

Displacement interferometer technique for plasma pressure diagnostic

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Within the framework of experiments to study the equations of state of material during the heating by the heavy ion beam of the SIS-18 accelerator several versions of interferometer setups were designed and application experience was obtained as well as first results.

The special features of these experiments with the SIS-18 heavy ion bunches are the short time of existence of plasma ~ 1 ms, the characteristic plasma size (0.1-1) mm and remote control during conducting the experiment, including the changing and installing of the targets.

Under these conditions the use of a noncontact optical technique where the setup is located at a distance to the target of 0.5-1 m. is preferable. Interferometric techniques with displacement and velocity measurement of the target surface provide high spatial and temporary resolution and can be successfully applied to velocity measurements and pressure determination[1].

1. Time resolved displacement measurement technique of close spaced surfaces

The scheme of the optical interferometer is shown in Figure 1. The laser beam was focused on the experimental setup in two closely fixed sapphire plates.

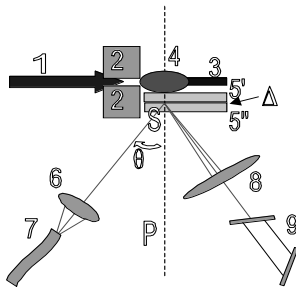


Figure 1. 1-ion beam; 2- shaping diaphragm; 3-plate of studied material; 4-plasma volume; 5,5''-sapphire; plates 6-lens $f=50$ mm; 7-receiving fiber $400 \mu\text{m}$; 8-lens $f=300$ mm; 9-He-Ne laser 10 mW; S-laser radiation focusing spot; P-axis of symmetry of interference field.

The reflection on the surfaces of the sapphire creates light from a point source S which is in the focus of lens 8, resulting in a system of concentric interference patterns with centres on the axis P, which passes through the focal spot. The distance between neighboring fringes observed under angle θ from the axis P depends on the distance between the reflecting surfaces Δ with a $\sim(1/\Delta)$ -proportionality.

The focused and reflected light is collected on the quartz-polymer fiber 7 which has a length of 100 m.

2. Michelson interferometer design for time resolved displacement measurement

For the measuring the time dependence at a controlled surface with respect to stand alone surface an optical scheme with a Michelson interferometer was used. Main elements are shown in figure 2.

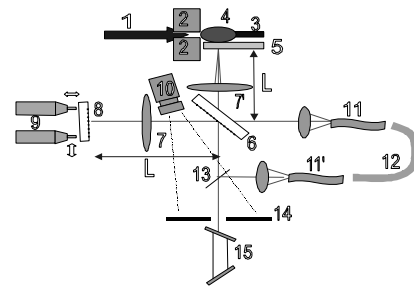
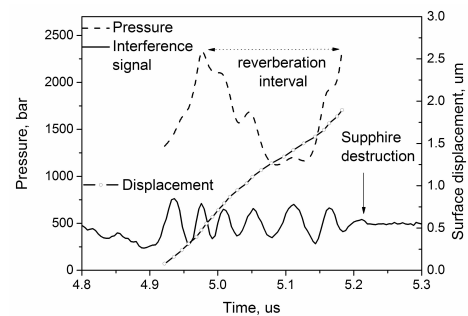


Figure 2. 1-heavy ion beam; 2-shaping diaphragm; 3-plate of studied material; 4-plasma volume; 5-plate of sapphire; 6-beamsplitter; 7-lens $f=300$ mm; 8-mirror; 9-position motors; 10-CCD camera; 11,11'-a 400 μm fibers with 50 mm lense;12-additional fibre line; 13-film beamsplitter; 14-screen; 15-He-Ne laser 10 mW.

In the interferometer two arms L are adjusted to fit the condition for a minimum optical path difference. A possibility of remote adjustment of the interferometer to the maximum amplitude of the interference pattern is provided by the CCD camera 10 and screen 14 with a 2.5 mm aperture for the passage of the laser beam (15). In the plane of the screen the interference pattern caused by the beam reflection at the sapphire plates and the mirrors 8, 6 can be observed. Simultaneously to the adjustment on the screen 14 an adjustment of the second beam interferometer after the beam splitter 13 is done to lens 11 and the fiber 12. . Shown in figure 3 are the recorded interference signals, sapphire surface displacement and pressure wave reverberation .



References

- [1] M. Kulish, A. Fertman, A. Golubev, A. Tauschwitz, and V. Turtikov Review of Scientific Instruments, V72, 5, pp. 2294-2297, 2001