Detection Efficiency of Silicon SPAD Detectors at Different Laser Repetition Rate and Mean Photon Number

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Single-photon avalanche photodiodes (SPADs) are widely used in photon-counting applications. The accurate determination of detection efficiency is therefore essential for reliable measurements in experiments operating at the single-photon level. In this study, we investigate the detection efficiency characteristics of two silicon SPAD detectors manufactured by Excelitas Technologies.Both detectors have a specified dead time of 23.5 ns and operate in Geiger mode for single-photon detection [1]. The objective of this work is to evaluate the influence of laser repetition frequency and the mean photon number per pulse on the measured detection efficiency of these detectors. Experiments were conducted at the Physikalisch-Technische Bundesanstalt (PTB) [2] using a stabilized diode laser operating at a wavelength of 683 nm with repetition frequencies ranging from 10 MHz to 80 MHz. The optical power was attenuated to achieve mean photon numbers per pulse (μ) between 0 and 0.4. This range allows investigation of the detector response from the single-photon regime to conditions where multi-photon events and dead-time effects begin to influence the measured count rate. The photon flux incident on the detectors was determined using a calibrated reference photodiode traceable to the national optical power standards at PTB. The detection efficiency was then calculated as the ratio between the corrected count rate and the incident photon flux. The experimental results are presented in Figure 1. The results indicate that the detection efficiency decreases with increasing mean photon number and laser repetition frequency. A detailed discussion of the results, together with a linear fit to the theoretical model[3], will be presented.

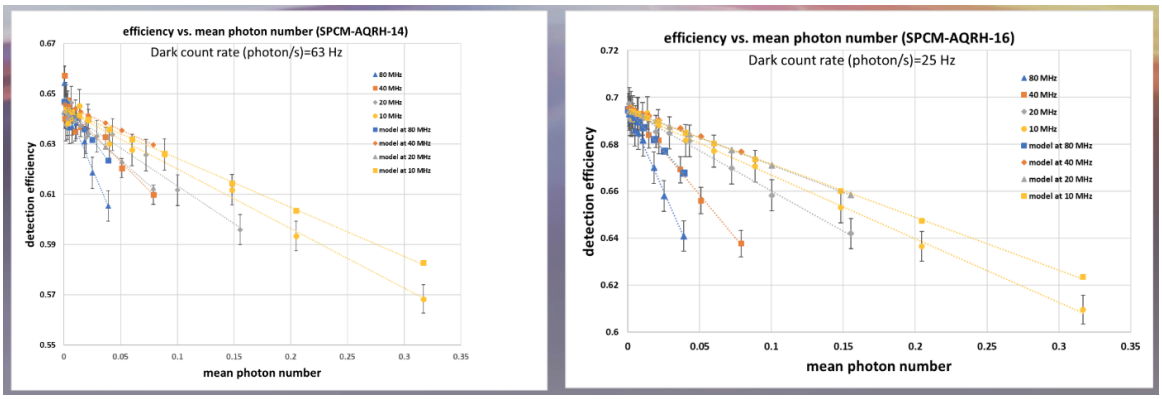

Fig. 1: *Detection efficiency at different mean photon number and laser repetition rate of SPAD detectors*

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References

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