admesy

ADVANCED MEASUREMENT SYSTEMS

Reflective colour measurement

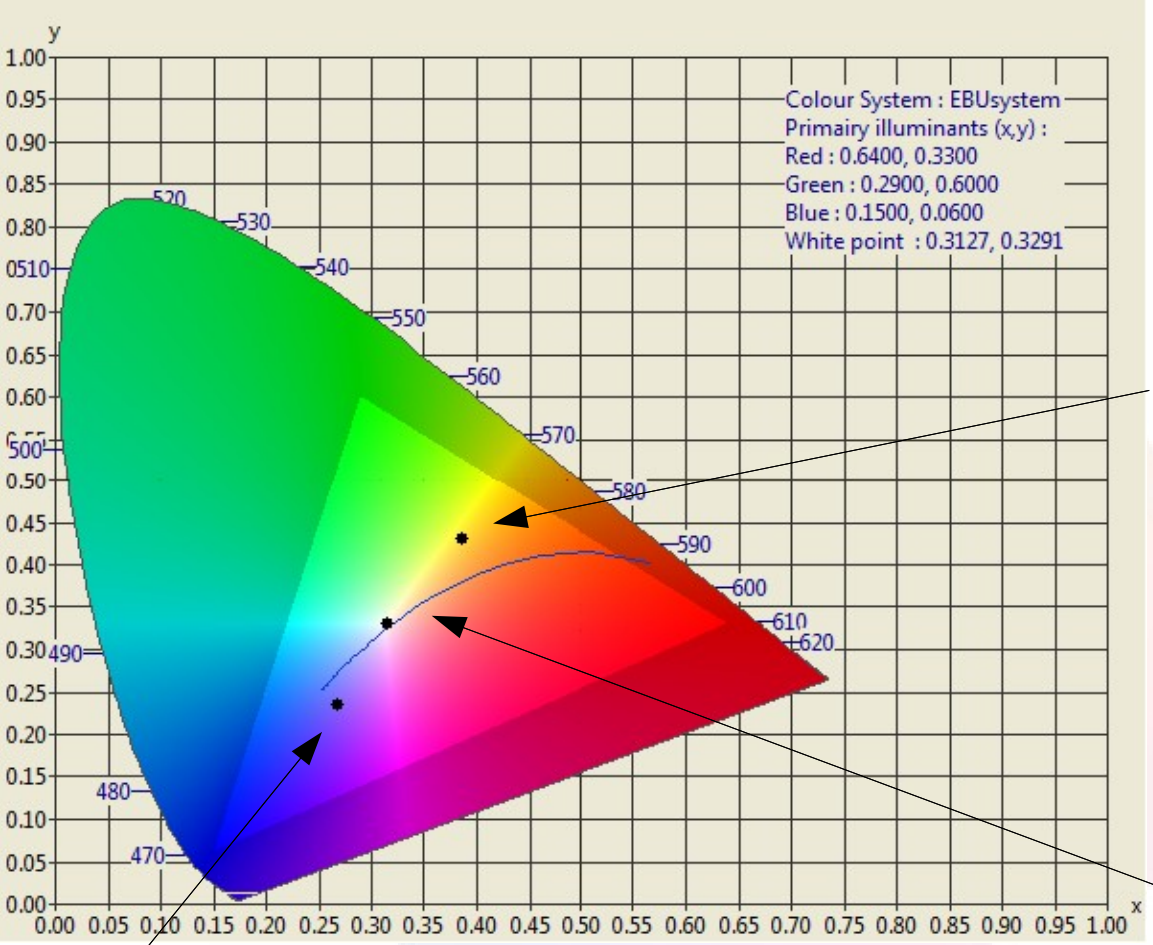
Using the ARGES 45^0 or the Brontes colorimeter and ALS-NW-45 light source

Reflective measurements : Reference

A reflective measurement needs a reference. This reference measurement will compensate for the used light source.

Example :
Consider a light source (yellow) to be used to measure a blue area.
As a result the blue area will show up nearly white, so this is not showing the colour of the blue area, but the combination of the white area and the used light source.
This result is expressed in the CIE colour triangle on the next page.

