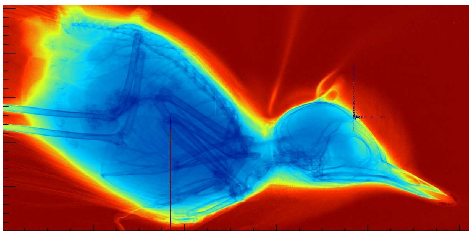

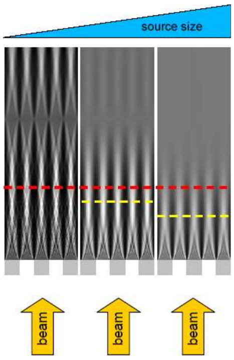

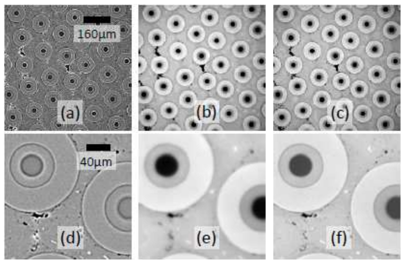

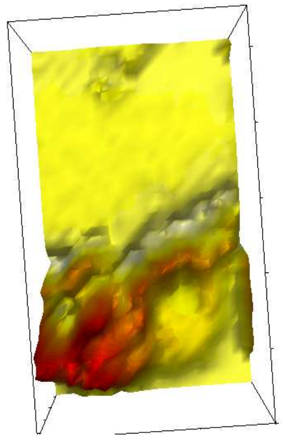

SLS Symposium on Imaging

Tuesday, June 5, 2012

10:00 to 12:15, WBGB/019

10:00 Single-Image Phase Contrast Micro-tomography at TOMCAT
S. Irvine, R. Mokso, P. Modregger, Z. Wang, F. Marone and M. Stampanoni

10:30 Compact X-ray grating interferometry for commerical table top scanners
T. Thüring, P. Modregger, Z. Wang, S. Andermatt, S. Haemmerle, S. Weiss, C. David, T. Grund, M. Stampanoni

11:00 Coffee

11:15 EIGER: a new single photon counting detector for Xray applications
V. Radicci, A.Bergamaschi, R. Dinapoli, D. Greiffenberg, B. Henrich, I. Johnson, A. Mozzanica, B. Schmitt, X. Shi

11:45 Infrared Microscopic Imaging: a Technique in Transition
L. Quaroni

Single-Image Phase Contrast Micro-tomography at TOMCAT

S. Irvine,[1,2] **R. Mokso,[1] P. Modregger,[1,2] Z. Wang,[1] F. Marone[1] and M. Stampanoni[1,3]**

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Of the phase contrast imaging modalities at TOMCAT, propagation-based or inline phase contrast imaging is the most simple to achieve experimentally, requiring merely a non-zero distance between sample and detector. Such simplicity means this technique is highly compatible with the ultra-fast tomography endstation [1], where increasingly complex set-ups with dynamic samples have become common. For many light materials at hard x-ray energies (typically 15-25keV), absorption contrast alone may be insufficient to enable the distinction between components, for which the enhanced visibility afforded by phase contrast becomes necessary. In a few cases, phase contrast may be present merely because the dimensions of the setup may be such that it is impossible to further reduce the sample-detector distance.

When the edge-enhancement leads to phase artefacts and/or difficulties with segmentation in a standard tomographic reconstruction (where the reconstructed function is related to the Laplacian of the phase distribution), a form of phase retrieval may be desirable to convert the edge contrast to area contrast. Single-image phase retrieval techniques, such as the well-established Transport-of-Intensity based algorithm [2] are highly convenient, especially for dynamic samples, as they do not require additional projections. This robust and computationally efficient, simple non-iterative approach has been successfully incorporated into the image-processing pipeline of TOMCAT and has been adopted with ease by many users. In this talk, which for those unfamiliar with the technique will include a fairly broad introduction, we will demonstrate this success through the examples of a diverse range of samples, from foams and alloys through to plants, insects and icecream.

