ICC Color Experts' Day

Bressanone

24 May 2019

Presentations

Sponsored by:

barbieri

SunChemical
a member of the DIC group
Color & Comfort

REV studio
SW RIP & Technologies for Digital Print

Presentations

Introduction to ICC colour management William Li, Kodak

Converting instrument readings into visual plausible colour measurements Andreas Kraushaar, Fogra

Using eciCMYK as working colour space for wide gamut printers (nChannel, CMYK+)
Peter Kleinheider, Prepress Digital

Advanced color management workflow for inkjet applications Dietmar Fuchs, Colorlogic

Textile colour management Max Derhak, Onyx Graphics

Color workflow challenges for dye-sublimation textile printing Marco Roos, Color-Concepts

RIP solutions for functional and decorative applications Arnaud Fabre, Caldera

Colour management for day/night (backlight off/on) backlit applications Dorin Pitigoi

Colour management on variable substrates Steven Harnie, LMNS Expert group

Devstudio hybrid profiles Massimo Ontani, Devstudio

Challenges in n-colour printing William Li, Kodak

Profiling for non-standardized printing conditions (CMYK or Multicolor, Digital or Conventional)
Jurgen Seitz, GMG

Measurement solutions for signage and digital textile printing Markus Barbieri, Barbieri Electronic

Measurement challenges and solutions for non-paper substrates Ray Cheydleur, X-Rite

The use of the M3 measurement condition in colour management James Vogh, X-Rite

The measurement and profiling of special materials: glass, leather, laminates, etc: problems and solutions, practical experiences Andrea DeRossi, Tecnologie Grafiche

Measurement of 3D textile features Michele Conni, Barbieri Electronic

Getting spectral data when you don't have spectral measurements Tanzima Habib, NTNU

Overcoming challenges surrounding color management in ceramic digital printing through new approaches
Jan Seguda, ColorGATE

For more information about ICC color management, see http://www.color.org

Introduction to ICC Colour Management

Bressanone, Italy

William Li (Kodak)

ICC co-chair

Importance of Colour

Importance of Colour

ICC Mission Statement

Create, promote and encourage evolution of an open, vendor-neutral, cross-platform colour management system architecture and components

Colour Management, Colour Alignment

Multiple Production Motivation

Multiple Production Motivation

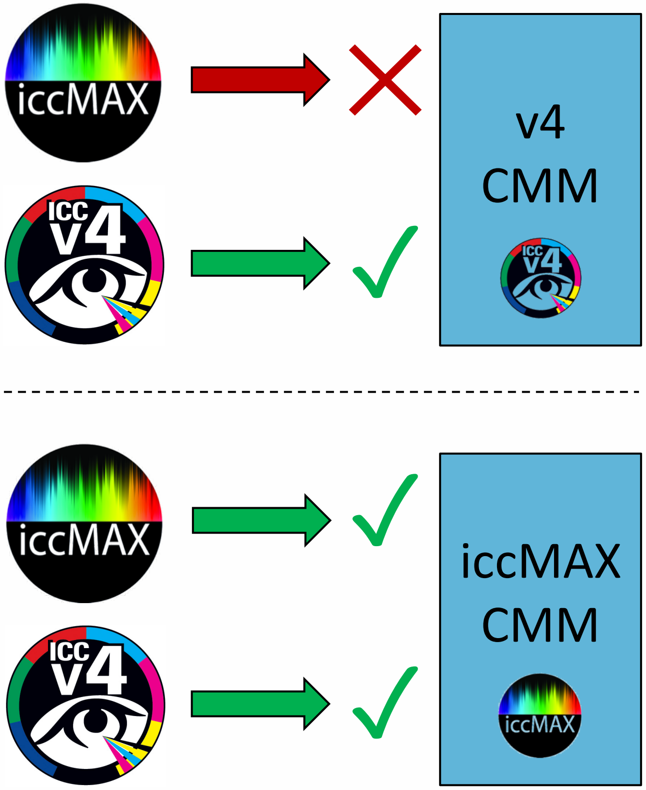
Multiple Production Motivation

Multiple Production Motivation

iccMAX vs. v4

iccMAX (ISO 20677) profiles have same header + tag structure as v4 (ISO 15076) profiles, but:

- Different values possible in header.
- Tag types from v4 + new tag types.
- Some v4 tag types deprecated.
- New color space types, PCS types, data tags.



Join the ICC

www.color.org

- Resources for members & public.
- Direct voice to international colour management community.
- Education, marketing, leadership!

Fogra

Converting instrument readings into visual plausible colour measurements

Agenda

1. Fogra - Exploring | Testing | Certifying
2. Colour measurement could be so easy
3. But, practically …
4. Summa

1. Fogra - Exploring | Testing | Certifying

Fogra -
Serving the print industry for over 60 years

Applied Research	**Expert opinions**
Testing & Certifications	**Standardisation**

1. Fogra - Exploring | Testing | Certifying

Building setups for measuring fluorescing inks


München, September 2017
Fogra-Forschungsbericht 80.008

Grundlagen der grafischen Standardisierung bei der Herstellung von Kunststoffkarten

Johannes Bartl
Uwe Bertholdt
Arne Müller

1. Fogra - Exploring | Testing | Certifying

Providing basis for managing transparent media

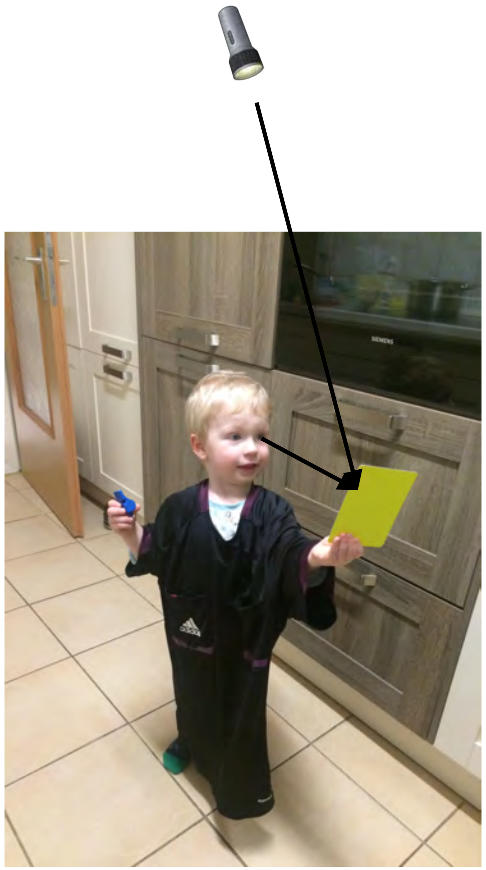
2. Colour measurements could be so easy

Make sure that you:

Measure as you see!

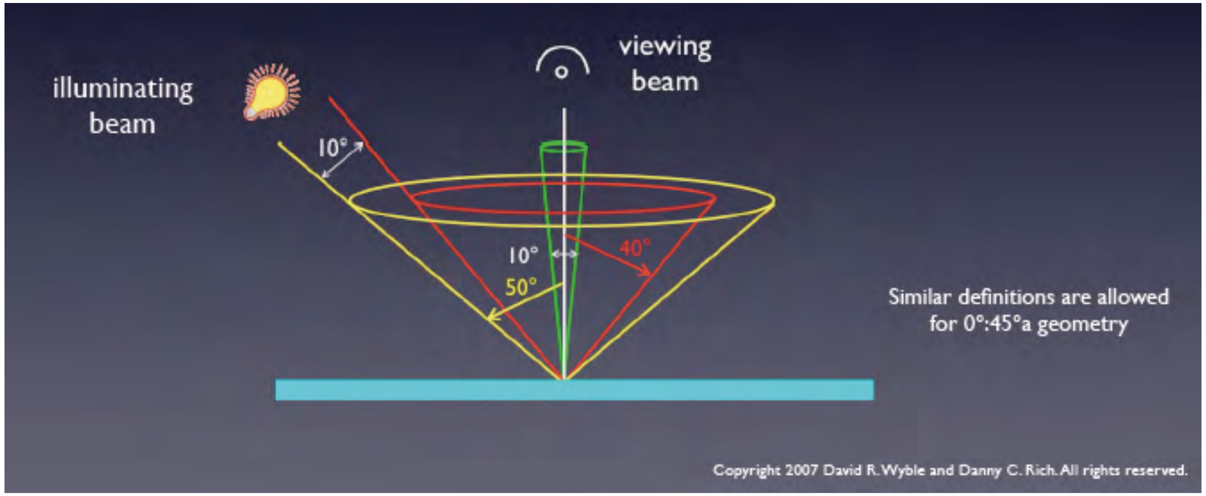
2. Standardized geometries work fine

And the best average for actual viewing is (some sort of) directional illumination and (glare free) viewing under 45° ➡️ 45°/0°



2. Standardized geometries work fine

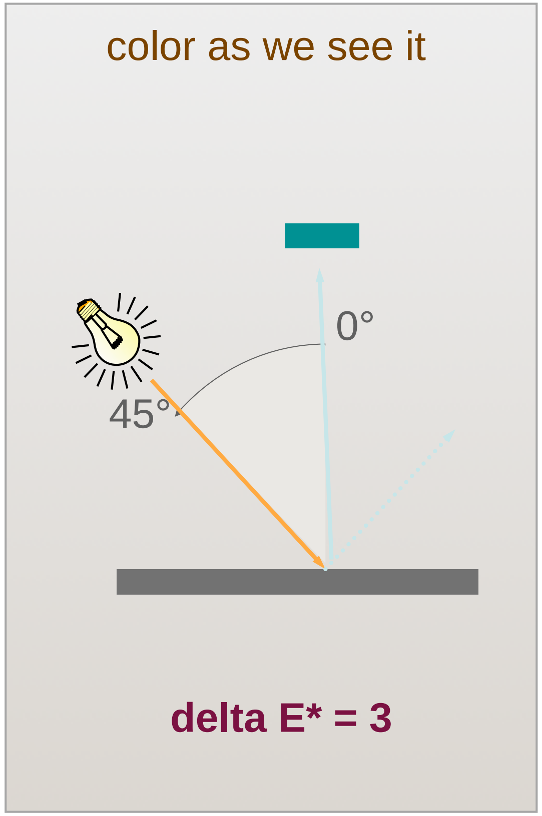
Geometry	Old	New	Definition
bidirectional	45/0	45°x:0°	incident at a single azimuth angle
		45°c:0°	circumferential (partial annular)
		45°a:0°	annular illumination
hemispherical	d/0	di:8°	diffuse illumination, specular included, 8° detection
		de:8°	diffuse illumination, specular excluded, 8° detection
		d:0°	used only when detection is at the normal



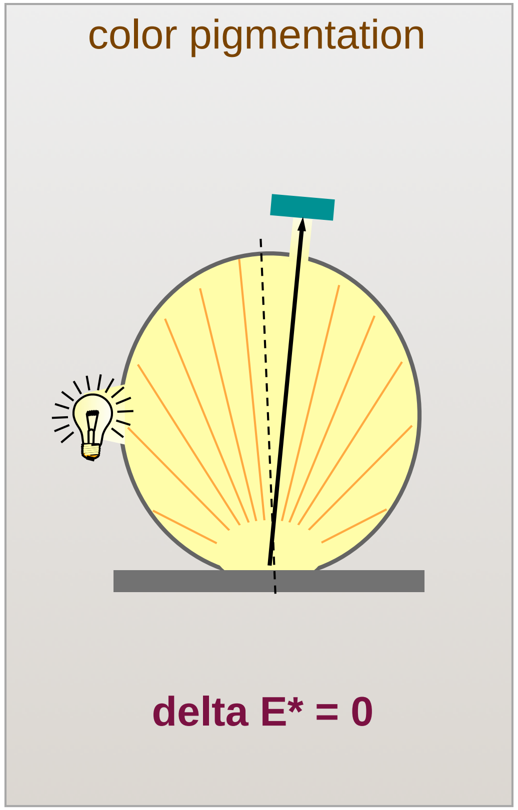
for objects that reflect „normally“ (no lateral diffusion), but with the need for small apertures (no real estate on the prints for control elements …)

2. Take care what to measure

45°x:0°

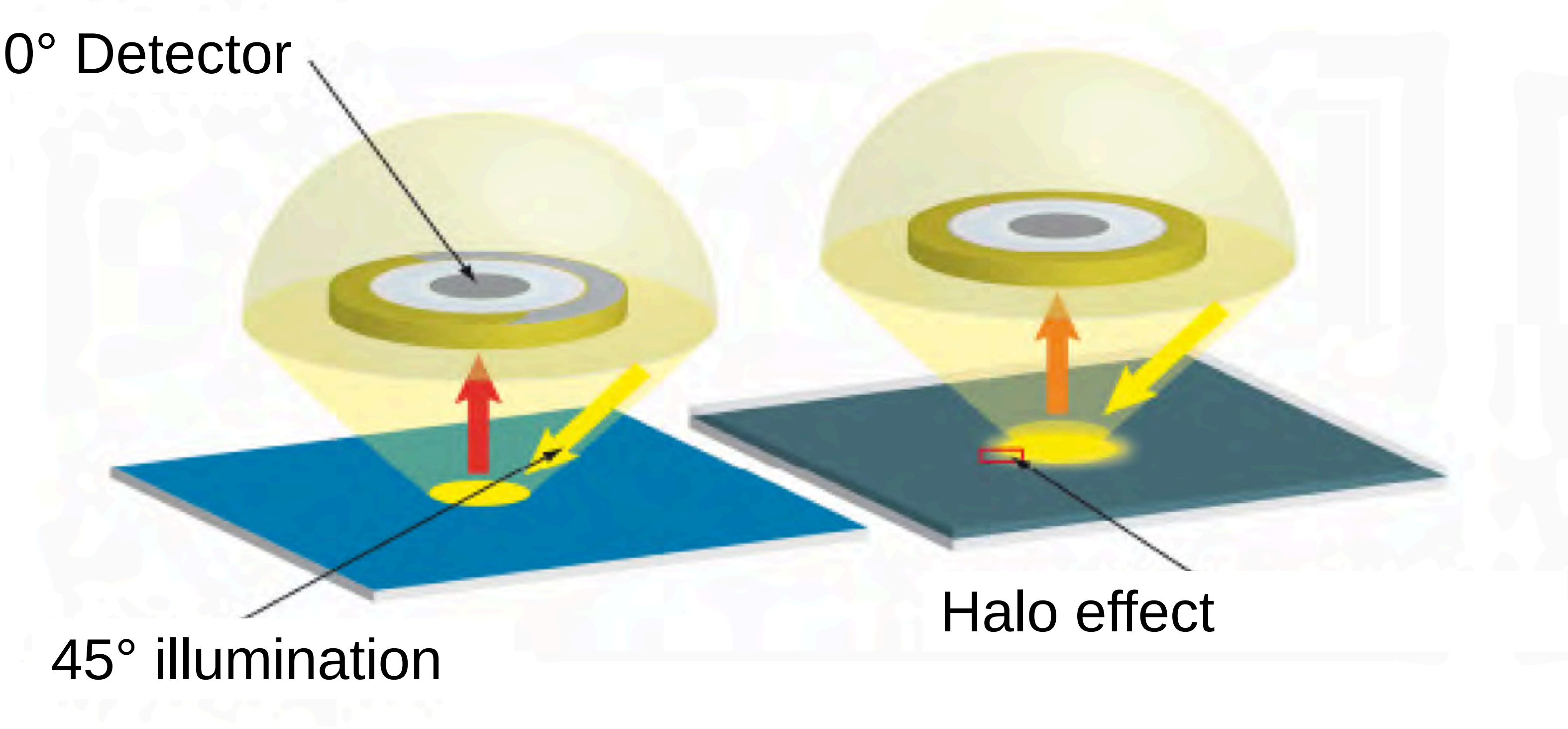


di:8°



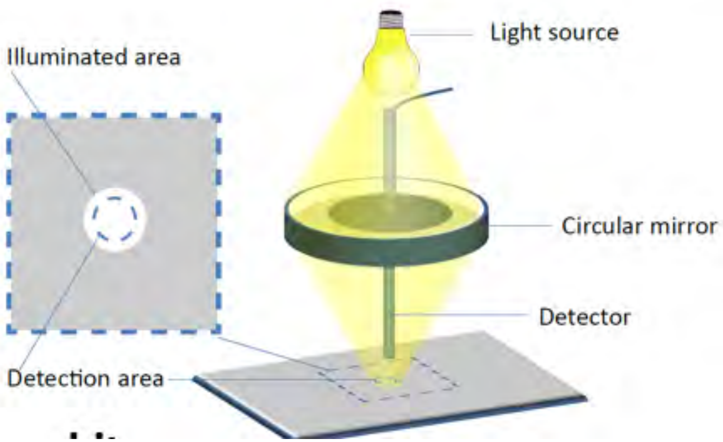
* Specular Included

2. as long as samples are not translucent



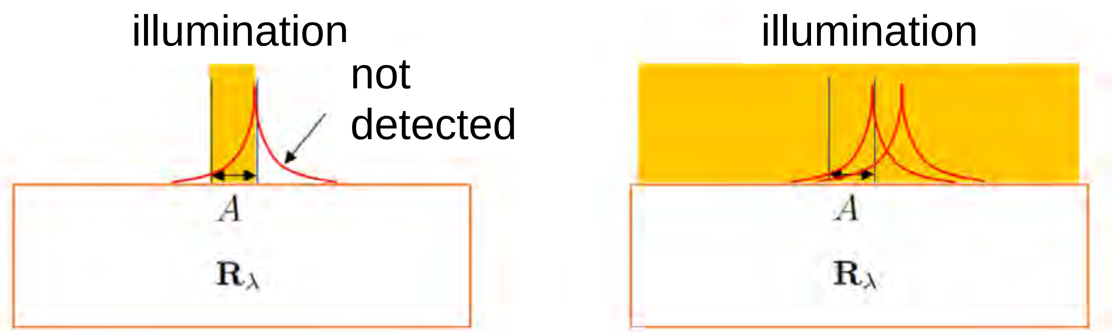
effect called:
¬translucent blurring
¬lateral diffusion
¬subsurface scattering

2. ISO 13655 defines over- and underfilling



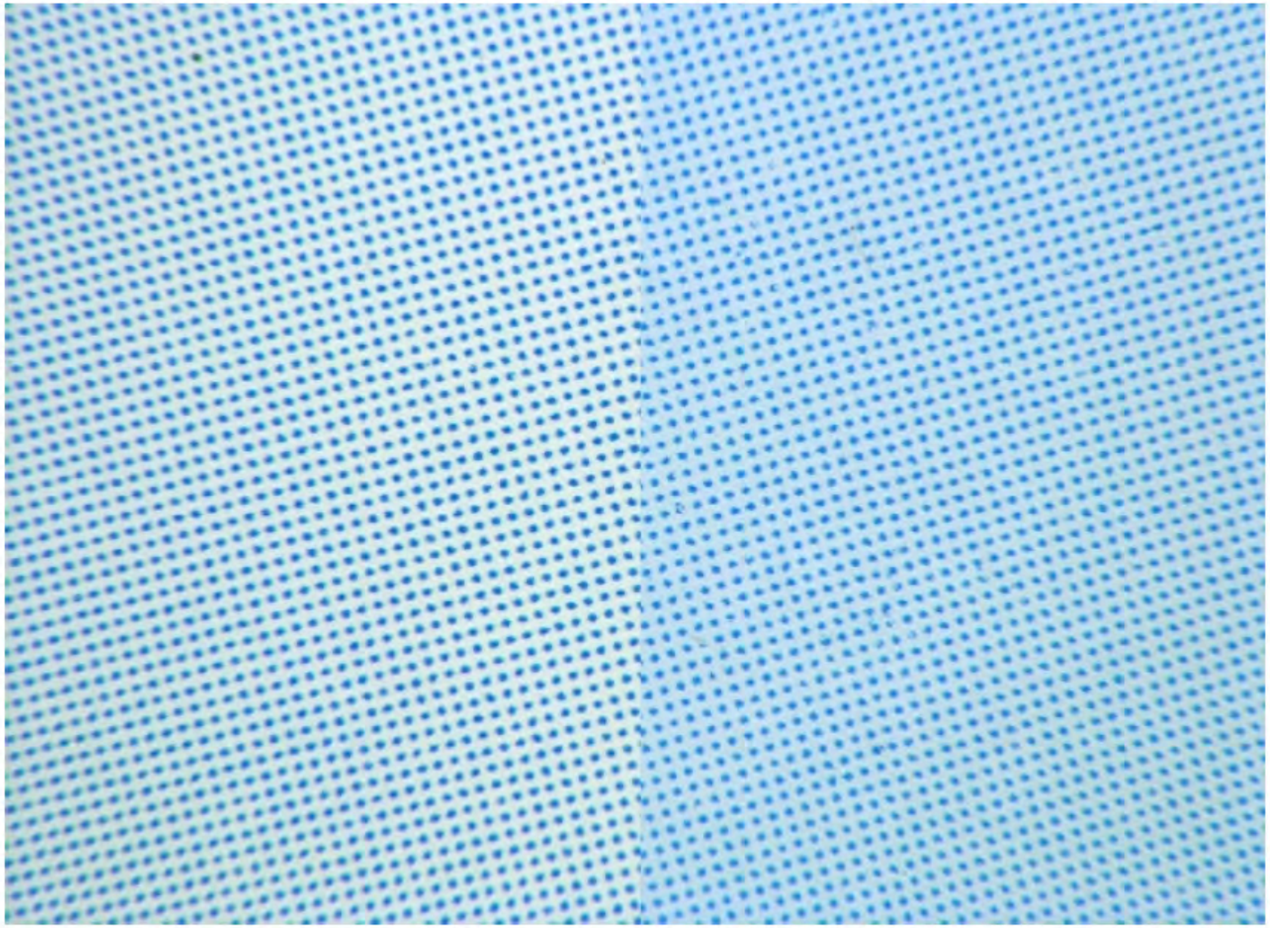
ISO 13655:2017 cites ISO 5-4 and requires:
“the realised boundary of the larger of the illuminator region and the receiver region shall be outside the boundary of the smaller by at least 2 mm.“ & opaque reference materials.

non plausible colour values



3. Some materials show lateral diffusion

60x magnified halftone on Polycarbonat

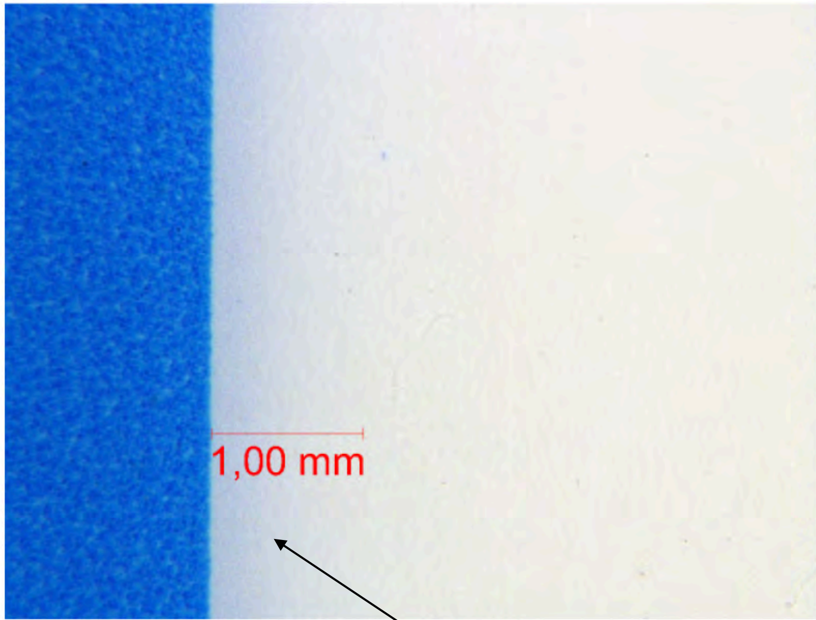


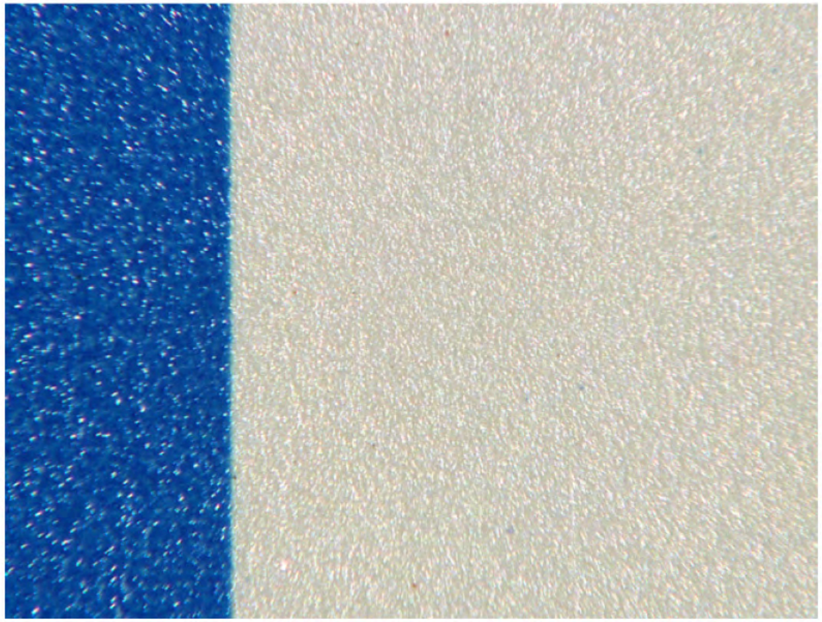
No lamination

200 µm think Polycarbonat-Overlay film

3. Some materials show lateral diffusion

60x magnified solid on Polycarbonat





200 µm think Polycarbonat-overlay film

No lamination

Blue shadow …

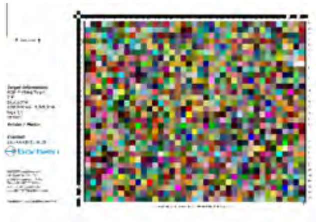
3. Also for 3D printing materials …

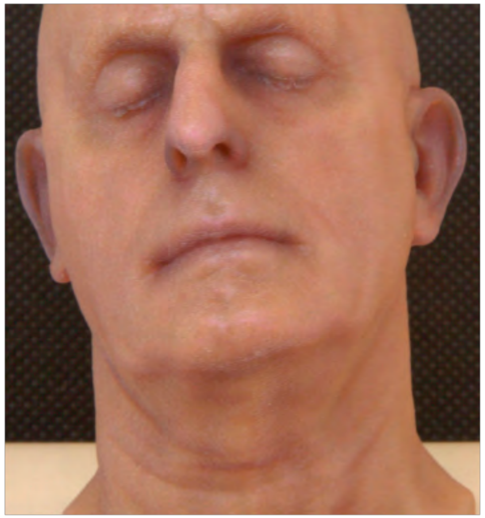
pulver and polyjet printing,

which require even more overfilling

3D softproof requires

- colour beside 45°/0° (BRDF)
- translucency assessment





http://cappsit.s3cloud.de

3. Proposing a method to measure „halo“

Method „edge loss measurement“ proposed:

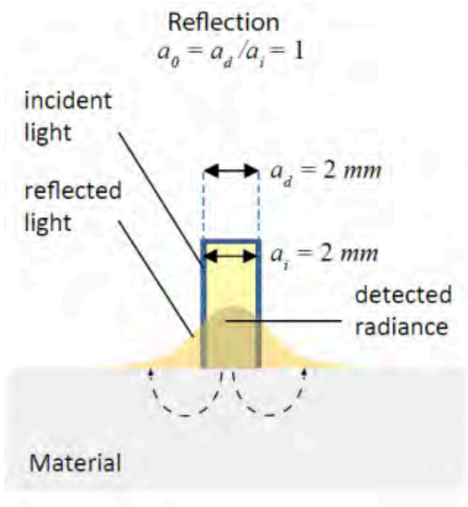
based on:


Fraunhofer

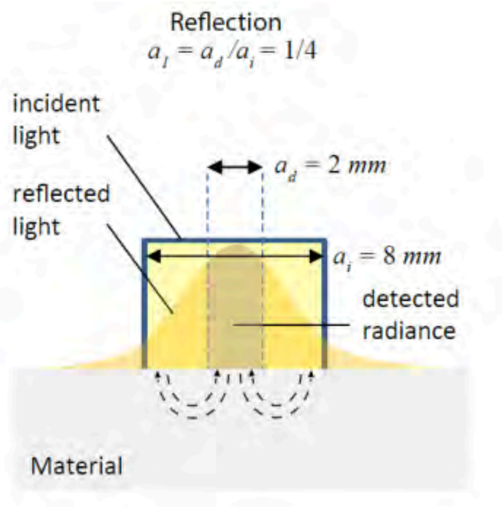
zbs

Fogra

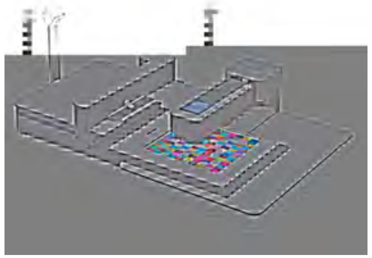
Prozessstandardisierung
im grafischen 3D-Druck
für 3DP- und FDM-Verfahren



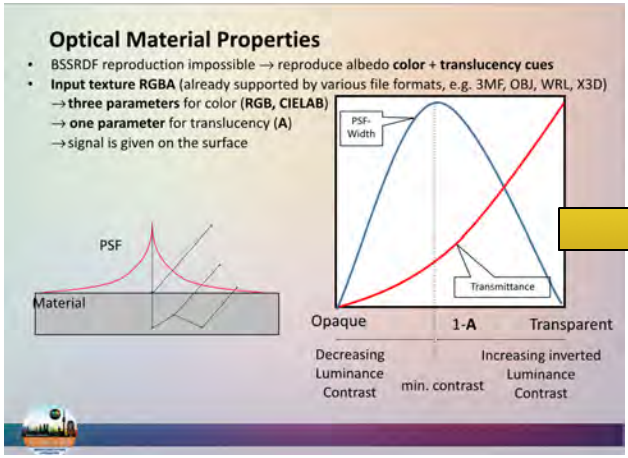
2 mm illumination

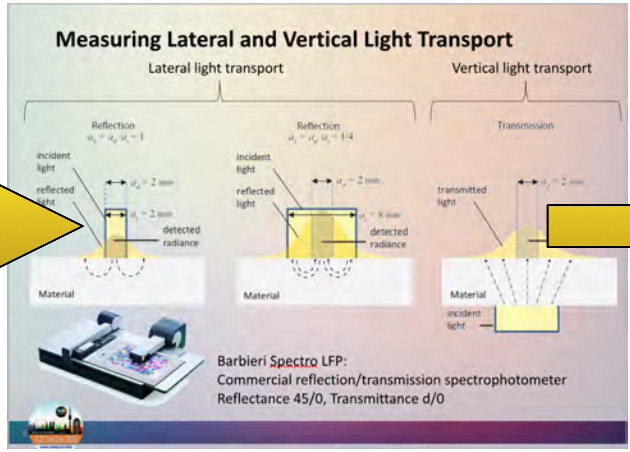


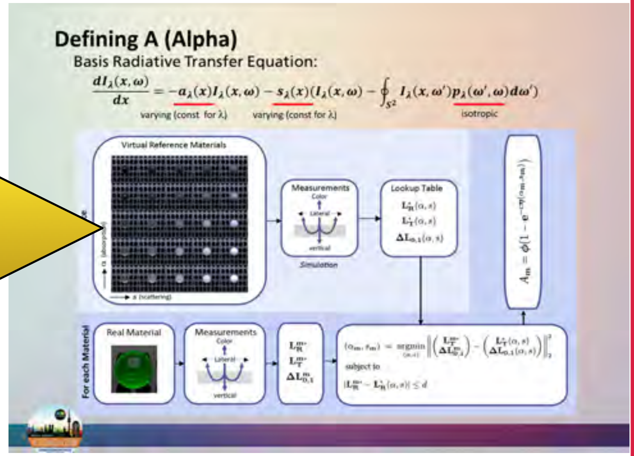
8 mm illumination

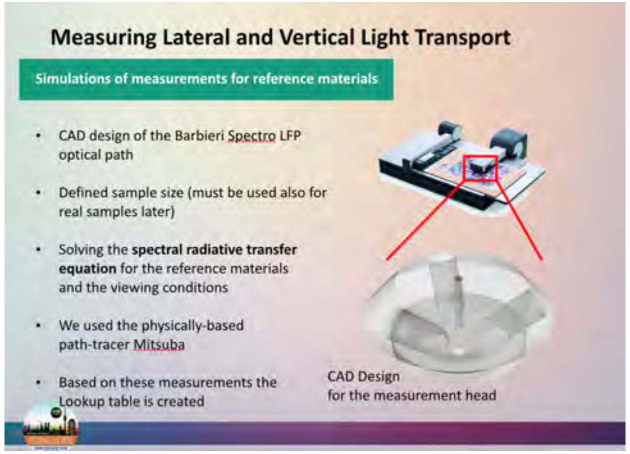


3. Metric details









Paper, Data and Matlab- / Mitsuba-Code is Publically Available:

https://arxiv.org/abs/1710.00546

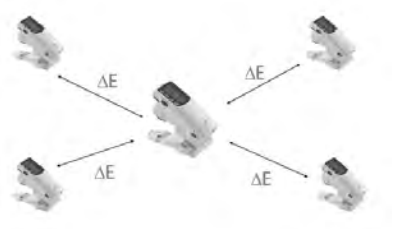
4. Take Home Message

- Since we print on anything which is not running away, there are more materials to come
  - plastics of all sort (including 3D prints)
  - ceramics
  - textiles
  - and many more
- Check your samples to be measured for visual plausibility
  ➡️ PSD Practical plausibility check
- Make a measurement as planed
- View that CIELAB value in Photoshop
- Proof that colour by means of a ISO 12647-7 conforming proofing setup
- Compare the sample with the rendering

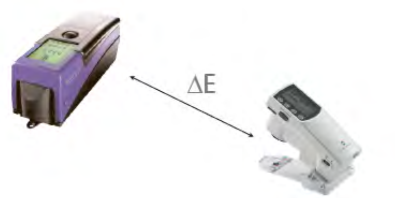
4. Summary

- Question all colour measurements
- Samples with no or less translucency can be measured as expected with 45°/0° geometry
- Use integrating sphere devices for matching physical objects (no appearance)
- Try to establish an uncertainty budget and judge your tolerances afterwards

Why not smaller tolerances?



Inter-Instrument agreement



Inter-model agreement

Intra-model agreement

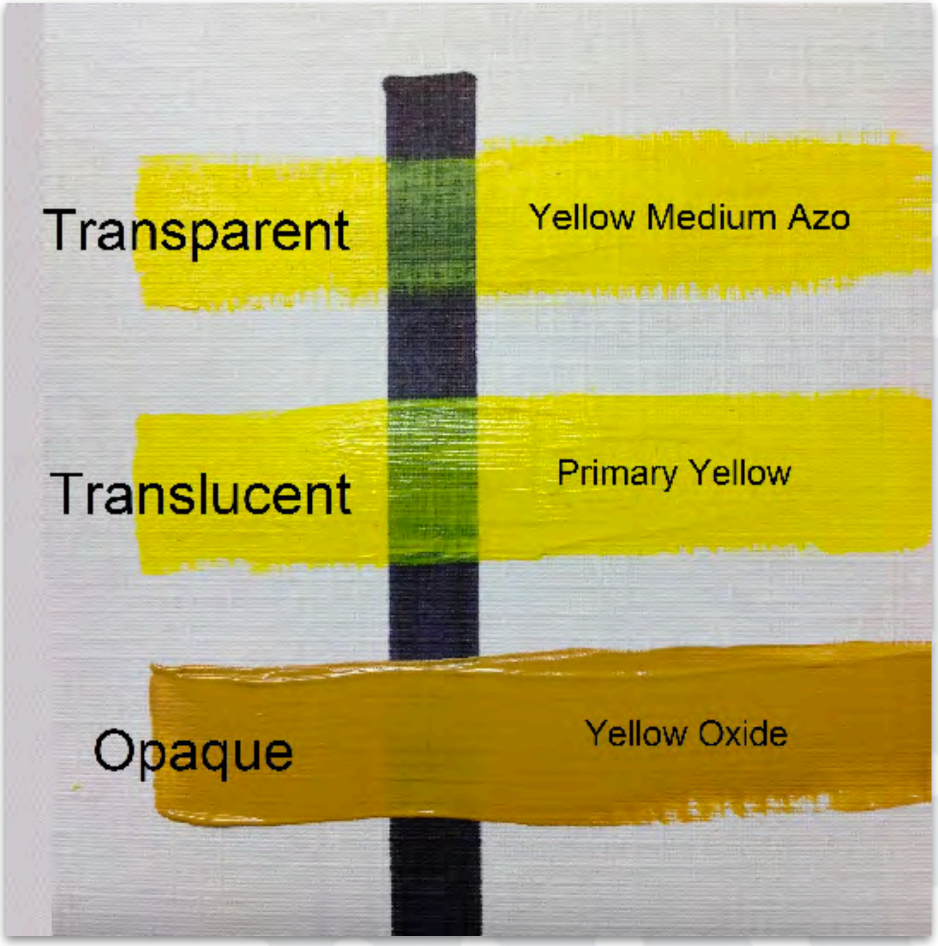
- Consult available guidance:
  - Technical report to come: „Assessment and validation of the performance of spectrocolorimeters and spectrodensitometers“
  - Fogra PSD handbook

5. Resume

„When you can measure what you are speaking about and express it in numbers, you know something about it"

Lord W. T. Kelvin, Lecture to the Institution of Civil engineers, London, 3 May 1883

Backup



translucency, *n*—the property of a specimen by which it transmits light diffusely without permitting a clear view of objects beyond the specimen and not in contact with it.

translucent, *adj*—transmitting light diffusely, but not permitting a clear view of objects beyond the specimen and not in contact with it.

transparency, *n—(1)* the degree of regular transmission, thus the property of a material by which objects may be seen clearly through a sheet of it.

transparent, *adj*—transmitting radiant energy without diffusion. (1990)

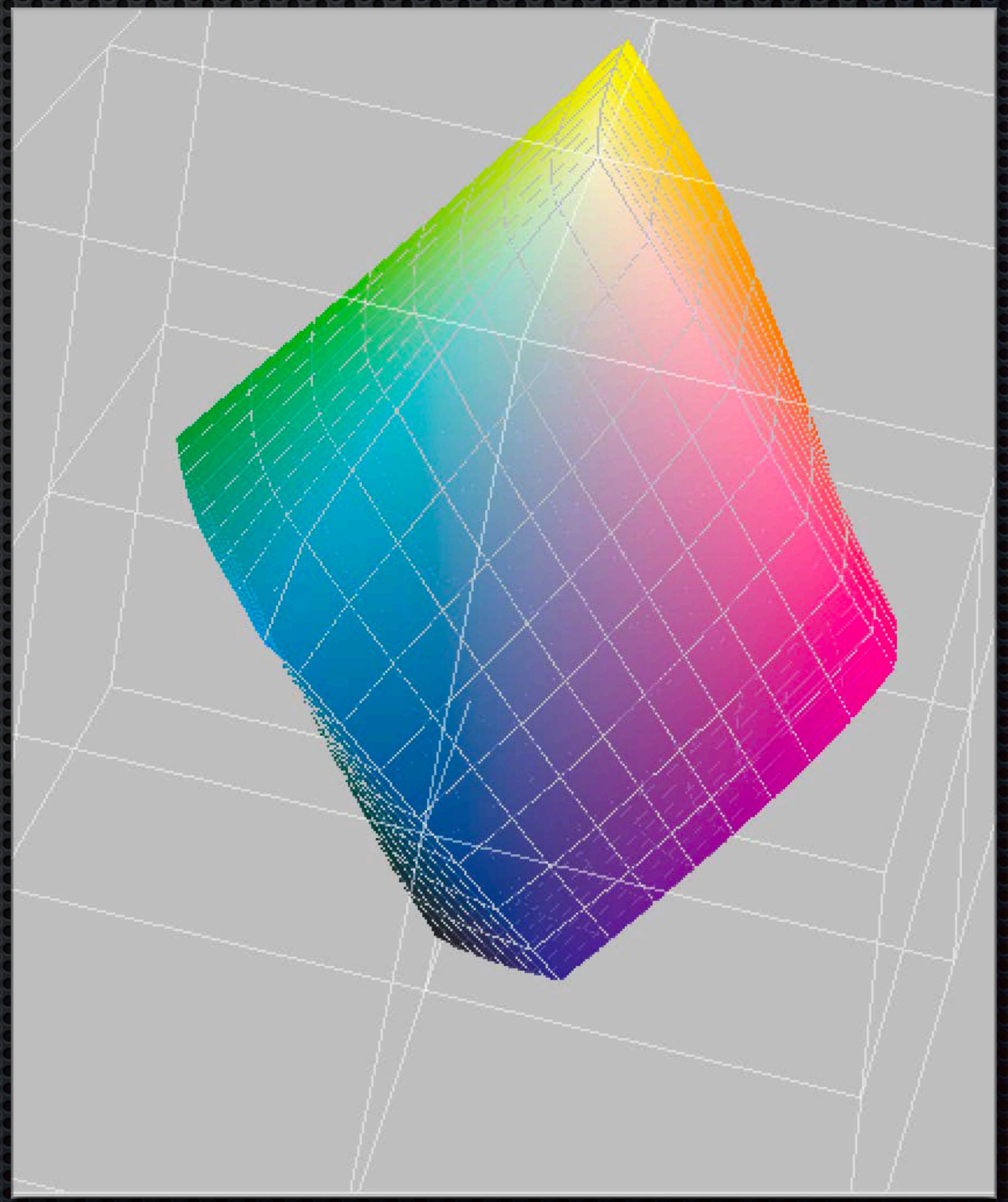
haze, *n—in transmission,*
(*1*) the scattering of light by a specimen responsible for the apparent reduction in contrast of objects viewed through it. **(D1003)**
(*2*) the percent of transmitted light that is scattered so that its direction deviates more than a specified angle from the direction of the incident beam. **(D883, D1003)**

Using eciCMYK as working color space for Wide Gamut printers

Peter Kleinheider
PrePress Digital, CTO

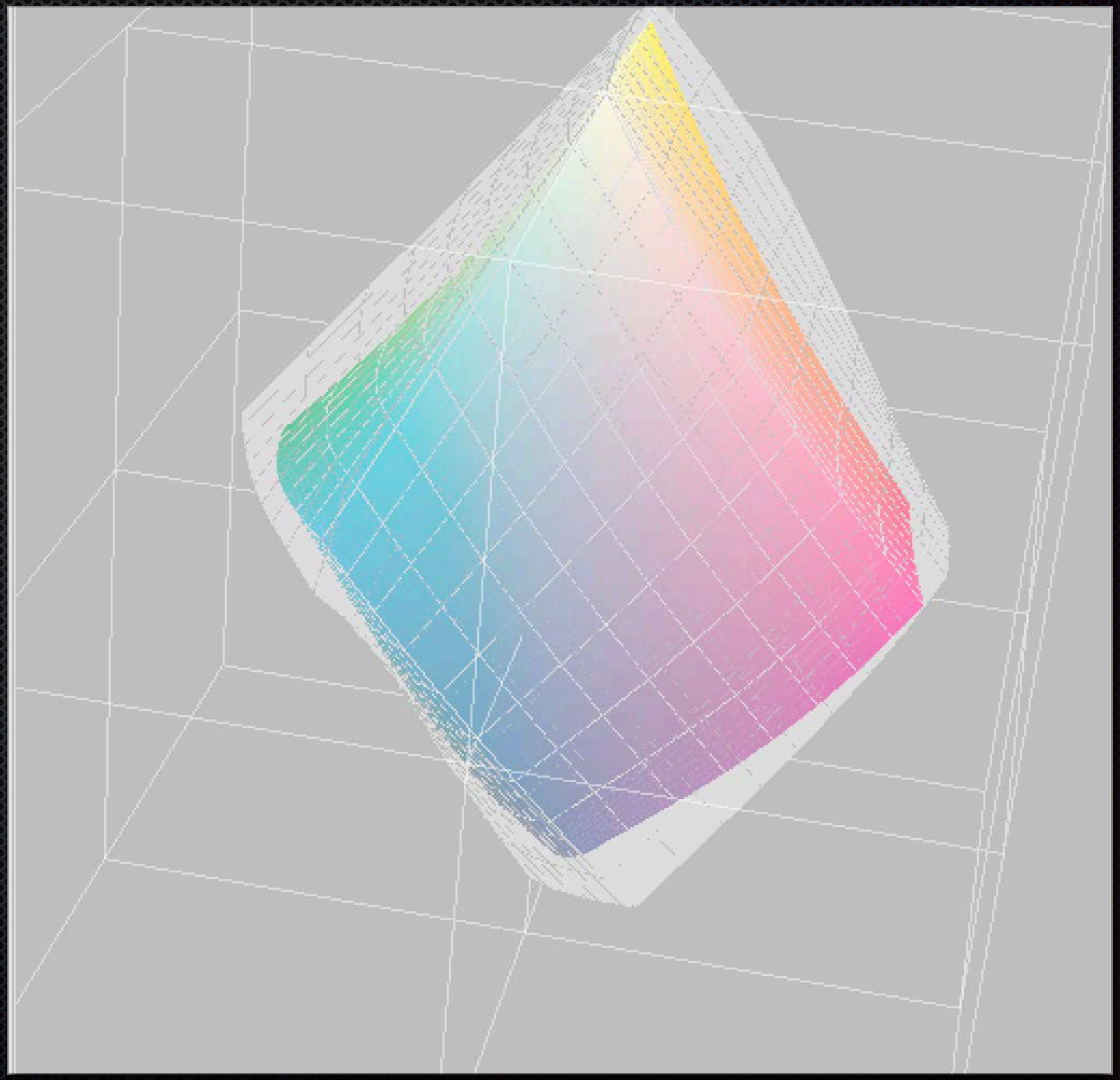
eciCMYK - Fogra53

- FOGRA53 is a CMYK based exchange space that primarily serves colour communication throughout the print production. It complements the existing 52 reference printing conditions that reflect actual offset based printing conditions. It was developed in light of the completed Fogra research project 10.057, that was establishing tools for a media neutral print workflow.



comparison of Fogra39 to Fogra53

- color angel of primaries and secondaries is very similar
- higher chroma
- different gray aixs




sRGB


ISO coated V2


eciCMYK

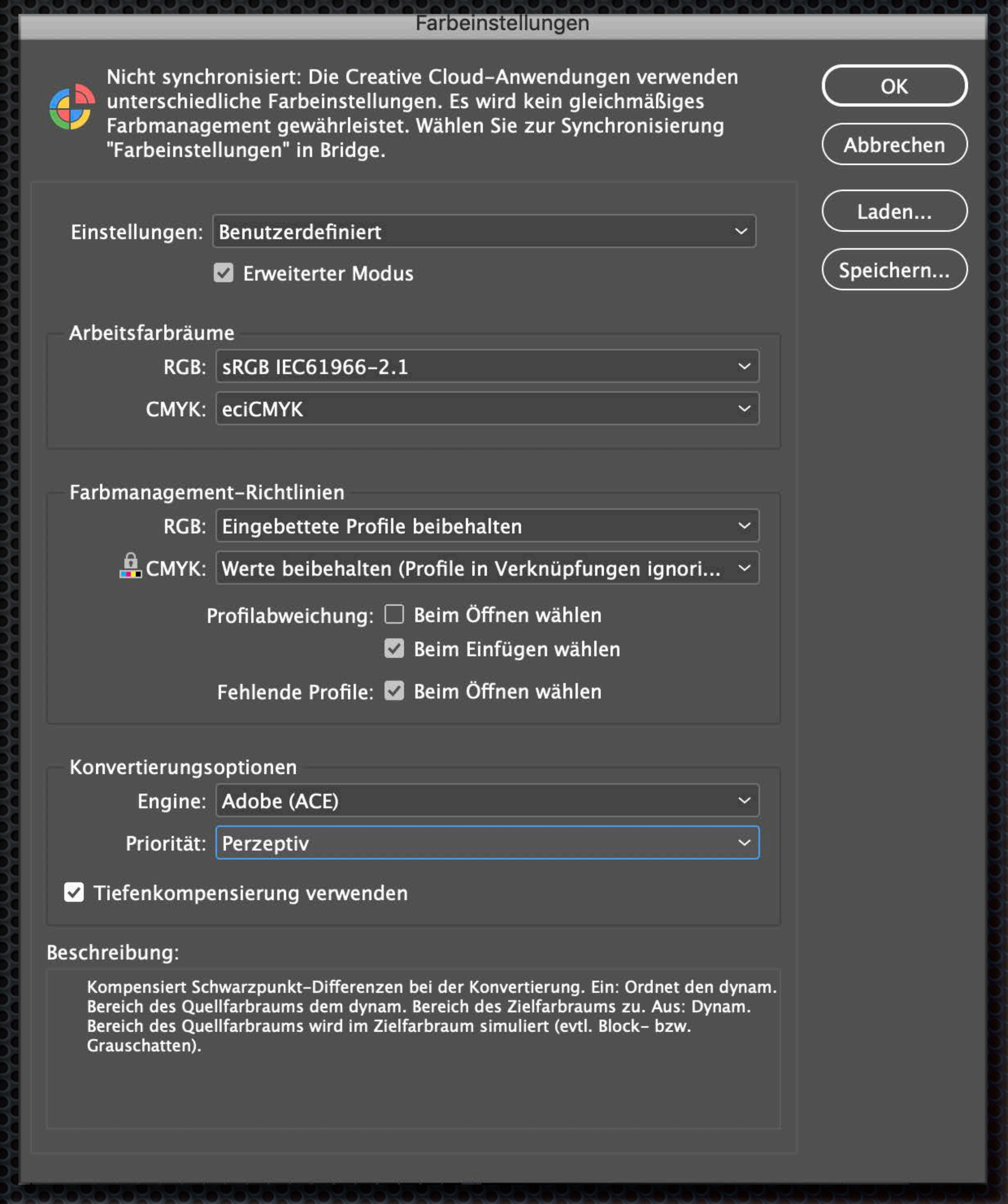

sRGB


ISO coated V2

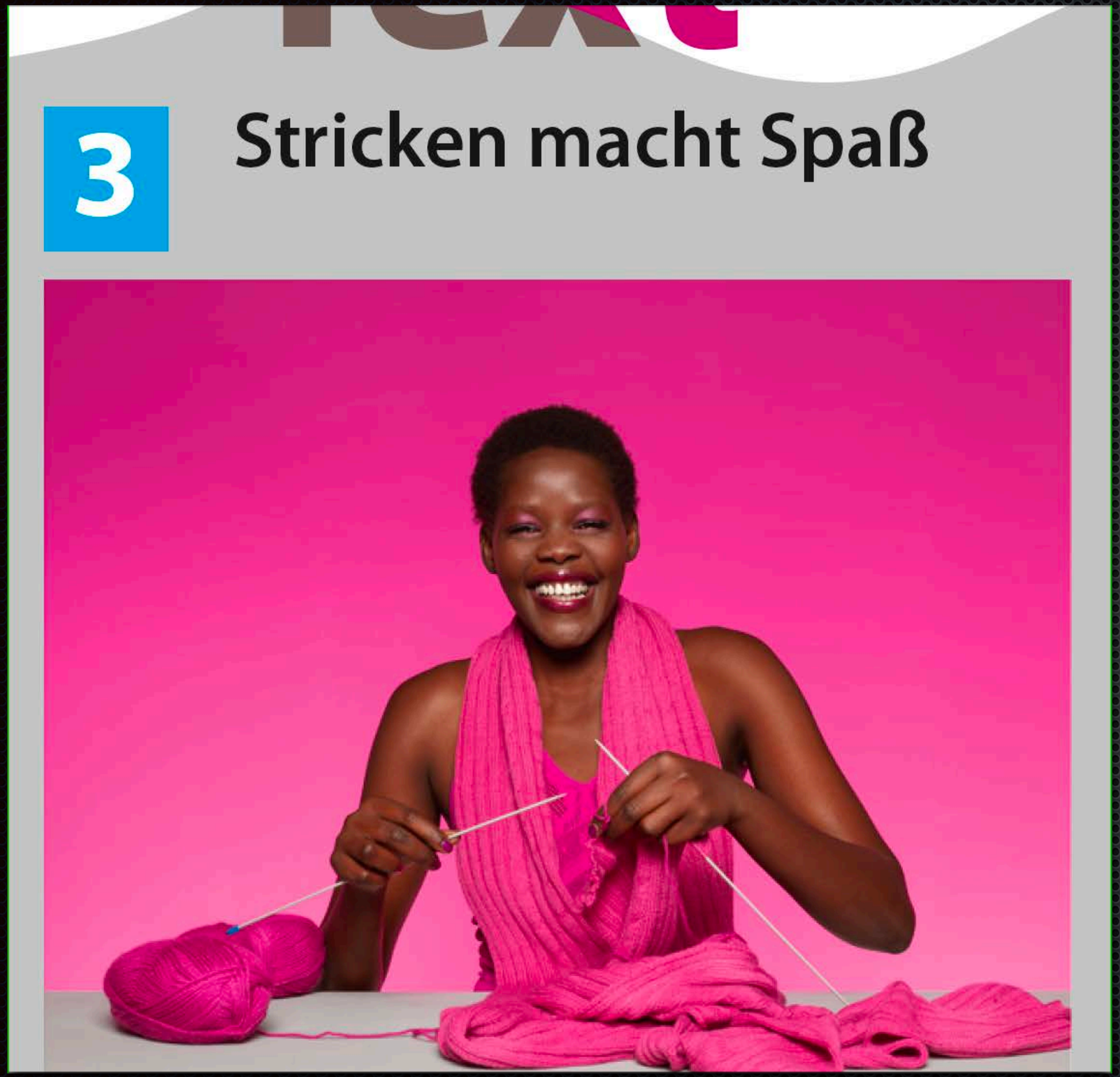

eciCMYK

eciCMYK as Output Intent

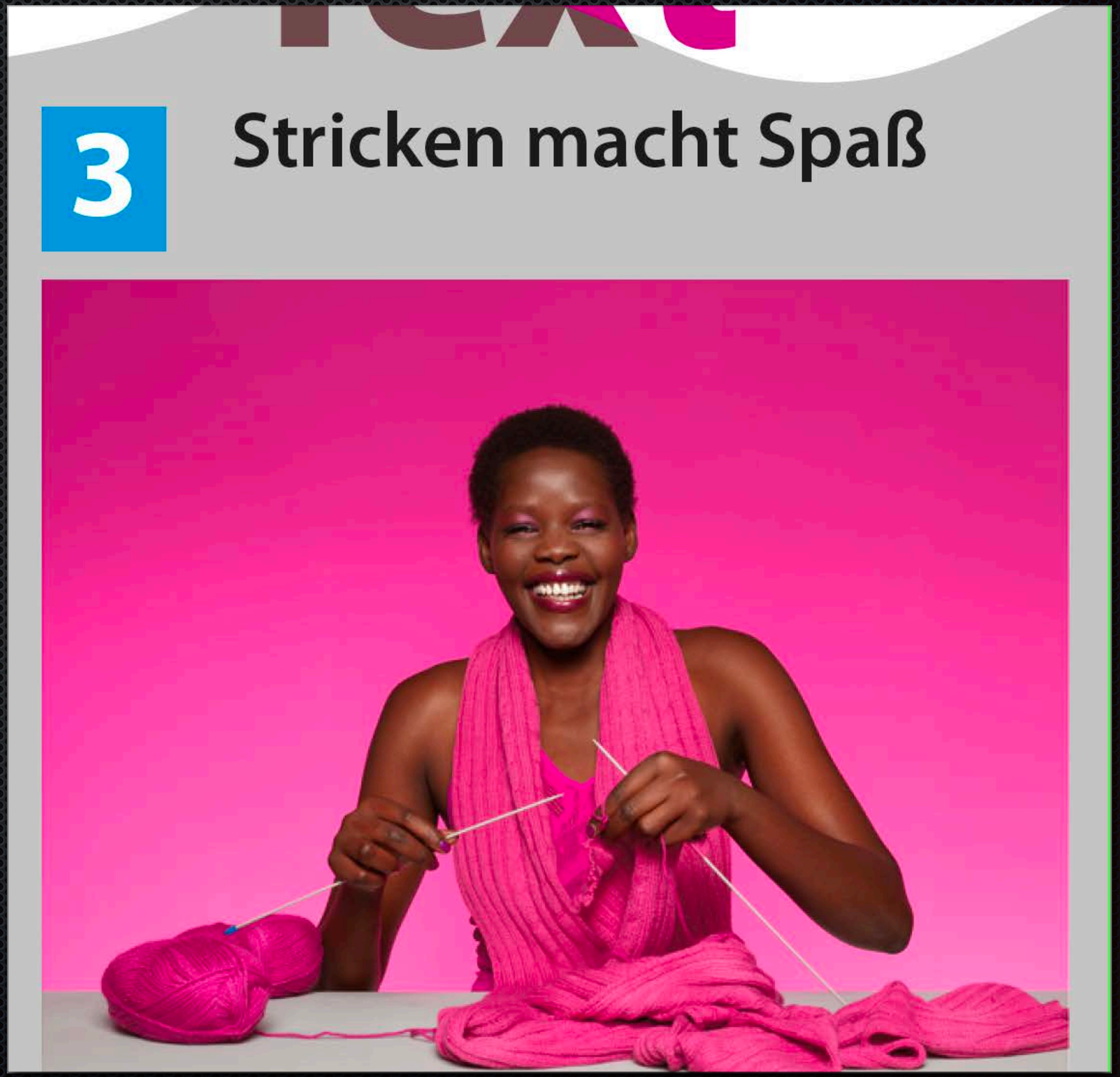
- What would happen, if someone used eciCMYK as the working color space in Adobe applications



eciCMYK as Output Intent / RGB



OI: ISO coated V2



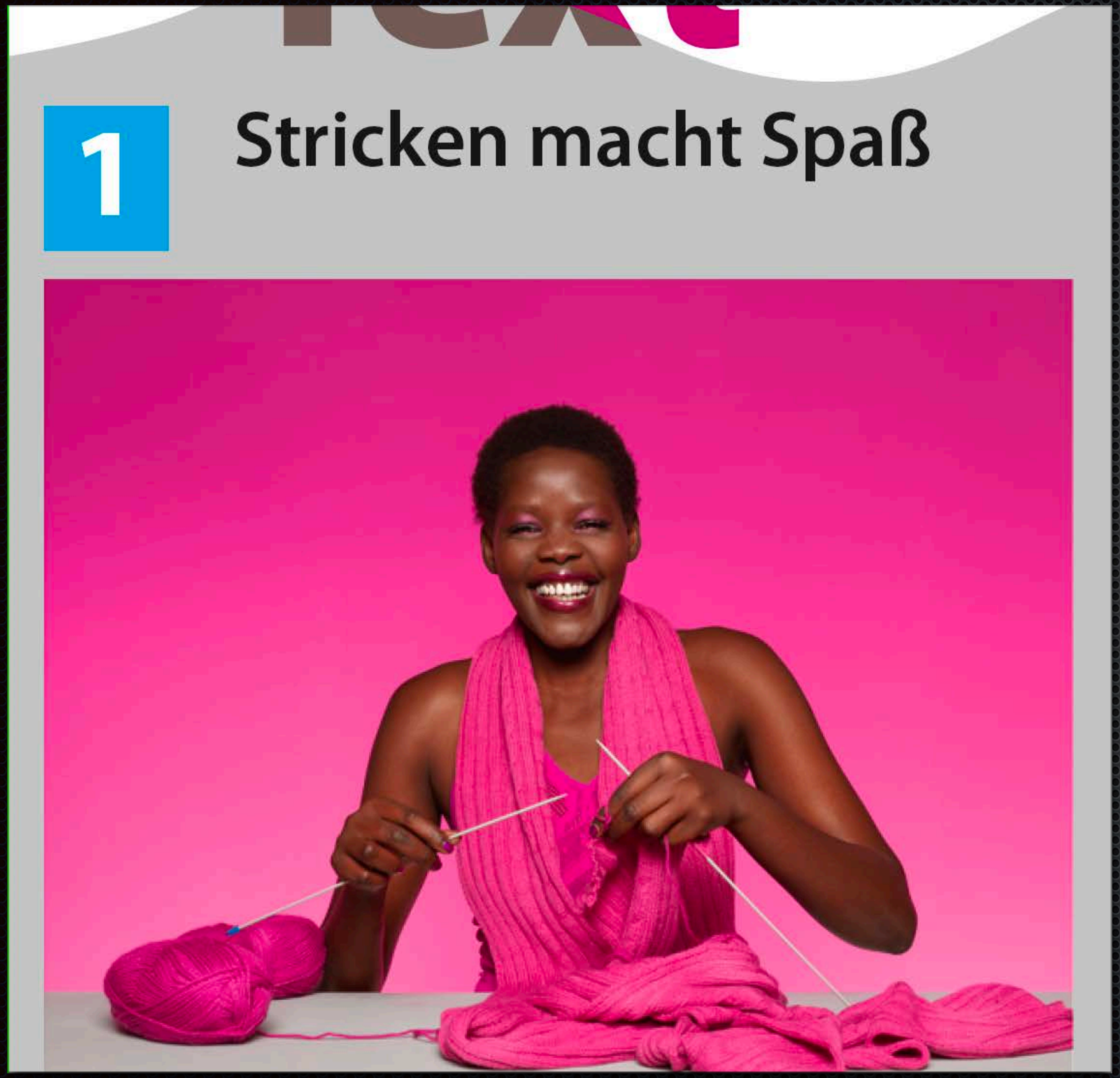
OI: eciCMYK

OI: ISO Coated V2

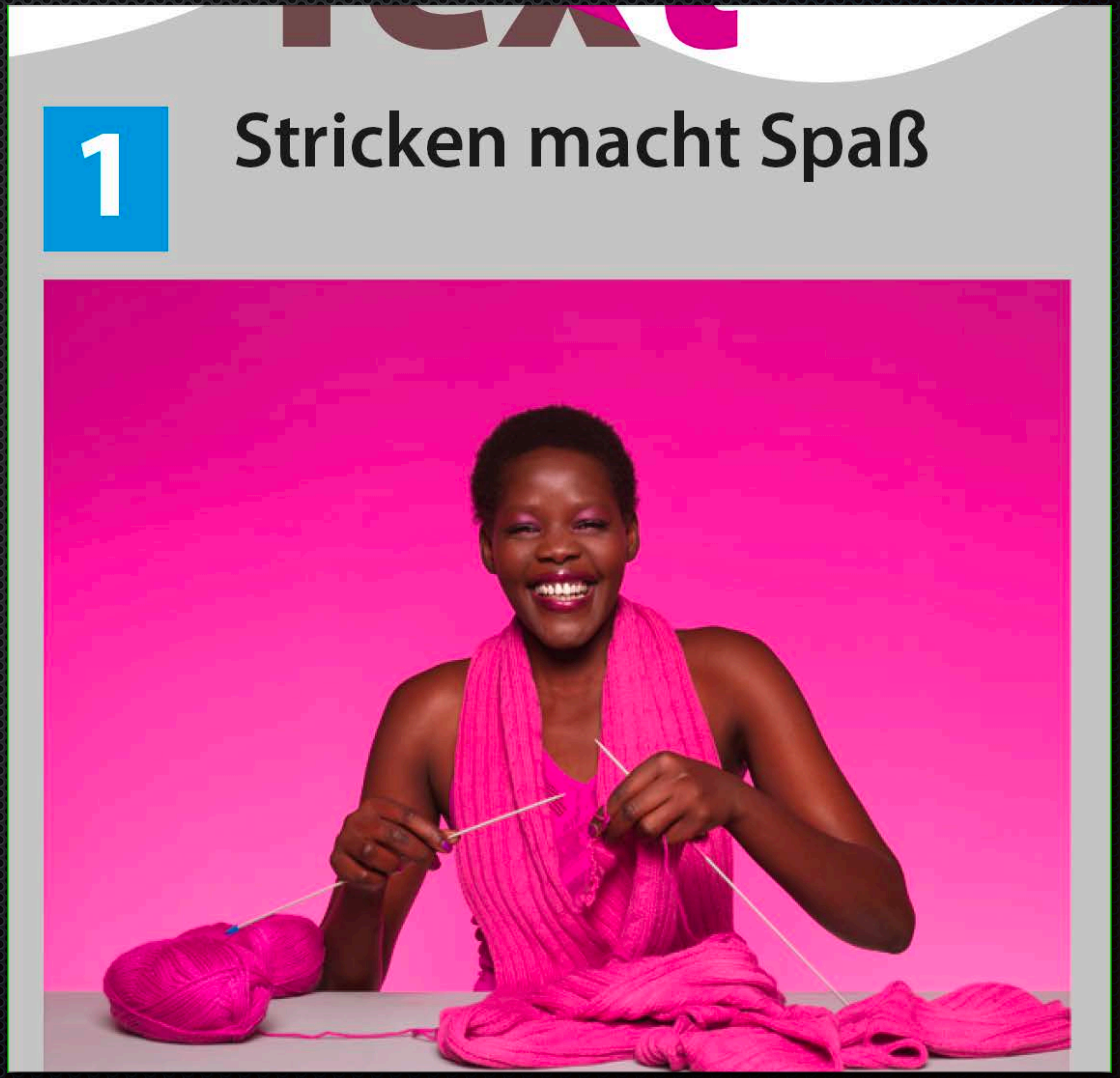
OI: eciCMYK

OI: eciCMYK
DL conversion of CMYK

eciCMYK as Output Intent / CMYK (F39)

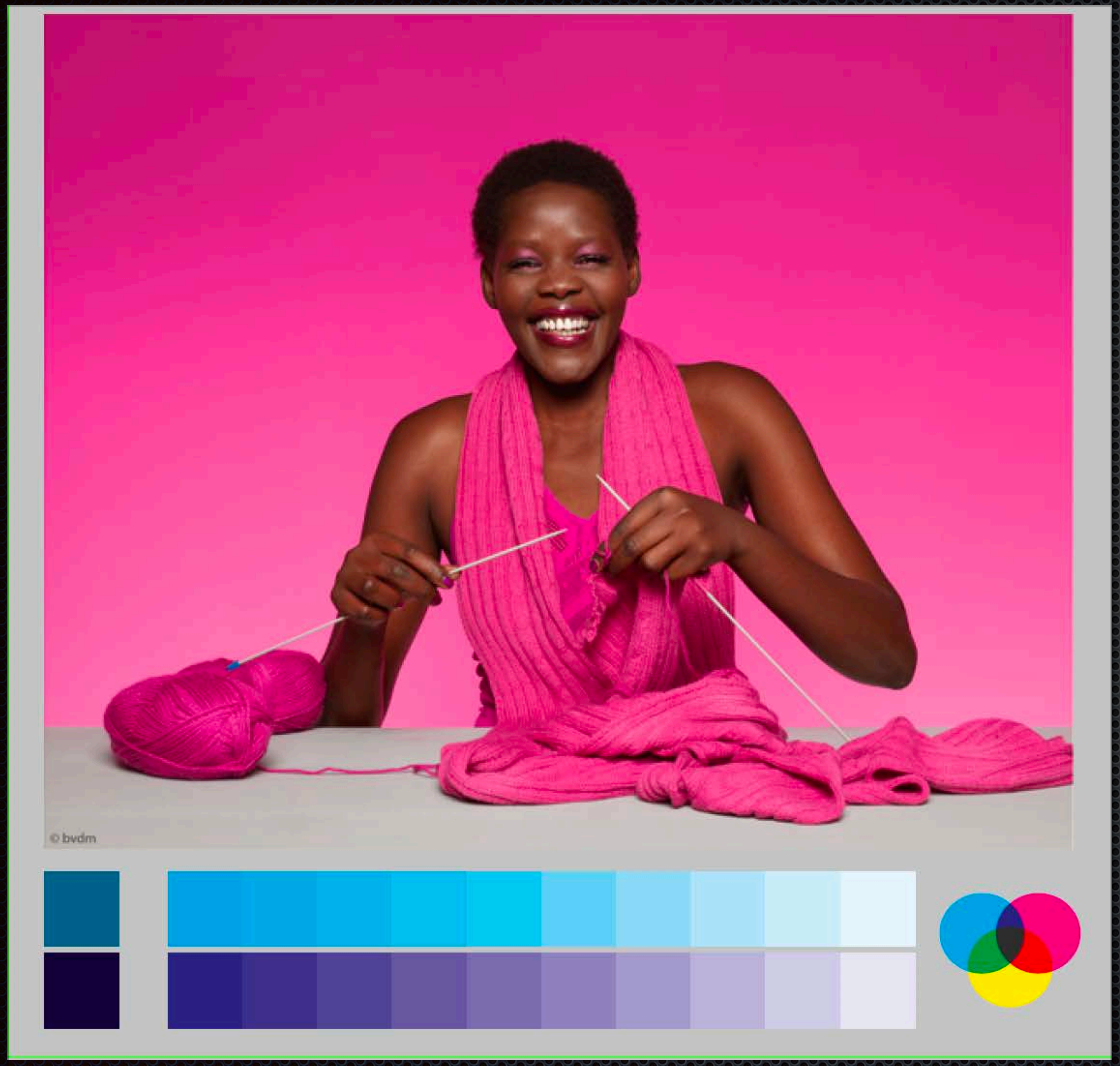


OI: ISO coated V2

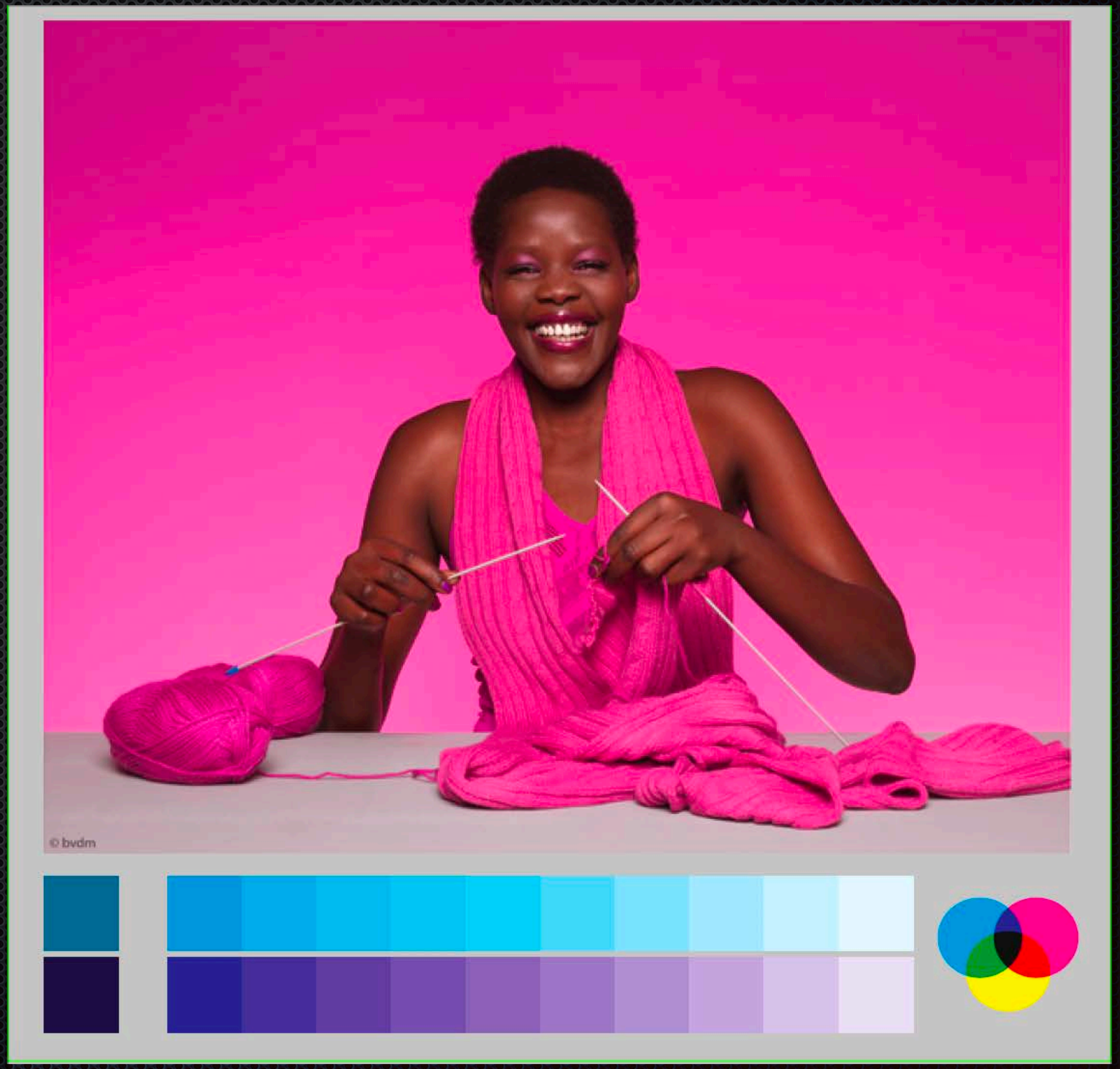


OI: eciCMYK

eciCMYK as Output Intent / CMYK (F39)

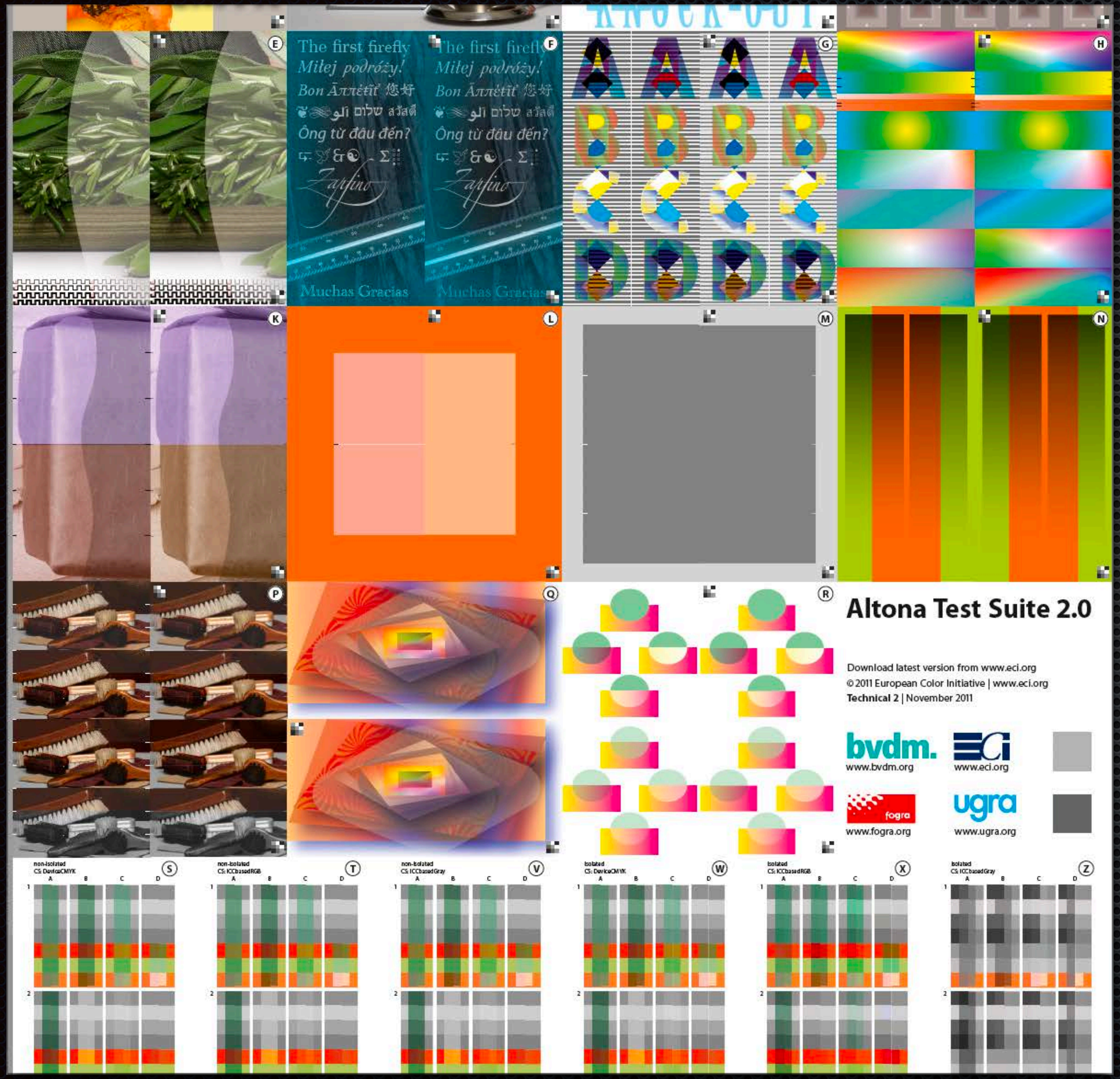


OI: ISO coated V2

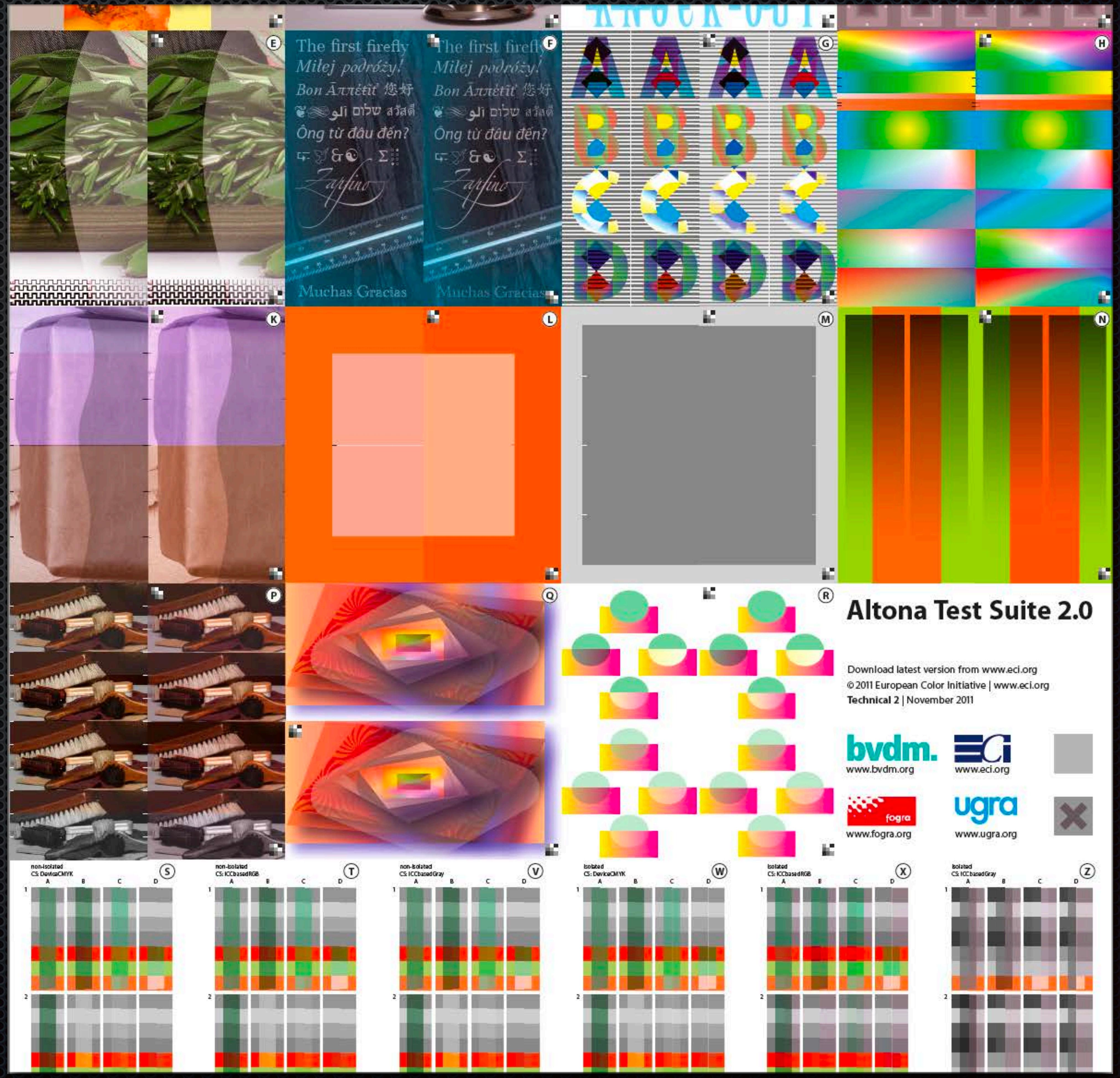


OI: eciCMYK

eciCMYK as Output Intent / CMYK (F39)



