

Professor of the Course of Rehabilitation Medicine at the Academy of  
Postgraduate Education under FSBU FSCC of FMBA of Russia



**SERGEY V. MOSKVIN**

# Basics of Low-Level Laser Therapy. Wound healing

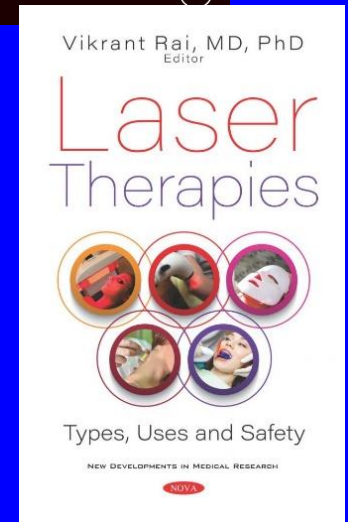
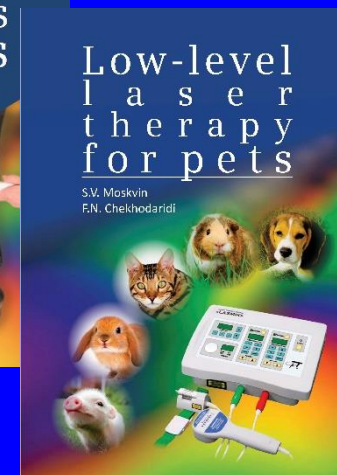
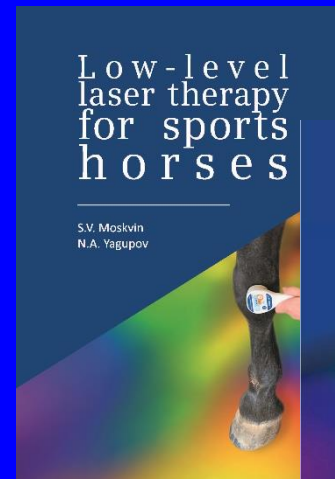
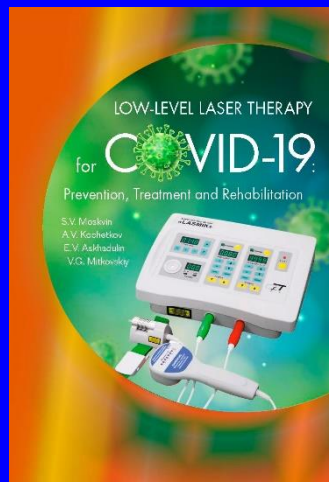
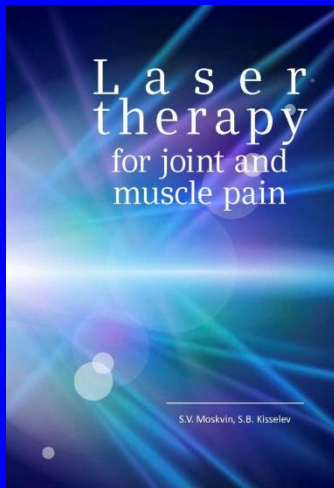
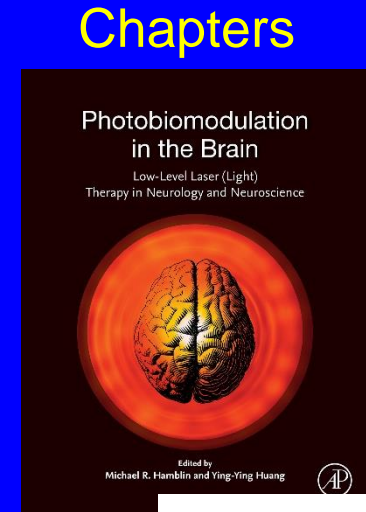
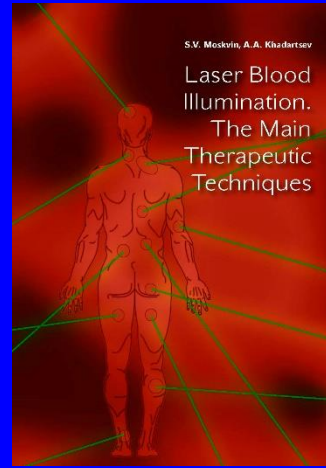
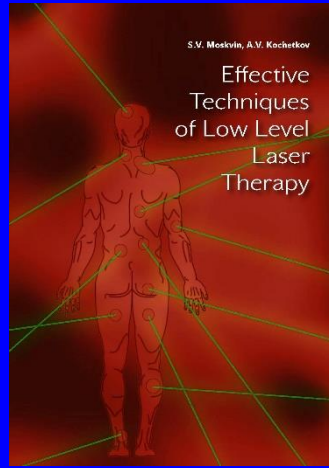
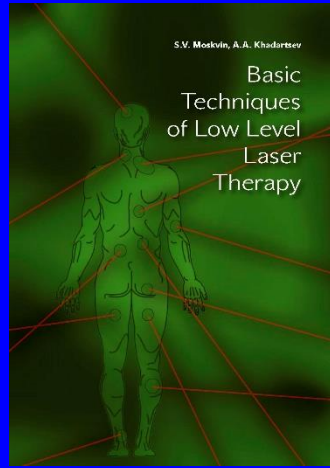
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<https://lazmik.ru>



# Our books



# LLLT - low-level laser therapy

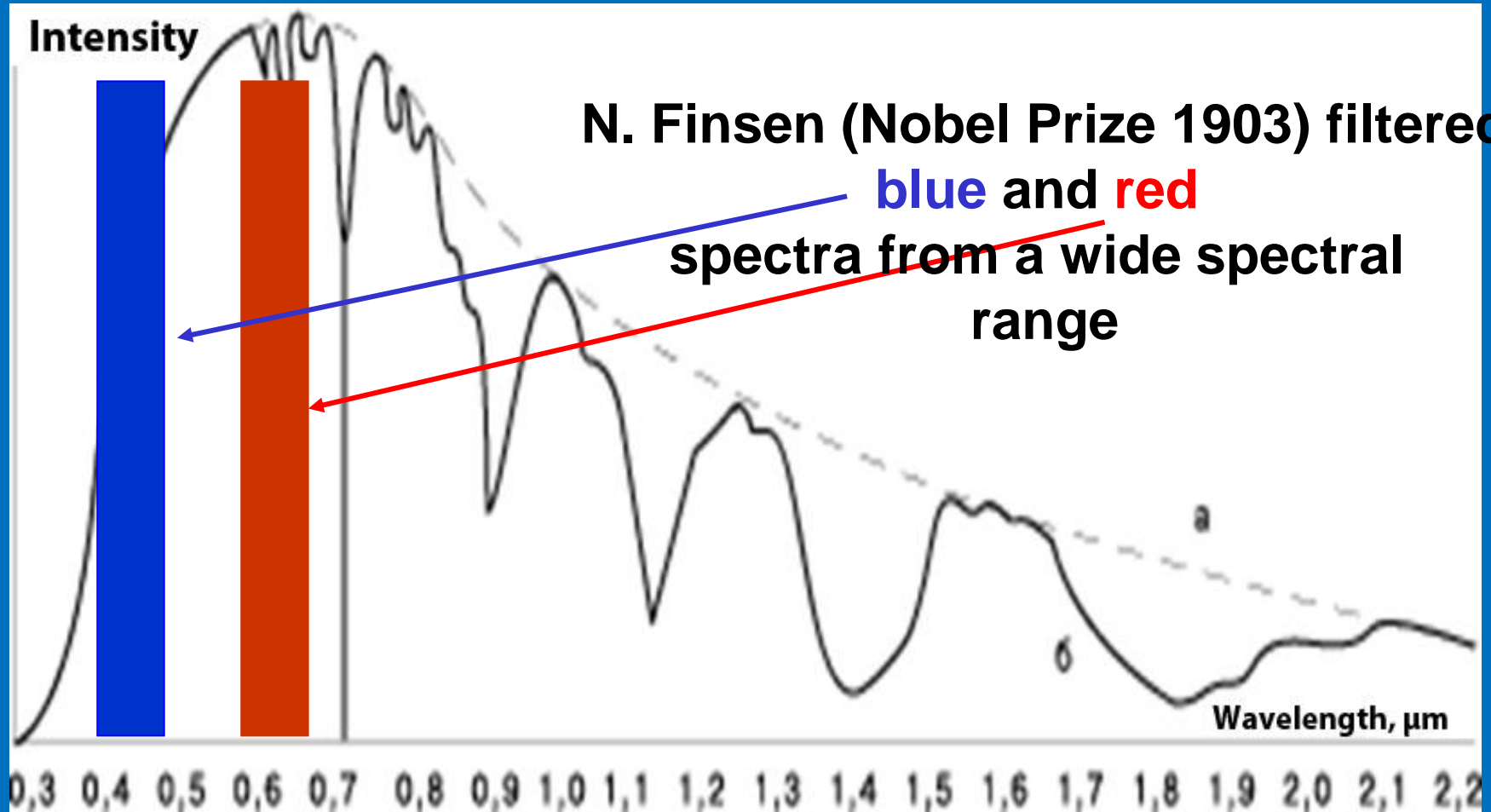
Only “laser”

