Developments on the 1.4 MeV/u pulsed gas stripper cell

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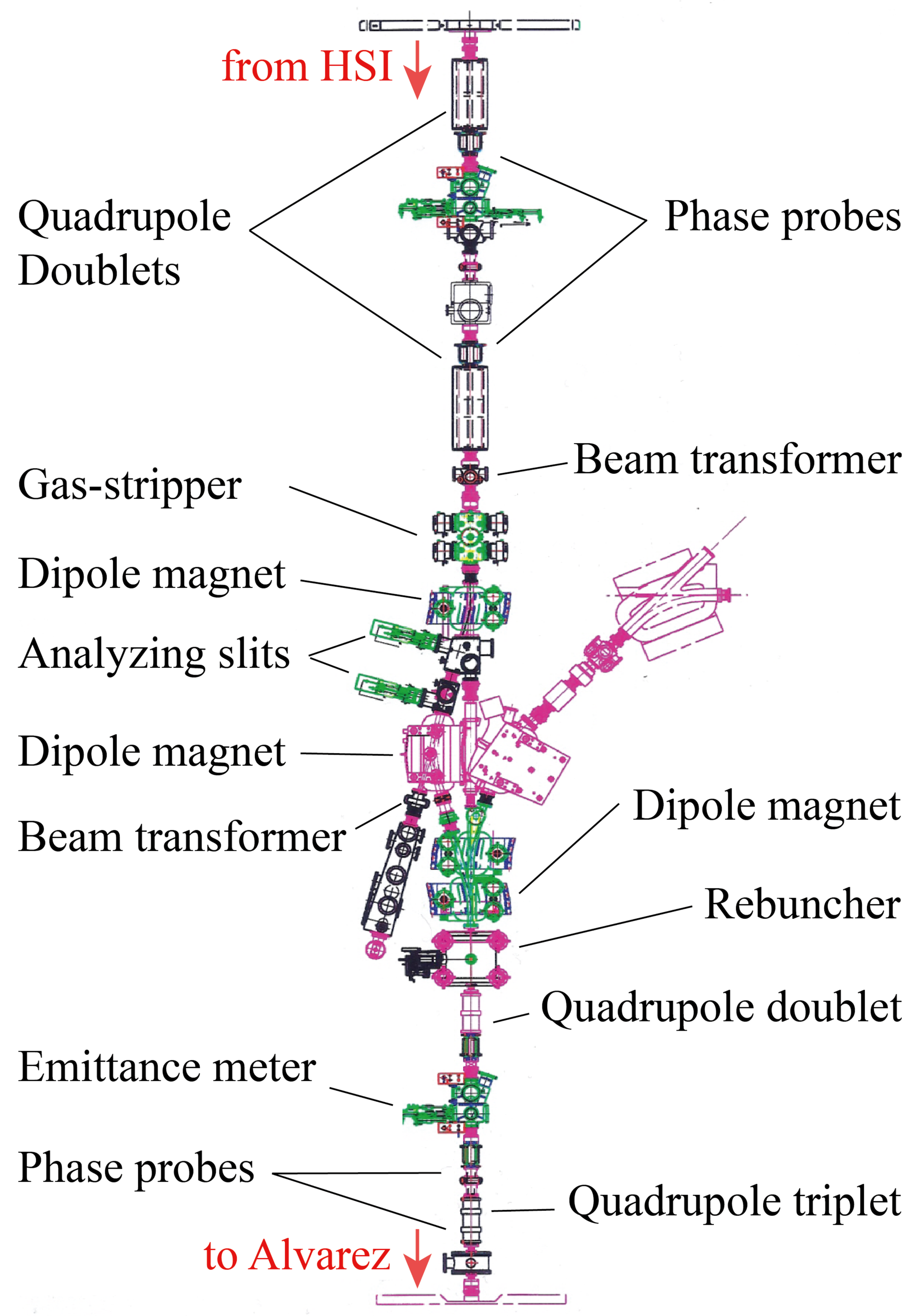
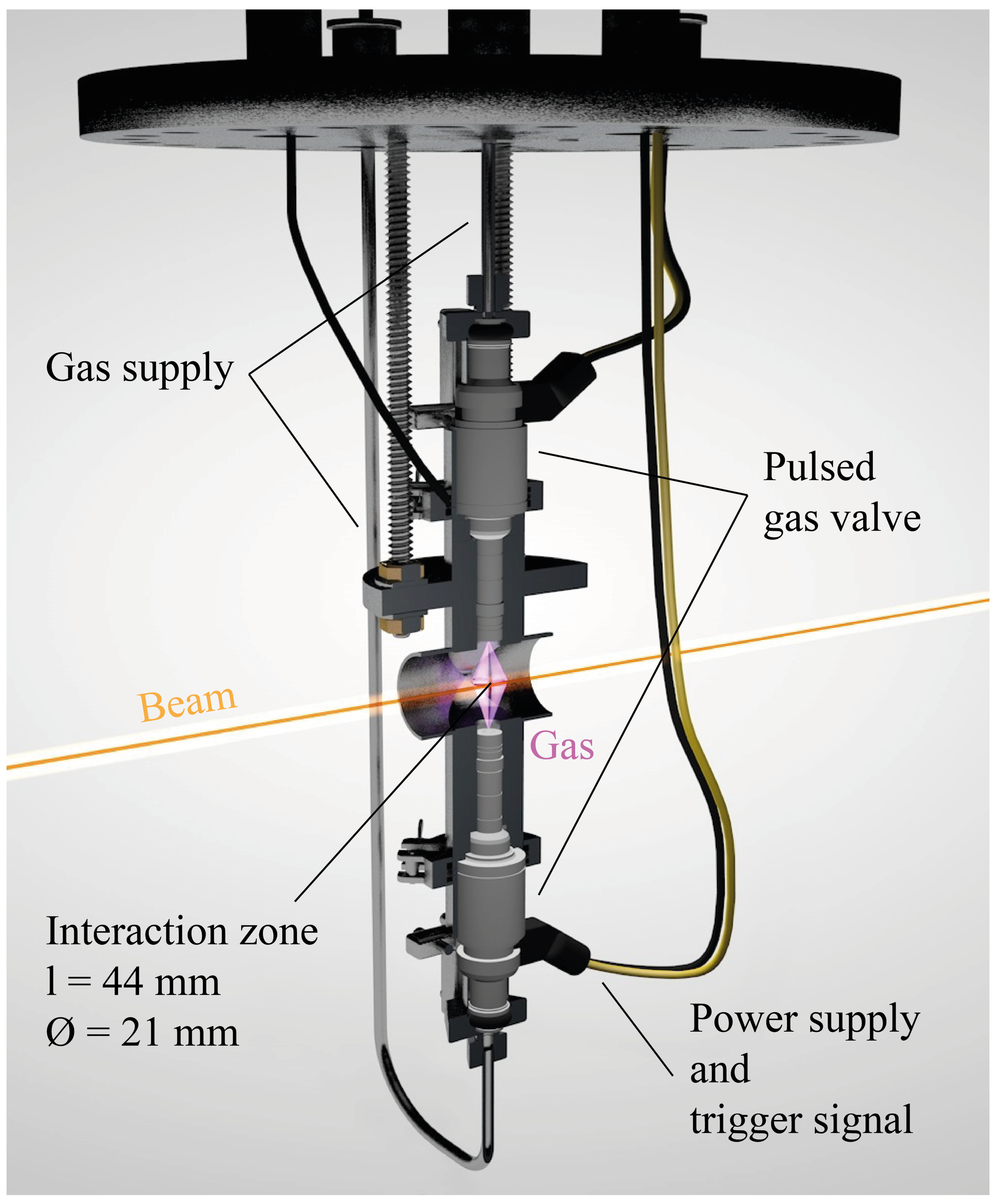
Abstract

