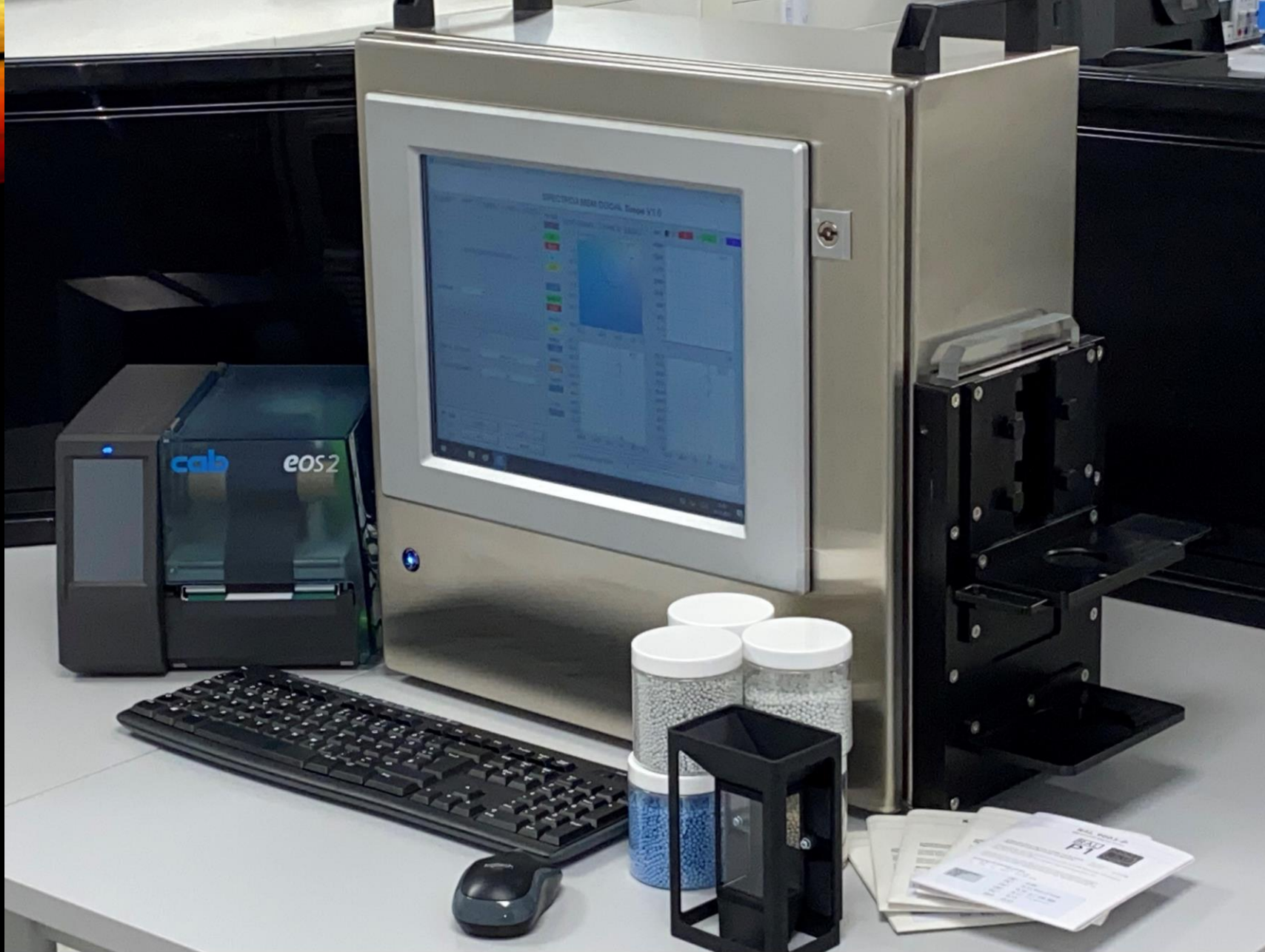# THE CYCLE OF COLOR

Making sure things don´t get too colorful when using plastic recyclates

# MEASUREMENT OF THE COLOR OF PLASTIC RECYCLATES BY MEANS OF THE LABORATORY DEVICE SPECTRO-3-0°/45°-MSM-ANA-LAB-P



Color measurement of plastic recyclate samples with the lab colorimeter SPECTRO-3-0°/45°-MSM-LAB-P

Lab colorimeter SPECTRO-3-0°/45°-MSM-LAB-ANA-P with cab eos2 label printer and RAL - plastic cards as well as recyclate samples
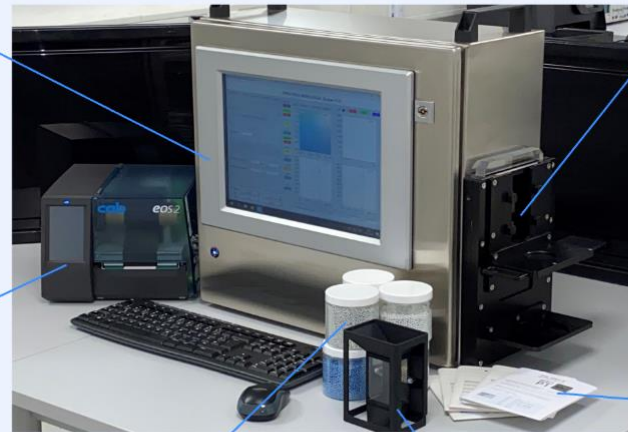
Evaluation unit including sensors, panel PC, USB interfaces, calibration card holder, support for sample holder, pellet hopper with sight glass, slider

Calibration card holder, holder for pellet samples, pellet hopper with sight glass, slider
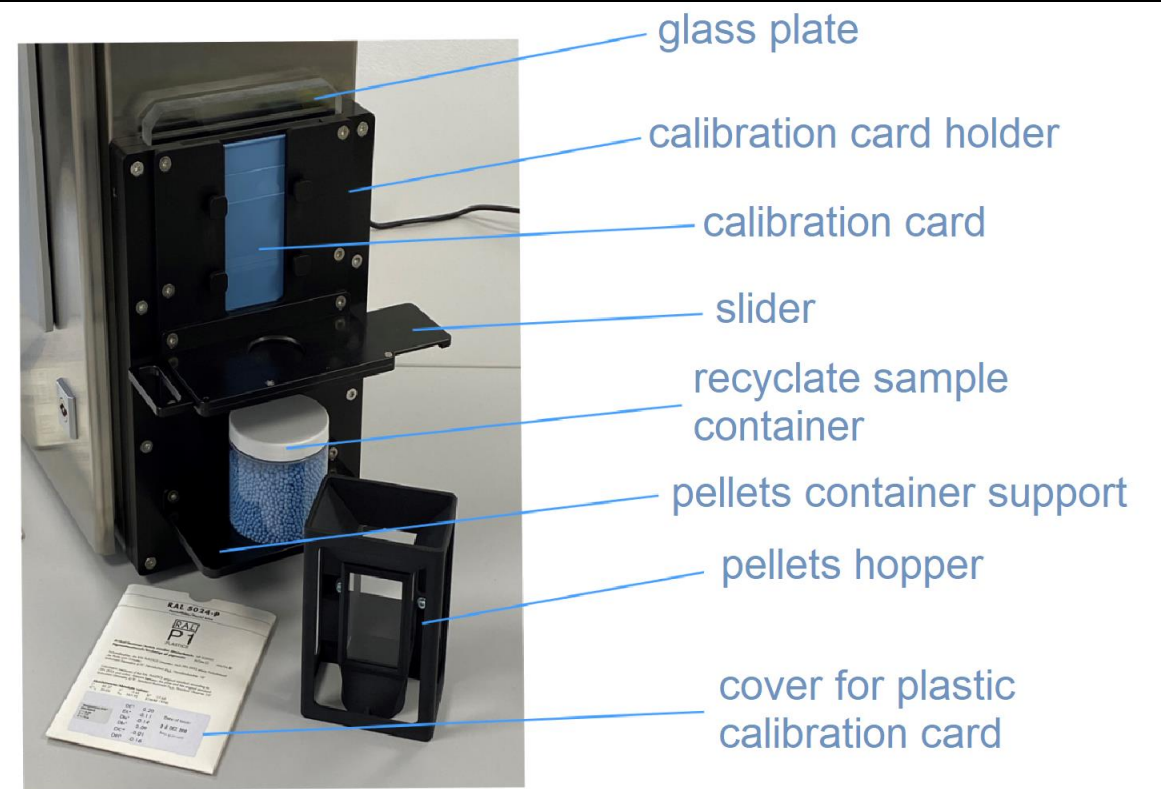
Label printer

