NATIONAL DEVELOPMENT PLAN 2020

EUROPEAN UNION
European Regional Development Fund

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UNIVERSITY OF LATVIA
ANNO 1919

Non-contact Skin Cancer Diagnostic System

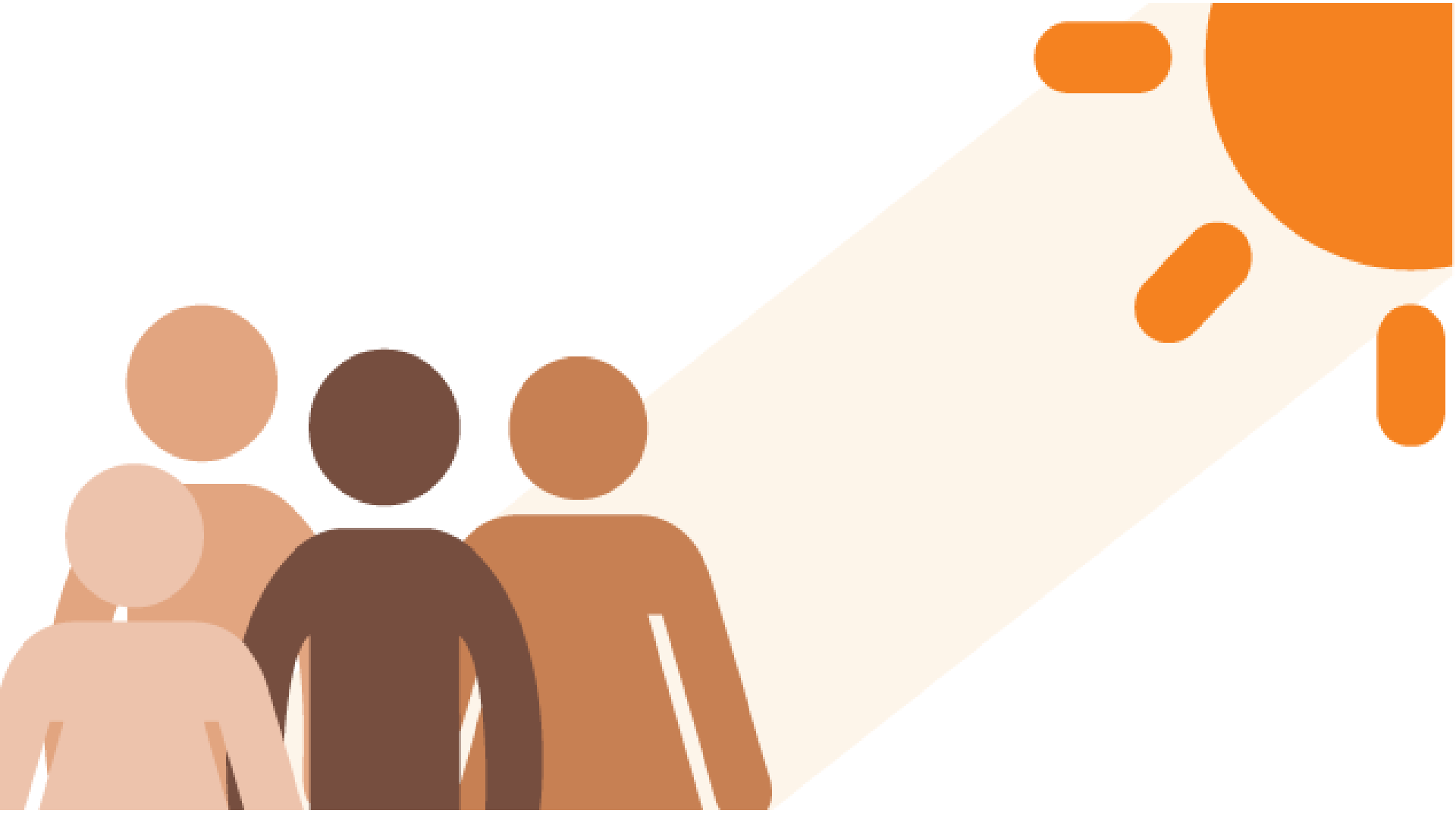
Results and challenges running cloud based diagnostics

Dr.sc.ing. Dmitrijs Bļizņuks
Riga Technical University

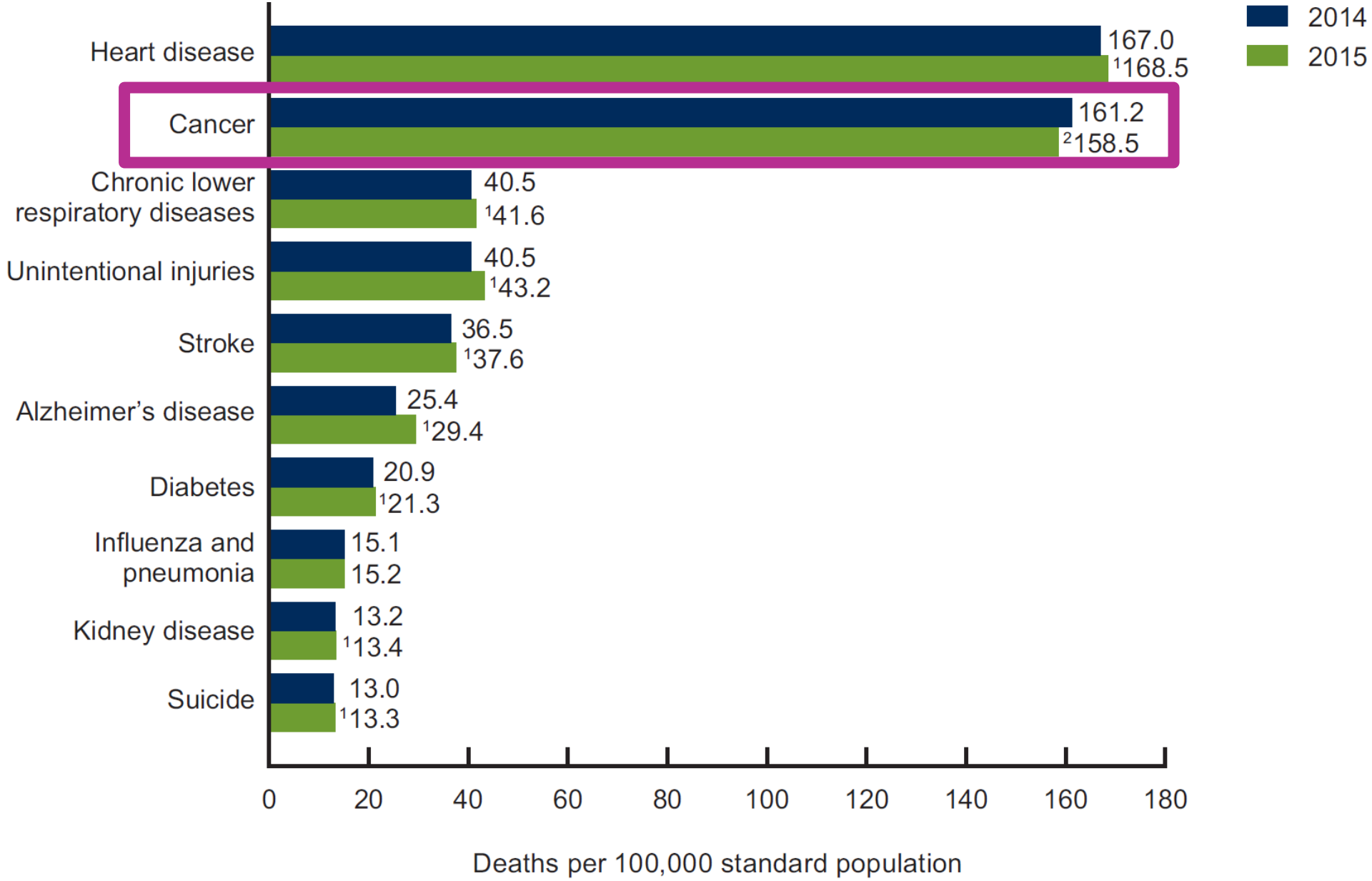
DOC Riga 2019

Outlines

- Skin cancer non-contact diagnostics
- Achievements
- Modular architecture: Pros & Cons
- Diagnostic algorithms



Age-adjusted death rates for the 10 leading causes of death in United States

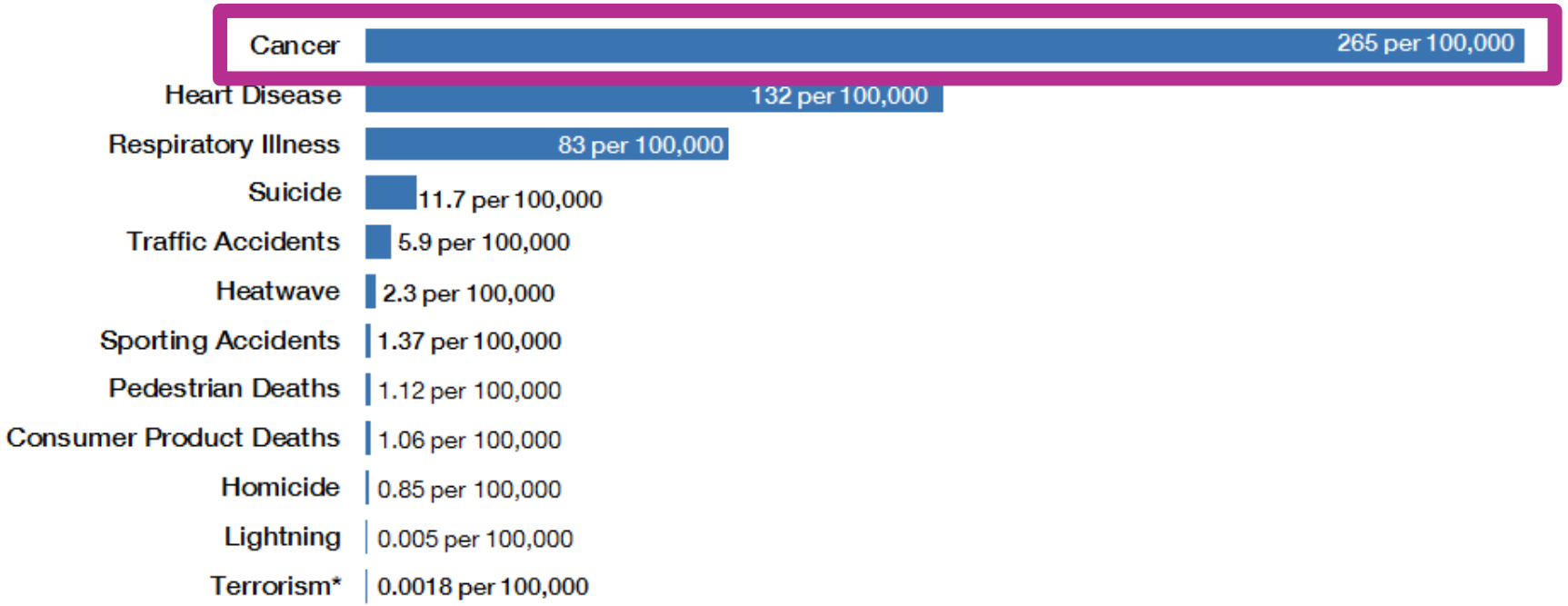


SOURCE: NCHS, National Vital Statistics System, Mortality.

Causes of death in the EU

Deaths per 100,000 people, 2013 or latest year. EU28.

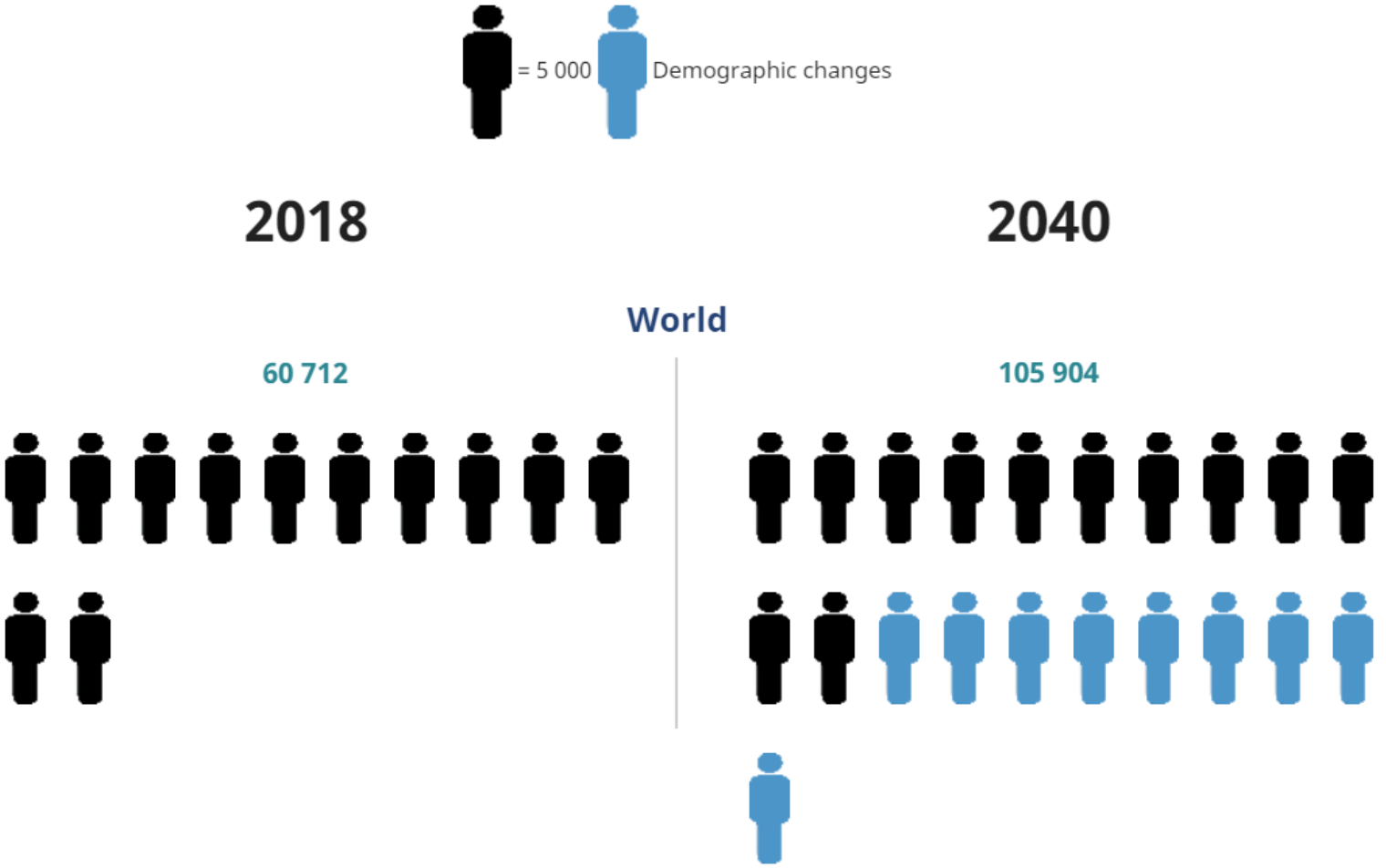
WORLD ECONOMIC FORUM
COMMITTED TO IMPROVING THE STATE OF THE WORLD



Source: Igarapé Institute

*2010-2014 average

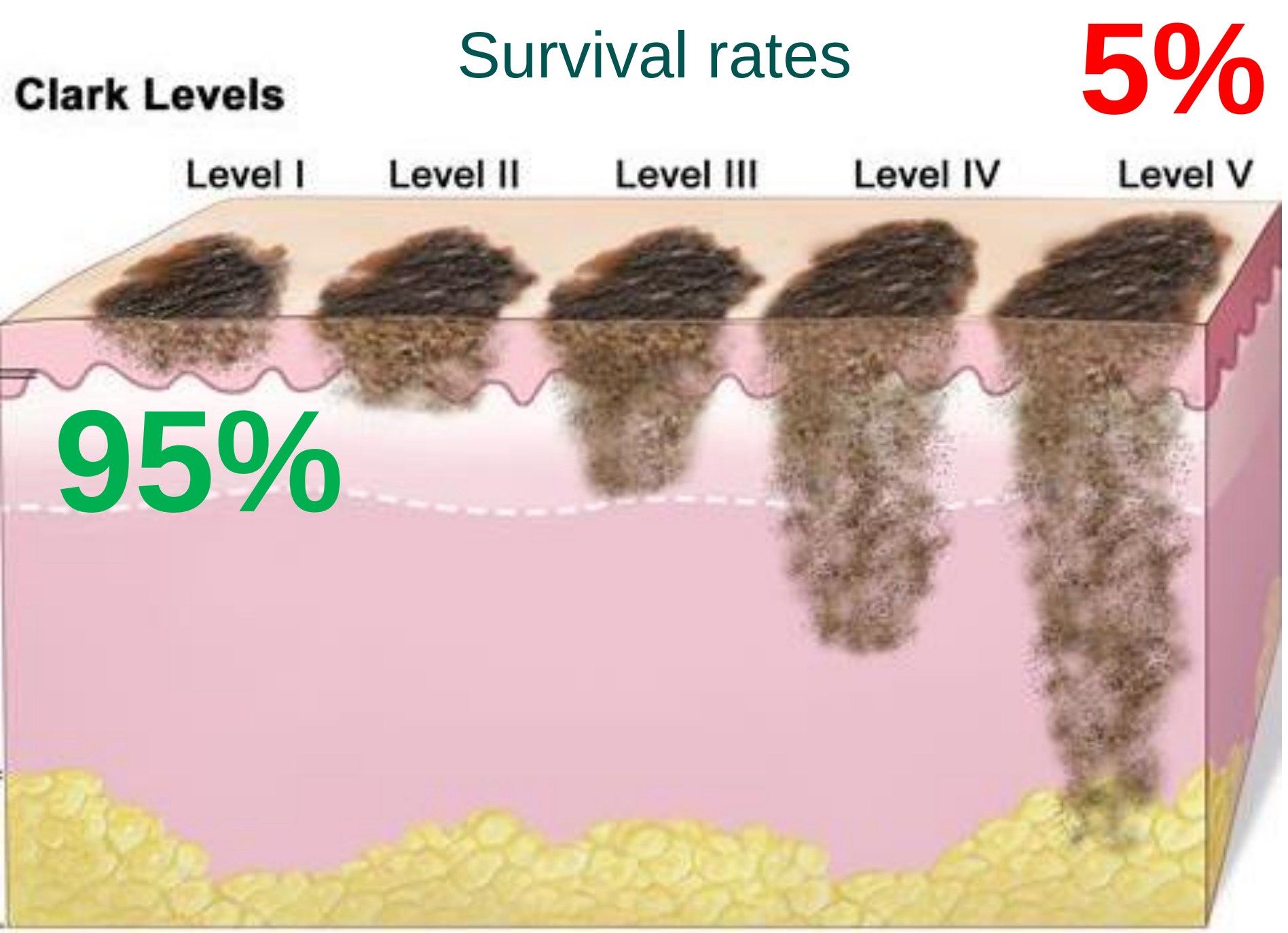
Estimated number of deaths from 2018 to 2040, melanoma of skin, both sexes, all ages



