Max-Planck-Institut
für Quantenoptik
BIBLIOTHEK
D-8046 Garching

MAX-PLANCK-INSTITUT FÜR QUANTENOPTIK

A simple mechanism for the release of laser targets

W. Fölsner, H. Haas, and R. Sigel

M P Q 67

October 1982

MPQ-Report 67

Dieser MPQ-Bericht ist als Manuskript des Autors gedruckt
Alle Rechte vorbehalten

This MPQ-report has been printed as author's manuscript
All rights reserved

Max-Planck-Institut für Quantenoptik
8046 GARCHING bei MÜNCHEN, Bundesrepublik Deutschland

MAX-PLANCK-INSTITUT FÜR QUANTENOPTIK

A simple mechanism for the release of laser targets

W. Fölsner, H. Haas, and R. Sigel

Max-Planck-Institut
für Quantenoptik
BIBLIOTHEK
D-8046 Garching

M P Q 67 October 1982

MPQ 67

A simple mechanism for the release of laser targets

W. Fölsner, H. Haas, and R. Sigel

Abstract:

A simple mechanism for the release of laser targets is described. The target is placed on a flexible support (steel ribbon) and adjusted into the focus of the laser beam. The support is then hit by the snapper of a rat trap. As snapper and support move downward at a velocity of ~ 20 ms^{-1} the target is left in position owing to its inertia. After ~ 2 ms, i.e. before appreciable motion due to the onset of free fall has occurred, the target is hit by the laser pulse. The apparatus has been successfully tested in ~ 100 target shots with the Asterix III iodine laser using solid spherical targets of steel, glass and vanadium with diameters greater than [redacted].

100 µm and recently also with hollow glass microballoons of 200 µm and 80 µm diameter.

This work was supported by Bundesministerium für Forschung und Technologie

Laser irradiated targets for laser fusion and laser plasma experiments are generally of highly symmetric geometrical shape. The support needed to place the target into the focal spot of the laser beam disturbs this symmetry. The presence of a support cannot always be excluded from influencing the behaviour of a laser irradiated target, thus introducing a certain ambiguity into the interpretation of the results. Examples are magnetic field generation and fast electron energy transport around a target or implosion symmetry of a directly driven fusion target. In such situations the use of unsupported targets is desirable. They have to be released by a suitable mechanism. Apparatus built for this application has already been described /1,2/. Such devices operate on the principle that the support of the target is rapidly withdrawn downward. In this manner the target is released and hit by the laser beam before its displacement due to free fall becomes important.

The apparatus described here also operates on this principle, but downward motion of the support is achieved in a somewhat different manner. Its particular advantage is its simplicity and the high velocity with which the support is removed.

The scheme of our apparatus is shown in Fig. 1. The target is placed in a dent on a steel ribbon which acts as a flexible support. The ribbon is fixed on a x-y-z positioner which serves for adjustment of the target into the focal spot of the laser. Near the target support a rat trap is installed. Upon release the rapidly moving snapper of the trap hits the flexible support and punches it downward. Owing to its inertia the target is left behind and subsequently hit by the laser beam.

The commercial rat trap has been slightly modified: its wooden base plate was replaced by a metal one (for vacuum reasons) and the front part cut away. The snapper is released electrically by a turning magnet. Flash photography showed that after impact snapper and support move downward with a velocity of 20 ms^{-1}.

The apparatus was tested with solid spherical targets of various materials (see below) with diameters in the range 300-2000 µm. Flash photography showed that a momentum transfer from the support to the target can occur,

making the spheres jump up initially. This problem was eliminated by empirically adjusting the relative position of support and trap. The most favourable point of impact of the snapper on the support was found to be close to the target.

The position of the free falling target was followed up to 10 ms by flash photography (see Fig. 2). It was found that the trajectory is indeed as expected for free fall. The scatter of the data at t = 2 ms is determined by the accuracy of position measurement of $\pm$ 20 µm. Only occasionally (see point at 10 ms) were deviations observed at later times, presumably because the point of impact varied owing to a lack of mechanical precision in the present apparatus. Flash photographs taken before and after removal of the support are shown in Fig. 3.

In irradiation experiments with the iodine laser the triggering sequence for the laser was initiated by the electrical contact between snapper and support. The laser pulse was set to occur after 2 ms, with the delay being determined by the time constant of the capacitor bank of the Faraday rotator in the laser. This delay was still acceptable because a free falling target moves only 20 µm in this time interval. On the other hand, at a velocity of 20 ms^{-1} of the downward moving support the target is already 4 cm clear of the support. This distance is entirely satisfactory for our present laser plasma experiments.

With this apparatus we have performed ~ 100 irradiation experiments without failure /3/. The following solid spherical targets have been irradiated or tested: glass 400-600 µm diam., steel 350-2000 µm diam., vanadium 300--550 µm diam., titanium 350-550 µm diam. For this class of targets, the approach described here was indeed very reliable.

