Progress on TB analysis

Giacomo Polesello
INFN, Sezione di Pavia
On behalf of the Pavia group

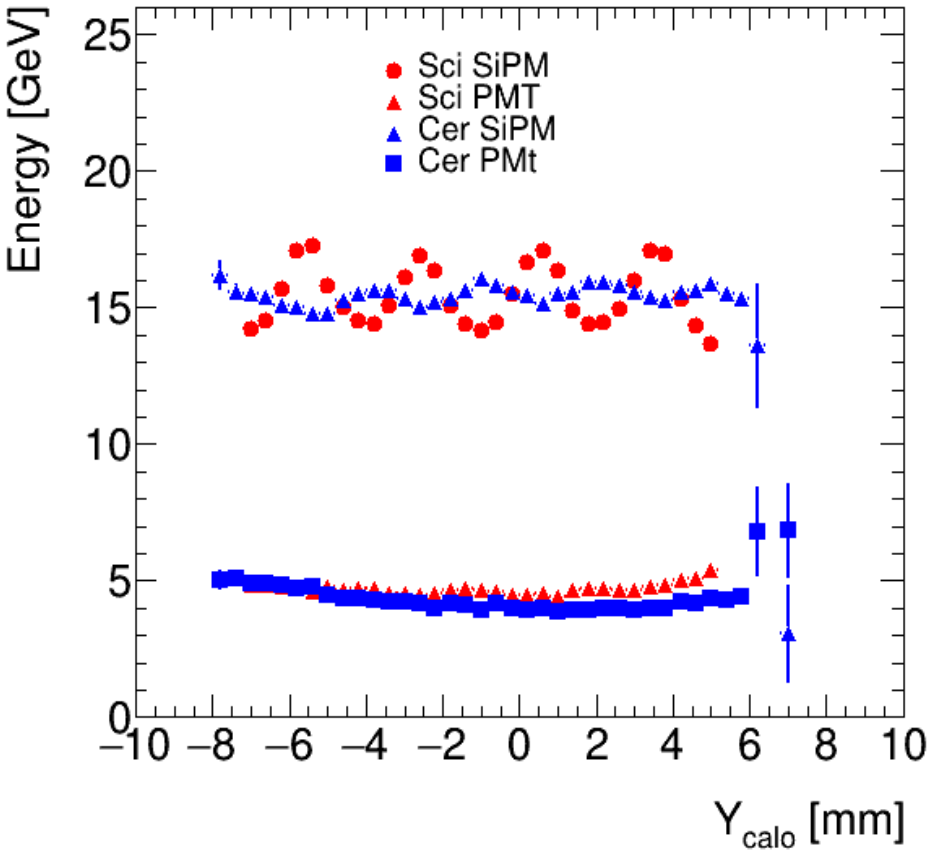
Introduction

New attempt at extracting experimental resolution for SPS test beam.

- Define algorithm for extracting energy measurement on single 20 GeV run without preshower
- For runs with preshower: select events with only 1 mip in preshower, and calculate linearity and resolution

  Only three energies workable: 10,20 and 30 GeV
- Compare with MC

The problem



Periodic structure in Y in SiPM

Phase of Sci opposite to phase of Cer, but amplitude very different

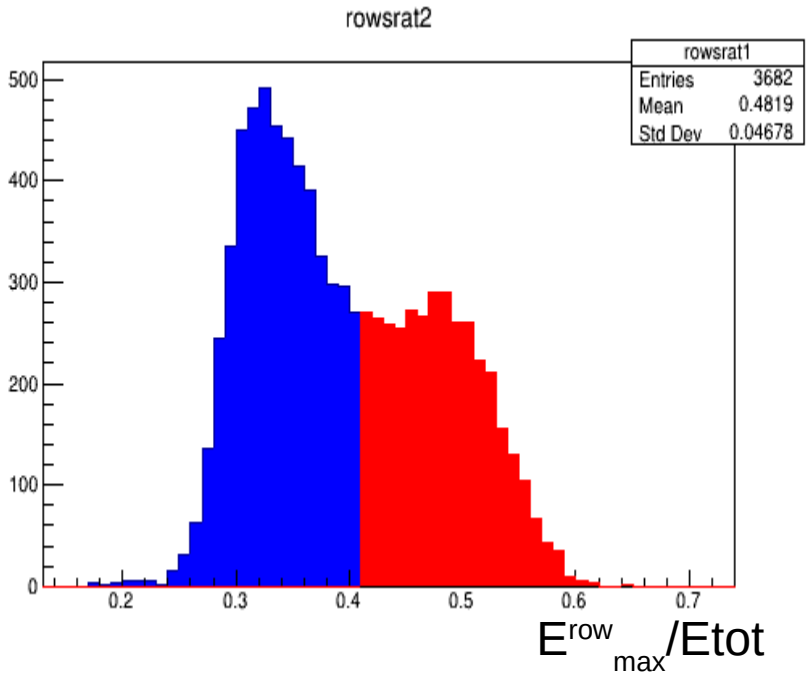
→ only partial cancellation when summing them

