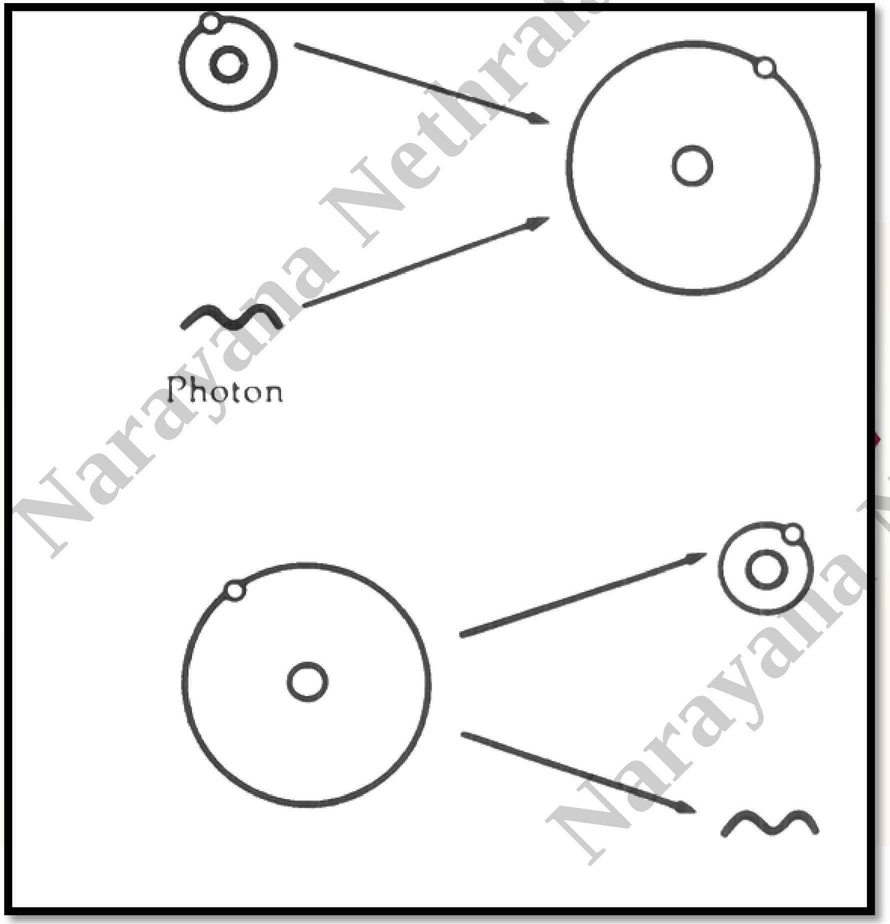
LASERS IN RETINA

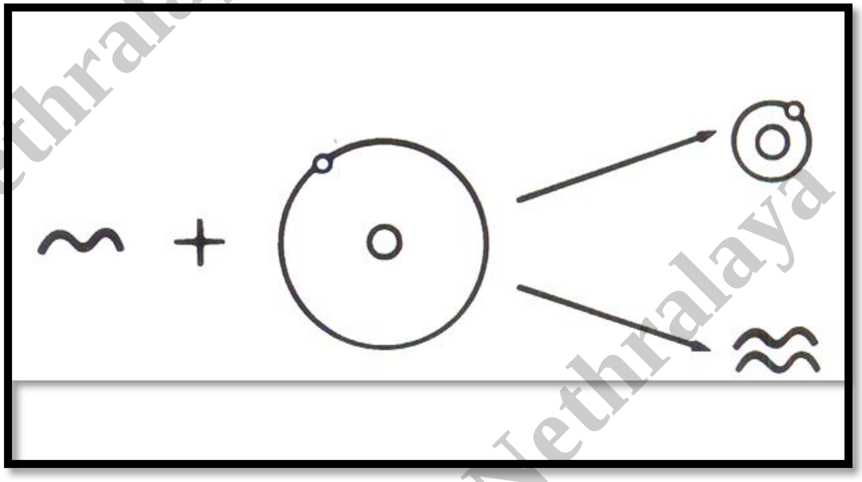
Light Amplification by Stimulated Emission of Radiation

