Preliminary results on Single particle resolution in Segmented detector (update)

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Outline

- MC Files Used for :
  - Single Particles
- Basic Idea of the Analysis: (Skip this time)
  - Calibration using electrons
  - Calibration using pions
- Results (Energy Resolution) :
  - Single Pions
- Conclusions/Ongoing Work

MC Files Used

- The MC files used are the ones the Adam has produced so far for :
  - A Segmented detector made out of lead glass composed of 10000 layers of 1 mm thickness each.
  - Single pions of energies 1- 5 - 10 and 20 GeV
  - Single electrons of energies 1- 5 – 10 and 20 GeV
  - The layers are “grouped” in various configurations of “active” (only ionization light read out) and “Cherenkov” (only Cherenkov light is read out) layers.
- These single files are used in order to “calibrate/correct” the detector response

  (so far only “ideal case” where each single particle resolution is estimated using its calibration/correction factors)

Simple Correction (using Total Information)

- Calibration using electrons :
  - Using the response of the segmented detector to electrons, we calculate the ratio of the total deposited energy due to ionization E_{sc} to the total deposited energy due to Cherenkov radiation E_{ce}:

$$Cal_e = E_{sc}/E_{ce} \qquad (1)$$

  - Then, using the response of the segmented detector to pions we calculate the function "f" such that:

$$E_{sc}/E_p = f(1-E_{ce} \text{ x } Cal_e/E_{sc}) \qquad (2)$$

where E_p is the incident energy of the pion.

Simple Correction (using Total Information)

- After obtaining from the previous step:
  - $Cal_e = E_{sc}/E_{ce}$ (1) AND
  - $E_{sc}/E_p = f(1-E_{ce} \times Cal_e/E_{sc})$ (2)
- We calculate the Jet energy E_{out} :

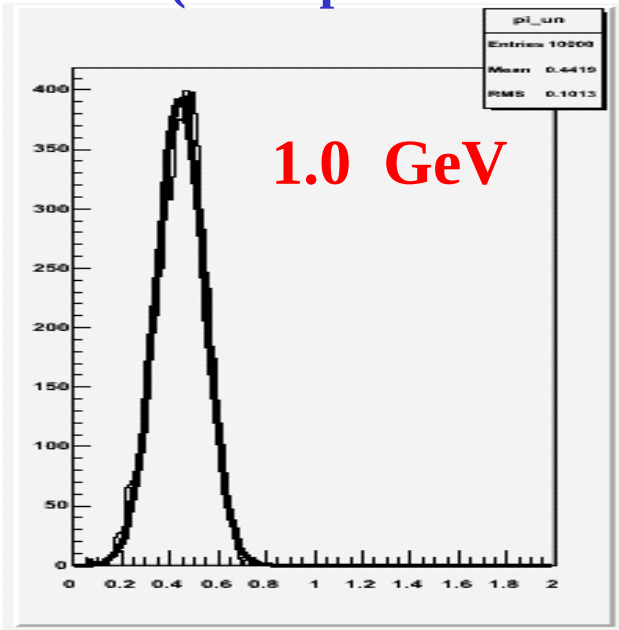
$$E_{out} = E_{sc}/f(1-E_{ce} \times Cal_e/E_{sc}) \quad (3)$$

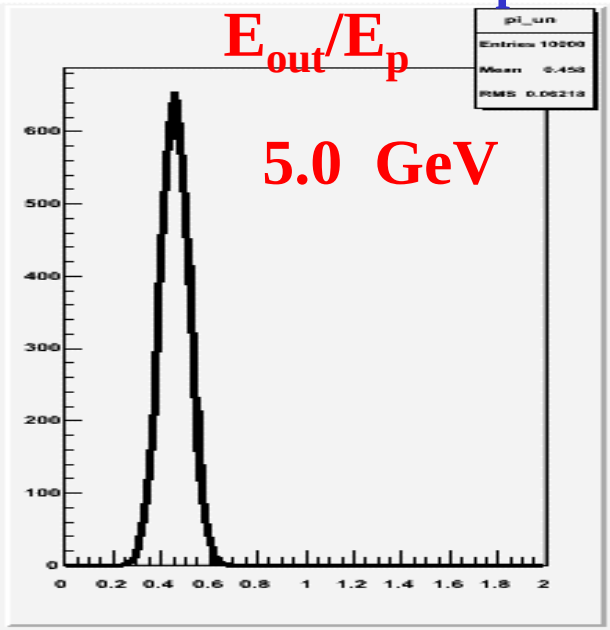
Different Segmentations studied so far

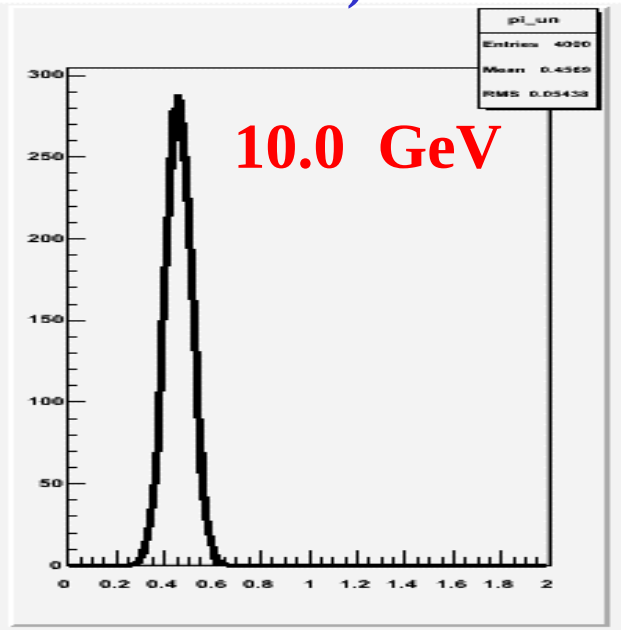
- The goal of the analysis is to study the energy resolution (corrected using , the simple (“overall”) correction first, and un-corrected) of the segmented calorimeter as a function of :
  - *Sampling fraction and thickness of Active Layers*
  - *Sampling fraction and thickness of Cherenkov layers*
- We have studied and will show preliminary results on the following configurations (all combinations):
  - ***Active Layer of 3 , 10, 20 , 30 , 40 mm***
  - ***Cherenkov Layer of 2 , 10 , 20 , 40 mm***
  - ***One case of Active Layer 30 mm Cherenkov Layer 2mm Passive Layer 18 mm***

