Laser (Medical Biophysics 3.LF)

Previous chapter: 5.1.3 Light

The word LASER stands for **Light Amplification by Stimulated Emission of Radiation**. The first theoretical postulates on a laser beam were laid down by Albert Einstein in the early twentieth century, describing the theoretical possibilities of a stimulated emission of light in 1916-1917. However, the first laser unit was not constructed until 1960, following other important discoveries in the area of the so called quantum radio technique (N.G. Basov and A.M. Prochorov of the former USSR and C.H. Townes of the USA received a Nobel Prize for these discoveries in 1964).

How Laser works

The nature and qualities of light can be interpreted in more ways, according to classic, relativistic or quantum physics. However, the basic nature of light itself as either a particle/corpuscular or an electromagnetic/wave mechanism cannot be understood by our senses and it is incomparable to any other level of reality. Therefore, we can only accept conclusions and deductions based on numerous experiments.

Specific qualities of Laser

- **monochromatic**: maintaining only one wavelength
- **polarized** – waves are absolutely spatially oriented on a defined area
- **coherent** – it is absolutely oriented in time - maxima and minima of all waves are identical in time and the waveforms are the same

Properties of Laser

- Wavelength of a monochromatic laser beam (in nm).
- Output pulse amplitude or mean (in mW).
- Output aperture (in m2).
- Mode, i.e. continuous
- Modulation frequency (in Hz)
- Power density (in J/cm2), i.e. power emitted per unit of area.

In medical application only high intensity laser beams were utilized. Lasers of this type provide a source of energy that can destroy (cut, shear) as well as evaporate and, using its thermic effect, cauterize tissue.

Types of Lasers

Sorting by Source

- **solid** lasers (ruby laser)
- **liquid** lasers
- **gas** lasers - helium-neon, argon
- **semi-conductor** lasers – the most important for non-invasive therapy lasers, with miniaturization of the source, robustness and immunity to damage and variety of wavelength requirements.

Sorting by Wavelength

- **blue** lasers – approx. 400-500 nm
- **green** lasers – approx.500-550 nm
- **red** lasers – approx. 600-700 nm
- **infra-red** lasers – approx. 700-950 nm

Sorting by Operation mode

- **pulse lasers** (pulse length = app. 0.1-1 microsec., peak output = app. 1-10W)
- **continuous lasers**
- **lasers with modulated operation** (peak output = app. 0.1-1 W).

Sorting by Beam Type

- **convergent** (point) beam
- **divergent** (widening) beam
- **laser scanners** – devices for irradiation of large areas
- **laser clusters** – generating several independent laser beams, which may be of various wavelengths

Sorting by Class/Power

- **Class 2**: up to an output of 1 mW
- **Class 3A** (3R, 3M): up to an output of 5 mW and output density of 25 W/m2
- **Class 3B:** up to 500 mW

Sorting by Use

- **simple pen lasers** ("laser-pen") – very limited range of frequency modes but great portability.
- **"pocket" lasers** – usually designed to fit in a physician's coat pocket; output up to hundreds of mW.
- **desk-top lasers** – usually supplied from the mains, the probe is connected with the device by cable.

Links

Next chapter: 5.2 IONIZING RADIATION AND RADIOACTIVITY
Back to Contents