The Abdus Salam
International Centre
for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

2443-19

Winter College on Optics: Trends in Laser Development and Multidisciplinary Applications to Science and Industry

4 - 15 February 2013

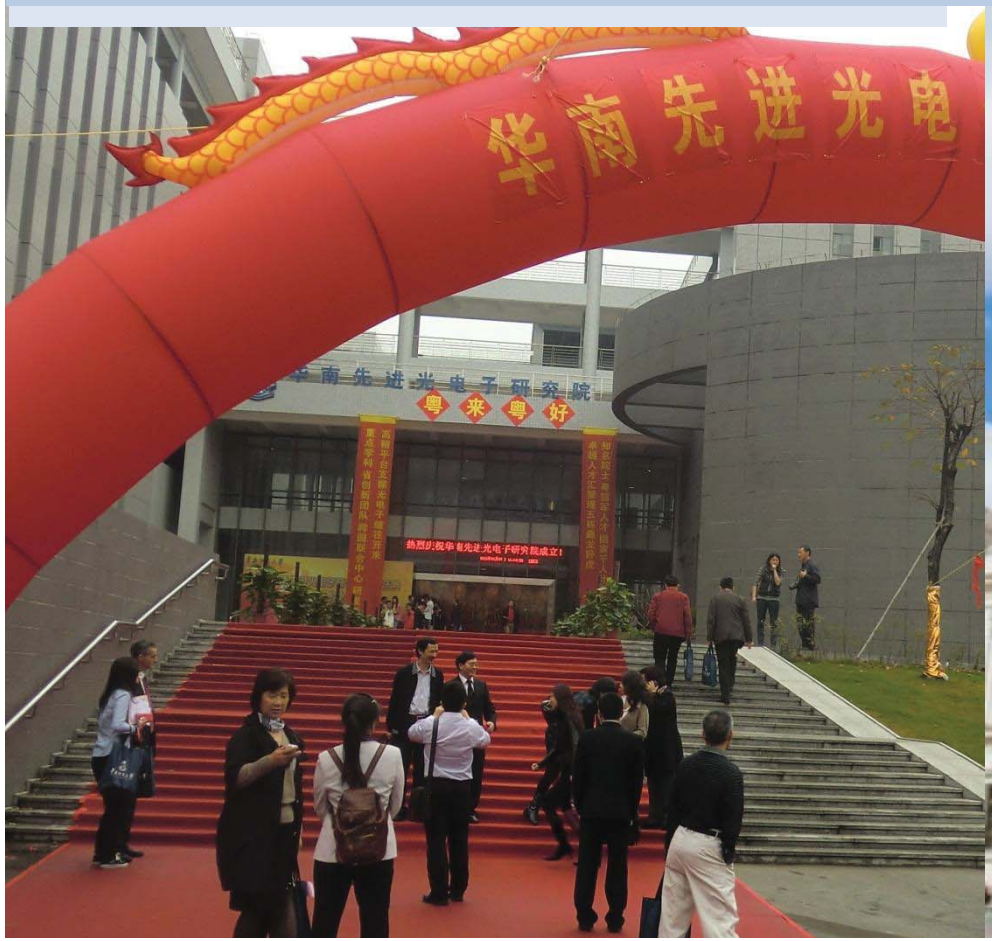
Biomedical applications (part 1+2)

K. Svanberg
Lund University Hospital
Sweden

Biomedical Applications

Biophotonics – Bridging the gap between medicine & physics

Katarina Svanberg
Department of Oncology, Lund University
Centre for Electromagnetic and Optical Research
South China Normal University, Canton, China




THE ABDUS SALAM
INTERNATIONAL CENTRE
FOR THEORETICAL PHYSICS
GUEST H


UNESCO
the
abdus salam ictp
trieste, italy

Networking and science walk together

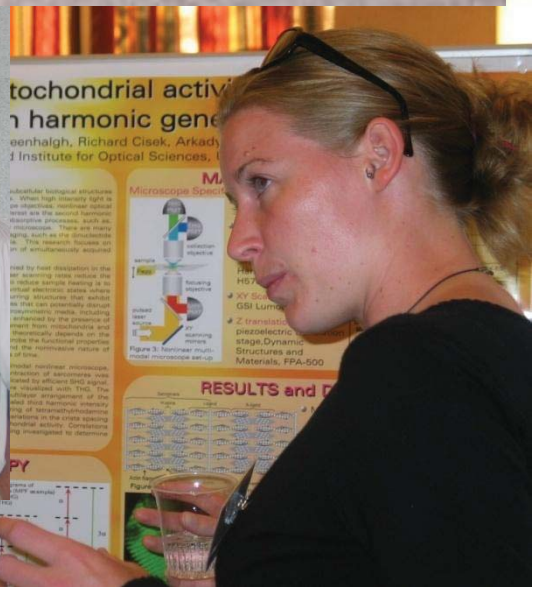
Take always advantage of meeting people

Listen to people – learn from them
(provided they have something important to teach you)

Be aware of your own competence – in particular you women

Work for improving the conditions for all of us

International Graduate summer school - Biophotonics´ 03, 05, 07, 09, 11 and 13



SPIE – The International Society for Optics and Photonics

- 195 Student Chapters, 27 countries
- 2,400 students involved in chapters
- 27% of SPIE Members are students (4,300)

The SPIE and the OSA student chapter at Osaka University together with the two Presidents Katarina Svanberg and Chris Dainty. Also seen are Elisabeth Rogan, CEO of OSA and Satoshi Kawata, the senior leader of the SPIE chapter


ISWLA'10
International Student Workshop
on Laser Applications 2010
May 25-28, Bran Romania

Student Chapters – the SPIE version

- 5,200 student members
- 180 student chapters in 36 countries: activity grants, training & networking
- 44 student events/training at conferences in 2012
- $350,000 is scholarships awarded annually
- Discounted memberships for students & early career
- Travel for 160 students to attend leadership training annually

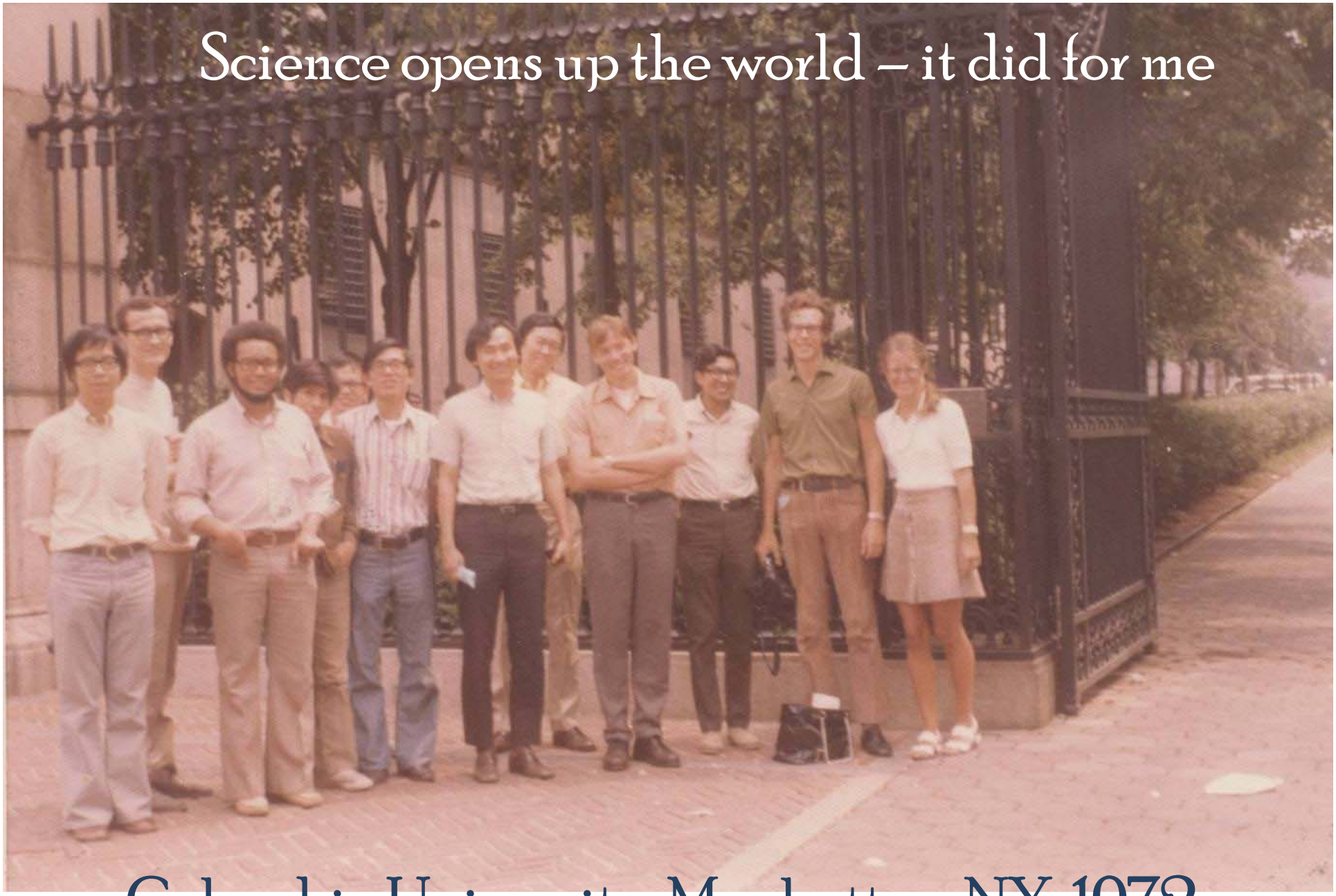
Mihai Pascu and Clementina Timus from the Institute of Laser, Plasma & Radiation Physics, Bucharest University together with Katarina Svanberg

Laura Mihai – the SPIE student chapter leader, Bucharest University, Romania

Visit to UNESCO for discussion about the ALOP programme

Accidental meetings may make the whole diffence

Sune Svanberg at his desk as a very young scientist



Columbia University, Manhattan, NY, 1972

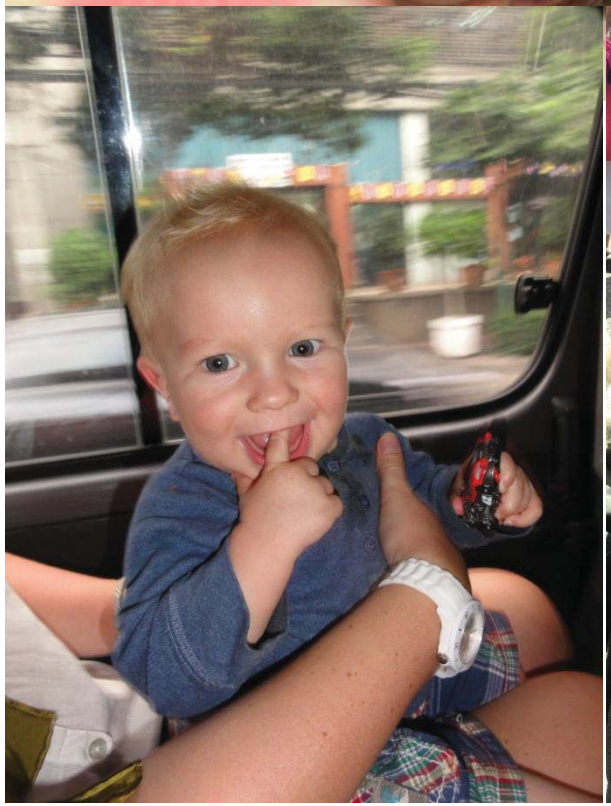

Professor
Ahmadou Wague

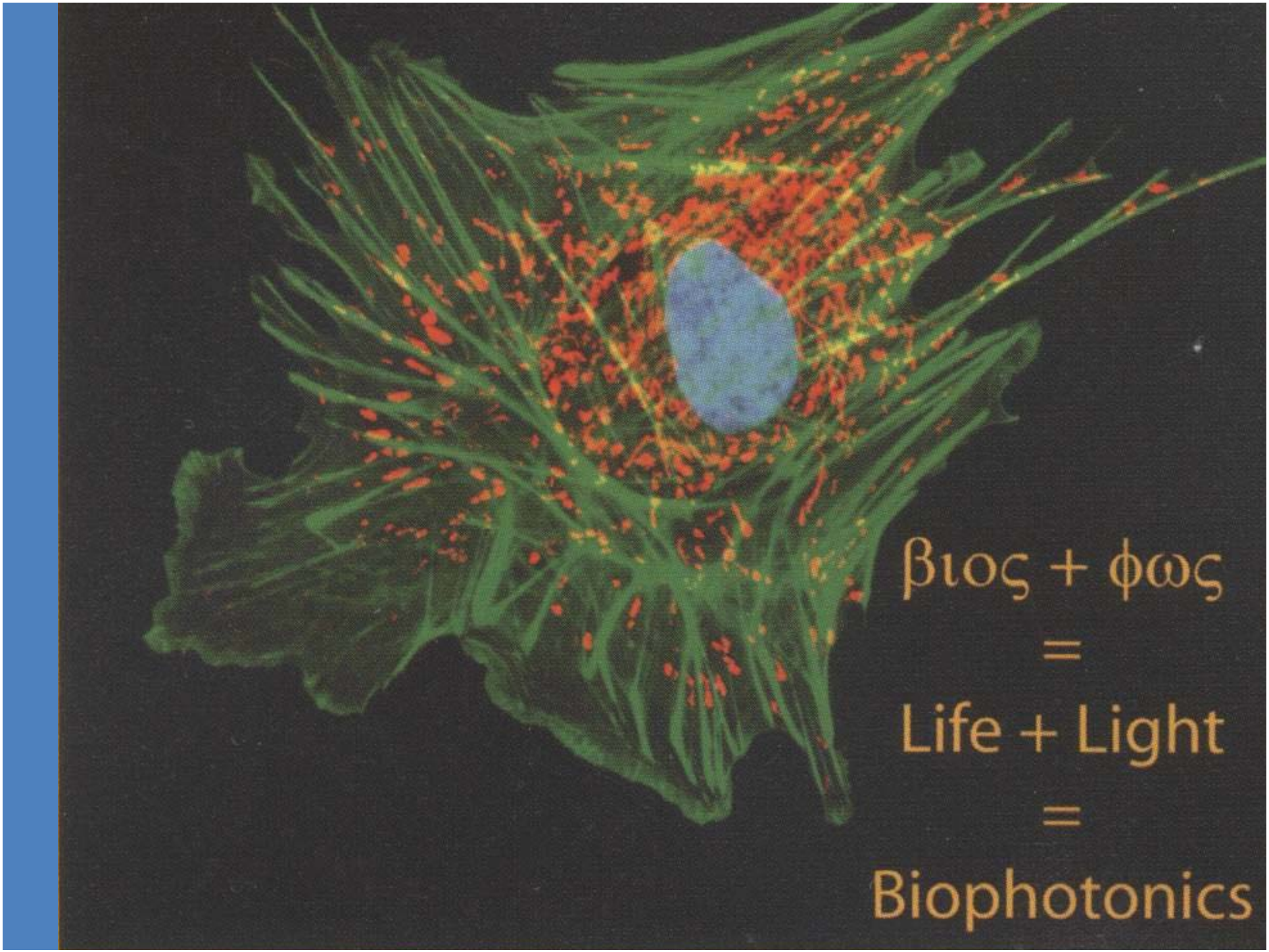

What a joy to see these happy faces!

Gwamuri Jephias
Department of Applied Physics
Bulawayo, Zimbabwe

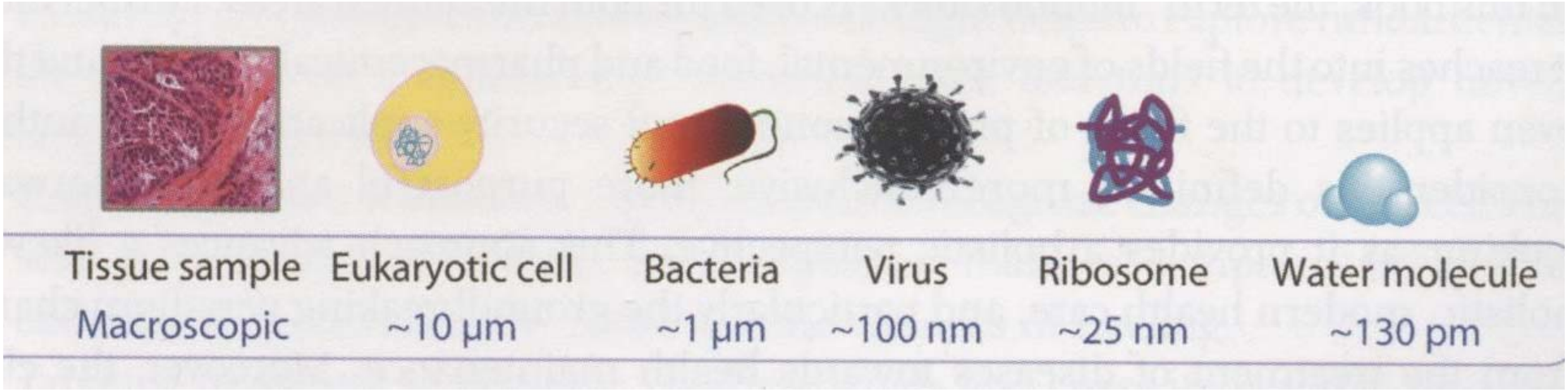

Some personal remarks
My origin on my Father´s side,:
A farm, 14 acres, 9 children born on the farm
2 died as small babies from
respiratory disese
St Oskabygd
Mother´s side,:
A poor
glass-worker´s
daughter

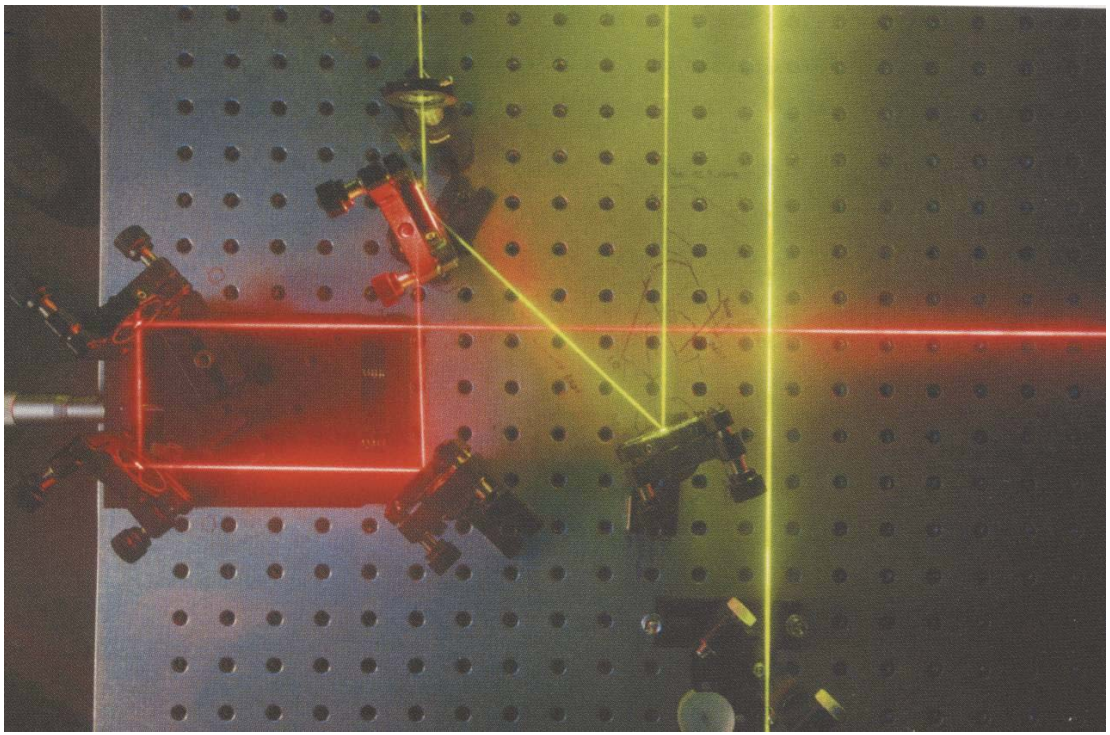
Ragnhild-
new born
Little Sister
-
Soon opening
her eyes
to the world
We as scientists
can help to make
the world a little bit
better place to live
for all of us!




βιος + φως
=
Life + Light
=
Biophotonics

Biological objects + light = BioPhotonics





Light-tissue interaction

Light

Absorption

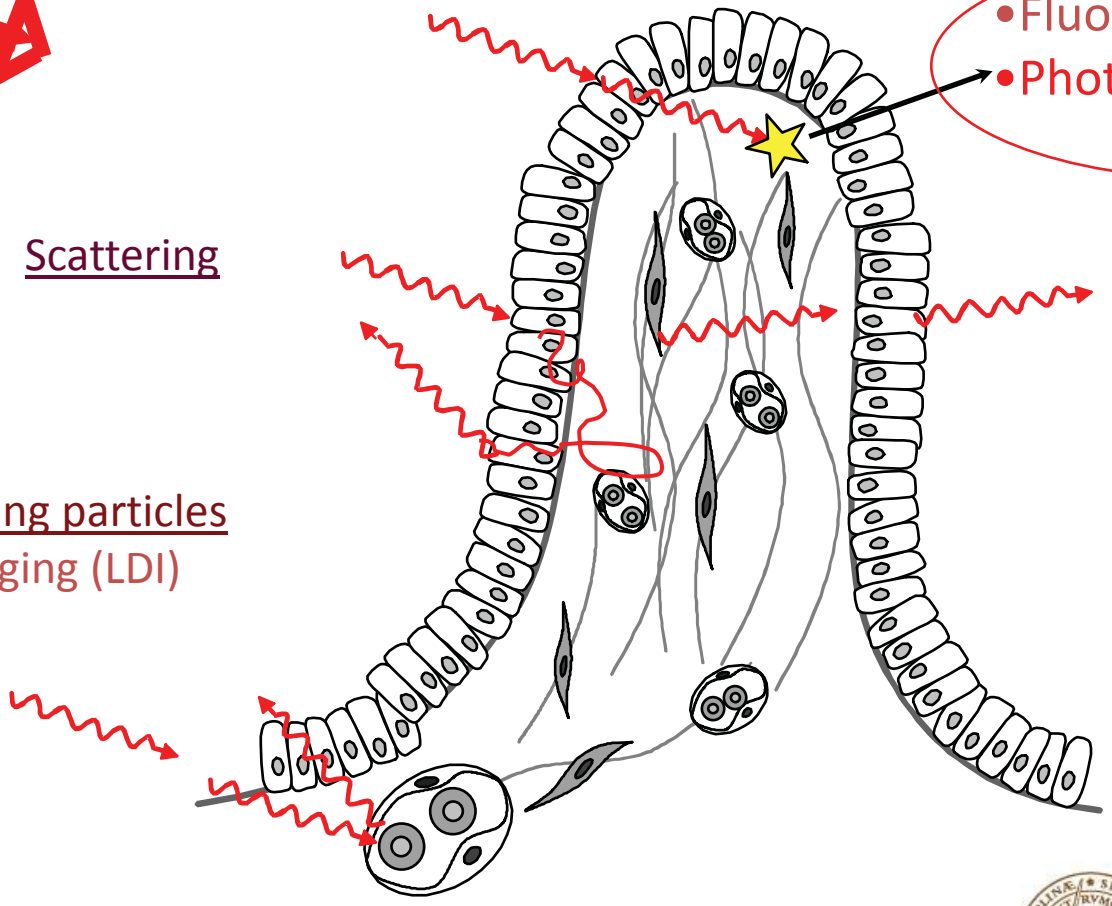
- Heat
- Fluorescence (LIF)
- Photochemistry (PDT)

Scattering

Transmission

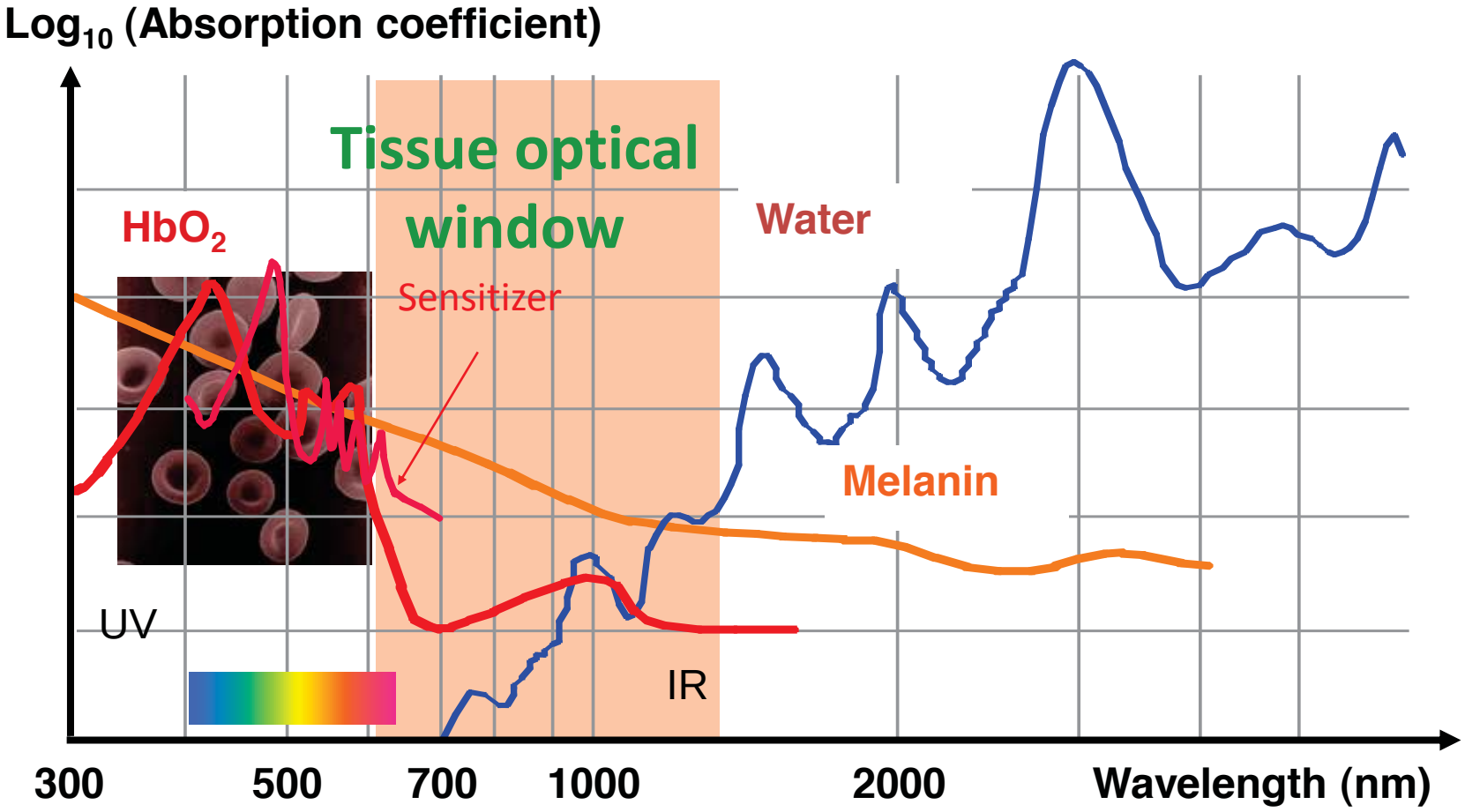
Scattering by moving particles

Laser Doppler imaging (LDI)

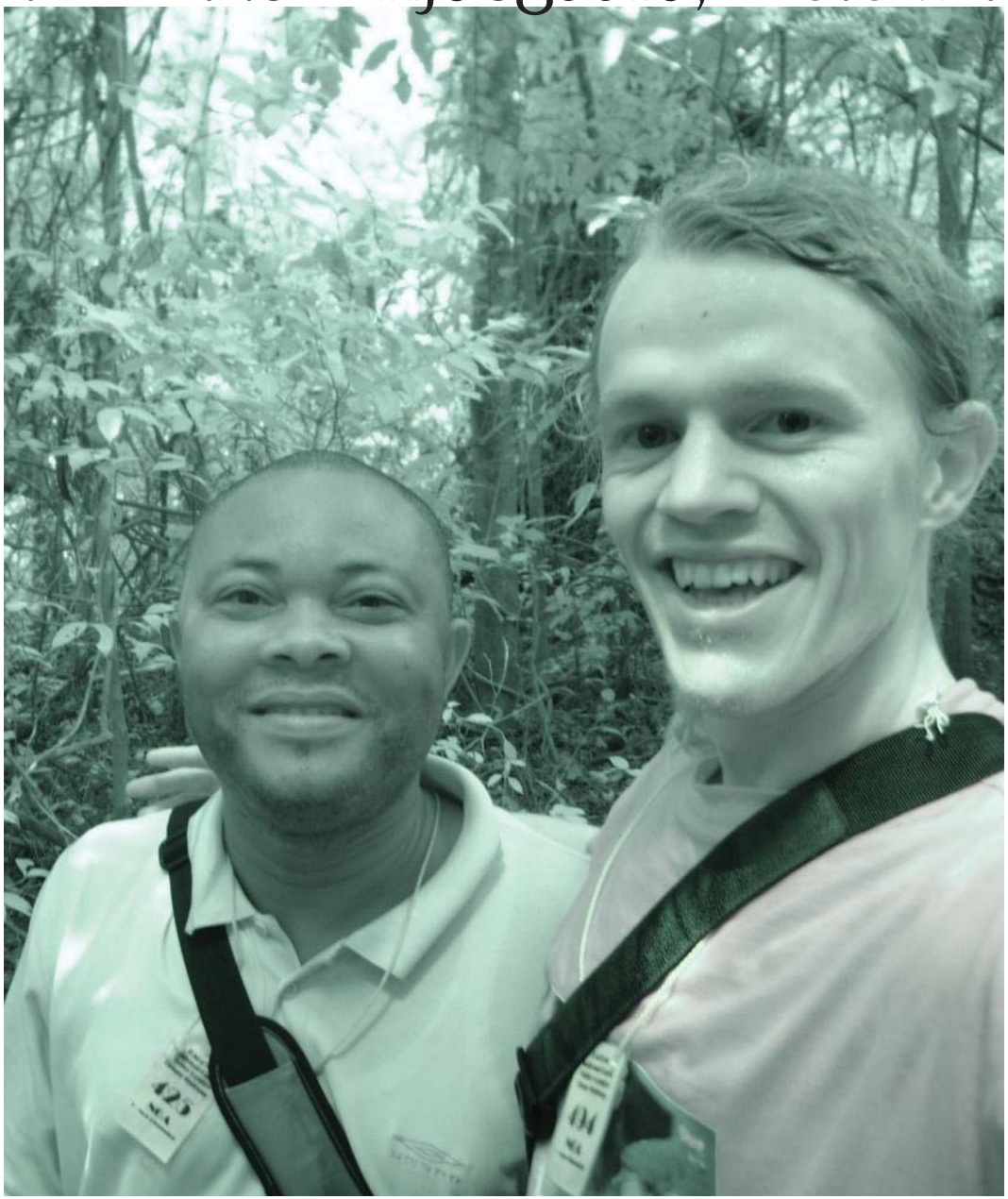


LUND UNIVERSITY

Light interaction with biological tissue
The main absorbers



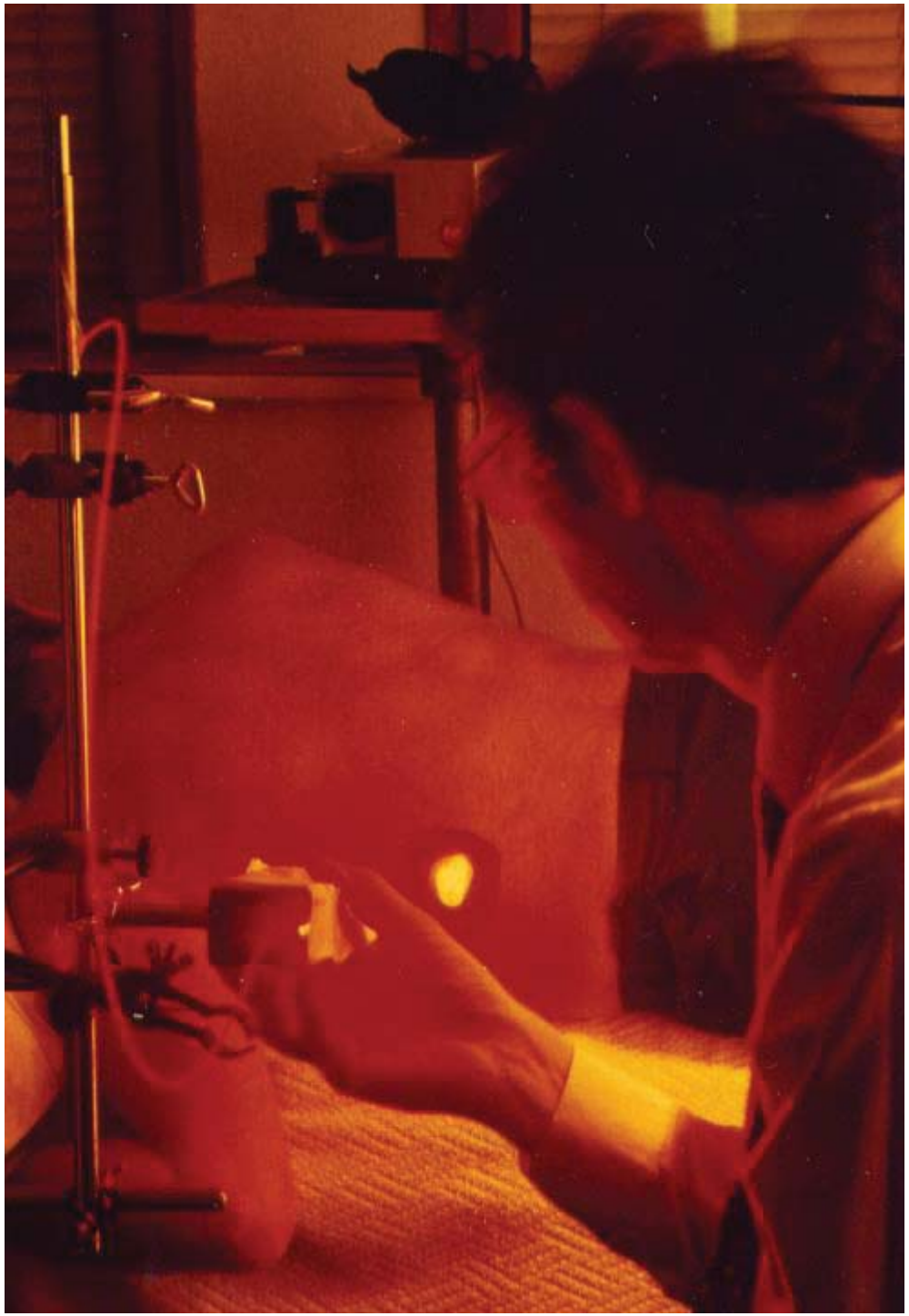
ICTP representative – Benjamin Anderson from Ghana together with Mikkel Brydegaard; Photo with an IR filter



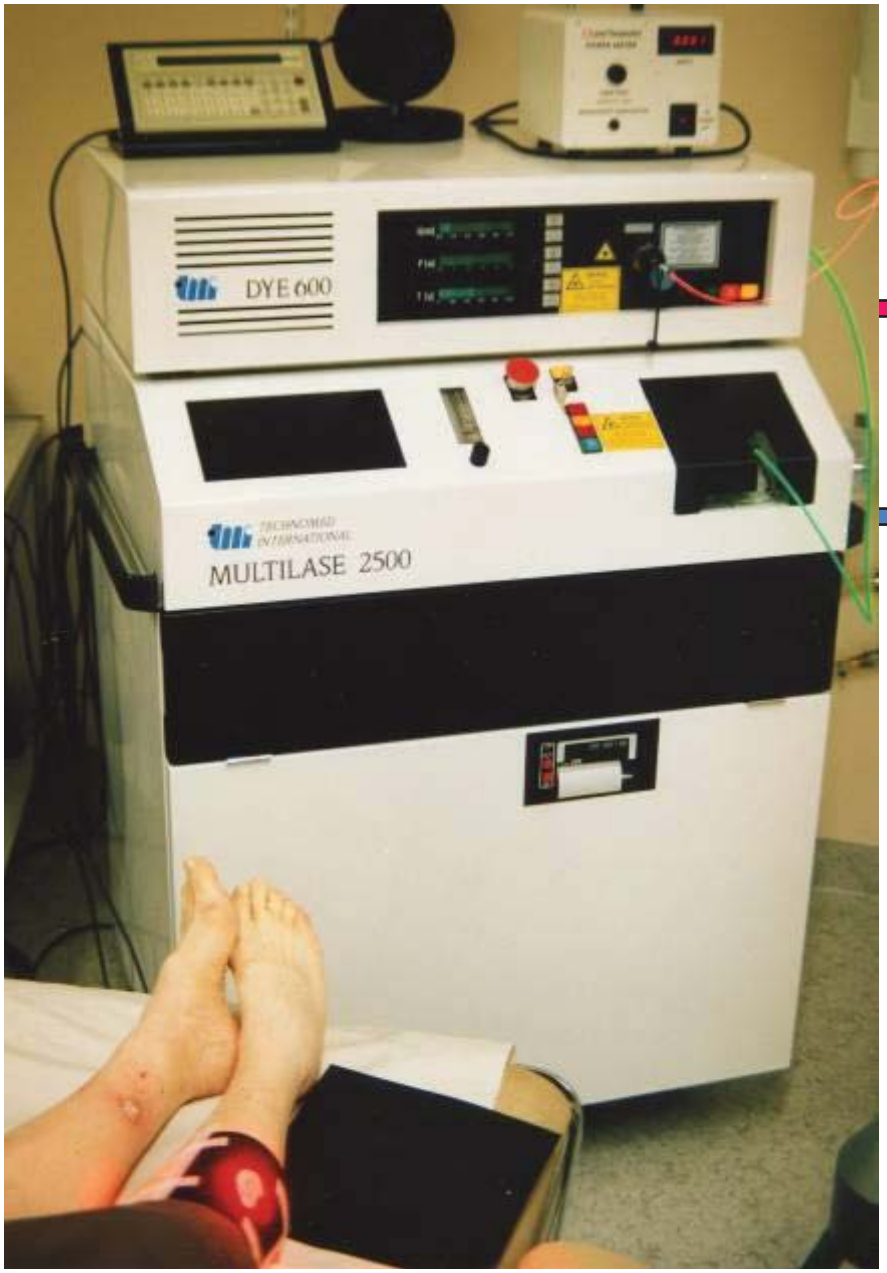
We started Biomedical Optical Research in 1982

1st clinical PDT session in Scandinavia was performed by us in 1987

Lund University Medical Laser Centre was established in 1991



PDT treatment at the Lund University Hospital (Oncology Department) with a frequency doubled Nd:YAG laser pumping a tunable dye laser



Clinically adopted diode laser

CeramOptec/BioLitec

Practical LEDs these days

Lund Biophotonics Group

Stefan Andersson-Engels
Katarina Svanberg
Sune Svanberg

Dmitry Khopyar
Märta Lewander
Erik Alerstam
Johan Axelsson
Niels Bendsøe

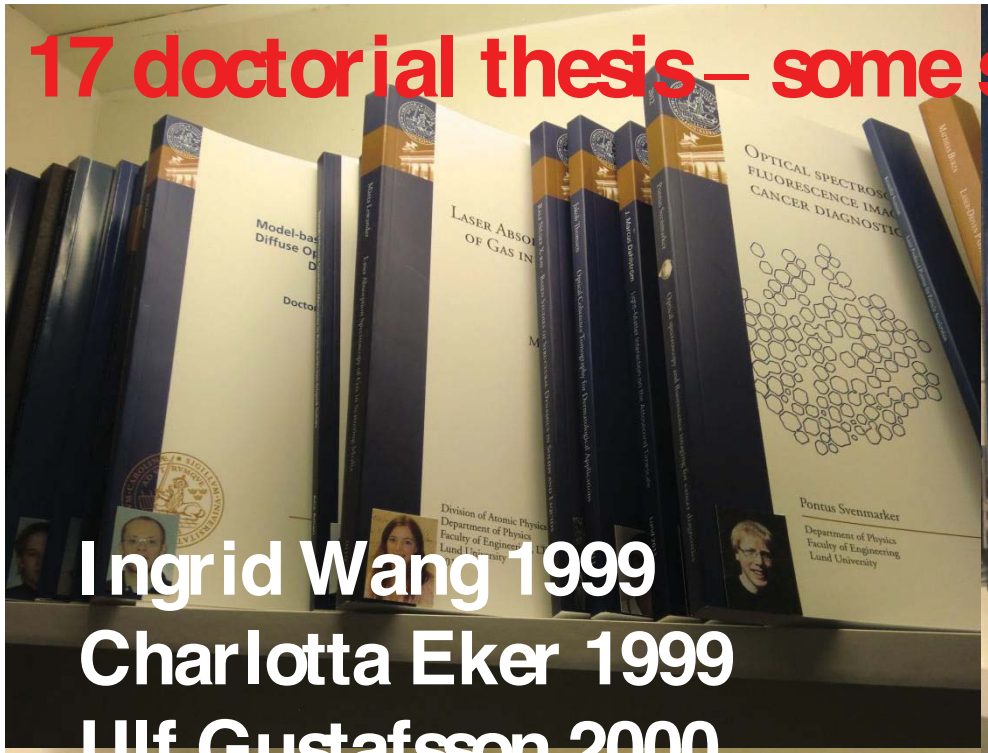
Haichun Liu
Hayian Xie
Emilie Krite Svanberg
Pontus Svenmarker
Tomas Svensson

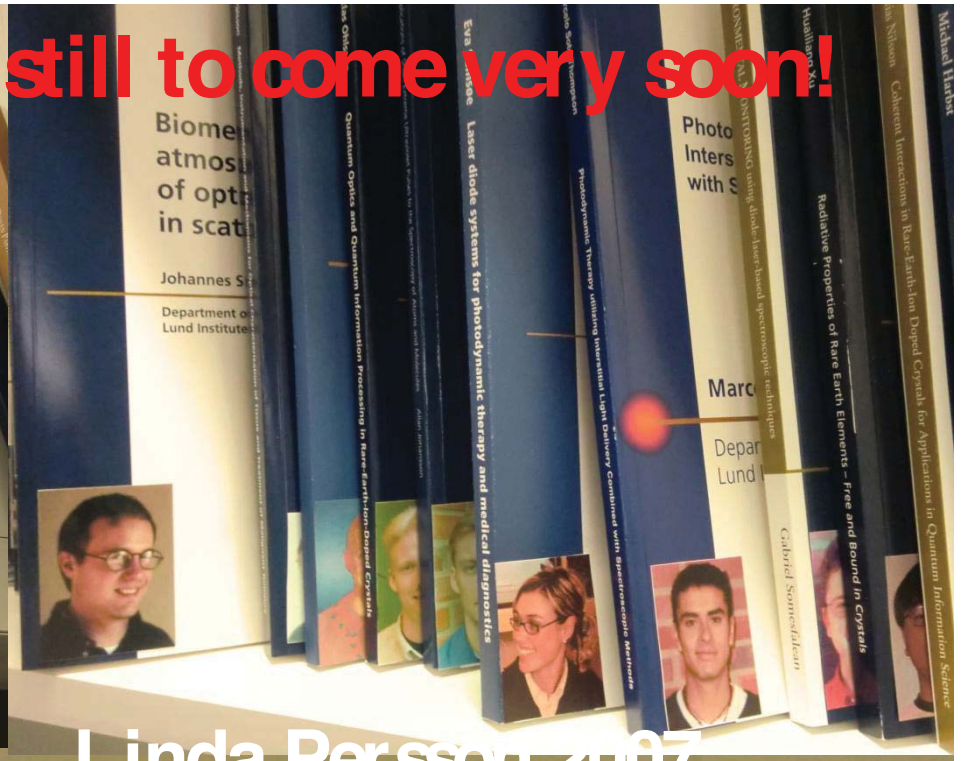
Gabriel Somesfalean
Zuguang Guan
Jonas Johansson
Peter Andersen
Can Xu
Mikkel Brydegaard

Lund University

Medical Laser Centre

17 doctorial thesis – some still to come very soon!





