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Image quality enhancement for skin cancer optical diagnostics

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NACIONĀLAIS ATTĪSTĪBAS PLĀNS 2020

EIROPAS SAVIENĪBA
Eiropas Reģionālās attīstības fonds

IEGULDĪJUMS TAVĀ NĀKOTNĒ

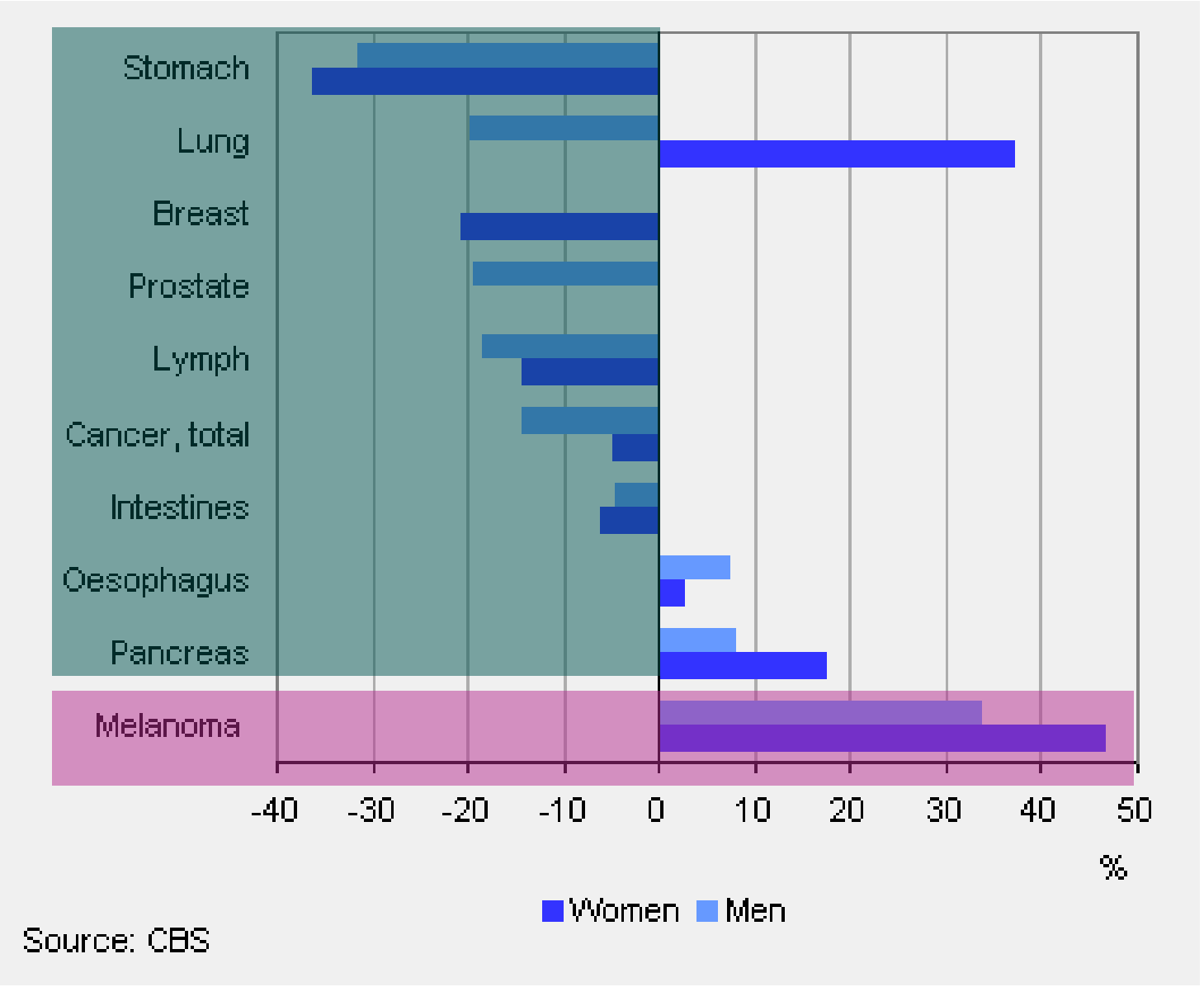
Outlines

- Skin cancer non-contact diagnostics
- Common quality flaws and their prevention
- Image quality in skin cancer diagnostics
- Enhancing images

