Characterisation of fading behaviour of coloured papers during simulated display in anoxia

J. Thomas[1], A. Klisińska-Kopacz[1], J. Sobczyk[1], Ł. Bratasz[1] and T. Łojewski[2]

[1]National Museum in Krakow, 1, 3 Maja Av, 30–062, Kraków
jthomas@muzeum.krakow.pl www.muz-nar.krakow.pl
[2]Jagiellonian University, ul. Ingardena 3, 30-060 Kraków

National Museum in Krakow

Jagiellonian University

Fading of coloured paper by photo-oxidation

MNK III-r.a. 14524; Description: *Portrait of Janina Bastgen*, 1933, pastel, 63.5x48.5, Signature and date: on the lower left: Ign. Witkiewicz / 1933 VI (T.B.) NP.NP

Change of the colour:

$$\Delta E = \sqrt{[(\Delta L)^2+(\Delta a)^2+(\Delta b)^2]}$$

- $\Delta E_{edge-background} = 6.51460$
- $\Delta E_{background-reverse} = 8.43682$

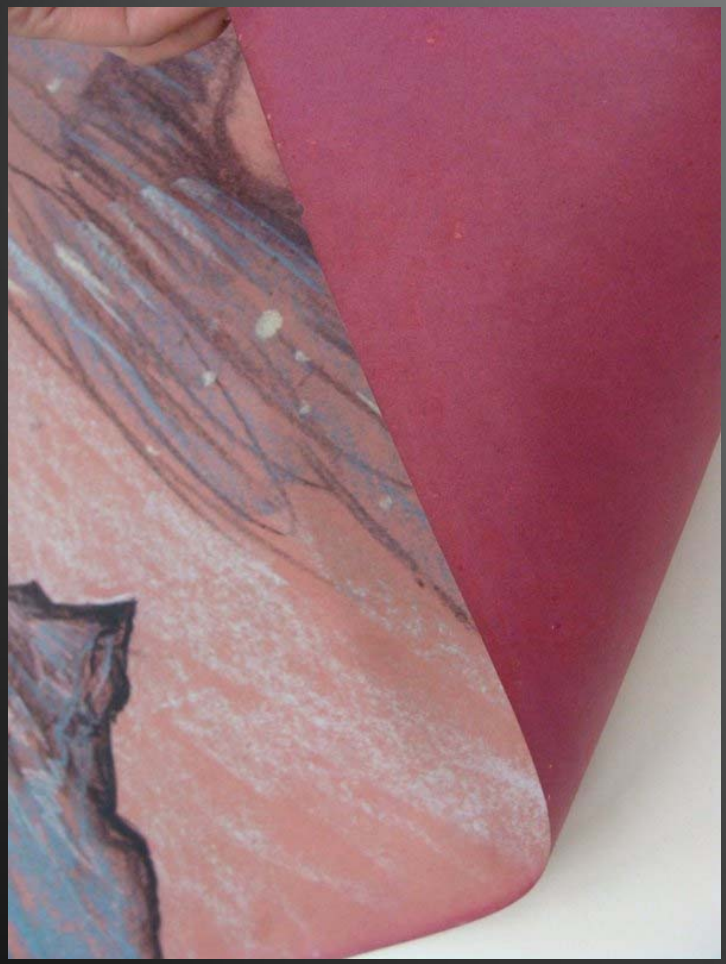
Fading of coloured papers by photo-oxidation

MNK III-r.a. 14616; Description: *Portrait of Stefan Szuman*, 1929, pastel, 64.6x48.8, Signature and date: on the lower left: T.B+d; on the lower right: Witkacy / 1929 IV / NP ½ r 2 + Cof.

Change of the colour:

