Contribution ID : **546** Type : **not specified**

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

Monday, 21 March 2022 18:15 (15)

Abstract

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-rays neutrons and the neutron background in underground facilities [5]. The operation of HENSA is based on the same principle that the Bonner Spheres Spectrometers (BSS) [6]. A topological modification of the detector geometry 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 ten He-3 tubes, each one embedded in different materials including high density polythylene moderators, cadmium shieldings and lead neutron converters. This setup allows for spectral sensitivity from thermal up to GeV's neutrons. For cosmic-rays 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 HENSA has been used to map the cosmic-rays neutron background along the spanish territory in quiet solar conditions during the beginning of the solar cycle #25. Currently, a new version of HENSA, called HENSA++, is being developed for space weather applications. In HENSA++, the total number of detectors is increased up to 15 in order to improve the spectral resolution at intermediate (1 eV – 100 keV) and high (20 – 300 MeV) energies, respectively. 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-rays neutrons campaign with HENSA are also presented.

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Session Classification : Red FNUC (Red Temática de Física Nuclear)

Track Classification : Red Temática de Física Nuclear (FNUC)