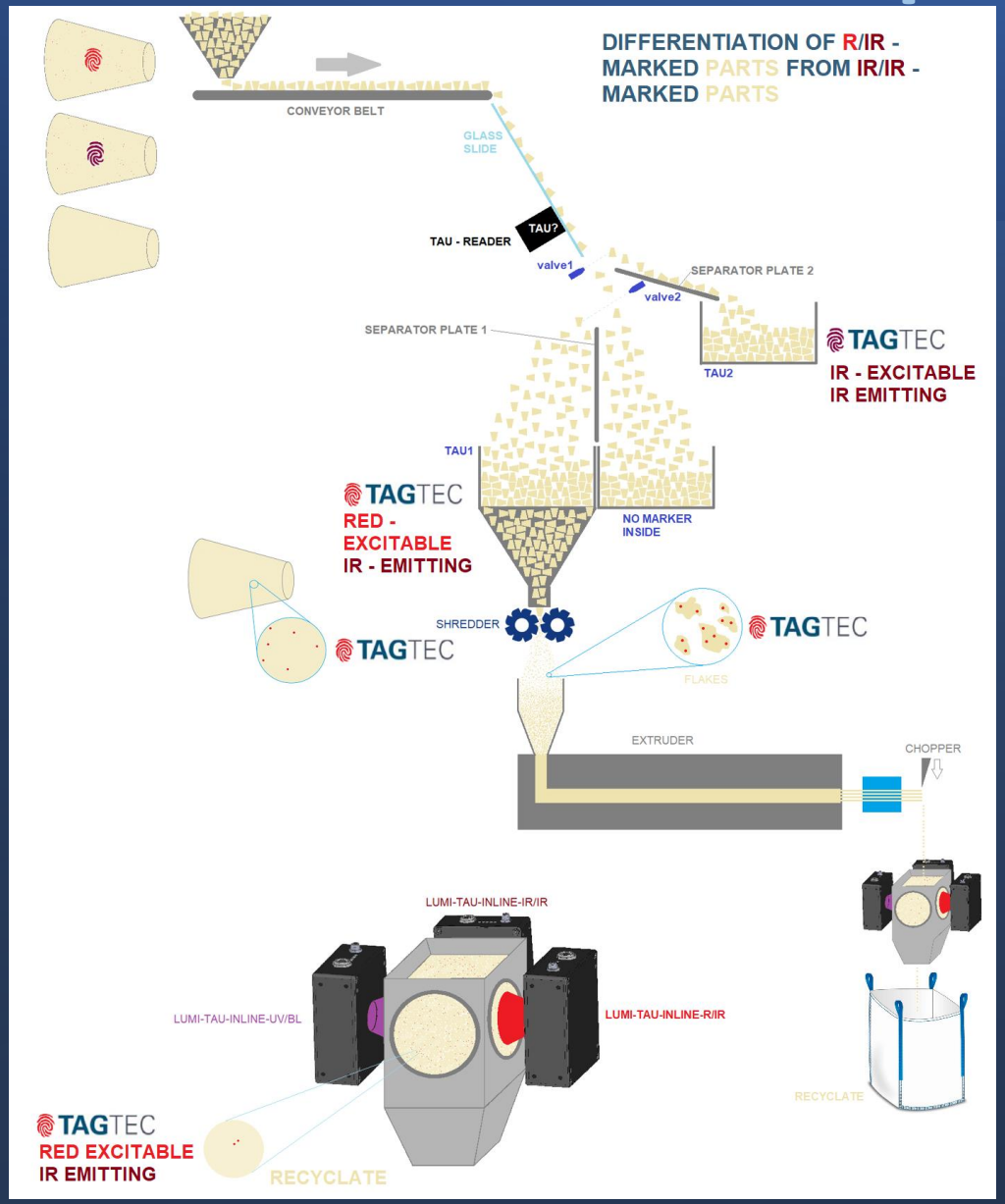
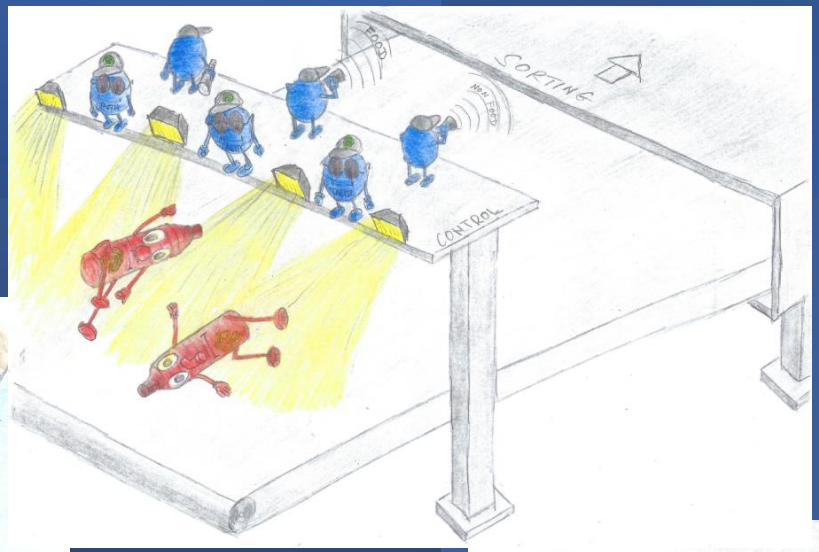
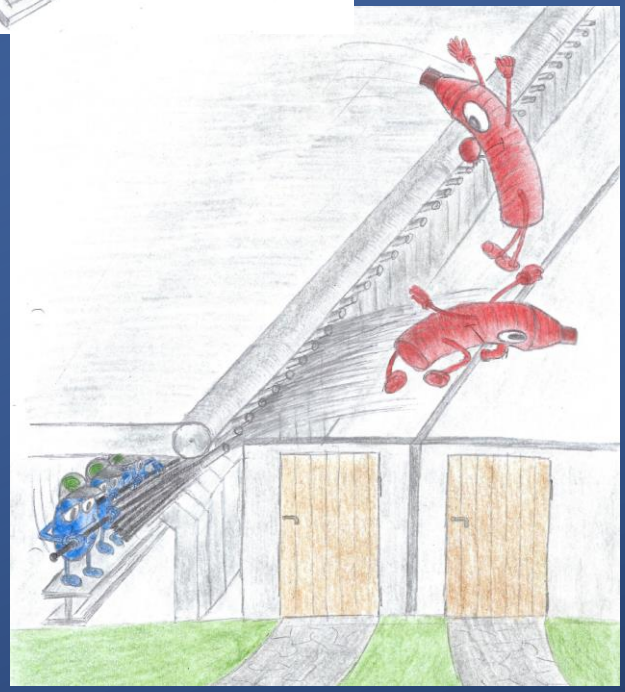
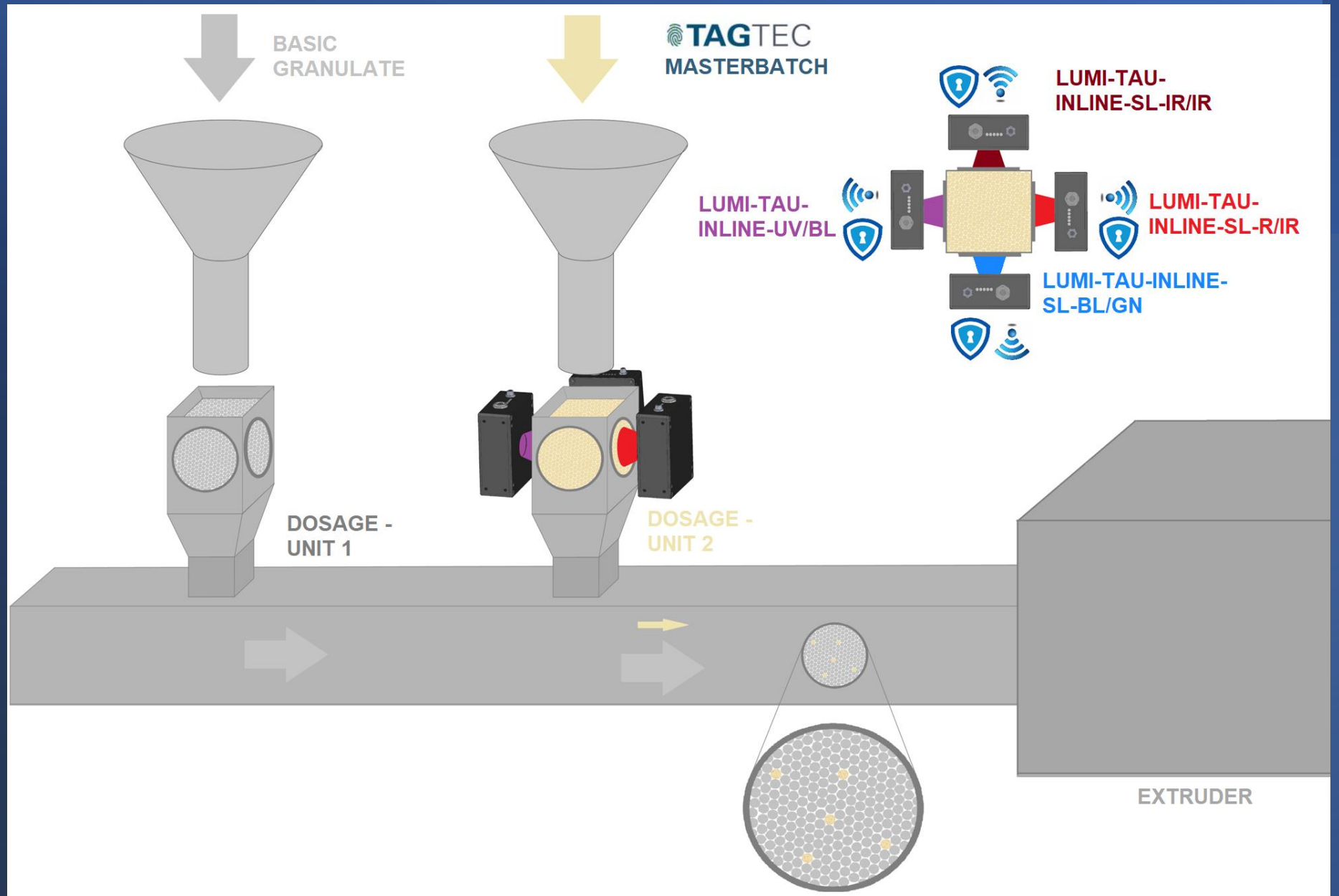
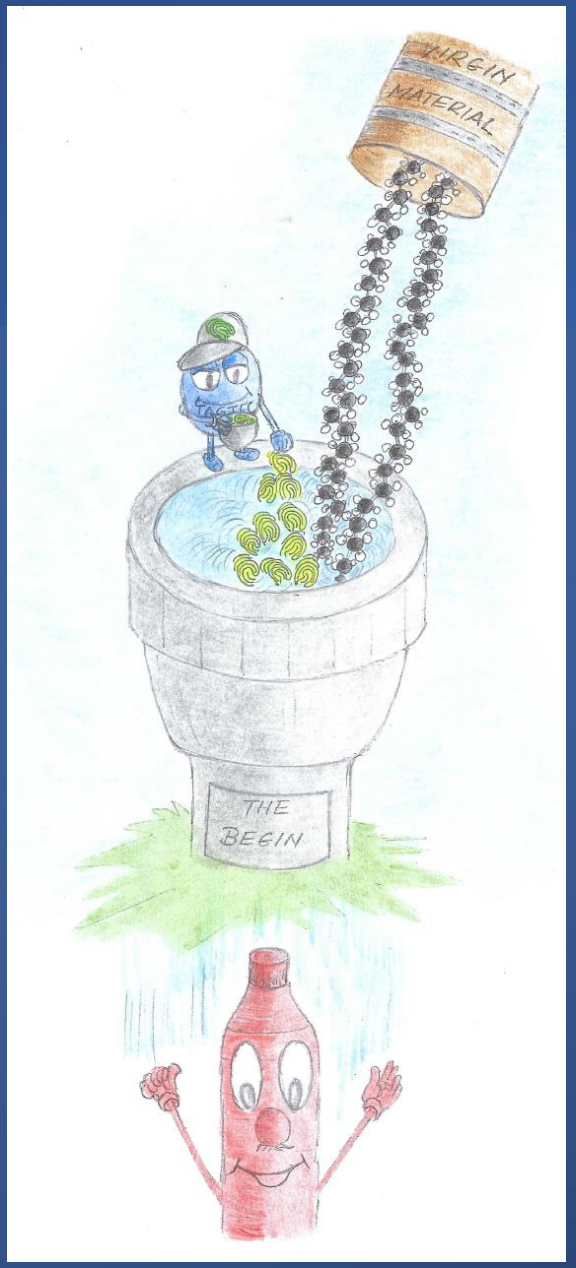
A brief comparision with reality