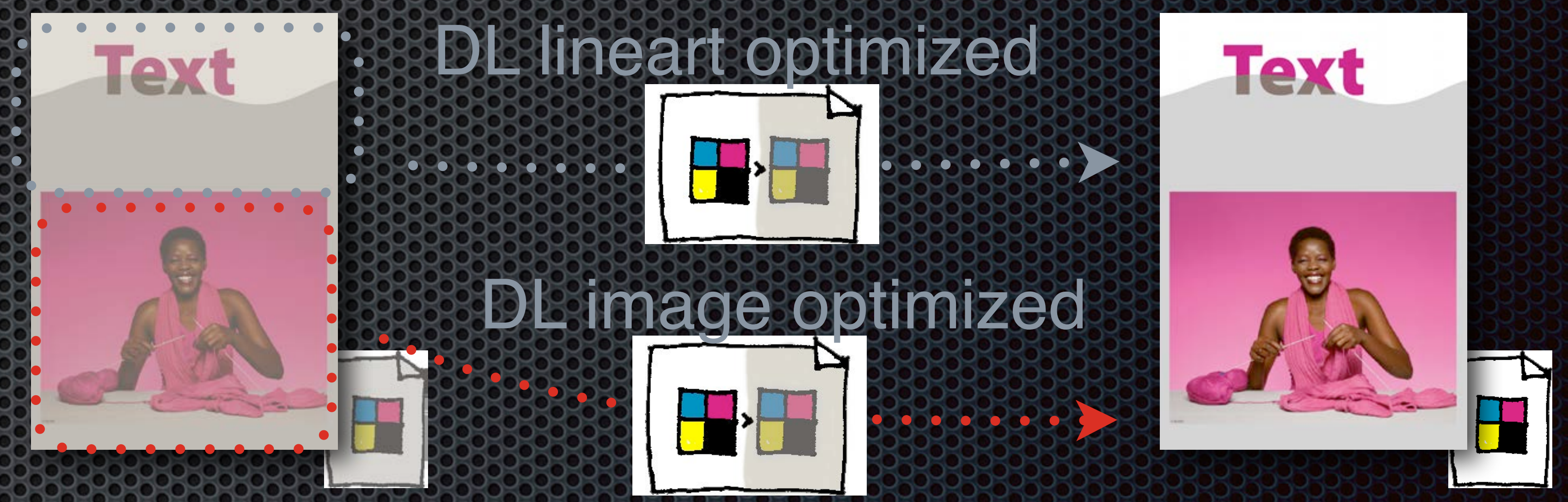
OI: ISO coated V2



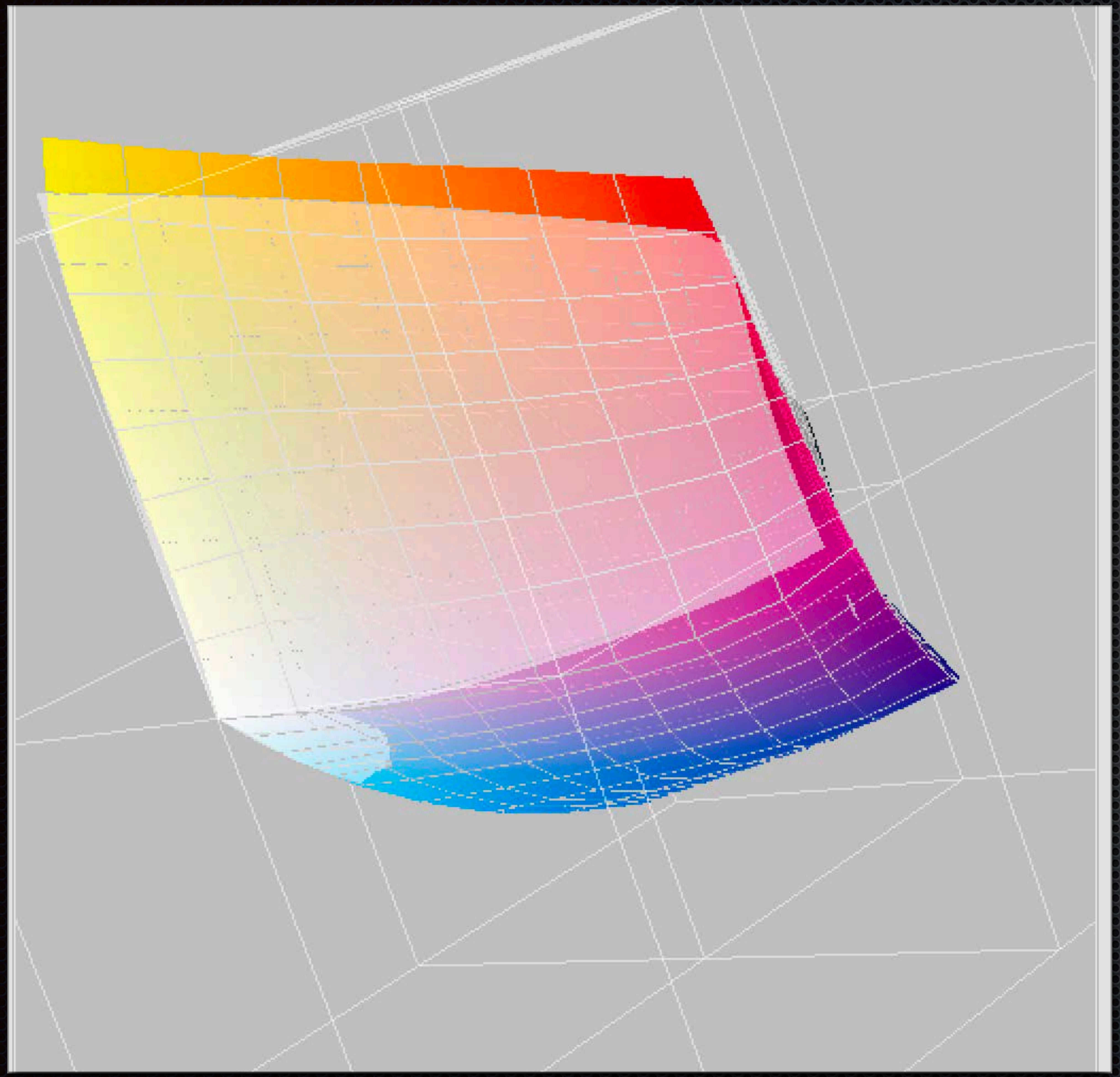
OI: eciCMYK

eciCMYK as Working color space

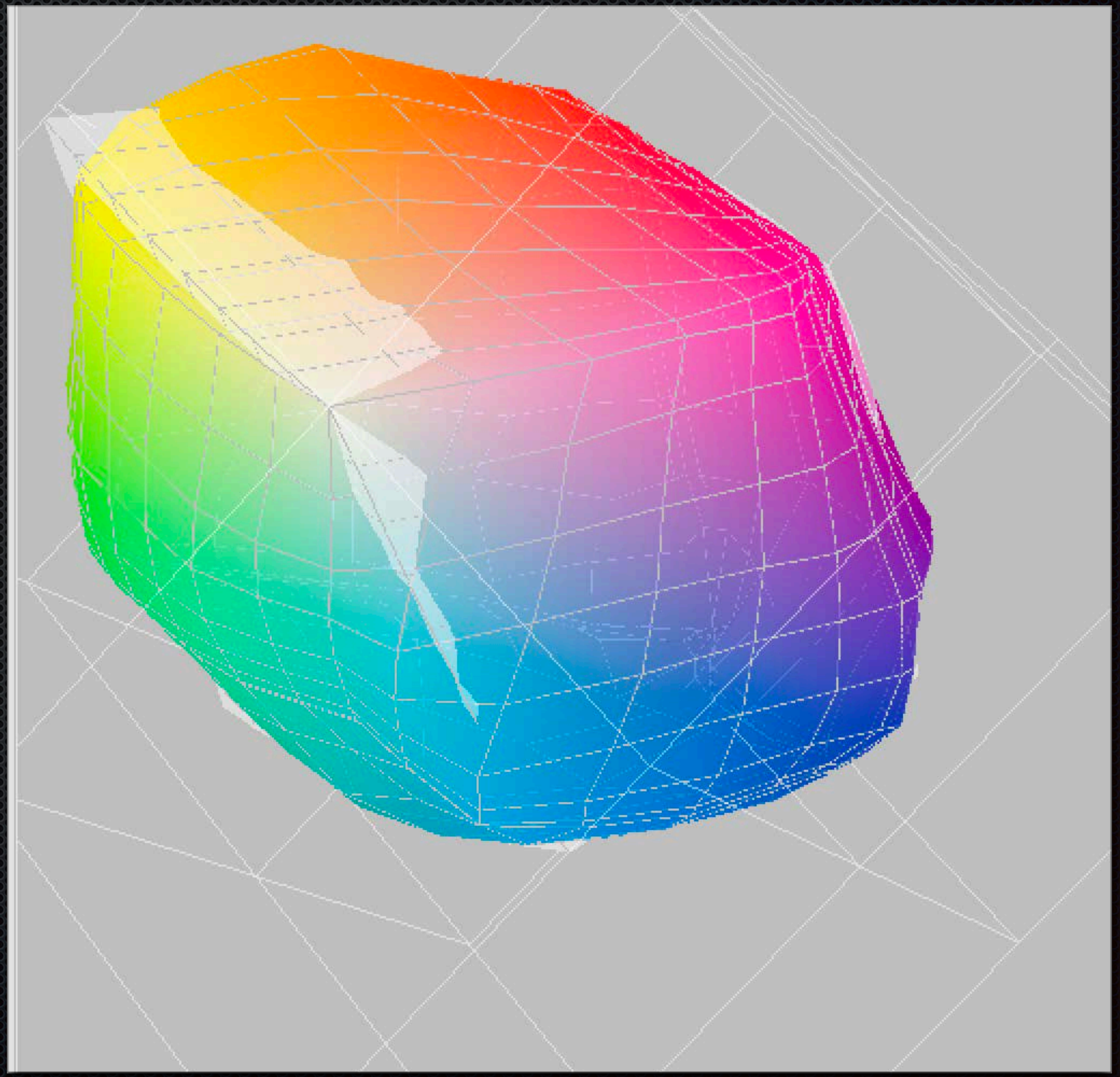
- works well for RGB images
- works OK for CMYK vector elements - conversion needed?
- CMYK images have to get converted (or need to get tagged)



Is eciCMYK really large enough?



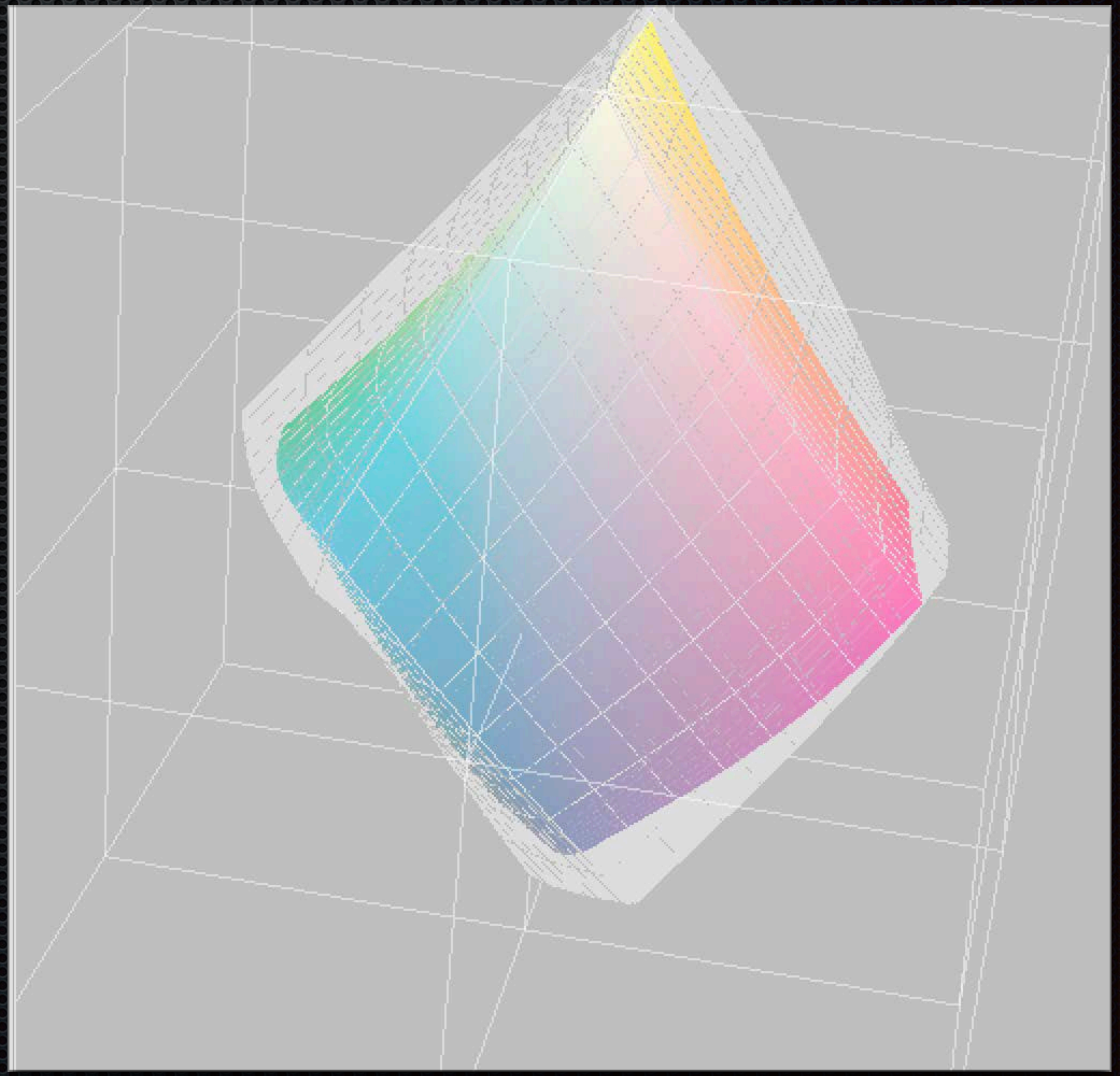
WT250 - CMYK



TAU330 - CMYKOVG

eciCMYK - Fogra53

- CONS
  - still too small for CMYK+ printers, when wanting to use the whole gamut
- PROS
  - CMYK color model in PDF
  - predictable colours while using a standardised larger color spaces



Sources

- Images: Shutterstock and roman16
- ICC profile: eciCMYK can get downloaded for free at www.eci.org - together with 3 free devicelink profiles
- Graycon tool: www.eci.org
- Altona technical 2 testpage: www.eci.org
- Composed page: part of color management workshop from Florian Süßl and Peter Kleinheider
- Gamut previews: CoPrA Profile Manager from ColorLogic

Thank you for your interest

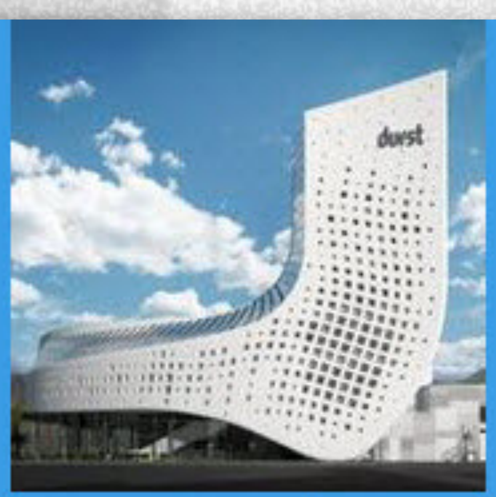
Peter Kleinheider - pk@prepress-digital.com

Advanced Color Management workflow for InkJet applications

ICC COLOR EXPERTS DAY
MAY 24, 2019

Colour Management for
Wider-Format Printing
on Non-Paper
Substrates

Hosted by Barbieri Electronic



HQ Durst Phototechnik AG
Bressanone, Italy

Dietmar Fuchs <dfuchs@colorlogic.de>
Product Manager
ColorLogic GmbH

ColorLogic

CrossXColor SDK

High-End **Color Management Solutions**

Color **Focused.** Technology **Driven.**

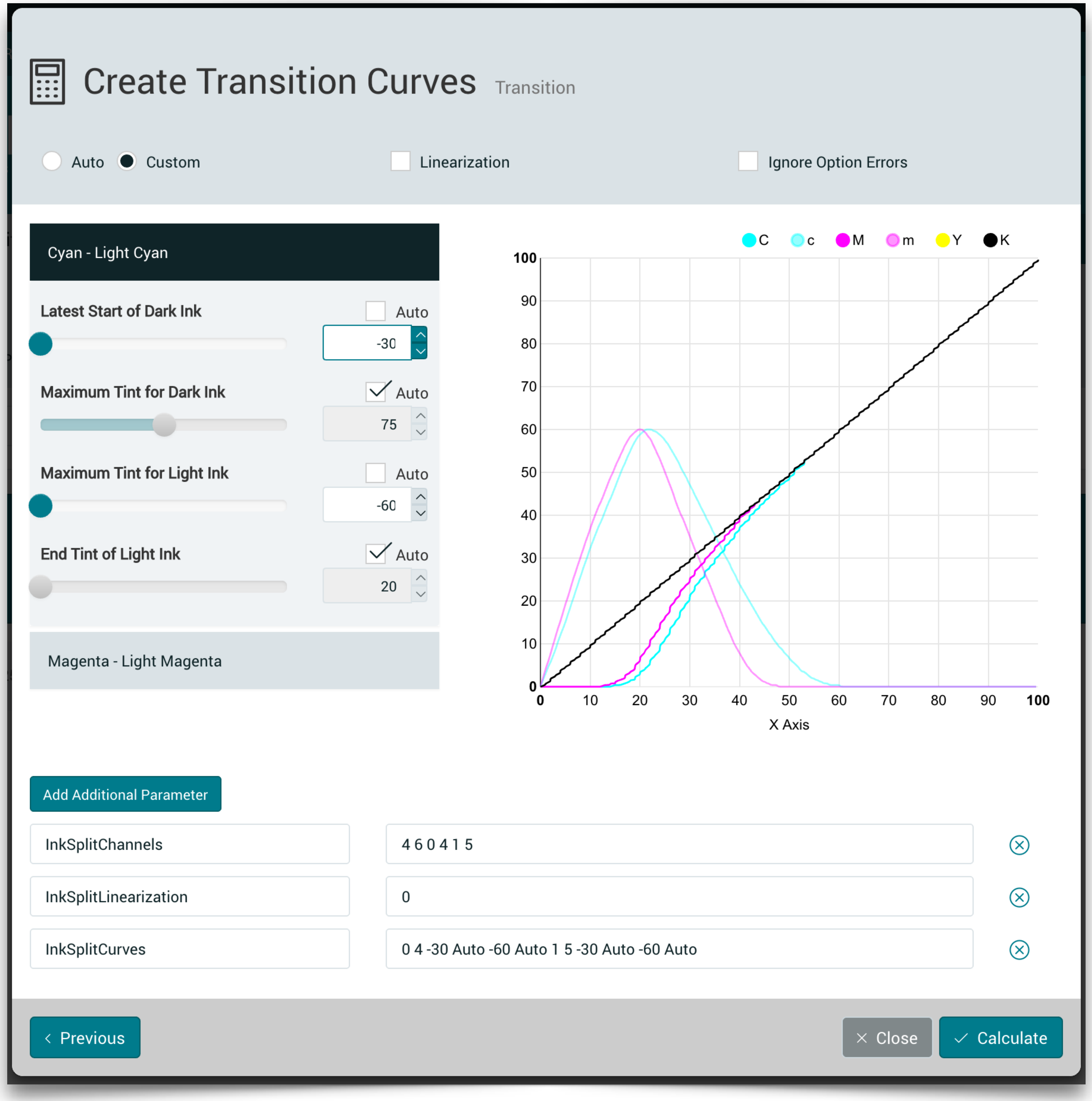
GENERAL CHALLENGES

Challenges of Color Management and Color Conversion in Ink Jet printing

- What factors make color management complex?
- Where in the process will it be problematic?
- What could a high quality color management workflow for inkjet look like?
- How can spot colors be printed in high accuracy with process colors?
- Considerations and solutions using the example of the Durst color management workflow

INKSPLITTING

- Splitting the *logical* channels (e.g. CMYK) to the *real ink* channels used from the printer (e.g. CcMmYK)
- Lighter areas in images/graphics shall use the light inks and darker areas the dark inks
- Good transition between light and dark inks is crucial for nice and smooth gradations
- Requests: Ink savings, take color acceptance into account, avoid peppering effect,…
- Often RIPs are missing controls for this or they are difficult to handle



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LINEARIZING

- Not linearized raw curves are often bumpy and have way to high dot gain
- Adjustments of the curves are always needed to avoid the ICC profile having to do too much work
- Often a channel wise ink limit is necessary
- Calculated linearization curves should be smoothed to avoid over compensation
- The entire color management should be in 16 bit

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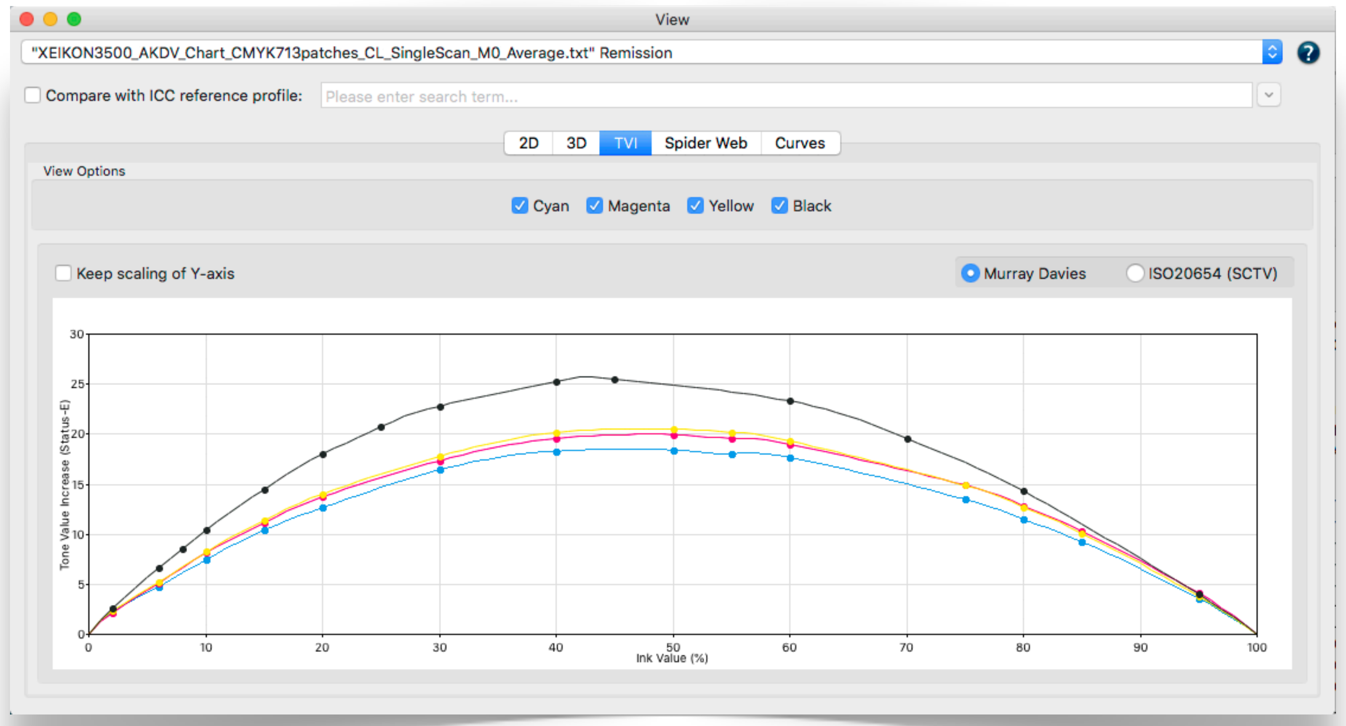
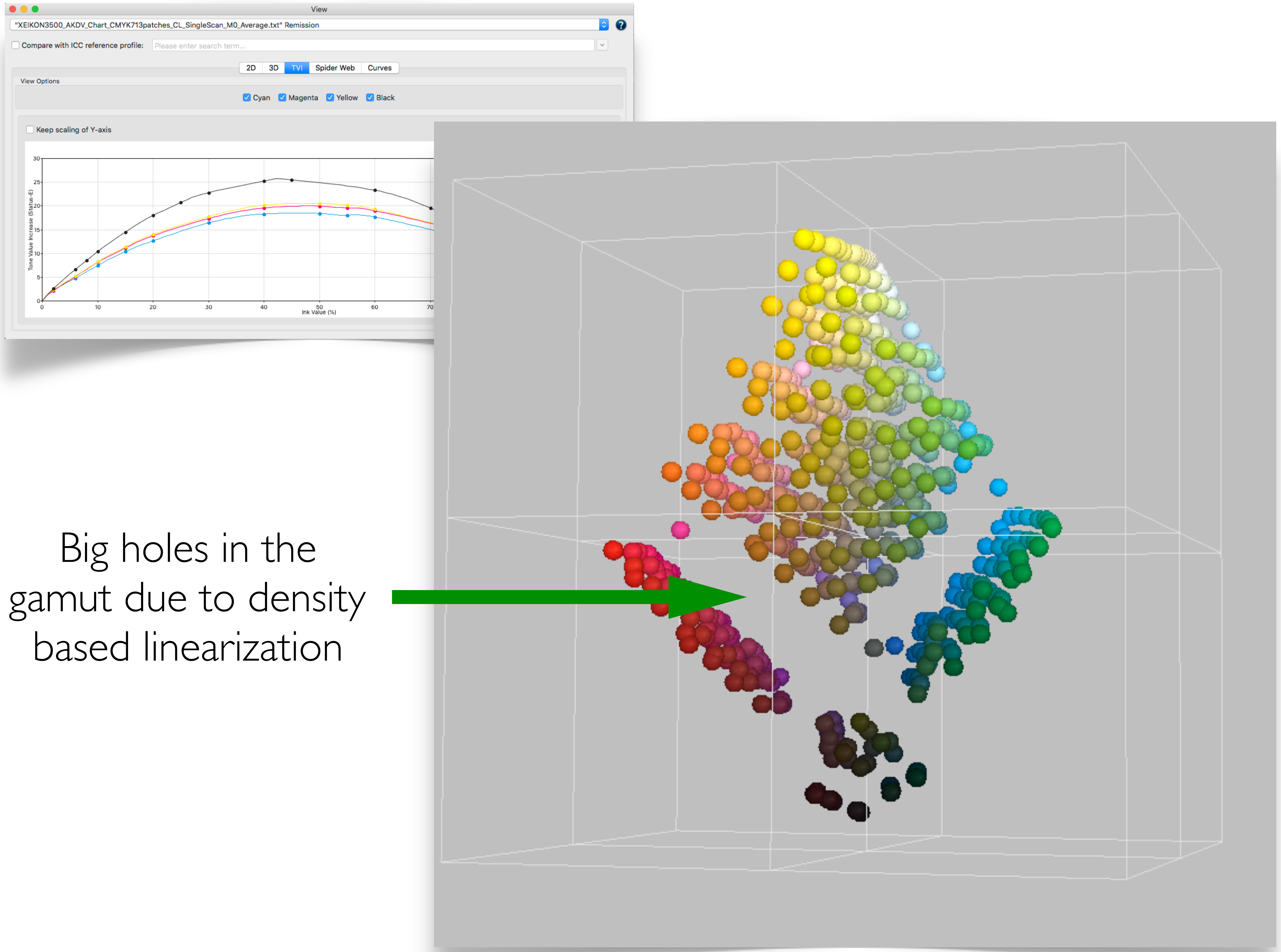
LINEARIZING

- Colorimetric linearizing (ISO 20654 - SCTV) is much better suited for ink jets than density based methods



LINEARIZING

Colorimetric linearizing (ISO 20654 - SCTV) is much better suited for ink jets than density based methods



Big holes in the gamut due to density based linearization

Color **Focused.** Technology **Driven.**

LINEARIZING

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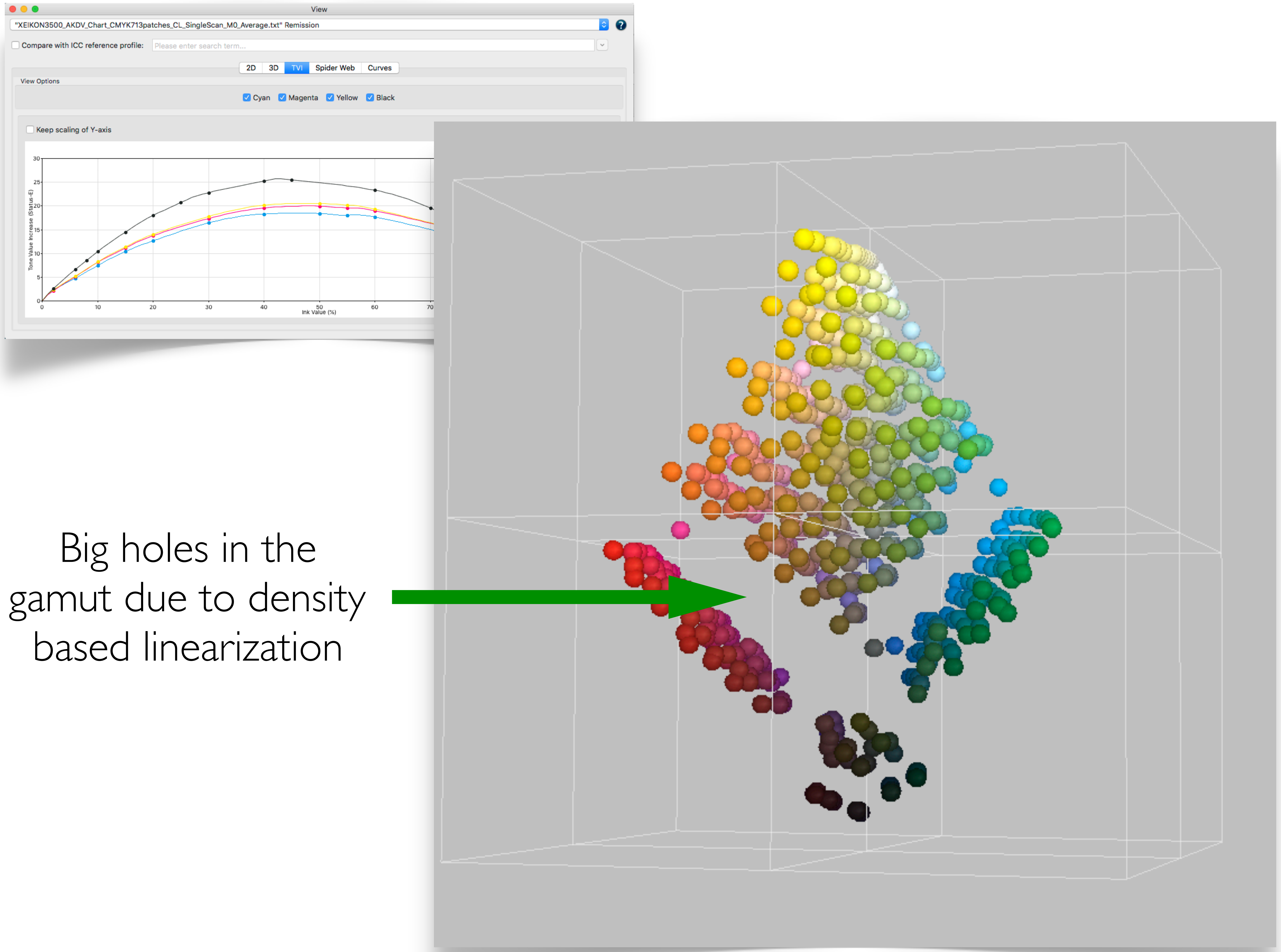
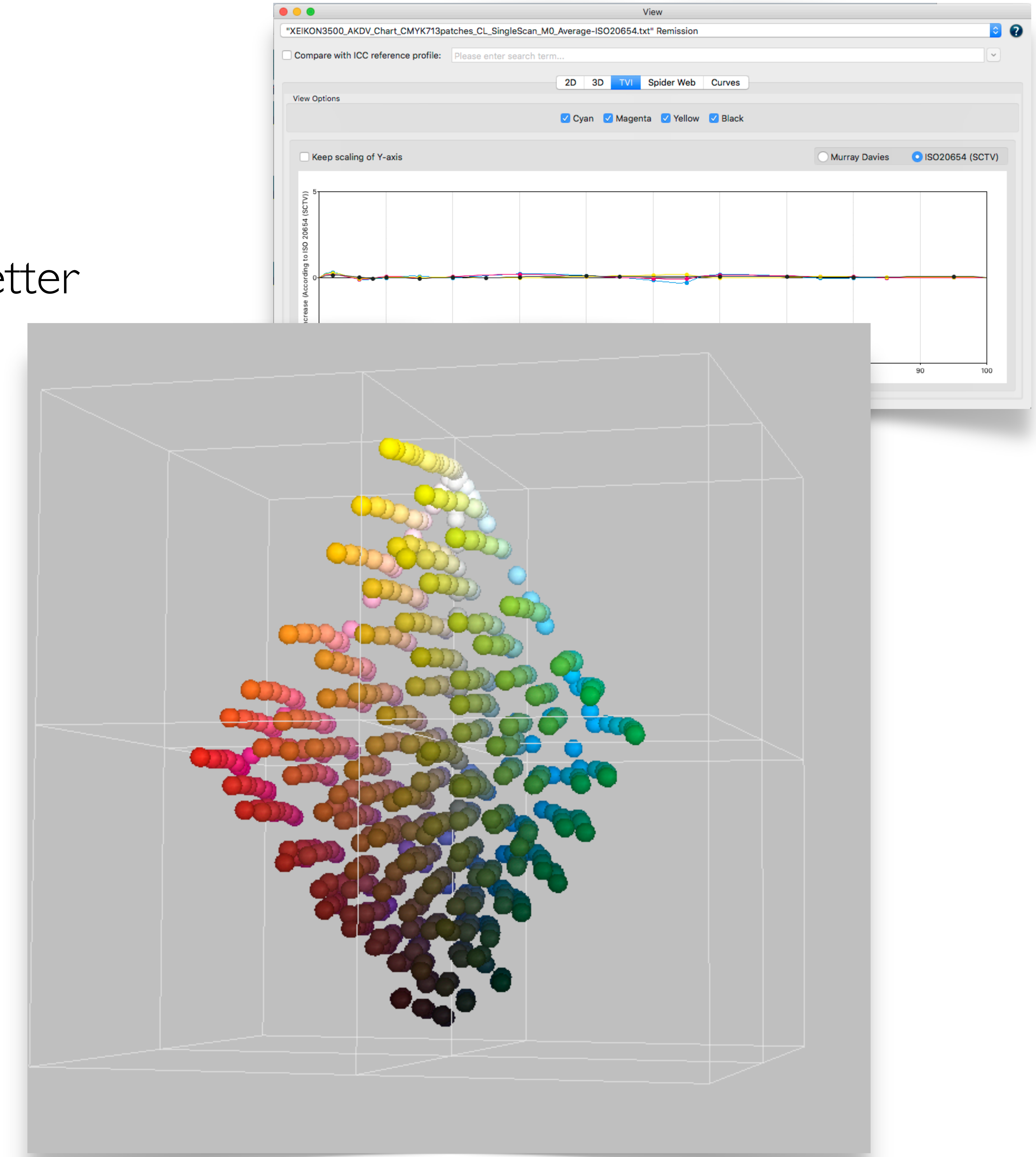
Big holes in the gamut due to density based linearization





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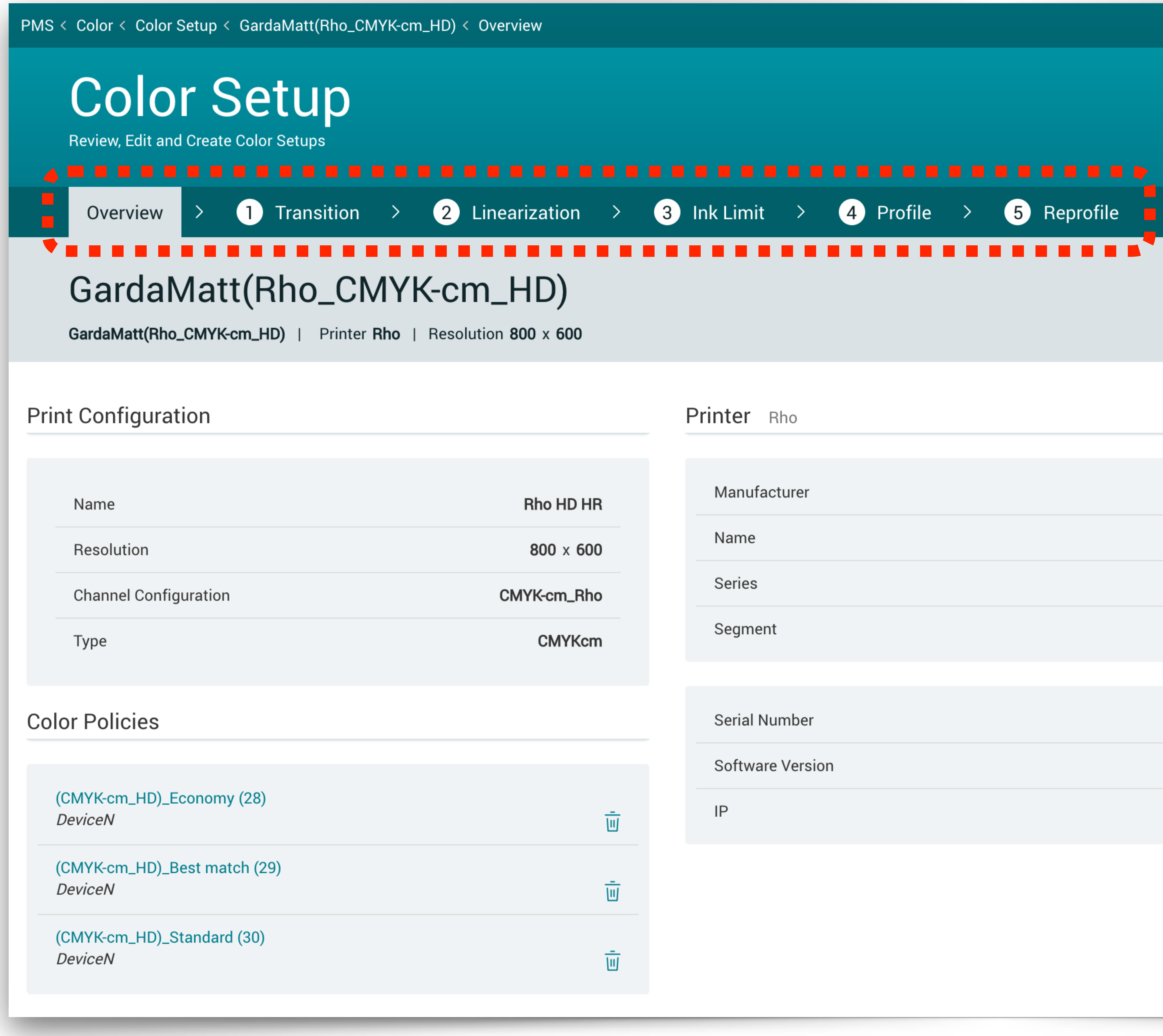
COMPLETE COLOR MANAGEMENT WORKFLOW

- This view shows the possible color management steps for <u>one</u> input color space
- Multiple input color spaces will typically be merged after step 3
- Many components are optional and may only be necessary for very high requirements
- Some steps (e.g. 9,10,11) may be conducted in a different order

Color **Focused.** Technology **Driven.**

OVERVIEW: DURST WORKFLOW*

- Calibration and profiling is done in a Wizard like user interface
- Transition/Linearizing – Ink Limiting – Profiling – Reprofiling
- Complexity is minimized with a straight forward user interface and logical steps
- Transition and linearization can be done in one or two steps
- The ColorLogic CMM combines all steps in one link table which improves speed and accuracy

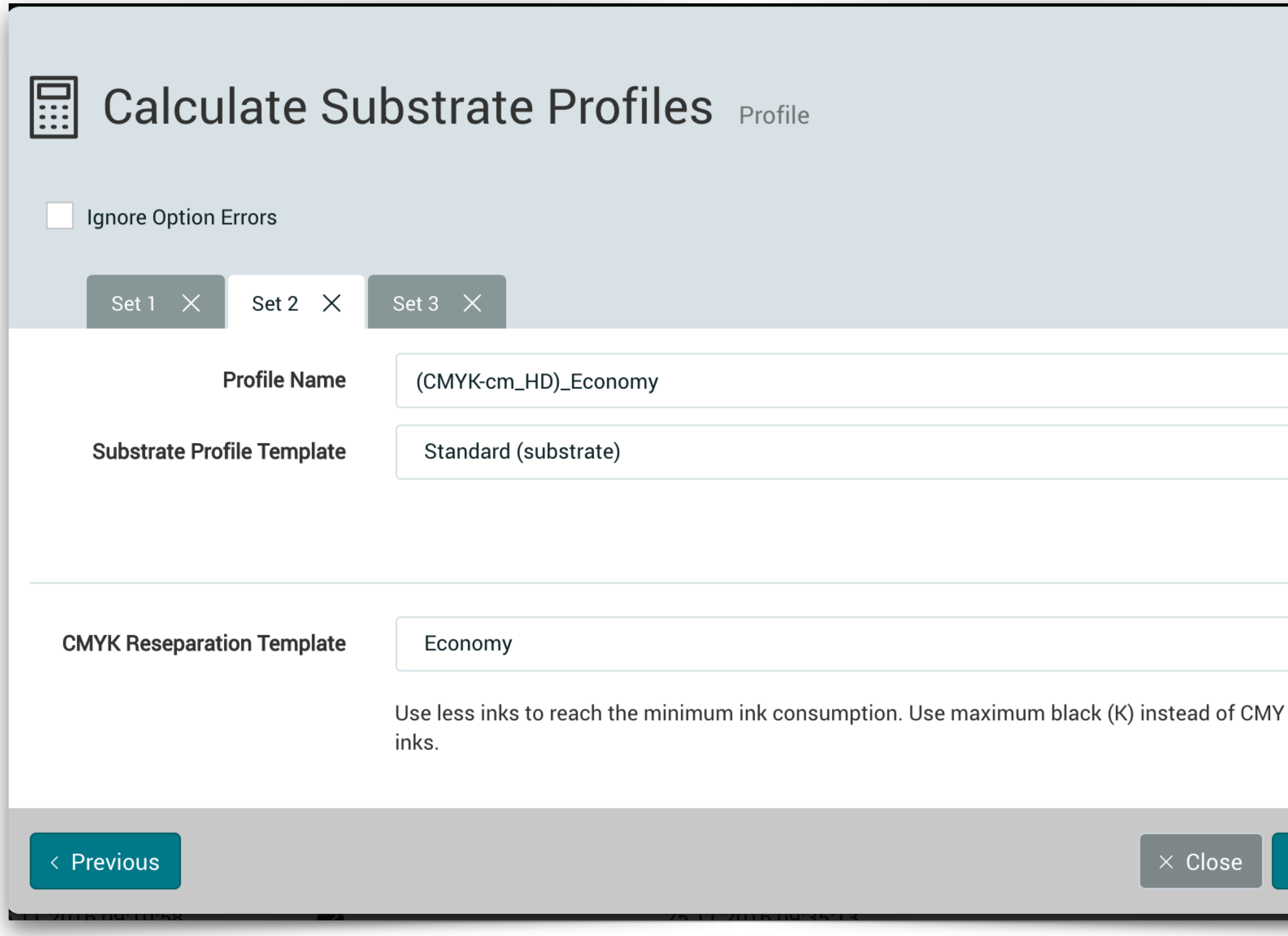


Color **Focused.** Technology **Driven.**

* The Durst Workflow is available for label, textile and corrugated applications

OVERVIEW: DURST WORKFLOW

- From one test chart measurement multiple profiles can be generated
- All calculations are based on spectral color data
- Ink Consumption: use the most beneficial ink amount and separations settings without scarifying spot color mapping
- CMYK or CMYK-OVG: use low priced ink sets for a job as the base inks are usually less expensive than additional inks
- Adjust the gray balance according to clients taste
- Manage the many possible profiles for a given workflow



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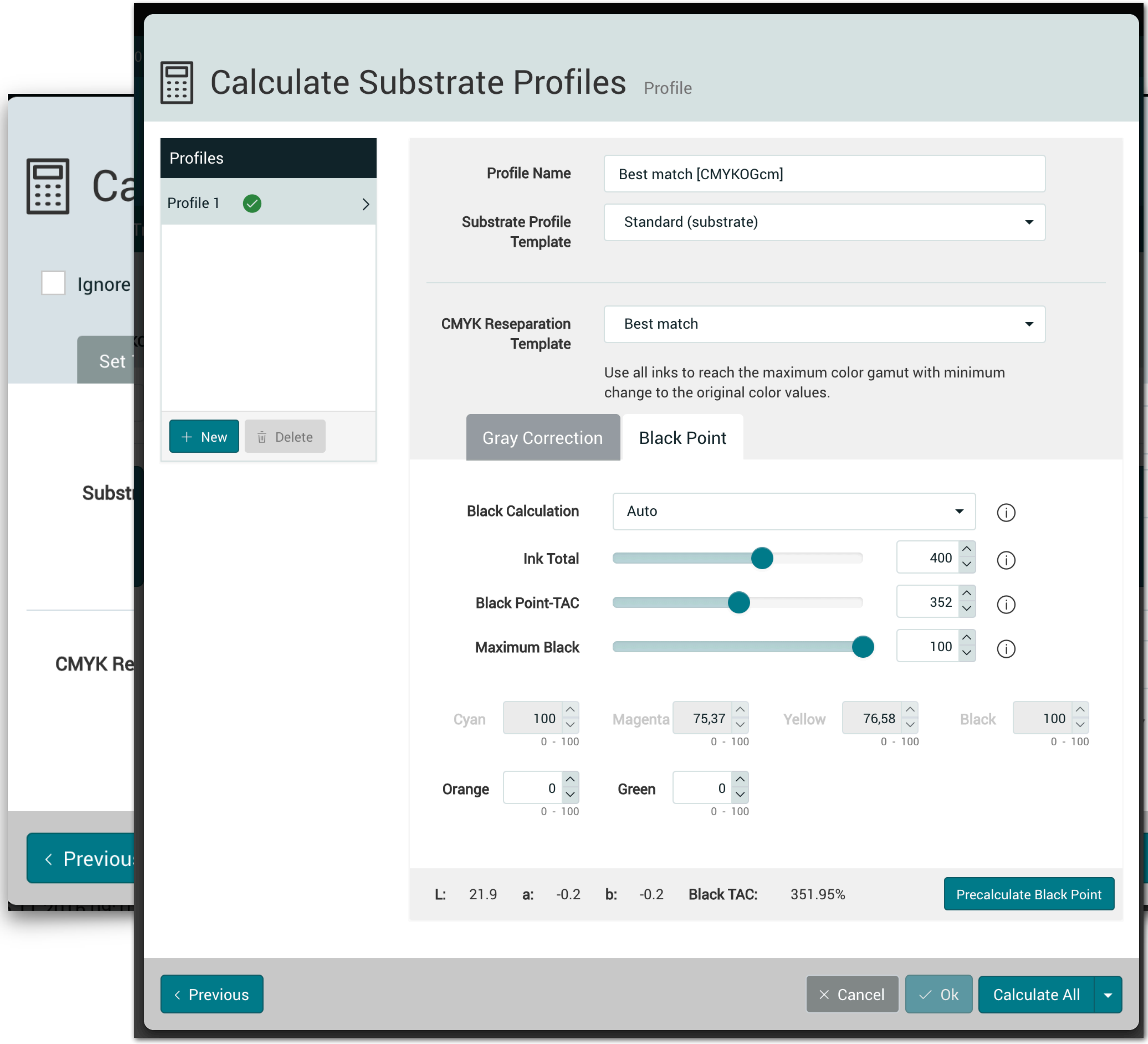

Color **Focused.** Technology **Driven.**

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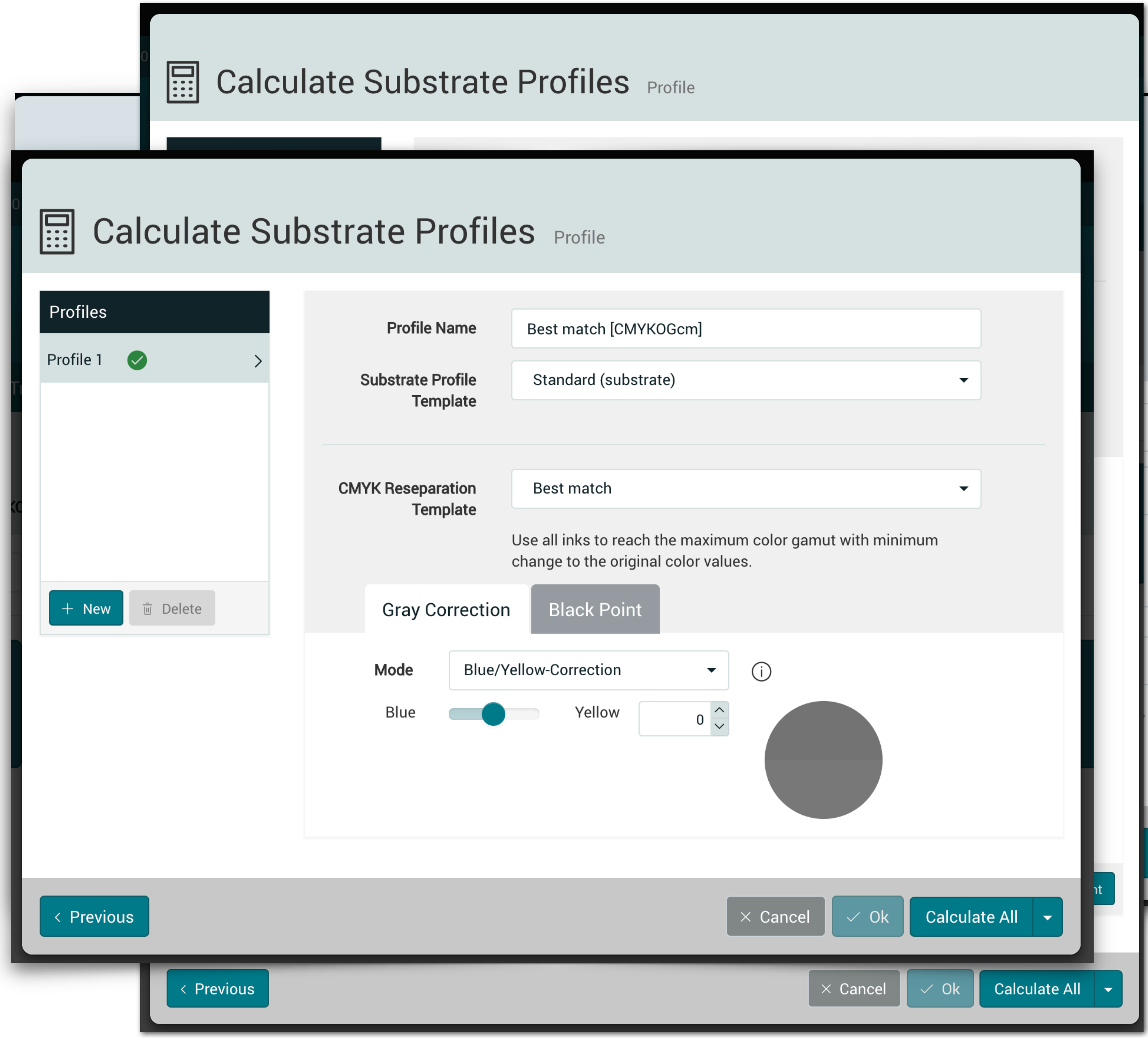
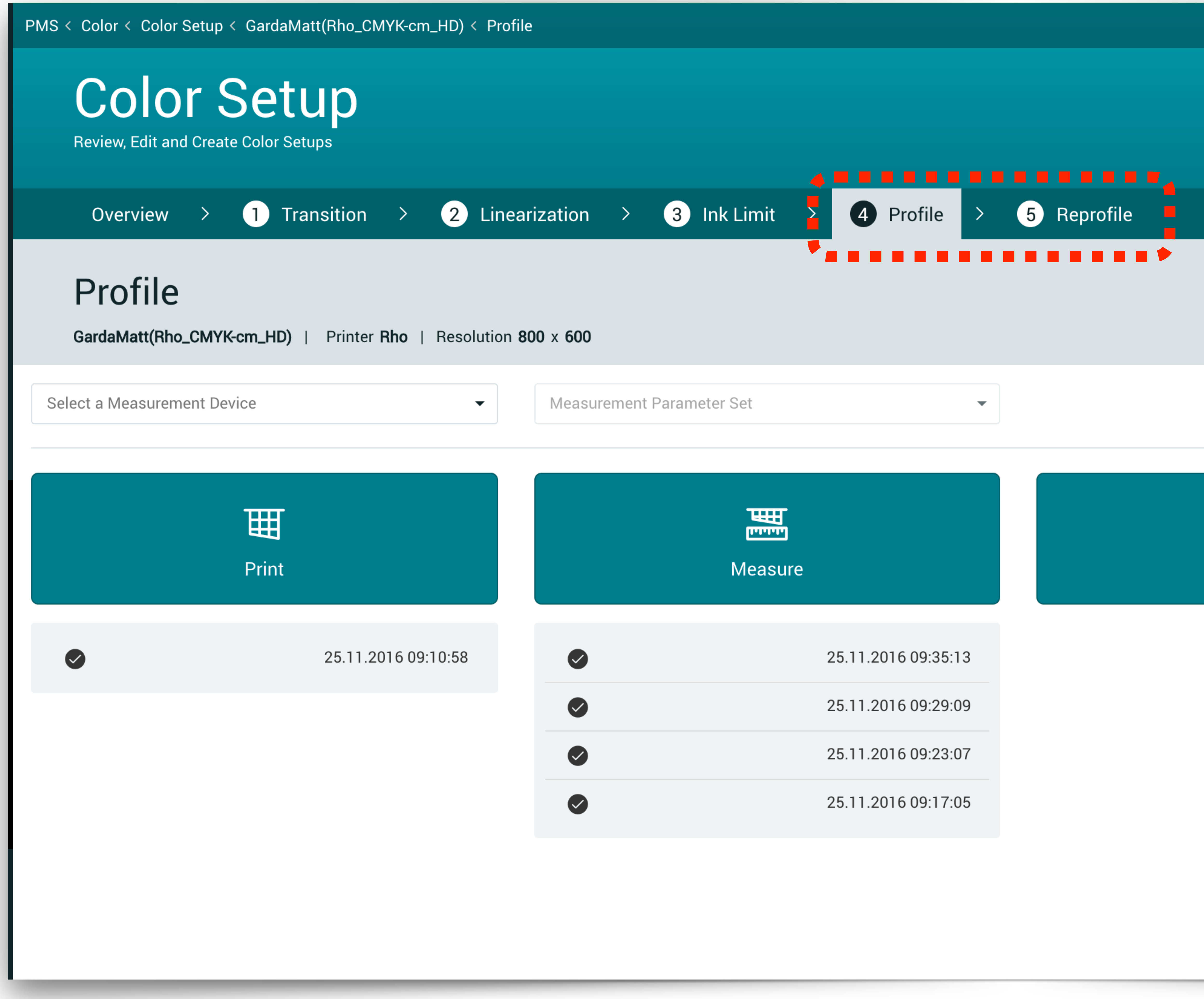


Color **Focused.** Technology **Driven.**

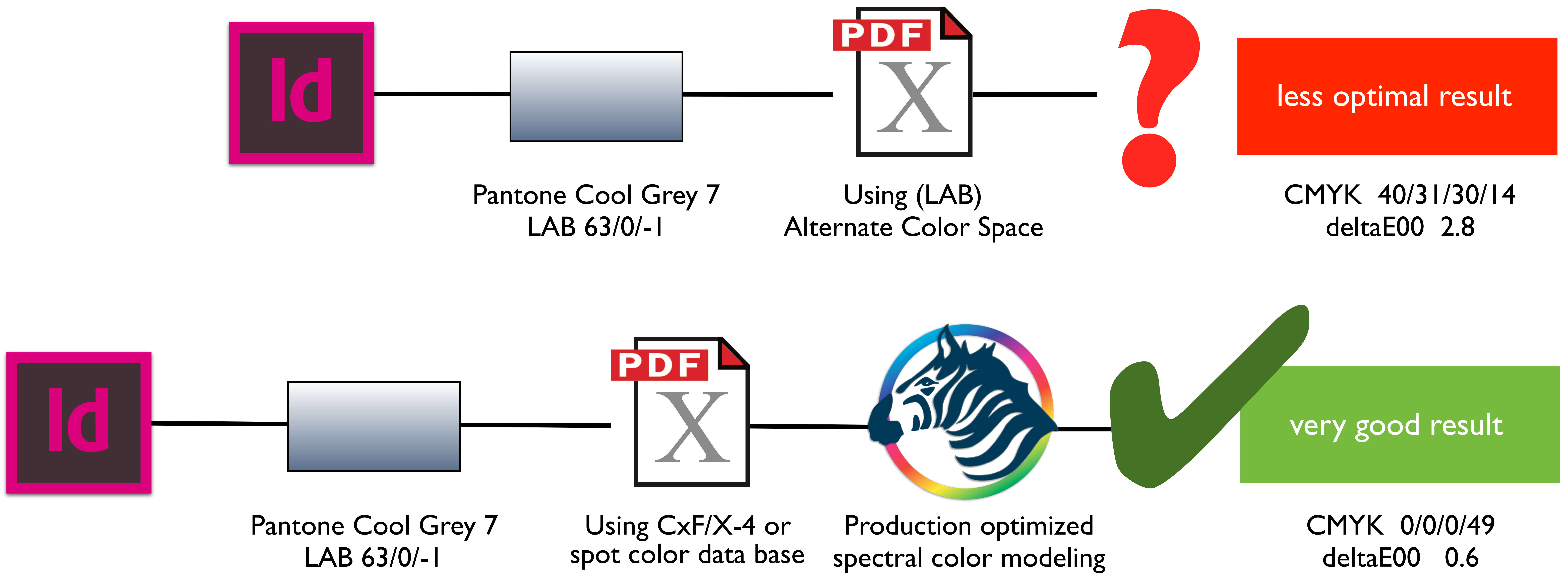
OVERVIEW: DURST WORKFLOW

- Reprofiling with Correction DeviceLink profiles
- Only a little color wedge needs to be printed to "record" the printer/paper deviations
- Allows matching reprints
- Provides more stability and simplifies process control



Color **Focused.** Technology **Driven.**

CONVERSION OF SPOT COLORS



Color **Focused.** Technology **Driven.**

COLORLOGIC TECHNOLOGY

"By using ColorLogic technology, all requirements could be resolved in a very flexible manner. Speed is important for us, but by combining all profiles in one color transformation loss in speed is a non-issue."

Hans Peter Schneeberger
CEO PrePress Digital

Dietmar Fuchs <dfuchs@colorlogic.de>

Color **Focused.** Technology **Driven.**

ICC Color Experts Day

May 24, 2019 Bressanone, Italy

Textile Color Management

Max Derhak
Principal Scientist, ONYX Graphics Inc.
Co-Chair, ICC

ICC

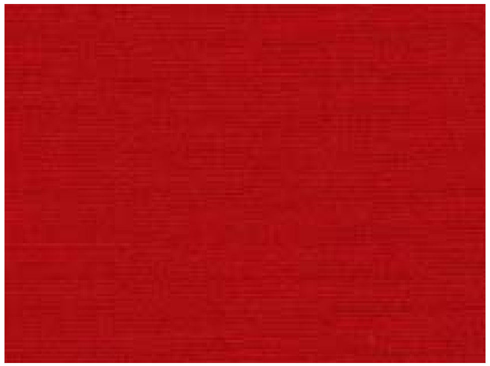
ONYX color

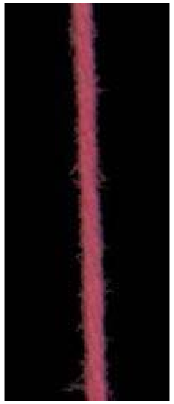
Colored Textiles

- Traditionally textiles are woven from colored threads
- Threads are formed from dyed fibers
- Patterns in textiles are formed by weaving multiple threads of different colors

Color management of threads

- Threads are woven into solid-color fabrics or thread windings
- Colors of solid-color fabrics or thread windings are measured by specialized color devices
- Experimentally Speaking - Woven fabric measurements can also be estimated from spectral image capture of individual threads (HKRITA)
- Dye recipes are often formulated by trial and error



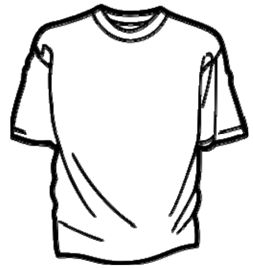


Textile Digital Printing Applications

- Apparel
- Interior décor
- Furniture
- Soft signage

Textile Printing Approaches

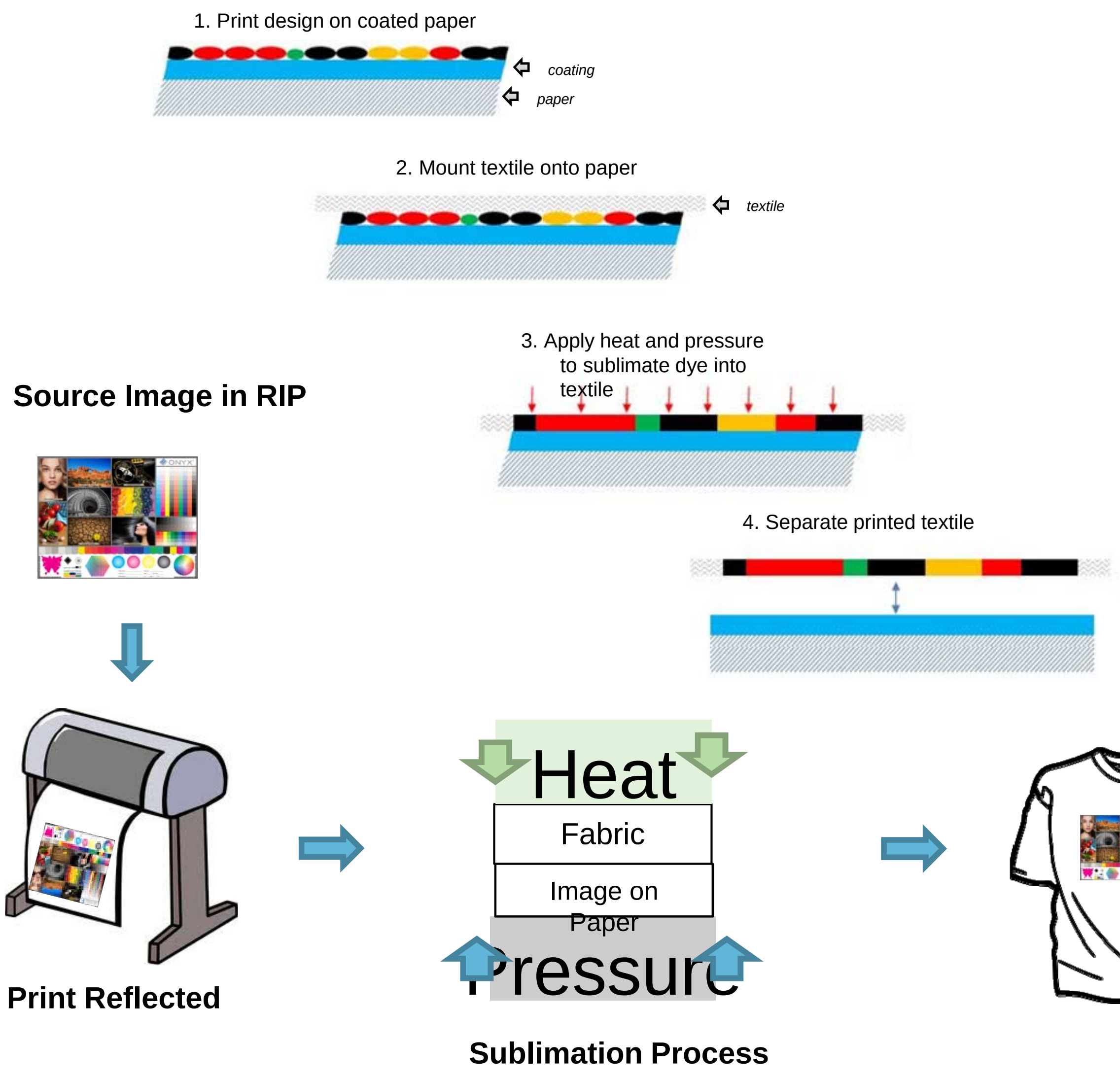
- **Direct Printing without Dye Sublimation**
  - Latex/UV/Hotmelt Printers
- **Direct Dye Printing**
  - Media treated to enable fixation
  - Media loaded into printer
  - Ink jetted onto media
  - Dye fixing process applied
- **Transfer Dye Sublimation**
  - Transfer media loaded into printer
  - Image printed reflected on transfer media
  - Image transferred to media with heat press

Issues:

- Ink adhesion (washing, rubbing)
- Color fastness (light)

Transfer Dye Sublimation Process

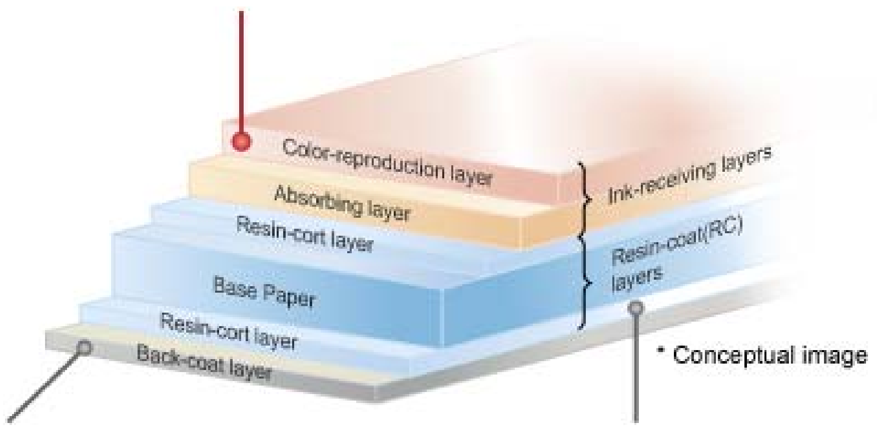


1. **Prepare source image in RIP**
2. **Print reflected on transfer paper with sublimation inks**
3. **Sublimate from paper to fabric**
   - Heated dye becomes gas and infuses into fabric fibers
   - Color of dyes on paper not the same as final color
   - Final output may change size due to heat

Colorant Surface Interactions

Coated Paper

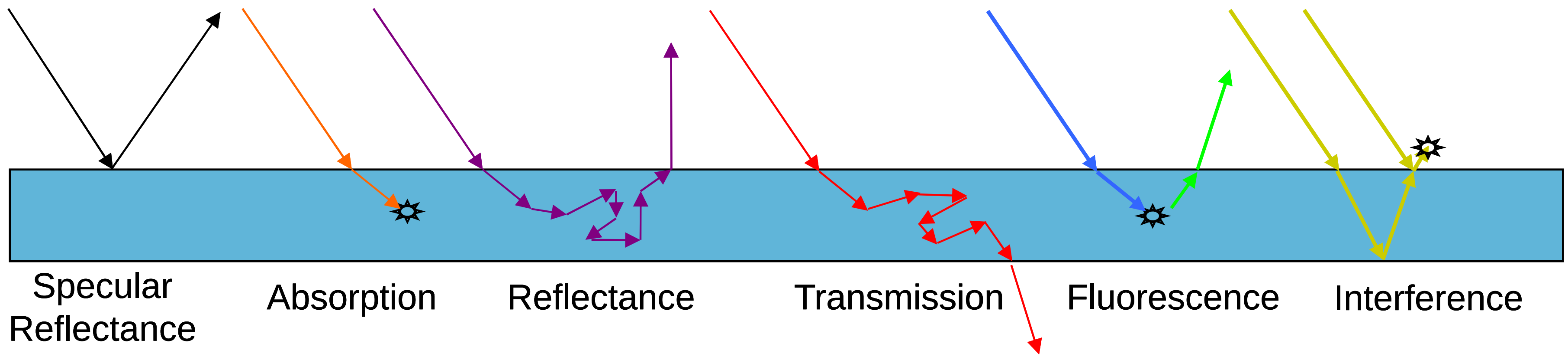
- Single “Flat” Surface
- Colorant Absorbs into Media



Textile

- Lots of Rounded Surfaces
- Uneven application of colorant

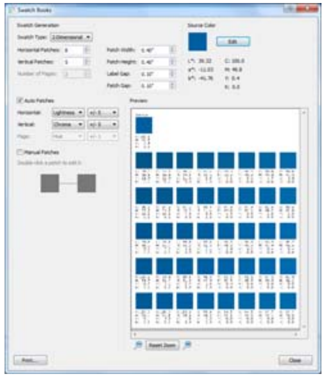
Light-Surface Interactions



How a photon interacts with a surface is dependent on its wavelength and the surface characteristics

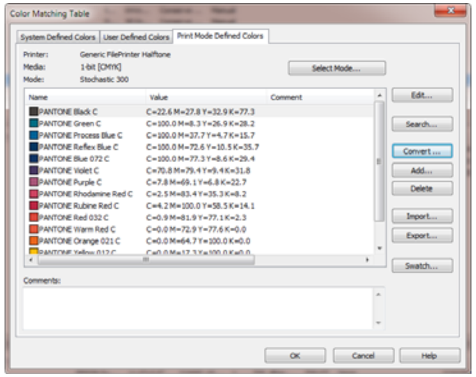
Results in challenges for measurement of printed textiles to correspond to visual appearance

Managing Color

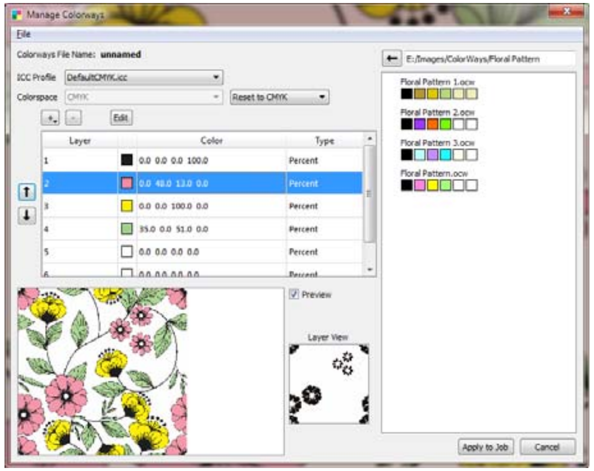


ONYX Swatch Book Tool

ONYX Named Color Setup



ONYX Colorways Configuration

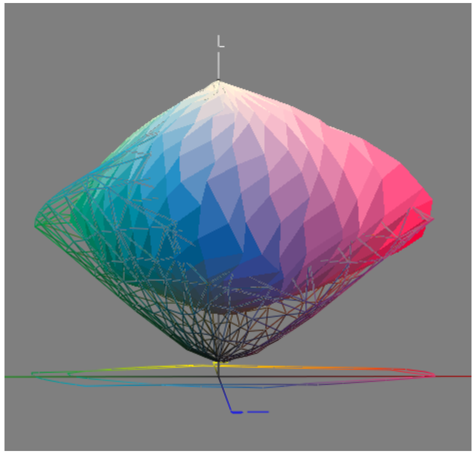


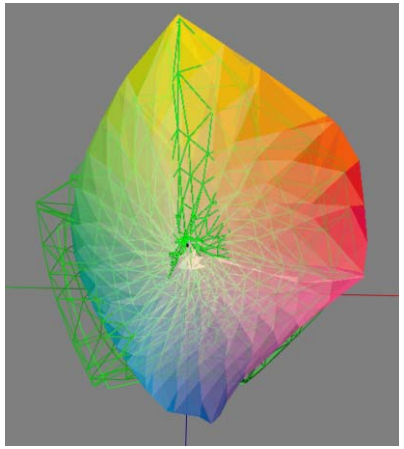
- **Manual**
  - — Print color swatches and use color recipes in design applications
  - — Use Named Spot Colors with device based color replacement
  - — Setup and use device color based Colorways palettes in RIP
- **Automated**
  - — Profile Media and Print Mode
  - — Use ICC Color Management

Textile Gamut Differences

- **Good gamut coverage of bright/ saturated yellow, orange, red, magenta, and blues**
- **Limits to dyes**
  — Magenta is more of a red
  — Cyan is more of a blue
- **Results in loss of green and violet portions of gamut**
  — Additional inks may be required to achieve these kinds of colors
- **Cannot get very dark**
  — Black Ink Issues
    – Black often formed by mixing Cyan, Magenta, Yellow dyes
  — Fibers of fabric scatter light resulting in lower densities

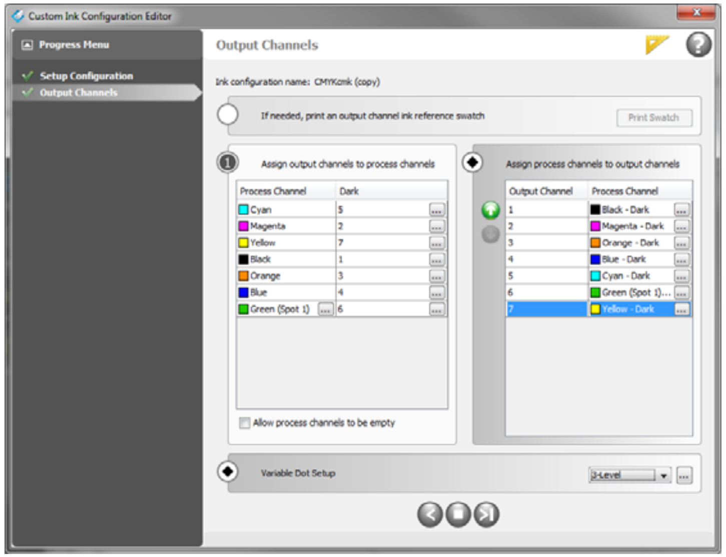
Offset gamut – wireframe
Dye sub transfer gamut - solid





Ink Channel Selection

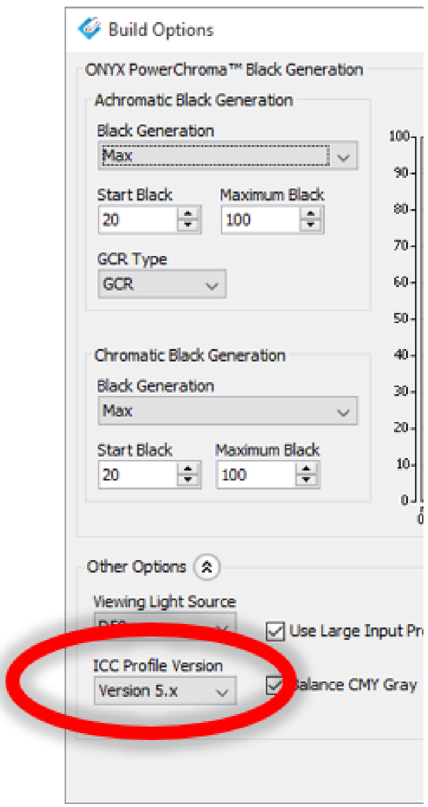
- **To get larger gamuts you may need to use additional inks**
  - —As supported by the print device
- **Software should be configured to correspond to inks in printer**
- **Support for color profiling of custom ink configurations is required**



ONYX Custom Ink Setup

Potential for using iccMAX with textile?

