Tekes

Finnish Funding Agency for
Technology and Innovation

MEASUREMENT AND CONTROL SCHEME OF NANO AND MICRO PARTICLES IN COMPLEX PROCESS SUSPENSIONS

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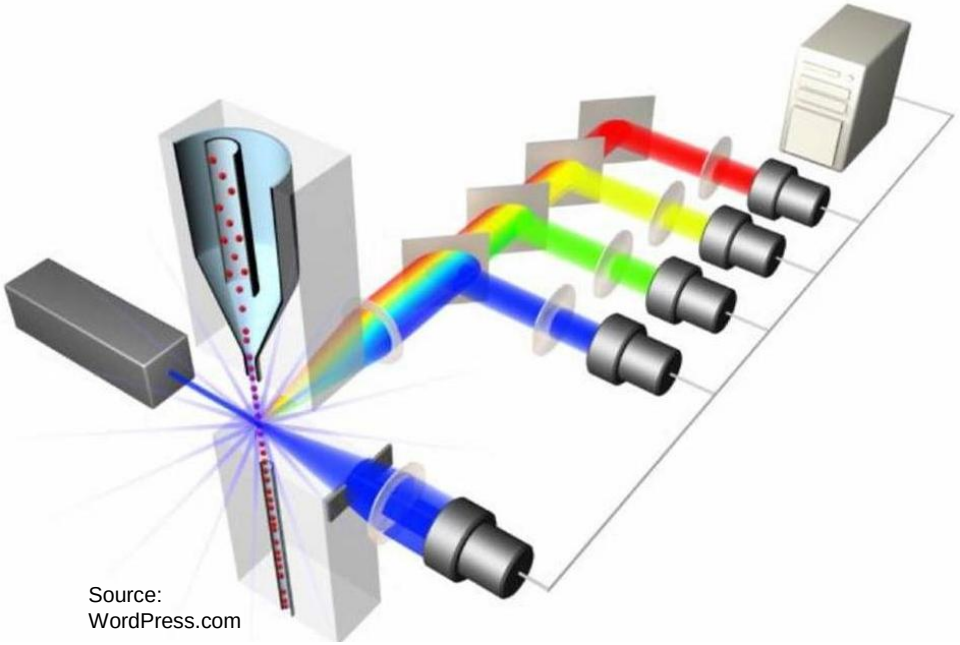
Challenges in pulp & paper particle analytics

- Wood extractives can be analysed conventionally by chromatography or microscopy methods
- Bacteria content can be assessed with polymerase chain reaction (PCR) and DNA replication
- Cellulose microparticles can be analysed with advanced microscopy (SEM, AFM, TEM...)
- These methods are:
  - Time consuming and laborious
  - Expensive
  - Require specific machinery and operators
  - Lack the capability for on-line use

Flow cytometry for particle analysis



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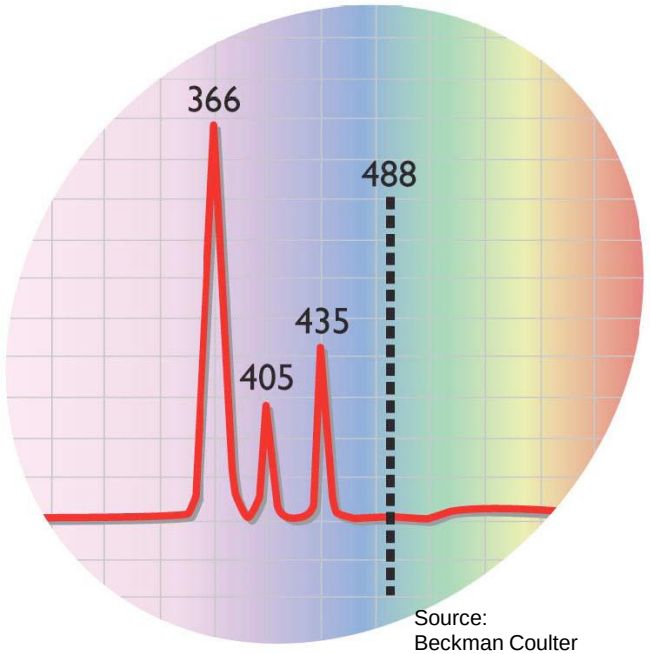


