Angular differential measurement of linear polarization of elastically scattered hard x-rays.

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Elastic scattering of photons from atoms and molecules, also known as Rayleigh scattering, is one of the fundamental processes in the interaction of light with matter. Understanding of this scattering process, in particular in the hard x-ray regime, is important for various applications such as medical imaging, material research and it also provides information about the inner structure of atomic and molecular systems [1,2]. Also from theoretical point of view, there is ongoing interest at present [3,4]. Former experimental studies of this scattering process have used either unpolarized or linearly polarized photon sources to investigate the angular distribution and absolute peak intensities of the scattered radiation. However, the polarization properties of the elastically scattered photons have not been resolved up to now. Due to recent development in coherent light sources on one side and highly-segmented semiconductor based detection systems [5,6] on the other, it became feasible to control both, the polarization of the incident as well as the scattered photons.
The present experiment at beamline P07-EH3 aims to measure the angular distribution and polarization of the initially linearly polarized hard x-rays, scattered off a high-Z target. Therefore, a Si(Li) Compton polarimeter, developed for experiments at the international FAIR facility, as well as standard Ge(i) detectors have been used. The data (see Fig. 1) are currently being evaluated.

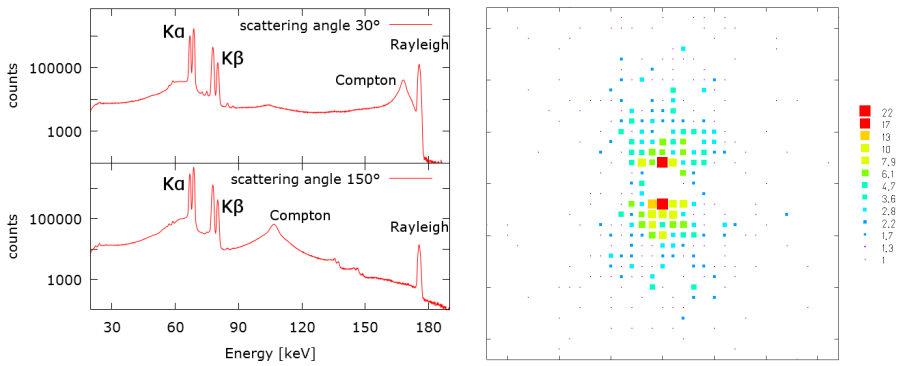

Figure 1: The left figure shows the Ge(i) detector response to the radiation, scattered off a thin Au-foil target. The synchrotron radiation energy was set to 175 keV. The characteristic target radiation $K\alpha_{2,1}$ and $K\beta_{1,2}$ is clearly visible. The 175 keV line corresponds to the elastic Rayleigh-scattering. The broader structure, shifting with the scattering angle, corresponds to inelastic Compton-scattering. The right figure shows the position distribution of photons, elastically scattered in the target at 120° and then Compton-scattered inside the Si(Li) detector crystal. The profound anisotropy indicates a high degree of the linear polarization of the Rayleigh-scattered photons from the Au target.

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