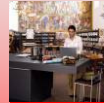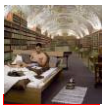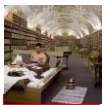# Parameters of Image Quality

Image Quality parameter

- Resolution
- Geometry and Distortion
- Channel registration
- Noise

- Linearity
- Dynamic range
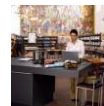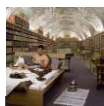- Color accuracy
- Homogeneity (Illumination)

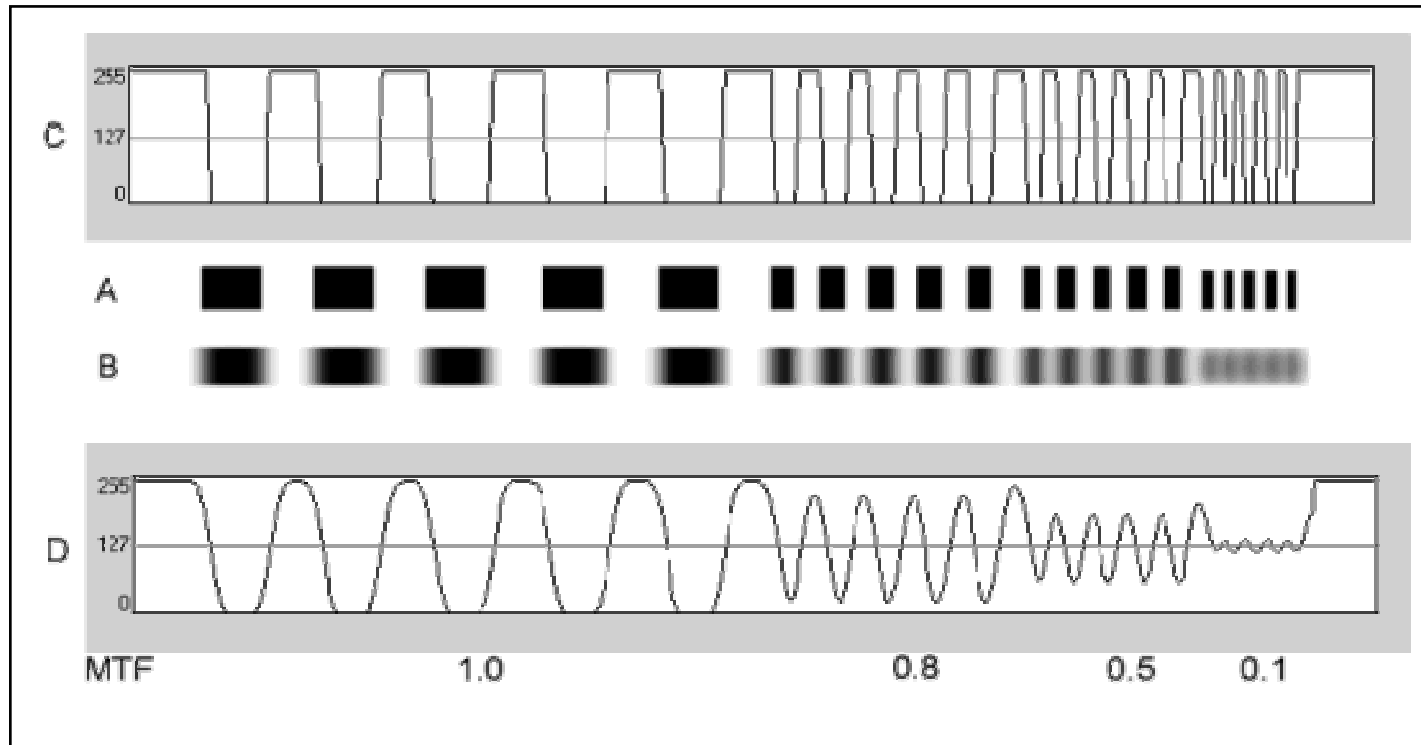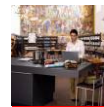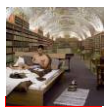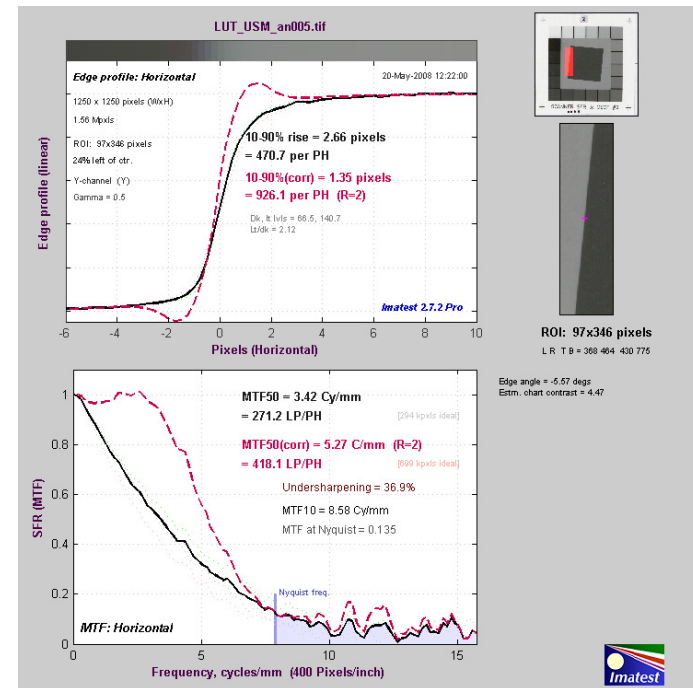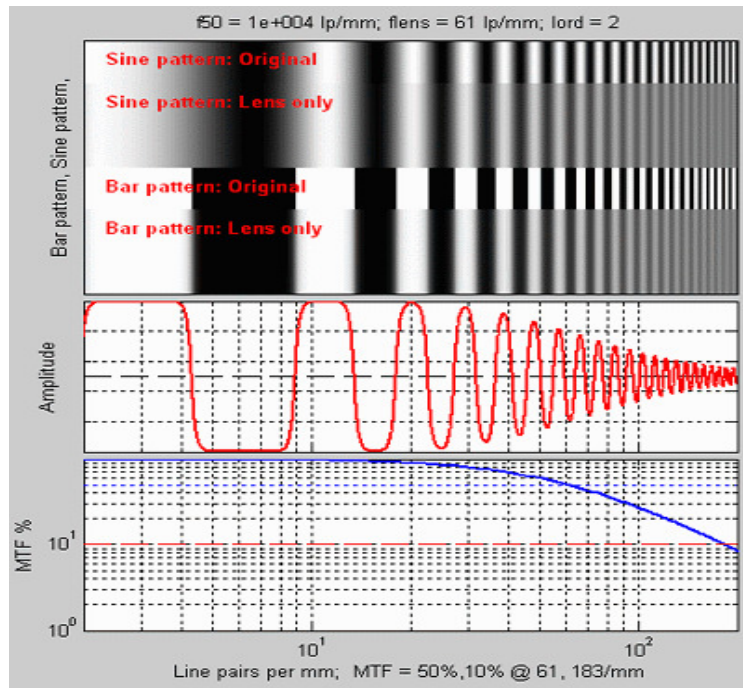# Resolution

- Usually Stated in ppi (dpi)

- More dpi/ppi gives no guarantee for resolved fine structures

- True resolution, optical resolution... These terms are not defined precisely

- So stating a certain resolution alone is not enough....