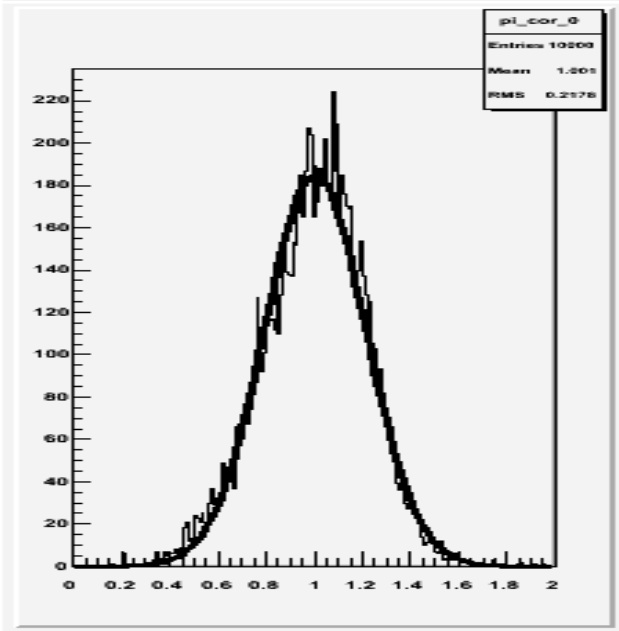
Results : Energy Resolution of Single Pions

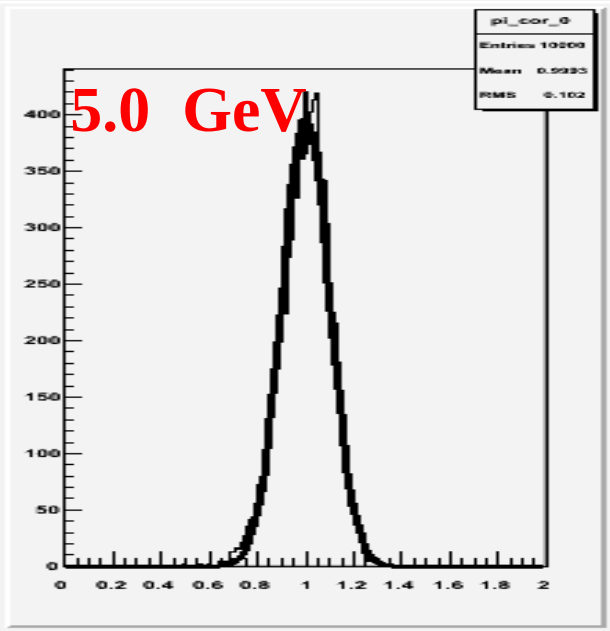
(Example of corrected and uncorrected response for the 3-2 case)