We have not yet tested hollow or smaller targets, i.e. targets with considerably lower mass. With these targets sticking to the support may present a problem /1,2/. Possibly this problem is less severe with our apparatus because acceleration of the support occurs abruptly.

Note added (Nov. 1982): Recently the apparatus was successfully tested with hollow glass microballoons (wall thickness of a few microns) of 200 µm diam. and 80-100 µm diam. The microballoons were placed on a graphite disc glued to the flexible support; they moved according to the laws of free fall and sticking was observed only in one of 12 shots. These results, however, were obtained only after evacuation of the test chamber to $< 3 \times 10^{-3}$ Torr; at ~1 Torr the microballoons received a downward velocity of several cm/s from air currents induced by the downward motion of the support.

References:

/1/ John L. Pack, T.V. George, and A.G. Engelhardt,
Rev. Sci. Instrum. 39, 1697 (1968)

/2/ KMS Fusion, Inc., Ann Arbor, Michigan 48106, Annual Report 1977

/3/ A. Maaswinkel, K. Eidmann, R. Sigel, S. Witkowski, F. Amiranoff, R. Fabbro, J. Hares, and J. Kilkenny,
24th Meeting of the American Physical Society, Division of Plasma Physics, New Orleans (1982)

Figure captions:

Fig. 1: Scheme of the apparatus.

Fig. 2: Trajectories of free falling spherical targets of various materials and diameters as measured by flash photography.

Fig. 3: Flash photographs of a spherical target (500 µm diam.) before (a) and 2 ms after (b) removal of the support.

