Der Farbfilm

1. Was für Farbfilme gibt es?
2. Verwendung
3. Aufbewahrung
4. Neue Möglichkeiten dank „File to Film“
5. Empfehlungen

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IMAGING
GUBLER

Das Problem

© 1968 by Fehrenbach Studios

Displayed 1968 Ektacolor print with severe magenta dye fading and loss of detail in skin tones and in the bride's dress while the groom's black tuxedo appears unaffected.

1950 Kodacolor print kept in the dark (note stain).

Courtesy of Sarah Wilhelm

1980 Agfacolor print kept in the dark (note cyan fade).

© Zavell Smith Photographers (3)

1970 Ektacolor RC print after 10 years of display.

1970 Ektacolor RC print after 10 years of display.

1973 Ektacolor RC print after 8 years of display.

© 1969 by Fehrenbach Studios

1969 Ektacolor RC print after 13 years of display.

Farbe ist vergänglich

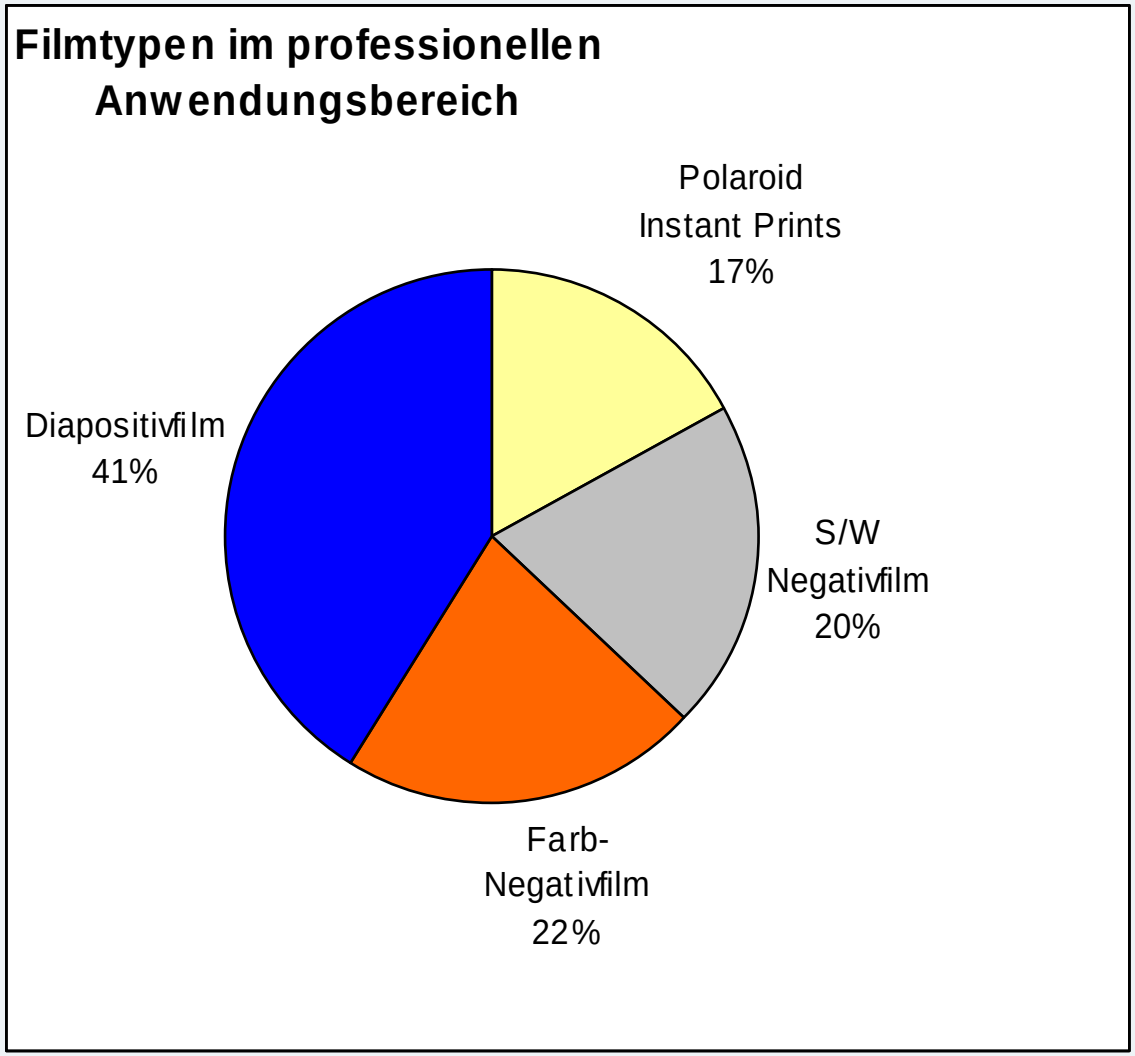
Farbfotos bestimmter Zeitabschnitte sind bereits verloren
(Kodacolor Film 1942-1953
Agfacolor Prints 1974-1982)

Weitere Verluste drohen

Auch im Dunkeln aufbewahrte Fotos nehmen Schaden

Digitalen Bildern droht ähnliches Schicksal

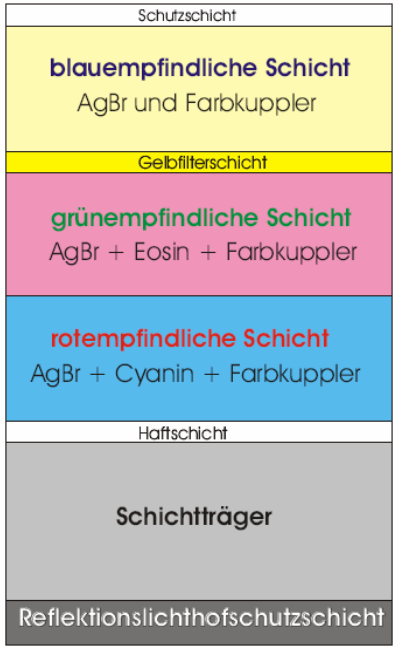
Das Problem (II)



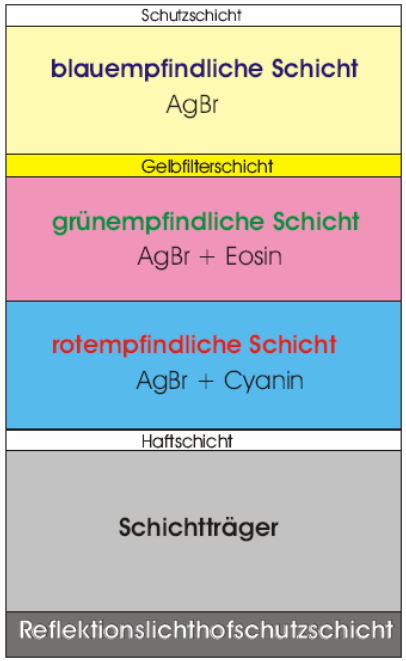
- Im Dokumentationswesen wird meist Diapositivfilm verwendet (Kodak Ektachrome)
- Dieser Film ist nicht langzeitig farbstabil.
- Im Laufe der Jahre wurde das Produkt und der Entwicklungs-prozess verbessert (oder auch verschlimmert…)