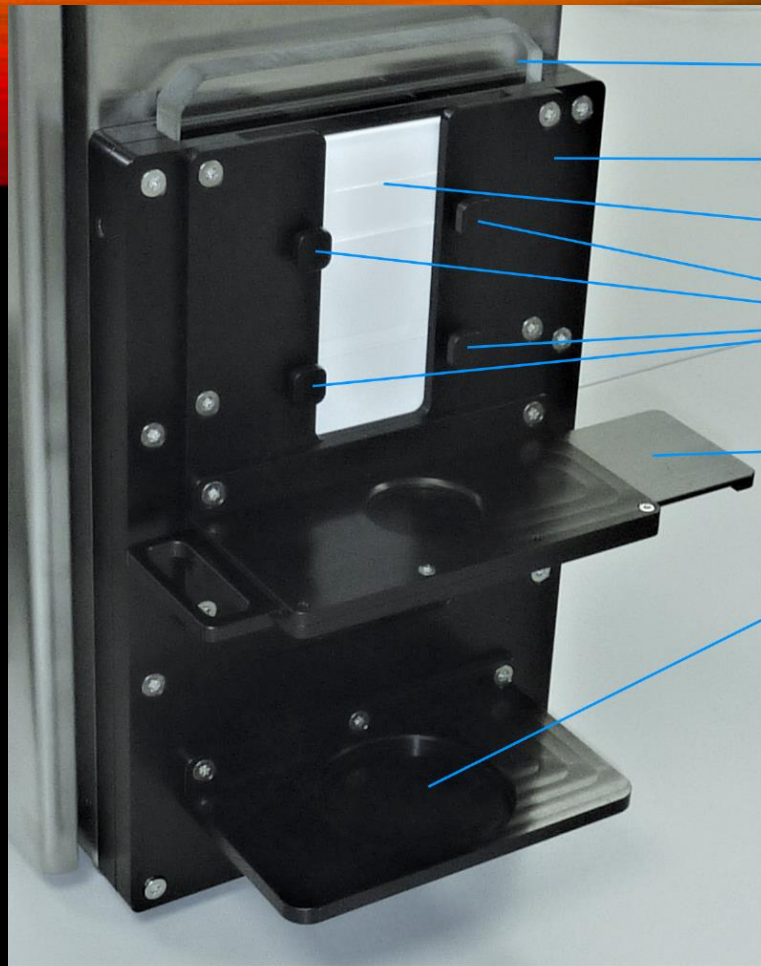Calibration cards

Pellet samples
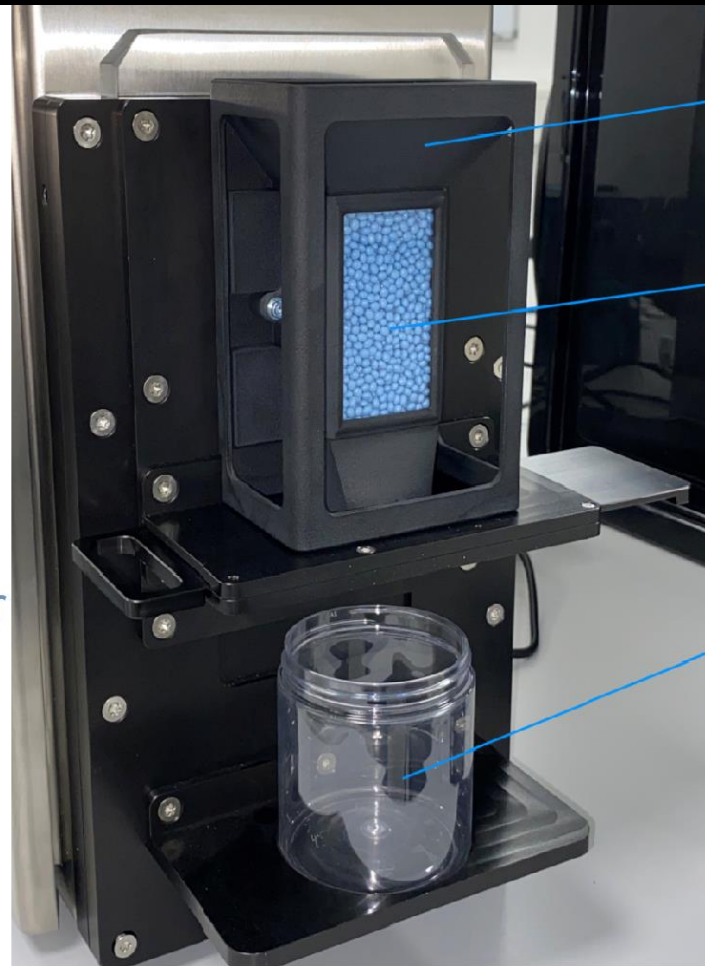
Pellet funnel with sight glass

Laboratory color measurement system
SPECTRO-3-0°/45°-MSM-ANA-P

panel - PC

mouse

keyboard

ON/OFF - switch

Ethernet - interface

fans

USB interfaces

+24V connection

+24V power supply

glass plate

calibration card holder

calibration card

slider

recyclate sample container

pellets container support

pellets hopper

cover for plastic calibration card

Electrical and mechanical interfaces of the lab colorimeter SPECTRO-3-0°/45°-MSM-LAB-ANA-P
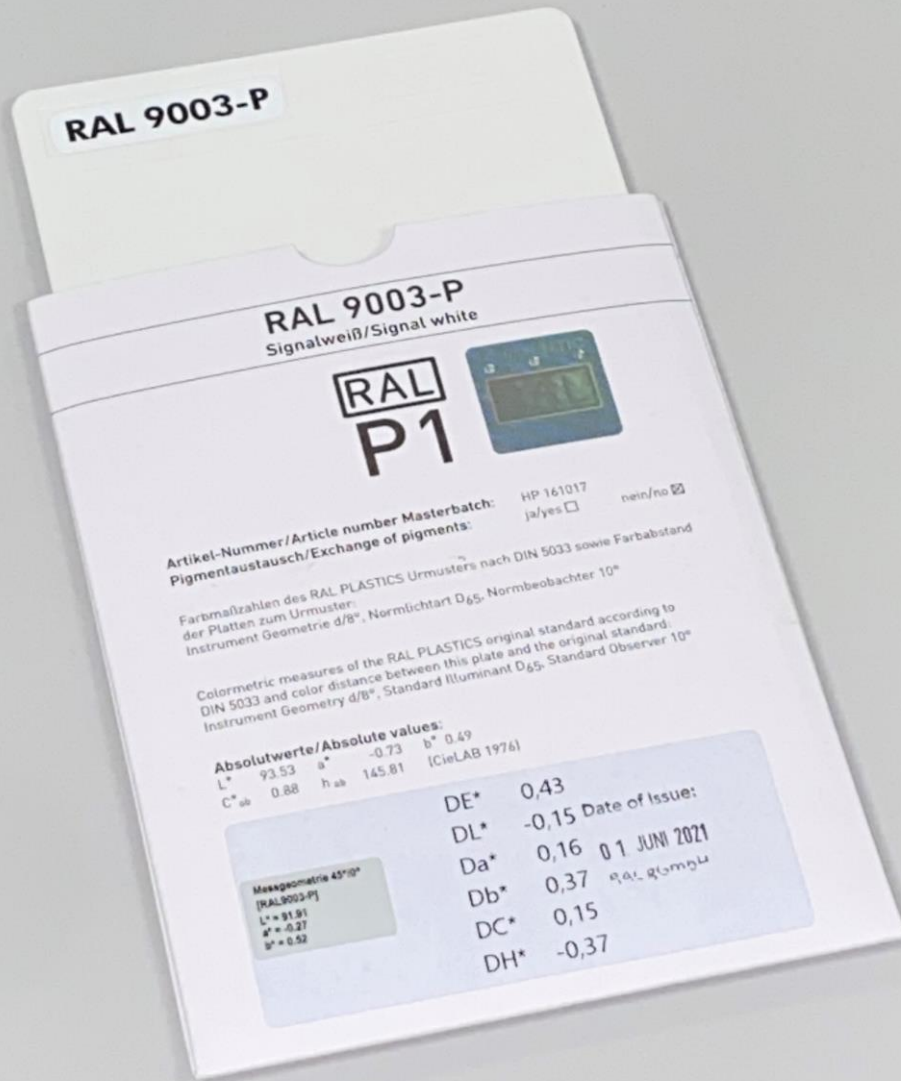
glass plate

calibration card holder

calibration card

mechanical interface for pellet hopper
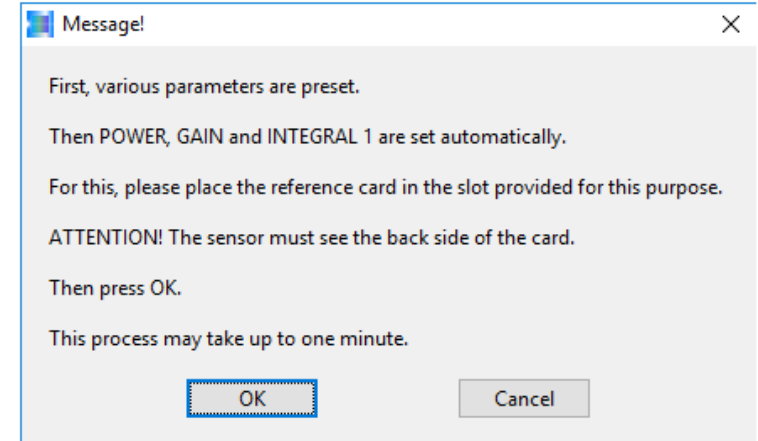
slider

holder for pellet sample container
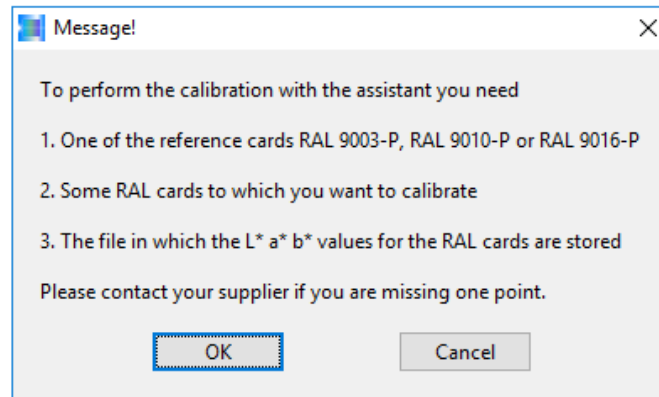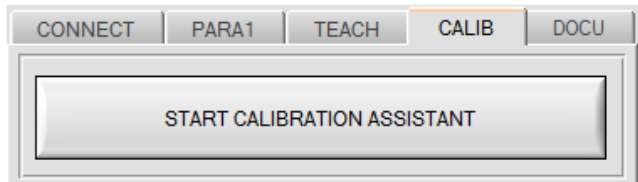
pellet hopper with sight glass

recyclate

pellet sample container

Calibration card holder with inserted RAL - plastic card (left) as well as with flanged pellet hopper and pellet sample container (right)

RAL - plastic cards with indication of L*a*b* - values, measured according to the diffuse/8° - and 45°/0° - method. Up to 300 different RAL - plastic cards are available.

| CONNECT | PARA1 | TEACH | CALIB | DOCU |

START CALIBRATION ASSISTANT

**Message!**   ✕

To perform the calibration with the assistant you need

1. One of the reference cards RAL 9003-P, RAL 9010-P or RAL 9016-P

2. Some RAL cards to which you want to calibrate

3. The file in which the L* a* b* values for the RAL cards are stored

Please contact your supplier if you are missing one point.

