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Optical methods to measure fast changing liquid micro flow

Luebeck Medical Engineering

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Motivation

- Flow sensors in medical applications
  - Thermal flow sensors
  - Differential pressure sensors
- Dynamic flow rates in medical applications
  - Peristaltic infusion pumps
  - Disposable infusion pumps
  - Implantable infusion pumps
  - Membrane pumps
  - Pulsating blood stream

http://www.sensirion.com/LD20-2000T

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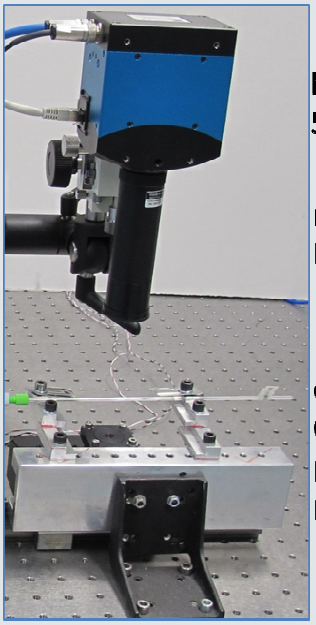
Capillary in combination with a high speed camera

- Flow range: 50 nl/ min - 500 µl/ min
- Acquisition time: 2 – 60 s



high speed camera
5000 fps

magnifying telecentric
Lense; 2x, 4x, 5x

capillary 150 µm, 300 µm,
600 µm, 1000 µm

Light source,
LED collimated

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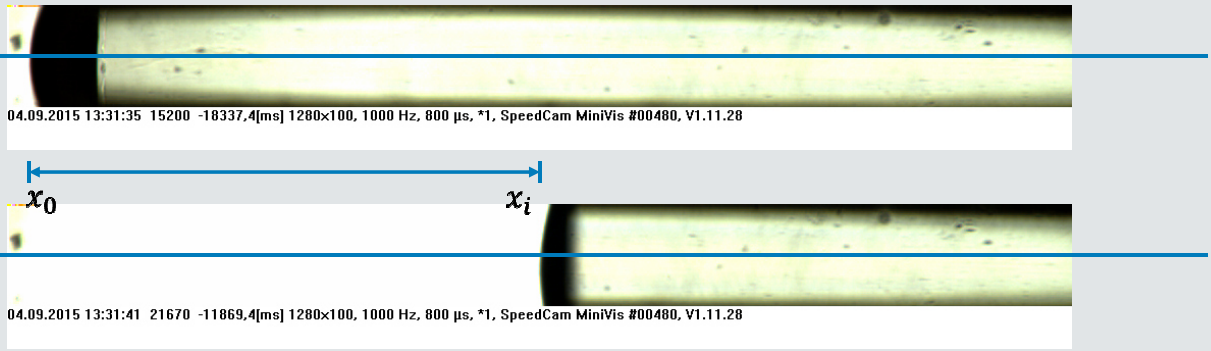
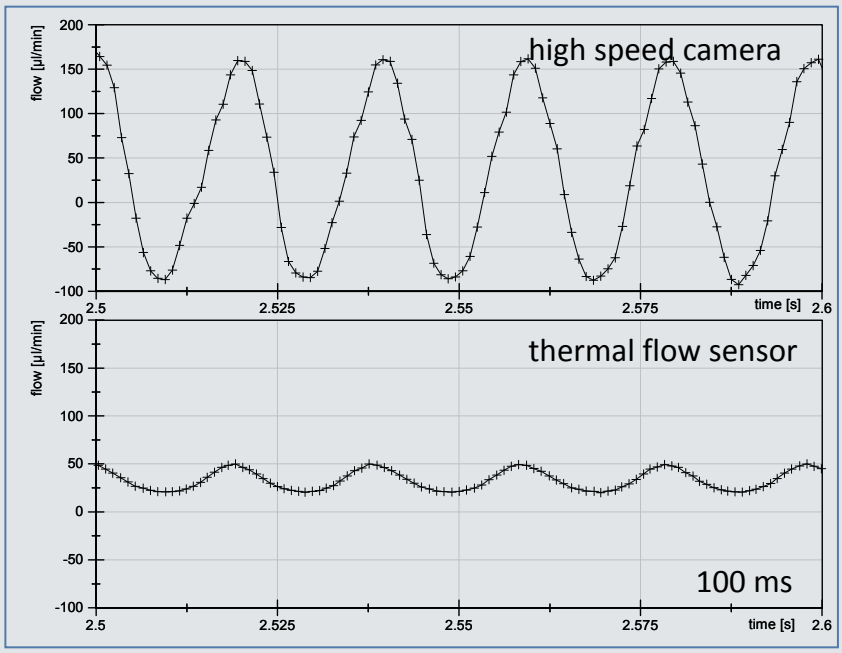
Method of measurement



$$Q = \left(\frac{\Delta x}{\Delta t}\right) \pi \cdot \left(\frac{D}{2}\right)^2$$

