Principles of Lasers

Module 1-6

of

Course 1, *Fundamentals of Light and Lasers*

OP-TEC

National Center for Optics and Photonics Education

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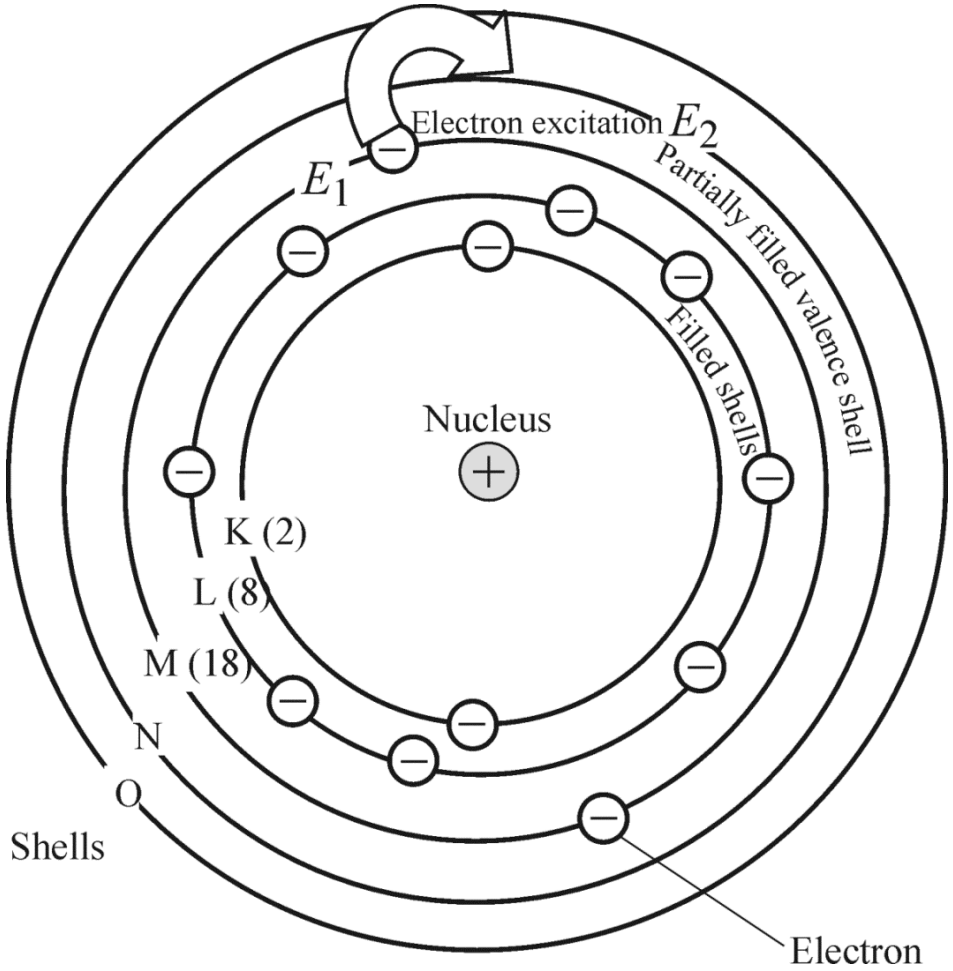
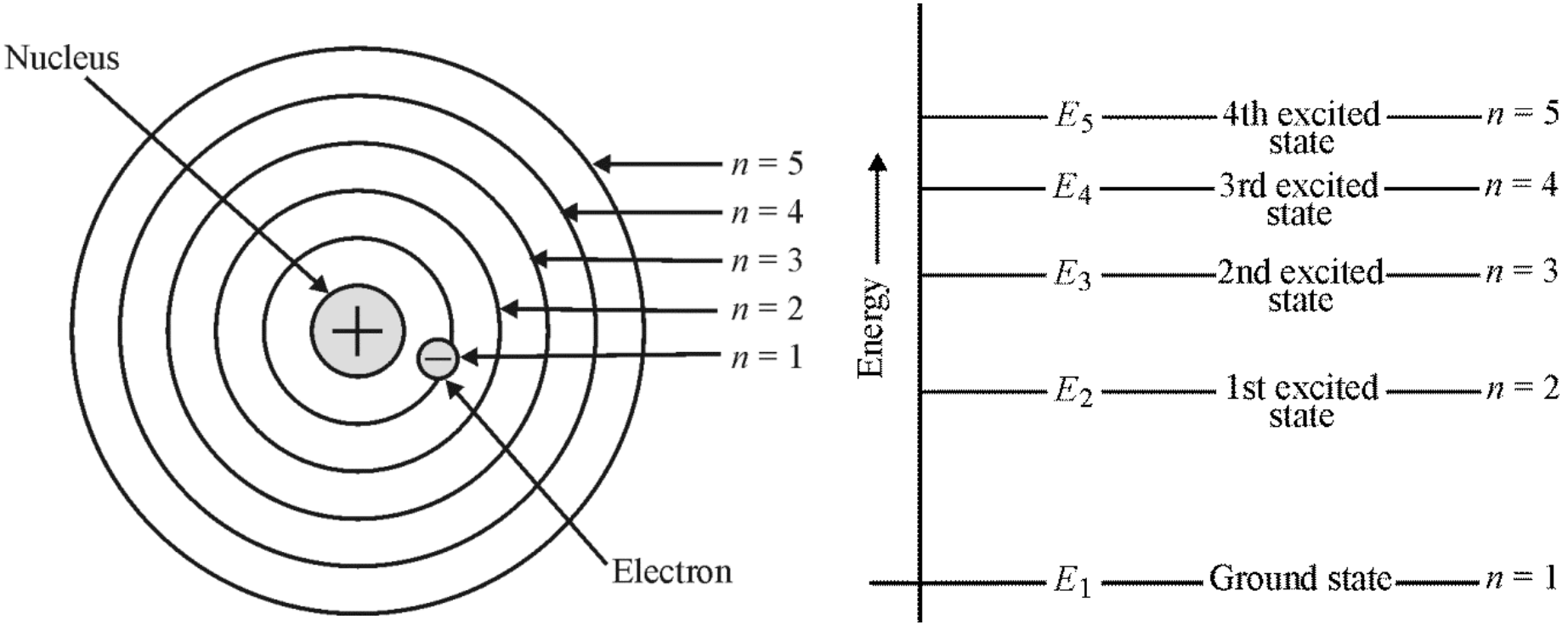


Figure 6-1 *A model of the atom based on Bohr's theory of atomic structure. The model shows five shells (K,L,M,N,O) that can be filled with electrons. The electrons in the shells move around the positive nucleus.*



(a) Hydrogen atom with allowable electron orbits showing electron in the innermost orbit — the lowest energy level

(b) Ground state energy level and first four excited energy states for a hydrogen atom

Figure 6-2 *Bohr electron orbits and corresponding energy levels for a hydrogen atom*

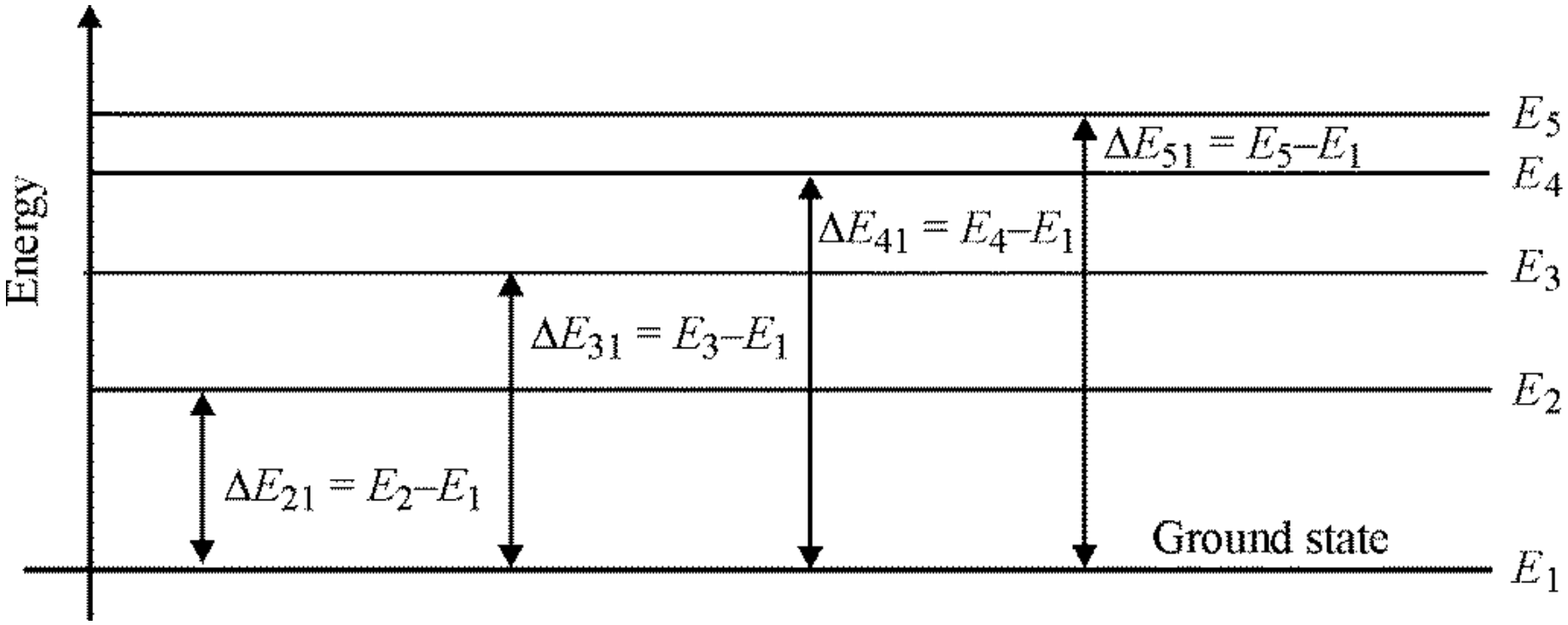


Figure 6-3 *Allowable amounts of energy that can be absorbed or emitted by a hydrogen atom in certain energy states*

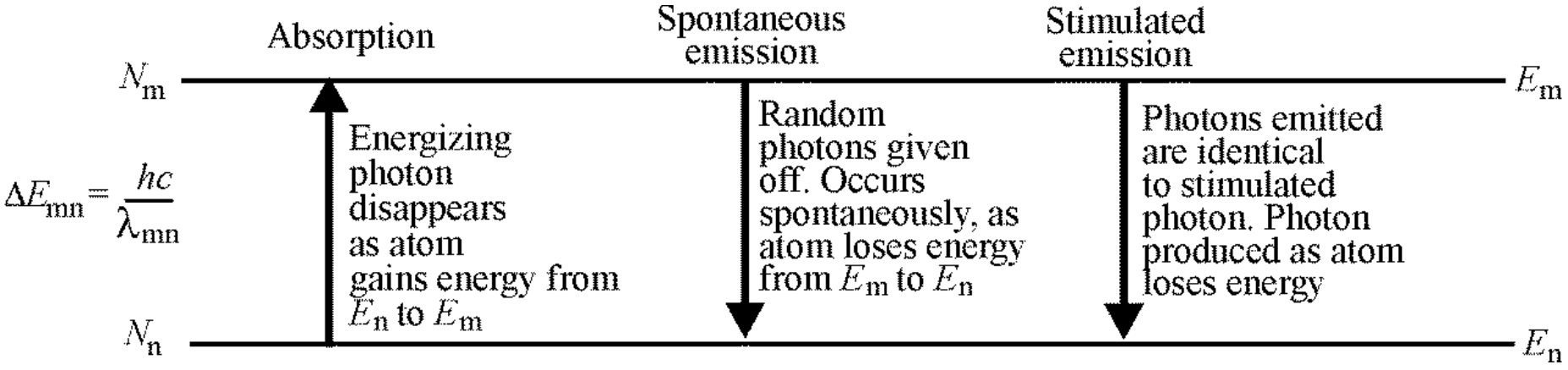


Figure 6-4 *Three radiative processes that involve photons and atoms and how they affect the populations N_m and N_n of two energy levels E_m and E_n*

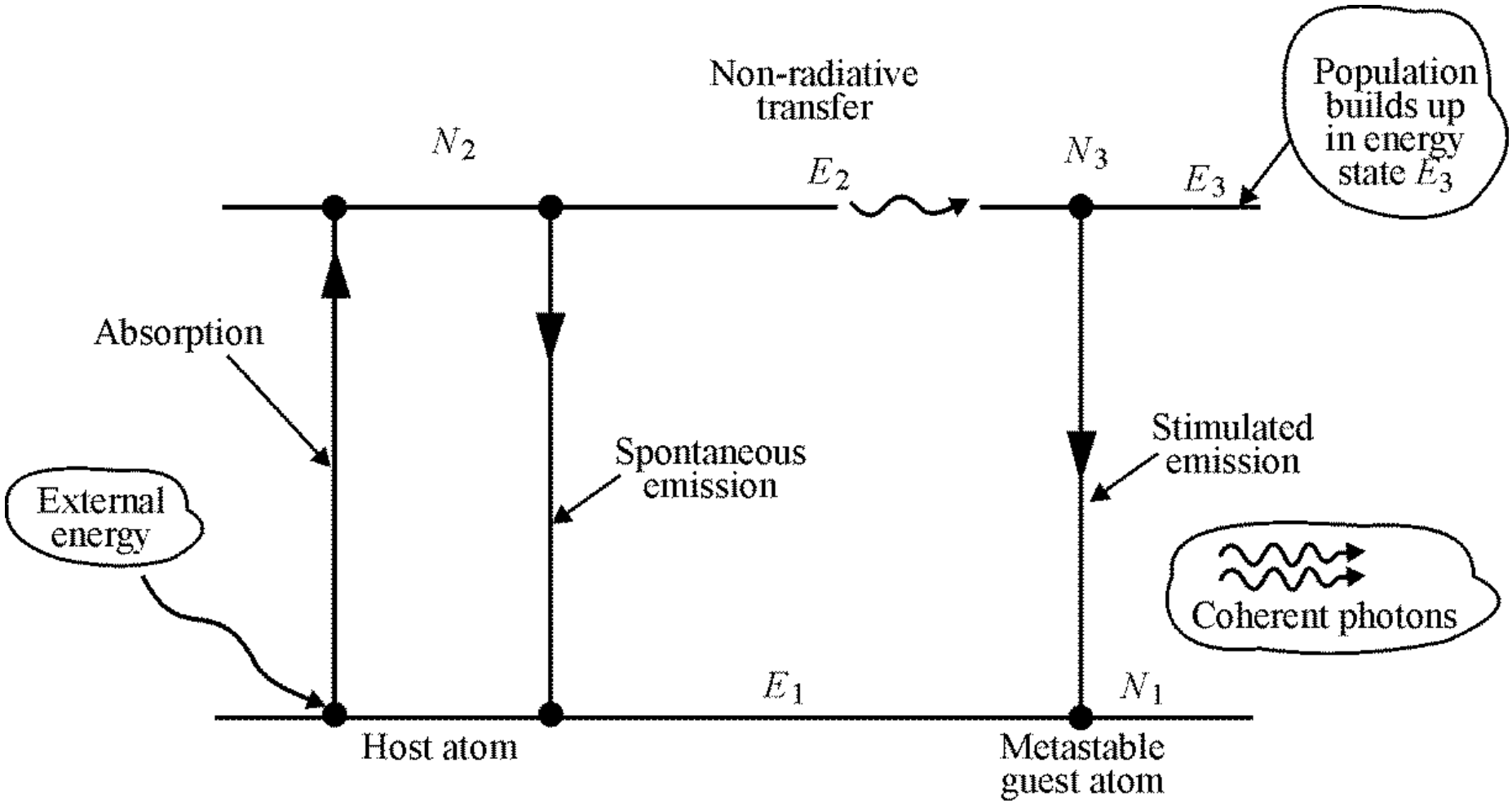


Figure 6-5 *Energy level diagram showing the process for producing a population inversion and the subsequent creation of coherent photons*