Data source:GLOBOCAN 2018
Graph production: Global Cancer Observatory (http://gco.iarc.fr/)

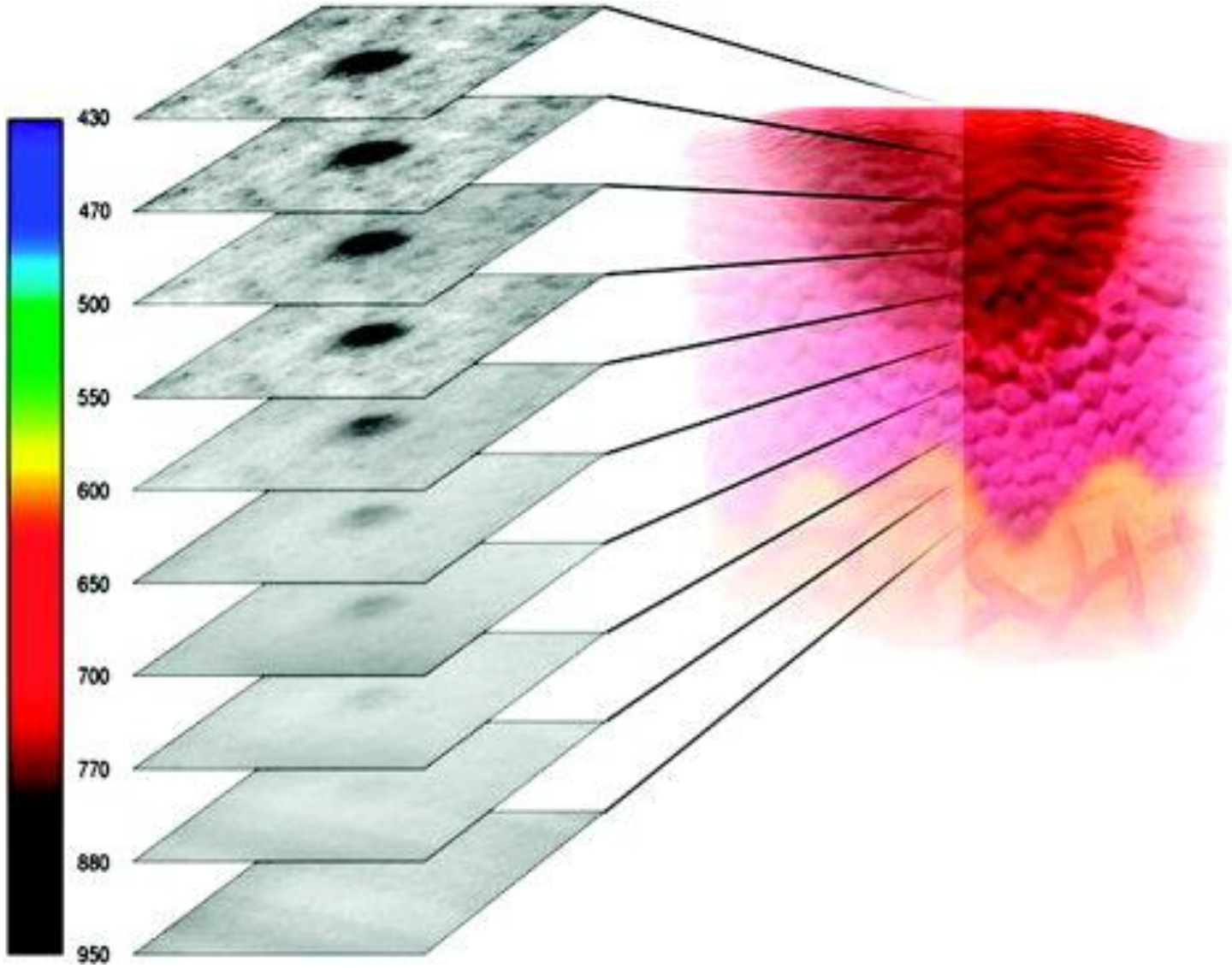
International Agency for Research on Cancer
World Health Organization

Survival rates

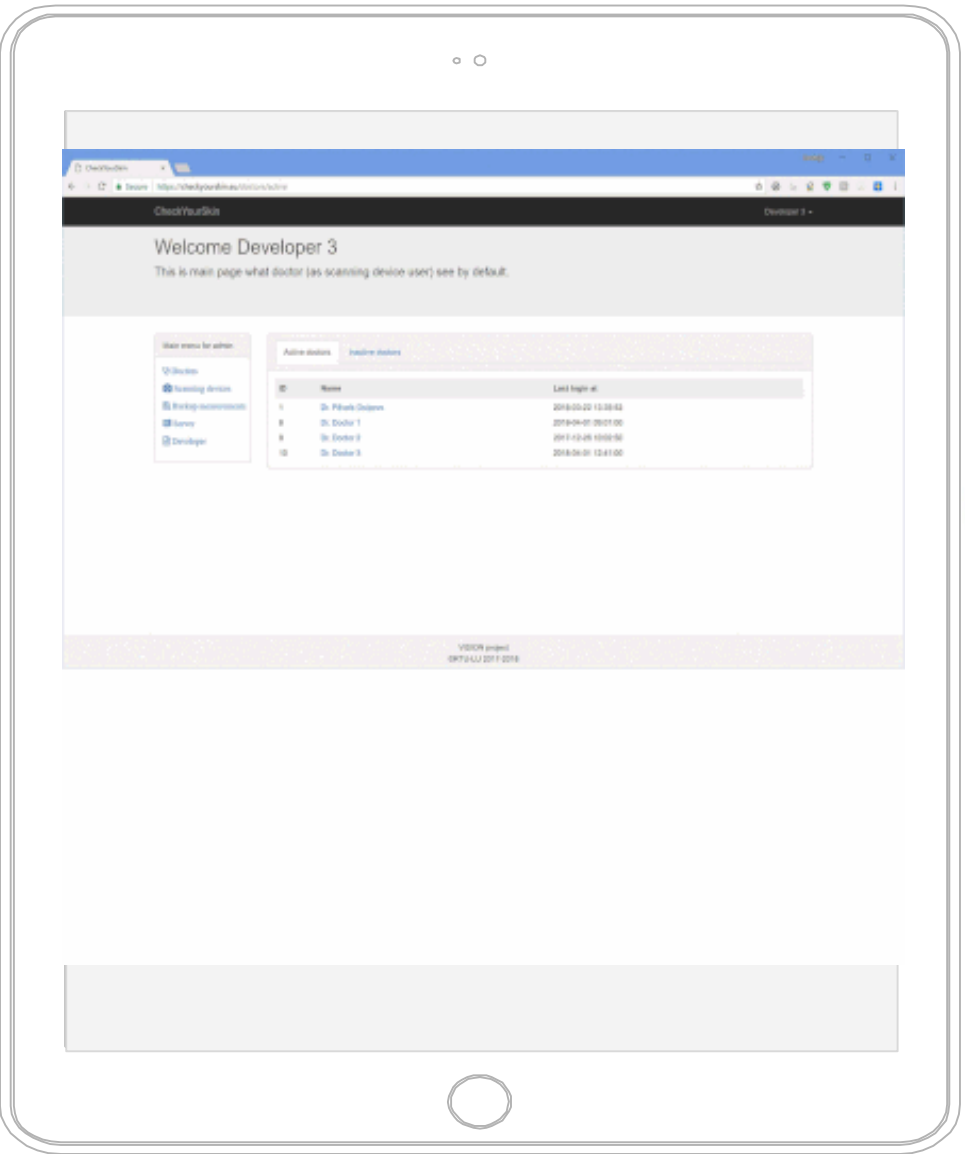


https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/melanoma-skin-cancer/survival

Wavelengths' skin penetration depth



Cloud service



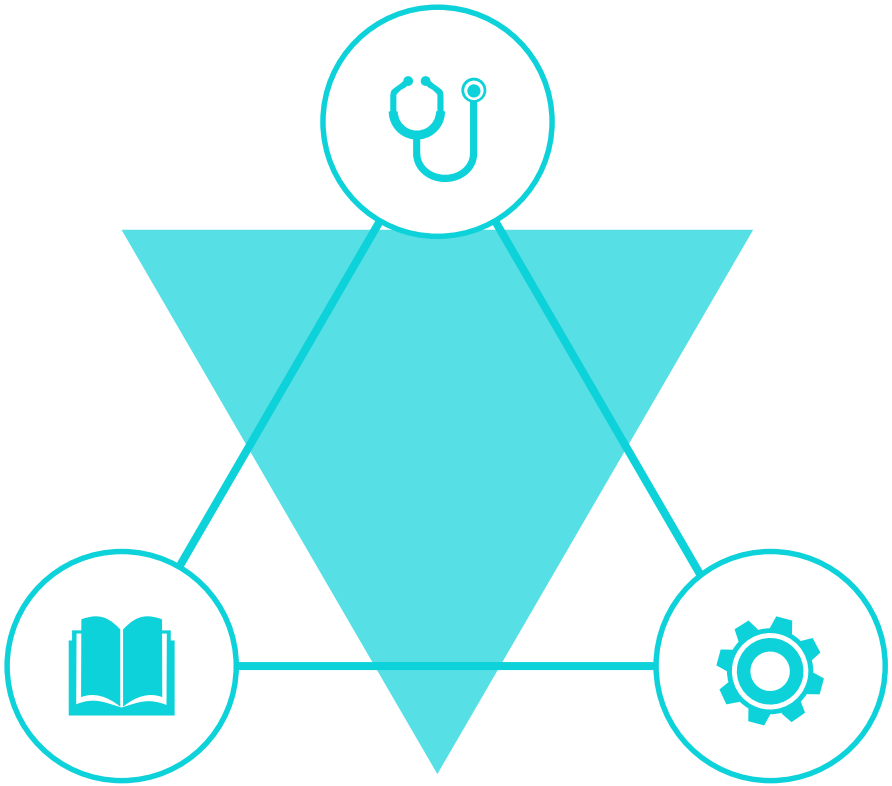
Handheld device

- More than 1500 lesions tested totally
- More than 1.5 years of testing in Latvian Oncology Clinics
- Tested by General Practice doctor
- Found 2 melanomas during two months
- Ongoing tests in Hungary and Bulgary

Diagnosis	Whole p' map	
	Sensitivity, %	Specificity, %
Melanoma	100	-
BCC	-	96
Seborrheic keratosis and hyperkeratosis	-	76
Other benign lesions	-	87
Tattoos	-	11
All non-melanoma lesions	-	80

Dermato-oncologists

Experienced doctors of the Oncology Center of Latvia

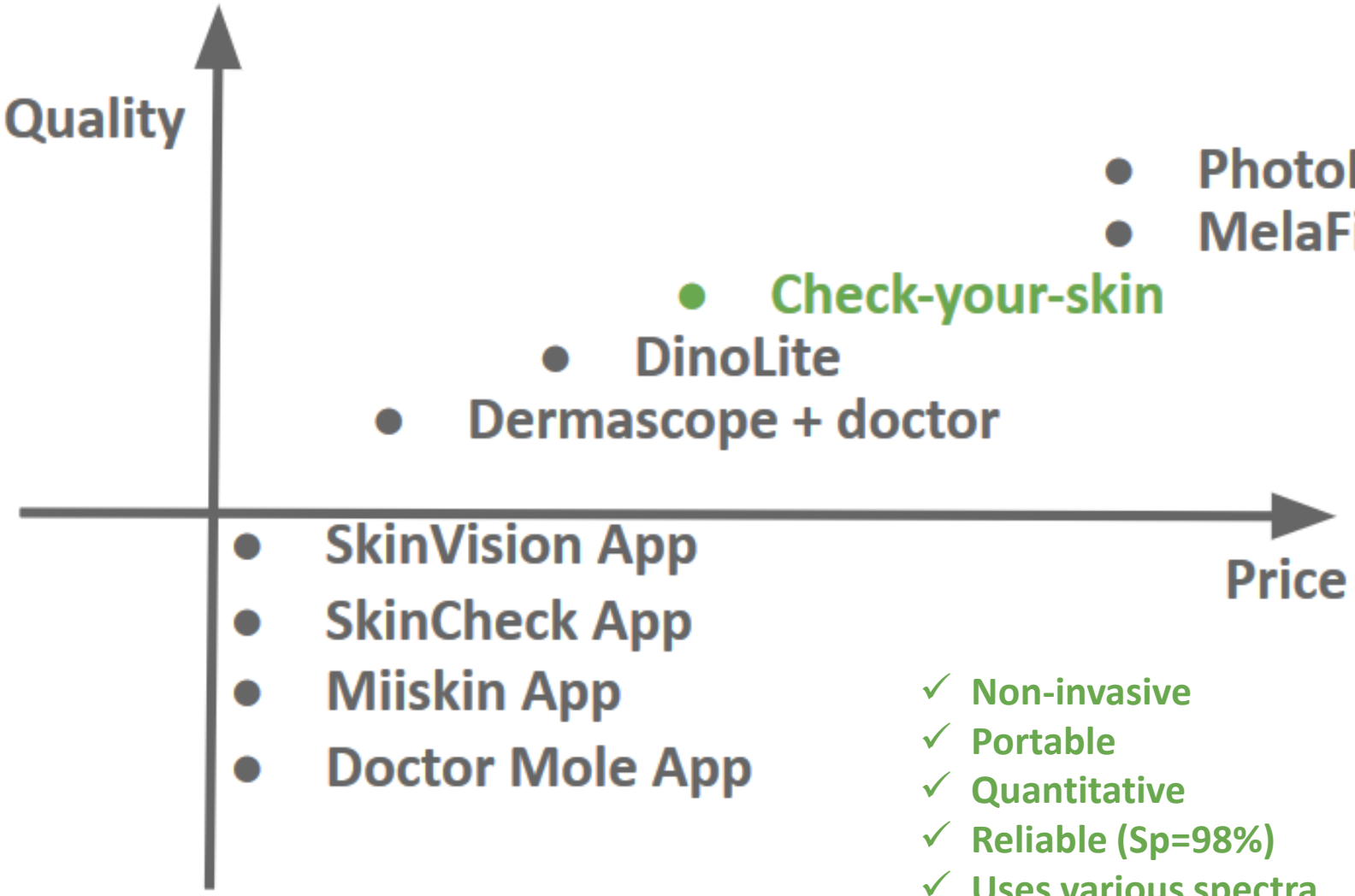


University of Latvia

10+ years of research in biophotonics
5 Dr.phys.

