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Simulations of absorption in the brain of gamma quanta from positronium atoms

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The poster shows the results of the research on the absorption in the brain of gamma quanta from positronium atoms created during the PET imaging.
Positronium imaging [1] is a new imaging method that allows to determine not only the location of the tumor, but also the degree of its malignancy [2]. It is the multi-photon imaging, which uses not only 2γ, but also 3γ annihilations. Amount of detected photons from decay into 2γ or 3γ give information about tissue structure. Moreover, the 3γ/2γ ratio allows the description of neoplastic changes [3]. The brain in these studies is approximated by a sphere with water. Monte Carlo simulations of positron decays and photon absorption in the brain and skull were performed. The simulation results were compared with theoretical calculations. The results of the percent events for which none of photons scattered in the head are as follows: 26.10 ± 0.05 % for para-positronium and 8.40 ± 0.03 % for ortho-positronium (absorption in the brain), 20.84 ± 0.05 % for para-positronium, 5.46 ± 0.02 % for ortho-positronium (absorption in the brain and in skull). The values of the ratio from the simulation are: 0.322 ± 0.002 for absorption in the brain and 0.262 ± 0.002 for absorption in the brain and skull. The dependence of absorption probability of photons in the head on the location of positronium atom decay in the brain is determined.
The poster will present the above-mentioned results and plots obtained in the simulations. The methods by which the simulation results were obtained will also be presented.
References
[1] P. Moskal et al., “Positronium imaging with the novel multi-photon PET scanner”, Science Advances (in press)
[2] P. Moskal, D. Kisielewska, C. Curceanu et al., “Feasibility study of the positronium imaging with the J-PET tomograph”,Phys. Med. Biol. 64:055017 (2019)
[3] B. Jasińska, P. Moskal, “A New PET Diagnostic Indicator Based on the Ratio of 3γ/2γ Positron Annihilation”,Acta Phys. Pol. B,48:1577-1582 (2017).

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