A Brief Guide to

Laser/IPL Hair Removal

DERMA-LASE
LASER & IPL TRAINING

Mike Murphy
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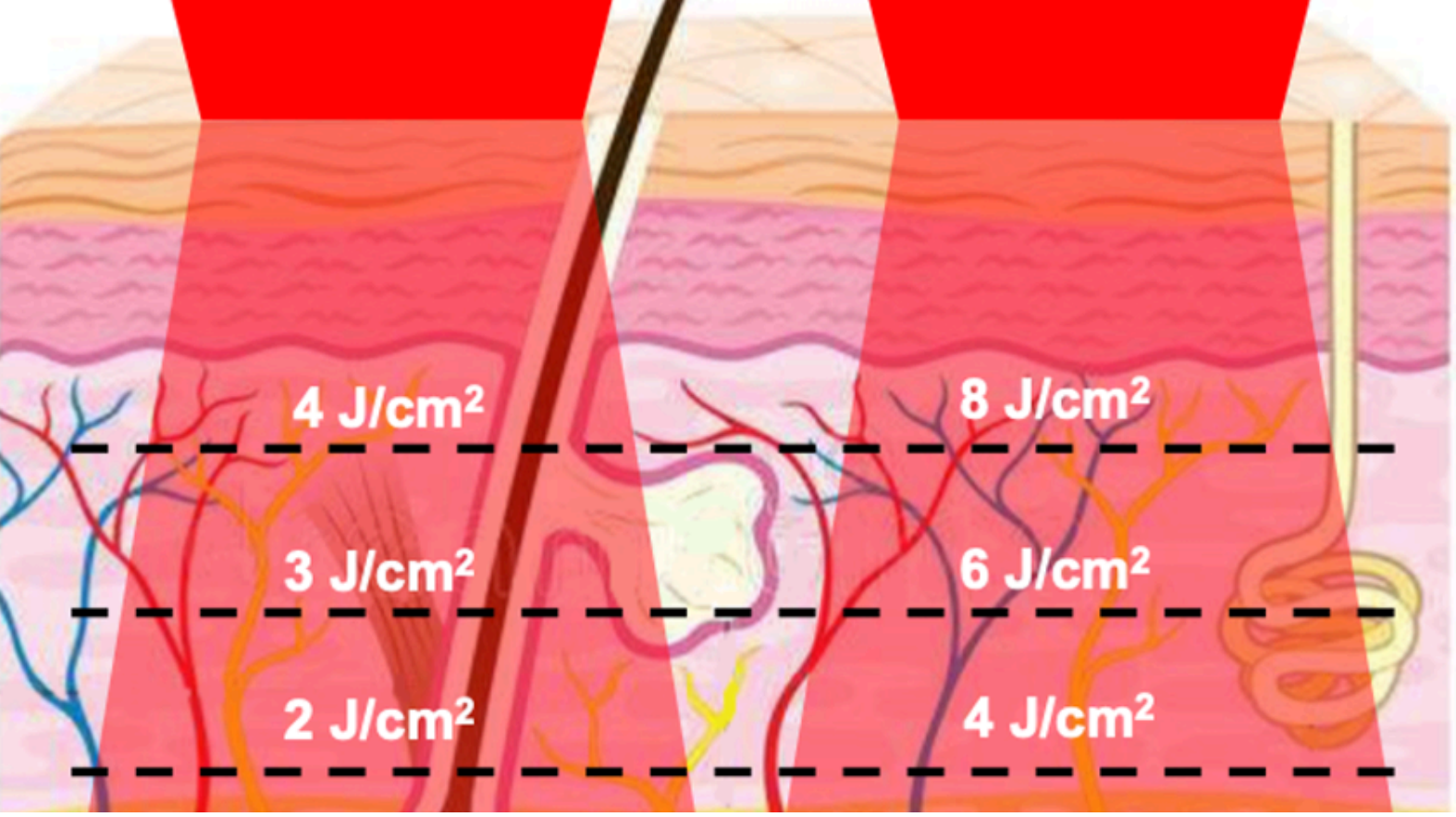
Ed. 2.2

DERMA-LASE

LASER & IPL TRAINING



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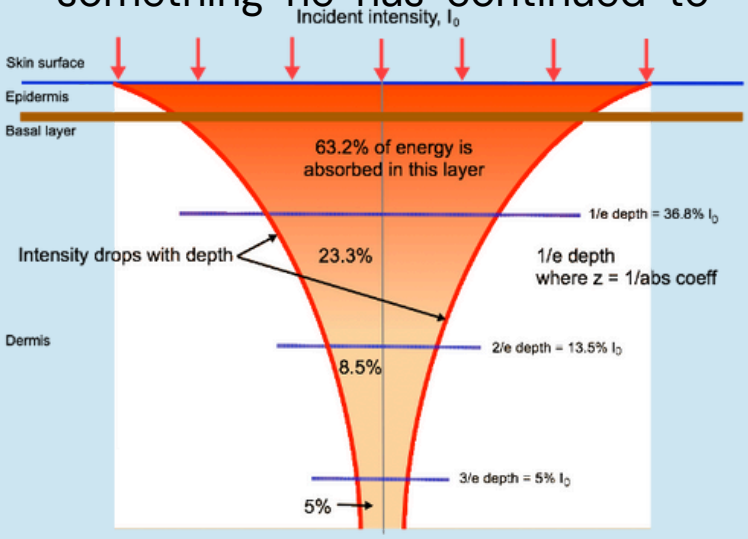
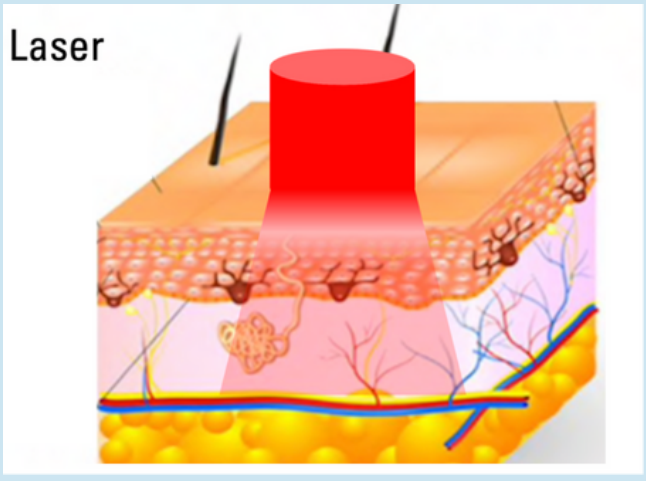
About Us

DERMA-LASE
LASER & IPL TRAINING

DermaLase was originally estabished in 1989 by Mike Murphy with the intention of selling and marketing their Q-switched ruby laser for tattoo removal. This came from the original research program in Canniesburn Hospital, Glasgow in the early 1980s.

Mike joined the research unit in 1986 and helped to develop the removal of paediatric port wine stains using a pulsed dye laser. He also began to design computer models to study the effects of laser energy in the skin - something he has continued to develop to this day.
Mike writes blog posts, Patreon articles and scientific papers discussing his research and clinical findings routinely. He presents his work at medical laser conferences around the world and loves a good pint of Guinness.





Lisa joined DermaLase in 2023 with a background in HR and aesthetics. She runs her own laser/IPL clinic treating hair, tattoos, blood vessels and various other skin problems.

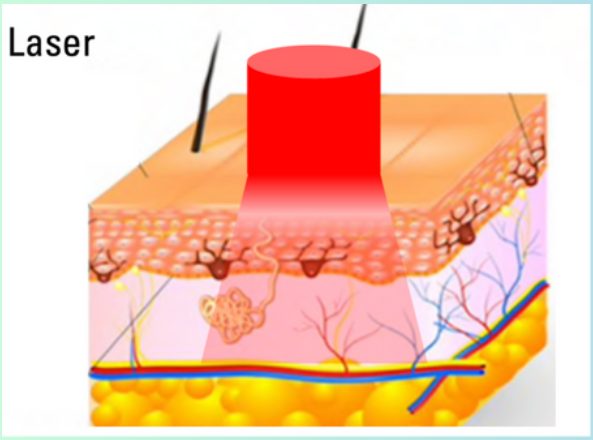
Terms and Expressions

There are many terms and expressions used when describing laser/IPL treatments. It is important to fully understand these expressions, otherwise you may not obtain the best results possible.

