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Study of a Muon Veto Cherenkov Detector for the XENON1T Experiment

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XENON is a dark matter direct detection experiment, consisting of a time-projection chamber (TPC) using xenon in double phase as sensitive detector medium. The XENON project is currently taking dark matter data at the Gran Sasso Underground Laboratory (Italy) with the XENON100 experiment (100 kg scale mass of target volume) devoted to explore the spin-indipendent elastic WIMP-nucleon scattering cross section at the sensitivity in the order of ~10^{-45} cm^2. In parallel to the operation of XENON100 an intensive R&D program for the next generation experiment (of ton scale mass) of the XENON project, XENON1T, is currently taking place. XENON1T will have a goal to reduce the background by two orders of magnitude compared to XENON100, pointing to a sensitivity in the order of 10^{-47} cm^2. In order to achieve this background level the employment of a passive shield is not sufficient and it must be complemented with an active system able to veto the underground residual muon flux. In this study we optimized this device consisting of a Cherenkov detector based on a water tank (~10m high and ~10m in diameter) equipped with photomultipliers (PMTs) of 8 inch diameter. The study has been carried out with a series of Monte Carlo simulations, based on the toolkit GEANT4, that showed the possibility to reach very high detection efficiencies in tagging the passage of both the muon and the shower secondary particles coming from the interaction of the muon in the rock.

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