

MARTA Concept of LATTES

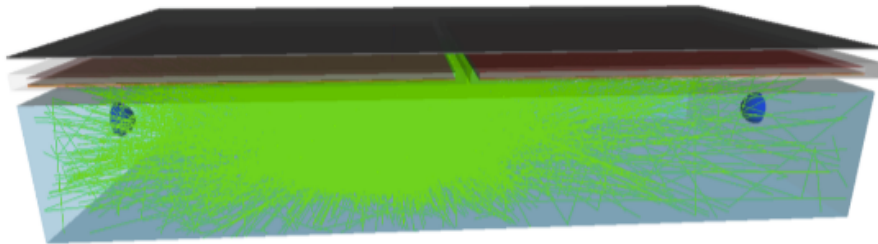
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Motivation

BASELINE design

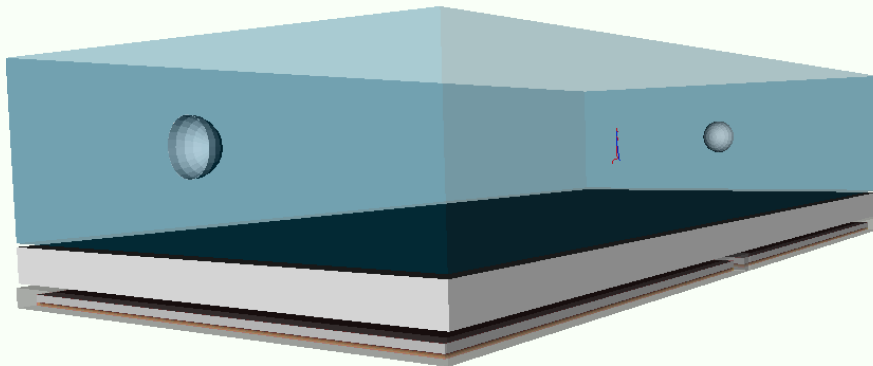


Pb plate 0.5 cm $\sim 1 X_0$

RPCs - shielded by $\sim 1 X_0$

WCD - shielded by $\sim 1 X_0$

MARTA design



Shielding generally:

- absorbs low-energy electrons
- converts high-energy photons

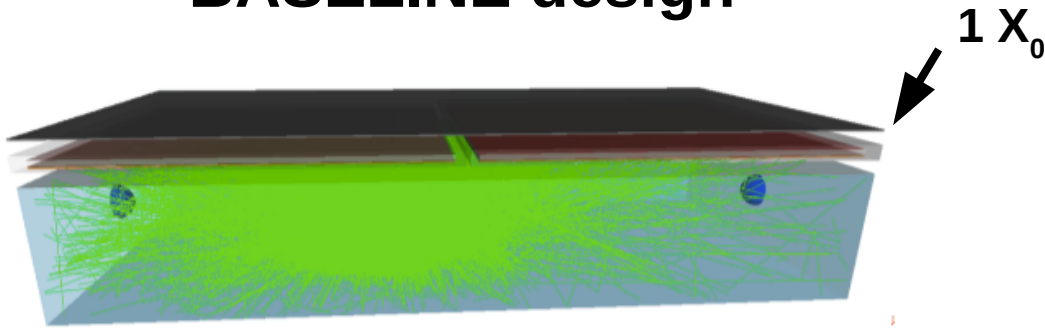
WCD - unshielded
(50 cm of water $\sim 1.4 X_0$)

Concrete precast 10 cm $\sim 1 X_0$

RPCs - shielded by $\sim 2.4 X_0$

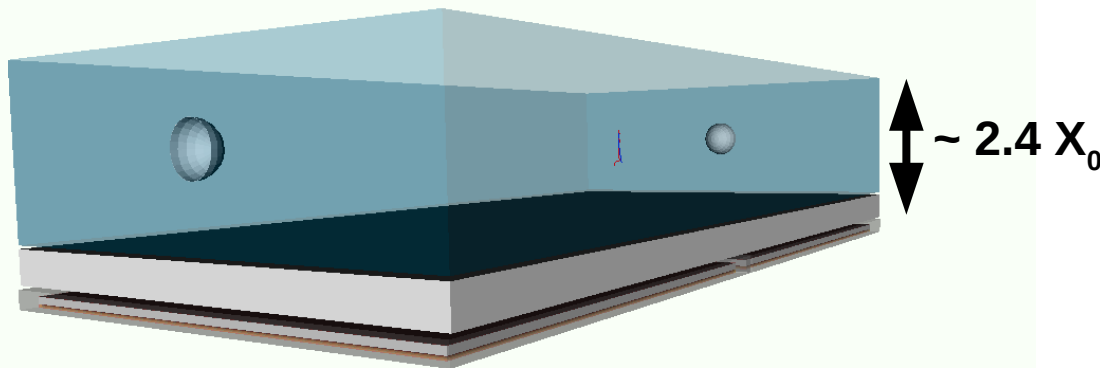
Motivation

BASELINE design



- In principle, both designs are ~ equivalent
-> need to be tested with simulations

MARTA design



- No need for Pb plate (~200 kg) in the MARTA design
-> **less demanding on cost and deployment, smaller temperature variations in RPCs**

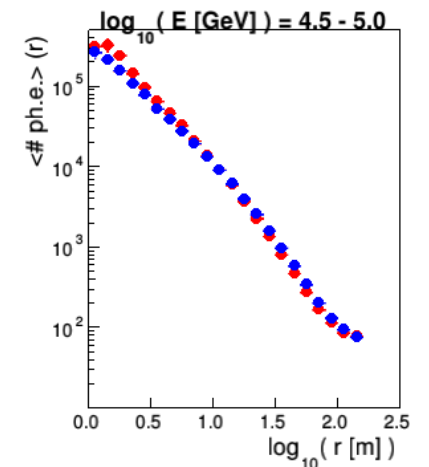
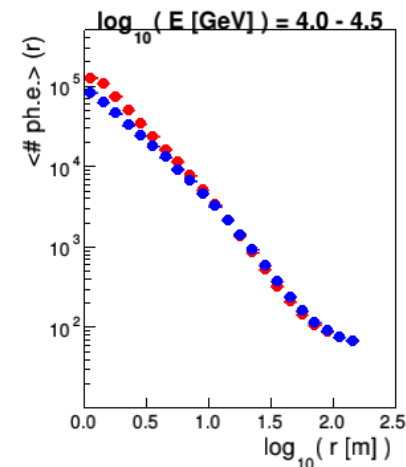
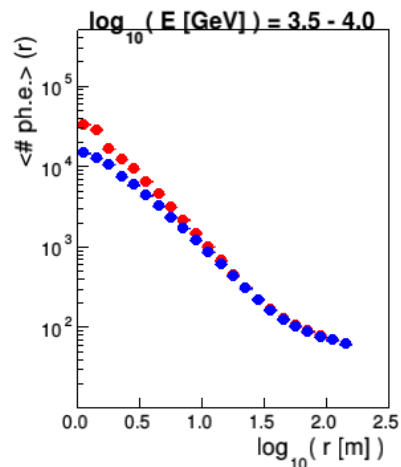
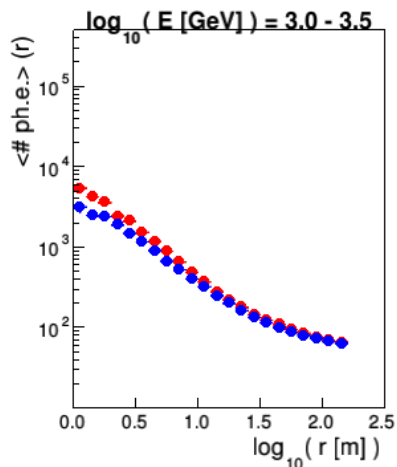
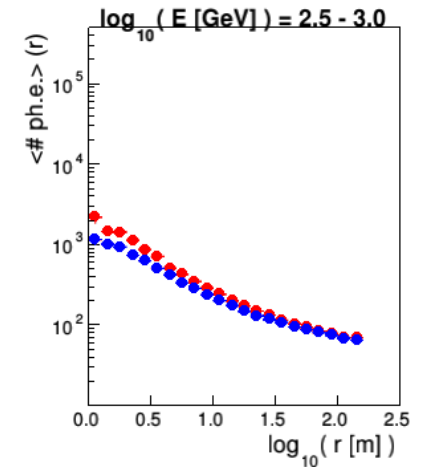
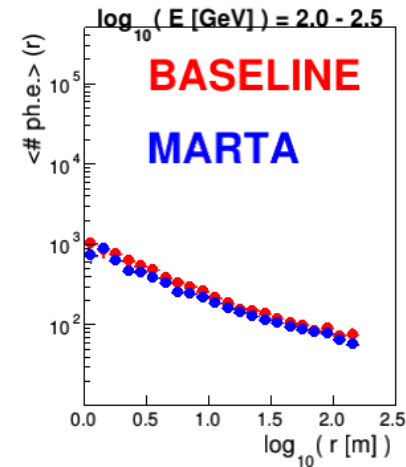
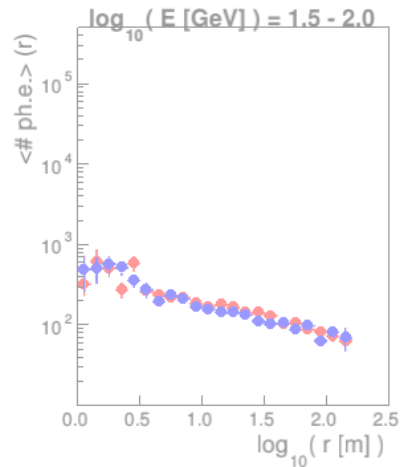
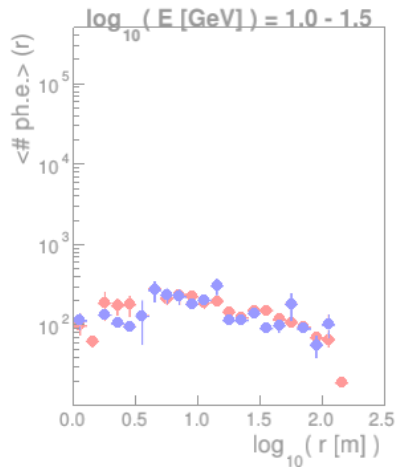
Simulations @ Prague