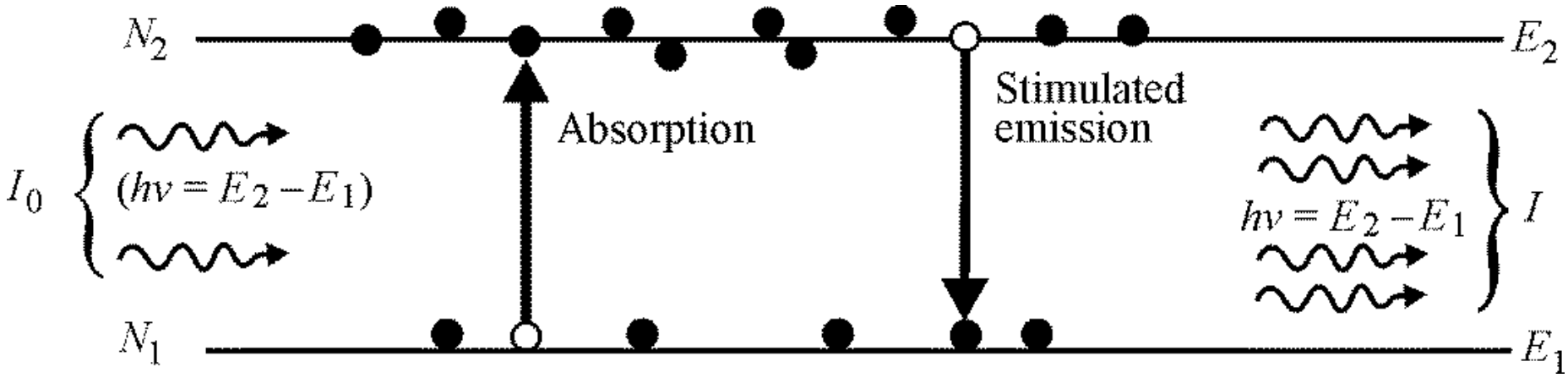


Figure 6-6 *Two-level atom with a population inversion $N_2 > N_1$, showing both absorption and stimulated emission. Initial beam intensity, I_0, is amplified, thereby making I greater than I_0.*

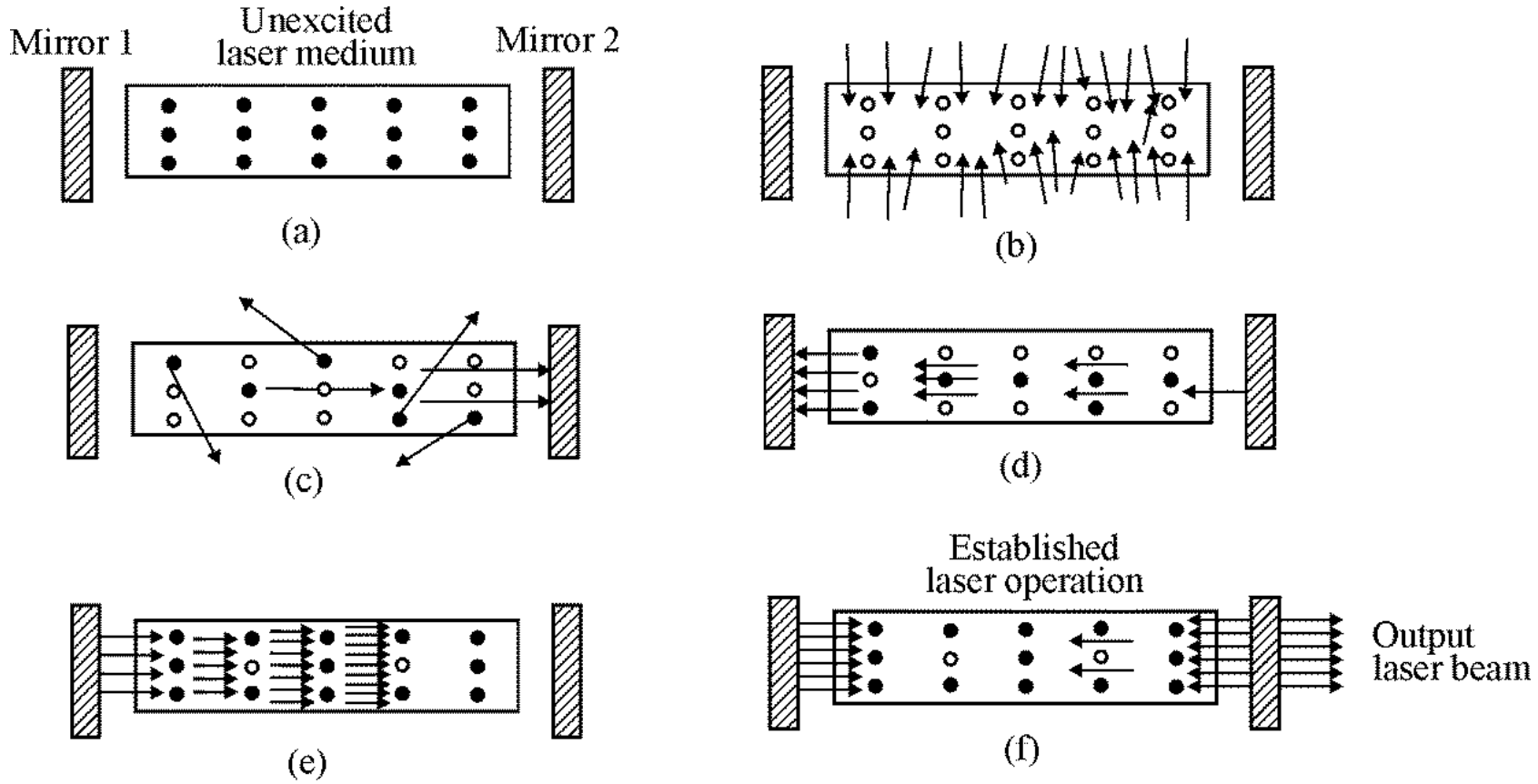


Figure 6-7 *Step-by-step development of laser oscillation in a typical laser cavity: (a) unexcited laser medium; (b) pumping of laser medium; (c) spontaneous and stimulated emission; (d) light amplification begins; (e) light amplification continues; (f) established laser operation*

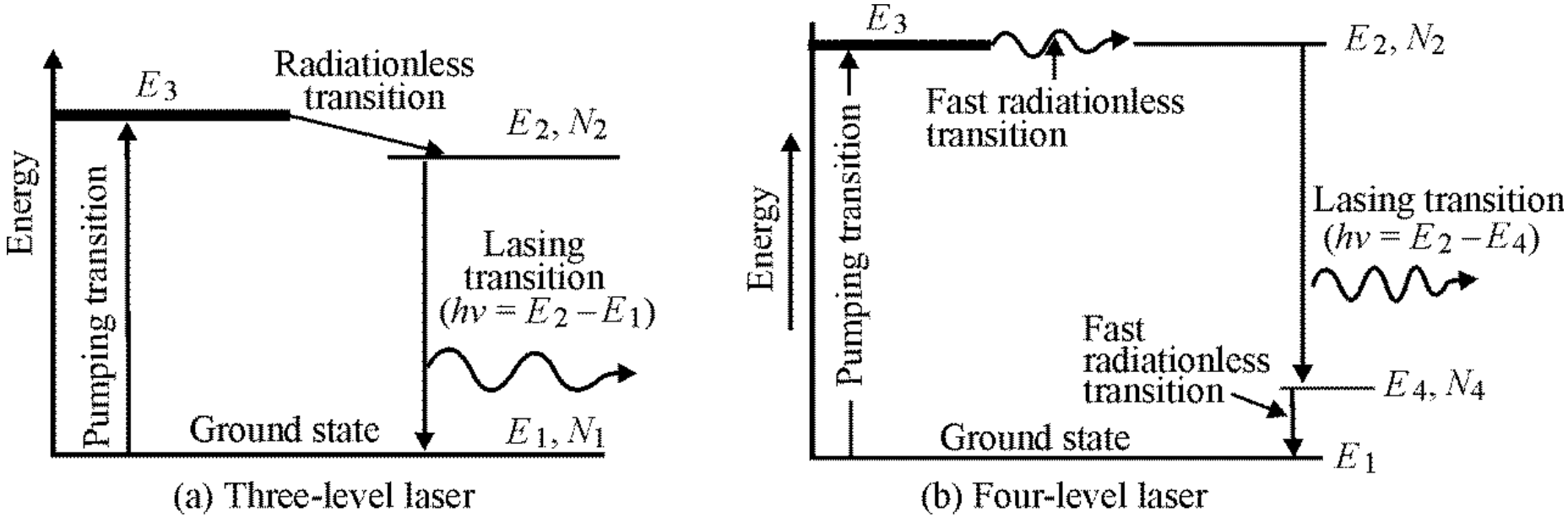


Figure 6-8 *Energy level diagrams for three-level and four-level lasers*

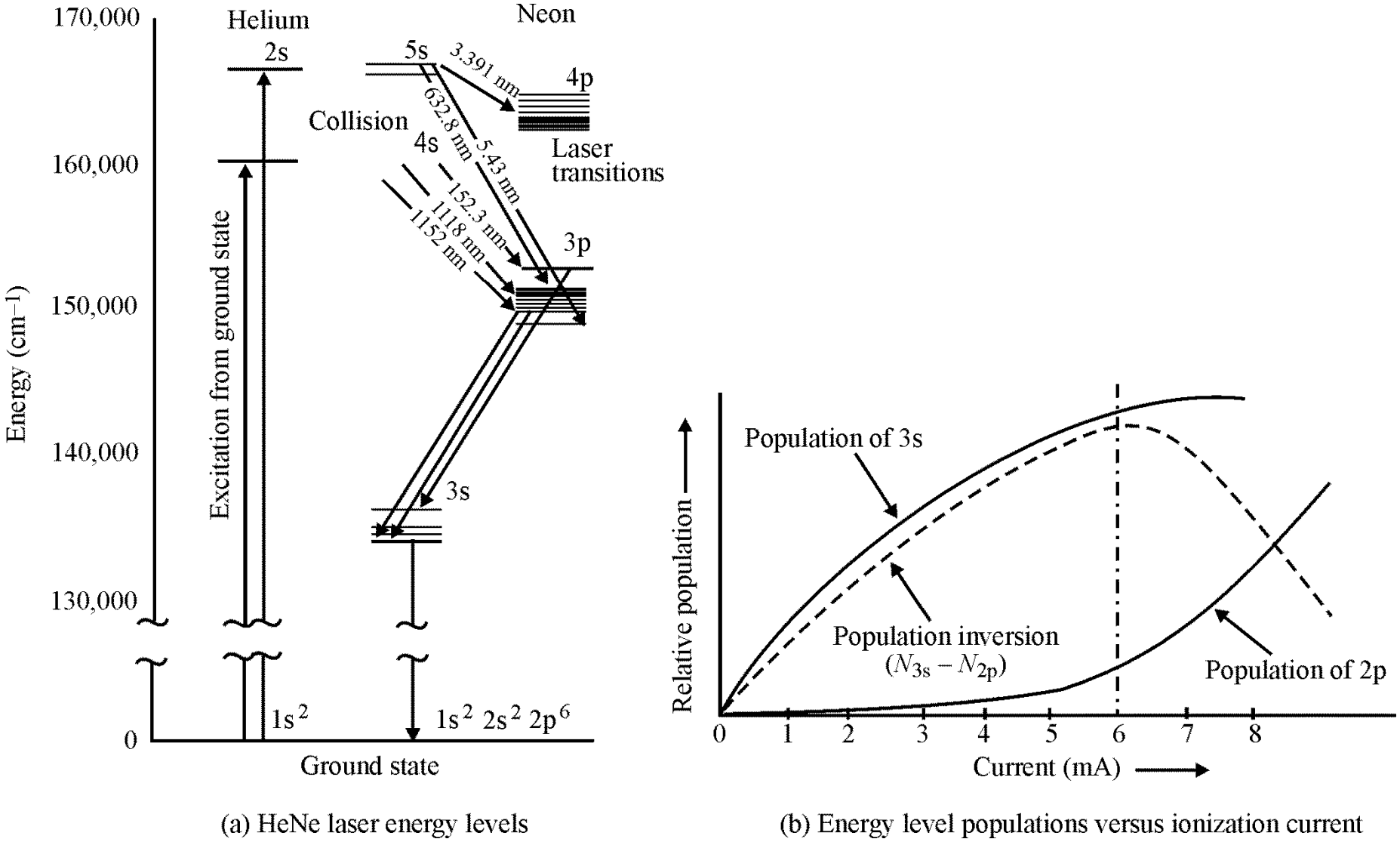


Figure 6-9 *(a) Simplified energy level diagram for a HeNe laser and (b) effect of increasing ionization current on output power*

