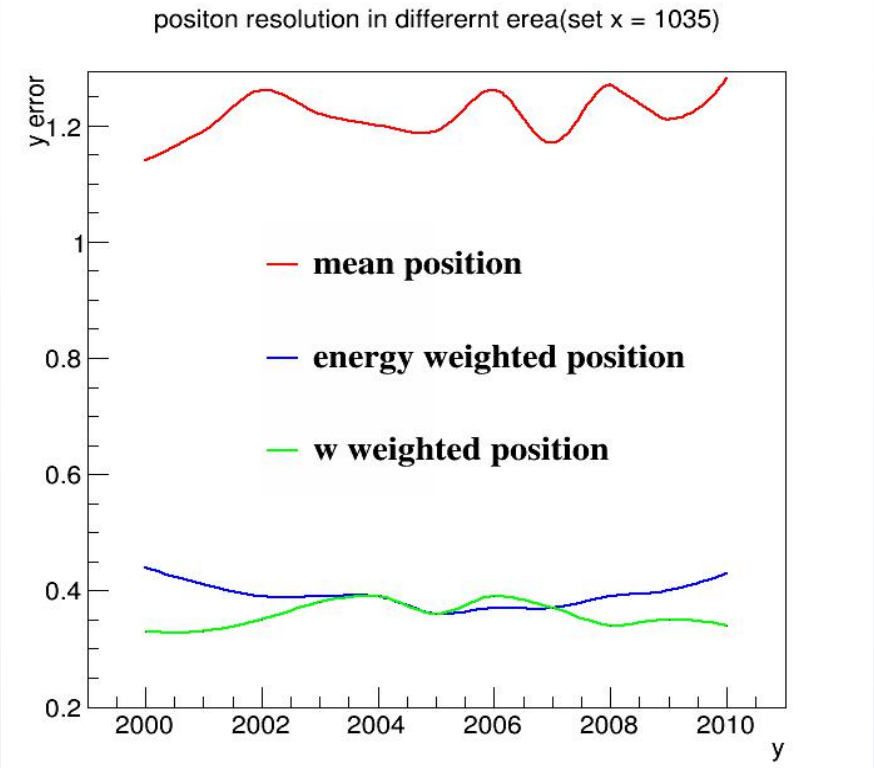
50GeV

补充：能量权重法的位置修正

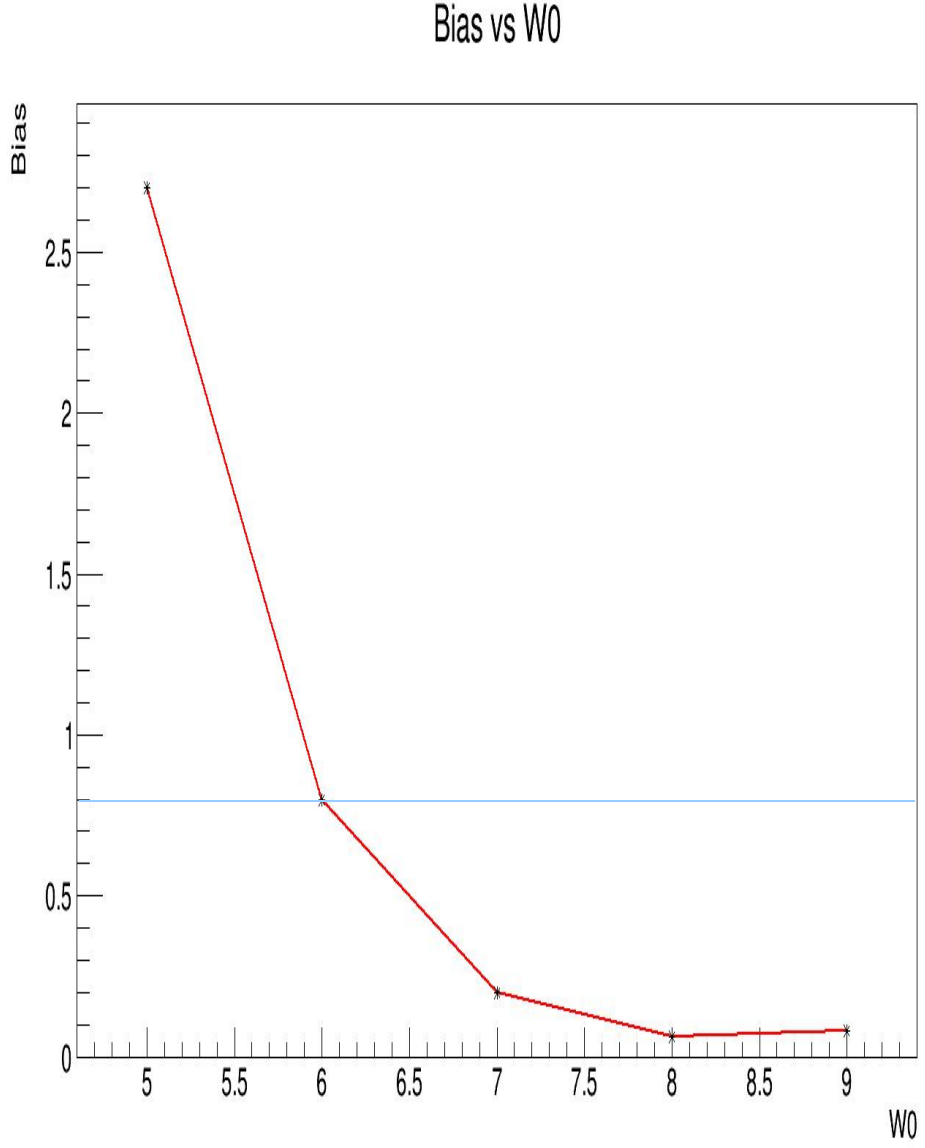