PROPERTIES OF LASER

- MONOCHROMATIC
- COHERENT
- POLARIZED
- COLLIMATED



Spontaneous emission



Stimulated emission

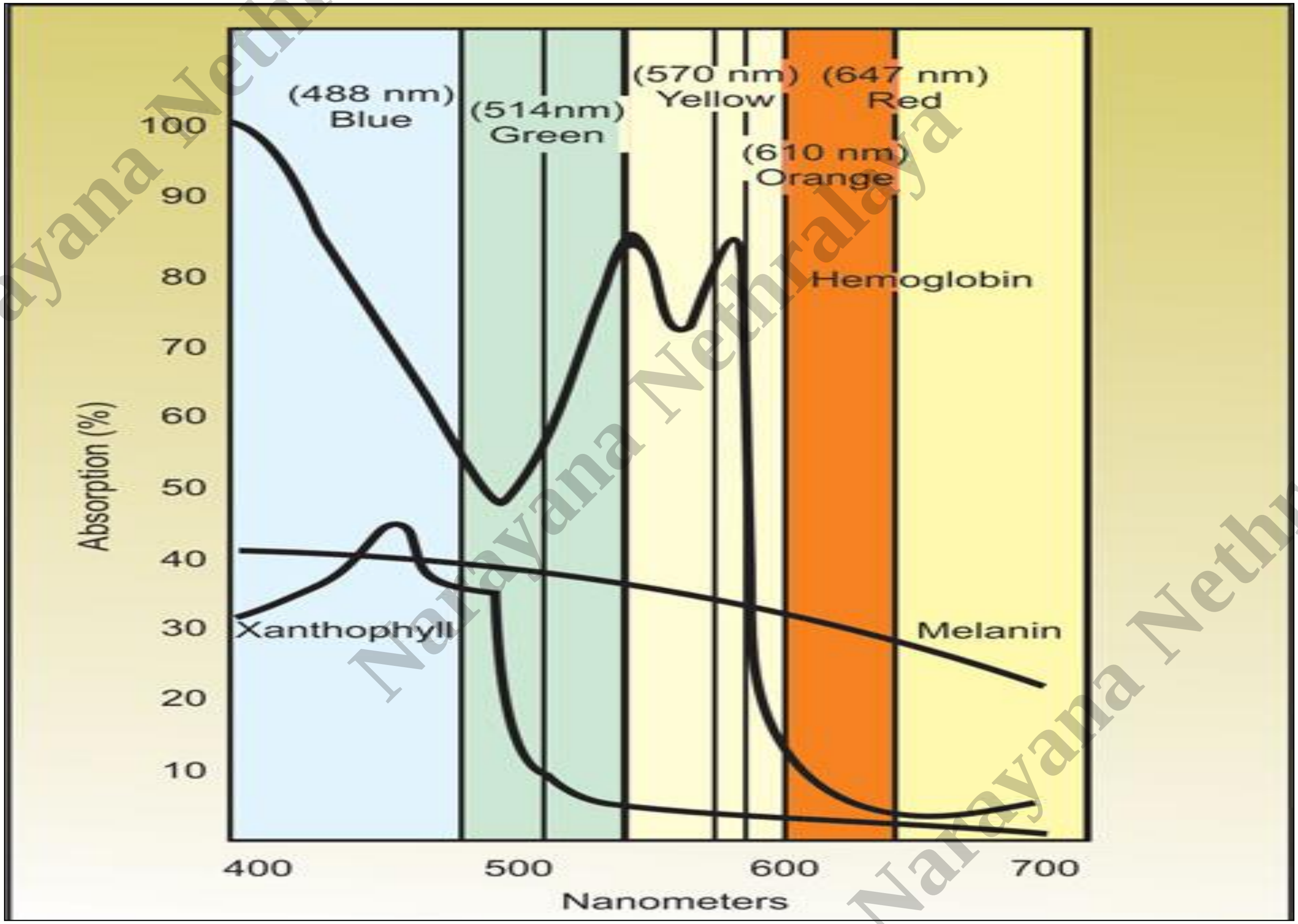
Lasing Medium used

Solid State	Ruby, Nd YAG, Erbium YAG
Gases	Argon, Krypton, He- Neon, CO2
Metal Vapour	Cu, Gold
Dyes	Rhodamine
Excimer	Argon Fluoride, Krypton Fluoride, Krypton Chloride
Diode	Gallium-aluminium-arsenide

LASER PARAMETERS

- **Power**
- **Exposure time**
- **Spot size**
  - magnification factor of the laser lens
- **Energy**

OCULAR PIGMENTS:ABSORPTION



THERAPEUTIC APPLICATIONS

- Diabetic Retinopathy
- RVOs
- CSCR
- CNVM
- PCV
- ROP
- COATS DISEASE

- Small vascular tumors
- Sickle cell retinopathy
- Arterial macroaneurysms
- Prophylactic lasering around peripheral retinal lesions

Laser tissue interactions

- Thermal effect
  - Photocoagulation
  - Photovapourization
- Photochemical effect
  - Photoradiation
  - Photoablation
- Ionising effect
  - Photodisruption

PHOTOCOAGULATION

Laser

↓

Target tissue

↓

Generate heat

↓

Denatures proteins(coagulation)

↓

Rise in temperature to about 50 degree centigrade will cause coagulation of tissue

Examples:
Argon514
Krypton 647
Freq doubled nd YAG 532
Long pulsed nd YAG
Diode805-810 nm

