



Ciências
ULisboa

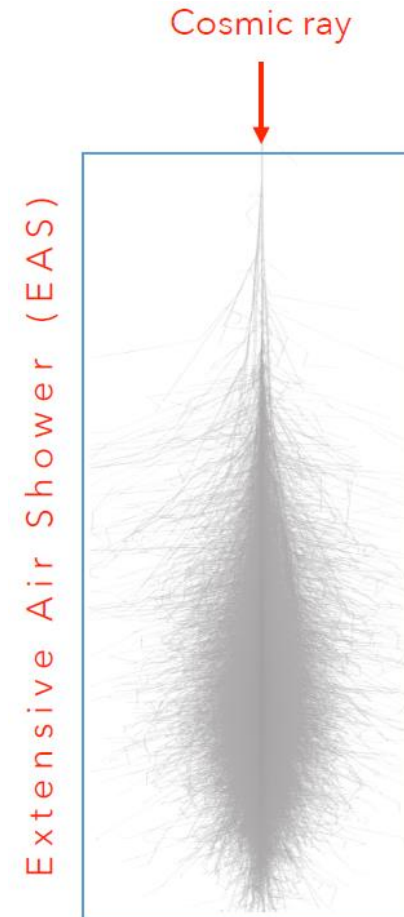
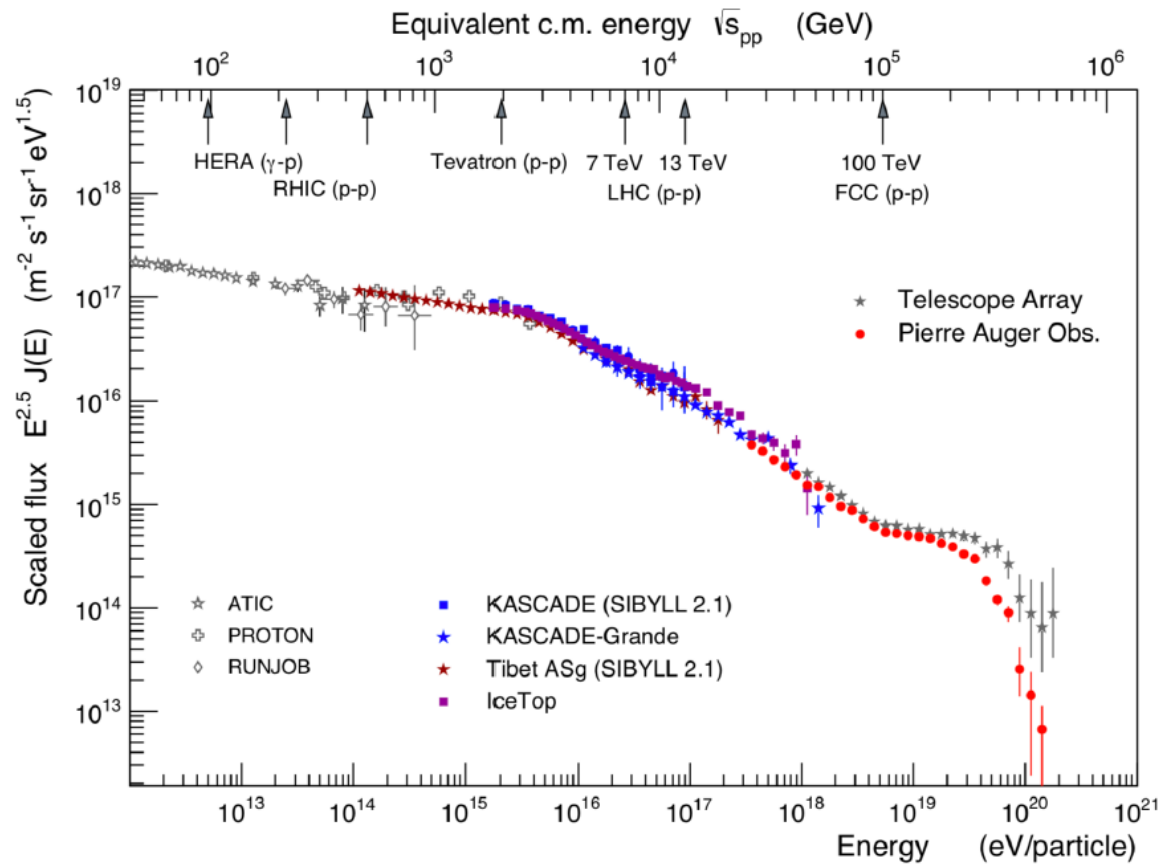