Measuring the blue sample using a yellow light source



(a) Light source colour

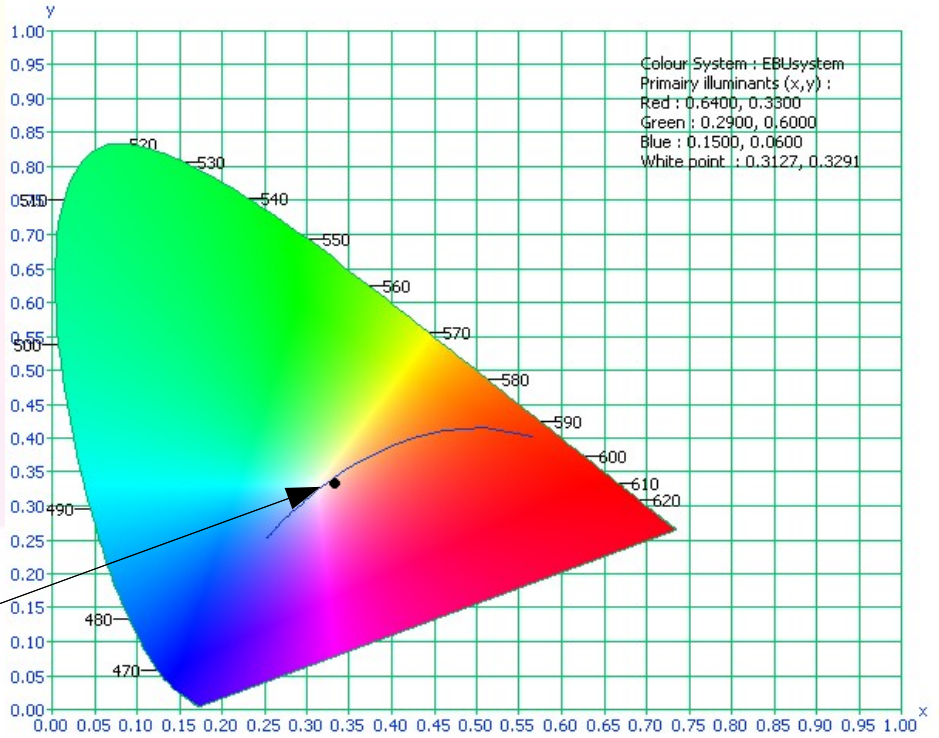
(b) Real sample colour

(c) Resulting colour only applicable with this used light source.

Since the resulting colour is only valid when using the exact same light source as used in the measurement, this result doesn't have much meaning regarding the sample itself.

In order to compensate for the used light source, a reference measurement is needed. This is usually performed on a white reflective standard with known reflectivity.

Let's assume the reflective standard to be perfect, meaning a 100% reflection and a total flat frequency response over the whole visible spectrum. In this case, the reference measurement will show up in the CIE colour triangle as the equal energy point (E).



E :
x = 0.333
y = 0.333

Once the reference measurement has been performed, it is also possible to recalculate the colour of a sample how it would show up under different lighting circumstances.
In the previous example, the blue sample would show up nearly white when lighted with yellow light. The actual white point that would be measured, would depend on the used yellow light source.
Once the reference light source has been measured, it is possible to judge a colour towards a selected light source. This way it is possible to show how a colour would look like when lighted by a D50 (yellowish) or D65 (daylight white) light source.

There are many different light sources on the market, with a large variation in colour spectrum. In reflective colour measured some have been standardized like the D50 source, which is often used in printing and photo industries.

The colorimeter contains a table of these standard light sources. These light sources can either be selected in the Arges/Brontes hardware (necessary for stand alone measurement) or the Admesy colorimeter application software.

The used white references can be seen on the next page.

White point references used by the Admesy colorimeters.

