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Proposal of a Conventional Matching Section as an Alternative to the Existing HSI MEBT Superlens at GSI UNILAC

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Introduction

We propose a conventional MEBT design as replacement for the current superlens system [1] in the high current injector (HSI) [2] of the GSI UNILAC. To reach the required 18 mA U^{4+} behind the HSI, the existing layout has to be upgraded. LORASR simulations show high losses in the superlens and bad matching conditions for the following IH-DTL for FAIR-required currents (see figures 1 and 2). The proposed MEBT section improves matching conditions for the IH-DTL and provides lossless transmission in the HSI behind the RFQ.

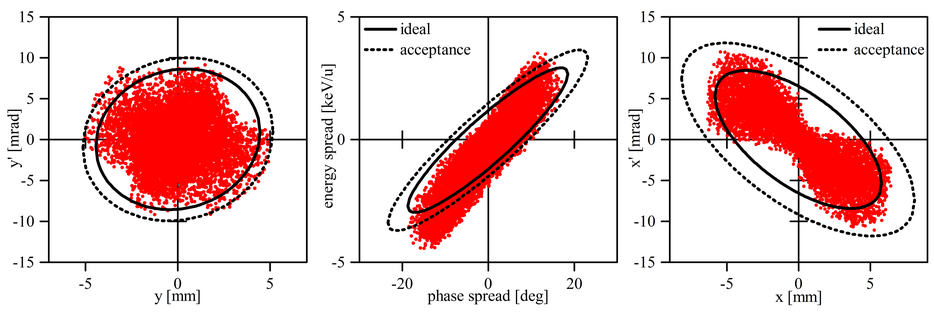

Figure 1: Output of the superlens for 20.75 mA U^{4+} compared to the acceptance of the IH-DTL.

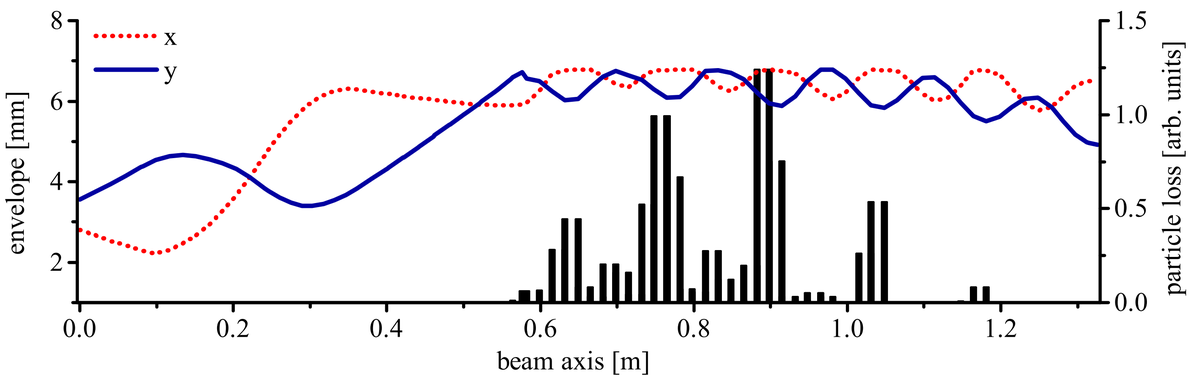

Figure 2: Loss profile of the current MEBT superlens for 20.75 mA U^{4+}.

Beam dynamics

- Beam is not limited by apertures (figure 3)
- No losses in the MEBT
- Transversal/longitudinal output is matched to IH-DTL
- Emittance growth in MEBT section is reduced to below 5%

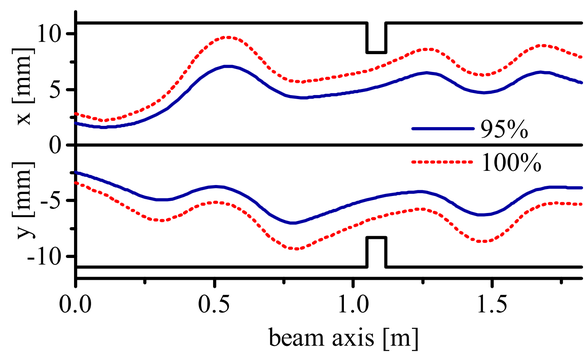

Figure 3: Transversal beam envelopes for the proposed MEBT section.

