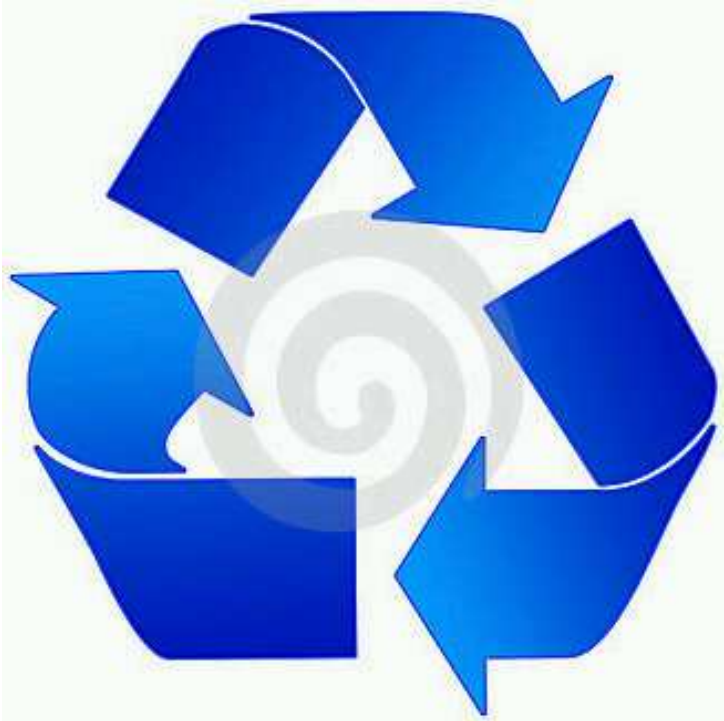
Science Perspective on Plastics Recycling and Reuse



Dr. ir. Maarten Bakker
Delft University of Technology

Chair Resources & Recycling, TUD

- Chair founded in January 2012
- Chair holder Prof. Dr. Peter Rem
- 2 Staff, 5 PhD, 2 Postdocs
- Large lab facilities, 3 technicians

Research in Solid Waste

- Sensor-based systems (today's presentation)
- Physics and technology for separating and sorting

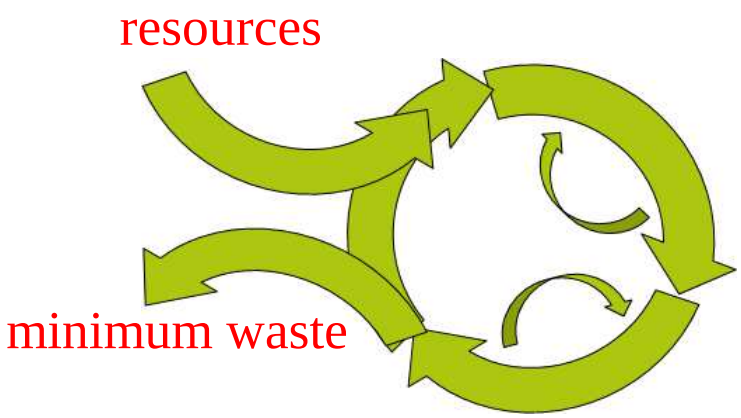
Education

- Master and minor programs
- Where: Delft (Civil, Aerospace, Policy & Management)
  and Leiden University (CML)

Research Opportunities

In transition to a Sustainable Circular Economy

- Transition to renewable/sustainable resources
- Build the CE infrastructure and lay down the rules



Reuse = recycling of EOL products
Recycling = reuse of EOL materials

Opportunity: which innovative technologies can boost the transition?