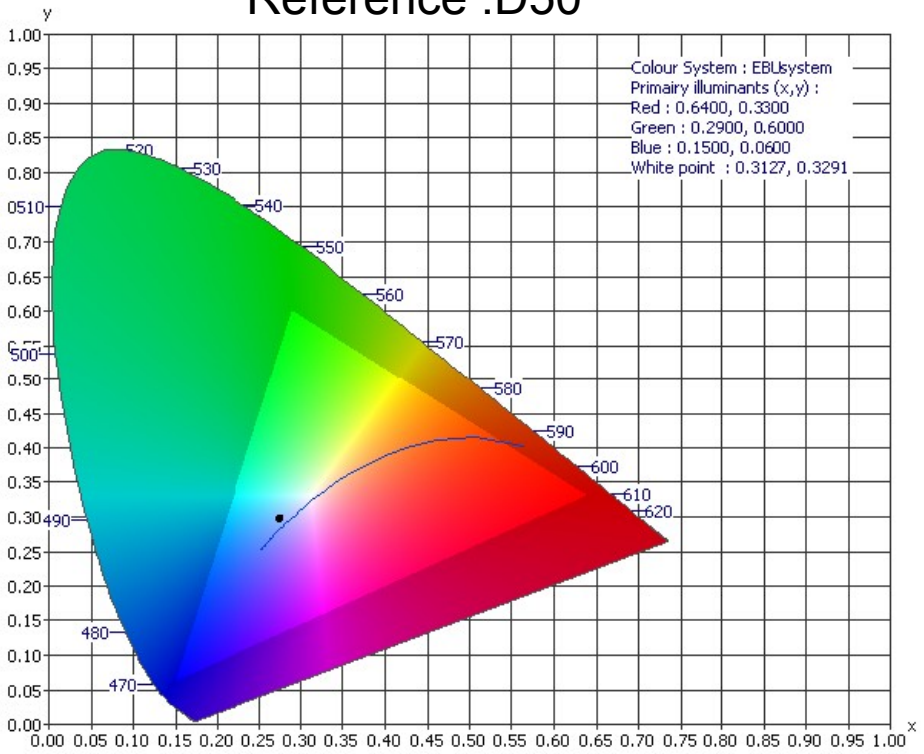
Reference white	X	Y	Z
A	109.8405	100.0000	35.5583
B	99.0899	100.0000	85.3242
C	98.0708	100.0000	118.1847
D40	99.6092	100.0000	60.9432
D42	98.7058	100.0000	65.4253
D50	96.3758	100.0000	82.4087
D55	95.6559	100.0000	92.0311
D65	95.0182	100.0000	108.7485
D75	94.9524	100.0000	122.5079
D90	95.2270	100.0000	138.5514
D95	95.3315	100.0000	142.9635
E	100.0000	100.0000	100.0000
F2	99.1869	100.0000	67.3944
F7	95.0392	100.0000	108.7460
F11	100.9631	100.0000	64.3522

Table 1: White point references

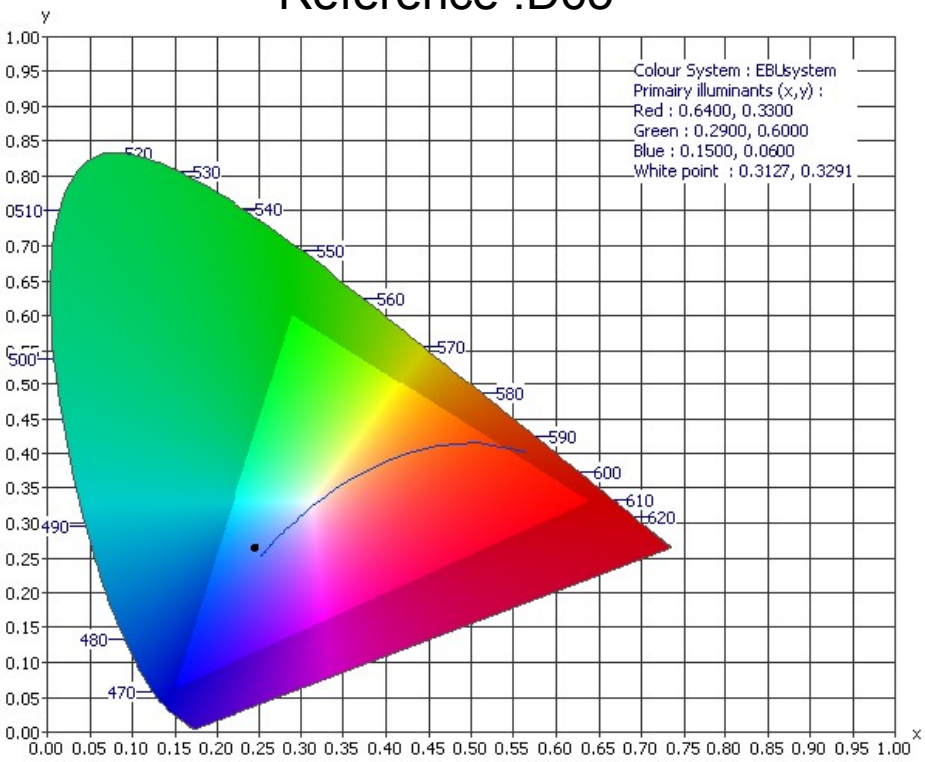
Results of different selected white points

The following measurement example was performed on a blue sample, using D50 and D65 selected white references.

