

Developments on the 1.4 MeV/u pulsed gas stripper cell

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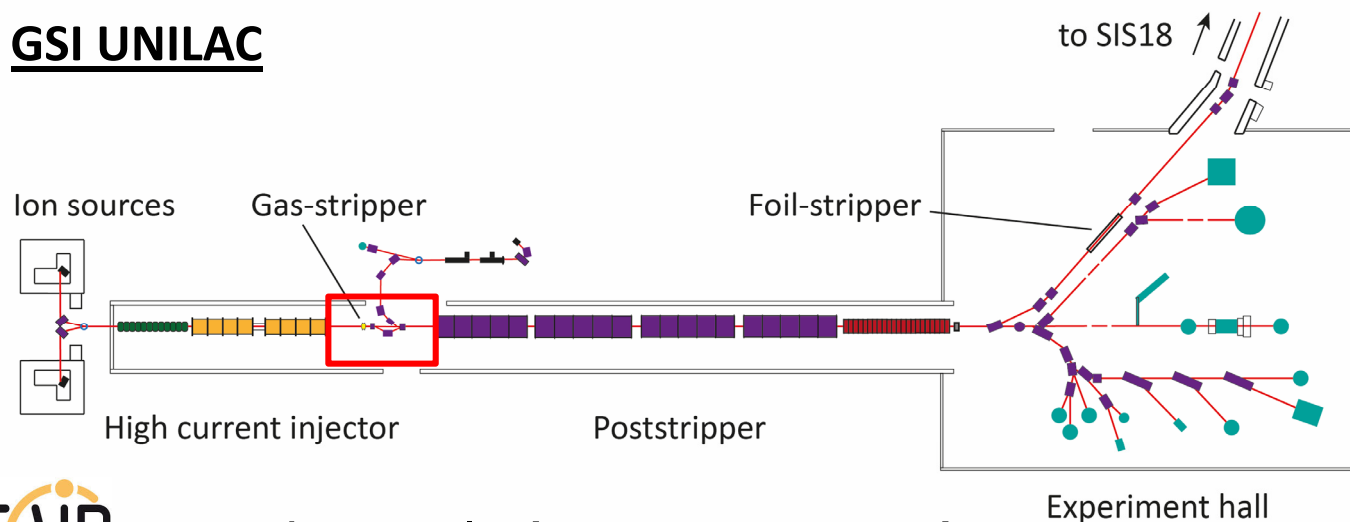
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GSI UNILAC

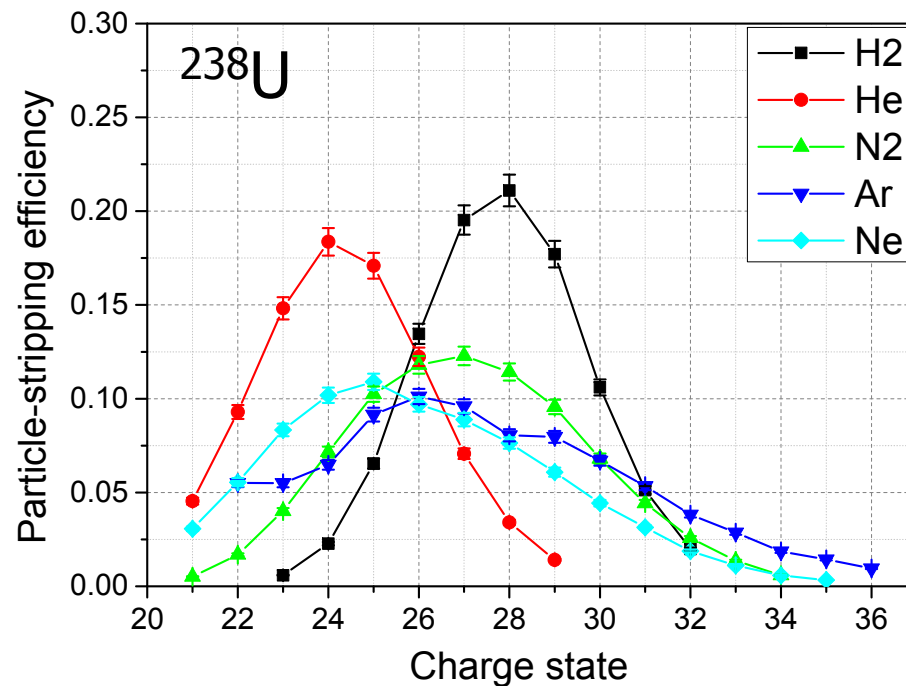
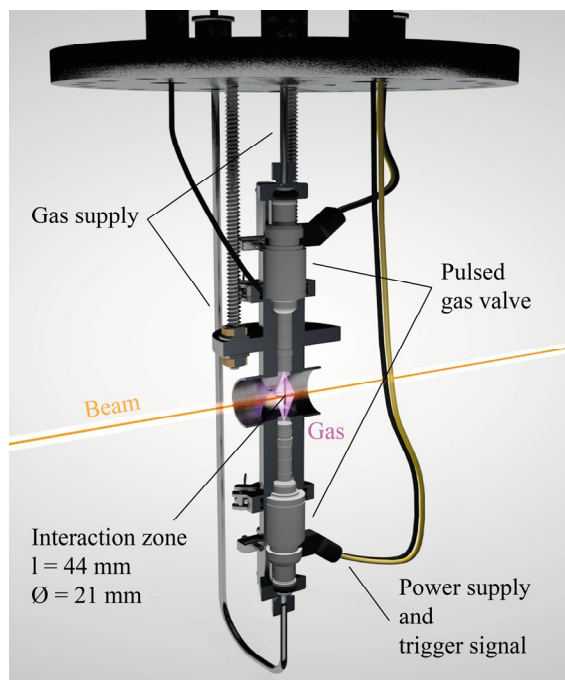


