Ultraviolet laser improved for human treatment

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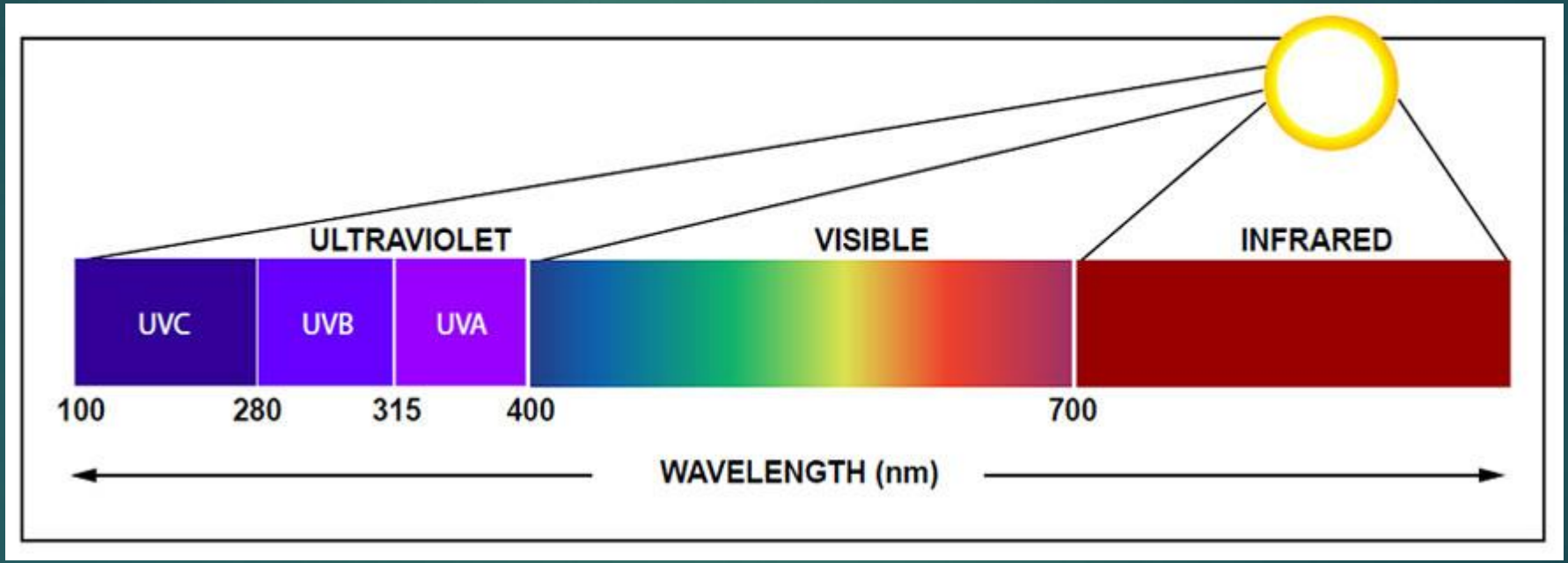
CONTENT

- What is ultraviolet (UV) radiation?
- How UV radiation is used in medicine?
- The effect of UV radiation on human bacteria's, viruses, microbes and microorganisms
- Milestones of development of laser devices for UV treatment in Russia
- Tuberculosis as a object for treatment
- Laser system “Amulet” : description and clinical exam results in comparison with conventional treatment methods
- Laser system “Talisman”: challenges and perspectives

What is ultraviolet radiation (UV)?

UV is part of the electromagnetic spectrum emitted by the sun



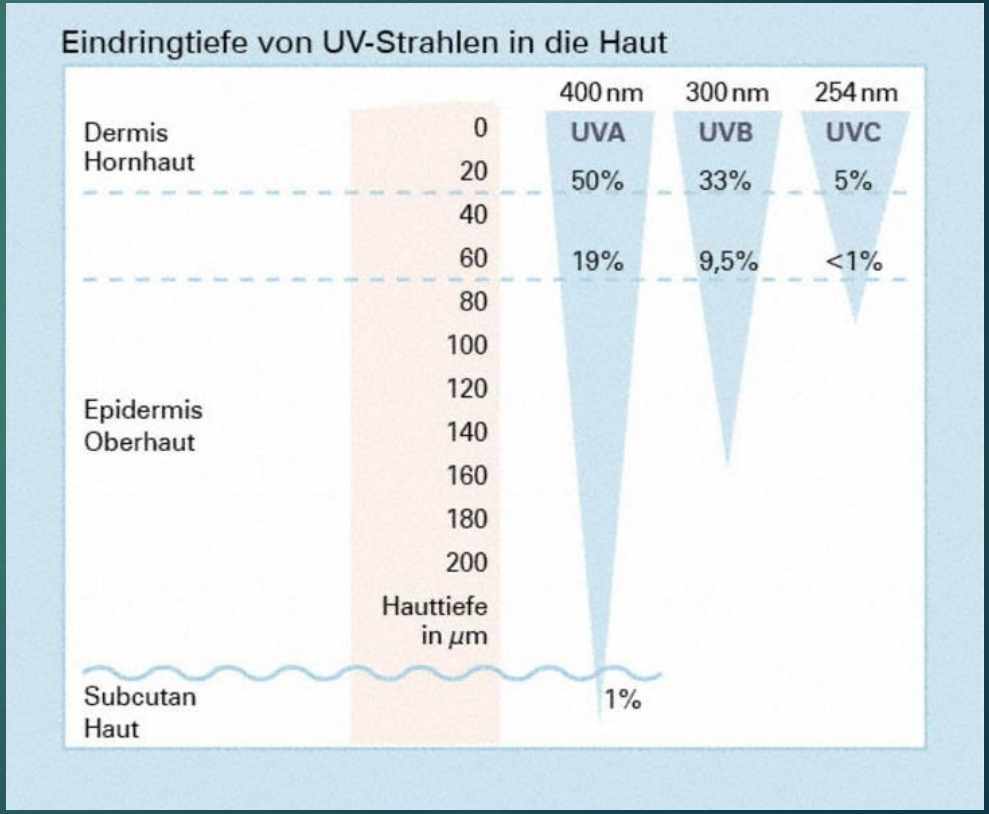
UV radiation sources: Sun!
Man-made ultraviolet sources: UV lamps, arc welding, UV lasers

Ultraviolet effect on human

differ in a penetration and in an effect on biological organisms

Other than UVA- and UVB radiation,
the depth of penetration of UVC radiation
into the human skin is very small.
The risk of skin cancer is therefore very low,
even when exposed to intensive UVC radiation.

