



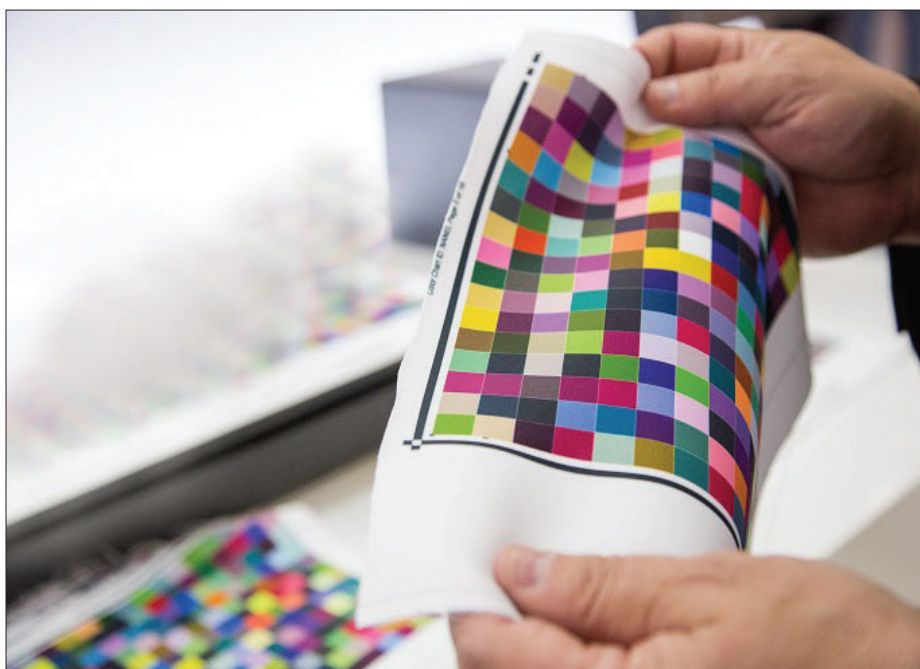
## Why larger Measuring Aperture counts

### Abstract

This white paper explains why a larger optical measuring aperture improves significantly accuracy and repeatability of measurements in digital large-format, flatbed and industrial printing. It gives also hints about how to get most accurate measurement results on special materials such as textiles.

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# 1 Introduction

The technical datasheets and specifications of every spectrophotometer, among other technical details, mention the measuring aperture. But why does this matter?

It is because, generally said, a larger measuring aperture gives more accurate results and higher repeatability.



Spectro LFP qb with 2, 6 and 8 mm aperture.

The measuring aperture defines the area the measuring device “sees” and captures the color values from. As bigger this area, as more information will be captured. This especially in large format, flatbed and industrial printing, including textile printing is of utmost importance. When measuring different kind of media, low resolution prints or UV printing, a bigger measuring area is requested.

The following statements are supported by the scientific paper: Nadile Nunes de Lima, “Measurement uncertainty for printed textiles”, Colour and Visual Computing Symposium (CVCS), 2018.

The Barbieri Spectro LFP qb is a device with switchable measuring aperture of 2, 6 and 8 mm as mentioned in this publication.

The findings in this publication are not limited to textile but they are valid for any kind of structured material used in digital Signage and Industrial printing.



Profiling chart with small and with large patches

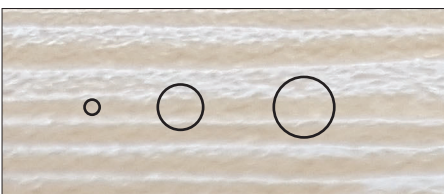
## 2 Reasons for more accurate measurements

When measuring structured materials, a larger optical aperture gives more accurate and repeatable results because:

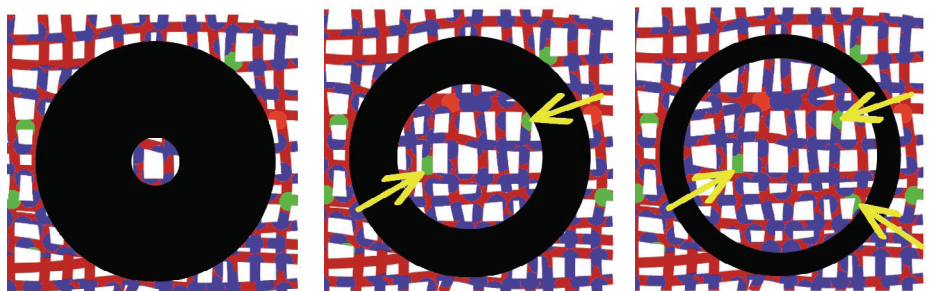
- a bigger aperture captures a larger area and therefore also information which is outside the area of a smaller aperture
- a bigger aperture compensates the scattered light due to the structured surface
- a bigger aperture compensates the potential shadows on structured materials

### 2.1 Structured media / low resolution prints

On structures media or low resolution prints it can happen that color information is located outside the measuring area when using a small aperture.



