Construction and test of a detection system for forward emitted XUV photons*

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The Institut für Kernphysik in Münster is currently developing a system for in-vacuum detection of XUV photons in the wavelength range from < 10 nm up to about 250 nm. The system will be installed at the ESR and consists of a movable cathode plate with a central slit that can be positioned around the ion beam axis to collect photons emitted in the forward direction during the de-excitation of stored highly-charged ions. Secondary electrons emitted from the cathode will be guided by a magnetic field and a system of ring electrodes to a multi-channelplate detector (MCP) placed inside the vacuum. A similar detection system for optical photons making use of a movable parabolic copper mirror and a photomultiplier outside the vacuum, has already successfully been applied in the detection of the HFS transition in lithium-like bismuth in the LIBELLE experiment [1, 2]. There it was demonstrated, that the introduction of a suitable optical system at the beam position does not disturb the stored ions apart from a small loss in beam current during the movement of the system.

The electromagnetic design of the detector setup was simulated and optimized using the SIMION 8.1 [3] package (see figure 1) and provided the basis for the actual detector construction. The electric and magnetic field settings from simulation are currently being optimized in test measurements in Münster.

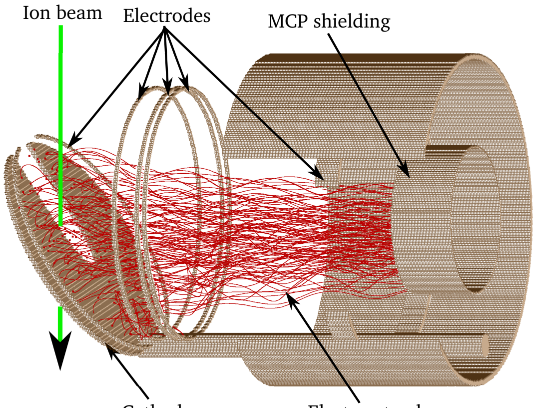

Figure 1: Electrode representation and simulated electron tracks calculated with the SIMION 8.1 package.

Figure 2 displays the setup of the detector system as it is used for these measurements. Five ring electrodes are placed between the cathode plate and the MCP, with the first electrode parallel to the cathode. The CF200 port into which the system can be retracted during injection of ions into the ESR actually acts as an additional sixth electrode on ground potential. Outside the vacuum chamber two solenoid coils are used to create a magnetic field which together with the electrostatic potential guides the electrons to the MCP. For the test measurements an UV-LED with a peak wavelength of 265 nm was installed inside the vacuum as photon source. The measurements aim to find electrode potential and magnetic field settings to maximize the detection probability for secondary electrons. Additionally, further simulations investigate improvements of the electromagnetic design, e.g. by an optimized coil geometry.

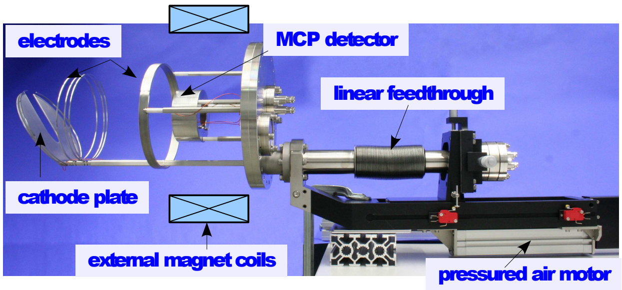

Figure 2: XUV detector system with schematically depicted magnet coils

The new detection system will be used for a measurement of the $^3\mathrm{P}_0 - {}^3\mathrm{P}_1$ splitting in beryllium-like krypton in an anti-collinear laser spectroscopy experiment at the ESR [4]. The meta-stable state $(1s^2 2s2p)\ ^3\mathrm{P}_0$ is populated during the production of the $^{84}\mathrm{Kr}^{32+}$ ions. For the excitation to the $(1s^2 2s2p)\ ^3\mathrm{P}_1$ state, a laser-beam is injected anti-collinear to the ions which are stored at a velocity of $\beta = 0.69$. Due to the Doppler shift, the required wavelength is red-shifted from 118 nm to 276 nm. The photons emitted during de-excitation to the ground state in the forward direction are in turn blue shifted to energies up to 170 eV.

References

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[2] V. Hannen *et al.*, Jinst 8 (2013) P09018

[3] SIMION package, Scientific Instrument Services, Inc., http://simion.com

[4] D.F.A. Winters *et al.*, *Laser spectroscopy of the* $(1s^2 2s2p)$ $^3P_0 - {}^3P_1$ *level splitting in Be-like krypton*, GSI Experiment E104

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