NACIONĀLAIS ATTĪSTĪBAS PLĀNS 2020

EIROPAS SAVIENĪBA
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ĪEGULDĪJUMS TAVĀ NĀKOTNĒ

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Towards the Scalable Cloud Platform for Non-Invasive Skin Cancer Diagnostics

Lead. researcher, Dr.sc.ing. Dmitrijs Bļizņuks

Riga Technical University

Faculty of Computer Science and Information Technology

13th International Young Scientist conference “Developments in Optics and Communications”

6 April 2017

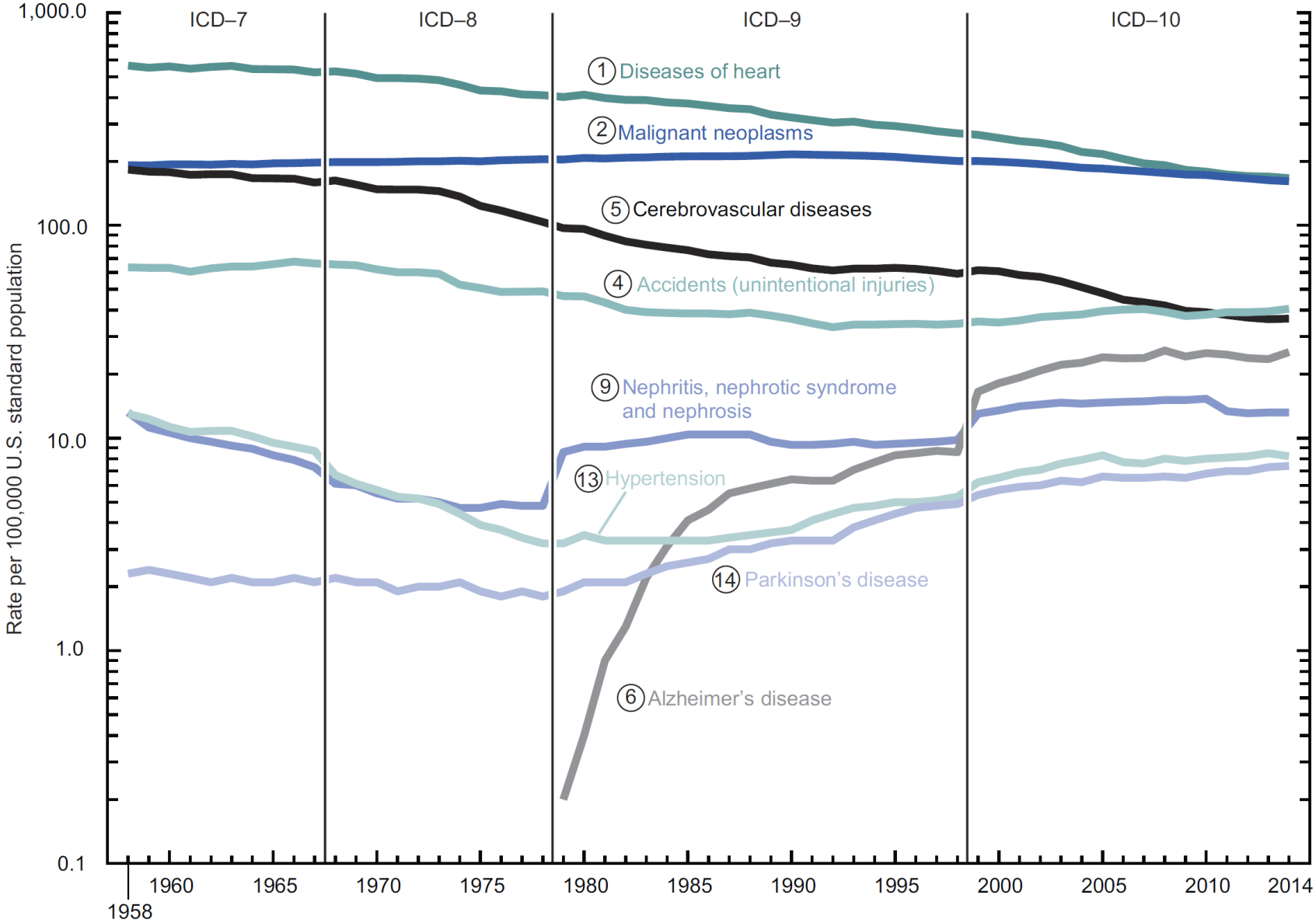
Outlines

- Background
- Skin cancer
- Existing devices and approaches
- Proposed architecture
- Challenges and future plans

Background

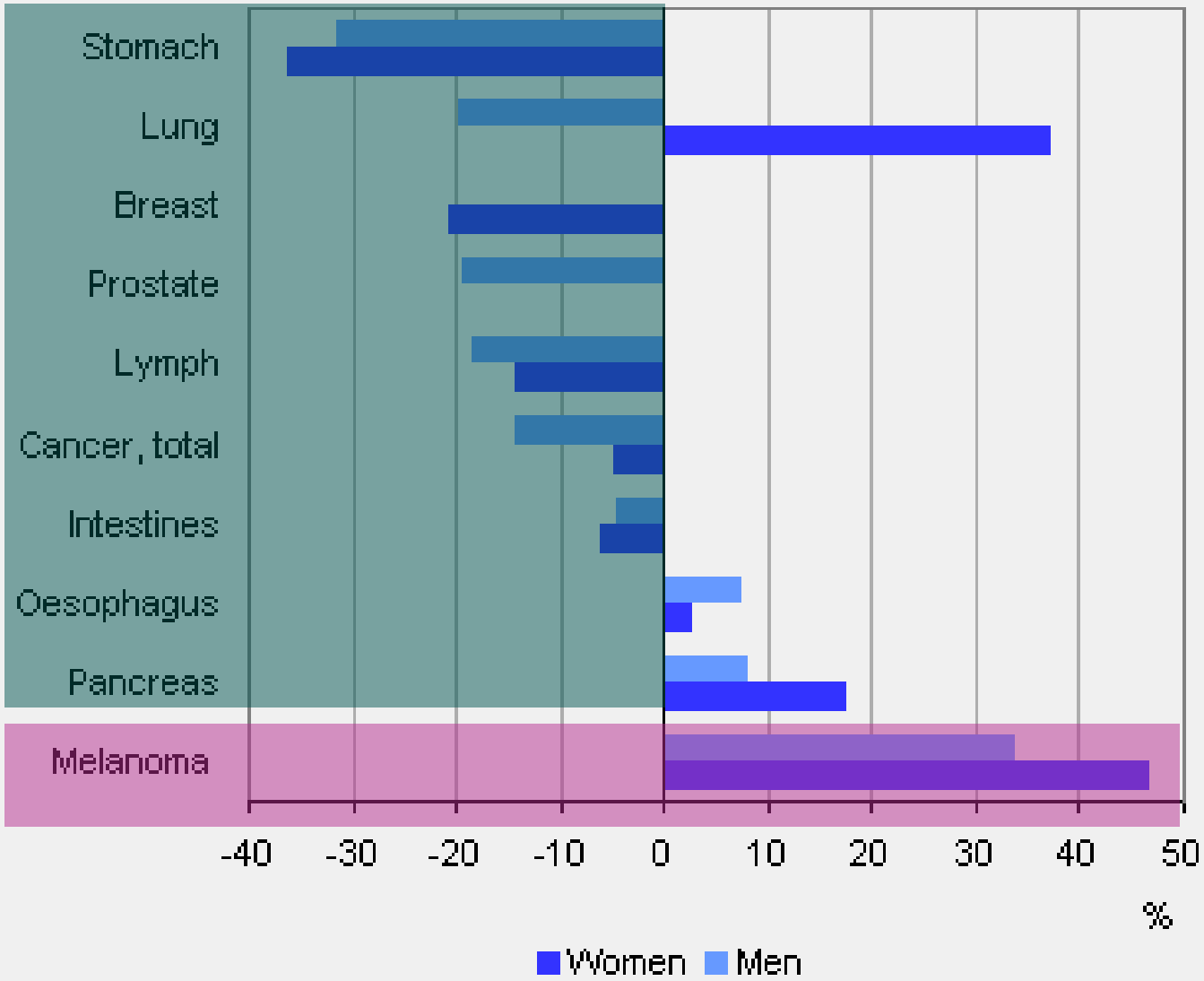
- PhD in Engineering, thesis "*Applying Sensor Networks Technologies in Time Critical Applications*"
- Research interests in wireless networks, embedded systems and industrial automation
- Cooperation with Biophotonics laboratory (Latvian Univertsity) from 2013 in the field of skin cancer diagnostics
- Ongoing project with Biophotonics laboratory "*Portable Device for Noncontact Early Stage Skin Cancer Diagnostics*"

