X-ray Spectral Phase-Contrast Imaging

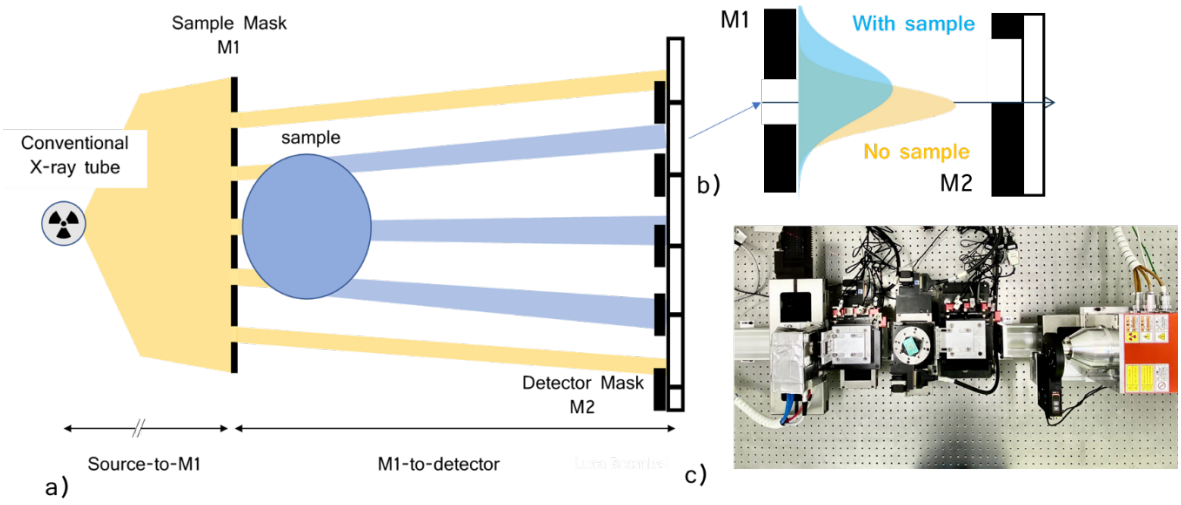
When traveling through matter, X-ray waves experience a reduction in the amplitude (attenuation) and a shift in the phase (phase shift) that provide complementary information on the investigated sample. For light materials, such as soft biological tissues, and at energies of radiological interest (10 – 100 keV), phase effects are prominent over attenuation. For this reason, imaging the phase (phase-contrast imaging) brings a major increase in visibility. On the other hand, heavier elements/compounds, such as bones or iodine-based contrast media, produce a large attenuation signal that is strongly dependent on the energy of the impinging X-ray beam. In this case, by probing the sample's attenuation properties at multiple energy levels (spectral imaging), it is possible to separate and quantify the presence of different materials. The goal of this project is to develop and apply combined spectral and phase-contrast imaging to samples of biomedical interest (e.g., ex-vivo small animals, virtual histology) for providing both high soft tissue visibility and quantitative elemental separation.

The project is carried out in the framework of the INFN's Young Researcher Grant on the theme "Photon-counting Edge-illumination Phase-contrast Imaging (PEPI)", hosted by INFN's laboratories in collaboration with the University of Trieste and the Synchrotron Elettra.

In this project, the PhD student will work on a new experimental setup, making use of structured absorbing optics enabling phase sensitivity (edge-illumination technique), a state-of-the-art X-ray spectral detector, and a micro-focus X-ray source. The candidate will be involved in the development of dedicated acquisition protocols and image reconstruction algorithms, as well as their application to relevant samples. Complementary experiments will be carried out at the medical imaging beamline SYRMEP at Elettra and the candidate will be also encouraged to apply for beamtime in other international synchrotron radiation facilities.

The candidate should have a good background in radiation-matter interaction and be familiar with general concepts of X-ray imaging. The knowledge of high-level programming languages, such as Python or Matlab, will be considered a plus but it is not essential.

Contact person: Dr. Luca Brombal – INFN Trieste
e-mail: luca.brombal@ts.infn.it



a) Sketch of a phase-contrast imaging setup based on the edge-illumination technique. b) Edge illumination working principle. The sample mask structures the incoming X-ray beam into non-interfering beamlets. Upon interaction with the sample, the beamlets are reduced in intensity (attenuation contrast), refracted (phase-contrast), and broadened (scattering contrast). c) Photograph of the setup at INFN laboratories in Trieste.