Status of AHCAL energy resolution
Topic: Run Selection

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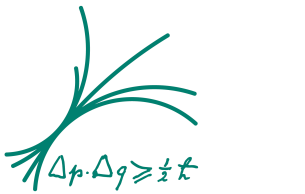
18.04.2011



Status of Software Compensation Analysis:

- Event Selection explained by Marina
- Now: Run Selection
  - Longitudinal profiles
  - Temperature
  - Muon peak position
  - Pedestal behaviour
  - Other differences
- To come: Software Compensation

Reconstructed runs

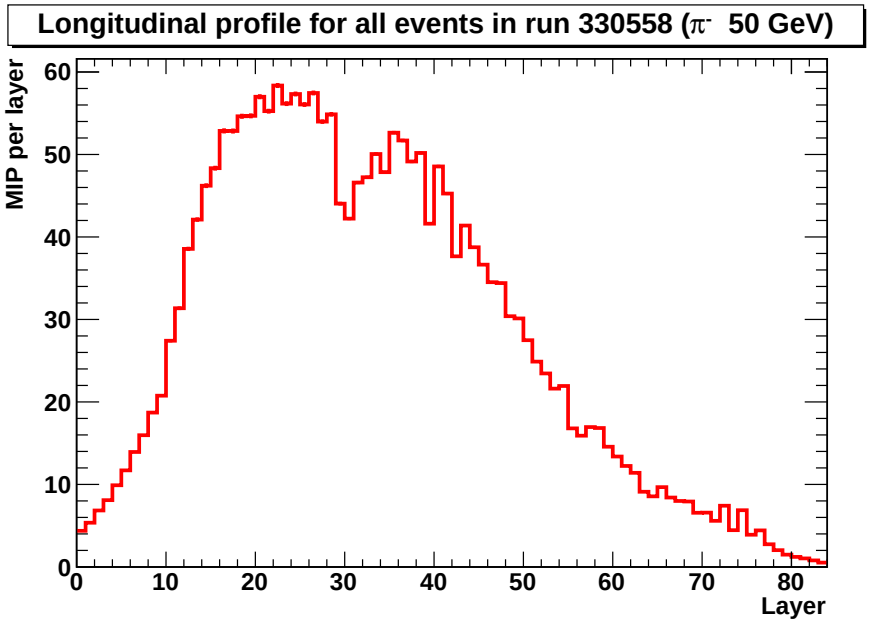
Reconstruction done with calice software version v04_01. Thanks to Daniel Jeans! $\Rightarrow$ 45 runs

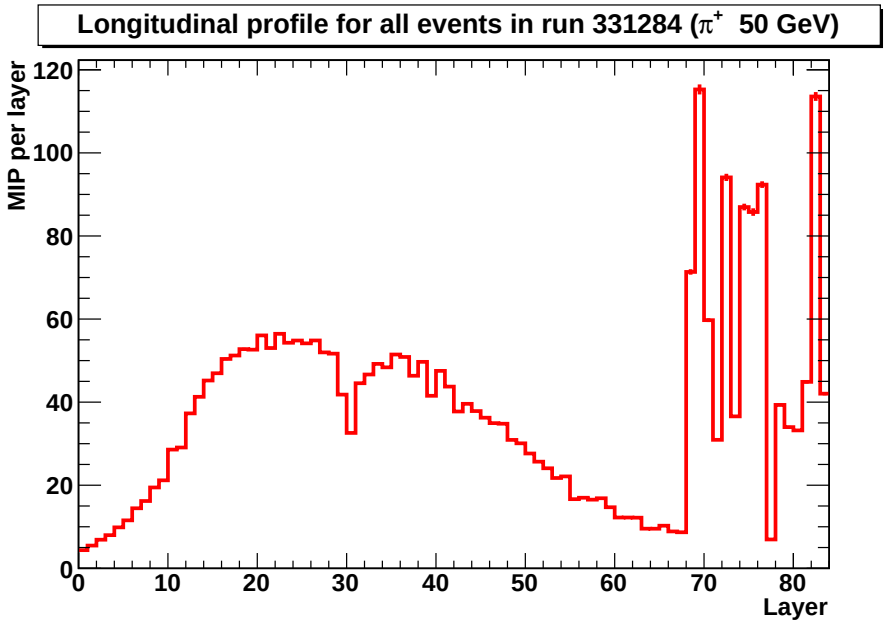
run number	pion type	beam energy
330325	π^-	25
330326	π^-	20
330327	π^-	18
330328	π^-	15
330332	π^-	10
330390	π^-	40
330391	π^-	50
330392	π^-	80
330412	π^-	40
330550	π^-	45
330551	π^-	35
330557	π^-	35
330558	π^-	50
330559	π^-	45
330560	π^-	40
330643	π^-	10
330647	π^-	15
330649	π^-	20
330650	π^-	25
330771	π^-	20
330777	π^-	10
330850	π^-	10

run number	pion type	beam energy
330960	π^-	35
330961	π^-	45
330962	π^-	80
331554	π^-	80
331556	π^-	60
331567	π^-	80
331568	π^-	60
331654	π^-	80
331655	π^-	60
331664	π^-	60
331280	π^+	80
331282	π^+	60
331284	π^+	50
331298	π^+	30
331324	π^+	80
331325	π^+	80
331333	π^+	60
331334	π^+	60
331335	π^+	50
331338	π^+	40
331339	π^+	40
331340	π^+	30
331341	π^+	30

