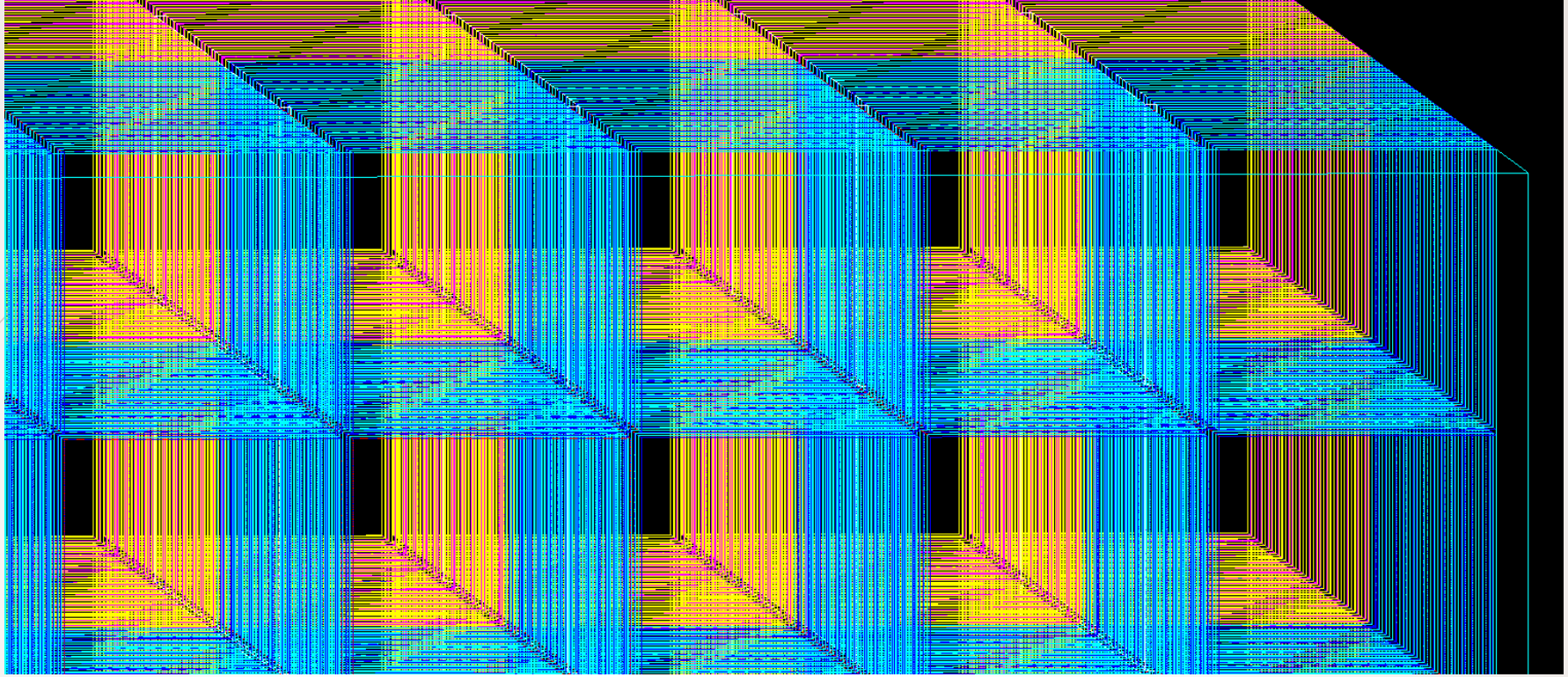

HCal simulations

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UCLA

Introduction

- Design of hadron calorimeters (HCal) at the EIC to provide measurement of jet energy with high resolution
- particle flow-style approach -- jet reconstruction at EIC
- EIC tracker and EMCal is supposed to measure about 95% of jet energy
- optimizing EMCal+HCal configuration

- parameter : Table rapidity/energy resolution

Energy resolution

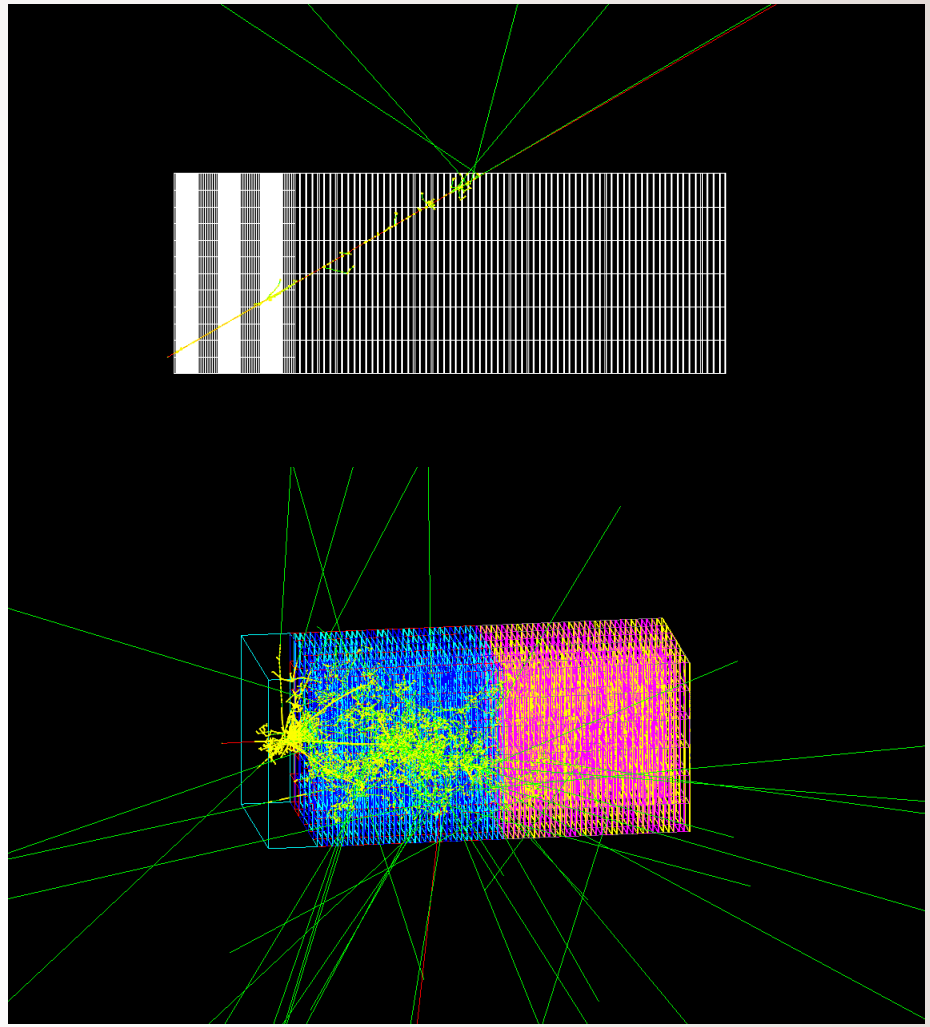
- Aim at a resolution (better than 40%/sqrt(E) + ~ 5%)
- However, it is a difficult task to achieve both high resolution with EMCal and HCal
- Challenging task : balancing EM and HAD responses
- detector and collider specific limitations : available space, dead material between EM and Had sections, choice of readout…

