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TITLE: SIMULTANEOUS VELOCITY INTERFEROMETRY AND ELECTRONIC STREAK PHOTOGRAPHY OF LASER-LAUNCHED PLATES

AUTHOR(S): D. L. Paisley, D. B. Stahl, I. A. Garcia

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Los Alamos National Laboratory
Los Alamos, New Mexico 87545

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Simultaneous velocity interferometry and electronic streak photography of laser-launched plates

D. L. Paisley, D. B. Stahl, and I. A. Garcia

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

ABSTRACT

Laser-launched, miniature, pseudo-one-dimensional flyer plates are evaluated by three distinct optical techniques that may be incorporated into an optical diagnostic system to give a complete understanding of the plate performance. These techniques are: velocity interferometry, streak photography, and pulsed laser stereo photography.

1. INTRODUCTION

Laser-launched miniature plates are traditionally evaluated separately by one of several high-speed, optical diagnostic methods. Velocity and acceleration profile are determined by velocity interferometry. Plate integrity is verified by pulsed laser stereo photography, and plate impact profile by electronic streak photography.[1] Since each plate can only be launched once, correlation of different plates and diagnostic techniques relies on the reproducibility of the experiments and the optical diagnostics. By incorporating several diagnostic techniques in an integrated system on each test, ambiguity is reduced and fewer tests are required.

2. SIMULTANEOUS VELOCITY INTERFEROMETRY AND STREAK PHOTOGRAPHY

Velocity interferometry requires comparison of diffuse-reflected, Doppler-shifted laser light from the accelerating surface to be compared with original laser light. Streak photography of plate impacts relies on the ionization of shocked air to emit pseudo white

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light, but whose wavelength does not carry information as is the case for interferometry.[2] Three requirements are necessary for simultaneous interferometry and streak photography: common optical axis on the target, depth of field over the total flight path of the plate and impact surface, and separation of the white light signal from the Doppler-shifted interferometry signal. By properly choosing the target and relay lenses, and using a dichroic beamsplitter all criteria can be met (Figure 1). The velocity profile can be integrated to determine flight distance versus flight time (Figure 2). By placing a transparent impact surface a known distance from the plate launch surface, the streak method records the flight time over a fixed distance The interferometrically-determined displacement versus time can be compared with the streak photography impact time (Figure 3). If good agreement is obtained ambiguity can be eliminated in both diagnostic methods. If lost fringes in the interferometer record are suspected, this method can be used to resolve the uncertainty.

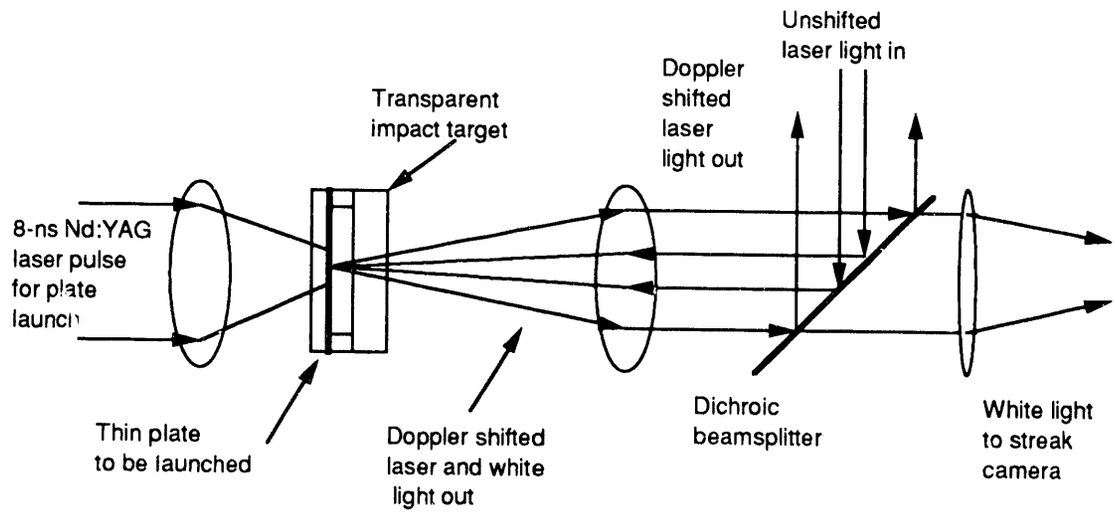

Figure 1. Experiment and technique for simultaneous velocity interferometry and streak photography.