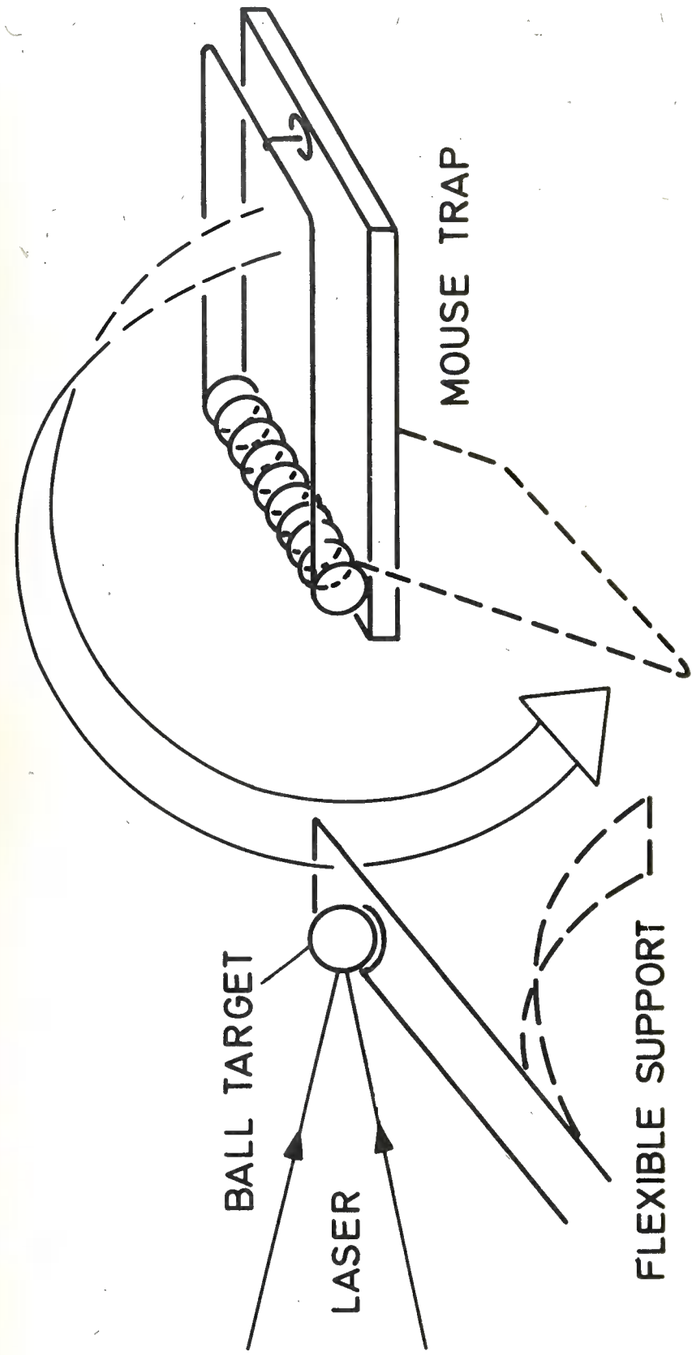


Fig. 1

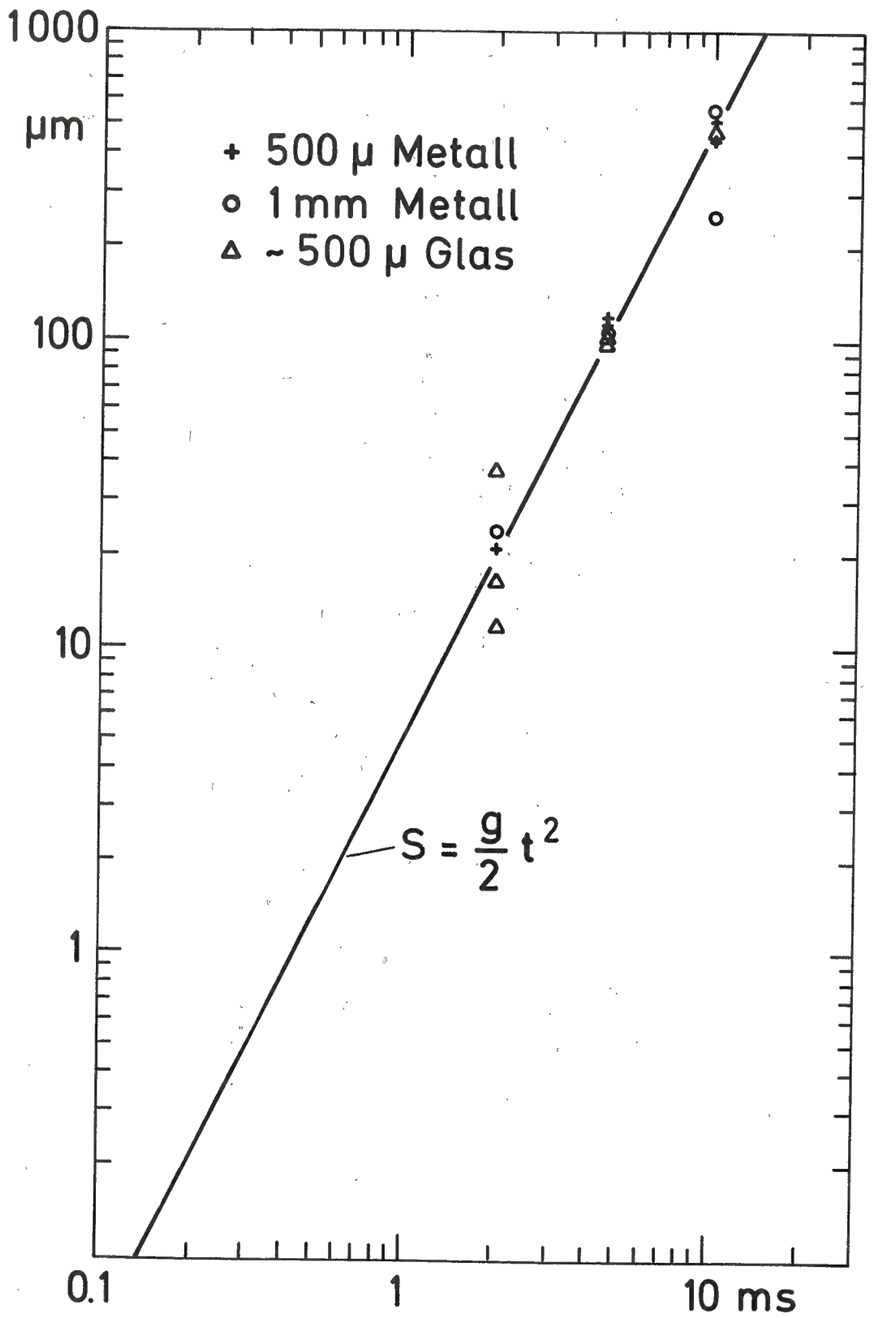
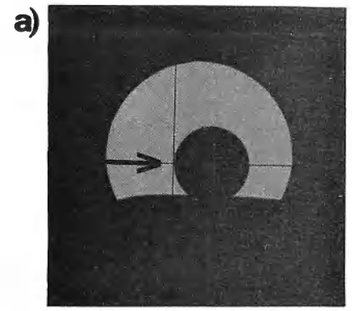

1000
µm
100
10
1
0.1
1
10 ms
+ 500 µ Metall
o 1 mm Metall
Δ ~ 500 µ Glas
S = g/2 t²

Fig. 2


a)

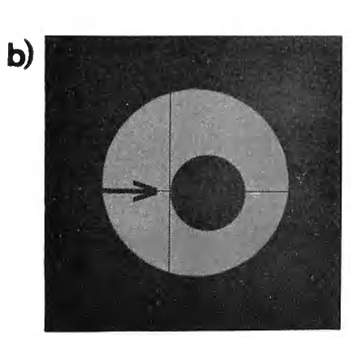

b)

Fig. 3