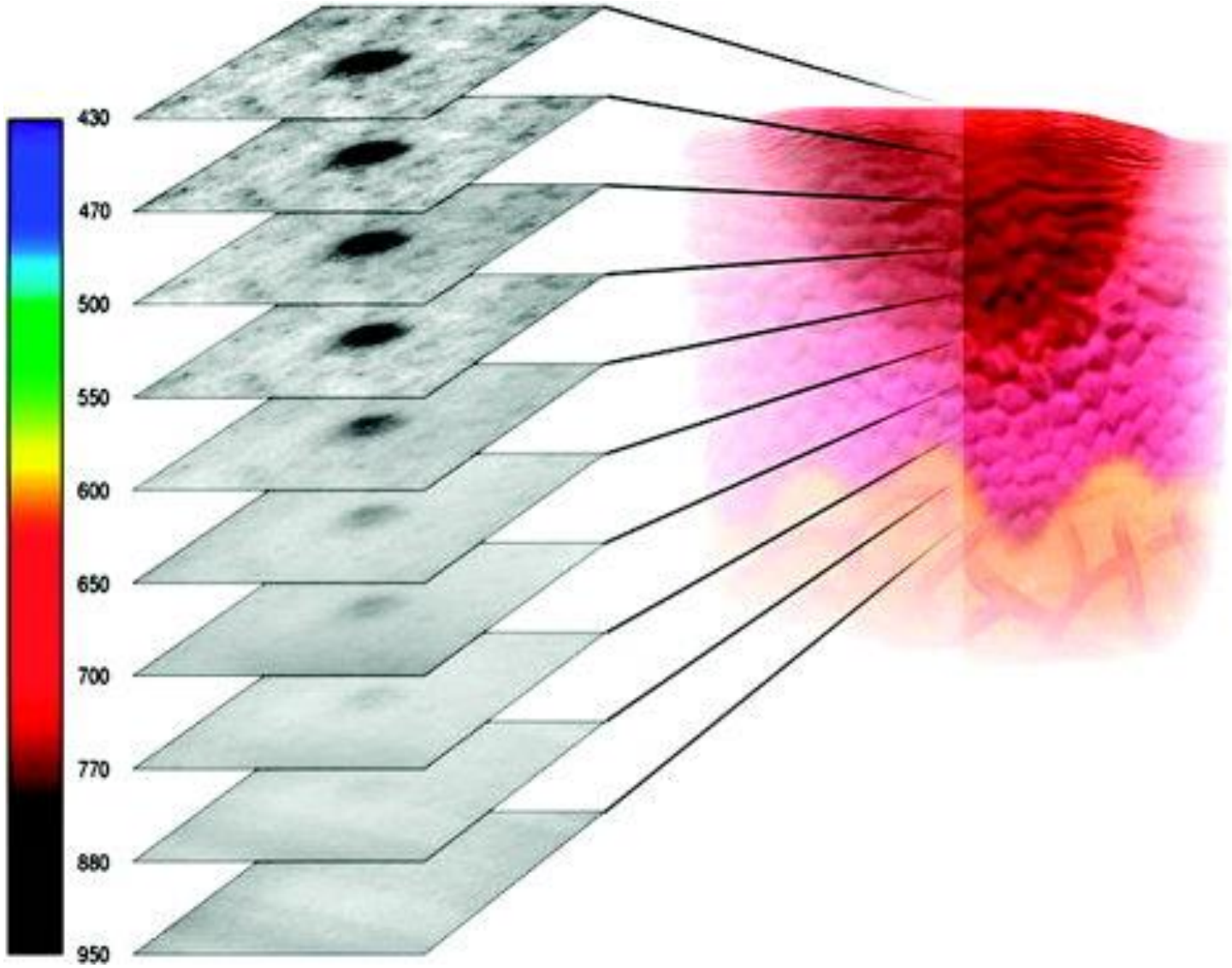
Why skin cancer?

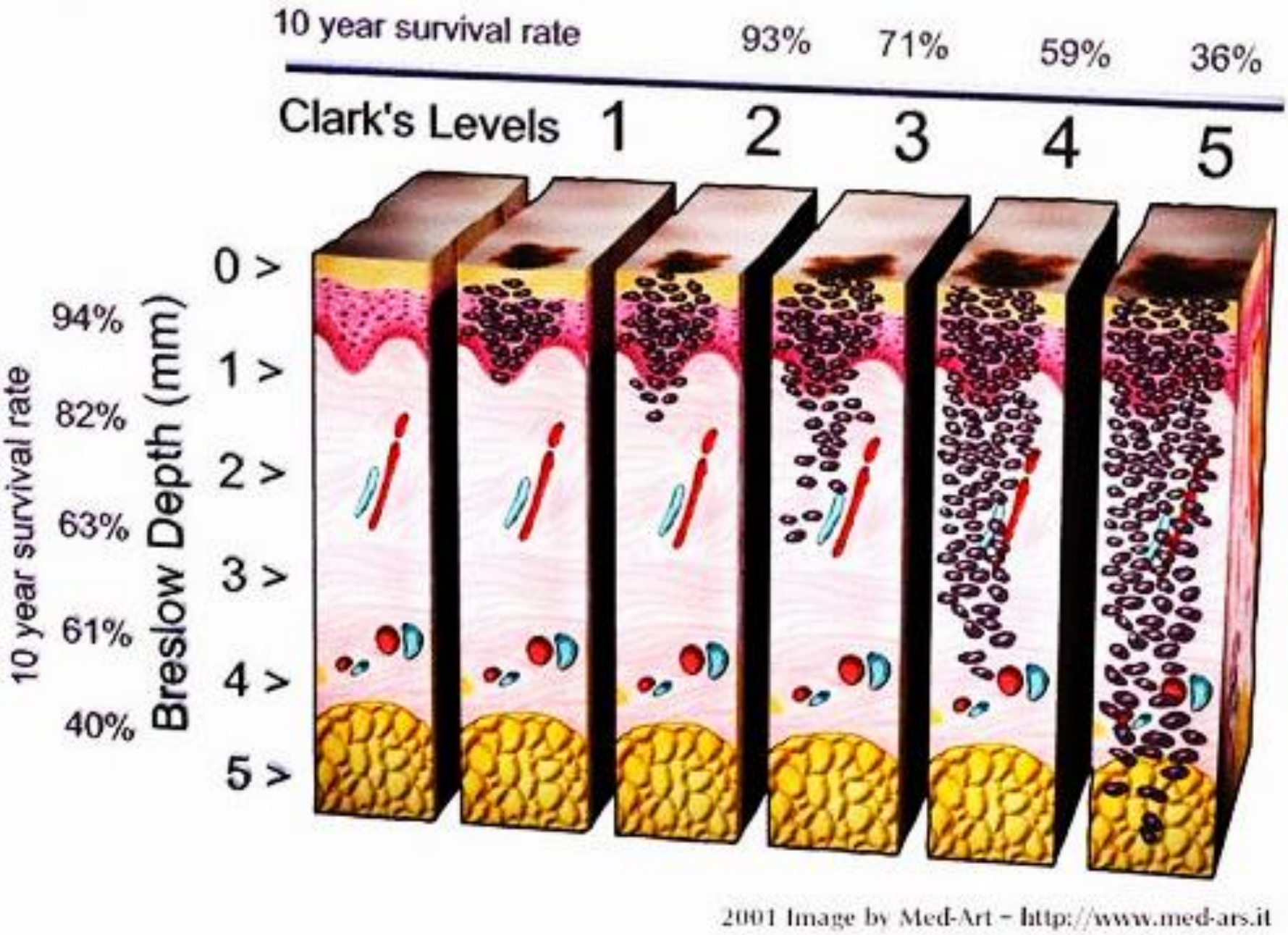
Why optical diagnostics?

