Laser-Spectroscopy for polymer sorting

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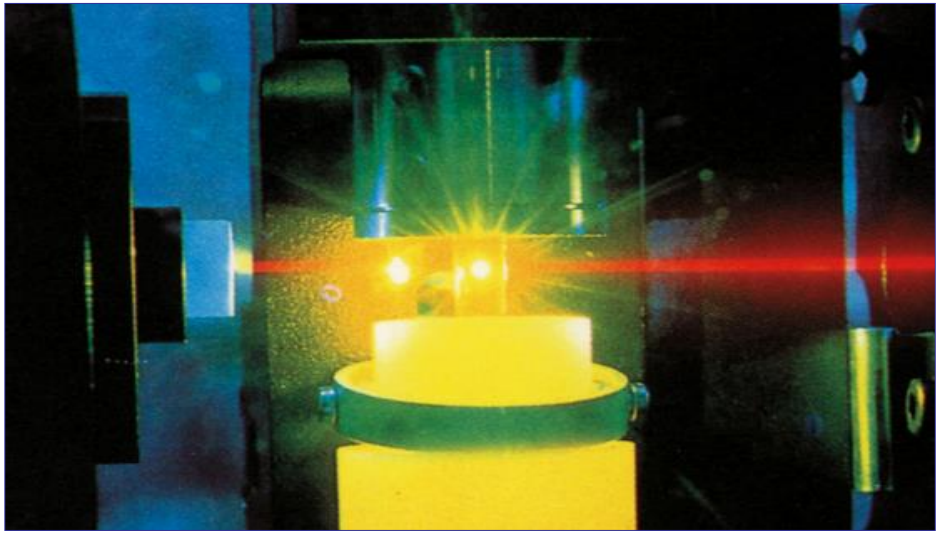
Amsterdam
March 30th, 2017

THE REVOLUTION IN SORTING

About UNISENSOR

- Non-destructive foreign substance detection *at speed of light in the process* with Optoelectronic sensor technology - mainly Absorption, Fluorescence and Raman spectroscopy
- Specialized in the
  - identification of substances (liquids, solids and gases) in industrial processes
  - measuring range: ppb - %
- Founded in 1990 by Prof. Dr.-Ing. Gunther Krieg
- Independent, family-owned company
- Providing Worldwide Service, e.g. in the U.S. by UNISENSOR USA Inc.



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UNISENSOR offer products for different industries based on spectroscopy

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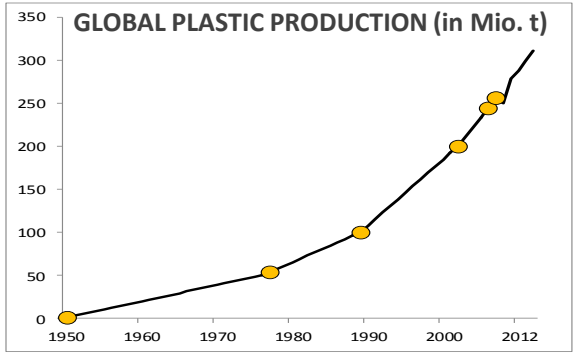
Plastic industry in the transition from a linear to a circular economy?

- **Global plastic production has increased by factor 200 since 1950 to over 300 Mio. t/ year. (Europe: 60 Mio t/y and stable for the last 10 years)***



- **Total mechanical plastic recycling rate is below 15%**. Higher recycling rates are ecologically desired, because it:**

  + saves resources (75% less oil; 65% less energy)

  + fosters collection and reduces littering

  - but: virgin production would be substituted

- **Free market (=recyclers) will move up recycling rates when:**

Value of unsorted fraction + (Shredder residue: PP, ABS, PS, ABS-PC, rest of plastics incl. PVC, rubber, wood, metal)

Processing / Sorting cost **<**

Value of all sorted/concentrated fractions

PP+ ABS + PS + ABS-PC + *Residual (rest of plastics incl. PVC, rubber wood, metal)*

* **Quelle: PlasticsEurope**

****Ellen MacArthur Foundation**

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Main challenge of plastic recycling: Generating pure fractions

- **Foreign material harm the processing and quality of the plastic and therefore limit the range of application of recycled material**

- **For high-end application, e.g. bottle-to-bottle recycling, the plastic stream has to be free of other material (5< ppm-level)**

- **Up to now there is no efficient sorting solution for sorting black plastics into different plastic types on the market**

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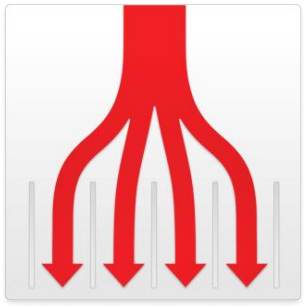
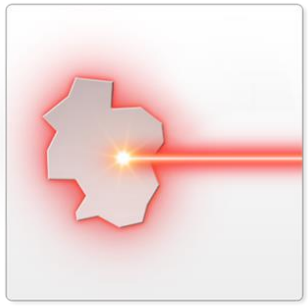
UNISENSOR offers plastic sortation based on High-Speed Laser Spectroscopy

The Principle of High-Speed Laser Spectroscopy

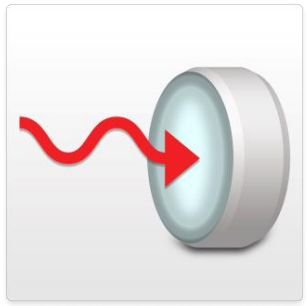
- Contaminants are detected in the material flow by virtue of their spectrum, i.e. their physical "fingerprint“ and sorted.



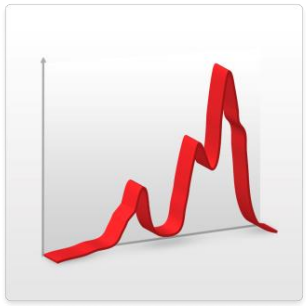
Feeding of the PET stream via hopper and chutes to the detection point



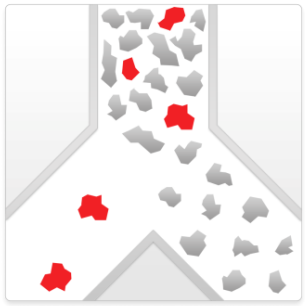
Optical excitation of material with high energetic laser light



Collecting fluorescence light / Raman scattering



Spectral analysis (physical “fingerprint”)



