



Special Sensors for the Process Industry

**Technology transfer at the Institute of
Safety Research**

ForMaT – a BMBF-initiative

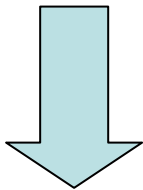


**Forschungszentrum
Dresden Rossendorf**

**Broad portfolio of sensor technologies at
Research Center Dresden-Rossendorf**



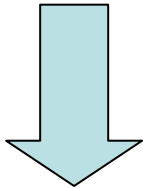
**Unique Expertise:
Imaging techniques and local process sensors for rough
operational conditions**



Starting Point

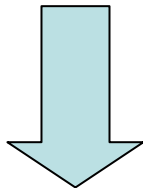


So far focusing on instruments for research purposes only



Goal:

Transfer from low-volume, scientific instruments to products ready for the market



The way:

ForMaT initiative subsidized by BMBF (analysis of opportunities)



Federal Ministry
of Education
and Research

Team



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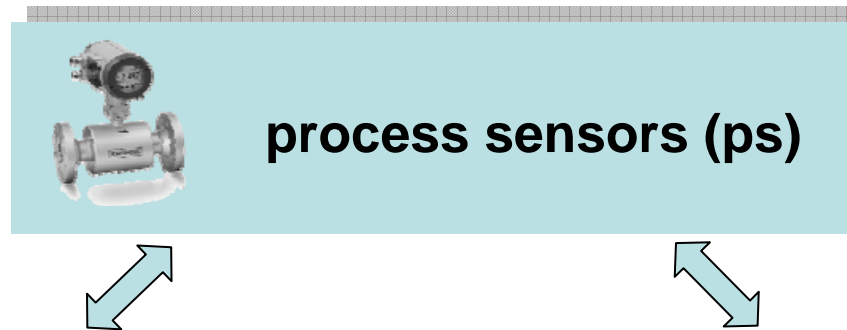
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Importance of process sensors



- ✓ higher process efficiency
- ✓ higher product quality

- ✓ lower energy consumption
- ✓ higher process availability

- PS is increasingly being used for the **further optimization** of existing industrial facilities
- PS can measure process information as well as **inter- and trend information** for control purposes
- Process data with higher **accuracy** are required for specific applications
- Necessity of measuring **spatial distribution** of process data

*NAMUR & VDI/VDE GMA Technology Roadmap Process-Sensors 2005-2015

Requirements on sensors for industrial applications

- possibility to operate **in the process**
- **real-time measurement** with sufficient sampling frequency
- reflect **current developments and trends** of process parameters
- visualize **interfaces or phases**
- **low cost**
- **failure-free**
- **intuitive** to operate