MTF (modulation transfer Frequency) or SFR (Spatial Frequency Response)
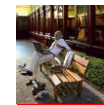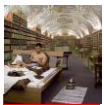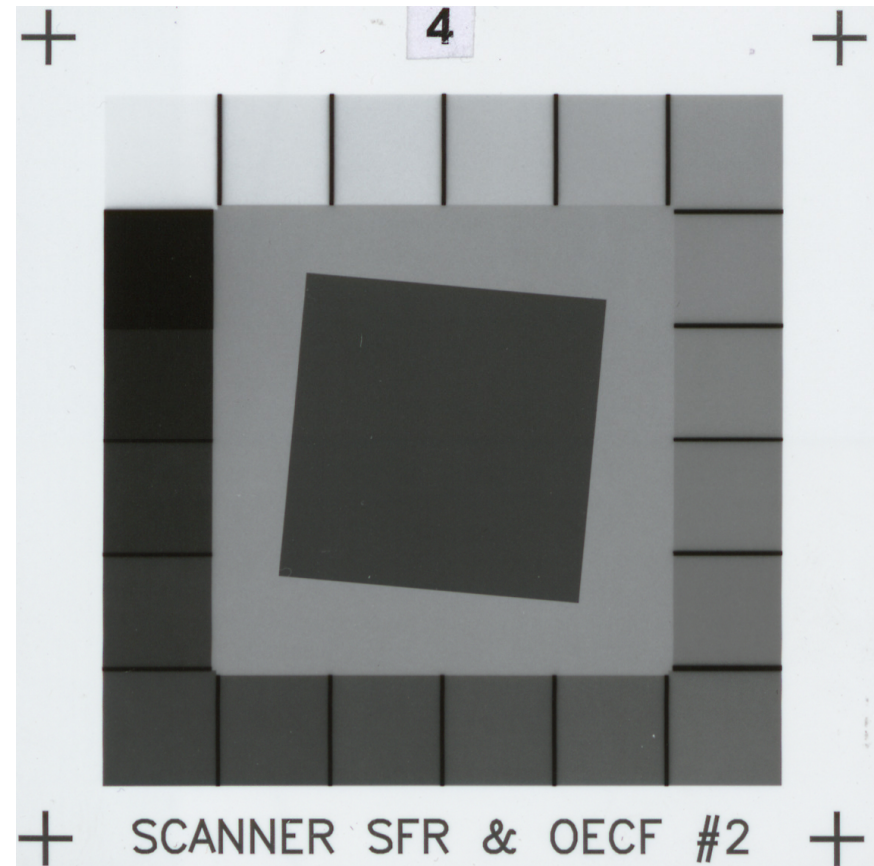
Typical MTF presentation

The Slanted Edge

- Method briefly described in ISO 12233 & 16067-1

- Gives Reliable MTF results just on a slanted density step by analyzing the spectrum of the edge response

- Easy to carry out

4

SCANNER SFR & OECF #2

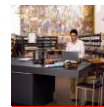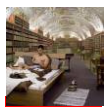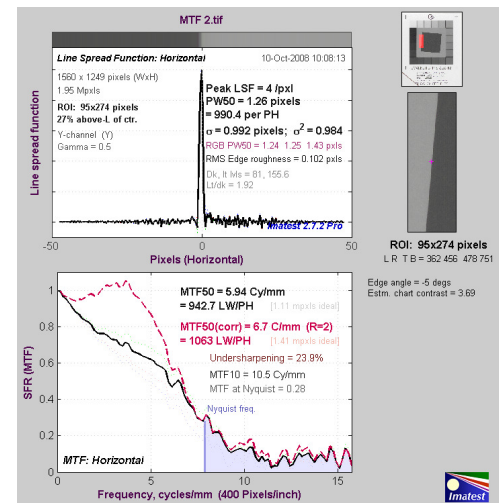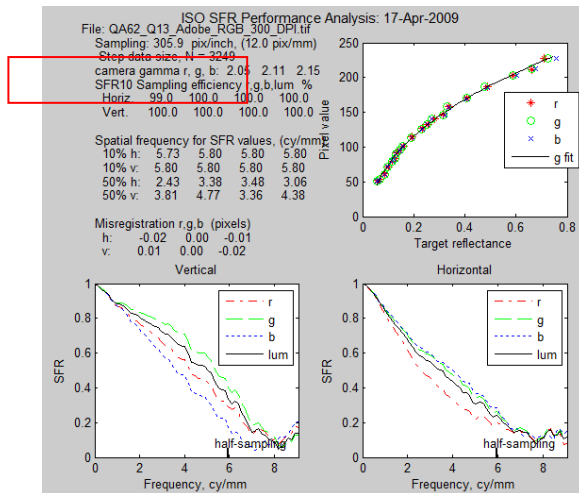ZEUTSCHEL

Resolution

measured as MTF (Modulation Transfer Function)
described in ISO 16067-1 (2004) with UTT or AI QA-62

METAMORFOZE (V0.8 May 2010)
• Recommend resolution depending on original format
• Sampling efficiency > 85 %* in any case

NARA
• 400dpi @ 7,9 lp/mm equal 10% MTF for color and grey (according to 16067-1)
• 600dpi B&W (may be interpolated from 400dpi color or grey)

Resolution
„Sampling efficiency"
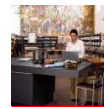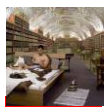
The relation between max. resolution according to 16067-1 and measured resolution is stated as sampling efficiency.
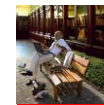
Sample
- Scan at 300dpi → 5.9 Cy/mm @ 10%

(according to ISO 16067-1)
- Measured result on that scan: 5,3 Cy/mm @ 10%

→5,3/5,9 * 100% = 89%

→Advantage: no need to state absolute values for different dpi levels in the requirements