Term	What it means...
Wavelength	The wavelength of light is essentially its 'colour'. Visible light exists in the range 400 to around 700 nanometres (nm) - this is from blue to red. Beyond the red part of the spectrum is the near-infrared spectrum, which is invisible to our eyes. But infrared light energy is typically felt as heat.
Energy	The energy of a beam of light is used to increase the temperature of the target - hair, blood, tattoos. The more energy we fire at these targets, the hotter they will become. We measure energy in 'Joules'.
Pulsewidth	Aka 'pulse duration' and 'pulse length'. The pulsewidth is how long a beam of light energy is applied - how long it is 'ON'. This may be from nanoseconds to milliseconds to hours! In some cases, a shorter pulsewidth will generate a higher temperature than a longer pulsewidth, simple because there is less time for the heat energy to 'escape' from the target during the delivery of the pulse. But sometimes, longer pulsewidths are better because they induce more 'cooking' of the target tissues.
Power	Power is simply how quickly, or slowly, we deliver the energy. If some energy is delivered over a short time, then its power is 'high'. If the same amount of energy is delivered over a long time, then it has a 'low' power. We measure power in 'Watts', named after the great Scottish engineer, James Watt.

Term	What it means...
Spot size	When we fire laser energy at skin, or paper or whatever, we can usually see an impression, of some sort. The size of that mark can be considered its 'spot size'. Many lasers fire circular spots and so we can measure their diameter and calculate their area. Some lasers, diodes, and all IPLs output square or rectangular spots - making it easy to calculate their areas.
Fluence	The fluence of a beam of light energy is the energy divided by its spot size area - in other words, the 'concentration' of energy onto the target. Higher concentrations (fluences) will usually induce greater temperature rises in the target. We quote fluences as 'Joules/square centimetre' usually (J/cm2).
Absorption	When photons of light hit atoms, they will either be absorbed or scattered. Absorption means that energy contained within each photon is 'taken' by the atom, thereby raising its vibrational state (temperature!!)
Scattering	If the photon's energy is not absorbed by an atom, then the photon will be sent on its way - usually in a different direction from its original. This is called 'scattering'. This phenomenon is important in skin teratments because it causes any light beam to spread out once it's in the skin. If you check 'fluence' from above, this means that the fluence decreases, as the light penetrates deeper into the skin.
Penetration Depth	The "useful" penetration depth of light energy is how deep it can go into the dermis while still inducing the desired reaction. This depends on the wavelength, fluence, spot size and pulsewidth.

Light, heat and the skin



Once the light energy has been absorbed by something, it is usually converted into heat energy. This increases the vibrations in the atoms, which is how we determine 'temperature'.

The trick is generating a sufficiently high temperature for an appropriate period of time, in the desired targets, without damaging the adjacent tissues. This is the core principle of 'Selective Photothermolysis' - the cornerstone of many of today's laser/IPL skin treatments.

This can be achieved by firing the correct amount of energy, over the correct time duration (pulsewidth) in the more useful spot size area (fluence) with the optimum wavelength(s).

Selecting all of these parameters properly is crucial in achieving good results. It doesn't matter which kind of light is used - lasers and IPLs deliver light energy is very similar ways. If the operator knows how to utilise their equipment properly, they will obtain the result they're after.

In addition to setting up the equipment properly, the operator must also know how to apply their light energy to the skin in a way which will maximise efficiency. This includes proper placement on the skin surface, effective skin cooling and optimum gaps between treatment session.

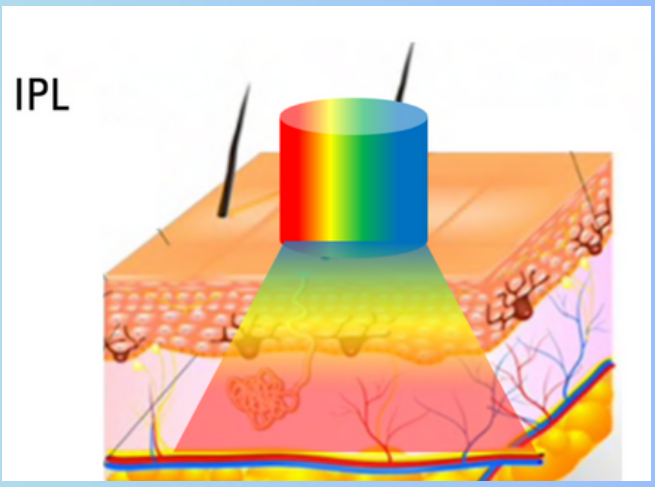
All of the above are important when considering laser/IPL treatments. Proper understanding of the processes and training are the best ways to achieve these goals.

How light energy interacts with the skin constituents is not trivial. It is, in fact, quite complicated and many researchers have studied this for decades.

All light entering the skin will encounter many, many scattering events before being finally absorbed or back-scattered out of the skin. All of these events depend strongly on the wavelength - red light penetrates much more deeply than blue light, mainly due to scattering.

Consequently, we must choose our wavelengths according to how deep the targets are. Once the light has reached our intended targets we need to maximise the amount of light energy absorption to ensure we achieve a suitable temperature increase. This means we must choose the wavelength according to the absorption characteristics of our intended targets too.

If our choice of wavelength is not good, we will never achieve good clinical results. This is why the choice of the correct wavelength(s) is so important.



Many people think that IPLs are somehow 'inferior' to lasers. This is a myth which is mostly perpetrated by laser salesmen. It is not true!

The fact is, when laser light enters the skin it rapidly loses two of its unique characteristics - the divergence and the coherence (You'll find many good articles online which describe these attributes). Once lost, the only remaining laser attribute is the single wavelength (monochromaticity).

Essentially, a laser beam becomes an intense beam of 'normal' light with a single wavelength in the skin - it is not a 'laser' beam any more. Just like IPL light!

How to treat hair

01 The Basics

There are some basic fundamentals to consider when treating hair with light-based devices such as lasers and IPL systems. It is important to understand these basics before embarking on a treatment, otherwise you may not achieve the best possible results...

02 The Light

Essentially, we fire light energy into the skin. A small fraction of it (typically less than 10%) is absorbed by melanin in the hairs. This is converted into heat energy, which raises the temperatures of those hairs.

If we push up those temperatures sufficiently high, we can 'cook' those follicles dead! This is called 'irreversible denaturation'. This is the goal of these treatments. To achieve that goal, we must deliver the correct amount of light energy (fluence), over an appropriate time (pulsewidth) with a suitable wavelength (colour).

03 The Hair

We use melanin in the hair shafts as the target for the light energy. Consequently, the hair MUST contain sufficient melanin to absorb enough energy to become hot enough for the process to work.

The hair MUST be 'dark' - light-based treatments cannot sufficiently heat blonde or grey or white hairs!!

"We canna change the laws of physics" as a great, fictional Scottish engineer once said, many years from now.

Critical Points

FIRSTLY, WHAT ARE THE 'CRITICAL' POINTS?

FLUENCE
PULSEWIDTH
SKIN COOLING
HAIR & SKIN COLOUR

To successfully, and irreversibly, destroy unwanted hair follicles we must apply the correct set of laser/IPL parameters with the proper technique.

But we must also consider the temperature rise in the epidermal melanin – this will occur, especially in darker skin tones, because the light has to pass through this layer to reach the follicles.

So, the epidermis will become hot too, and this will trigger the thermal pain nerves, just below the epidermis.

To minimise this thermal pain, we should apply the appropriate amount of skin cooling. This will also minimise unwanted tissue damage such as blistering and hyperpigmentation.

