

# Decoding Optical Aberrations in Laser Scanning Microscopy via a Detector-Array: Towards a New Adaptive Optics Architecture

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Fast detector arrays [1] and adaptive optics [2] are quickly revolutionizing fluorescence laser scanning microscopy (LSM). However, their combination to realize an easy architecture for high-resolution deep imaging has not been explored. Here, we show that the information provided by the detector-array about the detection/probing volume of a laser scanning microscope can also be used to directly assess optical aberrations without the need for a separate wavefront sensor. This information can be immediately integrated into the image reconstruction algorithm for image scanning microscopy (ISM) [3] to compensate for the optical aberrations occurring in the fluorescence emission path. It is possible to exploit the same information to correct aberrations in the excitation path with an adaptive optical element, such as a spatial light modulator or a deformable mirror. We believe that this can significantly simplify the implementation of adaptive optics techniques in laser-scanning microscopy.

[1] M. Buttafava *et al.*, “SPAD-based asynchronous-readout array detectors for image-scanning microscopy”, *Optica*, **7**(7), 755-765 (2019).

[2] M. J. Booth, “Adaptive optical microscopy: the ongoing quest for a perfect image”, *Light: Science and Appl.*, **3**, e165 (2014).

[3] M. Castello *et al.*, “A robust and versatile platform for image scanning microscopy enabling super-resolution FLIM”, *Nat. Methods*, **16**, 175-178 (2019).