Upcycling

WtE

types a, b, c ……

Producer A

primary cycle

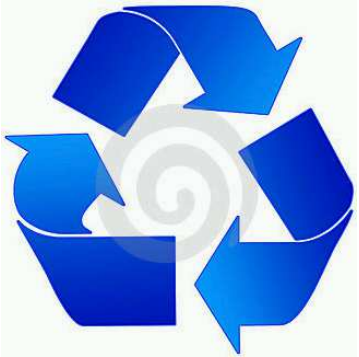
consumer

EOL collection

primary

recycled

Producer B



Wrong waste bin,
Blending, Pollutants,
(UV) Degeneration

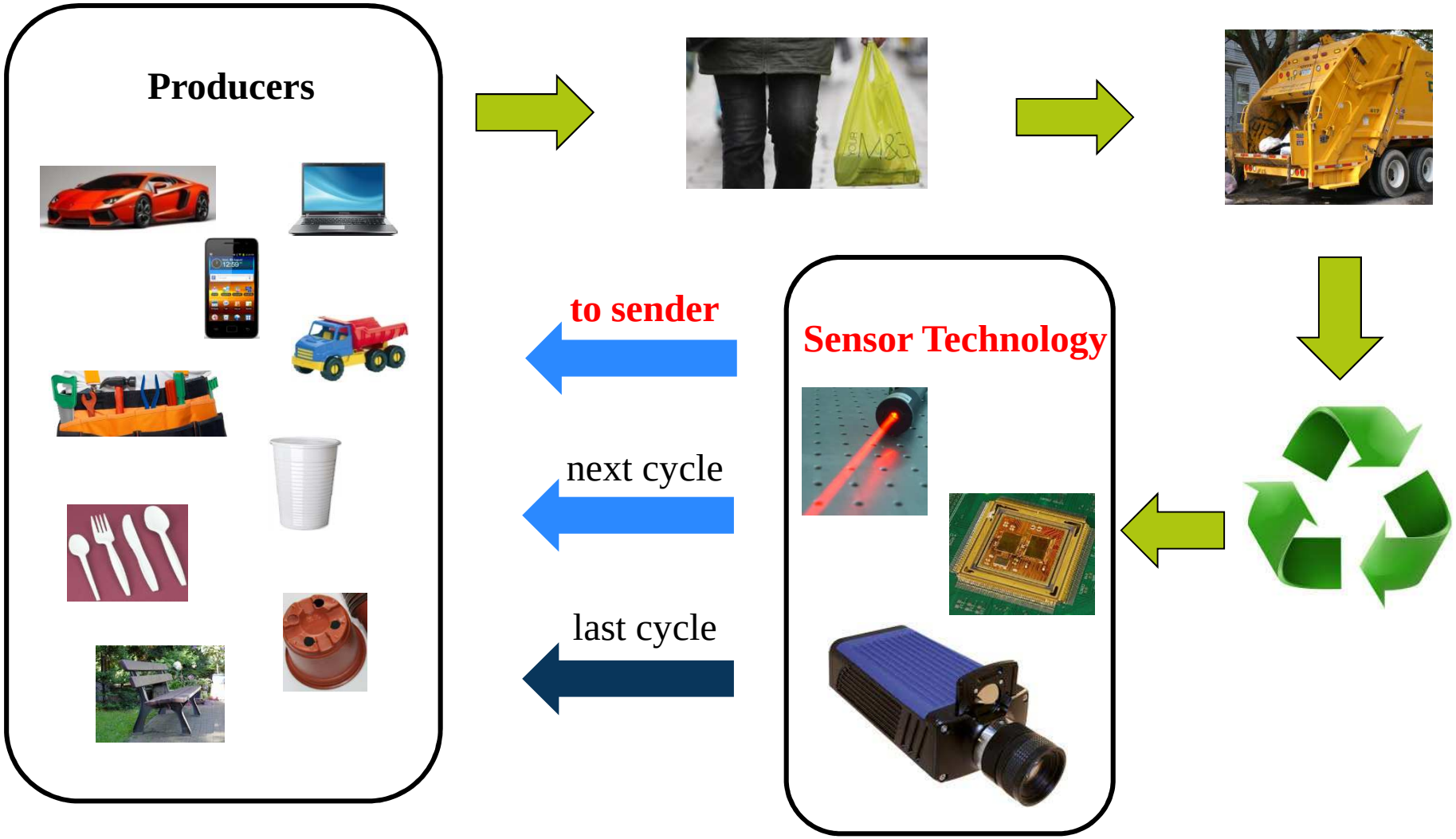
quality check

sorting

washing

plastics separation

‘Return to Sender’



