Color Measurement of Recyclates

Seamless color measurement inline, mobile, and in the lab – based on the same measurement principle and the very same technology, using the 0°/45° color measurement system
SPECTRO-3-FIO-MSM-ANA-DL
in combination with the sensor frontend
KL-D-0°/45°-85-…-D-S-A3.0-VIS

Sensor Instruments
Let's make sensors more individual

Increasing use of recycled materials

The increased use of recyclates worldwide is of great importance for several reasons:

- **Environmental protection:** The use of recycled materials reduces the need for new raw materials, which in turn reduces the extraction of natural resources and the associated environmental damage.
- **Reducing waste:** Recyclates help to reduce the amount of plastic waste that ends up in landfills or in the environment.
- **Circular economy:** In a circular economy, materials are kept in the economic cycle for as long as possible.
- **Energy saving:** Manufacturing products from recycled materials requires less energy than production from new raw materials.
- **Legal requirements:** In many regions of the world, requirements are set for the use of recyclates with the aim of promoting sustainability and reducing environmental impact.

Achieving perfect color consistency – one of the major goals in modern plastics recycling

The goal of plastics recyclers is to achieve a quality level as close as possible to virgin material. One of the key criteria in this context is color. Detecting color deviations as precisely as possible – ideally inline during the production process – is therefore essential. Accurate inline color measurement of recyclates starts with selecting the right measurement location within the production process. Challenging conditions, such as high material temperatures, moving pellets, and elevated humidity require robust and high-performance sensor technology.

In addition to inline systems, mobile devices and laboratory systems based on the same measurement principle should also be available, enabling seamless comparability of measurement results across the entire process chain.

Plastics recycling

Throughout the plastics recycling process, numerous measures are taken to achieve the high-quality standards demanded by plastic processors.
The ultimate goal is to deliver recycled material with properties comparable to virgin resin. Today, recycling is increasingly evolving into true upcycling.

Color plays a crucial role in determining the quality and market acceptance of the recycled plastics. Despite sophisticated color-sorting processes – typically performed in two stages, first on whole objects and then on flakes – continuous quality control remains essential to ensure consistent color quality throughout the recycling process.

At the same time, the industry is increasingly exploring closed-loop color control directly at the extrusion stage. By combining dosing units with inline color measurement technology, it becomes possible to automatically compensate for color variations and maintain a consistent product appearance in real time.

Real-time color control of recyclates – both inline during production and in the lab

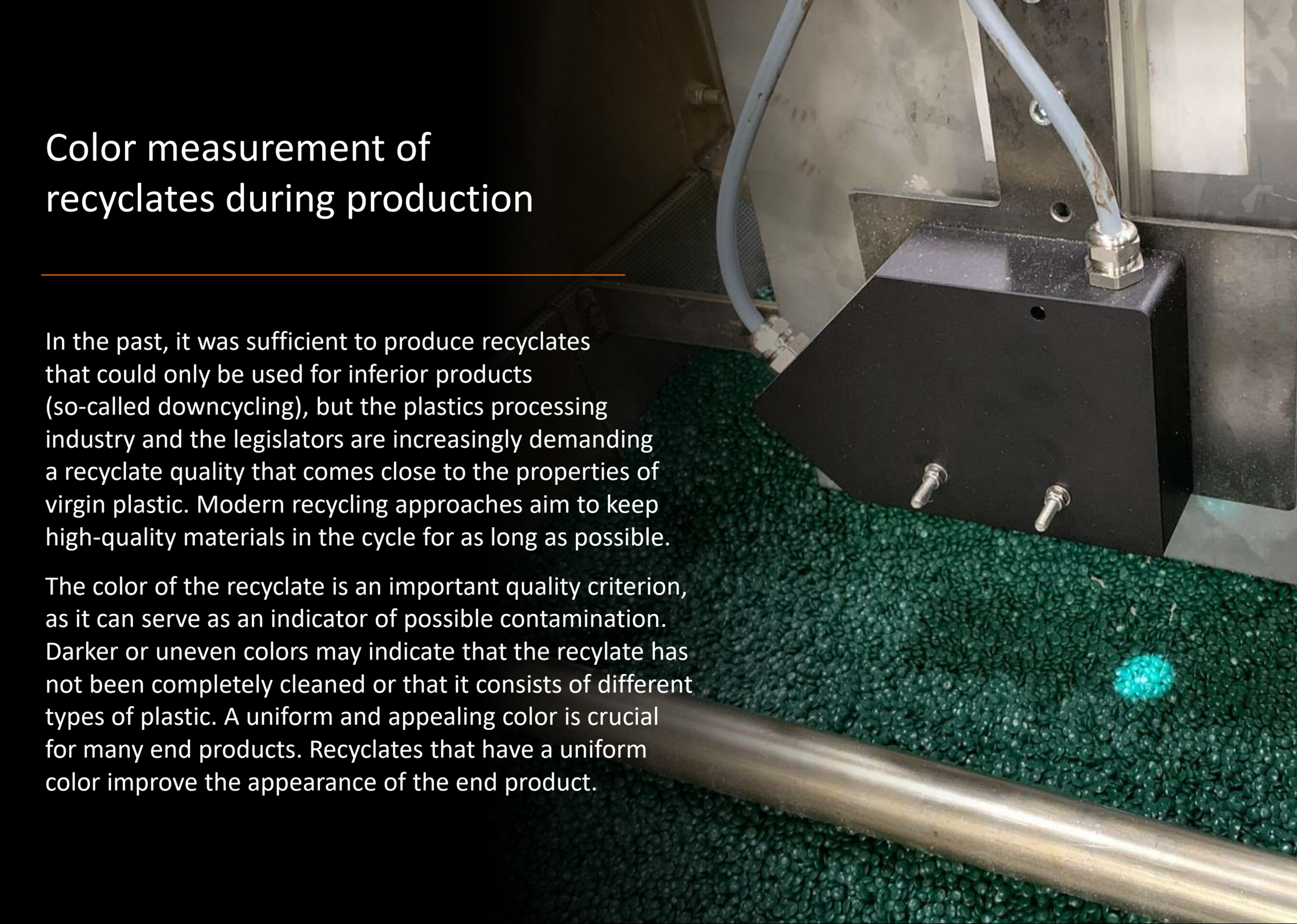
To enable a rapid assessment of the recyclate quality with regard to color, the measurement should be carried out immediatelly after pelletiting. The measurement can either be performed directly on the vibrating conveyor or through a sight glass at the silo. In addition, a sample can, of course, be taken from the ongoing production process and subsequently analyzed in the laboratory.

The measured values are displayed in the L*a*b* color space and compared with a predefined reference, allowing the determination of dL*, da*, db*, and dE values. To ensure full correlation between the inline measurements and the laboratory results, a calibration is performed in advance.

Color measurement of recyclates during production

In the past, it was sufficient to produce recyclates that could only be used for inferior products (so-called downcycling), but the plastics processing industry and the legislators are increasingly demanding a recyclate quality that comes close to the properties of virgin plastic. Modern recycling approaches aim to keep high-quality materials in the cycle for as long as possible.

The color of the recyclate is an important quality criterion, as it can serve as an indicator of possible contamination. Darker or uneven colors may indicate that the recylate has not been completely cleaned or that it consists of different types of plastic. A uniform and appealing color is crucial for many end products. Recyclates that have a uniform color improve the appearance of the end product.



Inline recyclate color measurement in a recycling plant

The first way which the color of recyclates can be measured is immediately after the extrusion process. The color sensor system is directed at the recyclate flow conveyed on a vibrating chute. Thanks to the robust design of the sensor system, reliable measurements can be made even at high recyclate temperatures, turbulently moving pellets and elevated humidity.

In addition, the color of the recyclate can also be monitored in the downstream dryer by means of a sight-glass measurement system.

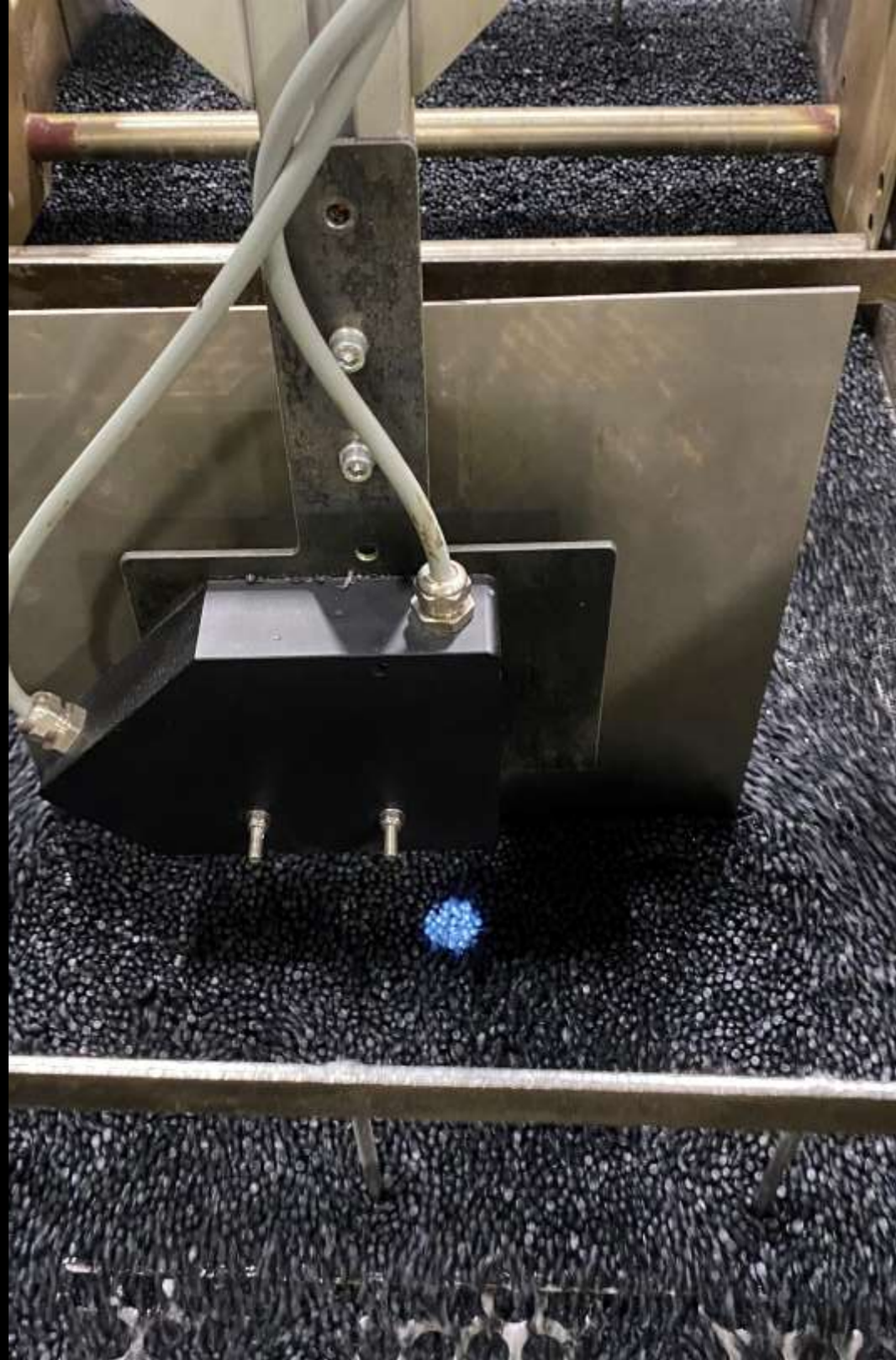
Inline color measurement at the vibratory drying system

The vibratory dryer is located directly downstream of the recyclate pelletizing process. At the rear end of the vibratory conveyor, the pellets are already dry enough to perform inline color measurement. However, it must be taken into account that the material is transported rather turbulantly along the vibratory conveyor and that varying material flow heights have to be expected.

Several measures can be implemented to overcome these technical challenges. First of all, a guide plate is used to reduce the material flow to a defined height directly atthe measurement position. This height is selected to match the 85 mm working distance of the sensor frontend KL-D-0°/45°-85-2000-A3.0. The random orientation of the pellets during measurement and the resulting intensity fluctuations can be compensated for in several ways. First, the optical measurement is performed over a larger number of pellets by using a light spot with a diameter of approximately 20 mm. Secondly, the measured values are averaged over an adjustable period of time. Due to the forward movement of the pellets, averaging can therefore be carried out over a length of, for example, 1000 mm (with a width of 20 mm).

The required system components:

KL-D-0°/45°-85-2000-A3.0-VIS (the optical measurement frontend)
SPECTRO-3-FIO-MSM-ANA-DL (the color measurement unit)
SI-PPC-500-15“ (the monitoring system)



KL-D-0°/45°-85-2000-A3.0-VIS + SPECTRO-3-FIO-MSM-ANA-DL

- Color space L*a*b*
- 0°/45°- measurement geometry
- 85 mm distance to the object
- Color accuracy: dE = 0.3
- RS232 (USB-, Ethernet-, and Profinet - Adapter)
- Connection to the monitoring unit SI-PPC-500-15"
- Frontend IP67
- Black anodized housing

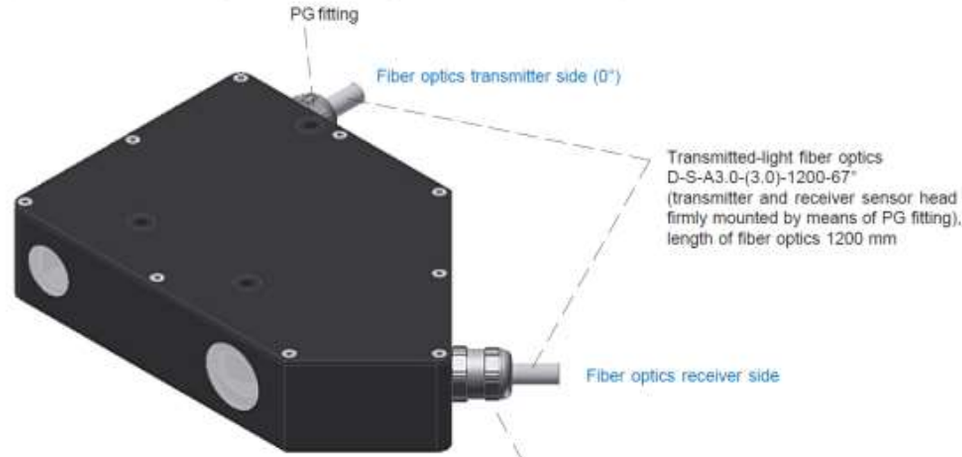
Connection to PLC:
8-pole fem. connector Binder series 712

Pin:	Color:	Assignment:
1	white	GND (0V)
2	brown	+24VDC (±10%)
3	green	IN0 (Digital 0: 0 ... 1V, Digital 1: +Ub - 10%)
4	yellow	OUT0 (Digital 0: 0 ... 1V, Digital 1: +Ub - 10%)
5	grey	OUT1 (Digital 0: 0 ... 1V, Digital 1: +Ub - 10%)
6	pink or black	OUT2 X, x, a*, u*, u' or C* (Analog: 0 ... +10V or 4 ... 20mA)
7	blue	OUT3 Y, y, b*, v*, v' or h* (Analog: 0 ... +10V or 4 ... 20mA)
8	red	OUT4 Z, Y or L* (Analog: 0 ... +10V or 4 ... 20mA)

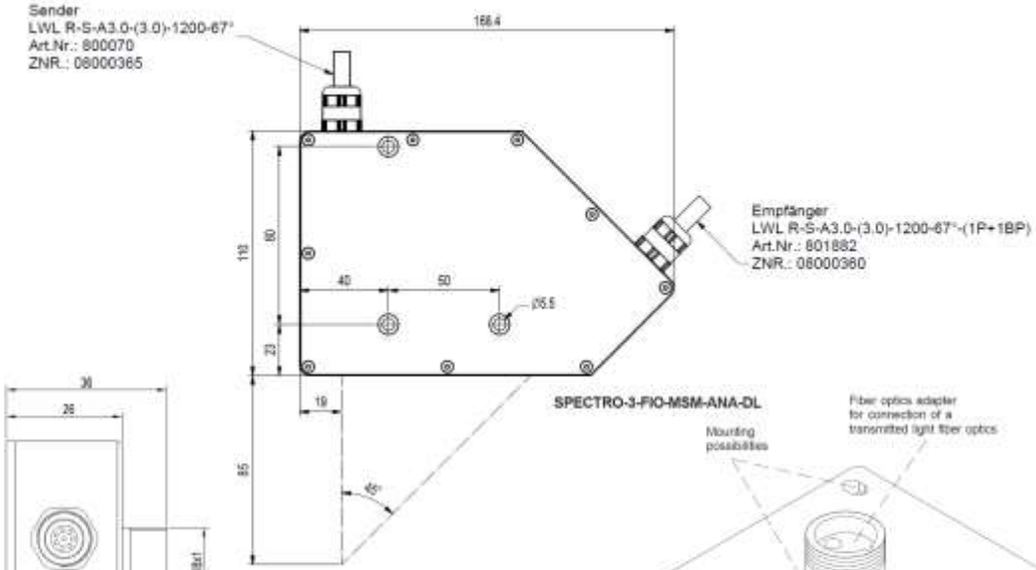
Connection to PC:
4-pole fem. connector Binder Series 707

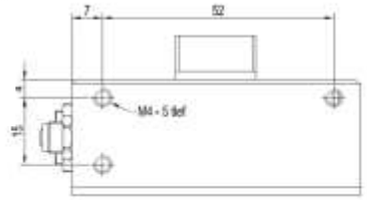
Pin:	Assignment:
1	+24VDC (+Ub, OUT)
2	GND (0V)
3	RxD
4	TxD

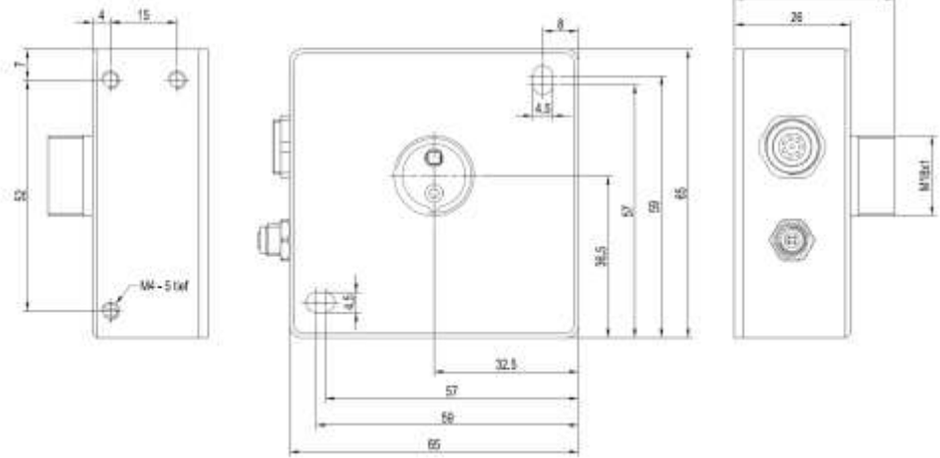
KL-D-0°/45°-85-1200-D-S-A3.0-VIS
Optical frontend with integrated transmitted-light fiber optics D-S-A3.0-(3.0)-1200-67°