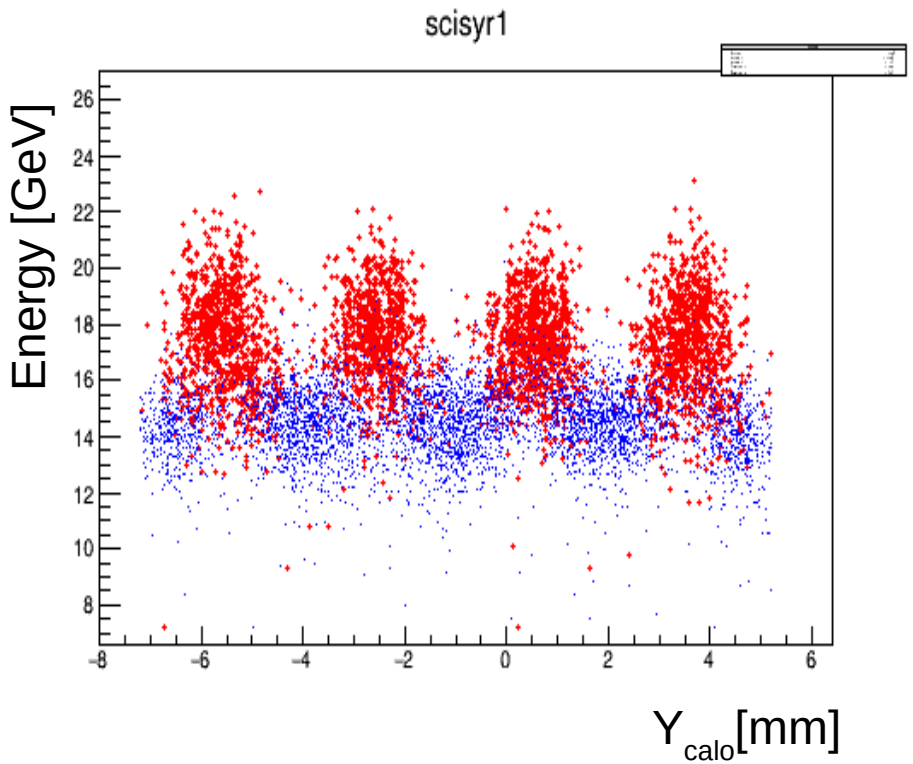
No such structure in PMT

Very large effect: ~10% in Sci

Need to correct for it to extract any sensible resolution

Previous attempt



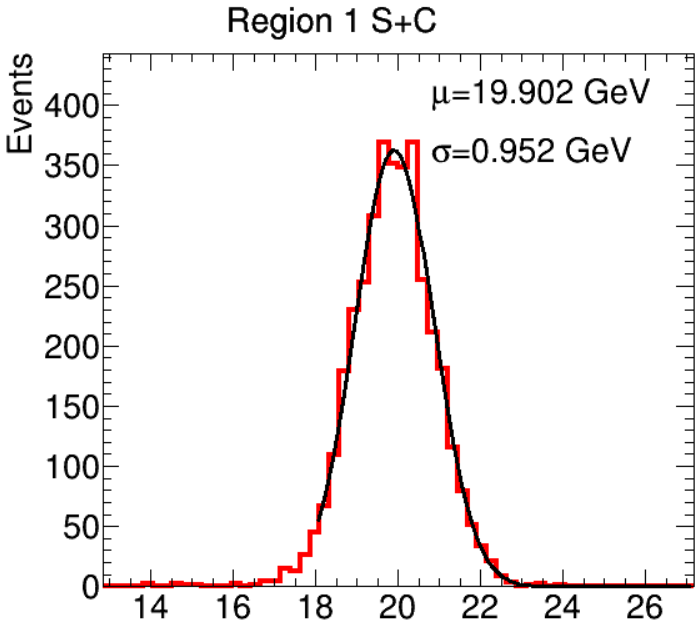


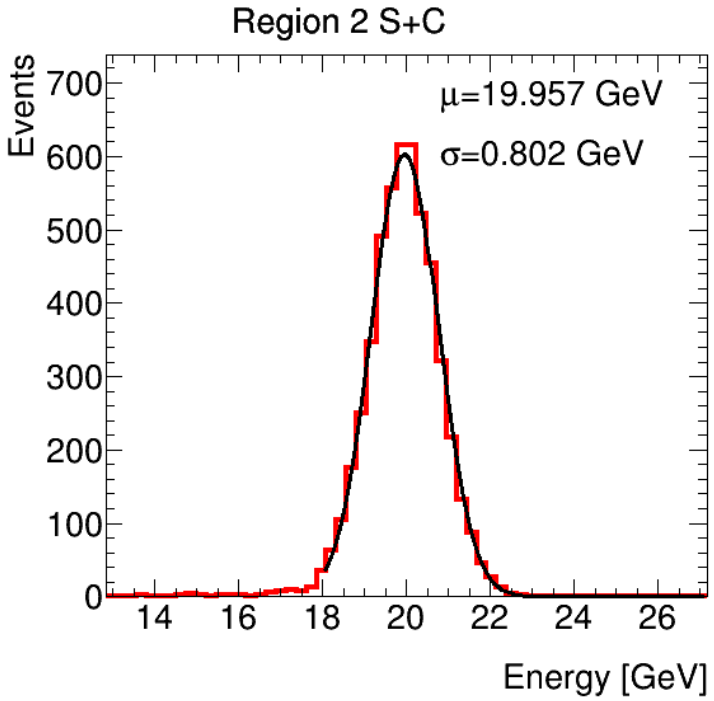
Calculate the ratio of the energy in the hottest scintillator row to the total sci energy:

$E^{row}_{max}/E_{tot}=R_E$

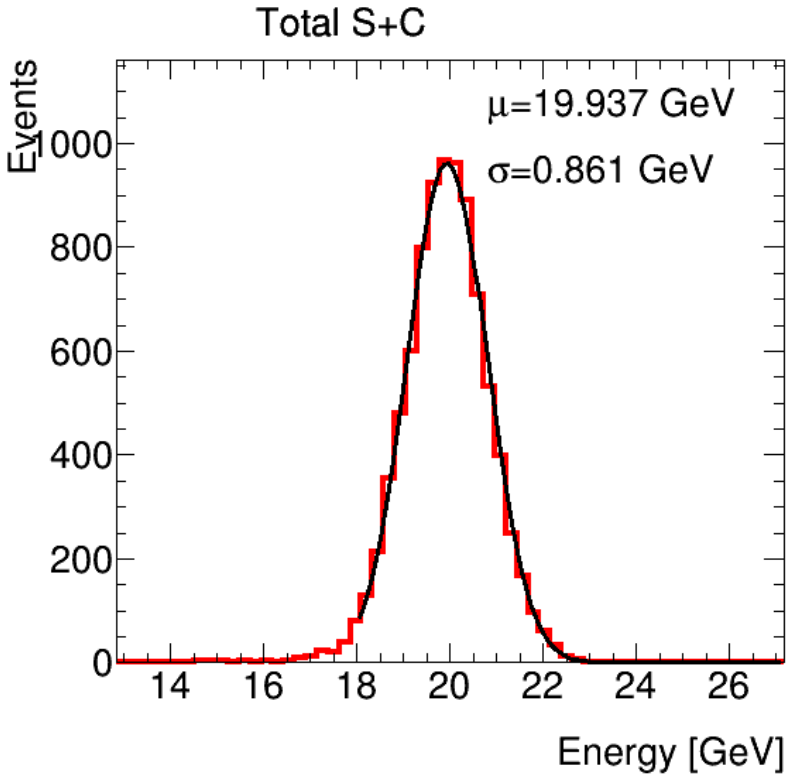
A cut at ~0.4 separates region of high and low response: calibrate separately in two regions

Resolution run 695
20 GeV No PS



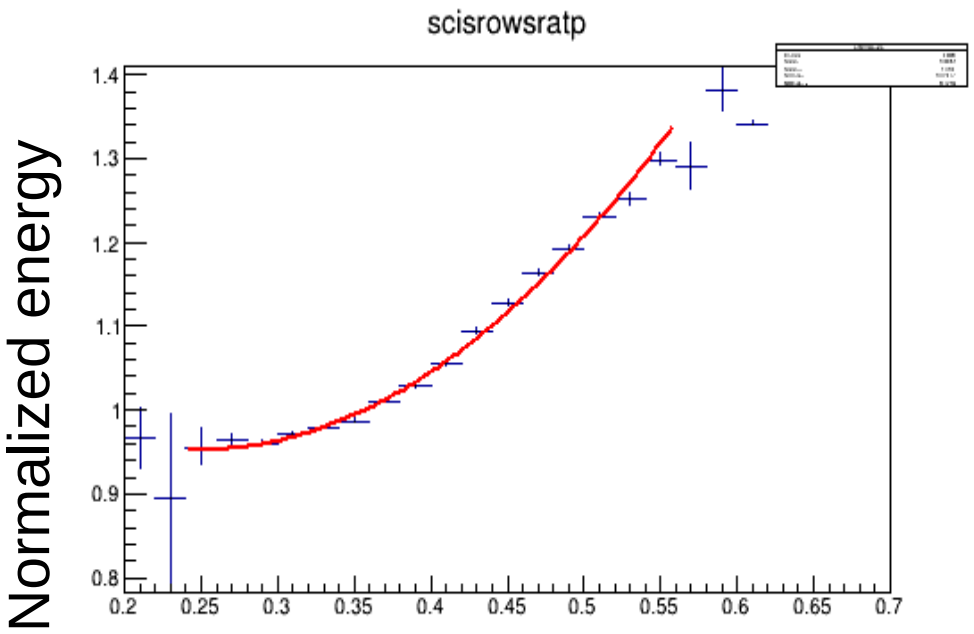


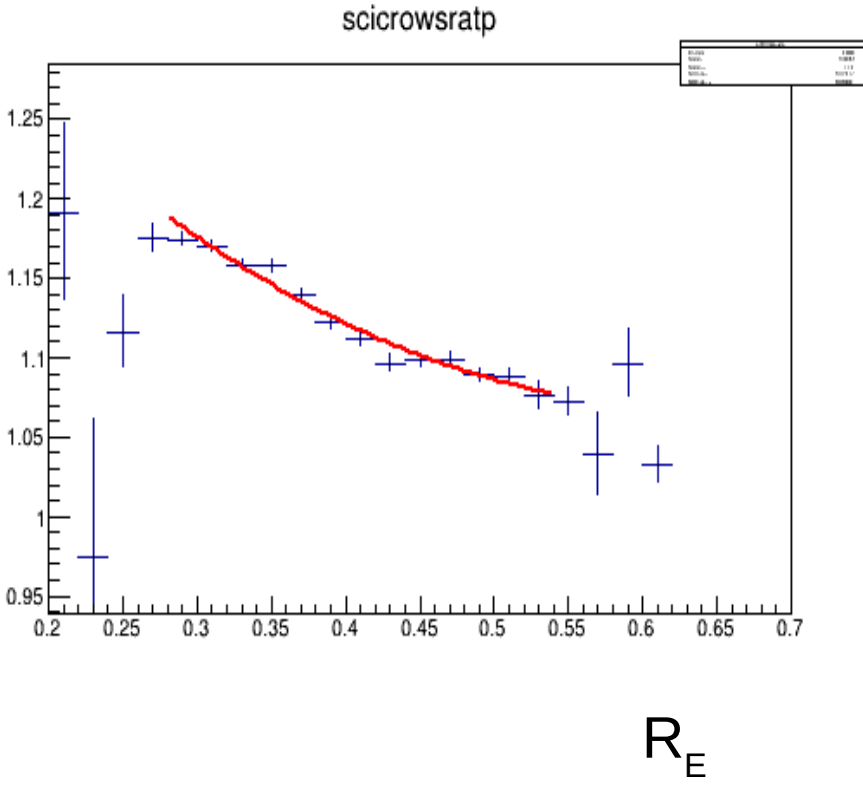
Pretty good resolution in region 2,
But mediocre resolution in region 2 results in not-so-satisfactory total resolution