Reference :D50

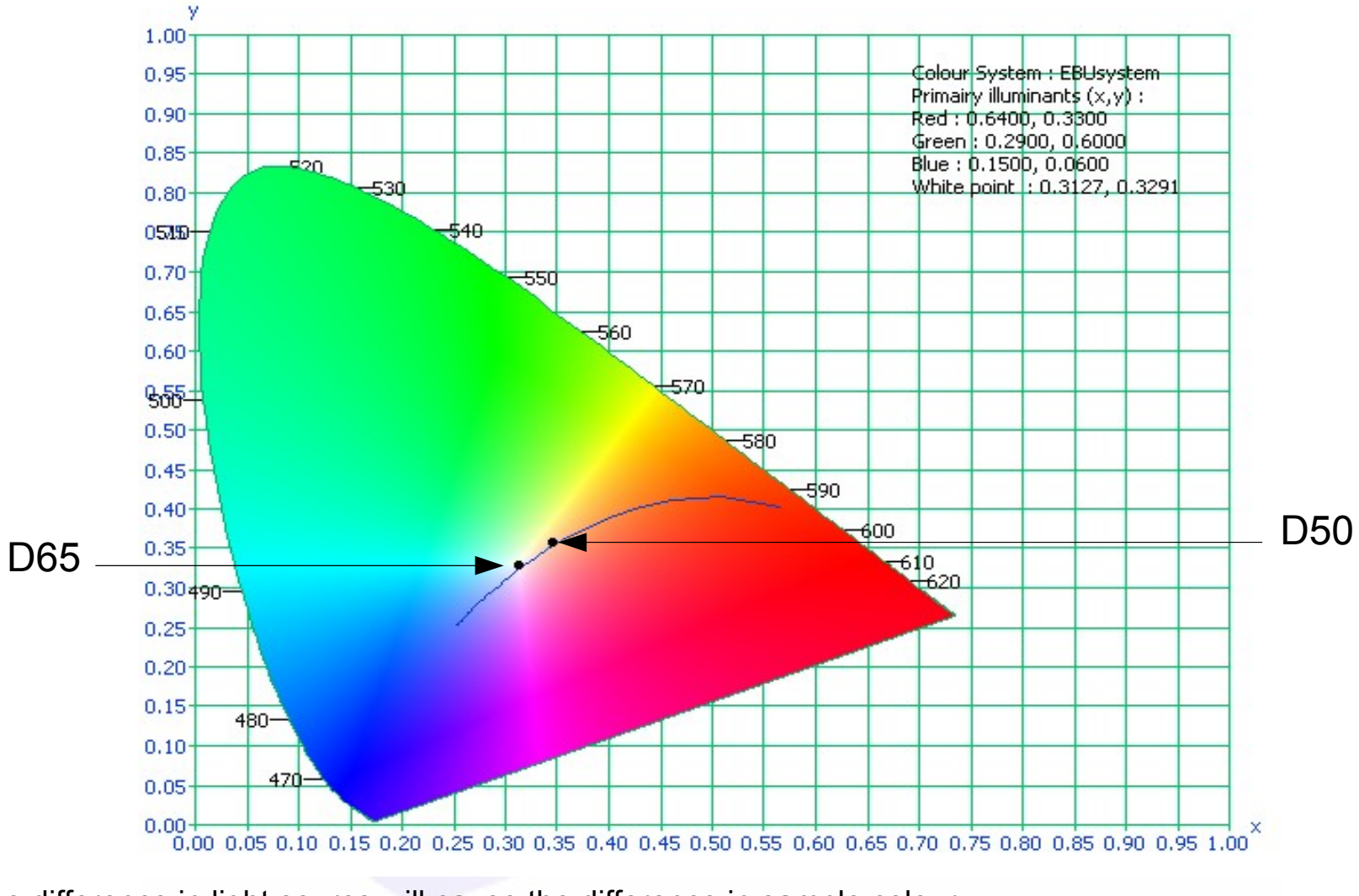


Reference :D65



Clearly the blue sample shows up more saturated blue when using D65 light when compared to D50 (more yellow) light.