Sender = original producer of the EOL material

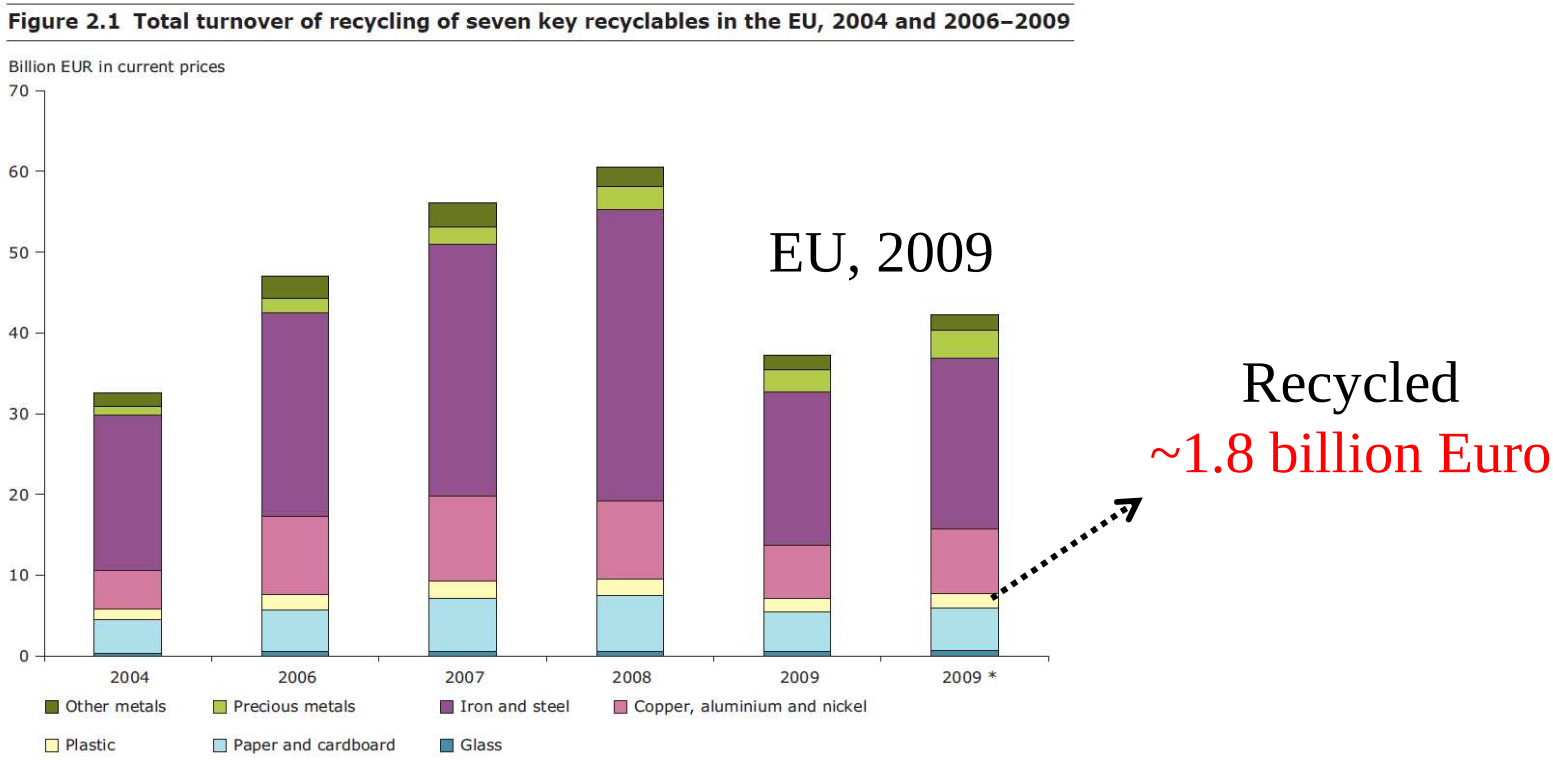
Validation of recycled plastics

(Source: Plastics Europe, 2012)