An overview of its use as a qualitative vs quantitative tool will be discussed, for both single and multi-materials, together with its in-essence behaviour as a low-pass filter. A simple new qualitative extension to this technique is also presented, i.e., an image fusion method which merges the slices reconstructed from raw phase contrast images and those after phase retrieval. Thus the improved contrast may be acquired without the associated loss of high-frequency information. The final weighting may be easily tuned by the user in order to best facilitate later segmentation.

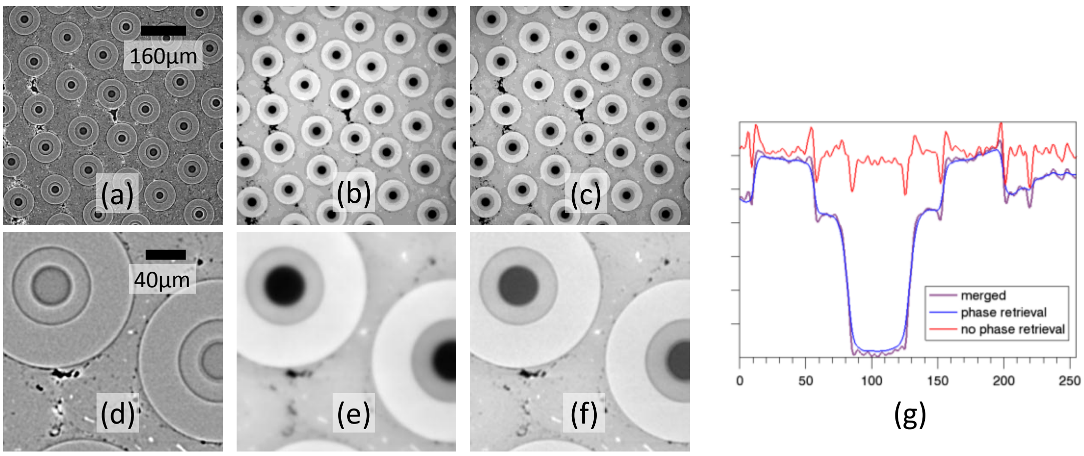

Fig 1: SiC fiber composite sample by a) standard slice reconstruction b) slice after phase retrieval of projections, c) slice containing merged information from slices a) and b). Corresponding zoomed-in regions are shown in d), e), and f). A line profile is shown in (g) for direct comparison.

[1] R. Mokso, F. Marone, M. Stampanoni, “Real Time Tomography at the Swiss Light Source”, *AIP Conf. Proc*. 1234, 87-90 (2010)
[2] D. Paganin, S. C. Mayo, T. E. Gureyev, P. R. Miller, and S. W. Wilkins, "Simultaneous phase and amplitude extraction from a single defocused image of a homogeneous object," J. Microsc. 206, 33-40 (2002).

Compact X-ray grating interferometry for commerical table top scanners

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Today's commercial X-ray micro computed tomography (CT) specimen systems are based on microfocus sources, 2D pixel array cameras and short source-to-detector distances (i.e. cone-beam configurations). High resolution is achieved by means of geometric magnification. The further development of such devices towards phase contrast (PC) techniques could significantly enhance their range of applications. Among the variety of available PC techniques, X-ray grating interferometry (GI) has favorable properties for differential phase contrast (DPC) imaging on conventional X-ray tubes [1,2]. Up to now, one of the major challenges was the design of GI on short setup lengths, which was due to the incompatibility of a high beam divergence and gratings based on planar silicon substrates.
In this presentation, we report on the design and characterization of a compact GI setup, which has been set up at PSI and is based on bendable gratings [3]. The total setup length is only 250mm, making the design ready for an integration into a commercial micro CT. With a minimum detector pixel size of 24µm and a maximum geometric magnification of approx. 5, the minimum achievable effective pixel size is around 5 microns, which now already approaches the resolution properties of GI at synchrotron setups. The field of view at this magnification level is approx.10mm.

