Oral presentation | II. Radiation, Accelerator, Beam and Medical Technologies：202-4 Medical Use of Quantum Beam

Thu. Mar 13, 2025 11:00 AM - 11:55 AM JST | Thu. Mar 13, 2025 2:00 AM - 2:55 AM UTC Room B(Zoom room 2)

[2B06-08] Medical Applications

Chair:Masaaki Kaburagi(JAEA)

11:00 AM - 11:15 AM JST | 2:00 AM - 2:15 AM UTC

[2B06]

Integration and Performance Evaluation of a TlBr X-ray Imager for CT Imaging Systems

*Moh Hamdan[1], Kenji Shimazoe[1], Hiroyuki Takahashi[1], Mitsuhiro Nogami[2], Keitaro Hitomi[2], Takanori Tsunashima[3], Takashi Nakamura[3] (1. The University of Tokyo, 2. Tohoku University, 3. Japan Display Inc.)

11:15 AM - 11:30 AM JST | 2:15 AM - 2:30 AM UTC

[2B07]

Study on estimation for temporal variation of dose rate using radiochromic gel dosimeter

*Ryosuke Narita[1], Masao Gohdo[2], Shin-ichiro Hayashi[3], Genichiro Wakabayashi[4], Yoshinori Sakurai[5] (1. Grad. Sch. Engineering, Kyoto Univ., 2. Saitama Univ., 3. Hiroshima International Univ., 4. Kindai Univ., 5. KURNS, Kyoto Univ.)

11:30 AM - 11:45 AM JST | 2:30 AM - 2:45 AM UTC

[2B08]

Development of High-resolution using Phase Shifting and Depth Of Interaction

*shuwei zhao[1], Takahashi Hiroyuki[1], Shimazoe Kenji[1] (1. the university of tokyo)

11:45 AM - 11:55 AM JST | 2:45 AM - 2:55 AM UTC

Time reserved for Chair

Integration and Performance Evaluation of a TlBr X-ray Imager for CT Imaging Systems

*Moh Hamdan[1], Kenji Shimazoe[1], Hiroyuki Takahashi[1], Mitsuhiro Nogami[2], Keitaro Hitomi[2], Takanori Tsunashima[3], and Takashi Nakamura[3]

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Abstract

This study develops and characterizes a TlBr-based direct-conversion flat panel detector (FPD) for X-ray imaging. Integrated with a rotating stage, the system was tested as a computed tomography (CT) imaging system, demonstrating its potential for advanced X-ray imaging applications.

1. Introduction

Direct-conversion FPDs are widely studied for medical and industrial X-ray imaging. The performance of these detectors heavily depends on the choice of conversion materials. TlBr stands out due to its optimal energy bandgap (2.68 eV), high atomic numbers (Tl: 81, Br: 35), and high density (7.56 g/cm³) [1]. This study develops and characterizes a direct-conversion FPD with a 25 μm thick TlBr film, evaluating its performance as a CT imaging system.

2. Materials and Methods

The TlBr film, deposited via evaporation, had a thickness of 25–50 μm and an active area of 29.61 × 39.48 mm² [2]. The electrodes included Au film for the top and ITO-coated glass for the bottom. A pixelated sensor matrix (168 × 126 pixels, 235 × 235 μm² each) was fabricated using low-temperature polysilicon thin-film transistor (LTPS TFT) technology (Figure 1(a)). CT imaging utilized a Raytech TX-120 X-ray tube (25–50 kV, 0.25–2 mA) with a 75 cm source-to-detector distance, 3 cm rotation center offset, and angle pitches of 1°–2° for 1000 frames per pitch (Figure 1(b)). Detector sensitivity was tested on plastics, metals, and electrolytic capacitors, with reconstruction via Filtered Back Projection (FBP).

3. Results and Discussion

The pixel intensity increased with rising X-ray tube voltage (30–100 kV, 2 mA), with saturation observed starting at 80 kV attributed to energy deposition in the high-energy region. The spatial resolution, determined from the LSF profile, ranged from 222 to 280 μm in terms of Full Width at Half Maximum (FWHM), primarily constrained by the pixel size (Figure 1(c)). The CT imaging using plastics, metals, and electrolytic capacitors are expected to distinguish the structures and shapes of the objects.

