Dark Noise Photon Emission in Silicon Photomultipliers

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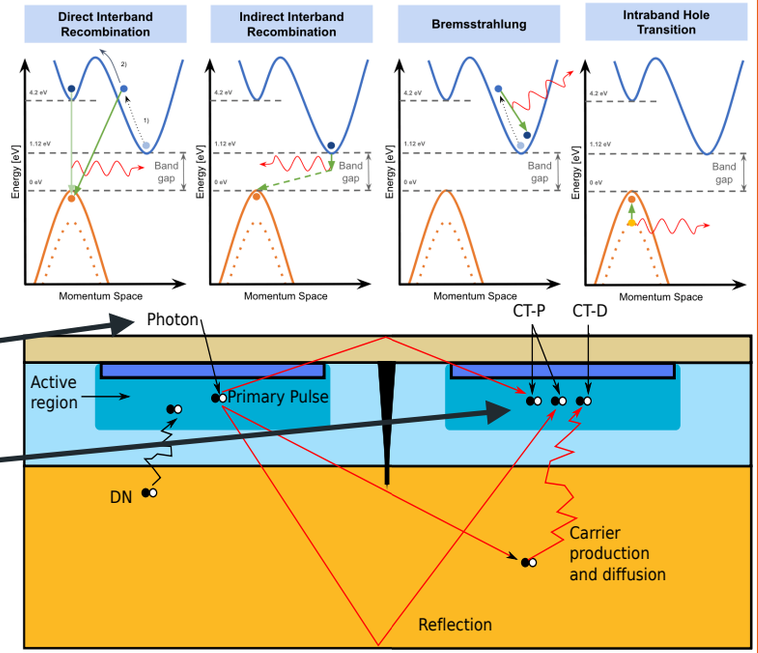
ABSTRACT

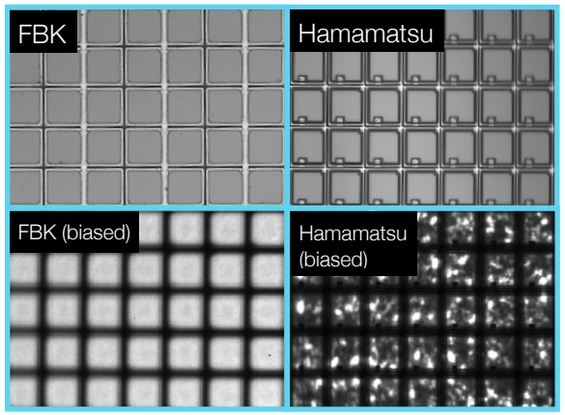
The Silicon Photomultiplier (SiPM) is the light detection device of choice for many next-generation astroparticle physics experiments. A SiPM is a densely packed array of single photon avalanche diodes (SPADs). In this poster, we summarize the physical processes involved in SPAD light detection and emission and discuss our methodology for characterizing the thermal and stimulated light emission of SPADs using our Microscopy with Injected and Emitted Light (MIEL) experiment.

INTRODUCTION

- Avalanches in silicon can radiate via several processes—e.g. recombination, bremsstrahlung

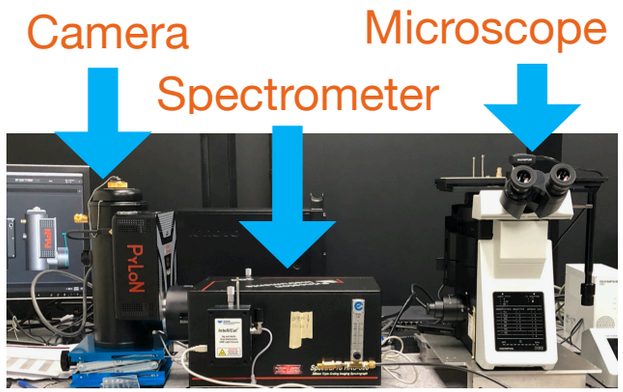


- Incident photons on SPAD generate charge avalanches
- Emission can trigger avalanches in neighbouring SPADs—i.e. *correlated optical cross-talk*