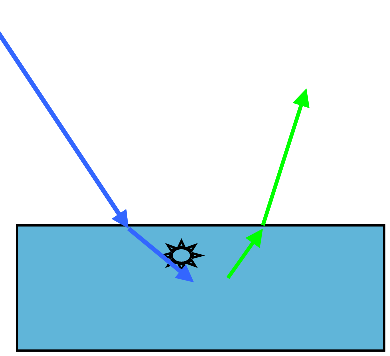
- **iccMAX provides a flexible and extensible platform for modeling and defining color workflows**
  - Support for fluorescence based PCS
  - Support for custom illuminants
  - Support for modeling observing conditions
  - Extended “programmable” transform encoding
- **Advancements in color measurement technology are needed to take advantage of many iccMAX possibilities**
- **Implementation of iccMAX functionality that takes advantage of these features is yet to be seen**



ONYX Profile Build Options

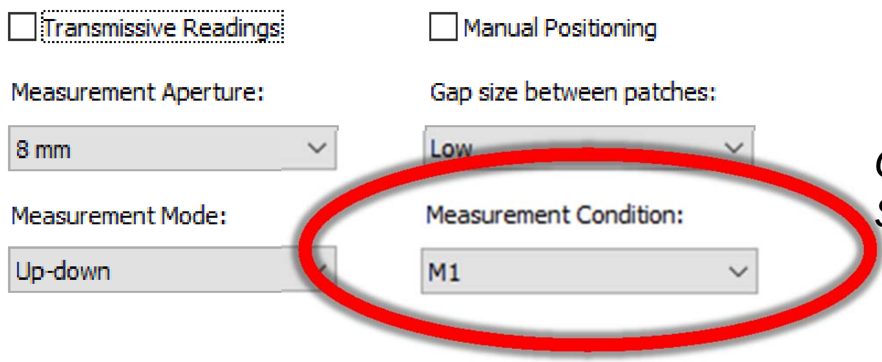
Textile Profiling Issues and Tips Part 1

- **Fabrics can have optical brighteners**
  - This results in false reading of blue light resulting in addition of yellow in final output
- **Dyes can Fluoresce**
  - Get really bright saturated colors
  - Results in very unreliable measurements



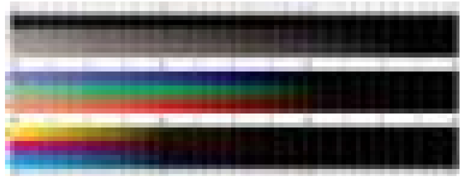
Fluorescence

- **Tip: Use M1 (part 1) measurements or manual color management**

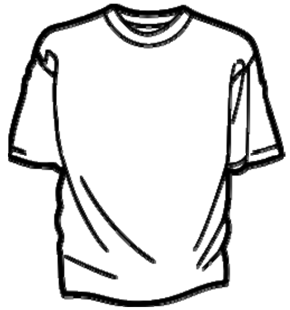


ONYX Color Device Setup

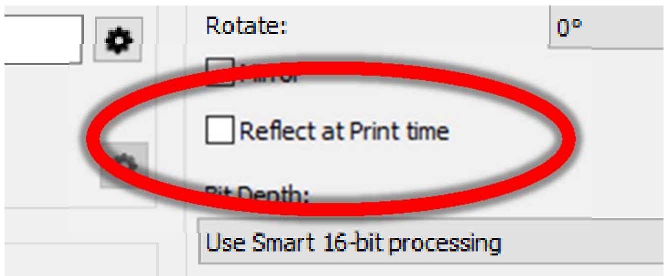
Textile Profiling Issues and Tips Part 2



- **Color changes due to sublimation**
  - Measure all color from final sublimated output
  - Process control of sublimation process is critical
  - Dyes result in different gamut shape
    - Black ink is actually a combination of CMY
  - Print with as much ink as possible to get richest blacks

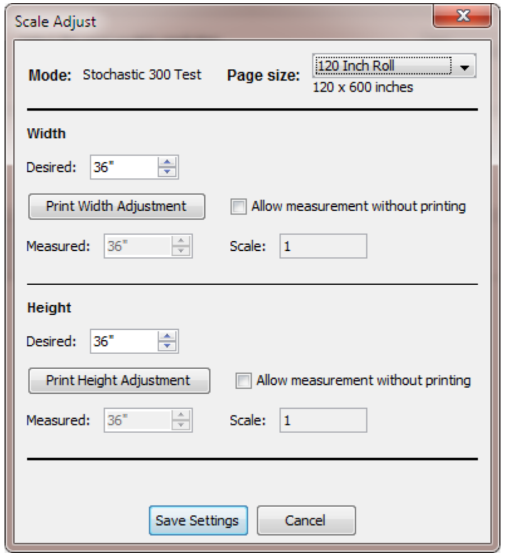


- **Things get reversed with transfer printing**
  - Set up your workflow for printing your final images reflected
  - Make sure color management swatches are also printed reflected



ONYX Quickset Setup

Textile Profiling Issues and Tips Part 3

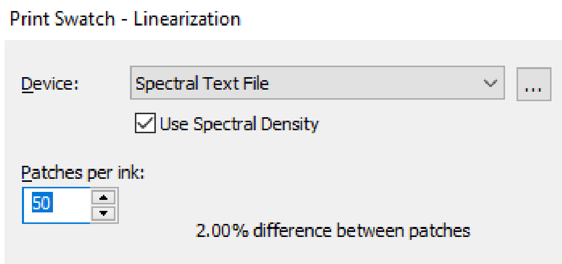


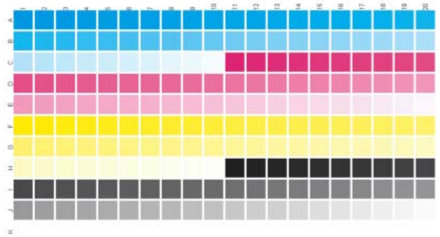
ONYX Print Mode Adjustment

- **Weave directionality causes variability in the measurements**
  - Tip: Print two swatches with second swatch rotated 90° from first swatch
    - Measure first and second swatch with averaging for single reading for each patch
  - Use M3 measurement mode (with polarizing filter) to reduce impact of measurement light source
- **Fabric shrinks or stretches**
  - Tip: Use resolution adjustment to compensate for shrinking / stretching

Textile Profiling Issues and Tips Part 4

- **Consider the number of patches when performing tone calibration**
  - More patches may reduce severity of spikes with measurements
    - The transition from zero to full color is very sharp
    - Sublimation is a very NON-linear process
  - Less patches avoids characterizing measurement noise





ONYX Linearization Print Swatch Dialog

Conclusions

- **Textile printing offers many opportunities**
- **Textile surface, media, and inks provide challenges to getting measurements of color that correspond to actual perception of color**
- **Managing color on textile has its challenges**
  - Manual approaches can work really well
  - Automated approaches are nearly the same as printing on conventional media when differences are accounted for
- **Important concepts:**
  - Getting good measurements, implementing process control, and using production workflow and color management software that you can trust

ONYX color

Thank You!

Challenge in real world color management for textile printing workflows

Marco Roos
CEO – Color Concepts

ICC Color Expert Day – Brixen May 2019

COLOR CONCEPTS
raising your standards

ColorBase™

“Real world color management”

- The owner of the print shop believes they’re the best
- The pre-press operator thinks it is a mess
- The printer operator is scared
- The most common color management system is yellow…..and self adhesive……

Different applications – different goals

- Digital textile printing can roughly be divided into three segments:
  - Soft signage (flags, signs, decoration)
  - Sportswear
  - Fashion and home decoration
- Each of the segments handle color requirements differently
  - Soft signage → same goals as we know from mainstream printing methods. Corporate identity and accurate color is key
  - Sportswear → similar to soft signage, with often an emphasis on "effect" colors
  - Fashion and home decoration → what the designer approves

Highlighted: Fashion and home deco textile

- The top three problems you might face when walking into an existing workflow:
  - The colors are approved by a designer and often based on taste
  - The printers are often not profiled correctly, creating huge delta E's between design and output
  - Different batches of textiles cause different color perceptions

Reference vs technically correct output

Printed using the properly profiled printer

Printed using the current printer and workflow

Measuring color vs perception

- Textile is a complex material due to it's surface structure and the (often) excessive use of OBA's
- Different production batches use the same material or yarn, but often show slight differences in appearance → causing different perceptions
- Color matching between different textiles always results in a trade off
- Spectral technology, appearance measurements and device link technology are all existing but not available in most workflow software used by textile printing companies → lots of manual labor and matching involved

Challenges

- The most common solution would be to use DeviceLink profiling technology to simulate the (incorrect) reference printer
  - Not many RIP software solutions in this field supports device link
- The printing and measuring process is time consuming:
  - Printing onto paper → sublimating onto fabric → measuring and adjusting → printing onto paper again etc. etc. (although HP is taking big steps here…)
  - Average profile creation process takes 3 hours
- Not many printing companies own proper measurement equipment

Introduction of “real” color management

- 40% of the challenge is psychological
  - ”we are great already”
  - “our customers are happy”
  - but…….what they’re really saying is: “we hate change”
- 40% is economical
  - Education and training is lacking, catching up will take time and money
  - Profiling and setting up workflows cause downtime in production
  - Measurement equipment, software tools are expensive in the hands of inexperienced operators
- 20% is technical
  - Difficulties in measuring, calculating and matching colors due to textile properties

Questions?

RIP SOLUTIONS FOR FUNCTIONAL & DECORATIVE APPLICATIONS

ICC EXPERT'S DAY 2019

CALDERA

SUMMARY

- STORY
- MARKETS
- APPLICATIONS
- CHALLENGES
- SOLUTIONS

STORY

FUNCTIONAL AND DECORATIVE

ALL COMES FROM INKS

- CMYK
- Light Inks
- Spot Inks: Orange / Blue / Green
- Uncolored Inks: White / Varnish / Metallics
- Dimensing
- Behavior change: Temperature / UV / PH / Water
- Glowing and Phosphorescent
- Conductive and electroluminescence

DIMENSING

AUDI TT HACK

PACKAGING APPLICATION

MARKETS

FUNCTIONAL AND DECORATIVE

FUNCTIONAL AND DECORATIVE MARKET

$107.9-$123 BILLION BY 2020

$13.6 BILLION BY 2023 FOR PRINTED ELECTRONICS

AVERAGE CAGR OF 8.3% TO 2022

UNTIL 15% FOR PRINTED ELECTRONICS

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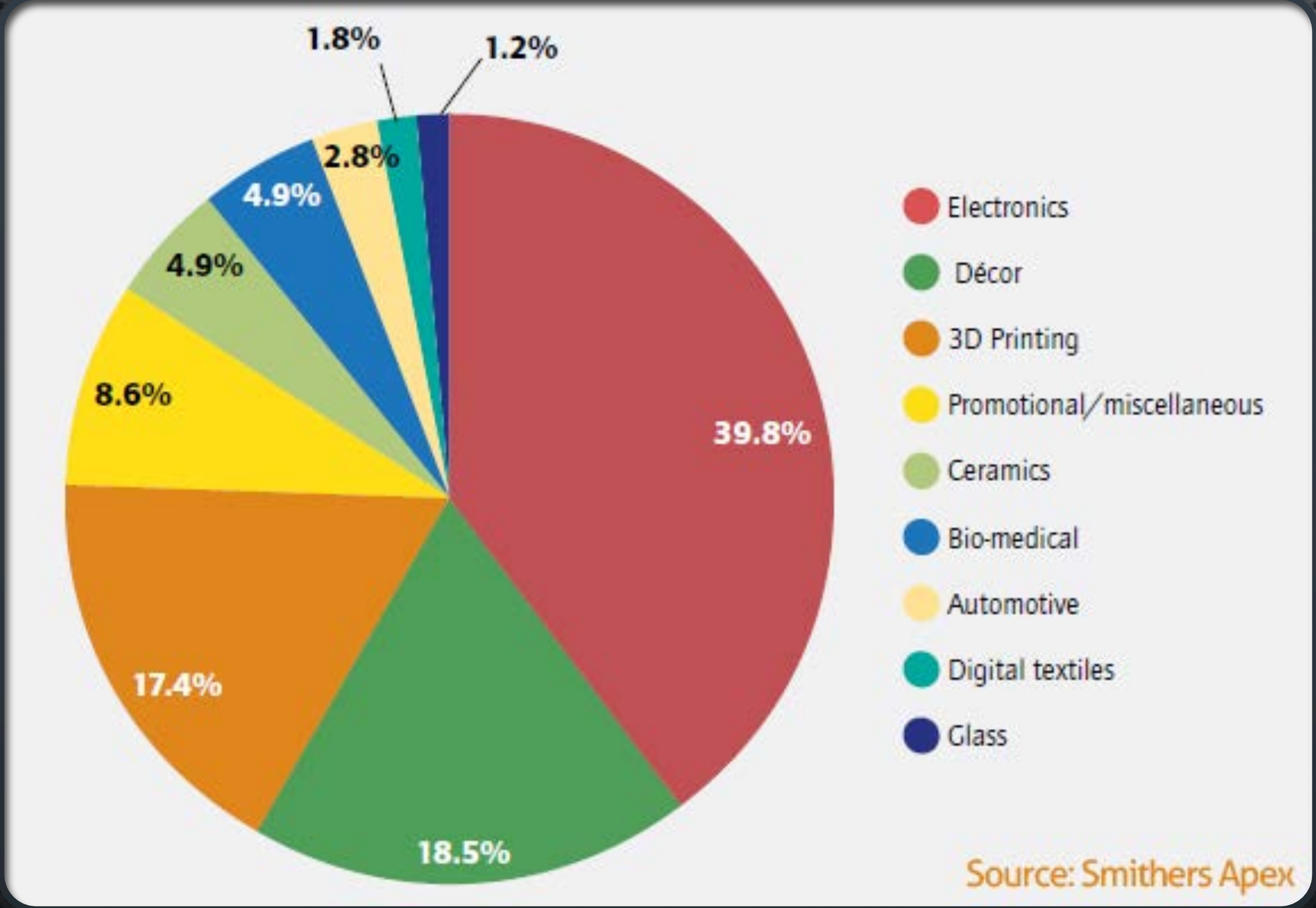

GLOBAL FUNCTIONAL INDUSTRIAL PRINT MARKET BY APPLICATION, 2020 ($ BILLION, CONSTANT VALUES)

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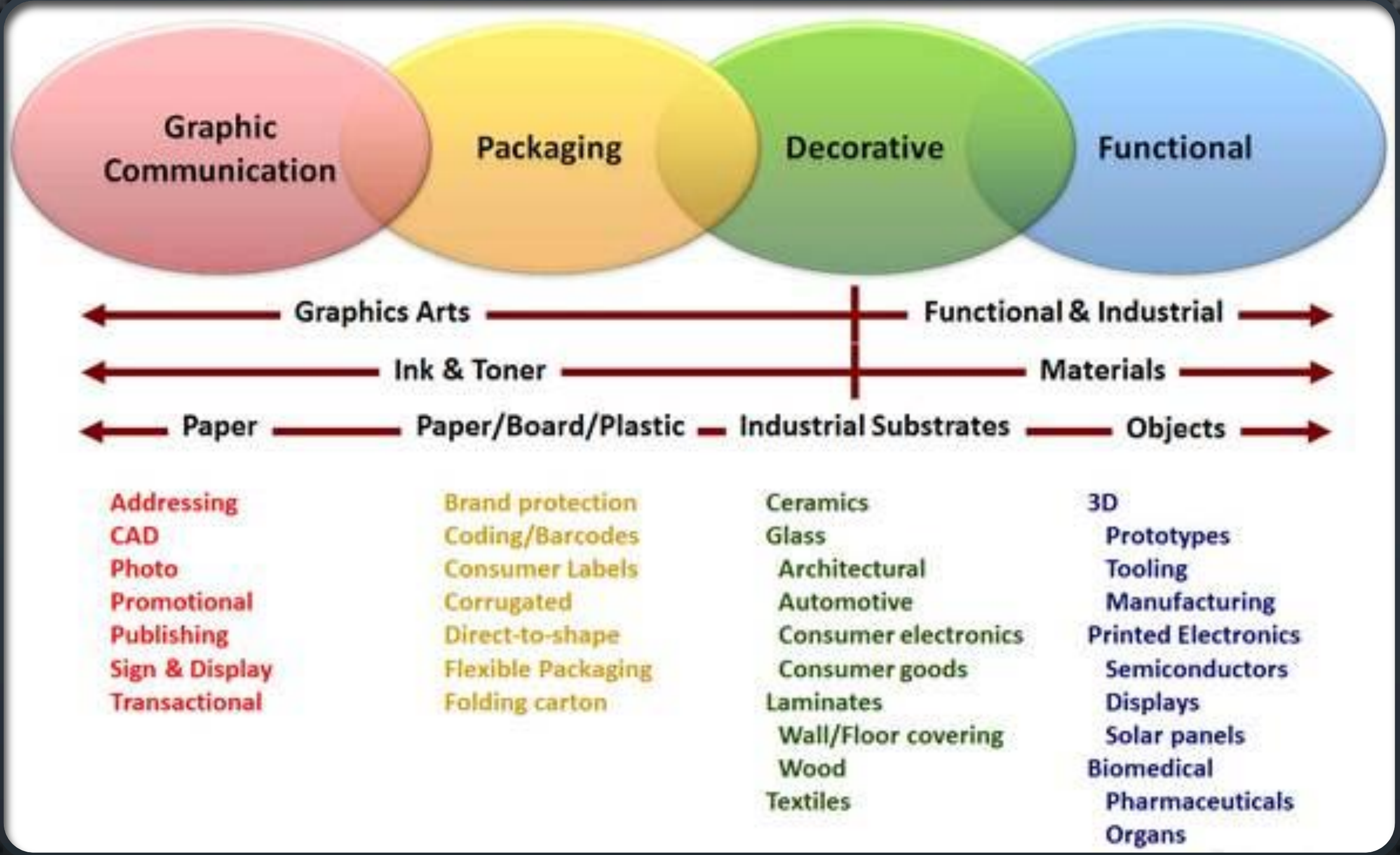
APPLICATIONS

Functional and Decorative



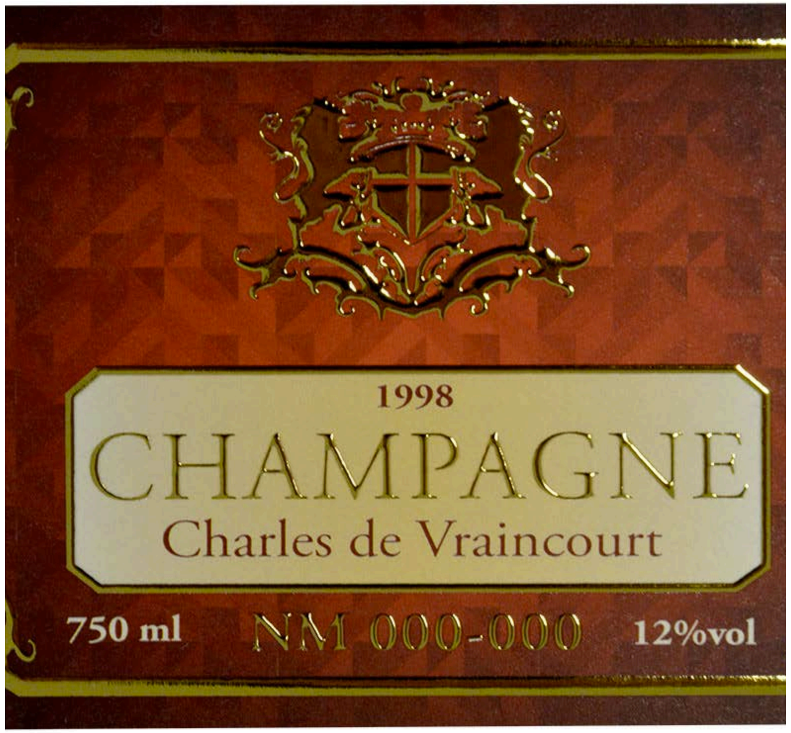
APPLICATIONS

INFOTRENDS - FIPS

CALDERA

PACKAGING / LABELS

- VARNISH
- GOLD

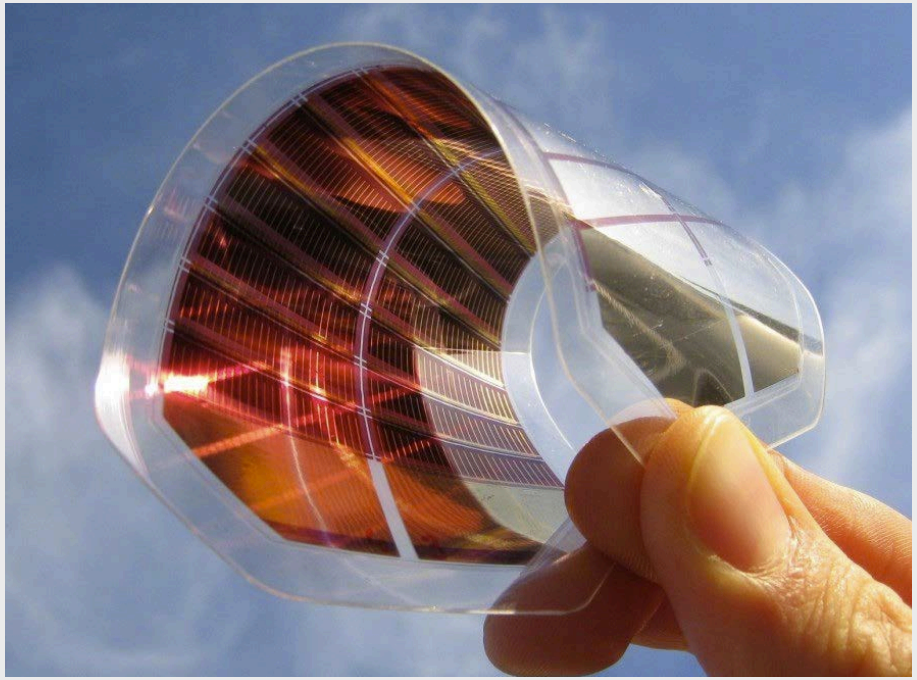


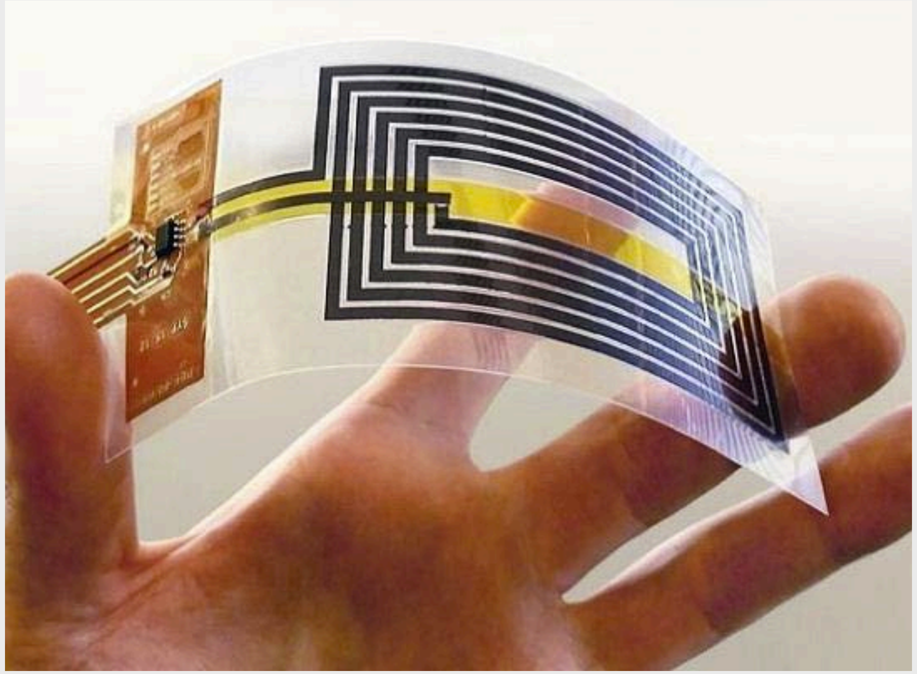
DECORATION

- Wallcoverings
- Canvases
- Wall Decals
- Window Covering
- Ceramics
- Textiles
- Laminates

FUNCTIONAL

- Energy Harvesting
- Wiring
- Energy Emitting
- Sensors





CHALLENGES

FUNCTIONAL AND DECORATIVE

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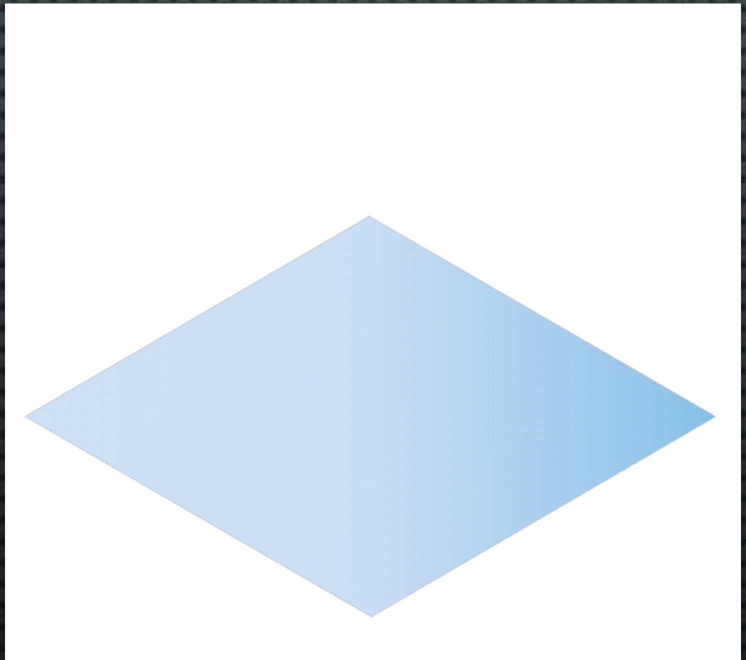
MULTI-LAYER



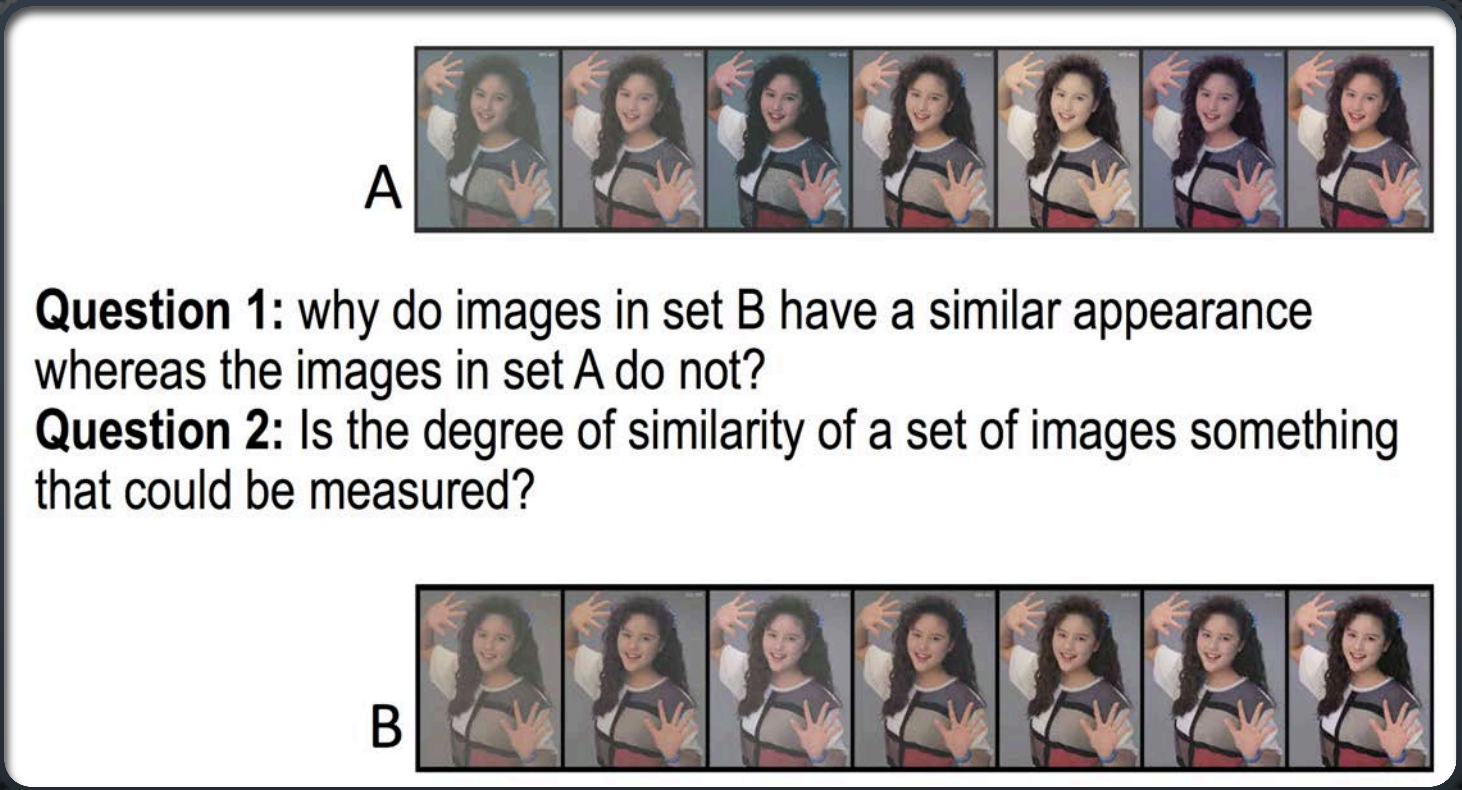
CALDERA

DAY

NIGHT

CALDERA

PRINT THE SAME EVERYWHERE



- FOGRA RESEARCH
  - COMMON APPEARANCE
  - SIDE-BY-SIDE

RIP SOLUTIONS

Functional and decorative

CALDERA

COLOR LAYERS

- Spectral – Accuracy
- Assumptions about Illuminant – Observer
- Media Color – Chromatic Adapatation
- RGB → LAB → CMYK – Flexibility
- CMYK → CMYK – Purity and Gradients

ICC Max – Accuracy

ICC v2-v4 PCS - D50/2°

ICC Colorimetric Intent – Chromatic Adapatation

ICC Device – Flexibility

ICC DeviceLink – Purity and Gradients

ICC LAYERS

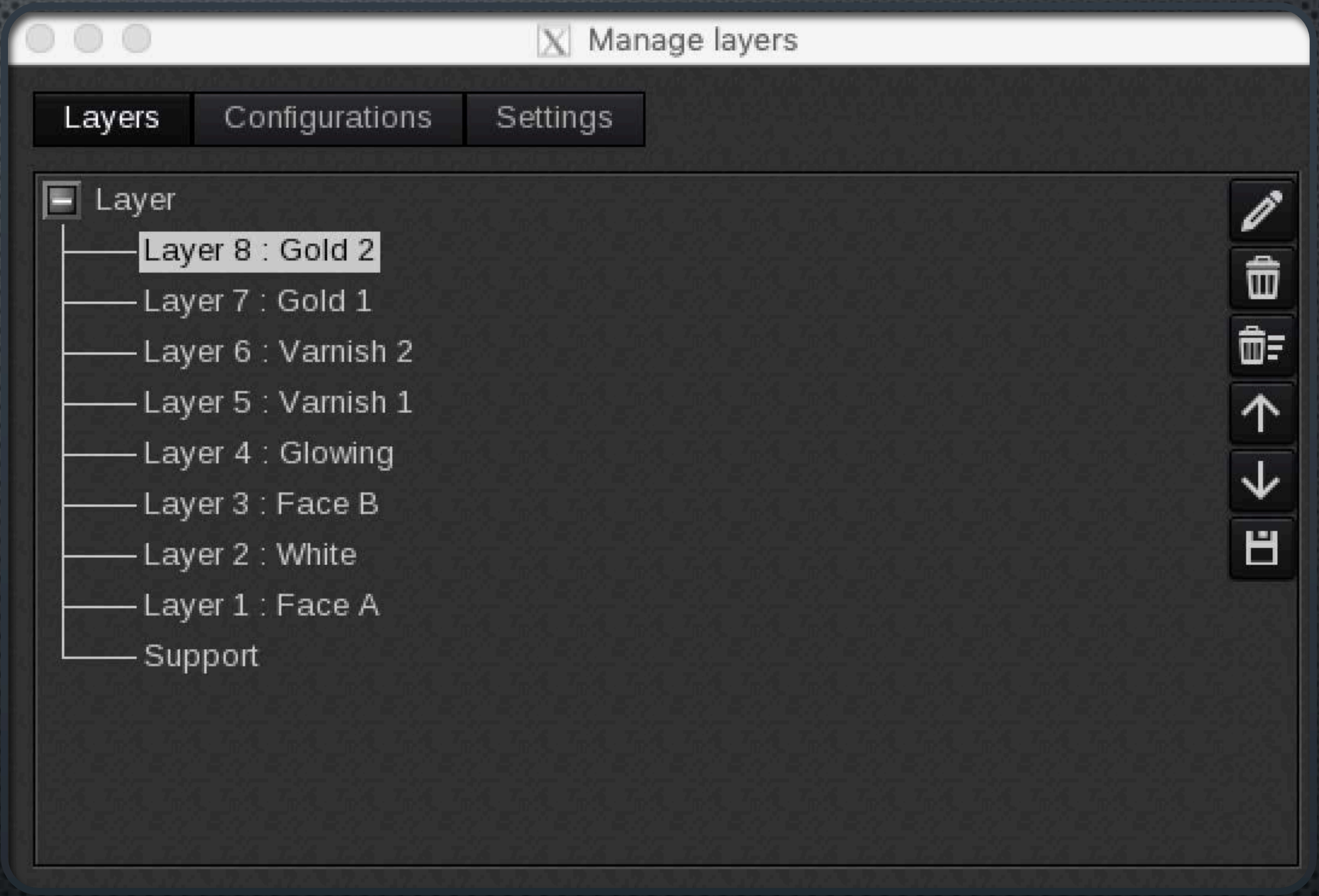
SPOT INKS VS. PROCESS INKS

Only Linearisation, not profiling	Calibration and Profiling
Prepare each Job	No preparation of Jobs
You can not measure	You can measure

EFFECTS OF MULTI-LAYER ON COLORS

Multi-Profiles

Multi-Jobs



CALDERA

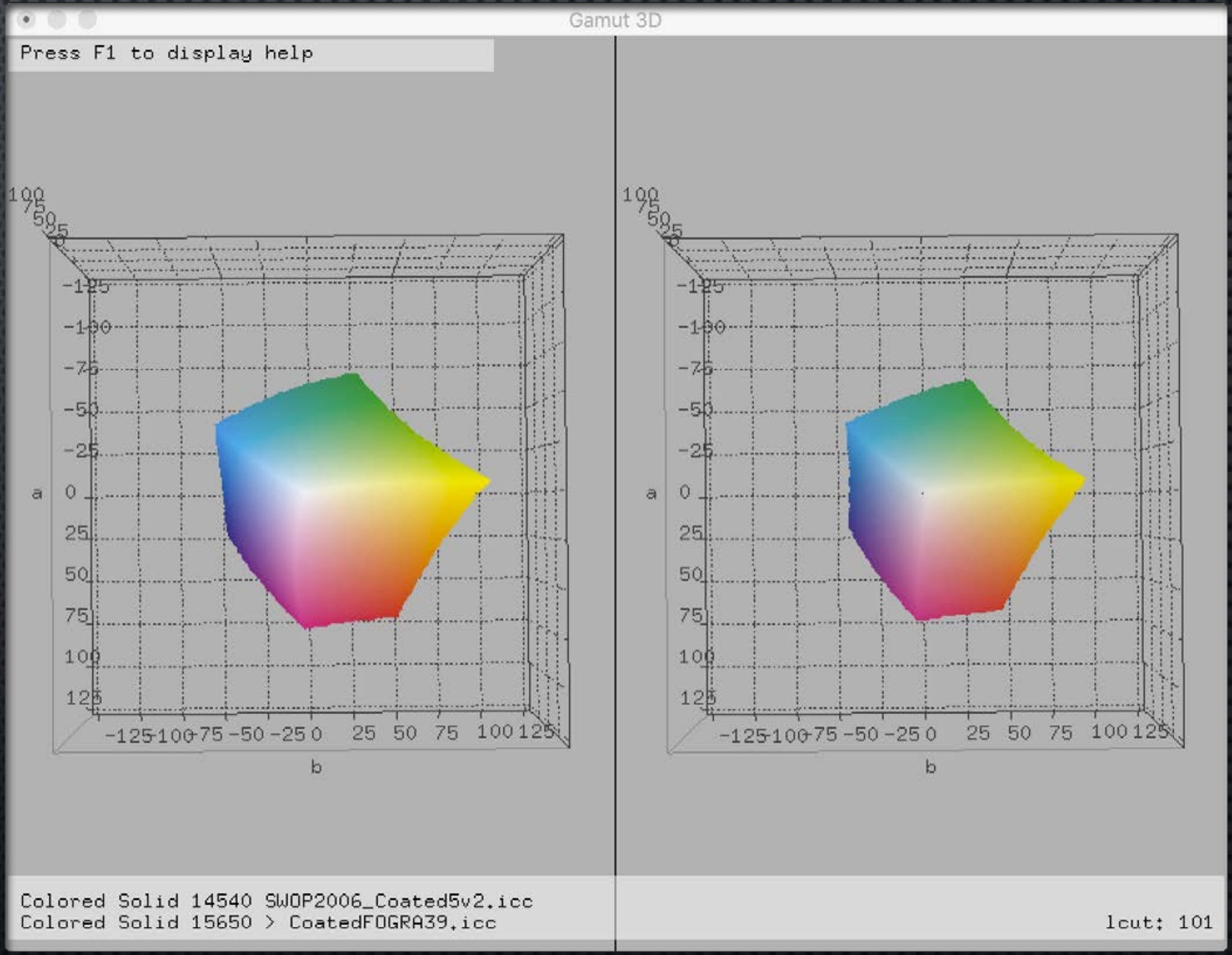
PRINT THE SAME EVERYWHERE EVERY TIME

UNICORN

COLOR SERVER

CLOSED LOOP

MACHINERY STABILITY



CALDERA

01

Linearization

=

Minimum property Activation

02

Ink Limit

=

Mixing Property Activation

03

Profiling

=

Behavior Prediction

04

Measuring Colors

=

Measuring Properties

COLORS / PROPERTIES ANALOGY

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QUESTIONS ?

SOURCES

- HTTPS://WWW.SMITHERSAPEX.COM/NEWS/2016/OCTOBER/FUNCTIONAL-INDUSTRIAL-PRINT-MARKET-FORECAST
- HTTPS://WWW.SMITHERSPIRA.COM/NEWS/2017/AUGUST/FUNCTIONAL-AND-INDUSTRIAL-PRINT-MARKET-GROWTH
- HTTPS://AFIP2019.ORG/NEWS/44-WHAT-IS-FUNCTIONAL-PRINTING
- HTTPS://WWW.SMITHERSPIRA.COM/INDUSTRY-MARKET-REPORTS/PRINTING/FUNCTIONAL-AND-INDUSTRIAL-PRINT-TO-2022
- HTTP://WWW.INFOTRENDS.COM/PUBLIC/CONTENT/SERVICES/FIPS/FIPS.HTML
- HTTPS://BLOG.DRUPA.COM/EN/FUNCTIONAL-AND-INDUSTRIAL-PRINTING-MARKET-TO-GROW-BY-ALMOST-50-PERCENT-2/
- HTTP://CIRCUITCELLAR.COM/TECH-THE-FUTURE/THE-FUTURE-OF-INKJET-PRINTED-ELECTRONICS/
- HTTPS://WWW.MARKETSANDMARKETS.COM/MARKET-REPORTS/PRINTED-ELECTRONICS-MARKET-197.HTML

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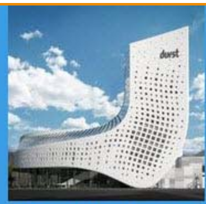
ICC COLOR EXPERTS DAY
MAY 24, 2019

Colour Management for
Wider-Format Printing
on Non-Paper
Substrates

Hosted by Barbieri Electronic



HQ Durst Phototechnik AG
Bressanone, Italy

COLOUR MANAGEMENT FOR BACKLIT APPLICATIONS

Mission:
Printing the Expected Backlit

Highlights

For later reading

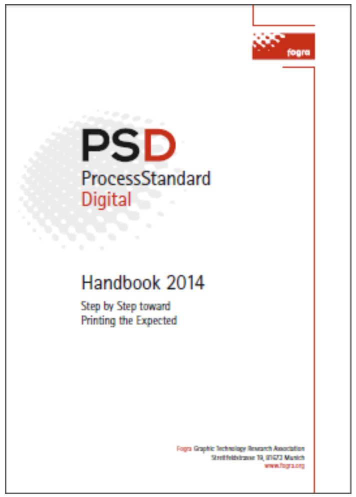
CURRENT BACKLIT APPLICATIONS IN PRACTICE

- Different lighting technologies and SPD's
- Different substrate properties (colour, fluorescence)

Source: Thomas Liesner - Vignold

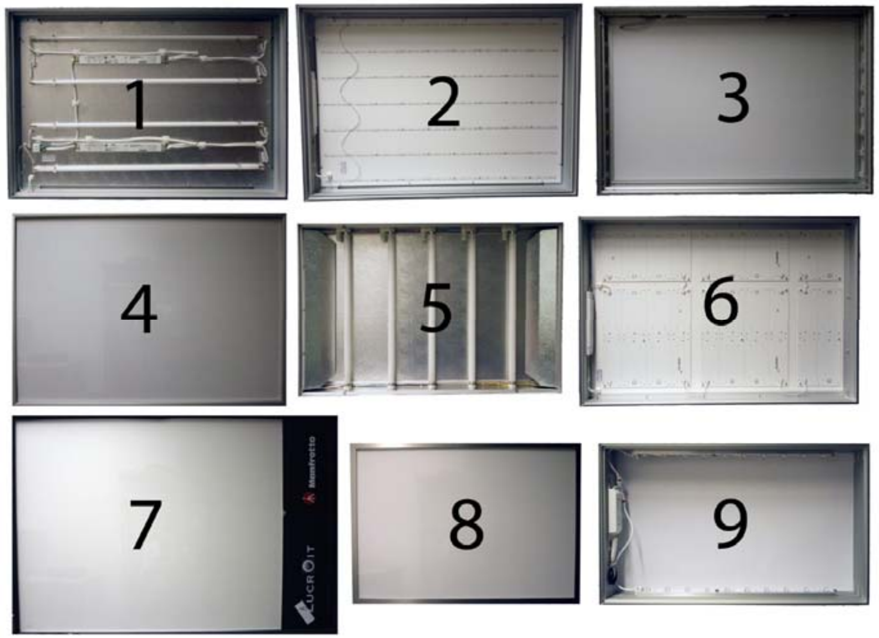
FOGRA RESEARCH PROJECT – COLOUR MANAGEMENT FOR BACKLIT MATERIALS

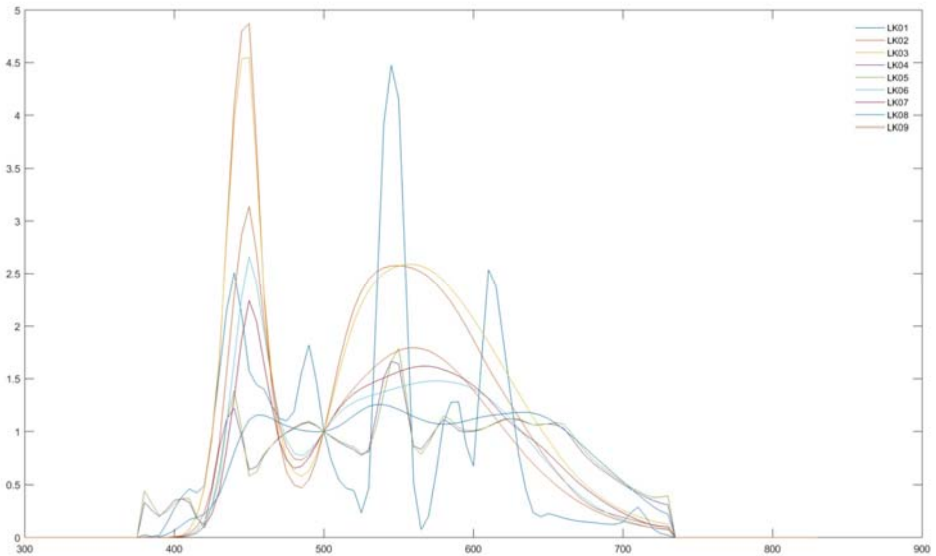
- **Concept for standardization (ISO 3664 and ISO 13655) by providing tools and guidelines for measuring, profiling and visual matching of transparent media**
- **https://fogra.org/en/fogra-research/wc-digital-printing/digital-printing-current-projects/backlit-2-623/colormanagement-for-backlit-materials.html**
- **Printing the Expected objective: adaptability to expectations**
  - Fogra ProcessStandard Digital – PSD industrial procedure
  - Fogra System and Process Check for Large Format Printing application (paused ISO project ISO/DTS 15311-3)



LK1..LK9 DESIGNATED LIGHTBOXES USED FOR THE PROJECT

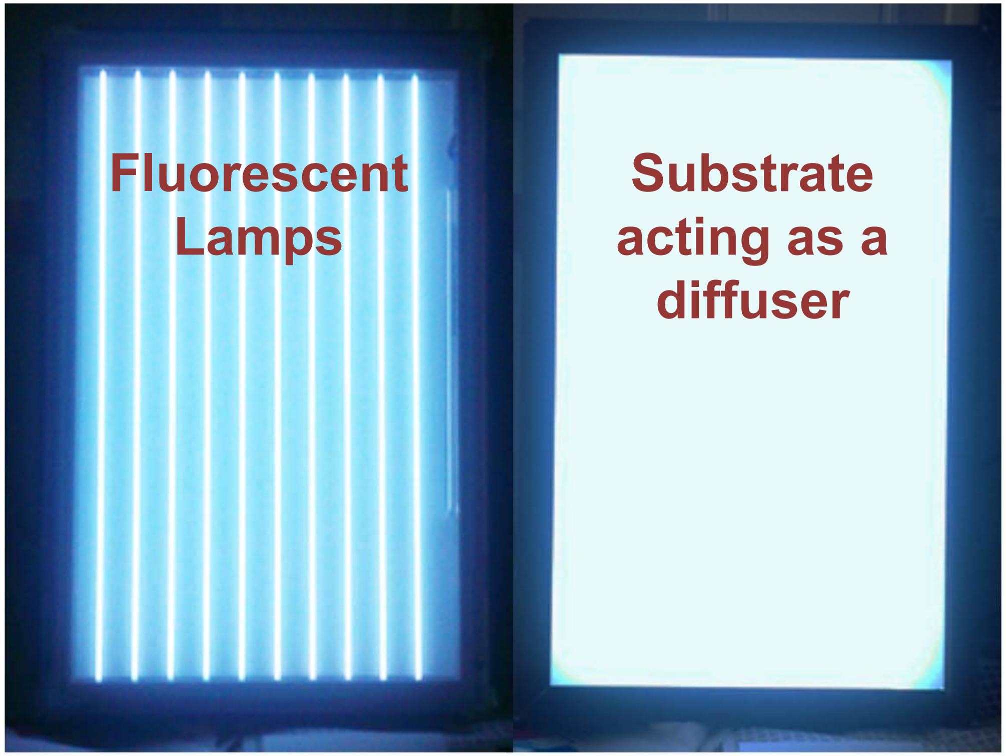
- **Different types and with different SPD were selected to provide the backlight using various lighting technologies**
  - Fluorescent tubes (LK1 and LK5)
  - Edge lit (side) LED (LK3, LK7 w/ diffuser, LK8 w/ diffuser and LK9)
  - Backlit LED (LK2, LK4 and LK6)

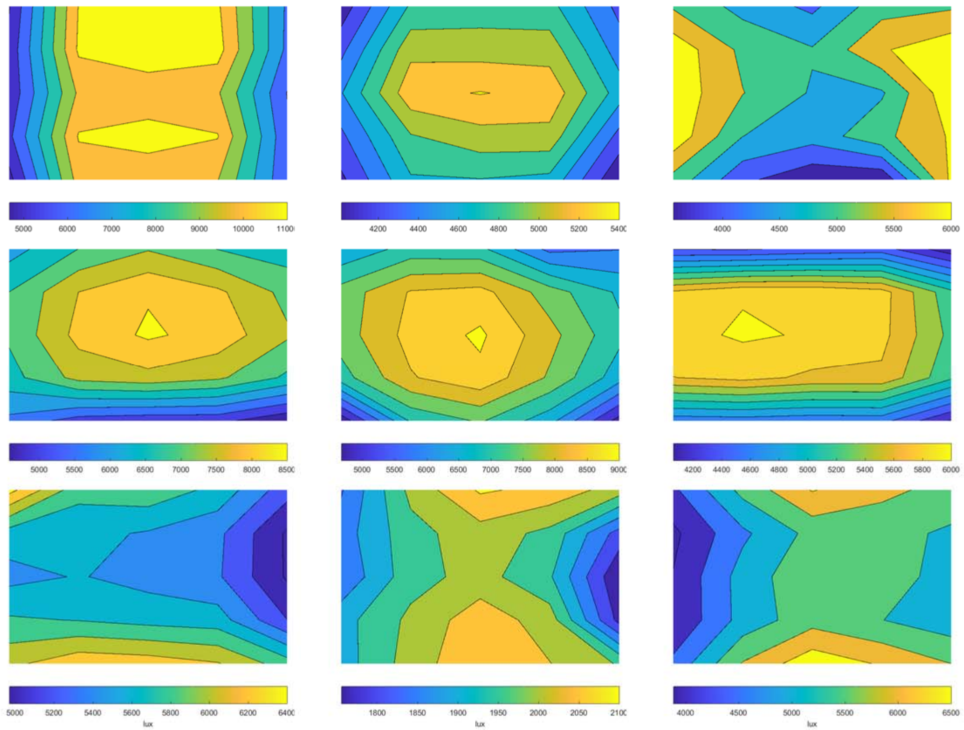




CHROMATIC ADAPTATION TO THE LIGHT BOX

- Relative substrate measurement count toward "Measure as we see"
- Light in the box count toward what we see





Lightbox without Substrate

Lightbox with Substrate

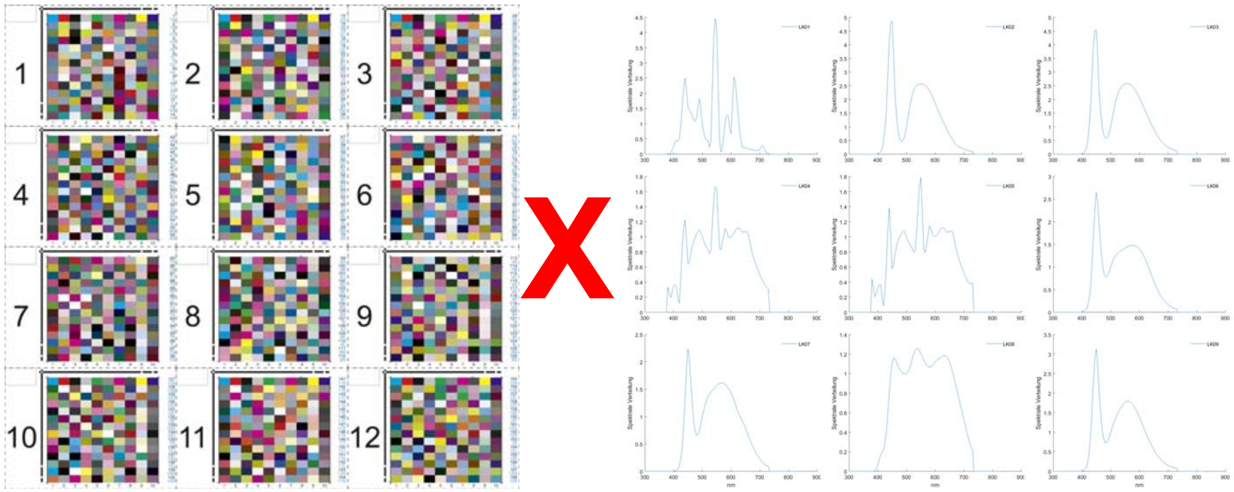
LK1..LK9 luminance variation relative to each lightbox min and max lux determination

COLOUR MANAGEMENT METHOD

⇨ **The combination of CMYK driving values with the spectral stimuli hitting the human eye is based on the additive model with the two sets being multiplied together wavelength by wavelength resulting the combined colour spectrum for each of the 1680 colour patches**

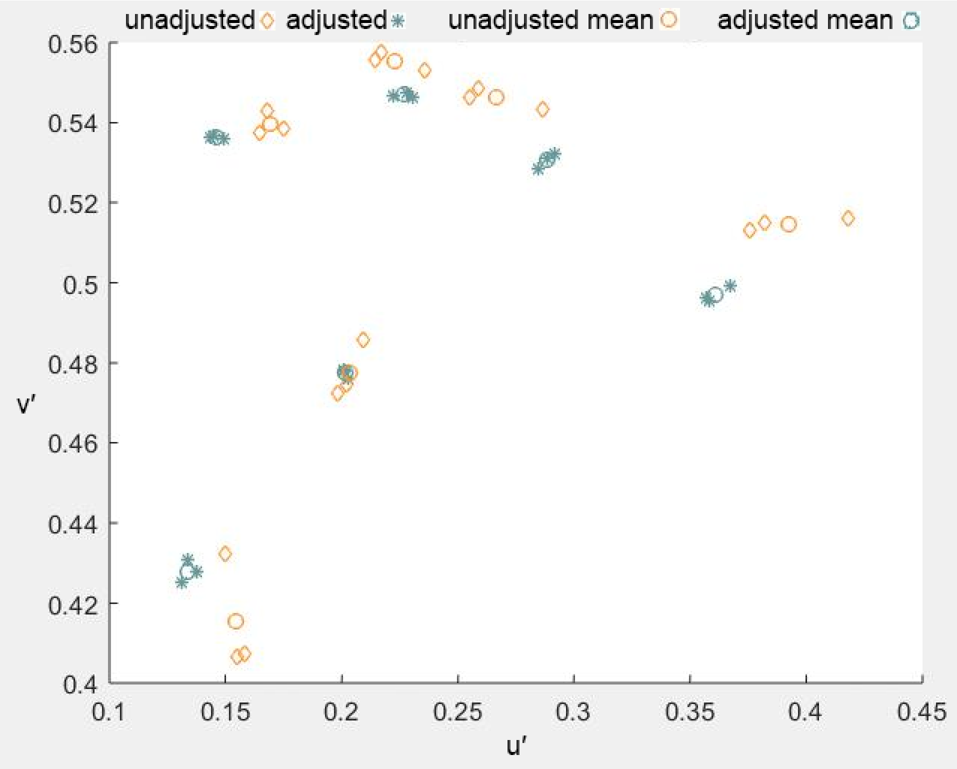
$$CS(\lambda) = T_{mr}(\lambda) \times S_{el}(\lambda)$$

λ is the wavelength, in nanometers (nm) in the available 380 nm to 780 nm range (min. from 400 nm to 700 nm range);
$CS(\lambda)$ is the combined transmittance at wavelength λ;
$T_{mr}(\lambda)$ is the media-relative transmittance at wavelength λ;
$S_{el}(\lambda)$ is the spectral power distribution of the light emitted through the substrate at wavelength λ.



VISUAL: BACKLIGHT OFF/LIGHT ON VS. BACKLIGHT ON/LIGHT OFF

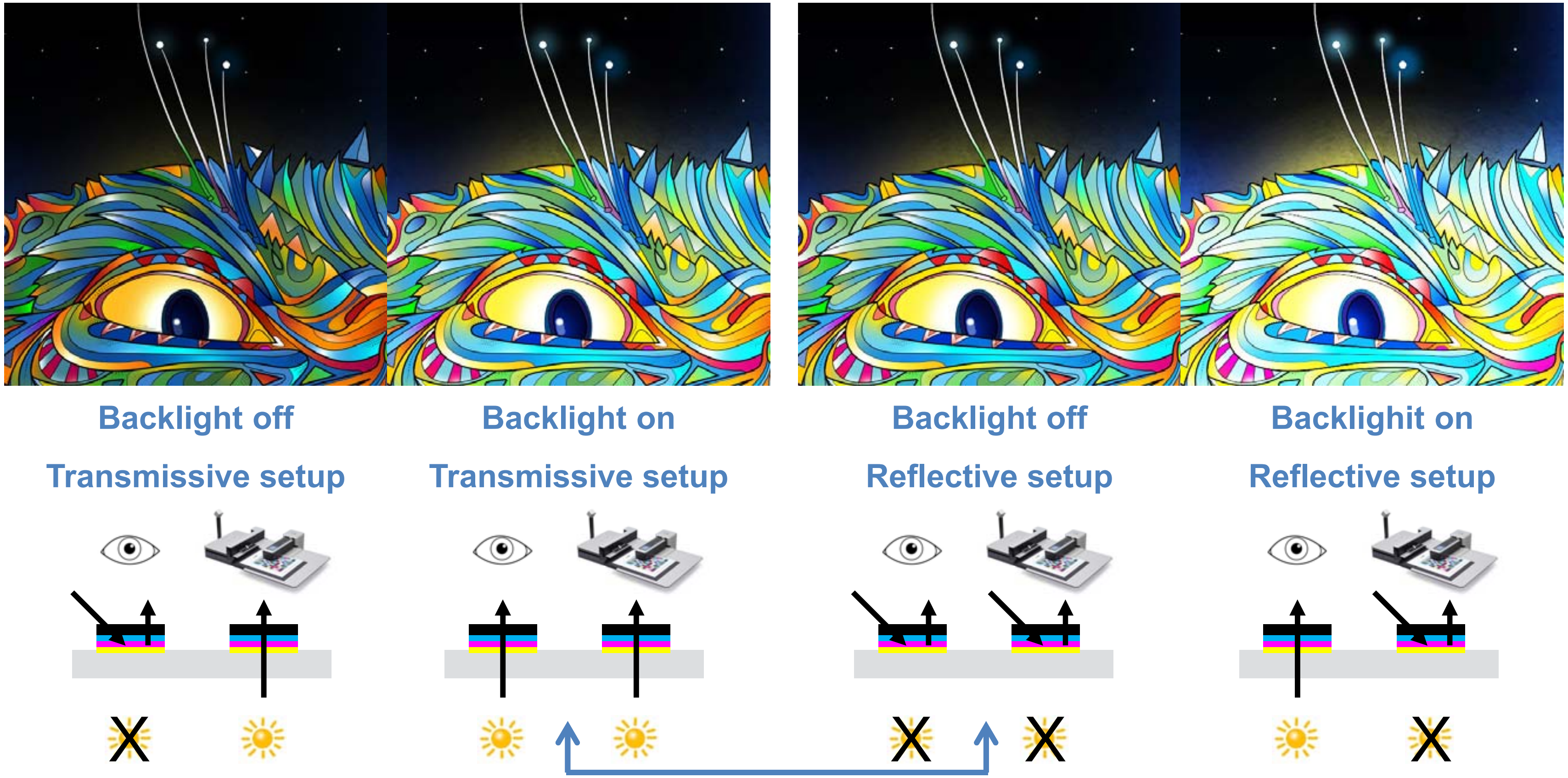
CIEDE2000 (ΔE*00) MCDM FOR SELECTED HUES OF THE COLORCHECKER 24



	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Unadjusted	7.89	6.01	4.69	5.43	5.43	1.74
Adjusted	1.76	2.27	1.02	1.97	1.48	0.66

DAY – NIGHT PRINTING APPLICATIONS (BACKLIGHT OFF/ON)

⇨ **The challenge:**



Backlight on/off – One setup to fulfill "Measure as we see"?

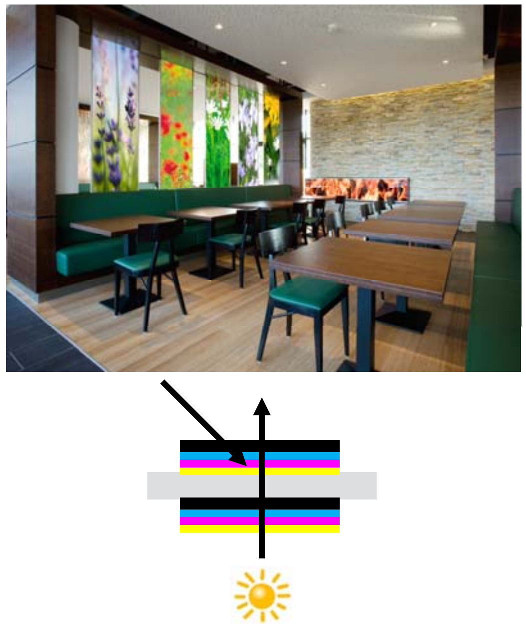
DAY – NIGHT PRINTING APPLICATIONS (BACKLIGHT OFF/ON)

- **Conclusion:**
  - Reproductions based on transmissive measurements will look correctly under backlight (light on) and too dark (no details, dull colours) under reflective light only (light off)
  - Reproductions based on reflective measurements will look correctly under reflective light only (light off) and too bright (no contrast, no chromatic colours, /) unde ı)

Night

Day

Day / Night



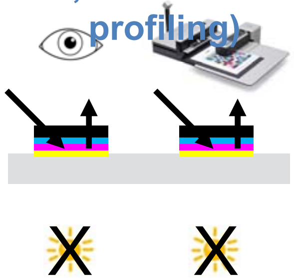
DAY – NIGHT TYPICAL APPLICATIONS IN PRACTICE

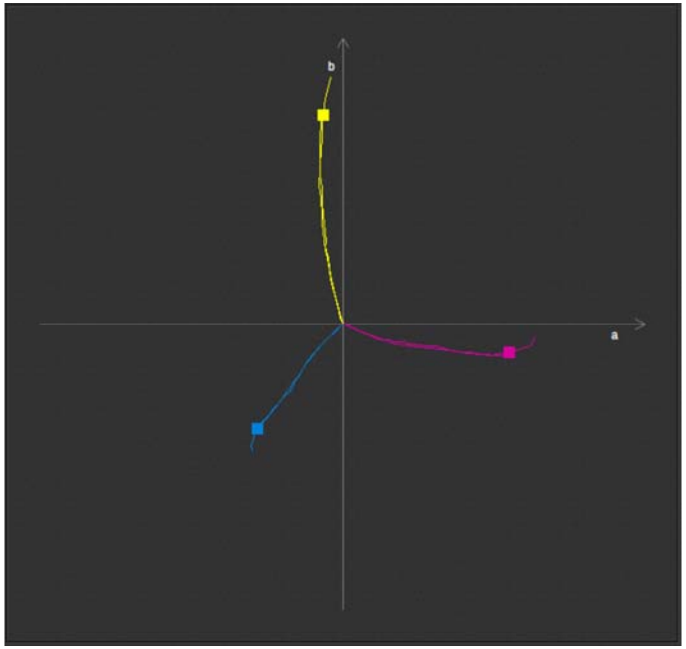
- **Double sided printing**
  - Roll-to-roll digital printing systems with double-sided print feature to allow registration of the front and back side
  - Typical substrates: Backlit PVC Banner, Citylight Paper
  - Setup mode:
    - Frontside - Reflective setup
    - Backside content is mirrored, ink is printed similar or as a fixed % of the Frontside
  - Method to do: find how to print Backside in relation to Frontside so both will match for their respective viewing condition
- **One sided printing using a white ink layer between two color layers**
  - Flatbed digital printing systems with White ink, printing with accurate positioning either as one time or multiple times over
  - Typical substrates : transparent substrates like Acrylic, Glass, Transparent SAV
  - Setup mode: Reflective setup/1st layer, White layer/2nd layer (Method to do: determine white ink % for optimum scattering), Reflective setup/3rd layer
  - Method to do: find how to print 2nd layer in relation to the 1st layer side so both will match for their respective viewing condition

COLORANT RESPONSE IN TRANSMISSION

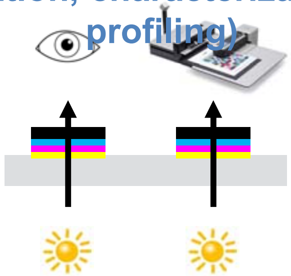
- Comparison and analysis of three setups related to the same printing combination

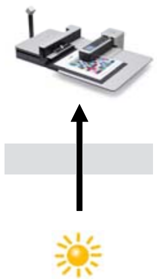
A – Reflective Frontside as reflective setup (adjustment, calibration, characterization and profiling)



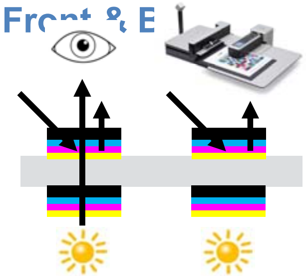


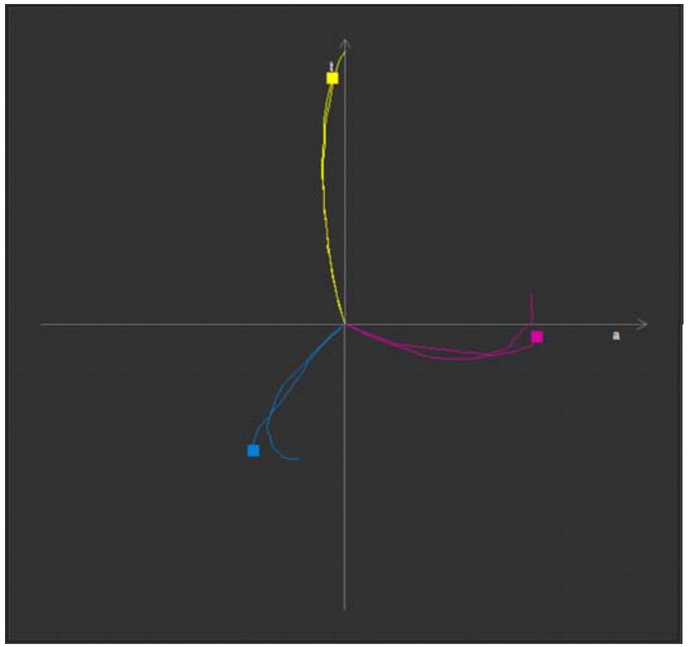
B – Backlit Frontside as transmissive setup (adjustment, calibration, characterization and profiling)





C – Dual sided Frontside/Backside as reflective setup (adjustment, calibration, characterization and profiling), identical Front & B





COLOUR MANAGEMENT METHOD

- **The CIE h° is consistent between A, B and C cases, allowing potentially a reasonable match in the following scenario**
  - The A case becomes the base for the colour management – proper setup for reflection (backlight off), reflectance measurement
  - The B case becomes the reference (aim) for the combined response of Frontside and Backside – aim setup for transmission (backlight on), transmittance measurement
  - Backside is calculated as a function of the Frontside – resulting setup for the combined Frontside/Backside for transmission (backlight on), from above transmittance measurements
- **The combined result can simply be described as:**

$$CS = Front_{tx} \times Back_{tx}$$

CS is the theoretical combined transmittance aiming to match the reference Backlit Frontside setup;
$Front_{tx}$ is the media-relative transmittance of Frontside setup only;
$Back_{tx}$ is the media-relative transmittance of Backside derived from Frontside setup

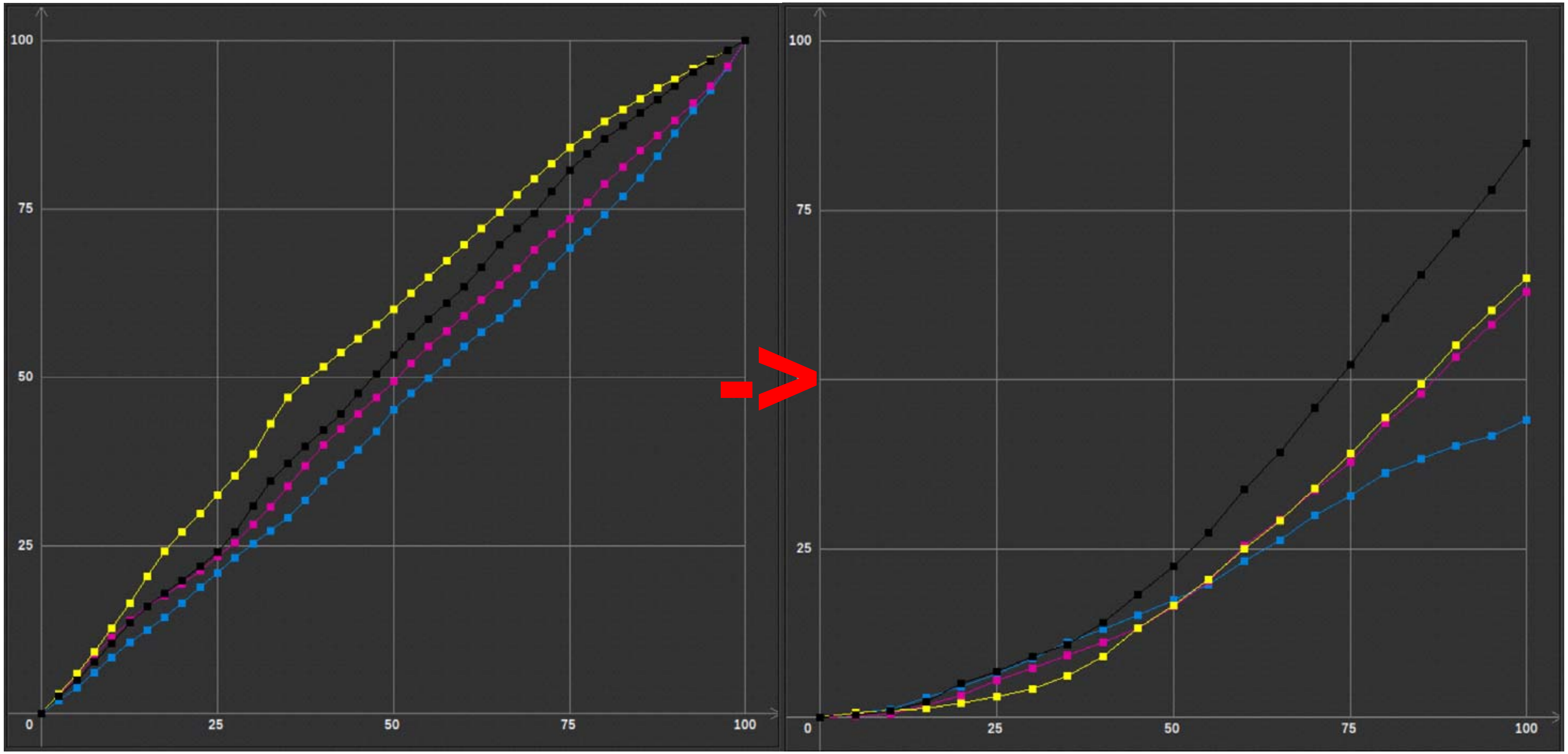
- **The formula to calculate the Backside derived from Frontside is still work in progress, but the results looks promising**
  - It provides media-relative transmittance spectral data for the CMYK primaries

PRACTICAL IMPLEMENTATION

- **Easiest is to modify the gradation of printing system primary colours e.g. CMYK on the Backside, similar with the current approach for Backside content where ink is printed as a fixed % of the frontside**
  - Frontside is fixed and can’t be adjusted anymore after the initial setup
  - Initial Backside is just a duplicate of the Frontside (ICC profile included)
- **Two measurements are needed**
  - Fixed part – Frontside gradation used for Reflective setup (case A) but measured as transmission this time
  - Aim part – Frontside gradation used for Transmissive setup (case B)
- **Adjustment curve is calculated for the Backside from the resulted media-relative transmittance spectral data according to the tone value formula implementation of the used printing workflow (e.g. ISO Status density, colorimetrical TVI, spectral density)**
- **The original Backside curve (initially same as Frontside) is replaced with the adjusted Backside curve (original ICC profile is maintained)**

RESULTS FROM A CITYLIGHT PAPER DUAL SIDED PRINTING COMBINATION

⇨ **Backside adjustment curve calculated for a typical printing workflow**

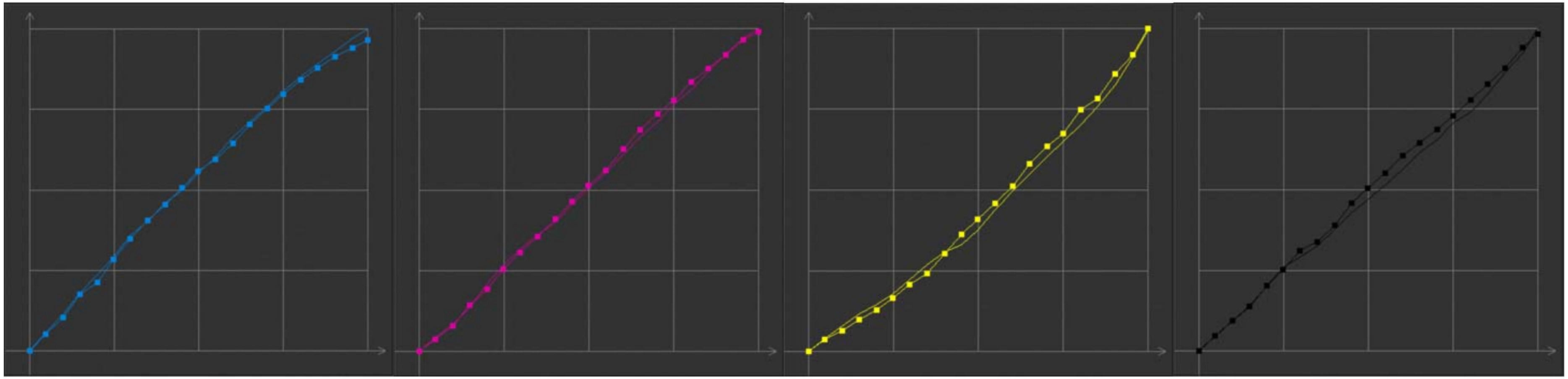


Initial Frontside / Backside TVI Curves

Backside TVI Curves

RESULTS FROM A CITYLIGHT PAPER DUAL SIDED PRINTING COMBINATION

- **The match between the Frontside Backlight gradations used as aim for the Transmission setup and the resulted combined Frontside/Backside gradations used for dual sided day night printing combination**



