Research Report
ICRR Inter-University Research Program 2020

Research Subject:

Observation of airshower fluorescence light at the TA FD site by using an Imaging UV telescope

Principal Investigator 研究代表者: Marco Casolino, 理化学研究所

Participating Researchers:

参加研究者　　戎崎俊一 : 理化学研究所, Lech PIOTROWSKI: 理化学研究所

滝澤慶之: 理化学研究所, 榊直人: 理化学研究所, 梶野文義: 甲南大学

佐川宏行: 東京大学, 竹田成宏: 東京大学, 荻尾彰一: 大阪市立大学

Summary of Research Result :

Work in 2020 was focused on the upgrade of EUSO-TA telescope and measurements with the Mini-EUSO detector from the International Space Station (ISS). Due to Covid-19 situation it was not possible to perform the observation sessions in Telescope Array site as planned, so most of the activities involved work on the hardware of the focal surface and upgrade of the data acquisition and storage system.

Specifically, in 2020 the main activities were:

1. EUSO-TA. We continued the refurbishment of the focal surface with a new readout system based on that of the space-borne detector, Mini-EUSO. The refurbishment work started in 2017 and progressed in 2020 with acquisition and calibration tests in ICRR. The new readout allows for a trigger on the full focal surface (both autonomous and triggered externally by Telescope Array) capable of the readout of various classes of events, from the fast Ultra-High Energy Cosmic rays to slower atmospheric phenomena such as lighting, meteors, and search for space debris. With this improvement of the acquisition system, it will be possible to broaden the science objectives and greatly improve the duration of the operations, also thanks to a remote-controlled interface.

2. Mini-EUSO/UV-Atmosphere is a high-sensitivity, next generation Ultraviolet (UV) detector to study and map UV emissions from the Earth and its atmosphere. The telescope consists of two 25 cm Fresnel lenses, and a 2304-pixel focal surface detector similar to that used in EUSO-TA. Launch took place in August 2019 and observations begun in October 2019 from the UV transparent window of the Zvezda module of the

Russian section of the ISS. All systems are standalone, only power is provided by the ISS. Data are partially downlinked from station computers and sent to Earth with Solid State Disks by Soyuz capsule. The instrument is also devoted to the study and mapping of Earth and atmospheric emissions in the UV band. Complemented by visible and Near Infrared cameras, it observes the night-time-Earth in different lighting conditions, looking for transient (from microsecond to second) phenomena such as bioluminescence and man-made emissions as well as observe space debris, meteors and search for strange quark matter.

In addition to the upgrade of the EUSO-TA focal surface, we plan to bring a set of prototype Mini-EUSO lenses on TA site to study the performance of the system which is functionally identical to the one which is flying on board the ISS.

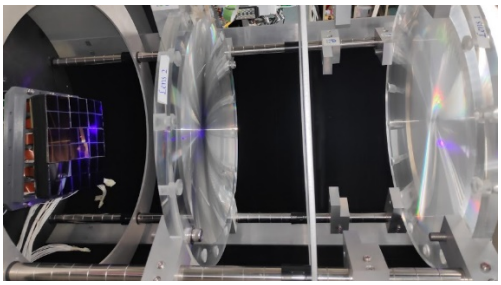

Figure 1: EUSO-TA refurbished focal surface. The Photo Detector Module (PDM) is composed by 36 Multi-Anode Photomultiplier Tubes, each with 64 independent channels (2304 total pixels) and arranged in groups of four (an Elementary Cell, EC). To the centre and right are two cEUSO lenses with the similar optical characteristics of Mini-EUSO. This optical system will also be tested in Telescope Array site.

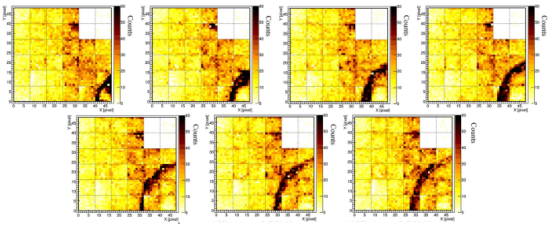

Figure 2: A sample of frames of an ELVE being observed in the focal surface. The top right EC unit of four MAPMT is temporarily working at a reduced voltage (about 1/100 sensitivity) due to a previous bright light that triggered the safety mechanism.

3. Analysis of existing data, gathered at the Telescope Array site, continued. This included measurements using the cosmic ray, Central Laser Facility and star luminosity. Data involved both the EUSO-TA detector and the payload of the first Super-Pressure Balloon flight which was tested in Telescope Array site in 2016.

Future work:

Work in 2021 will involve the observation campaign in Telescope Array, with the refurbished focal surface and the Mini-EUSO lenses. Also tests using the EUSO-SPB2 detectors (fluorescence and Cherenkov) are being planned to take place at the same time.

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