Calorimeter Intercalibration

Patrice Lebrun and Pierre-Antoine Delsart

IPN Lyon

Calibration Meeting

- Principle of intercalibration
- Methods studied
- Tests and results

Principle

- All physic process are ϕ independant.

$\Rightarrow$ what we measure must be ϕ independant.

- For η fixed, differences in ϕ are related to ϕ-intercalibration constants.

Events

We planned to use 2 types of events:

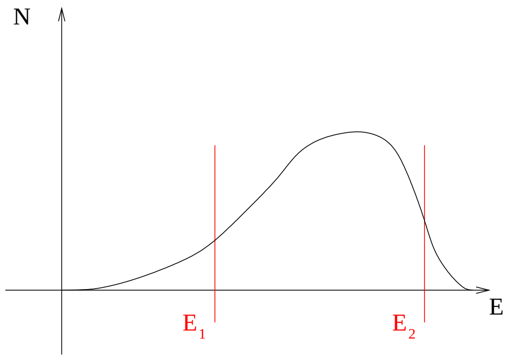
- Inclusive QCD.

$\Rightarrow$ 2 algorithms

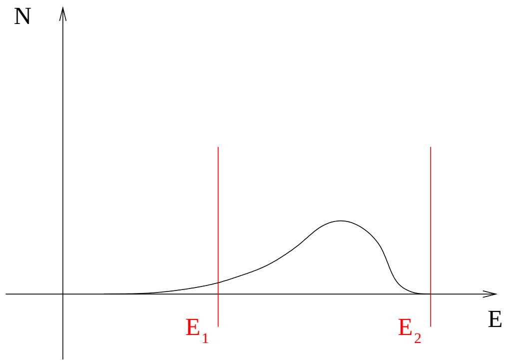
- W events.

$\Rightarrow$ 1 algorithm

W events



e^- energy distribution at η fixed



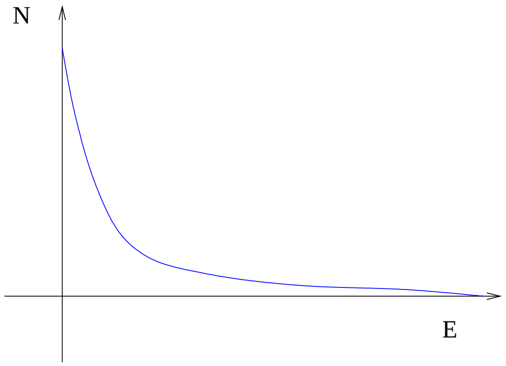
e^- energy distribution at η fixed in the ϕ_i module.

for each i $\alpha_i = \frac{E_i}{E}$

Iterative method (α are threshold-dependant)

Inclusive QCD events

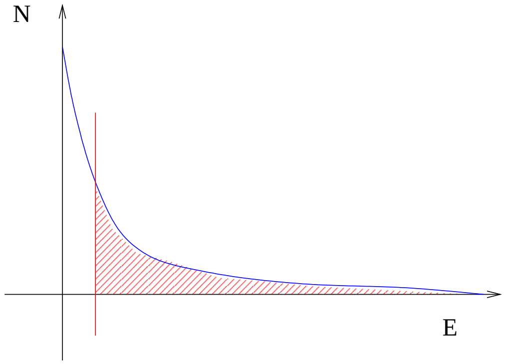
We expect an exponential distribution in energy.



We have tested 2 algorithms:

- Comparing some number of events :"N method" (method used in Run I)
- Comparing energies :"E method"

N method



$\rightarrow$ in reference, $N(E_{ref})$ =Number of events with energy $> E_{ref}$

$\rightarrow$ in unit i, $N_i(E_i)$ =Number of events with energy $> E_i$

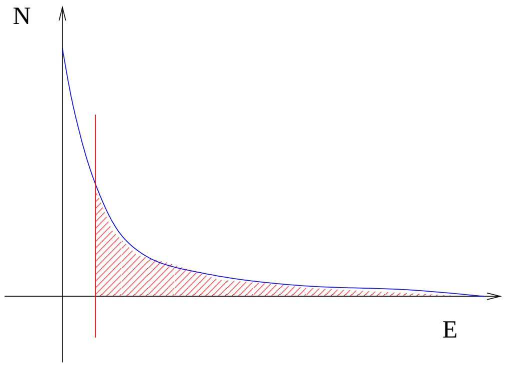
Intercalibration constant α_i : event with a measured energy E_{ref} in reference, has a measured energy $E_i = \alpha_i E_{ref}$ in unit.

