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Polycapillary Optics for precision measurements

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A novel x-ray source proposal based on radiations channeling in periodical structures will be presented. The state-of-the-art of polycapillary optics based systems applied for elemental analysis and x-ray imaging will be given paying main attention to μ-XRF and TXRF studies as well as to dedicated x-ray microscopy studies for advanced μ-tomography.
Many important medical imaging technologies require a high brightness and quasi-monochromatic x-ray source. They are well known as phase contrast imaging, coherent x-ray diffraction imaging, digital subtractive angiography, dichromography, time-of-flight imaging and mammography in part. Monochromatic radiation source results in better imaging, and, moreover, lower irradiation dose can be applied to patients, doctors or nurses. Another key solution of the idea relates to the selection of narrow band energy portion of radiation, mainly free from the hard X-ray radiation tail. It can be acquired by means of polycapillary optics (polyCO). For instance, X-ray channeling in polyCO can be used to deflect selectively defined portion of radiation emitted by the beam of electrons in a crystal (near 33 keV) through rather large angles (10÷15 degs) that would allow the radiation to be delivered to the patients. Hard tail of the radiation spectrum remains undeflected in such a way and the irradiation dose for a patient becomes much lower.
Based on the experience in the use of polyCO systems, recently the XLab Frascati collaborations have been strongly involved in studying the techniques for high resolution x-ray imaging and micro-tomography that intends in the development of a new imaging instrument to examine low contrast samples complicated by fast developing processes.
In order to get the reliable signal to noise ratio, typically available via SR dedicated x-ray optical devices, for the desktop solutions we have to increase the radiation fluxes from conventional sources. As known, manipulated through polyCO beams result in getting higher fluxes with respect to a pin-hole (with a gain factor of 102 ÷ 103). Moreover, polyCO semilenses can provide low divergent beams of mrad order. These features
make possible the realization of high resolution imaging of low contrast samples in the transmission mode without various algorithmic processes as typically done, for instance, for phase contrast imaging. This report presents the results on x-ray micro tomography for both static biological and fast dynamic samples as well as a possible future development of a polyCO-based experimental layout for biomedical imaging diagnostics, for the studies in material and environmental sciences, for diagnostics of hi-tech samples, etc.
The physics of polyCO-based imaging that substitutes the routine Math procedures of image filtering to improve the characteristics of image transfer will be discussed.

Primary author: Prof. DABAGOV, Sultan (LNF)

Presenter: Prof. DABAGOV, Sultan (LNF)

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