LaserLighT

Laser technology

Executive Company Profile:

Since the start we have build up a comprehensive knowledge and technical experience in developing Low Level Laser equipment and the key to success is based on the wish for a simple and functional design incorporated in all our lasers combined with a high degree of technical support and after sales service when buying and using e.g. our Compact CombiLaser.

The Compact CombiLaser is widely accepted by ENT doctors and therapists.

We are specialized in treating Tinnitus and other hearing disorders with:

Compact CombiLaser

Compact COMBILASER

Compact COMBILASER has been developed specially for treating Tinnitus.

Compact COMBILASER should treat both ears at the same time in order to avoid dizziness with a total energy of e.g. 2x500 mW – 30 Joule/min. per ear with 808nm laser probe.

Compact COMBILASER has a timer function from 0 to several hours that will stop treatment at the end of the session.

Treating Tinnitus with Compact COMBILASER
Low Level Laser Therapy (LLLT) for Tinnitus has been practiced for about 20 years in Europe and is beginning to be recognized and practiced in the US. There are indications it is very helpful for Tinnitus and other inner ear conditions.
LLLT was first developed for inner ear diseases by Uwe Witt, MD of Hamburg, Germany in the 1980's. Lutz Wilden, MD, of the Center for Low Level Laser Therapy in Bad Fussing, Germany developed it further and brought it to a wide range of patients.

Dr. Wilden's central thesis is that laser energy in the red and near infrared light spectrum is capable of penetrating tissue. It stimulates mitochondria in the cells to produce energy through the production of ATP (adenosine triphosphate).
Mitochondria are the power supplies of all cells; they metabolize (burn) fuel and produce energy for the cell in the form of ATP.
In stimulating the mitochondria, laser therapy can repair damaged tissue and return cells to a healthy state, reversing many degenerative conditions. If Low Level Laser Therapy stimulates mitochondria to produce more energy, it could be extrapolated that it might also help repair damage to the cochlea and restore some degree of hearing loss, thereby reducing Tinnitus.

The Compact CombiLaser emits dual wavelength beams which are visible red and near infrared. These laser beams are cool to the touch and do not cause discomfort. They are aimed into the auditory canal and through the mastoid bone behind the ear. The wavelength nature of these lasers allows them to penetrate tissue. Although the laser beams loses intensity rapidly, these lasers can have an effect on tissues 2 to 5 cm inside the body.
We are in the process to get the certification of:
G.M.P. Medical Device (Good Manufacturing Practice) ISO 13485

Compact COMBILASER is developed especially for the Tinnitus treatment. Laser treatment combined with relaxation treatment can, in many cases based upon research, relieve and moderate the Tinnitus. In some cases, it may remove the Tinnitus completely.
As a supplement, it is recommended to take Ginkgo Biloba or similar products, preferable one week before the first laser treatment.

Technical specifications:

Wavelength	650 nm (visibel)
Laser diode	InGaAlP
Laser diode power	100 mW
Output power	2 x 100 mW, CW (2 x 3 Joule / min.)
Wavelength	808 nm (invisibel)
Laser diode	GaAlAs
Laser diode power	500 mW
Output power	2 x 500 mW, CW ± 5% (2 x 30 Joule / min.)
Beam Divergence	1.0 – 1.5mRAD
Total output power	1000 mW 808 nm 200 mW 650 nm
No. of laser probes	4 separate point sources
Laser class	3 B
Product classification	2 a
Timer	0 – several hours
Electrical input	100 – 230V – Fuse 2A T
Net weight	2,1 kg
Medical Device	Certificate

CE Verification - **EMC Directive 93/42/EEC**
(Operation Environment: Medical Electrical Equipment)
Standard Applied: IEC 60601-1 and EC 60601-1-2

Compact CombiLaser is supplied with
two 650nm laser probes each giving 100mW
and two 808nm laser probes each giving 500mW

The laser probe

The laser diode is usually situated inside the probe itself. In some probes the laser diode is unprotected and mounted at the very end of the probe in such a way that the glass surface of the diode is in contact with the skin during treatment. When irradiating from a distance, the light is divergent, which is advantageous from the point of view of eye hazards. But when the laser diode glass surface is in direct contact with the skin, we have a very small “light spot” (typically in the order of 1 mm^2) which gives a very high power density. Further, the probe can be pressed against the skin, leading to tissue compression, which in turn causes the blood to move away from the beam. This will on the other hand increase the penetration depth and on the other lead to less effective treatment of blood cells than if the probe is not compressing the tissue.

In other probes the laser diode is mounted at some distance from the probe-end and there will be a distance (air) between the glass aperture of the laser diode and the skin. Depending on the distance and the angle of divergence of the laser light, the “light-spot” may be small or big with correspondingly high or low power density.

Energy density

Energy density is also named “dose” or “fluency”. The difference between power density and energy density is simply the time.

The power density is measured in watts per cm^2.
The energy density is measured in watt-seconds per cm^2, which is the same as joules per cm^2.