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



Wavelengths' skin penetration depth




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

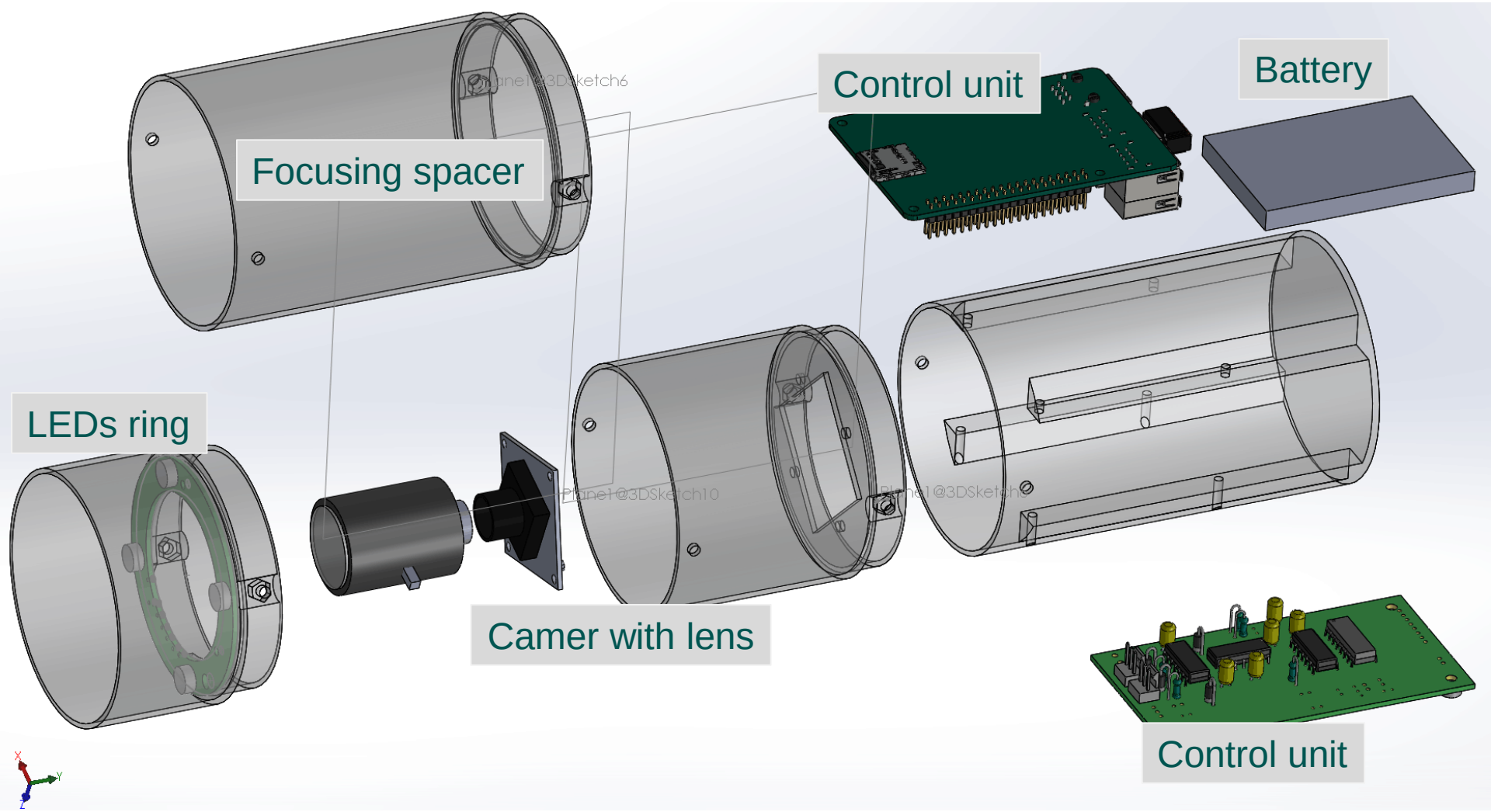
*”Almost **100%** will survive their cancer for 5 years or more after they are diagnosed at **Stage #1**”*

vs

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

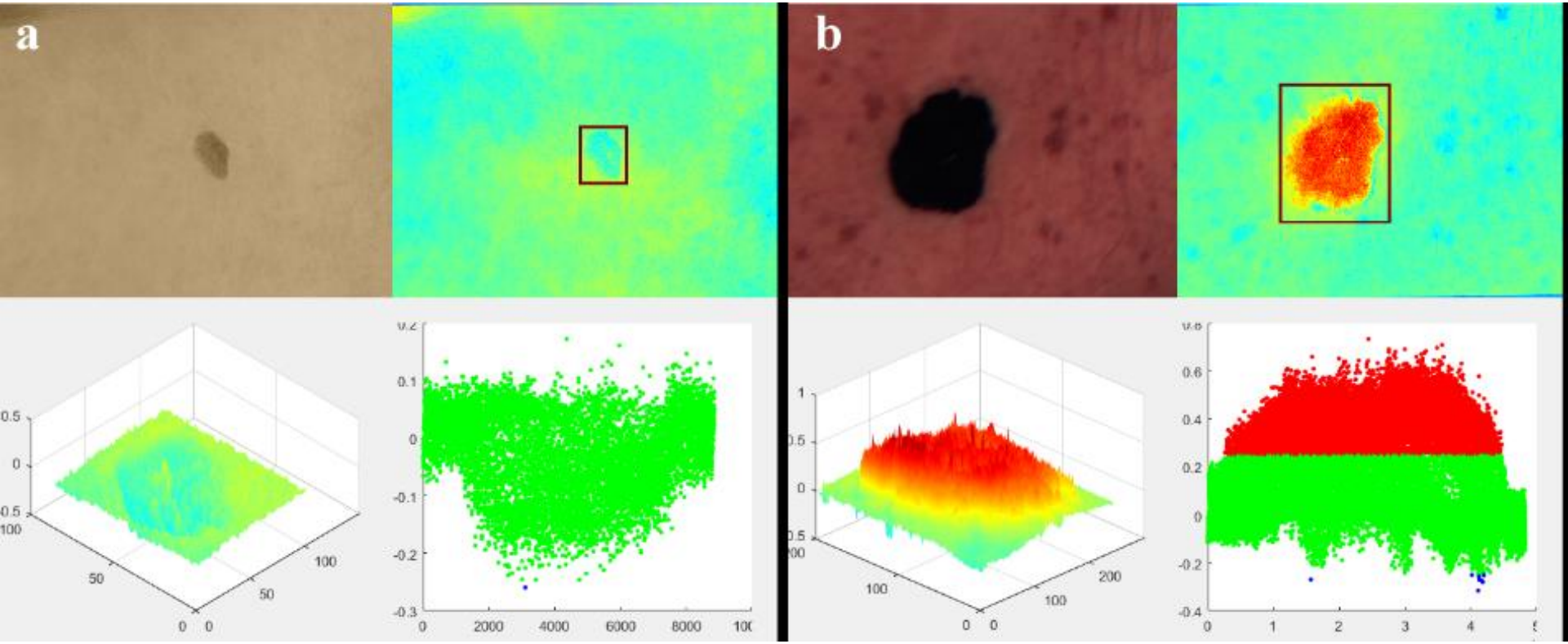
*Statistical Information Team at Cancer Research UK

