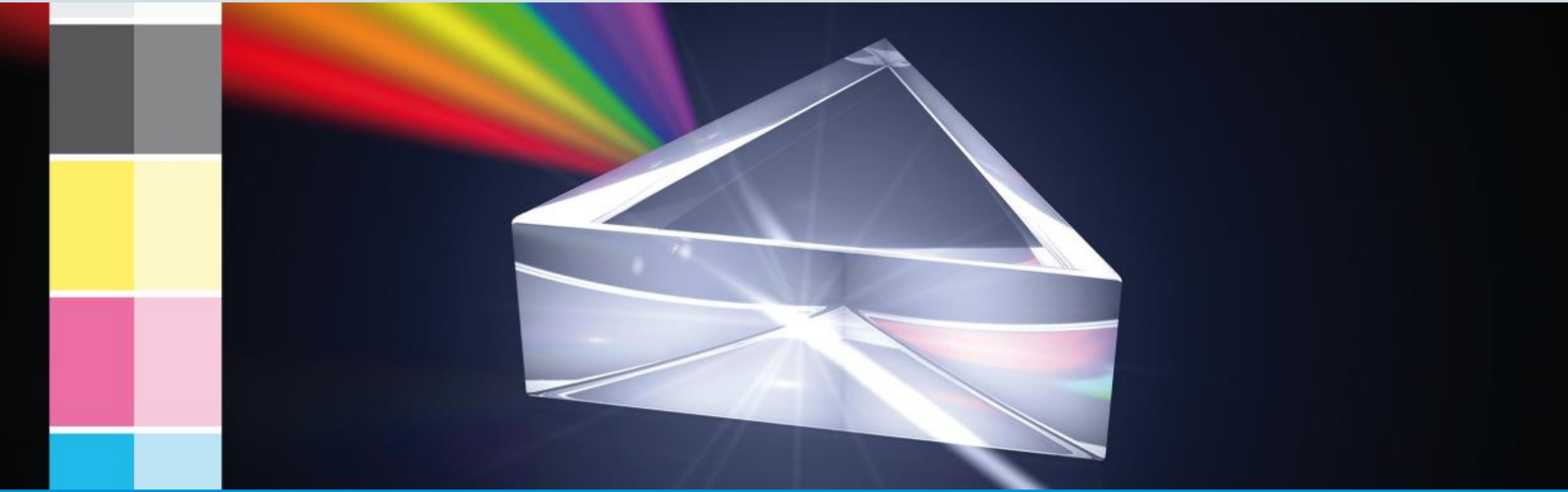
Intelligent Measuring Technology
when Color Quality counts

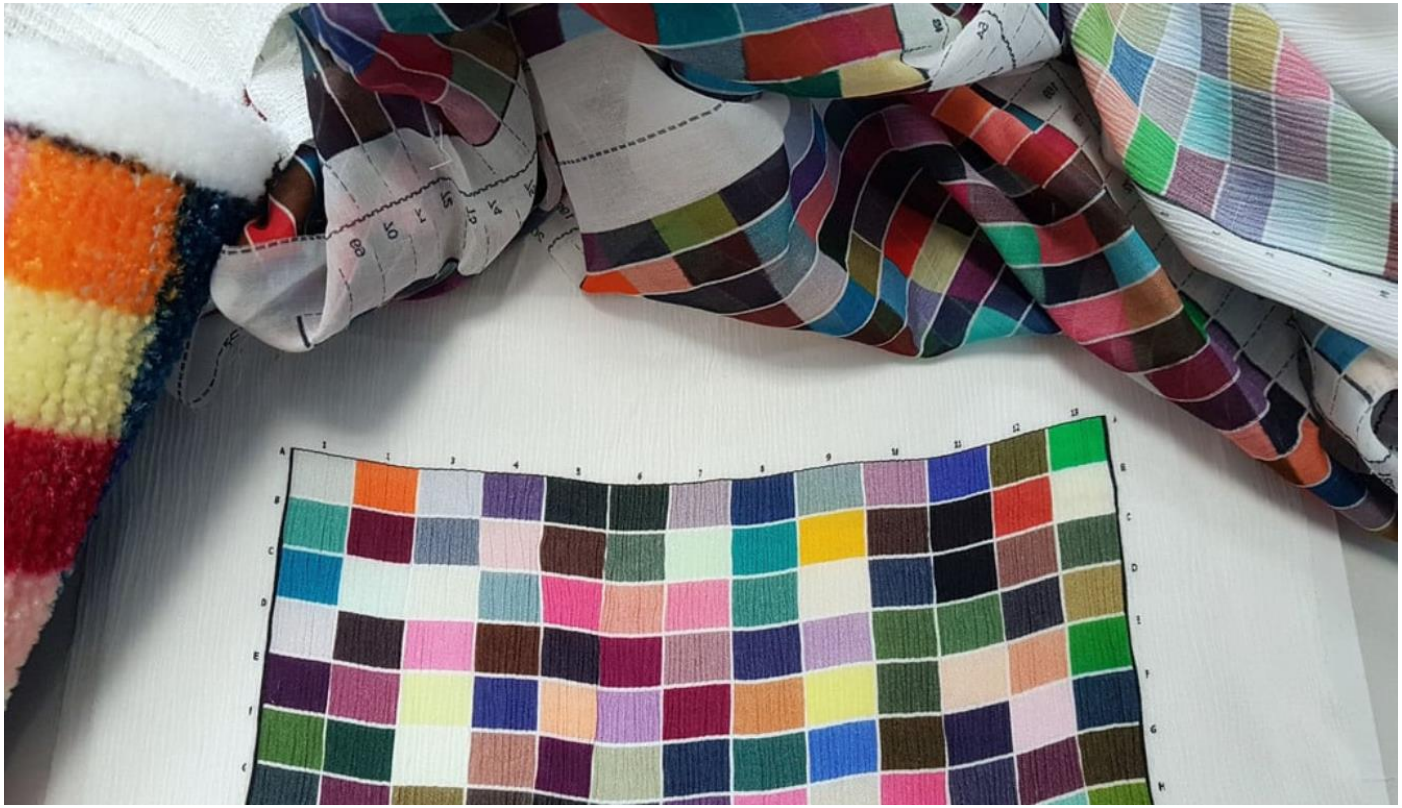
Measurement solutions for signage and digital textile printing