New try

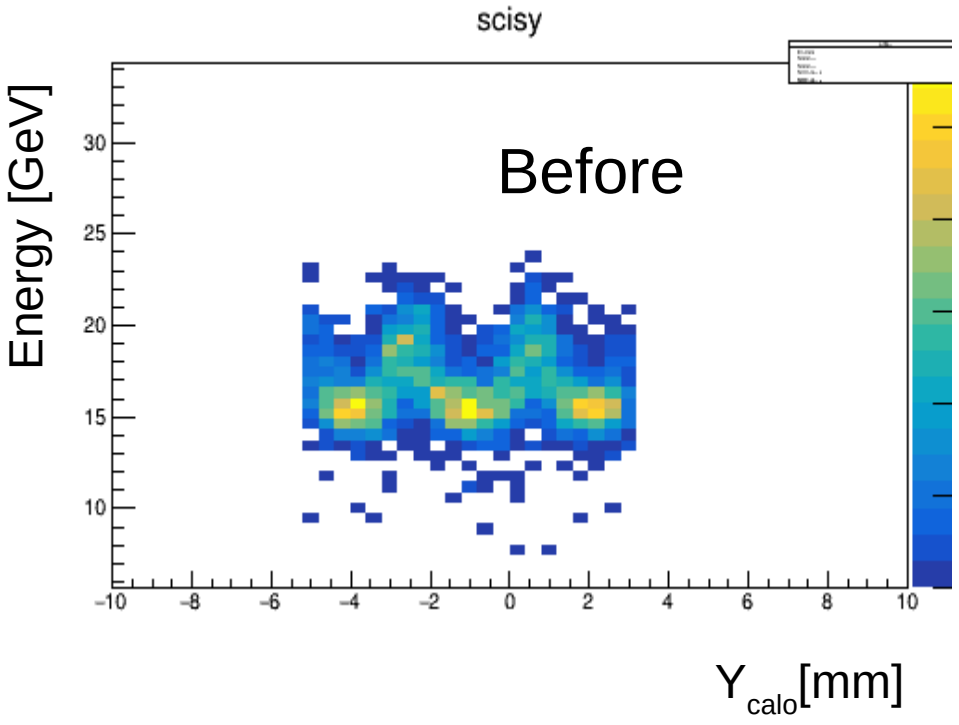
Study how response normalised to expected energy deposition depends from R_E

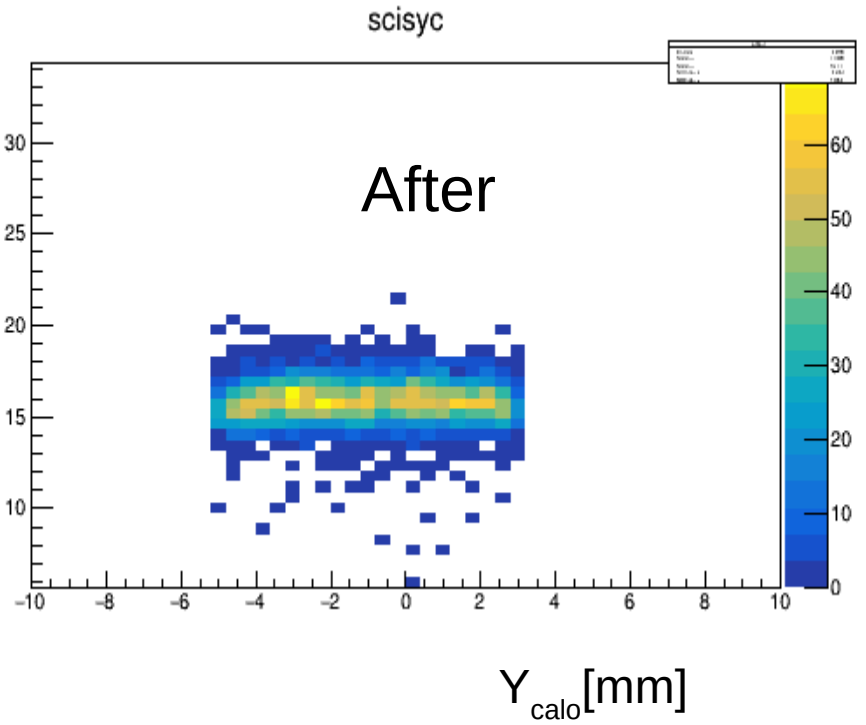




Easy to parametrise and correct for with $2^{nd}/3^{rd}$ deg polynomial

Impact of correction





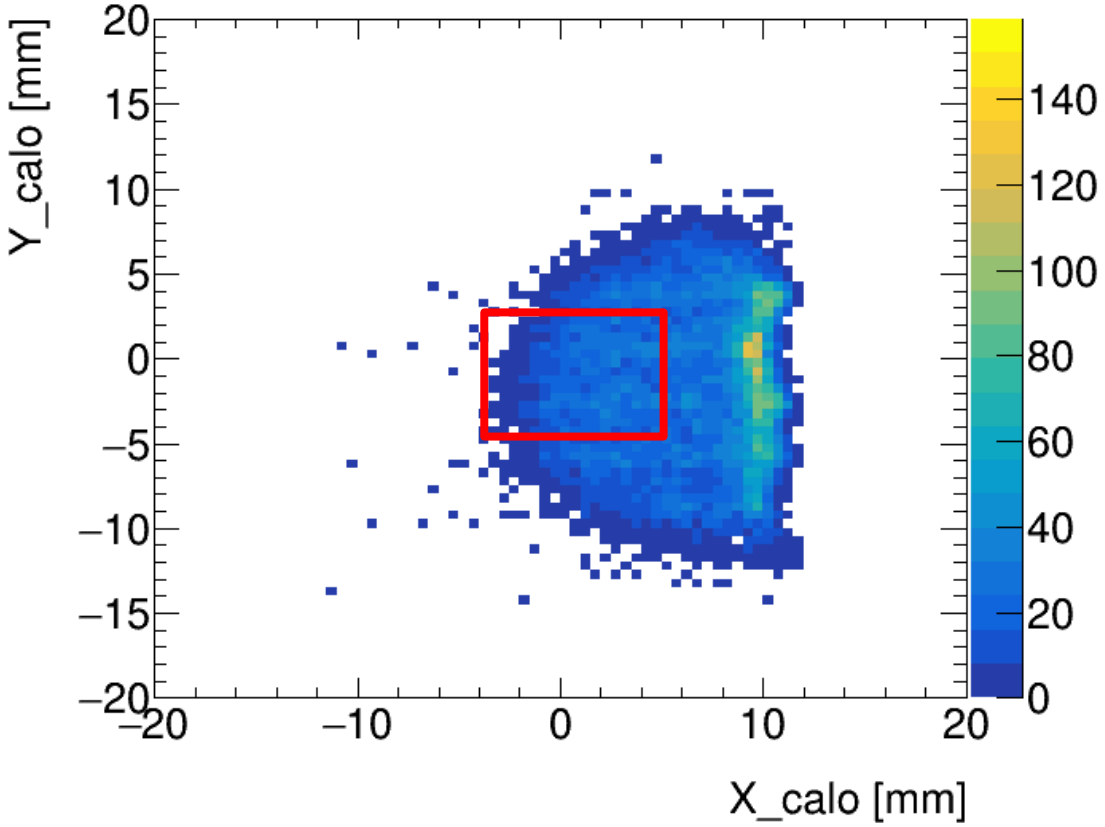
Parametrisation in R_E seems to smooth out

Y position dependence of response

Procedure

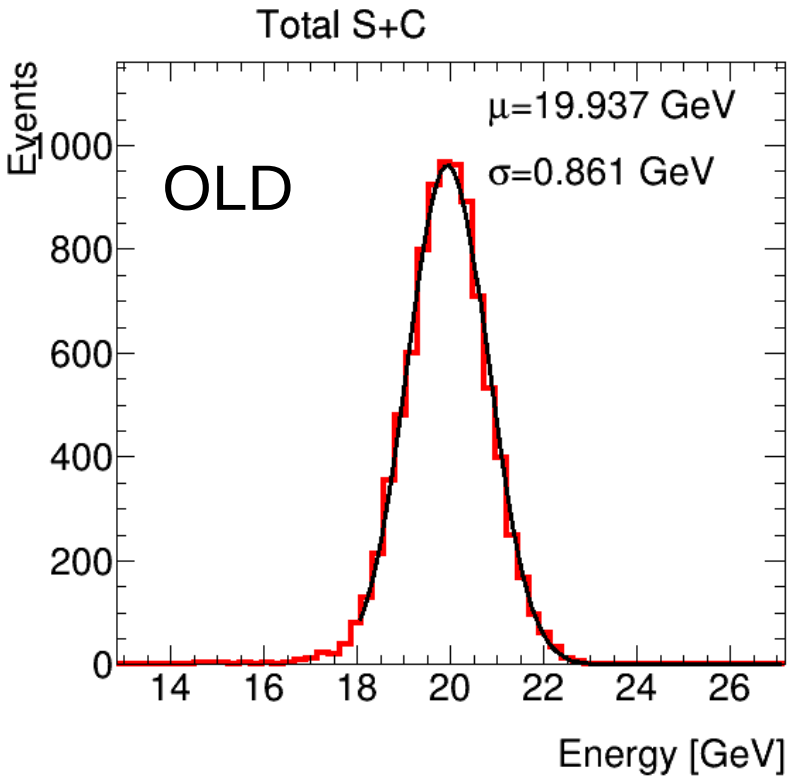
- Perform equalisation on run without preshower (20 GeV)
- Define fiducial based on sci barycenter in SiPMs
- For that fiducial calculate 3 numbers in MC
  - Energy in cell 0 (E_0)
  - Energy in surrounding 8 cells ($E_{(1,8)}$)
  - Leakage fraction f_{leak}
- Separately for Cerenkov and scintillator:
  - Calculate correction for PM $kPM=EPM/E_{(1,8)}$ where EPM is average energy in fiducial:
- For SiPM: parametrise E/E_0 as a function of R_E (E is average SiPM energy in each RE bin) → correction factor $k(R_E)$
- $E_{meas}=f_{leak}*0.5*(1/k_{sci}(R_E)*SiPM_{sci}+1/kPM_{sci}*PMT_{sci}+ 1/k_{cer}(R_E)*SiPM_{cer}+1/kPM_{cer}*PMT_{cer})$
- Use factors thus calculated for all energies