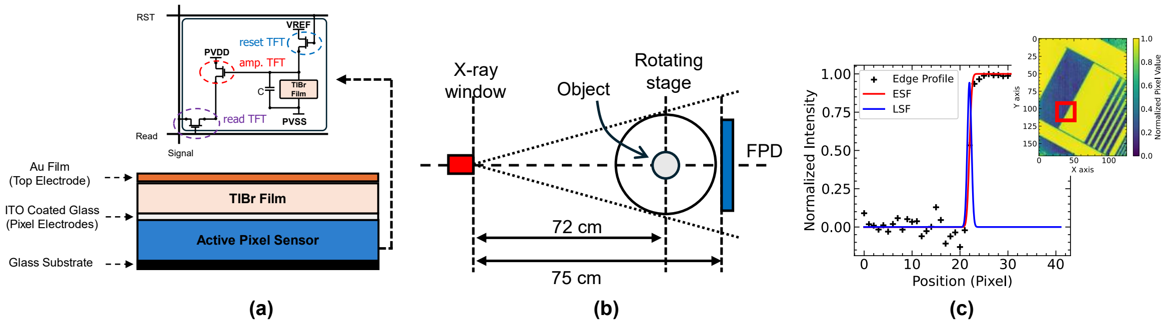

Figure 1. (a) TlBr-based direct-conversion FPD, (b) CT imaging setup, and (c) spatial resolution using ESF profile with FWHM of 22 μm.

4. Conclusion

The TlBr-based FPD exhibited strong X-ray imaging performance, with increasing pixel intensity up to saturation at 80 kV and a spatial resolution of 222–280 μm (FWHM). Preliminary CT results are expected to demonstrate its potential to distinguish object structures and shapes, highlighting its suitability for advanced X-ray imaging applications.

References

[1] M. Hamdan *et al.*, "Characterization of TlBr gamma detector based on electrical charge and Cherenkov light analysis," *Journal of Instrumentation*, vol. 19, no. 11, Nov. 2024, doi: 10.1088/1748-0221/19/11/C11017.

[2] M. Hamdan *et al.*, "The fabrication and characterization of direct conversion flat panel X-ray imager with TlBr film," *Nucl Instrum Methods Phys Res A*, vol. 1064, Jul. 2024, doi: 10.1016/j.nima.2024.169372.

ラジオクロミックゲル線量計を用いた線量率の経時的変化の推定に関する研究

Study on estimation for temporal variation of dose rate using radiochromic gel dosimeter

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ホウ素中性子捕捉療法のビーム強度の時間的変動を評価することを目的とした、ラジオクロミックゲル線量計を用いた線量率分布の経時的変化を評価するための手法について実現可能性を検討した。

キーワード：ホウ素中性子捕捉療法，品質保証，ゲル線量計，線量分布評価，経時的線量率変化

1. 緒言

我々は、ホウ素中性子捕捉療法(BNCT)の品質保証に関する多次元で簡便な測定手法の検討を行っており、空間情報を保持でき、測定が比較的簡便なラジオクロミックゲル線量計に注目している[1,2]。BNCT 装置によってはビーム強度の時間的変動が起こりうる[3]。そこで、ラジオクロミックゲル線量計を用いた線量率分布の経時的変化評価の実現可能性を検討した。

2. 実験

実験には主に Co-60 ガンマ線源を利用し、内寸が 10×10×0.5 cm^3、または 10×10×1.0 cm^3 の板状のゲル線量計を複数枚用意した。積層した板状ゲル線量計を 20×20×20 cm^3 の水ファントム内に配置した。ファントムの側面に面光源とカメラを対向に配置し、照射中のゲル線量計の着色の経時的変化を記録した（Figure 1, Figure 2）。

3. 結果・考察

着色変化率から評価した一層目のゲル線量計の空間平均の線量率は 1.0 Gy/min とほぼ一定であり、線源強度から算出したファントム前表面の水吸収線量率と近い数値であった。照射後 10 分間において化学的な反応遅延による線量増加は確認されなかった。

