Preliminary results of CdTe detector capabilities toward MRI-SPECT

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Introduction

In recent years there have been new interests in MR Hybrid systems, for instance, MR-PET, MR-SPECT that are expected to give us novel information by imaging simultaneously in both modalities. CdTe semiconductor detector for localizing radionuclide has new features not only high-energy resolution and compact size but also doesn't need Photo Multiplier that is very sensitive to magnetic field. Therefore it would be a good candidate in using with MRI system [1]. We investigated CdTe detector capabilities toward MR-SPECT system by measuring energy spectra changes and imaging a point source with and without magnetic field of MRI. Furthermore an effect of collimator for MR imaging was tested since it is considered that the collimator induces local eddy current, resulting in image artifact.

Methods

Figure 1 shows our CdTe module mounted on PCB. The CdTe detector consists of 10 x 10 elements that entire size 13.8 mm x 13.8 mm and each element is 1.2 mm x 1.2 mm square size segmented 0.2mm width, 0.6 mm depth gap. ASIC module includes charge amplifier and multiplexer for selecting a specified channel. Amplified signal from the ASIC is converted into 12 bits digital signal and that parallel signals is encoded to serial signal and then transmitted to outside of MR shielded room through optical fibers to avoid various noise interferences. Actual counting is performed in PC following the serial to parallel conversion. ^{57}Co point source (1.9 MBq) is used for the measurements and tested in both 1.5T and 3T. The detector was always placed perpendicular to the B0 field. The collimator covered the CdTe detector is made of laminated Tungsten sheets, the thickness 4 mm having 32 x 32 square holes and the each size 1.2 mm x 1.2 mm, which location is corresponding to each CdTe element as shown in Figure 2. MR imaging pursued using cylindrical phantom and the collimator is placed on one side of bottom of the cylindrical phantom. Axial, sagital and coronal plane parallel to the collimator were imaged changing phantom position and typical sequences (SE, FSE and GRE) were used for the imaging.

Results

Figure 3 shows a comparison of measured energy spectra between inside of 1.5T magnet bore and outside of MRI room. One of detector elements which is the closest channel of the ^{57}Co point source was chosen for prior to the measurement. No significant difference in both cases was observed and the same result was also in 3T cases. Figure 4 showed imaging results of the ^{57}Co point source placed above the center of CdTe detector. Although vertical and horizontal blur is seen due to collimator misalignment to the detector element and scattered effect, the same image was obtained with and without 3T magnetic field. Figure 5 (a) is MR imaging result of axial plane to examine a collimator effect and which scanned by FSE sequence had the most severe artifact in the three sequences. These kinds of artifact were exiting in axial plane of 30-35 mm depth far from the collimator and the cause can be explained by disruptive phase interference due to a local eddy current loop in the collimator induced by Gradient field. However similar artifacts are not seen in coronal plane (Figure 5 (b)) because the eddy current loop of coronal plane is parallel to Gradient field.

Conclusion

Our preliminary results demonstrated CdTe detector was fairly robust to the MR magnetic field and could be usable with MRI system simultaneously. While the artifact was observed in a certain condition, this could be improved adequately by changing the collimator formation.

Acknowledgment

This study was supported by a grant-in-aid from the New Energy and Industrial Technology Development Organization (NEDO).

Reference

1.O. Nalcloglu et al., "Development of MR-Compatible SPECT System: A Feasibility Study", Proc. ISMRM 15 (2007)

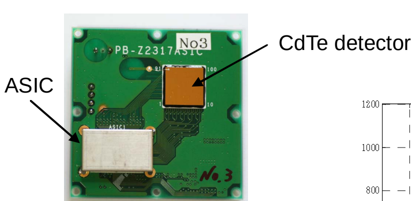


Figure 1 CdTe Moduel

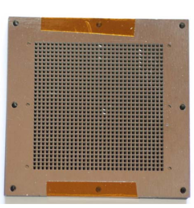


Figure 2 Collimator

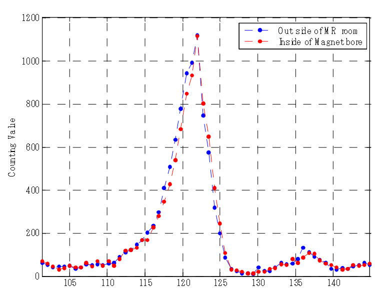
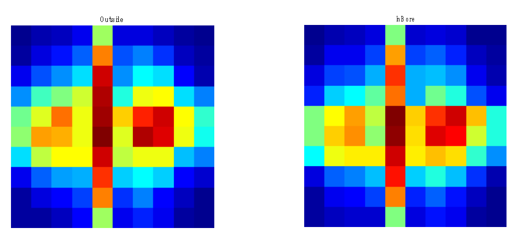
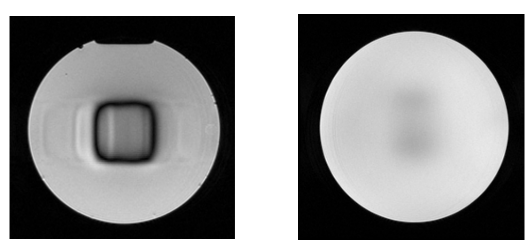


Figure 3 Co57 Energy Spectra at inside of 1.5T bore and outside.



(a) In 3T bore (b) Outside of MR room

Figure 4 Images of point source, 10 x 10 pixels



(a) Axial (b) Coronal

Figure 5 Phantom Images with collimator