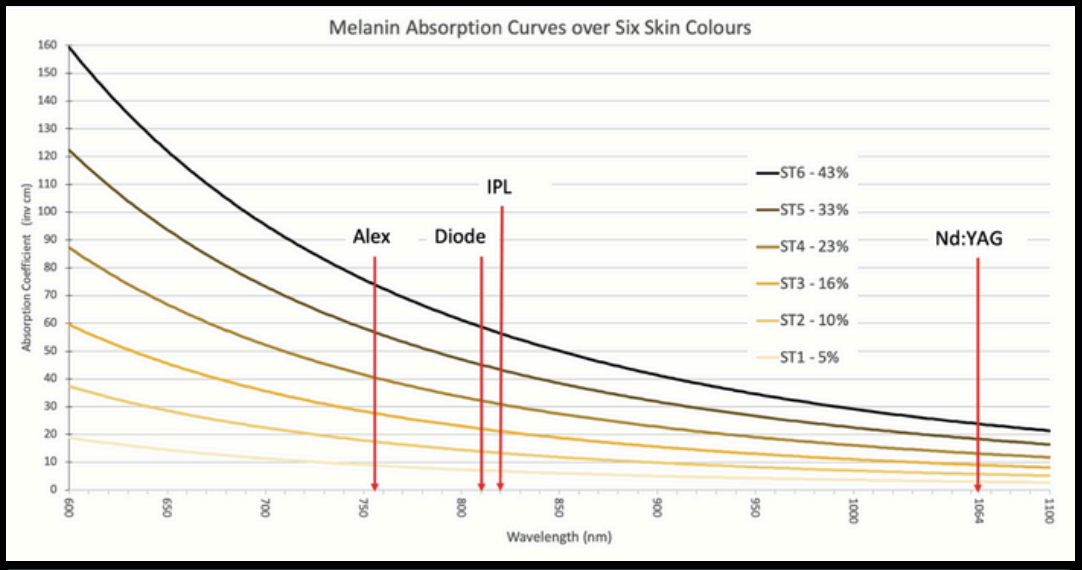
We recommend applying ice-packs to the skin surface for anywhere between two and six minutes, depending on the applied fluence and wavelength. Your patients/clients will love it!

Wavelength

WAVELENGTH IS SIMPLY THE COLOUR OF THE LIGHT ENERGY WE USE TO TARGET THE HAIRS.

You may have noticed that we didn't include 'wavelength' in our critical list on the previous page! That's because melanin - the main target chromophoire in hair - absorbs across the whole of the visible spectrum and into the near infrared too. So, all of those wavelengths will be absorbed by the melanin in hair, to some extent.

Generally, as the wavelength increases, the amount of light energy absorbed by the melanin decreases (see graphs below), in all skin tones.



As the graphs above show, the amount of light energy absorbed in the various skin tones (ST1 to ST6) varies significantly. Black skin (ST6) absorbs much more energy than light or pale skin (ST1). Black hair will absorb more energy than all of these skin tones, but we must be careful with very dark skin tones. The epidermal melanin will, essentially, steal light energy, meaning less will reach the dermis, and our intended targets - the melanin in the hair!

Fluence or 'Energy Density'

FLUENCE IS THE 'CONCENTRATION' OF LIGHT ENERGY INTO A SPOT

FLUENCE

Fluence, aka 'energy density', is the concentration of energy fired at the skin surface, and is usually expressed as Joules/cm2. Fluence directly determines the temperatures reached in the targets in the skin.

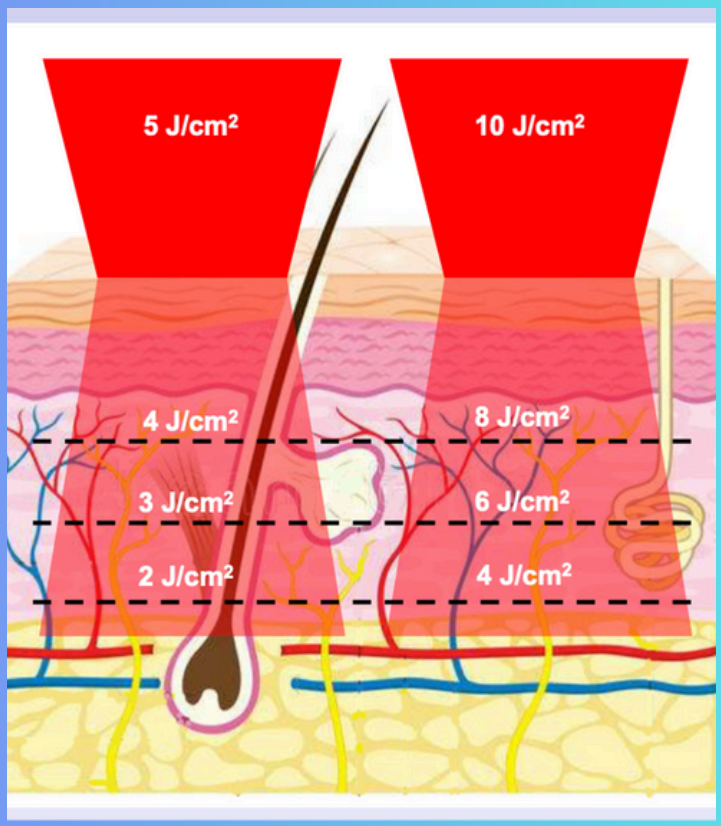
Many things in the skin will absorb light - hair, collagen, tissue water, nerves, blood etc... When they do, they will heat up as the light energy is converted into heat energy. This is usually what we are trying to do with these treatments - preferentially heat up a specific target. If we apply the correct does of light energy, we should be able to generate the right amount of heat in the desired target(s) and, hopefully, obtain the reaction we're after.

But, we must be very careful in choosing the right level of fluence - too much will destroy too much adjacent tissue and possibly create scar damage, while too little fluence will not create sufficient heat to do the job properly.

The trick is to choose the 'correct' fluence...

$$\text{Fluence} = \frac{\text{Energy (Joules)}}{\text{Spot size area (cm}^2\text{)}}$$

The fluence is absolutely CRITICAL in all photothermal skin treatments!!



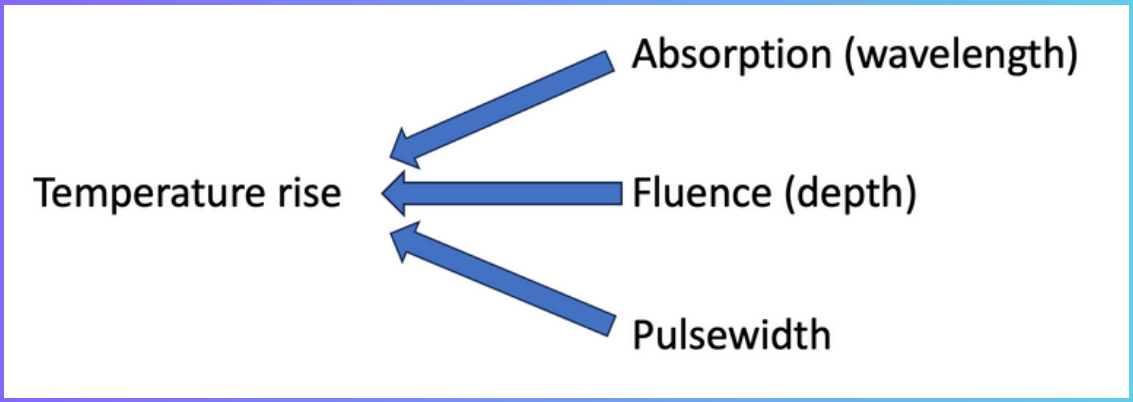
Most treatments 'fail' because the targets are hit with insufficient fluence leading to low temperatures in the hairs.

Fluence drops rapidly with depth - so we must compensate for this.