Age-adjusted death rates for selected leading causes of death: United States, 1958–2014



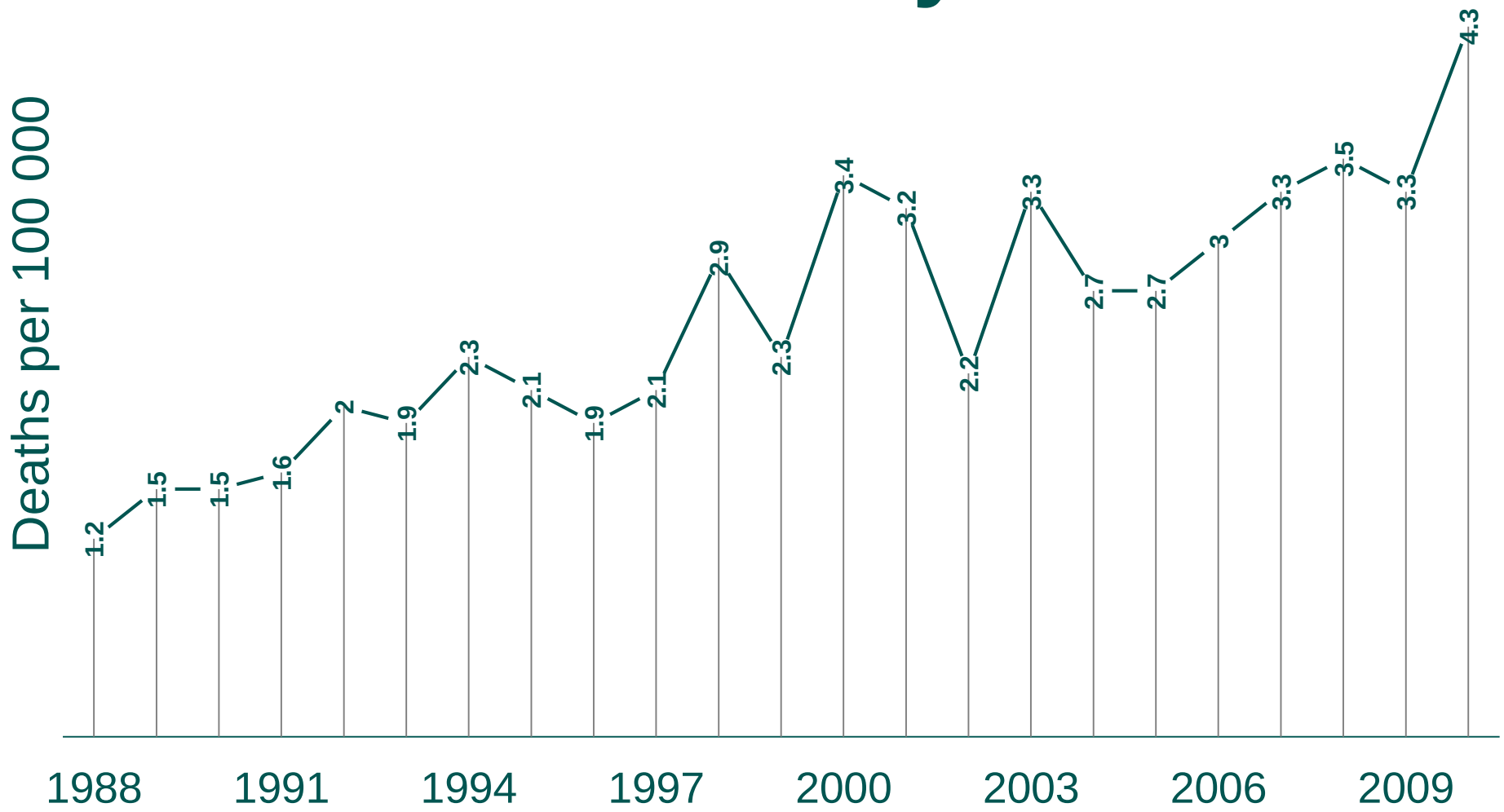
NOTES: ICD is the *International Classification of Diseases*. Circled numbers indicate ranking of conditions as leading causes of death in 2014.
SOURCE: NCHS, National Vital Statistics System, Mortality.

Changes in the risk of dying from cancer, 2010 relative to 2000

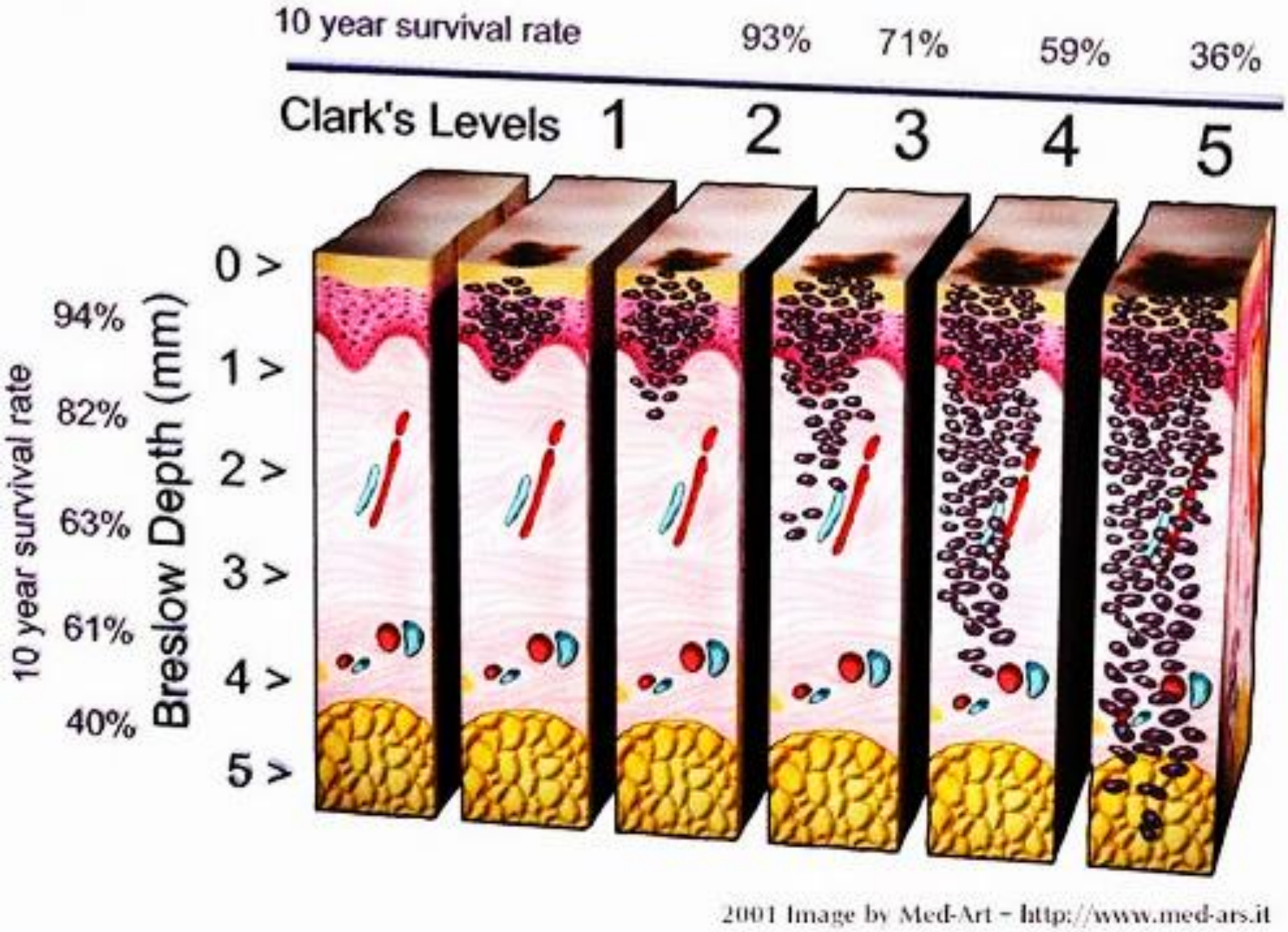


Source: CBS

Melanoma mortality rate



K. Azarjana, A. Ozola, D. Ruklisa, I. Cema, A. Rivosh, A. Azaryan, and D. Pjanova, "Melanoma epidemiology, prognosis and trends in Latvia," J. Eur. Acad. Dermatol. Venereol. 27(11), pp. 1352-1359, November 2013


