STREAK CAMERA TIME CALIBRATION PROCEDURES

By

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ABSTRACT

Time calibration procedures for streak cameras utilizing a modulated laser beam are described. The time calibration determines a writing rate accuracy of 0.15% with a rotating mirror camera and 0.3% with an image converter camera.

At the CIT Shock Wave Laboratory we routinely use streak cameras to record data from propellant and light gas gun experiments. Two different kinds of streak cameras are used: a rotating mirror camera[1] and an electronic image converter camera[2]. This paper describes the time calibration technique used on each of these cameras.

The rotating mirror streak camera writing rate is dependent on two parameters: the angular velocity of the mirror and the distance from the mirror surface to the film plane (the writing arm). During each experiment the angular velocity of the mirror is measured with a counter which counts the revolutions during the second the picture is taken. This measurement defines very well the angular velocity (the acceleration or deceleration rate being of the order of $\pm$ 2 counts out of 2000).

The writing arm is fixed by the structure of the camera and has a nominal value of eleven (11) inches. The issue is: what is the true writing arm length? Measurements were performed in our laboratory to accurately define this parameter on our camera.

The method used was to modulate a laser beam[3] with a pockel cell driven at a rate of ten (10) megahertz yielding a modulated light beam with pulses at fifty nanosecond intervals. A streak picture was taken of this light source (see Figure 1) at three different angular velocities. The distances between the light spots

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[1] B&W Model 339

[2] TRW Model 1D

[3] TRW Model 71B

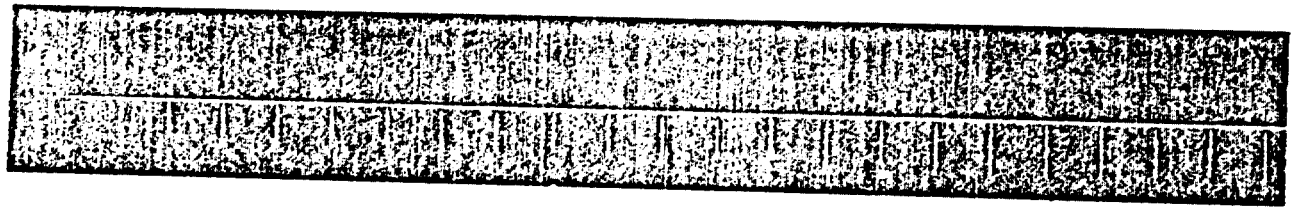

FIGURE 1. Streak record of modulated laser beam on rotating mirror camera (pulse interval 50 manoseconds).

were measured and a true writing rate was determined. This analysis yielded an average writing arm length of 10.992 $\pm$ .015" for our camera (see Table 1). Thus in this case, the nominal value was accurate to $\sim$.1% with a possible deviation of $\pm$ .14%. This calibrated writing arm is used for data reduction on all experiments.

The parameter which governs the writing rate on the electronic streak camera is the rate of change of the sweep voltages generated by the sweep circuit.

Due to the possible variation of this sweep rate (with temperature, supply voltage, etc.), it is desirable to have a time calibration on the streak record. The system we used (Davis, 1970) utilizes a pulsed laser light source, a pockel cell modulator, a modified radio transmitter modulation source (10 mHz) and various optics. Referring to Figure 2, the light beam from the laser is triggered on approximately 10 microseconds before impact. It passes through the pockel cell becoming modulated at a 20 megahertz rate (see Figure 3). The modulation voltage from the transmitter is gated on at the same time as the laser. (See Figure 4 for the 10 megahertz pulse). The frequency of the light modulation is double the electrical rate because the transmission of the pockel cell (for zero bias) is proportional to amplitude whether positive or negative. The laser beam is then focused on the slit at a point to the side of the experimental observation field. Figure 5 is an actual streak record from one of our experiments including the time calibration pulses. The resulting microdensitometer scan (Figure 6) of the light pulses shown in Figure 5 allow the camera

