

ENCODED MICROSCOPY FOR SCALABLE OPTICAL IMAGING OF THE BRAIN

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Studying and reverse-engineering the mammalian brain is one of the greatest challenges in life sciences. This is mainly due to the large number and small size of cellular elements and the high complexity of their connections. However, the traditional way of exploring neuronal function with microelectrodes is limited to few neurons and simple networks.

To overcome this limitation, many innovative approaches studying the brain rely on optical imaging, employing molecular probes which are engineered to be activated or interrogated by photons. Advanced optical techniques can explore living brain tissue with subcellular resolution. However, the requirements for these techniques to investigate neural systems extend beyond both spatial resolution to distinguish neuronal elements and temporal resolution to monitor neuronal signaling. In fact, multiple neuronal sites need to be simultaneously probed to account for the non-linear and non-stationary nature of the brain.

Encoded microscopy is an elegant approach to achieve simultaneous multi-site imaging. Multiple excitation beams are time- or frequency-encoded, and the detected emission signal is decoded into multiple channels with high spatio-temporal resolution. I will present a few advanced approaches of encoded microscopy suited to analyze structure, function and connectivity in different preparations. Emerging techniques of encoded high-throughput imaging systems to study large populations of neurons will be discussed.