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Interferometric Velocimetry in Laser Driven Inertial Confinement Fusion Research

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Velocity interferometer system of any reflector (VISAR) is an active velocity measurement technology of shockwave, Which can obtain velocity history of shockwave based on doppler frequency shift and difference frequency principle. It is a key way to carry out shock timing research in ICF, that diagnose velocity history of shockwave in target by interferometric velocimetry. Meanwhile, in the field of high-energy density physics research, an important way to carry out high-pressure physical properties research is to measurement shockwave velocity directly, and analyze the pressure, density and other thermodynamic states of the material.

Based on the 100,000 J laser facility, We have established VISAR, which can perform high-precision diagnosis of shockwave velocity history[1]. At the same time, we can obtain the evolution process of one-dimensional shockwave surface by deeply analysis of experiment data. Moreover, for complex physics experiments, we have established a positive calculation simulation ability, which can simulate the expected results combination with parameters of driven laser and target, as shown in Fig.1, thereby optimizing experimental design and helping to understand the experimental results. Recently, based on VISAR, our team have obtained the extreme thermodynamic state of iron close to TPa and 10,000 K temperature by mixed driven method of shock loading followed by isentropic loading. The loaded thermodynamic path will be introduced, under which the experimental data can be better used for the parameter verification of the equation of state.

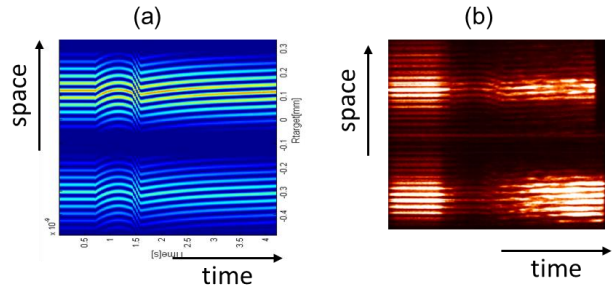

Fig. 1. Simulation and experimental results of dual-axis VISAR: (a): Simulation result; (b): experimental result.

In order to expand the application of VISAR in the research of ICF, and give full play to the technical advantages of interferometric velocimetry, we are developing dual-axis VISAR, wide-angle VISAR[2] and CUP-VISAR high temporal resolution diagnosis method of two-dimensional shockwave velocity field[3]. Among them, dual-axis VISAR is an important technique for study on implosion symmetry, which can obtain the shockwave evolution history of equator and polar region of target by performing microstructure in target. Wide-angle VISAR is a new diagnostic method derived from the dual-axis VISAR. By installing an ellipsoidal mirror in target, as shown in Fig. 2, it can diagnose the shockwave evolution process with a wide range of angles of target. So, it is expected to provide a new technique for the study of local symmetry during implosion compression. CUP-VISAR is a high temporal resolution diagnosis method of two-dimensional shockwave velocity field, based on compressed ultrafast photography (CUP) technology. It encodes and compresses the two-dimensional interference pattern, then decodes the compressed data to obtain every interferogram, in which the evolution process of two-dimensional velocity field can be extracted. Compared with the traditional 2D-VISAR, because of high temporal resolution and multi-photographing ability, CUP-VISAR is expected to provide a better method for study on the generation and evolution of hydrodynamic instability seeds.

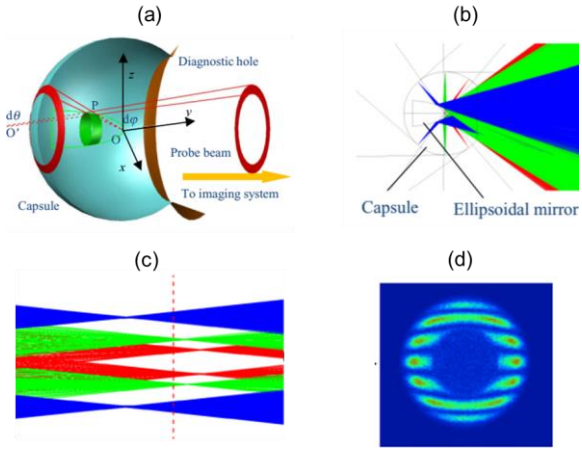

Fig. 2. Scheme and simulation result of Wide-angle VISAR: (a): Tracing model for simulation; (b): diagram of the imaging model; (c): output at image spot.

References
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