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Optical Coherence Tomography for examination of stratigraphy of easel paintings

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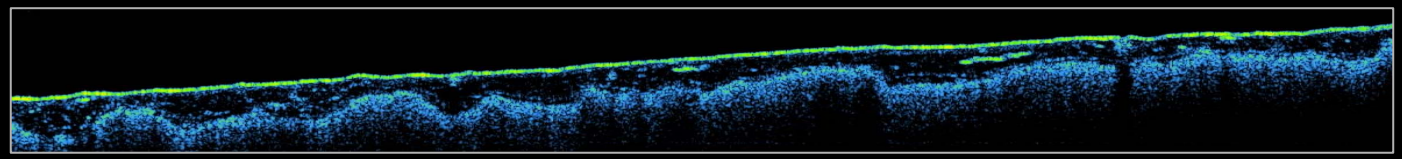
Oct4art: Toruń, 3–5 July 2008

Invasive vs noninvasive examination

sample examination (invasive)

~1mm

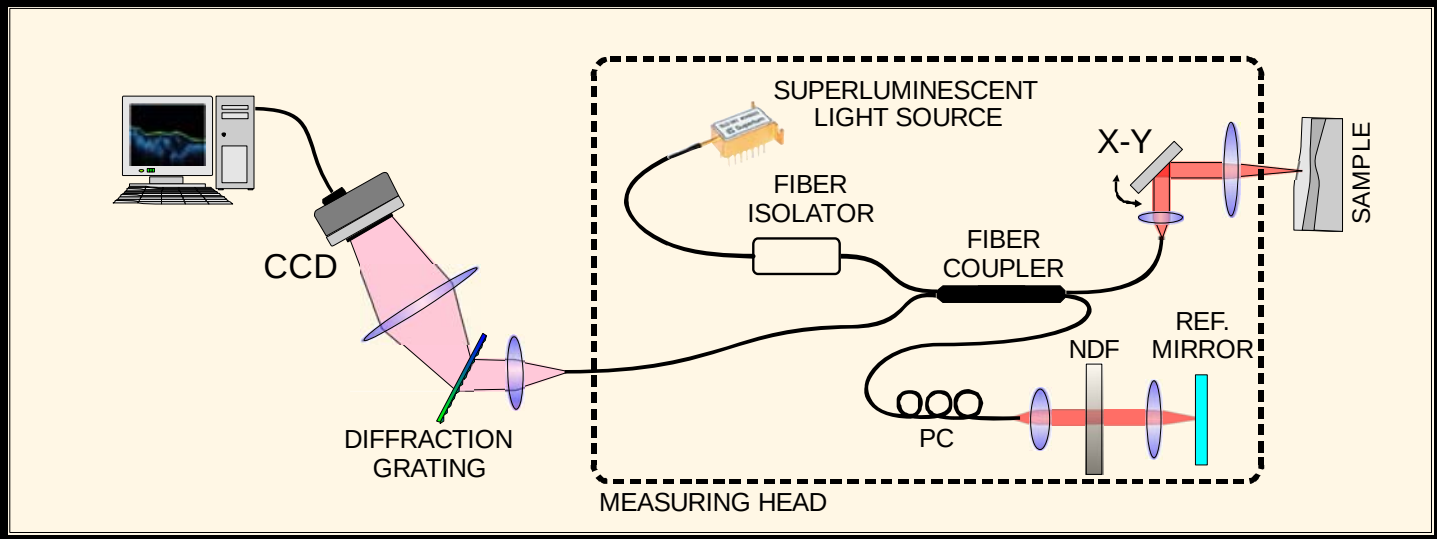
up to 20 mm



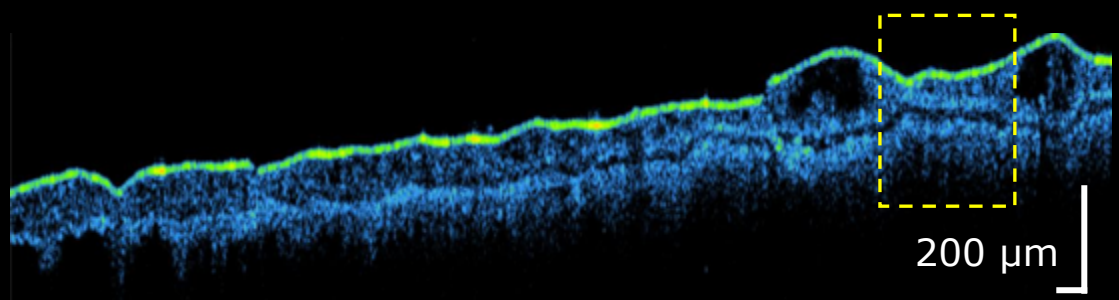
OCT tomogram (noninvasive)

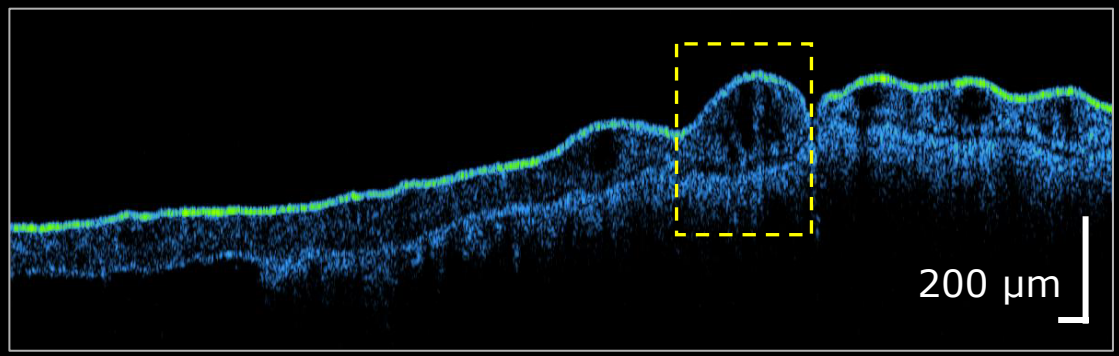
