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On noise treatment in radio measurements of cosmic ray air showers

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LOPES is an interferometric radio antenna array at the Karlsruhe Institute of Technology. It is triggered by KASCADE-Grande, and digitally measures the field strength of cosmic ray air shower induced radio pulses in the frequency range of 40-80 MHz. Due to the steep lateral distribution of the radio signal, its field strength often is - at least in some antennas - close to the noise level. Consequently, a correct treatment of the noise is of importance for the reconstruction of the lateral distribution, which is assumed to contain information about the primary energy and mass. Noise definitions applied so far, are originating from communication engineering. There, a signal usually has a power much larger than the noise, and lasts for a time significantly longer than its oscillation period, which is not true for air shower induced radio pulses. Hence, the noise has to be defined differently, and consistent with the definition of the radio pulse height (maximum of the field strength), e.g., to obtain a signal-to-noise ratio of 1 for vanishing pulse heights. Having such a consistent definition, the influence of noise has been studied with test pulses, allowing for a proper treatment of noise, even at low signal-to-noise ratios. Furthermore, the effect of noise on the slope of lateral distributions has been studied for LOPES events.

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