

Flamingo: Modular and portable light sheet microscopy framework for novel biological experiments inside and outside the optics lab

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Abstract

Novel microscope technology is typically developed in a physics or engineering lab, making it difficult for biologists to access the latest and greatest in microscopy: They can ask the inventor to collaborate, try to build their own copy, or wait until it becomes available commercially. These options each have drawbacks and will slow down the dissemination of the technology [1]. The goal of our Flamingo project has been to build shareable, modular, and mobile light sheet microscopes to unlock exciting new imaging experiments in scientific research laboratories. Each Flamingo microscope is tailored for the specific specimen and application to provide the best possible instrument for the collaborator. Potential light sheet microscopy users can test the technology for their specific research before committing and building their own microscope or buying a commercial setup. Using a Flamingo, scientists get first results very quickly, which is useful for high-risk experiments, newly established laboratories, or grant applications.

We created a microscope that packs all the optical performance of our existing stationary light sheet microscopes into a compact and modular framework. We can build microscopes for our own research more sustainably and can build various light sheet microscope configurations using the same components. The Flamingo microscopes handled a variety of biological samples and imaging challenges exceptionally well. Recently, our collaborators and we recorded stem cell migration in zebrafish larvae, the early development of Parhyale, brain activity in adult Danionella, cell flow patterns in mouse embryos, and early cell divisions in Hofstenia, among others. The entire Flamingo setup fits in two roller cases and can be moved from lab to lab, packed in the trunk of a car, and shipped over long distances. By now, we have collaborated with over 20 labs in more than a dozen institutions.

Flamingo is also an excellent tool for microscopy and biology courses as it is more accessible than the typical “black box” commercial microscope and is therefore well suited to teach the principles and concepts of light sheet microscopy. On the one hand, Flamingo makes light sheet microscopy more accessible to biologists; on the other hand, we benefit from the Flamingo by learning about exciting new imaging projects, getting access to new specimens, and integrating user feedback when building the next iteration of these instruments. We also see large potential in expanding our concept to areas beyond light sheet microscopy, and we would be happy to get new partners on board to push these ideas forward.