PHOTOCHEMICAL EFFECT

Photon + photosensitizer in ground state

3s high energy triplet stage

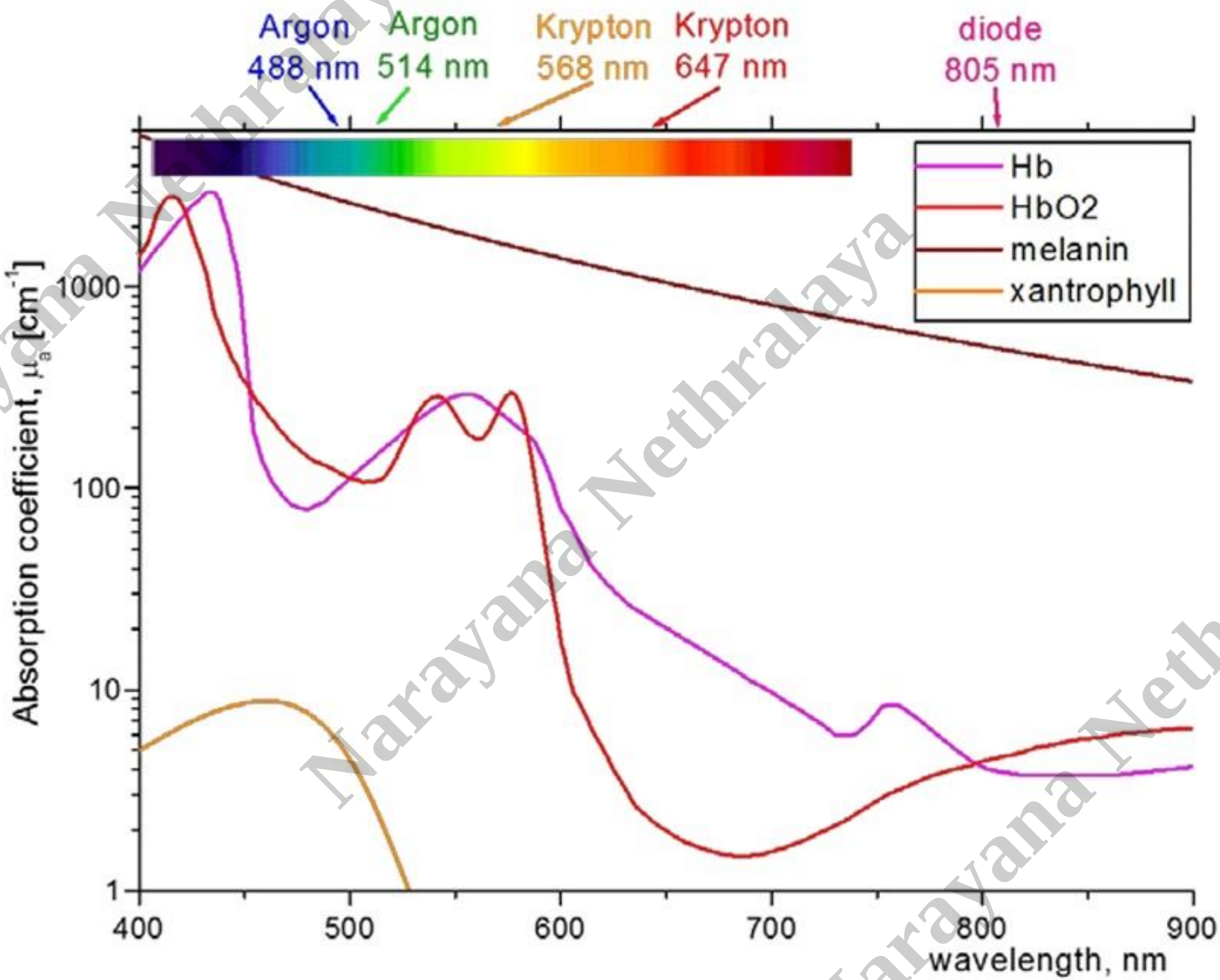
Molecular oxygen(singlet oxygen)

free radical(cytotoxic intermediate)

Cell damage, vascular damage, immunologic damage

Examples:

- Verteporfin 689nm



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YELLOW LASER (577nm)

- Outside the absorption spectrum of retinal xanthophylls
- Highest oxyhaemoglobin to melanin absorption ratio
- Combined absorption (melanin and oxyhemoglobin) - Energy concentration to a smaller volume
- High choriocapillaries absorption

*Joondeph BC, Joondeph HC, Blair NP. Retinal macroaneurysms treated with the yellow dye laser. Retina. 1989;9:187–92. [PubMed: 2595110]
* Mainster MA. Wavelength selection in macular photocoagulation.
Tissue optics, thermal effects, and laser systems. Ophthalmology. 1986;93:952–8.[PubMed: 3763141]

Lens	Image Magnification	Laser Spot Magnification	Field of View
Goldmann 3-mirror	0.93x	1.08x	140°
Mainster Widefield	0.68x	1.5x	118-127°
Mainster PRP 165	0.51x	1.96x	165-180°
Volk Quadraspheric	0.51x	1.97x	120-144°
Volk Super Quad 160	0.50x	2.00x	160-165°

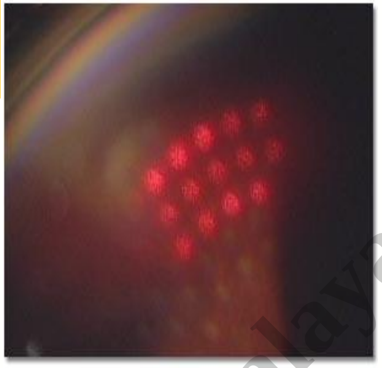
Contact lenses for PRP

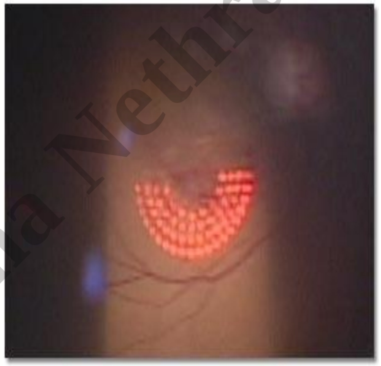
Lens	Image Magnification	Laser Spot Magnification	Field of View
Goldmann 3-mirror	0.93x	1.08x	140°
Mainster standard	0.96x	1.05x	90-121°
Mainster high magnification	1.25x	0.8x	75-88°
Ocular PDT 1.6X	0.63x	1.6x	120-133°
Volk area centralis	1.06x	0.94x	70-84°

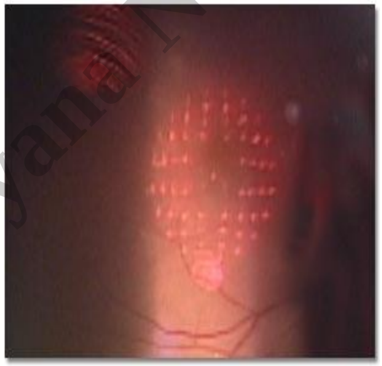
Lenses for Focal / Grid laser

Pattern Scan Laser

- **Launched in 2006**
- **Rapid**
- **More comfortable**
- **Advanced precision**
- **Easy to use**
- **Lesser scarring**







ADVANTAGES

- Less collateral retinal damage
- Different patterns of treatment
- Multiple spots in single pedal depression
- Increase in macular edema – relatively less
- Confluent/ overlapping burns –not possible
- Less duration, less pain

LIMITATIONS

- Inability to design the laser pattern
- Media opacities-limitations
- Retinal periphery often difficult

LASER INDIRECT OPHTHALMOSCOPE (LIO)