Aufbau eines Farbfilms

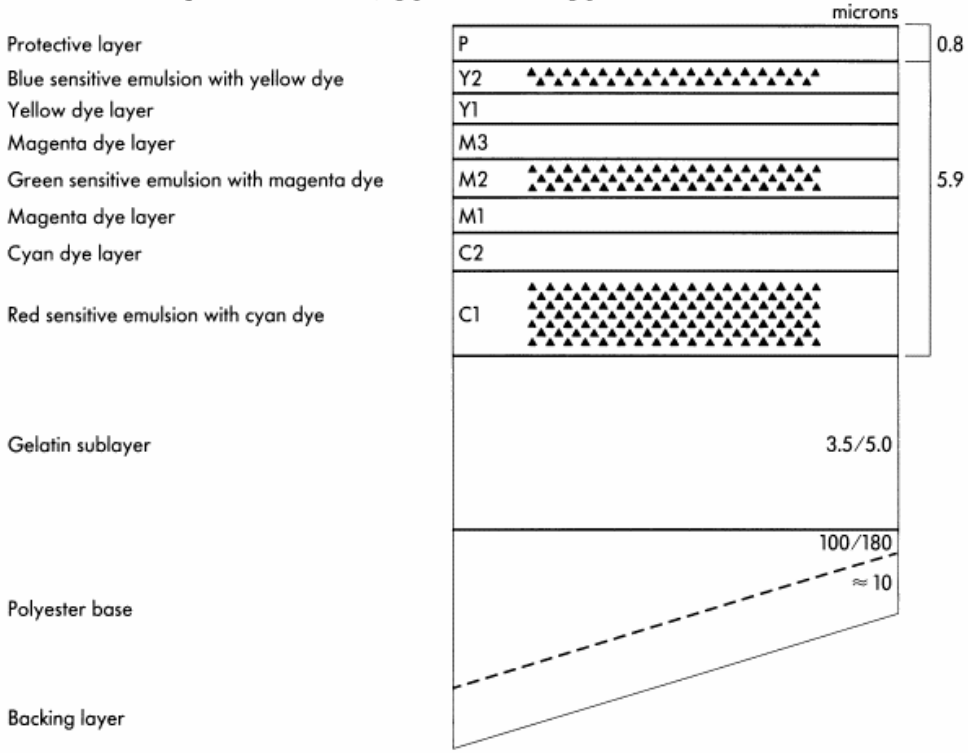
Ektachrome



Kodachrome



Ilfochrome Micrographics



Positiv-Farbfilme

Kodak Ektachrom (E6)

- 3 Schichtenfilm
- Farbkuppler in den Schichten eingelagert
- Gelbfilterschicht
- alle Schichten werden gleichzeitig farbentwickelt

Kodachrome (K14)

- 3 Schichtenfilm
- Farbkuppler nicht in den Schichten eingelagert (reiner S/W Film), daher sehr dünne Emulsionsschichten
- Gelbfilterschicht
- die Schichten werden einzeln mit farbigem Licht (Blau, Rot, und in einem Umkehrbad (für Grün) belichtet
- jede Schicht wird einzeln entwickelt nach entsprechender Belichtung
- Farbkuppler sind im Entwickler enthalten

Ilford Micrographics (P5)

- (bis 1991: Cibachrome Micrographics)
- 3 Azofarbstoffe, eingebettet in Silberhalogenid (viel stabiler als chromogene Farbstoffe)
- praktisch kornlos (3 Mikrometer)
- Kaum Streulichtprobleme (praktisch schwarze Emulsion
- wenig empfindlich (1 ASA)
- schwacher Dynamikumfang

Vor-/Nachteile

Kodak Ektachrom (E6)

- schnelle Entwicklung
- geringer Zeitaufwand, schnelle Ergebnisse
- preiswert
- einfache Handhabung bei der Verarbeitung
- Meterware
- alle Konfektionierungen (KB, 120, Planfilm)
- große Auswahl an Empfindlichkeiten + Filmen
  - cross Entwicklung (Diafilm in C41)
  - Tageslichtfilm (5600 K)
  - Kunstfilm (3200 K)
- jederzeit und überall erhältlich

Kodachrome (K14)

- Aufwändige Entwicklung
- hohe Schärfeleistung
- teuer
- nur Tageslichtfilm
- lange Lagerfähigkeit
- hohe Farbsättigung / Farbechtheit
- Kodachrom 25 ist der Referenzfilm für Kodak. An seiner Schärfeleistung, Farb-Intensität und Auflösungsvermögen werden viele anderen Filme gemessen.

Ilford Micrographics (P5)

- empfindliche Entwicklung
- höchste Schärfeleistung
- beschränkte Farbtreue
- teuer
- 1 ASA Empfindlichkeit
- lange Lagerfähigkeit
- höchste Farbstabilität
- Micrographics ist der Referenzfilm für die Langzeitstabilität von Bildinformationen.

Haltbarkeitsprobleme

- Auflösung eines Farbstoffs (chemische Alterung) („Fading“)
- Entstehung von farbverfälschenden Stoffen („Stains“, d.h. Vergilbung, Rotstich, …)

- Massive Effekte bei Lagerung am Licht; bei Dunkellagerung verlangsamt
- Abhängig von Luftschadstoffen, Temperatur, Luftfeuchtigkeit,…

Alterungstests

Stand der Technik: "Arrhenius fading test" (ANSI IT9.9-1990)*

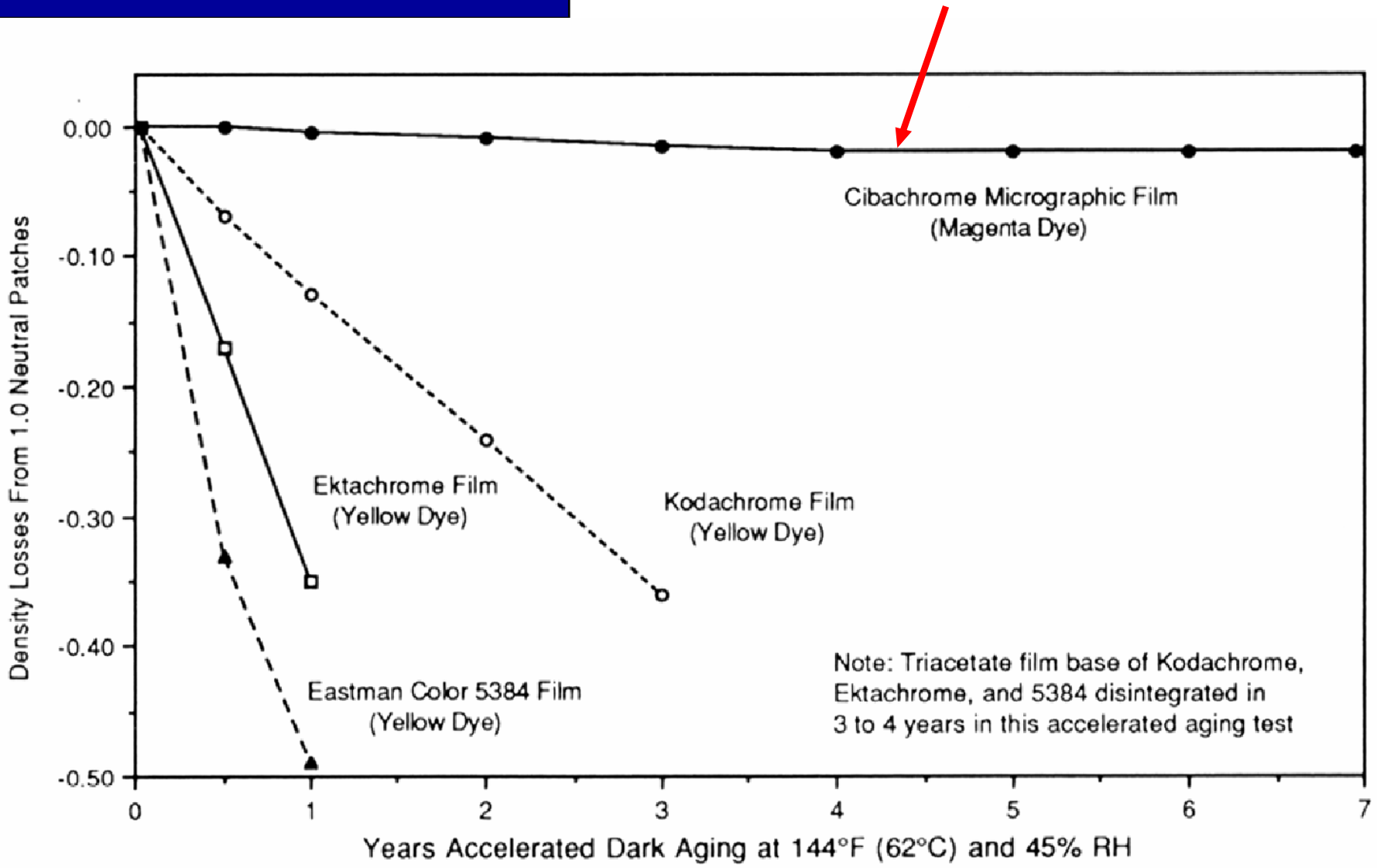
- Zeitbeschleunigte Verbleichung und Vergilbung
- Unter Normbedingungen (50% Luftfeuchtigkeit)
- für verschiedene Lagertemperaturen

Ergebnisse

- Angaben in % Farbpigmentverlust des instabilsten Pigments
- Angaben in Jahren bis zu einem 10-prozentigen Verlust an Pigmenten des instabilsten Farbstoffs

*ANSI IT9.9-1990, American National Standard for Imaging Media – Stability of Color Photographic Images – Methods for Measuring, American National Standards Institute, Inc., New York, New York, 1991.

