Perspectives for Italy - Brazil collaborations on space projects for high energy astrophysics

Since the entrance of Brazil in ICRANet a variety of projects have been started to be developed in the theoretical field of Relativistic Astrophysics (see Volumes 2 and 3 of the present Scientific Report) , in possible future joint space missions and in the development of a Brazilian Science Data Center (see Volume 1 of the present Scientific Report).

The first study of a possible joint space mission in the field of X ray Astronomy has origin with the MIRAX (Monitor e Imageador de Raios X) mission with PI João Braga, from INPE and member of the ICRANet Scientific Committee.

The original goal of the MIRAX mission has been to launch aboard the Brazilian satellite LATTES, scheduled in 2016, a payload devoted to monitor spectral and time variability of the X-ray sky using imaging telescopes in the energy band from 10 to 200 keV. Mirax will be hosted on the Lattes satellite together with EQUARS a Brazilian mission devoted to the observation of the Earth.

Since 2010 an Italian Consortium made of research groups operating at INAF institutes (IASF Bologna and Rome) and at the University of Ferrara, Physics Department, have proposed a payload configuration devoted to a deep broad band (1 keV- 10 MeV) study of Gamma Ray Bursts . In addition an all-sky monitoring in the 1-50 keV energy band has been planned.

The reference scientist for this proposal are Lorenzo Amati (IASF Bologna and adjunct professor of ICRANet), Marco Feroci (IASF Rome), and Filippo Frontera (University of Ferrara and adjunct professor of ICRANet). In Enclosure 1, a summary of the scientific goals is given.

A large number of leading Italian scientists, involved in GRB studies have approved the payload proposed and expressed strong interest to the feasible science. In addition to the Astrophysical community there is also a great interest of the Italian communities devoted to the study of Earth resources to the mission EQUARS.

With the advent of the IRAP PhD program and the ERASMUS Mundus Program a large number of Ph.D. Students are also participating to these research activities performing their thesis on topics related to the technological developments of new detectors and more

generally on theoretical research of Gamma Ray Bursts relevant to the MIRAX mission (see Enclosure 2).

In 2010 a proposal was presented to the Italian Space Agency (ASI) for getting financial support for this collaboration. ASI did not take any decision and requested a scientific evaluation of proposal to the Italian National Institute for Astronomy (INAF), that has delivered a positive evaluation. See also the letter of the ICRANet Director on this matter to the President of ASI (see Enclosure 3).

In the meantime, a collaboration on MIRAX has been requested by its PI to a collaboration of USA Institutes, led by Jonathan Grindlay from Harvard University, CFA, in Cambridge. This collaboration has submitted in February 2011 a proposal for a mission opportunity to NASA, that has not been approved in September 2011. In spite of that, the collaboration with Harvard on MIRAX continues on a different basis, with the goal of developing aboard LATTES a MIRAX payload devoted to a systematic Galactic plane monitoring in the hard X-ray band (10-200 keV), with a possible extension to lower energies.

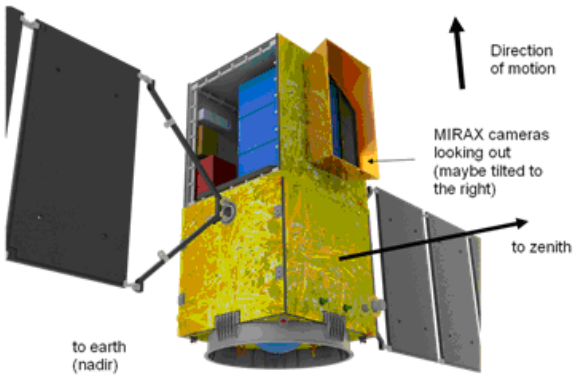
In view of this general situation, still pending any decision from ASI, in view also of a possible new official proposal by the Brazilian Space Agency AEB, it is considered high priority to keep all activities open between Italy and Brazil in Space Research. An highly desirable collaboration may well lead to collaboration in the strategic field of Gamma Ray Bursts between Italy and Brazil also in addition to the one offered by the MIRAX mission, exploiting future opportunities.