- Using standalone packages and the CORSIKA library (10 GeV-100 TeV) provided by Bernardo and Ruben
 - LATTESSim & LATTESrec
- 1.7 M showers for the MARTA design:
 - Photons with zenith angle 10° , LATTES at 5200 m a.s.l.
 - Energy spectrum E^{-1} , uniform in azimuth
 - Each Corsika shower 10-times with random core

Applied cuts to both concepts:

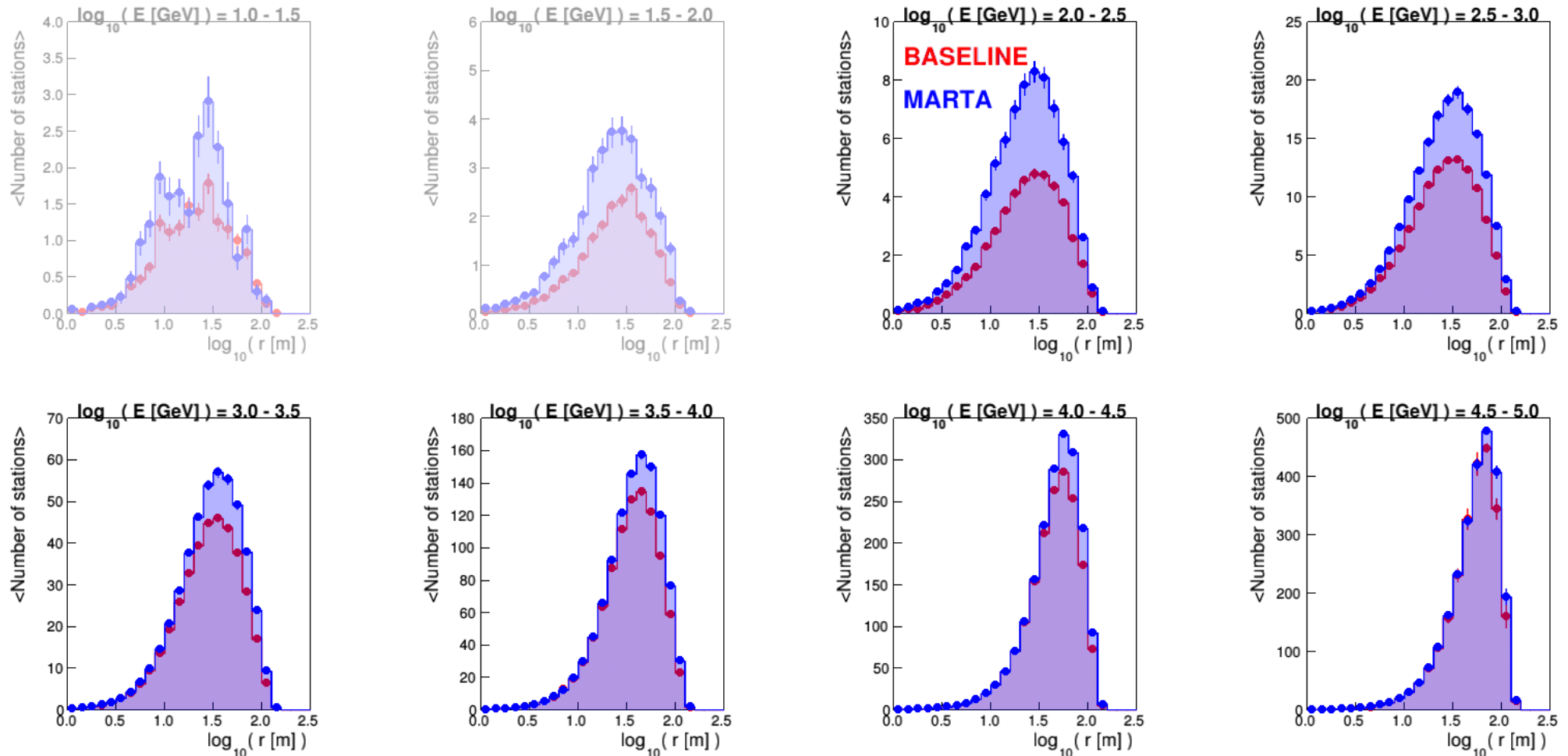
- WCD triggered (3 stations with 5 phe in each PMT)
- Sim. core closer than 70 m from the center of the array
- Quality cuts