References

[1] F. Pfeiffer et al., Nature Phys., 2 (258–261), 2006
[2] M. Engelhardt et al., Appl. Phys. Lett., 90 (224101), 2007
[3] T. Thüring et al., Appl. Phys. Lett., 99 (041111), 2011

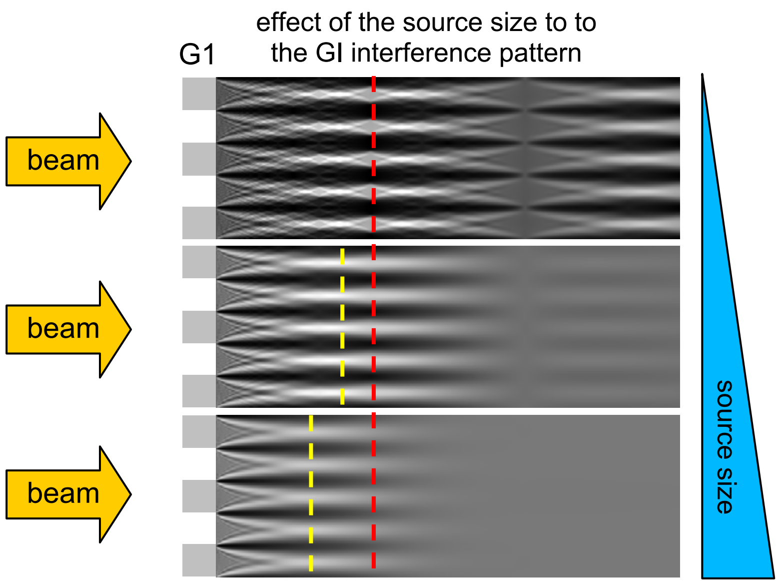

Fig. 1: Interference patterns generated by a phase grating (G1) for different focal spot sizes of the source (source size). A sample is typically placed directly upstream of G1. G1 shifts the phase of the wave front periodically by π. An increasing source size attenuates the intensity of the interference fringes at larger distances, which reduces the detectability of sample refraction.

EIGER a new single photon counting detector for Xray applications.

V. Radicci[1,2], A.Bergamaschi[1], R. Dinapoli[1], D. Greiffenberg[1], B. Henrich[1], I. Johnson[1], A. Mozzanica[1], B. Schmitt[1], X. Shi[1].

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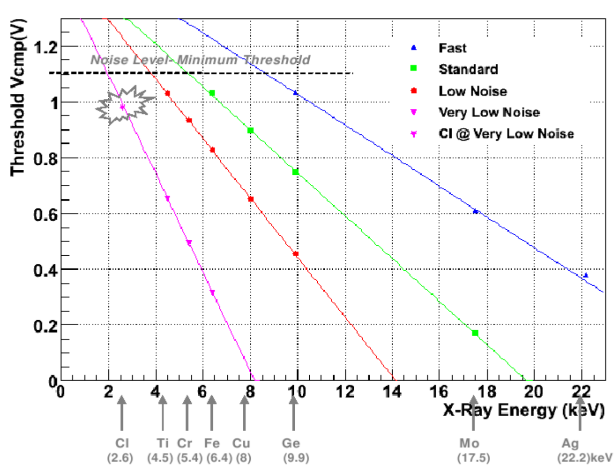
EIGER is the next generation of single photon counting pixel detector for synchrotron application designed by the PSI-SLS detector group.
It follows the widely utilized and successful Pilatus detector. The major advantages over the Pilatus system are the smaller pixel size (75 µm) and the possibility of reading out the previous image during an exposure which brings to a very high frame rate capability (22 kHz) and negligible readout dead time (4 µs).
These enhanced features will directly benefit many fields at synchrotron sources, especially research in the fields of Protein Crystallography, Small Angle X-ray Scattering, Coherent Diffraction Imaging and X-ray Photon Correlation Spectroscopy.
The presentation will cover details of the Eiger read out chip and discuss the performance. Energy calibration, noise, minimum energy threshold and rate capability measured on a single chip system with an X-ray tube and at the SLS-PSI synchrotron are shown. Trimming studies and threshold dispersion are also addressed.
Along with the first X-ray absorption images of a module (2x4 chips, 3.8x7.8 cm^2, 500Kpixel), the progress towards a larger area detector and multi modules detector systems (9Mpixels; 3x6 modules) is outlined.