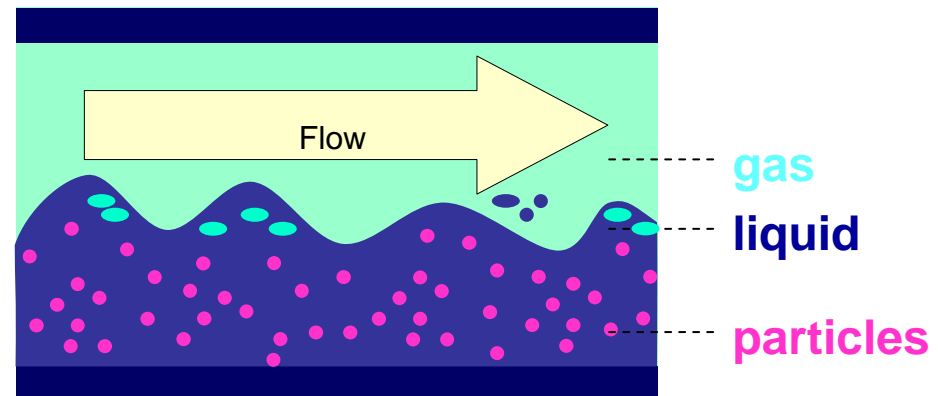


Multiphase flows

... have specific requirements on sensors

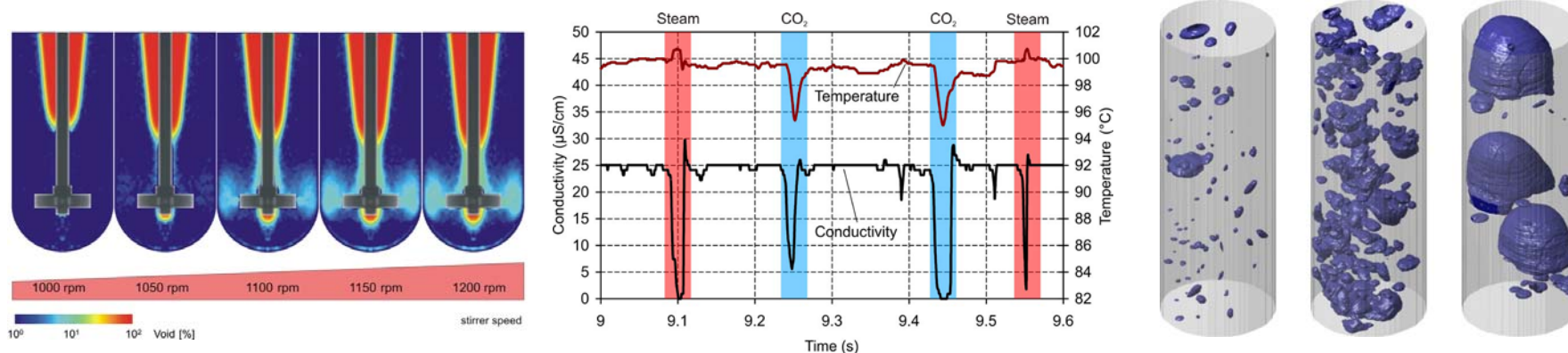
fast measurement of

- phase distribution
- particle size distribution
- phase velocities
- interfacial area density
- temperature and component concentration in each single phase



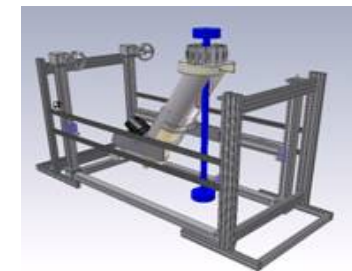
Measurement of multiphase flows is a main focus
of research at Forschungszentrum Dresden-Rossendorf

- phase measurement (for instance gas fraction)
- temperature field measurement
- imaging and spatial-resolved measurement techniques
- high-speed measurements and data acquisition
- sensor for high pressures and temperatures



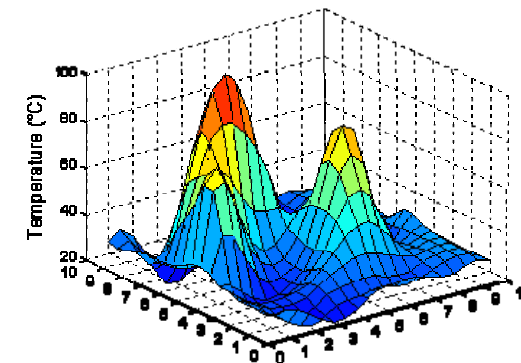
Technically matured sensors

- Needle probes
- Wire-mesh sensors
- Tomography
- Multi-channel, fast temperature measurement
- Optical flow microscope



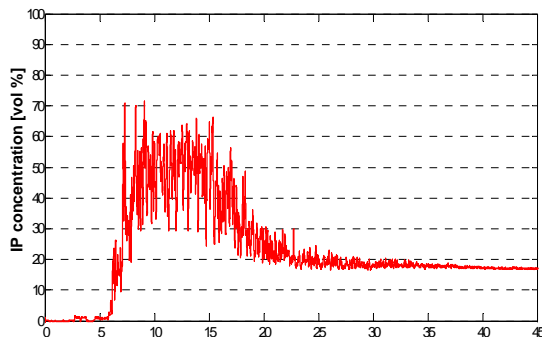
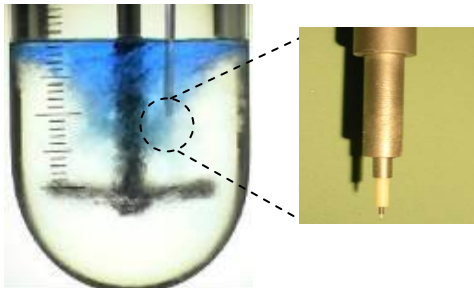
Sensor concepts in the stage of development

