A Memory Effect in sheet fed offset printing

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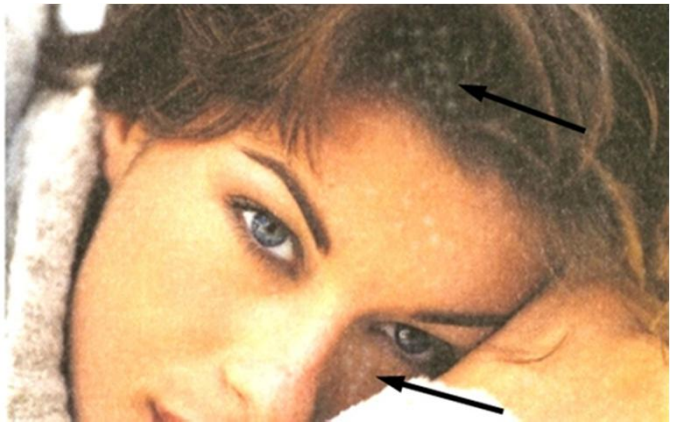
Print Mottle in Offset Printing

"Non uniformity of perceived print density"

uniformly printed image



non uniformly printed image

3 common types[1)]:

- Backtrap Mottle
- Water Interference Mottle
- Ink-trap Mottle

Sadovnikov, A., et al. (2008) Proceedings of SPIE- The International Society for Optical Engineering

Print Mottle in Offset Printing

Our initial aim:

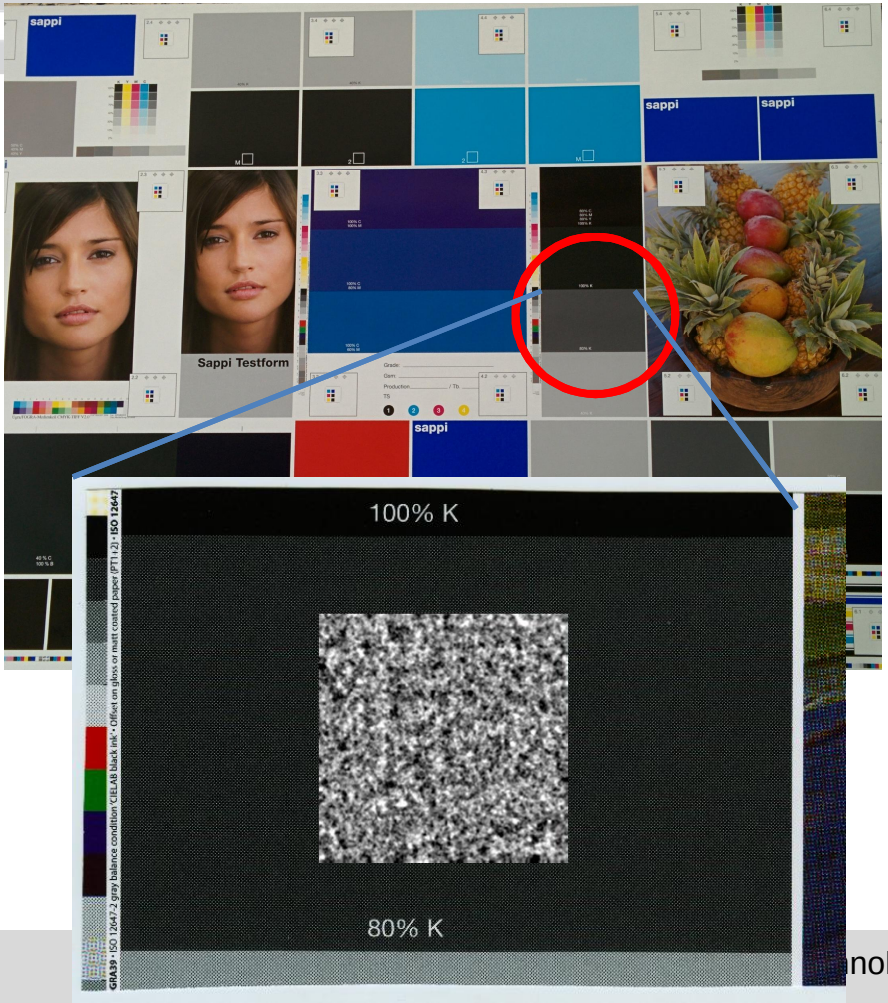
- correlation between local paper properties and print mottle
- study local back trap mottle

but

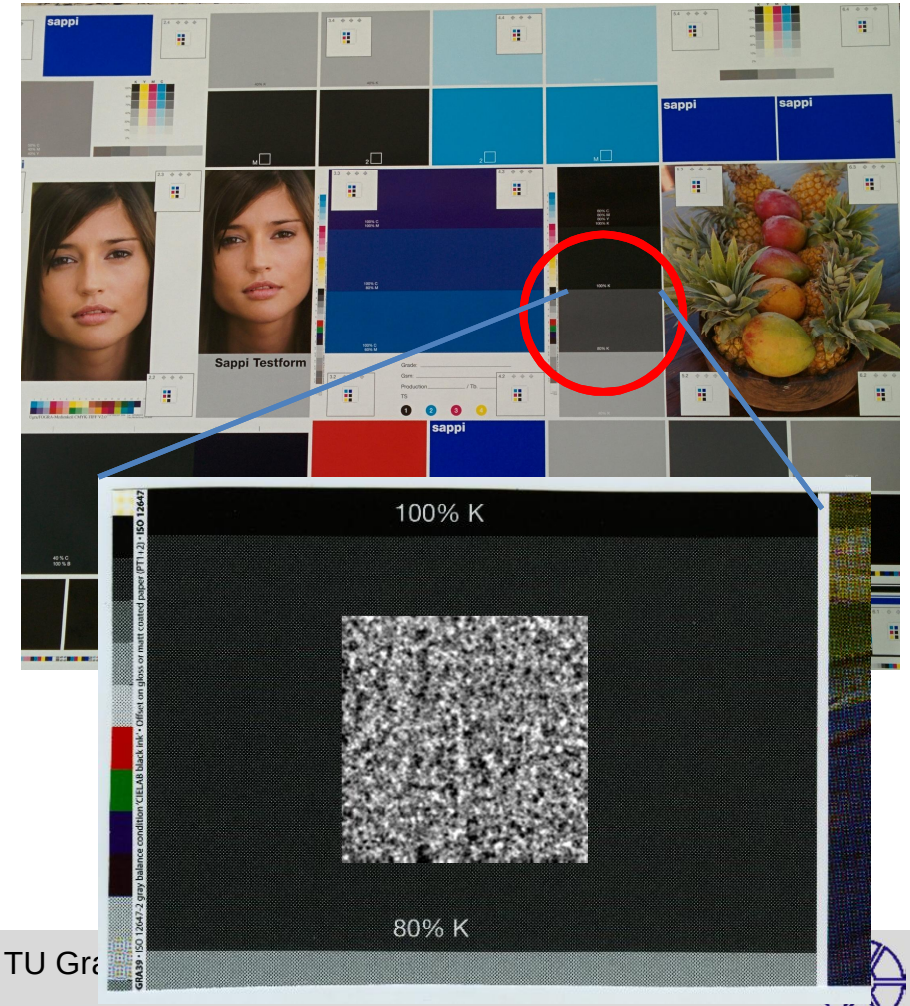
- instead of back trap mottle we found the Memory Effect