WCD - $\langle \text{LDF} \rangle$



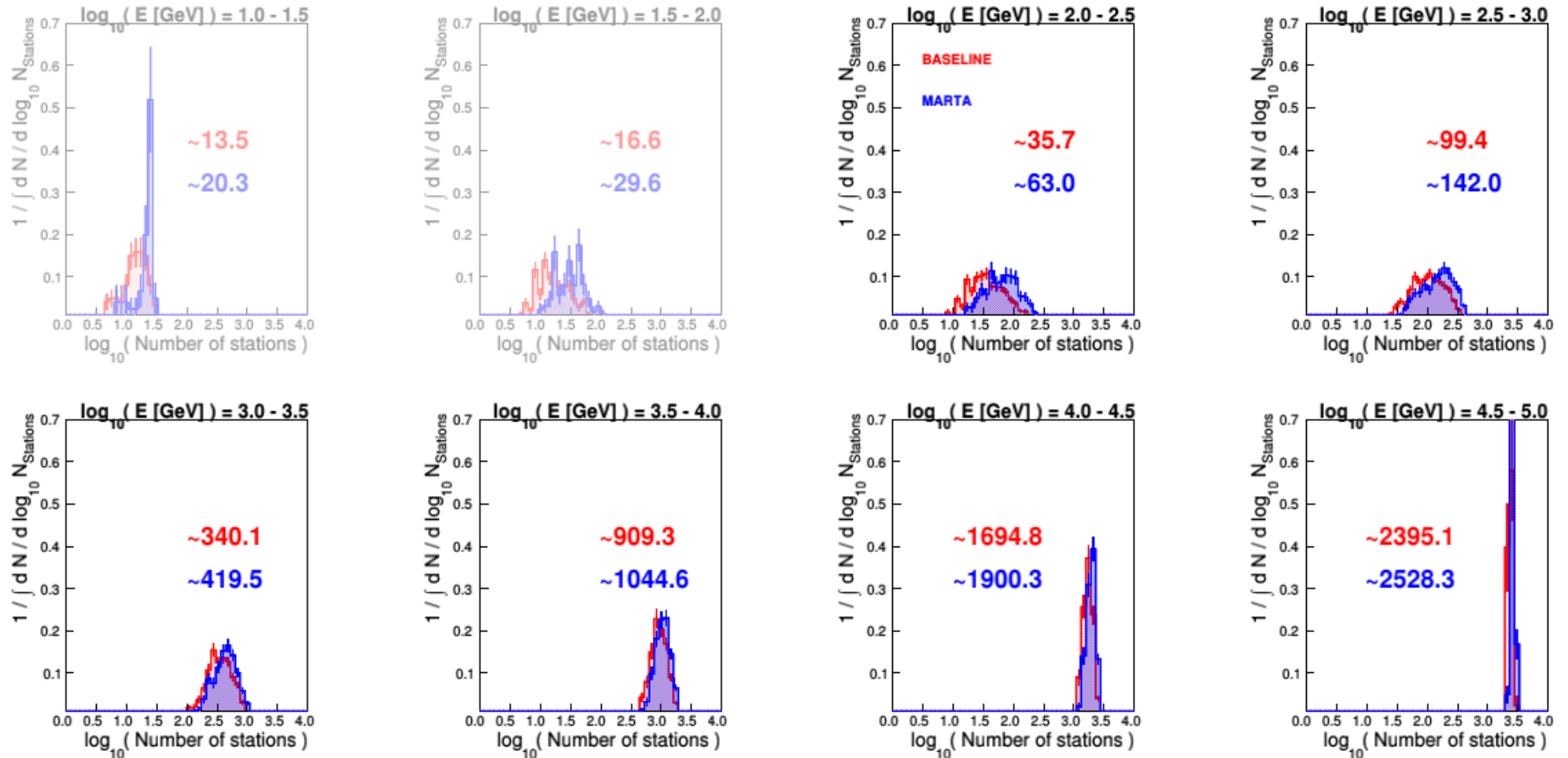
- Effect of converter
- Saturation of this effect

WCD - number of stations vs. core distance



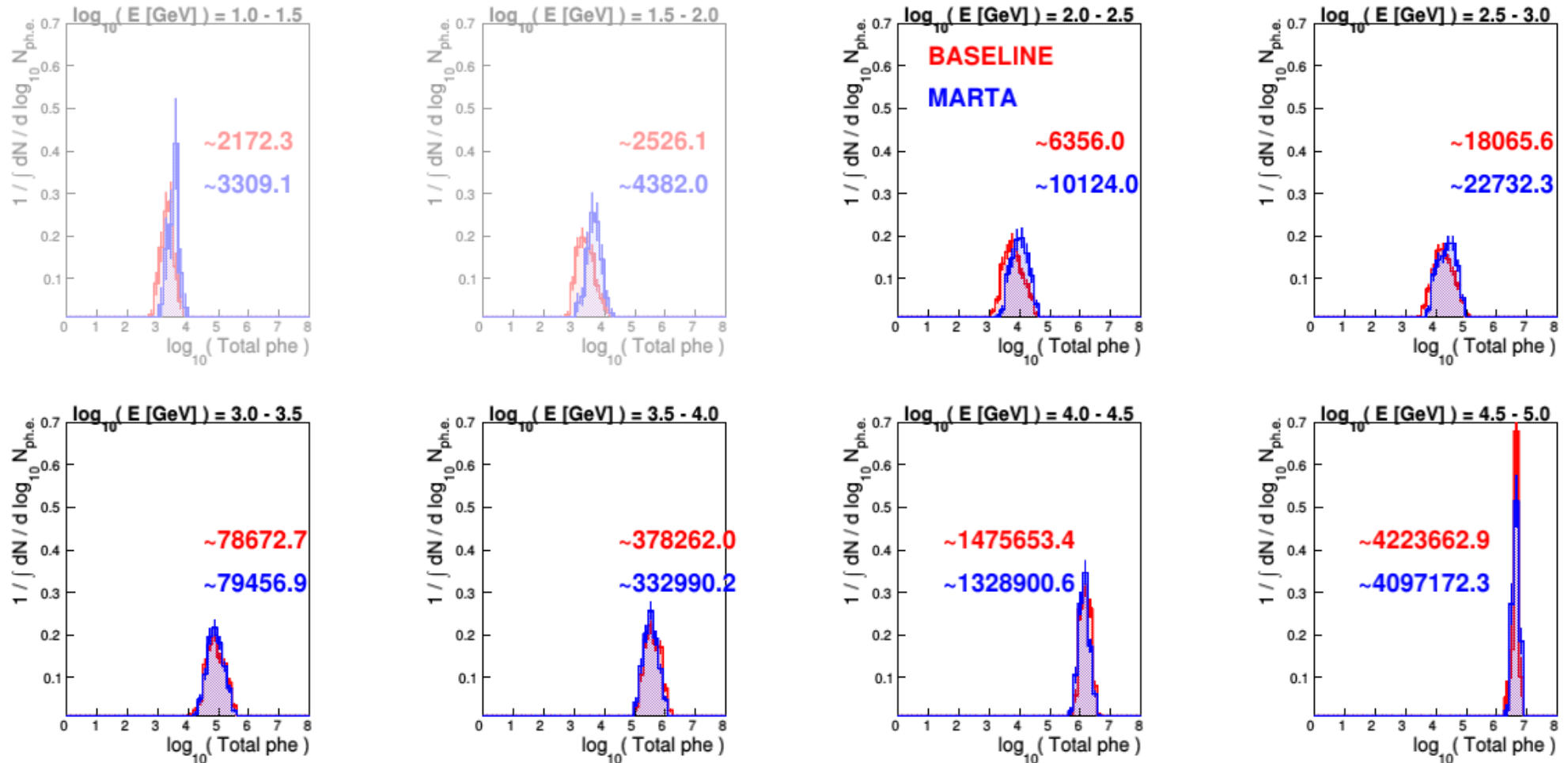
- Low-energy particles trigger more stations farther from the core without the converter (MARTA concept)
- Increasing the primary energy, the differences decrease because the shower footprint \sim size of array (70 m)

