Space Charge Investigation for FAIR with a 4-grid Analyzer∗

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4-grid Analyzer

The 4-grid Analyzer, or Retarding Potential Analyzer (RPA) is a device for measuring the space charge compensation of ion beams by analyzing the energy distribution of secondary ions accelerated by the beam potential. The RPA consists of four grids as shown in Figure 1. Grid one is on ground potential to avoid interruption with the ion beam. Grid two repels electrons coming from the beam tube. The voltage on grid 3 is retarding and can be varied from negative to positive electric potential to filter secondary ions produced during interaction between primary ions and residual gas in the beam. The fourth grid repels electrons produced in the Faraday cup at the end of the RPA. For capturing the signal a current to voltage transformer (I-U transformer) with a high signal acceptance is used.

Results-Overview

Measurements are performed at the Hochstrom test bench and the HOSTI (HOchStromTestInjektor) test bench under variable conditions. First measurements are done with a high current ion source (MUCIS), single hole extraction system with He and Ar gas. An example for the results is given in Figure 2.

Figure 2: (1) Measurement at Hochstrom test bench $U_{Extr} = 20\, kV, I_{FC} = 7\, mA$; (2) Results

For the example above $\Delta \Phi_{\text{uncomp}}$ is calculated to 122V. This results in a space charge compensation of 98%.

At HOSTI test bench the RPA is installed behind a superconducting solenoid to focus the ion beam. With the solenoid beam compensation can be destroid. For the example in Figure 3 space charge compensation varies round 97% based on $\Delta \Phi_{\text{uncomp}} = 23,7\, V$.

Outlook

It is planned to check on the time dependency of space charge compensation in a pulsed ion beams on HOSTI test bench. Various ion source types with different extraction systems for high current injection will be used to compare light and heavy gas operation as well as metal operation.

\[ \Delta \Phi_{\text{uncomp}} = \frac{I}{4\pi \cdot \epsilon_0 \cdot v_{\text{ion}}} \quad (1) \]

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