For calculation of energy density – see the chapter “Calculation of doses” below this chapter. Looking at a specific situation with laser light penetrating into tissue, we will have points and areas with high power density and other areas with low power density. If this distribution of light is held constant over a certain time, we will have an energy distribution that, at every point, is exactly proportional to the power distribution. If we keep the same situation going for ten times as long, we have an energy density (i.e. dose) that is ten times higher at every point reached by the light.

Calculation of doses

The dose is the amount of energy administered to a surface area of tissue. In the calculation we will measure area in cm^2. Energy can be measured in joules or calories (old measure). A joule is the same as a Ws (reads watt-second) where W stands for watt and s for second. The dose D is hence measured in joules per square centimeter (J/cm^2) and is calculated as

$$D = \frac{Pxt}{A}\left[J / cm^2\right]$$

Where P is the laser's output power in watts, t is the treatment duration in seconds, and A is the area treated, given in cm^2.
Choosing a variety of output powers and times, we can calculate the corresponding doses and present them in a table. The table below shows doses in J/cm^2, reached with a GaAlAs single-probe laser, for example, we can calculate, using the formula, that when treating an area of 1 cm^2 for a certain duration we achieve the dose (in joules) shown in the columns in the table.

	Output power from the laser								
Time/ cm²	**5 mW**	**10 mW**	**30 mW**	**60 mW**	**120 mW**	**240 mW**	**500 mW**	**800 mW**	**1000 mW**
1 sec	0.005 J	0.01 J	0.03 J	0.06 J	0.12 J	0.24 J	0.5 J	0.8 J	1.0 J
3 sec	0.015J	0.03 J	0.09 J	0.18 J	0.36 J	0.72 J	1.5 J	2.4 J	3.0 J
10 sec	0.05 J	0.1 J	0.3 J	0.6 J	1.2 J	2.4 J	5.0 J	8.0 J	10.0 J
30 sec	0.15 J	0.3 J	0.9 J	1.8 J	3.6 J	7.2 J	15.0 J	24.0 J	30.0 J
1 min	0.3 J	0.6 J	1.8 J	3.6 J	7.2 J	14.0 J	30.0 J	48.0 J	60.0 J
3 min	0.9 J	1.8 J	5.4 J	11.0 J	22.0 J	43.0 J	90.0 J	144.0 J	180.0 J
10 min	3.0 J	6.0 J	18.0 J	36.0 J	72.0 J	144.0 J	300.0 J	480.0 J	600.0 J
30 min	9 J	18 J	54 J	108 J	216 J	432 J	900 J	1440 J	1800 J

Dose to skin surface for different laser powers and exposure times per square centimeter area.

I would like to emphasize the following;
It is of the greatest importance that you know the output power of your laser! If you don't, you have no idea of the doses you give! It is not self-evident that the power of your laser is the same as when you bought it. Furthermore, the power specified in a brochure is frequently quite different from what you actually get out of your probe. The output should be measured from time to time! If you don't have a built-in power meter, you should check your laser with an external one regularly.

I often meet therapists who do not know what type of laser they are using. When asked, it is not unusual for them to respond "3B". Often they do not know what "dose" means, much less how to calculate one. Frequently, they have believed that the output power of the instrument was completely different from what it actually was.

Dose ranges

Biostimulation has been reported in the literature with doses from as low as 0.001 J/cm^2 to 10 J/cm^2 and more. How is this possible? Can we just use any dose? Certainly not – this is where we have to start thinking! There is a great difference between irradiating "naked cells" in the laboratory and treating a deep lying pain condition! In fact, a "dose" is a very complicated issue. It is a matter of wavelength, power density, and type of issue, condition of the tissue, chronic or acute problem, pigmentation, treatment technique and so forth. However, there is certainly a Therapeutic dose window". *Doses that are too low result in no or only a week effect*. If a dose above the highest one suitable is administered, weaker or no biological effects will result. With an even greater dose, the bio-suppressive range is entered (inhibiting effect result). This is most obvious in wound healing and stimulation of hair growth.
So which are the "correct" doses? Doses do not have to be "perfect" to produce a good biological response.
The table below gives you a rough view of suitable doses.

Indication	Laser type	Dose in J/cm^2
Open wound	HeNe	0.5-1.5
	InGaAlP	0.5-1.5
	GaAlAs	0.5-1.5
	GaAs	0.01-0.2
	CO_2	1-10
Wound periphery	HeNe	1-4
	InGaAlP	2-6
	GaAlAs	1-4
	GaAs	0.5-1
	CO_2	-
Superficial pain	HeNe	0.5-2
	InGaAlP	1-4
	GaAlAs	2-4
	GaAs	1-2
	CO_2	5-100
Deep lying pain	HeNe	-
	InGaAlP	-
	GaAlAs	4-10
	GaAs	2-5
	CO_2	5-100

Dose ranges for different lasers and indications

Doses for other lasers, like the Ruby laser and Nd: YAG lasers are not as well known. Mester's group used Ruby laser and indicated 1-2 J/cm^2.
As can be seen above, it appears that lower doses are required with GaAs laser than with HeNe laser. This has been observed by e.g. Abergel. In general, tissue tolerates higher "overdoses" of HeNe, InGaAlP and GaAlAs than of GaAs, which more quickly reaches an inhibiting level.