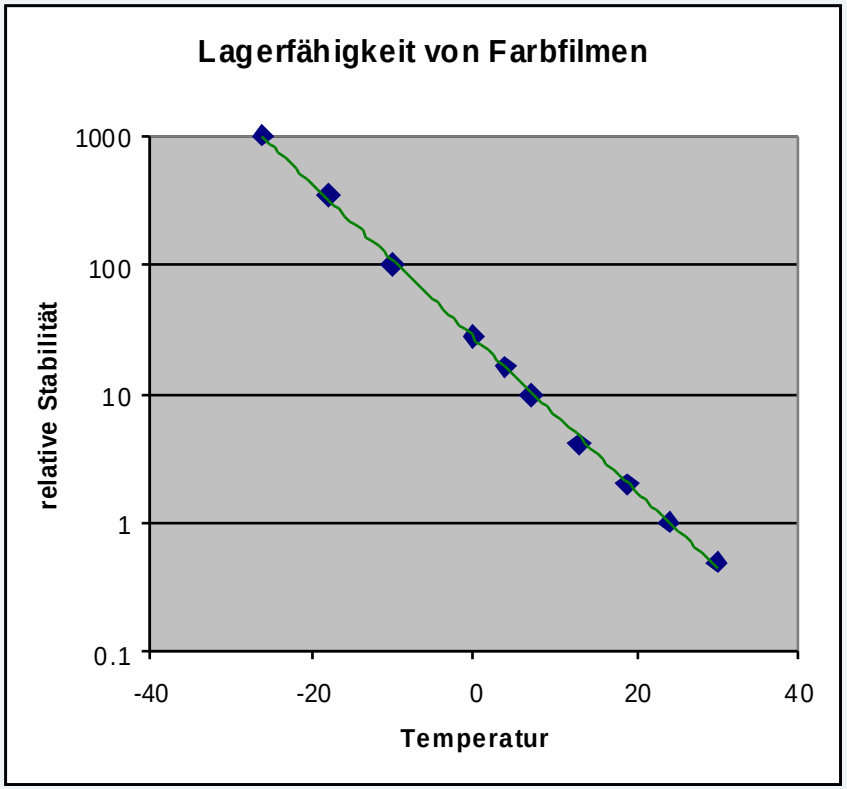
Haltbarkeits-Vergleich (im Dunkeln)

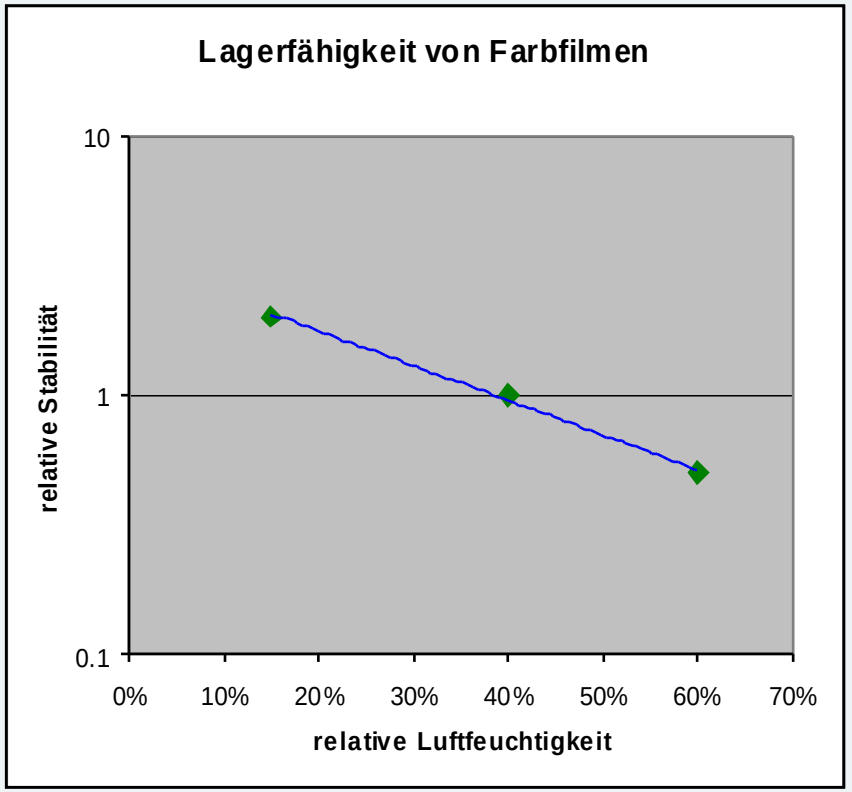


Lagerfähigkeit

- je kühler desto besser
- je trockener desto besser

(-> teure Lagerung!)





Charleton C. Bard et al., "Predicting Long-Term Storage Dye Stability Characteristics of Color Photographic Products from Short-Term Tests," Journal of Applied Photographic Engineering, Vol. 6, No. 2, April 1980.

Beispiele (Kodak)

Table 5.14 Unpublished Kodak Estimates of Dark Fading Stability for Kodak Color Materials (Applicable to Kodak Products Marketed from About 1960 Through 1977)

Estimated Storage Time for 10% Loss of the Least Stable Image Dye for Storage in the Dark at 75°F (24°C)
(Note: Predictions Are for Storage at 40% RH)

Note: These estimates are for a "just noticeable" 10% loss of the least stable image dye. To compare these data with those in other tables in this chapter, which present estimates for a 20% loss of dye density, the storage times given below should be multiplied by a factor of 2.3. (With many products, the dark fading curve is reasonably linear as fading progresses to the point of a 20% dye loss, and a simple multiple of 2x will be reliable. However, with some products the rate of fading gradually decreases as dark fading progresses, and a 20% density loss will take more than twice the storage time required for a 10% loss.)

The Process E-6 Ektachrome Professional films listed below were the initial versions manufactured in 1976; later versions of the films were significantly improved in dark fading stability, and it is believed that by the end of 1978 or early in 1979 all Kodak Process E-6 Ektachrome professional and amateur films had the same, improved stability. Kodak has not revealed when the improvements were made in each particular type of Ektachrome film, although it has been reported that Ektachrome Slide Duplicating Film 5071 was the first to be marketed with an improved dark fading stability.

These estimates are based on initial cyan, magenta, and yellow densities of 1.0 with full d-min corrected densitometry. These estimates are for dye fading only and do not take into account the gradual formation of yellowish stain. With print materials in particular (e.g., Kodak Ektacolor papers), the level of stain may become objectionable before the least stable image dye has faded 10%.

21 to 50 Years:

Kodachrome II Film (Daylight) [Process K-12]
Kodachrome II Professional Film, Type A [Process K-12]
Kodachrome-X Film [Process K-12]
Kodachrome II Movie Film (Daylight) [Process K-12]
Kodachrome II Movie Film (Type A) [Process K-12]

11 to 20 Years:

Ektachrome 160 Professional Film 5037 (Tungsten) [Process E-6]
Ektachrome Duplicating Film 6121 [Process E-6]
Ektachrome Slide Duplicating Film 5071 [Process E-6]
Ektachrome-X Film [Process E-4]
High-Speed Ektachrome Film (Daylight) [Process E-4]
High-Speed Ektachrome Film (Tungsten) [Process E-4]
Ektachrome EF Film 7241 (Daylight) [Process ME-4]
Ektachrome EF Film 7242 (Tungsten) [Process ME-4]
Ektachrome MS Film 7256 [Process ME-4]

6 to 10 Years:

Ektachrome 50 Professional Film 5018 and 6118 (Tungsten) [Process E-6]
Ektachrome 64 Professional Film 5017 and 6117 (Daylight) [Process E-6]
Ektachrome 200 Professional Film 5036 (Daylight) [Process E-6]
Ektacolor Slide Film 5028 [Modified Process C-22]
Ektacolor Print Film 4109 [Modified Process C-22]