Geometric Accuracy & Distortion
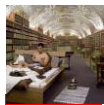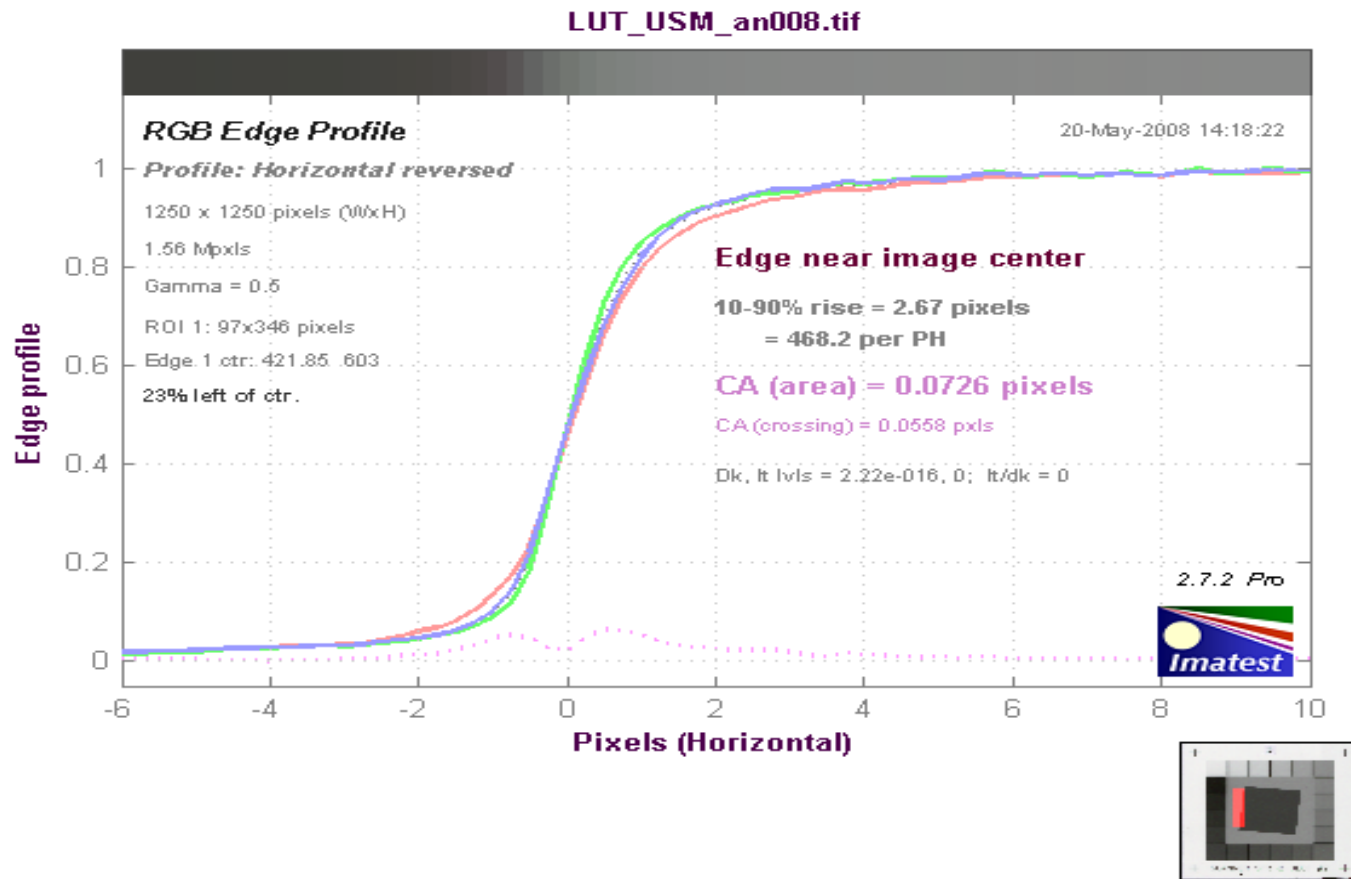
Geometric Accuracy & Distortion

METAMORFOZE

2 Possible errors

Distortion is separated into

- Barrel distortion
- Cushion distortion
    - →Both deform the length and the height of the original
    - →1% deviation max. allowed

NARA

- Images should have the same dimension both, horizontal and vertical.
- In the whole scanning area the max deviation should not be larger than 1/10 inch (2.54 mm) better 1/100 inch (0.254 mm).
- Squares of a checkerboard should not deviate in x and y.
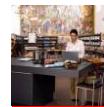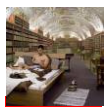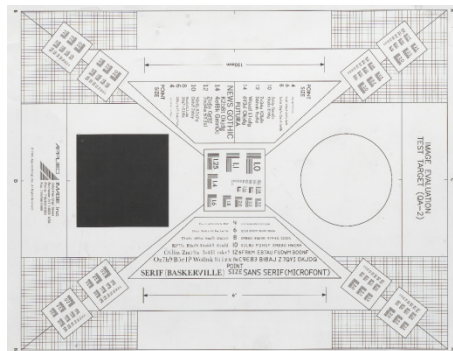
Channel registration

Geometrical deviation between the different color channels. Measured and stated in pixel.

METAMORFOZE

- Max. deviation and vertical +/- 0.5 pixel
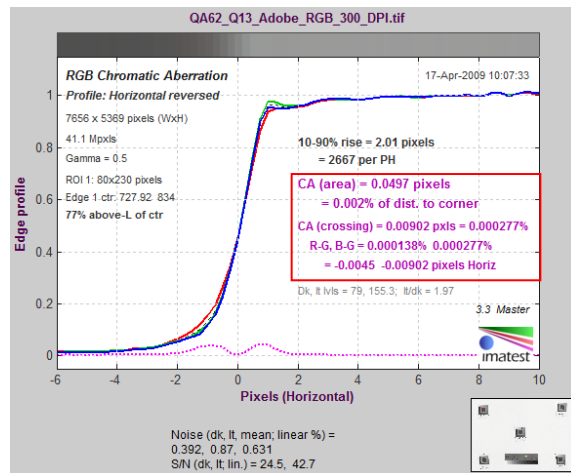
Zeutschel OS14000 A1 (0.05)

