

***New Revolution at the  
Interface of Science and  
Technology***

*Latchezar Avramov, Dr of Sc.*

# **Biomedical Photonics**

## **H A N D B O O K**

**Editor-in-Chief**

**Tuan Vo-Dinh**

**Oak Ridge National Laboratory  
Oak Ridge, Tennessee**



**CRC PRESS**

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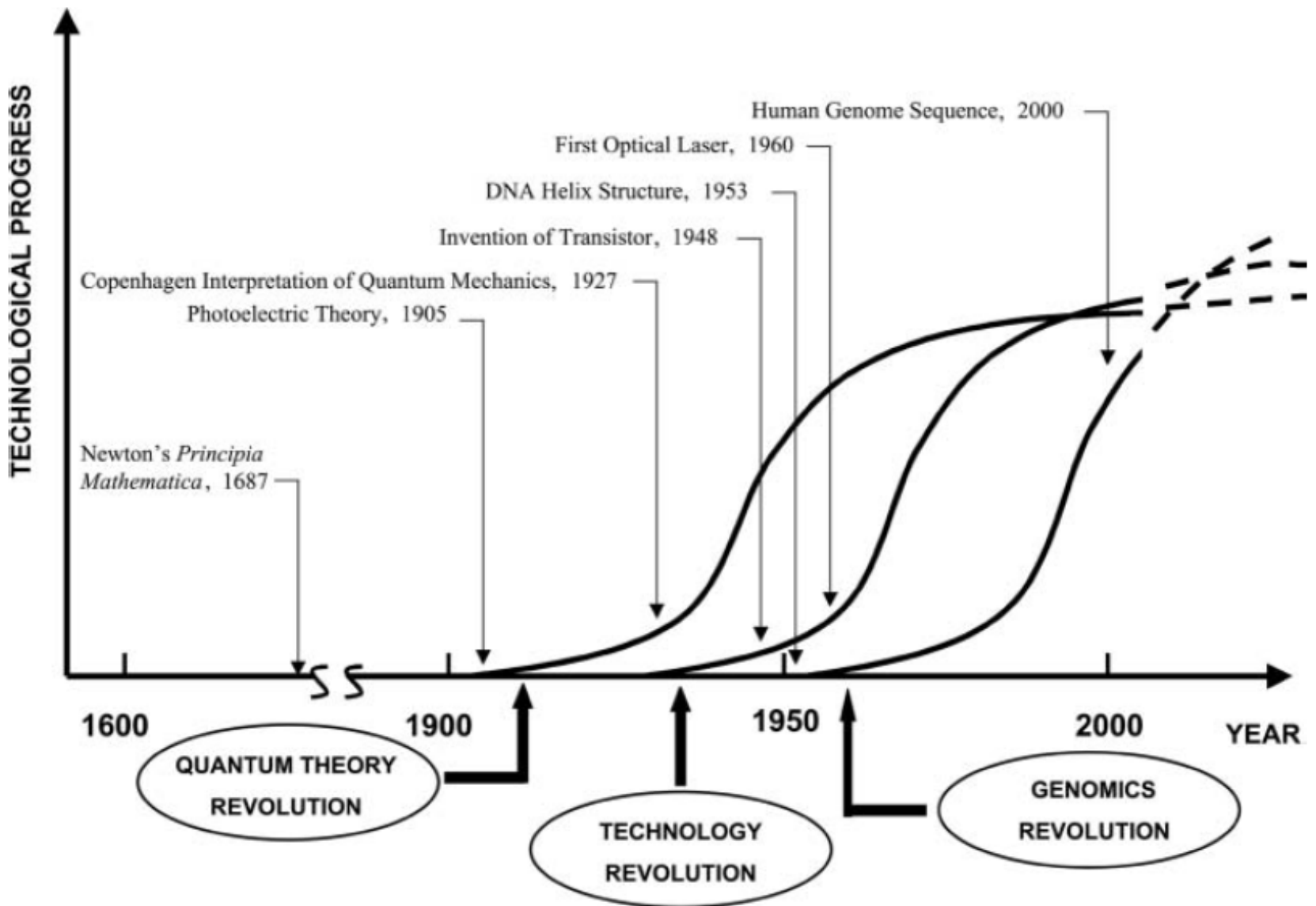
# ***Biomedical Photonics: Revolution at the Interface of Science and Technology***

***Tuan Vo-Dinh***

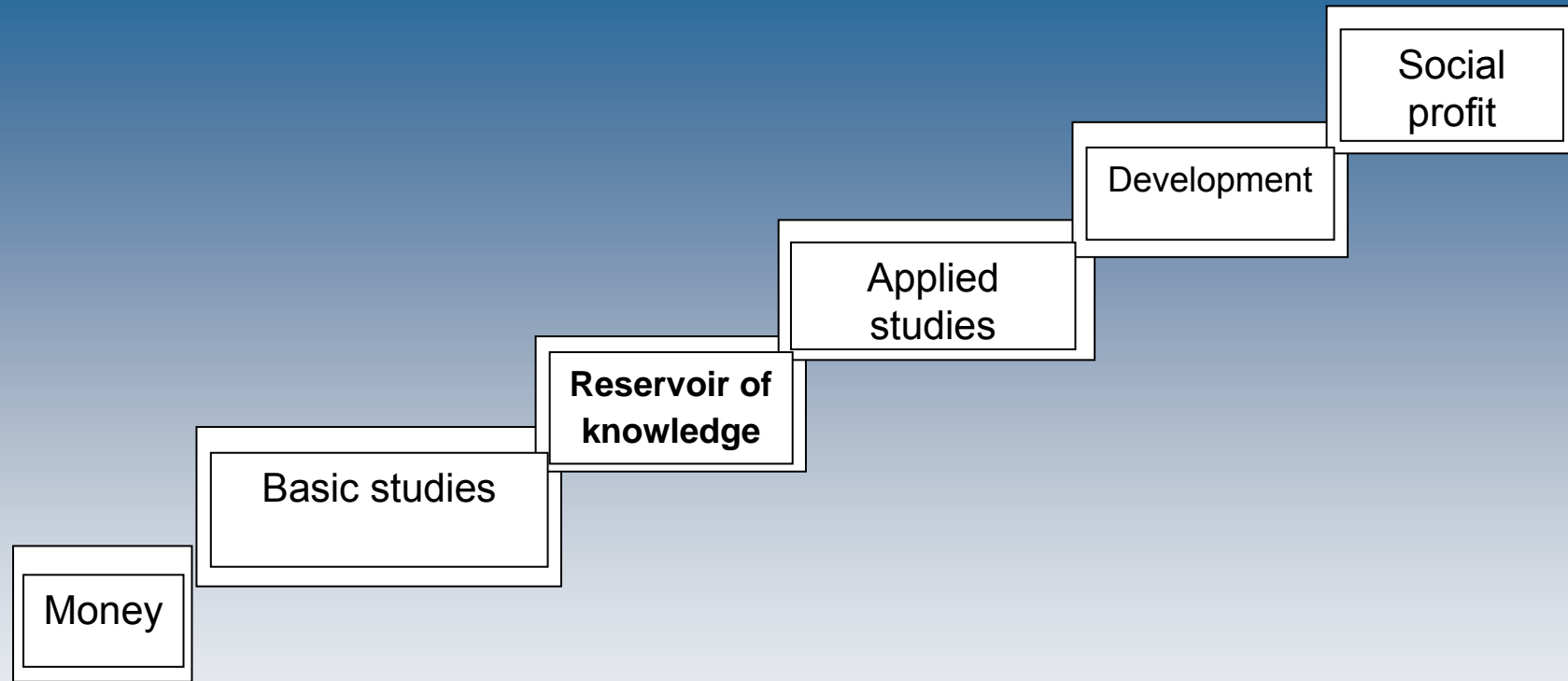
*The field of biomedical photonics is often not well defined because it has emerged from research conducted at the interface of the physical and biological sciences and engineering.*