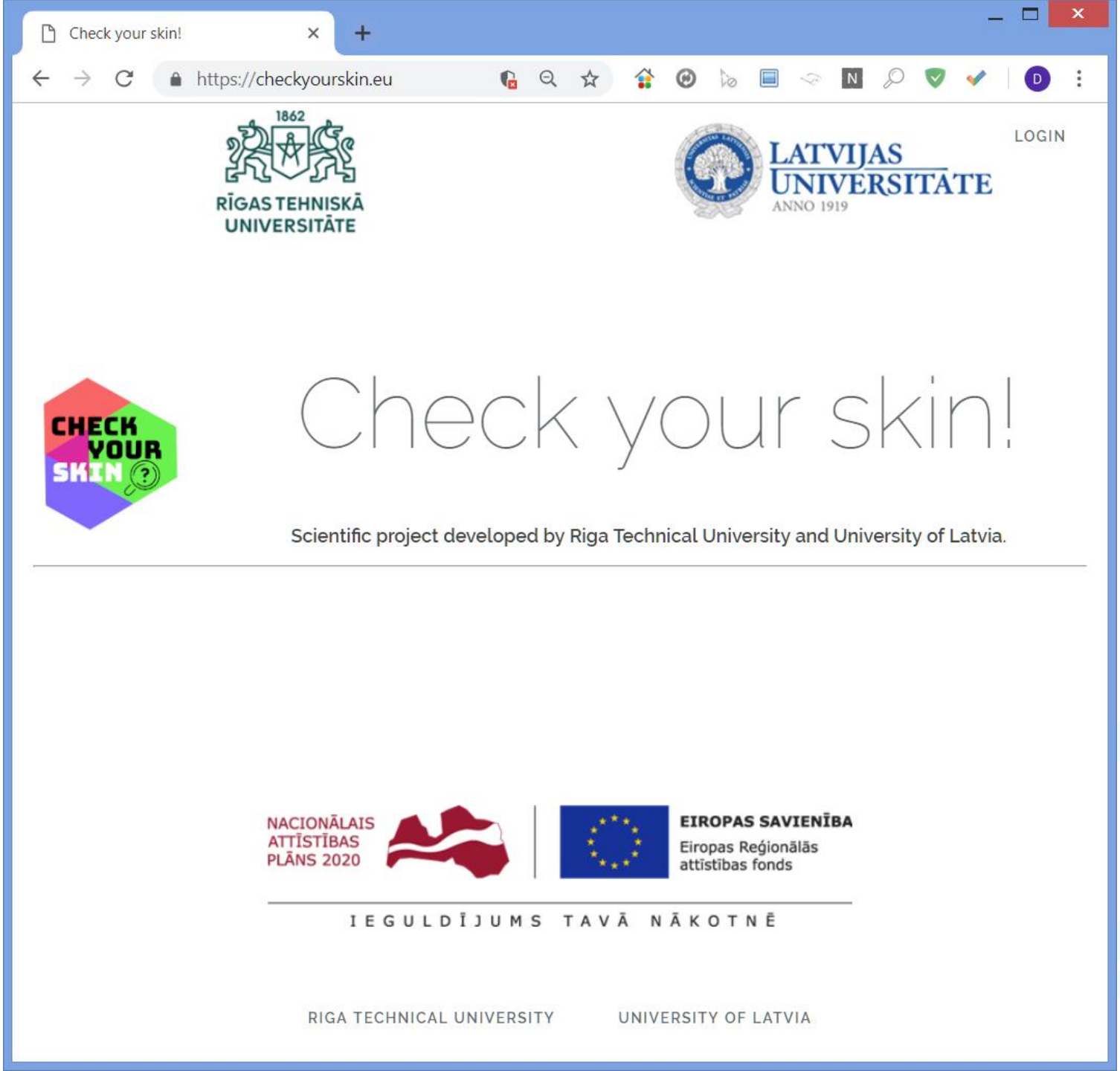
Riga Technical University

Hardware and software design
3 Dr.Sc.ing.



Main users
General Practice doctors

- ✓ Non-invasive
- ✓ Portable
- ✓ Quantitative
- ✓ Reliable (Sp=98%)
- ✓ Uses various spectra
- ✓ Image analysis within seconds
- ✓ Wireless
- ✓ Image evaluation in time (Archive)
- ✓ Affordable


Check your skin!
https://checkyourskin.eu
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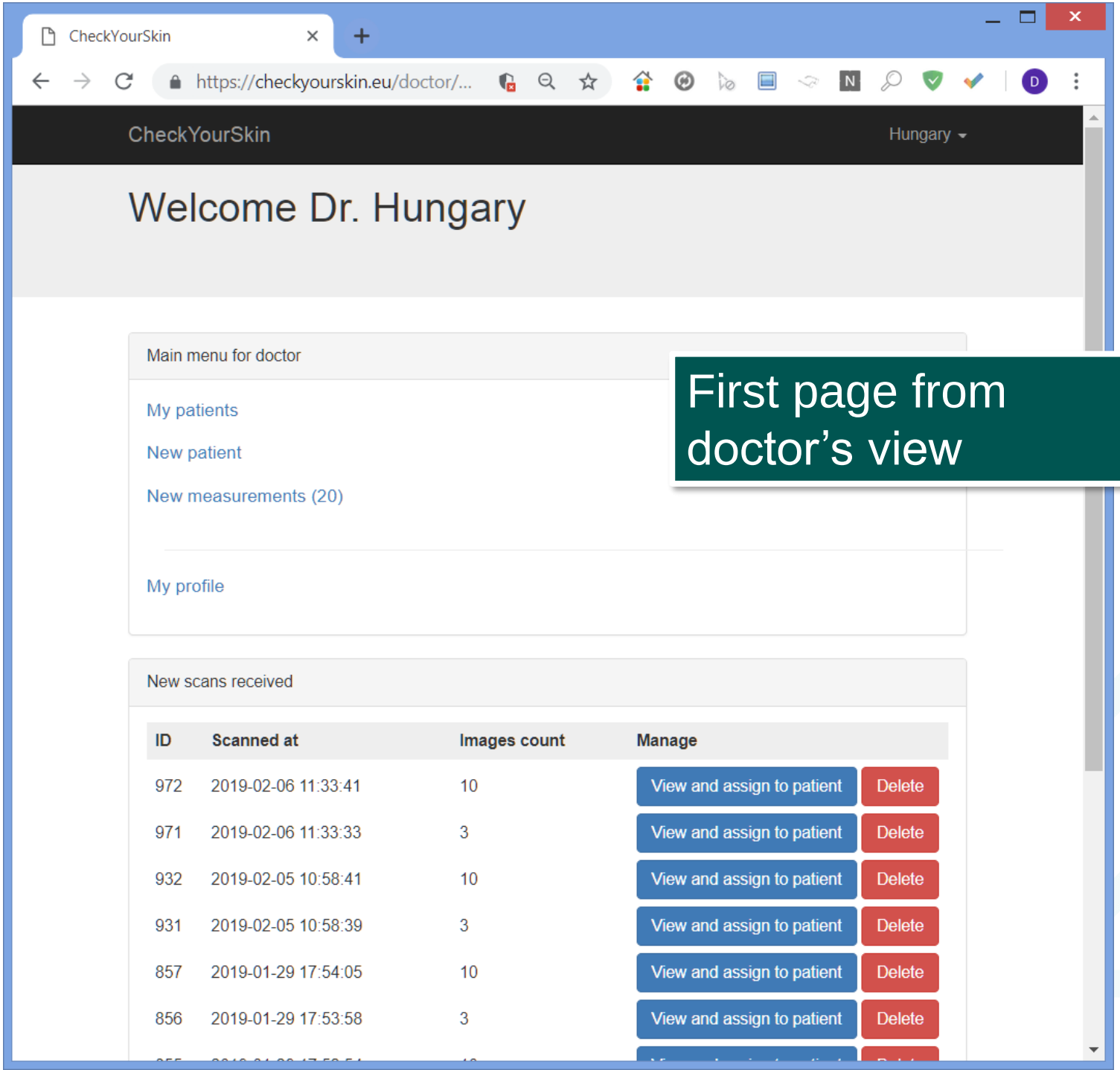
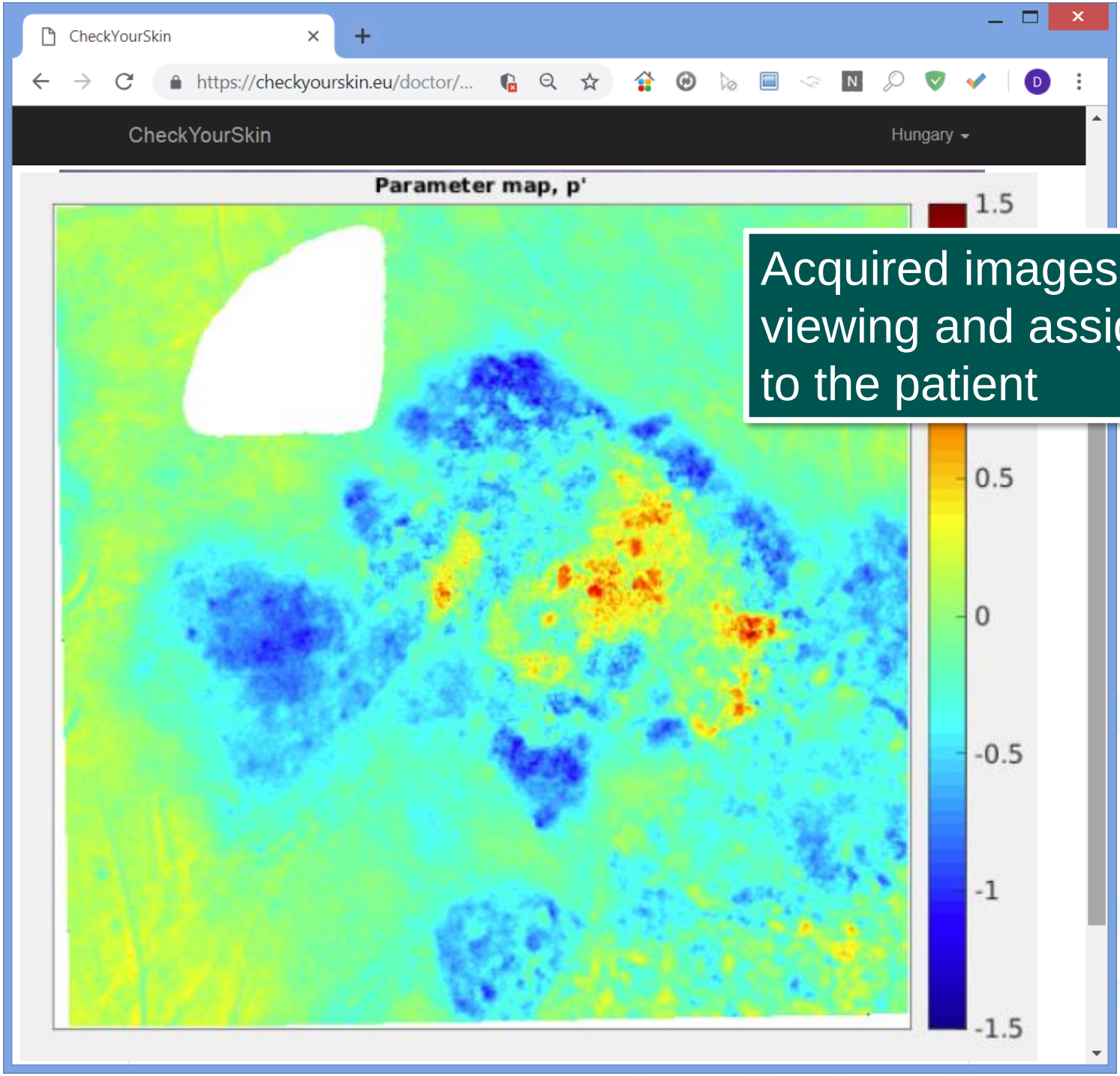
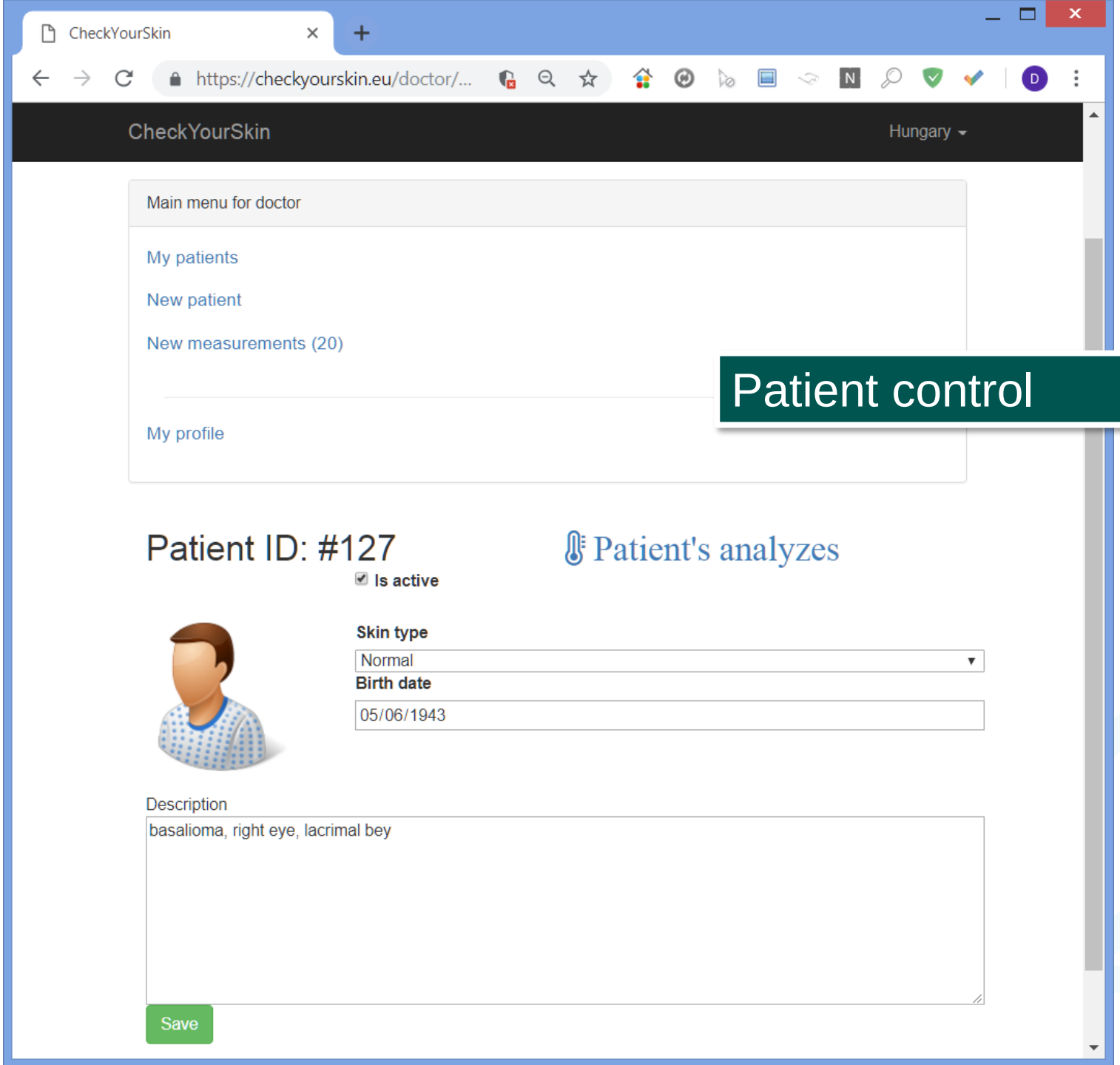
LATVIJAS UNIVERSITĀTE
ANNO 1919
LOGIN
CHECK YOUR SKIN
Check your skin!
Scientific project developed by Riga Technical University and University of Latvia.
NACIONĀLAIS ATTĪSTĪBAS PLĀNS 2020
EIROPAS SAVIENĪBA
Eiropas Reģionālās attīstības fonds
IEGULDĪJUMS TAVĀ NĀKOTNĒ
RIGA TECHNICAL UNIVERSITY
UNIVERSITY OF LATVIA