Source:
Beckman Coulter

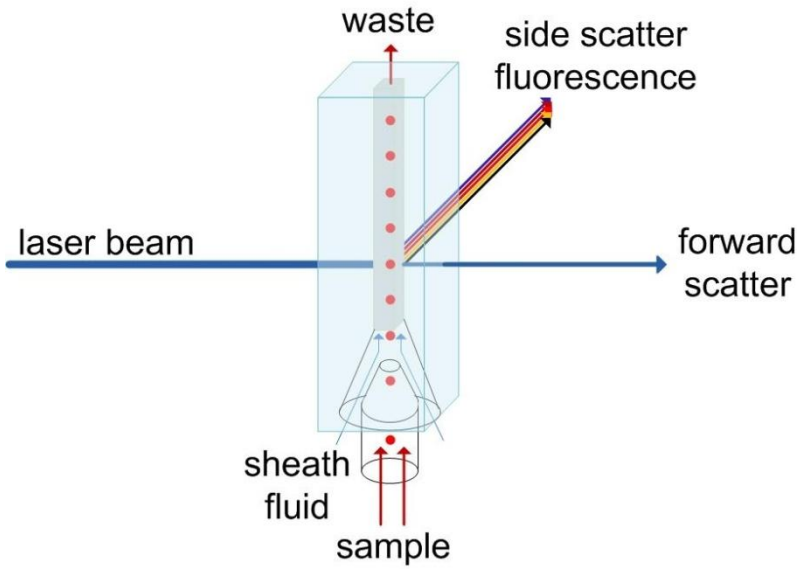
Advanced optical analysis on small scale particles

- Applicability to multiphase systems in paper production and water treatment
- Selective detection of particles and their properties
- Staining and marking of desired components from process streams
- Roadmap towards on-line measurement enabling automated process control

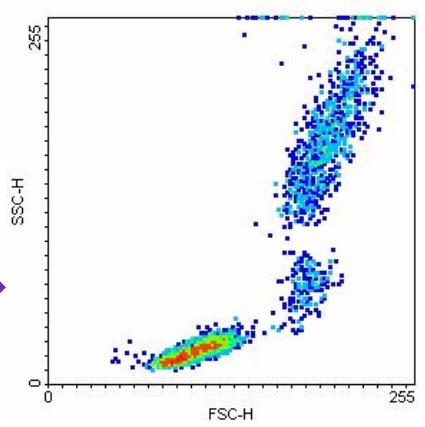
Basic principle of flow cytometry

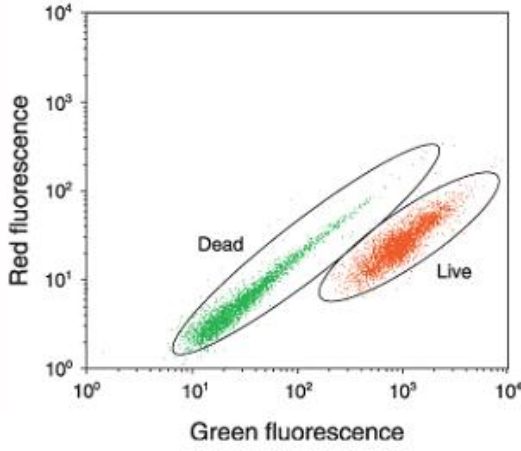
Beckman Coulter, Cell Lab *Quanta™ SC* MPL

1. Filtered sample particles are stained with selective, fluorescent dyes (*Fluorochromes*)
2. Stream of particles (0.1 – 200 µm) is aligned in cuvette with sheath fluid (*Hydrodynamic focusing*)
3. Illumination of particles by laser
4. Each excited particle emits fluorescent light that is detected, along with scattered light
   - Forward scattering (FSC) indicates the size of detected particles
   - Side scattering (SSC) relates to granularity of studied cells