$$\Delta E = \sqrt{[(\Delta L)^2+(\Delta a)^2+(\Delta b)^2]}$$

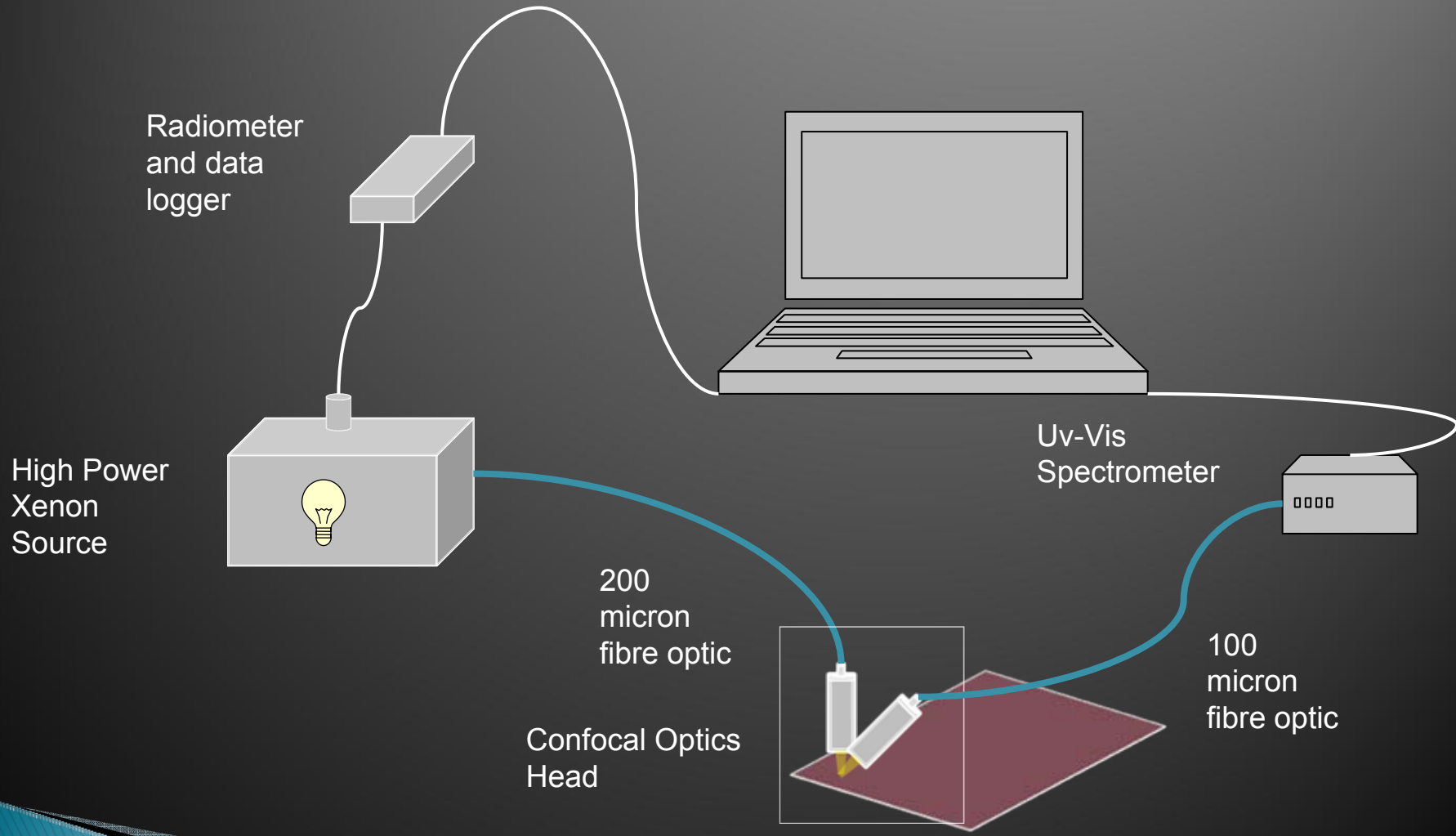
- $\Delta E_{edge-background} = 9.71802$
- $\Delta E_{background-reverse} = 8.49824$