Ingrid Wang 1999
Charlotta Eker 1999
Ulf Gustafsson 2000
Thomas Johansson 2002
Sara Pålsson 2003
Eva Samsö 2004
Marcelo Soto Thompson 2004
Lotta Gustafsson 2005
Jenny Svensson 2007
Ann Johansson 2007
Linda Persson 2007
Tomas Svensson 2008
Johan Axelsson 2009
Märta Lewander 2010
Erik Alerstam 2011
Jacob Thomsen 2011
Pontus Svenmarker 2012
Mikkel Brydegaard 2012

For the future, the network's overall goal remains unchanged. Europe holds a strong position in biophotonics research. We will continue to build on this world-class resource in order to address the 'Grand Challenge' of sustainable health care. «

Cross disciplinarity is the key

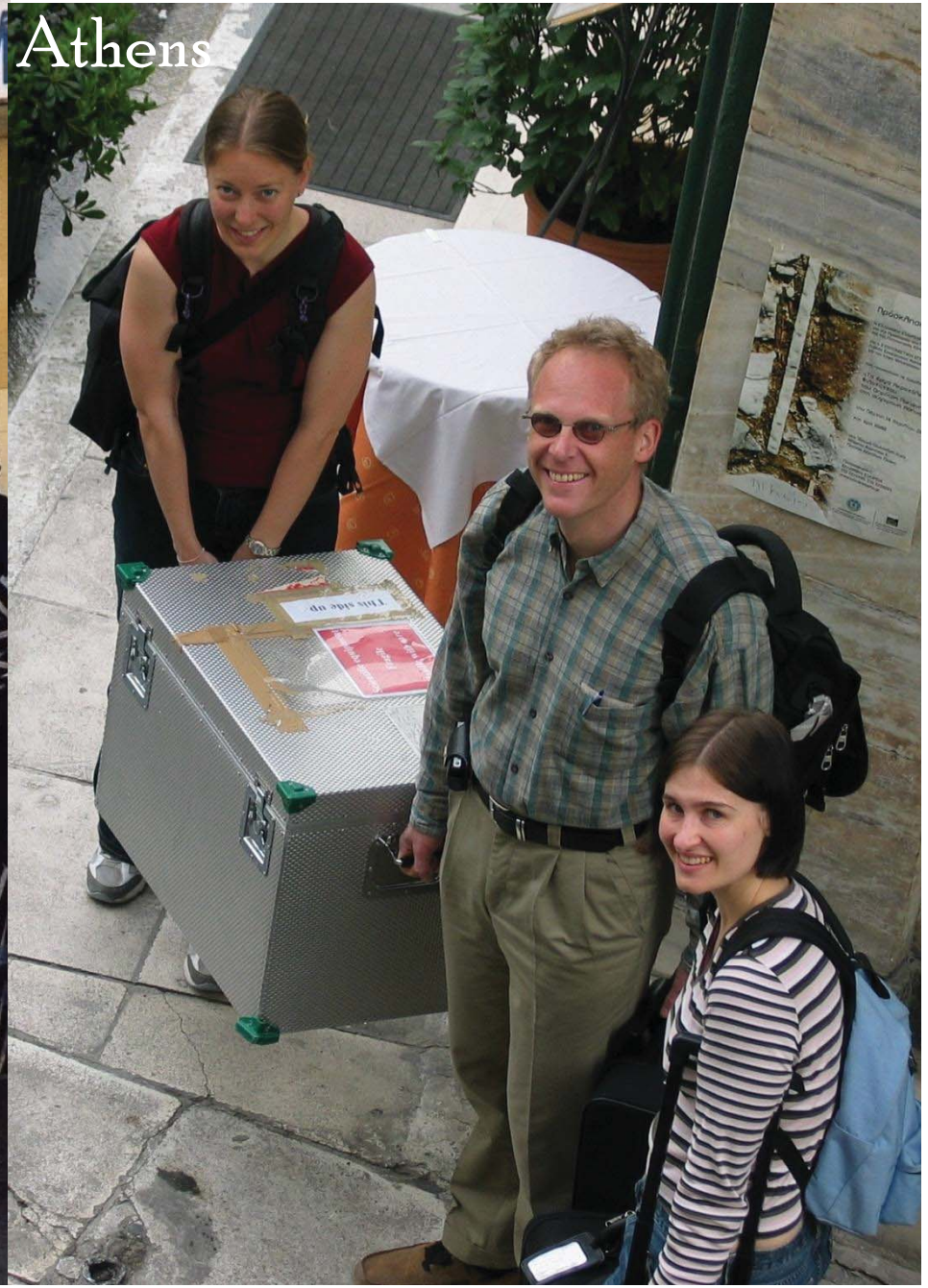
Collaboration over borders is a key

Biolitec & Friedrich Schiller University, Jena, Gernany

Oncology
Physics
Dermatology
Cell biology
Industry .....

Dermatology, Dakar, Senegal

National Technical University, Athens



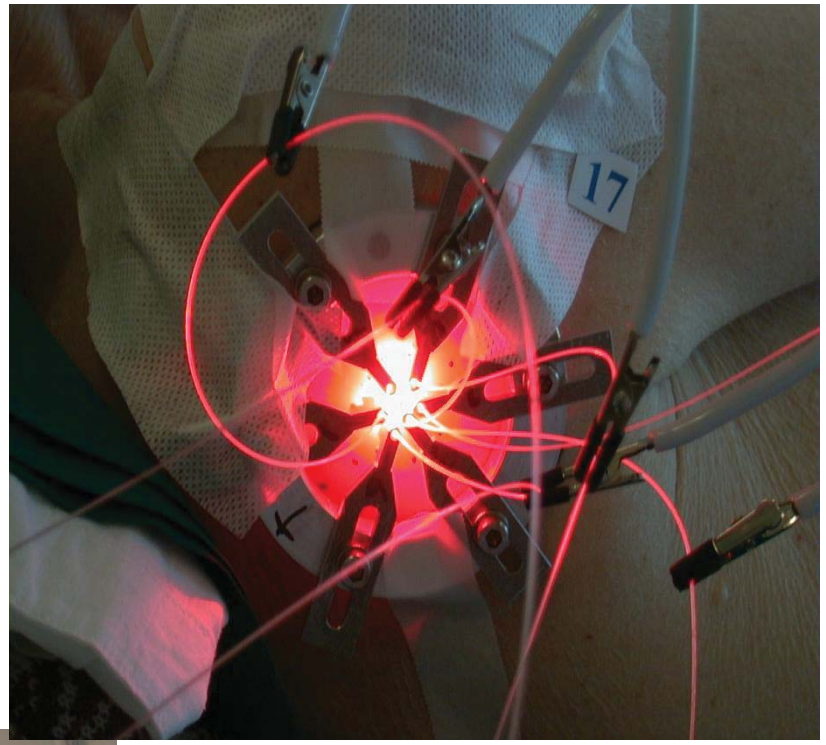

Collab oration in between professions is important
B
Läkare
Niels Bendsoe
Katarina Svanberg
Always include nurses in clinical trials

Coffea is an important aspect in science

Universities and hospitals where we performed joint clinical and preclinical work

- Radiumhospitalet, Oslo, Norway
- Karolinska Hospital, Stockholm
- Latvian Oncology Center, Riga
- Vilnius University, Lithuania
- London Medical College, GB
- Lübeck University, Germany
- St Pieter Hospital, Leuven, Belgium
- Friedrich Schiller University, Jena, Germany
- Padova University, Italy
- Porto Univeristy, Portugal
- National Technical University, Athens, Greece
- Cheik Ante Diop Hospital, Dakar, Senegal

Joint clinical/scientific collaboration at Latvia Oncology Centre, Riga



RIGA

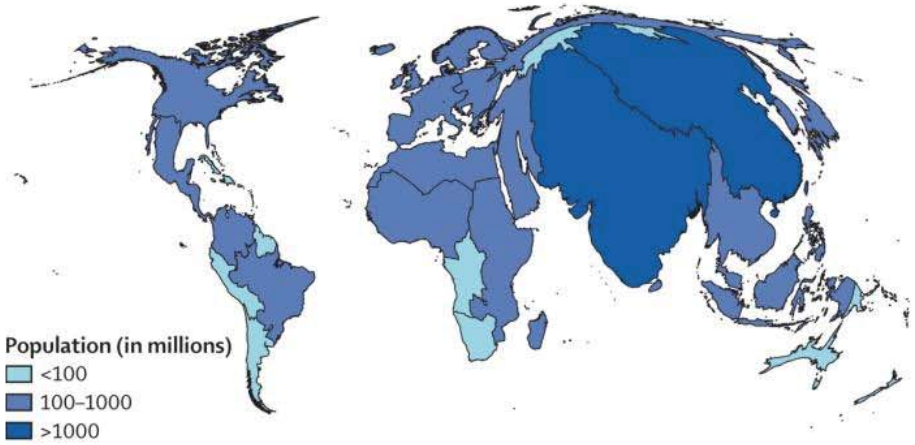
Alexander Derjabo,
Janis Kapostins
Janis Spigulis

LUND

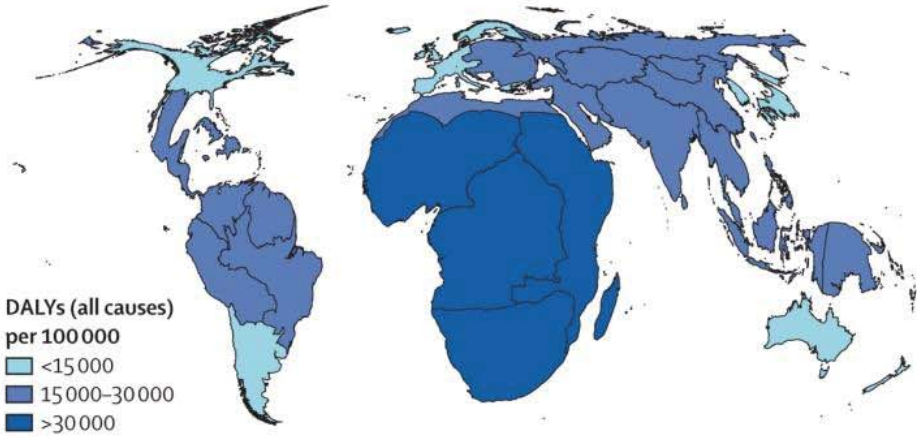
Katarina Svanberg
Niels Bendsoe, Thomas Johansson, Marcelo Soto Thomson, Sune Svanberg

The global perspective

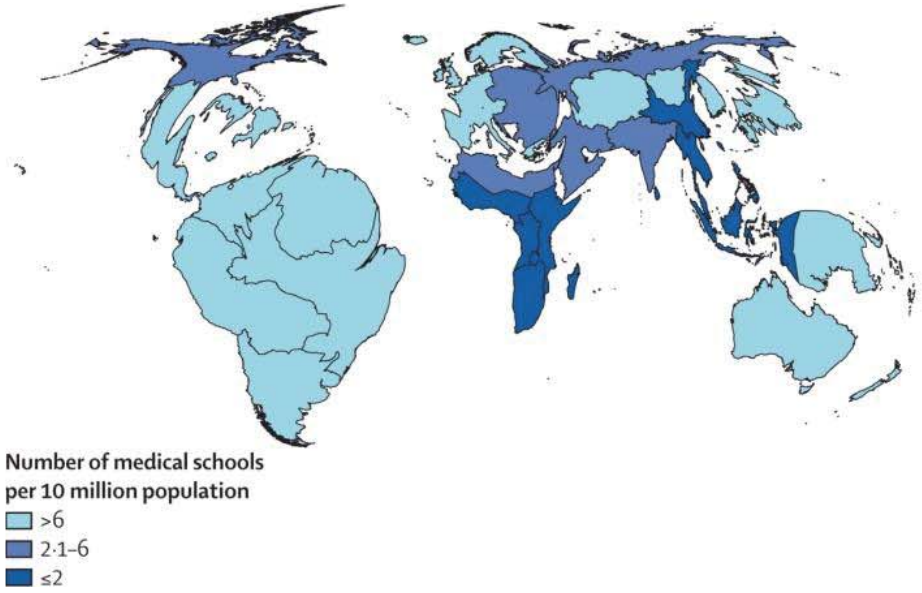
Population



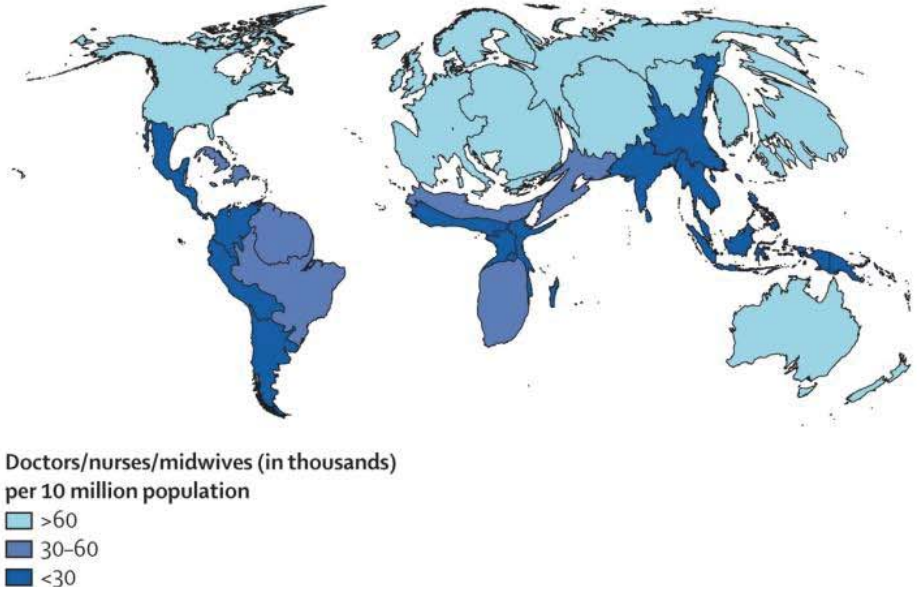
Burden of diseases



Number of medical schools



Work force



African-Lund Workshop visiting the Oncology Department

FROM LEFT TO RIGHT: Malick Diop, Sara Pålsson, Ababakar Abdalla, Kenneth Kaduki, Almamy Konte, K. Dzinavatonga, Jaidane Nejmedinne, Ahmadou Wague, Sune Svanberg, N. Ndolovu, M. Mathuthu, Katarina Svanberg and Niels Bendsoe.

Senegal, Kenya, Zimbabwe, Ghana, Sudan,Tunisia, Equador

Malick Diop
Ear Nose & Throat Department
Aristide University Hospital
Dakar, Senega

Ababacar Sadikhe Ndao
Department of Physics
Cheikh Anta Diop University
Dakar, Senegal

Ahmadou Wague
Department of Physics
Cheikh Anta Diop
University
Dakar, Senegal

Katarina Svanberg
Department of Oncology
Lund University
Medical Laser Centre
Lund, Sweden

Sune Svanberg
Department of Physics
Lund University
Lund, Sweden

Niels Bendsoe
Department of Dermatology
Lund University
Medical Laser Centre, Lund,
Sweden

Discussing treatment possibilities

The African wife cooking food for her husband at the Department of Dermatology, Dakar, Senegal

Wives never give up to support their husbands!

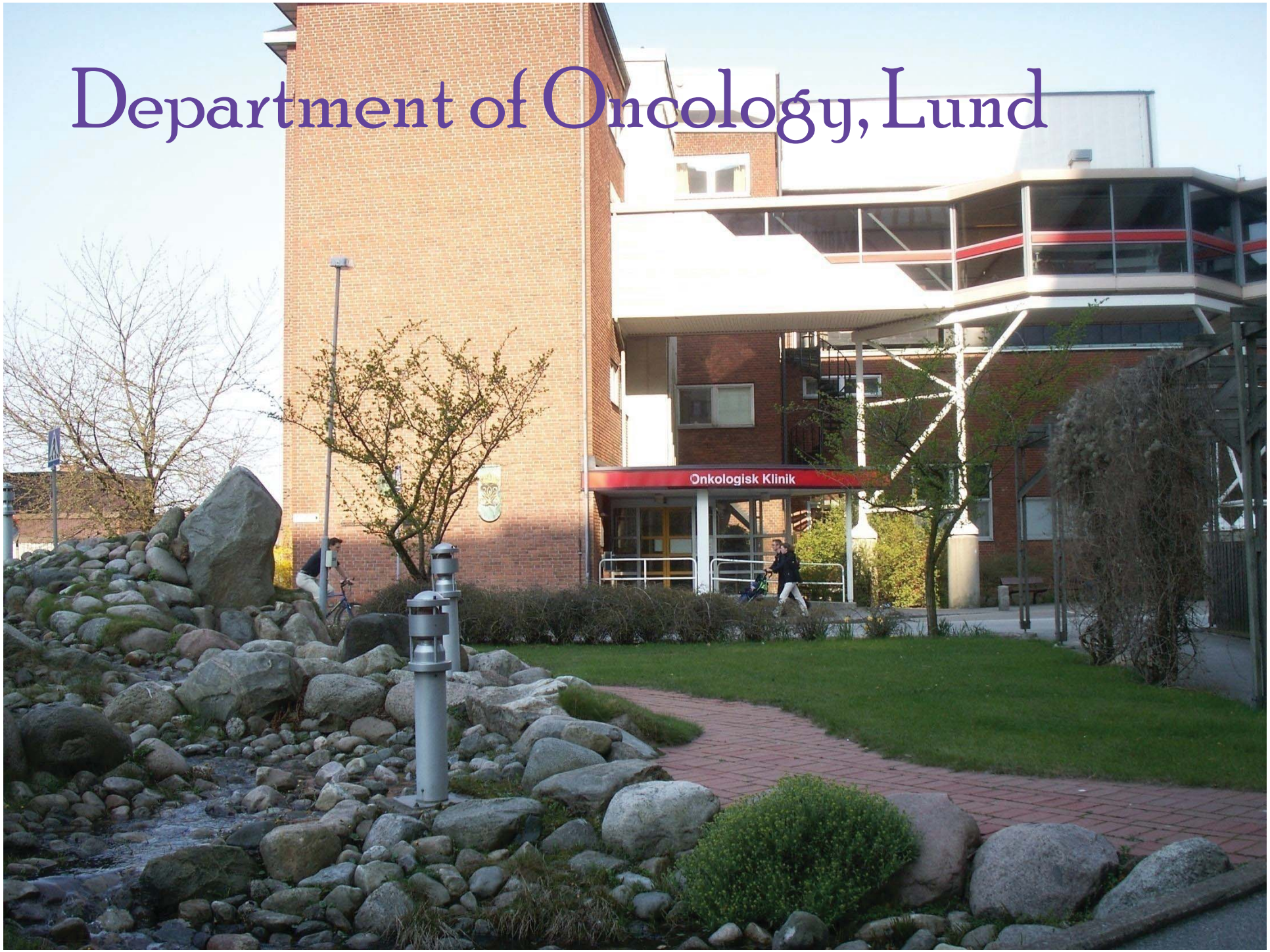
Photodynamic Therapy at the Arsitide le Dantec University Hospital Dakar, Senegal

Lund Medical Laser activities in Africa - Ante Diop University Dakar, Senegal

Training young students for work in the developing conuntries

Docs from two continents planning for joint work!

Department of Oncology, Lund



Cancer in Europe

4-5 new diagnosed cancers/1000 persons each year –
1 person every 15 minutes in Sweden (9 milj)

The cancer incidence varies from region to region -
Highest incidence in the urban areas
The highest incidence of breast- and prostate cancer
in big cities

Cancer In the US
Approximately 1.2 million people/year are
diagnosed with cancer.

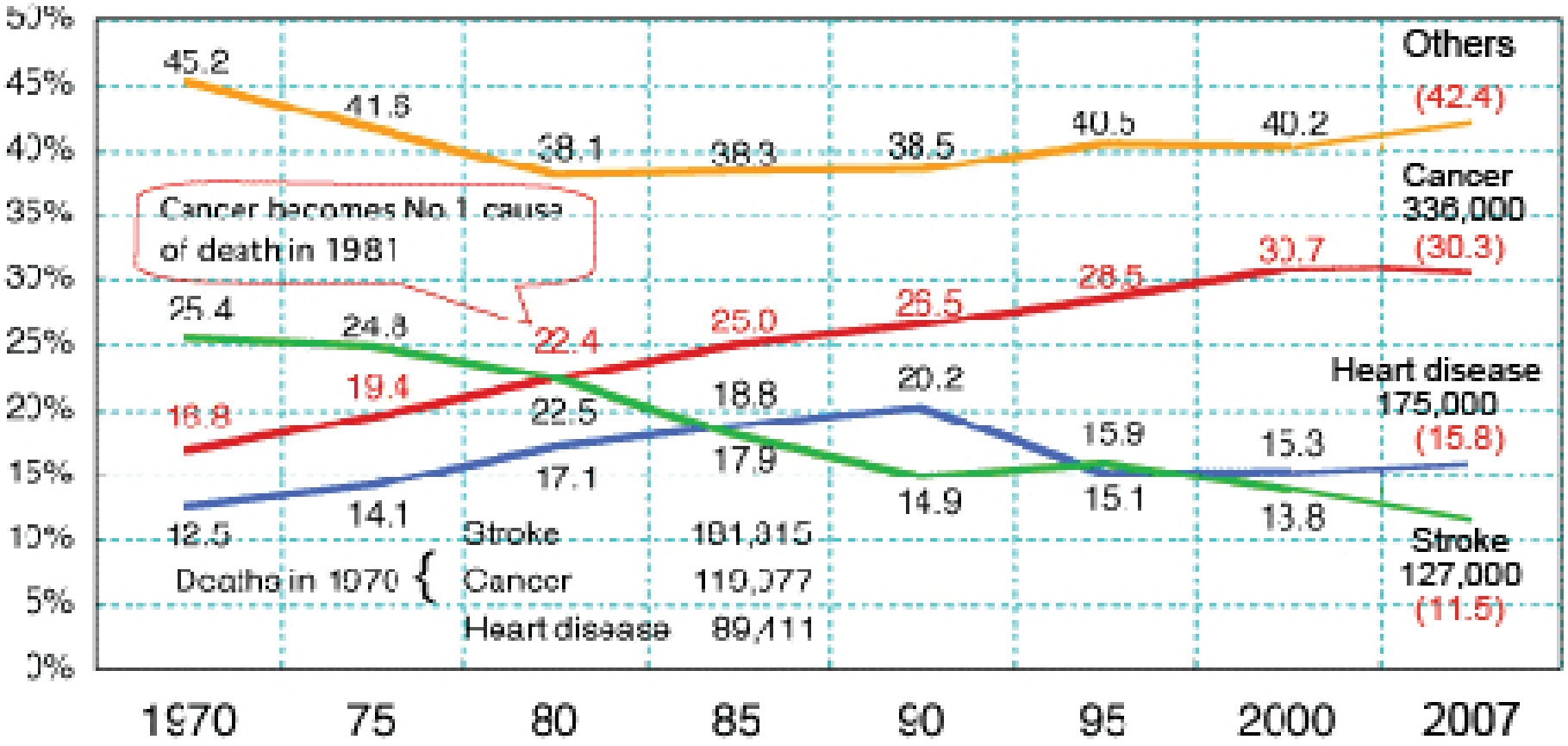
Approximately 30 % of all deaths in the Western World are caused by cancer.
Only cardiovascular disease causes more deaths.

Katarina Svanberg

Epidemiology
The cancer incidence is increasing

Urbansation	fast food
	obesity
	pollution
	family structure
Social habits	**SMOKING**
	giving birth to children at later age
	anticonceptual treatment
	less breast feeding
Life aspect	**AGE**

Death rates in Japan for various diseases



Approximately 30 % of all deaths in the Western World are caused by cancer.

Only cardiovascular disease causes more deaths.

The ten most common malignancies world wide causing cancer related deaths

Men	Women
Lung	Breast
Prostate	Cervix
Large intestine	Large intestine
Stomach	Stomach
Mouth & throut	Lung
Liver	Ovary
Oesophagus	Mouth & throut
Urinary bladder	Uterus
Lymphoma	Lymphoma
Leukemia	Leukemia

Skin cancer is an increasing problem with increasing costs!

Lund University

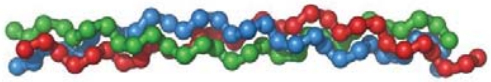
Medical Laser Centre

Modified from
Ringborg *et al.*

Katarina Svanberg

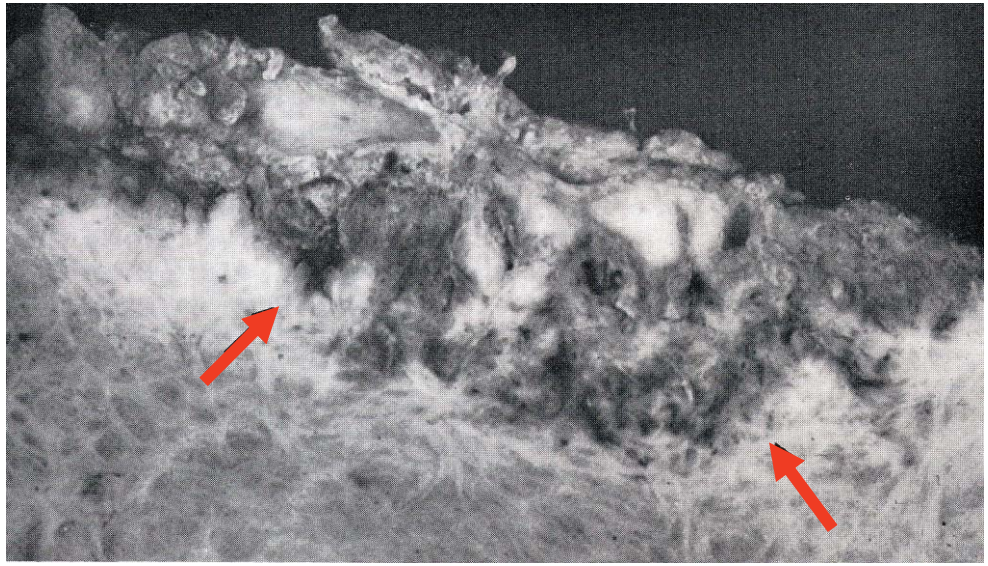
A benign tumour
(an adenoma)
clearly separated from the
normal non-affected tissue
below the tumour

The "line" in between
is composed of
collagen



Never a cross over
of tumour cells through
the border line

Benign and malignant neoplasias



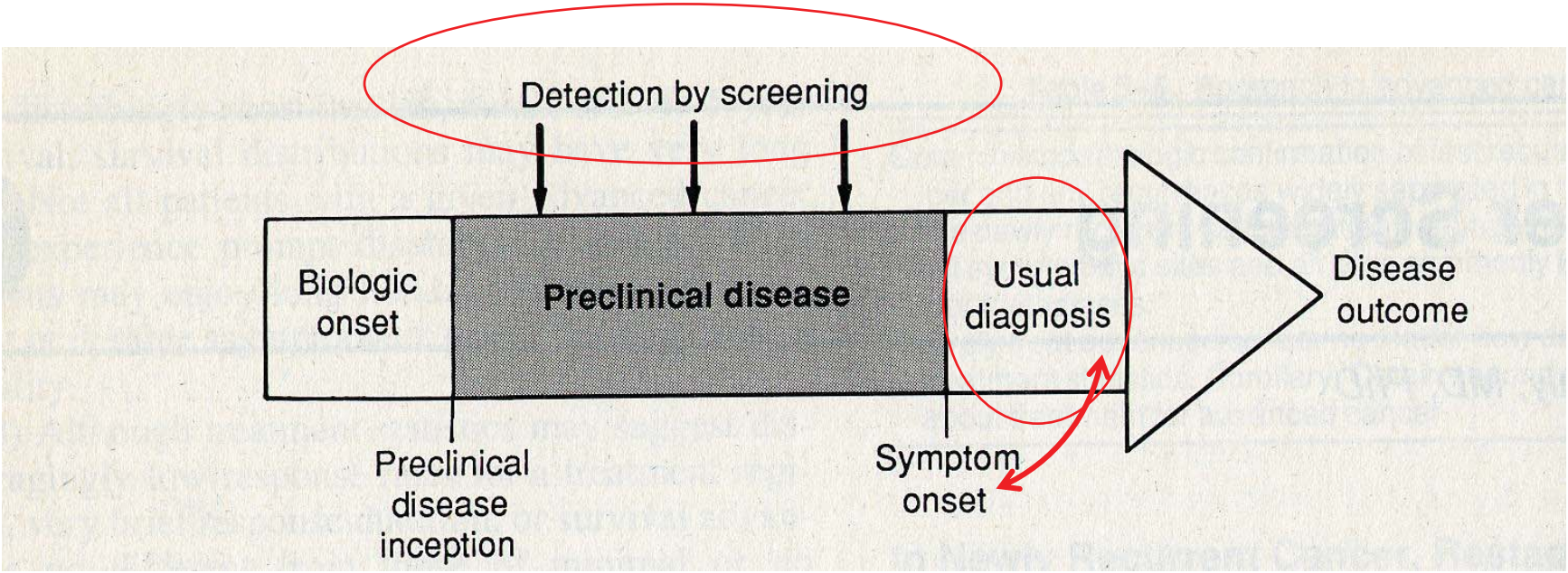
Benign lesion is:
- not life-threatening
- is slow growing
- will not disseminate (no metastasis)
- is amenable to remove with full cure for the patient

Malignant lesion has the potentials of:
- rapid growth
- invasion
- destruction of adjacent structures
- dissemination (metastasis)
- killing the patient!

