Characterisation of ion bunches by a single-pass non-destructive charge counter

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Synopsis We present non-destructive single-pass ion bunch detection and characterisation by measuring the induced image charge in a detection electrode. The presented technique allows direct determination of ion kinetic energy, absolute ion number and spatial ion bunch length. We will show the results of corresponding measurements with bunches of low-energy highly charged ions and discuss the minimum detectable number of charges.

The HILITE [1] Penning trap will provide well-defined ion targets to investigate laser-matter interactions in both the high-intensity and high-energy regime with highly charged ions. The experimental setup includes an Electron Beam Ion Trap (EBIT) and a velocity filter for access to highly-charged-ion bunches of a selected charge state.

For ion bunch detection and analysis we have implemented two distinct single-pass non-destructive charge counting devices [2]. They measure the time-dependent image charge induced by an ion bunch. From such a single-pass signal we can directly extract the kinetic energy, the number of ions and the bunch length. The non-destructive nature allows measurements of products and educts in laser-ion interactions.

We will show a brief overview of the HILITE experiment and present the implemented ion counting technique. This includes the theoretical background of induced image charges, the signal analysis method and calibration results for both kinetic energy and absolute ion numbers. Additionally, we will discuss the sensitivity of the setup and the minimum number of detectable ions. Also, we will outline approaches to further increase the signal-to-noise ratio to be even sensitive to less than ten ions per bunch.

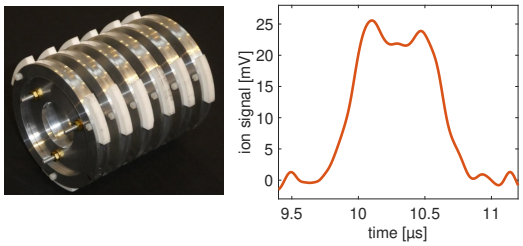

Figure 1. Picture of the detection electrode (left). Single-pass image charge signal induced by about 3000 Ar^{13+} ions (right).

References

[1] Vogel M, Quint W, Paulus G G and Stöhlker Th 2012 *Nucl. Inst. Meth.B* **285** 65
[2] Schmidt S *et al* 2015 *Rev. Sci. Inst.* **86** 113302

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