- Multiphase flow meter
- Temperature field measurement
- Velocity field measurement
- Autonomous process sensor



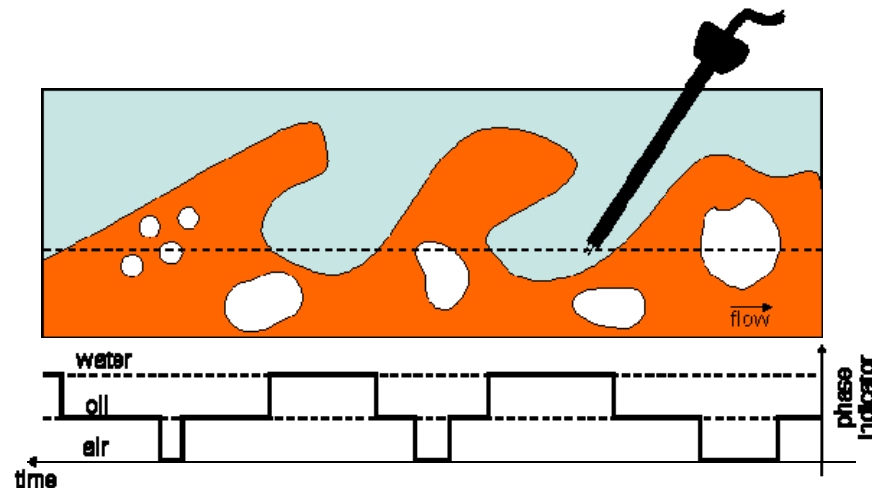
Needle Probes

Fast local measurement of phase, concentration and temperature



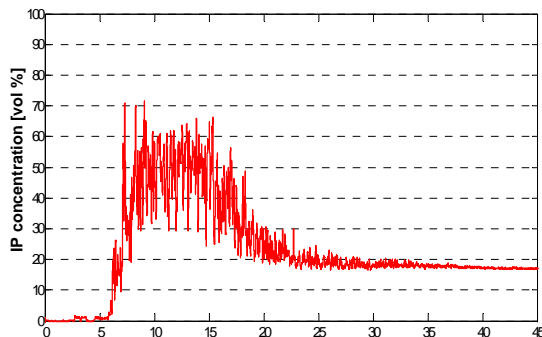
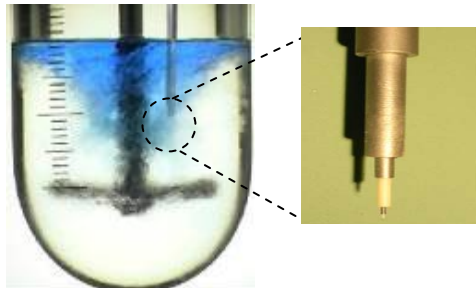
Functional principle

- Fast local measurement of impedance, phase indicator and/or temperature in process
- Temperature measurement up to 1 kHz, 0.5 K
- Phase measurement up to 10 kHz
- High accuracy of measurement due to triaxial electrode configuration
- Robust design



Needle Probes

Fast local measurement
of phases,
concentrations and
temperatures



Functional principle

- Fast local measurement of impedance, phase indicator and/or temperature in process
- Temperature measurement up to 1 kHz, 0.5 K
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- High accuracy of measurement due to triaxial electrode configuration
- Robust design