WCD - Total number of stations



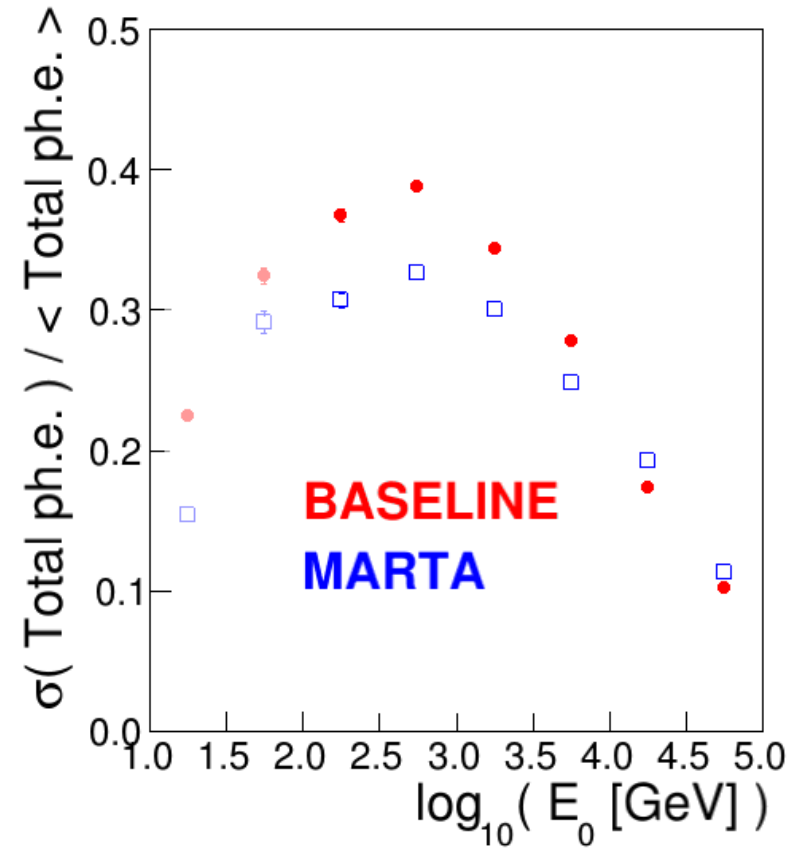
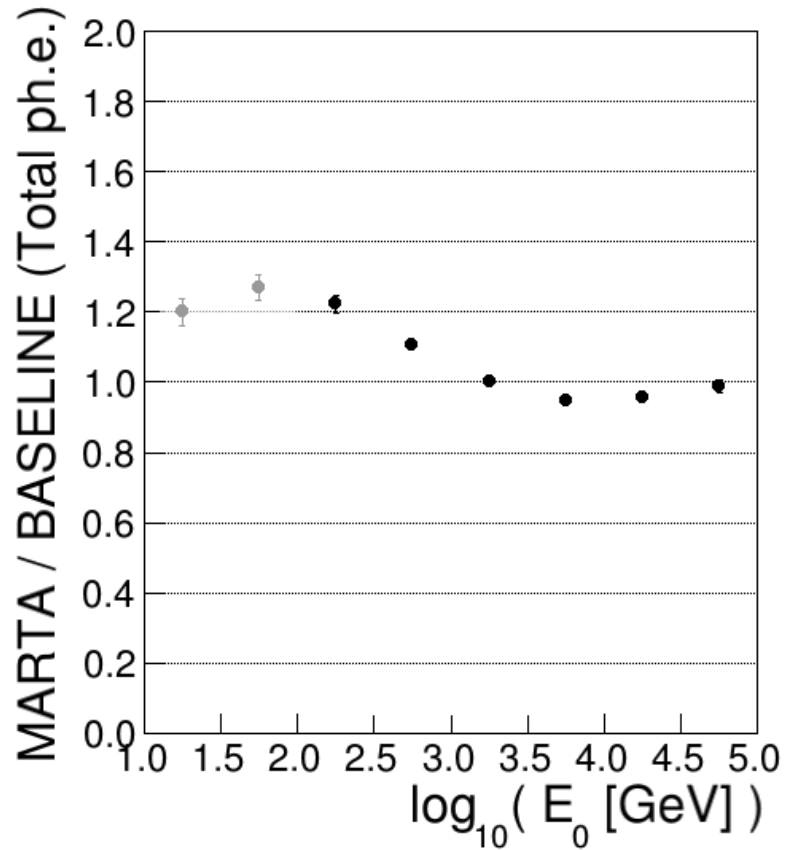
More triggered stations in **MARTA** concept

WCD - Total # ph.e. per shower

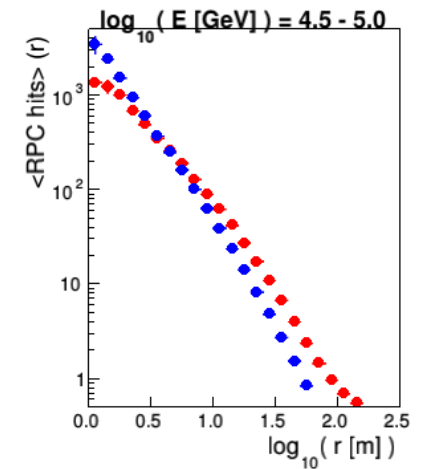
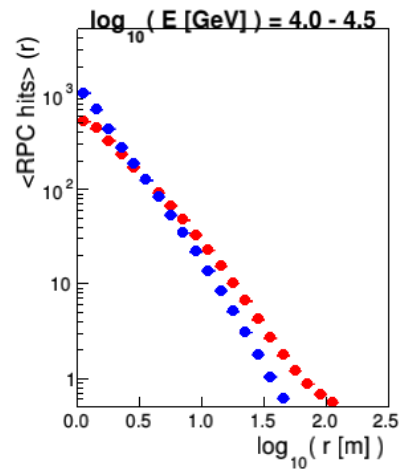
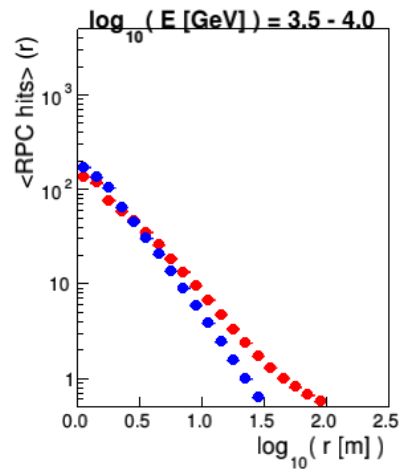
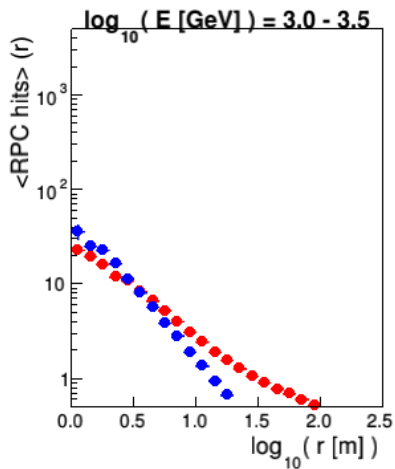
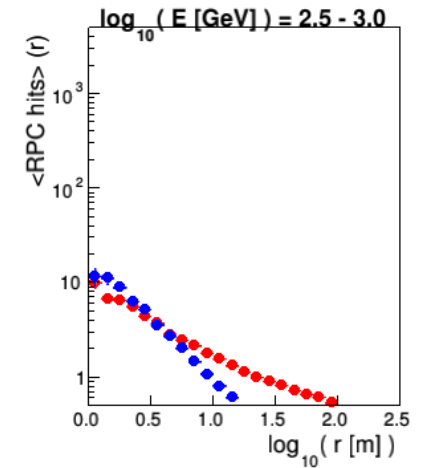
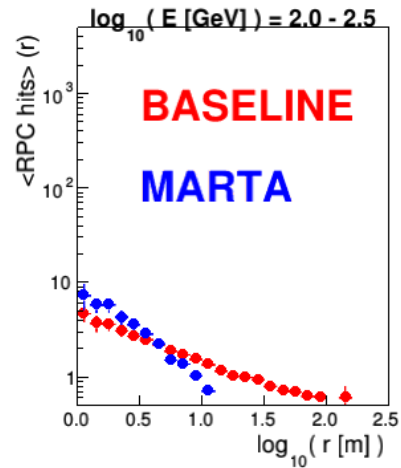
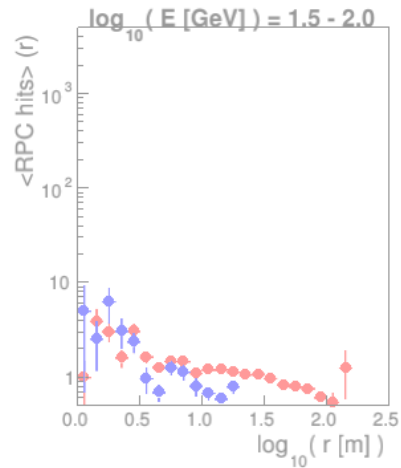
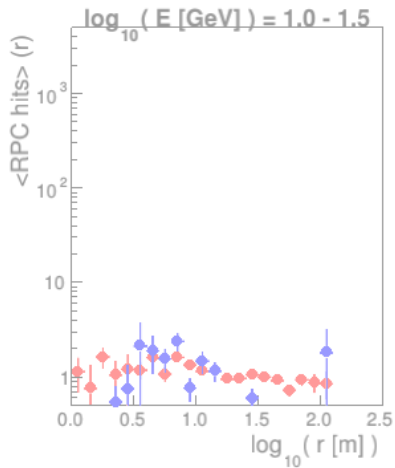


Consequence of the total number of stations

WCD - moments of Total ph.e.