10 year survival rate
93%
71%
59%
36%
Clark's Levels
1
2
3
4
5
10 year survival rate
94%
82%
63%
61%
40%
Breslow Depth (mm)
0 >
1 >
2 >
3 >
4 >
5 >
2001 Image by Med-Art - http://www.med-ars.it

*”Almost **100%** will survive their cancer for 5 years or more after they are diagnosed at **Stage #1**”*

vs

*“Almost **10%** men and **25%** women will survive their cancer for 5 years or more after they are diagnosed at **Stage #4**”*

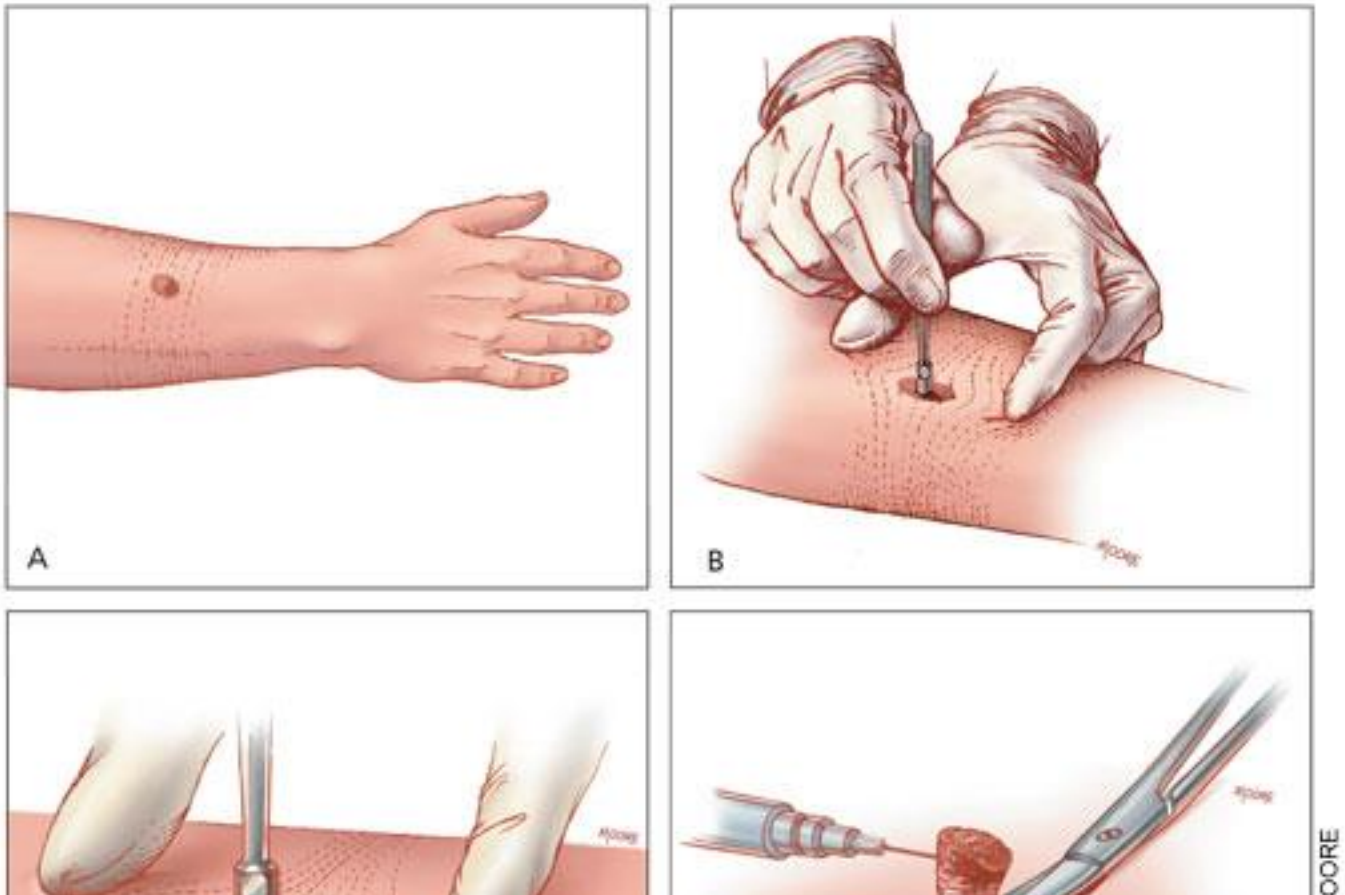
*Statistical Information Team at Cancer Research UK

How to detect melanoma?

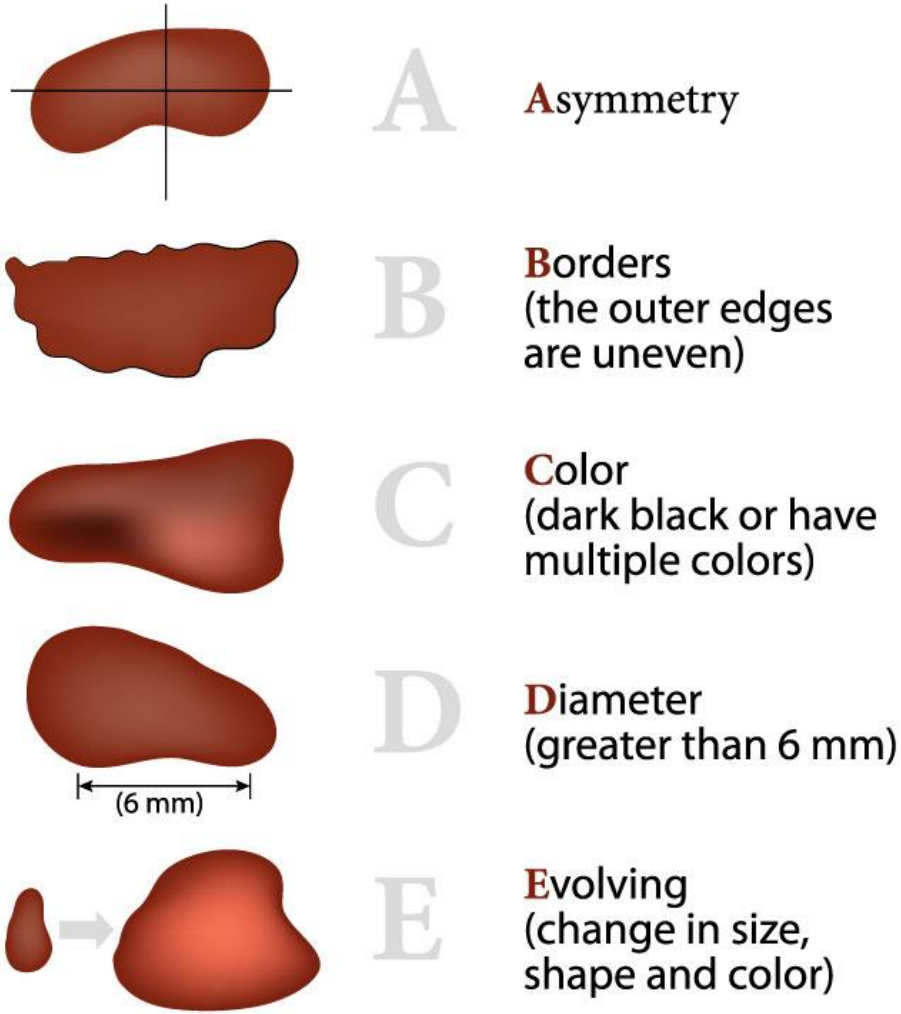
Biopsy – 100%

Easy ?

No!