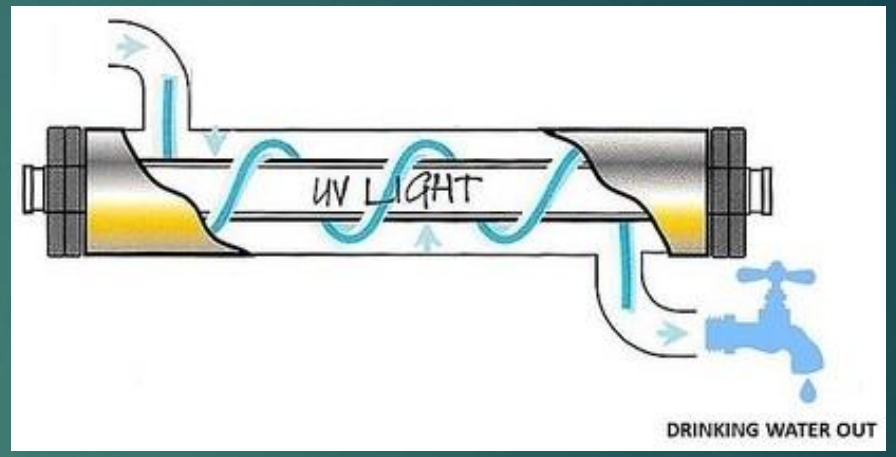
Research in later years showed that the short wave and the strong energy of the UVC radiation mainly causes a photo-chemical effect in the thymines. This molecular change makes the DNA unusable for the essential biological process of transcription (metabolism) and replication (cell division). A cell is sufficiently inactivated.



How UV radiation is used in medicine?

Ultraviolet waves are effective in killing bacteria and viruses

Sterilization of equipment, air and water in operating rooms



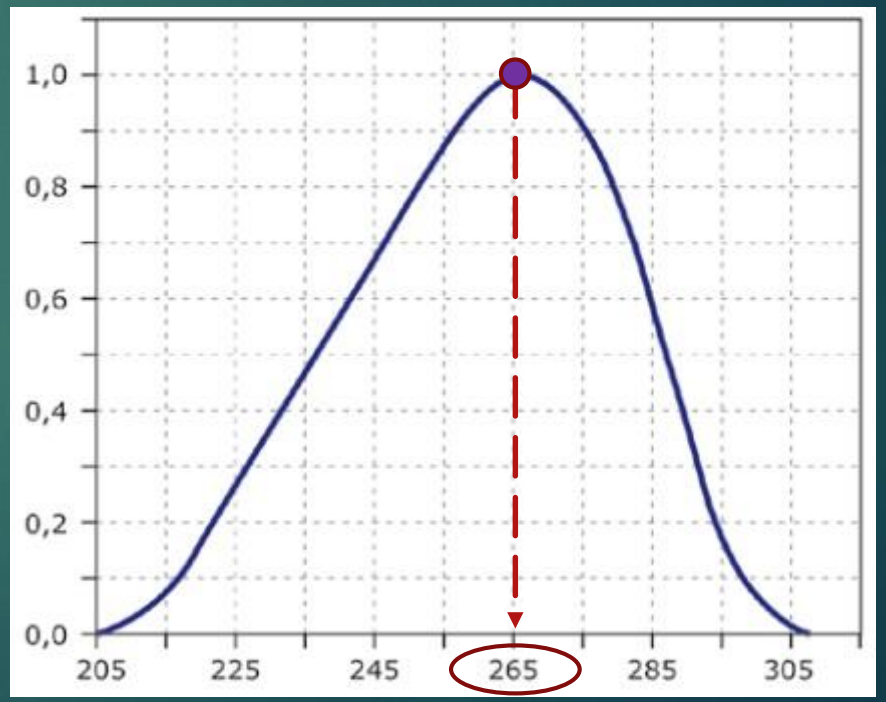
light therapy: treatment of acne and psoriasis

UV radiation effect on human bacteria's, viruses and microbes

- The antiseptic effect of UV radiation is mainly determined by photochemical reactions that result in irreversible decrease of the affected region and its disappearing

- The resistance of various types of microorganisms to UV radiation varies considerably: from small doses for bacteria to very large doses for spores and protozoa

- The bactericidal curve displays the dependence of the proportion of dead microorganisms as a function of UV radiation.



UV radiation effect on microorganisms

The effectiveness of a disinfection method based on UVC is connected to the dosage used

$$E = N \times \mathrm{t}$$

N- intensity of UV radiation [mW/cm2]
t- time of UV exposure [s]
E- irradiation dose [mJ/cm2]

E is a measure of bactericidal energy transferred to microorganism.

With UV-C technology it is possible to destroy more than 99.9% of all pathogens within seconds, without addition of chemicals, without harmful side effects, inexpensively, highly efficiently and absolutely reliably.

Values of irradiation doses needed for inactivating some of the microorganisms are listed in Table

Irradiation doses needed for inactivating 99.9% of the microorganisms

Bacteria	
Aeromonas hydrophila	1,54
Agrobacterium tumefaciens	
Bacillus anthracis	4,5
Bacillus anthracis spores	54,5
Bacillus megaterium	3,75
Bacillus megaterium (spores)	2,7-9
Bacillus paratyphosus	3,2
Bacillus subtilis	5,8-7,1
Bacillus subtilis (spores)	11,6-25
Clostridium perfringens spores	20
Clostridium tetani	4,9-13
Corynebacterium diphtheriae	3,4
Eberthella typosa	2,1
Enterococcus	10
Enterocolitica faecium	4
Escherichia coli	1,3-3
Fecal Streptococcus	10,0-15,0

Klebsiella terrigena	2,61
Legionalla longbeachae	1,5
Legionella bozemanii	1,8
Legionella dumoffii	2,25
Legionella gormanii	2,4
Legionella micdadei	1,5
Legionella pneumophila	0,9-2,49
Leptospira Spp.	3,2
Micrococcus candidus	6
Micrococcus lysodelkticus	23
Micrococcus Lutea	9
Micrococcus piltonencis	8,1
Micrococcus radiodurans	20,5
Micrococcus sphaeroides	10
Mycelial propagules	15
Mycobacterium tuberculosis	5,8-10
Neisseria catarrhalis	4,4
Phytomonas tumefaciens	4,4

Irradiation doses needed for inactivating 99.9% of the microorganisms (continue)

