A transverse electron target for FAIR

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Synopsis

As new approach to investigate electron-ion interaction processes a transverse electron target is planed for the NESR (New Experimental Storage Ring) at the FAIR facility using the crossed beam technique. An overview of the status and the design of the electron target will be given.

Using the crossed beam technique for electron-ion interaction is a well suited concept for storage ring experiments. It promises a better energy resolution than an internal gas target by one order of magnitude. In comparison with a longitudinal electron target it allows not only the detection of charge changed ions, but also of emitted photons and electrons under large solid angles. Therefore a transverse electron target opens the perspective to new types of experiments in atomic physics.

It offers cross section measurement for astrophysical data as well as for ion beam physics eg. for beam lifetimes in storage rings and beam transport, like from an ECRIS to the following LINAC at the Fair facility. Beyond the investigation of direct electron impact ionization (DI), excitation (DE) and different recombination processes, resonant and non-resonant electron scattering studies will be possible and also nuclear excitation studies from resonant electron capture. Due to its design, based only on electrostatic fields, the influence of those on the different interaction processes can be examined.

The target is dedicated to the NESR at the new Facility for Antiproton and Ion Research (FAIR) [1] finally, but will be tested at the Frankfurt Low Energy Storage Ring (FLSR) at Frankfurt University [2]. The electrostatic storage ring is designed for ions and molecules up to energies of 50keV. It offers with its four experimental areas with beam focus points of 3x4mm² size an optimal test environment to gain first experiences with the crossed beam technique and the target itself.

For the use of the transverse electron target in a storage ring a simple design without any magnetic fields was chosen. Simulations with the EGUN code [3] shows that it works for electron beam energies between 10eV and 10keV. To reach a higher perveance limit the design uses a sheet beam of 10cm length in ion beam direction with electron trajectories as parallel as possible in the interaction region. By the chosen electrode setting high electron currents will be achievable also for low electron beam energies and high electron densities above 10⁹/cm³ can be realized according to the simulations. Compared to previous electron target designs [4,5] the new Frankfurt electron target has an open geometry which allows the direct access to the interaction region with x-ray detectors. To determine the overlap factor for absolute cross section measurements the animated beam technique will be used to scan the ion beam.

For the planned design, first approximations for expected interaction rates of DI and the radiative recombination (RR) from known cross sections give results due to [6] in the order of 10³kHz (DI) and 10²Hz (RR) for a mediate charge state of argon ions with an energy of 1keV.

An overview of the progress in development of the transverse electron target will be presented.

References

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