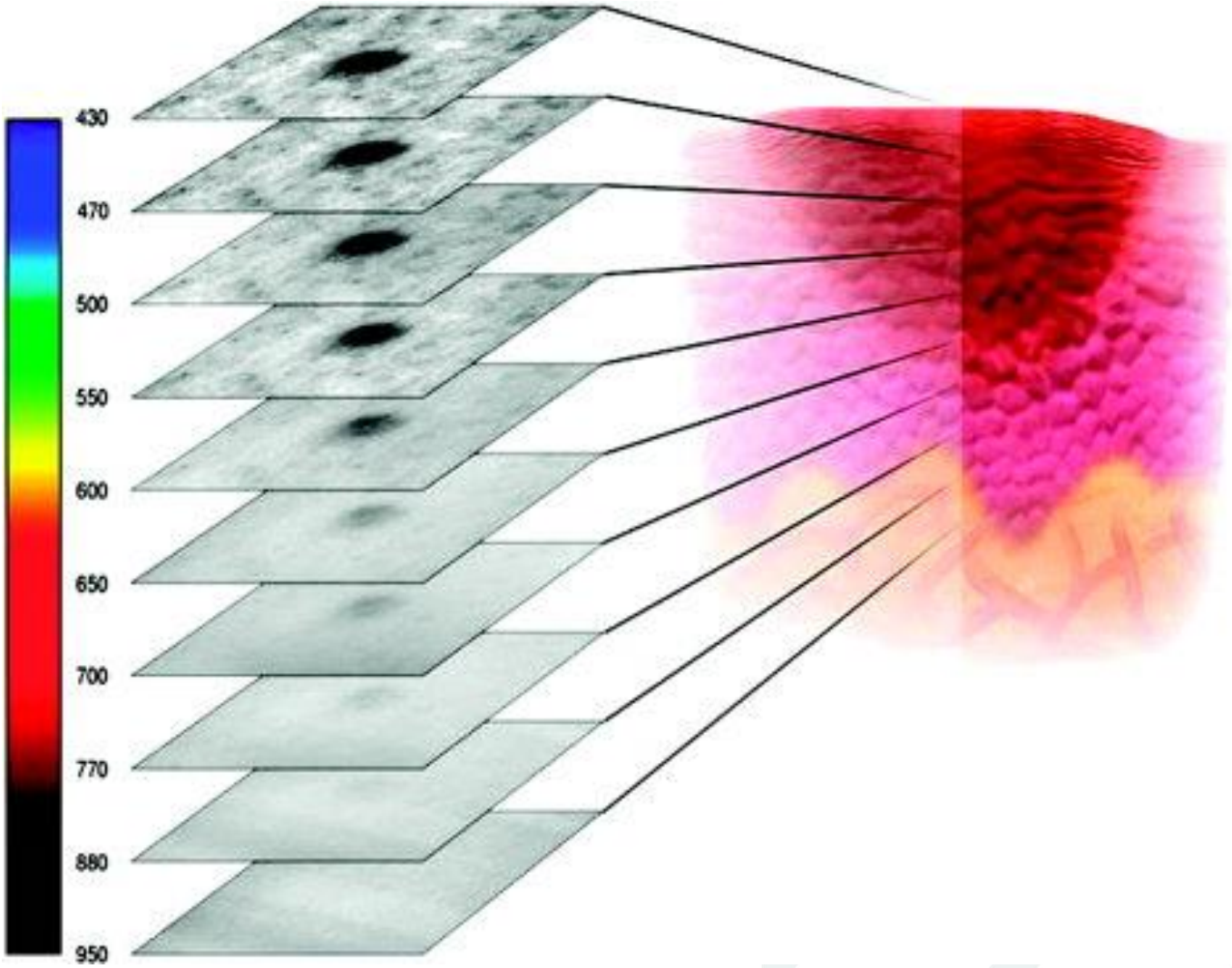
Dermatologist or self screening



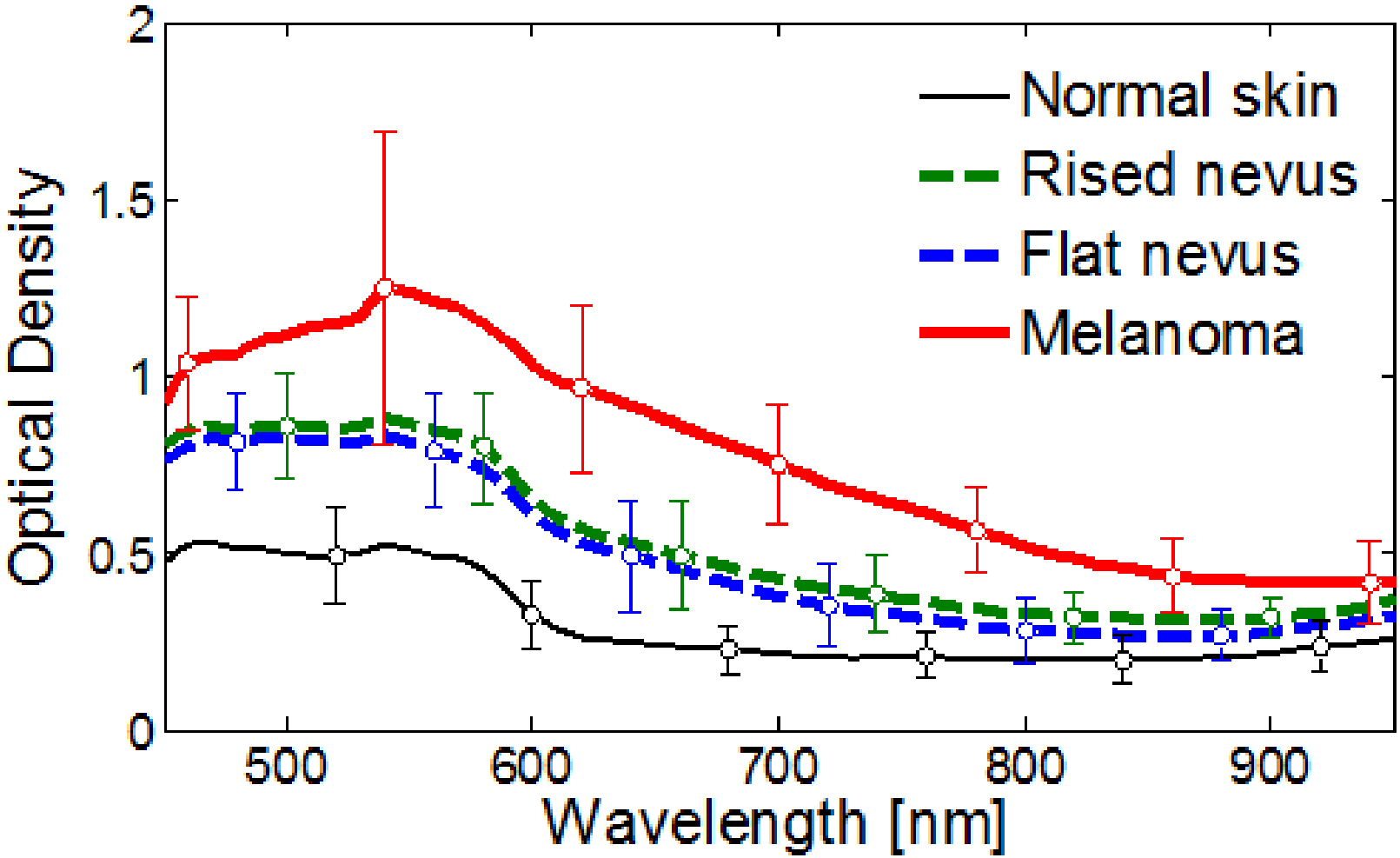
Availability of diagnostics

- Regular full body analysis
- According to SCREEN project in the German state of Schleswig-Holstein, state achieved reduction for 48% in deaths due to skin cancer
- Same results were not achieved on the national level
- Possible reason — lack of dermatologists

Wavelengths' penetration depth



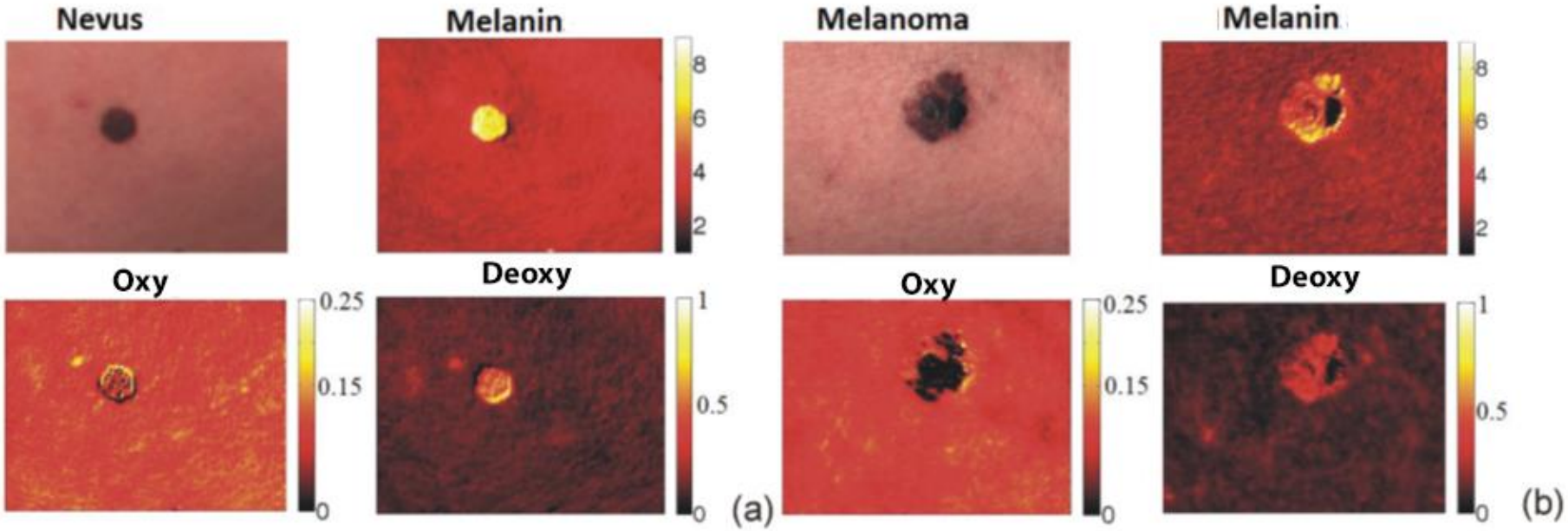
Optical Density spectra of skin lesions



D.Jakovels et al. Application of principal component analysis to multispectral imaging data for evaluation of pigmented skin lesions, Proc. SPIE 9032, Biophotonics—Riga 2013, 903204 (November 18, 2013)

Example of analysis

- Natural (RGB) images are visually similar
- Multispectral analysis allows noticeable differentiation in healthy and skin with pathology



KaWe Med ©

DermLite ©

Schuco ©

What kind of equipment is available for diagnostics?