Study of the muon production depth at PeV energies

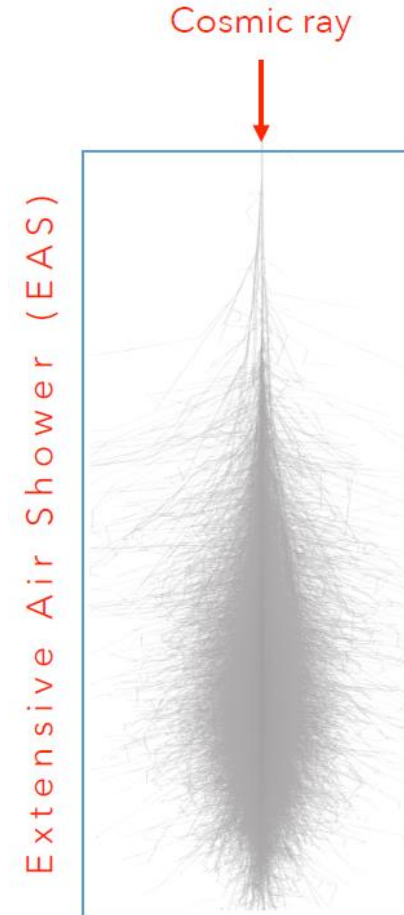
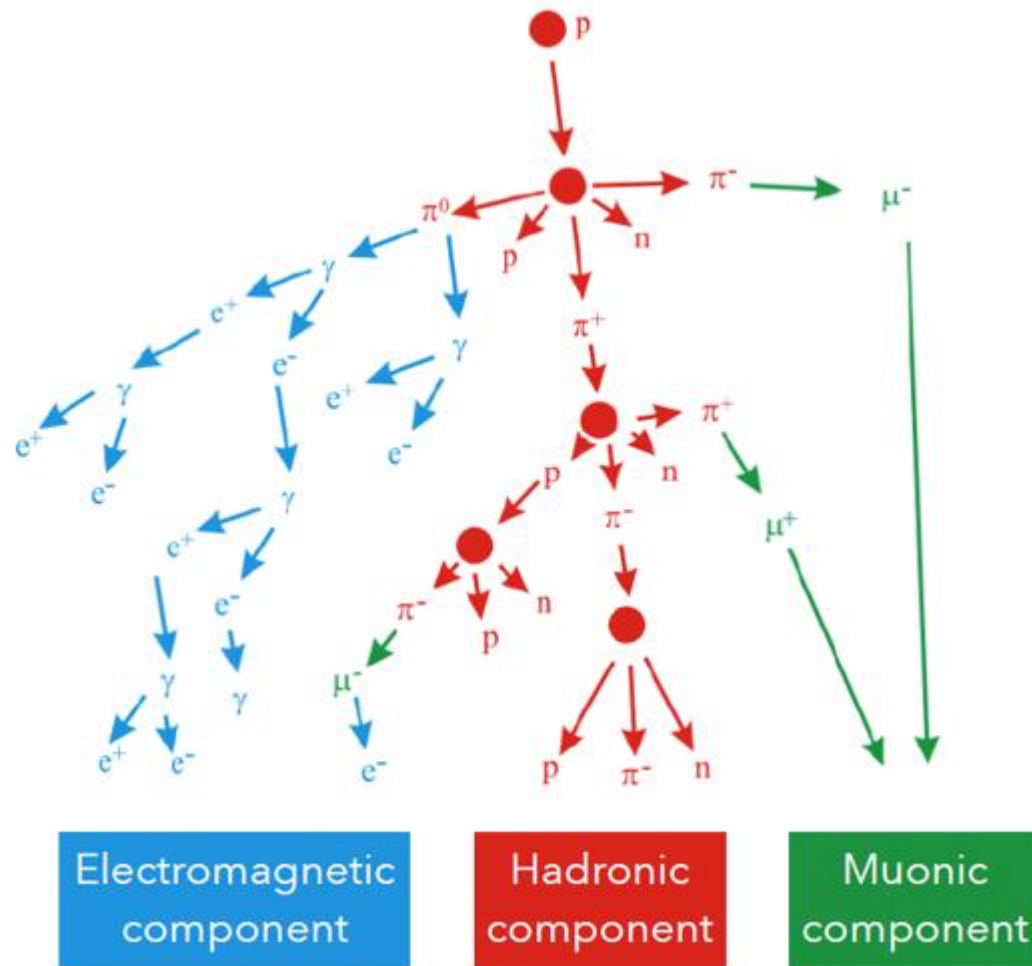
Margarida Sousa, no. 56422

Supervisor: Prof. Ruben Conceição

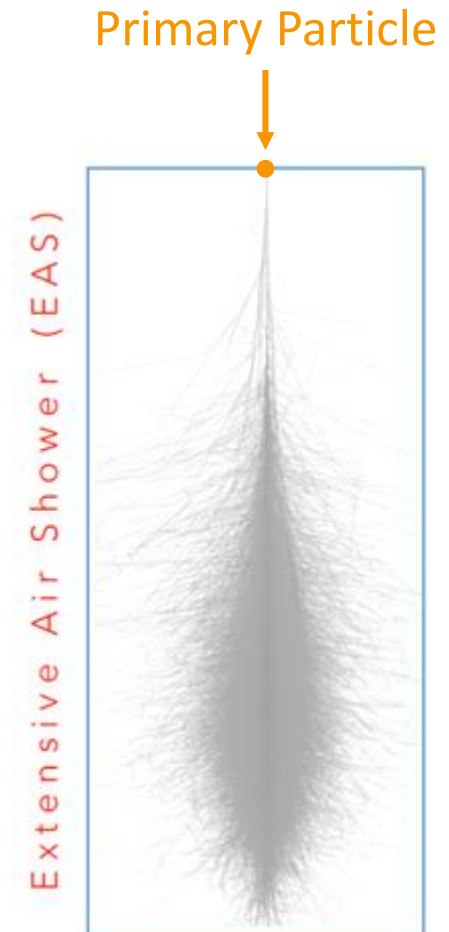
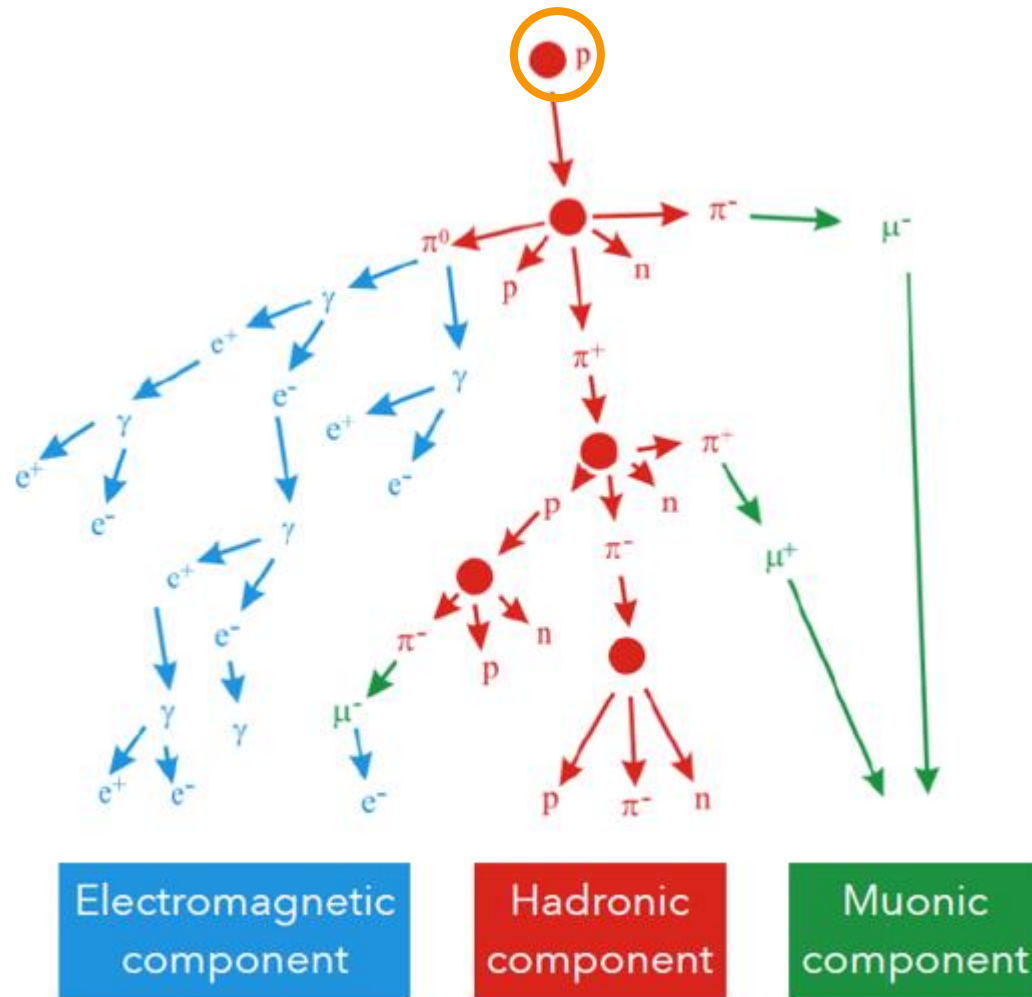
Cosmic rays at the highest energies