**NO!** low-level laser ~~(light)~~ therapy

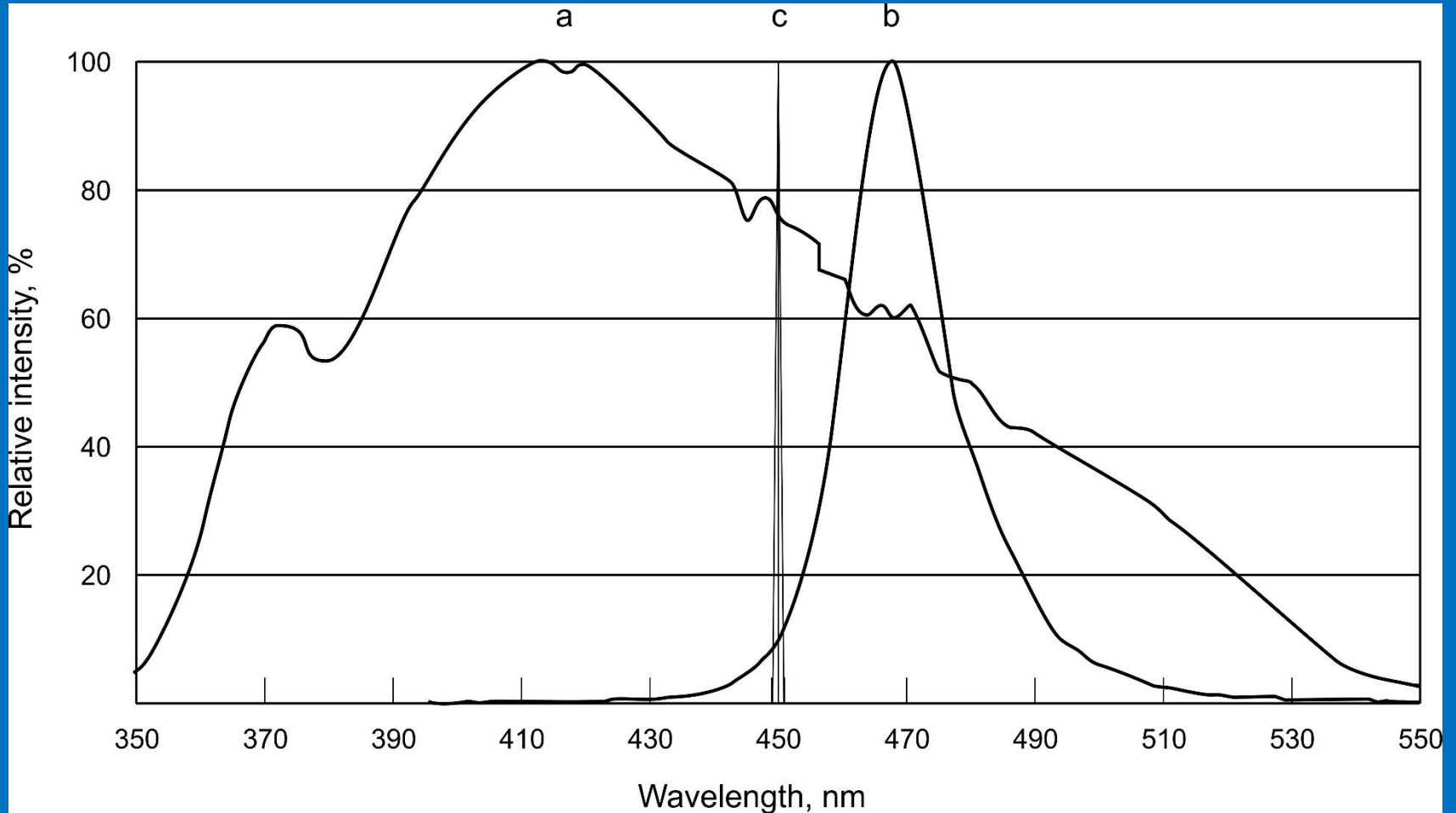
LLLT  $\neq$  PBM!

LLLT is not PBM!

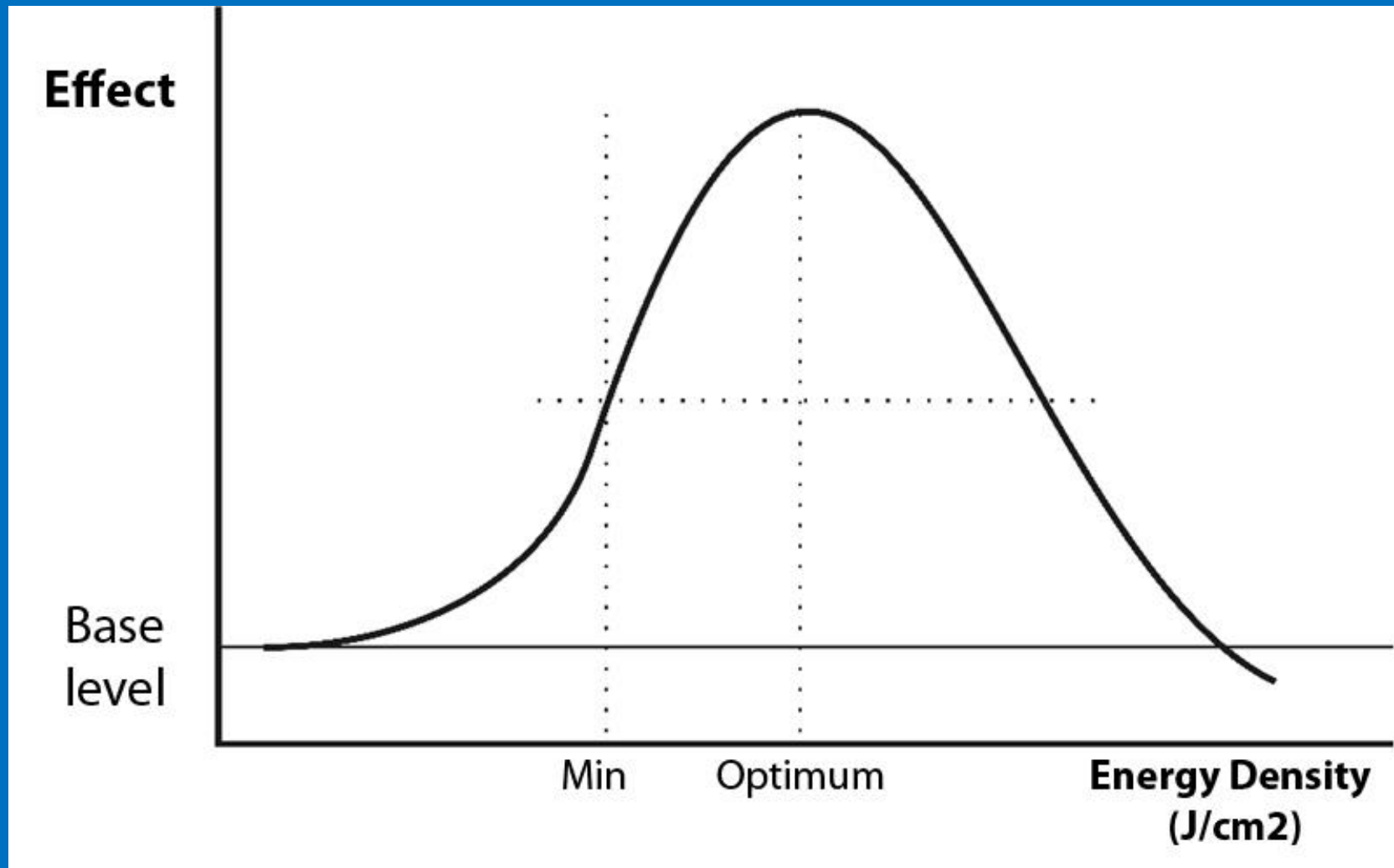
# Solar spectrum before (a) and after (b) passing the atmosphere



