Experimental results

1. Current-voltage characteristics

The laser lases successfully with the applied voltage (V_d) ranging from 21 to 30 kV. Fig. 5 shows that peak discharge current (I_p) rises linearly with the discharge voltage as expected. The total circuit inductance may be calculated from the current rise time ($\frac{t}{4}$ ~ 1 μS) to be ~ 2.6 μH, which is rather high. If this value of L is used to calculate peak discharge current from the relationship $I_p = \sqrt{c/L}V$, for pure LC circuit at V_d ~ 25 kV, I_p ~ 6 kA. This discrapancy from the experimental value of ~ 3 kA may be due to resistive loss in the sparkgap and the discharge.

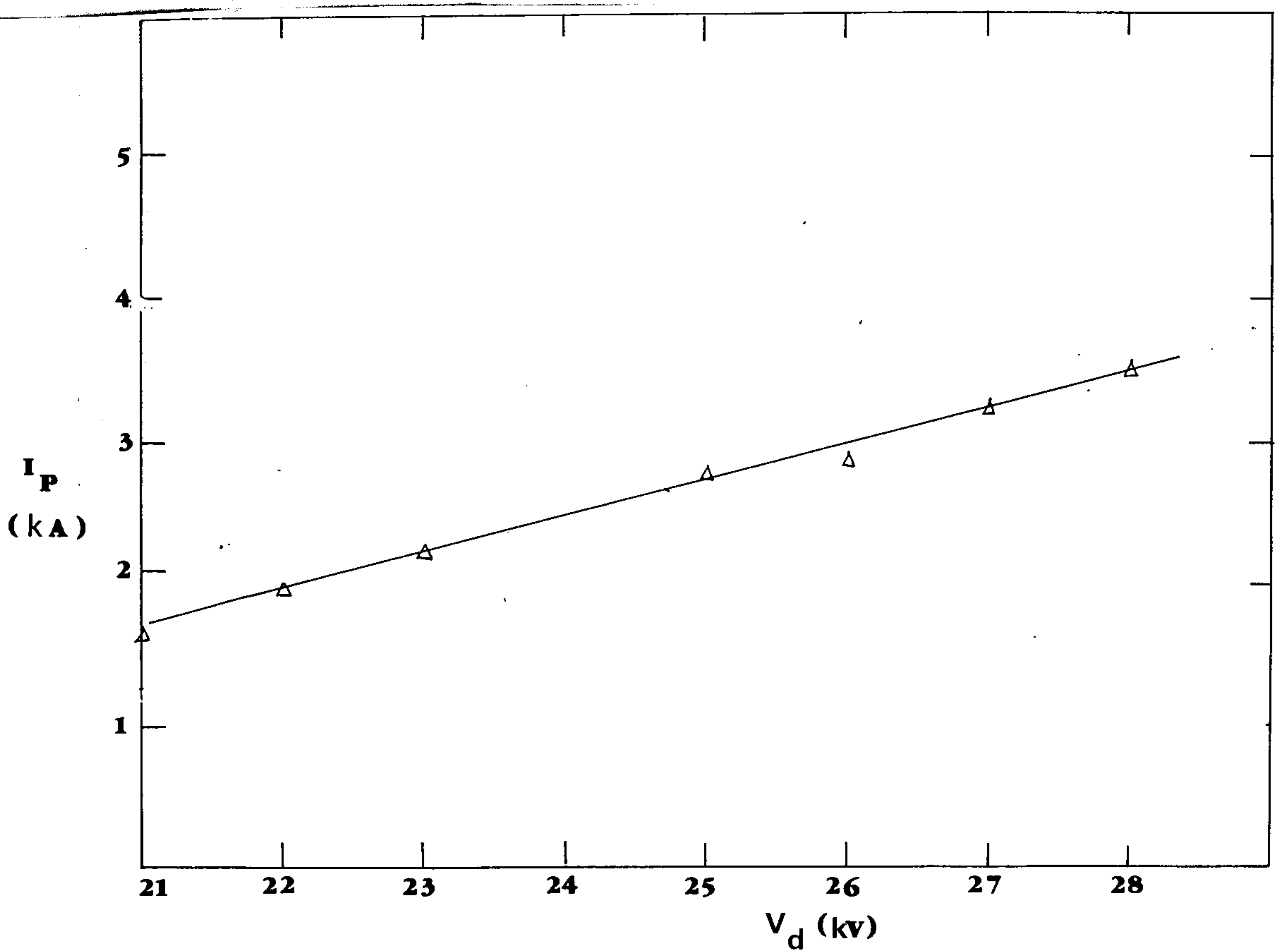

Fig. 5 Peak discharge current vs. charging voltage

2. Time delay between preionization and the main discharge. Fig. 6 shows a typical current signal

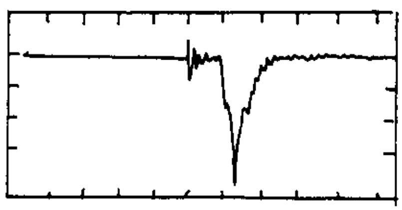

Fig. 6 Typical current oscillograph recorded on Tektronix 585
[V_d ~ 25 kV, I_p ~ 2.8 kA, gas $CO_2 : N_2 : He$ 1:1:20
energy 80 mJ, horizontal time scale ~ 2μS/div]

