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Optical simulations of the DarkSide-20k Outer Veto

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The DarkSide-20k (DS-20k) experiment seeks to directly detect dark matter in the form of weakly interacting massive particles (WIMPs). DS-20k is a two-phase liquid argon (LAr) Time Projection Chamber (TPC) with an active volume of 50 tonnes, which is built in the Outer Veto. The Outer Veto is approximately 650 tonnes of atmospheric argon (AAr) in a membrane cryostat, designed to veto cosmogenic neutron backgrounds in the TPC. The Outer Veto will tag cosmogenic neutron backgrounds based on the signal that muons or their associated showers may make in it.

The optical properties of the Outer Veto define its ultimate efficiency for tagging cosmogenic signals. To understand the response of the Outer Veto to muons and optimize its performance, the effects of various design considerations on the light yield and uniformity of the outer veto are explored.

Optical simulations were performed with a geant4-based framework.

The modeling was carried out for different options for the number of photosensors and their position. Cosmic muons were used in the simulation. Different options for the location of the flanges were considered. The light yield was calculated for each configuration.

As a result of studying the optical characteristics of the Outer Veto, it was found that light yield varies depending on several design parameters, including the number and location of photosensors and the choice of reflector.

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