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Modeling the X-ARAPUCA's thin-film dichroic filters using physics informed neural networks

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The X-ARAPUCA is the latest iteration of a family of devices capable of detecting single photons from liquid argon scintillation, serving as the building blocks of DUNE's Photo Detection System. Along with the instrumentation for the device, a full physics simulation called ArapucaSim was created that can replicate the observed efficiencies of real devices. This makes it a useful tool for looking for alternatives to both materials and geometries. A bottleneck that results from the simulation of the dichroic filters, which are in charge of trapping the photons inside the X-ARAPUCA's, plagues the simulation's efficiency. Here, we present an alternative model that shifts the computational load to a previous stage, namely the training of a physics informed neural network (PINN). During the ArapucaSim runtime, the PINN's receives the photon's wavelength and incidence angle as input and returns the probabilities of either transmitting, absorbing, or reflecting the photon. This calculation is faster than using a transfer matrix model and at least as fast as interpolating a fine-grained table with the filter's characteristics. The training uses both sources of information, the transfer matrix and measured characteristics, to generate a final algorithm that is less computation intensive during runtime and requires less data to be trained than the interpolation option.

Poster prize

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