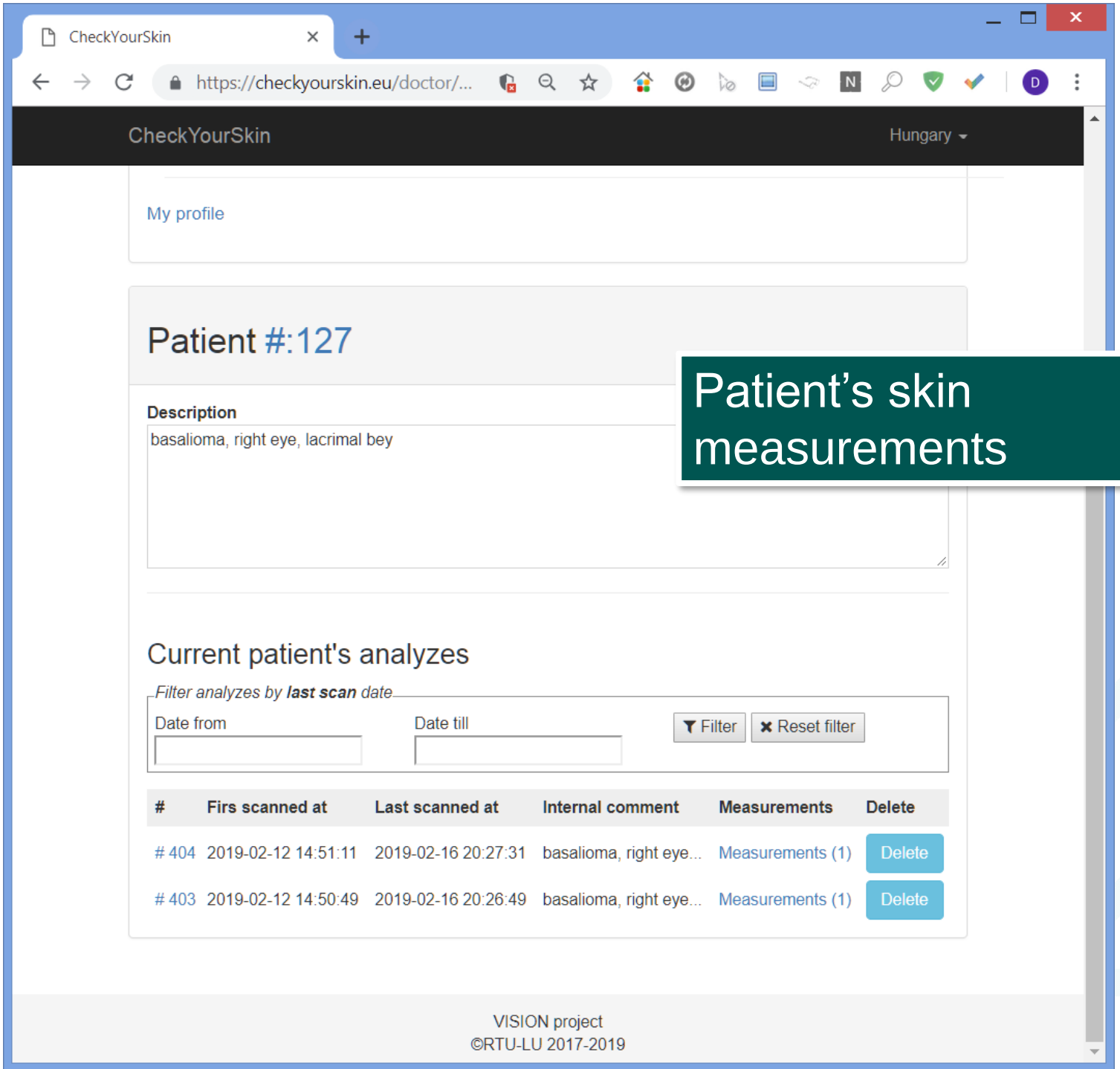


First page from doctor's view

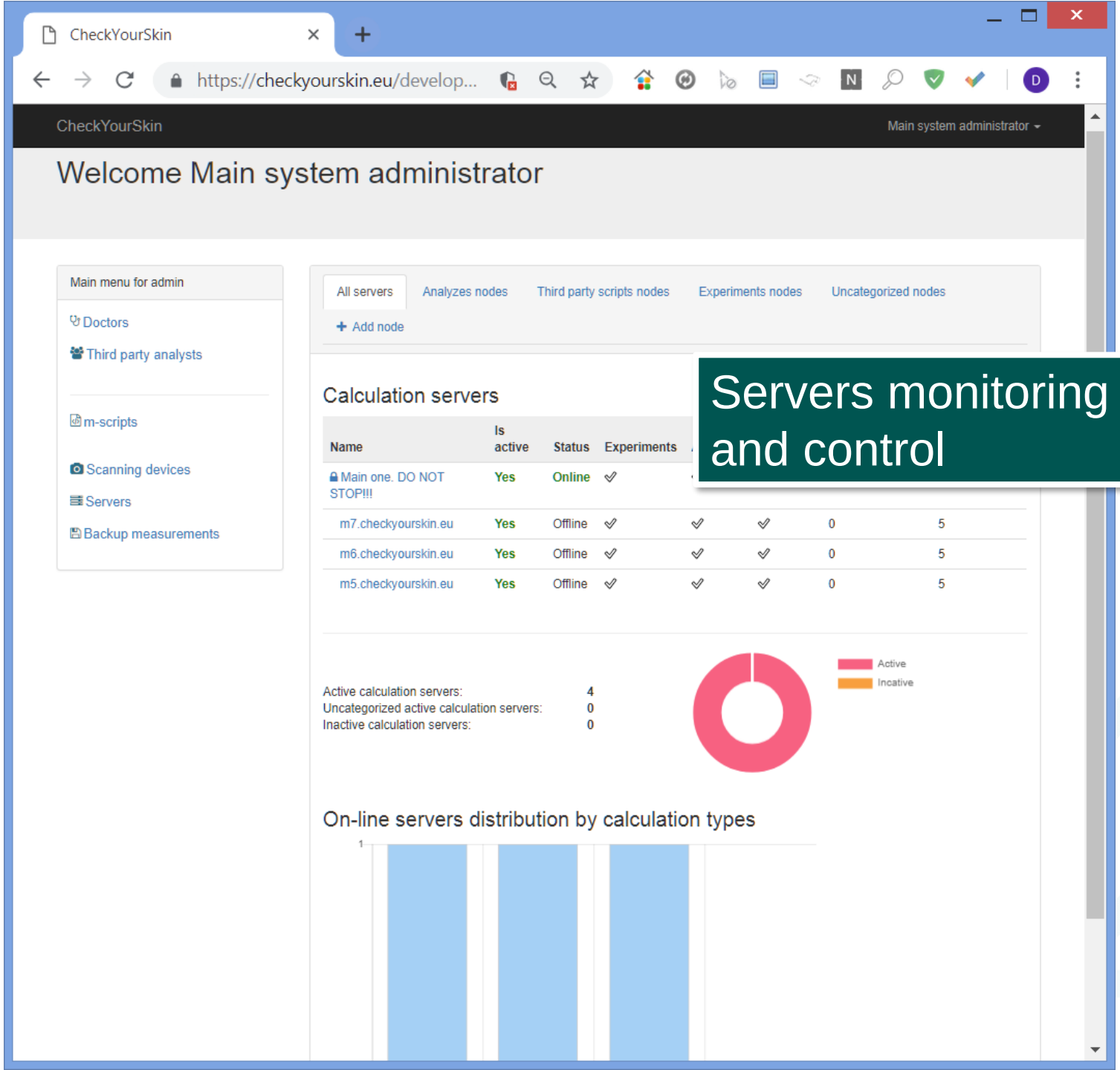


Acquired images viewing and assigning to the patient

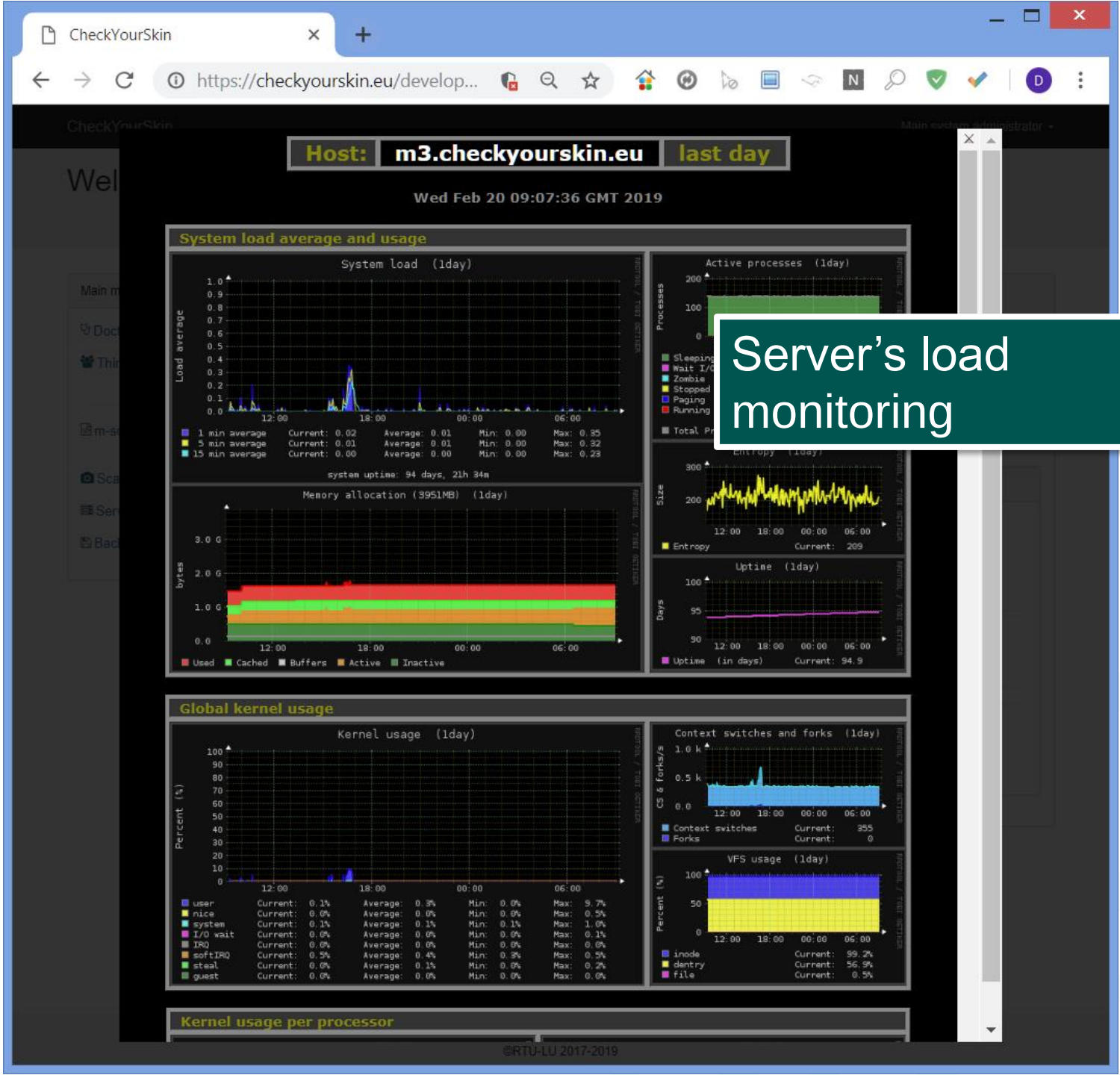

CheckYourSkin
https://checkyourskin.eu/doctor/...
CheckYourSkin
Hungary
Main menu for doctor
My patients
New patient
New measurements (20)
My profile
Patient control
Patient ID: #127
Is active
Patient's analyzes
Skin type
Normal
Birth date
05/06/1943
Description
basalioma, right eye, lacrimal bey
Save

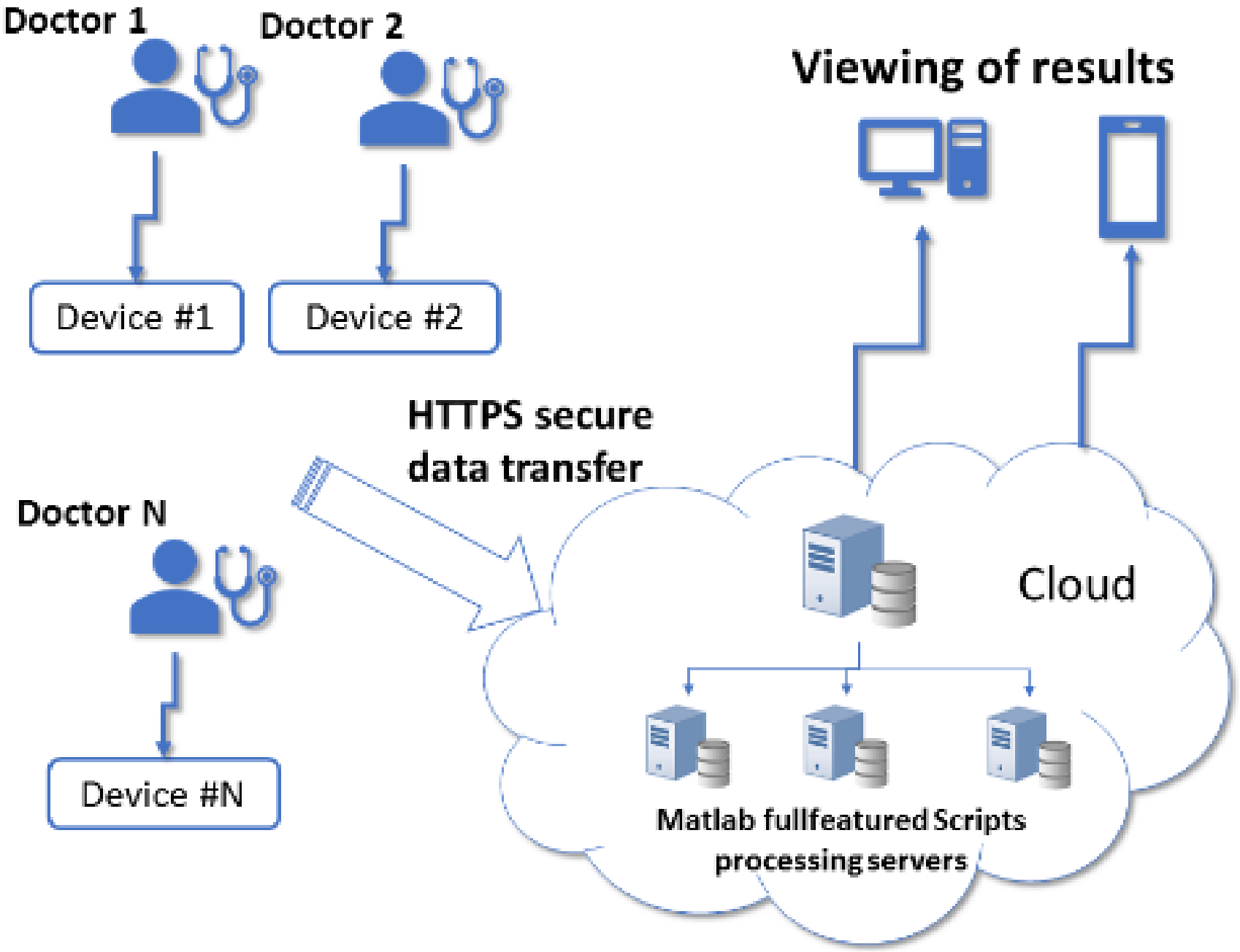


Patient's skin measurements

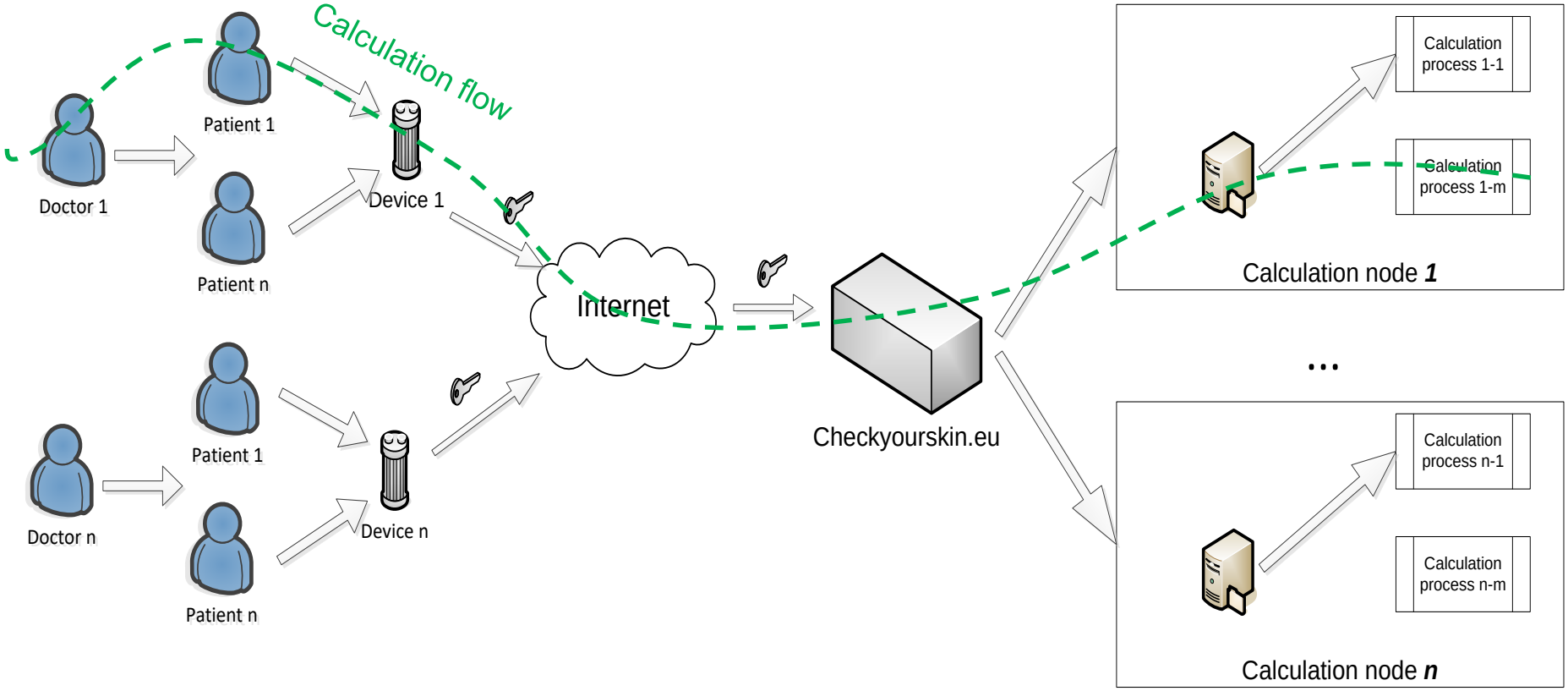


Servers monitoring and control

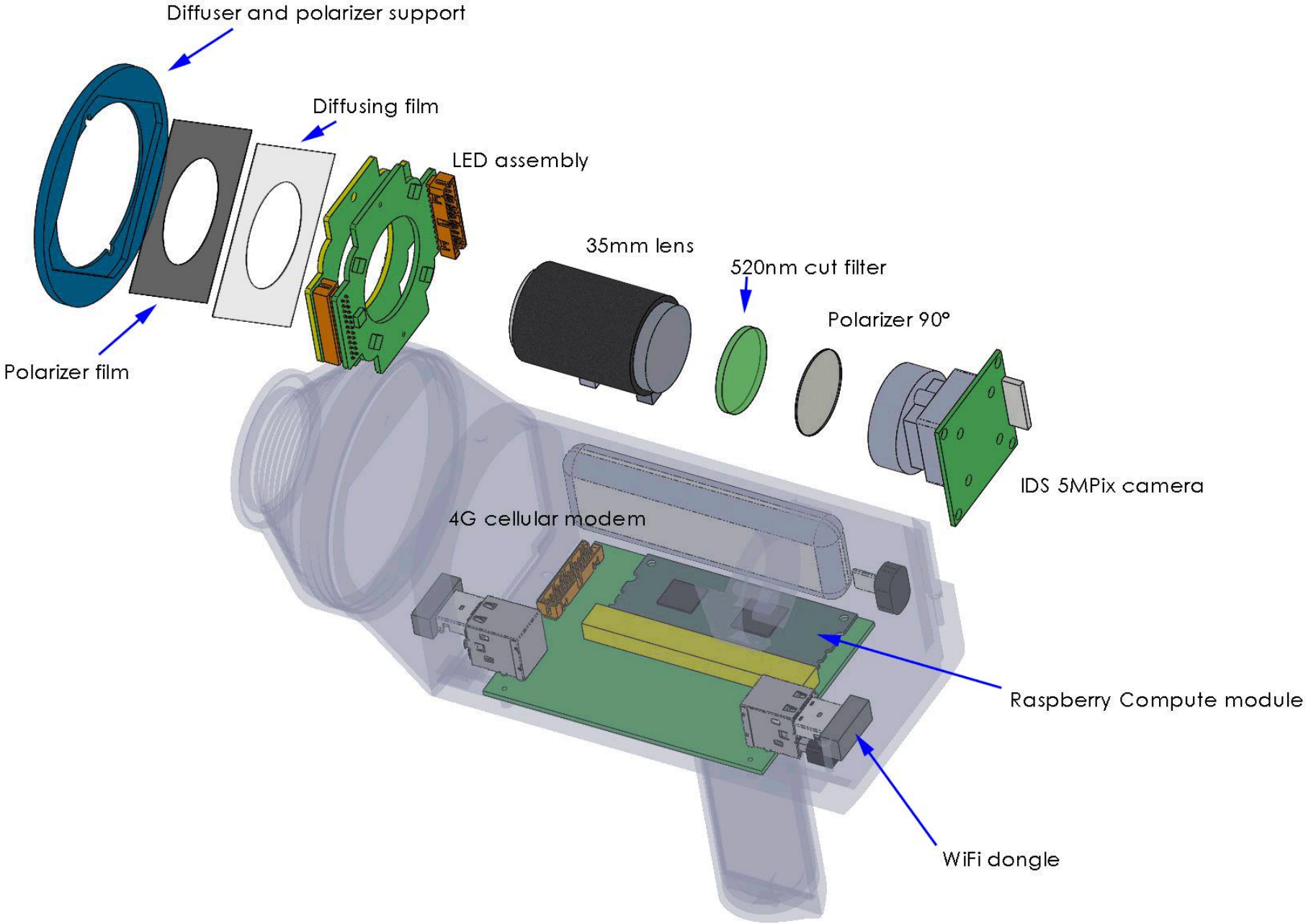

CheckYourSkin
https://checkyourskin.eu/develop...
Host: m3.checkyourskin.eu
last day
Wed Feb 20 09:07:36 GMT 2019
System load average and usage
System load (1day)
Active processes (1day)
Memory allocation (3951MB) (1day)
Entropy (1day)
Uptime (1day)
Global kernel usage
Kernel usage (1day)
Context switches and forks (1day)
VFS usage (1day)
Kernel usage per processor
Server's load monitoring
©RTU-LU 2017-2019