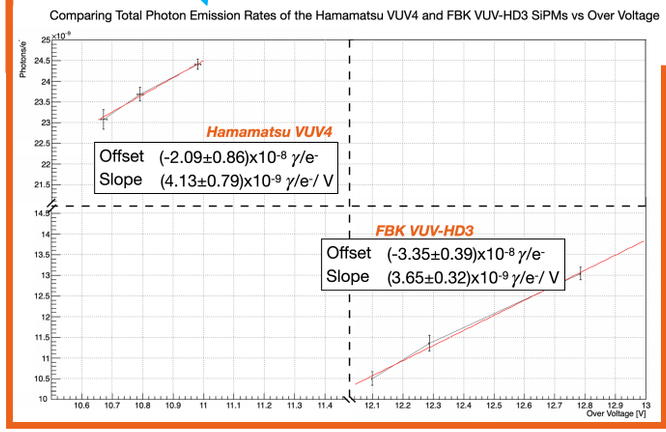


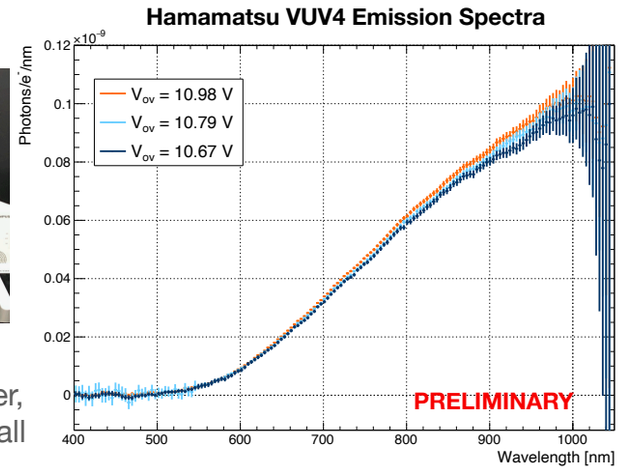
- To characterize cross-talk, we need to understand SPAD emission
- Our Microscopy with Injected and Emitted Light (MIEL) experiment aims to study two SiPM designs
- FBK VUV-HD3 SiPM (left) and Hamamatsu VUV4 MPPC (right)

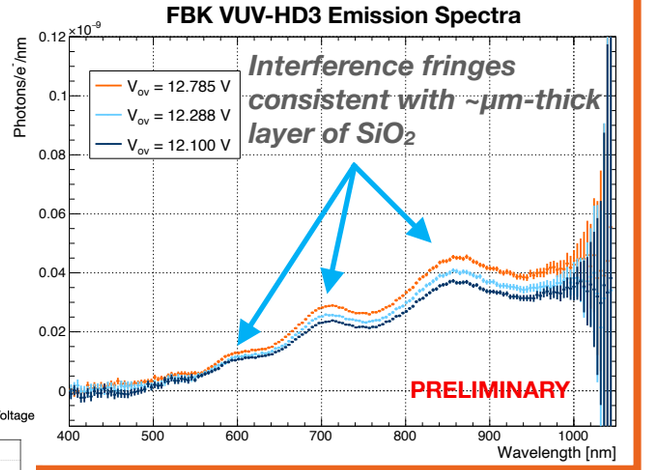
MEASUREMENT & ANALYSIS



- MIEL uses microscope to magnify SiPM emission, direct light through spectrometer, then capture image in CCD camera (now all in dark enclosure)
- VUV4 is emitting roughly twice as many photons as VUV-HD3 under the same conditions
- SiPM response in photon yield vs. over-voltage is similar for both the VUV4 and VUV-HD3







SUMMARY & OUTLOOK

- Publication on dark noise spectra expected within the month
- Upgrading to radiometric calibration
- Laser stimulated emission measurements to follow; aiming for publication by summer 2021

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