Characterization of cluster laser plasma using bremsstrahlung X-ray emission and Rayleigh scattering

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When working with cluster plasma, an important task is to characterize its parameters, which is necessary for understanding the processes occurring in the plasma, as well as for computer modeling. We characterize cluster radius, electrons concentration and temperature for several gas–cluster targets (N_2, O_2, Ar, and Kr). To estimate cluster radius Hagena's scaling laws [1] and experimental Rayleigh scattering (of a 470 nm probe laser beam) are used for a backing pressure 1-40 bar. The plasma temperature is determined from the slope of x-ray bremsstrahlung spectra when target is irradiated by relativistic intensity (5 TW, 30 femtosecond, 800 nm, 5×10^{18} W/cm^2). The maximum plasma temperature $T_e = 10 \pm 3$ keV, was observed for Kr at 40 bar pressure For light atoms (N_2, O_2), the optimal cluster size and plasma concentration were experimentally found at which various types of secondary radiation are generated efficiently as a result of 10 MeV electrons acceleration. When the same cluster size or electron concentration or temperature are achieved for heavy atom targets, the overall efficiency is much lower. Based on the obtained data, the separate effects of gas type, cluster size, and cluster concentration on the bremsstrahlung spectra and other processes were estimated.

[1] Gupta K, Jha N, Deb P, Mishra D R and Fuloria J K 2015 *J. Appl. Phys.* **118**(11)