Longitudinal Profile:

Example of normal (left) and noisy run (right)

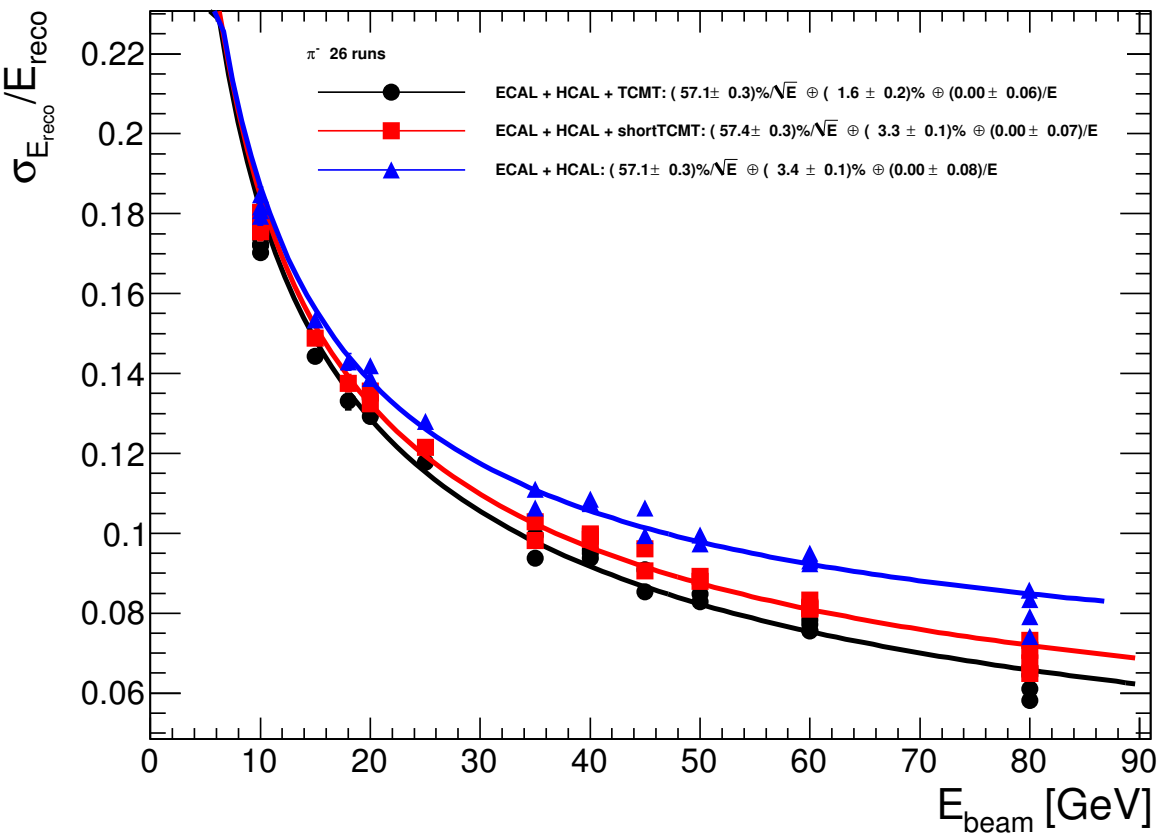




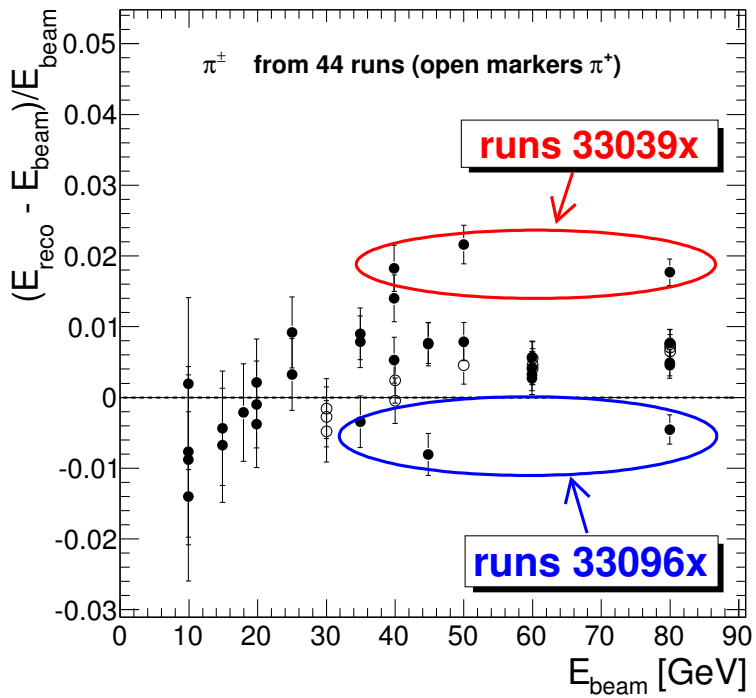
Longitudinal profiles are inspected to estimate run quality.
More examples of run quality study can be found in Vasiliy's talk on main meeting in December 2008. The run 331284 with extremely noisy TCMT was rejected.