OK        Cancel

**Message!**   ✕

First, various parameters are preset.

Then POWER, GAIN and INTEGRAL 1 are set automatically.

For this, please place the reference card in the slot provided for this purpose.

ATTENTION! The sensor must see the back side of the card.

Then press OK.

This process may take up to one minute.

OK        Cancel

For the calibration of the lab color measuring system the RAL - plastic cards are used. Three different white tones are available for the white balance: RAL9003-P, RAL9010-P and RAL9016-P. One of these three RAL - card types should be used for the white balance. After placing one of the three cards in the calibration card holder, the software of the measuring system adjusts to the white surface of the RAL - plastic card in an optimal way.
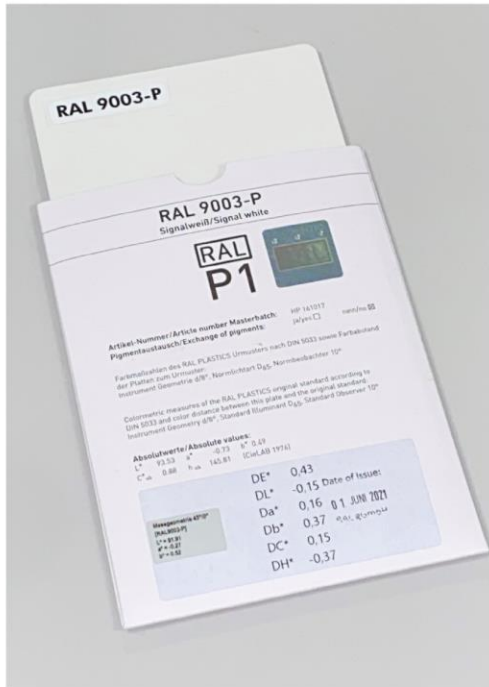
In the following example the RAL9003-P was used as reference card for the white balance. All L*a*b* - color values of the approx. 300 RAL - plastic cards are available on the files **RAL Plastic Plate measured with Hunter Lab - 45°_0°** as well as **RAL Plastic Plate Standard d_8°**.
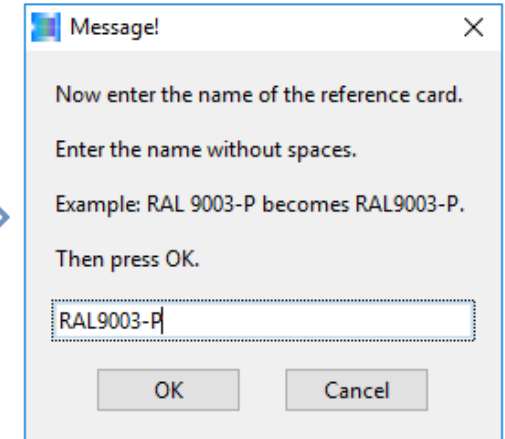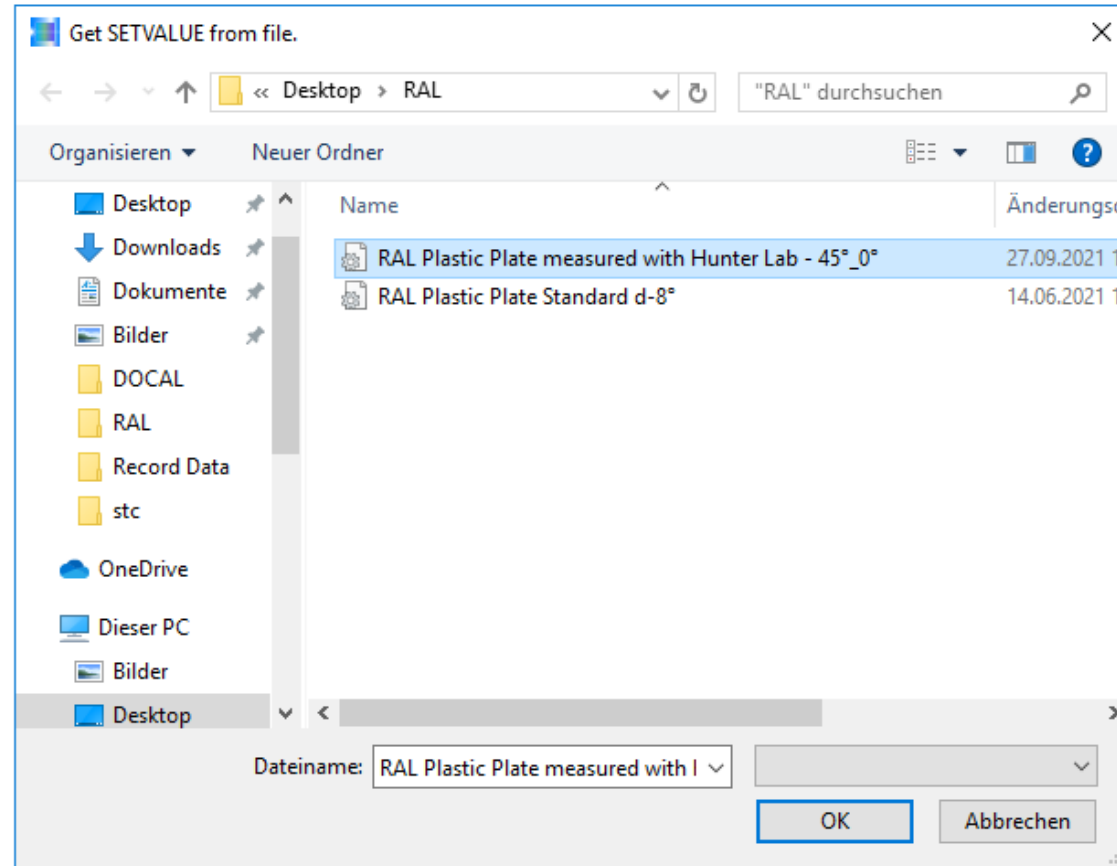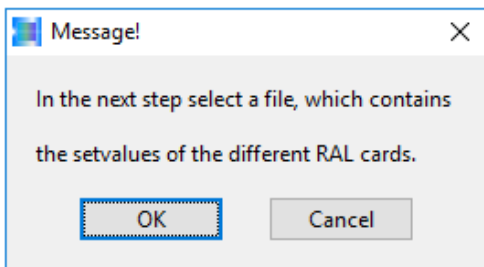
Selection of the color measurement standard: 45°/0° or d/8° method; 45°/0° is recommended here, since the laboratory color measurement system also works according to this measurement method. After selecting the file the used RAL - card type must be entered, in the example here: RAL9003-P.