BASIC
GRANULATE
TAGTEC
MASTERBATCH
LUMI-TAU-
INLINE-SL-IR/IR
LUMI-TAU-
INLINE-UV/BL
LUMI-TAU-
INLINE-SL-R/IR
LUMI-TAU-INLINE-
SL-BL/GN
DOSAGE -
UNIT 1
DOSAGE -
UNIT 2
EXTRUDER


VIRGIN
MATERIAL
THE
BEGIN

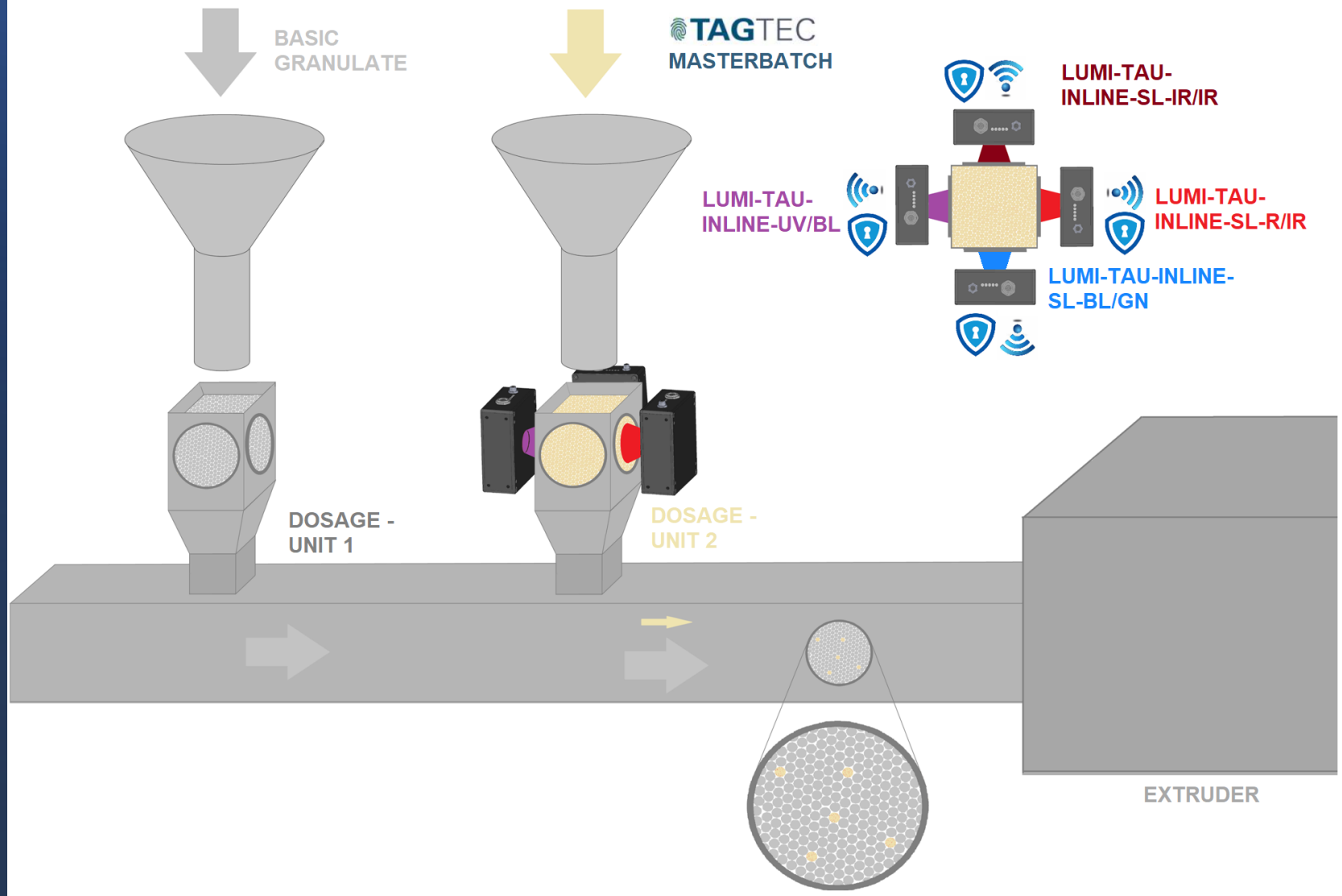
In the following, a concept will be presented that enables a clear allocation of the plastic packaging in its respective physical state. By means of suitable marker technology, a marked package or parts of the package, for example flakes or pellets, can be assigned to a specific group. By using different markers, different groups can be defined, for example:

- Food
- Detergents
- Body care
- Chemical special products

At best, the plastic material should be reassigned to the same use, the same group, after a complete cycle.

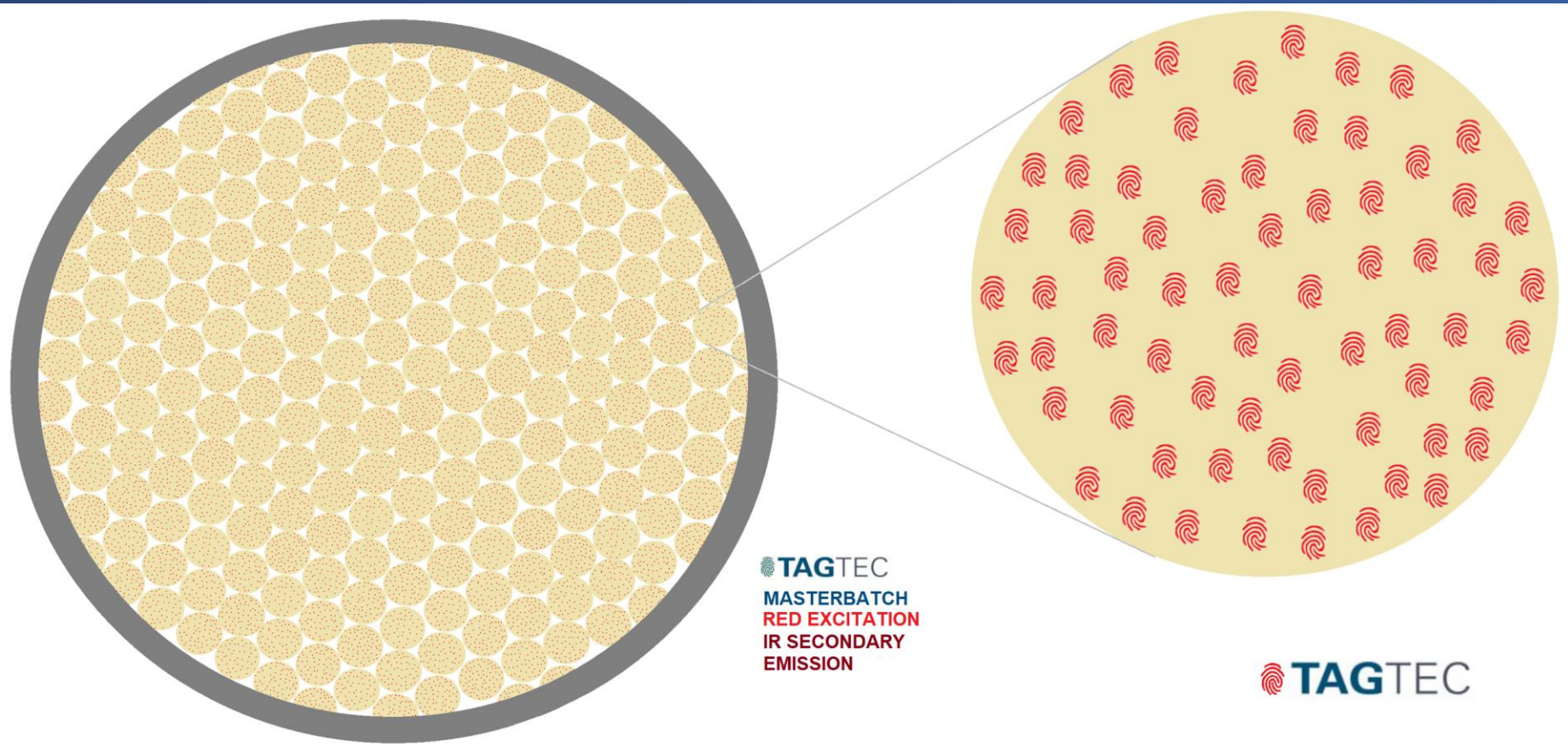
FROM PELLET TO PELLET

TAGTEC



For example, the first life cycle of a plasstic package starts with an appropriately marked (with TAGTEC - marker), which is selected depending on the respective group membership: FOOD, DETERGENTS, BODY CARE and CHEMICAL SPECIAL PRODUCTS.
The dosing units can be used to determine the marker concentration in the plastic packaging. Sensors are used to check whether the correct marker is used in the correct concentration. The TAGTEC - markers are designed in such a way that they do not interfere with each other. In the extruder, the granulate mixture is liquefied and with the help of a suitable injection mold, the production of the desired plastic packaging can take place. The TAGTEC - marker is correspondingly robust and therefore resistant to temperature and pressure. The TAGTEC - marker particle size is only a few µm.

TAGTEC



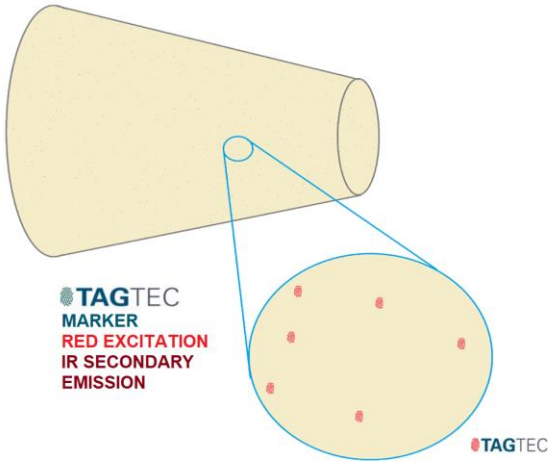
The TAGTEC - marker shown here can be excited using red light, with secondary emission in the near infrared (NIR) range. The marker shows phosphorescent behavior. The duration of the afterglow serves as a measured variable (TAU).
In addition to the TAGTEC - marker that can be excited in the red and respond in the NIR range, there are markers that can be excited in the UVA range and provide a time-delayed optical response in the visible wavelength range.
Furthermore, there are markers that can be excited with blue light (the time-delayed optical response is then in the green wavelength range, for example) and then there are NIR excitable markers, whose time-delayed response is also in the NIR range. The smallest amounts of marker are sufficient for the plastic packaging and parts of the plastic packaging (flakes, pellets) to be reliably detected by the respective sensor system.