FAIR: Low duty cycle ($\leq 200 \mu\text{s}$, 1-3 Hz)

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P. Scharrer et al., in Proceedings of IPAC16



P. Scharrer et al., in Proceedings of HIAT15

Applied gases: H₂, He, Ne, N₂, O₂, Ar, CO₂

TUPRC001

^{238}U , ^{209}Bi , ^{50}Ti , ^{40}Ar
 ion beams on H_2 gas

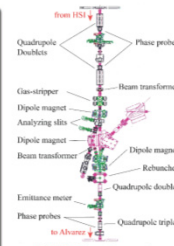

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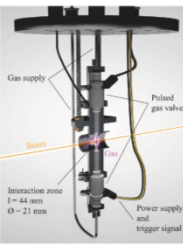
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Abstract

- 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 $^{198}\text{U}^{28+}$ 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

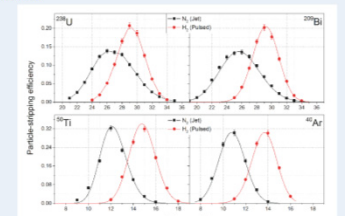


GSI UNILAC gas stripper section



Setup of the top flange of the pulsed gas stripper

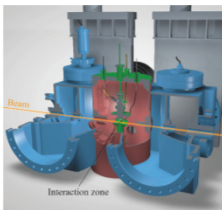
Results



Saturated charge state distributions for ^{238}U , ^{209}Bi , ^{50}Ti and ^{40}Ar ion beams 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	λ [μm/cm ²]	dE [keV/u]	θ_{max} [mrad]	θ_{max} [mrad]	ϵ_x (est., norm., 90%) [mm-mrad]	ϵ_y (est., norm., 90%) [mm-mrad]
^{238}U	N_2 (jet)	8	14 ± 5 (1.1)	26.6	13.9 ± 0.8	0.76 (at 3.7 μA, 20ns)	0.84
	H_2 (Pulsed)	21	40 ± 5 (2.9)	29.2	21.0 ± 0.8	0.56 (at 6.1 μA, 20ns)	1.07
^{209}Bi	N_2 (jet)	8	—	25.5	13.9 ± 0.8	0.64 (at 1.8 μA, 20ns)	0.72
	H_2 (Pulsed)	17	40 ± 5 (6.4)	29.1	20.2 ± 0.8	0.42 (at 2.8 μA, 20ns)	0.82
^{50}Ti	N_2 (jet)	7	—	12.1	12.2 ± 1.3	—	—
	H_2 (Pulsed)	12	70 ± 5 (5.4)	14.8	11.9 ± 1.3	—	—
^{40}Ar	N_2 (jet)	6	—	10.8	20.6 ± 1.2	0.30 (at 102 μA, 11ns)	0.42
	H_2 (Pulsed)	17	100 ± 5 (7.1)	15.7	30.1 ± 1.2	0.61 (at 126 μA, 14ns)	0.72

Comparison of the estimated target thickness λ , energy loss dE, average charge state q_{avg} , maximum stripping efficiency ϵ_{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

The authors are grateful for the support of the GSI ion source and UNILAC staff. This contribution was assisted by the LINAC16 Student Financial Support.