Ideal for

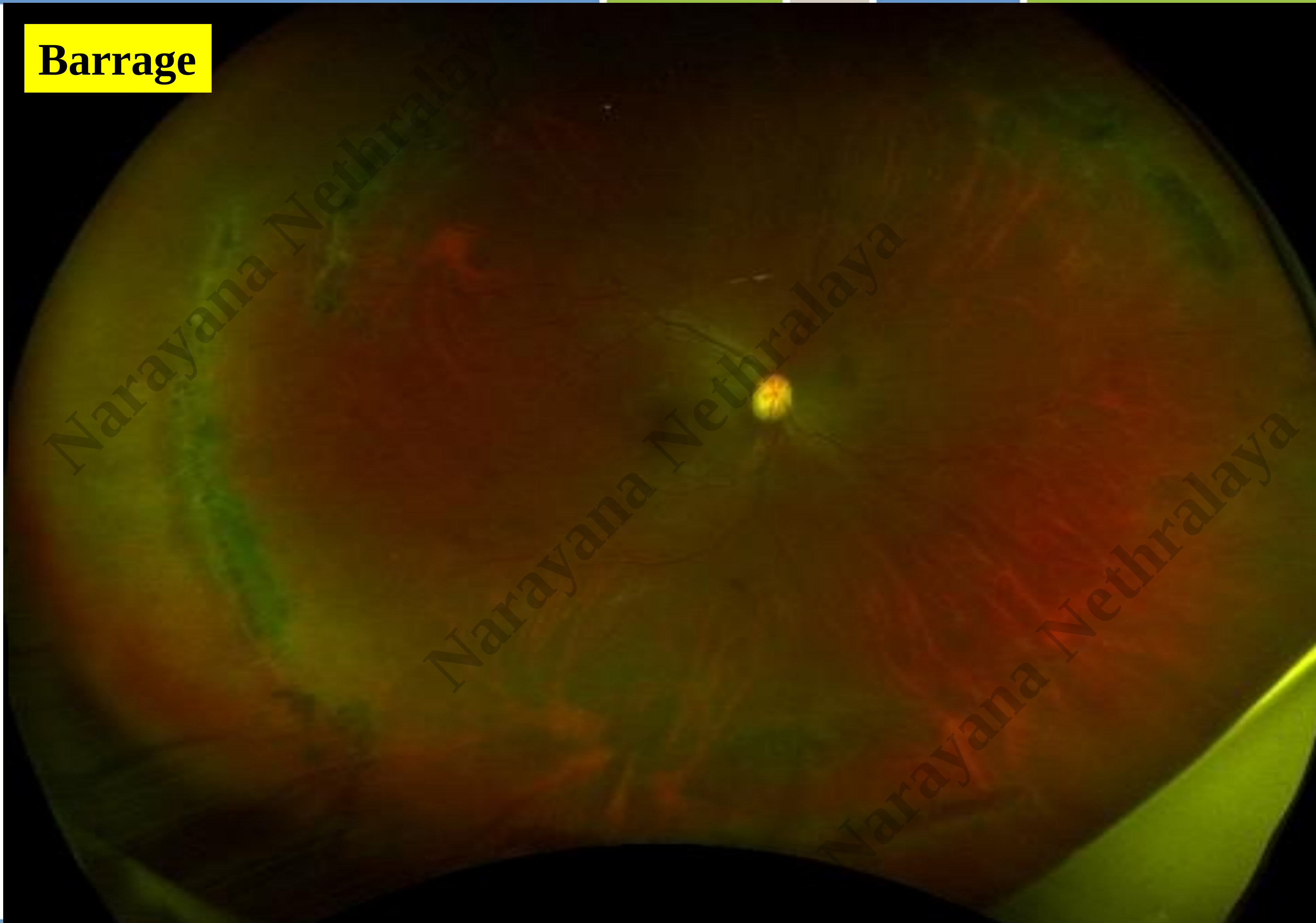
- Extreme peripheral lasers
- Children under GA
- Small pupil, intraocular gas, lental opacities

Spot Size altered by

- Dioptric strength of condensing lens
- Refractive status of eye (H< E < M)

