

Phase Contrast X-ray Tomography of Biological Tissues: How can 3d virtual Histology help to fight Covid-19?

Tim Salditt, Institut für Röntgenphysik, Universität Göttingen,

X-rays can deeply penetrate matter and thus provide information about materials or biological matter in 3d and at high resolution. Until recently, however, this potential of hard x-rays in view of penetration, spatial resolution, contrast, and compatibility with environmental conditions was not fully exploited due to the limitations of x-ray focusing optics and phase retrieval methods. With the advent of partially coherent radiation, efficient phase retrieval algorithms and the perfection of focusing optics, the situation has changed. We show how these developments work hand-in-hand towards full field imaging and multi-scale tomography of functional 3d structures. We explain how the central challenge of inverting the coherent diffraction pattern can be mastered by iterative reconstruction algorithms in the optical near-field [1]. Finally, we present biomedical applications, including 3d virtual histology of human brain tissue [2], and most timely : 3d histopathology of lung associated by severe progression of Covid-19 [3].

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[2] M. Töpperwien, F. Van der Meer, C. Stadelmann, and T. Salditt *Three-dimensional virtual histology of human cerebellum by X-ray phase-contrast tomography*, Proceedings of the National Academy of Sciences (2018), 201801678

[3] M. Eckermann, J. Frohn, M. Reichardt, M. Osterhoff, M. Sprung, F. Westermeier, A. Tzankov, C. Werlein, M. Kuehnle, D. Jonigk and T. Salditt *3d Virtual Patho-Histology of Lung Tissue from Covid-19 Patients based on Phase Contrast X-ray Tomography* eLife 2020;9:e60408 doi: 10.7554/eLife.60408 (2020)

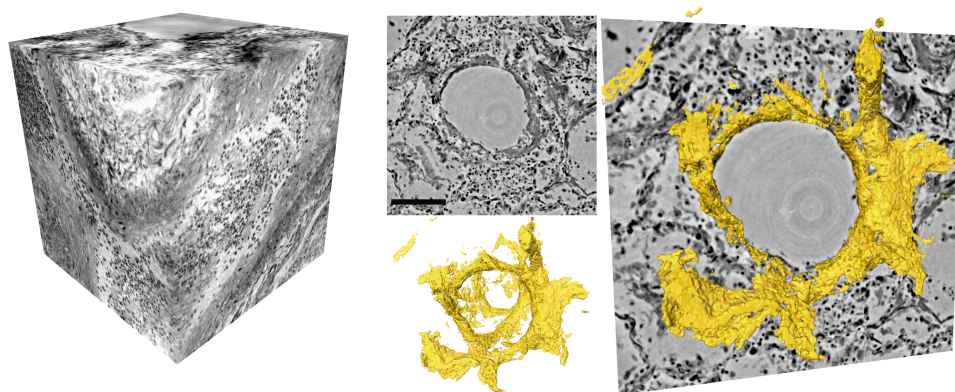


Figure. (left) 3d volume of human lung tissue (reconstructed density) affected by Covid-19, (right) rendering of hyaline membrane clogging the alveolar wall [5].