Temporal correlation between diagnostic methods is obtained by superimposing the Nd:YAG laser pulse for launching the plate on both optical recording systems.

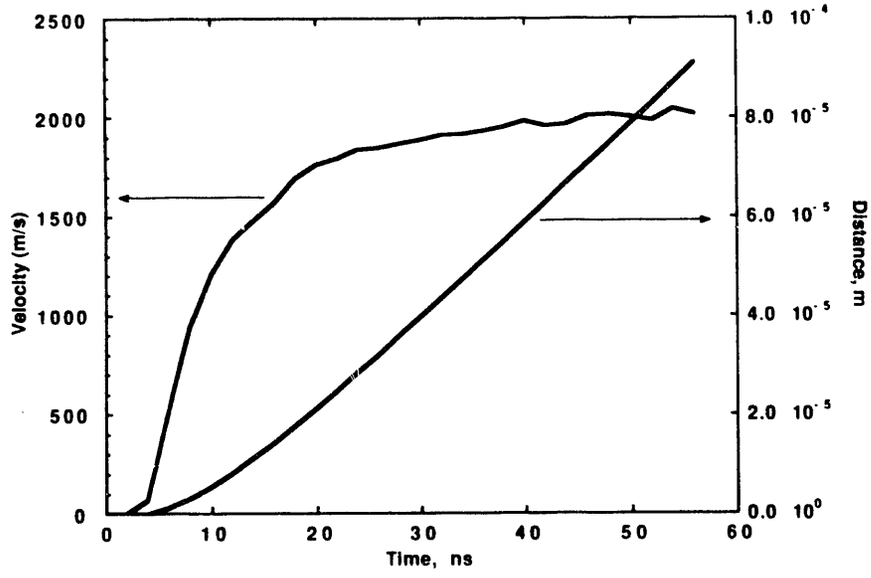

Figure 2. Both plate velocity and integrated distance are represented as a function of time without transparent impact target.

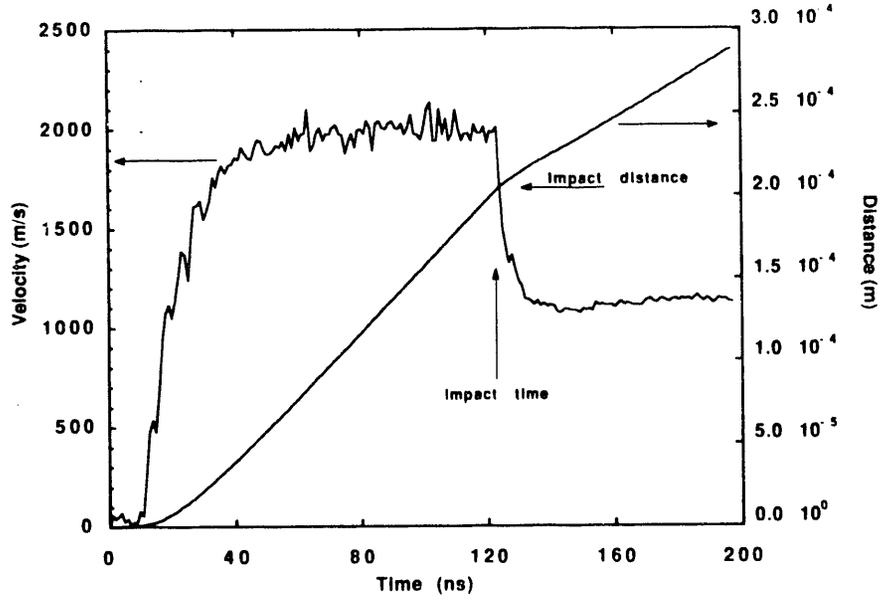

Figure 3. Transparent impact target placed 200-μm from plate launch agrees with ingegrated velocity profile for distance the plate has travelled.