Modified from Robbins *et al.*

Katarina Svanberg

The goal is to find the cancer early as this improves the prognosis for the patient



Modified from
G.R. Weiss

5-year survival for different staging in lung cancer

(histopathologically non-small lung cancer)

Stage I	T1N0M0 **60%**		T2N0M0 38%
Stage II	T1N1M0 34%		T2N1M0 24%
Stage IIIa	T3N0M0 22%	T3N1M0 9%	T1-3N2M0 13%
Stage IIIb	T4N0-2,M0 7%		T1-4N3M0 3%
Stage IV	M1 **1%**		

Optical tissue diagnostics

Spectroscopic techniques:

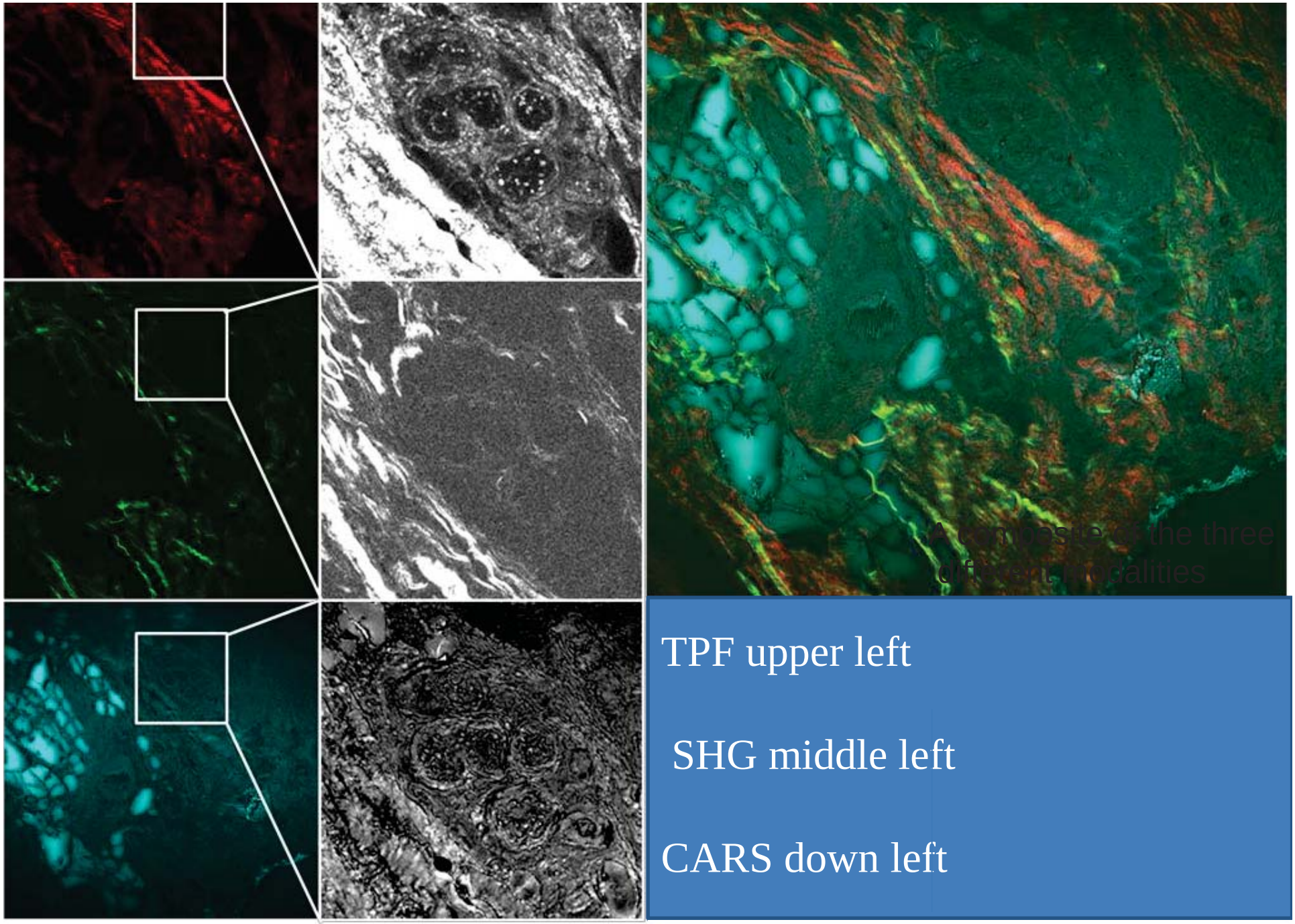
Fluorescence

Reflectance

Elastic Scattering

Raman

LUND UNIVERSITY



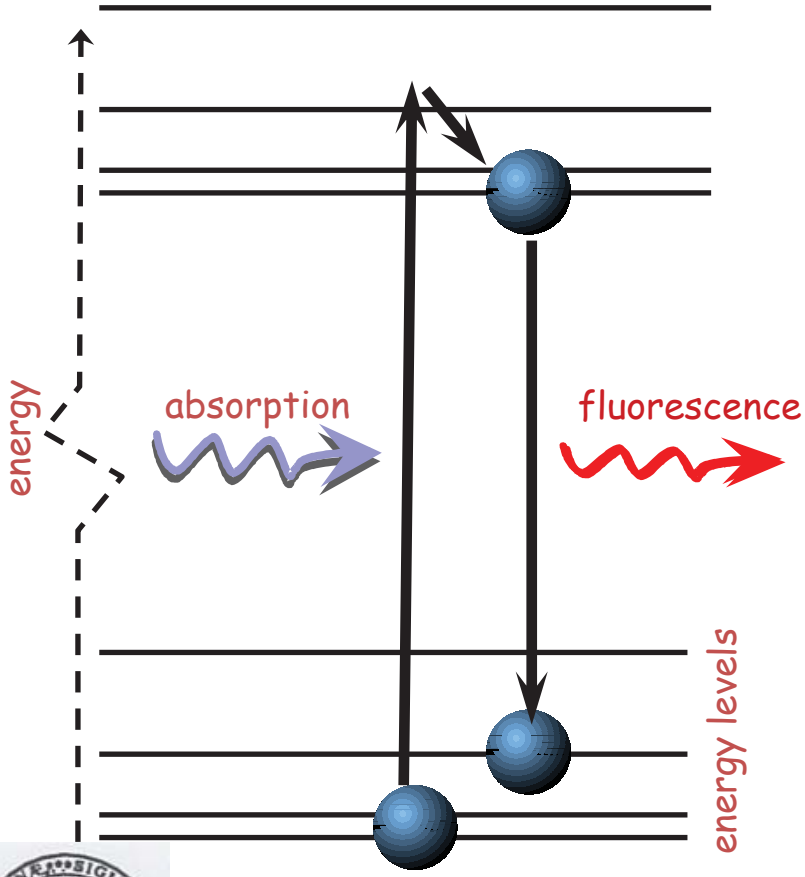
TPF upper left

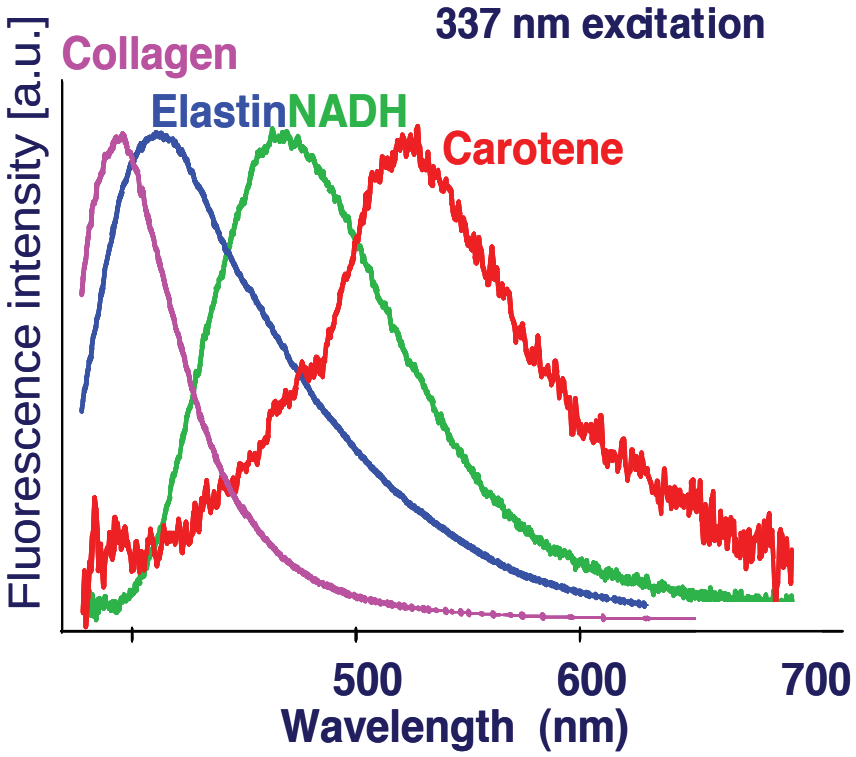
SHG middle left

CARS down left

Collaboration with Photonics Center, Jena

Fluorescence excitation & emission
Autofluorescence



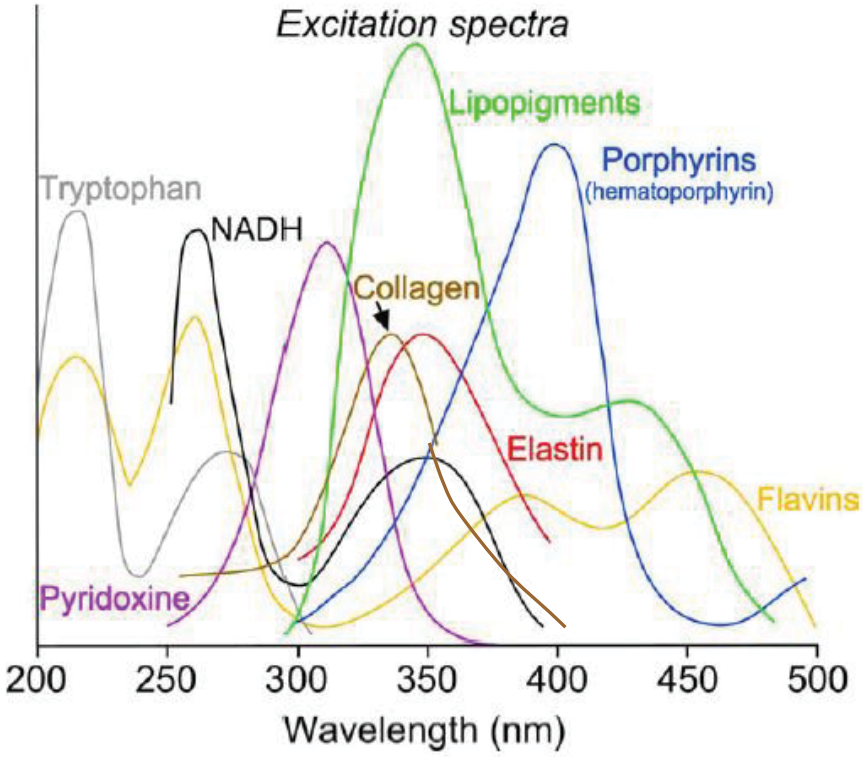


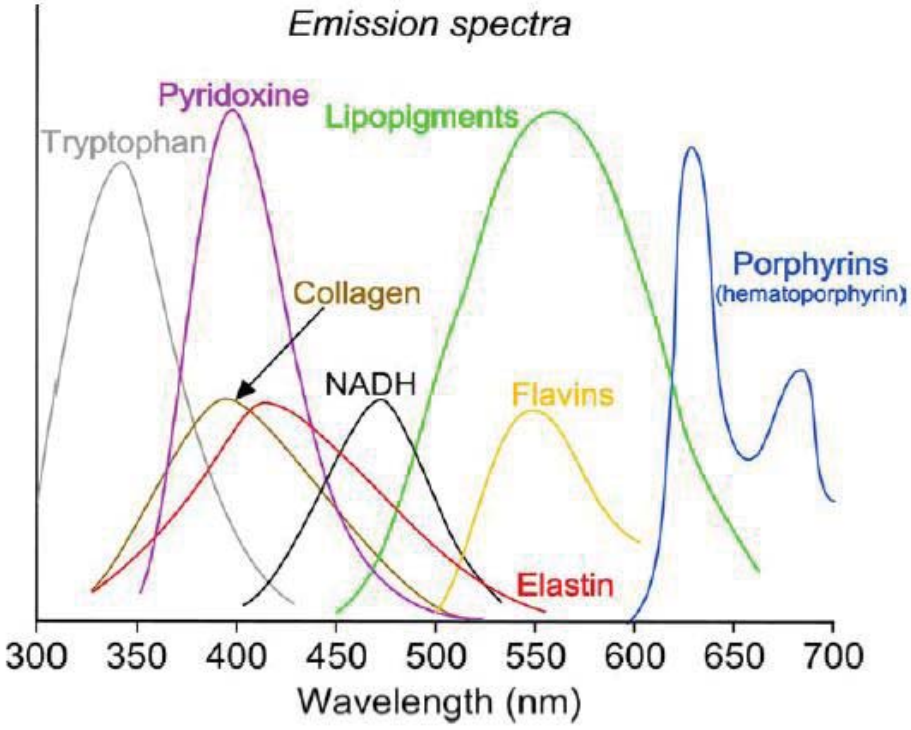
Lund University

Medical Laser Centre

Katarina Svanberg

Excitation and emission spectra for endogenous and exogenous fluorophores





Adapted from Wagnieres, Photochemistry and Photobiology 1998, 68(5), pp. 605

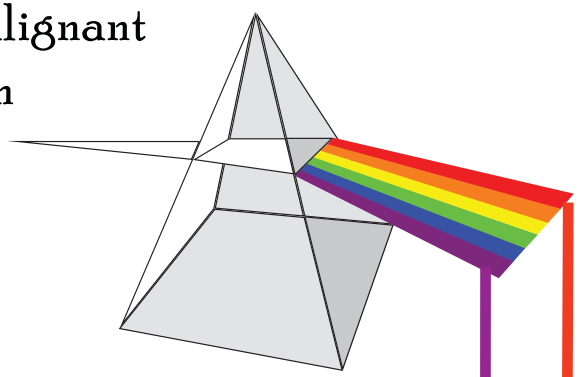
Choice of wavelength

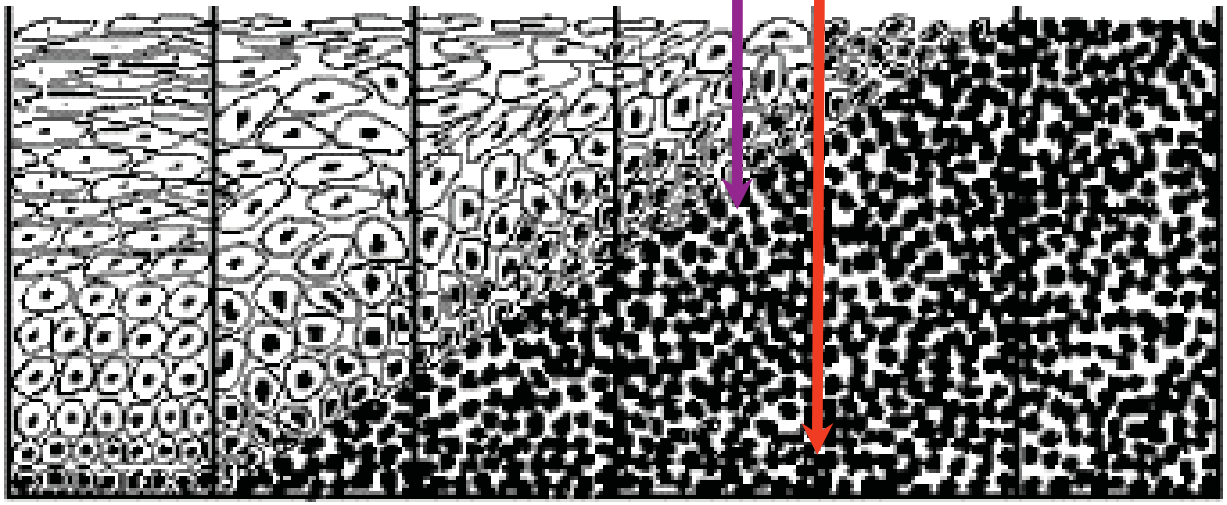
Fluorescence detection

UV or near-UV excitation light
(337 - 405 nm)

Shallow penetration - premalignant or carcinoma *in situ* detection

Upwelling fluorescence not "diluted" from deeper tissue





Photodynamic therapy

"Red" light (635 - 750 nm)

-to match the absorption peak of the photosensitizers

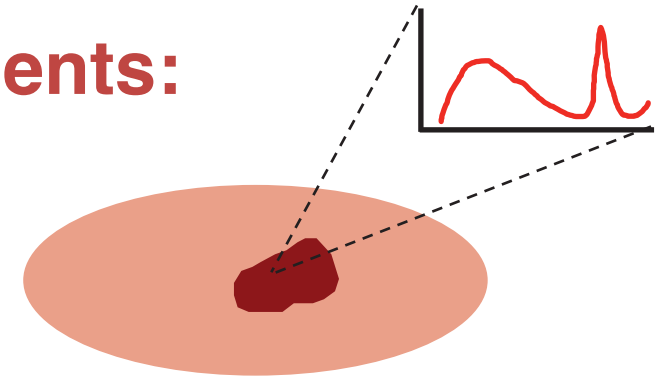
-to obtain deep tissue penetration

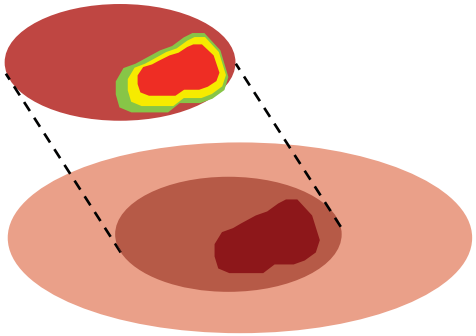
(TUMOUR THERAPY)

Different geometries

Point measurements:

- All colours
- In one single point





Imaging measurements

- One or few colours
- Over the whole area

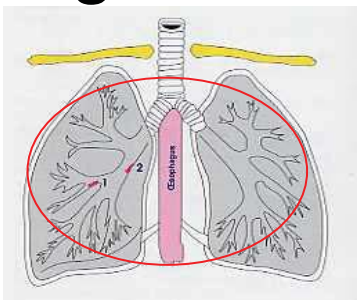
Tissue fluorophores/chromophores

Endogenous Tissue Fluorophores

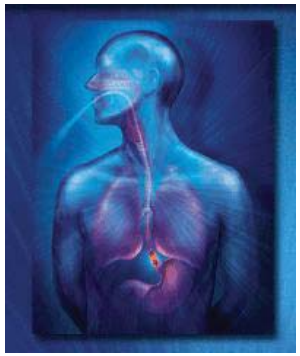
Extracellular	Intracellular
Collagens	NADH/NAD+
Elastin	Oxidised flavins
mucin	Keratin
	Melanin
	Porphyrins
	Lipofucin
	Vitamin B derivatives
	Cholosterols
	Aromatic amino acids

Example of clinical applications

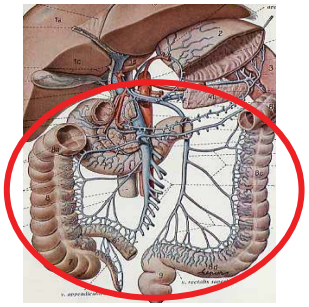
Endoscopic diagnostics & treatment



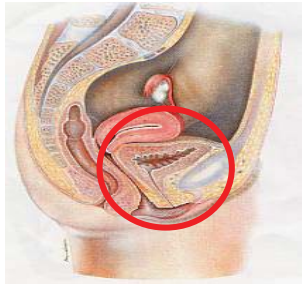
Bronchus



Oesophagus



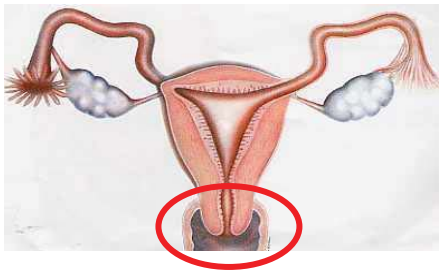
Large intestine - colon

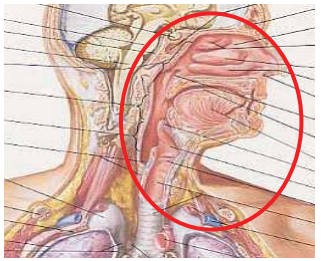


Urinary bladder

Surface (direct) detection & treatment

Cervix





ENT

Skin

Lund University

Medical Laser Centre

Katarina Svanberg

Skin cancer – related costs

Approximately 150 000 benign naevi are excised yearly to a cost of 30 000 000 Euro in Sweden

49/50 persons are operated ”unnescessarily”

Total costs for skin cancer treatment each year:
125 000 000 Euro – Sweden
1 000 000 000 Euro - Germany

Better diagnostics/treatment needed

Challenges of today in the clinic

Field cancerisation – how to localise areas to treat – target decision

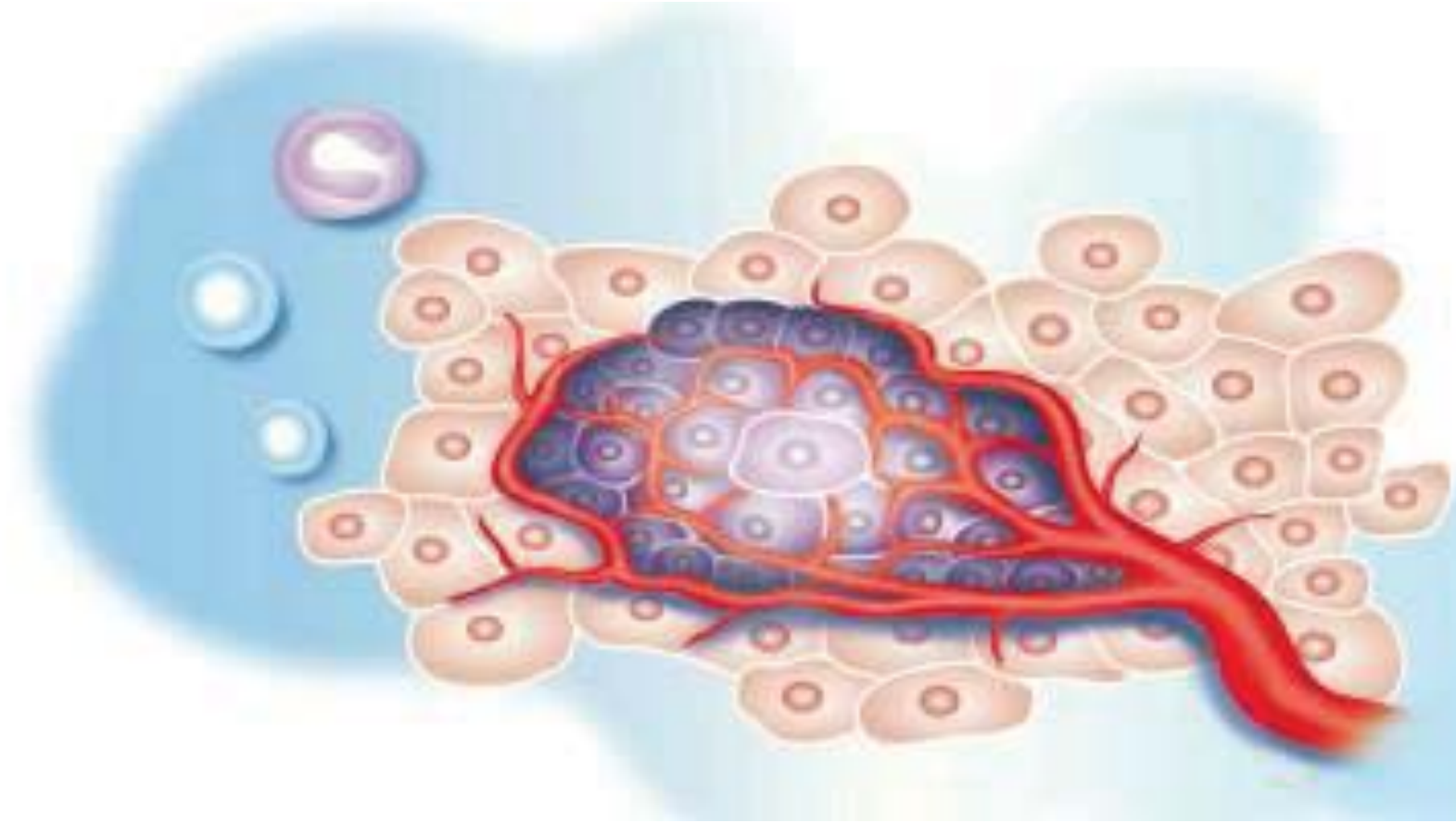
Katarina Svanberg

Challenges of today in the clinic

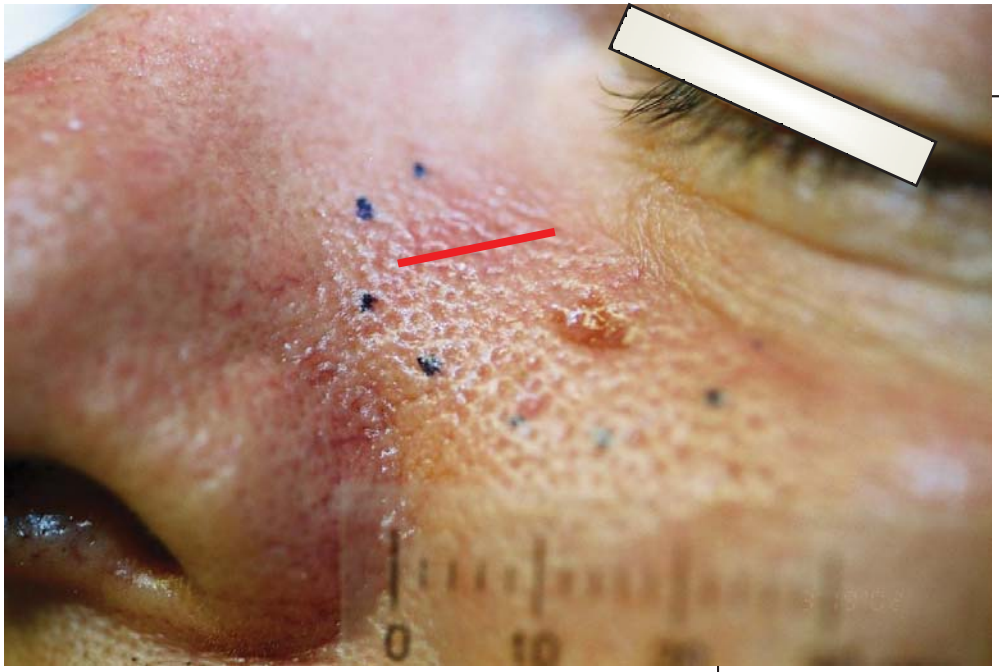
Field cancerisation – how to localise areas to treat – target decision

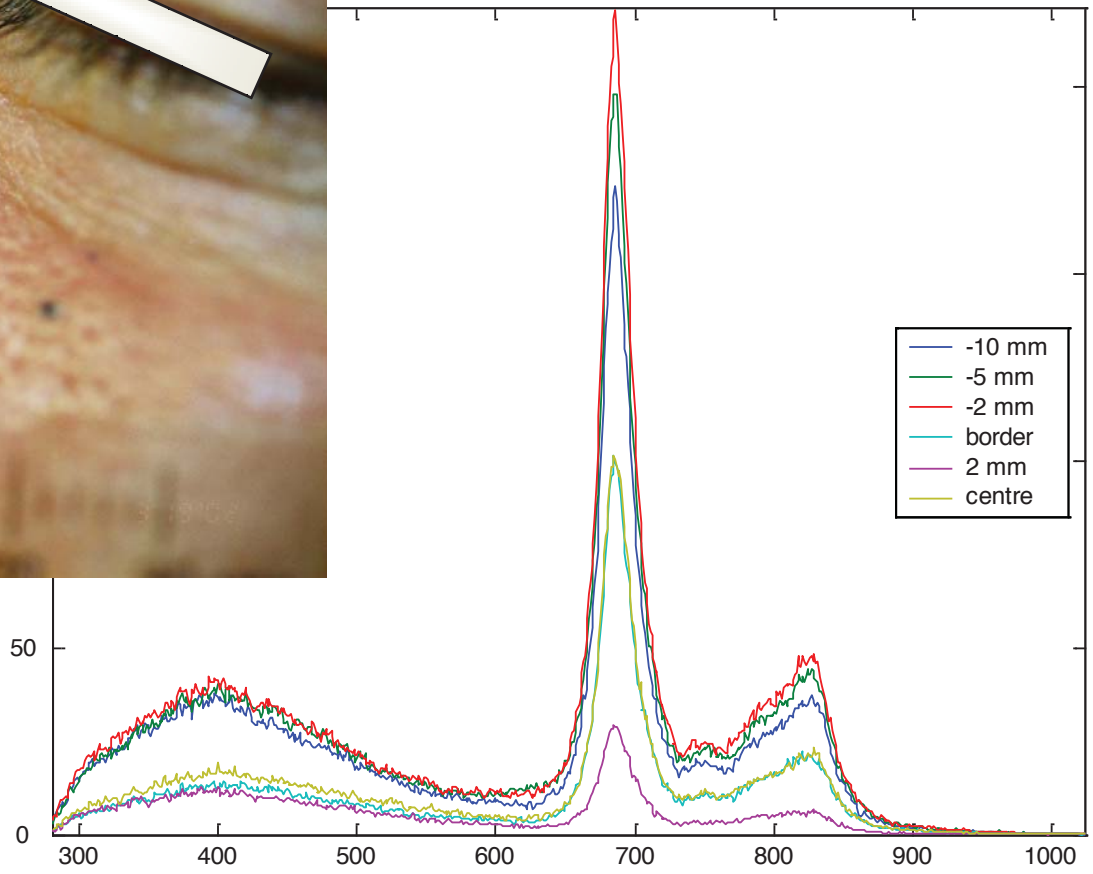
Katarina Svanberg

Tumour borders ?

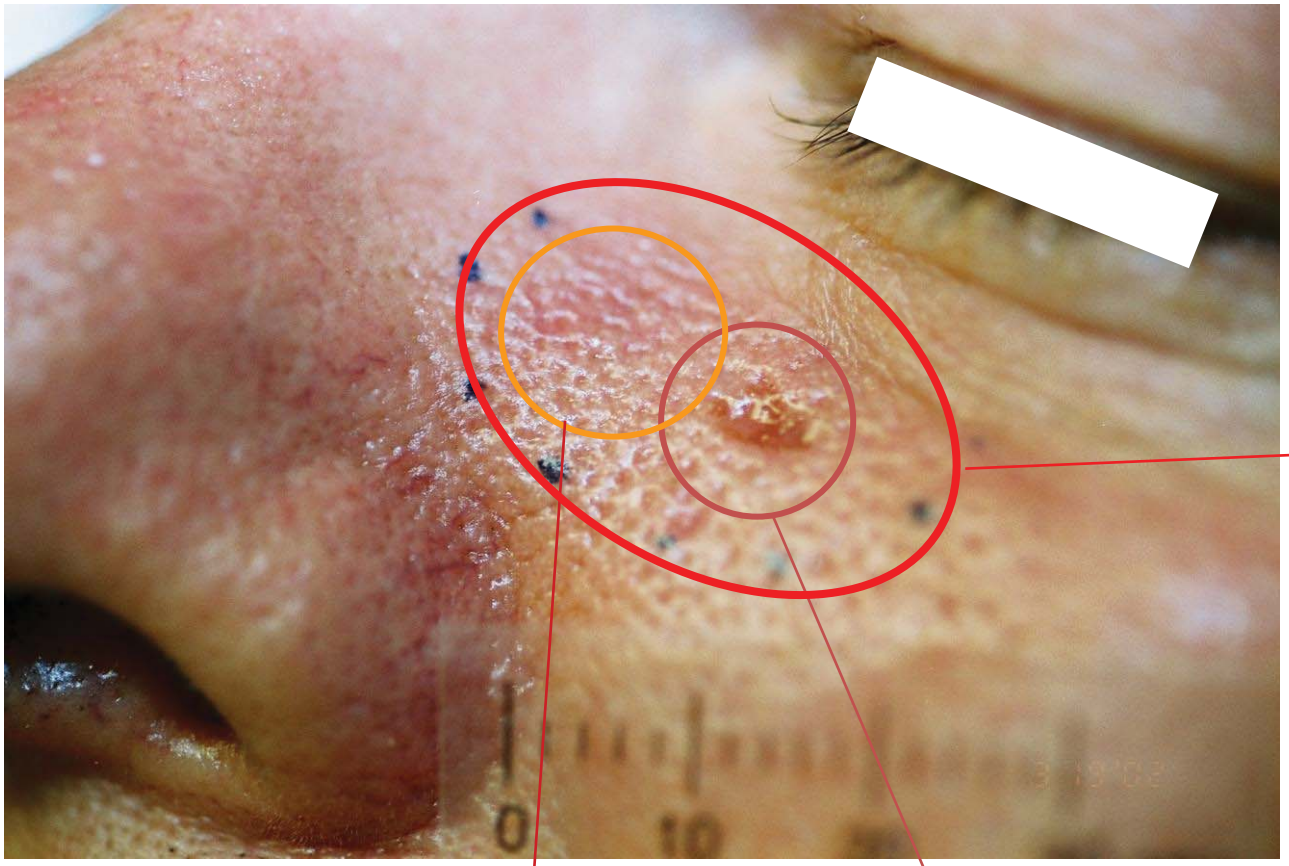


Where are the tumour borders?





Treatment target definition

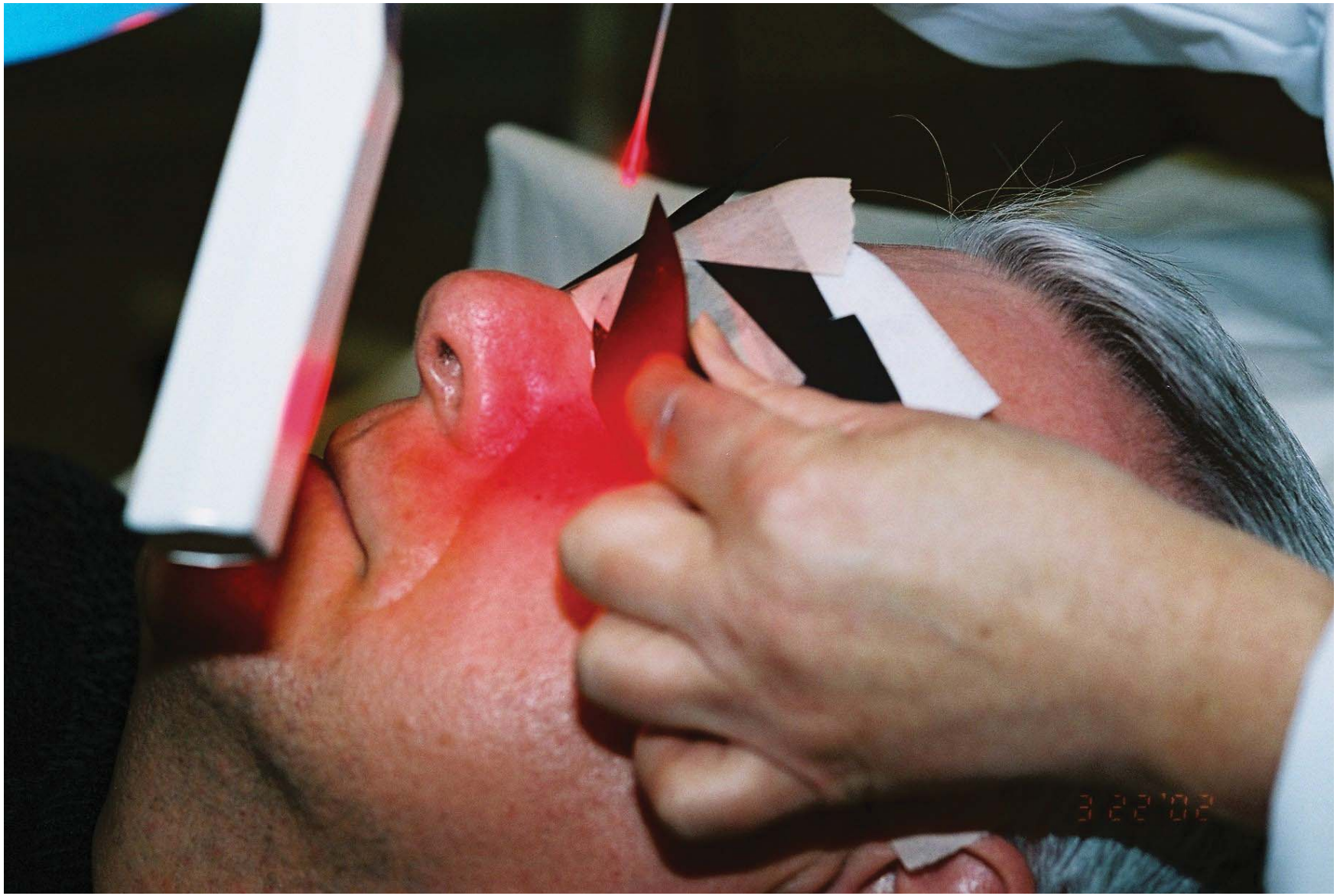


Interactively defined treatment borders

By fluorescence revealed additional tumour area

Clinically judged tumour borders

Photodynamic Therapy with interactive target definition



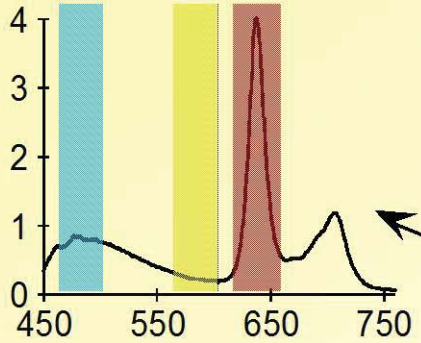
Fluorescence measurements – tumour border detection

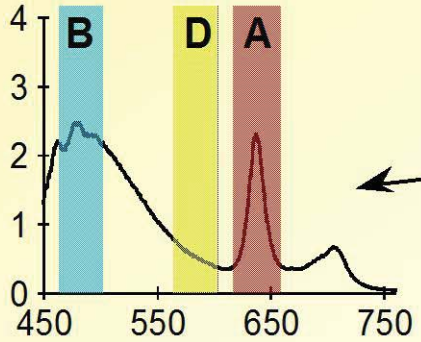
Lund University

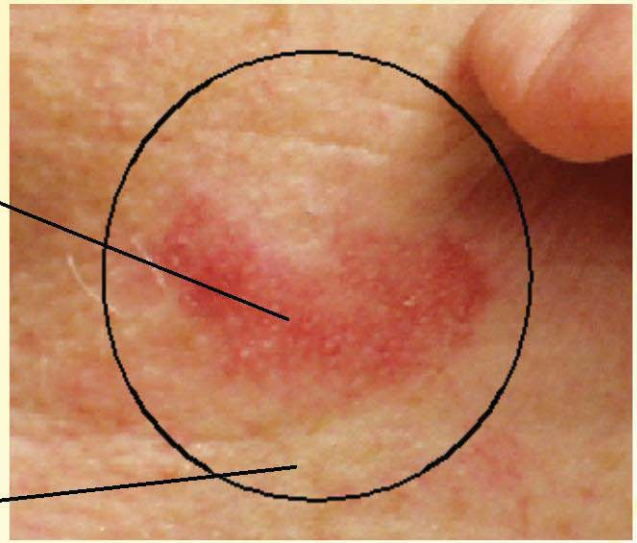
Medical Laser Centre

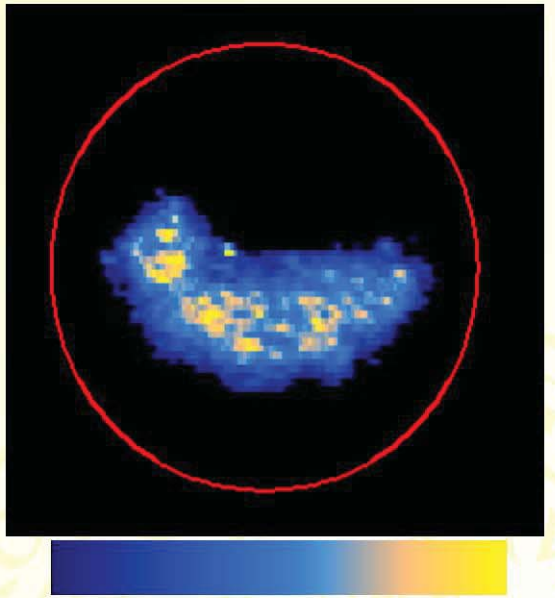
Katarina Svanberg

Multicolour Fluorescence Imaging





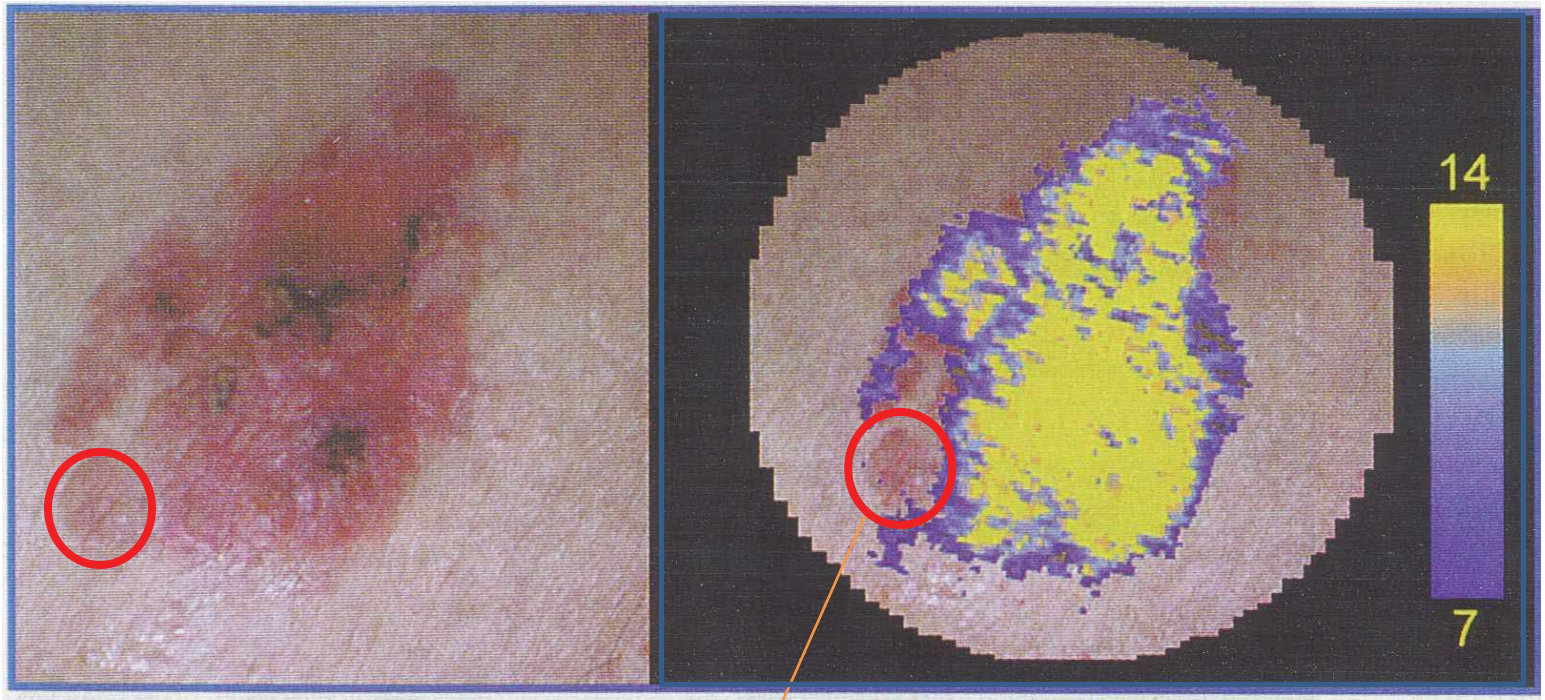




$$F_c = \frac{A - k_1 D}{k_2 B}$$

$$\frac{\text{Red} - \text{Yellow}^{5}}{\text{Blue}^{12}}$$

Benign – Malignant ?