DermDOC ©

MoleMAX ©

Imaging equipment

- High price,
- Not portable,
- Proprietary hardware and software

MoleMax ©

DermDOC ©

Low cost portable equipment

Portable, affordable

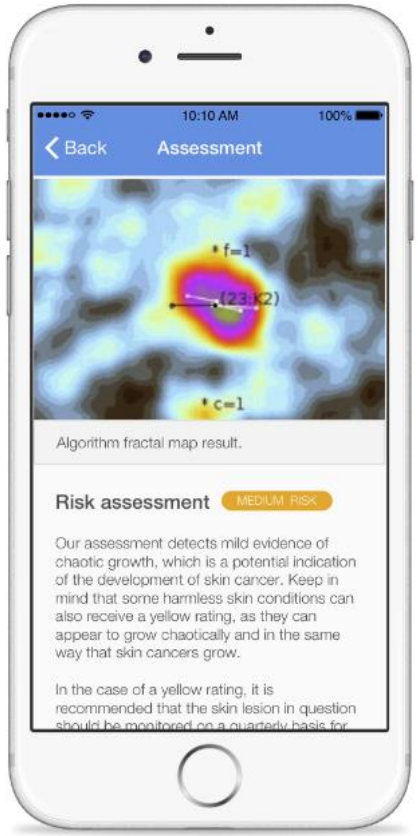
Hard to update and support

J.Spigulis et al. SkImager: a concept device for in-vivo skin assessment by multimodal imaging, Proceedings of the Estonian Academy of Sciences, 2014, 63, 301–308

Further steps

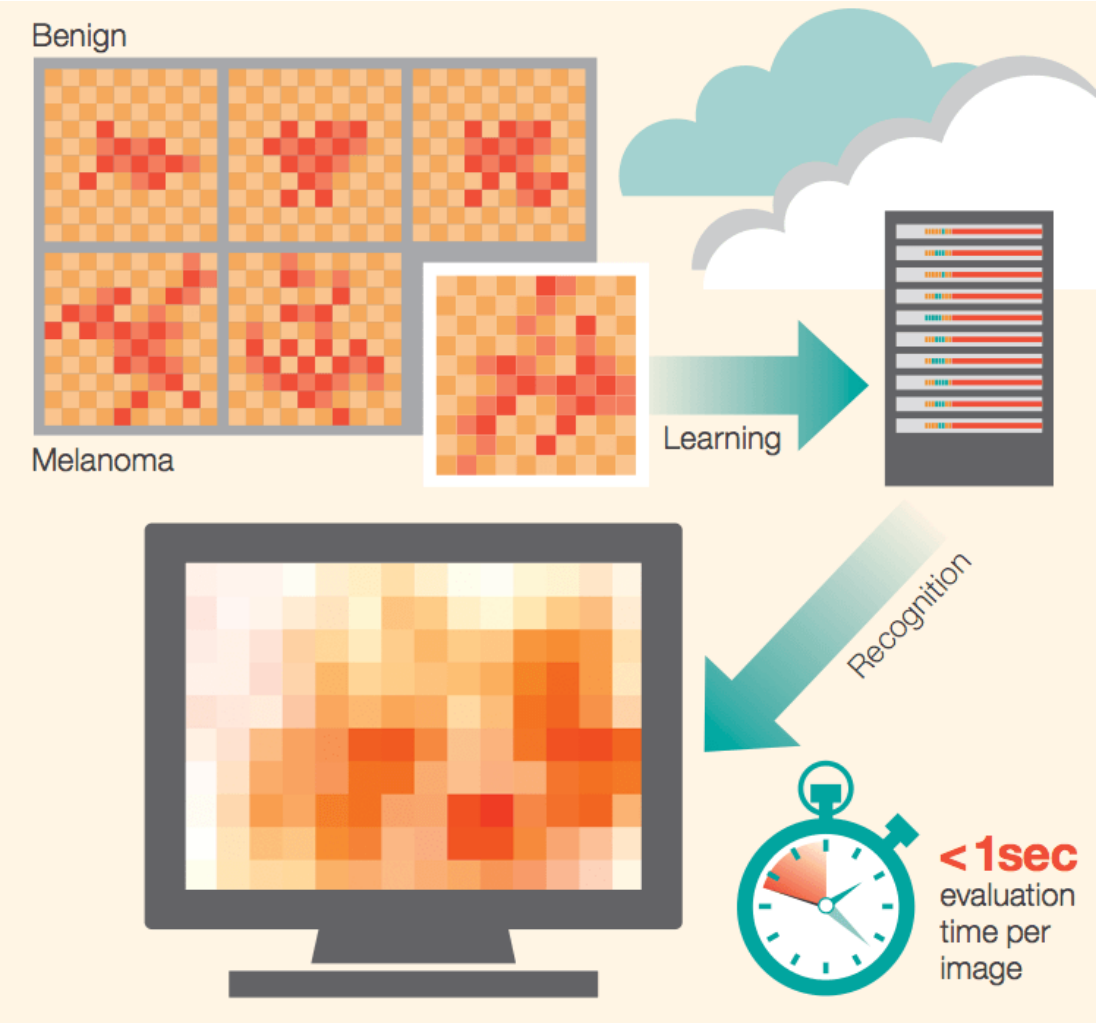
PC as visualization and processing unit

Further steps



- Smartphone as image source
- Images analyzed by dermatologists
- Image quality and illumination features are limited by smartphone

Supercomputer power



IBM WATSON

Further steps

Smartphone with additional module for illumination

SkImager

- Illumination
- Imaging
- Processing
- Displaying

Proposal

- Illumination
- Imaging
- ~~Processing~~
- ~~Displaying~~
- Transmittion

«+»

- All in one
- No extras

«-»

- Limited CPU power
- Special processing techniques
- Hard to change hardware

«+»