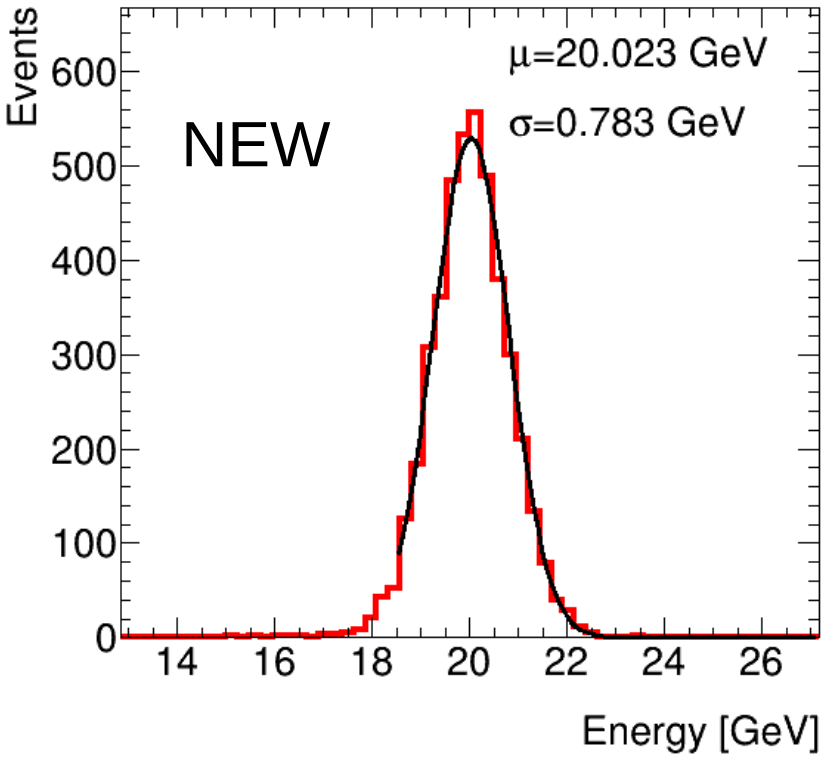
Fiducial



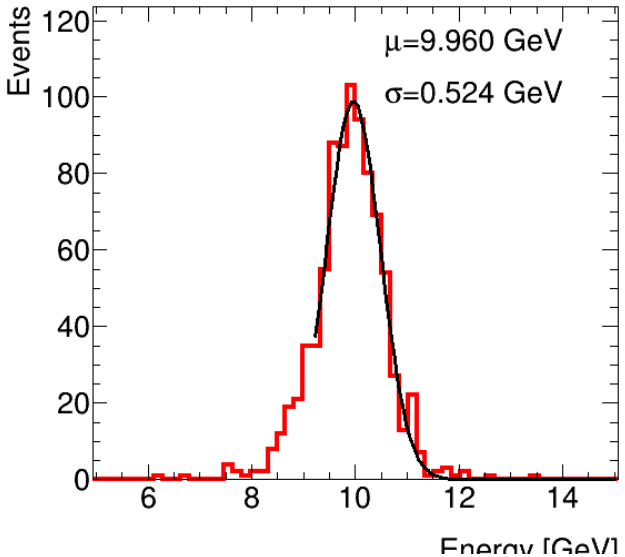
Reduce fiducial somewhat wrt previous try
to minimise possible dependence on SiPM/PMT intercalibration

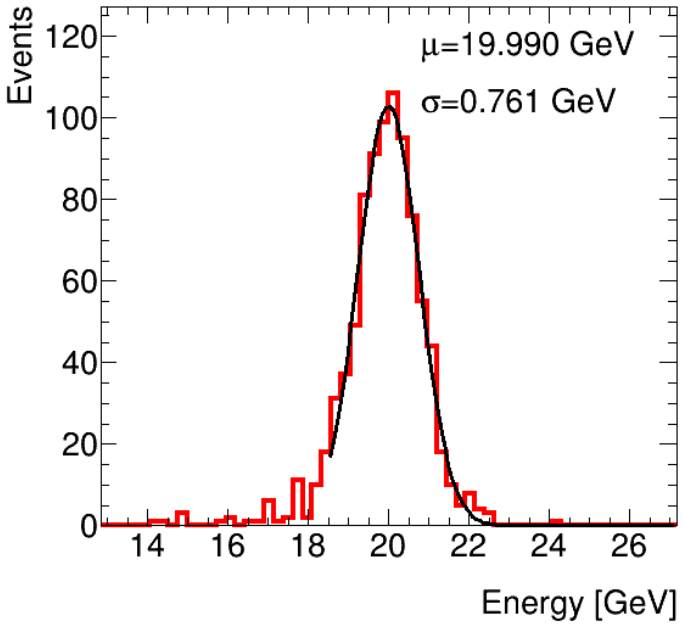
Run 695 (20 GeV no ps)

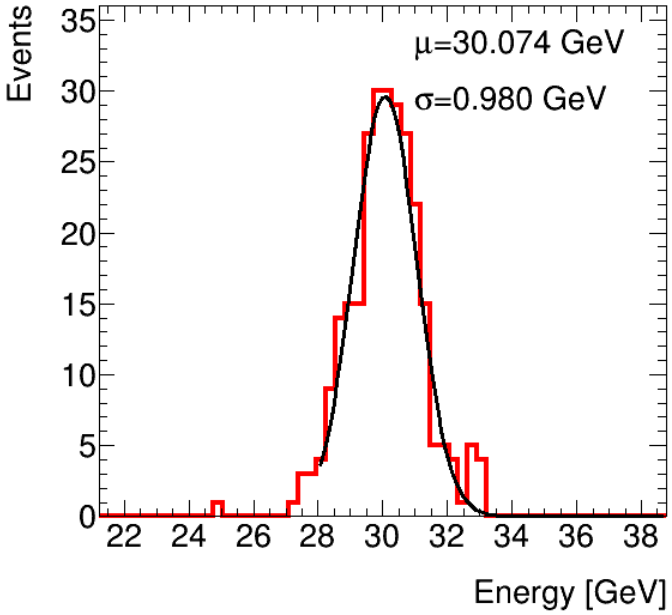




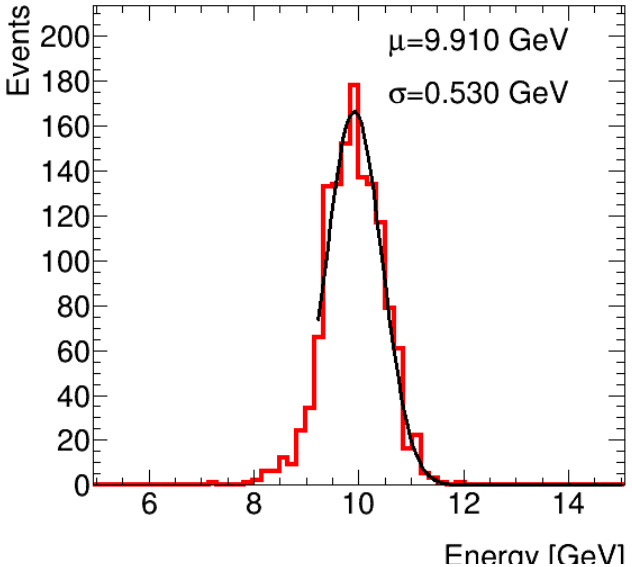
distributions data (Pshower 1mip)