Proposed system



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

Diagnostic algorithm



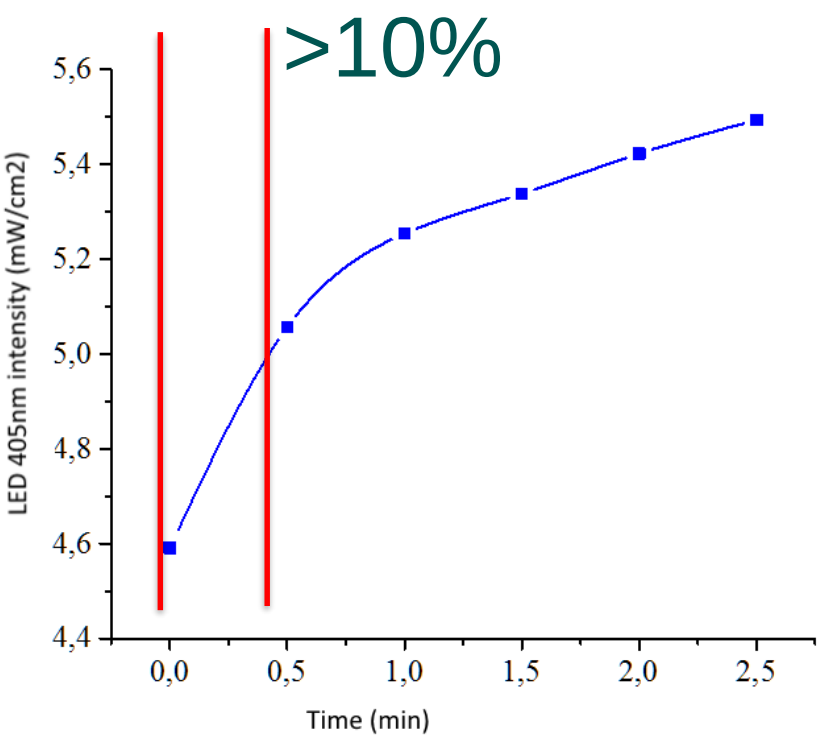
- Healthy skin and nevi, the parameter $p^{'} \in [-0.3; 0.25]$, *green and yellow hues*;
- For melanomas, $p^{'} > 0.25$, *red and orange hues*;
- For basal cell carcinoma, $p^{'} < -0.3$, blue and cyan hues

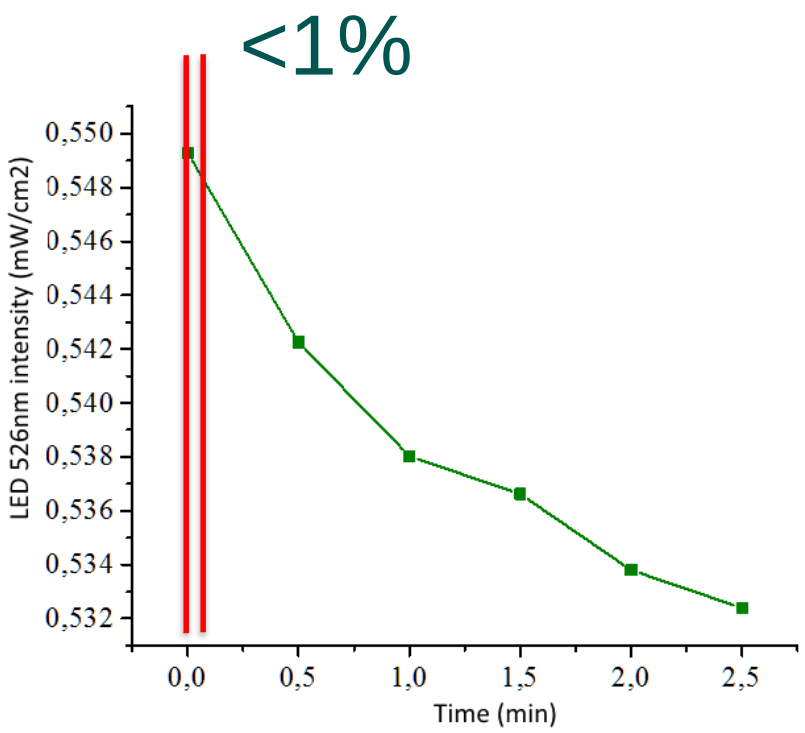
Ilze Ļihačova, Ādas onkoloģisko patoloģiju novērtējums ar multispektrālās attēlošanas metodēm, PhD thesis, (2015)

Imaging system

- illuminating light source,
- lens and filters,
- camera sensor and sensor data readout hardware,
- image storage format.

