5 Parameters Explained:

1) **Wavelength**
2) **Power**
3) **Spot Size**
4) **Pulse Width**
5) **Cooling**

Wavelength

Each wavelength propagates to a different location (depth) in tissue according to it's own unique absorption characteristic. Medical laser wavelengths range from 193nm – 10,600nm. We will sub divide that range into 4 sections consisting of Ultra Violet (193nm – 400nm), Visible (400nm – 750nm), Near Infrared (750nm – 1300nm) and the Mid Infrared (1300nm – 10,600nm).

Each section has its own unique targets, when we leave one group and travel into another group our tissue target and response changes. This is the reason we have marked specific boarders within range.

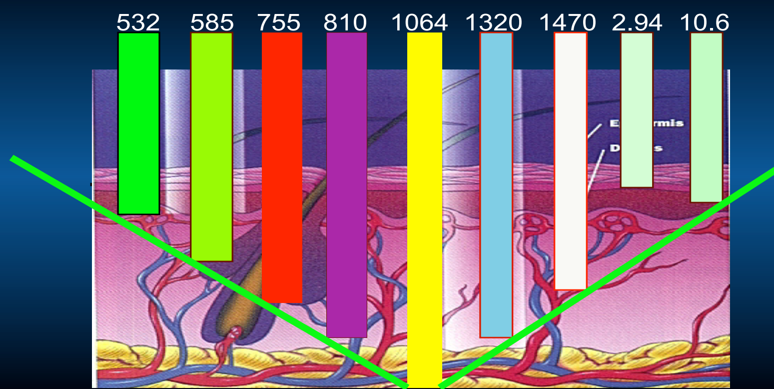
UV primarily looks for protein and has a very limited absorption length or penetration in tissue.

Visible light looks for a color opposite and its depth or absorption length increases as its absorption coefficient in tissue decreases. As the absorption coefficient decreases it will take more power to get heat down to that location of the target.

Near IR is what we refer to as the "Grey Zone". You have lost the absorptions of color targets and have not reached water in the mid infrared. If you can imagine colors in shades of grey, this is what these wavelengths see. The darker the shade of grey will have the highest absorption.

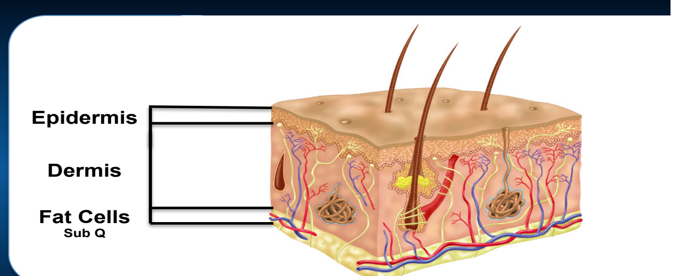
Mid IR as stated above, this is where water begins to become the primary target chromophore. As the absorption in water increases, it becomes more superficial in it absorption length. The sub range of 1300nm – approximately 1900nm will have a warming effect on tissue or bulk heating depending on the energy used. The remaining range of 1900nm – 10,600nm are known as ablative wavelengths used for tissue removal. Note that the non ablative wavelengths, 1300nm – 1900nm can be concentrated into smaller spot sizes which will in fact results in tissue necrosis, cellular death.

Absorption Length



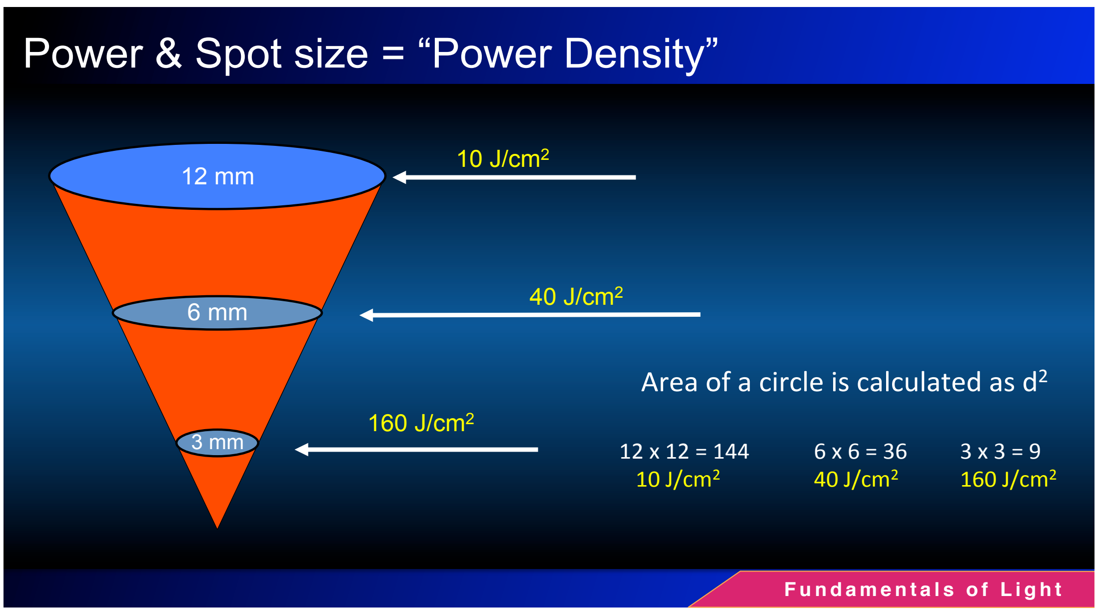
Where is the Target Located?