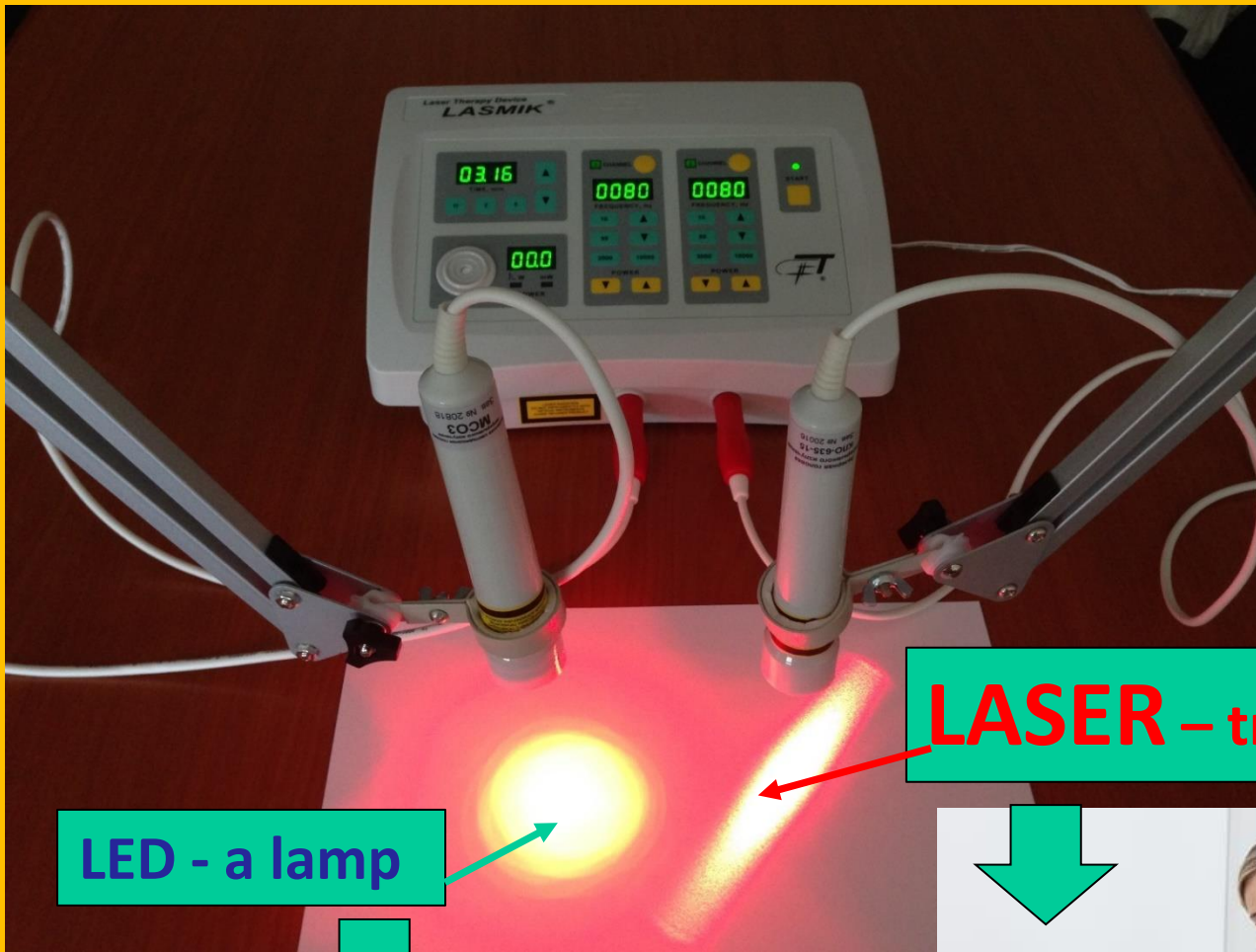
# The spectrum width of Finsen's lamp with a filter (a), LEDs (b), lasers (c)



# Energy-dependent (biphasic) effect of low-intensity laser light (LILL) interaction with biological tissues ( $ED = T \times P_{av./S}$ )







**LASER – treatment & health**

**LED - a lamp**



**LASER**



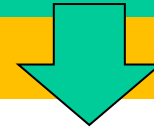
**LIGHT SOURCE**



**LED**



**COMPARISON OF  
TRANSPORT**





# Energy and spatial-temporal organization of LLLT effects on the body

## Energy component of the impact

$$\text{Energy} = P_{\text{av.}} \times T \text{ (J)}; \text{ED} = (P_{\text{av.}} \times T) / S \text{ (J/cm}^2\text{)}$$

$$\text{For pulse mode} - P_{\text{av.}} = P_{\text{p.}} \times \tau_{\text{p.}} \times F \text{ (mW)}$$

$P_{\text{av.}}$  – average output power (1-200 mW)

$P_{\text{av.}}$  – very strongly depends on the wavelength ( $\lambda$ , nm)

$P_{\text{av.}}$  – proportional to frequency for pulse mode

$P_{\text{p.}}$  – pulsed power (5-100 W)

$\tau_{\text{p.}}$  – pulse duration (100-200 ns)

$F$  – frequency (10 – 10 000 Hz)

$T$  – exposure time (30, 100 or 300 s – local; 3-15 min - ILBI)

$S$  – impact area (1 cm<sup>2</sup>)

\*ED – energy density; ILBI - intravenous laser blood illumination

## Spatial-temporal component of the impact

- exposure time (biorhythms)
- modulation frequency (biorhythms)
- periodicity of exposure (biorhythms)
- light spot area
- localization of exposure

# The parameters of effective low-level laser therapy

The main rule – all parameters of laser action must be specified in the following sequence:

- wavelength and mode of operation of the laser;
- average or pulsed power of illumination;
- frequency for pulsed or modulated mode;
- localization and area of impact;
- exposure to the zone and the total time of the procedure;
- number and frequency of procedures.

Area of illumination is distinguished by special nozzles.

# The parameters of effective low-level laser therapy

In low-level laser therapy, there is **no** such parameter as "dose" or "dosage"!

There is "energy" = power  $\times$  time (W  $\times$  s) [J] and "Energy density" = Energy / area [J/cm<sup>2</sup>].

They are absolutely not necessary!

**1  $\neq$  1  $\neq$  1 !**

The calculation only hinder the effectiveness of LLLT!