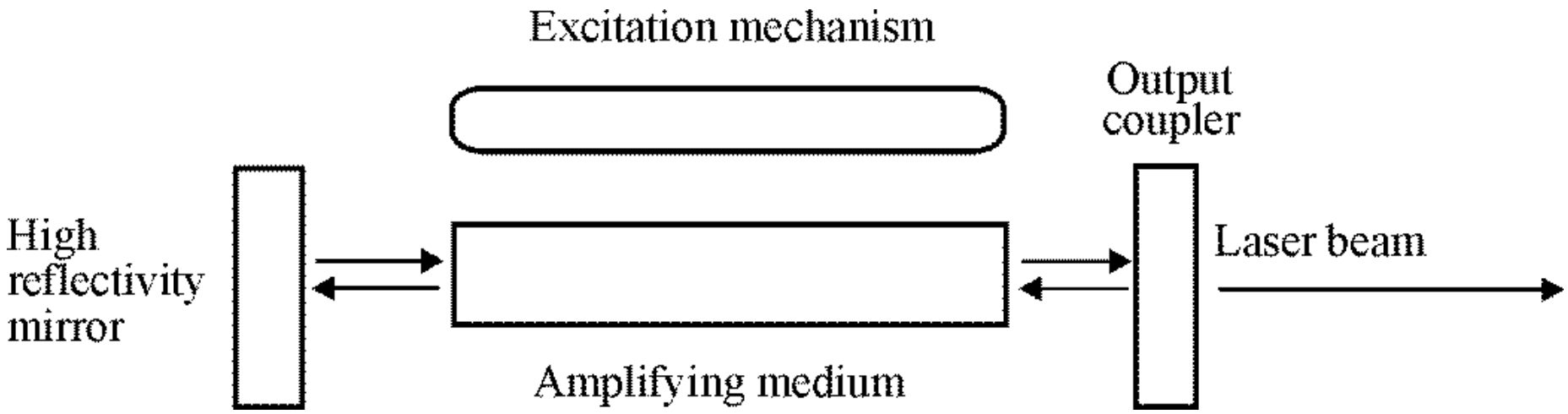


Figure 6-10 *Schematic diagram showing the basic structure of a laser*

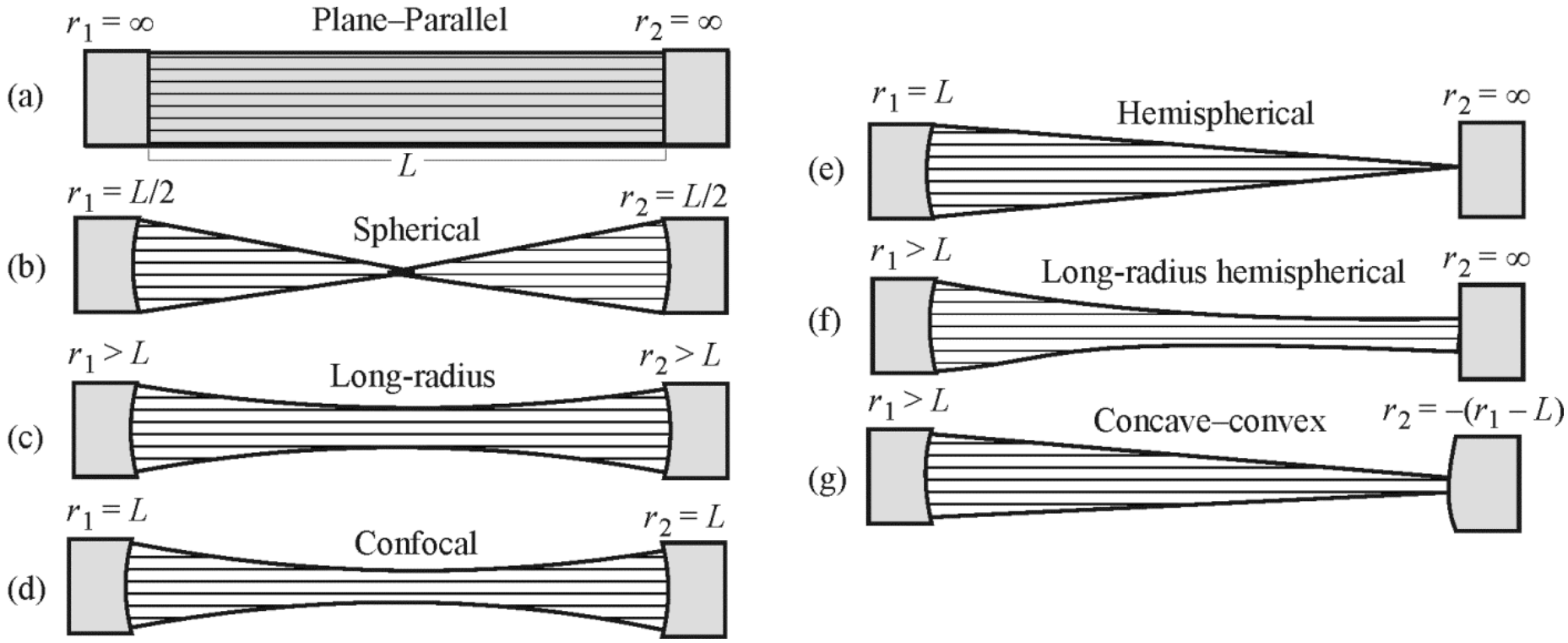


Figure 6-11 *Different cavity configurations used in lasers*

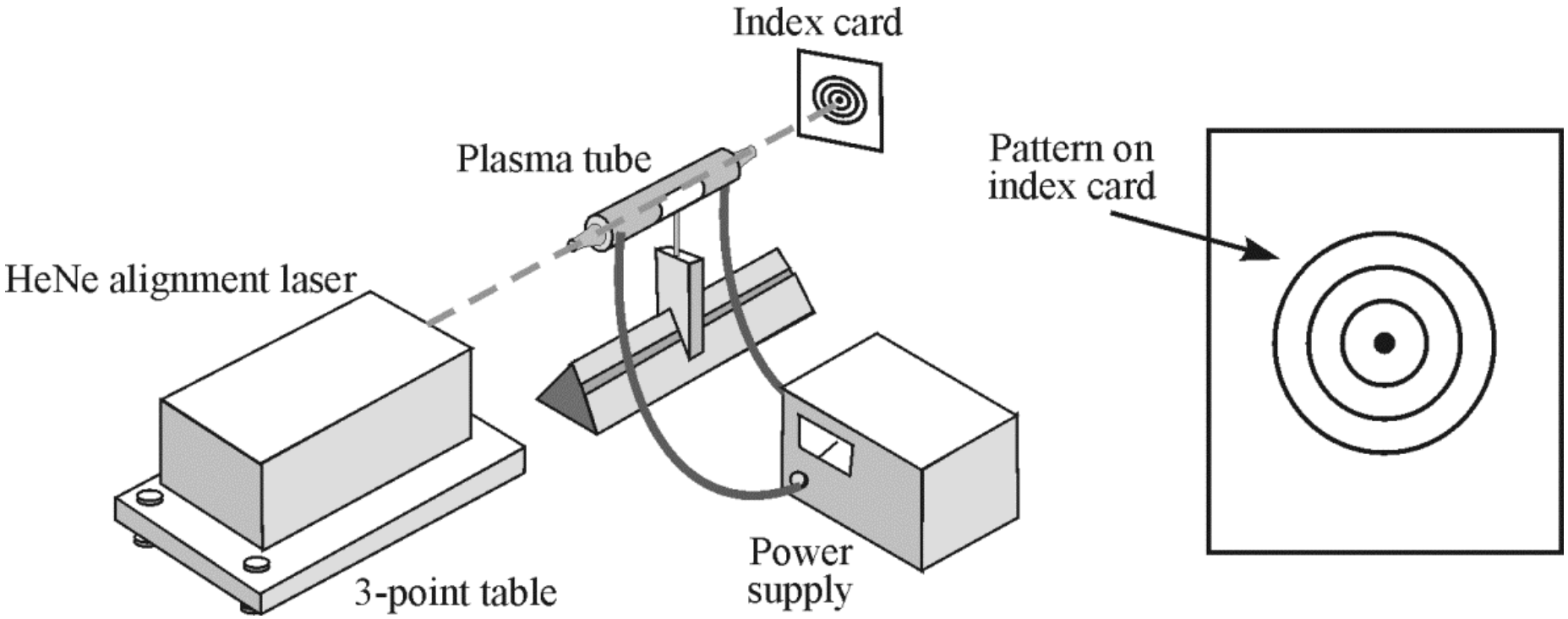


Figure 6-12 *Initial setup for alignment*

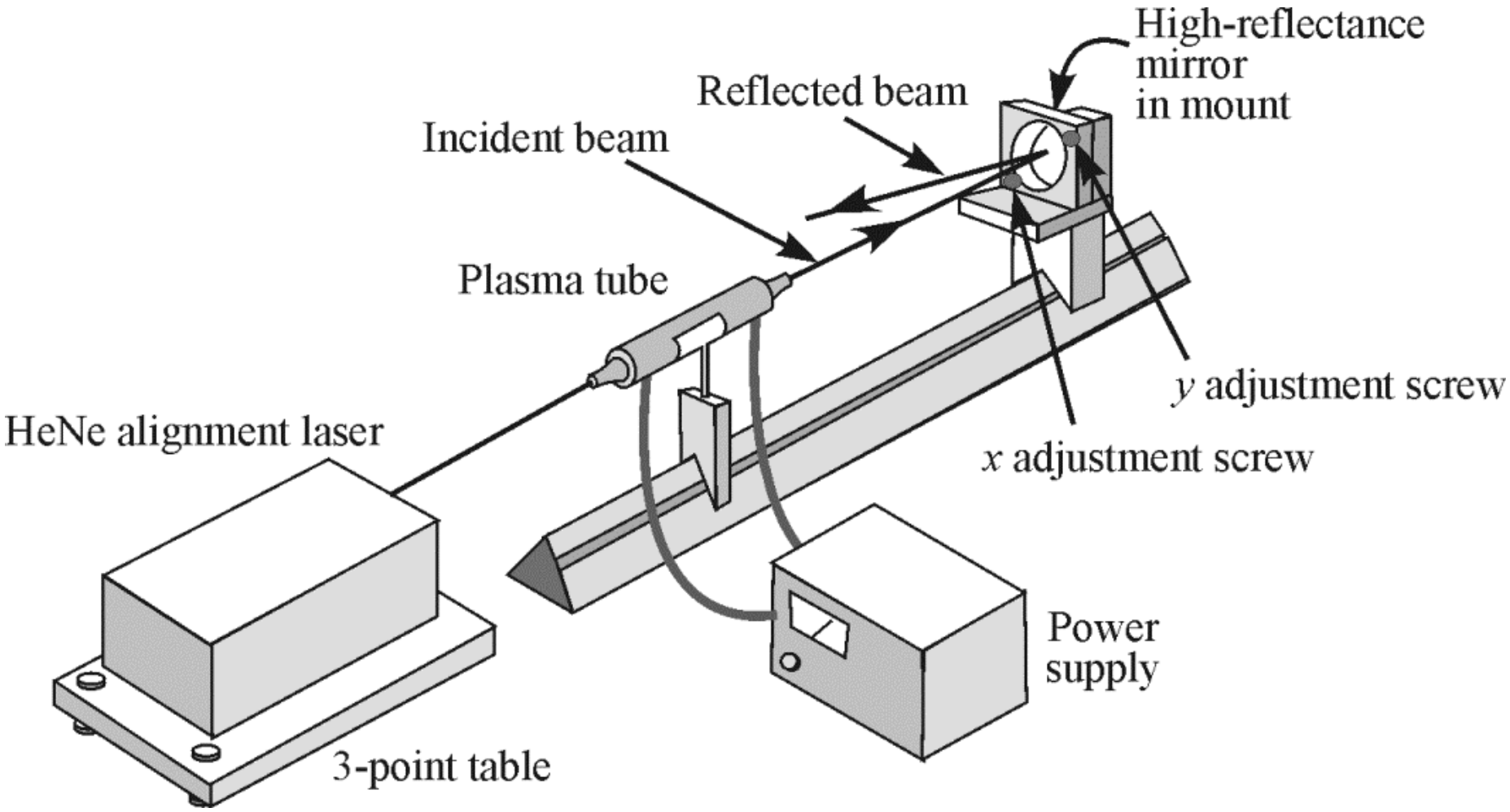


Figure 6-13 *Initial alignment of HR mirror*

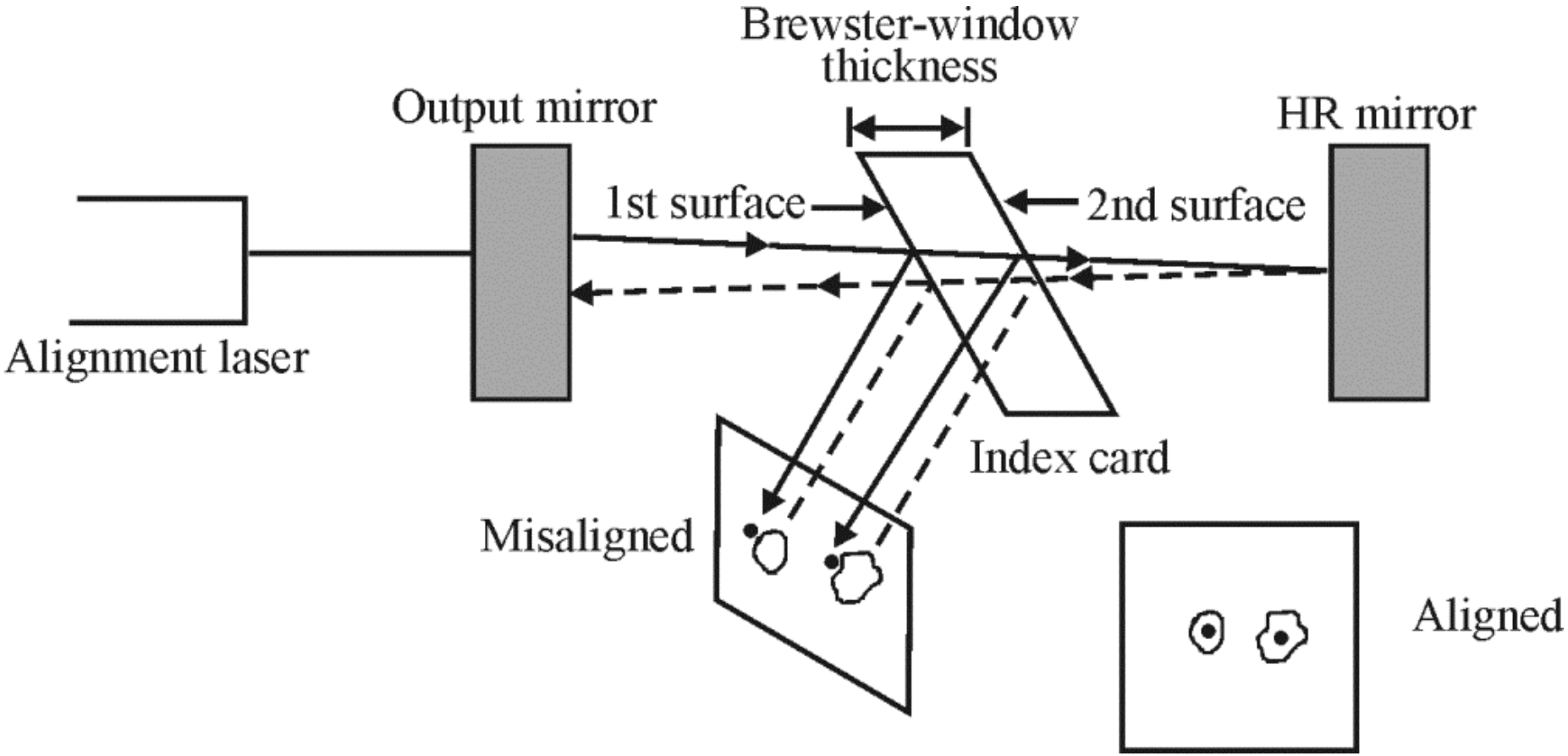


Figure 6-14 *Final alignment of HR mirror*

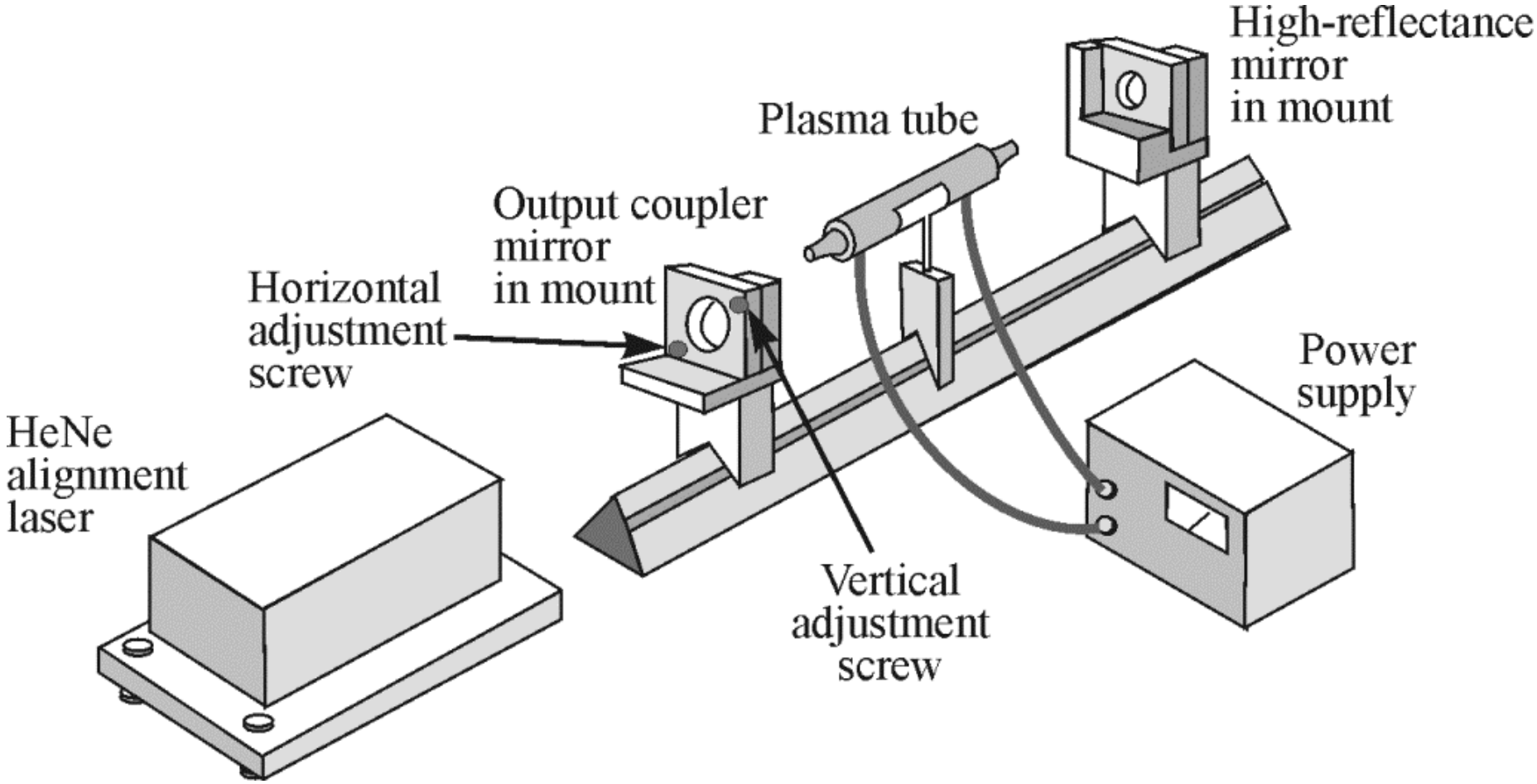


Figure 6-15 *Alignment of the output mirror*

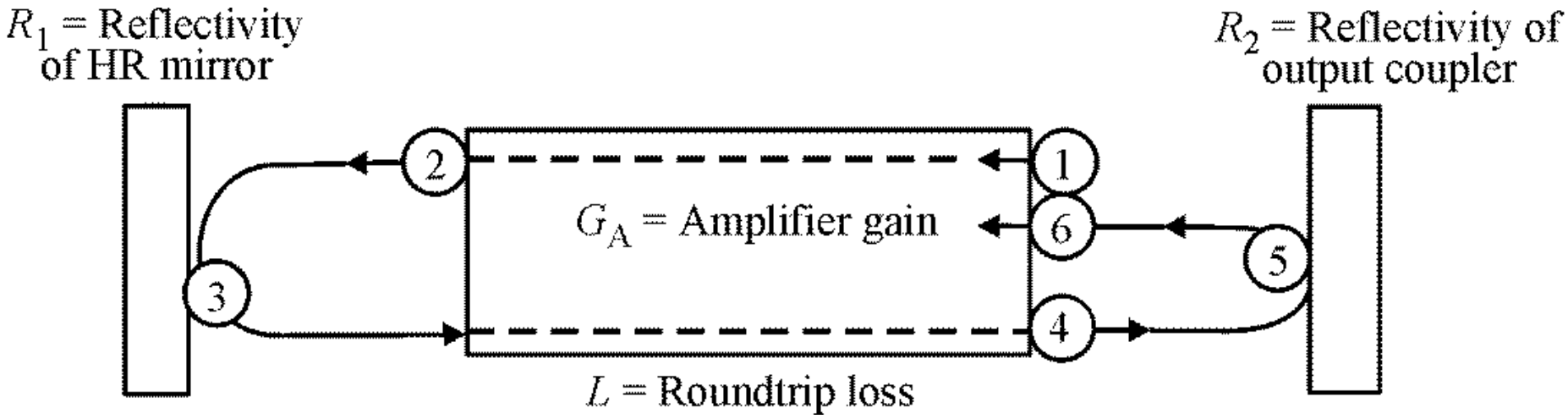


Figure 6-16 *Loop gain of a laser*