1st calibration card

After calibration to the white reference (RAL9003-P), several local reference points can now be stored in the color space for more precise adjustment of the color measurement system. It is recommended to use RAL - plastic cards, which visually corresponds to the produced recyclate in terms of color. After selecting a suitable RAL plastic card, it is entered into the software (here: RAL9002-P) and then positioned in the calibration card holder. After clicking the OK software button twice, the L*a*b* color values of the RAL plastic card and the XYZ color values of the color measuring system are entered into the respective calibration table.
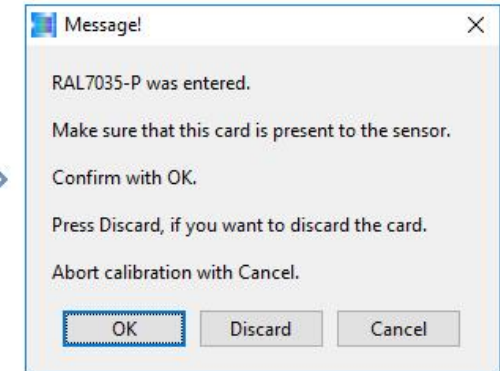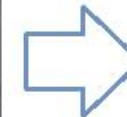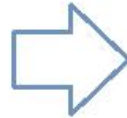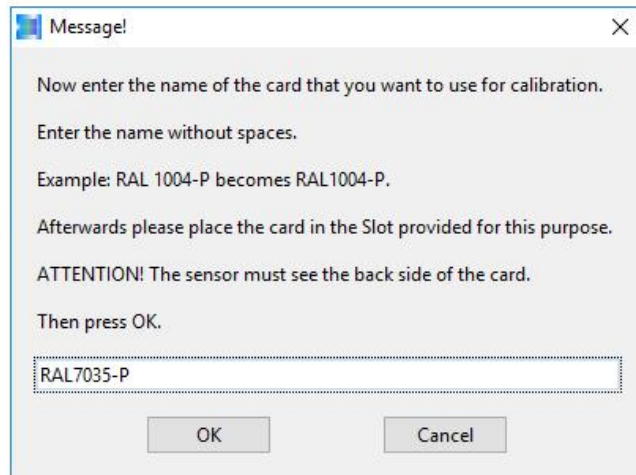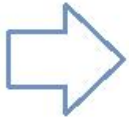
The calibration table can be supplemented by entering further reference points (here: RAL7035-P). For this purpose, the RAL plastic card RAL7035-P is placed in the calibration card holder. Enter "RAL7035-P into the software and then confirm twice with a mouse cklick on the OK software button.
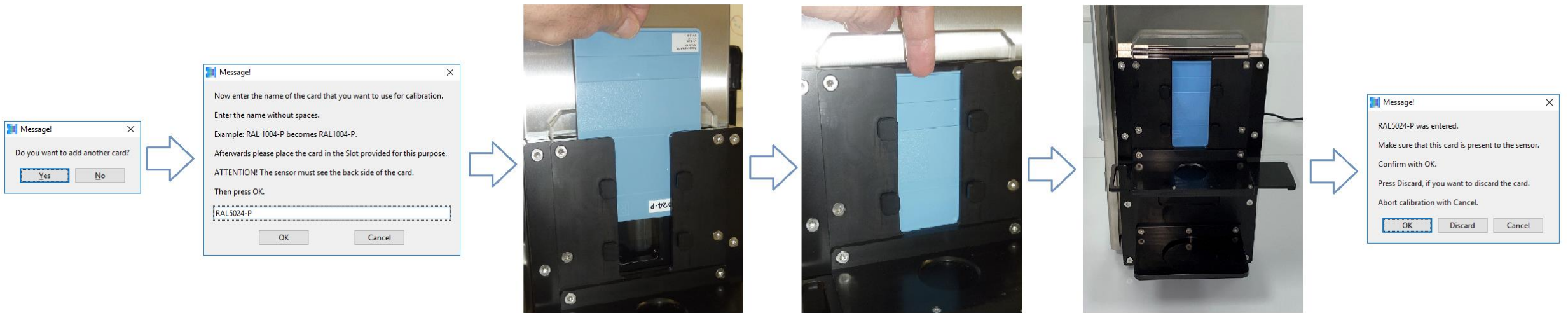
Adding another calibration card (here: RAL5024-P) to the calibration table:
*Place the RAL - card in the calibration card holder.
*Input of "RAL5024-P" into the software.
*Confirm twice by mouse click with OK.
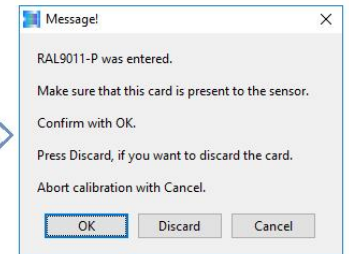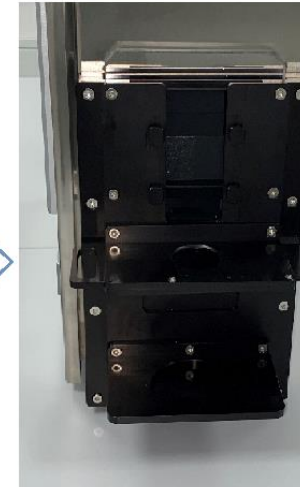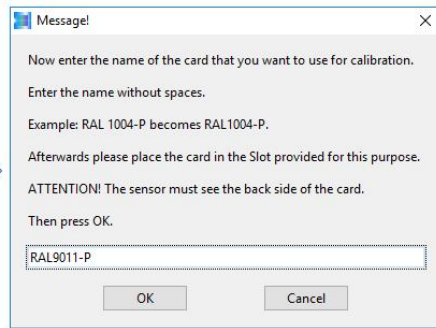
Again the software inquires for a further RAL plastic card, in our example this is the RAL9011-P. After inserting the RAL plastic card into the calibration card holder and entering "RAL9011-P" in the software and conforming twice by clicking the OK software button, an entry is made, in our example the 5th in the SETVALUE TABLE as well as in the ACTUAL XYZ VALUE TABLE.

5th calibration card

**Message!** ✕
Do you want to add another card?
[Yes] [No]

➡

**Message!** ✕
Calibration was successful.
Calibration data will be sent to sensor.
[OK] [Cancel]

➡

**Message!** ✕
Calibration data have been sent to the EEPROM of the sensor.
[OK]

➡

**Message!** ✕
UCAL has been activated and all parameter were sent to the EEPROM of the sensor.
[OK]
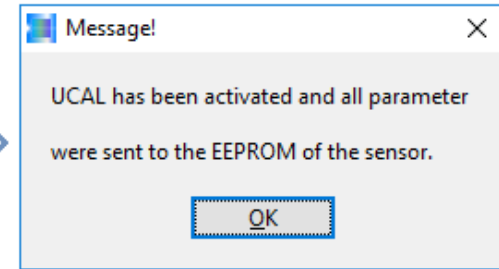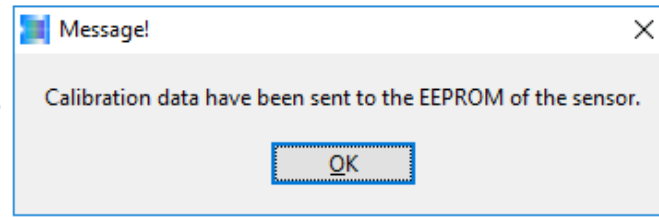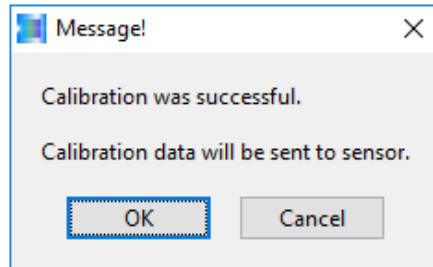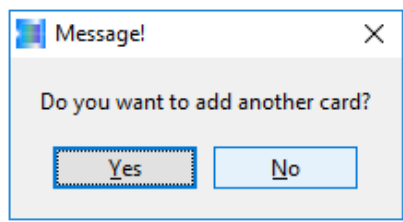
In our example we are finished with the RAL plastic cards to which the color measuring system should be calibrated and the question for further RAL plastic cards can be answered with "No" (mouse click on the "No" - field of the software). The software informs that the calibration was successful and that the calibration data has been taken over and stored in the non-volatile memory of the controller in the color measuring device after confirming "OK" twice via mouse click. Furthermore, the software informs that the CALIB mode UCAL has been activated, i.e. the sensor system now uses the currently entered calibration values to determine the color values. The activation or the UCAL mode was stored in the non-volatile memory of the sensor-internal controller.
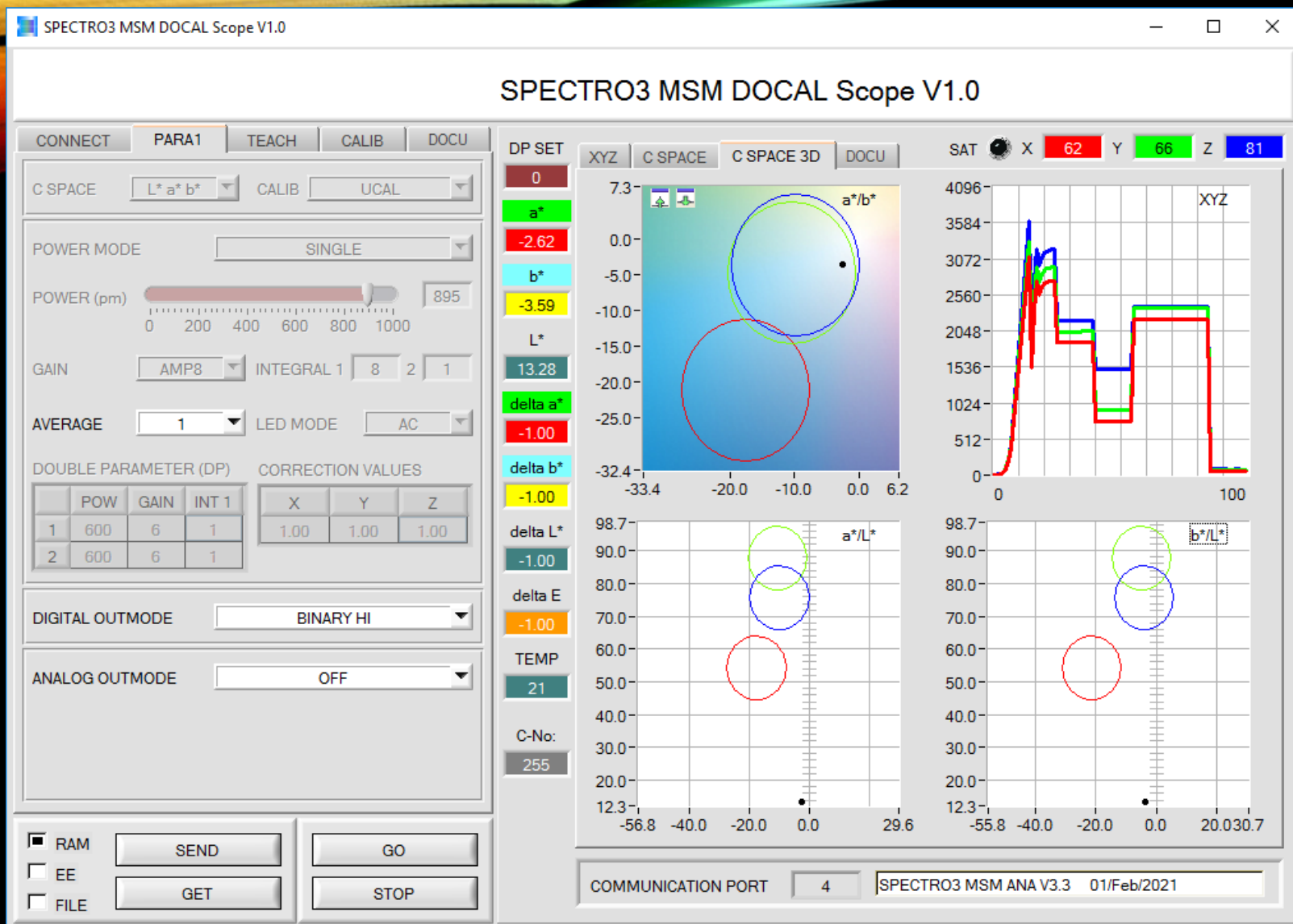
PARA1 user interface of the SPECTRO3 MSM DOCAL Scope V1.0 software after calibration. The value in the AVERAGE input field should be changed from 1 to 32768. Then click on EE and confirm with SEND via mouse click.
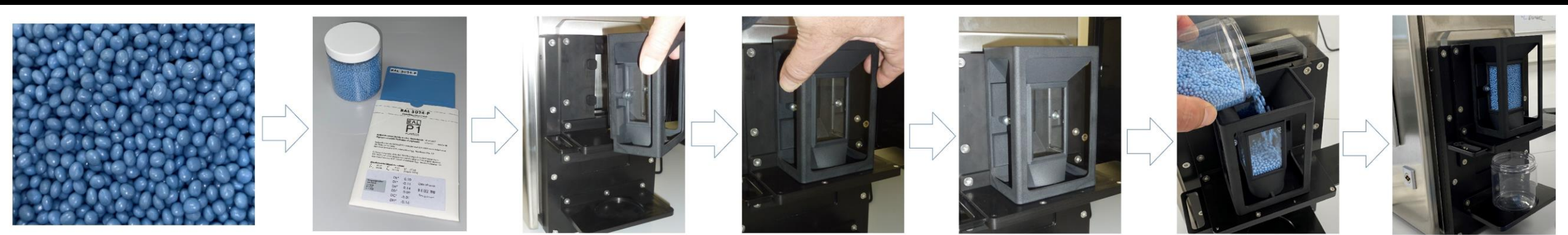
The actual measurement process is now to be carrierd out on the basis of a recyclate that is very close in color to the RAL plastic card RAL5024-P from a purely visual point of view. In this process, several recyclate samples are taken at specific time intervals from ongoing production using the sample containers and fed to the lab colorimeter. First, it is necessary to attach or flange the recyclate pick-up unit (pellet hopper unit) to the calibration card pick-up unit. Four elongated holes are provided on the rear of the recyclate pick-up unit for this purpose. In addition, four bars matching the elongated holes are provided on the calibration card pick-up unit to allow the recyclate pick-up unit to be flanged on. After the recyclate pick-up unit has been mounted, the recyclate sample can be fed in. After filling the recyclate pick-up unit, the empty recyclate container should be positioned below the recyclate pick-up unit (pellet hopper unit) in the recess provided for this purpose.

