



Reflective colour measurement

Using the Brontes colorimeter and ALS-NW-45 light source.



Reflective measurements : Reference

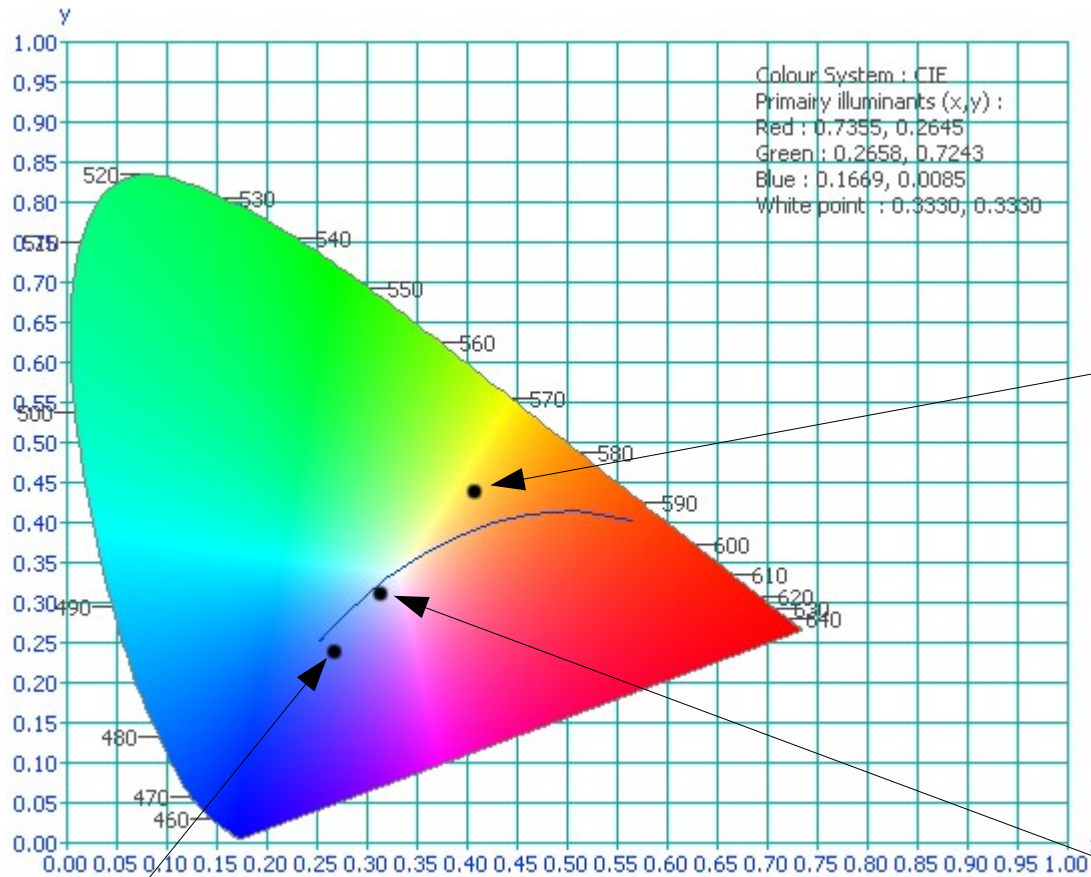
A reflective measurement needs a reference. This reference measurement will compensate for the used light source.