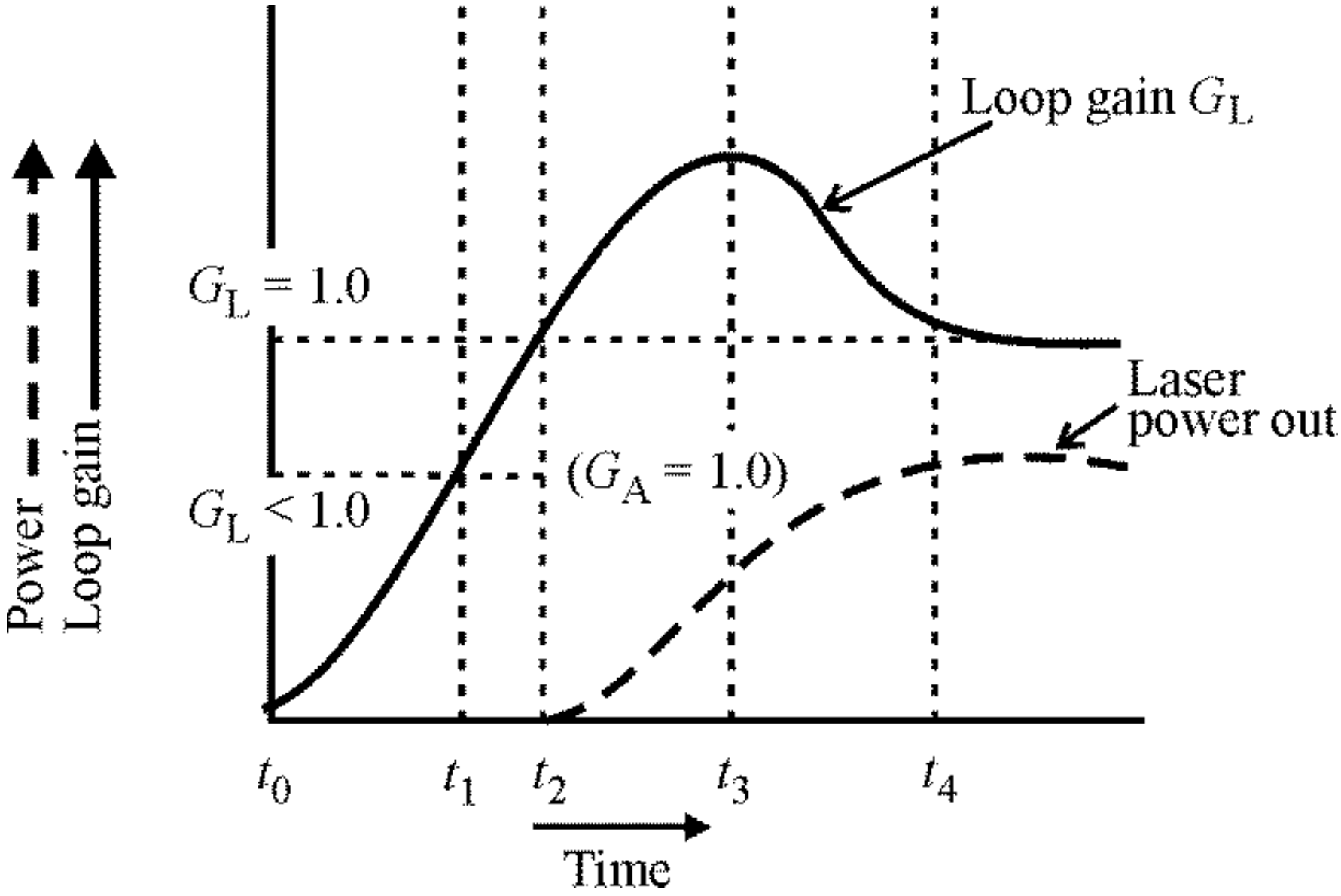


Figure 6-17 *Loop gain and output power in CW laser*

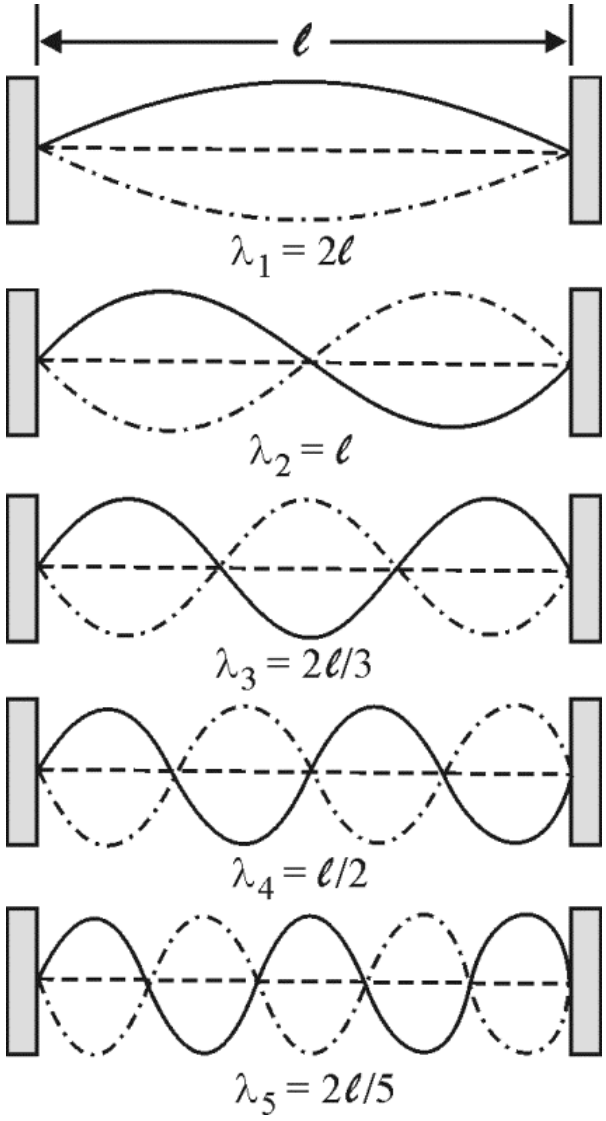


Figure 6-18 *Longitudinal modes as determined by standing waves set up between the cavity mirrors*

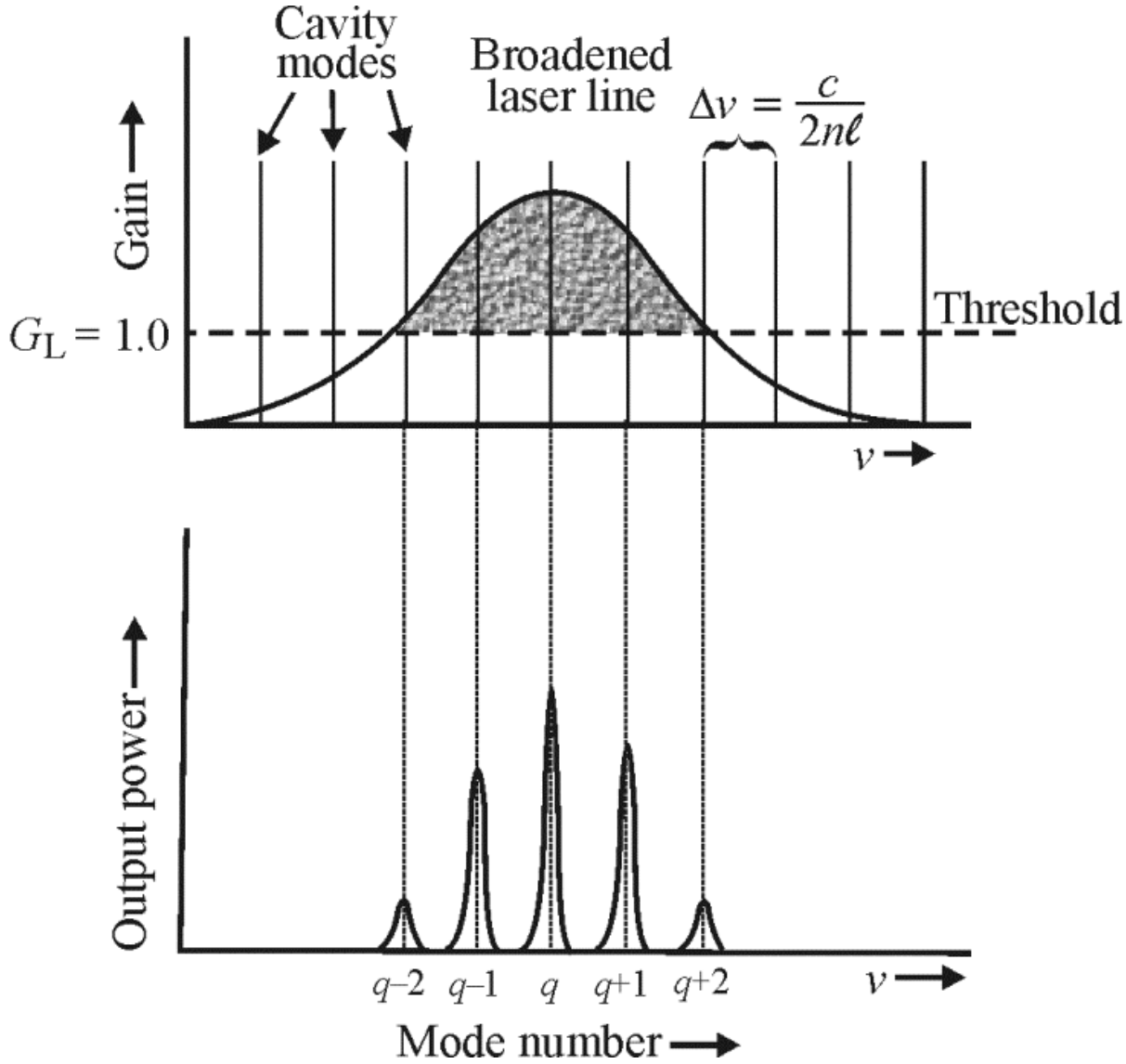


Figure 6-19 *Spectral distribution of laser output showing several longitudinal modes with various loop gains* G_L

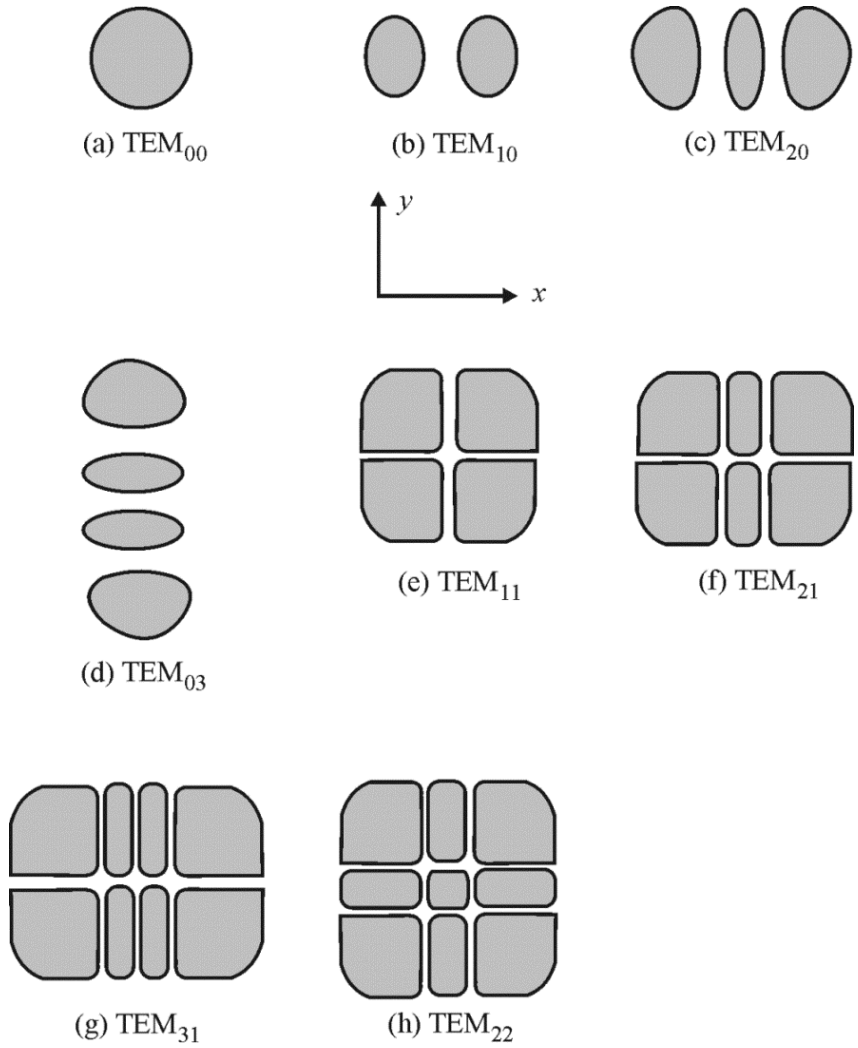


Figure 6-20 *Traverse electromagnetic modes of a laser beam. The "dark regions" are regions of high brightness; the "white" vertical and horizontal lines are regions of low or zero brightness.*