Agenda

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

Improving accuracy and repeatability of color measurements

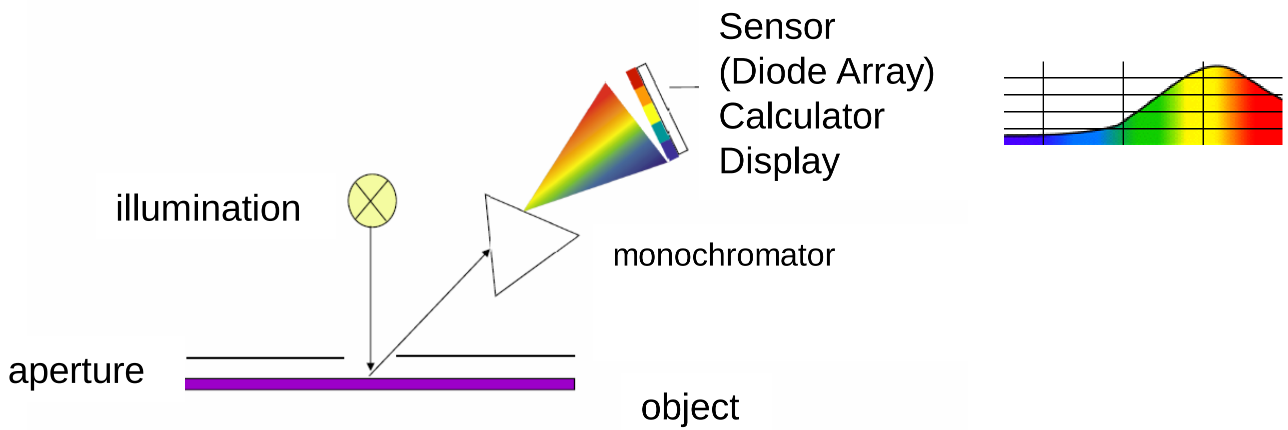


how to get most accurate measurement results on special materials

Instrument description

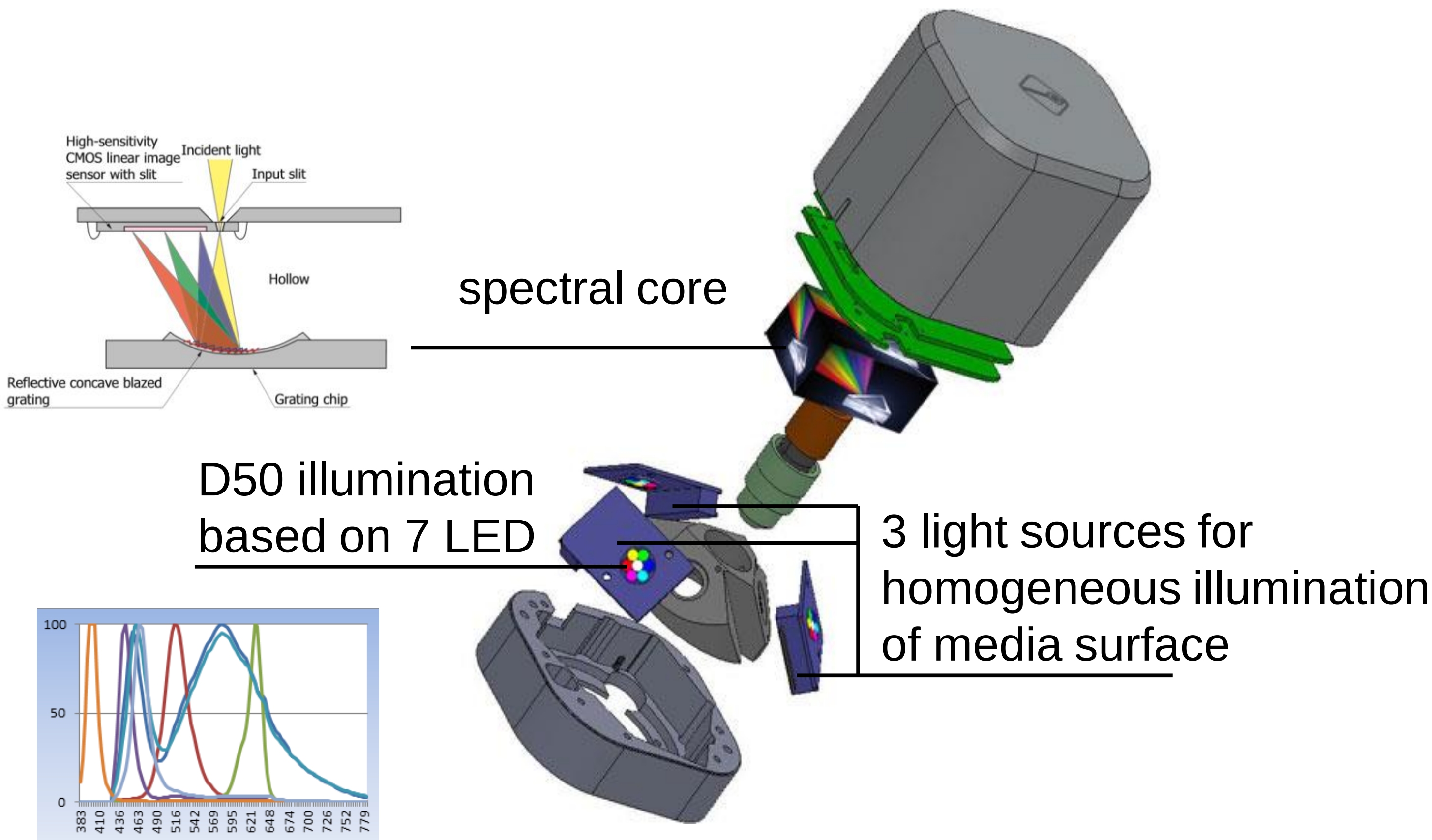
Spectrophotometer

- 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

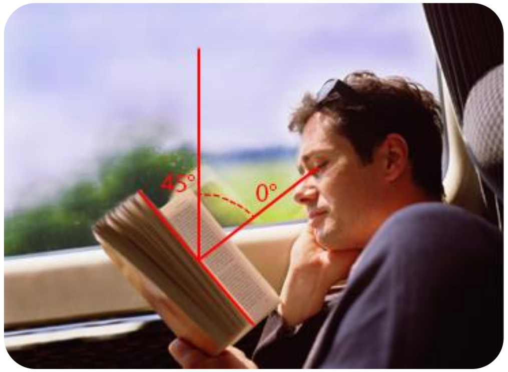
Barbieri qb-technology



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:

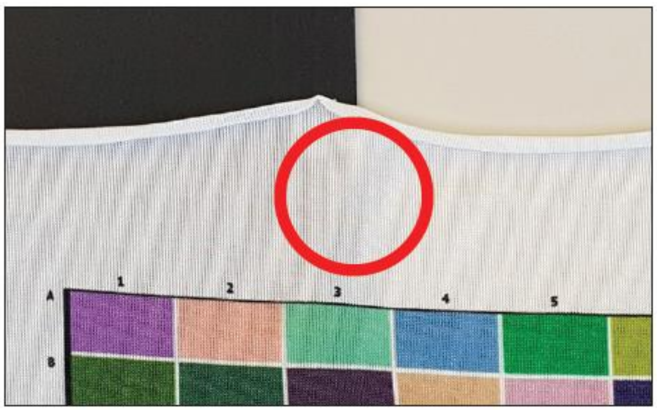
When a specimen is translucent, at least to some degree, some of the illuminating light penetrates the specimen and scatters laterally to points outside of the area viewed by the instrument detector, causing the reported reflectance values to be lower than they would be if all the reflected light were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