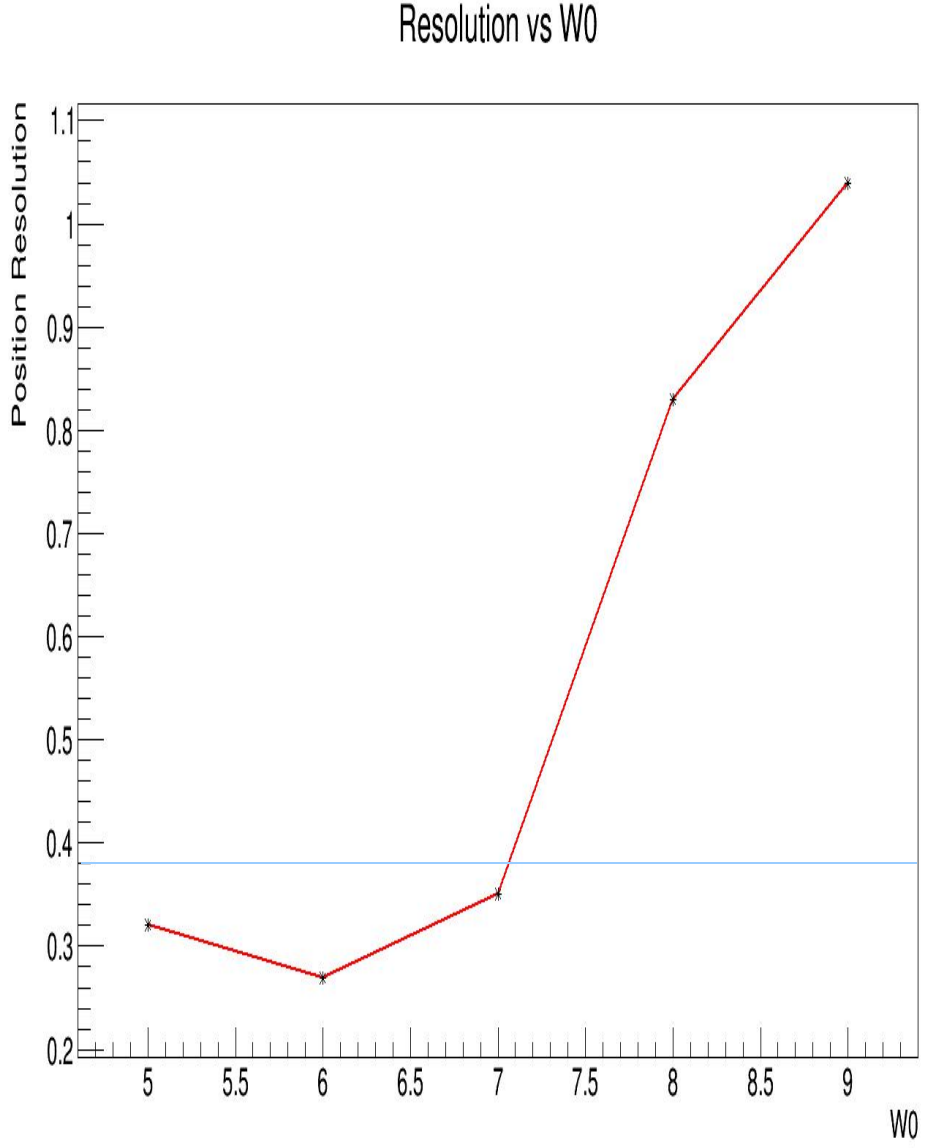
$$X_{Calc} = \frac{\sum_i w_i x_i}{\sum_i w_i},$$