$$\boxed{N_i(E_i) = N(E_{ref}) \Rightarrow E_i = \alpha_i E_{ref}}$$

Algorithm

- Choose a reference E_{ref} (this fixes $N(E_{ref})$)
- In unit i find E_i such as $N(E_i) = N(E_{ref})$
- $\alpha_i = \frac{E_i}{E_{ref}}$

E method



$\rightarrow$ in reference, $S(E_{ref})$ =Sum of energies $> E_{ref}$

$\rightarrow$ in unit i, $S_i(E_i)$ =Sum of energies $> E_i$

Intercalibration constant α_i : event with a measured energy E_{ref} in reference, has a measured energy $E_i = \alpha_i E_{ref}$ in unit.

$$\boxed{S_i(E_i) = \alpha_i S(E_{ref}) \Rightarrow E_i = \alpha_i E_{ref}}$$

Algorithm

- Choose a reference E_{ref} (this fixes $S(E_{ref})$)
- In unit i find E_i such as $\frac{S_i(E_i)}{S(E_{ref})} = \frac{E_i}{E_{ref}}$
- $\alpha_i = \frac{E_i}{E_{ref}}$

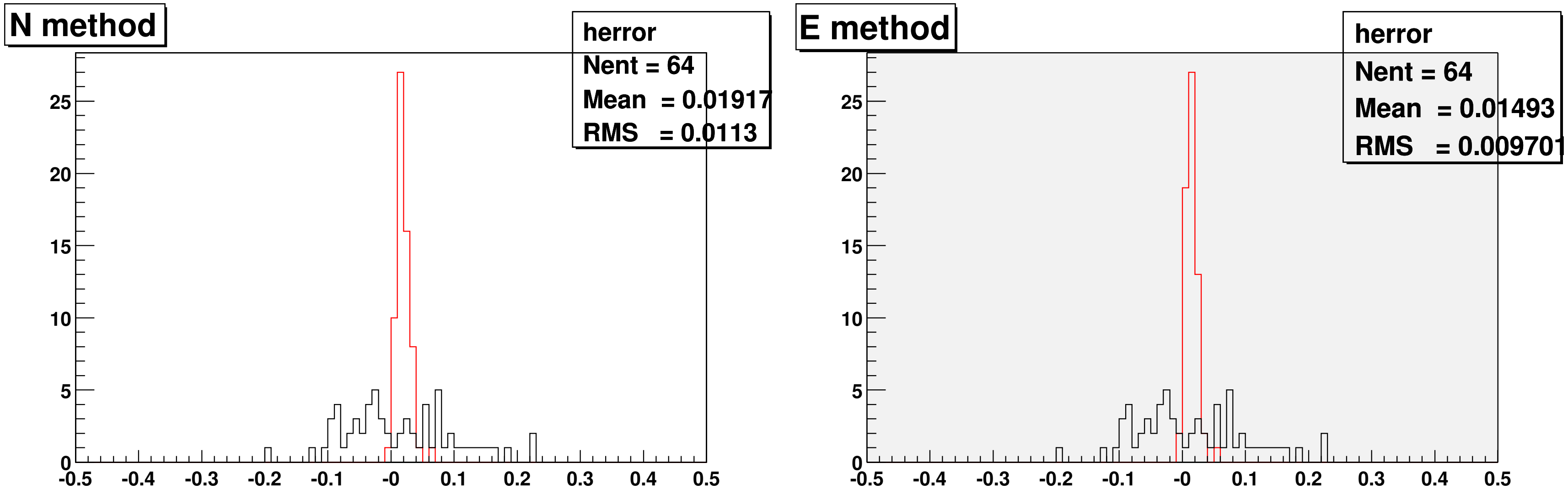
Tests

- Generate a random distribution of events
  - W events : events simulated with ATLFast
  - Inclusive QCD : exponential distribution.
- Choose IC constants and uncalibrate.
- Apply algorithms to re-find IC constants