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

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

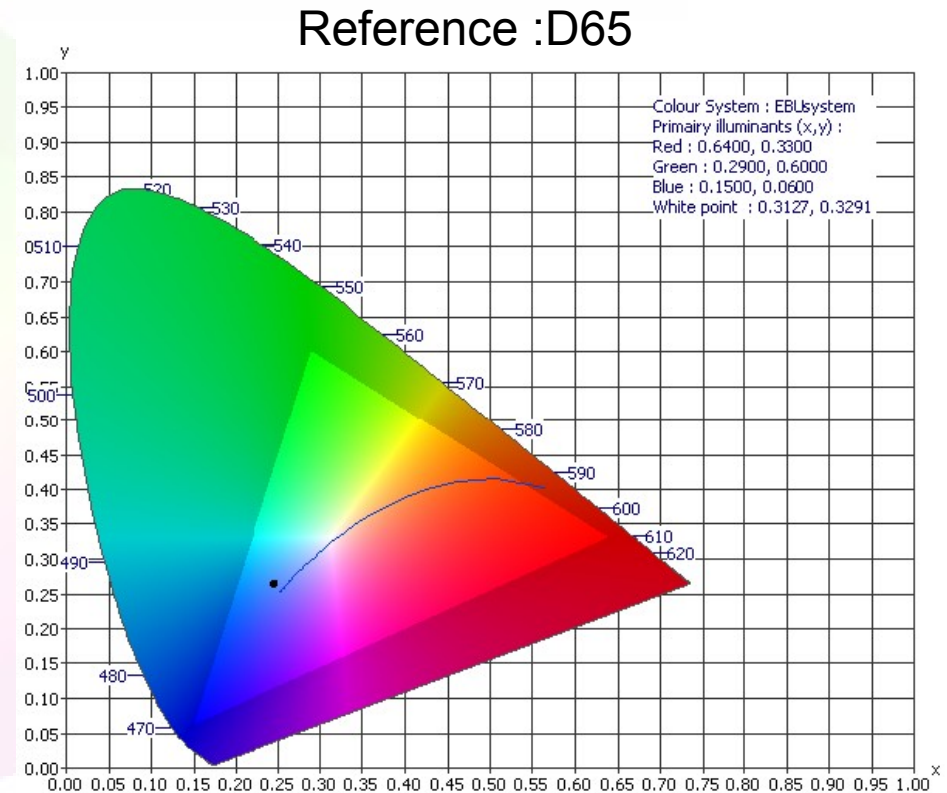
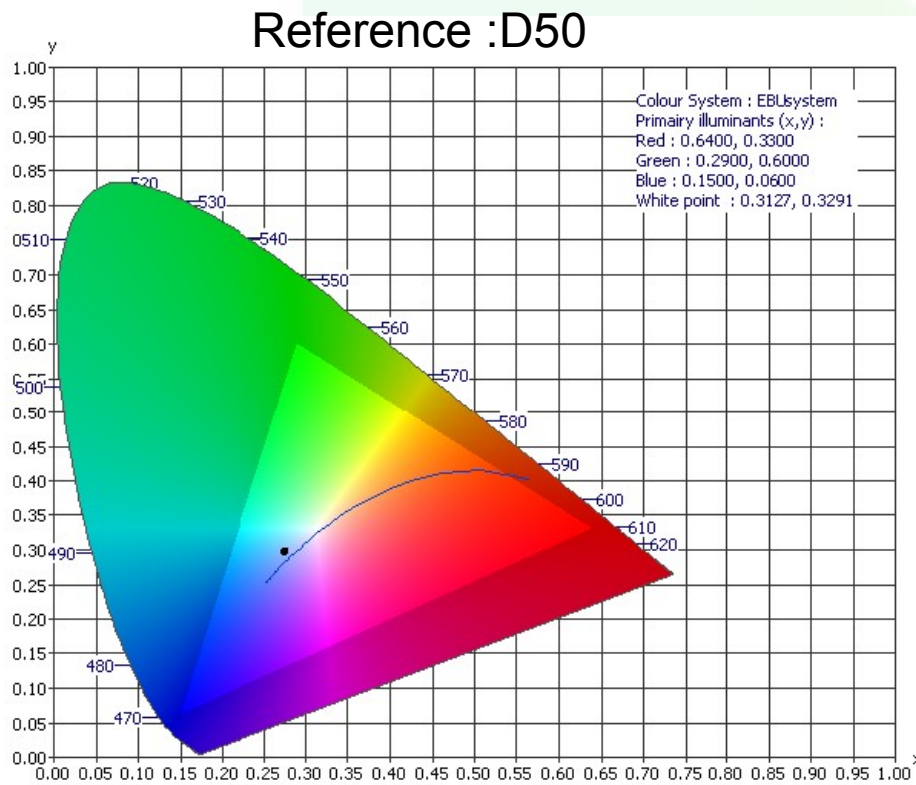
White point references used by the Brontes colorimeter.