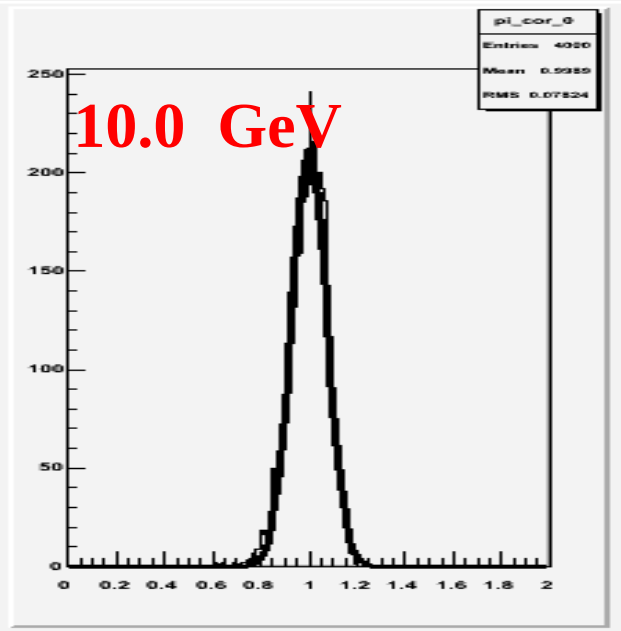






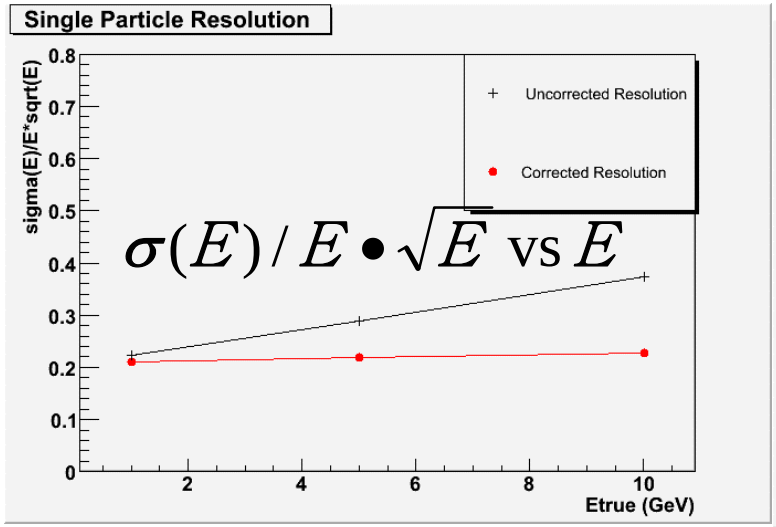


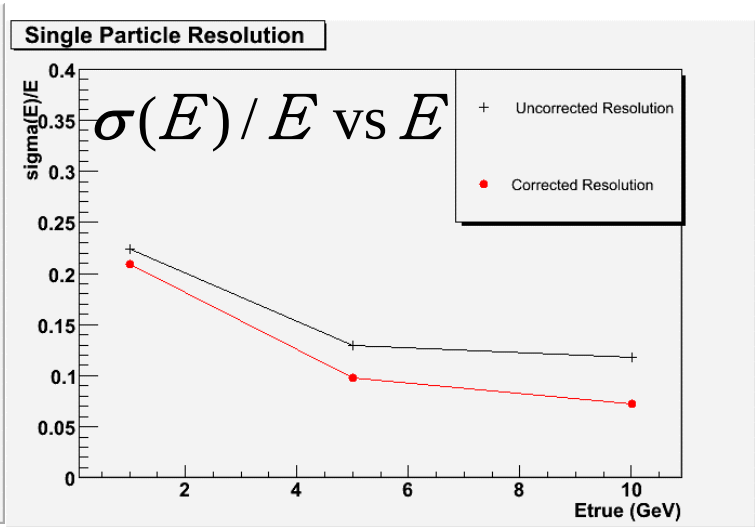




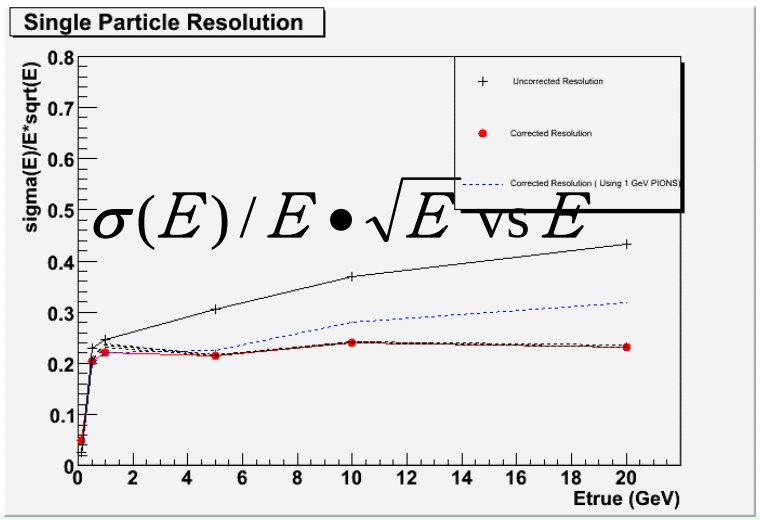
Results : Energy Resolution of Single Pions

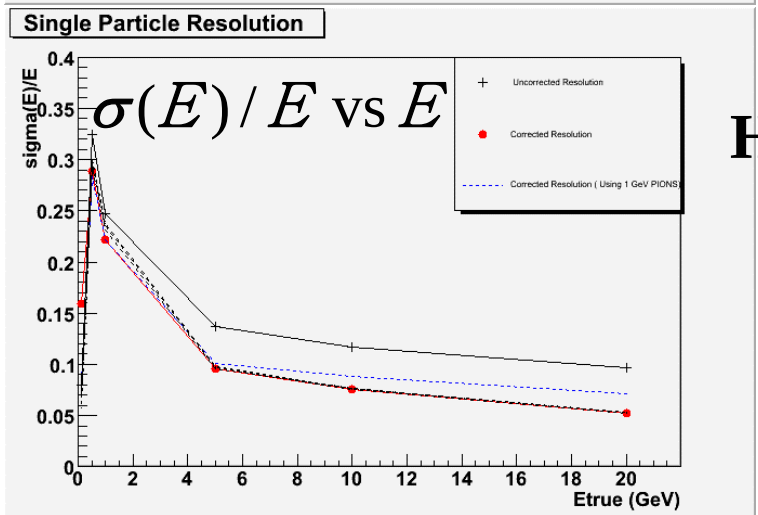
(Energy Resolution for the 3-2 case)





3_2 Case





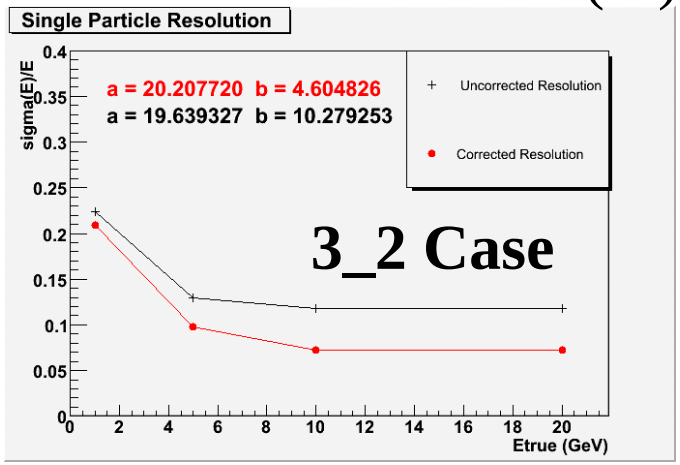
Homogenous Case

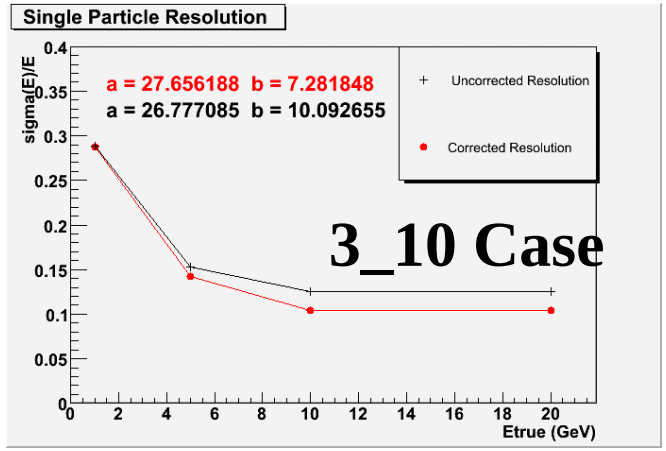
- **Black is uncalibrated response , Red is calibrated (corrected) response following the steps of the calibration chain described previously. The energy resolution after the correction is improved. For the 3_2 case the results are very similar to the large homogenous calorimeter.**