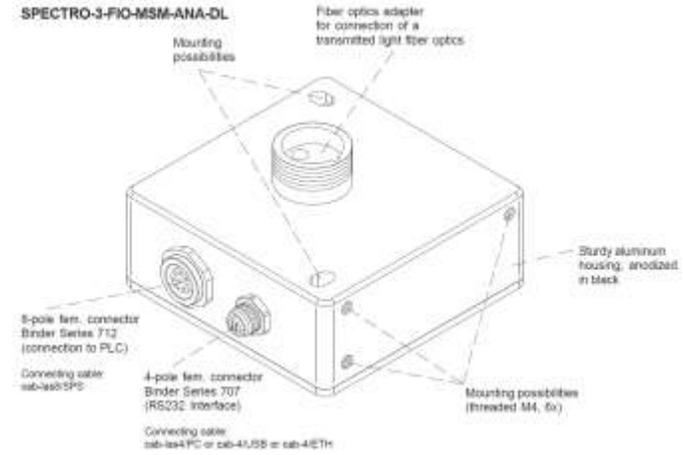
KL-D-0°/45°-85-1200-D-S-A3.0-VIS







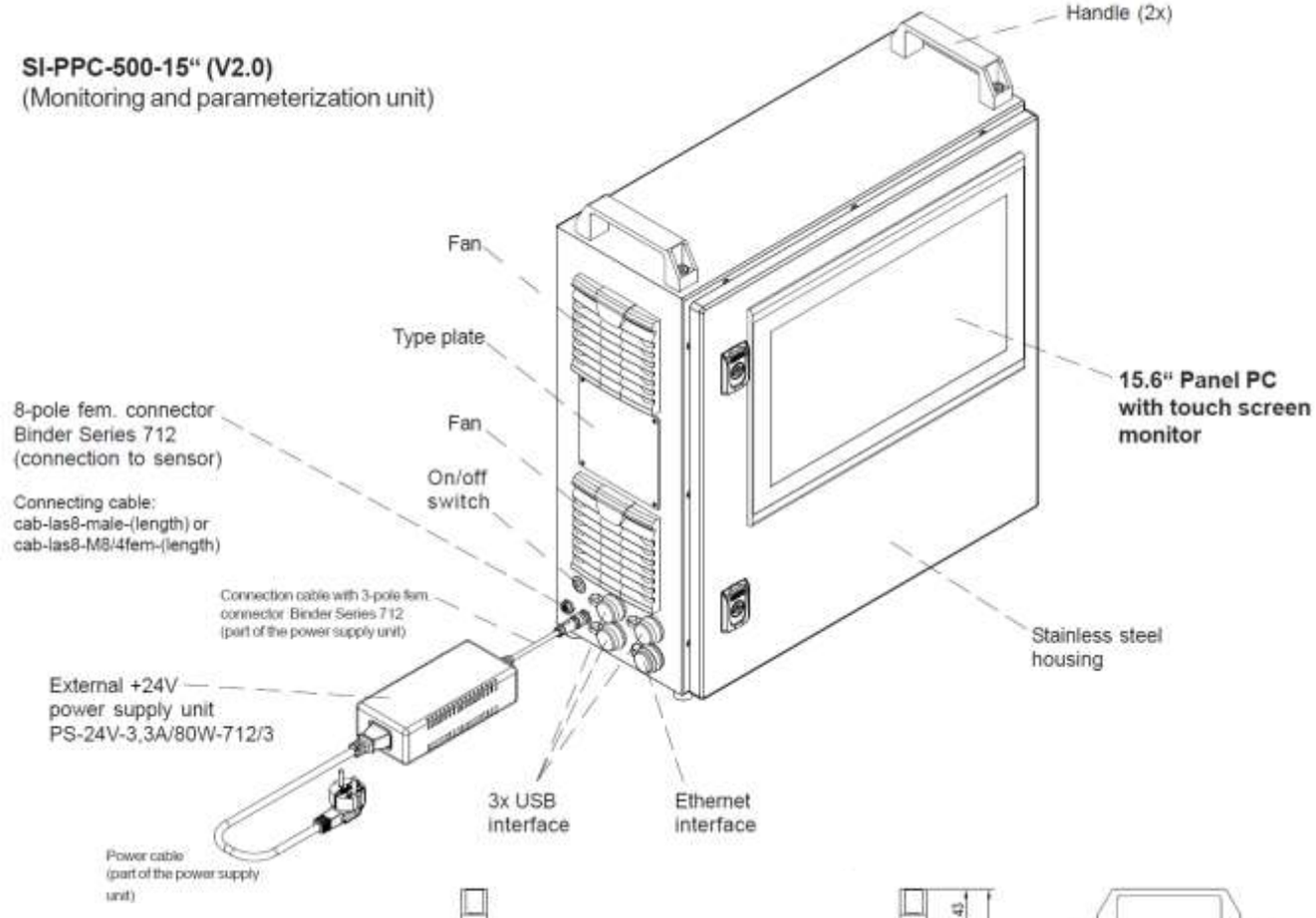
SPECTRO-3-FIO-MSM-ANA-DL

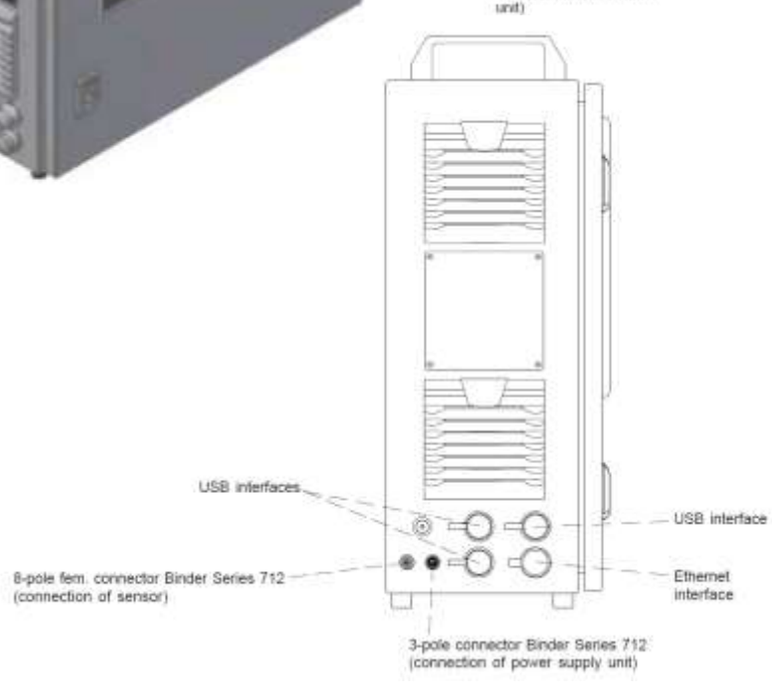


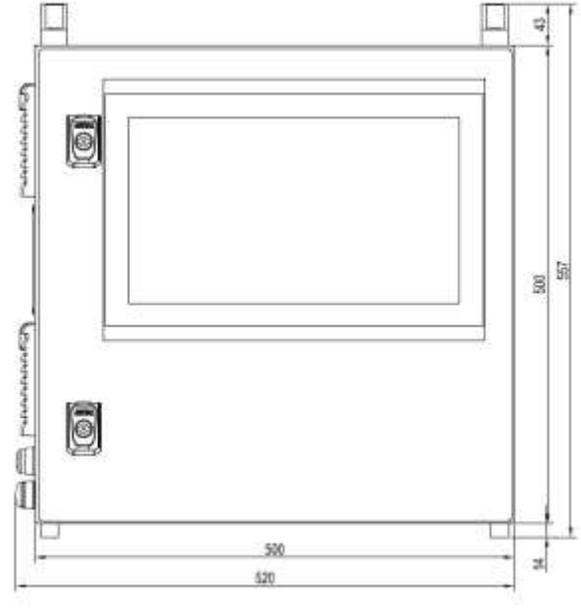
SI-PPC-500-15“

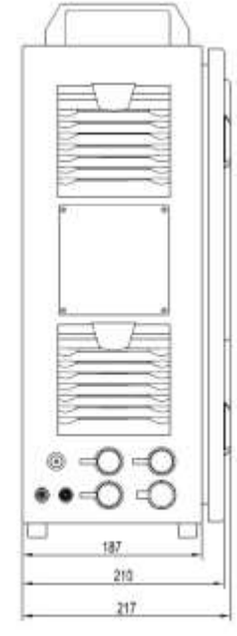
- 15.6" - Monitor
- Stainless-Steel housing
- +24V - Power Supply
- USB - Interface
- Ethernet - Interface
- I/O - Interface

SI-PPC-500-15“ (V2.0)
(Monitoring and parameterization unit)









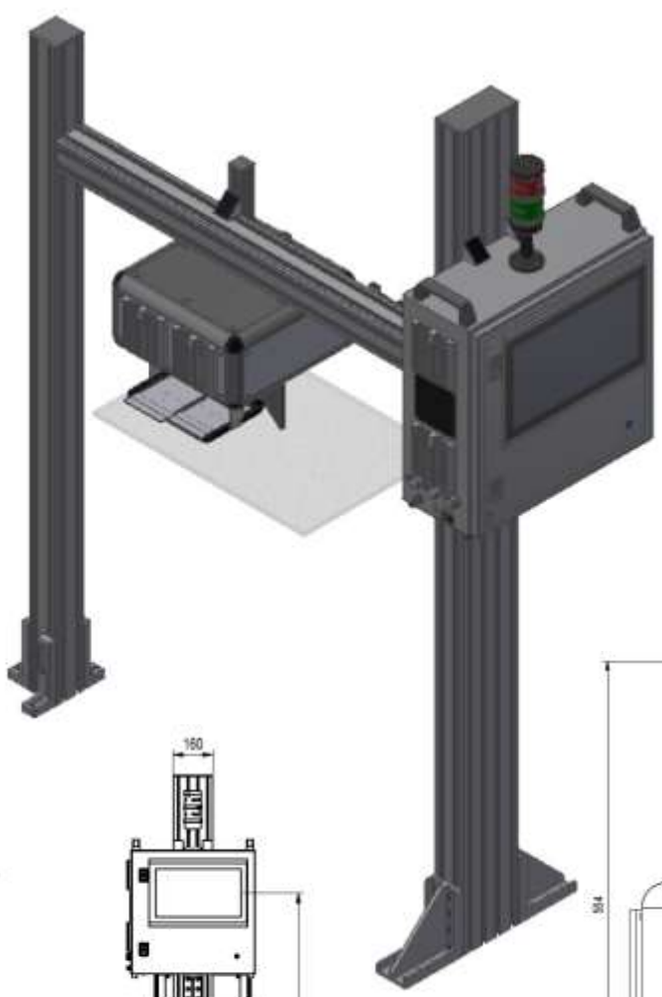
Inline color measurement system featuring additional sensors for distance control, temperature monitoring, contamination detection, and polymer type identification

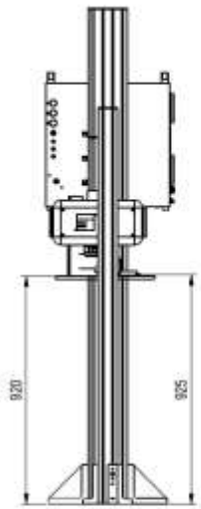
An enhanced measurement system that can also be installed at the vibratory dryer is a combination of a color measurement system and a polymer type identification system operating in the NIR range. In addition, a laser distance sensor provides information about the current material flow height, making it possible to detect whether a material buildup is occuring (for example due to a clogged screen causing the material to overflow into the waste channel) or whether insufficient material is being supplied from upstream in the process. In both cases, neither the color sensor nor the NIR sensor can deliver reliable measurement values. The pellet fow height monitoring system therefore informs the operator at the right time to check the screen or to verify whether there is an issue with the pelletizing process.
To prevent unacceptable contamination of the measurement system optics, a contamination sensor has been integrated into the system. This sensor alerts the operator in good time whenever contamination of the optics is detected. In additon, a non-contact temperature sensor provides information about the temperature of the pellet flow, which is also important for accurate color determination. By means of a monitoring unit, the data is presented to the operator in a clear and user-friendly manner. Furthermore, the system can be connected to the data network via Ethernet.

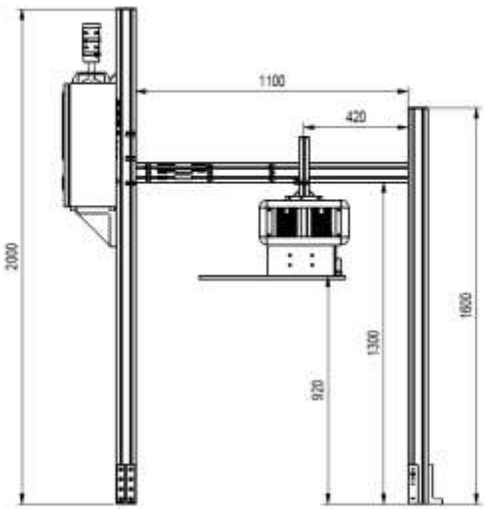
The required system: **NIRCOL-SYS-85**

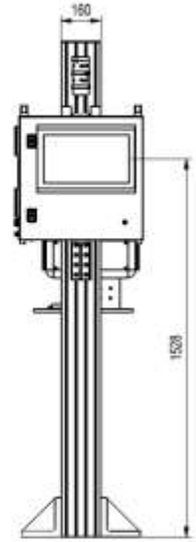
NIRCOL-SYS-85

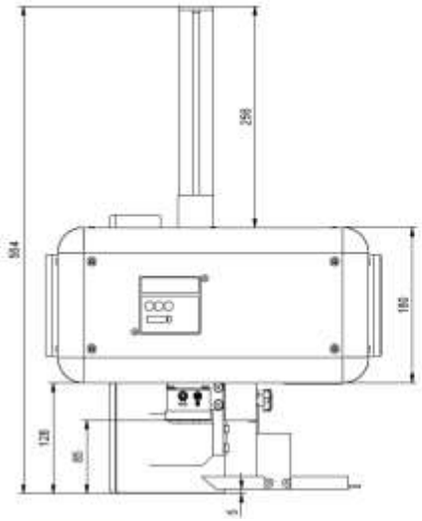
- Color Measurement L*a*b* (dE = 0.3)
- NIR Measurement N*i*r* (dNir = 0.3)
- Temperature Measurement
- Contamination Measurement
- Pellet Stream Height Measurement
- Material Build-Up Alarm caused by Screen Blockage
- Warning Beacon
- USB-A Interface
- Ethernet Interface

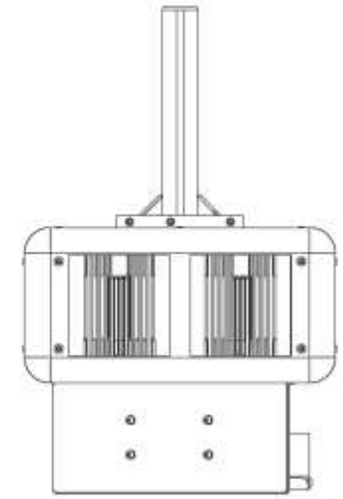


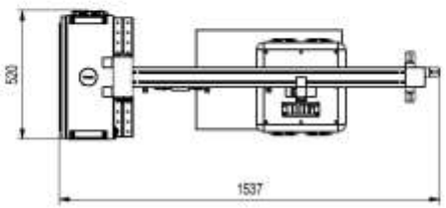




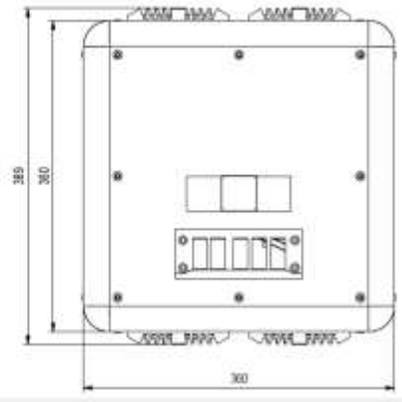




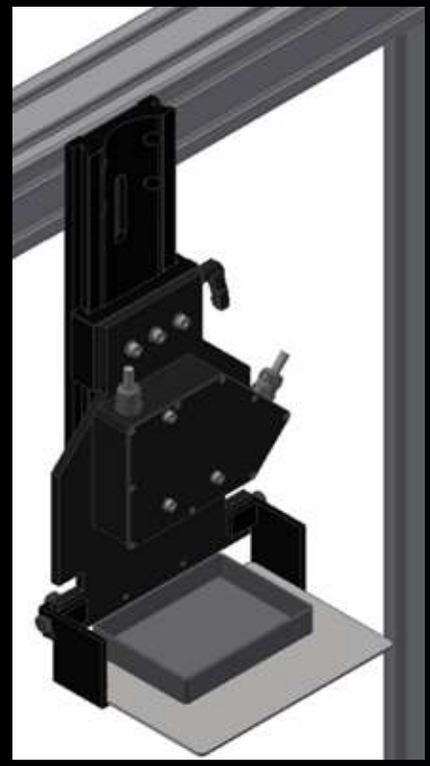




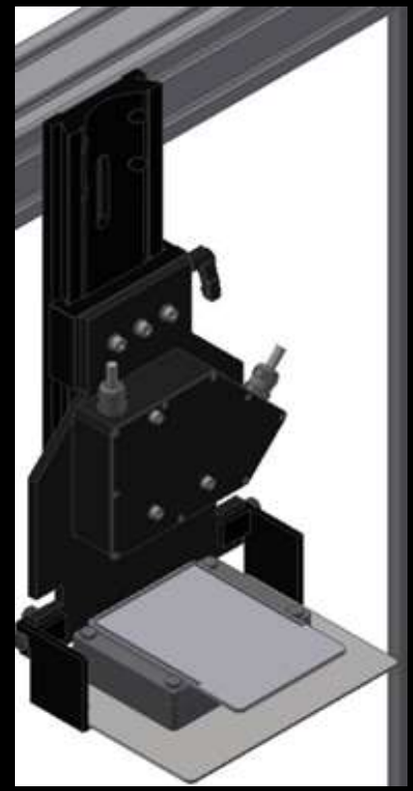
Interface to the Sensor Frontend



The compact inline color measurement system COL-SYS-85-CL for the vibrating



The COL-SYS-85-CL system is a simplified inline version designed exclusively for color measurement. Here as well, the pellet stream height required for acurate measurement is defined by means of a flat plate acting as a pellet shield. Calibration is performed directly on the height-regulated pellet stream. For this purpose, the operator software provides a dedicated calibration function. The operator is guided step-by-step through the entire calibration procedure, for example indicating when a sample must be taken for laboratory measurement. In addition, the system calculates an average color value during the predefined calibration period.

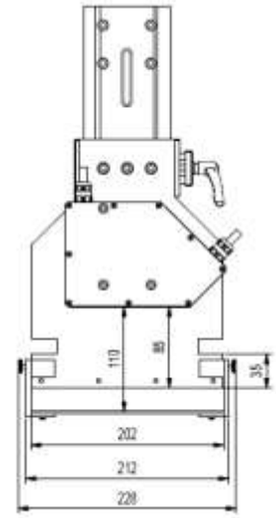


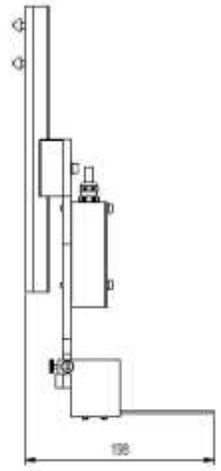
The white balance of the color measurement system is also carried out directly on the production line. For this, only a mounting plate for the RAL reference card needs to be installed.

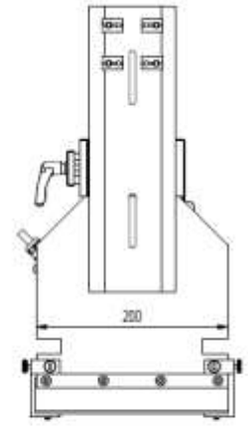
Furthermore, the system also allows reference samples to be taught in directly. In this case, the reference granulate is placed into a tray, which is then positioned onto the mounting plate. The TEACH procedure is then started, while the tray is moved underneath the light spot in a figure-eight pattern. Afterwards, the holder can be removed again, and the measurement system continuously displays the deviations in dL*, da*, db*, as well as the dE value relative to the taught reference.

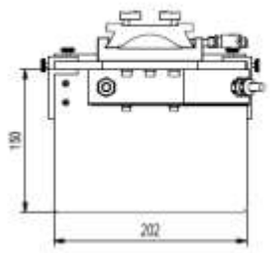
COL-SYS-85-CL

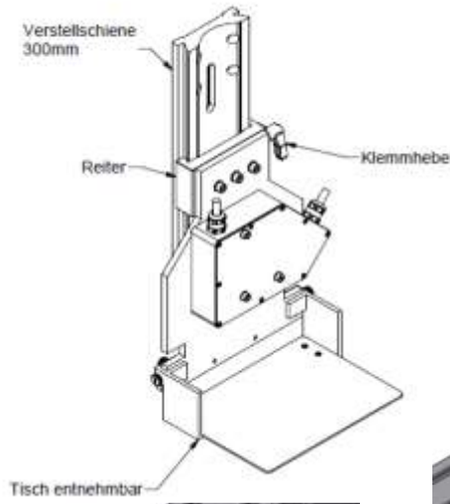
- Color Measurement L*a*b* (dE = 0.3)
- Warning Beacon
- USB-A Interface
- Ethernet Interface
- Sample Tray Holder
- Inline Calibration with Pellet Samples
- Inline Calibration using Plastic Reference Cards

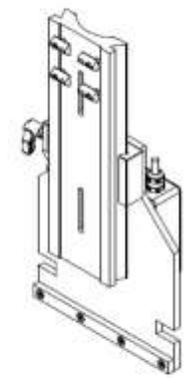


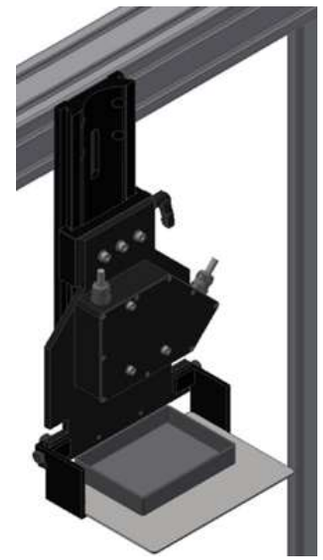


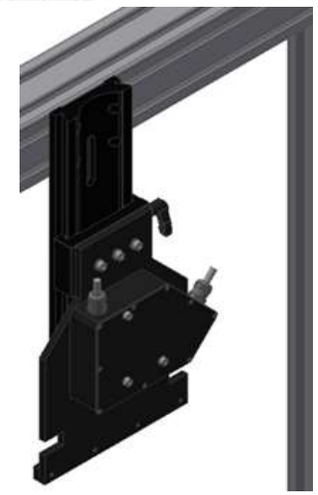


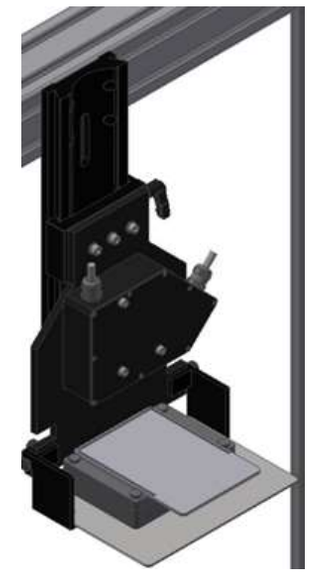










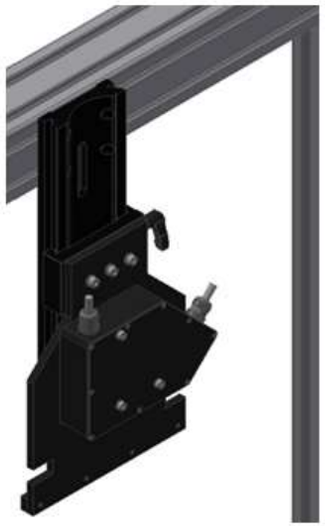


Calibration of the inline color sensor system COL-SYS-85-CL on site

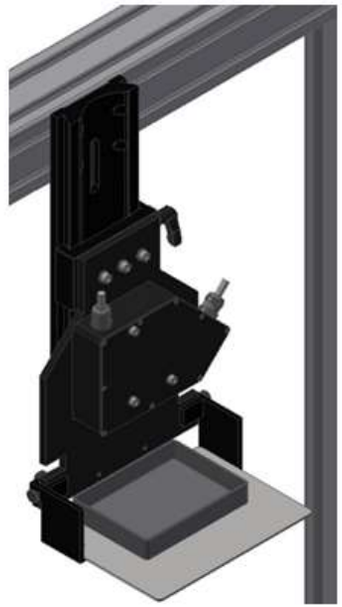
Calibration of the inline color sensor is extremely simple and does not require the system to be dismantled. A white plastic card (RAL) only needs to be placed in front of the sensor system at the prescribed distance for the white balance.

Calibration (UCAL) to the respective product is carried out using recycled material and the measurement data from the laboratory. After a one-off calibration to the respective recyclate type, the calibration data can be easily imported from the respective file.

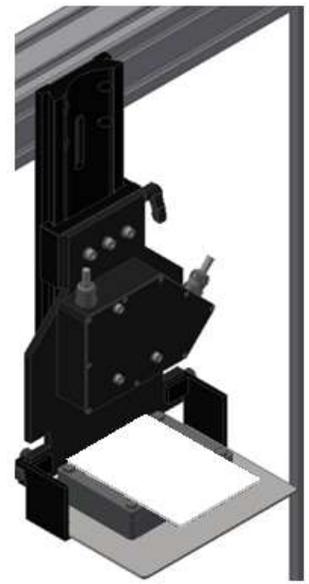
Option 1: Sensor System Calibration for the Current Pellet Production based on Laboratory-Measured L*a*b* Values



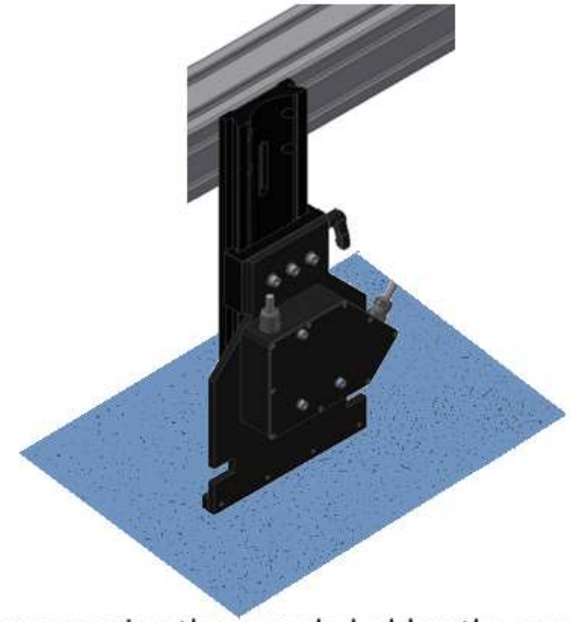
Sensor Frontend without Sample Holder



Sensor Frontend with Sample Holder and Tray

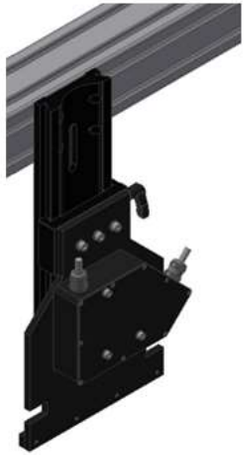


Sensor Frontend with Sample Holder, Tray, Distance Holder and White RAL Plastic Card for White Calibration

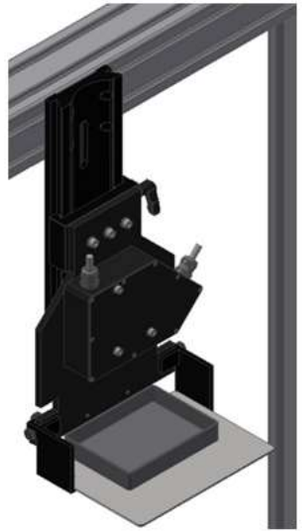


After removing the sample holder, the sensor frontend can be repositioned into the pellet stream using the linear guide. An inline calibration based on the current recyclate can then be initiated. At the same time, a reprersentative recyclate sample is taken and measured using laboratory color measurement device. The resulting L*a*b* values are subsequently transferred to the inline color measurement system, ensuring excellent correlation between inlinde and laboratory measurements.

