Calibration services for health care

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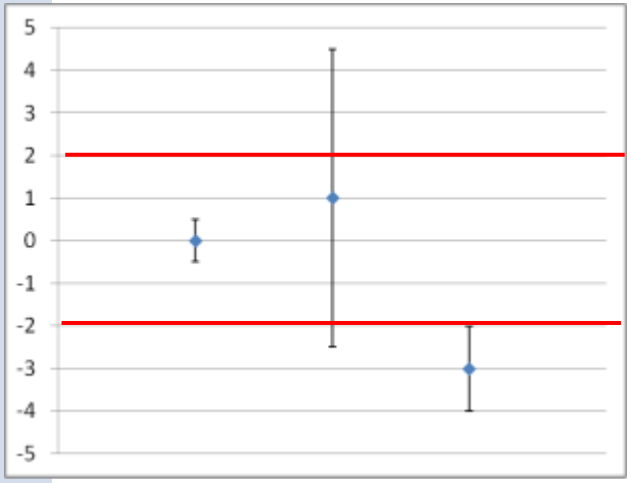
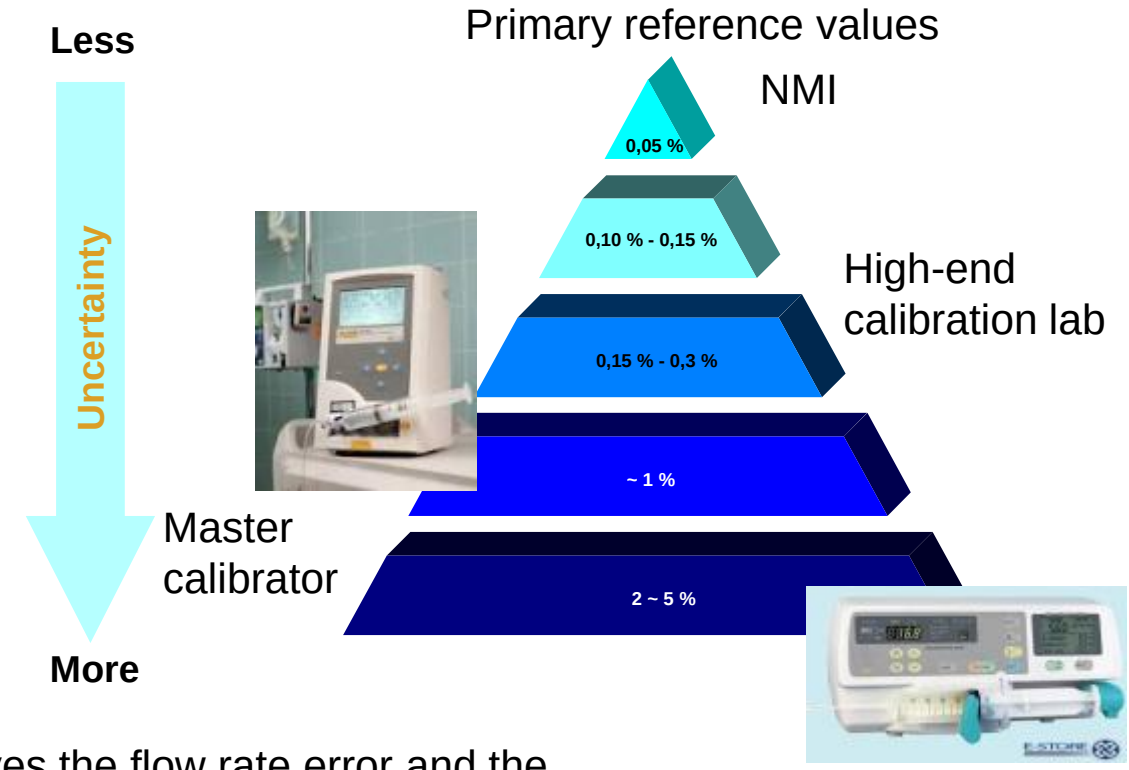
Content

- Why calibration? Why traceability to SI-Units?
- 3 types of primary standards
  - Gravimetric method
  - Water front tracking in a capillary
  - Liquid thermometer method
- Validation of primary standards by means of inter comparison

Why calibraton? Why traceability to SI-Units?

Uncertainty of calibration has to be 3 (5) times smaller than the stated accuracy of the device under test or the maximum permissible error





- A sound calibration gives the flow rate error and the uncertainty in that error
- Traceability is a guarantee for quality of calibration results

EMRP HLT07 – Metrology for Drug Delivery

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EMRP
European Metrology Research Programme
Programme of EURAMET
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EURAMET

VSL Dutch Metrology Institute

CMI

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METAS

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3 Types of Primary Standards