- **Pigmented Lesions**
  – DE junction and Above
- **Vascular**
  – DE junction and Below
- **Water**
  – Through out the epidermis and dermis
- **Hair**
  – Dermis and Subcutaneous



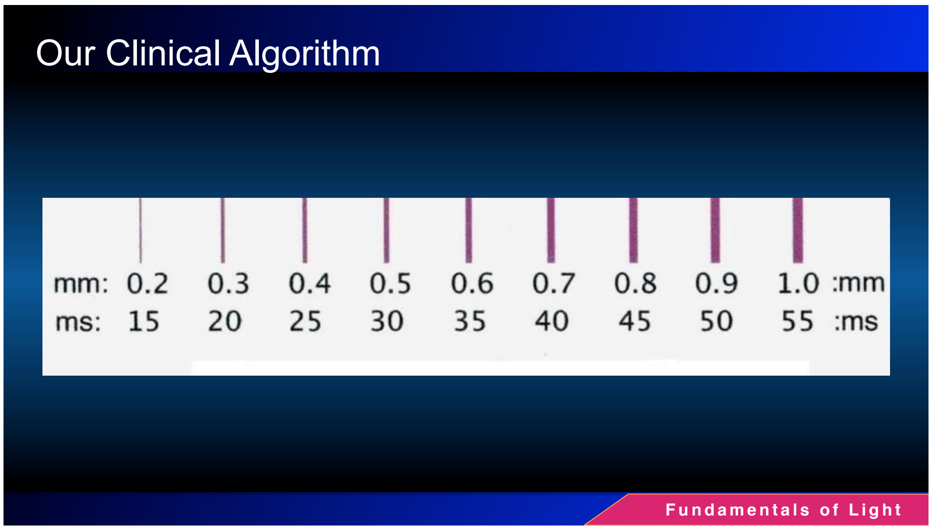
Power & Spot Size

These two parameters are always combined to give us a desired power density (temperature) expressed in J/cm^2. Once we transmit down to the tissue target we wish to effect we must have sufficient heat to uniquely change that target. This is accomplished by concentrating a select number of photons around the target known as J/cm^2. This is how hot the heat source will be when it reaches and surrounds the target. It should be known that larger spot sizes would allow wavelengths to achieve their maximum absorption length within tissue. Smaller spots may choke back or limit the depth potential of the wavelength. One may conclude that the smaller spot is like putting a governor or limiter to the wavelengths ability to transmit deeper into tissue.



Pulse Width

This is the specific time the target needs to be exposed to the aforementioned heat source once it reaches the target. Smaller targets need less time to uniformly heat to a selected temperature. Larger volume targets naturally take longer exposure times of the same heat source to achieve the selected temperature measured in ^{0}C. If you take too long in heating up a smaller target, it will begin to give the heat absorbed to surrounding tissue before reaching the desired ^{0}C. This will require you using excessive energy, which is never desirable. Thermal Relaxation Time (TRT) is the cool down time for the target. We must deliver the energy (heat) into the target faster than it's ability to cool. We always strive to use the least amount of energy to uniquely affect the target, which leads to fewer complications. Conversely if we use too short of a delivery time we do not allow for total saturation of heat in the target and that leaves the target not completely affected. The ideal time for selectively heating a target using the least amount of energy is approximately ½ of the calculated thermal relaxation time.