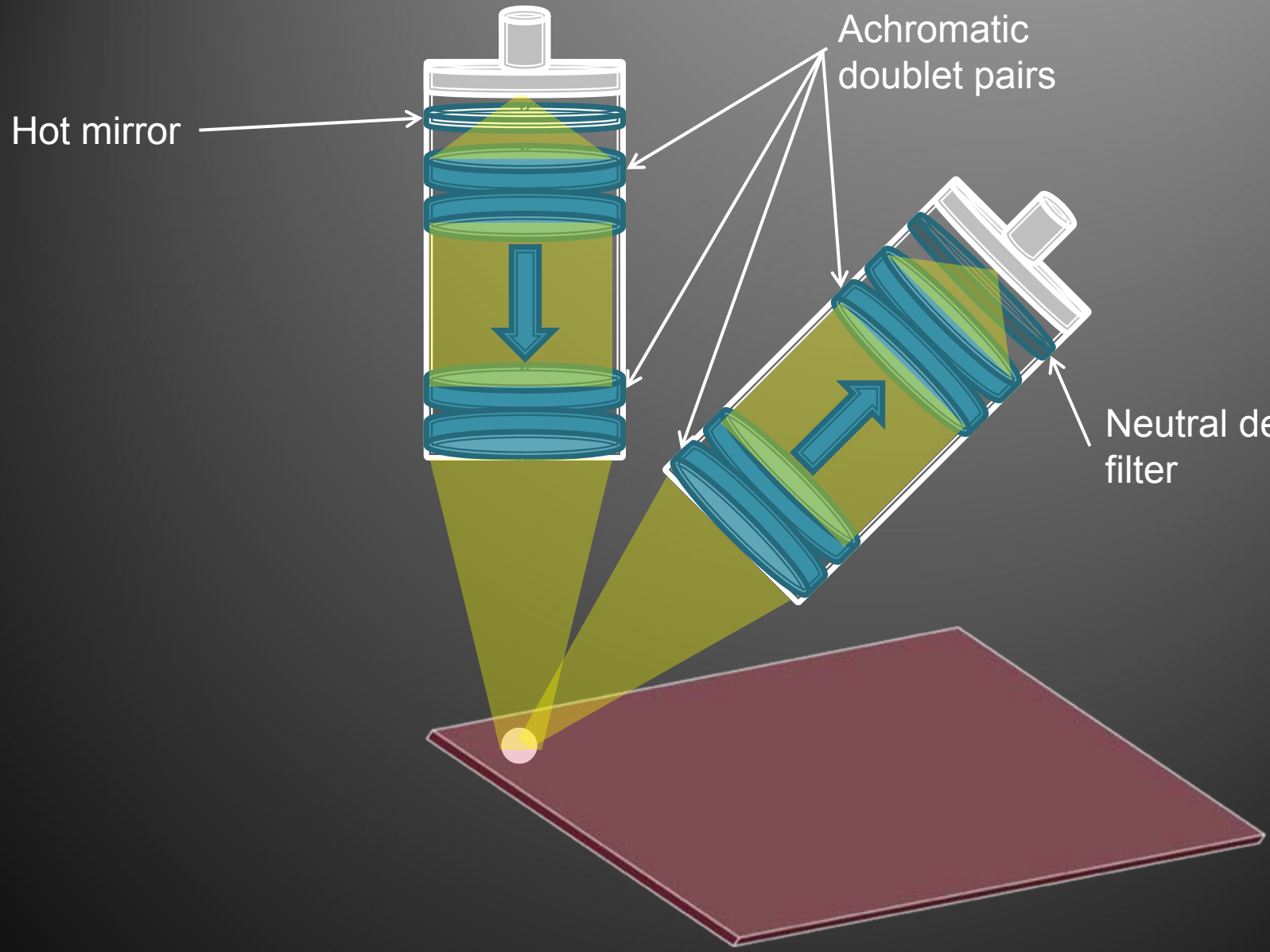


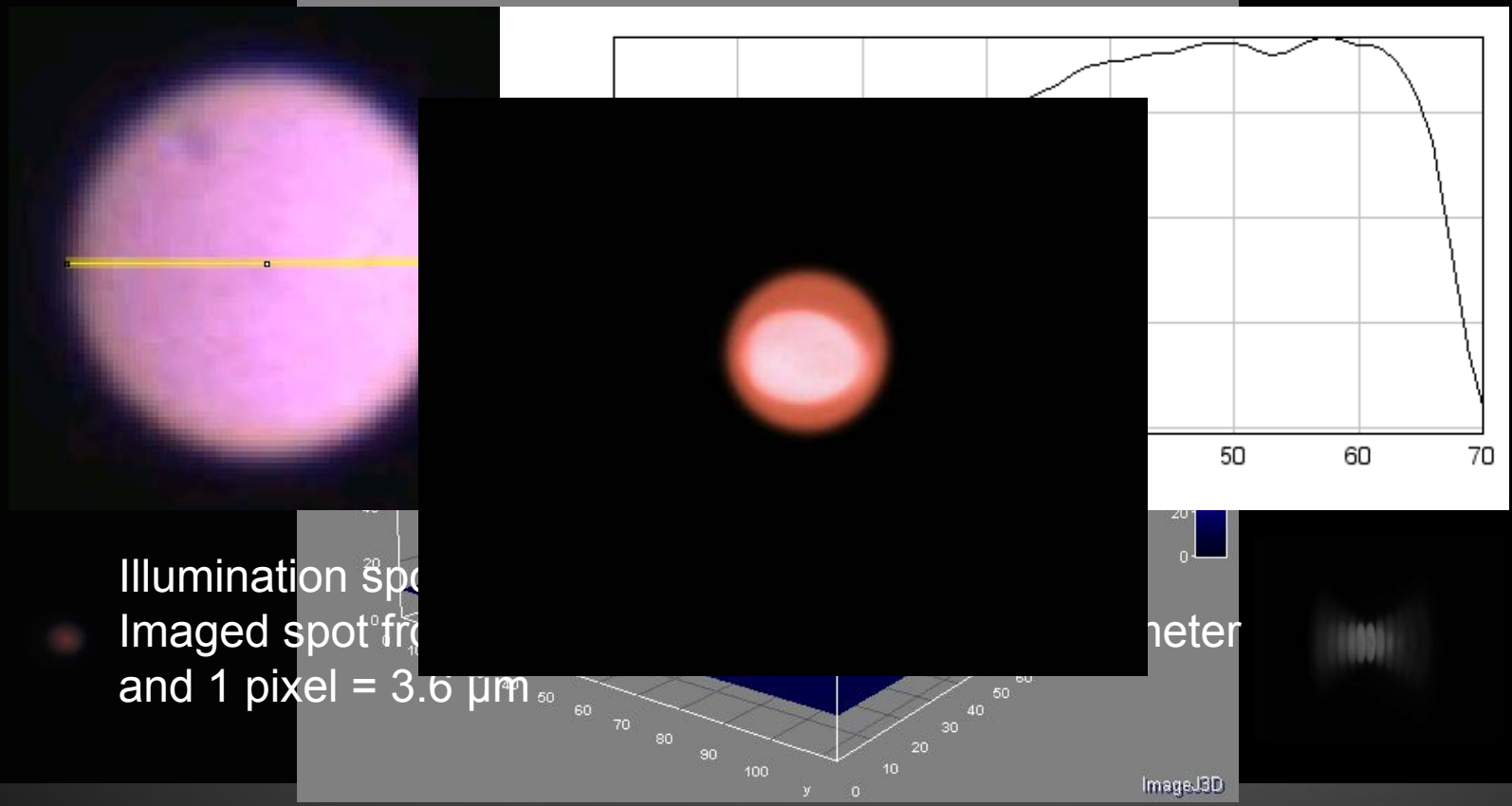
- The extreme fading of the exposed *recto* surface is apparent when compared to the unexposed *verso* surface and the edges.

Microfadeometer

Room atmosphere tests of coloured paper samples from both modern and historic sources


Radiometer
and data
logger
High Power
Xenon
Source
Uv-Vis
Spectrometer
200
micron
fibre optic
Confocal Optics
Head
100
micron
fibre optic