NARA

- Deviation not larger than 0.5 pixel
- The smaller the better
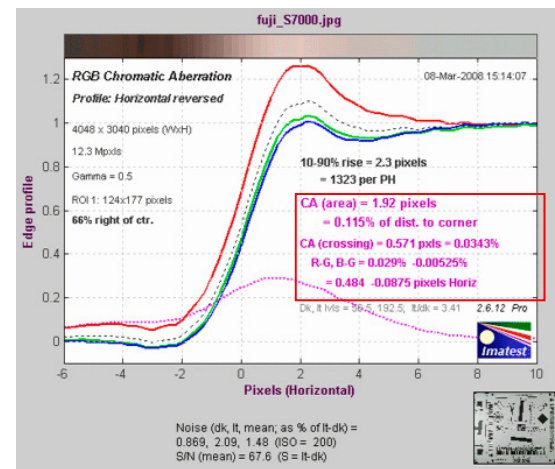
Digital Camera (1.92)
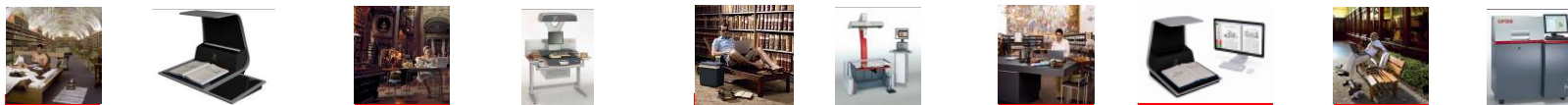
Noise
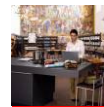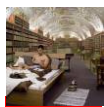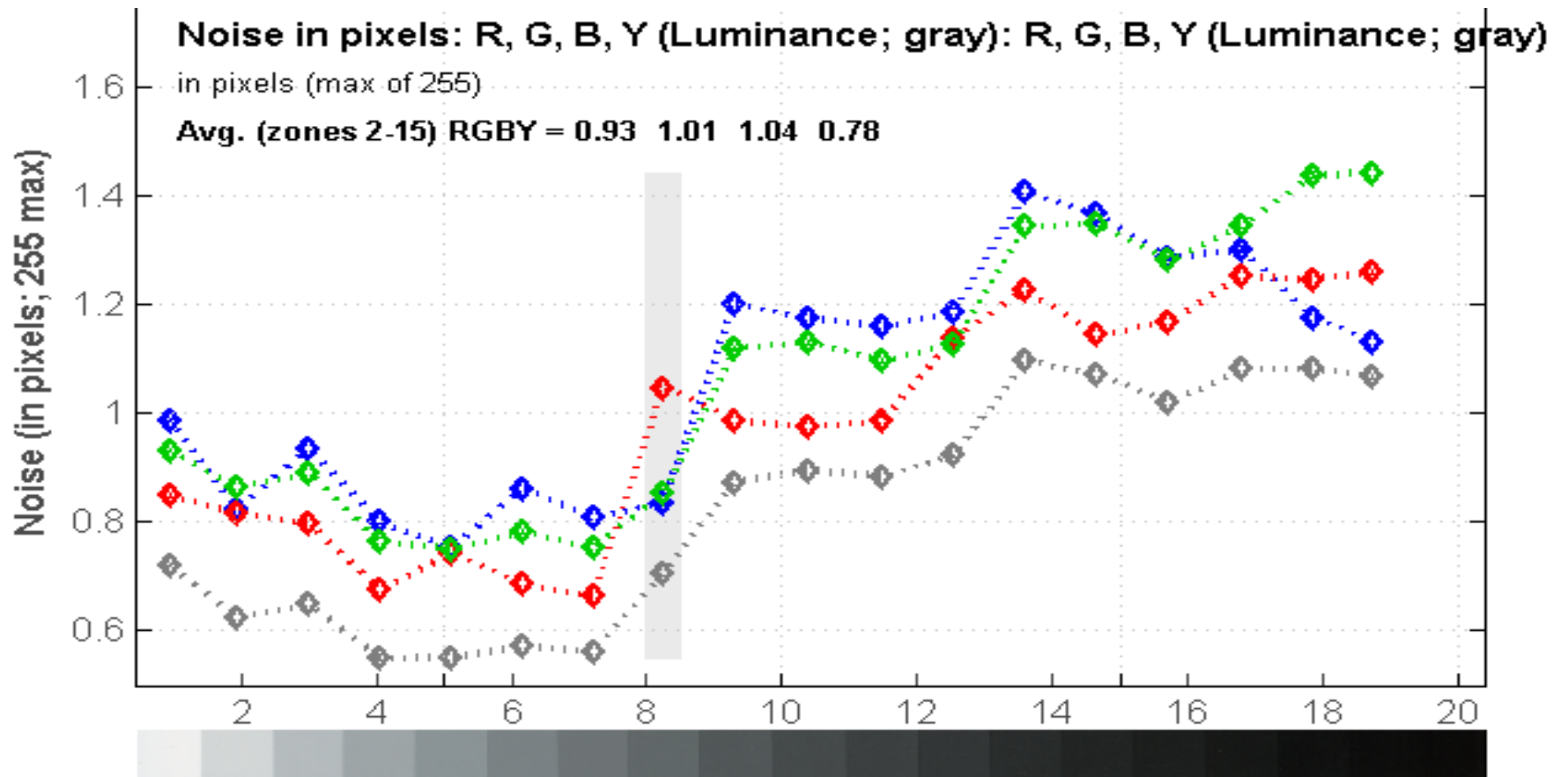
Noise

stated as standard deviation of each single pixel of a
grey target form the average

METAMORFOZE
- Less noise is better
- Max noise level allowed is 4

NARA
- For test and non photographic originals < 1
- Photographic original with a Dmax larger than 2< 0.7
- The smaller the better

OECF

Tonal Reproduction

	85 .07	68 .17	54 .27	43 .37	34 .47	27 .57	21 .67	17 .77	13,5 .87	1,07 .97	8,5 1.07	6,8 1.17	5,4 1.27	4,3 1.37	3,4 1.47	2,7 1.57	2,1 1.67	1,7 1.77	1,4 1,85