Data is dot plotted to reveal clusters of particles with varied properties





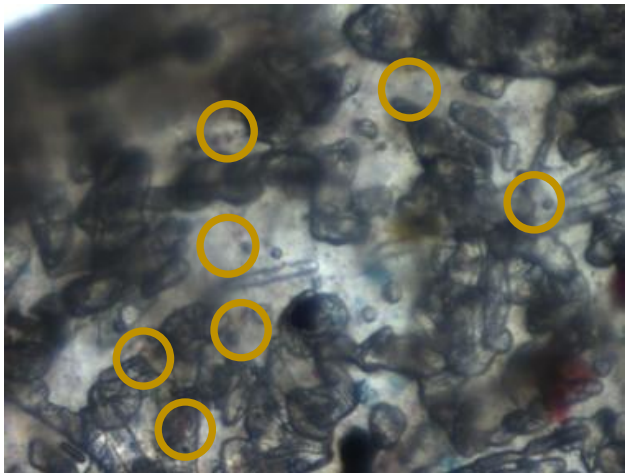
Outlooks for FCM applicability

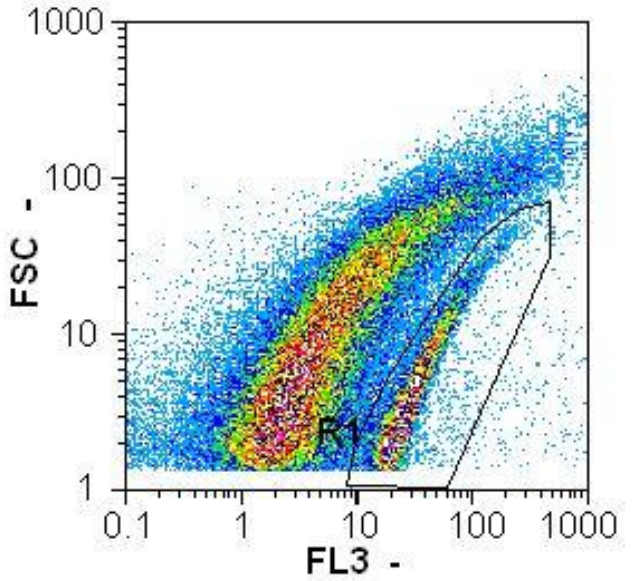
From laboratory towards on-line applications

1. Identification of pitch and other tacky contaminants
   - Adaptive chemical dosage and separation process control
   - Runnability and product quality control
2. Qualitative and quantitative measure of bacteria
   - Specifically for monitoring and control of activated sludge process
3. Characterization of lignocellulose microparticles
   - Evaluation of particle size and composition

Case 1: Colloidal and aggregated pitch

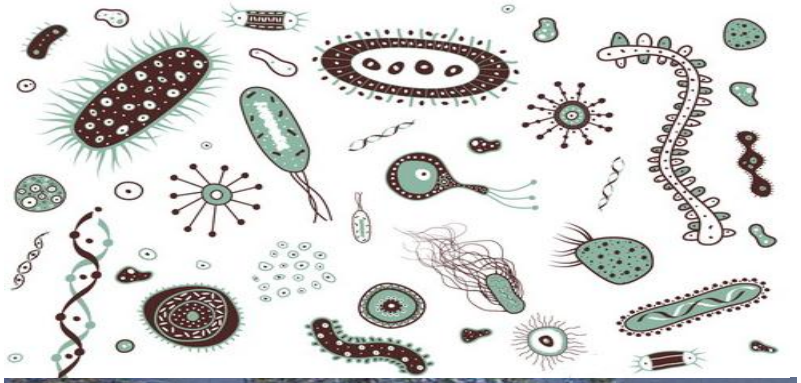
- Analysis of wood pitch particles and other hydrophobic components from mechanical pulp and process waters
- Studied parameters:
  - Number of pitch particles in sample
  - Size distribution (colloidal or aggregated)
  - Hydrophobicity
- Selectivity of particle staining
- Reference to counting by microscope, extraction, turbidity, etc. methods