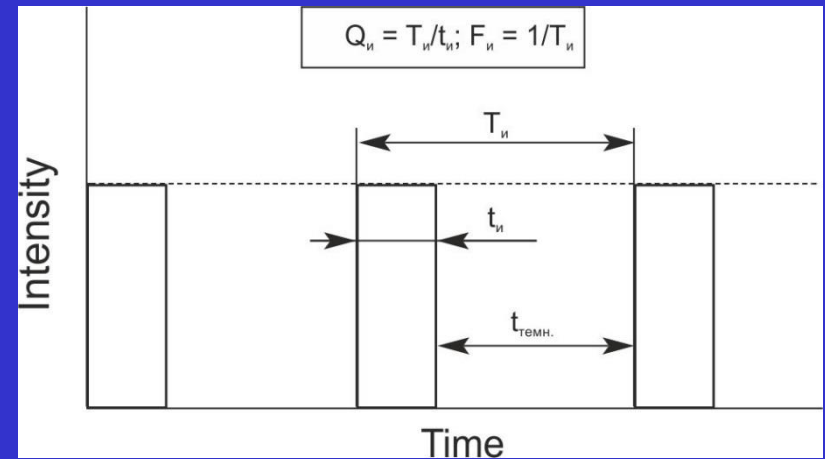
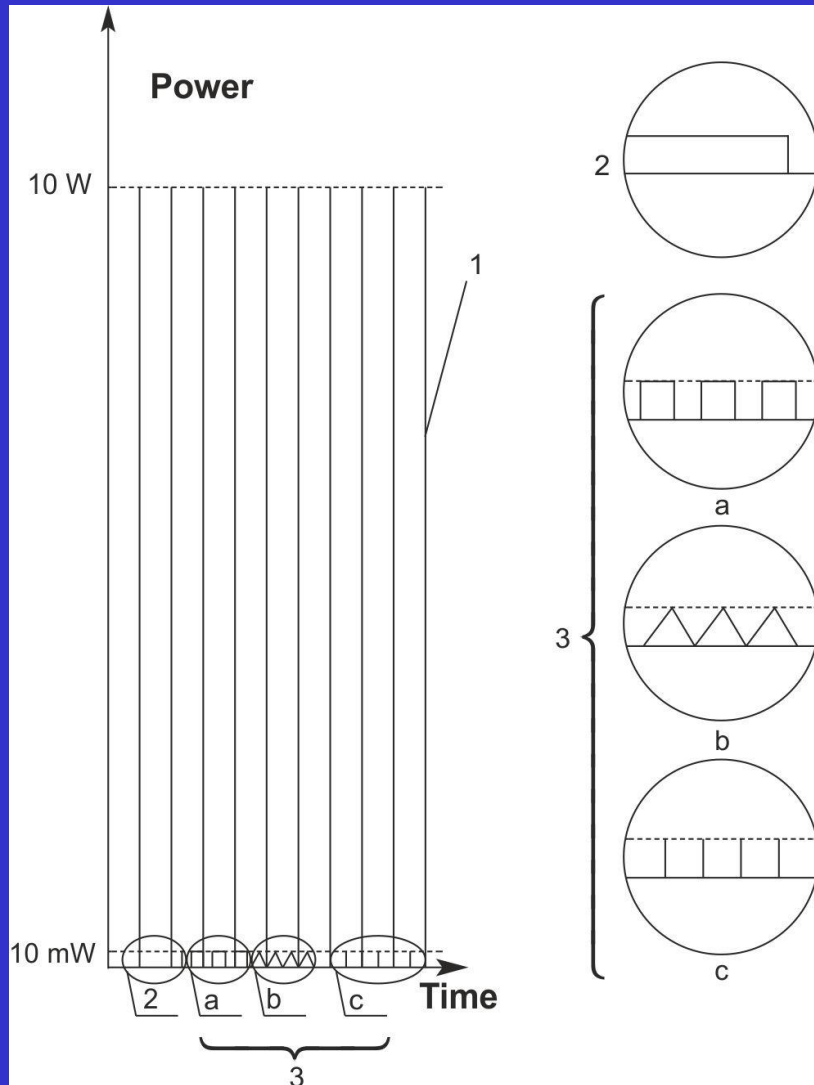
# The parameters of effective low-level laser therapy

The ED may be the same (most often the optimal  $1\text{J}/\text{cm}^2$ ) with a wavelength of  $635\text{nm}$  (red spectrum).

Three different situations (assuming a contact-mirror technique and an effective area of  $1\text{cm}^2$ )

Power, mW	Time, s	Energy, J	Effect
1	1000	1	No
10	100	1	Yes!!!
1000	1	1	No

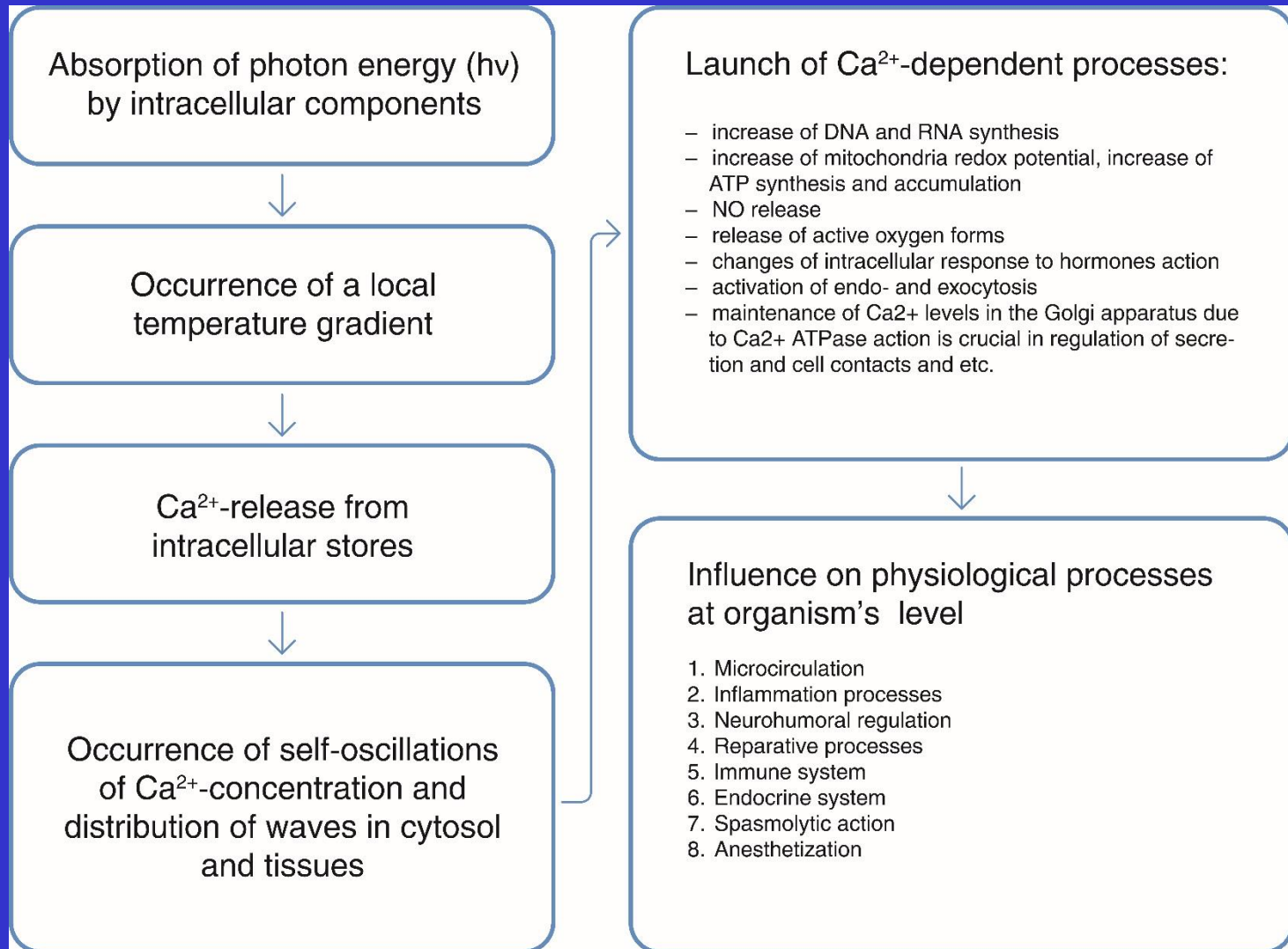
# Different illumination modes



$$P_{av.} = P_p. \times \tau_p. \times F$$

During modulated illumination, average power does not change in the modulation frequency, and in the pulsed mode, laser light is directly proportional to pulse repetition rate!

