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A novel investigation of the ion temperature and hydromotion of stagnating z-pinch plasma using Stark-broadened line shapes[1]

DROR ALUMOT, EYAL KROUPP, EVGENY STAMBULCHIK, DMITRY OSIN, ALEXANDER STAROBINETS, VLADIMIR BERNSHTAM, LEONID WEINGARTEN, YITZHAK MARON, Weizmann Institute of Science, Rehovot, Israel, INGO USCHMANN, Friedrich-Schiller University, Jena, Germany, AMNON FISHER, Technion - Israel Institute of Technology, Haifa, Israel — In imploding plasmas, there is a severe lack of detailed experimental data on the thermalization processes that govern the ion temperature at stagnation, and on the energy delivered to radiation. Here, we report on a novel spectroscopic system, used to determine the temporally-resolved ion temperature and total ion kinetic energy, as well as the electron temperature and density. We use a neon Z-pinch, imploding under a 500-kA, 500-ns current pulse, and observe a hot-and-dense plasma core stagnating on axis for $\sim$ 10 ns. A two-spectrometer diagnostic system is employed, simultaneously recording two groups of optically-thin lines: He-like satellites to Ly_α and high-n H-like Ly_δ and Ly_ϵ lines, with ultra-high resolutions in spectrum, time and space. The ion temperature is obtained, as a function of time, by analyzing the ion-correlation-affected shapes of the Stark-broadened high-n lines. The total Doppler width yielded the total ion kinetic energy. The ion temperature is found to be substantially lower than the hydrodynamic-motion energy, the dissipation time of which is determined as well.

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