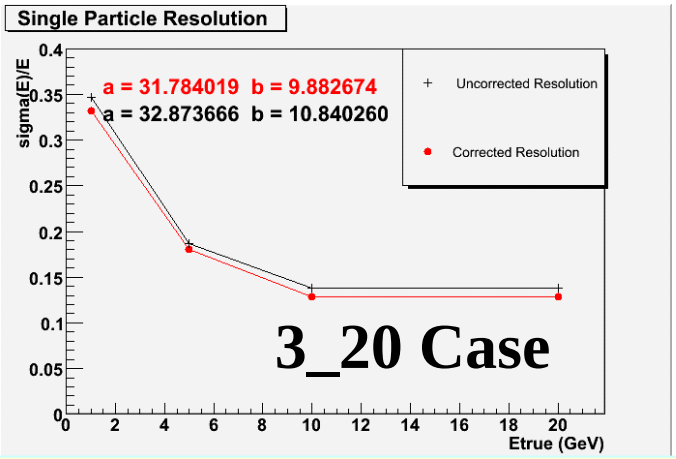
Results : Energy Resolution of Single Pions

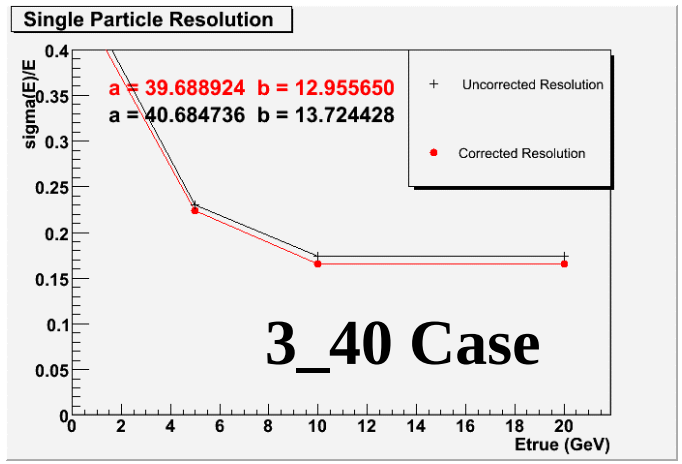
Corrected vs Uncorrected for the various cases

$\sigma(E)/E$ vs E







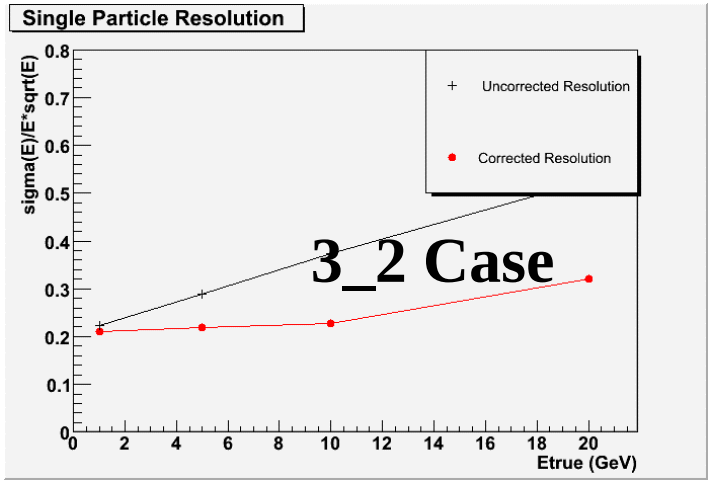


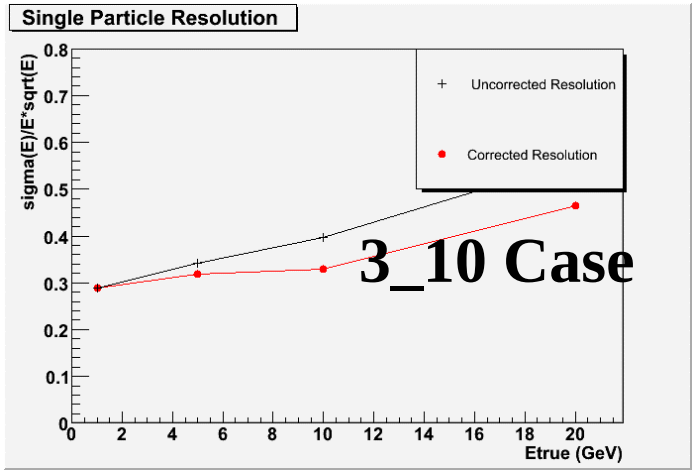
- **Black is uncalibrated response , Red is calibrated (corrected) response following the steps of the calibration chain described previously.**
- **The energy resolution after the correction is always improved with respect to the uncorrected case.**

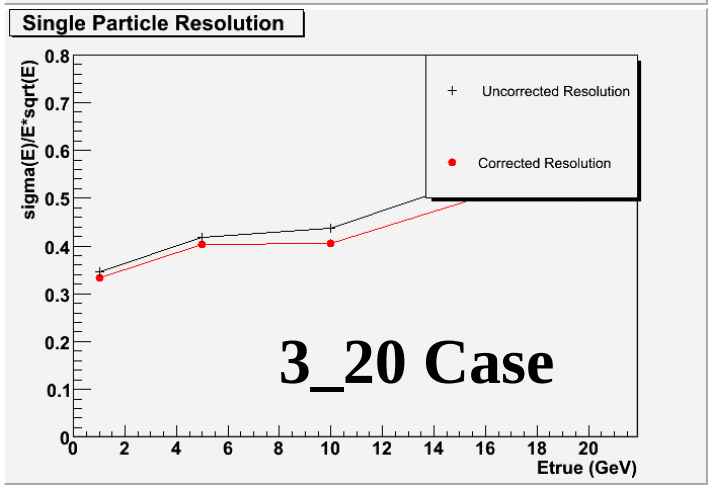
Results : Energy Resolution of Single Pions