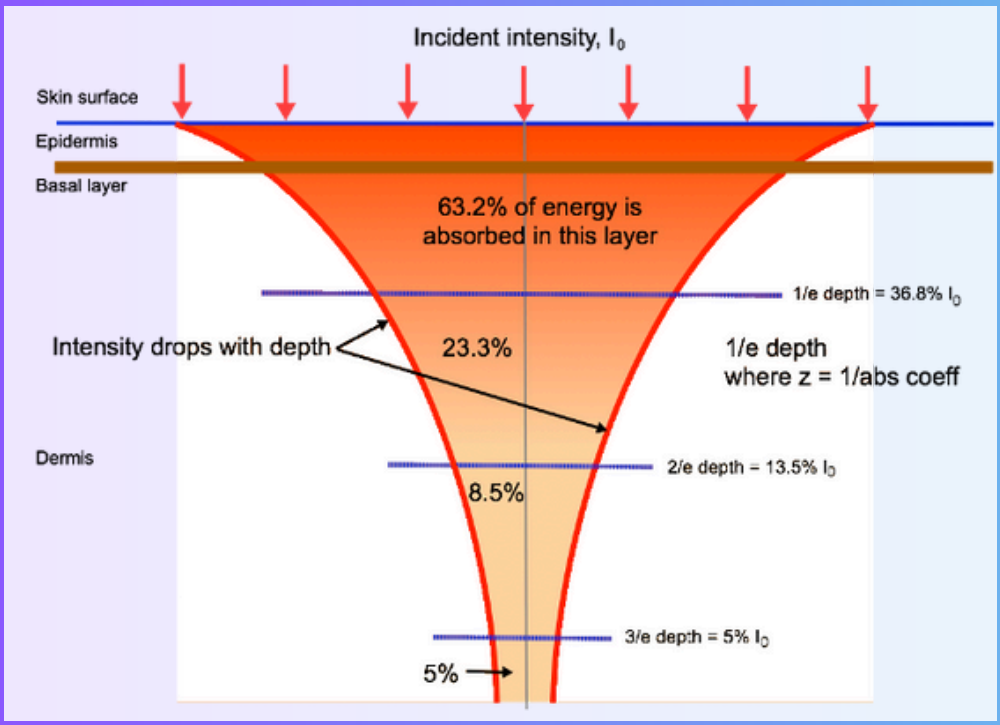
Consequently, deep targets require higher fluences to ensure the required temperatures are attained.

Higher fluences have a deeper effect in the skin. Deep follicles need higher fluences to ensure good results. But this also means more skin cooling must be applied to minimise unwanted tissue damage.

Do not treat over tattoos, scars or damaged skin!



The point of these treatments is to push up the temperature of the targets so that they 'cook', irreversibly. In hair follicles, we need to cook the stem/germ cells sufficiently well so that they cannot regenerate the follicle when it goes back into the anagen phase of the growth cycle (see later in this booklet).



The success of all photothermal treatments depends strongly on the fluence used. Higher fluences will result in more successful outcomes, but it also means we need to cool the skin more too, to minimise epidermal damage! Successful photothermal treatments are, in essence, a balance between heating and cooling.

There are three main issues to consider when choosing the fluence - the maximum depth of the target, the absorption (coefficient) of the target and the pulsewidth (see next section).

All of these will influence the final temperature rise in the target.

The image on the left shows how rapidly the fluence drops with depth - it is exponential. This poses a serious problem...

Deeper targets will receive much less light energy than superficial ones. These are more difficult to destroy.

Likewise, we must choose an appropriate pulsewdith, otherwise the targets will not be sufficiently hot.

Many poor results are caused by the incorrect choice of the fluence.

Fluence → Temperatures → Success

Incidentally, 'fluence' and 'fluency' are two different things...

Pulsewidth

PULSEWIDTH IS HOW LONG THE LIGHT ENERGY IS APPLIED TO THE SKIN

Pulsewidth	Applications
Nano or picoseconds	Tattoos Pigmentation Skin rejuvenation
Milliseconds	Hair Blood vessels Pimentation Skin rejuvenation
Seconds/minutes	Skin rejuvenation

The choice of pulsewidth is an important part of the whole laser/IPL process. It determines whether the reaction will proceed as we require, or not. If it's too short, we may not achieve sufficient 'cooking' of the targets - if too long, we may damage too much tissue (i.e. burnt!!!).

But it's a wee bit more complicated than that...

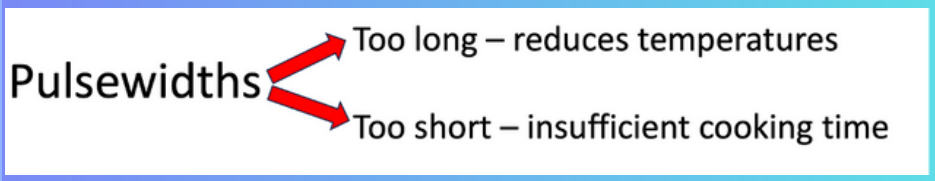
The pulsewidth has a very important effect on the treatment processes - for certain treatments such as tattoo removal, we must deliver the energy very quickly to minimise any loss of heat from the targets. So, we use extremely short pulses - typically nano or picoseconds. 1 nanosecond is a billionth of a second, while a picosecond is even shorter.

By doing this, we ensure that the temperature rises are very high - hundreds of degrees, usually. This generates the steam reaction we are after in tattoos (see the 'Tattoo' booklet).

In laser/IPL hair removal we must employ millisecond pulses. These deliver the fluence in such a way that the desired temperatures are attained and a sufficient 'cooking' time is applied to the germ/stem cells.

Imagine you wanted to boil an egg. You bring water in a pan to the boil - that's the 'fluence'. If you placed an egg in this boiling water and removed it after only 20 seconds, most of it would be uncooked. Only the outer region of the albumin (white) of the egg would be denatured. A 20 second 'pulsewidth' is clearly not enough! We know that boiling an egg properly needs around 3.5 to 4 minutes. It is precisely the same with hair follicles - they must be 'cooked' for the right time to ensure germ cells are fully denatured. By doing this, those follicles will not regrow.

Permanent hair removal is entirely possible using lasers and IPLs - if they are applied correctly.



For hair removal, the pulsewidth is not as important as the fluence. If the fluence is sufficiently high, then the pulsewdith becomes almost trivial. However, may laser operators use too low a fluence where the pulsewidth becomes more critical.

A particular problem exists with diode lasers. These come in a large range of output powers, which confuses many people. A 20 J/cm2 fluence from a 1000 Watt diode laser will not generate the same results as exactly the same fluence from a 5000 Watt diode. This is because the 1000 W laser delivers that fluence over a pulsewidth five times longer than the 5000 W laser!!! During that extended pulsewidth, much of the heat energy is lost to the surrounding skin, thereby lowering the maximum temperature increase.

This issue is not so much of a problem with other devices - it is peculiar to diode lasers!

Skin Cooling

SKIN SURFACE COOLING IS CRITICAL FOR ALL PHOTOTHERMAL TREATMENTS – BEFORE AND AFTER!

When you think about it, we are deliberately trying to 'burn' the hair follicles. We are inducing high temperatures in them, to effectively kill them so they cannot regrow. That is the point of these treatments.

But this will also generate high temperatures in other parts of the skin too - especially in the melanin in the epidermis. This leads to pain (the pain nerves trigger at 45C) and possible blistering and hyper- and hypopigmentation.

To counter these issues, we must apply sufficient skin surface cooling before the application of the laser/IPL energy.

Pre-cooling

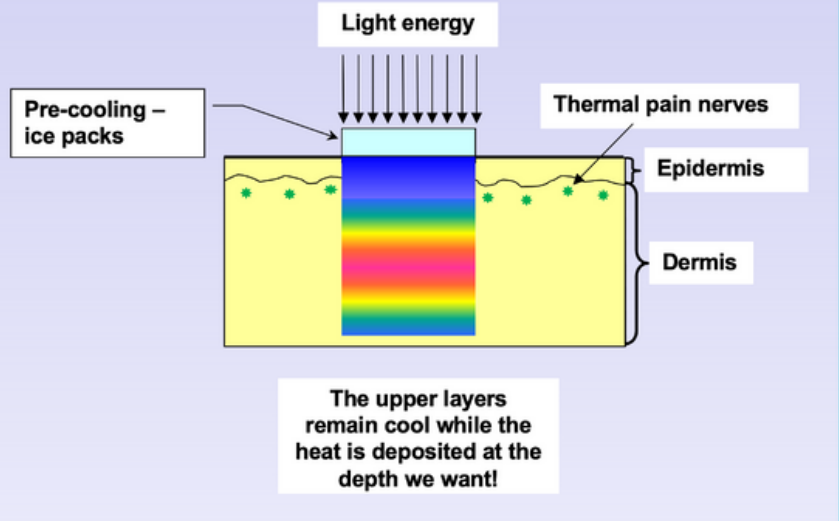
If the temperature of the pain nerves is reduced significantly (by more than 20C) then when they become hot, due to the adjacent epidermal melanin absorbing some of the light energy, their temperature will need to be raised by 30C, or more, to trigger the pain sensation.