- Quick module changing
- Flexible displaying

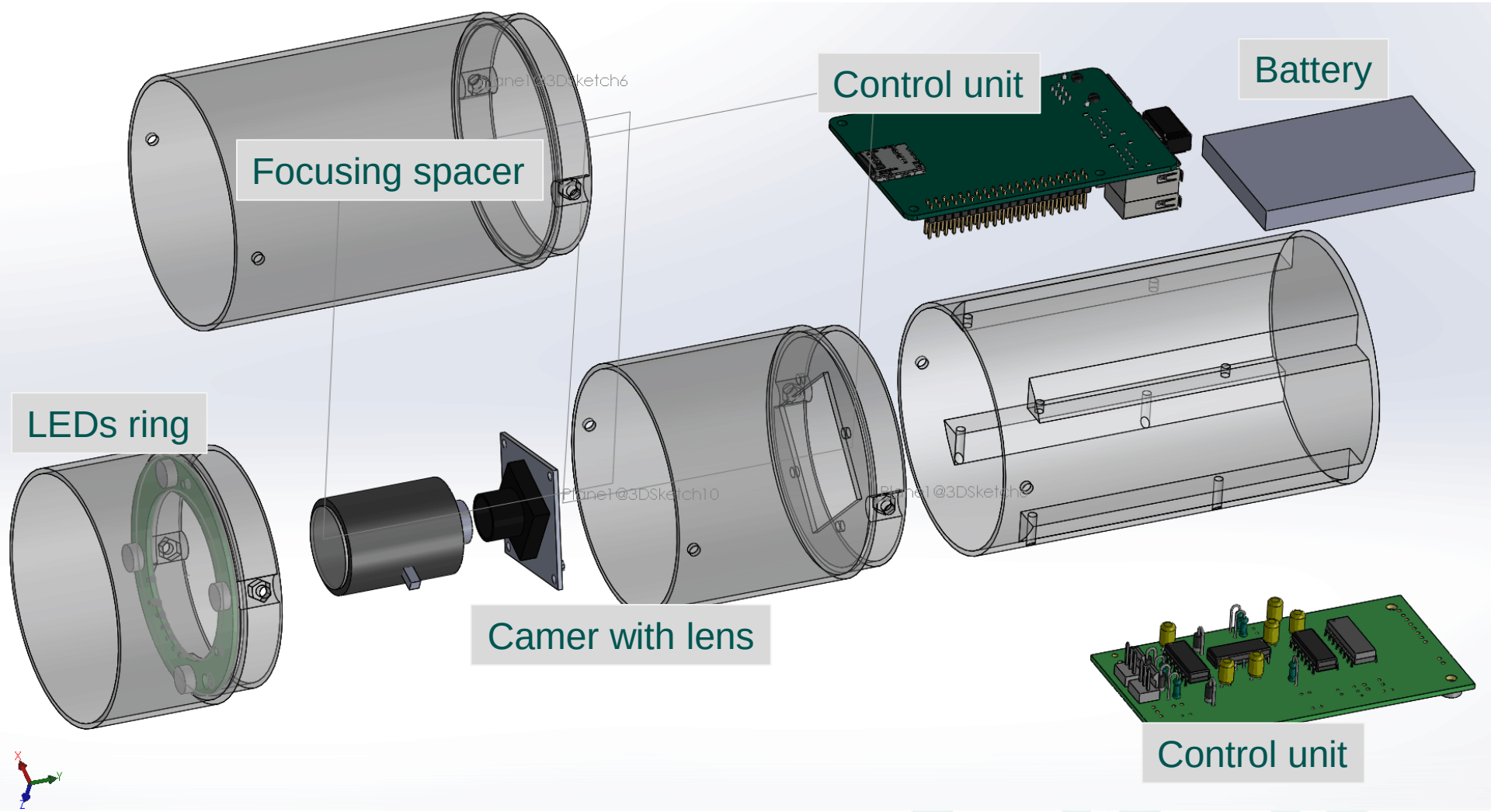
«-»

- Need for some displaying device

Proposals

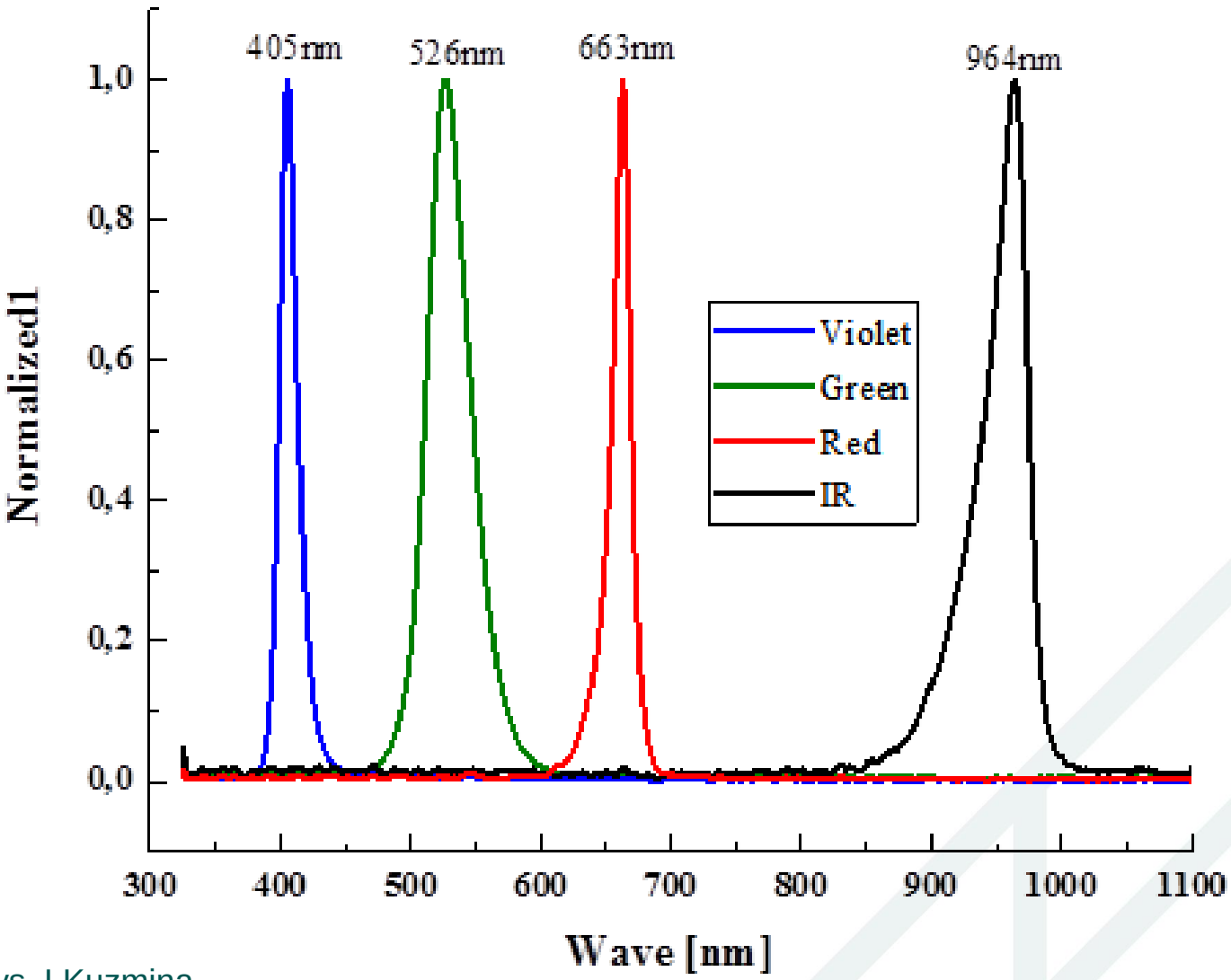
- Portable
- Easy to use
- Quick prototype transition from lab to user
- Easy exchange of modules
- Fast implementation of processing algorithms
- No limitation on processing power

Proposed system



D.Bļizņuks, D.Jakovels, I.Saknite, J.Spigulis “Mobile platform for online processing of multimodal skin optical images”

Proposed system



*Dr.phys. I.Kuzmina

Proposed system

Battery (>8 hours of service)

WiFi module (Access Point)

IDS camera 1 – 5 MPix

3 LEDs diffuse reflection 535 / 640 / 950 nm

1 LED fluorescence – 405nm

Control unit (Raspberry Pi)