The measurement can now begin. So that the deviations dL*, da* and db* from a reference value can also be displayed, this must be first defined. This is made possible by entering the L*a*b* reference color values in the so-called TEACH TABLE. The SPECTRO-3-0°/45°-MSM-LAB-ANA-P software can store up to three different reference color triplets. The values can be entered via the keyboard after clicking on the respective field in the TEACH TABLE, but also by means of suitable recyclate samples, whose values (after the recyclate sample has been filled into the recyclate pick-up unit, named as the pellet hopper unit) are stored in the a*b*L* fields of the selected line after selecting the line number (in the TEACH TABLE) and after clicking on the TEACH DATA TO field of the software.
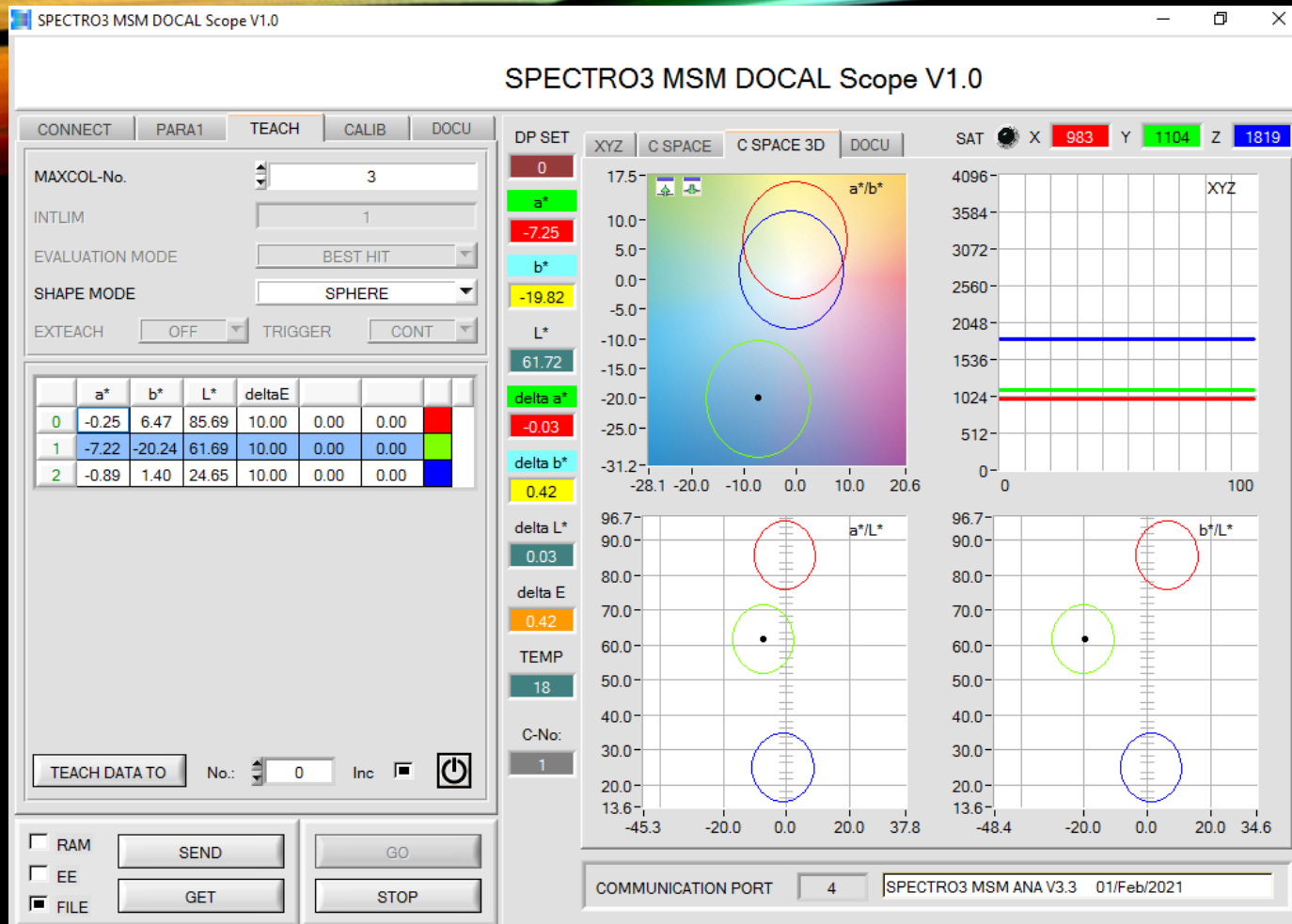
The TEACH TABLE is now filled in and the color measurement of the recyclate samples (in our example the pastel blue recyclate samples) can be continued. The pastel blue recyclate reference was stored in row 1 of the TEACH TABLE: a* = -7.22, b* = -20.44, L* = 61.69. After clicking the GO software button, the current L*a*b* values of the recyclate sample, as well as the dL*da*db* color deviation values (deviation to the reference values), and furthermore the dE value, thus the deviation from the reference, stored in the TEACH TABLE, in the color space in entirety, are displayed in the column roughly in the middle of the PC screen.
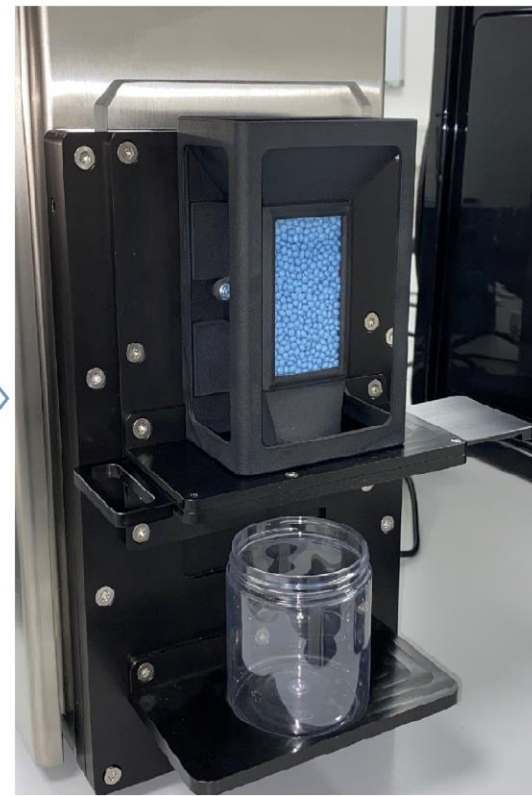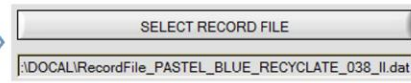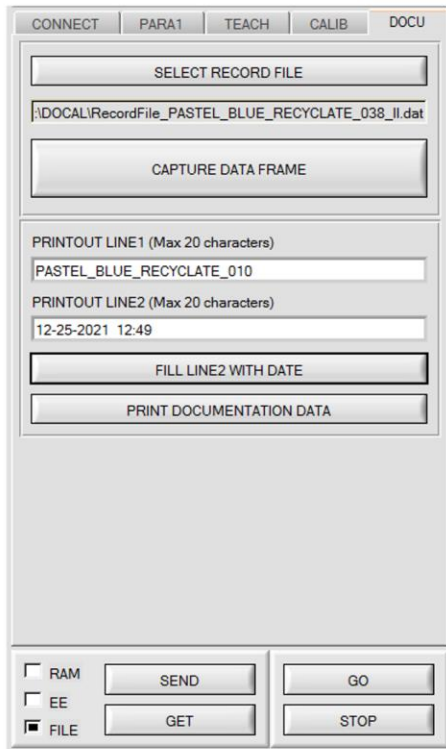
The color values L*a*b* of the respective recyclate sample, as well as their deviations dL*da*db* from the matching reference in the TEACH TABLE, can now be saved in a file that has yet to be created. After clicking the software button "SELECT RECORD FILE" the file name and the file location can be defined, in our example: \DOCAL\RecordFile_PASTEL_BLUE_RECYCLATE_038 _II.dat. After placing the recyclate sample in the recyclate pick-up unit (pellet hopper unit), the measurement can now be triggered by clicking the "CAPTURE DATA FRAME" software button. Parallel to the recording of the color values L*a*b*, the color deviations dL*da*db* to the matching color reference a*b*L* stored in row1 in the TEACH TABLE, the date as well as the time, a graphical display also takes place in the SPECTRO3 MSM DOCAL Scope V1.0 software, also in the DOCU menu item.