Our geometry

We focus on EMCal+HCal configuration with three geometry variations

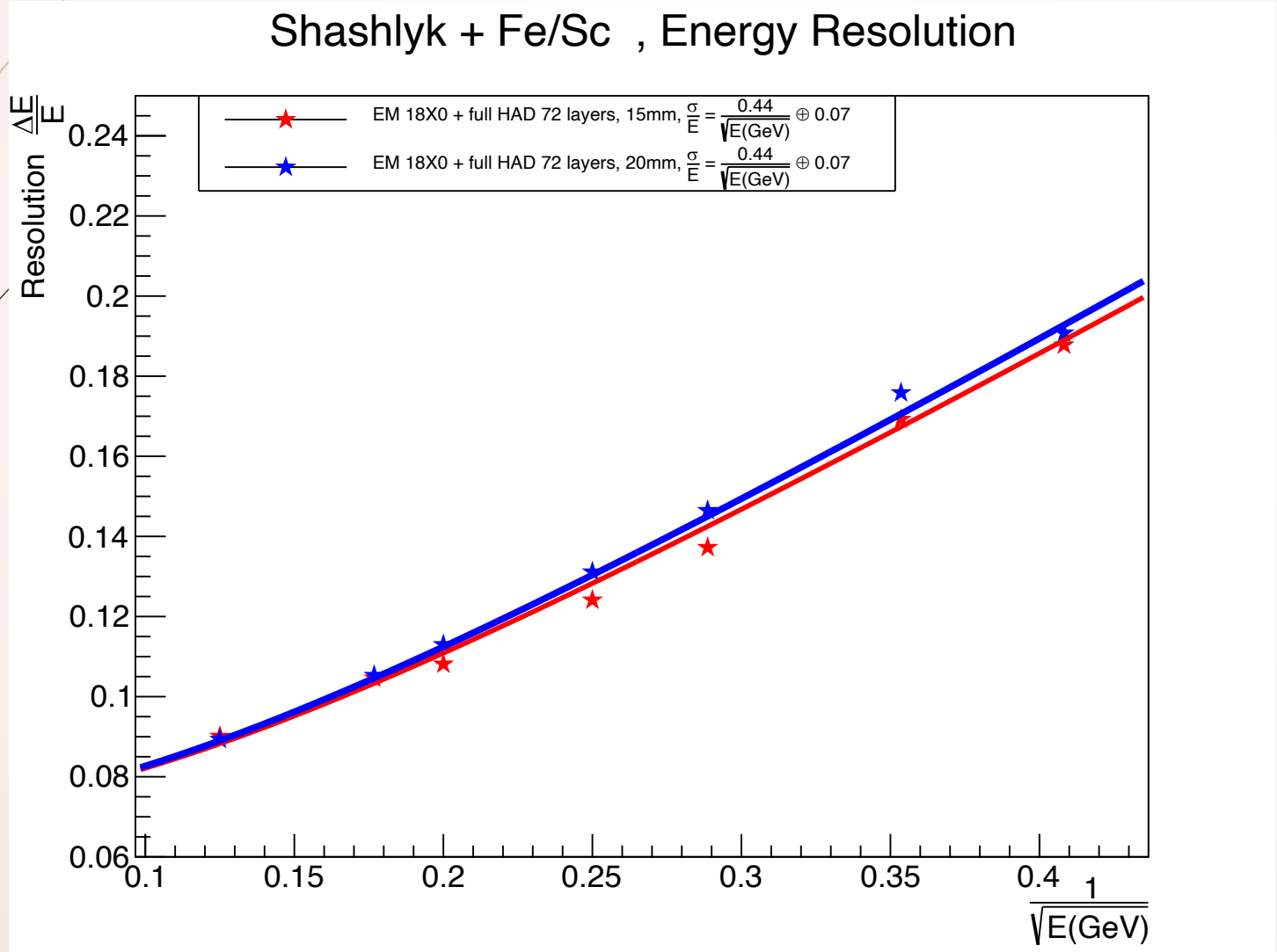
- 1. shashlyk (36 layers of EMCal + HCal)
- 2. shashlyk (one full EMCal + HCal)
- 3. WLS/Fe (one full EMCal + Hcal with fibers and dead layers)

- ECAL ~ 40 cm long
- HCal each ~83 cm long,
- transverse size 60 x 60 cm.



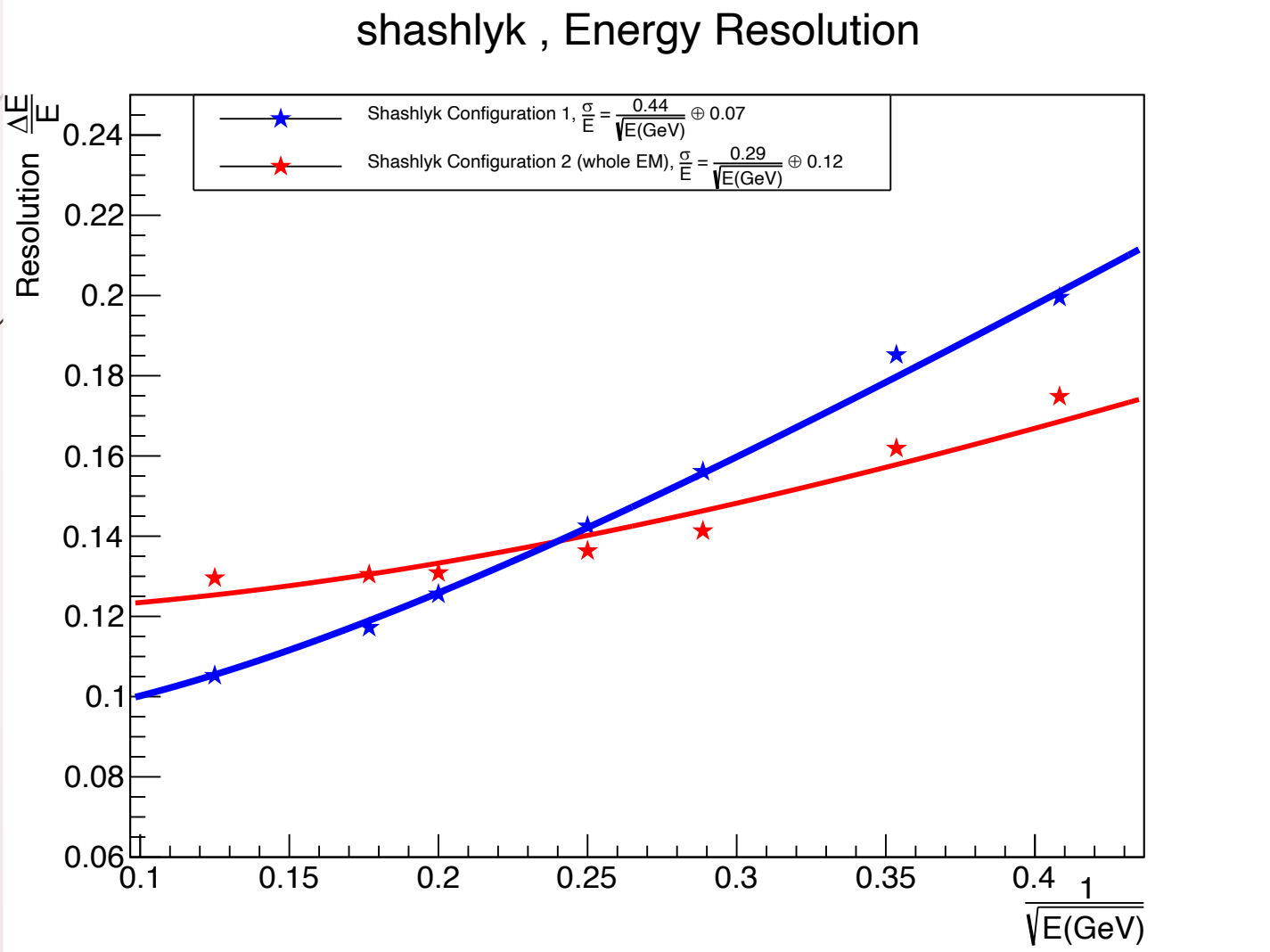
- Production cut: 0.01cm
- Physics list: FTFP_BERT_HP
- Energies: 6, 8, 12, 16, 25, 32, 64 GeV