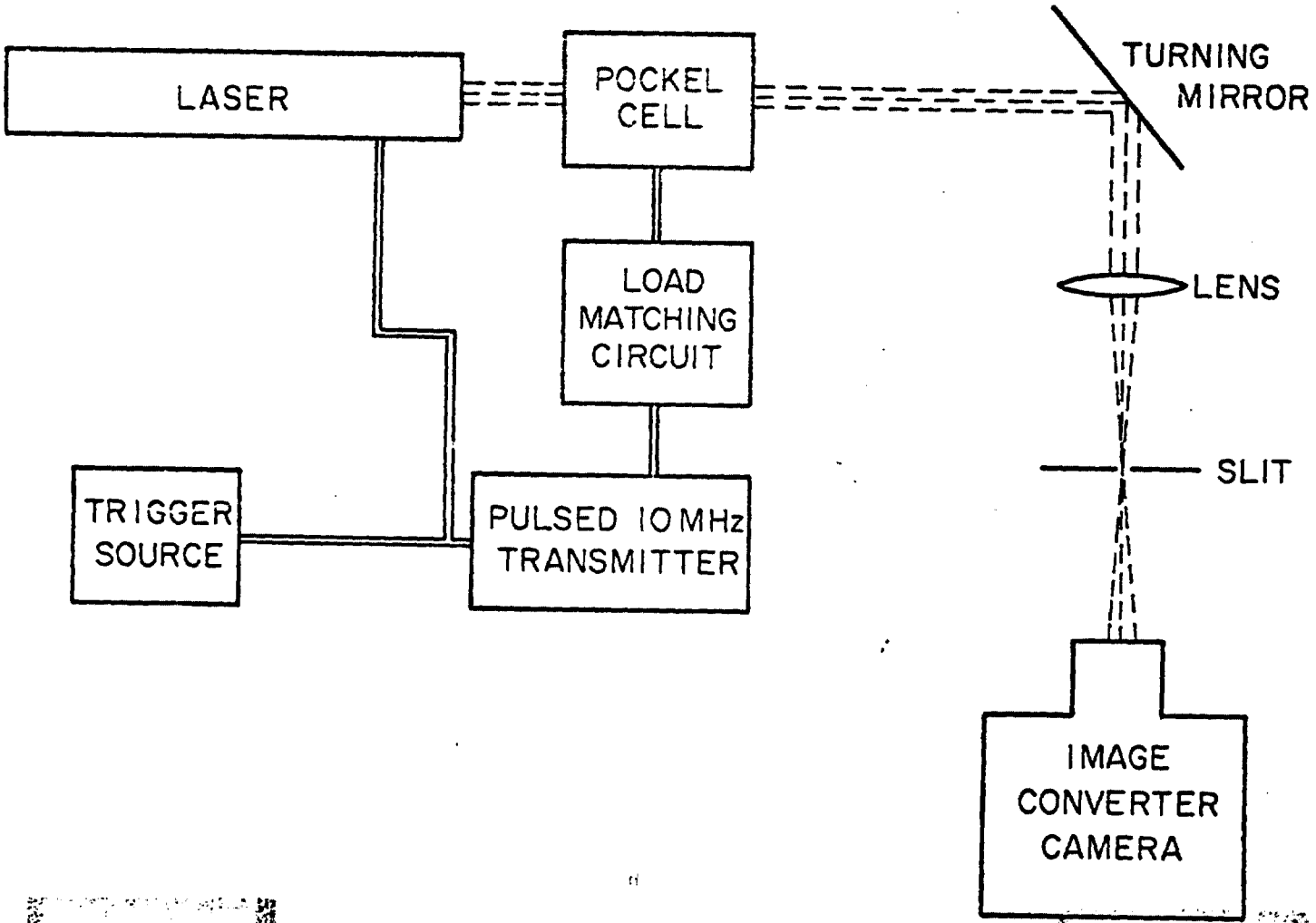

FIGURE 2. Equipment layout for streak calibration of image converter camera.

