Semester or MSc project proposal

3D device modelling of miniaturized SPADs

General Information:

Laboratory: Advanced Quantum Architecture Laboratory (AQUA)
Partners: EPFL
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Location: Neuchâtel (travel and lunch allowance - lump sum)
Starting date: ASAP
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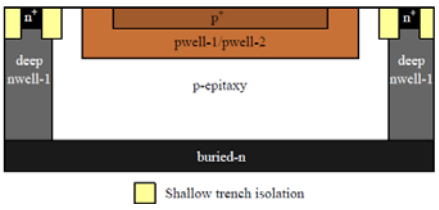
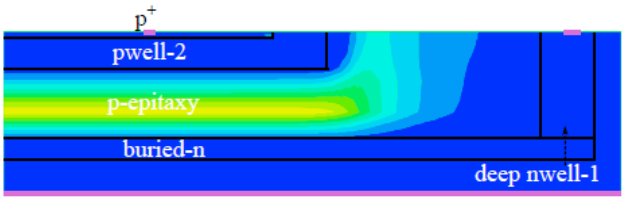
Background:

Recent advances in CMOS-compatible single-photon avalanche diodes (SPADs) have attracted great attention for a wide variety of scientific and industrial applications. Developed in standard CMOS in 2003, the SPAD pixel size has continuously reduced and image sensor size increased. The current pixel array record is 512×512, corresponding to 0.26 megapixel. Achieving SPAD sensors with high spatial resolution, up to multi-megapixel, will enable to expand their potential toward novel applications in fluorescence microscopy, automotive sensing, and 3D robotic vision.

To construct compact and cost-effective multi-megapixel SPAD cameras, it is crucial to investigate further miniaturization of the SPAD pixels toward 3-7 μm, which can be arrayed in small sensor formats. However, reducing the active area dimensions to a few micrometers may lead to a dramatic decrease of photon detection probability (PDP) and increase the risk of premature edge breakdown due to three dimensional effects in the electric field distribution.





Objectives:

The objective of this work is to construct a 3D device simulation model with TCAD, and clarify the impact of pixel miniaturization on basic SPAD performance parameters, e.g. PDP and dark count rate (DCR).

Tasks:

- Literature research
- 3D device modelling with TCAD Simulator (Synopsys Sentaurus)
- Proposing scaling laws of SPAD performances