RGB Values

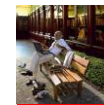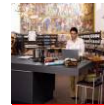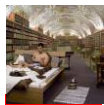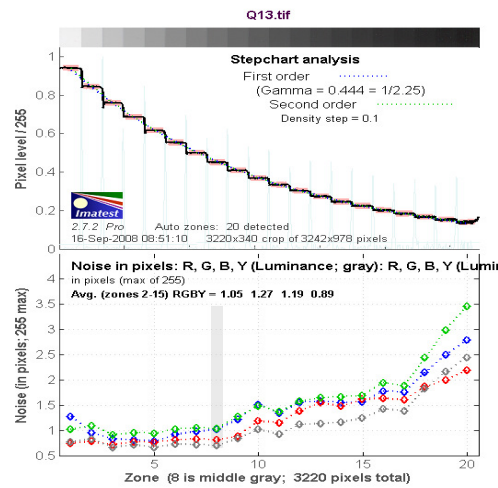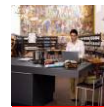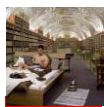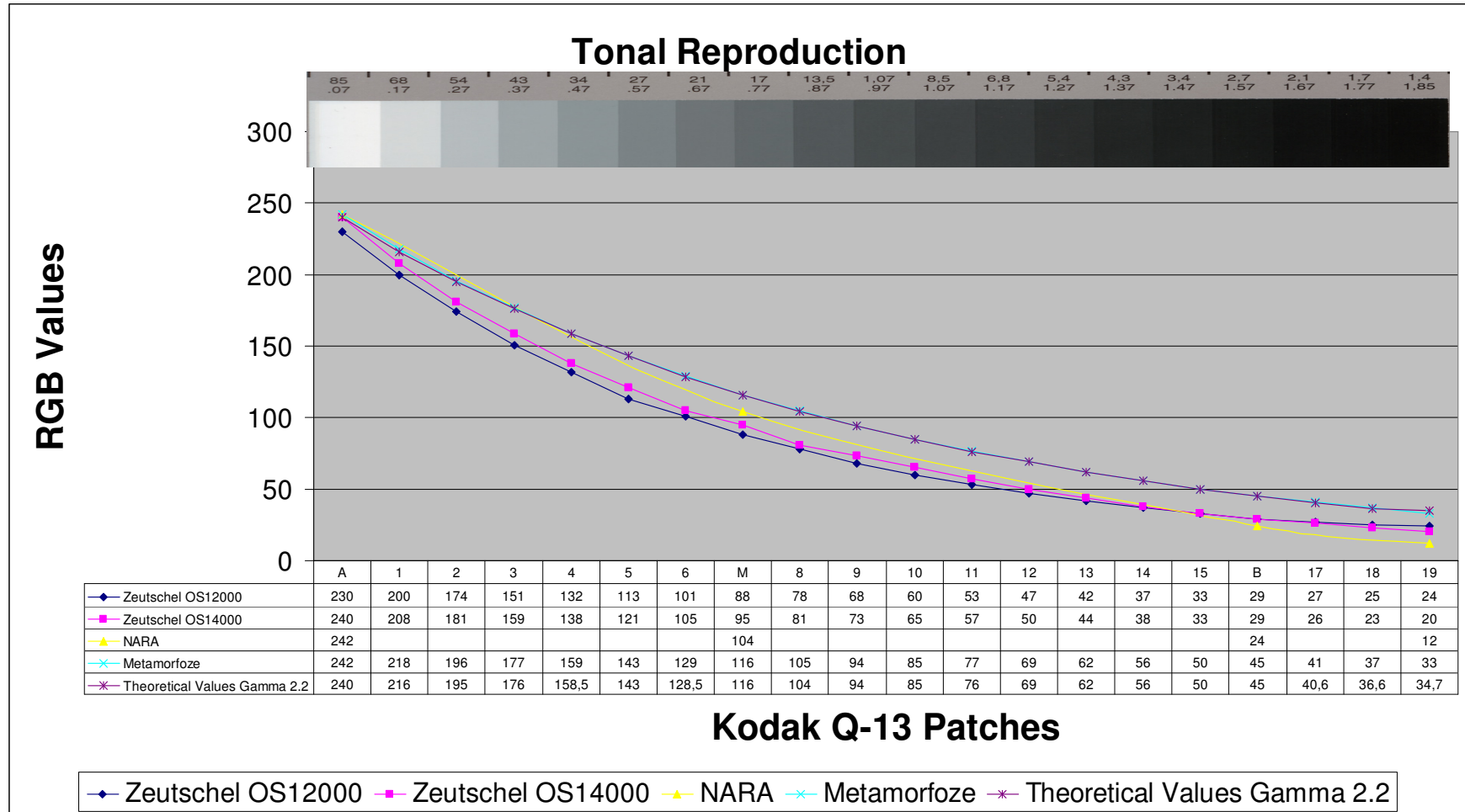|	A	1	2	3	4	5	6	M	8	9	10	11	12	13	14	15	B	17	18	19
Zeutschel OS12000	230	200	174	151	132	113	101	88	78	68	60	53	47	42	37	33	29	27	25	24
Zeutschel OS14000	240	208	181	159	138	121	105	95	81	73	65	57	50	44	38	33	29	26	23	20
NARA	242							104									24			12
Metamorfoze	242	218	196	177	159	143	129	116	105	94	85	77	69	62	56	50	45	41	37	33
Theoretical Values Gamma 2.2	240	216	195	176	158,5	143	128,5	116	104	94	85	76	69	62	56	50	45	40,6	36,6	34,7

Kodak Q-13 Patches

Legend: Zeutschel OS12000 — Zeutschel OS14000 — NARA — Metamorfoze — Theoretical Values Gamma 2.2

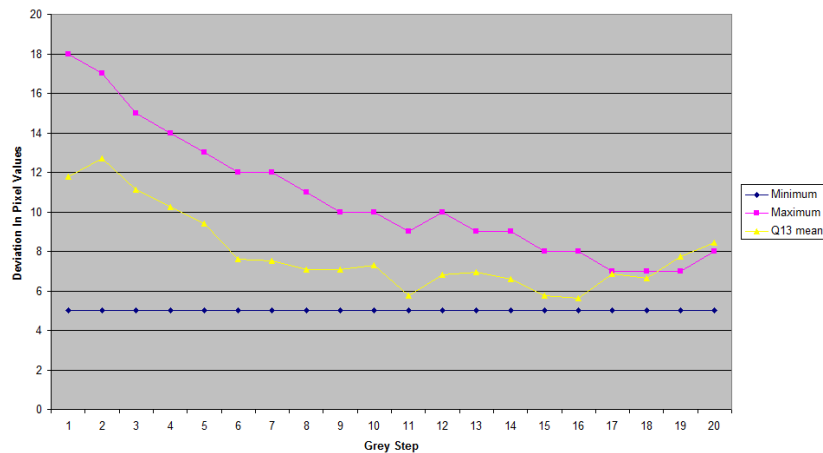ZEUTSCHEL

Linearity/OECF

.
Depending on the standard (NARA/Metamorphoze/...) different OECF Characteristics are required

METAMORFOZE

- Grey step transfer based on Lab (human view) is required,
- Max deviations are stated for Lab or AdobeRGB/eciRGBv2color spaces

NARA

- OECF according to ISO 14524 (1999)
- AdobeRGB RGB values for light, medium grey and dark grey are tested

| Red	Green	Blue	AdobeRGB mean Value	min.	max.
242,73	242,76	242,82	242,8	236	249
219,75	219,73	219,65	219,7	212	224
197,14	197,11	197,08	197,1	191	201
177,23	177,23	177,2	177,2	172	181
159,46	159,44	159,38	159,4	155	163
142,64	142,63	142,55	142,6	140	147
128,56	128,57	128,45	128,5	126	133
115,15	115,12	114,97	115,1	113	119
104,16	104,13	103,94	104,1	102	107
94,422	94,469	93,936	94,3	92	97
83,792	83,832	83,664	83,8	83	87
75,897	75,915	75,637	75,8	74	79
69,098	69,01	68,756	69,0	67	71
61,708	61,69	61,435	61,6	60	64
54,822	54,778	54,685	54,8	54	57
49,736	49,599	49,578	49,6	49	52
45,965	45,864	45,765	45,9	44	46
41,888	41,704	41,297	41,6	40	42
39,128	38,682	38,356	38,7	36	38
34,912	34,507	33,958	34,5	31	34
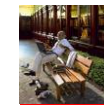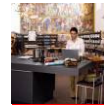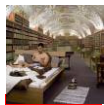
Dynamic range