Illumination stability





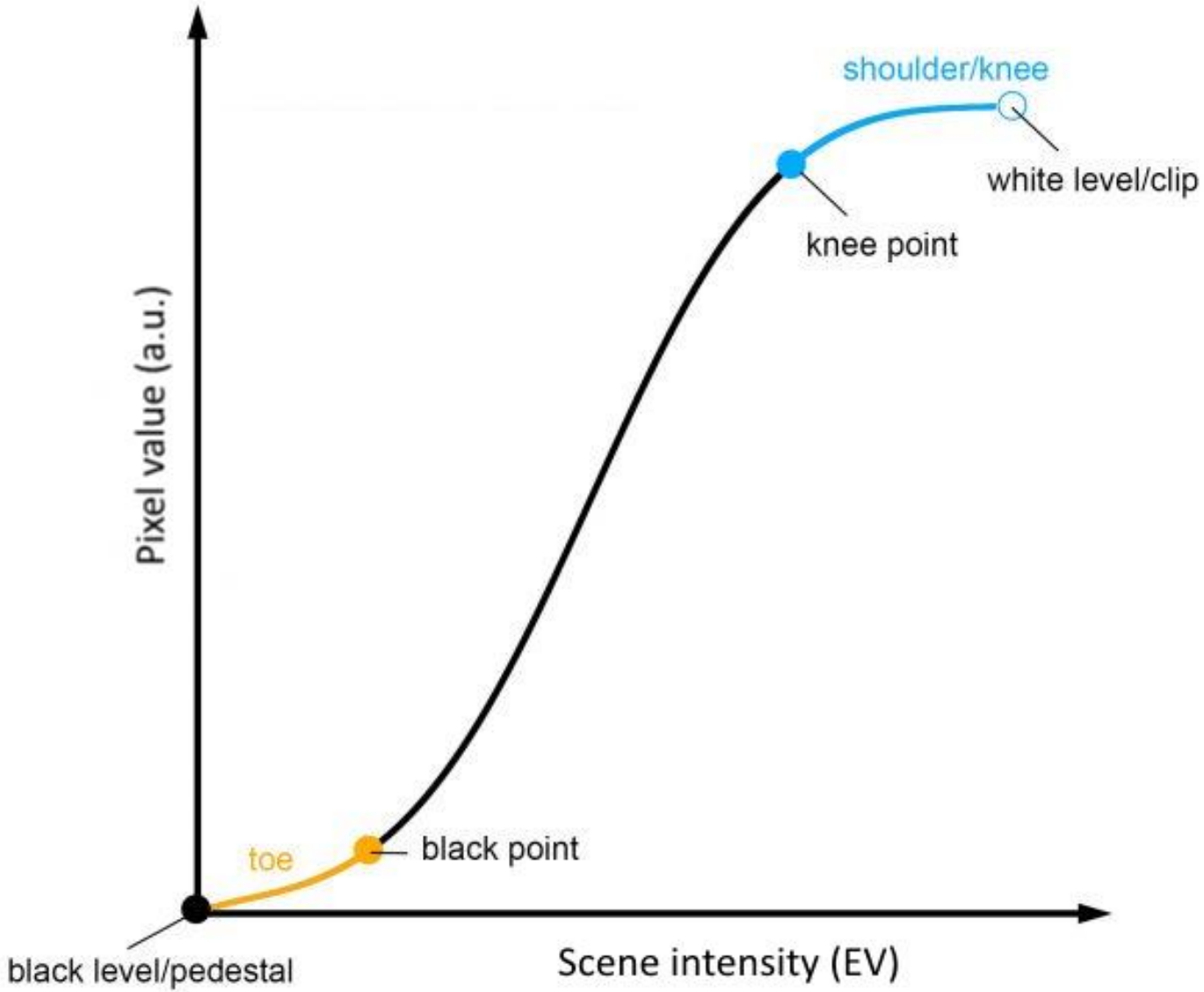
Ultraviolet 405nm vs 525nm LED illumination change in time