The first group of small noisy pulses is due to UV preionization, followed by the main discharge current after a time delay t_d. In agreement with Dyer and James[2], time delays of 1-4 μS sastifactory initiate homogeneous arc free discharges. The time delays decrease with increasing discharge voltages as shown in Fig. 7, the time delay seems to level off to ~ 1 μS beyond V_d = 26 kV.

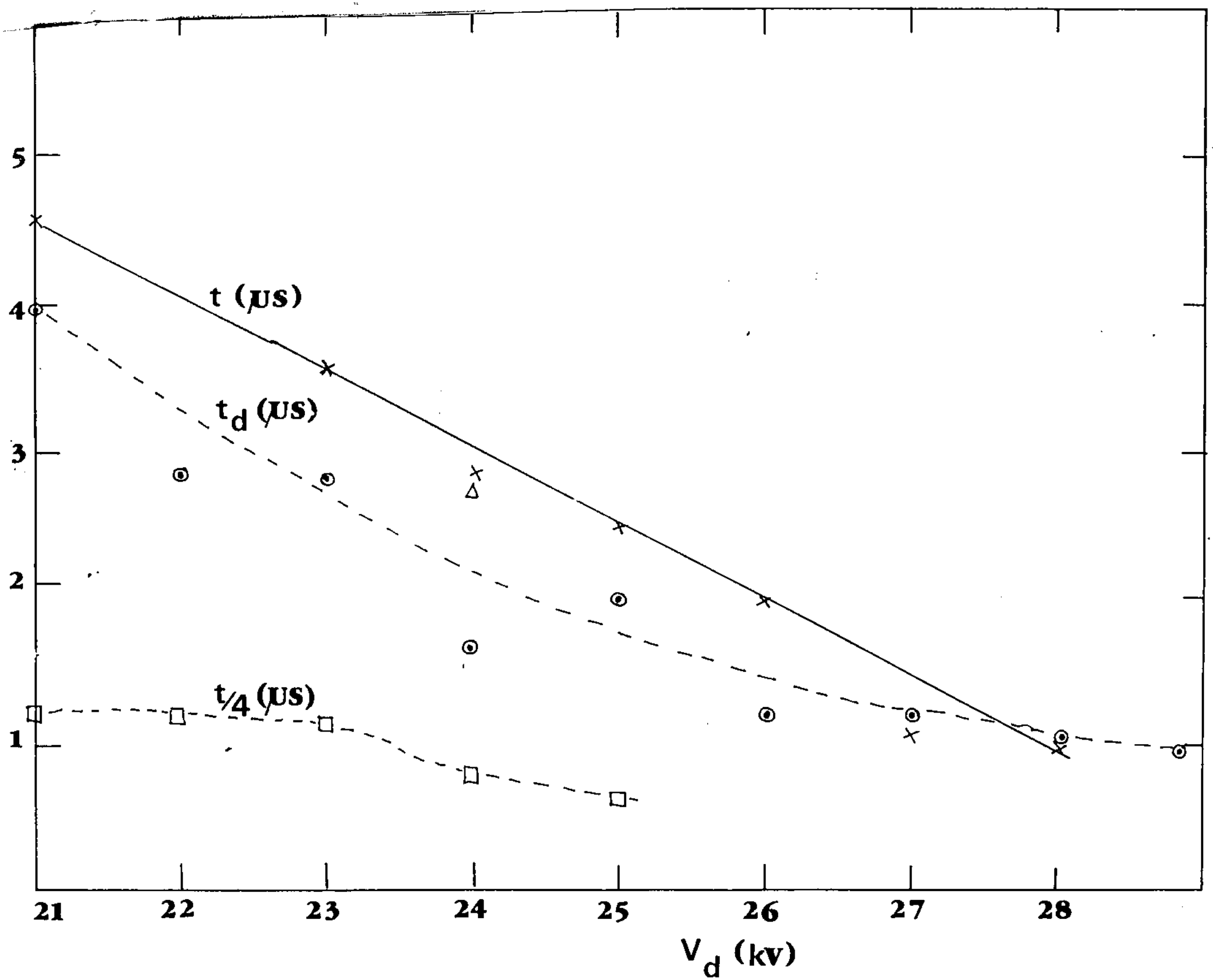

Fig.7 **Time delay (t_d) between preionization and main discharge as a function of discharge voltage**

