STUDY OF THE FEASIBILITY OF WARM DENSE MATTER GENERATION USING ELECTRIC EXPLOSION of metal FOIL UNDER MEGAAMPERE CURRENT DRIVE

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Warm Dense Matter (WDM) [1] is the state of matter in the range between condensed matter and ideal plasma, which has higher temperature than condensed matter, but lower temperature and higher density than the traditional ideal plasma. In this range, which is often characterized by temperatures of 1< *T*< 50 eV and densities of  ( is solid density), matter cannot be described by theories applicable to ideal plasma or condensed (solid) matter. Understanding WDM properties is a challenging physical problem, because this state of matter is hard to simulate theoretically or produce/measure experimentally under laboratory conditions. The task of WDM generation is of interest for a wide range of applications. WDM occurs in the core of gas-giant planets, and in engineering and physical applications it forms in systems with fast solid-to-plasma transition, such as exploding wires or quickly heated (by laser or high magnetic fields) materials.

This paper investigates a WDM generation system by electric explosion of a thin cylindrical metal foil enclosed in an insulator. This experimental setup is close to experiments on foil opening switches [2], which transfer the magnetic flux to infinite load and provide the homogeneity of the WDM and present availability of WDM for the diagnostics. The electric explosion of the metal foil can be realized by currents of explosive magnetic flux compression generators (EMG) or high current stationary facilities. As examples of such current sources this paper considers the helical EMG with an opening switch and stationary facility PHELIX [3] of LANL.

A diameter 200 mm EMG with an explosive opening switch can deliver a current of ~5 MA with a characteristic rise time of 0.3 μs. It is shown that in such the WDM generation system driven by the EMG with the opening switch one can obtain a large volume of matter with density on the order of (0.01-1) of solid density and temperature about 2-3 eV.

The PHELIX facility is a small-size capacitor bank coupled to the current transformer; it allows to reach load currents 3 – 5 MA with characteristic times ~10 μs. The paper shows that in a system with using of this facility significant volumes of uniform WDM with the density of ~ 0.1-1 g/cm3 and temperature of 3-4 eV can be obtained with good accessibility for measurements. A way to recover the WDM parameters based on electrotechnical measurements and exploded foil boundary velocimetry is described.

References

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