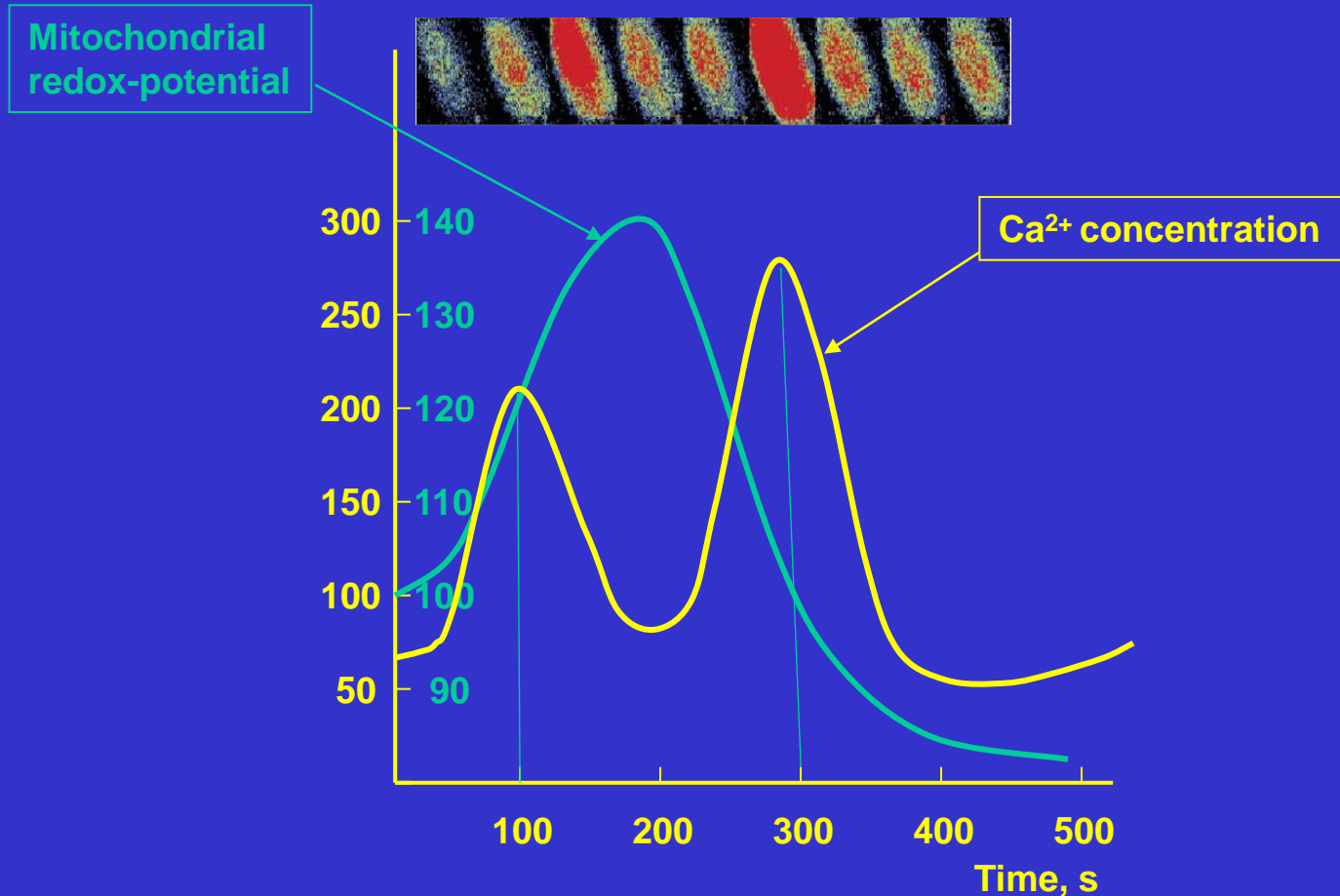
# The sequence of the development of biological effects of laser exposure





# Intracellular $\text{Ca}^{2+}$ oscillations evoked by laser light

(Alexandratou E., Yova D., Handris P. et al. Human fibroblast alterations induced by low power laser irradiation at the single cell level using confocal microscopy // Photoch. & Photob. Sciences. – 2002, 1 (8): 547-552.)



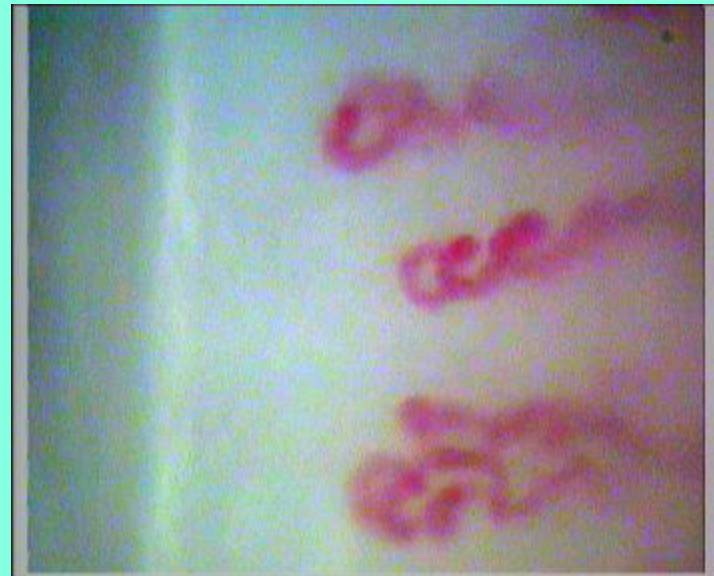
# **Main mechanisms of the biological action of LLLT at the organismal level**

- 1. Activation of central blood flow and microcirculation**
- 2. Increased lymph flow**
- 3. Anti-inflammatory effect**
- 4. Restoring the immune system**
- 5. Stimulation of reparative processes**
- 6. Hormonal system activation**
- 7. Activation of the nervous system (central and peripheral)**
- 8. Analgesia**
- 9. ...**

**A patient suffering from diabetes mellitus 2 type (about 4 years) before treatment (depleted capillary network, reduced blood flow, capillary deformation typical of diabetic microangiopathy)**

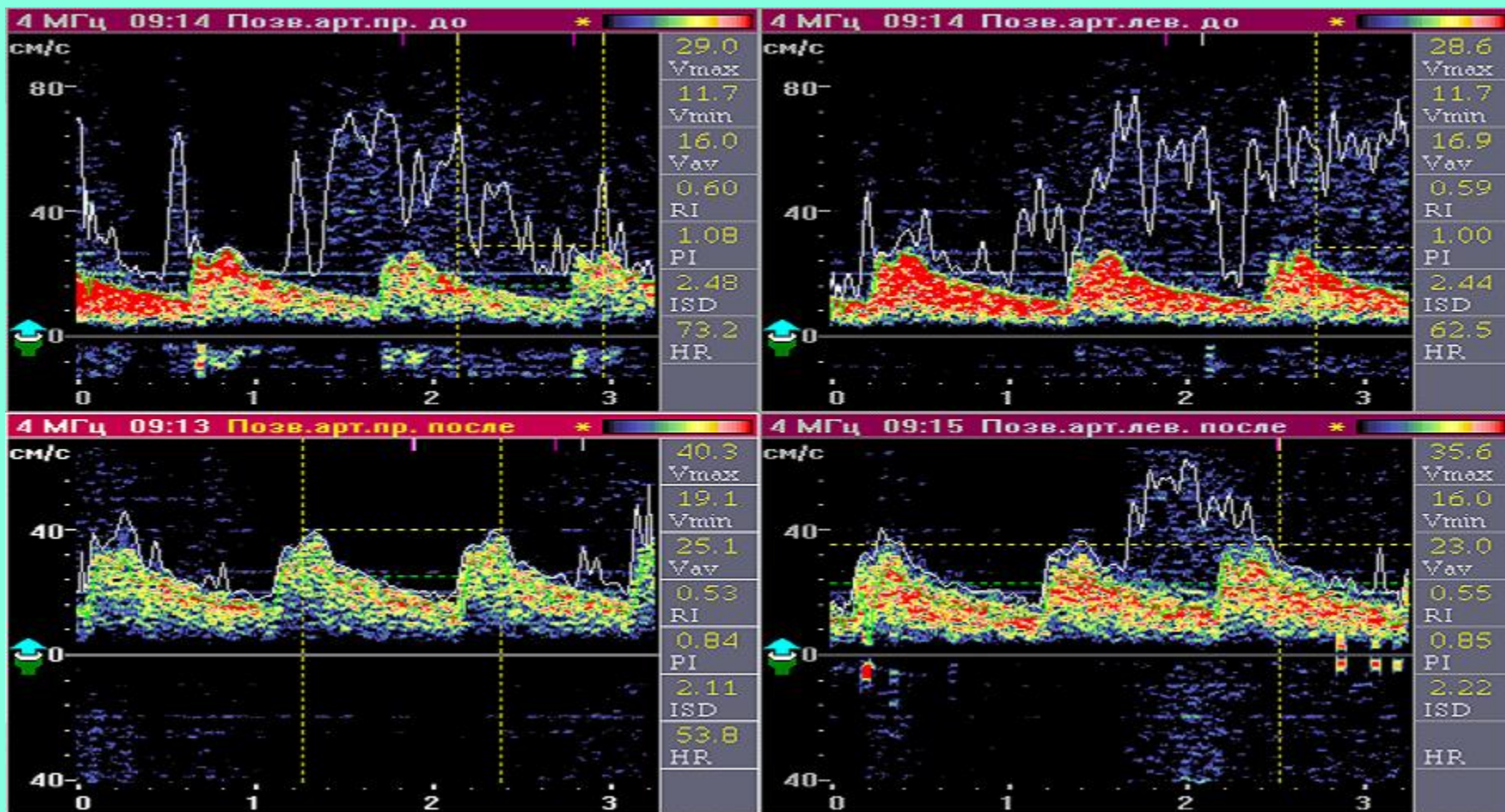


**The same patient after ten sessions of LLLT – increase of capillary network density, blood flow velocity, form of capillaries**