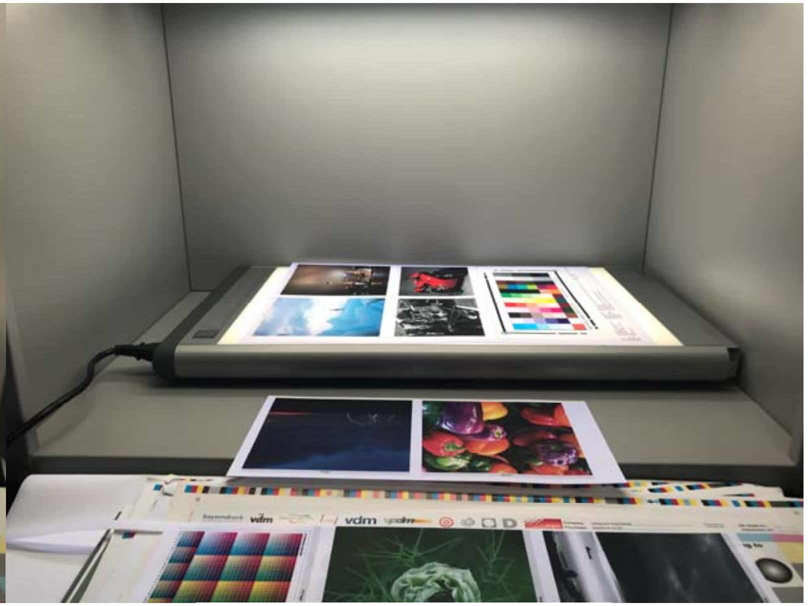
- **Current formula for media-relative transmittance spectral data measurements of 1680 CMYK combinations (Universal LFP chart) – Avg. 2,5 ΔE^{*}_{00} /Max. 6,0 ΔE^{*}_{00}**

MORE TO DO

- **Further study of the methods and their combined results**
  - Finding more printing combinations suitable for testing, especially for dual sided printing with functional registration system for Frontside/Backside
  - Improving the formulas
  - Evaluation of OBA's influence for both reflection and transmission in mixed light environments

Backlight/Reflection
On

Low UV in Reflection



Backlight/Reflection
On

High UV in Reflection

THANK YOU FOR YOUR ATTENTION

Q & A

dorinp@transilvae.ro

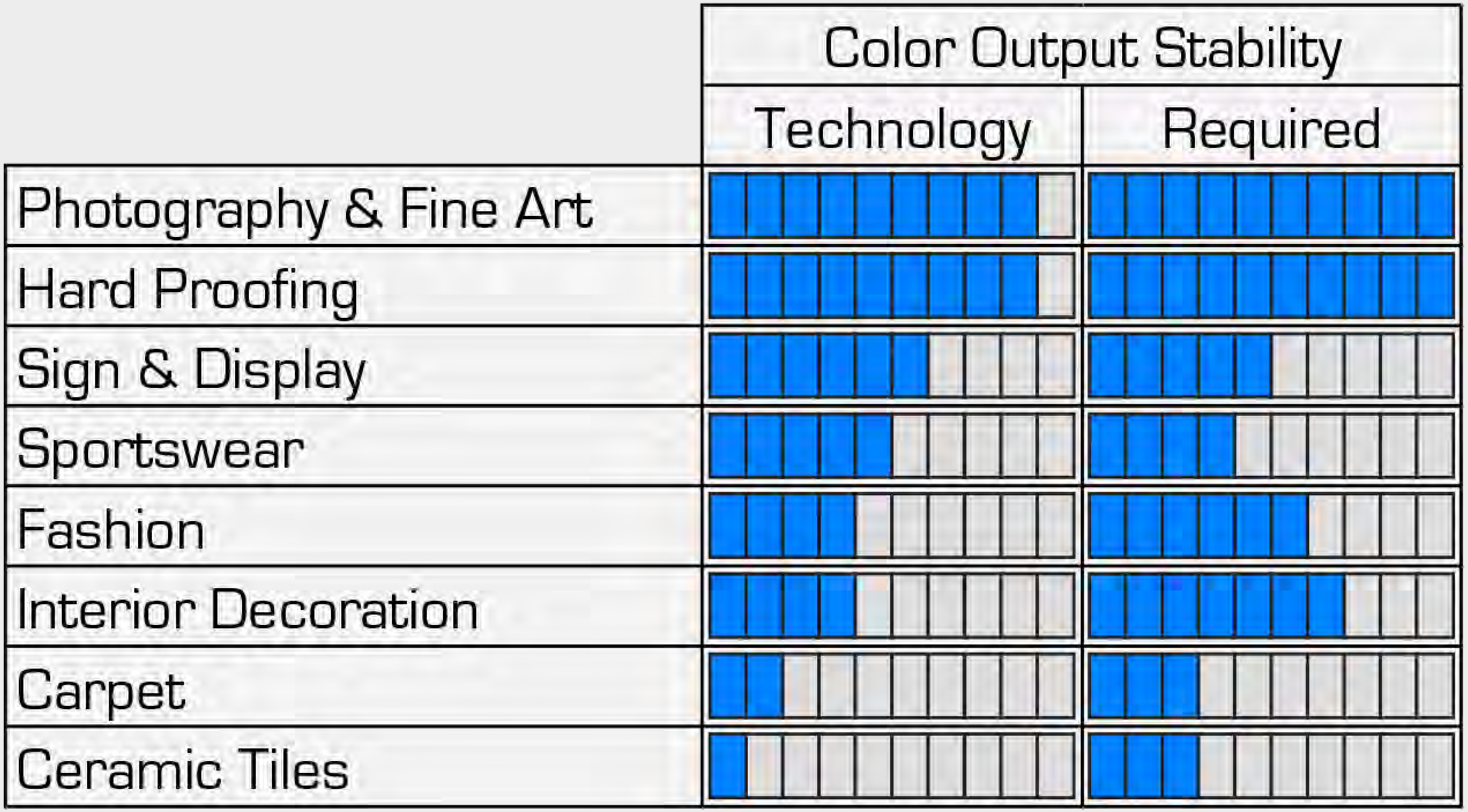
Color Management & Calibration for variable substrates

ICC COLOR EXPERTS DAY
MAY 24, 2019

Colour Management for
Wider-Format Printing
on Non-Paper
Substrates

Hosted by Barbieri Electronic

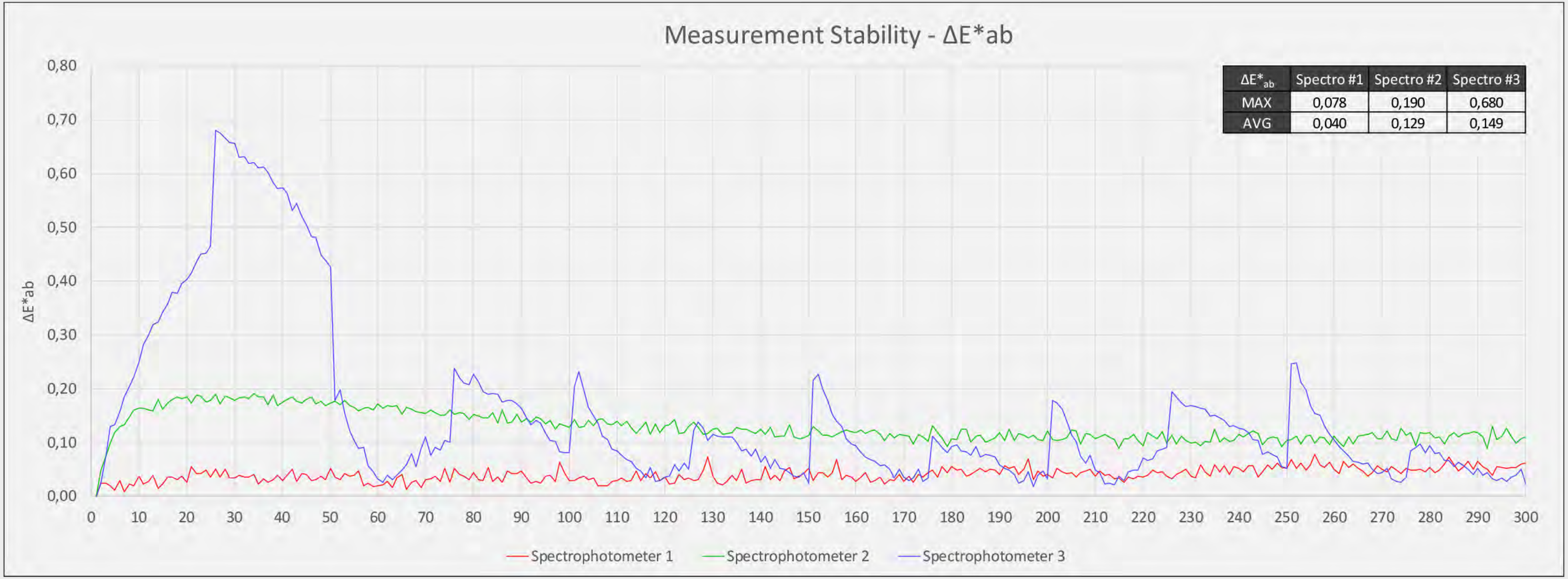
HQ Durst Phototechnik AG
Bressanone, Italy



Digital Print Applications

- New calibration
- Quality control + correction
- Color Matching

Color Calibration



Spectrophotometer Repeatability

Printer Type	Epson Pro 3880 - Large Format A2+		
Application	Photography / Proofing		
Production Speed	4 m²/h	Total Patch Count	1170

Patch Nr	Color	L	a	b	ΔE*ab Nearest	ΔE*ab 5th Nearest
23		8,017	1,459	-11,673	4,304	7,164
825		8,832	6,921	-9,338	2,818	5,996
853		8,850	-9,184	-13,012	3,362	5,596
866		9,477	-6,082	-11,532	2,046	5,266
465		9,670	4,273	-8,866	2,818	5,952
412		9,886	2,081	-3,151	4,578	6,315
939		10,009	6,442	-18,982	4,373	6,138
826		10,130	1,016	-20,070	2,643	6,579
566		10,133	14,227	-14,914	4,739	7,673
693		10,165	-13,176	-12,080	3,451	5,527
666		10,224	13,197	-5,741	2,402	5,633
959		10,399	-5,087	-9,999	4,263	5,163
733		10,442	-16,577	-5,037	3,581	5,507
146		10,464	14,682	-25,788	5,410	7,181
829		10,527	-7,832	-3,991	3,873	5,323
232		10,547	-10,239	-10,310	2,548	4,614
598		11,117	9,067	-0,099	3,041	5,609
1103		11,129	2,627	-30,702	3,797	8,057
743		11,152	10,981	-5,702	2,402	5,355
710		11,196	-13,080	-4,068	2,442	4,730
482		11,215	-7,492	-21,853	4,302	6,972
95		11,261	18,481	-1,718	1,627	5,975
791		11,262	7,701	-28,000	3,106	7,367
855		11,302	2,356	-18,116	2,643	4,908
1146		11,369	24,059	-31,479	3,655	7,875
64		11,395	-2,232	-9,517	2,676	6,613
109		11,493	36,781	-57,897	4,573	10,275
11		11,558	18,184	-36,720	3,781	7,268
450		11,743	29,147	-43,383	4,095	6,405
731		11,862	22,242	-19,039	4,263	8,260
				Average	3,448	6,377

Printer Type	MS JPK-EVO 320 - High Volume Sublimation		
Application	Interior Decoration / Fashion		
Production Speed	800 m²/h	Total Patch Count	416

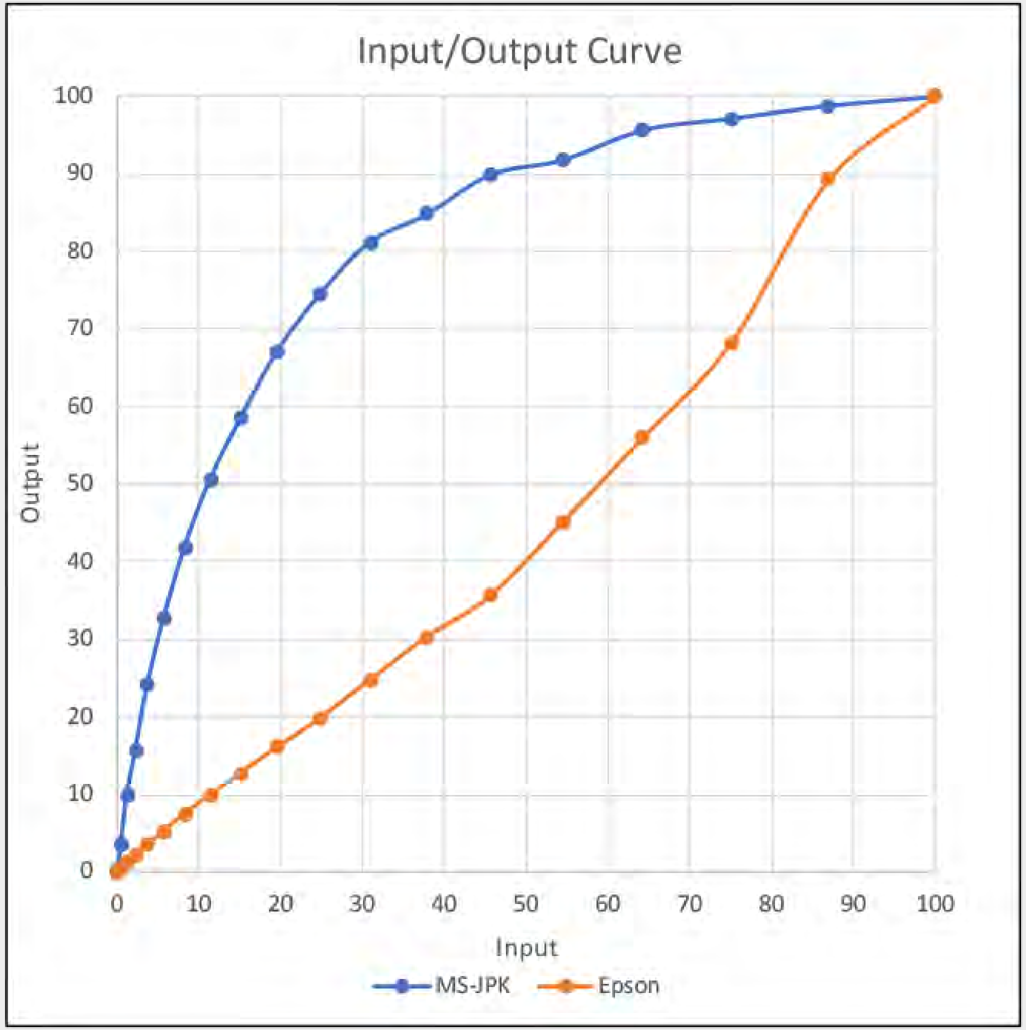
Patch Nr	Color	L	a	b	ΔE*ab Nearest	ΔE*ab 5th Nearest
360		16,885	-0,189	-4,031	0,079	2,558
290		16,927	-0,181	-4,097	0,079	2,588
252		16,966	-0,146	-4,163	0,084	2,604
249		17,338	1,980	-2,943	0,330	0,693
278		17,426	4,178	-2,054	0,273	0,545
342		17,451	7,234	-1,388	0,591	2,048
92		17,452	1,997	-2,634	0,141	0,437
322		17,476	2,104	-2,545	0,141	0,470
369		17,495	1,826	-2,519	0,211	0,400
401		17,507	7,142	-2,026	0,477	1,955
245		17,542	1,529	-2,254	0,295	0,647
120		17,543	3,274	-1,811	0,264	0,381
286		17,564	3,536	-2,108	0,054	0,477
134		17,594	4,317	-1,889	0,132	0,401
62		17,612	3,514	-2,099	0,054	0,426
309		17,618	5,300	-1,734	0,092	0,582
285		17,625	7,567	-1,844	0,477	2,352
95		17,648	5,219	-1,701	0,092	0,528
200		17,688	4,098	-1,600	0,189	0,277
317		17,695	3,510	-1,614	0,343	0,471
12		17,704	1,712	-2,418	0,258	0,470
101		17,720	3,125	-1,682	0,182	0,397
289		17,720	4,317	-1,929	0,132	0,356
333		17,728	4,145	-1,403	0,207	0,349
410		17,735	4,800	-2,009	0,189	0,463
236		17,744	5,182	-1,418	0,301	0,585
208		17,798	3,986	-1,706	0,121	0,281
299		17,800	4,524	-1,425	0,145	0,326
171		17,827	4,723	-1,753	0,173	0,283
74		17,840	3,241	-2,042	0,078	0,377
				Average	0,206	0,824

Distance of color points in 3D space

- Long-term repeatability
  - 300+ measurements
  - DeltaE Max < 0.3 : Acceptable
  - DeltaE Max < 0.1 : Good
- Measurement speed & averaging
  - Averaging improves characterization accuracy
  - Measuring 5+ ICC targets requires time
  - Reduction of erroneous data
- Inter-Instrument Agreement
  - Output correction & color matching

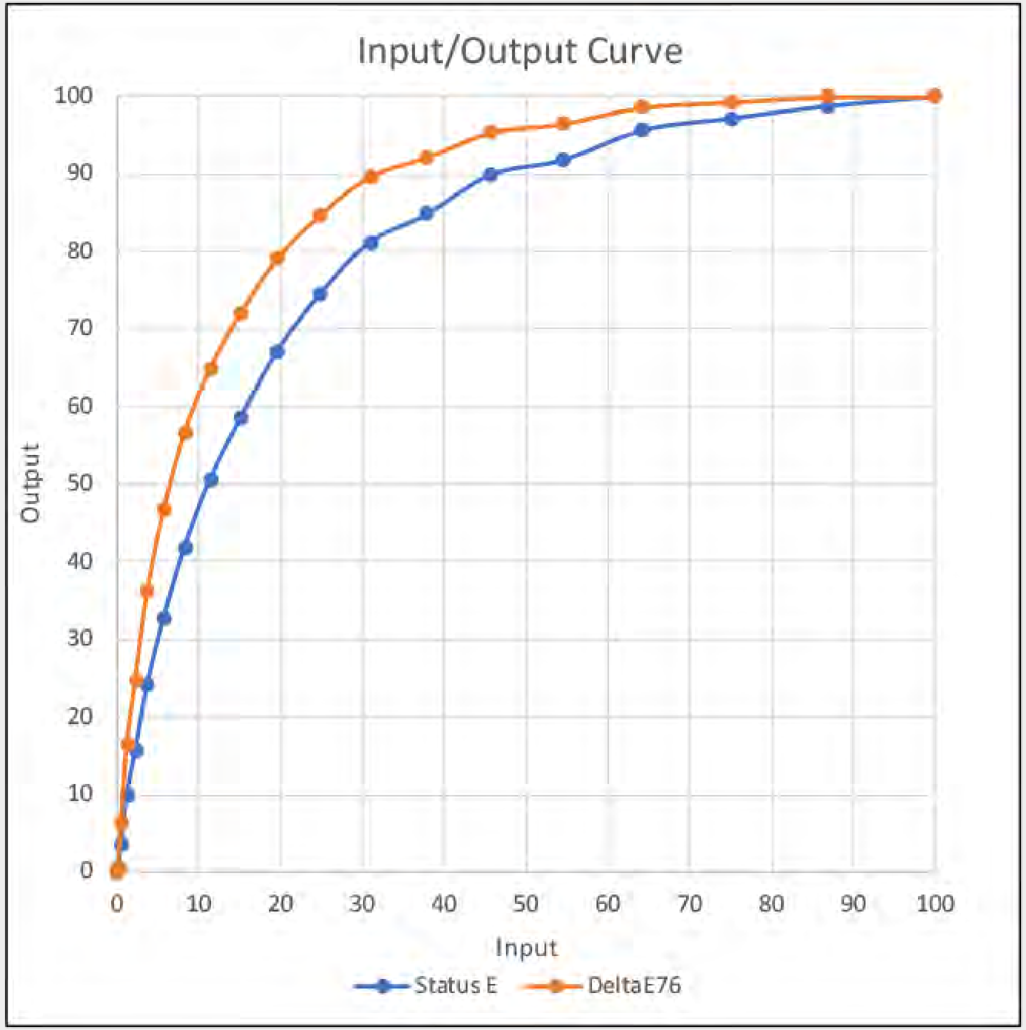
Spectrophotometer Requirements

Input	MS-JPK	Epson
0,00	0,00	0,00
0,03	0,22	0,05
0,19	0,34	0,23
0,58	3,60	0,60
1,26	9,98	1,24
2,31	15,65	2,19
3,79	24,25	3,50
5,76	32,69	5,22
8,29	41,77	7,43
11,41	50,55	9,83
15,19	58,59	12,72
19,69	67,23	16,08
24,94	74,64	19,83
31,01	81,25	24,77
37,92	84,84	30,26
45,75	89,95	35,66
54,52	91,83	45,12
64,29	95,68	55,96
75,10	97,19	68,25
86,98	98,82	89,25
100,00	100,00	100,00

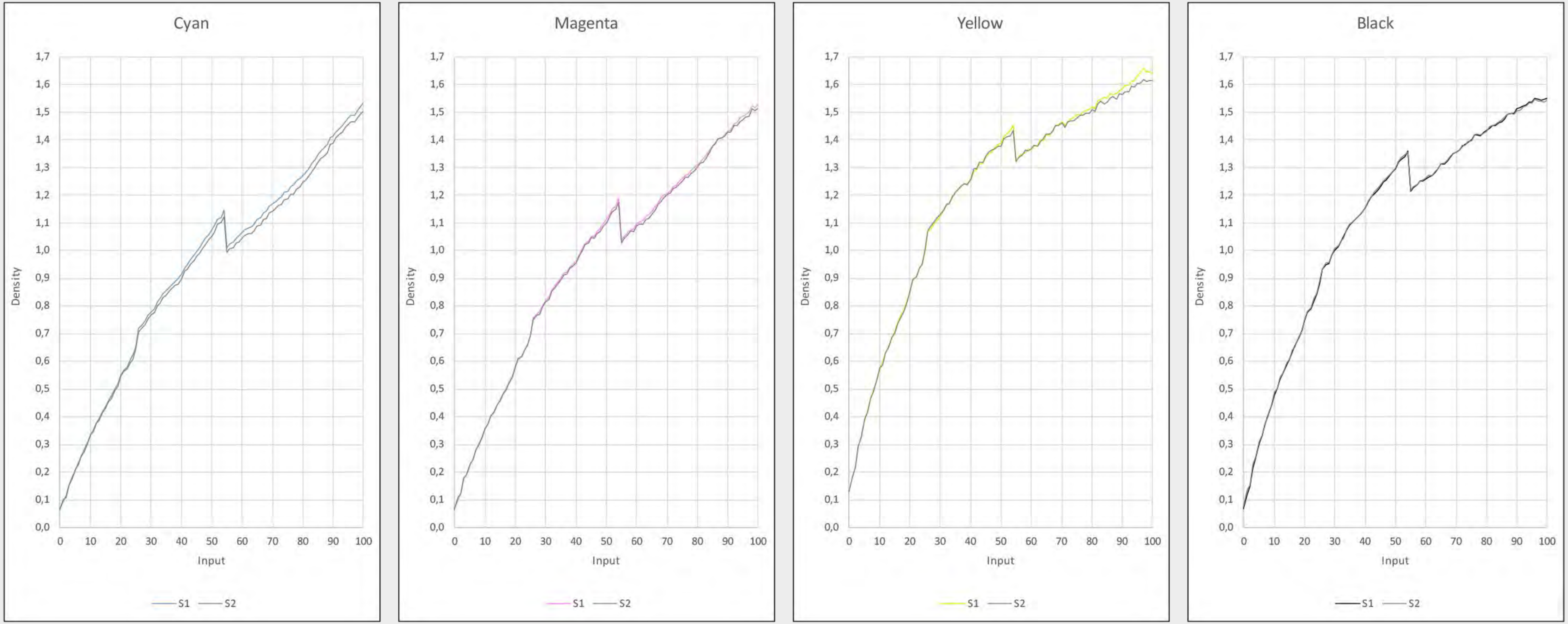


Ink Channel Linearity

Input	Status E	DeltaE76
0,00	0,00	0,00
0,03	0,22	0,32
0,19	0,34	0,46
0,58	3,60	6,20
1,26	9,98	16,37
2,31	15,65	24,77
3,79	24,25	36,29
5,76	32,69	46,61
8,29	41,77	56,57
11,41	50,55	64,88
15,19	58,59	72,12
19,69	67,23	79,16
24,94	74,64	84,77
31,01	81,25	89,72
37,92	84,84	92,20
45,75	89,95	95,41
54,52	91,83	96,52
64,29	95,68	98,65
75,10	97,19	99,36
86,98	98,82	99,98
100,00	100,00	100,00

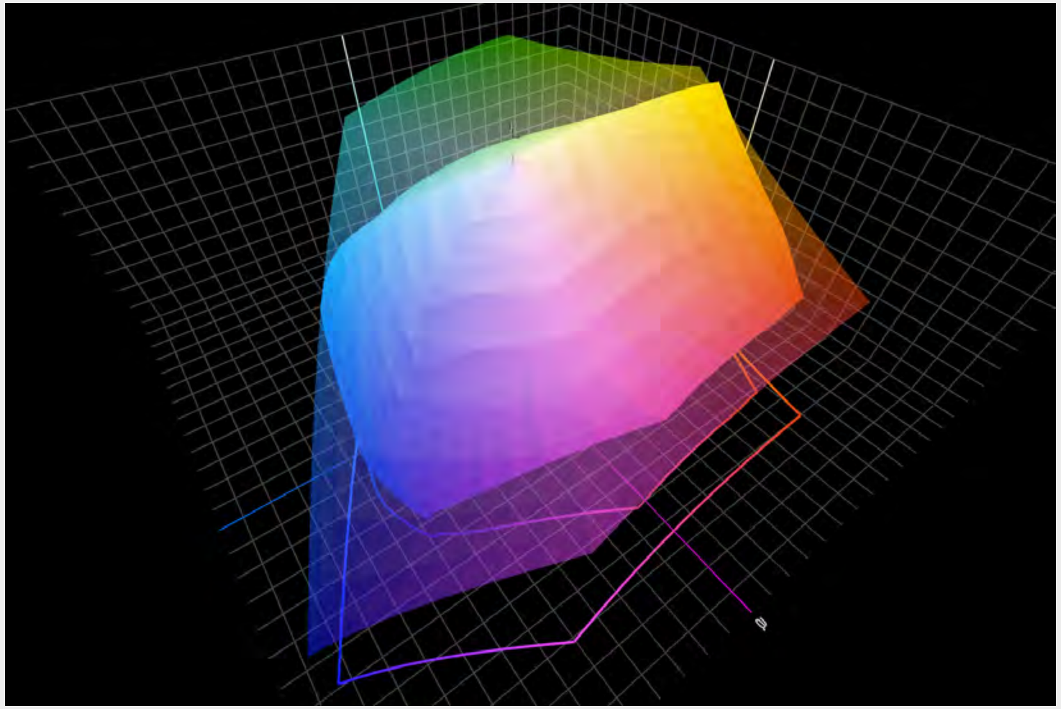


Linearization Methods

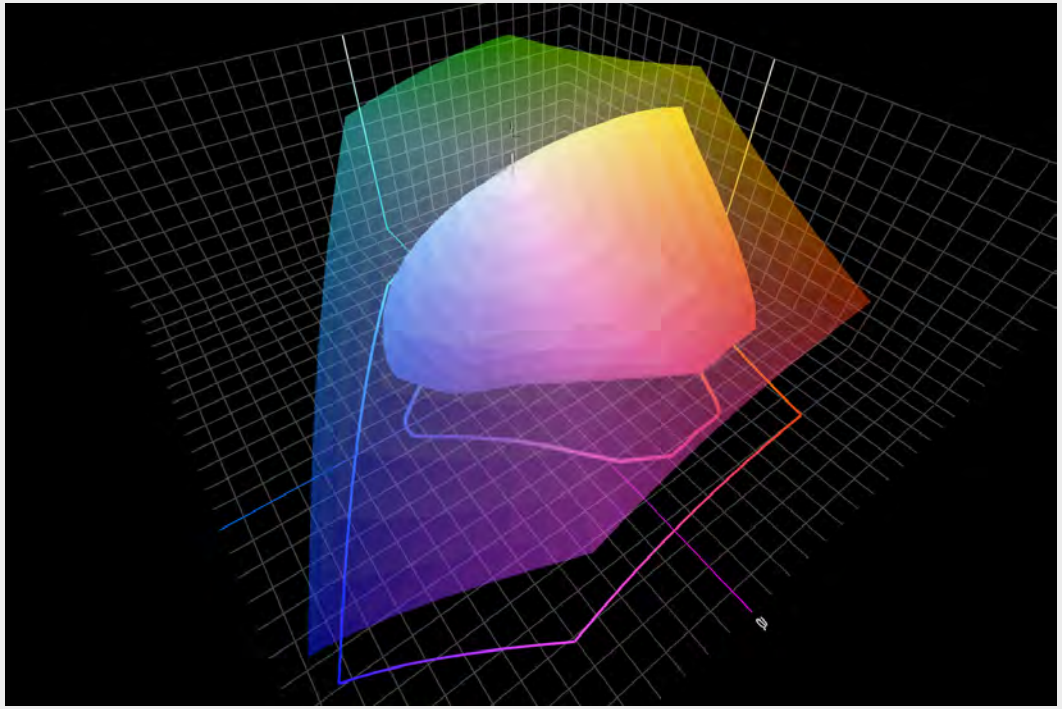


Ink Channel Matching

Epson Pro 3880



MS-JPK Evo 320



Performance of Rendering Intents

Color Gamut & Rendering Intents

ICC COLOR EXPERTS DAY

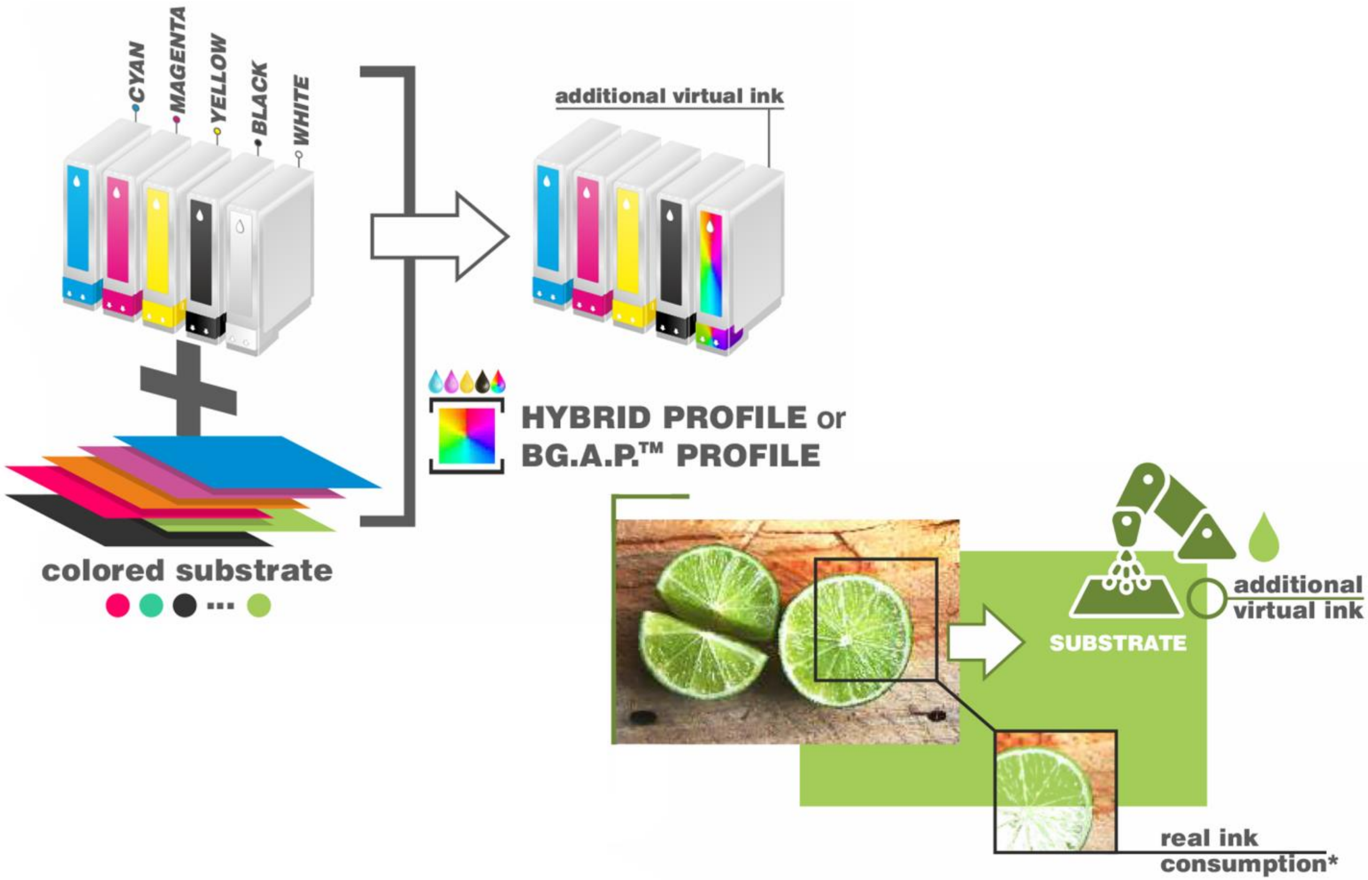
MAY 24, 2019

Colour Management for
Wider-Format Printing
on Non-Paper
Substrates

Hosted by Barbieri Electronic

HQ Durst Phototechnik AG
Bressanone, Italy

A new approach for printing on colored substrate: **BG.A.P.**™ or Hybrid Profiles



BackGround-Adaptive Profiles (**BG.A.P.**™)

Are designed for the calibration of:

- Printing systems with a "White" colorant printed on colored media.

Or, more generally:

- Printing systems where one colorant has such tristimulus values that can be used as a better reference white compared to the media itself.

The traditional printing process (CMYK):

- Uses semi-transparent inks (‘process inks’) that absorb selected parts of the spectral reflectance of the substrate.
- These inks are defined as subtractive.
- “reference white” is defined as absence of ink.

The white-ink printing process (CMYK+W):

Uses the same 'process inks' on the previous slide plus one ink (White) that has a non-selective spectrum and usually is more opaque than the other inks.

- White ink is not subtractive.
- White ink can be printed with variable densities.
- White ink can be used as basis for the other inks.
- "reference white" is defined as 100% of white ink (or the maximum printable white in on the selected surface).

The ICC standard.

Colorimetric data must be embedded into the profiles using a profile connection space (PCS).

The PCS defined in ICC specification 4.3 is based on the CIE1931 standard observer. In short, PCS can be either CIEXYZ or CIELab relative to the illuminant CIE d50.

The PCS color space encodings are based on media-relative colorimetry in which tristimulus values are scaled to the range of the *mediaWhitePointTag*.

The *mediaWhitePointTag* specifies the CIEXYZ tristimulus of the media white point.

6.3.2.2 Translation between media-relative colorimetric data and ICC-absolute colorimetric data

The translation from ICC-absolute colorimetric data to media-relative colorimetry data is given by Equations (1) to (3).

$$X_r = \left[\frac{X_i}{X_{mw}}\right] X_a \tag{1}$$

$$Y_r = \left[\frac{Y_i}{Y_{mw}}\right] Y_a \tag{2}$$

$$Z_r = \left[\frac{Z_i}{Z_{mw}}\right] Z_a \tag{3}$$

where

X_r, Y_r, Z_r	are the media-relative colorimetric data (i.e. PCSXYZ);
X_a, Y_a, Z_a	are the ICC-absolute colorimetric data (i.e. nCIEXYZ);
X_{mw}, Y_{mw}, Z_{mw}	are the nCIEXYZ values of the media white point as specified in the mediaWhitePointTag;
X_i, Y_i, Z_i	are the PCSXYZ values of the PCS white point.

"Media-relative" colorimetry is consistent with the fact that the human visual system adapts its response to the highest-energy stimulus in the visual field.

This is true as long as the highest-energy stimulus is enough bright and neutral to allow adaptation.

When this type of relative colorimetry is used, the color of the substrate has no effect on the device gamut.

In **BG.A.P.**™ profiles the color of the media is not the highest-energy stimulus in the visual field, so the human visual system doesn't adapt to it.

Instead the human visual system adapts to the tristimulus of the 100% of white ink.

Measurements are scaled by the tristimulus of the white ink, not by the one of the media.

The *mediaWhitePointTag* specifies the cieXYZ tristimulus of the 100% of white ink.

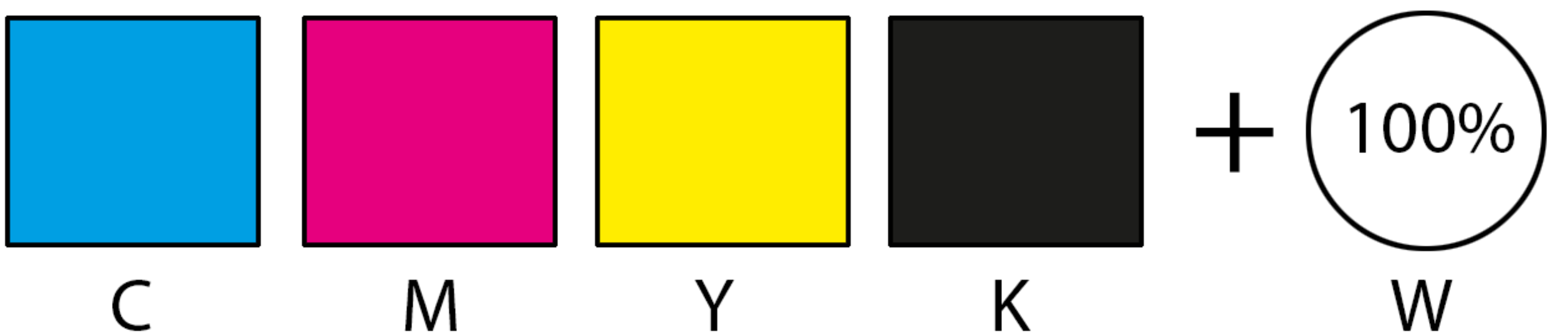
When this type of relative colorimetry is used, the color of the substrate has a huge effect on the device gamut.

If the substrate contributes to the device gamut, then it can be considered as a colorant.

We can refer to CMYK+W colorspaces as to CMYK+(media color) ones.
(examples: CMYK +blue, CMYK +orange, CMYK +green, etc.)

THE BASIC CMYK GAMUT

Since the reference white is the 100% of white ink, the whole CMYK colorspace printed on a flat layer of 100% of white ink can be considered the basic CMYK colorspace.



GREYSCALE INK FUNCTIONS

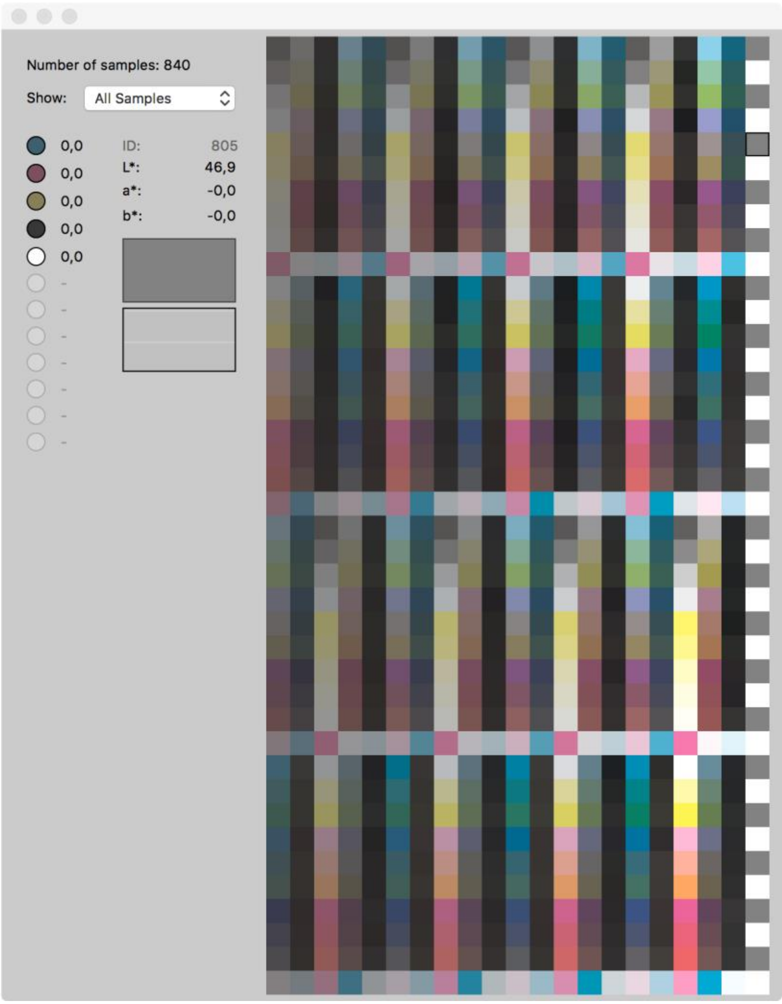
Minimum Luminance = 8,272

Process : Idle.

done.

<< BACK | QUIT | NEXT >>

Example 1:
GREY SUBSTRATE



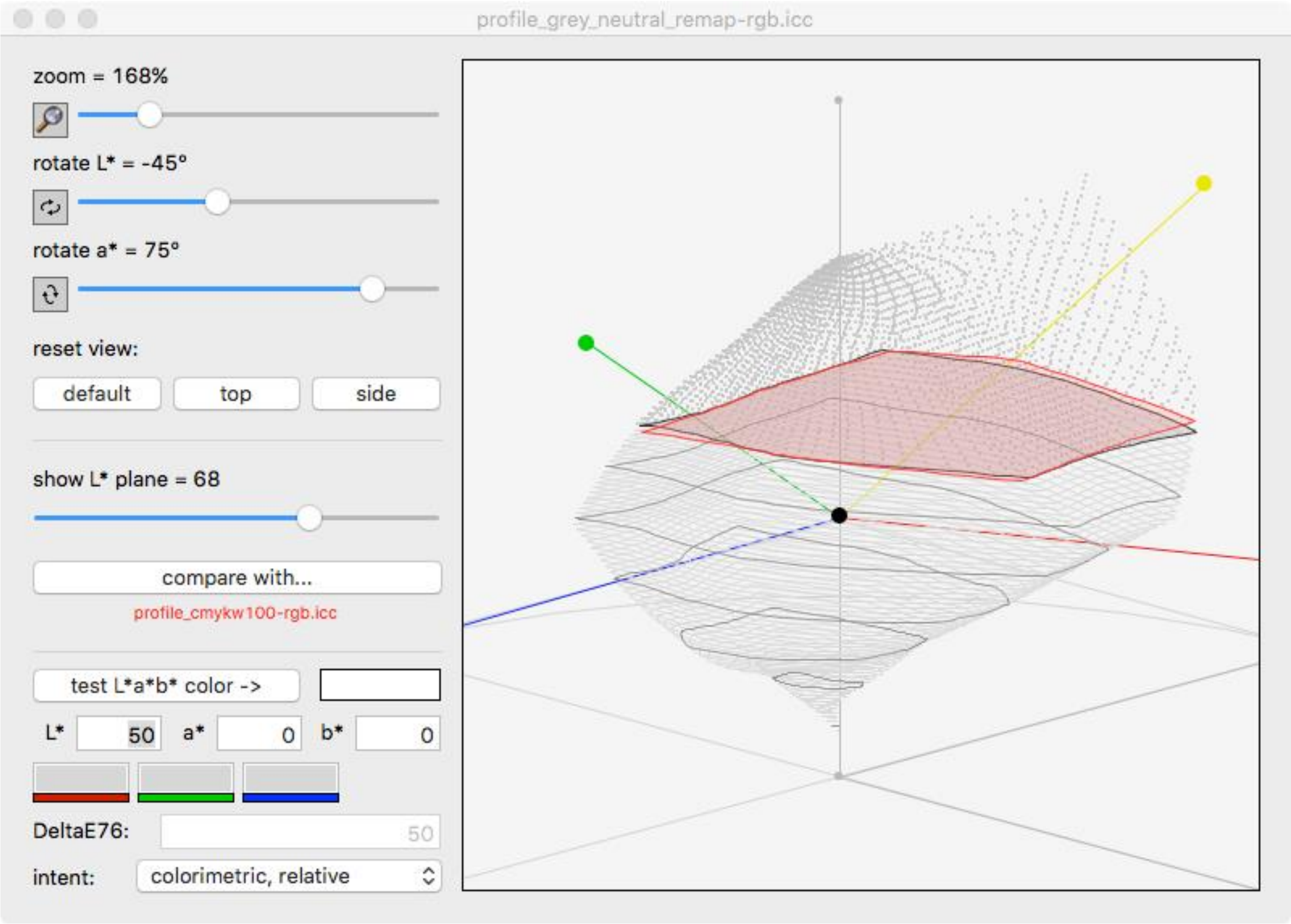
GREYSCALE INK FUNCTIONS

Minimum Luminance = 8,521

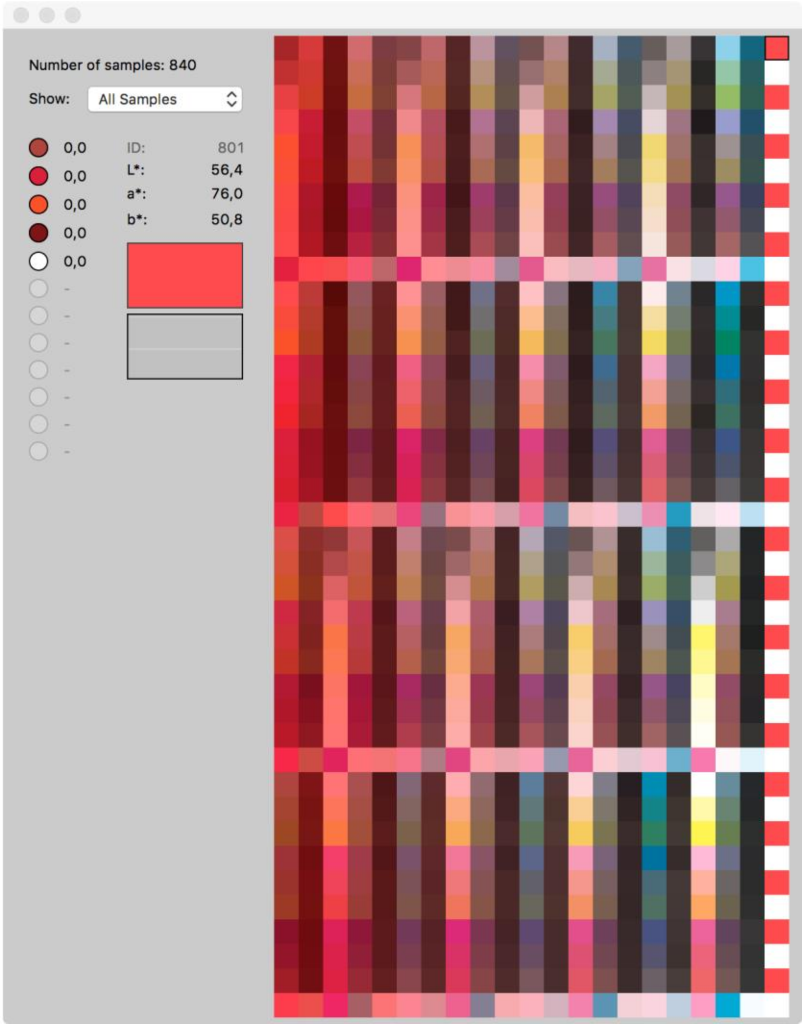
Process : Idle.

done.

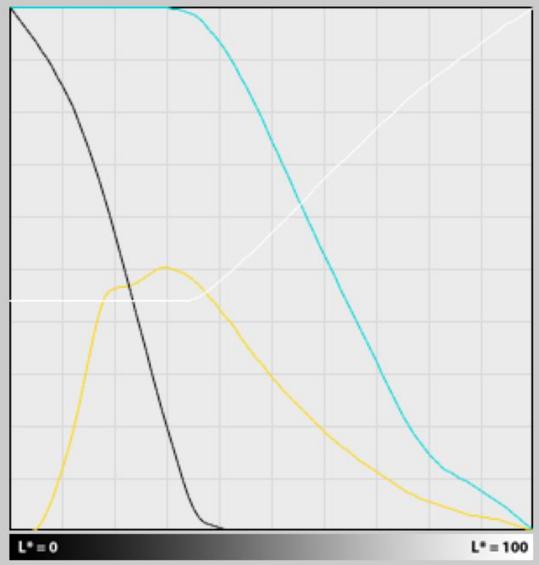
<< BACK | QUIT | NEXT >>


profile_grey_neutral_remap-rgb.icc
zoom = 168%
rotate L* = -45°
rotate a* = 75°
reset view:
default
top
side
show L* plane = 68
compare with...
profile_cmykw100-rgb.icc
test L*a*b* color ->
L*
50
a*
0
b*
0
DeltaE76:
50
intent:
colorimetric, relative

Example 2:
RED SUBSTRATE



GREYSCALE INK FUNCTIONS

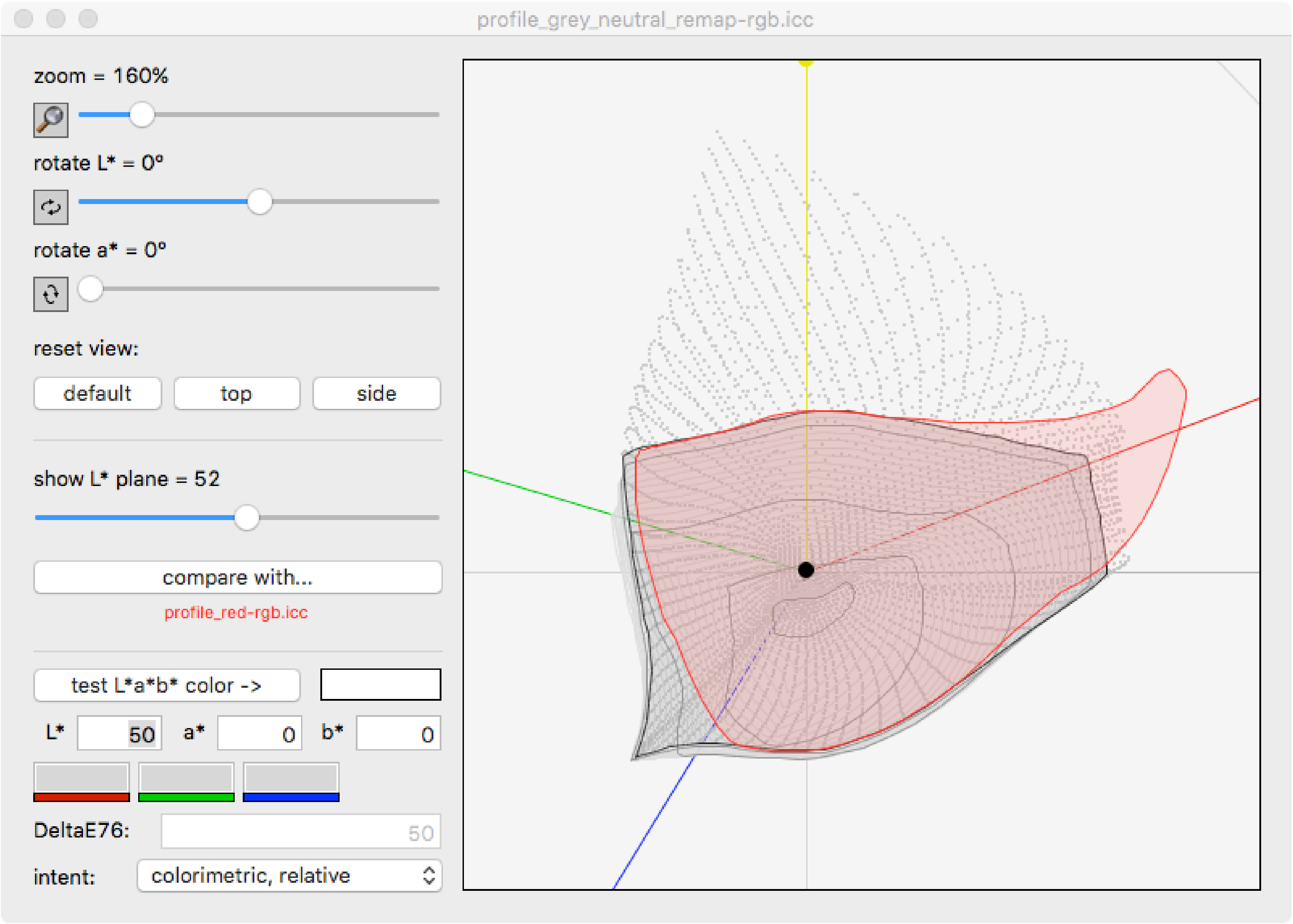


Minimum Luminance = 11,356

Process : Idle.

done.

<< BACK QUIT NEXT >>


profile_grey_neutral_remap-rgb.icc
zoom = 160%
rotate L* = 0°
rotate a* = 0°
reset view:
default
top
side
show L* plane = 52
compare with...
profile_red-rgb.icc
test L*a*b* color ->
L* 50
a* 0
b* 0
DeltaE76: 50
intent: colorimetric, relative


BASIC CMYK
COLOR SEPARATION
devstudio
C
M
Y
K
W


BGAP
COLOR SEPARATION
devstudio


C
M
Y
K
W

BG.A.P.™ ADVANTAGES:

LOWER COST.
Lower ink consumption of both white and process colorants.

MORE COLORS.
Expanded color gamut of the system when the substrate color lies beyond the boundaries of the process colorants' one.

MORE FLEXIBILITY.
It allows to obtain special effects on textured or reflective materials and preserves the original look and feel of the surface of the printing medium. The image "merges" to the surface.

Some examples…

DTG market, T-Shirt pleasing to the touch and to the sight

Natural leather: print with hybrid profile allows a much more natural look and

Gold paper

Alluminum or silver paper

Alluminum Dibond

Wood

Thanks for your attention

SW RIP & Technologies for Digital Print

Challenges in N-Colour Printing

Bressanone, Italy
William Li
Colour Products Manager
Kodak

ECG vs. CMYK

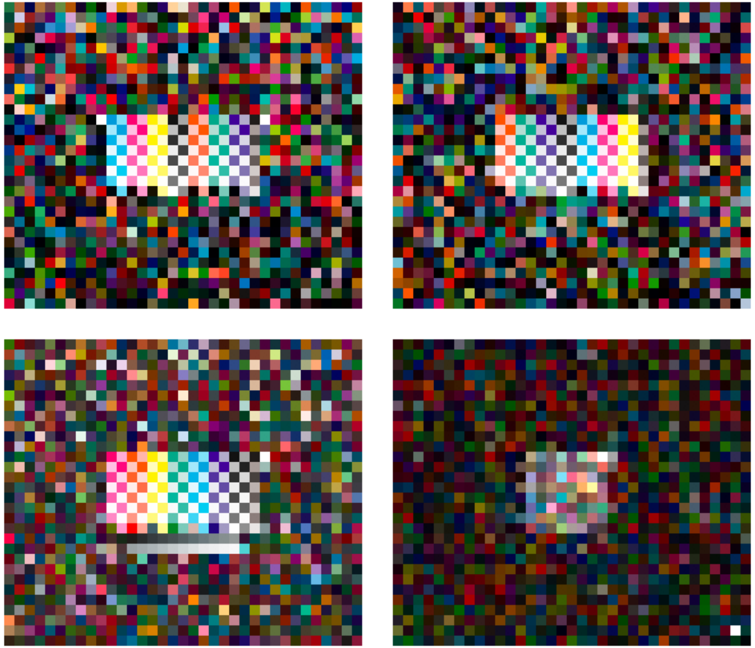
Challenge 1: Characterization

- **Combinatorial Math:**
  - 10^4 vs. 10^7

- **Light-inks vs. Gamut Expansion**

Multi-Vendor Approach for International Standards

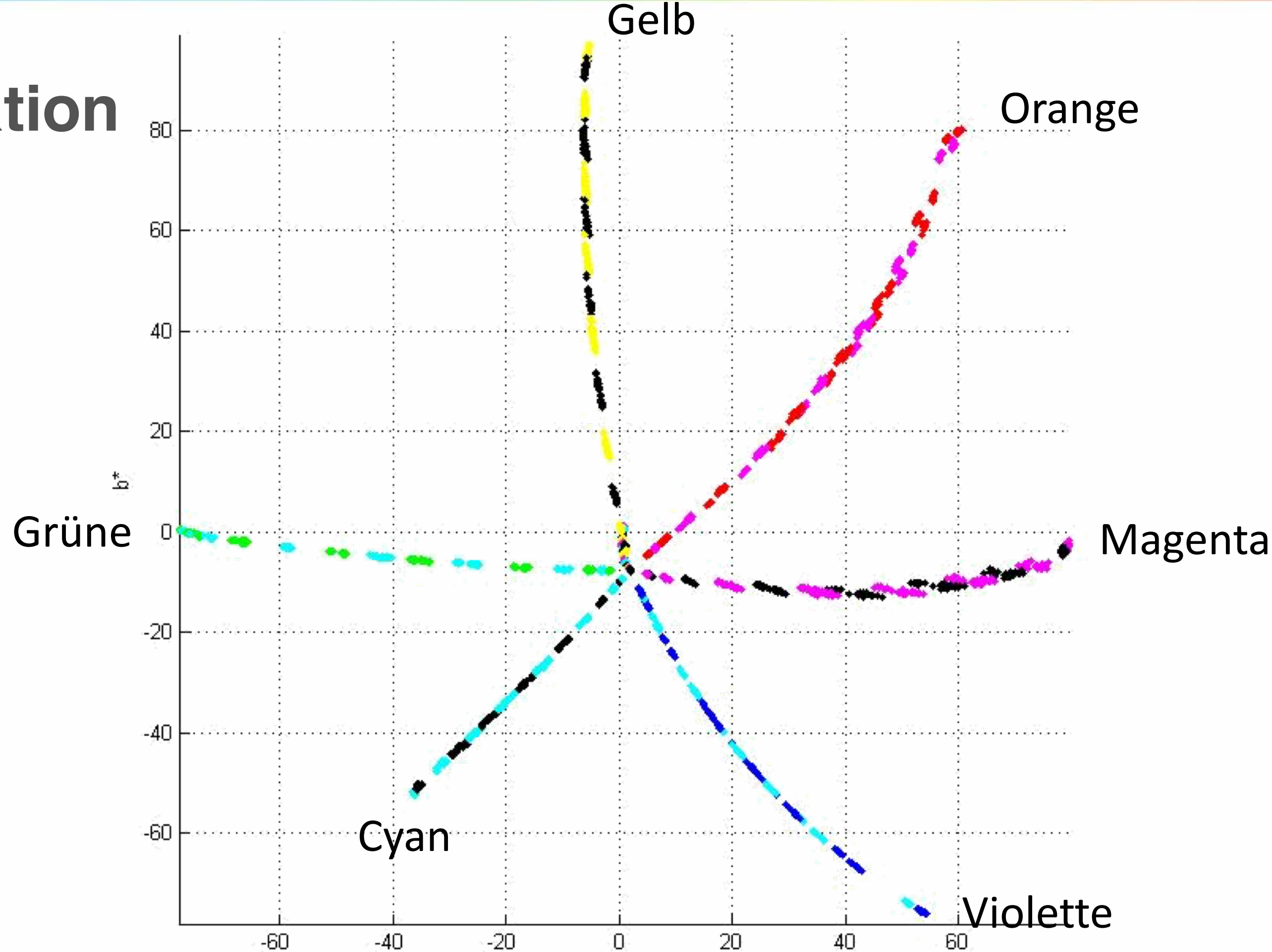
- ECG target currently under development (since 2017) for 7-colour print systems.
- Development almost complete.

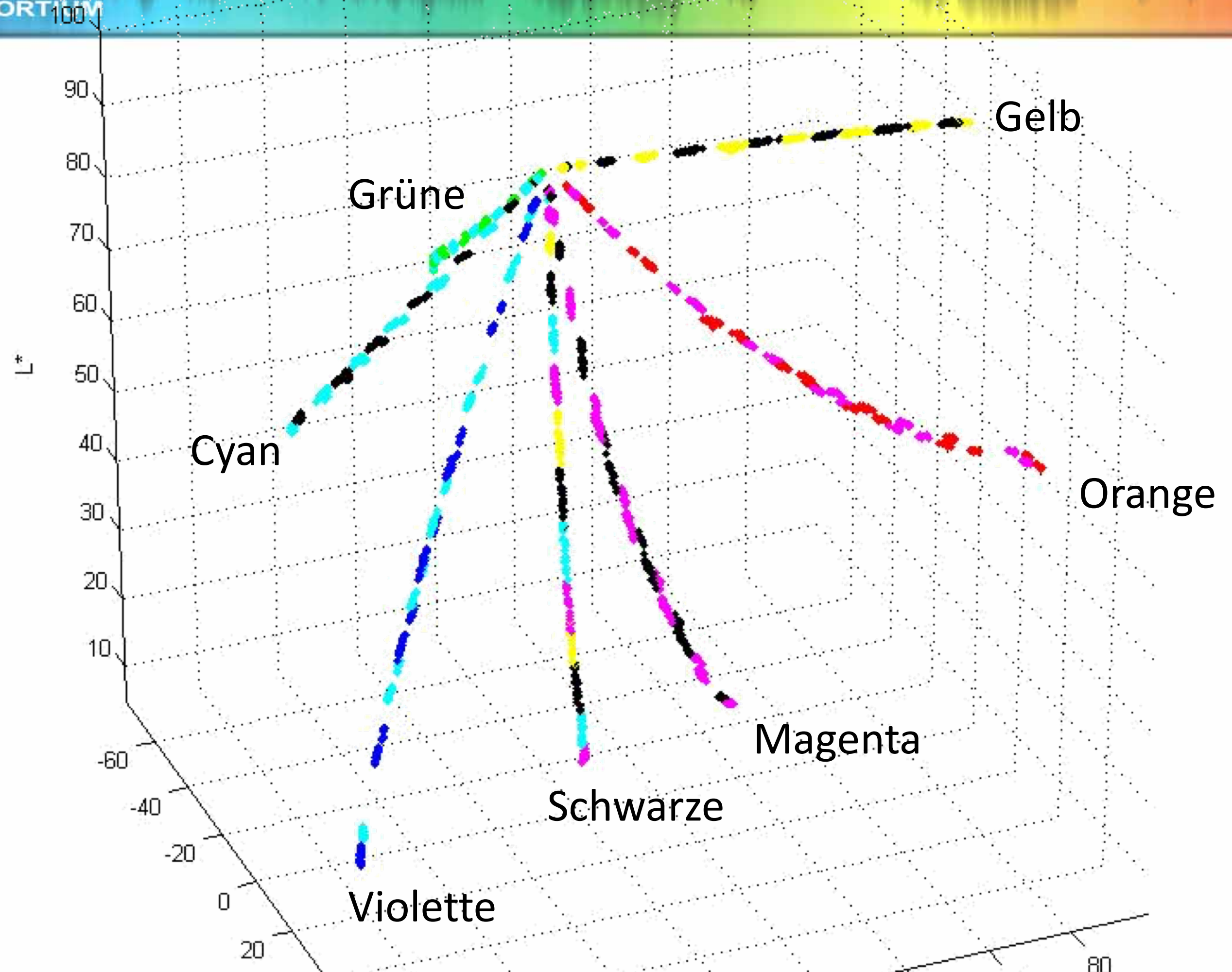


Challenge #2: Printing/Inking

- Curl of spider
- Ink loading
- Alignment (not as major an issue for inkjet)
- Screening

Characterization




Gelb
Grüne
Cyan
Orange
Magenta
Schwarze
Violette
L*
100
90
80
70
60
50
40
30
20
10
-60
-40
-20
0
20
80

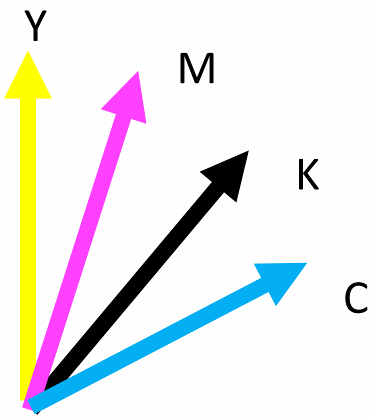
Screening


CHOCOLATE SCHOKOLADE
CHOCOLATE CHIP SCHOKOLADE CHIP
TIRAMISU
MINT MINZE
DARK CHOCOLATE

Screening: KCMY

4 colors (KCMY):

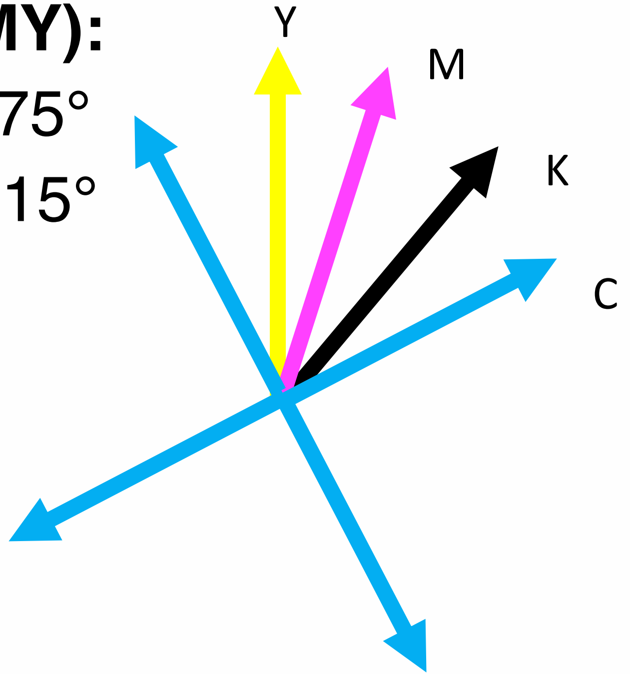
- C = 15° / 75°
- M = 75° / 15°
- K = 45°
- Y = 0°

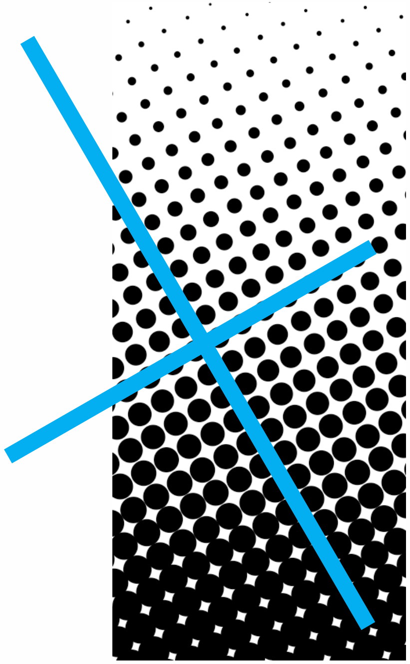


Screening: KCMY

4 colors (KCMY):

- C = 15° / 75°
- M = 75° / 15°
- K = 45°
- Y = 0°

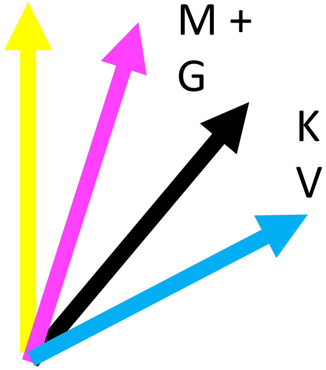




Screening: KCMYOGV

7 colors KCMYOGV:

- C = O = 15° / 75°
- M = G = 75° / 15°
- K = V = 45°
- Y = 0°

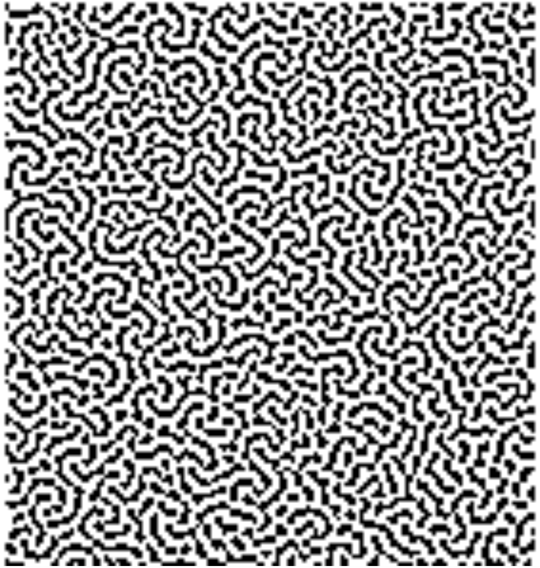


Screening: KCMYOGV via FM

Different screen per color.

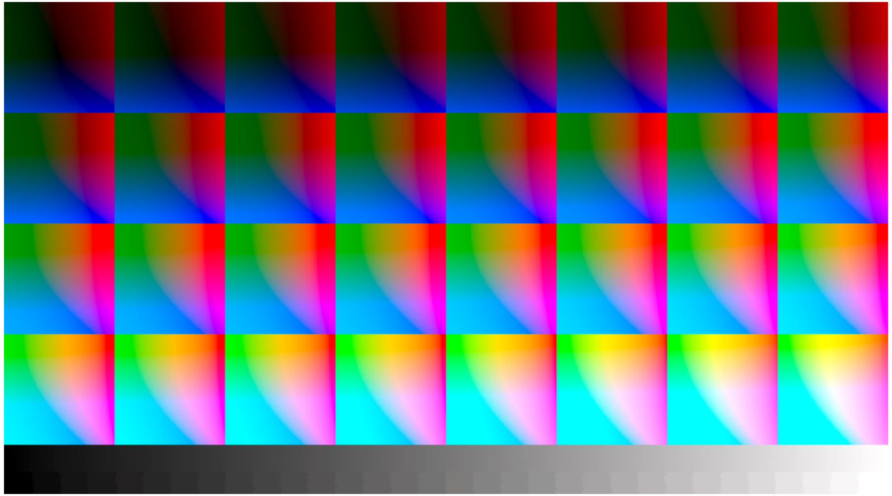
No frequency correlation between screens!

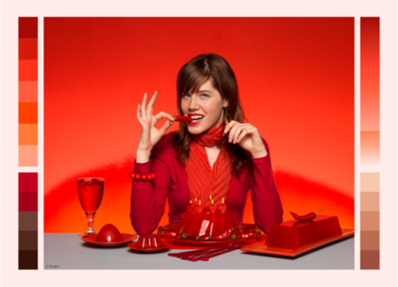
No moiré!

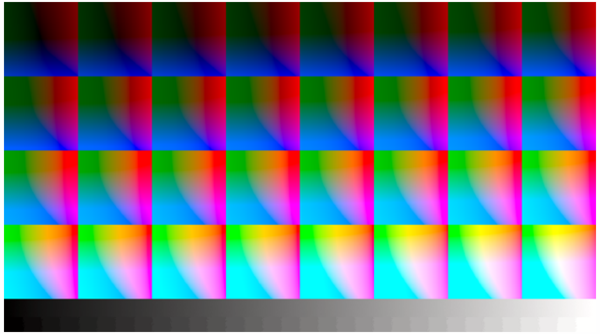


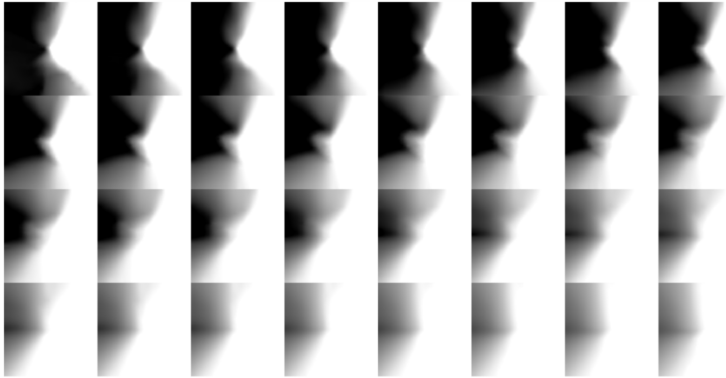
Challenge #3: Colour Separation

Obtain smoothness



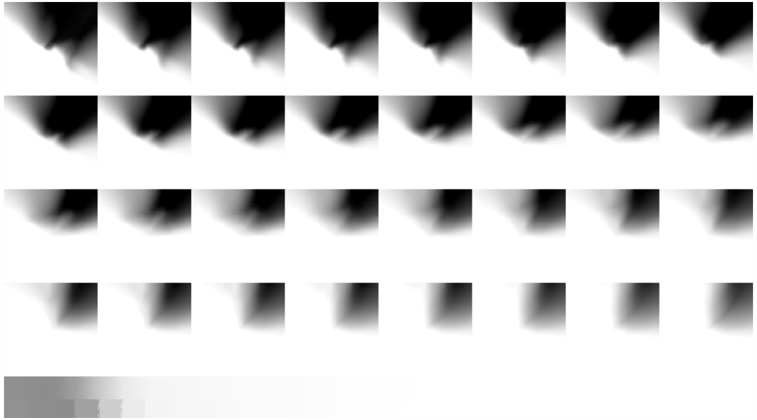


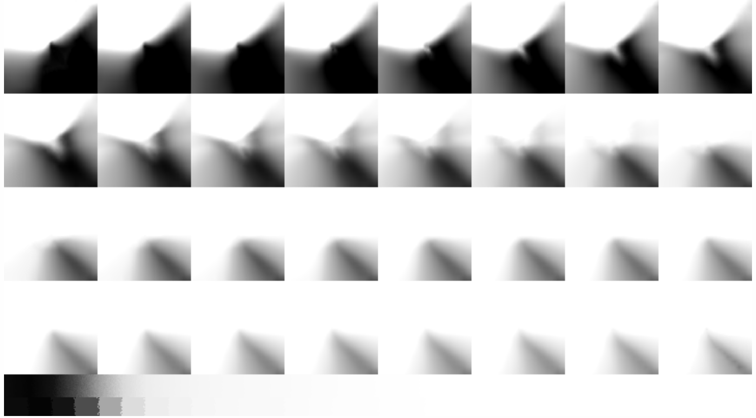




Grüne

Orange





Violette

Challenge #4: Calibration Measurement

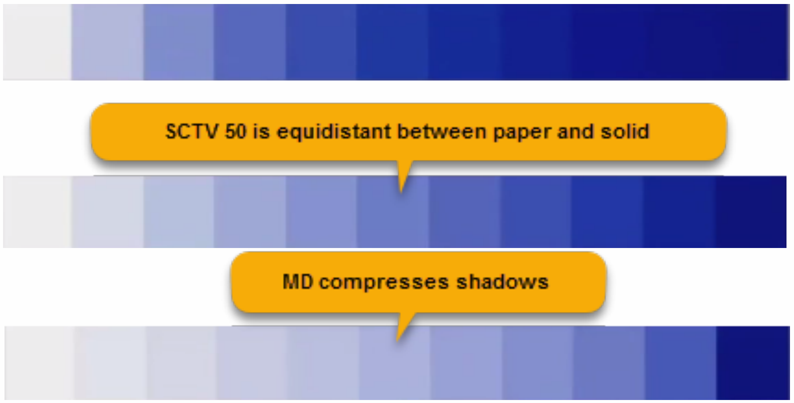
Linear SCTV target curve creates equal distribution of tones

- 50% appearance (Lab value) is half way between paper and solid
- Tone steps are equidistant across entire range
- Open smooth shadows and highlights

Uncorrected press run

Corrected by SCTV

Traditional EDA correction using Murray-Davies



Thank you!

Profiling non-standardized printing conditions

Jürgen Seitz

24th May 2019

ICC Color Experts Day, Bressanone

gmg color


gmg color
gmg color
gmg color
gmg color
gmg color

GMG Produkt Portfolio

Colormanagement by GMG

GMG ColorServer

Automatic color conversions ensuring consistent results across different substrates.

GMG InkOptimizer

Automatic reduction of chromatic inks resulting in better print stability and significant ink savings.

GMG SmartProfiler

Easy-to-use calibration and profiling wizard for digital and large format systems.

GMG ColorPlugin

The ingenious plugin for Photoshop turns complex retouching tasks into simple ones that anyone can master.

GMG ColorMaster

GMGs unique and outstanding RGB-Workflow, most efficient to highest color quality.

GMG OpenColor

Innovative profiler exactly predicting how your inks will interact on press.

Proofing by GMG

GMG ColorProof.

Internationally renowned plug-and-proof solution for printing contract proofs unrivaled in terms of color accuracy and consistency.

GMG DotProof

Market leader for printing halftone proofs, this is the only software solution that genuinely simulates dot patterns in contract proof quality.

GMG FlexoProof

Contone and halftone proofing solutions with additional special effect features for the packaging market.

GMG ProofControl.

Proof verification tool for printing and measuring control strips and evaluating the measurements according to print or in-house standards.

GMG ProofMedia

GMG provides best-quality proof media with optimally matching profiles for all contract proofing requirements.

In-depth Expert Knowledge and Customized Services

GMG Academy

Gain valuable first-hand expert knowledge with training from GMG Academy.