Turnover: 87 billion Euro (57 Mt, 47 Mt after export)

Converters: 202 billion Euro in sales

Recycled: EU 26%, NL 40%



source: Eurostat

Opportunities for Sensors

1. **Upcycling before downcycling**

   ✓ Secure the best quality
   ✓ Inline qualification (bulk)

2. **Information on waste flows**

   ✓ Identify source of a material
   ✓ Inline, continuous monitoring

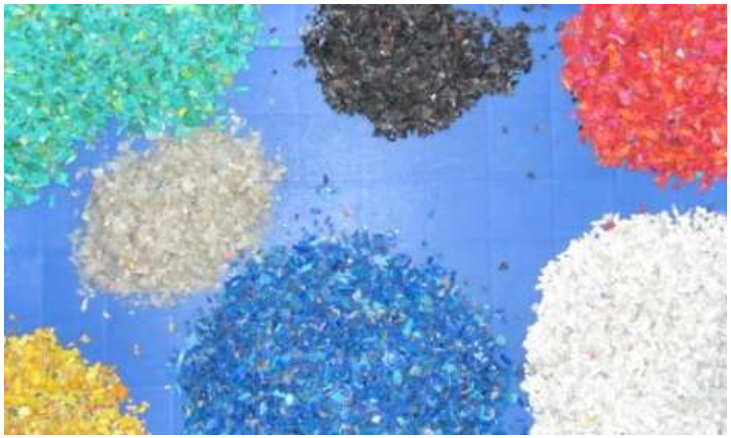
3. **Increase economy of scale**

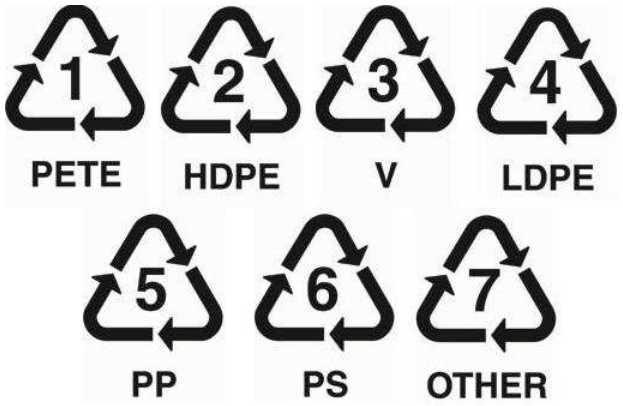
   ✓ Big city recycling:
   efficient collection & sorting
   ✓ Recycling as first option

