A GATE in silico evaluation of the γ-eye preclinical system, for imaging alpha and beta radiopharmaceuticals.

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Background: Alpha and beta emitters present a highly potentiality as therapeutic agents in clinics[1]. Novel compounds using radionuclides such as Ac-225, Pb-212, At-211, Ra-223, Lu-177 are increasingly tested in preclinical stage for the development of future emerging radiopharmaceuticals. Monte Carlo simulations serve as gold standard for the optimization of imaging protocols and systems' development. In the proposed study we investigate the different parameters of the novel γ-eye™ preclinical imaging system[2] for dynamic imaging of such radionuclides. The current study is an in silico investigation based on experimental proof-of-concept and results.

Material and Methods: The GATE[3] toolkit v9.1 is used for the execution of all the imaging simulations. A previously validated simulated model of γ-eye™ system was used as baseline[4]. In the current study, several modifications on the parallel-hole collimator's characteristics were investigated alongside with the variation of the height of the pixelated scintillator. A thorough investigation has been done varying the diameter of the collimator's hexagonal holes from 1.2mm up to 3.5mm, as well as the collimator thickness from 30mm up to 45mm (lead). In addition, the pixelated crystals are fixed 1.5mm with a varying depth from 3mm up to 10mm.

Preliminary results: A series of different radionuclides were tested for the efficient imaging using the γ-eye™. Our imaging system has been optimized for imaging Lu-177, Pb-212, Ac-225. For our purpose we simulated several phantoms including i) vials for image quality, ii) capillaries and point sources for spatial resolution and iii) vozelized mouse phantoms for preclinical applications. Figure 1 presents indicative simulated results of Ac-225 and Pb-212.

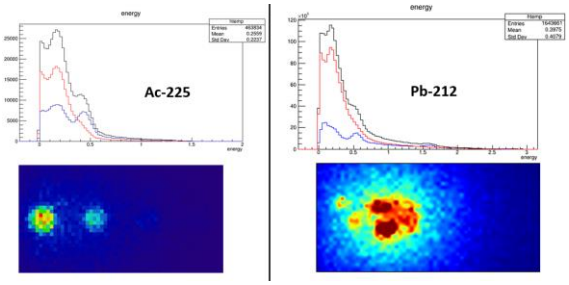

Figure 1: Left (Ac-225): Vials with different activity concentrations. Right (Pb-212): Mouse activity distribution. Total, scattered and unscattered counts are presented in the respective spectra.

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[2] M. Rouchota *et al.* Mol Imaging,(2021)
[3] D. Sarrut *et al.* Phys Med Biol, 66 (2021)
[4] R. Ricci *et al.* Crystals, 9 (2019):398