Sorting out foreign material

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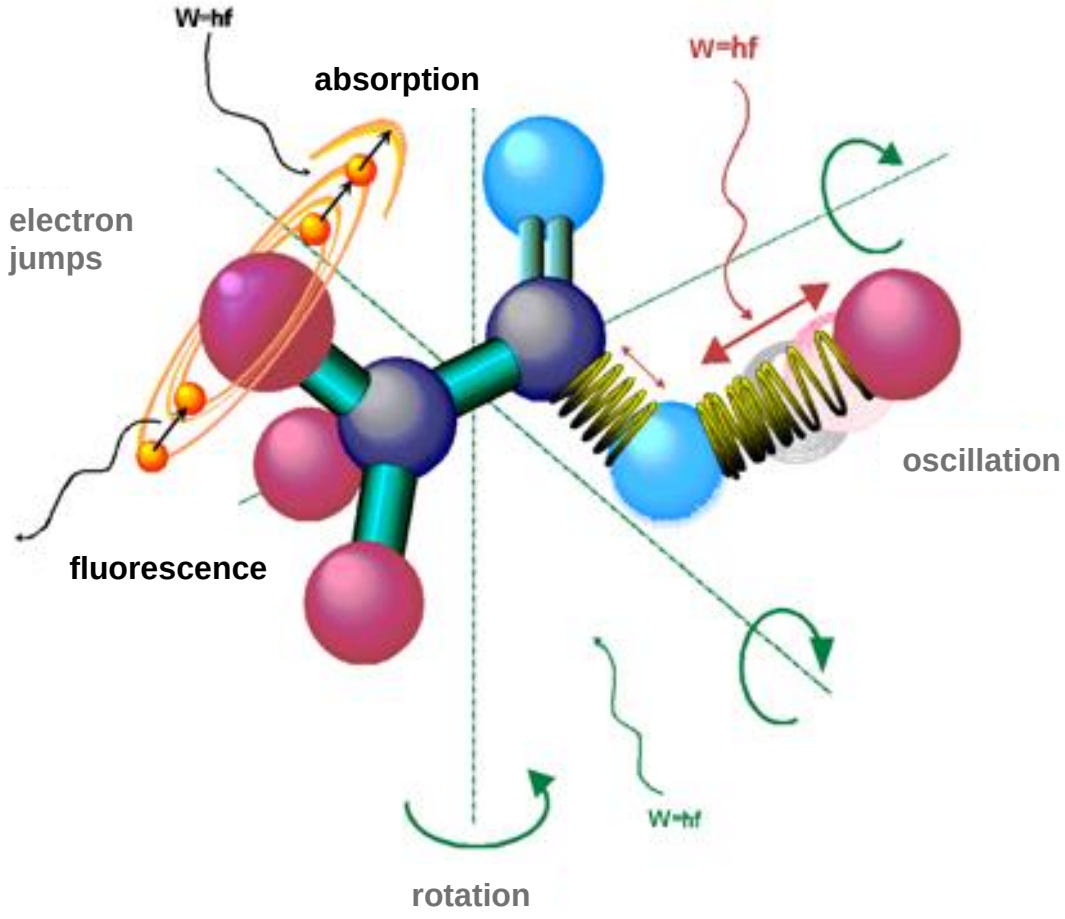
Material specific spectra generated by Laser Fluorescence and Raman Spectroscopy



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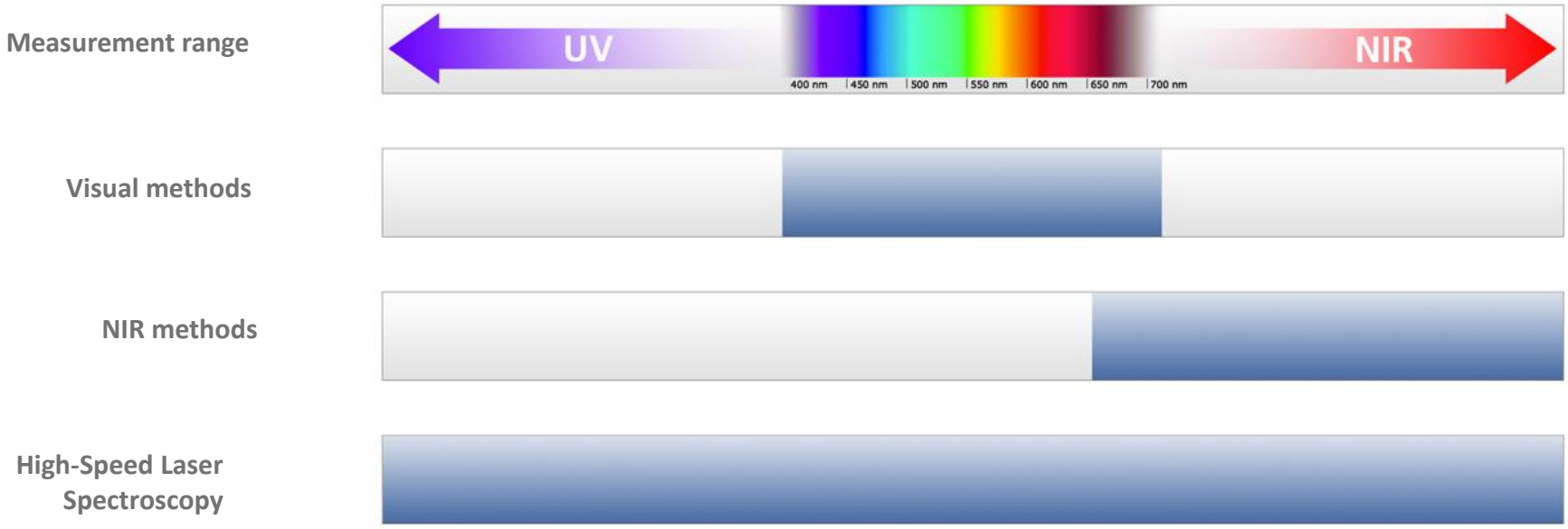
For precise, comprehensive substance identification, the POWERSORT technology uses wideband, highly differentiating spectra