TAGTEC

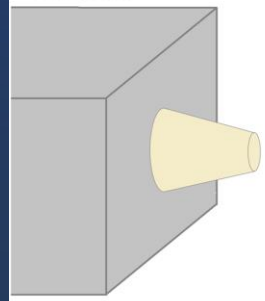
LUMI-STAR - TECHNOLOGY:

INDIVIDUAL RECOGNITION AND TRACKING

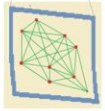
LUMI-STAR-INLINE-R/IR



EXTRUDER

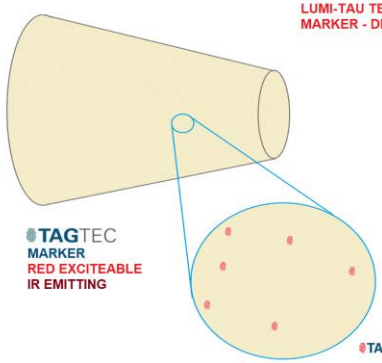


LUMI-STAR-INLINE-R/IR

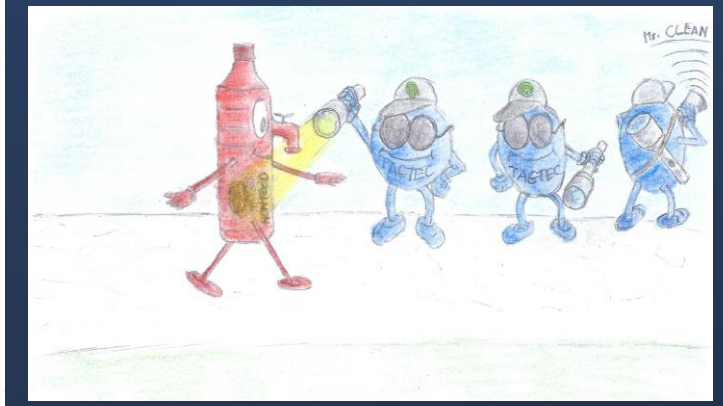


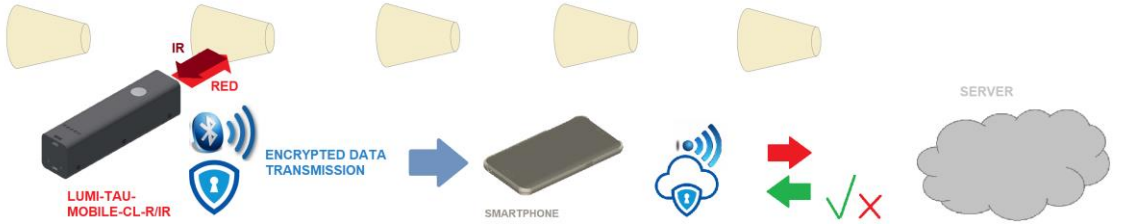
RECORDING OF THE STAR - CODE AND STORE AS REFERENCE (INDIVIDUAL CODE)

LUMI-TAU TECHNOLOGY:
MARKER - DETECTION



LUMI-TAU-MOBILE-CL-R/IR

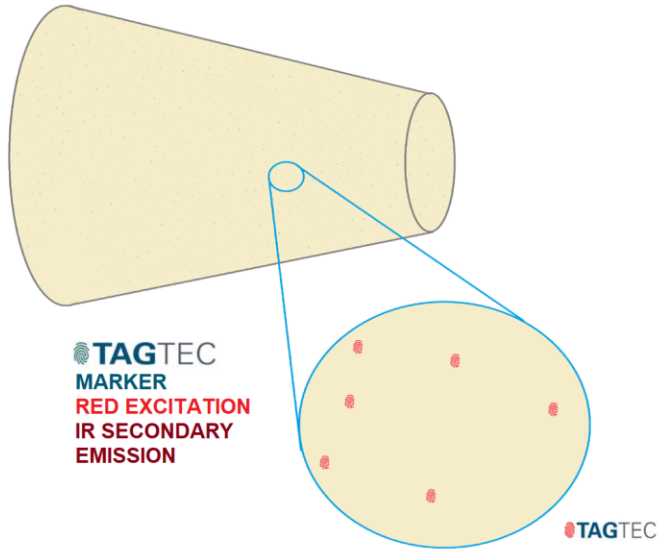


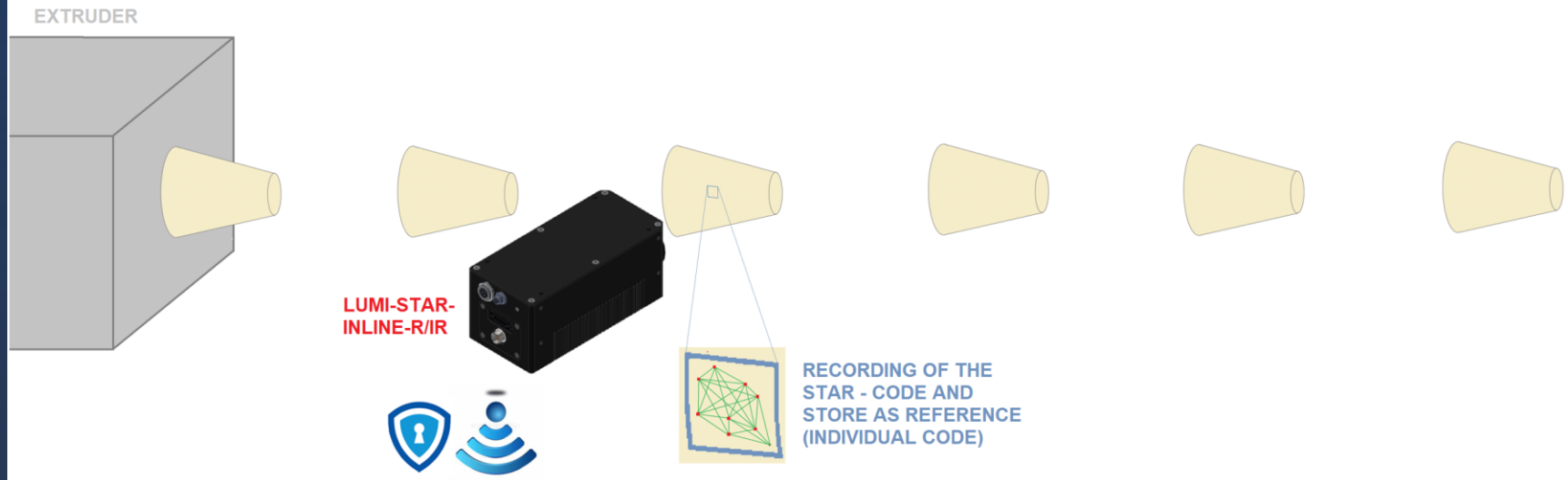


LUMI-STAR - TECHNOLOGY:

INDIVIDUAL RECOGNITION AND TRACKING

LUMI-STAR-INLINE-R/IR

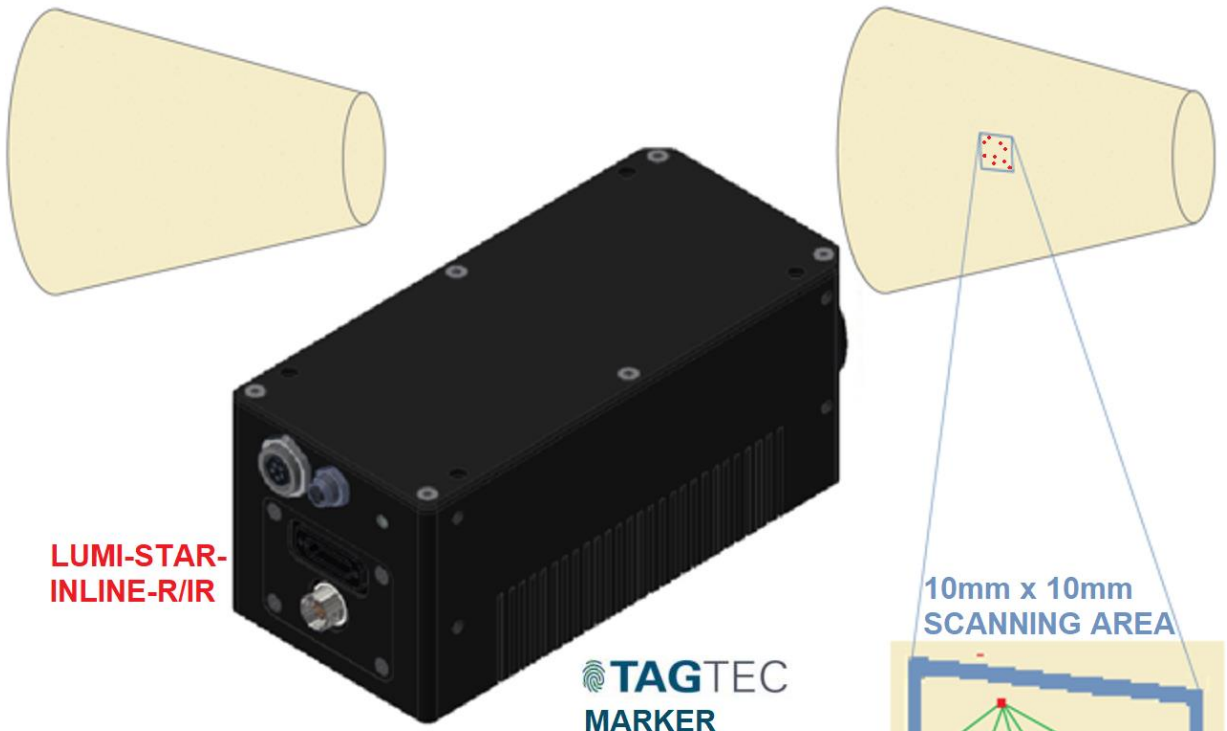




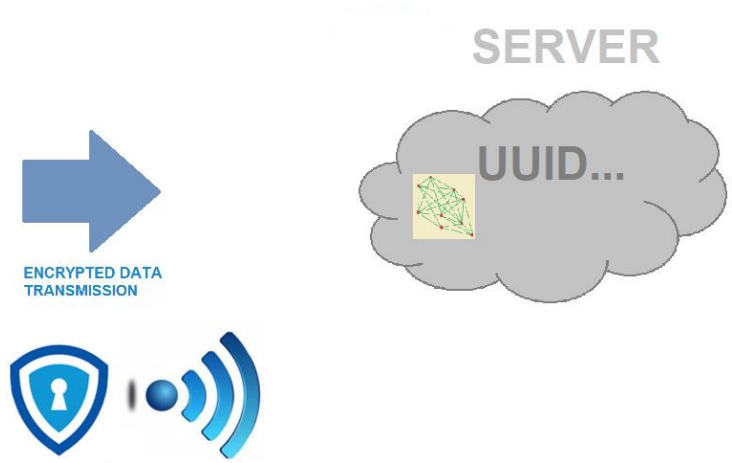
In addition to the identification of group membership defined by respective TAGTEC - marker, it is now also possible to generate an individual code (the so-called STAR code) for the plastic after the injection molding process using STAR technology. During illumination of a specific area (approx. 10mm x 10mm) on the packaging, with light of the appropriate excitation wavelength, the TAGTEC - marker particles are excited to fluoresce, forming an individual "star pattern". The constellation of the luminous particles is stored in the system in coded form for each plastic packaging recorded as a reference. In addition to the UUID (Universally Unique Identifier), other data such as date, time, geodata, machine data and production data are usually stored in the system. When queried later, the UUID of the plastic packaging can now be recognized by means of the LUMI-STAR system.

