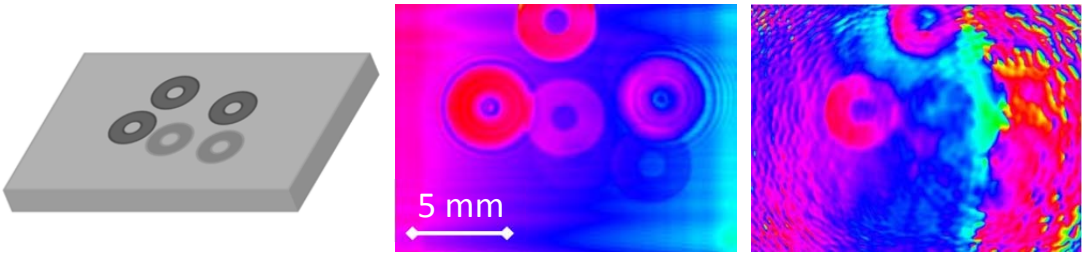
THz tomography

We are looking for highly motivated students with a background in optics, physics or mechanical engineering. Empa provides state-of-the-art facilities in a cutting-edge research environment.



THz tomography of a plate with double-sided ring structure: Object, simulated and experimental results of a holographic reconstruction. Diffraction effects around the rings at the surface not in focus are clearly visible (courtesy P. Zolliker).

Computed tomography (CT) using x-rays is a ubiquitous technique to reveal inner structures of a body or object [1]. It is based on absorption or phase contrast images taken from different projection angles. In the simplest case, the object volume is reconstructed from the projections based on the Radon transform and Fourier slice theorem.

Terahertz radiation also penetrates a wide variety of visually opaque materials such as polymers and ceramics [2]. Its wavelength lies in the range of 70-500 µm, which makes the measurement set-up insensitive to vibrations and object roughness. In contrast to x-ray CT, THz radiation is non-ionizing. However, when refractive index gradients are large, refraction at material interfaces and diffraction at structures on a sub-mm length scale occur, which make the assumption of projection along straight rays fail.

In this master thesis, a step towards elimination of the diffraction effect is made. First, meaningful test objects are designed in an appropriate material and simple geometry (block, cylinder, …) to validate the tomographic approach. They are then fabricated using 3D-printing or laminating, possibly in combination with laser ablation. Using a THz laser and a bolometer camera, these objects will be measured in transmission and under various angles. Holographic reconstruction algorithms will be applied and, depending on the skill of the applicant, improved to finally reconstruct the refractive index volume distribution of the test object.

You will learn about THz technology, wave propagation and holographic reconstruction algorithms, measurement and fabrication technology, and you will work towards publishing the results. For more information contact Dr Erwin Hack (erwin.hack@empa.ch). In your application please include a short motivation letter, your educational background and BSc grades.

[1] T.M. Buzug, *Computed tomography: from photon statistics to modern cone-beam CT*. (Springer, Berlin; London, 2008).
[2] J.P. Guillet, B. Recur, L. Frederique, B. Bousquet, L. Canioni, I. Manek-Honninger, P. Desbarats, and P. Mounaix, "Review of Terahertz Tomography Techniques," J. Infrared, Millimeter, Terahertz Waves **35** (4), 382-411 (2014).