In the treatment of healthy, optimally working tissue, almost any dose can be used without noticeably macroscopic negative effects. This is e.g. the case in the use of surgical lasers cutting, evaporating and coagulating tissue, using very high power and energy densities. Right outside the destructive zone, very high levels of power density and dose occur, but this is not found to be negative.
When irradiating “naked cells”, in an open would, for example, the optimal dose id much lower than when irradiating through overlying skin. The dose and the treatment interval differ depending on whether the condition in the tissue is chronic or acute, but also on whether we primarily want to treat pain or achieve a more long-term effect. As stated before, specifying the “right” dose for a particular condition is not easy.
Numerous parameters must be taken into account: wavelength and output, contact or non-contact with skin/mucous membrane, type of tissue, acute/chronic, how deep in the tissue you want to reach, the patient’s general condition, the skin’s pigmentation, etc. “The right dose” may sometimes be whatever the instrument is able to deliver.

Dose per point

In the treatment of trigger points and acupuncture points the dose is often said to be a number of joules per "point", the assumption being that a point is something small. We have defined a "point" as an area that is 5 mm in diameter (= 0.2 cm^2) or less. This means that if we hit the skin with the light concentrated to this small area and administer 1 joule, we have given 1 J "per point", and if this "point" is 0.2 cm^2, the dose value is 5 J/cm^2.
Diagrammatically this may appear as below:

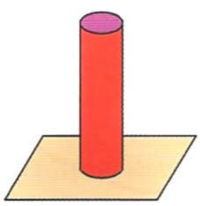
If this is one square centimeter (1 cm^2) and 1 joule of energy is applied equally over its total area, then the energy density is 1 j/cm^2 in every point over the total area.

$100 \text{ mW} \times 10 \text{ sec}/1 \text{ cm}^2 = 1 \text{ J/cm}^2$

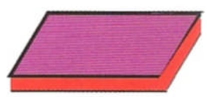
If the red spot shown in the figure is the area of light from a laser probe applied in contact with the skin, held still during the exposure time and having an area of 0.1 cm^2. Then the energy density is 10 J/cm^2 in every point over the spot area if 1joule of energy is applied.

$100 \text{ mW} \times 10 \text{ sec} / 0.1 \text{ cm}^2 = 10 \text{ J/cm}^2$

However, the average over the whole 1 cm^2, is 1 J/cm^2.



Unevenly distributed light = unevenly distributed dose



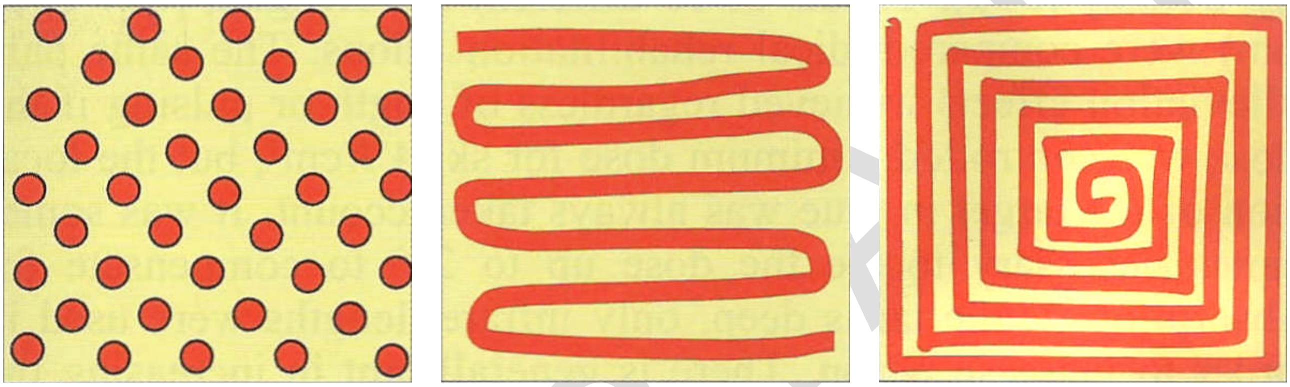
Evenly distributed light = evenly distributed dose

Distributed light

Point treatment is used in the treatment of trigger points and in laser acupuncture. A suitable dose for a trigger or acupuncture point is 1 to 4 joules.

More about treatment technique

When treating a certain area, different techniques may be used. Some therapists use the "spot" technique, meaning that they hold the probe still, move it slightly, hold it still, etc. Others use a scanning technique, sliding the probe over the skin. Different figures can be used and it does not really matter what technique you use as long as you have a good idea about the doses you give. Whether one treats clockwise or anti -clockwise is of no relevance.