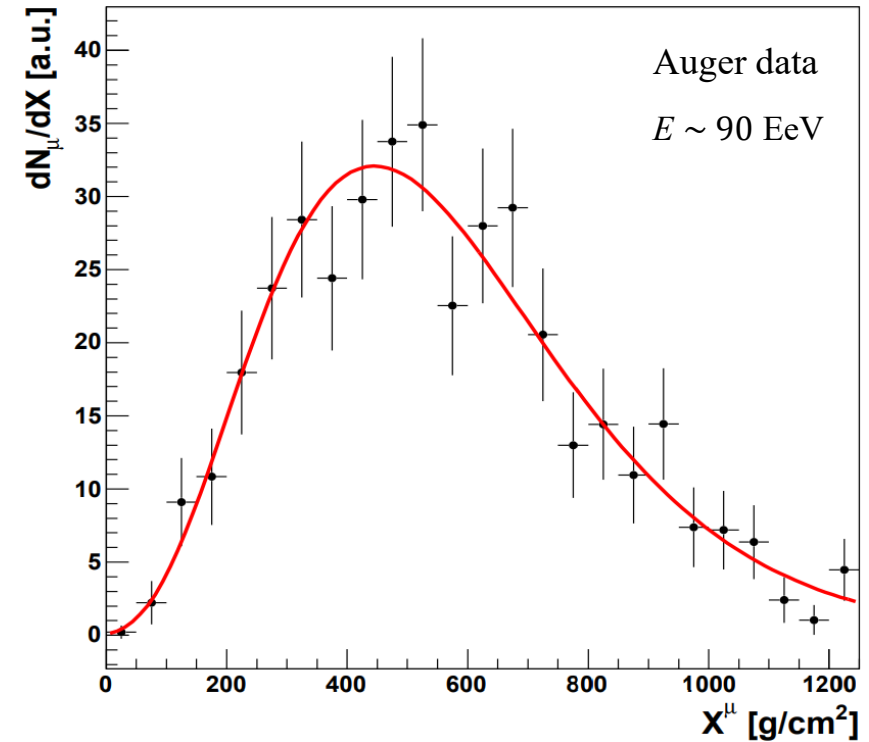
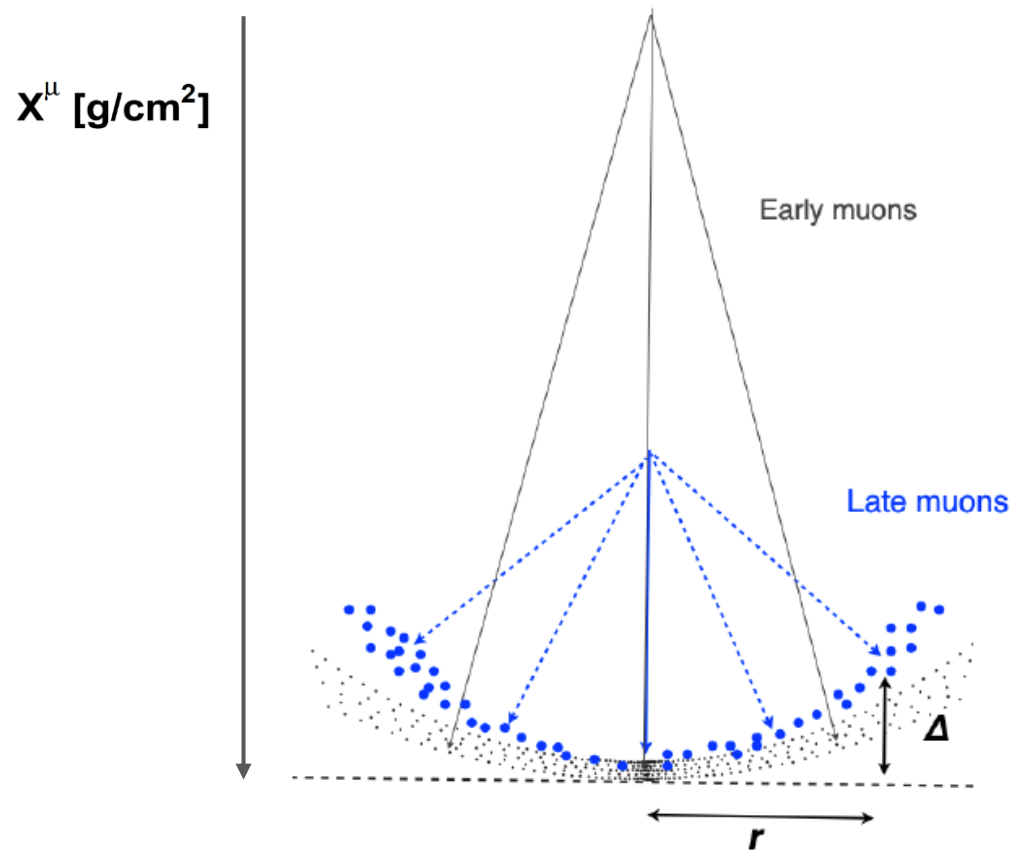
Extensive Air Showers



