Performance of a modified 1.4 MeV/u gas stripper for $^{238}U^{4+}$

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The GSI UNILAC will serve as an injector system for the FAIR facility. Therefore it has to meet high demands in terms of beam brilliance. A key projectile for FAIR will be ^{238}U [1]. In current routine operation U^{4+}-ions from a MEVVA ion source are accelerated to 1.4 MeV/u by the High Current Injector (HSI). Inside the adjacent gas stripper, the charge state of the ions is increased to raise the efficiency of further acceleration. Behind the stripper, a system of dipole magnets allows the selection of ions with the desired charge state (U^{28+}) [2].
To increase the beam intensity after the gas stripper, an upgrade program has started to increase the stripping efficiency into the desired charge state. The current gas stripper is based on a supersonic N_2-jet, created through a laval nozzle at 0.4 MPa back-pressure. The continuous gas flow limits the usable gas pressure due to the high gas load for the differential pumping system. This also prevents the optimal use of other promising stripper gases, as a saturated charge distribution cannot be reached [3].
To overcome this limit, a modified gas stripper setup was developed [4]. The flange with the laval nozzle on top of the main stripper chamber was replaced by a new flange, featuring a pulsed gas valve designed for a back-pressure of up to 12 MPa and an opening time down to a few microseconds. The new flange is shown in Fig. 1. To prevent the gas from instantaneous removal, an extension was added to the flange with a T-fitting at the end to match the beam line. This creates a high-pressure interaction zone for the stripping process. The valve is located in the extension, facing down towards the beam line. The pulsed gas injection is triggered by a timing signal of the central accelerator control unit. The valve is opened only when a beam pulse passes the stripper and closed immediately afterwards, decreasing the gas load for the pumping system and lowering the gas consumption by a factor of up to 200.
During two measurement campaigns in 2014 the new stripper setup was tested with a U^{4+}-beam (1 Hz, 100 µs pulse length). An opening time of 0.5 ms was used for the pulsed gas valve. The opening time was chosen based on pressure measurements near the gas inlet as well as beam current measurements behind the stripper. Besides N_2, which allowed comparing the setup to the current gas-jet stripper, the charge spectra were measured for various other gases (H_2, He, O_2, Ne, Ar and CO_2).
For all used gases except H_2, a saturation of the charge state distribution was observed with an increase of the back-pressure. The beam emittance and the energy loss were measured using the determined settings for a saturated charge state distribution. Additionally, the stripping

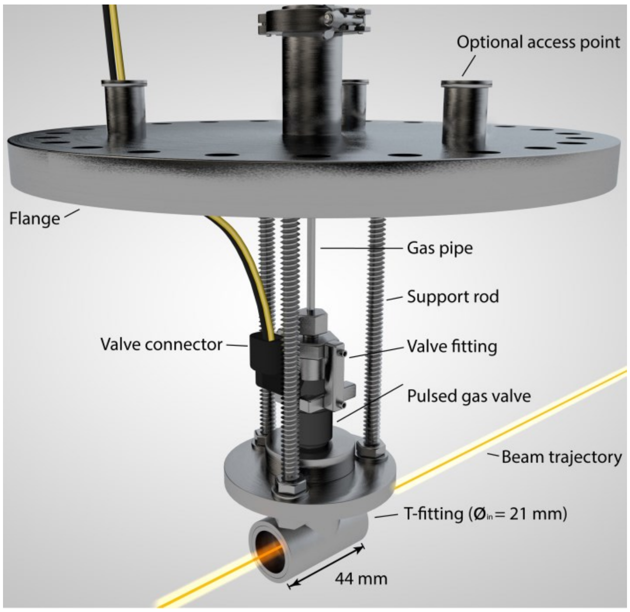

Figure 1: Model of the new stripper flange

efficiency was measured for every populated charge state. A saturation of the charge state distribution with H_2 could not be observed due to the pressure limitations of the pulsed gas valve. Therefore, one can assume that the average charge state will rise, if the pressure is increased further.
Using H_2 with the pulsed gas cell, it was possible to set a new record for the U^{28+} beam intensity behind the gas stripper at the GSI UNILAC [5].
The pulsed gas injection enables various possibilities for the use at the GSI UNILAC, including the simultaneous use of different stripper gases for particular ion beams. Preparing for routine operation, the pulsed gas cell has to be tested and optimized for all to be used types of ion beams.

References

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