Hot mirror
Achromatic doublet pairs
Neutral density filter

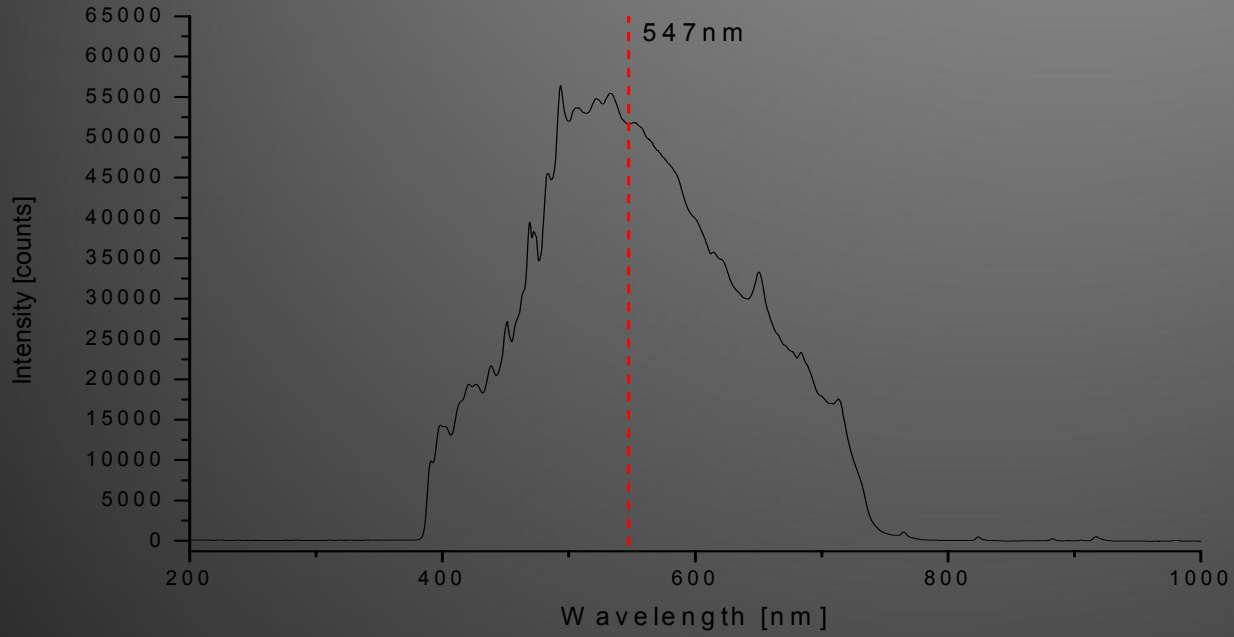


Illumination spo
Imaged spot fr neter
and 1 pixel = 3.6 µm

Characterisation of illumination spot

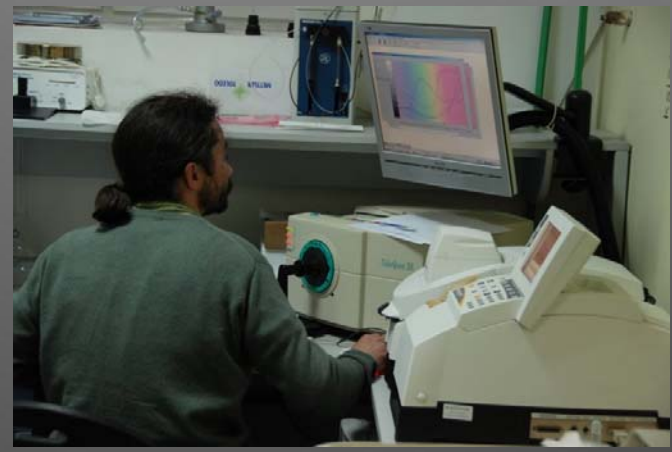
Images of spot were taken using a bare CMOS sensor and imaging software, point of focus determined by eye

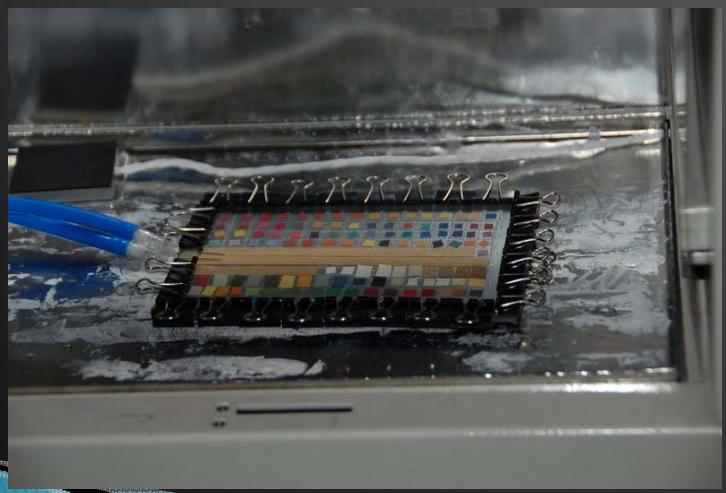
Spectral distribution and beam power calculations



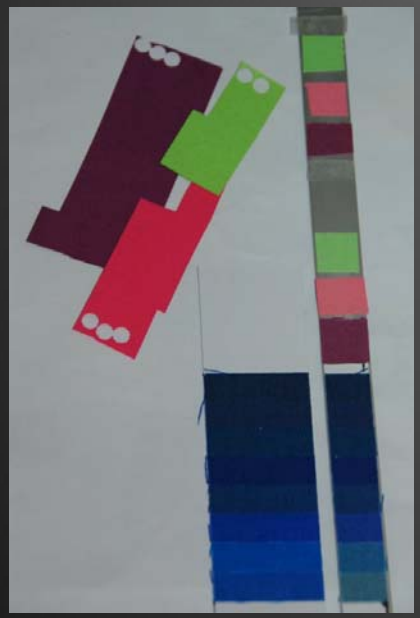
laser wavelength set prior to measurement [nm]	reading [mW]	beam power after recalculation	
		[mW]	[W/m^2]
400	0,4050	0,2960	5,934·10^6
500	0,2795	0,2553	5,119·10^6
547	0,2395	0,2395	4,802·10^6
600	0,2000	0,2192	4,396·10^6
700	0,1470	0,1880	3,769·10^6