TAGTEC

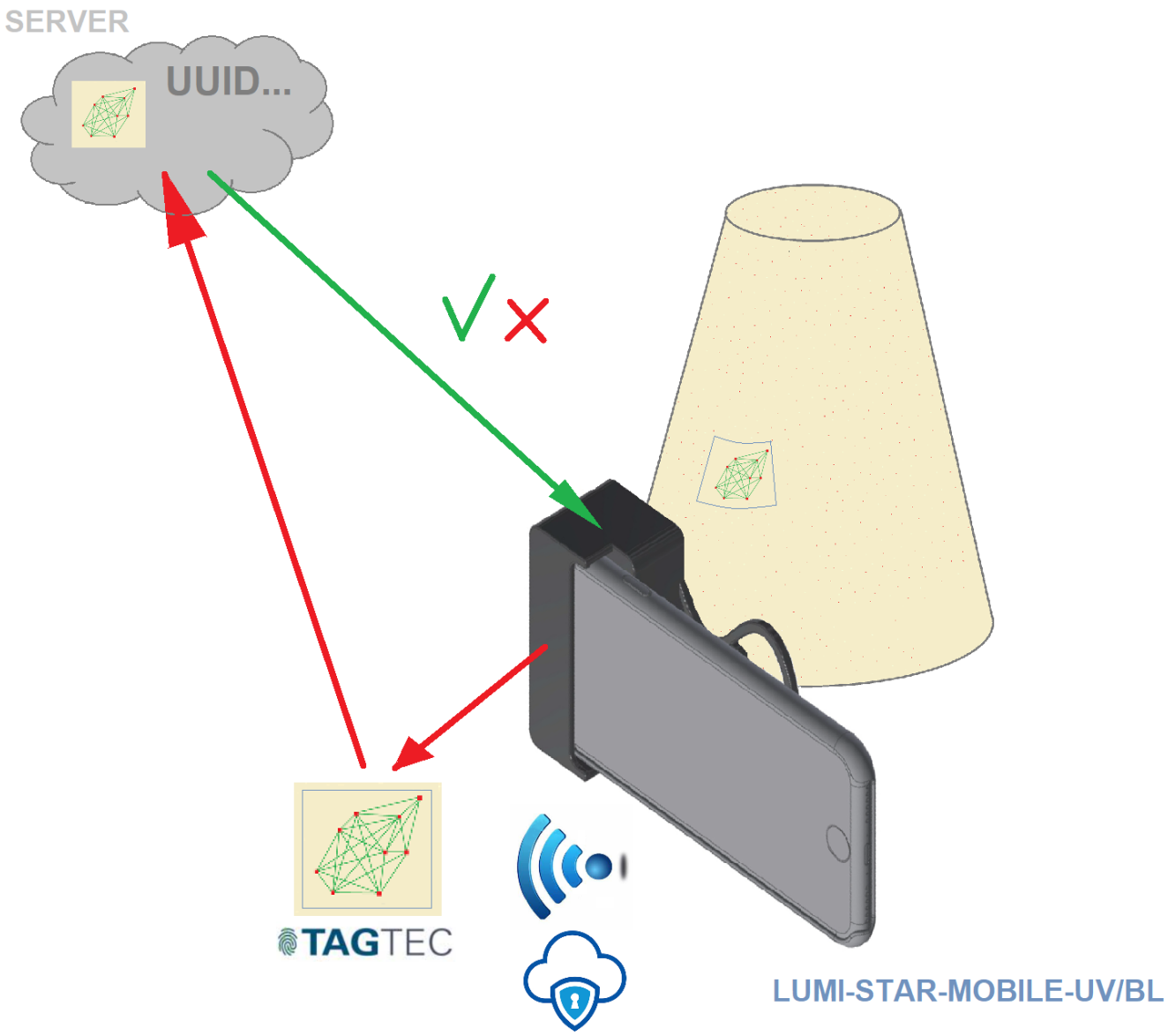
LUMI-STAR - TECHNOLOGY: INDIVIDUAL CAPTURE



A few fluorescent particles in an area of 10mm x 10mm are sufficient to generate a unique individual code. The particle constellation (particle code) is transmitted encrypted via LAN to a server by means of LUMI-STAR-INLINE-... and stored there as a reference -> Particle Code Recording.

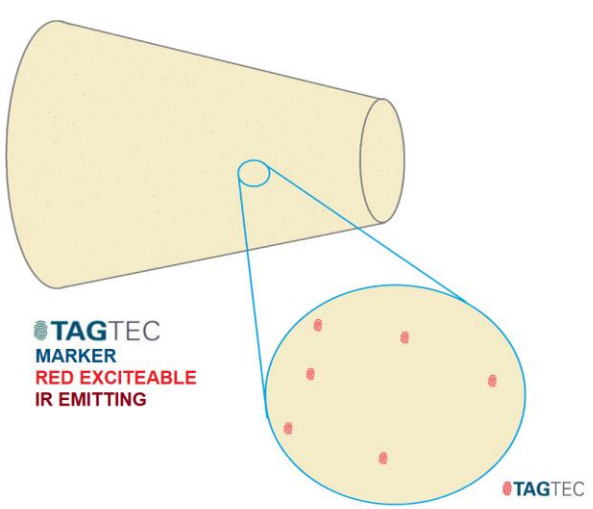


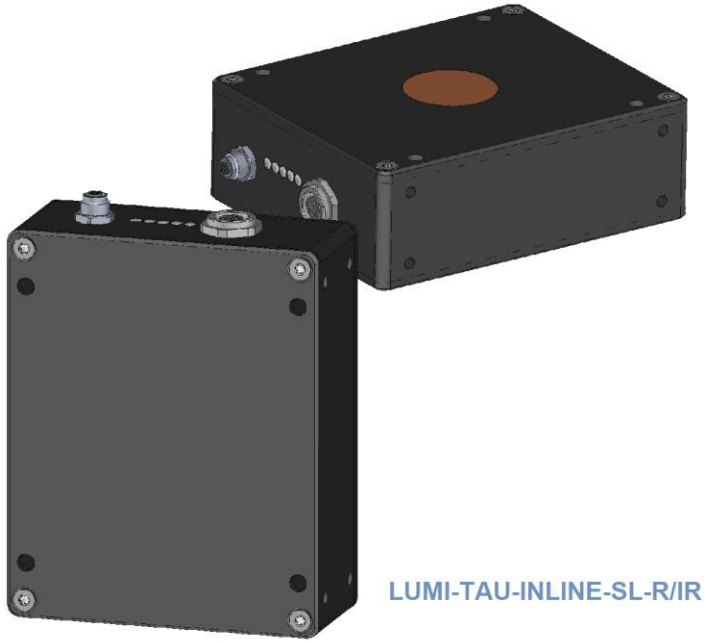
TAGTEC



The STAR code can also be recorded on a mobile basis using the LUMI-STAR-MOBILE-... devices. The sensor system has been designed as a shell for this purpose, thus allowing it to hold a smartphone. Using the smartphone's image processing unit, the STAR code can now be recorded at the point on the packaging where the reference code was originally recorded using LUMI-STAR-INLINE-... immediatelly after production of the plastic packaging. The STAR code, including geodata, date and time, is then forwarded to the designated server in encrypted form via WLAN. This checks the STAR code and searches for the reference, the so-called digital twin. If there is a match, a corresponding entry is made in the supply chain software, otherwise an error message is displayed.

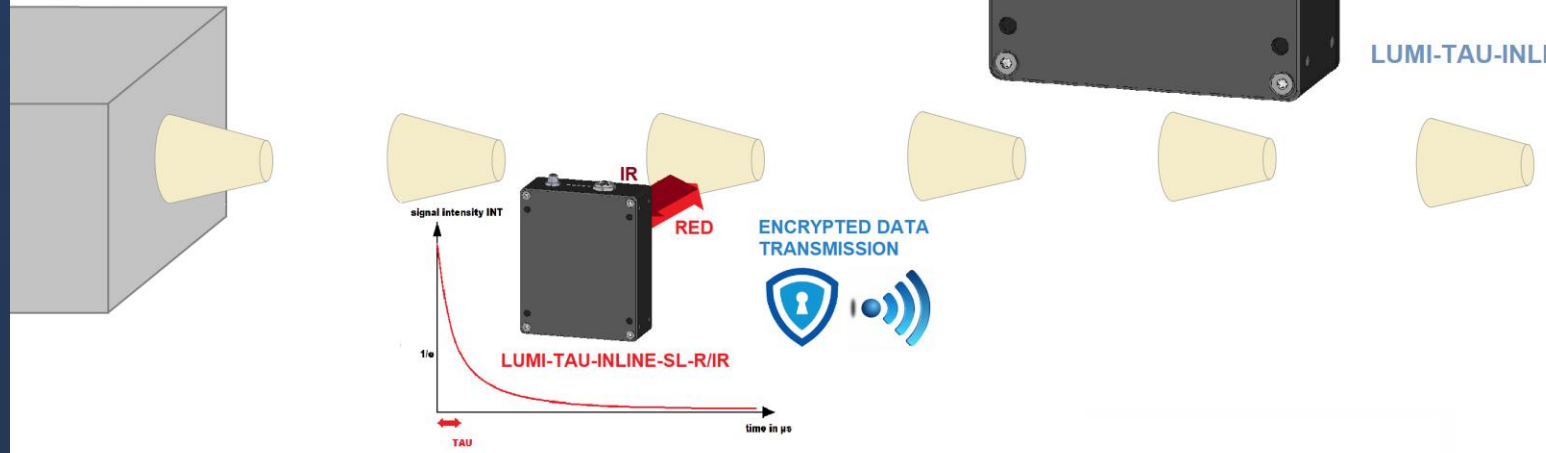
LUMI-TAU TECHNOLOGY:
MARKER - DETECTION





LUMI-TAU-INLINE-SL-R/IR

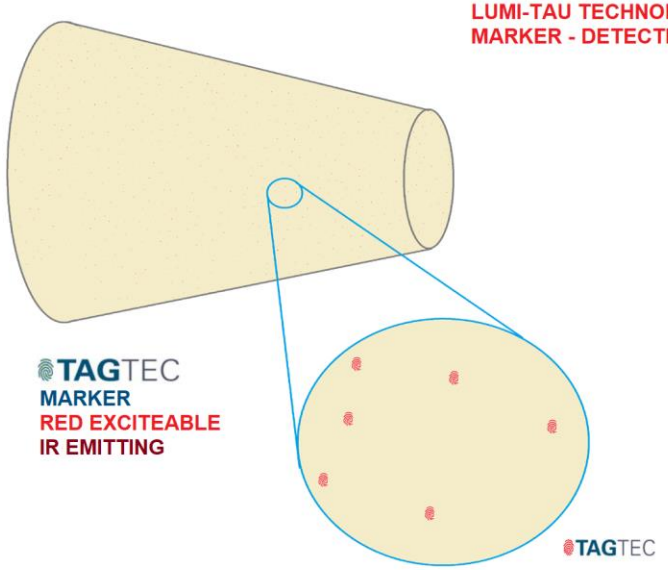
EXTRUDER



During the production of the plastic packaging, the TAU - Reader LUMI-TAU-INLINE-SL-... can be used to check inline whether the correct TAGTEC - marker is used in the appropriate concentration. Both the TAU value (the decay time constant of the response signal) and the intensity value INT of the signal can be monitored, and faulty objects can be sorted out in real time. Furthermore, the data can be passed on in encrypted form to supply chain monitoring software. Blockchain technology can then be used to track the product group throughout its lifecycle, if needed.

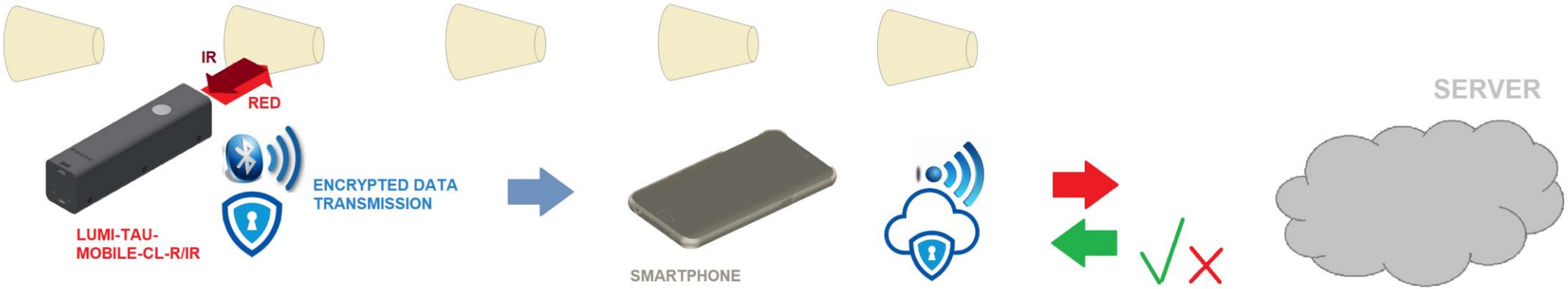
TAGTEC

LUMI-TAU TECHNOLOGY:
MARKER - DETECTION

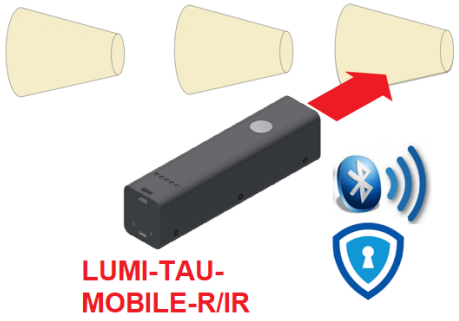


LUMI-TAU-MOBILE-
CL-R/IR

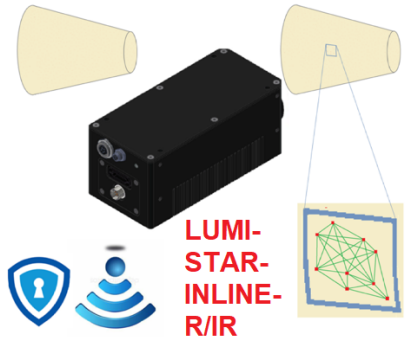
The physical size characteristic of the TAGTEC - marker can now also be recorded using the LUMI-TAU-MOBILE-... mobile unit. The mobile device can transmit measurement data such as time constant (TAU) and signal intensity (INT) together with the geodata, date and time in encrypted form via Bluetooth to a smartphone and via a smartphone to the server via WLAN, whose software monitors the supply chain, among other things. The APP of the smartphone then receives a feedback from the server that the supply chain has been correctly complied with or not complied with up to that point.