*The field of biomedical photonics did not emerge as a well-defined, single research discipline like chemistry, physics, or biology. Its development and growth have been shaped by the convergence of three scientific and technological revolutions of the 20th century:*

- *The quantum theory revolution (1900–1950s)*
- *The technology revolution (1940s–1950s)*
- *The genomics revolution (1950s–2000)*



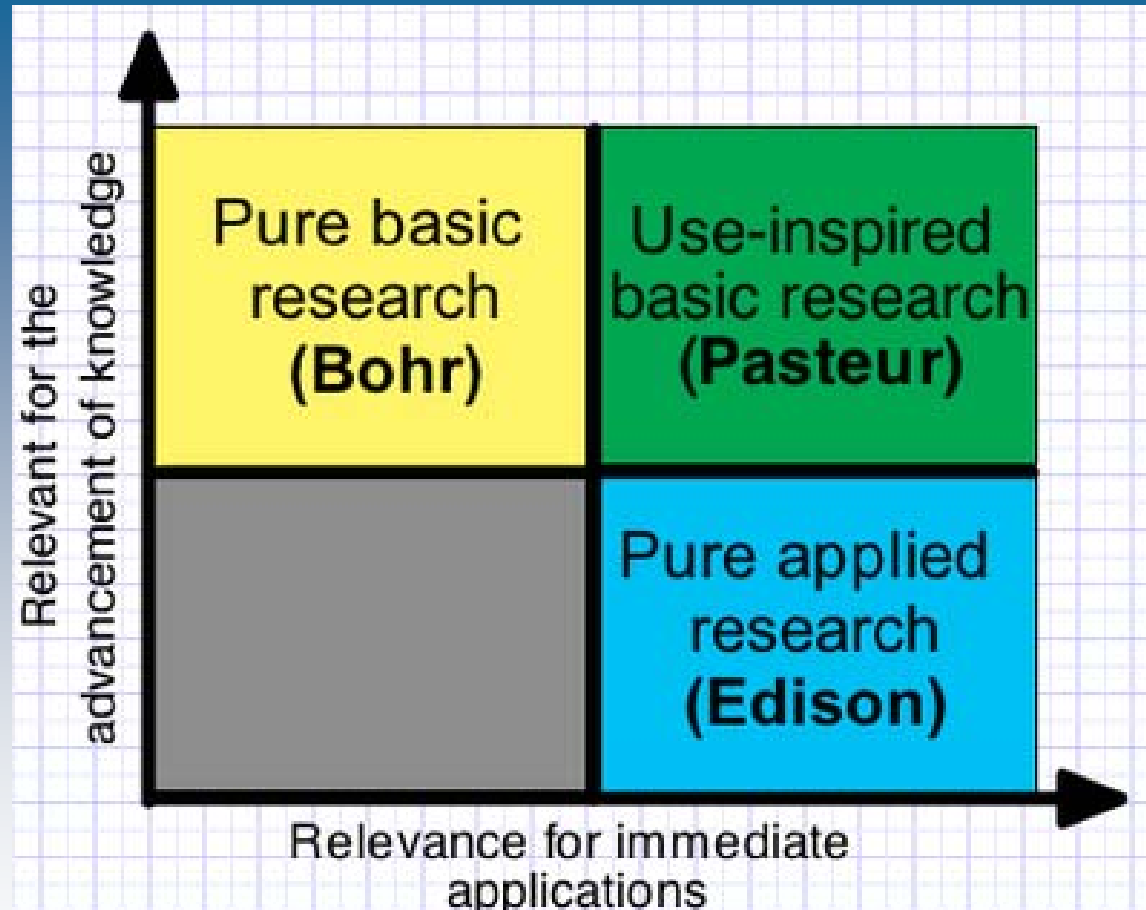
# ***Social Contract for Science***



## ***Linear Model of science***

**Dr. Vannevar Bush**, *Director of the Office of Scientific Research and Development, 1945*

# *Pasteur's Quadrant*



*Vannevar Bush - Donald Strokes, 1997*

# ***Social Contract for Science***

- **Mode 1 knowledge production** is executed within universities and is dominated by an academic agenda with little interest in application, while
- **Mode 2 knowledge production** (Gibbons et al., 1994) is done in intensive interaction with application and is driven by a broad range of interests.

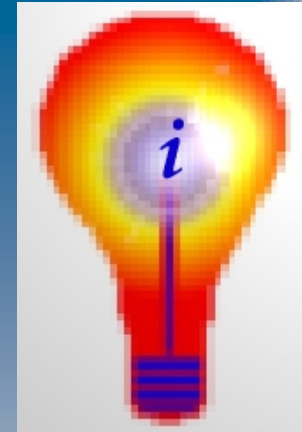
***“...to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion.”***

(strategic goal for 2010 set for Europe at the Lisbon European Council - March 2000)





# *Structure of the Innovation Process*

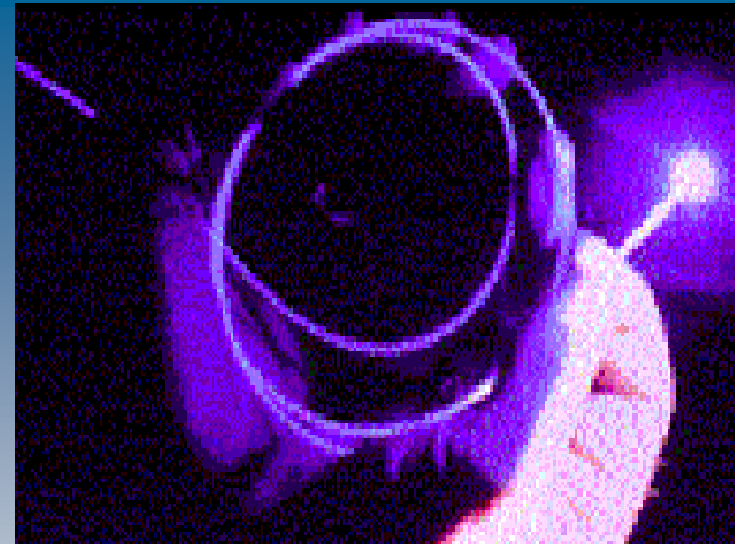
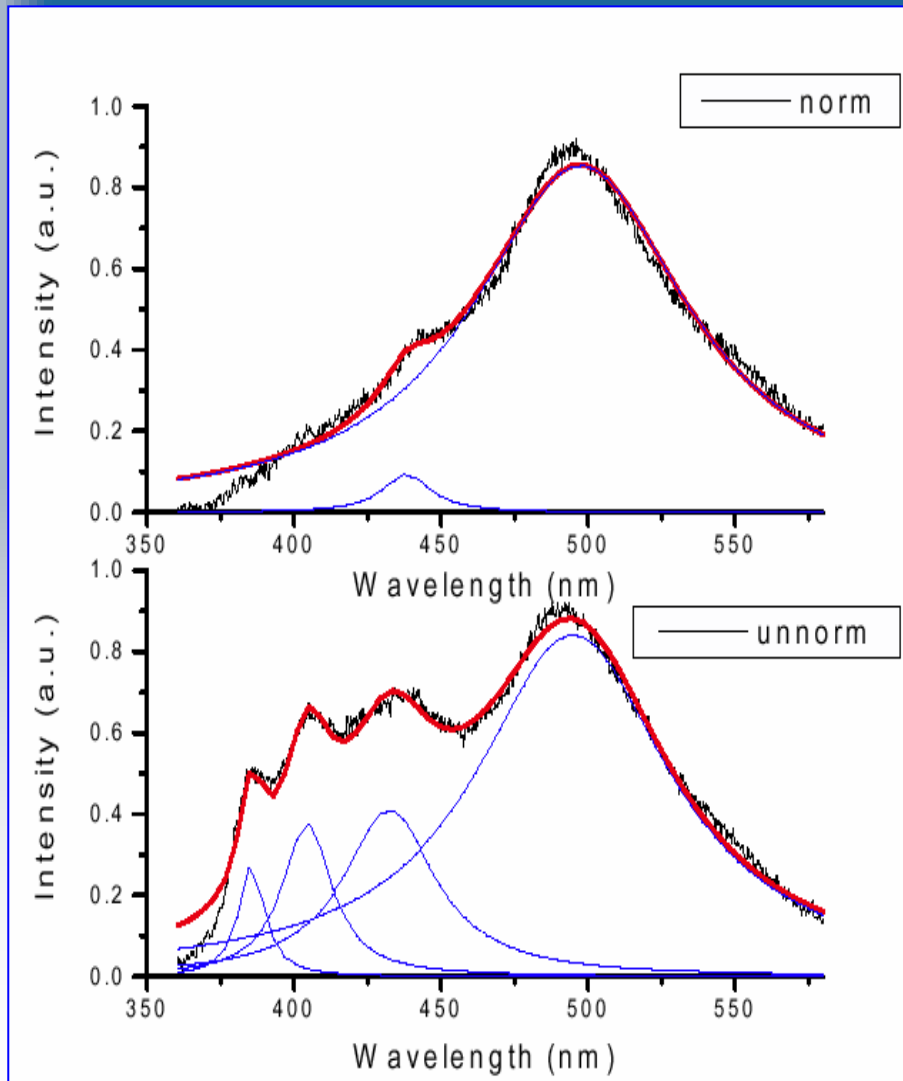