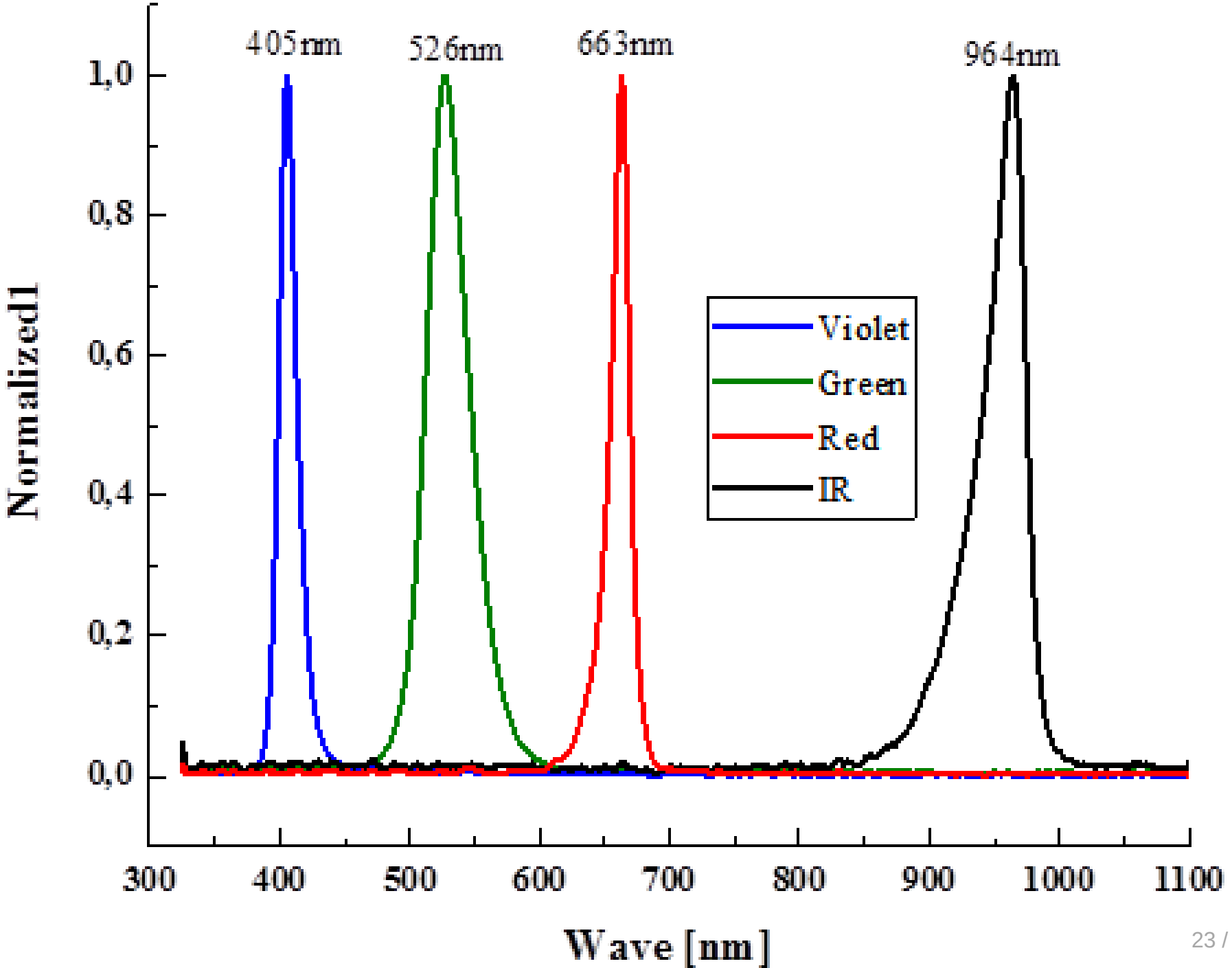

Doctor 1
Doctor 2
Viewing of results
Device #1
Device #2
HTTPS secure
data transfer
Doctor N
Cloud
Device #N
Matlab fullfeatured Scripts
processing servers

Cloud based diagnostics (SaaS)

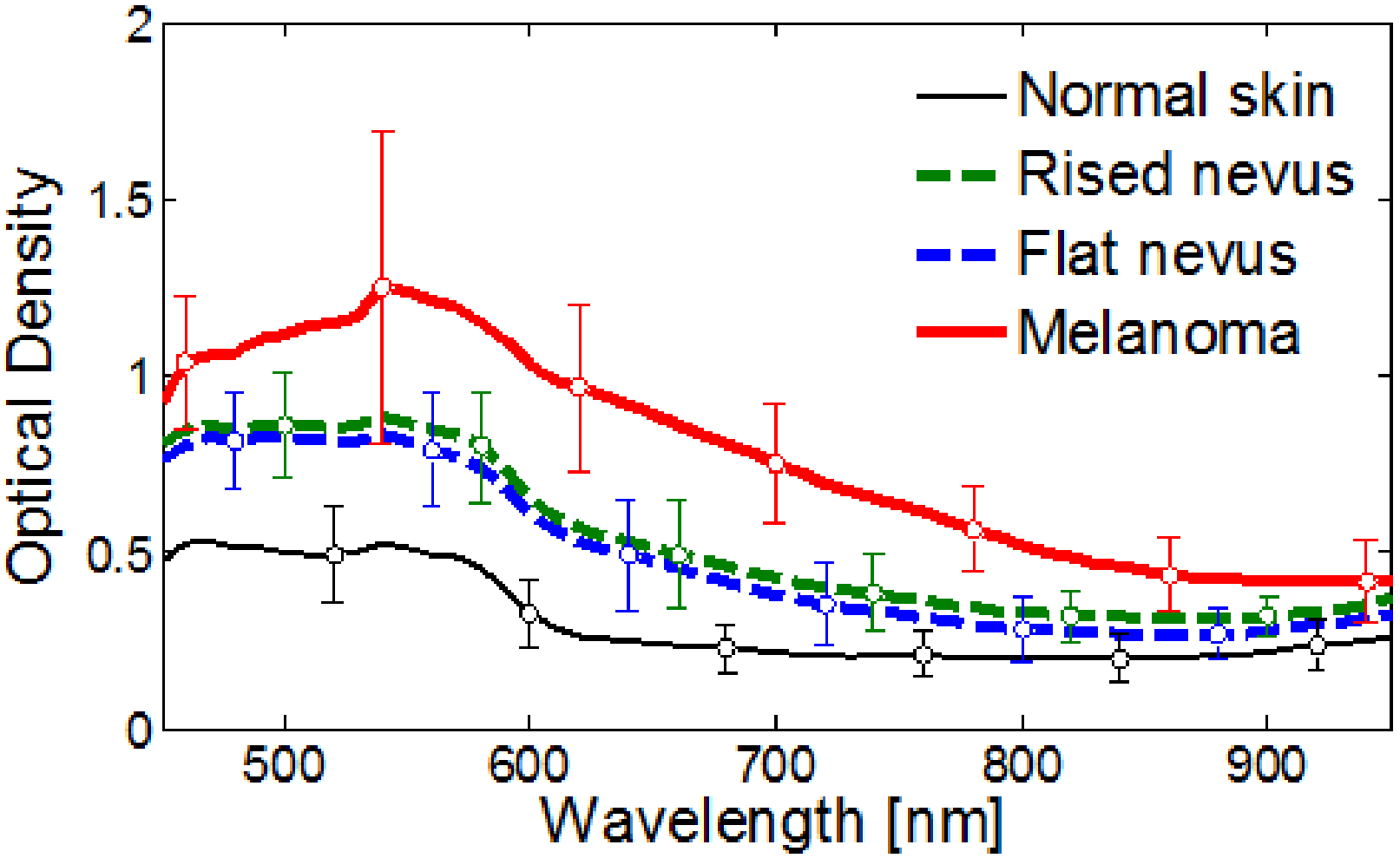


Could be used as a standalone service for various image analysis

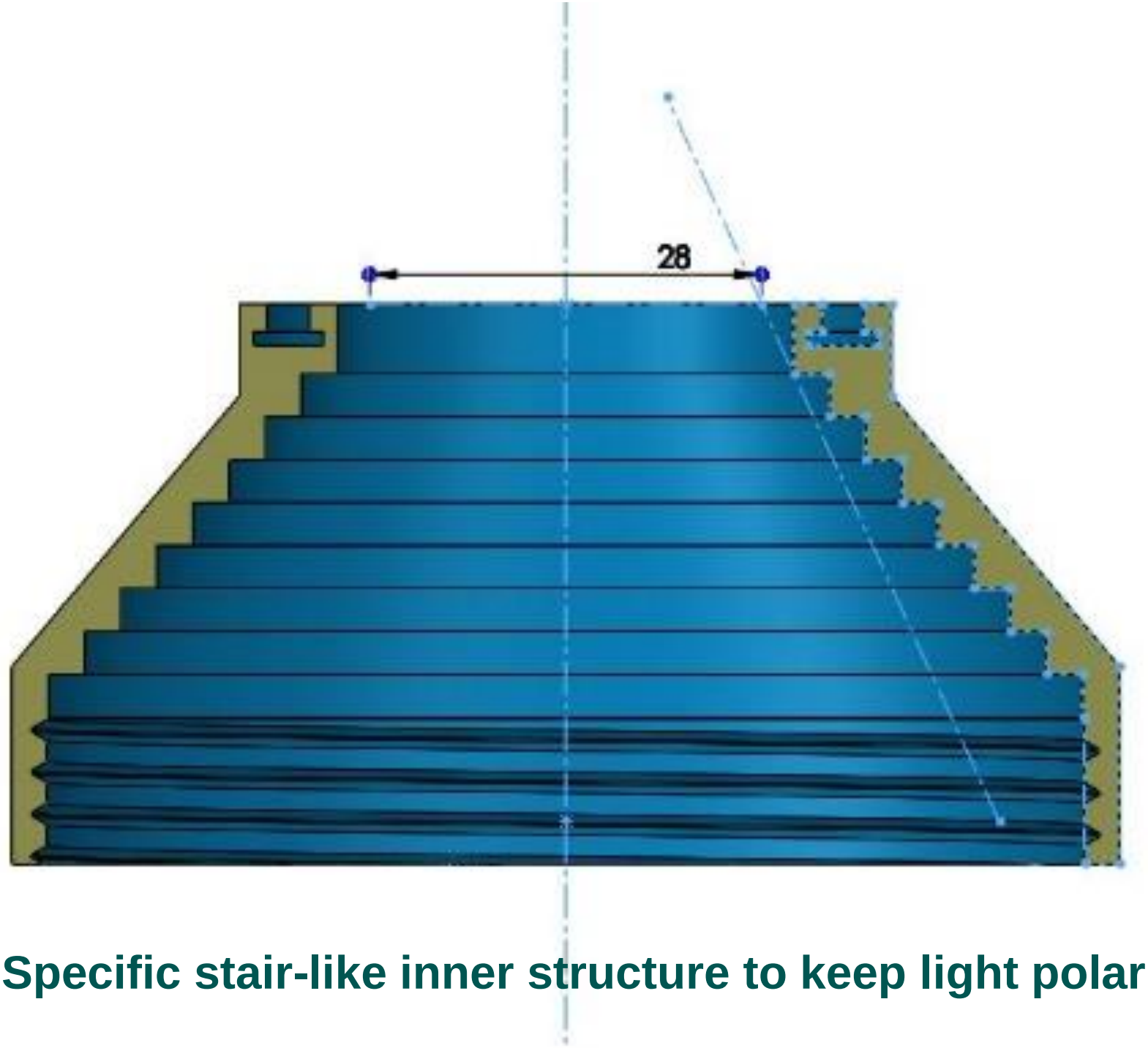

Diffuser and polarizer support
Diffusing film
LED assembly
Polarizer film
35mm lens
520nm cut filter
Polarizer 90°
IDS 5MPix camera
4G cellular modem
Raspberry Compute module
WiFi dongle


405nm
526nm
663nm
964nm
1,0
0,8
0,6
0,4
0,2
0,0
Normalized1
Violet
Green
Red
IR
300
400
500
600
700
800
900
1000
1100
Wave [nm]

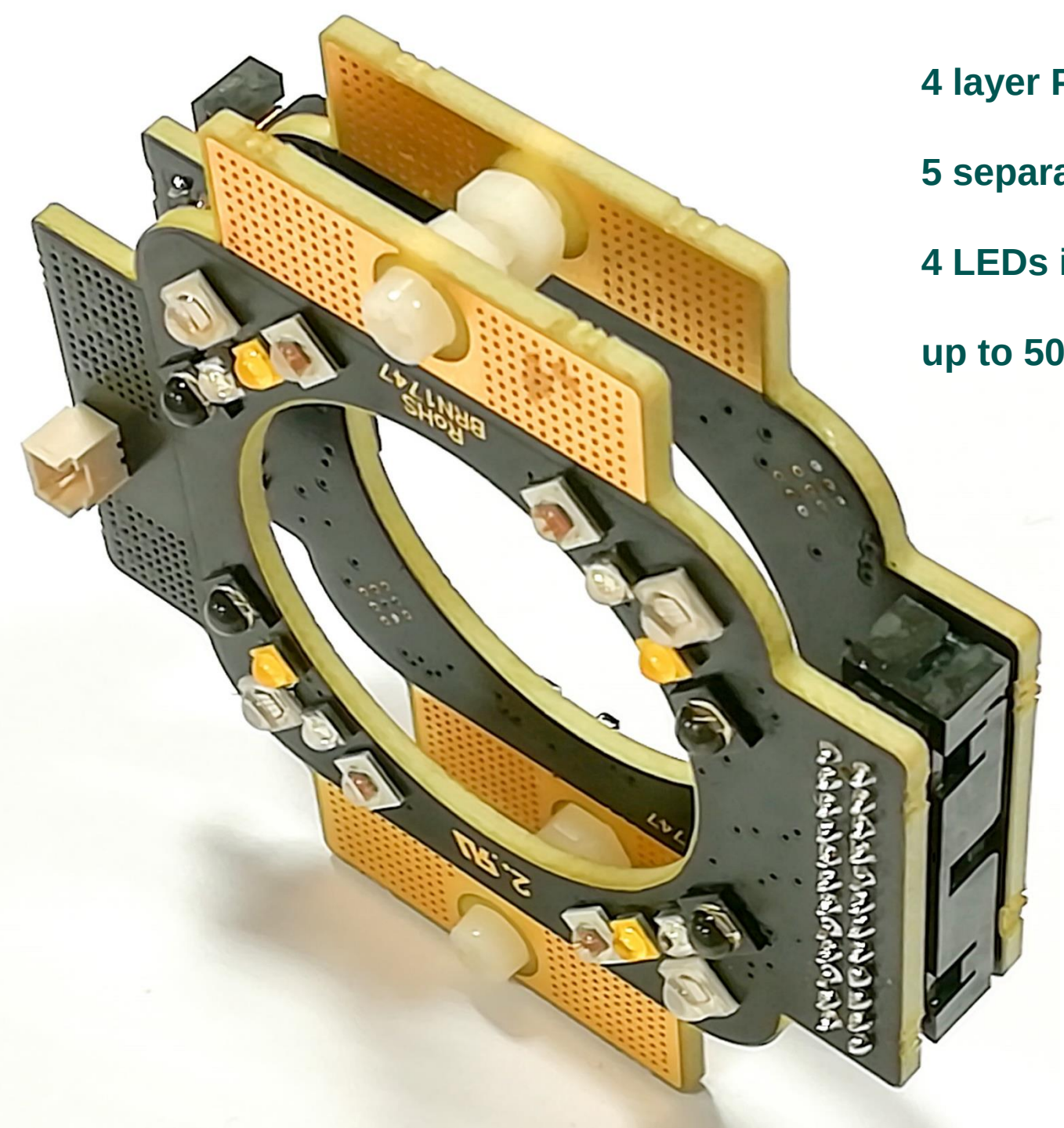
Optical Density spectra of skin lesions



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)



