Contribution ID: **29** Type: **Talk**

The Extremely Brilliant Brain: The Isotropic Micrometric Human Brain Dataset

Tuesday 10 September 2024 11:30 (15 minutes)

Introduction
Brain atlases derived from MRI are a common tool for neuroscientists to understand the anatomy of the brain. However, as MRI has a limited resolution, these tools give a poor insight into fine structures [1]. This is why different groups have developed microscopy-based atlases which nevertheless require hours of sequential cutting and mapping [2,3]. Thus, we unveil a 7.72-micron brain dataset acquired with HiP-CT (Hierarchical Phase-Contrast Tomography), enabled by the Extremely Brilliant Source upgrade of European Synchrotron Radiation Facility (ESRF, Grenoble) and its beamline BM18, as a proof of concept for high-throughput anatomical studies.

Methods
The whole brain was obtained from LADAF (Grenoble). As part of our published protocol [4], it was fixed in formalin and prepared in a 70% EtOH / agar mix, followed by degassing. HiP-CT scanning was performed at the beamline BM18 of the ESRF with an isotropic voxel size of (7.72 µm)3; reconstruction and phase retrieval were performed with the PyHST2 toolbox. The dataset was aligned to the BigBrain space [2] using voluba (https://www.ebrains.eu/tools/voluba). Finally, structure tensor analysis [5] was conducted on the dataset.

Results & Discussion
Following the structure tensor analysis (cf. Figure 1), the fiber tracts can be studied in areas which were not resolved with MRI like the zona incerta [6]. Besides, the resolution enables the study of both white matter and blood vessels at the same time, along with the segmentation of smaller structures such as the choroid plexus. The strength of this dataset lies in the resolution, and in the isotropic and distortion-free imaging; thus, it should be used in a similar and complementary fashion to the BigBrain [2]. Alignment within the BigBrain space will enable the comparison of HiP-CT data with complementary microscopic modalities such as cytoarchitectonic maps and polarized light imaging.

Figure 1 (cf. attached file): Fractional-anisotropy map of a coronal slice of the Extremely Brilliant Brain, which reveals fibers in the striatum.

Conclusion
This unique dataset enables a label-free study of the brain at a micrometric scale, which bridges low-resolution in vivo techniques and high-resolution microscopy.

References

[1] K. H. Maier-Hein et al., Nature Communications 2017, 8, 1349.
[2] K. Amunts et al., Science 2013, 340, 1472.
[3] S. Ding et al., Journal of Comparative Neurology 2016, 524, 3127.
[4] C. L. Walsh et al., Nature Methods 2021, 18, 1532.
[5] N. Jeppesen et al., Composites Part A: Applied Science and Manufacturing 2021, 149, 106541.
[6] S. N. Haber et al., Biological Psychiatry 2023, 93, 1010.

Primary authors: CHOURROUT, Matthieu (University College London, Department of Mechanical Engineering); Dr YAGIS, Ekin (University College London, Department of Mechanical Engineering); Mr WANJAU, Eric

(University College London, Department of Mechanical Engineering); Dr BRUNET, Joseph (University College London, Department of Mechanical Engineering); Dr STANSBY, David (University College London, Department of Mechanical Engineering); THOENNISSEN, Julia (Forschungszentrum Jülich, Institute of Neurosciences and Medicine (INM-1)); GUI, Xiaoyun (Forschungszentrum Jülich, Institute of Neurosciences and Medicine (INM-1)); DICKSCHEID, Timo (Forschungszentrum Jülich, Institute of Neurosciences and Medicine (INM-1)); Dr BELLIER, Alexandre (European Synchrotron Radiation Facility, Laboratoire d'Anatomie des Alpes Françaises (LADAF)); Dr TAFFOREAU, Paul (European Synchrotron Radiation Facility); Prof. LEE, Peter (University College London, Department of Mechanical Engineering); Dr WALSH, Claire (Univeristy College London, Department of Mechanical Engineering)

Presenter: CHOURROUT, Matthieu (University College London, Department of Mechanical Engineering)

Session Classification: Contributed Talks - Multimodal data acquisition and processing (co-Chairs: Jordan DeKraker, Timo Dickscheid)