Laser Scalpels

Another use of focussed lasers is their deployment as highly focussed and intense scalpels. Such a focussed laser can generate cavitation in a highly select region. Known as *photodisruption*, the focused laser light creates cavitation bubbles that cut through tissue and thus generate precise microscopic incisions that are of great potential value in many surgical procedures. Known as *light scalpels*, Nd:YAG laser pulses have, for example, become a well-established tool in non-invasive intraocular surgery (Vogel *et al.* (1996), Steiner (1998), Krishnamurthy and Powers (1994), Choy (1998), Ibsen *et al.* (2013)).

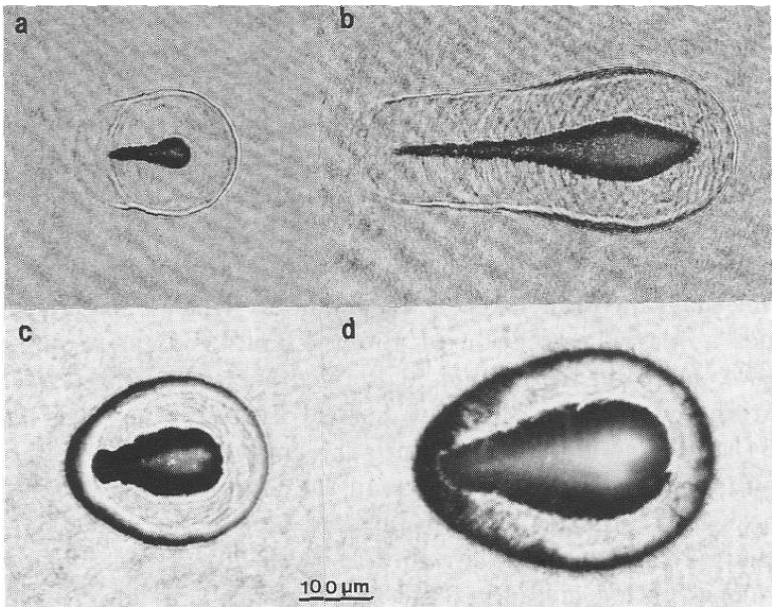

Figure 1: Shockwaves and bubbles formed at the focal point by picosecond laser pulses (a and b) and by nanosecond pulses (c and d). Beam coming from right. From Vogel *et al.* (1996).

The key to these tools is to produce repetitive, low energy pulses that have a very small damage range and thus limit undesirable collateral damage. As Vogel and his co-workers have demonstrated (see, for example, Choy (1998), Ibsen *et al.* (2013)), the extent of the damage is proportional to the cube root of the pulse energy, and therefore the objective is to use the lowest energy laser pulse that still causes cavitation. Vogel *et al.* (1996) have shown that this can be achieved by reducing the duration of the laser pulses and that picosecond pulses are therefore superior to nanosecond pulses. Some of their photographs are reproduced in figure 1; each frame shows the extent of both the shock wave associated with the initiation of cavitation and, inside that, the cavitation bubble itself. The laser pulse is arriving from the right and the shape is of the images is, in part, determined by the shape of the focal volume.