Graphical as well as numerical display of the L*a*b* - color values, the dL*da*db* - color deviations an the dE - value for the matching color reference in the TEACH TABLE in the menu item DOCU.
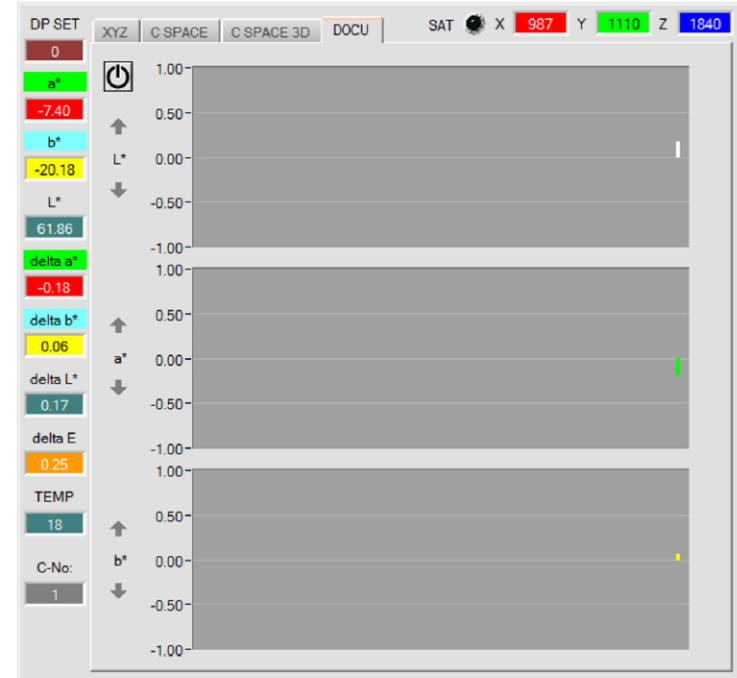
A numeric output of the data including text field can be done for example by means of a label printer (cab eos2). For text input, 2 text lines are available (each with a maximum of 20 characters), but the 2nd line can also be used for the date and time (click on "FILL LINE2 WITH DATE"). After filling in the two lines, the label can now be created by clicking on "PRINT DOCUMENTATION DATA" and then selecting the printer, including a mouse click on the OK - software button. The software then acknowledges the successful label printing with "Print successful". With a mouse click on the OK software button, the software and the color measurement system are available for a new measurement.
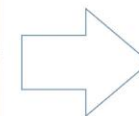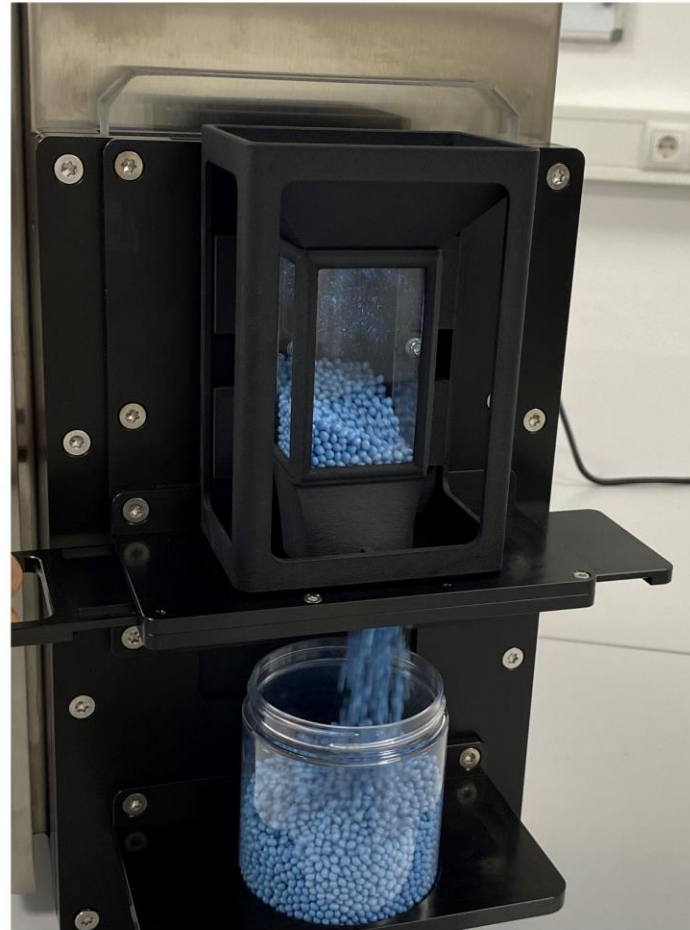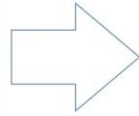
After the label has been printed, the recyclate sample can be removed from the recyclate pick-up unit (pellet hopper unit) by pulling the slide and at the same time filled into the empty recyclate sample container. The label created for the recyclate sample can then be attached to the sample container.
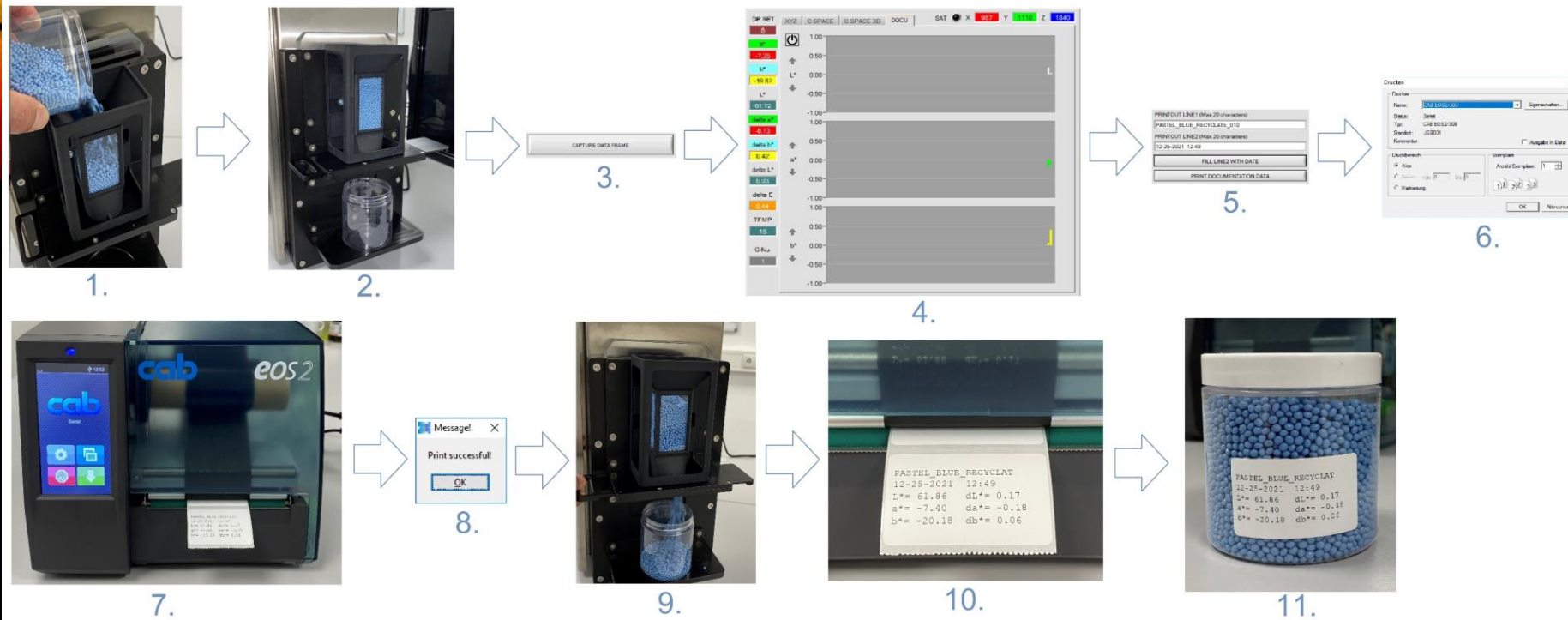
1. After another pellet sample has been taken, the pellets are filled into the recyclate pick-up unit (pellet hopper unit).
2. Placing the now empty pellet sample container in the recess provided for this purpose below the pellet hopper unit.
3. Activation of the measurement by mouse click on the CAPTURE DATA FRAME software button.
4. In the right part of the software interface the current L*a*b* - values and the dE value are displayed numerically and the dL*da*db* - values numerically as well as graphically. In addition, the values are saved in the selected file together with the time and date.
5. In line 1 on the label to be created, text but also numbers and special characters can be entered. Line 2 can be used in the same way as line 1, or the date and the time can be entered.
6. By clicking on the OK - software button, the label printer will be prompted to create the label.
7. The label will be created on the label printer.
8. A message is displayed, that the printing process was successful.
9. The pellets can now be removed from the pellet hopper unit by pulling the slide. The pellets are thereby filled into the already placed, empty pellet sample container. Now only the lid has to be screwed on and
10. Peeling the label from the backing material.
11. Sticking the label onto the pellet sample container.
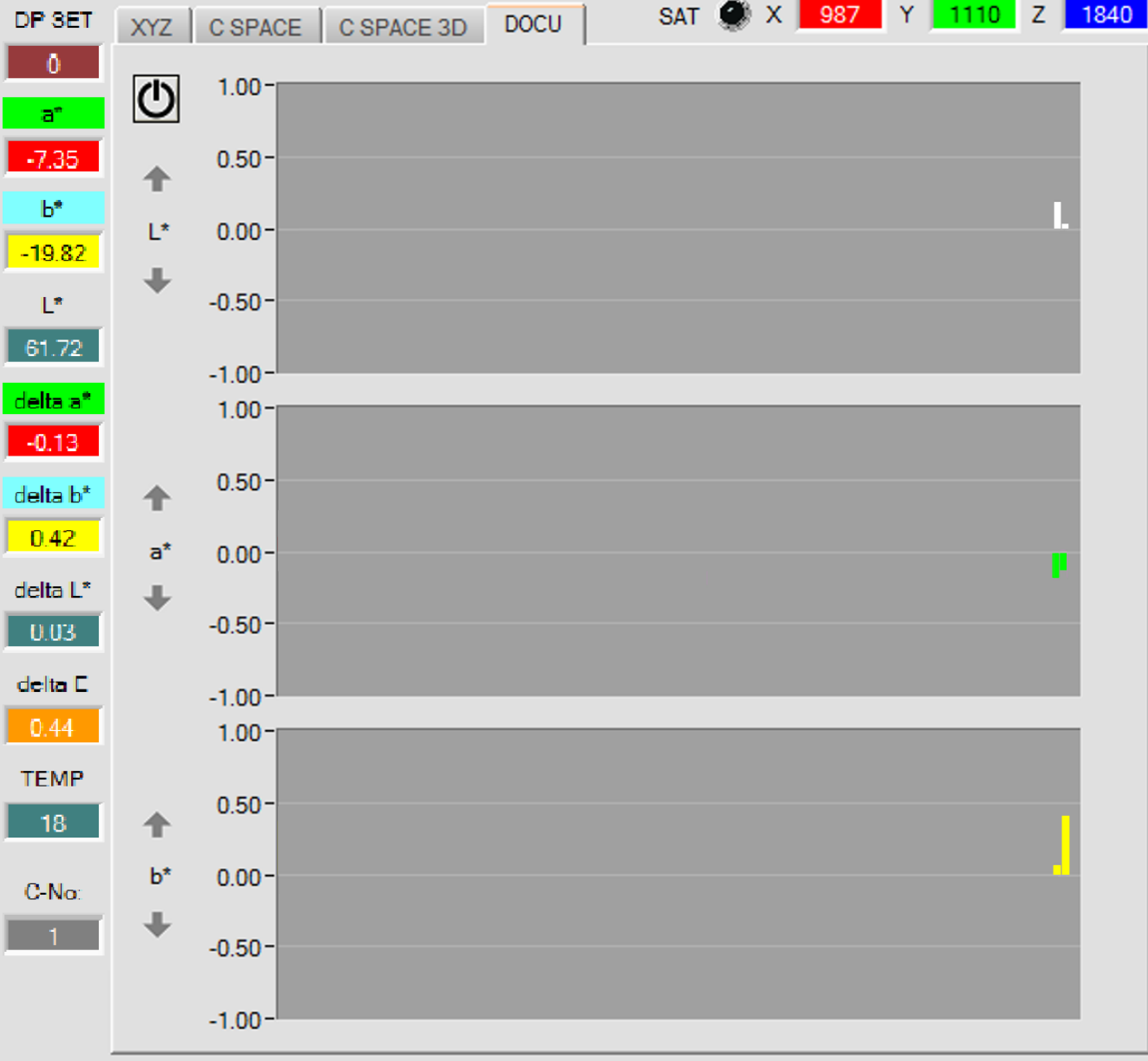
2nd measurement