$$w_i = \max\left\{0, \left[W_0 + \ln\left(\frac{E_i}{E_T}\right)\right]\right\},$$

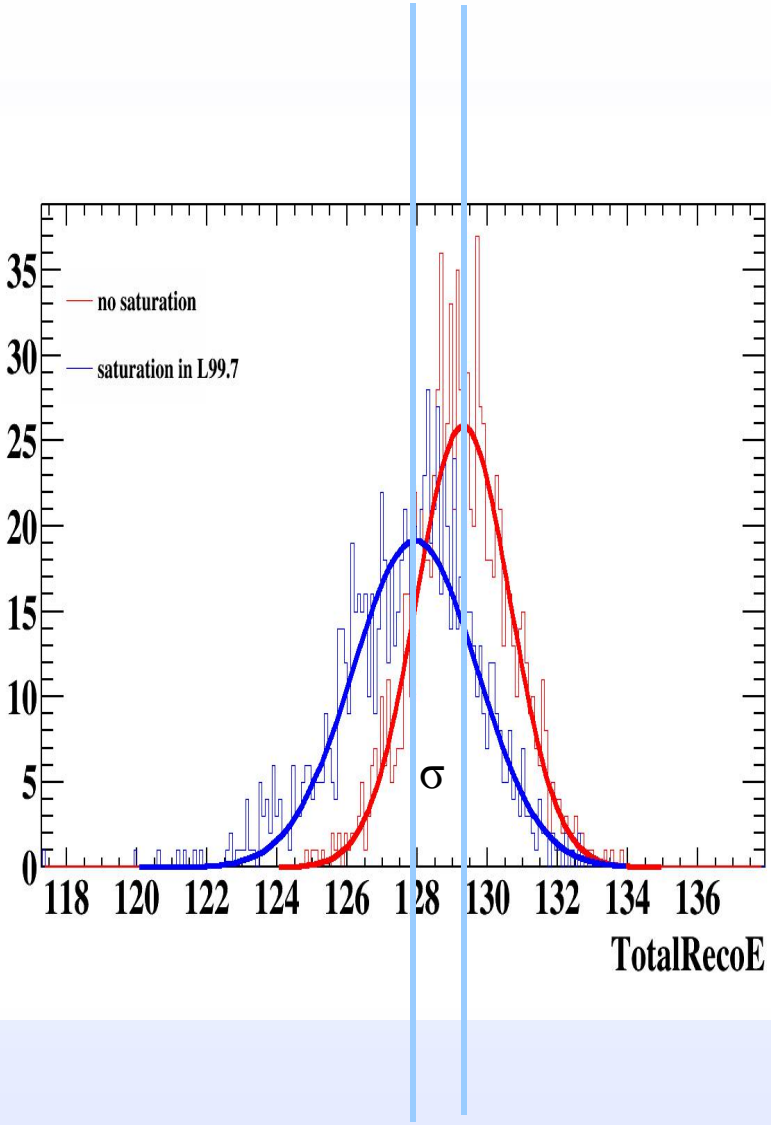


W0 = 7

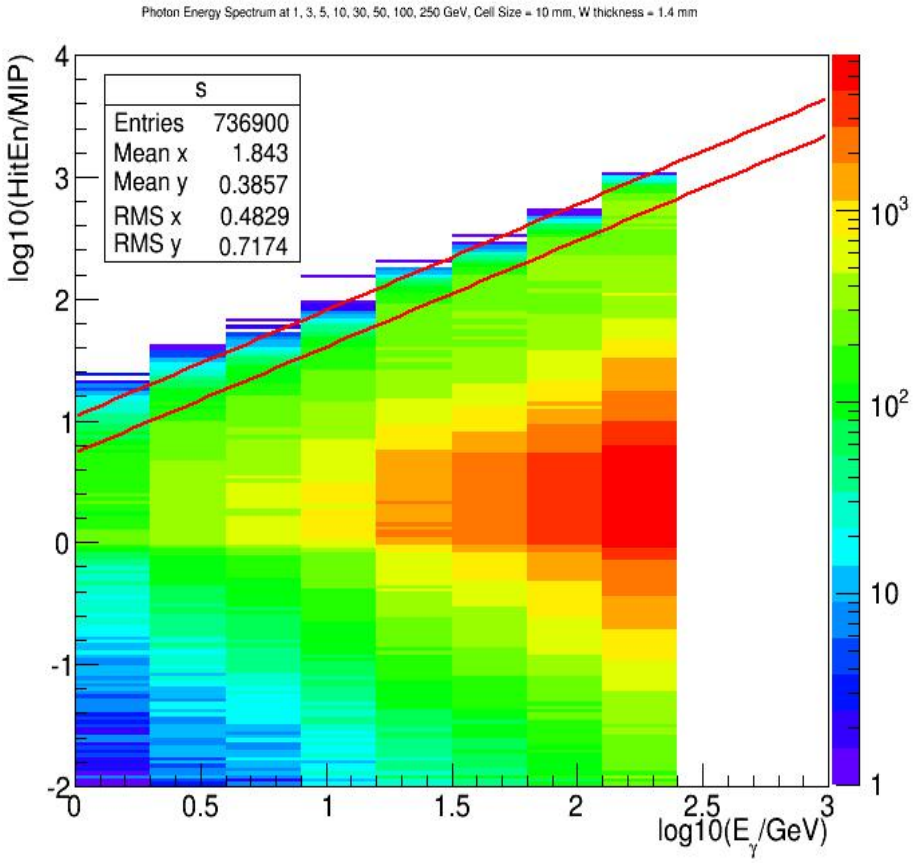

Bias vs W0
Bias
2.5
2
1.5
1
0.5
0
5
5.5
6
6.5
7
7.5
8
8.5
9
W0


Resolution vs W0
Position Resolution
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
5
5.5
6
6.5
7
7.5
8
8.5
9
W0

