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Pareto Optimal Solutions for a Neutron Radiography Collimator

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Neutron radiography is a non-destructive technique extensively used in the investigation of materials. The integrity of the investigation depends in part on the quality of the radiographic image produced by a neutron radiography system. A neutron collimator is one of the components that contribute to the quality of radiograph. Optimization of a neutron collimator entails finding the balance between two conflicting objectives, namely the size of homogeneous (flat flux) region and the intensity of the neutron beam flux. The diameter and the position of the collimator aperture are among the parameters that determine the homogeneity and the intensity of the neutron beam flux. It is desirable to find the best parameters for a neutron collimator design. A collimator optimizer based on ray tracing and multi-objective particle swarm optimization techniques was designed, implemented and tested to provide design parameters in the form of Pareto optimal solutions. The desired optimal solutions for the aperture diameter and position can be chosen from the set of Pareto optimal front graphs, to suite the conditions of a particular neutron radiography system. The test results showed that the Pareto optimal front graph has a linear form, and all Pareto optimal solutions were found to be at the closest position from the neutron source.

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