Selected Research Topics

Sensor bulk measurements

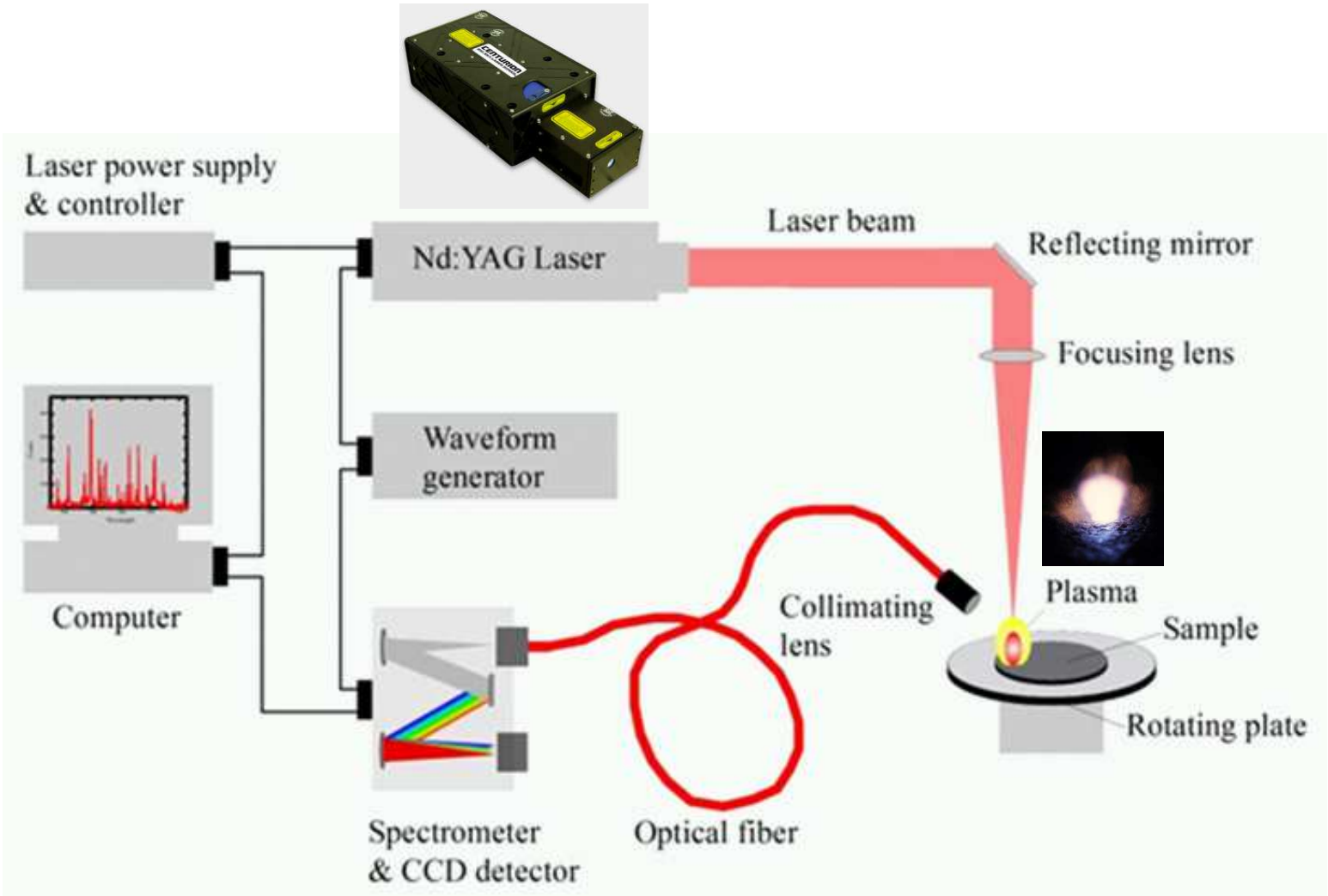
Challenge: take millions of measurements/sec of moving flakes, and sort them according to colour, type and/or additive.





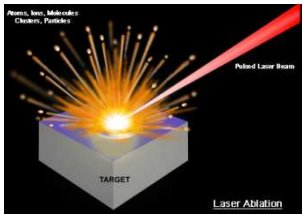
Additives (fire-retardants, fibres, fillers, etc.)

