

TAROGÉ experiment and reconstruction technique for near-horizon impulsive radio signals induced by Ultra-high energy cosmic rays

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Executive Summary

Taiwan Astroparticle Radiowave Observatory for Geo-synchrotron Emissions (TAROGÉ) is antenna arrays sitting on high coastal mountains of Taiwan, pointing to the Pacific Ocean for the detection of near-horizon extensive air showers (EAS) induced by ultra-high energy cosmic rays and Earth-skimming tau neutrinos. TAROGÉ would improve the detection capability by collecting both the direct emissions and the ocean-reflected signals on a vast area of ocean which is visible from Taiwan's high mountains. Four TAROGÉ stations in Taiwan have been deployed in the past few years. The latest deployed station TAROGÉ-4 has been equipped with a new trigger system by using Surface Acoustic Wave (SAW) filters based multi-bands coincidence technique. This new trigger system provides an effective discriminating power for impulsive geo-synchrotron signals against suburban anthropogenic backgrounds.

The major systematic error of event source direction reconstruction in TAROGÉ-4 comes from ground reflection effect. Conventional interferometric method based on waveform cross-correlation for near-horizon calibration events leads to a mis-reconstruction result, bias about 4° in elevation angle. The event source direction is extremely important for discriminating upward-going and downward-going signals. We've developed a new algorithm based on mapping and folding of differential ground reflection response between channels which can be feasibly and accurately measured through drone-borne calibration system. With this novel method, TAROGÉ-4 has achieved sub-degree angular resolution for near-horizon events.