Specific stair-like inner structure to keep light polarizatio



4 layer PCBs

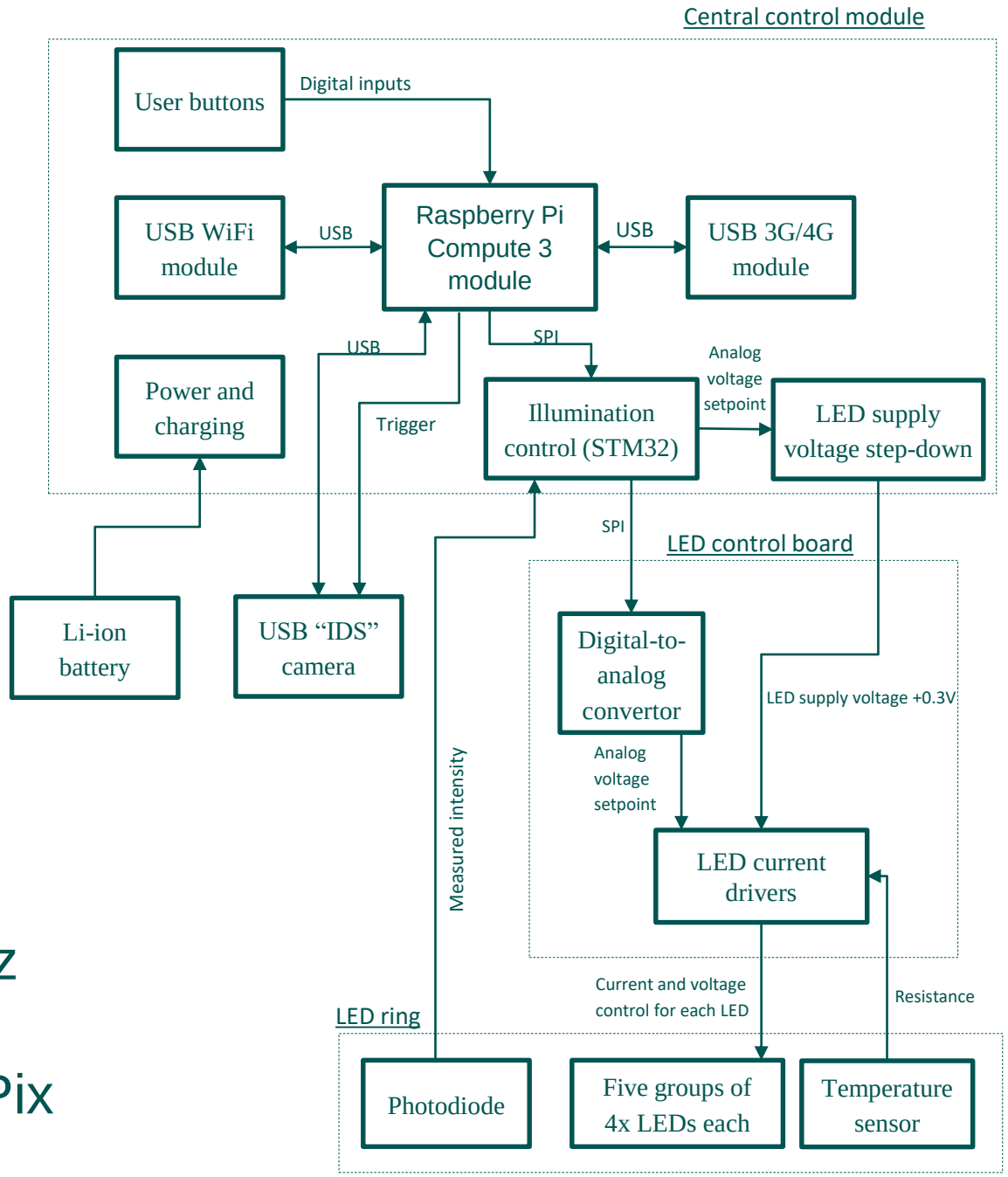
5 separately controlled LED grou

4 LEDs in each group

up to 500mA to each diode

Modular architecture

- LED illumination,
- LED control,
- Camera,
- Central module,
- Wireless connectivity.



