Offered Master thesis project in X-ray Optics group	
Principal Investigator:	Dr. Jürgen Mohr
Institute	Institute of Microstructure Technology (IMT), Karlsruhe Institute of Technology
Research group	X-ray Optics (Emerging X-ray optics project) https://www.imt.kit.edu/x-rayoptics.php
Duration	6 months
Topic	Mathematical modeling of propagation of X-rays in parallel beam and cone beam through X-ray lens array
Tutor of the thesis	MSc. Andrey Mikhaylov andrey.mikhaylov@partner.kit.edu Dr. Danays Kunka

At KIT/IMT emerging X-ray optical components are developed to broaden the capabilities of imaging techniques. Optical components such as compound X-ray lens arrays allow performing phase-contrast imaging, which offers enhanced information about the inner structure of the various objects in addition to conventional attenuation contrast. This contrast is due to physical phenomena of refraction and scattering of X-rays while passing through the object under investigation.

Non-interferometric wave front sensing methods have been proposed recently to perform phase and scattering contrast retrieval via single projection image within simplified setup [1]. Single-shot setup configuration, apart from micro focus X-ray tube and X-ray camera, includes single compound X-ray lens array to provide enhanced information on the material structure in several directions ensuring thorough characterization of the object under investigation. In this approach, the incident beam is periodically modulated by a single compound X-ray lens array, and the distortion of the regular pattern introduced by the object is recorded with a single exposure and then analyzed.

Due to the fact that this type of optical components is proposed relatively recently, it is necessary to carry out comprehensive research to optimize the design and structure. This research should include not only practical studies but also mathematical modeling. The optics of X-rays differ from the optics of visible light because that the refractive index in the matter is less than the refractive index in the vacuum.

In this Master thesis, a model of propagation of X-rays in a parallel beam (synchrotron or synchrotron-like source) and cone beam (conventional X-ray tube) through X-ray lens array will be developed. The results of the work will be used to optimize the design of X-ray lens arrays to work with laboratory X-ray sources.

You will be a part of a highly motivated and friendly team working with an experienced supervisor to contribute to a cutting-edge research project and present an impressive work for your Master thesis.

Requirements: experience in programming in Python or MATLAB, knowledge of geometrical optics.

Keywords: X-ray lenses, ray tracing, mathematical modeling

Literature

[1] Rolo, T. D. S A Shack-Hartmann sensor for single-shot multi-contrast imaging with hard X-rays. arXiv preprint arXiv:1802.10045. (2018).
[2] Boye, P. Nanofocusing refractive X-ray lenses. PhD thesis (2009).