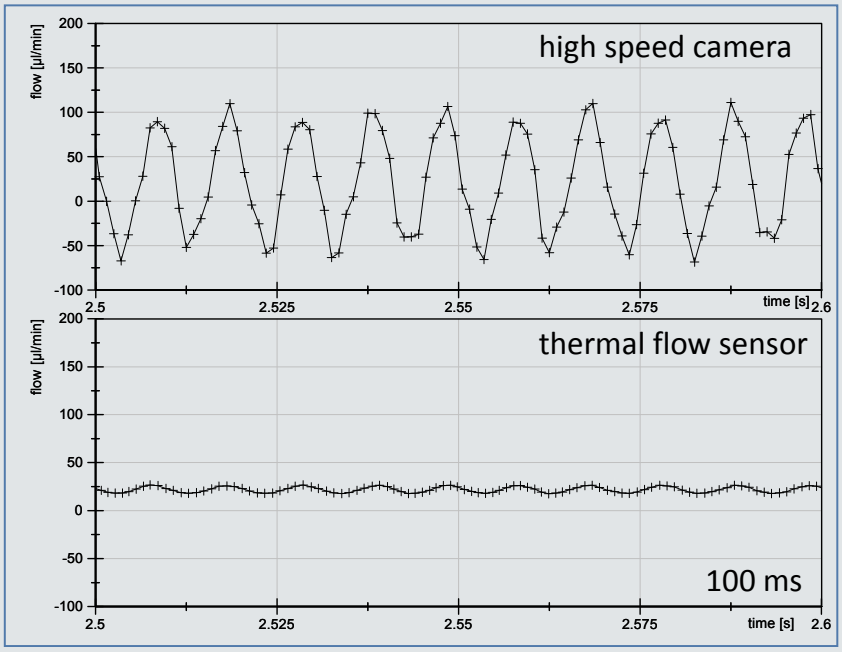
Q: flow
Δx: displacement of liquid front
Δt: time step

Piezo actuated membrane pump, 50 Hz



Sample rate 1 kHz

Piezo actuated membrane pump, 100 Hz



Sample rate 1 kHz

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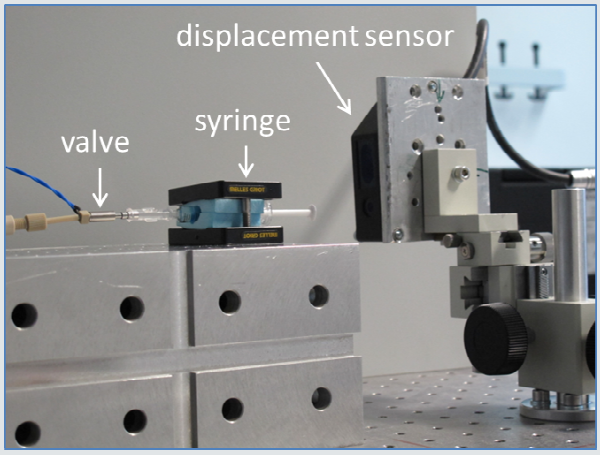
Syringe in combination with a displacement sensor



- Flow range: 500 µl/ min - 50 ml/ min
- Sample rate: 1.5 kHz – 30 kHz (49.02 kHz/ 10 mm)
- Acquisition time: 1 – 600 s

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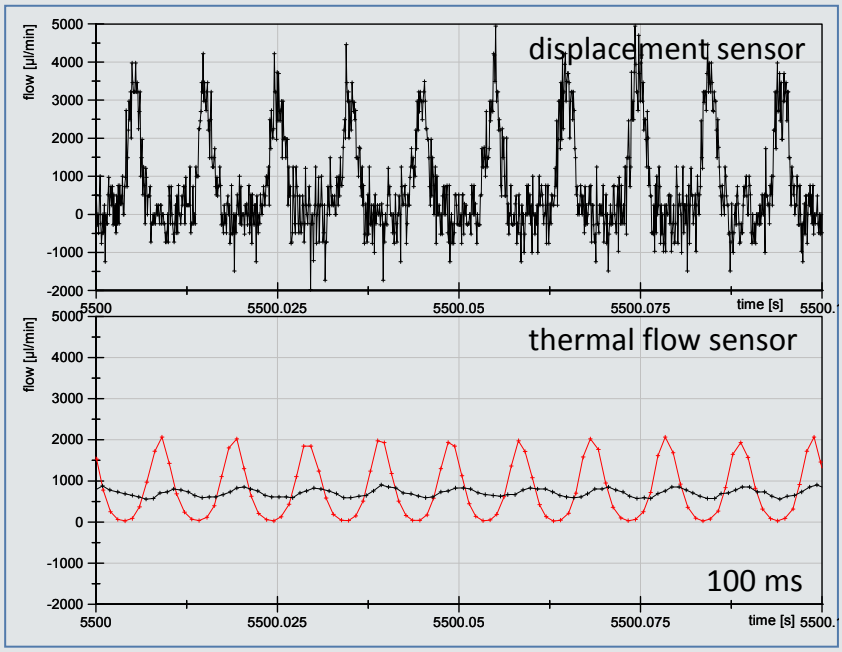
Piezo actuated membrane pump, 100 Hz



