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Prospects of silicon photomultipliers for ground-based cosmic ray experiments

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An established technique to study ultra-high-energy cosmic rays is the detection of extensive air showers induced in the atmosphere of the earth. Thereby cascades of secondary particles are produced consisting of a hadronic, an electromagnetic and a muonic component. Especially the determination of the number of muons and the amount of fluorescence light produced during the shower development allows us to infer the mass composition and energy of the primary particle. Thus, these are important observables for air shower experiments like the Pierre Auger Observatory in Argentina.

The steady development of semiconductor devices the last years resulted in highly improved photon sensors, e.g. silicon photomultipliers (SiPMs). The small package and moderate bias voltage (< 100 Volts) of these silicon devices allows for compact and robust designs.
Detailed detector simulations, the development of dedicated front-end electronics as well as construction and investigation of detector prototypes are needed to study the applicability of SiPMs for cosmic ray experiments.

We present our findings for two different detector techniques: First, we present the fluorescence telescope prototype, FAMOUS. Its basic principle is based on a Fresnel lens focusing the incoming light onto a camera instrumented with 64 SiPMs. Secondly, scintillator detectors designed for an improved determination of the muonic component in air showers of current experiments and their benefit from the high photon detection efficiency of SiPMs are presented. An SiPM adaption is also studied in the scope of AugerPrime, the upgrade of the Pierre Auger Observatory.

Presentation type

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