A basal cell carcinoma (left) as seen through a fluorescence imaging system (right) provides a clear delineation of the lesion.

Benign naevus

LUND UNIVERSITY

Traditional diagnosis versus optical characterisation

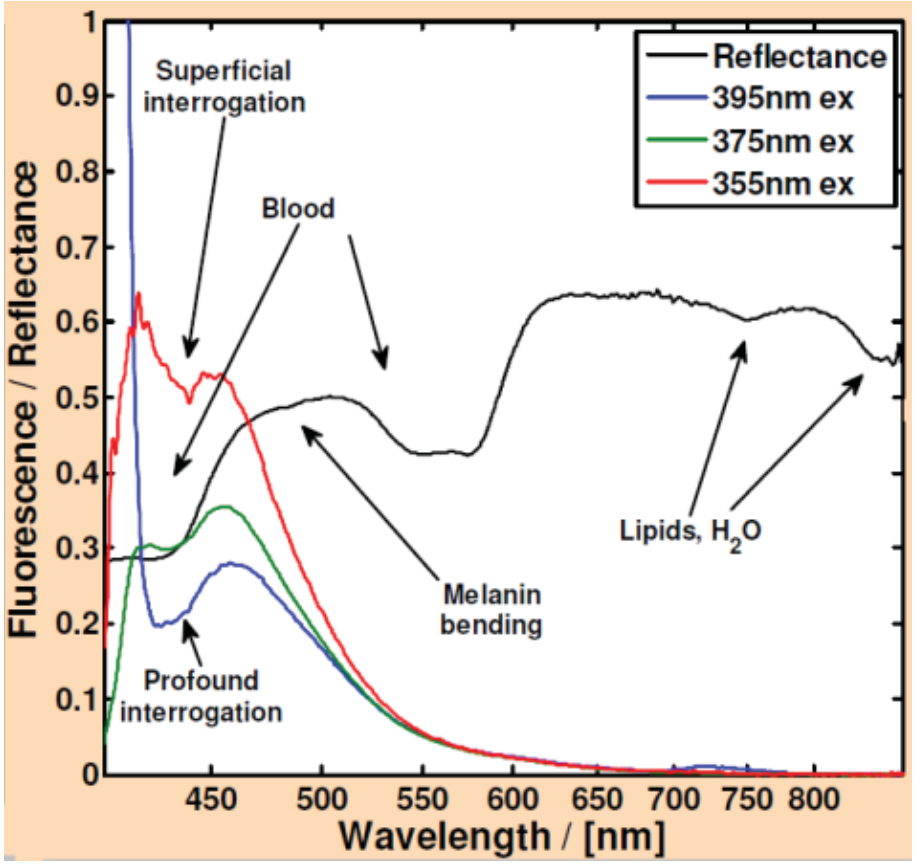
Punch biopsy

Optical detection

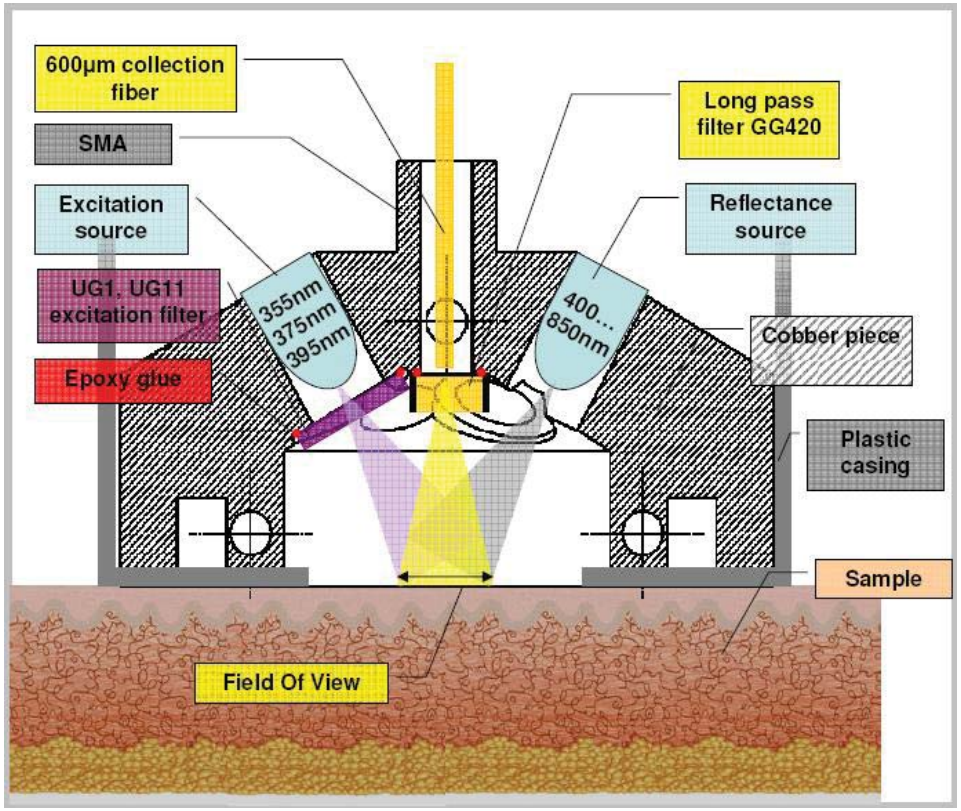
Equipment developed
by Mikkel Brydegaard et al.

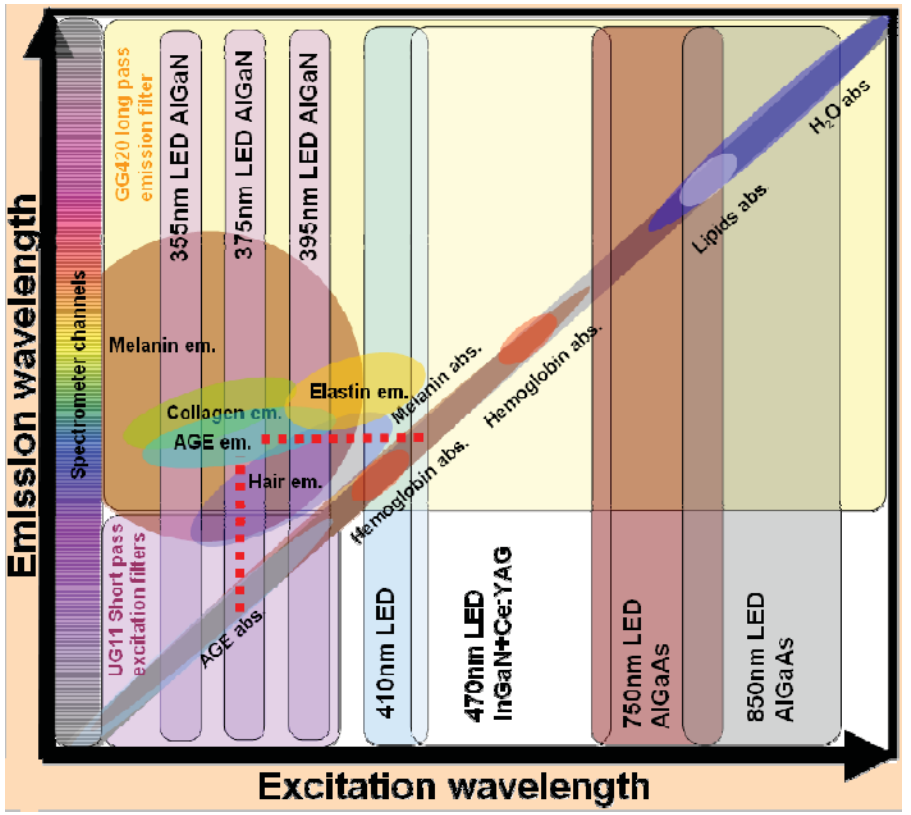
Katarina Svanberg

LED based multiple exctation fluorescence and reflectance sensor



Monitoring system for multiple excitation fluorescence and reflectance monitoring





Efforts in improving women health

Cervical tissue detection to prevent development of cancer

Lund University

Medical Laser Centre

Katarina Svanberg

Optical Tissue Diagnostics of cervical precancer & cancer

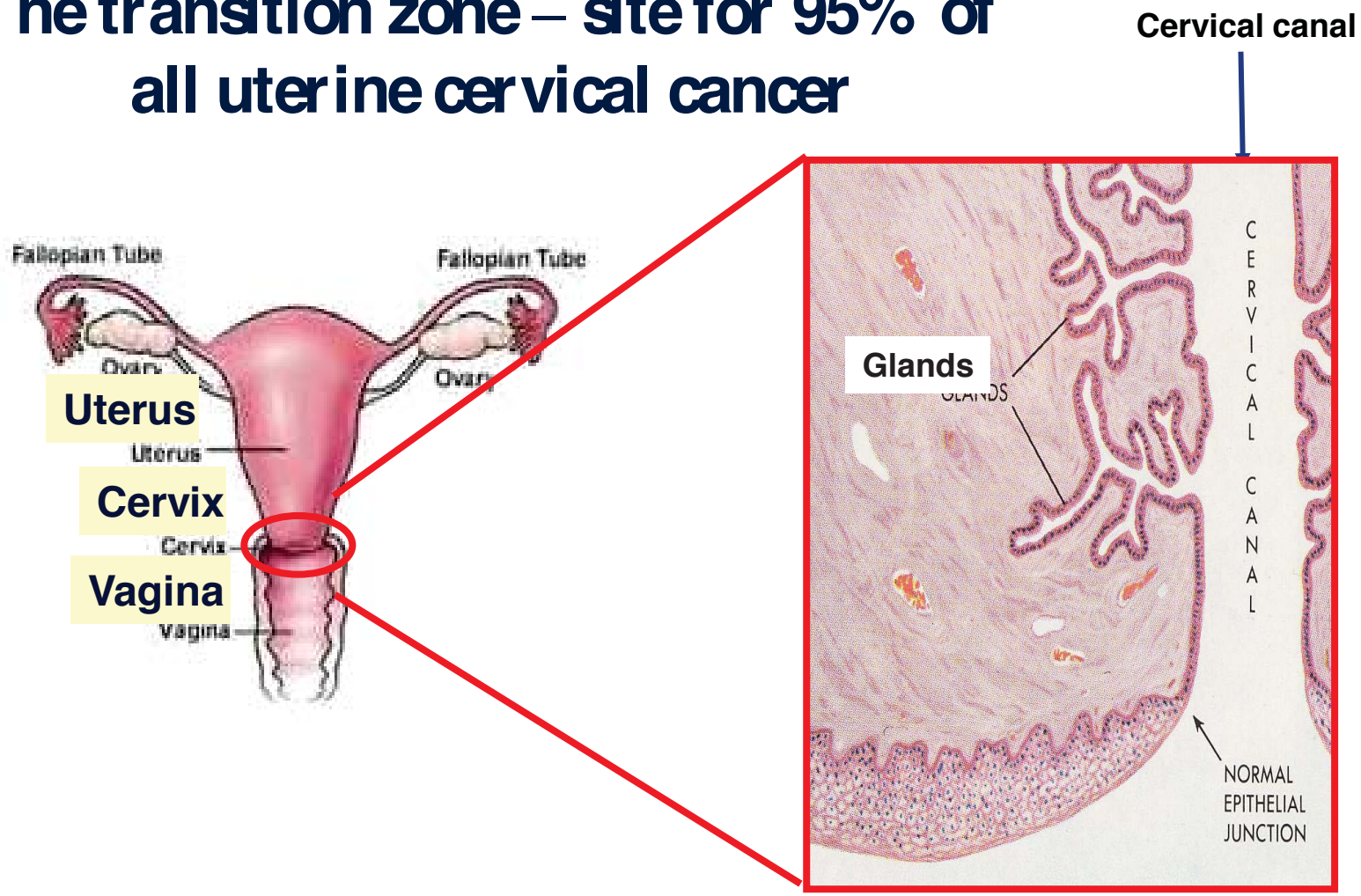
111 patients included

Lithuanian Oncology Centre

Out patient clinics

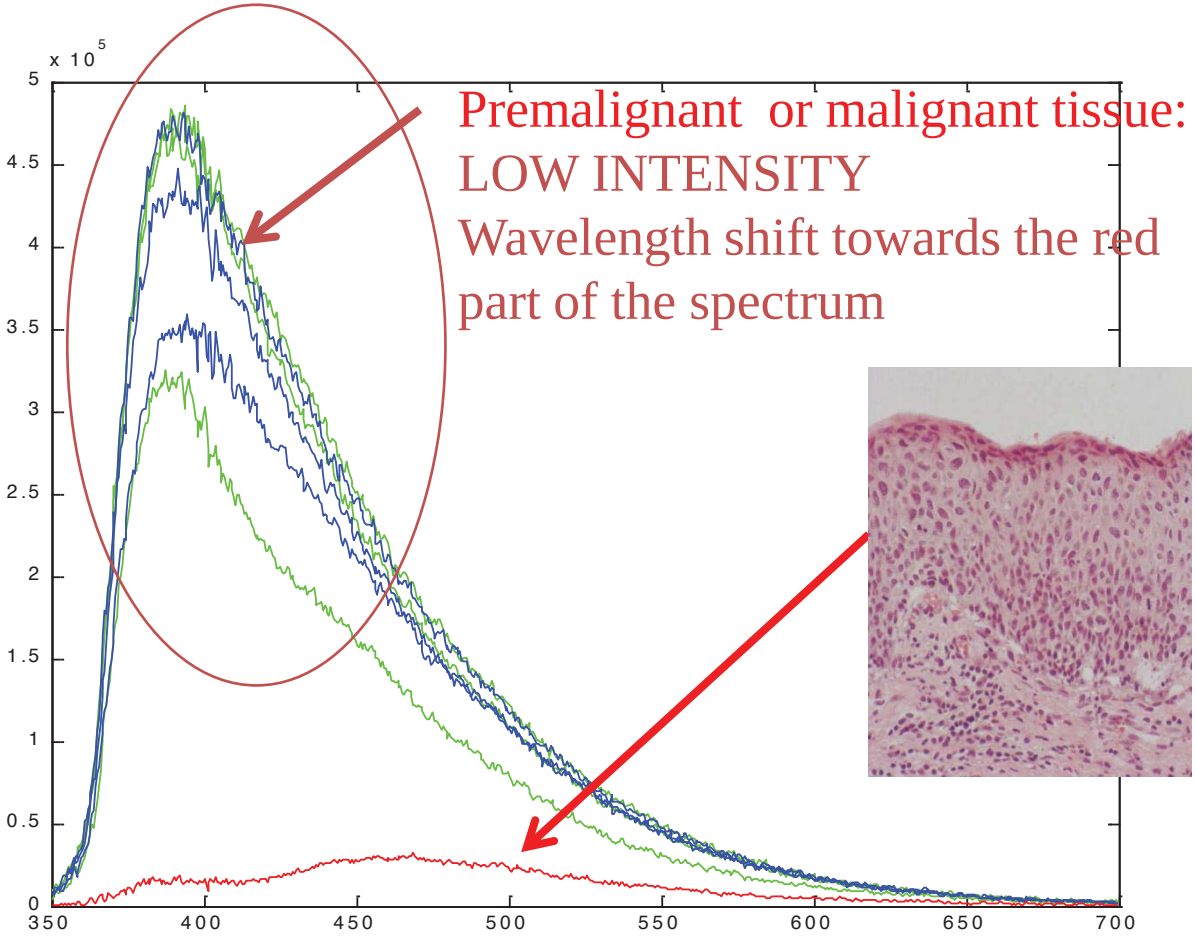
Vilnius University Hospital – The Gynaecology Department

The transition zone – site for 95% of all uterine cervical cancer



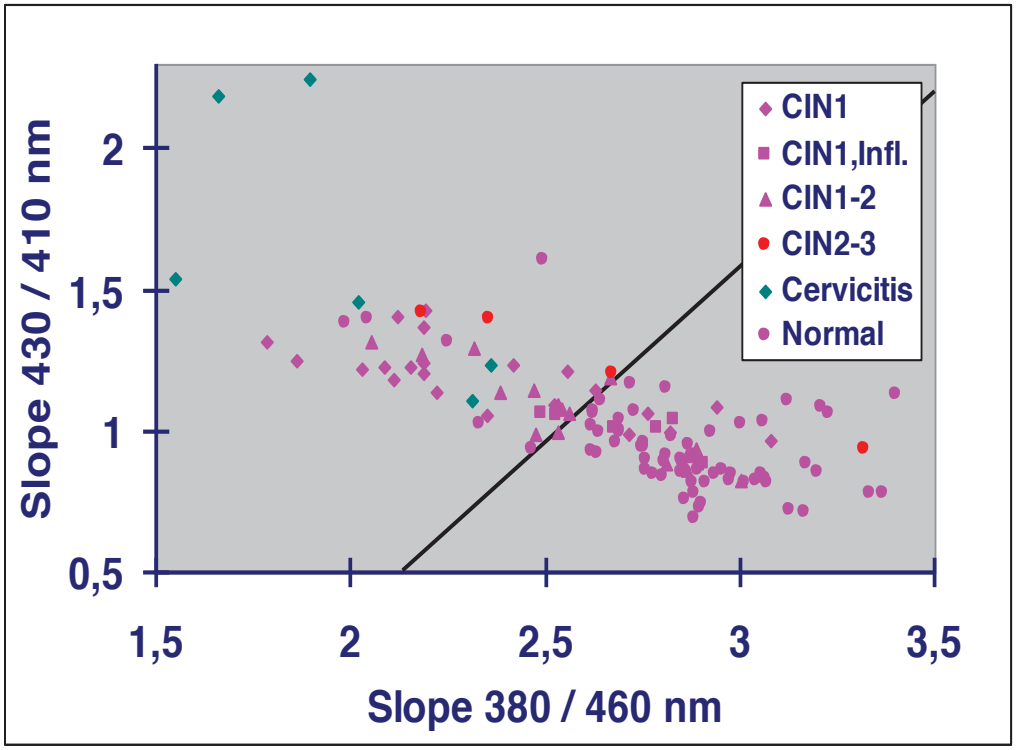
Optical Tissue Diagnostics in the Uterine Cervical Area

Autofluorescence



Separate inflammation from neoplasia

Laser-induced **autofluorescence** data – cervicitis/precancer

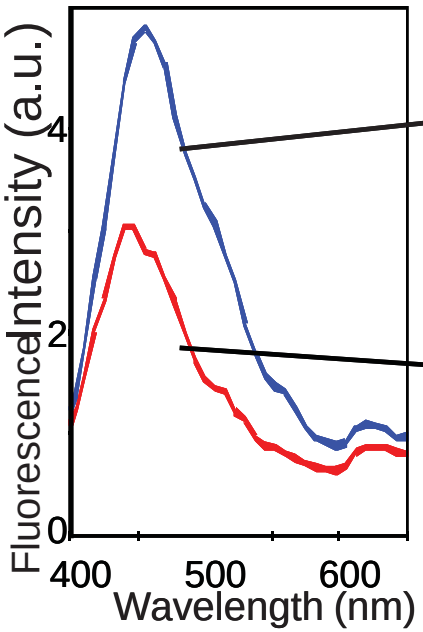


CIN

- Sensitivity 67%
- Specificity 91%

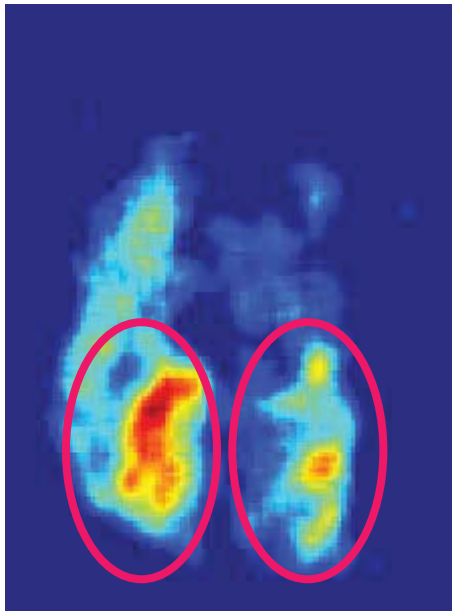
Exc. 337 nm

Real-time fluorescence imaging in conjunction with colposcopy



a. Spectra

b. Colposcopic Image

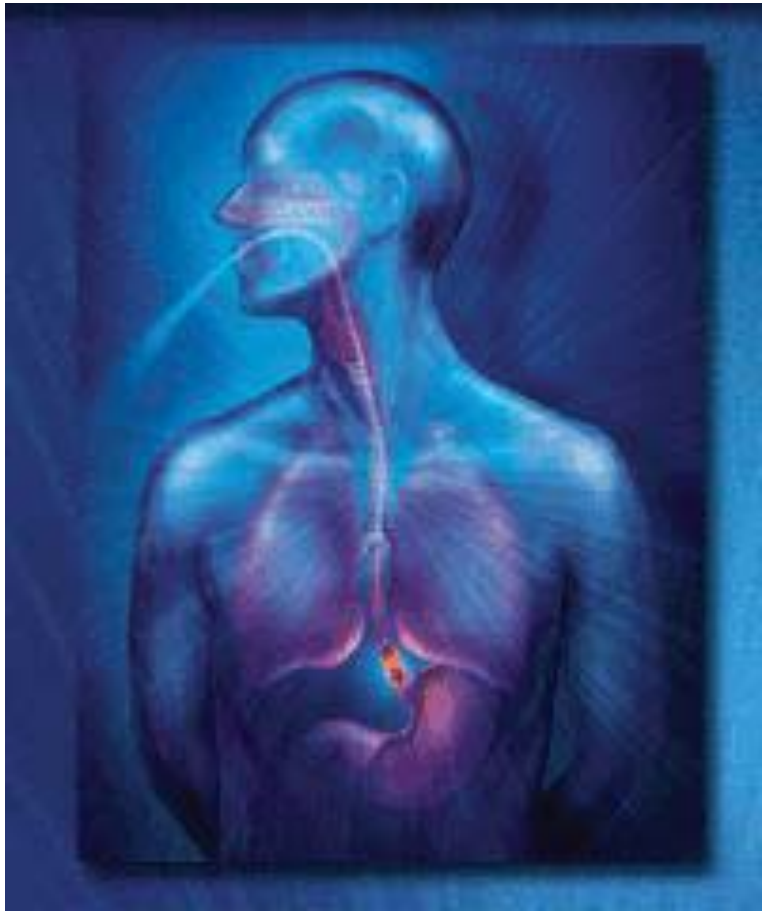


c. Processed Fluorescence

Treatment considerations!

Collaboration with STI Inc., Honolulu, USA

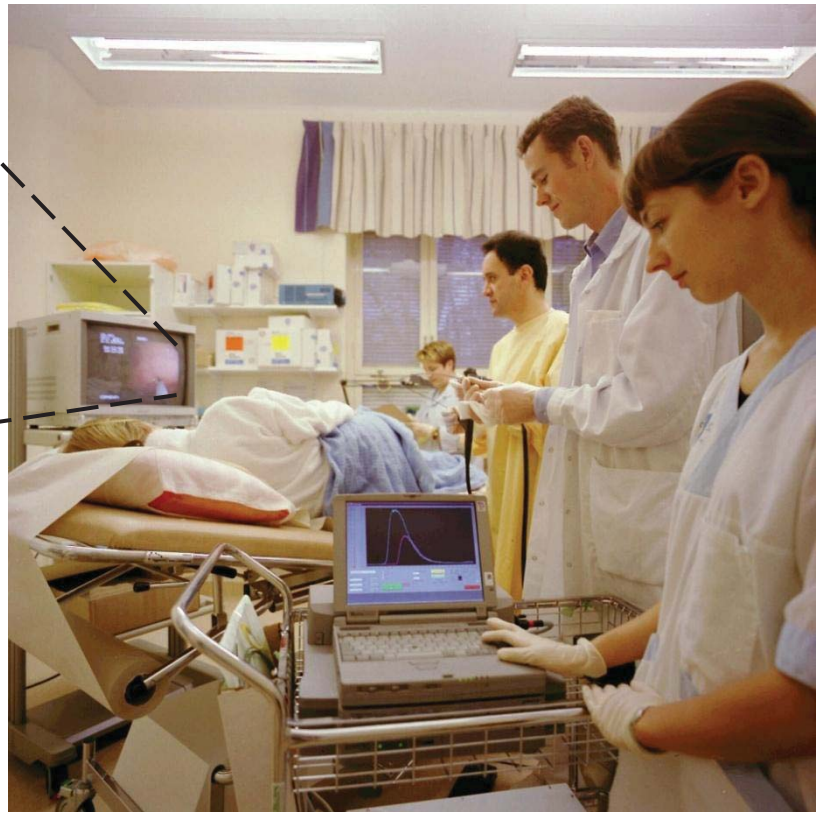
Barret´s oesophagus –
guided biopsy sampling in the metaplastic mucosa



Picture from Axcan Pharma Inc.

Clinical measurements at Karolinska Hospital, Stockholm

The probe fibre in contact with a polyp



Non-neoplastic:

Neoplastic:

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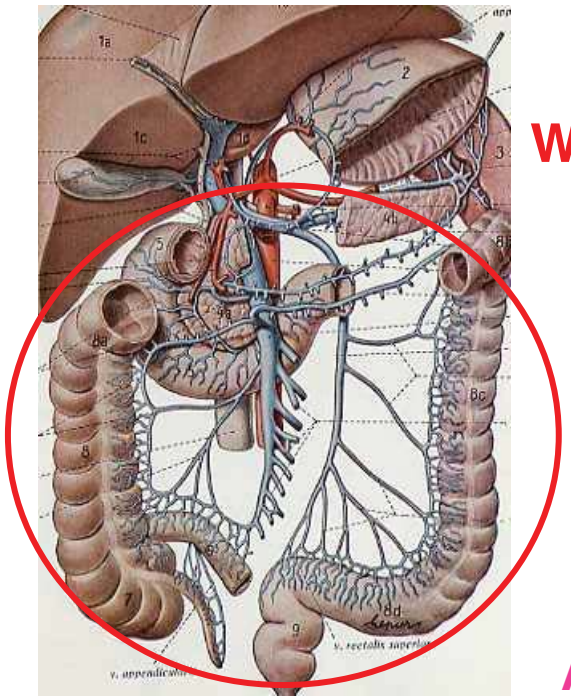
Separate metaplasia/hyperplasia from neoplasia



Large intestine - colon

What is the interpretation if the clinical appearance is

Various kinds of polyps

Neoplastic

Non-neoplastic

Adenomatous polyps
Villous adenomas
(in particular flat sessile lesions - often overseen in colonoscopy)

Hyperplastic or metaplastic

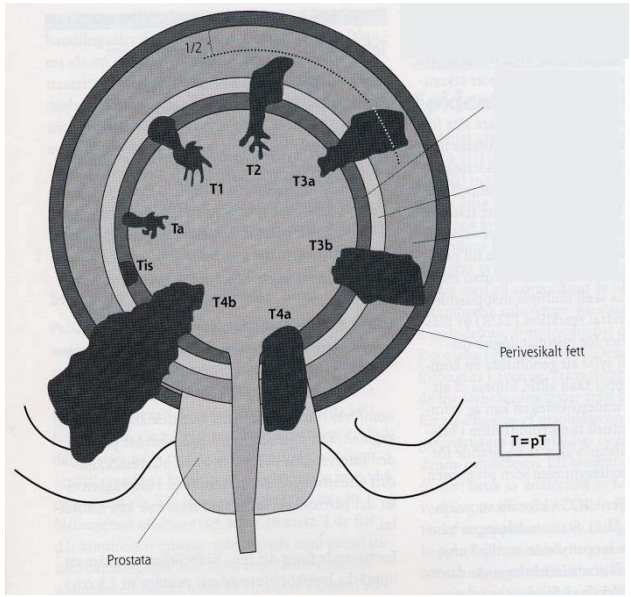
10% Carcinoma *in situ* in these

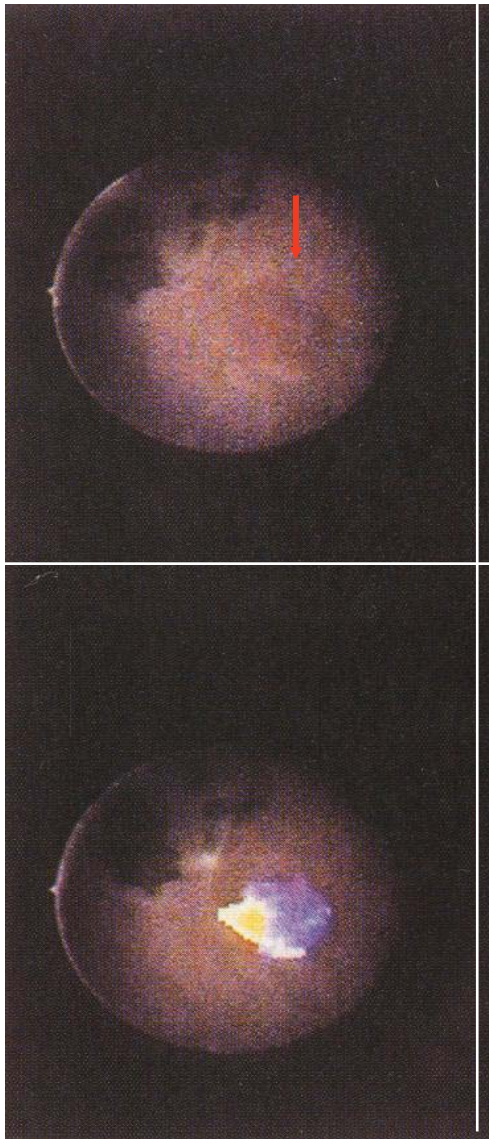
PDT treatment
Multiple polyp resection
Tumour bed illumination

Visualise precancer (dysplasia) & non-invasive tumours

Ca *in situ*
(Tis)

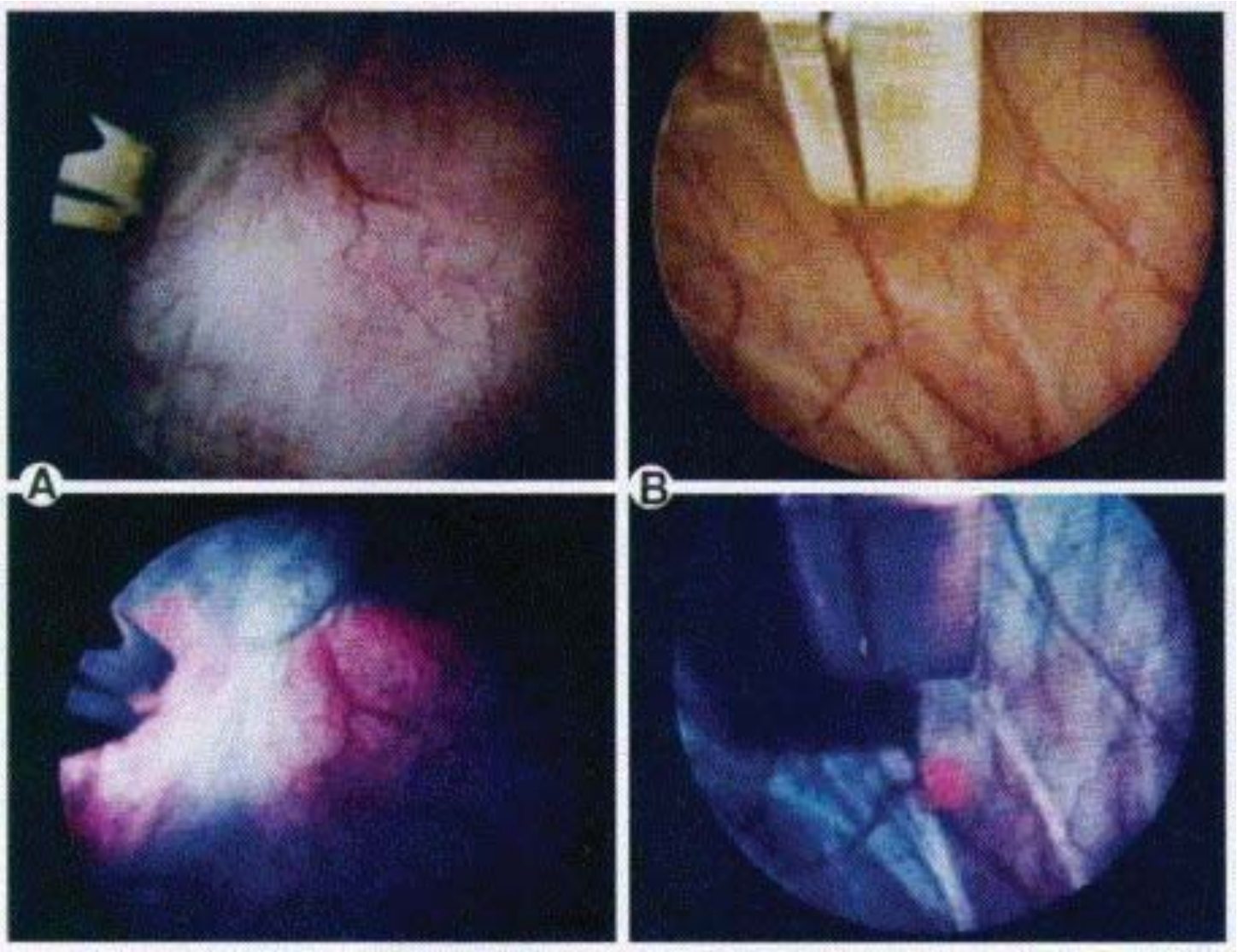
Urinary bladder tumour detection





Endoscopic view

Fluorescence image



Herbert Stepp et al.