Phytomonas vulgaris	2,6
Proteus vulgaris	2,6-3
Pseudomonas aeruginosa	2,5-5,5
Pseudomonas flourescens	3,5
salmonella anatum	8,2
salmonella derby	3
Salmonella enteritidis	4,0-6
Salmonella infantis	4
Salmonella paratyphi	2,1-3,5
Salmonella typhimurium	1,9-2,2
Sarcina lutea	20
Serratia marcescens	2,4
Shigella dysenteriae	0,9-2,2
Shigella flexneri	1,7
Shigella flexneri (paradysenteriae)	1,7
Shigella paradysenteriae	1,7
Shigella sonnei	3
Spirillum rubrum	4,4

Staphylococcus albus	1,8-3,3
Staphylococcus aureus	2,6-5
streptomycete spores	8
Streptococcus faecalis	4,4
Streptococcus hemolyticus	2,2
Streptococcus lactis	6,2
Streptococcus pyogenes	2,2
Streptococcus viridans	2
Vibrio cholerae	0,6-3,4
Vibrio comma	6,5
Yeast	
Saccharomyces cerevisiae	6
Saccharomyces cerevisiae	6
Saccharomyces ellipsoideus	6
Saccharomyces ellipsoideus	6
Saccharomyces sp	6
Torula sphaerica	6
Spores of mold	

Irradiation doses needed for inactivating 99.9% of the microorganisms (continue)

Aspergillus amstelodami	66,7
Aspergillus flavus	54-60
Aspergillus glaucus	44-48
Aspergillus niger	100-180
Cladosporium herbarum	60
Muscor mucedo	65
Muscor racemosus	17
Muscor racemosus A	17-19,4
Muscor racemosus B	17-19,4
Oospora Iactis	5,0-6,0
Penicillium chrysogenum	44-50
Penicillium digitatum	44
Penicillium expansum	12,0-13,0
Penicillium roqueforti	13-14,5
Rhisopus nigricans	110-120
Scopulriopsis brevicaulis	80
Viruses	
Coliphage	3,6-18,6

Coxsackie virus type B-5	6
Hepatitis A	3,7-7,3
Influenza virus	3,6
Poliovirus	7,5
Poliovirus 1	5-7,5
Reovirus 1	15
Rotavirus	8-11,3
Rotavirus SA-11	8,0-10
Tobacco mosiac	240
Protozoa (helminthes)	
Cryptosporidium parvum	20
Giardia muris	20
Giardia lamblia(Lamblia intenstinalis)	20
Nematode eggs	40
Paramecium	40
Algae	
Chlorella vulgaris	12
Blue Green	30

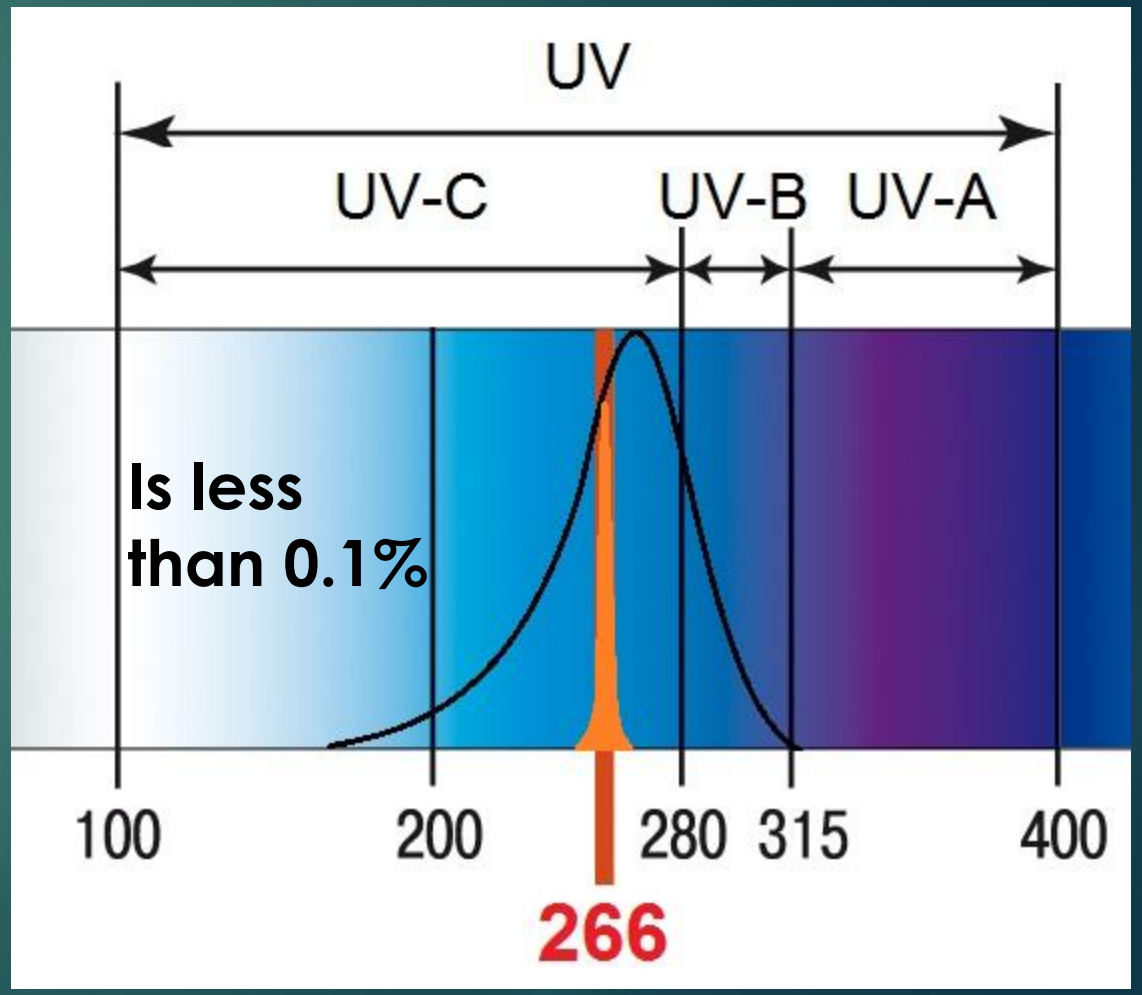
UV radiation effect on microorganisms (continue)

The most harmful for human health are viruses and bacteria in the vegetative form, such as