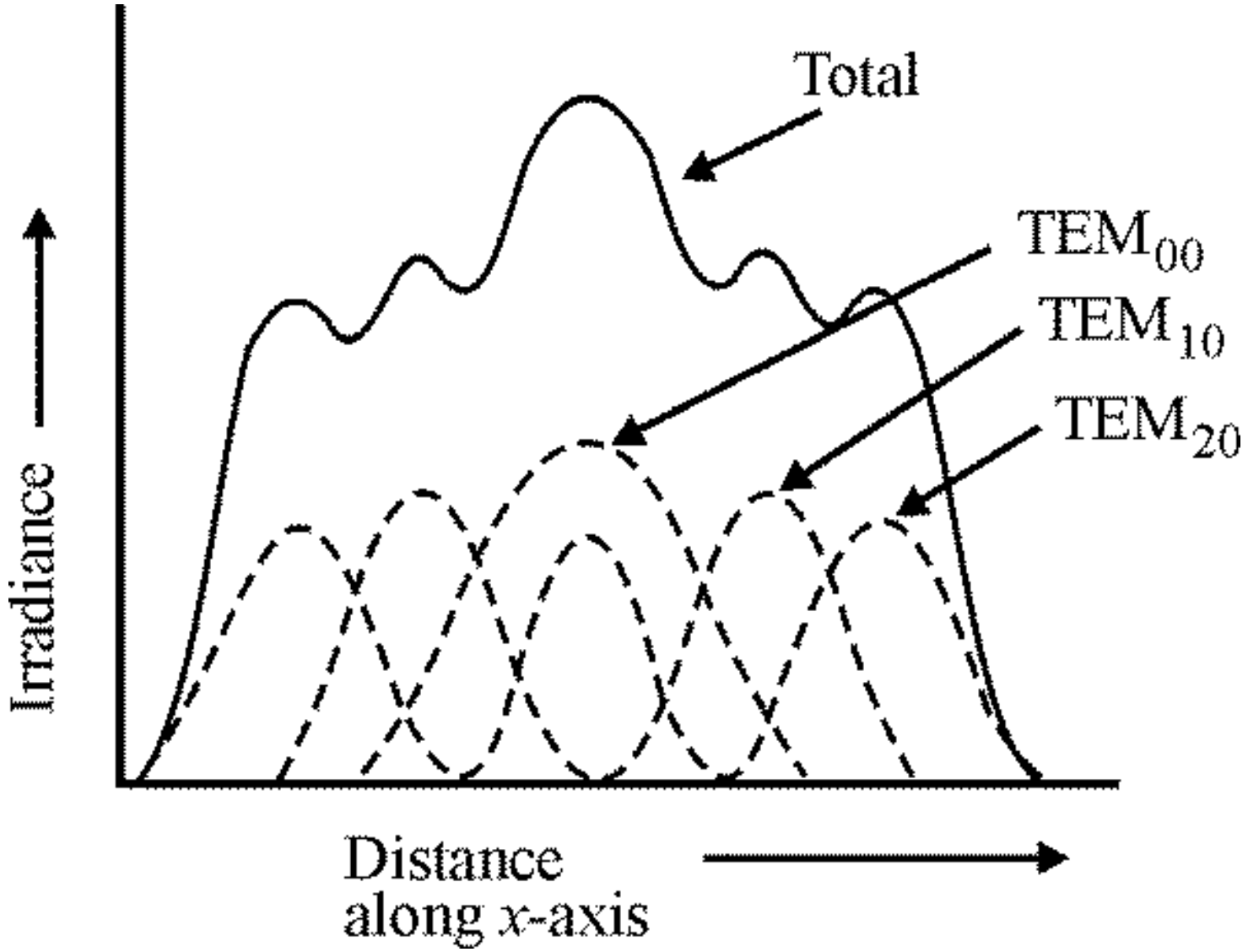


Figure 6-21 *Superposition of three transverse modes*

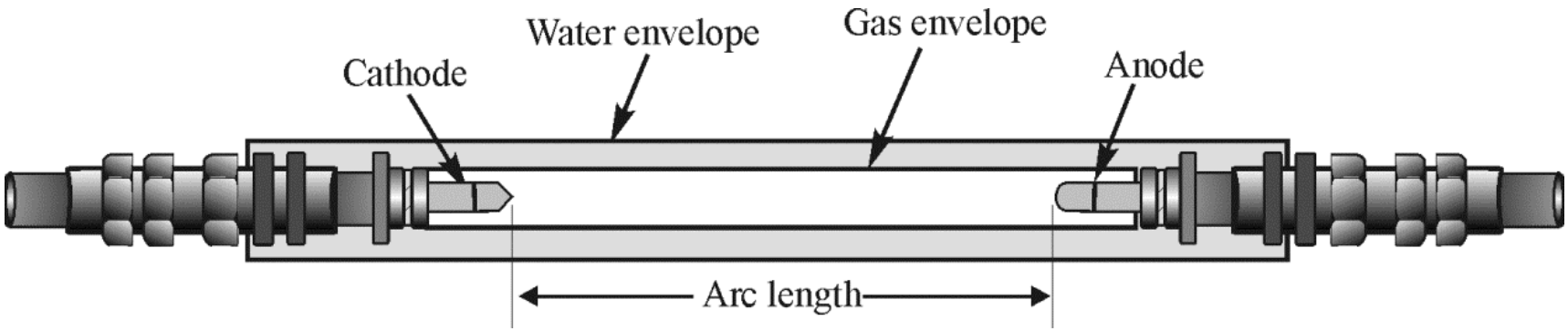


Figure 6-22 *Schematic diagram of a water-cooled flash lamp*

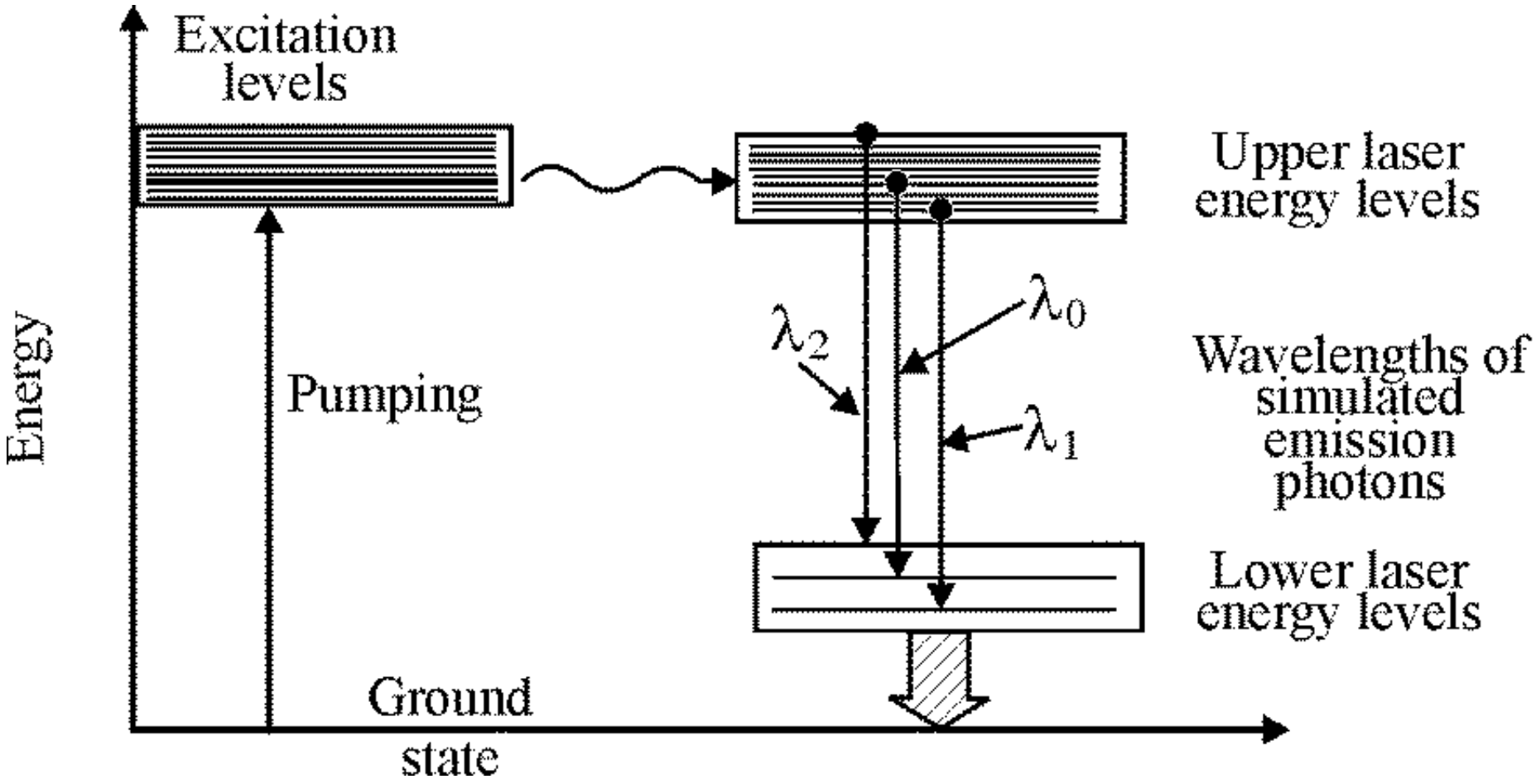


Figure 6-23 *Different wavelengths of photons produced by transitions of atoms between different energy positions in the broadened upper and lower energy levels*

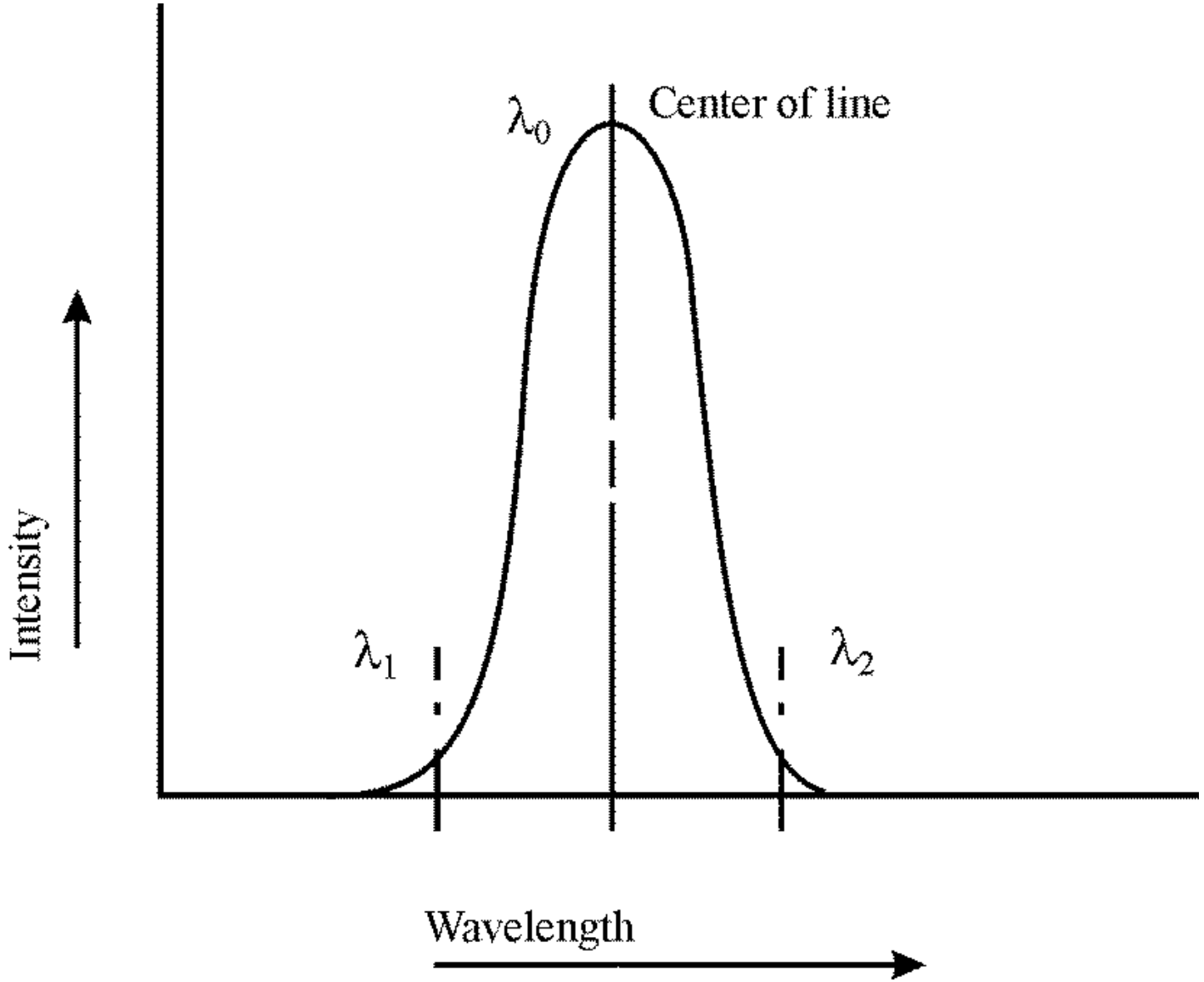


Figure 6-24 *A linewidth-broadened laser line*

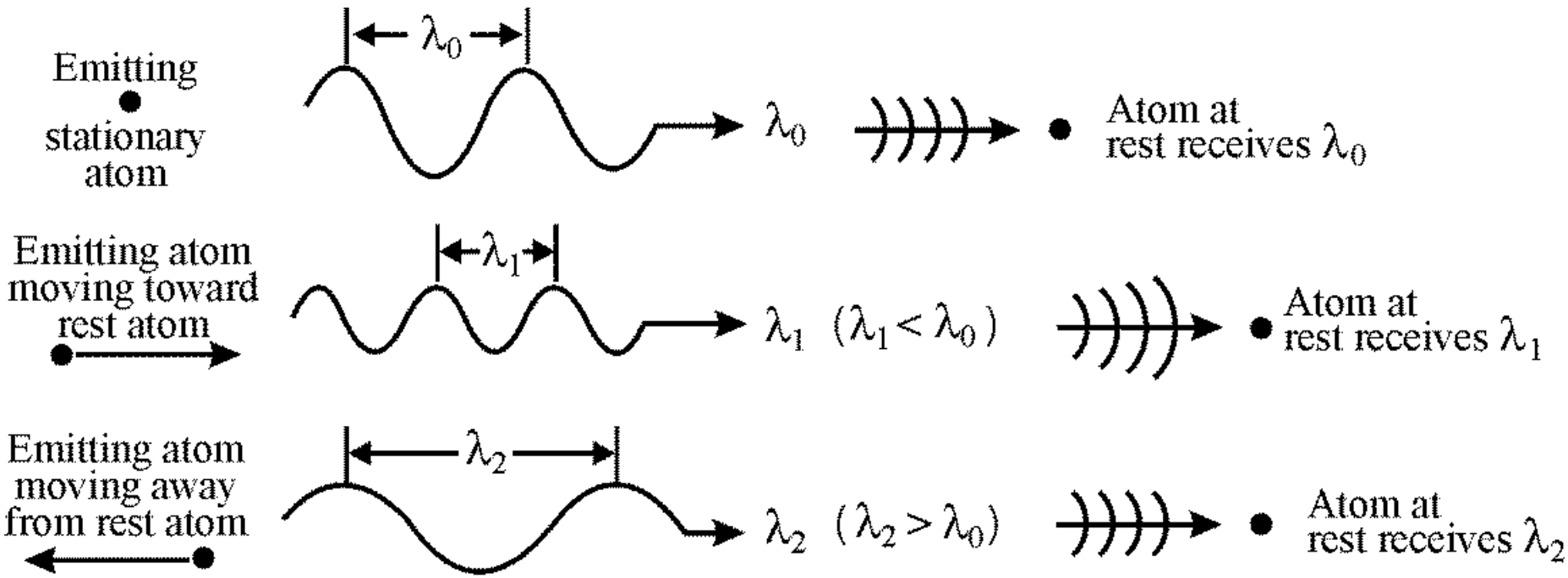


Figure 6-25 *Wavelength of a photon emitted by a stationary or moving atom as "seen" by an atom at rest*