Minimization of effect of leakage:

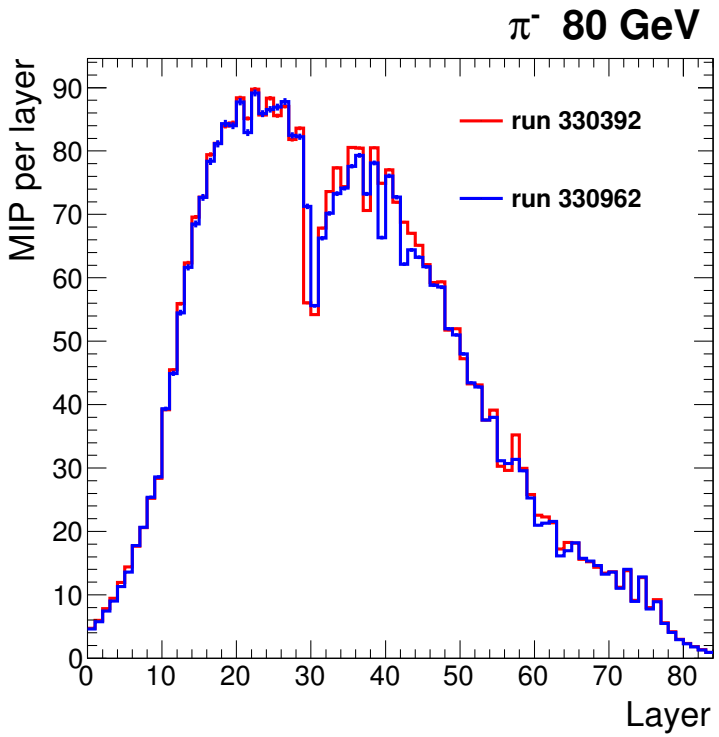
In spite of the selection of events with shower start at the beginning of HCAL leakage affects resolution at higher energies therefore TCMT is necessary for studied energy range.
Constant term is increasing with less calorimeter parts.



Difference for same beam energies



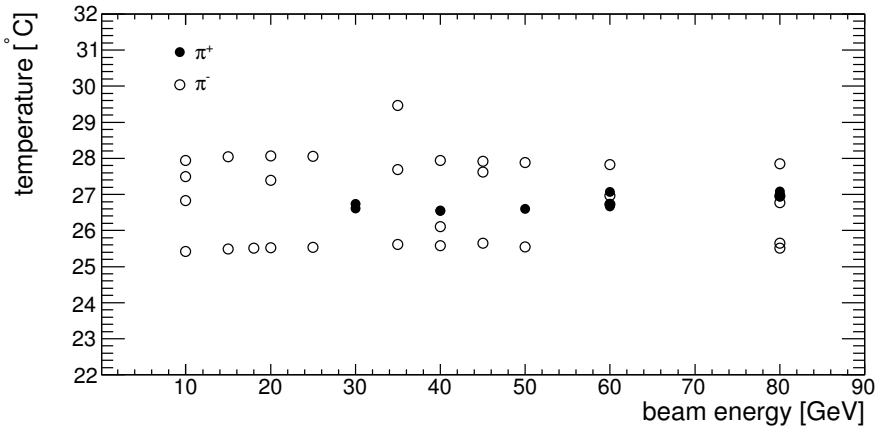
Groups of runs with systematically lower or higher deposition.

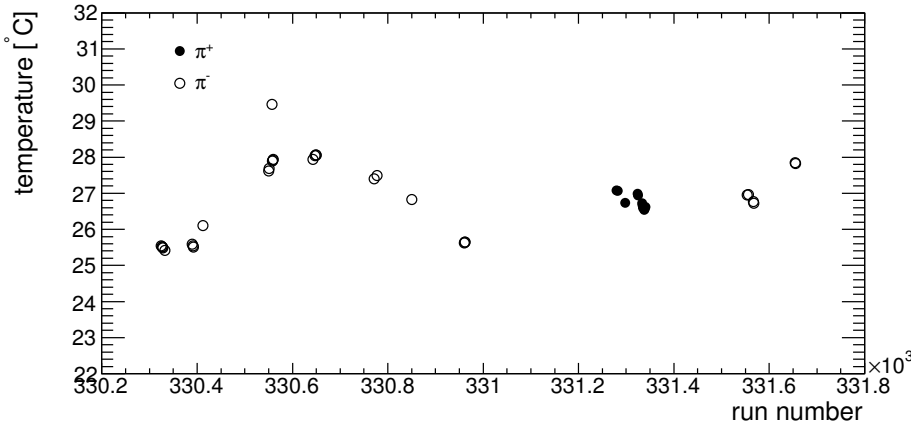


Longitudinal profiles for two 80-GeV π^{-} runs from different groups. Different behavior of the same layers is clearly seen.

Temperature

Look at temperature, muon peak, pedestal behaviour.