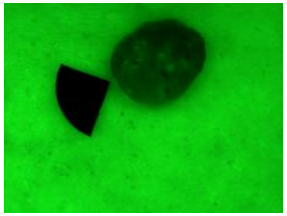
3G → 4G

WiFi 2.4GHz → 5GHz

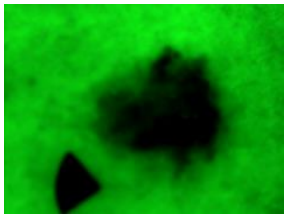
Camera 1 Mpix / 5MPix

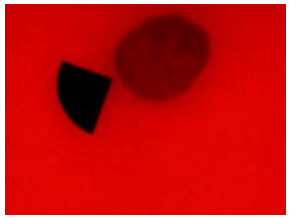
Nevus

Melanoma

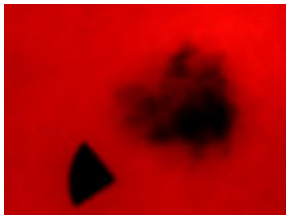


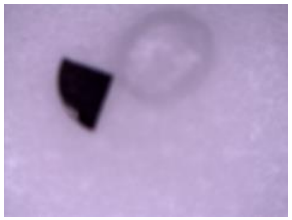
λ=535nm



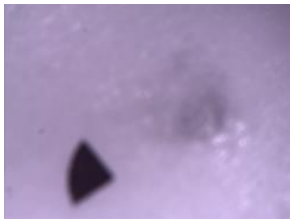


λ=660nm

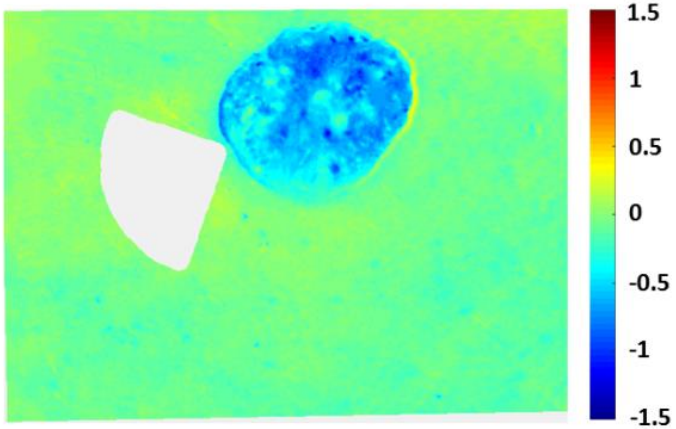




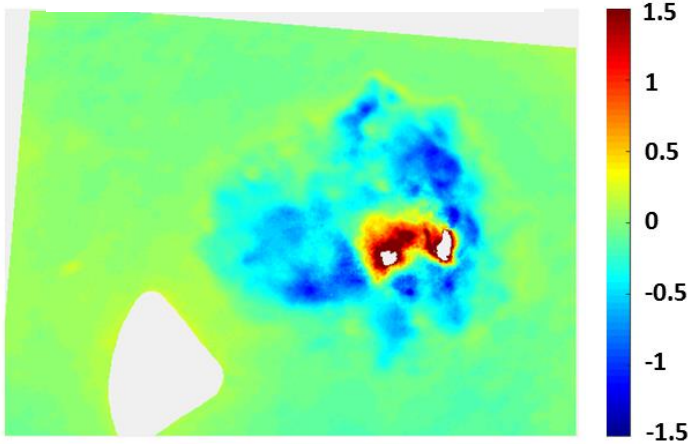
λ=950nm



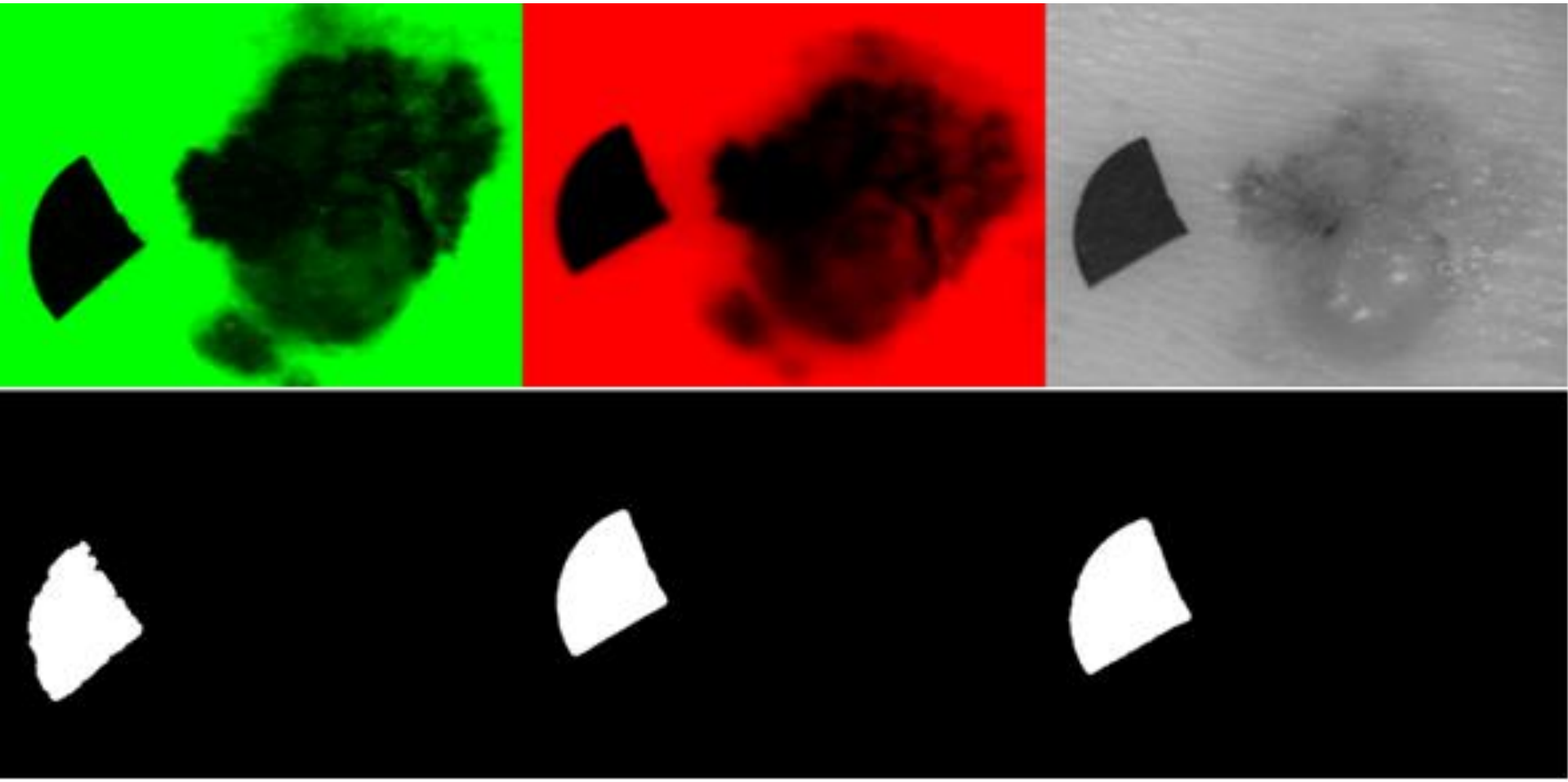
p’ karte



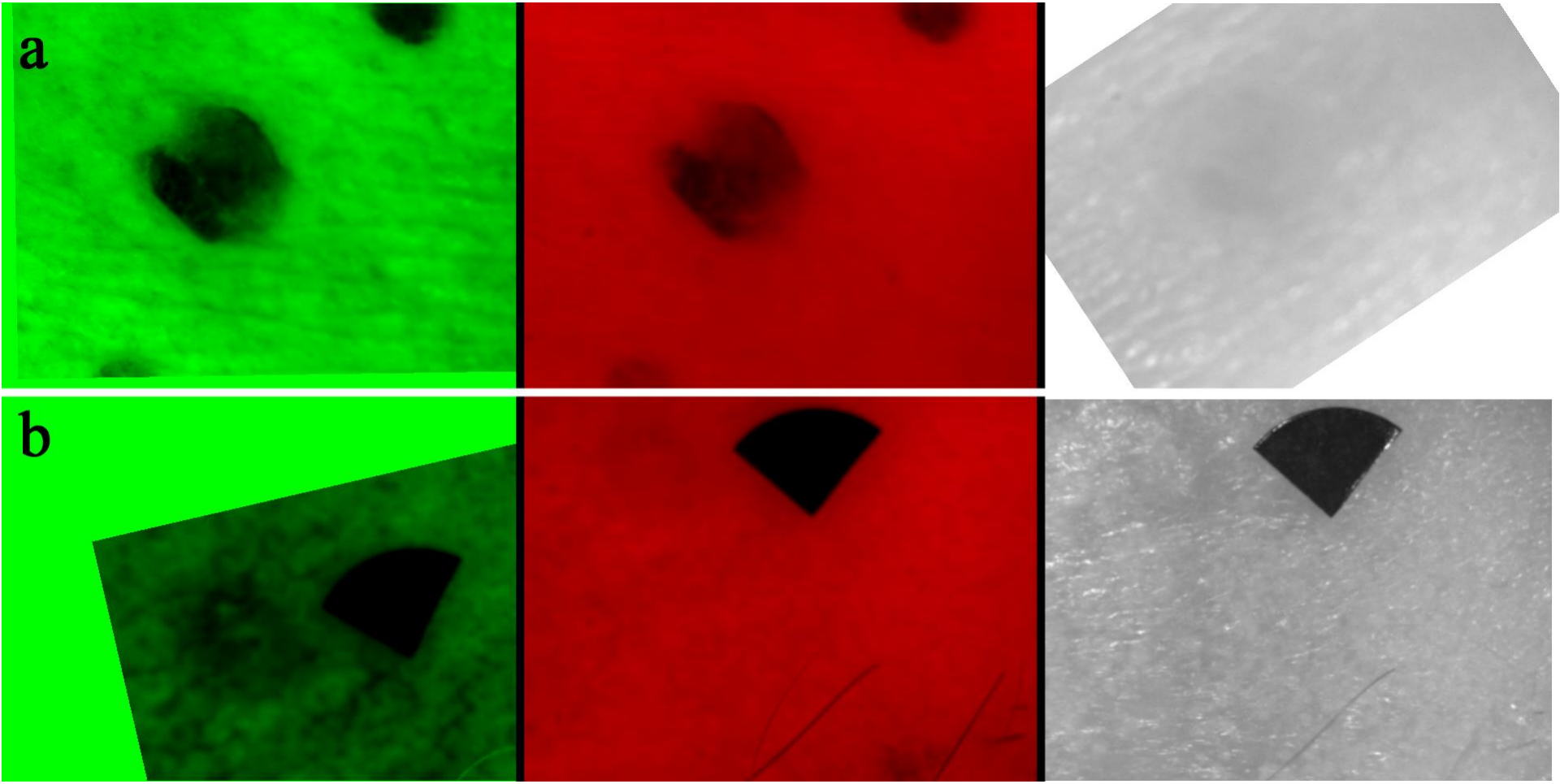
p’ karte



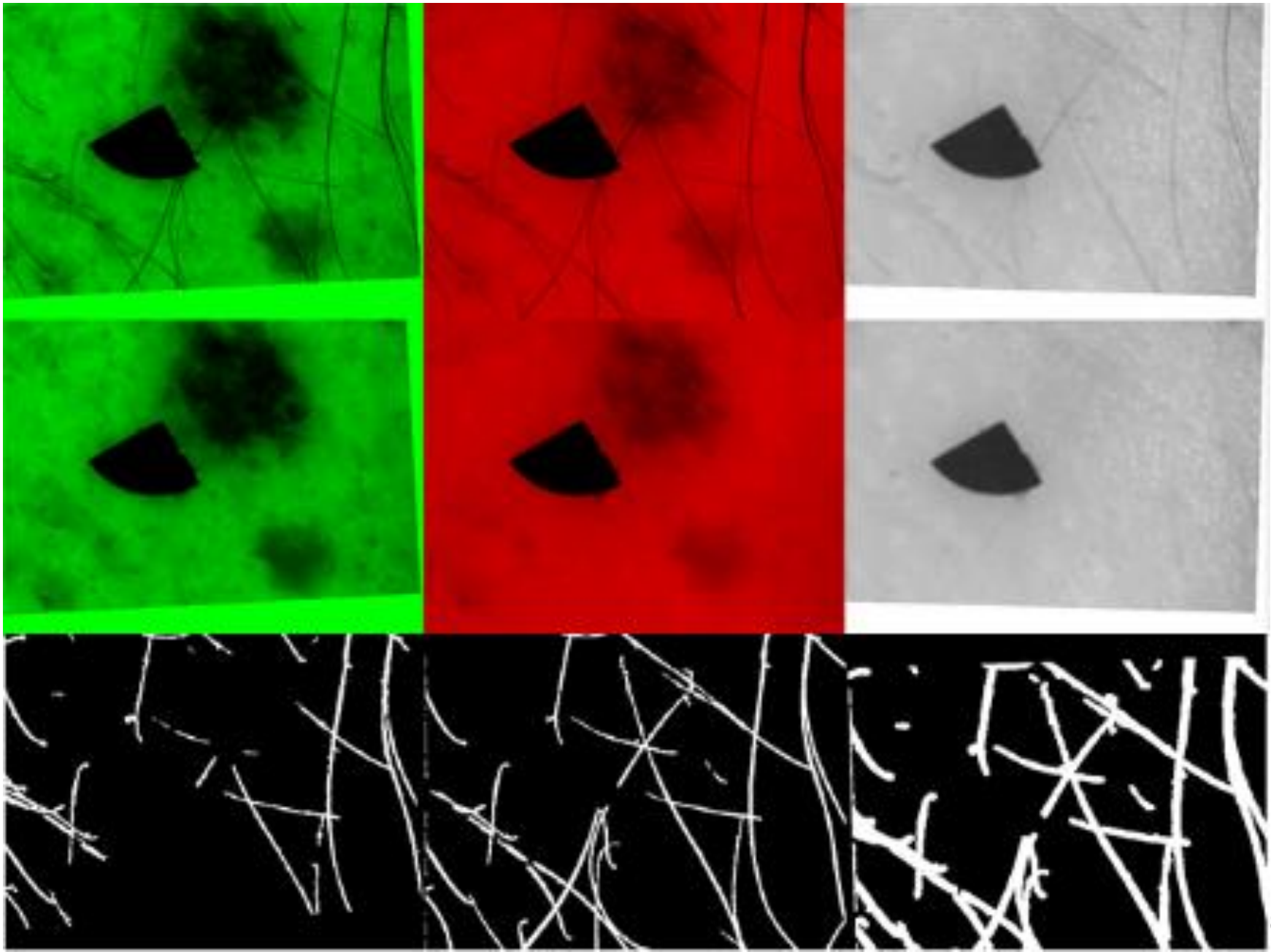
Searching for marker



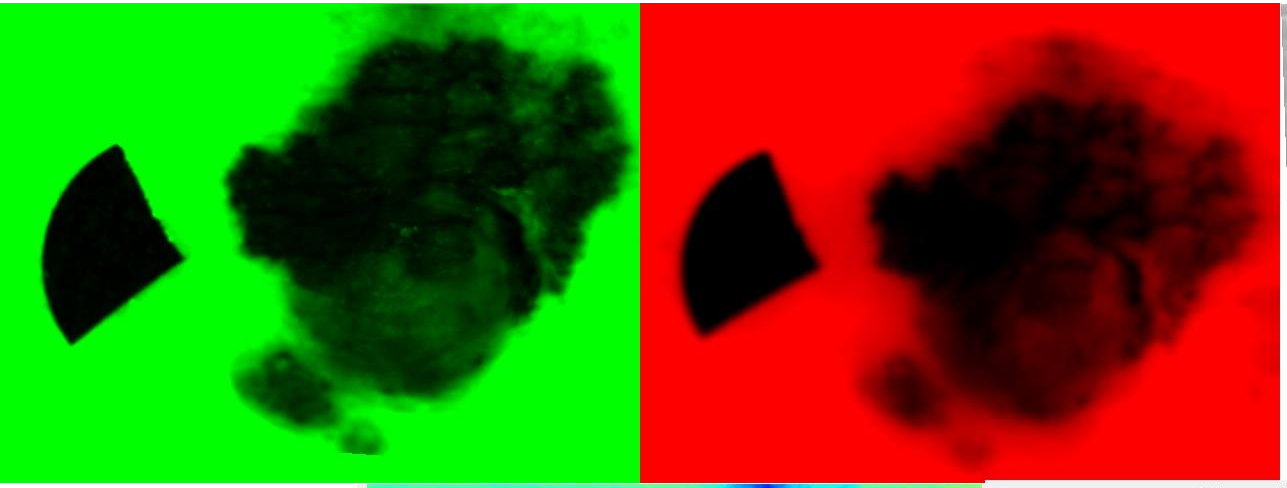
Stabilizing by marker

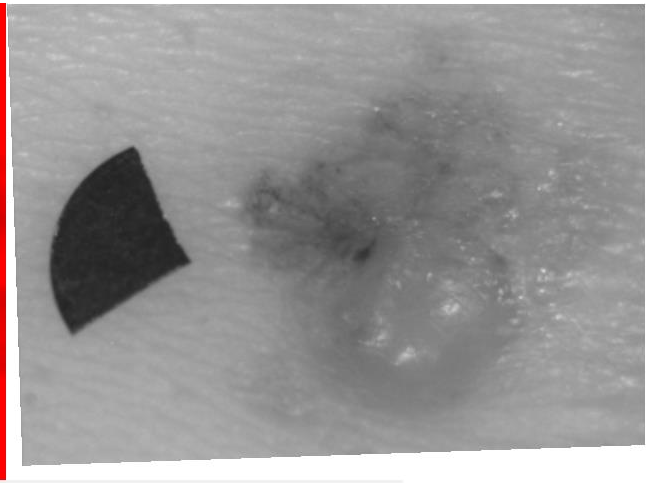


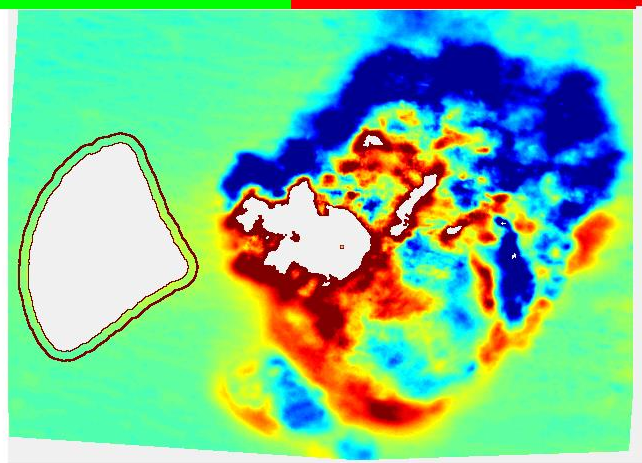
Removing hair

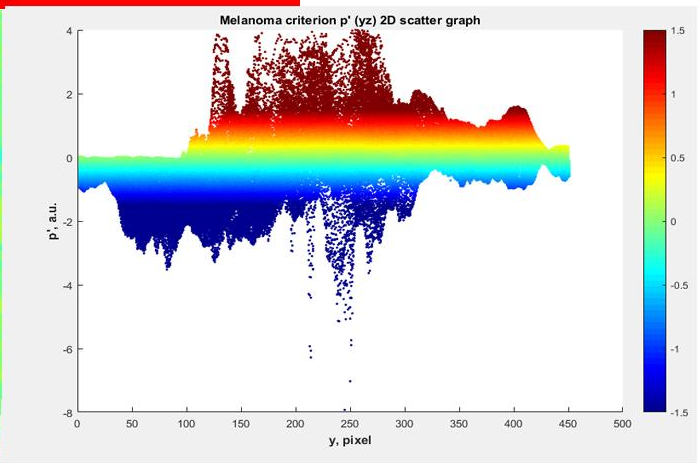


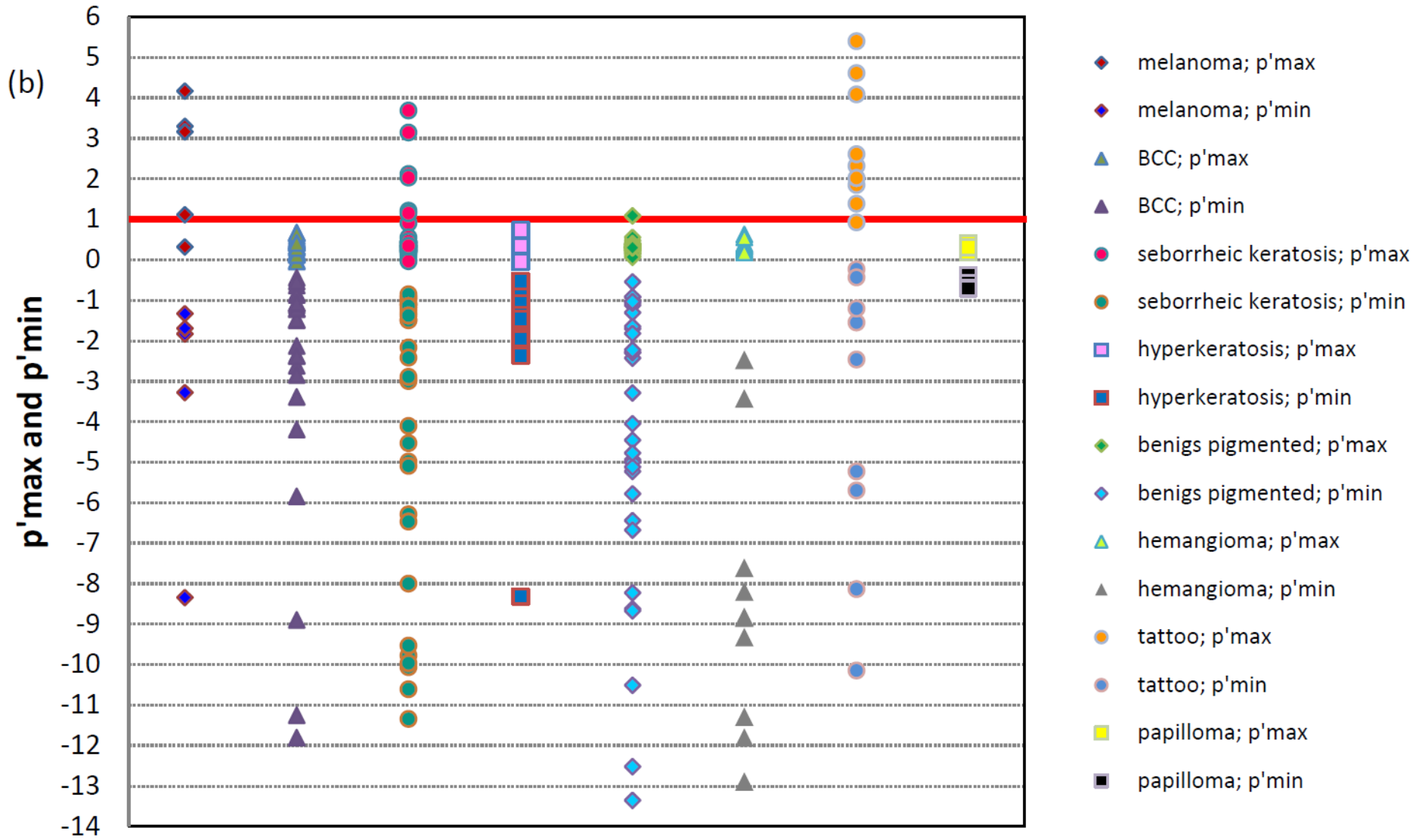
Searching for healthy skin



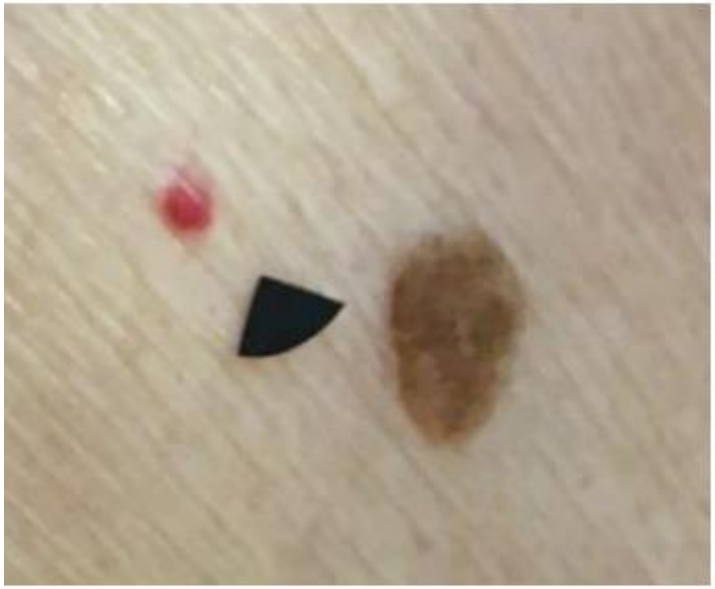


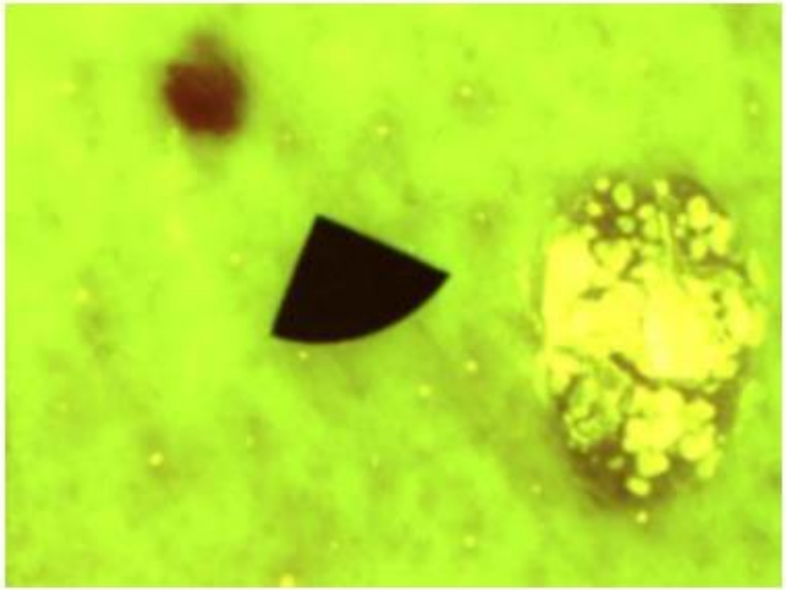




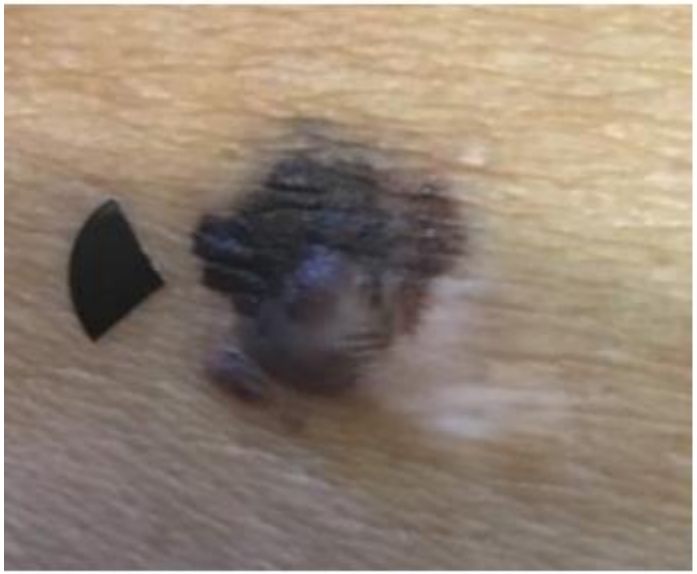

(b)
p'max and p'min
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
melanoma; p'max
melanoma; p'min
BCC; p'max
BCC; p'min
seborrheic keratosis; p'max
seborrheic keratosis; p'min
hyperkeratosis; p'max
hyperkeratosis; p'min
benigs pigmented; p'max
benigs pigmented; p'min
hemangioma; p'max
hemangioma; p'min
tattoo; p'max
tattoo; p'min
papilloma; p'max
papilloma; p'min