GMG Services

Reliable expertise on all aspects of color management, installation, ongoing support and system maintenance

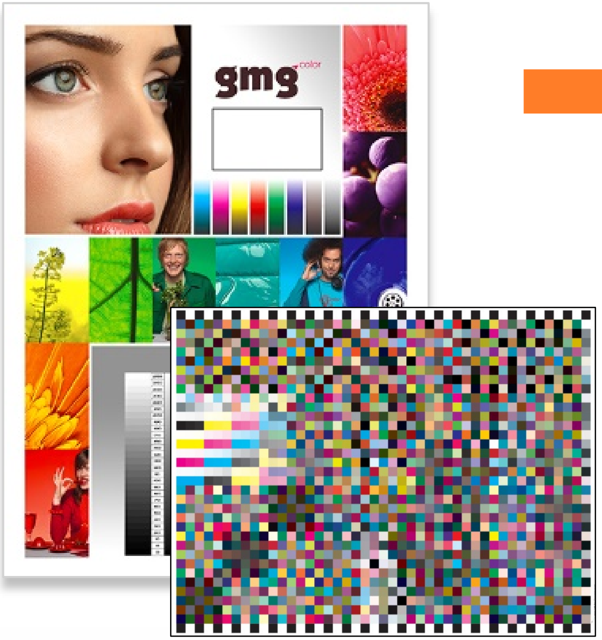
GMG Consulting

From creation and prepress to production, analyzing and optimizing the whole color management chain

Agenda

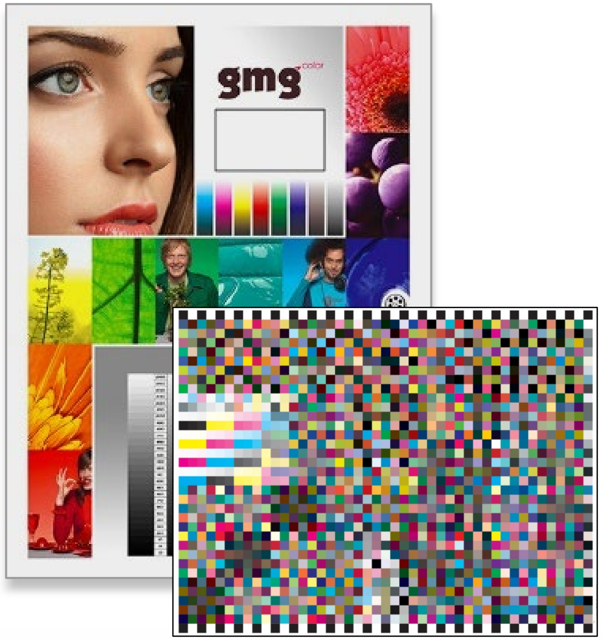
Input

characterization



Output

characterization / profiling/separation/optimization / process control



About standardized and non-standardized printing

- Standards for CMYK Offset-printing are defined for:
  - inks
  - media
  - color on media
  - process

  …

- Leaves only a reduced number of variables to be adjusted in production:
  - ink densities
  - plate curves
  - …

About standardized and non-standardized printing

- Standardized printing is accompanied by tools for a universal and consistent data handling and color prediction

CRPC 1-7

PSO

SWOP

FOGRA39

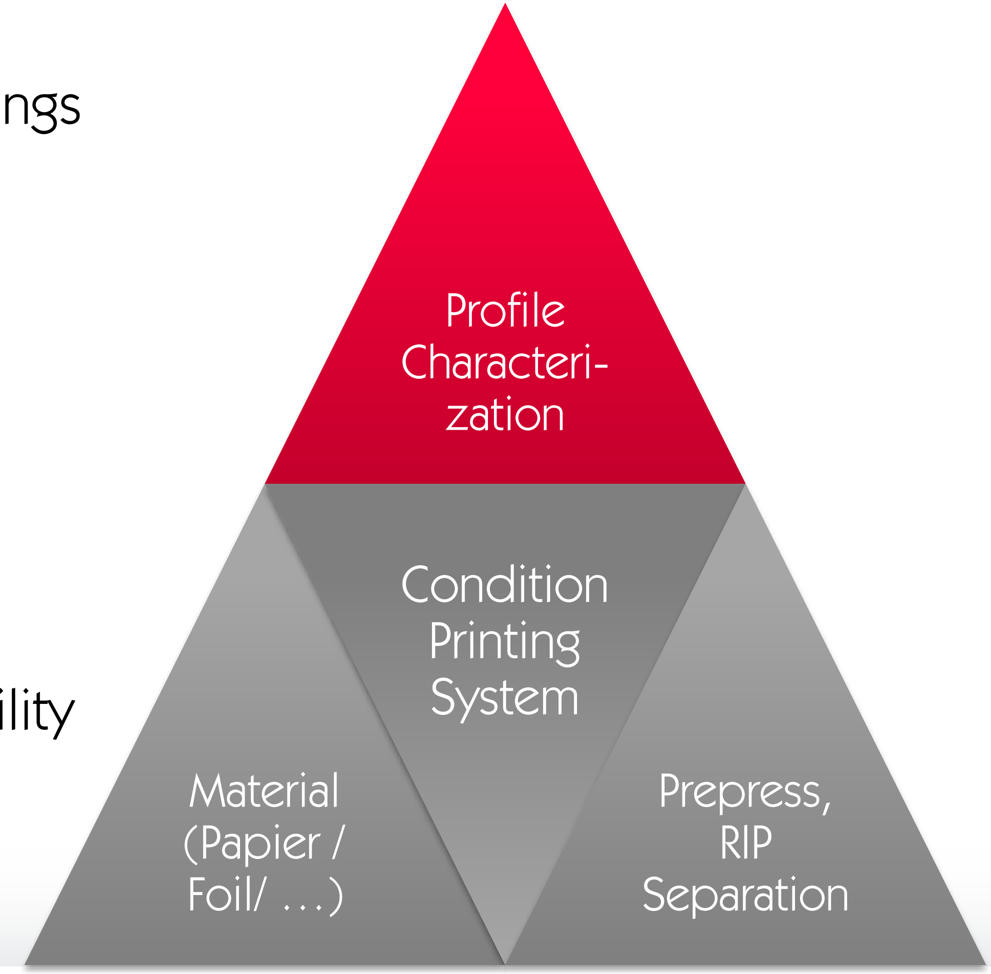
JapanColor

- Non-standardized printing setups are basically starting from scratch
  - no standard ink-set
  - no standard media
  - no reference for color on media
  - standard process description
  - ...

About standardized and non-standardized printing

- evaluation and check of actual setup and settings
- Everything clean and ready-to-go?
- Ink-split, ink-cut, total ink-coverage, …
- Rip-settings?
- ….

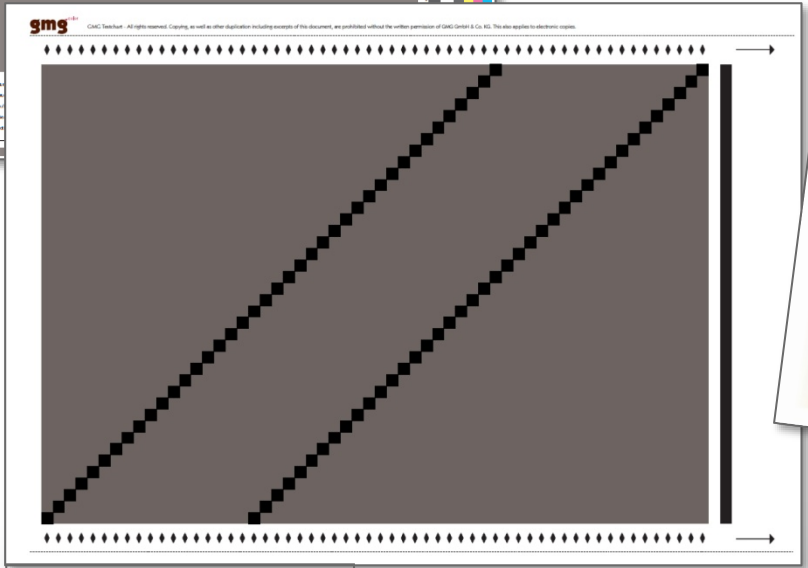
- In a non-standardized setup, more responsibility shifts to the prepress departement



gmg color

Characterization of a process

Visual Test Form

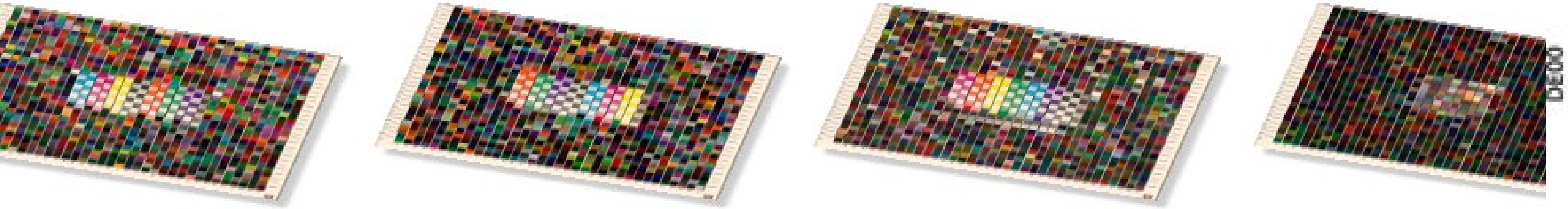


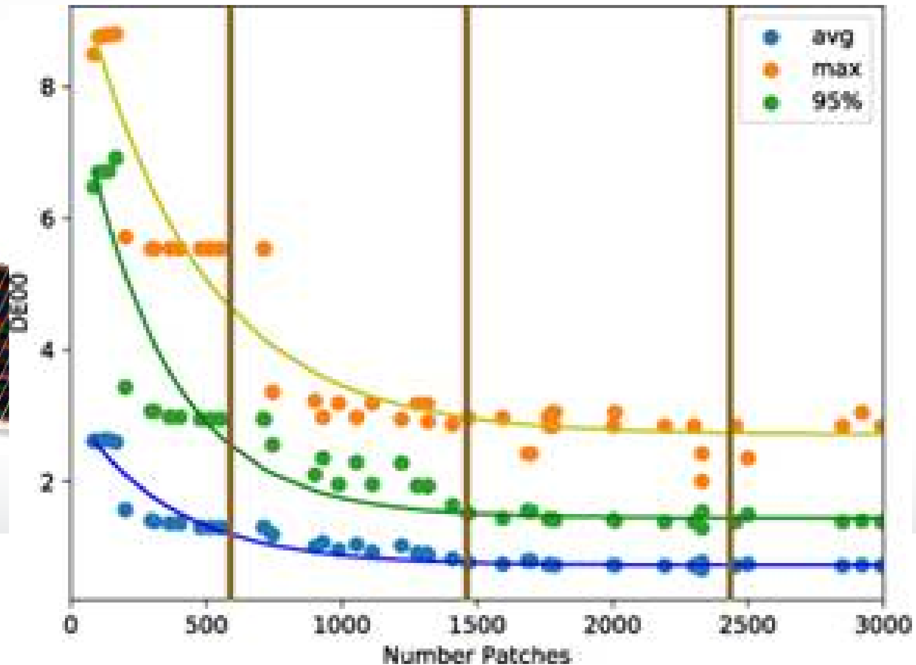
Homogeneity Test Form

gmg color

Characterization of a process

- The characterization of 4 color front-end systems may use standard testcharts (ISO 12642)
- Standard-Multicolor-Testcharts for 5, 6 or 7-c processes are just under development. Proprietary charts are most often used.
- The characterization is to be the representation of a defined output setup.

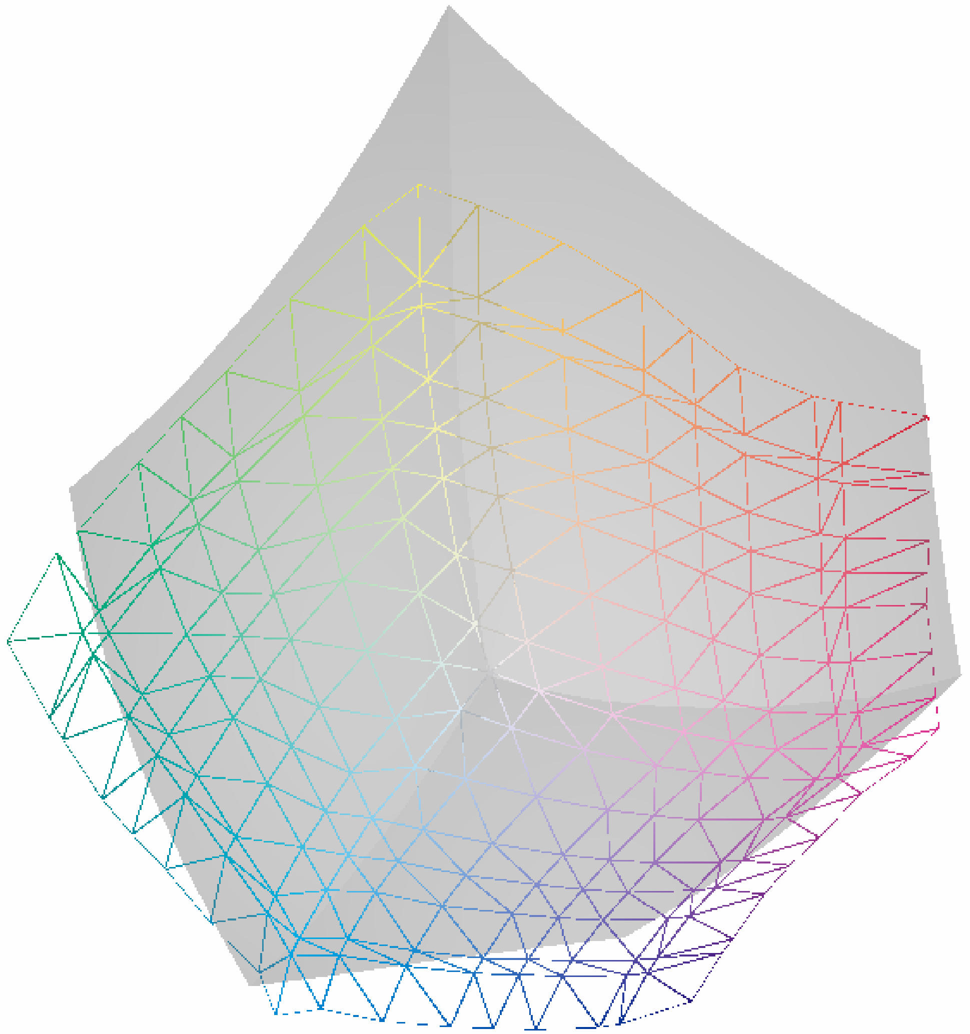




gmg color

Profiling, Separation, Optimization

- Profiling is the process when your characterization is compared to another characterization. (e.g. input data is delivered in F39)
- Profiling quality comes from:
  - gamut mapping
  - separation
  - exceptions, where needed (e.g. pure black etc)
- Usecase dependent settings!
- Consistent color appearance.



Profiling, Separation, Optimization

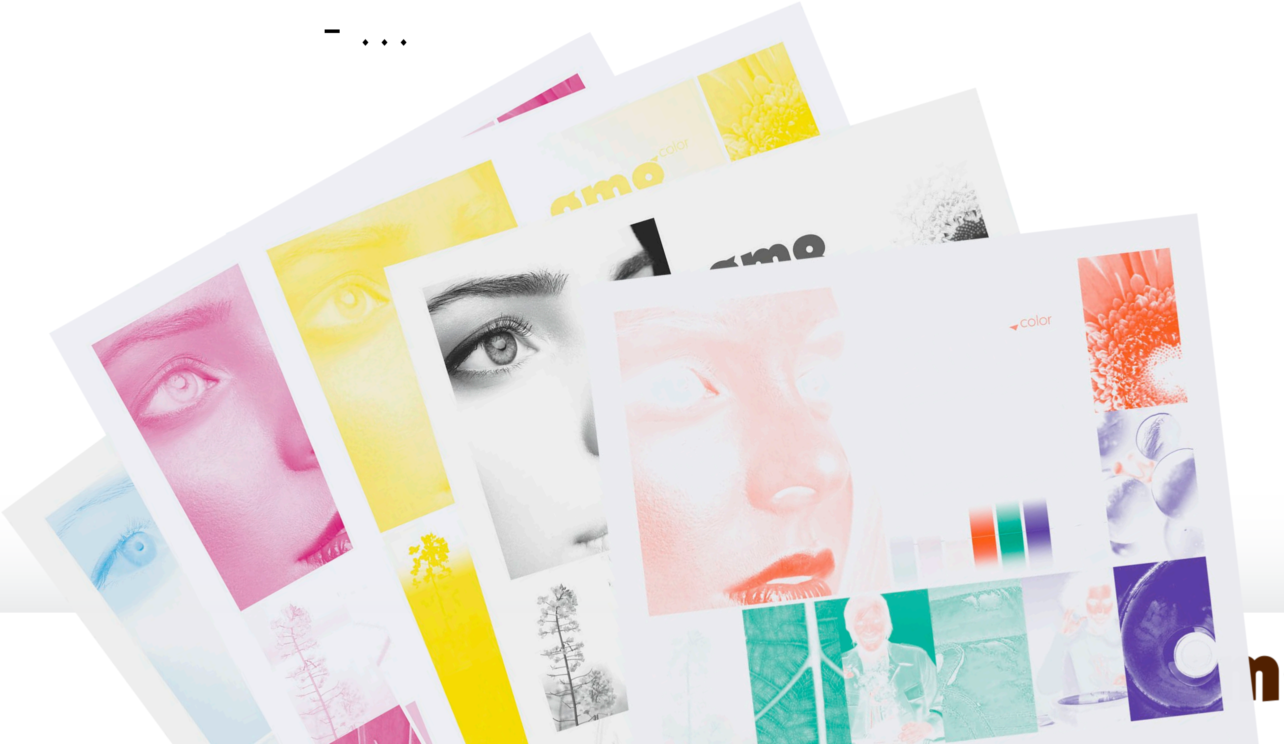
reference

„my simulation“

gmg color

Profiling, Separation, Optimization

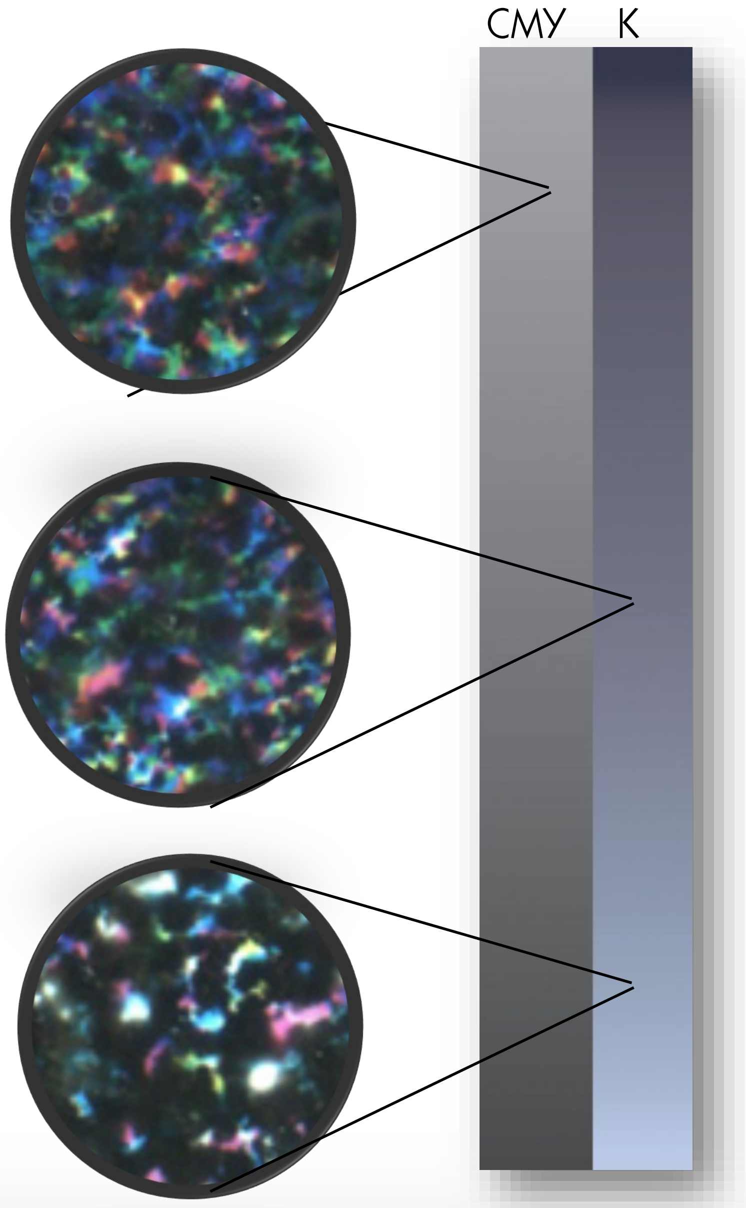
- Optimization stands for usecase-specific adjustments like:
  - ink saving
  - image enhancement
  - …



Light GCR
93/91/73/**42**

Medium GCR
67/60/44/**60**

Strong GCR
31/19/5/**84**



Process Control

reference

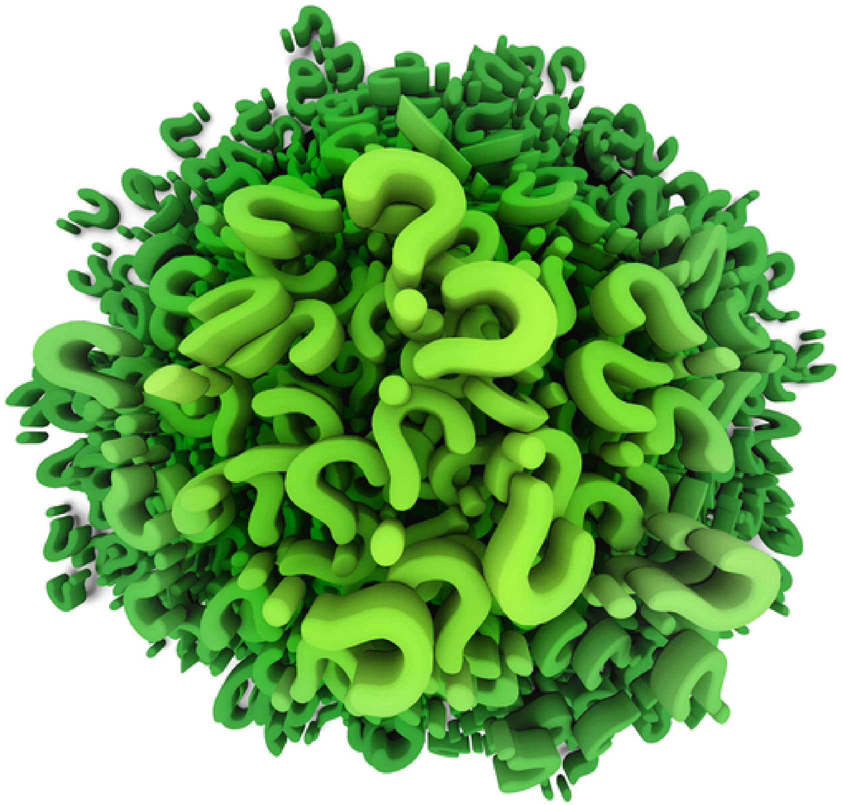
„my simulation“

Process Control

reference

„my simulation“

Fragen?

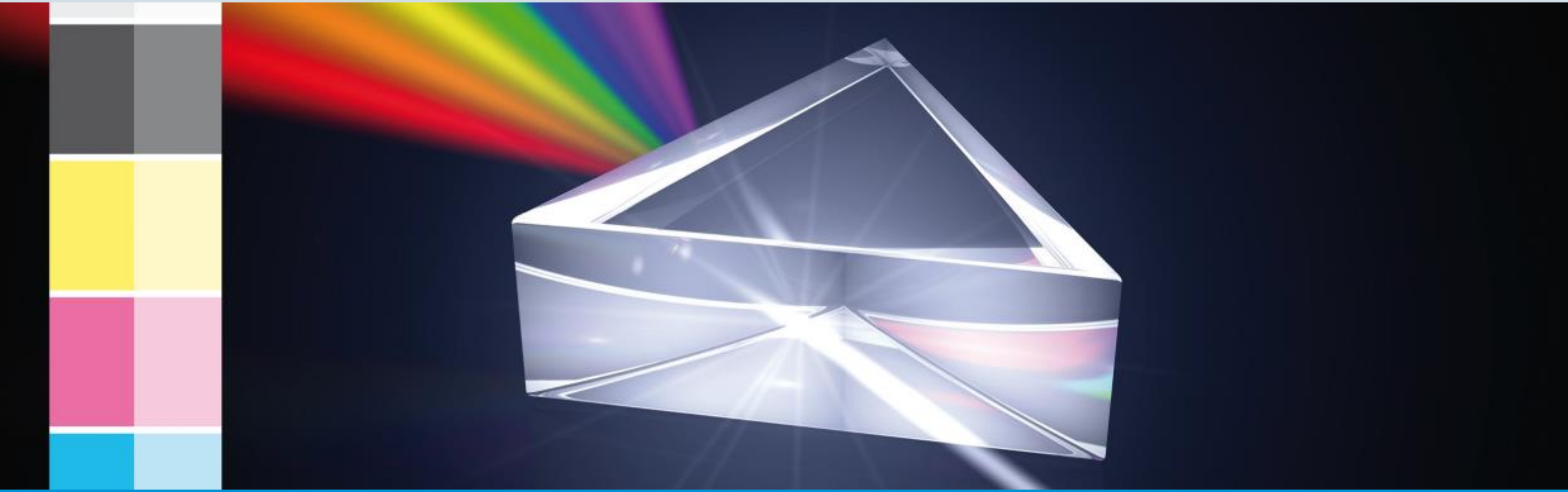


Wherever a color goes
it stays that color

gmg color

**Intelligent Measuring Technology
when Color Quality counts**

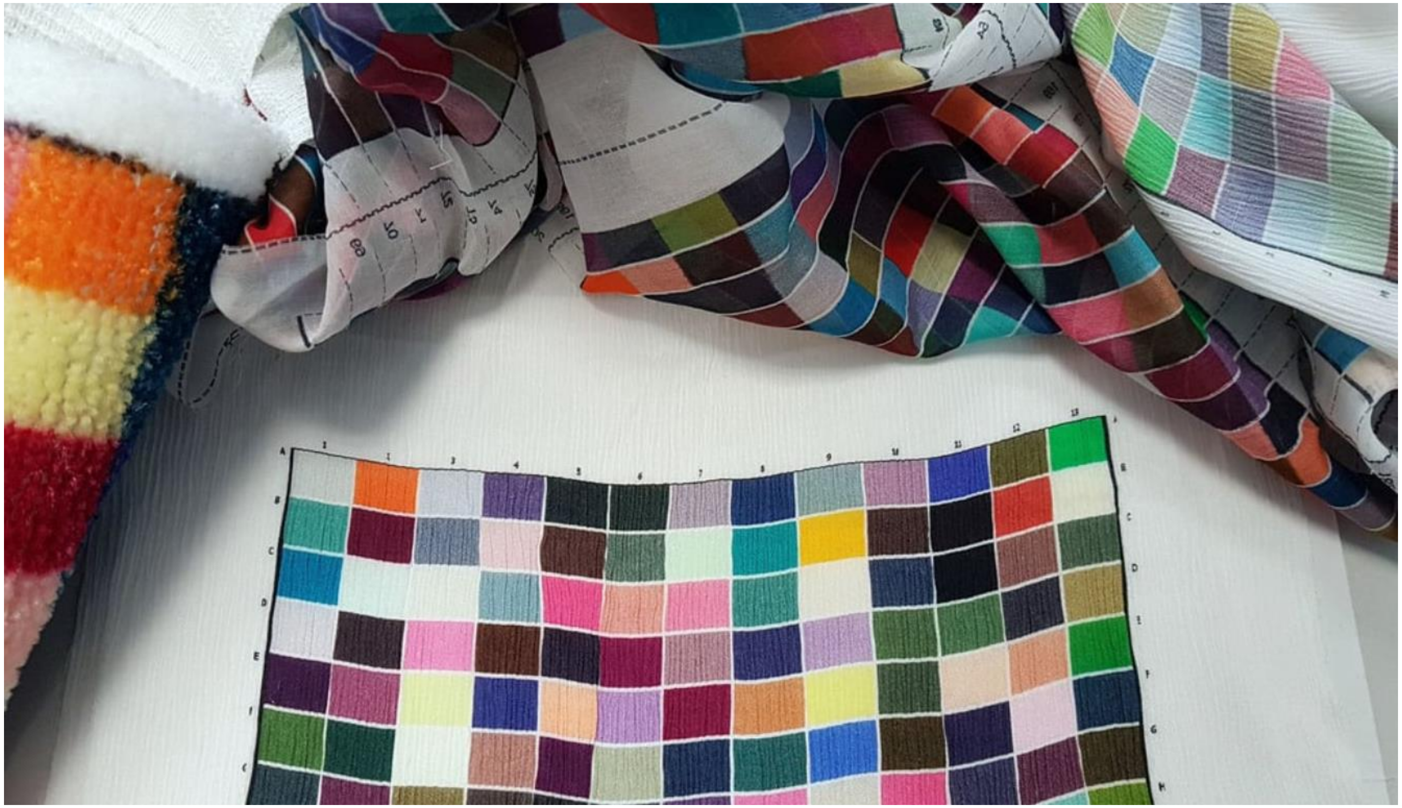
Measurement solutions for signage and digital textile printing



Agenda

- What is a spectrophotometer
- Reflectance measurements
- Textile measurements
- Measure Transparent Materials
- Computer vision helps measurements

Improving accuracy and repeatability of color measurements

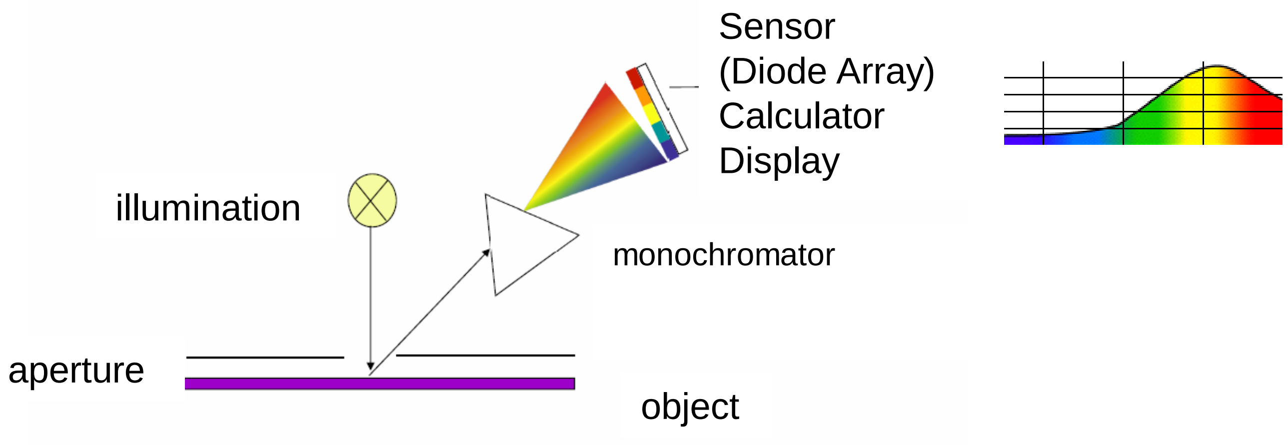


how to get most accurate measurement results on special materials

Instrument description

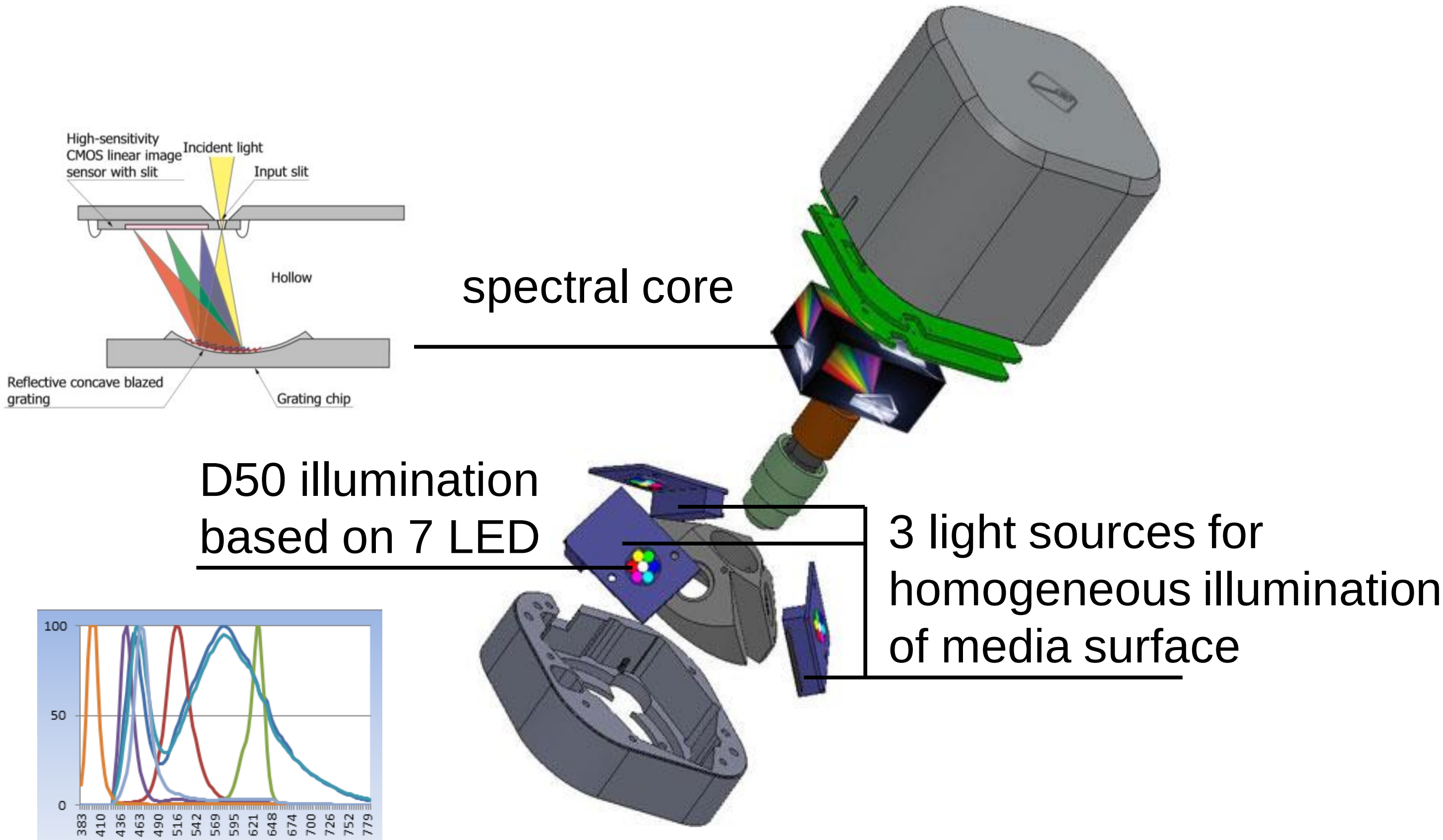
Spectrophotometer

- Used to measure the reflection or transmission properties of a material as a function of wavelength
- Determining the reflectance or transmittance involves careful consideration of the geometrical and spectral conditions of the measurement



Scheme of a spectrophotometer

Barbieri qb-technology

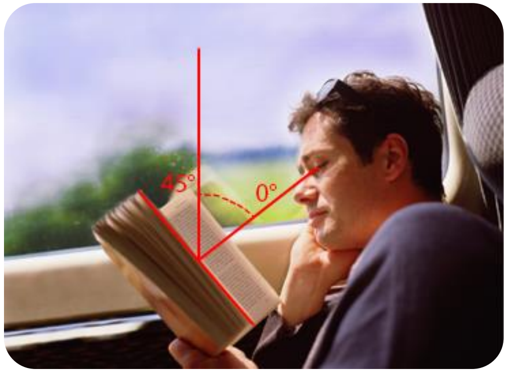


Spectrophotometer measuring head

Reflectance measurement

Optics:

the 0°:45° or 45°:0°annular or circumferential geometry provides the best correlation to the reflectance seen by a human observer using the standard viewing conditions



Illumination over filling or under filling:

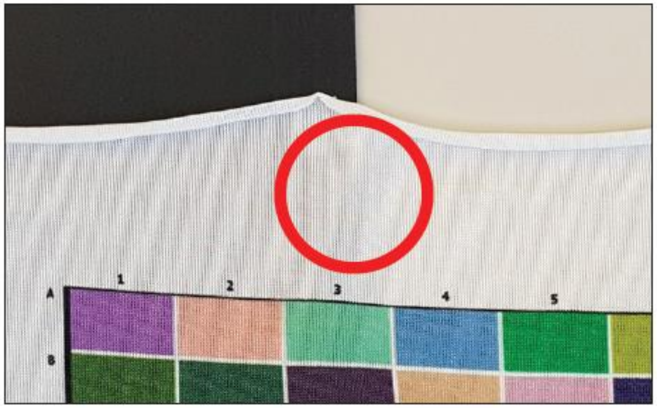
When a specimen is translucent, at least to some degree, some of the illuminating light penetrates the specimen and scatters laterally to points outside of the area viewed by the instrument detector, causing the reported reflectance values to be lower than they would be if all the reflected light were collected (translucent blurring error)

Reflectance measurement

Media Opacity

As in digital printing plenty of different media are used, every media shows different opacity.

Textile with low opacity

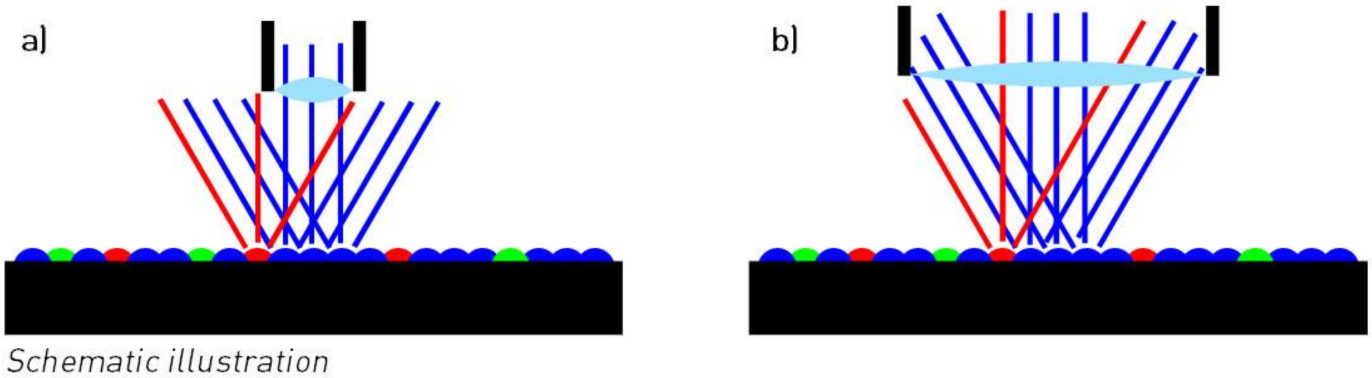


Textile with higher opacity

Black or white backing for the sample holder

Variable Measuring Aperture

UV Ink



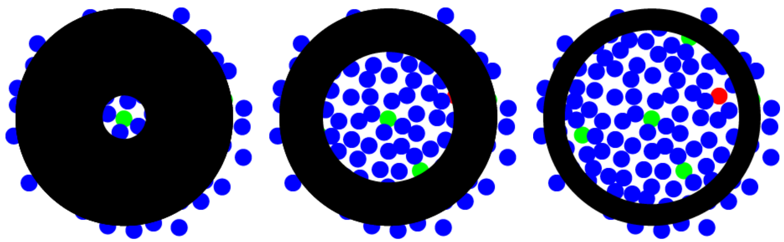
Small aperture

Large aperture -> more accurate

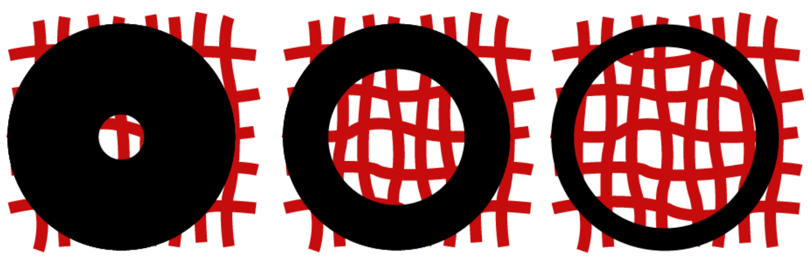
Best results on UV prints: 6 mm aperture

Variable Measuring Aperture

Low resolution prints:

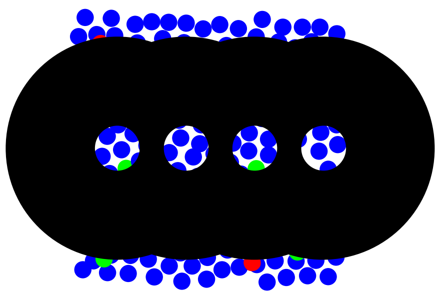


Textiles, structured media:

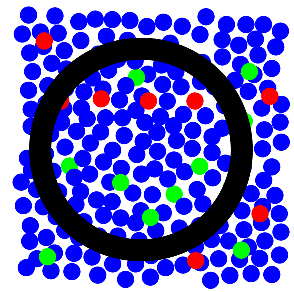


Variable Measuring Aperture

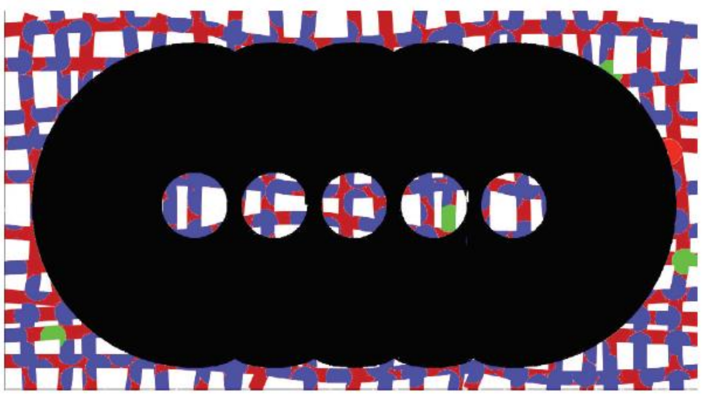
Multiple measurements vs. large aperture

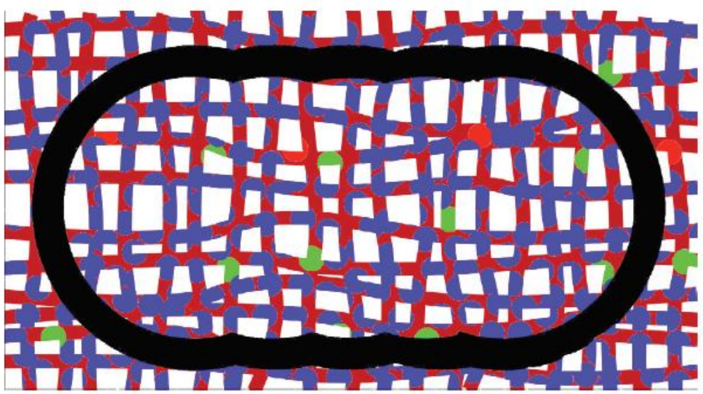


Multiple measurements



Large aperture





=> Large aperture often more accurate than multiple measurements

Variable Measuring Aperture

Select the best Patch size for your target

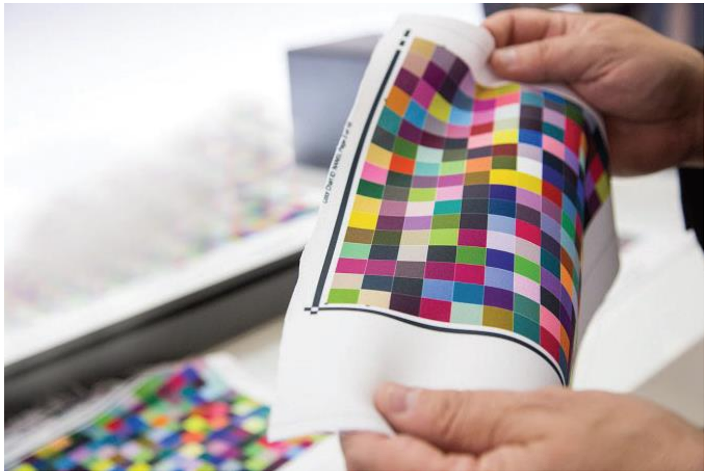
Measuring aperture size comparison

Diameter	Measuring Area	Area difference
2 mm	3 mm²	
6 mm	28 mm²	9 times larger than 3 mm²
8 mm	50 mm²	17 times larger than 3 mm²

Measuring Textiles

Experiment:

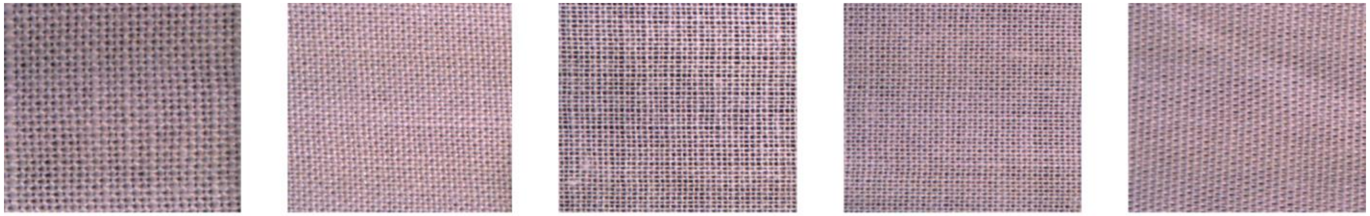
Verify effects of texture on measurement reproducibility of the spacial orientation and location of measurement on textile samples.



The objective of this experiment was the analysis of different measurement instruments on digitally printed textiles, focusing on repeatability and reproducibility aspects of measurement uncertainty for textiles.

Measuring Textiles

Sample textile data set



(a) Sample 1 (b) Sample 2 (c) Sample 3 (d) Sample 4 (e) Sample 5

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Name	Half Panama	Popeline 40/40	Voile	Woven 30/30	Woven 30/22
Thickness	250 microns	237,5 microns	125 microns	150 microns	175 microns
Thread count (per cm^2)	25x20	40x30	36x28	40x30	50x22

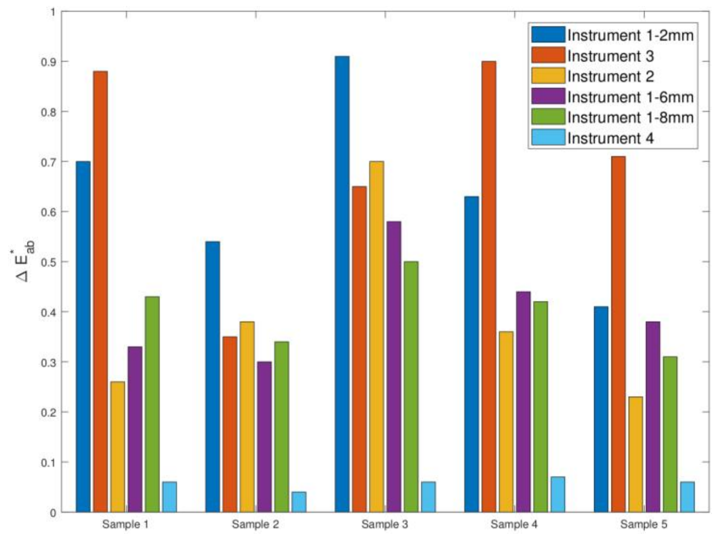
Measuring Textiles

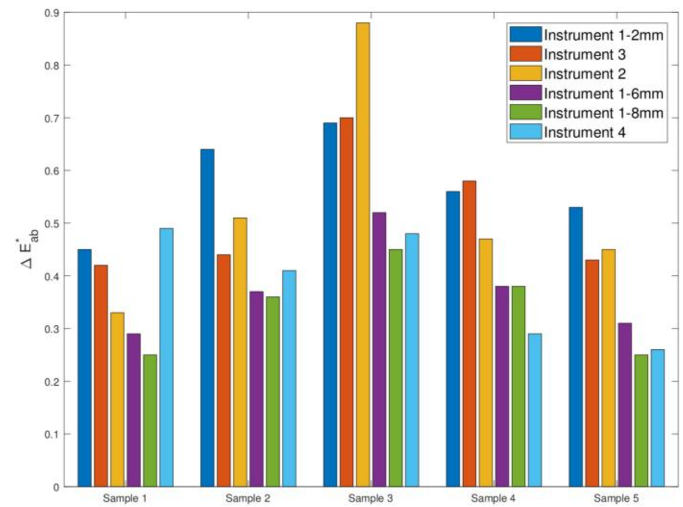
Sample Instruments from different vendors

	Instrument 1	Instrument 2	Instrument 3	Instrument 4
Geometry	Circumferential 45°:0° (3-point circumferential illumination)	Circumferential 45°:0° (annular illumination)	0°:45°	d:8°, Diffuse illumination
Geometry standard conformance	ISO 13655:2017, ISO-5-4	ISO 13655:2009	DIN 5033	Unspecified
Aperture	Switchable between 2, 6 and 8 mm	4.5 mm	3 mm	8 mm
Aperture (over or under-filled)	Over-filled	Under-filled	Unspecified	Over-filled
Light source	7 narrow-band LEDs	Gas-filled tungsten	Gas-filled tungsten	Gas-filled tungsten
Detector	Diode array	Diode array	Unspecified	Blue-enhanced silicon photodiodes
Inter-instrument agreement	Avg: 0.5 ΔE^*_{00} Max: 1.0 ΔE^*_{00}	Avg: 0.4 ΔE^*_{94} Max: 1.0 ΔE^*_{94}	0.3 ΔE^*_{ab}	Avg: 0.20 ΔE^*_{ab} Max: 0.40 ΔE^*_{ab}
Spectral range and interval	380nm to 750nm at 10nm	380nm to 730nm at 10nm	400nm to 700nm at 10nm	400nm to 700nm at 10nm
Short-term repeatability	Spot: 0.05 ΔE^*_{00} (standard deviation, 10 measurements made with white BCRA) Scan: <0.2 ΔE^*_{00}	0.1 ΔE^*_{94} on white (D50, 2°, mean of 10 measurements every 3 seconds on white)	0.03 ΔE^*_{ab}	0.05 ΔE^*_{ab} on white ceramic (standard deviation)

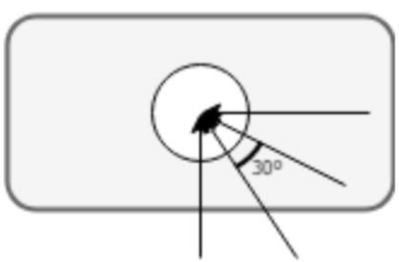
Measuring Textiles

Average ΔE*ab using different instruments

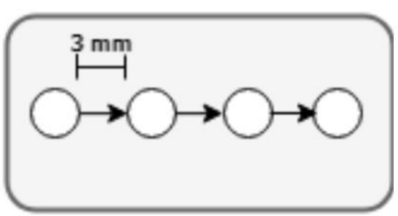




Rotation

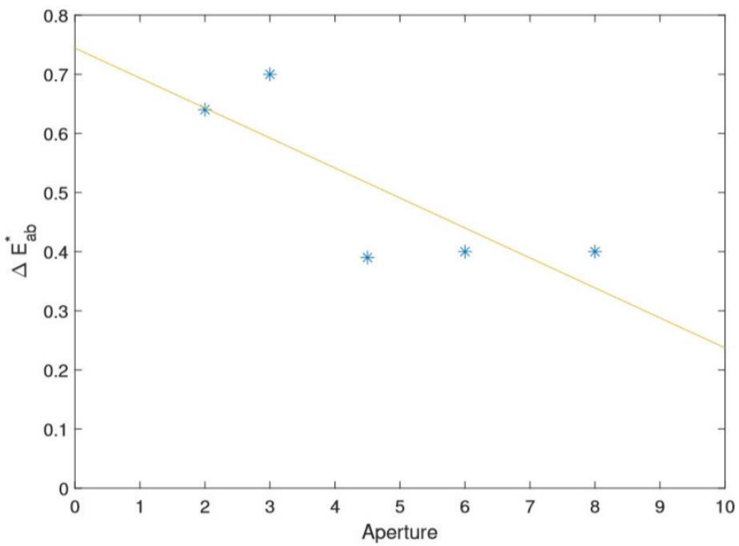


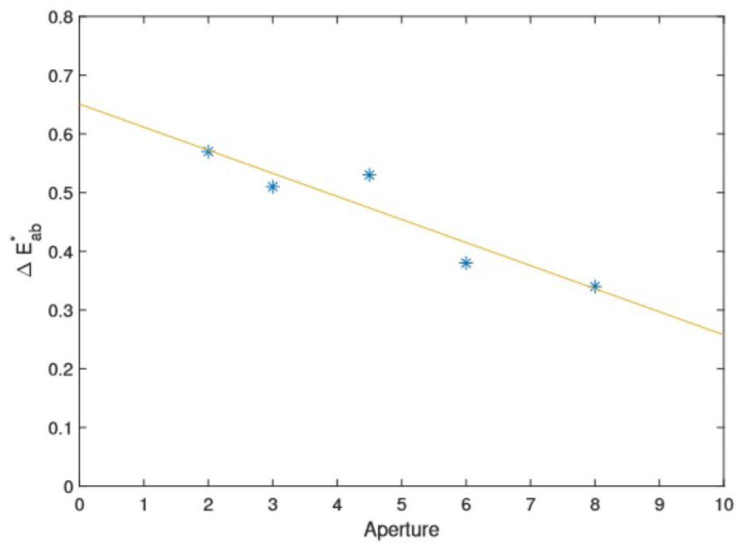
Translation

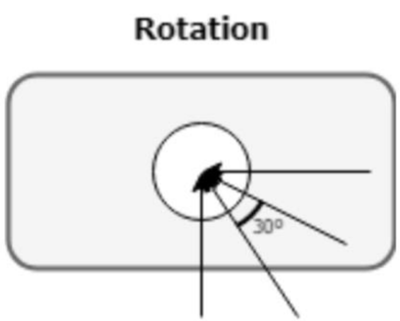


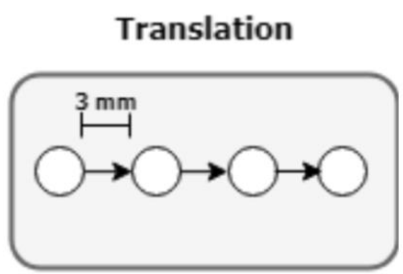
Measuring Textiles

Average ΔE*ab against measuring aperture









Measuring Textiles

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How to get Maximum Accuracy

The best measurement accuracy and repeatability on difficult media such as textiles can be achieved by:

1. Choose the right sample holder
2. Use wide measuring aperture
3. Multiple measurements per patch (using wide aperture)
4. Use automatic measurements (to avoid the influence of the human handling errors)

Measure Transparent Materials

Where to use transmission measurements

printed image is viewed through an illumination from behind the image

prints on textiles, glass or similar transparent / translucent materials

measurement of thin, flexible transparent or translucent material very similar as when measuring paper materials

measuring thicker material such as glass however does require a basic understanding on the limitations

Measure Transparent Materials

Backlit Color Management Applications

Backlit Alone
When looking at a backlit print on a light box, the human eye will adapt relatively to the white point of the backlit print. The observer is seeing/expecting a colorful picture using the full gamut capabilities offered by the material and ink.

Backlit near Backlit
two prints are viewed on light booths where either the media can be different (in color cast or in translucency) or the light booth color temperature and brightness.

See FOGRA Research Project:
https://www.fogra.org/en/fogra-research/wc-digital-printing/digital-printing-current-projects/backlit-2-623/colormanagement-for-backlit-materials.html

Measure Transparent Materials

Backlit Color Management Applications

Backlit near Reflective Proof
Same as above, but in addition a proofing profile needs to be applied to the image.

Day / Night application
One print is viewed in Reflection mode during the day and on a light booth during the night.

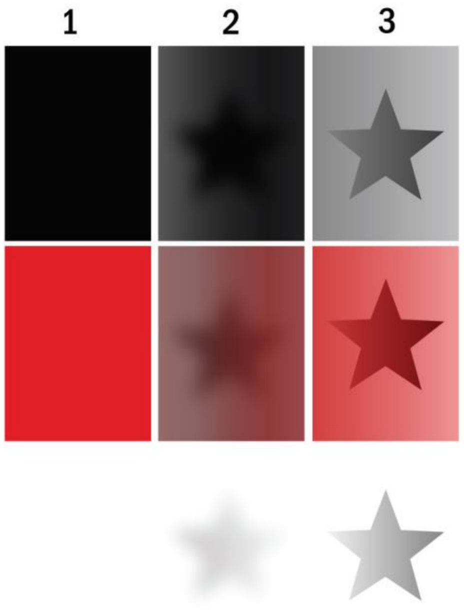
Measure Transparent Materials

Transparency, Translucency, Opacity

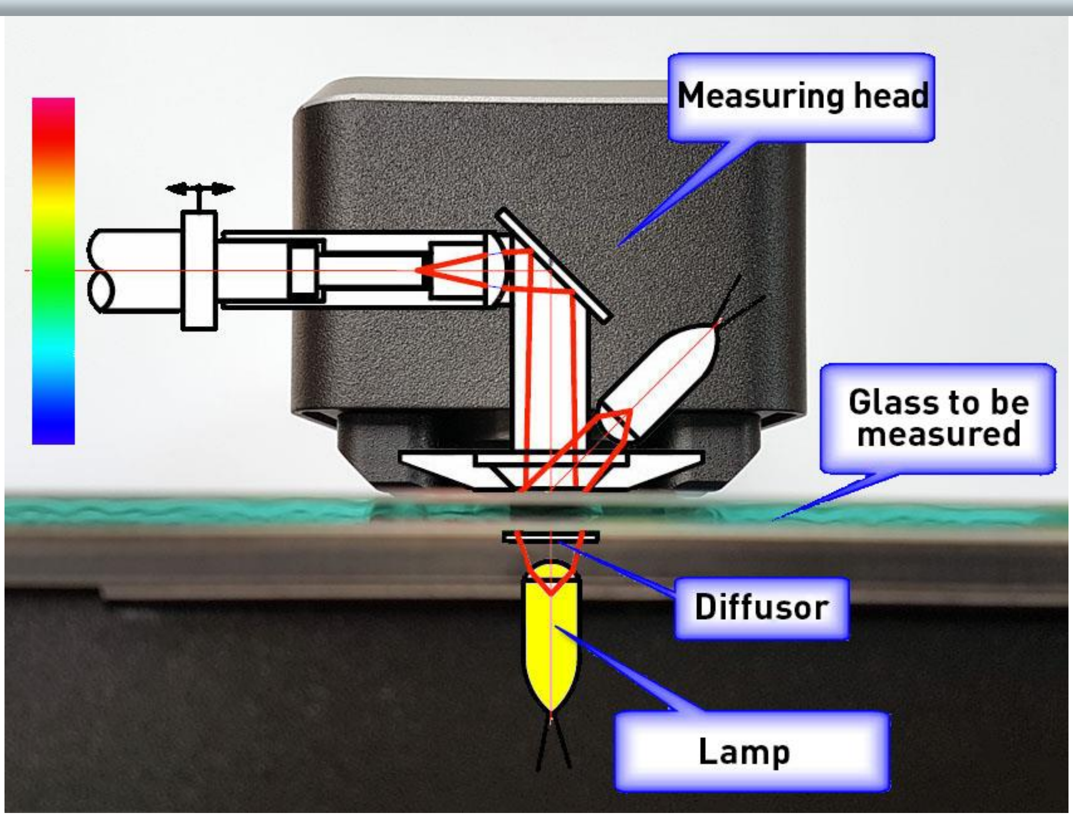
1.) Materials which do not transmit light are called opaque.

2.) Translucency (also called translucence or translucidity) is a superset of transparency: it allows light to pass through but will be scattered.

3.) Transparency is the physical property of allowing light to pass through a material without being scattered.



Backlit measurements



The measuring head touches the glass and is in a distance of the glass thickness to the lamp/ diffusor. In this situation, the measuring head can see also light coming from outside and therefore cause wrong readings.

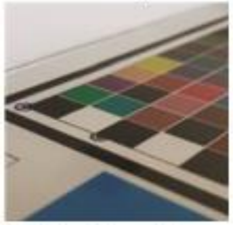
Measure Transparent Materials

Printing considerations

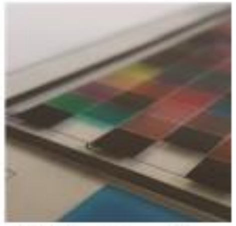
Glass should be measured in the same way as the final result will be looked at. The diffusor of the instrument (light source for transmissive readings) should be at the side of the light source and the measuring head at the side of view. This can cause 2 situations:

a) Print side towards measuring head: this is the preferred measuring method, as the measuring head only sees the light coming through the patch to be measured.

b) Print side behind (towards diffusor): the thicker the glass, the more light comes sideways into the measuring head causing erroneously dark patches to become lighter.



Printed on the top side



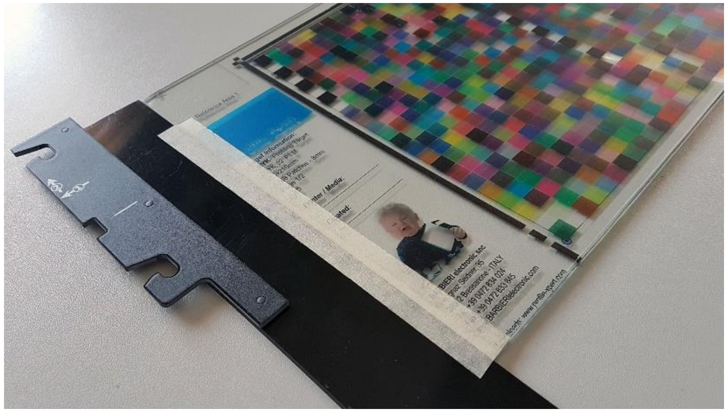
Printed on the bottom side

Measure Transparent Materials

Reference area

Barbieri targets have a “reference area” in the upper left corner of the target. Do not cut off this reference area.

If printing with white ink backing, also the reference area must be printed white.

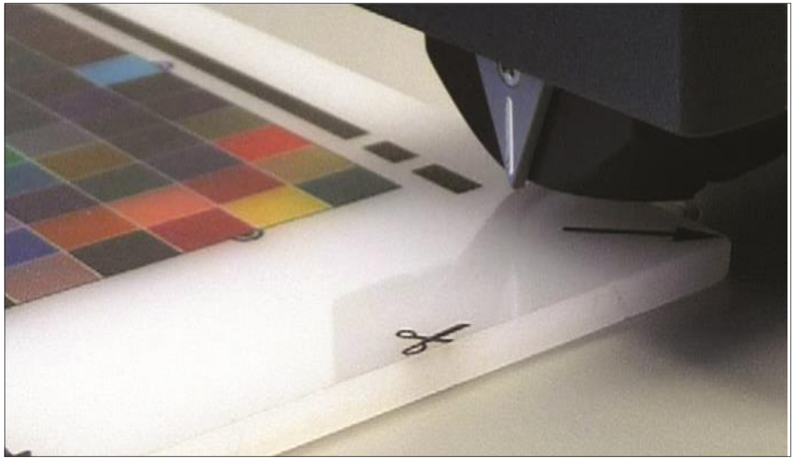


Measure Transparent Materials

Opal glass

Opal / translucent glass is measured the same way as fully transparent glass. Measuring time is slower, as the instrument gets lower light level and therefore adjusts measuring time accordingly.

In this lower light condition, the stray light influence is more critical and the thinner the Opal glass is, the better the measuring results will be.



Measure Transparent Materials

Colored glass or medias

All measurements are relative to the “reference area” on the target. This means, the instrument assumes the white point to be in the reference area and gives it a value of L*=100, a*=0, b*=0. This works great for color management applications which assume a “white background”, as it corresponds to the interpretation of the human eye which also adapts image interpretation to this reference white point.

Note: When using colored glass, this method makes it impossible for the ICC profile to use the “absolute colorimetric intent” to match colors as “absolute” and “relative” intents are equal. If absolute colorimetric matching is required, the reference area on the target must be substituted with a transparent area of same thickness.

Measure Transparent Materials

barbieri®

How to get Maximum Accuracy for transmission measurements

The best measurement accuracy and repeatability can be achieved by:

1. Verify if a thin media of the same type is avaiable (thin glas)
2. Choose the best sample holder
3. Make media relative measurements calibrating the instrument on the Reference area
4. Select an appropriate measuring aperture
5. Use multiple measurements/patch

Measuring textiles made easy and accurate

barbieri®

Computer vision helps to reduce measurements error

Special textile holder to fix charts

SpectroLFPqb sensing unit

“Patch recognition”: center of each patch detected even if chart is distorted.

Opens a universe of new

…recognize chart, page, size, etc.
…avoid handling mistakes (wrong chart)
…recognize a unique target ID (barcode, QR code)
…measure just single areas in a picture

Thanks

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Measurement Challenges For Non Paper Substrates

Ray Cheydleur

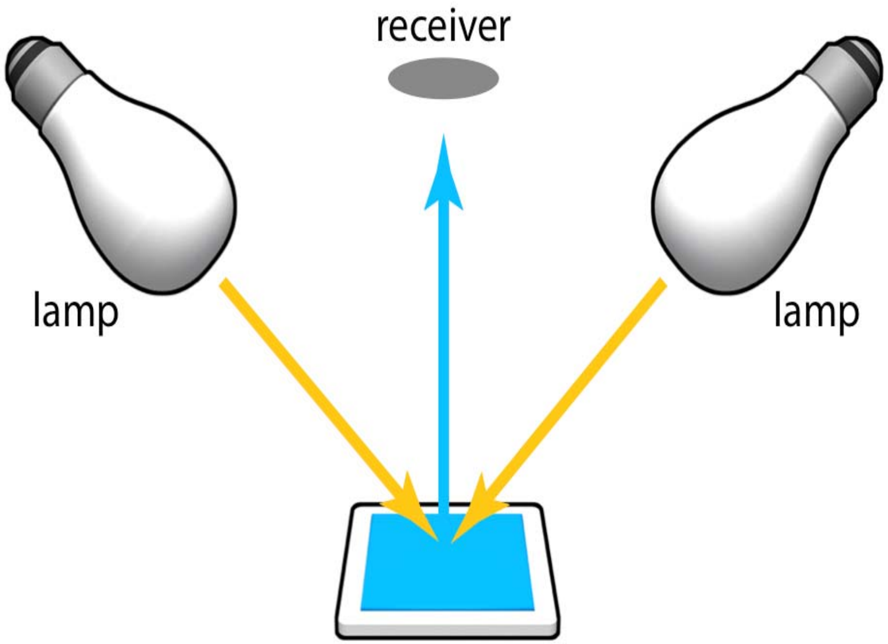
Market Manager

Printing, Packaging and Imaging

X-Rite Pantone

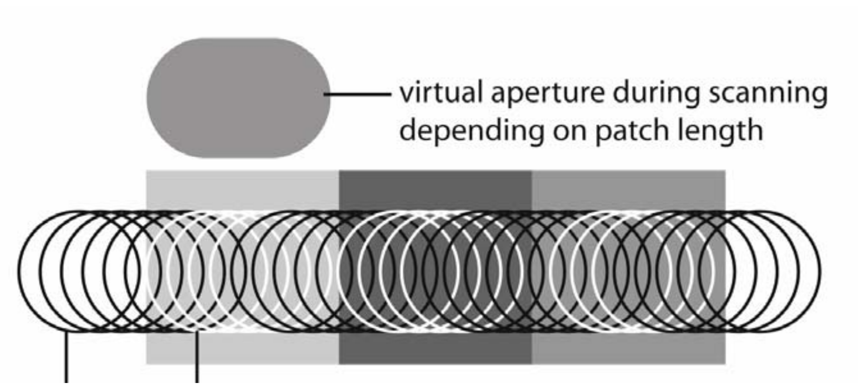
Let’s start with the Basics

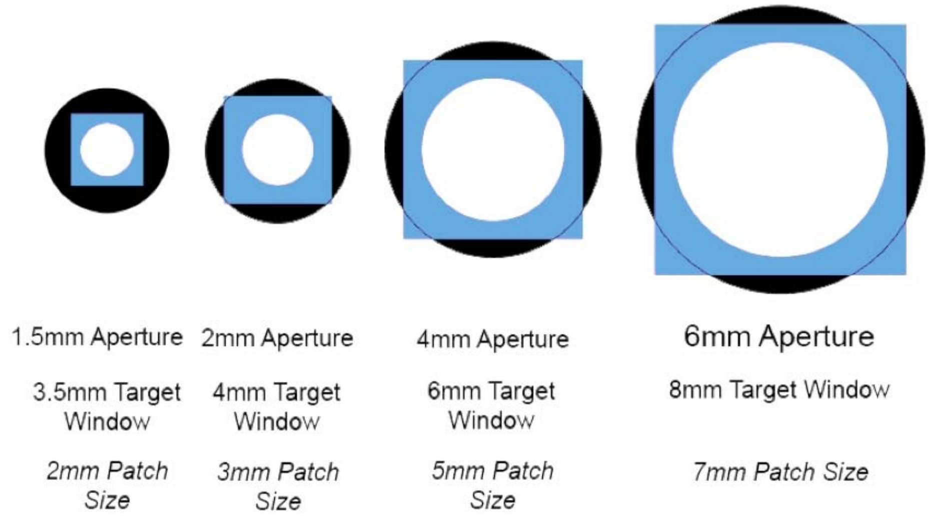
- Classic paper measurement is done with a 0:45 or 45:0 measurement device
- Spectrophotometer (a.k.a. Spectro) – A device that illuminates a sample, and measures the amount of light reflected (or transmitted) at various wavelengths



Aperture Size

- **Traditionally in print the smallest aperture appropriate for the linescreen or DPI is used**
  - Substrate is very smooth and homogeneous
- **In grand format this is not always the case**
  - Printer may be capable of finer DPI
    - May not be used depending on application/speed
- **Non paper substrates are often rougher**
  - Better to use a larger aperture
- **Other options**



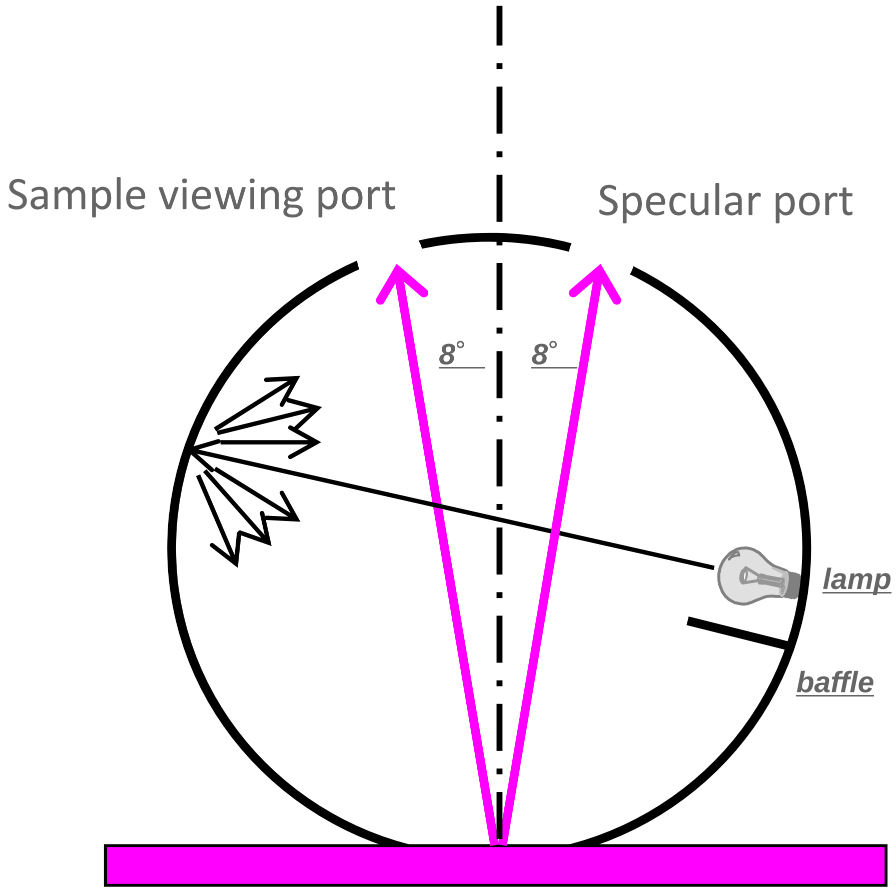


Non 0:45 devices

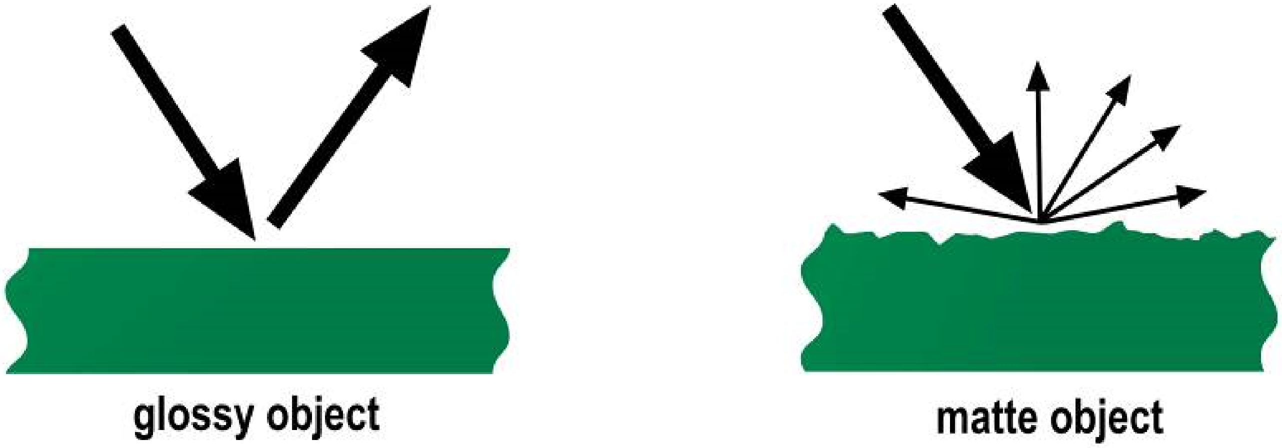
- **Sphere D:8**
- **Transmission**
- **Imaging Spectros**
- **Multiangle spectros**

Traditional Industrial Geometry

- **Sphere D:8**

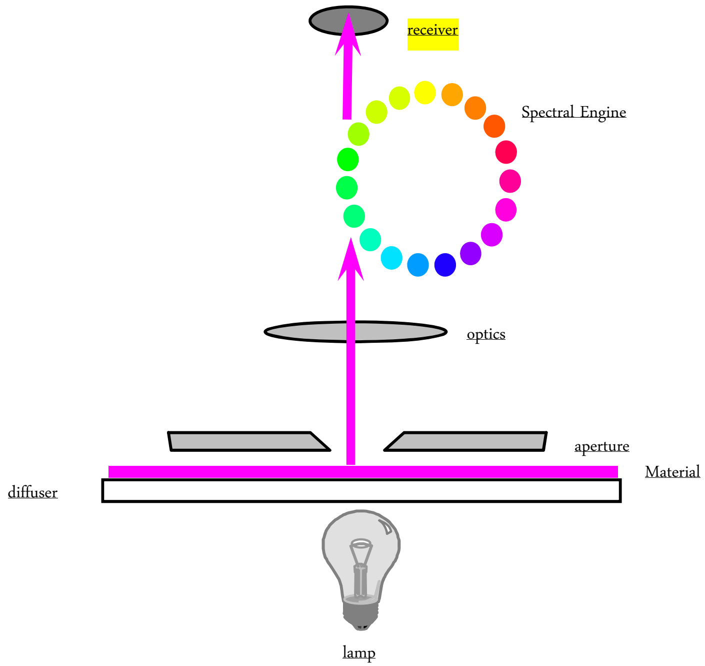


So Glossy, Flat or Matte – Is that all?



