CEMIS-Oulu

research in measurement technology related to mining

Tekes
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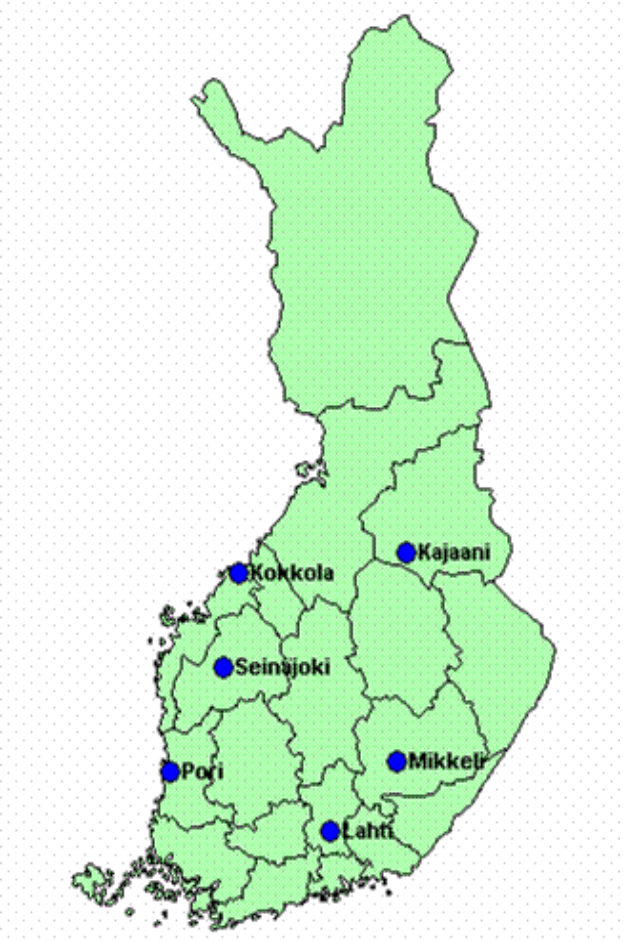
KAJAANI UNIVERSITY CONSORTIUM

- Regional university units in Finland are organized into six university consortiums
- Kajaani University Consortium is a department of University of Oulu

- Unit of Measurement Technology (CEMIS-OULU) is one of the units in Kajaani University Consortium
- Collaborating universities: Oulu, Jyväskylä, Lapland and Eastern Finland.

- Other units included:
  - AIKOPA
  - Sports Technology
  - Teachers education



CEMIS-OULU: History

- One unit of Kajaani University Consortium
- Founded in 2011 by merging former laboratory of biotechnology, measurement and sensor laboratory, research actions of CWC in Kainuu and research actions of TOL in Kainuu.
- One director, three research groups
- Research groups:
  - Analytical and bioanalytical chemistry (Sotkamo)
  - Optical spectroscopy (Kajaani)
  - Image based measurements (Kajaani)

University of Oulu, Unit of Measurement Technology, CEMIS-Oulu 2013

- Organisation of about 50 specialists located in **Kajaani** and **Sotkamo**

- Unit is performing internationally high level applied research in optical spectroscopy, image based measurements and in analytical chemistry and bioanalytics.

- **Main application areas** are measurements and measurement technology in connection to mining, environment , well being (sports and health), renewable forest industry and bioenergy.
- Budget in 2013 is about 4,5 M€, out of which over 85% is external funding.
- Outcome in 2012: 18 peer-reviewed scientific papers and 24 conference or trade papers

FIELD OF OPERATION

- Applied research
- Collaborative research
- Product development projects
- Education
- Research and analysis services