Comparison between absorber thickness 15/3 and 20/2 mm with all layers



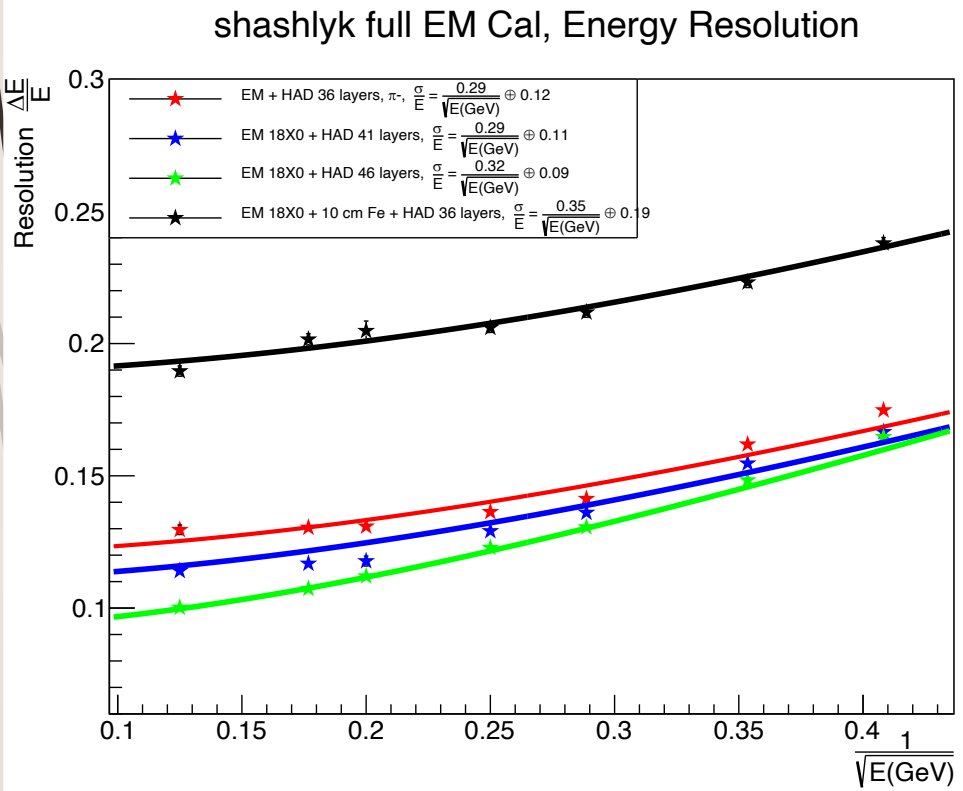
- Particle direction At 20 degree.
- π+ π
- Almost the same, absorber thickness 20 mm has a bit higher resolution.
- Resolution ~ 44% plus a constant ~ 0.07

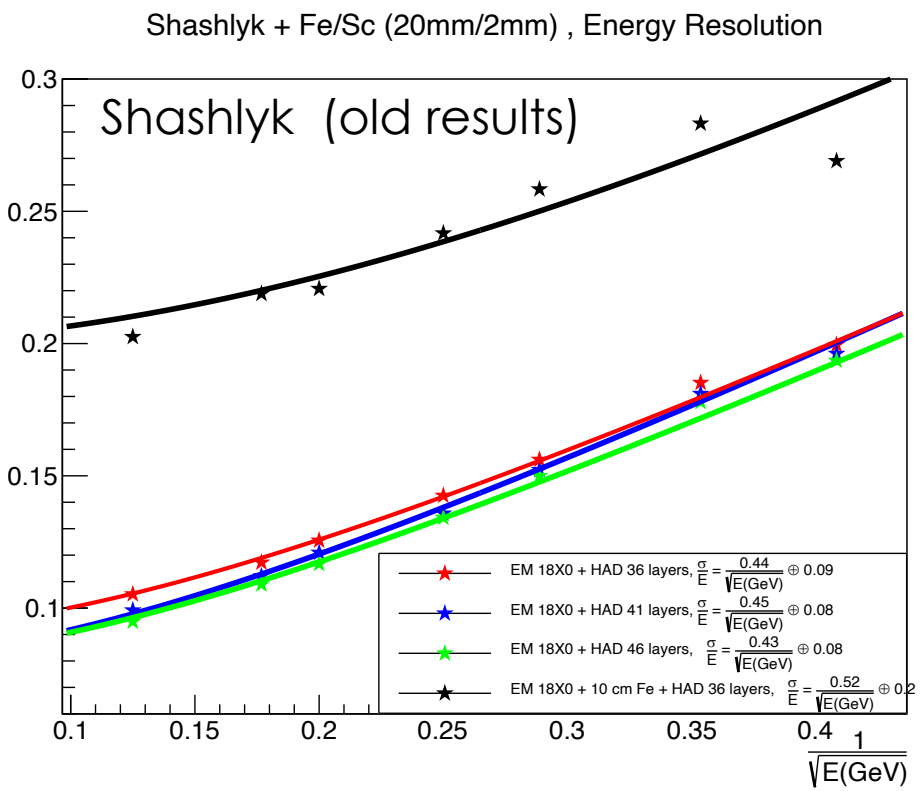
Comparison between EM Cal configuration



- π+ π
- Configuration 1: particle direction~20 degree
- Configuration 2: whole EM Cal, direction ~ 3 degree.
- The resolution is lower in configuration 2

