

The JEM-EUSO Experiment on board the International Space Station

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Abstract: JEM-EUSO is a Fresnel-optics refractive telescope devoted to the observation of Extreme Energy Cosmic Ray (EECR) showers in the Earth's atmosphere. The observation principle is the detection of fluorescence light emitted by particles showering in the atmosphere. This instrument will be placed on board the International Space Station (ISS) from the JEM exposed facility. Its goal is the study of the sources of EECR and the determination of the origin and nature of these particles with high precision, thanks to the increase in statistics due to the larger exposure.

Key words; cosmic rays, International space station.

The Extreme Universe Space Observatory on the Japanese Experiment Module (JEM-EUSO) of ISS is the first mission1 that will study from space Extreme-Energy Cosmic Rays (EECR). JEM-EUSO will observe Extensive Air Showers (EAS) produced by EECRs traversing the Earth's atmosphere from above. For each event, the detector will make accurate measurements of the energy, arrival direction and nature of the primary particle using a target volume far greater than what is achievable from ground. The corresponding increase in statistics will help to clarify the origin and sources of EECRs as well as the environment traversed during production and propagation. This will bring new light onto particle physics mechanisms operating at energies well beyond those achievable by man-made accelerators. The spectrum of scientific goals of the JEM-EUSO mission includes as exploratory objectives the detection of high-energy gamma rays and neutrinos, the study of cosmic magnetic fields, and tests of relativity and quantum gravity effects at extreme energies. JEM-EUSO (see Figure 1) is a 2 ton apparatus which will observe from space the Earth's night atmosphere. It will measure the UV (300-400 nm) fluorescence tracks and the Cherenkov reflected signal of the Extensive Air Shower induced by EECR interaction in the atmosphere. A system of Fresnel lenses will focus the UV-light from EAS on a focal surface composed of about 6,000 multianode photomultipliers for a total of 300,000 channels. The light is detected by the focal plane electronics which records the track of the EAS with a time resolution of 2.5 micro-seconds and a spatial resolution of about 0.75 km (corresponding to 0.1°). These time-segmented images allow to determine the energies and directions of the primary particles. A multi-layer parallel architecture has been devised to handle the data flow and select valid triggers, reducing it to a rate compatible with downlink constraints. Each processing level filters the event with increasingly complex algorithms using ASICs, FPGAs and DSPs in this order to reject spurious triggers and reduce the data rate.

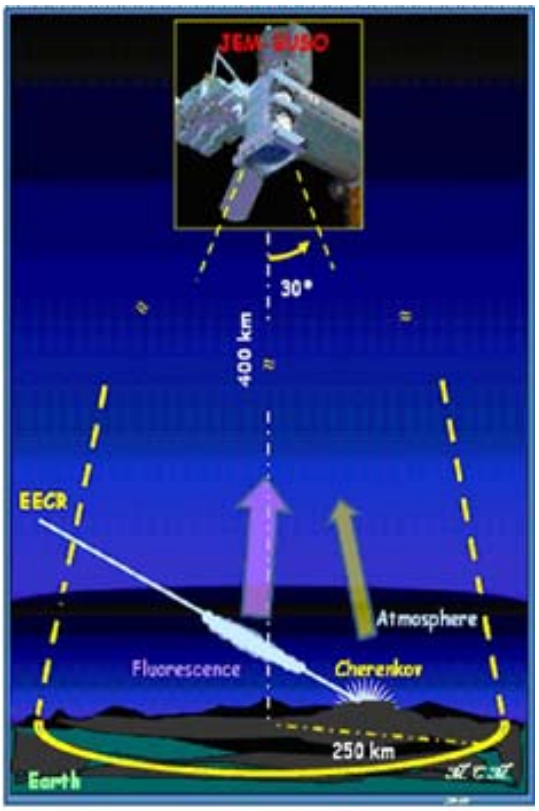

Figure 1 Principle of observation of JEM-EUSO on board the ISS

Reference

1) Y. Takahashi et al, The JEM-EUSO mission, New Journal of Physics, 11, 065, 009, 2009.