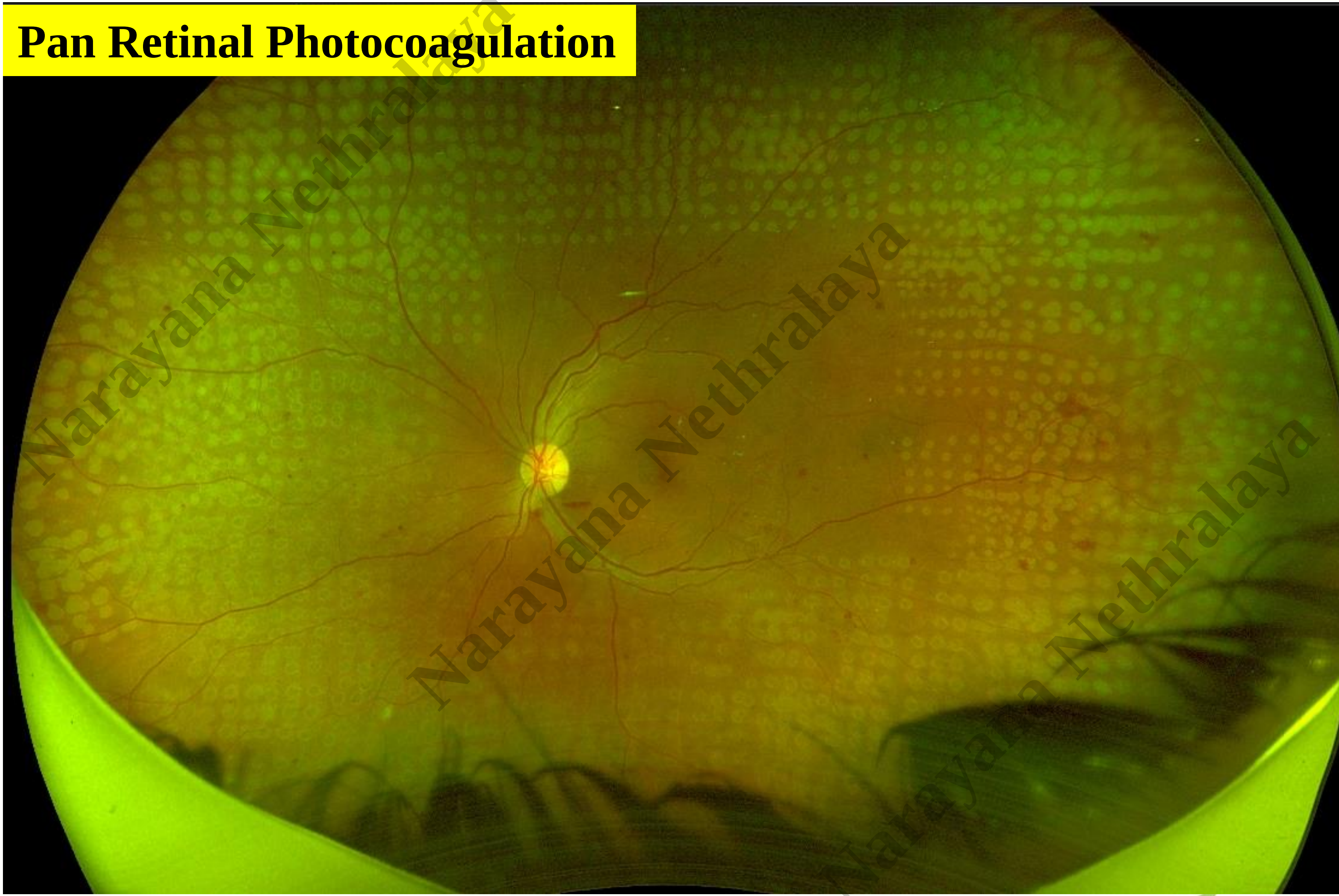
TYPES OF LASER PATTERNS

- Barrage
- Pan Retinal Photocoagulation
- Sectoral Laser
- Focal Laser
- Micropulse

