Thermal simulations of a C beam stripper for experiments at Spiral2*

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We present 3D thermal simulations (excluding hydrodynamics) of a wheel shaped beam stripper made of solid C that has been designed for use in the FISIC (Fast Ion-Slow Ion Collision) experiments at the SPIRAL2 facility. The inner radius, R_1 of the target is 32 cm, the outer radius, R_2 is 35 cm while the beam is perpendicular to the target surface at a radius, R_0 = 33 cm (see Fig. 1). The target is rotated at a rate of 2000 rpm. Several ion species including

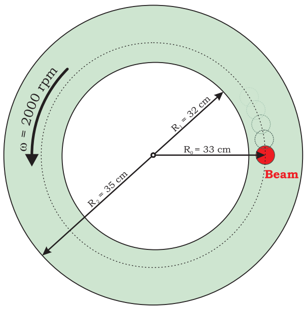

Figure 1: Stripper geometry.

Ne, Ar and Ni, with the following beam parameters, have been considered. The transverse ion beam intensity distribution in the focal spot is assumed to be Gaussian with σ = 0.5 mm corresponding to the most extreme case. At the exit of the LINAC, the beam comprises of particle bunches, each bunch having a duration of 1 ns while the bunch frequency is 88 MHz that leads to a separation of 10.36 ns between two neighboring bunches.

Detailed simulations have been done for the following sets of beam and target parameters.

Case 1: Ne^{7+} with E = 5 MeV/u, I = 10 pμA and N = 6.25x10^{13}/s. Two different target thicknesses, namely, 13 and 100 μg/cm^2, respectively, have been considered.

Case 2: Ar^{13+} (a) with E = 4 MeV/u, I = 10 pμA and N = 6.25x10^{13}/s. Three different target thicknesses including, 4.4, 20 and 320 μg/cm^2, respectively, have been used.

(b) with E = 14 MeV/u, while using four different target thicknesses, namely, 9.5, 32, 105 and 750 μg/cm^2.

Case 3: Ni^{18+} (a) with E = 10 MeV/u, I = 1 pμA and N = 6.25x10^{12}/s. Five different target thicknesses including, 34, 60, 80 190 and 1300 μg/cm^2, respectively, have been considered.

(b) with E = 14 MeV/u, again using five different target thicknesses, namely, 42, 60, 95, 200 and 1450 μg/cm^2, respectively.

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These simulations have been performed using a 3D computer code PIC3D [1] which includes ion energy deposition, heat conduction and thermal radiation losses. Two different values of the emissivity, ϵ, namely, 0.2 and 0.8, have been used to check the influence of emissivity on target cooling.

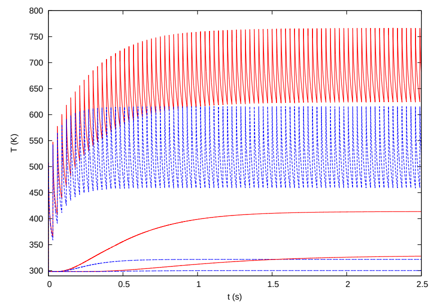

Figure 2: Temperature vs time at R_0 (top curve), R_1 (middle) and R_2 (lowest); red curves (ϵ = 0.2), blue curves (ϵ = 0.8); Ar^{13+}, E = 4 MeV/u, I = 10 pμA and target thickness = 320 μg/cm^2.

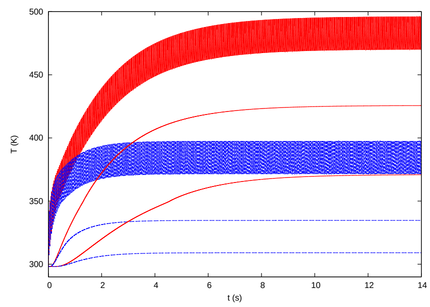

Figure 3: Same parameters as in Fig. 2, but using Ni^{18+}, E = 10 MeV/u, I = 1 pμA and target thickness = 1300 μg/cm^2.

It is seen in Figs. 2 and 3 that the temperature at the center of the focal spot remains safely below the sublimation temperature of C. However, the possibility of material damage due to thermal stresses needs to be addressed. This work is in progress.

References

[1] V.E. Fortov et al., Intnl. J. Impact Eng. 33 (2006) 244.

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