Colour difference between D50 and D65



The difference in light source will cause the difference in sample colour.
This is also a wanted effect as it may be important to know the colour of a sample in different environments.

Reflective measurement using the ARGES 45⁰.

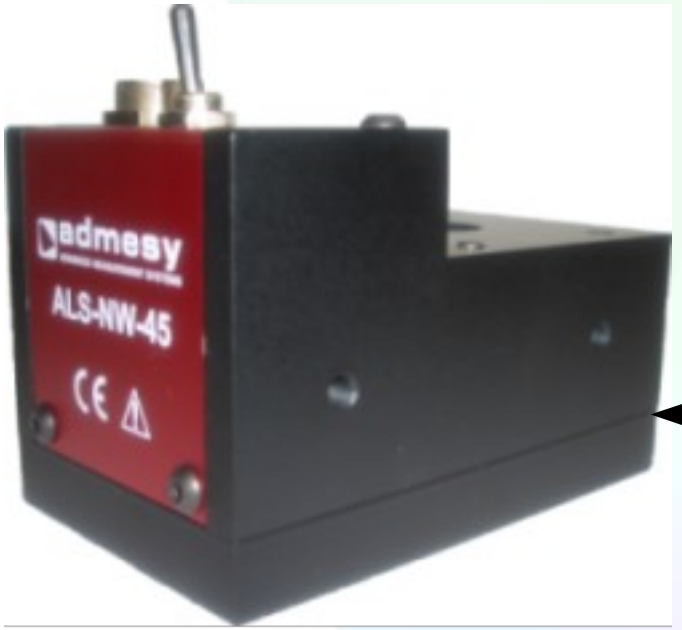
The ARGES 45⁰ contains a bottom plate, which can be removed for non-contact measurements. The ideal working distance in that case is equal to the bottom plate thickness.

Bottom plate for contact measurement.

Bottom plate removed.
Working distance is equal to bottom plate thickness.

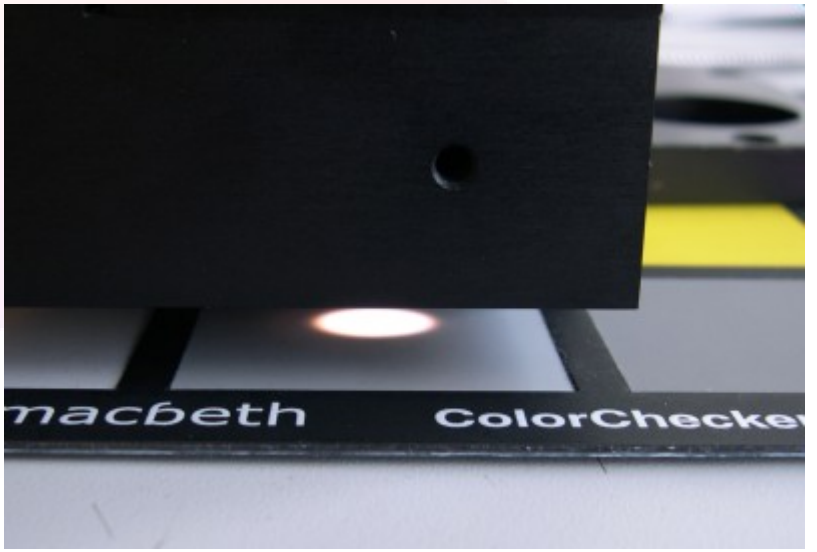
Reflective measurement using the ALS-NW-45 light source.

The ALS-NW-45 contains (same as ARGES 45^0) a bottom plate, which can be removed for non-contact measurements. The ideal working distance in that case is equal to the bottom plate thickness.



Bottom plate for contact measurement.

Bottom plate removed.
Working distance is equal to bottom plate thickness.



Advantages ARGES 45^0 regarding ALS-NW-45.

