Status of the *g*-factor experiment for highly charged calcium*

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Measurements of the anomalous magnetic moment of the electron bound in hydrogenlike ions with spinless nuclei have proven to be highly-sensitive tests of calculations based on bound-state quantum electrodynamics (BS-QED). The calculations of the *g*-factors of the electron bound to hydrogenlike carbon and oxygen and their corresponding measurements performed by the collaboration between GSI and the University of Mainz [1, 2] agreed down to the 9^{th} significant digit.

Presently, an experiment on highly-charged calcium is prepared [3, 4], which is expected to yield a precision on the level of 10^{-9} for the electronic *g*-factor of $^{40,48}Ca^{17,19+}$. This experiment makes use of an in-trap electron-beam ion source (EBIS) with which the charge breeding of the ions is performed by electron-impact ionization. This is a major issue, since the environmental requirements (4 K and $\sim 10^{-16}$ mbar) complicate the use of an electron gun for the production of the highly-charged ions [5]. Thus, a setup for properly characterizing the source was prepared (figure 1).

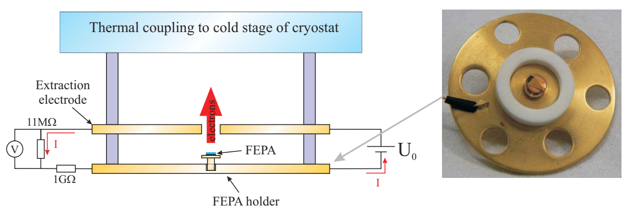

Figure 1: Setup for testing the electron gun (left) and a photograph of the holder of the FEPA, including an isolator ring made out of MACOR (right).

The cathode of the EBIS is based on a field-emission-point array (FEPA) manufactured in collaboration with the TU-Darmstadt [6]. The emission of electrons is achieved by applying a voltage between the FEPA and an extraction electrode, which creates the required, high electric field. The electron current emitted is measured directly as the current supplied by the voltage source to the cathode in order to compensate for the loss of electrons at the tips. This current produces a measurable voltage drop at the inner 11 MΩ resistance of a voltmeter.

Most important to us is the extracted electron-current behavior with respect to the voltage applied: an I-V curve. The curve in figure 2 was taken at a temperature of 5.4 K and shows a typical result, where one can easily distinguish three operating regions:

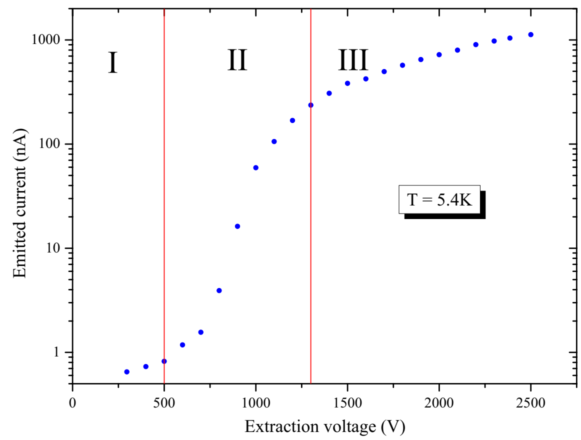

Figure 2: I-V curve taken at 5.4 K. The three operating regions are: I - non-emitting regime; II - electron emission; III - saturation.

- I - Non-emitting regime: at low voltages, there is no field emission. There are, however, small leak currents measured with the voltmeter. The slope corresponds to a resistance of 100 GΩ.
- II - Electron emission: above a certain field strength, electrons tunnel out and the current increases abruptly.
- III - Saturation: caused by the decrease in work-function of the metal due to the heating effect during field emission, deformations at the tips, and space-charge and screening effects [7].

During 2006, numerous experiments have been carried out in order to test and characterize the mini-EBIS. Systematic studies were made to understand its dependence on the temperature and geometry. Meanwhile, all the experimental setup for the production of highly-charged ions and the corresponding *g*-factor measurement has been completely finalized, including the control system needed for the first measurement stages.

References

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* Work supported by the EU, the BMBF, the DFG and the Helmholtz association (VH-NG-037)
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