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

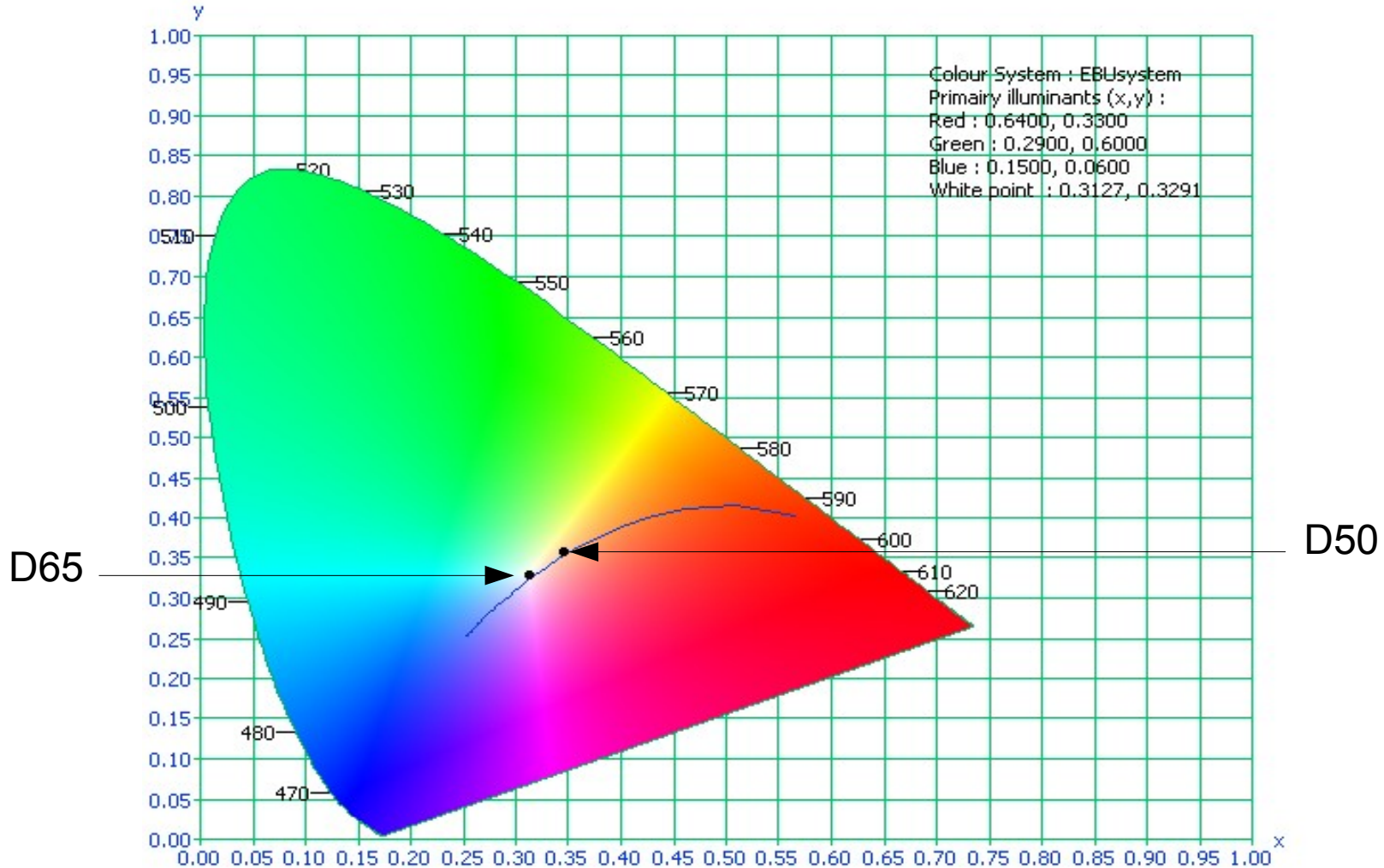
Results of different selected white points

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



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.

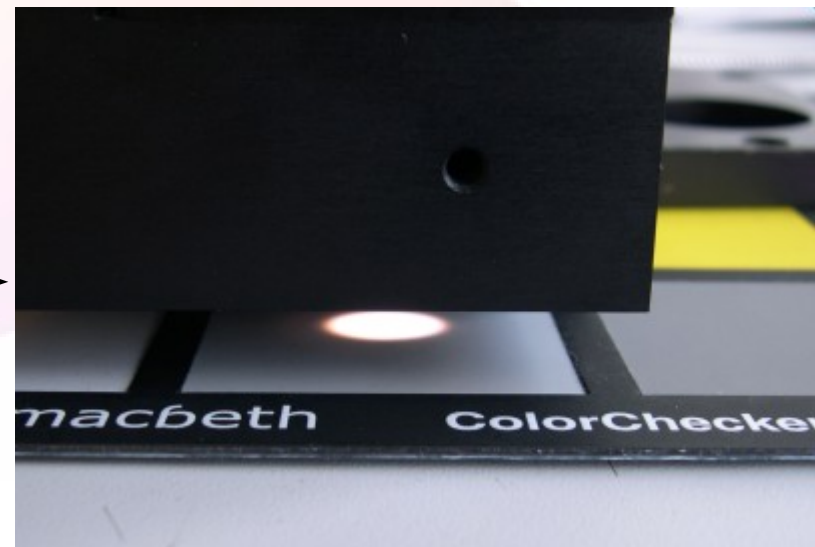
Reflective measurement using the ALS-NW-45 light source.