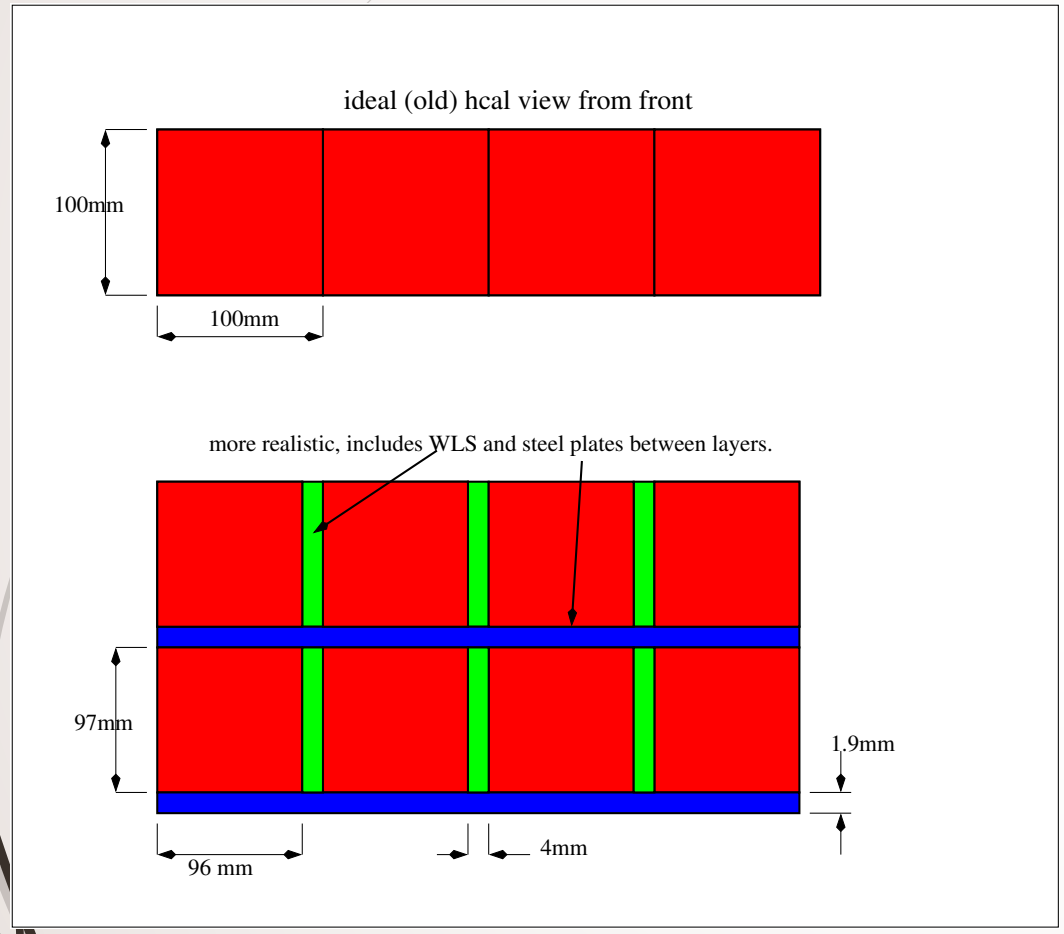
Different number of HCal layers configuration

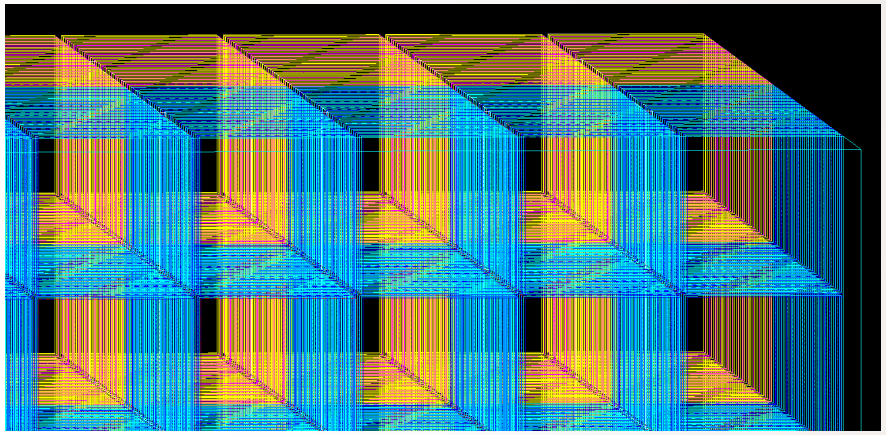




- π+ π
- Different number of HCal layers
- The more Hcal layer, we have higher resolution, from 29 ~ 32%
- Dead layer results have highest resolution.