# Arteriodilatate effect. Ultrasound dopplerography dynamics after one course of LLLT



# Main low-level laser therapy techniques

## 1. External, local:

- locally (percutaneously) stably
- locally (percutaneously) labile
- laser acupuncture
- paravertebrally
- on the projection of internal organs
- on the projection of immune organs

## 2. Intracavitary illumination

## 3. Intravenous laser blood illumination (ILBI)

## 4. Laser ultraviolet blood illumination (LUVBI)

## 5. Non-invasive laser blood illumination (NLBI)

## 6. Combined techniques:

- magnetic-laser therapy
- vibro-magnetic-laser therapy
- laser-vacuum therapy
- laser phoresis



# Laser therapy device Lasmik®

Block concept of laser therapeutic devices:  
basic block + laser heads + nozzles





# Types of wounds

1. **Excisional, circular**
2. **Bruised**
3. **Gunshot**
4. **Long-term non-healing trophic ulcers**
5. **Diabetic**
6. **Burns (thermal and chemical) with a large affected area**
7. **Purulent (infected)**
8. **Toxic (snakebites, mucositis)**

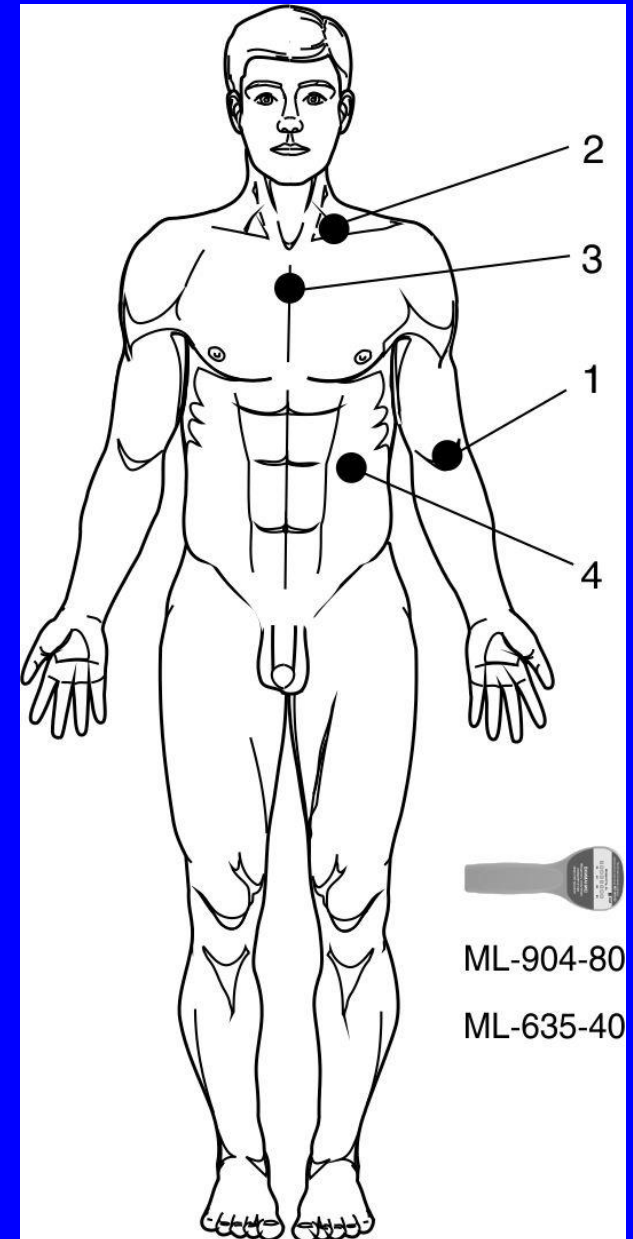
**In addition, the wound healing process depends on a number of circumstances: localization, number and size of the affected area, the presence of concomitant pathologies, venous insufficiency, hypoxia, neuropathy, etc.**

# General principles of laser wound therapy

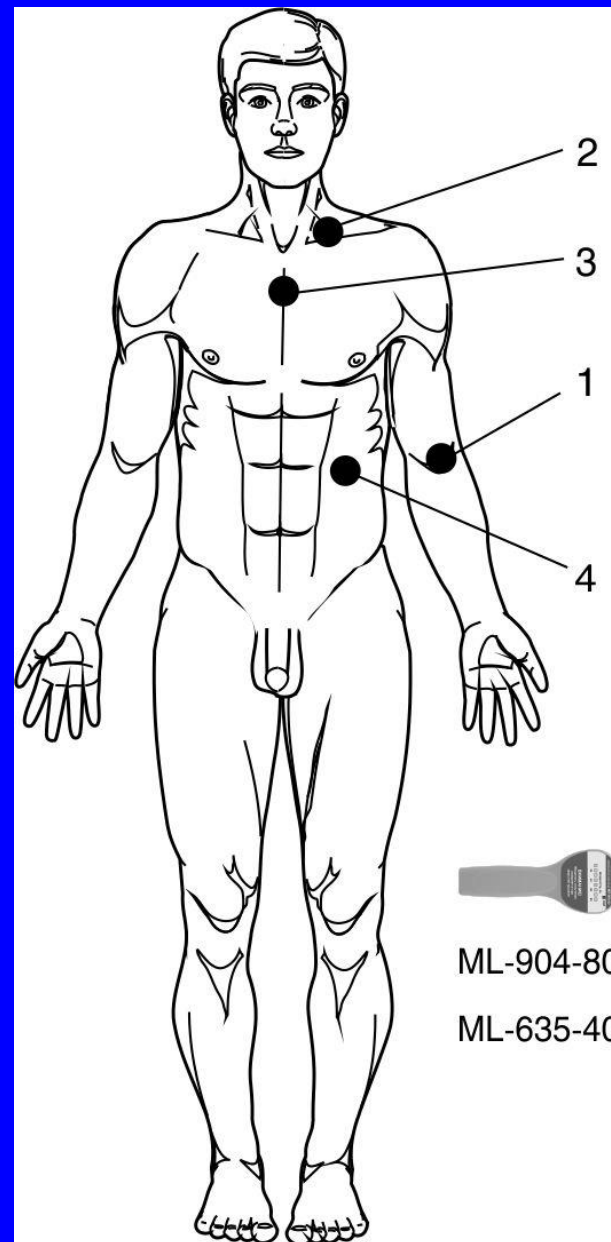
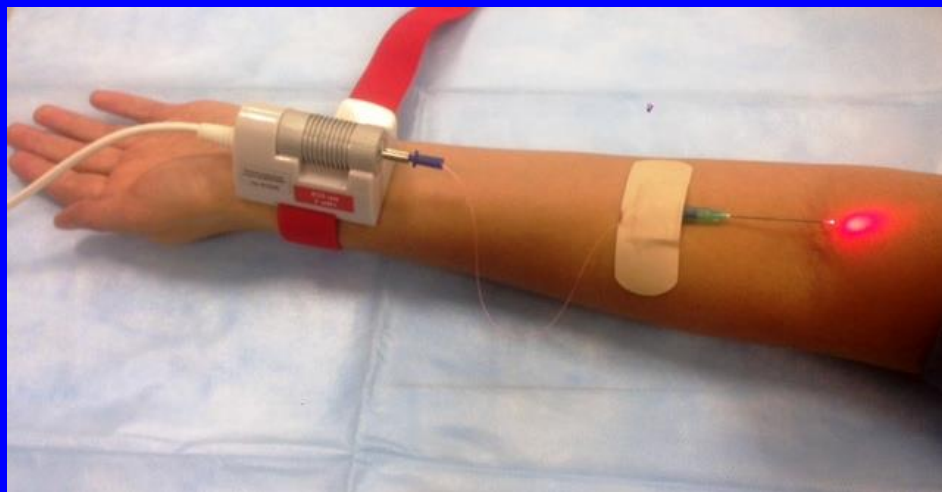
1. It is obligatory to use one of the variants of laser blood illumination (ILBI or NLBI), and also to conduct local wound illumination. The first provides a systemic effect on the body, the second – local effects.
2. While laser blood illumination techniques are always identical, local illumination depends on the type of wound and the techniques can be very different.
3. With local exposure, a stable technique is always used.
4. Low-level laser therapy is effective in most cases as a mono-method, but it is better to combine LLLT with other methods of treatment, especially for trophic ulcers, diabetes mellitus, venous insufficiency and neuropathy.

