EXTATIC

Extreme-ultraviolet and X-ray Training in Advanced Technologies for Interdisciplinary Cooperation

EXTATIC Project Proposal 2016

Project Title	Laser-generated short-wavelength sources for single-shot imaging
Home University	Czech Technical University, Prague, Czech Republic
Home University Supervisor	Prof. Jiri Limpouch
Host University	Military University of Technology, Prague
Host University Supervisor	Prof. Henryk Fiedorowicz
Third University	University of Southampton
Third Supervisor	Prof. W.S. Brocklesby
Associated Partner(s)	Institute of Physics, AS CR, Prague
Associated Partner Supervisor(s)	Dr. Jaroslav Nejdl
Project Outline (max 250 words)	High-order harmonic generation (HHG) is a well-established technique to produce highly coherent beams in the range of XUV and/or soft X-ray with ultra-short pulse durations [1]. The high degree of coherence of HHG beam makes these sources ideal candidates for "lens-less" coherent diffraction imaging [2] or digital holographic techniques [3]. However, using these sources in high-resolution imaging of microscopic samples usually requires multi-shot exposure due to the low energy of a single pulse. A promising approach to boost the energy of a single harmonic while preserving its coherence properties is its amplification in a plasma column with strong population inversion of two ionic levels with dipole transition matching the harmonic wavelength [4]. Other plasma sources generating X-ray radiation such as plasma betatron or inverse Compton source [5] are based on laser-driven relativistic electron beams and produce low-divergence beams of energetic radiation with a small source sizes. That enables their use in phase-contrast imaging of high density objects. These sources of short wavelength radiation have proven to be efficient alternatives to large scale facilities such as synchrotron or free electron lasers. Moreover, these sources benefit from short pulse durations and possibility of intrinsic jitter-free synchronization with another laser pulse, which makes them ideal candidates for probes of fast phenomena. Their stability is, however, strongly dependent on stability of the driving laser beam. That is why their employment in single shot operation mode would eliminate this drawback. Development of one of these sources and its employment for imaging will be performed using 25 TW Ti:sapphire laser chain at PALS facility in Prague.
Relevant Reference(s)	[1] Z. Chang, Fundamentals of Attosecond Optics, CRC Press 2011. [2] J. Goodman, Introduction to Fourier Optics, 3rd Ed., Roberts & Company

	2005. [3] T. Kreis: Handbook of Holographic Microscopy, WILEY-VCH 2005. [4] Ph. Zeitoun et al. Nature **431**, p. 426-429 (2004), DOI: 10.1038/nature02883 [5] S. Corde et al. Rev. Mod. Phys. **85**, p. 1 (2013)
Lead University Profile	The Czech Technical University in Prague (CTU) (www.cvut.cz) is the largest university of its kind in Czech Republic and offers studies for all levels of university education: Bachelor, Master and Doctoral. There are about 20 000 students studying at CTU who are educated by highly qualified research and teaching staff. Department of Physical Electronics is part of the Faculty of Nuclear Sciences and Physical Engineering. There are two Extatic PhD students studying at department. Members of group collaborate with new facilities ELI- beamlines and Hilase. The specific areas of research activities in the field include: HV pulsed technics, XUV sources and their applications, XUV optics, laser-matter interactions. We are taking part in EU, international and national grant agency projects and also collaborate with industrial companies as Rigaku or EPPRA.