Uranium high current development at UNILAC

Winfried Barth[1,2], Aleksey Adonin[2], Christoph E. Düllmann[1,2,3], Peter Gerhard[2], Manuel Heilmann[2], Ralph Hollinger[2], Egon Jäger[2], Jadambaa Khuyagbaatar[1,2], Joerg Krier[2], Paul Scharrer[1], H. Vormann[2], Alexander Yakushev[2], Stepan Yaramyshev[2]

[1] Helmholtz Institute Mainz, Germany
[2] GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany
[3] Johannes Gutenberg-Universität Mainz, Mainz, Germany

Previously a peak record had been achieved in 2007 (Fig.1), while 30% of the FAIR- U^{28+} beam current was accomplished at the end of the transfer line. Caused by a strong High Current Injector (HSI) performance degradation, up to October 2014 the available beam current dropped down to 13% of the design value only. After re-optimization of the complete front end system the HSI is again able to deliver a high uranium beam current. In a short run applying the new fast pulsed high density H_2-gas cell more than a factor of three higher U^{28+} beam current is now available at 1.4 MeV/u. The stripper performance could be optimized applying significantly higher target densities. The new U^{28+} intensity record exceeds the latest peak record by 56% (Fig. 1).

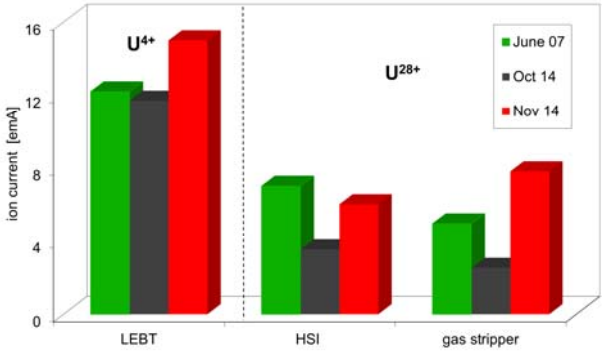

Fig. 1: Achievement of a new uranium beam (28+) intensity record at GSI-HSI and gas stripper section. The former U^{28+}-peak value (2007) was exceeded by 56%.

A new fast pulsed high density gas cell [1] was successfully commissioned with uranium beam from the GSI HSI. Besides, the entire Injector system was optimized for high beam intensity operation. A 25% higher U^{4+} beam current extracted by a newly developed multi aperture beam extraction system (VARIS ion source [2,3]) were used to optimize the Low Energy Beam Transport system and matching line to the RFQ. A beam current of 15.3 emA (Fig. 2) was available for injection into the RFQ. In particular the most sensitive Medium Energy Beam Transport section was optimized for high current high transmission beam transport applying a slightly different set of rf-parameters. With this the HSI was allowed for stable and reliable high current uranium operation. A careful matching of the high power (0.5 MW pulse power) U^{4+} beam to the gas stripper cell was accomplished resulting in a U^{28+} beam current of 7.7 emA (Fig. 2) after stripping and charge separation at 1.4 MeV/u.

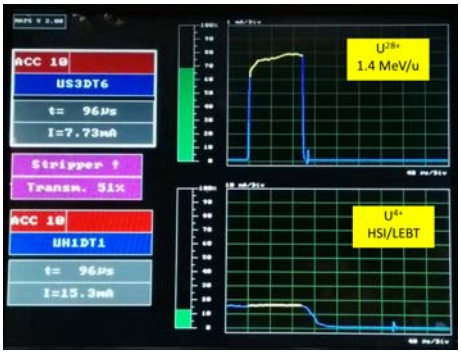

Fig. 2: Beam transformer measurement after careful optimization of a VARIS-uranium beam.

The world intensity record for U^{28+} pulse operation could be reached after less than three days of beam time, including 15 hours beam time spent for commissioning of the H_2-gas cell-stripper. More than 50% of U^{28+}- FAIR intensity requirements (and 65% of beam brilliance) was achieved at 1.4 MeV/u. Increased beam currents for all heavy ions are expected - stripper tests are envisaged using Pb-, Au-, Ta-, Xe-, Kr-, CH_3-beams. An upgrade of the HSI [4-6] is potentially sufficient to meet the FAIR performance at the GSI-UNILAC. Further optimization of stripper performance should be started in an advanced machine experiment program. Beam acceleration up to 11.4 MeV/u and transport to SIS18 is the next step to confirm high intensity operation in the SIS18.

References

[1] Scharrer P., et al., Performance of a modified 1.4 MeV/u gas stripper for $^{238}U^{4+}$, GSI scientific report 2014.

[2] Hollinger R., et al., Status of Vacuum Arc Ion Source Development for Injection of High Current Uranium Ion Beams into the GSI Accelerator Facility, Nucl. Instrum. Meth., B 239 (2005) 227.

[3] Hollinger R., et al., Development of a Vacuum Arc Ion Source For Injection of High Current Uranium Ion Beam into the UNILAC at GSI, Rev. Sci. Instrum., Volume II, 2004.

[4] Kolomiets A., et al., Upgrade of the UNILAC High Current Injector RFQ, LINAC08, Victoria, BC, Canada, p. 136-138 (2008).

[5] Vormann H., et al., Straight injection of an intense uranium beam into the GSI high current RFQ, IPAC2014, Dresden, Germany, p. 3217-3219 (2014)

[6] Yaramyshev S. et.al., Advanced Beam Matching to a High Current RFQ, LINAC2014, Geneva, Suisse, to be published (2014).

DOI:10.15120/GR-2015-1-FG-GENERAL-05