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Measurement and simulation of the muon-induced neutron yield in lead

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Rare signal searches, such as those performed for direct dark matter detection and neutrinoless double beta decay experiments, are typically carried out in deep underground laboratories, with the consequence that the rock over-burden of such facilities dramatically reduces many of the background signals that would be present if the experiments were conducted in surface laboratories. As improved sensitivity is achieved, the need to characterise and mitigate remaining backgrounds becomes ever more important. One of the most problematic backgrounds that still remains is that of cosmic-ray muon-induced neutrons with the potential of becoming a limiting factor for next generation rare event searches.

A measurement will be presented of the neutron production rate in lead by high-energy cosmic-ray muons of mean energy of 260 GeV at a depth of 2850 m water equivalent. The measurement exploits the delayed coincidences between muons and the radiative capture of induced neutrons in a highly segmented tonne-scale plastic scintillator detector. Detailed Monte Carlo simulations reproduce well the measured capture times and multiplicities and, within the dynamic range of the instrumentation, the spectrum of energy deposits. By comparing measurements with simulations of neutron capture rates a neutron yield in lead has been obtained.

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