The ALS-NW-45 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.



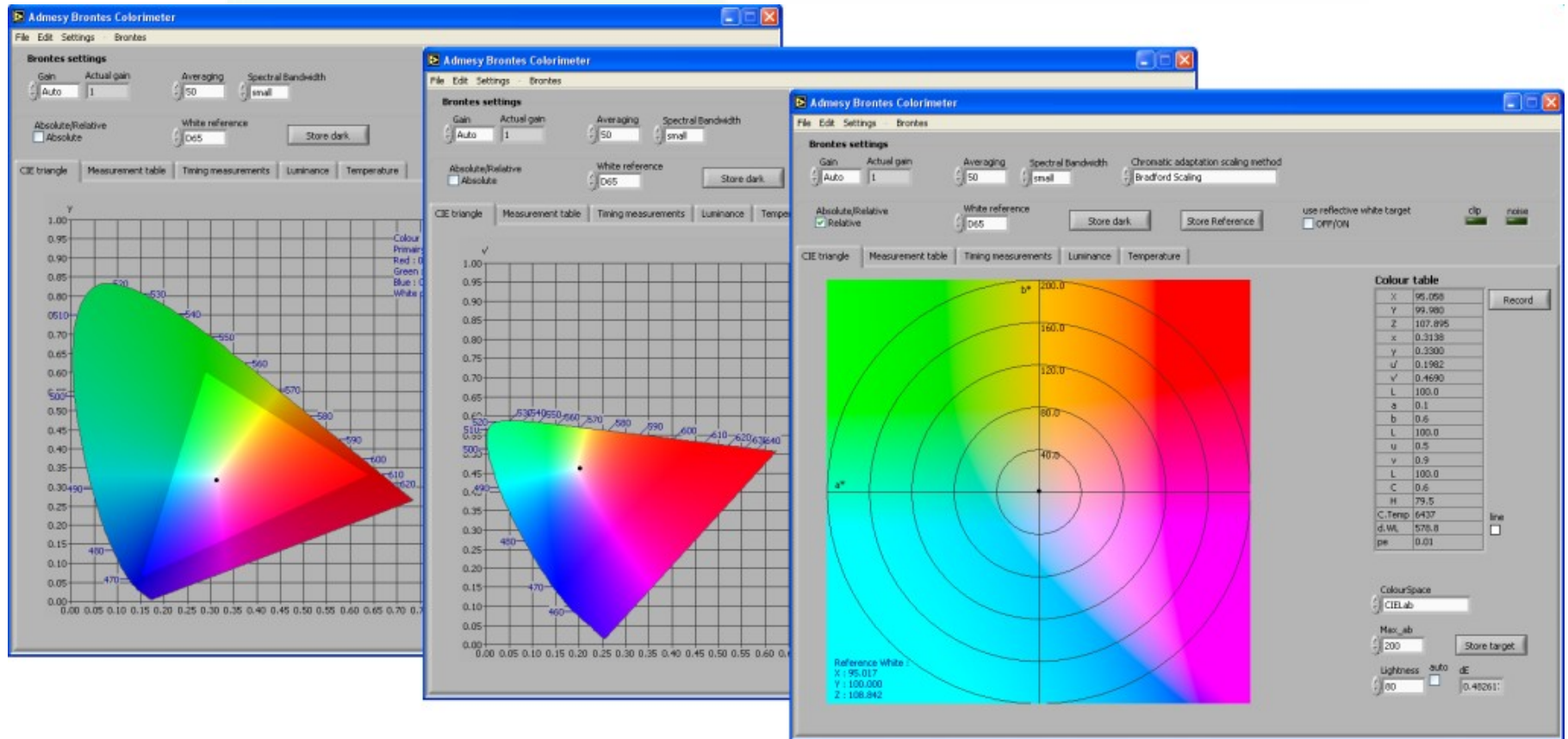
← Bottom plate for contact measurement.