## Intravenous laser blood illumination (ILBI)

<b>ILBI-635:</b> $\lambda$ , nm	635 (red)
Power, mW	2-3
Time, min	10-20
Localization	1 ( <i>v. mediana cubiti</i> )
<b>ILBI-525:</b> $\lambda$ , nm	525 (green)
Power, mW	2-3
Time, min	5-10
Localization	1 ( <i>v. mediana cubiti</i> )
<b>LUVBI®:</b> $\lambda$ , nm	365 (UV)
Power, mW	2-3
Time, min	2-5
Localization	1 ( <i>v. mediana cubiti</i> )



# Intravenous laser blood illumination (ILBI)



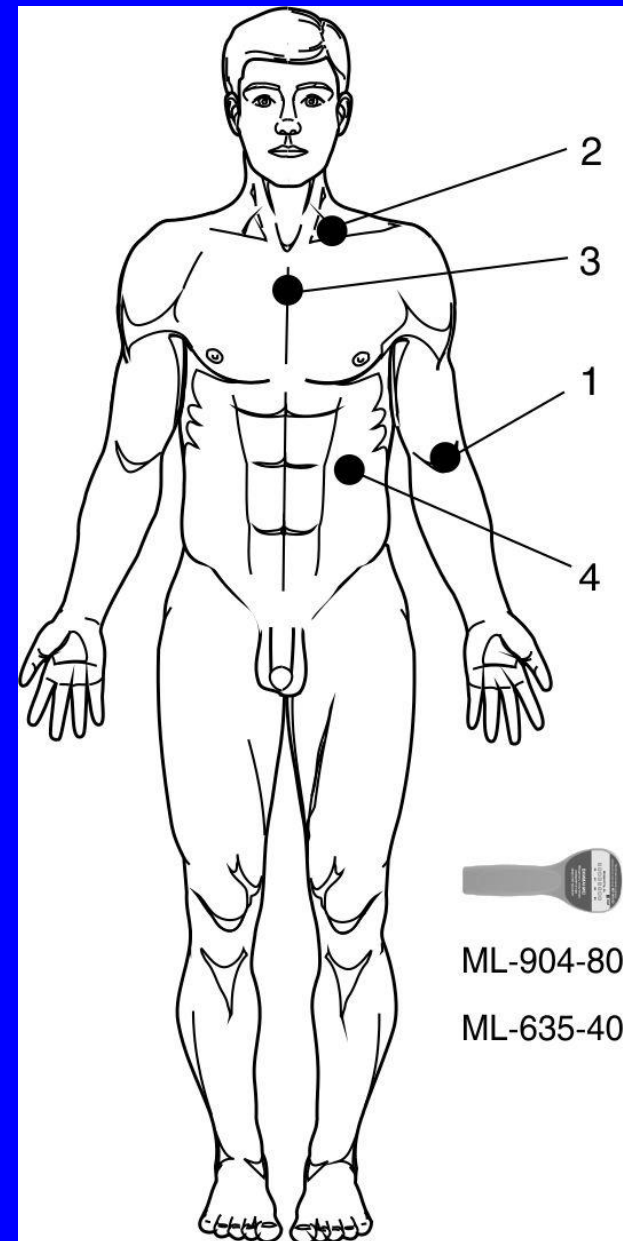
## Intravenous laser blood illumination (ILBI)

Day	Method
1-st (Monday, for example)	LUVBI®
2-nd (Tuesday)	ILBI-635 or ILBI-525
3-rd (Wednesday)	LUVBI®
...	ILBI-635 or ILBI-525
...	LUVBI®
...	ILBI-635 or ILBI-525
...	LUVBI®
...	ILBI-635 or ILBI-525
...	LUVBI®
...	ILBI-635 or ILBI-525

# Non-invasive laser blood illumination (NLBI) #1

Parameters	Laser head	
	ML-904-80	ML-635-40
$\lambda$ , nm	904	635
Mode of operation	Pulse	Pulse
Pulse duration, ns	100-200	100-200
Power, W	80	40
Surface area, cm <sup>2</sup>	10	10
Number of laser diodes	8	8
Power density, mW/cm <sup>2</sup>	8	8

Laser head	Frequency, Hz	Time, min	Localization
ML-635-40	80	5	2 (above the collarbone on the left)
ML-904-80	80	1,5	3 (thymus)
ML-904-80	80	1,5	4 (spleen)

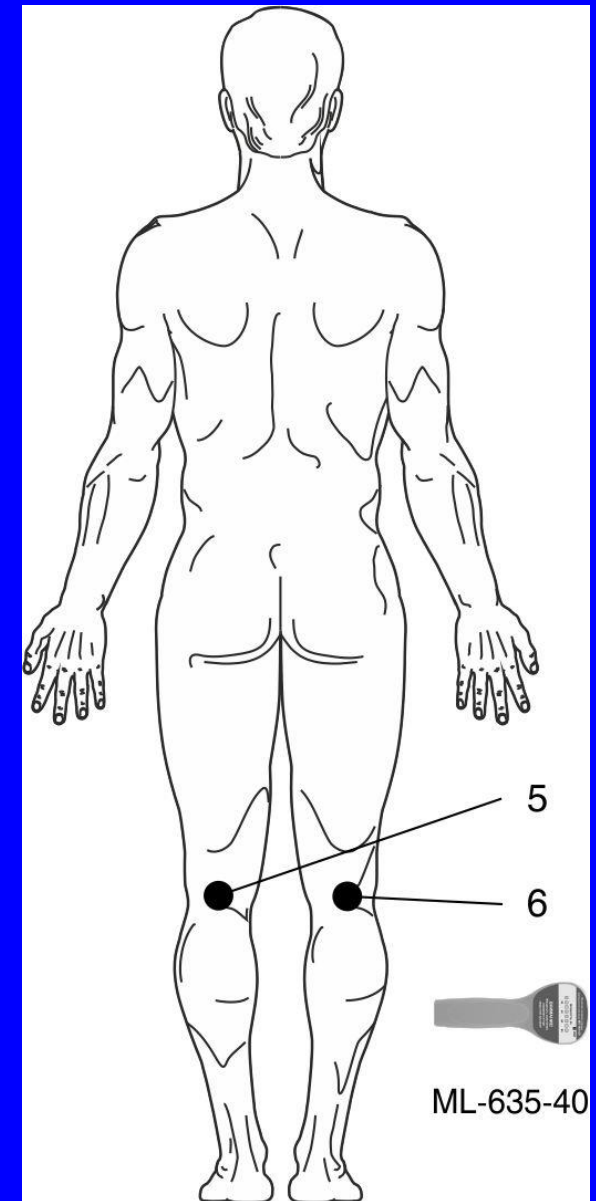




# Non-invasive laser blood illumination (NLBI) #2

Parameters	Laser head	
	ML-904-80	ML-635-40
$\lambda$ , nm	904	635
Mode of operation	Pulse	Pulse
Pulse duration, ns	100-200	100-200
Power, W	80	40
Surface area, cm <sup>2</sup>	10	10
Number of laser diodes	8	8
Power density, mW/cm <sup>2</sup>	8	8

Laser head	Frequency, Hz	Time, min	Localization
ML-635-40	80	2	5
ML-635-40	80	2	6
ML-635-40	80	1,5	3 (thymus)
ML-635-40	80	1,5	4 (spleen)



# Mucositis in cancer patients after chemotherapy

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**ILBI-525 + LUVBI® alternate every other day, 5 procedures**

**or**

**NLBI #1 – for adults, 5 procedures daily**

**NLBI #2 – for children, 2-5 procedures daily**

**Local illumination (in the mouth or outside) is not performed!**

**Treatment efficiency  $\cong$  100% (pain reduction, wound healing)**

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**7 days after starting  
chemotherapy, before LLLT (boy,  
9 years old, Ewing sarcoma of the  
8th right rib )**



**After 5 procedures (NLBI) # 2  
It is very important to start treatment as early as  
possible to prevent the development of mucositis**



