Research Report
ICRR Inter-University Research Program 2020

Research Subject:

Study of UHECR origin using the TAx4 Fluorescence Detectors

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Summary of Research Result :

To search for the origin of ultra-high energy cosmic rays, continuous operation of the Telescope Array experiment and TALE experiment, their data analyses and operation of the new extended array, TAx4, were performed.

After the successful commissioning of the new SD array and the new FD telescopes by the end of FY2019, FY2020 was a time to accumulate data. In early FY2020, however, activity was significantly suppressed due to the COVID-19 pandemic. Not only travel between US and Japan, also travel inside US was strongly restricted. In this situation we developed a new style of operation by introducing remote FD observations and remote SD monitoring with minimum in-person access to the site. In the late FY2020, the new style is established to keep a stable data taking. Highlight in the FD operation is an introduction of the hybrid trigger. Once an air shower event is triggered by an FD telescope and if it satisfies criteria, a trigger signal is sent to an SD control tower. If the SD tower identifies any waveform data of SDs in a predefined time window, the waveform is recorded regardless of the SD own trigger criteria. These data allow a precise geometry reconstruction in the FD data analysis even below the energy threshold of the SD own dataset. With an efficient collaborative works between US-Japan-Korea members, finally, hybrid trigger system was successfully installed. Though the CRAYS calibration could not be performed as scheduled due to the limitation of the expert travel in Japan, the experimental setup was rearranged for a smooth calibration when it will become possible.

New analysis results of TA and TALE are reported in the journals. Highlights are listed in the publication list below.

Publications:

1. R.U. Abbasi et al., “Evidence for a Supergalactic Structure of Magnetic Deflection Multiplets of Ultra-high-energy Cosmic Rays”, ApJ, 899:86 (2020).
2. R.U. Abbasi et al., “Search for Large-scale Anisotropy on Arrival Directions of Ultra-high-energy Cosmic Rays Observed with the Telescope Array Experiment”, ApJ Lett., 898:L28 (2020).
3. R.U. Abbasi et al., “Measurement of the proton-air cross section with Telescope Array’s Black Rock Mesa and Long Ridge fluorescence detectors, and surface array in hybrid mode”, Phys. Rev. D102, 062004 (2020).
4. R.U. Abbasi et al., “The Cosmic-Ray Composition between 2 PeV and 2 EeV Observed with the TALE Detector in Monocular Mode”, ApJ, 909:178 (2021).
5. R.U. Abbasi et al., “Search for Ultra-High-Energy Neutrinos with the Telescope Array Surface Detector”, JETP, 131, 255-264 (2020).
6. J.W. Belz et al., “Observations of the Origin of Downward Terrestrial Gamma-Ray Flashes”, JGR Atmosphere, 125, 1-26 (2020).

No.