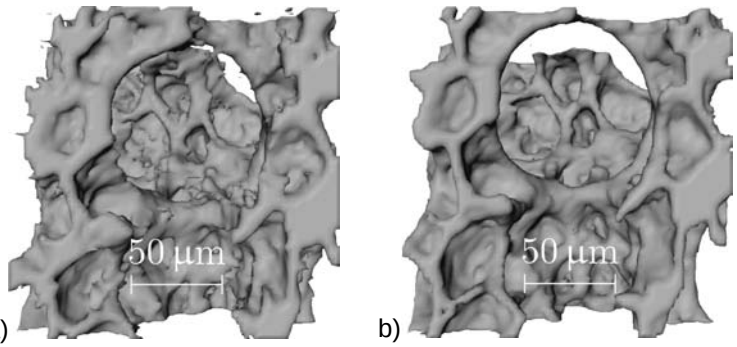
Quality driven expansion of the field of view in synchrotron radiation x-ray tomographic microscopy

David Haberthür[1], Christoph Hintermüller[2], Marco Stampanoni[2,3], Johannes Schittny[1]

[1]*Institute of Anatomy, University of Bern, Switzerland*
[2]*Swiss Light Source, Paul Scherrer Institut, Villigen, Switzerland*
[3]*Institute of Biomedical Engineering, University and ETH Zürich, Switzerland*

haberthuer@ana.unibe.ch

Abstract:
The acinus represents the functional unit of the pulmonary gas-exchange area. Until now the generation and investigation of its three-dimensional (3D) skeleton was either limited by the resolution or the sample volume. Therefore, at the beamline TOMCAT (Swiss Light Source) we developed a method to combine multiple synchrotron radiation X-ray tomographic microscopy (SRXTM) scans to one large 3D-dataset. By combining 3-5 tomographic scans perpendicular to the rotational axis, the sample volume visible in the resulting tomographic datasets could be enlarged to a cylinder of 1.5 mm in height and up to 7 mm in diameter at an isometric voxel length of 0.74µm. Compared to a single scan, this corresponds to a nine- to 25-fold increase in visible volume.
The required number of projections for each of the subscans was calculated based on a balance between the requested resolution versus total scanning and processing time. We were able to decrease the scanning time by 86 % while keeping the quality of the tomographic datasets at a high level, permitting automated segmentation and reconstruction (see figure 1). Stacking multiple wide field scans on top of each other results in an even larger 3D-dataset containing several acini, all at a resolution permitting an automated segmentation and skeletonization of the airspace in heavy metal stained, paraffin embedded rat lungs.
We would like to call this method wide field SRXTM (WF-SRXTM). We conclude that WF-SRXTM scanning provides an unrestricted high resolution three dimensional view of the lung parenchyma. Since ventilation and particle deposition are directly linked to the structure of the airways in the lung, analysis and simulation of these two properties are now possible.



a) b)

Figure1: Region of interests in the tree-dimensional datasets obtained with the fastest (a) and gold-standard protocol (b).