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## High Resolution Hard X-Ray Spectrometer FOCAL for Testing QED in Strong Fields

Aiming for an accurate testing of QED effects on the ground state binding energy in high-Z H-like ions, novel high resolution x-ray spectrometer apparatus has been developed for experiments at the Experimental Storage Ring (ESR) at GSI, Darmstadt. Namely, the twin crystal-spectrometer assembly, Bi-FOCAL, operated in the Focusing Compensated Asymmetric Laue geometry has been arranged for accurate x-ray spectroscopy at the ESR gas-jet target. The reflected x-rays are detected by specially built 2D position-sensitive micro-strip Germanium detectors. These detectors provide position, energy as well as time resolution which is vital for using the FOCAL spectrometer at storage ring.

In a dedicated beamtime at the ESR, Lyman- $\alpha$  transitions of H-like Au<sup>78+</sup> were measured with the FOCAL apparatus. The energy resolution corresponding to about 60 eV FWHM at 63 keV photon energy has been achieved surpassing the best semiconductor detectors by almost one order of magnitude. The achieved statistical uncertainty of 2.2 eV is groundbreaking for a crystal spectrometer operated in the region of hard x-rays of H-like high-Z ions. The systematic effects associated with the uncertainties of the ion beam velocity and the gas-jet position give the main contribution to the total uncertainty and have to be reduced in future runs. This experiment represents the first high-resolution wavelength-dispersive measurement of hard x-rays stemming from a high-Z H-like ion and thus it demonstrates the feasibility of this method at heavy-ion storage rings, such as ESR.

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