MISSION and VISION

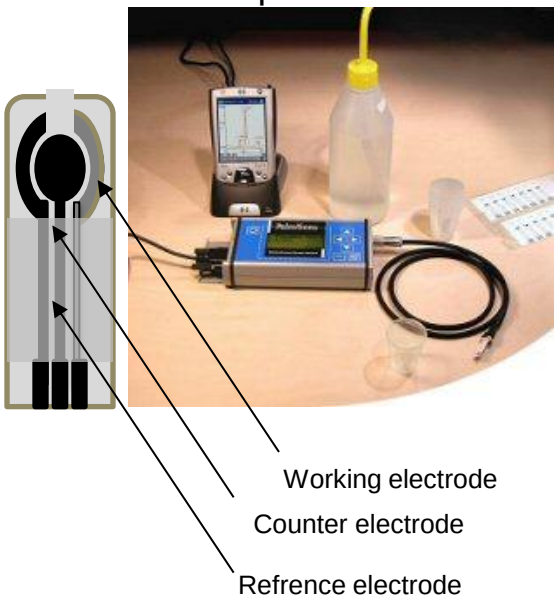
- Perform applied research in the fields of bioeconomy: application areas; mining, environmental measurements, wellbeing, modern wood industry, food industry
- Technologies: Analytical chemistry and bioanalytics, optical measurement technology (optical spectroscopy and image based measurements)
- Create international level knowledge in measurement technology and new innovations for industry to utilise.
- The unit will strengthen it's level of knowledge in order to become known player in chosen research areas at national and international level.
- This is achieved by strengthening international and national networking and the level of knowledge.

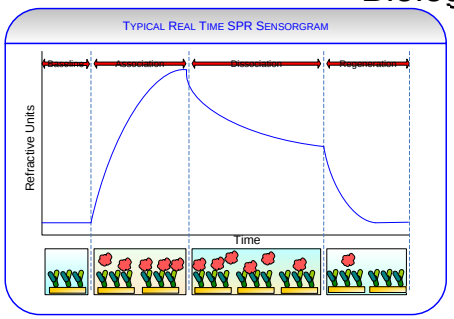
Analytical chemistry and bioanalytics

Example:

On-site measurement unit for low copper Consentration (up to 10 ppb)

Electrochemical measurements in Screen printed elctrodes





Biological / Recognition Element
- Enzymes
- Antibodies
- Nucleic acids
- Binding Proteins
- Molecular imprinted polymers

RACE

Rapid and Cost-Effective methods for Detection of Environmentally Harmful Compounds from Waste Waters

- The aim of the project is to develop rapid, easy-to-use and cost-effective monitoring methods for environmental estrogens and toxic compounds in industrial process water including mining and communal waste waters

- The monitoring methods would be based on optical spectroscopy and biosensor technology.

- Project will be conducted with co-operation between university of Oulu, university of Eastern Finland and Finnish environmental institute. The cost estimates of the proposed project is 622 063 euro

- Project is funded through TEKES Vesi-program

NICK

Novel methods for online monitoring environmentally critical substances (primarily nickel) in process and waste water streams

- The aim of the consortium is to provide a unique, integrated measurement and monitoring platform for environmentally and economically feasible mining operations.

- Research projects is designed to cover the following areas:
  - Electrochemical sensors
  - Colorimetric detection
  - LIBS-technology

- This work will be carried out in close co-operation between University of Oulu, Department of Physics at Tampere University of Technology, VTT and MIKES

- Funded by **TEKES** from Green mining-program

Green Mining

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CEMIS development program2011-2014
ONNI

- To develop rapid measurement solutions for environmental measurements of process industry

- Platform development for electrochemical measurements

- Field usable pilot instrument

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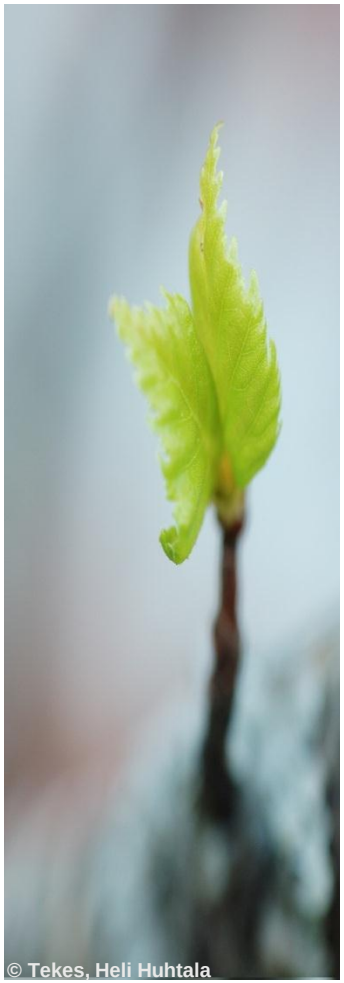
MEAN

Mercury free and automated on-line trace metal analyzatori



- There is clear need towards on-line measurement instrument to determine low metal concentrations.
- The aim of this work is to further **develop novel and rapid on-line methods** for measurements of low metal contents and especially focus to develop new business opportunities for on-line measurements.
- Commercialization of efforts should be to serve its purpose as well as possible and create new business potential for developed measurement instrument.
- **Application areas:** Mining , chemical and process industry and environmental monitoring
- Funded by **TEKES** (TUTLI, with Vesi-program)

Sulphur Compounds in Mining Operations – Environmental Impact Assessment, Measurement and Emission Abatement – SULKA

- Sulphur is involved in metal production at all stages from the mining operations until the metals.