1.
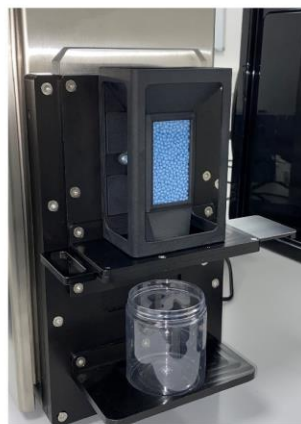
2.

3. CAPTURE DATA FRAME

4.

5.

6.

7.

8. Print successful!
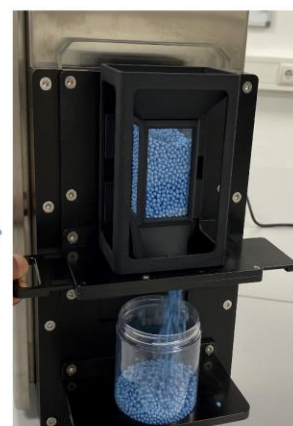
9.

10.

11.

3rd measurement

3rd measurement

1.
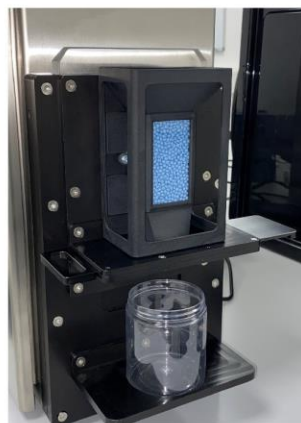
2.

3. CAPTURE DATA FRAME

4.

5.

6.

7.

8. Print successful!
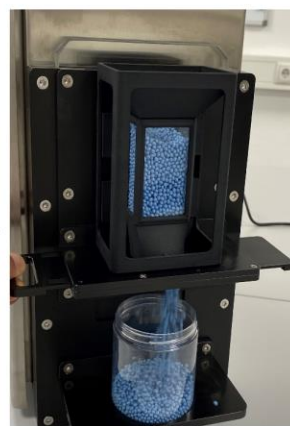
9.

10.

11.

100th measurement

100th measurement

Datei | Start | Einfügen | Seitenlayout | Formeln | Daten | Überprüfen | Ansicht | Hilfe | Teilen | Kommentare