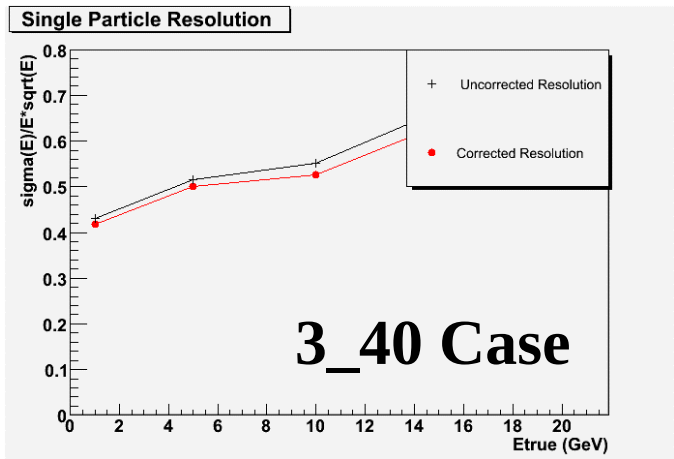
Corrected vs Uncorrected for the various cases

$$\sigma(E)/E$$







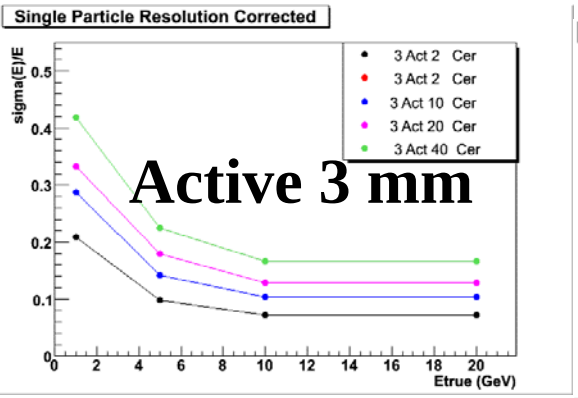


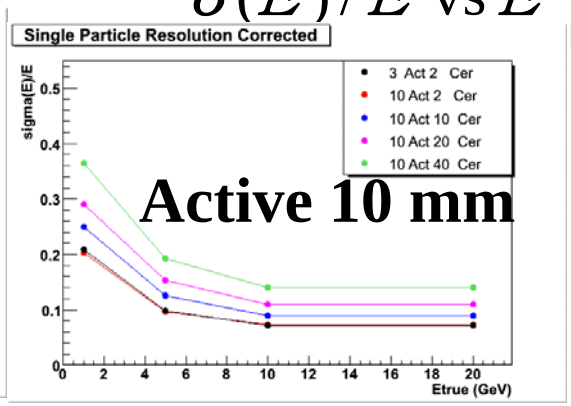
- **Black is uncalibrated response , Red is calibrated (corrected) response following the steps of the calibration chain described previously.**
- **The energy resolution after the correction is always improved with respect to the uncorrected case.**

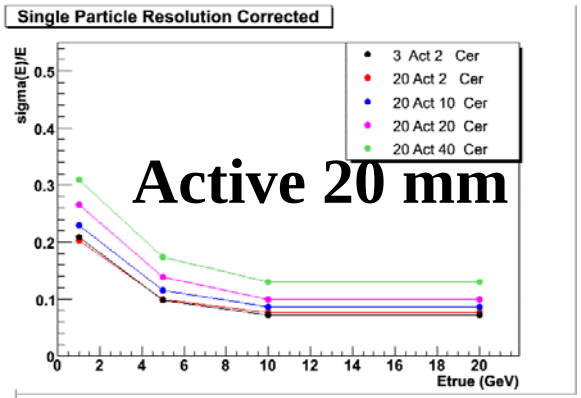
Results : Energy Resolution of Single Pions

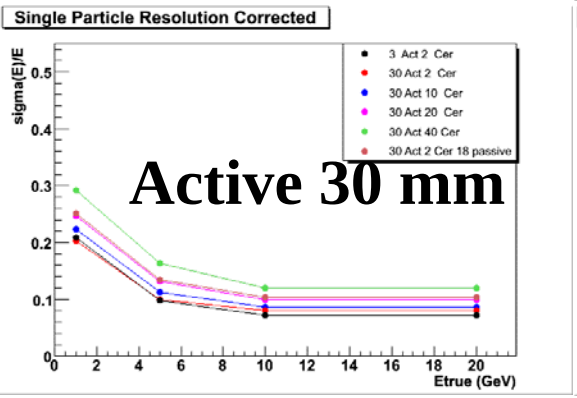
Corrected for the SAME ACTIVE LAYER THICKNESS

