μ-XRF for thick specimens

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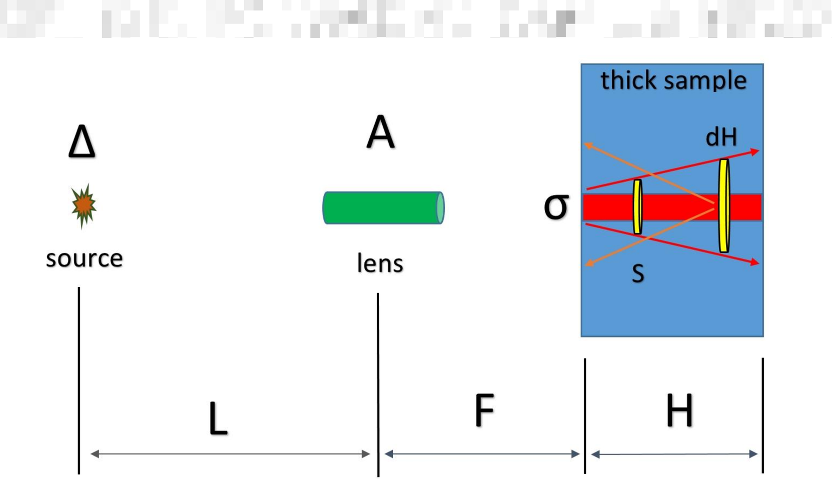
When studying samples without destruction by x-ray fluorescence analysis, the thickness of the investigated sample is limited by the depth of total absorption of the outgoing and the excitation radiation. When analyzing complex geological objects containing high-Z atoms, the excitation energy can reach several tens of kiloelectronvolts, which can cause x-ray fluorescent light from a depth of several hundred micrometers. However, focused on the surface of the specimen the primary beam is defocused with depth; its cross-section under the conditions discussed in the report can become significantly larger than the focus size. This effect is especially significant when the x-ray source is small, for example, for the SKIF synchrotron source. Based on the geometric model of the actinic voxel, the conditions for optimal choice of the excitation energy and focusing conditions of the initial x-ray beam are discussed.

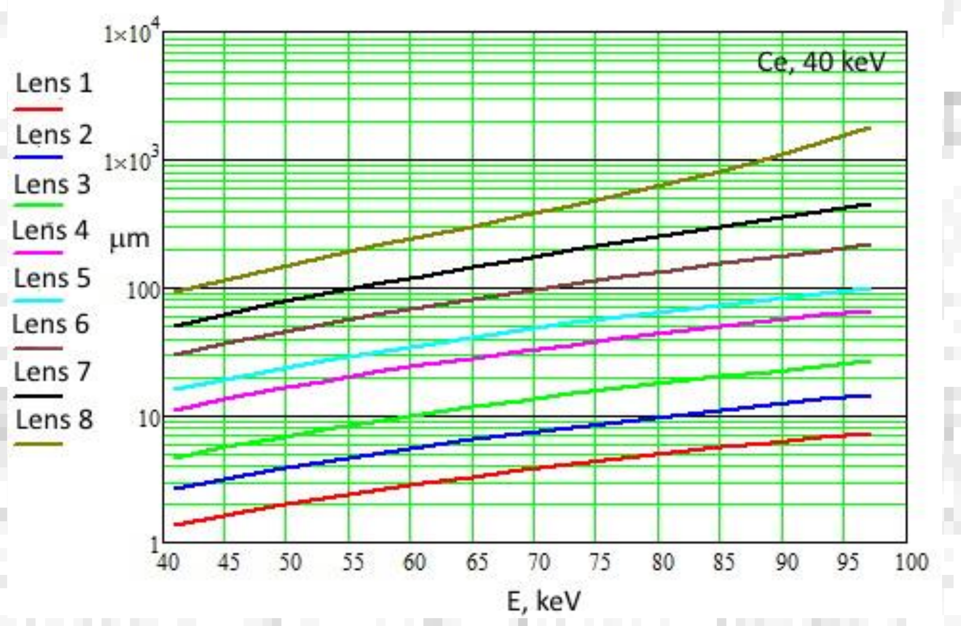
Fluorescence yield from X-ray beam focused to a voxel