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



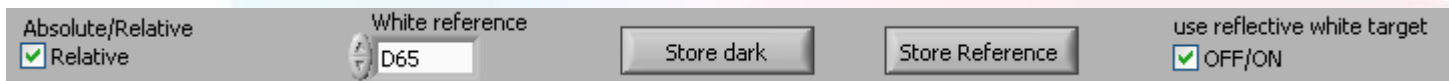
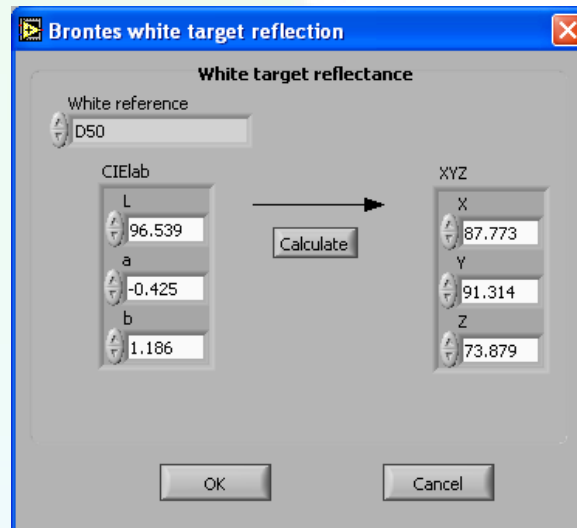
Reflective measurement using the Brontes application

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



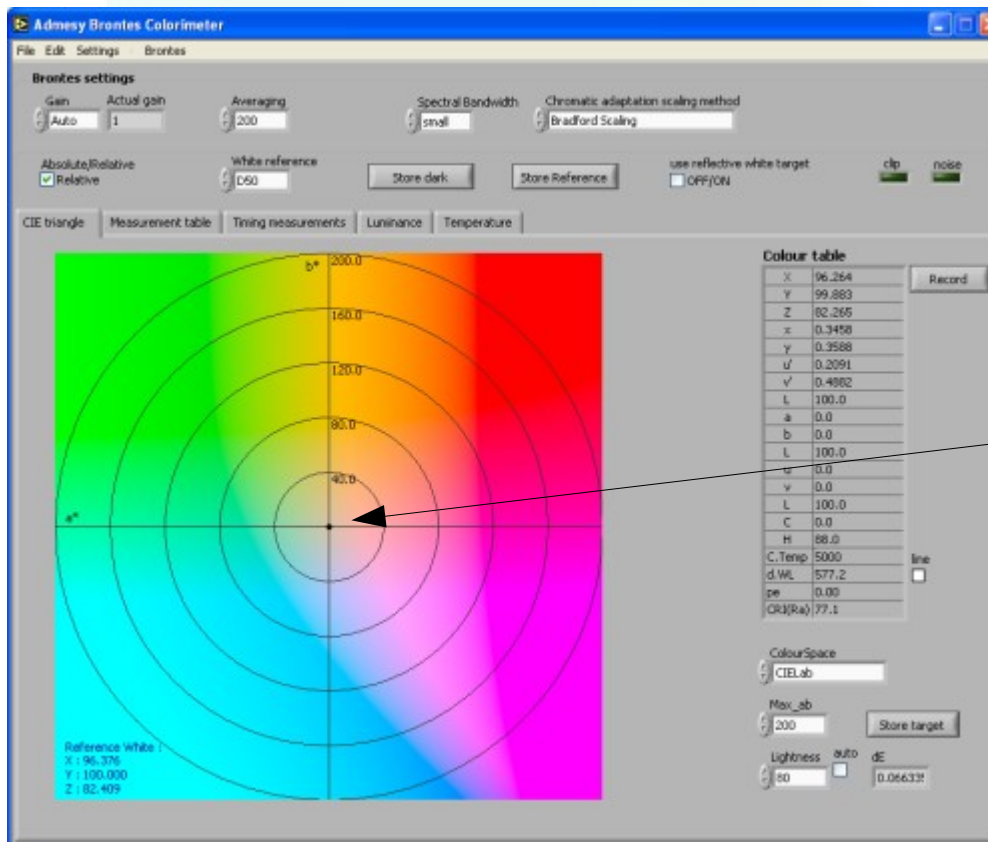
In order to use the white standard settings, “use reflective white target” must be selected. When not selected, the software will use $X, Y, Z = 100, 100, 100$. After this, a reference measurement can be carried out using the “Store reference” button.

The white reference can be selected via the “White reference” pull down menu.

