

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

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GPPU Experimental Point (GEP): 4

Goal of Study

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

Contents

The new photon sensor, MPPC, has many pixels of avalanche photodiode (APD) in the sensitive area and the MPPC signal is the sum of all fired APD. By operating each APD in the Geiger mode, MPPC can have a large enough gain to detect a 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 detectors.

In this lecture, we obtain the skill to operate multi MPPCs by using the EASIROC board which was developed for this purpose. At first, we evaluate the basic performance and features of MPPC such as the relation between the operation voltage and signal gain. Then, we move to the readout of the scintillator hodoscope array with MPPC. In this detector, a wavelength shifting (WLS) fiber is embedded in the hole made on 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 X direction and 8 segments for Y direction. We try to read out the 128 channels of MPPCs with EASIROC board. As an advanced course, by making the special trigger with FPGA module, 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巻第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 period for about one week)
- ◇ 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	Summer 2026
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 Day 2 and Day 3, we set a data accumulation period of about one week.