- The main aim of the SULKA-project is to generate new information about the environmental impact of sulphur emissions originating from mining industry, and to develop new methods to measure and monitor but also to minimize the sulphur containing emissions coming from mining operations.

- CEMIS-OULU aims to develop novel methods to determine sulphur compouds from different water fractions. Utilization of biosensor tecnology to measure sulphur compounds will be also studied.

- The project is carried out in different areas of expertise, with the participation of five different partners. Coordinator Prof. R. Keiski.

POHJOIS-POHJANMAA
Council of Oulu Region

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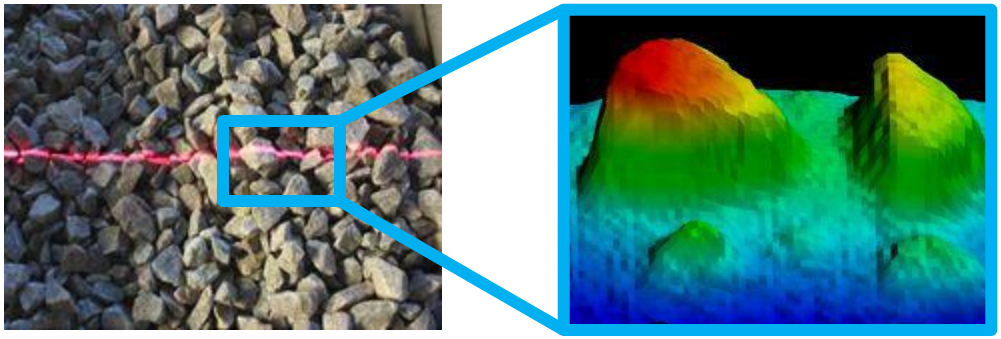
RAIKU

Raekoon reaaliaikainen ja kustannustehokas hallinta louhinnasta tuotteeksi – uusia menetelmiä ja liiketoimintaratkaisu kiviainestuotannon optimointiin

- Hankkeessa kehitetään mittausmenetelmä ja liiketoimintaratkaisu murskatun kiviaineksen rakeisuuden hallintaan
- Hyödyntäjä: perustettava mineraalialan palvelu/teknologiayritys
- Asiakkaat: kaivos- ja kiviainesteollisuus
- TEKES TUTLI-rahoitus 2012-2013, liitetty Green Mining-ohjelmaan, budjetti 630 000 €



