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The WATCHMAN Demonstration: Remote Reactor Monitoring Using a Gadolinium-Doped Water Cherenkov Detector

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The emission of antineutrinos from fission products in nuclear reactors offers a path to discover, monitor, or exclude the existence of reactors at distances of tens to hundreds of kilometers. The WATCHMAN (WATer Cherenkov Monitor of AntiNeutrinos) experiment is a proposed kiloton volume gadolinium-doped water Cherenkov detector designed to demonstrate this capability. Antineutrinos are detected in WATCHMAN through the delayed coincidence signal produced by an inverse beta decay event. The gadolinium acts as a neutron capture agent, boosting the delayed signal energy from a 2.2 MeV gamma (released following deuteron formation) to an average of 8 MeV released following a neutron capture on gadolinium. The boost in the delayed signal energy considerably reduces otherwise overwhelming background rates; depending on the chosen construction site, WATCHMAN will observe a few antineutrino events per day, with similar background event rates. The primary goal of the WATCHMAN experiment is to demonstrate the tracking of a nuclear reactor's operation at a 10-25 km standoff. Successful deployment would also pave the path towards operating 100 kiloton –1 megaton volume gadolinium-doped water antineutrino detectors, a necessary step for ˜100 km distance monitoring.

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