Contribution ID: **187**   Type: **Poster presentation**

HILITE - stored ions for non-linear laser-ion experiments

Tuesday, 31 August 2021 19:32 (4 minutes)

We have designed, built and operated the HILITE (High-Intensity Laser Ion-Trap Experiment) Penning trap which is designed to extend the research of the interaction of high-intensity or high photon-engergy laser pulses to highly-charged ions. The binding energy of electrons in highly-charged ions such as hydrogen-like carbon is comparable to the photon energy of XUV to X-ray free-electron lasers and are now accessible by multi-photon ionisation. The electric field between an electron in hydrogen-like neon is comparable to the electric field of a high-power laser with an intensity of about $10^{20}\,\frac{W}{cm^2}$ and can be ionised via field ionisation. In the mentioned systems, ionisation cross sections can be predicted precisely by theoretical models with comparably little computational effort and can be hence compared with the experimental values. It is also possible to measure the laser intensity in case the ionisation cross sections are known.
Using a Penning trap we can compose a single-species ion-cloud with well-known ion charge state, ion number and ion-cloud shape. The trap is built in the so-called *open-endcap* design to allow both laser and ion access from outside. The ions are produced externally by an Electron-Beam Ion Trap (EBIT), selected by a Wien filter, and captured dynamically in the trap centre [1].
For example, C^{2+} and C^{5+} ions have been captured, detected inside the ion trap and stored for roughly a quarter of an hour. In addition, we have characterised the ion trap content destructively after ion ejection using time-of-flight spectroscopy.
For ion-cloud formation, a cycle time of less than one minute is aspired, for which the current storage time is sufficient.
Last year we have moved the HILITE Penning trap to a photon user facility for the first time, in the present case FLASH at DESY in Hamburg. We have connected both systems and brought the trap back in operation successfully. We have had to deal with unexpected bad vacuum conditions which has allowed us only the storage of C^{2+} ions for a short time. We have used the 10 Hz master clock of the FLASH FEL to synchronise the ion capture, ejection and detection procedure with the laser pulses. During laser-ion interaction, the ions have been located about 20 mm around the trap centre in axial direction where the laser waist diameter has been nearly constant. This allowed for a good overlap of the stored ions with a laser focus of a well-known shape. The interaction of the laser with the stored ions has lead to loss of the initially stored C^{2+} ions which can be assigned to laser ionisation.
We will present the setup, the commissioning results and results from our first beamtime. We will also present envisaged upgrades of the setup.

[1] N. Stallkamp et al. X-Ray Spectrom 49(2020) 188-191

Is this abstract from experiment?

Yes

Name of experiment and experimental site

HILITE / GSI Helmholtzzentrum für Schwerionenforschung

Is the speaker for that presentation defined?

Yes

Details

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https://www.physik.uni-jena.de/APIX

Internet talk

No

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Session Classification: Poster Session