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Muon number rescaling in simulations of air showers

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>What is contribution about ? We present a new method to derive muon rescaling factors R_μ, by analyzing reconstructions of simulated extensive air showers (EAS).

>What have we done? In order to take into account the muon discrepancy between data and MC, we can use simulation **for EPOS-LHC (iron) at 10^{19} eV as a MOCK-DATA set**, but p, He, N, Fe simulations with QGSJETII-04 as Monte Carlo (MC) signal.

The ground signal at 1000 m — Rescaling factor for electromagnetic part of EAS — Rescaling factor for muonic part of EAS

$$S_{1000}^{MOCK-DATA}(R_E, R_\mu)_{i,j} = R_E S_{EM,i,j}^{MC} + R_\mu R_E^\alpha S_{\mu,i,j}^{MC}$$

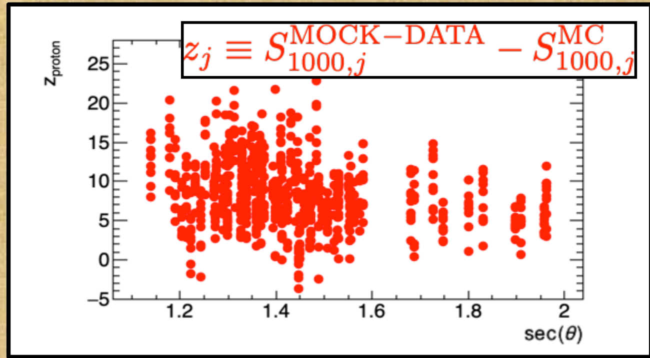
- The z-variable used is connected to the muon signal at 1000 meter, and is roughly independent of the zenith angle, but depends on the mass of primary cosmic ray. Assuming that rescaling factor for electromagnetic part of air shower is R_E=1, we obtain:

$$S_{\mu,i}^{MC} = \frac{z_i}{R_{\mu,i} - 1} \quad \text{for } R_E{=}1$$

- The performance of the z-method is tested by using Monte Carlo shower simulations for the hybrid detector of the Pierre Auger Observatory.

>Why is it relevant / interesting? Having an individual z-value from each simulated hybrid event, the corresponding signal at 1000 m, and using a parametrization of the muon fraction, g_μ in simulated showers, we can calculate the multiplicative rescaling\ parameters of the muon signals in the ground detector even for an individual event, and study its dependence as a function of zenith angle and the mass of primary cosmic ray. The method can reproduce an average muon signal calculated for iron with EPOS-LHC within 2 – 4%.

>What is the result? The method gives a possibility not only to test/calibrate the hadronic interaction models, but also to derive the beta exponent, describing increase of the number of muons as a function of primary energy and cosmic-ray mass.



$$R_{\mu,i,j}(\theta) = 1 + \frac{z_{i,j}(\sec(\theta))}{g_{\mu,i}(\theta) \times S_{1000,i,j}^{MC}(\sec(\theta))} \quad \text{for } R_E{=}1$$