Contribution ID : **24** Type : **Poster**

Multi-purpose SLM-light-sheet microscope

A classical Selective Plane Illumination Microscope (single light-sheet, generated using a cylindrical lens) suffers from a number of issues, such as shadow artefacts, scattered out-of-focus background and limited FoV (Field of View). A variety of advanced techniques in light-sheet microscopy have been proposed to tackle these issues, and previous publications have shown how image quality can be improved by rejecting out of focus light (structured illumination and pencil beam scanning), reducing shadow effects (light-sheet pivoting), or increasing the effective FoV by moving the focus of the light-sheet across the imaging FoV (tiling).

We have developed a SLM-SPIM system which is able to perform all the above-mentioned techniques. To obtain such a versatile system, we integrated a phase-only Spatial Light Modulator (SLM) into the illumination arm of a classical SPIM. We will present our system and discuss how the SLM, placed in a Fourier plane, allows to modulate the microscope's light-sheet in an easy and programmable manner. We will illustrate the results obtained performing different imaging techniques on samples of fluorescent beads, Zebrafish (*Danio rerio*) embryos, and optically cleared whole mouse brain samples.

With its simple design and the use of a computer-reconfigurable SLM, we believe our system represents an ideal platform for manipulating the illuminating light-sheet to apply a range of advanced imaging techniques on a single microscope, and also to explore combinations of multiple techniques and potentially trial new ones. The modular nature of our system also offers the possibility to choose between three slightly different setups, which result in different light-sheets, in thickness and height, and in a different conjugation of the SLM with the sample plane. We will discuss the consequences of the different conjugations and how the setup can be selected according to the characteristic of the sample and the imaging technique to be performed.

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Session Classification : Posters