STATUS OF THE BEAM DYNAMICS DESIGN OF THE NEW POST - STRIPPER DTL FOR GSI - FAIR

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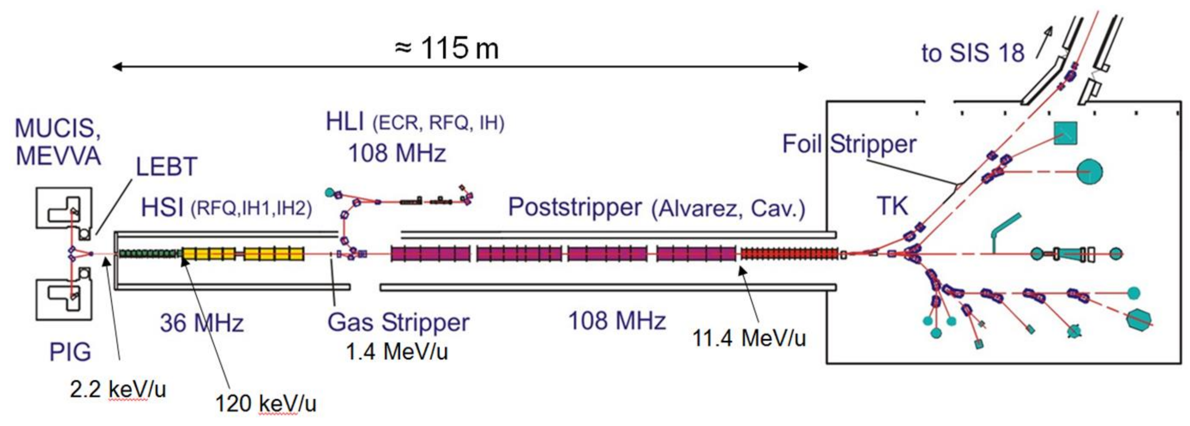
Abstract
The GSI UNILAC has served as injector for all ion species since 40 years. Its 108 MHz Alvarez DTL providing acceleration from 1.4 MeV/u to 11.4 MeV/u has suffered from material fatigue and has to be replaced by a new section [1]. The design of the new post-stripper DTL is now under development at GSI. An optimized drift tube shape increases the shunt impedance and varying stem orientations mitigate parasitic rf-modes [2]. This contribution is on the beam dynamics layout.

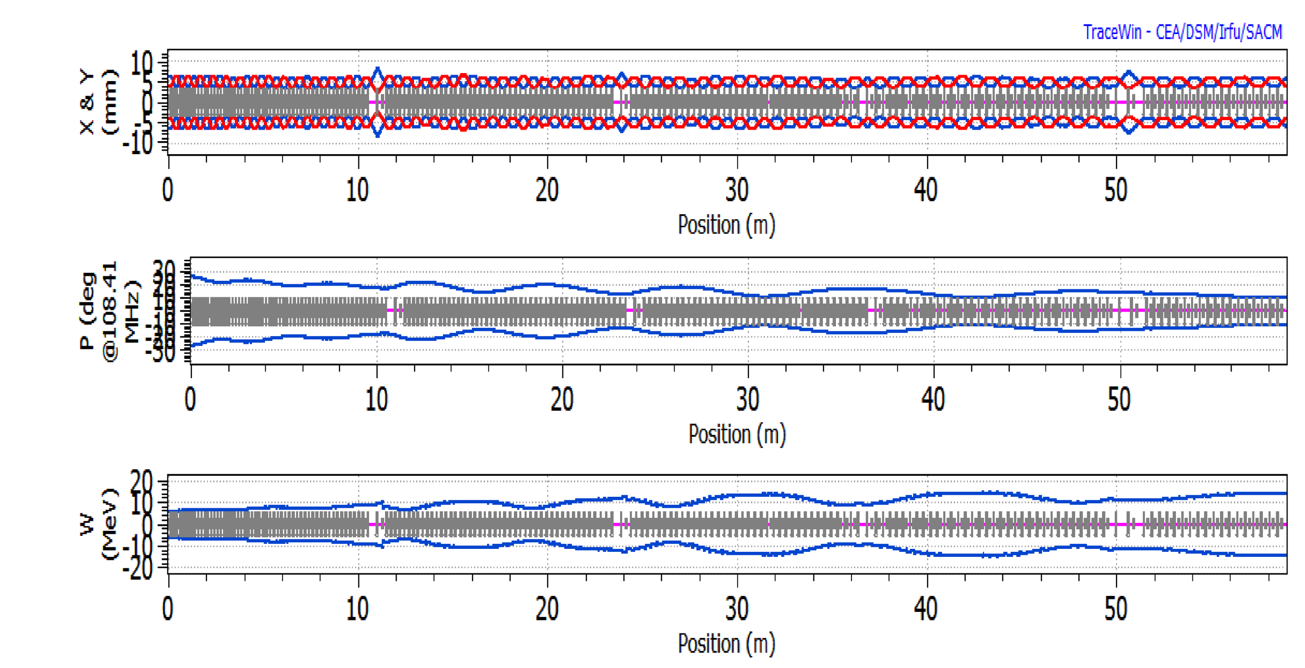
The UNIversal Linear ACcelerator (UNILAC) at GSI