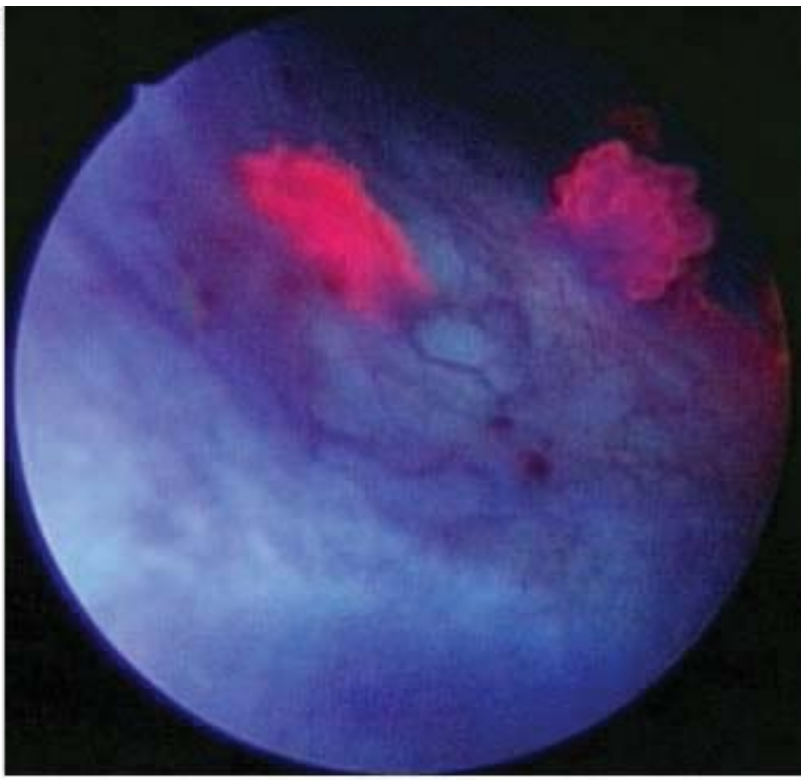
Edited by Roy Pottier, Barbara Krammer, Reinhold Baumgartner and Herbert Stepp

Photodynamic Therapy with ALA

A Clinical Handbook

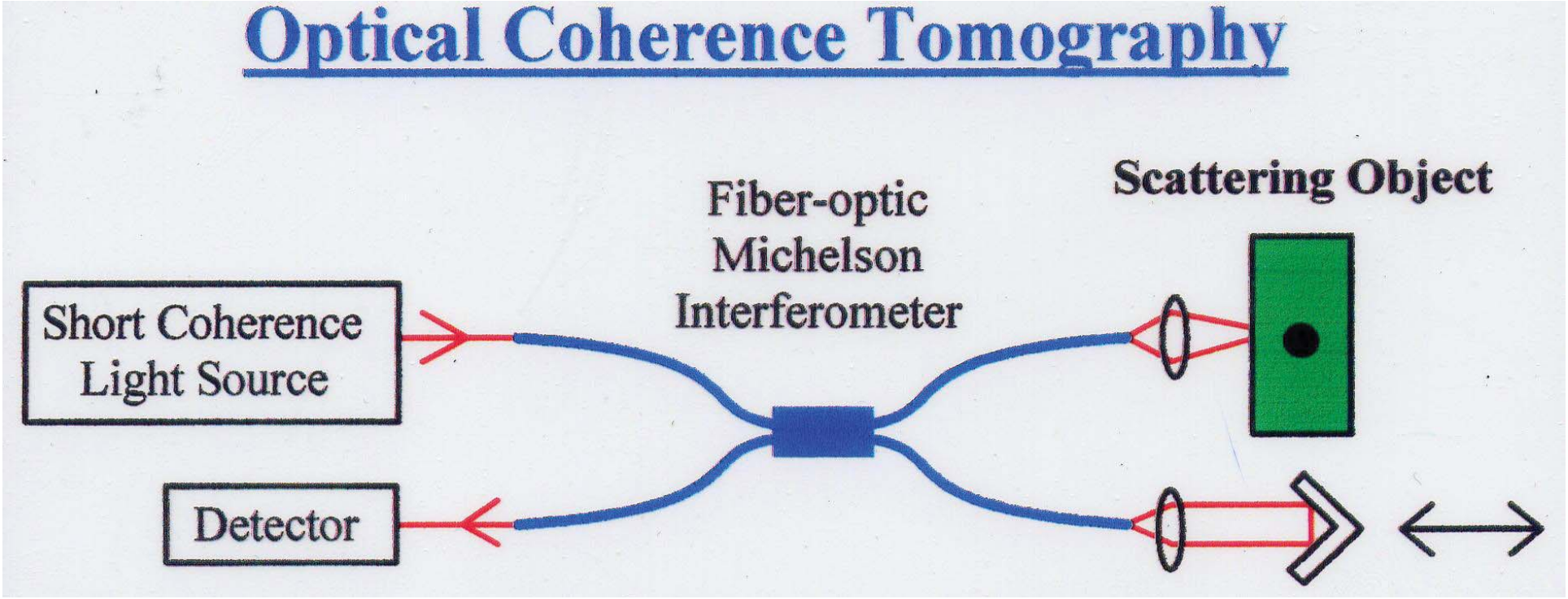
RSC Publishing

(a)



(b)

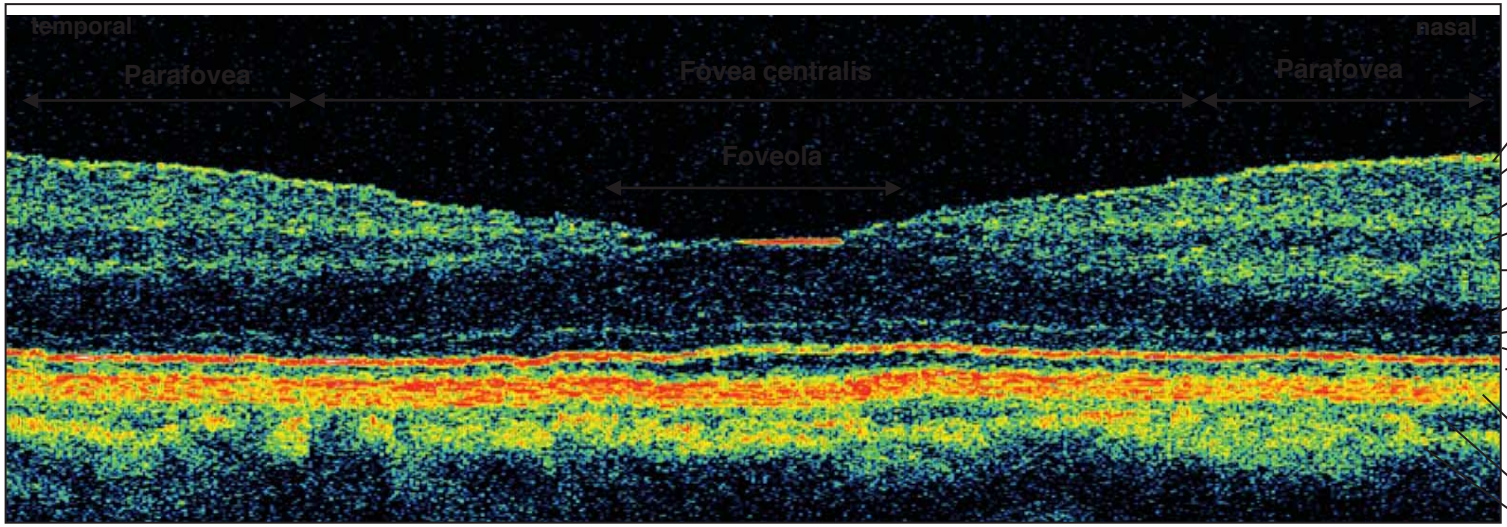
A success development of a photonics-related technique introduced in the clinic



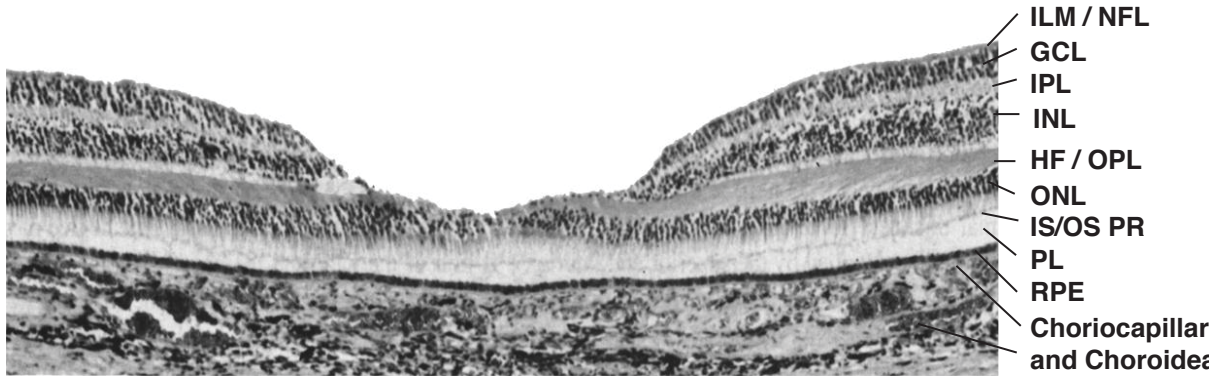
Fujimoto et al.

Ophthalmology Vessels Skin

In Vivo Ultrahigh Resolution OCT versus Histology



250 μm



Gass J.D.M., 1997

W. Drexler et al.; Vienna

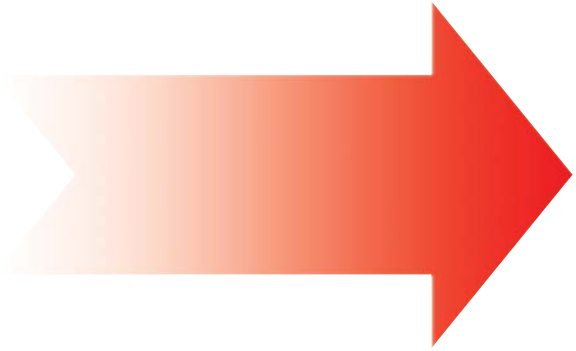
W. Drexler et al. *Nature Medicine*, Vol 7, No. 4, 502-507, 2001

Photodynamic therapy

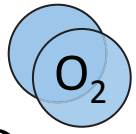
Three crucial components in PDT

Sensitiser

Light



Tumour Destruction



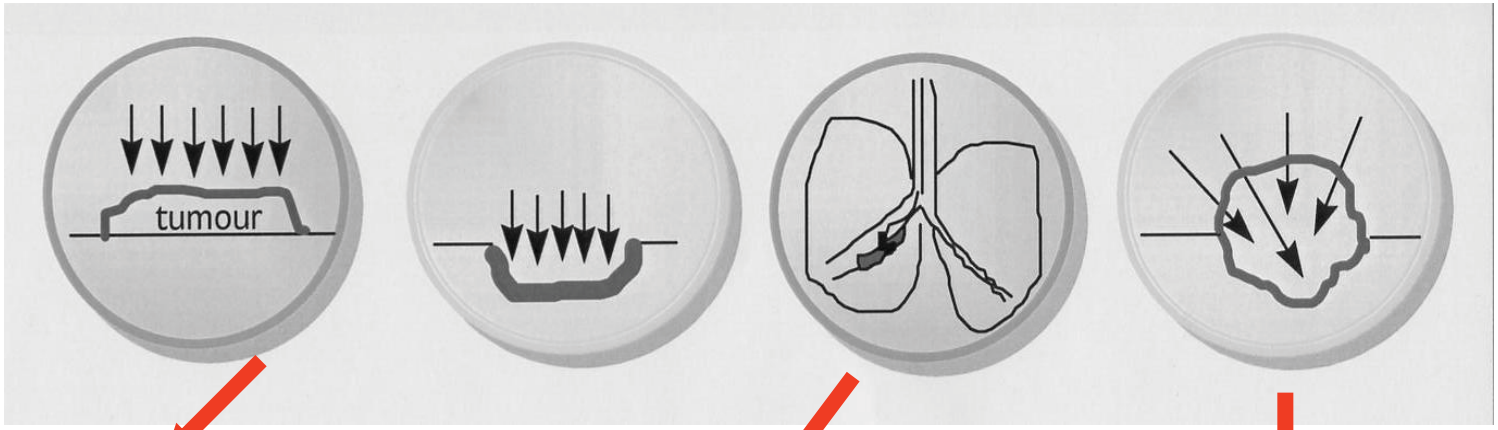
Oxygen

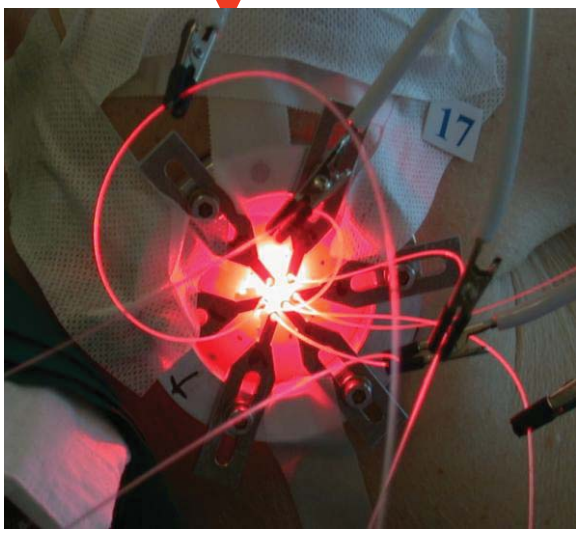
Primary effect (~days) – Direct tumour cell toxicity

Secondary effect (~ weeks) – Vascular damage, Apoptosis

Various PDT-modes for light delivery

Superficial Tumour bed Endoscopical Interstitial





Tumour localising agents - photosensitisers (PDT) tumour markers (LIF)

	RED Absorption Peak
Haematoporphyrin derivative (HpD), (Photofrin)	630 nm
δ-aminolevulinic acid (ALA)	635 nm
Mesotetrahydroxyphenychlorin (mTHPC), (Foscan)	652 nm
Tin Etiopurpurin (Pyrlytin)	660 nm
Benzoporphyrin, (Verteporfin)	690 nm
Phthalocyanins	720 nm
Lutetium texaphyrin (Lutrin)	732 nm
Bacteriochlorophyll (Tookad)	760 nm

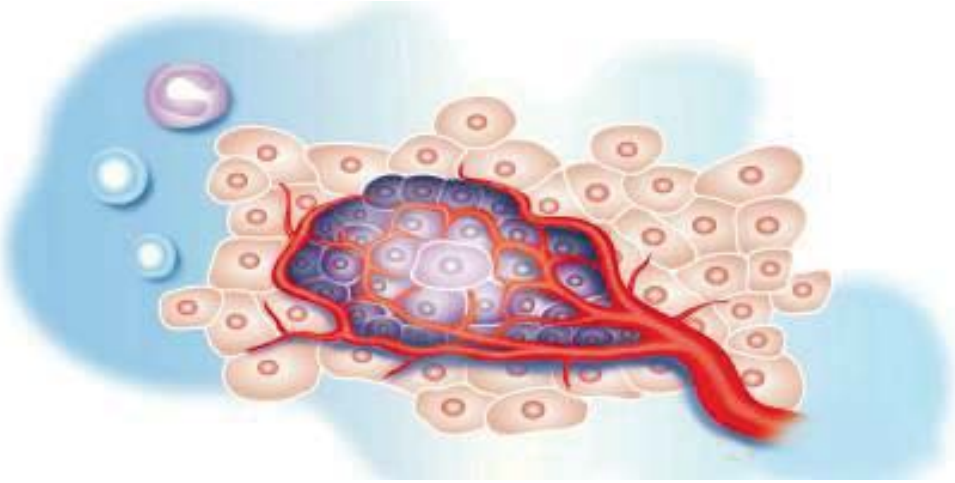
Why selectivity?

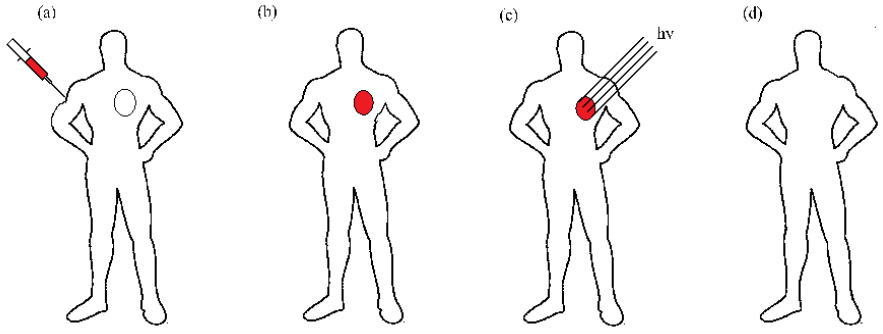
Affluent blood flow to the tumour – insufficient blood flow from the tumour (trapping)

Leaky blood vessels in the tumour

Lower pH in tumour

For ALA an enzymatic response



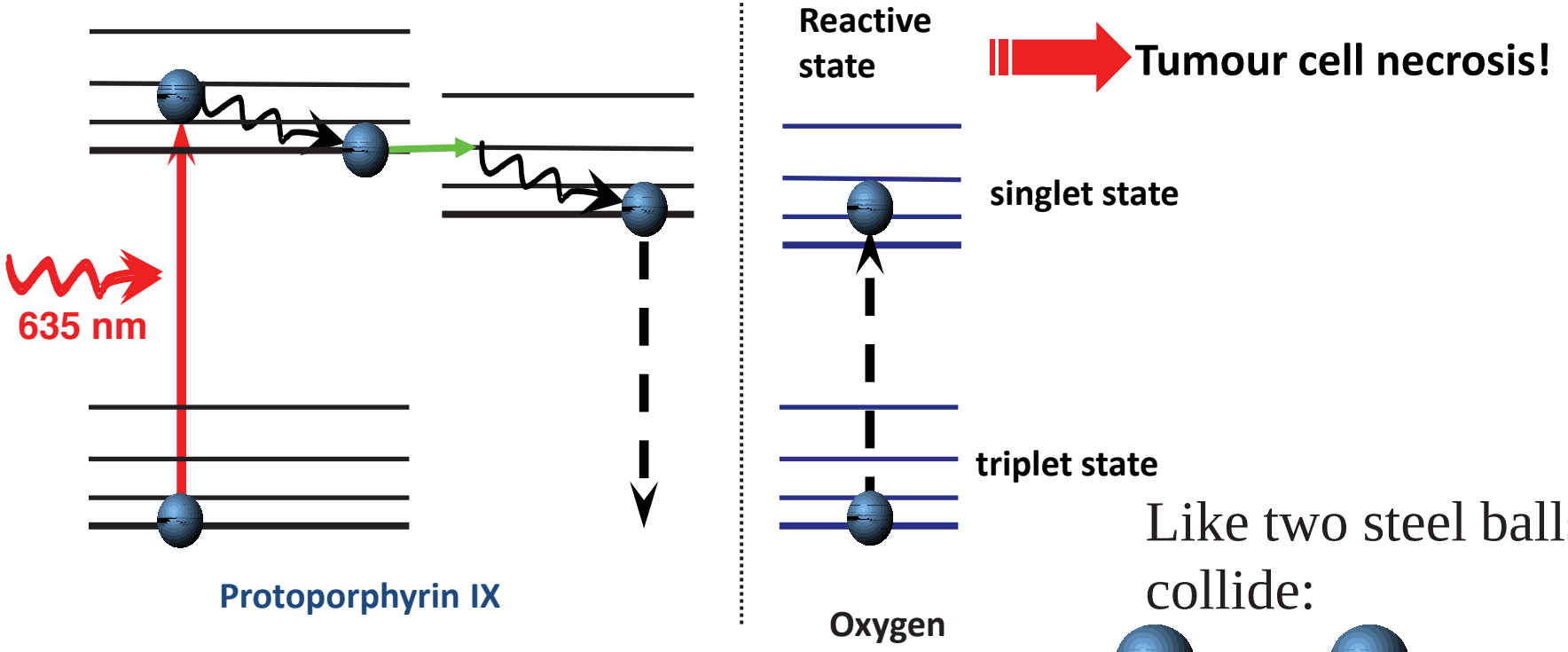


The tumour destruction process

The sensitizer molecule gains excess energi by light excitation

The excess energi

Tissue triplet oxygen is transformed to cytotoxic singlet oxygen



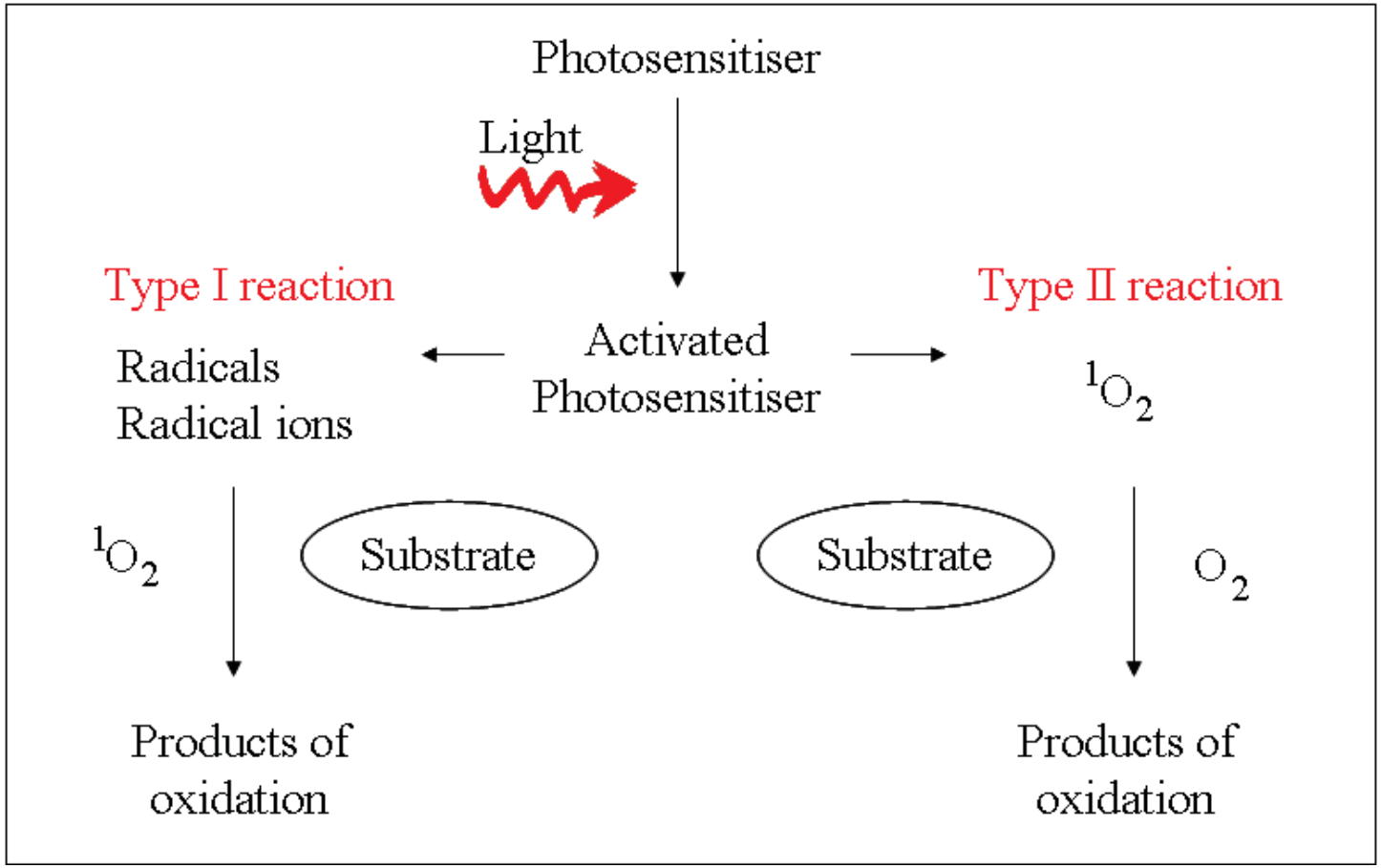
Like two steel balls collide:

Lund University

Medical Laser Centre

Katarina Svanberg

Type I and Type II reactions in PDT



Katarina Svanberg

Photodynamic Therapy

PDT characteristics:

- Tumour selectivity
- Can be repeated
- No accumulated toxicity
- Fast healing
- Minimal scaring
- Organ function is retained

Systemically given it causes skin sensitisation

Nodular basal cell carcinoma

In Lund we have PDT-treated 2500 skin malignancies & performed Phase III clinical trials.

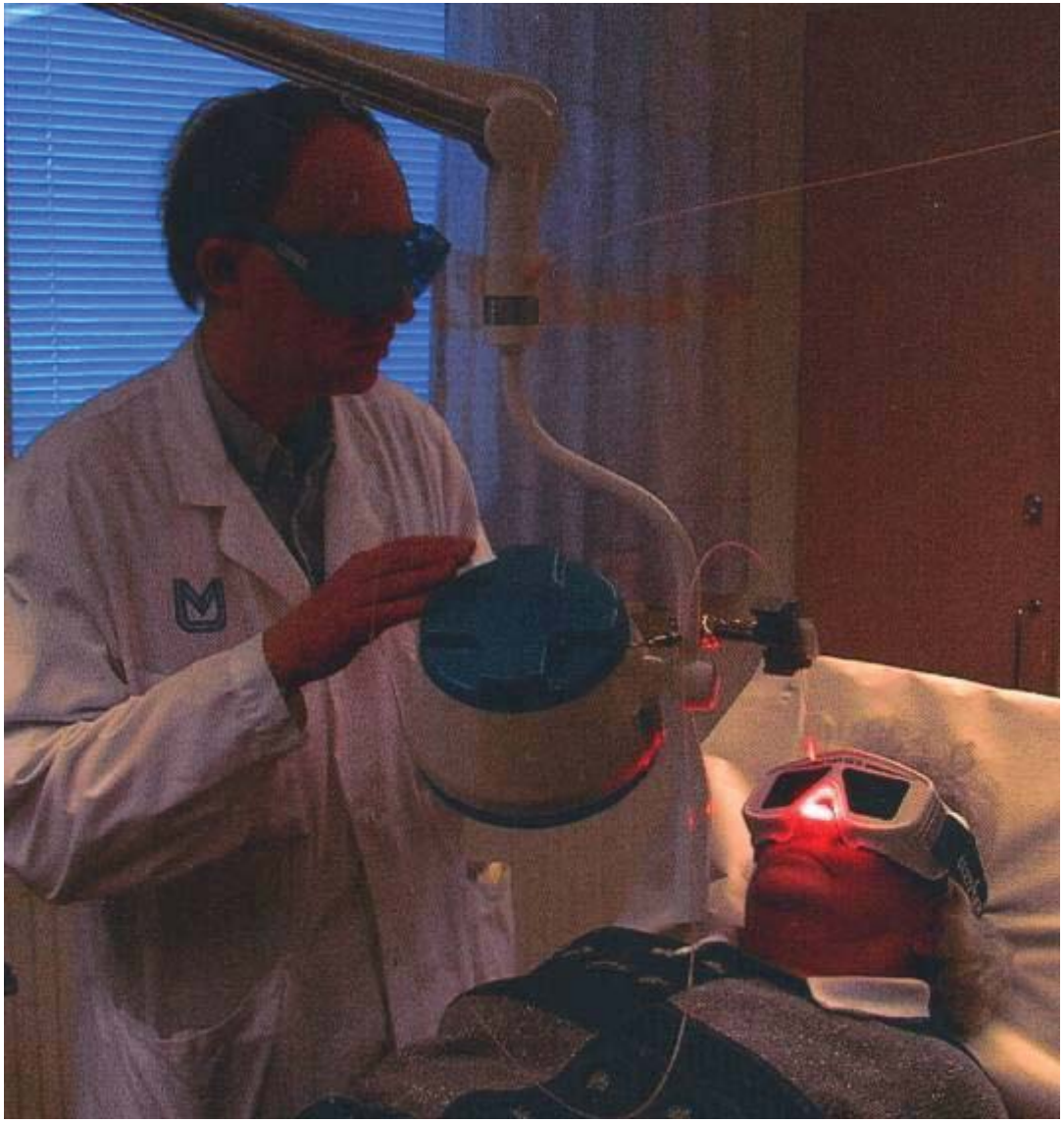
Katarina Svanberg

Indication for PDT

Primary and/or Recurrent skin malignancies

- Large lesion >4 cm
- Multiple lesions
- Sensitive location
  - Face
  - Pretibial etc
- Underlying cartilage
  - Ear
  - Nose
- Elderly people

- Excellent cosmetic outcome
- Short healing time
- Comparable respons to conventional techniques



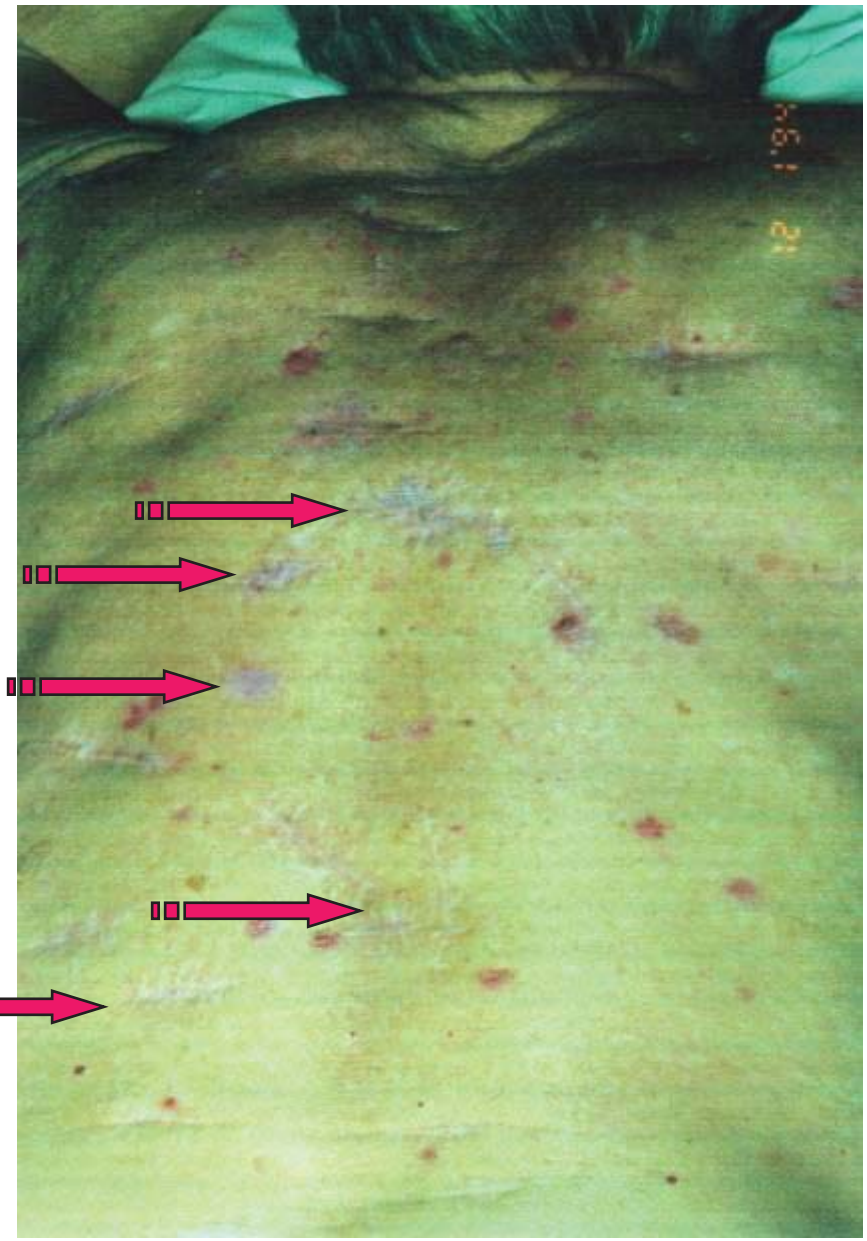
Katarina Svanberg

What are the indications for PDT of skin malignancies?

e.g.,

- Multiple skin lesions
- Large skin lesions (diameter 5 cm or more)
- Lesions in sensitive areas

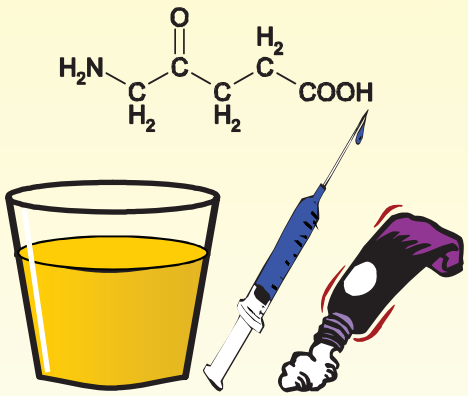
Surgical scar



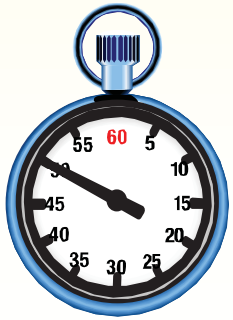
Superficial basal cell carcinoma

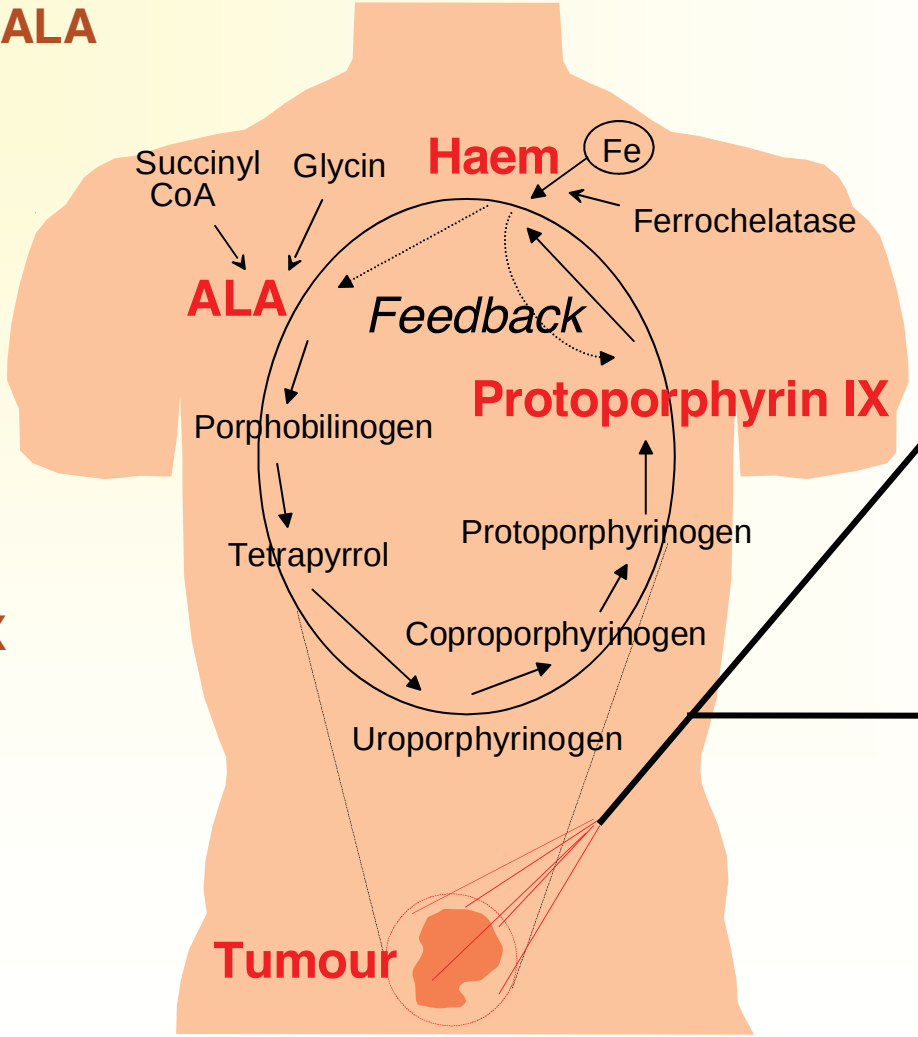
Photodynamic therapy (PDT)

