



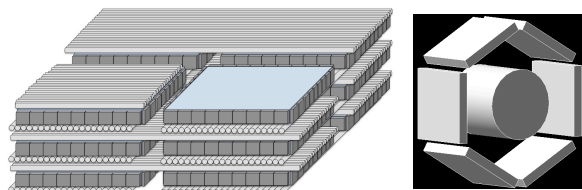
Abstract

We are developing a new gamma ray detector for Positron Emission Tomography (PET). The detector consists of scintillator plates, wavelength-shifting fibers (WLSFs) and silicon photomultipliers (SiPMs). In this study, the detector performance for 511-keV gamma ray was demonstrated by an experiment. We made a 511-keV gamma beam from ^{22}Na enter the setup and reconstruct incident position and energy by analyzing signal of SiPMs.

Introduction

- Recently we are developing a new gamma ray detector using WLSFs and scintillator plate for PET [1].
- Concept of the detector

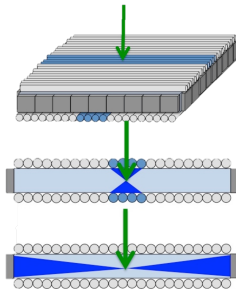
- The detector consists of several layers.
- Six detectors are around the human body.



- Each layer consists of scintillator plates. WLSFs cover each surface of each 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

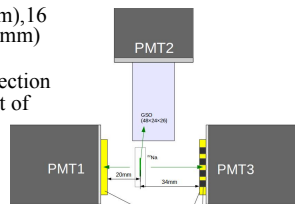
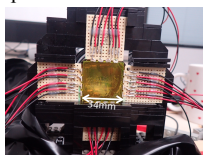
- When a gamma incident to the plate and deposit energy, the light emitted isotropically.
- The light leaked out from the crystal propagates WLSFs.
 - The incident position of gamma ray is measured.
- The light satisfied total reflection condition detected by SiPMs on side.
 - Then deposit energy and incident time of gamma are measured.



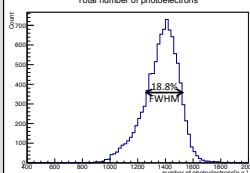
- The detector has an advantage that it probably achieves the high position resolution by using WLSFs with 0.2 mm diameter.
- It is expected the position resolution and the energy resolution are a few mm [2] and approximately 10% [3], respectively.
- In this study, the detector performance for 511-keV gamma ray is demonstrated by an experiment.

Experiment : energy resolution

- A GAGG scintillator (34×34×4mm), 16 MPPCs (each effective area = 3×3mm) are used.
- A method of taking data and a selection of event is same as the experiment of position measurement.



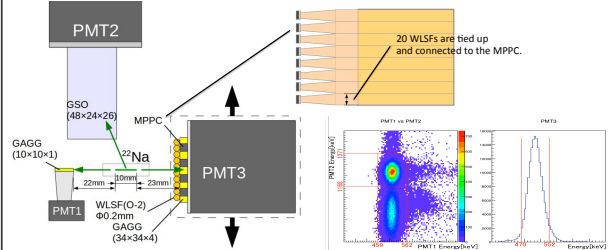
- The distribution of total photoelectron of 16 MPPCs has the peak at 1410 p.e..
- The energy resolution is also calculated and it is approximately 18.8% (FWHM).
- In this experiment, the effective area of MPPCs cover only 26.5% of GAGG surface.
- If 100% of surface is covered, the peak and the resolution is estimated to be 5320 p.e. and 9.7%, respectively.



Experiment of position measurement

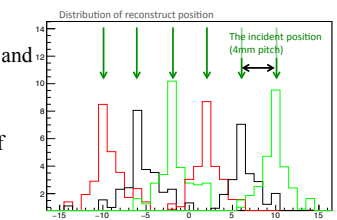
- Experiment 1 -- Demonstration of position measurement.

- A GAGG scintillator, 160 WLSF[O-2] (Kuraray Co., Ltd.), MPPCs (Hamamatsu Photonics Co., Ltd.) are used.



- When reference using PMT1 and the main detector using PMT3 observe energy more than 341 keV as well as reference using PMT2 observe 700 keV simultaneously, PMT1~3 and MPPCs are read signals.

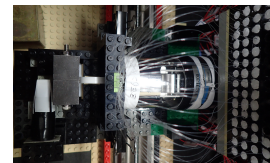
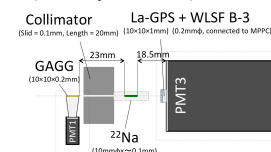
- Events that PMT1 and PMT3 observe 511-keV gamma ray and PMT2 observes 1.27 MeV gamma-ray are selected.
- The incident position is reconstructed by the center of gravity calculation of fiber's position and number of photoelectron of MPPC.



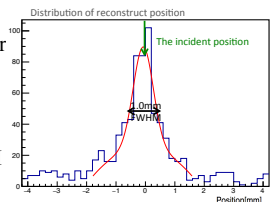
- The reconstructed positions are corresponding to the incident positions obviously.

- Experiment 2 -- Estimation of position resolution.

- A La-GPS [(La,Gd)2Si2O7(Ce)] scintillator, 48 WLSF[B-3] (Kuraray Co., Ltd.) are used.



- 48 WLSFs cover surface of La-GPS [(La,Gd)2Si2O7(Ce)], and each fiber is connected to MPPC
- A method of taking data and a selection of event is same as exp.1.
- The distribution of reconstructed position has sharp peak, and FWHM is 1.0 mm.



Conclusion

- A new PET detector using WLSFs are demonstrated.
- The estimated energy resolution is 9.7% for 511-keV gamma ray.
- The position resolution was 1.0 mm (FWHM) for 1 mm thickness La-GPS scintillator.

Reference

- H.Ito, et al., IEEE Medical Imaging Conference 2014, 8-15 Nov. 2014, Seattle, Washington, USA
- A.Kobayashi, et al., Advancements in Nuclear Instrumentation Measurement Methods and their Applications, 223, Apr. 20-24 2015, Lisbon Convention Center, Portugal
- N.naomi et al., Advancements in Nuclear Instrumentation Measurement Methods and their Applications, 220, Apr. 20-24 2015, Lisbon Convention Center, Portugal