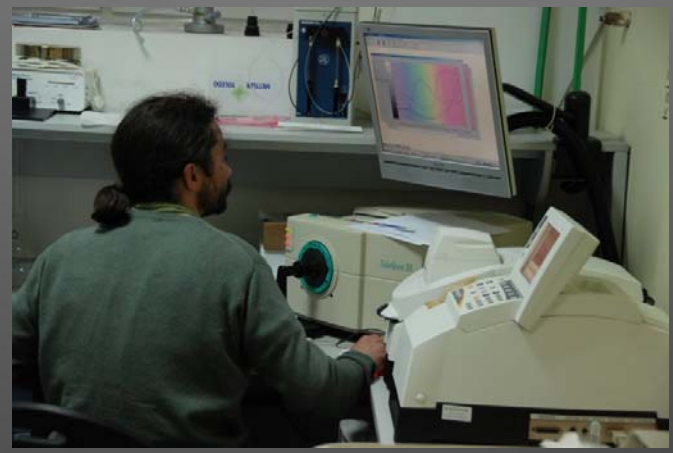
A survey of dyes on paper





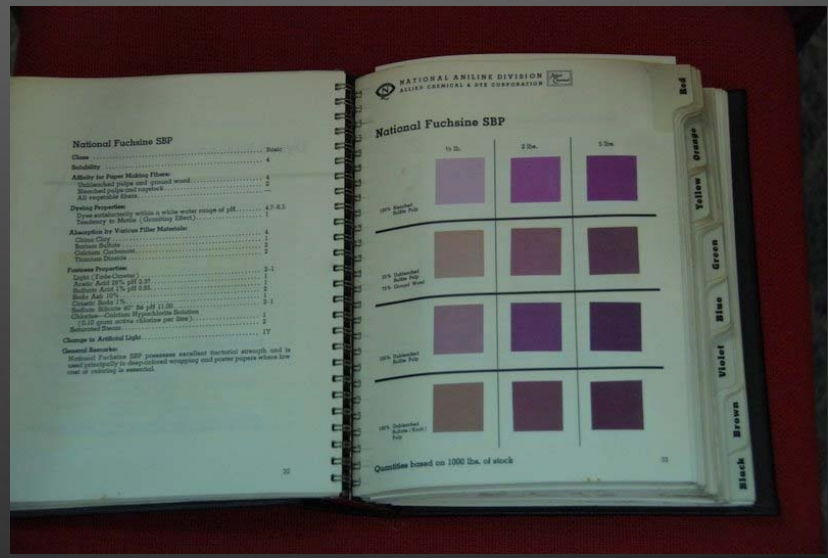
Modern papers and blue wool standards



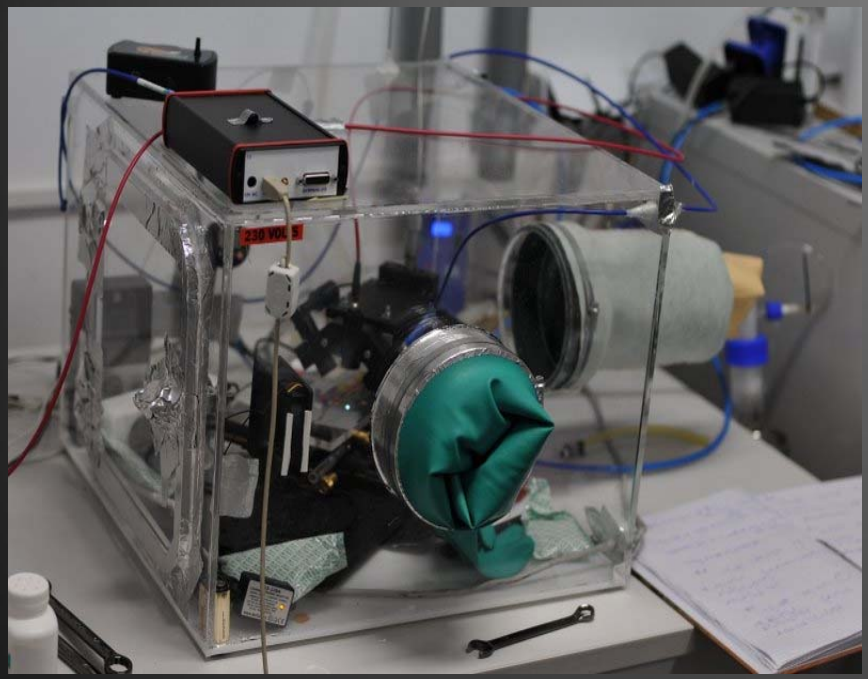


Samples prepared on aluminium strips for exposure in a Suntest XPS+ and measurement with a Hunter lab instrument