A1 | $f_x$

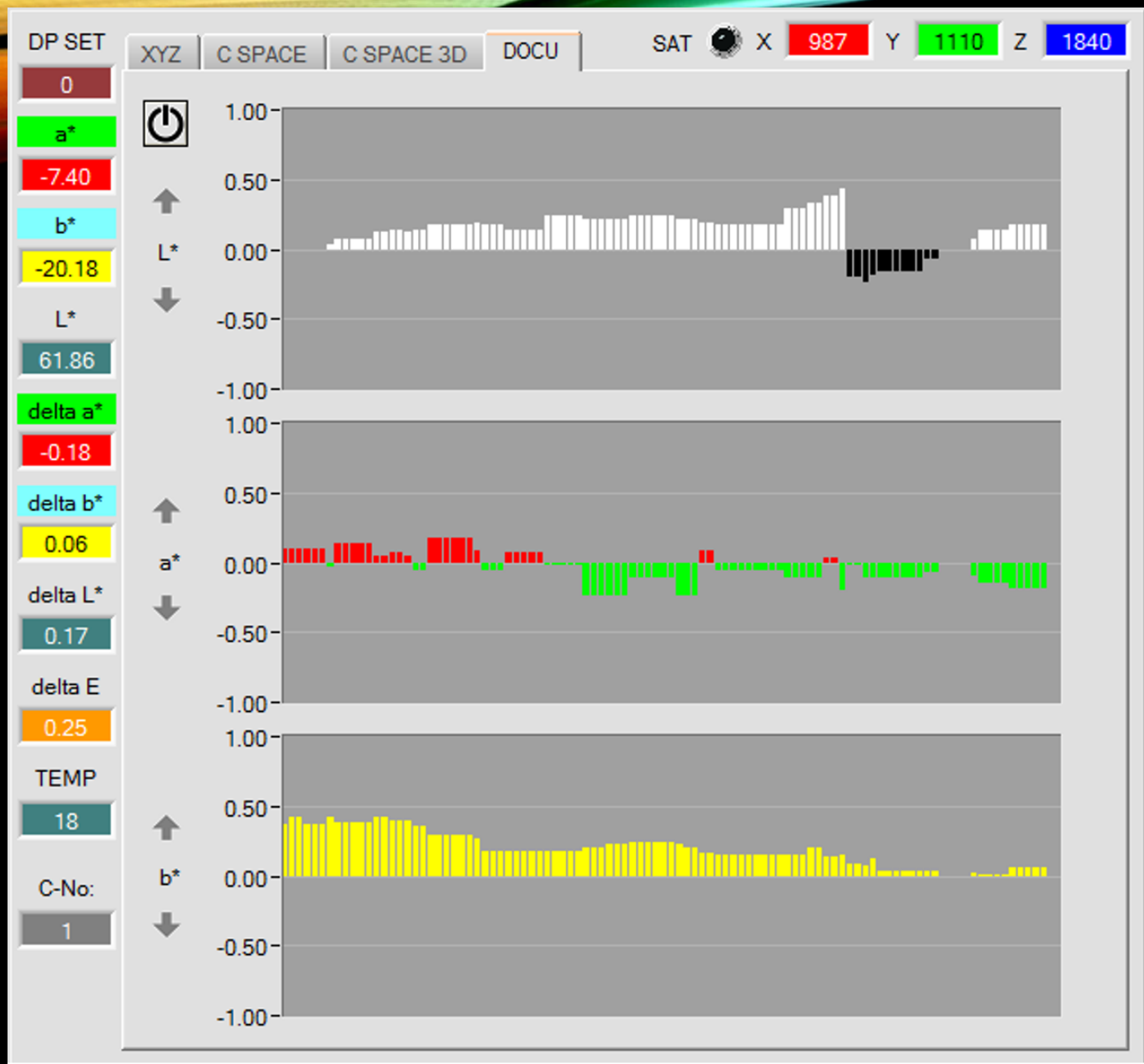| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | |
| 2 | Record results of: SPECTRO3 MSM DOCAL Scope V1.0 | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | DATE | TIME | X | Y | Z | L* | a* | b* | delta E | delta L* | delta a* | delta b* | COLOR | TEMP | |
| 5 | 12-25-2021 | 12:39:10 | 983 | 1103 | 1819 | 61.688 | -7.122 | -19.870 | 0.382 | 0.000 | 0.097 | 0.369 | | 1 | 18 |
| 6 | 12-25-2021 | 12:39:16 | 983 | 1103 | 1817 | 61.688 | -7.122 | -19.820 | 0.429 | 0.000 | 0.097 | 0.418 | | 1 | 18 |
| 7 | 12-25-2021 | 12:39:18 | 983 | 1103 | 1817 | 61.688 | -7.122 | -19.820 | 0.429 | 0.000 | 0.097 | 0.418 | | 1 | 18 |
| 8 | 12-25-2021 | 12:39:20 | 983 | 1103 | 1819 | 61.688 | -7.122 | -19.870 | 0.382 | 0.000 | 0.097 | 0.369 | | 1 | 18 |
| 9 | 12-25-2021 | 12:39:21 | 983 | 1103 | 1819 | 61.688 | -7.122 | -19.870 | 0.382 | 0.000 | 0.097 | 0.369 | | 1 | 18 |
| 10 | 12-25-2021 | 12:39:22 | 983 | 1103 | 1819 | 61.688 | -7.122 | -19.870 | 0.382 | 0.000 | 0.097 | 0.369 | | 1 | 18 |
| 11 | 12-25-2021 | 12:39:23 | 983 | 1104 | 1819 | 61.717 | -7.249 | -19.819 | 0.422 | 0.029 | -0.030 | 0.420 | | 1 | 18 |
| 12 | 12-25-2021 | 12:39:44 | 986 | 1106 | 1823 | 61.761 | -7.084 | -19.854 | 0.414 | 0.073 | 0.134 | 0.385 | | 1 | 18 |
| 13 | 12-25-2021 | 12:39:45 | 986 | 1106 | 1823 | 61.761 | -7.084 | -19.854 | 0.414 | 0.073 | 0.134 | 0.385 | | 1 | 18 |
| 14 | 12-25-2021 | 12:39:46 | 986 | 1106 | 1823 | 61.761 | -7.084 | -19.854 | 0.414 | 0.073 | 0.134 | 0.385 | | 1 | 18 |
| 15 | 12-25-2021 | 12:39:46 | 986 | 1106 | 1823 | 61.761 | -7.084 | -19.854 | 0.414 | 0.073 | 0.134 | 0.385 | | 1 | 18 |
| 16 | 12-25-2021 | 12:39:47 | 986 | 1106 | 1823 | 61.761 | -7.084 | -19.854 | 0.414 | 0.073 | 0.134 | 0.385 | | 1 | 18 |
| 17 | 12-25-2021 | 12:39:52 | 987 | 1108 | 1824 | 61.805 | -7.178 | -19.815 | 0.442 | 0.117 | 0.041 | 0.424 | | 1 | 18 |
| 18 | 12-25-2021 | 12:39:53 | 987 | 1108 | 1824 | 61.805 | -7.178 | -19.815 | 0.442 | 0.117 | 0.041 | 0.424 | | 1 | 18 |
| 19 | 12-25-2021 | 12:39:54 | 988 | 1109 | 1827 | 61.827 | -7.144 | -19.851 | 0.419 | 0.140 | 0.075 | 0.388 | | 1 | 18 |
| 20 | 12-25-2021 | 12:39:55 | 988 | 1109 | 1827 | 61.827 | -7.144 | -19.851 | 0.419 | 0.140 | 0.075 | 0.388 | | 1 | 18 |
| 21 | 12-25-2021 | 12:39:56 | 987 | 1108 | 1825 | 61.805 | -7.178 | -19.839 | 0.418 | 0.117 | 0.041 | 0.399 | | 1 | 18 |
| 22 | 12-25-2021 | 12:39:59 | 987 | 1109 | 1828 | 61.827 | -7.273 | -19.887 | 0.382 | 0.140 | -0.054 | 0.351 | | 1 | 18 |
| 23 | 12-25-2021 | 12:40:00 | 987 | 1109 | 1828 | 61.827 | -7.273 | -19.887 | 0.382 | 0.140 | -0.054 | 0.351 | | 1 | 18 |
| 24 | 12-25-2021 | 12:40:00 | 990 | 1110 | 1832 | 61.857 | -7.045 | -19.948 | 0.379 | 0.169 | 0.173 | 0.291 | | 1 | 18 |
| 25 | 12-25-2021 | 12:40:01 | 990 | 1110 | 1832 | 61.857 | -7.045 | -19.948 | 0.379 | 0.169 | 0.173 | 0.291 | | 1 | 18 |
| 26 | 12-25-2021 | 12:40:02 | 990 | 1110 | 1832 | 61.857 | -7.045 | -19.948 | 0.379 | 0.169 | 0.173 | 0.291 | | 1 | 18 |
| 27 | 12-25-2021 | 12:40:03 | 990 | 1110 | 1832 | 61.857 | -7.045 | -19.948 | 0.379 | 0.169 | 0.173 | 0.291 | | 1 | 18 |

RecordFile_PASTEL_BLUE_RECYCLAT

Bereit | 100 %

Open the file RecordFile_PASTEL_BLUE_RECYCLAT_038_II
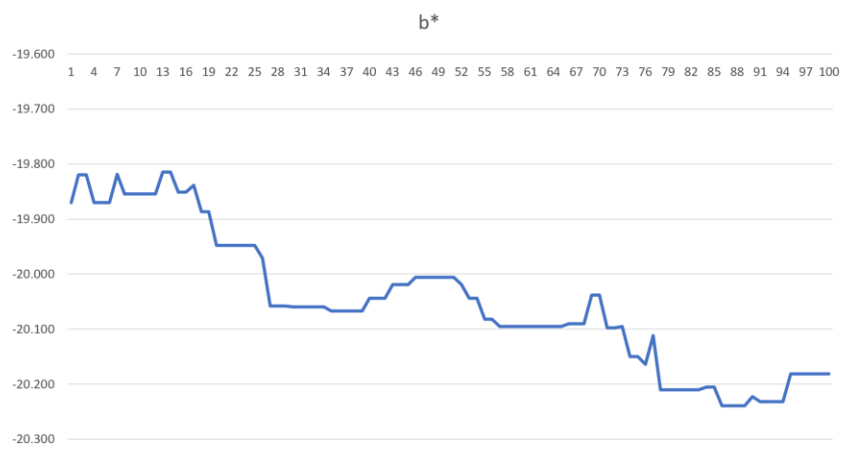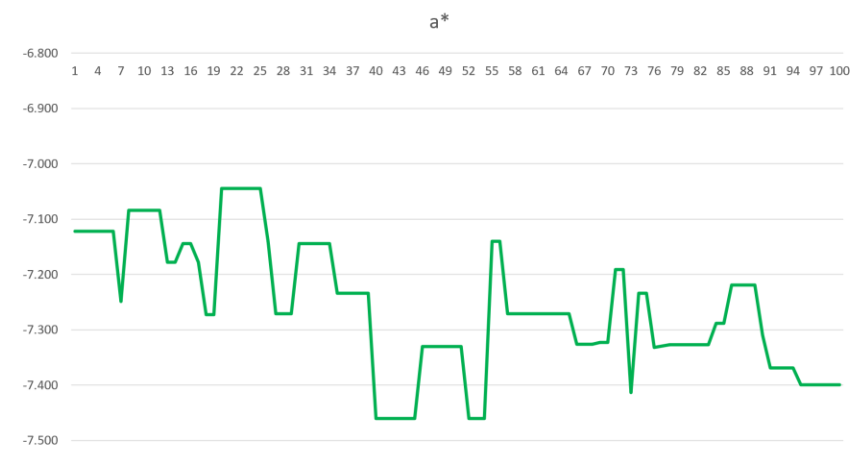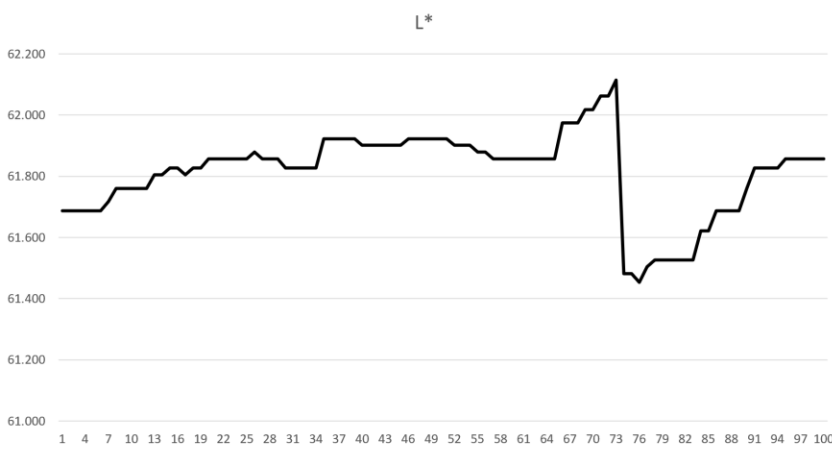
Graphic display of the measured 100 L*a*b* color values