

## Ultrahigh resolution small animal positron emission tomography for mouse brain imaging

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In a previous study, we developed a mouse brain dedicated positron emission tomography (PET) scanner using a staggered 3-layer depth-of-interaction (DOI) detectors employing a 1 mm crystal pitch to achieve high resolution while minimizing the parallax error. However, the axial field of view (FOV) was 11 mm which limited the sensitivity substantially. In this study, we present the initial results of a second generation small animal PET scanner featuring an extended axial FOV for high sensitivity mouse brain imaging. The small animal PET scanner had a 52.5 mm inner diameter and 51.5 mm axial FOV. The LYSO crystal array had the pixel pitch of 1 mm and total thickness of 15 mm. The PET scanner consisted of 4 rings each of which had 16 DOI detectors. Each DOI detector consisted of a 3-layer staggered LYSO crystal array and 4×4 SiPM (Hamamatsu, S14161-3050HS-04, Japan) array with a pixel pitch of 3.2 mm. The SiPM anode signals were multiplexed using a resistive network and then digitized by a custom-made DAQ. The coincidence data were generated by using coincidence process software with a coincidence window of 10 ns. The peak absolute sensitivity was 2.84% with an energy window of 400-600 keV. The 0.55 mm rod structures of a resolution phantom were resolved using the OSEM algorithm. In vivo mouse brain images with <sup>18</sup>F-FDG showed clear identification of cortex, thalamus, and hypothalamus. In conclusion, our PET scanner can serve as a useful molecular imaging tool for neuroscience research using rodent models.

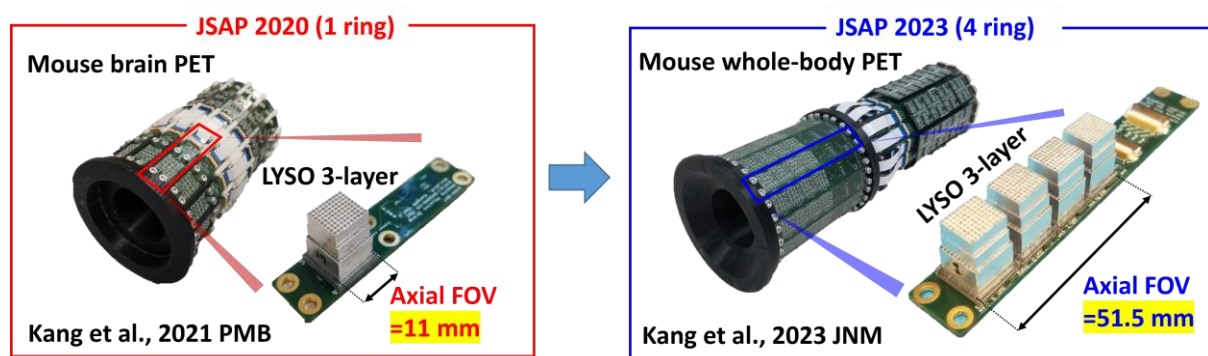


Fig. 1. A comparison between the JSAP 2020 (1 ring) and JSAP 2023 (4 ring).

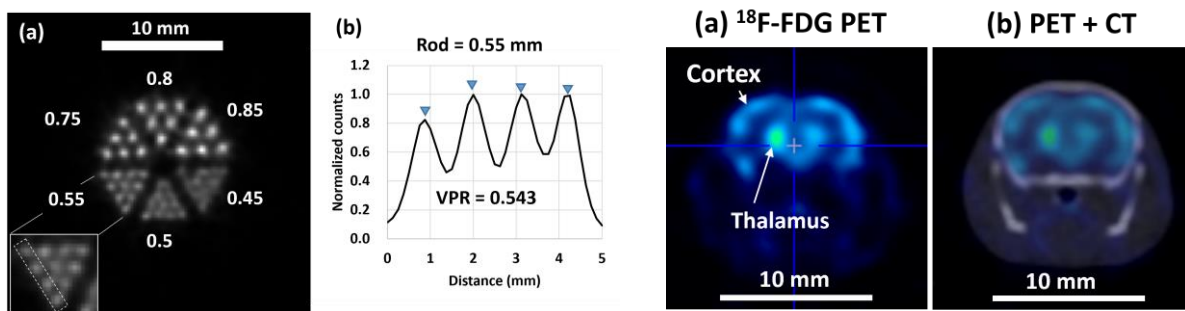


Fig. 2. (a) The OSEM image of a resolution phantom and (b) line profile along the rod diameter of 0.55 mm.

Fig. 3. (a) In vivo mouse brain PET image using <sup>18</sup>F-FDG tracer and (b) fusion image between the PET and X-ray CT.