gives an information about the max. density range a system can reproduce. This range is limited by the electronics, the color depth and the noise in the shadows. The linearization (OECF characteristics) influences the dynamic range too.
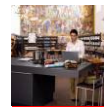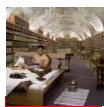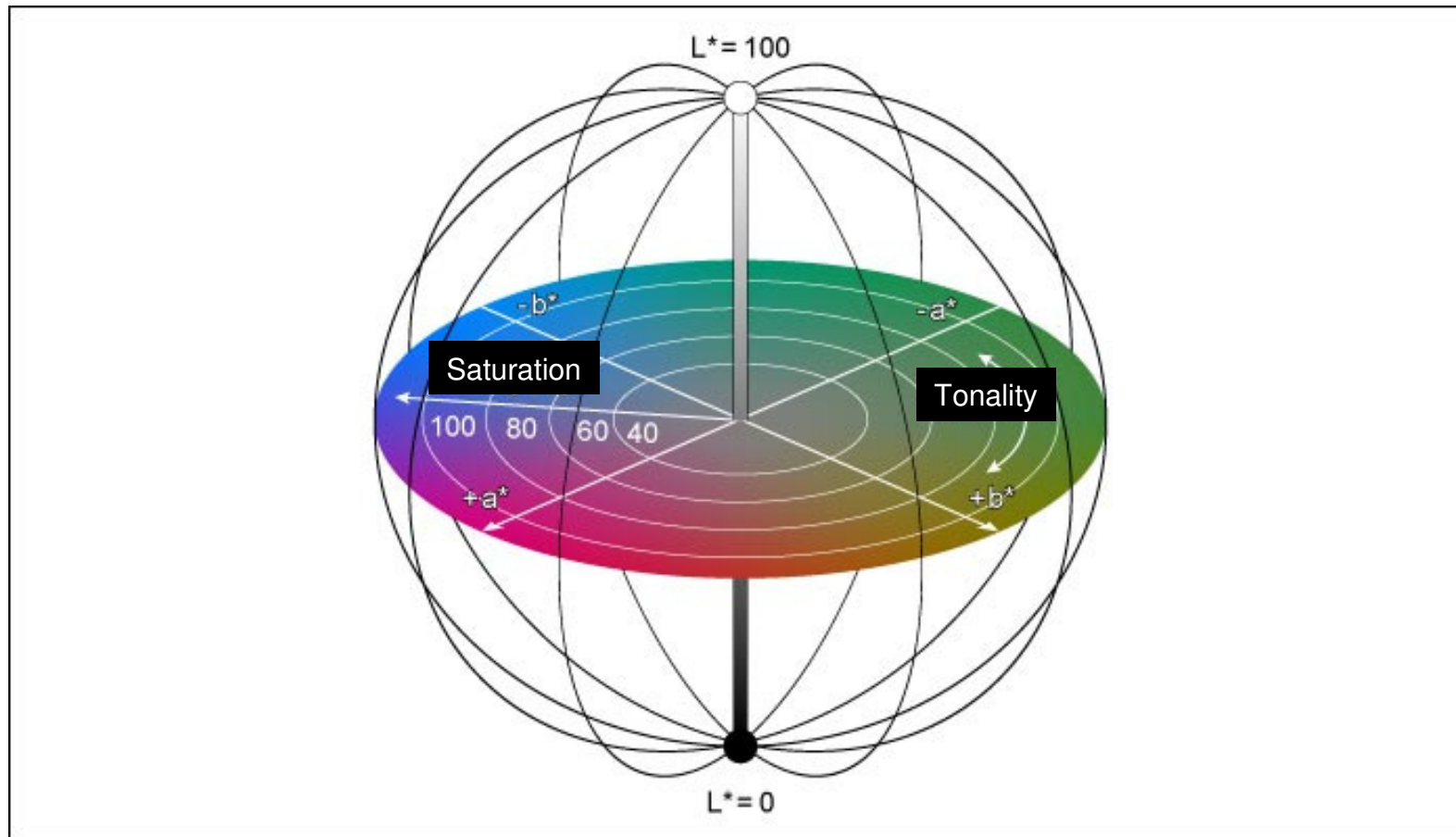
METAMORFOZE
- No grey step is allowed to show more than 1/6 (16,67%) noise.
- sample: pixel values of the Q-13 patch is 33. noise at this level is 3. so the dynamic range is 33/3=11, i.e. 1/11 (9%) of the image is noise.

NARA
- The density range of the original must not exceed the dynamic range of the scanner
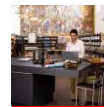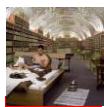
Color accuracy

Color Accuracy

Is tested with a reference target e.g. UTT, IT8, GretagColorCheckerSG. The (L*a*b*) values of each patch are known and will be compared with the corresponding values from the scan of this target. The deviation is stated in Delta E (ΔE) (= vector distance of the two color values in L*a*b*). The smaller the ΔE values the better.
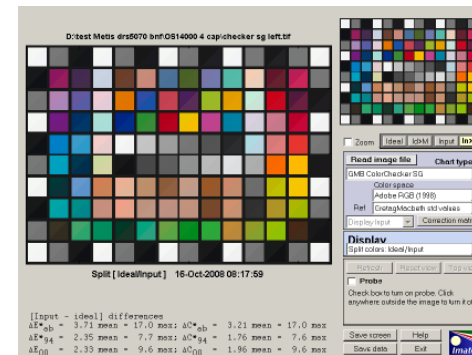
METAMORFOZE

- Smaller
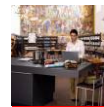- Excellent is a values <5 (mean) <10 (single patch)
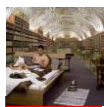- Acceptable is <12; <25

NARA

- No recommendations
- ICC workflow recommended
- Images should be transferred to Adobe RGB(1998) color space
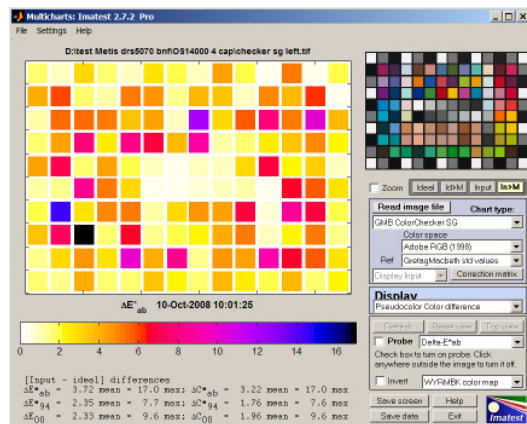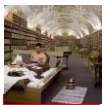

Pseudo color (the lighter the better)

Split Color (patch and scanner value)

Homogeneity

- Influenced by illumination, optics, image sensor
  - Deviation on a homogeneous white target measured in pixel or optical density
- Noise & Fix pattern
 - Are local in-homogeneities. These are not observed in this measurement

Homogeneity

Reproduction of a homogeneous white surface is analyzed

## METAMORFOZE

- The difference in pixel values between center and corner, as well as in-between every corner must not exceed 8 in any channel. This corresponds to an optical density of D 0,03. The max. white level in this test must not exceed 248 (RGB).