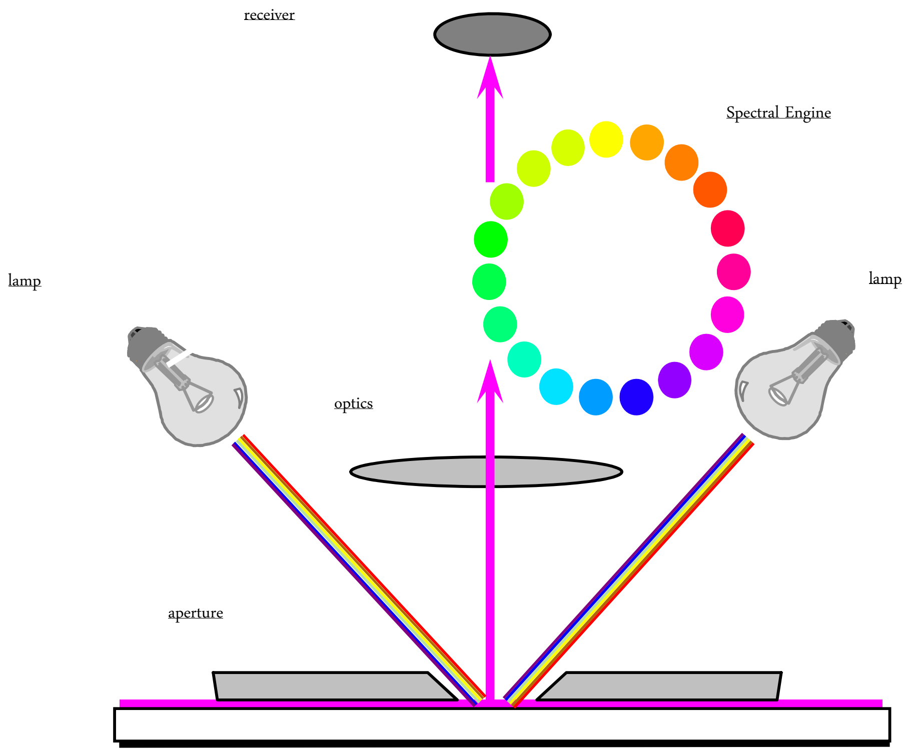
Transmission

- **Aperture Size**
- **Definition of the light**
  - D50
  - "D50"
  - Other
- **Material being measured**
  - Vinyl/Film
  - Fabric
- **End use**
  - Day/Night backlight



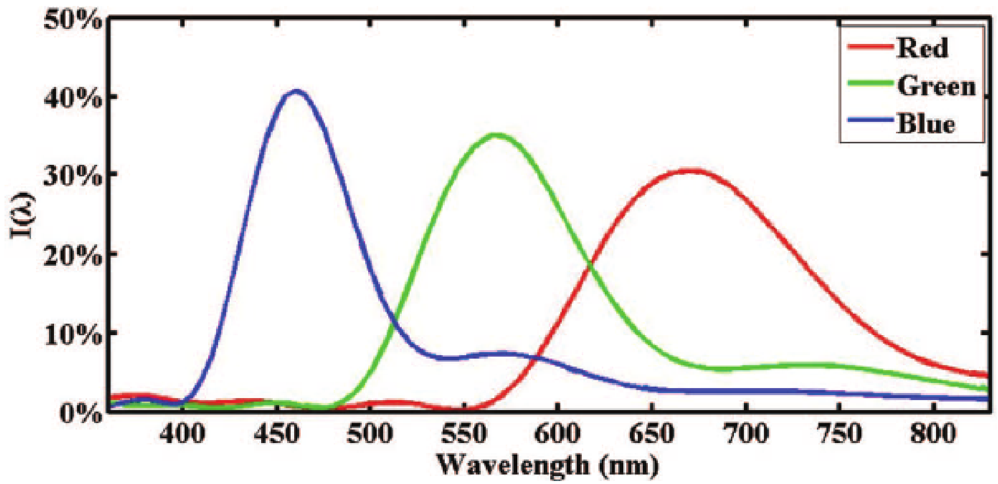
Traditional Spectro

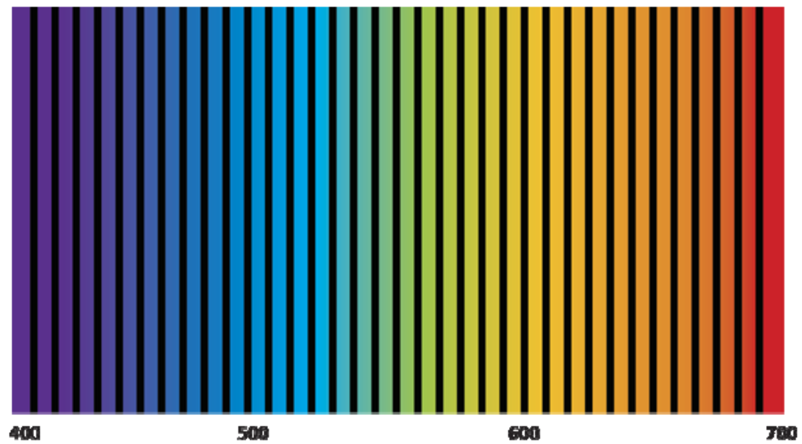
- **Capture the light reflected by the sample that is inside the aperture – a single set of reflectance data**



Imaging Spectro

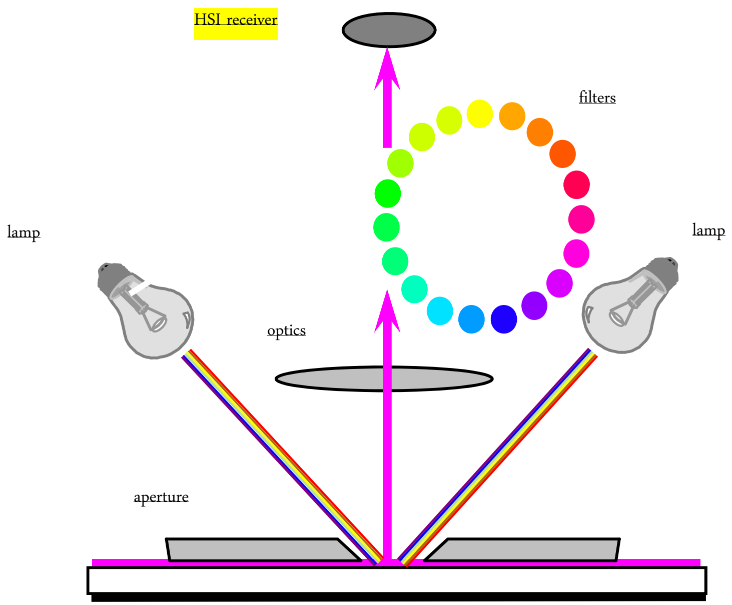
- **HSI – Hyper Spectral Imaging**
  - Uses a “true-color” camera, capable of providing reflectance data per pixel vs. typical RGB color cameras





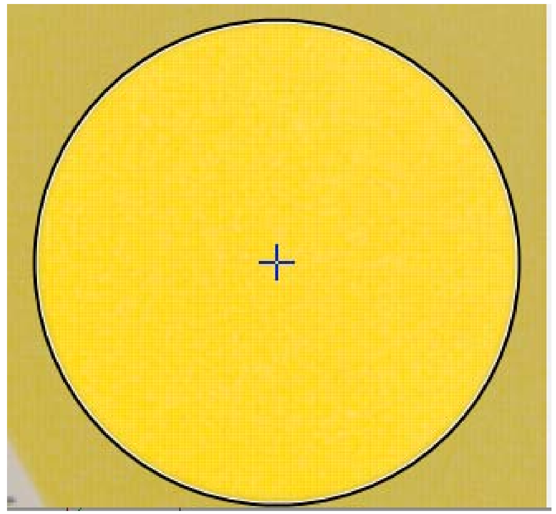
Imaging Spectro

- **Capture the light reflected by the sample that is inside the aperture – a set of reflectance data per pixel**



Use Case #1

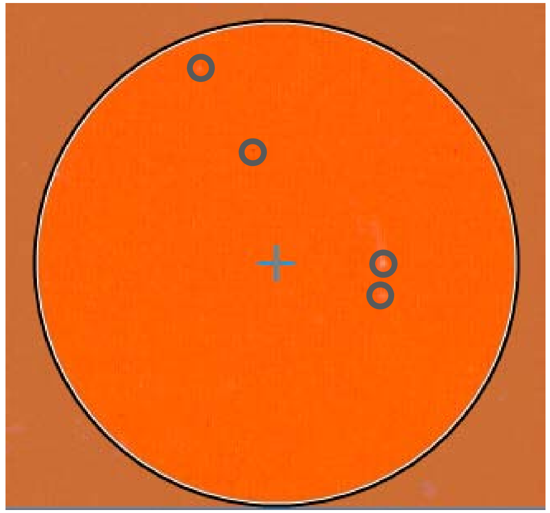
- **Standard Spot Measurement (Simple)**
  - Whatever fills the aperture is measured
  - Combined reflectance data for all pixels
  - Mimics a traditional Spectro maintaining inter-instrument agreement



Sample Traditional HSI Simple

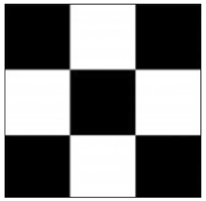
Use Case #2

- **Removing artifacts/defects (Smart Spot)**
  - Measure the full area
  - Smart Spot algorithm eliminates the pixels that are outliers – defects, pin-holes, shadows, highlights, etc.
  - Compare Simple & Smart Spot for print quality



DL*	Da*	Db*	DE*	DE2000
0.72 L	0.07 R	1.60 Y	1.75	0.67

Smart Spot vs Simple



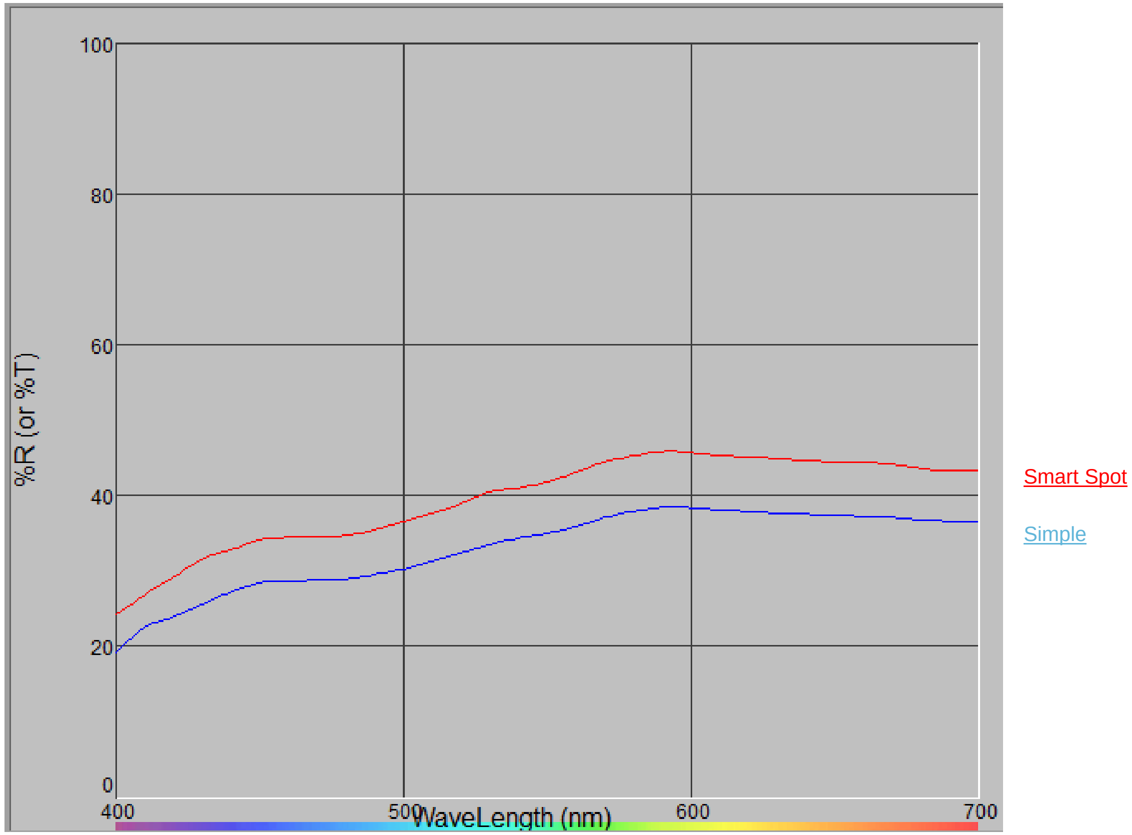
Sample

Traditional

HSI Smart

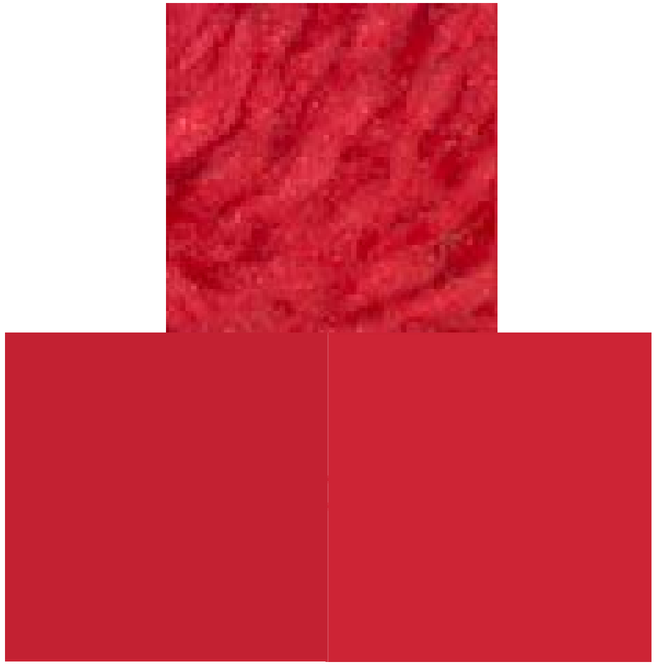
Use Case #2

- **Stucco – an extreme example**



Use Case #3

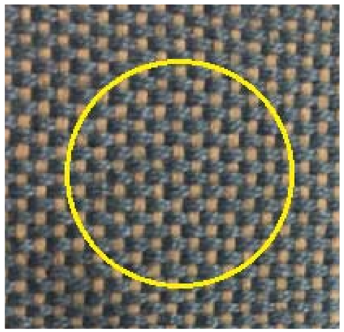
- **Color Standards & Formulation**
  - Customer provided color standards can provide challenges
  - Smart Spot provides the real desired color

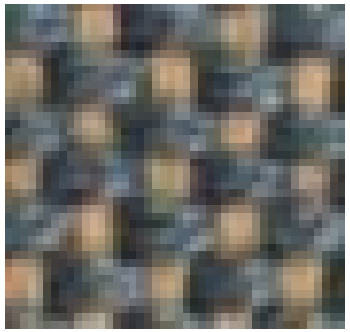


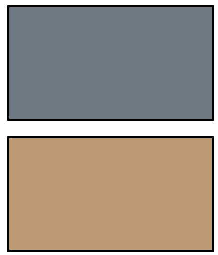
Simple Smart Spot

Use Case #4

- **Multi-Color Measurement**
  - Does not require a full patch for each color
  - A textile example



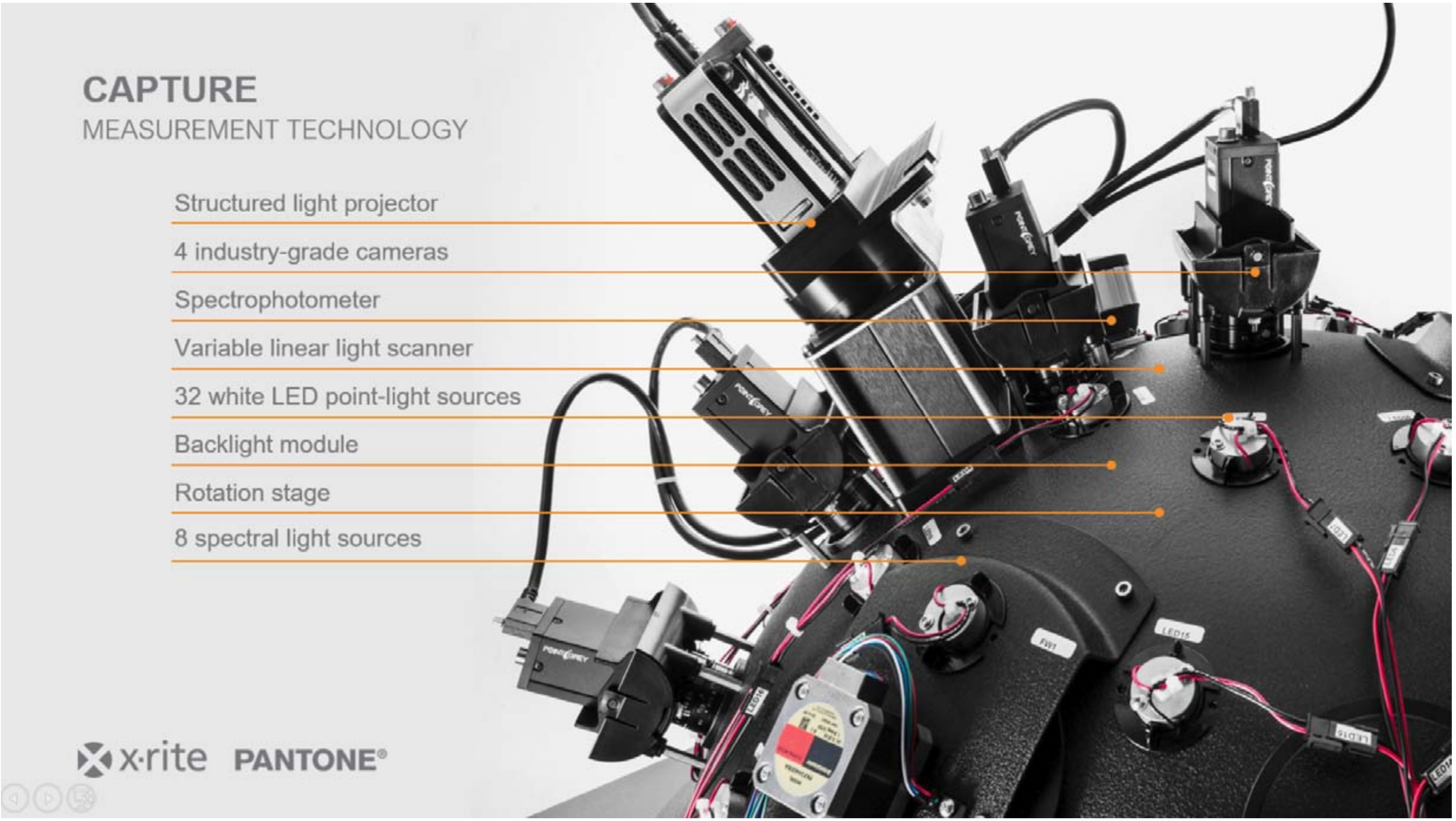




Imaging Devices in Other Workflows

- TAC Ecosystem
  - Total Appearance Capture TAC7
  - Pantora Material Hub
  - AxF Files
  - Virtual Light Booth
- Material capture for 3D design

Imaging Devices in Other Workflows



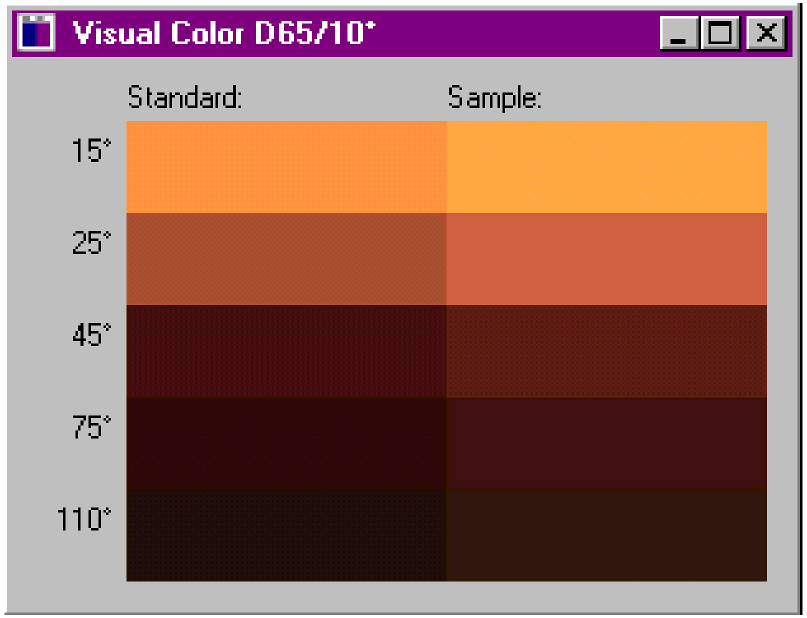
Imaging Devices in Other Workflows

Imaging Devices in Other Workflows

- **MA-T Multi-Angle Instruments**
  - Traditional & Imaging
  - 6 or 12 measured angles
  - Imaging for effect QC

Multi-Angle Measurements Why We Use Them

- **Change Optical Properties with Illumination and Viewing Angles**
  - Metallic
    - Extend / enhance the gloss or specular appearance
  - Mica / Interference additives
    - Change appearance at all viewing angles. Some may introduce strong shifts in both lightness and hue
  - Pearlescent
    - Make surfaces appear to shimmer
      - haze effects



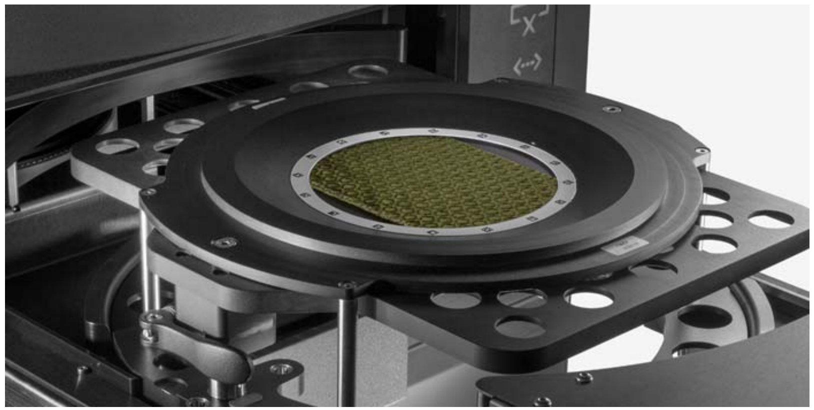
Thank You

The use of the M3 measurement condition in colour management

ICC Color Experts' Day, Bressanone

Colour Management and Colour Measuremnet

- Colour Management has the goal of obtaining desirable colour matches across different devices and media.
    - Want the colour we see on screen to match the colour that is printed
    - Colour management relies on accurate colour measurements of the devices and media so that the desired match can be achieved
- Differences between devices and media make colour measurement challenging
    - Can’t measure a display and a printout in the same way
    - UV?
    - Surface reflections



Colour Measurements

- **Colour Measurements need to be made in a way that is appropriate for what is being measured and how the colours will be viewed.**
  - **Larger aperture for Textiles**
  - **Spherical vs 0/45**
  - **UV content of measurement light should match UV content of viewing environment if OBA is present**

ISO 13655: 2009/2017 – MEASUREMENT CONDITIONS

Specifies spectral measurement conditions for graphic arts

- **Measurement illumination conditions**
  - **M0: Should be CIE Illuminant A (many legacy spectrophotometers)**
    - **undefined UV amount**
    - **covers unknown illuminants as well**
  - **M1: CIE Illuminant D50, 1 for paper (OBA) only**
    - **Part 1 is D50 match use for all fluorescence (ink, papers, etc)**
    - **Part 2 Calculated UV response to emulate UV excitation of OBA's (for paper only)**
    - **Use with ISO 3664:2009 viewing condition**
  - **M2: UV cut**
    - **Little energy below 420 nm, continuous illumination above**
  - **M3: Polarization Filter with UV cut equal to M2**
    - **Special use cases**

M3 – POLARIZATION

Colour Assessment independent of the surface

- **Polarization reduces reflections caused by the surface reflection or bronzing**
- **One method of density comparison between wet and dry inks.**
- **It also removes UV equivalent to M2.**
- **Is used in ISO 12647 as an option for density process control.**

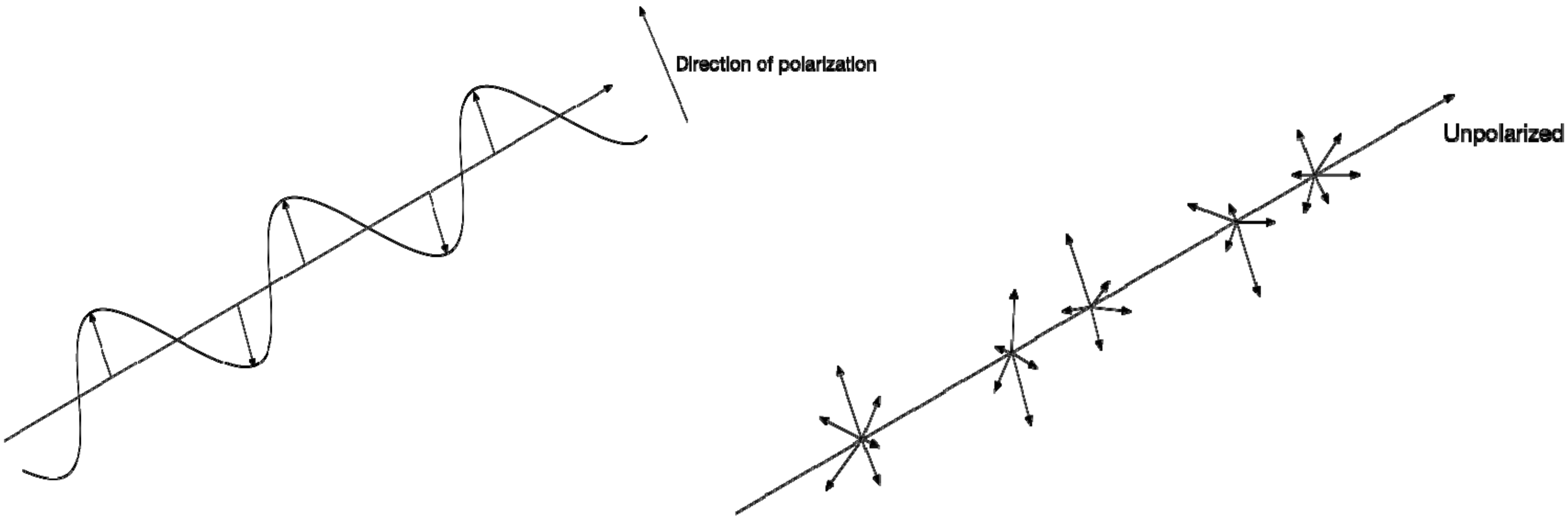
Attention: **There is no viewing condition that matches this measurement condition**

M3 and Colour Management

- M3 measurements can be used to build an ICC profile
- Supported in the measurementType tag in iccMAX
- What happens to colour management when M3 is used?
  - Do colours printed using an M3 based profile match colours on an ICC profiled screen?
  - Do colours printed using an M3 based profile match colours printed using a M2 profile?
  - Do colours printed using a M3 profile for one type of media match colours printed using a M3 profile for a different type of media?

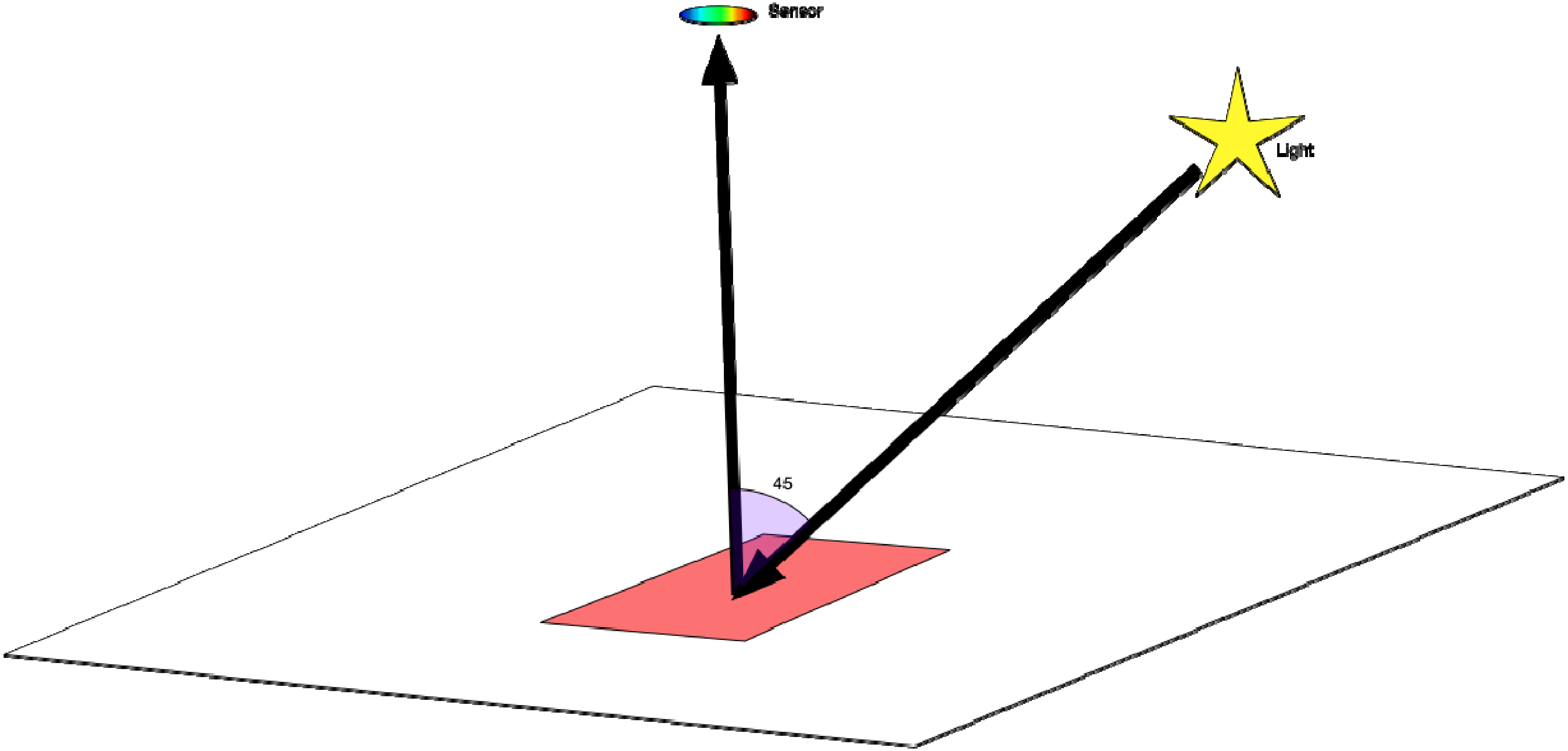
Polarization

- **Polarization is a property of light (and other transverse waves) that specifies the orientation of the oscillations**



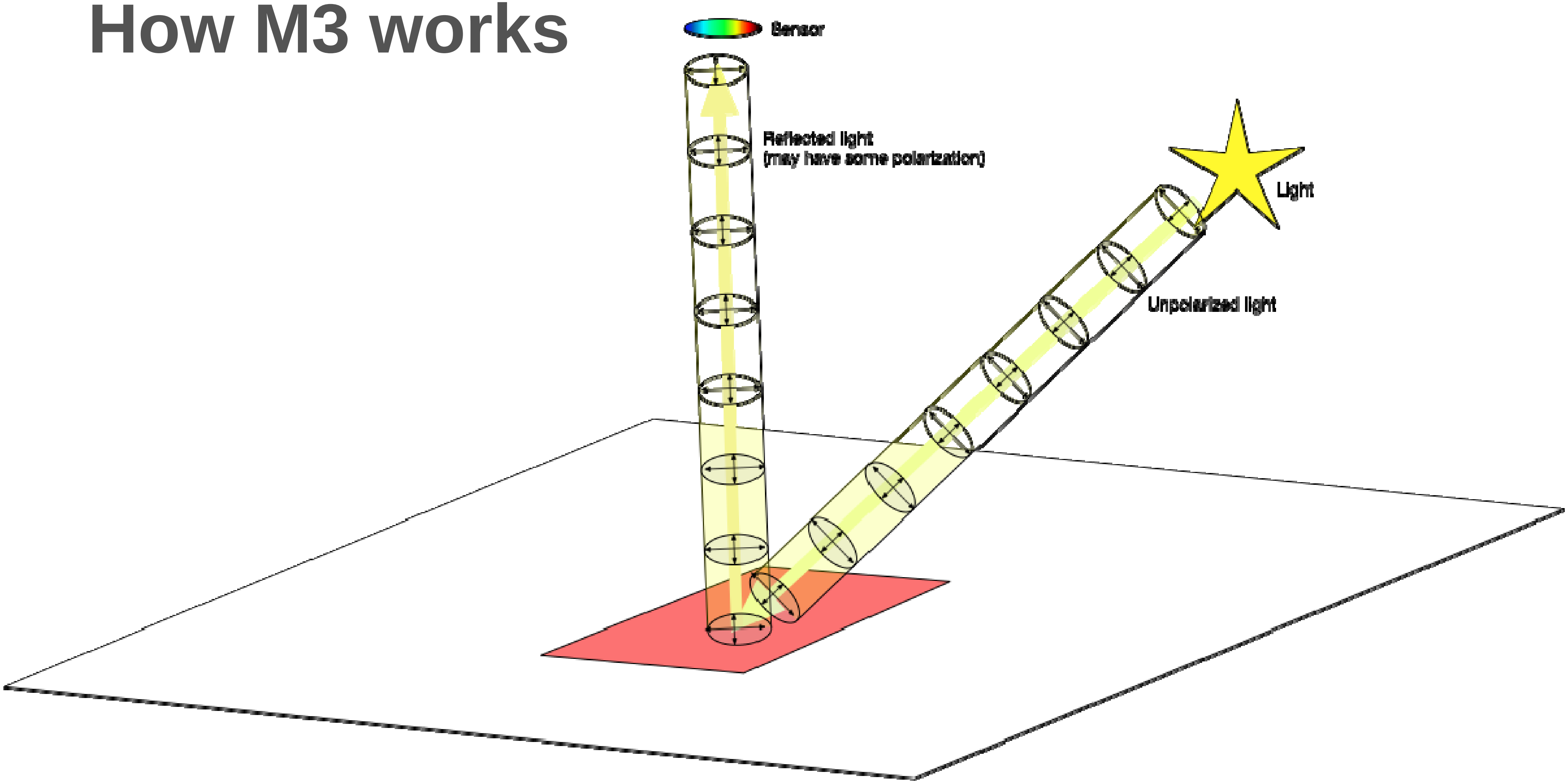
- Also Elliptical and circular polarization

How M3 works



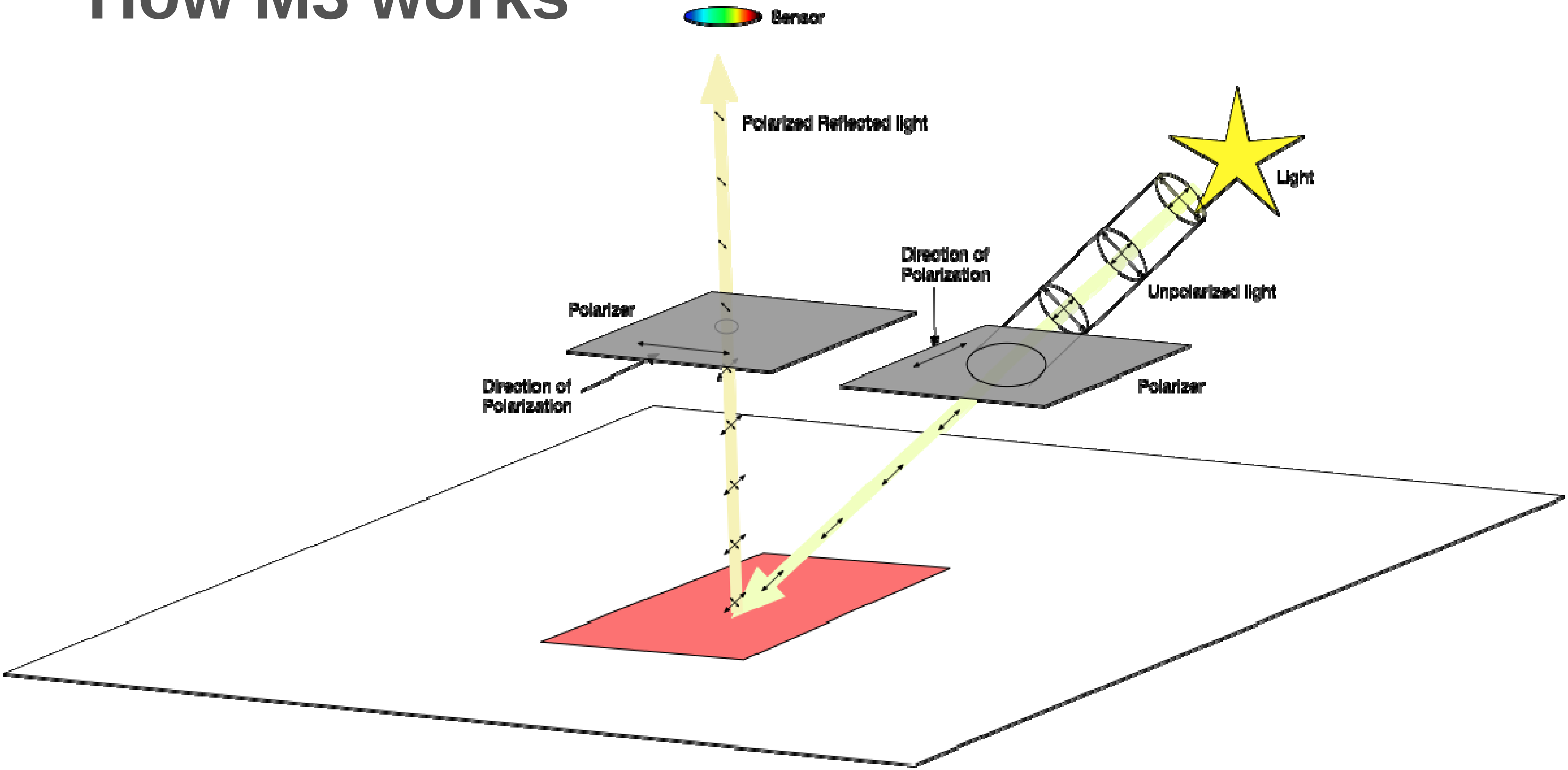
45/0 Geometry

How M3 works



M0/M1/M2

How M3 works

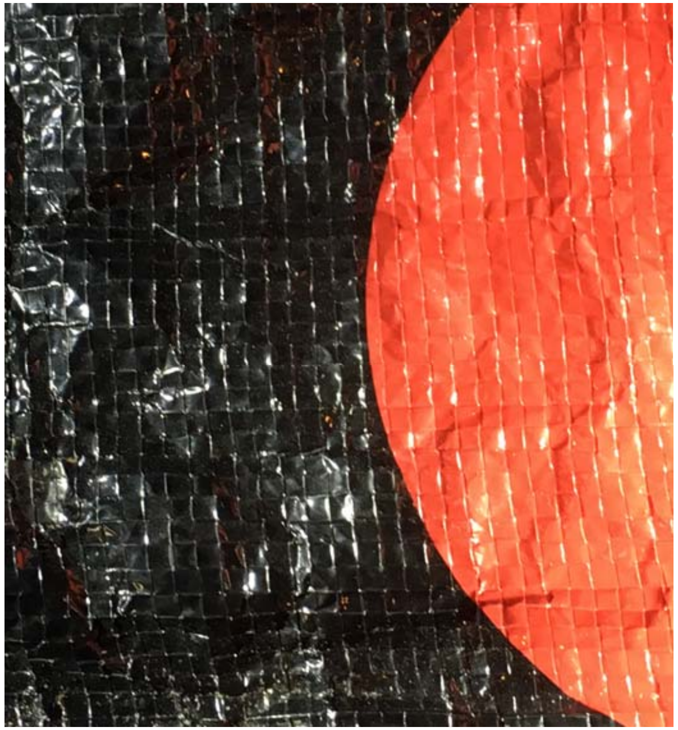


M3

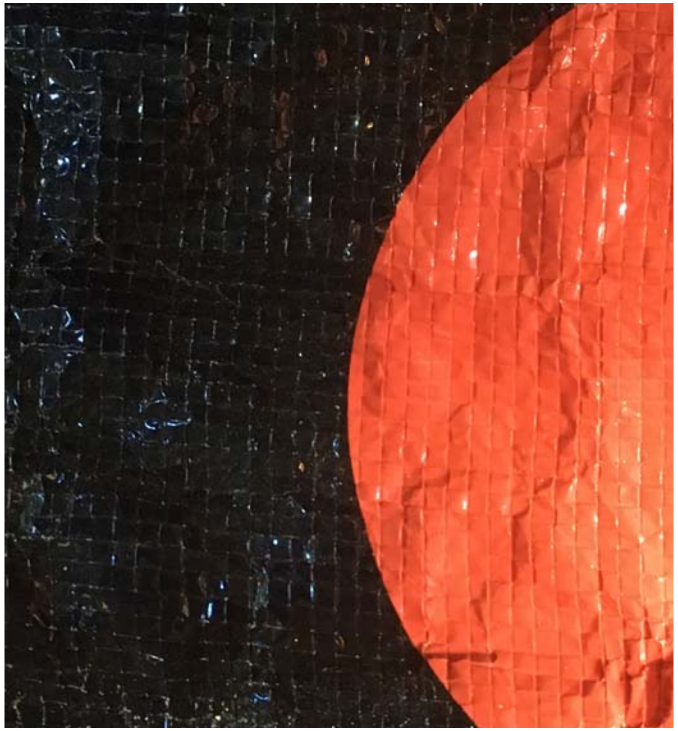
Removing Reflectances with Polarization

- **Specular reflections retain polarization direction and can be eliminated by using polarization.**

Polarized light source



No polarizer on camera



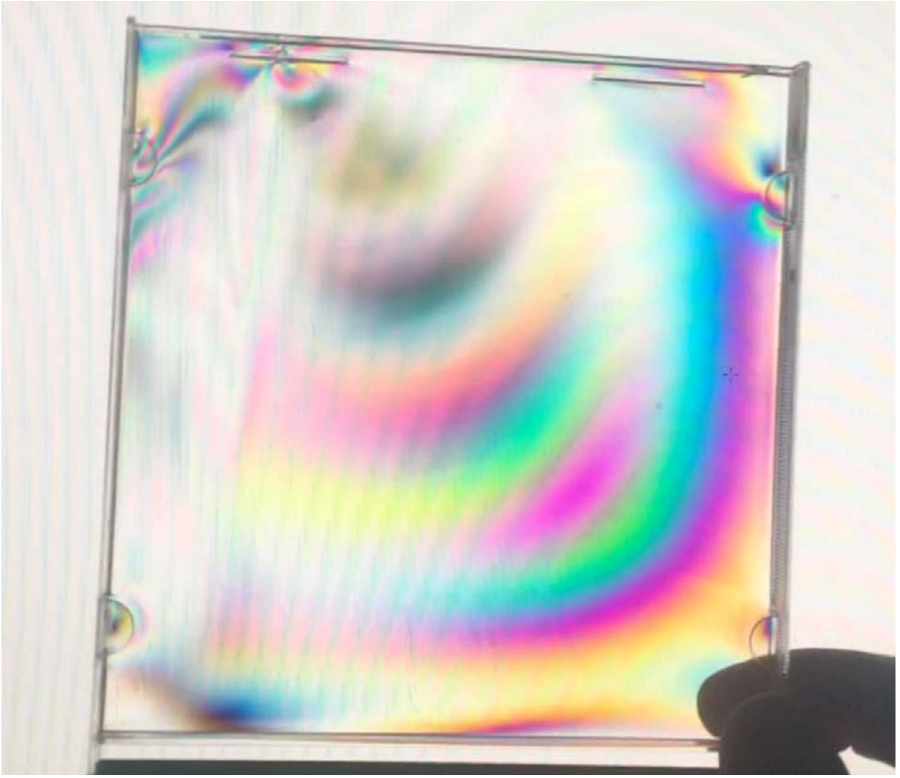
Polarizer on camera

M3 has no UV

- **Textiles and Papers often have optical brightness**

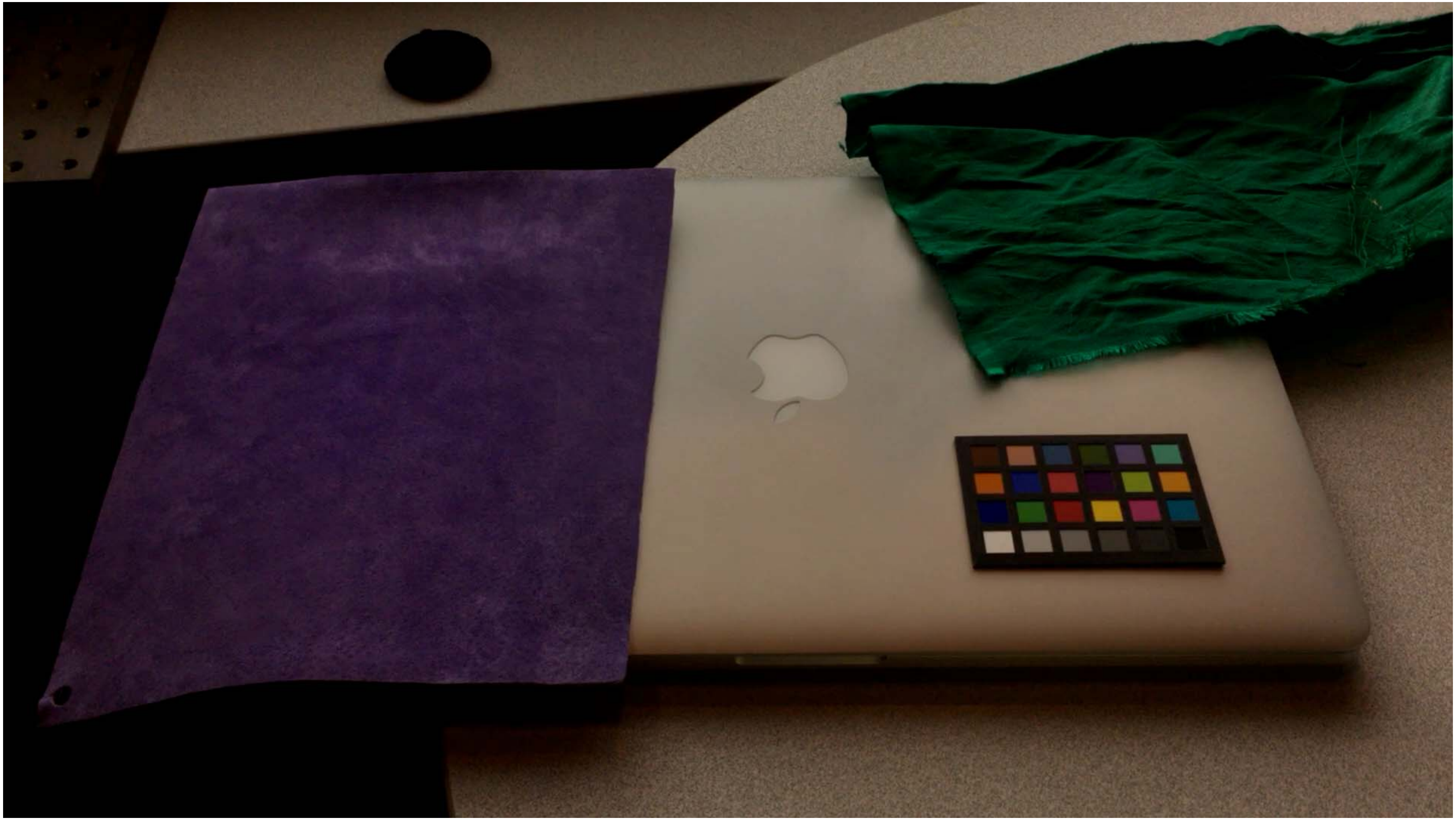
Other Effects of Polarization

- **Polarization is used to analyze stress in objects. Photoelasticity is illustrated here.**



- **Polarization effects can occur internally in an object**
  - **When measuring in M3 mode the internal polarization effects can impact the measured colour**

What does the M3 look like?

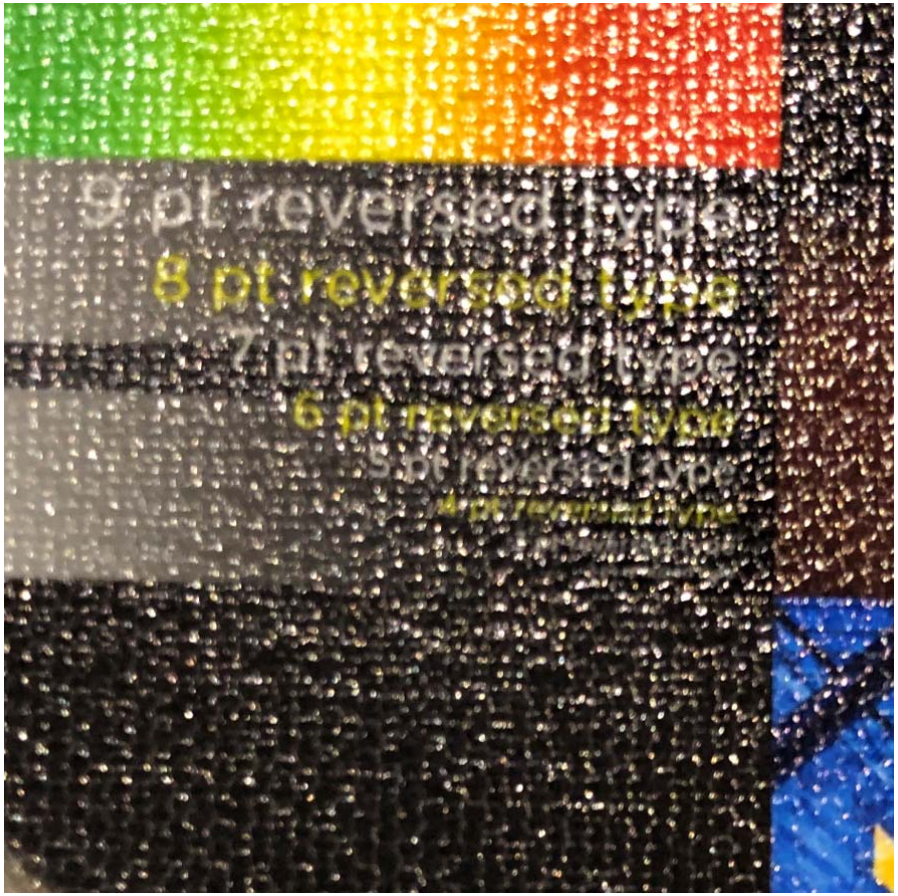


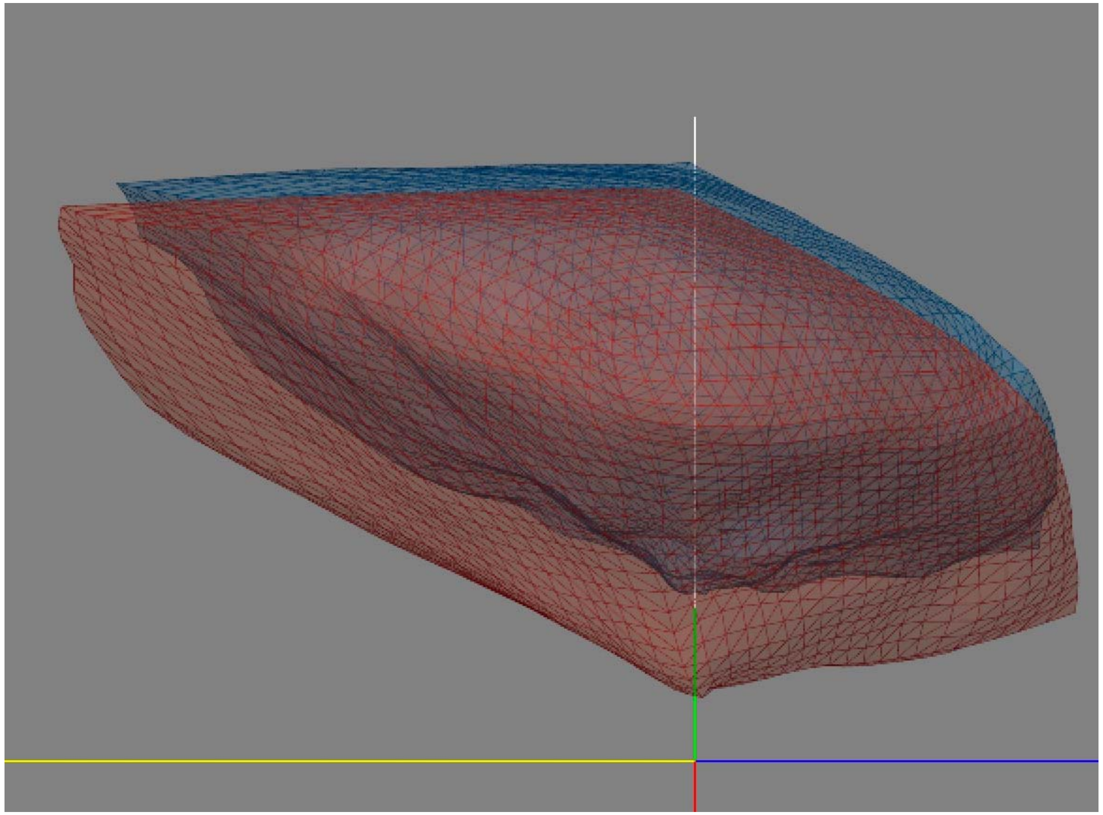
Why M3 might be used for colour management

- **Measurement of first surface reflections is undesirable**
  - **Causes too much noise in measurements**
  - **First surface reflections are discounted when colour is being viewed**
  - **Ink is still wet**

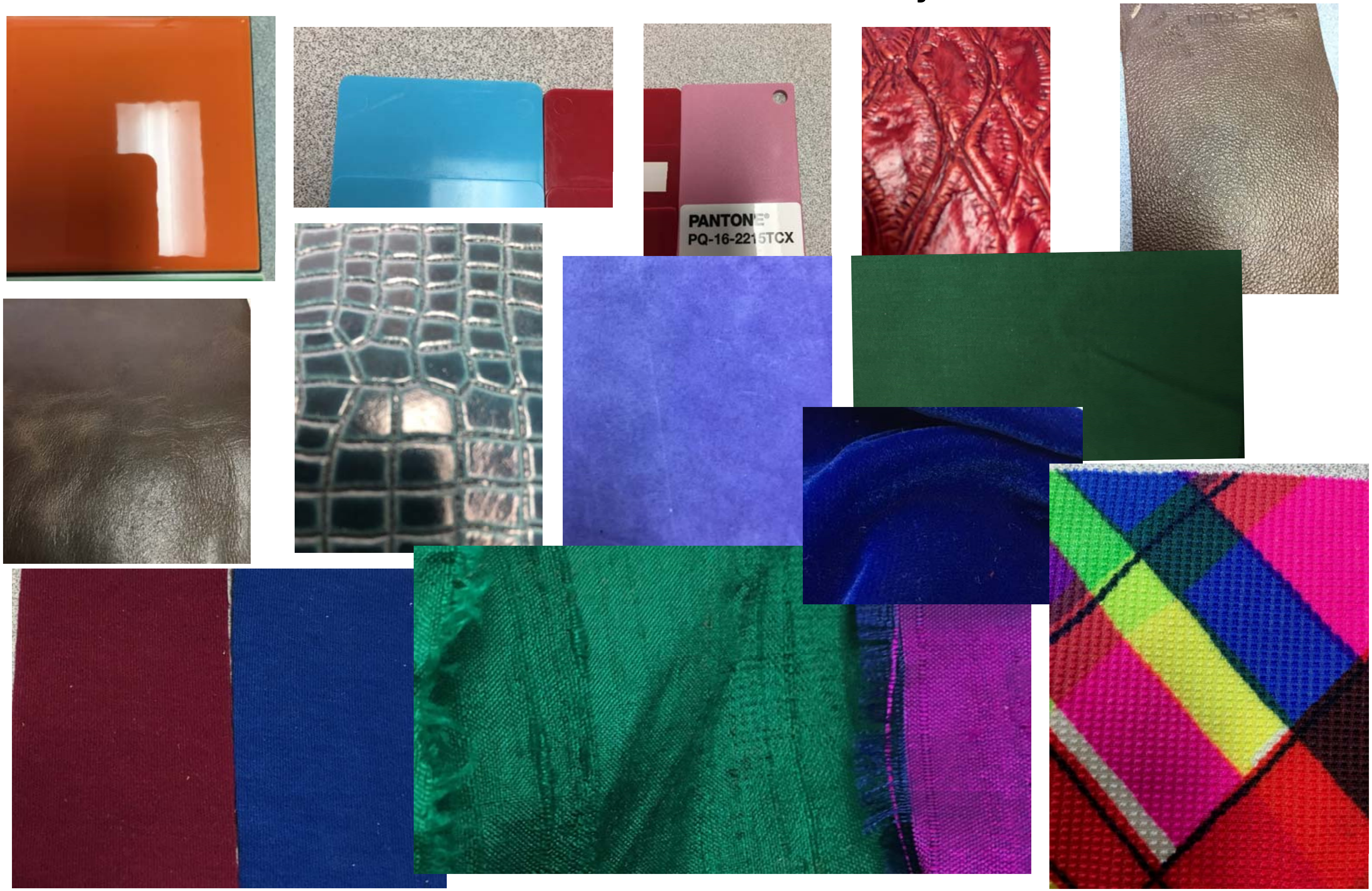
Why M3 might be used for colour management

M2 & M3 profile of rough and glossy material





Assortment of Measured Objects



Differences between M2 and M3 for various media that were measured

M2

M3

Compare M2 & M3

Differences between M2 and M3 for various media that were measured

	Fabrics	Leather	Ceramic	Brushed Metal	Plastics
Maximum DeltaE	14.6	24.0	2.76	45.8	5.8
Minimum DeltaE	3.2	1.4	0.5	45.8	2.9
Average L_{M2}-L_{M3}	5.6	8.3	0.27	45.8	2.2

- **The difference between a M2 & M3 measurement is dependent on the individual properties of the media**
- **The differences can be very small to extremely large**
- **M3 is typically darker than M2**
- **The collection of plastic, metal, and ceramic objects measured was limited**
  - **It is expected that a broader range of surface properties would produce much greater variation in results**

Two Gray objects

Ceramic tile and laptop computer

	M2 L*	M3 L*
Laptop computer	75.2	29.4
Ceramic Tile	58.1	57.6

- The laptop computer appears to be lighter than the ceramic tile.
- The M2 measurements show the laptop as being lighter than the tile.
- The M3 measurements show the laptop as being darker than the tile.
  - Only a darker tile would have a matching M3 measurement, therefore if two different materials have the same M3 measurements, it doesn't guarantee that they will have the same appearance.

How well does M3 work in a colour managed workflow?

Matching colour patch

Printout from
inkjet on paper

Leather sample

1. Find colour patch on printout that matches the sample
2. Compare M3 of sample to M2 of printout
3. Compare M2 of sample to M2 of printout

If M3 measurements can be correctly used for colour management, the M3 measurement of the sample should match the M2 measurement of the matching colour patch on the printout.

Differences between M2 & M3 measurements for different media that visually match

- **Media was chosen so that M0/M1/M2 measurements would be problematic**
- **Colors were chosen so that OBA impact was small**

	pink leather	purple leather	tan leather	green cloth	black cloth	pink cloth	red cloth	blue cloth	cyan plastic
DeltaE M3 & M2	3.9	8.7	8.2	3.5	7.3	2.9	4.8	4.9	0.92
DeltaE M2 & M2	3.3	4.1	1.8	2.8	7.2	6.1	3.1	2.5	1.12

- **For problematic media, neither M2 nor M3 is going to provide great results**
- **M2 seems more likely to produce better results, but in some cases M3 will work better.**

Conclusion

- The M3 measurement condition doesn’t correspond to a real viewing condition
- Two objects with the same visual appearance can have different M3 and M2 measurements
- M3 measurements should be used with caution when used for color management

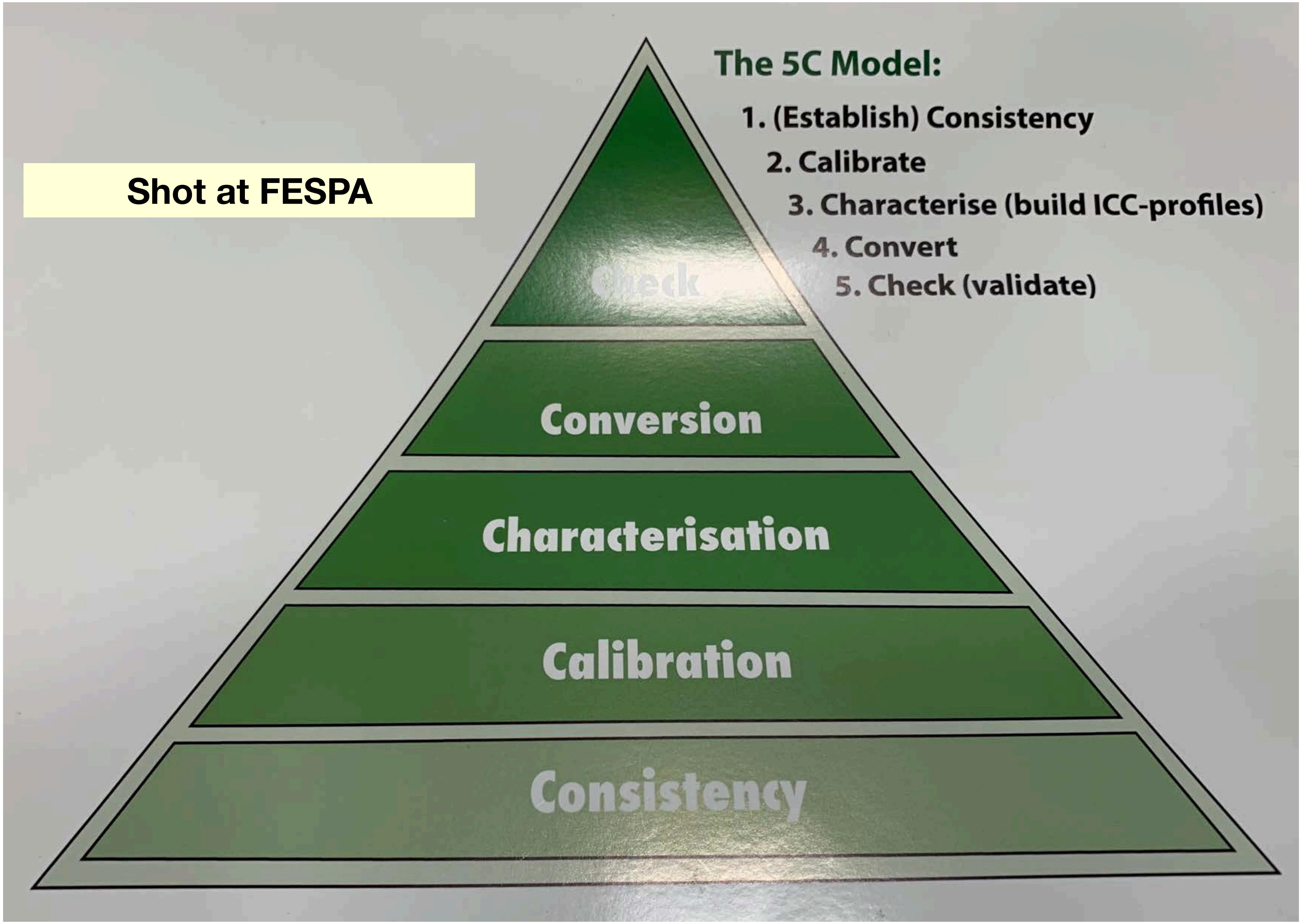
Questions?

The measurement and profiling of special materials: glass, leather, laminates, etc: problems and solutions, practical experiences

TECNOLOGIE GRAFICHE
COLOR EXPERIENCE

Andrea De Rossi

5C Model: valid for all Print Process and Media



Shot at FESPA

When the best quality for Industrial Printing?

Bad Printer

Bad Media

Bad Ink

Bad Print

Bad Profile

Bad Color

Good Printer

Good Media

Good Ink

Good Print

Good Profile

Good Color

10 Tips for Inkjet Industrial Printing

1- Air-conditioned environment, free from dust

2-Media stabilized in the work environment

3-Inks with low miscibility, good wettability and adequate surface tension

4. Purged and well-wet heads.

5. Absence of printing/physical defects such as Banding and Bleeding

6. Medium with planar printing surface, clean, dry, dust free

and without electrostatic charge

7. Setting of print modes appropriate to the Media

8. Print preliminary Test Form for checking the printer settings

9. Printer calibration: amount of ink suitable for the type of support

10. Printer profiling

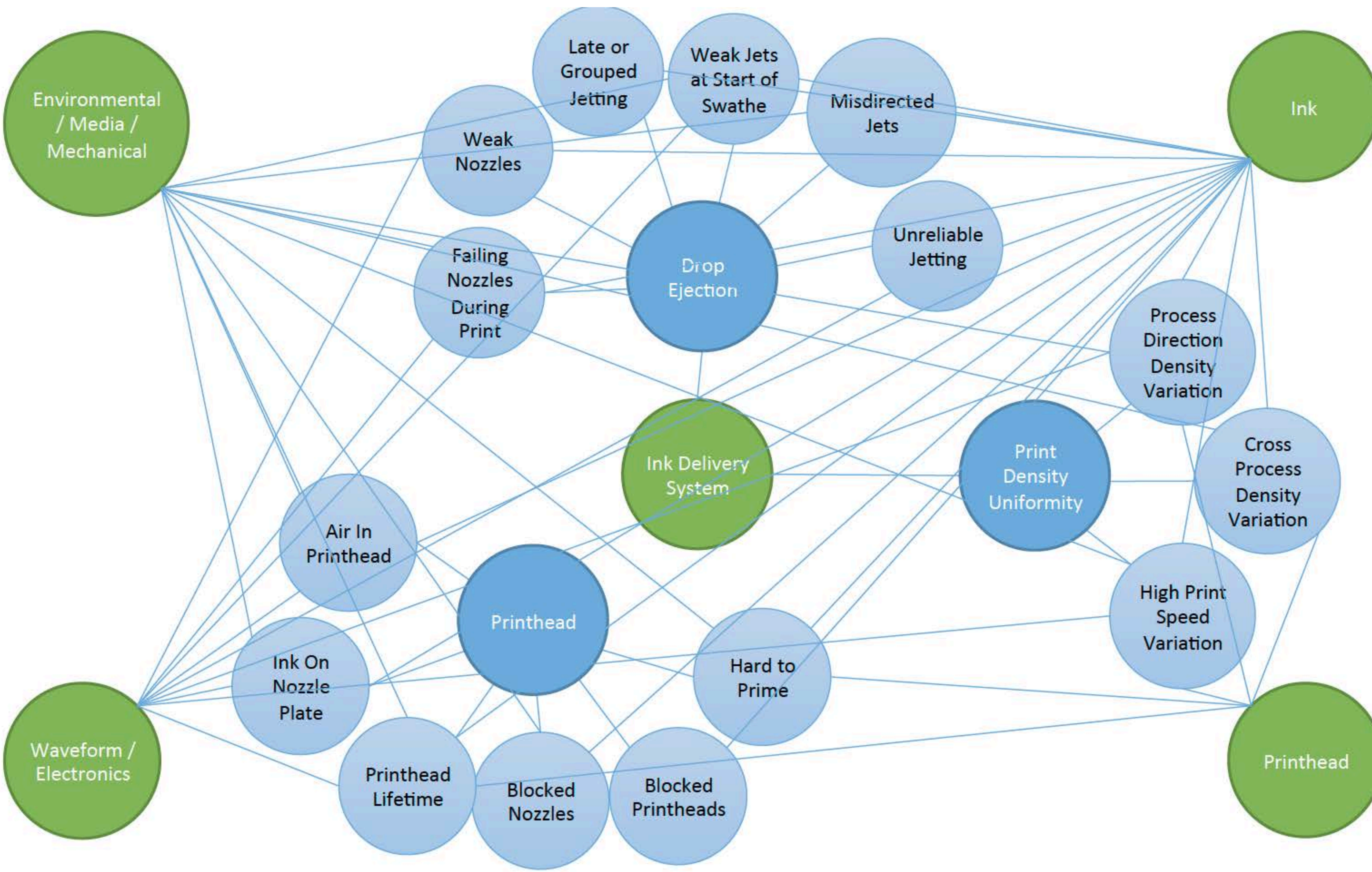
The Variables in Digital Printing

When we are printing on structured materials the technical difficulties increase for the presence of many variables that interact in the printing process.

The principal variables are:

- Printer Mechanics
- Printhead
- Waveform /Electronics
- Ink Delivery System
- Ink
- Media
- Environmental
- Color Management

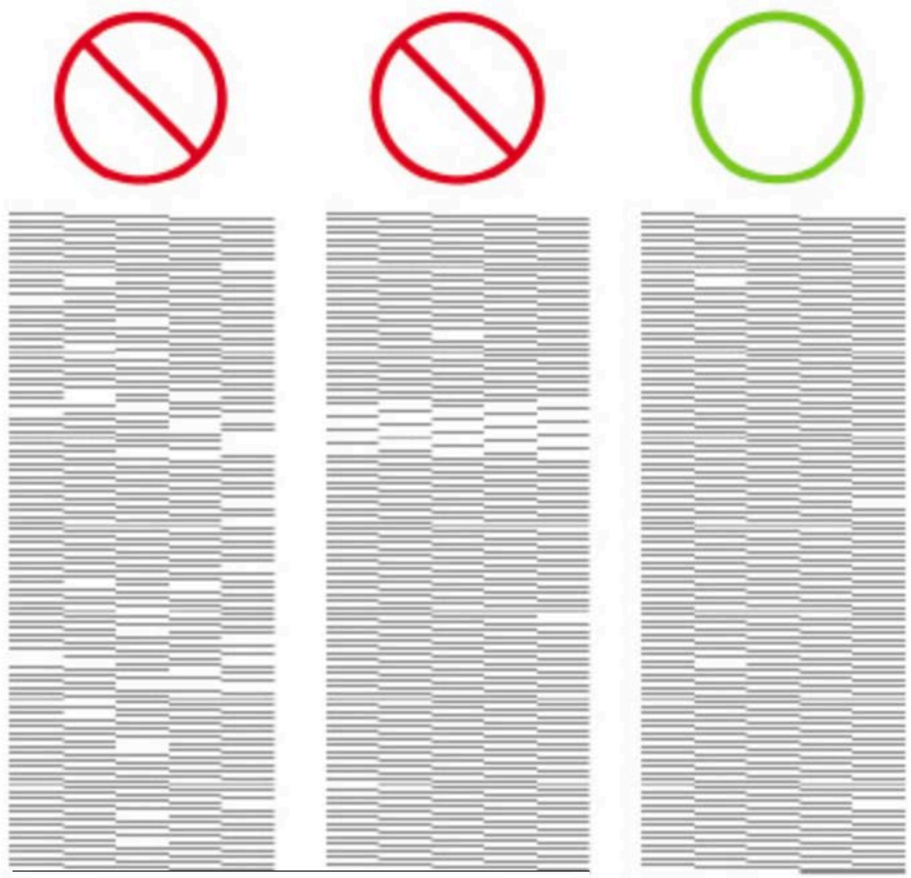
The interaction between the different variables

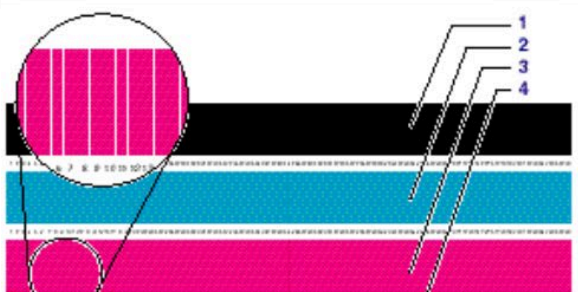


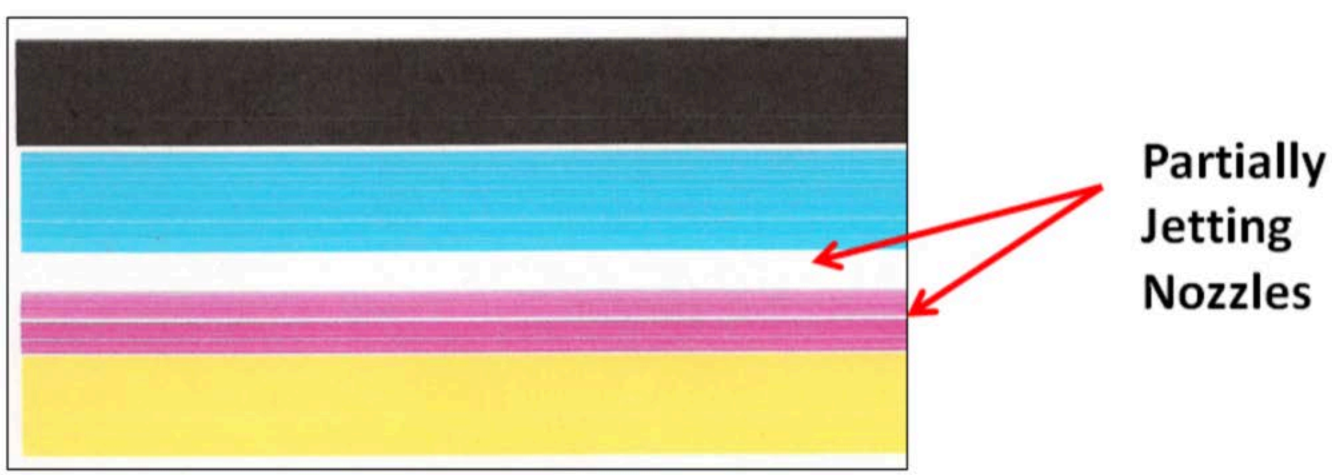
What influence Inkjet Printing Quality

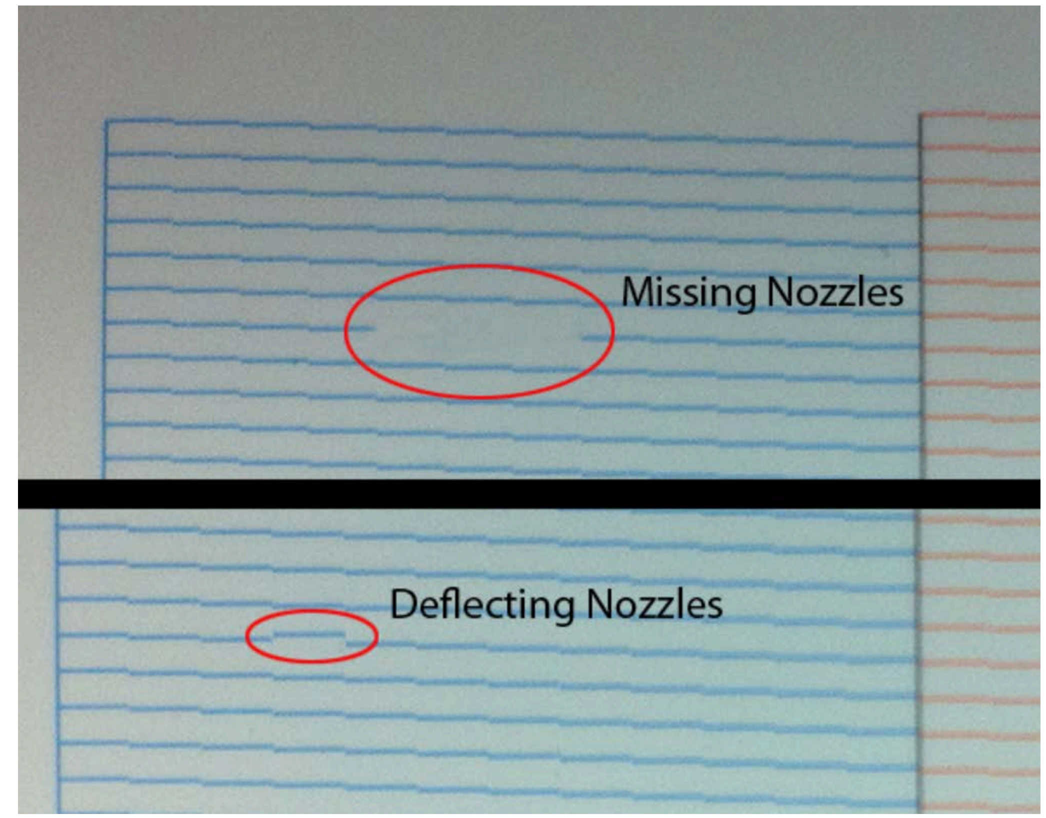
- Feeding and mechanics
- Heating/time: before, during and after printing
- Power of the UV/UV-Led lamp
- Head distance from the media
- Print Mode: resolution, directionality, printing steps
- Print speed
- Type of screen pattern
- Ink adhesion and fixing on media
- Ink thickness (density)
- Time of Ink drying
- Printer Calibration
- TAC
- Profiling
- Color Management by DLP
- RIP setting and color conversion

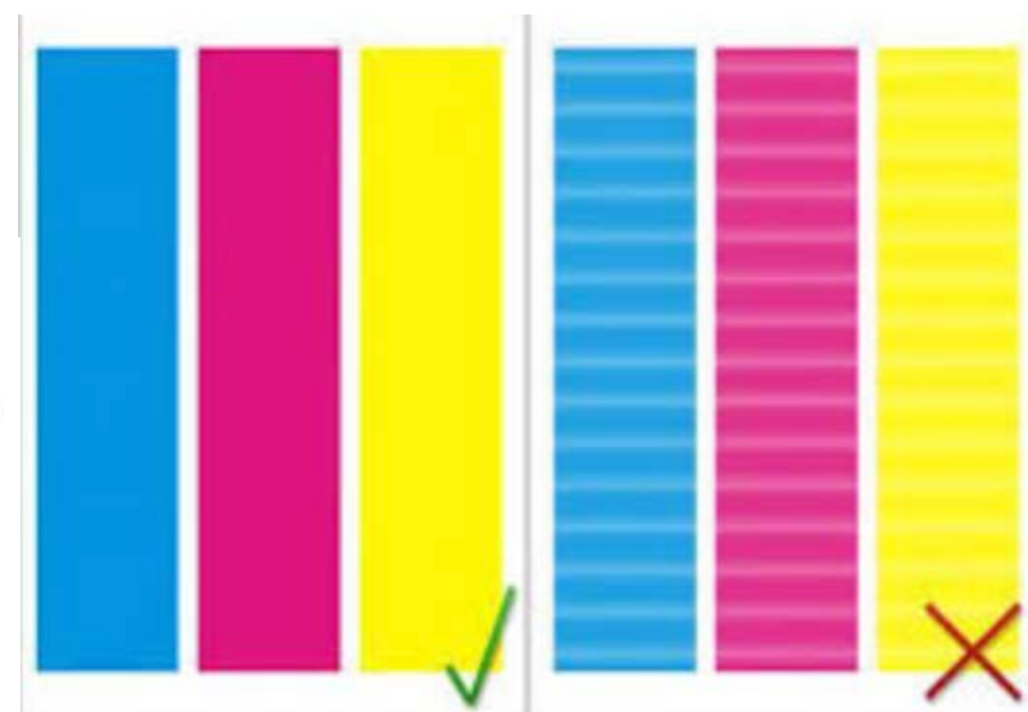
Head Printing Control Test





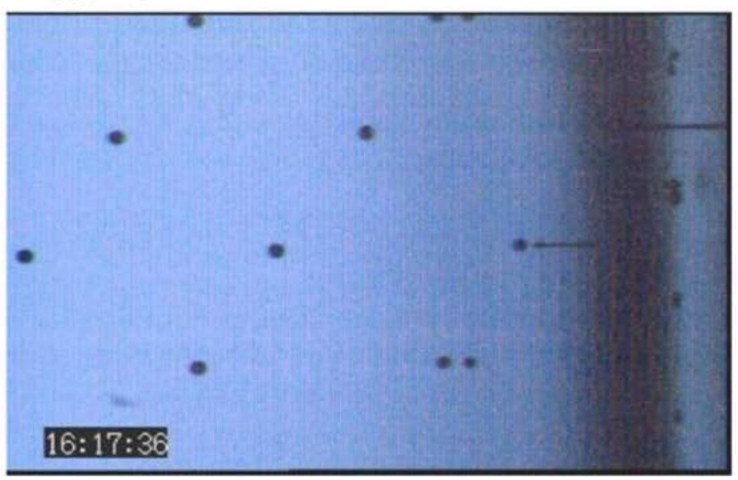




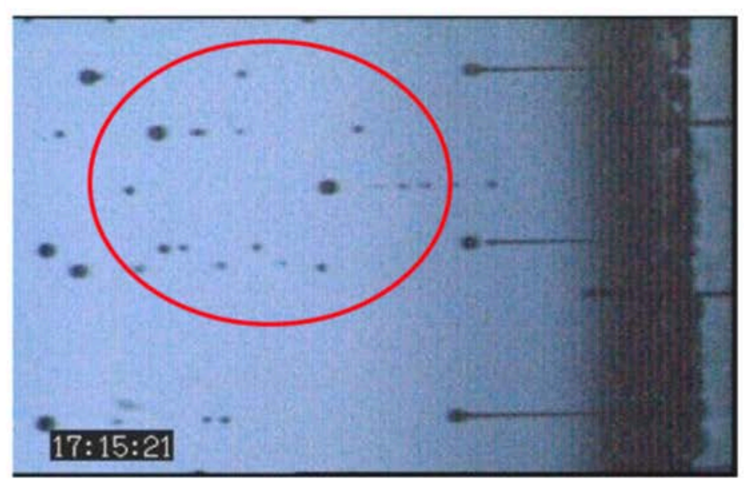


Satellite drops in single-pass printing

<OK>



<Satellite>

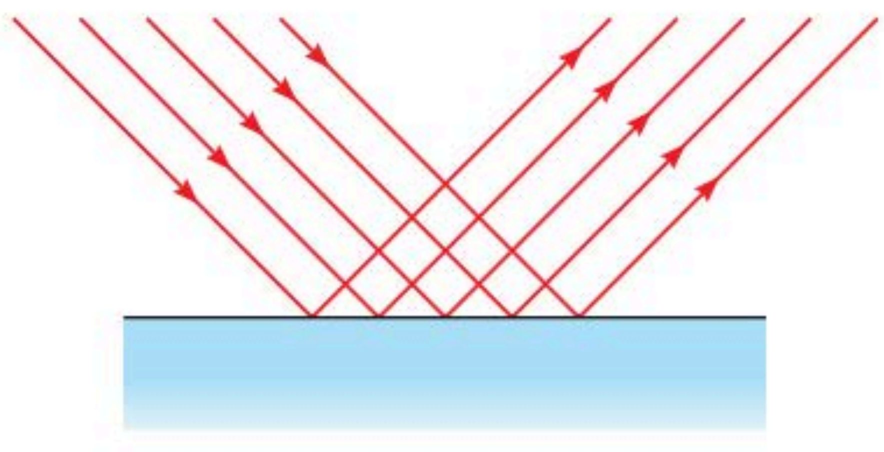


First problem to be solved e to check constantly!

