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Radiation Fields, Effects and Risks in Human Space Missions (5)

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FUZZY LOGIC TRIGGER IN THE DISTINCTION OF PIERRE AUGER OBSERVATORY'S SIGNALS FROM NEUTRINO-INDUCED SHOWERS - APPLICATION AND ANALYSIS IN THE STUDY OF ULTRA-HIGH-ENERGY COSMIC RAYS

Abstract

One of the most influential factors in space development is cosmic radiation and its detrimental effects on microelectronics and life outside of the protection of Earth's atmosphere. While most primary cosmic rays are ~ 300 MeV protons, the energies of the most energetic ultra-high-energy cosmic rays (UHECR) have been observed to approach $3 \cdot 10^{20}$ eV. The question of origin and precise composition of those is a subject of extensive studies, in which a crucial role is played by neutrinos due to lack of deviation by magnetic fields and thus the possibility of back-tracing to their original sources. This paper presents the application and analysis of fuzzy logic in the distinction of signal profiles originating from neutrino-induced showers from the photomultipliers of the water Cherenkov detectors of Pierre Auger Observatory. The patterns of ADC traces from surface detectors were simulated in CORSIKA and OffLine packages for various zenith angles, slant depth (the 1st point of interaction), energy and type of particles (protons and neutrinos), uploaded via In-System Memory Editor into FPGA ROM, processed and read from corresponding RAM, and finally analyzed offline and compared with MATLAB platform. Based on four estimators (Coefficients of Exponentially Attenuated Tails, Rising Speed, Area over Threshold and Shape) a fuzzy logic trigger has been verified, resulting in a promising preliminary analysis. The trigger also serves as additional saturation input for the transmission channel from the surface detector to the Central Data Acquisition System allowing for registration of a particular, possibly crucial, event - even if the trace is misrecognized it can be later easily rejected in offline analysis.