

FULLY PROGRAMMABLE ARRAY MICROSCOPE BASED ON ACOUSTO-OPTIC MODULATION AND CMOS PINHOLING

R. Bola¹, D. Treptow¹, D. Romero², S. Lumbreras¹, F. Lumbreras², E. Martín-Badosa¹,
M. Montes-Usategui¹

¹Optical Trapping Lab - Grup de Biofotònica, Universitat de Barcelona, Martí i
Franqués 1, 08028 Barcelona, Spain

²Computer Vision Center & Computer Science Department, Universitat Autònoma de
Barcelona, Edifici O, 08193 Bellaterra, Spain
E-mail: raul.bola@ub.edu

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Over the last decades there have been many efforts to develop a fast and efficient programmable array microscope (PAM) [1]. A PAM is a very powerful concept that combines the benefits and capabilities of many existing confocal microscopes into the same device, so the user can decide the best operating mode depending on the sample or experimental requirements. The most successful implementations of PAMs use either a DMD or a SLM in the optical setup but both approaches present some limitations in terms of light efficiency (DMDs) or modulation speed (SLMs). Here, we present a new PAM prototype that uses two novel technologies for both sample excitation and confocal filtering. On the one hand, we have developed a fully programmable illuminator using modified acousto-optic deflectors (AODs). By computing and synthesizing complex radio-frequency signals and injecting them into the AOD cell we can project on the sample almost any excitation pattern and shift them following any scanning protocol at very high speeds (150 kHz), with high optical efficiency. Then for the confocal filtering and final image reconstruction we use a custom designed CMOS camera that can be selectively read in the same way the sample is scanned. Sensor partial readout significantly increases the effective framerate (over 20 kHz) and directly provides confocal images, since the selected pixels themselves act as virtual pinholes [2]. With these two key ingredients, our PAM becomes a very versatile instrument: it allows high-speed imaging while still being compatible with image scanning microscopy and other super-resolution techniques, future new excitation patterns and smart scanning approaches.

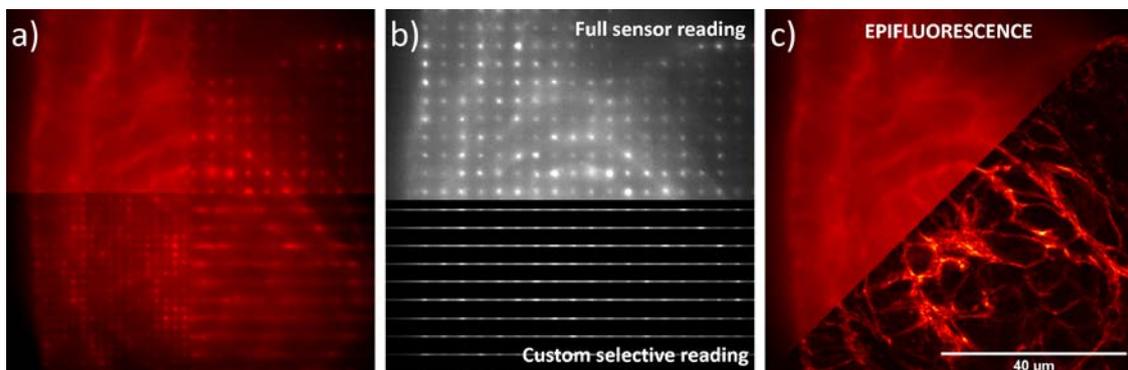


Figure 1. Fluorescence images of the actin network (phalloidin-TRITC) of a chick embryo. a) excitation with different patterns, b) custom sensor reading scheme, c) final confocal image.

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[2] D. Vucinic, Y. M. Chi, M. W. Hetzer, G. Cauwenberghs, T. J. Sejnowski, *Advances in Imaging, OSA Technical Digest (CD)*, paper NWA6 (2009).