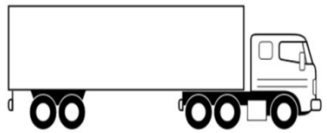
TAGTEC



LUMI-TAU-MOBILE-R/IR

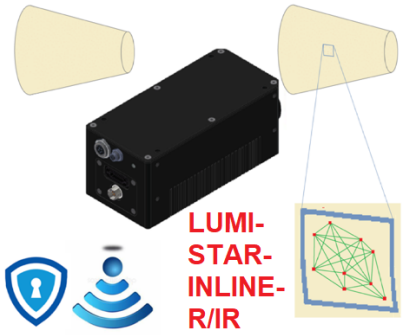


LUMI-STAR-INLINE-R/IR

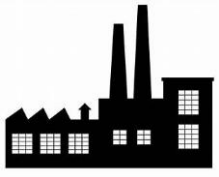


TRANSPORT

LUMI-TAU-MOBILE-R/IR



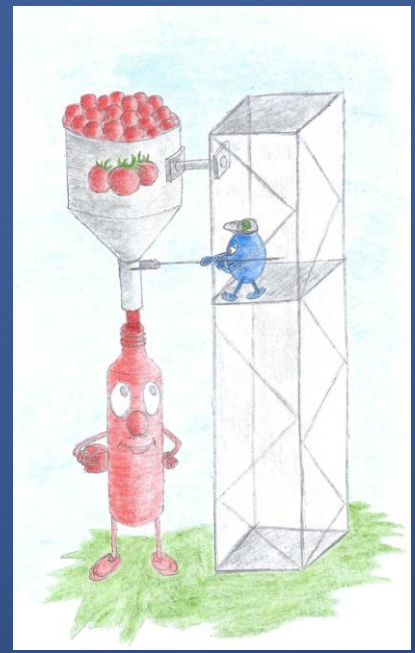
LUMI-STAR-INLINE-R/IR

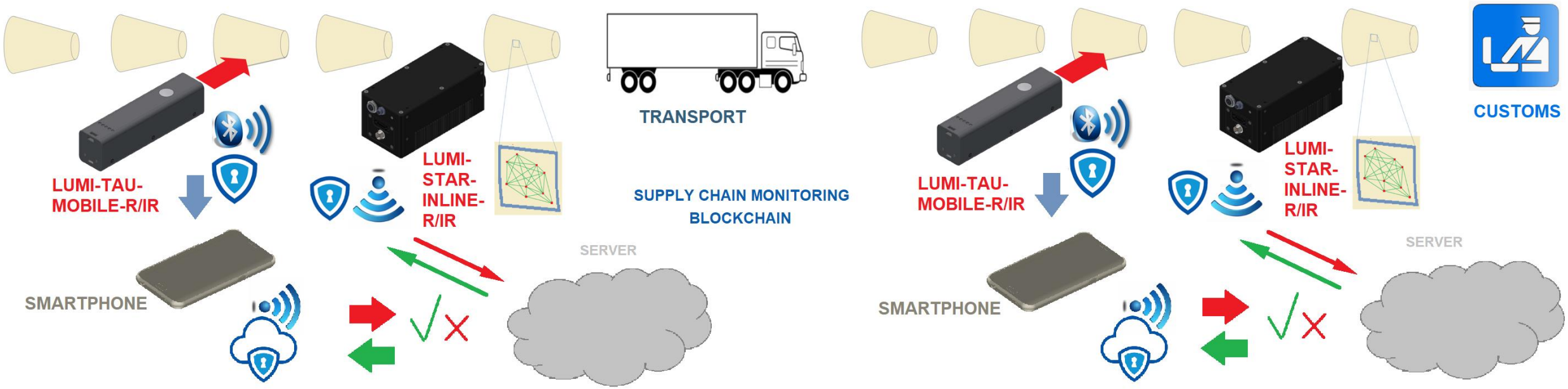


FILLING STATION

SUPPLY CHAIN MONITORING
BLOCKCHAIN

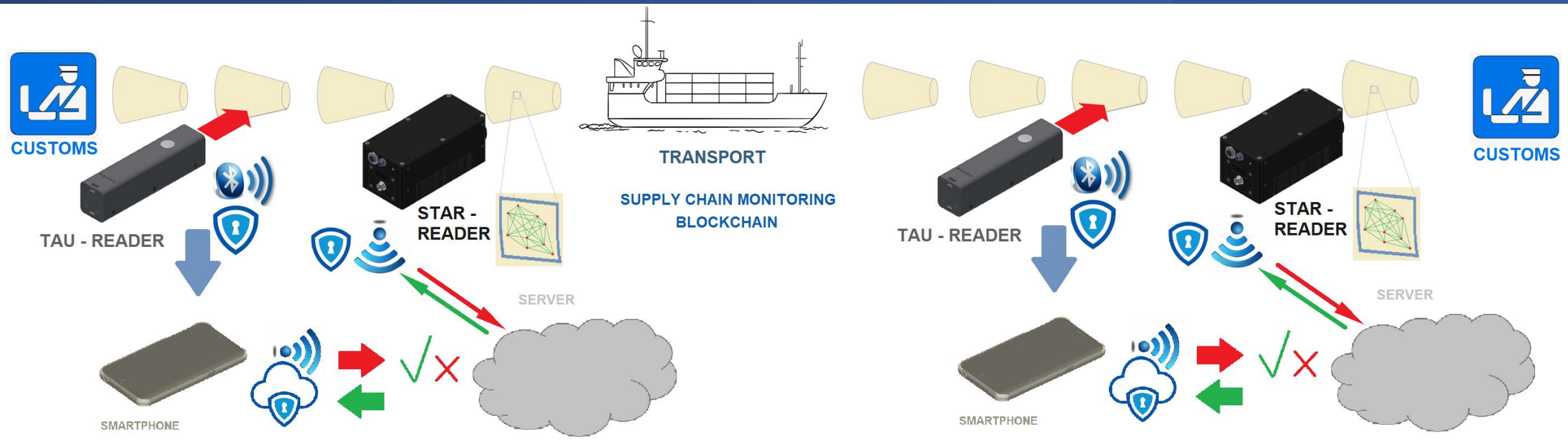
SUPPLY CHAIN MONITORING
BLOCKCHAIN





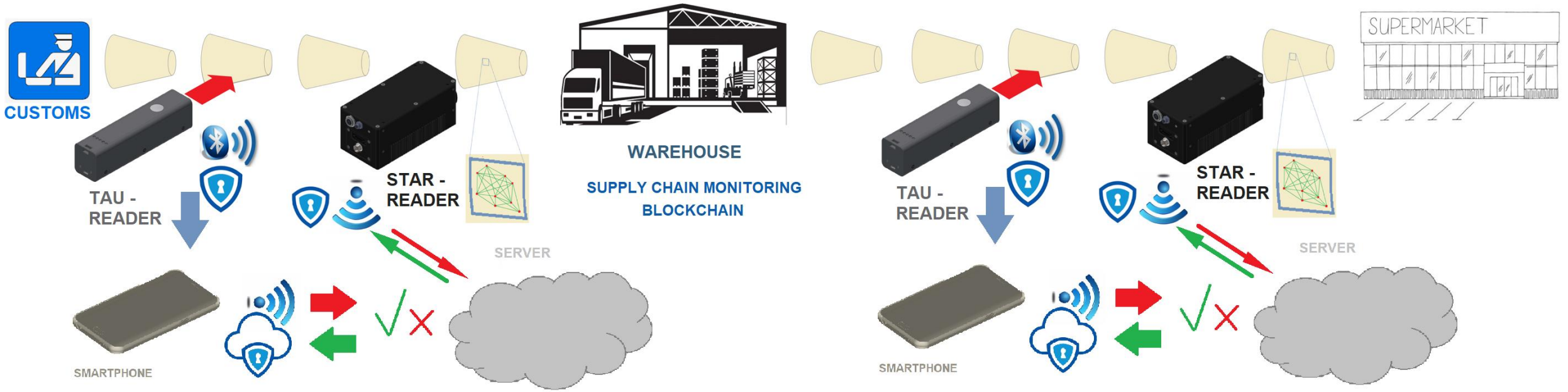
At the individual points in the supply chain, a check can now be carried out using INLINE or MOBILE devices. With the help of the TAU devices, the group code can be monitored, while the STAR devices determine a code that applies individually to the respective object.

TAGTEC



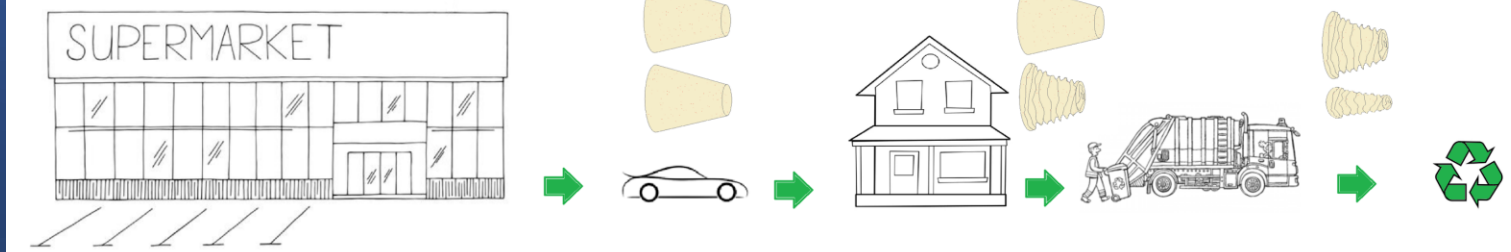
With the help of the block chain technology, the relevant data can now be queried at the individual control points. A fault in the chain can be detected immediately.

