6. Conclusion

This study presents the feasibility of a complete optical electrical model used to simulate the signal formation of a scintillation detector consisting of Si-based arrays of single photon counters. Validation with both theoretical calculations as well as measurements show that the model can accurately predict the response of SiPM single photon counting arrays to scintillation light. This model can be used as a tool to further understand the dependence of this response on basic detector characteristics, such as rise and decay time of the scintillator/photodetector, and can help to understand the contributions of each component to important performance parameters, such as light output and time resolution.

In addition, the combination of optical and electrical properties of the detector under the same simulation framework may allow for more accurate correlation of unknown parameters at the scintillation level to well defined parameters at the electrical response level by using appropriate signal processing techniques. Such correlation is highly desired in imaging modalities such as time of flight PET (ToF-PET), where accurate extraction of timing information has shown to depend on a variety of detector parameters in both the crystal and photodetector level [9].

It is expected that the findings of this study will guide the selection of the best combination of attributes that will optimize performance in scintillation detection. We aim at using the developed optical electrical model to guide the design of future radiation detectors in PET. Especially given the dominating trend in PET technology towards continuous, full detector signal digitization, models such as the one presented in this work will enhance the effort to extract the maximum amount of information based on signal processing methods and corrections.

Future work involves optimization of the model in order to properly account for detector response changes under the presence of optical crosstalk [27], afterpulses and dark counts [28]. The prediction of the detector response shape at the non-linear regime is currently under study given the improved timing performance of the devices under operating conditions near device saturation.

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