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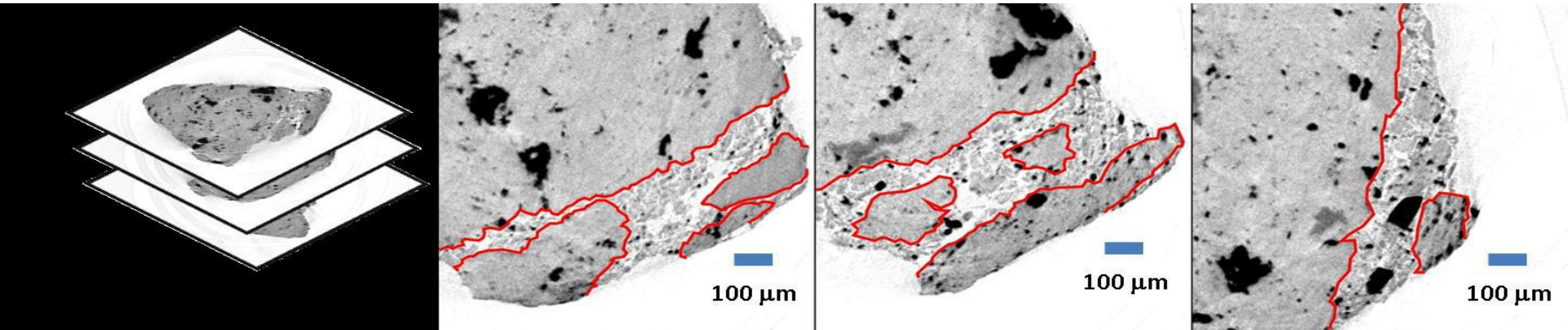
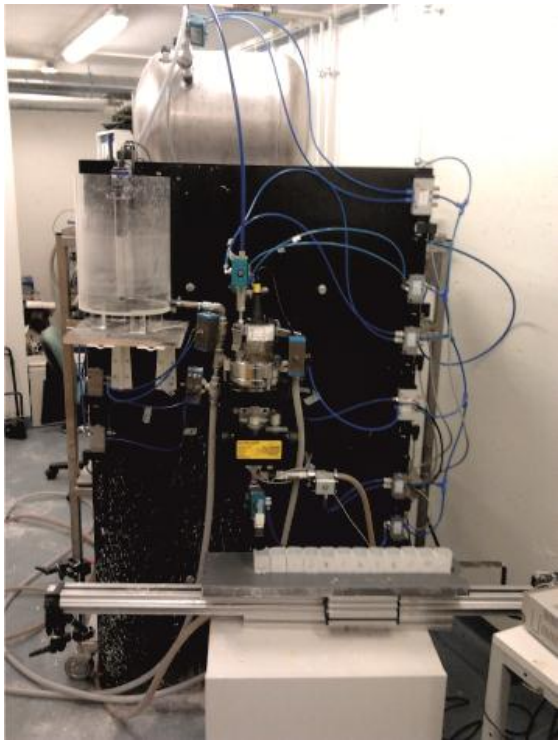
Mineraaliagglomeraatin rakenne

- Sovellettiin **µ**CT-kuvausta mineraalipartikkeleiden liimautumisrakenteen tutkimiseen
- Agglomeraattipalleron rakenne vaikuttaa merkittävästi prosessin toimintaan
- Tomografinen kuvaus tuottaa tarkat leikekuvat palleron koko tilavuudesta
- Menetelmä soveltuu myös tuotannon aikana tapahtuvaan at-line -monitorointiin



CEMIS kehittämisohjelma 2011-2012 ja **MineFiltr**-hanke 2013-2014

Suotautin



- **kehitettiin** laitteisto paperimassojen suotautuvuuden tutkimiseen laboratorioympäristössä.

- Laitteistolla mitattu erilaisia paperimassoja mm. **sakeutta ja suodoskäyriä**.

- Kiintoaineen ja veden erottaminen tärkeä prosessi mm. **metsä- ja kaivannaisteollisuudessa**. Tehostamalla veden erottamista kiintoaineesta saadaan kustannussäästöjä.
- Laitteiston etuina **muunneltavuus** -> mahdollista käyttää eri teollisuuden alojen prosessien tutkimiseen pienillä muutoksilla, kuten esimerkiksi kaivoslietteiden mittaamiseen.
- Jatkohanke **Kaivannaisteollisuuden lietteiden suotautuvuus ja mittaamisen kehittäminen, MineFiltr,** saanut rahoituksen TEKES-EAKR ja liittynyt Green Mining-ohjelmaan