6 to 10 Years (continued):

Ektacolor 37 RC Paper ("Kodacolor Print") [Process EP-3]
Ektachrome RC Paper, Type 1993 [Process R-5]
Eastman Color Negative II Film 5247 (1976 improved version) [Process ECN-2]

Less Than 6 Years:

Ektachrome Film 6115, Daylight Type [Process E-3]
Ektachrome Film 6116, Type B [Process E-3]
Ektachrome Professional Film (Daylight) EP120 [Process E-3]
Ektachrome Professional Film, Type B (Tungsten) EPB120 [Process E-3]
Ektachrome Duplicating Film 6120 [Process E-3]
Ektachrome Slide Duplicating Film 5038 [Process E-4]
Vericolor S Film [Vericolor Process]
Vericolor L Film [Vericolor Process]
Vericolor II Film, Type S (original version) [Process C-41]
Vericolor II Film, Type L [Process C-41]
Kodacolor-X Film [Process C-22]
Ektacolor Professional Film, Type S [Process C-22]
Ektacolor Professional Film 6101, Type S [Process C-22]
Ektacolor Professional Film 6102, Type L [Process C-22]
Ektacolor Internegative Film 6008 and 6110 [Modified Process C-22]
Eastman Color Negative Film 5254 and 7254 [Process ECN]
Eastman Color Negative II Film 5247 and 7247 (orig. versions) [Process ECN-2]
Eastman Color Print Film 5381 and 7381 [Process ECP]
Ektachrome 40 Movie Film 7262 [Process EM-25]

Beispiele (Ilford)

Table 5.12 Predicted Dark Fading Stability of Ilford Color Print Materials, Color Negative Films, and Slide Films (from Data Supplied by Ilford and Based on Arrhenius Accelerated Dark Fading Tests)

Estimated Storage Time for a 20% Loss of the Least Stable Image Dye for Storage in the Dark at 75°F (24°C)

(Note: Predictions Are For Storage at 40% RH)

Boldface Type indicates products that were being marketed in the U.S. and/or other countries when this book went to press in 1992; the other products listed had been either discontinued or replaced with newer materials. Ilford is a subsidiary of the International Paper Company, an American company headquartered in Purchase, New York. These estimates are based on initial cyan, magenta, and yellow densities of 1.0 with full d-min corrected densitometry. Unlike chromogenic materials, Ilfochrome prints and microfilms (called Cibachrome prints and microfilms, 1963–91) can be expected to remain virtually free of stain even after prolonged storage.

	Estimated Years of Dark Storage
Ilfochrome Rapid OHP Film (CTR.F7) [overhead transparency film] (1991—) (Process P-22 and P-4)	**"more than 500" ***
Cibacopy RC Papers and Polyester-Base Print Materials [processed in Ilford Cibacopy and Ilfochrome Rapid Systems KP-30/40, CC-1217Z/E, CC-1012, CC-120/180, as well as other systems employing P-17, P-22, P-222, and P-4 chemicals] (1976–91)	"more than 500" *
Cibachrome-A II Print Material (CPSA.1K) [high-gloss polyester-base print material] (Process P-30 and P-30P) (1981–89 for "initial type") (1989–91 for "improved type")	"more than 500" *
Cibachrome-A II Print Material (CRCA.44M) ["Pearl" semi-gloss RC paper] (Process P-30 and P-30P) (1981–89 for "initial type") (1989–91 for "improved type")	"more than 500" *
Cibachrome-A II Print Material (CF.1K) [low-contrast, high-gloss polyester material] (Process P-30 and P-30P)	"more than 500" *
Silver Dye-Bleach Color Microfilm:	
Ilfochrome Micrographic Film Type M & Type P Cibachrome Micrographic Film Type M & Type P [high-resolution color microfilms] (Process P-5) (1984—)	**"more than 500" ***
Chromogenic Materials for Printing Color Negatives:	
Ilford Ilfocolor Deluxe Print Material (ILRA.1K) (RA-4) (high-gloss polyester-base print material manufactured by Ilford in Switzerland using emulsion components supplied by Konica; the stability of the Ilford product is believed to be similar if not identical to Konica Color QA Super Glossy Print Material Type A3 — see Table 5.5a and Table 5.15) (1991—)	**(not disclosed)**
Ilford Colorluxe Print Material (IL.1K) (EP-2) (high-gloss polyester-base print material manufactured by Ilford in Switzerland using emulsion components supplied by Konica; the stability of the Ilford product is believed to be similar if not identical to Konica Color Type SR [SG] print material — see Table 5.5b and Table 5.15) (1990—)	**(not disclosed)**
Ilford Ilfocolor Deluxe Translucent Display Film (ITRA.F7) (RA-4) (translucent, polyester-base display material manufactured by Ilford in Switzerland using emulsion components supplied by Konica; the stability of the Ilford product is believed to be similar if not identical to Konica Color Trans QA Display Film Type A3 — see Table 5.15) (1992—)	**(not disclosed)**
Chromogenic Color Negative and Color Slide Films:	
Ilford Ilfocolor HR 100 Film (C-41)	(not disclosed) **
Ilford Ilfocolor HR 200 Film (C-41)	(not disclosed) **
Ilford Ilfocolor HR 400 Film (C-41)	(not disclosed) **
Ilford Ilfochrome 50 Film (E-6)	(not disclosed) ***
Ilford Ilfochrome 100 Film (E-6)	(not disclosed) ***
Ilford Ilfochrome 200 Film (E-6)	(not disclosed) ***

* This author's accelerated tests conducted at 62°C (144°F) and 45% RH suggest that Ilfochrome (Cibachrome) images are essentially permanent in dark storage — they are probably even more stable than Kodak Dye Transfer prints (i.e., longer than 600 years for a 20% density loss of the least stable dye when stored at 75°F [24°C] — see Table 5.13). Like Dye Transfer prints, Ilfochrome polyester-base prints remain virtually free from stain formation — even after prolonged storage in the dark or display under adverse conditions (Ilfochrome RC-base prints, however, can develop yellowish stain after exposure to light during extended display).

** These now-discontinued Ilford Ilfocolor HR color negative films were made for Ilford by Agfa-Gevaert in Germany and are believed to have stability characteristics identical to Agfacolor XR films of the same ISO rating (see Table 5.10); these Ilfocolor film were marketed from March 1987 until May 1988. Prior to 1987 Ilfocolor films are believed to have been supplied to Ilford by Konica.

*** These now-discontinued Ilford Ilfochrome transparency films were made for Ilford by Agfa-Gevaert in Germany and are believed to have stability characteristics that are identical to Agfachrome CT films of the same ISO ratings (see Table 5.10); these Ilfochrome films were marketed by Ilford from March 1987 until May 1988. Prior to 1987 Ilfochrome films are believed to have been supplied to Ilford by Konica.

Empfehlungen für analoge Bildbestände

Variante A (konventionell)

- Triage machen, gefährdete Vorlagen identifizieren
- Verfilmen auf Micrographics Farbmikrofilm (als Dia)

Variante B (digital)

- Triage machen, gefährdete Vorlagen identifizieren
- Digitalisieren der gefährdeten Bestände
- Digitale Bildbearbeitung / Farbkorrektur
- Ergänzen mit Metadaten
- Belichten auf
  - Micrographics Farbmikrofilm
  - archivfestes Fotopapier