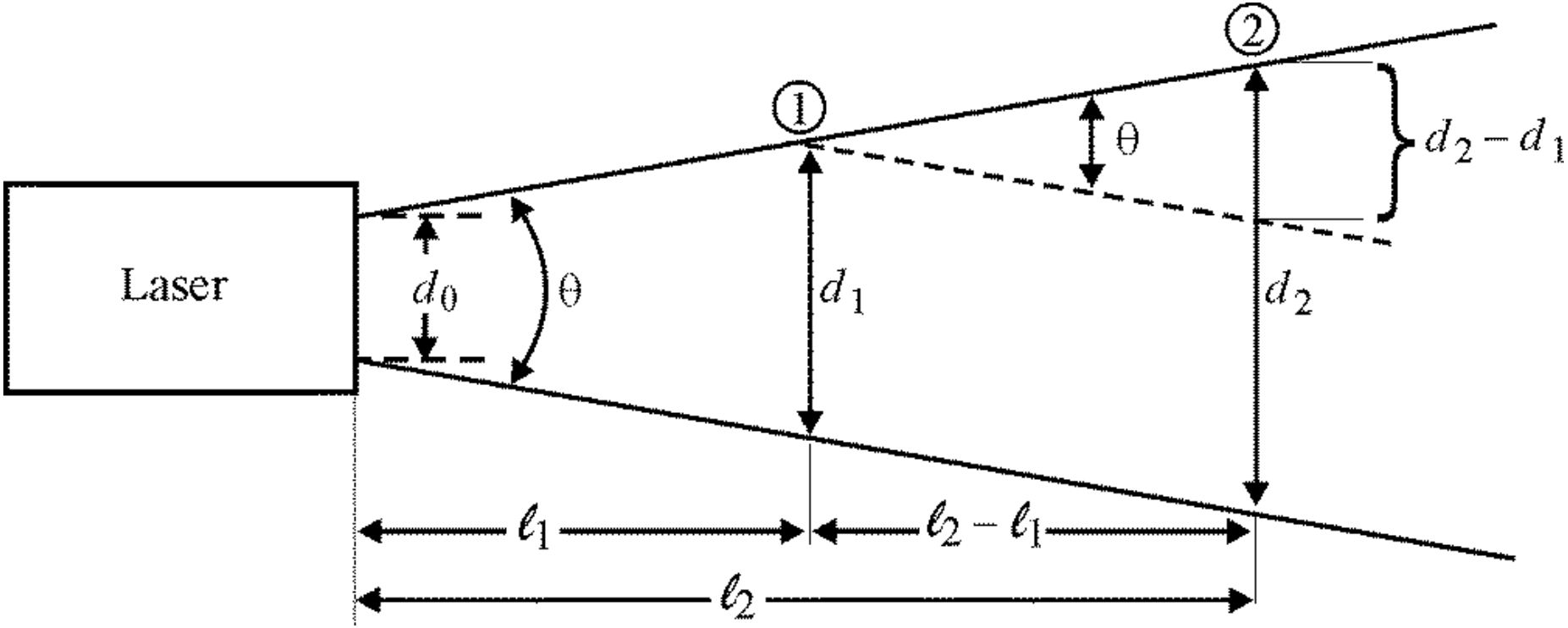


Figure 6-26 *Beam divergence of a laser beam*

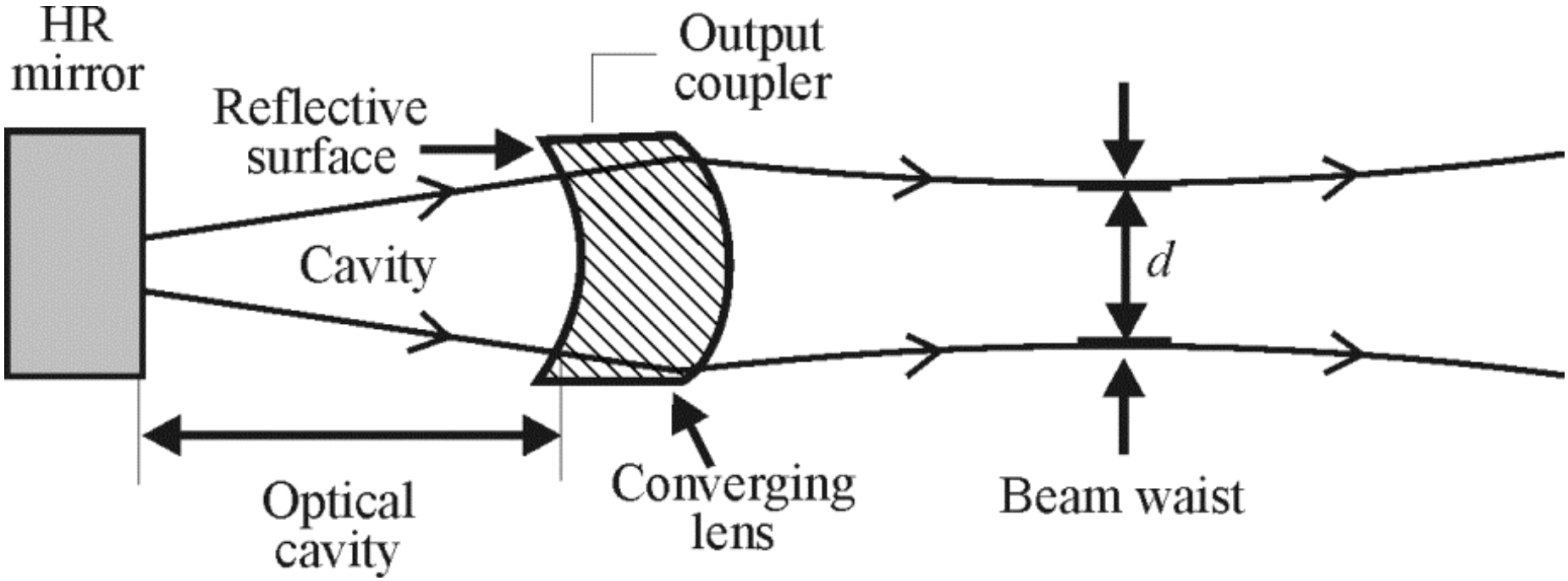


Figure 6-27 *Collimation of a laser beam by a mirror/lens output coupler*

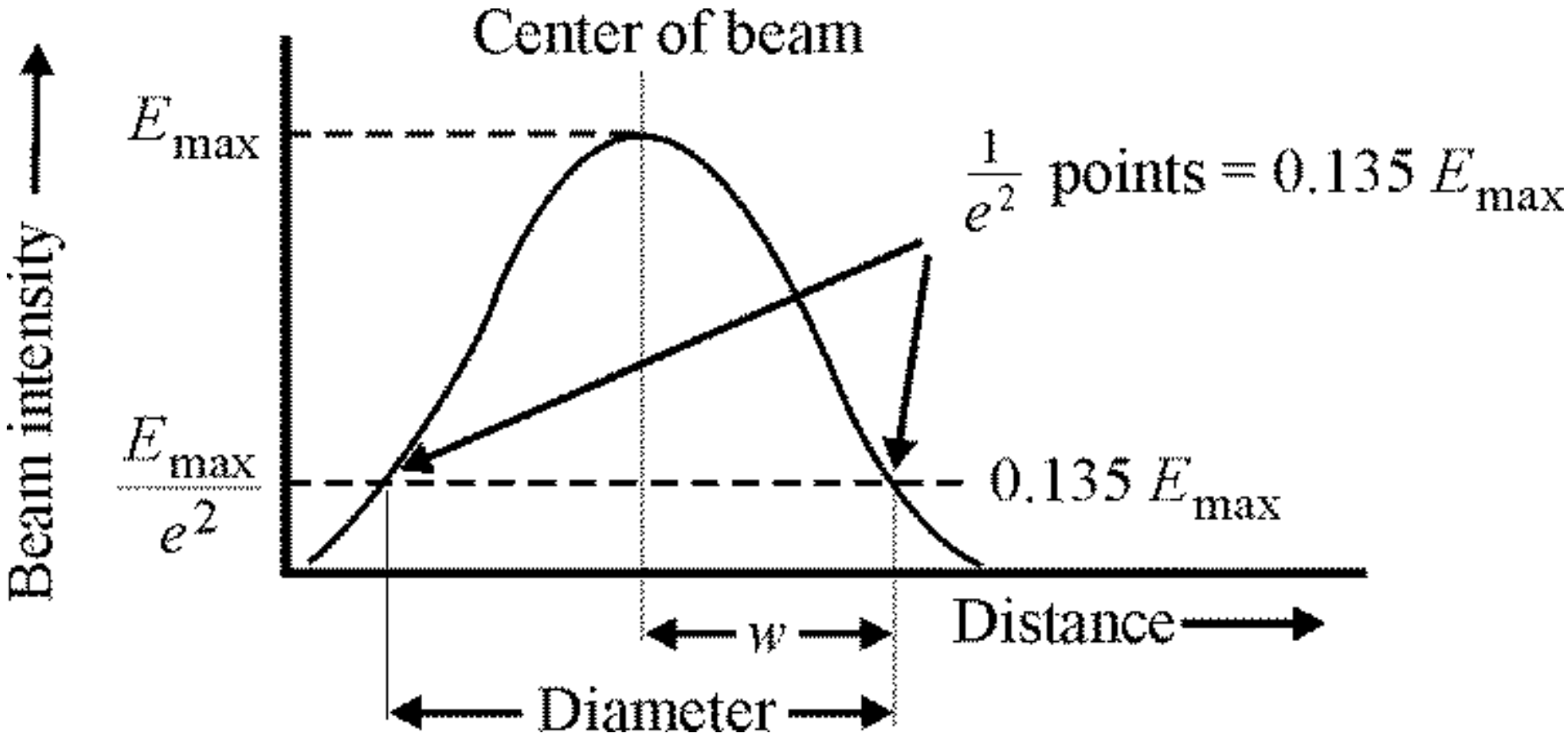


Figure 6-28 *Width of a TEM_{00} laser beam at the $1/e^2$ points*

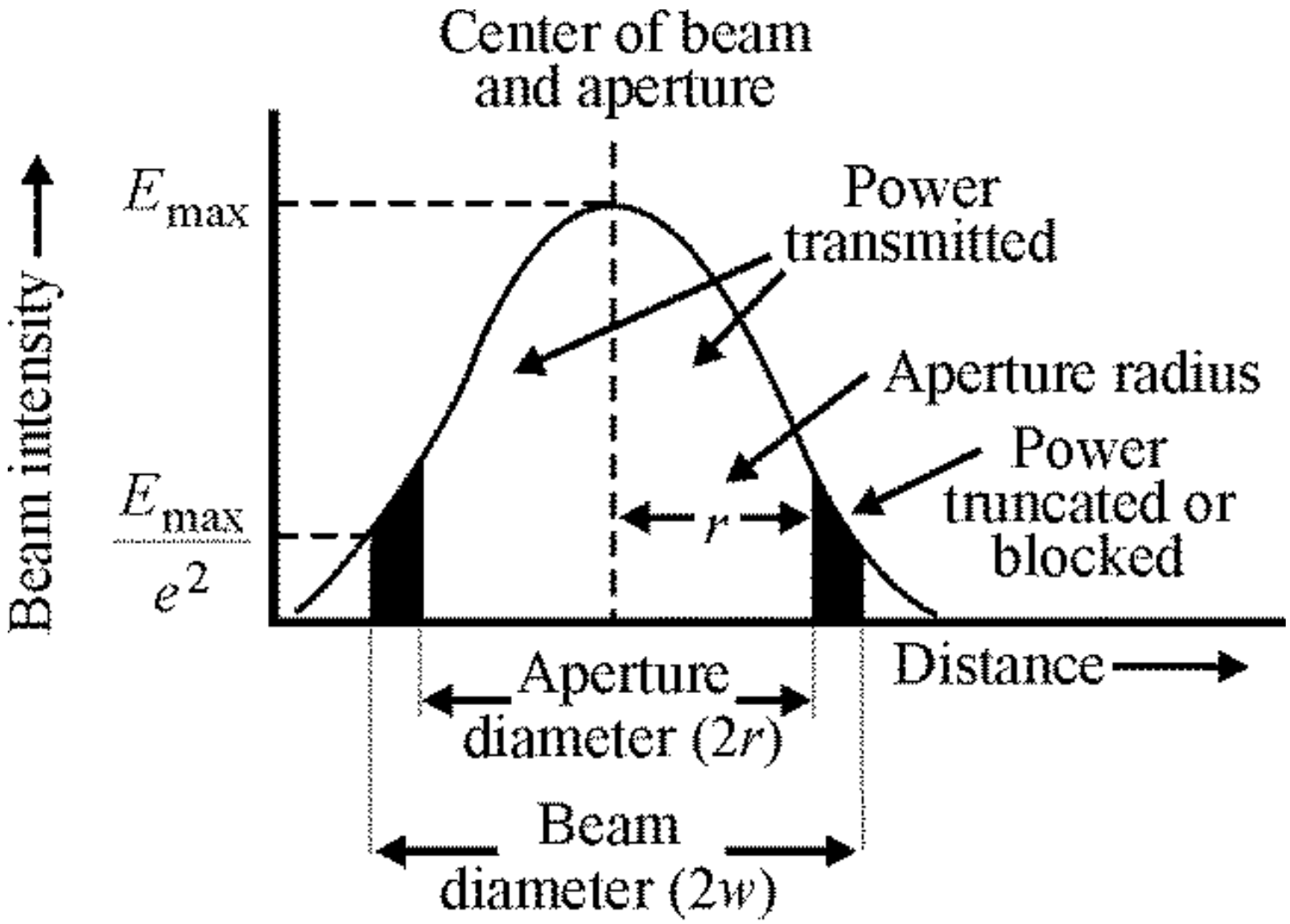


Figure 6-29 *Transmission of a TEM_{00} laser beam through an aperture smaller than the beam diameter.*

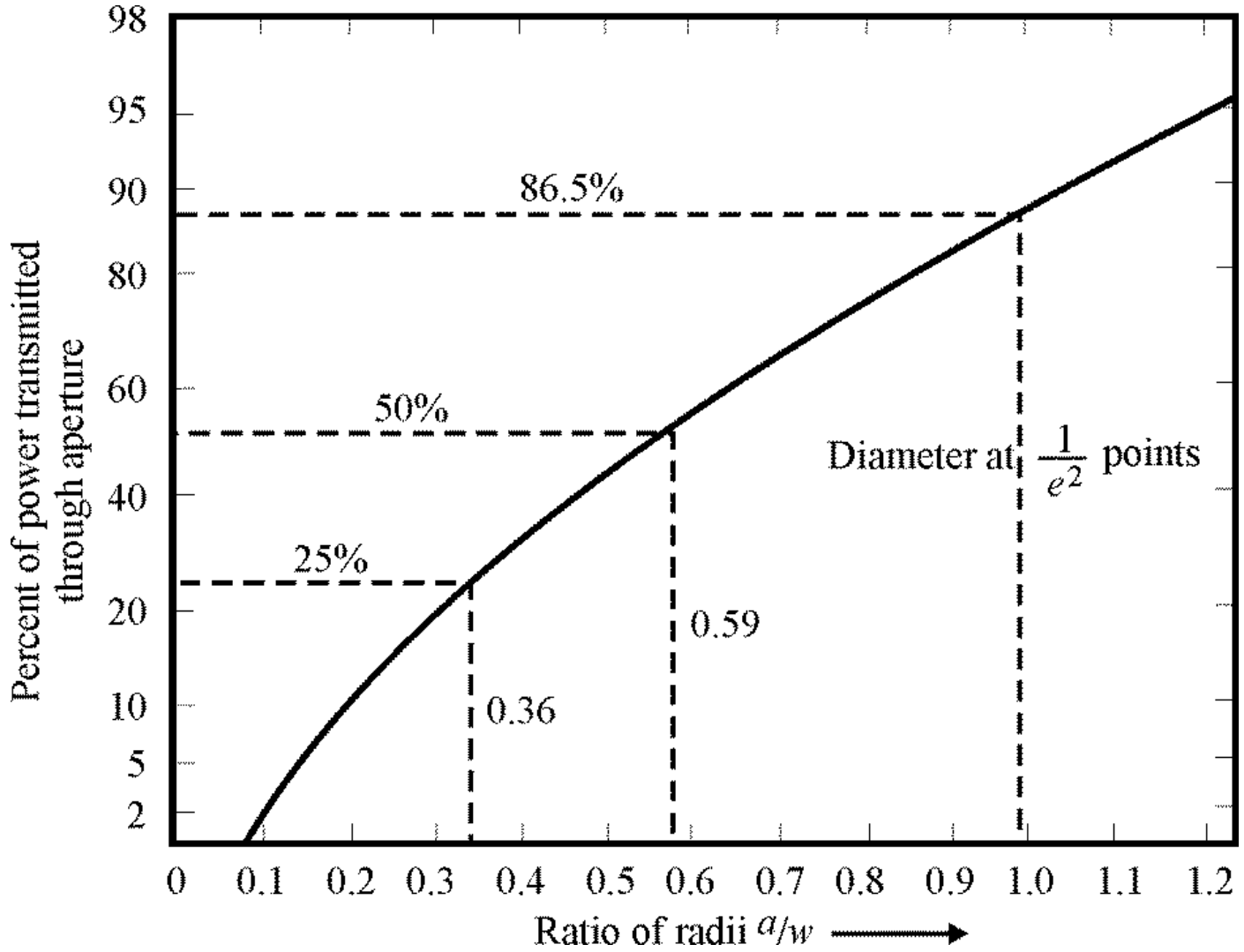


Figure 6-30 *Graph showing percent of beam power transmitted versus the ratio of aperture radius to beam radius for a* TEM_{00} *beam*