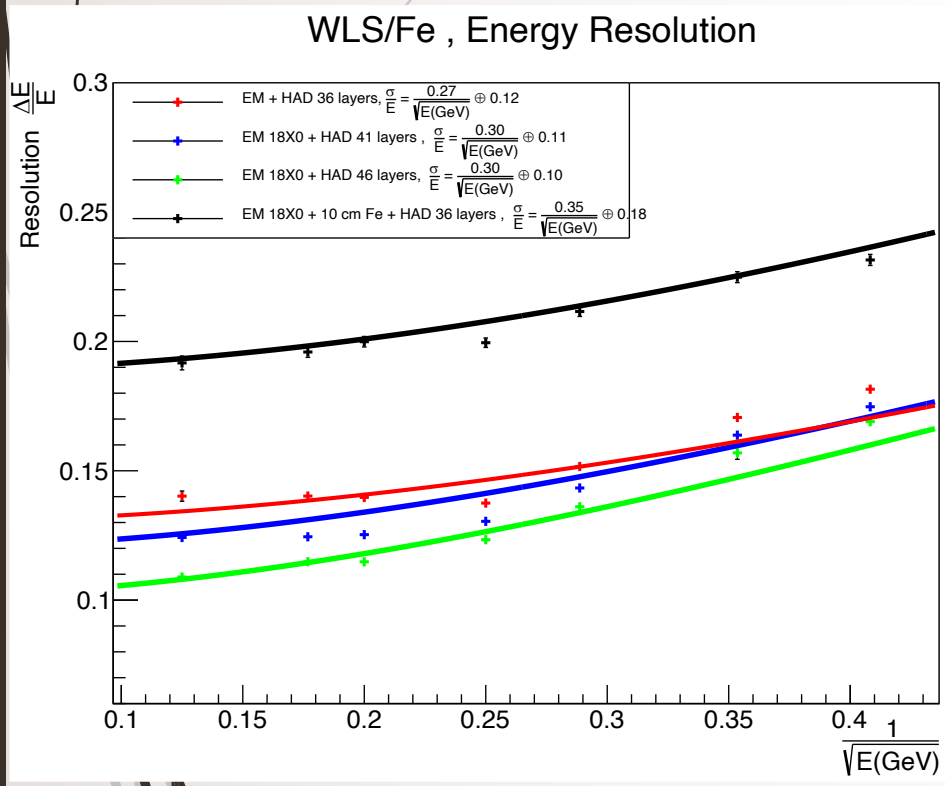
New Geometry : WLS/Fe

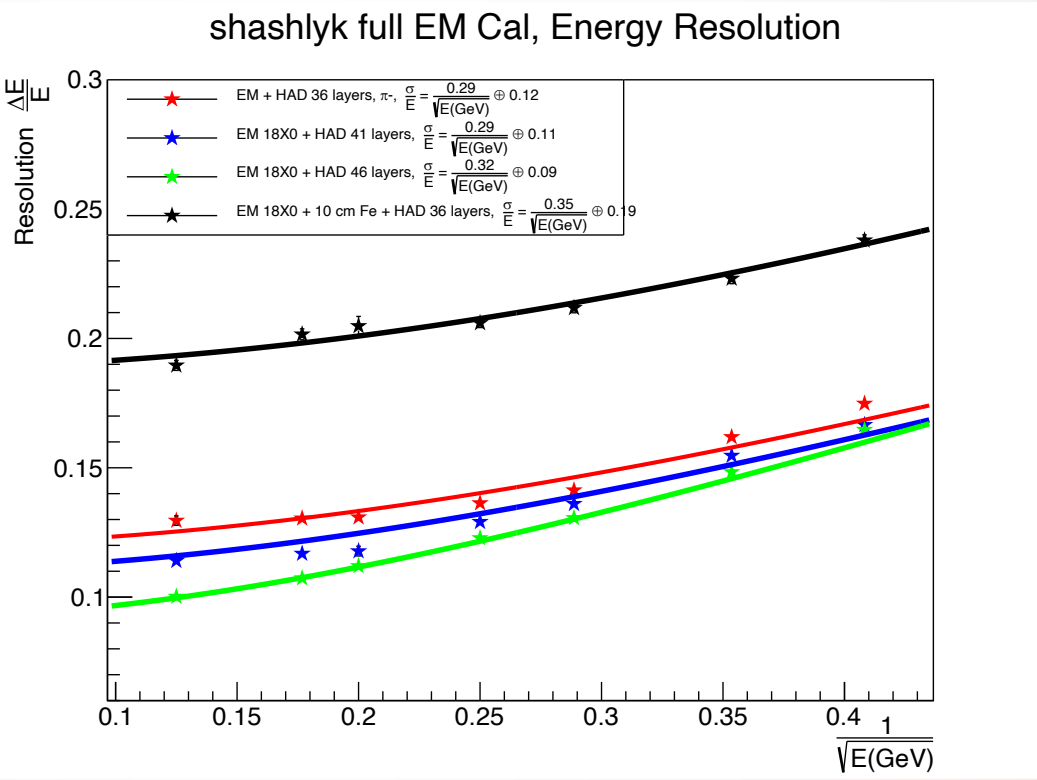




- Modify the Had Cell calorimeters to be closer to real case
- Old: 6*6 (so 600mm * 600 mm)
  - Into new (600mm * 593.4 mm)
- small angle (at 3 degrees)

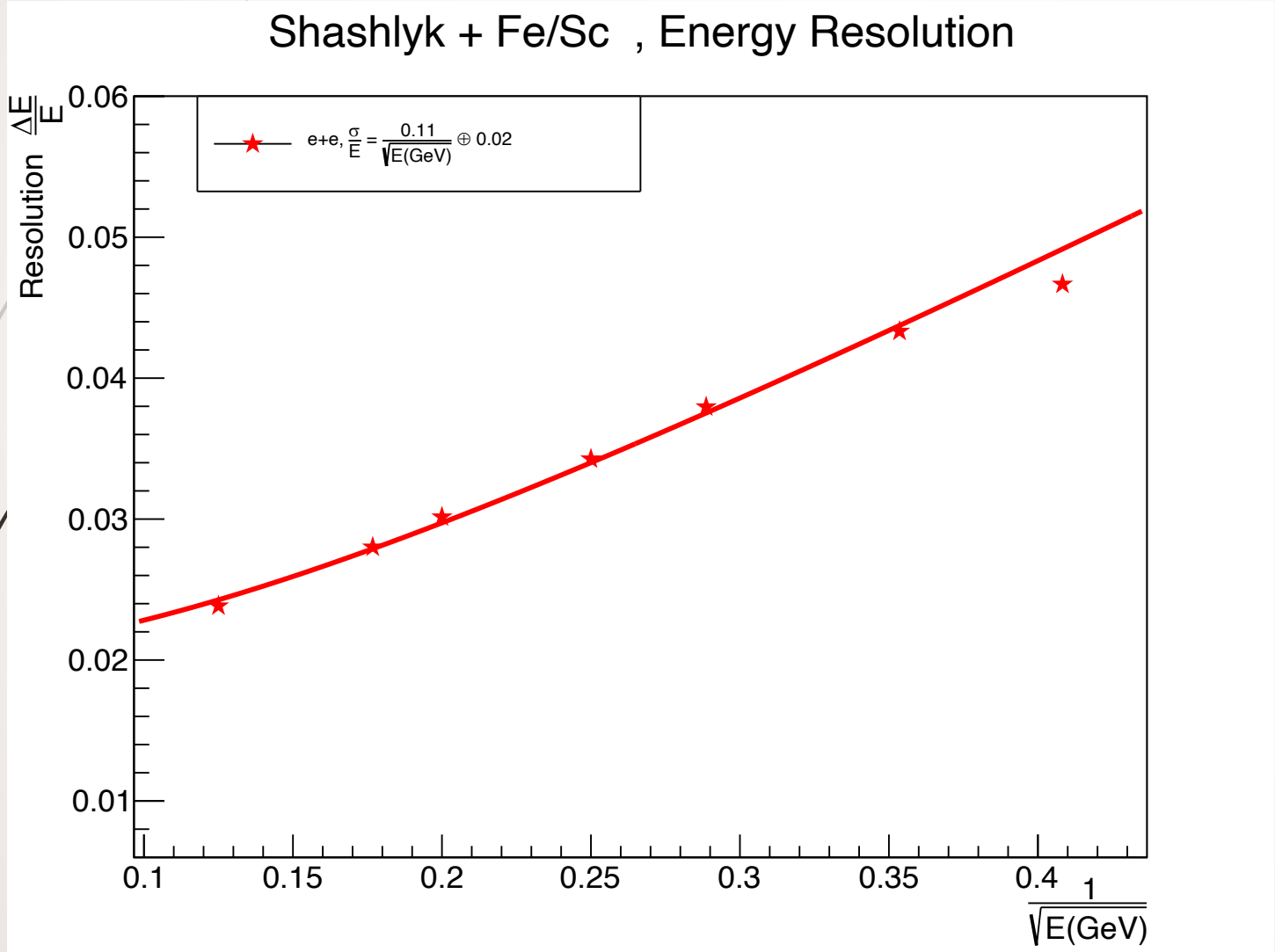
WLS+Fe Results





- Quite similar results for four cases
- WLS+Fe material does not make large change

Results for pure e+e



- e + e for electron
- at 3 degree
- Resolution is ~ 0.11

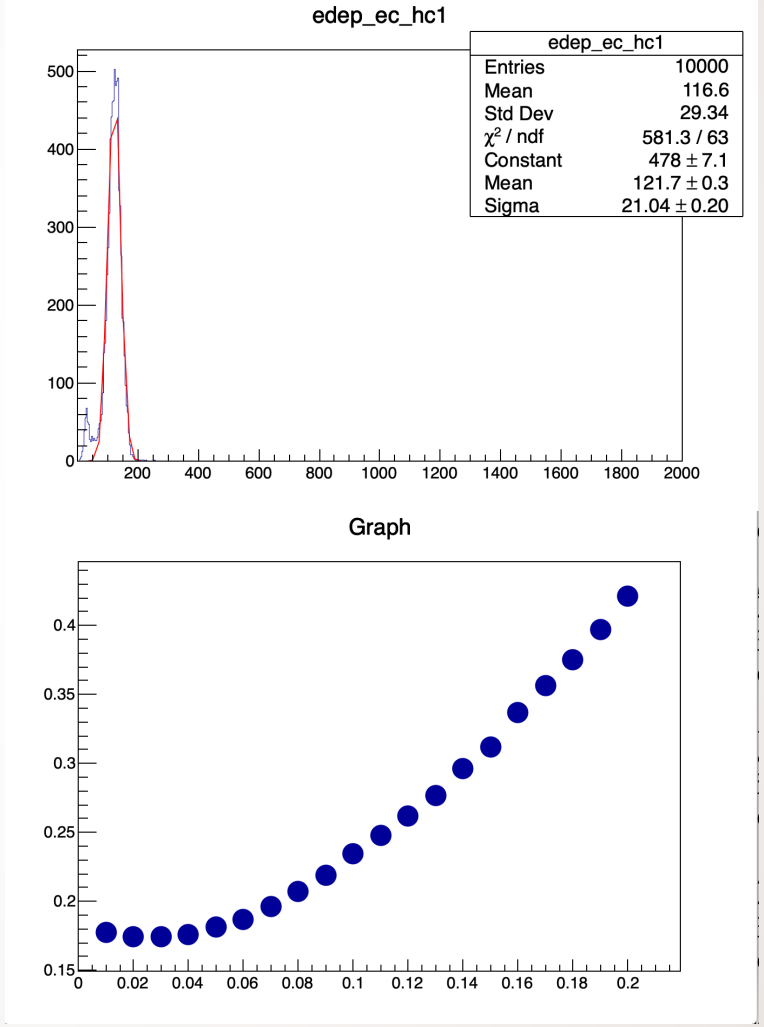
- **Now we only have data from one whole EM Cal**