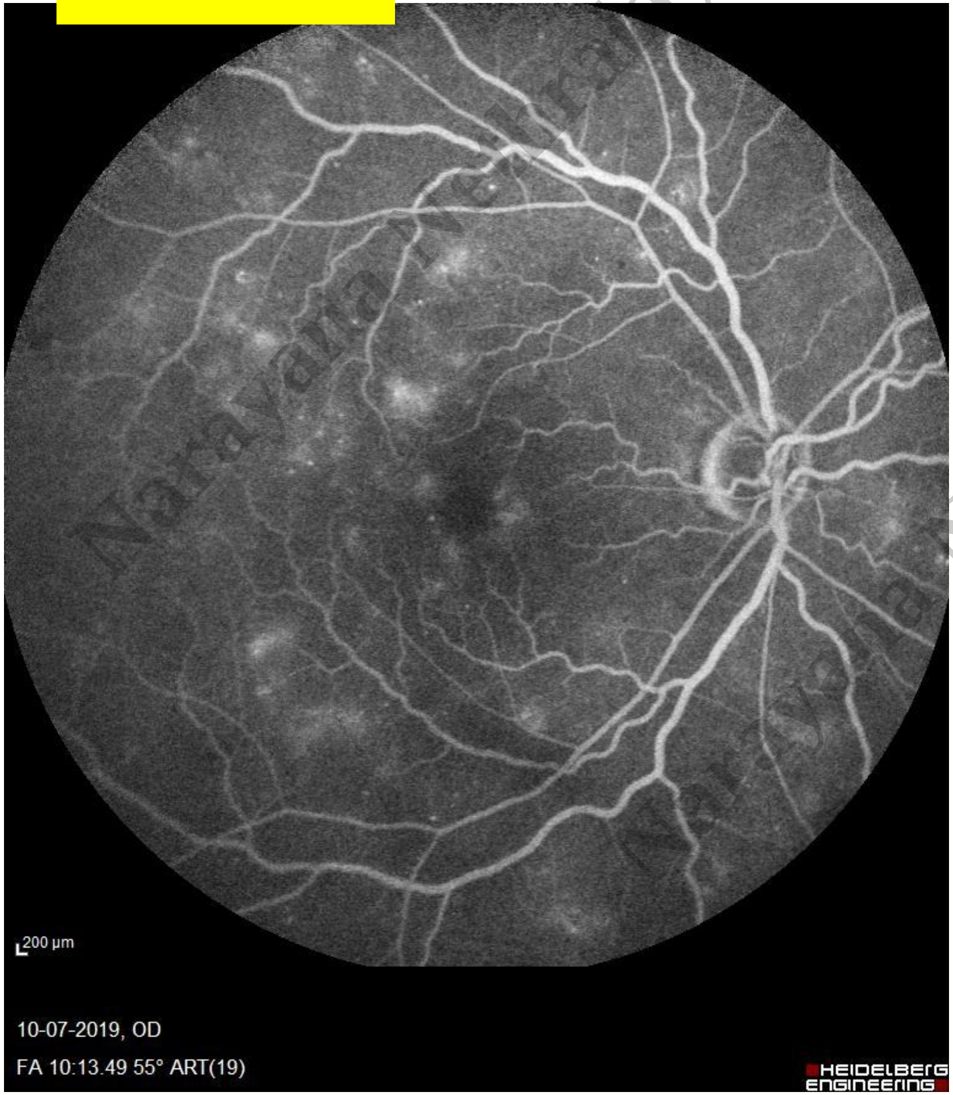

Barrage

Sectoral Laser

Pan Retinal Photocoagulation

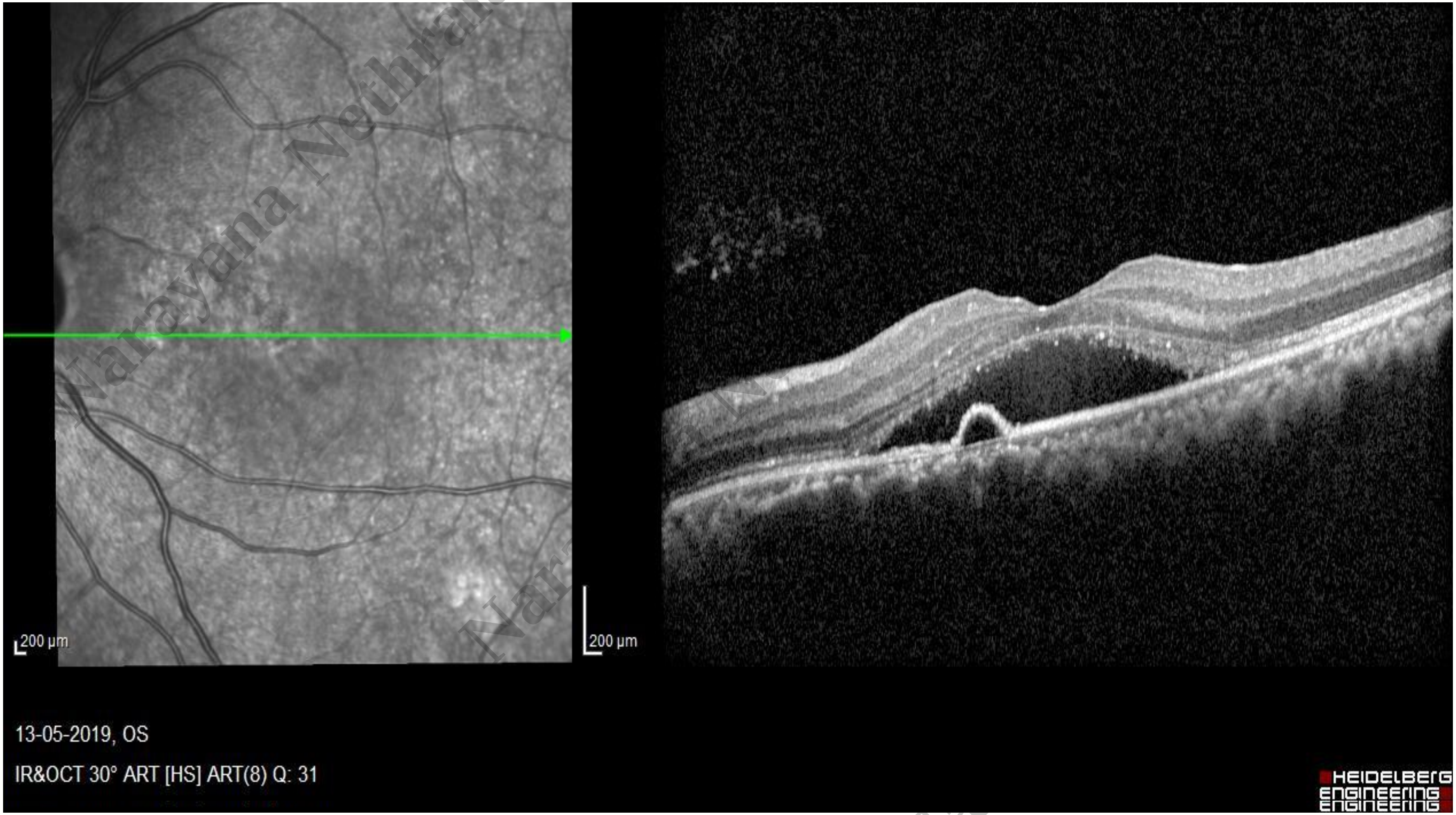


Focal laser


200 µm
10-07-2019, OD
FA 10:13.49 55° ART(19)
HEIDELBERG ENGINEERING


MultiColor
200 µm
10-07-2019, OD
MColor 30° ART(5)
HEIDELBERG ENGINEERING

Micro pulse


200 µm
200 µm
13-05-2019, OS
IR&OCT 30° ART [HS] ART(8) Q: 31
HEIDELBERG ENGINEERING

THE MICROPULSE LASER

- laser energy was delivered in short pulses or “micro pulses”

- **DUTY CYCLE -** The duty cycle is the fraction or percentage of the time span during which the laser energy is emanated compared to the span it is not or the cumulative relaxation time between pulses

***Pankratov MM. Pulsed delivery of laser energy in experimental thermal retinal photocoagulation. ProcSoc Photo Opt Instrum Eng. 1990;1202:205–13.**

- **ON time: duration of each micropulse**
- **OFF time: time between successive micropulses,**