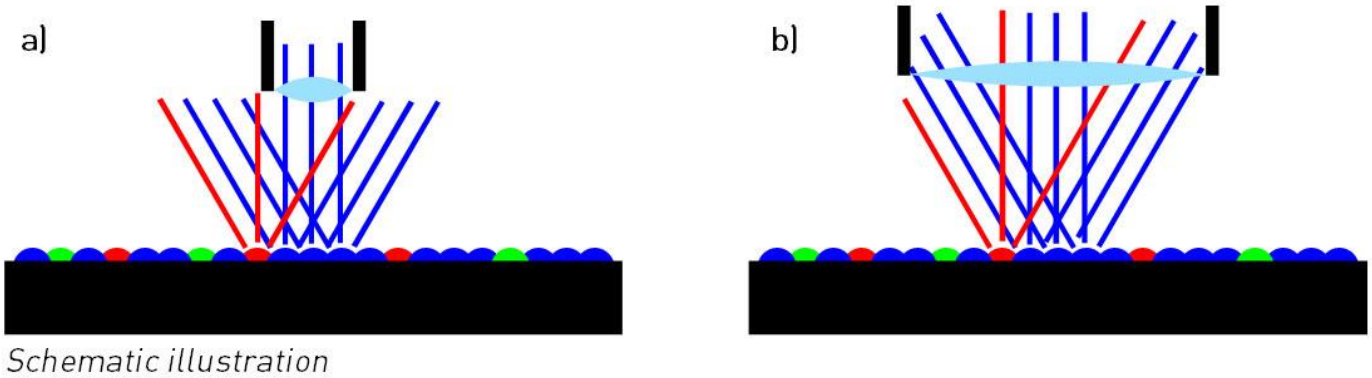


Textile with higher opacity

Black or white backing for the sample holder

Variable Measuring Aperture

UV Ink



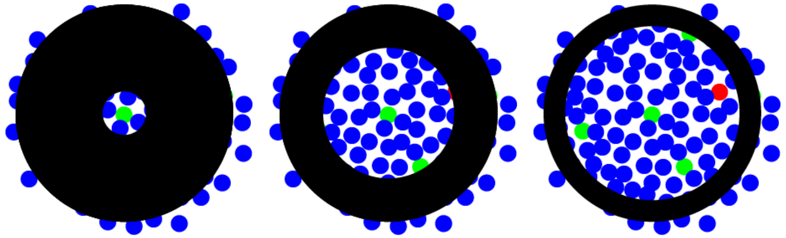
Small aperture

Large aperture -> more accurate

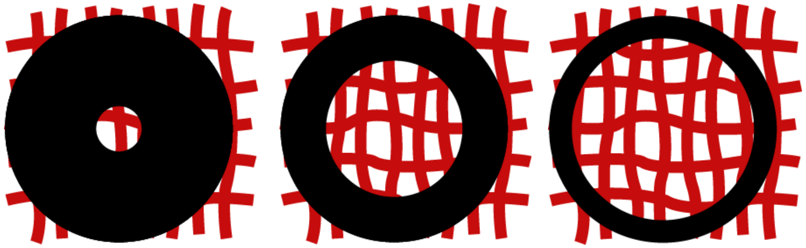
Best results on UV prints: 6 mm aperture

Variable Measuring Aperture

Low resolution prints:

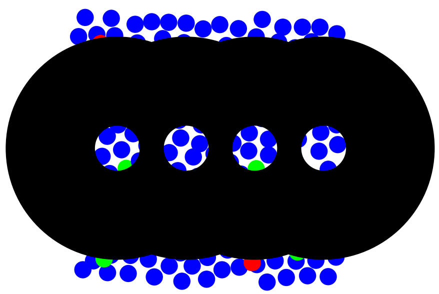


Textiles, structured media:

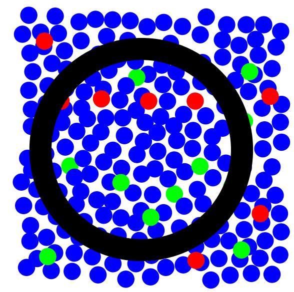


Variable Measuring Aperture

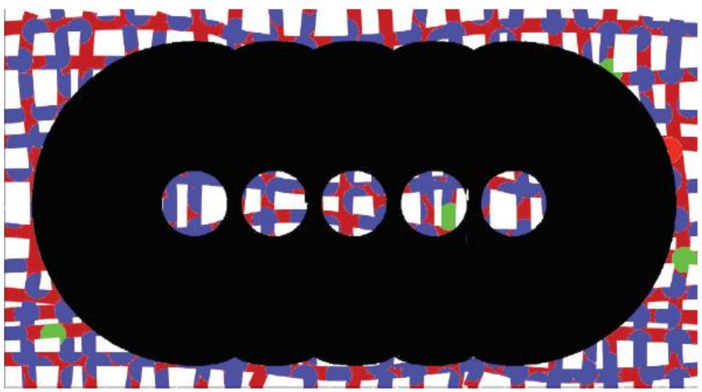
Multiple measurements vs. large aperture

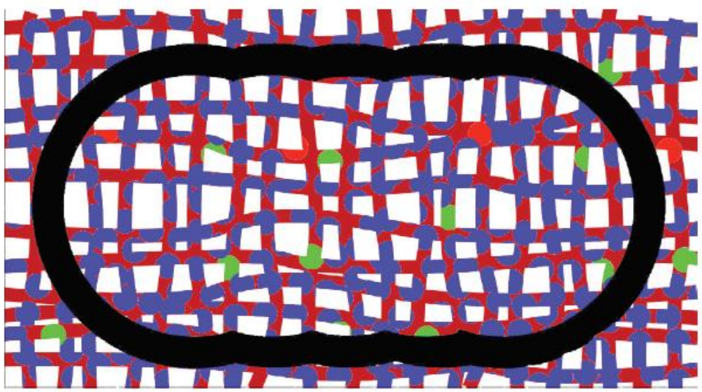


Multiple measurements



Large aperture





=> Large aperture often more accurate than multiple measurements

Variable Measuring Aperture

Select the best Patch size for your target

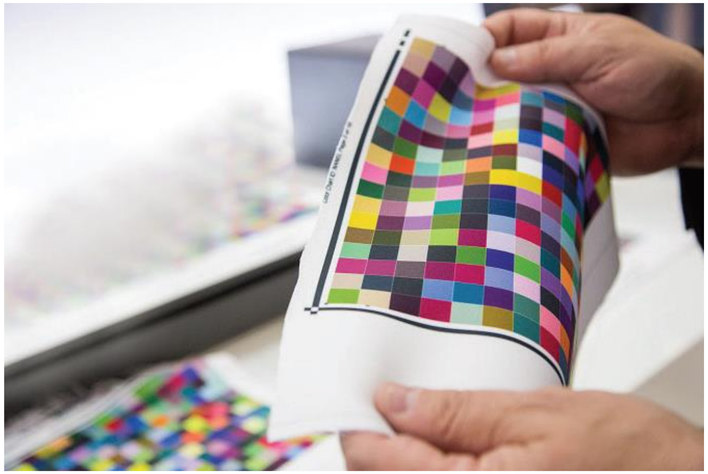
Measuring aperture size comparison

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.

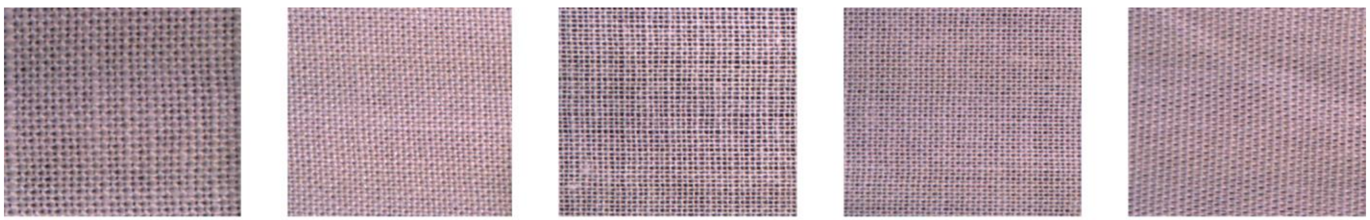


The objective of this experiment was the analysis of different measurement instruments on digitally printed textiles, focusing on repeatability and reproducibility aspects of measurement uncertainty for textiles.

