Performance Demonstration for PET Detector Using 0.2 mm phi Wavelength-Shifting Fibers

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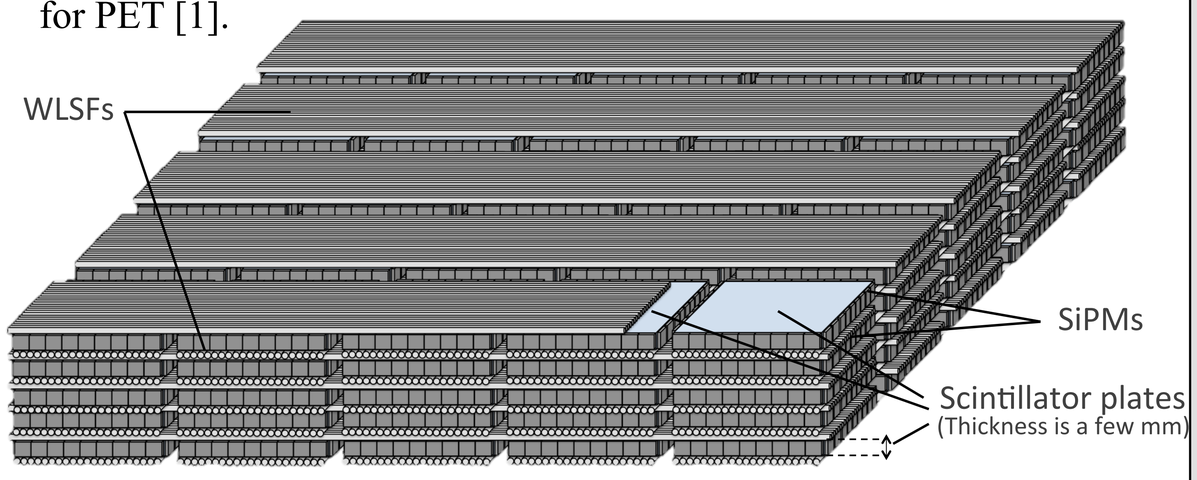
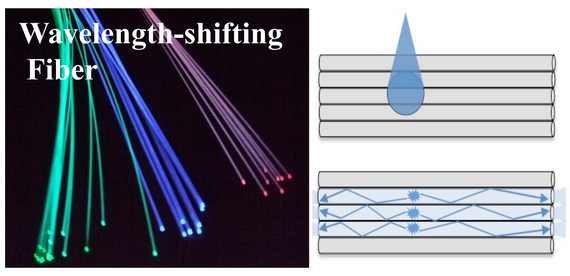
Abstract

We are developing a new gamma ray detector for Positron Emission Tomography (PET). The detector consist of scintillator plates wavelength-sifting fibers (WLSFs) and silicon photomultipliers (SiPMs). In this study, the detector performance (the position resolution and the energy resolution) for 511-keV gamma ray was demonstrated by an experiment.

Introduction

Recently we are developing a new gamma ray detector using wavelength-sifting fibers (WLSFs), scintillator plate and SiPMs for PET [1].





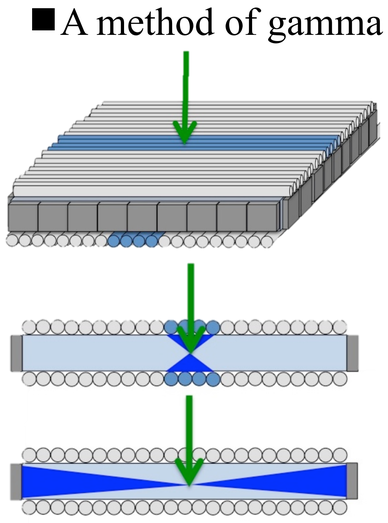
- Wavelength-sifting-fiber is an optical fiber which contain wavelength-sifter in its core.
- This fiber has property that absorb light, re-emit and propagate light to ends.

→It roles very fine photo devise by connecting to photo-detector.

■Detector concept

- The detector consists of several layers of scintillator plates.
- WLSFs cover each surface of scintillator plate along each axis (x or y).
- Ends of each fiber are connected to silicon photomultipliers (SiPMs).
- On each side of plate SiPMs are glued.