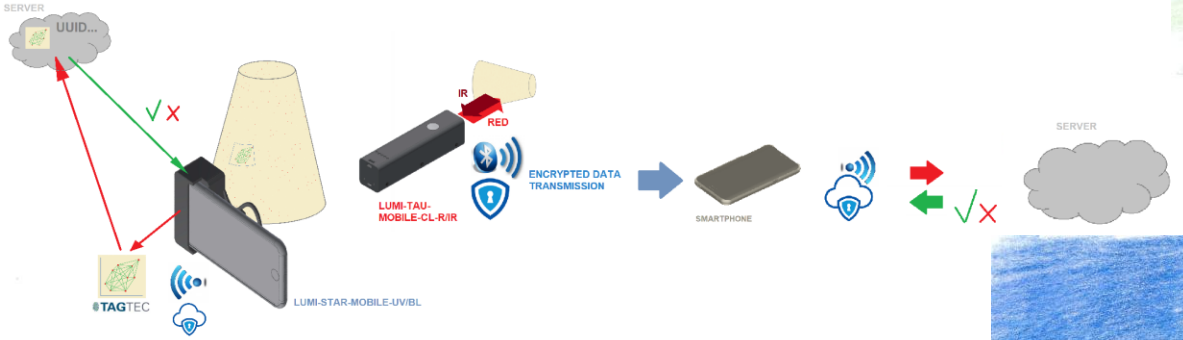
TAGTEC

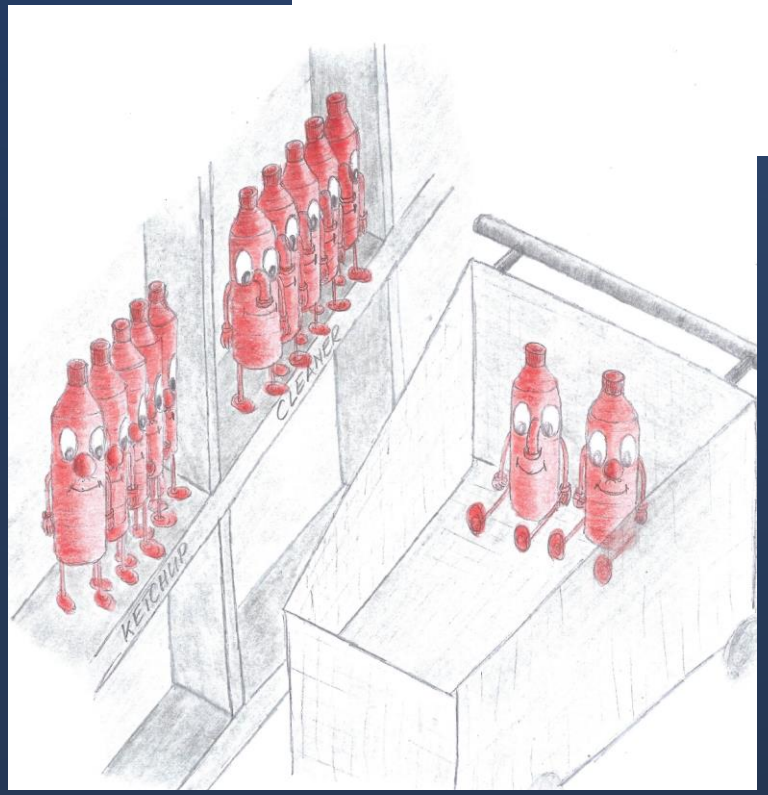


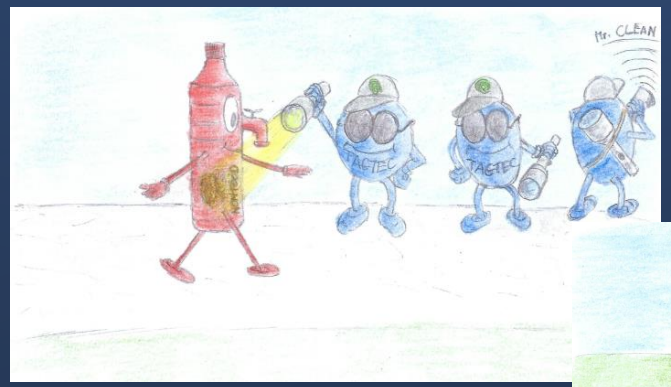
Supply chain verification usually extends to B2B - exchange of goods, thus product tracking usually ends at B2C - exchange of goods.

TAGTEC

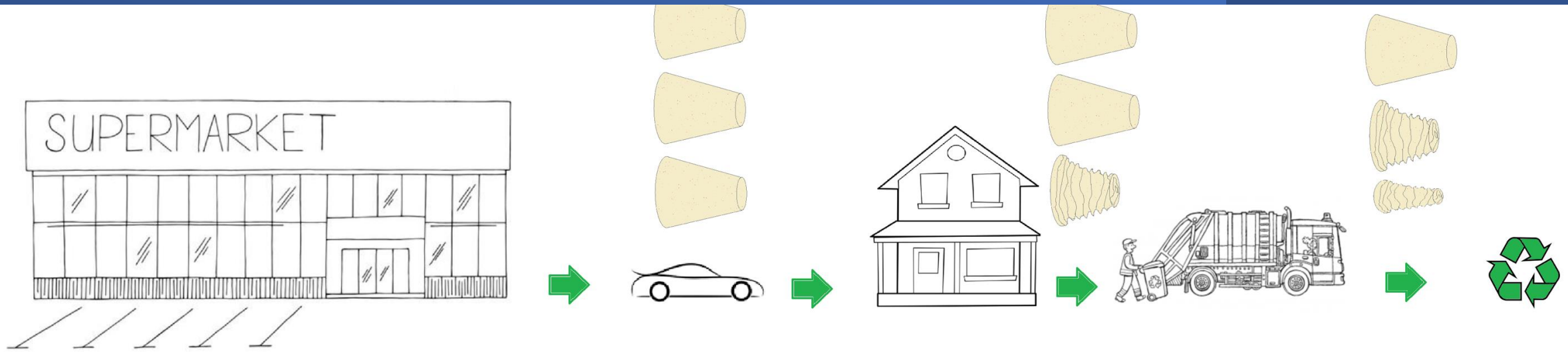

SUPERMARKET

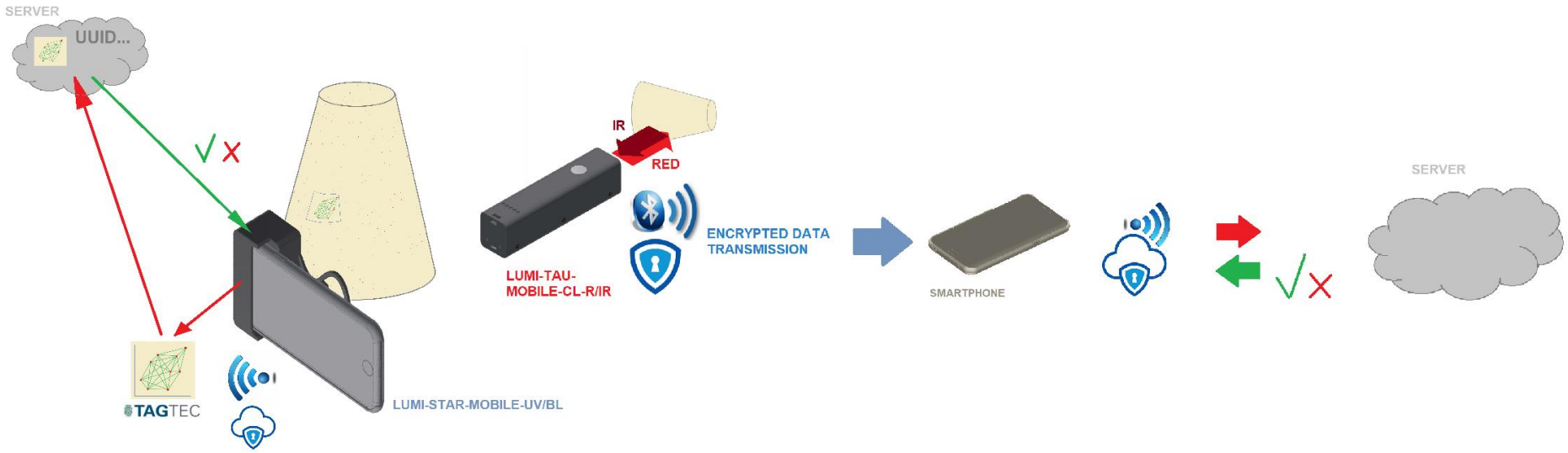

SERVER
UUID...
IR
RED
LUMI-TAU-MOBILE-CL-R/IR
ENCRYPTED DATA TRANSMISSION
SMARTPHONE
SERVER
TAGTEC
LUMI-STAR-MOBILE-UV/BL