Fields of Application

- Power plants
- Chemical reactor
- Process engineering

Operational Conditions

- Temperature up to 300°C
- Pressure up to 20 MPa

Status

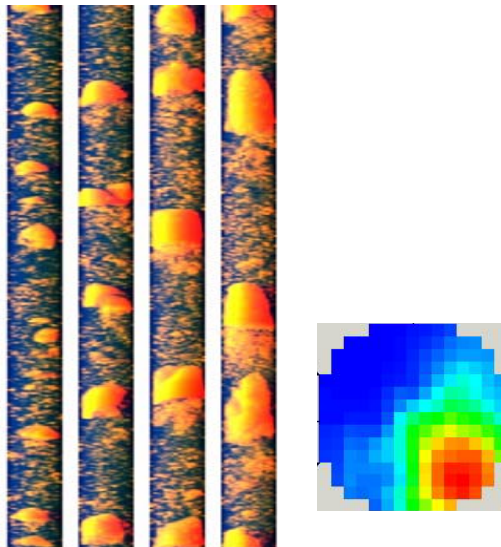
small series

Costs

approx. 10 kEUR / system

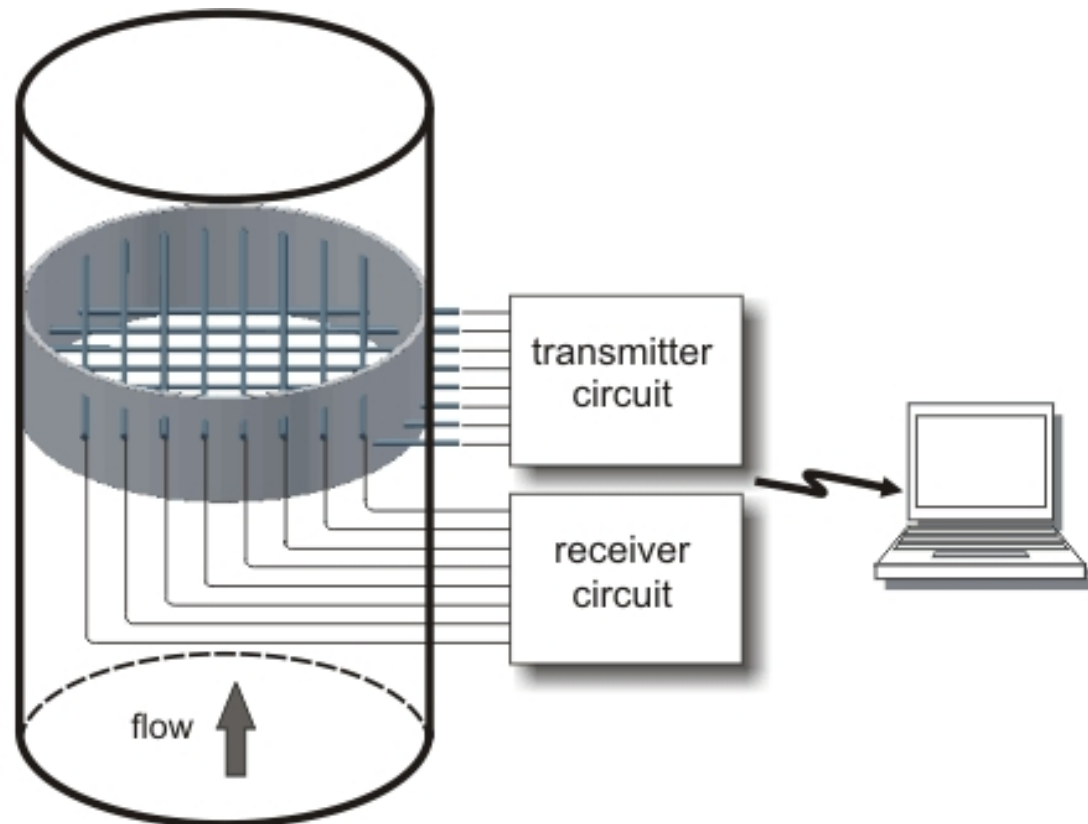
Wire-mesh sensors

Visualization of phases
and interfaces



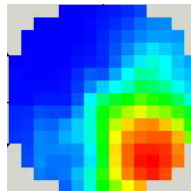
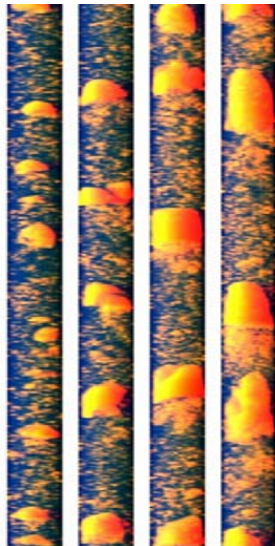
Functional principle

- Fast two-dimensional measurement of phases in cross-sections of vessels
- Visualization of flows with extreme velocity (10,000 frames per second)



Wire-mesh sensors

Visualization of phases and interfaces



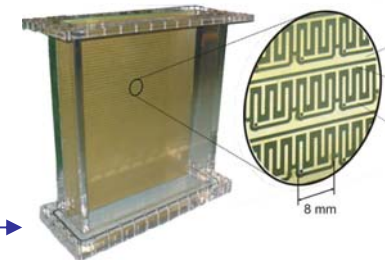
Functional principle

- Fast two-dimensional measurement of phases in cross-sections of vessels
- Visualization of flows with extreme velocity (10.000 frames per second)

Fields of Application

