Hierarchical Imaging of the Human Brain with Hard X-rays

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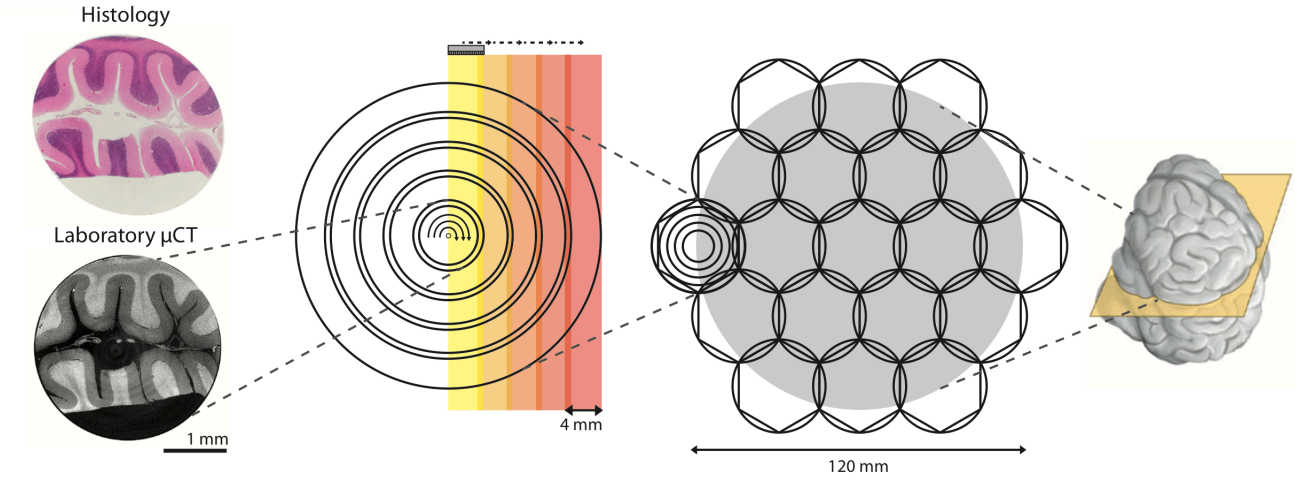
Three-dimensional brain imaging with (sub-)cellular resolution plays a critical role in understanding the brain in health and disease because the brain's micro- and nano-structure is closely related to function. The gold standard for neuroimaging is histology, which takes advantage of well-established tissue preparation and staining protocols as well as optical or electron microscopy, however three-dimensional imaging requires serial sectioning due to limited penetration depth. X ray-based approaches are complementary [1], with short wavelengths and deep penetration allowing for non-destructive analysis of neuroanatomy across many length scales [2]. The possibility of brain imaging with advanced laboratory sources can help to overcome certain challenges standing in the way of hierarchical full brain X-ray imaging. These include optimizing sample preparation, utilizing alternative contrast mechanisms (e.g. grating interferometry), understanding morphological changes from the *in vivo* state through death and fixation [3], and extending the field of view of high-resolution X-ray imaging [4]. Each of these topics would be more easily achieved with the accessibility lab sources, especially as new developments close the quality gap to synchrotrons. We will present our team's progress on hierarchical neuroimaging and a roadmap for future developments with a particular focus towards the role of advanced laboratory sources.



Histology and X ray-based virtual histology (left) provide complementary information for neuroimaging, even with laboratory sources [1]. One challenge towards imaging larger volumes is increasing field-of-view [3]. We suggest a combined mosaic-style approach, which could be implemented in advanced laboratory sources provided that the beam is not highly divergent.

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