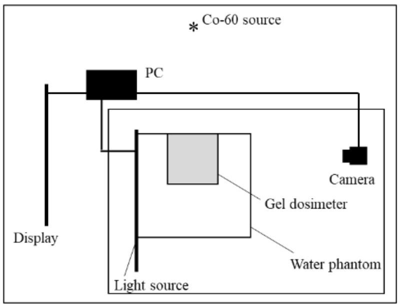

Figure 1 Experimental setup

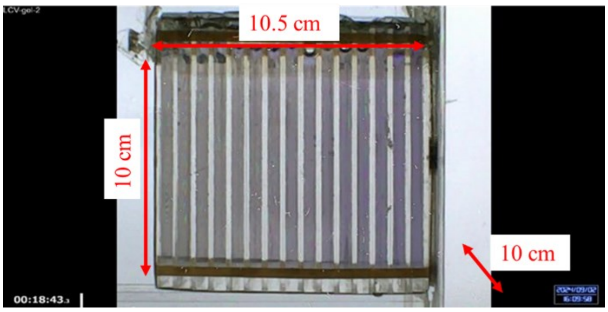

Figure 2 Captured image during irradiation

参考文献

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[2] Narita et al., 2024. J. Phys.: Conf. Ser., 2799, 012009

[3] Nakamura et al., 2024. Sci. Rep. 14, 11253

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Development of High-resolution using Phase Shifting and Depth Of Interaction

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Abstract

PET is crucial for diagnosing cancer, heart disease, and neurological disorders. Improving Depth of Interaction (DOI) accuracy reduces parallax errors, enhancing spatial resolution. Traditional methods using segmented scintillators are precise but costly. Our Double Side Readout (DSR) method with cost-effective monolithic crystals and phase-shifting achieved 1 mm resolution. Experiments with Cs-137 validated this efficient and practical PET imaging solution.

Keywords: Double side readout, Phase shifting, Depth of interaction.

1. Introduction

PET is particularly significant for diagnosing cancer, heart disease, and neurological disorders. Enhancing Depth of Interaction (DOI) accuracy in PET detectors improves spatial resolution by reducing parallax errors, which blur images, especially for larger objects. While advanced systems like segmented scintillators and 3D crystal arrays improve resolution, they are costly and complex. What's more, current 3 mm Silicon Photomultiplier (SiPM) systems are limited, prompting the need for innovative, cost-effective solutions to advance PET imaging capabilities.

2. Methods and Results

The Double Side Readout (DSR) method provides a cost-effective approach to enhancing Depth of Interaction (DOI) accuracy in monolithic crystals by utilizing the signal ratio A/(A+B) from both sides of the crystal as shown in Figure 1a. In our experiment, an 8×8 MPPC array (2 mm × 2 mm pixels) was paired with a 16×16 YAP scintillator array (0.9 mm × 0.9 mm pixels). A phase-shifting technique was applied, shifting the detector by half a pixel along the x and y axes to achieve quarter-pixel sampling as shown in Figure 1b and 1c, effectively improving spatial resolution to 1 mm without requiring denser configurations.

Coincidence experiments with a Cs-137 source validated this approach, showing distinct spectral peaks and consistent alignment across shifts. Dual-side readout, integrating MPPCs on both scintillator sides, captured and correlated signals, further enhancing DOI accuracy. This method demonstrated superior spatial resolution and image clarity,

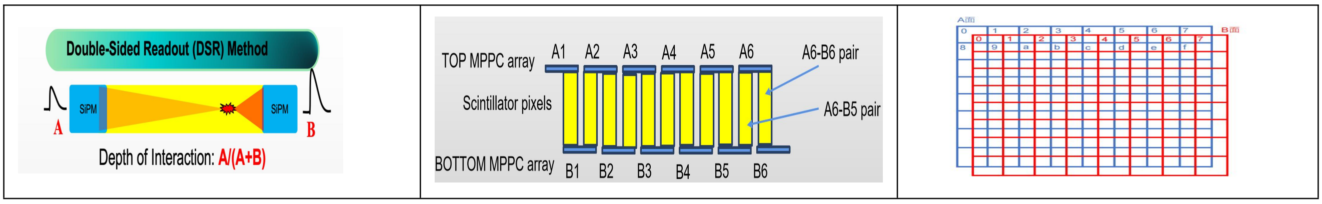

Figure 1 a Depth of Interaction b 1D phase shifting c 2D phase shifting

3. Conclusion

I successfully prove the phase shifting principle and test the DOI with double side readout to achieve 1mm spatial resolution.

References

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