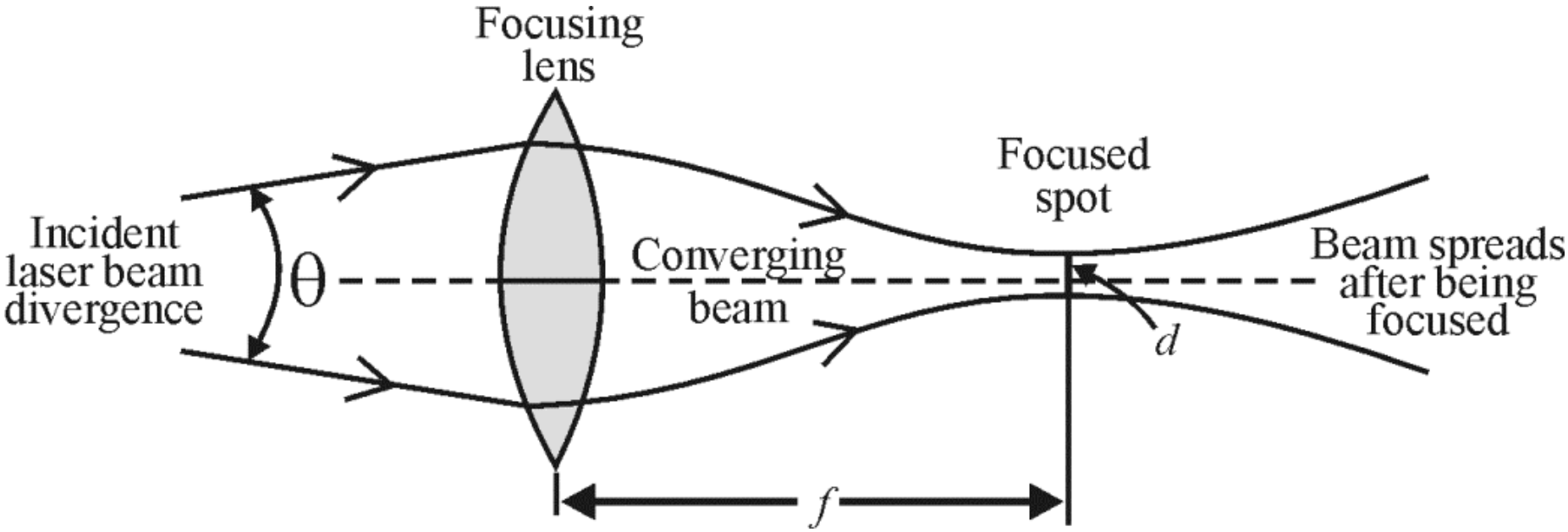


Figure 6-31 *Focusing a laser beam*

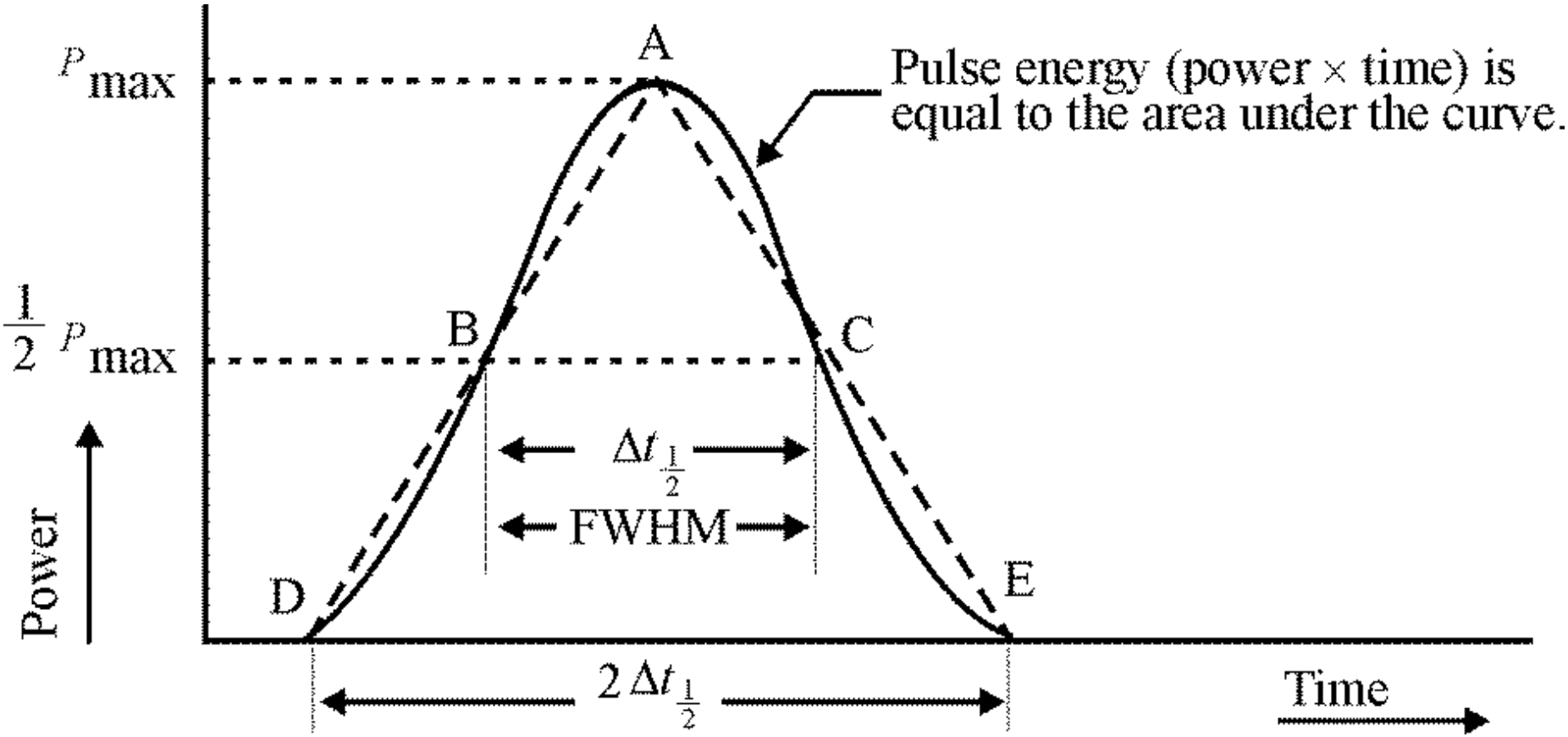


Figure 6-32 *Energy in a laser pulse*

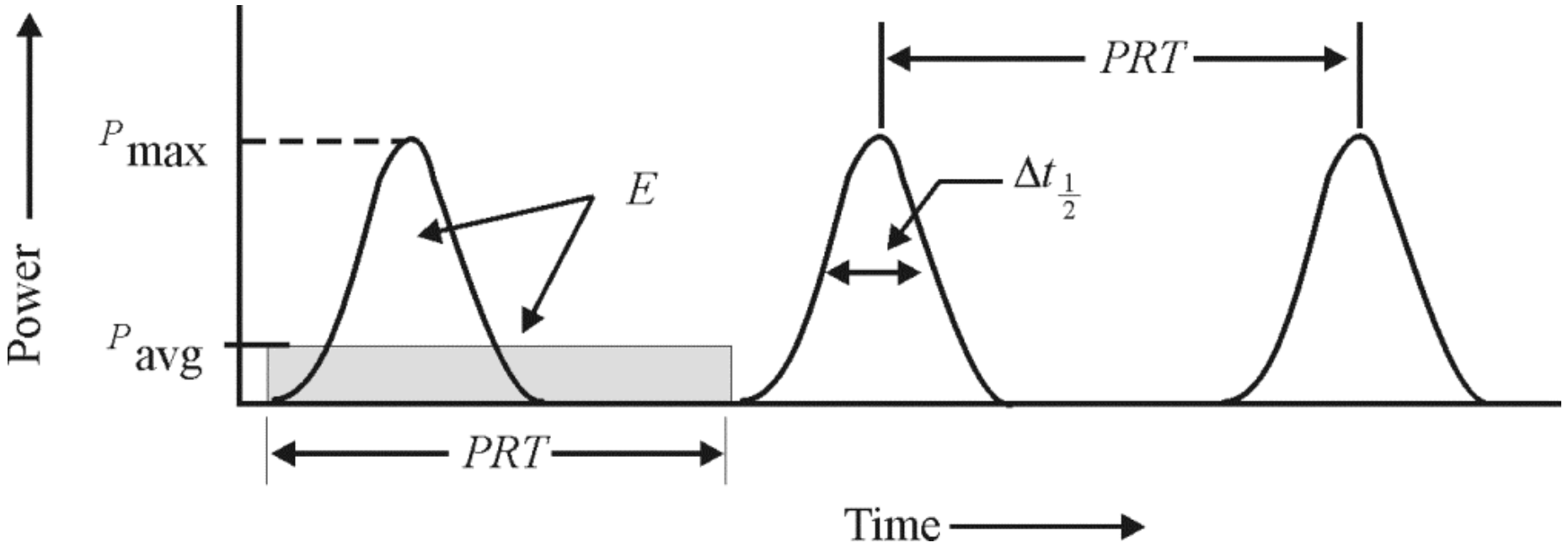


Figure 6-33 *Average power and pulse repetition time of a pulse in a pulse train*