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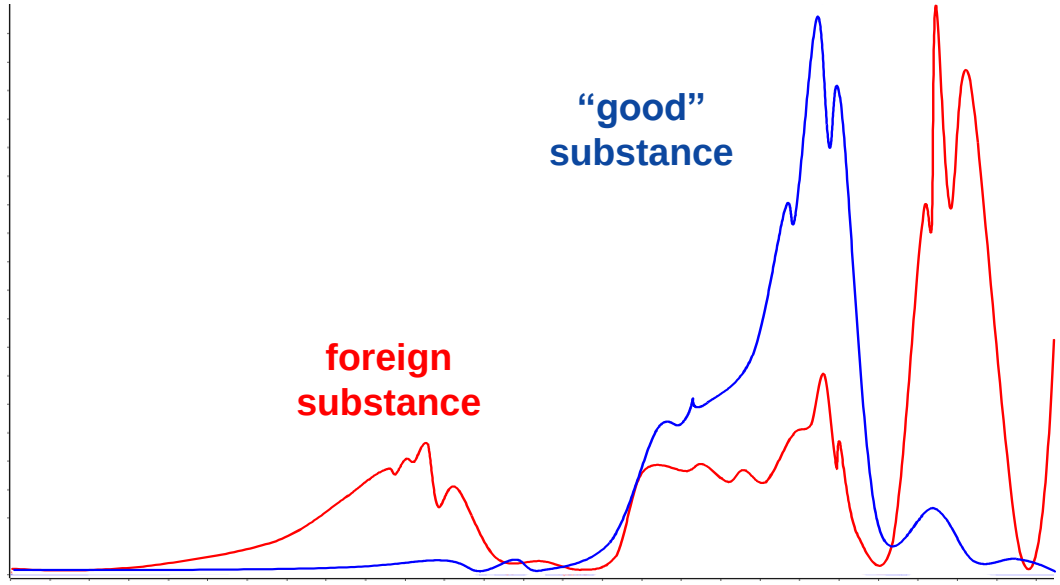
Every material has its own significant fingerprint

The wideband, high-resolution, substance-specific spectra permit precise substance identification and thus differentiation between the “good” substance and foreign material.



1 million spectra / second

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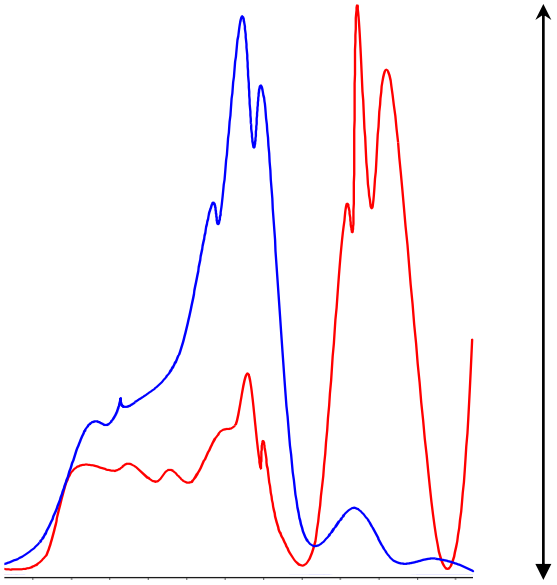
Clear (low noise), distinctive signals allow to generate 1.000.000 spectra/sec.
→ Result: high resolution or high throughput



Clear (low noise) signals allow shortest exposure times.
Every 1 µs (microsecond) one complete fingerprint is captured

- Resolution:
  Powersort 200 > 2 mm
  Powersort 360 > 8 mm

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High-Speed Laser-Spectroscopy allows to achieve highest purity level or high throughput

1 Mio. spectra per second

Highest resolution: POWERSORT 200

- PET, Black and Mixed Plastic Sorting
- 4 Sorters in One
- up to 3 tons/hr
- <1,5 – 20 mm Grain Size

High throughput and flexibility: POWERSORT 360

- Black and Mixed Plastic Sorting
- 8 Sorters in One
- up to 10 t/hr (8 x 1,25 t/hr)
- 8 – 75 mm Grain Size (designed for shredder material)

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World Premiere: POWERSORT on K 2016

- Technology is beeing used for sorting black material since 2010
- New machine frame especially designed for sorting shredder residue and optimized for laser spectroscopy

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Fields of application of POWERSORT 200

PET Recycling

WEEE/ASR-Treatment

Production waste

Pellets

Purifying of flakes before extrusion

Lowest contamination

Quality assurance

Sorting for specific plastics in a existing process

Sorting

Sorting and purifying

Pure fractions

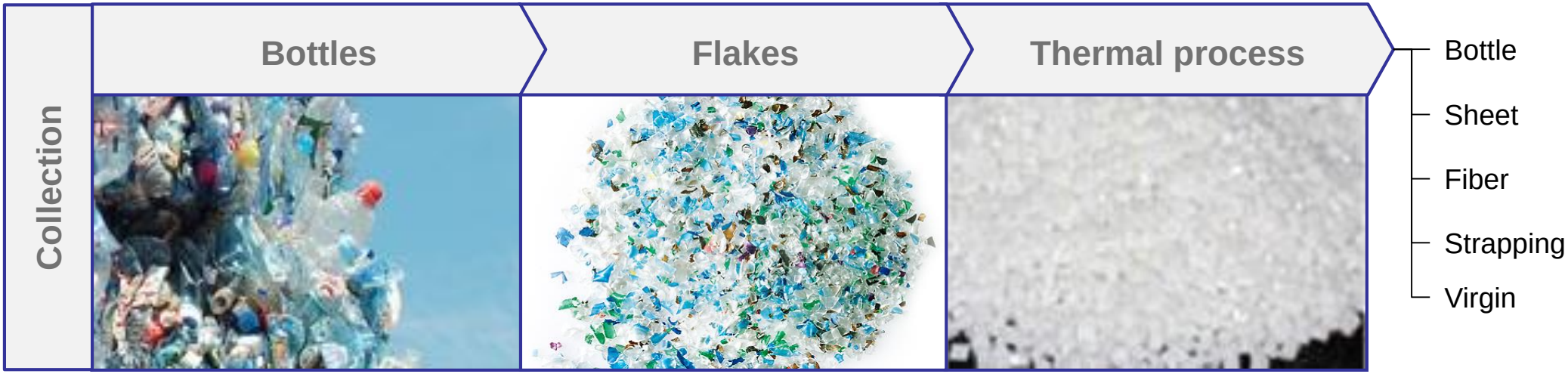
Quality assurance

Purifying of pellets

Pure fractions

Quality assurance

PET-Recycling Process Scheme



- De-balling
- Separation
  - Manual
  - Mechanical
  - Sensorbased systems
    - Color / Metal
    - Foreign Material
- Grinding

- Washing
- Separation
  - Mechanical
  - Sensorbased systems
    - Color / Metal
    - **Foreign Material**

- Extrusion
- SSP
- Decontamination

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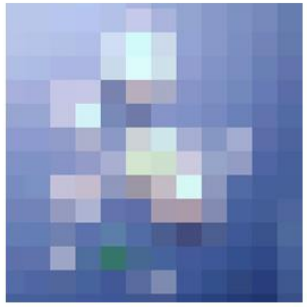
The high resolution achieved with POWERSORT 200 permits even the tiniest particle sizes to be detected.

