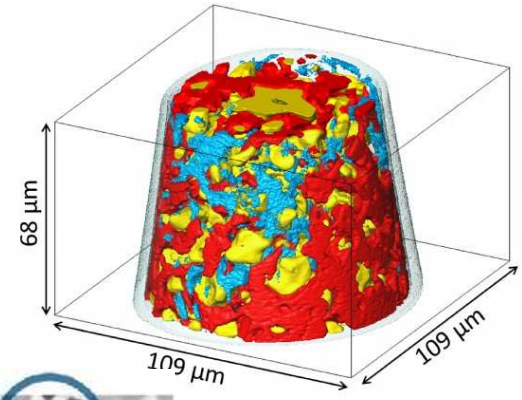

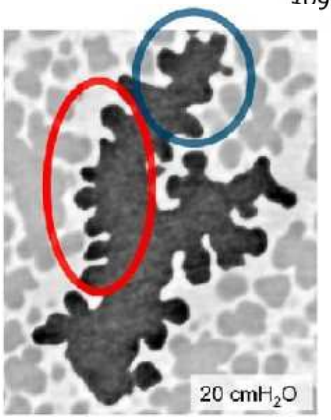

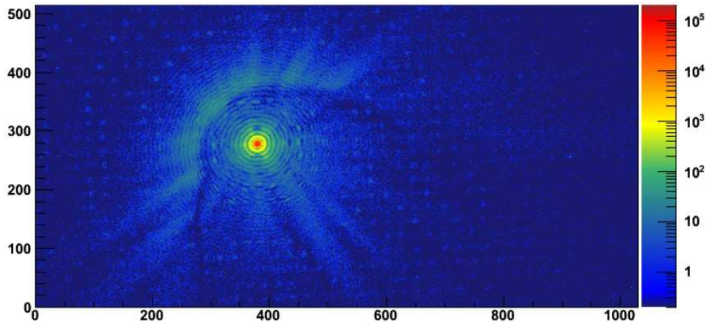

SLS Symposium on

Tomography

Tuesday, November 11, 2014

10:00 to 11:45, WBGB/019

10:00 Composition and morphology of composite materials achieved by ptychographic X-ray tomography
Julio C. Da Silva, M. Guizar-Sicairos, A. Diaz, M. Holler, P. Trtik, J. van Bokhoven, O. Bunk and A. Menzel

10:30 Performance of the EIGER single photon counting detector
Gemma Tinti, A. Bergamaschi, S. Cartier, R. Dinapoli, D. Greiffenberg, I. Johnson, J. H. Jungmann-Smith, D. Mezza, A. Mozzanica, B. Schmitt and X. Shi

11:00 Coffee

11:15 In-vivo study of lung physiology with fast X-ray tomographic microscopy
Goran Lovric, I. Vogiatzis, J.C. Schittny, M. Roth-Kleiner, M. Stampanoni and R. Mokso

Composition and morphology of composite materials achieved by ptychographic X-ray tomography

J. C. Da Silva[1], M. Guizar-Sicairos[1], A. Diaz[1], M. Holler[1], P. Trtik[1], J. van Bokhoven[1,2], O. Bunk[1], A. Menzel[1]

The properties of composite materials are affected by the arrangement of the different material phases within their 3D structures. Therefore, the ability of visualizing these structures in the critical length scale of nanometers can improve the engineering of these composites. Here we show that the combination of ptychography and computed tomography allows reconstructing the complex-valued refractive index 3D map of the sample in the nanometer range[1,2]. This 3D map is used to investigate the localization of the different material phases, the intermaterial pore space and, in certain cases, to determine the composition of each component of the composite without spectroscopic measurements. As first application example, we quantitatively characterize the products formed by the hydration of cement paste[3]. The water content and stoichiometry of one of its material phases, the calcium-silicate-hydrates, is determined from the tomography dataset. As a second application example, we determine the three-dimensional structure of a commercial catalyst containing zeolite and clay, and their interparticle porosity[4]. We show that the ability to visualize the 3D structure of materials in the nanoscale by ptychographic X-ray tomography opens new possibilities of studies of these materials.

