SLS Symposium on

Microstructure and Imaging

Tuesday, January 31, 2017

10:00 to 12:15, WBGB/019

10:00 TOMCAT Special Seminar of Prof. Konukoglu
"Quantitative medical image analysis for personalized decisions"

Abstract: *Advances in acquisition technologies and increasing use of images are giving computational image analysis and modeling important roles in patient-care and biology. This presentation will aim to present an overview of our previous expertise in medical image computing and future research plans in the field. I will provide examples from our earlier research for various applications and hope to start discussions around possible collaborations.*

10:30 High-energy phase and dark-field contrast
Matteo Abis, M. Buechner, Z. Wang and M. Stampanoni

11:00 Coffee

11:15 Towards the reconstruction of the mouse brain vascular networks with high-resolution synchrotron radiation X-ray tomographic microscopy
Alessandra Patera and M. Stampanoni

11:45 *In-vivo* lung Imaging activities at TOMCAT
G. Lovric, C.M. Schlepütz, I. Vogiatzis Oikonomidis, J. C. Schittny, M. Roth-Kleiner, and M. Stampanoni

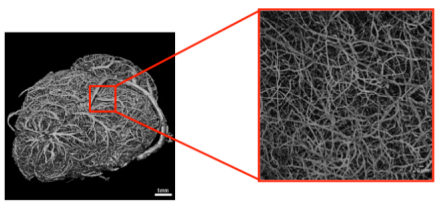

Figure 2: Whole mouse brain vessel microstructure segmentation

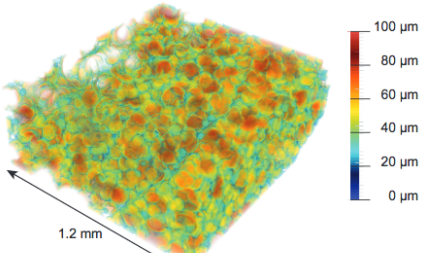

Figure 1: Lung Microstructure: segmentation at the aleveolar and acinar scale with 30cm H20 pressure.

Towards the reconstruction of the mouse brain vascular networks with high-resolution synchrotron radiation X-ray tomographic microscopy

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The formation and progression of several vascular diseases in the brain is accompanied by changes in the vessel micro-structure and morphology. A clear visualisation and an in-depth knowledge of the vascular system is essential for better understanding the pathophysiological mechanisms of neurovascular disorders. The brain vasculature architecture is currently documented at 16 μm resolution in micro-Computed Tomography (CT) [1] and about 5.9 μm pixel size with synchrotron-radiation based micro-CT [2]. Within the context of the Human Brain Project (HBP), we aim at using synchrotron radiation X-ray tomographic microscopy at the Swiss Light Source of the Paul Scherrer Institute (Switzerland) as a key technology for reconstructing, in a non-descructive way, the entire vascular system of the mouse brain at 1 μm resolution. The sample is prepared by intravascular filling with consecutive embedding of the tissue, adopting a protocol suggested by [3]. 800 local CTs are performed to cover the whole brain volume with a pixel size of 0.65 μm, thus resulting in a total of 7 TB of datasets to be processed. To address this challenge, we extend the method in order to work on several scans by enabling the use of many machines in parallel, thus allowing the stitching and analysis of such large datasets. At this point, these pioneering efforts are pointing towards new horizons in the investigation of large biological samples with 3D high spatial resolution.

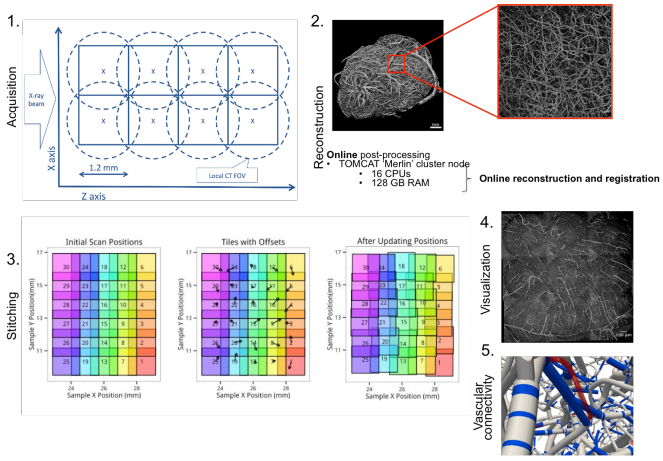

Figure 1: A schematic overview of the project- from image acquisition to processing of TB- sized dataset of the mouse brain