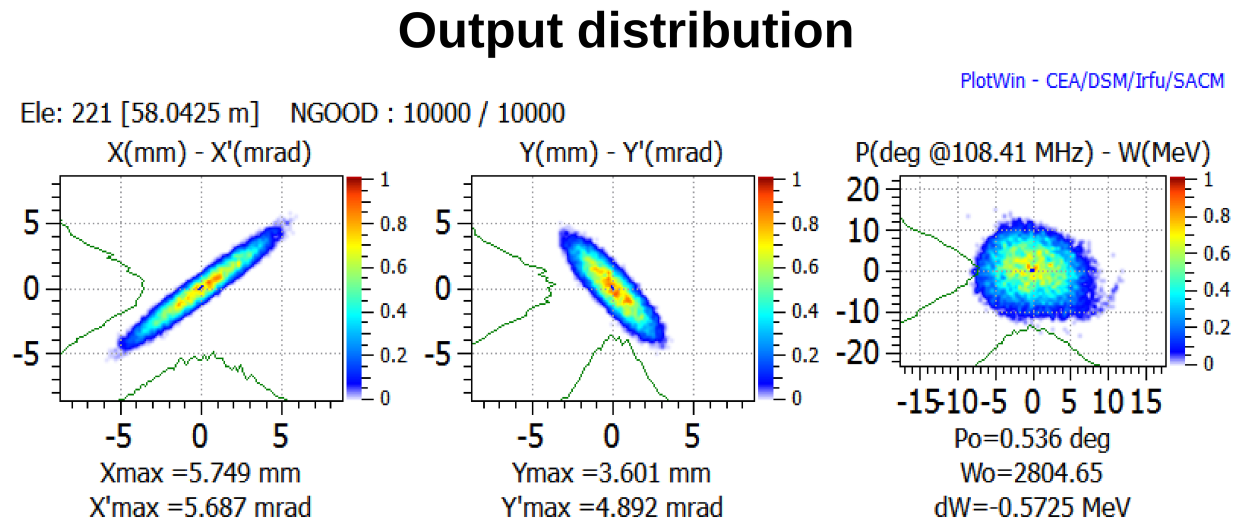
Parameters of the upgraded UNILAC

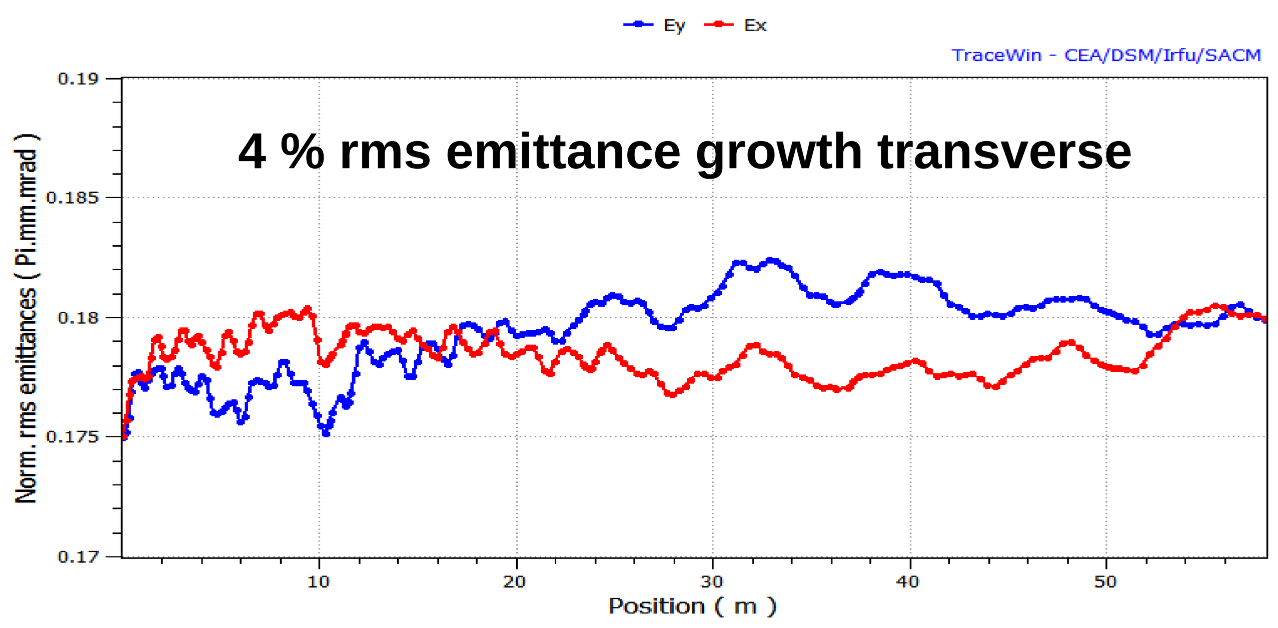
Ion A/q	≤ 8.5
Beam Current	1.76 A/q mA
Input Beam Energy	1.4 MeV/u