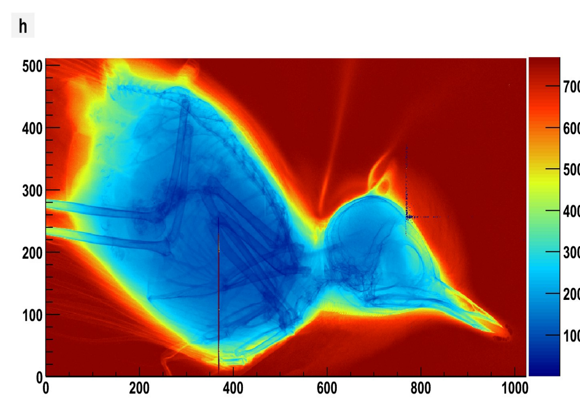


Figure left: Energy calibration measured with an X-ray Cu tube and fluorescent targets; the chip is operated with different gains of the preamplifier from *Fast settings (blue)* to the *Low noise* mode (violet) used for low energy operation.
Figure right: First X-ray image of an Full EIGER module (500Kpixel)

Infrared Microscopic Imaging: a Technique in Transition

Luca Quaroni, Infrared Beamline, Swiss Light Source

State-of-the art microscopic mapping and imaging with infrared light is based on the generation of absorption contrast, where specific vibrational absorption bands are plotted in two-dimensional space to provide projections of the sample. The use of synchrotron light provides an advantage in brightness in the middle infrared spectral region and an advantage in flux and brightness in the far infrared spectral region. In the first generation of IR beamlines this advantage has been exploited to map absorptions in the sample in a confocal scanning spectromicroscopy approach. This approach will be presented using examples from experiments run on SLS X01DC (Figure 1) and similar beamlines. The application of 2D MCT detectors, which allow a full-field imaging approach, has been recently extended to synchrotron IR beamlines, providing the opportunity to increase the rate of image collection. The two designs will be discussed in terms or comparative performance in imaging and spectroscopy applications.

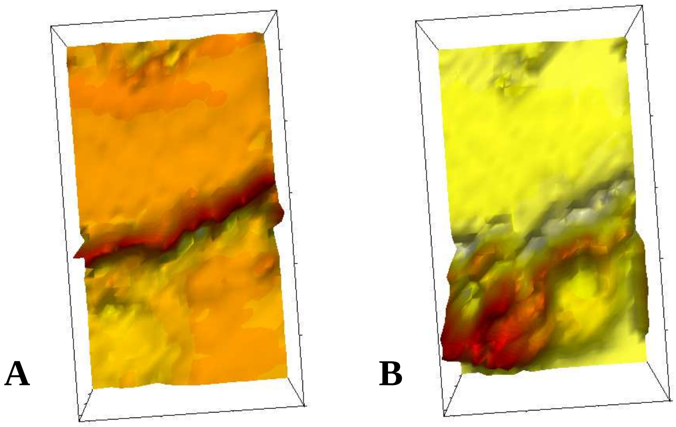


Figure 1. Distribution of inorganic salts in a weathered paint chip based on contrast generated by mid infrared absorption from oxoanions. Red corresponds to high absorption and white to no absorption.
A – Carbonate. B – Oxalate.

The presentation will be concluded by a brief description of the changing landscape due to the introduction of quantum cascade lasers as benchtop infrared light sources and of the opportunities provided by the use of coherent synchrotron emission in the far infrared spectral region.