Gamma-ray inspection of rotating object

T. Kambara,[*1] H. Haba,[*1] and A. Yoshida[*1]

We are developing a new method to determine the spatial distribution of positron-emitting RIs on a rotating object, based on the same working principle as medical PET systems, but simpler and less expensive. In the method called gamma-ray inspection of rotating object (GIRO), an object with positron-emitting sources continuously rotates and a couple of gamma-ray detectors move in parallel back and forth on either side of the object. The rate of simultaneous detection of two positron-annihilation gamma rays as a function of the detector position and orientation of the object yields a sinogram, from which the source distribution on the object is reconstructed by a maximum-likelihood expectation maximization (ML-EM) algorithm. The principle and some results of test measurements with a prototype instrument have been reported.[1,2] The instrument has since been modified so that the detectors move back and forth instead of the rotating object.

We used ^{22}Na sources for the test measurements: two point-like sources (1.55 and 64 kBq) and one with a two-dimensional RI distribution (149 kBq). Since we required more intense sources with more variety of activity-distribution patterns, we attempted to use new two-dimensional sources with ^{89}Zr nuclide ($T_{1/2}$=78 hours), which was produced by a ^{89}Y(d,2n)^{89}Zr reaction at the AVF cyclotron with a 24-MeV deuteron beam. We prepared a filter paper cut out to letters ("RIKEN RIBF" with a character height of 26 mm) and figures of a circle (60 mm ϕ), a square (40 mm $\times$ 40 mm), and a rectangle (30.5 mm $\times$ 83 mm), and dripped a hydrochloric acid solution of ^{89}Zr on them. The paper pieces were then dried and sealed between plastic sheets and used as sources for GIRO. GIRO was equipped with two NaI scintillation detectors with 6-mm wide and 3-cm thick vertical collimators. The object rotated at 150 rpm, and the linear motion of the detectors was 2-mm/step and 1 step/10s over a $\pm$74-mm range. The source distributions were reconstructed from the sinograms by ML-EM,[3] and compared with those obtained by imaging plates.

Figure 1 shows an image of a composite of the square, rectangle, and circle. The average activity was approximately 1.17 MBq during the measurement time of 19.4 hours. The GIRO image (right) reproduces not only the shape of the source but also the gross pattern of the activity distribution on the source taken by an imaging plate (left). Figure 2 shows an image of the source cut out as letters. The average activity was approximately 1.15 MBq during the measurement of 16.8 hours. The letters are only roughly reproduced.

The present experiments show that GIRO can well reproduce the gross structure of the two-dimensional source distribution, but the reproduction of structures finer than the collimator width is difficult.

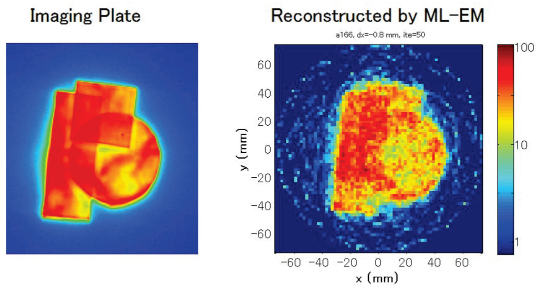

Fig. 1. Imaging plate (left) and image reconstructed from sinogram by GIRO (right) of a composite of figures.

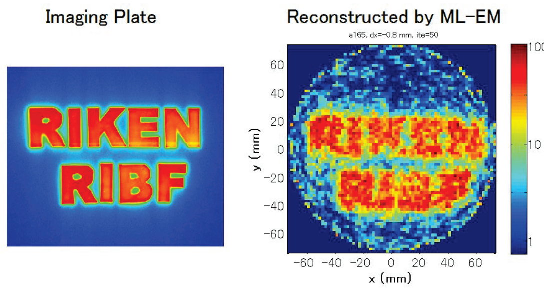

Fig. 2. Imaging plate (left) and image reconstructed from sinogram by GIRO (right) of letters.

References
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*1 RIKEN Nishina Center