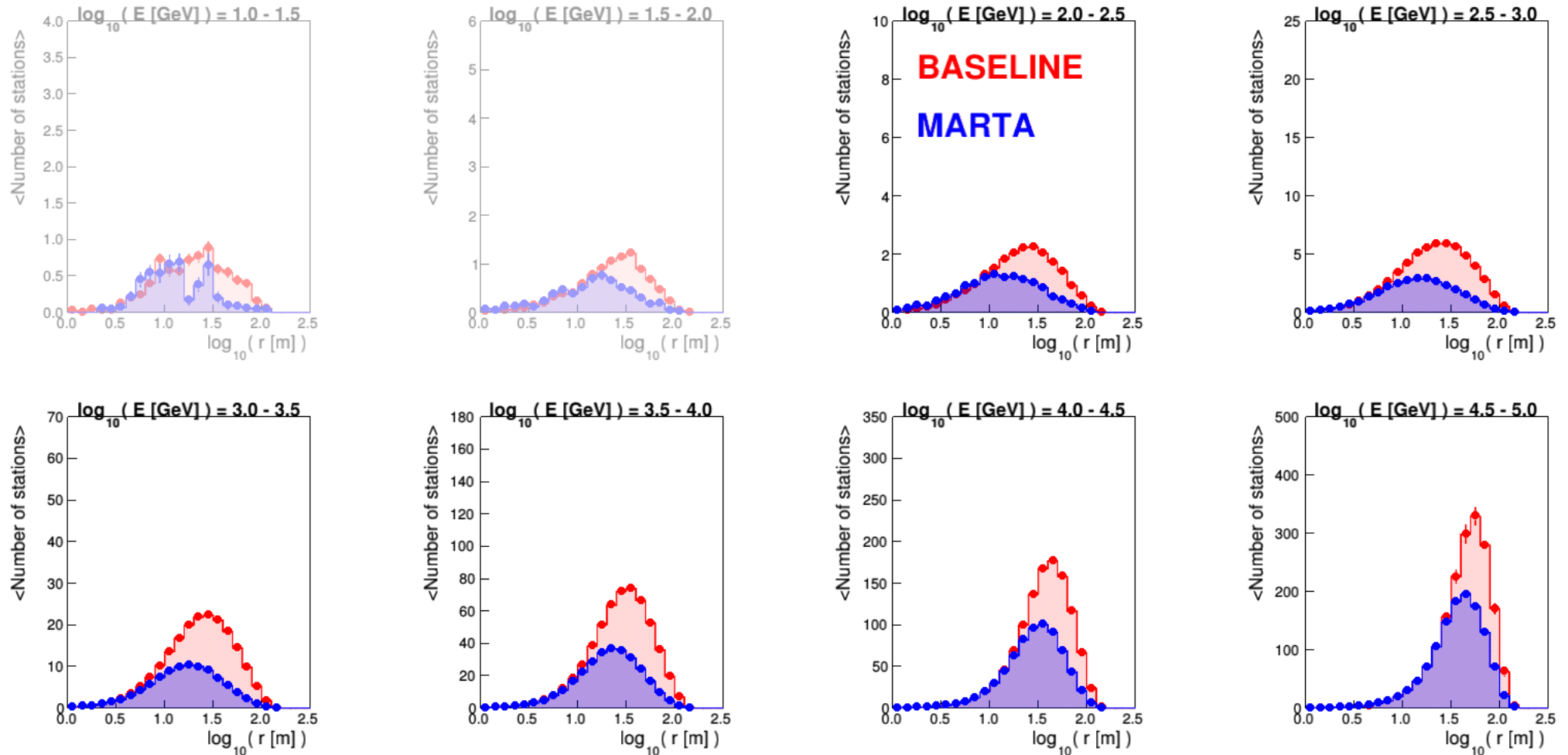


RPC - $\langle \text{LDF} \rangle$



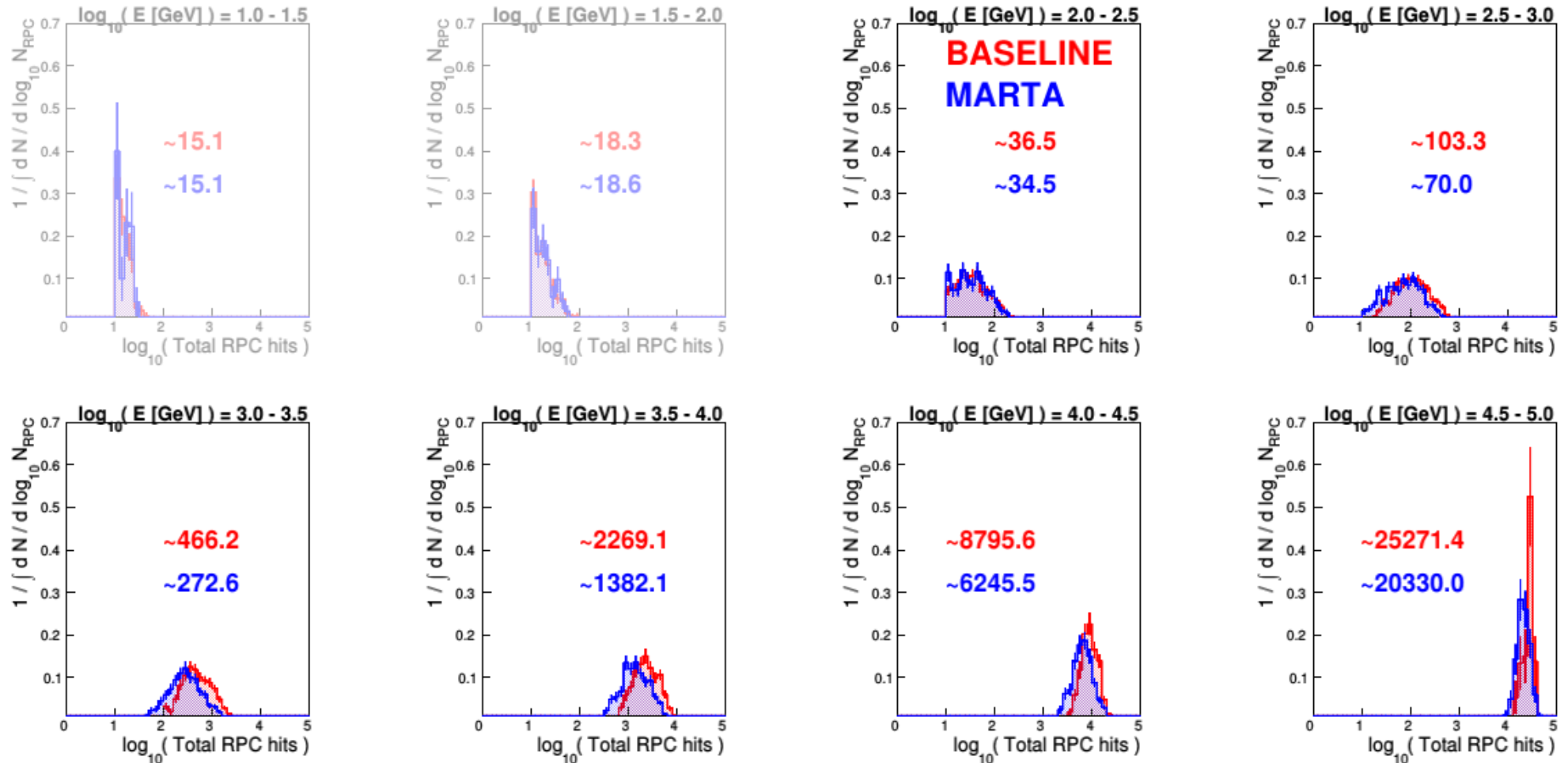
More $X_0 \rightarrow$ steeper LDF

RPC - Number of stations vs. core distance



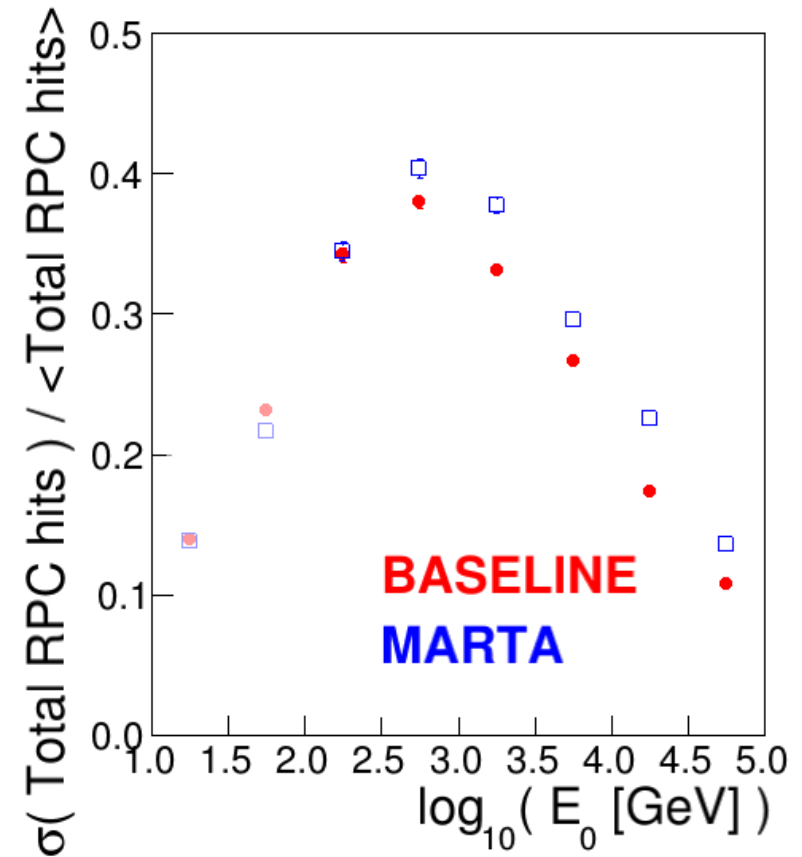
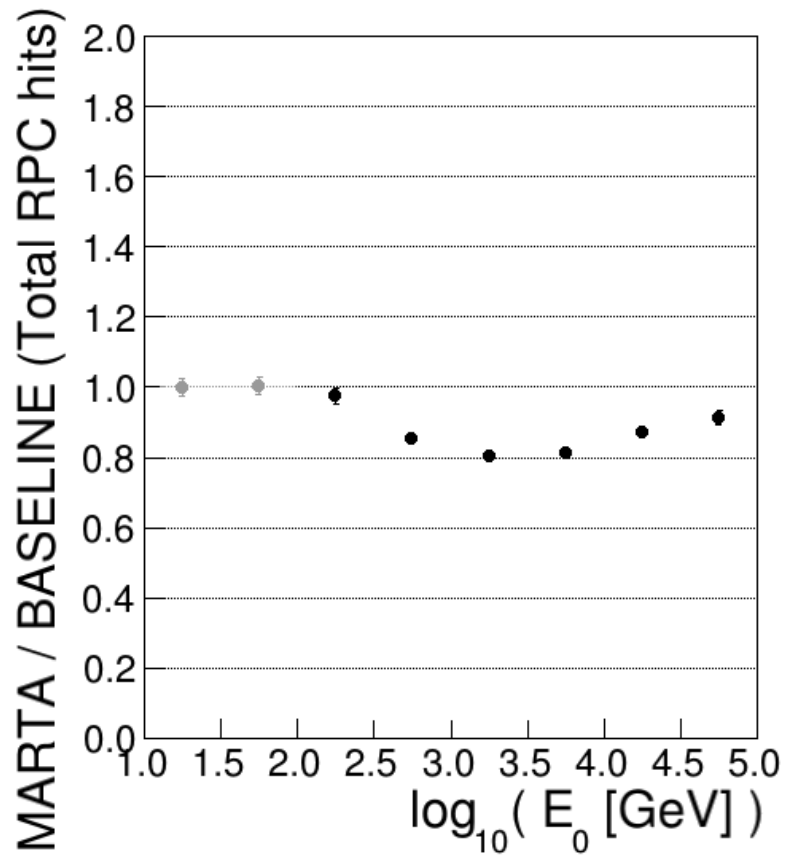