- **Salmonella typhosa (typhoid fever)**,
- **Vibrio cholerae (cholera)**,
- **Shigella dysenteriae (dysentery)**,
- **Hepatitis virus (viral Hypatit A)**,
- **Mycobacterium tuberculisias (tuberculosis**),
- **Pseudomonas aeruginosa**

UV lamp vs 266 nm laser efficiency

Taken from http://medbe.ru/novinki/ultrafioletovaya-lampa-dlya-dezinfektsii-pomeshcheniy-indigo-clean/

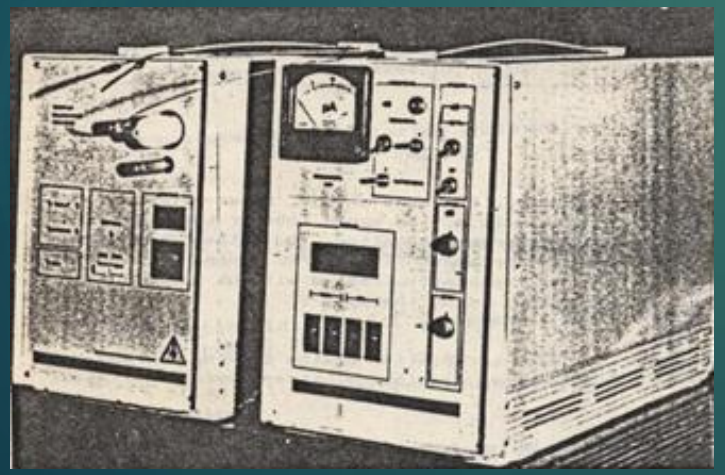


Milestones of development of laser devices for UV treatment in Russia

Research on UV radiation treatment were conducted in major medical and research centers and mainly in Prokhorov General Physics Institute in Moscow.

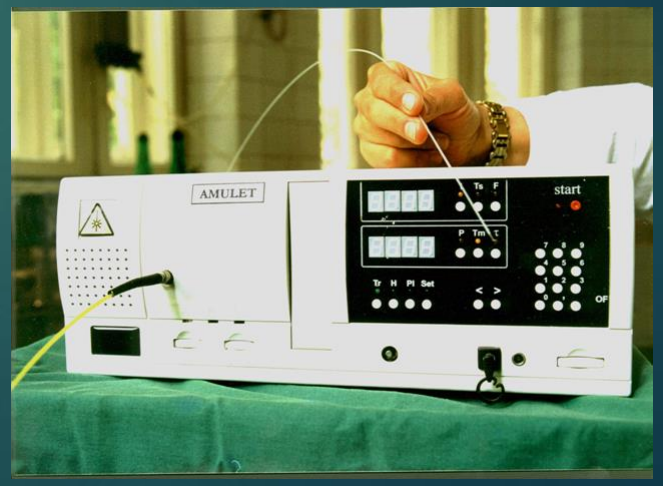
In 1994, a method was patented in Russia

1993-1999
Nitrogen laser at 337 nm
"ALMICIN"



1997-2003
Excimer laser at 248 nm
"MARIA"

1998-2003
Solid state laser at 266 nm
"AMULET"



More than 1200 patients were treated by the above devices and were fully recovered

Tuberculosis

Tuberculosis (**TB**) as the most stable form of disease accompanied with a whole composition of pathogens. By testing on the TB, the test on the wide composition of pathogens achieves.

Tuberculosis is spread through the air when people who have active TB in their lungs cough, spit, speak, or sneeze.

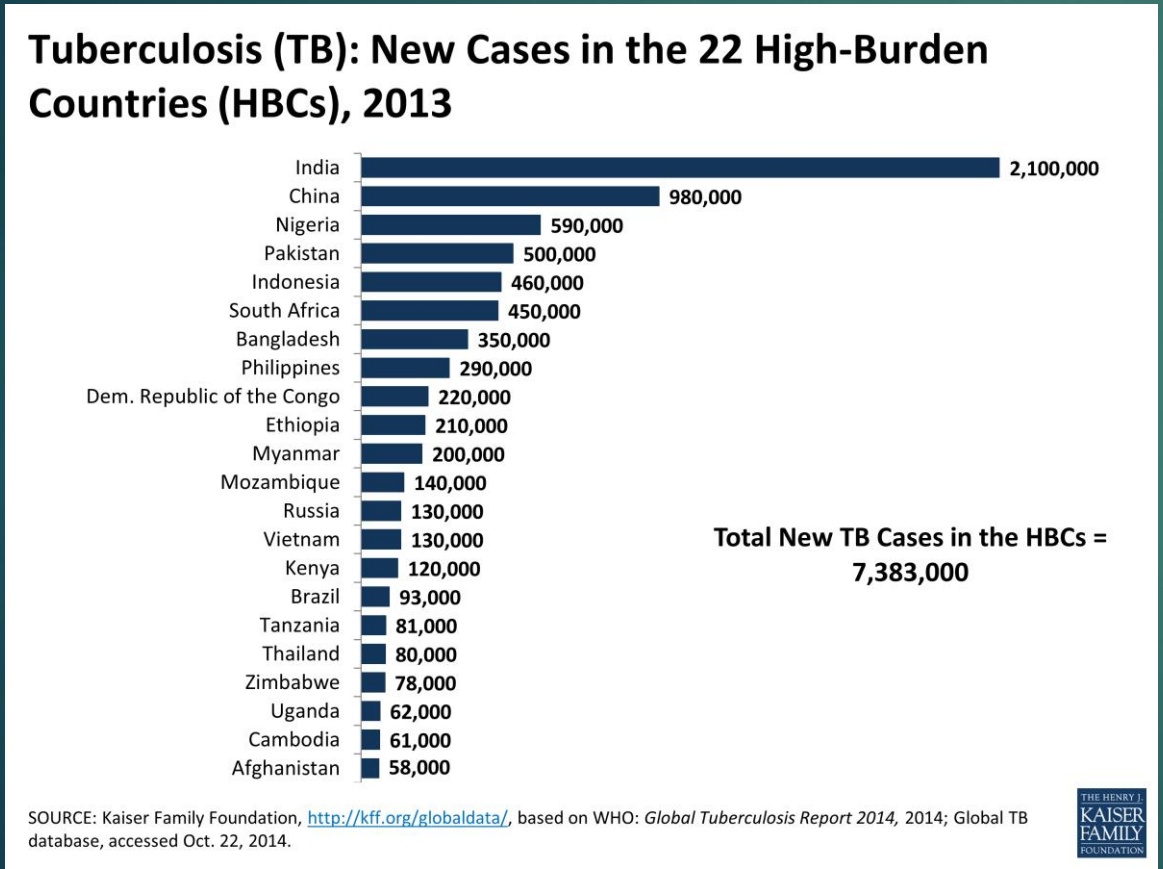
The immune system either kills the germs, or "walls off" the TB bacilli, introducing them into a latent state for years.