Extensive Air Showers

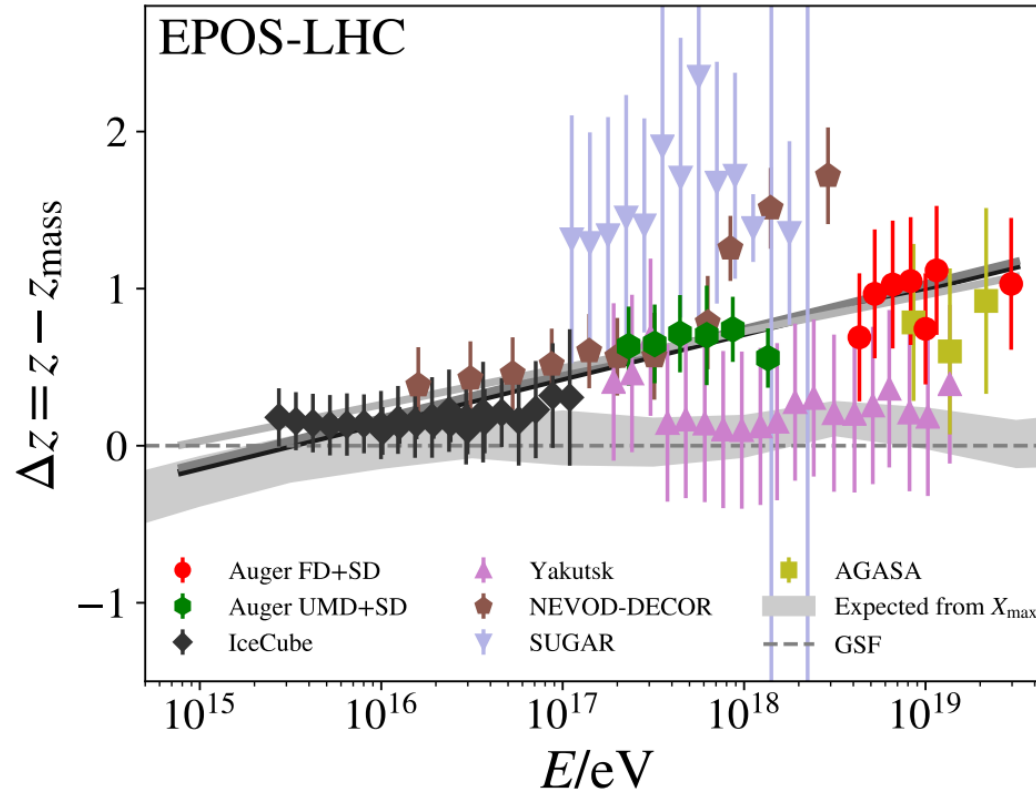


Muon Production Depth



- The relation between the shower geometry and the muon arrival delay relative to the shower front plane allows to obtain the position of muons upon their creation.

EAS Muon Puzzle

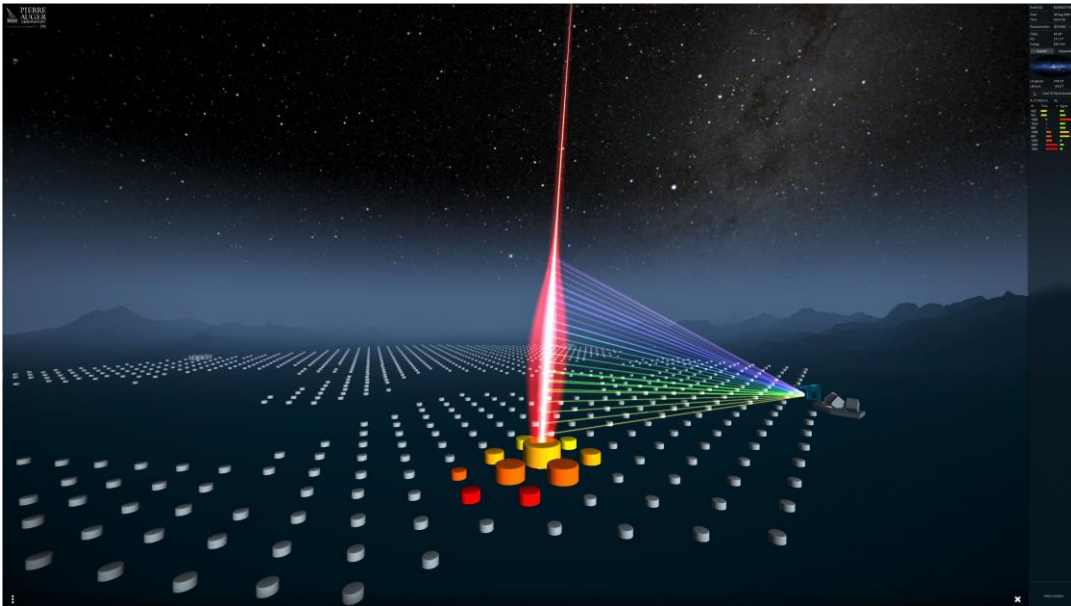


- Data from the Pierre Auger Observatory reveals that models and simulations underpredict the number of muons in extensive air showers.