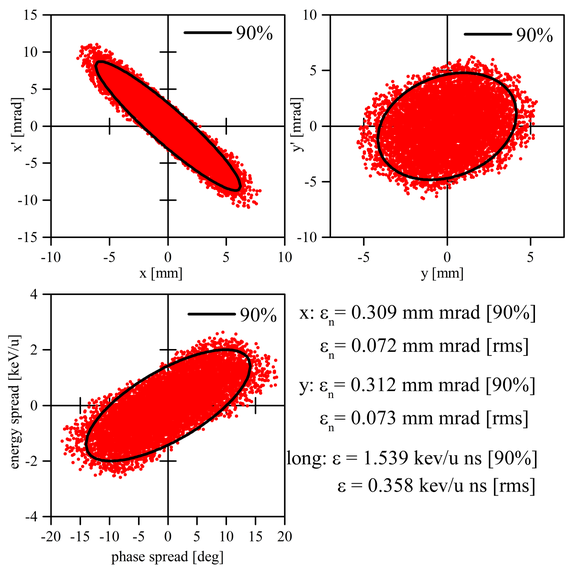

Figure 4: Output distributions of the proposed MEBT section.

Output of	RFQ	Superlens	→ IH-DTL	Prop. MEBT	→ IH-DTL
X-X' ϵ_n [mm mrad]	0.069	0.108	0.162	0.072	0.117
Y-Y' ϵ_n [mm mrad]	0.070	0.09	0.158	0.073	0.138
Ph-W ϵ [keV/u ns]	0.349	0.389	1.279	0.358	0.517

Table 1: RMS emittances along the HSI for the existing and the proposed MEBT.

References:

[1] U. Ratzinger, R. Tiede, "A New Matcher Type between RFQ and IH-DTL for the GSI High Current Heavy Ion Prestripper LINAC", Proc. LINAC96, Geneva, Switzerland, pp. 128-130

[2] U. Ratzinger, "Commissioning of the new GSI high current linac and HIF related RF linac aspects", Nucl. Instr. and Meth. A 464, pp. 636-645 (2001)

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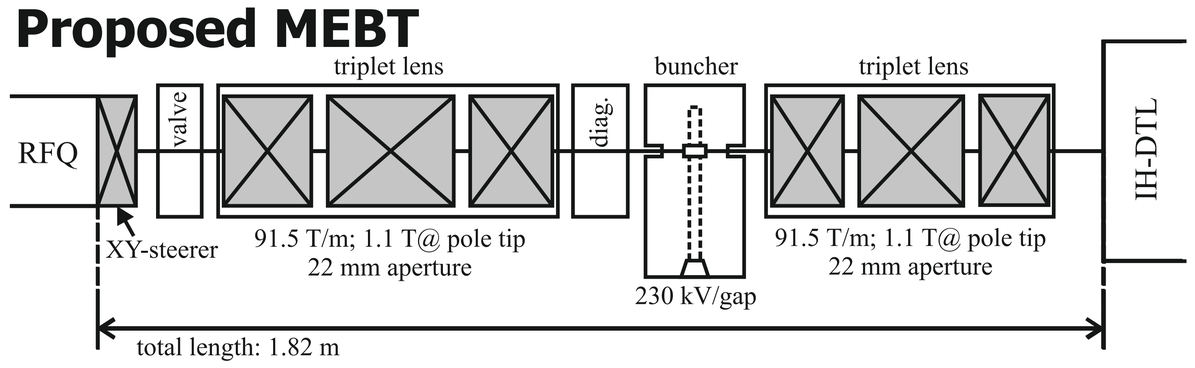
Proposed MEBT



- Design current 20.75 mA U^{4+}
- Two quadrupole triplet lenses
- Two-gap drift tube buncher
- Improved matching to IH-DTL
- Full transmission
- Reduced emittance growth

IH-DTL

Proposed MEBT output has wider energy spread and shorter phase spread. For ideal transmission, the starting phase of the first IH-DTL gap is decreased by 5°.

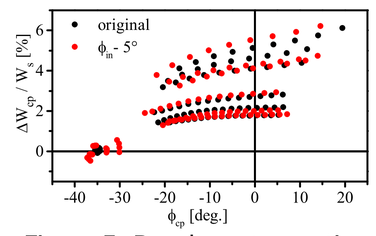


Figure 5: Bunch center motion of the IH-DTL.