Measuring Textiles

barbieri®

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

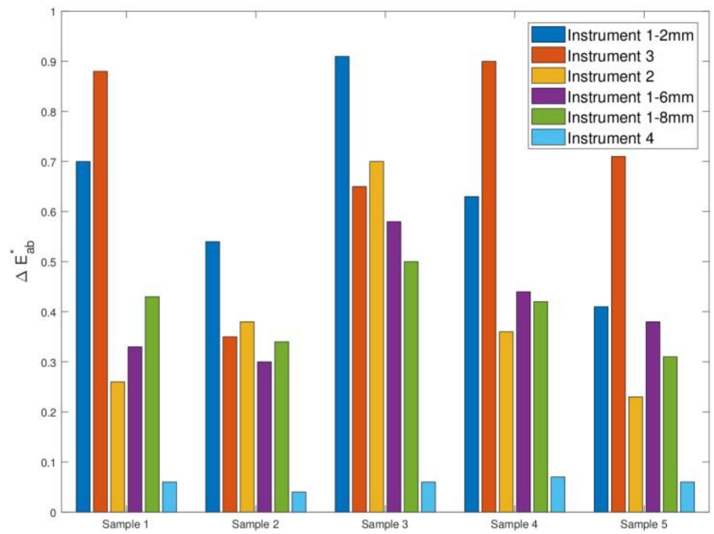
Measuring Textiles

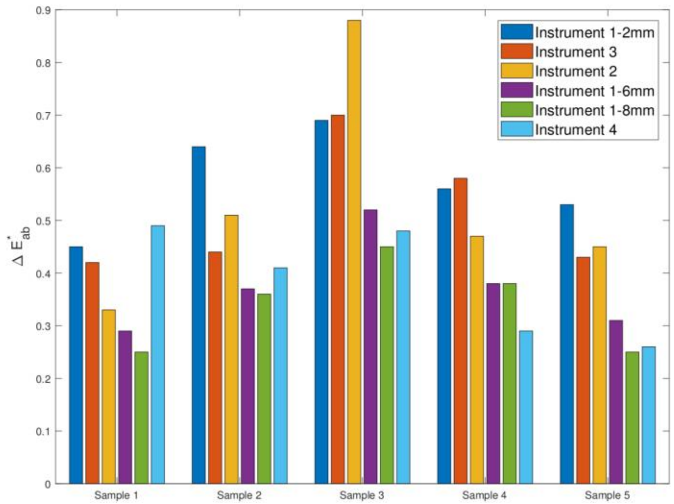
Sample Instruments from different vendors

	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)