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3. Kosten
    1. Erstellung
    2. Lagerung/Migration)
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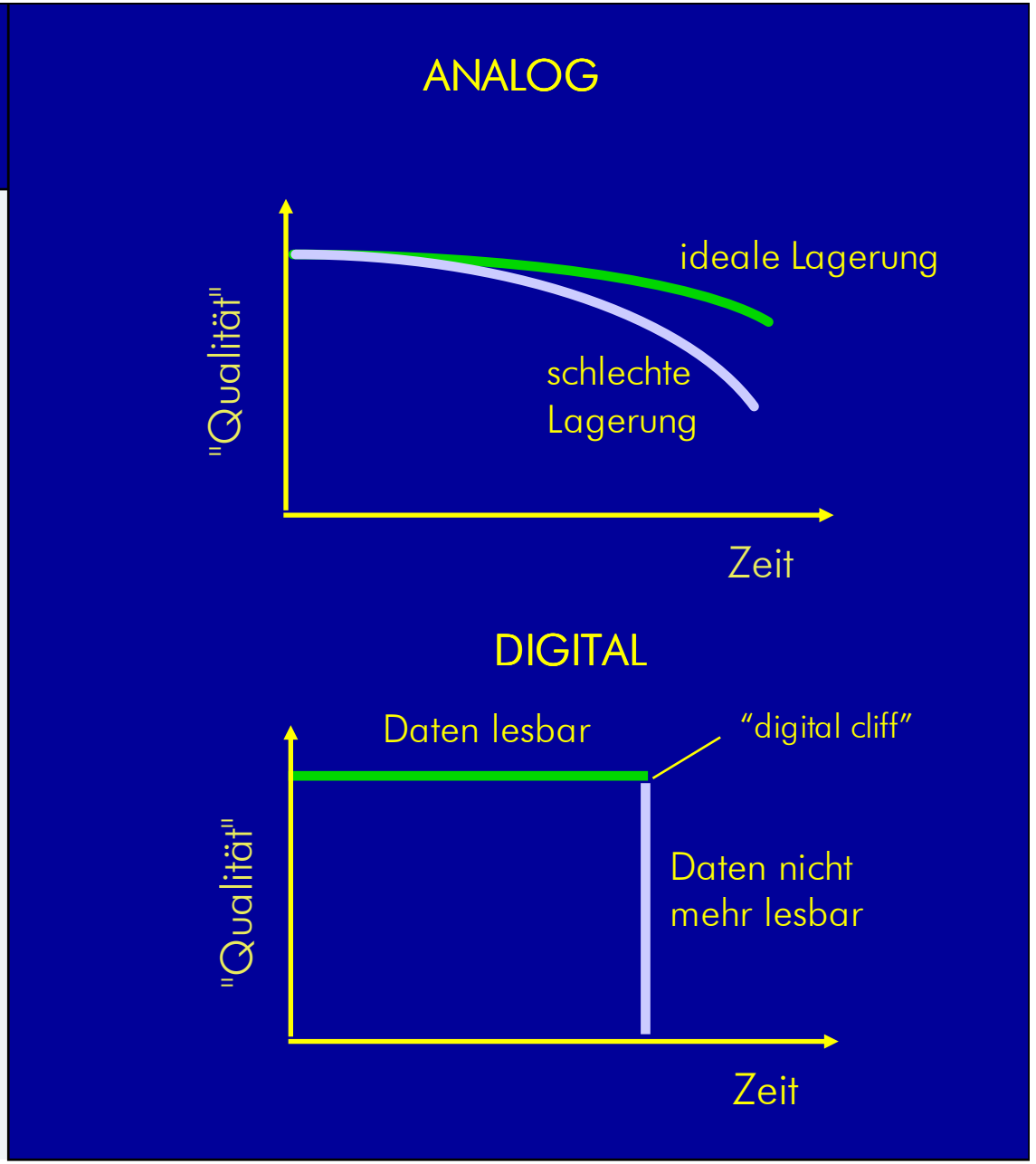
Erweiterte Problemstellung

- Digitale Bilder erweitern / verstärken den Problemdruck
- Digitale Bilddaten sind gefährdeter als analoge Bestände

- Ausdruck mit Inkjet-Druckern sind i.d.R. viel weniger stabil als Photopapiere



Haltbarkeit von Digital-Photopapieren

Table 5.7 Comparative Dark Fading and Yellowish Staining of Polaroid, Fuji, and Kodak Instant Color Prints; Canon and Kodak Digital Copier/Printer Color Prints; Color Offset Printing; Mead Cycolor Prints; and Thermal Dye Transfer and Ink Jet Color Prints for Digitized Pictorial Images and Computer-Generated Images

Number of Days Required for a 20% Loss of the Least Stable Image Dye in Accelerated Dark Fading Tests at 144°F (62°C) and 45% RH

Test duration of up to 6 years (2,190 days).

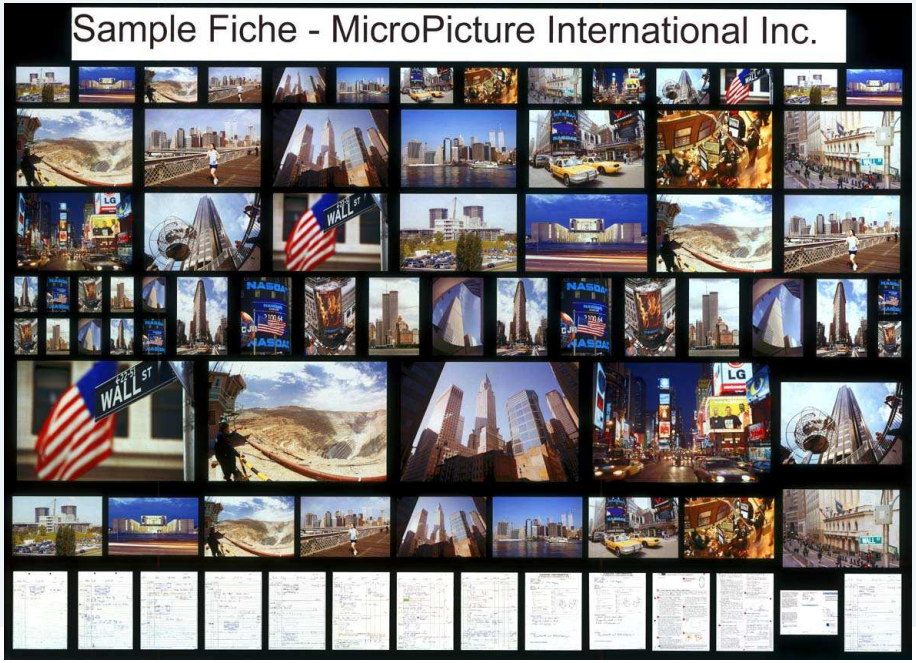
Type of Color Print Product	Days for 20% Loss of Least Stable Image Dye	Days to Reach d-min Color Imbalance of 0.10	Yellowish Stain (Blue Density) Increase After 180 Days
Iris Ink Jet Color Prints [scanned, electronically produced prints] (Ink jet color prints made on 100% cotton fiber paper with Iris Graphics, Inc. 3047 printer using the "Standard" Iris ink set; test prints made in 1992.)	**>1,095 (—)** [estimated]	**>1,095 (C+Y)** [estimated]	**+0.01Y**
Stork Ink Jet Color Prints [scanned, electronically produced prints] (Ink jet prints made with a Stork Bedford B.V. ink jet printer using both the "Standard" and "Reactive Dyes" ink sets; prints made in 1992.)	**>1,095 (—)** [estimated]	**>1,095 (C+Y)** [estimated]	**+0.01Y** [estimated]
Polaroid 600 Plus Prints **Polaroid Autofilm Type 330 Prints** **Polaroid Type 990 Prints** Polaroid Spectra Prints Polaroid Image Prints (Spectra name in Europe) [continuous-tone instant photographic prints] (Because of high levels of yellowish stain that form over time in normal dark storage, Polaroid Spectra prints, Image prints, 600 Plus prints, and other Polaroid products using the Spectra emulsion are not recommended for other than short-term applications.) (1986–91 for Spectra prints) (1988— for other prints)	**>1,095 (—)**	**(see text for discussion)**	
Polaroid Spectra HD Prints **Polaroid Image Prints** (Spectra in Europe) [tentative] [continuous-tone instant photographic prints] (Because of high levels of yellowish stain that form over time in normal dark storage, Polaroid Spectra HD prints, Image prints and other Polaroid products using the Spectra HD emulsion are not recommended for other than short-term applications.) (1992—)	**>1,095 (—)**	**(see text for discussion)**	
Polaroid Vision 95 Prints (in Europe) **Polaroid " ? " 95 Prints** (name in Asia) [tentative] **Polaroid " ? " 95 Prints** (name in North & South America) [continuous-tone instant photographic prints] (The internal structure of Vision 95 prints is basically the same as that of Spectra HD and 600 Plus prints; however, the rate of formation of yellowish stain that occurs over time in dark storage is said by Polaroid to be "somewhat reduced" compared with that of Spectra HD and 600 Plus prints. The names Polaroid will use for Vision 95 products in non-European markets were not available at the time this book went to press.) (1992— for Vision 95 products sold in Germany) (1993— for Asia, North and South America, and other markets)	**>1,095 (—)**	**(see text for discussion)**	
Kodak Kodamatic Instant Color Prints [continuous-tone instant photographic prints] (1982–86)	1,400 (–M)	36 (C+Y)	+0.14Y
Canon Color Laser Copier Prints [scanned, electronically produced prints] (Xerographic plain-paper digital color copier/printer; test prints made in 1989.)	**>730 (—)**	**>730 (C+Y)**	**+0.03Y**
Kodak ColorEdge Copier Prints [scanned, electronically produced prints] (Xerographic plain-paper digital color copier/printer; test prints made in 1992.)	**>730 (—)** [estimated]	**>730 (C+Y)** [estimated]	**+0.03Y** [estimated]
Polaroid Polacolor Prints [initial type] [continuous-tone instant photographic prints] (1963–75) (peel-apart prints)	>500 (—)	>500 (C+Y)	+0.03Y
Mead Cycolor Prints [continuous-tone photographic prints] (Mead Imaging Corporation microencapsulated acrylate image color prints made with a Noritsu QPS-101 Cycolor Slideprinter; test prints made in 1988.) (1988—)	**>500 (—)**	**500 (C+Y)**	**+0.06Y**
Fuji 800 Instant Color Prints [continuous-tone instant photographic prints] (1984—) (available only in Japan)	**470 (–M)**	**55 (C+Y)**	**+0.20Y**
Fuji FI-10 Instant Color Prints [continuous-tone instant photographic prints] (1981—) (available only in Japan)	**300 (–M)**	**160 (M+Y)**	**+0.19Y**
Kodak PR10 Instant Color Prints [continuous-tone instant photographic prints] (initial type: 1976–79)	250 (–M)	90 (C+Y)	+0.14Y
Kodak Ektatherm Color Prints* [scanned, electronically produced prints] (Thermal dye transfer color prints made with Kodak XL 7700 Digital Printer; test prints made in 1992.)	**65 (–C)**	**80 (C+Y)**	**+0.21Y**
Sony Mavigraph Still Video Prints* [scanned, electronically produced prints] (Thermal dye transfer prints made with Sony UP-5000 ProMavica Color Video Printer; test prints made in 1989.)	**6 (–C)**	**Data Not Available**	**Data Not Available**

