

Searching for ν_τ disappearance in the SHiP experiment

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We study the expected sensitivity to the mixing between sterile and tau neutrinos directly from the tau neutrino disappearance in the high-energy fixed target experiment. Here, the beam energy is large enough to produce tau neutrinos at the target with large luminosity. During their propagation to the detector, the tau neutrino may oscillate into sterile neutrino. By examining the energy spectrum of the observed tau neutrino events, we can probe the mixing between sterile and tau neutrinos directly. In this paper, we consider Scattering and Neutrino Detector (SND) at SHiP experiment as a showcase, which uses 400 GeV protons from SPS at CERN, and expect to observe 6,300 tau and anti-tau neutrinos from the 2×10^{20} POT for 5 years operation. Assuming the uncertainty of 10%, we find the sensitivity $|U_{\tau 4}|^2 \sim 0.08$, (90% CL) for $\Delta m_{41}^2 \sim 500 \text{ eV}^2$ with 10% signal-to-background ratio. We also consider a far SND at the end of the SHiP Hidden Sector Decay Spectrometer (HSDS), in which case the sensitivity would be enhanced to $|U_{\tau 4}|^2 \sim 0.02$. Away from this mass, the sensitivity becomes lower than $|U_{\tau 4}|^2 \sim 0.15$ for Δm_{41}^2 less than 100 eV^2 or Δm_{41}^2 greater than 10^4 eV^2 .

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