- GSI UNILAC will serve as injector for FAIR
- Pulsed gas stripper setup was developed in the course of upgrade program for the UNILAC
- Pulsed gas injection enables practical use of H_2 and He
- Increased $^{238}U^{28+}$ intensities were measured using H_2
- For standard operation at the UNILAC, various different ion beams are used
- Stripping performance of the pulsed gas cell was tested using ^{238}U, ^{209}Bi, ^{50}Ti, and ^{40}Ar beams on H_2, He, and N_2
- Saturated charge state distributions were measured for all ion beams and compared to measurements with the previously existing N_2-jet gas stripper
- Use of H_2 enabled increased average charge states for all utilized ion beams
- More narrow charge state distributions were measured for ^{238}U and ^{209}Bi, allowing for increased beam intensities

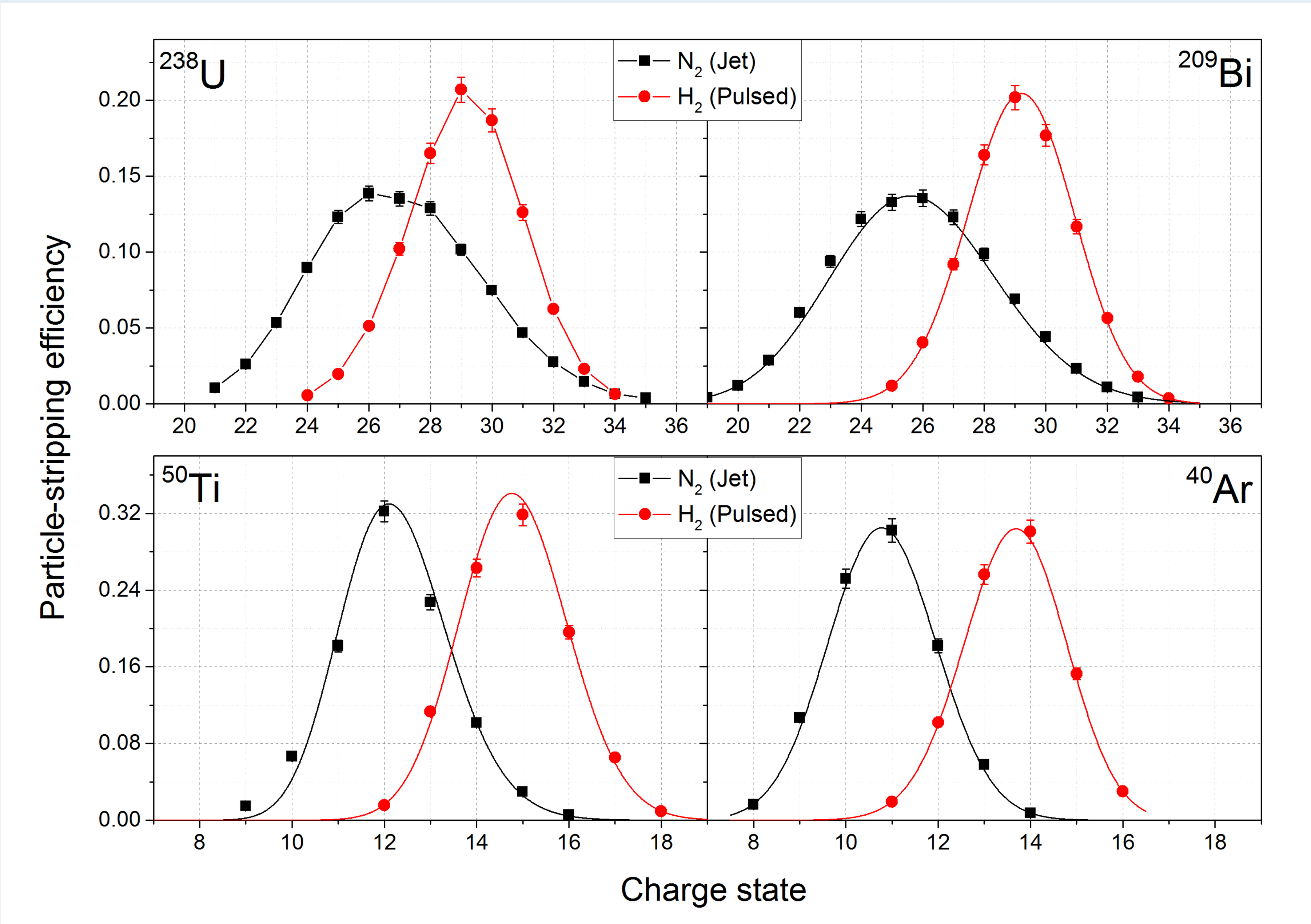


GSI UNILAC gas stripper section



Setup of the top flange of the pulsed gas stripper

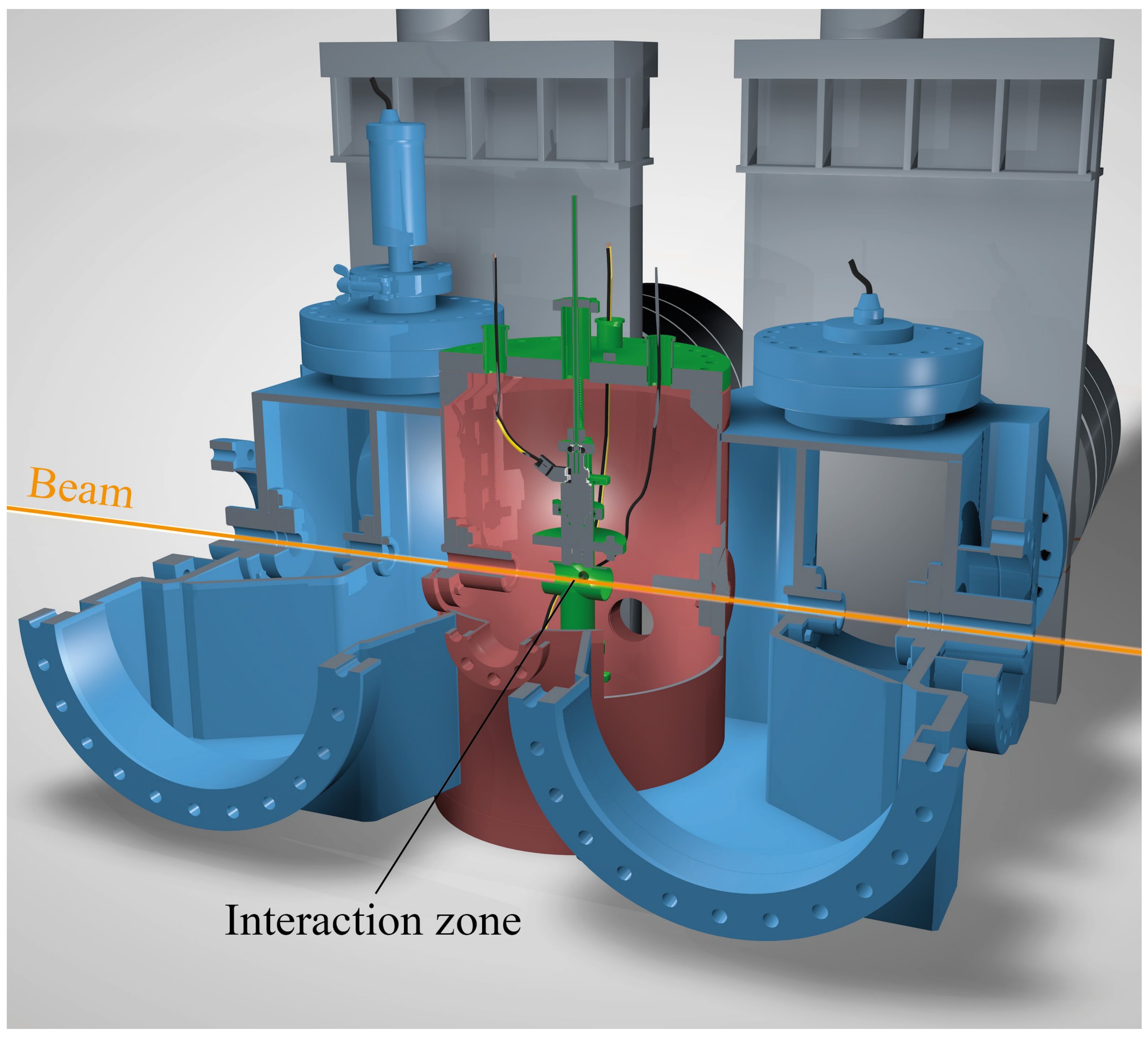
Results