Cooling

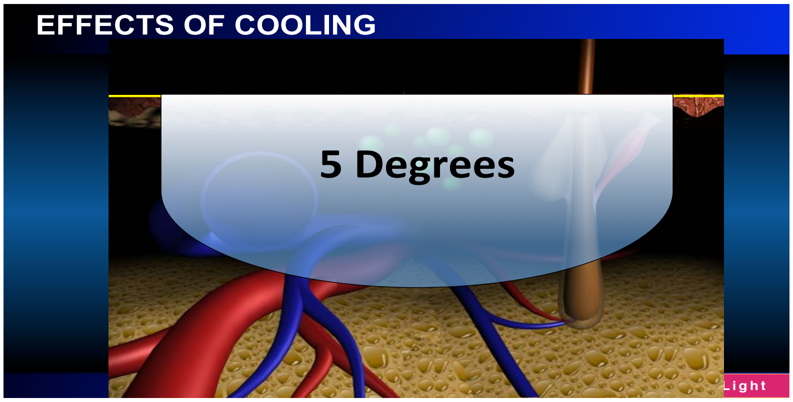
The use of cooling below 20⁰C is purely anesthesia in my opinion. I recommend utilizing 4 cooling temperatures consisting of 5, 10, 15 & 20⁰C. If your target location in tissue is over 4mm deep the use of 5⁰C will protect the tissue structures down to the target but not cool the intended target. As the target location becomes more superficial you will need to decrease your protection to avoid cooling the target your trying to heat.

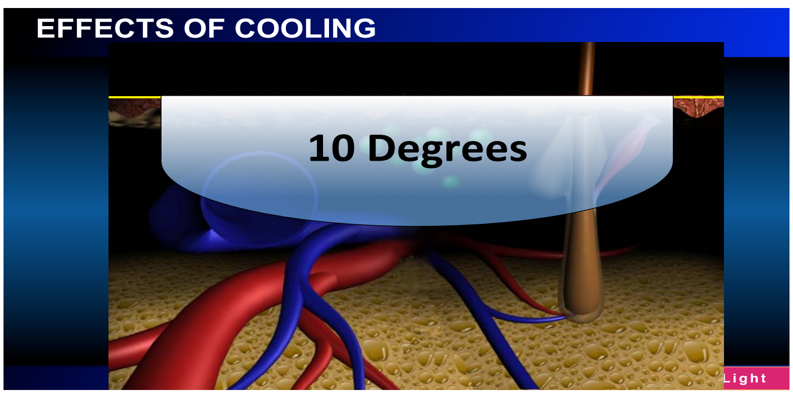
Deep = 5⁰C

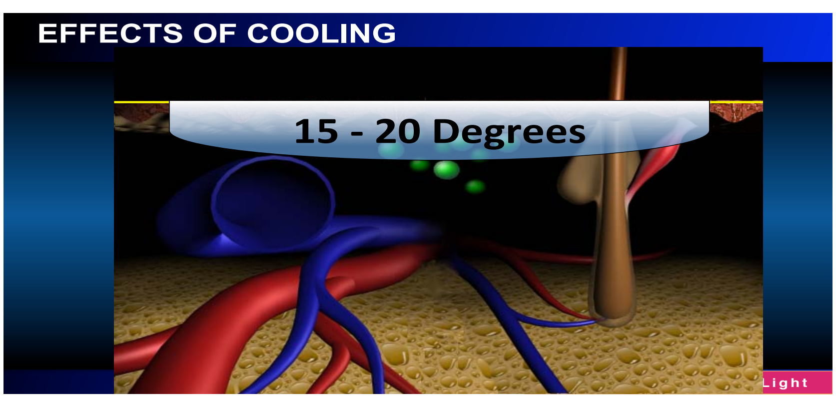
Medium = 10⁰C - 15⁰C

Superficial = 20⁰C

Using too much cooling will force you to increase your energy (J/cm^2) and we do not like using more energy as it increases our risk of complications.


EFFECTS OF COOLING
5 Degrees
Light


EFFECTS OF COOLING
10 Degrees
Light


EFFECTS OF COOLING
15 - 20 Degrees
Light

Intense Pulsed Light (IPL)

Intense Pulsed Light is not a laser, the excitation source is one or multiple xenon flash lamps that emit an output spectrum commonly in a range of 400nm – 1400nm. Different manufacturers may use different variations of this range lamps, you should always ask for their specific ranges. The photons produced are channeled down to tissue through some form of optically clear crystal to tissue. These crystals often have a high sapphire content to aid in both transmission and conduction with tissue. The higher the sapphire content the more conduction and protection of tissue. Furthermore; these crystals are often cooled to either a static temperature or variable temperatures to protect the more superficial tissue as indicated in cooling section.