2, 6 and 8 mm measuring aperture on a wallpaper



2 mm aperture

6 mm aperture

8 mm aperture

## 2.2 UV Ink

When printing with UV inks, the ink can be cured on the surface, which creates an uneven and rough surface. The light will be scattered, and a small aperture is not able to get the whole color information.

## 2.3 Media with low Opacity

As in digital printing plenty of different media are used, every media shows different opacity. Especially on media with low opacity a larger optical measuring aperture ensures higher accuracy.



Textile with low opacity



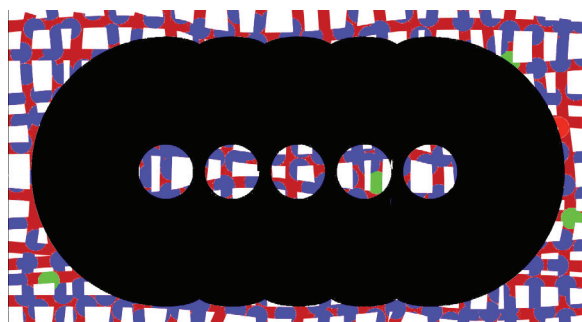
Textile with higher opacity

## 3 Multiple Measurements

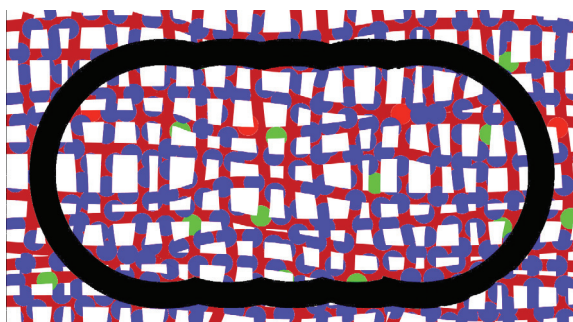
Performing more measurements per patch and averaging them, results in more accurate measurements. But using a small aperture it still gives not the right picture. The reason is the movement is on one direction only. This in case of low resolution or structured media will still result in inaccurate measurements.

For structured media such as textiles averaging multiple measurements per patch makes sense, but a big measuring aperture is more appropriate.

### Schematic illustration: multiple measurements on textile



5 measurements with small aperture



5 measurements with wide aperture

## 4 Relation Aperture Size / Measuring Area

Even if there is always mentioned the aperture size, what really matters is the measuring area. The following table shows how much influence a slightly wider aperture on the measuring area has.

Diameter	Measuring Area	Area difference
2 mm	3,14 mm <sup>2</sup>	
6 mm	28,26 mm <sup>2</sup>	9 times larger than 3 mm <sup>2</sup>
8 mm	50,12 mm <sup>2</sup>	17 times larger than 3 mm <sup>2</sup>

## 5 How to get Maximum Accuracy

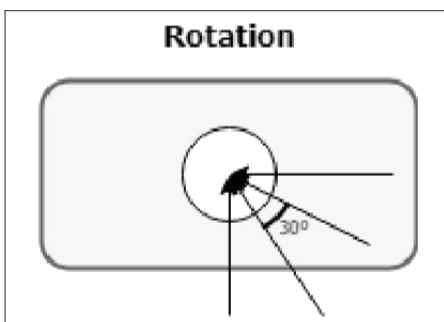
The ultimate measurement accuracy and repeatability on difficult media such as textiles can be achieved by:

1. Using wide measuring aperture
2. Multiple measurements per patch (using wide aperture)
3. Fully automatic measurements (to avoid the influence of the human being)

## 6 Extracts from the Scientific Paper

The paper proves that:

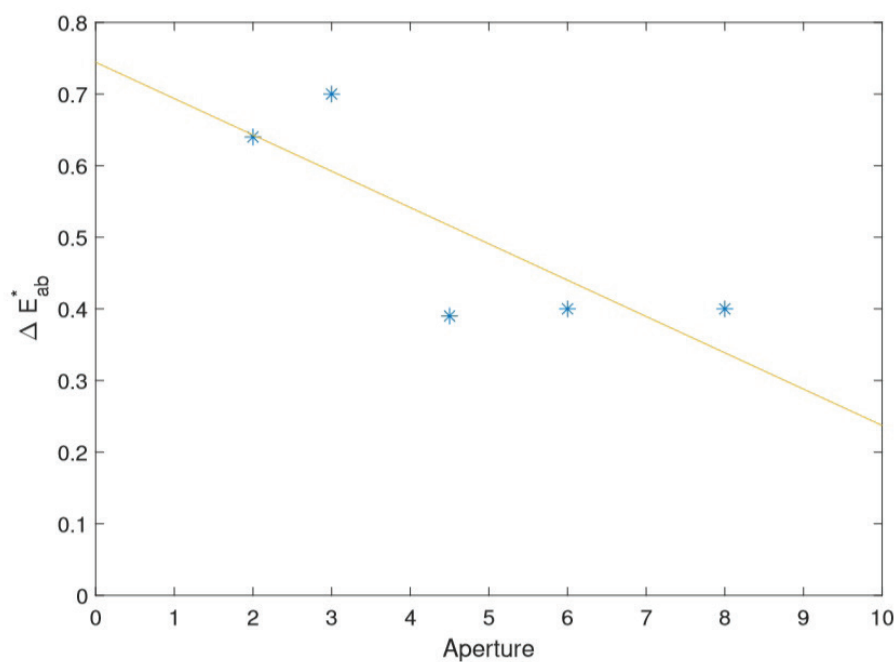
- a) With bigger measuring aperture the rotation gives less impact on the measurement results.
- b) With bigger measuring aperture the translation gets higher accuracy.
- c) If opacity of the media is low, a bigger measuring aperture delivers more accurate measurements.
- d) Measuring in scanning (automatic) improves the measurement quality and with bigger measuring aperture it gets even more accurate.



Representation of measurement rotating instrument

### 6.1 Rotation

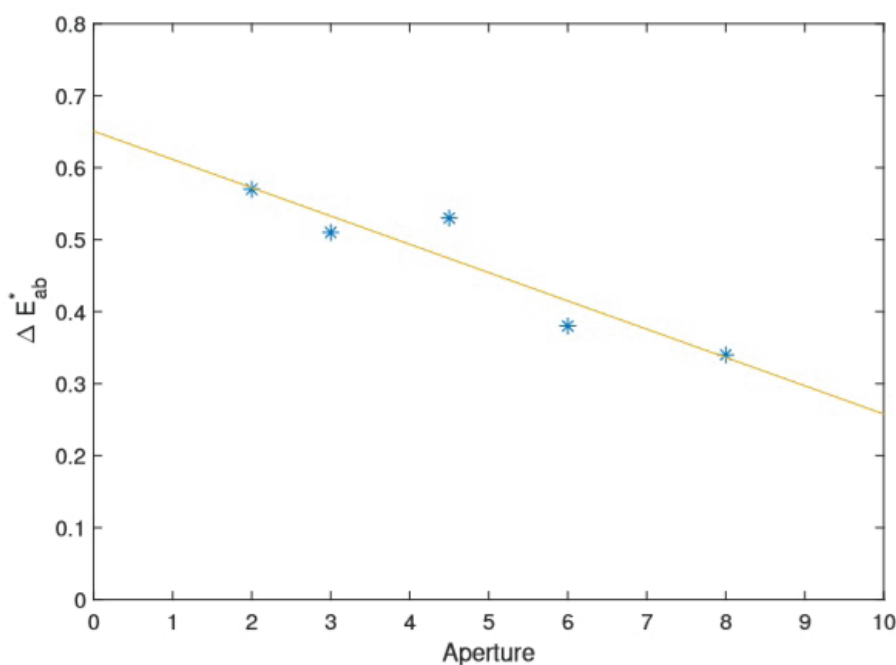
In this test spot measurements have been done and the measurement device has been rotated by 30° each measurement. The results show that as smaller the measuring aperture, as bigger the DeltaE and as bigger the aperture as lower the DeltaE.



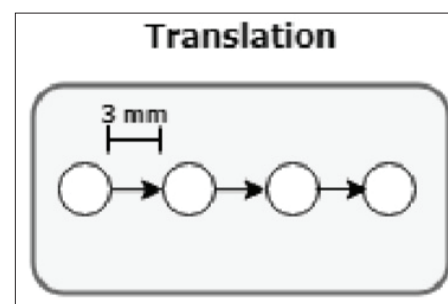
Average  $\Delta E^*_{ab}$  against aperture for measurements rotating instruments

## 6.2 Translation

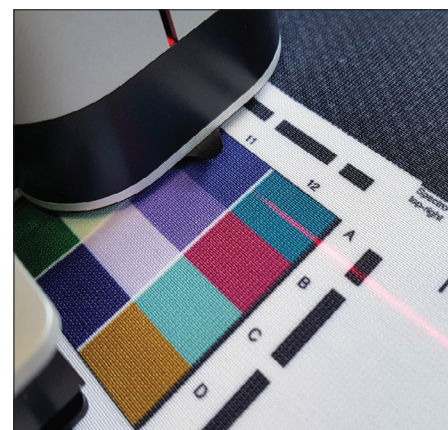
In this test measurements have been done by moving the instrument by 3 mm horizontally for each measurement. It shows that the small apertures give higher DeltaE and the bigger 8 mm aperture shows the highest repeatability.