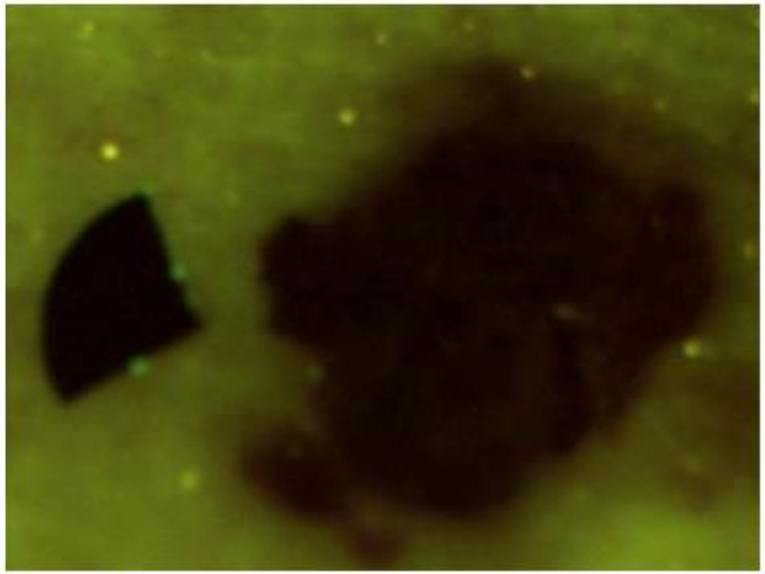
Seborrheic keratosis



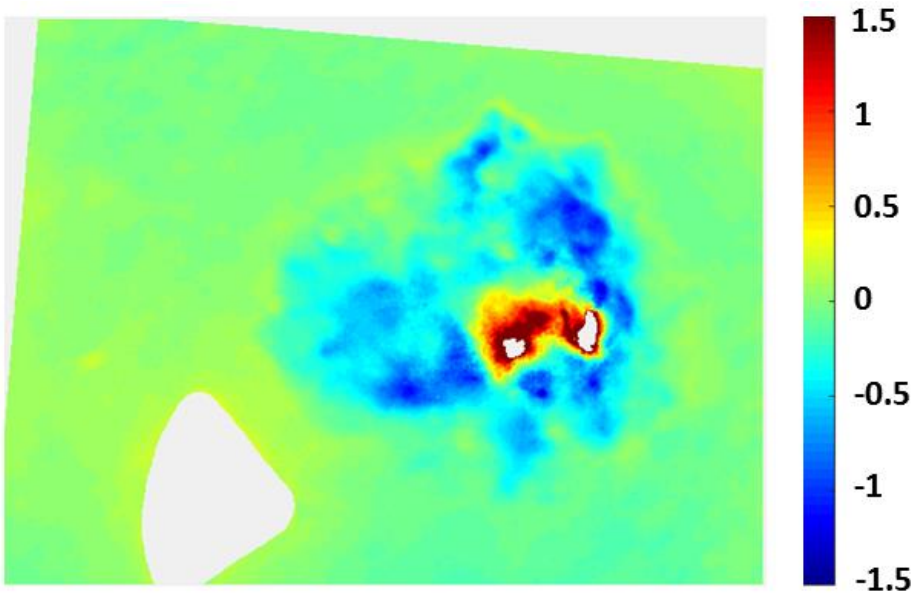


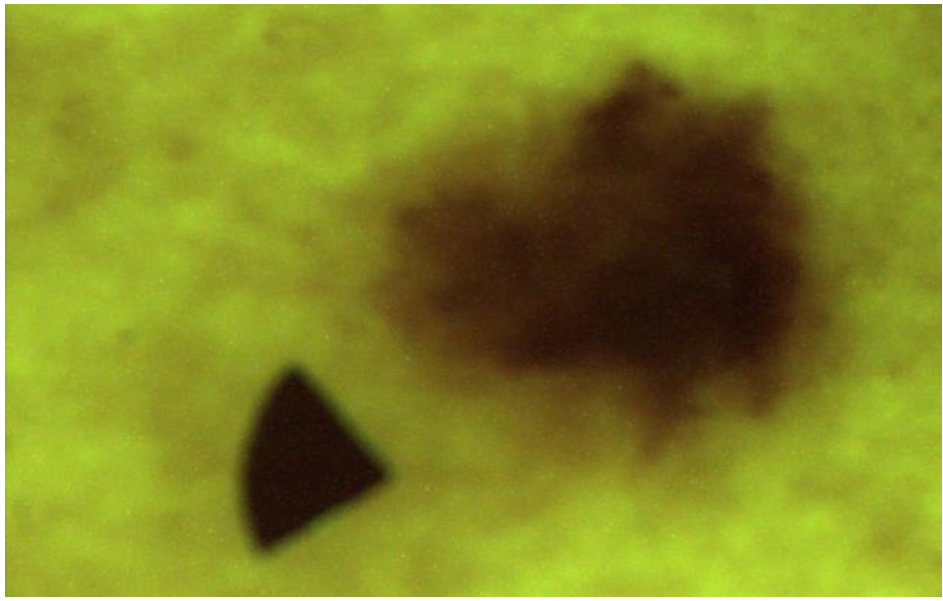
Malignant melanoma

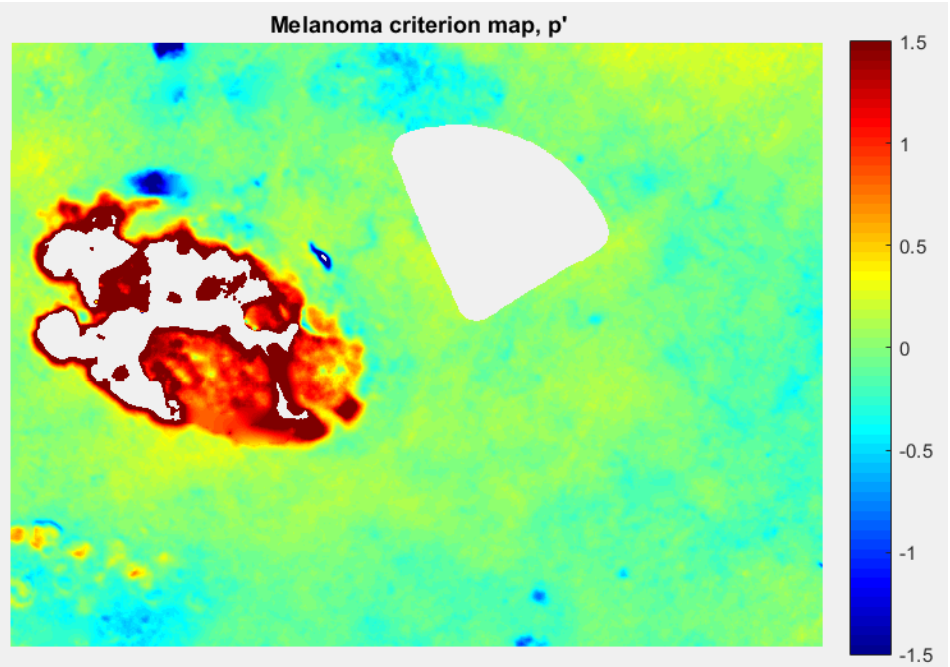


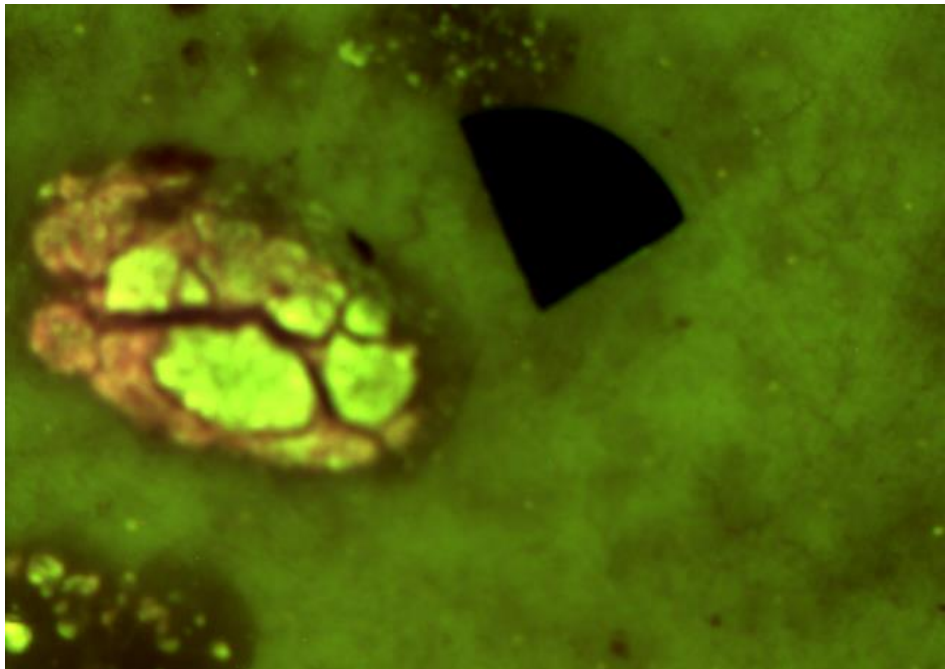


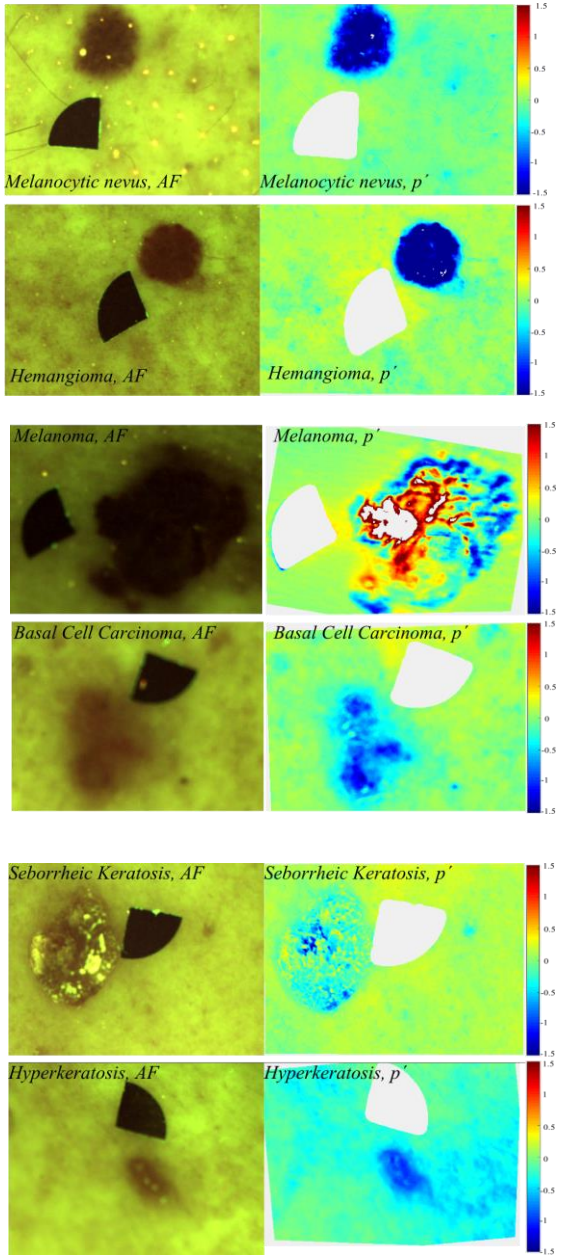
MELANOMA VS SEB.KERATOSIS



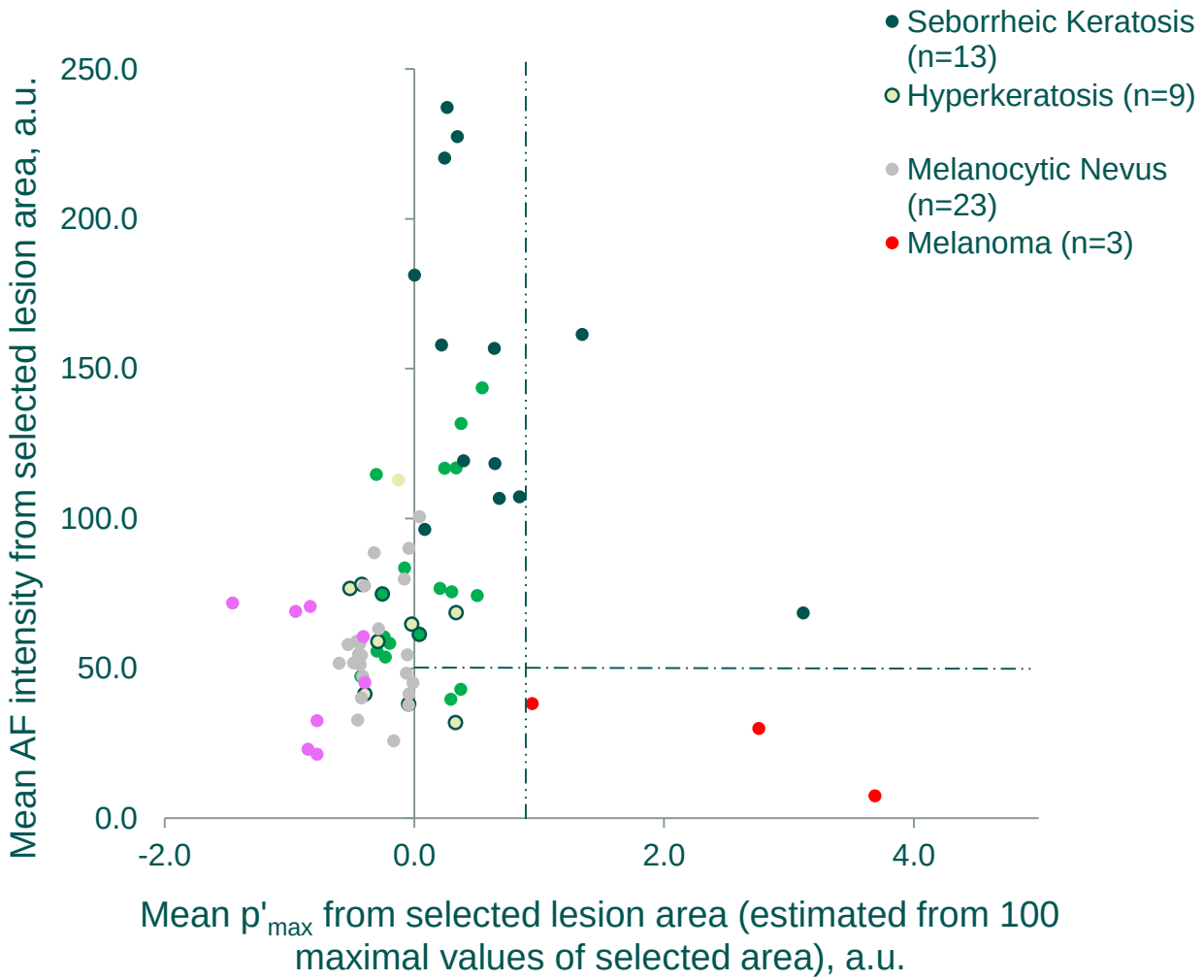






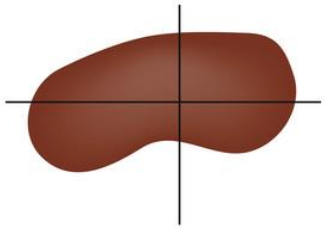


$$p' = lg\left(\frac{I(526)\cdot I_{skin}(663)\cdot I_{skin}(964)}{I_{skin}(526)\cdot I(663)\cdot I(964)}\right)$$



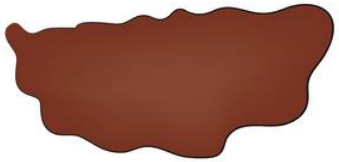
I. Lihacova, K. Bolochko, E. V. Plorina, M. Lange, A. Lihachev, D. Bliznuks, and A. Derjabo, "A method for skin malformation classification by combining multispectral and skin autofluorescence imaging," SPIE Proc 10685, 1068535 (2018).

ABCDE rule for the early detection of melanoma



A

Asymmetry

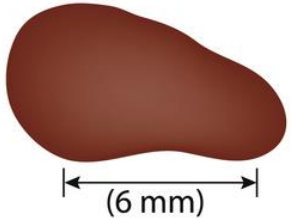


B

Borders
(the outer edges
are uneven)

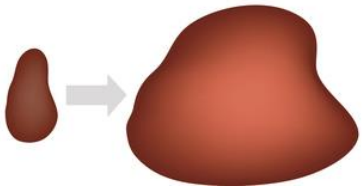
C

Color
(dark black or have
multiple colors)



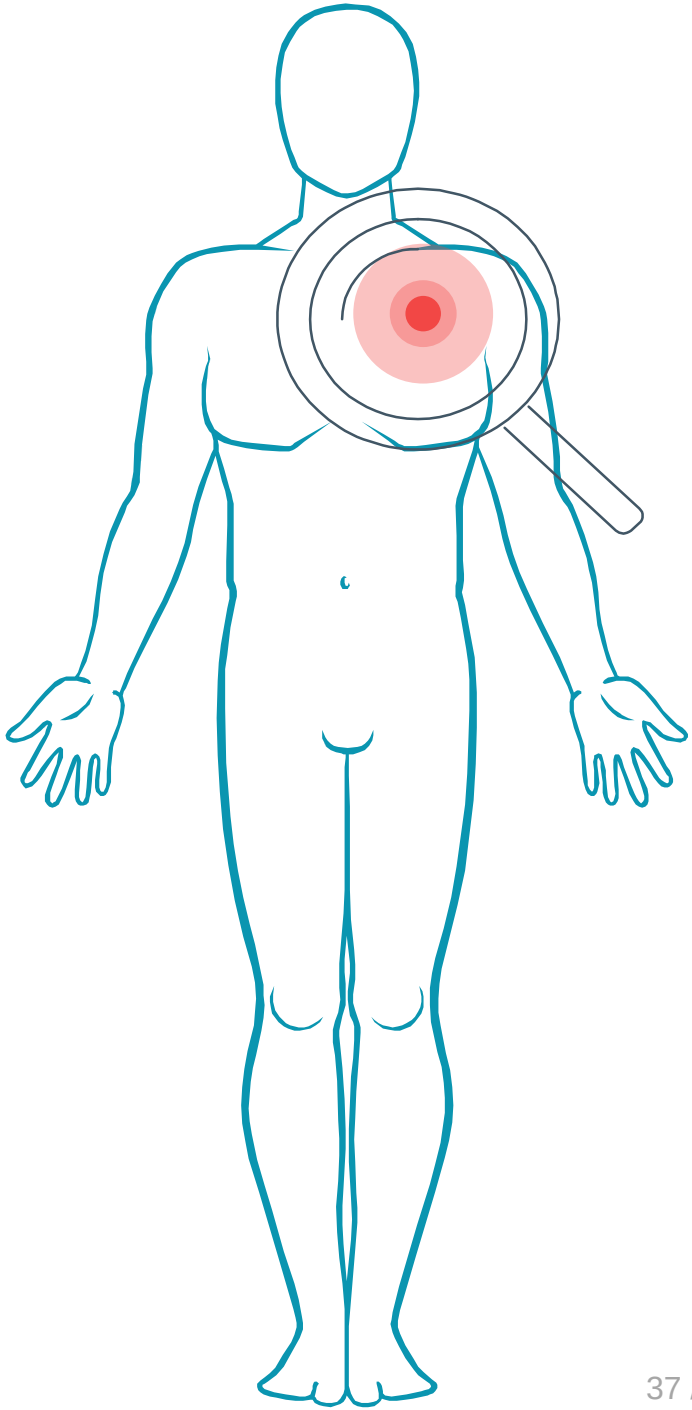
D

Diameter
(greater than 6 mm)



E

Evolving
(change in size,
shape and color)



Acknowledgements

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