# Free propagation phase contrast in classical microCT improves image quality especially in weakly absorbing specimens

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## Background:

In-line free propagation phase contrast is an emerging x-ray imaging technique that exploits the phase shift of the incident x-ray beam within a specimen instead of its attenuation. It has been proven that this method dramatically increases the contrast-to-noise ratio and therefore the image quality especially in weakly absorbing samples[1]. However, a certain degree of spatial coherence in the x-ray beam is required, which basically limited this approach to Synchrotron applications.

## Methods & Results:

Based on our results, we believe that the needed degree of coherence has been overestimated. Recent publications show that also in x-ray microscope systems phase contrast can be exploited[2]. We demonstrate that also in the Skyscan 1272 phase contrast effects can be found. Usually that leads to an undesired edge enhancement, which hampers threshold based segmentation, especially in high resolution scans. Here we demonstrated that so-called single distance phase retrieval algorithms[3] can be applied leading to an improved contrast-to-noise ratio and edge-sharpness (Figure 1) and better prerequisites for image segmentation (Figure 2).

## Conclusion & Outlook:

Our data indicates the presence of phase contrast in scan obtained with an Skyscan 1272 microCT and shows that if phase retrieval is applied the image quality can be dramatically improved. In current experiments we analyse the relationship between, pixel size sample to detector distance, filtration and refractive index of the specimen. We believe that slight modifications in the design of the system (such as increasing the cabinet length) would further improve the phase contrast capabilities of that device.

## References:

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3. Gureyev, T. E. et al. Refracting Röntgen's rays: Propagation-based x-ray phase contrast for biomedical imaging. J. Appl. Phys. 105, 102005 (2009).

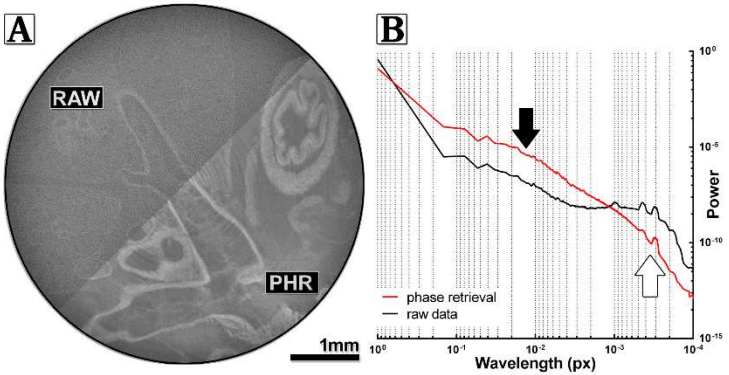


Figure 1 high resolution scan of a phosphotungstic acid stained mouse lung embedded in paraffin (pixel size 1µm, sample-to-detector distance 23cm). (A) shows a comparison between direct reconstructed (RAW) data and reconstruction after application of single distance phase retrieval (PhR). Clearly a higher contrast-to-noise ratio can be found in PhR. (we measured a factor of 10) (B) comparison between the radial averaged power spectrum of the RAW data set (black) and the phase retrieved data set (red). A higher power in the medium frequency range depicting the image details can be found for PhR (black arrow) and a strongly reduced power in the high frequency range mainly depicting the noise (white arrow).

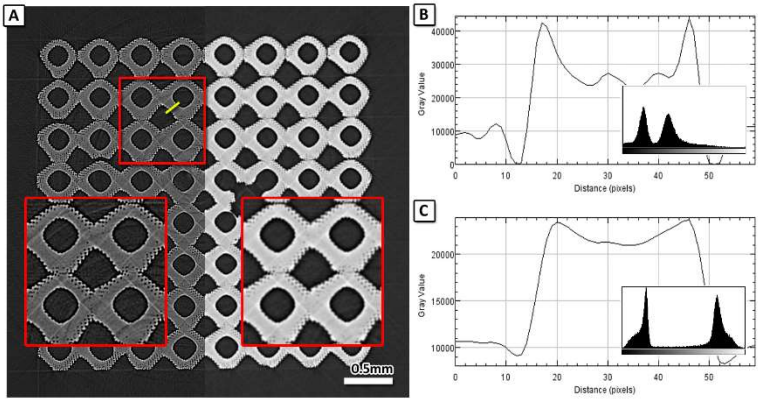


Figure 2 Comparison of a scan of a low absorbing polylactate scaffold (A) left without and right after phase retrieval. The profile plots (B) without phase retrieval and (C) after phase retrieval at the position indicated by the yellow line in (A) demonstrate strong edge effects in (B) and a more accurate profile in (C). Moreover, the inserted histograms show a dramatically better separation and therefore a more reliable segmentation between air and scaffold in the phase retrieved data set (C).