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Optical Photon Transport in Plastic Scintillator

We have constructed a GEANT4-based detailed model of photon transport in plastic scintillator blocks and wavelength-shifting fibers and have used it to study the performance and light collection of several scintillator-based detectors. The central feature of the model is accounting for the spectral properties of all materials such as reflectivity, refractive index, absorption lengths, and photodetector quantum efficiency. It also accounts for wavelength-shifting absorption and emission from the wavelength shifter as well as its fluorescent quantum yield. We have validated the model by comparing simulations and measurements for the double beta decay experiment NEMO-3, the neutrino oscillation experiments MINOS, NOνA, and MINERvA as well as several benchtop measurements. The simulations accurately reproduce measurements of the scintillator uniformity and light collection. In this poster, we discuss details of the model and the comparison of measurements and simulations. We show that the agreement is improved if wavelength-dependent properties of the calorimeter are taken into account and use the model to optimize the light collection for the SuperNEMO calorimeter as well as for the future neutrino oscillation experiment TASD.

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