Performance of the HSI is significantly improved due to the better matching of MEBT and IH-DTL by the proposed design.

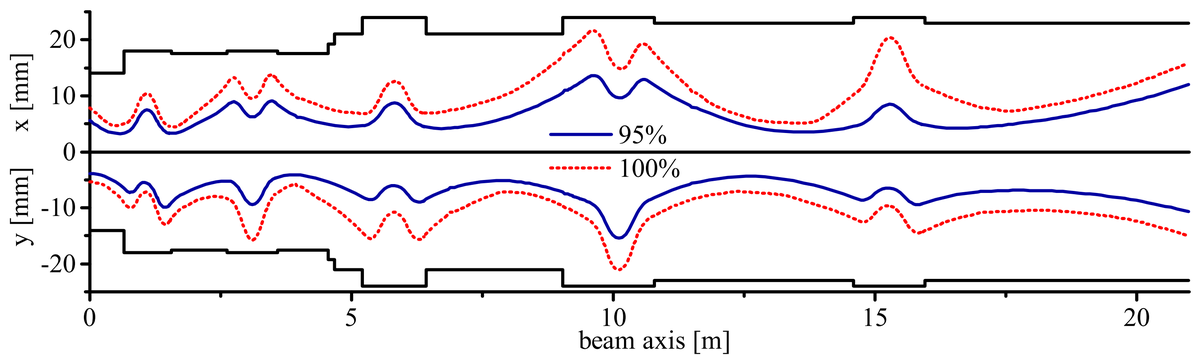


Figure 6: Transversal envelopes of the IH-DTL with injection from the proposed MEBT section.

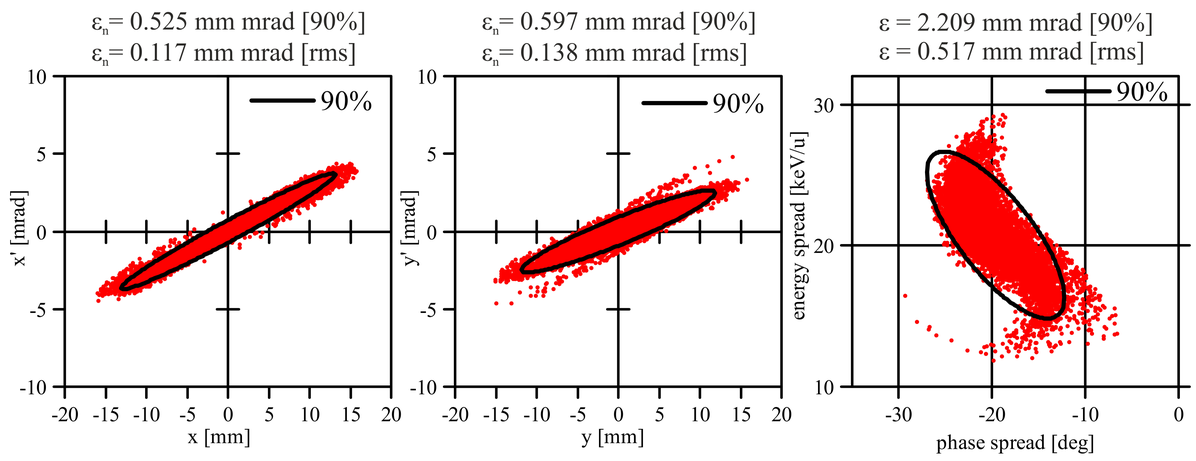


Figure 7: Output distributions of the IH-DTL with injection from the proposed MEBT.

- Superlens was matched to original RFQ electrodes
- Proposed MEBT design is based on new RFQ output with higher design current

Results:

- Lossless transmission through the IH-DTL
- Higher flexibility for varying current
- Significant improvement on output emittances

IH-DTL out with	Superlens		Prop. MEBT
X-X' ϵ_n [mm mrad]	0.162	-27.8 %	0.117
Y-Y' ϵ_n [mm mrad]	0.158	-12.7 %	0.138
Ph-W ϵ [keV/u ns]	1.279	-59.6 %	0.517

Table 2: IH-DTL output RMS emittances for the existing and the proposed MEBT section.