The SOCT instrument

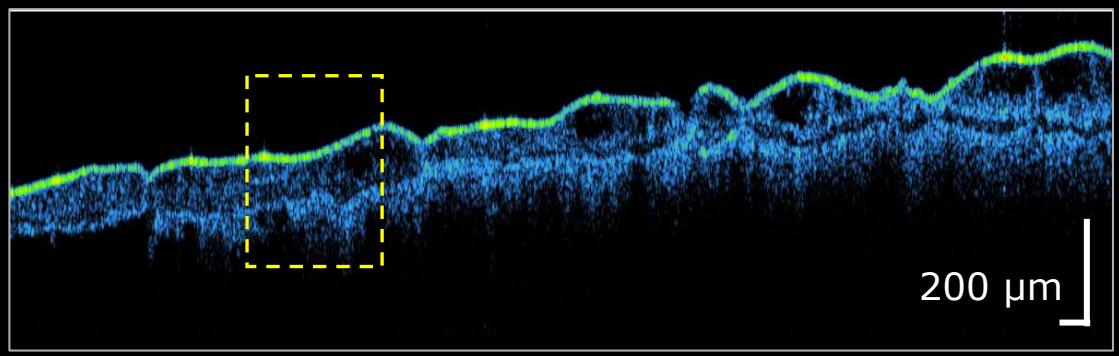
- Central wavelength: 840 nm
- Bandwidth (FWHM):50 nm
- Very low irradiation: 200 – 800 μW
- Axial (in-depth) resolution Δz = 9 μm (in media)
- Transverse resolution Δx ~15 μm
- Sensitivity: 108 dB A/D conversion: 12 bits
- Acquisition rate:
  - 40 μs/A-scan
  - 0.2 s / 2D image (cross section, 5000 A-scans)
  - OCT movie: 16 frames/s x 1200 A-scans
  - real time monitoring: 2 frames/s x 400 A-scans