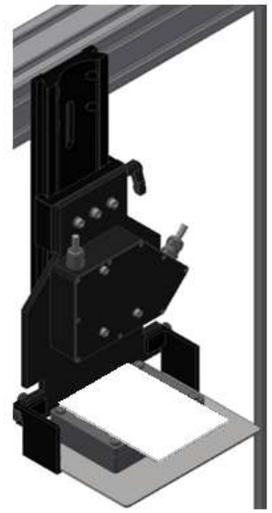
Option 2: White Calibration and Teaching-In of a Recyclate Rreference



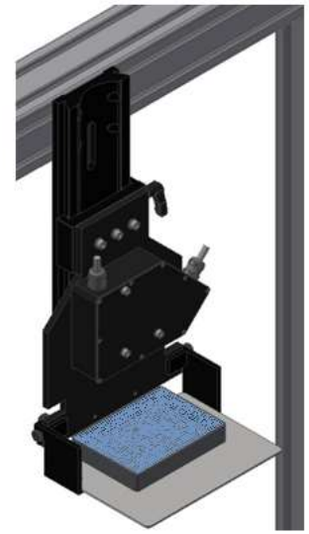
Sensor Frontend without Sample Holder



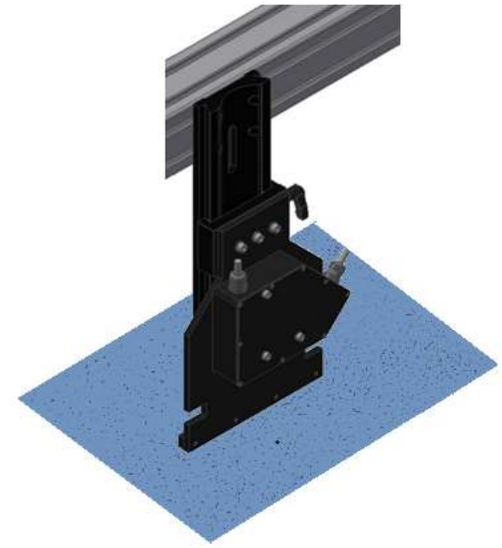
Sensor Frontend with Sample Holder and Tray



Sensor Frontend with Sample Holder, Tray, Distance Holder and White RAL Plastic Card for White Calibration



Sensor Frontend with Sample Holder and Reference Sample in the Tray.
The L*a*b* color values of the reference measured by the sensor are stored in a table together with user-defineable tolerance limits. During inline color measurement, the current color values are continuously compared with the stored reference values. The ultimate goal is to produce recyclate with color characteristics that match the reference as closely as possible, ensuring consistent and reproducible product quality.



Sensor Frontend in Measurement Position:
First, the sample holder must be removed and the shield inserted into the product stream. During this procedure, the sensor-to-product-surface distance remains fixed at 85 mm.
The sensor system is now ready to perform inline color measurements. The objective is to achieve color values during pellet production that are identical to those of the reference, ensuring consistent and reproducible product quality.

Inline color measurement of pellets through a sight glass mounted on a pellet dryer

The color of plastic pellets can be measured inline through a sight glass mounted directly on the pellet dryer. This non-contact measurement approach enables continuous monitoring of the pellet color during the production process without interfering with the material flow.

An optical measurement system positioned outside the dryer detects the moving pellets through the sight glass under defined illumination and observation conditions. The measured color values are typically output in the L*a*b* color space and can be continuously compared with stored reference values.
As a result, deviations such as dL*, da*, db*, and dE can be detected immediately and reliably.

This measurement principle is particularly suitable for harsh industrial environments with elevated temperatures and moving pellets, where direct sensor installation inside the process would be difficult.

By integrating the system into a monitoring unit, operators receive a clear real-time overview of the granulate color quality and can react quickly to process fluctuations or quality deviations.

The required system:

SPECTRO-3-0°/45°-MSM-INLINE-ANA
SI-PPC-500-15“

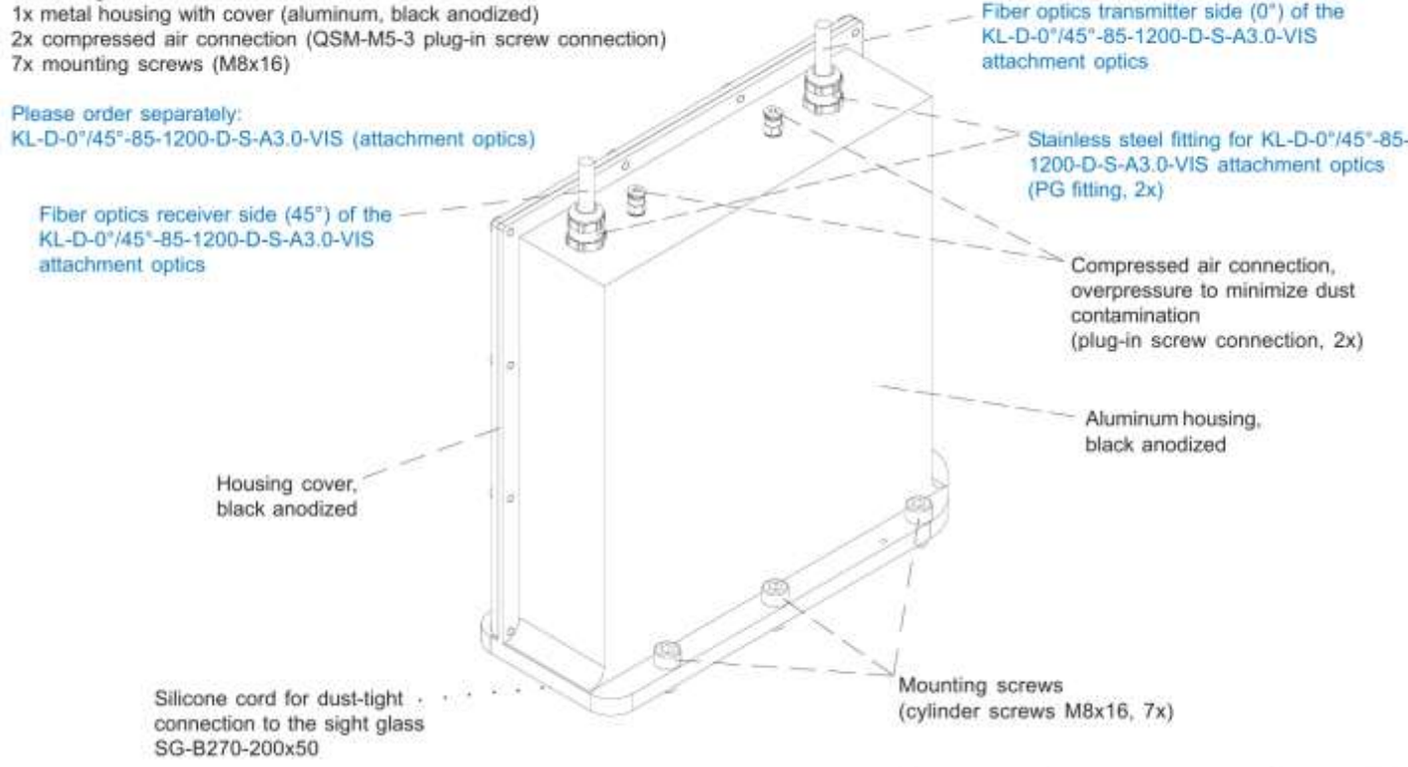
SPECTRO-3-0°/45°-MSM-INLINE-ANA

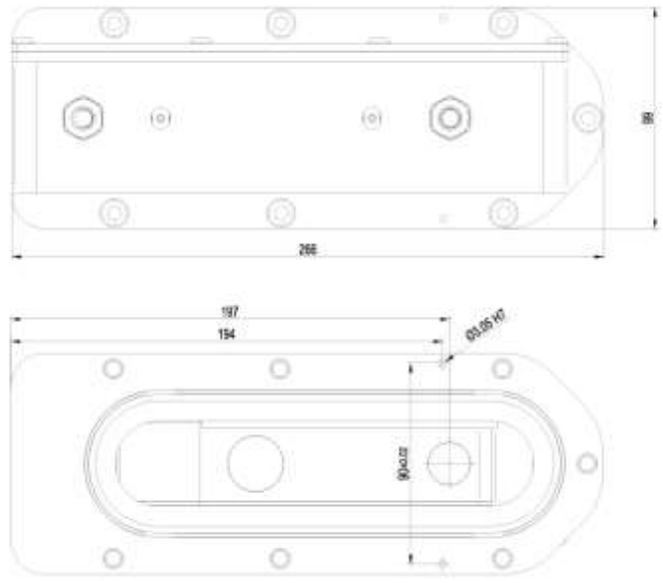
- Reliable Inline Color Measurement through a Sight Glass
- Non-contact Inline Monitoring of the Recyclate
- Inline Color Monitoring in Silos and Dryers, also at elevated Temperatures
- Fully compatible with the SI-PPC-500-15" Monitoring and Evaluation Unit
- Fault Indication via a Signal Beacon (SI-PPC-500-15")
- High Color-Measurement Accuracy (dE = 0.3)
- I/O - Interface (SI-PPC-500-15")
- Ethernet and USB Connectivity for Process Monitoring and Data Logging (SI-PPC-500-15")

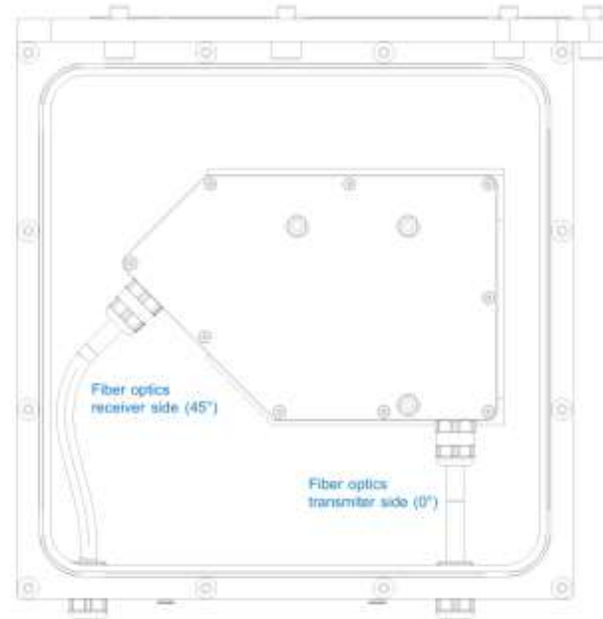
KL-D-0°/45°-85-OH (integration housing)

consisting of:
1x metal housing with cover (aluminum, black anodized)
2x compressed air connection (QSM-M5-3 plug-in screw connection)
7x mounting screws (M8x16)

Please order separately:
KL-D-0°/45°-85-1200-D-S-A3.0-VIS (attachment optics)

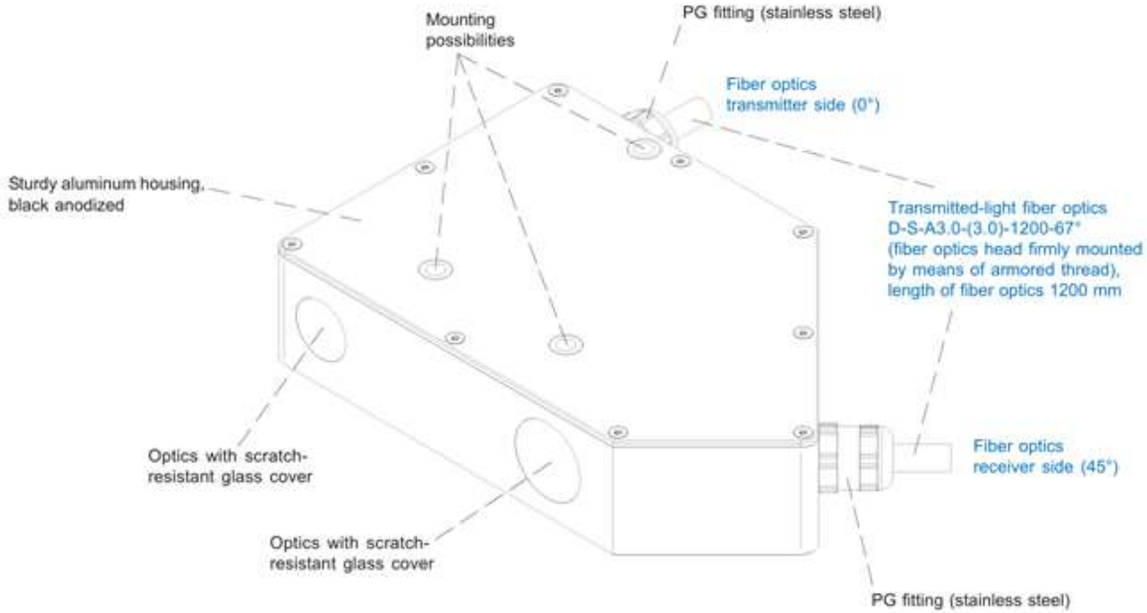


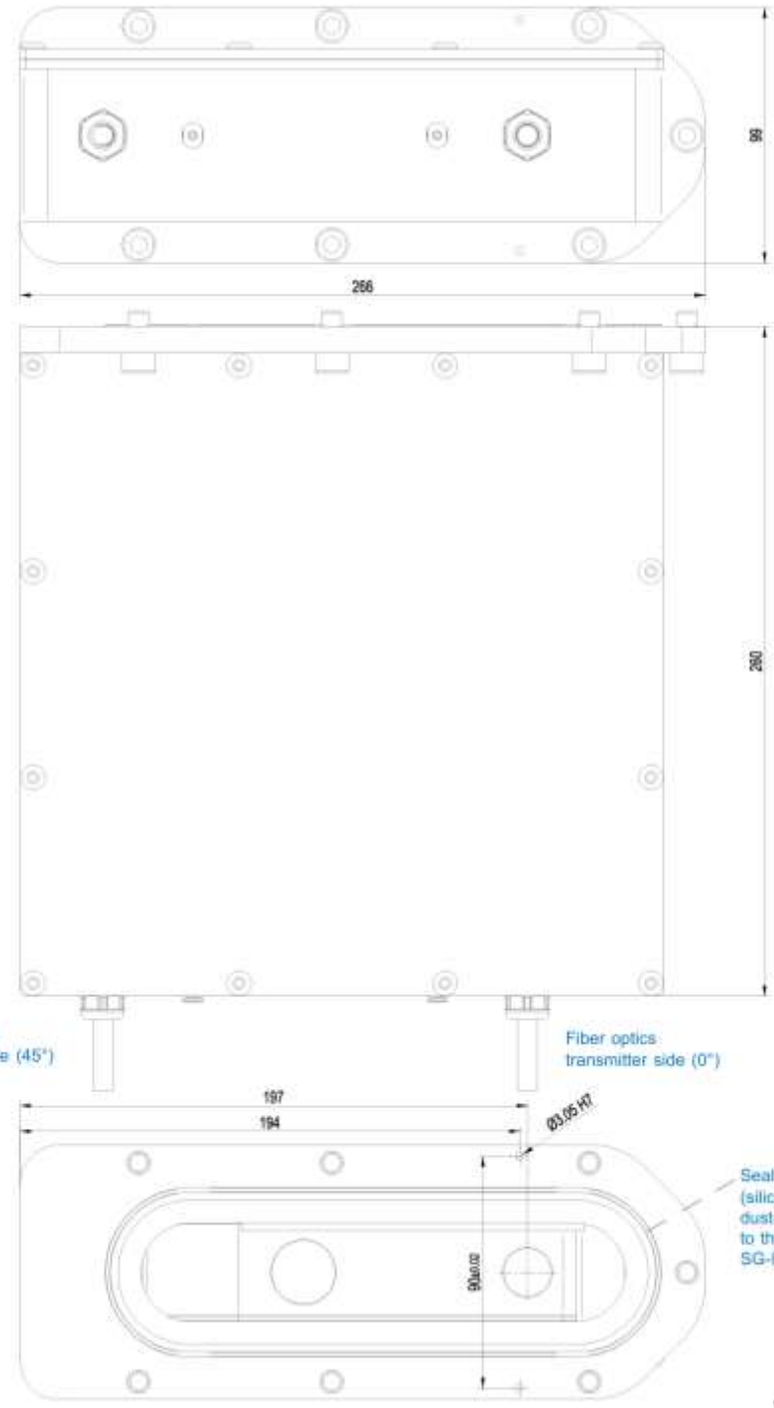




SPECTRO-3-0°/45°-MSM-INLINE-ANA

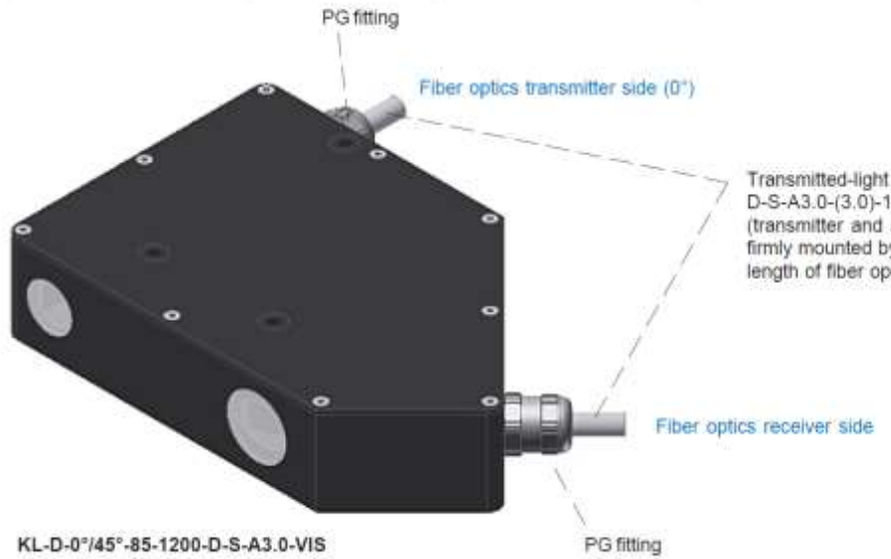
KL-D-0°/45°-85-OH





KL-D-0°/45°-85-1200-D-S-A3.0-VIS

Optical frontend with integrated transmitted-light fiber optics D-S-A3.0-(3.0)-1200-67°



KL-D-0°/45°-85-1200-D-S-A3.0-VIS

Calibration of the inline color measurement system SPECTRO-3-0°/45°-MSM-INLINE-ANA

Since the inline color measurement device SPECTRO-3-0°/45°-MSM-INLINE-ANA measures the target object through a sight glass, a sight glass must also be used during the calibration process. For this purpose, the frontend of the inline measuring device is removed from the production line and placed onto the CALIB-0°/45° calibration unit.

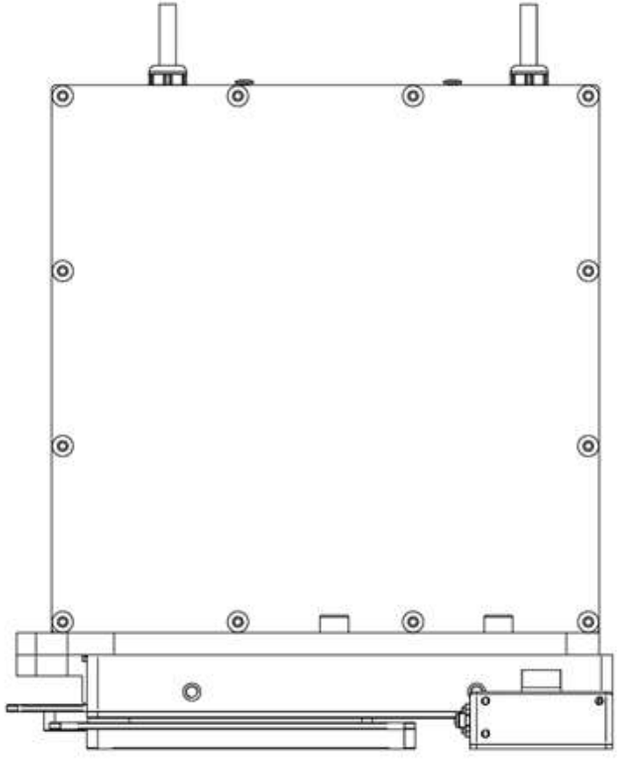
In combination with the calibration unit, RAL cards can then be used for the white balance adjustment (for example, a RAL 9010 card and for calibration of the colors to be measured (either standard RAL cards or customer-specific plastic reference cards or even granulates with a known L*a*b* value).

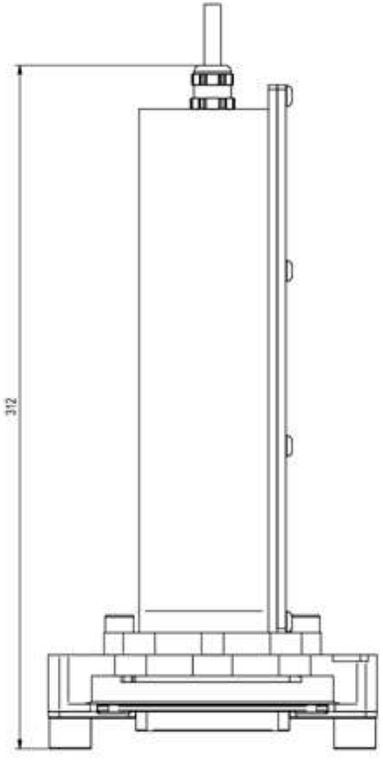
The calibration itself is carried out using the DOCAL software in combination with a calibration wizard. After successful completion of the calibration procedure, the calibration data are stored in a calibration file.