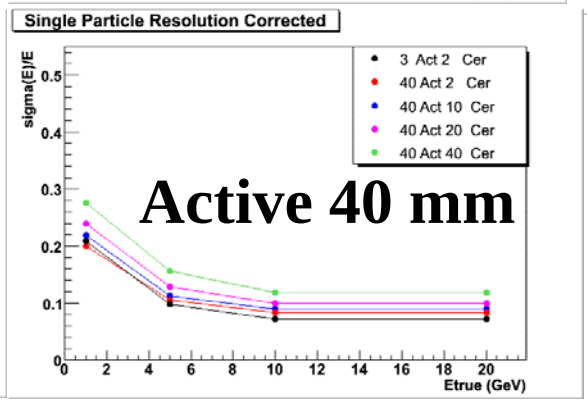
$\sigma(E)/E$ vs E









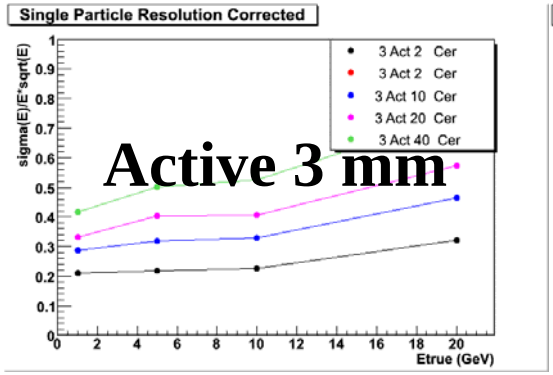


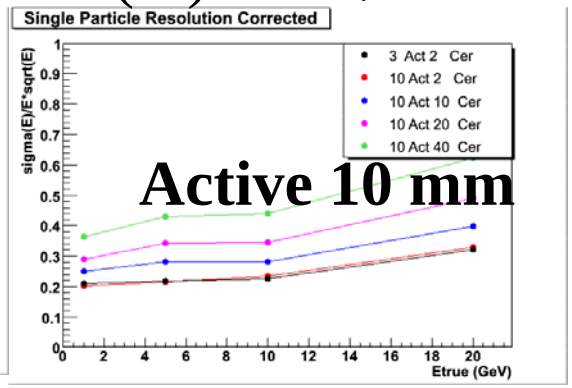
- **The energy resolution improves , for all active layer thicknesses, when the Cherenkov layer thickness decreases.**
- **The energy resolution of the 30_20 case and the 30_2_18 case are almost identical = > ie one does not gain anything when the Cherenkov layer is made thicker than 2 mm (need to study perhaps for more such cases?)**

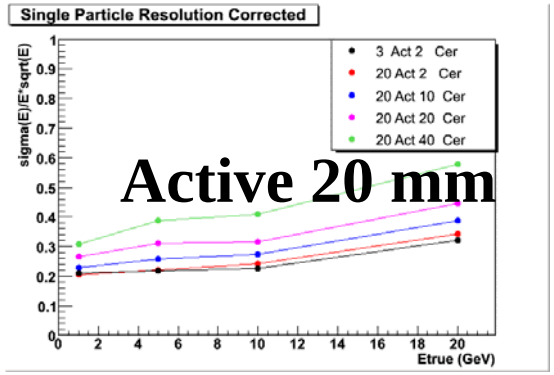
Results : Energy Resolution of Single Pions

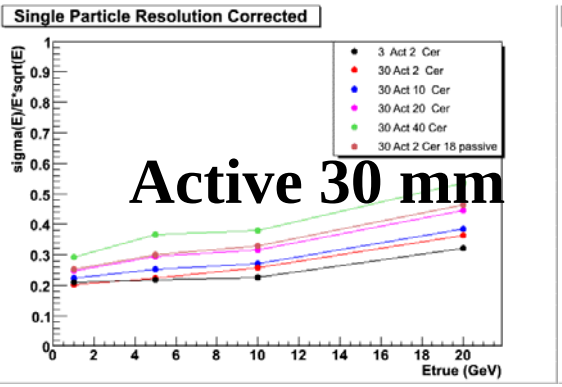
Corrected for the SAME ACTIVE LAYER THICKNESS

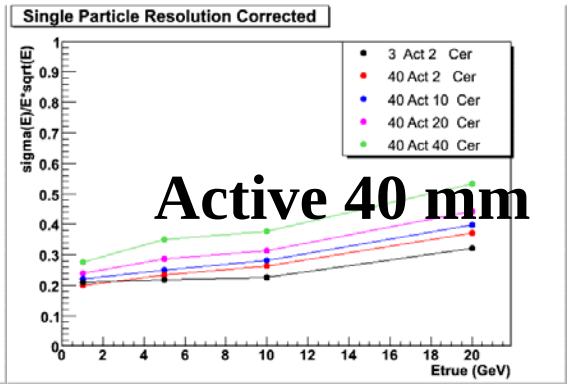
$$\sigma(E)/E \bullet \sqrt{E} \text{ vs } E$$











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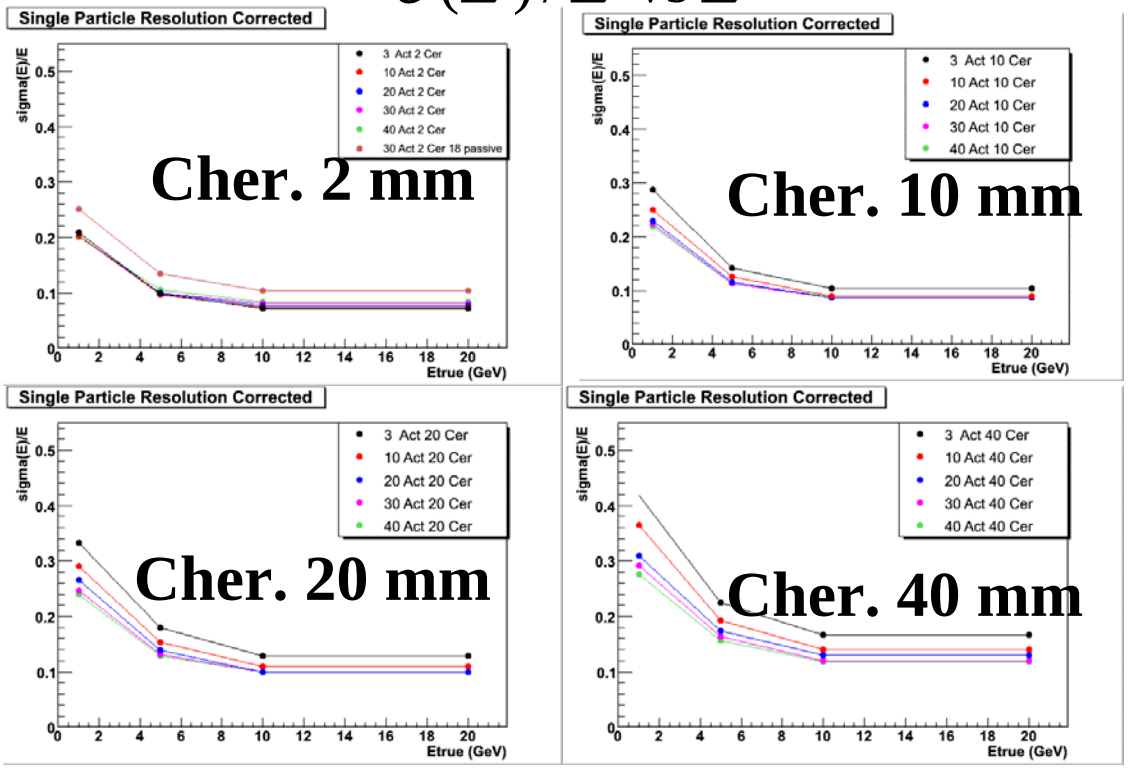
- **The energy resolution of the 30_20 case and the 30_2_18 case are almost identical = > ie one does not gain anything when the Cherenkov layer is made thicker than 2 mm (need to study perhaps for more such cases?)**