Using the CIE Lab colour space

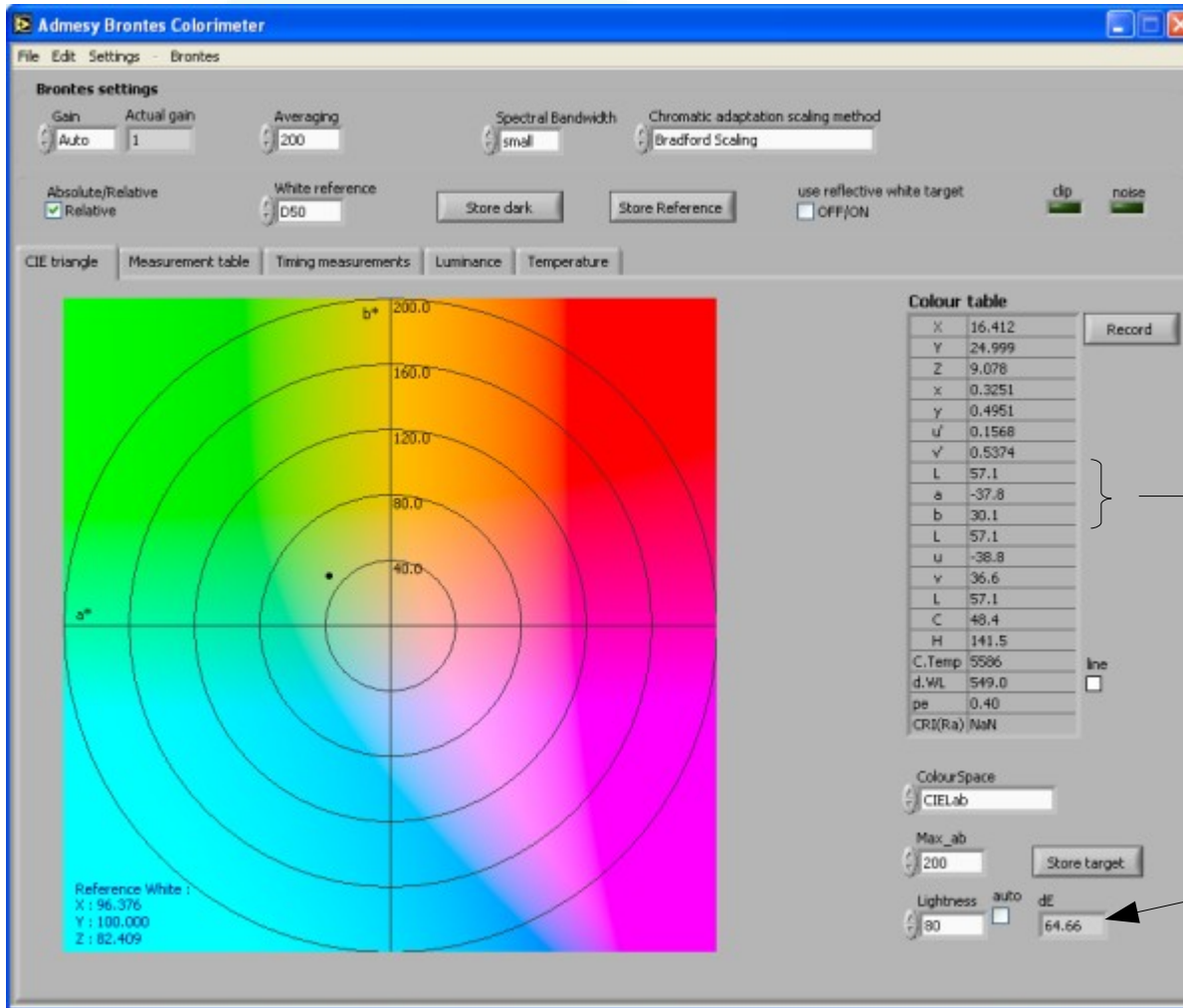
The CIE Lab colour space is used to measure colour versus a selected light source.

Just specifying an 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 though.



Brontes application showing CIE Lab colour space and reference measurement.

The following screenshot shows the measurement of a green sample.



Lab values

ΔE value :
The difference from
a target value.
(in this case the
white standard)

Using the ΔE value

The ΔE value expresses the difference in colour and lightness in one value. This value can be used for on-line applications to determine a Go/NoGo situation.

The ΔE 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 Brontes application is the CIE 1976 standard.

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

Other standards like CIE1994, CIE2000 or CMC can be supported though.

Using the Brontes + ALS-NW-45 it is possible to measure ΔE values lower than 0.01 for colours near to the white target and about 0.1 for colours with 20% reflectance of the white target.

The ΔE value is quite suitable to measure 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 (L,a or b) to measure differences.