Re-weighting method

- Old optimal weighting : $E' = E/C$, where C is our weight constant.
- Re-weighting method for hcal towers :
- In each event, For each tile:

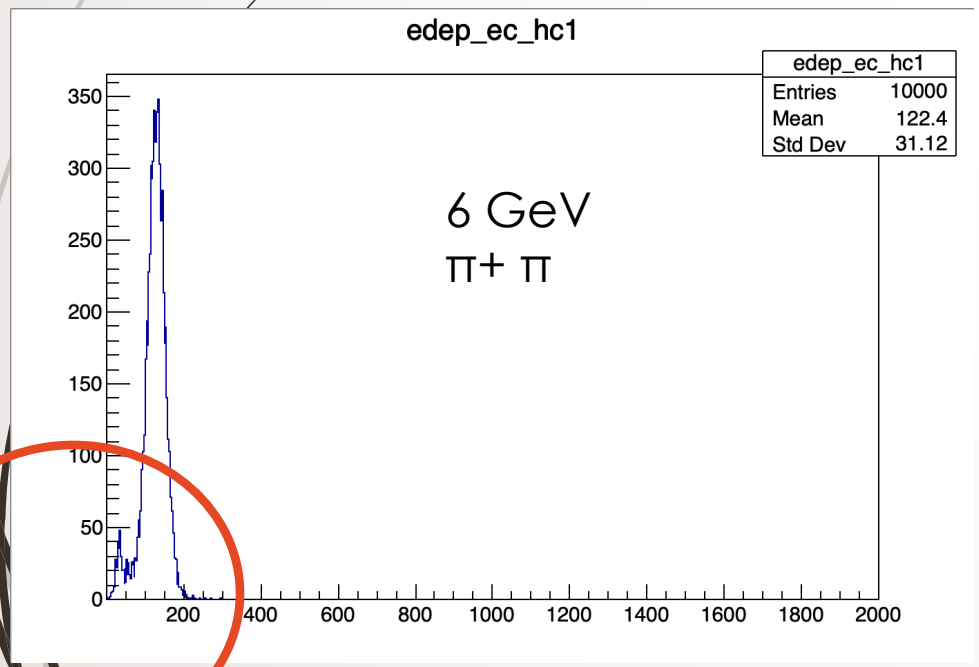
$$E' = E\left(1 - \frac{C}{E_{tot}}E\right)$$

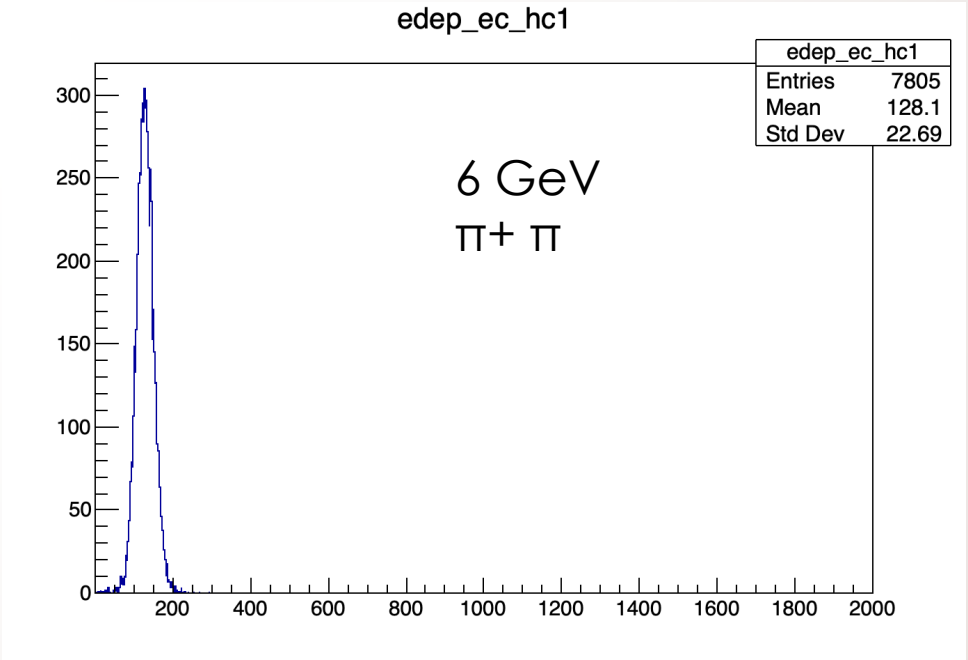
- where E_{tot} is total energy for all tiles
- C is our weight constant (0.01- 0.2)



Controlling longitudinal leakages

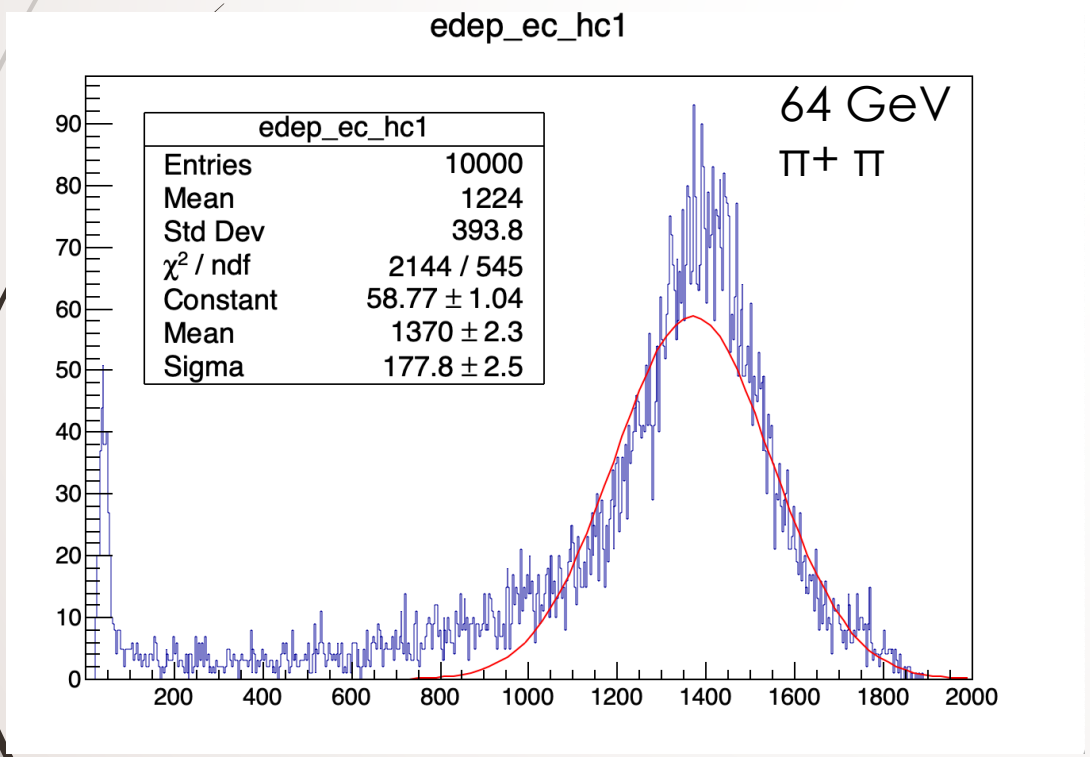
- tail catcher : where last few layers of HCal section has additional independent readout
- set the number of tails = 3
- threshold = ratio between energy of tail catcher over total = 0.022