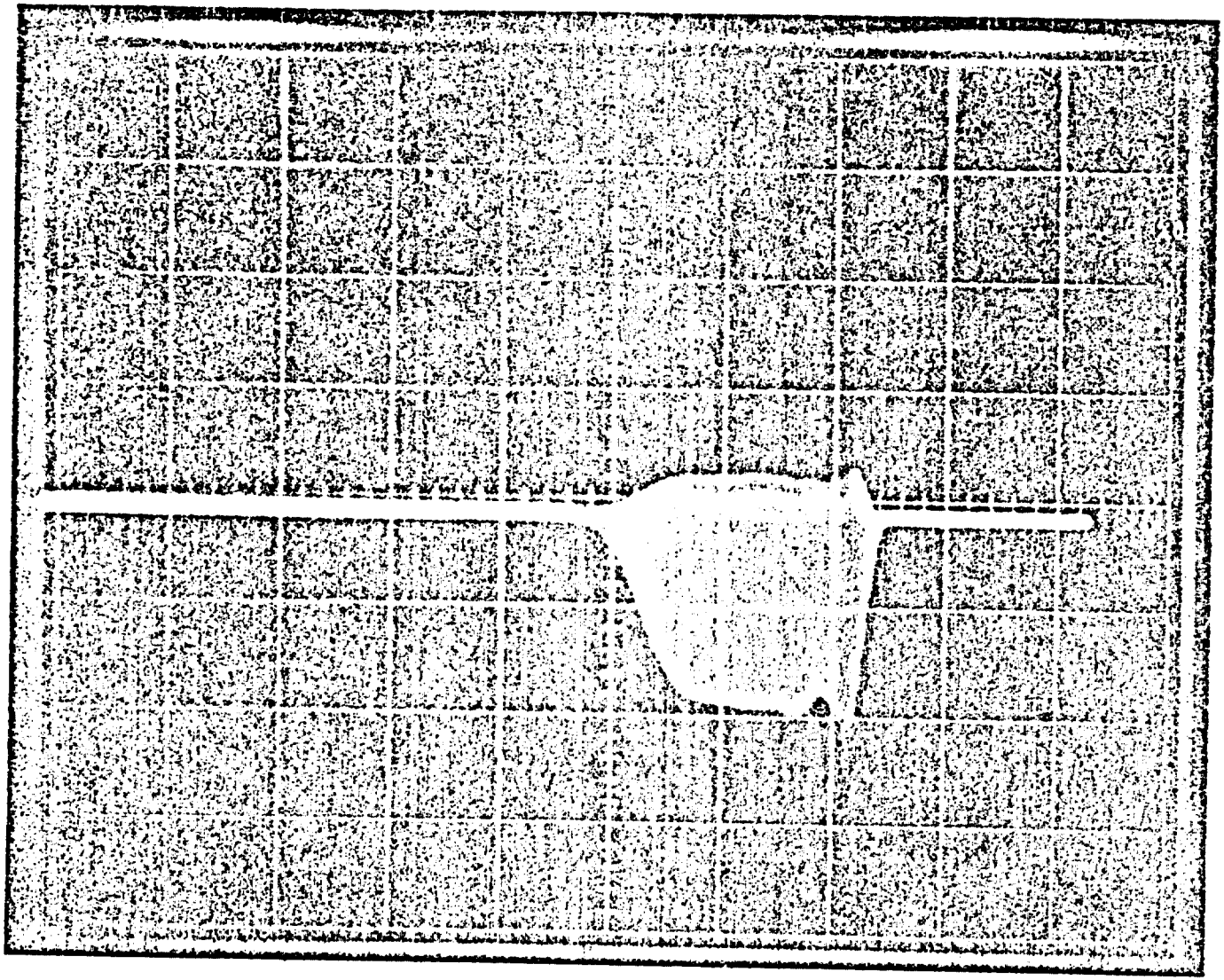

FIGURE 3. Oscilloscope trace of photodiode output showing envelope of modulated light beam (vertical 20 mv/div; horizontal 20 μs/div).