- Fluid flow in pipes
- Chemical reactors
- Components of industrial facilities
- Filter systems
- Dynamic fluid level measurement →

Planar array sensor



Operational Conditions

- Temperature up to 250°C
- Pressure up to 7 MPa
- Flow velocity up to 10 m/s

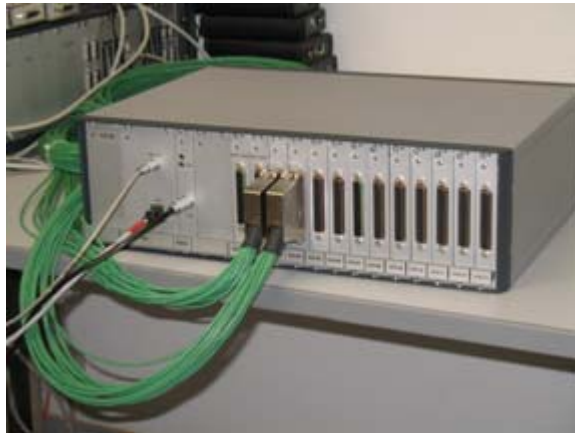
Status

small series

Costs

approx. 70 kEUR / system

Fast, Multi-channel Temperature Measurement



Functional Principle

- 200-channel measurement system for parallel temperature data acquisition at 1 kHz
- use of micro-thermocouples
- measurement uncertainty of 0.5 K

Fields of Application

- Power plants
- Process Engineering
- Monitoring systems for industrial facilities, components and buildings
- ...
- overall there, where IR-cameras are not suitable

Operational Conditions

- Temperature up to 250°C

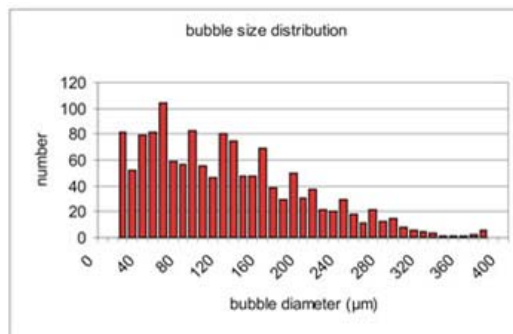
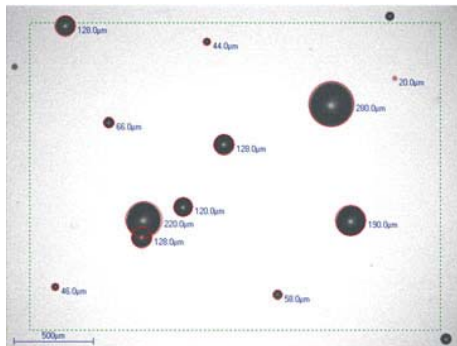
Status