## *PROBLEM !*

- *Academic institutions – high investigative, low innovative potential*
- *SME – high innovative, low investigative potential (40% of innovations / 5% expenses; 10-20% outlive)  
“American Research and Development, Boston, 2005”*

***“FROM RESEARCH TO  
ENTERPRISE”***

# OPTICAL SPECTROSCOPY

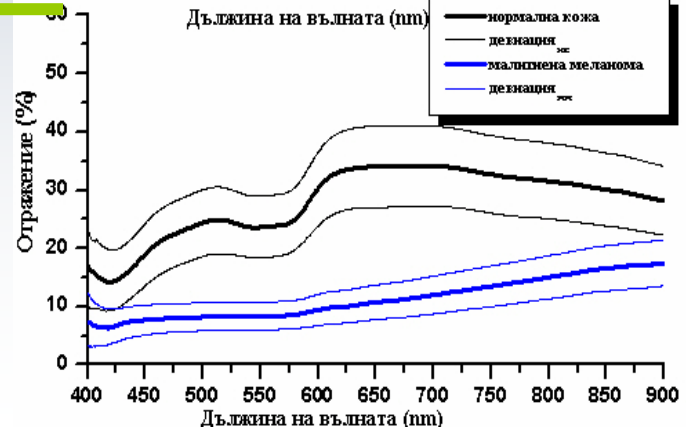
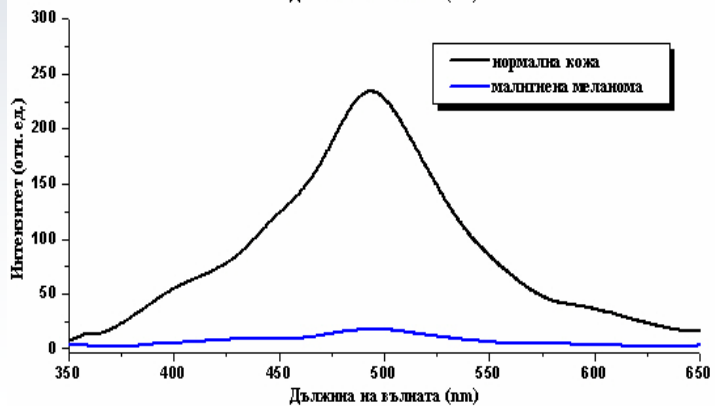
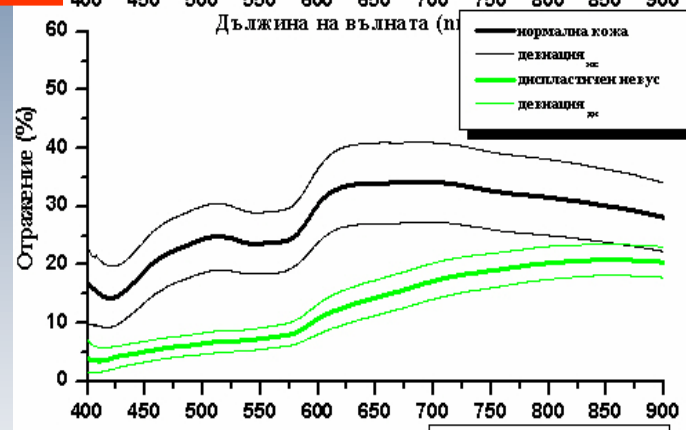
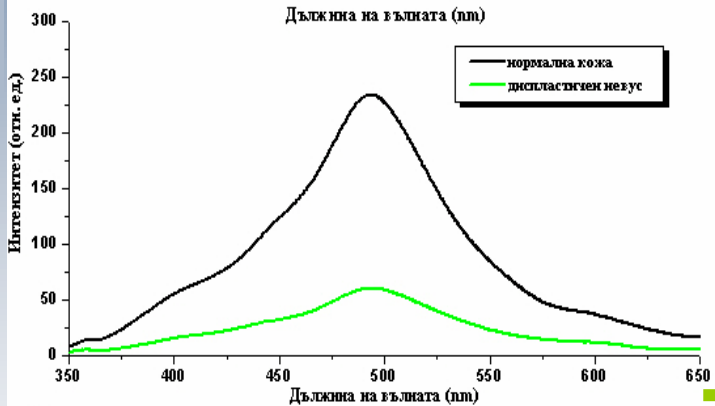
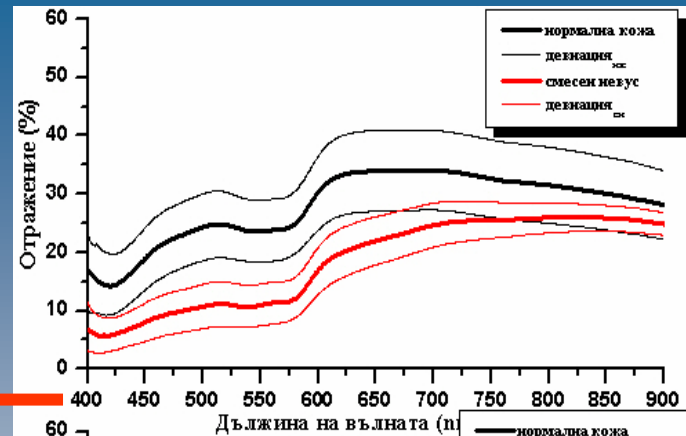
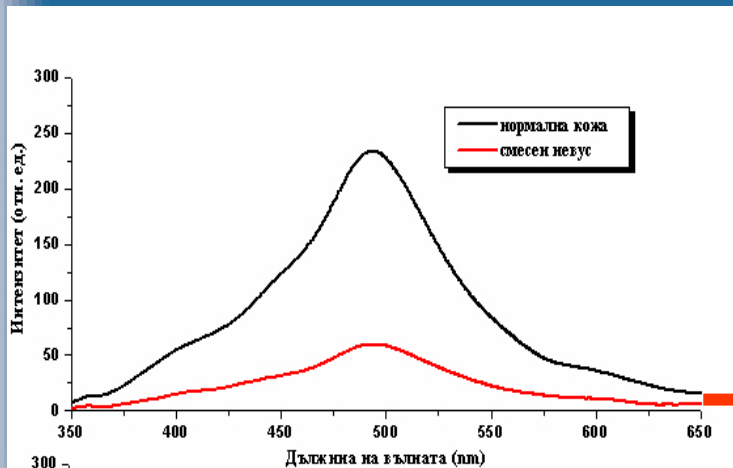