*** Note:** Heat-accelerated dark fading tests may not give a meaningful indication of the long-term stability of prints of this type — see text.

Mikrofilm ab Daten – bereits möglich!

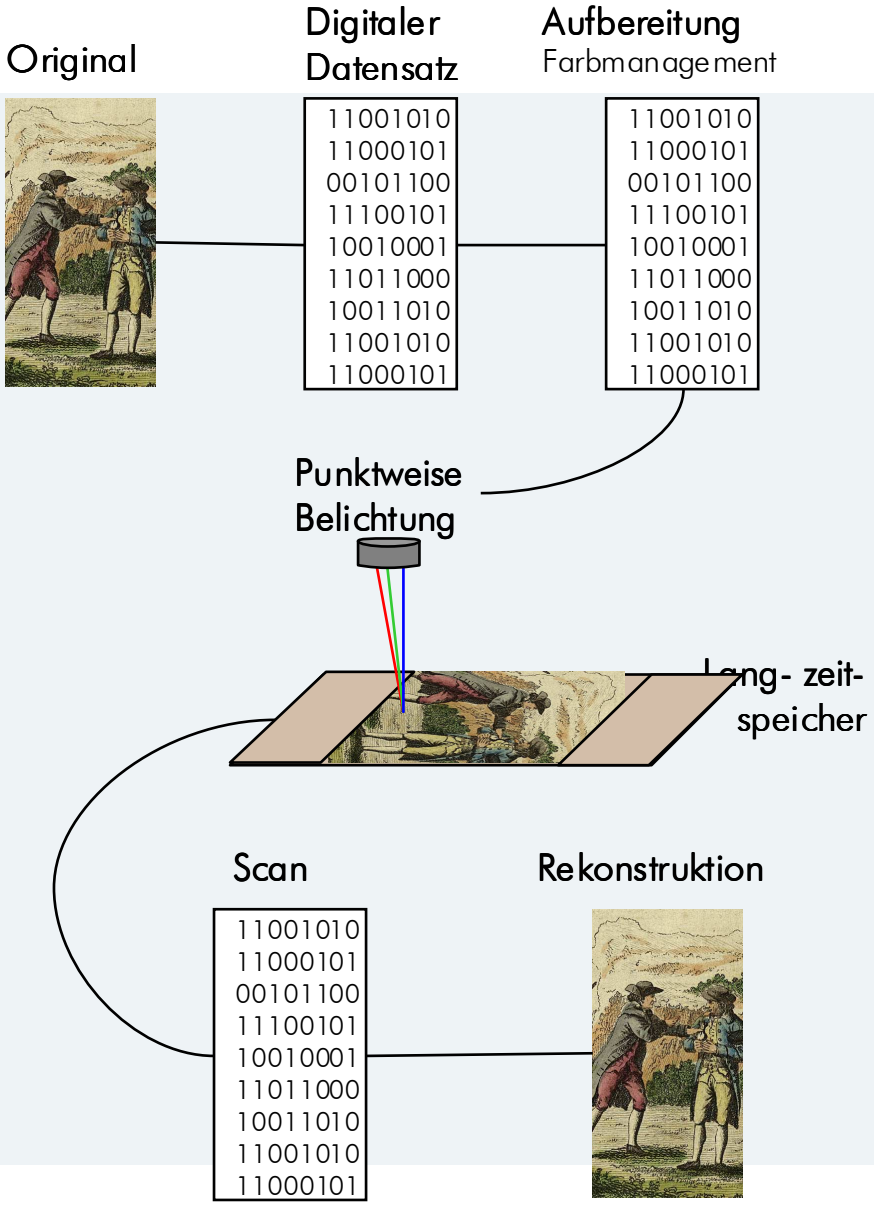
1. 35mm

2. 105mm



Funktionsprinzip

- Digitalisiertes Original als Ausgangslage
- Belichtung Bildpunkt um Bildpunkt
  - Jeder Punkt 24 bit Information
  - Abstand der Punkte: 3-6 µm
- Farbgebung durch drei Laser; Steuerung der Laser-Intensität für jeden Punkt (3 x 8 bit Farbinformation)
- Mikrofilm = Datenspeicher
  - Analogie zu CD
  - chem. Veränderung anstatt physikalische Vertiefung
  - Farbinformation in jedem Punkt
- Für farbechtes Belichten: Farbmanagement
  - Targetinformation (Filmeigenschaften)
  - Modifikation des Datensatzes



IMAGING GUBLER

Laser s/w

- Günstiger als Farblaser
- S/W Mikrofilm
  - Negativ-Film
  - KB-Format (35 mm)
- Graustufen-Simulation durch Rasterung
  - Möglich dank sehr hoher Auflösung (2 µm/12000 dpi)
- Als „Lasertape“ vermarktet
- Standardisierte Beigabe von Metadaten

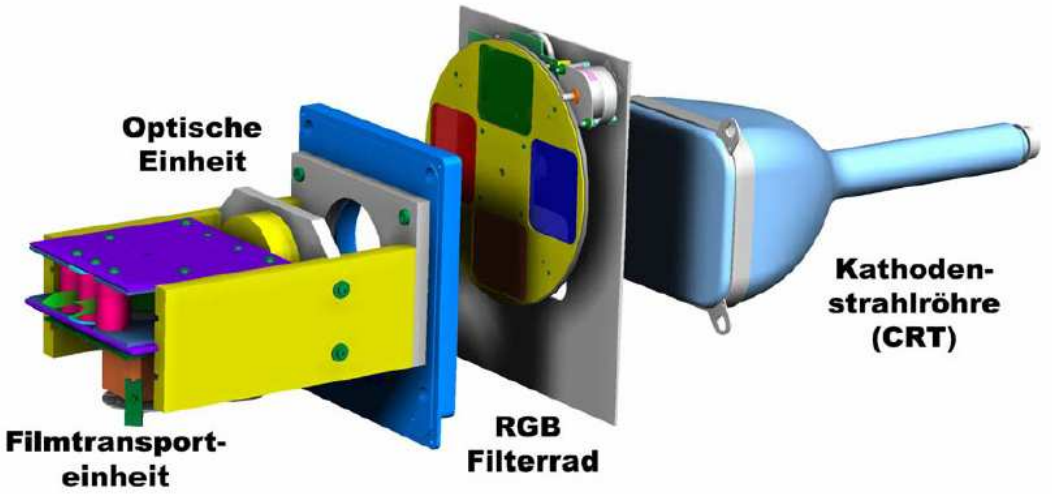
CRT Belichter

- Seit vielen Jahren bekannt
- Für s/w; Farben durch 3fache Beleuchtung
- Kostengünstig (für s/w)