Results : Energy Resolution of Single Pions

Corrected for the SAME CHERENKOV LAYER THICKNESS

$\sigma(E)/E$ vs E

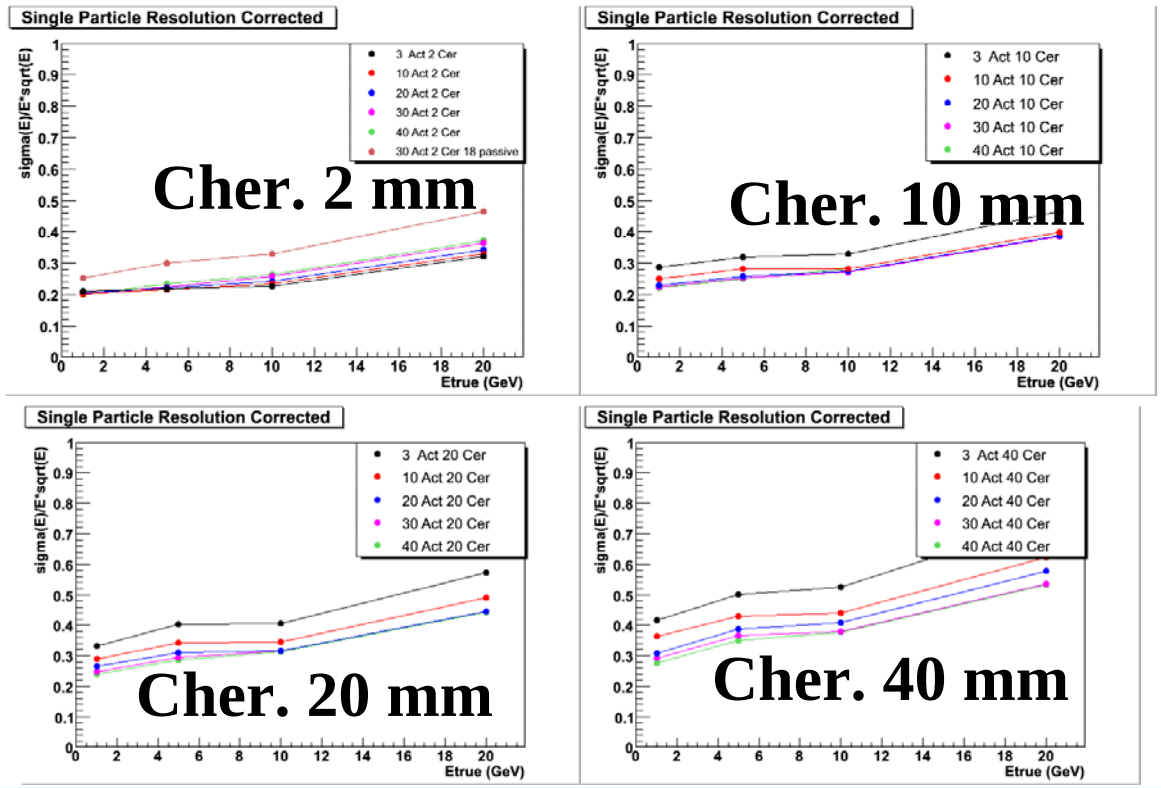


– **The energy resolution improves , for all Cherenkov layer thicknesses, when the Active layer thickness increases. For the case of a 2 mm thick Cherenkov layer nearly any Active layer thickness give the same results**

Results : Energy Resolution of Single Pions

Corrected for the SAME CHERENKOV LAYER THICKNESS

$\sigma(E)/E \bullet \sqrt{E}$ vs E



– **The energy resolution improves , for all Cherenkov layer thicknesses, when the Active layer thickness increases. For the case of a 2 mm thick Cherenkov layer nearly any Active layer thickness give the same results**

Summary/ On going work

1. **For the single particle case and when using the "simple" (using total ionization and Cherenkov light) correction the results are very promising (energy resolution better than 30% / sqrt(E)), and for thin active and Cherenkov layers (3_2 case) very close to the "homogenous" case.**

- **The corrected energy resolution for the 30_20_0 case and the 30_2_18 case are almost identical. That indicates that ~ 2mm of Cherenkov Layer are adequate in order to obtain good energy resolution for single particles.**

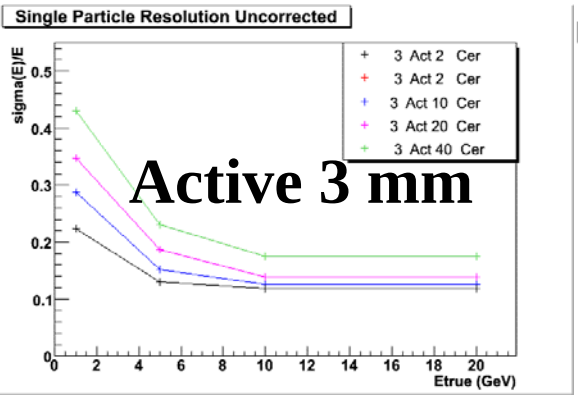
- **Next time would like to repeat the same study for jets (as we did for the homogenous case) and study the results.**