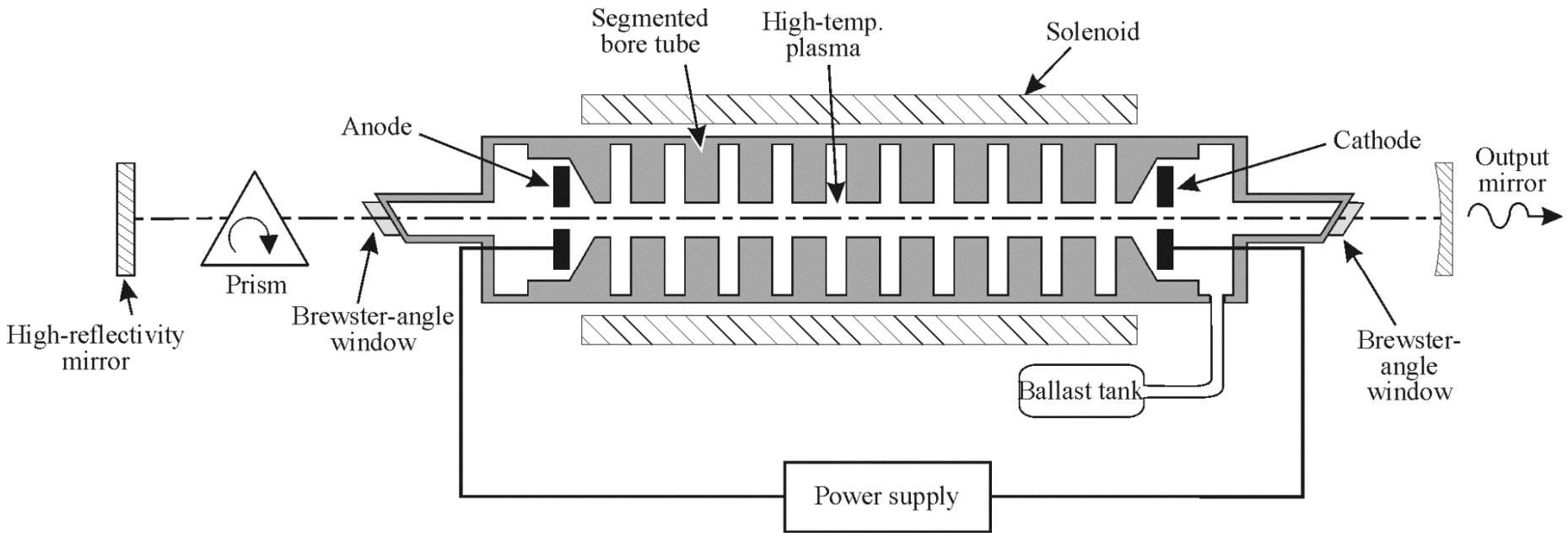


Figure 6-34 *Schematic diagram of an Argon laser*

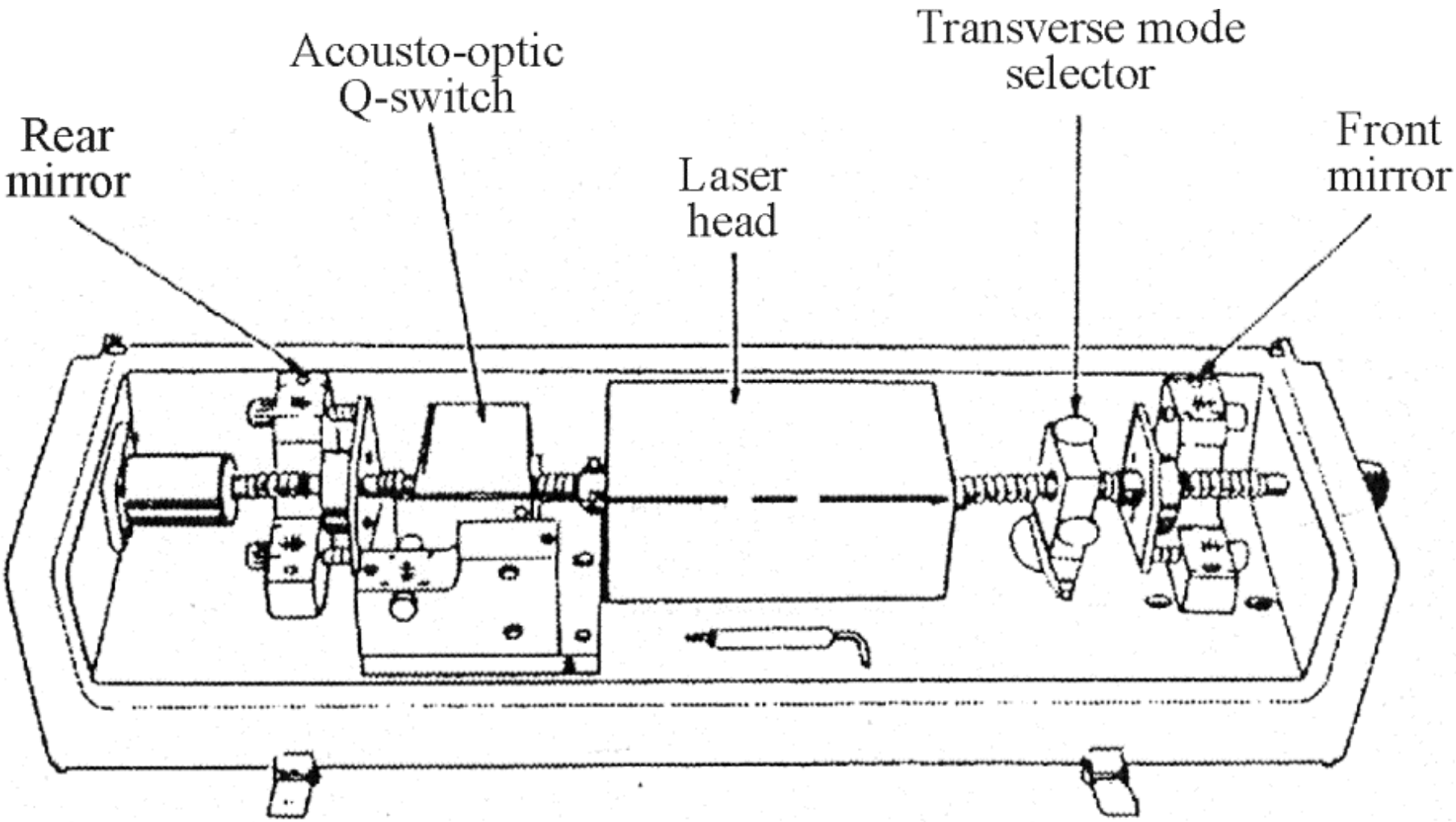


Figure 6-35 *Schematic diagram of a Nd:YAG laser*

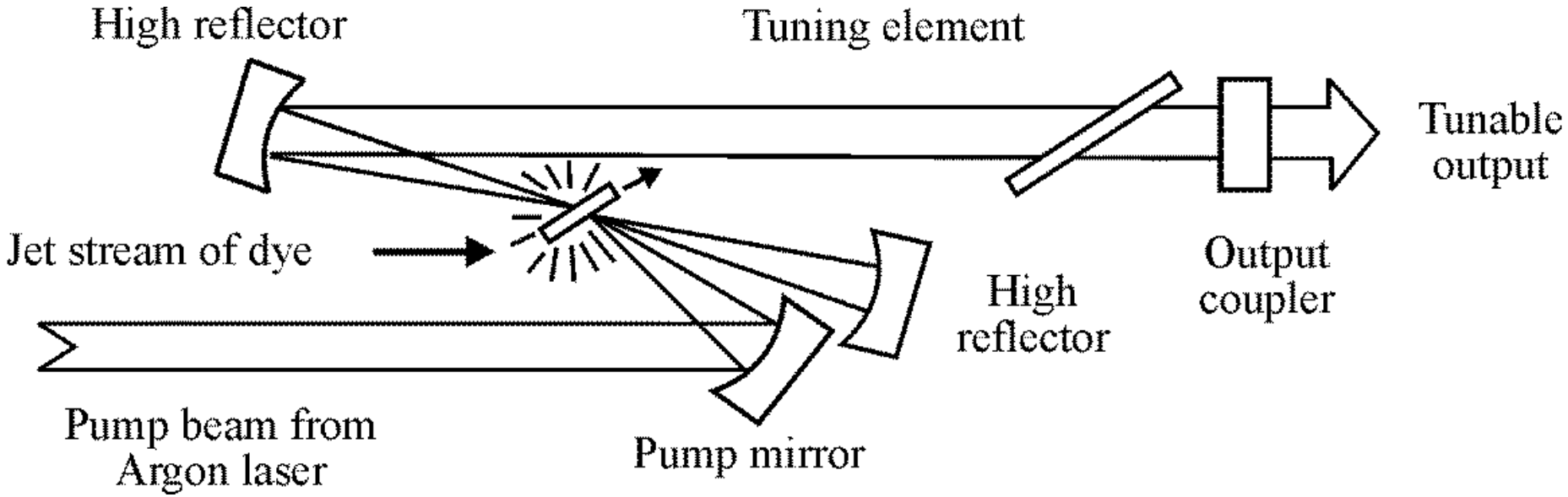


Figure 6-36 *Schematic diagram of a dye laser pumped by an Argon laser*

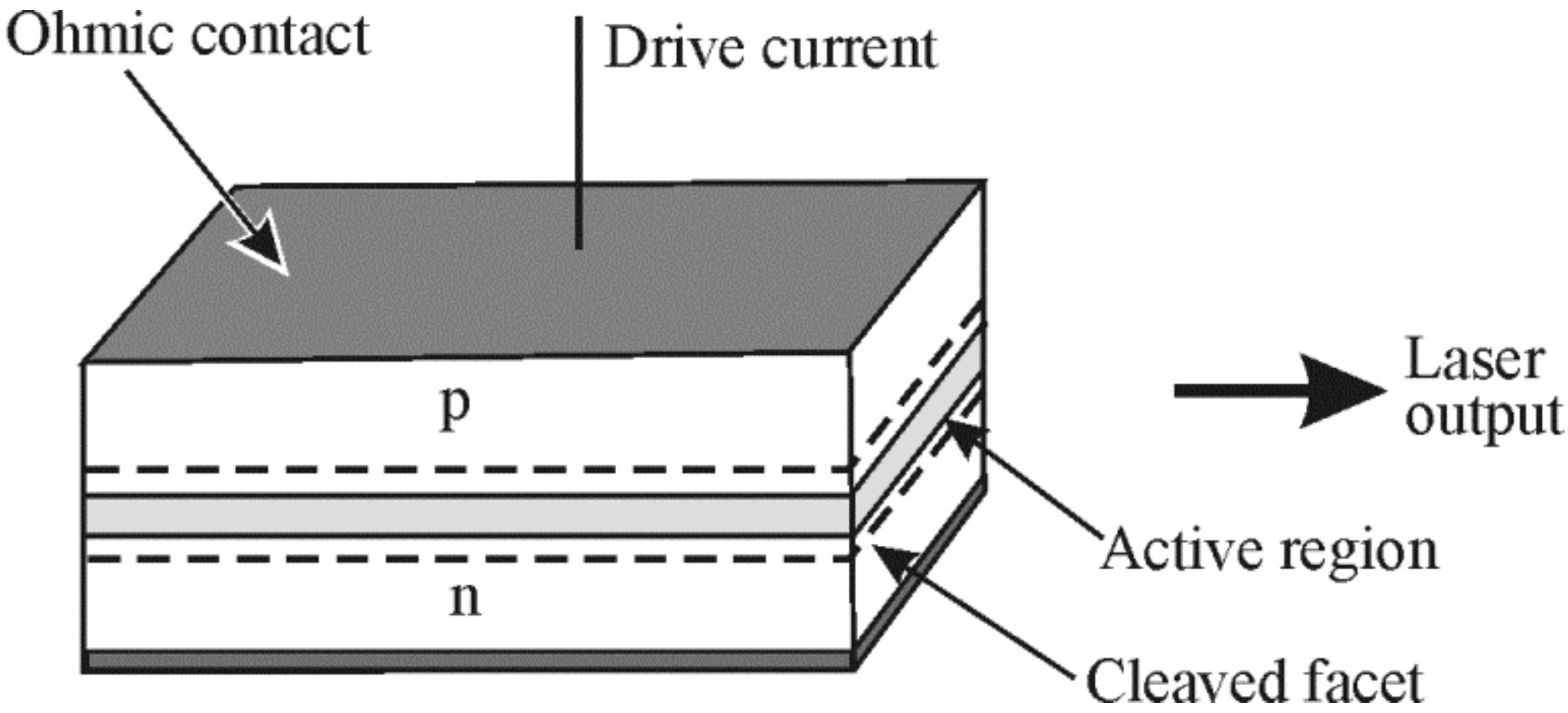


Figure 6-37 *Schematic diagram of a diode laser*

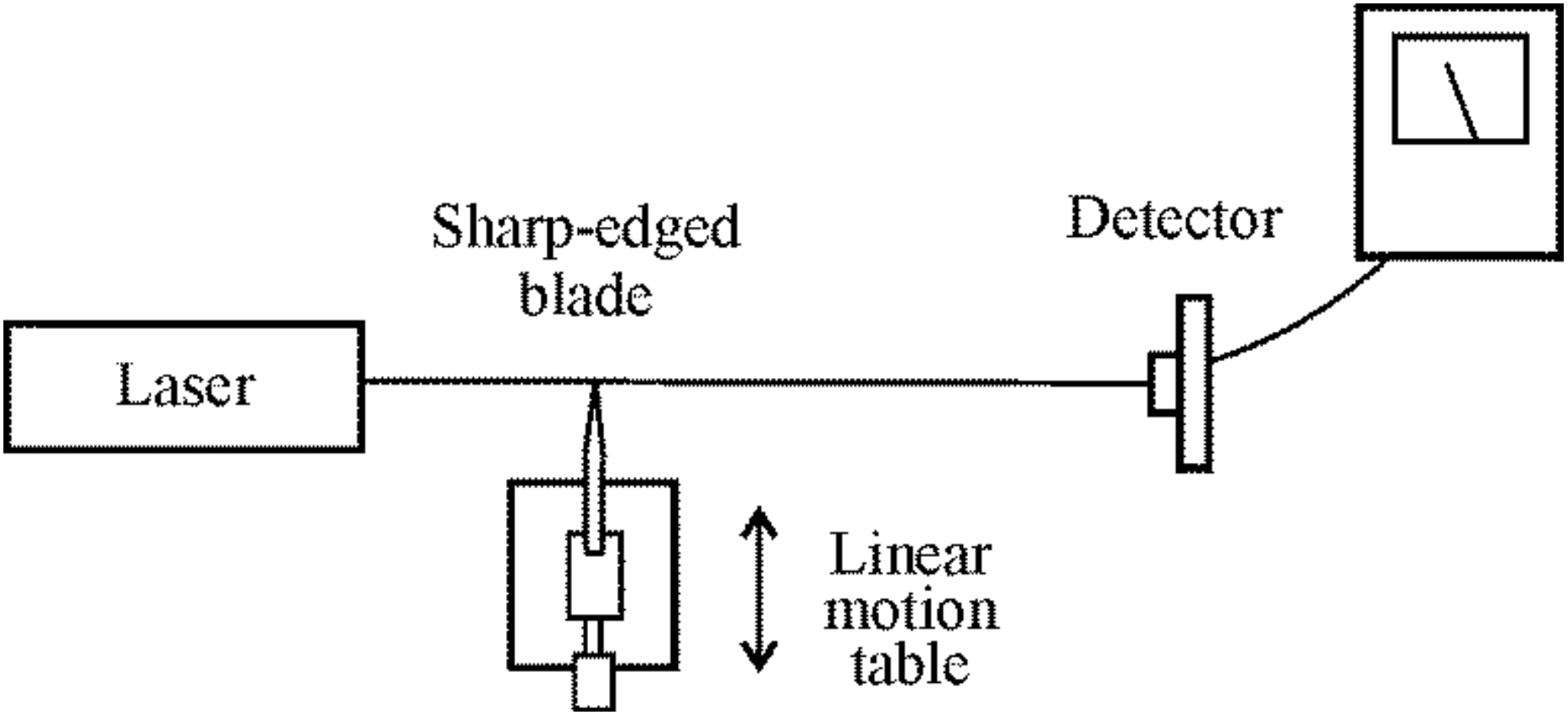


Figure 6-38 *Experimental set up for measuring beam diameter* (Laboratory 1-6A: Measurement of Beam Diameter and Beam Divergence)

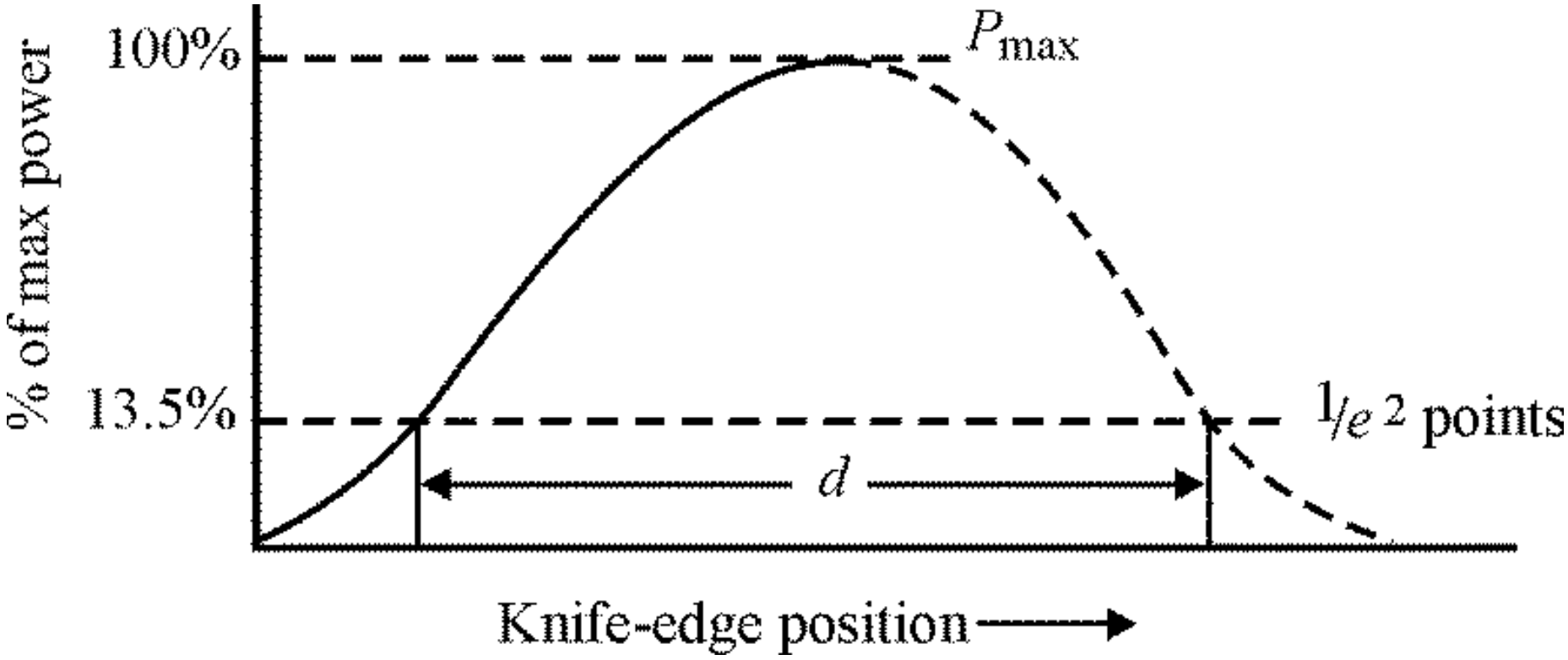


Figure 6-39 *Graph showing power read by detector head versus knife-edge position in the beam. The dotted portion of the curve is completed based on symmetry.*
(Laboratory 1-6A: Measurement of Beam Diameter and Beam Divergence)

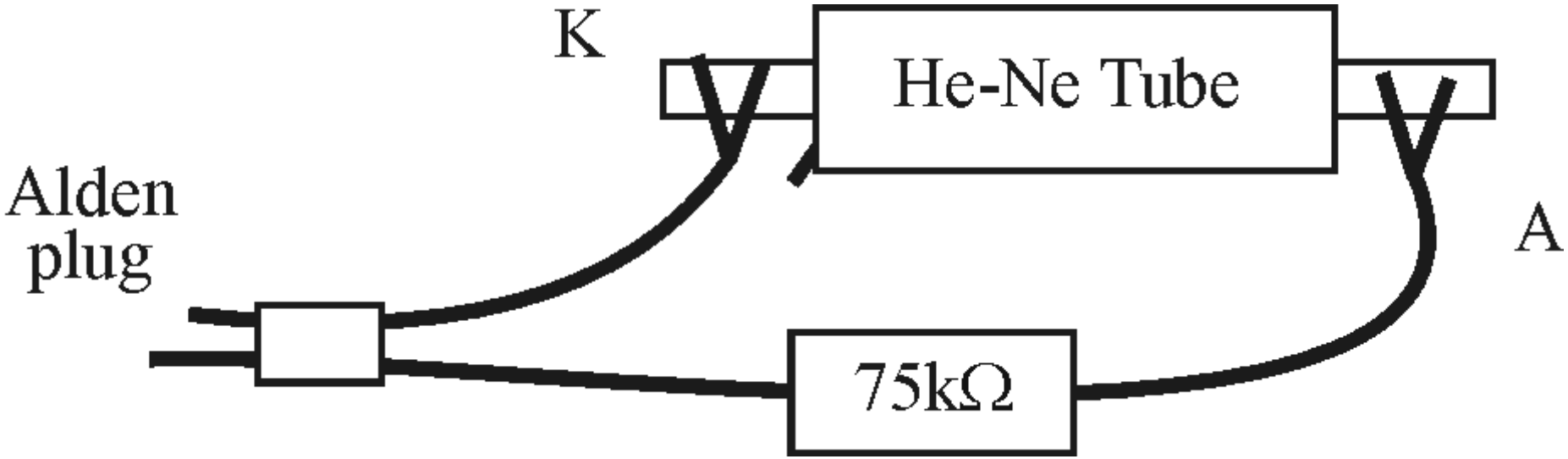


Figure 6-40
(Laboratory 1-6C: HeNe Lasers and High Voltage Testing)