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Calibration of the DANSS detector with stopped atmospheric muons and their decays

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The Detector of the AntiNeutrino based on Solid Scintillator (DANSS) is placed near the reactor core of the Kalinin NPP (10.9-12.9 m) and acquires a very high statistics of antineutrino events. DANSS is placed on a mobile platform which allows measuring the far/near ratio using the same detector. One of the main goals of the experiment is to scrutinize the sterile neutrino hypothesis. A large fraction of the allowed parameter space was excluded by DANSS: for some values of Δm^2 the exclusion goes up to $\sin^2(2\theta) < 0.01$, which had become the best in the world. Such an experiment requires precise energy measurements which makes energy calibration very important. A comparison of the calibration results for different positions of the detector is important for understanding the relative efficiency — an important source of systematic uncertainty in the sterile neutrino studies.

The report covers calibration with atmospheric muons stopped inside the sensitive volume of the detector including their decays in the Top and Bottom positions. The high granularity of the DANSS detector allows a high precision reconstruction of muon tracks. Stopped muons allow exploration of a wide range of energies. Such muons were selected by applying geometrical constraints and searching for a subsequent electron or positron. The spectrum of the selected Michel electron/positrons is used for determining the energy scale coefficient. Energy losses of muons stopped in the sensitive volume of the detector grow rapidly near the stop point. The Bragg's curve built using the muon energy release along its track is sensitive not only to the energy scale but also to nonlinear effects: the Birks coefficient, and the Cherenkov radiation intensity. Calibration via the Bragg's peak and Michele electrons complements the results of calibration via radioactive sources and ^{12}B beta decays. A comparison of calibration at different positions advances the understanding of the DANSS performance. Obtained results reveal time stability which reflects good understanding of energy scale behaviour during the experiment.

Neutrino Properties

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Neutrino Telescopes & Multi-messenger

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Neutrino Theory & Cosmology

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Data Science and Detector R&D

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