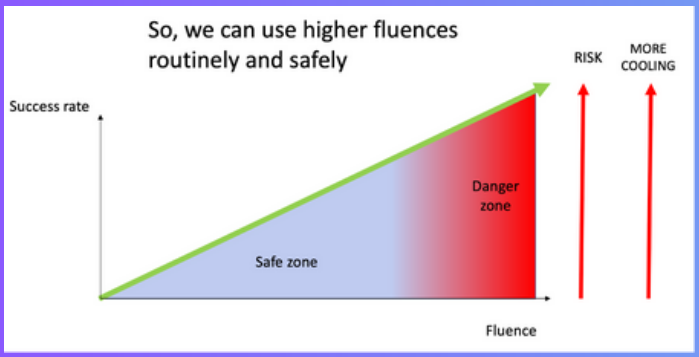
This makes the whole process much more comfortable for the patient/client, and reduces the likelihood of unwanted thermal damage.

Post-cooling

A quick calculation shows that less than 10% of the light energy we fire at the skin surface is actually absorbed by the hair melanin. A significant chunk is lost to back-scattering out of the skin altogether. But this still leaves a substantial amount of light energy in the skin, looking to 'cook' something...

We must try to remove as much of this excess heat energy as quickly as possible, to minimise unwanted tissue damage in the collagen. For this reason, we should apply surface cooling immediately after the treatment. It is best to apply ice packs onto each area as soon as that area has been treated.





More cooling means we can apply higher fluences safely - leading to better results...

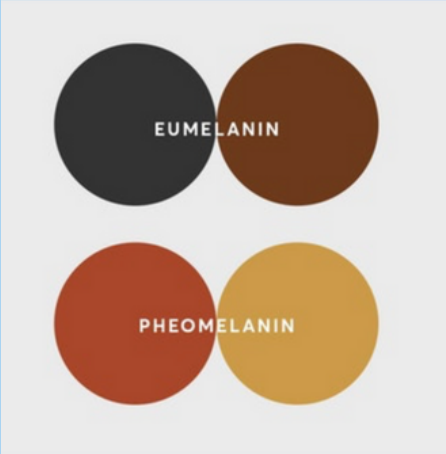
Clinical tests have clearly shown the huge benefits of pre- and post-cooling during laser hair removal treatments. Not only are they much more comfortable for the patients/clients, they also reduce tissue damage.

Hair Colour

THE COLOUR OF THE TARGET HAIR IS VERY IMPORTANT

The colour of all hair is determined by the content of melanin. There are two main types of melanin - eumelanin and pheomelanin.

Most people's hair will contain a mix of eumelanin and pheomelanin. A higher concentration of eumelanin will result in brown and black hair, whilst a higher concentration of pheomelanin will usually show as red hair.



Both of these pigments absorb light across the full visible spectrum. However, pheomelanin does not absorb as strongly as eumelanin in the wavelength region that we typically use for laser/IPL hair removal.

In fact, laboratory data indicates that 'red' hairs require about twice as much fluence as 'black' hairs to induce the same temperature rise. This is why it is difficult to effectively treat red hair! The required fluences would most likely damage the surrounding skin tissue too much.

Black and brown hair mostly contain eumelanin, to varying concentrations. 'Brown' hair has a wide range of concentrations ranging from 'light' to 'dark' browns. Even blonde hair is just a very light brown colour in that it has very low concentrations of eumelanin. Grey and white hair has almost no melanin at all.

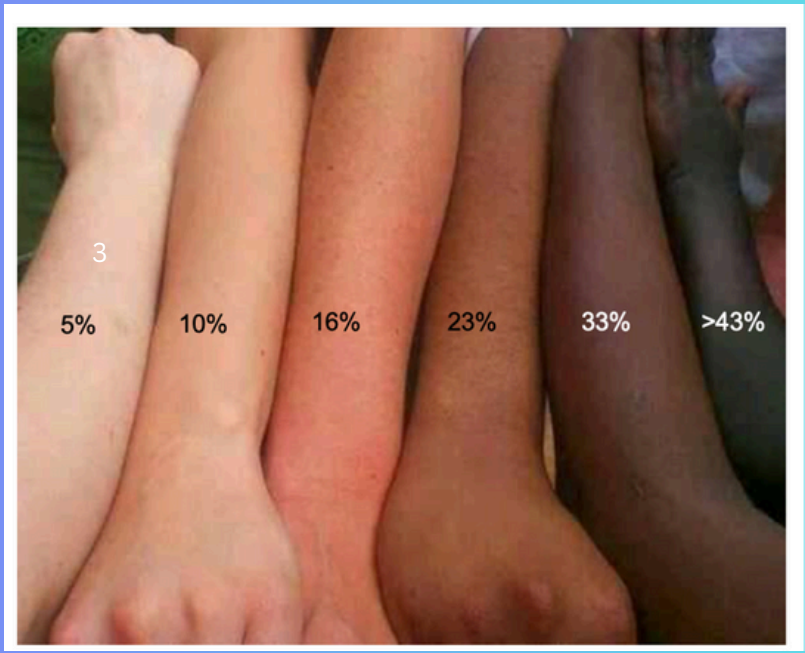
This has a significant effect on the amount of light energy they can absorb. The more melanin a hair contains, the more light energy it will absorb and the higher the temperature rise will be induced. The image below shows how this works...

Hair Colour	Melanin Concentration	Absorption
Black	Very high	Very strong
Brown	Medium to high	Strong
Blonde	Low	Poor
Grey	Very low	Very poor

Skin Colour

THE SKIN COLOUR DETERMINES THE DURATION OF PRE-COOLING

Skin colour comes from the concentration of melanosomes, which are created by melanocytes in the basal layer (stratum basal) of the epidermis.



The 'Fitzpatrick' Scale

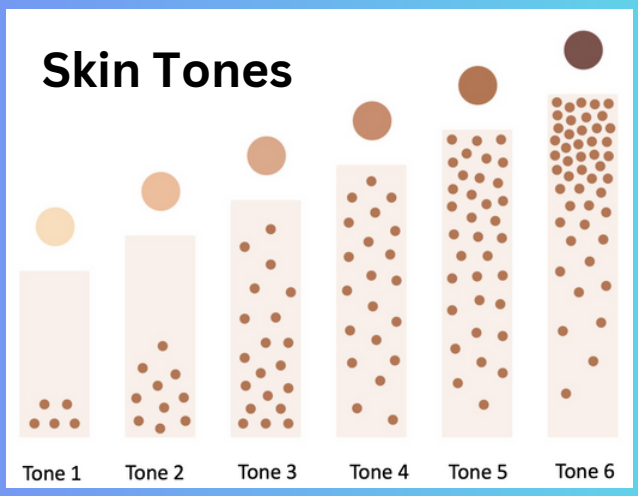
Dr Fitzpatrick was a dermatologist based in San Diego, California in the 1970s and 80s. He mostly dealt with skin cancer patients and developed a 'scale' to determine the likelihood of a person developing skin cancer.

His scale is based on the reaction of skin to ultra-violet light energy (which we never use in hair removal treatments).

Some bright spark in the medical laser industry 'hijacked' his scale back in the 80s and decided it could be used to determine skin 'colour' - it can't!!

Your skin colour depends on the concentration of melanosomes, at the time it is viewed! Its 'Fitzpatrick' is irrelevant!!! Red laser/IPL light does not correlate with ultraviolet light.

Darker skins have a greater concentration of melanin - from around 5% in Skin Tone 1, up to over 43% in Skin Tone 6. As a direct consequence, darker skins will always become hotter than lighter-coloured skins, for the same applied fluence.



We prefer to use a '*Skin Tone*' method to help determine the skin's colour.