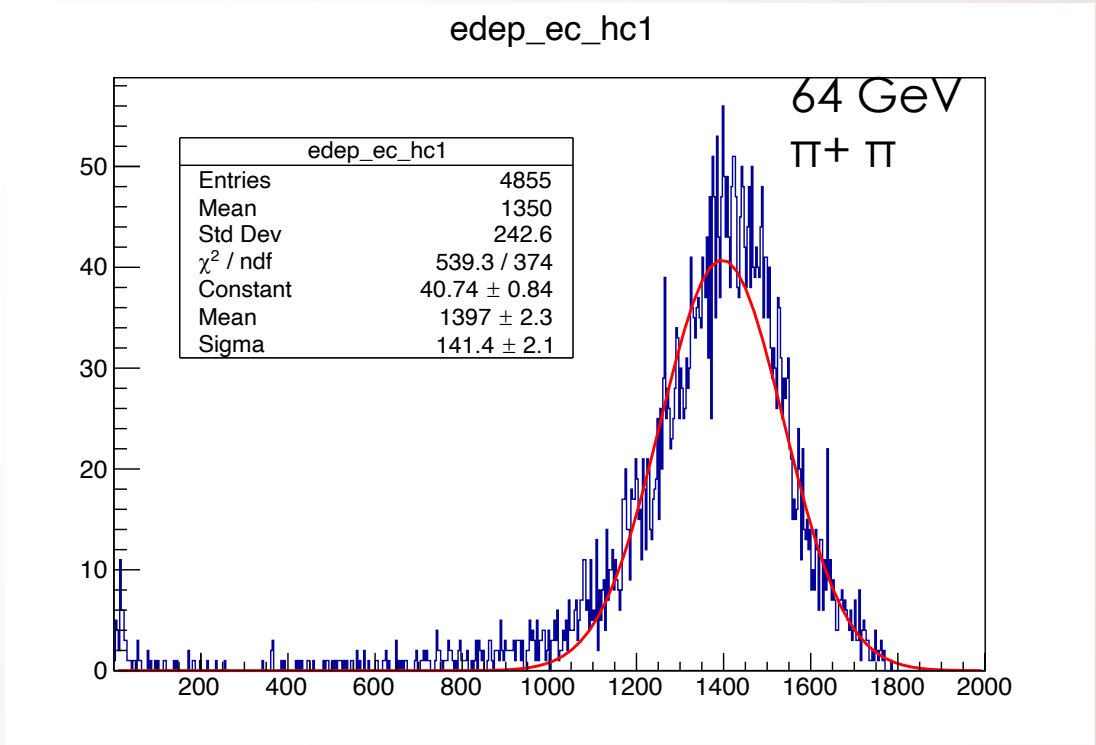




Re-weight method + cutting tails

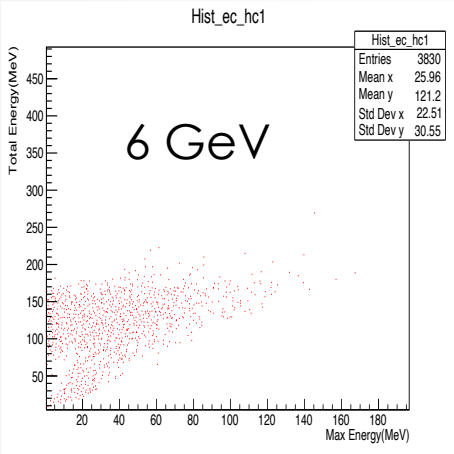
- Total energy distribution for old method and new re-weight method, for the pions of 64 GeV
- After applying tail catcher and re-weight, we have a better gaussian.

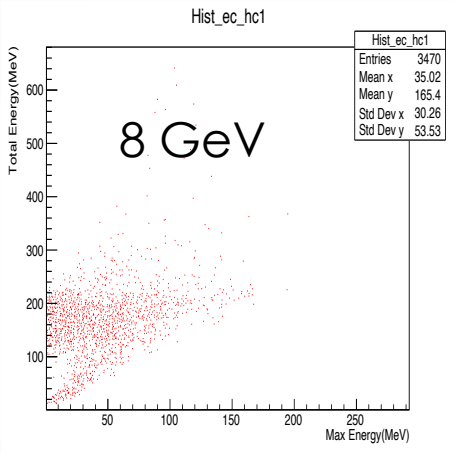


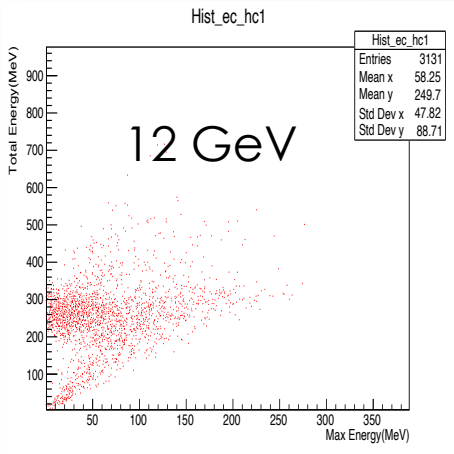


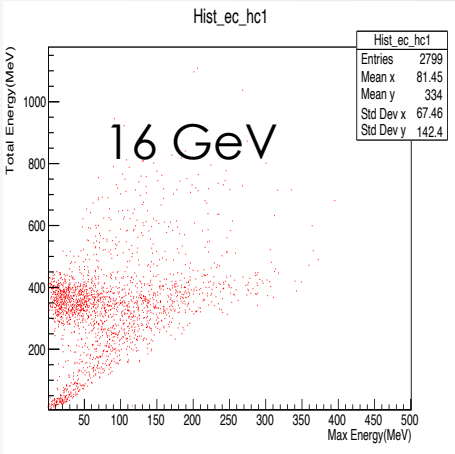
Scatter of max energy distribution of single tower against total energy

