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Two-dimensional wavelet trigger in radio detection of cosmic rays

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The radio technique allows a detail study of the electromagnetic part of an air shower in the atmosphere and provide information complementary to that obtained by surface detectors water Cherenkov tanks, which are predominantly sensitive to the muonic content of an air shower at the ground.
A large-scale radio detector array needs a sophisticated self-trigger, due to the limited communication data rate. One of the promising attempts to observe ultra high-energy cosmic rays (UHECRs) by the detection of their coherent radio emission is a wavelet trigger based on a FPGA.
The main motivation of a development based on much more sophisticated algorithms is that the efficiency of the radio self-trigger is often very low. Most registered events contain only noise. A significant improvement of the trigger efficiency is the crucial factor. A lot of off-line data analysis requires a non-negligible amount of man-power. A much wiser approach would be to develop a much more efficient trigger. The developing wavelet trigger is an alternative proposal to the currently operating algorithms.

The paper presents first results from the two-dimensional wavelet trigger,
implemented to the new Front-End Board based on the Cyclone V FPGA 5CEFA9F31I7. The board contains 3 inputs for 3 PMTs from water Cherenkov surface detector + 2 inputs for radio detector with two polarizations. The wavelet trigger investigates a distribution of partial power contributions for two Fourier indices, simultaneously in time and frequency domains.

Radio signals were measured by the LPDA antenna in relatively contaminated environment in Lodz (Poland). We tested the wavelet trigger for radio signals: direct and cleaned by various filters.

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