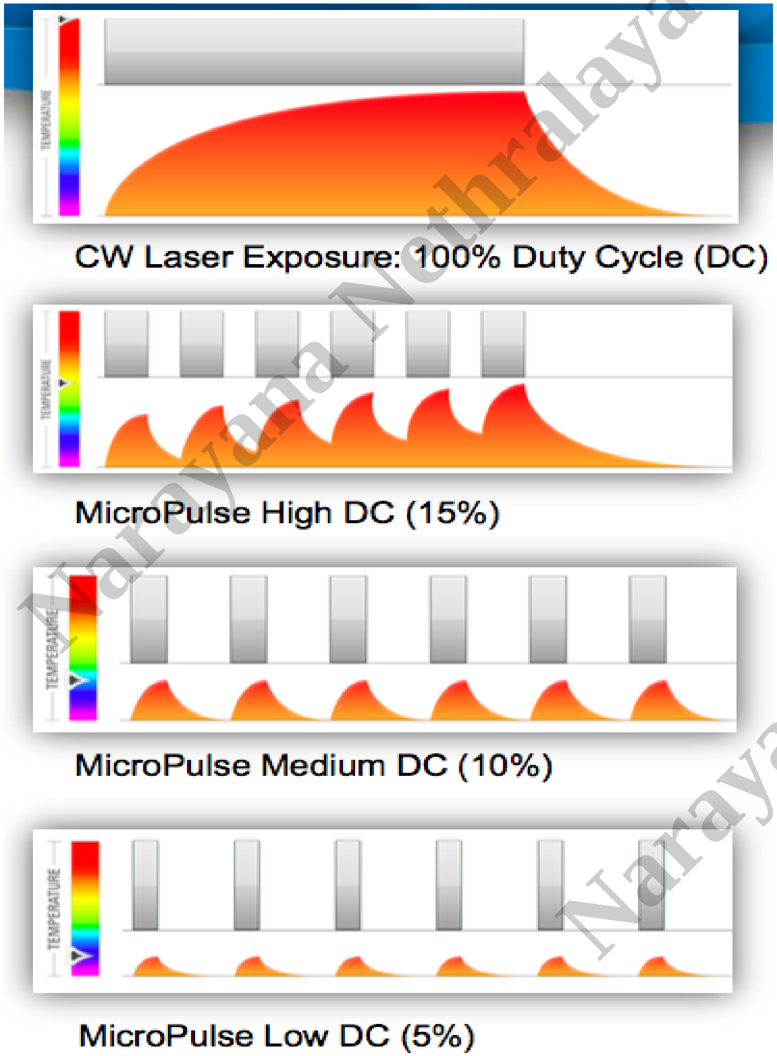
- **Period T = ON + OFF time**

- **Duty cycle = ON time / T**

  (should not be more than 15%)

- **Frequency = 1/T**

- **Off time reduces heat in tissues and regulates the thermal isolation of each pulse**



- ***In conventional, continuous-wave (CW) photocoagulation, a rapid temperature rise in the target tissue***

  ↓

  THERMAL BLOOMING

- ***MicroPulse technology "chops" a laser beam into a train of repetitive short pulses***

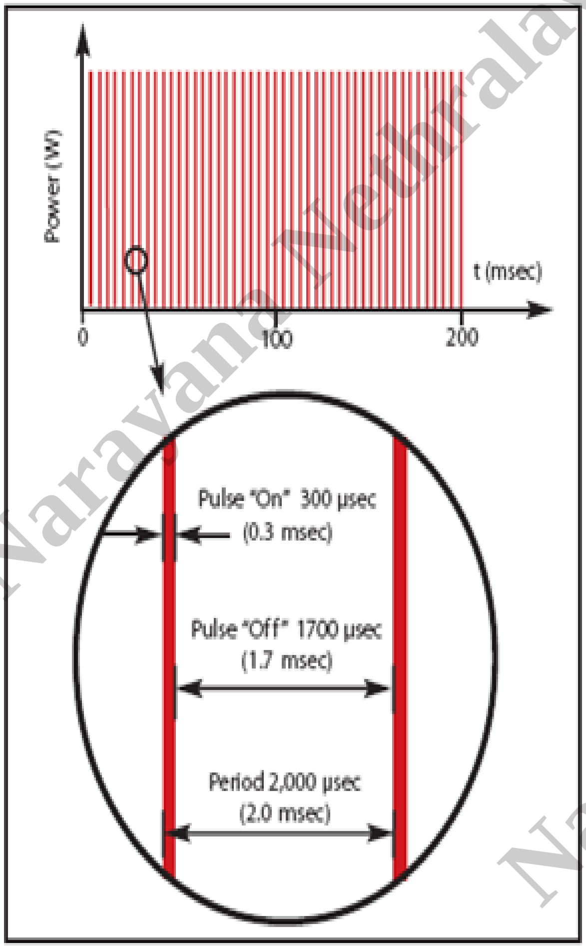
  ↓

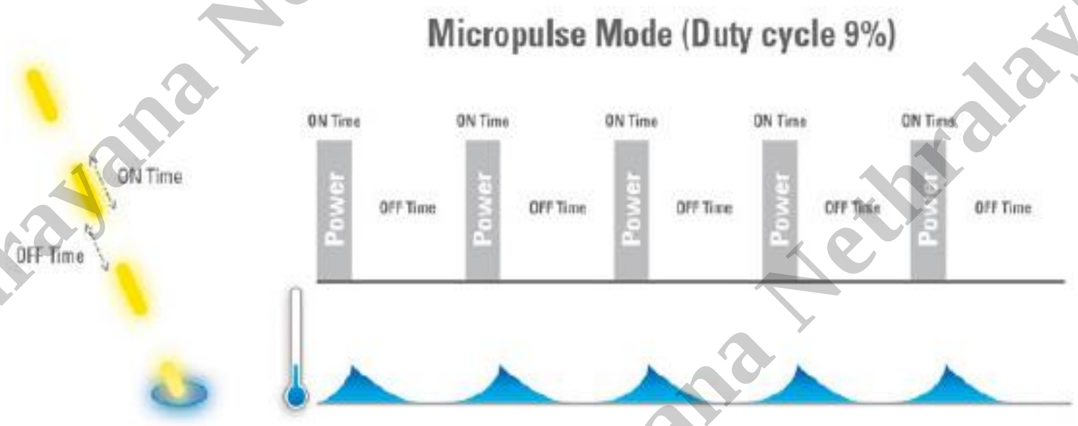
  no heat built up

***Mainster MA. Laser-tissue interactions: future laser therapies. Diabetic Retinopathy: Approaches to a Global Epidemic. Association for Research in Vision and Ophthalmology Summer Research Conference 2010; 31 July; NatcherCenter, National Institutes of Health, Bethesda MD. 2010.**