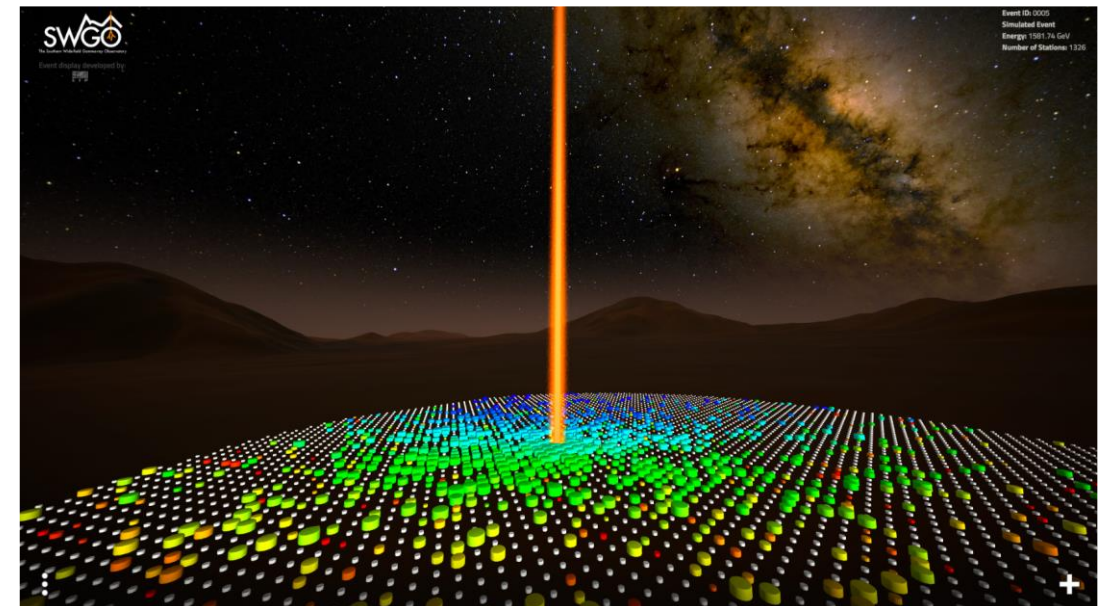


PIERRE
AUGER
OBSERVATORY

VS



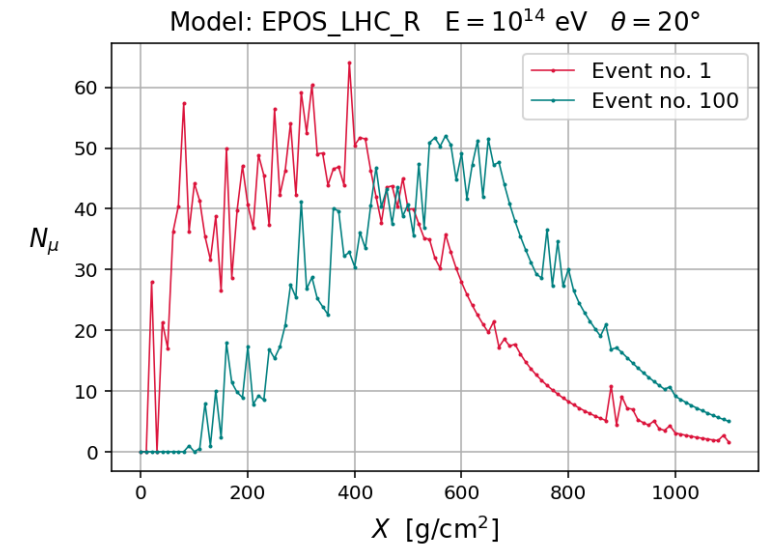
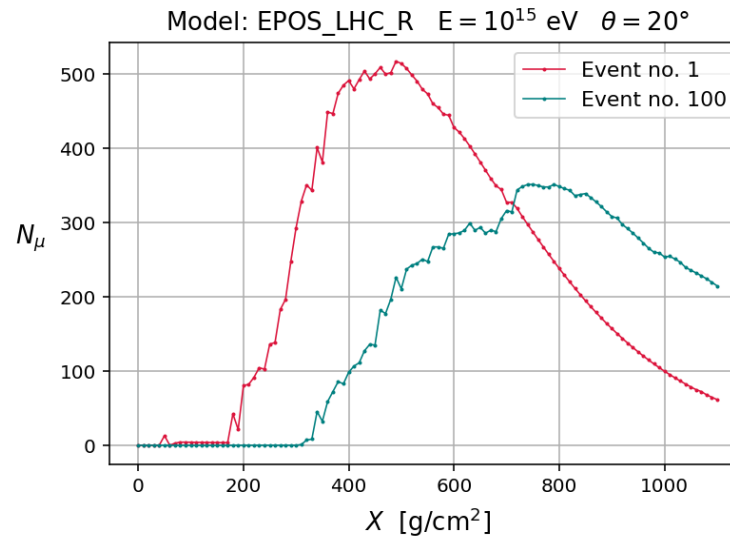
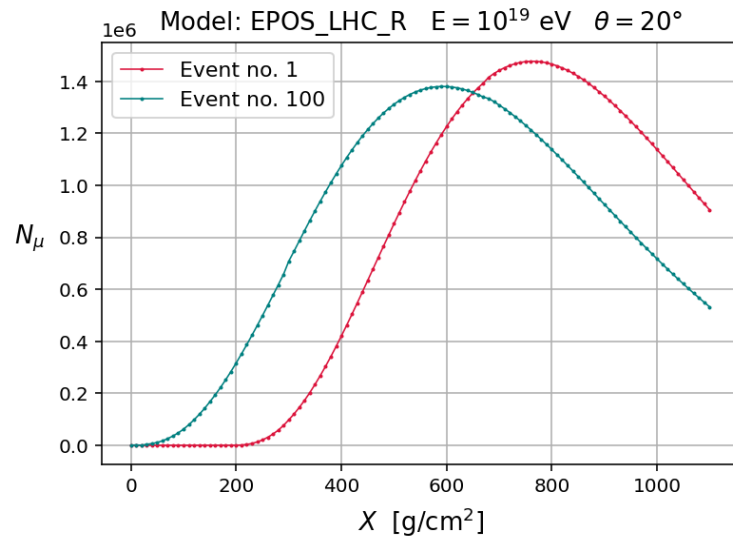
Altitude: 1400 m
Energy range: ~ 10 PeV – 100 EeV