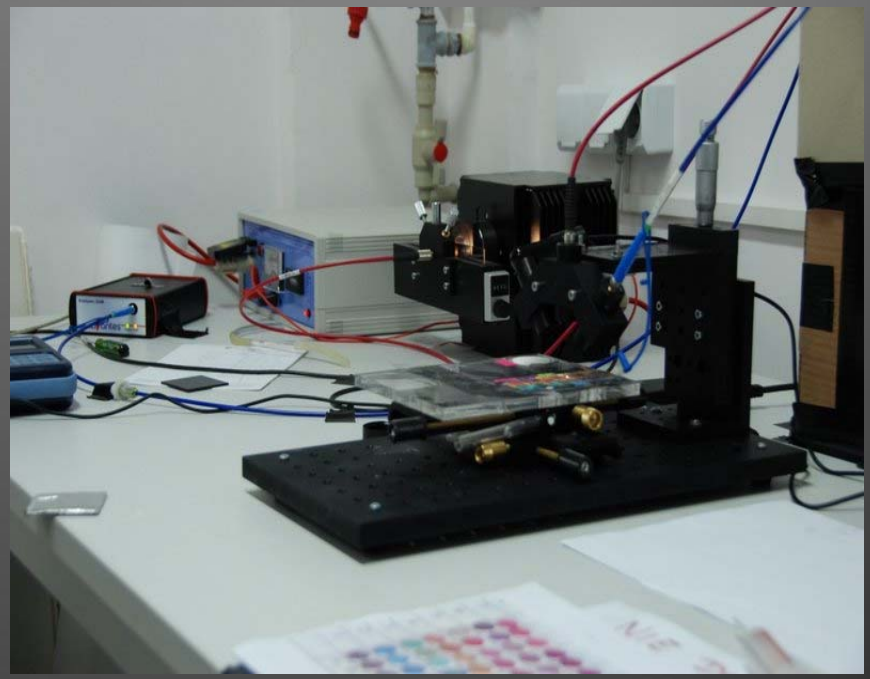
Historic samples



Anoxia vs. room atmosphere

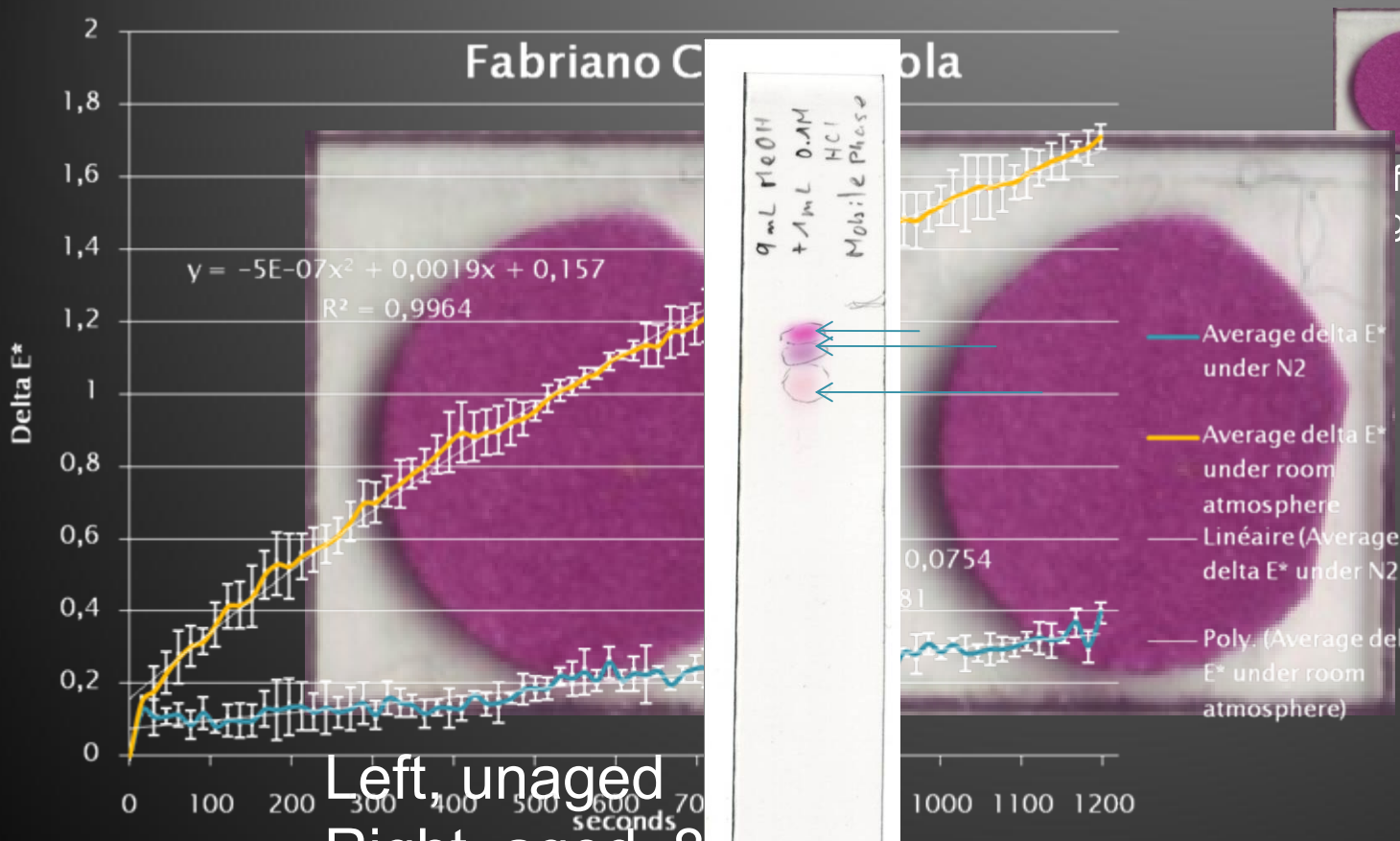


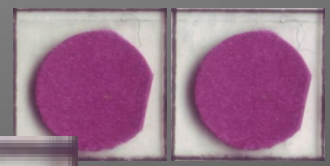
The microfadeometer in a glove box for measurements