POWERSORT 200:
up to 1,000,000
measurements / second



by comparison:
100,000
measurements / second

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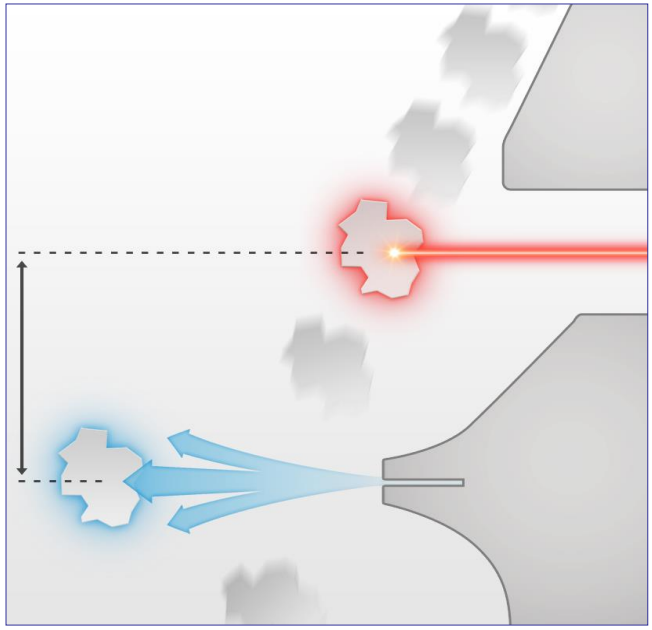
High Ejection Efficiency as a Prerequisite for Low False Reject Rates

For Spectral Analysis POWERSORT 200 is equipped with:

- **Short distance between measurement and ejection**
  (< 1.2” / < 30 mm)
- **Substance specific control of the ejector unit**



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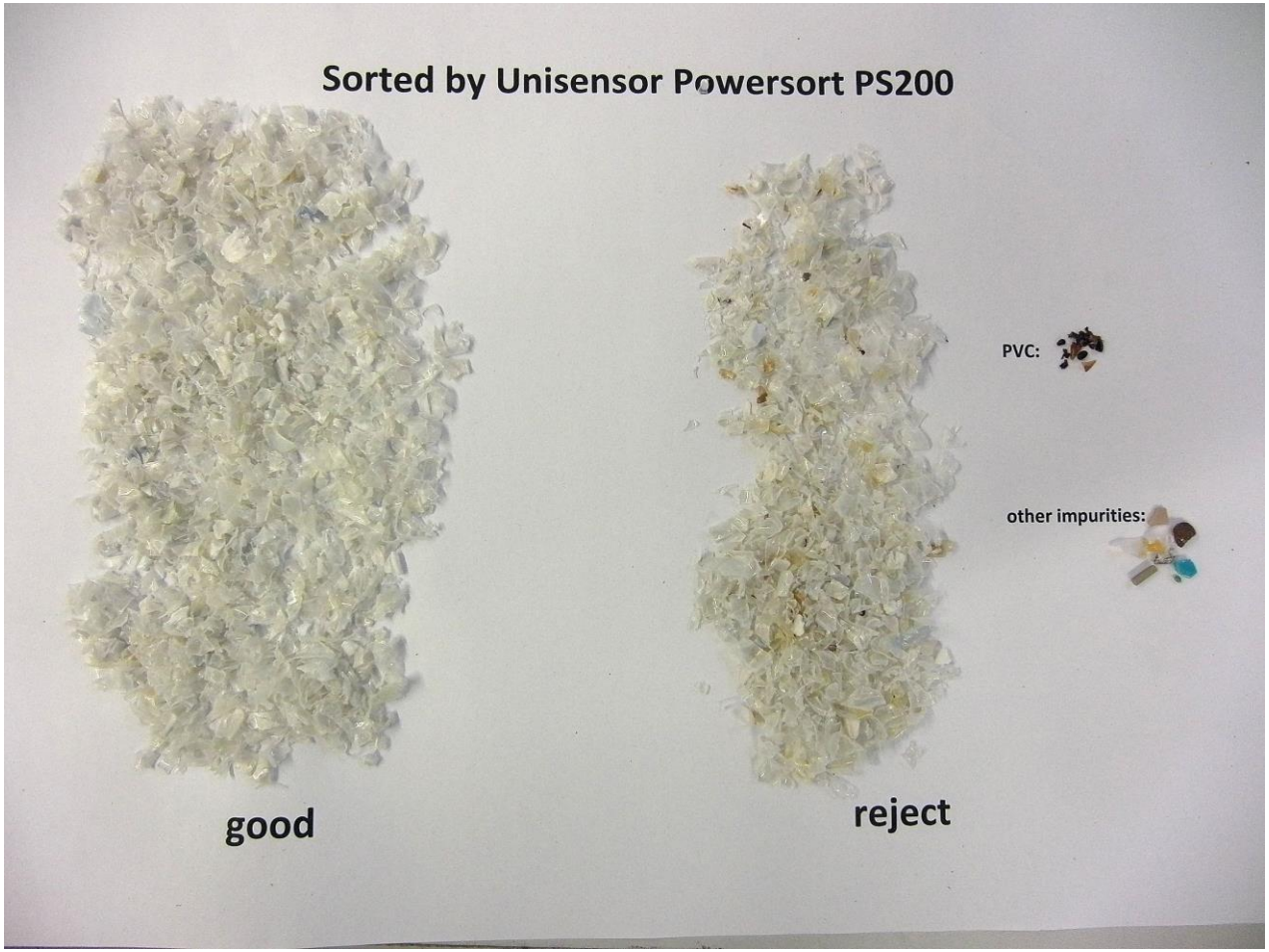
Test Results



Set-up:
Throughput: 2.5 t/h

Input quality:
Good material quality

- PVC: 20 ppm
- Few contaminations, i.e. PET-TIO2, silicone, blends (not measured)