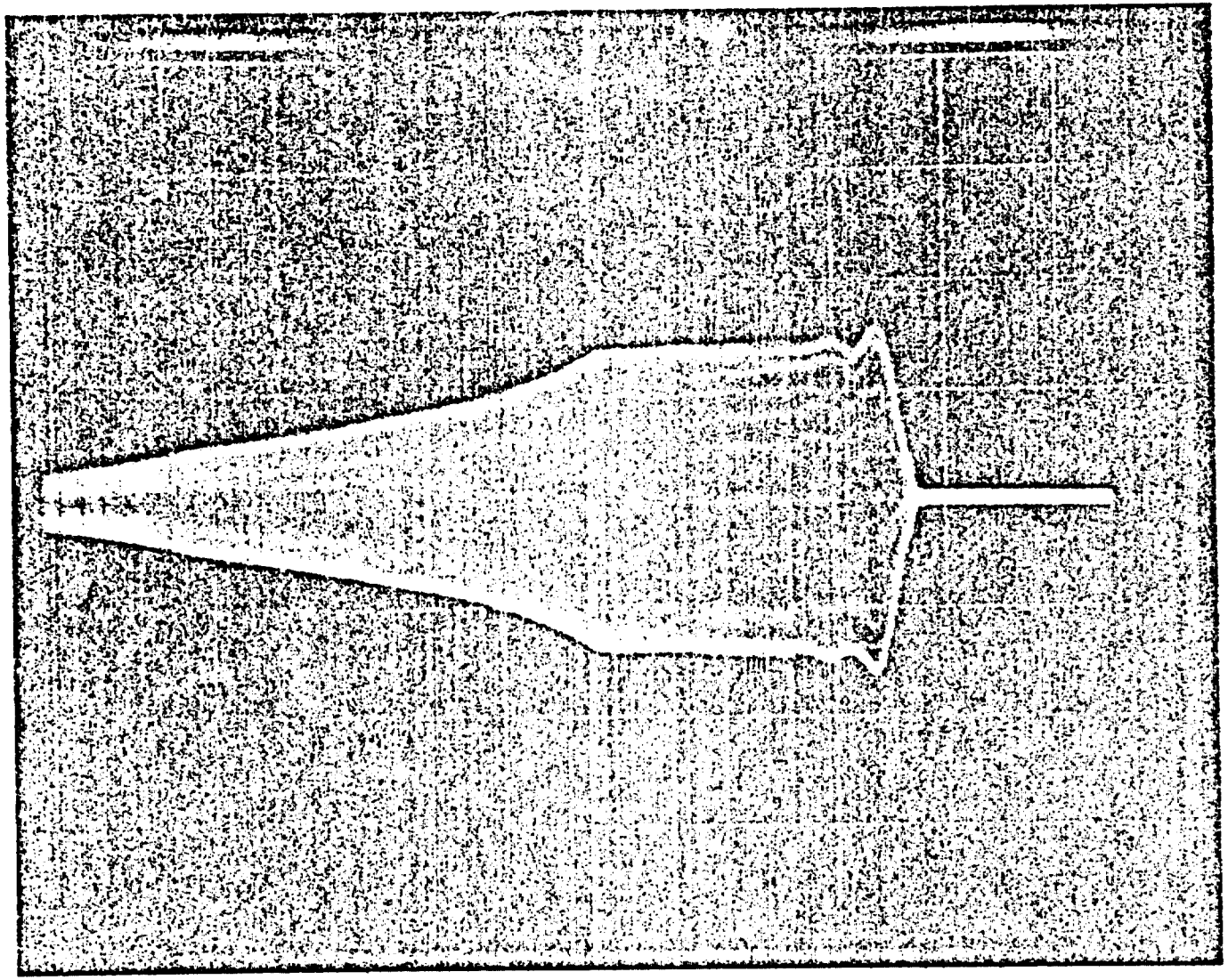

FIGURE 4. Oscilloscope trace of pulse of 10 mHz modulation signal (vertical 20 mu/div; horizontal 20 μs/div).