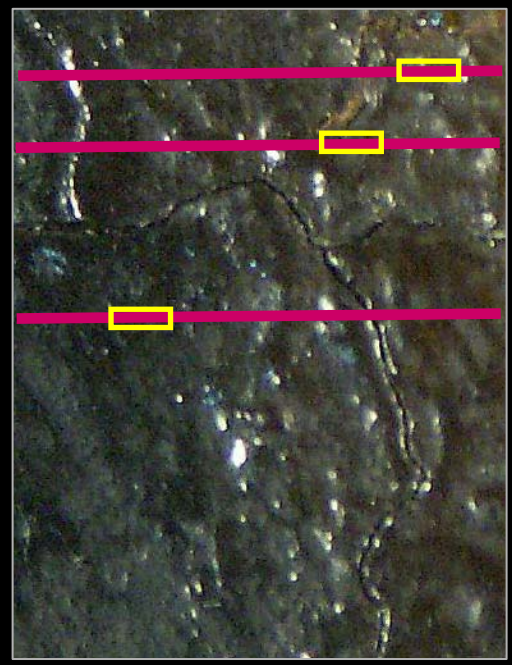


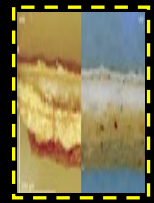
Is the sample representative?











average sample size

~ 1 mm

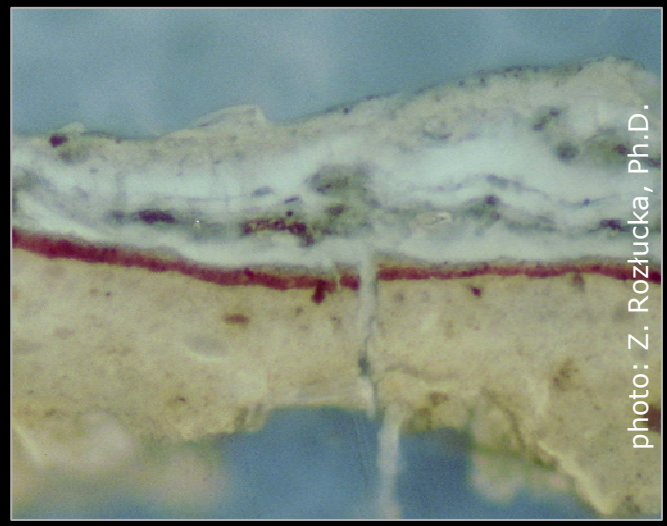
Examined oil paintings

Saint Leonard
(XVIIIth c.)

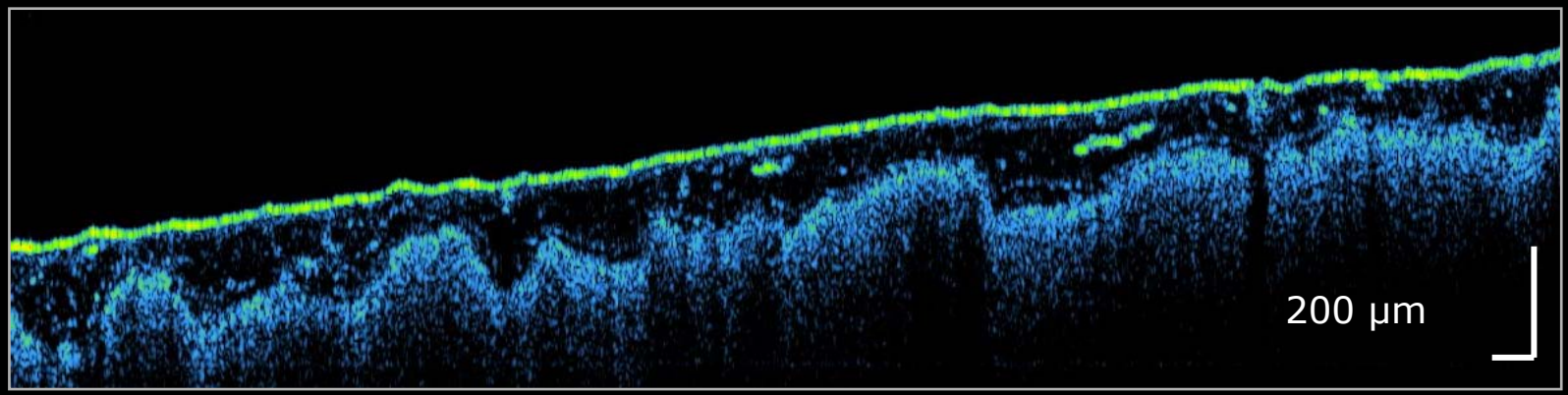
Virgin and Child
(XVIIIth c.?)