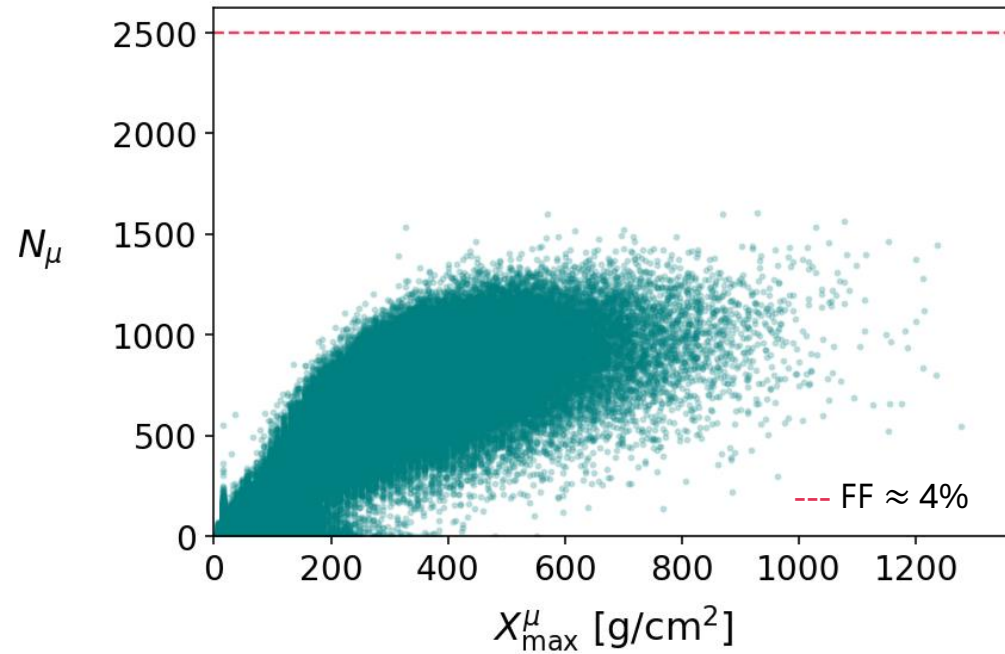
Altitude: 4770 m
Energy range: ~ 100 GeV – 10 PeV

Characterisation of MPD at PeV energies

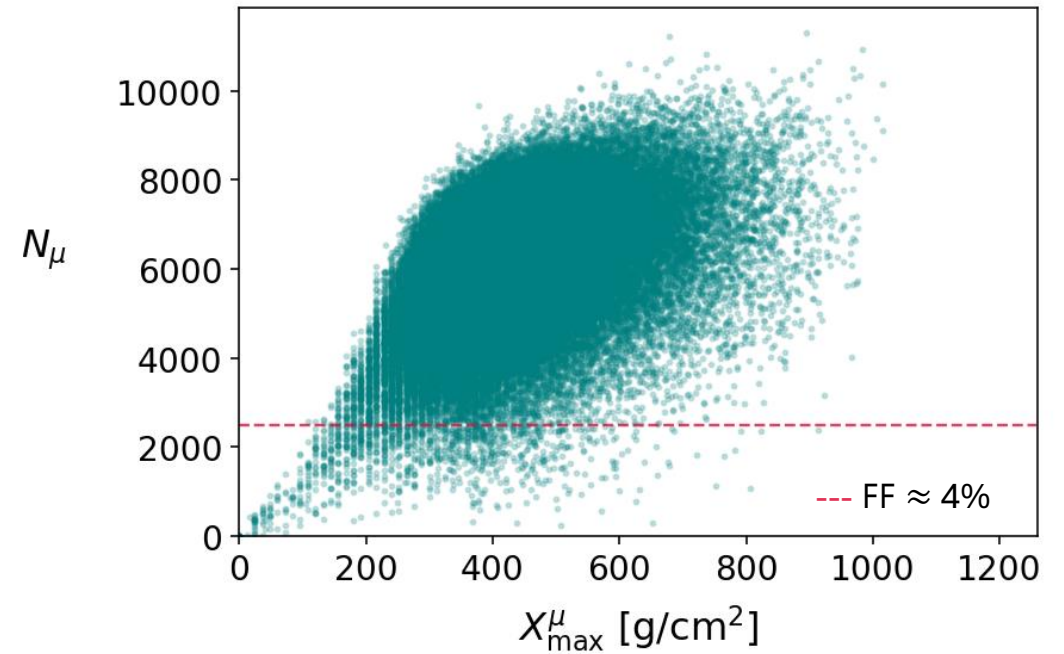
Objective: Research the Muon Production Depth of Extensive Air Shower with the Southern Wide-field Gamma-ray Observatory.