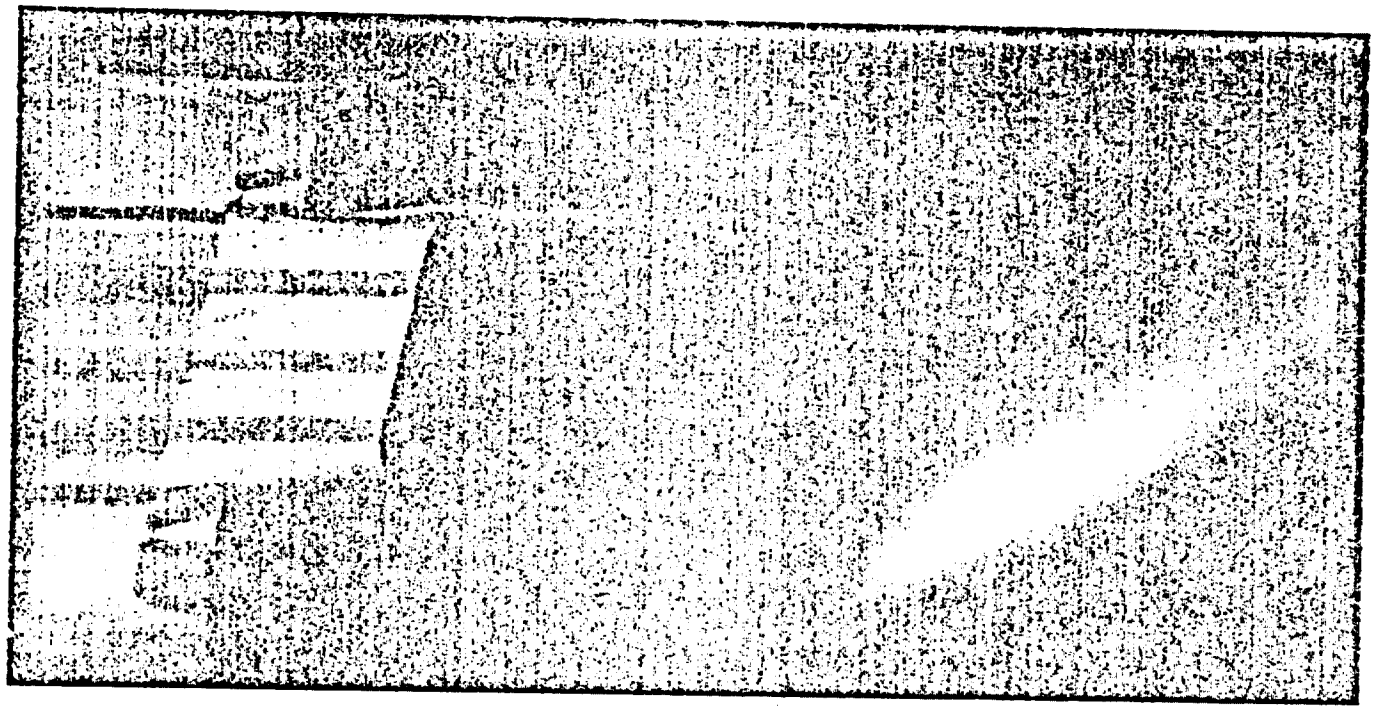

FIGURE 5. Actual shot record showing laser pulses applied simultaneously with shot data.

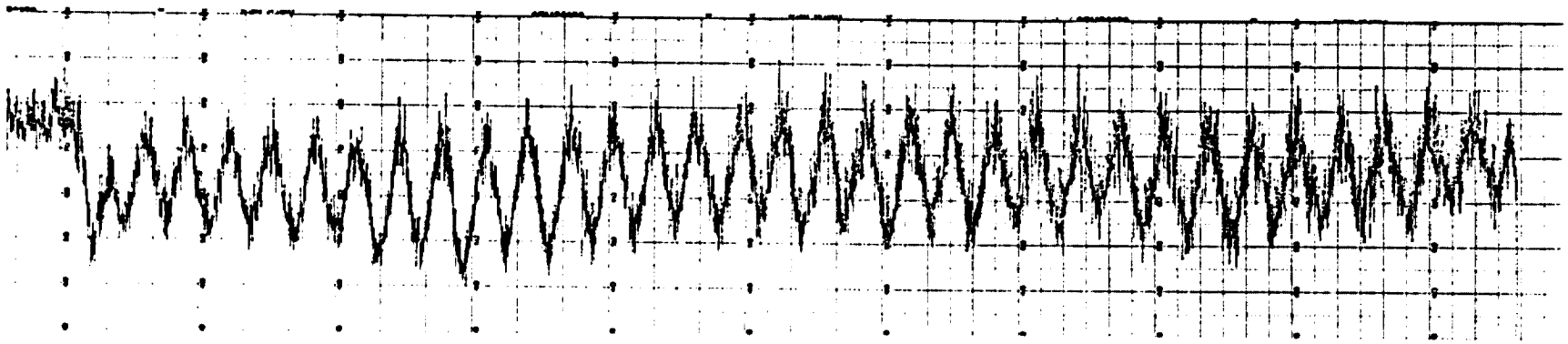

FIGURE 6. A microdensitometer trace of the light pulses in Figure 5 along the length of the streak.

writing rate to be determined to within about 0.3% at any place along the streak (which is about 1.7 μsec in duration). The writing rate of the TRW model 1D camera is found to consistently decrease by about 1% over the streak record.

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REFERENCE

Davis, T. J., 1970, Rev. Sci. Instrum., 41 p. 920.

TABLE 1

Revolutions per Second	Observed Velocity (mm/μs)	Writing Arm Length (inches)
2000 ± 2	7.0152 ± .0060	10.989 ± 0.014
2038 ± 2	7.1599 ± .0063	11.007 ± 0.015
2121 ± 2	7.4334 ± .0063	10.980 ± 0.014
	Average	10.992 ± 0.015

FIGURE CAPTIONS

Figure 1. Streak record of modulated laser beam on rotating mirror camera (pulse interval 50 manoseconds).

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