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Hardware upgrades to the DEAP-3600 dark matter detector to enhance WIMP sensitivity

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This talk describes hardware upgrades for the DEAP-3600 dark matter direct detection experiments, which uses over 3 tonnes of liquid argon (LAr) as a scintillation target and is located 2 km underground at SNOLAB in Sudbury, Canada. These upgrades aim to maximize the detector's sensitivity to WIMP dark matter by removing the dominant sources of background. Operations with the upgraded detector are expected to begin in 2025. The experiment holds the most stringent exclusion limit in argon for WIMP masses above 20 GeV/c^2, thanks to an extraordinary discrimination power between electronic and nuclear recoil pulses.
Sensitivity was limited by backgrounds induced by alpha activity. Over the years, the collaboration developed a thorough understanding of the backgrounds in DEAP-3600, in particular two leading alpha-particle backgrounds. The first category of events originates from the lower part of the detector neck, a shadowed region of the detector where only a fraction of scintillation light from LAr enters the central volume. An innovative pyrene-doped polystyrene wavelength-shifting coating was applied to the neck, allowing the tag of alpha neck events with a distinctly slow re-emission time constant compared to the TPB used elsewhere. The second category of events comes from degraded alphas from particulates in the LAr. A particulate filtration system and an upgrade of the LAr process systems allow for removal of any such particulates in the new LAr fill. These hardware upgrades will allow DEAP-3600 to significantly reduce the observed background, reach the designed WIMP sensitivity and test the feasibility of large-scale single-phase LAr detectors to achieve background-free conditions.

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