Memory Effect

sheet nr.: 4



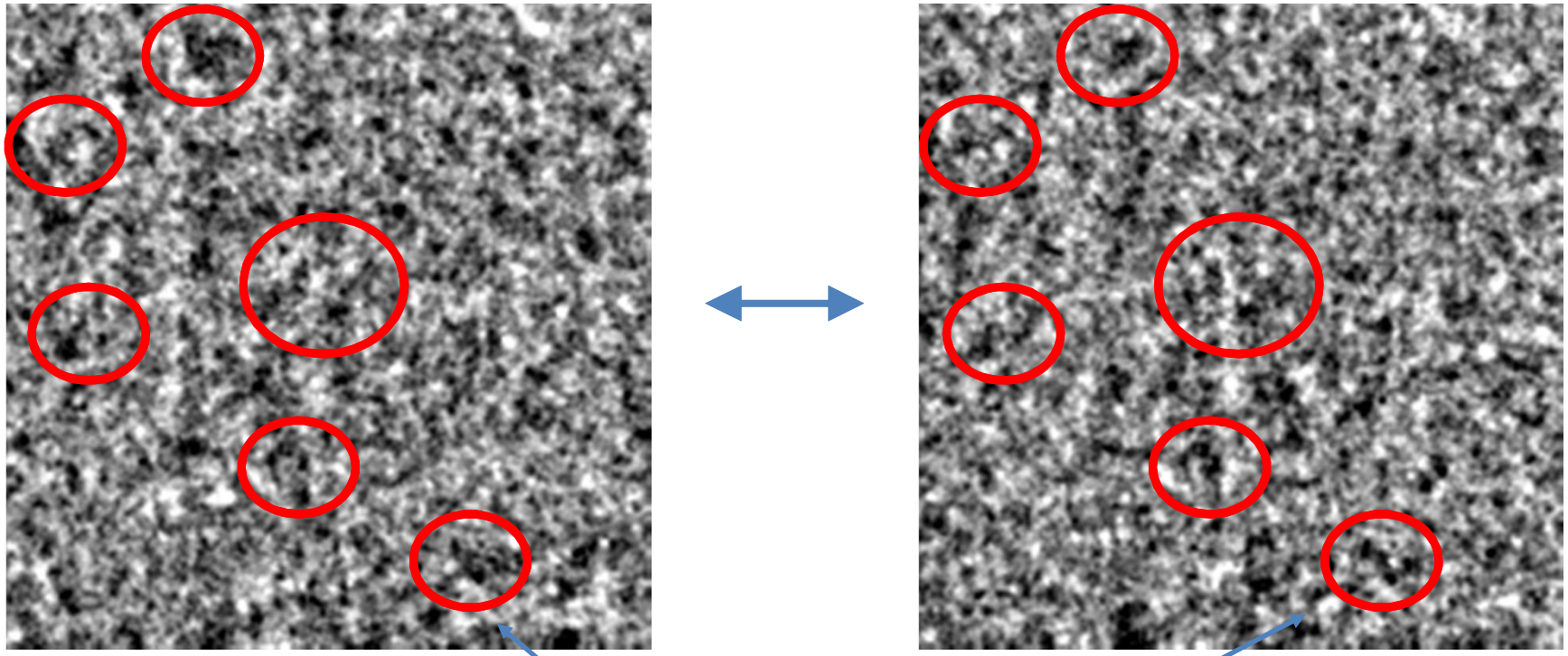
sheet nr.: 2587



Memory Effect

sheet nr.: **4**

sheet nr.: **2587**



The *exact same position* of colour fields on two different printed sheets.

Memory Effect

Hypothesis: Local patterns are transferred from rubber blanket to the printed sheets.

“Similarity of print mottle patterns over thousands of printed sheets.“

print mottle patterns are stable
- in time
- in location

Print Trial

Printing Machine:

Heidelberg SM XL 8

6 colours (sequence: K C M Y P B)

8000 sheets/hour

K: first black
C: cyan
M: magenta
Y: yellow
P: pantone blue
B: second black

Paper Samples:

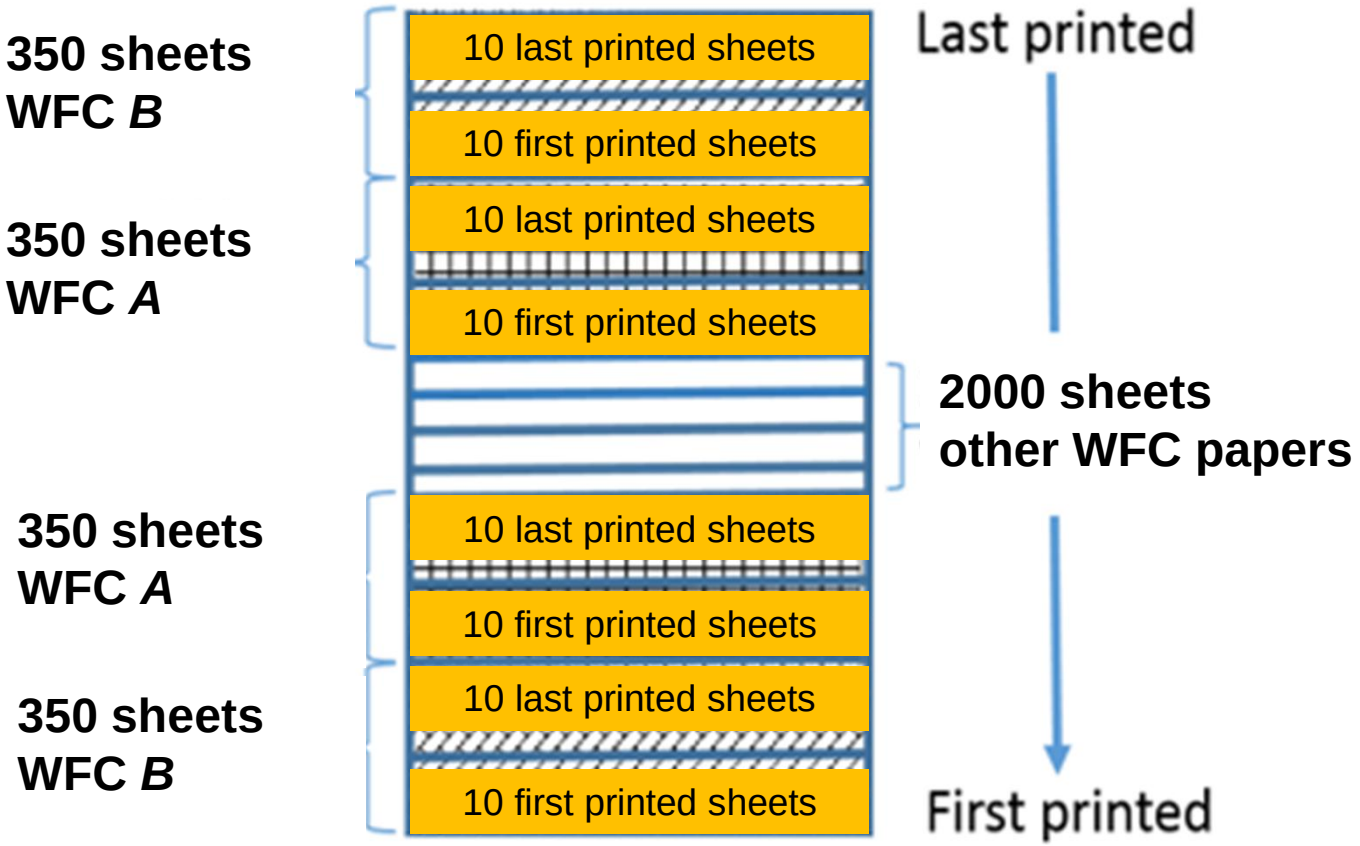
Wood Free Coated (WFC) 115 g/m², cw: 24 g/m² per side

two samples:

- WFC A
- WFC B

Print Trial

for evaluation: 80 printed sheets



Investigated color fields

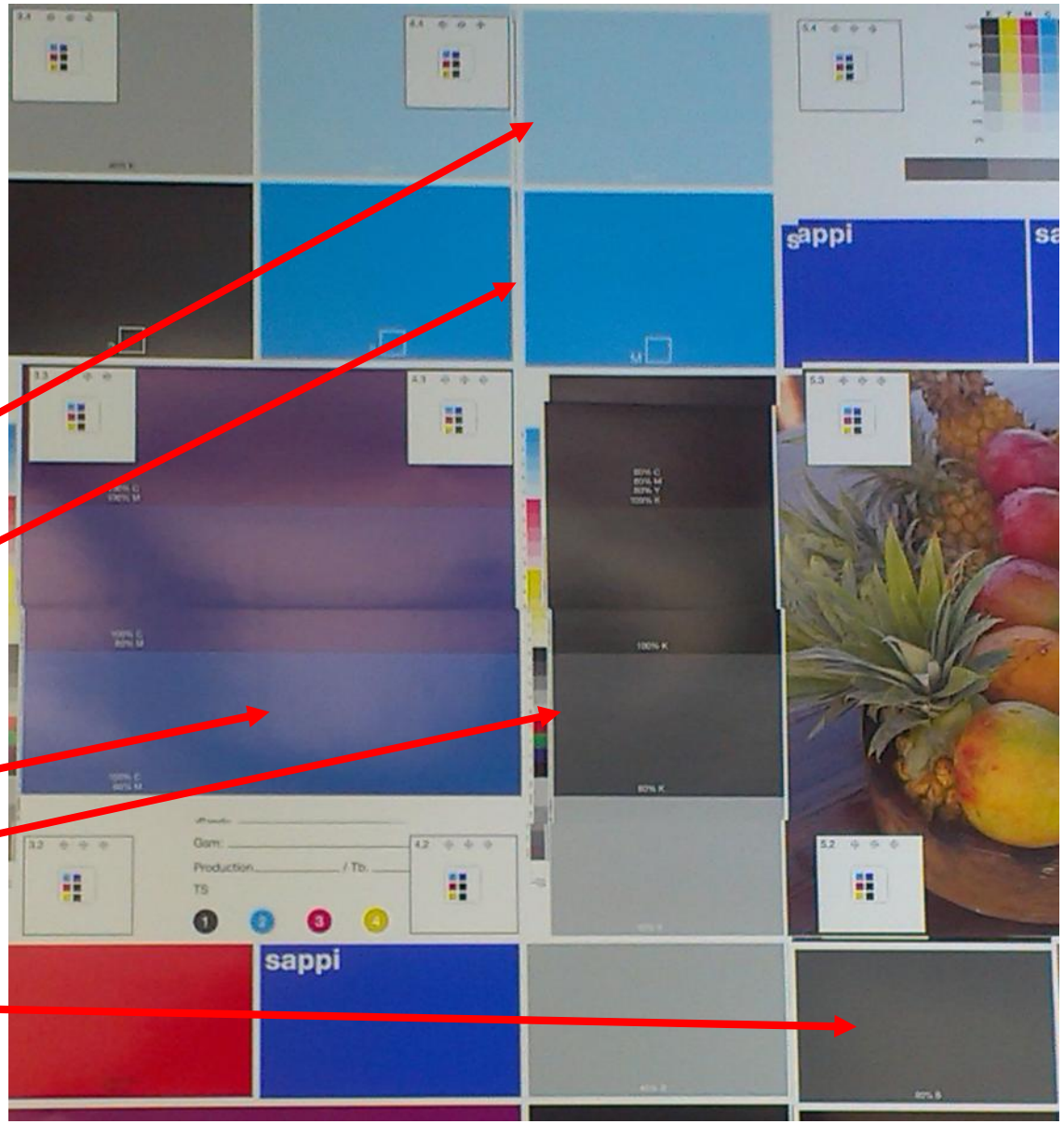
40% C

100% C

100%C 60%M

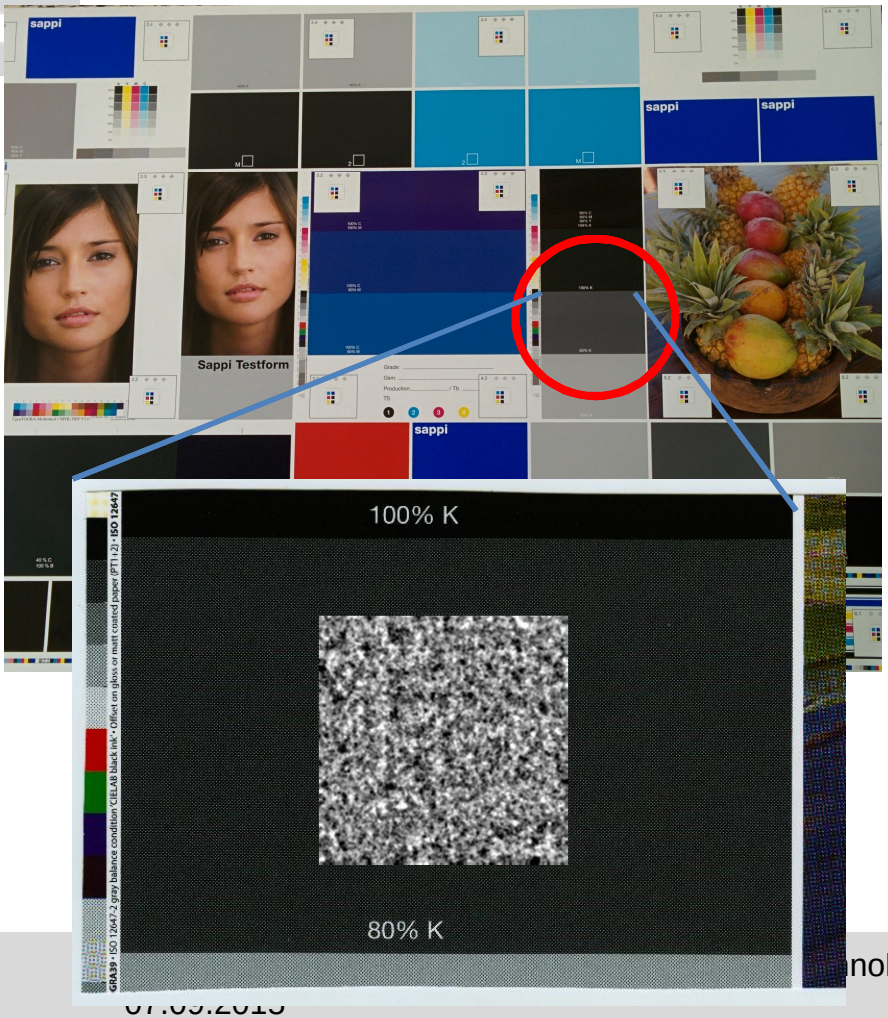
80% K

80% B

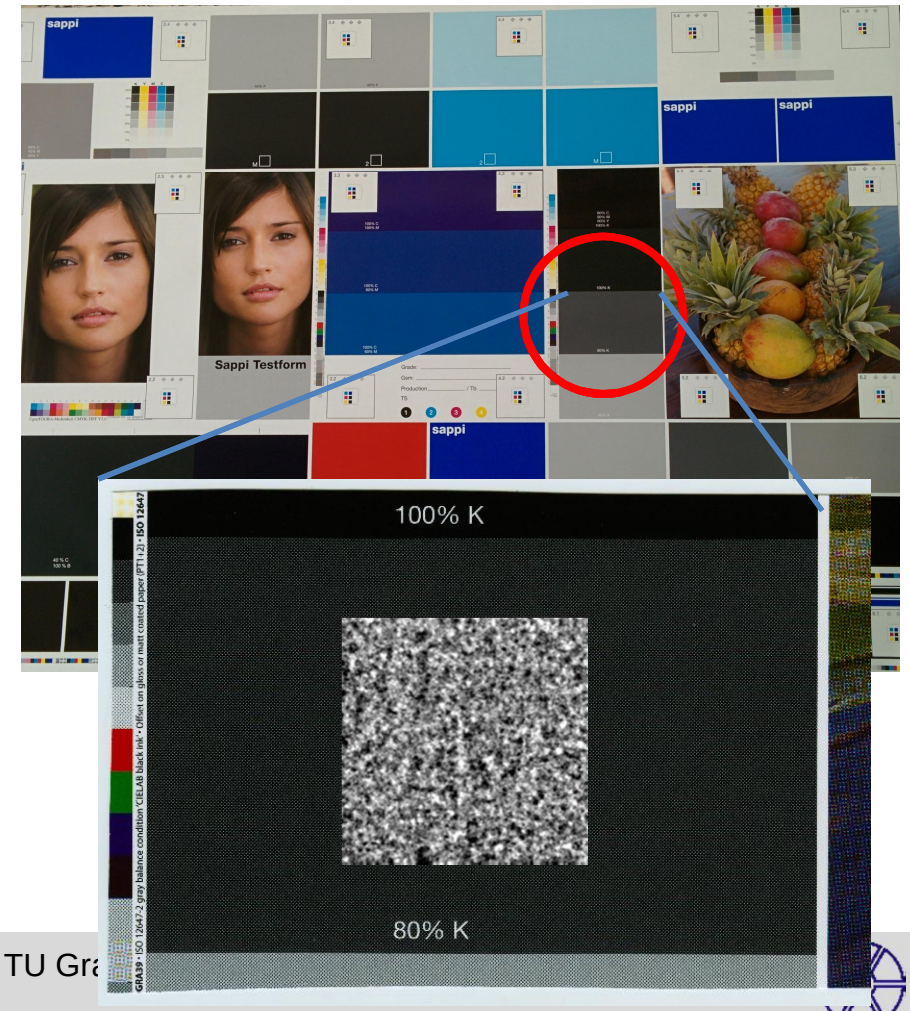


Registration (Alignment) of Colour Fields

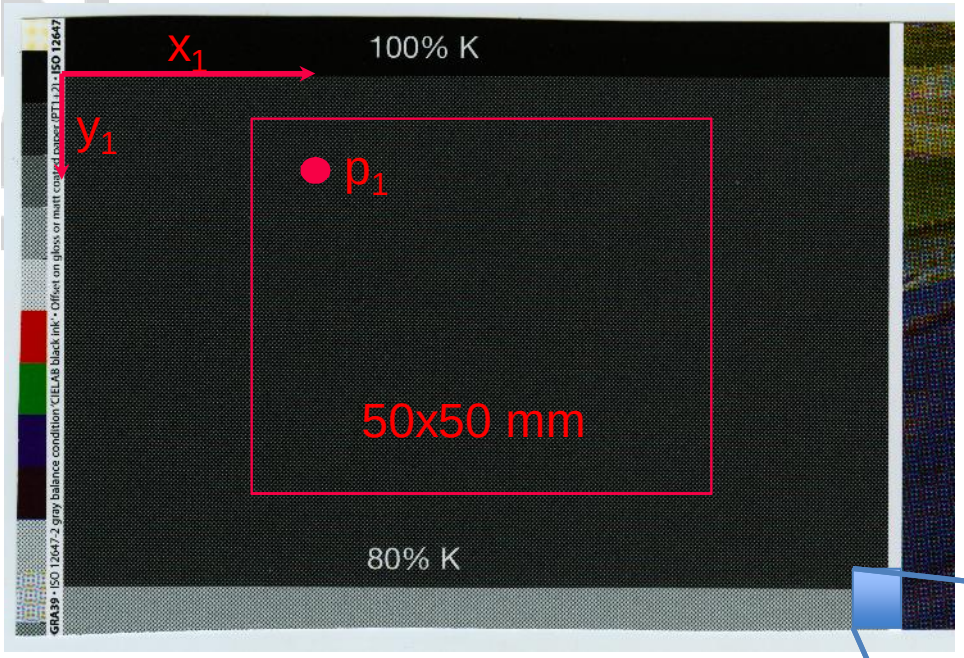
sheet nr.: 4



sheet nr.: 2587



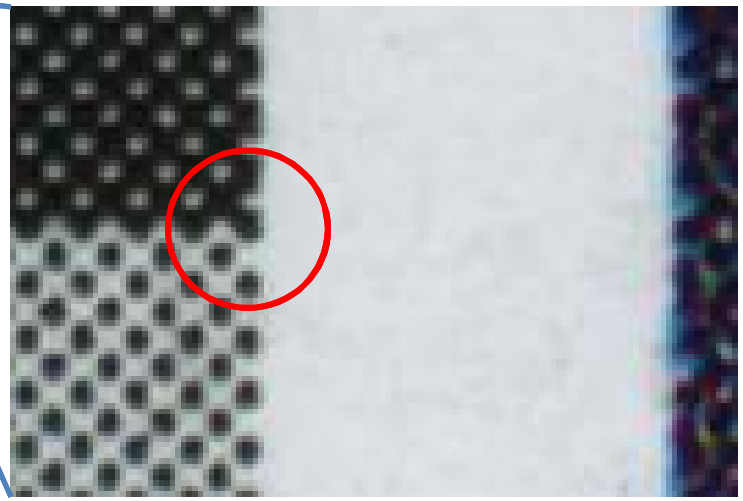
Registration (Alignment) of Colour Fields



