Small SPAD-arrays for confocal fluoresence lifetime imaging

J. Hummert[1], M. Tillmann[1], F. Koberling[1], T. Roehlicke[1], M. Wahl[1], I.M. Antolovic[2], U. Ortmann[1], V. Reiter-Scherer[1], R. Erdmann[1]

[1] PicoQuant GmbH, Rudower Chaussee 29, 12489 Berlin, Germany, info@picoquant.com; [2] Pi Imaging Technology SA, EPFL Innovation Park, 1015 Lausanne, Switzerland, info@piimaging.com.

Abstract

Confocal microscopy is an essential tool in many academic disciplines due to its intrinsic sectioning capability. It combines naturally with time-resolved single photon detectors and time-correlated single photon counting (TCSPC) devices. This has established it as the leading platform for time resolved investigation methods such as fluorescence lifetime imaging (FLIM) and fluorescence correlation spectroscopy (FCS). Recently, high-performance SPAD-arrays featuring few tens of pixels have become available. Combining these with suitable multi-channel TCSPC-devices opens up new possibilities in confocal time-resolved sensing.

In this work we present the two central hardware building blocks: PicoQuant's latest multi-channel TCSPC device and a cooled high-performance 23-pixel SPAD-array developed jointly with Pi Imaging Technologies. We show how the combination of these devices can bring superresolution imaging modalities such as image scanning microscopy (ISM) to the realm of lifetime imaging. The main benefit of ISM is an increase in SNR and lateral resolution, a gain that is fully compatible with lifetime information. We discuss how advanced data processing can be applied to FLIM-ISM for additional performance gains. We see the application of small arrays to superresolution-imaging as just one example how this technology can shape the future of confocal time-resolved microscopy. Many more applications are and will potentially be discovered in the coming years as the hardware becomes more readily available.