The microfadeometer in a climate controlled room for measurements

Comparison of the fading rates in anoxia and room atmosphere

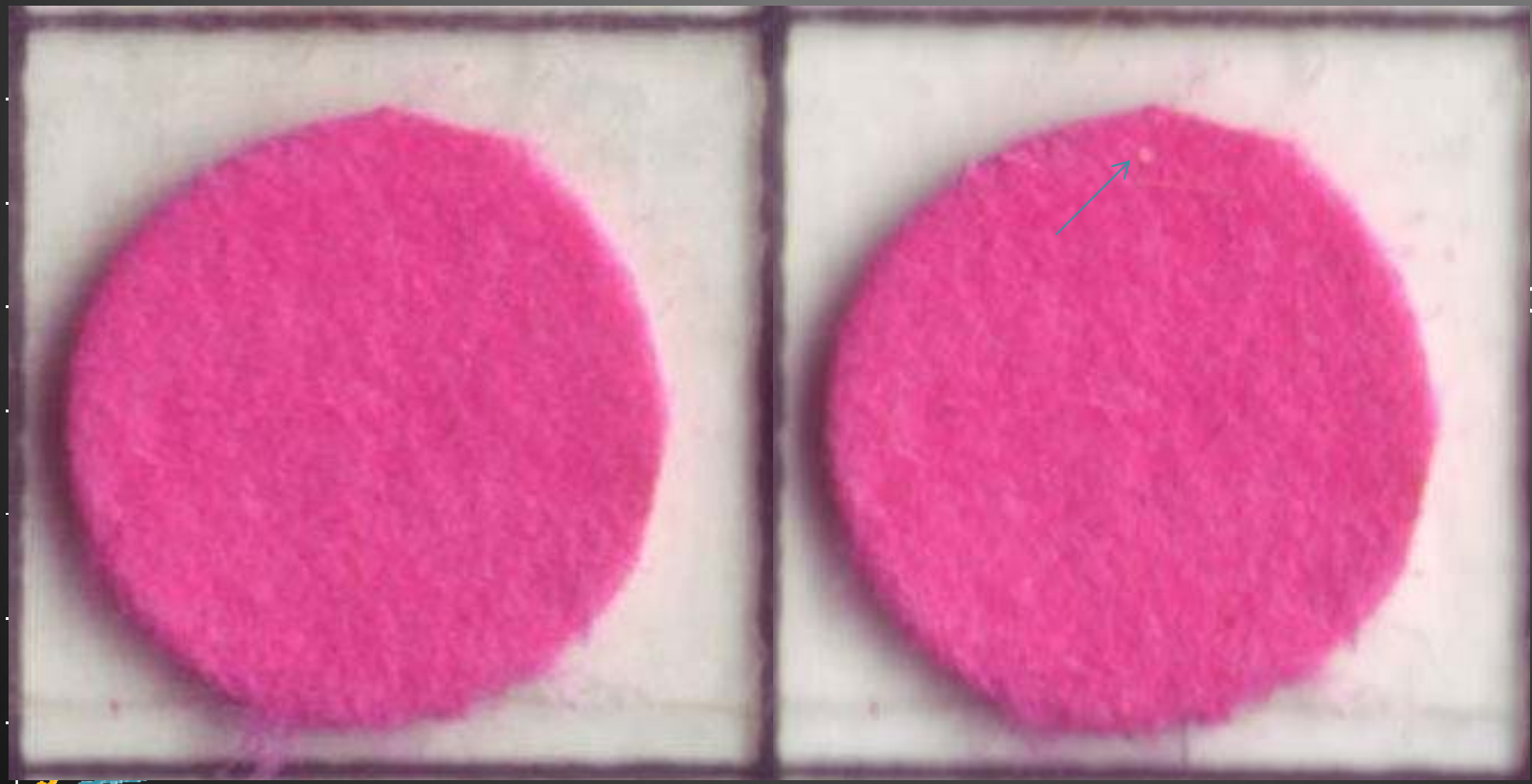




ft, unaged
ght, aged 8 spots

A developed TLC plate of dyes extracted with DMSO from viola

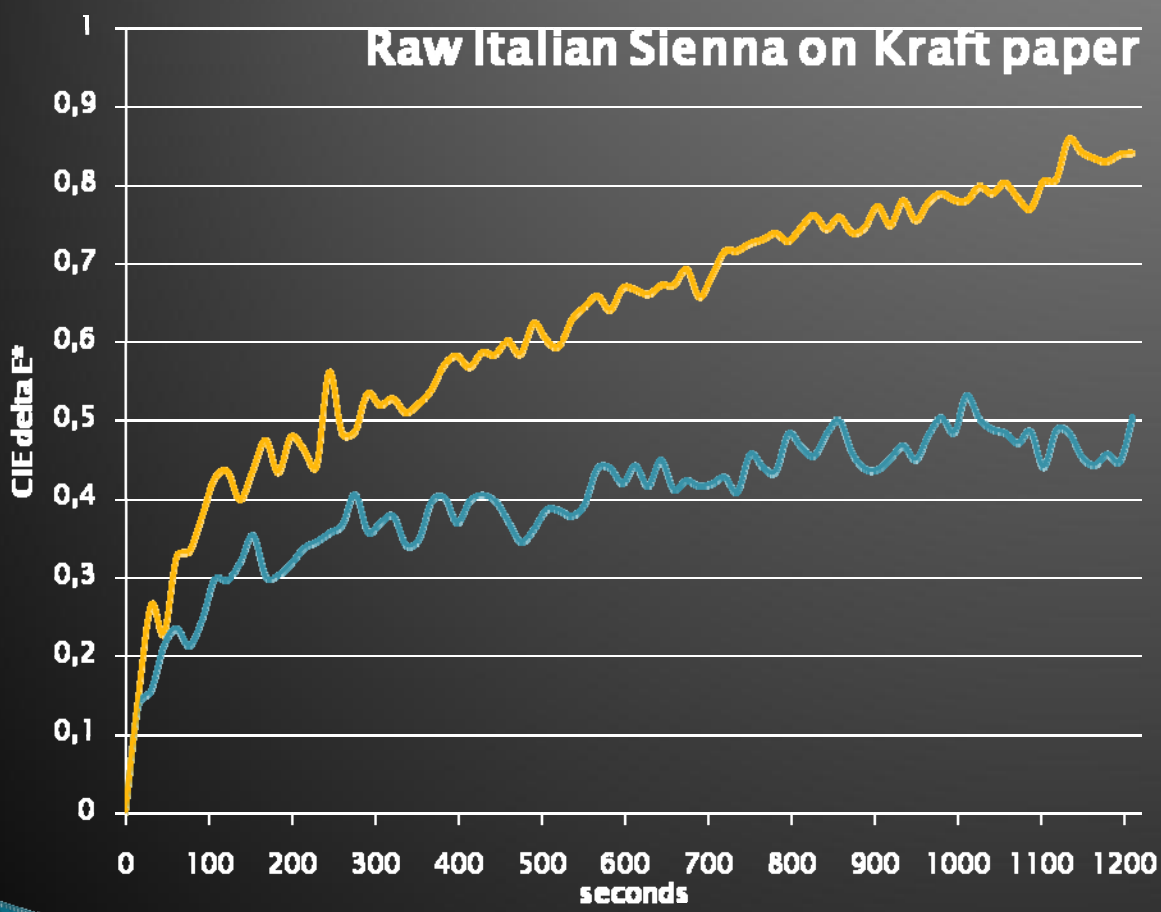
Rhodamine 6GX

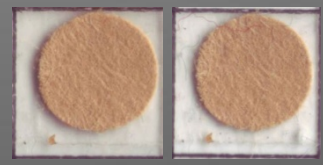


Left, unaged

Right , aged in 3 spots

Raw Italian Sienna





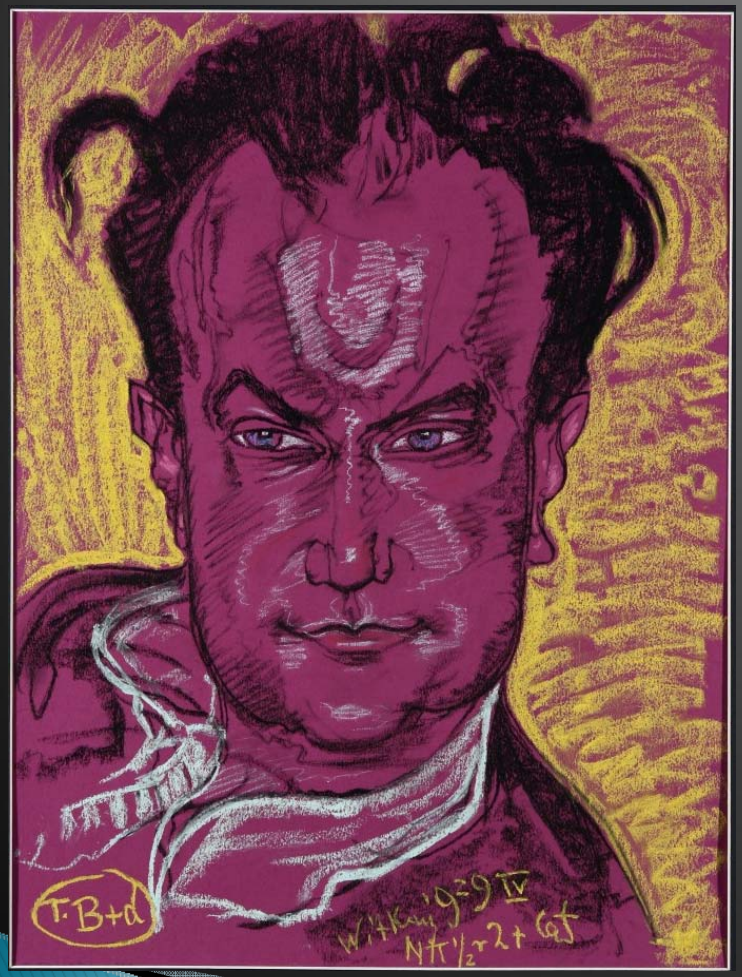
Left, unaged
Right, aged at 3 spots

Preparing to analyze a blue pigment on a Witkacy Pastel

A Brüker Artax XRF spectrometer is positioned over the pastel prior to measurement

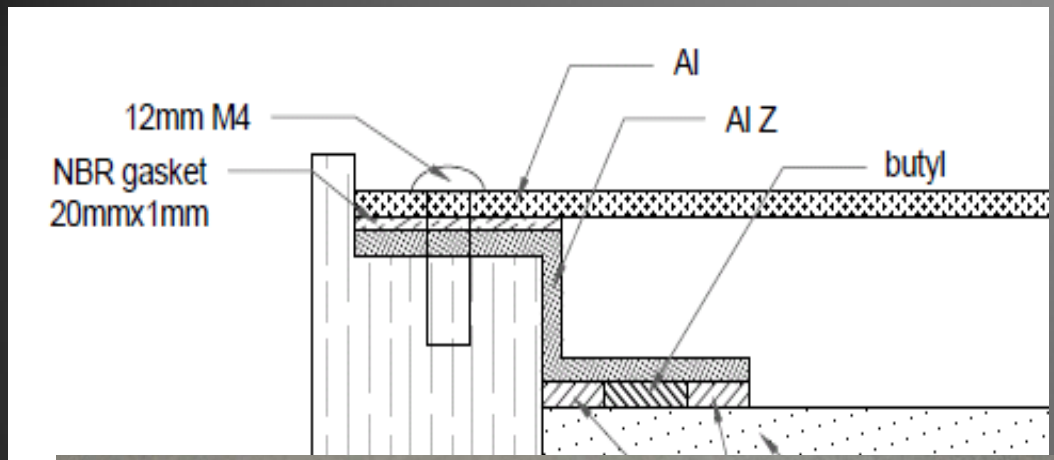
Preparation of a reproduction

The original *Portrait of Stefan Szuman*



A copy of the *Portrait of Stefan Szuman*

Copies of *the Portrait of Stefan Szuman*



A schematic of the cross section of the anoxic frame design

A prototype A5 size anoxic frame for use in a Suntest XPS+ chamber

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Conclusions

- Microfadeometers are a useful tool for rapidly screening the light fastness of materials
  - They can be used to test the effect of specific atmospheres (anoxia in this case, but also other polutants)
  - They are micro-damaging, and if properly employed no visible damage is apparent
  - They can be used on the reverse of monofacially faded objects to estimate the historic light dose and determine further colour change potential
- Of the dyes on paper surveyed, most faded slower in anoxia
- Despite the single name, historic dyes are complex mixtures of chromophores
  - The variability between manufacturers will be evaluated in the future.
- There is a potential effect of paper substrate on light fastness, this will be investigated in the future

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Thank you.