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Update on 3Dpi: PET Scanner with Xenon-doped Liquid Argon and SiPM

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The 3Dpi scanner is a Total-Body, Time of Flight, Positron Emission Tomography (PET) imaging device with silicon photomultiplier (SiPM) and a xenon-doped Liquid Argon (LAr) scintillator with the aim of ultra-low-dose imaging for pediatric and pregnant patients. The scanner has an axial field-of-view of 200 cm and consists of nine double-sided concentric rings of SiPM panels. The xenon doping to the LAr scintillator has a few advantages: 1) fast scintillation, 2) suppression of the long tail of the LAr scintillation light, and 3) wavelength shifting to xenon scintillation. These advantages, in turn, improve the time resolution and detection efficiency of positron-electron annihilation signals. Moreover, lowering the operating temperature of the SiPMs to the LAr temperature significantly reduces the dark count rate of SiPMs.

The 3Dpi scanner project is a medical imaging application of the ongoing research and development efforts of the DarkSide collaboration, which is focused on dark matter direct detection experiments using LAr targets. The 3Dpi Monte Carlo simulation package has been derived from the DarkSide simulation package based on the Geant4 toolkit.

I will present the results that we recently published on the performance of the 3Dpi scanner using established NEMA NU 2–2018 standards for spatial resolution, sensitivity, image quality, count rate performance, and timing resolution. I will also discuss the future plan of the 3Dpi project.

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