- Stations with **non-zero RPC hits** considered
- More stations with RPC hit by low-energy particles in **BASELINE** concept

RPC - Total RPC hits



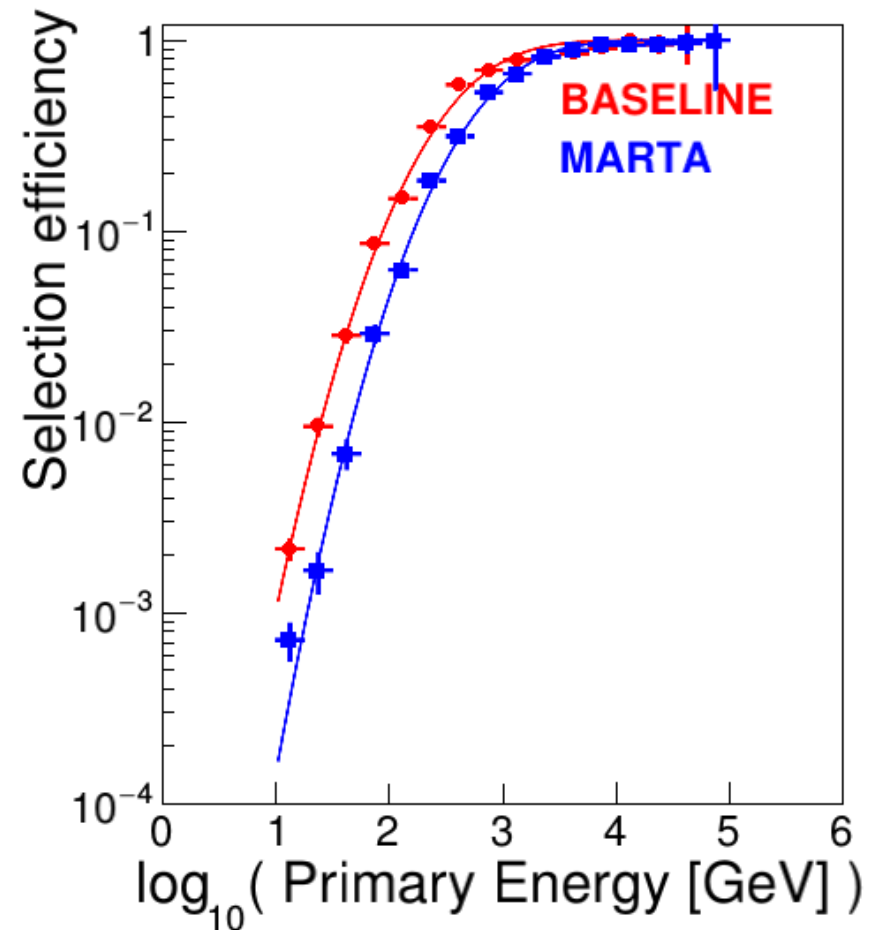
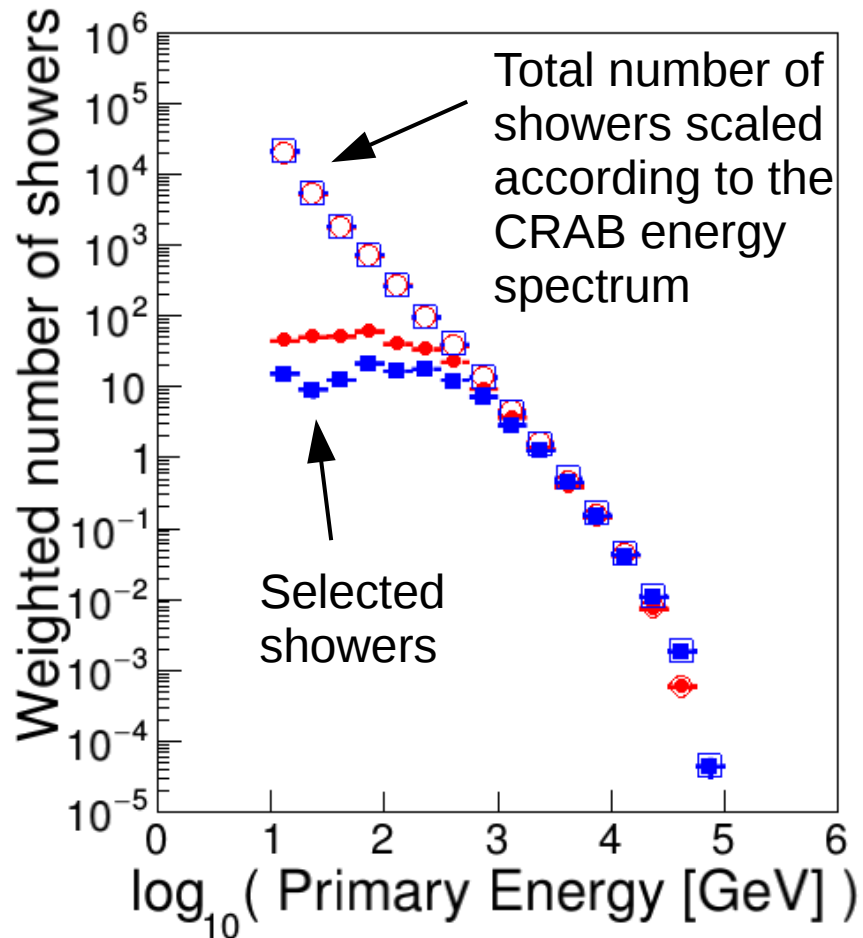
Consequence of more stations with hit RPCs in
BASELINE and more <RPC hits> in **MARTA**

