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

M. Schwemlein[1,2,3], *K.-H. Blumenhagen*[4,5], *T. Gassner*[4,6], *T. Groß*[7], *A. Gumberidze*[1,2], *R. Märtin*[4,6], *N. Schell*[8], *U. Spillmann*[4,6], *S. Trotsenko*[4,6], *G. Weber*[4,6], *and Th. Stöhlker*[4,5,6]

[1]ExtreMe Matter Institute EMMI, Darmstadt, Germany, ; [2]FIAS, Frankfurt a.M., Germany;
[3]PI, Univ. Heidelberg, Germany; [4]HI-Jena, Jena, Germany; [5]IOQ, Univ. Jena, Germany; [6]GSI, Darmstadt, Germany;
[7]IGVP, Univ. Stuttgart, Germany; [8]HZG, Geesthacht, Germany

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.

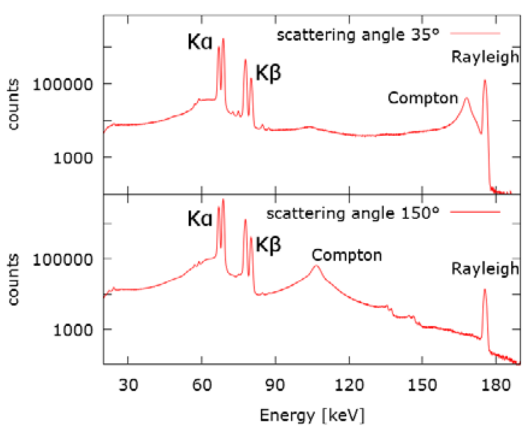

Figure 1: Ge(i) detector response to synchrotron radiation that is scattered at a Au target under 35° and 150°. The characteristic target radiation $K\alpha_2$ (67 keV), $K\alpha_1$ (68.8 keV), $K\beta_1$ (77.9 keV) and $K\beta_2$ (80.1 keV) is clearly visible. The 175 keV line correspond to elastic Rayleigh-scattering. The broader structure, shifting with the scattering angle, correspond to inelastic Compton scattering.

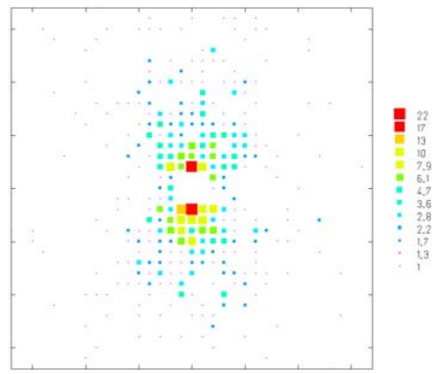

Figure 2: 175 keV X-rays are elastically scattered in the Au target at a scattering angle of 120°. These Rayleigh photons are again Compton-scattered in the Si(Li) detector crystal. The figure shows their position distribution inside the Si(Li) detector with respect to the scattering position.

The present experiment 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 experiment took place at the DESY PETRA III beamline P07-EH3, where nearly 100% linearly polarized photons in the hard X-ray regime can be produced.

Fig. 1 shows the Ge(i) detector response to the radiation, coming from the target. A thin Au foil was used as the target. The synchrotron radiation energy was set to 175 keV. Fig. 2 shows the position distribution of Compton scattered photons (elastically scattered in the target) inside the Si(Li) detector crystal. The anisotropy indicates a high degree of linear polarization of the Rayleigh-scattered photons from the Au target. The data are currently being evaluated.

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