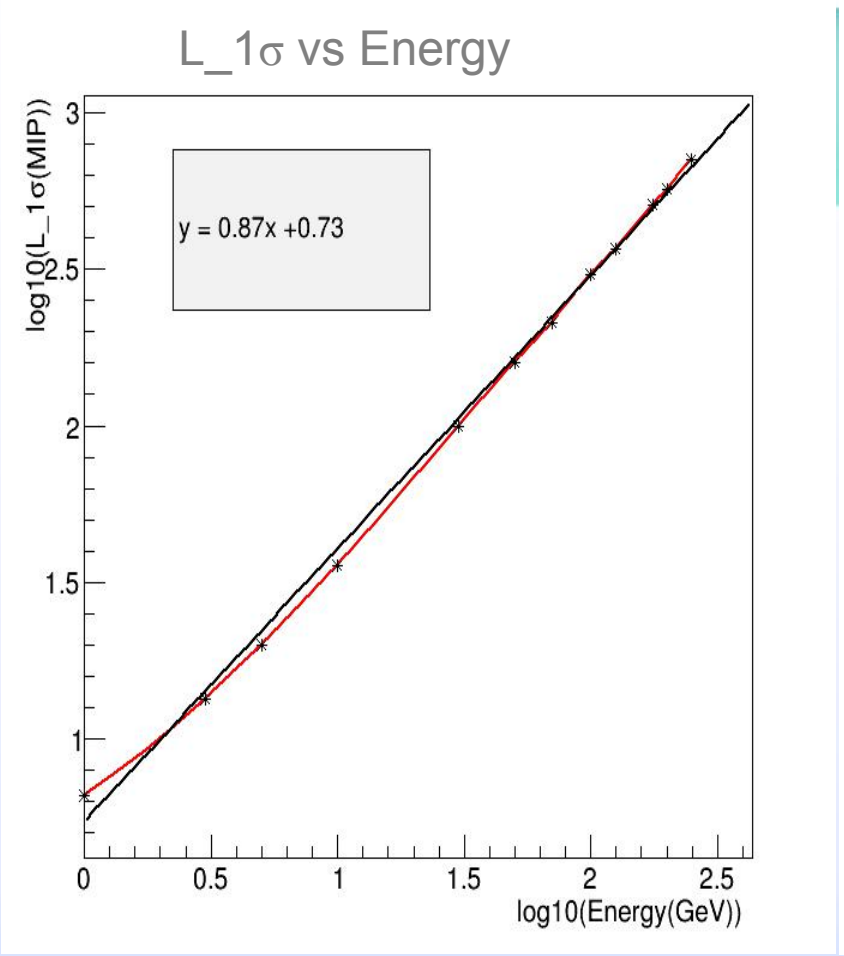
补充：L_1σ

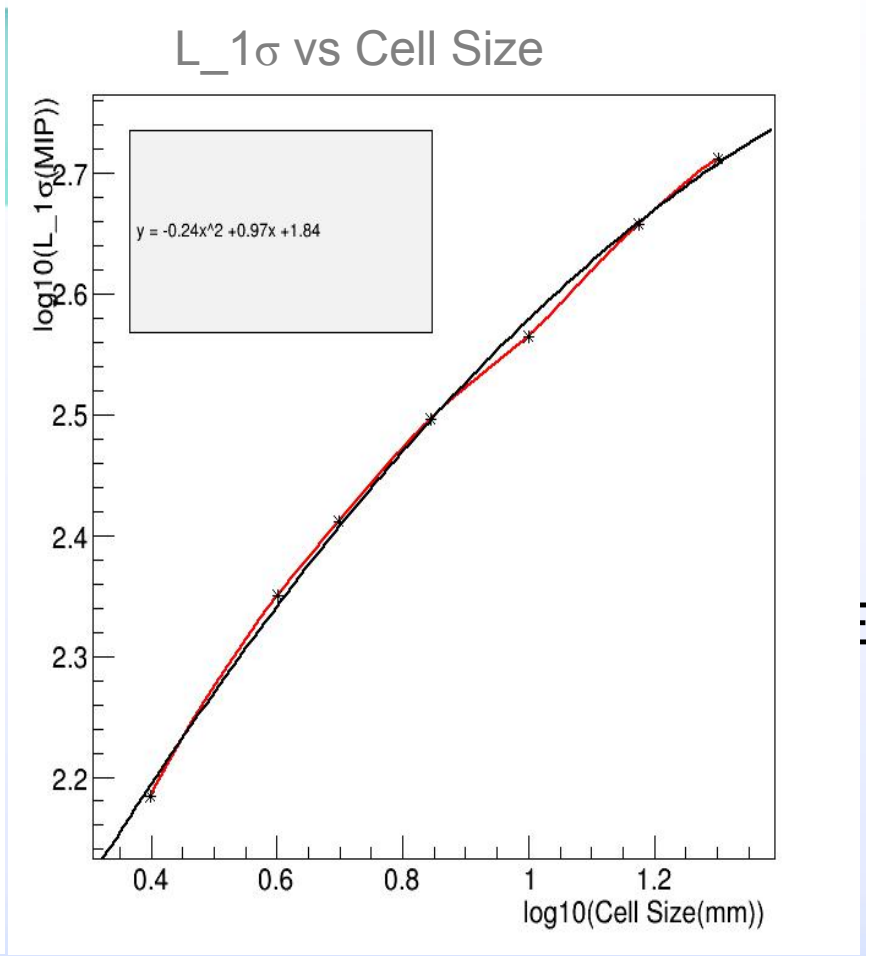


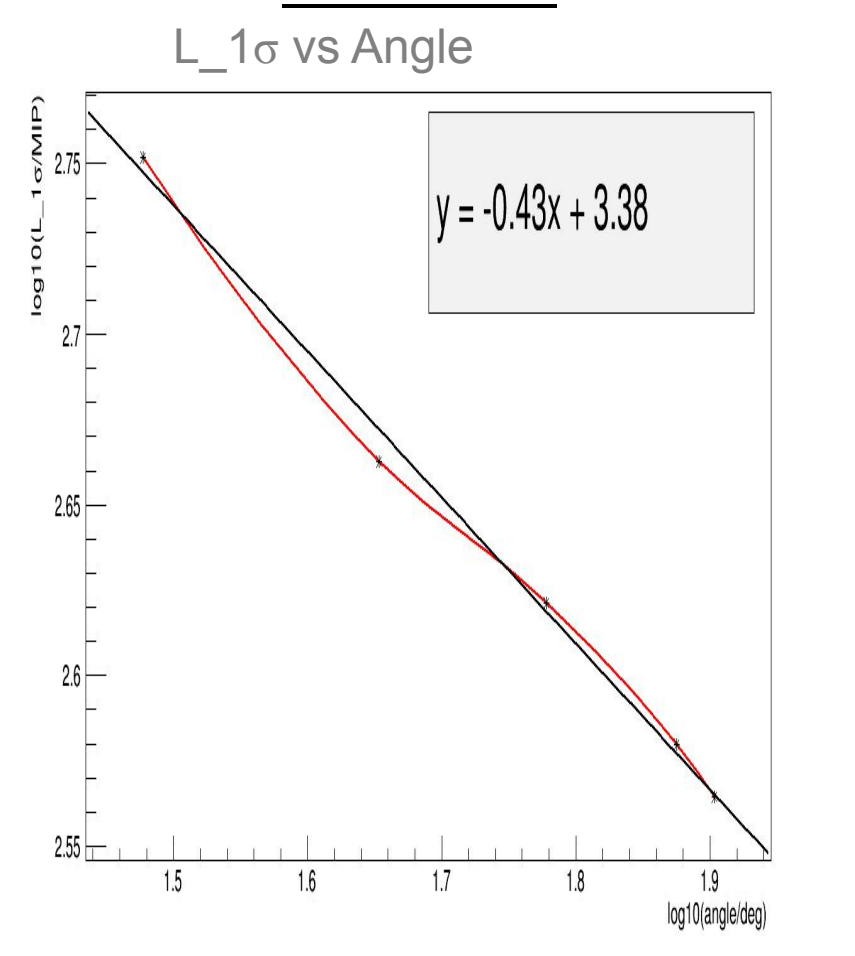
右图为将L_1σ参数化后的直线与Hit能谱的叠加图，可以看到，图线呈现相当的谐和性



补充:Hit能谱边缘位置的参数化







L_1σ = 0.87x - 0.24y^2 + 0.97y - 0.43z + 0.82 x = log(Energy) y = log(Size) z = log10(Angle)