For **photobleaching** algorithms, long (>20s) exposures required

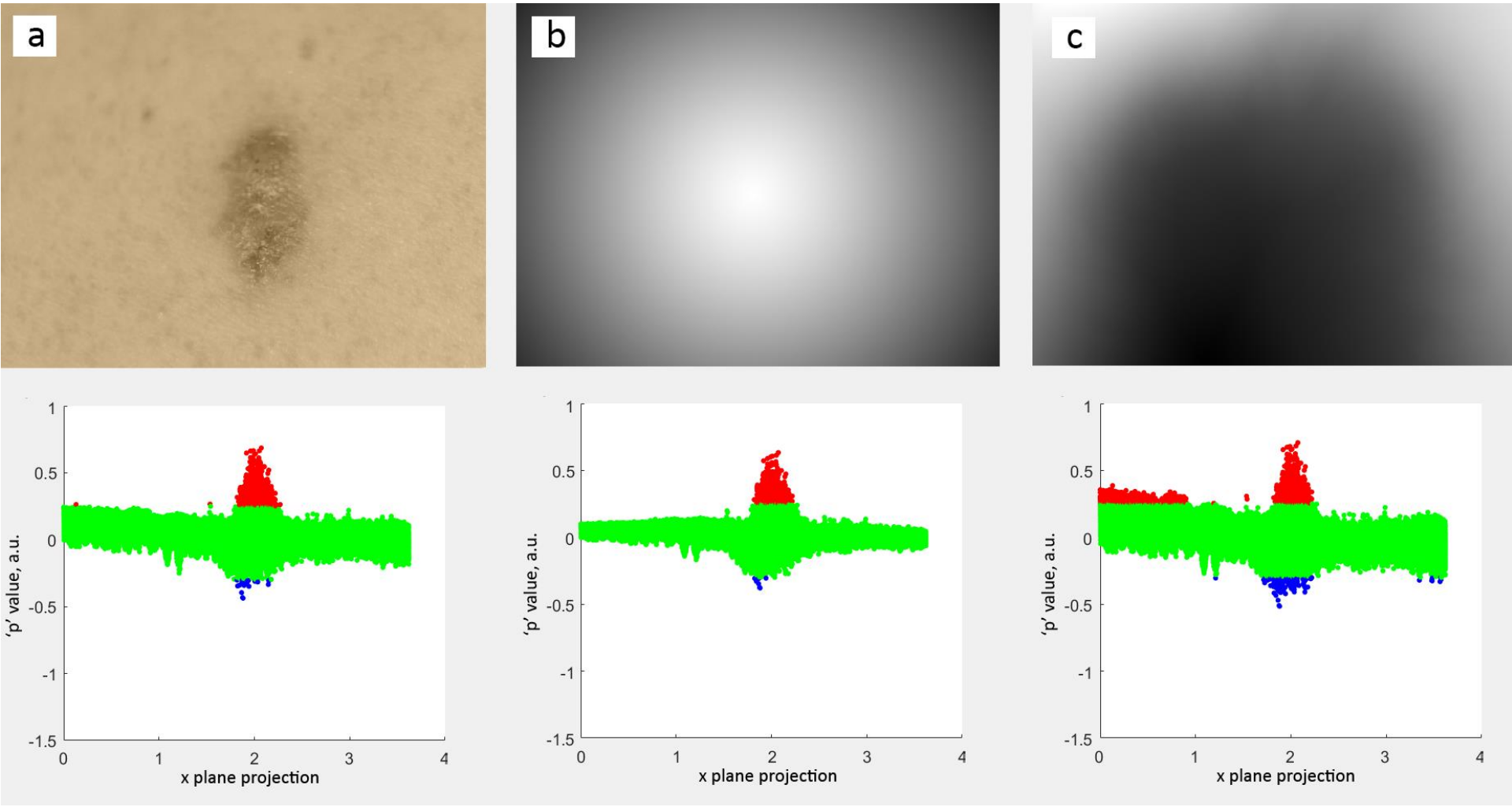
Lens and filter impact

- Reduction of the amount of light,
- Changing scenes' depth of field,
- Light reduction on periphery (vignetting),
- Distortions (barrel/pincushion),
- Sharpness reduction (MTF chart),