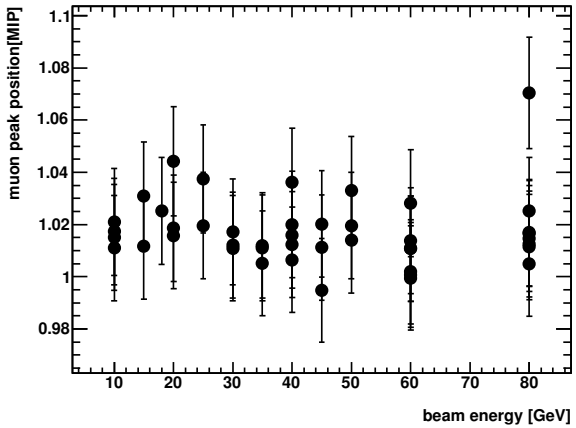


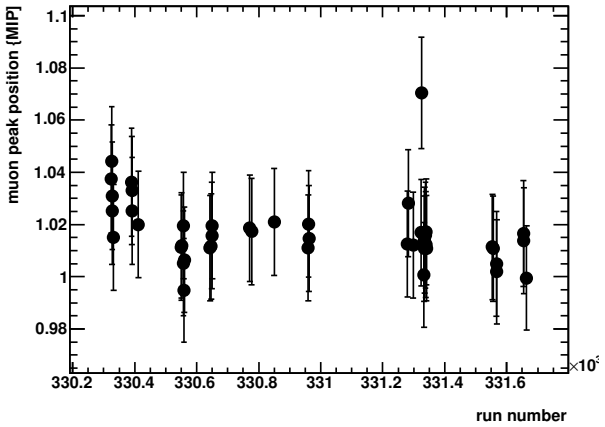


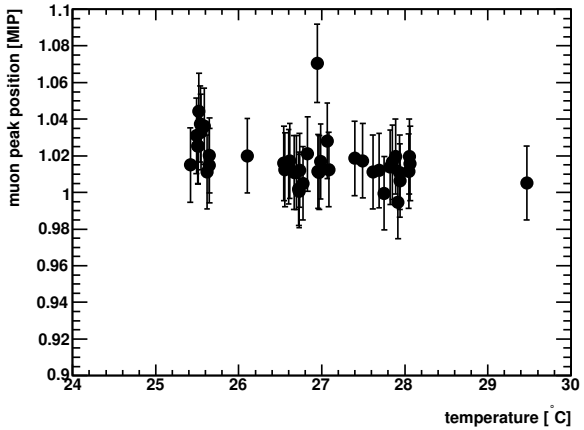
- Different runs periods are visible

Muon peak position

Look at temperature, muon peak position, pedestal behaviour.



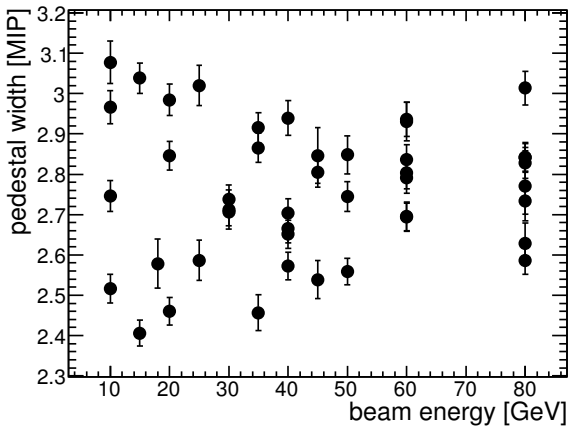


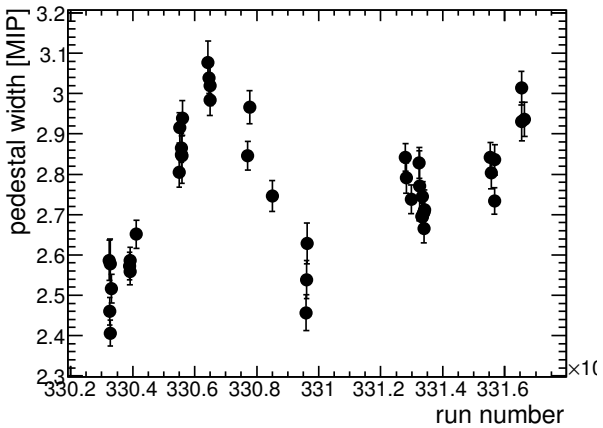


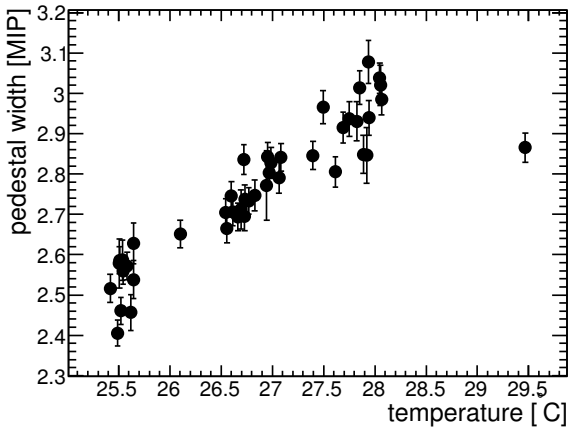
- Run with highest value of muon peak (80 GeV, 331325) will be rejected
- Run with lowest value of muon peak (45 GeV, 330559) will be rejected

Pedestal behaviour

Look at temperature, muon peak position, pedestal behaviour.