Results: $X_{\max}^{\mu}$ vs N_{μ}



S1: EPOS LHC-R model, $E = 10^{14}$ eV, $\theta = 20^\circ$.



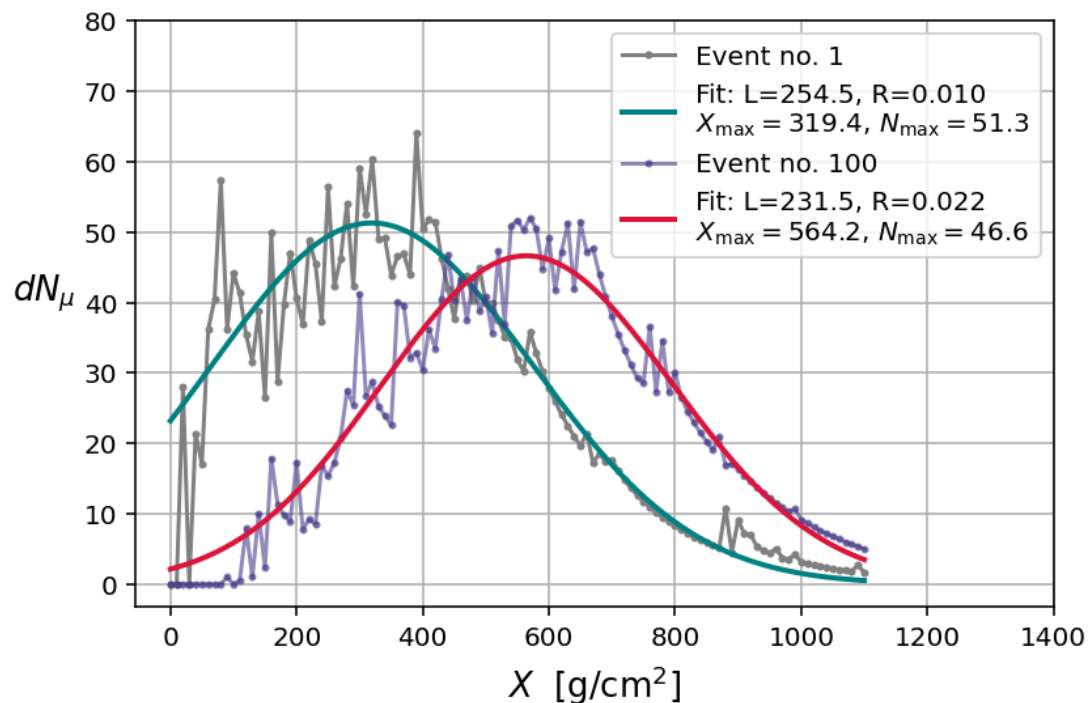
S2: EPOS LHC-R model, $E = 10^{15}$ eV, $\theta = 20^\circ$.

The image features a light blue background with decorative wavy lines in the corners. The top-left corner has several dashed orange lines. The bottom-right corner has a solid orange line and several dashed orange lines.

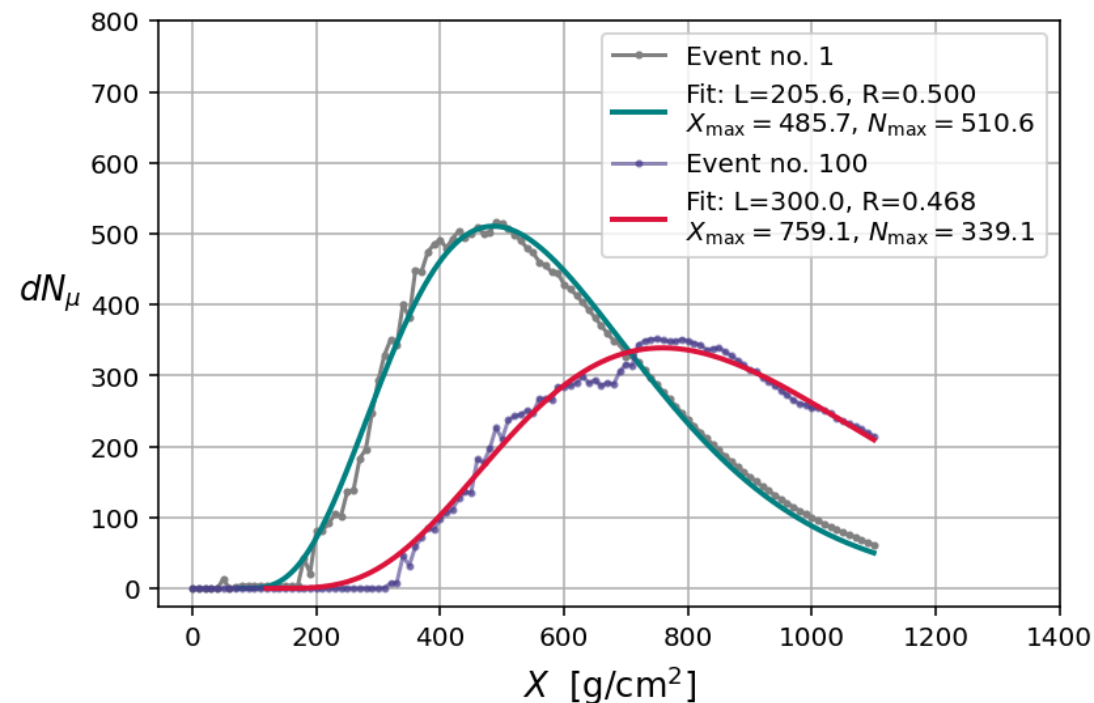
Questions?

