Development of X-ray refractive optics for new diffraction limited X-ray sources.

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New ultimate parameters of the beam provided by the diffraction-limited sources – new synchrotrons with the reduced horizontal emittance will open up a unique opportunity to build up a new concept for the beam transport and conditioning systems based on in-line refractive optics [1]. In addition to traditional micro-focusing applications, the refractive optics can provide the various beam conditioning functions in the energy range from 3 to 200 keV: condensers, micro-radian collimators, low-band pass filters [2], high harmonics rejecters [3], and Fourier transformers [4]. Taking an advantage of reduced horizontal source size, the refractive optics integrated into the front-end can transfer the photon beam almost without losses from the source directly to the end-stations. In this regard, development of diamond refractive optics is crucial [5-8]. The implementation of the lens-based beam transport concept will significantly simplify the layout of majority of the new beamlines [9], opening novel opportunities for the material science research under extreme conditions [10-11].

The field of applications of refractive optics is not limited to beam conditioning, but can be extended into the area of Fourier optics, coherent diffraction and imaging techniques [12–18]. Another promising direction of refractive optics development is in-line X-ray interferometry. Recently proposed bi- and multi-lens interferometers can generate an interference field with a variable period ranging from tens of nanometers to tens of micrometers in paraxial geometry opens up the opportunity to develop new X-ray phase contrast imaging and interferometry techniques to study natural and advanced man-made nano-scale materials [19-20]. Finally, it can be used for the coherence and wave-front characterization of hard X-rays sources [21].

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