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Nuclear Astrophysics at ELI-NP: the ELISSA prototype tested

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The Extreme Light Infrastructure-Nuclear Physics (ELI-NP) facility, under construction in Magurele near Bucharest in Romania, will provide high-intensity and high-resolution gamma ray beams that can be used to address hotly debated problems in nuclear astrophysics, such as the accurate measurements of the cross sections of the 24Mg(
,)20Ne reaction, that is funda-
mental to determine the effective rate of 28Si destruction right before the core collapse and the subsequent supernova explosion [1], and other photo-dissociation processes relevant to stellar evolution and nucleosynthesis [2].
For this purpose, a silicon strip detector array (named ELISSA, acronym for Extreme Light Infrastructure Silicon Strip Array) will be realized in a common effort by ELI-NP and INFN-LNS (Catania, Italy), in order to measure excitation functions and angular distributions over a wide energy and angular range. According to our simulations, the final design of ELISSA will be a very compact barrel configuration, leaving open the possibility in the future to pair a neutron detector with the array. The kinematical identification will allow to separate the reaction of interest from others thanks to the good expected angular and energy resolutions.
A prototype of ELISSA was built and tested at Laboratori Nazionali del Sud (INFN-LNS) in Catania with the support of ELI-NP. In this occasion, we have carried out experiments with alpha sources and with a 11 MeV 7Li beam. We used X3 and QQQ3 silicon-strip position sensitive detectors manufactured by Micron Semiconductor ltd. Thanks to our approach, the first results of those tests show up a very good energy resolution (better than 1%) and very good position resolution, of the order of 1 mm. At very low energies, below 1 MeV, a worse position resolution is found, of the order of 5 mm, but still good enough for the measurement of angular distribution and the kinematical identification of the reactions induced on the target by gamma beams. Moreover, a threshold of 150 keV can be easily achieved with no cooling. We will discuss technical details of the detector and present results regarding Monte Carlo simulation, energy resolution and detection thresholds of ELISSA, the physical cases to be investigated.
To sum up, these tests allow us to say that the X3 detectors, as well the standard QQQ3 detectors, are perfectly suited for nuclear astrophysics studies with ELISSA. In particular, ELISSA will allow us to determine a much more accurate cross section for the 24Mg photodissociation to be used in nuclear reaction network calculations to improve the knowledge of the pre-supernova chemical composition.

Primary author: GUARDO, Giovanni Luca (LNS)

Presenter: GUARDO, Giovanni Luca (LNS)

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