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High-power electron gun for electron-ion crossed-beams experiments

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Synopsis We present a high-performance electron gun to be employed in crossed-beams electron-ion collision experiments. High electron currents, e.g., 1 A at 3.5 keV, have already been demonstrated verifying the results of electron optics simulations carried out prior to the mechanical construction of the gun. Currently, the device undergoes a major test phase in a specifically constructed ultra high vacuum setup before the integration into the ion beamline of the Giessen crossed-beam experiment.

The available electron density in the interaction region of electron-ion collision experiments is a key factor determining the experimental sensitivity to the processes to be studied. Employing state-of-the-art technology of electron-emitting materials and advanced methods for the design of space-charge-limited beams, an electron gun could be realized previously producing electron currents as high as 0.45 A at 1000 eV [1]. For already decades, this gun has been successfully used in the electron-ion collision experiments at our institute (see, e.g., [2, 3]).

Here, we report on the implementation of a new high-power electron gun to be employed in electron-ion collision experiments. The design study has already been reported previously [4]. The new gun produces a ribbon shaped electron beam with a width of about 60 mm. The height of the beam is energy dependent and is typically 1 to 2 millimeters. Including cathode and electron collector the gun comprises 10 separate electrodes providing several modes of operation and a high versatility with respect to optimizing the electron beam properties depending on the purpose of a given experiment. Test measurements on a prototype version constructed on the basis of the electron-optics modelling have experimentally confirmed the parameters predicted by the simulation calculations. Electron currents reaching up to 1 A at 3500 eV electron energy could be obtained.

After recent profound reconstruction of the electrode supports and insulations, the gun has been made less susceptible to sparking and surface electric currents. Additional diagnostic possibilities allow measurements of loss currents to all electrodes providing an improved real-time information on the electron current in the interaction region. The electron gun is presently implemented in an ultra-high vacuum setup that can be installed in an arbitrary ion beamline. The setup facilitates in-situ alignment of the electron beam with the ion beam and allows one to use the "animated beams" technique for the determination of absolute electron-ion collision cross sections [2]. The unit with the associated mechanisms for positioning and linearly translating the electron gun together with its water cooling system is shown in Figure 1. Shielding-electrodes providing regions with well defined electric field gradients for the ion beam on it's way through the electron gun are also visible.

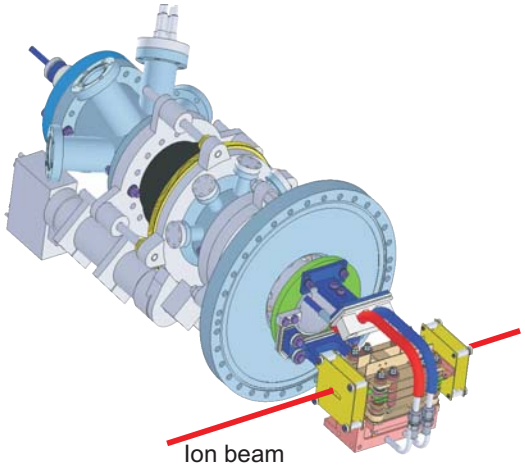

Figure 1. Schematic view of the electron-gun installation.

References

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