Contamination after sorting:
PVC < 3 ppm
Other contaminants: non measurable

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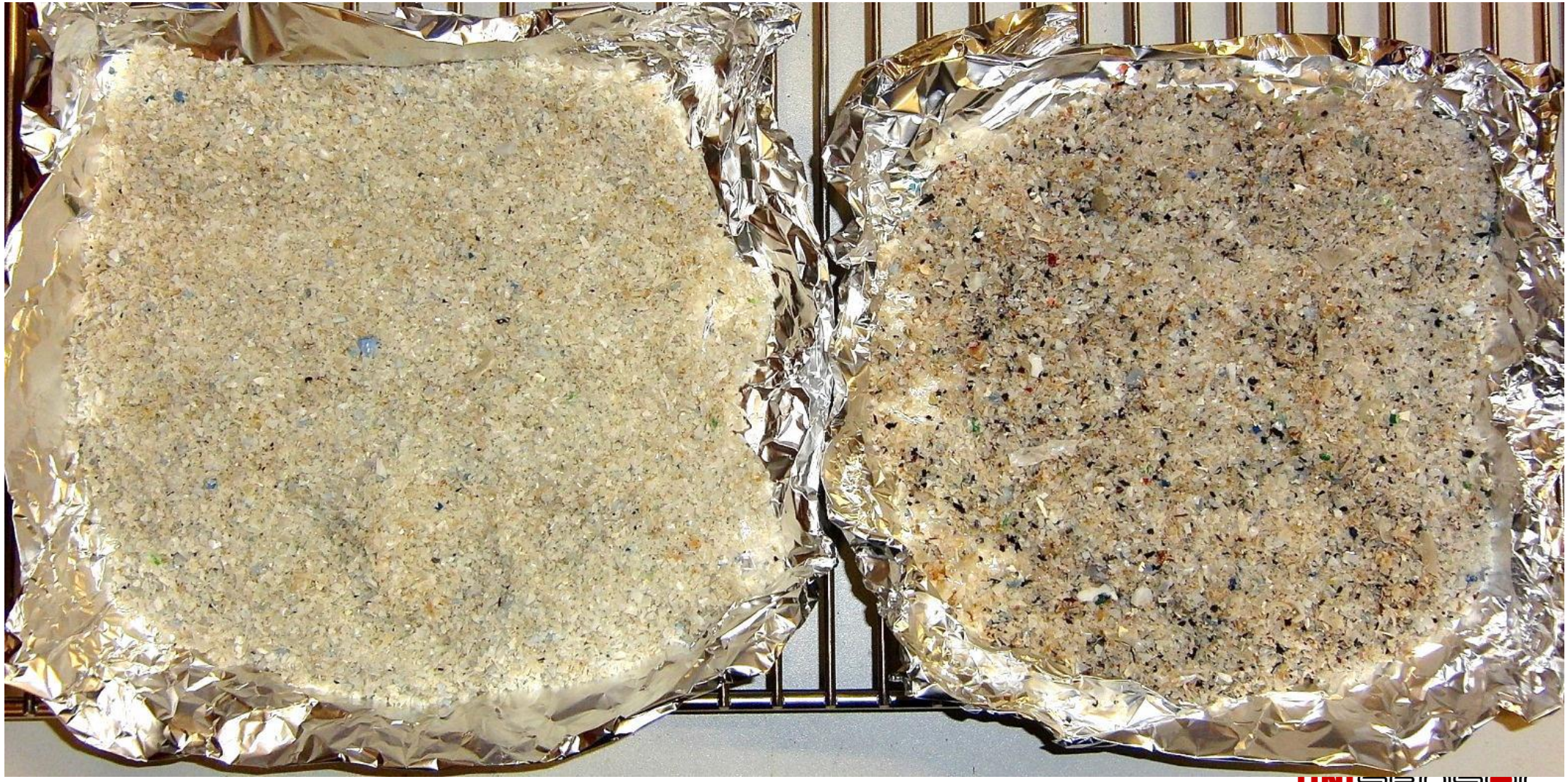
Test Results – Sorting of fines



Test Results – Sorting of PET with TiO_2

Although it cannot be distinguished from crystalline PET by eye, PET with TiO_2 can be clearly identified and sorted with POWERSORT.

Crystalline PET

PET with TiO_2

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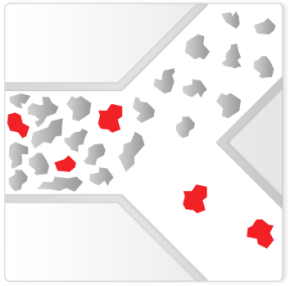
Test Results – Sorting of PET with yellowing additives

Quality of sorting with transparent PET contaminated with PVC, nylon, multilayer, blends, etc.

“Good” Fraction



“Bad” Fraction

220 °C / for 30 min.

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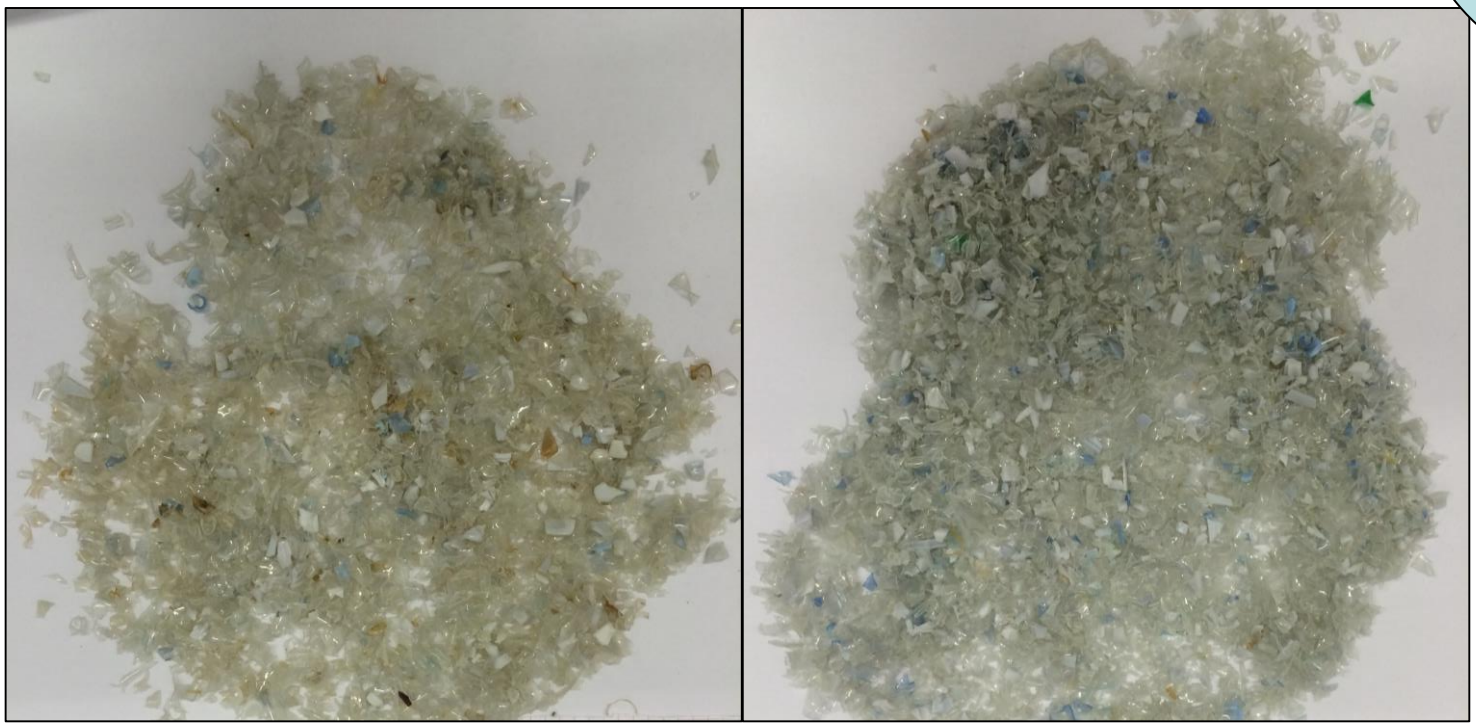
Test Results – Typical US kerbside material

Representative for all Western non-deposit collection schemes

Before sorting **After sorting**



220 °C / for 30 min.