The ARGES 45^0:

Contains a self monitoring light source, meaning that the light output is optically stabilized within ±0.1%,

Light source output within a range of ±0.3% over full life time,

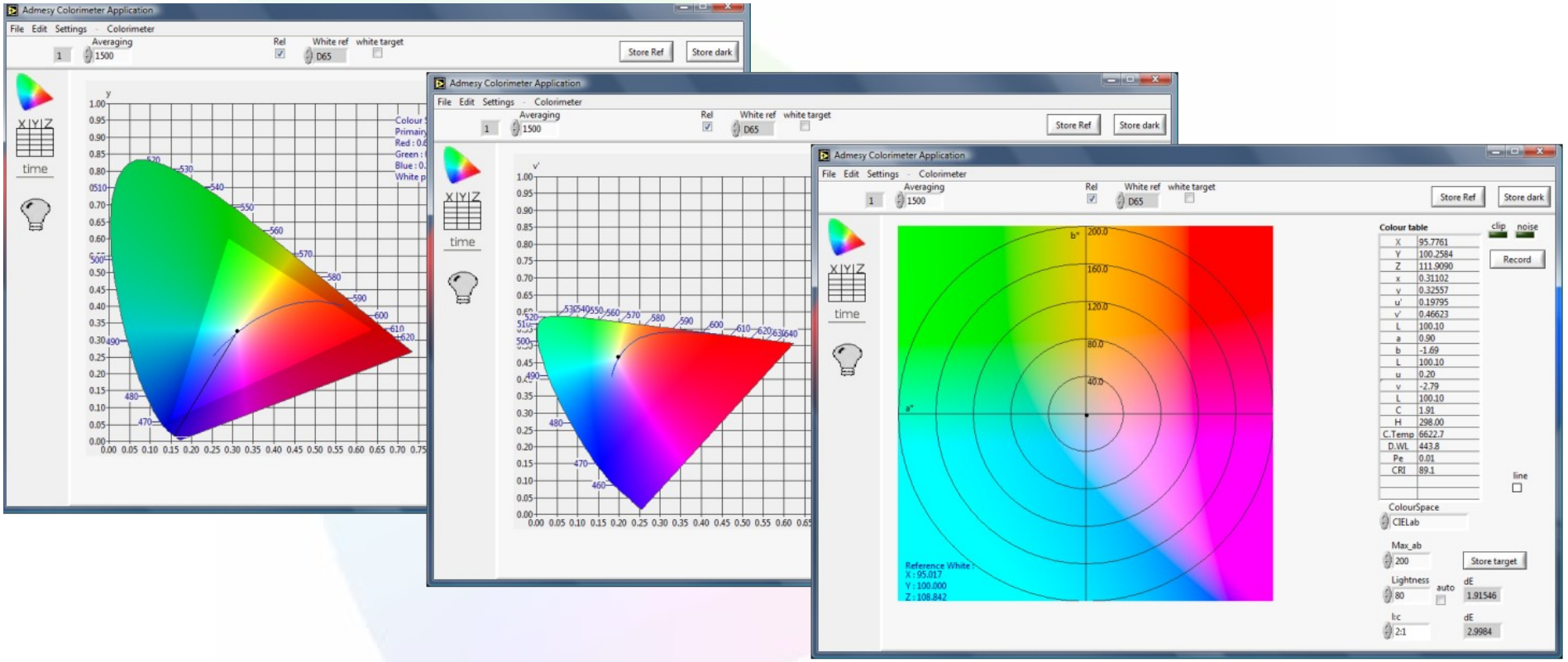
Has no warm up time, so can directly be used and is temperature independent.

Is more compact in size compared to an ALS-NW-45 and a Brontes together, making it easier to implement in in-line productions.

Note: reflective measurement with a ALS-NW-45 is always combined with a Brontes.

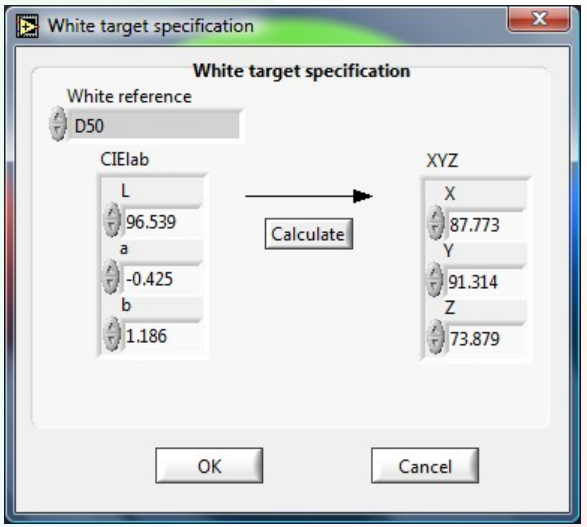
Reflective measurement using the Admesy colorimeter application

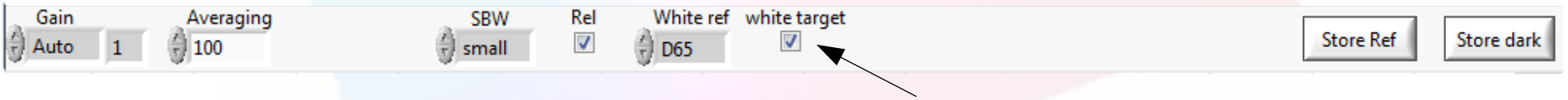
Reflective measurement can be shown in either Yxy, Yu'v' or CIE L*a*b* colour spaces.



