Silicon photomultiplier as a position sensitive detector of Cherenkov photons

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Abstract

A type novel photon detector, silicon photomultiplier, has been tested in view of measuring Cherenkov photons in Ring Imaging Cherenkov (RICH) counters. One of the benefits if compared to other position sensitive detectors which are used in RICH counters is their insensitivity to the high magnetic fields. They have several other advantages (lower operation voltage, less material) over the conventional photomultiplier tubes. They also have a high peak photon detection efficiency ($\approx 20\%$), a high gain of $\approx 10^6$ and a good time response. Due to their dimensions, they allow compact, light and robust mechanical designs. All this would make them a very promising candidate for a photon detector of Cherenkov photons in a RICH counter. However, due to their serious disadvantage, a very high dark rate ($\approx 10^6$ Hz/mm^2), they have up to now never been used in ring imaging Cherenkov detectors, where single photon detection is required at low noise. Because the Cherekov light is prompt, this problem can in principle be solved by using a narrow time window (< 10 ns) for signal collection. In addition, it is possible to further increase the signal-to-noise ratio by using light collection devices.

The talk will focus in results of recent studies on how to adapt this photo-sensor to single photon counting. We will discuss single photo-electron pulse height and timing distribution, as well as uniformity of the response of individual SiPMs, of various producers and with different pixelisation. We will also report on studies how to increase the efficiency of such a detector with different light collection systems. Finally, the design optimization of a proximity focusing RICH counter with silica aerogel as the radiator medium and a SiPM array as the photon detector will be discussed.

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