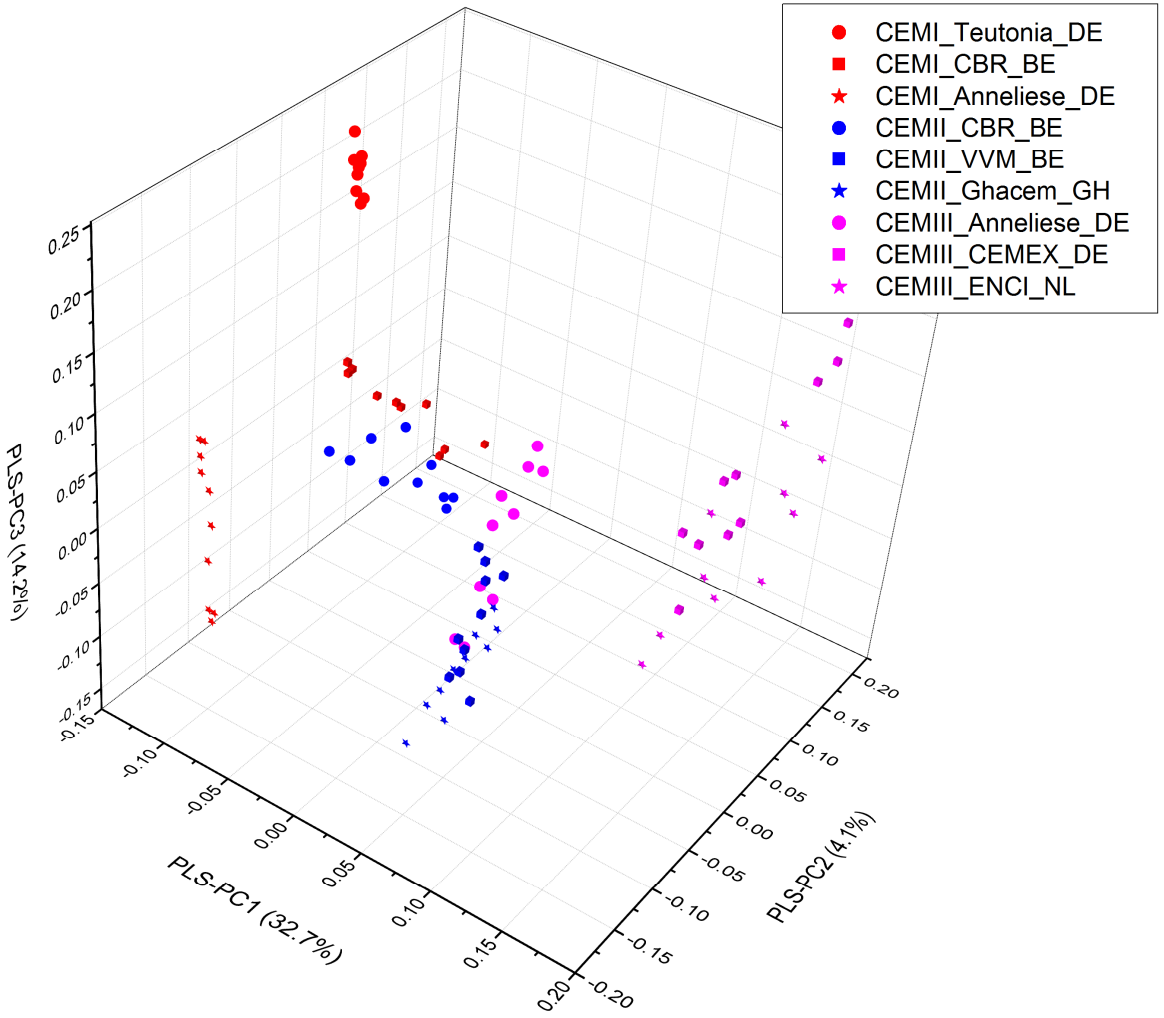
Laser Induced Breakdown Spectroscopy



Identify Cement origins (TUD)