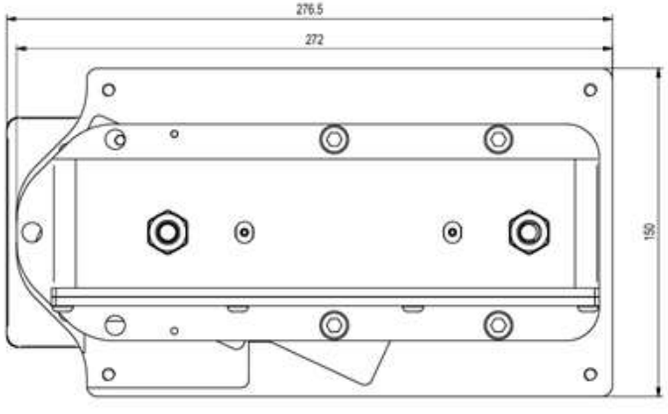
Finally, the frontend can be reinstalled on the production line.

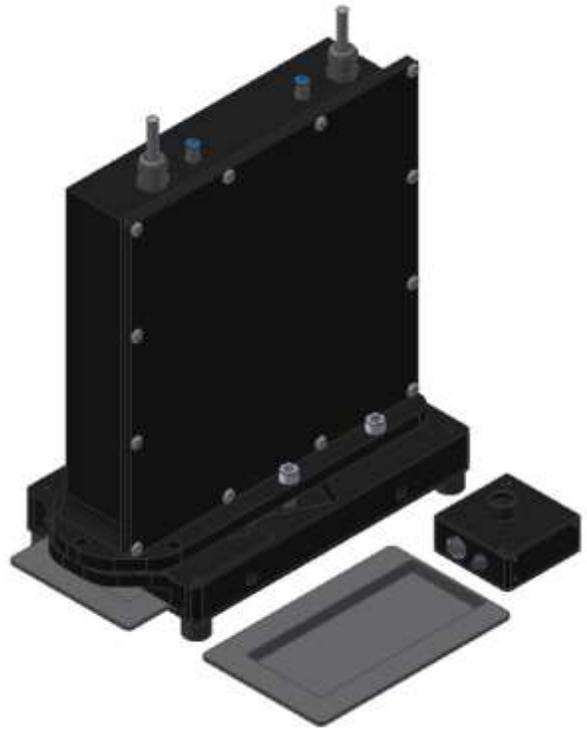
SPECTRO-3-0°/45°-MSM-CMU

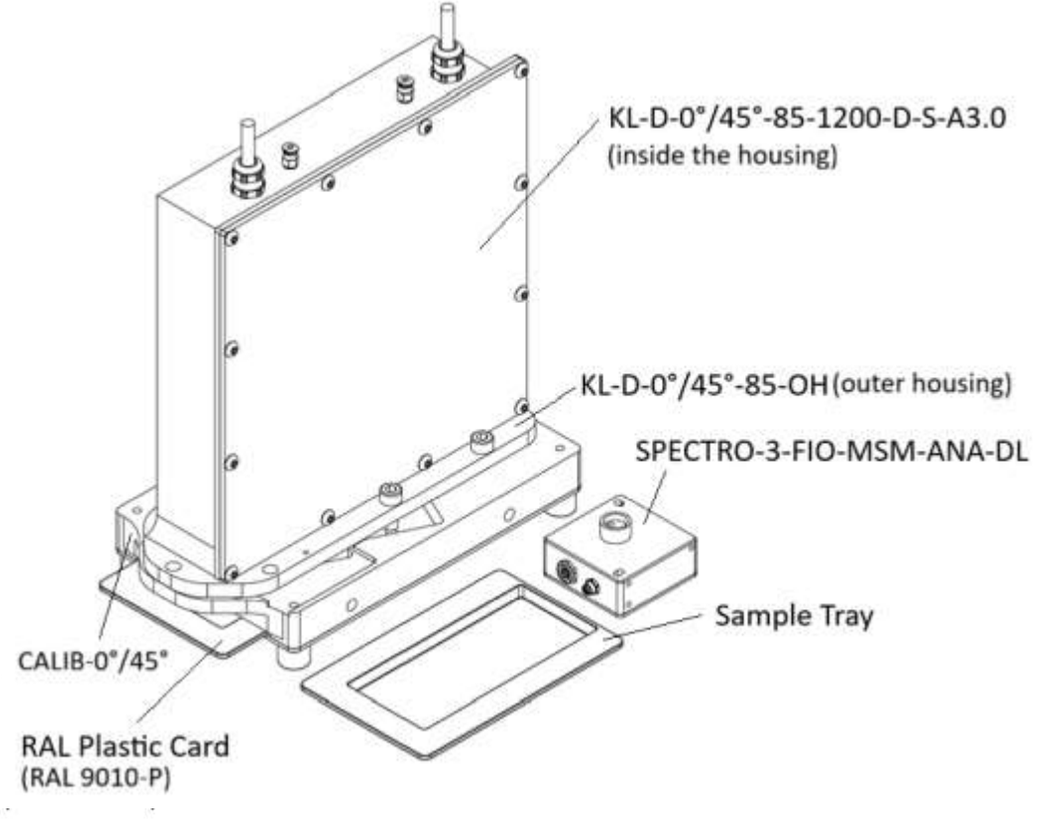
- The CALIB-0°/45° - unit can be used for calibrating the SPECTRO-3-0°/45°-MSM-INLINE-ANA - System
- RAL Plastic Card for White Reference Calibration
- The Sample Tray can be used for Reference Pellets











Stabilization of the pellet color by controlling the dosing of additives at the dosing units directly upstream of the extruder

Volumetric dosing units can be controlled relatively easily by external signals (0V to 10V or 4mA to 20mA). An electric motor drives the feeder screw of the dosing unit, whereby 0V corresponds to a standstill of the screw and 10V represents the maximum dosing rate.

For each type of plastic pellet to be produced, a specific recipe is typically defined, specifying the required amount of the respective masterbatch or additive in order to achieve the desired color. In most cases, four dosing units upstream of the extruder are required to adjust the color of recycled materials.

Today, the dosing quantities are usually determined empirically by the operator. During production, the operator must also continuously react to fluctuations in the flake stream and manually fine-tune the dosing rates accordingly.

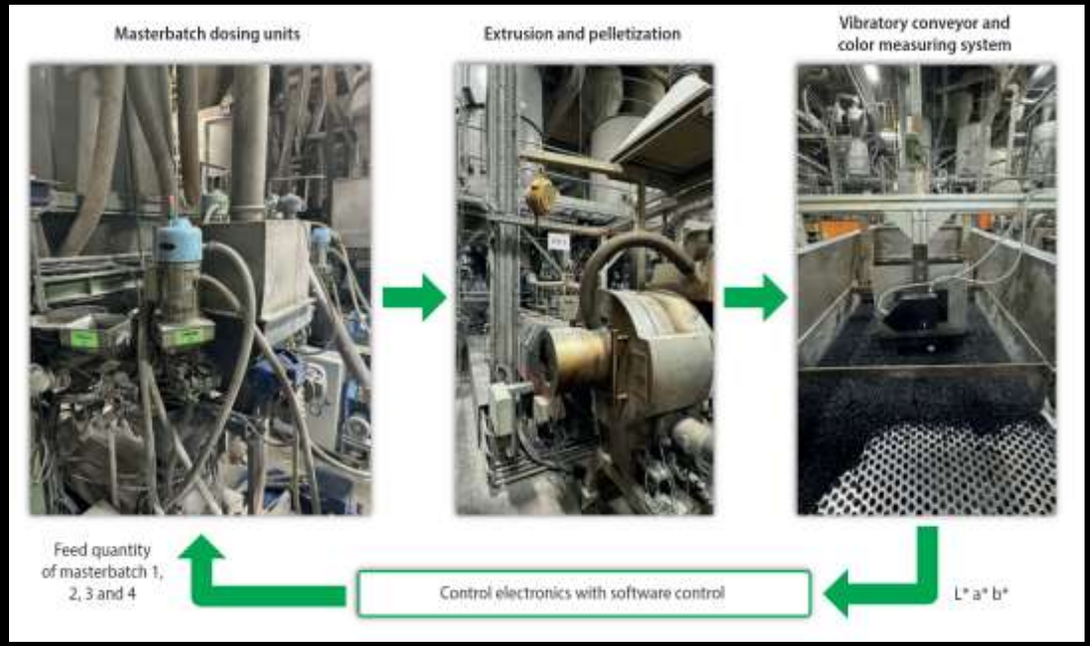
In the future, this process is intended to be controlled automatically via a closed-loop control system. For this purpose, a color measurement system is installed either at the vibrating dryer directly after pelletizing or at the pellet dryer itself. The recipe parameters defining which additive or masterbatch is to be added and at what dosing rate are entered via the SI-PPC-500-15“ monitoring system.
The fine adjustment of the dosing rates is then carried out automatically by the control algorithm of the color measurement system.

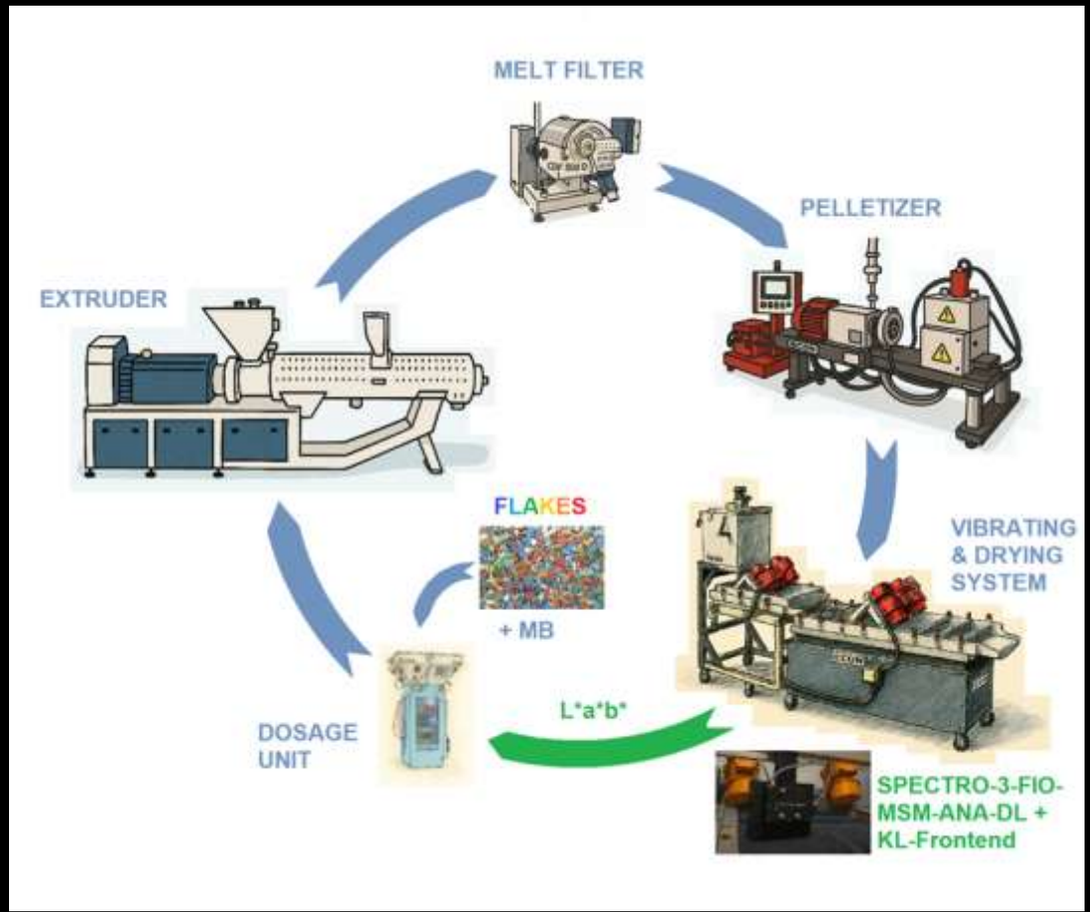
The closed-loop control system for stabilizing the color of recycled material

A typical recipe for producing recycled material contains information about which masterbatches or additives are used in the respective dosing units and the quantities to be added.

In most cases, two dosing units are used to achieve the desired L* value – one for white and one for black masterbatch. A third dosing unit is used to adjust the a* value, typically by adding either a red or green masterbatch. The fourth dosing unit is utilized to control the b* value, using either a yellow or blue masterbatch.

Since the color composition of the plastic flake material fed into the extruder is subject of fluctuations, slightly more or less masterbatch must be added from the respective dosing unuts based on the dosing values specified in the recipe. Using the closed-loop control algorithm of the SI-PPC-500-15“ monitoring system, the predefined L*a*b* color values are continuously stabilized. Since the control parameters depend on the residence time of the polymer passing through the extruder(s), melt filter, pelletizer, and drying conveyor, the software provides the option to manually enter and adjust these parameters.

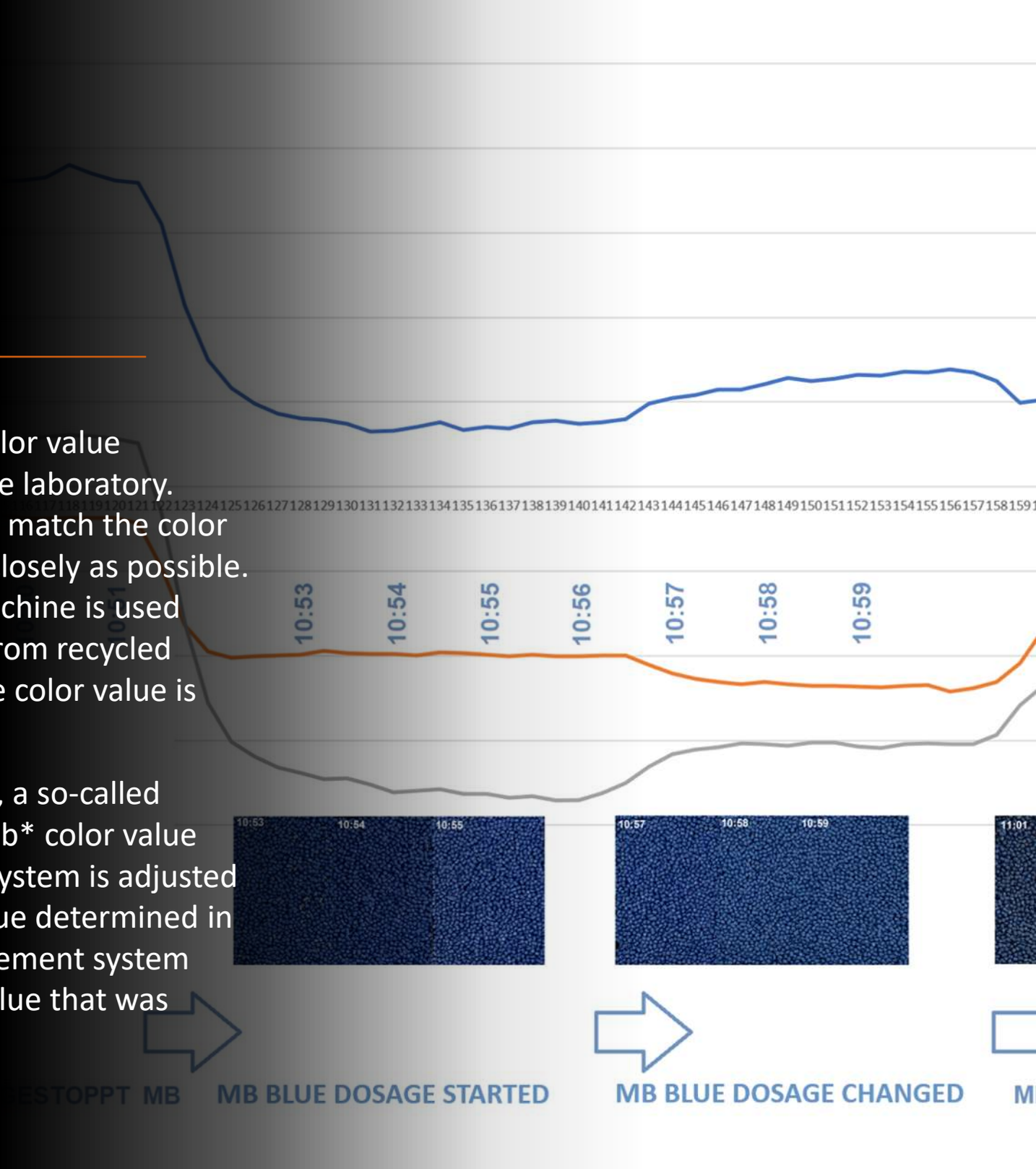




Measurement accuracy and comparability of color values

In many recycling plants, the L*a*b* color value of a recyclate is already measured in the laboratory. The color value measured inline should match the color value determined in the laboratory as closely as possible. In many cases, an injection molding machine is used to produce an injection-molded plate from recycled material taken from production and the color value is then determined.

To ensure that both color values match, a so-called user calibration is carried out. The L*a*b* color value determined by the inline color sensor system is adjusted accordingly after entering the color value determined in the laboratory. The inline color measurement system then displays the same L*a*b* color value that was measured in the laboratory.

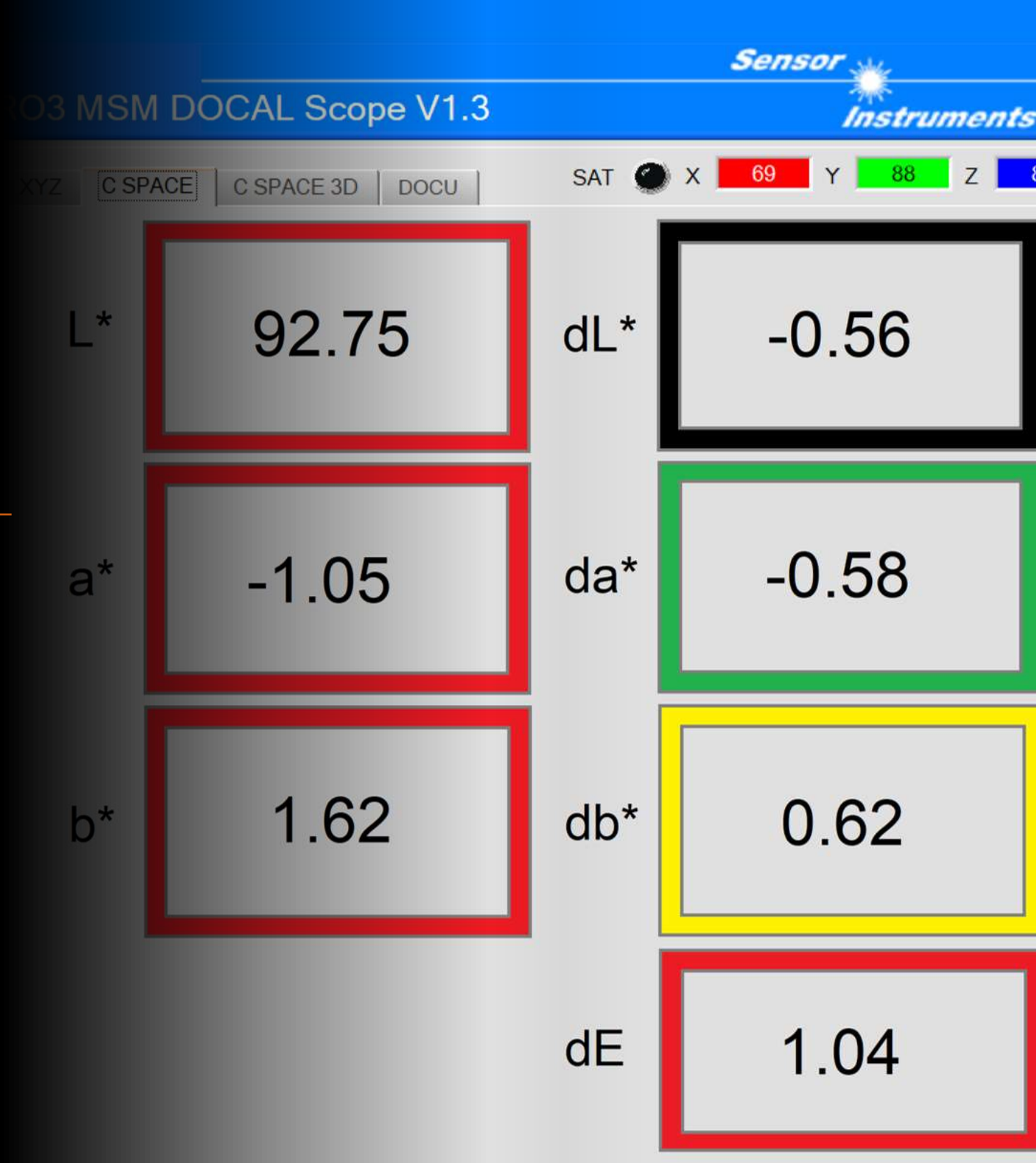


Display and recording of the color values determined inline

The DOCAL Windows® software is used to display the L*a*b* color values numerically and graphically, as well as their deviation dL*da*db* from the target value. At the same time, the data is stored in a file on the panel PC and the data can also be transmitted via fieldbus (ProfiNet) or Ethernet.

Display of color values using DOCAL software

Software that enables both simple calibration and convenient display of the color measurement values in both numerical and graphical form. Furthermore, the tolerances of a reference sample can be individually defined and called up as required.



Determining the recyclate color values using a mobile color measurement system

The mobile color measurement system can be used to obtain color measurement data more quickly than in the laboratory, even without an installed color sensor system. A recyclate sample can be taken on site from production and fed into the mobile unit (hopper capacity: 11 liters). The mobile color measurement system is calibrated in the same way as the inline unit.

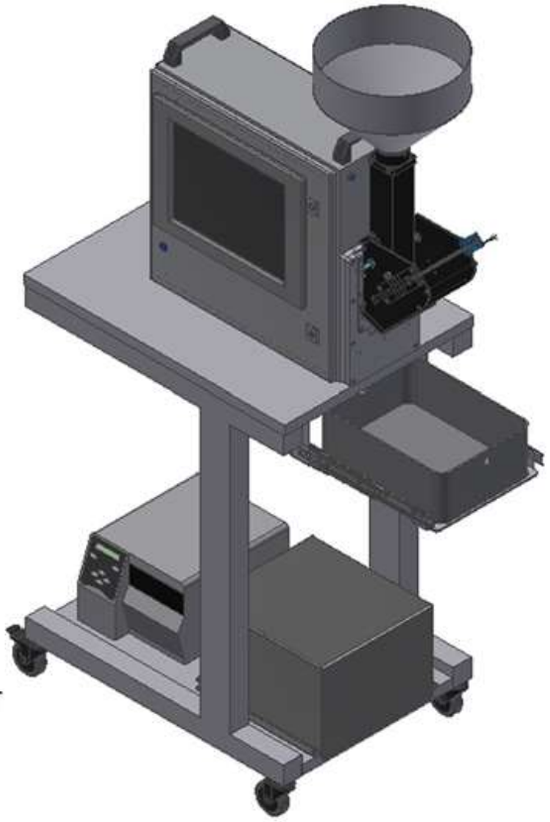
The device is equipped with a slot which, during measurement operation, is occupied by a placeholder. During the calibration procedure, the placeholder can be removed and repülaced either by RAL color cards or by the respective customer-specific injection-molded sample plaques. After completion of the calibration procedure, the RAL card or the customer-specific plastic sample plaque is removed again, the placeholder is repositioned, and the measurement process can be continued.

