TAROGE-M: Radio Observatory on Antarctic High Mountain for Detecting Near-Horizon Ultra-High Energy Air Showers

Shih-Hao Wang for the TAROGE and the ARIANNA collaborations

Executive Summary

The TAROGE-M observatory is an autonomous antenna array on the top of Mt. Melbourne (∼2700 m altitude) in Antarctica, designed to detect radio pulses from ultra-high energy (over 10^{17} eV) air showers coming from near-horizontal directions. The targeted sources include cosmic rays, Earth-skimming tau neutrinos, and most of all, the anomalous near-horizon upward-going events of yet unknown origin discovered by ANITA experiments. The detection concept follows that of ANITA: monitoring large area of ice from high-altitude and taking advantage of strong geomagnetic field and quiet radio background in Antarctica, whereas having significantly greater livetime and scalability.

The TAROGE-M station, upgraded from its prototype built in 2019, was deployed in January 2020, and consists of 6 log-periodic dipole antennas pointing horizontally with bandwidth of 180-450 MHz. The station had continuous operation since the deployment with the live time of $\sim$ 30 days, until it was interrupted by failure at cold start due to a malfunctioning power component. Galactic noise variation is observed in forced-trigger events and is used to calibrate the receiver response. The performance of event reconstruction at near-horizontal directions is calibrated with drone-borne transmitter, and the $\sim 0.3^{\circ}$ angular resolution is obtained . A preliminary cosmic-ray search was performed in 30-day data, and several cosmic-ray candidate events are found. According to the detection simulation, the energy threshold of the station is about 300 PeV. This means TAROGE-M station is able to detect ultr-high-energy air showers.