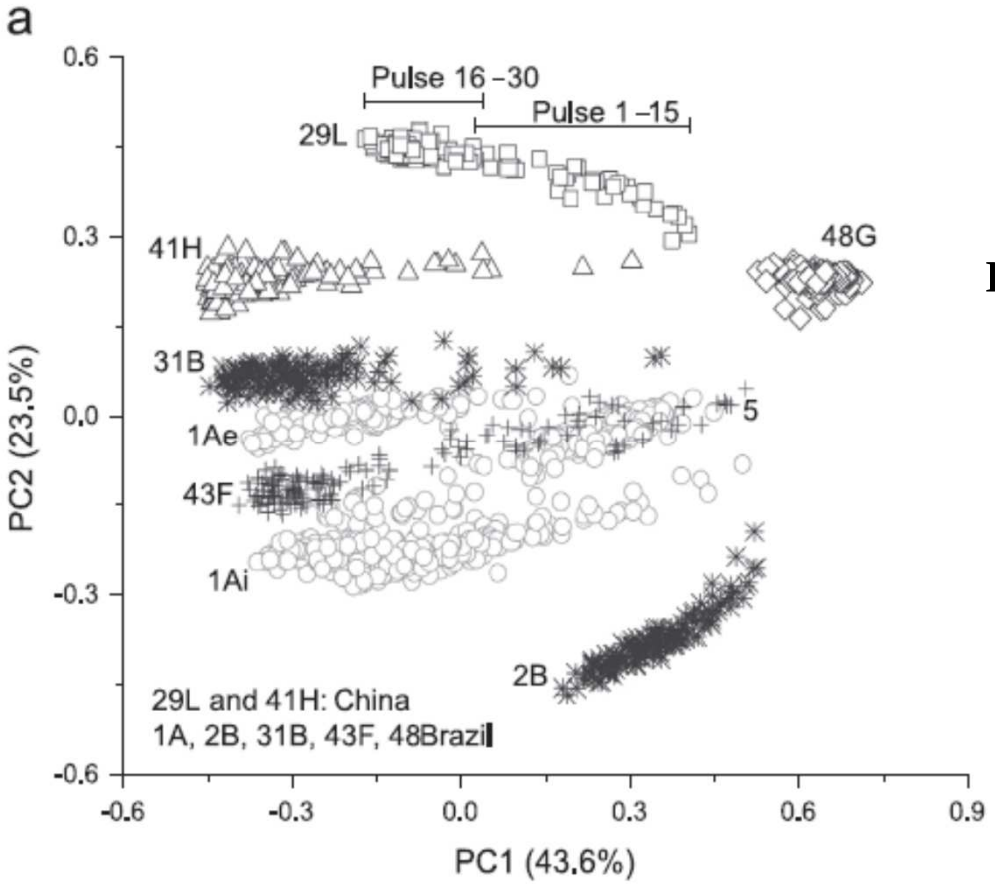
Back-tracing cement types to country of origin and manufacturer with LIBS



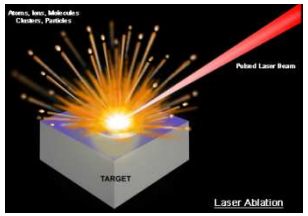


Identify Mobile Phone origins

Source: F. Aquino and E. Pereira-Filho (São Carlos, Brazil), Talanta 134, p65-73, 2015



Back-tracing white polymer mobile phone scrap to country of origin and manufacturer, with LIBS