Saturated charge state distributions for ^{238}U, ^{209}Bi, ^{50}Ti, and ^{40}Ar ion beams (100 µs beam pulse length, 1 Hz repetition rate) after passing the N_2-jet gas stripper (black) and the pulsed H_2-gas stripper (red). Corresponding target thicknesses are listed below.

Ion	Stripper	X [μg/cm^2]	dE [keV/u (%)]	q_{max}	η_{max} [%]	ϵ_x (tot., norm., 90 %) [mm·mrad]	ϵ_y (tot., norm., 90 %) [mm·mrad]
^{238}U	N_2 (Jet)	8	14 ± 5 (1)	26.6	13.9 ± 0.5	0.76 (at 3.7 mA, 28+)	0.84
	H_2 (Pulsed)	21	40 ± 5 (2.9)	29.2	21.0 ± 0.8	0.56 (at 6.1 mA, 29+)	1.07
^{209}Bi	N_2 (Jet)	8	-	25.5	13.9 ± 0.6	0.61 (at 1.8 mA, 26+)	0.72
	H_2 (Pulsed)	37	80 ± 5 (6.4)	29.1	20.2 ± 0.8	0.82 (at 2.8 mA, 29+)	0.82
^{50}Ti	N_2 (Jet)	7	-	12.1	32.2 ± 1.3	-	-
	H_2 (Pulsed)	32	76 ± 5 (5.4)	14.8	31.9 ± 1.3	-	-
^{40}Ar	N_2 (Jet)	6	-	10.8	29.6 ± 1.2	0.39 (at 102 μA, 11+)	0.42
	H_2 (Pulsed)	37	100 ± 5 (7.1)	13.7	30.1 ± 1.2	0.83 (at 126 μA, 14+)	0.72

Comparison of the estimated target thickness X, energy loss dE, average charge state q_{max}, maximum stripping efficiency η_{max}, and horizontal and vertical beam emittance, ϵ_x and ϵ_y (corresponding beam current and ion charge state shown in brackets) of the N_2-jet gas stripper and the pulsed H_2-gas stripper.



Main parts of the gas stripper: The stripper flange (green) is located on top of the main stripper chamber (red). The windowless gas target is enabled by a four-stage differential pumping system (partly shown in blue).

Conclusion

- Saturated charge state distributions were measured for ^{238}U, ^{209}Bi, ^{50}Ti, and ^{40}Ar ion beams on H_2, He, and N_2
- Increased average charge states were measured for all ion beam types by using the pulsed H_2 target
- This allows use of higher charge states without loss of efficiency, enabling a reduced power consumption of adjacent accelerator structures
- For ^{238}U and ^{209}Bi ion beams, a more narrow charge state distribution was observed
- This enables significantly increased beam intensities for beam ions with the populated charge states
- In general, the increased applied target thickness results in increased energy loss and beam emittance

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