Treatment Technique

The question at hand is not how many joules are delivered during a treatment session - that information may in fact be entirely irrelevant. The question is how many joules actually reach the diseased tissue. The two figures may be widely divergent.

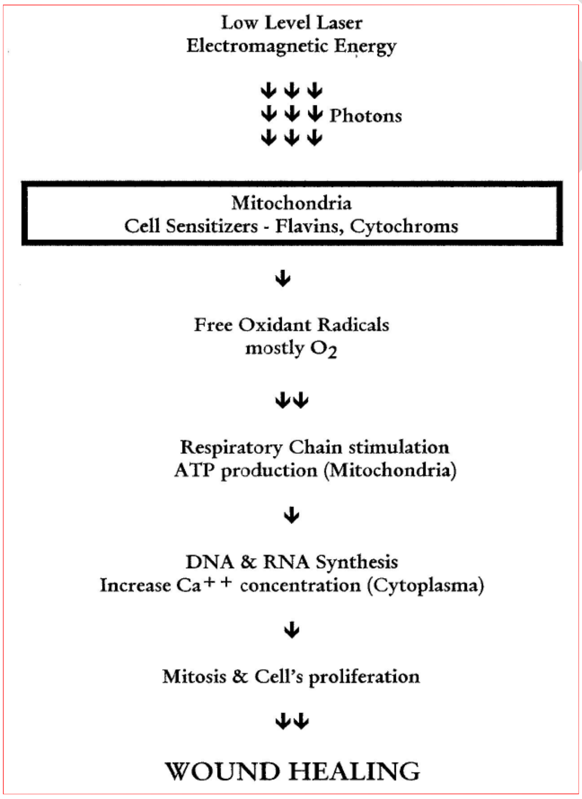
When treating a known anatomical point located just beneath the skin, there are large dose differences depending on whether the light is delivered from a distance with a narrow collimated beam, from a distance with a divergent beam (spread out over a larger area), in contact with the skin, or in contact with added pressure. The difference between remote, contact and pressure treatment is great. The amount of energy (number of photons) reaching the inflamed tissue may vary a lot. Saying that "3 joules per point" were delivered may be meaningless for purposes of comparison. One therapist may end up delivering a dose (and/or power density) 100 times greater than that delivered by a colleague, although the same "dose" was given! Or, even if the dose is the same, taken as an average over a certain area, the power density can differ very much, giving different treatment results. If the diseased tissue is deeper still, a new problem arises: where in the tissue is the treatment target?

Another important factor which comes into play is the skill of the therapist. If the diagnosis is correct, it is easier to know which tissue to irradiate. If the therapist has a good knowledge of anatomy, he or she will also know how to reach the tissue with the lowest possible energy loss. It may be necessary to place the patient in a particular position so that intervening muscles move out of the way and reveal the target. In such situations, the dose delivered by a qualified therapist may exceed that delivered by an unqualified colleague by a thousand-fold. Comparing the number of "joules delivered" in such a case is meaningless. It may very well be the case that therapist number one has found the right point and applied pressure to ensure minimum power loss. Therapist number two has irradiated from a distance, through an intervening layer of muscles, covering the target area by chance and luck. If therapist number two thinks that lasers are ineffective, we can understand why.

Technique and expertise mean a lot. The outputs of 13 different laser wavelengths (604-1219 nm) were compared in medical rehabilitation applications. The same pain alleviation effects were achieved regardless of wavelength or pulsing if the dose was controlled. The minimum dose for skin was 4 J/cm^2, but the location of the target in the tissue was always taken into account. It was sometimes necessary to increase the dose up to 20 J/cm^2 to compensate for absorption. If the target was deep, only infrared wavelengths were used in order to increase penetration. There is generally no point in increasing the dose if the wavelength has a low penetration factor; the penetration of the particular wavelength must be taken into account. However, as mentioned before, pain treatment needs higher doses as e.g. wound healing.

Studies clearly show that a “joule” is very much a relative concept. The dose recommendations make the assumption that the joule is delivered in a more or less optimal manner. This means, in most cases of local treatment, that it is delivered as close to its anatomical target as possible.

What is low level laser?