***Mainster MA. Decreasing retinal photocoagulation damage: Principles and techniques. SeminOphthalmol. 1999;14:200–9. [PubMed: 10758220]**

- **Laser energy is dispensed in a "envelope" of micro pulses.**
- **These summate to reach the level needed for activation of cytokine expression and VEGF down regulation.**





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TARGETED RETINAL PHOTOCOAGULATION

- Examples

  -feeder vessel photocoagulation in choroidal neovascularization

  -focal laser photocoagulation in the treatment of DME

  -selective laser to areas of nonperfusion

- selectively treat ischemic retinal areas and adjacent intermediate areas showing leakage on angiography

COMPLICATIONS

- Constriction of peripheral visual field
- Night vision defects
- Reduction in contrast sensitivity
- Macular edema
- ERM formation
- Choroidal effusion
- Vascular occlusion or spasm
- Perforation of Bruchs membrane

IEC 60825-1 -- Laser classes

UniversiteitLeiden

Leiden Institute of Physics

NCDH	IEC	Range	Hazard
I	1	**< 1 µW**	No hazard
n.a	1M	**< 1 µW entering the pupil**, Total power < 0.5 W	No skin hazard; hazardous for eye if viewed through optical instruments; **no optics**
II	2	**< 1 mW; 0.25 s, 400-700 nm**	No hazard for skin or eye: protection by the eye reflex
n.a	2M	**< 1 mW/Pupil 0.25s, 400-700 nm**; Total power < 0.5 W	No skin hazard; hazardous for eye if viewed through optical instruments; **no optics**
IIIa	3R	**< 5 x Class 2;** 0.25 s, 400-700 nm < **5 x Class 1**; 100s, invisible light	Hazardous for the eye, but nor for the skin
IIIb	3B	**> 3R, max 0.5 W**	Hazardous for both, eye and skin
IV	4	**> 3B**	Hazardous to eye and skin, fire hazard

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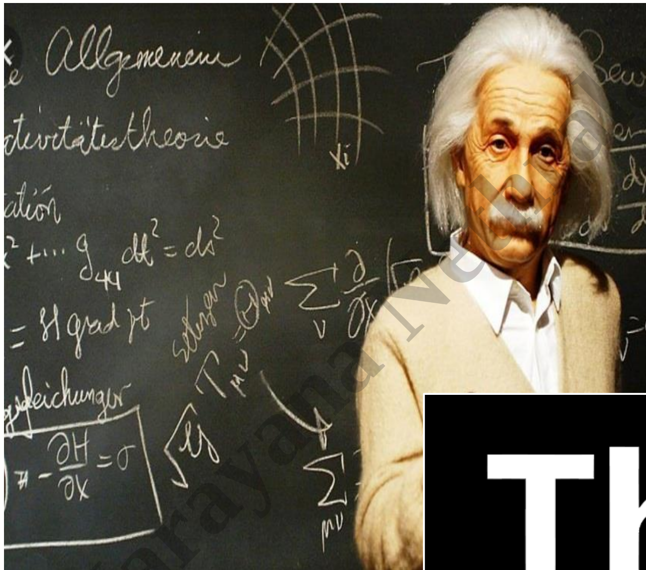
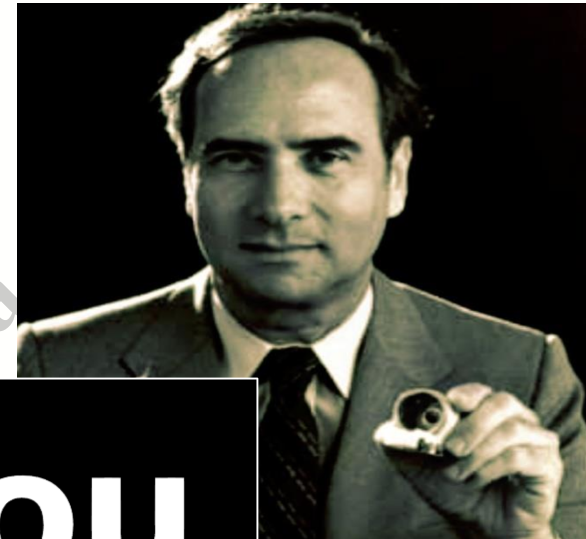
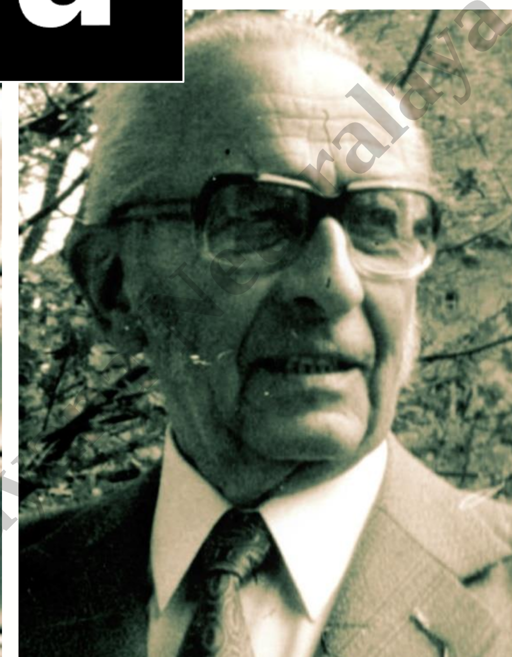




Thank You





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