Virgin and Child
(XIXth c.)

Multi-layered varnish

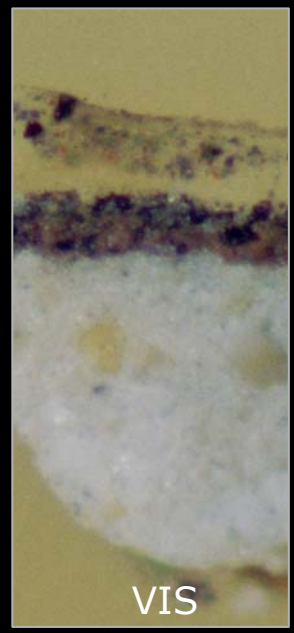


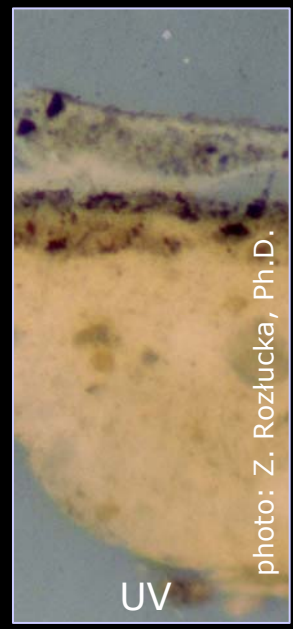
UV fluorescence

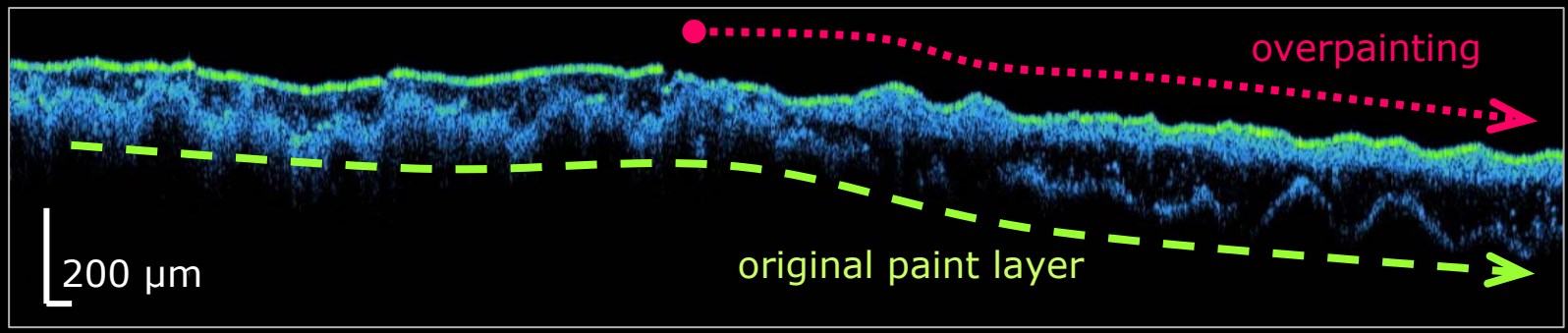


up to four layers of varnish visible in the tomogram

Authentication of layers

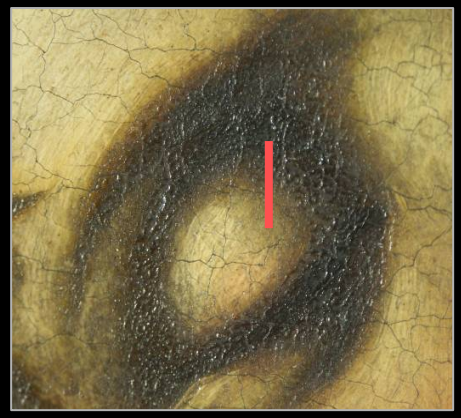


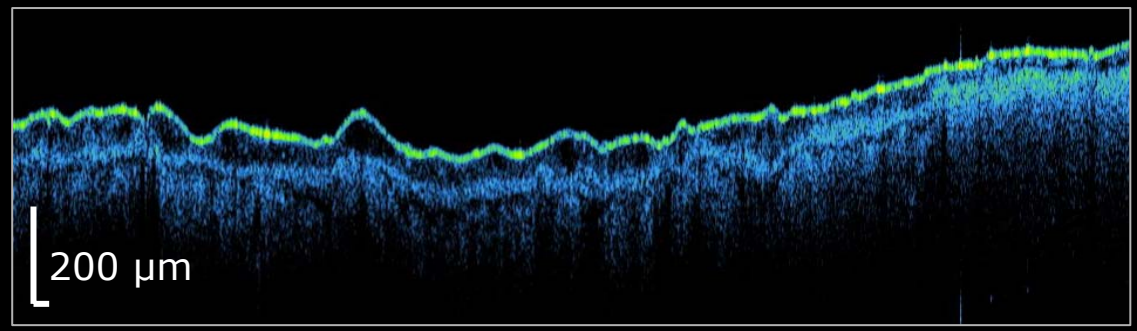




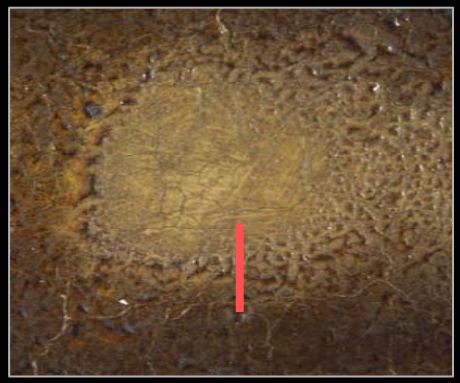
partial overpainting lying on the varnish