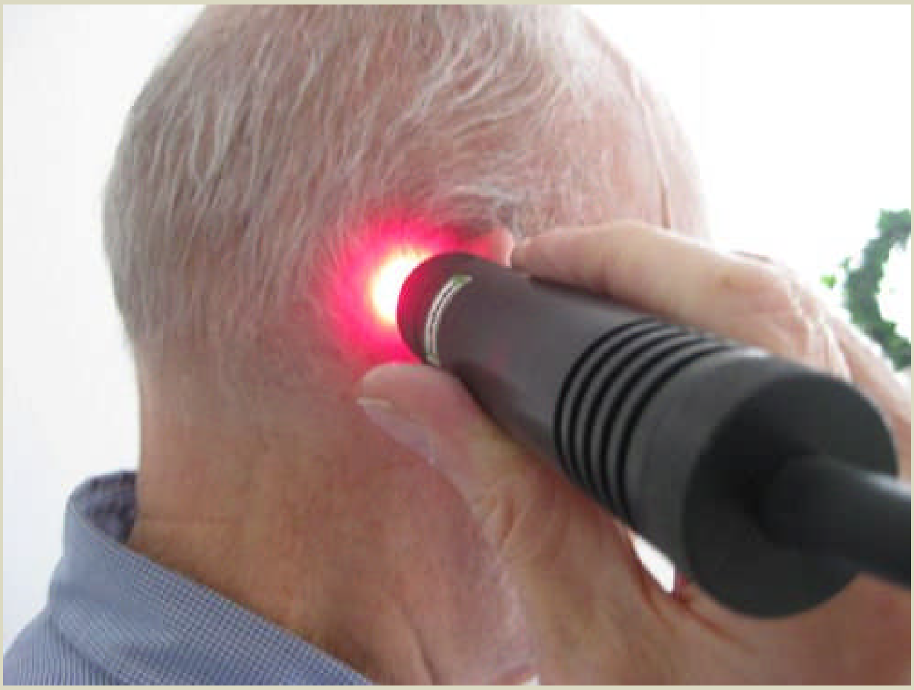


Laser is an electromagnetic beam of light and should not be confused with ultrasound. Both involve electromagnetic oscillations, but laser light is non-mechanic, as it is of electric rather than mechanical character. The number of oscillations is 500,000,000,000,000 per second (Hertz). Light has totally different characteristics to sound, as light can change the chemical structure of cells, something sound is unable to do. Laser light has special properties which make it very different from ordinary lamplight, as its photons are able to accelerate cell proliferation and the wound healing processes. We believe that the energy released stimulates endogens such as flavins and cytochromes, which are components in the cell respiration chain.

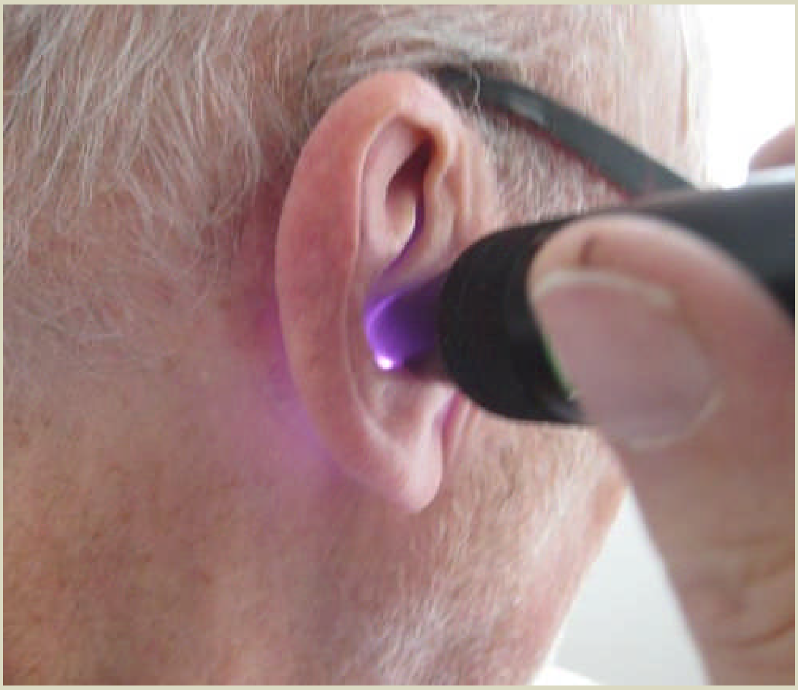
The energy absorbed is transformed into free oxidant radicals that are a more powerful form of oxygen, which stimulate the respiration chain and increase ATP production in the mitochondria. ATP production then activates formation of DNA & RNA that boosts calcium-ion concentration in the cytoplasm. This process is necessary to increase cell partition, to facilitate the wound healing process.

Can you reduce your Tinnitus? - Yes you can!