The required system:

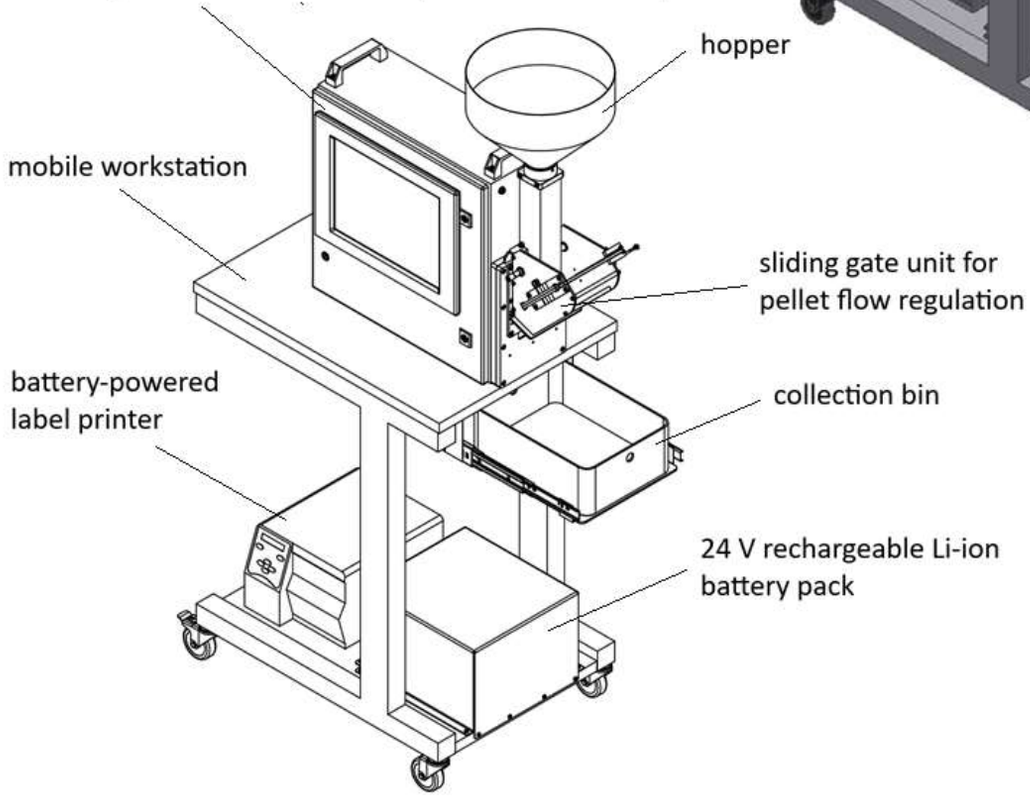
SPECTRO-3-0°/45°-MSM-MOBILE-ANA-P

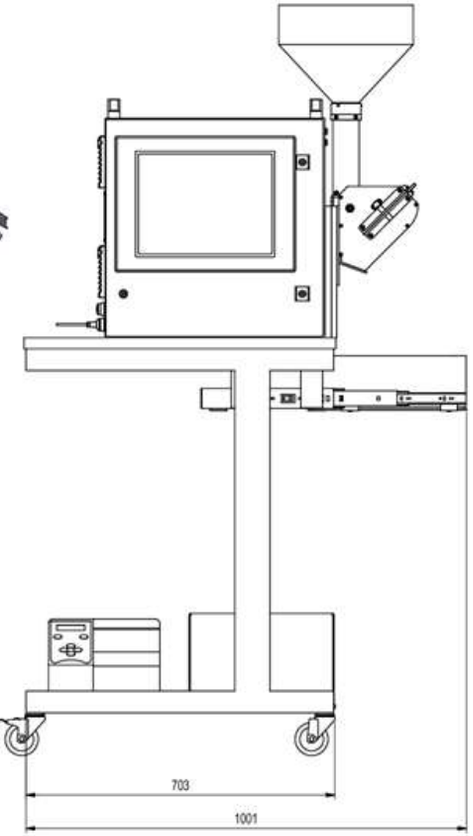
SPECTRO-3-0°/45°-MSM-MOBILE-ANA-P

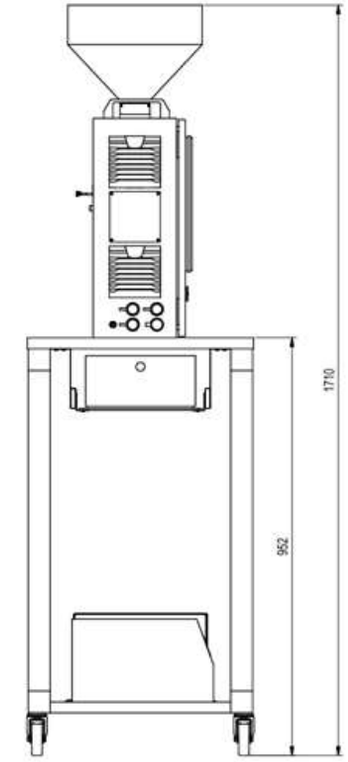
- self-contained unit
- powered by rechargeable
  24 V Li-ion battery
- battery-powered label printer
- 15" industrial panel PC
- 0°/45° color sensor
- high color measurement accuracy
  with a typical dE of 0.3
- mobile unit
- 11-liter hopper
- collection bin

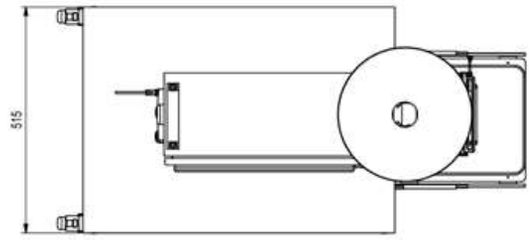


stainless-steel evaluation unit with integrated panel PC, SPECTRO-3-FIO-0°/45°-MSM-ANA-DL color sensor, and a KL-D-0°/45°-85-1200-D-S-A3.0 optical fiber assembly









Determination of the recyclate color values in the laboratory

The L*a*b* color value of a recyclate sample can also be determined with high accuracy (dE < 0.3) using the color laboratory device, without the need to first produce an injection-molded plate from recyclate at great expense.

The high color accuracy is achieved by measuring the recyclate flow and continously averaging the measured values. This eliminates the influence of the random position of the individual granules in the light spot of the measuring device.

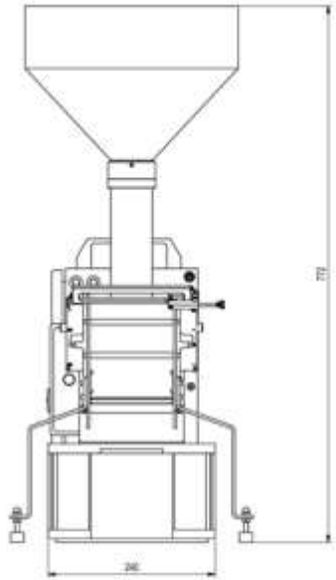
Calibration of the measurement system is carried out in the same way as with the MOBILE system: loosen the knurled screw, remove the placeholder card, insert the RAL plastic card or an equivalent customer-specific card, and start the calibration procedure. After completion of the calibration, remove the calibration card and reinsert the placeholder card. Tighten the knurled screw.

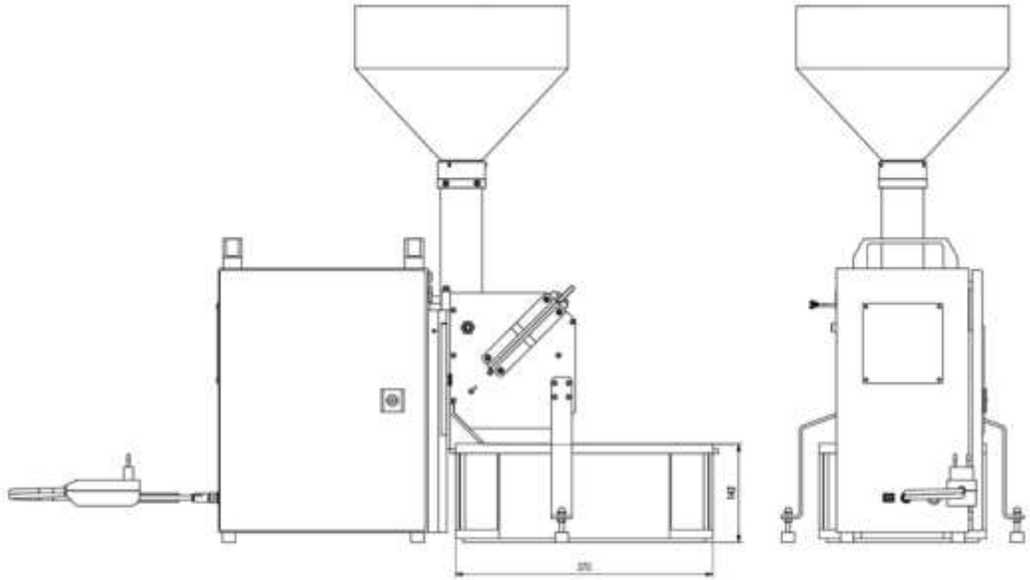
The required system:

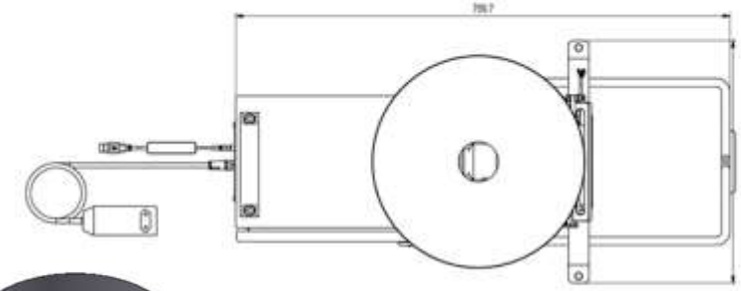
SPECTRO-3-0°/45°-MSM-LAB-ANA-LF

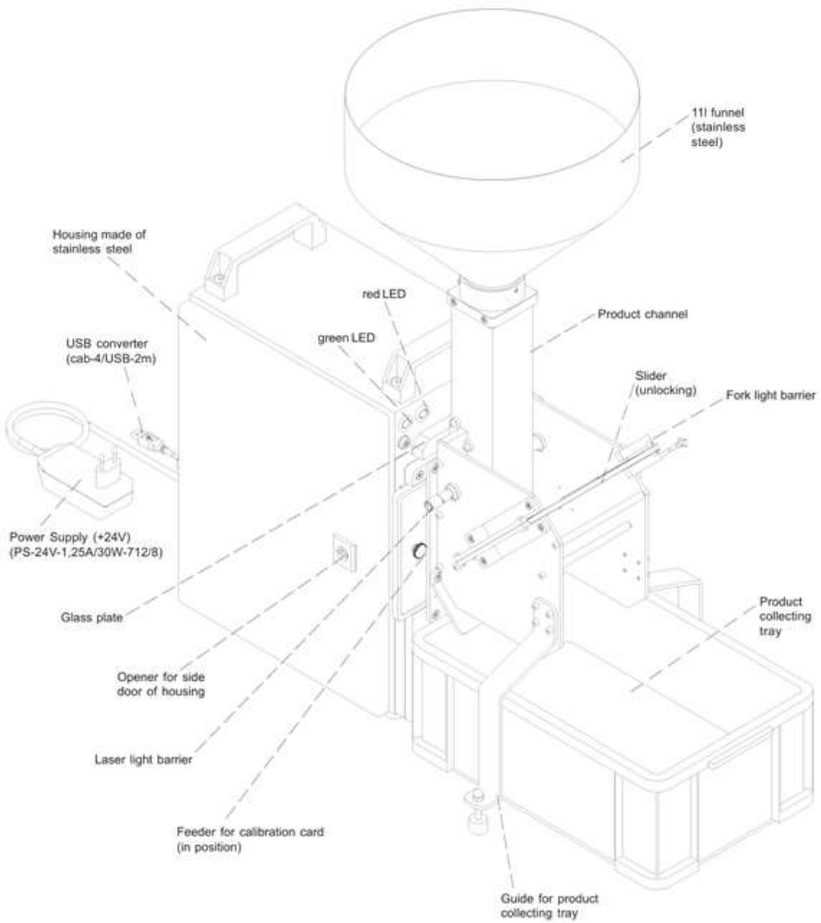
SPECTRO-3-0°/45°-MSM-LAB-ANA-LF

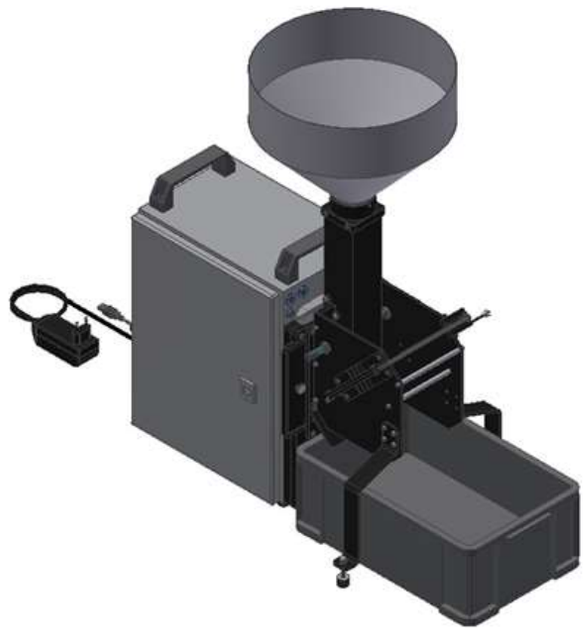
- stainless-steel housing
- 24 V power supply
- 11 liter hopper
- high color measurement accurracy
  dE < 0.3
- collection bin
- Ethernet, USB - interface
- 0°/45° color sensor

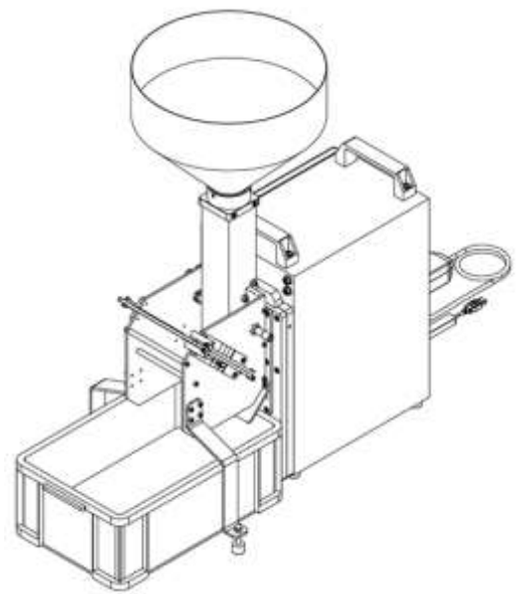












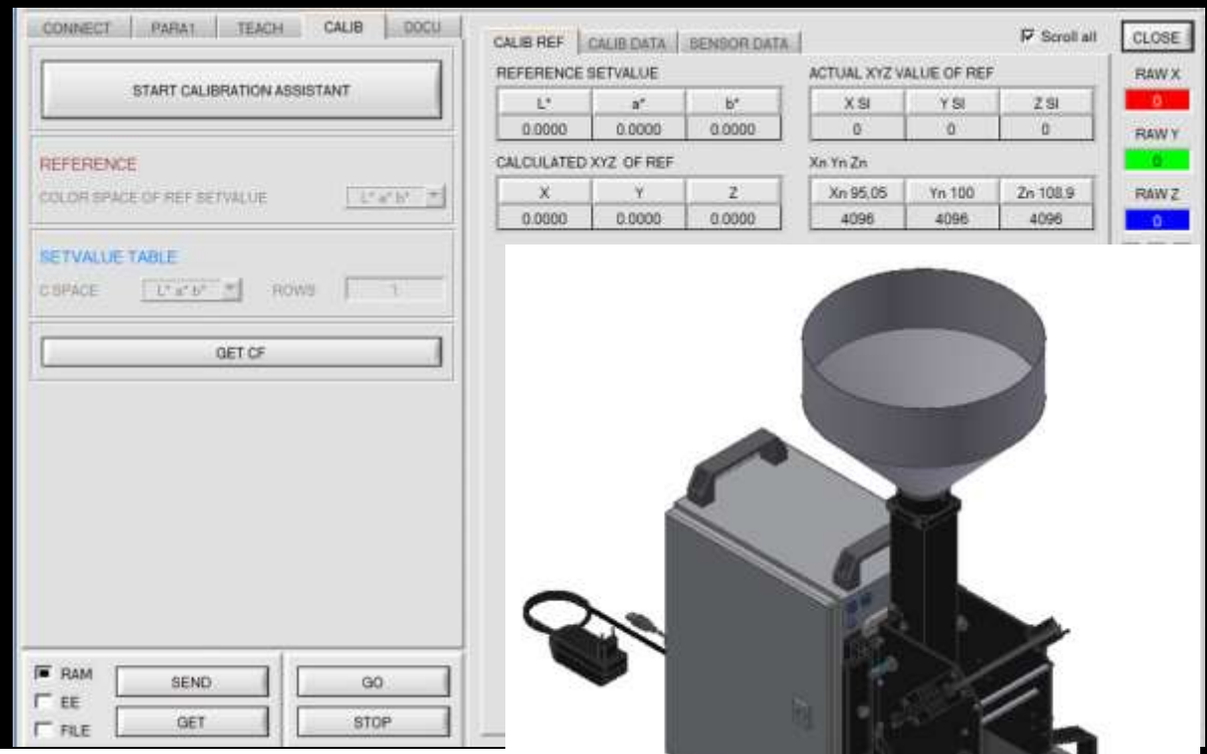
Calibration using the DOCAL software SPECTRO3-MSM-DOCAL-Scope V$_{X.X}$

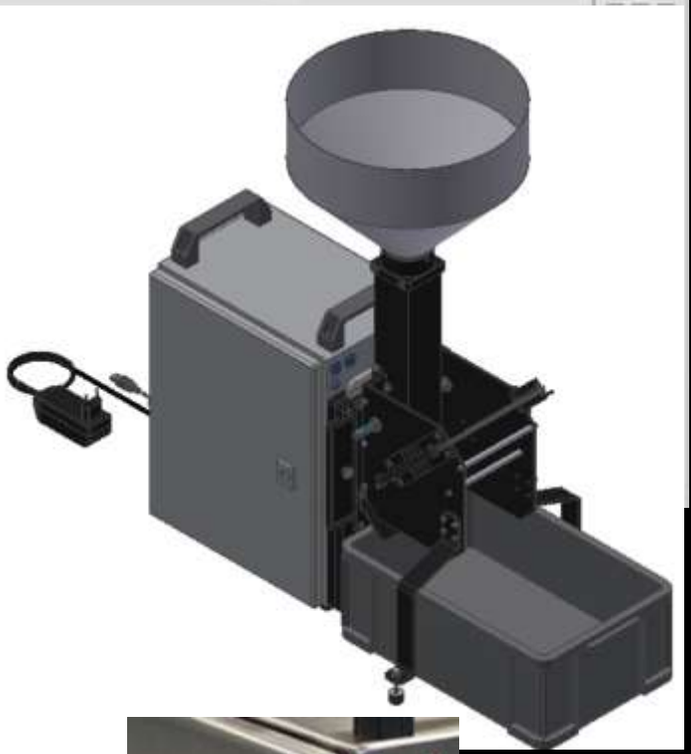
With the aid of the calibration wizard, calibration of the system is designed to be extremely simple. First, the user is prompted to select a suitable RAL card for white balancing purposes (for example RAL 9010).

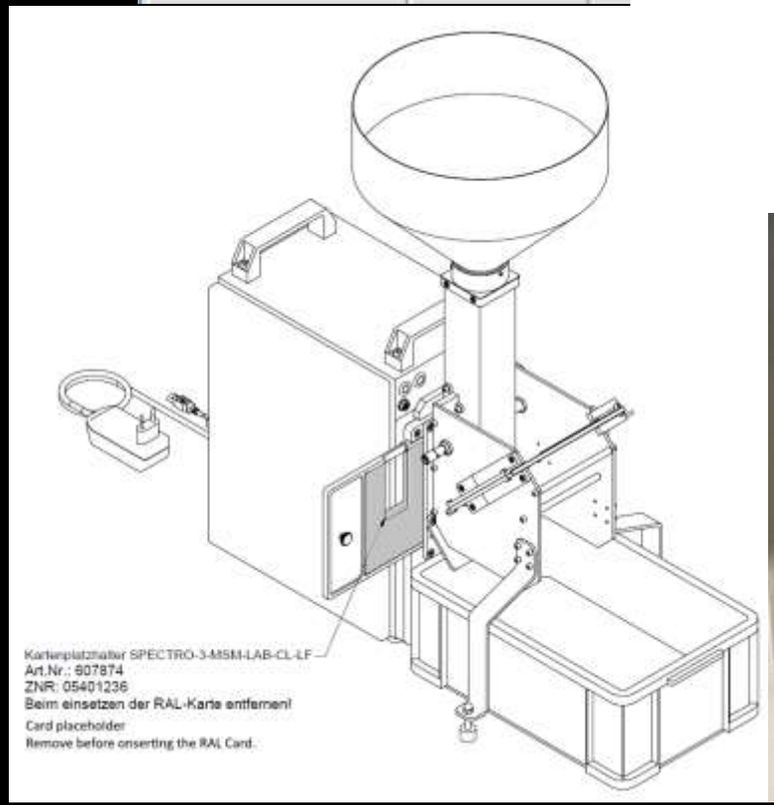
Afterwards, the operator can decide whether the calibration procedure should be continued using RAL cards, customer-specific cards, or granulate with a known L*a*b* value.

If the operator chooses the granulate method, the hopper must be filled with the corresponding granulate, and the calibration is carried out while the granulate passes through the system. In the event that the operator chooses to use plastic cards for calibration, these must be inserted into the designated slot according to the instructions. During normal measurement opteration, this slot is occupied by a placeholder card.

Subsequently, the respective L*a*b* value of the granulate is entered via DOCAL software (the software wizard prompts the user accordingly), and the calibration procedure can then be completed by saving a calibration file.