# Trophic ulcers and long-term non-healing wounds of the lower extremities

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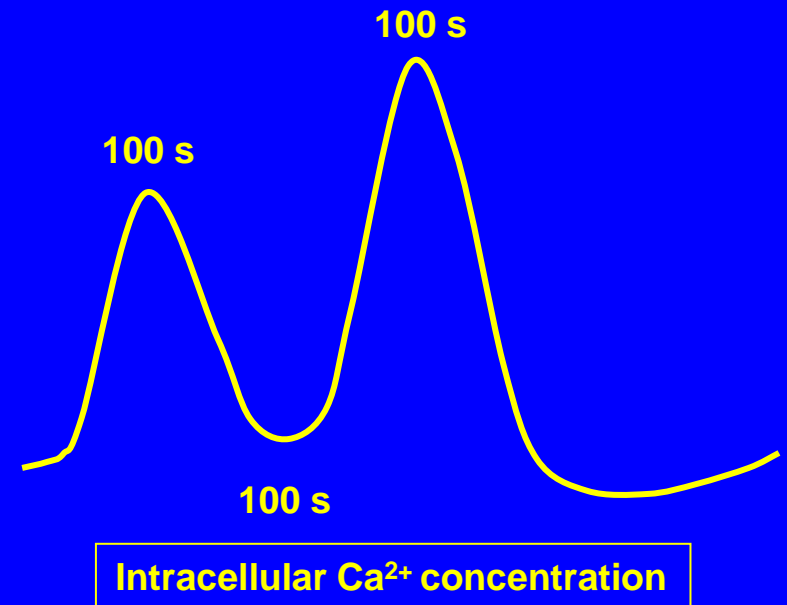
**ILBI-525 + LUVBI®** alternate every other day, 12 procedures  
or

**NLBI #2** – 15 procedures daily or every other day

+ local (stable on the wound)

Laser head	Frequency, Hz	Time, min
<b>ML-635-40</b>	80	1,5
Deep period	–	1,5
<b>ML-904-80</b>	80	1,5

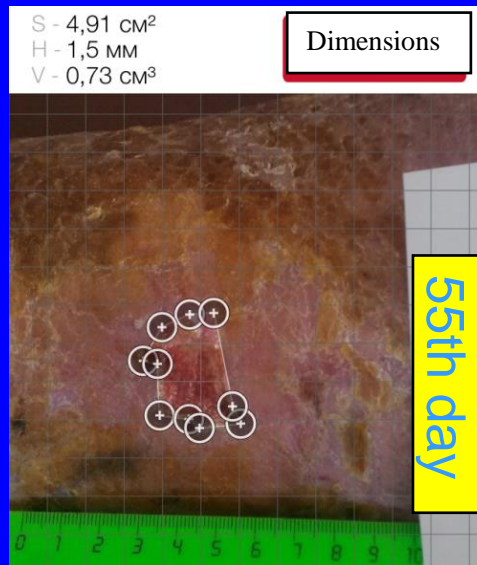
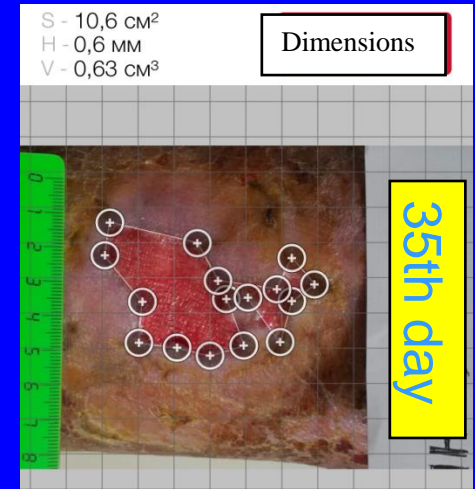
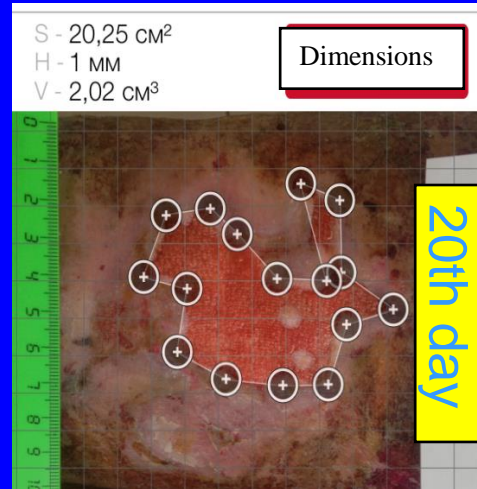
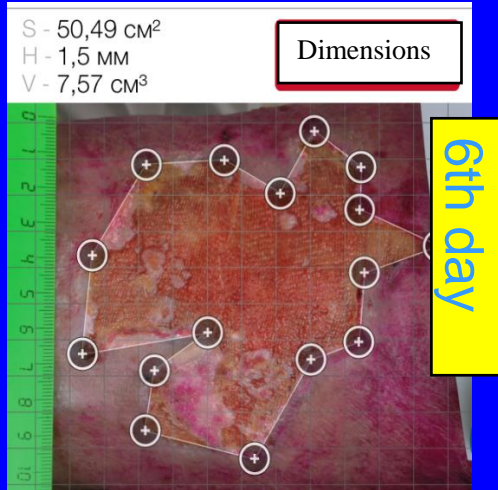
**100 s  $\cong$  1,5 min**



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**Treatment efficiency is  $\cong$  60%** (complete wound healing), with the selection of an individual treatment regimen, supplementation of LLLT with other methods, the efficiency increases to 93-95%

**Clinical case study 1. Male, 50 years old, trophic ulcer, chronic venous insufficiency of grade CEAP C6, Es, the wound did not heal for 8 years, complete healing 78 days after the initial examination (LLLT course of 15 procedures, 3 weeks)**



**Clinical case study 2. Female, 52 years old, trophic ulcer of the left leg without venous insufficiency, duration of the disease is more than 2.5 years, initial examination**

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**Clinical case study 2. Female, 52 years old, trophic ulcer of the left leg without venous insufficiency, duration of the disease is more than 2.5 years, 10 days after the start of the LLLT course**

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Clinical case study 2. Female, 52 years old, trophic ulcer of the left leg without venous insufficiency, duration of the disease is more than 2.5 years, 30 days after the start of the LLLT course





**Clinical case study 2. Female, 52 years old, trophic ulcer of the left leg without venous insufficiency, duration of the disease is more than 2.5 years, 44 days after the start of the LLLT course (the course consisted of 15 procedures daily or every other day). The wound has practically healed, the treatment is over.**

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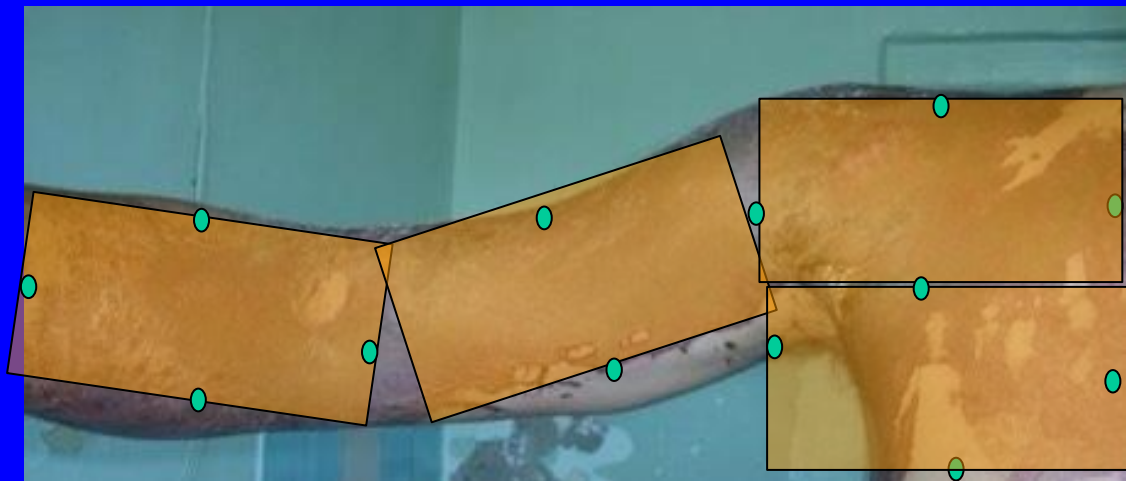


## Burns of large area – >10% of the body surface

ILBI-525 + LUVBI® alternate every other day, 10 procedures  
or

NLBI #1 – for adults, 10 procedures daily  
+ local illumination - along the edges of the area corresponding to 1% of  
the surface of the whole body ( $S_{av}$ ) = palm area ( $S_p$ )

Laser head (1 laser diode)	$\lambda$ , nm	Mode of operation	Pulse duration, ns	Power, W	Power density, mW/cm <sup>2</sup>	Time, s	Number of points
LO-904-20	904	Pulse	100	15-20	15-20	4-5	S*4-2



Reduction of treatment duration, pain relief, survival of 99% of patients



**Thank you!**

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