平成 29 年度共同利用研究・研究成果報告書

FY2017 Joint Usage research・Research result report

研究課題名:Research subject

和文(in Japanese)：紫外線撮像望遠鏡による TA サイトでの空気シャワー蛍光光の観測

英文(in English)：Observation of airshower fluorescence light at the TA FD site by using an Imaging UV telescope

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研究成果概要:Research results summary

The JEM-EUSO collaboration aims to study Ultra-High Energy cosmic rays from space with the development of a large area telescope to be installed on board the International Space Station. It is carried forth by a collaboration of about 200 researchers from 13 countries. Several precursor instruments on ground, stratospheric balloons or space have been built or are under completion. The core of these activities is the EUSO-TA installation at the Telescope Array site in Utah. EUSO-TA is housed in a building in front of the TA fluorescence detector in Black rock mesa.

EUSO-TA detector consists of two, 1 square meter Fresnel lenses with 11 degrees of field of view and a focal surface of 36, 64-channel Multi-Anode photomultipliers, for a total of 2304 pixel. Data are sampled every 2.5 microseconds (thee speed is determined by the shower development in the atmosphere as seen from space at an altitude of 400 km) and stored locally.

At EUSO-TA, we also tested the gondola of the EUSO-SPB (Super Pressure Balloon) detector. EUSO-SPB is a NASA sponsored long-term duration balloon flight which was successfully launched from New Zealand in April 2017. Following the success of EUSO-SPB, a second super pressure balloon flight is currently under development (EUSO-SPB2) and the flight is planned by 2021 to sturdy both Ultra High energy cosmic rays and Cherenkov light emitted by tau neutrino induced showers.

Mini-EUSO, a standalone detector with 2304 pixel and a two Fresnel lens optics will be placed on board the ISS by beginning of 2018. K-EUSO, the first space-borne UHECR detector has begun phase A/B in Russia, with the construction of the prototypes of the optics and electronics under way.

The possibility of observing cosmic ray events triggered by TA or generated by TA Central Laser Facility (CLF) has been an invaluable help in characterizing and improving the performance of the electronics and optics of all the systems and calibrate the various telescopes.

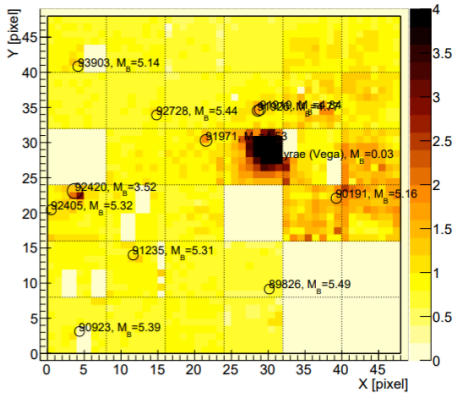

Figure 1: Sum of 1280 frames acquired with EUSO-TA with the position of the brightest stars superimposed, using the Hipparcos catalogue. Each star is labelled with the catalogue number or the star name in case of Vega, followed by the star's magnitude in the Johnson B filter for objects of MB ≤ 5.5. The colour scale denotes the brightness of each pixel in arbitrary units after flat fielding.

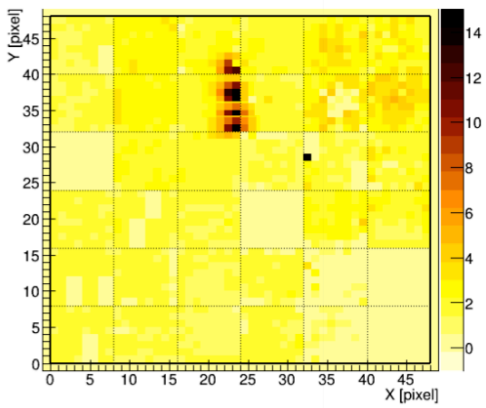

Figure 2: A meteor track detected by EUSO-TA. The picture shows the overlap of four averages of 1280 frames. The color scale denotes the uncalibrated detector counts. The apparent brightness of the meteor in collected data varied from MB = 2.4 to MB = 4.06.

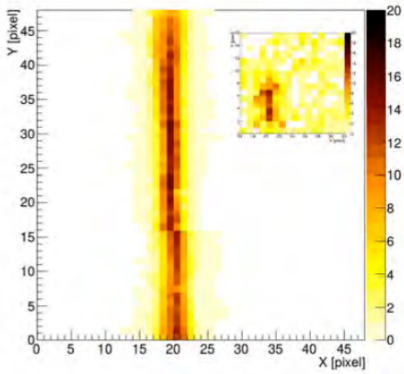

Figure 3: An average of 259 tracks of the CLF laser, for a telescope elevation angle of 10 deg. The panel shows a zoomed part of a single frame containing the laser. The colour scale denotes the uncalibrated detector counts.

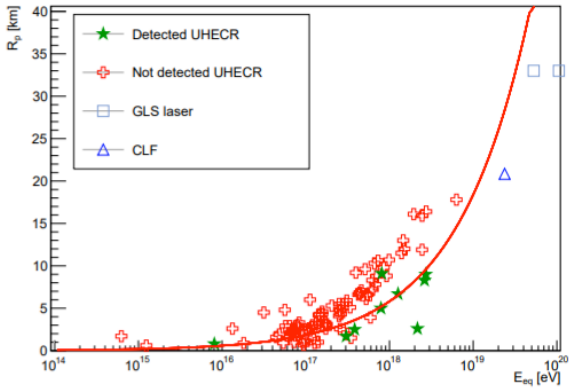

Figure 4: All UHECR detected by TAFD in the EUSO-TA field of view during its operation
with non-detected events and laser shots superimposed. The vertical axis shows the distance to the shower axis. The fit to the detected points, explained in the main text, suggests a conservative estimate of the EUSO-TA detection energy threshold.

In FY2017 the activities have focused on:

1. Analysis of the data gathered with the EUSO-TA telescope and the payload of the EUSO-SPB (Super Pressure Balloon) at the Telescope Array. This has included the calibration of the focal surface, the measurement with constant or slow moving signals such as stars, clouds and planes, the observation of meteors and UHECR events.

2. The upgrade work of the EUSO-TA focal surface module with a second-generation readout based on the one of Mini-EUSO. This readout will allow for a full focal surface trigger (both autonomous and triggered externally by Telescope Array) and readout of various classes of events, from the fast Ultra-high Energy Cosmic rays to slower atmospheric phenomena such as lighting to meteors and search for space debris. With this upgrade of the PDM readout, it will be possible to broaden the science objectives and greatly improve the duration of the operations, also thanks to a

remote-controlled acquisition system. Work is foreseen to be completed by FY2018

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