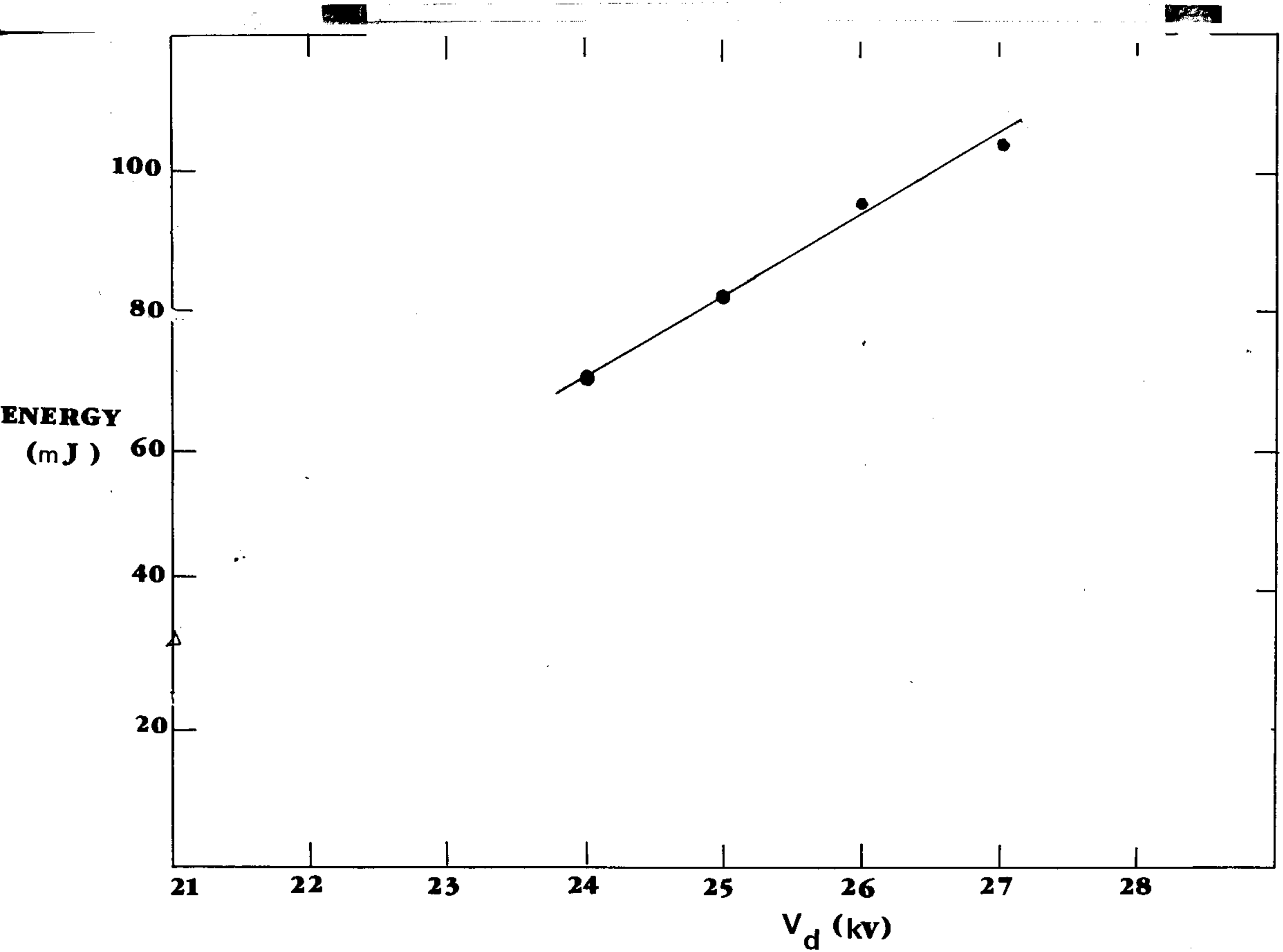

Fig. 8 Laser output energy vs. charging voltage

At V_d = 30 kV, arc discharge frequently occurs due to insufficient time allowed for the ionization of gas to reach favourable E/P ratio, where E = electric field between electrodes, p = gas pressure. V_d = 30 kV, E/P is ~ 8.57 kV/cm atm.

Addition of Tri-n-Propylamine chemical by bubbling through nitrogen gas line causes the discharge to change from pink to white colour, but no lasing occurs. Probably too high proportion of chemical is used.

3. Laser energy and power

The laser energy has been measured between V_d = 24-27 kV, the energy increases linearly with the discharge voltage, as shown in Fig. 8. At V_d ~ 25 kV, the stored energy = $\frac{1}{2}$ CV^2 = 58.8 J, the wall plug efficiency is less than 1 %, which is rather low. This is not surprising, since no attempt has yet been mode to optimize the discharge circuit. Signal from photon drag detector is very noisy due to electrical interference, an estimate of laser pulse duration is inferred from the current pulse (~1 μS). The laser power is then calculated to be P ~ 80 kW which is reasonable when comparing with other results.