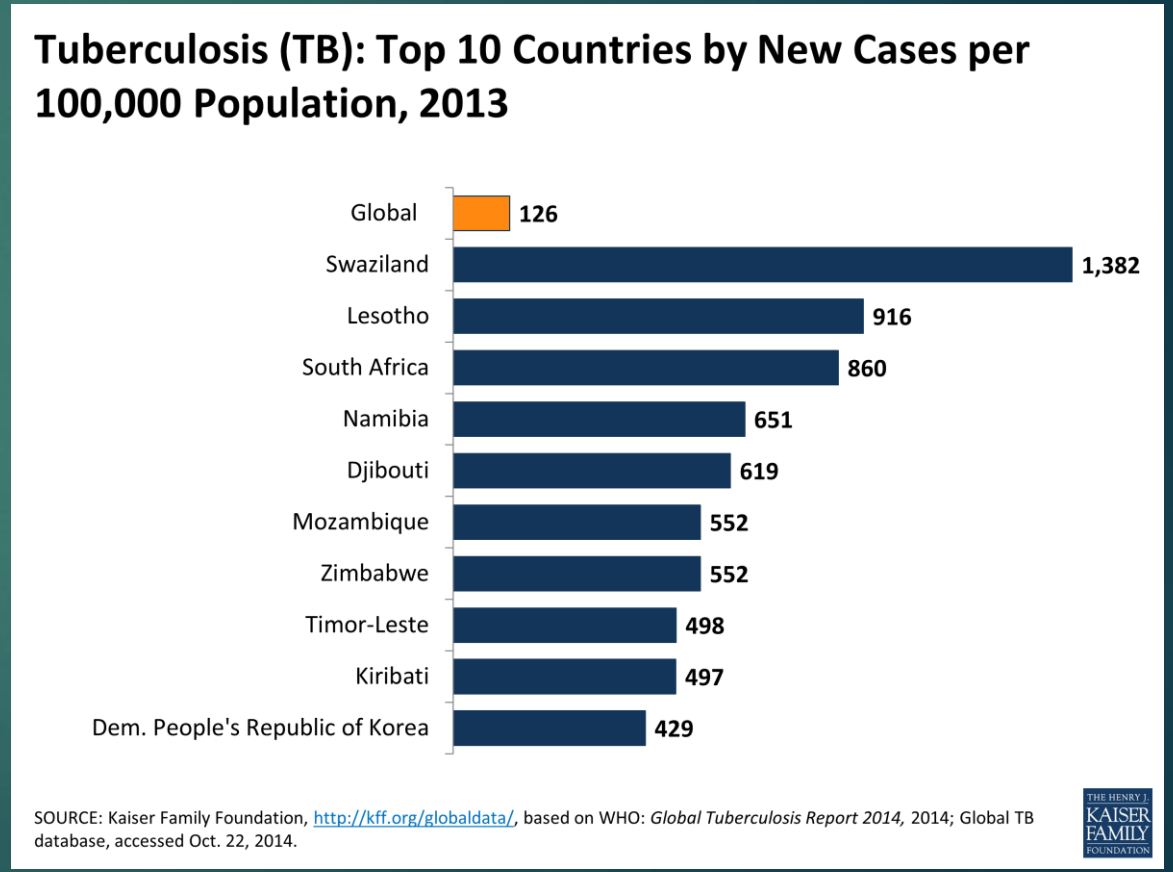
The weakness of the immune system to fight against the TB bacilli leads to the development of active disease, when TB bacilli multiply and destroy the body.

Tuberculosis (GLOBAL facts)

- **One-third** of the world's population is thought to be infected with TB
- In 2014, there were **9.6 million cases** of active TB which resulted in **1.5 million deaths**
- TB is among the **three greatest causes of death among women** aged 15-44
- About **80% of people in many Asian and African** countries test positive while **5–10% of people in the United States** population tests positive by the tuberculin test
- **Every second** someone in the world is infected with TB bacteria

Tuberculosis in the world





Tuberculosis (continue)

The main cause of TB is *Mycobacterium tuberculosis*, a small, aerobic, nonmotile bacillus.

It is sufficiently resistant to environmental influences:

- in the river water it can persist for up to 5 months,

- in the ground 1-2 years,

- in the street dust - up to 10 days,

- in rooms with ambient light - more than a month.

