Beam dynamics layout of the compact LEBT*

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The present high current VARIS ion source [1] delivers about 50 mA of uranium beam and about 8 mA of U^{4+} was measured behind the HSI. In order to increase the beam intensity downstream the HSI, a dedicated straight LEBT for uranium is proposed as a part of the upgrade and further development of the high current heavy ion linac UNILAC for the Facility for Antiproton and Ion Research (FAIR).

A symmetric beam is required at the entrance to the RFQ. The beam Twiss parameters are determined to be α_f=0.6, β_f=13.6 cm/rad and the transverse acceptance of the RFQ is calculated as A_f=280 π mm mrad. 15.4 mA U^{4+} are inside the RFQ-acceptance already at the source. Beam dynamics design has been performed with the TRACE-3D code [2]. It is optimized to maximize the primary component inside the RFQ acceptance and to minimize the secondary component and transport almost all U^{4+} ions which are in the acceptance form source to RFQ. Beam dynamics simulations have been performed using the multi-particle tracking TRACK code [3]. A macro-particle distribution is generated at the entrance of the new LEBT from the measured phase space distribution directly behind the ion source post acceleration gap. Fig. 1 illustrates final particle distributions at the exit of the LEBT.

Simulations show that 60% (10.5 mA) of the undesirable U^{3+} beam is removed by the aperture and collimator and the remaining U^{3+} beam will be lost in the RFQ. About 50% (15.4 mA) of the U^{4+} beam is transported from the source to the RFQ (for the U^{4+} particles within the RFQ-acceptance, 100% transmission is achieved from the ion source to the RFQ) when the space-charge effects are fully compensated. When the space-charge effects are included (for example 95% compensated), 81% (14.2 mA) of the undesirable U^{3+} beam is removed by the aperture and collimator, and about 44% (14.2 mA) of the desired U^{4+} beam is delivered to the RFQ (for the U^{4+} particles within the RFQ-acceptance, 93% transmission is achieved). The FAIR requirements still impose improvement to 25 mA within the RFQ-acceptance. To this end further developments of the source performance are planned.

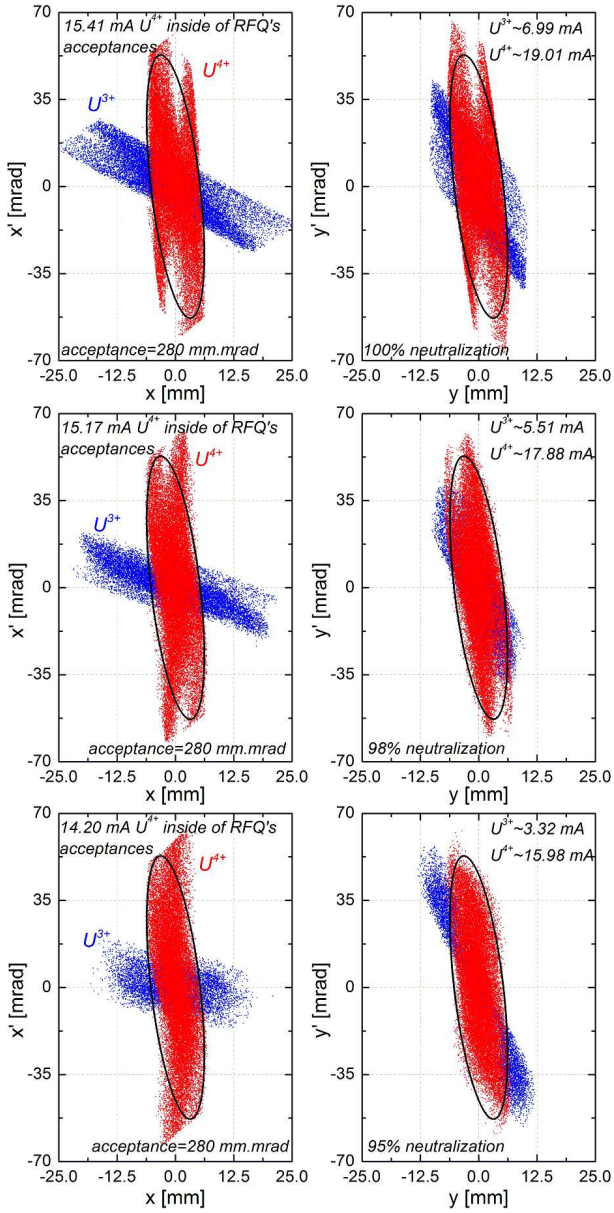

Figure 1: Particle distributions at the exit of the LEBT. Space-charge compensation factor is 100%, 98%, and 95%, respectively. Blue dots indicate the U^{3+} particles, red dots indicate the U^{4+} particles and black ellipses indicate the acceptance of the RFQ.

References

[1] R. Hollinger et al. ReV. Sci. Instrum. **75**, 1595 (2004).

[2] K.R. Crandall et al. LA-UR-97-886 (1997).

[3] P.N. Ostroumov et al. http://www.phy.anl.gov/atlas/TRACK/.

* PSP code: 7.1.2.1.

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