

Project Title:

Study on the performances of the JEM-EUSO mission

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The JEM-EUSO mission is a space based Ultra High Energy Cosmic Ray observatory planned to fly on the International Space Station in FY 2016. This project sees the collaboration of more than 250 scientists from 13 countries. The Computational Astrophysics Laboratory led by Toshikazu Ebisuzaki and Marco Casolino plays a key role in developing the instrument and planning the mission.

Ultra High Energy Cosmic Rays (UHECR) are extremely high energy ($1e20eV$) particles propagating in space. Both the sources and mechanisms responsible for the production of such enormous energies are presently unknown. Moreover the extremely high energies offer the unique opportunity to test the interaction of matter at energies many millions of times higher than reachable by any human made accelerator.

In order to solve the longstanding UHECR origin problem and starting the study of physics at such high energy we are in the process of constructing a UV telescope in order to detect the light emitted by the cascades of secondary particles generated by UHECR as they interact with Earth's atmosphere. This telescope will be placed on the International Space Station (ISS) and monitor atmosphere from above.

Due the very high risk related with the space mission 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 (The 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.

During the past year I was mainly concentrating on the production of the results for my PhD thesis.

For this purpose I concluded the study on the trigger performances of the instrument. In this context I was simulating the JEM-EUSO detector in order to assess the background rate map on the instrument, the ability of the instrument to reject background, the ability of the detector to accept real events and the number of triggered events.

Moreover I was performing studies on different mission configurations. In fact, the instrument can be tilted to achieve larger exposure but at price of a lower efficiency. The determination of the most appropriate tilting angle must be done following deep simulation studies.

I was assessing the impact of different primary particle on the trigger performances by simulating Protons and Iron particles.

The size of the triggered event was also estimated and confronted with the trigger budgets. In order to do that the average number of triggering focal surface modules had to be estimated for different conditions. Moreover the estimation of the fraction of the focal surface with signal, the duration of the signal, the distribution of the signal on the focal surface had to be studied. In order to do this extensive calculations have been performed. All the mentioned results have been added to my PhD thesis but not published yet.

In the present moment I am preparing the second part of my thesis which includes results on the reconstruction algorithms. More in detail after the trigger signal has been issued the response of the detector is expected to be sent to ground. Such a response will be interpreted in order to reconstruct the basic parameters of the cascades.

In the course of my PhD work I developed algorithms for the energy and particle type reconstruction. At the moment I am performing simulations for the estimation of the systematics on the procedure. Once this step will be completed I will proceed with the simulation and reconstruction of a realistic sample of events in order to estimate the JEM-EUSO energy resolution and particle type reconstruction capabilities.

The reconstructed spectrum will be then assessed together with the non reconstructable fraction of events.

The capability of separating different primaries will be also estimated.

All the results will be included in my thesis and will therefore be published within a couple of months.

Further publications will follow after the completion of my thesis.