

# 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  $8 \times 8$  MPPC array ( $2 \text{ mm} \times 2 \text{ mm}$  pixels) was paired with a  $16 \times 16$  YAP scintillator array ( $0.9 \text{ mm} \times 0.9 \text{ mm}$  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,

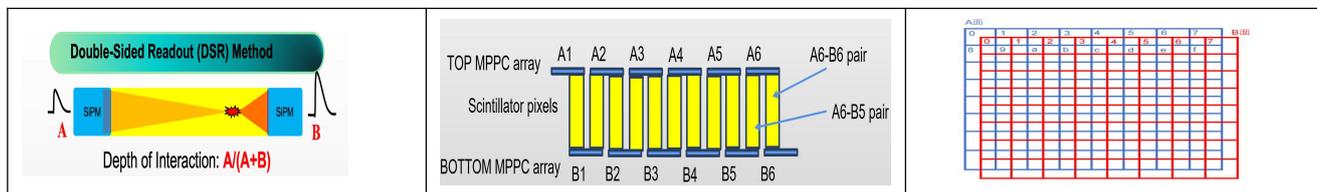


Figure 1 a Depth of Interaction b 1D phase shifting c 2D phase shifting

## 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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