NARA

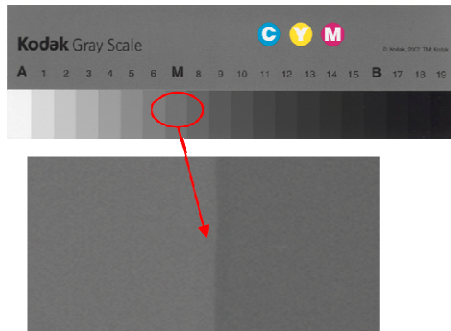- Max lightness or color deviation allowed < 8 steps for RGB (3% or less for optical density)
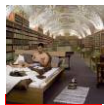
Some examples from our scanner series
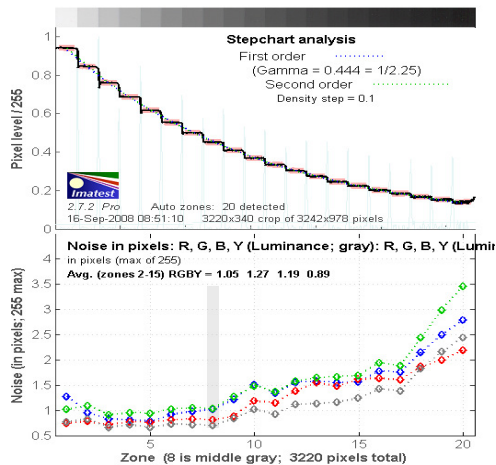# OS14000
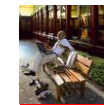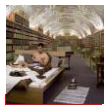
OS14000 noise

Visually and measure compared to competition
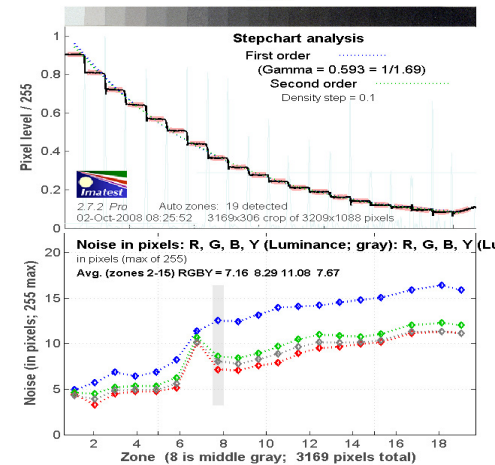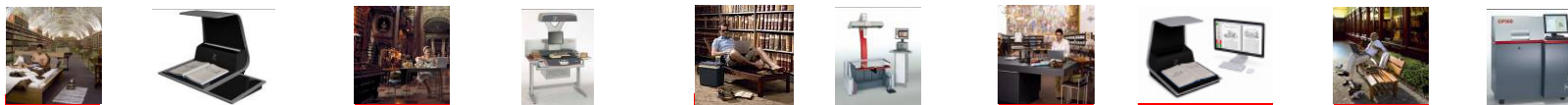

Zeutschel OS14000 A1
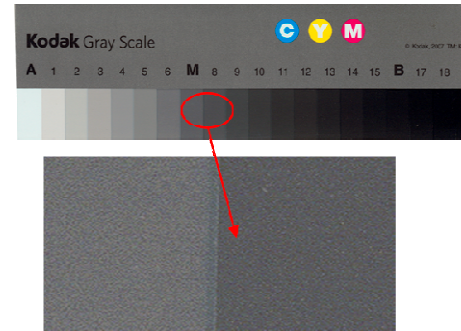
Competitor

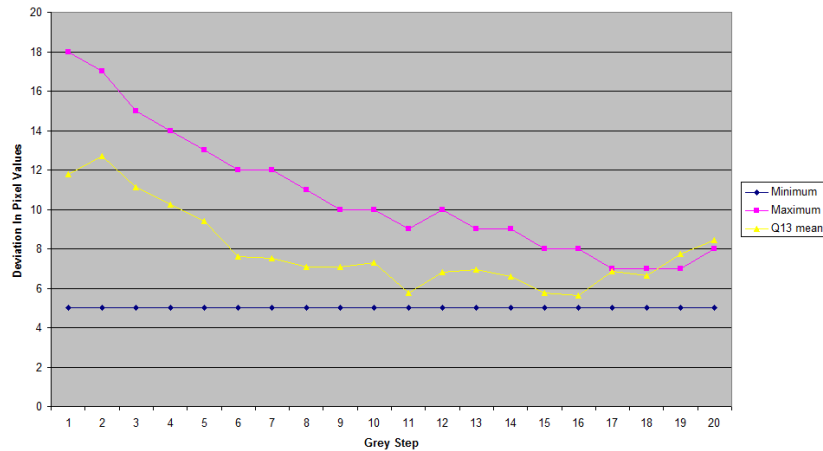Zeutschel OS14000 A1 noise 4
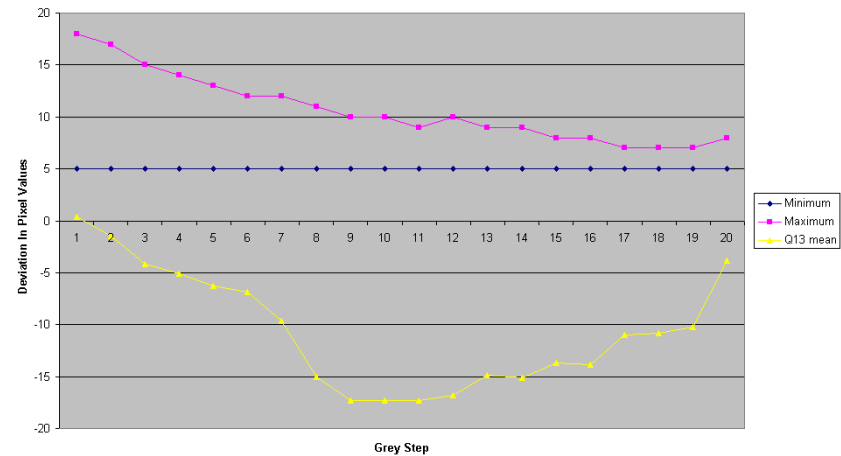
Competitor noise > 15

OS14000, OECF

OS14000 allows loading of different Look-Up-Tables. This flexibility allows the reproduction of nearly any OECF characteristics.