References

[1] Heinzer, S. et al. (2008). Novel three-dimensional analysis tool for vascular trees indicates complete micro-networks, not single capillaries, as the angiogenic endpoint in mice overexpressing human VEGF (165) in the brain. Neuroimage 39, 1549–1558; doi: https://doi.org/10.5167/uzh-705

[2] Zhang, M.-Q. et al. (2015). Ultra-high-resolution 3D digitalized imaging of the cerebral angioarchitecture in rats using synchrotron radiation. Sci. Rep. 5, 14982; doi: 10.1038/srep14982

[3] Xue S. et al. (2014). Indian-Ink Perfusion Based Method for Reconstructing Continuous Vascular Networks in Whole Mouse Brain. PLoS ONE 9(1): e88067. doi: 10.1371/journal.pone.0088067

In vivo lung imaging activities at TOMCAT

G. Lovric[1,2], C. M. Schlepütz[1], I. Vogiatzis Oikonomidis[1,3], J. C. Schittny[3], M. Roth-Kleiner[4], and M. Stampanoni[1,5]

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Lung failure represents the leading cause of morbidity and mortality worldwide and is the 4th leading cause of death in Switzerland [1]. Studying the fundamental pathogenic pathways of various lung diseases requires the understanding of the processes taking place at the microscopic and functional scale in the lung. Previously, we have realized for the first time *in vivo* synchrotron-based tomographic imaging of lungs at the alveolar scale with pixel sizes down to a micrometer [2]. In our recent efforts we have slightly moved our focus to the study of several lung disease models, both by *in vivo* and *post mortem* tomographic imaging.

Here, we present our latest developments at the TOMCAT beamline in view of instrumentation and the accompanying components for achieving this type of experiments. We describe our multi-purpose imaging endstation design for high-resolution micrometer-scaled sub-second tomography [3]. The most recent results from *in vivo* experiments are shown and a general overview of the current lung imaging activities at TOMCAT is given, where we outline both the current limitations and the future perspectives in the context of novel applications to related scientific fields.

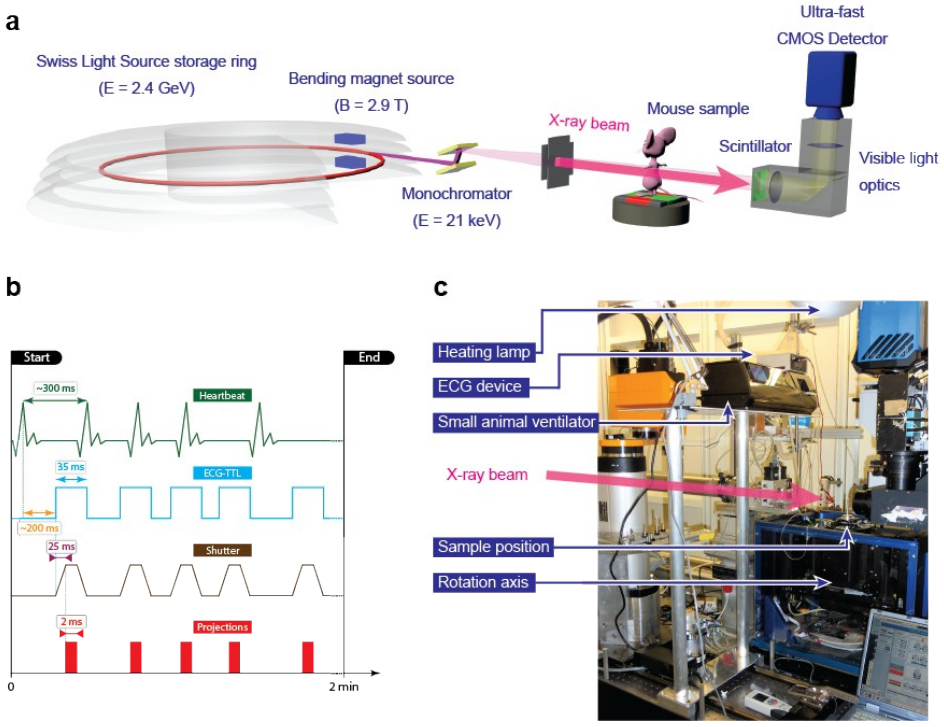

Fig. 1: Schematic of the experimental setup at the X02DA TOMCAT beamline.

References

[1] Statistik Schweiz, "Sterblichkeit, Todesursachen", http://www.bfs.admin.ch/.
[2] G. Lovric, PhD thesis, ETH Zurich (2015), http://doi.org/bd3z.
[3] G. Lovric, R. Mokso, C. M. Schlepütz, and M. Stampanoni, Phys. Medica **32**(12), 1771 (2016), http://doi.org/bp54.