Results

Inclusive QCD events

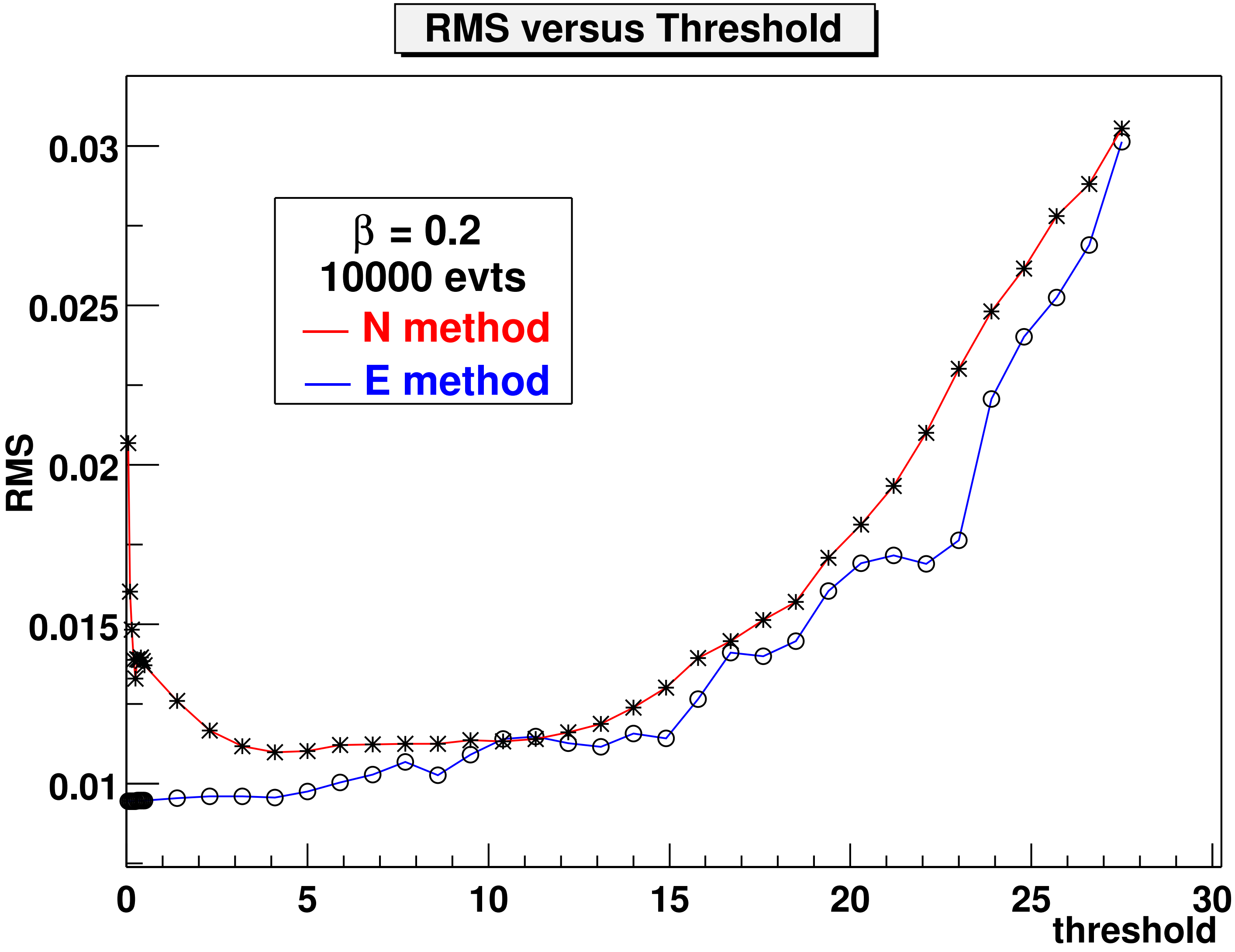
- 10000 events
- Random α (with $\sigma = 0.1$)
- Exponantial distribution : $\sim e^{-\beta E}$ ($\frac{1}{\beta}$: energy scale)