- Run with highest temperature (35 GeV, 330557) will be rejected

Even and odd events:

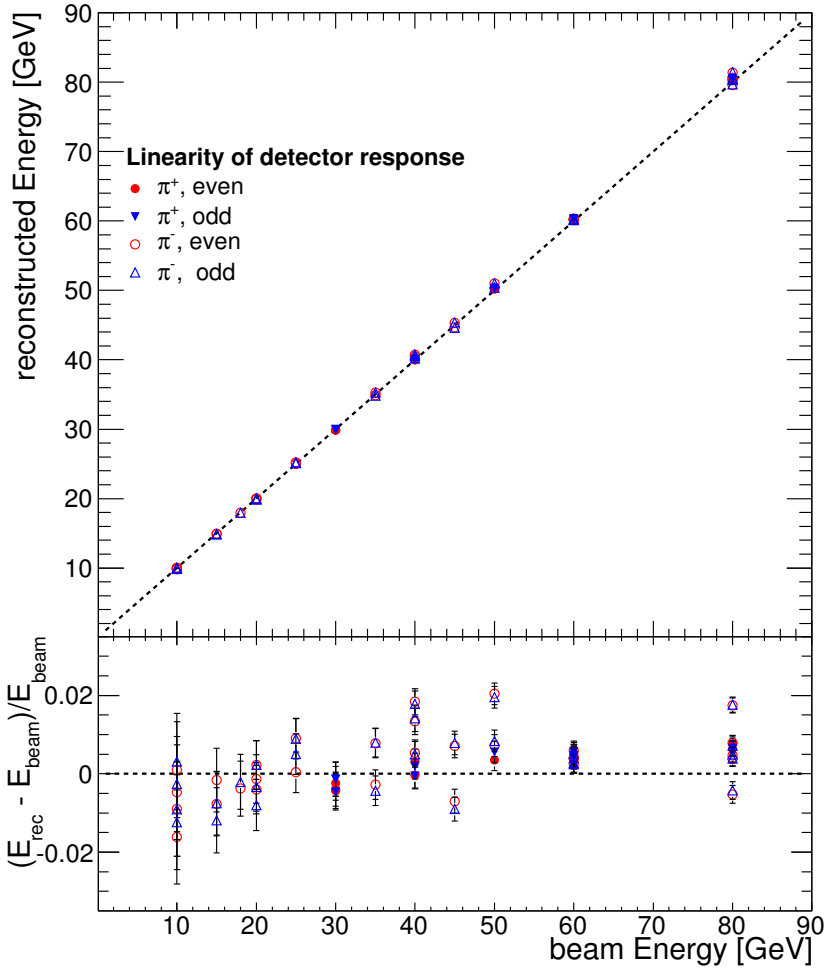
- Need two independent data samples
  - determination of software compensation factors
  - application of software compensation
- Need to be independent of run selection effects

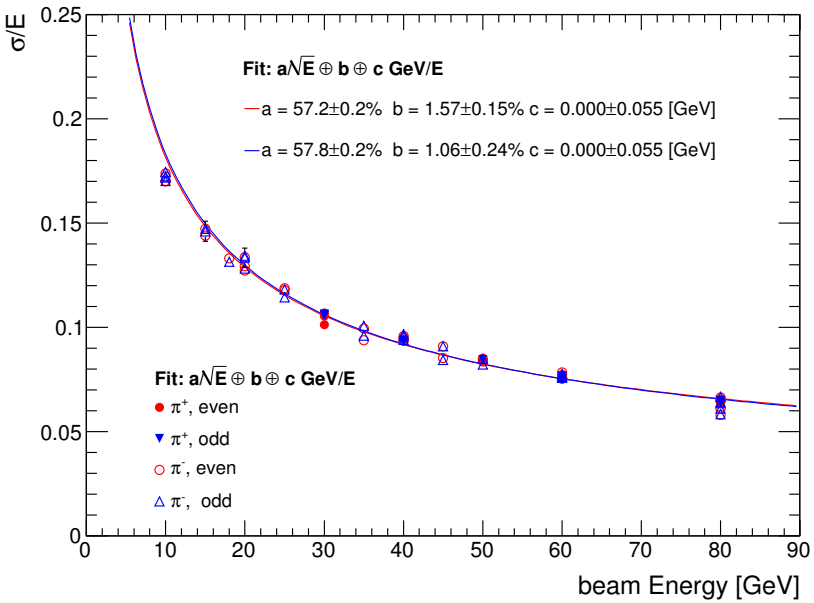
$\Rightarrow$ Split each runs in even and odd event

Even and odd events:

Without the previous rejected runs.

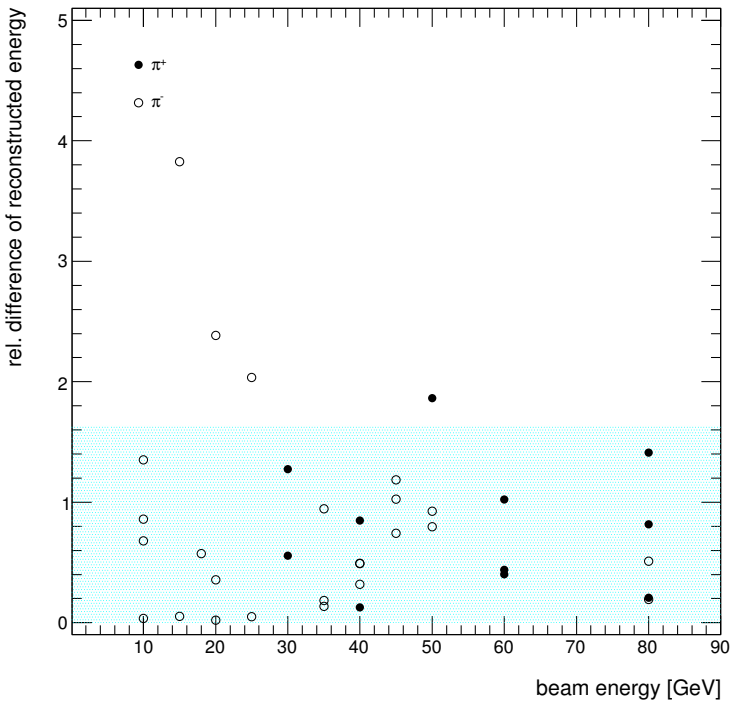
Resolution fit is not the same for even and odd events.