Sample rate 10 kHz

Sample rate 1 kHz

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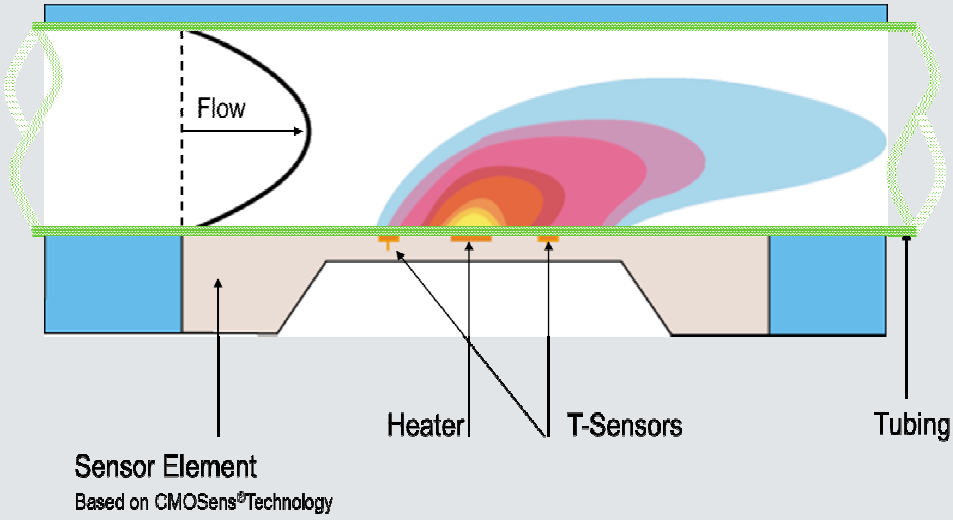
Liquid Flow Sensor Packaging

Cross section view of the flow channel



SENSIRION
THE SENSOR COMPANY

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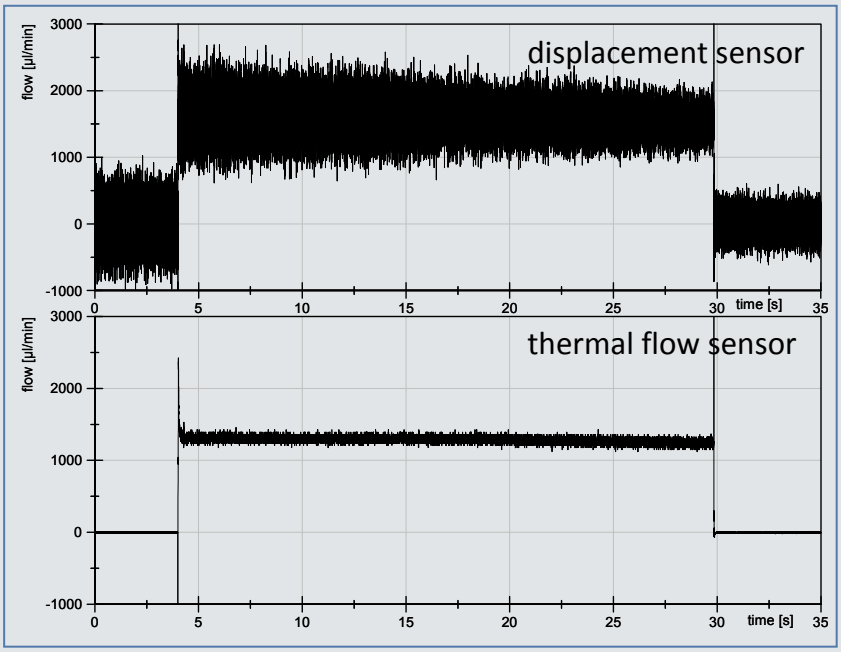
Continous flow, 20 mm



noise

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Conclusion

Capillary in combination with a high speed camera

- Fast changing micro flow from 50 nl/ min to 500 µl/ min capillary in combination with high speed camera
- Sample rate 1kHz, limited by high speed camera

Syringe in combination with a displacement sensor

- Fast changing micro flow from 100 µl/ min to 10 ml/ min
- noise level
- Stick slip effect

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Thank you for your attention!

Questions? → Answers!

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