Contribution ID: **29** Type: **Contributed Oral**

Modelling the photodetection efficiency of SiPMs from the near UV to the IR

Here we present an experimentally verified model for characterising the photodetection efficiency of silicon photomultipliers (SiPMs). This work has been performed in the context of improving detector response for any SiPM based experiment requiring accurate photon simulations. The model is based on comprehensive measurements of photon detection efficiency for two UV sensitive Hamamatsu and FBK devices. Measurements have been under illumination from 350-900nm at various bias voltages, angles of incidence and temperatures. This permits a detailed description of optical transmission into the device, the internal junction structure, and the probabilities of charge carriers producing avalanches.

This model is a powerful tool to aid in assessing detector performance across a range of optical inputs and characterising optical cross-talk between SiPMs, as it can be generalized to a broad range of devices. In addition, we will discuss extensions to the model including temperature dependance, internal electron transport and surface microstructure effects. Lastly, this model can inform future device design, as we hope to show the possibility of producing a silicon SPAD with a photon detection efficiency close to unity.

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Session Classification: Evening 3 - Dark Matter Searches

Track Classification: Dark Matter Searches