

## Characterizing cross-talk in linear SPAD array and harnessing it for system calibration

In this work, we present a detailed study of cross-talk in a linear single-photon avalanche diode (SPAD) array using the LinoSPAD2 detector, which features 512 time-resolved channels with a timing precision of 40 ps r.m.s. By characterizing and leveraging cross-talk effects, we were able to calibrate the intrinsic delays in the system readout, reducing the uncertainty in the position of coincidence peaks from  $\pm 10$  ns down to  $\pm 50$  ps. While such detectors are increasingly used in diverse fields – from quantum communications to time-resolved imaging and quantum-assisted astronomy – their performance can be critically affected by inter-channel cross-talk, especially in photon correlation measurements such as the Hanbury Brown and Twiss (HBT) effect. Cross-talk can mimic genuine correlation signatures, posing a fundamental challenge in experiments relying on spatial or temporal intensity correlations.

We compare two versions of the LinoSPAD2 sensor: one equipped with microlenses to enhance photon collection efficiency, and one without. Our measurements reveal a clear difference in cross-talk behavior between the two. Specifically, we observe that the addition of microlenses, while beneficial for photon detection efficiency, also leads to a measurable increase in cross-talk probability between neighboring channels. We analyze the spatial decay of cross-talk and discuss its implications for experiments sensitive to second-order correlations. These findings offer valuable insight into the trade-offs involved in SPAD array design and optimization for low-noise, high-resolution single-photon detection.

[1] Kulkov, Sergei, et al. "Inter-pixel cross-talk as background to two-photon interference effects in SPAD arrays." *Journal of Instrumentation* 19.12 (2024): P12015.

[2] Kulkov, Sergei, et al. "Characterizing and exploiting cross-talk effect in SPAD arrays for two-photon interference." *arXiv preprint arXiv:2504.01185* (2025).