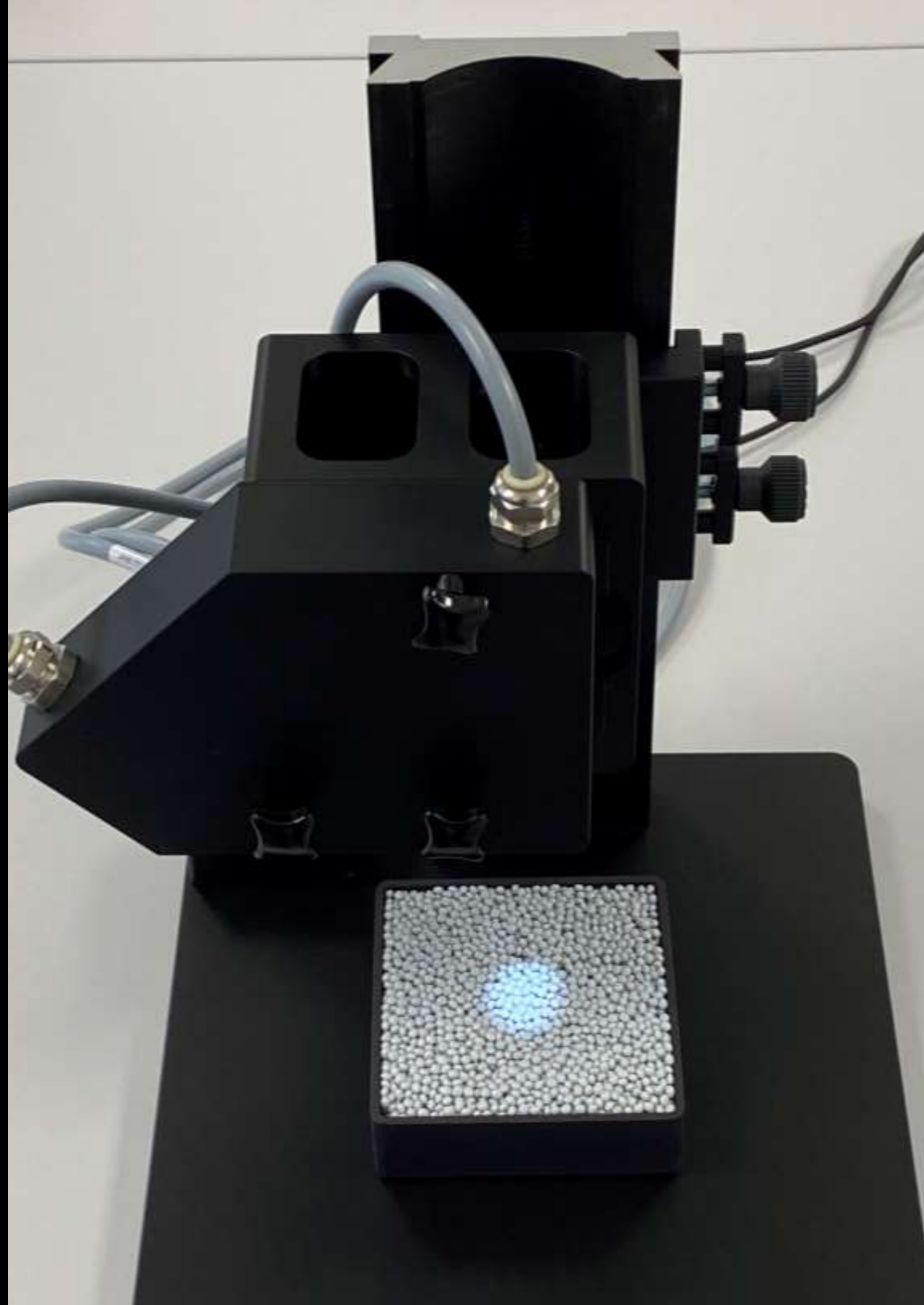


Compact laboratory system for measuring the color of recyclates

A very compact and inexpensive color measurement system was created using a measuring table top and an optomechanical rail. The recyclate samples are filled into the supplied trays and moved laterally under the light spot in a figure-of-eight movement. This also achieves an accuracy comparable to inline measurement.

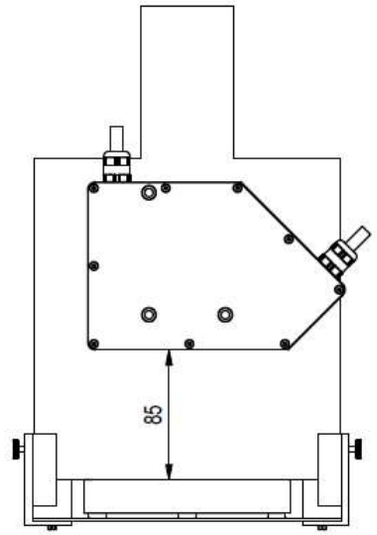
The required system:

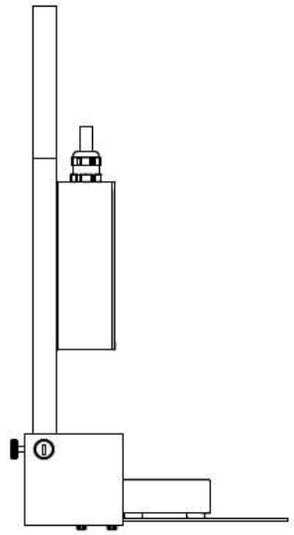
SPECTRO-3-0°/45°-MST

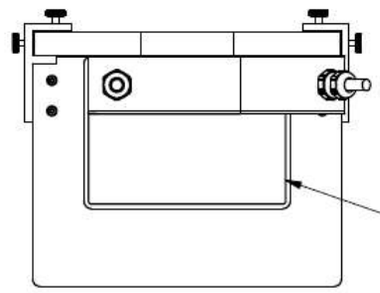


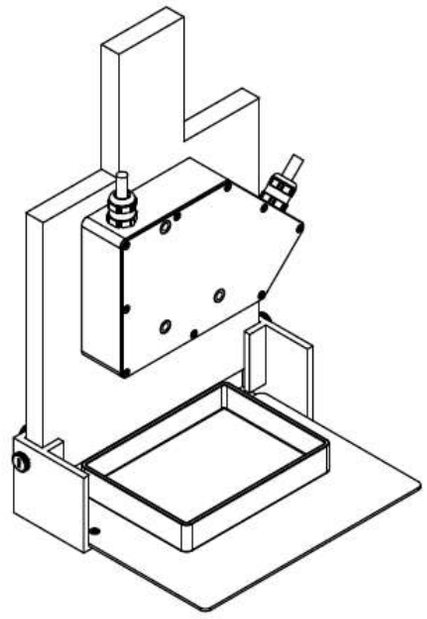
SPECTRO-3-0°/45°-MST

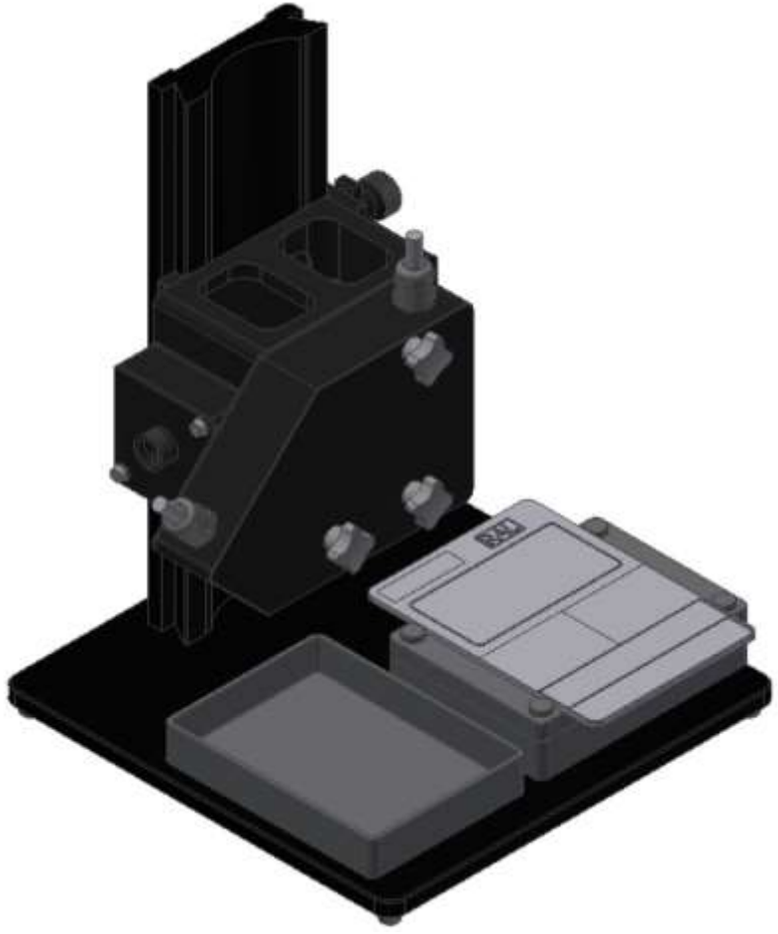
- color measurement of pellets
- color measurement accuracy dE < 0.3
- calibration using RAL plastic Cards and, alternatively, pellets
- 0°/45° color sensor
- DOCAL software can be employed for calibration and Monitoring
- pellet sample trays available
- RAL plastic cards available

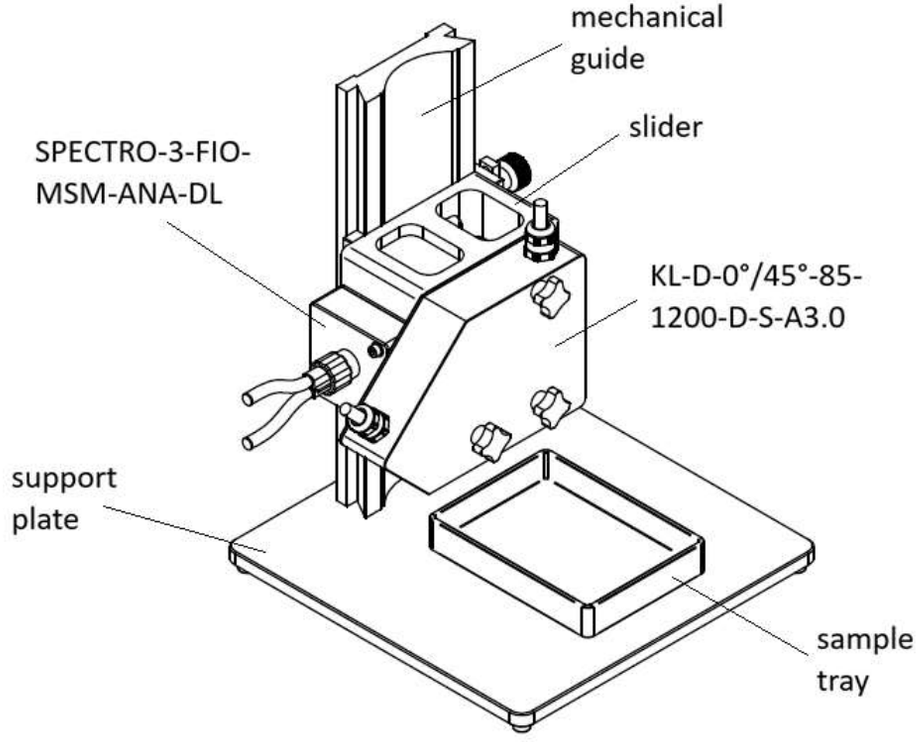










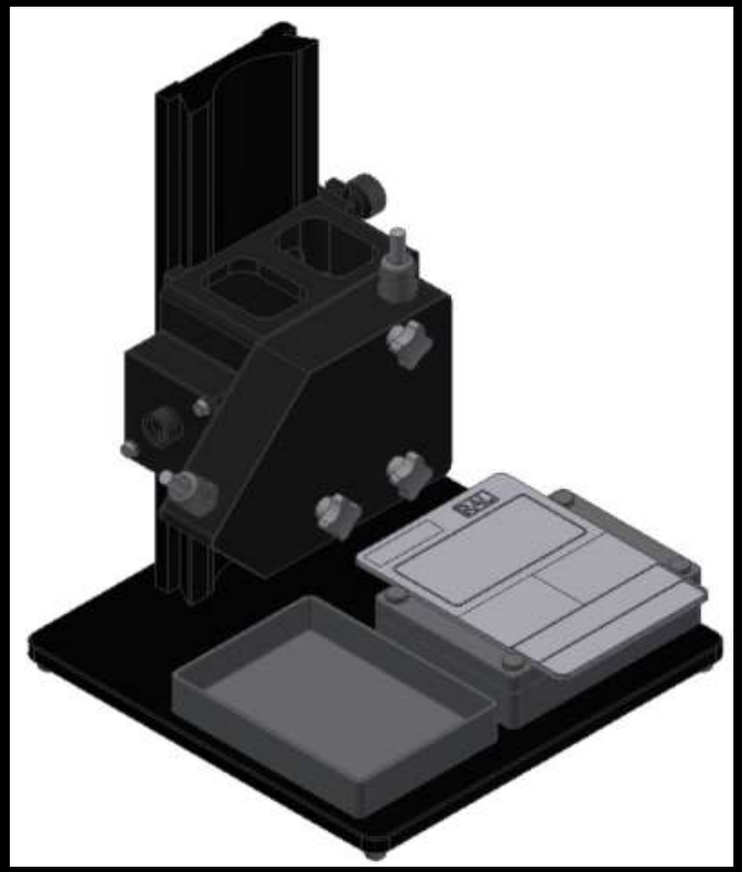


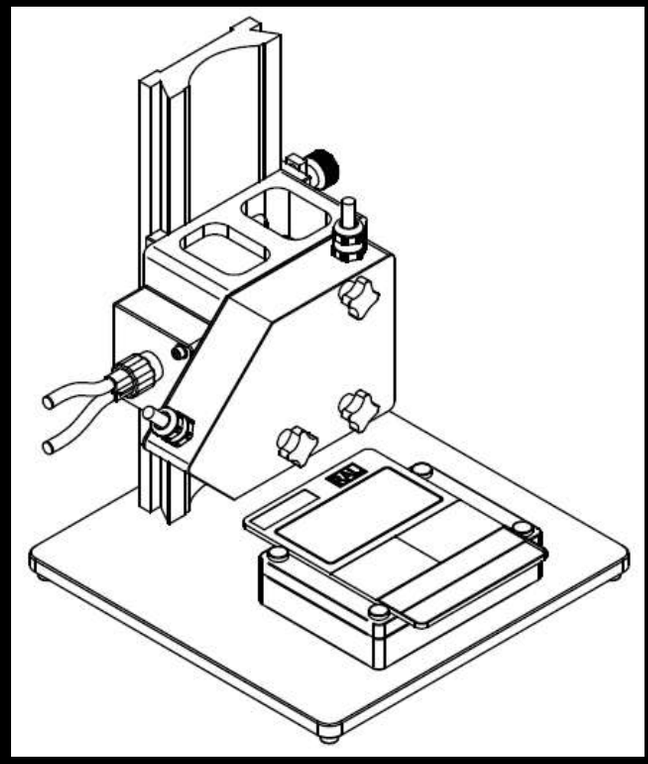
Calibration using the DOCAL software SPECTRO3-MSM-DOCAL-Scope $V_{x.x}$

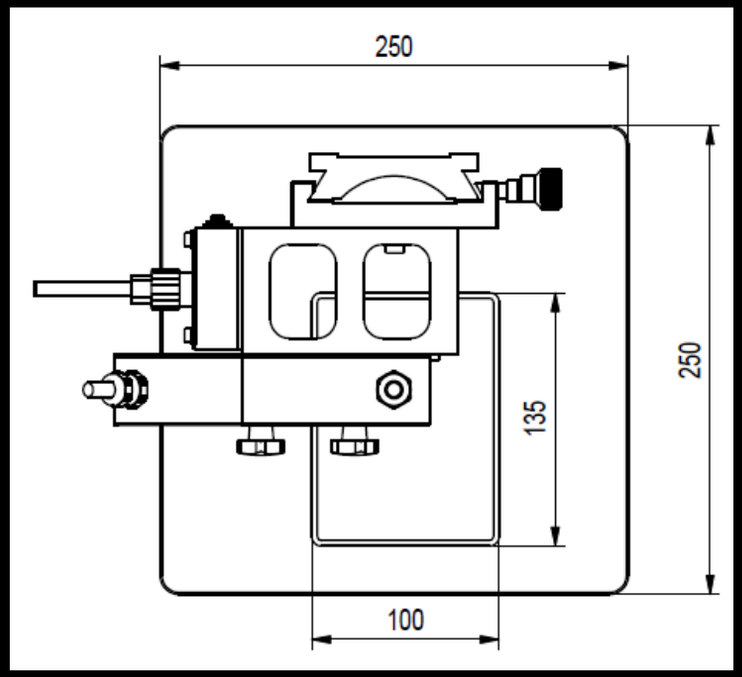
With the SPECTRO-3-0°/45°-MST laboratory measurement device, calibration is carried out in the same way as with the compareable inline system. The calibration process is performed using DOCAL software and ist integrated wizard.

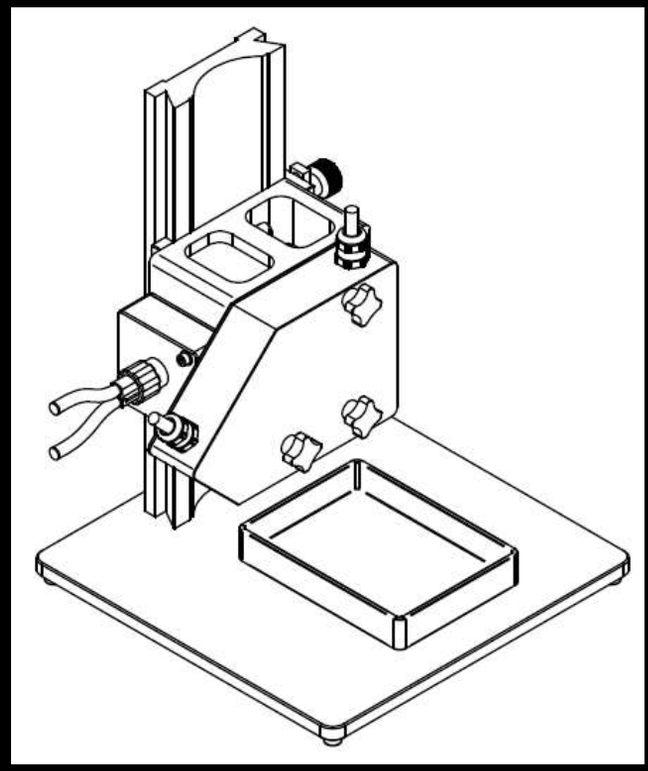
After the white balance adjustment, the operator can decide whether to continue the calibration procedure using RAL plastic cards, customer-specific reference cards, or granulates with known L*a*b* values.

At the end of the calibration process, the calibration data is likewise stored in a calibration file.



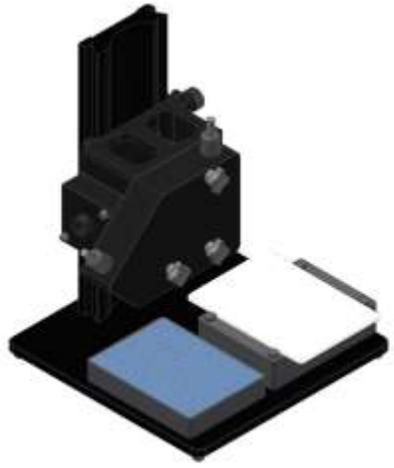




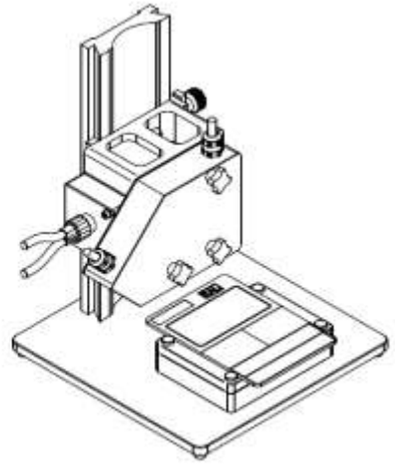


Calibration of the SPECTRO-3-0°/45°-MST

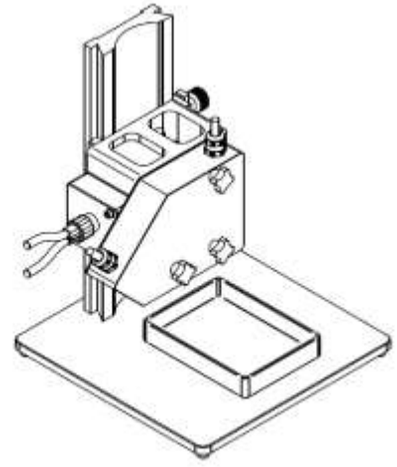
Using the DOCAL software, both a white balance Adjustment and a calibration to a pellet reference can be performed. Two different tray types are available for this purpose: one tray (standard height) for the pellet reference sample and a second tray (half height), which is additionally used for positioning the RAL plastic color card.



The operator is guided step by step through the calibration process. At this, the user can choose between performing a white balance adjustment and calibrating the system to a pellet reference sample.



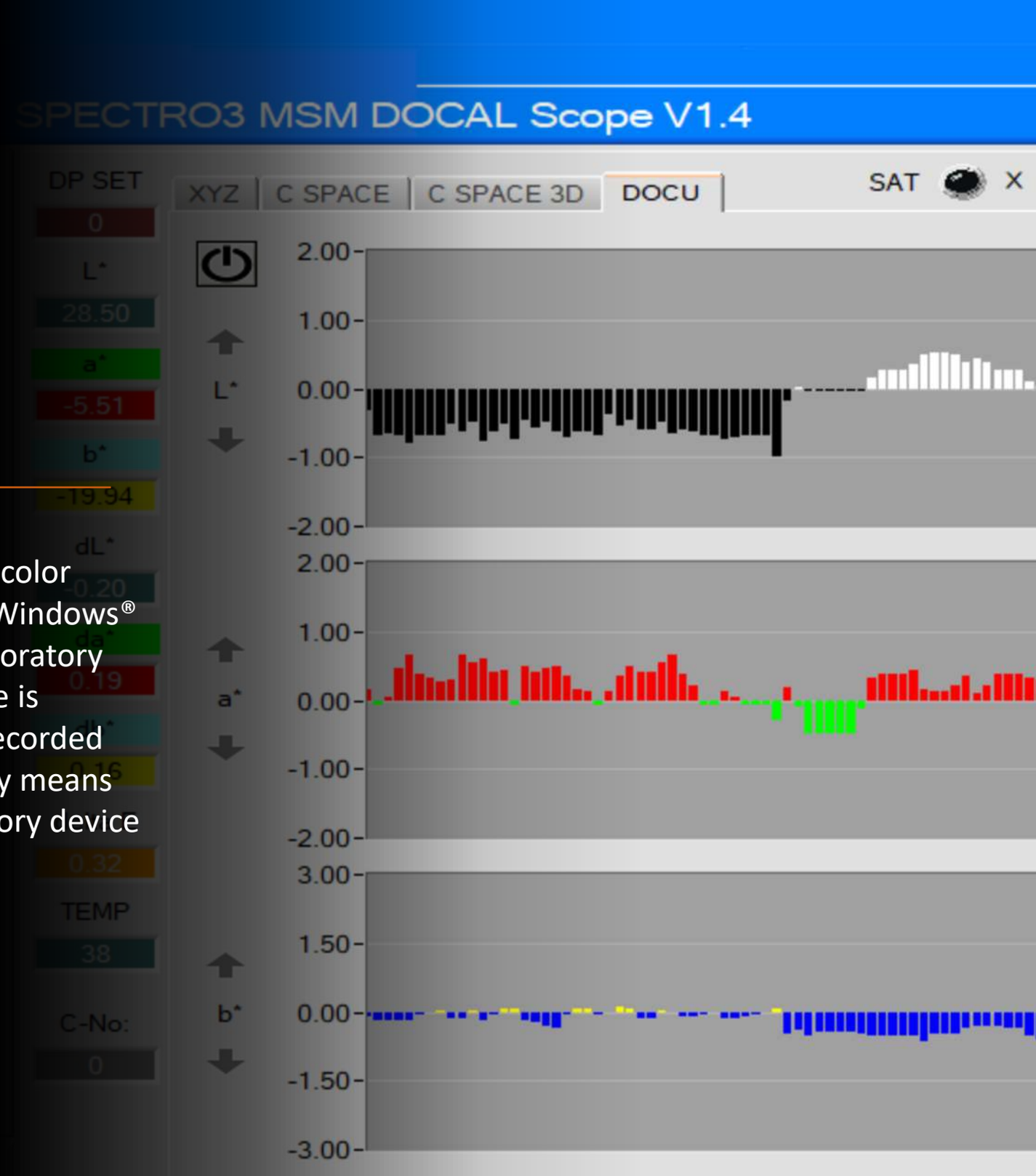
For the white balance adjustment, the white RAL plastic card (e.g. RAL 9010-P) is placed on the two trays, and the white balance mode is started via the software. During this process, the system is adjusted to the corresponding L*a*b* color values of the RAL card. The color data of the card can be downloaded from a file available on the Sensor Instruments Website.