Since using all these wavelengths would see each and every target in tissue, we use cutoff filters to block or limit certain wavelengths. These filters are mostly "High Pass" filters which block wavelength less than the number on the filter and allow wavelengths above that number to pass thru. By blocking the lower number wavelengths, you can locate the heat source deeper into tissue without damaging the more superficial structures the shorter wavelengths see.

Most common filters include:

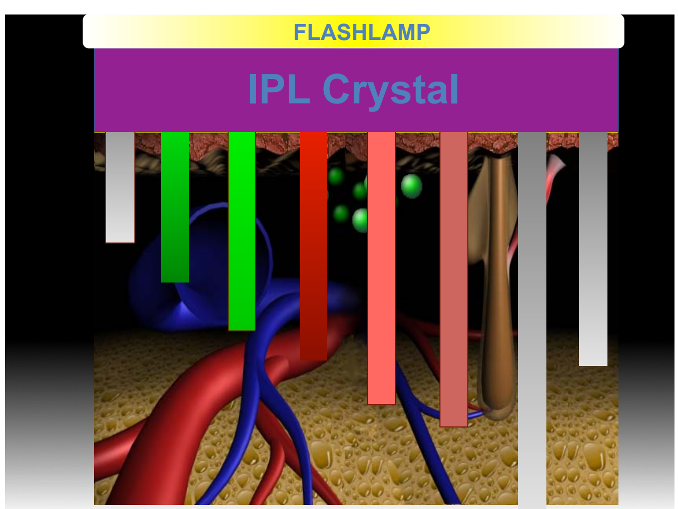
Pigment @ 515nm

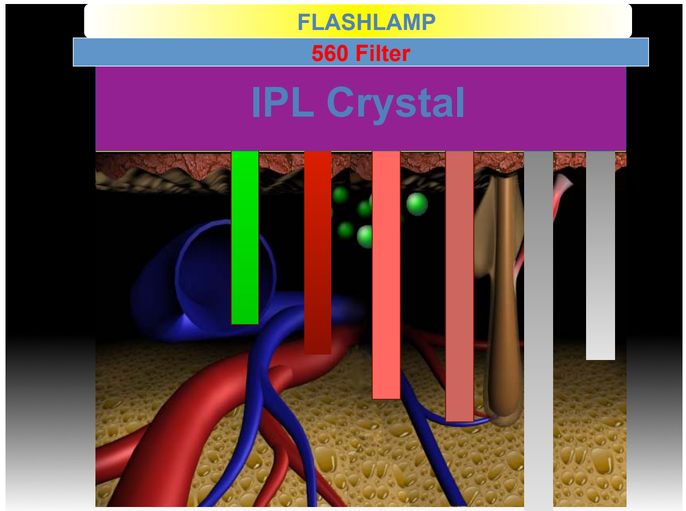
Vascular @ 560nm & 590nm

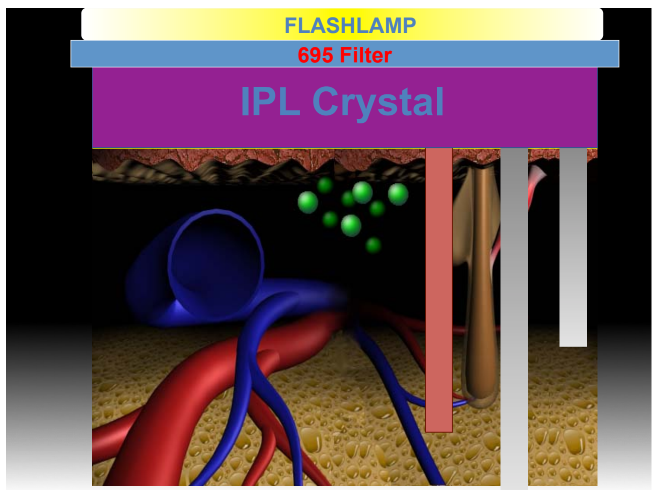
Hair @ 640nm & 695nm

Treating pigmented lesions we use 515nm – 1400nm with the peak of absorption at 515nm that looks for targets superficially. When we want to look for vascular targets below that area we use a 560nm or 590nm (590nm used for darker skin types).

Below are examples of how that would work.







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