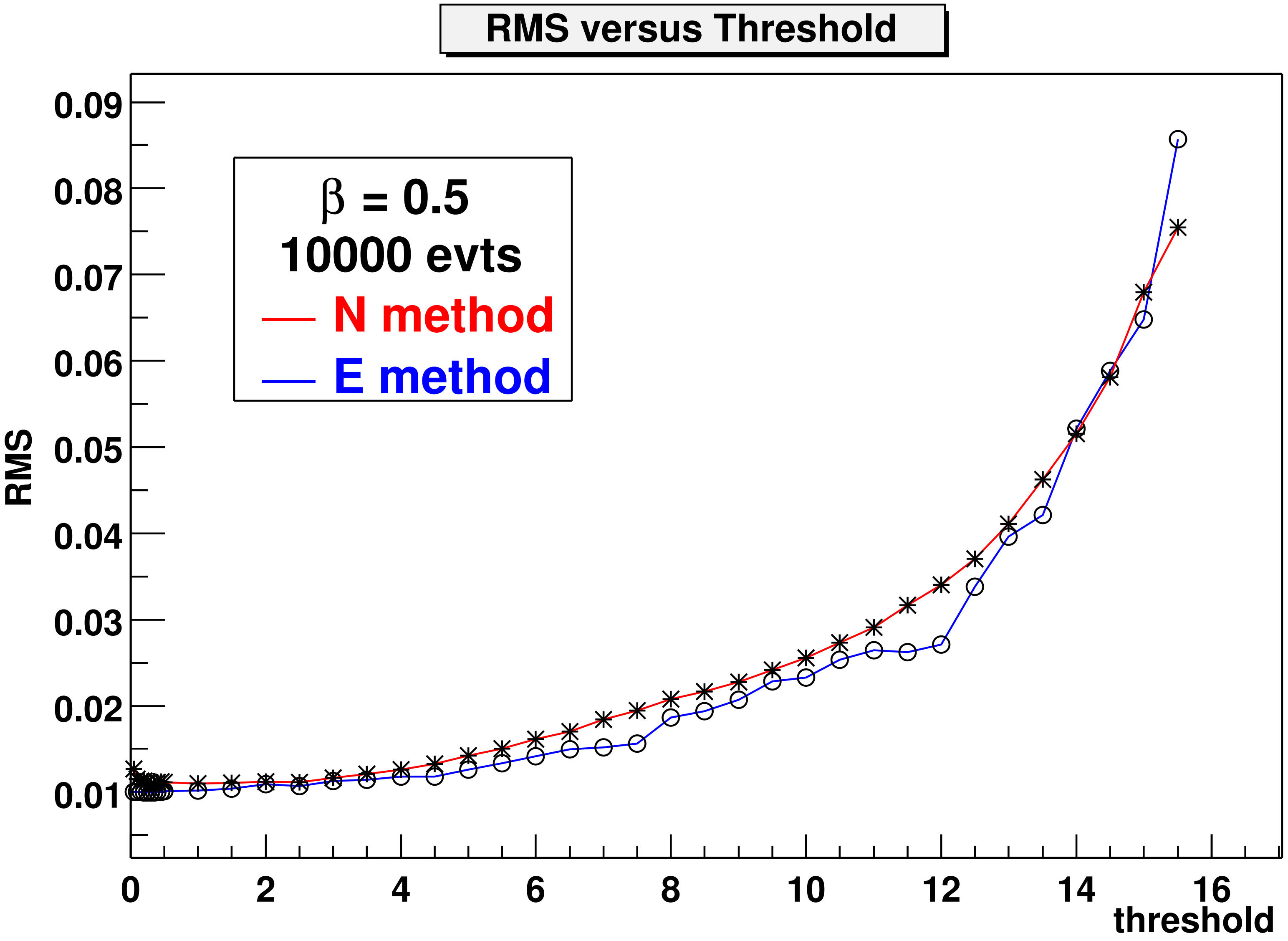
Corrected α

($\beta = 0.2\text{Gev}^{-1}$)