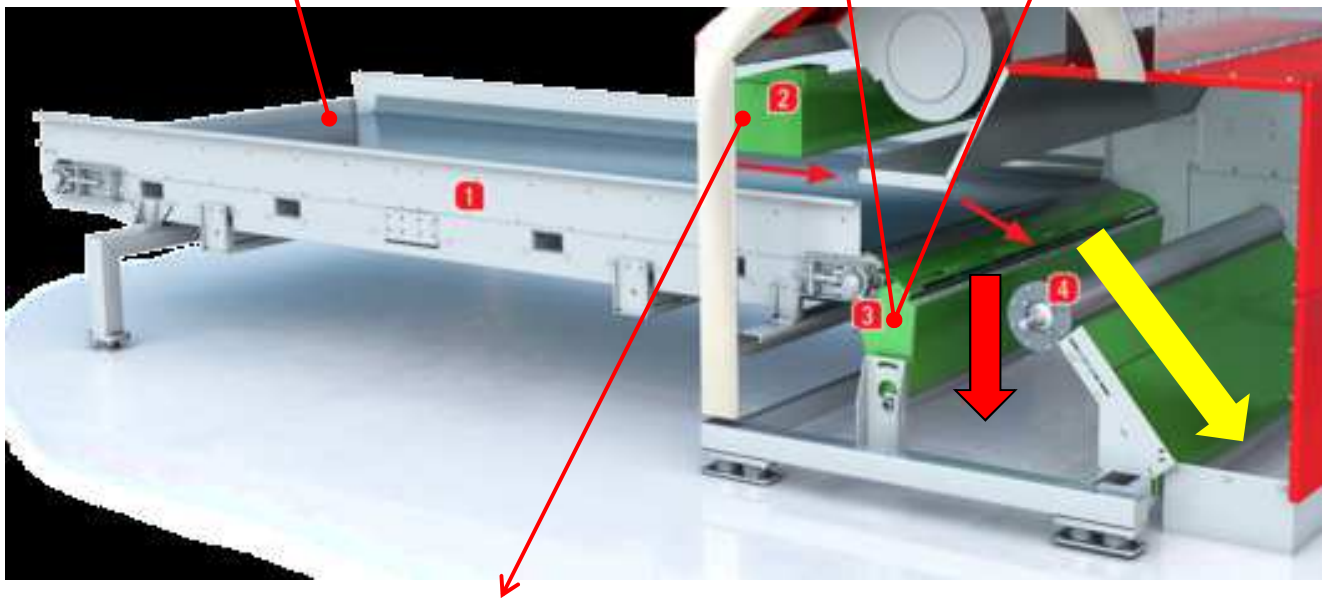


Mechanical limitations in sorting

flakes on the belt

air blowbar

nozzle



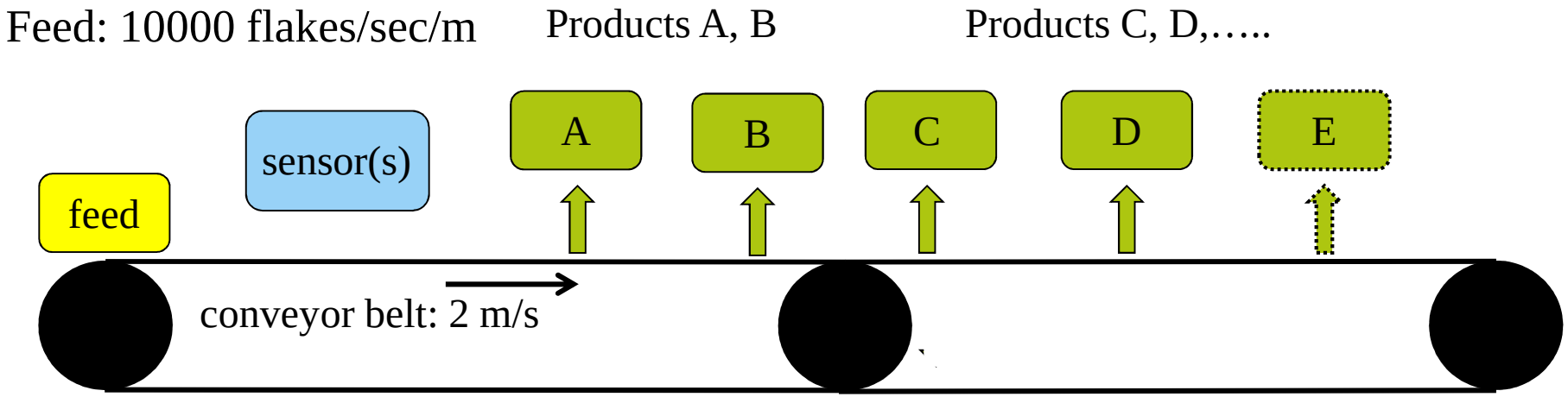
source:
Redwave

In comparison: sensor systems can deliver up to millions of detections/sec !

More products per sorting machine

Challenge:

How to remove the targeted flakes from the moving belt without disturbing the other ones?



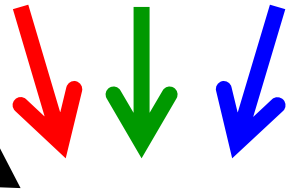
(1/3) Recycling in the Big City

Desired:
A flexible and adoptive collection & sorting system, suitable for:

- High rises, low buildings, rural
- New areas / crowded old areas
- Monitoring of participation
  (back-tracing, localized feedback)
- Automated, efficient sorting
- Automated quality control

(2/3) A hybrid approach to collection

Home sorting: put each material in its own colour bag (up to 4 types)



+ a barcode on each bag for back tracing & statistics

collect all types in one container

(3/3) A hybrid approach to collection

(Source: Optibag, Sweden)

1-4 types

recovered materials

Separation and sorting of colour bags

1-4 types

Grey waste

Quality control + register barcodes