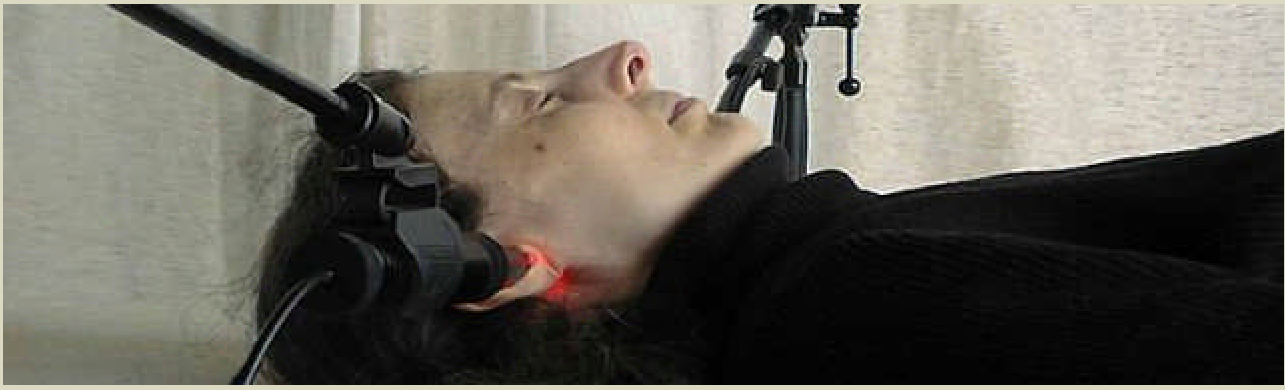
C. H. Brogemeyer



This is only to illustrate the visible 650nm laser light from Compact CombiLaser



This is only to illustrate the invisible 808nm laser light from Compact CombiLaser



Tinnitus patient being treated with CW laser light from Compact CombiLaser.

The patient is lying in a comfortable position and the lasers are carefully aimed in each ear and turned on. The two laser probes are mounted on a floor stand and carefully aimed.

The Compact CombiLaser treats with 2 continuous Laser diodes (CW) with strong energy at a time.

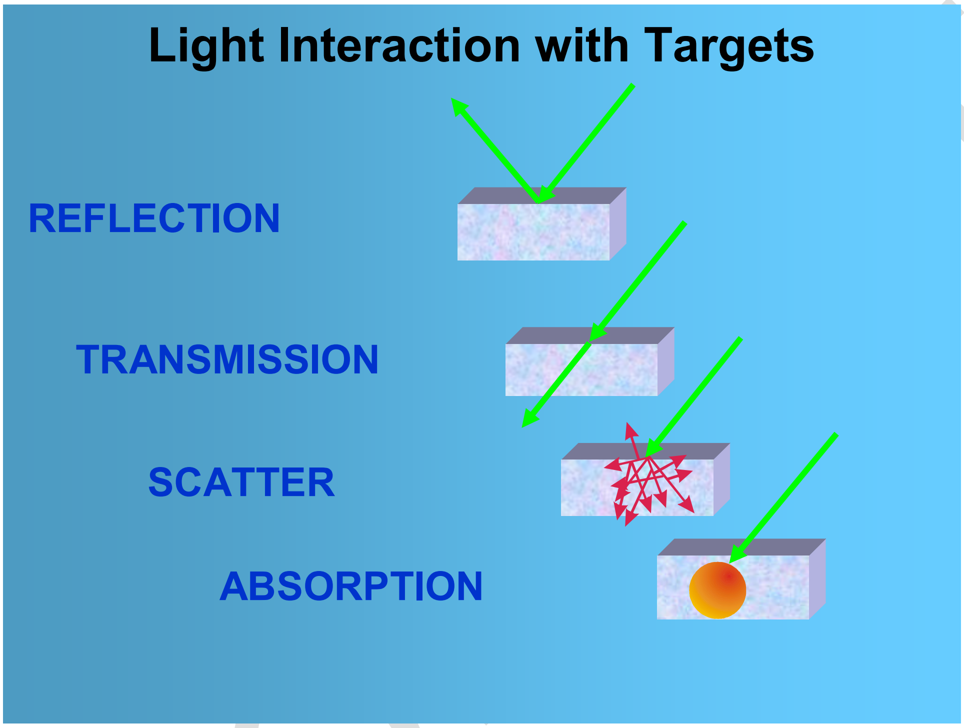
The Compact CombiLaser emit dual CW wavelength beams (650nm and 808nm) which are respectively red and near infrared. These laser beams do not cause any discomfort.

They are aimed into the auditory canal (808nm) and through the mastoid bone behind the ear (650nm).

The wavelength nature of the Compact CombiLaser allows them to penetrate tissue. Although the laser beams loses intensity rapidly, these laser beams can have an effect on tissues 2 to 5 cm inside the body.