LIF Spectra of normal human  
skin and basal cell carcinoma

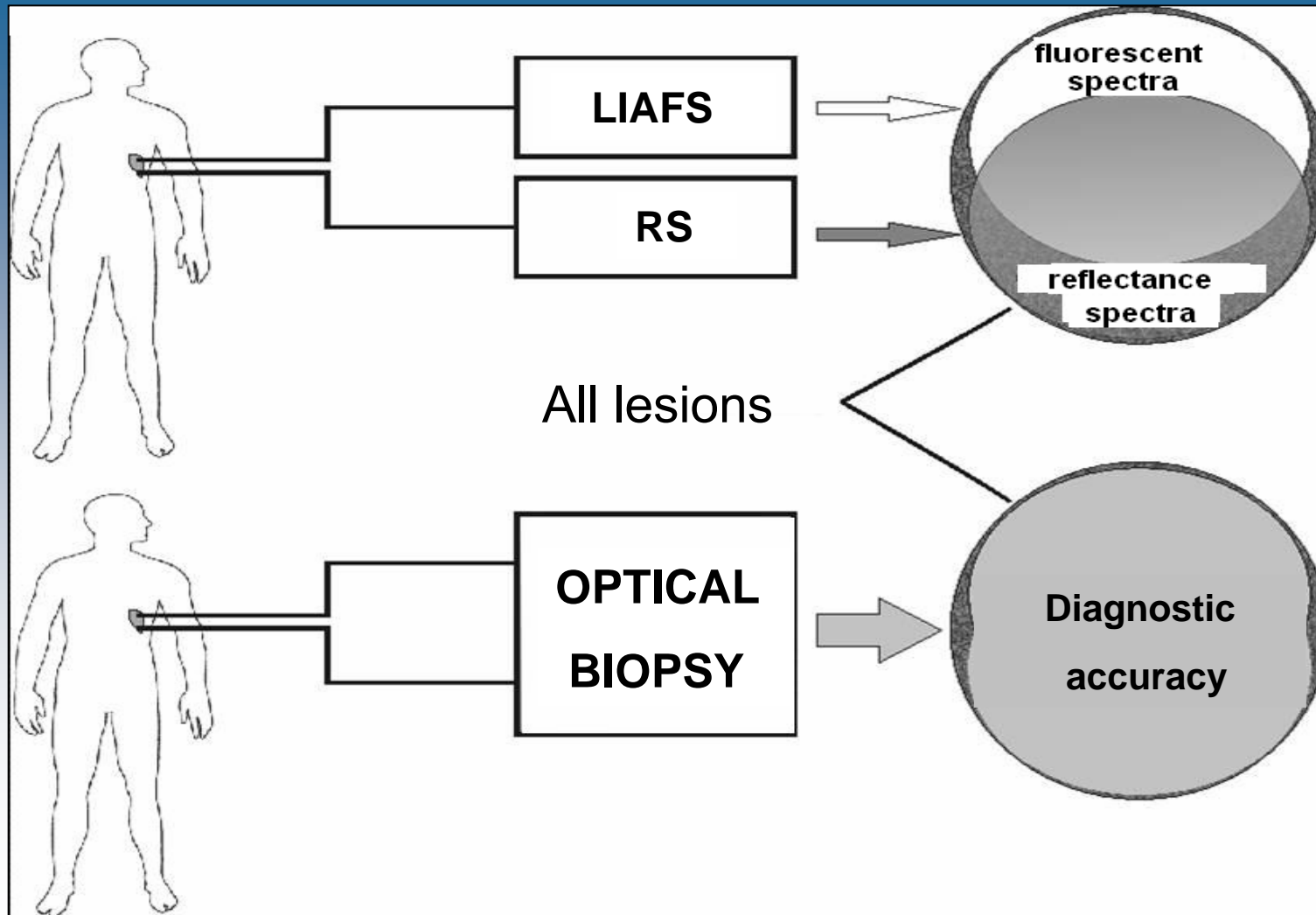


Algorithms for tumor diagnosis

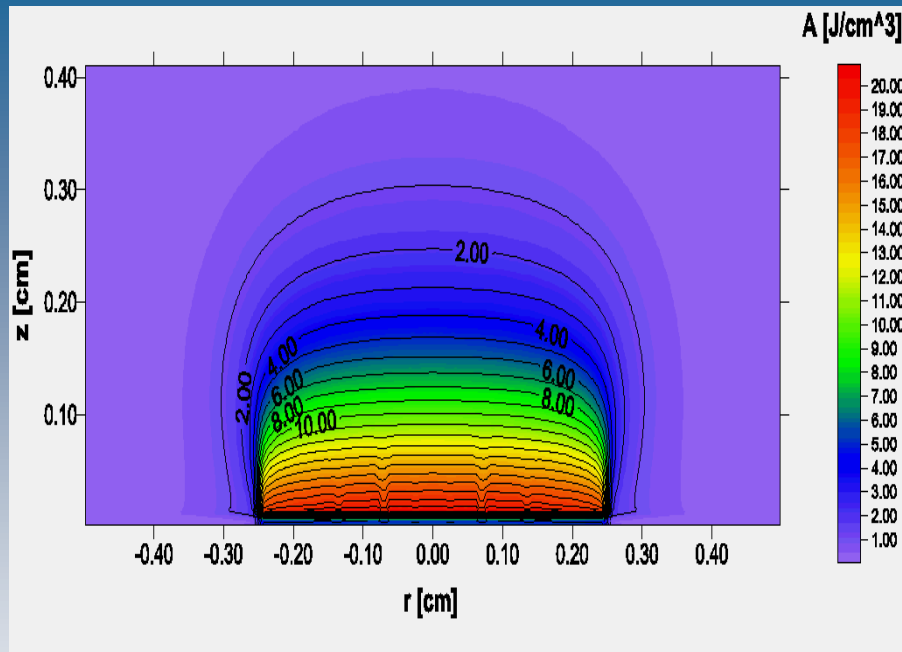
# Experimental Results



# OPTICAL BIOPSY



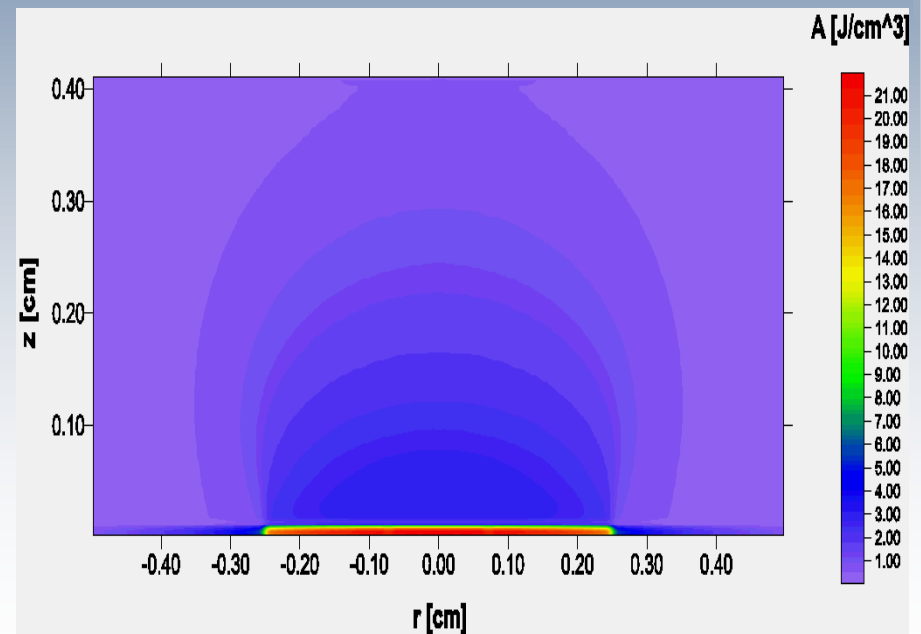
# “Monte-Carlo” modeling of interactions of laser radiation with human skin