Registration was performed with corner of color field as marks[1)].

Result →

stack of 80 aligned images
for each examined colour field

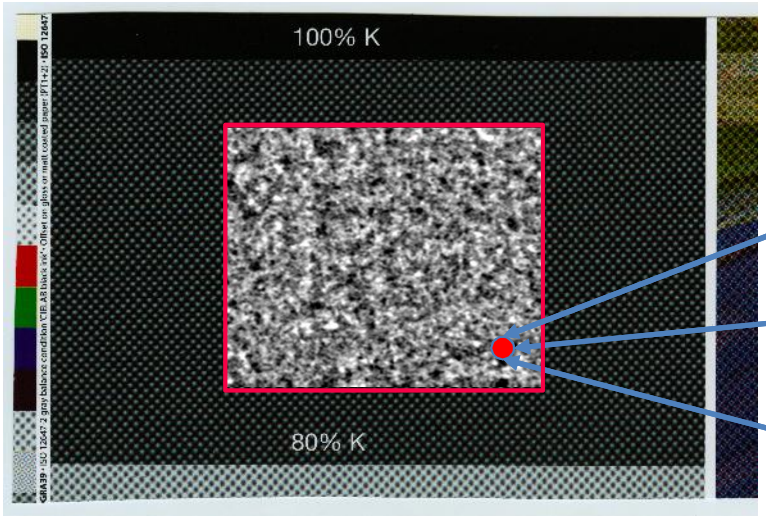


Size of colour field: 100x70mm
Scanned at 1200 dpi = 21.17 µm/pix

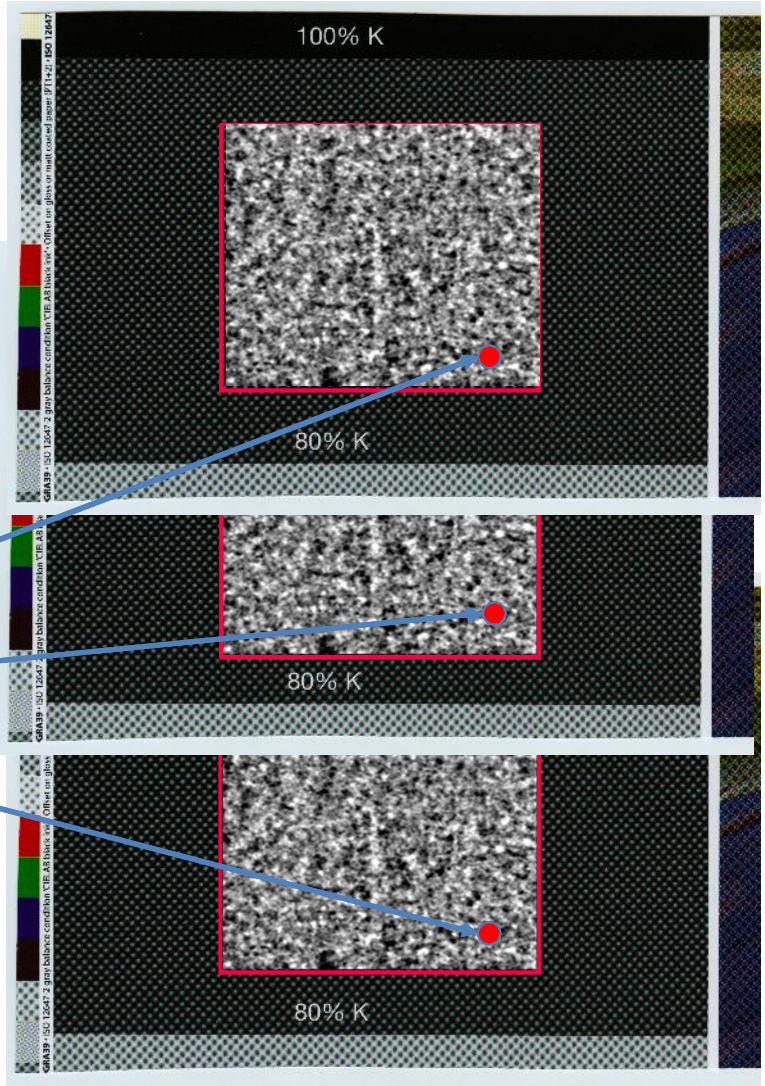
[1)] Hirn, U. et al., (2008). Registration and point wise correlation of local paper properties. *Nordic Pulp and Paper Research Journal*, 23(4): pp. 374–381.

