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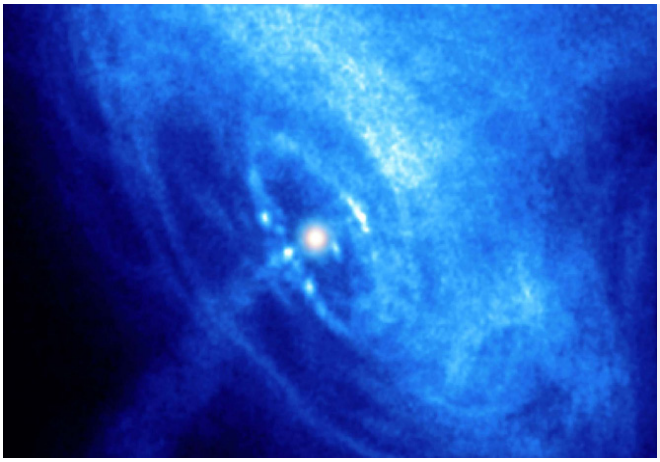

THE CRAB PULSAR X-RAY: POLARLIGHT CONFIRMS THE SUCCESS OF THE ALL-ITALIAN TECHNOLOGY

Super efficient X-ray detectors deriving from Italian technology are studying the Crab Pulsar from a nano satellite in Earth orbit: it is the Chinese space mission PolarLight, which published its first results on May 12 on Nature Astronomy. The PolarLight collaboration, which also involves researchers from the INFN and the National Institute for Astrophysics INAF, appears to have recorded a decrease in the degree of polarization in the radiation emitted by the Crab Pulsar during a glitch, a rapid acceleration of the neutron star's rotation, due to a sudden rearrangement of its nucleus. This variation could be linked to a readjustment of the pulsar's magnetosphere and the consequent variation over time of the polarization angle of the high energy radiation emitted.

However, in addition to the scientific result, PolarLight confirms the success of the technology used, and this is crucial in view of the future IXPE mission. The PolarLight mission, which is the result of a collaboration between Italy and China, was born, in fact, as a technological demonstrator, i.e. with the aim of testing the new observation technique, developed in 20 years by the INFN Pisa Division and INAF-IAPS of Rome, and based on the Gas Pixel Detectors (GPD). This is the same technology as the detectors on IXPE (Imaging X-ray Polarimetry Explore), the NASA satellite that will be launched in 2021, in collaboration with the Italian Space Agency ASI, in which INFN and INAF take part.

PolarLight is a payload the size of a 10 cm cube, installed in a Cubesat consisting of 6 units and launched in a low heliosynchronous orbit on October 28, 2018. In addition to the detector, this cube houses the reading electronics, developed by INFN, which manage both the detector, by acquiring its data and transferring it to memory, and the high voltage lines.

More specifically, PolarLight flies with an electronic reading chip that is the technological heart of the detector, developed entirely in INFN laboratories, which functions as a sort of "camera" for traces of low-

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energy electrons. The main challenge in its realisation consisted in being able to achieve the granularity necessary to reconstruct the morphology of these microscopic traces and track their direction, which is the direct link with the polarization of the incident radiation that needs to be measured. The difficulty lays in putting together a series of conflicting and difficult to reconcile requirements: a very finely segmented pixel device (a 50 micron step), but at the same time a large area to work on the focus of an X-ray optic, that could be read quickly, equipped with very low noise electronics, and low consumption in order to operate in space. It also required reading electronics that would be able to guide and extract the signal for a subsequent analysis, which from a technical point of view is far from being a negligible task. One of the peculiar characteristics of the chip is the ability to automatically select the region inside which an electron has left its mark: returning to the parallel with the photographic camera, it would be like having an intelligent CCD (Charged Coupled Device) that selects the object you are interested in a photo by itself. This allows to significantly reduce the reading time. This chip is the result of a process that lasted for years which, through the design and construction of three generations of chips (gradually larger and more performing), led to the current version, which has flown on PolarLight and which allowed us to plan the future IXPE polarimetry mission.

The technological success of the PolarLight mission, therefore, marks the culmination of a long R&D program, brought forward thanks to the fundamental contribution of Rolando Bellazzini, who allowed to bring a new all-Italian technology into space for the first time, and provides confirmation of the potential of the future IXPE mission, which will use the exact same chip. ■