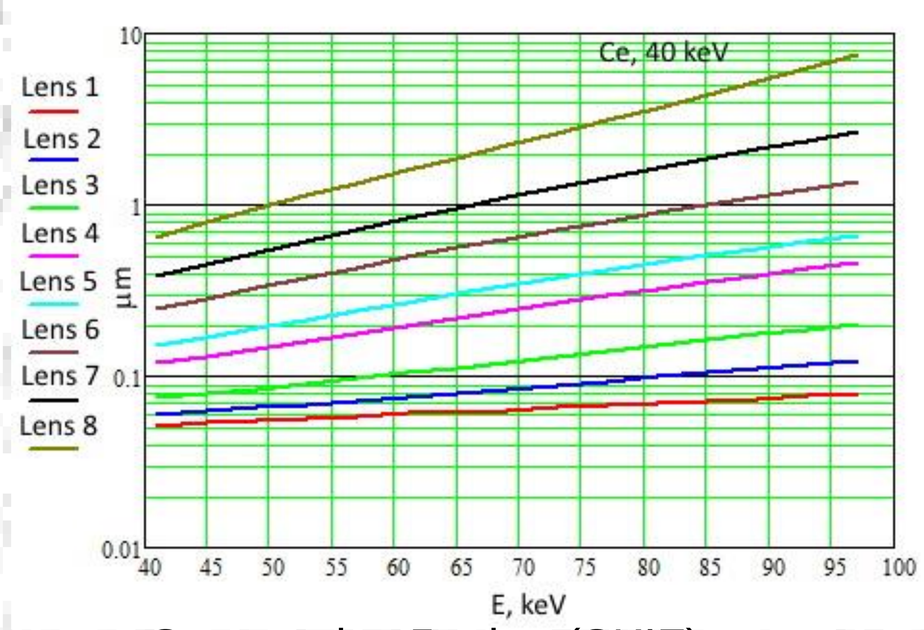
X-ray voxel forming by an x-ray refractive lens in the specimen

Lens number	Structure number	Aperture, μm	Curvature radius, μm	Structure length, μm
1	216	40.85	4.6	127
2	157	60	6.6	164
3	129	84.6	9.8	213
4	88	128.3	15.9	312
5	75	156.2	19.4	367
6	57	214.9	27.4	484
7	45	278.6	35.4	611
8	35	369	47.6	778

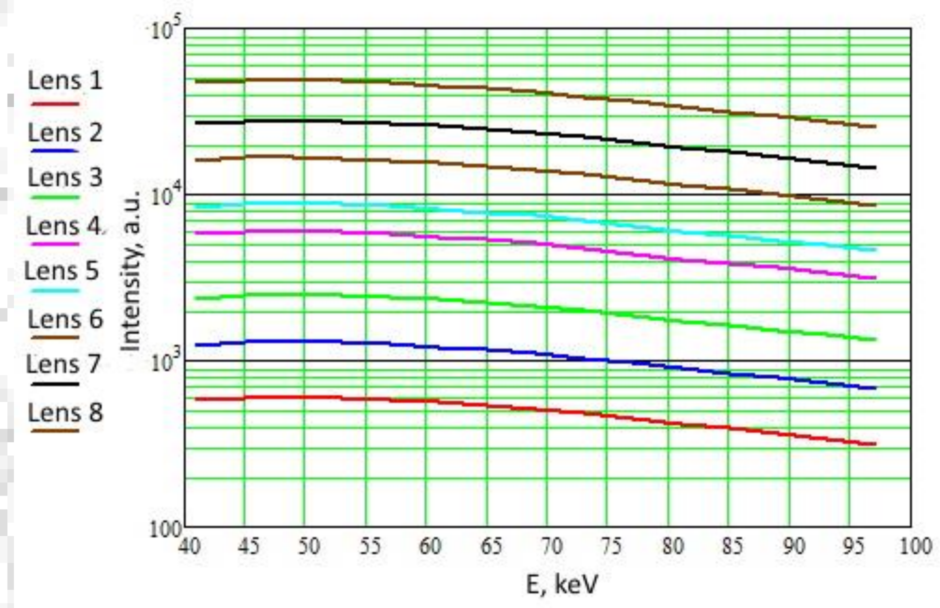
X-ray refractive lens parameters, produced by KIT