Output Beam Energy	3-11.7 MeV/u
Beam Pulse Length	200μs
Beam Repetition Rate	10 Hz
Rf Frequency	108.408 MHz

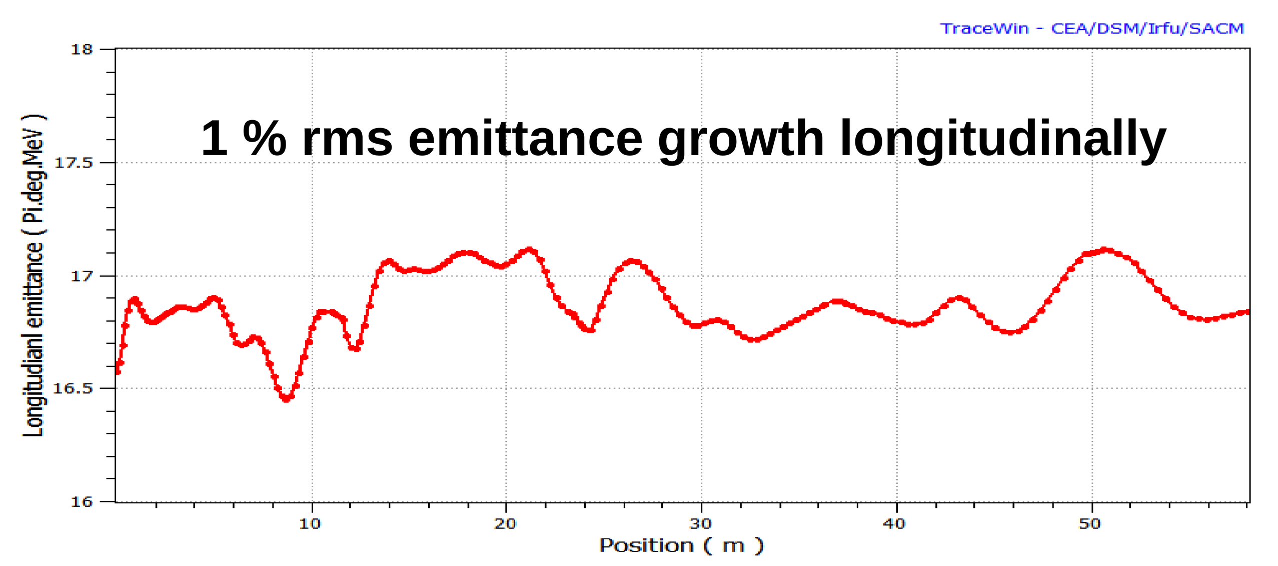
Beam dynamics simulations for the complete new Alvarez DTL