1. Administration of ALA

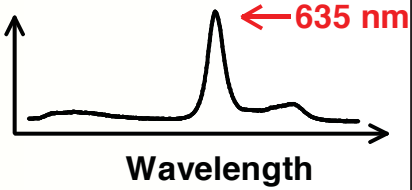


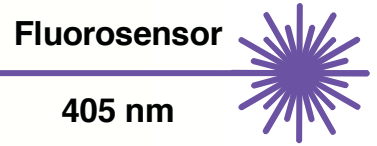
2. Build-up of Protoporphyrin IX



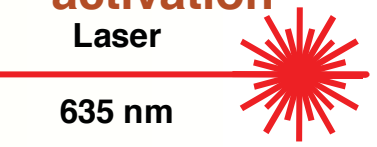


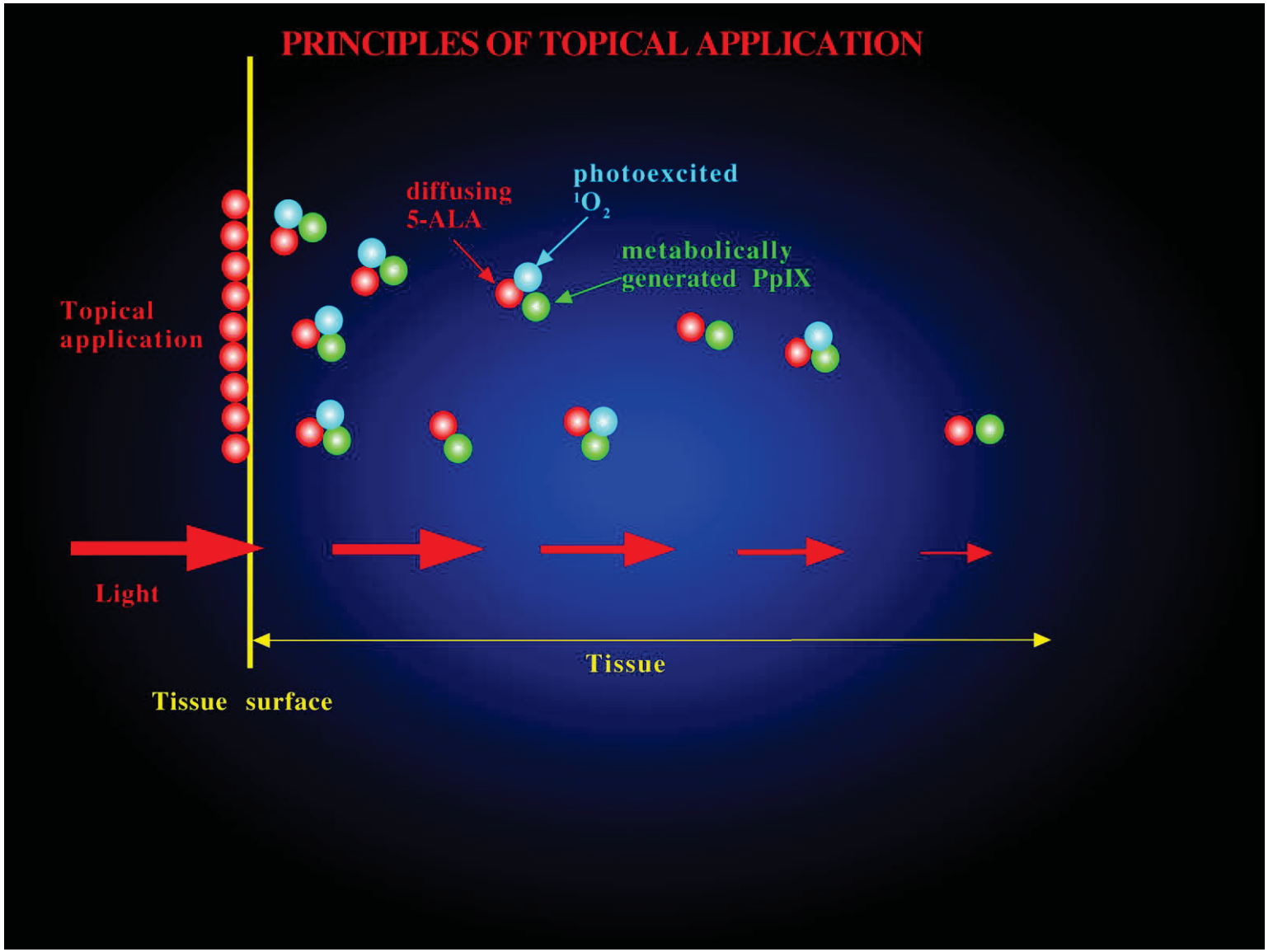
3. Fluorescence diagnostics





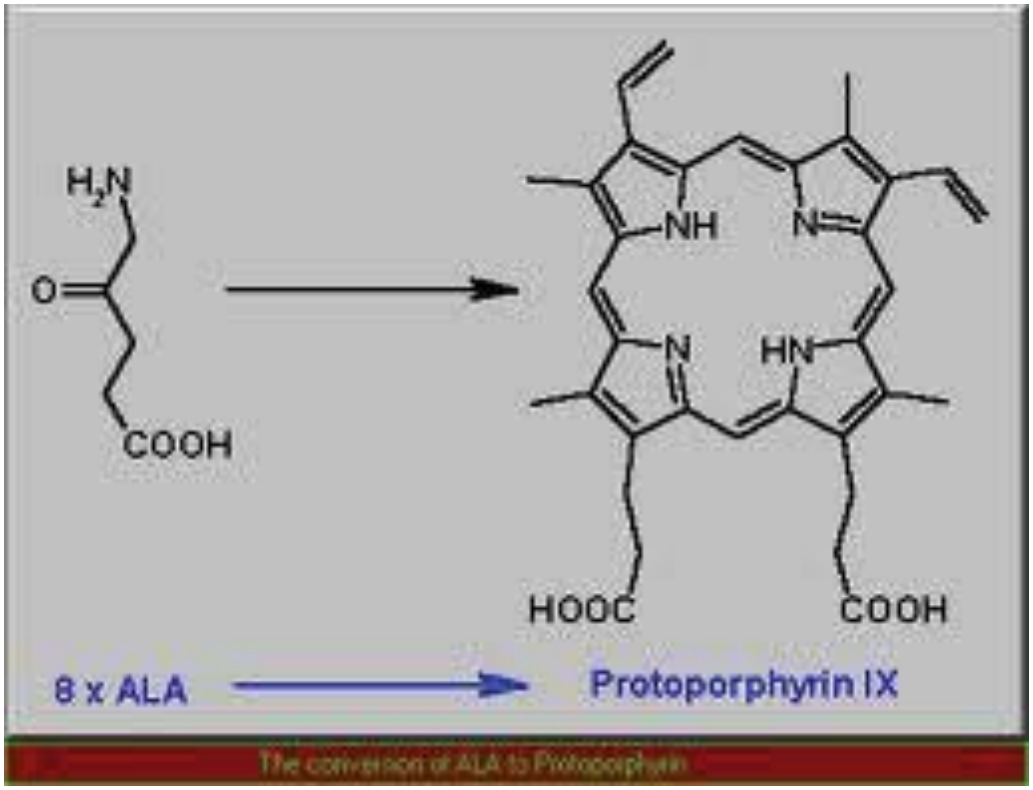
4. Photochemical activation



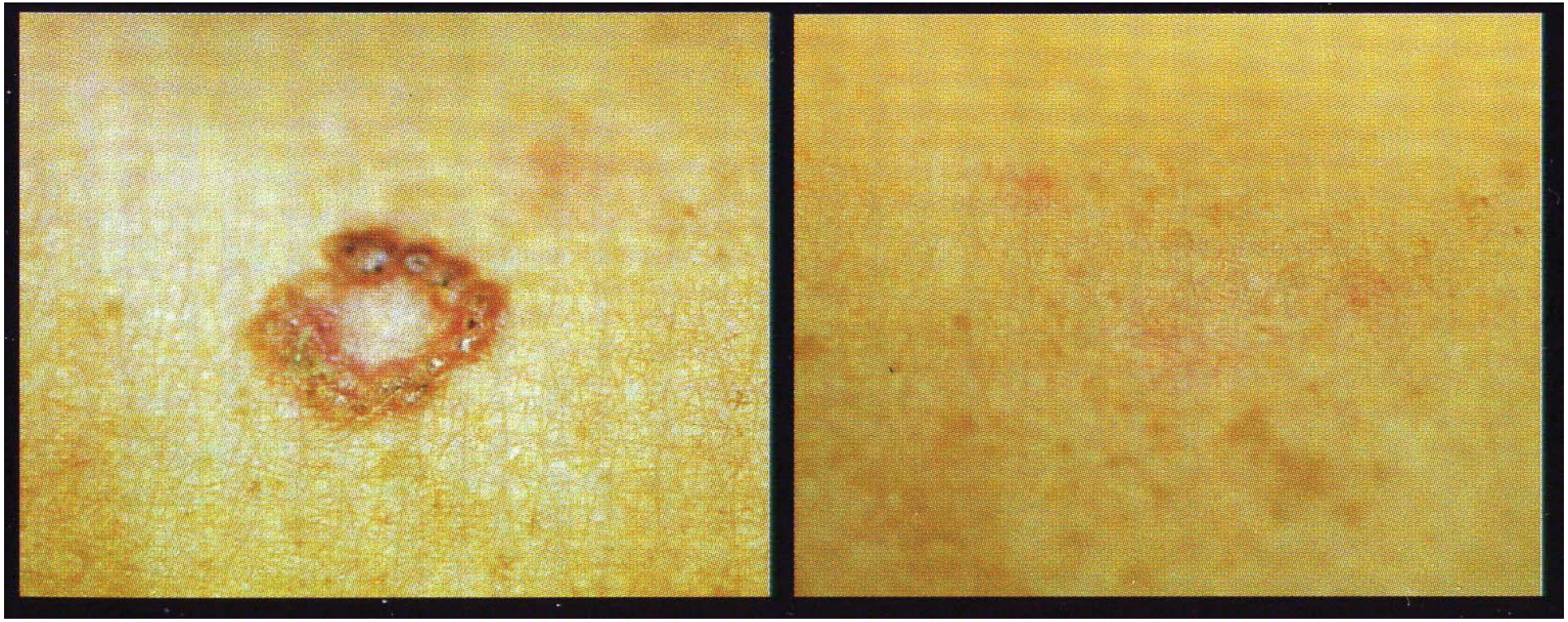


From L. O. Svaasand

ALA to Protoporphyrin IX
in several enzymatically generated steps



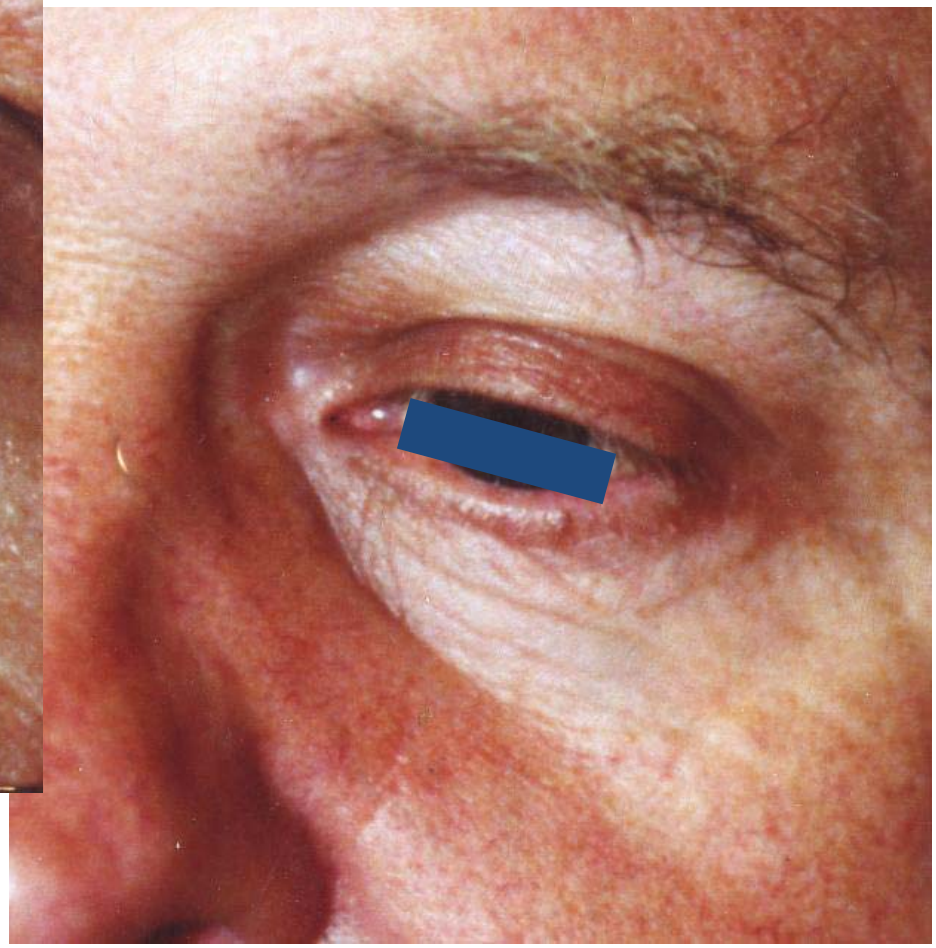
ALA PDT Treatment of a nodular Basal Cell Carcinoma – one of our first patients



Histopathology showed compete response; some elastosis

Pre PDT

9 months
post ALA-PDT



Cutaneous T-cell lymphoma

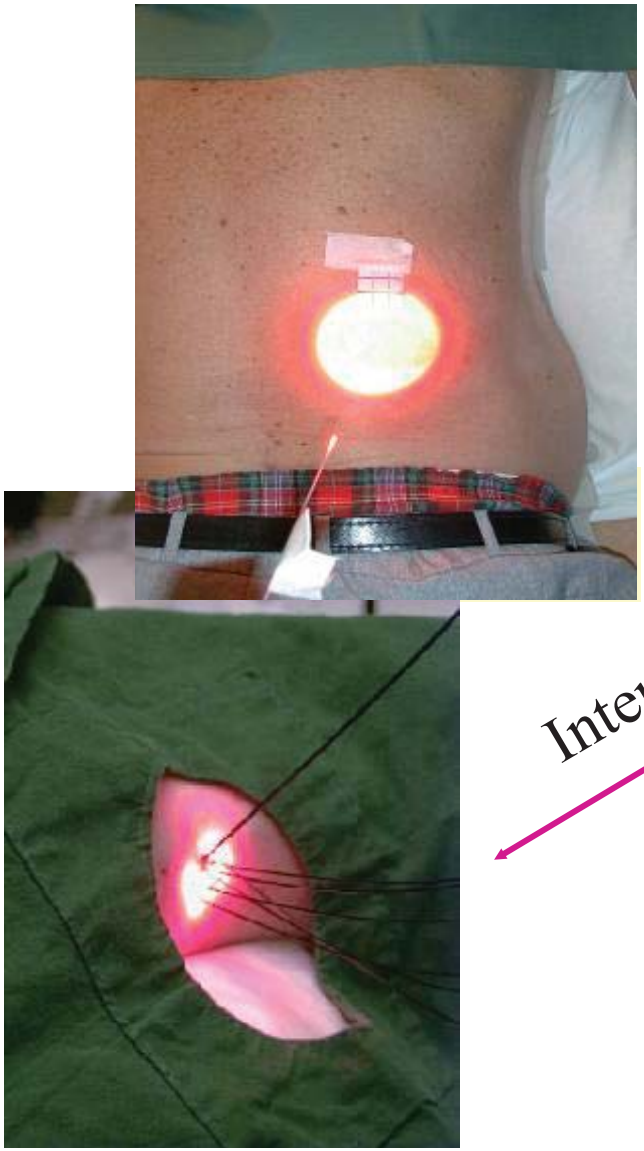
Katarina Svanberg

ALA-PDT of a squamous cell carcinoma

***Prior* to ALA-PDT**

3 months *post* ALA-PDT

How to overcome the limited penetration with superficial illumination?



Tissue penetration

Interstitial PDT

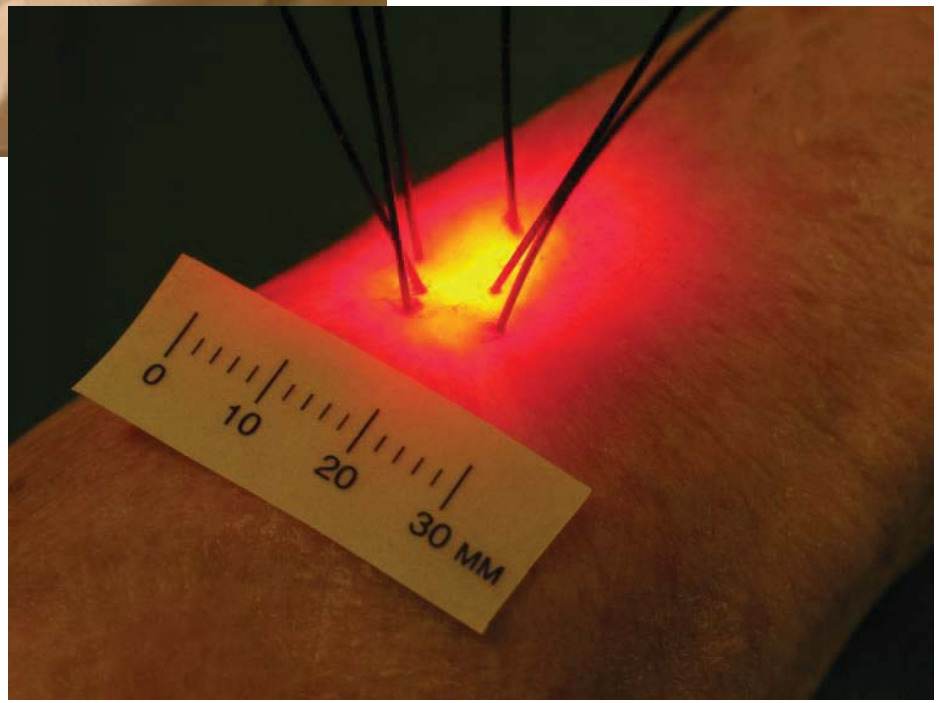
Up to cm:s

Up to mm:s

Lund University

Medical Laser Centre

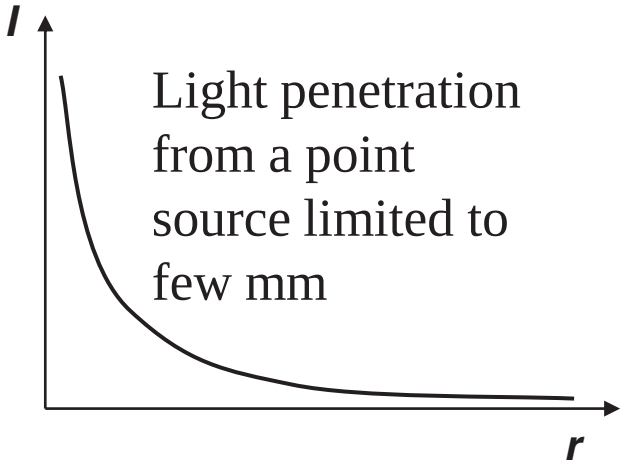
Katarina Svanberg



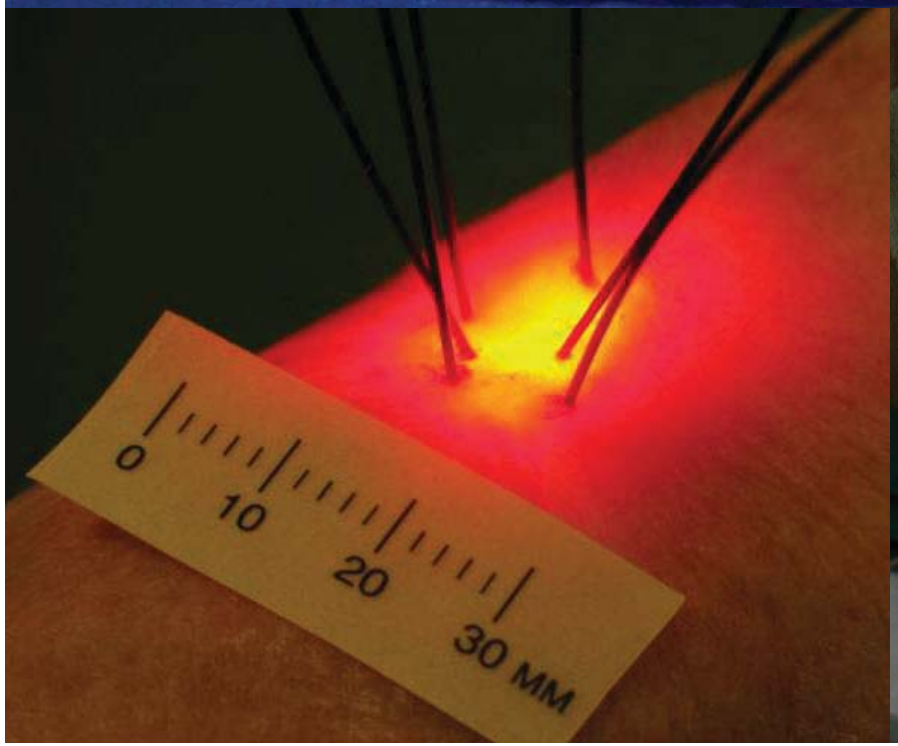
Optical fibres inserted into the tumour mass

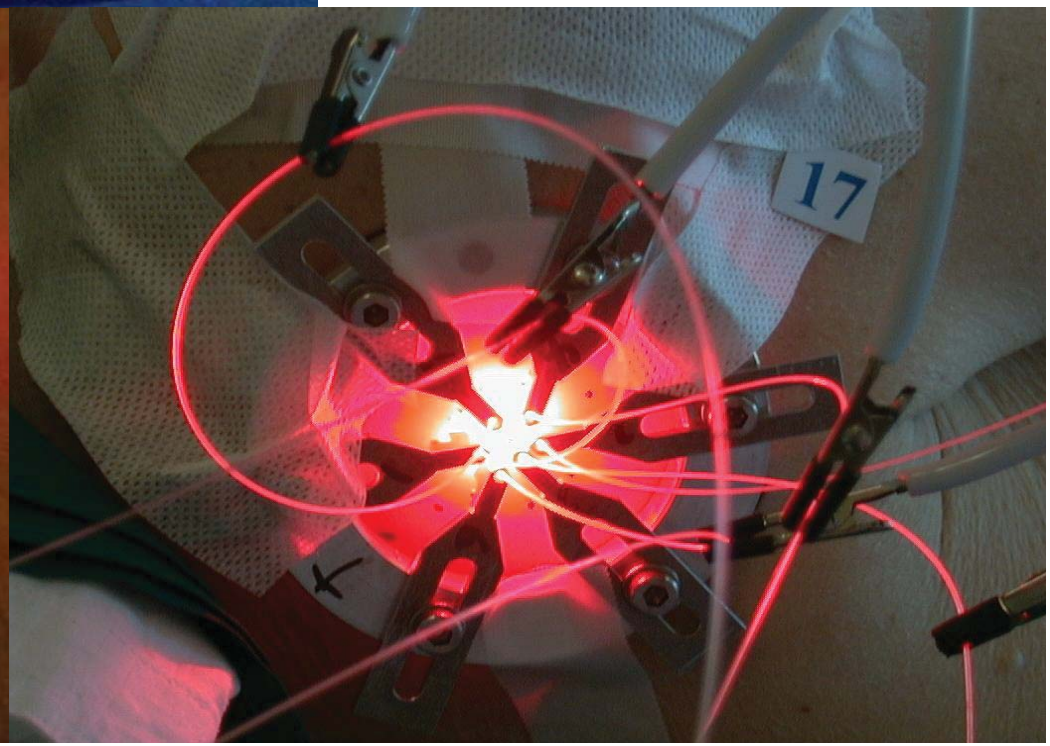
Motivation for Interstitial PDT

Johansson et al. JBO (2006)
Wang et al. Br. J. Dermatol. (2001)
Stefan Andersson-Engels



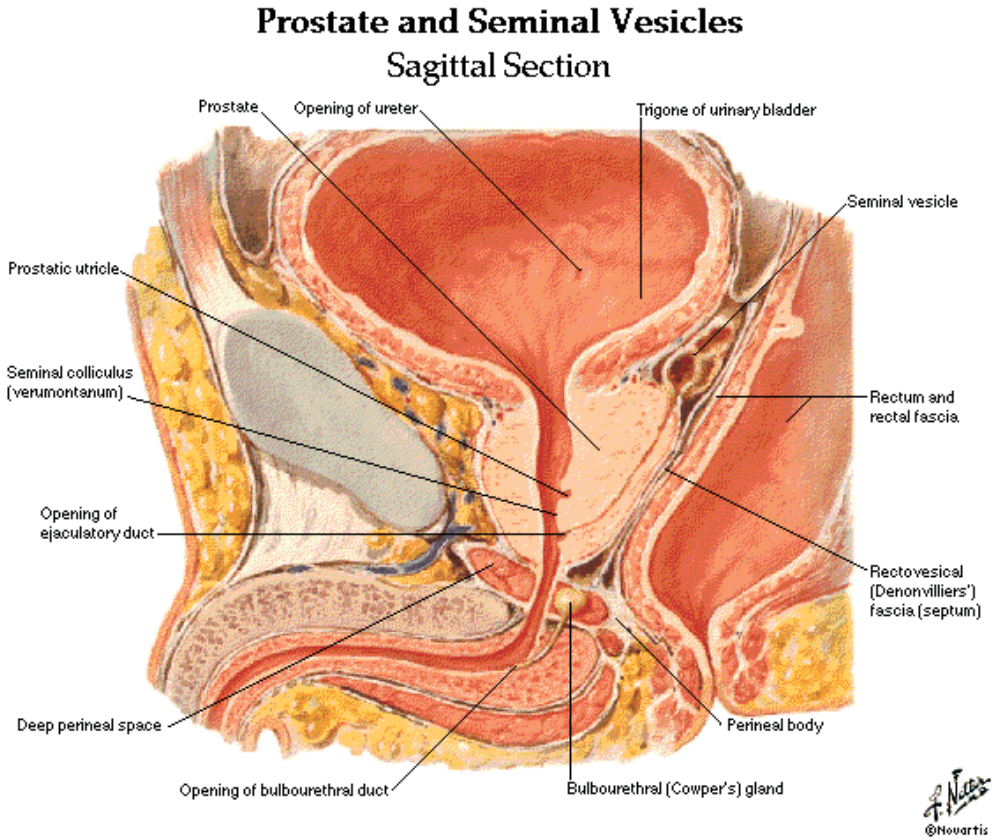
Light penetration from a point source limited to few mm



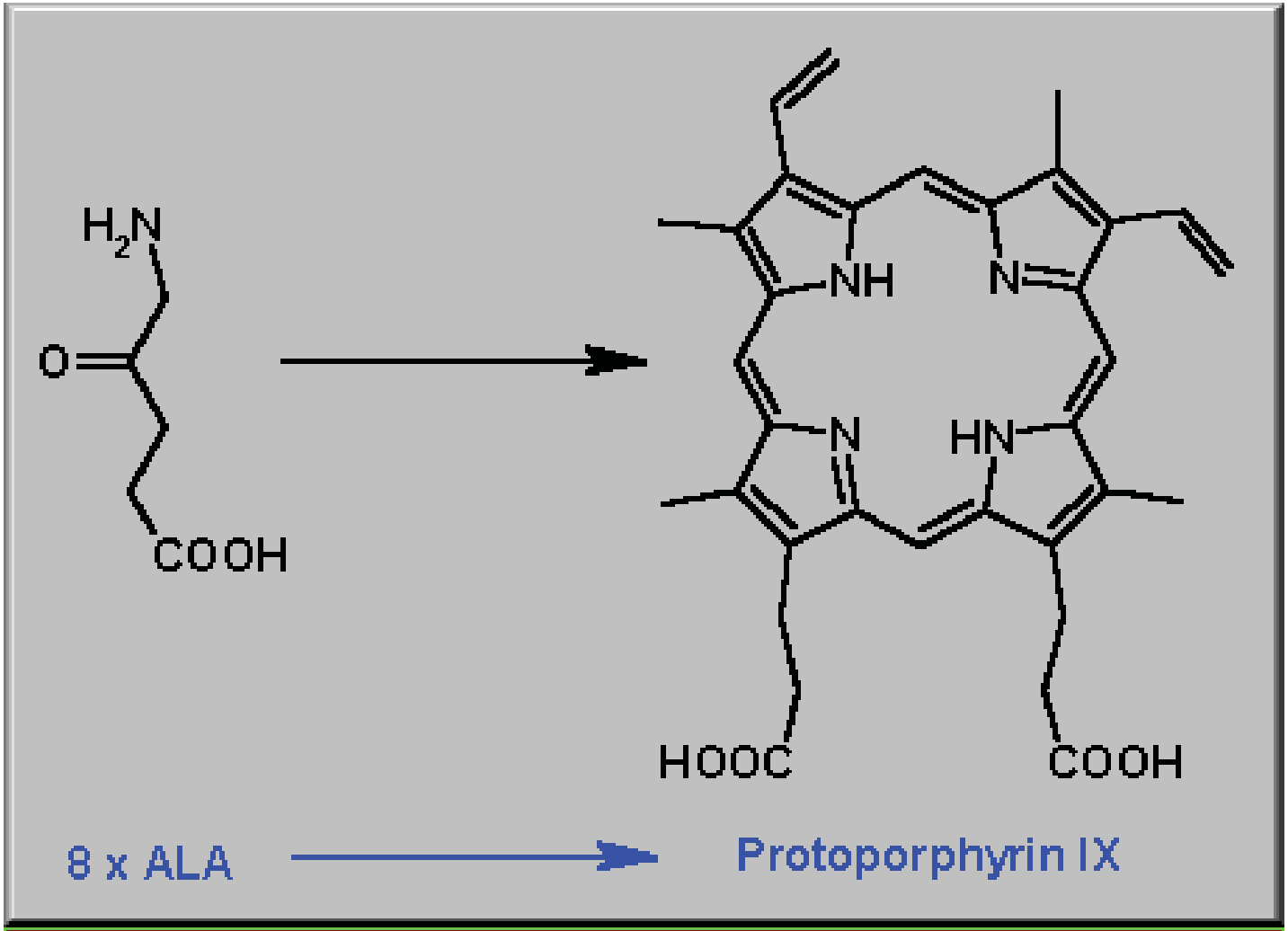


Challenging indication for PDT

- Prostate recurrent cancer post XRT
- The alternative is hormone therapy
- More toxic than anticipated



Katarina Svanberg



The conversion of ALA to Protoporphyrin

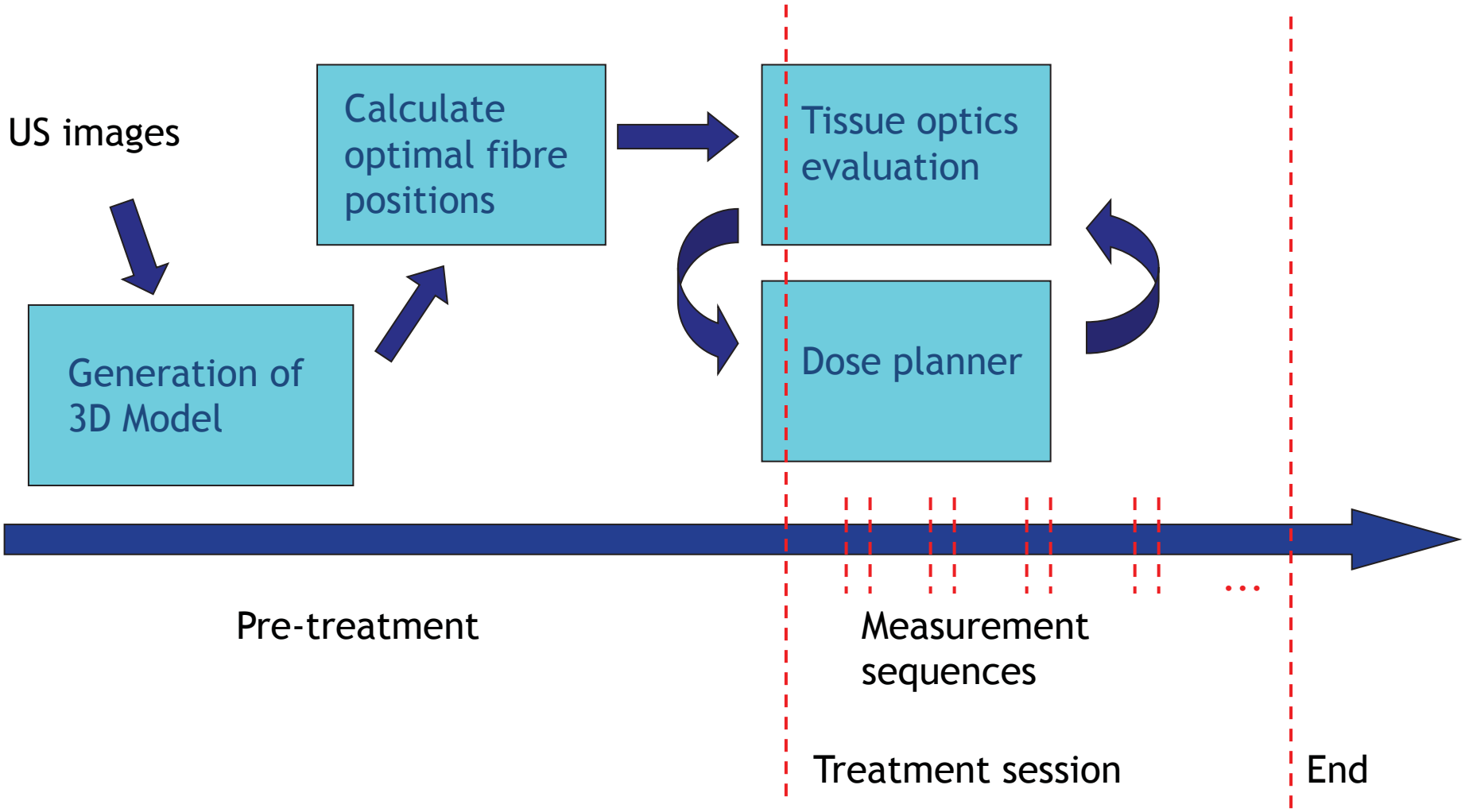
Fiber-based laser therapy system for interstitial PDT

The instrument:

- 18 combined treatment/monitoring fibres
- Therapeutic light: 652 nm for mTHPC
- On-line treatment control based on therapeutic light transmission
- Applied to prostate cancer therapy

In collaboration with SpectraCure AB, Lund

IDOSE – Flow chart



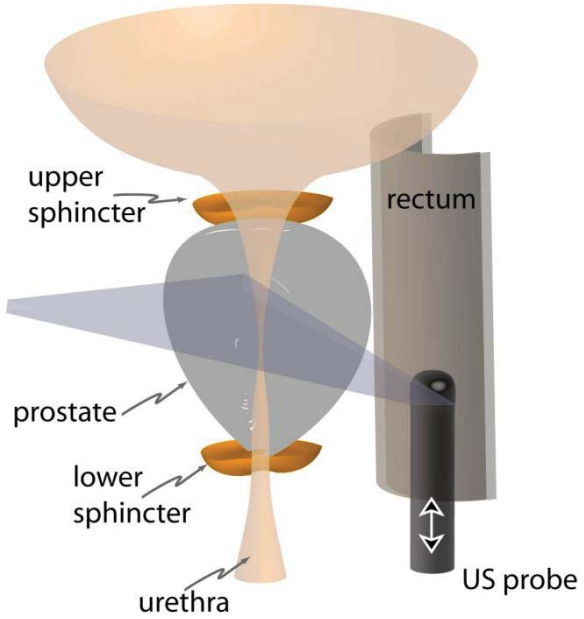
Pre-Treatment Planning

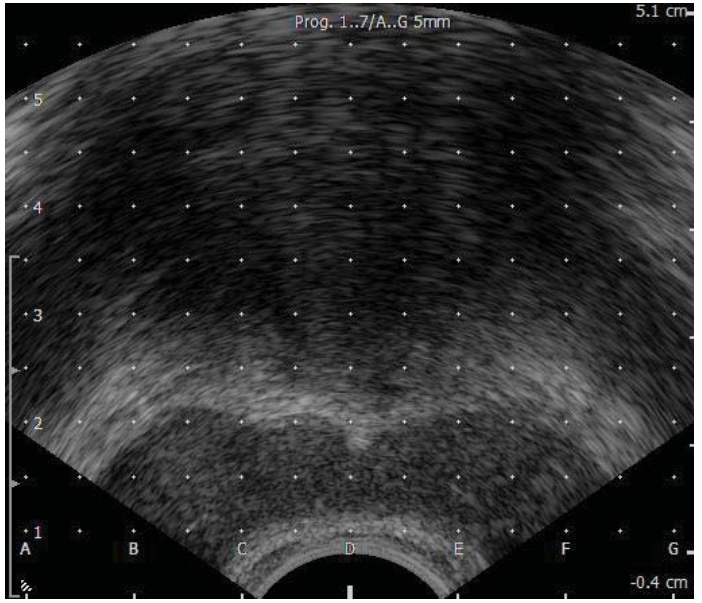
Ultrasound investigation

3D prostate model

Fiber positioning

Johansson et al. Med. Phys. (2008)
Axelsson, Swartling et al. (in press)



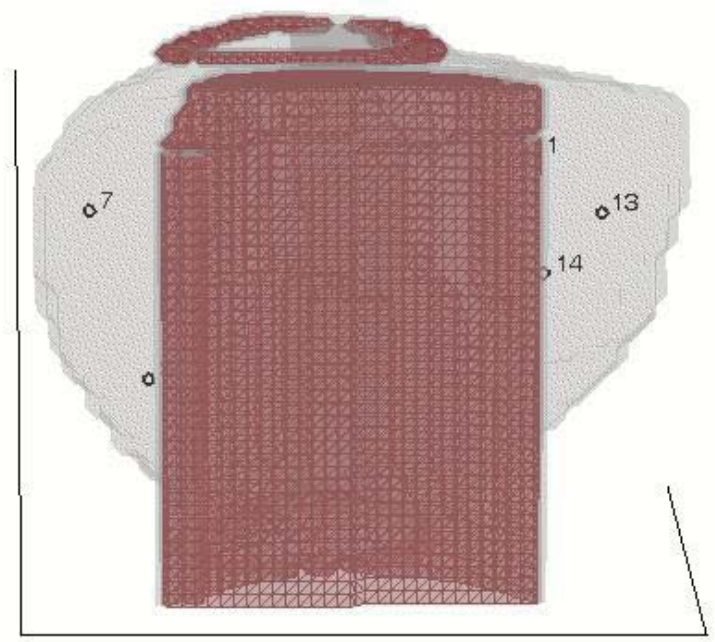


Stefan Andersson-Engels
Johan Axelsson

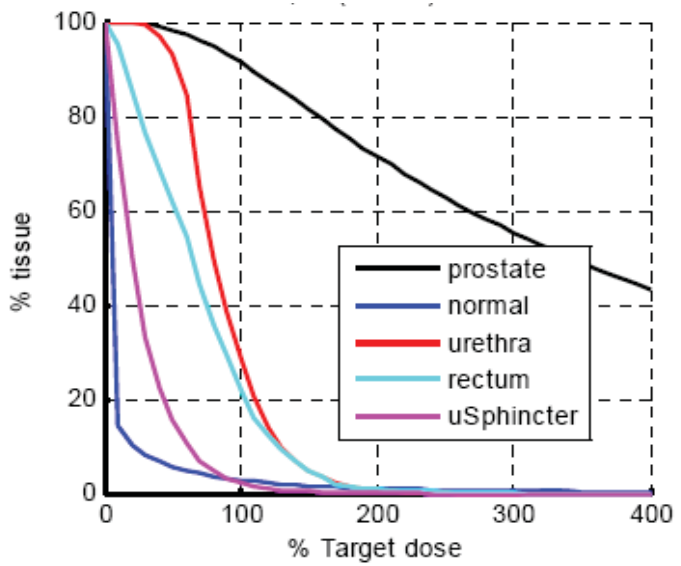
The treatment geometry

Johansson et al. SPIE 5863 (2005)
Johansson et al. Med. Phys. (2008)
Axelsson et al. Opt. Exp. (2007)

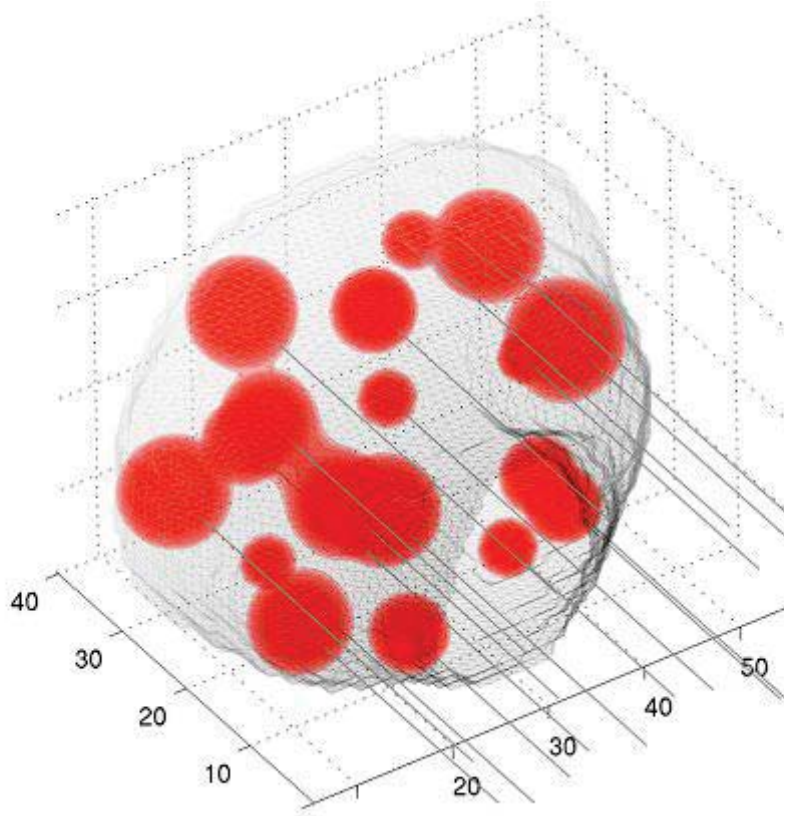
- Optical fibres are **positioned to optimize treatment** of prostate gland with minimal effect on nearby organs at risk
- 18 fibres allow low-resolution **tomographic reconsruction** of the important treatment parameters