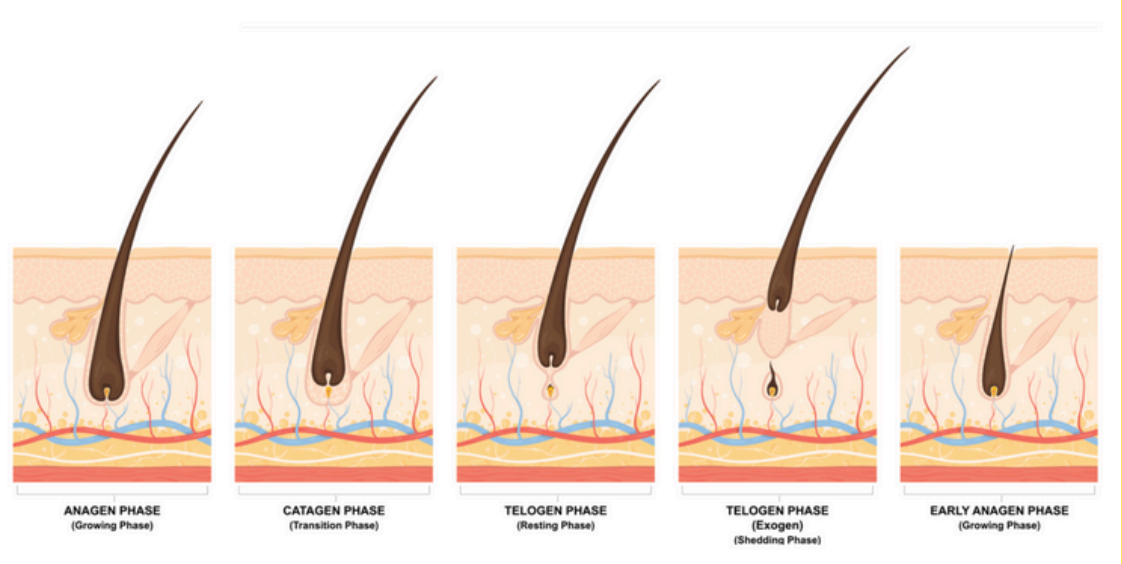
Using the numbers in the above image, we can choose a Skin Tone based on the melanin concentration, *at the time of treatment* - naturally, this tone can vary across a person's body (all the time!), and can vary depending on exposure to UV light from the sun or a sunbed.

The skin tone essentially indicates how hot the epidermis will become when exposed to laser/IPL light energy. This then informs us how much pre-cooling we should apply before delivering that energy.

Darker skins MUST be pre-cooled more than lighter skins.

Hair Growth Cycle

THE IMPORTANCE OF THE GROWTH CYCLES



Every hair follicle goes through the same cycle - anagen - catagen - telogen - anagen...

We can only kill the germ cells when the follicle is in the anagen phase. In fact, recent research indicates that we can only kill them in around 50% of the anagen phase!! The problem is that we don't know when the hairs we are treating are in the desired phase - it is impossible to tell!

The table on the right shows some data taken from a study which looked into the anagen/catagen/telogen phase of hair in a number of volunteers.

As we can see, there is a wide variation of durations of both anagen and telogen phases (the catagen phase tends to be around 10 to 14 days in most people across the body).

Body Area	% Resting Hairs Telogen	% Growing Hair Anagen	Duration of Telogen (weeks)	Duration of Anagen (weeks)	Follicle Density (per cm^2)	Follicle Depth (mm)
Chin	30	70	10	52	500	2-4
Upper Lip	35	65	6	8-20	500	1-2.5
Arm Pits	70	30	12	16	65	3.5-4.5
Bikini	70	30	12	16	70	3.5-5
Arms	80	20	16	12	80	2-4
Legs & Thighs	80	20	20	16	60	2-4.5
Breast	70	30	12	8-12	65	2-4
Scalp	10-15	85-90	12-16	2-6 years	125-200	5 - 7

Richards-Merhag data

This poses a problem for anyone looking to do laser/IPL hair removal - when do we treat people? Is it after a typical telogen phase, or after a complete anagen phase? The answer is not at all obvious! So, we constructed a computer model to look into this in more detail. It turns out that the answer is surprisingly simple...

Time between treatments

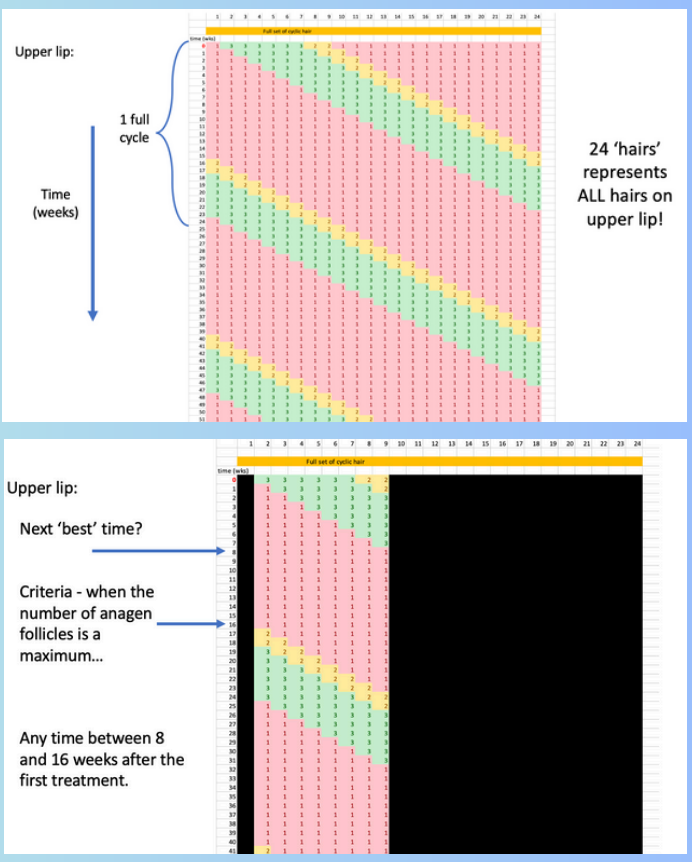
HOW LONG SHOULD WE LEAVE BETWEEN SESSION?

A computer model was designed to look at the growth cycles of hairs across the body. In this model we looked at the anagen, catagen and telogen durations for each site. These were coloured pink, yellow and green, respectively, in the model (see right).

For upper lip hair follicles, we assumed that the anagen phase lasted for 8 weeks, 2 weeks for the catagen phase and 6 weeks for the telogen phase - based on the Richards-Merhag data. We found that 24 columns represented every hair in the upper lip area.

When a follicle was 'killed' the column was turned black (right). This then showed which follicles remained alive and in which part of each phase they were.

From this, it was easy to see when most follicles were back in the anagen phase.



Mike's computer model for the upper lip based on the data from the Richards-Merhag study.

This model was repeated for all the body areas where data was available. It was further refined by reducing the 'efficiency' of the treatment from 100 to 80 to 60%. We found that, at a 60% efficiency, the total number of treatment sessions required to kill all the follicles was typically between 6 and 8.

In general, the longer the gap between sessions, the more anagen follicles will be available for the next treatment.

Given that many laser/IPL operators quote this range of sessions, it is clear that most operators are working in the range 50 to 60%, in terms of efficiency.

If we can improve our efficiency, we will reduce to total number so sessions required.

The above model indicates that we can remove hair, from any body site, given a sufficient number of treatment sessions. However, the 'best' time is anywhere between four and twelve weeks, depending on the area. There is no 'perfect' number - it merely alters the total number of sessions overall!

Techniques - Stamping, SHR and SHR Stacking

These are ***techniques*** - not devices!

Stamping

In the 'stamping' mode, we usually apply high fluences (typically above 20 J/cm^2) onto the skin, but with only one shot on each area. The idea is that the fluence is sufficiently high to induce all of the damage in just one shot. But, such high fluences may also damage the skin (especially if there is no pre-cooling!!), so we do not go over the same area again. This will generate a lot of heat energy in that area, so pre- and post-cooling are definitely required.

SHR

'SHR' is also known as 'gliding' or 'in-motion'. This technique was developed by a dermatologist who was trying to reduce the pain of diode laser hair removal. Rather than doing the obvious thing - applying ice cooling - he chose to slide his laser handpiece up and down the treatment area, using a low fluence, typically 10 J/cm^2. This require multiples shots at the same area to 'build up' the temperature in the follicles. While this is a feasible approach, it can be very inaccurate since it is difficult to know if sufficient heat has been applied in each area. Many people use this technique today, but generate poor or patchy results, because they do it badly.

SHR Stacking

This technique combines the above two - multiple shots are fired at the hair, but without moving the handpiece. In essence, the energy pulses are 'stacked' on top of each other. Using low fluences, between 10 and 20 J/cm^2, the laser operator might fire four or five, or more, pulses into the same area on the skin. As with the SHR technique above, this 'builds up' the heat energy in each area, but without the gliding motion.