■A method of gamma rays detection

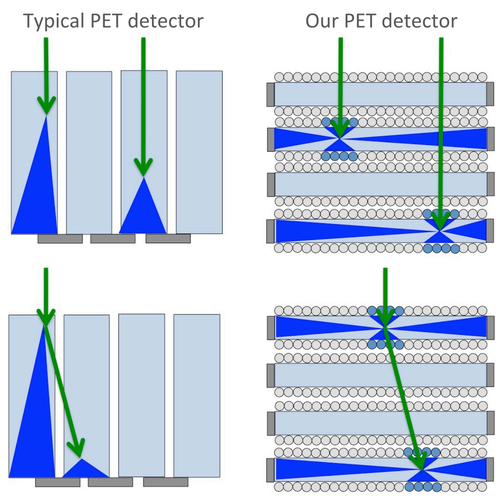


- When a gamma incidents to the plate and deposit energy, the light emitted isotopically.
- The light leaked out from the crystal absorbed WLSFs.
  →The incident position is measured.
- The light which is satisfied total reflection condition, is detected by SiPMs on side.
  →Energy and incident time are measured.

■Advantages of this Detector

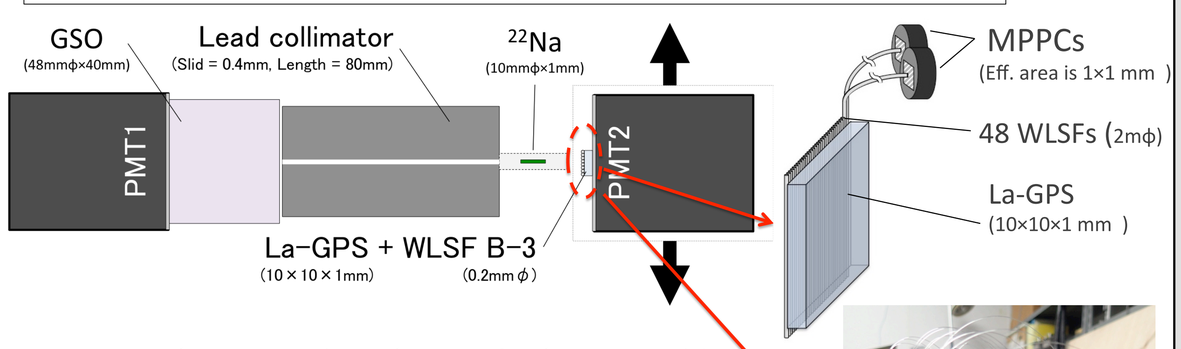
(1) It probably achieves the high position resolution by using 0.2 mm WLSFs.

(2) A layered structure of scintillator plate makes getting DOI information and discrimination of Compton scattering event more easier.

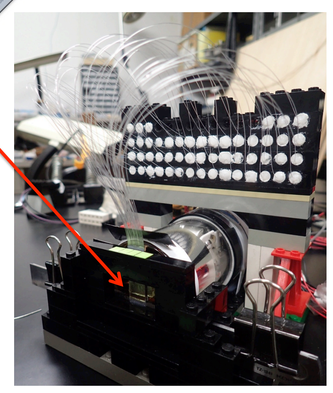


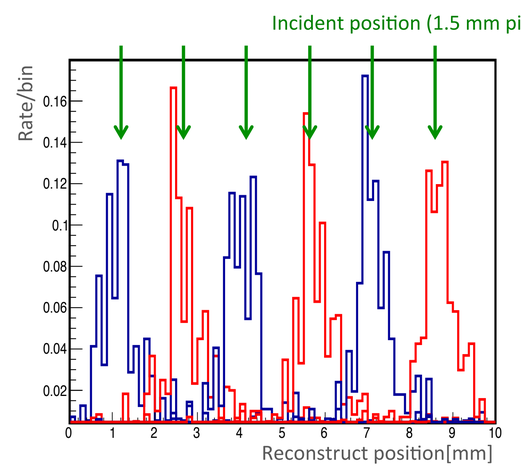
In this study, the detector performance for 511-keV gamma ray is demonstrated by an experiment.