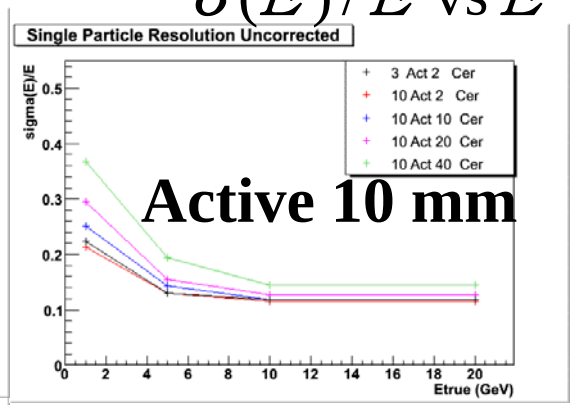
BAKCUP

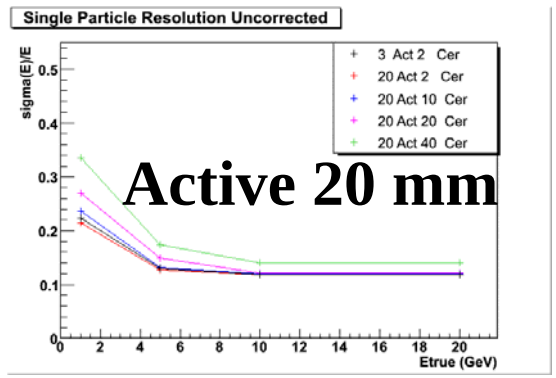
Results : Energy Resolution of Single Pions

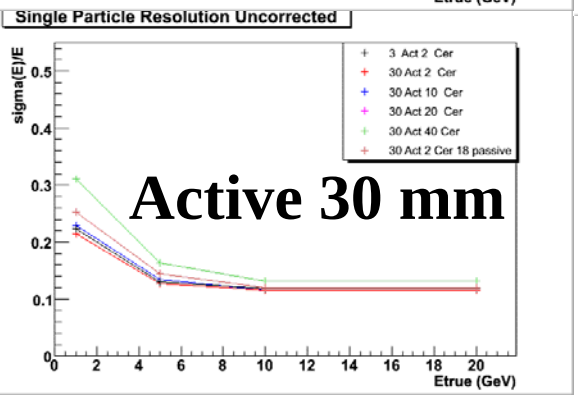
Uncorrected for the SAME ACTIVE LAYER THICKNESS

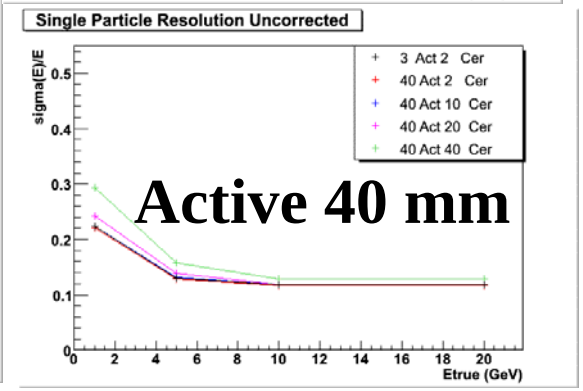
$\sigma(E)/E$ vs E









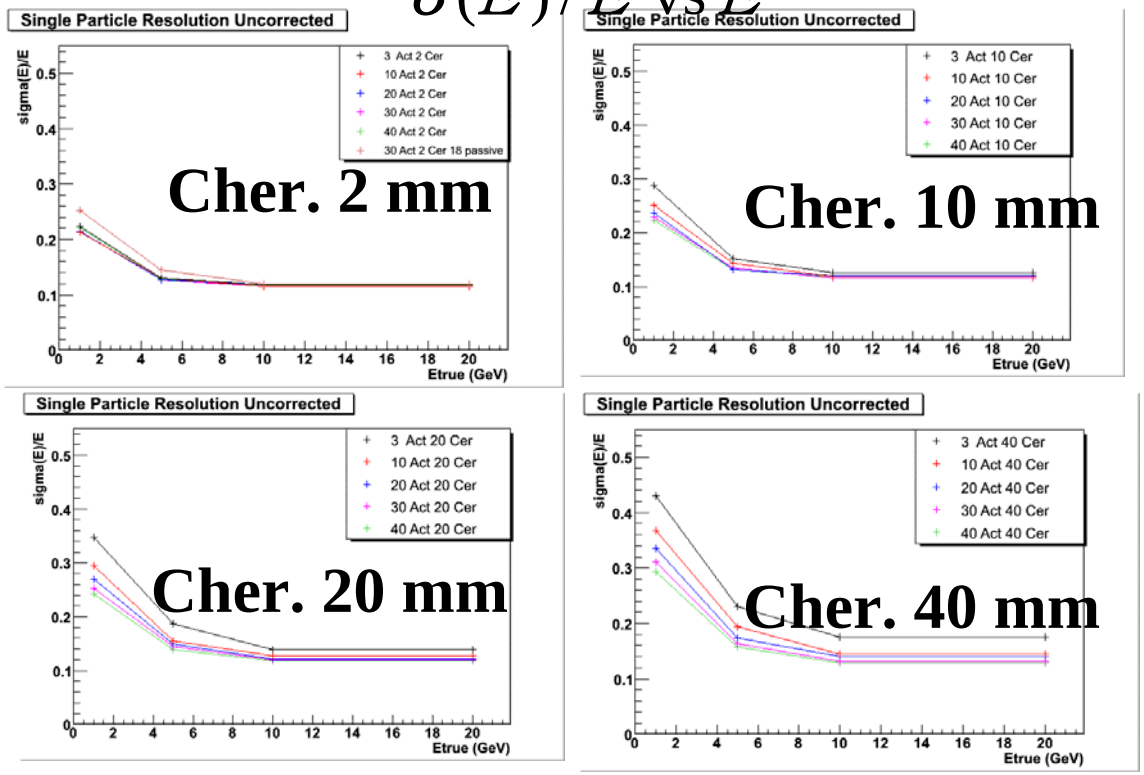


- **The energy resolution improves , for all active layer thicknesses, when the Cherenkov layer thickness decreases.**
- **The energy resolution of the 30_20 case and the 30_2_18 case are identical(as expected)**

Results : Energy Resolution of Single Pions

UnCorrected for the SAME CHERENKOV LAYER THICKNESS

$\sigma(E)/E$ vs E



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