Summary

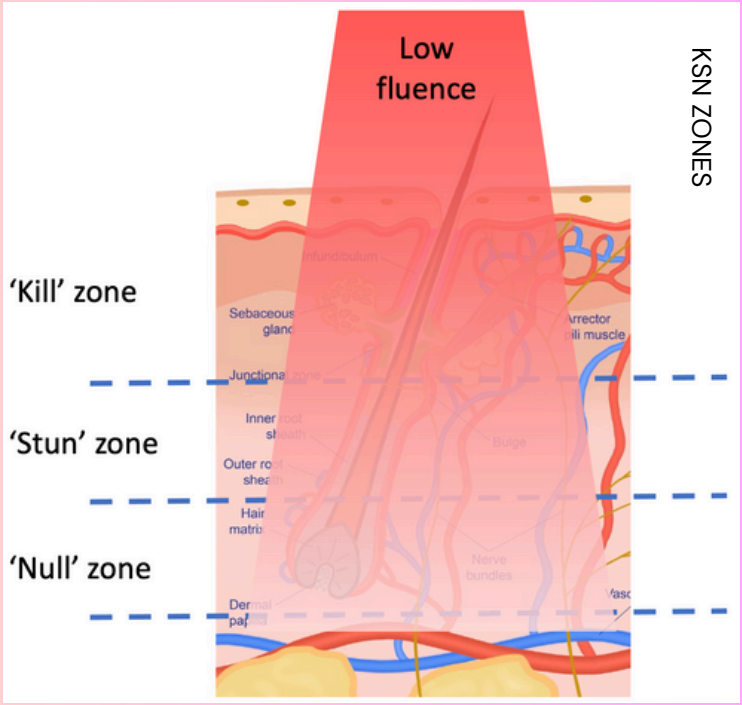
The important thing is to be sure you are generating enough heat in the follicles. It doesn't really matter how you do it - each of the above techniques work. We prefer the 'stamping' method since it gives a bit more precision and control over what is being delivered to the skin.

The KSN Zones

There are three ‘zones’ we should consider when performing laser/IPL hair removal:

The ‘Kill’ zone

For most fluences applied to the skin surface, there will be a “kill” zone where the follicles will be irreversibly destroyed. The depth of this zone depends entirely on the fluence delivered.

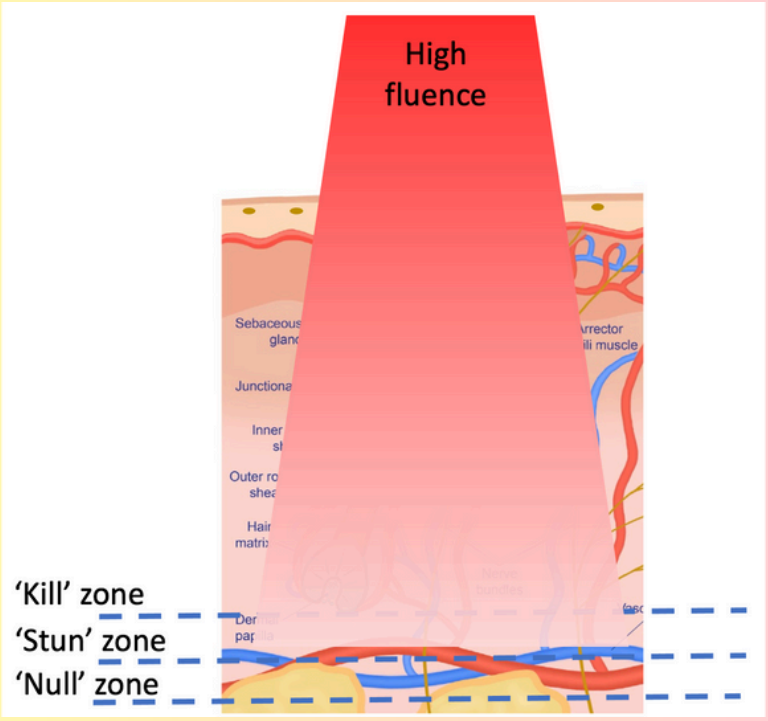


The ‘Stun’ zone

Below the ‘kill’ zone there exists the ‘stun’ zone. In this region, the fluence is not sufficiently high to cook ALL of the germ cells in those deeper follicles - only a portion of them. Those follicles will regenerate in the next anagen phase and regrow, usually with finer, lighter-coloured hairs.

The ‘Null’ zone

Below the ‘stun’ zone will be the ‘null’ zone where the fluence may have raised the temperature of the germ cells slightly but not enough to have any meaningful effect on them. These follicles will regrow as normal, within no obvious signs of damage.



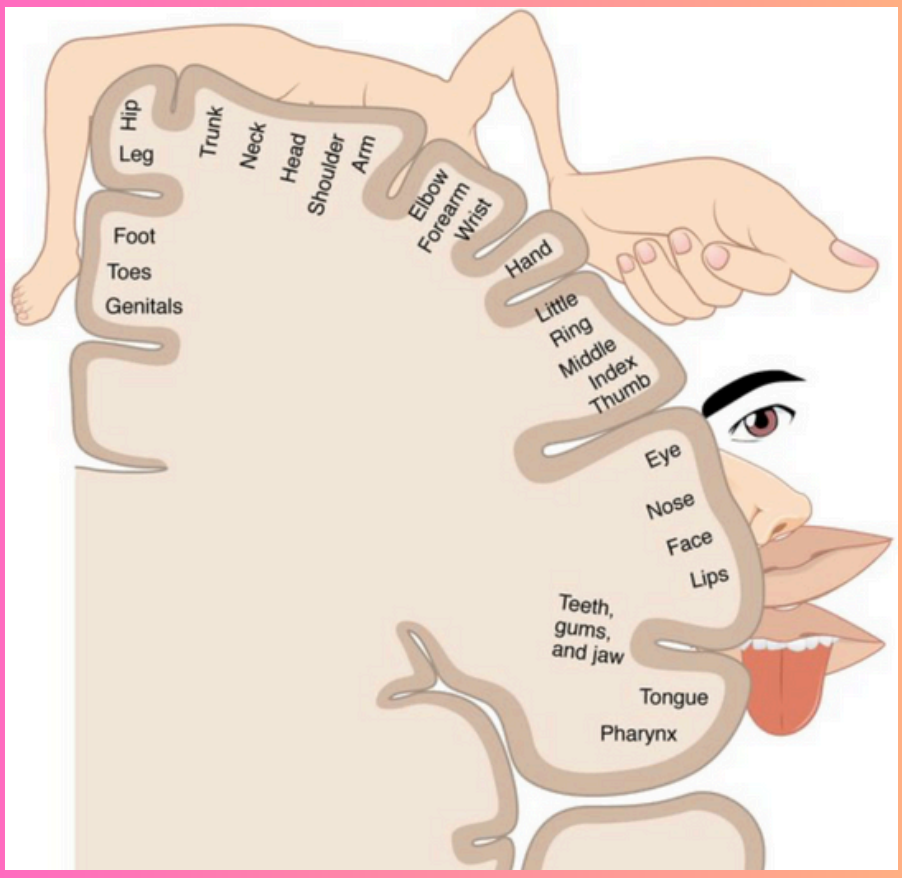
The depth of each of these zones depends on the fluence. Higher fluences will always irreversibly destroy deeper follicles by ‘pushing’ down the kill zone (left). If you see some hairs ‘re-growing’, usually finer and lighter in colour, then this indicates that the fluence used was too low.

Deeper follicles will likely have survived the previous treatment(s). This is particularly true with those body sites where follicles can be very deep such as the underarms, bikini areas and the scalp. Higher fluences must always be used in those regions to ensure good success levels.

Nerve Density

The thermal pain receptors are called ‘thermal nociceptors’. Studies have shown that these are typically triggered at around 45 degrees Celsius - that is the temperature at which pain is felt. Below this we feel heat, but not pain. Given that our usual dermal temperature is around 35 degrees, or so, it only takes a 10 degree rise in temperature to trigger pain.

But, we should also consider the density of nerves in each body site.