White standard values and reference white selection.

The white standard values (reflectivity and colour) can be set via the Settings->White target menu in the Brontes application

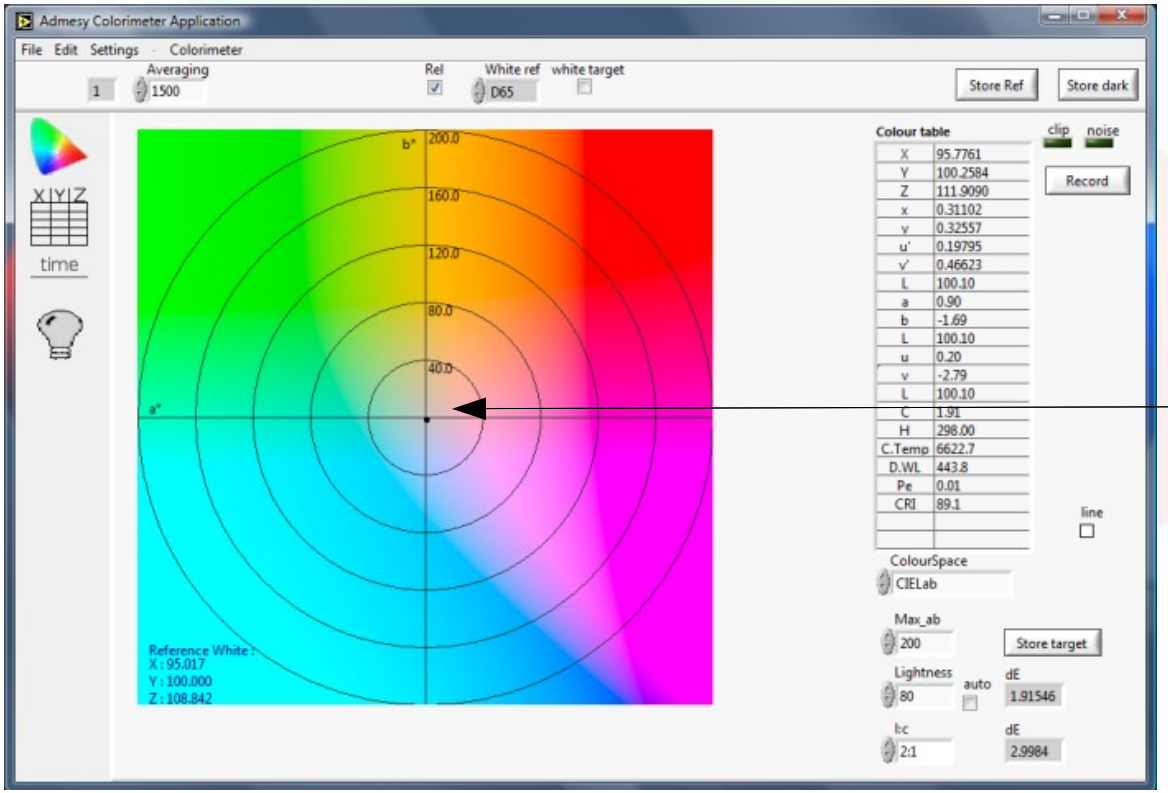




In order to use the white standard settings, “white target” must be selected.
When not selected, the software will use X,Y,Z = 100,100,100.
After this, a reference measurement can be carried out using the “Store ref(erence)” button.
The white reference can be selected via the “White reference” pull down menu.

