HIGH SPEED DEEP TISSUE MULTIPHOTON BRAIN IMAGING

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1. THE NEED FOR DEEP TISSUE IMAGING

Neurophotonic imaging has a challenging set of requirements for new types of instrumentation. The brain exhibits many dynamic phenomena, including electrical activity (which may be probed optically[1]), as well as blood flow[2], and to complicate matters further, many of the most interesting phenomena occur in 3D structures located hundreds of microns below the surface of the *cortex*, or outermost layer of the brain. It is therefore necessary to image them using a technique that exhibits *axial resolution*, or the ability to unambiguously distinguish light emitted from different z-planes, without compromising on pixel throughput.

2. HIGH-THROUGHPUT TEMPORAL FOCUSING

To solve this problem, we present a complete brain imaging system that combines a custom-designed high-throughput wavelength agile temporal focusing microscope, high multiphoton-cross-section long-wavelength quantum dots, and custom-written software able to process datasets that are several hundred gigabytes in size. This system is used to demonstrate imaging of vasculature up to 500µm into a live mouse brain, take 4-megapixel images at 100fps, and map blood flow over a region 5mm in diameter with a flow resolution of less than 5µm. An example of tissue penetration can be seen in Figure 1. We will discuss some of the design constraints in this system, performance, and prospects for further improvements.

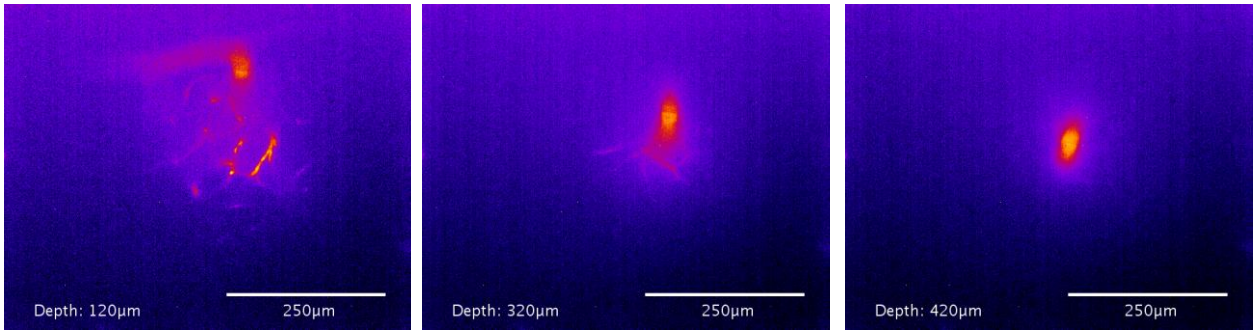

Figure 1: Imaging vasculature over 400um deep into the mouse brain using temporal focusing multiphoton microscopy combined with custom-made quantum dots

3. REFERENCES

1. Y Gong et al., Science 350(6266):1361 **2015**
2. OT Bruns *et al.*, *Nat. Biomed. Eng.* 1(4):56 **2017**