- Differences in wavelength transfer (chromatic aberrations).

Imaging sensor light response



Non-uniform light field effects



a) Uniform field
b) Vignette effect
c) Unequal light field, affecting final diagnostic result

False positive melanoma diagnosis

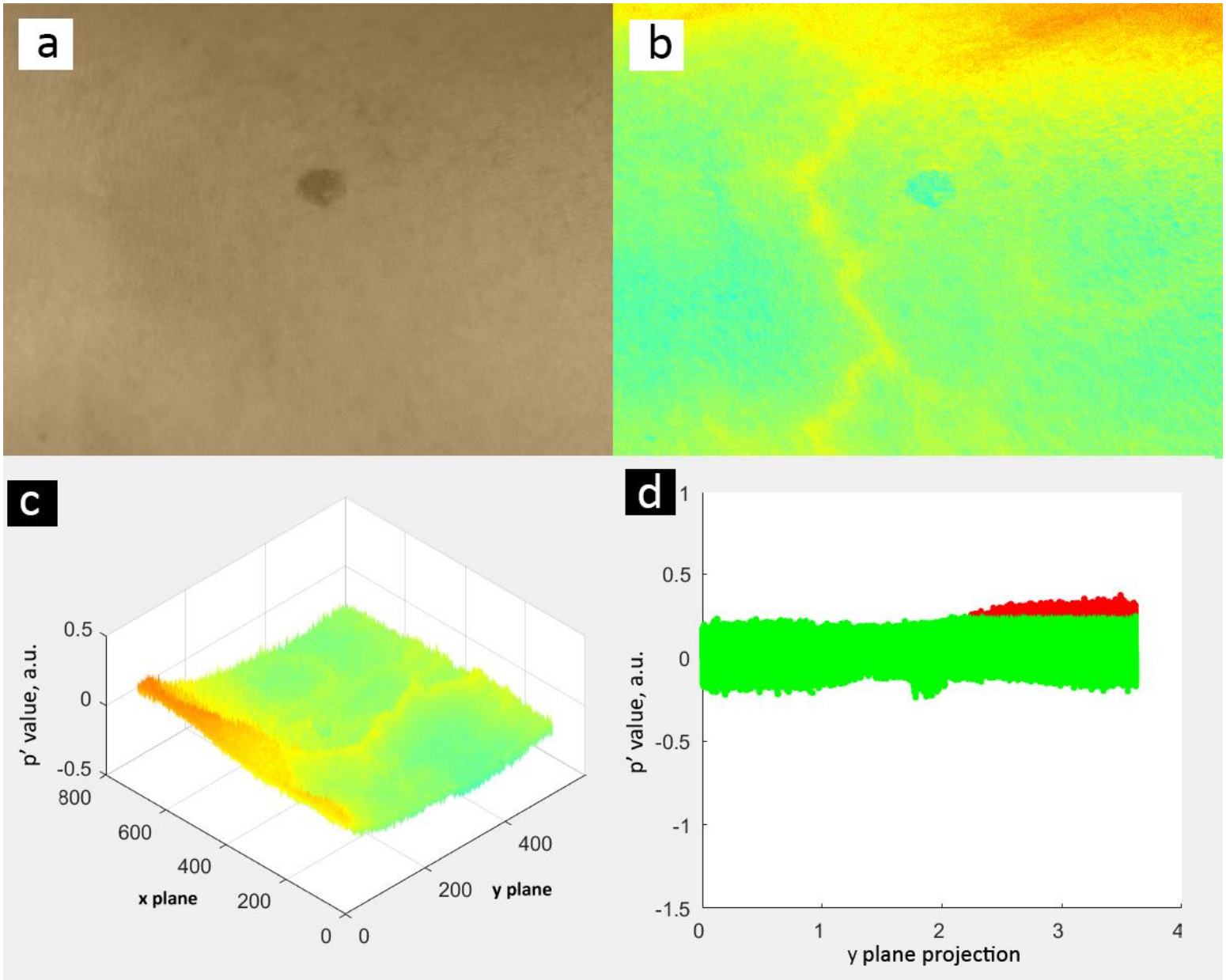
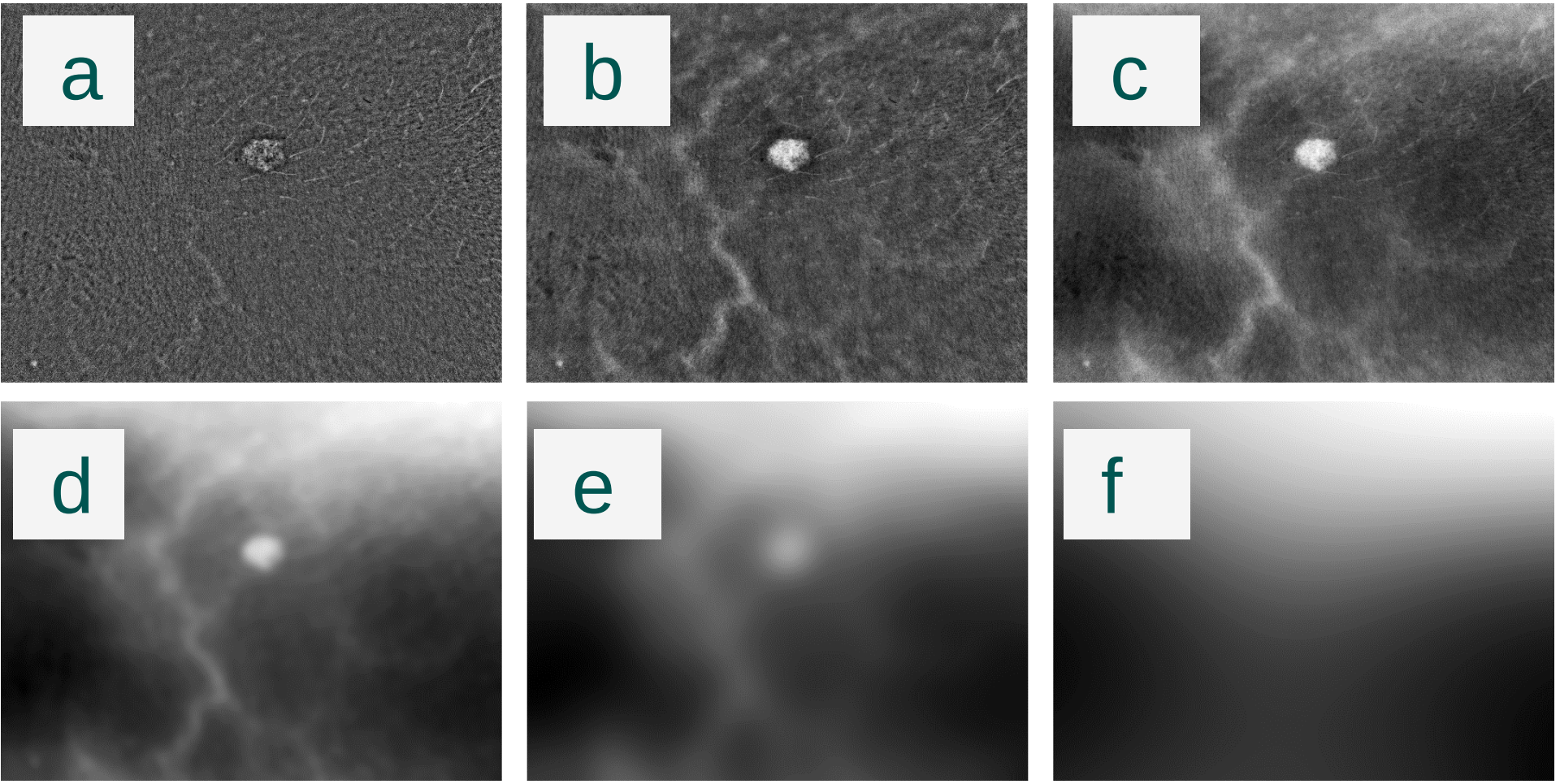