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Production waste can be recovered even when it is black and to highest quality levels.

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Fields of application of POWERSORT 360

POWERSORT 360 was especially developed for sorting shredder residues.

WEEE

Sorting WEEE-Shredder Residue

ELV

Sorting Automotive Shredder Residue

Sorting into different Plastics: ABS, PS, ABS-PC, PP/PE

Generating a mixed plastic fraction: ABS, PS, ABS-PC, PP/PE

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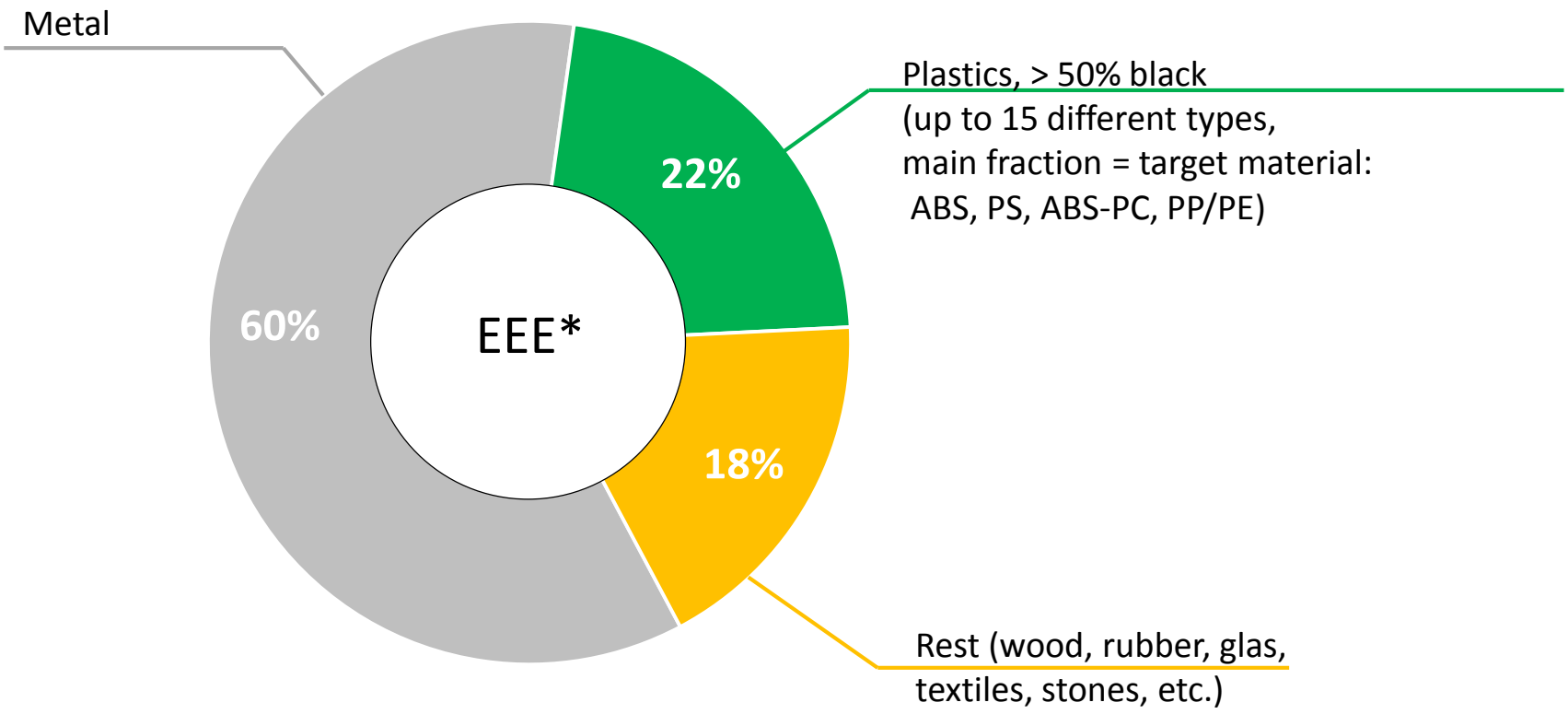
EEE consist of about 25% plastics. Trend: rising.