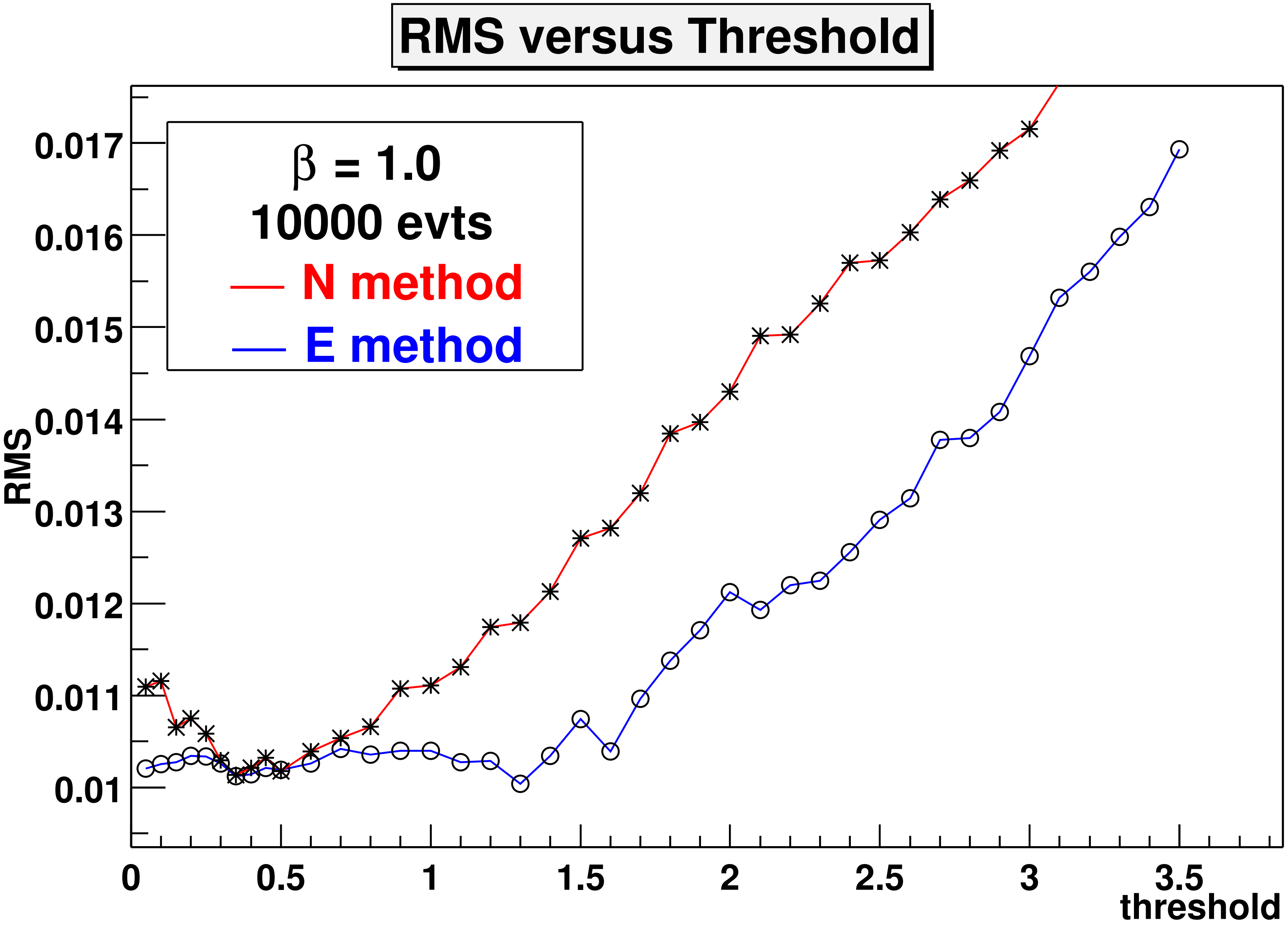
Results


RMS versus Threshold
β = 0.2
10000 evts
N method
E method
RMS
0.03
0.025
0.02
0.015
0.01
0
5
10
15
20
25
30
threshold

Results


RMS versus Threshold
β = 0.5
10000 evts
N method
E method
RMS
threshold
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0
2
4
6
8
10
12
14
16

Results


RMS versus Threshold
β = 1.0
10000 evts
N method
E method
RMS
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0
0.5
1
1.5
2
2.5
3
3.5
threshold

Simulated events

- We could not test these methods on full simulations.
- Energy distribution is roughly exponential ($\sim e^{-\beta E}$).
- Energy scales are low ($\beta > 1\mathrm{GeV}^{-1}$)

Conclusions

For inclusive QCD events :

- Need lots of events in each unit to be precise.
- Best precision (statistical): $\frac{\sim 100\%}{\sqrt{N}}$
- Will intercalibrate on low energies.