Laser Beam

This issue of GIM International presents a Product Survey on rotating lasers. Laser: a light beam coming from a survey instrument, used for distance measurement, levelling, guiding and pointing. Laser: light amplification by stimulated emission of radiation. Laser, I know what it is, I know what it does, but how does it work?

A laser is a device that creates a narrow, intense beam of coherent and monochromatic light generated by particles (atoms or molecules) that emit radiation. The easiest way to understand the working of a laser device is by considering its two-level system: particles have only two energy levels, an upper and a lower state, separated by some energy difference. Electrons in the lower state can be excited to the upper state, usually by heat. Upon returning to a lower state the particle emits light. Usually particles behave independently of each other and the resulting light can be of any wavelength (colour).

Stimulated Emission
However, the emission of radiation can be stimulated to produce light of a particular wavelength. This occurs when a particle in the upper state interacts with a photon matching the energy separation of the levels; the particle may decay, emitting another photon with the same phase and wavelength as the incident photon, resulting in two photons for the price of one. This process is known as stimulated emission. The resulting beam consists of light of a single wavelength; the light is said to be monochromatic. Wavelength is determined by the amount of energy released when the electron falls to a lower state. The beam is also coherent, meaning that the photons move in step with each other; they have the same phase. The divergence of the beam is small, resulting in a very concentrated and narrow ray of electromagnetic energy. A flashlight, on the other hand, releases weak and diffuse light in many directions. Lasers differ greatly in properties, as well as in wavelength, size and efficiency.

History
Albert Einstein recognised the existence of stimulated emission in 1917, but not until the 1950s were ways found to transfer the theory into practice. In 1954 Charles Townes, researcher at Bell Labs US and, independently, Basov and Prokorov in Russia, suggested a practical method of achieving lasing using ammonia gas, which produced amplified microwave radiation instead of visible light (called a Maser). For this the scientists shared the 1964 Nobel Prize for Physics. In 1958 Townes and Arthur Schawlow in a paper entitled Infrared and Optical Masers calculated the conditions needed to produce visible laser light. T. Maiman used a ruby crystal to demonstrate the first true laser in 1960.

Safety
Compared to other light sources, the light produced by lasers is in general far more monochromatic, directional, powerful and coherent. But there is a price to be paid for these beneficial properties: lasers can do harm to the human eye and skin, and to the environment. Lasers are subject to safety classification dependent upon the potential for causing biological damage, and this is of great significance qua usage. Four broad categories are used in laser classification, and every laser should be labelled according to one of these.