**Design a Total-Body Time-Of-Flight Positron Emission Tomography (TB-TOF-PET) Scanner Using Monte Carlo Method and Using Xenon-doped Liquid Argon detector**

A.Zabihi[1]*, M.Wada[1], X.Li[2], A.Renshaw[3], A.Ramirez[3], M.Lai[4], F.Gabriele[5], C.Galbiati[6,7], D.Franco[8]

[1]Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences, ASTROCENT, Warsaw, Poland
[2]Lawrence Berkeley National Laboratory, Berkeley, United States of America
[3]Department of Physics, University of Houston, Houston, United States of America
[4]Department of Physics, University of Cagliari, Cagliari, Italy
[5]INFN Cagliari Division, INFN, Cagliari, Italy
[6]Gran Sasso Science Institute,L'Aquila 67100, Italy
[7]Department of Physics, Princeton University Princeton, United States of America
[8]APC, University of Paris, CNRS, Astroparticle and Cosmology, Paris, France

**Background:** PET is a powerful medical imaging method for cancer screening. The ongoing R&D of the scanner is based on a GEANT4 simulation, which allows for optimization of the system geometry. It is a medical imaging application of the DarkSide collaboration, whose main aim is to directly detect dark matter particles via liquid Argon (LAr) targets [1-2]. With these advances in hand, the principle of 3DΠ has been developed.

**Material and Methods:** 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 LAr has been doped with liquid Xenon. This shifts the average emission to 178 nm, to better fit the SiPM's responsivity. We evaluated the performance of the 3DΠ scanner using the NEMA NU 2–2018 standardized tests for spatial resolution, sensitivity, image quality, count rate performance, and timing resolution. Figure 1 shows the phantoms and sources for the image quality test.

**Preliminary results:** The preliminary results of the NEMA tests are generated by the GEANT4 simulation of the 3DΠ scanner and the analysis was conducted via ROOT. The sensitivity is 510.39 kcps/MBq at the center and 439.95 kcps/MBq at a 10 cm offset. The peak noise-equivalent count rate (NECRs) is 6.93 ×104 kcps, for an activity of 176.02 MBq and its respective scatter fraction is 35%. These preliminary results demonstrate that our scanner's system performance is comparable to, if not better than, other commercial scanners.

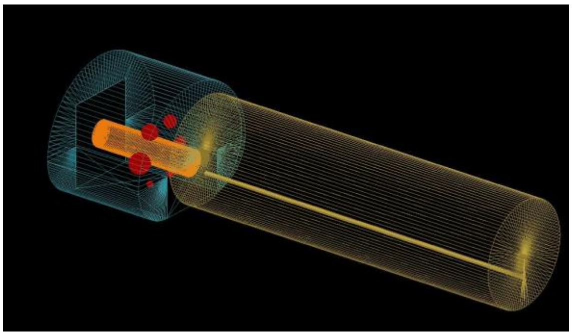

*Figure 1: image quality phantoms and sources.*

[1] P. Agnes et al. (The DarkSide Collaboration), Phys Lett. B 743, 456 (2015).
[2] C.E. Aalseth et al. (The DarkSide Collaboration), Eur. Phys. J. Plus 133, 131 (2018).