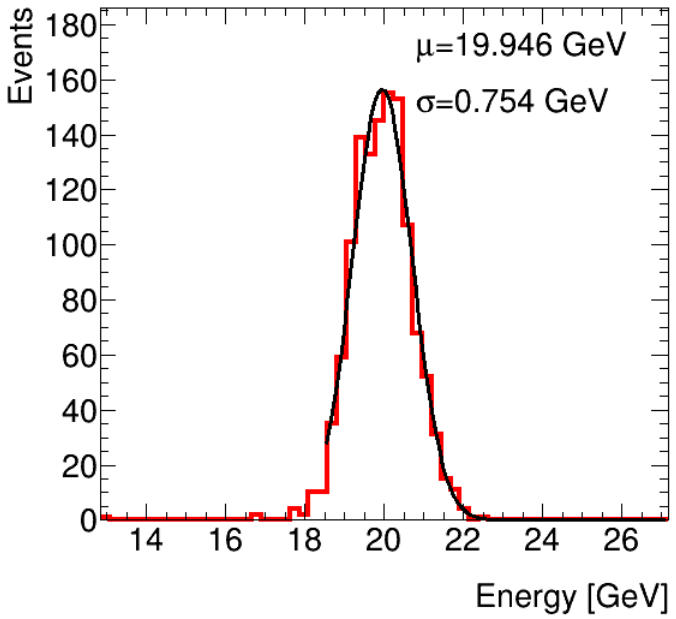


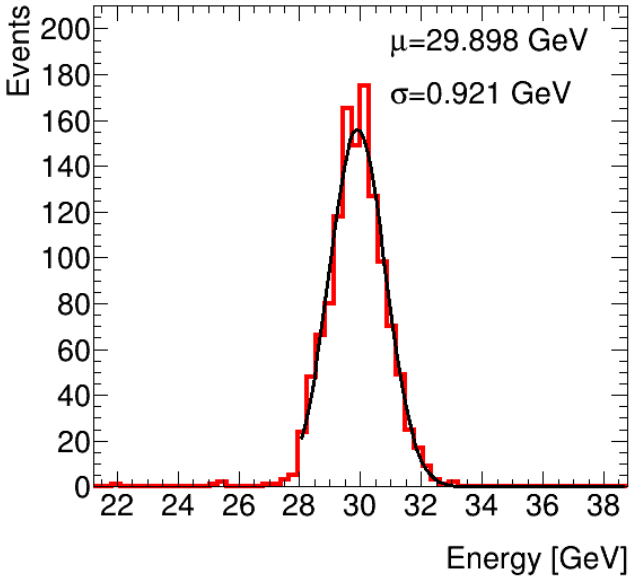




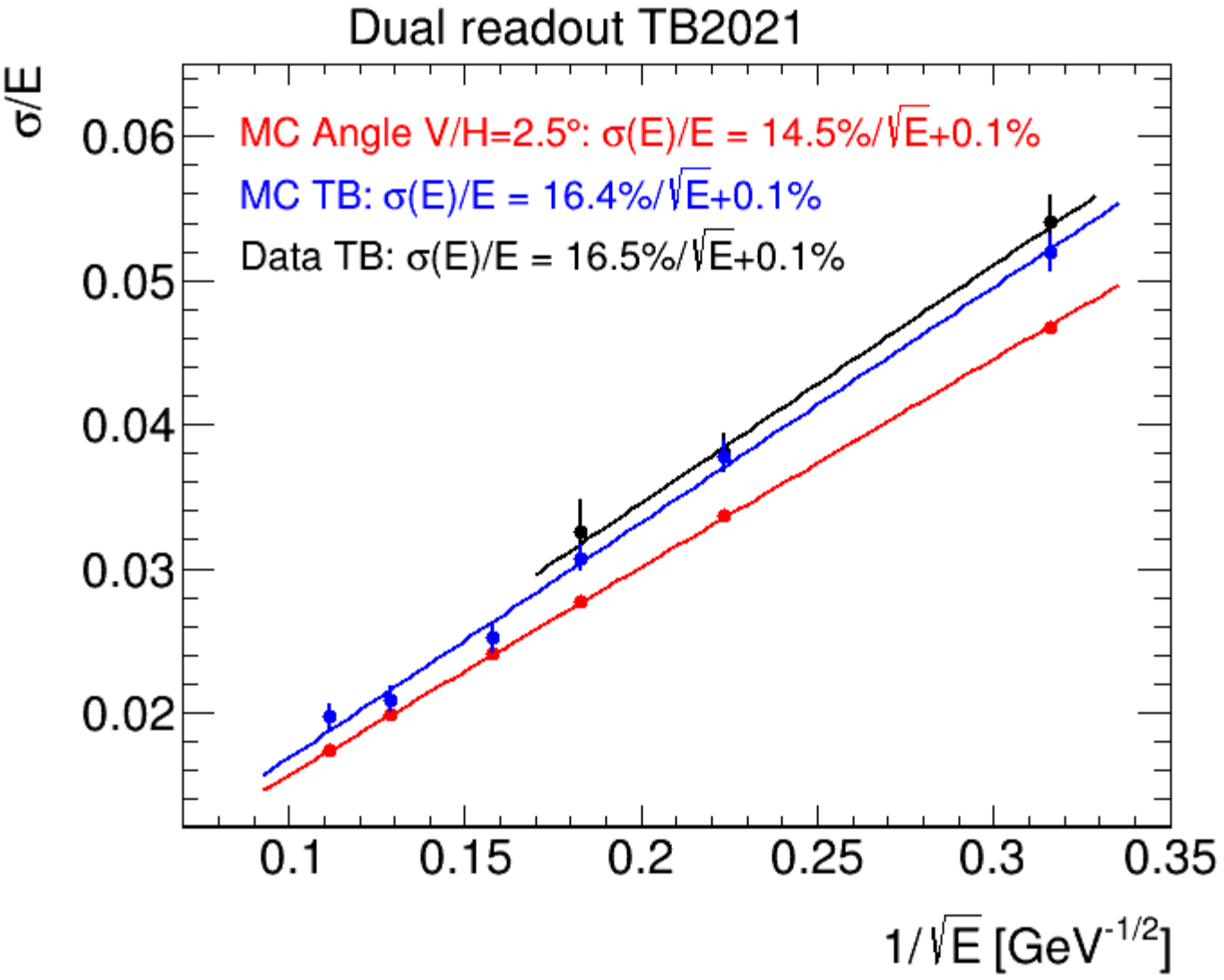
Distributions MC (Pshower 1 mip)



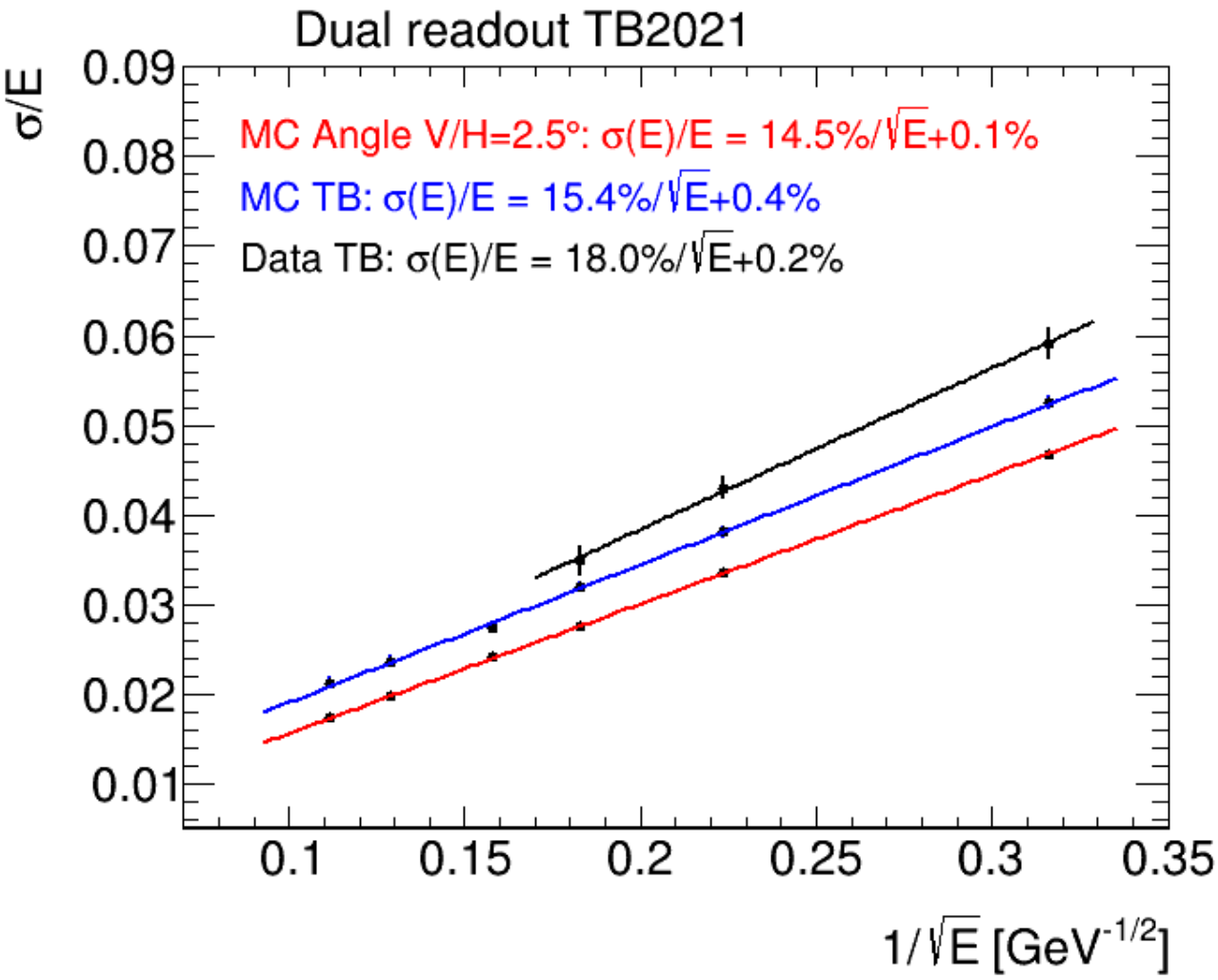




Results


Dual readout TB2021
σ/E
MC Angle V/H=2.5°: σ(E)/E = 14.5%/√E+0.1%
MC TB: σ(E)/E = 16.4%/√E+0.1%
Data TB: σ(E)/E = 16.5%/√E+0.1%
0.06
0.05
0.04
0.03
0.02
0.1
0.15
0.2
0.25
0.3
0.35
1/√E [GeV^-1/2]