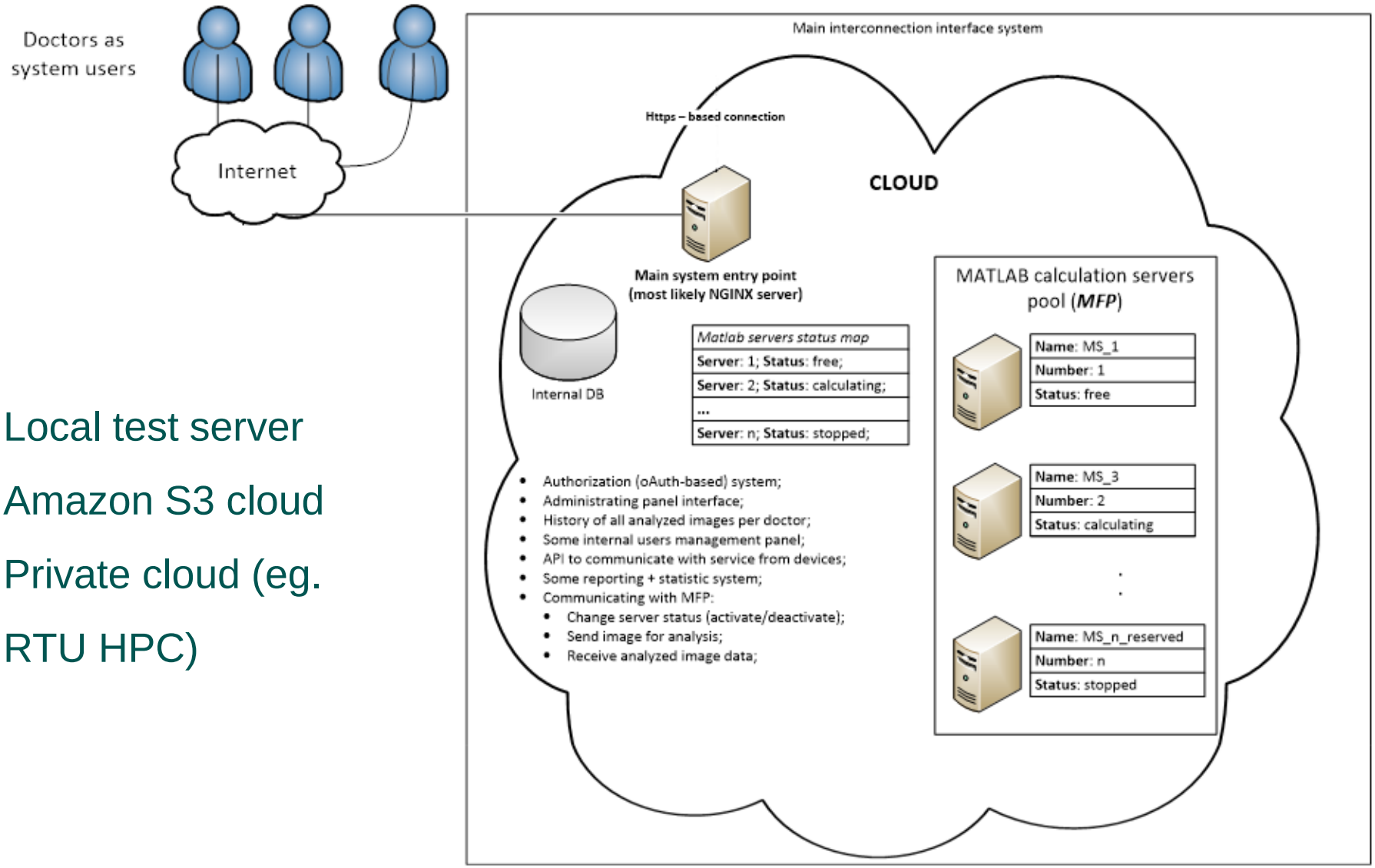
IDS camera driver forms video stream

WEB server forms real time video stream

Remote Matlab servers

D.Bļizņuks, D.Jakovels, I.Saknite, J.Spigulis “Mobile platform for online processing of multimodal skin optical images”

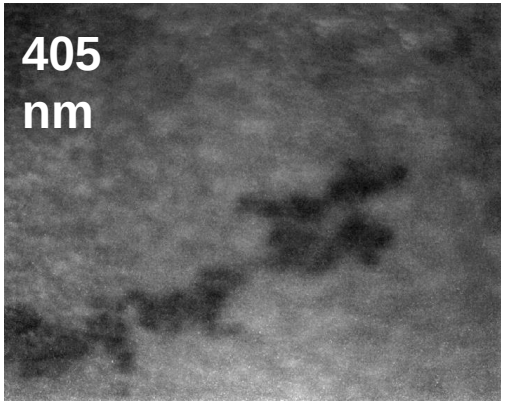
Cloud processing

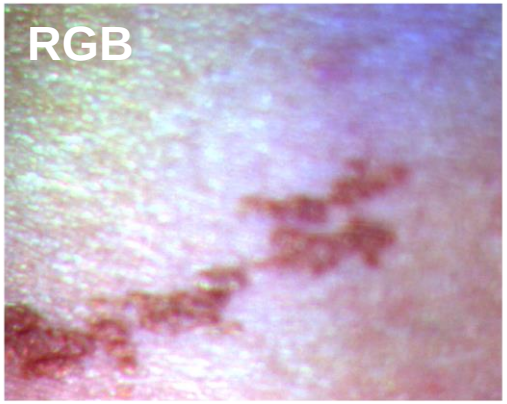


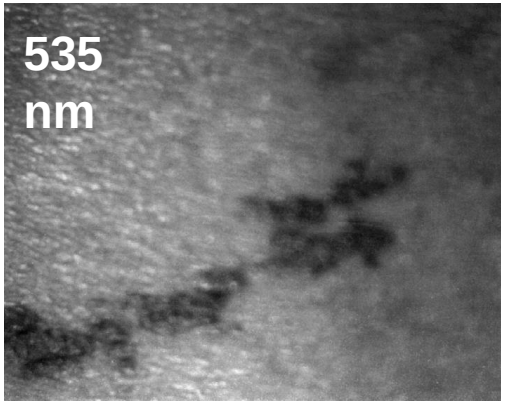
1. Local test server
2. Amazon S3 cloud
3. Private cloud (eg. RTU HPC)

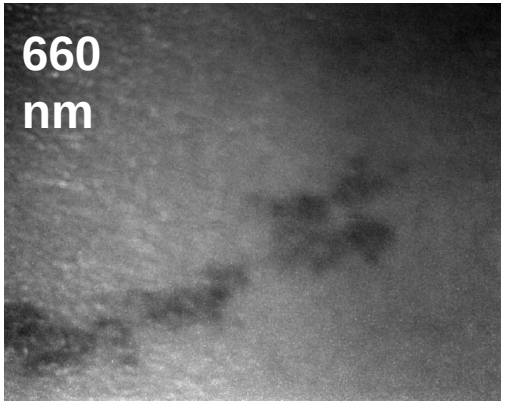
*Dr.sc.ing. P.Osipovs

Image examples

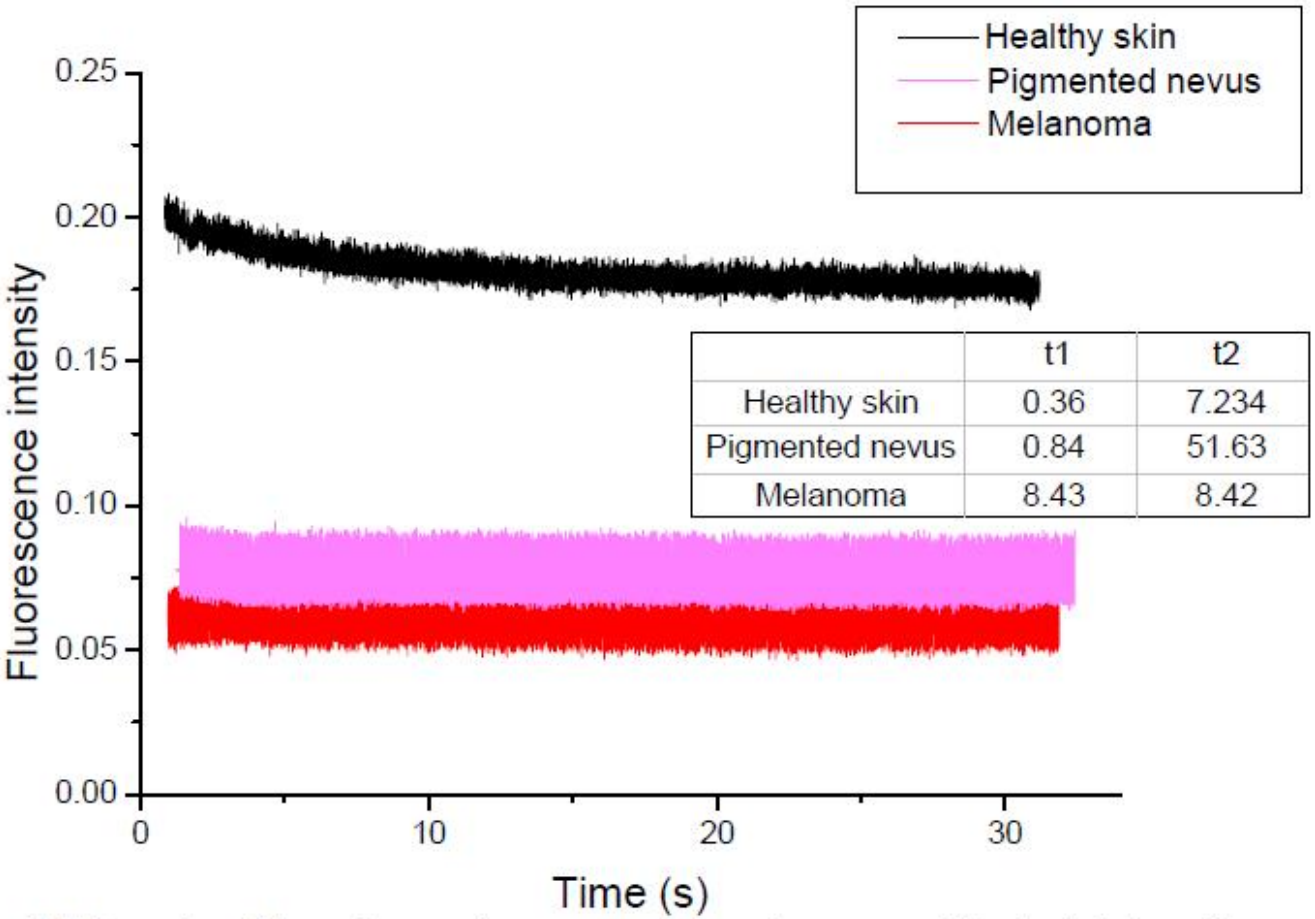






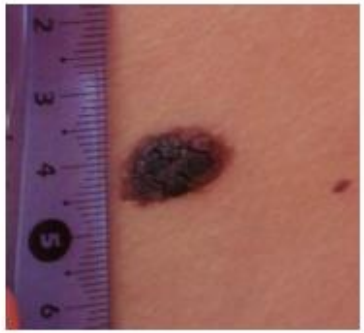


Photobleaching (405nm)