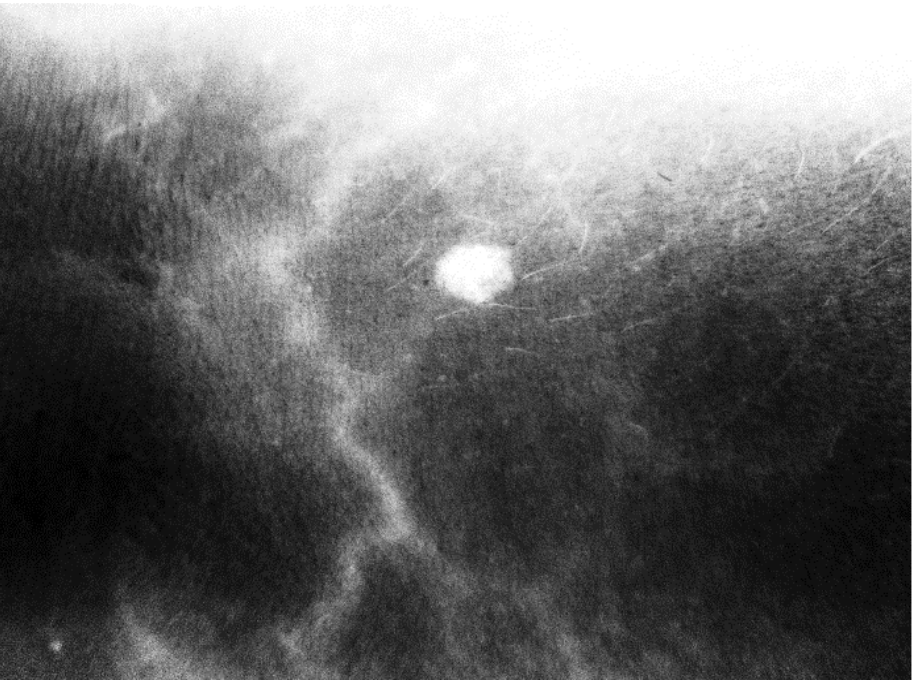
Image frequency separation



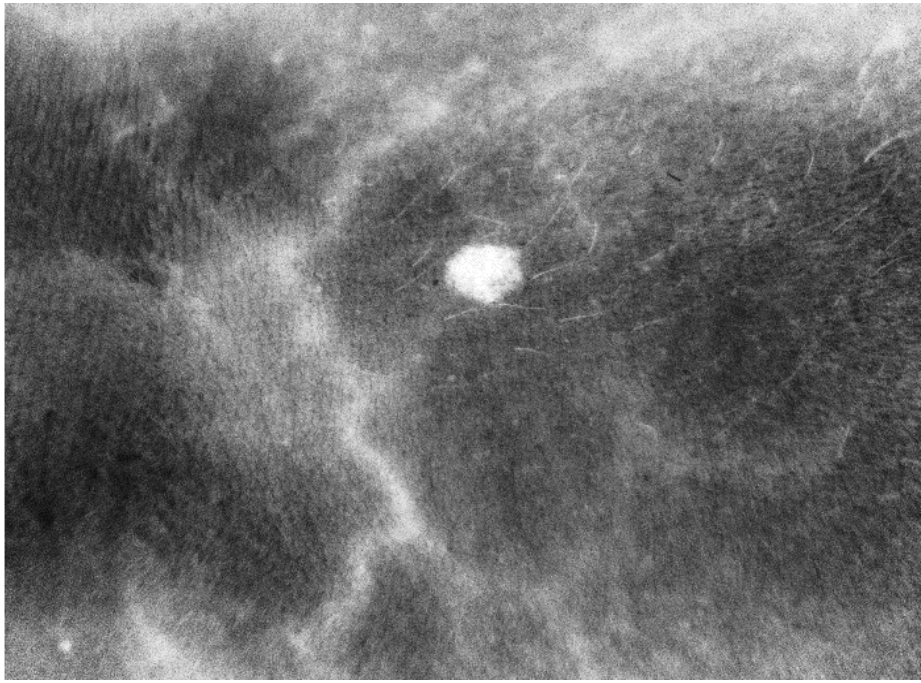
High frequencies of skin image: a) 5 px, b) 20 px, c) 120 px

Low frequencies of skin image: d) 5 px, e) 20 px, f) 120 px

Skin image high pass filtering

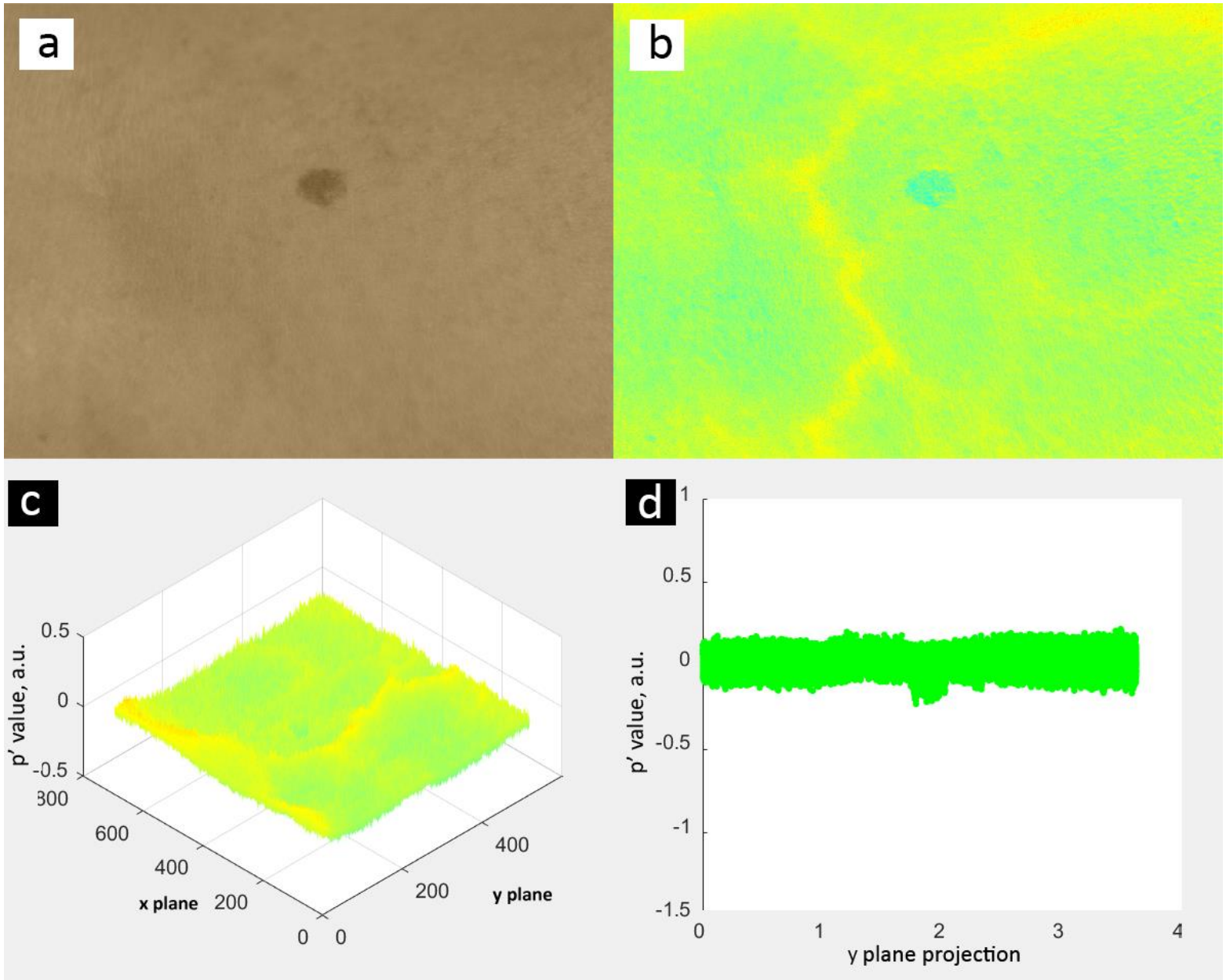


Original skin image



High pass filter

Filtered image obtaining correct diagnosis



Further work and challenges

- Examined objects should be smaller and have higher spatial frequency (sharper edges) than unwanted light.
- Filter parameters should be found empirically.
- Obtaining filtering parameters from image segmentation results.

Acknowledgements

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