The Domestic Nuclear Detection Office under the Department of Homeland Security continues to fund research for replacement radiation portal monitors (RPMs). A replacement technology being considered is layered thin polymeric scintillating films. It is thought the amount of lithium-6 needed for the films will dominate the cost of such a replacement detector, thus it is desired to minimize the amount of lithium-6 needed in the detector while still meeting the detection criteria set forth by Pacific Northwest National Lab and DHS. Proper placement of the neutron absorbing layers can greatly reduce the number of layers needed. For examples, it is necessary to build up the thermal flux with moderation in order to effectively utilizing the large thermal cross section of lithium-6, making a strictly alternating layered design inefficient. Genetic Algorithms, a search heuristic mimicking evolution, were applied to a discretized binary representation of the problem using the PyEvolve toolkit. Populations were evaluated with Monte Carlo simulations ((MCNPX) for the expected performance, with crossover and mutations as the genetic operators. Fitness proportional and tournament selection were used to select individuals for subsequent generations. After the populations converged, it was found that a significant reduction in the number of layers is possible.

The optimal design is the to have four 100 micron PEN films spaced inside the 12.7 cm of the RPM8, with a 1.96 cm moderator and 5.39 cm reflector.

The optimal designs consist of 1.96 cm of high density polyethylene (HDPE) moderator, a 100 micron film mounted on 0.49 cm of poly methyl methylate (PMMA), a 0.49 cm HDPE spacer, another 100 micron film mounted on 0.49 cm of PMMA, 1.47 cm of HDPE, a third 100 micron film mounted on 0.49 cm of PMMA, another 1.47 cm of HDPE, a fourth and final film (mounted on 0.49 cm of PMMA), and a 5.39 cm reflector.

This design has an interaction rate of 4.20 interactions per second per ng calforium-252, with an interaction rate of 0.251 interactions per gram lithium-6.