Source size 588 mkm (VEPP-4 synchrotron source), beamline L = 32 m

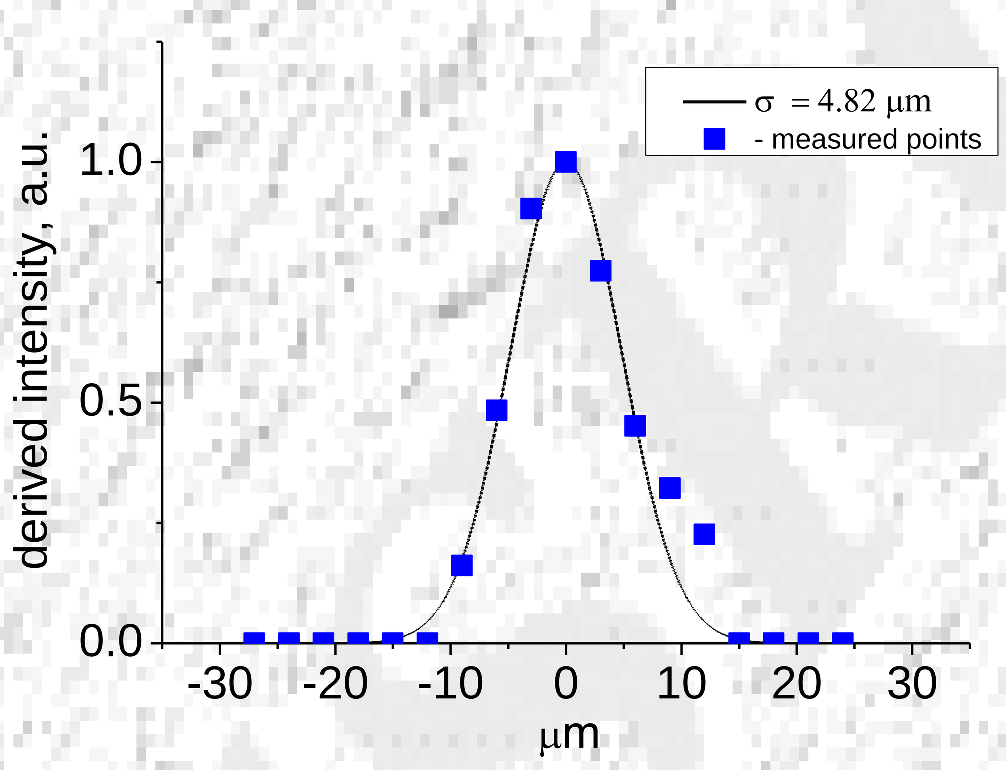


Source size 5 mkm (SKIF), beamline L = 40 m

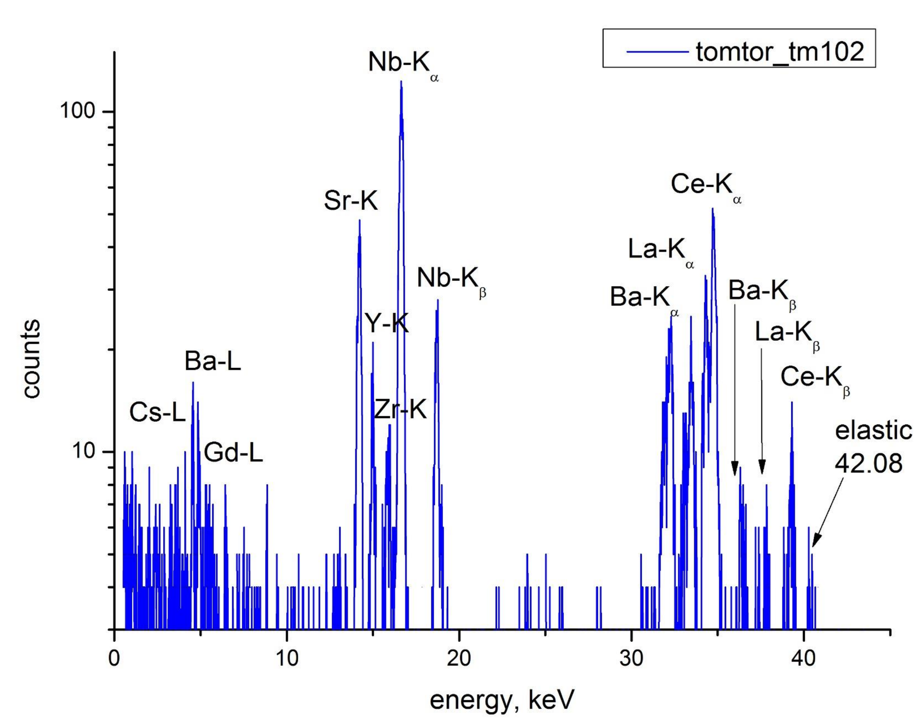


Intensity yield from the voxel

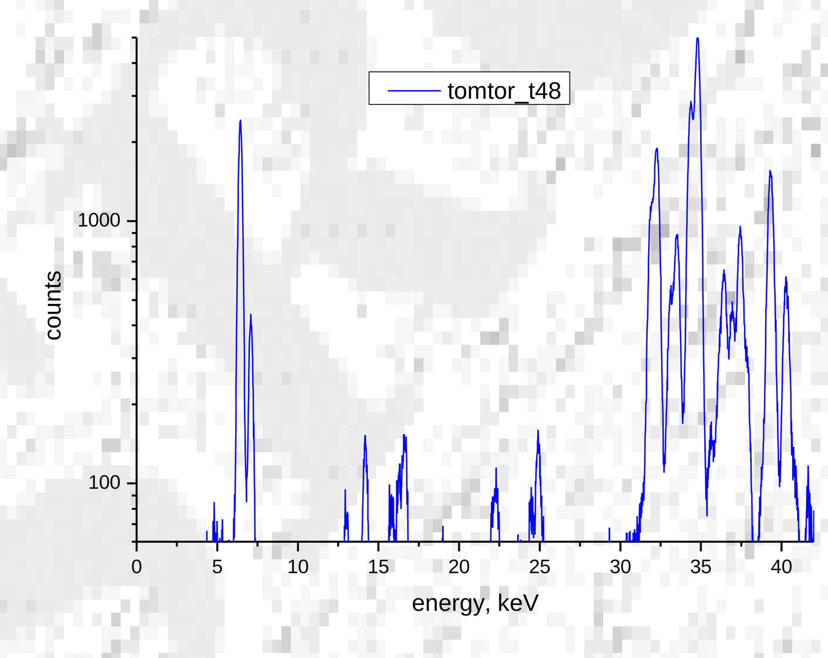
XRF with focused x-ray beam of 42 keV at VEPP-4 synchrotron source



Derived intensity from the knife-edge scan across spot size in vertical direction yields a size of 11 μm



X-ray fluorescence from the voxel behind the 11 μm x-ray focal spot



X-ray fluorescence from the voxel behind the x-ray beam with cross-section of 2 x 2 mm

Acknowledgement

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Conclusion

It is shown in the work that the cross section of the irradiated voxel, initiated by the primary x-ray beam focused on the sample surface, increases in depth of the sample, which is especially noticeable for a large radiation source. A focus size of 11 μm in diameter was achieved for a photon energy of 42 keV, and the use of a focused beam helps to reduce the intensity background.