ID de Contribution: **13** Type: **Non spécifié**

3DΠ: A Novel Total-Body PET Scanner Using Xenon-Doped Liquid Argon Scintillator for Outstanding Detection Sensitivity

jeudi 8 juin 2023 10:20 (15 minutes)

The 3DΠ project is an application in medical physics of the ongoing R&D from the DarkSide collaboration, which is aimed at the direct detection of dark matter particles via Liquid Argon (LAr) targets. The collaboration has demonstrated the power of LAr detector technology and has made significant strides in low-radioactivity argon procurement and cryogenic photosensor development and fabrication, which have been applied in the development of the 3DΠ scanner.

The 3DΠ project is a novel design of a Total-Body (TB), Time Of Flight (TOF), Positron Emission Tomography (PET) scanner that uses a scintillator system of Xenon-doped Liquid Argon (LAr+Xe) and silicon photomultiplier (SiPM) panels. The Xenon doping of the LAr scintillator suppresses the long-lifetime component of the LAr scintillation light, allowing for higher data rate and hence higher patient doses if required for a given application. As the de-excitation process in the mixture allows for direct energy transfer from argon excimers to xenon and direct emission of xenon light, it is expected to be faster compared to fluorescence processes of a wavelength shifter (WLS). Furthermore, studies have demonstrated that lowering the operating temperature of SiPMs to match the temperature of LAr substantially decreases the dark count rate within the SiPM.

Based on current simulations, the 3DΠ scanner will have an axial length of 2 m, an inner radius of 45 cm, and an outer radius of 64 cm. The outer and inner surfaces, as well as the end-caps, are 4 mm sheets of titanium, which form the cryostat and enclose 9 concentric, annular layers of PTFE, each containing two arrays of SiPMs.

The initial findings from the NEMA tests indicate that the spatial resolution of the 3Dπ detector is on par with that of commercial detectors. The TOF resolution was measured as 160 ps. Additionally, the sensitivity of the detector is measured at 564.02 kcps/MBq at the center and 501.13 kcps/MBq at a 10 cm offset. The noise-equivalent count rate (NECR) reaches up to 1.5 Mcps at an activity concentration of 5.3 kBq/mL and increases to 3 Mcps at 21.2 kBq/mL. These preliminary results suggest that our scanner's system performance is comparable to, if not superior to, other commercial scanners.

Overall, the 3DΠ project shows promise in developing a cost-effective and competitive PET scanner that can potentially reduce PET scanning time or patient dose due to its outstanding detection sensitivity.

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

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

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

Classification de Session: Medical Imaging, Chair Nicolas Beaupère