CALCULATION OF ATMOSPHERIC MUONS FROM COSMIC GAMMA RAYS

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The production of muons in atmospheric showers initiated by gamma rays with energies below 10 TeV is calculated using the Monte Carlo code FLUKA. An overview is given of the capabilities of FLUKA for the simulation of high-energy gamma ray showers. This includes a discussion of the models which are important for muon production and transport as well as of various biasing techniques. These techniques are essential to obtain results with reasonable statistical significance. The reliability of the FLUKA predictions is demonstrated by comparisons to data on muon production induced by hadronic cosmic ray primaries.
Muon production in gamma ray initiated showers is studied by assuming mono-energetic gamma rays impinging vertically on top of the atmosphere. The full electromagnetic and hadronic shower is calculated from the top of the atmosphere down to sea level in a three-dimensional geometry. Various general properties of the muons reaching sea level and of their ancestors in the cascade are discussed. These properties include the dependence of the muon multiplicity at sea level on the energy of the primary gamma ray, the height of the muon production, the identity and generation number of the ancestors, as well as radial and energy distributions.