Usage Report for Fiscal Year 2015

Project Title:

Study on the performances of the JEM-EUSO mission

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The JEM-EUSO collaboration is committed to the development of space based Ultra High Energy Cosmic Ray observatories. In this framework we are developing mission concepts like JEM-EUSO, K-EUSO, the EUSO-Balloon, mini-EUSO and TA-EUSO. This project sees the collaboration of more than 300 scientists from 16 countries. The Computational Astrophysics Laboratory led by Toshikazu Ebisuzaki and Marco Casolino plays a key role in this effort. The group leads, in fact, the development of detectors like K-EUSO, TA-EUSO and mini-EUSO, supervises the production of the Fresnel lenses of the telescopes and of the photodetectors.

Ultra High Energy Cosmic Rays (UHECR) are high energy particles (above 10^{19} eV) propagating in space. Both the sources and the mechanisms responsible for the production of such enormous energies are presently unknown.

The space detection of cosmic rays, the ultimate goal of the JEM-EUSO collaboration, offers the possibility to increase the observational exposure of such extremely rare particles of at least one order of magnitude compared to ground arrays. Above such energies just one particle per km^2 per century can in fact be detected and therefore only a detector from 400 km altitude and with a large field of view can achieve a sufficient exposure.

In such conditions space detectors can in fact monitor surfaces of the order of 10^5 km^2.

Due to the high risk related to the space busyness massive simulation studies must be performed prior to the mission launch. Moreover the data processing framework has to be established in order to analyze the scientific output of the mission.

In particular, we are involved in the development of the simulation framework for the JEM-EUSO mission - ESAF (Euso Simulation & Analysis Framework). The ESAF software takes care of the simulation of the Cosmic Ray events, the propagation of light to the instrument and the simulation of the instrument itself. Moreover it performs the data analysis on the detector response in order to recognize the signal on the focal surface, determine arrival direction, energy and type of incoming particle.

The signal can be imagined as a spot moving on the focal surface. By means of fits on the position and timing of the signal the direction can be inferred. Thanks to the luminosity as function of time the energy of the primary can be also calculated. Another observable we are going to retrieve is the depth of the maximum of the shower. Thanks to this parameter we can give a rough estimation of the average mass of the particle population.

In the past year I could however not simulate on the Hokusai cluster since I had to develop the algorithms for the future work. I was therefore only working on my local machine at my institution without running any mass simulation in RIKEN.

I hope in the coming year to be able to perform simulations as in the previous years.

The publication shown here has been published in 2015 but has been prepared and accepted in 2014. This publication has been described in detail in the 2014 report.

The ICRC proceeding shown here is also resulting from the work done in 2014 although it was written in 2015.

In both cases RICC and RIKEN appear in the acknowledgements and in the affiliation list.

Fiscal Year 2015 List of Publications Resulting from the Use of the supercomputer

[Publication]

F. Fenu et al. “Performances of JEM–EUSO: energy and X max reconstruction” Exp Astron (2015) 40:183–214

[Proceedings, etc.]

F. Fenu et al. “The JEM–EUSO energy and X max reconstruction performances”, Proceedings of the 34th International Cosmic Ray Conference, (2015) The Hague