Registration and Filtering of Colour Fields

pass band filterting (FFT) in 1-16 mm wavelength band
→ relevant region for print mottle



First printed (Nr. 1)



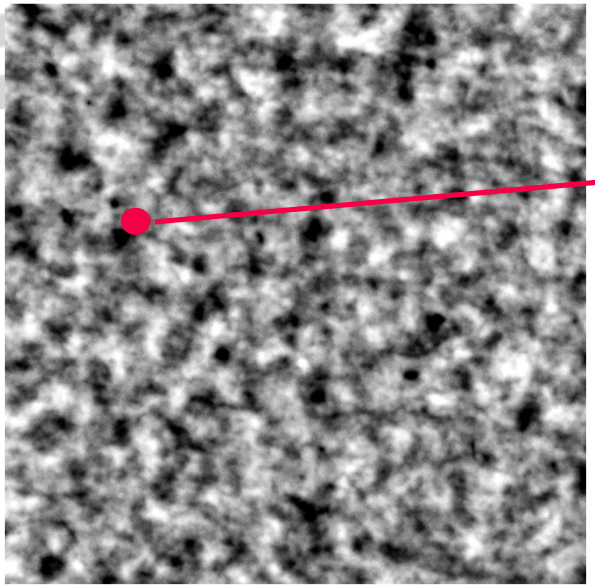
Nr. 2

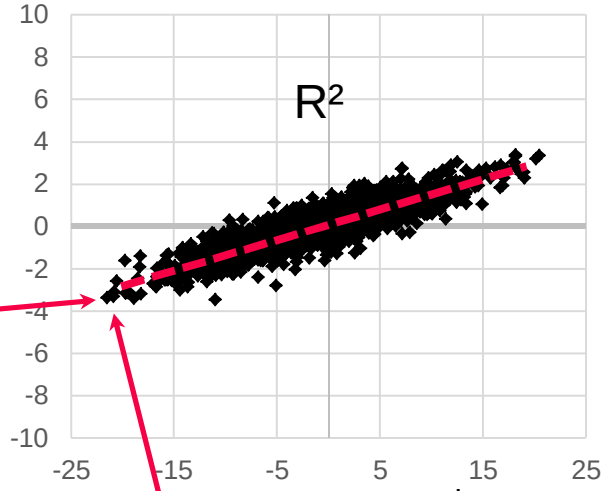
Nr. 3

...

Similarity of Print Mottle Patterns → R^2

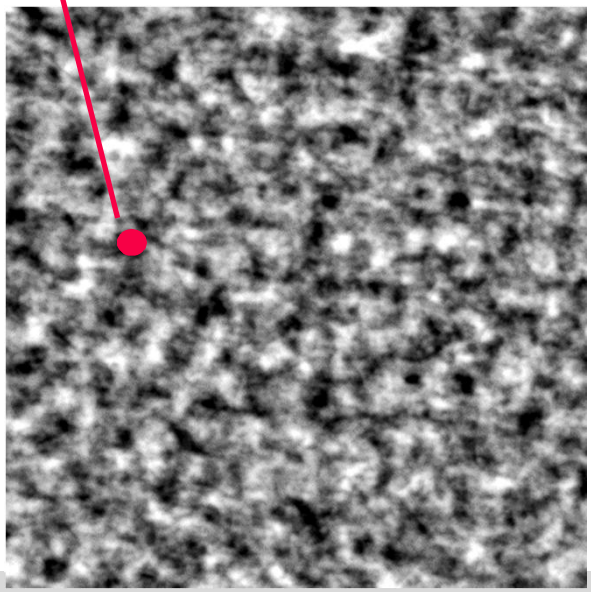
image of 1st printed sheet





point wise correlation

image of 2nd printed image

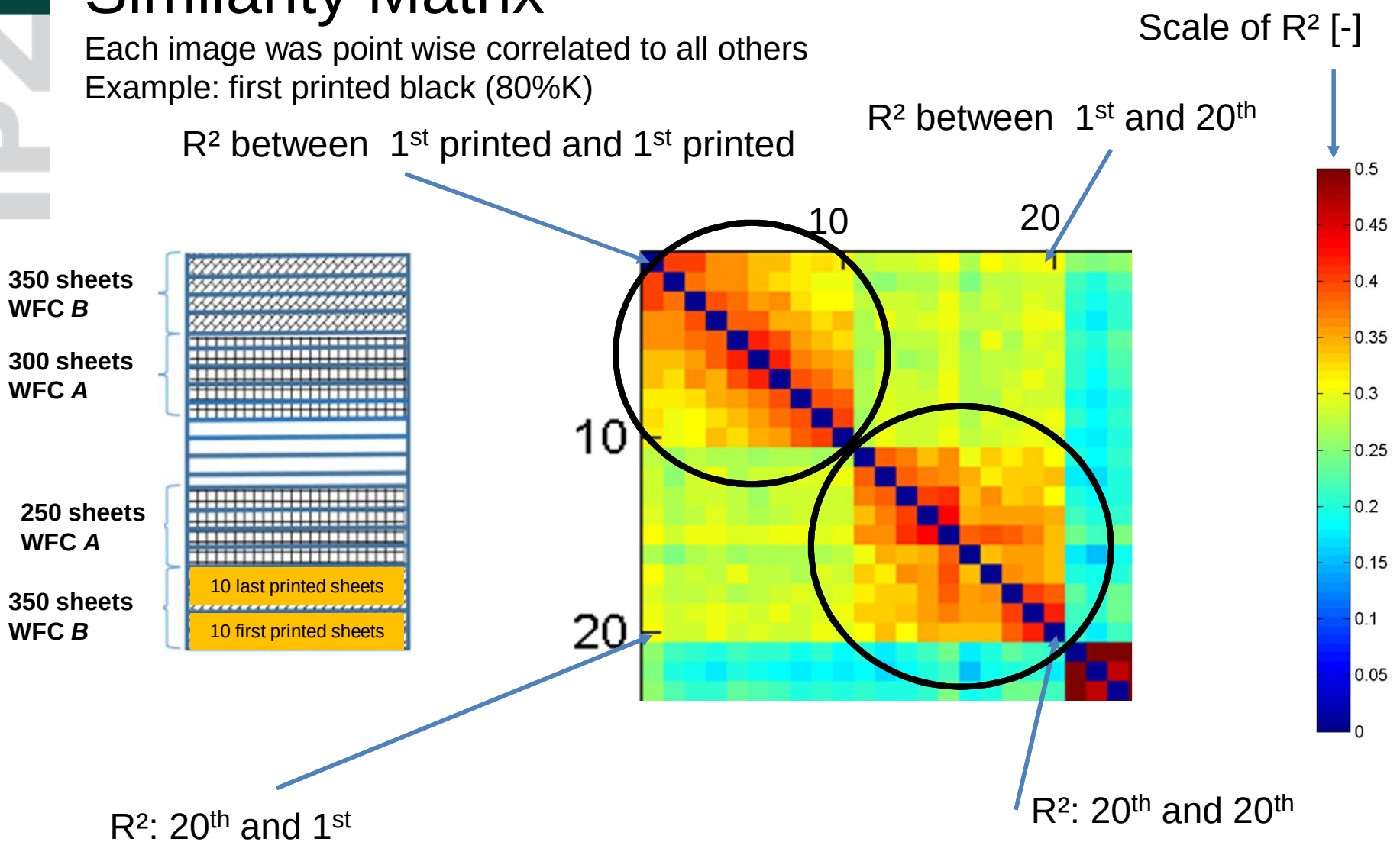


pass band filtered (FFT) images
(1-16 mm wavelength band)