For the calibration using a reference pellet sample, the known L*a*b* color values of the sample are entered into the DOCAL software, and the calibration process is started by activating the corresponding software button. After specifying the measurement time for the calibration procedure, the sample is moved beneath the sensor head in a figure-eight pattern. Once the measurement time has elapsed, the calibration factors are calculated automatically, and the calibration process is completed.

DOCAL software for laboratory equipment

In addition to the inline and mobile color measurement systems, the DOCAL Windows® software can also be used in the laboratory in the same way. The only difference is that the measurement data is not recorded continuously, but rather triggered by means of additional sensors on the laboratory device or via mouse click.



Plastics processing

Storage of recyclates in silos: Modern silo systems are equipped with advanced control technology that monitors and controls the operation to ensure a smooth process.

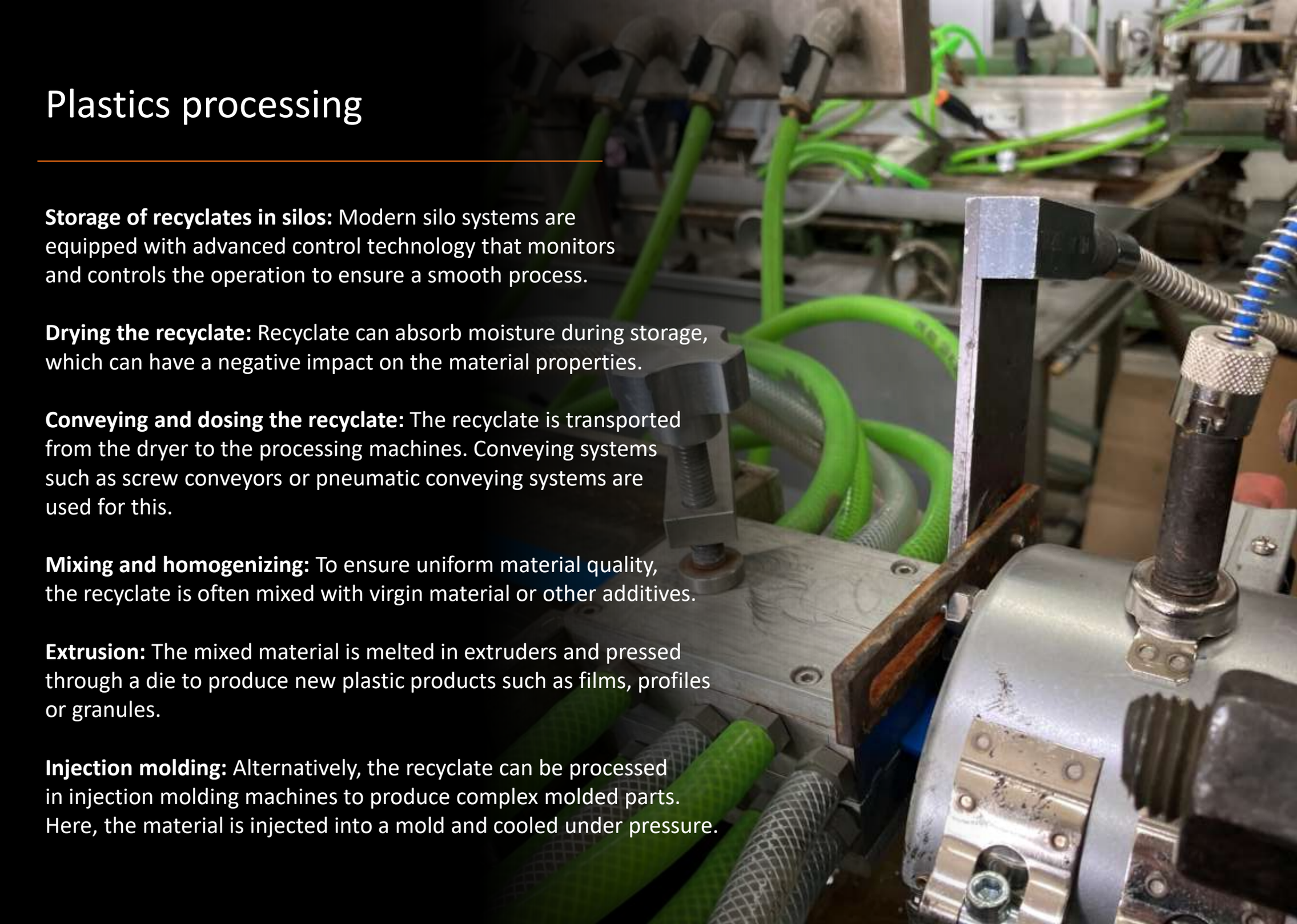
Drying the recyclate: Recyclate can absorb moisture during storage, which can have a negative impact on the material properties.

Conveying and dosing the recyclate: The recyclate is transported from the dryer to the processing machines. Conveying systems such as screw conveyors or pneumatic conveying systems are used for this.

Mixing and homogenizing: To ensure uniform material quality, the recyclate is often mixed with virgin material or other additives.

Extrusion: The mixed material is melted in extruders and pressed through a die to produce new plastic products such as films, profiles or granules.

Injection molding: Alternatively, the recyclate can be processed in injection molding machines to produce complex molded parts. Here, the material is injected into a mold and cooled under pressure.



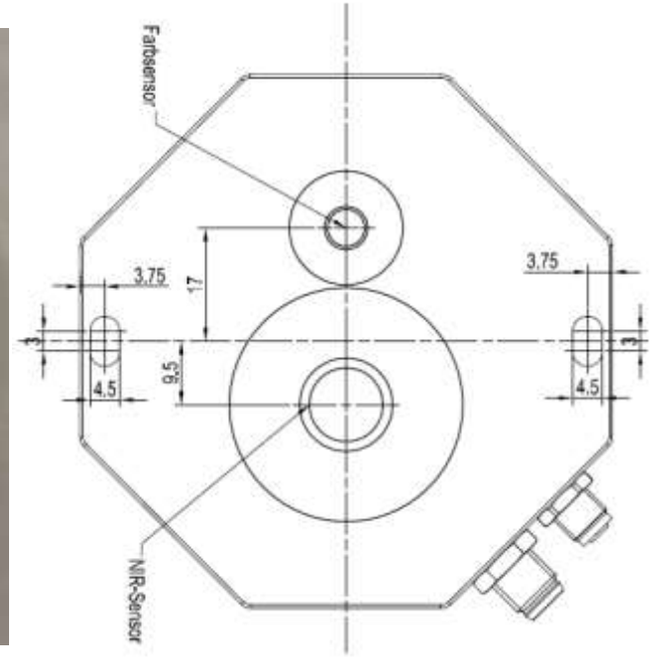
Color measurement of recyclates in the plastics processing industry

Due to the increasing use of recyclates in the processing industry, it is advisable to carry out an incoming inspection in order to prevent any fluctuations in the quality of the recycled material.

The SPECTRO-T-4-10-DIF-VISNIR enables color verification of the recyclate at various stages throughout the production process:

- At the silo
- At the material feed container
- At the dosing unit

SPECTRO-T-4-10-DIF-VISNIR



Connection to PLC:
4-pole M8 connector Binder Series 768/718

Pin:	Color:	Assignment:
1	brown	+24VDC (±10%)
2	white	IN0 (Digital 0: 0 ... 1V, Digital 1: +Ub - 10%)
3	blue	GND (0V)
4	black	OUT0 (Digital 0: 0 ... 1V, Digital 1: +Ub - 10%)

Connection to PLC:
4-pole M8 connector Binder Series 768/718

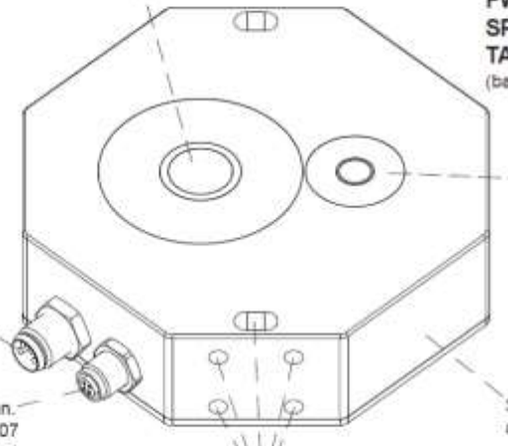
Pin:	Color:	Assignment:
1	brown	+24VDC (±10%)
2	white	RS485-A
3	blue	GND (0V)
4	black	RS485-B

Connection to PC:
4-pole fem. connector Binder Series 707

Pin:	Assignment:
1	+24VDC (+Ub, OUT)
2	GND (0V)
3	RxD
4	TxD

SPECTRO-T-4-10-DIF-VISNIR (I/O version)
SPECTRO-T-4-10-DIF-VISNIR-RS485 (RS485 version)
(incl. Windows® PC software SPECTRO-T-4-DOCAL-Scope)

VISNIR:
In the VIS range: a white light source and an integrated triple receiver for the red, green, and blue components (signals X, Y, Z).
In the NIR range: three light sources with different wavelengths and a broadband photodiode (signals NIR1, NIR2, NIR3).



NIR sensor
(with diffuser disc at transmitter side and IR filter at receiver side)

Color sensor
(with volume scattering disc for generating diffuse light)

4-pole M8 connector
Binder Series 768/718
(connection to PLC)

Connecting cable:
cab-M8/4

4-pole fem. conn.
Binder Series 707
(RS232 interface)

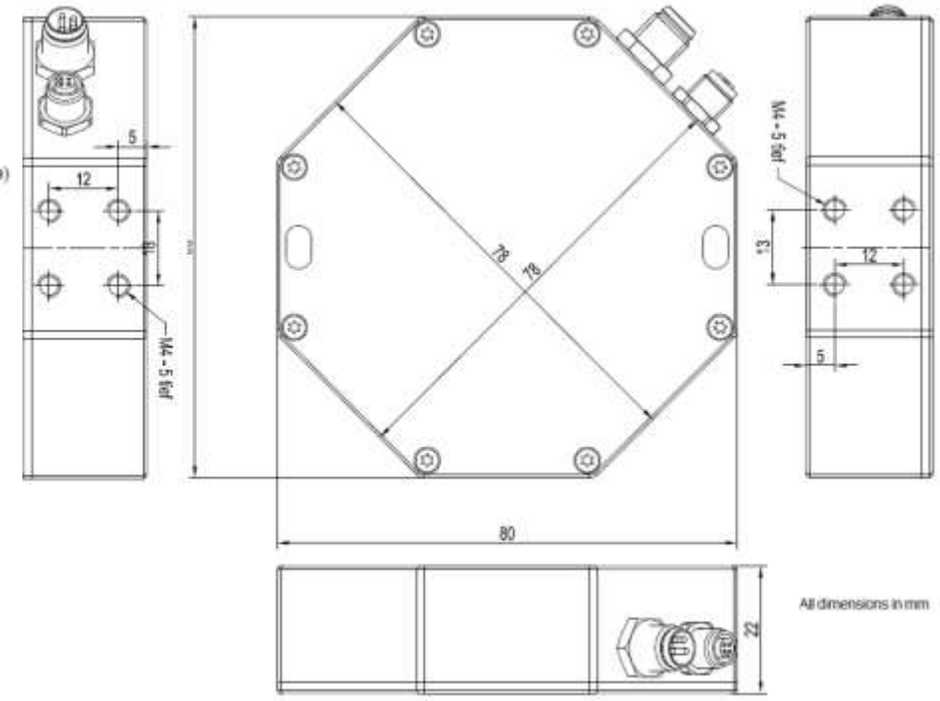
Connecting cable:
cab-las4/PC, cab-4/USB, cab-4/ETH-500, or cab-4-PNET-500

Sturdy aluminum housing, anodized in black

Mounting possibilities (two-sided), some with M4 thread

Accessories:

SG-B270-75 (sight glass)
FW-B270-75-OFL (offline unit)
SPECTRO-T-4-10-HANDLE (handle)
TABUN-13" (V1.1)
(battery-powered tablet PC)



All dimensions in mm

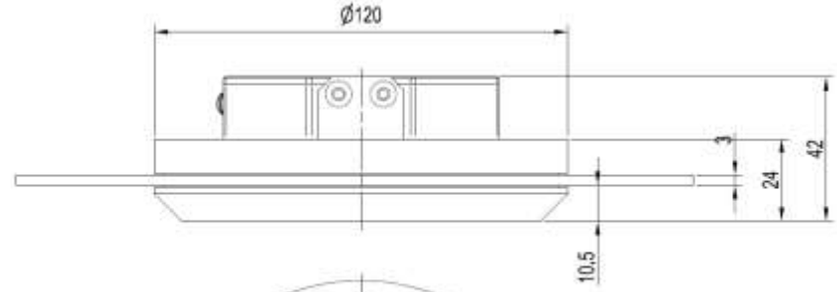
Recyclate color measurement at the silo

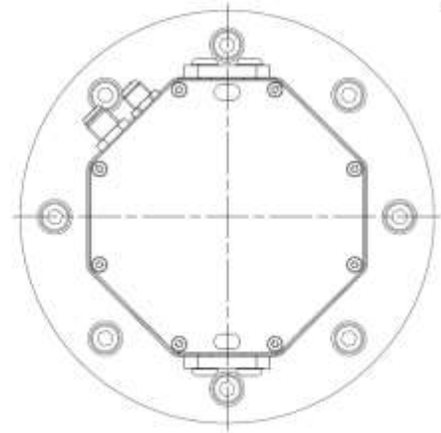
A sight glass is placed at a suitable location on the granulate silo and a suitable color sensor (0°/45° or d/0° method) is then installed. The color values are also evaluated using the DOCAL Windows® software.

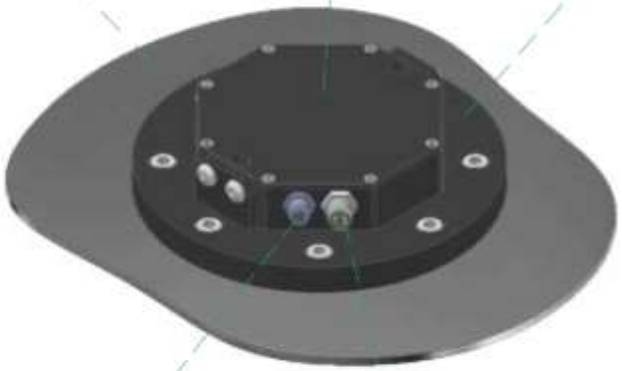
SPECTRO-T-4-INLINE-VISNIR

- Color Measurement (L*a*b*), dE < 0.3
- NIR Measurement (N*i*r*), dNir < 0.3
- Sight Glass Assembly Fixture
- Crown Glass
- +24V Power Supply
- Serial Interface (RS232, Ethernet, ProfiNet, USB)
- Connection Capability to the Monitoring Unit SI-PPC-500-15"

Installation in silos or dosing systems, for example:





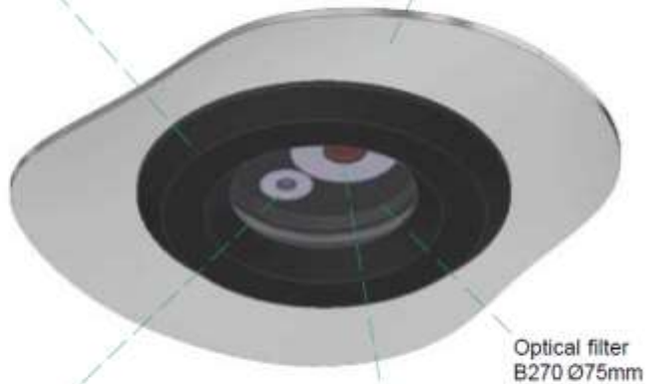


Color/NIR sensor
SPECTRO-T-4-10-DIF-VISNIR or
SPECTRO-T-4-10-DIF-VISNIR-RS485

Installation-side stainless steel wall (view: outside) for mounting the inline system (e.g., silo, dosing system)

Sight glass
SG-B270-75
(aluminum housing, anodized in black

Installation-side stainless steel wall (view: inside) for mounting the inline system (e.g., silo, dosing system)



Optical filter
B270 Ø75mm

4-pole fem. connector
Binder Series 707
(RS232 interface)

Connecting cable:
cab-4/USB,
cab-4/ETH-500 or
cab-4-PNET-500

4-pole M8 connector
Binder Series 768/718
(connection to PLC)

Connection by means of ppower supply
PS-24V-1,25A/30W-M8/4

Color/NIR sensor
SPECTRO-T-4-10-DIF-VISNIR or
SPECTRO-T-4-10-DIF-VISNIR-RS485
Color sensor optics
(with volumetric diffusor on the transmitter side and longpass filters on the receiver side)

Color/NIR sensor
SPECTRO-T-4-10-DIF-VISNIR or
SPECTRO-T-4-10-DIF-VISNIR-RS485
NIR sensor optics
(with volumetric diffusor on the transmitter side and IR filter on the receiver side)

Drilling pattern for mounting of SG-B270-75 sight glass

Recyclate color testing during material feeding and dosing

A recyclate color check can also be carried out at the material feed container.
The system operator is informed about the color quality of the recyclate used at an early stage. Furthermore, color measurement data can be transmitted to the quality assurance department in real time.

The dosing unit offers another option for measuring the color of the recyclate.
The color system can be installed after attaching an appropriate sight glass.
The color evaluation is carried out using the DOCAL Windows® software.

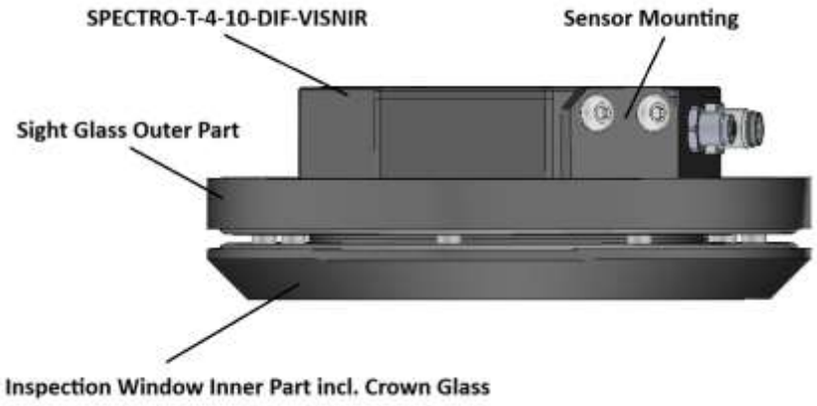
SPECTRO-T-4-INLINE-VISNIR

Measurement Method
The **SPECTRO-T-4-INLINE-VISNIR** measuring system is a **hybrid system** consisting of a color measuring unit and an NIR measuring system. Both units are integrated in a common aluminum housing, and each determine the measurement data using the **three-range method**. Using a shared sight glass, measurements can be taken directly on the granulate or flakes. Using Windows software, both the color values **L*a*b*** and the NIR values **N*i*r*** are displayed graphically and numerically. Furthermore, the deviations from a specified reference are displayed and the measured values are framed in color if the tolerance is exceeded. The trend is also displayed, and the measurement data are saved in a format that can be read with Excel and Word.

Where are measurements taken?
The measuring system is ideal for determining the quality of the granulate in silos, bag emptying bins and dryers, but also ideally in dosing units. The **quality of the color of the granulate** can be determined and the measuring system also provides information about the **quality of the plastic type**, whether the plastic type has the required degree of purity. In a dosing unit, corrective action can be taken in regular operation in conjunction with virgin material and corresponding masterbatches in the event that the tolerance limits with regard to color or plastic type are exceeded or not reached.

What accuracy can be achieved?
Due to the size of the measuring spots, the diffuse illumination using high-power LEDs and the high measuring frequency, **dE and dN values of 0.3** are achieved, particularly with moving material.

