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3DΠ, A Total-Body Positron Emission Tomography scanner, using Xenon-doped Liquid Argon detector

A good alternative to pure liquid argon (LAr) in scintillation detectors is Xenon-doped liquid argon. By doping the LAr with xenon, the long-lifetime component of the LAr scintillation light can be suppressed, allowing for the scanner to handle higher data rates, and hence higher patient doses, if required for a given application. Also, the most modern photosensors to date have very low efficiency for detecting light at LAr wavelength (128 nm). The photon detection efficiency (PDE) is well above 40% at 420 nm [1], above 20% at 172 nm [2] and above 12% at 128 nm [3]. Initial studies have shown that as the xenon concentration is increased the light yield that was measured by the photosensors used in these studies increased and the energy resolution improved as the concentration of xenon was increased, an expected result due to the fact that a fraction of the scintillation light is now emitted at the 172 nm wavelength of xenon scintillation, which is more efficiently converted to visible light by the TetraPhenylButadiene (TPB) as a wavelength shifter [4,5]. 3DΠ is a novel design of Time Of Flight Positron Emission Tomography, TOF-PET, with LAr and silicon photomultiplier (SiPM) as the scintillator - photosensor system. This project is an application in medical physics of the DarkSide collaboration [6,7], whose main aim is the direct detection of dark matter particles via LArliquid Argon targets. The preliminary results of the Monte Carlo simulation, demonstrate that scanner system performance, according to NEMA NU 2-2018 standardized guide, is comparable to that of commercial scanners.
Keywords: Noble liquid detectors, Scintillators, Argon, Xenon, TOF-PET
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Auteur principal: ZABIHI, Azam (Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences, ASTROCENT, Warsaw, Poland)

Co-auteurs: Dr WADA, masayuki (Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences, ASTROCENT, Warsaw, Poland); Dr LI, Xinran (Lawrence Berkeley National Laboratory, Berkeley, CA 94720, Stati Uniti); Dr LAI, Michela (University of Cagliari, Department of Physics, Cagliari, Italy); Prof. RENSHAW, Andrew (University of Houston, Department of Physics, Hoston, United States of America); M. RAMIREZ, Alejandro (University of Houston, Department of Physics, Hoston, United States of America); Dr GABRIELE , Federico (INFN Cagliari Division, INFN, Cagliari, Italy); Prof. GALBIATI, Cristian (Gran Sasso Science Institute, L'Aquila 67100, Italy-Princeton University, Department of Physics, Princeton, United States of America); Dr FRANCO, Davide (APC, University of Paris, CNRS, Astroparticle and Cosmology, Paris F- 75013, France)

Orateur: ZABIHI, Azam (Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences, ASTROCENT, Warsaw, Poland)

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