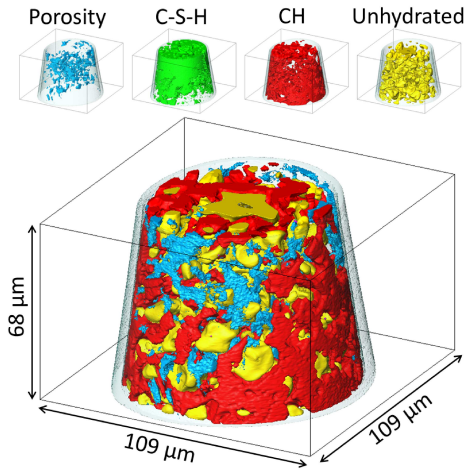

Figure – 3D rendering of the different material phases separated by color in the 3D volume of hydrated cement paste within a capillary imaged by ptychographic X-ray tomography. Each component is rendered separately in the top.

References

[1] M. Dierolf *et al.* Nature 2010, 467, 436-439.
[2] A. Diaz *et al.* Phys. Rev. B 2012, 85, 020104(R).
[3] J. da Silva *et al.* Submitted 2014.
[4] J. da Silva *et al*. Submitted 2014.

Performance of the EIGER single photon counting detector

G. Tinti[a,b], A. Bergamaschi[a], S. Cartier[a,c], R. Dinapoli[a], D. Greiffenberg[a], I. Johnson[a], J. H. Jungmann-Smith[a], D. Mezza[a], A. Mozzanica[a], B. Schmitt[a], X. Shi[a]

[a] *Paul Scherrer Institut, 5232 Villigen PSI, Switzerland*
[b] *European Synchrotron Radiation Facility, 38043 Grenoble, France*
[c] *Institut for Biomedical Engineering, University and ETH Zürich, Zürich, Switzerland*

EIGER [1] is a single photon counting hybrid pixel detector being developed for applications at synchrotron light sources in the energy range from a few to 25 k*e*V. It features a small pixel size (75×75 μm^2), low noise, a large dynamic range, a high frame rate (up to 22 kHz) and the possibility to construct large detector systems. These characteristics make EIGER an excellent detector for many synchrotron applications, such as coherent diffraction imaging and ptychography [2], X-ray photon correlation spectroscopy, small and wide-angle X-ray scattering and powder diffraction.

An EIGER module is a hybrid detector composed of $\approx 8 \times 4$ cm^2 silicon sensor bump bonded to 4×2 readout chips, for a total of 500 kpixels. An EIGER module is already in operation at the cSAXS beamline at the Swiss Light Source (figure 1). The EIGER modules are the building blocks of large area detectors: a 1.5 and a 9 Mpixel systems are under development for the cSAXS beamline.

In this seminar, the module calibration will be discussed, with emphasis on the choice of the optimal operation settings as a function of photon energy. The performance regarding threshold dispersion and minimum achievable threshold will be presented. In addition, the progress towards the production of larger multi-module systems will be discussed.

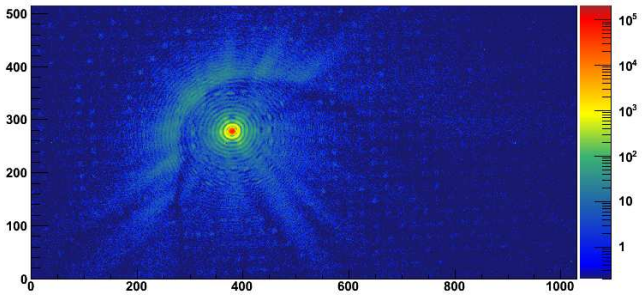

Figure 1: Example of a diffraction pattern recorded by an EIGER module at the cSAXS beamline. The dynamic range extends from 10^6 photons/s to a single photon/s.

References

[1] R. Dinapoli et al., *EIGER: Next generation single photon counting detector for X-ray applications*, *Nucl. Instr. Meth. A*, **650** (2011) 79.

[2] M. Guizar-Sicairos et al., *High-throughput ptychography using Eiger: scanning X-ray nano-imaging of extended regions*, *Optics Express* **22 - 12** (2014) 14859.

