# Novel lab-based X-ray phase-contrast and dark-field tomography

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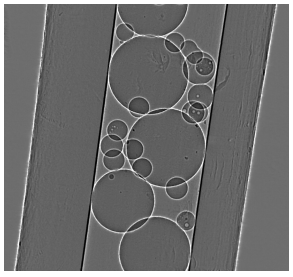
The X-ray Nano-Imaging Group at the University of Southampton, headed by Dr. Pierre Thibault, focuses its activities on the development of high-resolution X-ray phase-contrast techniques and their applications in life and materials sciences. Our expertise in advanced algorithmic methods for image reconstruction is applied to a variety of imaging schemes. In addition to regular measurement runs done at multiple synchrotron radiation facilities in the world, we are now able to produce high-resolution X-ray images in our lab, thanks to a newly installed high-brilliance liquid-metal-jet source, the only one used for this purpose in the UK.

We are looking for a determined and motivated student to work on the implementation, development and applications of X-ray phase-contrast techniques based on modulations of patterned X-ray beams. In particular, the successful candidate will (1) optimise the setup for speckle-based methods; (2) manage collaborations with European partners for applications of speckle-based tomography with relevant biomedical, geological and palaeontological samples; (3) plan and participate to benchmarking experiments at different synchrotrons; and (4) work toward the first demonstration of near-field ptychography at a lab source.

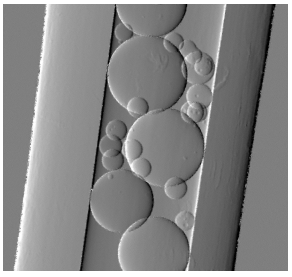
The candidate should have a good background in optics and atomic physics. Good programming skills (ideally in python, C/C++ or matlab) are essential. Past experience with X-ray equipment is valuable but not essential.

This scholarship, available only to United Kingdom and European Union citizens, provides full support of fees, student grant and some research support over a period of 3.5 years.

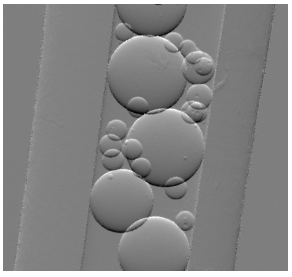
Interested candidates should send a cover letter and their CV (including the name and coordinates of two references) directly to Dr. Pierre Thibault (pierre.thibault@soton.ac.uk) by the 15th of July 2018.



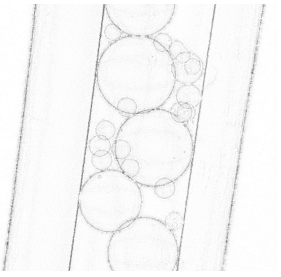
Transmission



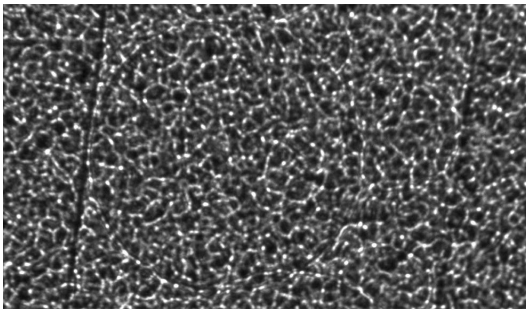
Refraction (x)



Refraction (y)



Dark field



X-ray speckle pattern

Speckle-based X-ray imaging: An X-ray modulator is placed in the X-ray beam to form an intensity pattern at the detector. Depicted here is a random pattern produced by sand paper. This pattern is attenuated and distorted when a sample in introduced in the beam. These small variation are analysed to form images of the sample. Multiple such images are then combined to form a tomographic volume.

## Fast X-ray tomo-ptychography

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X-ray ptychography is a high-resolution imaging technique that relies on the measurement of multiple X-ray diffraction patterns produced when the X-ray beam from high-brilliance synchrotron sources is scattered by a sample. The technique is now being developed in all synchrotron radiation facilities in the world, including Diamond Light Source, the UK synchrotron, conveniently located one hour away from the University of Southampton. The X-ray nanoimaging group has played a central role in the development of ptychography, and currently maintains *ptypy* (ptycho.github.io/ptypy), one of the few available phase retrieval packages able to reconstruct images from ptychographic datasets. New features are constantly added to the package to improve speed and robustness, and to support new data collection schemes.

The objective of this project is to find new ways of making ptychography faster. Work will be done at the computational level, for instance to improve and expand the current development of GPU accelerated reconstruction engines, and at the hardware level, by exploring faster data acquisition scheme. In the latter case, the work will be conducted primarily at the Diamond Light Source.

The selected candidate should have a good knowledge of optics and be enthusiastic about data analysis and programming (especially in python and C/C++). Past experience with X-ray equipment is valuable but not essential.

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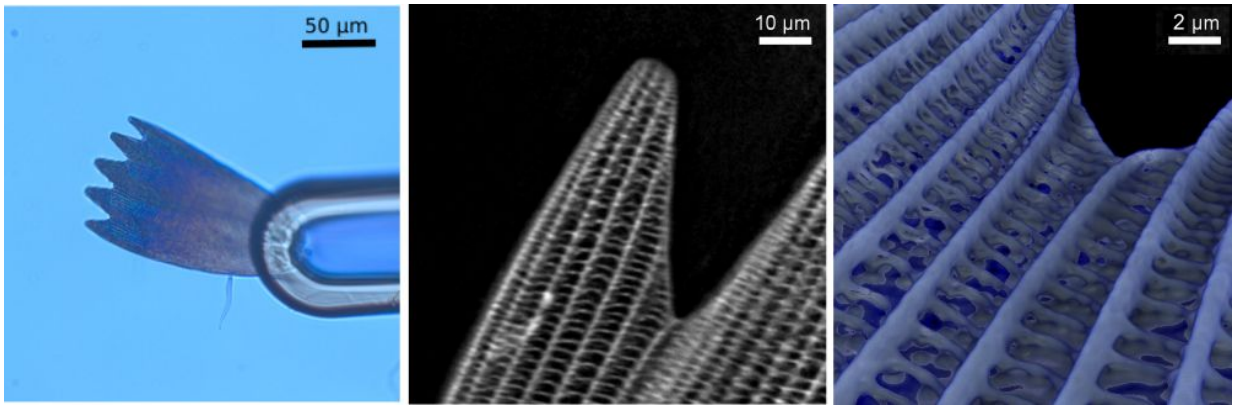


The vibrant blue colour of Pansy butterflies is the result bioengineered photonic crystals. Left: a single wing scale. Center: a ptychographic X-ray image of the sample, from data collected at the Diamond light source. Right: Rendering of the tomo-ptychographic reconstruction.