prototype

Costs

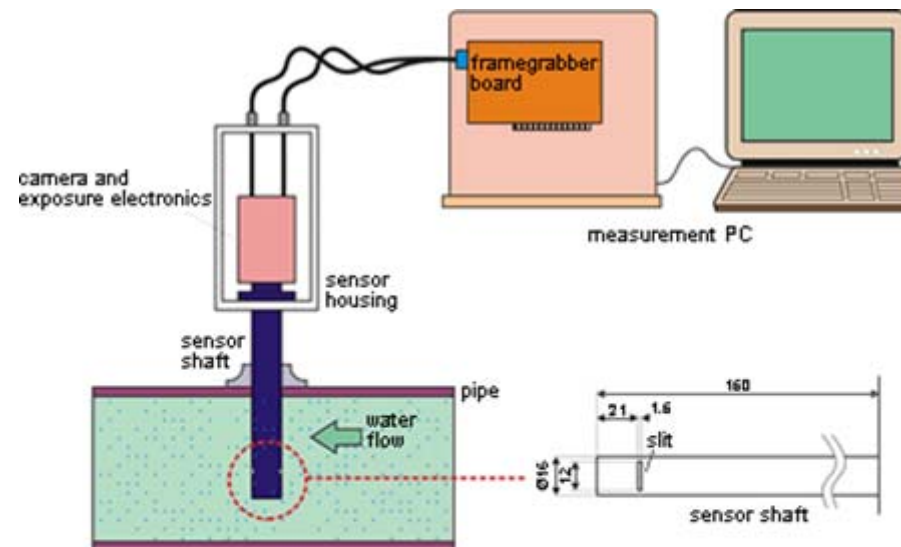
approx. 50 kEUR / system

Optical Flow Microscopes

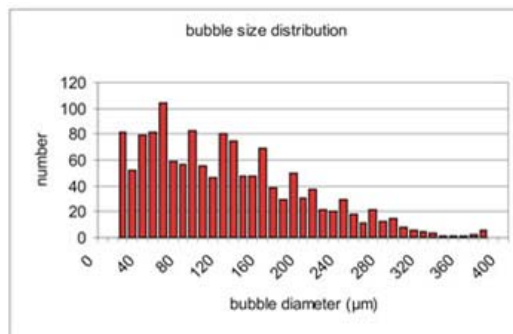
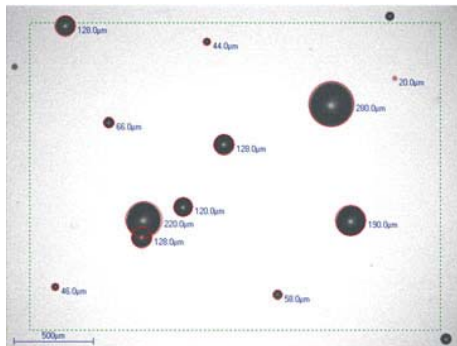


Functional Principle

- Transmitted light images of particles using endoscopic imaging systems
- Developed for high pressure and temperature
- Image resolution up to 30 Hz (increase is possible)
- Resolution approx. 3 µm



Optical Flow Microscopes



Functional Principle

- Transmitted light images of particles using endoscopic imaging systems
- Developed for high pressure and temperature
- Image resolution up to 30 Hz (increase is possible)
- Resolution approx. 3 µm

