Contribution ID: **118** Type: **Poster**

3D reconstruction of the positron annihilation position using J-PET modules coupled to an intense positron beam

Wednesday, 29 June 2022 16:49 (1 minute)

A dense positronium beam is currently under development at the Anti-Matter Laboratory (AML) of the Department of Physics of the University of Trento. Positronium (Ps) is the bound state of an electron and its antiparticle, the positron (e^+). Despite the short lifetime (singlet state, para-, has a lifetime of 125ps, the triplet state, ortho-, of 142ns), Ps atoms are the easiest lab-produced matter-antimatter bound systems. In order to produce the Ps beam, we start with a ^{22}Na radioactive source, which emits positrons in a wide range of energies [1]. Part of these positrons is moderated to a few eV of energy by a solid noble gas film on top of the source [1]. The moderated charged particles are then magnetically velocity selected and transported. Up to now we obtained a continuous beam with up to 50000 positrons per second per millicurie. To produce dense clouds of Ps, the continuous positron beam will be bunched with a buffer-gas Penning trap [2]. The 104 e^+ bunches will be accelerated to keV of energy and implanted into silicon target engineered with nanochannels cover in silica, from which the positronium atoms are emitted in vacuum [3]. The positronium so obtained has a short lifetime, for this reason our laboratory already tested a two-photon transition which excite Ps in a metastable state with lifetime of 1.1 μs [4].
Thanks to the longer lifetime, metastable Ps has been suggested as a candidate for inertial sensing measurements on this exotic matter-antimatter system [5]. A proposed measurement scheme requires that metastable Ps bunches cross through a deflectometer composed by a series of grids. The passage of Ps through the deflectometer create a fringe pattern whose vertical displacement is indicative of the external force exerted on the bunch. In order to measure this displacement, it is necessary a 3D reconstruction of the annihilations on the grids [5]. In view of this objective, the Jagiellonian- Positron Emission Tomography (J-PET) [6-7] modular detector has been considered. Each J- PET module is composed by 13 inexpensive plastic scintillator strips [7], permitting a spatial reconstruction of the annihilation points.

In this work, we will present the preliminary results from the test of the J- PET modules on the AML continuous positron beam. The e^+ have annihilated on a plane and only two modules have been used to reconstruct their annihilation position. In this configuration, a spatial resolution of a couple of millimetres has been demonstrated. This result shows the applicability of J-PET modules for the construction of a detector for Ps inertial sensing measurements.

[1] A. P. Mills Jr. et al., Appl. Phys. Lett. 49, 1121 (1986)
[2] R. G. Greaves et al., NIM B 192 (2002)
[3] S. Mariazzi et al., Phys. Rev B 105, 115422 (2022)
[4] C. Amsler et al., Phys. Rev. A 99, 033405 (2019)
[5] S. Mariazzi et al., Eur. Phys. J. D 74, 79 (2020)
[6] P. Moskal et al., Science Advances 7 (2021) eabh4394
[7] P. Moskal et al., Nature Communications 12 (2021) 5658
[8] P. Moskal et al., Phys. Med. Biol. 66 (2021) 175015

The authors gratefully acknowledge the support of Q@TN, the joint laboratory of the University of Trento, FBK- Fondazione Bruno Kessler, INFN- National Institute of Nuclear Physics, and CNR- National Research Council; the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie Grant Agreement No.754496 –FELLINI; Canaletto project for the Executive Programme for Scientific and Technological Cooperation between Italian Republic and the Republic of Poland 2019-2021. The authors also gratefully acknowledge support from the Foundation for Polish Science through programmes TEAMPOIR.04.04.00-00-4204/17; the National Science Centre of Poland through grant nos. 2019/35/B/ST2/03562; the Ministry of

Education and Science through grant no. SPUB/SP/490528/2021; Jagiellonian University through project no. CRP/0641.221.2020.

Primary author: POVOLO, Luca

Co-authors: SHARMA, Sushil; MARIAZZI, Sebastiano (Universita degli Studi di Trento and INFN (IT)); PENASA, Luca (Universita degli Studi di Trento and INFN (IT)); DULSKI, K. (Jagiellonian University, Poland); GAJOS, A. (Jagiellonian University, Poland); KACPRZAK, K. (Jagiellonian University, Poland); KORCYL, G. (Jagiellonian University, Poland); NIEDZWIECKI, S. (Jagiellonian University, Poland); CARAVITA, R. (TIFPA/INFN, Trento, Italy); MOSKAL, P. (Jagiellonian Univeristy, Poland); BRUSA, Roberto Sennen (Universita degli Studi di Trento and INFN (IT))

Presenter: POVOLO, Luca

Session Classification: Poster