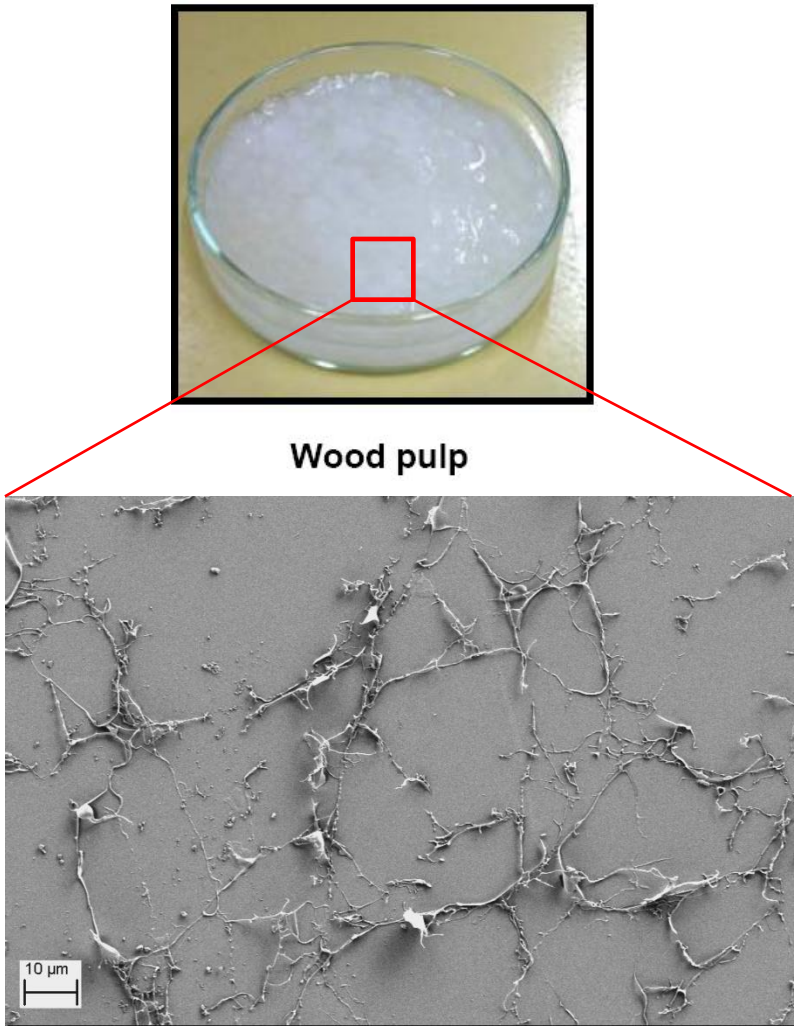
Case 2: Micro-organisms and bacteria

- Bacteria counting with two different nucleic acid stains
  - bacteria with intact cell membranes fluoresce green light
  - bacteria with damaged membranes exhibit red fluoresce signal
- Rapid and reliable method for measuring the bacteria content and type from activated biosludge and other environmental samples
- Results are referenced to sludge floc and dewatering properties



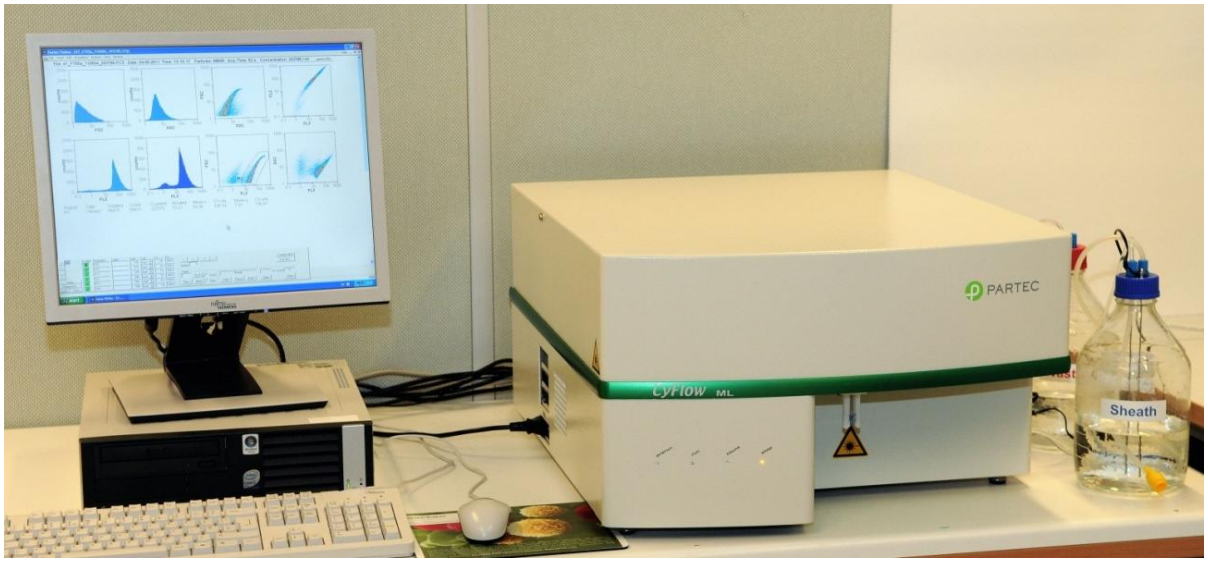
Case 3: Micronized wood components

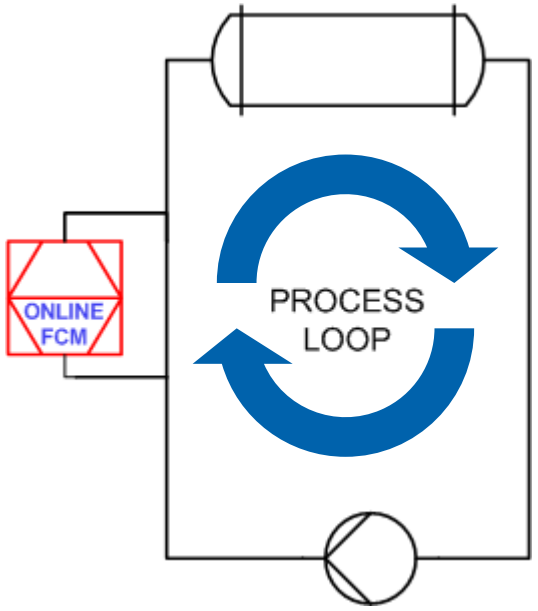
- Evaluation of FCM in micronized cellulose analysis
  - Size distribution
  - Form factors and aspect ratio
  - On-line applicability
- Selective fluorescent dyeing of fibre components
  - Cellulose
  - Hemicellulose
  - Lignin
  - Lipids



Current development efforts

- Sample pre-treatment options
- Selective fluorescent staining of specific components
- On-line sampling and automated sample feed to FCM
- Automated interpretation of results





Thank you for your attention!

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