

A lightning detection system for studying transient phenomena in cosmic ray observatories

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Transients of the atmospheric electric field could cause anomalous events in surface particle detectors of cosmic ray observatories. A better understanding of these phenomena requires accurate lightning data at the observation sites. We present the design and implementation of a monitoring system capable of detecting and storing lightning discharges. The station also records environmental data containing temperature, barometric pressure, relative humidity, and steady-state atmospheric electric field. The acquisition window per lightning event contains information of the first return stroke and the subsequent ones during 1.2 seconds at a sampling frequency of 100 kHz. The acquisition timing resolution (10 ns) allows a lightning strike location error < 10 m. A GPS receiver provides the absolute time of the station. 3-dimensional mapping of lightning discharge can be reconstructed in detail using a monitoring network of at least three stations.

We also present preliminary measurements during a thunderstorm episode (2019-11-09). The event lasts about 2 hours, recording a maximum electric field peak of ~ 15 kV/m. The atmospheric potential was ~ 27 MV with an estimated thunderstorm cloud-base height of ~ 2 km. At least four lightning events occurred during the thunderstorm period. Such discharges released an electric field > 5 kV/m.