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 detector 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 photo diode (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 an enough large gain to detect a single photon. The sensitive area of MPPC is rather small (typical size is 1 x 1 mm2). 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, 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 wave length 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 comic ray or the lifetime of the cosmic ray muon.

GPPU Experimental Course

N2 (GEP=4)

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)

☐ Days 3

Analysis of data (photon yield, detection efficiency, etc.) (experiment)

☐ Days 4

Analysis of the accumulated date

☐ Lifetime measurement of muon

☐ Angular distribution of emitted electron or positron

Summary presentation

Other Details

Course Period	2020 Summer
Place	Rm. 637, Science Complex B
Number of Students	1—8
Evaluation method	The evaluation method will be based on the report of analysis (60 %) and presentation with discussion (40%).

In Addition

Between Days3 and Day 4, we set data accumulation period of one day.

In 2020, due to the wide spread of the new corona virus (COVID-19), it is not clear whether we can hold a normal experimental lecture. If the situation does not become normal and students cannot attend the on-site experimental lecture, we will organize a limited version of lecture. We try to prepare experimental video and data will be taken by staff. Then students will analyze such data or past data. Therefore, if students including M2 students can wait for the normal lecture, we recommend class in next year or later. We accept students who have to get GEP point in this fiscal year.