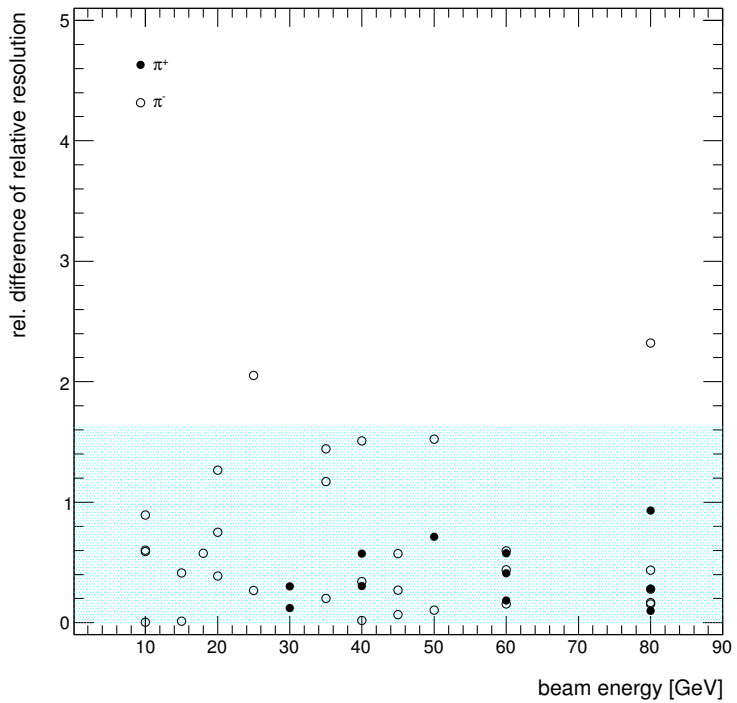




Difference between even and odd:

- Linearity:
  Error $\Delta(E_{even} - E_{odd})$ should not be much smaller than the difference itself $E_{even} - E_{odd}$
- Resolution:
  Error $\Delta((\frac{\sigma}{E})_{even} - (\frac{\sigma}{E})_{odd})$ should not be much smaller than the difference itself $(\frac{\sigma}{E})_{even} - (\frac{\sigma}{E})_{odd}$