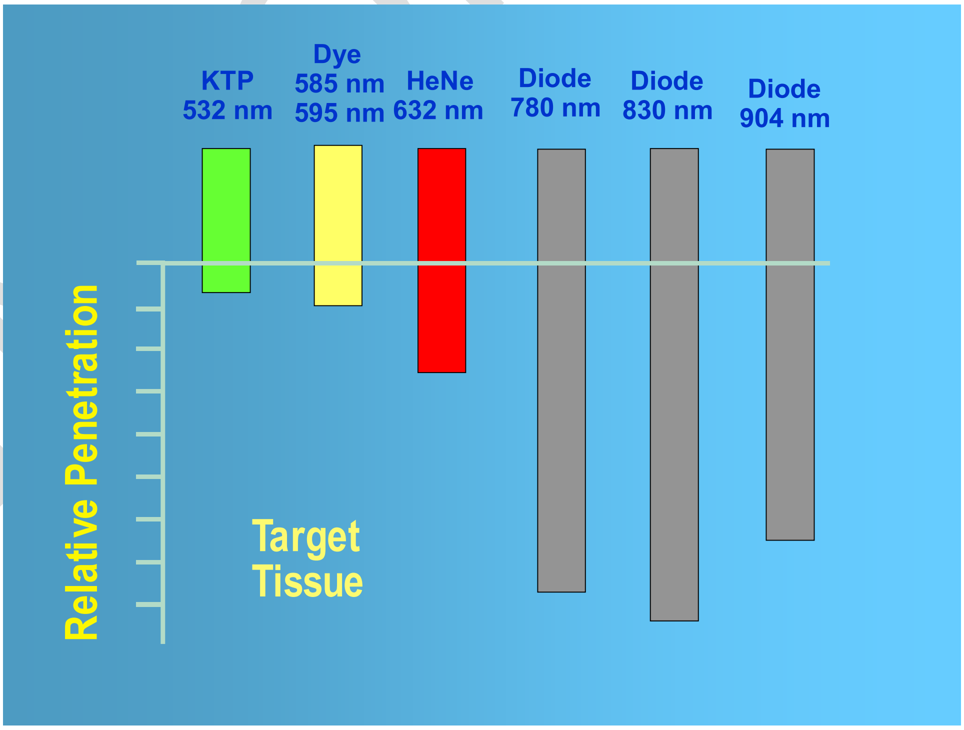
Low Level Laser (LLLT) in practice

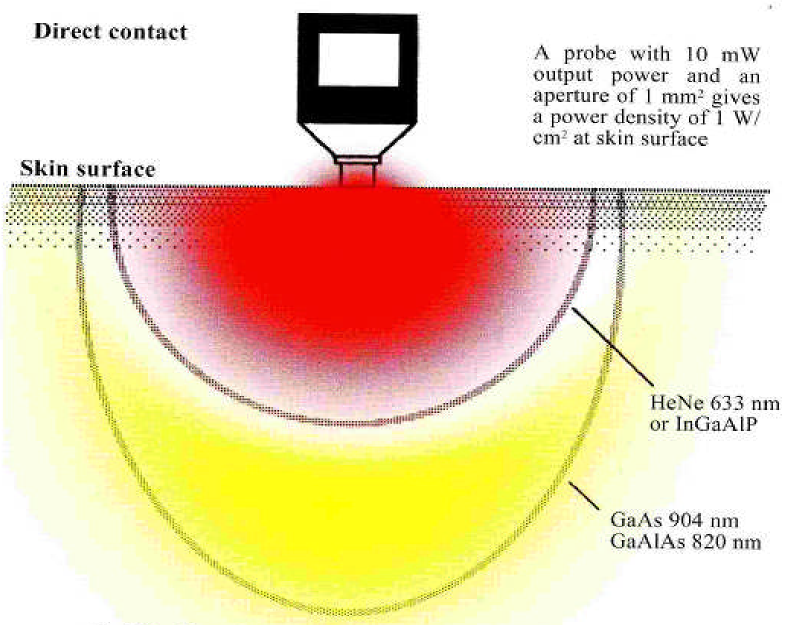
(Edited by C. H. Brogemeyer)



Because laser energy is a form of light, it must obey the physical properties of light. It might first of all be reflected, in which all of the light energy bounces off the target, such as sunlight off a mirror. It may be transmitted, in which almost all of the energy passes through the target, like sunlight through a clear window. It may be scattered, in which the components of the target allow light to enter, but divert it from its direct path. Some light may emerge from the target, such as sunlight through frosted glass, but the target is translucent rather than transparent. Or the light energy may be absorbed, transferring its energy in the target. If you think of the effect of sunlight on a dark-colored suit, or on a black car, you can see that one of the mechanisms of transfer is from light to heat. All of these occur to some extent when a laser is beamed on target tissue. Some of the energy is reflected from the horny layer of the skin. Some is transmitted into the tissue. Some is scattered by the components of tissue, proteins, blood, melanin and water, and some is ultimately absorbed in the tissue. Of all of these, however, the most important for us is absorption.

The first law of photobiology states that without absorption, there can be no reaction. The important lesson we learn from this is that we must therefore choose our wavelength so that the photons will be absorbed in our target.





The light from the laser distributes in the tissue lika a ball or an egg independently if the incoming beam is parallel or divergent. The is, however, dependent on the wavelengths of the light. Short wavelengths give a smaller but fairly round ball, whilst longer wavelengths give a more eggshaped light distribution.

Figure 3.8 Depth of penetration, direct contact

Here you can see the wavelength-dependent penetration of various wavelengths into tissue. The visible light lasers are absorbed selectively in blood and melanin, so their penetrative capacity is small. The near infrared (invisible) lasers are absorbed in protein and water, but as the water absorption is lowest at from 808 nm to 840 nm, photons in this waveband penetrate best.