ABER

- Beschränkte Auflösung
- Nur für empfindlichen Film
  - ungeeignet für farbigen Mikrofilm mit 1 ASA
- Beschränkte Qualität
  - Überstrahlung von benachbarten Gebieten

PRINZIPBILD: FUNKTIONSPRINZIP DIGITALER FILMRECORDER



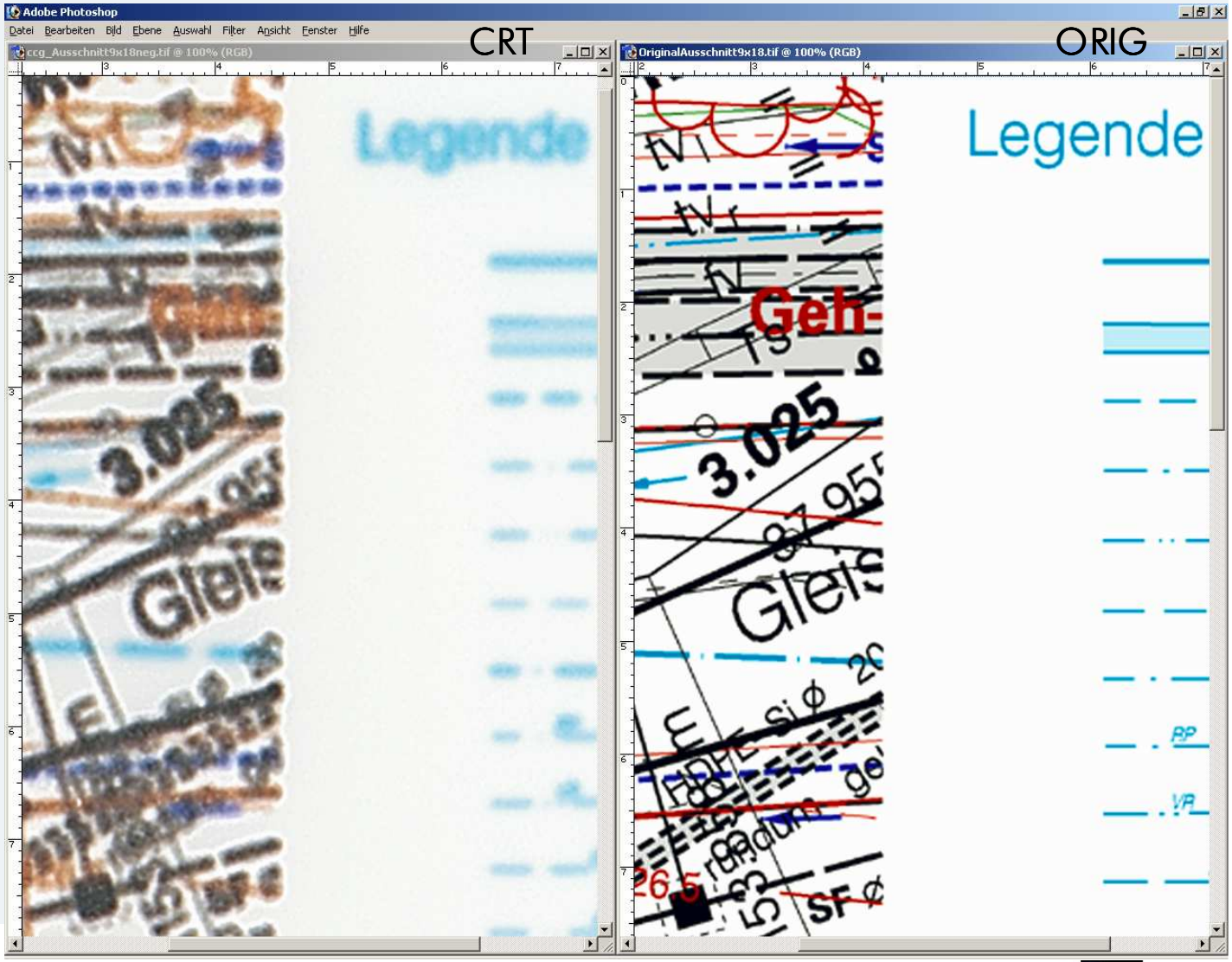
CRT Belichter Resultate

Plandaten A0 (1.4 GB auf 4x5 Fiche)