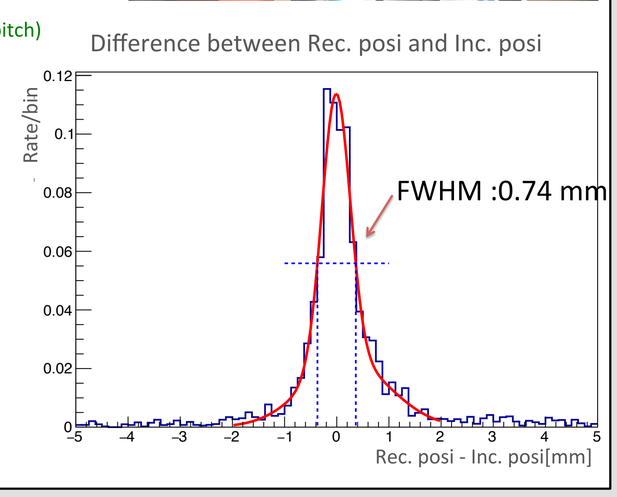
Experiment of the position resolution



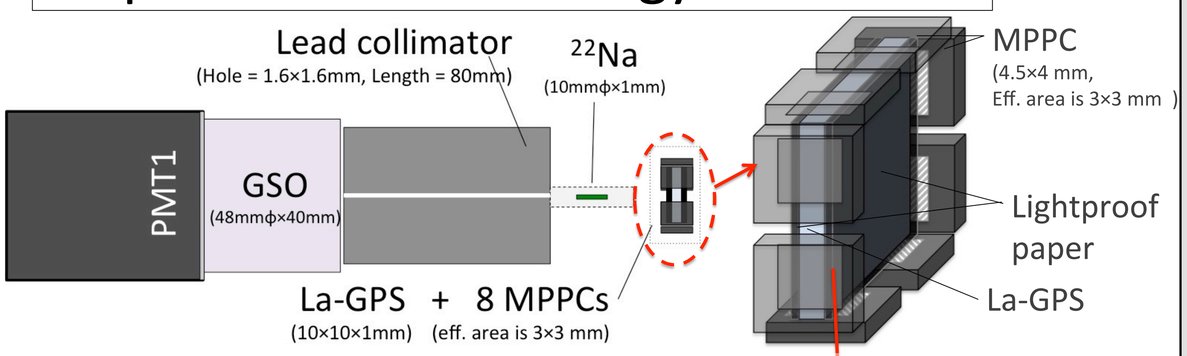
- Events that PMT1 and PMT2 observe 511-keV gamma ray simultaneously are selected.
- The incident position is reconstructed by the center of gravity calculation of fiber's position and number of photoelectron of MPPC.
- The reconstruct positions are corresponding to the incident positions obviously.
- The distribution of reconstruct position has sharp peak, and FWHM is 0.74 mm.



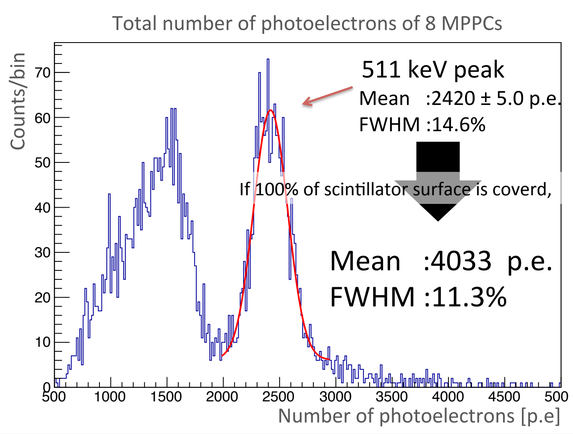


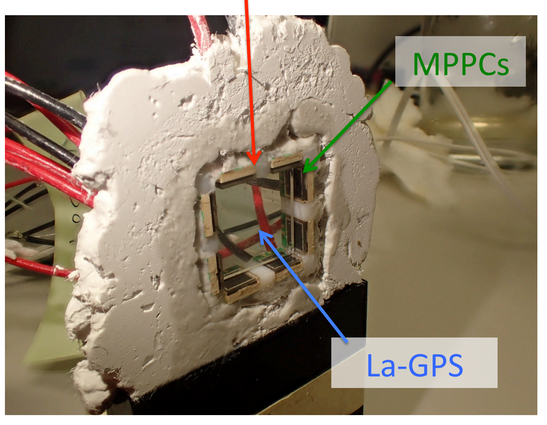


Experiment of the energy resolution



- Events that PMT1 observes 511-keV gamma ray are selected.
- MPPC's Effective area covers 60% of side surface.





Conclusion

- A new PET detector using scintillator plate, WLSFs and SiPM is demonstrated with 511-keV gamma ray.
- The estimated energy resolution is 11.3% for 511-keV gamma ray.
- The position resolution was 0.74 mm (FWHM) for 1 mm thickness La-GPS scintillator.

Acknowledgement

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Reference

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[2] A.Kobayashi, *et al*., Advancements in Nuclear Instrumentation Measurement Methods and their Applications, 223, Apr. 20-24 2015, Lisbon Convention Center, Portugal
[3] N.naomi *et al*., Advancements in Nuclear Instrumentation Measurement Methods and their Applications, 220, Apr. 20-24 2015, Lisbon Convention Center, Portugal