Old Results



MC yields better resolution than data

Conclusions

New attempt at extracting resolution for events with only 1 mip in preshower, based on

- MC driven normalisation factors at 20 GeV
- Correct for modulation in vertical direction parametrising smooth variable sensisitive to modulation

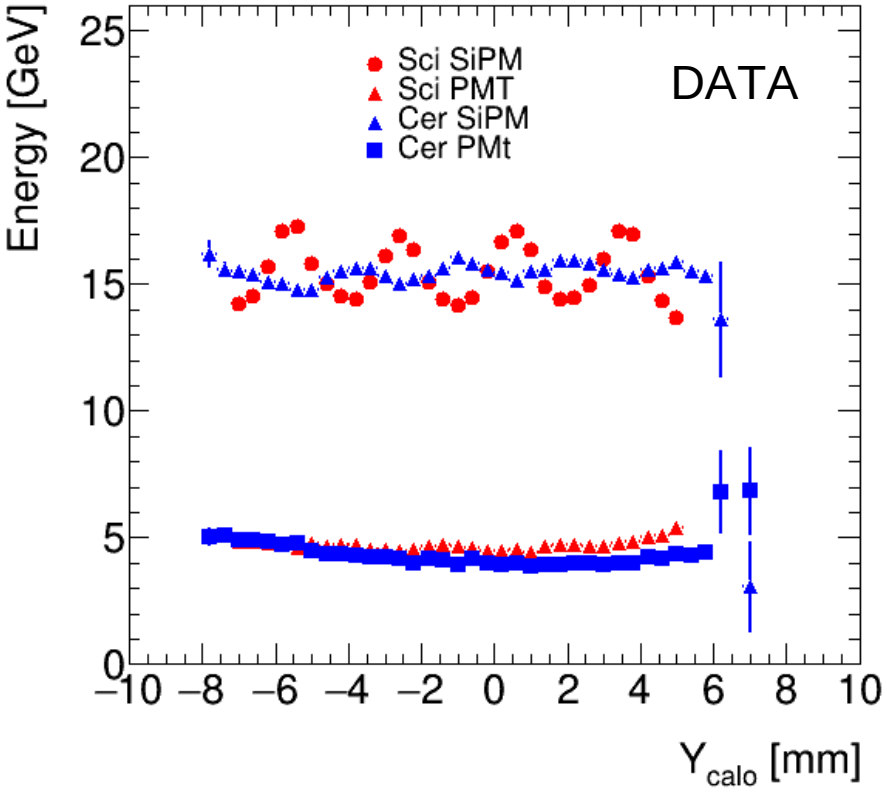
Obtain reasonable performance figures

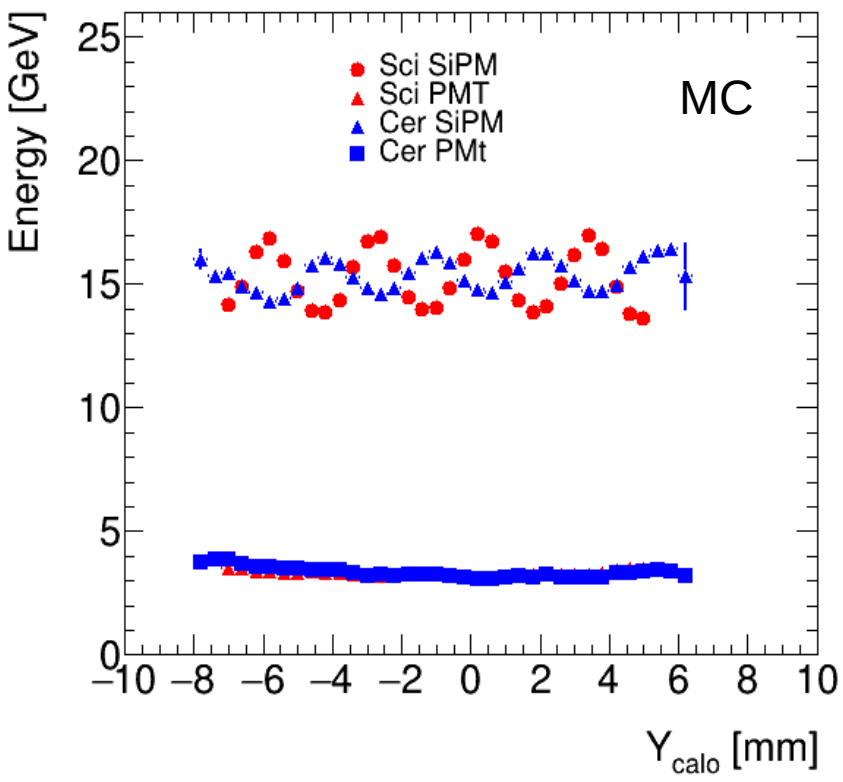
Effect of different cerenkov modulation in data and MC made irrelevant by correction

Will try a little bit of fine-tuning on response parametrisations

Backup

Variation in MC



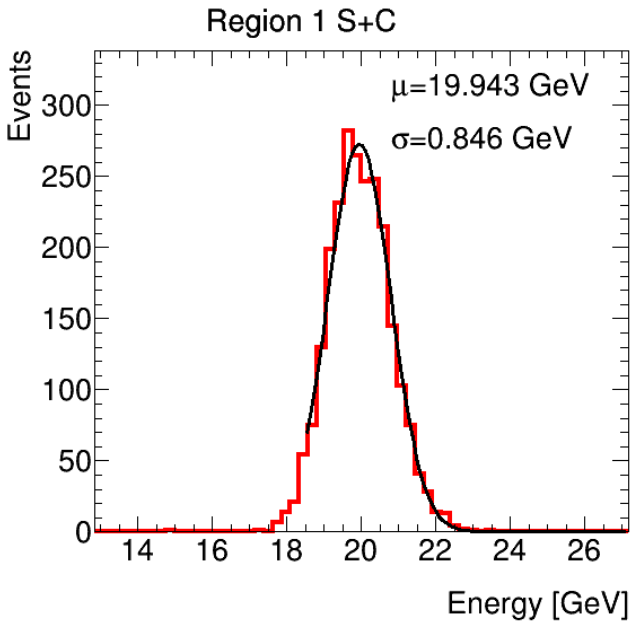


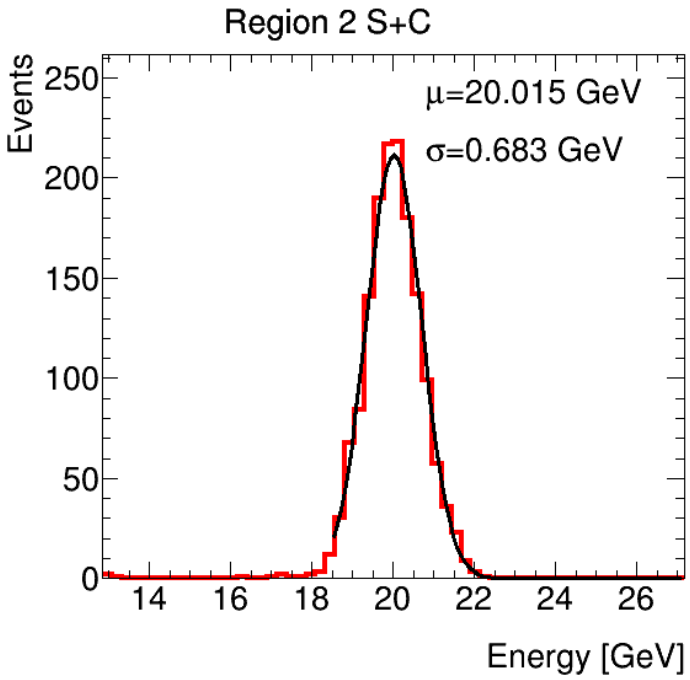
Amplitude variation well reproduced for Scintillator

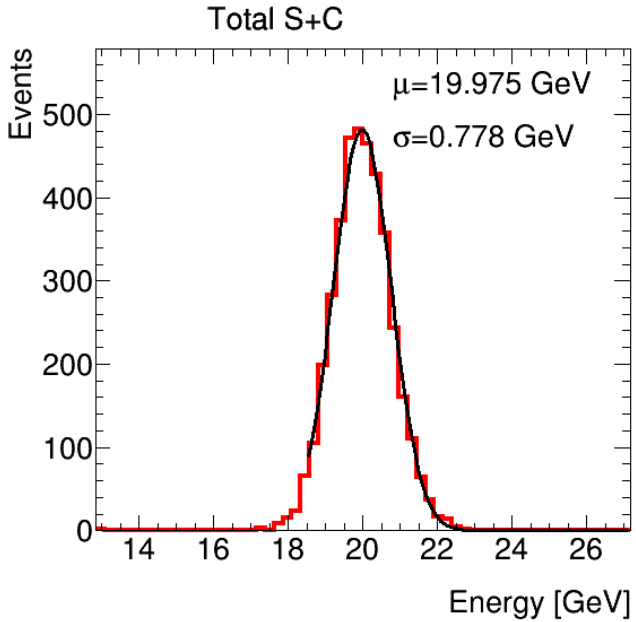
For Cerenkov much smaller variation in data → when summing