Belichtet und wieder eingescannt mit 2540 dpi

- Diffusion generiert Unschärfen
- Feine Abstufungen fehlen

➢ untauglich

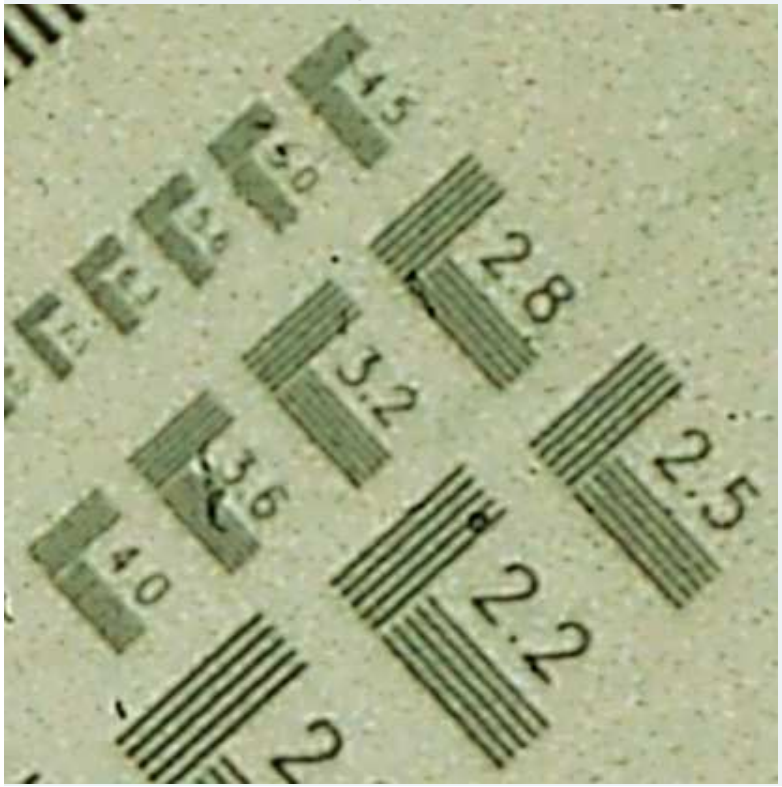


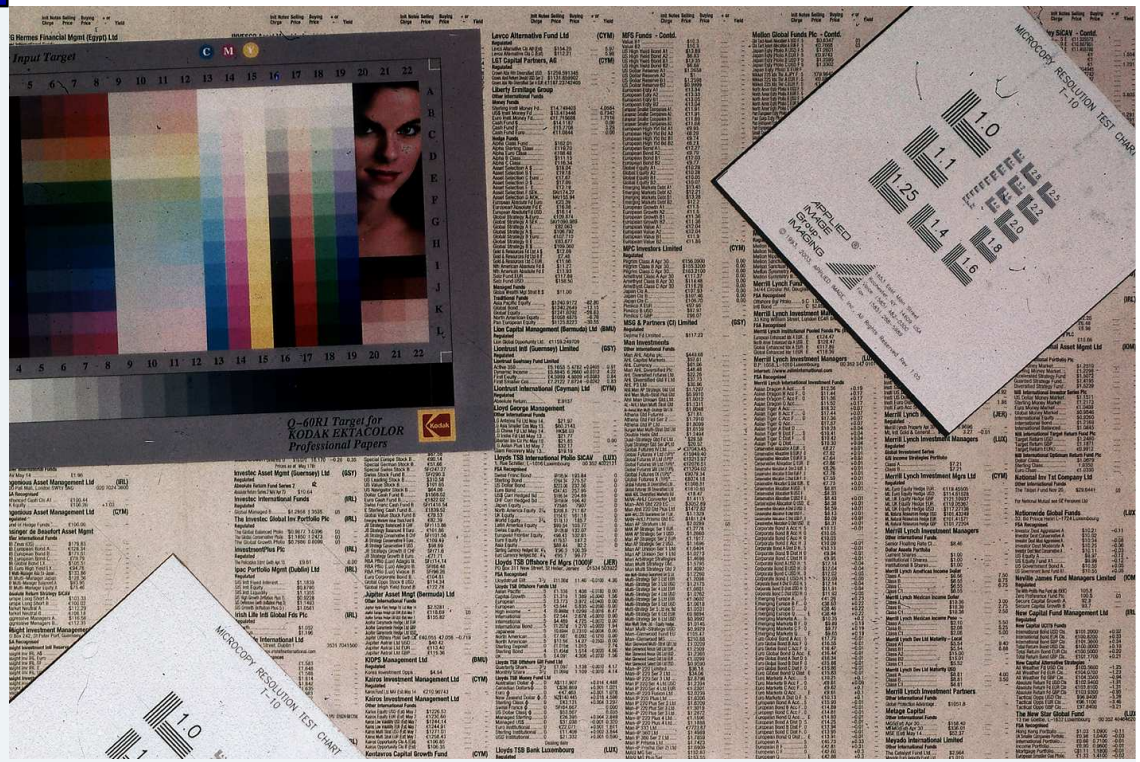
LCD Belichter

- Verfilmung ab LCD Bildschirm
- max. 81 MPixel mit patentiertem Verfahren (9 MPixel Bildschirm, 9 Aufnahmen)
- Auflösung 100 Doppellinien/mm
- Für 16 und 35 mm Rollfilm
- 3 s / Bild (SW, 9 MPx), langsmer bei Verwendung von Farbmikrofilm
- Einbelichtung von Metadaten
- für Graustufenvorlagen sehr gute Resultate

Leistungsfähigkeit

- Auflösung





- Farbtreue

Kinofilmbelichter

- Bekannt, erprobt
- Akzeptable Qualität
- rasche Belichtungszeit
  3,8 sec pro 4k Bild
- Bildpunkt-Grösse
  6 μm (=4200 dpi; = 8.4 MB/cm2)

ABER

- Formatbeschränkung
  24 x 18 mm (35-mm Film)
- Beschränkte Auflösung pro Bild
  4.000 x 3.100 Pixel (4k Auflösung)

Festkörper-Laserbelichter

Diabelichter (kommerziell)

- Formate bis 11 x 14 inch
- Pixelgröße 12.5 µm (40 Linienpaare/mm)
- bis 1.5 GB / Blatt
- Belichtungsmedium Ilford-Farbmikrofilm
- Belichtungszeit ca. 20 sec pro Bild

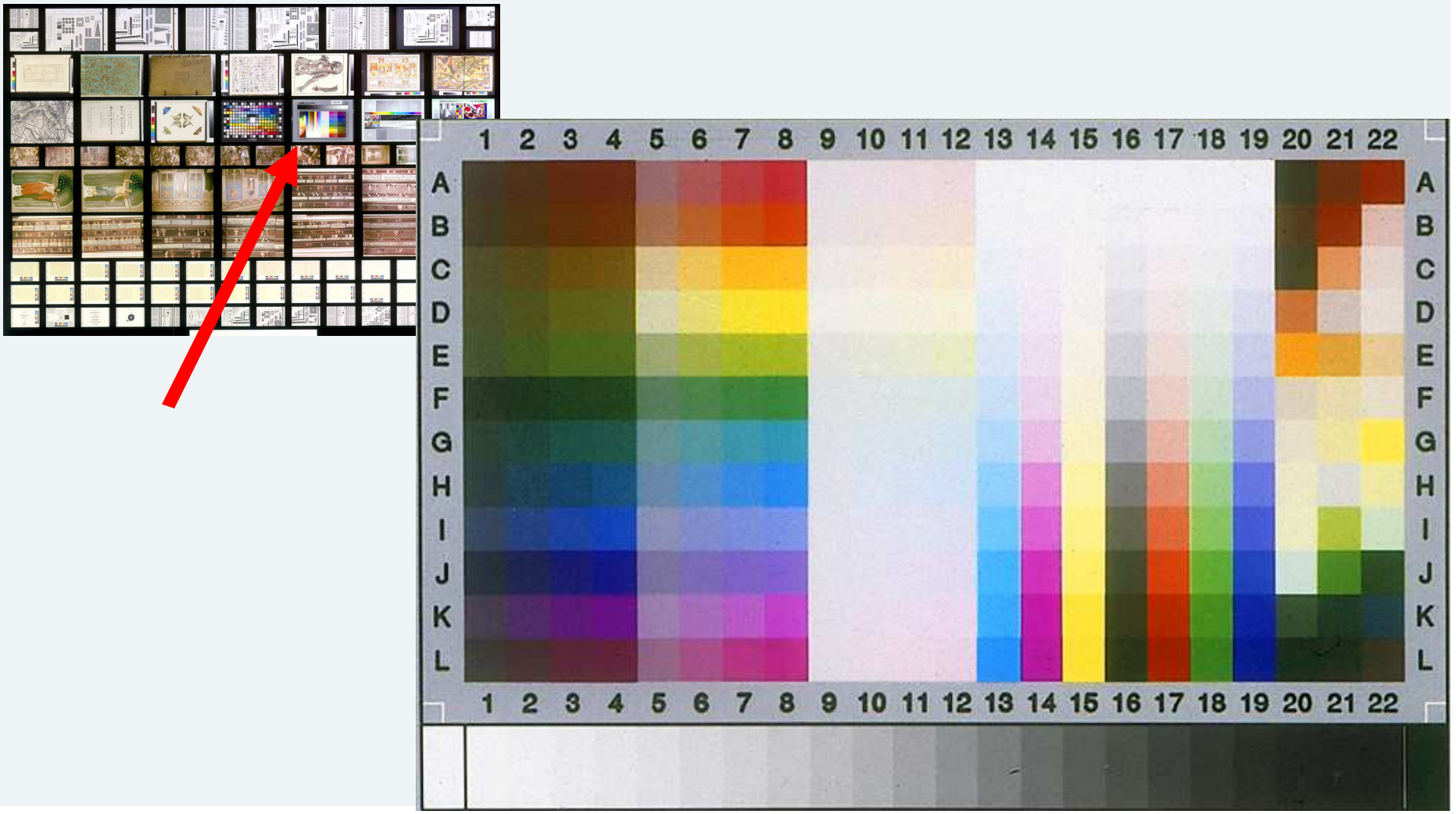
Entwicklungsprojekt A

- Bildfenster 32 x 45 mm
- Pixelgröße 3 µm (160 Linienpaare/mm)
- Bildformat 10000 x 15000 Pixel
- Belichtungsmedium Ilford-Farbmikrofilm
- Belichtungszeit ca. 20 sec pro Bild

Entwicklungsprojekt B

- Bildfenster 105 x 148 mm
- Pixelgröße 3.3 µm (150 Linienpaare/mm)
- Bildformat 30‘000 x 45‘000 Pixel (4 GB)
- Belichtungsmedium Ilford-Farbmikrofilm
- Belichtungszeit 40 Vollfichen / h

Beispiel



Empfehlungen

Nach dem heutigen Stand der Technik:

- Für Farbbilder:
  - Belichtung mit Festkörperlaser auf Farbmikrofilm
  - Auf Farbmanagement achten (Standards nutzen)
  - Gesamten Workflow, gesamte Datenkette beachten
  - Metadaten mit einpflegen (standardisiert)

- Für S/W Objekte
  - Belichtung mit Laser auf S/W Mikrofilm
  - Metadaten mit einpflegen (standardisiert)
  - günstiger; oft gut genug