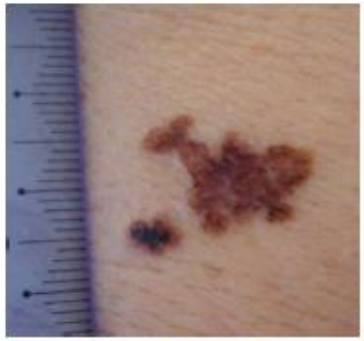


	t1	t2
Healthy skin	0.36	7.234
Pigmented nevus	0.84	51.63
Melanoma	8.43	8.42

AF from healthy, pigment nevus and melanoma with photobleaching parameters (*t1*, *t2* corresponds to τ_1 and τ_2)



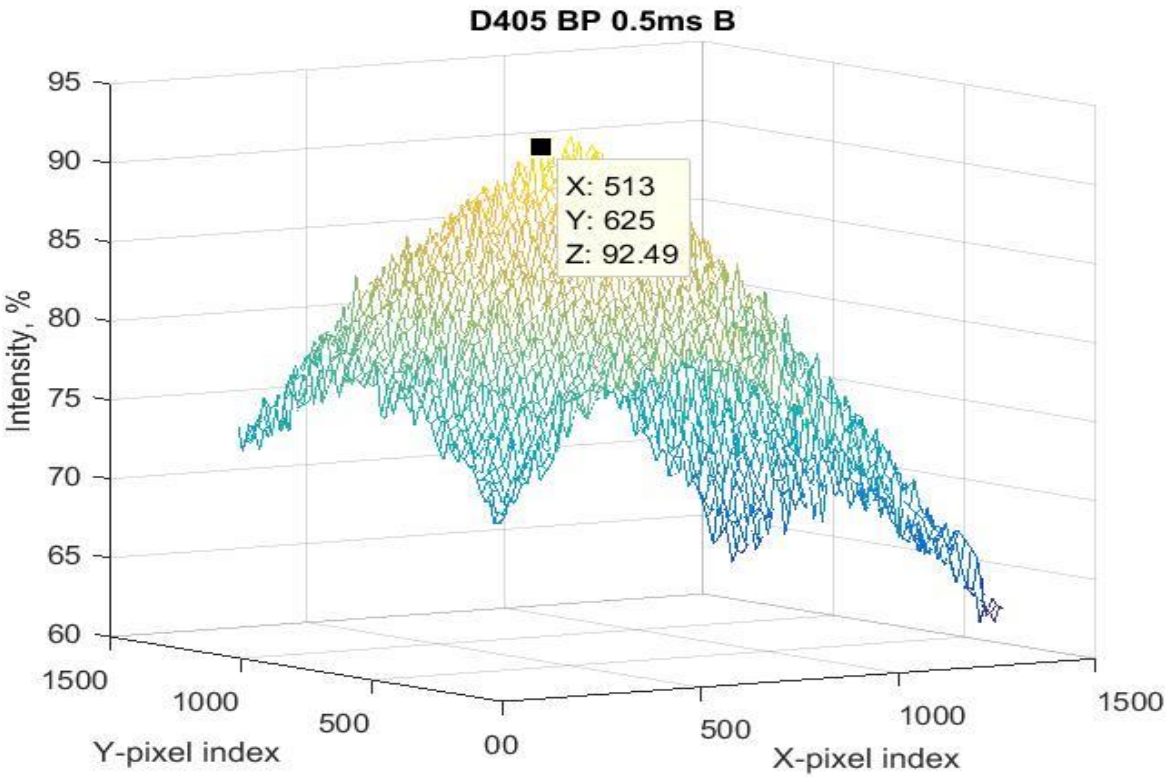
Intradermal



Melanoma

I.Ferulova,A.Rieba,J.Lesins,A.Berzina,A.Lihachev,J.Spigulis Portable device for skin autofluorescence photobleaching measurements

Nonuniform illumination



405nm

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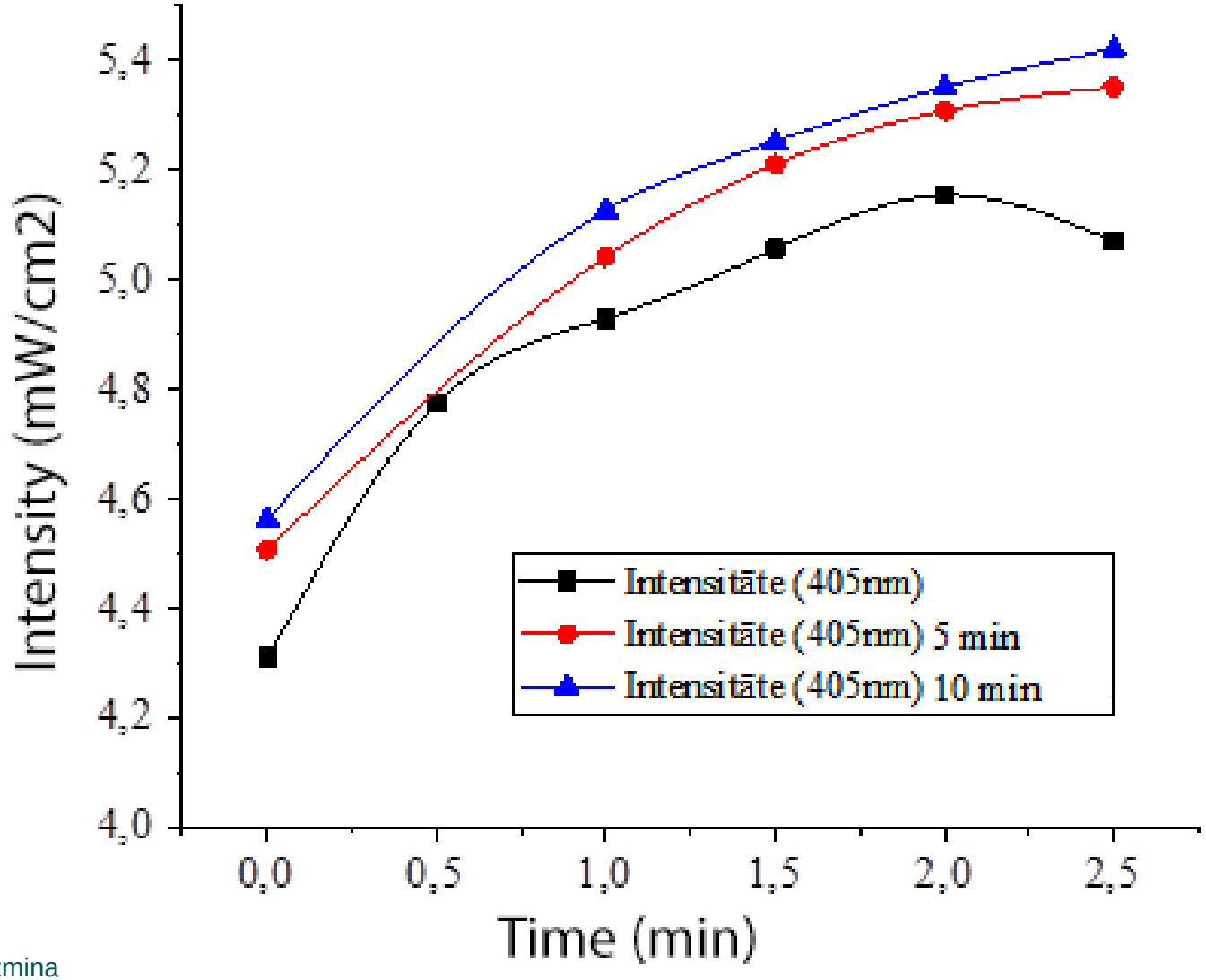
Intensity drift due to temperature



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Projekts Nr: 1.1.1.1/16/A/197

„Portatīva ierīce ādas vēža agrīnai bezkontakta diagnostikai”