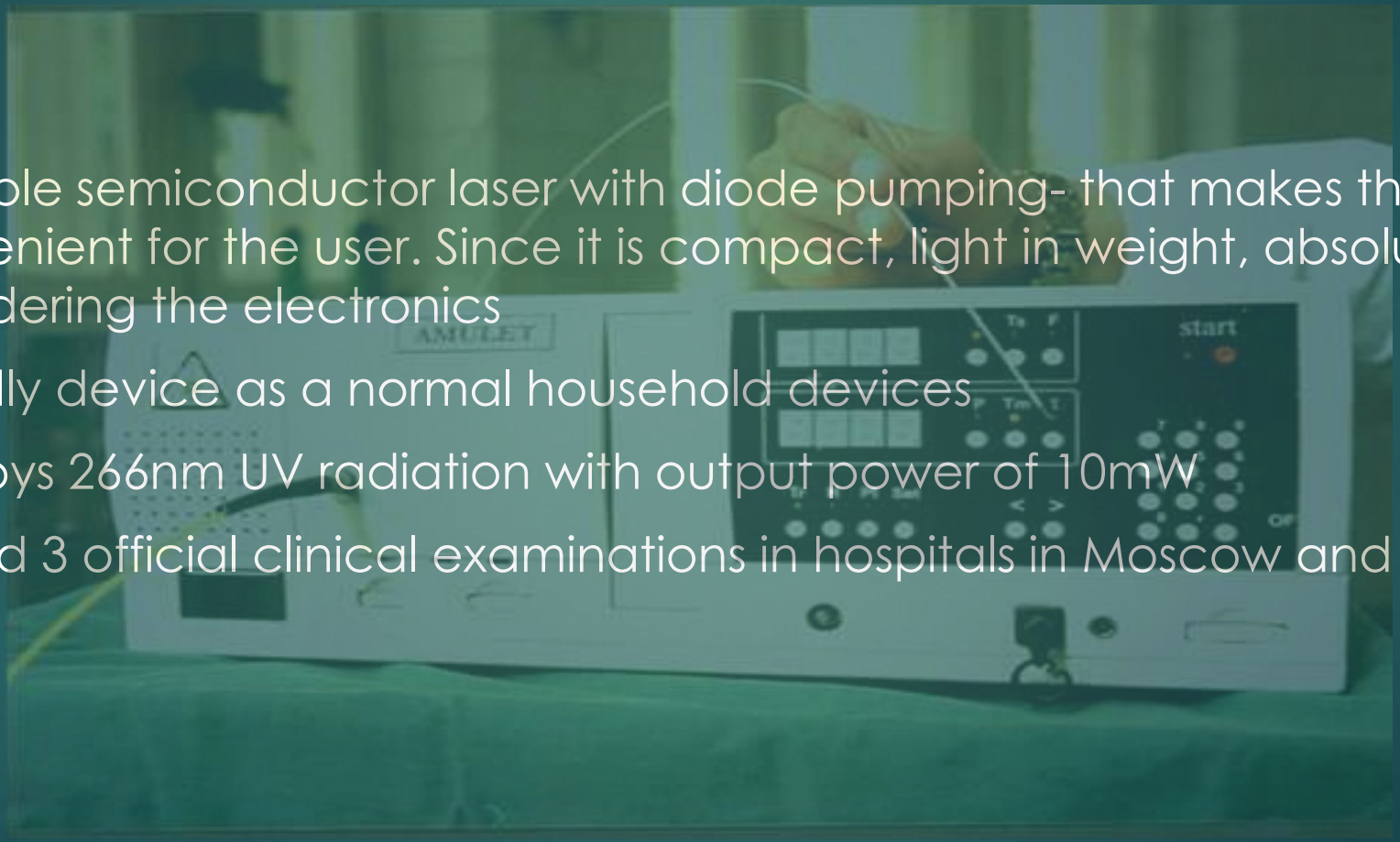
It is well withstands heat up to 85 ° C and cooled to -200 ° C.

Ultraviolet Amulet rays sterilize it in 2-3 minutes.

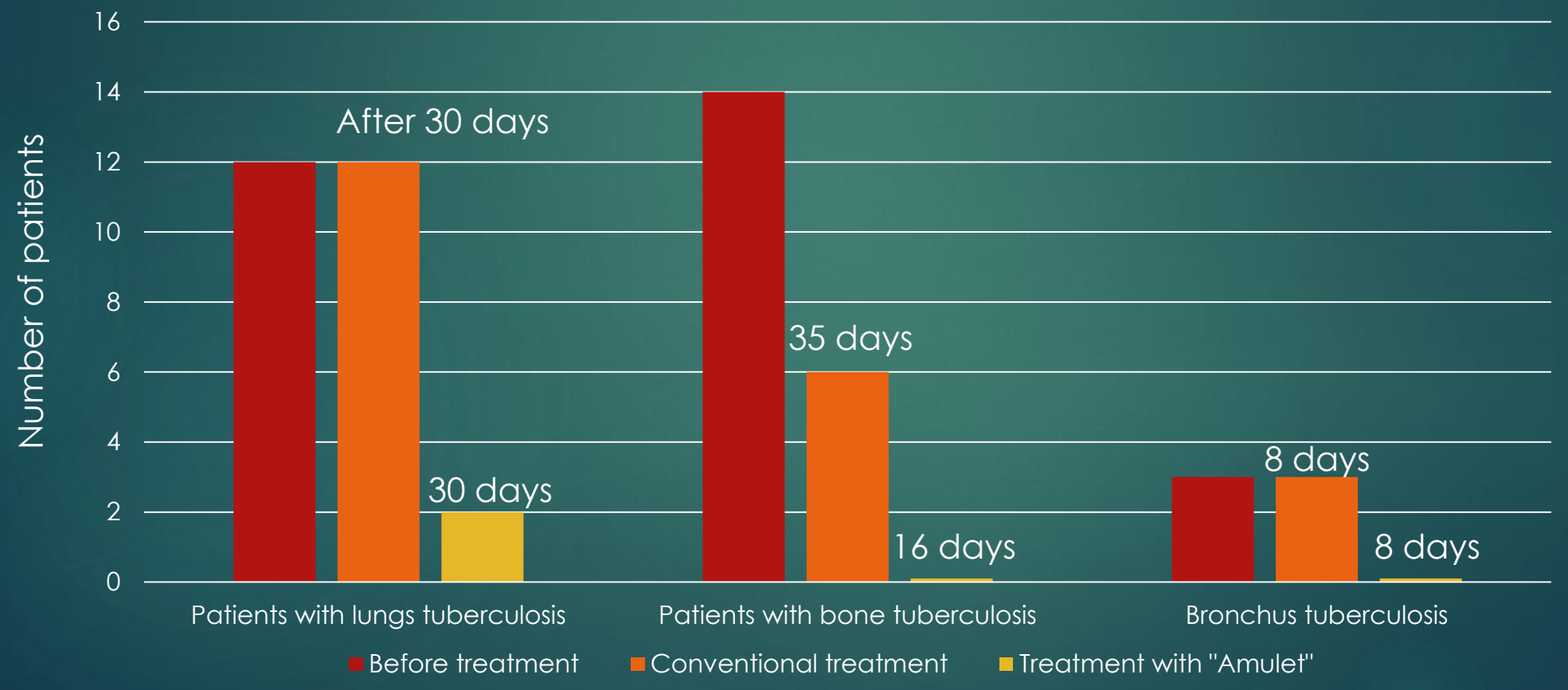
Laser system “Amulet”

Description

- Portable semiconductor laser with diode pumping- that makes the usage convenient for the user. Since it is compact, light in weight, absolutely safe considering the electronics
- Friendly device as a normal household devices
- Employs 266nm UV radiation with output power of 10mW
- Passed 3 official clinical examinations in hospitals in Moscow and Moscow region



“Amulet” clinical exam results in comparison with conventional treat



Clinical exams reports

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ

КОМИТЕТ ПО НОВОЙ МЕДИЦИНСКОЙ ТЕХНИКЕ

ВЫПИСКА ИЗ ПРОТОКОЛА № 2

Заседание комиссии по инструментам, приборам, аппаратам и материалам, применяемым в общей хирургии.