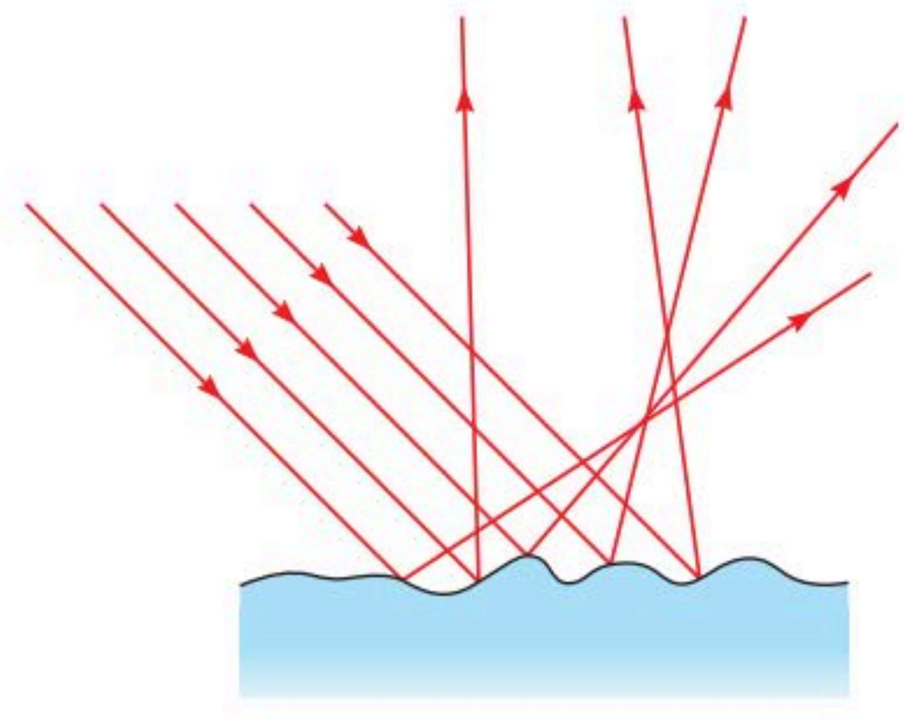
Satellite drops nebulization

Defected printing: directional printing lines

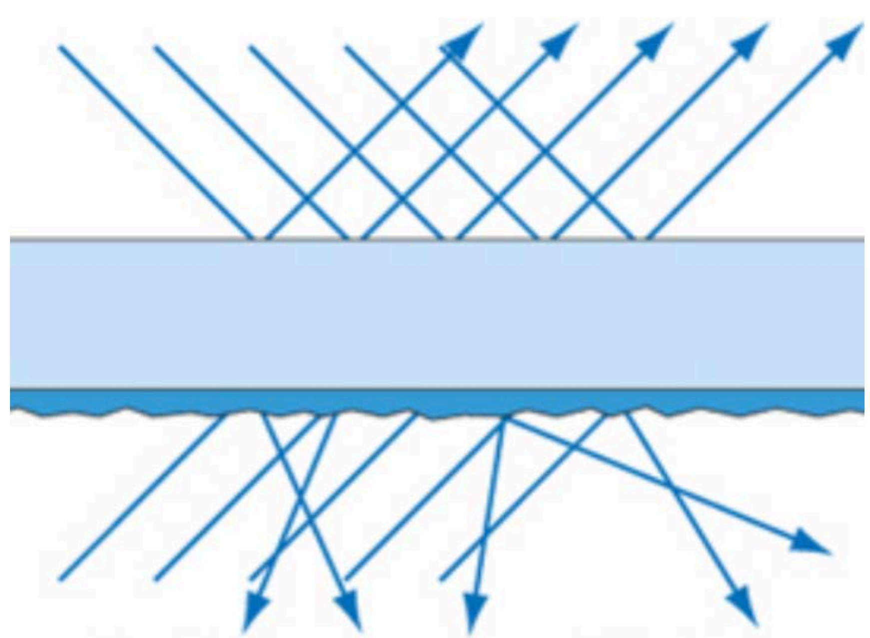
Reflective and Trasmissive Media



Specular Reflection



Diffusion Reflection



Media requirements

Pre surface treatment (plasma/crown)

Primer coated treatment

Flat surface

Planarity an uniformity

Regular thickness

Cleaner surface

Dry surface

Surface without defects and irregularities

Surface without dust and dirt

Elimination of electrostatic charge

Surface without OBA (possibly)

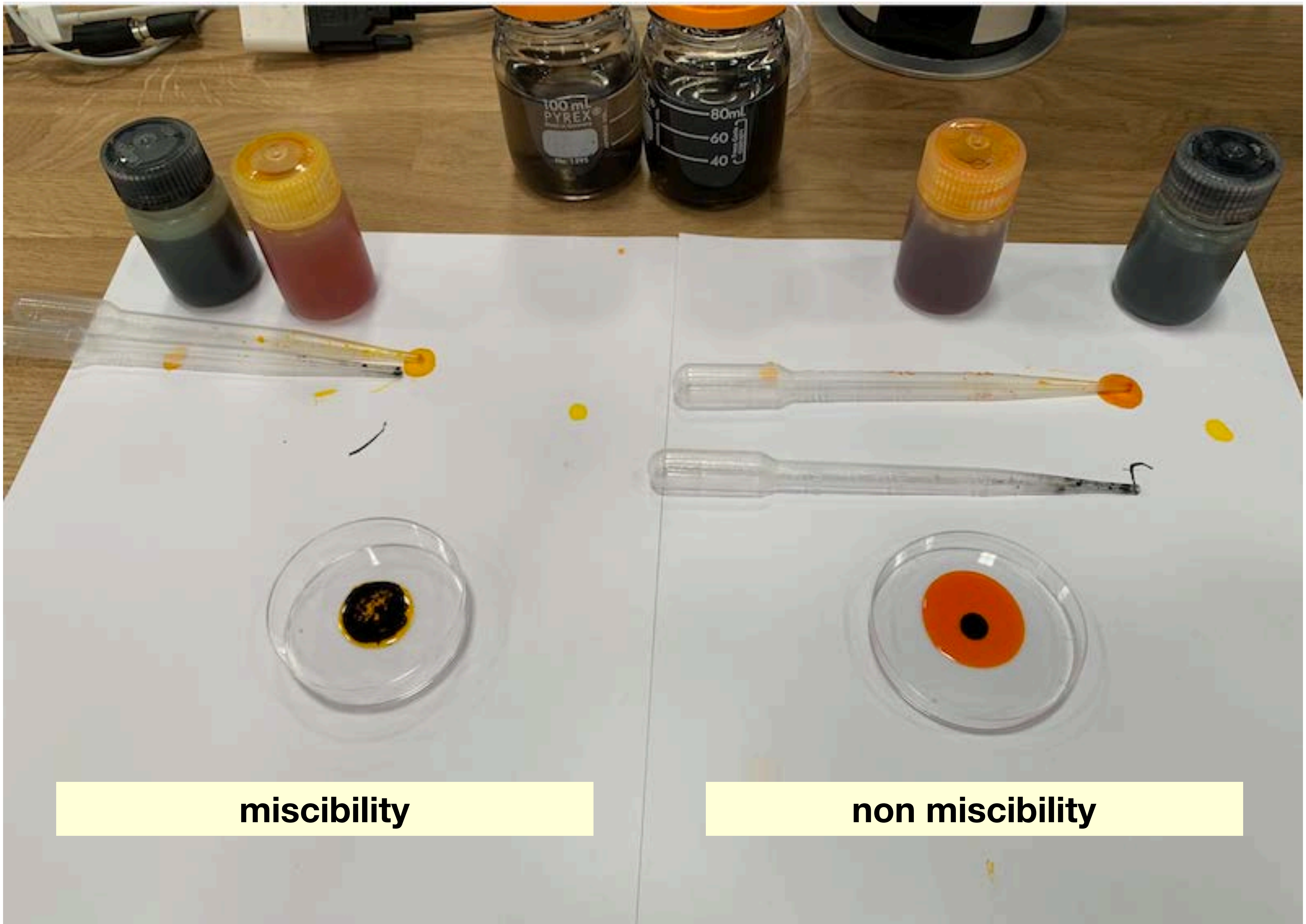
How to treat Media

- Cleaning the material with a carbon brush
- Or dust extractor
- Remove the electrostatic charge from the surface with
- With carbon brush
- Use gloves to avoid leaving fingerprints on the surface:
- Antistatic gloves to not load dust on the support
- With plastic materials, a corona pretreatment is recommended
- Check thickness of the material with micrometer

Ink requirements

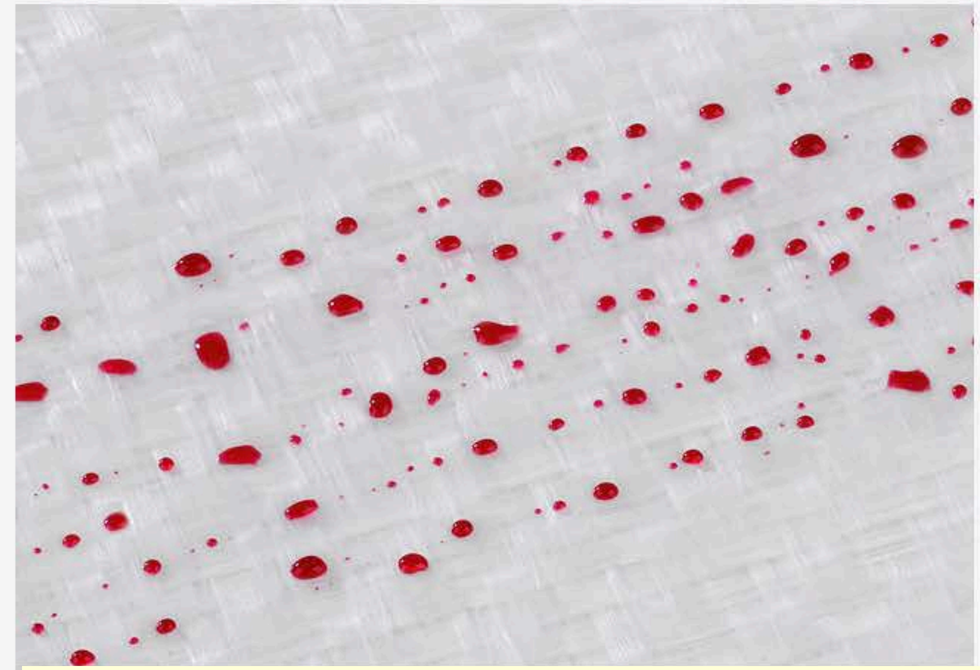
QUALITY PRINT PROPERTY	APPLICATION PROPERTY
wettability	scretch resistance
adhesion	resistance to forming
non-miscibility	not migration
not bleeding	outdoor resistance
no smearing	waterproof
uniform spreading	light fastness
spreadability	no grainy
low thickening	flexible fiber
easy to dry	
surface tension	

Checking the ink properties

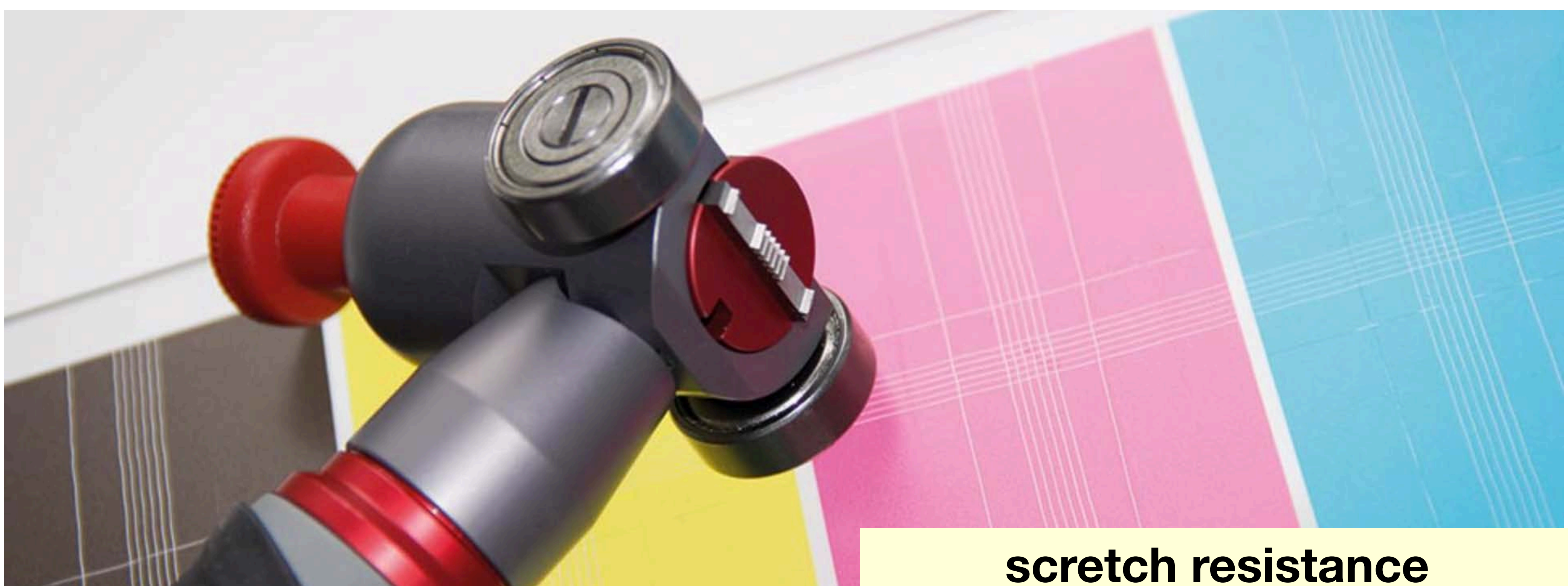


Preliminary Ink Control

good wettability



poor wettability



scretch resistance

UV Ink Adesion Testing *(ASTM Tape Test)*

Printer Consistency

Control of the status of the printer (head):

head cleaning, head alignment, feeding, efficiency, ink alimentation, lamp UV set, heating set…

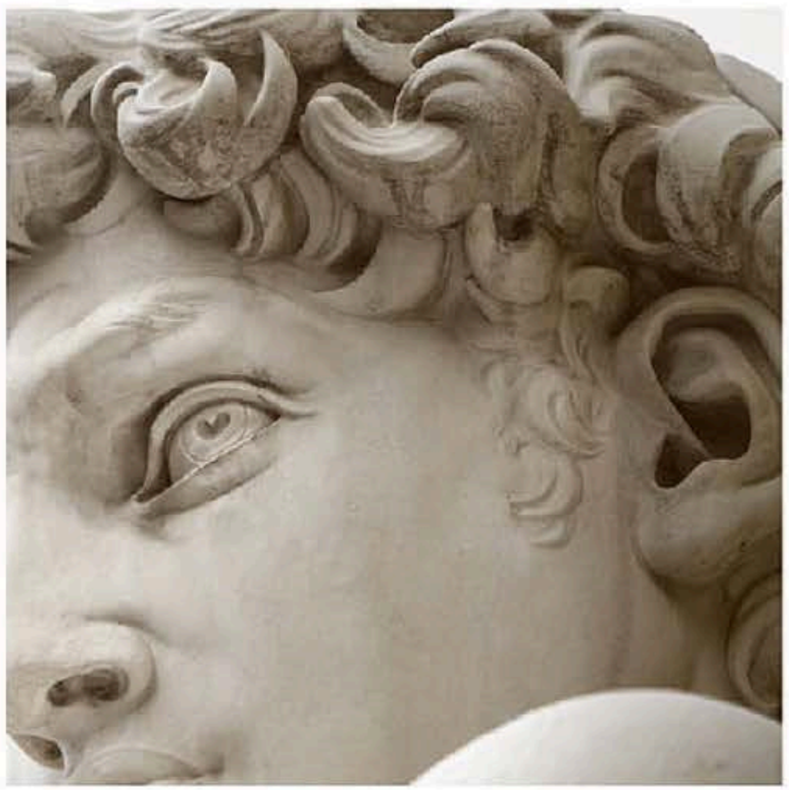
Set the print mode:

head height, speed/resolution, print direction, number of pass, type of screen pattern, type of drop (single, variable)

Test the printing setting (Calibration):

sharpness of the texts, Ink coverage, uniformity, screen texture, overprinting, grainy of the black ink (GCR!)

What type of screen pattern?



Original

Ordered Dithering

Error Diffusion

Put less ink is possible!

It does not dry, counterprint, smear, peel, crack,

stain, dirty colors, grays and darkens the print

Too much Ink

Reference

high level of inking

Calibration goal

reduce excess ink

good ink adhesion

good ink trapping

good color balance

Good tonali gradation (TVI 15-20%)

good gray balance

Linear printing output

Color Variations with bad Calibration

Reference

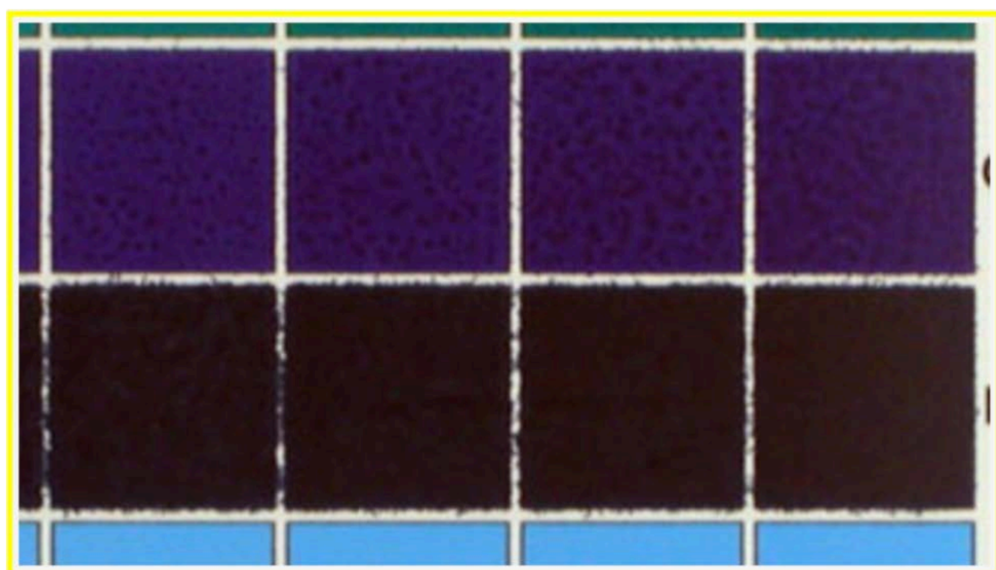
Printed samples

Calibration: less ink better quality!

Define the ink limit for single ink

Define the ink limit for double overprint ink

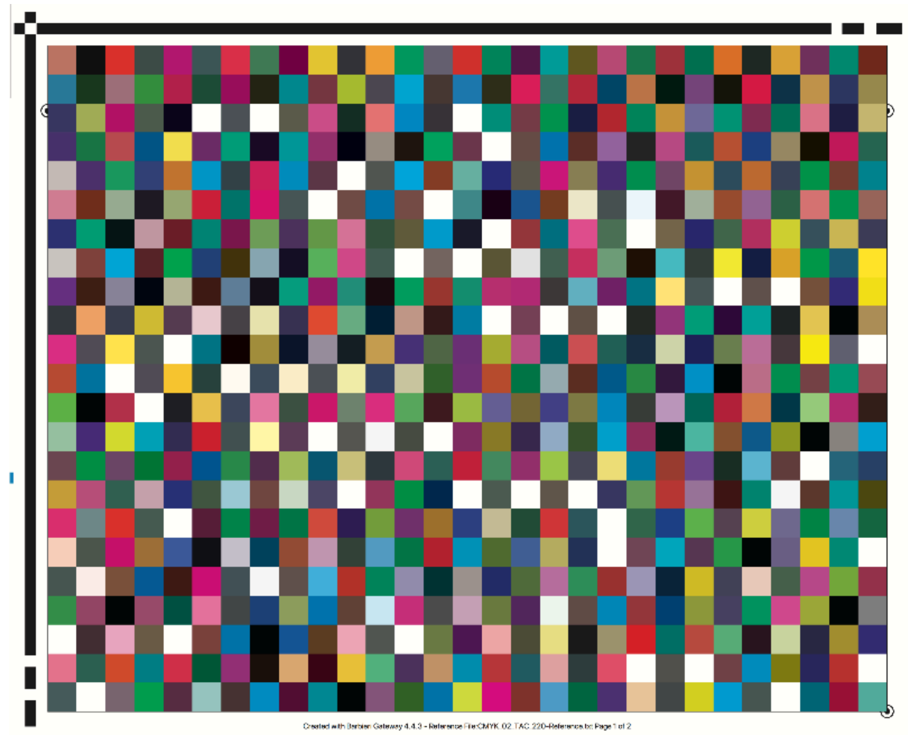
Define the ink limit for triple overprint ink



Print the TIC-TEST (Hutchinson) for define the

TAC of Color Target and the width of separator lines

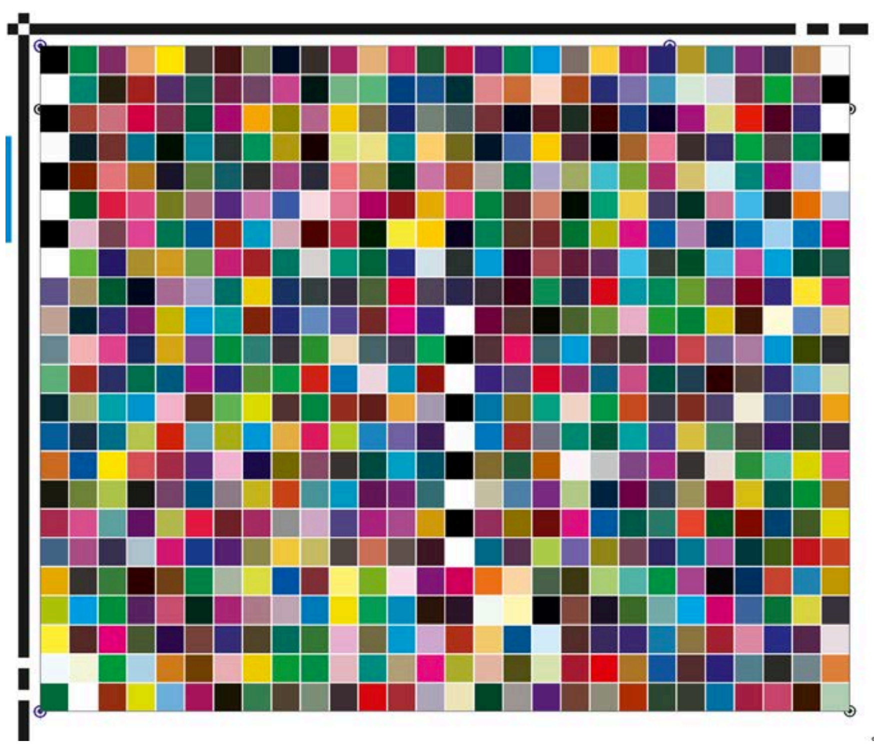
Special Color Target with separator lines



for photography paper
Ultrachrome ink

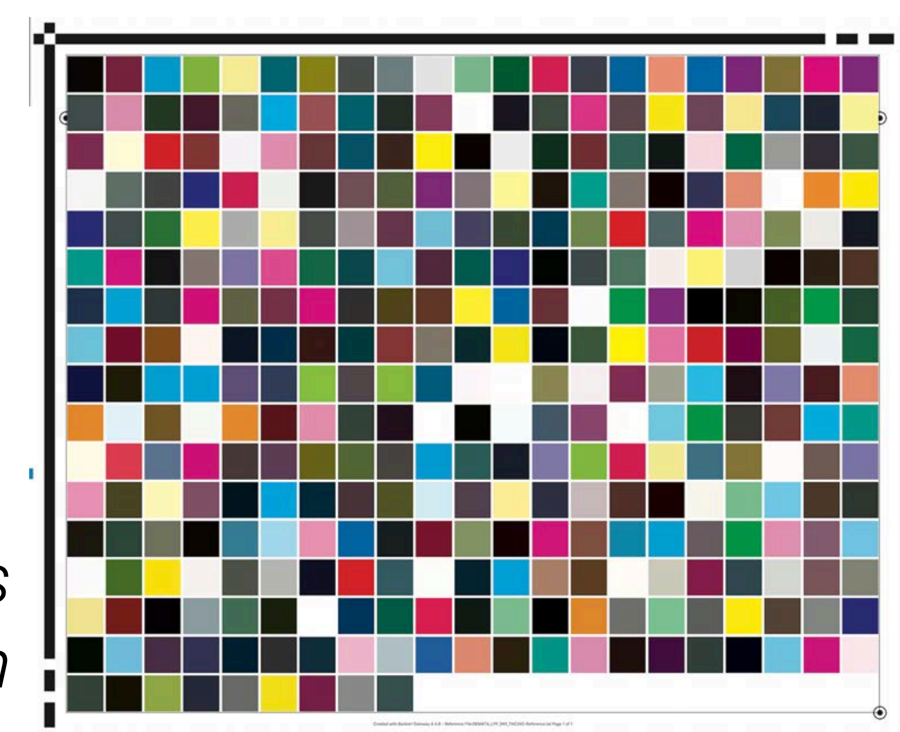
Without separator lines

for vinyl
and solvent ink



separator lines
0,5 mm

For glass
and dye ceramic ink



separator lines
1mm

General Evaluations before print Color Target

Analysis of the media structure and OBA

Analysis of the ink drop on the media

Analysis of the inking defects:

adhesion/trapping, drop enlargement

spreadability, wettability, ink splitting…

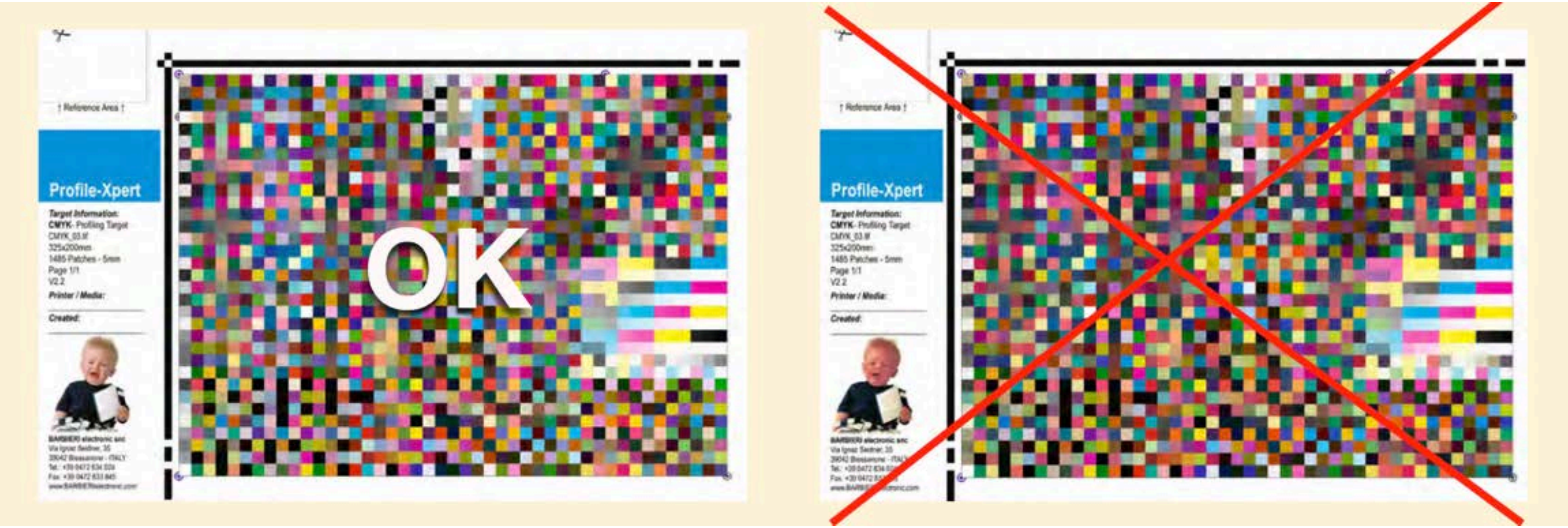
Choosing the best screen pattern (type of screening)

which is more adapt at the media structure

and limits optical interference defects

Get the best visual color contrast on Color Target!

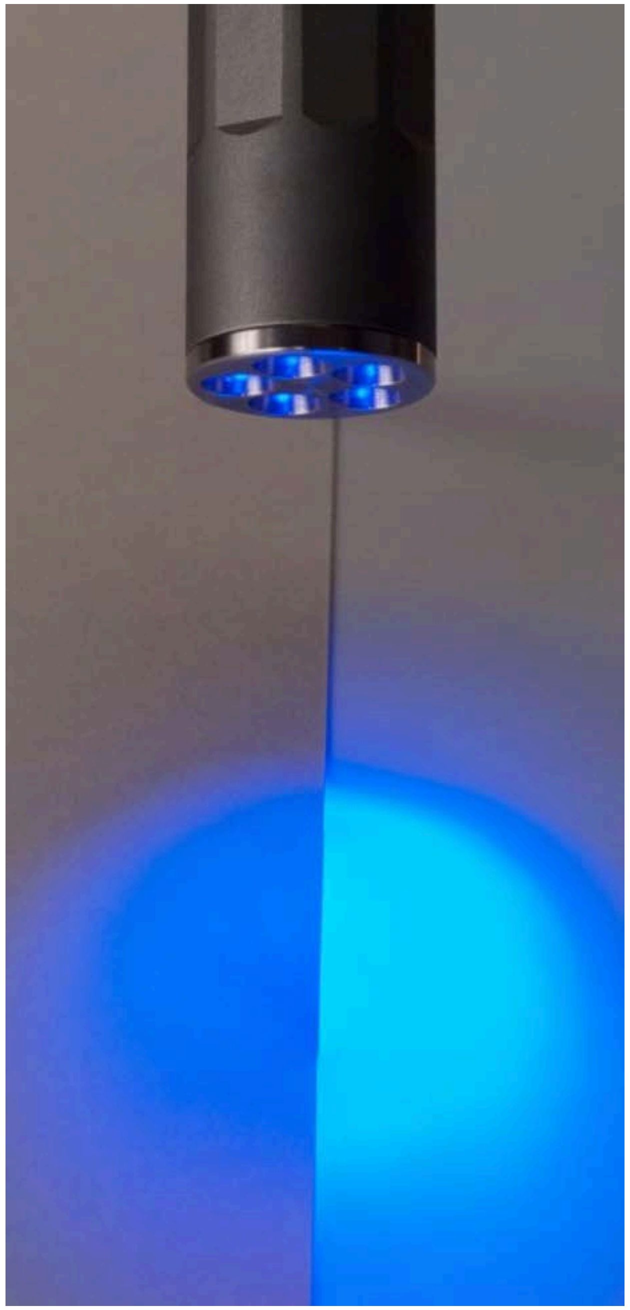
Color Target printed well



good visual contrast between the neighboring color patches

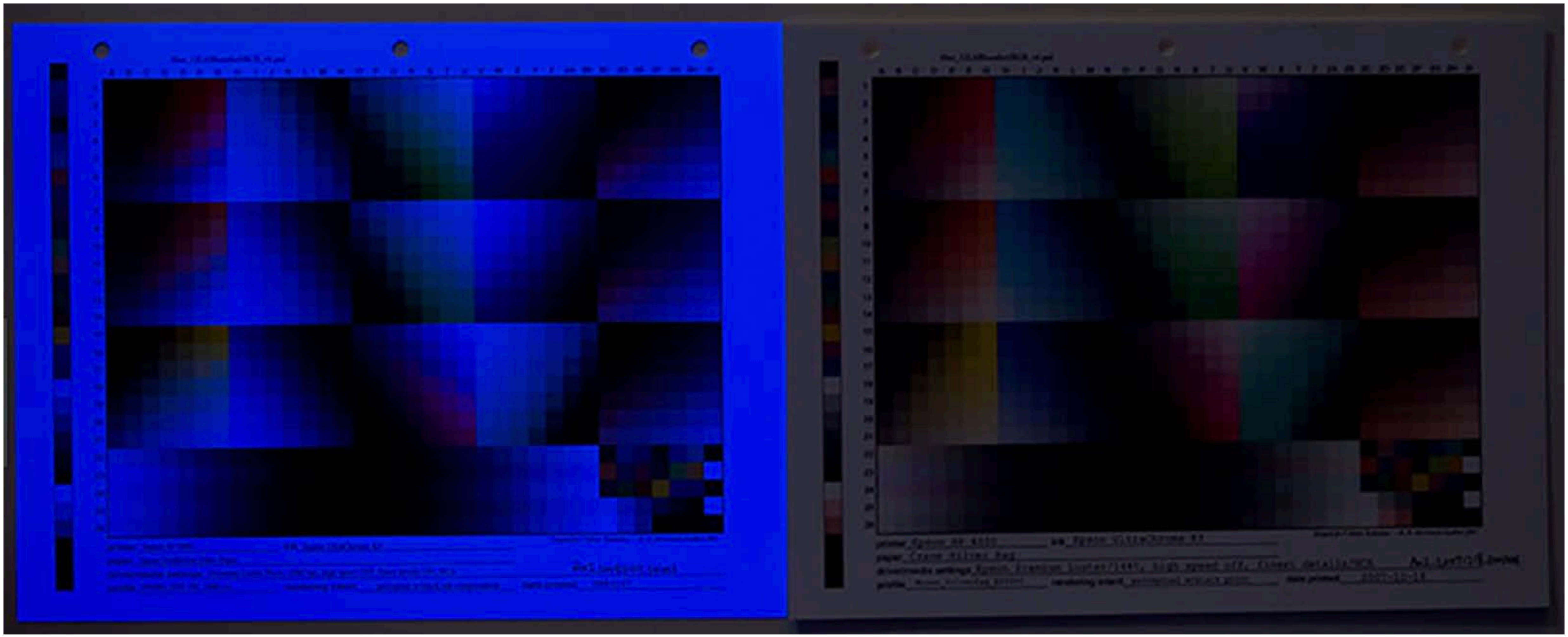
and no dominant color!

OBA




Seventh Generation
laundry detergent
Conventional
laundry detergent

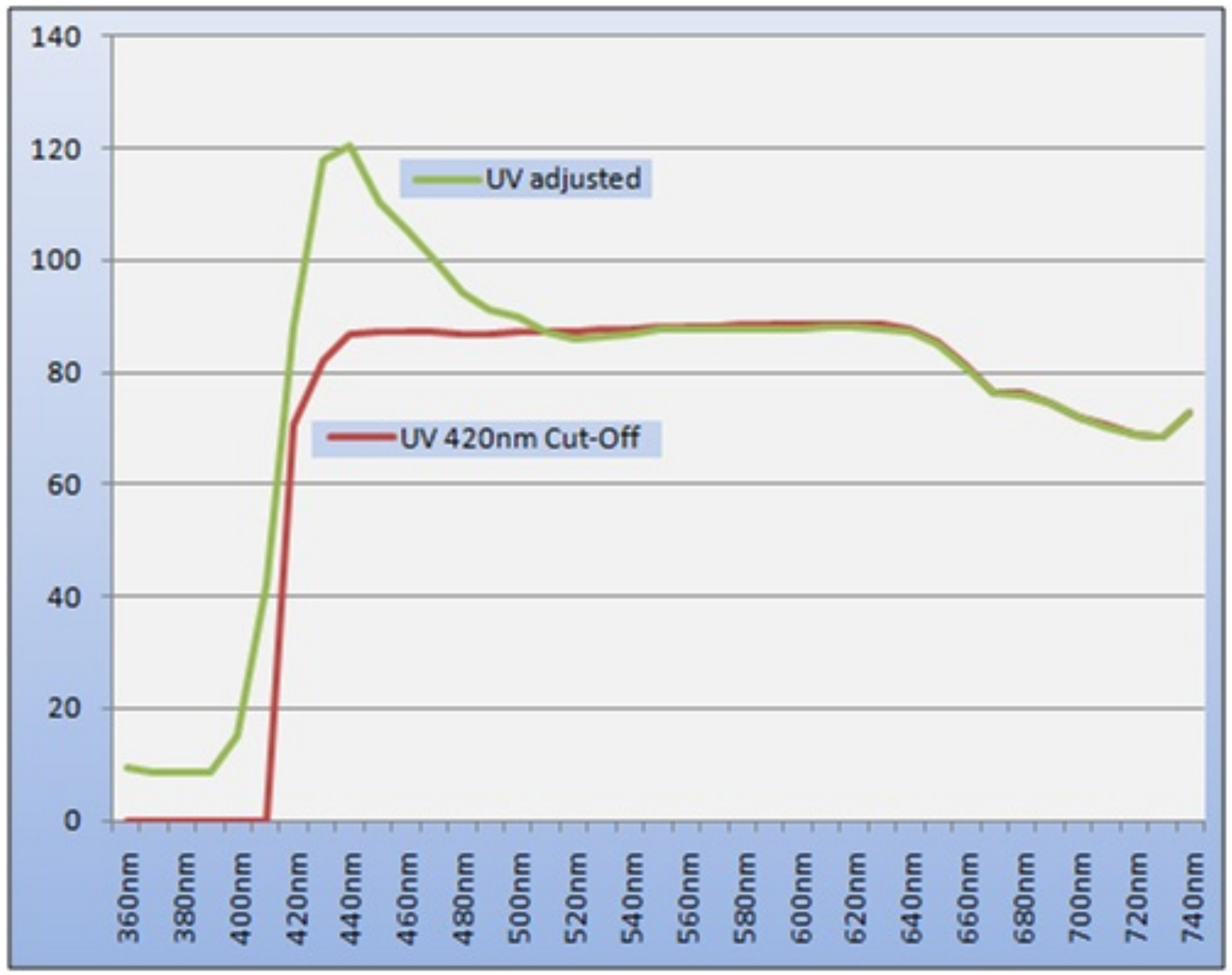
What Color do you measure on the Color Target?



Viewed under UV light

Viewed in black room

Recommended Measurement Method M2 (UV Cut)



The OBA optical brightener(fluorescent) contained in the papers and fabrics have a peak of spectral remission in the Ultra-Violet area but they also emit as peak Blue color in the visible area of the visible around 420-430 nm. The UV Cut filter cuts this abnormal reflection by preventing incorrect measurements on substrates and light colors (seen bluish) that a wrong ICC profile created with M0 measurements trees to neutralize, compensates with a consistent amount of the complementary yellow color.

The Media surfaces

Smooth

Microporous

Porous

Absorbent

Textured

Structured

Matte

Glossy

Substrates white point

White

L	96.10
a	-0.47
b	1.03

Leather

White

L	92.82
a	1.64
b	-6.96

PVC

White

L	88.48
a	-1.26
b	0.97

Forex-1

White

L	90.47
a	-1.04
b	-3.76

Vinyl

White

L	91.85
a	2.26
b	-11.61

Blueback Paper

White

L	85.37
a	0.21
b	2.40

Ceramic

The color changes with the white point of the substrates
and the "spreading/adhesion" of the ink

Measurement diaphragm aperture

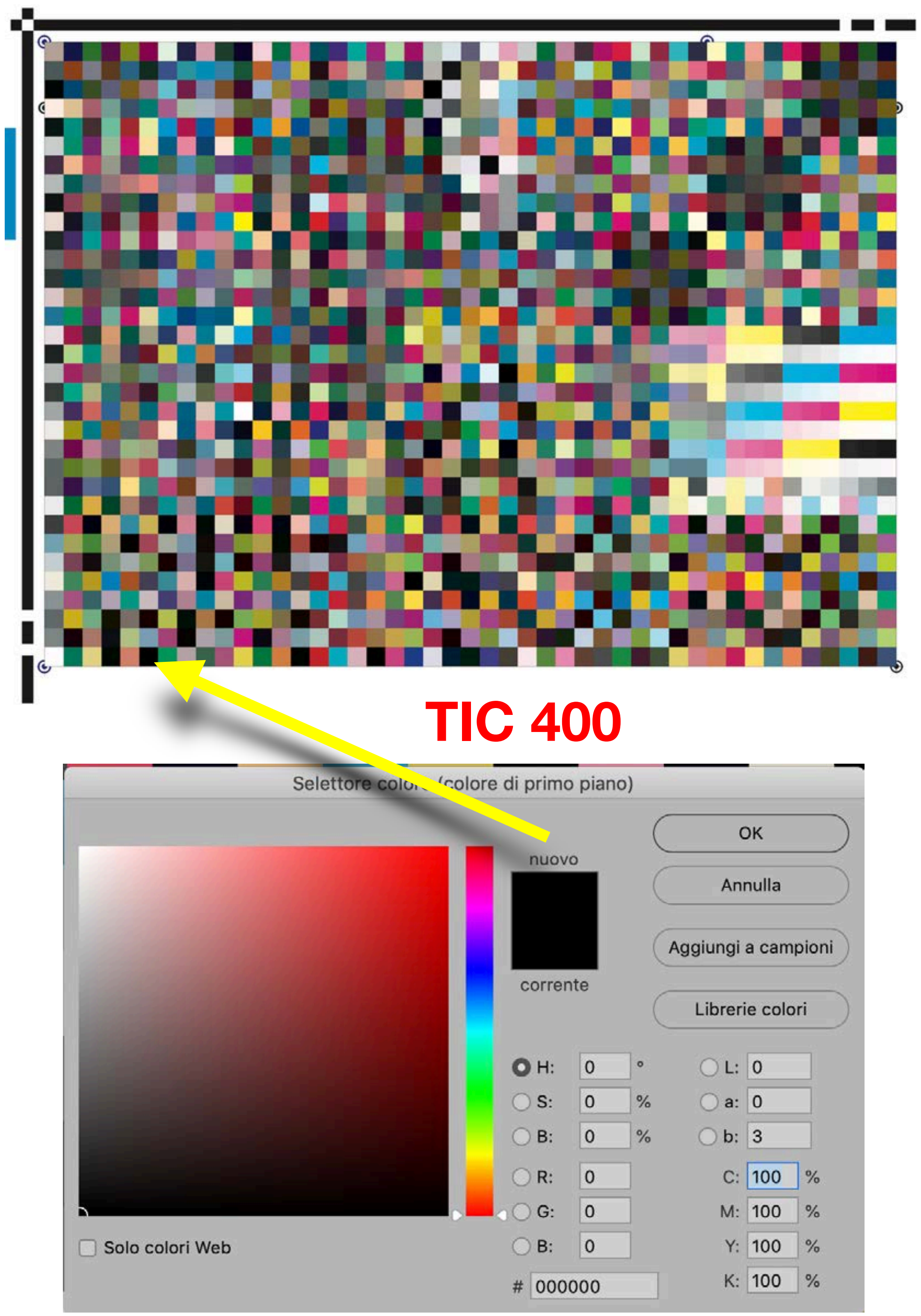
Color Measurement Systems	Aperture mm	Area coverage mm2	*Quante volte >
	8	50,24	**5,23**
	6 (scan area6x60)	28,26 (360)	**2,94** (37,46)
Generic	3,0 /3,5	9,61	1*

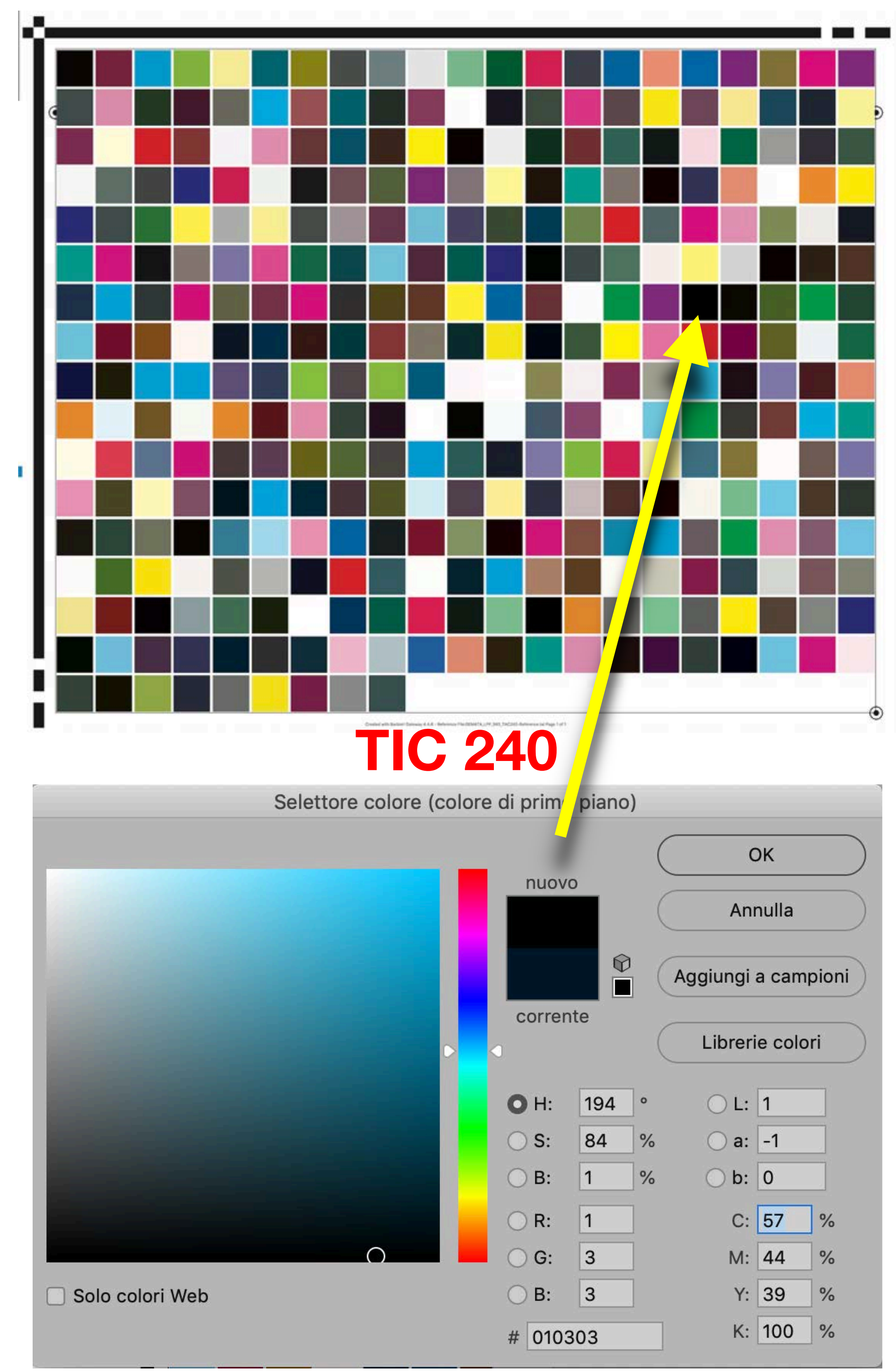
Larger aperture = better measurement accuracy

Media / Color Measurement System

Color Measurement Systems	Spectrophotometer 0°/45°	Spectrophotometer Spherical	Spectral scanner	RGB Camera
Media	*Aperture diameter mm.*	*Applications*	*Applications*	*Applications*
Paper / carton board	3			
Corrugate	6-8			
Plastic/Vinyl	3-6			
Textile/Fabrics	6-8	X		
Wood/Laminates	6-8			
Glass/Plexiglass	3-6			
Metal	3-6	X		
Ceramics	6-8	X	X	X
Leather	6-8			
Cakes	3-6			
Speed	FAST	SLOW	SLOW	FAST

Industrial Printing: Color Target with lower TAC



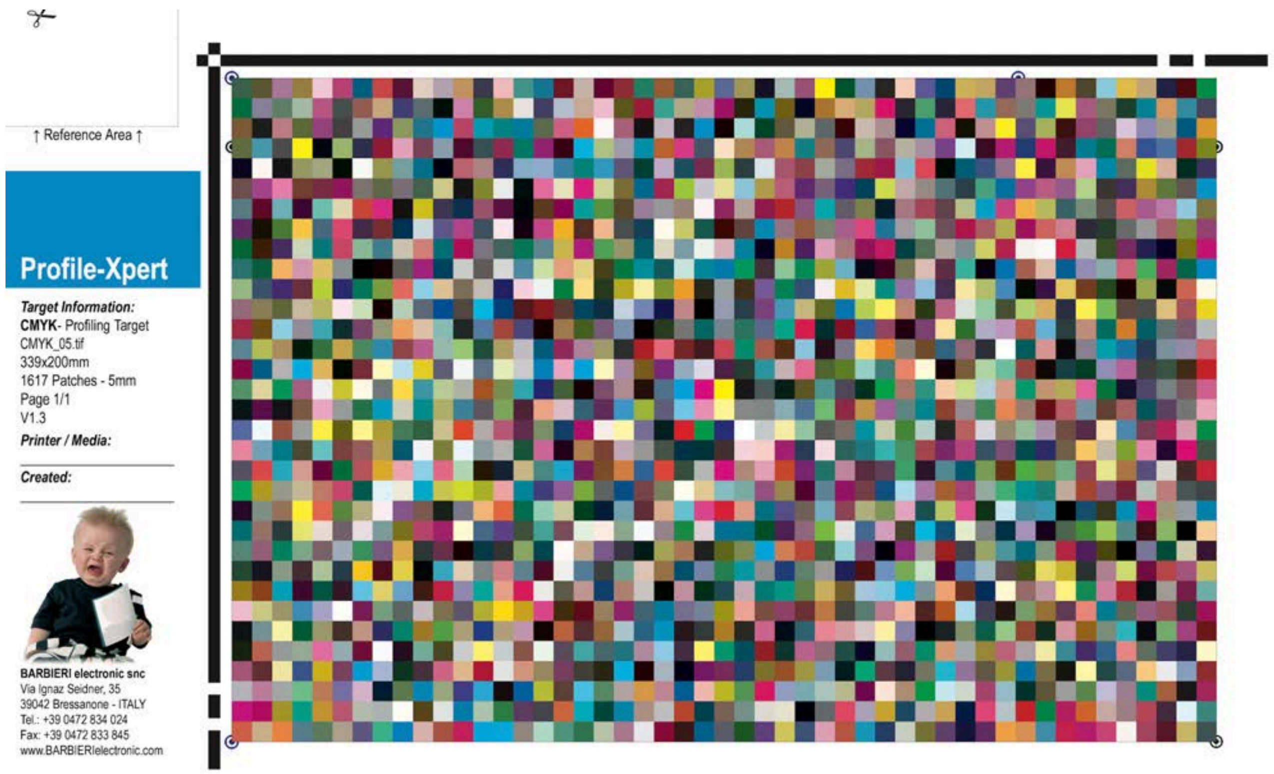


Each Media its Color Target

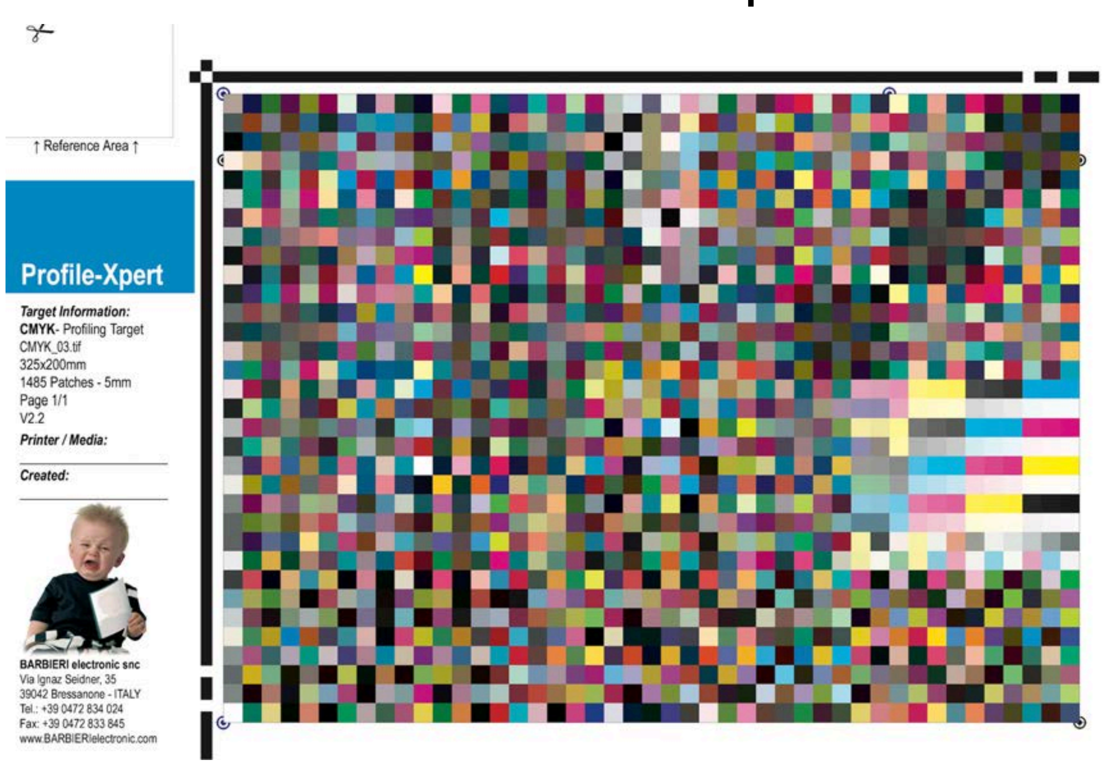
Media	No. Colors	Patch size (mm)	No. Patches Type Color Target	No. Pages	Media No. Traget	TIC For calibration
Paper	4	3	1617 (IT8-7/4)	1	1	330
Corrugate	4	6/8	1288 (CMYK_02)	2	2	300
Plastic/Vinyl	4	6	1617 (IT8-7/4)	1	1	300
Fabric	6/8	8	CLR 2740/3340	7/9	2	350
Laminate /Wood	4	6 (8)	1288 (CMYK_02) 1485 (CMYK_10)	2 6	1	300
Glass/Perspex	4	6 (8)	1288 (CMYK_02)		1	220
Metal	4	6	1288 (CMYK_02)		1	250
Ceramic	4	6 (8)	1288 (CMYK_02)	2	2	250
Leather	4	6	1288 (CMYK_02)	2	1	250
Cake (confectionery	4	6	356	1	1	200

** optimization with Rescaling to no. 1617 patches with ColorAnt*

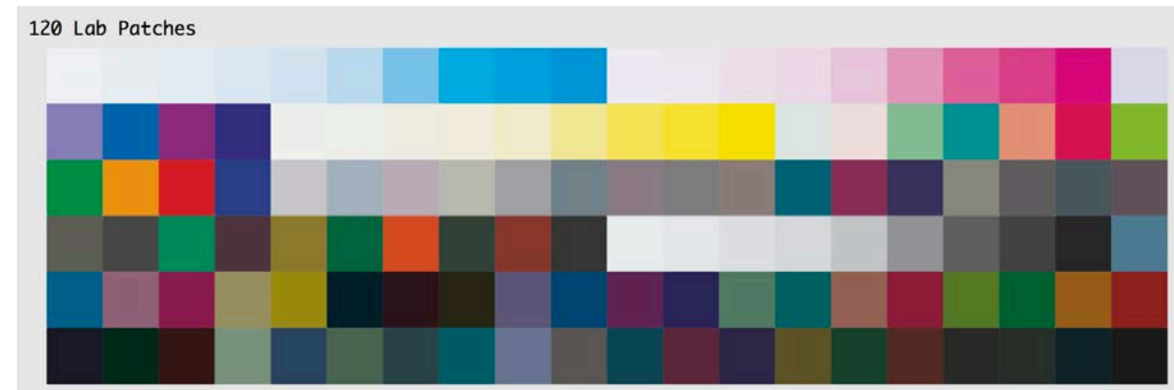
Color Target: types and number of patches



IT8-7/4: 1617 patches



ECI_2002: 1485 patches



ColorLogic: 120 patches

Fogra Mediawedge: 72 patches

ColorLogic: 48 patches

ColorLogic: 40 patches

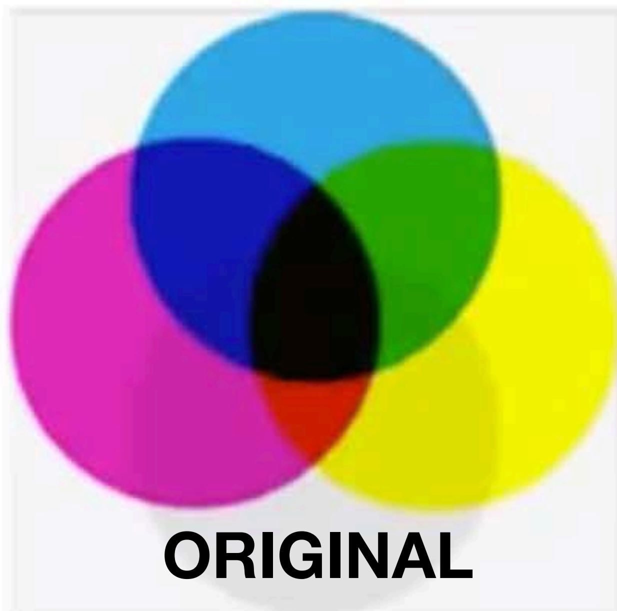
Mini-Target for small media and limited print area

Type of Mini Target	No. Colors	No. Patches	TAC
Barbieri	4	48	270
IdeaAlliance_CW_2013	4	84	300
Fogra Mediawedge_v3	4	72	300
Fogra MediaWedge Multicolor 5C® V1	5	78	300
Fogra MediaWedge Multicolor 6C® V1	6	78	300
Fogra MediaWedge Multicolor 7C® V1	7	104	300
Fogra MediaWedge Multicolor 8C® V1	8	104	300

** optimization with Rescaling to no. 1617 patches with ColorAnt*

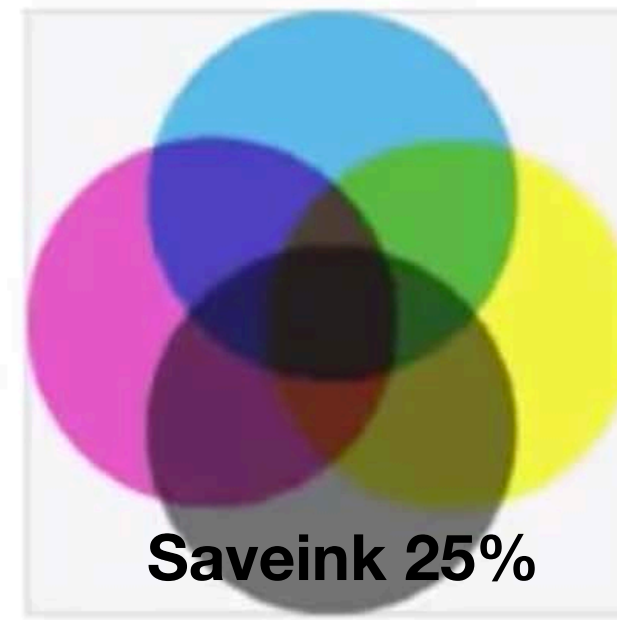
Different TAC for different Media

TAC 330



TAC 300

TAC 250



TAC 200

Saveink > 40%

TAC 109

Saveink > 67%

TAC= Total Amount Coverage

TAC for the different Media

TAC	Type of MEDIA	Job type
400	textiles/sublimation	flag with migration on the opposite side
350	textiles/sublimation	flag with migration on the opposite side
325	banner/Forex/foam	Structured media
300	90% of Media for Sign	best price to consumption ratio
275	Wood (brown colors)	UV ink crust reduction
250	Ceramic / Metal	low-drying materials
225	Glass / confectionery	low-drying materials
200	Glass / confectionery	low-drying materials
< 200 (130-160)	Glass dye ceramic ink	Very low ink thickness

Thanks for your attention!

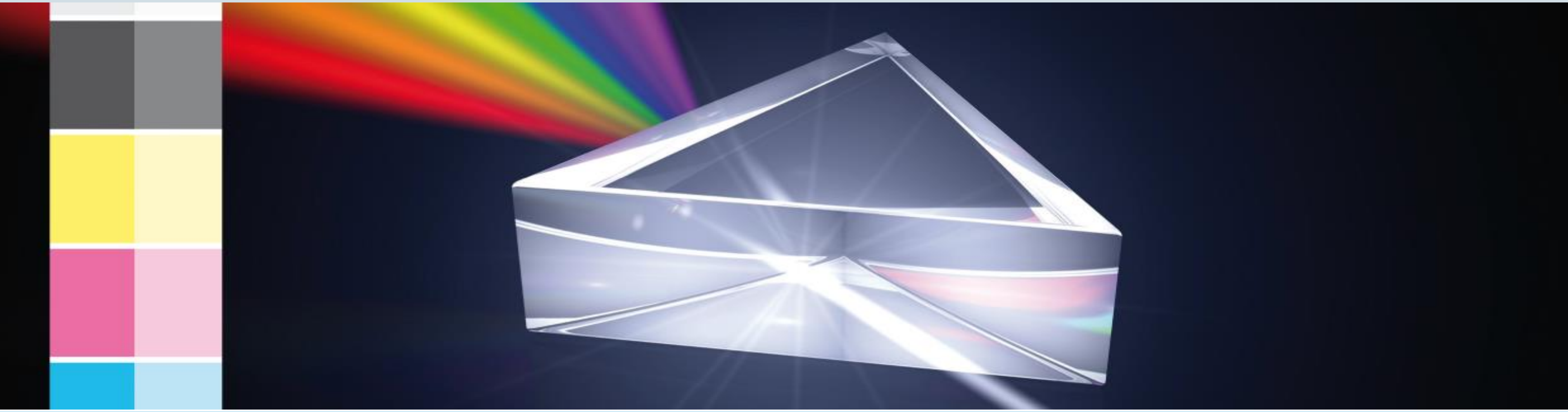
Andrea De Rossi

derossi@tecnologiegrafiche.it

barbieri®

Measurement of 3D textile features

Michele Conni
R&D Engineer at Barbieri Electronic
Ph.D. candidate at NTNU



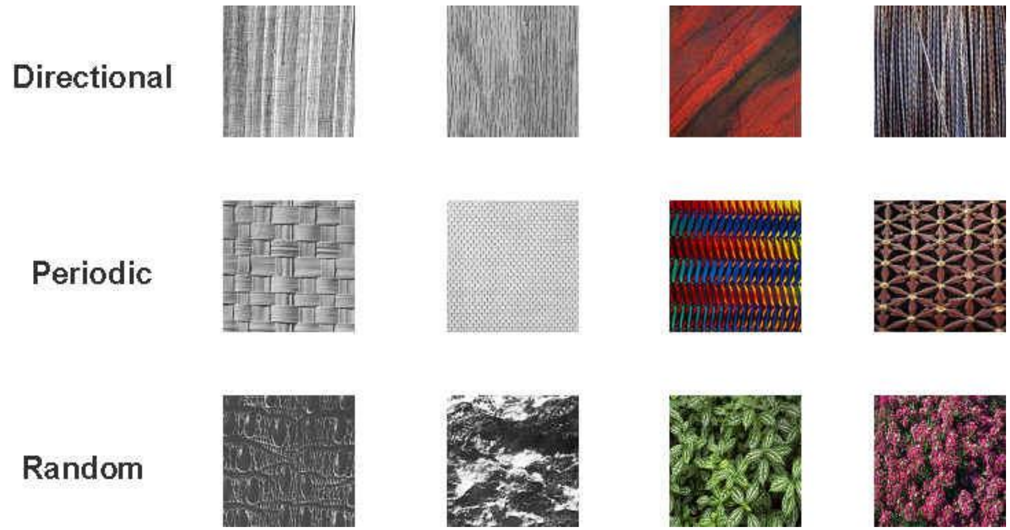
Outline

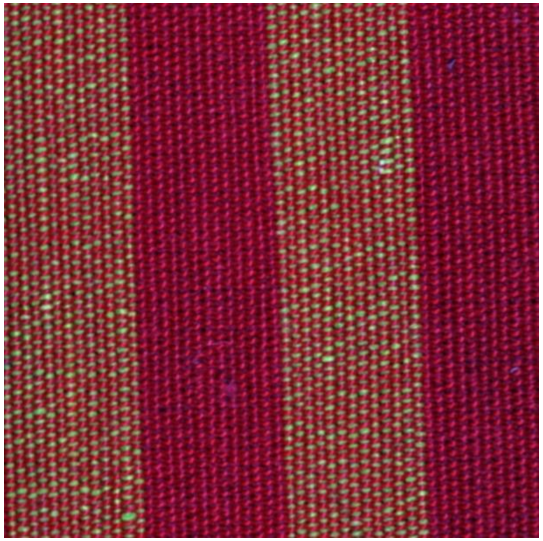
1. Introduction
2. Texture measurement
3. Textile classification
4. 3D analysis
5. Current study

1. Introduction

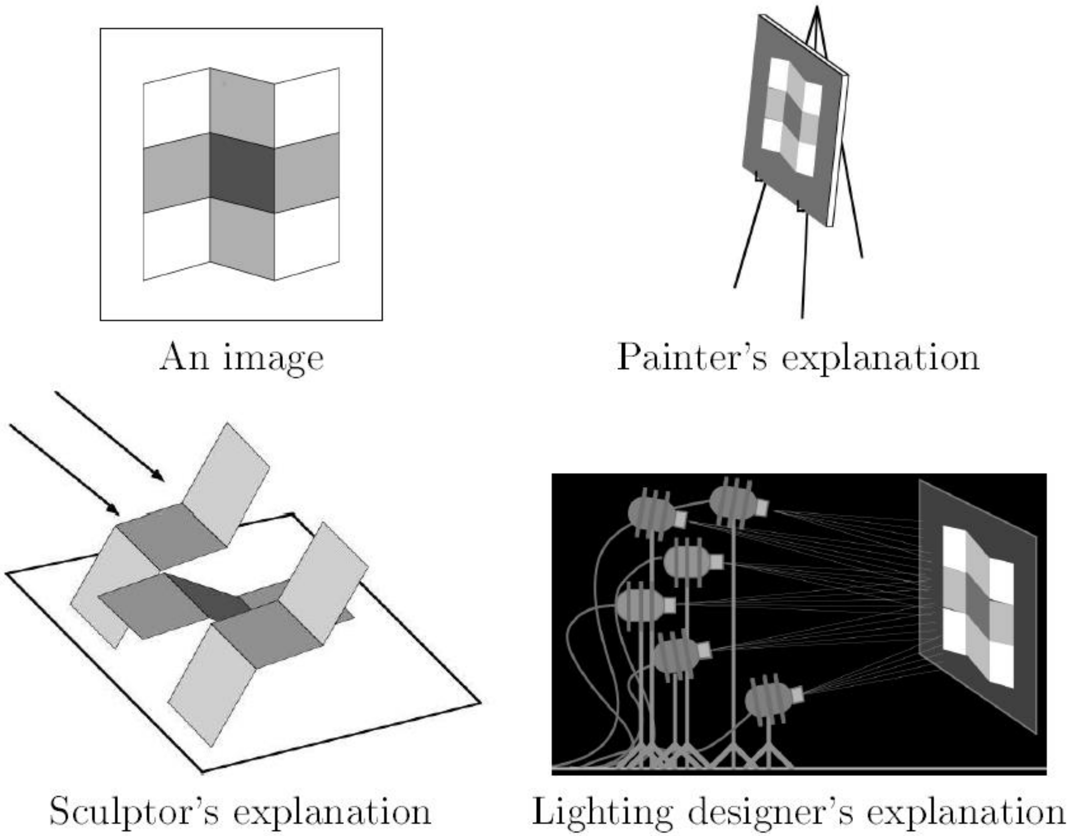
Texture

- "No formal definition of texture exists, intuitively this descriptor provides measures of properties such as smoothness, coarseness and regularity." [Gonzalez, 2002]
- Usually refers to a scene taken from a single object/material characterized by spatial complexity



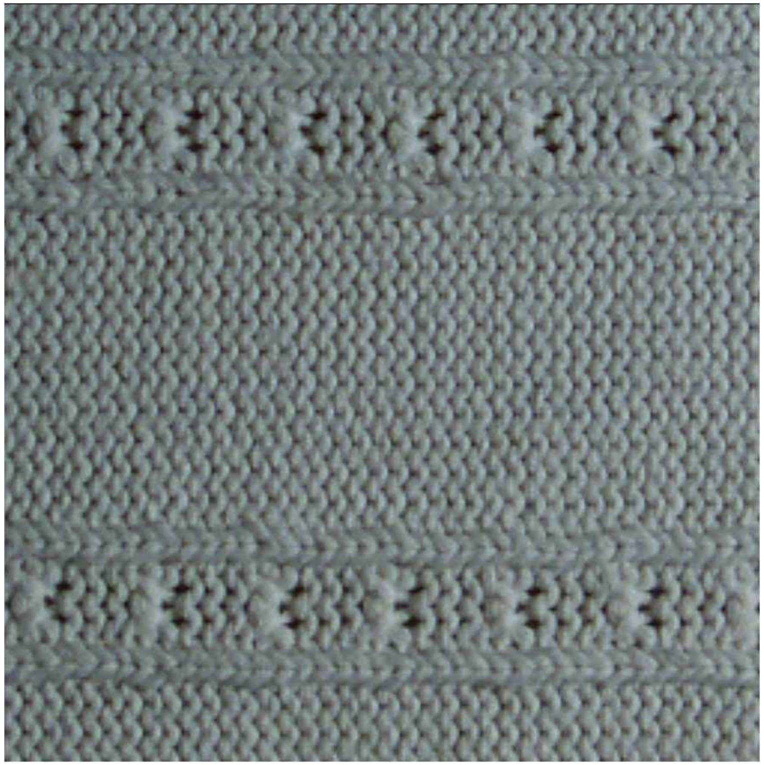
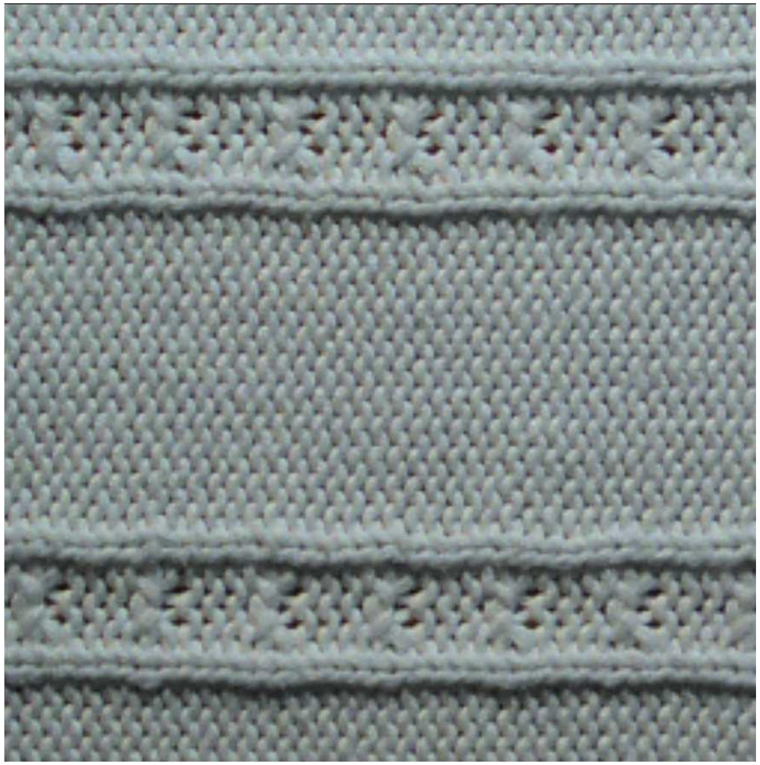


The workshop's metaphor



From [Quéau, 2015]

