Muons as a tool for background rejection in IACT arrays

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Motivation

Muons are long known to be useful for background rejection in gamma-ray astronomy [1], but this potential is yet to be fully exploited for IACT arrays.
They are produced in very large numbers in hadronic air-showers, but rarely in electromagnetic ones.

simulated muon images

Muons in showers

Simulated over 10^7 showers started by both protons and gamma-rays.

Muons are "**detectable**" if:

1. Bright enough to trigger
2. Inside the telescope field of view
3. Far enough from main shower for minimal overlap (i.e. muon signal is distinguishable)

Rejection power

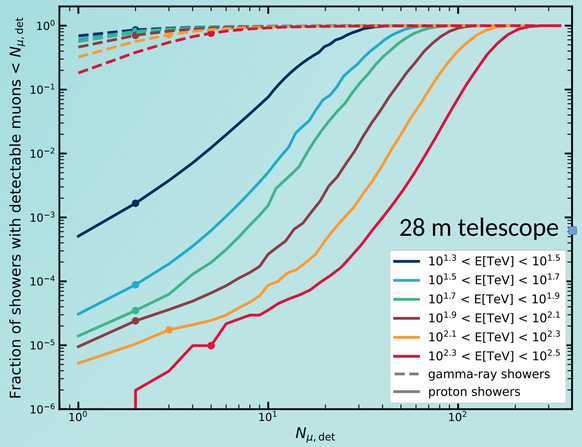

Figure 2: Cumulative distribution of the number of detectable muons by a 28m telescope in gamma-ray (dashed) and proton (solid) showers for several primary energies. A round dot marks the position of 70% gamma-ray efficiency.

Efficient muon identification can lead to a background rejection power of up to 10^{-5} above tens of TeVs

Simplified Muon Model

Analytical treatment of Cherenkov light production and telescope response

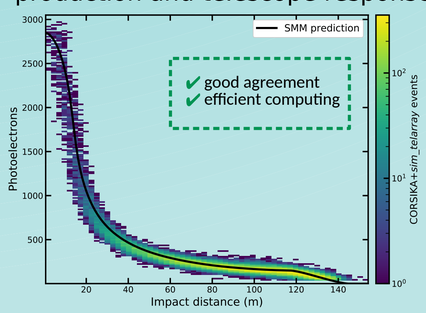

Figure 1: Number of photoelectrons collected by the telescope camera as a function of impact distance. The prediction of the SMM is compared to that of a full simulation [2]

Telescope size

Telescope mirror needs to be large to be able to detect sufficient muons

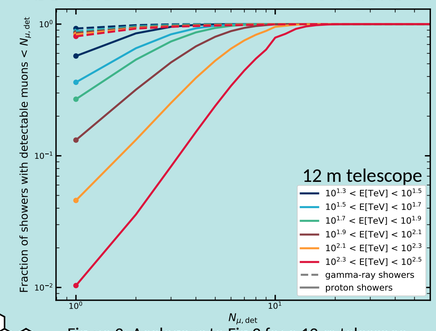

Figure 3: Analogous to Fig.2 for a 12 m telescope. The rejection capability is much worse due to the reduced light-collection area.

References

[1] T. K. Gaisser et al. Gamma-ray astronomy above 50 TeV with muon-poor showers, PRD, 43(2), 314 (1991)

[2] K. Bernlöhr. Simulation of imaging atmospheric Cherenkov telescopes with CORSIKA and simtelarray. Astropar. Phys., 30(3), 149 (2008).