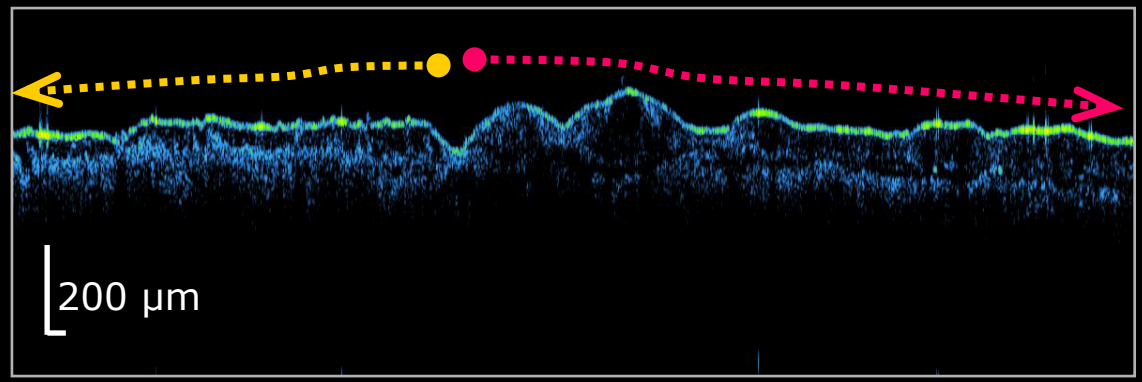
Authentication of layers





glazes under homogeneous varnish layer

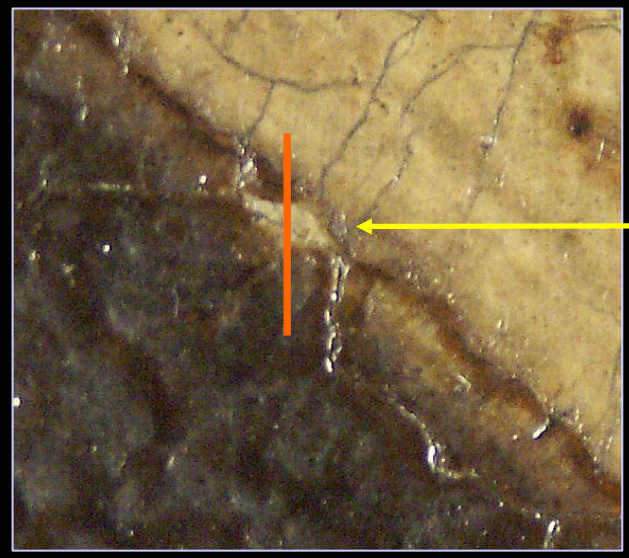




right and left part of the tomogram are unlike – which may indicate different time of their origin

The advise from Dr Elżbieta Szmit-Naud is gratefully acknowledged

Authentication/condition of layers



surface defect caused by mechanical abrasion

microscopic examination shows as if the damage was limited only to the uppermost, thick brownish layer

the OCT proves more - an internal crack at boundary between two varnish/glaze layers, which may suggest that they do not come from the same period

The advise from Dr Elżbieta Szmit-Naud is gratefully acknowledged

Discoloration of glazes

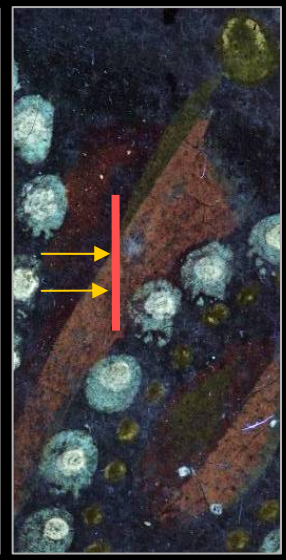
VIS

UV fluorescence

photo: D. Mausolf, W. Grzesik

in some cases UV/VIS examinations give confusing results – areas with no visible pigment give strong UV fluorescence

