

Scintillator hodoscope array read by multi-pixel photon sensor (MPPC)

Instructor: Koji Miwa (koji.miwa.c4@tohoku.ac.jp)

GPPU Experimental Point (GEP): 4

Goal of Study

In this lecture, we aim to obtain knowledge and the experience of pixelated photon detectors (MPPC is the one of the pixelated photon detector produced by Hamamatsu photonics) which are widely used in the particle and nuclear experimental fields. We expect that students understand the basic features of MPPC and also learn how to operate multi MPPCs by operating multi MPPCs attached to a scintillator hodoscope.

Contents

A semiconductor photodetector, MPPC, consists of a large number of pixels of avalanche photo diode (APD) in the sensitive area. The MPPC signal is created as the sum of the fired APD pixels. By operating each APD in the Geiger mode, MPPC can have enough gain to detect single photon. The sensitive area of MPPC is rather small (typical size is $1 \times 1 \text{ mm}^2$). However, MPPC can be operated in the magnetic field and its cost is rather low. Therefore MPPC is one of the best photon sensors to read out fine segmented scintillation detectors such as scintillation fiber detector.

In this lecture, you will acquire the skills to operate multi MPPCs using the EASIROC board developed for this purpose. First, we evaluate the basic performance and features of MPPC such as the relation between the operation voltage and signal gain. Then, we proceed to read out the scintillator hodoscope array by MPPC. In this detector, wavelength-shifting (WLS) fibers are embedded in the holes drilled in the surface of the scintillator. The scintillator hodoscope array consists of 128 scintillators with WLS fibers and has a layer configuration of 8 segments for the X direction and 8 segments for the Y direction. We try to read out the 128 channels of MPPCs by EASIROC board. As an advanced course, we try to measure the angular distribution of cosmic ray or the lifetime of the cosmic ray muon.

Textbook and References

- [1] 次世代光検出器 Pixelated Photon Detector : 生出秀行、音野瑛俊、山下 了、日本物理学会誌 第 66 卷第 01 号 p.20.
- [2] A beam position fiber counter with scintillation fibers and multi-pixel photon counter for high intensity beam operation: R. Honda *et al.*, *Nucl. Inst. Meth A* **787** 157 (2015).

Progress Schedule

- ◇ Day 1
 - Basics of MPPC and its readout (lecture)
 - Readout of a single MPPC with EASIROC board (experiment)
- ◇ Day 2
 - Readout of a single MPPC (check of MPPC feature) (experiment)
 - Readout of a multi MPPC (gain adjustment, DAQ) (experiment)
 - Analysis of data (photon yield, detection efficiency, etc.) (experiment)

 - (Data taking for cosmic ray)
- ◇ Days 3
- ◇ Days 4
 - Analysis of the accumulated data
 - ✓ Lifetime measurement of muon
 - ✓ Angular distribution of emitted electron or positron
 - Summary presentation

Other Details

Course Period	2024 Summer
Place	Rm. 501A, Science Complex A
Number of Students	1—4
Evaluation method	The evaluation method will be based on the report of analysis (60 %) and presentation with discussion (40%).

In Addition

Between Days2 and Day 3, we set a data accumulation period of several days.