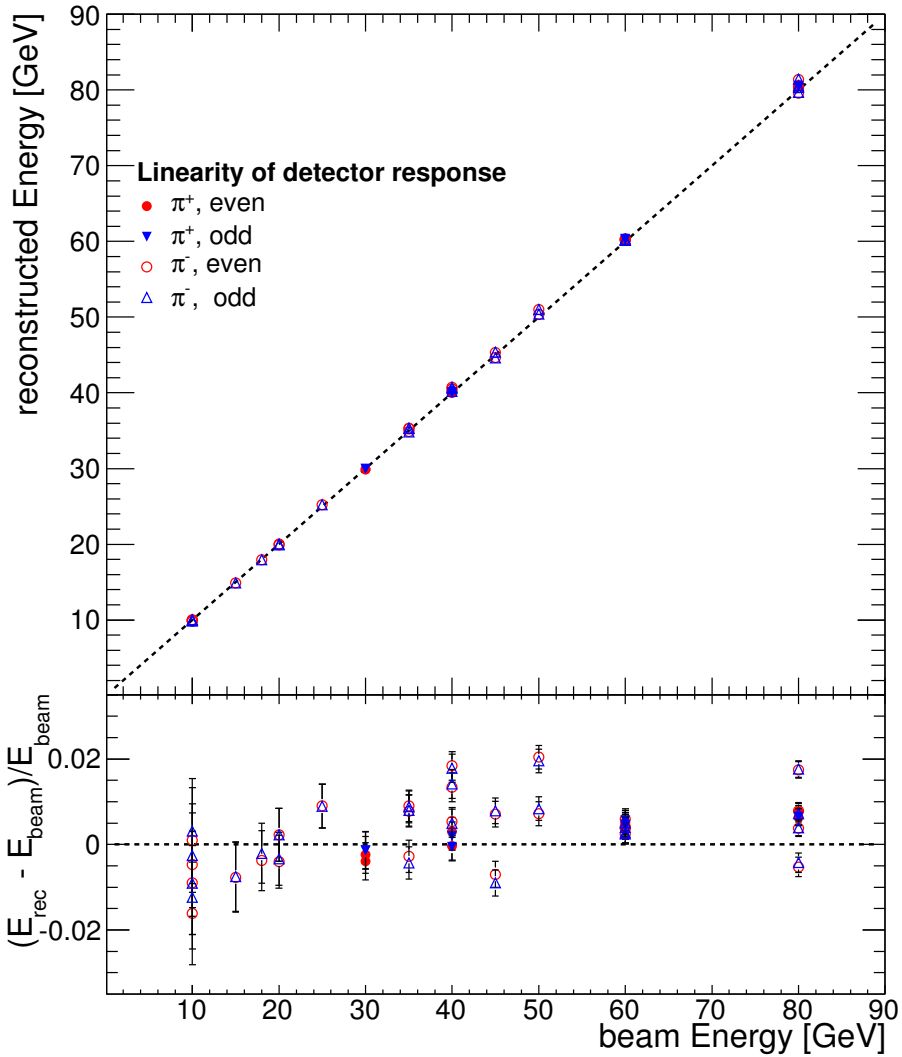


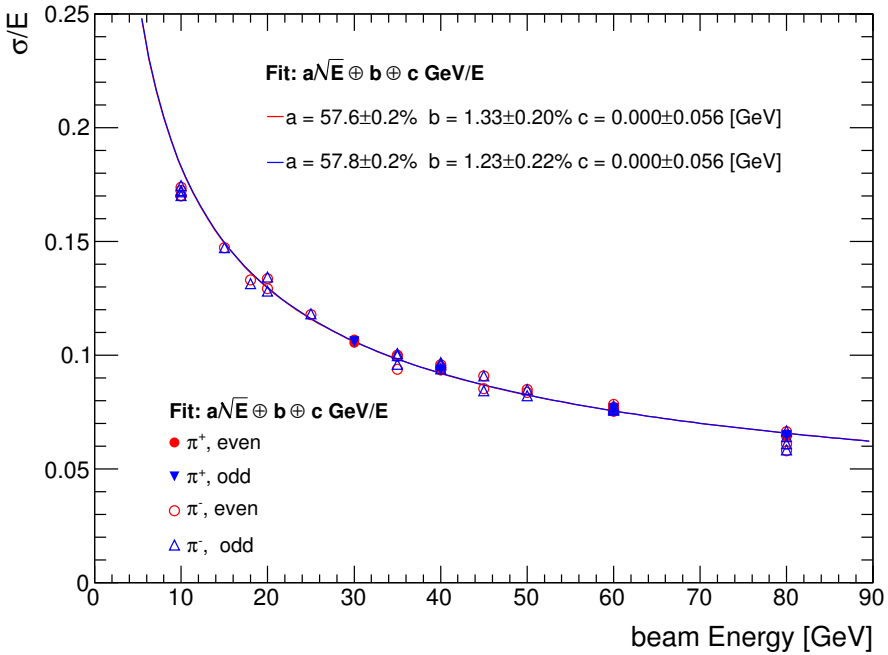
Selection:

- Only keep runs in confidence level of 90% , e.q. only keep runs for which the following relations are fullfilled:
  - $\frac{E_{even}-E_{odd}}{\sqrt{(\Delta E_{even})^2+(\Delta E_{odd})^2}} < 1.64$

    and
  - $\frac{(\frac{\sigma}{E})_{even}-(\frac{\sigma}{E})_{odd}}{\sqrt{(\Delta(\frac{\sigma}{E})_{even})^2+(\Delta(\frac{\sigma}{E})_{odd})^2}} < 1.64$
- $\Rightarrow$ 6 runs have to be excluded (330325 (25 GeV); 330326 (20 GeV); 330647 (15 GeV) ; 331567 (80 GeV); 331335 (50 GeV); 331341 (30 GeV))
- In total 10 from 45 runs are rejected.

Selected Runs:

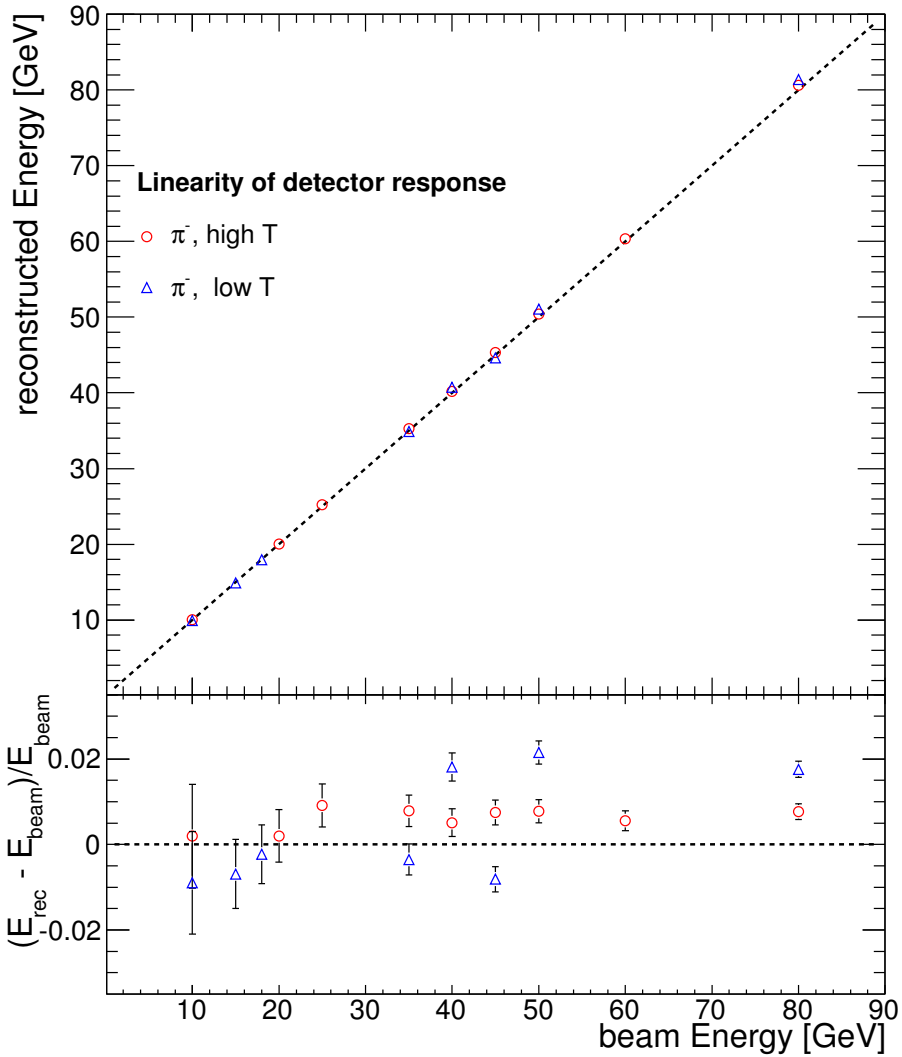


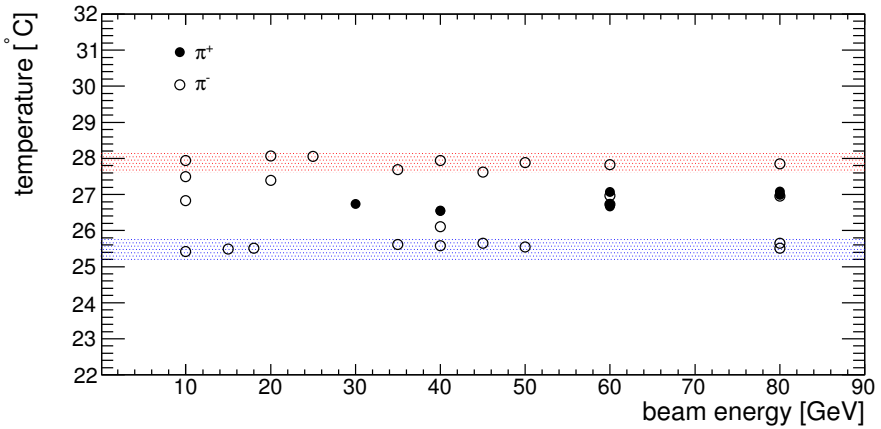


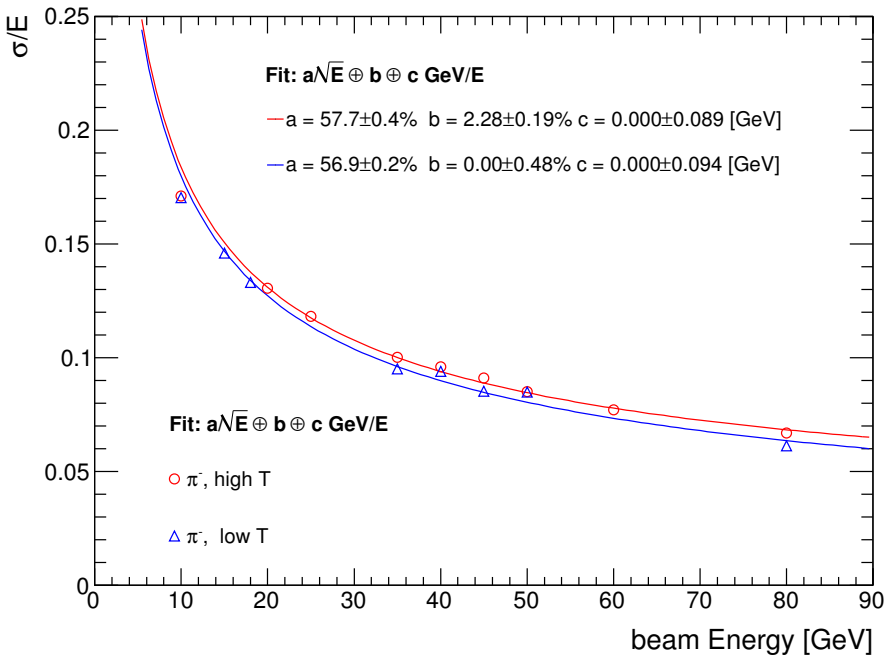
Conclusion:

- No obvious reason why even and odd events look different
- Reconstructed energy and resolution look better with several run selection criteria
- ToDo:
  - In the end we would like to have one runs per beam energy to not bias the fits
  - Both Software Compensation method and are much less work than event and run selection

One run per beam energy; low and high temperature







Error calculation

- $\Delta E_{beam} = \sqrt{0.12^2 + 0.001^2 \cdot E_{beam}^2}$
- ΔE_{rec} from fits
- $\Delta \sigma_{rec}$ from fit
- $\Delta(\frac{\sigma_{rec}}{E_{rec}}) = \sqrt{(\frac{\Delta \sigma_{rec}}{E_{rec}})^2 + (\frac{\sigma_{rec} \cdot \Delta E_{rec}}{E_{rec}^2})^2}$
- $\Delta \frac{E_{rec} - E_{beam}}{E_{beam}} = \sqrt{(\frac{\Delta E_{rec}}{E_{beam}})^2 + (\frac{E_{rec} \cdot \Delta E_{beam}}{E_{beam}^2})^2}$

Energy resolution fit:

$$\frac{\sigma}{E} = \frac{a}{\sqrt{E}} \oplus \frac{b}{E} \oplus c = \sqrt{\frac{a^2}{E} + \frac{b^2}{E^2} + c^2} \quad (1)$$

- No parameter is limited or fixed

All runs are split in even and odd event numbers. For each run the reconstructed energy and resolution is determined twice.