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Impact of Light Concentrators on Antineutrino Detection in WATCHMAN

There is great interest within the nonproliferation community to establish remote monitoring of nuclear reactors at distances greater than several tens of kilometers. Large-scale neutrino detectors could be designed for exactly this purpose. The WATER Cherenkov Monitor for Anti-Neutrinos (WATCHMAN) is proposed as the first such detector for the new Advanced Instrumentation Testbed (AIT) at Boulby Underground Laboratory, UK. Here we study the development of light concentrators instrumented around photomultiplier tubes in WATCHMAN. The theory of non-imaging optics as applied to light concentration was used to establish the ideal curvature for such a detector, which approaches the thermodynamic limit of light collection. Monte Carlo simulations for a range of light concentrator shapes, sizes, and materials were performed to determine the optimized concentrator design for a realistic reactor monitoring scenario. The details of these light collection studies and the overall impact on reactor antineutrino detection sensitivity are discussed.

Mini-abstract

Light collection studies of concentrators on PMTs with applications in nuclear nonproliferation.

Experiment/Collaboration

WATCHMAN-AIT

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