* div, e.a. Sensor Based Sorting 2014, D. Arends

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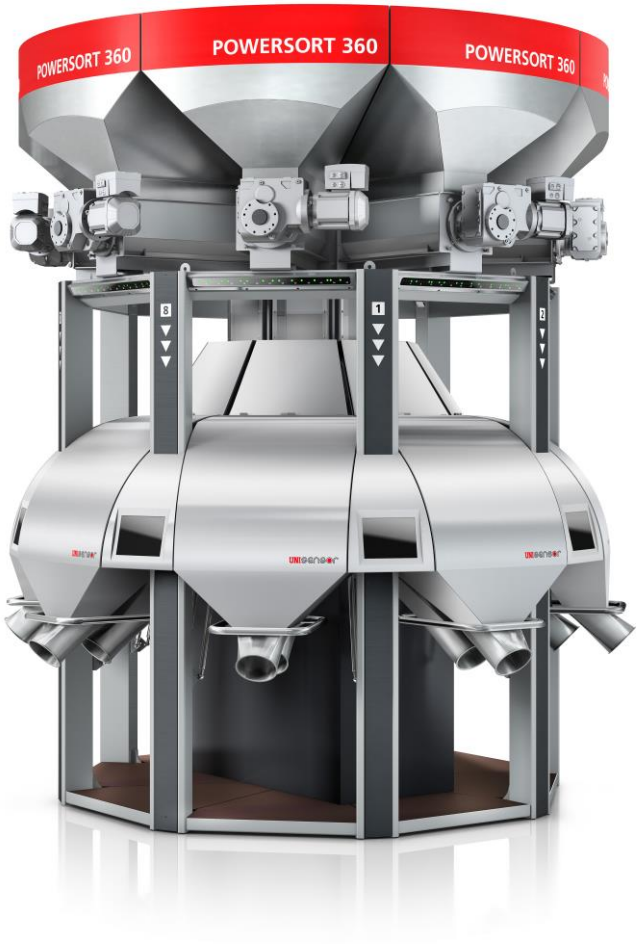
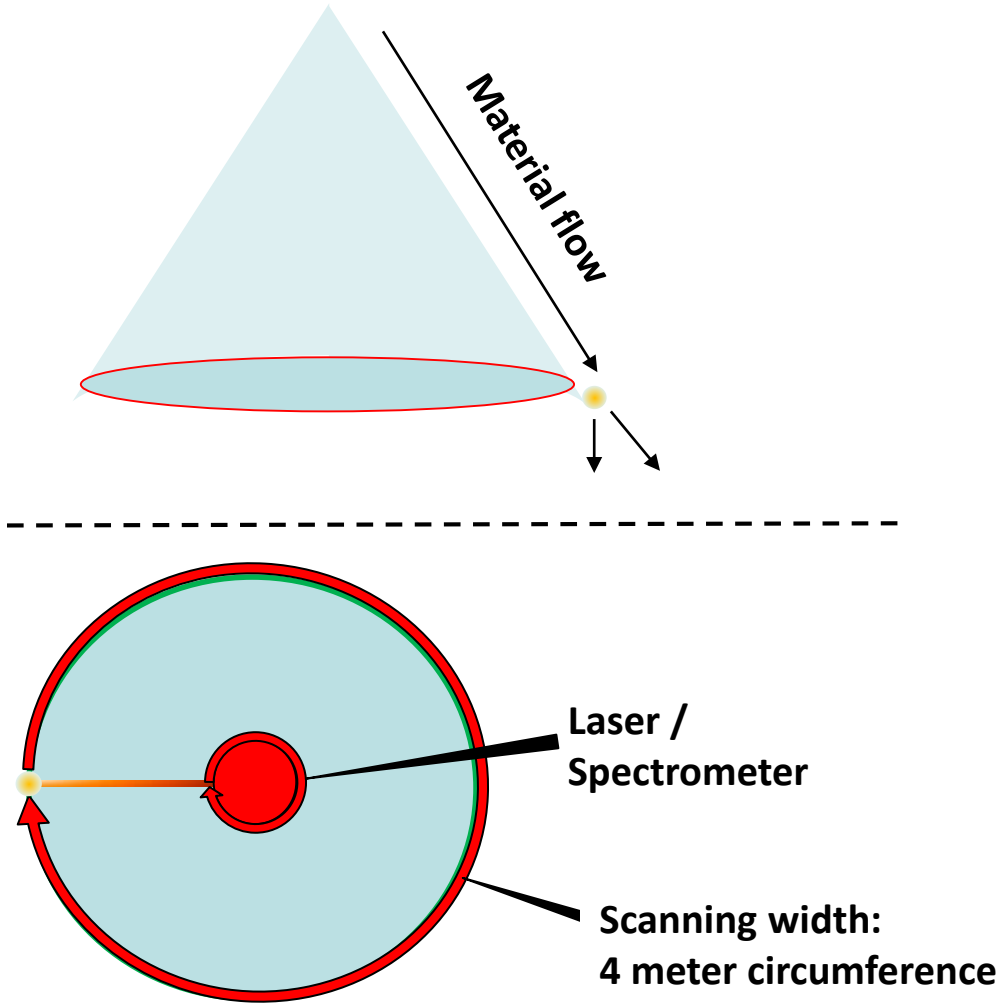
POWERSORT 360: Revolutionary Machine Design:
4 meters effective scanning width + possibility of multiple sorting on a very small footprint





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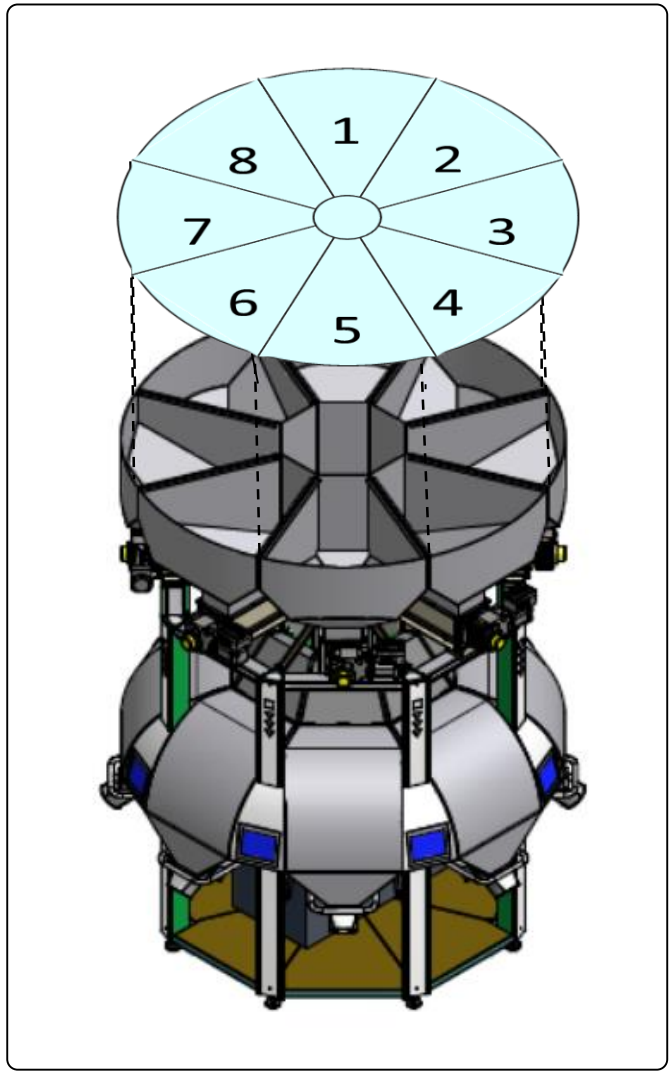
POWERSORT 360 consist out of 8 independent sorters offering maximum flexibility for all sorting tasks



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The chute system allows high throughput with good material separation

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Shredder residue is directly sorted into the target plastic types