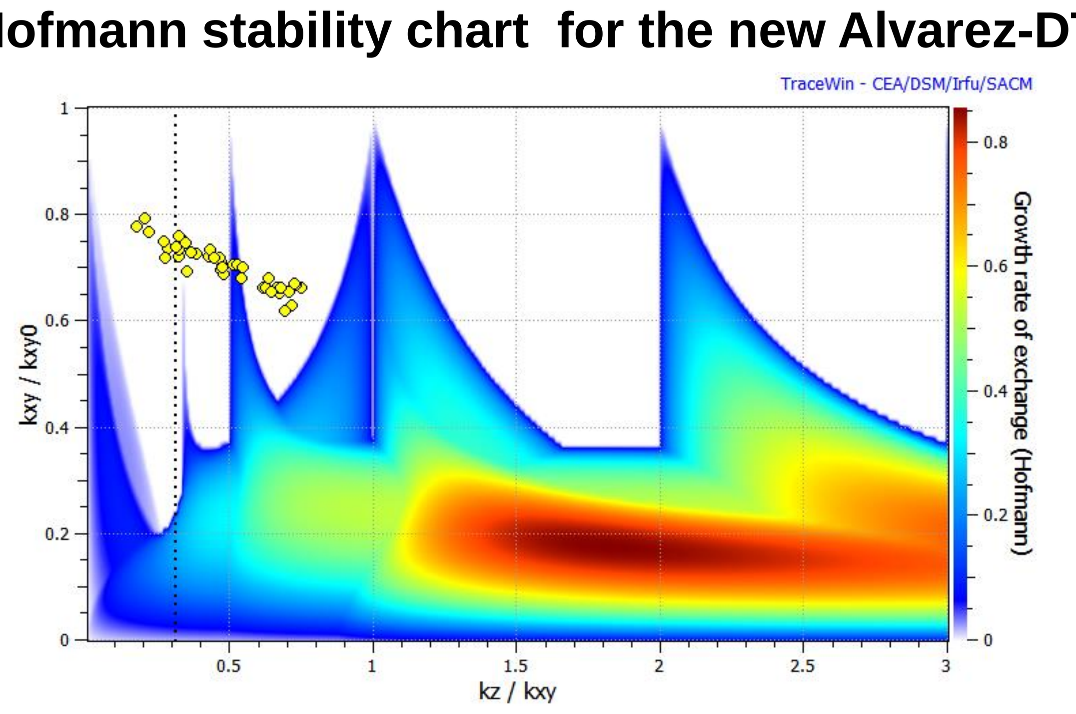
Output distribution







Hofmann stability chart for the new Alvarez-DTL

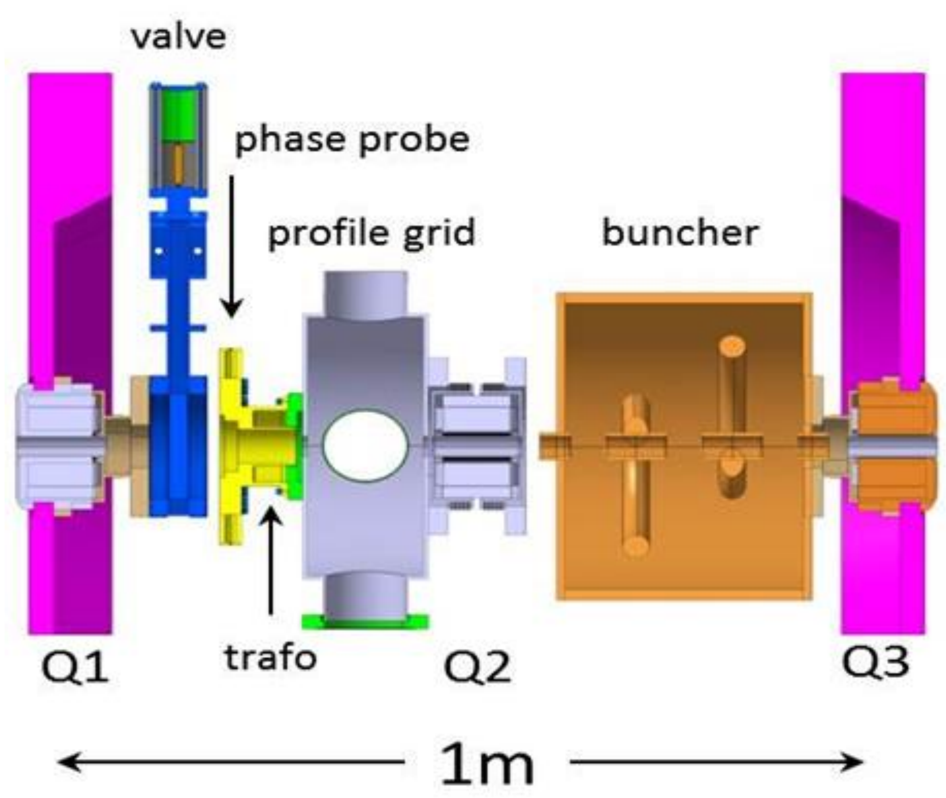


Studied Models

- "hard edge" model for E-field and B-field with identical quadrupoles in each drift tube (effective length of 96mm);
- 3D field maps for E-field, analytical field model for B-field with identical quadrupoles;
- 3D field maps for E-field and B-field with identical quadrupoles;
- "hard edge" model for E-field and B-field with three groups of quadrupoles (effective lengths 96 mm, 122 mm and 140 mm);
- 3D field maps for E-field, analytical field model for B-field with three groups of quadrupoles as above.

DELIVER PRACTICALLY THE SAME RESULTS !