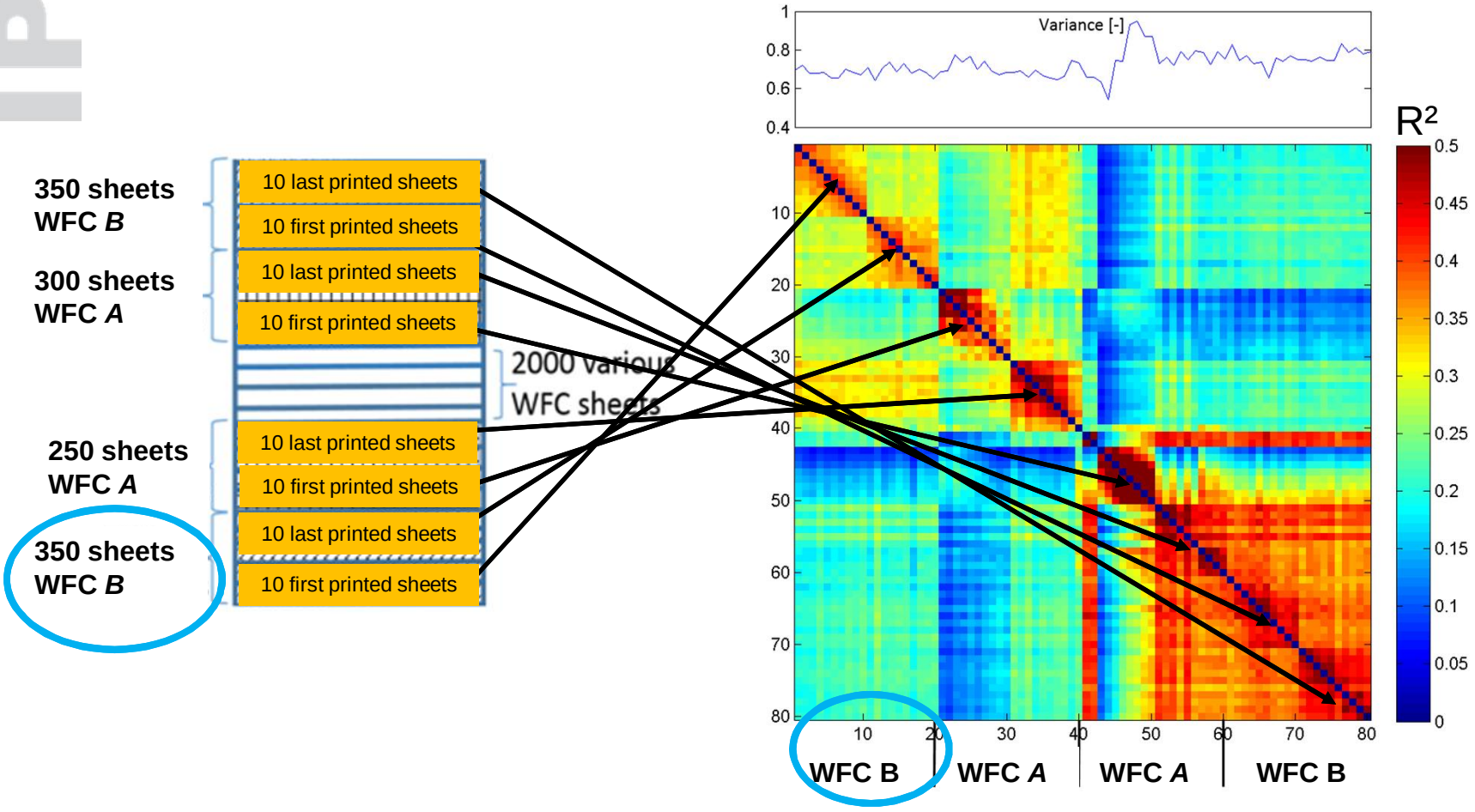
Sample size: 50x50 mm

Similarity Matrix

Each image was point wise correlated to all others
Example: first printed black (80%K)

