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X-ray imaging of brain

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Comprehensive mapping of neural networks of animal brains is a formidable but very exciting challenge. The complexity of the complete network is beyond the current technology to describe, analyze and understand. It is now a consensus that the first step towards understanding brain functions is to construct a basic map – a connectome – showing the neural network at the level of single neurons and connections. As one of the six "high priority challenges" in the US BRAIN Initiative: "Maps at multiple scales: Generate circuit diagrams that vary in resolution from synapses to the whole brain", we believe our imaging strategy using synchrotron x-rays will transform this vision onto reality.

The key element in our technology arsenal is the phase contrast micro- and nano-tomography. The high-performance x-rays photons provided by the new facilities such as synchrotrons and x-ray free electron laser opens the door for x-ray microscopy to an unprecedented level of performance. The technology to focus hard-x-rays photons has made great progress in the past decade. However, practically achieving nanometer scale resolution remains a formidable technology challenge. The development of nanotechnology to fabricate nanostructured device impact unexpectedly x-ray microscopy by providing the long sought optics required to achieve high resolution and high contrast. Using the same x-ray photons with the nanotomography instrument, the fine details of the same specimens can be imaged in 3D with <20 nm resolution. This allows us to examine the smallest network features, such as dendrites and dendritic splines, within specific regions, important features to understand how the whole brain network functions.

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