Special attention is devoted to possible collaboration also in the Space infrastructure between Italy and Brazil: a collaboration in the small launcher with the actual interest of Brazil to develop a Brazilian Launch vehicle for small satellites missions and the Italian lead VEGA launch vehicle. In addition there is a clear interest from Brazil in utilizing the Luigi Broglio base at the San Marco Platform of the ASI in Kenia.

It is appropriate to summarize he Italian payload proposed for MIRAX.

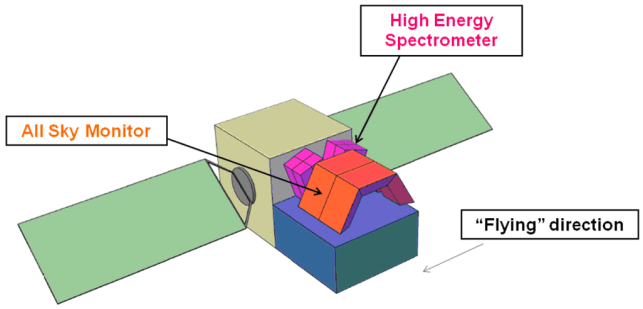
The Italian payload we propose for MIRAX (for details see Enc. 1) is composed of two independent instruments, aimed at two main observational objectives: a) detection, localization and wide-band (about 1 keV – 10 MeV) spectral and timing measurements of Gamma Ray Bursts (GRBs); b) All Sky Monitoring, i.e., long-term monitoring of celestial sources and discovery of new ones. Particular care will be devoted to the monitoring of the Galactic plane. The instrumentation is then be composed of a thee pairs of coded-mask X-

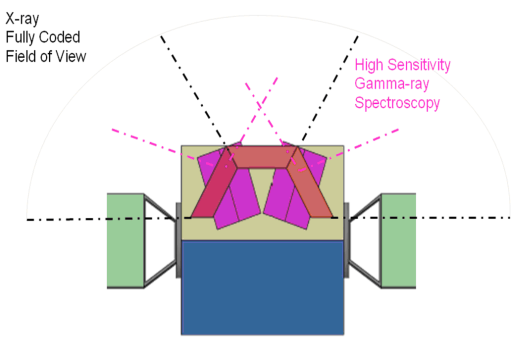
ray imagers (X-Ray Monitor, XRM) and two modules of 4 scintillator spectrometer units (Soft Gamma-ray Spectrometer, SGS).



The instrumental approach to achieve the science goals is to use separate detectors for the low and high part of the energy band. The low energy (about 1 - 50 keV) is best covered with Silicon detectors, whereas the high energy portion of the spectrum (15-10000 keV) is covered with inorganic scintillators in phoswich (= PHOSsphor sandWICH) configuration. Given that the LATTES satellite hosts along with MIRAX the payload EQUARS devoted to the observation of the Earth, it will move like the International Space Station, with the MIRAX zenith continuously drifting and covering 360 deg in each orbit. This zenith-drift properties allows to observe almost the entire sky in an orbit if the field of view of the MIRAX telescopes is as large as possible in the direction orthogonal to the direction of motion of the spacecraft, while in the other direction it can be smaller, being covered through the satellite motion. We have achieved this goal by adopting the configuration illustrated in in the Figure below.

The XRM consists of a 3 pairs of Silicon Drift detectors (initially developed for the ALICE experiment for the CERN/LHC accelerator) surmounted by mono-dimensional coded masks . The SGS consists of two modules of 4 phoswich units each. The detector units are made of NaI(Tl) and CsI(Na) scintillators viewed from a single photomultiplier (PMT). The photon energy lost in each scintillator can be established from the pulse shape analysis of the signals provided by the PMT. The same technique was successfully developed for the PDS instrument aboard BeppoSAX, one of the most sensitive instruments launched thus far. The phoswich configuration is the best technique to derive unbiased spectra in the hard X-/gamma-ray energy band.





Enclosure 1