Gaisser-Hillas fit

$$N(X) = N_{\max} \left(1 + \frac{R(X - X_{\max}^{\mu})}{L} \right)^{\frac{1}{R^2}} \exp \left(-\frac{X - X_{\max}^{\mu}}{LR} \right)$$

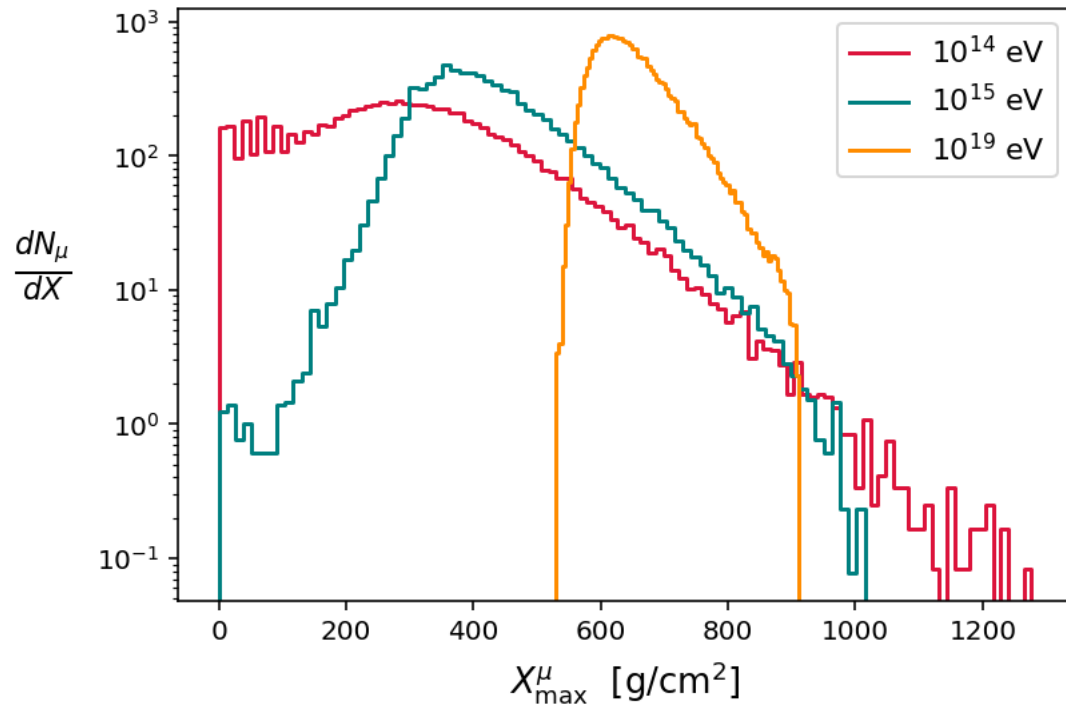


S1: EPOS LHC-R model, $E = 10^{14}$ eV, $\theta = 20^\circ$.

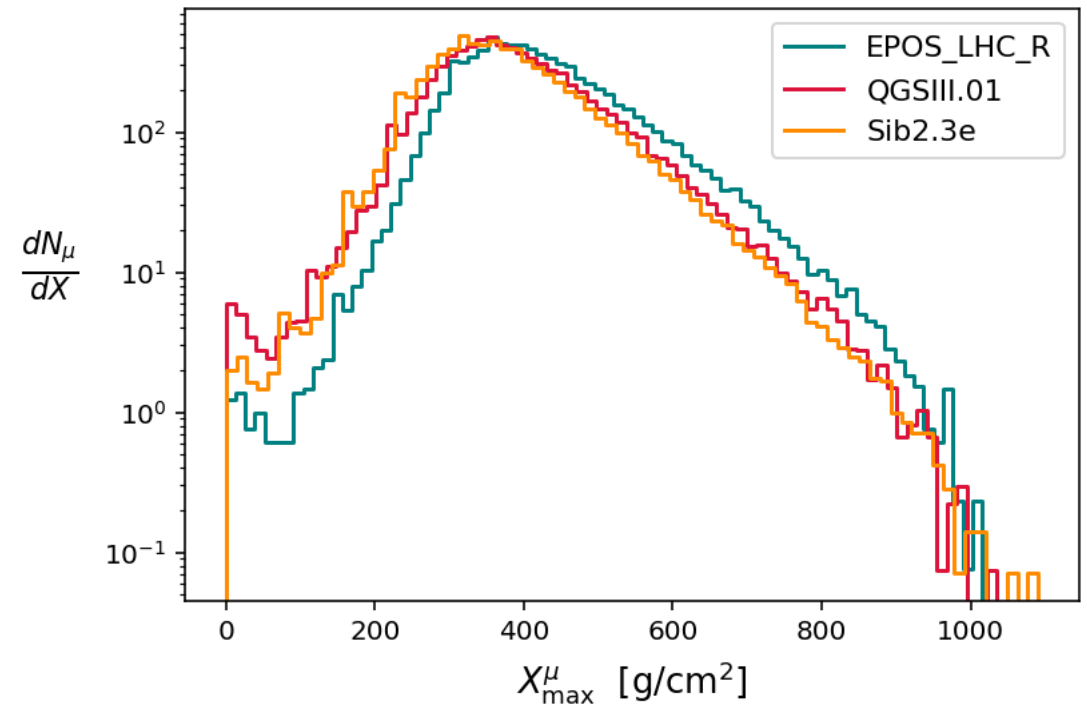


S2: EPOS LHC-R model, $E = 10^{15}$ eV, $\theta = 20^\circ$.

Results: $X_{\max}^{\mu}$ distributions



S1, S2 and S3: EPOS LHC-R model, $\theta = 20^{\circ}$.



S2, S6 and S9: $E = 10^{15}$ eV, $\theta = 20^{\circ}$.