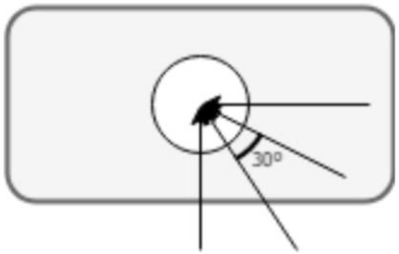
Measuring Textiles

Average ΔE*ab using different instruments

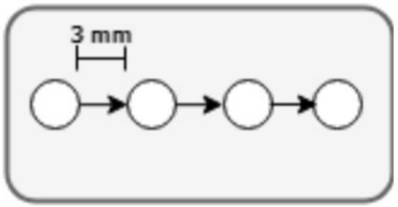




Rotation

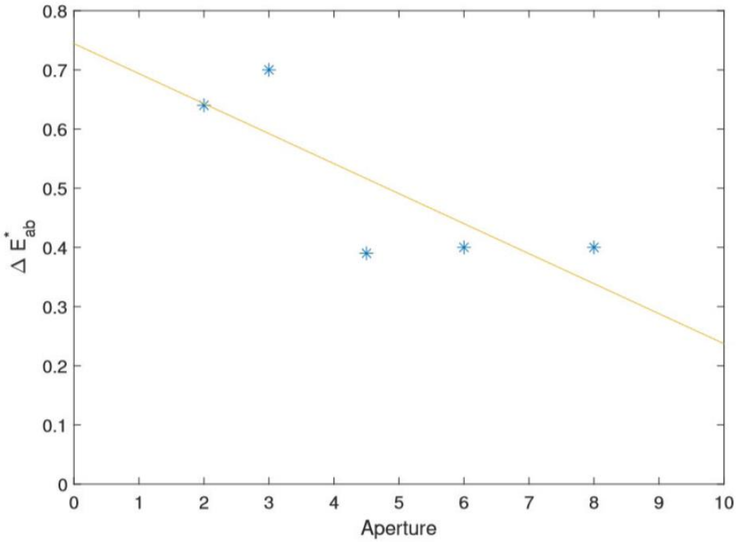


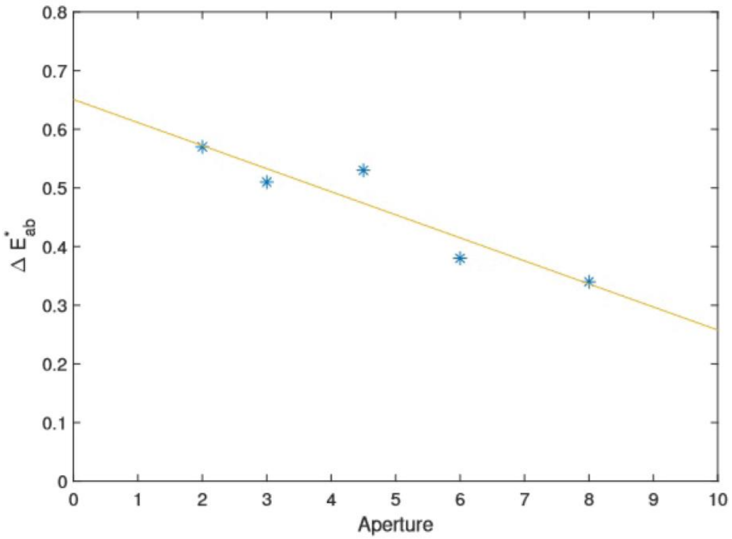
Translation



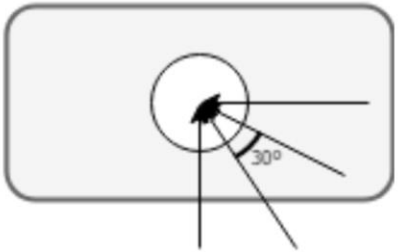
Measuring Textiles

Average ΔE*ab against measuring aperture

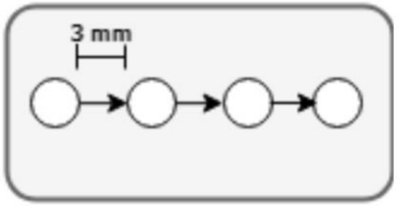




Rotation



Translation



Measuring Textiles

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.

