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Polycapillary-Based X-Ray Tomography of Complex Samples with Porous Matrix

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X-ray computed tomography (CT) is one of the most advanced methods for the non-destructive investigation of the internal structures of various objects. Researchers have been developing instrumentations for the CT research over several decades. As a result, some modern units can provide a spatial resolution of about several microns but their contrast resolution is often not high enough for CT analysis. The problem becomes even more evident for the studies on the imaging of low-absorbing and consequently low-contrast objects at conventional X-ray tube based table-top facilities. Indeed, organic porous objects are extremely hard to investigate at laboratory facilities, and the corresponding X-ray images obtained are characterized by low quality. Moreover, CT imaging of the objects composed by both low and high absorbing parts is even more problematic due to the mistakes occurring during mathematical reconstruction [1]. These mistakes may result in various "artefacts"in final reconstructed images. One of the ways to increase the image quality for such objects is to utilize a more intense X-ray flux going through the investigated sample. High radiation flux on a sample can be obtained by either the X-ray source current or the longer exposition time. Both these options have an obvious drawback: they require either greater maximum X-ray source power or longer measurement time. An alternative approach is based on the application of X-ray concentrating optical elements, for instance, polycapillary lenses or semilenses, in experimental setups in order to collect photons from the primary divergent beam and guide them to the sample [2, 3]. On the other hand, controlling the geometry of the primary beam provides us with an additional option necessary for a new approach in 3D tomography.

In this work, a test sample consisting of low absorbing porous matrix and high absorbing central part is studied at the Xlab Frascati laboratory tomography stages using two approaches based on polycapillary optics. The first approach is based on the use of a conventional CT scheme modified by the presence of a polycapillary semilens between the X-ray source and the object. The second one relies on a confocal scheme [4, 5] enabling us to scan the object under study point by point while recording the intensity of secondary (fluorescent and scattered) X-rays.

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