§34. Development of Position Measurement Module for Flying IFE Target

Tsuji, R. (Faculty of Eng., Ibaraki Univ.),
Norimatsu, T. (Institute of Laser Eng., Osaka Univ.)

We have been developing the position measurement method using Arago spot[1]. Figure 1 shows Arago spot appeared in the centre of the spherical ball shadow. The position of the flying IFE target will be measured by the orthogonal pulsed divergent laser beams shown in Fig. 2.

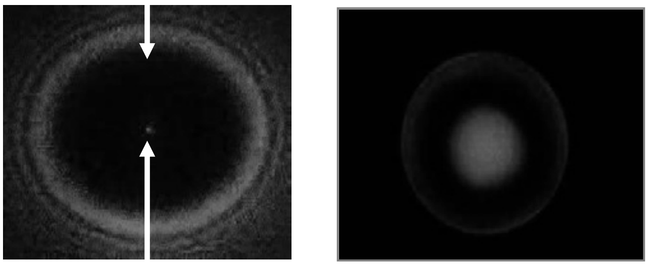

Fig. 1. Arago spot in the shadow of the ball.

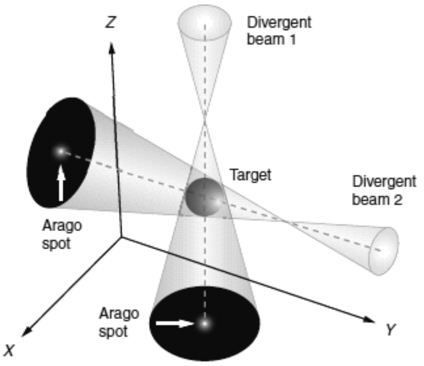

Fig. 2. Orthogonal pulsed divergent laser beams.

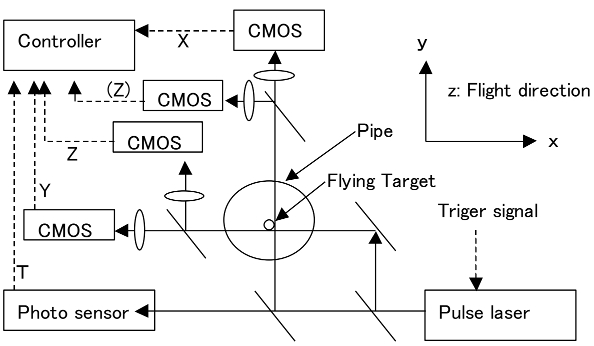

Fig. 3. System of position measurement unit.

Figure 3 shows a system of position measurement unit (PMU) for flying IFE target. To measure the target position within the accuracy of 1 μm, the pulse width is shorter than 10 ns. We had a N_2 laser installed in our PMU. Optical and mechanical design study of PMU using N_2 laser is finished and the PMU with N_2 laser is under construction.

A cylindrical lens is used to convert raw two dimensional Arago spot image (~MB) into one dimensional line image (~kB) for real-time image processing[2]. Preliminary experiment of data conversion using cylindrical lens with He-Ne laser was a success as shown in Fig. 4..

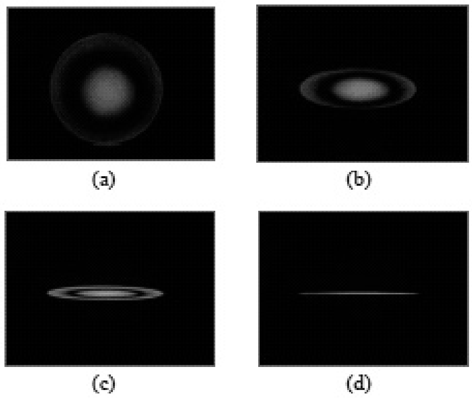

Fig. 4. data conversion of Arago spot.

Similar experiment with N_2 laser is planed in the next year. Design study of real-time image processing board using micro-controller is in progress.

Two methods for calculating the trajectory of the injected target has been developed. First method uses a heavy target. Fitting the parabolic orbit, the X, Y and Z coordinate of the local origin of the i-th PMU can be obtained[3]. After that, we can convert data sequence of the local position variables to global position variables. When injected target passes through the i-th PMU, the injected target is irradiated by the pulsed laser and the local position (x_i, y_i, z_i) of the injected target in the i-th PMU is recorded with the flashing time T_i. The arrival time T_A that the injected target reaches the center of the reactor (z=0) can be calculated by the equation of motion. The target position at the time T_A can be also calculated by the equation of motion[3].

Second method uses optimization techniques for the data sequences of few tens of injected targets[4]. An approximate formula for arrival time and arrival position can be obtained to minimize the total error between the experimental values and calculated values of the data sequences.

1) Saruta, K. and Tsuji, R.: Jpn. J. Appl. Phys., **47** (2008) 1742.
2) Sakauchi, H. and Tsuji, R., Plasma and Fusion Research **4** (2009) S1012.
3) Tsuji, R. et al.: “Trajectory Calculation of Injected Inertial Fusion Energy Target”, CIFE5-3, Conf. on Inertial Fusion Energy 12, Yokohama, Japan April. 2012.
4) Tsuji, R., to be presented in IFSA2013.