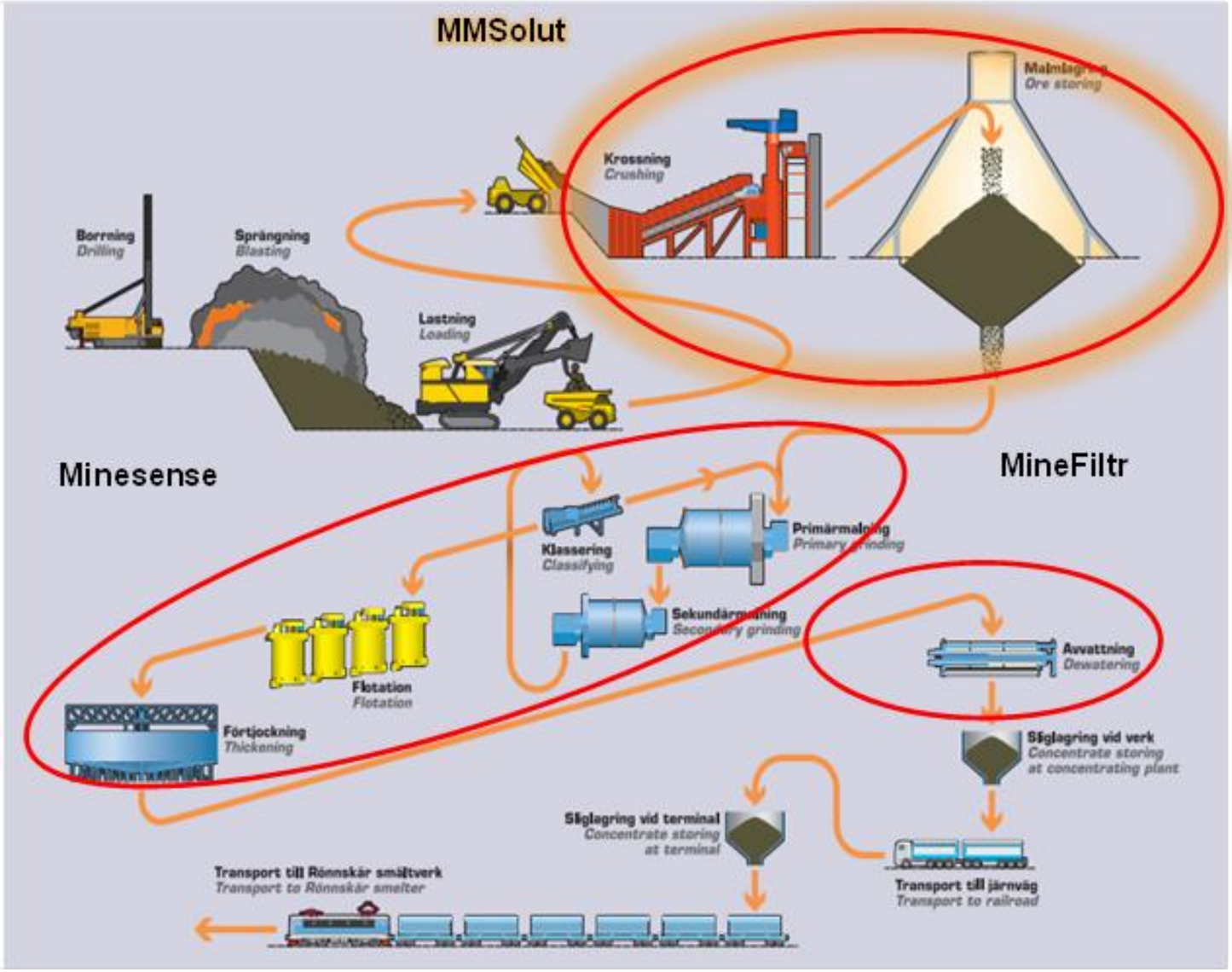
Kaivannaisteollisuuden lietteiden suotautuvuus ja mittaamisen kehittäminen

MineFiltr

- Tavoite:
- Lisätä kaivannaisteollisuuden lietteiden veden poistoon ja erityisesti suodatukseen liittyvää mittaustekniikkaa sekä osaamista.

  - Mittaustekniikan siirto metsäteollisuudesta kaivannaisteollisuuteen
- Veden ja energian käytön tehostaminen.

MineFiltr-project

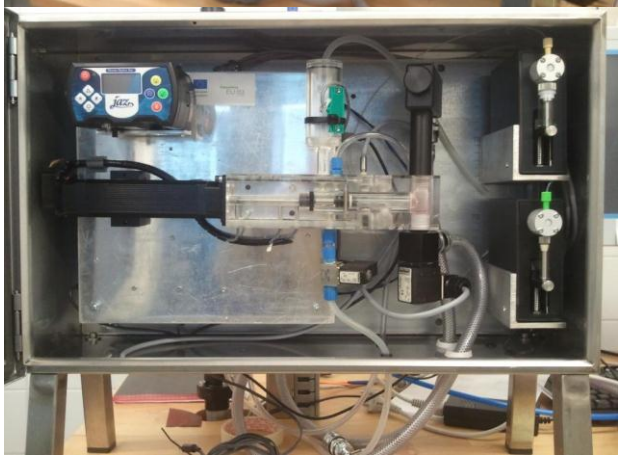


Kenttäkäyttöinen nesteiden optinen online-mittalaite

- **Sovellutukset:** teollisuusprosessien kontrolloin ja hallinta mittaustulosten perusteella

