Production of ^{44m}Sc for multiple-isotope PET

T. Fukuchi,[*1] S. Yano,[*2] H. Haba,[*1] and Y. Watanabe[*1]

We have been working toward the development of a next-generation positron emission tomography (PET) system, known as multiple-isotope PET (MI-PET). MI-PET is designed to coincide with γ-ray using additional detectors and identify the tracer by detecting the prompt γ-ray, which is emitted after positron emission from positron-γ emitter. Figure 1 shows an image and schematic illustration of the developed MI-PET system. The system is composed of a PET system and additional γ-ray detectors. The PET system consists of pixelized gadolinium orthosilicate (GSO) scintillation detectors and has a ring geometry with an inner diameter and width of 95 mm and 37.5 mm, respectively. Eight bismuth germanium oxide (BGO) scintillation detectors constitute the additional eight detectors, each with a dimension of $50 \times 50 \times 30$ mm^3, arranged in two rings mounted on each side of the PET ring.[1)]

For multiple-isotope imaging using MI-PET, at least one positron-γ emitter is necessary as a tracer. Scandium-44 is one of the candidates for the specific radioactive tracer for MI-PET owing to its large positron and γ-ray emission ratio and moderate half-life (^{44}Sc: 3.97 h, ^{44m}Sc: 58.61 h). Therefore, we studied the production of ^{44m}Sc and its imaging using MI-PET.

For ^{44m}Sc production, we used ^{nat}CaO powder as the target material, which was pressed into a disk with an inner diameter and thickness of 10-mm and 376-mg/cm^2, respectively. The target was irradiated for 3 h with a 24-MeV deuteron beam having an intensity of 3.0 μA at the RIKEN AVF cyclotron. The irradiated CaO target was dissolved in 6 M HCl and evaporated to become dry. Subsequently, the residue was dissolved in 5 mL of 2 M HCl. The solution was passed through an anion exchange resin column (DGA resin, particle size: 50–100 μm) filled in a Muromac column.[2)] The resin was then washed with 5 mL of 2 M HCl and ^{44m}Sc was eluted from the resin with 10 mL of 0.1 M HCl. Finally, approximately 2.0 MBq of ^{44m}Sc with 90% radiochemical yield was obtained.

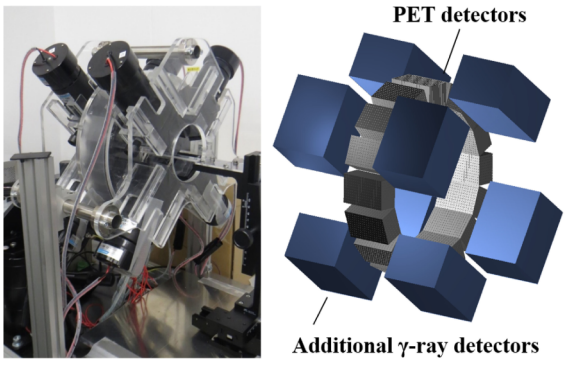

Fig. 1. Image (left) and schematic illustration (right) of the developed PET system.

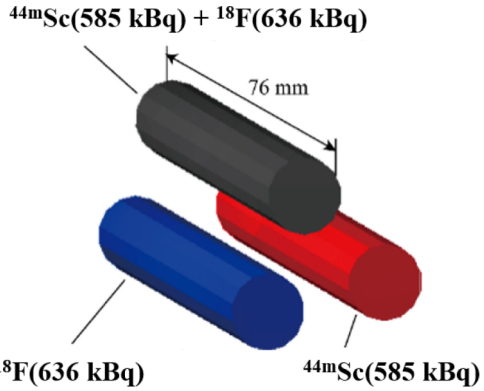

Fig. 2. Illustration of rod phantom configuration.

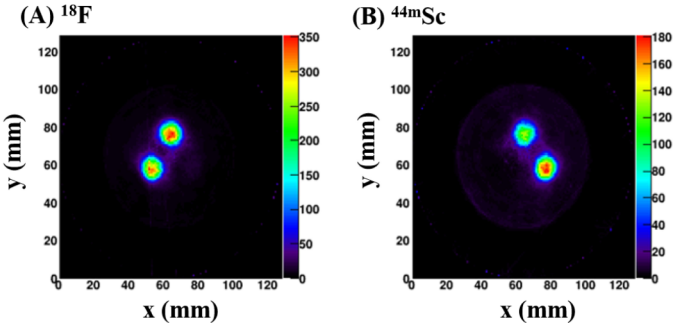

Fig. 3. The x-y plane projection images of rod phantom. Images were reconstructed with (A) absence or (B) presence of γ-ray detection.

To test the imaging ability of the MI-PET system for ^{44m}Sc, we scanned a dual radionuclide rod phantom that comprised three cylindrical rods with a diameter and length of 10 mm and 76 mm, respectively. Scandium-44m and ^{18}F (pure positron emitter) dissolved in water were poured into the rods. The first rod had ^{44m}Sc (585 kBq) and ^{18}F (636 kBq) activities. The second and third rods had ^{44m}Sc (585 kBq) and ^{18}F (636 kBq) activities, respectively. The configuration of this rod phantom is illustrated in Fig. 2. The rods were positioned parallel to the scanner's axial direction and a 30-min scan was performed.

Figure 3 shows the reconstructed phantom images as the x-y plane projection images of the rod phantom with the absence (A) or presence (B) of γ-ray detection. From these images, the distribution of ^{44m}Sc and ^{18}F is evident.

This study demonstrates the feasibility of ^{44m}Sc imaging using MI-PET. In future, we will conduct multiple isotope animal experiments using ^{44m}Sc and the other PET tracer. We will also synthesize useful MI-PET drug labeled with ^{44m}Sc.

*1 RIKEN Center for Biosystems Dynamics Research
*2 RIKEN Nishina Center

References

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