OS14000 fulfills NARA and
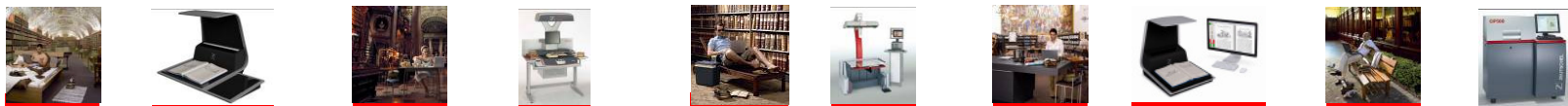
Competitor

Metamorfoze Specification for 100%.

OECF Metamorfoze for AdobeRGB

Competitor AdobeRGB

OS14000 dynamic range

Typical values OS14000:

- AV1 = approx. 4
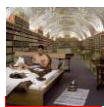- AV2 = approx. 2
- AV4 = approx. 1.4
- AV8 = approx. 1.2

This results in a signal to noise ratio at a RGB of 35:

- AV1 = 8.75 –**11.4 %** of noise
- AV2 = 17.5 – **5.7 %** of noise
- AV4 = 25.0 – **4.0 %** of noise
- AV8 = 29.1 – **3.4 %** of noise

Competitor:

Noise is about 15 →

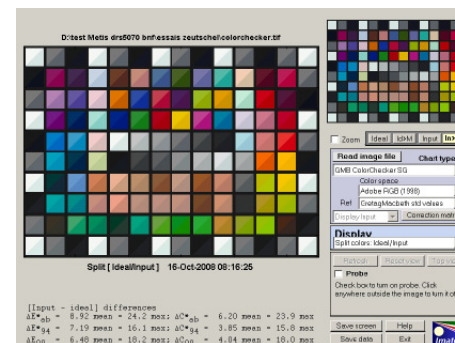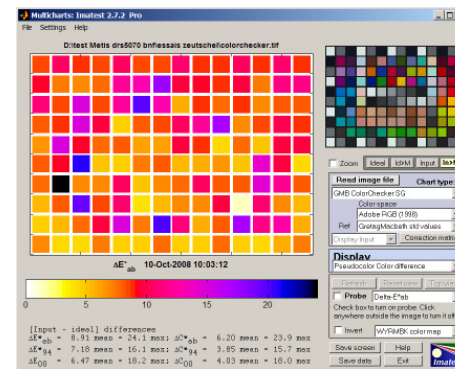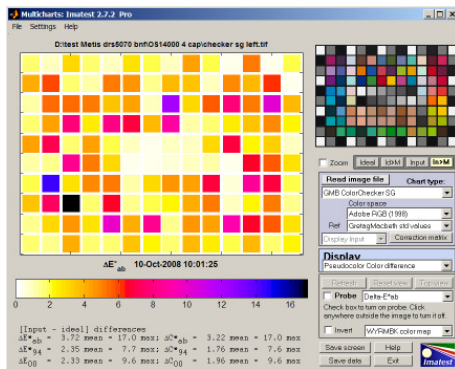A signal to noise ratio of 2.3, means . **42.9 %** of the image information is noise

OS14000 color accuracy

OS14000 typically shows a color accuracy of 3.6 – 4.5 ΔE depending on the OECF characteristic chosen.

Competitor (product is advertised with it's color accuracy) shows a mean delta E 8.92 ΔE

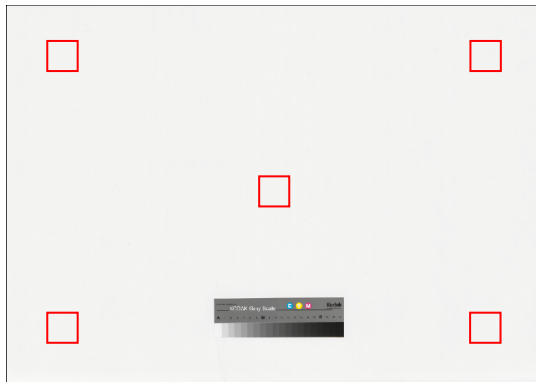Zeutschel OS14000 A1 AdobeRGB – ΔE 3.72

Competitor AdobeRGB – ΔE 8.92

OS14000 homogeneity

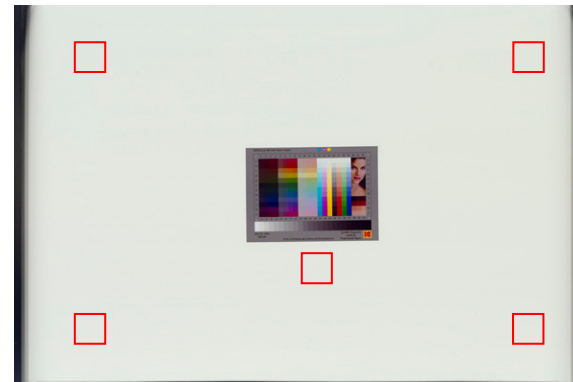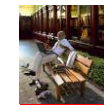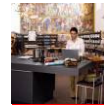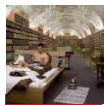OS14000 A1 is typically < 5 pixel in the whole imaging area.

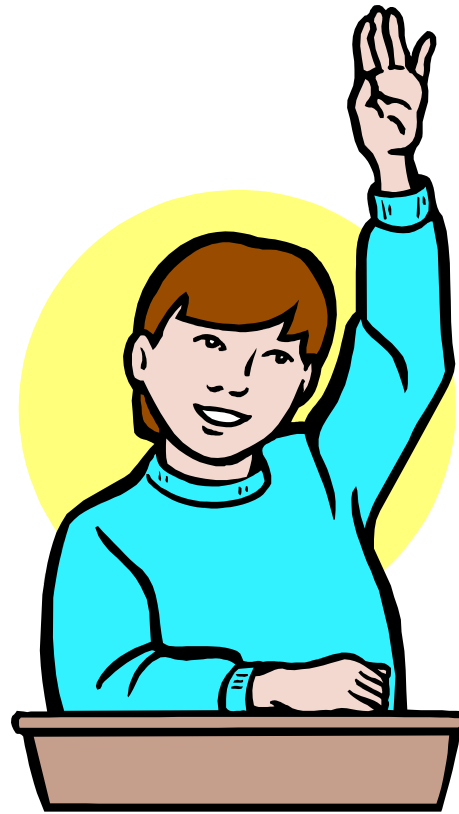Competitor shows 8 pixel deviation in the area.

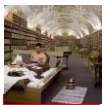Zeutschel OS14000 A1 < 5 Pixel difference

8 Pixel difference in competitors scan

Time for Questions and answers

Thank you for your attention!

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