Комиссия, учитывая результаты испытаний и представленный ЗАО «Энергомаштехника» (Москва) акт устранения замечаний, выявленных в ходе испытаний, рекомендует к серийному производству и применению в медицинской практике, к регистрации и внесению в Реестр разработанное ЗАО «Энергомаштехника» (Москва) изделие медицинской техники (код ОКП 944420) под уточненным наименованием:

«Установка УФ-лазерная полупроводниковая портативная со световодом для введения излучения в пораженную область через инъекционную иглу при лечении деструктивных форм легочного и костного туберкулеза УЛуф-01/10-«Амулет».

Выпуск осуществлять в соответствии с заявляемой потребностью.

Класс в зависимости от потенциального риска применения –2б.

Перерегистрацию провести через десять лет.

П.П. Председатель комиссии **А. М. Шулутко**

Выписка верна:

Секретарь комиссии **М.Н. Егорочкина**

методов лечения ЦНИИТ РАМН,

д. м. н., профессор В. Г. Добкин

Федеральное государственное бюджетное учреждение "ДАЛЬНЕВОСТОЧНЫЙ НАУЧНЫЙ ЦЕНТР ФИЗИОЛОГИИ И ПАТОЛОГИИ ДЫХАНИЯ" Сибирского отделения Российской академии медицинских наук

Российская Федерация 675000 г. Благовещенск, ул. Калинина, 22 тел.: (4162) 33-18-19

№

Генеральному директору ООО «Талисман ЛТ»

На сегодняшний день имеются многочисленные результаты проводившихся с 90-х годов исследований, подтверждающие эффективность применения УФ лазерного излучения при лечении туберкулеза и заболеваний, сопровождающихся гнойными и воспалительными процессами.

К сожалению, практическому распространению этого, безусловно, эффективного метода препятствует то, что сегодня для УФ лазерной терапии доступны лишь установки на основе газовых и эксимерных лазеров, которые отличаются высокой стоимостью, значительными эксплуатационными затратами, габаритами, весом и энергопотреблением, требуют создания специально оборудованных рабочих мест и высококвалифицированного персонала. Лишь единичные медицинские центры могут позволить себе приобретение таких установок.

Компактный и простой в использовании лазерный комплекс, прошедший клинические испытания, позволит значительно расширить область применения УФ лазерного излучения в медицинской практике и может найти применение практически в каждом клиническом учреждении РФ.

Заместитель директора по научной и лечебной работе Федерального государственного бюджетного учреждения «Дальневосточный научный центр физиологии и патологии дыхания» Сибирского отделения РАМН д.м.н., проф., заслуженный врач РФ В.П. Самсонов

гнойных

выпуску

диодной накачкой «Амулет» и внедрению его в клиническую практику гнойной хирургии.

Руководитель клинических испытаний

Д-р мед. наук, профессор В.Н. Лавров

НАУЧНО-ИССЛ

Ap roductio

Deci 3

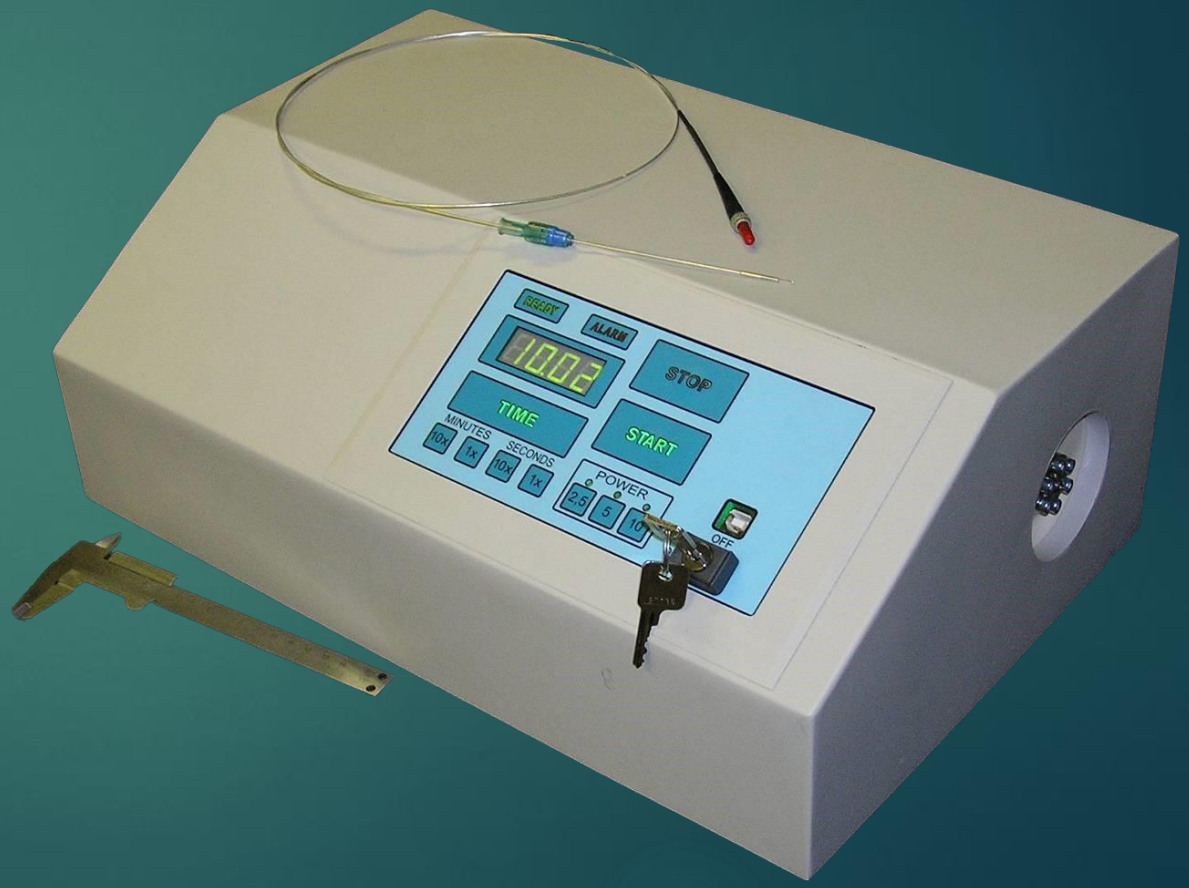
2003-2007“Amulet”

2007-2011“Talisman”

Despite the shown high performance during the examination, “Amulet” has shown its low reliability for the real life clinics use.