Sci+Cer MC is much more stable than data

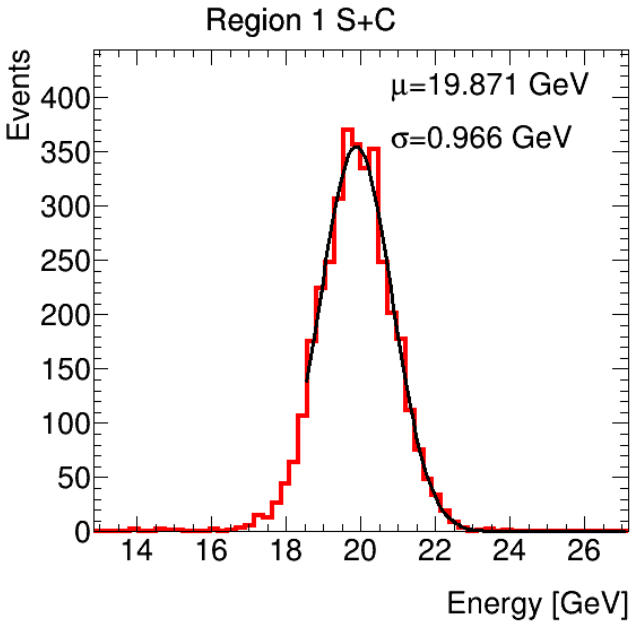
8005

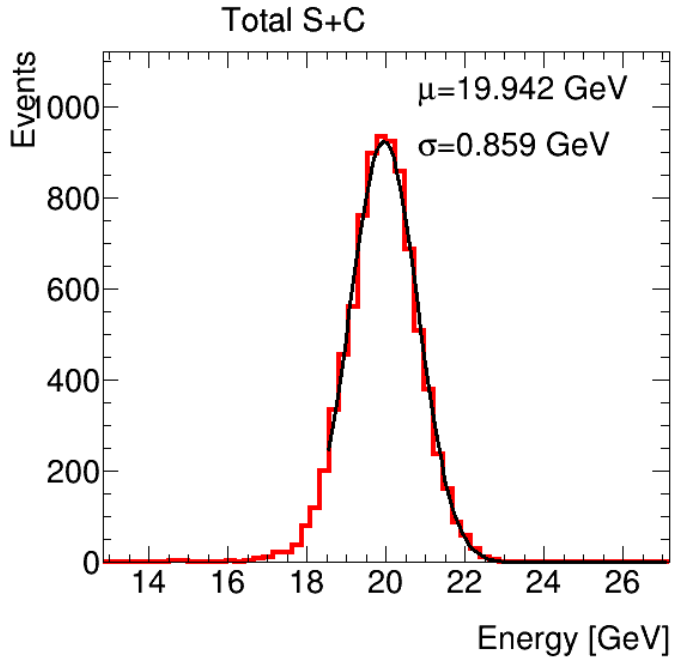

Region 1 S+C
Events
μ=19.943 GeV
σ=0.846 GeV
Energy [GeV]

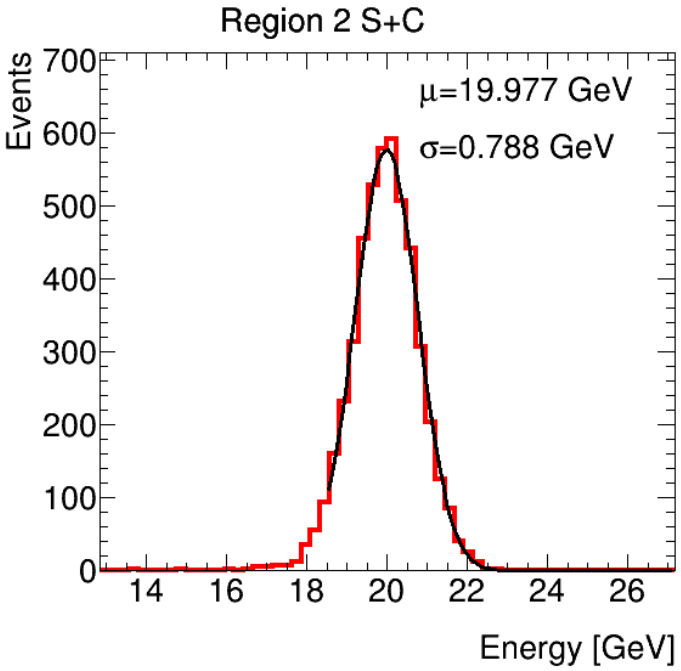

Region 2 S+C
Events
μ=20.015 GeV
σ=0.683 GeV
Energy [GeV]


Total S+C
Events
μ=19.975 GeV
σ=0.778 GeV
Energy [GeV]

695

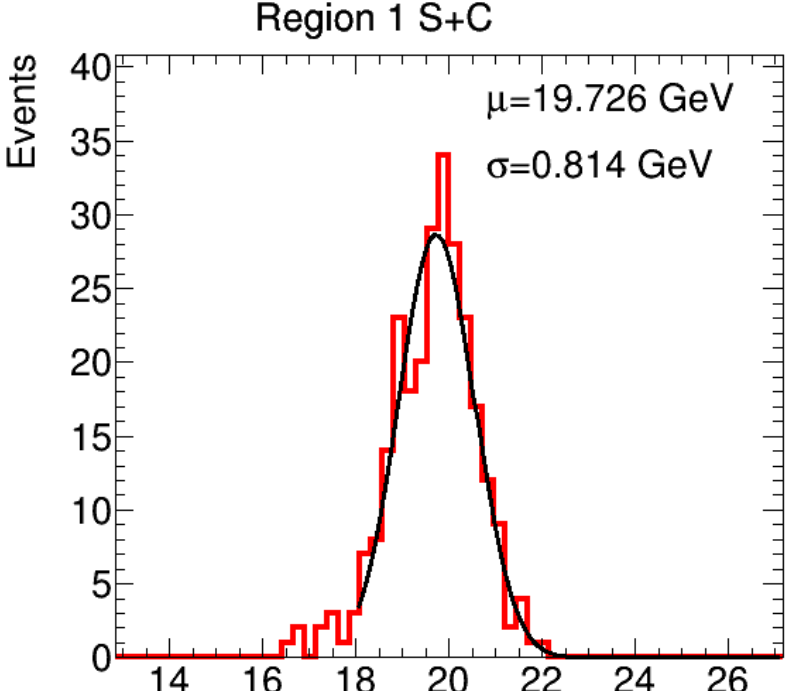

Region 1 S+C
Events
μ=19.871 GeV
σ=0.966 GeV
Energy [GeV]

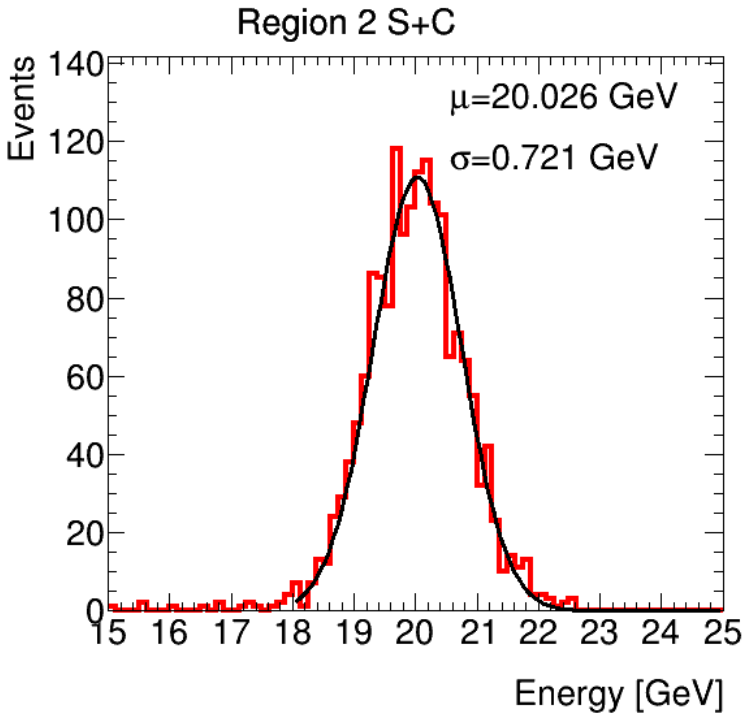

Total S+C
Events
μ=19.942 GeV
σ=0.859 GeV
Energy [GeV]