CLEANER
KETCHUP

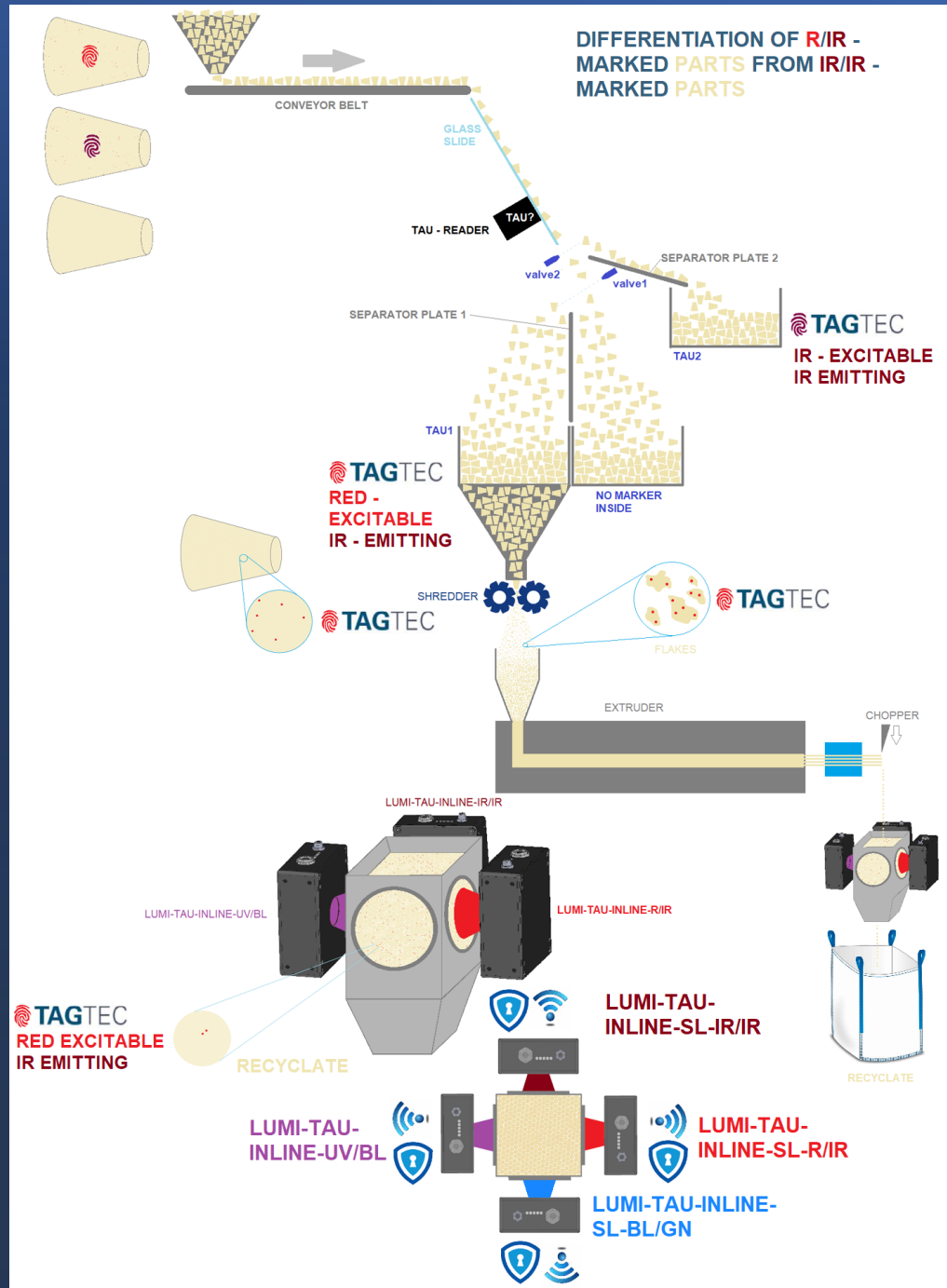

Mr. CLEAN

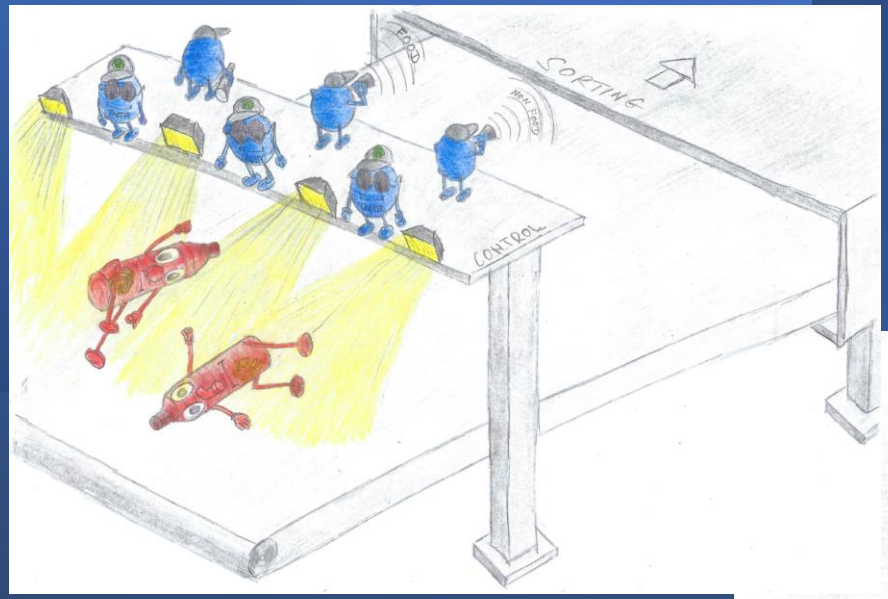

Mr. TOMATO

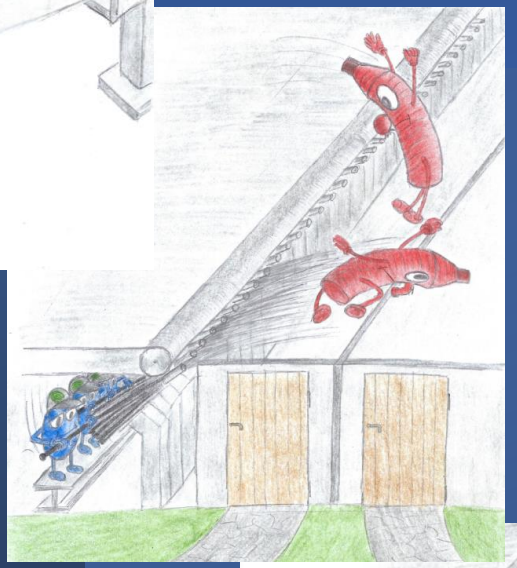


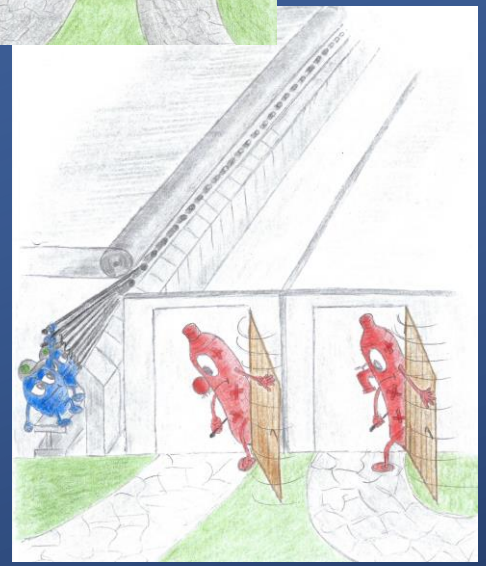


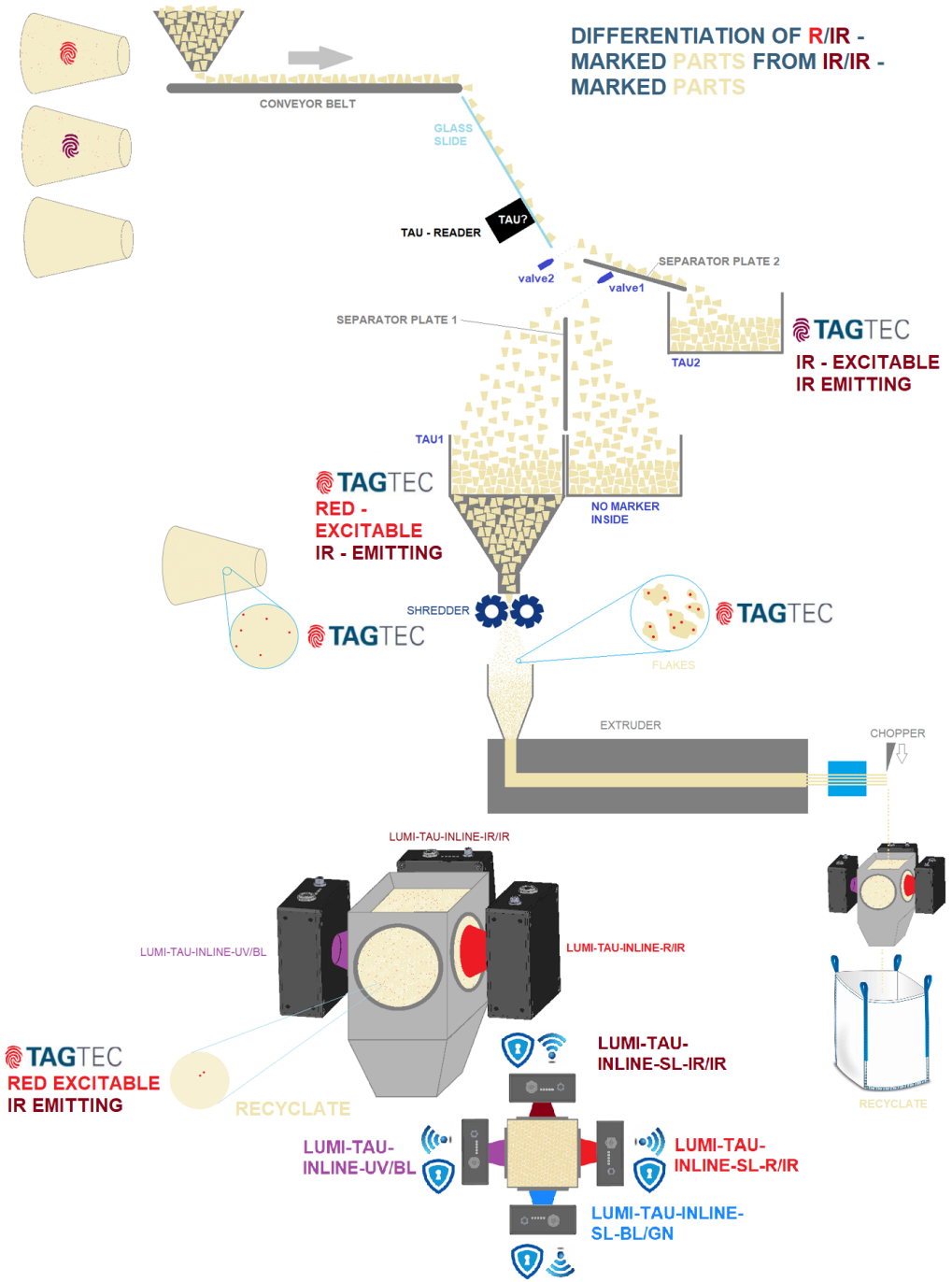
But also in the C - range the consumer has the possibility to control the plastic packaging by means of a mobile STAR- or TAU- reader. However, the verification of the STAR - code usually ends at a deformation of the packaging. With the TAU - Reader, however, even deformed packages can still be detected clearly.


DIFFERENTIATION OF R/IR - MARKED PARTS FROM IR/IR - MARKED PARTS
CONVEYOR BELT
GLASS SLIDE
TAU - READER
TAU?
valve2
valve1
SEPARATOR PLATE 2
SEPARATOR PLATE 1
TAU2
TAGTEC
IR - EXCITABLE IR EMITTING
TAU1
NO MARKER INSIDE
TAGTEC
RED - EXCITABLE IR - EMITTING
SHREDDER
TAGTEC
TAGTEC
FLAKES
EXTRUDER
CHOPPER
LUMI-TAU-INLINE-IR/IR
LUMI-TAU-INLINE-UV/BL
LUMI-TAU-INLINE-R/IR
TAGTEC
RED EXCITABLE IR EMITTING
RECYCLATE
LUMI-TAU-INLINE-SL-IR/IR
RECYCLATE
LUMI-TAU-INLINE-UV/BL
LUMI-TAU-INLINE-SL-R/IR
LUMI-TAU-INLINE-SL-BL/GN


SORTING
CONTROL





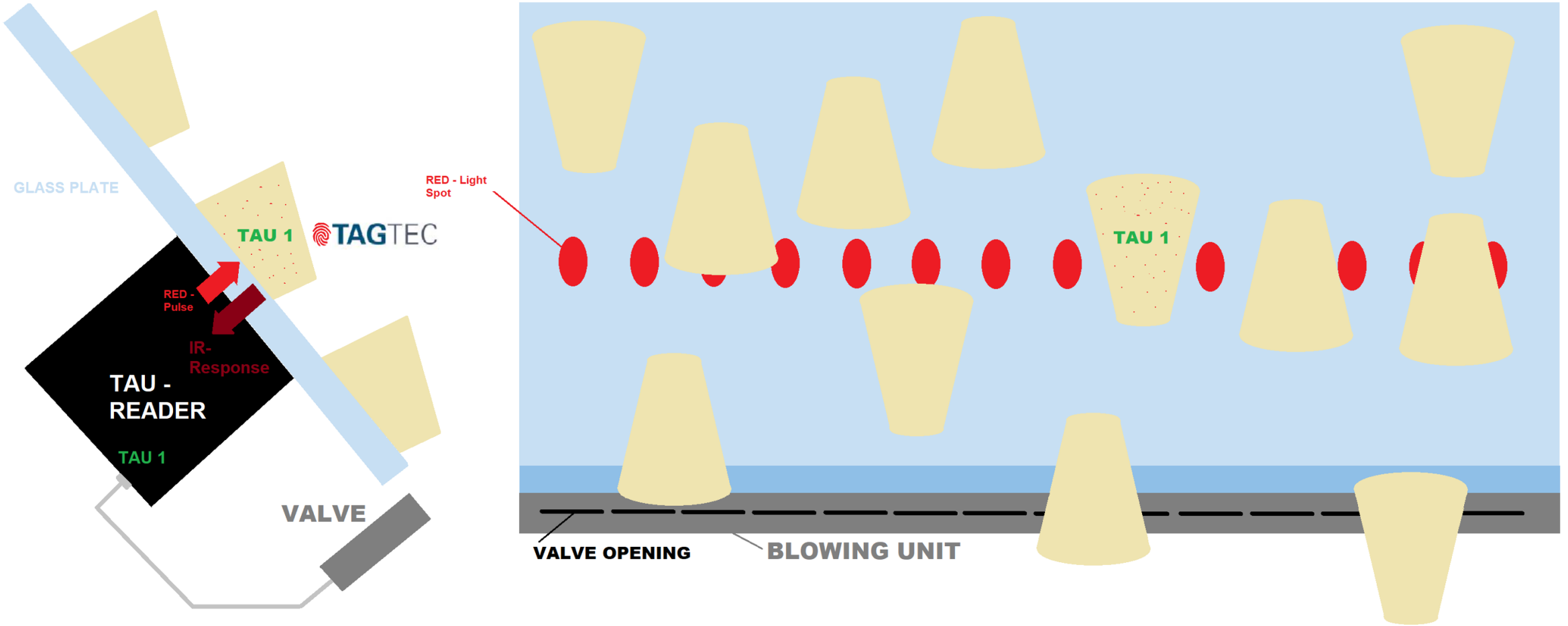


The plastic packaging pre-sorted by the consumers is then sorted by color in the recycling plant and then differentiated and sorted by type of plastic (PP, PE, PET, PVC, HDPE, ...) using NIR sensor technology or NIR spectral line camera systems. Three fractions are usually separated per system. In order to achieve complete product stream separation, a cascaded approach must also be taken here. Each system has two sorting units; sorting (two units per system) is carried out with blast air valve strips, whose valves are activated specifically after respective type of plastic has been identified. For each system, valves on the blast air bar selectively sort out objects at an angle of 90° to the product flow, while a second bar sorts out the detected objects in exactly the opposite direction (i.e., at -90°). A similar procedure is now followed after the color sorting and the plastic type sorting for the separation by type of use. The plastic packaging already sorted by color and plastic type is now examined and sorted with regard to the intended use:

- Nahrungsmittel TAGTEC (FOOD)
- Waschmittel TAGTEC (DETERGENTS)
- Körperpflege TAGTEC (BODY CARE)
- Chemische Spezialprodukte TAGTEC (SPECIAL CHEMICAL PROTUCTS)