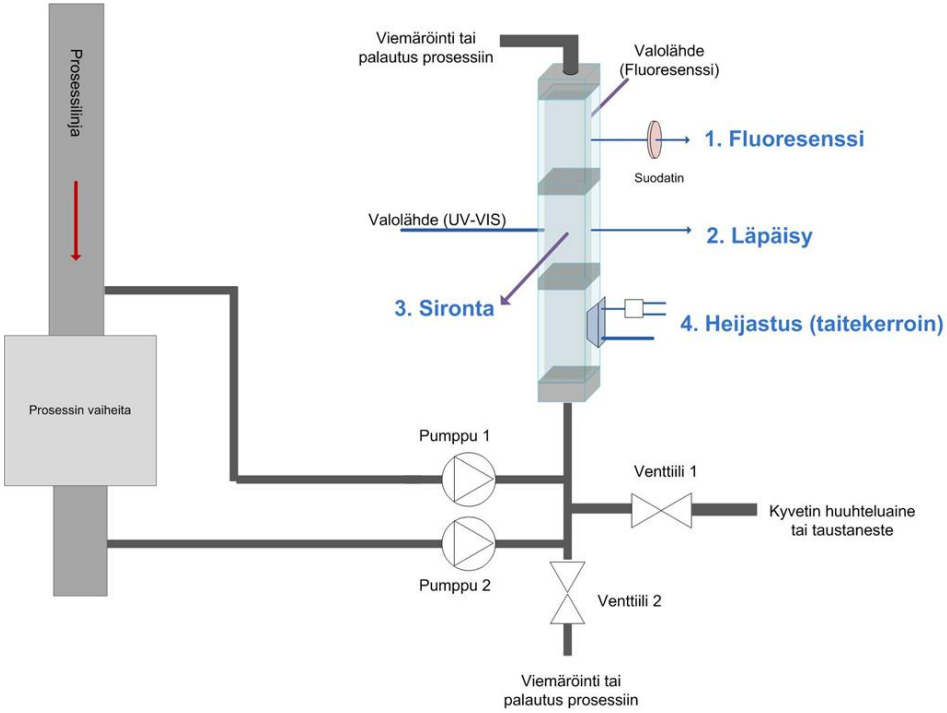
- Laitteen **tärkeimmät** ominaisuudet:
  - Läpäisyn mittaus (Absorptio, transmittanssi)
  - Sironnan mittaus
  - Taustan/referenssin mittaus
  - Optinen näytematka 20 mm
  - **Optisten pintojen puhdistus**

- **Web-pohjainen** mittaustietojen seuranta



CEMIS development programme 2011-2012
OPTICAL MEASUREMENT SYSTEM FOR PROCESS MONITORING

- Equipment for real-time monitoring of characteristics of process solutions and process status. **On-line –measurement for** liquid samples.



- **1 - 5 erilaista optista mittausta**
  - Fluoresenssi
  - Heijastus (taitekerroin)
  - Läpäisy
  - Sironta
  - Mahdollisuus lisätä mittauspaikkoja

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- **Profilation of bacteria using DNA analysis**
- **Application:** industrial process control , diagnosis of sickness, food research

1) NÄYTTEEN ESIKÄSITTELY (KONSENTROINTI)

↓

2) DNA:n eristys

↓

3) **PCR (2 leimaa) + Restriktio**

Finnzymes Phusion Bacterial Profiling Kit

↓

4) PCR –tuotteen puhdistus

↓

5) PCR –tuotteen kuivaus (lähetys)

↓

6) CE-analyysi (Biocenter, Oulu)

↓

7) Tulosten käsittely, bakteerien tunnistus
Peak Scanner

Tutkittuja näytematriiseja:

- Paperiteollisuus
- Metsäteollisuus
- Kaivosteollisuuden vesinäyte
- Biokaasuprosessinäyte
- Hevosen lanta
- Maaperä
- Humaani sylki
- Kasvinäyte (nokkonen)

