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Spectrometry of cosmic-rays neutrons with HENSA++: project status and future developments

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Neutrons are produced continuously as a secondary radiation from cosmic-rays interactions in the upper atmosphere of our planet. The characterization of such secondary neutrons is connected with different fields such as environmental radioactivity [1], single event upsets (SEUs) in microelectronics [2], the physics of cosmic-rays and space weather [3].
In this work, the High Efficiency Neutron Spectrometry Array (HENSA++) is presented [4]. HENSA++ is intended for high efficiency measurements of cosmic-ray neutrons and the neutron background in underground facilities [5]. The operation of HENSA++ is based on the principle of the Bonner Spheres Spectrometer (BSS) [6]. The use of large 3He tubes has enabled to improve the detection efficiency between 5 up to 10 times over the standard BSS [6]. The current version of HENSA++ is composed by an array of fifteen He-3 tubes, each one embedded in different materials including high density polyethylene neutron moderators, cadmium neutron shieldings and lead neutron converters. This setup allows for spectral sensitivity from thermal up to GeV's neutrons. For cosmic-ray neutrons, the high detection efficiency of HENSA++ provides near real-time measurements of the neutron spectrum on a time scale of tens of minutes up to few hours, thus enabling possible applications in space weather as a neutron monitor with spectral sensitivity. Moreover, in 2020, the older version of HENSA++, HENSA, has been used to map the cosmic-ray neutron background along the Spanish territory in quiet solar conditions during the beginning of the solar cycle #25. In the present work, the status of the design methodology for HENSA++ and the challenges for the reconstruction of wide energy range spectra (thermal up to 1 GeV) from BSS measurements are discussed. Preliminary results from the 2020 cosmic-ray neutrons measurement campaign with HENSA and some test measurements with HENSA++ are also presented.

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