RPC - moments of Total RPC hits

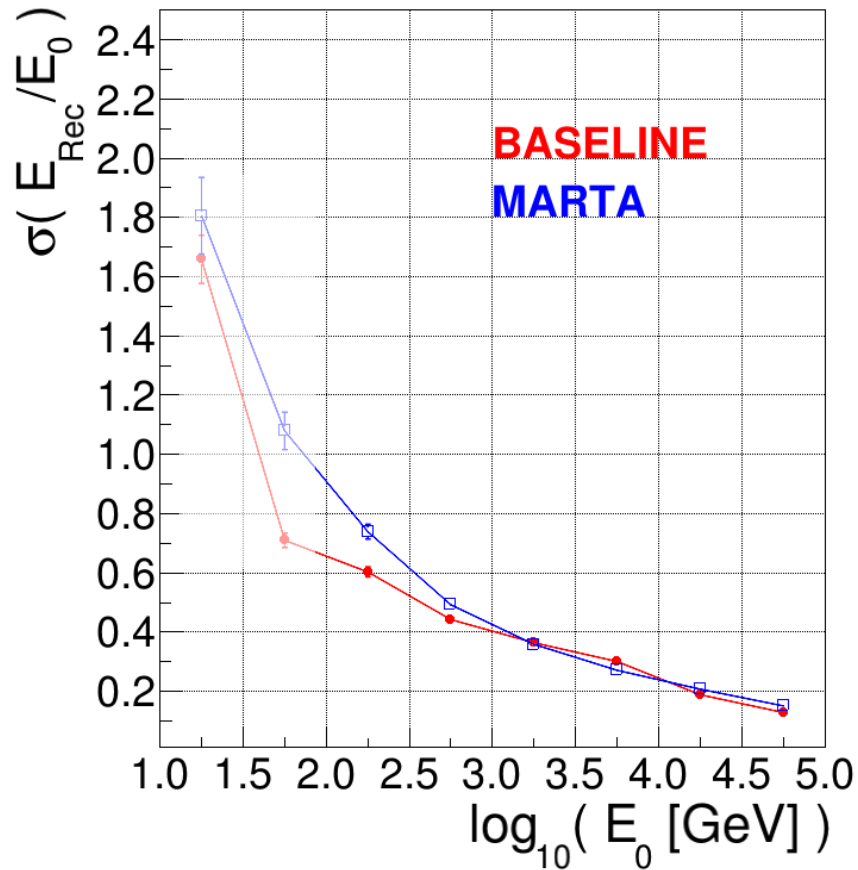


Selection efficiency

- Sim. Core < 70m
- WCD triggered
- Rec. Core < 70m
- LDF fit quality

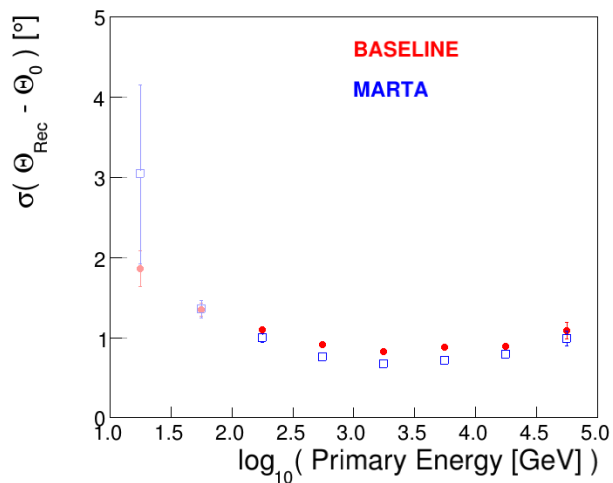
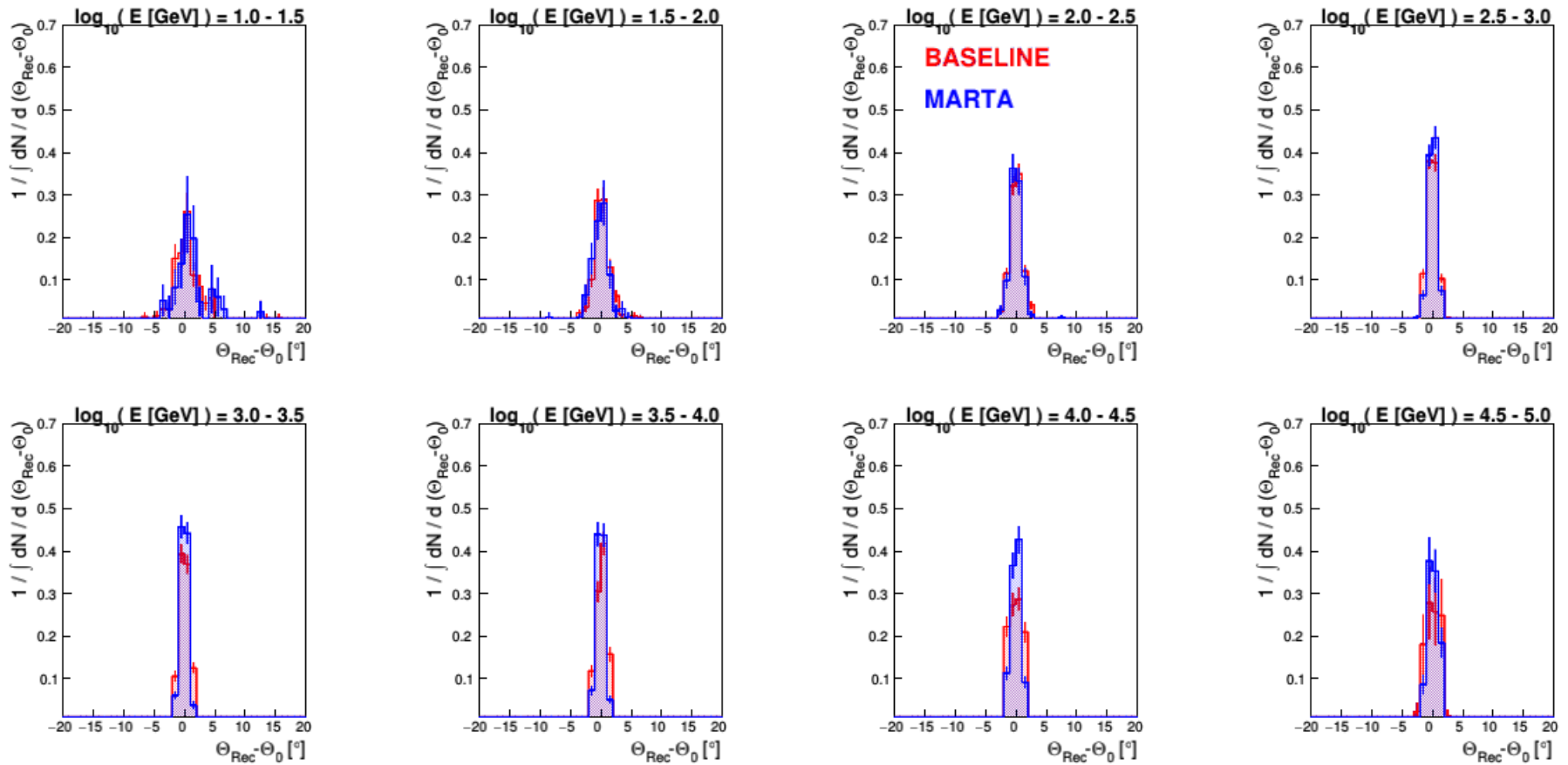


Energy resolution



First estimate, energy calibration needs to be improved...

