Developments towards a transverse free-electron target for the storage ring CRYRING@ESR

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Synopsis A transverse free-electron target for crossed-beams collision studies is currently being developed. The target will be installed in the main experimental section of the FAIR storage ring CRYRING@ESR. The setup will allow for electron-ion collision studies with highly charged ions on an unprecedented level of detail that comprises, e.g., the angle-differential observation of photon emission.

The storage ring CRYRING@ESR will be one of the first operational devices at the upcoming anti-proton and heavy-ion accelerator facility FAIR. As a part of the program of the SPARC collaboration it is intended to install a dedicated sheet-beam free-electron target at CRYRING@ESR [1]. Electron-ion collision studies with transverse electron targets were conducted at low-energy single-pass beam lines since the 1960s [2] but a crossed-beams setup has never been realized at a heavy-ion storage ring, yet.

Currently, a new electron gun is being developed (Fig. 1) that advances previous multi-electrode arrangements [3, 4, 5] with adaptations to the special requirements at CRYRING@ESR, namely, free space for the circulating ion beam and stringent vacuum conditions with residual gas pressures of the order of 10^{-11} mbar. The multi-electrode layout enables a detailed control of electron-beam parameters such as beam size, electron density and electron energy. Maximum electron energies up to 12.5 keV are envisaged. The typical beam-size in the interaction region is 8×80 mm^2 at an electron density of up to 10^9 cm^{-3}.

The set-up is optimized for spectroscopy of photons thus enabling many new opportunities for experimental access to fundamental electron-ion collision processes including excitation, recombination, elastic scattering and ionization. In contrast to collision studies at a gas-jet target, no target nucleus is present. Hence, observations of electron-impact excitation or electron-ion recombination are not obscured by competing processes like proton-impact excitation or non-radiative capture. A further advantage is that the electron-ion collision energy can easily be changed over a wide range without changing the ion energy.

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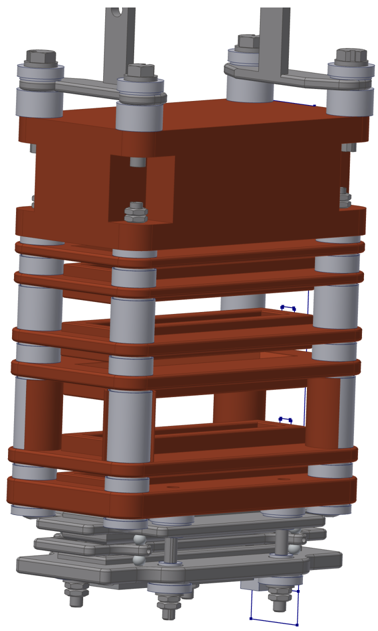

Figure 1. Current design of the new electron gun, which is still being optimized. The electron beam is directed bottom to top.

References

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