HIGH-SPEED CARDIAC IMAGING IN ZEBRAFISH

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For most vertebrates, the heart is an essential organ. Its periodic, self-contained beating ensures that oxygen is distributed across the organism. Cardiac dysfunction can have immediate adverse effects, including heart failure and sudden cardiac death. Although cardiac development and factors that affect it are ideally imaged in intact living organisms, structural studies of the heart have long been limited to the microscopy of fixed and stained sections. The process of excision, fixation, sectioning and staining introduces artifacts that defeat precise measurements and changes the spatial relation of cardiac components. Moreover, studies of cardiac dynamics and continuous development have not been possible at all.

To address this, we build custom light sheet microscopes for recording high-resolution images of the beating zebrafish heart. The high-speed optical sectioning capabilities and minimized phototoxicity of light sheet microscopy, and zebrafish’s optically accessible heart make a perfect match for in vivo cardiac imaging [1]. We capture three-dimensional cardiac dynamics with post-acquisition synchronization movie-stacks [Fig. 1], obtain static high-resolution reconstructions by stopping the heart with light using optogenetics and resolve non-periodic phenomena like arrhythmia and hemodynamics by high-speed volume scanning with an electrically tunable lens. 3D reconstructions from light sheet microscopy data with high spatial and temporal resolution offer unique insights into the anatomy and function of the intact zebrafish heart without fixation artifacts. Here, we will discuss our technical solutions for in vivo cardiac imaging and present resulting data.