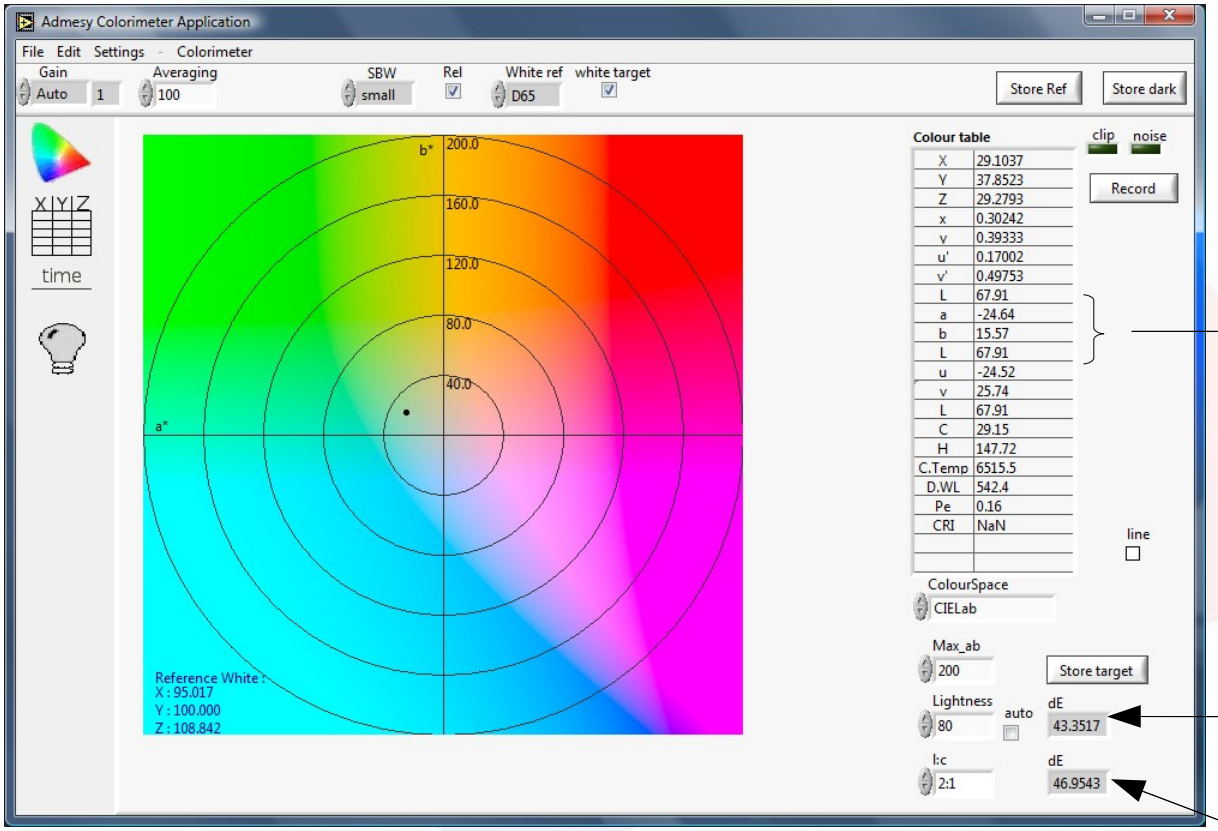
Measuring in the CIE Lab colour space

The CIE Lab colour space is used to measure colour versus a selected light source.
Just specifying a Lab value does not make sense unless the used light source is specified as well. In general when no light sources is specified, D50 is assumed as it most widely used.



Admesy colorimeter application showing CIE Lab colour space and reference measurement.

The following screen shot shows the measurement of a green sample.



Lab values

ΔE CIE 1976 value :
The difference from a target value.

ΔE CMC value.

Using the ΔE value

The ΔE value expresses the difference in colour and reflectivity (luminance) in one value. This value can be used for in-line applications to determine a Go/NoGo situation.
The dE value depends on two CIE Lab measurements :
1) target colour
2) sample colour
It is important that both measurements are carried out using the same chosen white reference.

The formula used in the Admesy colorimeter application is the so called CIE 1976 standard:

$$\Delta E = \sqrt{(L_1 - L_2)^2 + (a_1 - a_2)^2 + (b_1 - b_2)^2}$$

The CMC (Color Measurement Committee) standard is based on the L*C*h color model.

Using the Arges 45^0 or Brontes + ALS-NW-45 it is possible to measure dE values lower than 0.05 for colours near to the white target and about 0.1 for colours with 20% reflectance of the white target.

The dE value is quite suitable to measure if there is a difference in either L, a or b or all of them.
It is also possible to just focus on colour (a,b) or just one parameter (a or b) to measure differences.