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Optimization of the multilayer detector SND (Scattering Neutrino Detector) for neutrino physics and physics beyond the Standard Model

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\geometry{a4paper, margin=1in}
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\section*{Optimization of the multilayer detector SND (Scattering Neutrino Detector) for neutrino physics and physics beyond the Standard Model}

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The \textbf{SHiP} (Search for Hidden Particles) experiment at the SPS at CERN is aimed at searching for particles beyond the Standard Model. \textbf{SHiP} is a fixed target experiment with a 400 GeV proton beam energy.

For neutrino physics tasks and the search for light dark matter particles in \textbf{SHiP}, it is planned to use the neutrino detector \textbf{SND} (Scattering and Neutrino Detector), consisting of a sequence of layers of magnetized iron (1.7 T) as an absorber, a \textbf{SciFi} tracker in the form of scintillating fibers with a diameter of 250 μm, and layers of scintillator (\textbf{Sci}) with a thickness of 1.5 cm and granularity of 1 cm $\times$ 1 cm, which will register energy deposition.

To reconstruct the interaction pattern in the neutrino detector of all flavors or hidden particles, it is necessary to determine the momentum and energies of all particles produced in deep inelastic neutrino scattering and in the decay of short-lived particles—tau leptons or charm mesons, and the interaction vertex in the detector material.

Simulation of neutrino interaction with iron was carried out based on the \textbf{GENIE} v3 neutrino event generator. The response in the tracker and scintillators was modeled using the \textbf{GEANT4} software package. It is assumed that the momentum of the particle will be determined by the curvature parameter of its trajectory in the magnetic field. The average momentum determination error for muons was about 12\%, while the accuracy of neutrino interaction vertex reconstruction based on tracker data was $\sim$1.5 cm. For the considered detector configuration, the energy resolution was $\sim 50\%/\sqrt{E}$ for pions with energies from 1 to 100 GeV. Signal image parameters in the scintillation matrix were used to determine interaction properties.

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Section

Neutrino physics and nuclear astrophysics

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