$\lambda = 1.32 \mu\text{m}$

Laser power

$\lambda = 1.06 \mu\text{m}$

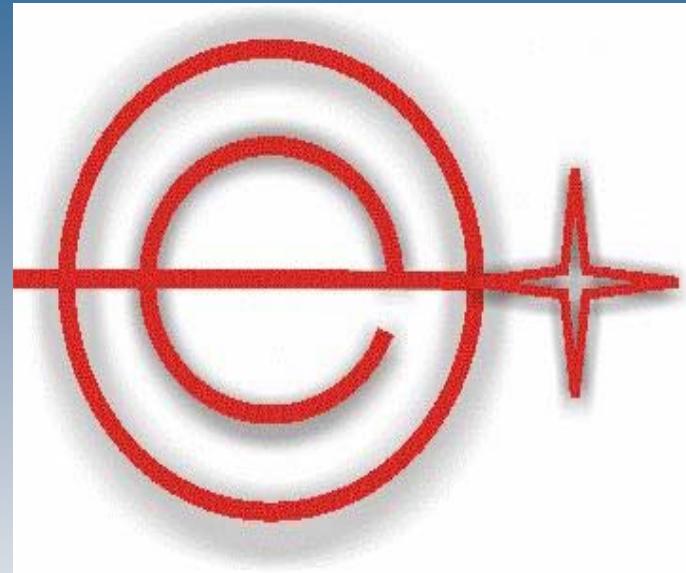


*Opportunity of development of computer-planned personal laser procedures*

# *Scientific and technological transfer*

## *Spin-off №1*

*“OPTELLA” Ltd.*



*More of the products of **OPTELLA** are implemented in the health service sector in Bulgaria and they have shown very good clinical results in the area of surgery, oncology, ophthalmology and urology.*



# "MEDIRAY" laser systems family



МИНИСТЕРСТВО НА ЗДРАВЕОПАЗВАНЕТО

УТВЪРЖАВАМ

ЗАМ.МИНИСТЪР:



Семерджиев

РАЗРЕШЕНИЕ

за въвеждане на апаратура и инструментариум в  
здравната мрежа

В съответствие с Инструкция №6 от 19.09.1991 г. на МЗ за  
контрол при въвеждането на нова медицинска апаратура и инструментариум  
/ДВ, бр.84 от 1991 г./ и на основание резултатите от изпитванията, Ми-  
нистерството на здравеопазването дава настоящето РАЗРЕШЕНИЕ за:

АПАРАТУРА /ИНСТРУМЕНТАРИУМ/: Лазерна медицинска система  
"ДУЕТ 100/30"

ОБЛАСТ НА ПРИЛОЖЕНИЕ: ХИРУРГИЯ  
ПРОИЗВОДИТЕЛ: "ОНТЕЛЛА" – ООД гр. София  
ВНОСИТЕЛ:

СТАНДАРТИЗАЦИОНЕН ДОКУМЕНТ: ОН 0486725-94

СЕРТИФИКАТ ЗА СЪОТВЕТСТВИЕ:

РЕЗУЛТАТИ ОТ ИЗПИТВАНИЯТА: ПОЛОЖИТЕЛНИ

-ТЕХНИЧЕСКИ: Протокол № 57 от 23.12.1997 г. ЦИЛ при "ЛОТ"-ЕАД

-КЛИНИЧНИ: Протокол от Катедра Обща хирургия при ДУБ  
"АЛЕКСАНДРОВСКА", проф. Р. Гайдарски

ЗАБЕЛЕЖКА /ПРЕПОРЪКИ/:

Дата: 03.02.1998 год.

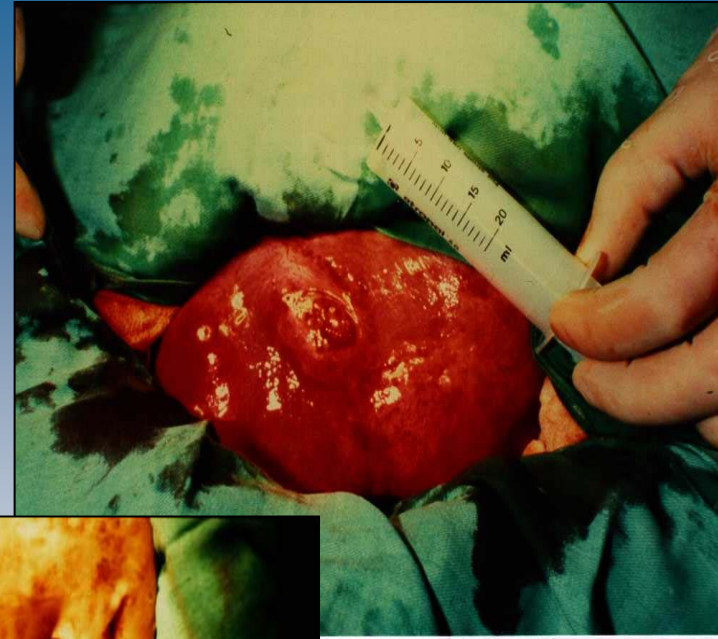
НАЧАЛНИК ОТДЕЛ:

инж. Т. Илиев

*Surgical laser system "MEDIRAY 100/40" – introduced in State University Hospital "Aleksandrovska" with Permission of the Ministry of Health for introduction in the health service system.*



# ***“MEDIRAY” in the operating room***



# "MEDIRAY" laser systems family



РЕПУБЛИКА БЪЛГАРИЯ  
МИНИСТЕРСТВО НА ЗДРАВЕОПАЗВАНЕТО  
MINISTRY OF HEALTH

София 1000, ул. "Св. Неделя" 5 тел. : 86 31; факс: 981 18 33; телекс: 22 430, 23 654;  
5 "Sv.Nedela" Sq., 1000 Sofia, BG Tel.: (+3592) 8631; fax (+3592) 981 18 33; telex 22 430, 23 654.

