Dark count measurements of SiPM detectors*

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The advantages of SiPMs as compared to conventional photomultipliers are high photon detection efficiency, moderate bias voltages, magnetic insensibility, and small size. Limitations for their usage in experiments come from dark count rate and after pulsing. These properties are a function of temperature and were measured here for two sensors. The temperature of the sensors was controlled by placing them in a Peltier-cooled light-tight aluminum box.

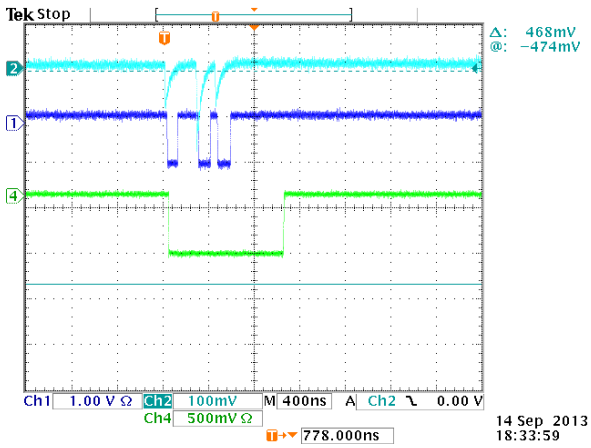

Figure 1: Oscilloscope example for dark count signals from a SiPM S10362-11-100P [1] at room temperature. The top trace shows a dark count with two after pulses. The middle one shows a gate from a discriminator which counts all signals, the bottom gate counts the groups, excluding the after pulses.

Electronic sensors (LM35AH) measured the temperature at two positions of the walls. Measurements were done when the temperature difference was below 0.5^{o}C. The dark count signals were followed by after pulsing, an example is shown in Fig. 1, top trace. In order to distinguish between true dark counts and after pulsing, we counted the hits with the help of two electronic gates from a discriminator. The $1\mu s$ long gate (bottom row) counted the dark counts, the short one of 100ns (middle row) includes after pulsing.

The count rate per second and square millimeter is shown in Fig. 2, for two devices. The error bars are within the symbol size. The top curves are for a S10362-11-100P from Hamamatsu [1], the bottom curves for PM3375 with trench technology from Ketek [2]. The closed symbols and

	PM3375	S10362-11-100P
Area	3x3 mm^2	1x1 mm^2
Cell pitch	75 μm	100 μm
Geo. effi.	72%	78.5%

Table 1: Geometric properties of the measured sensors.

open symbols denote the count rate without and with after pulsing, respectively. For each measurement the breakthrough voltage was determined and the device operated at 1 V overvoltage. The decrease of the dark count rate with decreasing temperature is clearly seen. It drops by a factor of two for a temperature decrease of 8.2^{o}C and 9.8^{o}C for the Hamamatsu and Ketek sensor, respectively. These values are close to the expected decrease of a factor 2 every 8^{o}C [3]. For both sensors the amount of after pulses decreases with decresasing temperatures as can also be seen in Fig,2 by the larger rate difference for closed and open symbols at the higher temperatures

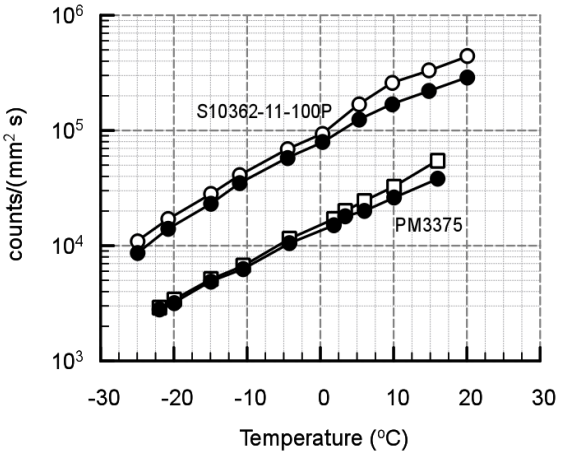

Figure 2: Dark count rates for two SiPMs. The open symbols denote the pulse rate including after pulsing, the closed symbols denote the pulse rate excluding after pulses.

References

[1] http://www.hamamatsu.com

[2] http://www.ketek.net/

[3] NIM A567 (2006) 48, D. Renker

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