

Production of ν_τ neutrinos and $\bar{\nu}_\tau$ antineutrinos - elaborate calculation for a fixed target experiment SHiP

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We discuss how to calculate cross sections as well as rapidity, transverse momentum and energy distributions of ν_τ and $\bar{\nu}_\tau$ produced from the direct $D_s^\pm \rightarrow \nu_\tau/\bar{\nu}_\tau$ and chain $D_s^\pm \rightarrow \tau^\pm/\tau^\mp \rightarrow \nu_\tau/\bar{\nu}_\tau$ decays in $p+^{96}\text{Mo}$ scattering with proton beam $E_{\text{lab}} = 400 \text{ GeV}$ at $\sqrt{s_{NN}} = 27.4 \text{ GeV}$. Both direct neutrinos and neutrinos from τ lepton decays (chain decays) are included. The τ decays are simulated with the help of the `\textsc{Tauola}` code and include large number of decay channels. In our calculations we include D_s^\pm from charm fragmentation ($c \rightarrow D_s^+$ and $\bar{c} \rightarrow D_s^-$) as well as those from subleading fragmentation of strange quarks/antiquarks $s \rightarrow D_s^-$ and $\bar{s} \rightarrow D_s^+$. The $s \neq \bar{s}$ asymmetry of the strange quark content of proton is included. The different contributions to D_s^\pm and $\nu_\tau/\bar{\nu}_\tau$ are shown explicitly. We discuss and quantify a not discussed so far effect of asymmetries for production of ν_τ and $\bar{\nu}_\tau$ caused by (helicity) polarization of τ^\pm from the first (weak) decay $D_s^\pm \rightarrow \tau^\pm$. We try to estimate also effect of the production asymmetry caused by subleading fragmentation mechanism and discuss related uncertainties. A potential measurement of the asymmetry is discussed. Estimates of a number of observed $\nu_\tau/\bar{\nu}_\tau$ in the $\nu_\tau/\bar{\nu}_\tau + ^{208}\text{Pb}$ reaction, with 2m long target are given with the help of the NuWro program. We refer also to the production of the high-energy (anti)neutrinos in the atmosphere.

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