SPECTRO-T-4-INLINE-VISNIR



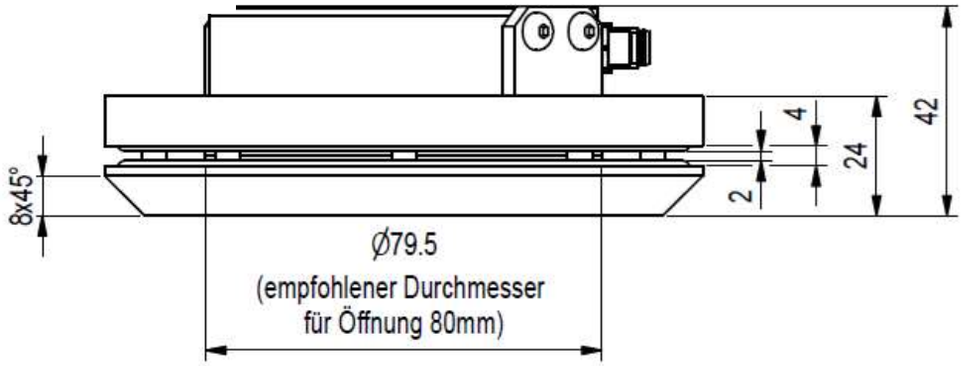
- DOCAL - Software
- Color Measurement (L*a*b*), dE < 0.3
- NIR Measurement (N*i*r*), dNir < 0.3
- Sight Glass Assembly Fixture
- + 24V Power Supply
- RS 232 Interface (Ethernet-, ProfiNet-, USB - Adapter available)
- I/O - Type and RS485 Type available
- Black anodized Aluminum Housing
- Crown Glass

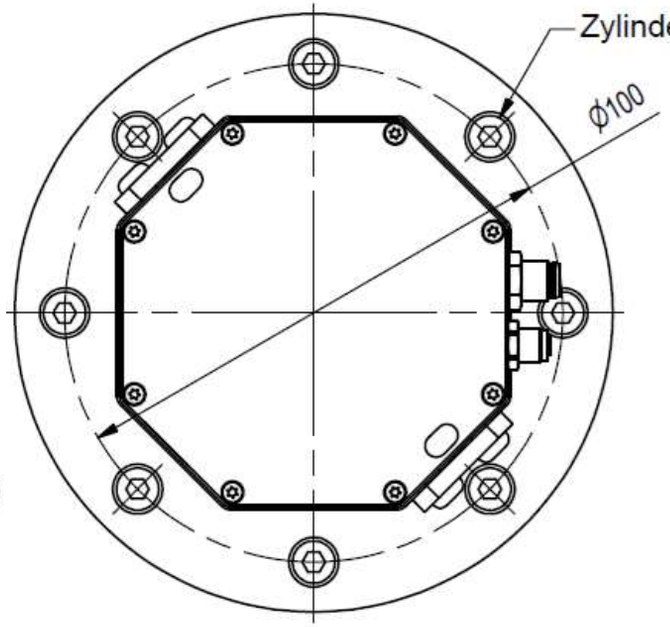
RS485 version

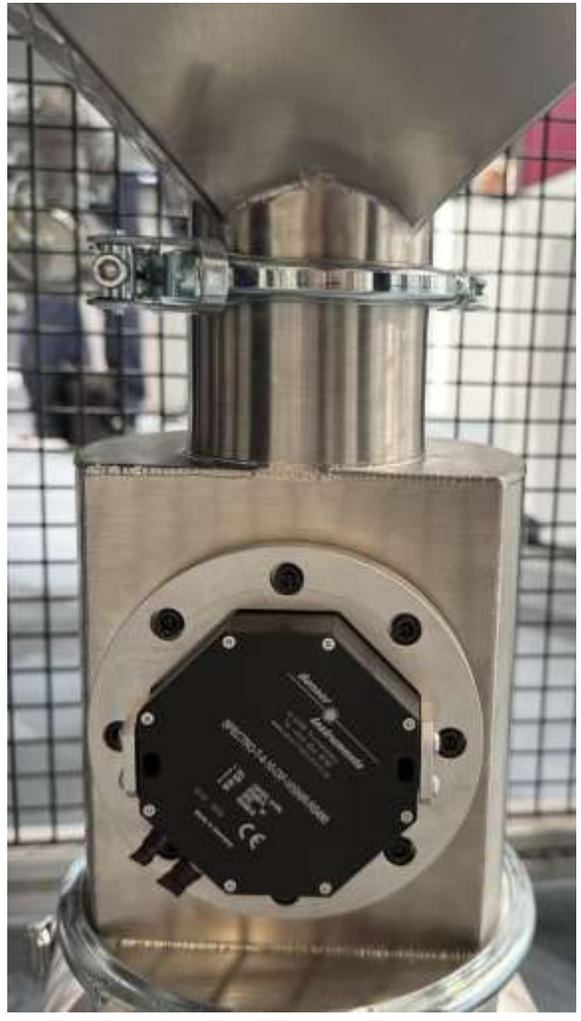
Connection to PLC:

4-pin M8 Binder Series 768/718

Pin:		
1	brn	+24VDC (±10%)
2	wht	RS485-A
3	blu	GND (0V)
4	blk	RS485-B







Digital - I/O version

Connection to PLC:

4-pin M8 Binder Series 768/718

Pin:		
1	brn	+24VDC (±10%)
2	wht	IN0 (Digital 0: 0 … 1V, Digital 1: +Ub - 10%)
3	blu	GND (0V)
4	blk	OUT0 (Digital 0: 0 … 1V, Digital 1: +Ub - 10%)

One sensor. Three worlds. Mobile. Lab. Inline.

SPECTRO-T-4 brings the same proven technology from incoming goods inspection to the laboratory and directly into production. Check pellets immediatelly upon delivery – even inside a big bag. No sampling, no delays, no compromises.

Simply place the sensor into the granulate, start the measurement, and sweep the sensor head in a figure-eight motion. Within moments, you receive precise color and NIR data with repeatability down to dE/dNir = 0.3.

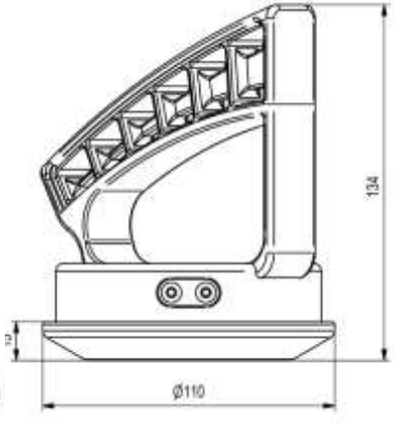
Powered by the TABUN unit, SPECTRO-T-4-MOBILE delivers hours of field operation, enabling fast, reliable decisions whereever quality matters.

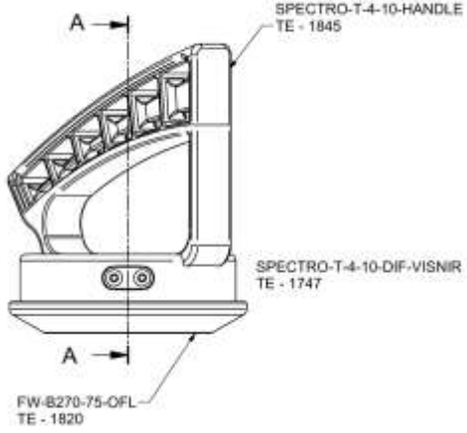
SPECTRO-T-4-MOBILE-VISNIR

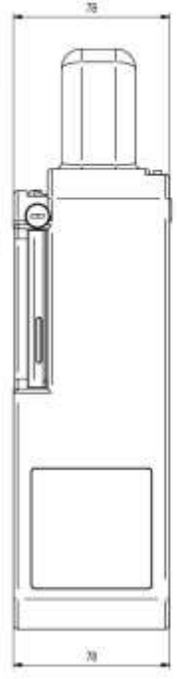
- Off-grid power supply
- Portable touchscreen PC
- RS232/USB-C adapter
- DOCAL - software for monitoring
- OK / NOK indicator (green-red LED)
- Built-in buzzer
- Color control (L*a*b* and dL*da*db*)
- Polymer type control (N*i*r* and dN*di*dr*)
- WLAN
- Bluetooth
- On-board keyboard
- Surface pen

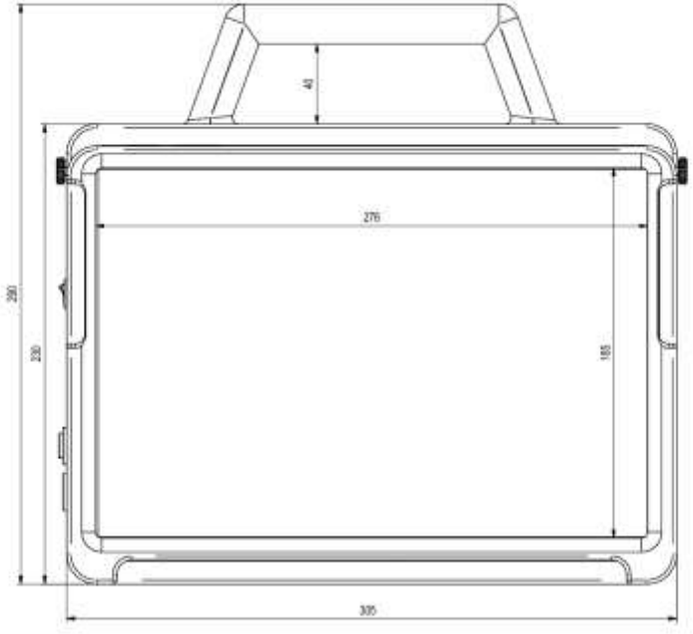
Connection to PLC:
4-pin M8 Binder Series 768/718

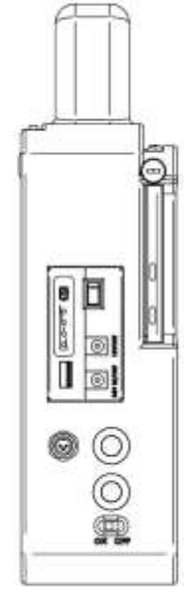
Pin:		
1	brn	+24VDC (±10%)
2	wht	IN0 (Digital 0: 0 … 1V, Digital 1: +Ub - 10%)
3	blu	GND (0V)
4	blk	OUT0 (Digital 0: 0 … 1V, Digital 1: +Ub - 10%)











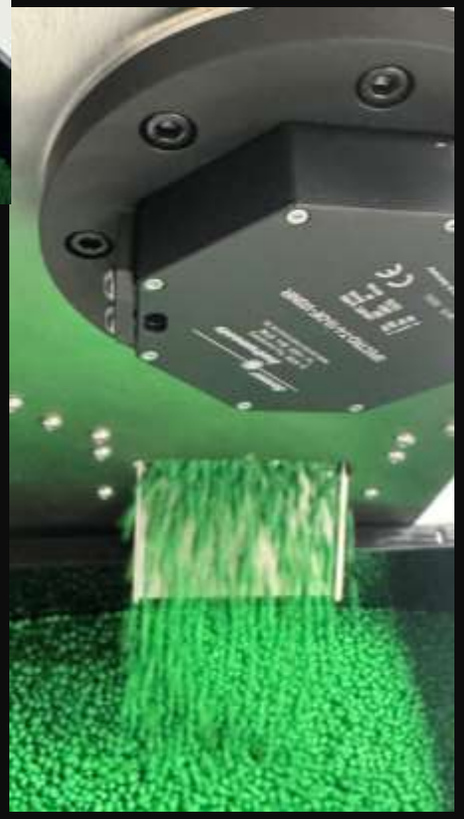
One sensor platform – Lab, Inline, and Mobile

Measure with the same sensor technology everywhere and compare results with confidence. Whether in the laboratory, directly on the production line, or with a mobile device, you always work with a consistent measurement principle.

Pellets are measured continuously in the process stream through a protective sight glass that keeps the optics safely isolated from the material flow. As the pellets move through the measurement area, their random orientation is naturally averaged out, delivering highly stable and representative results.

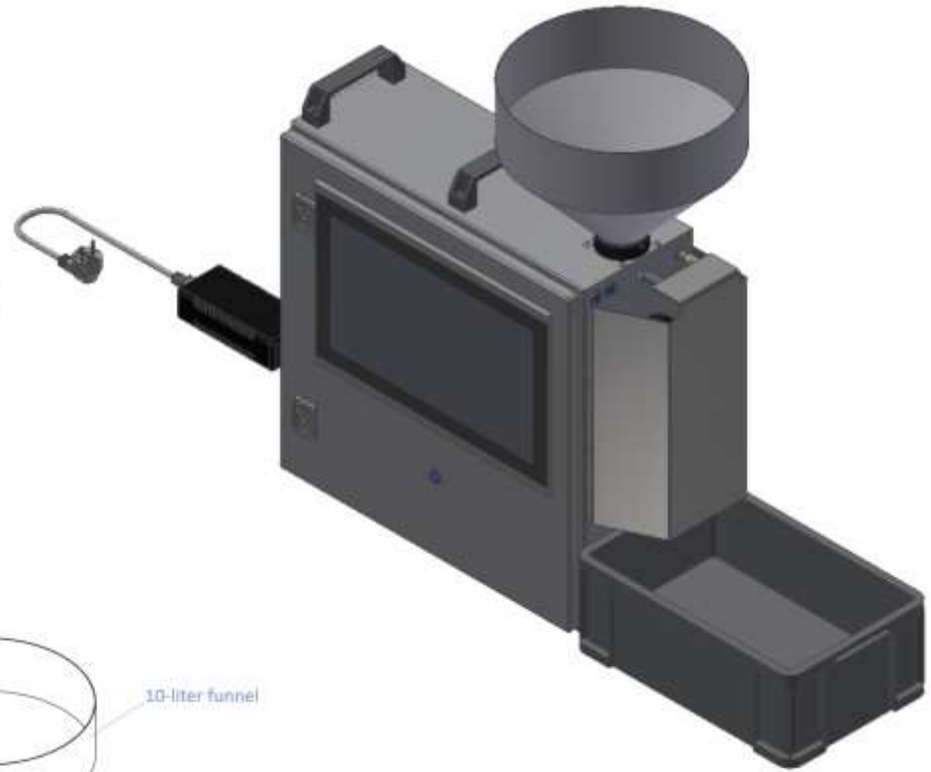
Within just a few seconds, the system generates reliable color and NIR values with outstanding repeatability of up to dE = 0.3 and dNir = 0.3.

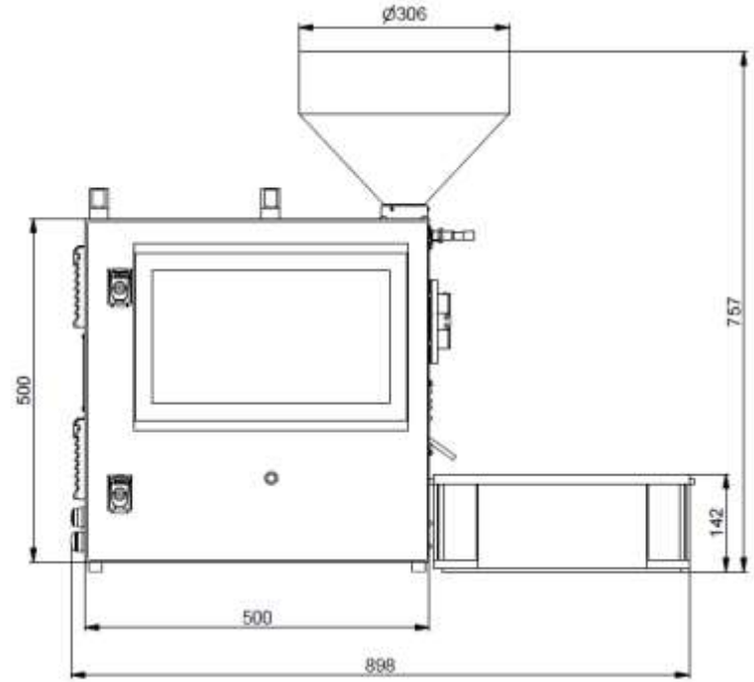
Simply press a button and let the system do the rest.

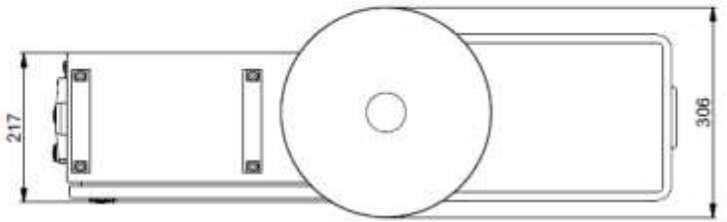


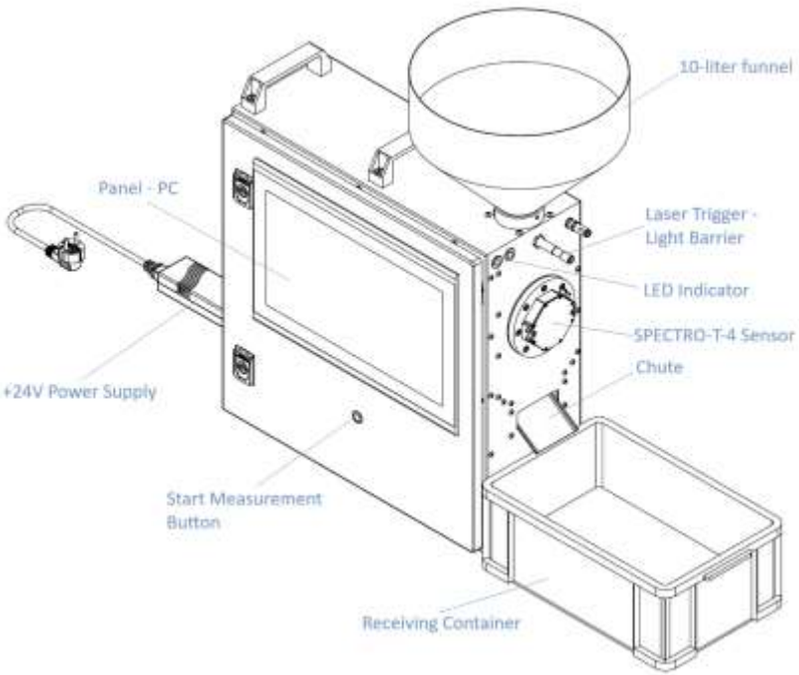
SPECTRO-T-4-LAB-VISNIR

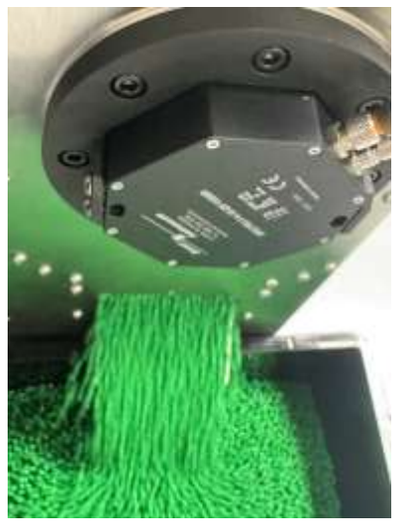
- Panel - PC
- DOCAL - Software
- Color Measurement (L*a*b*)
- NIR Measurement (N*i*r*)
- 10 Liter Funnel
- Automatic Measurement Stop
- Receiving Container Status Check
- Measurement Accuracy Color: dE < 0.3
- Measurement Accuracy NIR: dNir < 0.3
- Measurement Start by Button press
- Stainless Steel Housing
- Ethernet Interface
- USB Interface
- +24V Power Supply











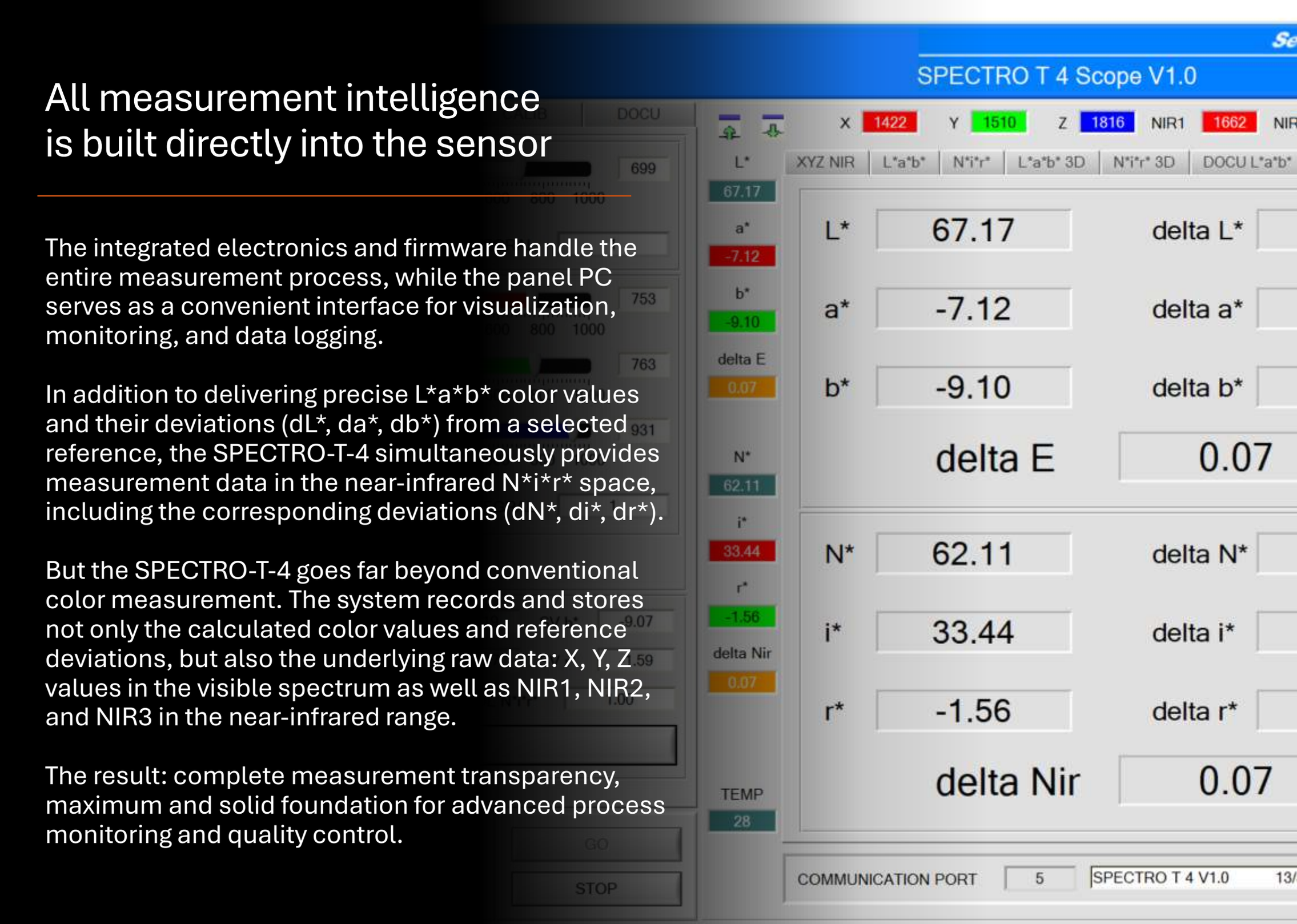
All measurement intelligence is built directly into the sensor

The integrated electronics and firmware handle the entire measurement process, while the panel PC serves as a convenient interface for visualization, monitoring, and data logging.

In addition to delivering precise L*a*b* color values and their deviations (dL*, da*, db*) from a selected reference, the SPECTRO-T-4 simultaneously provides measurement data in the near-infrared N*i*r* space, including the corresponding deviations (dN*, di*, dr*).

But the SPECTRO-T-4 goes far beyond conventional color measurement. The system records and stores not only the calculated color values and reference deviations, but also the underlying raw data: X, Y, Z values in the visible spectrum as well as NIR1, NIR2, and NIR3 in the near-infrared range.

The result: complete measurement transparency, maximum and solid foundation for advanced process monitoring and quality control.



The DOCAL software

From production to quality assurance, everyone sees the same data in real time.

Powerful trend monitoring detects process deviations before they become problems, helping operators take action at the right moment, integrated communication with master controllers enables automated dosing adjustments whenever tolerances are exceeded.

Critical deviations stand out instantly through intuitive visual alerts, color-coded trend indicators, and highlighted data values – ensuring maximum process transparency and control.

Clarity about the Recyclate

Detect Color in Pellets and Flakes

Maintain control over color consistency and prevent discrepancies

Our specialists are happy to tell you more about it

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Sensor Instruments

Let's make sensors more individual