Fields of Application

- Power plants
- Process engineering
- Particle technology

Operational Conditions

- Pressure up to 8 MPa
- Temperature up to 200°C

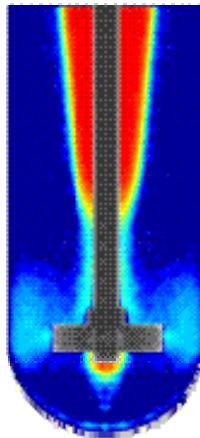
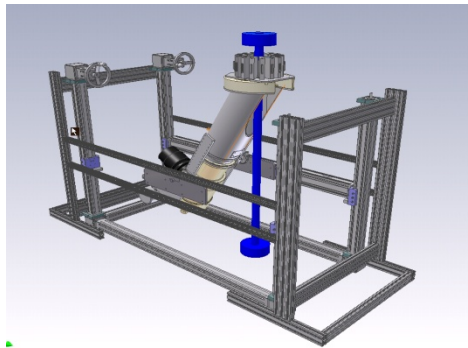
Status

prototype

Costs

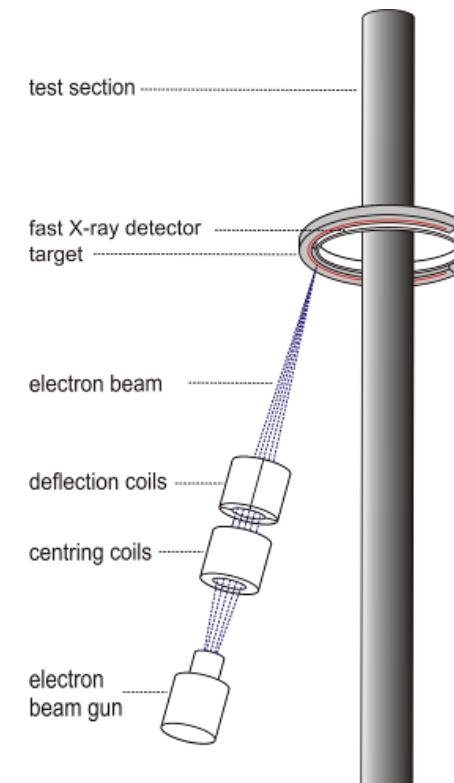
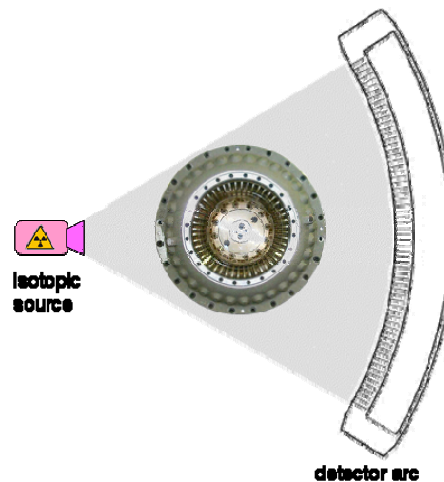
approx. 50 kEUR / system

Radiation-based techniques

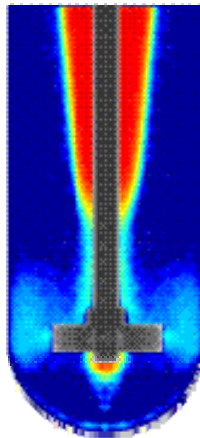
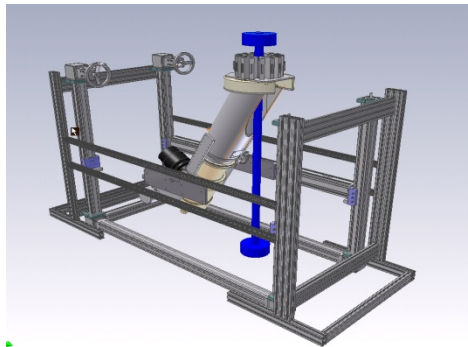


Functional Principle

- Non-invasive density measurement or cross-section imaging of processes using x-rays or gamma-rays
- densitometry – single-beam density measurement
- γ -ray tomography – cross-sectional imaging with rotating scanner
- x-ray tomography – fast imaging with electron beam scanner