“Angular” resolution



Summary

- **Both concepts of similar performance**
- WCD
 - more stations with WCD signal in MARTA concept
 - BASELINE concept with converter helps to trigger showers with smaller footprint
- RPC
 - somewhat smaller number of RPC hits in MARTA concept, but the angular resolution not affected

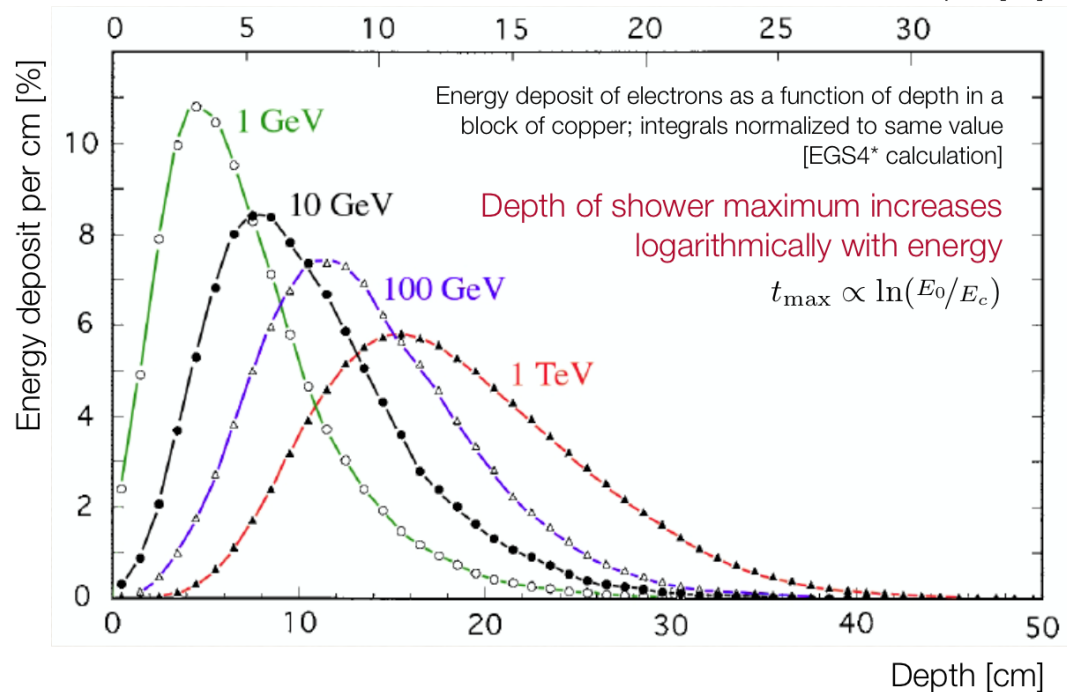
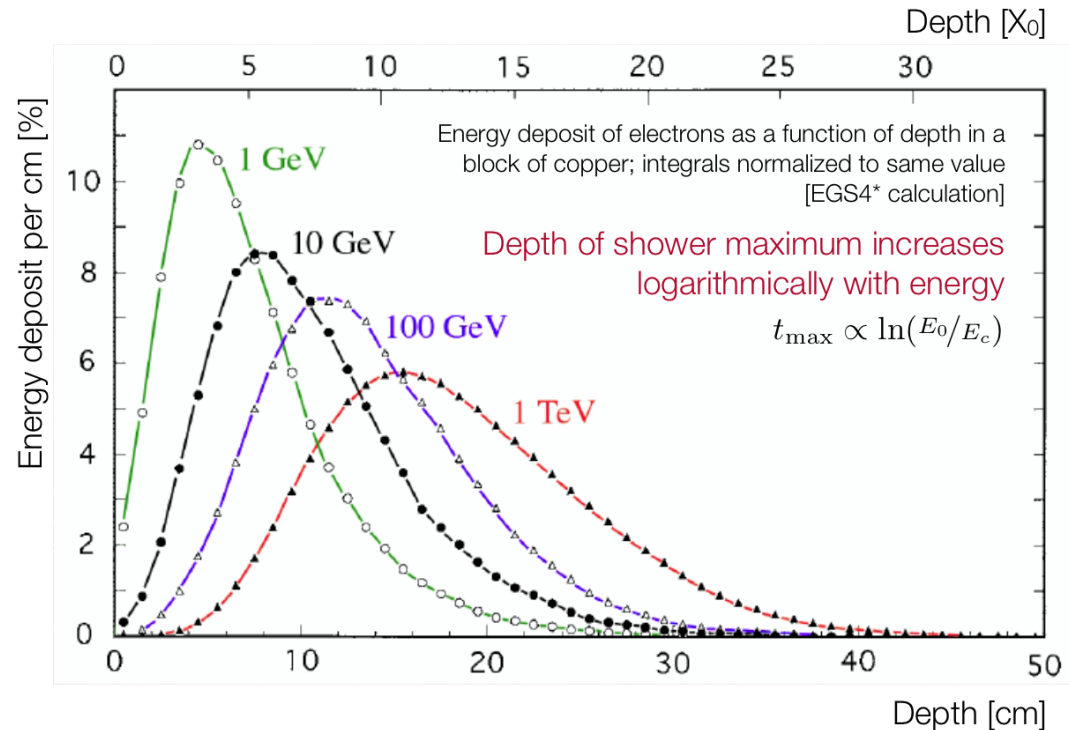
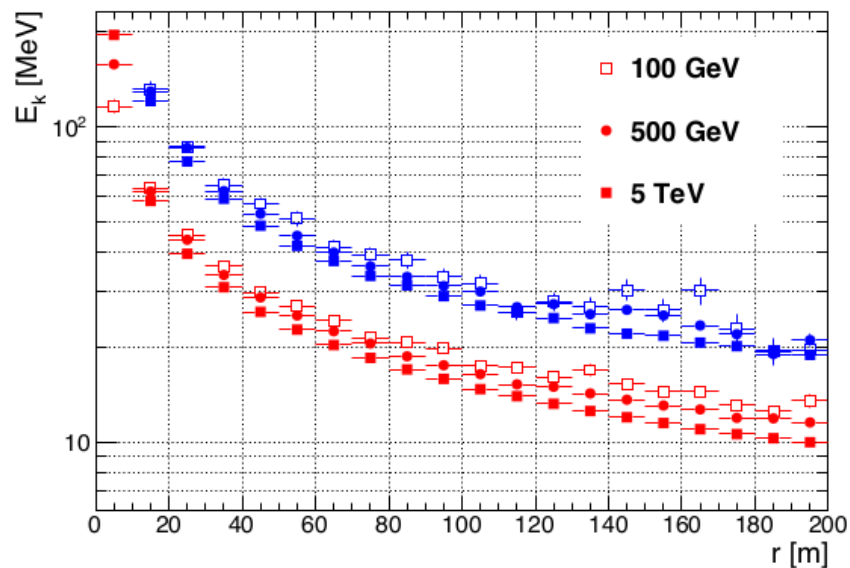


Figure 5: Mean kinetic energy for photons (red) and electrons (blue) as a function of the distance to the shower axis, for different primary energies.

It would be useful to see particle densities at WCD and RPC levels for MARTA and BASELINE stations for gammas with 1 MeV, 10 MeV, ..., 10 GeV

Figure 6: Left : Energy spectra for photons (red) and electrons+positrons (blue) within 40m from the shower axis. Right : Inverse cumulative of the left curves. The primary energies are 100 GeV, 500 GeV and 5 TeV.

Below 100 GeV Topology discriminator ignored

