HILITE – A well-defined ion target for laser experiments

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Synopsis We present a Penning-trap-based setup for the study of light-matter interactions in the high-power and/or high-intensity laser regime, such as multi-photon ionization and field ionization. The setup applies ion-cloud formation techniques to highly charged ions to the end of specific target preparation, as well as non-destructive detection techniques to identify and quantify the interaction educts and products.

The **H**igh-**I**ntensity **L**aser **I**on **T**rap **E**xperiment (HILITE) [1] aims to investigate the interaction of highly charged ions with extreme laser fields. To this end, we have built the setup based on an open-endcap Penning trap that facilitates the controlled formation of an ion target comprised of selected species, to superimpose it with a high-intensity and/or high-energy laser beam, and to non-destructively detect the confined ion species. To cover a broad range of laser parameters and hence different laser-matter interaction regimes, the setup is built in a compact fashion and allows transport to various large-scale laser facilities.

The Penning trap (see figure 1a) is located in the centre of a 6T superconducting magnet and cooled to cryogenic temperatures. The ions are provided by a dedicated source (EBIT), operated in a pulsed extraction mode to create a bunched beam of highly charged ions. These can be pre-selected by a velocity filter and decelerated by a pulsed drift tube. After deceleration, the ions are dynamically captured inside the trap by appropriate switching of electrode voltages. A single-pass ‘charge counter’ is placed on either side of the trap to determine the number, energy and structure of the incoming and outgoing ion bunches in a non-destructive way [2].

We will present the current status of the setup that has successfully demonstrated ion extraction and selection by the source and velocity filter, as well as transport, deceleration and storage inside the trap. So far, storage times of the order of several tens of minutes have been achieved. Furthermore, we will show the planned measurements at the free-electron laser FLASH@DESY (see figure 1b).

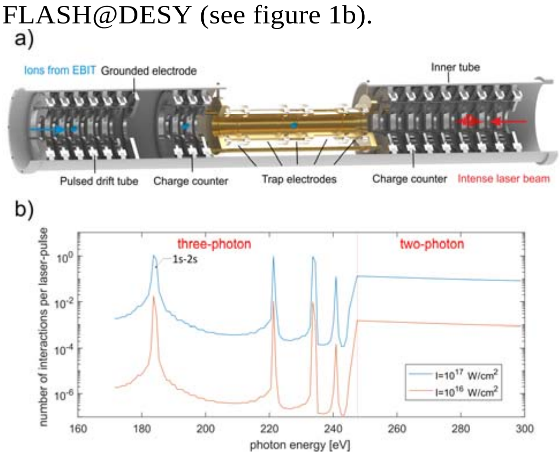

Figure 1. **(a)** Schematic of the Penning trap setup including deceleration and single-pass non-destructive ion detection devices. **(b)** Expected ion yield for hydrogen-like carbon for the proposed measurements in the X-ray photon-energy regime based on theoretical predictions [3].

References

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