УТВЪРЖДАВАМ  
ЗАМ. МИНИСТЪР:  
Д-р Ат. Кундурджиев

## РАЗРЕШЕНИЕ

за въвеждане на медицинска апаратура и  
инструментариум в здравната мрежа

В съответствие с Инstrukция № 6 от 19.09.1991г. на МЗ за контрол при въвеждането на нова медицинска апаратура и инструментариум /ДВ, бр.84 от 1991г./ и на основание резултатите от изпитванията, Министерството на здравеопазването дава настоящето РАЗРЕШЕНИЕ за: Лазерна медицинска система "МЕДИРЕЙ У"

ОБЛАСТ НА ПРИЛОЖЕНИЕ: Урология и онкология  
ПРОИЗВОДИТЕЛ: "ОПТЕЛЛА" – ООД гр. София  
ВНОСИТЕЛ:  
СТАНДАРТИЗАЦИОНЕН ДОКУМЕНТ: ОН 04 86725-94  
СЕРТИФИКАТ ЗА СЪОТВЕТСТВИЕ:

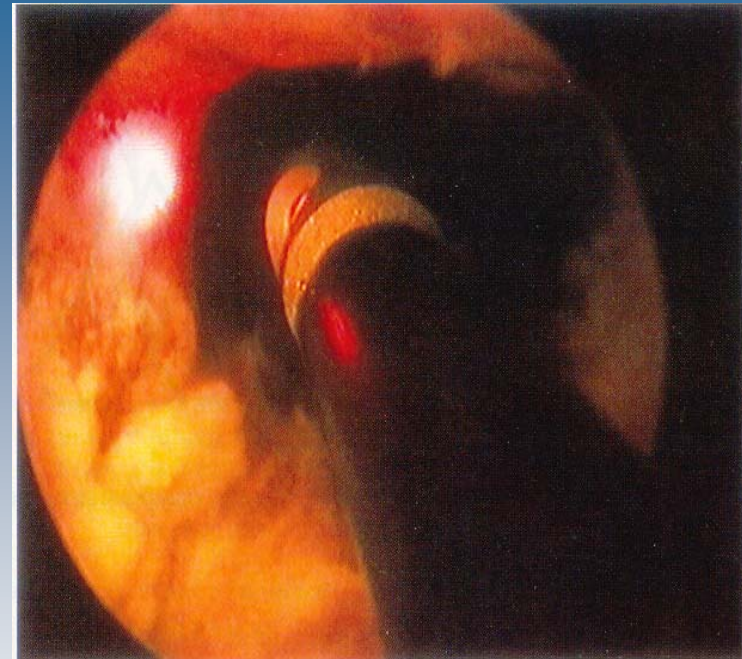
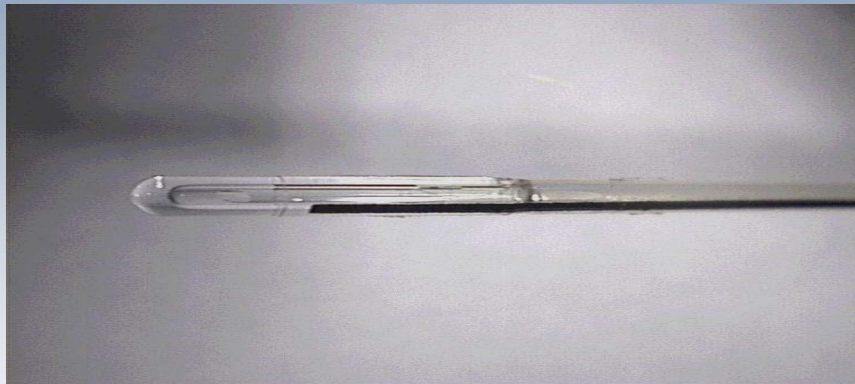
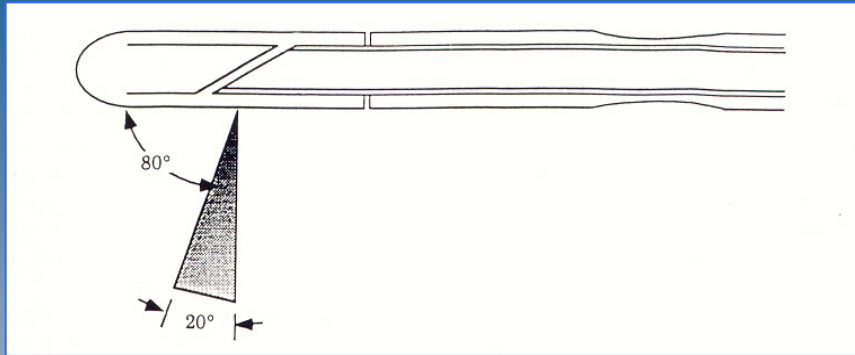
РЕЗУЛТАТИ ОТ ИЗПИТВАНИЯТА: положителни  
- ТЕХНИЧЕСКИ: протокол № 57/23.12.1997 г. ЦИЛ при "ЛОТ" -ЕАД  
- КЛИНИЧНИ: протокол за клинични изпитвания издаден от Отделение по урология при Национален онкологичен център.

ЗАБЕЛЕЖКА /ПРЕПОРЪКИ:  
Дата: 03.07.2000 г.

ГЛ. ЕКСПЕРТ:   
инж. Т. Илиев

*Laser medical system with applications in urology and urological oncology  
"Mediray U" - introduced in the National Centre of Oncology with Permission  
of the Ministry of Health for introduction in the health service system.*

# ***“MEDIRAY” laser systems family***



*For the first time in Bulgaria new method “Laser no contact transurethral coagulation of the prostate adenoma” was developed and introduced in clinical practice*



# “MEDIRAY” laser systems family



РЕПУБЛИКА БЪЛГАРИЯ  
МИНИСТЕРСТВО НА ЗДРАВЕОПАЗВАНЕТО

София-1000, пл.Св.Неделя №5

тел.9301 102, факс 9811833

Изх.№ 47-ср-8 / 04.11.2001г.

УТВЪРЖДАВАМЕ  
ЗАМ. МИНИСТЪР: д-р П. Танев



## РАЗРЕШЕНИЕ

за въвеждане на медицинска апаратура и  
инструментариум в здравната мрежа

В съответствие с Инstrukция № 6 от 19.09.1991г. на МЗ за контрол при въвеждането на нова медицинска апаратура и инструментариум /ДВ, бр.84 от 1991г./ и на основание резултатите от изпитванията, Министерството на здравеопазването дава настоящето **РАЗРЕШЕНИЕ** за: Лазерен апарат за терапия “МЕДИРЕЙ 04”

ОБЛАСТ НА ПРИЛОЖЕНИЕ: ОФТАЛМОЛОГИЯТА

ПРОИЗВОДИТЕЛ: “ОПТЕЛЛА” – ОДД гр. София

ВНОСИТЕЛ:

СТАНДАРТИЗАЦИОНЕН ДОКУМЕНТ: БДС 5500-90, БДС 12.2.006.0-80

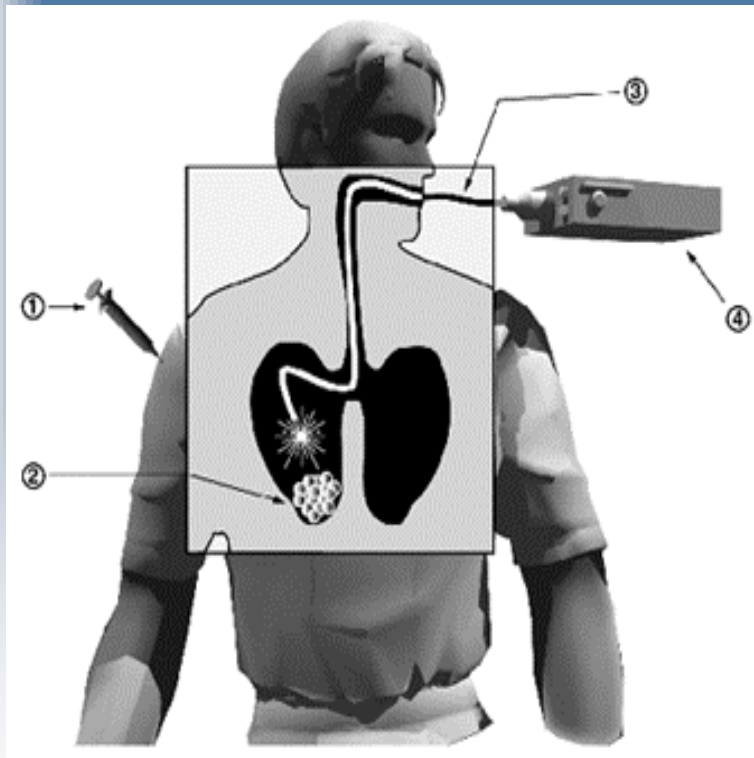
СЕРТИФИКАТ ЗА СЪОТВЕТСТВИЕ: ТЕХНИЧЕСКА СПЕЦИФИКАЦИЯ  
РЕЗУЛТАТИ ОТ ИЗПИТВАНИЯТА : ПОЛОЖИТЕЛНИ

- ТЕХНИЧЕСКИ: Протокол от изпитване издаден от Център за изпитване на електронна и офис техника – “ВИЦ-ИЗОТ” – ЕООД.