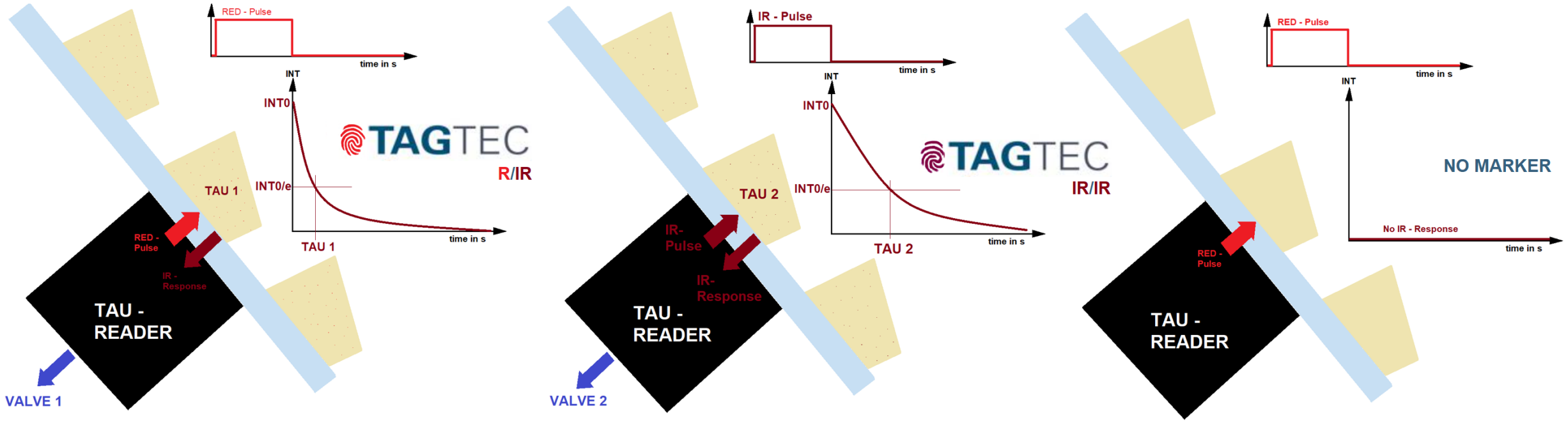
Here, too, three fractions can be separated per sorting unit. The sensor system, the TAU - reader, can recognize two different TAGTEC - markers. The objects are then separeted via two blowing air bars. The respective TAGTEC marker reacts only to the respective excitation light source, an influence by the respective other light source is not present. In order for the 4 fractions to be separated, the plastic packaging that has not yet been detected must be sent through a second sorting unit, whose TAU reader searches for the other two TAGTEC markers (cascaded process). After separation by type of use, the objects are first shredded and then processed into recyclate in the extruder. Before the recyclate is filled, a final check is made with regard to the proportion of the respective TAGTEC markers in the recyclate. This information can then be passed back to supply chain monitoring.

TAGTEC



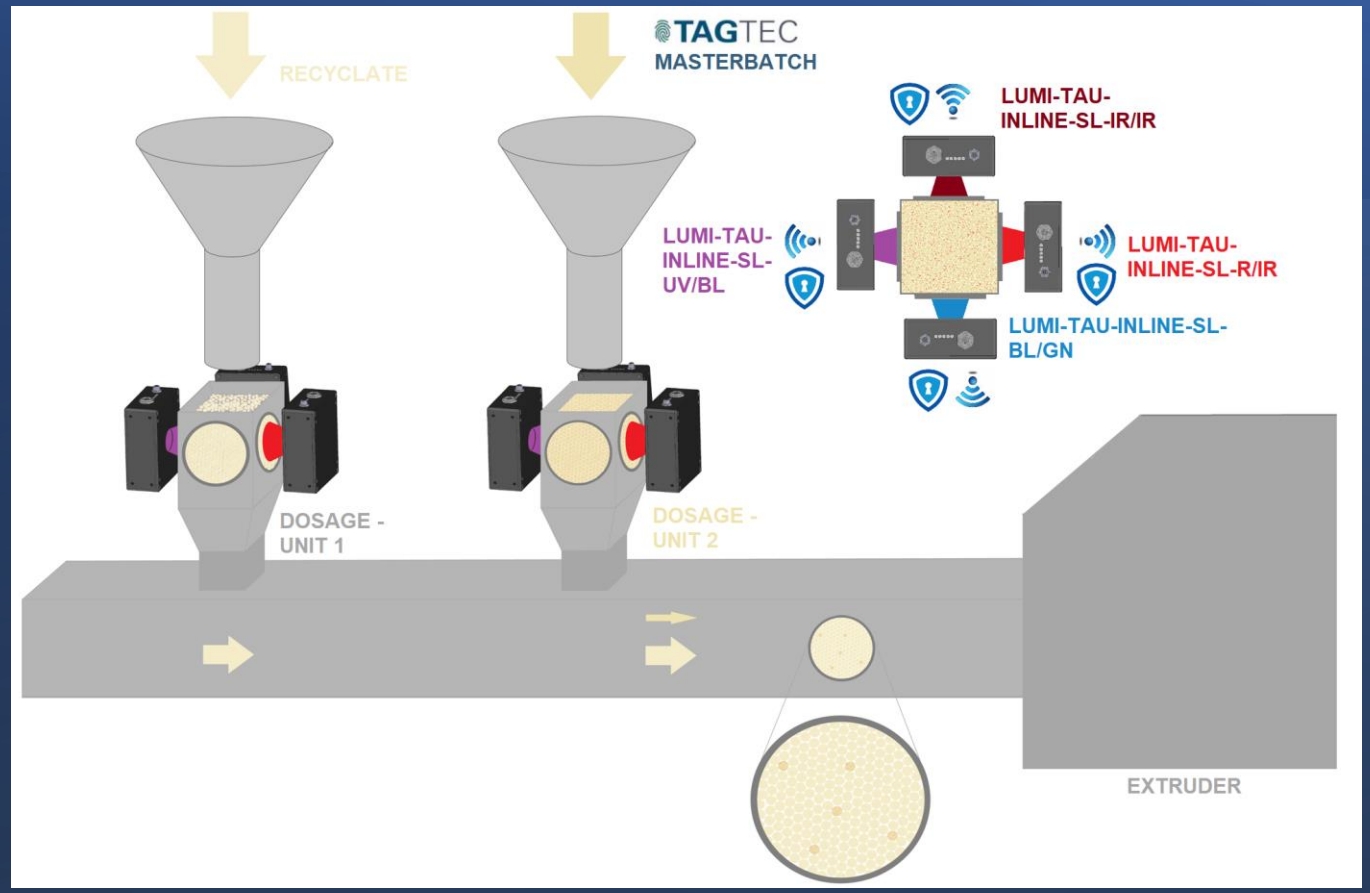
Now, in order to sort a sufficient quantity of plastic packaging per unit of time, several TAU readers must be arranged next to each other. Together, these form a detector line. If an object is detected by a TAU reader (each TAU reader has two excitation light sources and can detect two TAGTEC markers at the same time), the blow-off valves assingned to the respective TAU reader are activated with a time delay and the detected plastic packaging is sorted out from the product flow.

LUMI-TAU TECHNOLOGY: MARKER - DETECTION



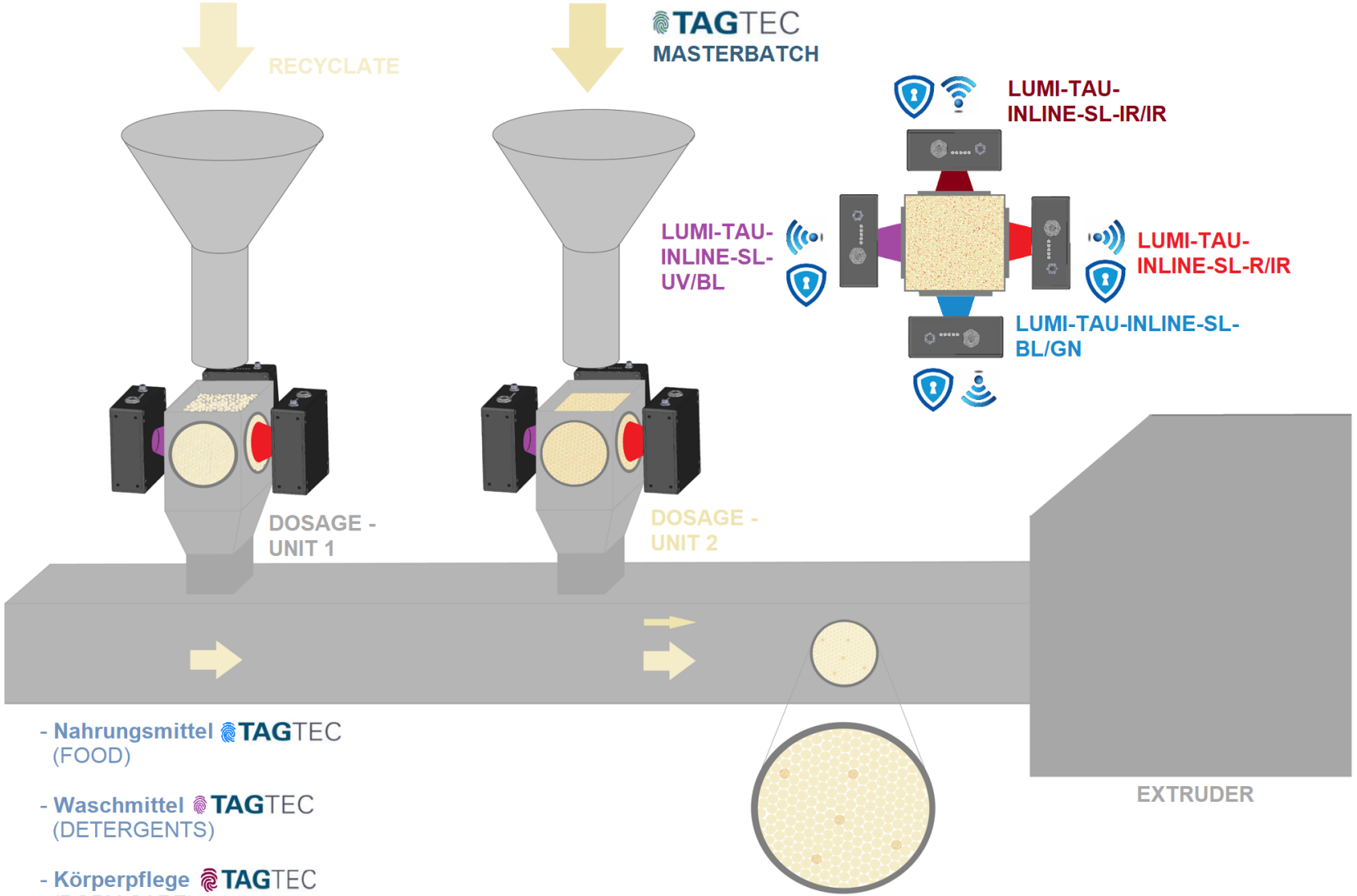
In order to avoid mutual interference of TAGTEC markers, TAGTEC markers are used which cannot influence each other. This is achieved with the help of TAGTEC markers, which react to different excitation wavelengths, but provide no signal response (no secondary emission) in the remaining wavelength range. The time constant (decay time of the signal response) is another indicator for the respective TAGTEC marker.

TAGTEC


RECYCLATE
TAGTEC
MASTERBATCH
LUMI-TAU-
INLINE-SL-IR/IR
LUMI-TAU-
INLINE-SL-
UV/BL
LUMI-TAU-
INLINE-SL-R/IR
LUMI-TAU-INLINE-SL-
BL/GN
DOSAGE -
UNIT 1
DOSAGE -
UNIT 2
EXTRUDER


JUNGBRUNNEN


JUNGBRUNNEN



From Pellet to Pellet

Now the cycle is closed, instead of virgin granulate, recyclate can now be used. By means of the two dosing units, the TAGTEC marker content intended for the respective plastic packaging can now be set. Both dosing units are equipped with the sensors required to detect the respective TAGTEC marker components. This allows a targeted search for residual TAGTEC markers. For example, if FOOD plastic packaging is produced, the percentage of TAGTEC markers in the recyclate should be as high as possible, while the remaining TAGTEC markers (DETERGENTS, BODY CARE, SPECIAL CHEMICAL PRODUCTS) should not exceed a certain percentage threshold. Using a suitable TAGTEC masterbatch, the missing amount of TAGTEC marker (TAGTEC in this example) is then added.

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TAGTEC