The laser burn pattern on the Aquadag(R) coated paper is shown in Fig. 9

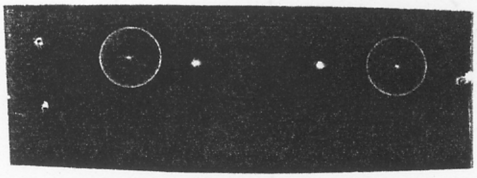

Fig.9 The laser burn pattern

The rough measure of energy variation over beam cross-section is obtained by scanning the thermopile side y relatively to the beam. The result is shown in Fig. 10

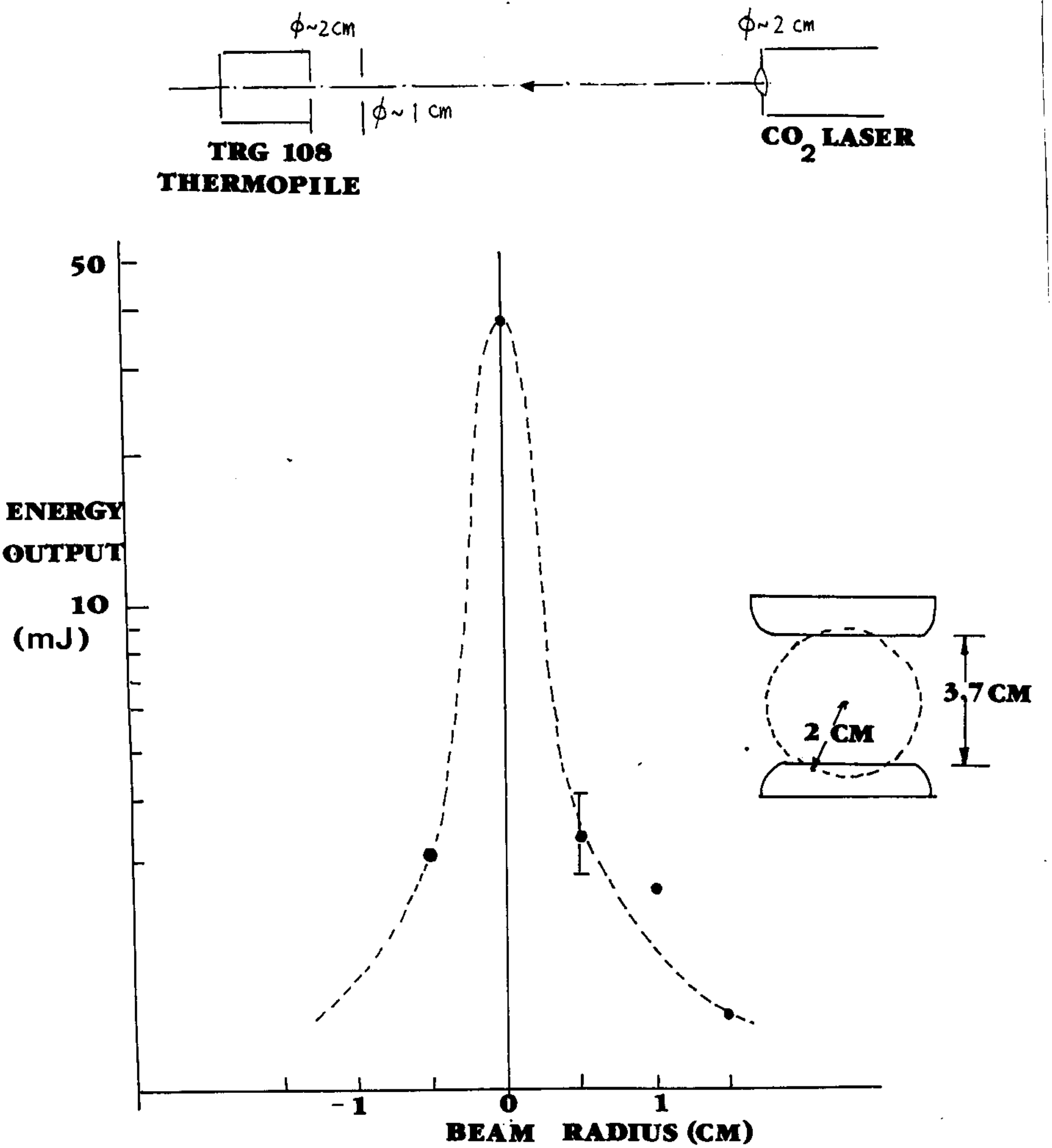

Fig. 10 Variation of the laser energy across the beam