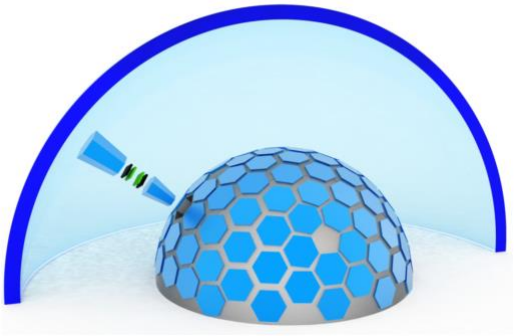
The Crystal Eye X and gamma ray detector for space missions

Executive summary

F. Barbato; A. Abba, A. Anastasio, G. Barbarino, A. Boiano, R. de Asmundis, I. De Mitri, L. Ferrentino, F. Garufi, F. Guarino, R. Guida, S. Papa, F. Renno and A. Vanzanella

With the observation of the gravitational wave event of August 17th 2017 and then with those of the extragalactic neutrino of September 22nd, the multi messenger astronomy era has definitely begun. With the opening of this new panorama, it is necessary to have a perfect coordination of the several observatories. Crystal Eye is an experiment aimed at the exploration of the electromagnetic counterpart of the gravitational wave events, that represent the missing observational link between short gamma-ray bursts and gravitational waves from neutron star mergers. The experiment we propose is a wide field of view observatory. The Crystal Eye objectives will be: to alert the community about events containing soft X-ray and low energy gamma-ray, to monitor long-term variabilities of X-ray sources, to stimulate multi-wavelength observations of variable objects, and to observe di use cosmic soft X-ray emissions.
The Crystal Eye (See FIG.1), will be a modern version of the Fermi-GBM detector, designed for a mission on the International Space Station (ISS) and thanks to its compactness can be usable as an optical module to be mounted on other satellites. With this device, we aim to improve the localization capability of the GRBs.



The Crystal Eye pixel will be made by hexagonal trunks of pyramid of LYSO crystals. Each pixel is composed by two parts, a UP pixel and a DOWN pixel, designed to be one the continuum of the other. Between the two pyramids an additional layer is interleaved. This is dedicated to the housing of SiPMs and their front end electronics.
A Crystal Eye pathfinder has been designed and realized to be tested in view of the mission on the Space Rider by ESA. The prototype is made by 4 pixels. The mission is aimed at testing in the space environment the LYSO crystals, the MPPC-arrays and the DAQ board.
Moreover we will have the chance to characterize the background at the Space Rider orbit. For this prototype LYSO crystals from different brands and with different treatement of the surfaces were used.
A custom electronics has been developed, based on citiroc1A by WEEROC chip and Zynq7020 by Xilinx. The prototype underwent to preliminary test to check the electronics correct operation.
These first test gave important information about the LYSO activity and response and so a very important hint on the best treatment for the surfaces.
In few months the prototype will start the space qualification tests.