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Elastic scattering of linearly polarized hard x-rays

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Synopsis We investigated the elastic scattering of linearly polarized 175-keV photons by a neutral gold target. The angular-differential scattering cross section and the linear polarization of the scattered radiation were measured.

Quantum Electrodynamics (QED) effects in fundamental light-matter interactions are particularly pronounced in heavy (high-Z) atomic systems. Photons emitted by such systems provide experimental access to the detailed understanding of the underlying interaction. In the current contribution, we concentrate on elastic photon scattering (Rayleigh scattering) in the hard x-ray range namely in combination with a high-Z target. Although Rayleigh scattering (sometimes called virtual photoionization) is a very well-established process, experimental data for the hard x-ray range (beyond 100 keV) are rather rare, in particular with respect to the polarization properties of the scattered radiation [1]. Also with respect to theory this process is still a quite challenging task since it must be treated in second order perturbation theory [2]. Recently, photon polarization effects in elastic scattering were studied in a theoretical investigation and the assumed models can now be tested with our experimental data. Here, we report on an experiment where we investigated the elastic scattering of linearly polarized 175-keV x-rays by a thin gold foil. We note, for the first time, not only the angular distribution, but also the linear polarization of the scattered photons was measured for linearly polarized incident photons. The incident photon beam in our experiment was provided by the High Energy Material Science Beamline P07 [3] at the synchrotron PETRA III at DESY, Hamburg. Using a dedicated target chamber, the beam was scattered off a thin gold foil (1.036 μm) and the scattered photons were detected by standard germanium detectors as well as by a double-sided, position sensitive Si(Li) detector. The latter allows to study the linear polarization properties of the radiation by means of Compton polarimetry [4]. An overview of recent experiments where this technique was applied is given in [5]. Figure 1 shows two-dimensional position data from the polarimeter, see caption for details.

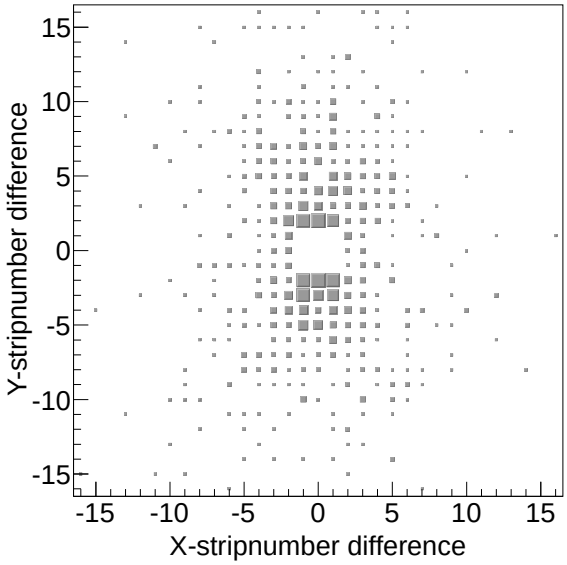

Figure 1. Preliminary data of the 2D position distribution of photons that were Compton-scattered inside the polarimeter crystal. The anisotropy indicates a strong linear polarization of the incident radiation, which consisted of photons that were elastically scattered in the gold target at a scattering angle of 120°.

References

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