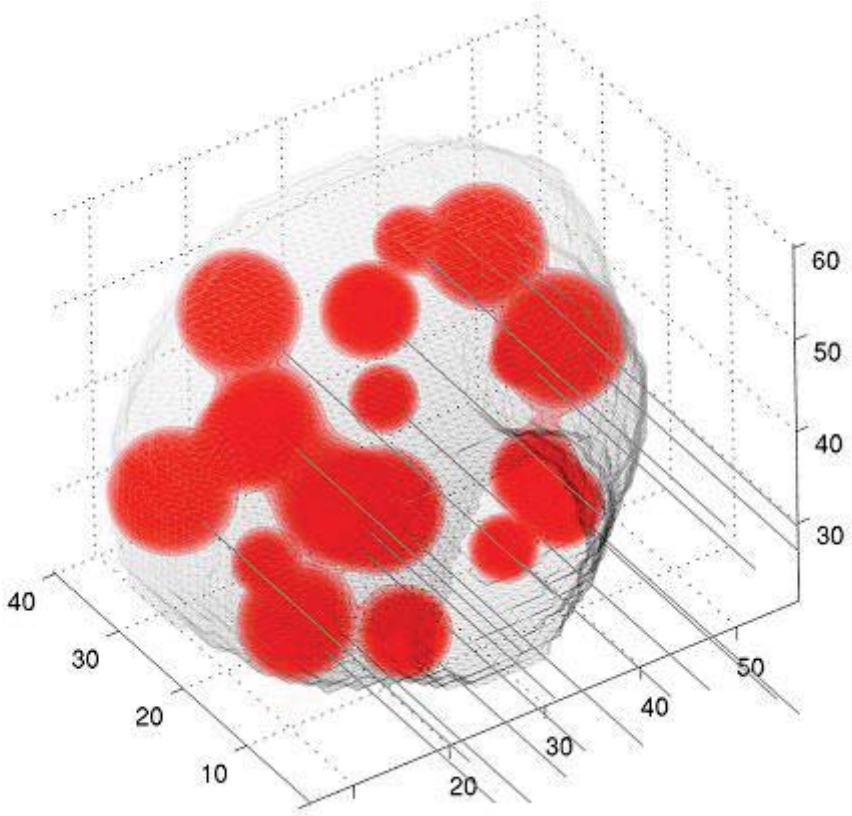


Dose Volume Histogram

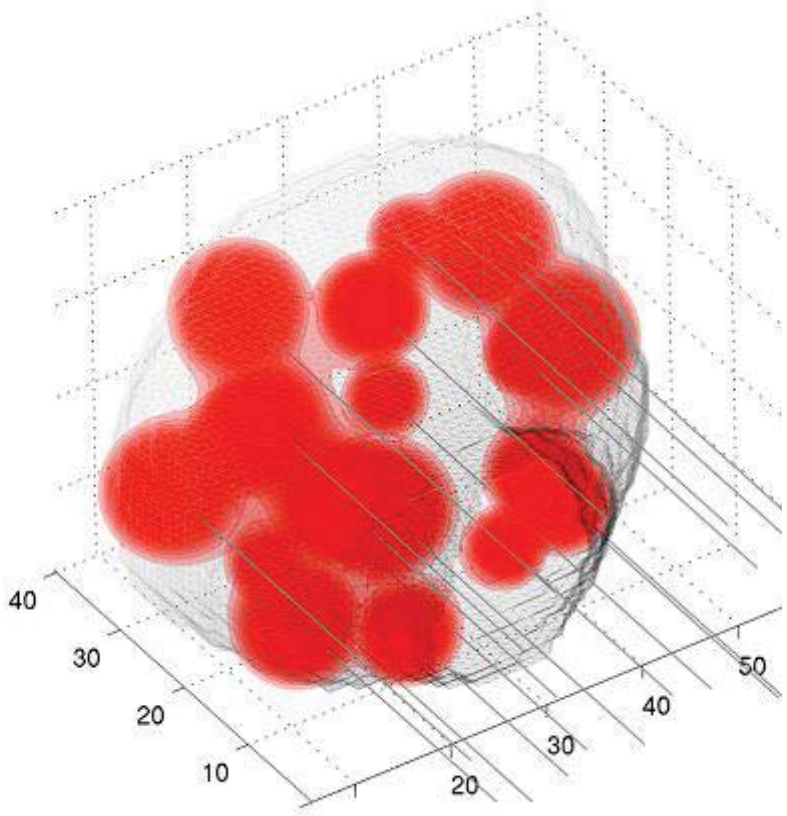


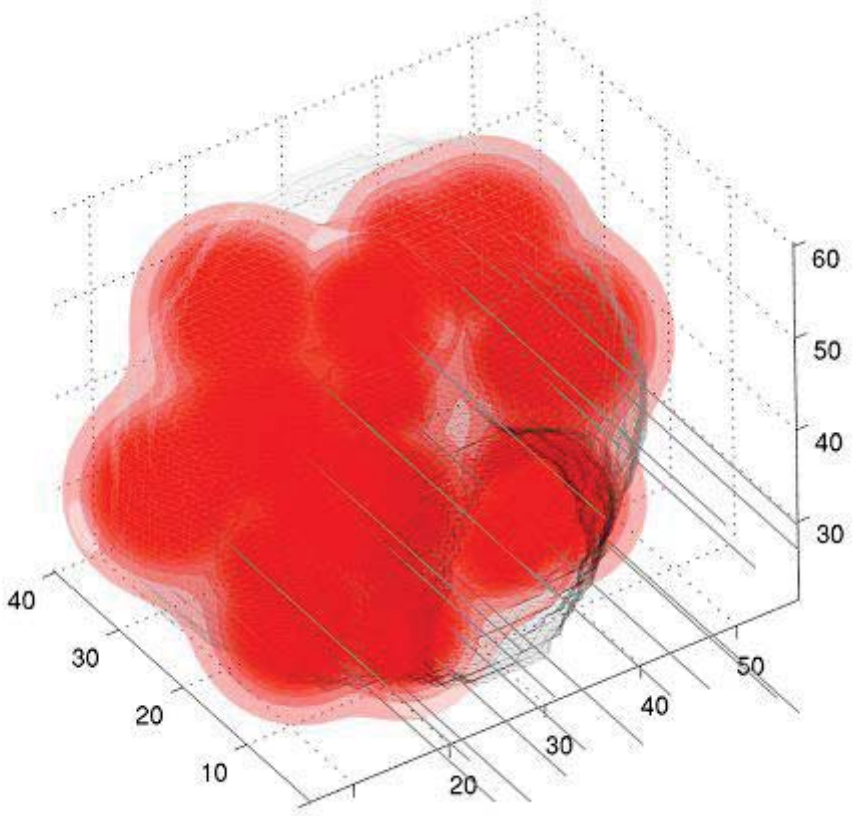
Stefan Andersson-Engels
Johan Axelsson



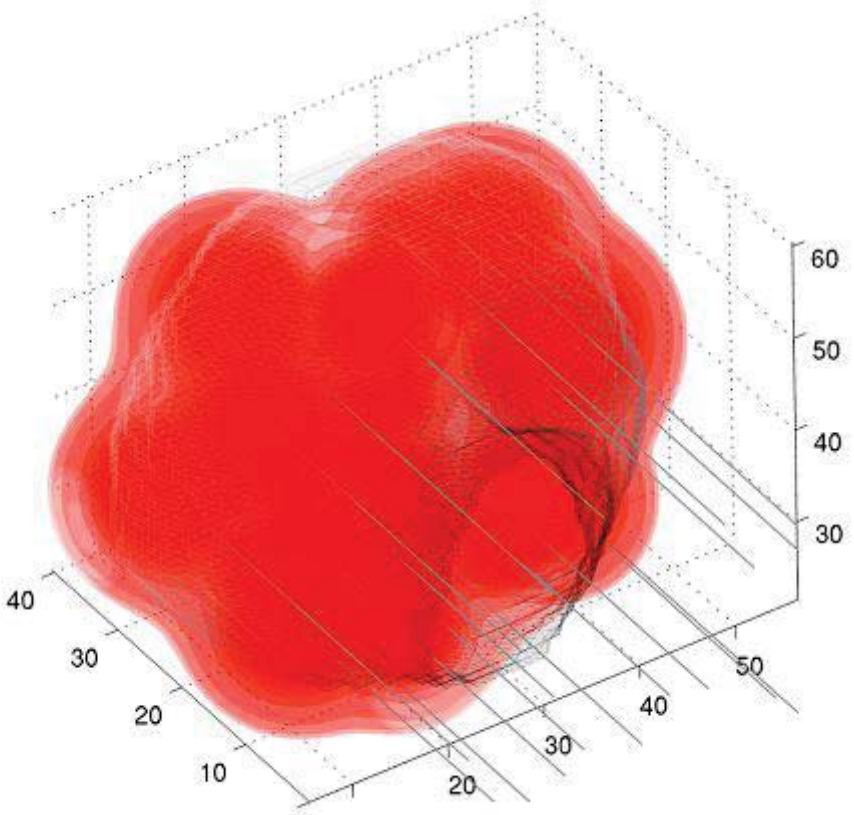


SpectraCure

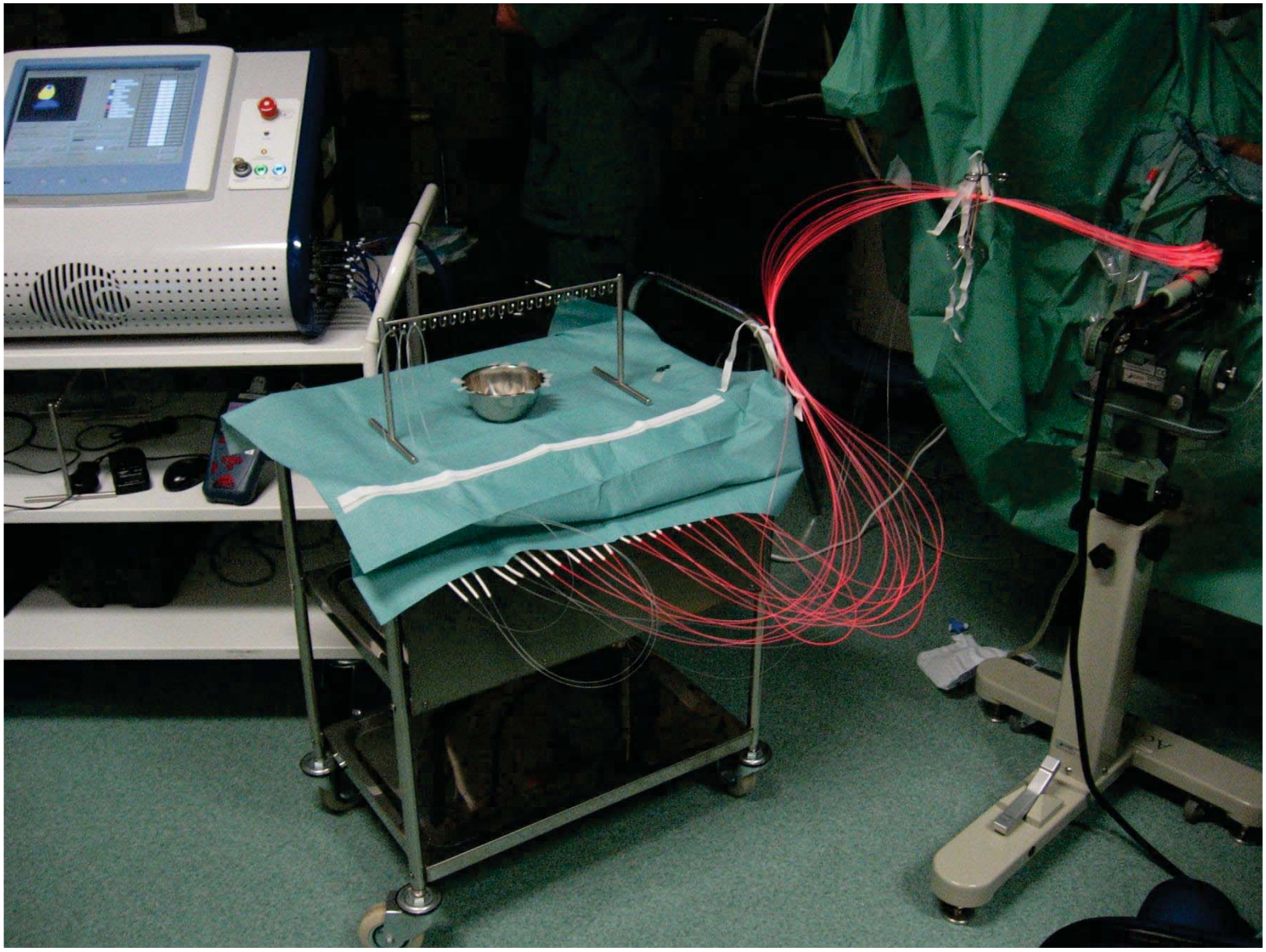




SpectraCure



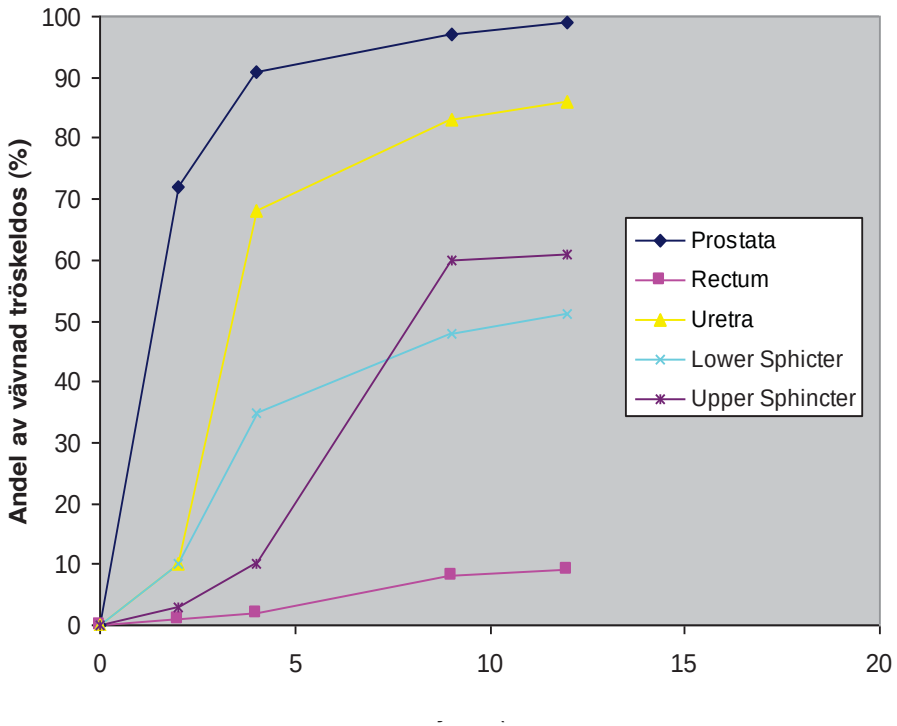
SpectraCure



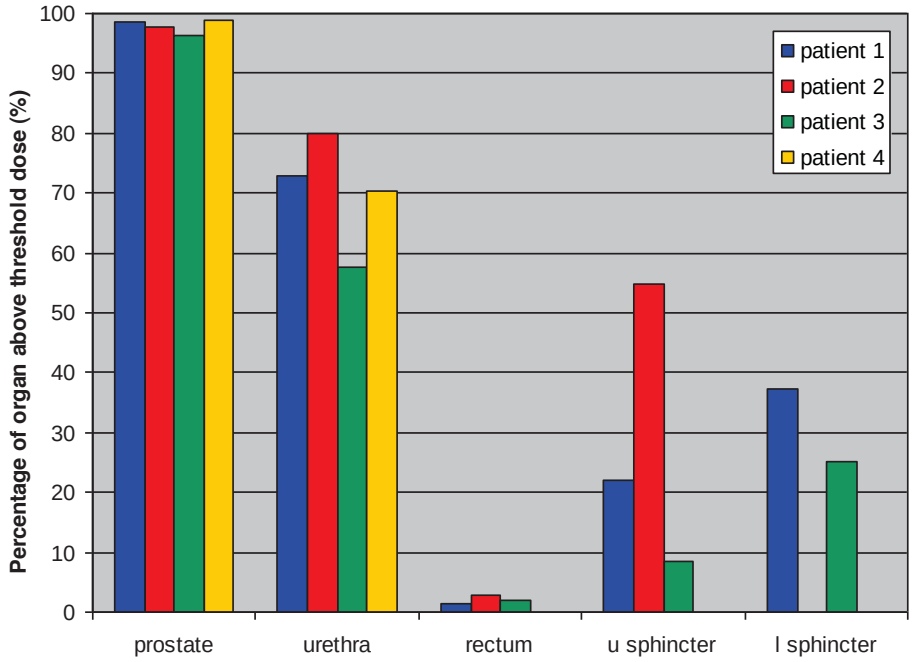
SpectraCure

Results - dosimetry

The treshold dose for each tissue type /%)

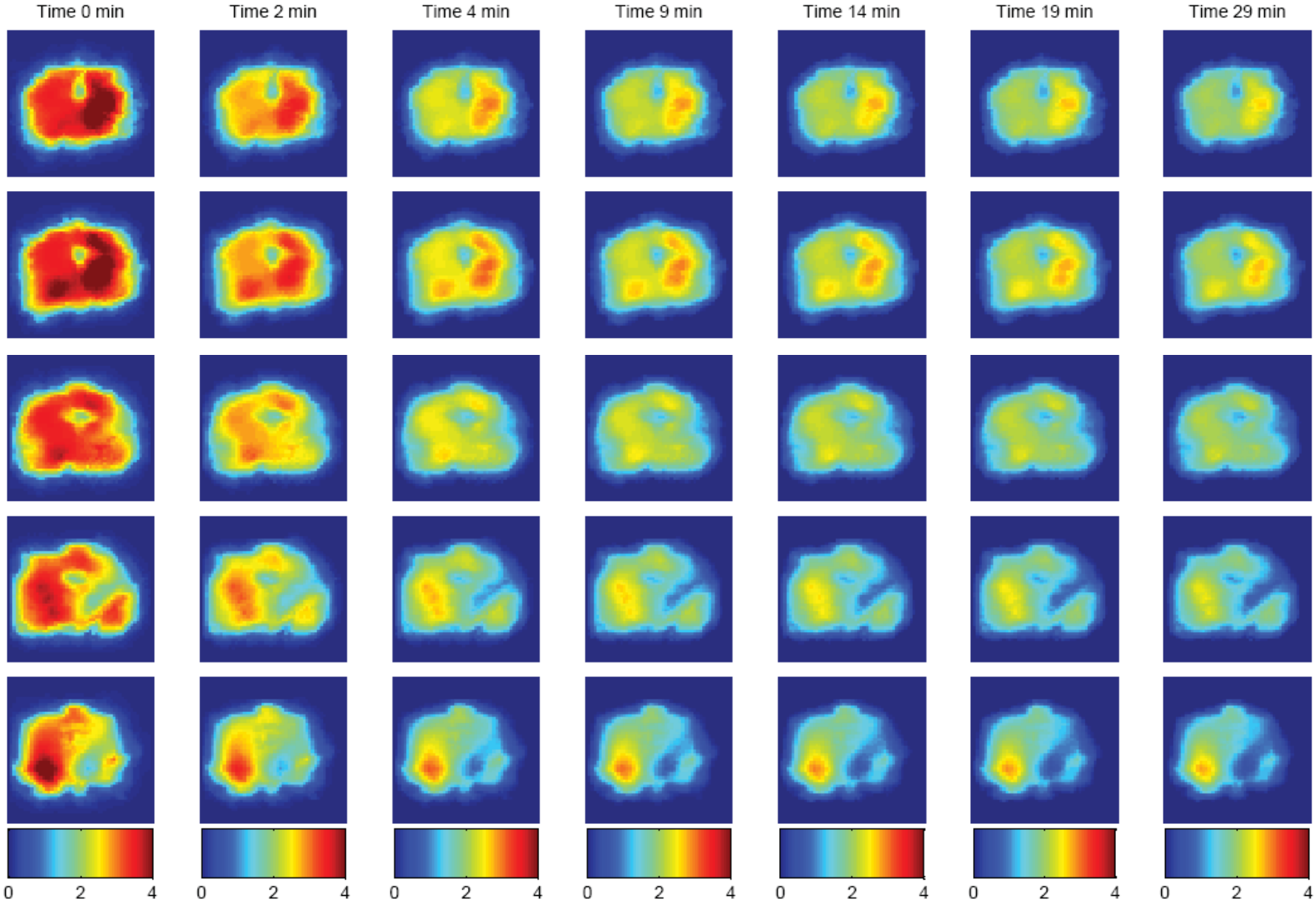


Laser illumination time (min)

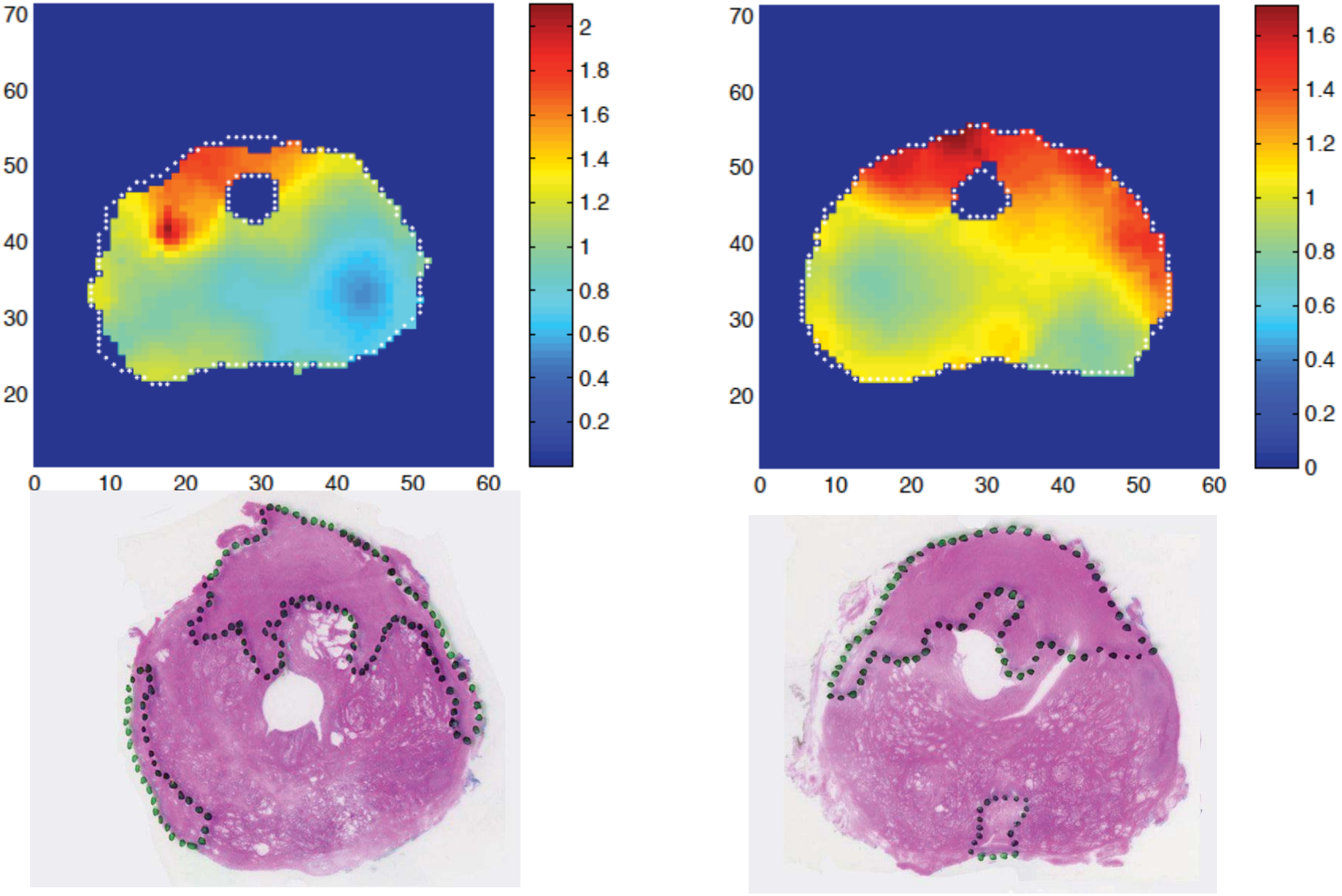


Tissue type	Acc. limit
prostate	>95
urethra	<90
rectum	<80
u sphincter	<80
l sphincter	<50

3 D mapping of the fluorescence of the sensitiser Foscan in the treated prostate gland



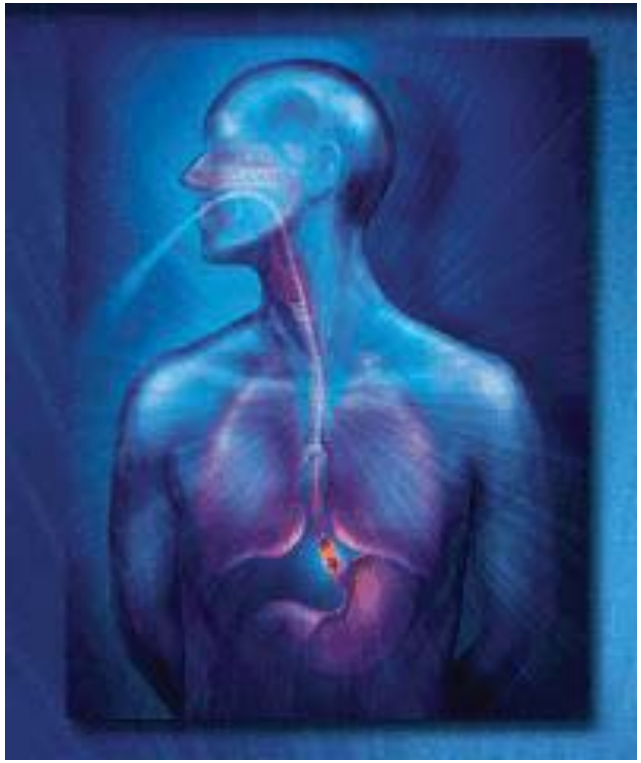
Correlation in between sensitiser content & histopathological outcome



Challenging indication for PDT

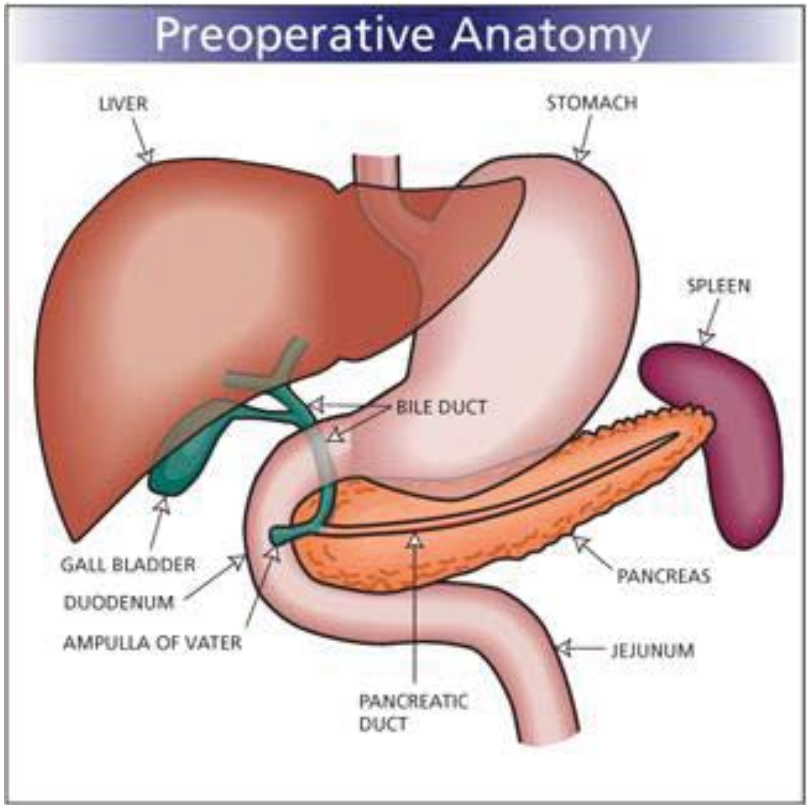
Barrets Oesophagus

- A precancerous condition for adenocarcinoma
- Caused by GERD
- The alternative is mechanical mucosectomy

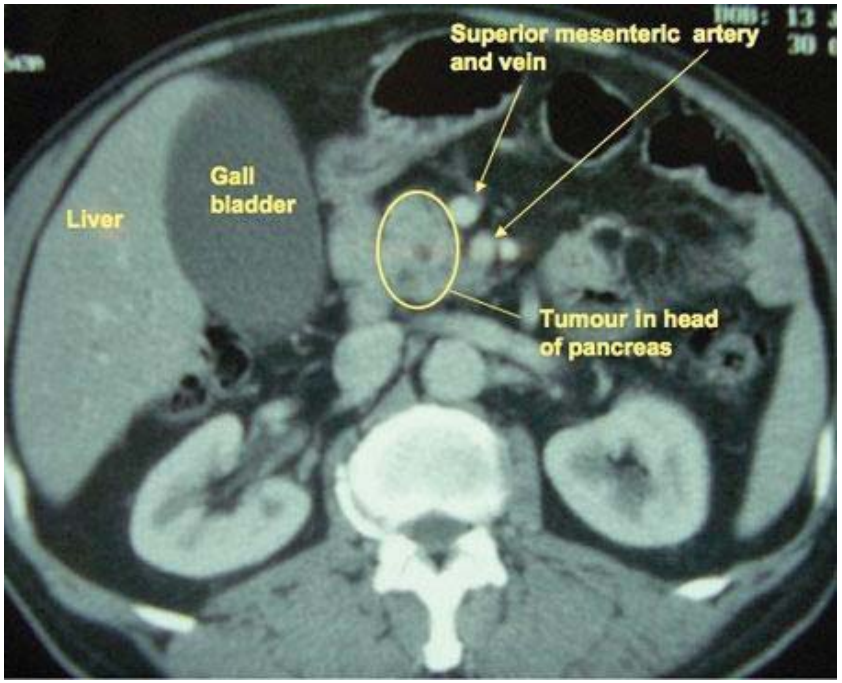


Challenging indication for PDT

Pancreas cancer

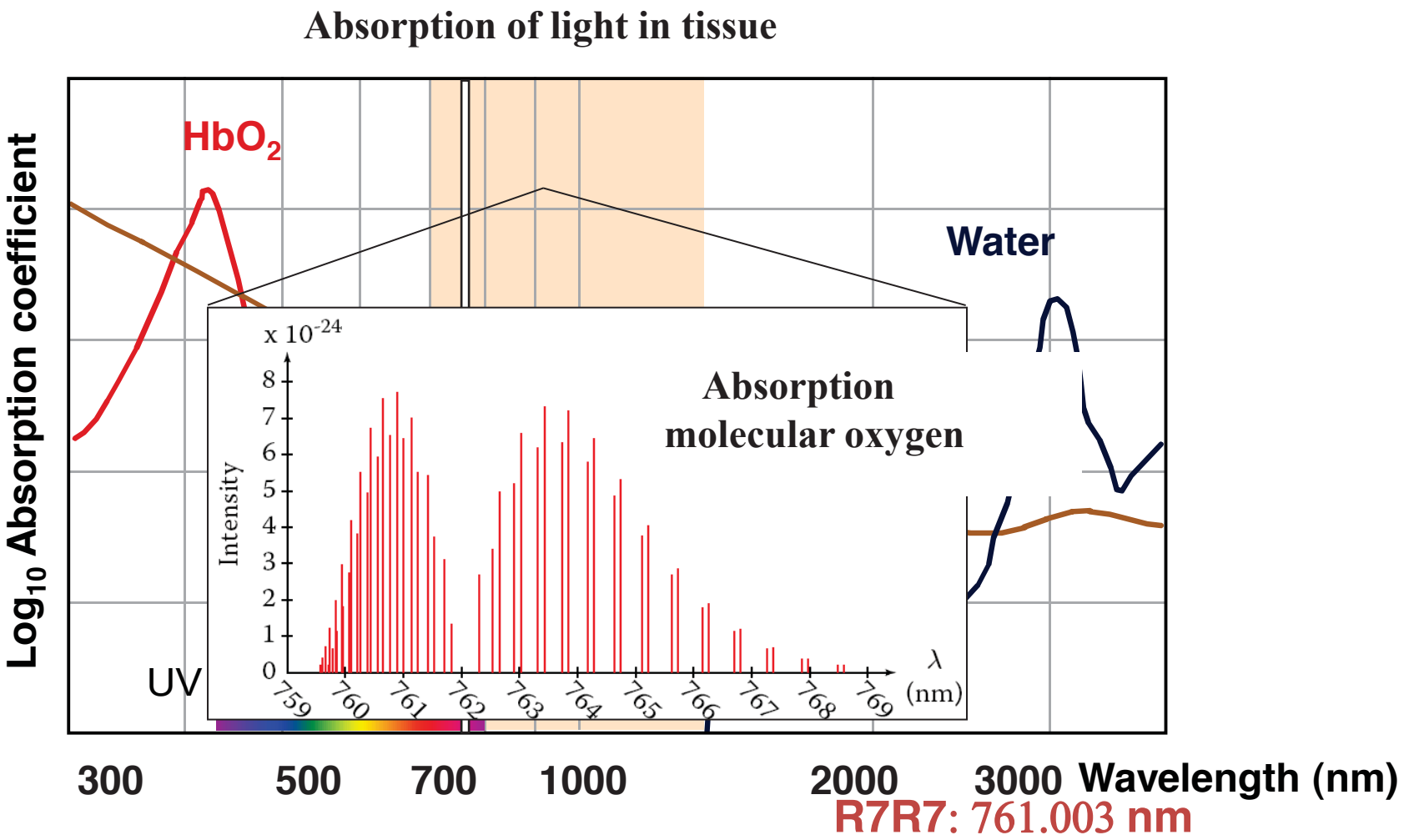


- Poor prognosis
- Late diagnosis
- 10-15% are operable at diagnose
- To shrink the tumour
- To make the tumour operable

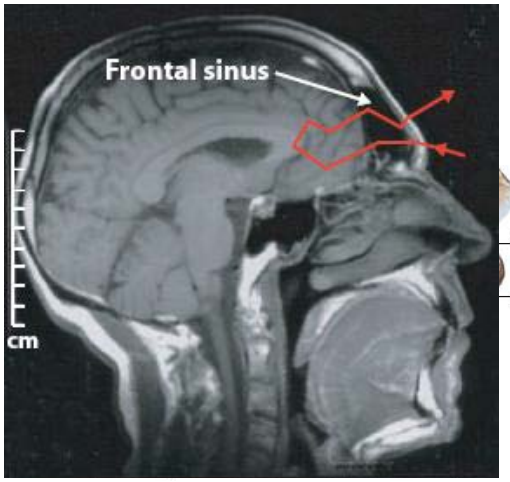


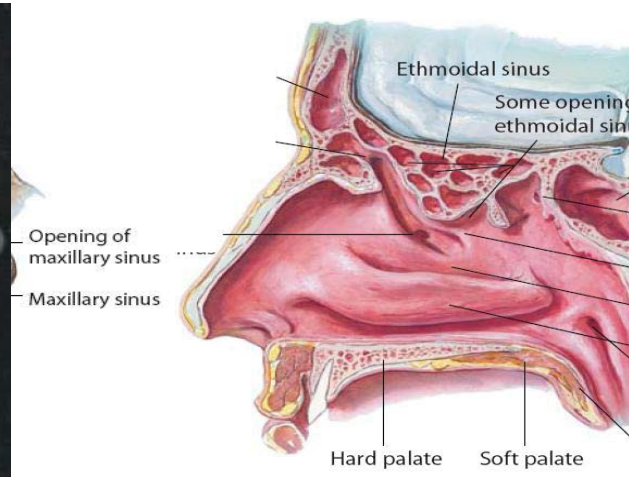
Clinical, laser-based, fluorescence diagnostics and photodynamic therapy of a malignant tumour.
Insert: Endoscopic view of the vocal cords (left) and the same view with a colour-coded fluorescence image superimposed (right). The yellow area indicates the presence of a squamous cell carcinoma.