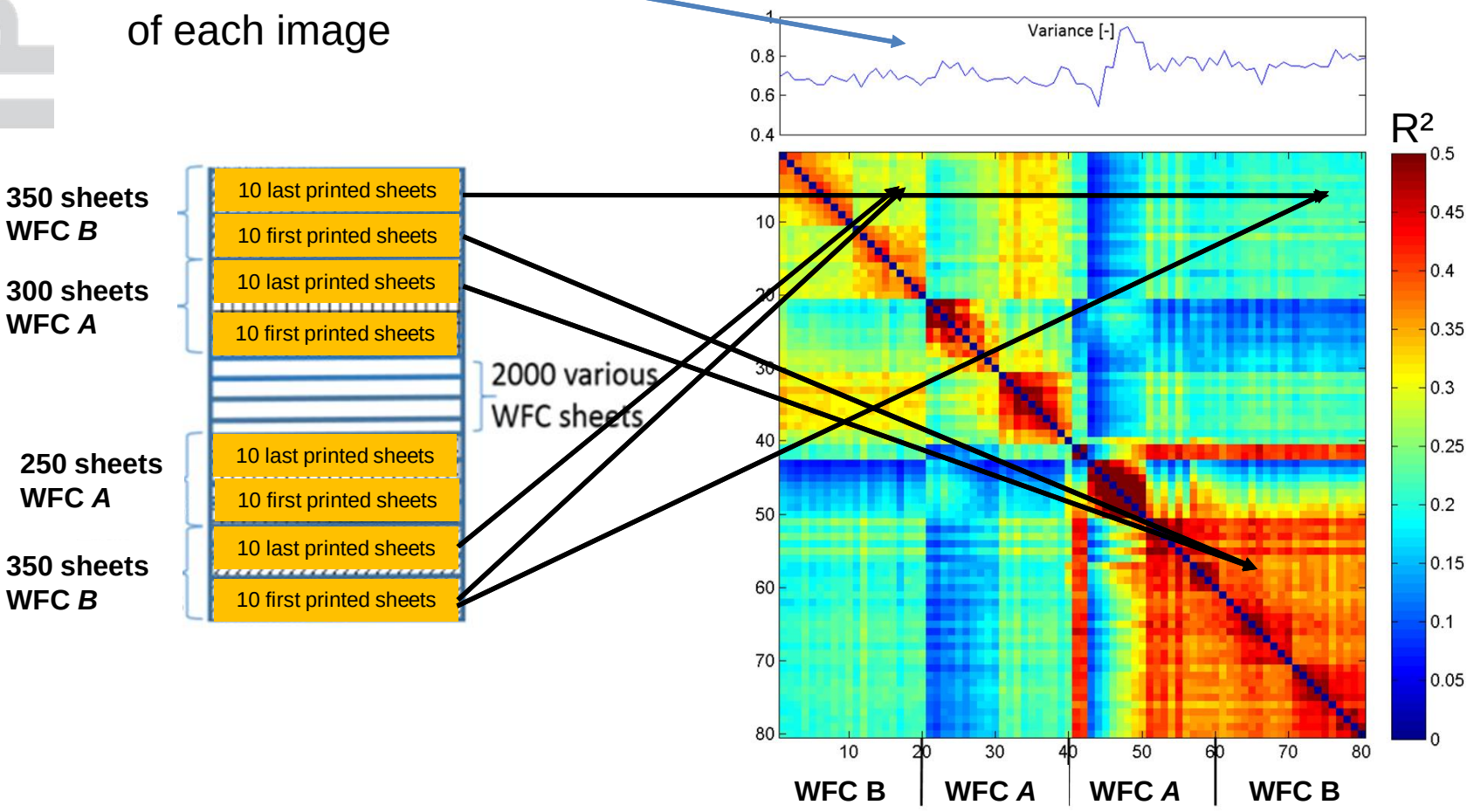


80% K, pass band 1-16 mm

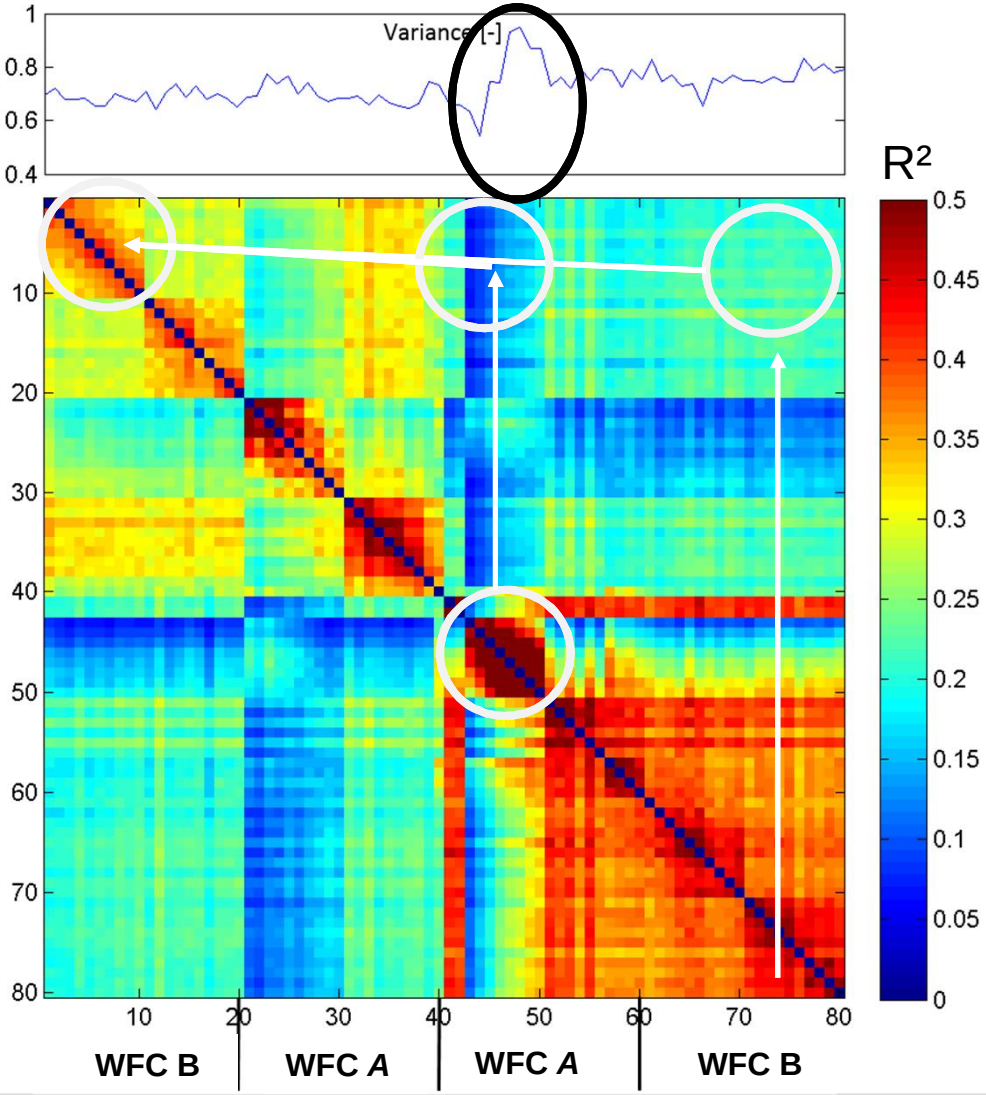


80% K, pass band 1-16 mm

calculation of variance
of each image

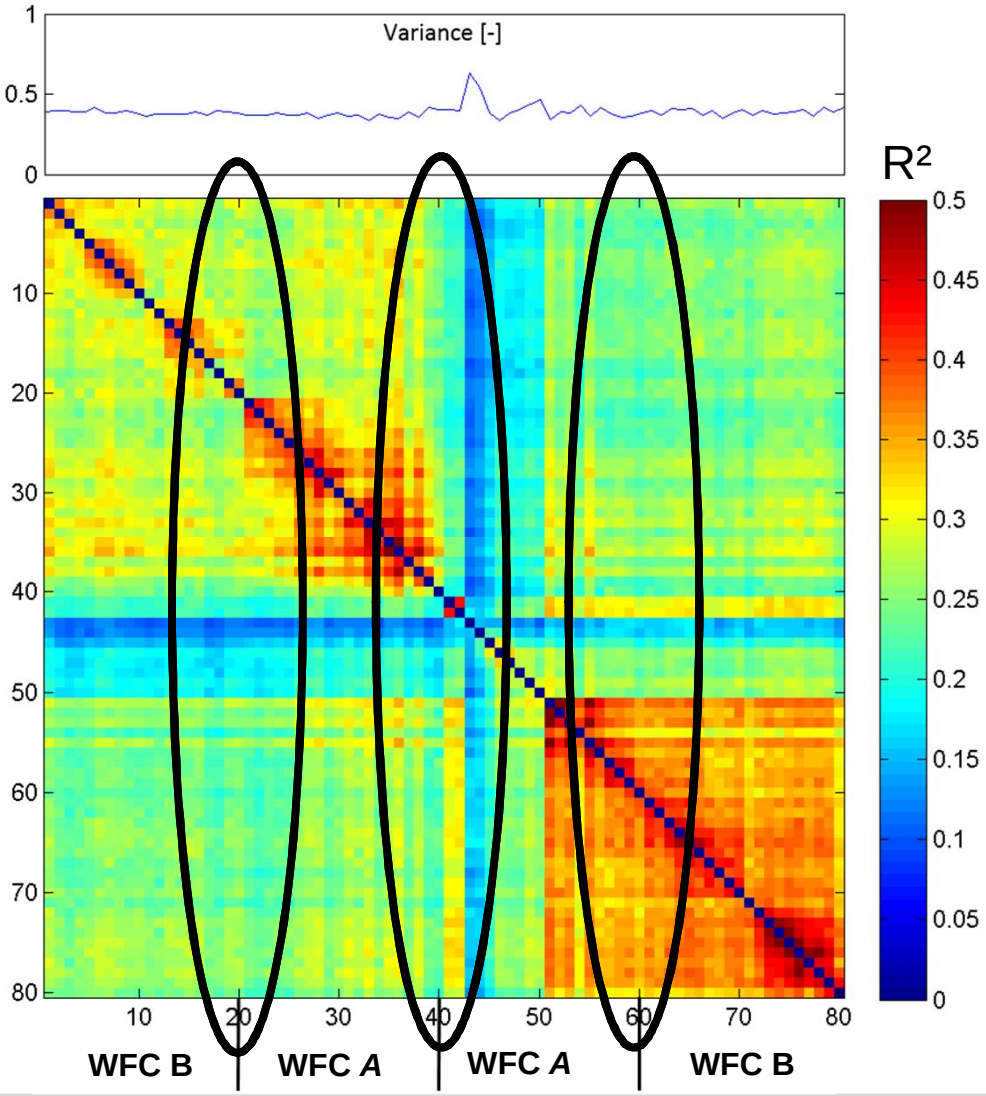


80% K, pass band 1-16 mm



- high similarity between images close to each other in the stack (R^2 = 0.40-0.50)
- print defect rises variance (R^2 > 0.50)
- structure seems to reoccur after print defect
- reasonable similarity between images over more than 3000 sheets (R^2 = 0.20-0.30)

