

4D in vivo blood flow mapping using SPIM- μ PIV in the zebrafish heart

Light sheet microscopy is an ideal tool for precision mapping of flow fields on a microscopic scale, due to its optical similarities with particle image velocimetry, which on a macroscopic scale is a mature technique in fields such as aerospace engineering. Several challenges exist that mean it is difficult to obtain high-quality 3D velocity data in a living sample, but we will show how optical gating allows us to enhance the measurement quality dramatically, by applying statistically rigorous correlation-averaging techniques on the periodic flow within the beating heart.

We show how our approach enables high-precision mapping of blood flow throughout the heartbeat, and quantification of actual pumped volumes in the presence of flow regurgitation. We explore the repeatability of the flow across heartbeats, as well as the distinction between blood plasma flow and transport of the red blood cells themselves. Finally, we present preliminary results showing recovery of the out-of-plane velocity component, permitting full 3-dimension, 3-component velocity mapping throughout the heartbeat.

Our novel results illustrate the applicability of SPIM- μ PIV as a reliable, truly non-invasive in vivo microfluidics imaging modality, with no need for micro-injection of fluorescent beads. We propose this will enable researchers to merge quantitative flow and structure information in 4D as an input and validation for computational models of heart mechanics.

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Terms and Conditions

Yes

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Session Classification : Neurobiology applications of light sheet microscopy

Track Classification : Light sheet fluorescence microscopy