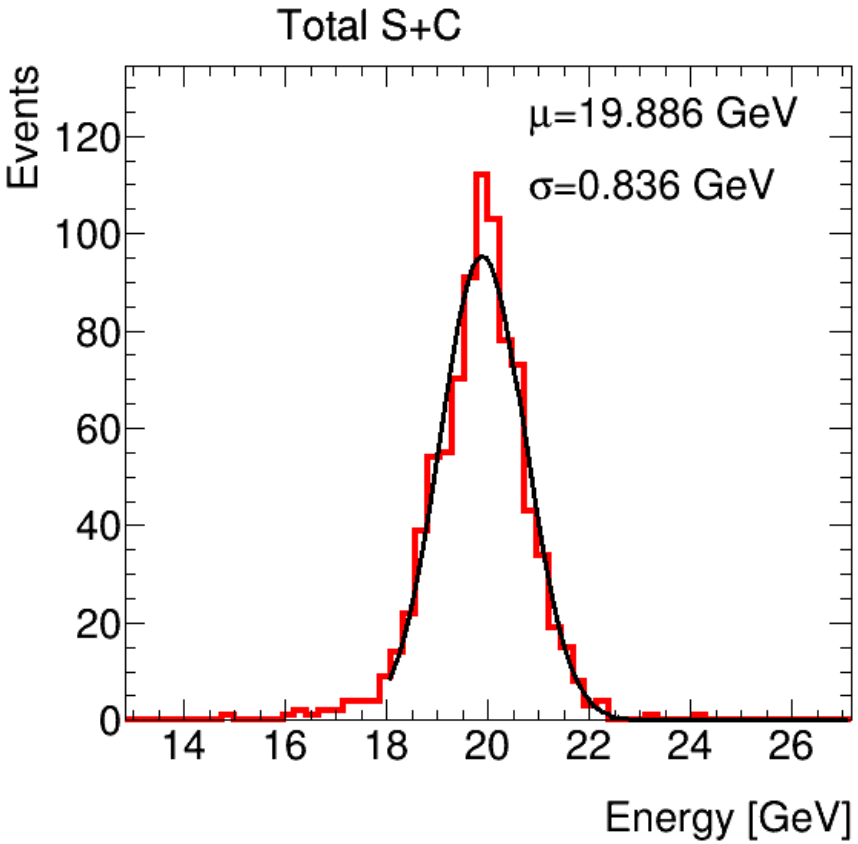

Region 2 S+C
Events
μ=19.977 GeV
σ=0.788 GeV
Energy [GeV]

Resolution run 694

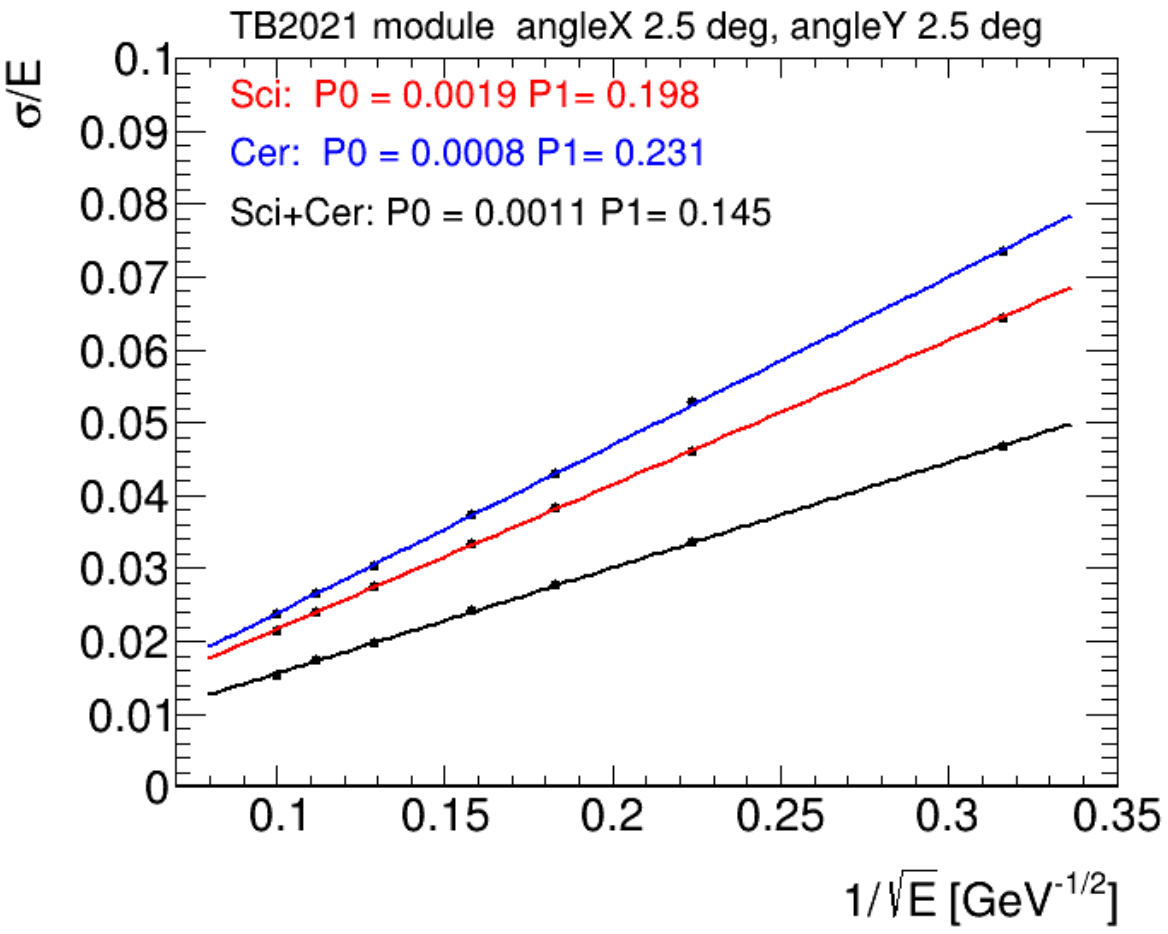
20 GeV PS 1 mip







EM resolution for TB2021 simulation with rotated calo



xrot=2.5 degrees

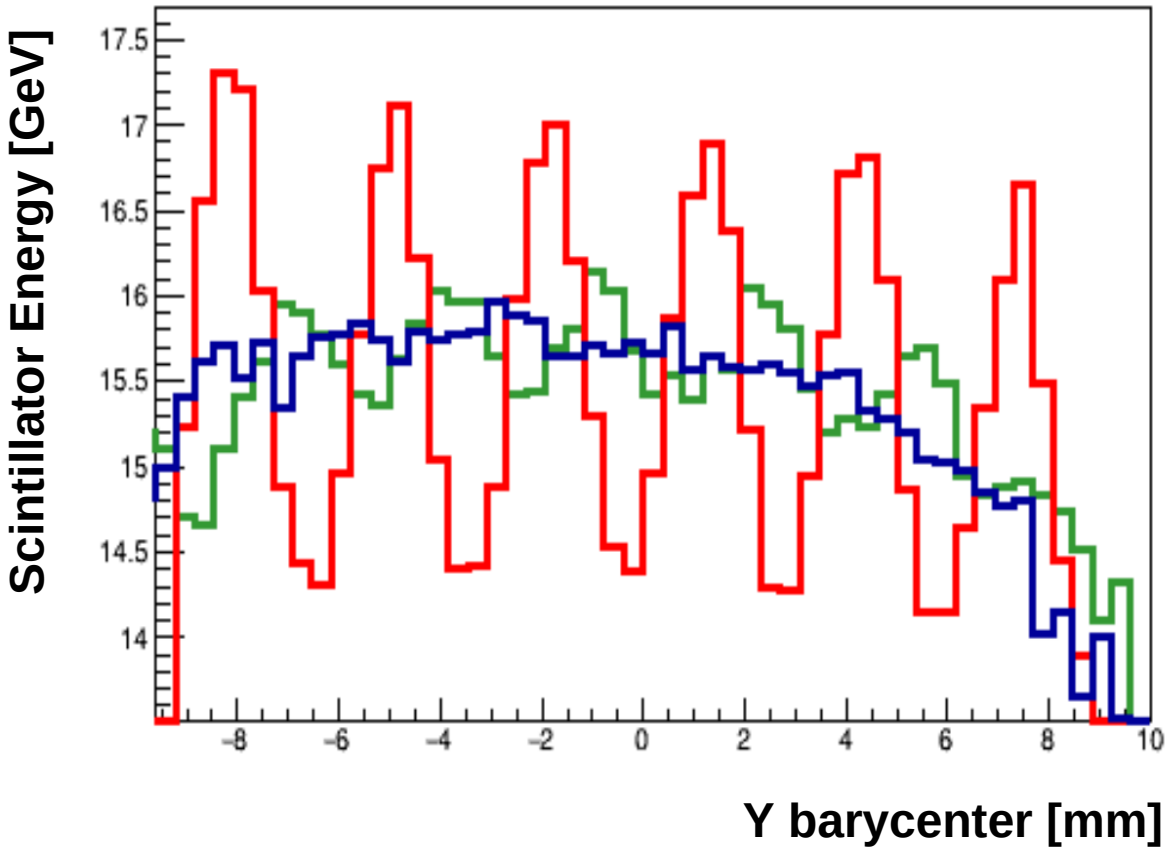
yrot=2.5 degrees

An EM resolution of 14.5%/sqrt(E) should be achievable with TB2021 module if all instrumental effects can be mastered

Definition of optimal beam angle in TB

On simulation:

angular scan round x and y axis looking for minimum angle in two directions yielding no modulation of response in x and y direction



xrot:

0 degrees

1.5 degrees

2.5 degrees