3. PULSED LASER STEREO PHOTOGRAPHY OF LASER-LAUNCHED FLYER PLATES

Pulsed-laser stereo photography has been performed on miniature laser launched plates. The second harmonic of the 1.06-μm Nd:YAG plate-launch laser is used to illuminate the plate. Since the 1.06-μm and 532 nm beams are collinear and synchronized, only a dichroic beamsplitter and an optical time-delay path are necessary for photographing the plates. To determine integrity, planarity, and flight distance at a given time, the plate is viewed with a stereocamera along the velocity vector (Figure 4). By viewing the plate orthogonal to the velocity vector, the mechanical method of separating the plate from the continuous foil is evaluated (Figure 5).

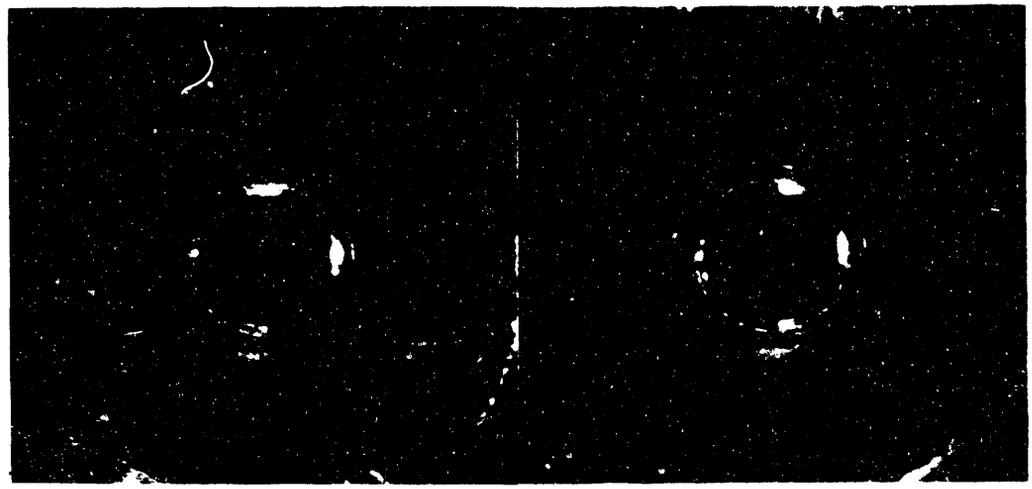

Figure 4. Stereo pair of a plate in flight and taken along the velocity vector of the plate, shows plate integrity and profile (from Reference 2, p. 765, fig. 2).

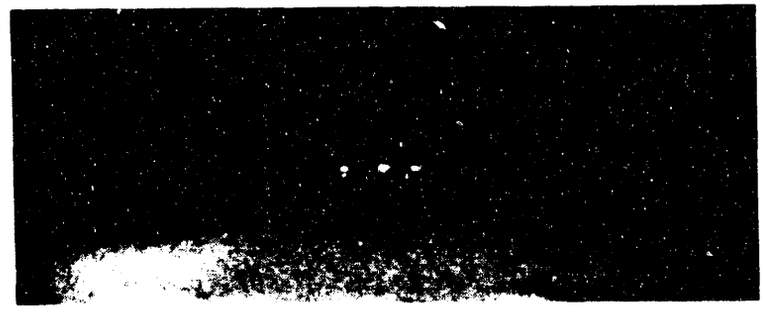

Figure 5. One half of a stereo pair taken orthogonal to the plate velocity vector shows the plate separating from the foil.

4. SUMMARY

Simultaneous use of diagnostics of two or more independent optical techniques enhances the credibility of each method, eliminates ambiguity, and reduces the number of tests.

5. REFERENCES

1. D. L. Paisley, et al., "Interferometry, streak photograph, and stereo photography of laser-driven miniature flying plates," Proceedings of the 19th International Congress on High-Speed Photography and Photonics, B. Garfield and J. Rendell, eds., SPIE Vol. 1358, pp. 760-765.

2. D. L. Paisley, et al., "Velocity interferometry of miniature flyer plates with sub-nanosecond time resolution," High Speed Photography, Videography, Photonics, and Velocitmetry '90, Proc. SPIE Vol. 1346, pp. 172-178, 1990

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