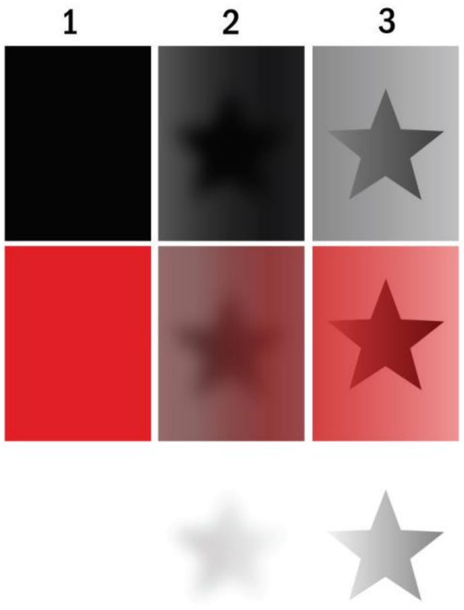
Measure Transparent Materials

Transparency, Translucency, Opacity

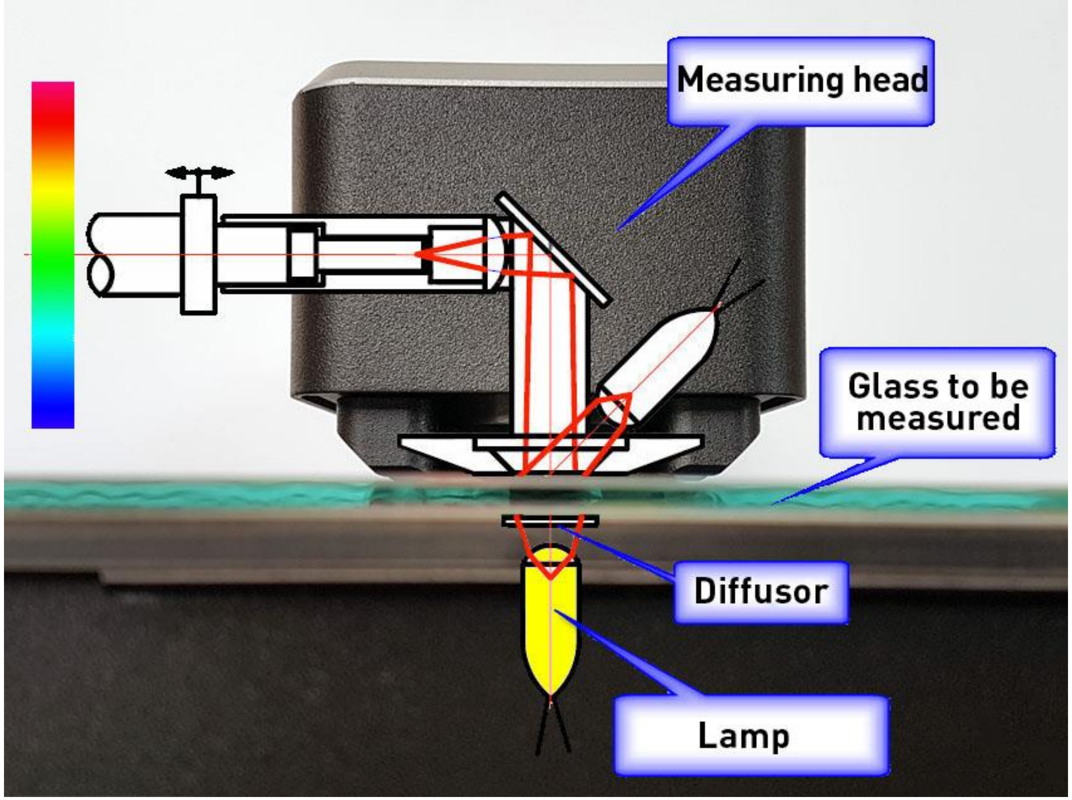
1.) Materials which do not transmit light are called opaque.

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.

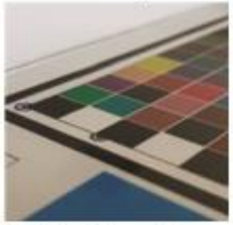
Measure Transparent Materials

Printing considerations

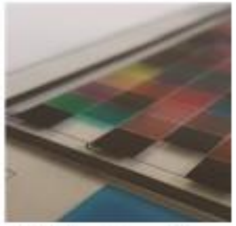
Glass should be measured in the same way as the final result will be looked at. The diffusor of the instrument (light source for transmissive readings) should be at the side of the light source and the measuring head at the side of view. This can cause 2 situations:

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



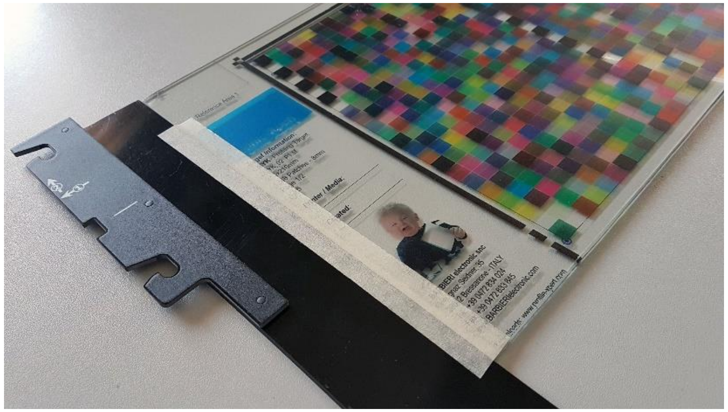
Printed on the bottom side

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.

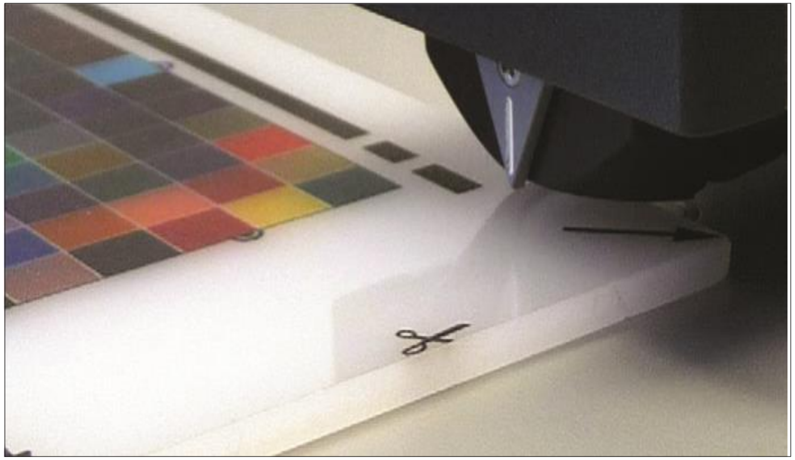
If printing with white ink backing, also the reference area must be printed white.



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

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

Computer vision helps to reduce measurements error

Special textile holder to fix charts

“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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