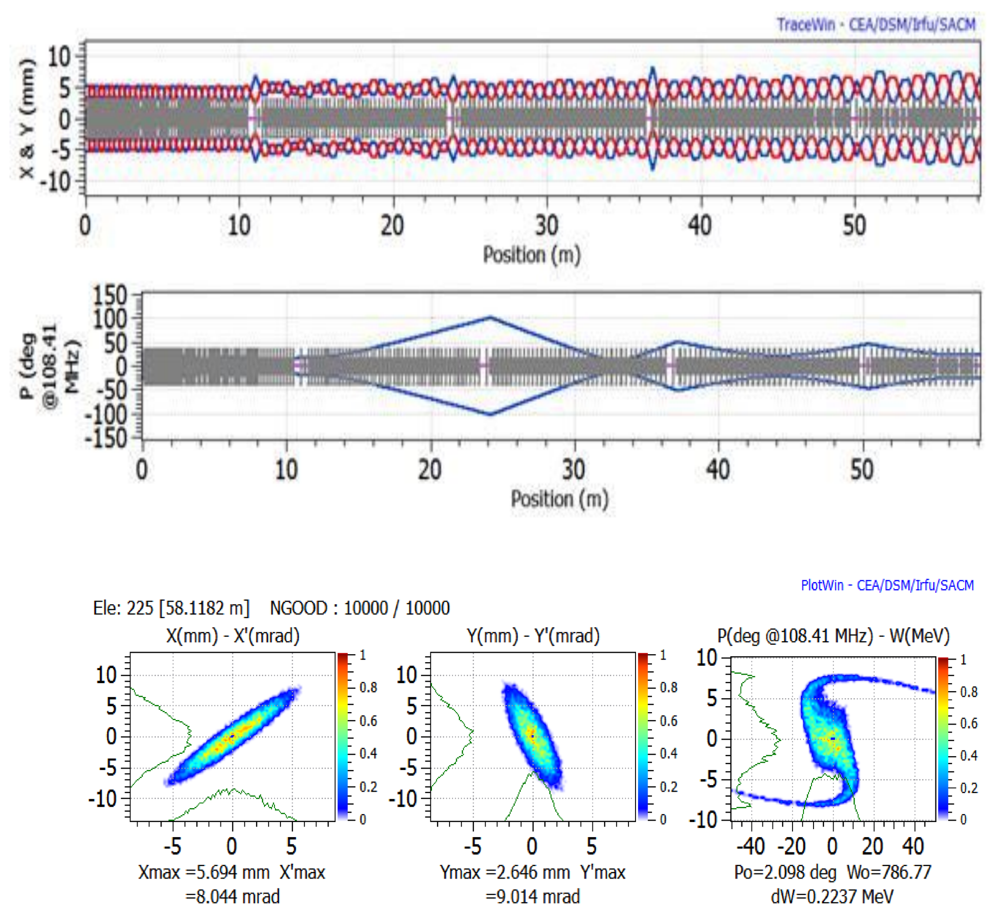
Intertank section



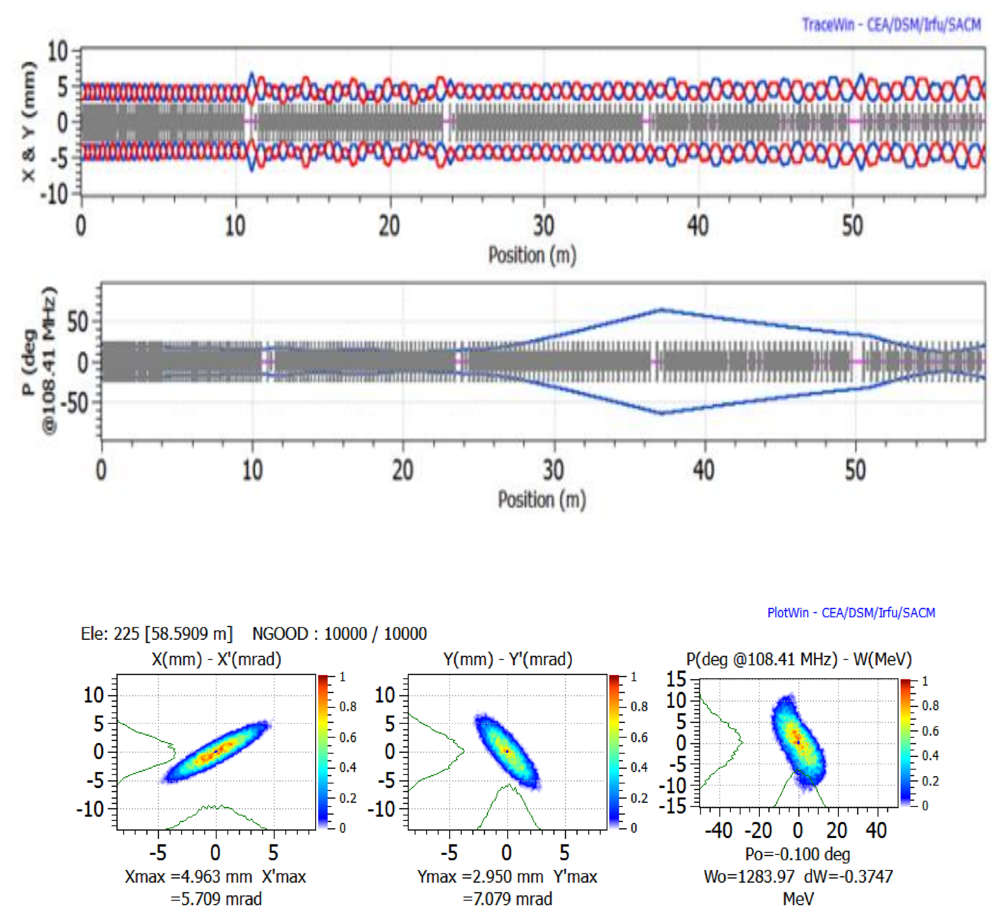
Alvarez DTL for transport of low energy beams

Additionally to the FAIR injector function, the UNILAC will serve nuclear physics experiments conducted close to the Coulomb barrier, i.e. it must deliver energies in the range from about 3.0 MeV/u up to 11.7 MeV/u. These non-FAIR scenarios require low beam currents but high duty cycles. In this case the rf-power of some tanks is switched off. The intertank bunchers are used to maintain a reasonable bunch length up to the DTL exit.

RF is off for A2-A5 → 3.3 MeV/u



RF is off for A3-A5 → 5.4 MeV/u



Conclusion

The beam dynamics simulations for the new post-stripper DTL were done for $^{238}U^{28+}$ using the TraceWin code [6]. The behaviour of the beam in the proposed structure was investigated for different zero current phase advances, as without current, as for the current of 15 mA. Different field models show perfect coincidence in beam dynamics. Beam dynamics simulations along the complete Alvarez DTL were done for the zero current phase advance k_0 of 65^0 for each tank. The intertank sections allow for a matched solution and provide place for the diagnostics. The tranverse rms emittance growth for the complete Alvarez DTL is about 4%, longitudinally - it is about 1%. New Alvarez DTL serves also for the non-FAIR scenarios.

References
[1] L. Groening, et al., HIAT 2015, Japan, 2015
[2] X. Du, et al., IPAC 2015, USA
[3] FAIR Baseline Technical Report, Vol. 2, GSI Darmstadt, Germany, 2006, p. 335.
[4] S. Appel, SIS18 Injection: Parameter Studies on MTI with space charge and longitudinal aspects, talk, Uranium Accelerator Chain Review, GSI, Darmstadt, Germany, (Nov 2013)
[5] S. Mickat et al, Die UNILAC Post-Stripper-Sektion – Zustandsaufnahme und Betriebsrisiko, interner Report, GSI, Darmstadt, Germany (April 2013)
[6] TraceWin http://irfu.cea.fr/Sacm/logiciels/index3.php
[7] L. Groening et al., Phys. Rev. Lett 102, 234801 (2009)
[8] L. Groening et al , Phys. Rev. Lett 103, 224801 (2009)