In-vivo study of lung physiology with fast X-ray tomographic microscopy

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

[1] *Swiss Light Source, Paul Scherrer Institute, 5234 Villigen, Switzerland*
[2] *Institute for Biomedical Engineering, ETH Zurich, 8092 Zurich, Switzerland*
[3] *Institute of Anatomy, University of Bern, 3012 Bern, Switzerland*
[4] *Centre Hospitalier Universitaire Vaudois, University of Lausanne, 1015 Lausanne, Switzerland*
Goran.Lovric@psi.ch

Lung failure represents the leading cause of morbidity and mortality worldwide and is the 4th leading cause of death in Switzerland [1,2]. Despite the fact that recent decades have brought forth a huge clinical progress in treating lung injuries, including e.g. the immediate postnatal treatment of very preterm infants, two hypotheses on the structural alterations in the gas-exchange area during breathing are still under debate: a heterogeneous distention pattern of different lung areas and a homogeneous cyclic opening-and-collapse of all alveoli. Current techniques for performing lung imaging with small animal models at synchrotrons [3,4], however, were unsuccessful so far either by only applying 2D imaging or due to insufficient temporal and/or spatial resolution.

We present the methodology for low-dose in-vivo studies in view of instrumentation, image acquisition and post-processing. and describe how to achieve a compromise between spatial resolution and radiation dose for in-vivo experiments [5]. Furthermore, we show the application of a recently developed toolbox for quantitative 3D lung data analysis, allowing for the first time a detailed investigation of air-recruitment mechanisms and overextension patterns at the micrometer scale in mice and rats lungs. Our strategy for deciphering lung filling and air recruitment patterns as well as a future outline for in vivo imaging are described. Finally, comparative values of the radiation dose are given and the perspectives of in-vivo studies at micrometer scales is discussed.

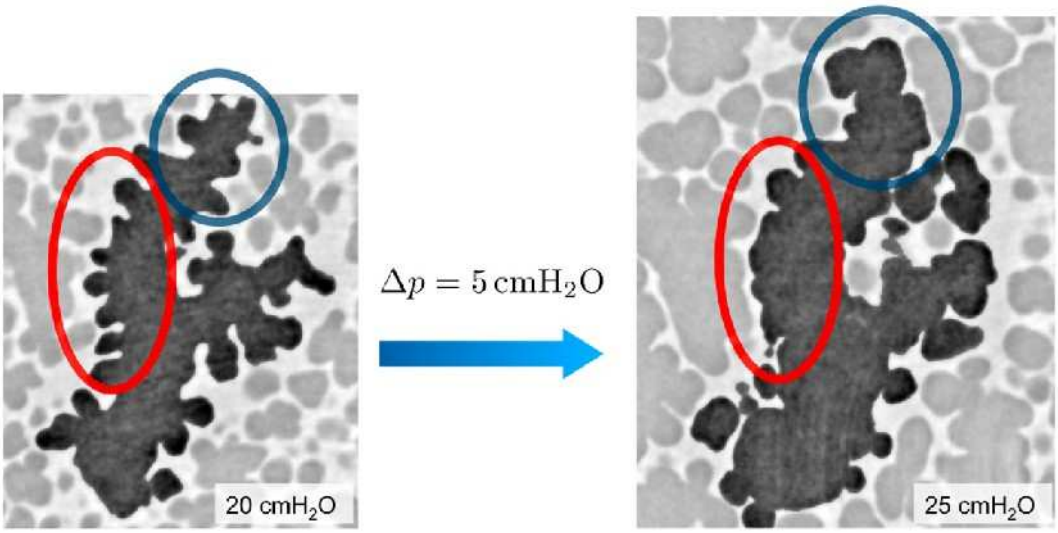

Fig. 1: Non-linear and regional changes in the lung occuring at increasing peak-inspiratory pressures. The width of the field of view is approximately 400 µm.

References

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[5] G. Lovric, S. F. Barre, J. C. Schittny *et al.*, J. Appl. Crystallogr. **46**(4), 856 (2013).