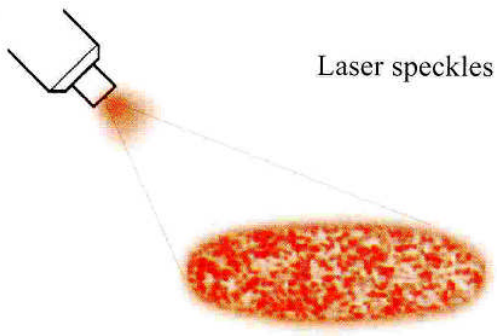


Figure 1.5 Laser speckles

If a rough surface is illuminated by visible laser light, the laser light shows a speckle structure due to interference. This phenomenon is called laser speckles and occurs in the eye of the viewer.

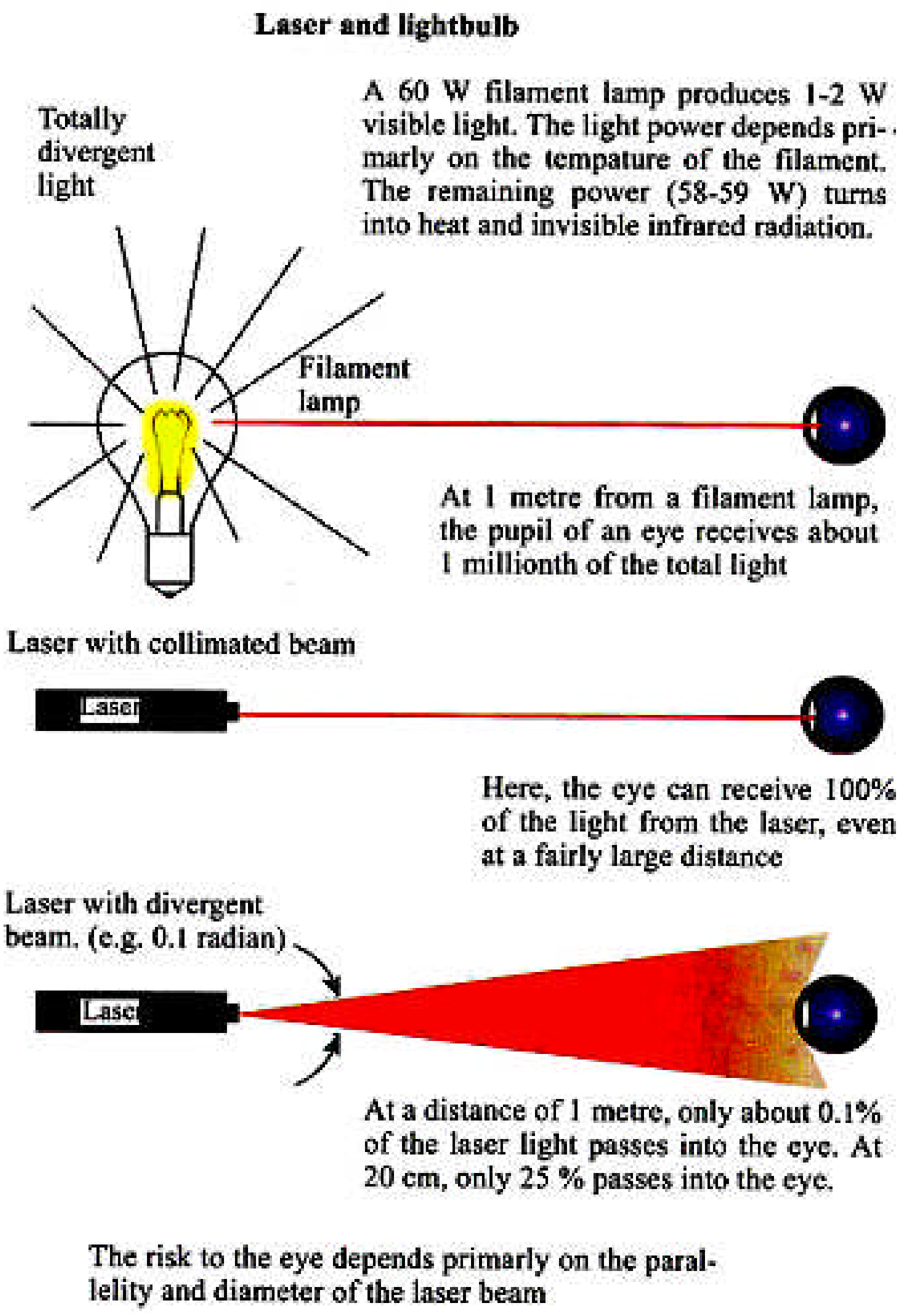


Figure 1.8 Laser and light-bulb

Note:
Some of the information and pictures given in this brochure is from the book Laser Therapy edited by Jan Tunér and Lars Hode.