Status of the High-Energy Linac Project at GSI

B. Schlitt, G. Clemente, W. Barth, and W. Vinzenz
GSI, Darmstadt, Germany

To assure reliable operation for FAIR, a new high-intensity heavy-ion injector linac for SIS18 (high-energy (HE) linac) was proposed as replacement for the existing post-stripper linac at the GSI UNILAC. A linac for short beam pulses, low repetition rate, and fixed end energy is under investigation. The first proposal [1, 2] included to extend the pre-stripper to 3 MeV/u to achieve higher charge states around U^{38+} behind the gas-stripper and the linac end energy was boosted to 22 MeV/u. Recently, a less ambitious solution was favoured without an extension of the pre-stripper linac and keeping U^{28+} for acceleration along the new HE linac and in SIS18 (Fig. 1, Table 1). Six 108 MHz IH-type drift-tube linac cavities within a total length of about 24 m accelerate the ions up to 11.4 MeV/u as provided by the existing linac. Fast pulsed quadrupole triplet lenses suitable for multi-beam operation are used for transverse focusing in between the IH cavities (Fig. 2). Quadrupole magnets inside the cavities should be avoided. This new HE linac solution is less expensive as the previous one and the existing gas-stripper section does not need to be shifted to a new location. The new solution leaves plenty of space within the existing UNILAC tunnel available for future linac energy upgrades (Fig. 1). In addition, alternative solutions to the present nitrogen gas stripper, like carbon foil strippers [3], a plasma stripper [4], and the use of low-Z gases like hydrogen at the gas stripper [5] are being investigated in order to generate higher charge states.

RF Systems

A preliminary study for 108 MHz, 1.8 MW high-power amplifiers for short-pulse low duty cycle operation was performed in collaboration with industrial partners. It is based on a TH558SC tetrode from THALES Electron Devices which is widely used worldwide for broadcast as well as for scientific applications. Thus, there is no known risk concerning the long-term availability of this tube for the coming decades. Pilot studies concerning solid-state driver amplifiers and amplifier supply units based on state-of-the-art technologies as well as for a modern digital low-level RF (LLRF) system were started.

Outlook

Design and construction of a prototype IH cavity as well as of a prototype RF amplifier are planned for 2013 – 15, followed by high-power RF tests and beam tests at GSI. Tests of a digital LLRF system on loan from an industrial partner are planned at GSI for 2013.

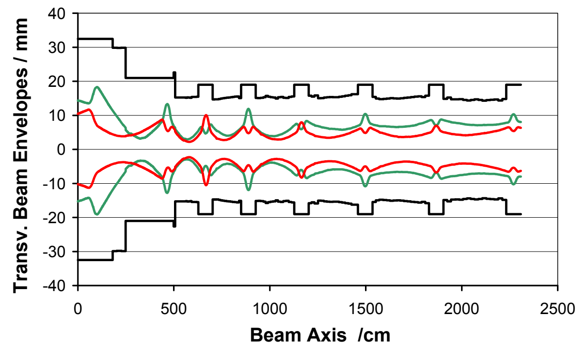

Figure 2: Hor. (red) and vert. (green) 99 % beam envelopes for a 20 mA U^{28+} beam along the HE linac.

Table 1: Main design parameters of the proposed linac

Design ion species	$^{238}U^{28+}$	
Design beam current (pulse)	15	mA
Max. mass / charge ratio	8.5	
Input beam energy	1.4	MeV/u
Output beam energy	11.4	MeV/u
Total acceleration voltage	85	MV
Linac length	ca. 24	m
RF frequency	108.4	MHz
Beam pulse length	≤ 100	µs
Beam repetition rate	≤ 4	Hz
RF duty factor	≤ 1	%
No. of IH-DTL cavities	6	
Cavity length	1.6 – 3.5	m
Max. RF power / cavity (incl. beam loading)	1300	kW

References

[1] B. Schlitt, G. Clemente, W. Barth, and W. Vinzenz, in: GSI Scientific Rep. 2011, p. 296.
[2] B. Schlitt et al., in: Proc. HIAT2012, p. 191.
[3] H. Vormann et al., this report.
[4] C. Teske, Y. Liu, S. Blaes, and J. Jacoby, Physics of Plasmas **19**, 033505 (2012).
[5] B. Schlitt, H. Vormann et al., this report.

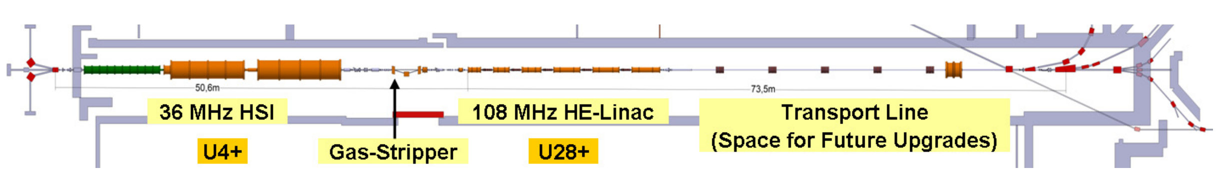

Figure 1: The proposed new 108 MHz high-energy (HE) linac within the existing UNILAC tunnel at GSI.