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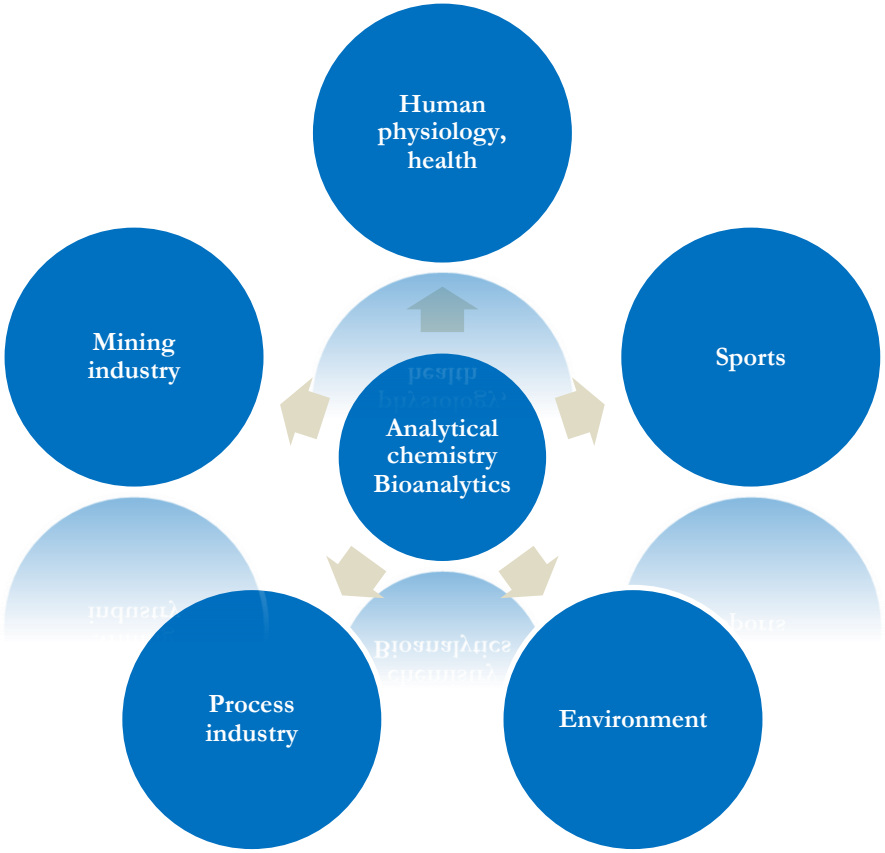
Analytical chemistry and bioanalytics

Competence focuses:

- To develop biosensors and analytical methods to specifically define the desired bio-molecules, metals and environmental compounds
- Research towards developing novel bioanalytical methods for process measurements (on-line)
- Research and analytical services



Optical spectroscopy group

- Group generates knowledge to the optical measurement technology – the focus of research is the reliability of measurements and on-line sensors.
- Know-how is increased by scientific work, which utilized methods and devices of optics and optical spectroscopy.
- Developed measurement technology is tested and exploited with natural waters and industrial suspensions.

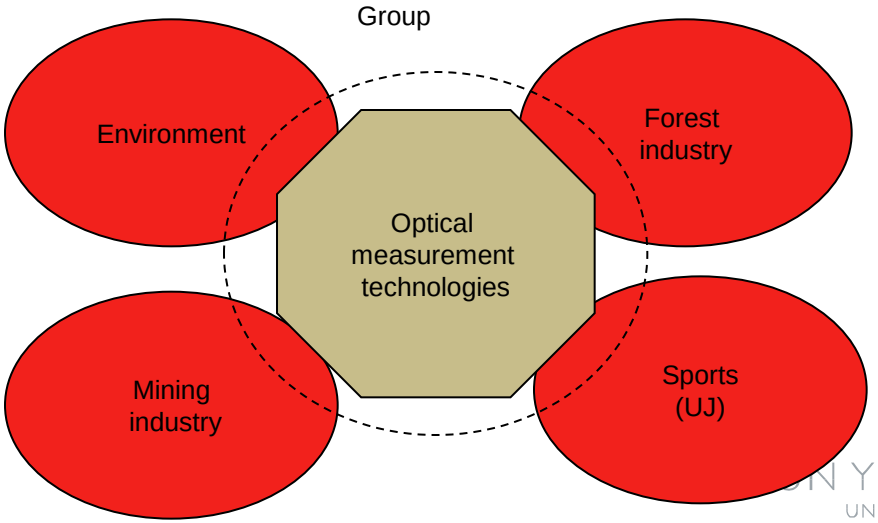


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Image-based Measurements -group

- Develops image-based methods for on-line inspection of industrial materials
- Adapting e.g. the latest biomedical image – based methods for industrial applications
- Analysing the microstructure of materials by measuring the scattered light field
- Applying 3D shape and tomographic methods for macroscopic and microscopic particle characterization