This image shows the relative pain nerve density across the body. Some areas - fingers, face, tongue - have higher densities of pain nerves.

This means that these areas will ‘feel’ more pain compared with other body regions.

We must be aware of this when applying photothermal treatments.

If we apply some fluence onto the legs, the patient/client may not feel much sensation (especially if they were pre-cooled with ice). However, the same fluence may trigger a painful response on the face or hands. This may be simply due to the higher density of nerve endings at this sites.

The pain also depends on the skin colour - darker skin tones will absorb more of the light energy, leading to higher temperatures in the epidermis and subsequently more pain.

Remember, the pain is caused by a combination of fluence, skin tone and nerve density. This can be effectively mitigated with proper ice-cooling - before and after each treatment.

SUMMARY

This booklet is a very brief introduction to the world of laser/IPL treatment of hair. Here are the more salient points:

In a nutshell, it all comes down to energy/fluence! This is the stuff which drives every reaction in the skin. If you choose the correct energy coupled with the correct spot size, pulsewidth and wavelength, you will achieve your goal.

Hair

The real targets are the stem/germ cells around the follicles

Light can kill these cells only in the anagen phase - which varies significantly across the body

The hairs must be dark - i.e. contain sufficient melanin

The best situation is 'dark hair, light skin tones' - high contrast

Pulsewidths between 1 and 30 ms are ideal in most situations

Too low a fluence will typically result in the regrowth of finer, lighter-coloured hairs

The longer the gap between sessions, the fewer sessions will be required, overall

Fluence

Fluence is critical in achieving successful outcomes

Fluence directly determines the rise in temrpatures in the hair follicles and germ cells

Higher fluences must be applied for deeper follicles

The final success of any laser/IPL hair treatment is strongly dependent on the applied fluence

Skin Cooling

Pre-cooling is important to minimise pain and protect the upper skin layers

Ice-cooling is the most efficient way to apply skin cooling

It reduces pain, swelling and pigmentation changes

Post-cooling is required to extract excess heat energy after the treatment

You cannot rely on the cooling tips of devices to cool the skin sufficiently.

Use ice packs!!

The Technologies

There are four light-based technologies ued for hair removal these days:

Long-pulsed Alexandrite Lasers

These lasers deliver a 755nm wavelength in pulsewidths around a few milliseconds, typically. The 755nm wavelength is strongly absorbed in melanin, so it is mostly used on paler skin tones. It is not used on darker skin due to the greater risk of epidermal damage. The pulsewidths tend to be in the lower millisecond range, typically between 1 and 10 ms.

Long-pulsed Nd:YAG Lasers

The LP Nd:YAG laser delivers a 1064nm wavelength, again in a few milliseconds. However, this wavelengh is quite poorly absorbed in melanin (around one third that of the 755nm Alexandrite wavelength), which means that significantly higher fluences must be applied to the hair to induce the desired reaction. Since it is so poorly absorbed in melanin, this laser is the 'safest' when treating very dark skin tones, such as black skin. However, it can be used on all skin tones quite safely.

Diode Lasers

Diode lasers use an array of tiny diode semiconductor lasers, which each deliver a small amount of energy. They typically output a 808nm or a 810nm wavelength - it doesn't really matter. This range of wavelengths is absorbed less effectively than the 755nm Alexandrite, but more than the 1064nm Nd:YAG. But diode lasers are different from the other technologies in that they can come in a wide variety of powers. This means that it can be quite 'tricky' trying to compare them as they can deliver the same fluences, but over different pulsewidths! Lower power systems may require more than 100ms to deliver a decent fluence - however, this is not so important as long as the required fluence is used.

Intense Pulsed Light Systems

Some people say that IPLs cannot remove hair - they don't know what they're talking about! Of course they can! But they are usually a little more difficult to use than lasers, as they require more in-depth knowledge. With the correctly applied fluence and filters, they can easily remove hair in many skin tones (not very dark or black). The advantage of IPLs is that they also have other treatment applications such as removing blood vessels and benign pigmentation.

Finally, there is no such thing as a "Gold Standard" laser or system - that's just marketing baloney!!

TIPS...

Here we tell you about some tips we have picked up over the years.

You cannot ‘over-cool’ the hair!!

Black/very dark hair is significantly darker than the skin. So, it is difficult to ‘over-cool’ the hair, as a consequence. Our tip is to always cool for more time, rather than less.

‘Cold’ pain to prevent ‘hot’ pain’

In essence, you want your customers to complain about how cold the pre-cooling feels, to minimise them complaining about the heat of the IPL/laser.

Leave longer gaps between sessions

Our model shows that leaving longer gaps between sessions means that there will usually be more anagen follicles ready for treatment next time. By doing this, you reduce the overall number of treatment sessions.

“Under promise, over deliver”

One of our mantras is to ‘under promise and over deliver’. It is good approach to customer service since your customers should always be happy with their outcomes. Don’t promise the Earth - that has already been taken!

Don’t go over tattoos

When doing laser/IPL hair removal, do not go over, or too near to, tattoos. This may cause unwanted damage.

Fluence is KING!

Fluence is the real “driver” of all photothermal treatments including hair. It is the fluence which determines whether you will achieve a good result or not. But it must be balanced by the pre-cooling.

Don’t rush treatments

Some people rush their treatments - trying to get as many customers through the day as possible. This is not good business practice. It is much better to take your time and provide good, effective results.

Check your equipment

All lasers/IPLs will lose efficiency over time. If you are busy with your device, get it checked by a laser/IPL engineer regularly, to ensure you are delivering the correct fluence every time. Make sure they calibrate your device - EVERY TIME!!

No overlapping

Do not overlap when in ‘stamping’mode - you will deliver too much energy to the same area!

Plume....

Finally - plume!! That’s the stuff which fills the air after laser treatments. It consists of bits of skin and hair and other stuff. Studies have shown this to be quite nasty! Take care by wearing appropriate masks - N99s are good - and/or installing an extractor unit in your laser room.

How to treat hair

FOUR FINAL MESSAGES

Fluence ⟷ Hair depth

Skin cooling ⟷ Skin colour

As fluence ↑, cooling must also ↑

and

As skin colour ↑, cooling must also ↑

Pre-cooling: reduce pain

and

Post-cooling: reduce tissue damage

Fluence → Success!!!

Mike Murphy has been investigating laser-tissue processes and treatments since 1986. He has published many peer-reviewed papers, articles and books on various topics including the removal of hair, tattoos, blood vessels, pigmentation using lasers and IPL systems.

He continues to research all of these areas and still presents his work at international medical laser conferences.

He has published three books on this subject:

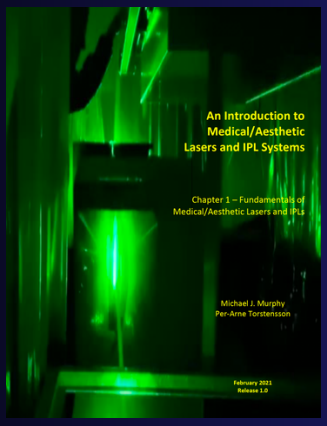
An Introduction to Medical/Aesthetic Lasers and IPL Systems

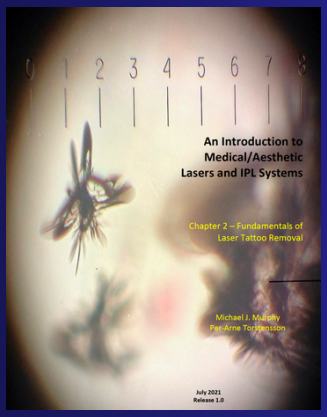
An Introduction to Laser Tattoo Removal

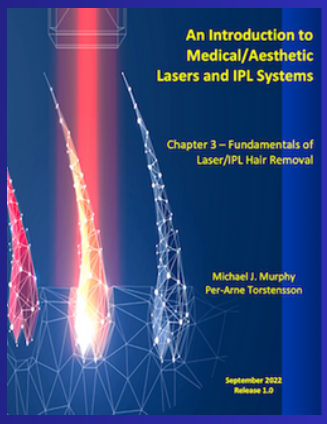
An Introduction to Laser/IPL Hair Removal

This translation was created by a machine.
My apologies if it is not quite correct.

You can find his blog at '**MikeMurphyBlog.com**'







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