- КЛИНИЧНИ: Протокол от клинични изпитвания издаден от УМБАЛ “АЛЕКСАНДРОВСКА” – проф. д-р В. Танев.

*Ophthalmologic laser system for therapy and biostimulation “Mediray04” introduced in State University Hospital “Aleksandrovska” with Permission of the Ministry of Health*

# Photodynamic Medicine



1. *Patient is injected intravenously with a light-sensitive drug.*
2. *The drug is retained by malignant tissue, remaining inactive until exposed to a specific wavelength of laser light.*
3. *Laser energy is directed to the tumour through flexible fiberoptic device*
4. *When activated by the laser's light, the drug creates a toxic form of oxygen that destroys the cancerous cells with minimal damage to surrounding healthy cells.*

# ***Dermatological photodiagnosis***





# Photodynamic Therapy



Base cellular carcinoma  
before PDT



Base cellular carcinoma  
3 months after PDT



*“MediRay PDT” – introduced in M Center “St. Tomah” and M Center “Integrative Medicine”*

# Fluorescence Endo Spectroscopy

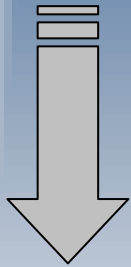
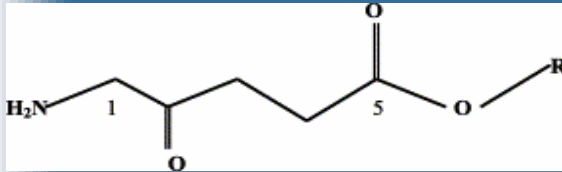


*Optical system for fluorescence spectroscopy of the gastrointestinal tract*

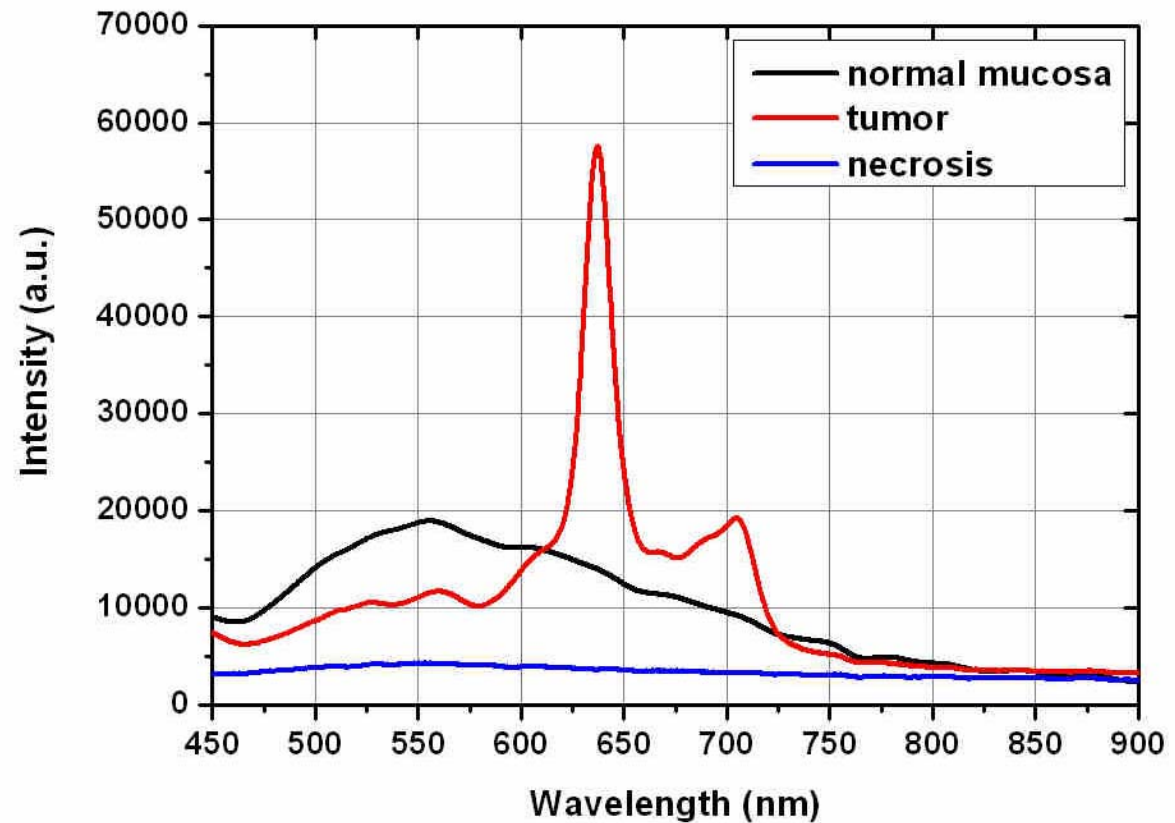
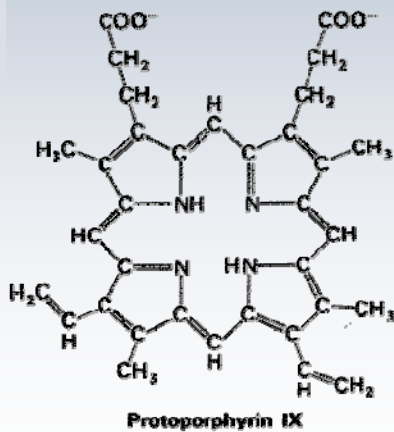


# Fluorescence Endo Spectroscopy

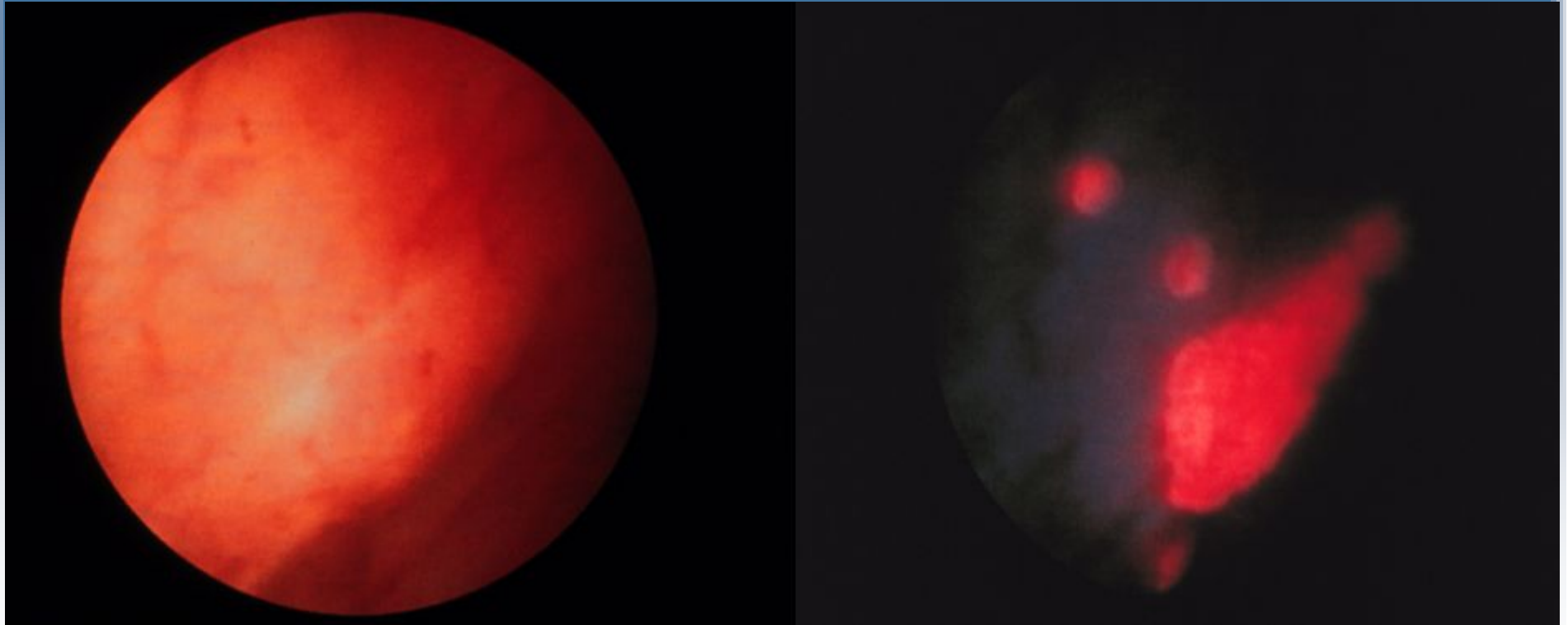
*Fluorescence of normal mucosa, tumor and necrosis of esophagus*