Average  $\Delta E^*_{ab}$  against aperture for measurements translating samples

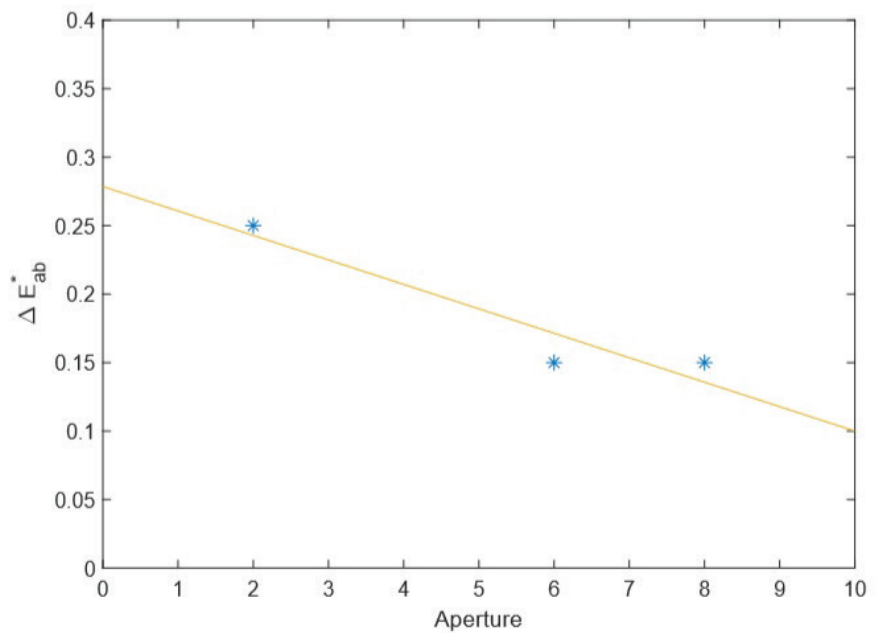


Representation of measurement with horizontal translation



## 6.3 Scanning

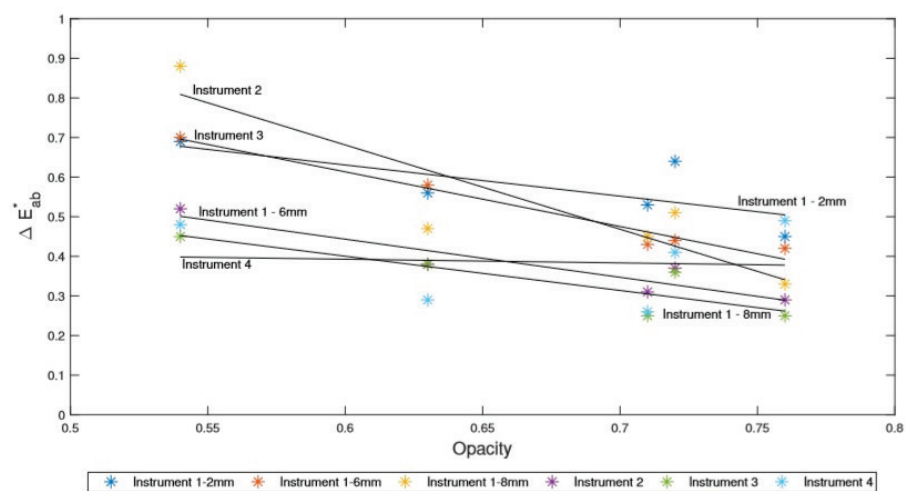
Scanning behaves the same way as manual spot measurements and shows also that a bigger aperture grants the highest repeatability.



Average  $\Delta E^*_{ab}$  against aperture for measurements on scanning mode

## 6.4 Opacity

There is also a relation between opacity of the media and measuring aperture. In all tests, rotation, translation and scanning, as less opaque a material is as more important it is to use a bigger aperture to get repeatable measurements.



Average  $\Delta E^*_{ab}$  against opacity for measurements translating samples

## Barbieri Measuring Devices

Automatic devices for printer setup. Reflection and transmission readings:



Portable device for process control (and printer setup). Reflection readings only:



## About Barbieri

Barbieri is an internationally operating manufacturer and supplier of intelligent color measurement systems which ensure the highest image quality for professional digital printing. The international Barbieri technical laboratory continuously discovers new features, characteristics and applications to improve products and assist clients for improved performance.

**Barbieri is the color measurement market leader for wide and large format, flatbed and industrial printing.**

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