Only exclude leak

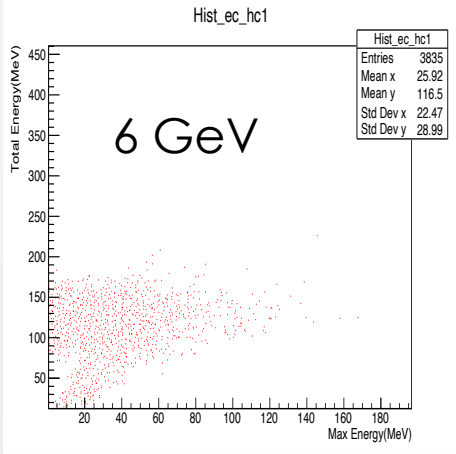


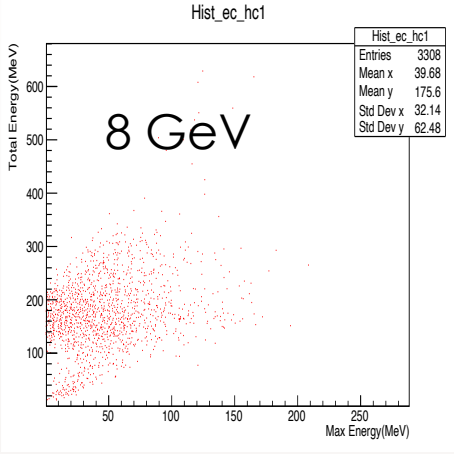


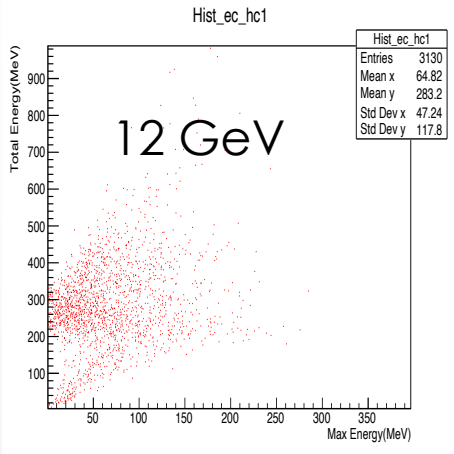


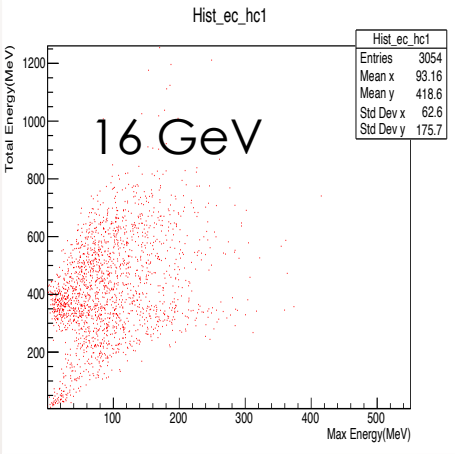


After



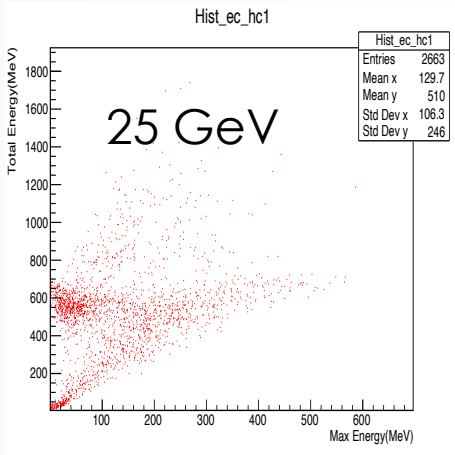


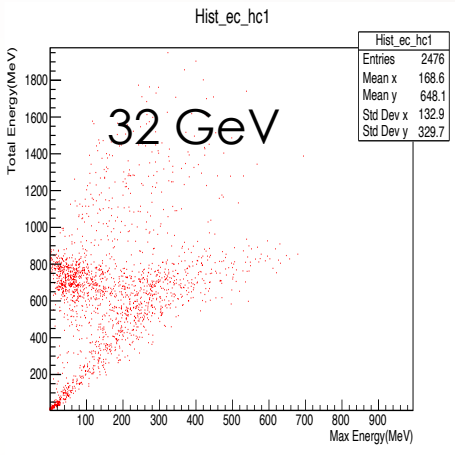


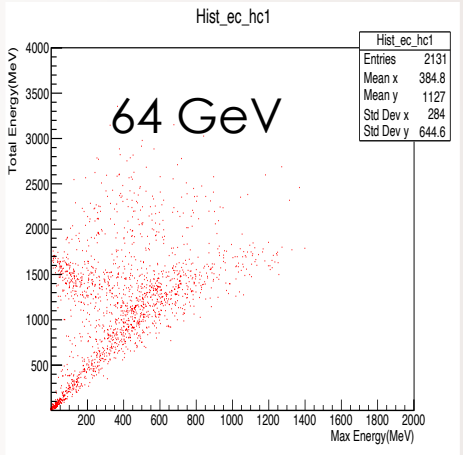


exlude the leak and apply weight

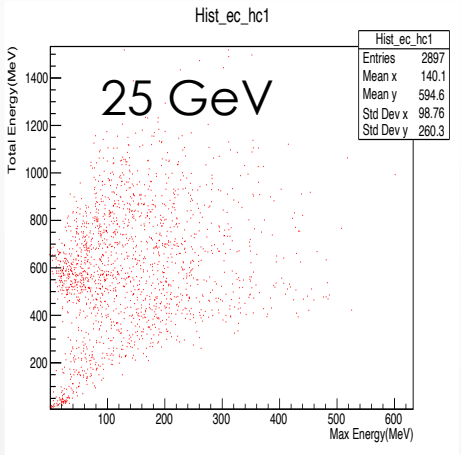
Only exclude leak

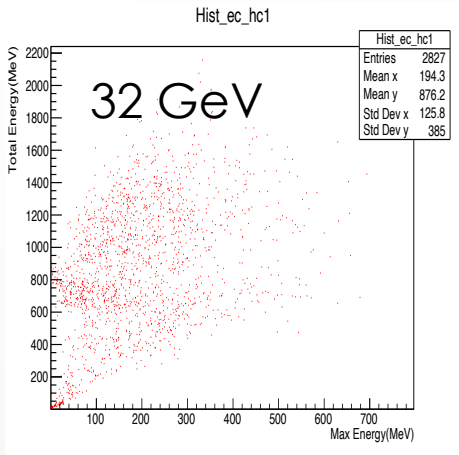


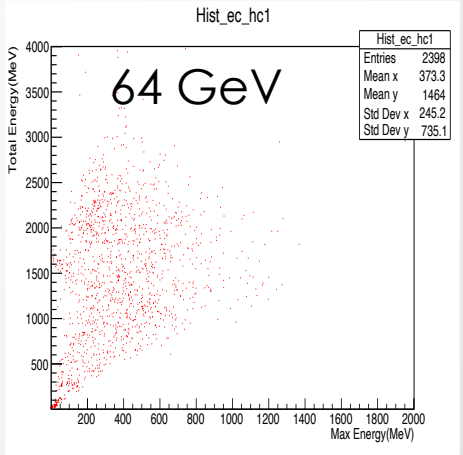




After







Conclusion

- Energy resolution for shashlyk configuration is about 44% plus a constant 0.07
- Using full EM instead of different layers would decrease the resolution.
- Adding WLS/Fe layers does not change the resolution much.
- The reweighting method could a good approach to check out the energy resolution. More to be explored in the future.

Thank you.