2 h - 8 h  
depending of  
the organ



# *Endo Spectroscopy 2-D visualization – Colon Tumor*



# “DESCARTES PRIZE 2004”

## Project “APLOMB”

Project coordinator:

*Prof Peter TOWNSEND*

- *University of Sussex UK*

*Partners:*

- *Universidad Autonoma de Madrid, Spain*
- *ElectronTubes Ltd, UK*
- *Photek Ltd, UK*
- *Laser Zentrum Hannover, Germany*
- *Institute of Metal and Technology, Slovenia*
- *Optella Ltd, Bulgaria*
- *Novara Technology, Italy*
- *Centro de Investigaciones, Spain*



**“Advanced Photocathodes  
for Luminescence Optimization  
in Medicine and Biology”**



НАГРАДИ ЗА НАУКА  
"ПИТАГОР"  
2009



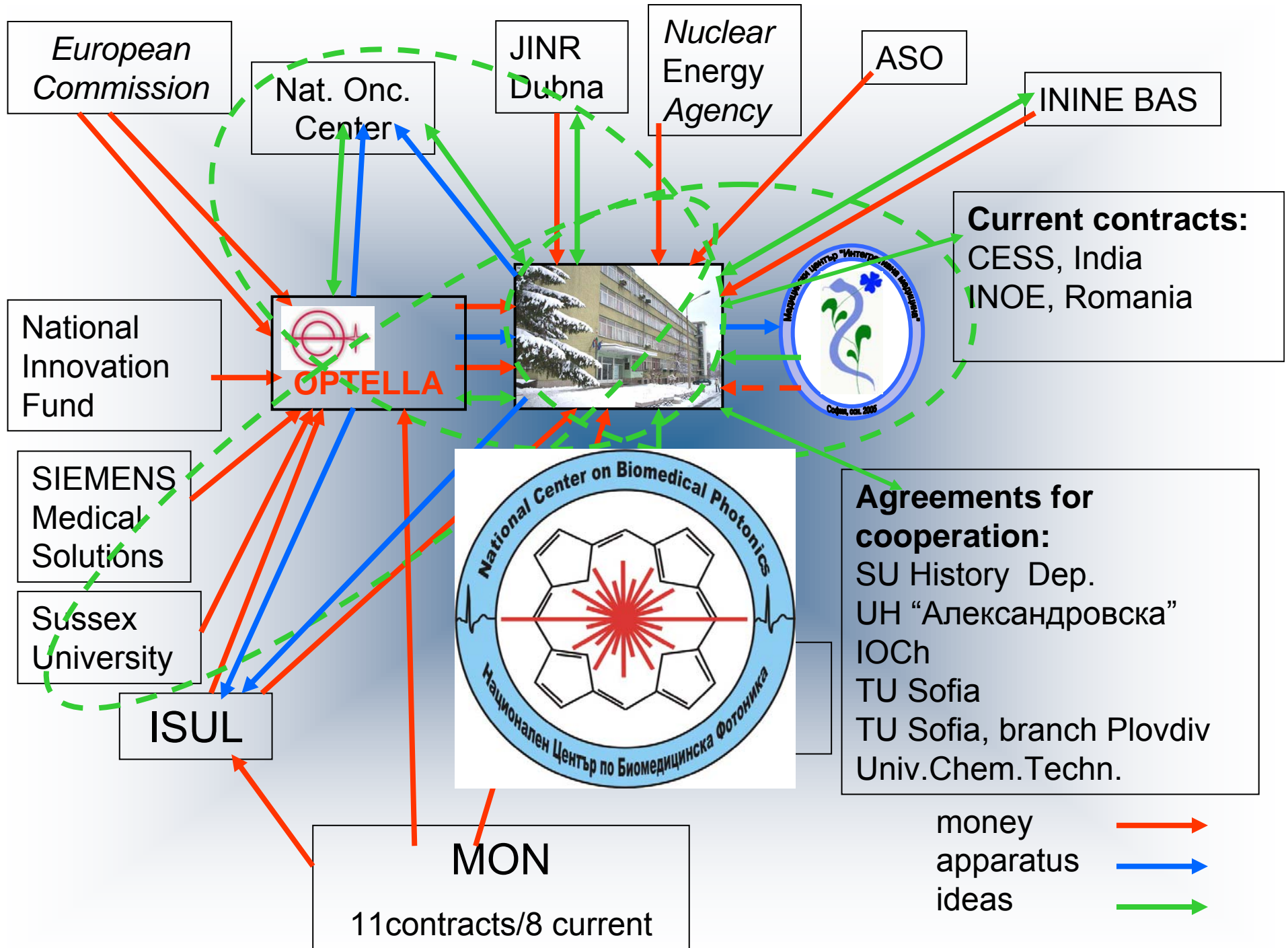
# Scientific and technological transfer

## Spin-off 2



*The Medical Center is the first private clinic in Bulgaria, specialized in integrative medicine, where Optella's laser systems are in use*





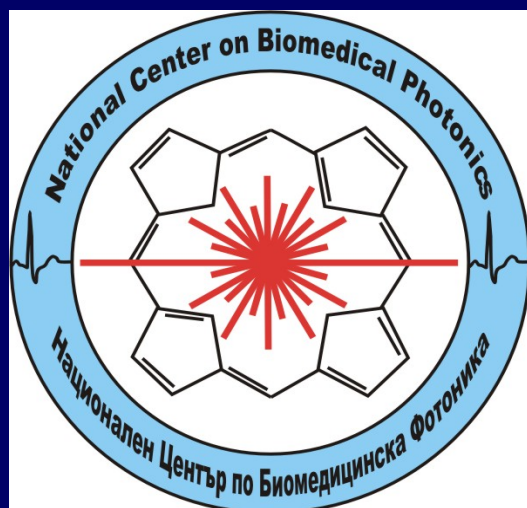


# THE NATIONAL BIOPHOTONICS & IMAGING PLATFORM IRELAND



Homepage

A 30 million euro platform funded under the Higher Education  
Authority of Ireland 2006 г.



# НАЦИОНАЛЕН ЦЕНТЪР ПО БИОМЕДИЦИНСКА ФОТОНИКА

1 700 000 лева – Министерство на Образованието  
и Науката

2008 г.

*Thank you for your attention*