Radiation-based techniques



Functional Principle

- Non-invasive density measurement or cross-section imaging of processes using x-rays or gamma-rays
- densitometry – single-beam density measurement
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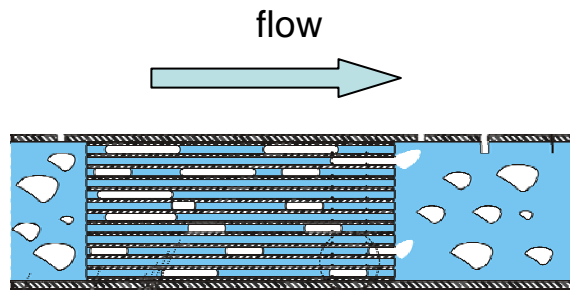
Fields of Application

- Phase measurement in laboratory, pilot plants or real industrial facilities
- Non-destructive testing

Status

- Devices for services are available
- Construction of scanners is possible

Multiphase Flow Meter



Functional Principle

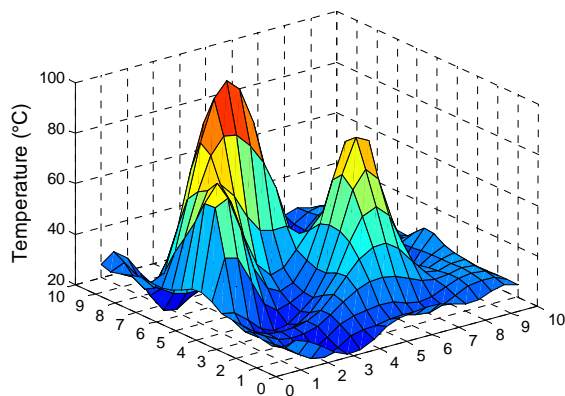
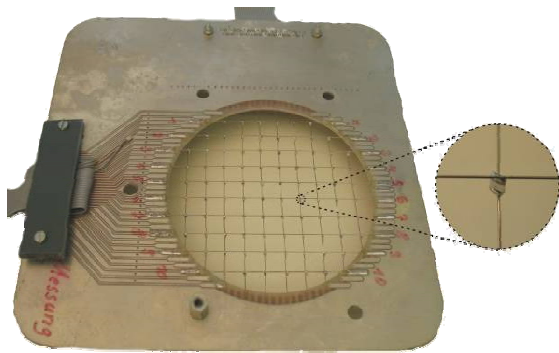
- Separated measurement of phase volume fractions and phase velocities in flow of mixtures based on the principle of wire-mesh sensors
- Calculation of partial volume flows based on acquired data

Fields of Application

- Process Engineering
- Power Plants
- Oil Industry

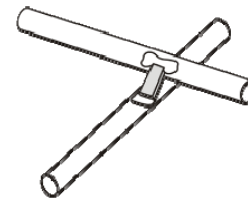


Temperature field and velocity field measurement



Functional Principle

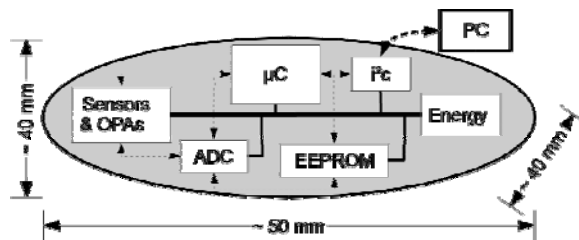
- Two-dimensional, fast measurement of temperature or flow velocity (anemometry)
- use of advanced wire-mesh sensor technology (intelligent crossing points)



Fields of Application

- Power plants
- Process engineering
- Drying plants
- Agriculture
- Monitoring of industrial facilities

Autonomous process sensors



Functional Principle

- Battery-operated particles at the size of table tennis balls for continuous acquisition of process data
- For processes that are of difficult access

Fields of Application

- Biogas fermenter
- Cleaning stations
- Monitoring systems for food and animal feed
- Food technology
- Process engineering in general



1. Are you interested in the presented sensor systems?

2. Where do you need....

- imaging
- fast
- robust

measurement systems in your processes, equipments or facilities?

3. Which fields of application can you identify?

4. What are the technical requirements?

5. To what extend would you apply the new measurement systems?

6. Are there any other interested parties?