Material directly from the shredder

ABS 15% PS 13% PC-ABS9% PP 3% 60%

Purity > 98%

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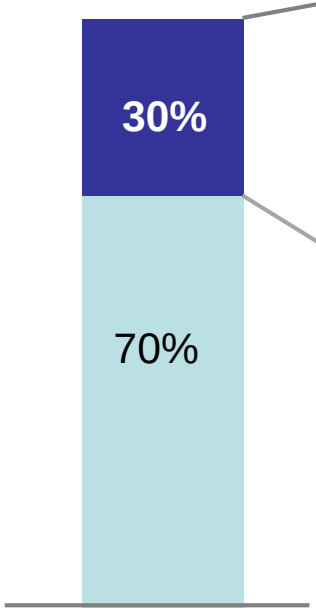
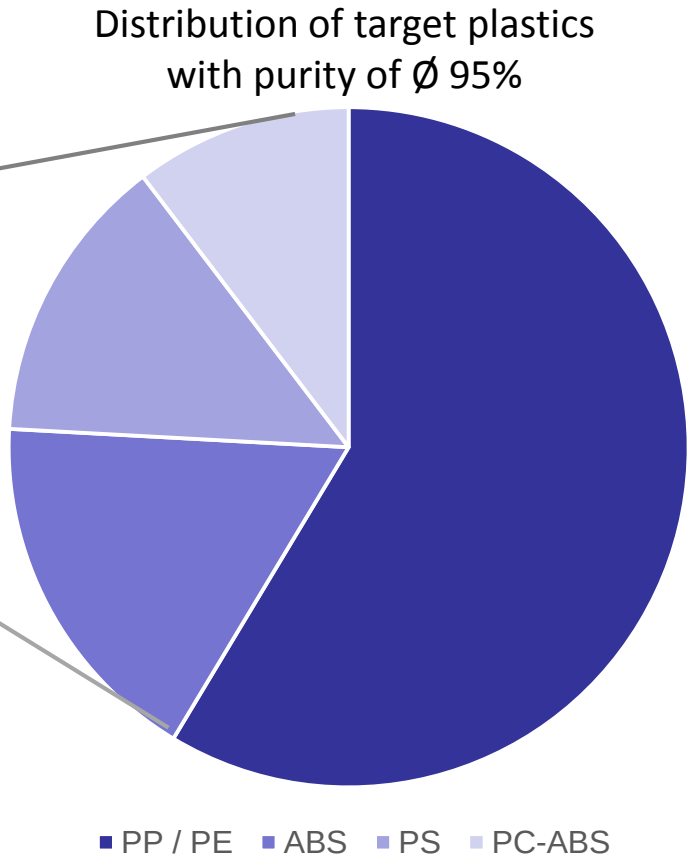
CUSTOMER EXAMPLE: POWERSORT 360 generates single fractions of PP/PE, ABS, PS and ABS-PC with a purity of around 95%

Target plastics
(PP/PE, ABS, PS, PC-ABS)

Rest:
- Non-target plastics (POM, PMMA, etc.)
- Wood
- Rubber
- Textile, etc.



(Heavy) Shredder Residue



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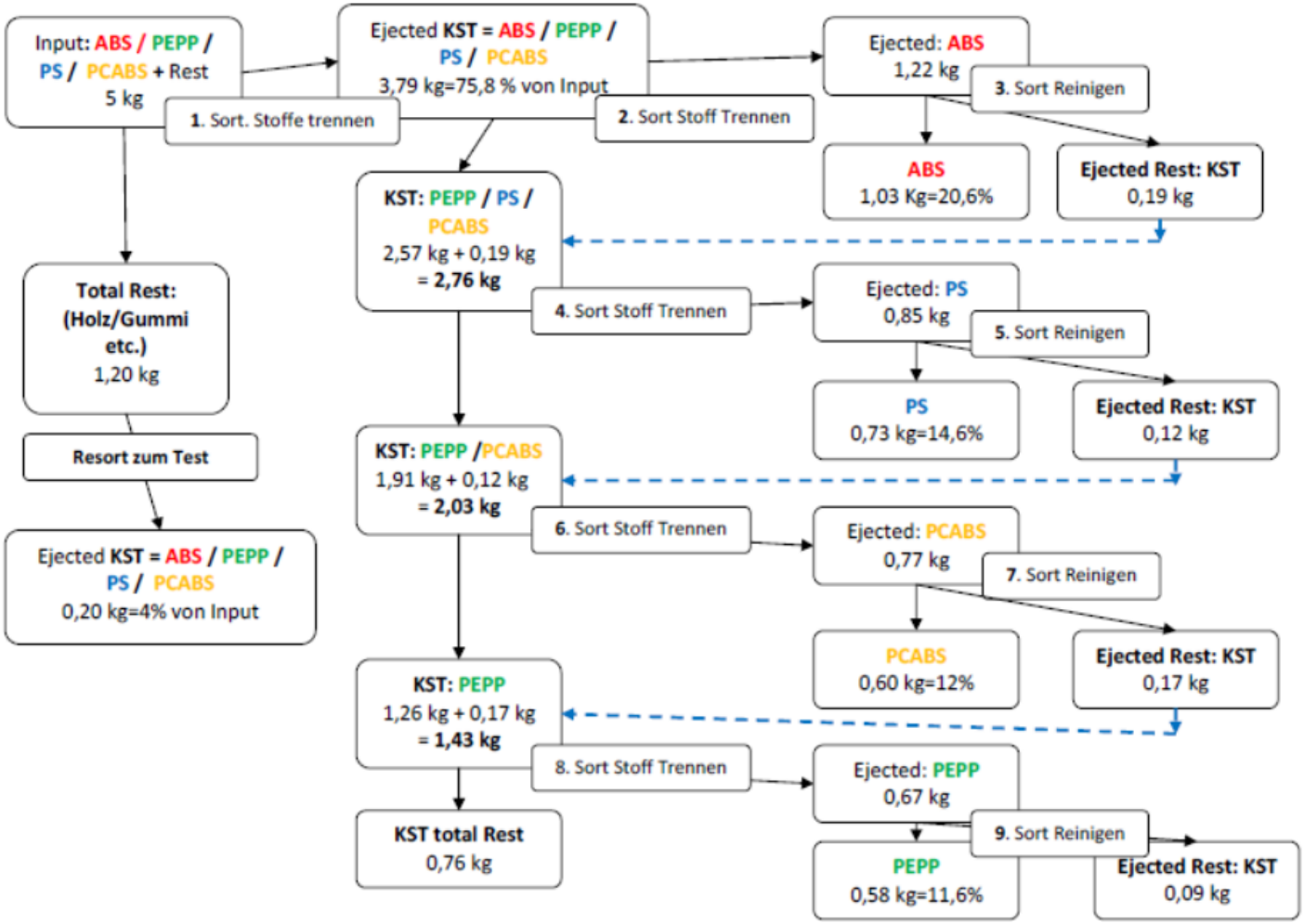
For an efficient sorting into different fractions high total sorting capacity is necessary



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Example WEEE

Reject:
non-target plastics, wires, rubber, wood, etc.

ABS, PS, ABS-PC fractions: >98%

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Last but not least: Award winning technology….

Nomination for German Federal President‘s Award for Technology and Innovation - 2010

German Environmental Award - 2014

ECR Award 2014: Supply chain: Recyclate Initiative

Thank you for your attention!

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