Commissioning of a high-power electron gun for electron-ion crossed-beams experiments

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Synopsis A high-power electron gun delivering a ribbon-shaped electron beam with energies of 10-3500 eV and high currents at all energies is currently being commissioned at the electron-ion crossed-beams setup in Giessen. As compared to the formerly used electron gun [1], the new one will enable us to perform measurements of cross-sections for electron-impact ionization of ions in a wider energy range and, consequently, for ion charge states that were not accessible before.

In an electron-ion crossed-beams experiment, the experimental sensitivity is mainly determined by the densities of both beams in the interaction region. Formerly, an electron gun producing an electron beam with energies of up to 1000 eV has been successfully operated at our institute [2]. Aiming at the extension of the available range of accessible electron energies and densities, a new high-power electron gun has been developed and built. It delivers a ribbon-shaped beam with high currents at all energies variable between 10 and 3500 eV [3, 4]. The predicted high electron currents and good beam transmission have already been demonstrated [5].

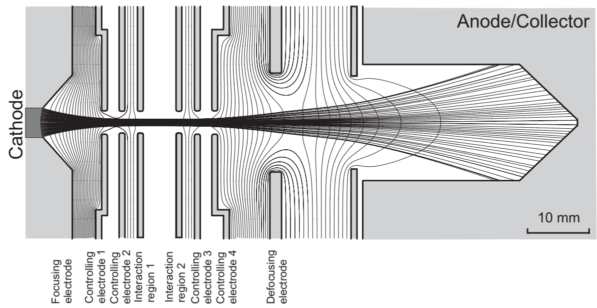

Figure 1. Simulated electron propagation in the new electron gun.

This type of electron gun consists of nine electrodes (Figure 1): The cathode/focusing electrode, the controlling electrodes 1-4, the interaction region 1 and 2, the defocusing electrode and the anode/electron collector. This configuration allows for a variety of operational modes (Table 1) and, thus, the independent control of the energy and density of the electron beam available in the interaction region by variation of the electrostatic potential between the cathode and the controlling electrode 1 (the extraction electrode) while leaving the potential between the cathode and the interaction region constant. Moreover, a potential trap in the interaction region can be controlled, and also a deceleration of the electrons right in front of the collector is possible.

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Table 1. Some possible operation modes of the electron gun. Column 2 provides the ratios of potentials on the cathode/focusing electrode, controlling electrode 1, controlling electrode 2, controlling electrode 3, controlling electrode 4, defocusing electrode and collector, respectively. The interaction region is on the ground potential and, thus, corresponds to the relative zero point.

Operation mode	Potentials on electrodes
High-energy	-1:0.05:0.05:0.05:0.05:-1:0
High-current	-1:4:0.05:0.05:4:-1:0
No potential trap	-1:0.05:-0.15:-0.15:0.05:-1:0
Reduced power	-1:0.05:0.05:0.05:0.05:-1:-0.5

Here, we report on the current status of the commissioning of this electron gun. The electron gun is integrated into the experimental electron-ion crossed-beams setup in Giessen. Employing the animated crossed-beams technique [6], first cross sections for electron-impact ionization of xenon and helium ions were measured [5]. The measurement of more cross sections is intended for the near future. Further investigations concerning, e.g., space-charge effects in the high-density electron beam are currently performed.

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