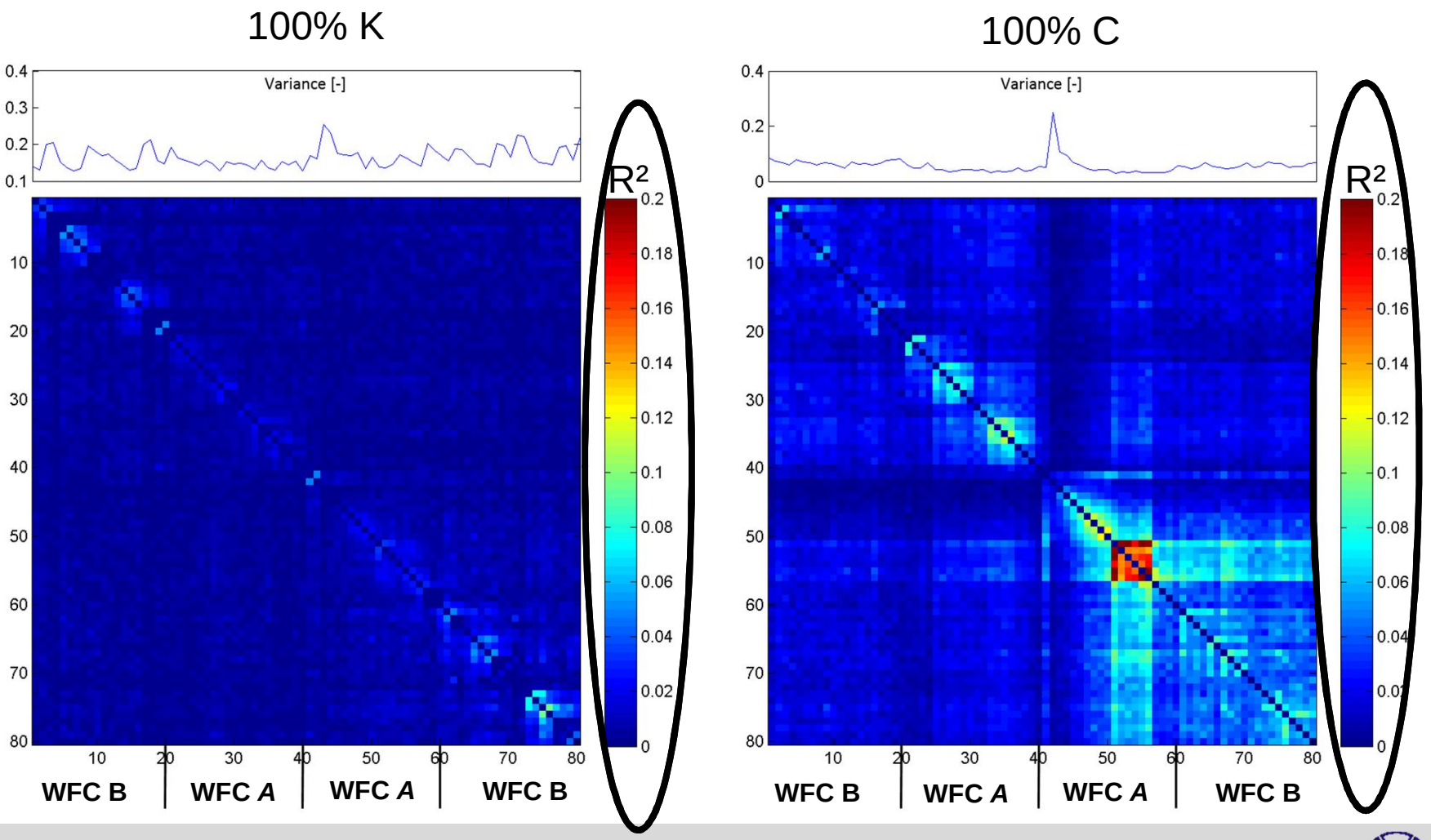
100% C & 60 % M, pass band 1-16 mm



- high similarity between images close to each other in the stack
- Memory Effect appears over different paper grades

→ pattern could be transferred by rubber blanket

Full Tone Colour Fields (1-16 mm)



Conclusion

- We have developed a method to detect similarity of print mottle patterns

Memory Effect patterns:

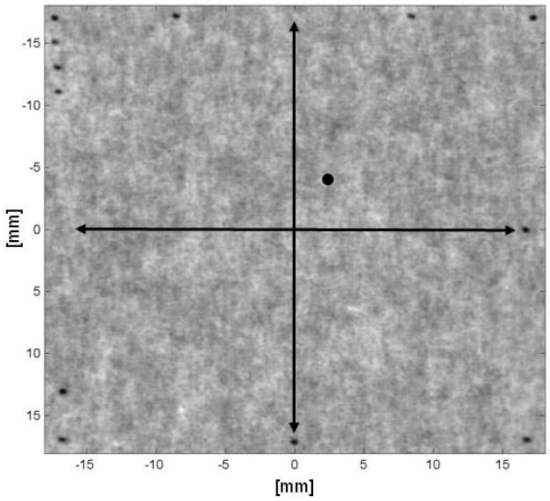
- are systematically transferred
- appear on the *exact same* location in one colour field
- reoccur or stabilise after print defects
- are traceable over more than 3000 sheets
- only observed for screen printing

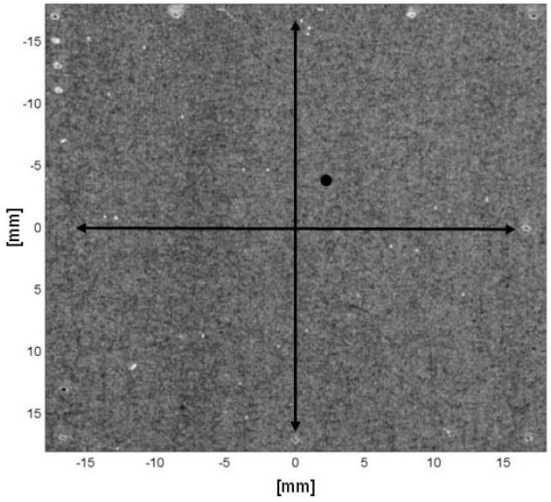
Memory Effect seems to be generated by printing machine

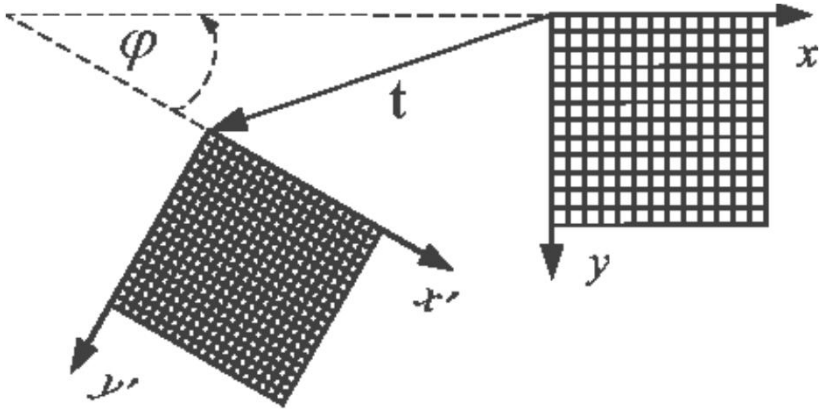
Acknowledgments

océ
ZEPA
FFG
BASF
The Chemical Company
sappi
ANDRITZ
OMYA
mondi
rethink.
storaenso

Shape Preserving Coordinate Transform







$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \mathbf{t} + s \cdot \begin{pmatrix} x \\ y \end{pmatrix} \cdot \mathbf{r}$$

$$= \begin{pmatrix} t_x \\ t_y \end{pmatrix} + s \cdot \begin{pmatrix} x \\ y \end{pmatrix} \cdot \begin{pmatrix} \cos\varphi & \sin\varphi \\ -\sin\varphi & \cos\varphi \end{pmatrix}$$

x,y	target image coordinates
x',y'	source image coordinates
t	translation vector
r	rotation matrix
φ	rotation angle
s	scale parameter