Discoloration of glazes

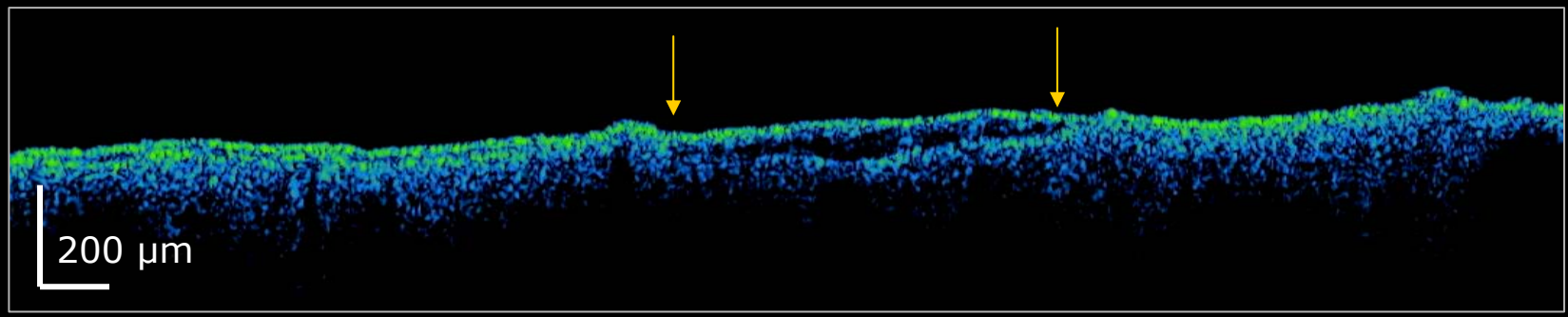


VIS

UV

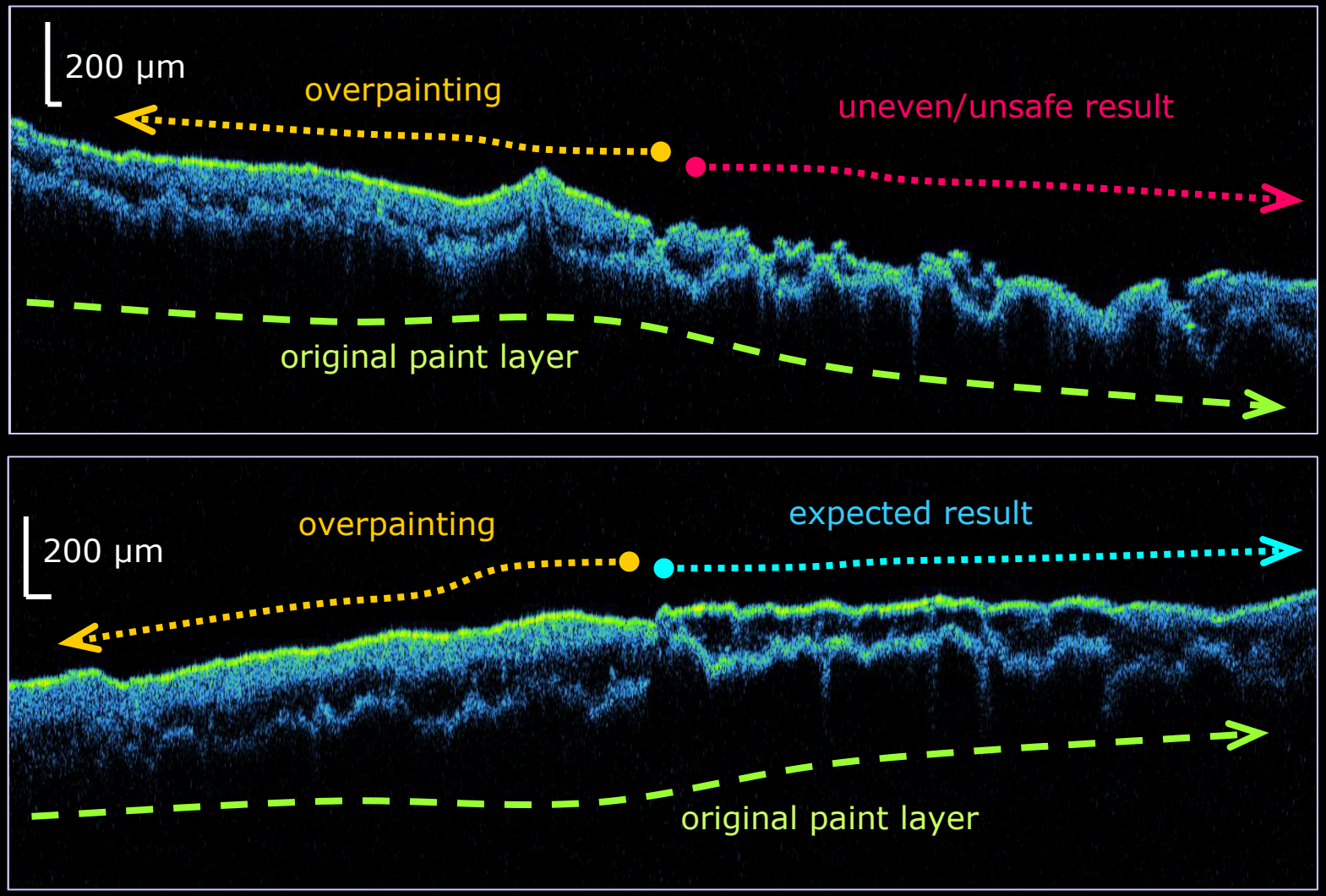
virtual reconstruction

photo: D. Mausolf, W. Grzesik



the OCT examination reveals a discoloured glaze layer (thicker between arrows)

Monitoring of overpainting removal



trials of overpainting removal with different solvent compositions; results evaluated traditionally and by means of the OCT

OCT for artwork stratigraphy - summary

- painting's technique, condition, and history
  - sequence and character of varnish and glaze layers:
    - number of varnish/glaze layers
    - existence of overpaintings
    - discolouration of glaze layers
  - volume rendering – 3D maps and profilometry

- treatment monitoring:
  - varnish/overpainting removal by traditional means
  - monitoring of laser ablation of varnish