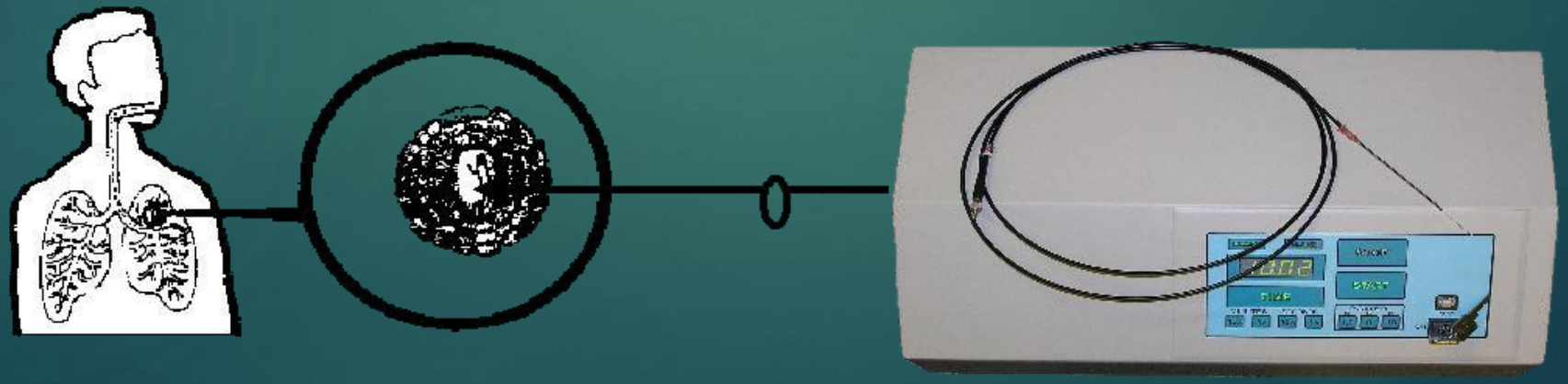
The optical scheme of the laser was unable to survive in the conditions of constant mechanical shocks and complete sterilizations.

This disadvantage become a barrier for mass production.



“Talisman” parameters

Wavelenght, nm	266
Average radiation power, mW	3 - 10
Repetition rate, kHz	10-20
Pulse duration, ns	5-6
Output radiation	Optical fiber
Optical fiber diameter	400-750
Required power, 220V/50Hz, W	<200
Life time, hours	>2000
Dimensions, mm	290x170x450
Weight, kg	<12



“Talisman” advantages

- Stable to outward forces optical scheme;
- Convenient and intuitive interface for medical and other staff;
- Equipped with new developed types of optical fibers with variety of scatter's oriented for

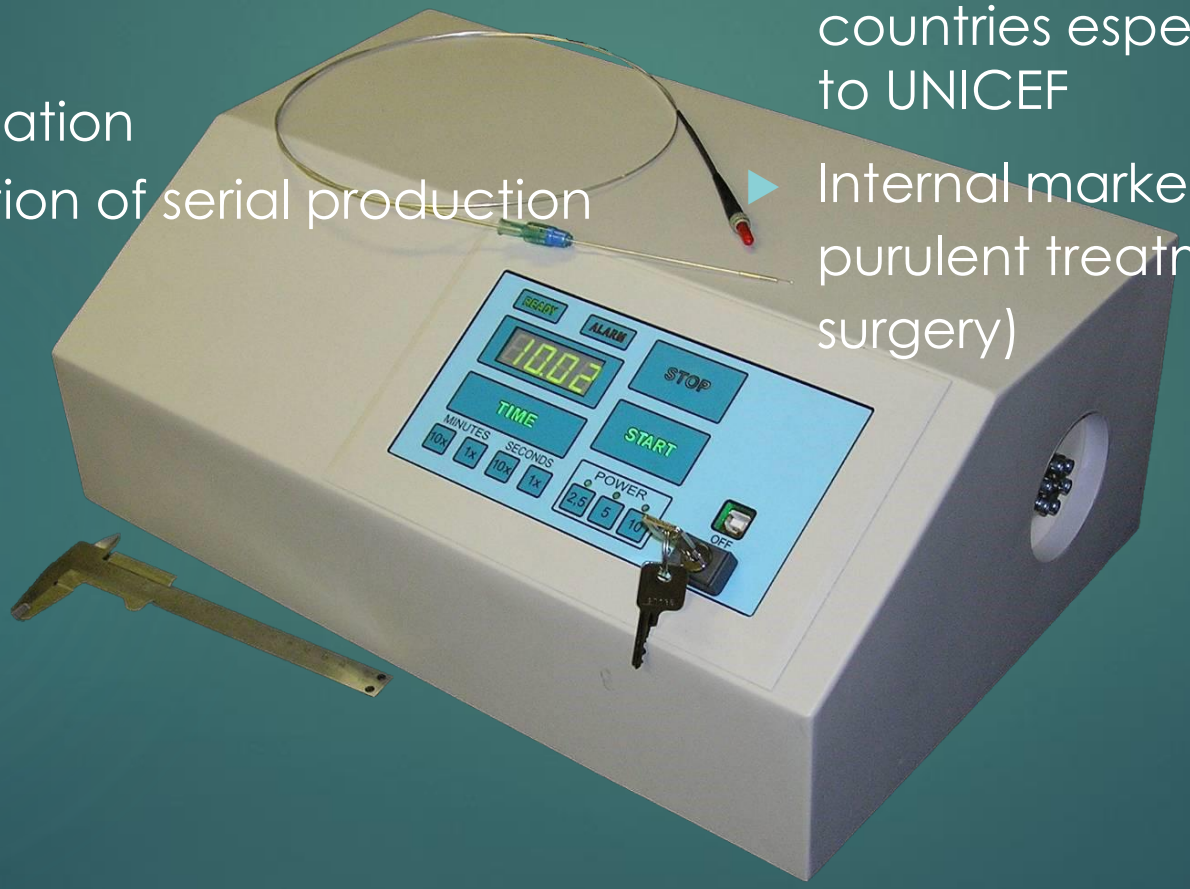
  - lungs,

  - bronchus,

  as well as targeted for wound surface treatments;
- Advanced hermeticity of the construction able to withstand while sterilization by any cool evaporation methods

Challenges and perspectives

- State-of-the-art device designing & styling
- EU certification
- Organization of serial production
- High export potential to number of countries especially in Africa and Asia, to UNICEF
- Internal market (for inflammatory& purulent treatments, for the use in surgery)



Welcome to cooperation!