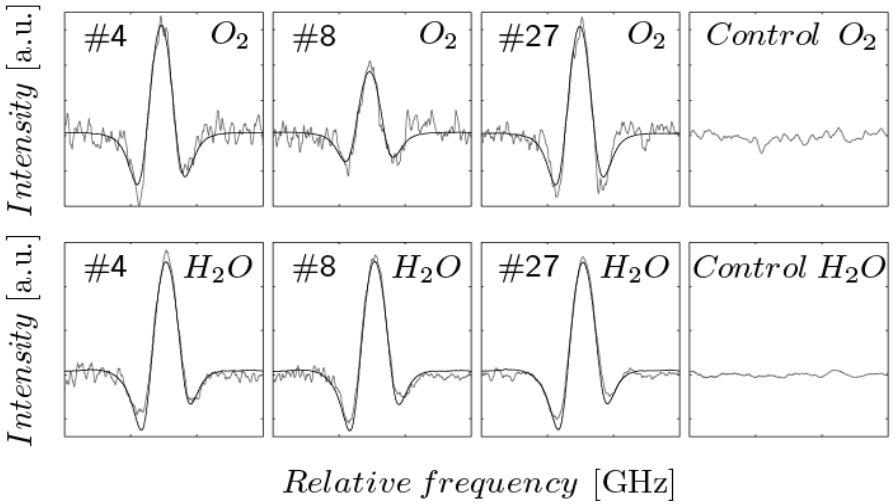
Tissue Absorption

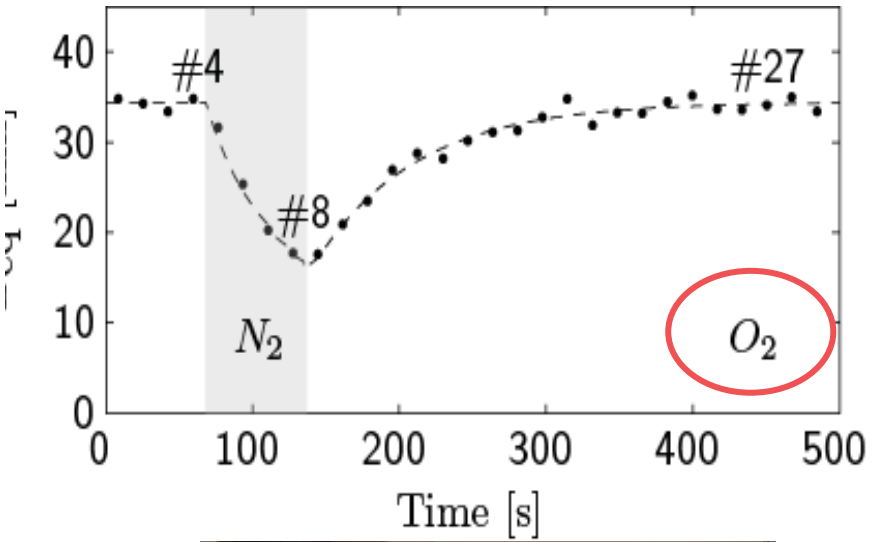


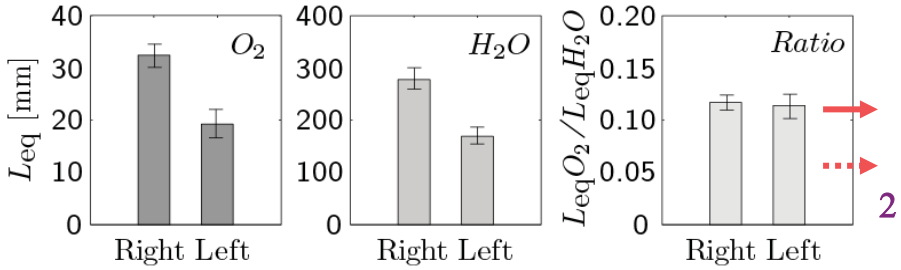
Sinusitis diagnostic by laser-spectroscopic measurement of oxygen and water vapour

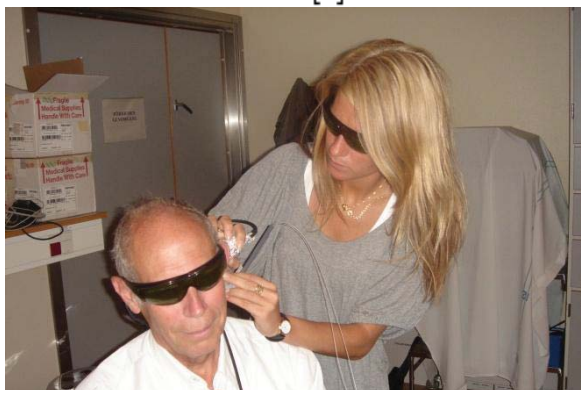




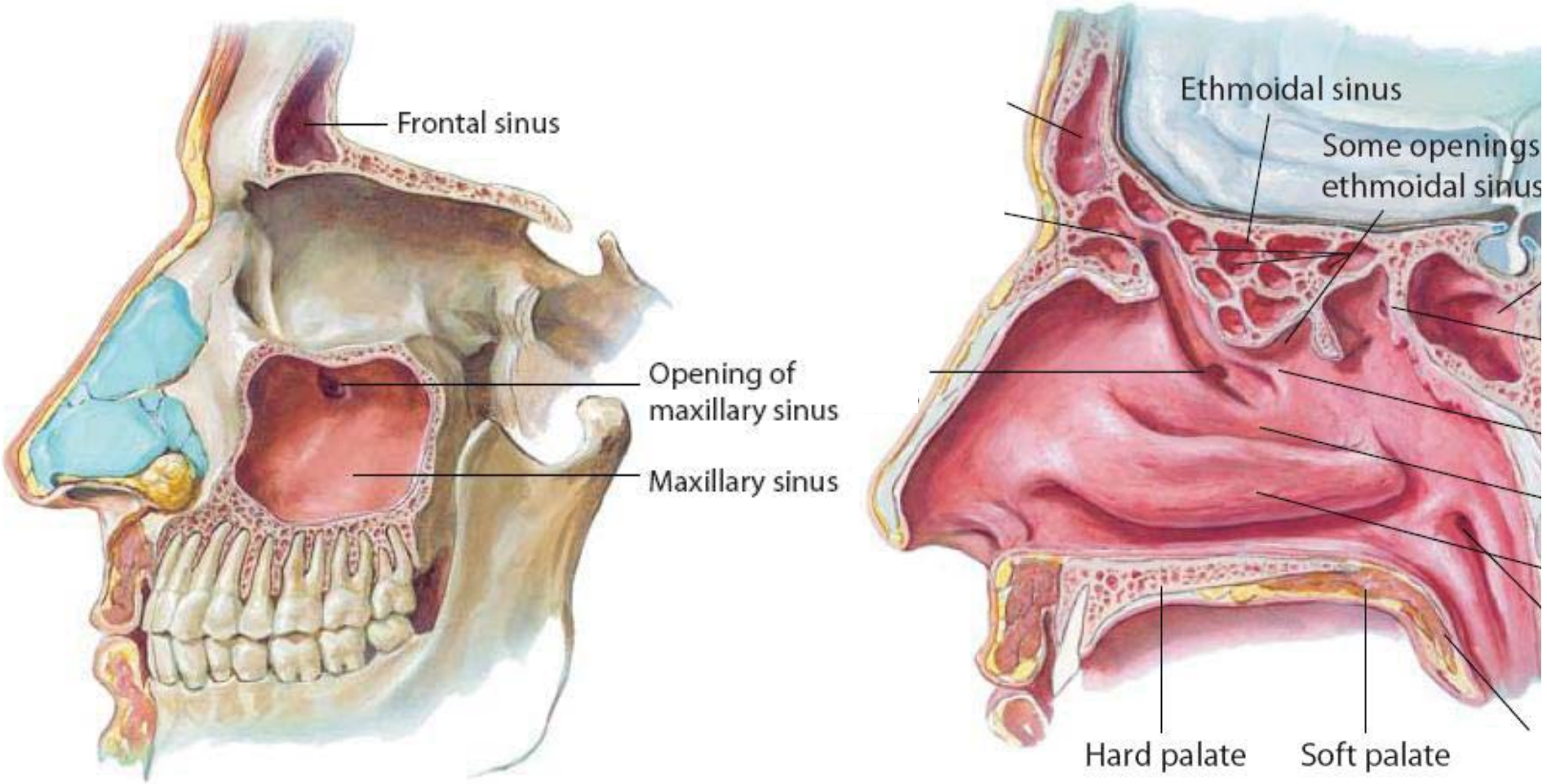








Gas in Scattering Media Absorption Spectroscopy (GASMAS) for paranasal sinus detection



Paranasal sinuses

Sinusitis: Inflammation in the paranasal sinuses

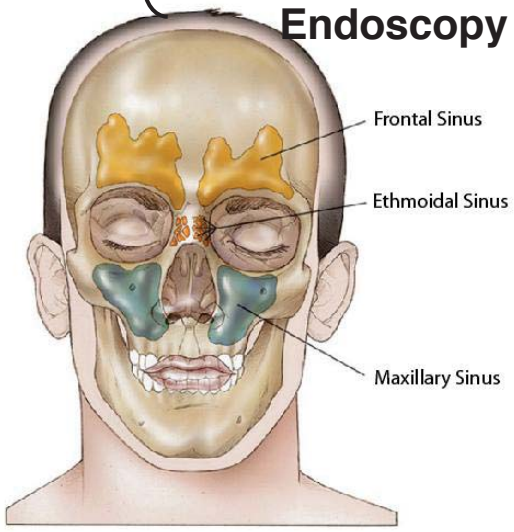
Common disease

No easy diagnostic tool available

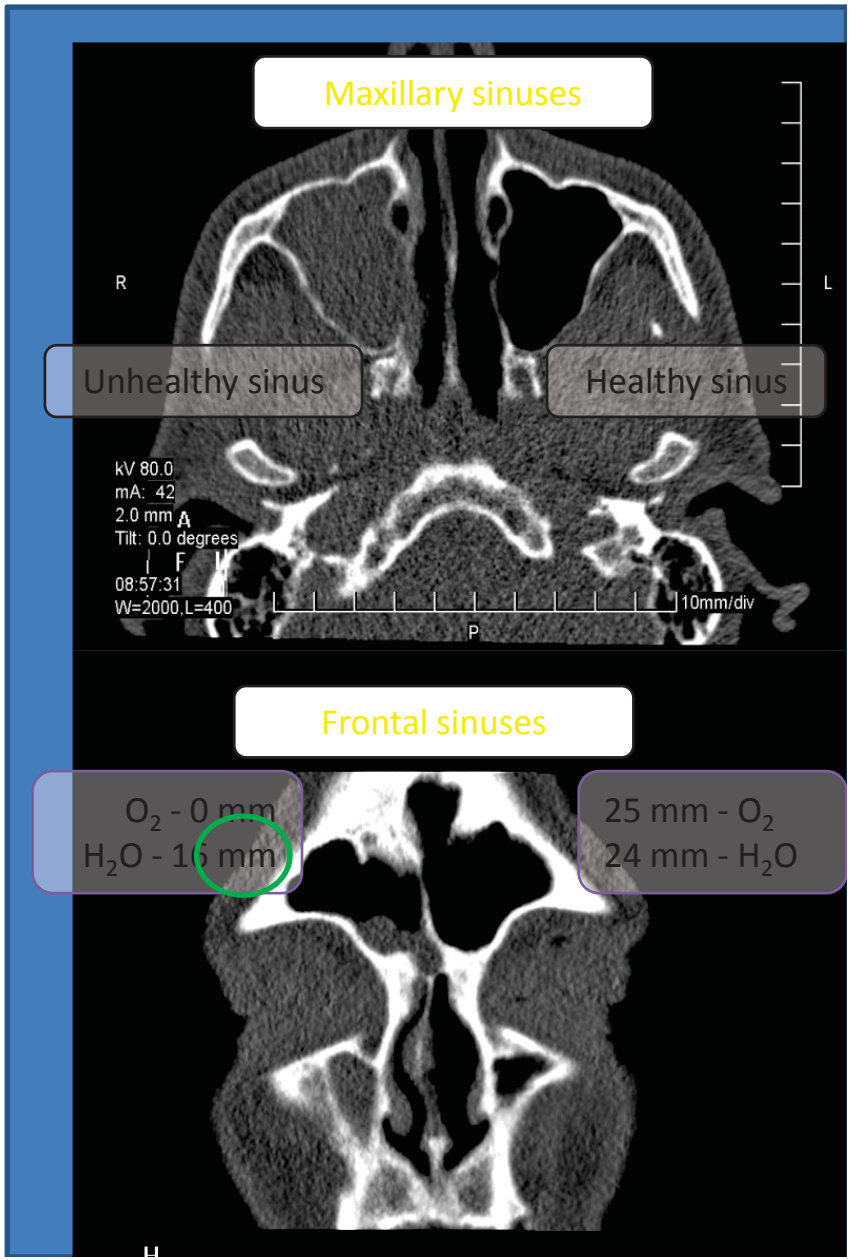
Obstruction & blockage

Diagnostic methods

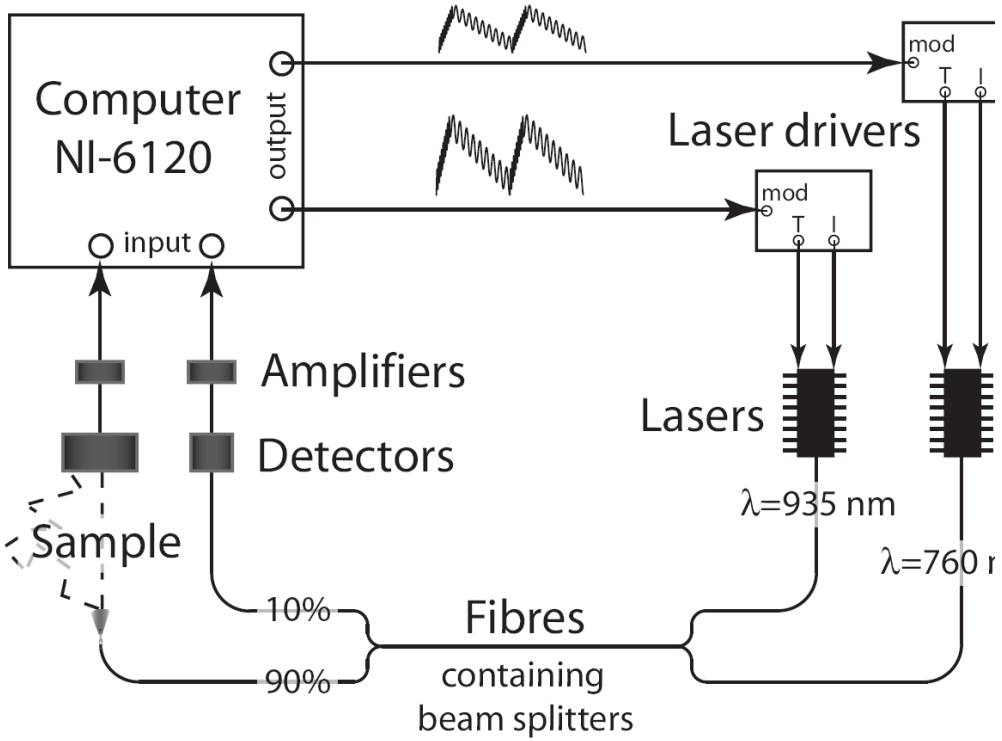
- **Clinical examination**
- **Computer tomography**
- **Endoscopy**

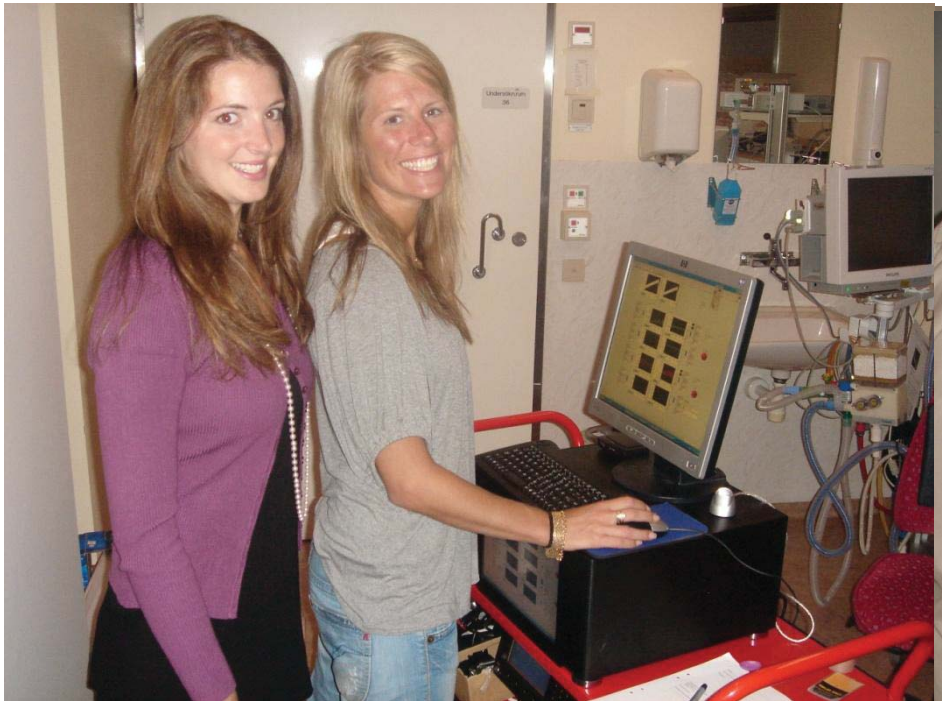


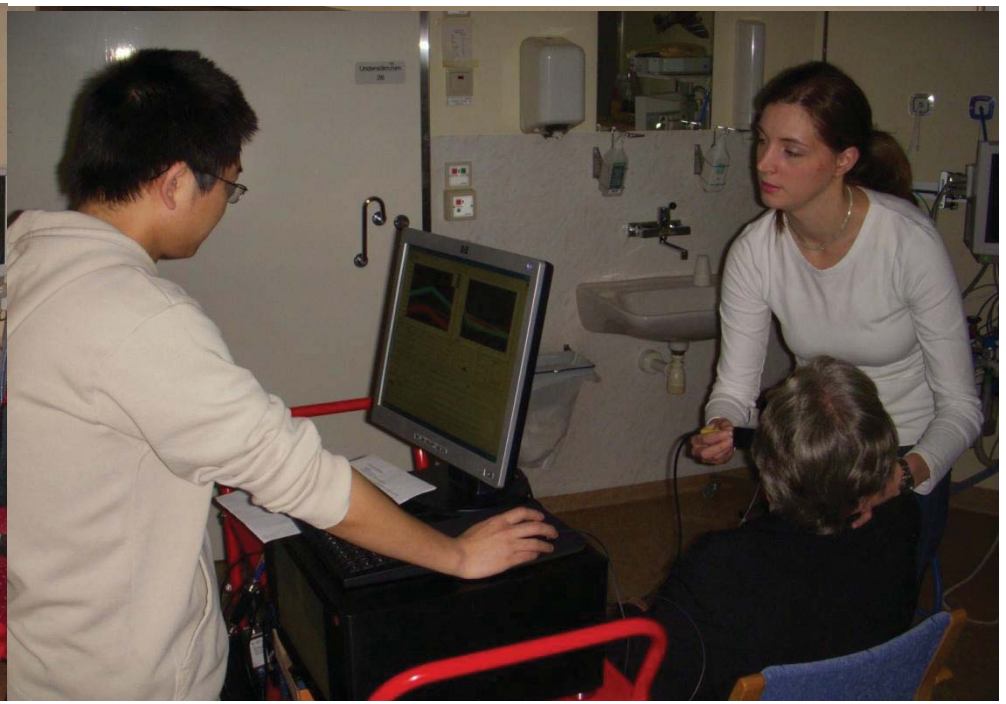
Lewander et al.



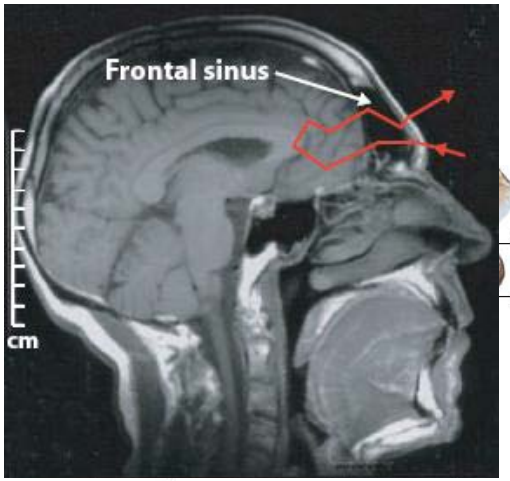
Clinical trial on 40 patients referred to CT scanning

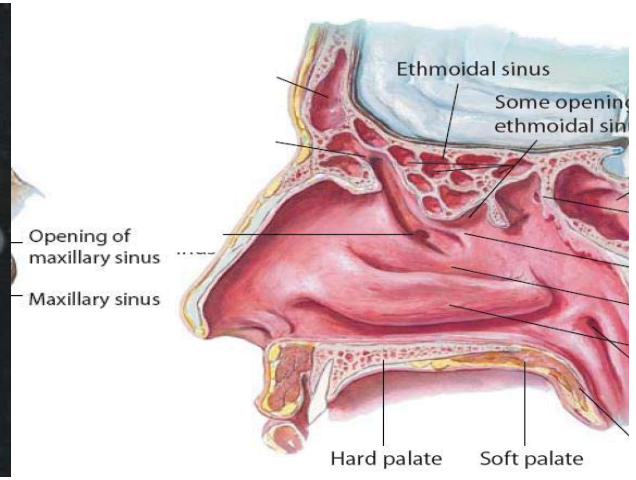


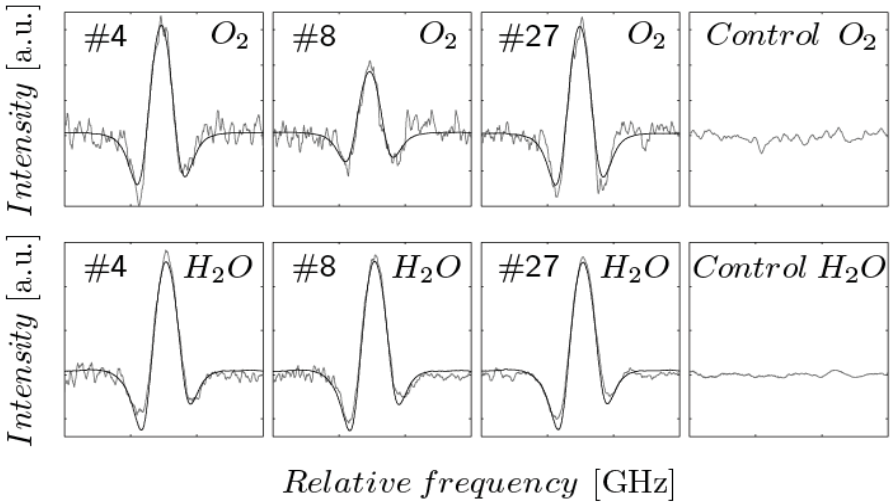


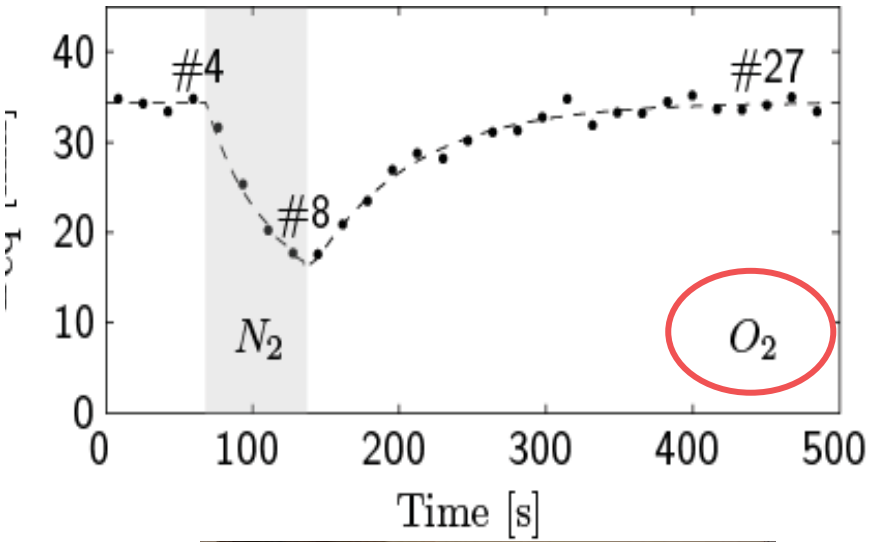


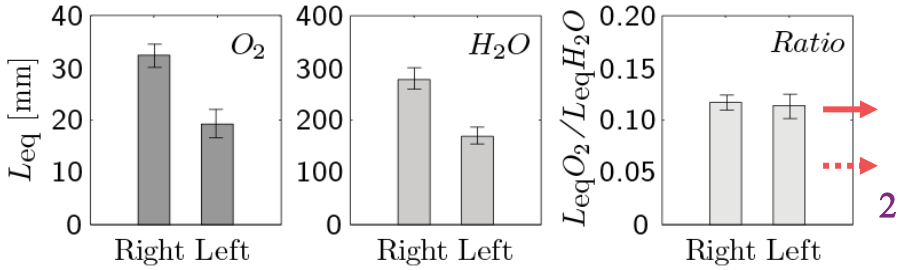
Sinusitis diagnostic by laser-spectroscopic measurement of oxygen and water vapour

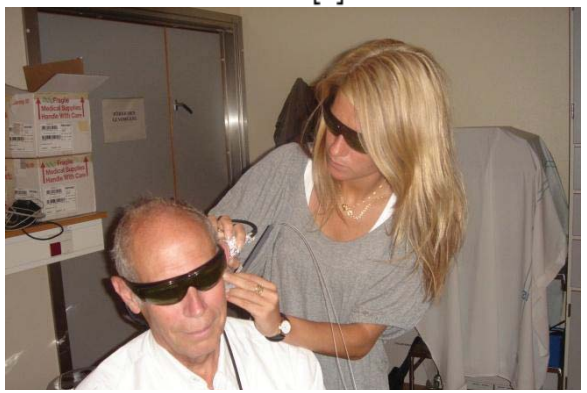


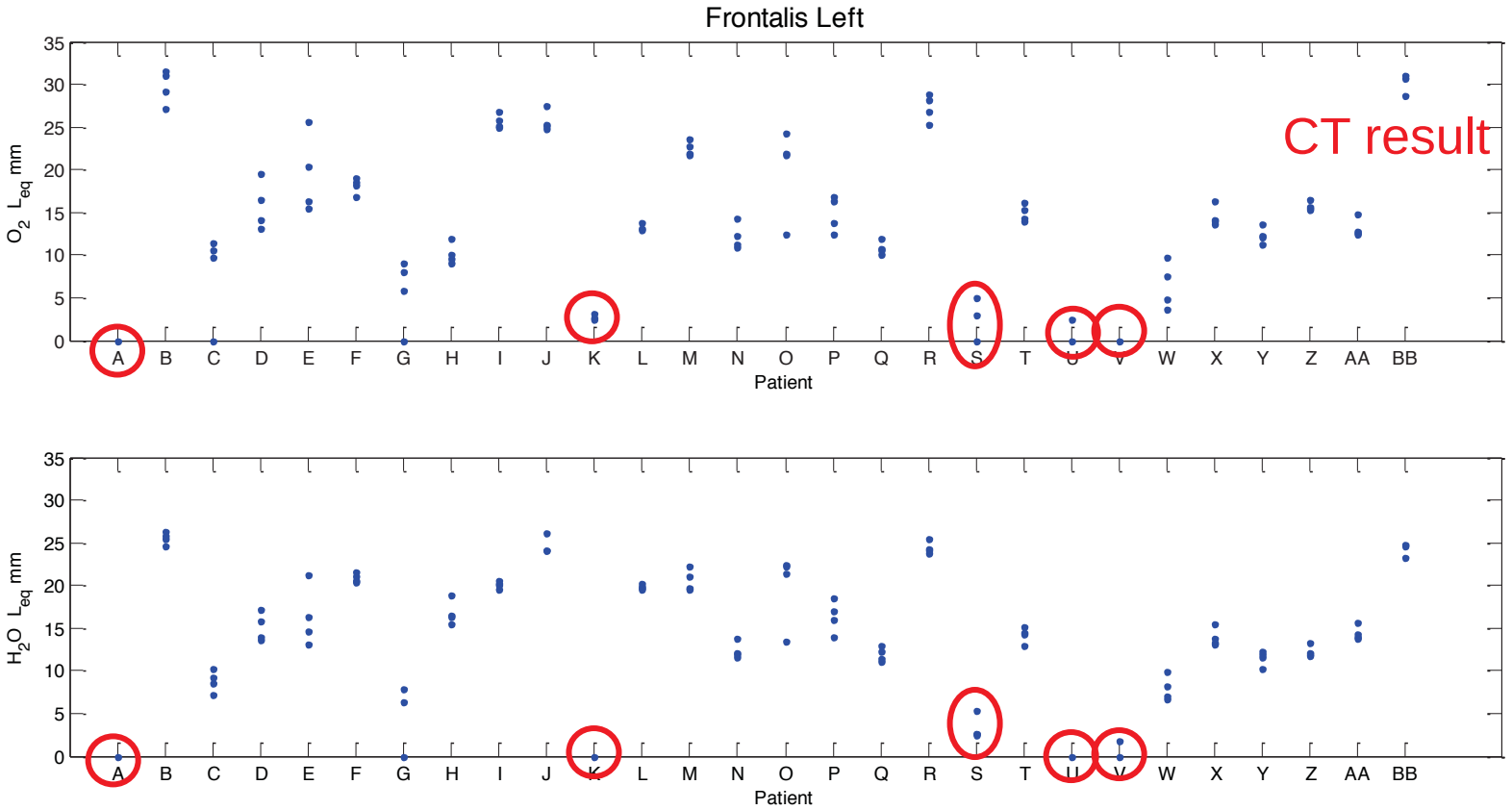












GASMAS correlation to CT scan results

Lewander et al. 2009

Pediatrics and Neonatology

Clinical challenges ~ 24 h non-invasive surveillance
Spectroscopic techniques

Spectroscopic techniques ~ as compared to conventional techniques for surveillance

Back ground in detection of sinusitis with GASMAS
Gas in Scattering Media Absorption Spectroscopy

Lund University
Medical Laser Centre

Preterm born babies

- Born before the 37th week of pregnancy
- 8-10% of all pregnancies in the US
- Not fully developed organs

-in particular the lungs

- Low weight

Preterm born babies

Respiratory distress syndrome (RDS)

- a breathing disorder
- more often if born ≥6 weeks early
- 50% week 26-28; 25% week 30-31
- lack of alveoli liquid coating - surfactant
- collapse of the lung alveoli
- insufficient oxygen saturation
- damage to organs
  - in particular the brain

Preterm born babies

Respiratory distress syndrome (RDS)

Conventional surveillance of the babies:

Blood sampling for oxygen gas analysis
X-ray-based investigations (CT)

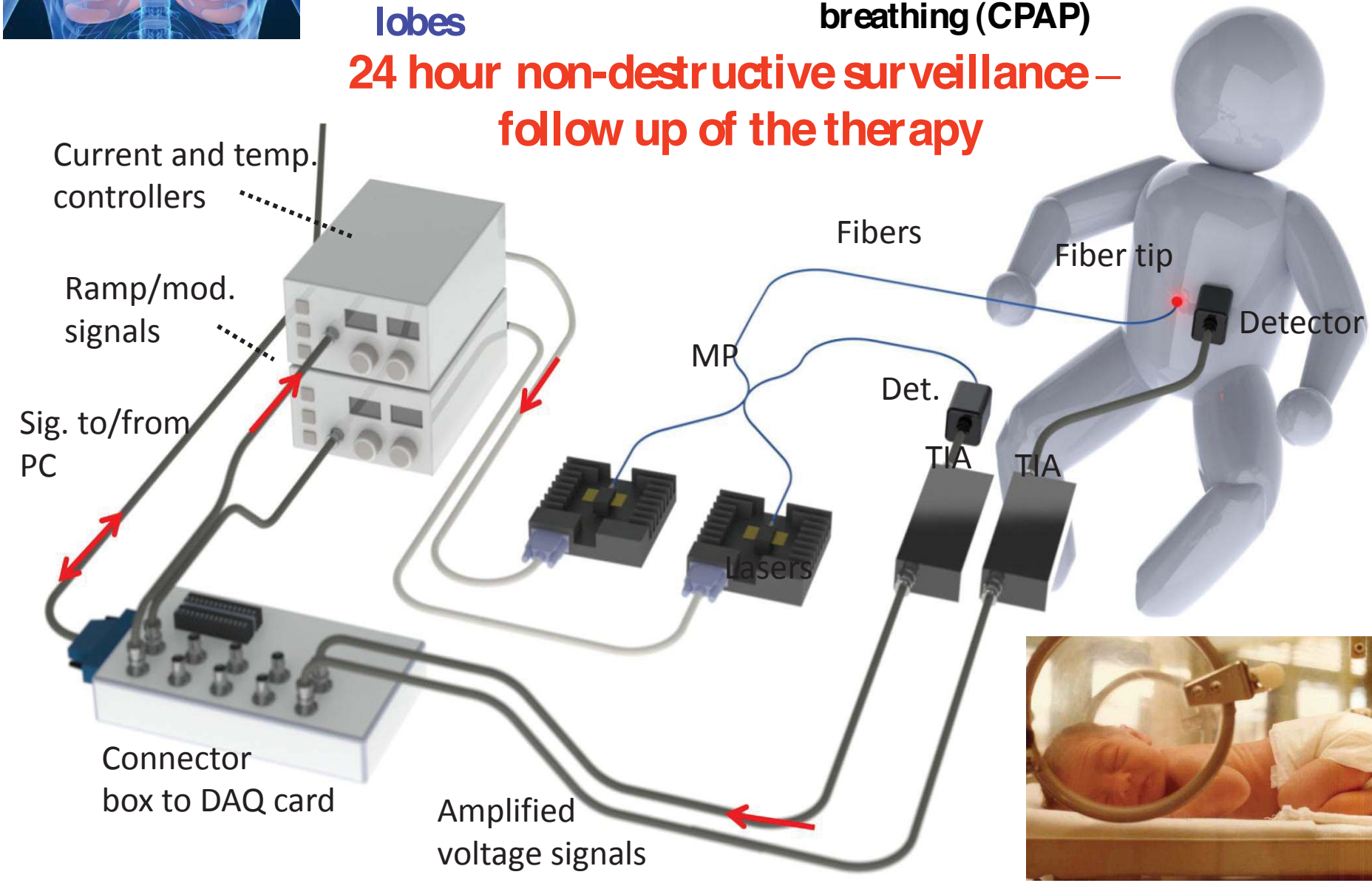
The spacial distribution of the air/O_2 in the lung lobes

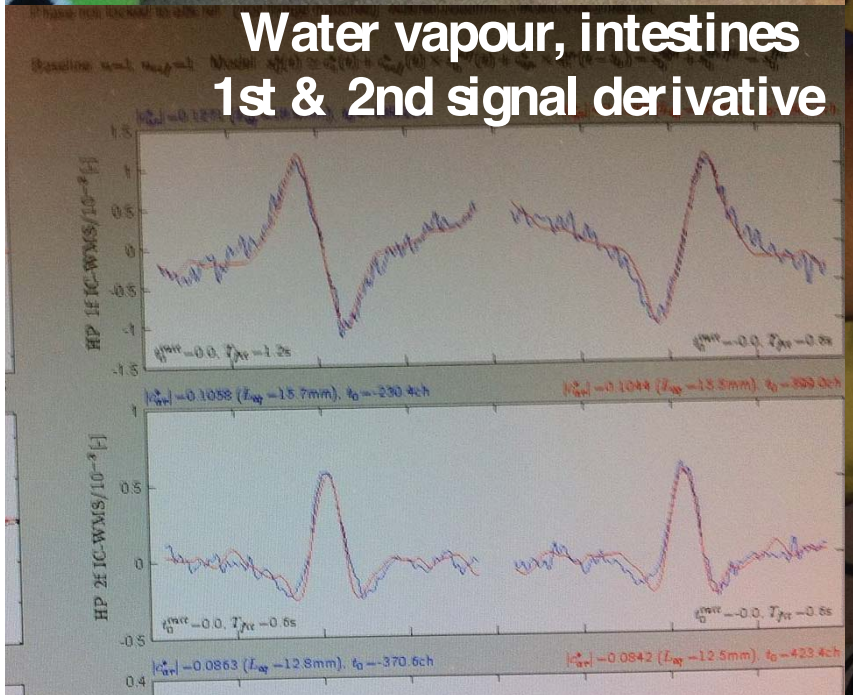
GASMAS

Therapy of the pre-term infants with RDS

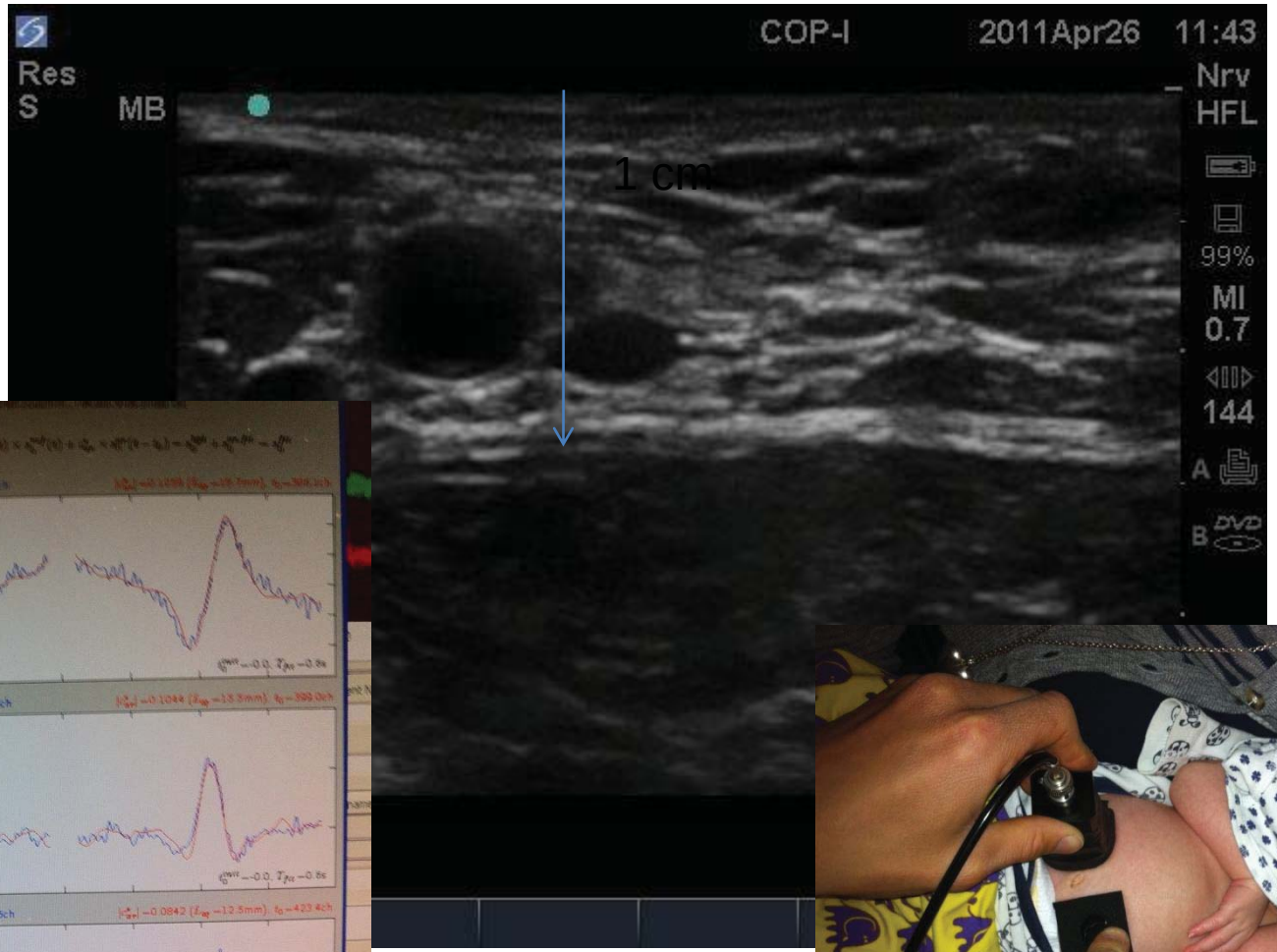
1. **Artificial surfactant to the lungs**
2. **Warm moist oxygen**
3. **Continous Positive Airway Pressure breathing (CPAP)**

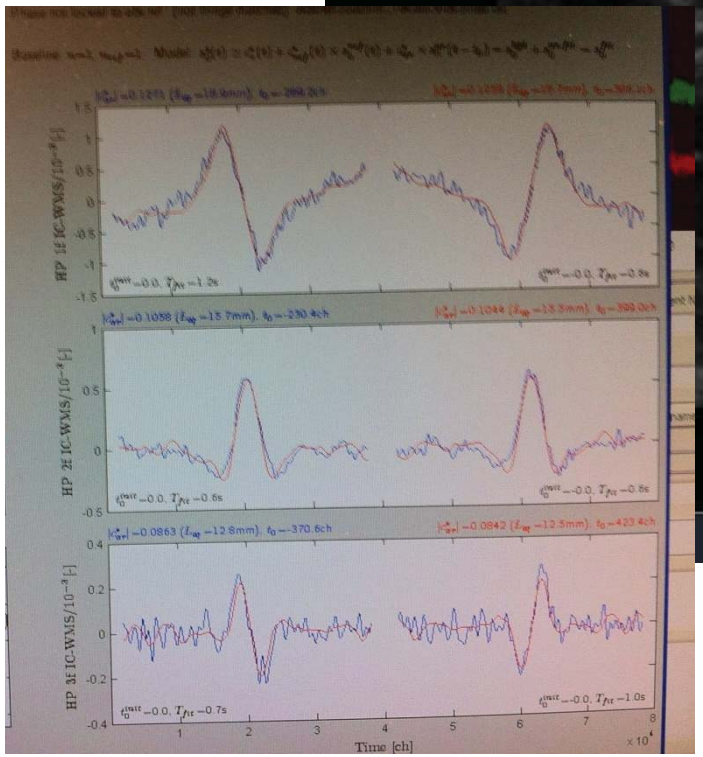
24 hour non-destructive surveillance – follow up of the therapy




Water vapour, intestines
1st & 2nd signal derivative

Ultra sound image taken over the stomach area with the intestines (2 weeks old non-preterm baby)





Science certainly brings people together!

Arbetet fortsätter i Lund och i Kina!

The sun rising up over the mountains at Lago Maggiore, Stresa