Texture perception

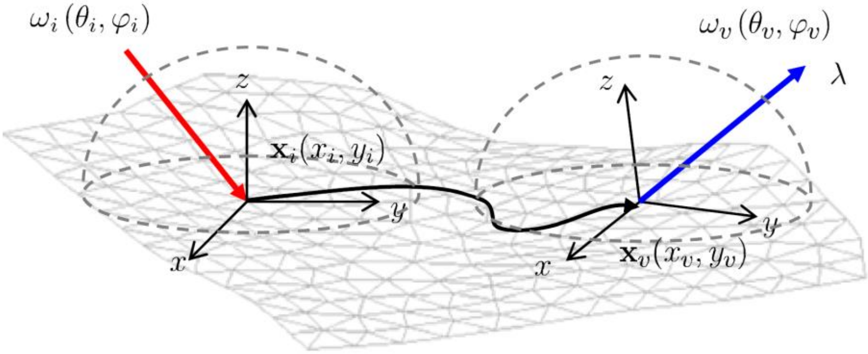



From [Dong, 2005]

2. Texture measurement

Complete surface measurement

- General Reflectance Function (GRF): 16 variables source, detector, collision, emission coordinates + time and frequency of generation and detection
- Bidirectional Surface Scattering Reflectance Distribution Function (BSSRDF): 9D (scattering)
- Bidirectional Texture Function (BTF): 7D (surface)
- Bidirectional reflectance distribution function (BRDF): 5D (point)
- Drawbacks: lengthy and expensive processes, cumbersome data management



From [Haindl, 2013]

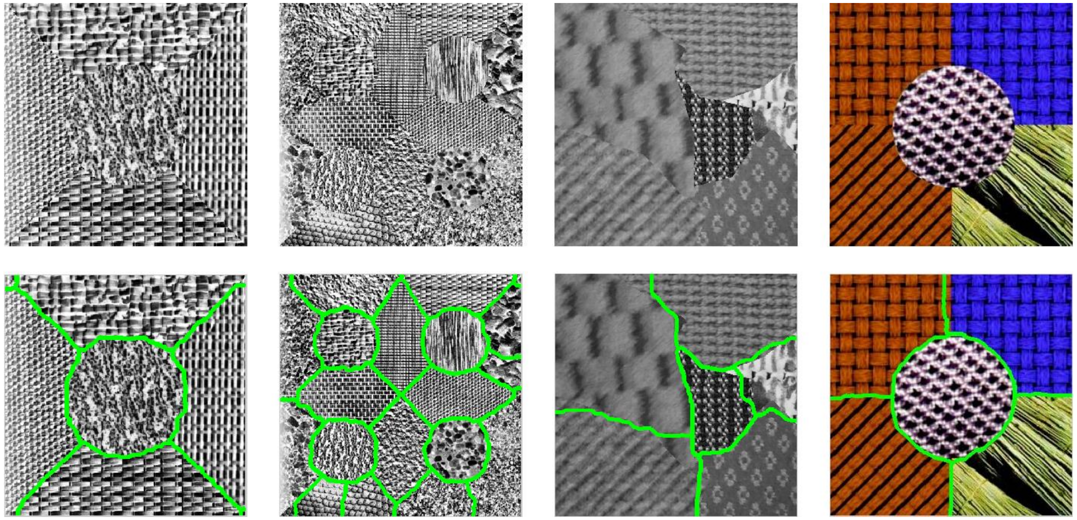
BTF

- Bidirectional Texturing Function: spatially varying BRDF applied to texture, at different angles and illuminations

From [columbia]

Texture features

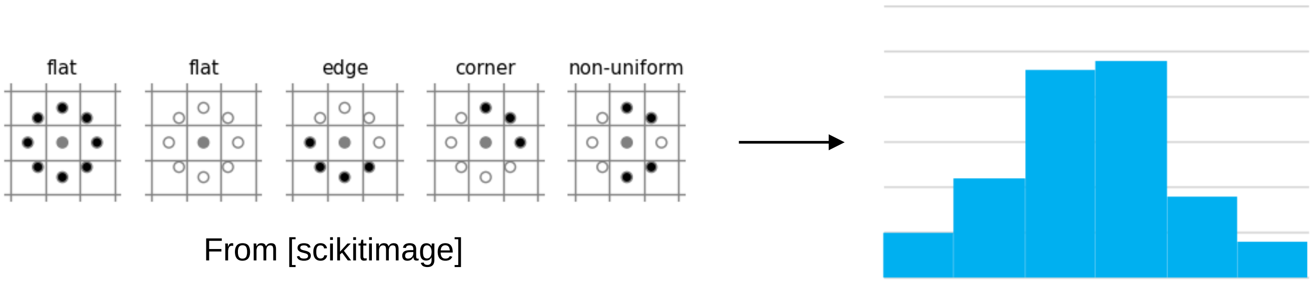
- Julesz' conjecture: human texture perception is correlated to the second order statistics of the scene [Julesz, 1962]
- Higher orders usually are not discriminable [Julesz, 1975]
- Haralick translated this into (statistical) textural features [Haralick, 1973]



From [Storath, 2014]

Texture features

- Used to extract significant information from images
- Two main groups: statistical (e.g. GLCM, LBP) and spectral (e.g. Gabor filters, wavelet transform)
- Standard procedure: grayscale image

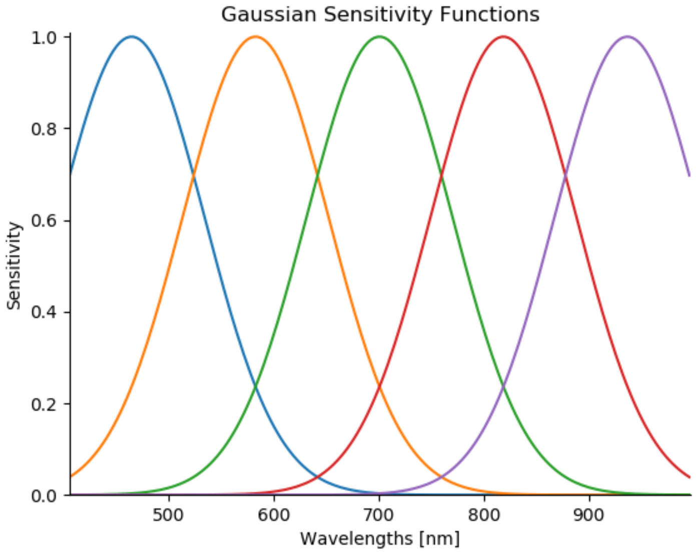


From [scikitimage]

3. Textile classification

Spectral texture

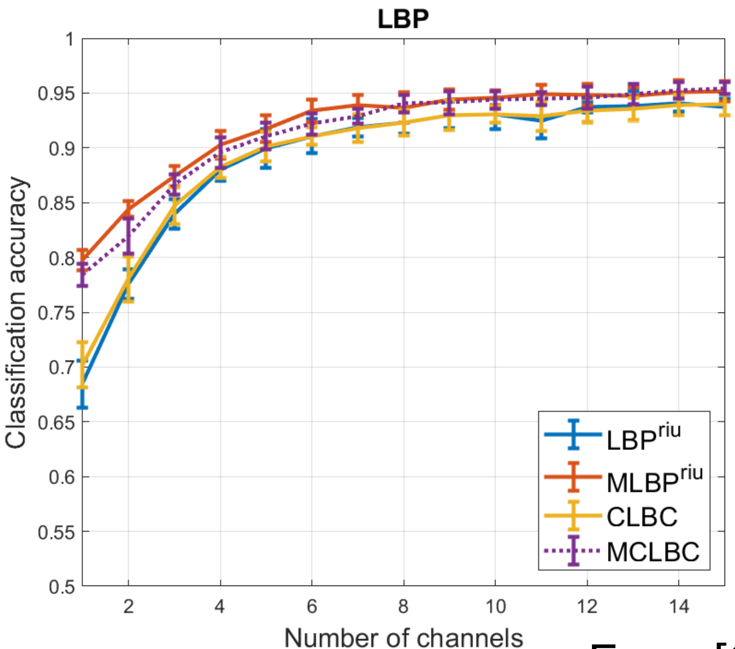
- How many channels are needed to measure texture?
- Benchmark: classification
- Measurement of a set of texture materials
- Classification accuracy vs number of channels
- Spectral sensitivities have been simulated

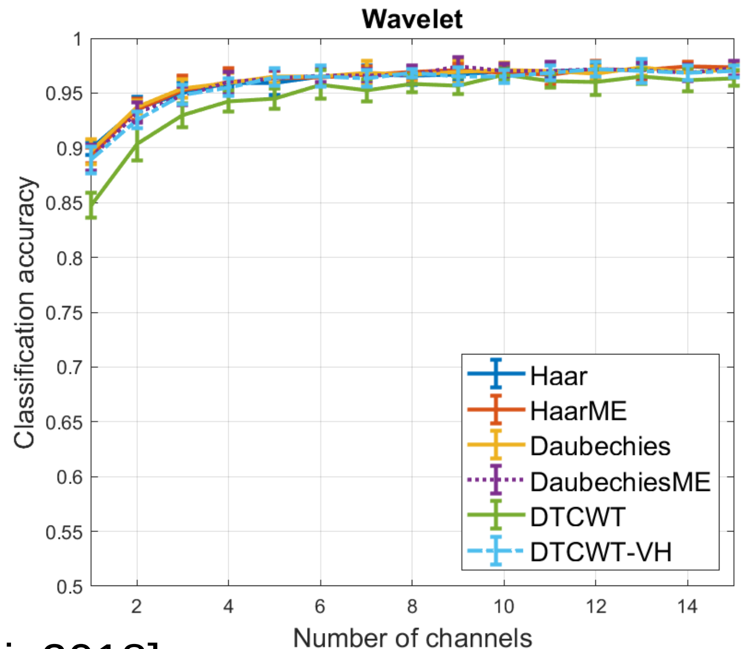


From [Hyspex]

Results

- Optimal number of channel depends on the feature extraction method (from 4 to 7)
- Best performace: spectral analysis



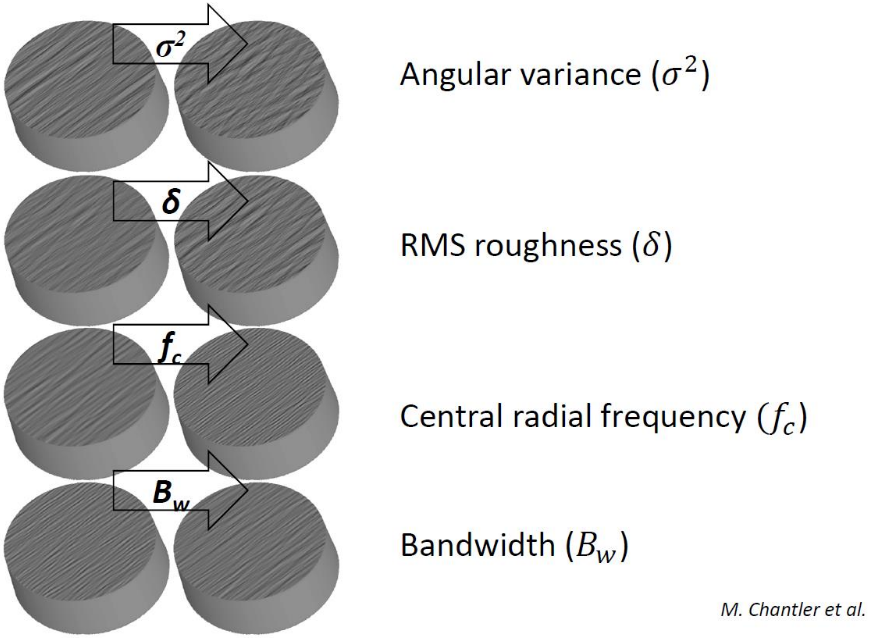


From [Conni, 2018]

4. 3D analysis

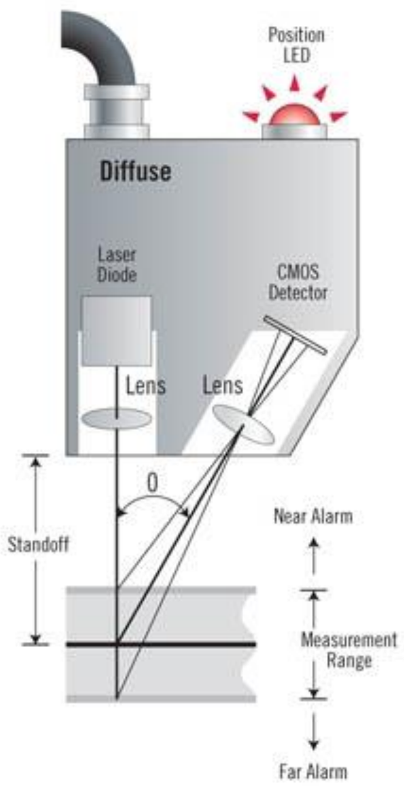
3D texture analysis

- Same approaches can be used on topographical information
- Takes into account only surface texture
- Effect of light strongly influences perception
- Problems: non-Lambertian surface effects

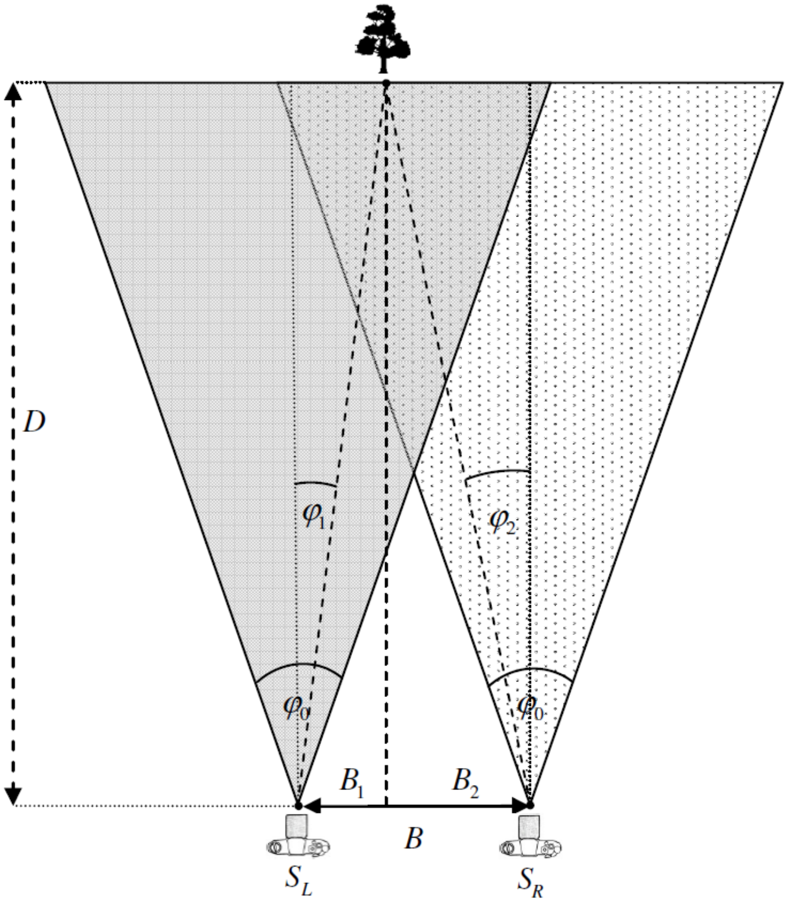


From [Shah, 2012]

Topography measurement



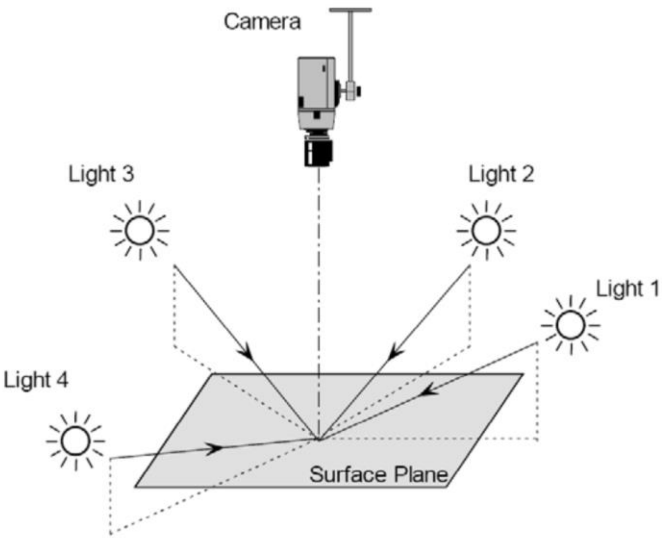
Laser Triangulation
From [MTI Instruments Inc.]



Stereoscopy
From [Mrovlje, 2008]

Photometric stereo

- Requirements:
  - *n* lighting sources
  - fixed camera
  - Lambertian surface
- Problems:
  - shadows
  - specular reflections
  - ambient light

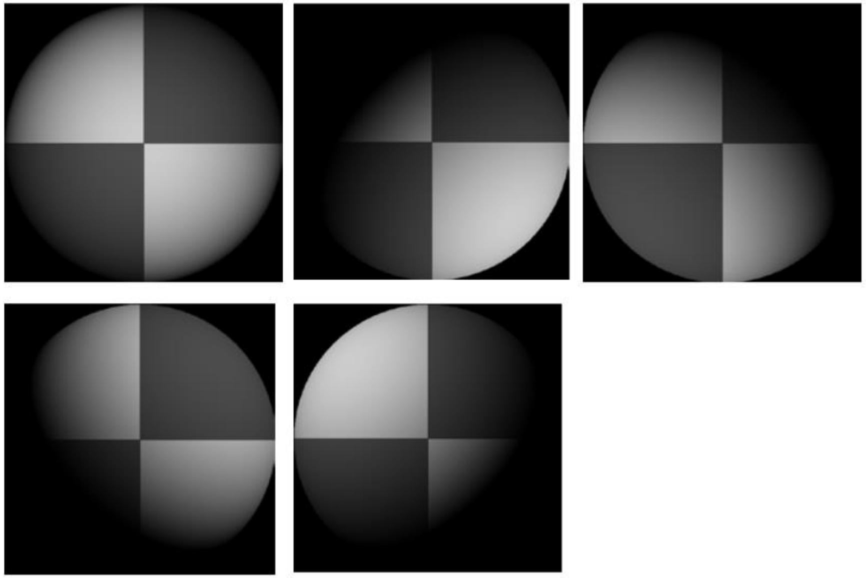


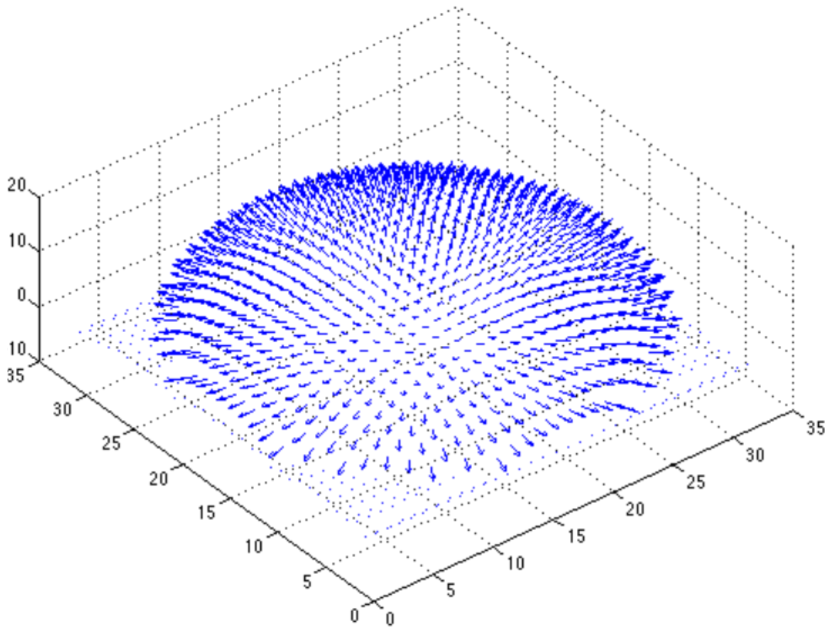
From [Pollefey]

Albedo ρ Normals $\mathbf{n}$ Shape

From [Quéau, 2015]

Photometric stereo





From [Pollefey]

5. Current study

Current work

- Texture attributes for textiles:
  - The principal descriptors of texture can be derived with psychophysical experiments
  - 10 textile design groups around the world
  - Aim: definition of fundamental textile texture attributes
  - Set of 21 white samples, 5 words each
  - Aim: correlation with actual measurements
- Effect of texture on colour perception
- Review of multispectral snapshot techniques

From [Shrestha, 2014]

Conclusions

- **Texture perception** has a big role in textile visual appearance
- For monochromatic textiles, texture information is given by the *3D* **structure** of the sample
- This can be extracted with various measuring techniques, and can be summarized through **features**
- Features have been linked to the **human visual system**, and many of them have been derived after psychophysical evaluations
- Features can be used for computer vision procedures, such as segmentation and classification
- **Classification** has been used to evaluate how many spectral channels give complete texture information for different features
- Aim: derive **relationship** between measurements and features

Thank you for your attention

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The Norwegian
Colour and Visual Computing
Laboratory

NTNU

Getting spectral data when you don't have spectral measurements



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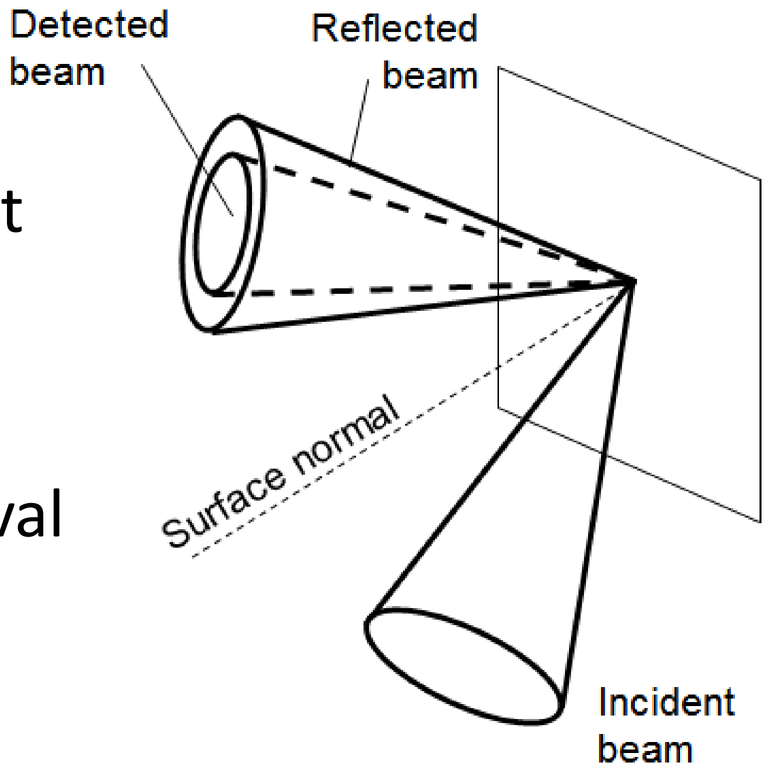
Aim

- There are many cases where the desired colour reproduction is defined spectrally – e.g. for brand colours
- Moreover, in a color management workflow it is now possible to use spectral data as input or to get spectral data as output using iccMAX.
- In many situations spectral data is not available. Therefore it is helpful to find ways to estimate spectral data from colorimetric values such as XYZ
- Our goal is to provide good estimates of spectral reflectance from tristimulus values

Reflectance factor

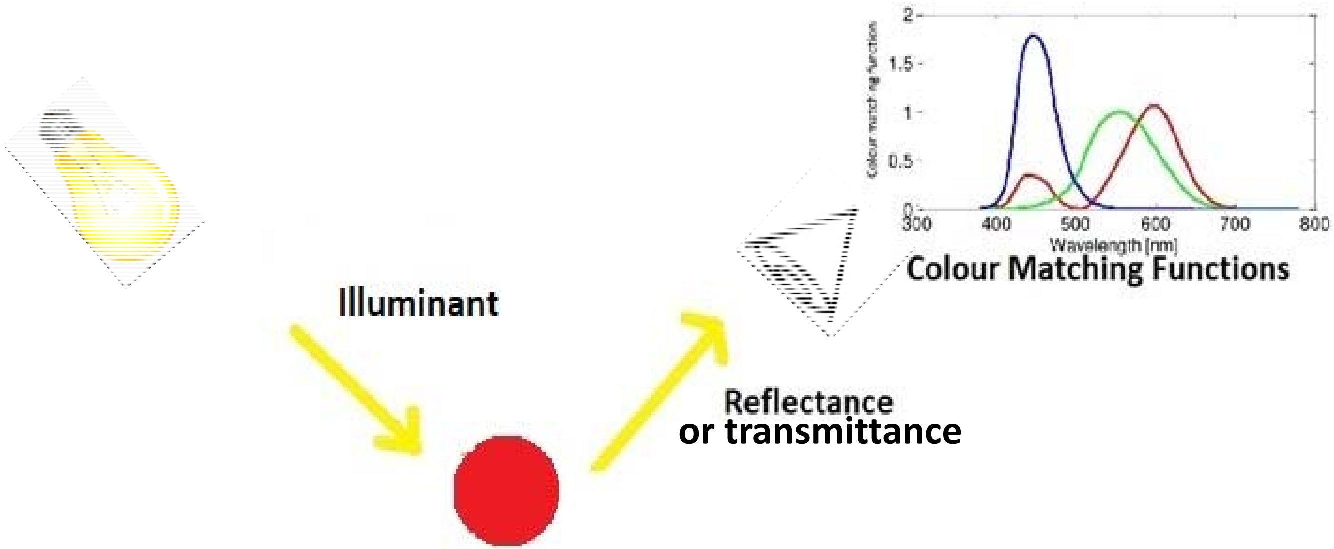
- "Ratio of the radiation reflected by a body delimited by a given cone to that reflected by the perfect reflecting diffuser identically irradiated or illuminated." (ISO 13655)
- This reflectance factor defined at specific wavelength intervals over the visible range.

E.g. 380 to 780 nm at 1 nm interval



Spectral data to tristimulus values

- We obtain XYZ and CIELAB from spectral reflectance or transmittance.



= XYZ

Uses of spectral data

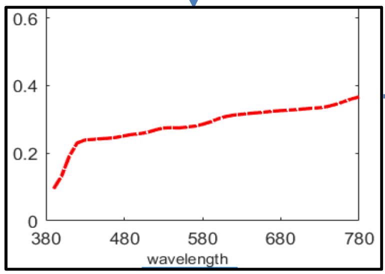
- Calculating colorimetric values
- Understanding the properties of an object independent of the source light or the viewing conditions
- Characterizing a printer with a physical model
- Spectral output of a printer helps avoid metameric matches
- Data hiding (E.g. Hiding watermarks)

Spectral data from tristimulus values

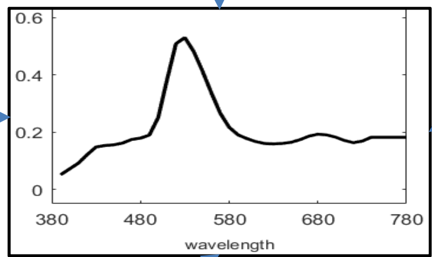
Reflectance Database

Principal Components

Tristimulus Values



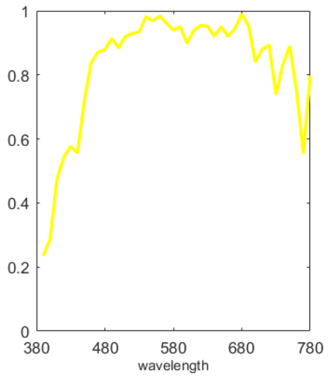
Average Reflectance



Estimated Reflectance

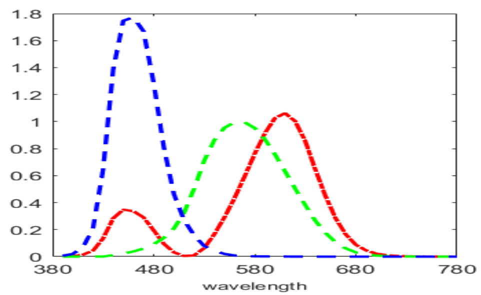
Weight set

=



Illuminant

X

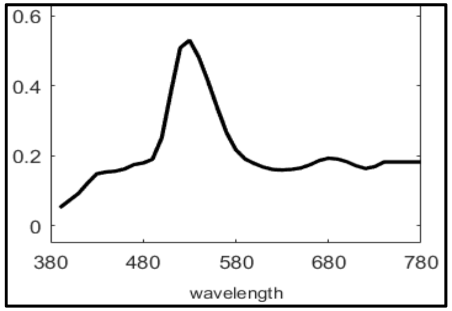


CMF

[Fairman, H. S., & Brill, M. H. (2004).]

Estimated Reflectance

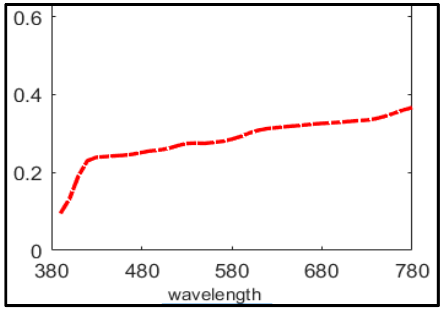
R*



Estimated Reflectance

=

Vo



Average Reflectance of the database

\+

E

Principal Components

X

C

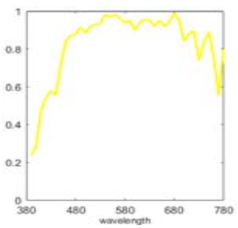
Coefficients

- Principal Components - The K eigenvectors having the highest associated eigenvalues which contain the variance data of the training reflectances.
- Coefficients – PC co-ordinates that weight the columns of E additively to estimate the residual between the original reflectance spectrum and the mean of all reflectance spectra.

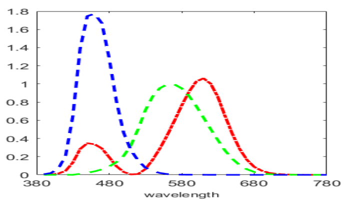
Tristimulus constrained coefficients

- The PC coordinates for estimating reflectance from tristimulus values has to be tristimulus constrained.

$$C = (A^T E)^{-1}(T - T_{avg})$$

A =


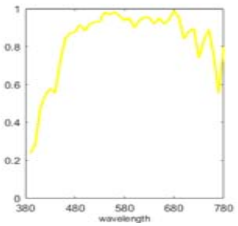
Illuminant

x


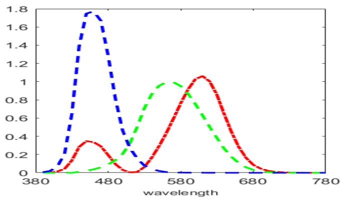
CMF

T = Tristimulus value

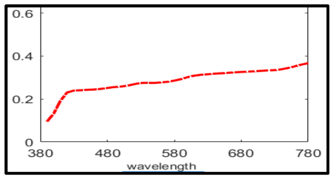
E = Principal Components

T_{avg} =


Illuminant

x


CMF

x


Average Reflectance

Tristimulus value of the average reflectance of the database

Weighted Reflectances

2. Spectral Estimation using weighted PCA [Agahian et. al]

$$d = 1 / ((\Delta E_{2000}(\underbrace{XYZrso}_{\text{Computed Using Training Reflectance}}, \underbrace{XYZt}_{\text{Test Tristimulus Value}}) \underbrace{+0.01}_{\text{To avoid division by zero}})$$

- **Weighted Training Reflectances = $[d_1 R_1, d_2 R_2, \ldots, d_i R_i]$**

$$R = Eo + E((A^T E)^{-1}(T - A^T Eo))$$

Methods

Dataset 1 → Training set
Dataset 1 → Test set

Dataset 2 → Training set

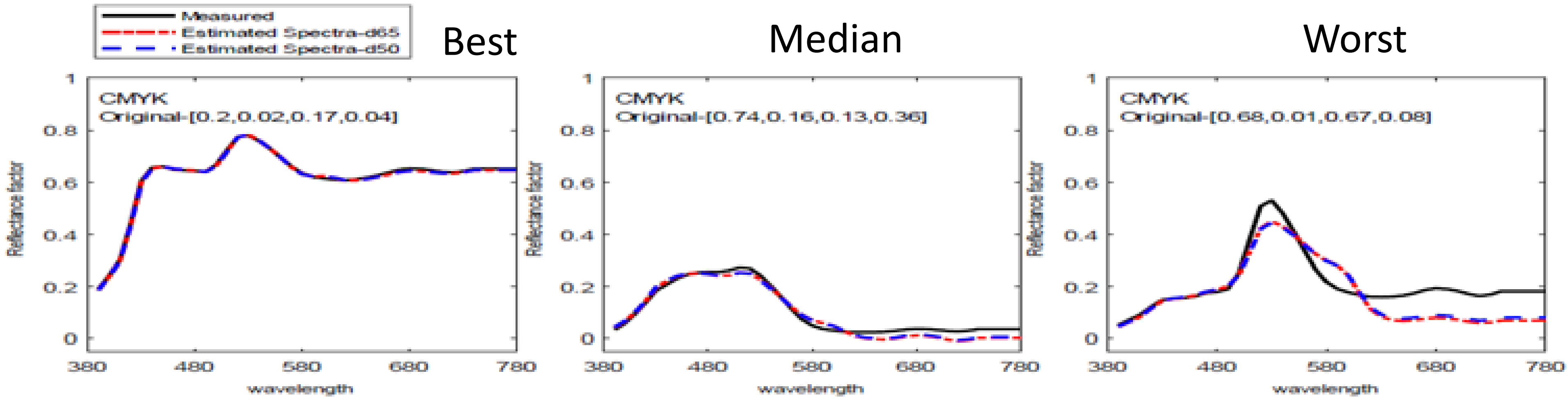
Workflow 1

Training **Dataset 1**
↓
Calculate the Pcs
↓
Estimate reflectance for test Dataset 1
↓
Evaluate against the ground truth for test Dataset 1

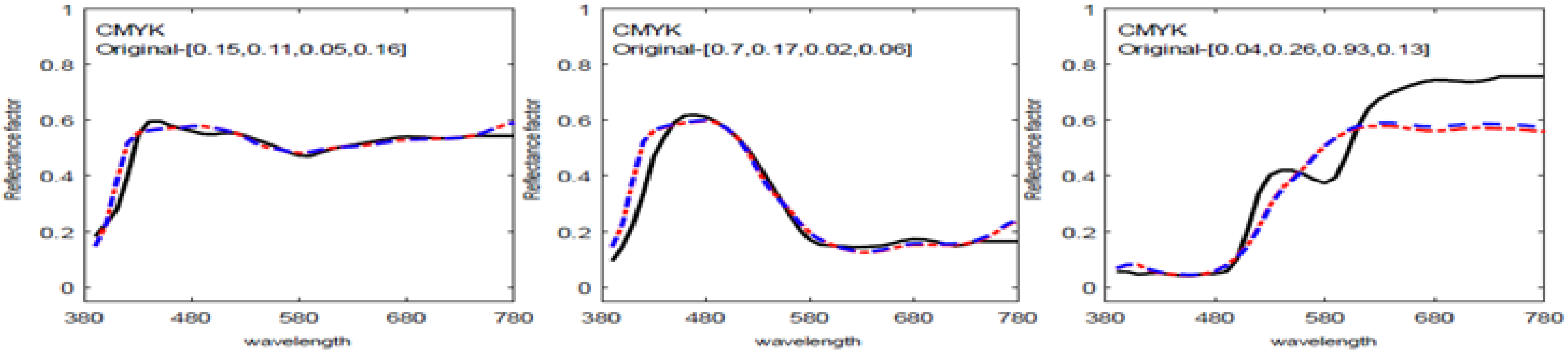
Workflow 2

Training **Dataset 2**
↓
Calculate the Pcs
↓
Estimate reflectance for test Dataset 1
↓
Evaluate against the ground truth for test Dataset 1

Results



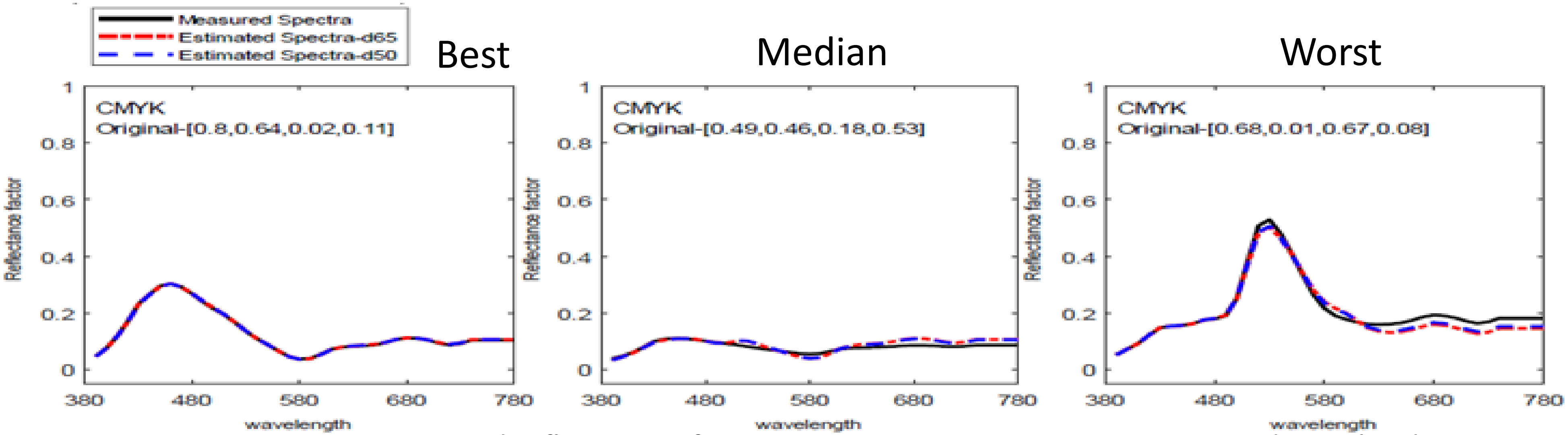
Estimated reflectance of Test Dataset 1 using training Dataset 1 and classical PCA



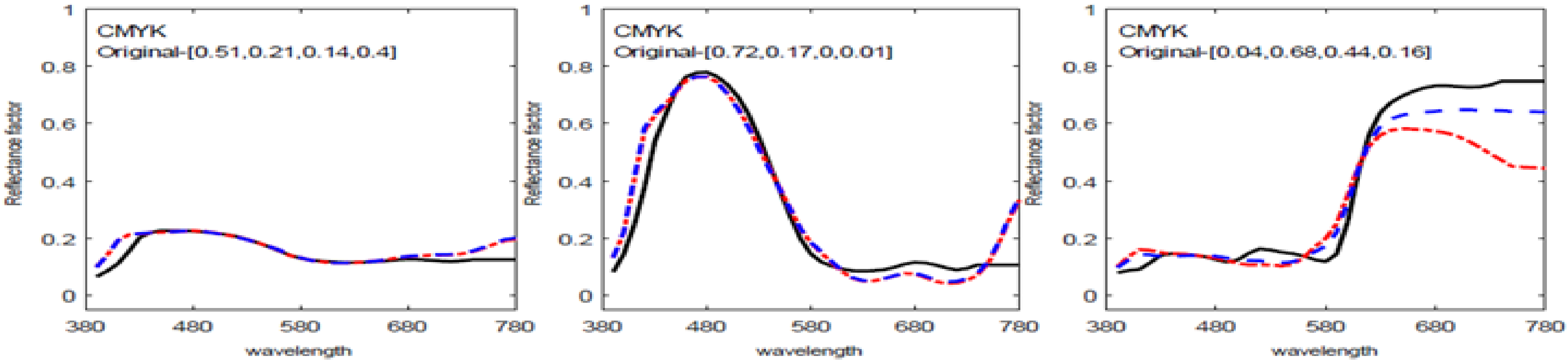
Estimated reflectance of Test Dataset 1 using training Dataset 2 and classical PCA

Results

Best Median Worst



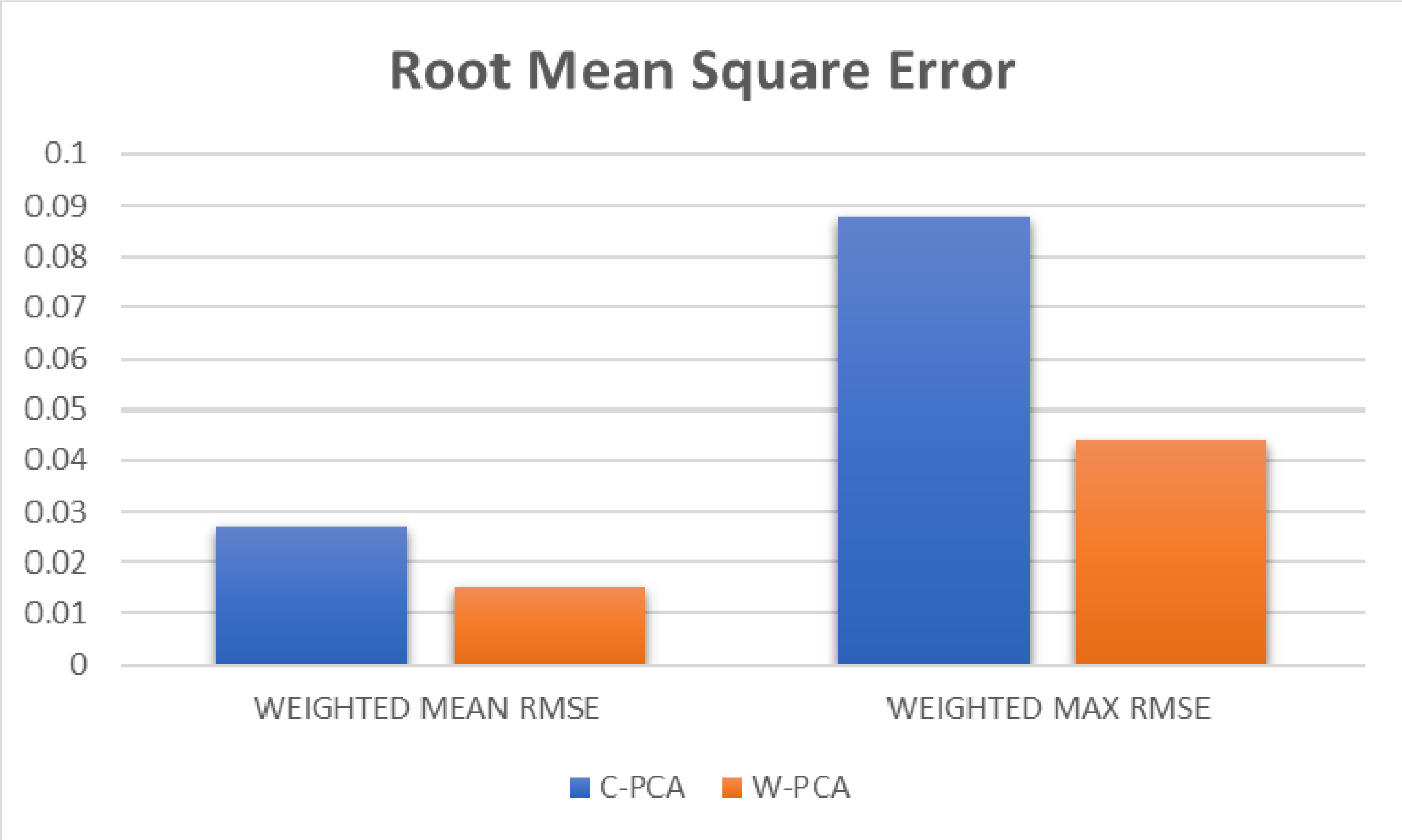
Estimated reflectance of Test Dataset 1 using training Dataset 1 and weighted PCA



Estimated reflectance of Test Dataset 1 using training Dataset 2 and weighted PCA


durst

Analysis


Root Mean Square Error
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
WEIGHTED MEAN RMSE
WEIGHTED MAX RMSE
C-PCA
W-PCA

Analysis

	WEIGHTED MEAN ΔE00			WEIGHTED MAX ΔE00		
	D65/D50	**D65/C**	**D65/A**	**D65/D50**	**D65/C**	**D65/A**
C-PCA D65	0.55	0.18	1.96	4.44	1.96	12.57
C-PCA D50	0.58	0.17	0.90	5.94	2.51	4.52
W-PCA D65	0.26	0.09	0.94	4.62	1.53	13.84
W-PCA D50	0.18	0.06	0.35	0.84	0.33	1.49

Metamerism Index

Analysis

To increase accuracy of the estimated reflectance

- the illuminant and cmf

chosen should be the same or closer to the illuminant and cmf used in the test XYZ.

Chromatic Adaptation

- Chromatic Adaptation: “Visual process whereby approximate compensation is made for changes in the colors of stimuli, especially in the case of changes in illuminants.” [CIE, e-ILV]

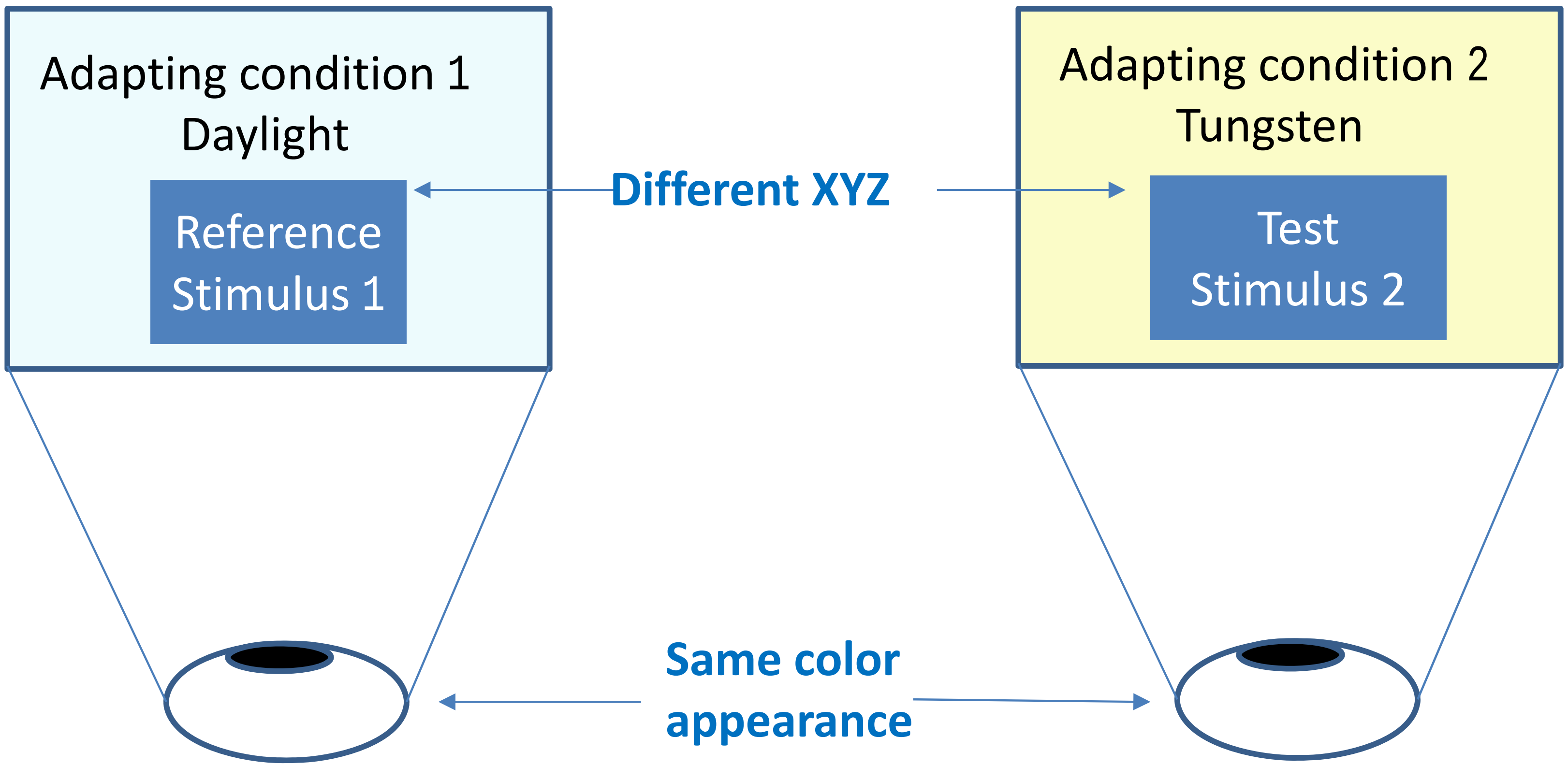
Same scene under different Illuminants

Visual appearance

http://www.psy.ritsumei.ac.jp/~akitaoka/sakkakuWS2019.html

Corresponding colors

- Corresponding colors: colors that perceptually match under different adapting conditions.

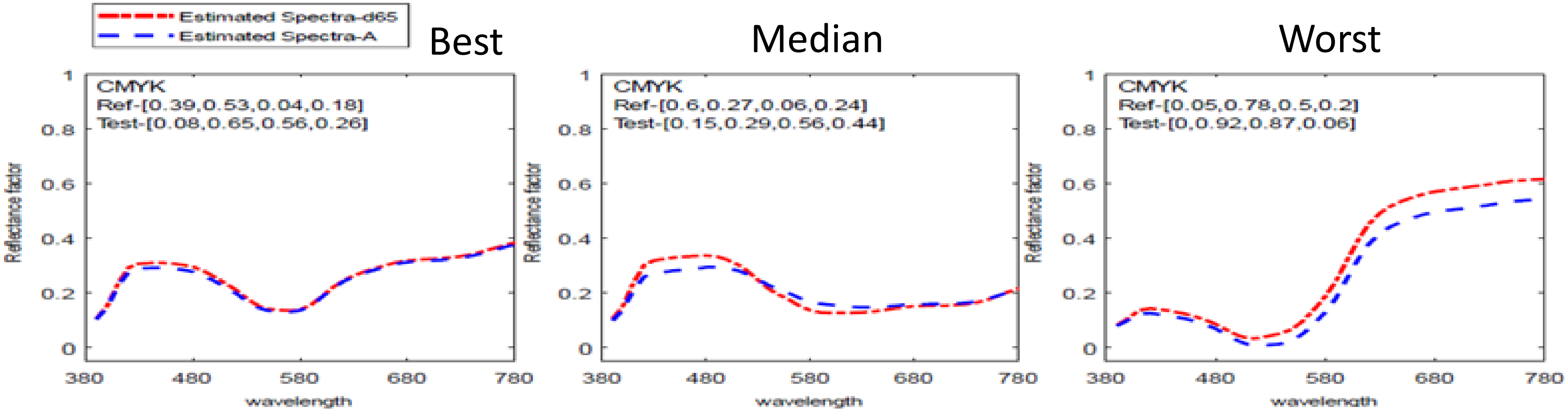


Spectral data of corresponding colors

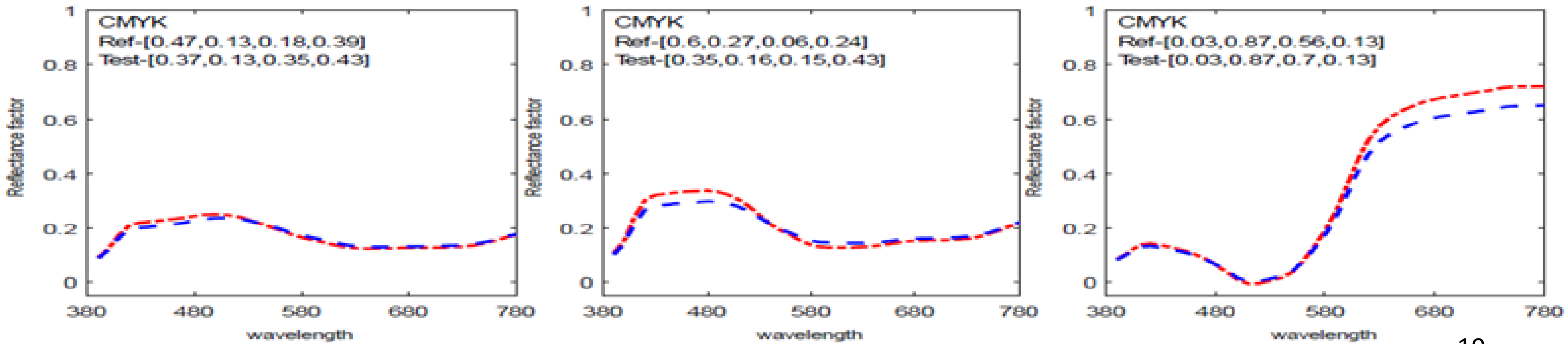
- Chromatic adaptation transform is performed on XYZ colorimetric data, so spectral data is not available.
- Our goal is to estimate from chromatically adapted XYZ data

Result of Corresponding Color datasets

Best Median Worst

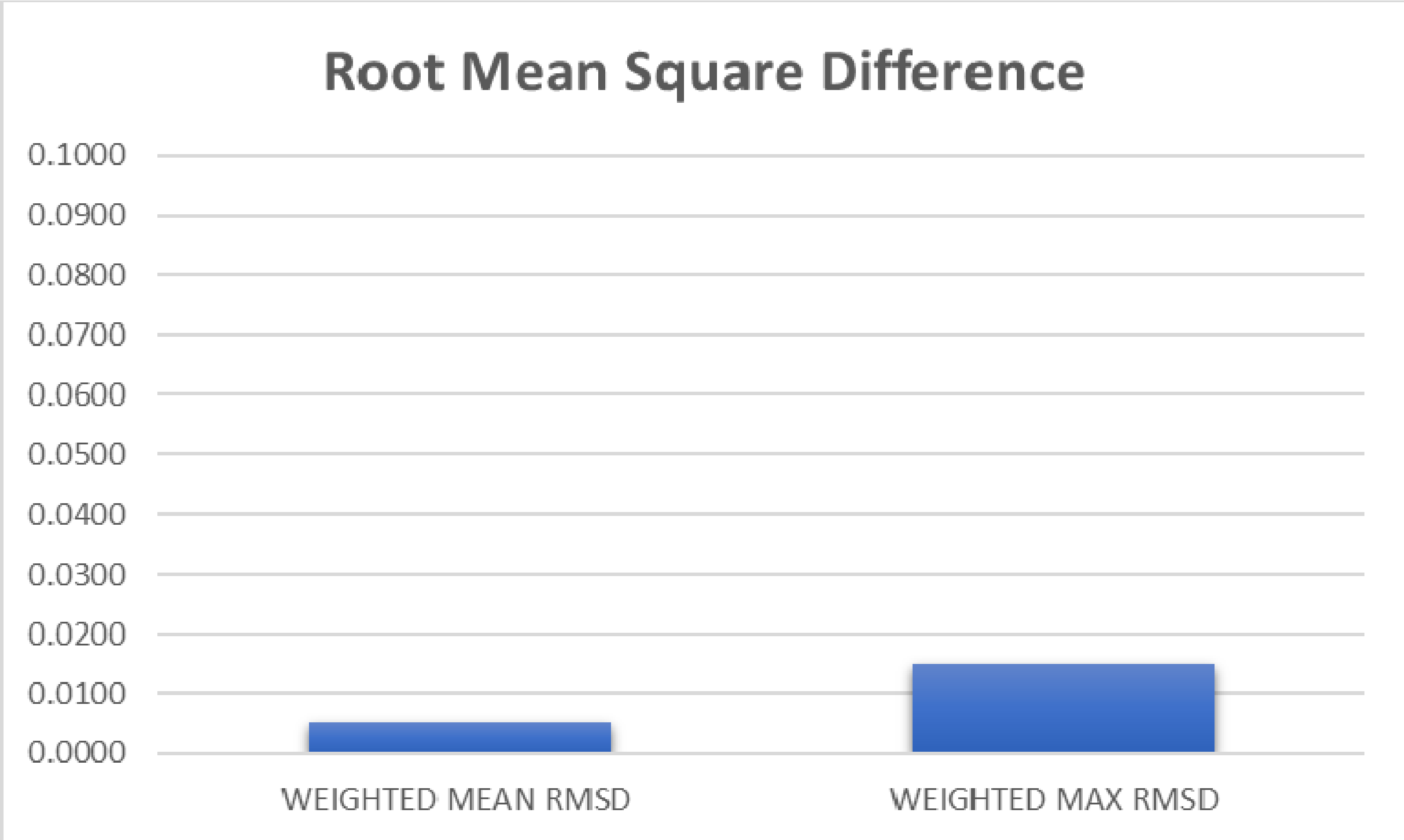


Estimated reflectances of Lutchi (A) using classical PCA

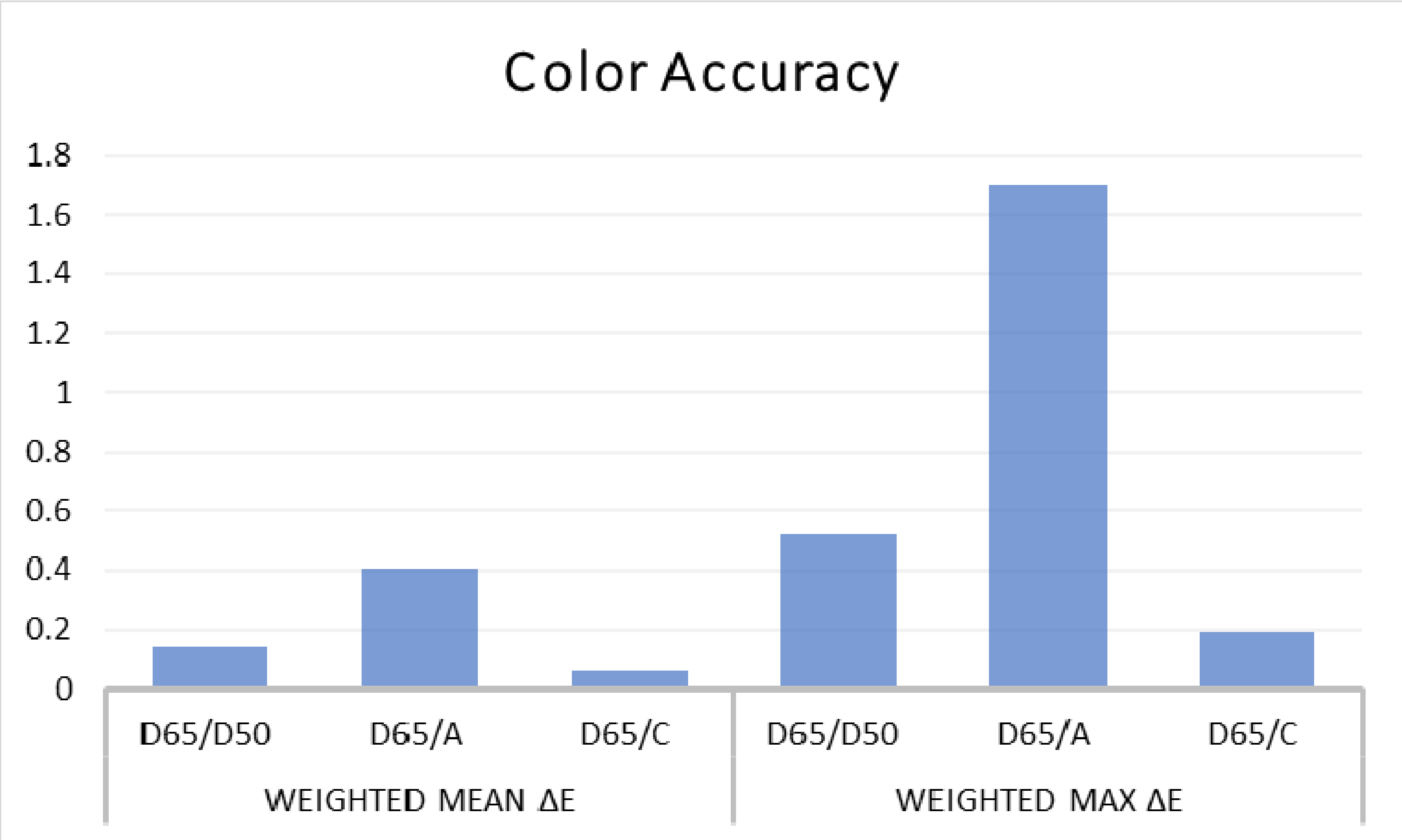


Estimated reflectances of Lutchi (D50) using classical PCA

Analysis


Root Mean Square Difference
0.1000
0.0900
0.0800
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
WEIGHTED MEAN RMSD
WEIGHTED MAX RMSD

Analysis


Color Accuracy
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
D65/D50
D65/A
D65/C
D65/D50
D65/A
D65/C
WEIGHTED MEAN ΔE
WEIGHTED MAX ΔE

Conclusion

- Spectral estimation can be done with good performance
- The reflectance database has to be selected carefully and should correspond well to the test material.
- Classical PCA can obtain spectral data from XYZ values efficiently with acceptable metamerism index values.
- Classical PCA is better than Weighted PCA is better but the computation cost is high.
- It is possible to get spectral estimates from chromatically adapted data

Thank you for your attention

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Web: www.colorlab.no

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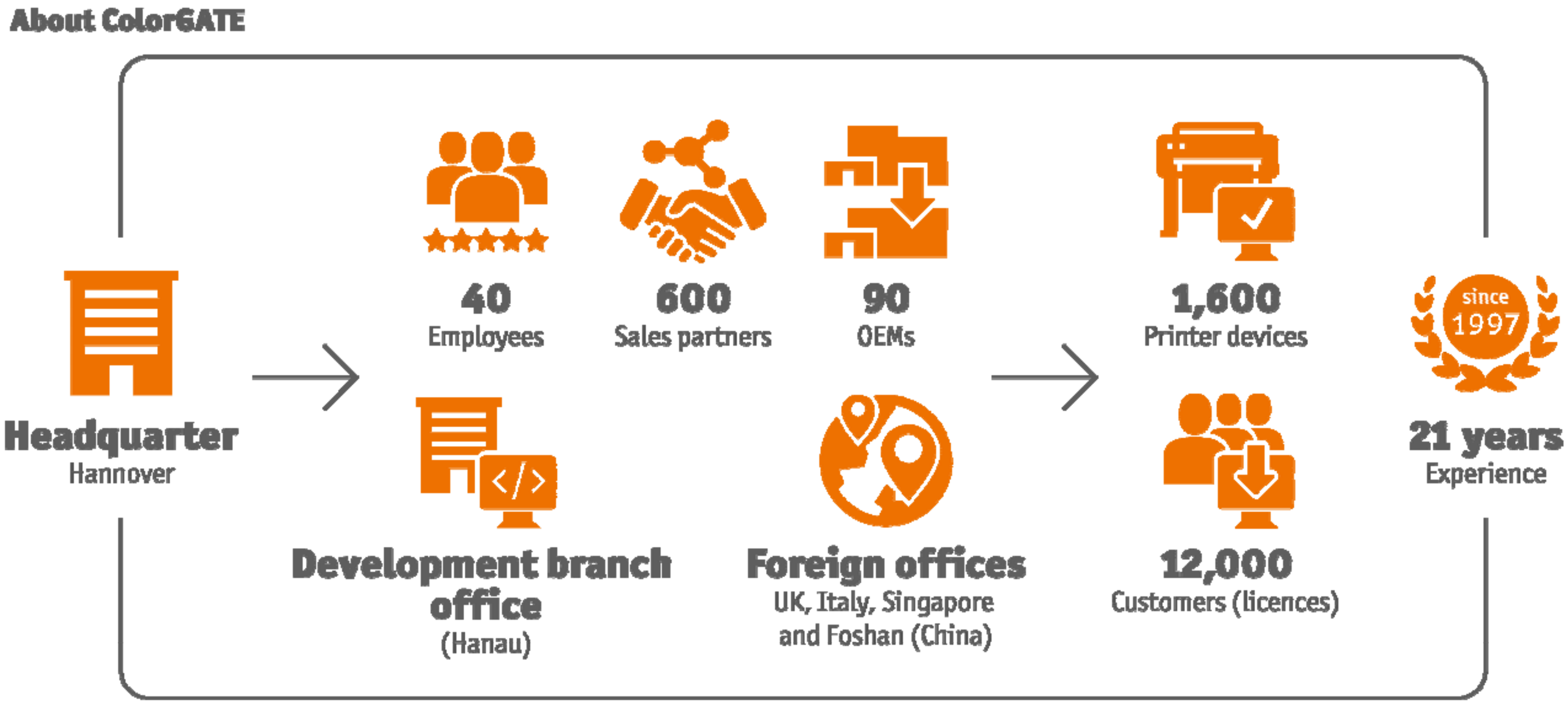

Table of content

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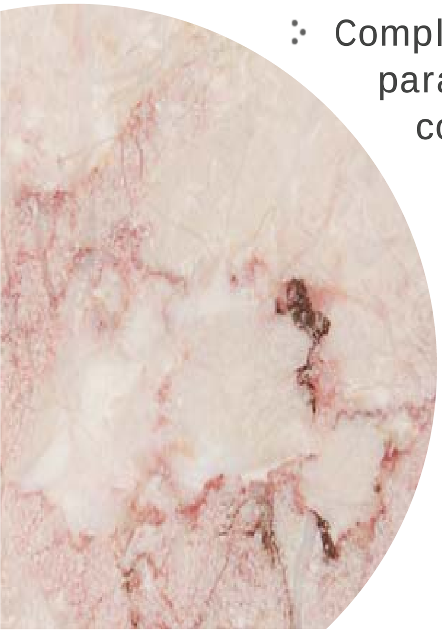
- measurement devices
- Fingerprint - a new approach to ICC profiling
- Workflowanimation

Challenges in the digital decoration of ceramic materials

The color-consistent decoration of ceramic products is a big challenge due to varying natural materials and the complicated production, which for example provides a firing process between 800° and 1400° C.

Challenges

- Often changing and non-standardized raw materials (e.g. frits, feldspar, clay, quartz, kaolin, silica, chemicals etc.)
- Complex and demanding production process whose parameters partly have a considerable influence on color development (e.g. compounding, pressing, engobing, glazing, drying, firing)
- Different compositions and formats require different kiln profiles
- Non standadized ink sets, configurations, effekt inks and colors



"With the ColorGATE solution it is much easier to produce fast, color-consistent prints specifically for the ceramics industry."

Barbara Galster, Deutsche Steinzeug

Unsuitable and suitable measurement technology

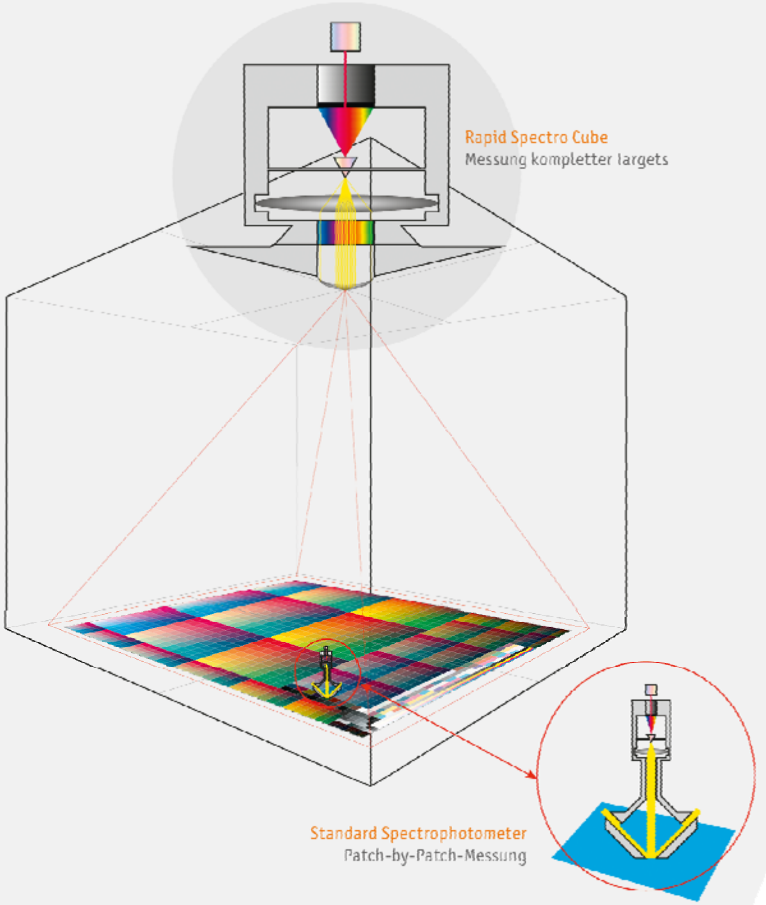
Rapid Spectro Cube (RSC)

All-in-one Color Management solution for ultrafast color measuring and ICC profiling for industrial digital printing applications.

ColorGATE
Innovative Solutions
Committed to Color

RAPID
SPECTRO
CUBE

Rapid Spectro Cube vs. Standard Spectrophotometer
Messung kompletter Targets vs. Messung Patch-by-Patch Messung



„What you see is what you get" - "Measure like your own eyes"

Typical spectrophotometers for graphical applications are specialized to read the single patches of printed media in a standard compliant way according to their fixed illumination and sensor geometry. They apply low-resolution sensors which make the process very time-consuming and it may lead to incorrect measurements of structured or translucent or reflective surfaces, with the consequence that obtained measurement data is useless for accurate color management.

The RSC, however, with its high-resolution sensor technology is able to read a large surface at once and provides accurate measurement results, even for surfaces that are difficult to measure to characterize them precisely. In doing so, the reading method of the RSC corresponds to the actual color impression of the human eye.

RAPID SPECTRO CUBE

Measurements and profiles can be acquired from different conditioned substrates, such as.

From non-white/tinted or colored substrates, such as:

- Corrugated
- Leather
- Wood, ceramics
- Metallic surfaces

From translucent substrates, such as:

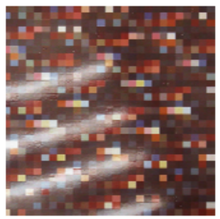
- Backlit materials
- Glass
- High gloss ceramic tiles
- High gloss finished décor panels
- Metallic surfaces

From structured substrates, such as:

- Carpets
- Ceramic tiles
- Leather
- Textiles

Target on substrate

Final print on substrate



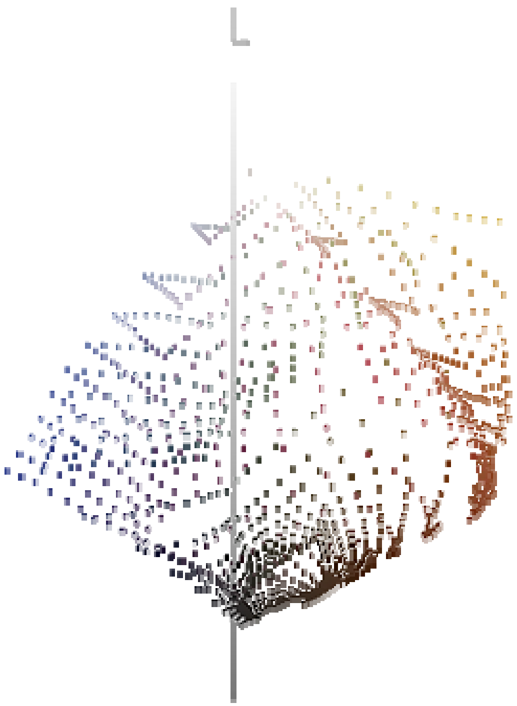
Target on substrate

Final print on substrate

Fingerprint Module (FPRM)

Patented technology for a “digital color twin”

ICC Profile versus Fingerprint Profile



Standard ICC Profile

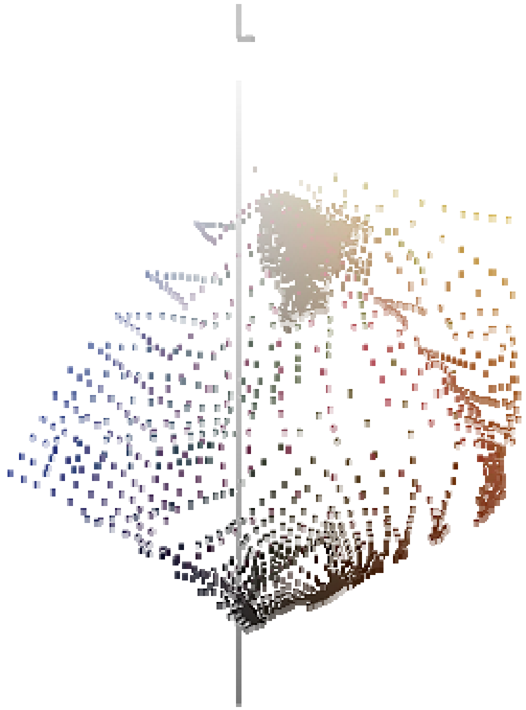
≠

design

=

color description
of design

=



Fingerprint Profile

Fingerprint Module (FPRM): **How does it work?**

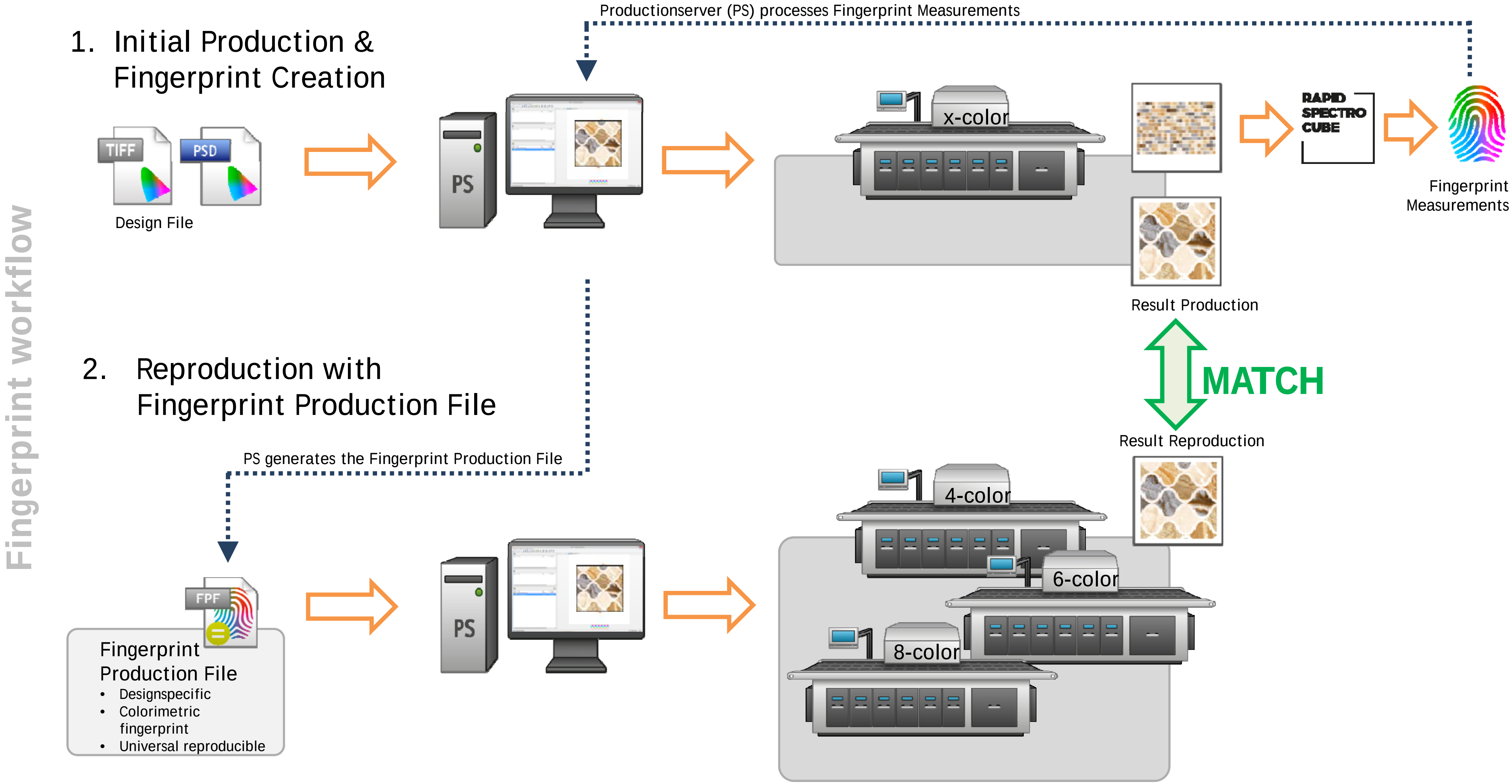
The production file will be saved including the embedded color characterization.

This fingerprint production file, which includes a colorimetric specification of the initial print, represents a digital master that provides a reliable reference so that future reprints can be reproduced exactly and color consistent.

Print data

colorimetric specification

Fingerprint production file


Fingerprint workflow
1. Initial Production & Fingerprint Creation
Productionserver (PS) processes Fingerprint Measurements
TIFF
PSD
Design File
PS
x-color
RAPID SPECTRO CUBE
Fingerprint Measurements
Result Production
MATCH
Result Reproduction
2. Reproduction with Fingerprint Production File
PS generates the Fingerprint Production File
FPF
Fingerprint Production File
• Designspecific
• Colorimetric fingerprint
• Universal reproducible
PS
4-color
6-color
8-color

Workflowanimation/Cooperation with Durst

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