Gravimetric method

Flow rates
100 nl/min – 10 ml/min

Water front tracking in capillary

Flow rates
5 nl/min – 1 μl/min

Liquid thermometer method

Flow rates
30 nl/min – 1.5 μl/min

3 Types of Primary Standards

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Water droplet

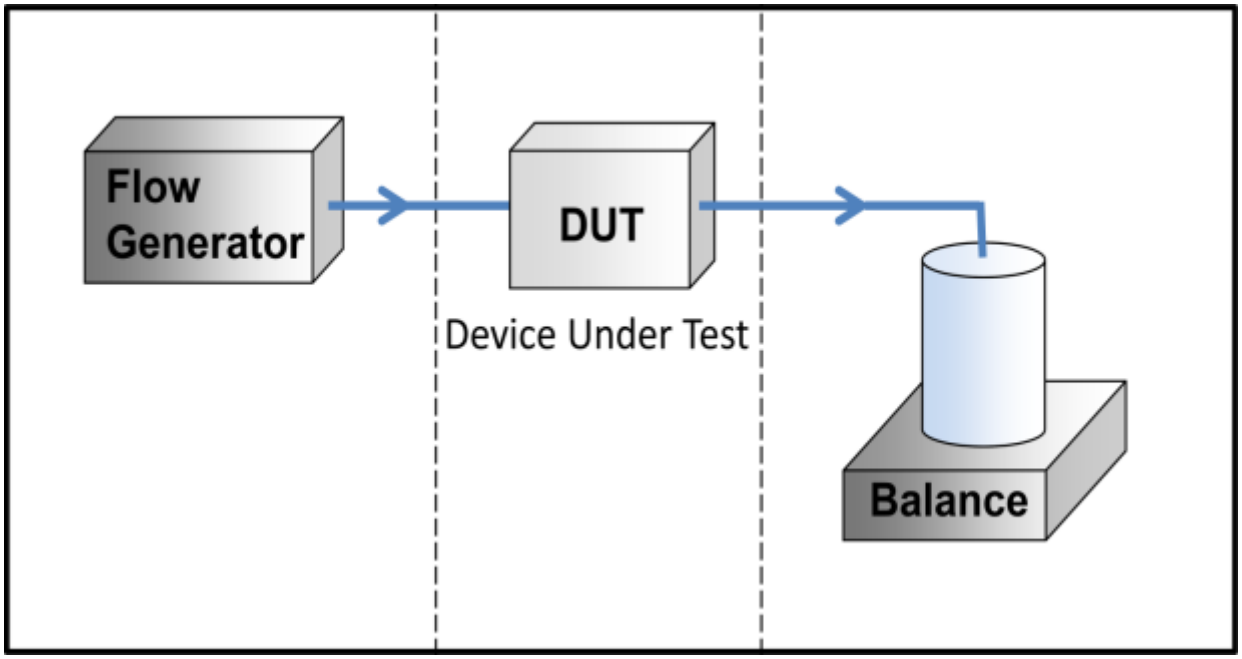
Size 50μl
(Pharmacology, Wikipedia)

Flow rate **10 ml/min**,
time to get the droplet: **0.3 s**

Flow rate **100 nl/min**,
500 min (8h 20 min)
working day in Switzerland

Flow rate **5 nl/min**,
Full week (24/7)

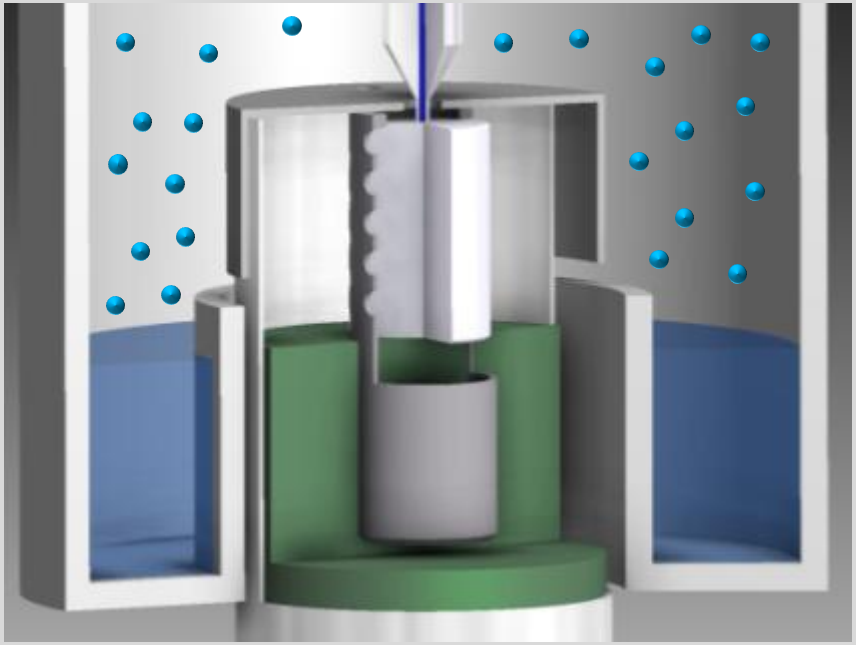
Gravimetric Method



- 2 types of collecting water in beaker to avoid droplet formation and minimize evaporation
- 2 principles for flow generator

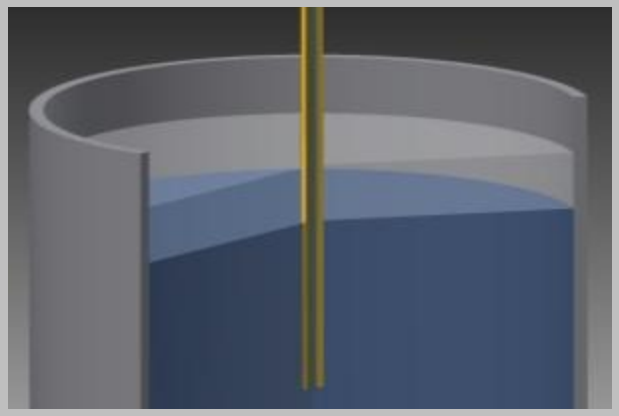
2 types of collecting water in beaker to avoid droplet formation and minimize evaporation

Water Bridge to waterabsorbing materials in saturated air

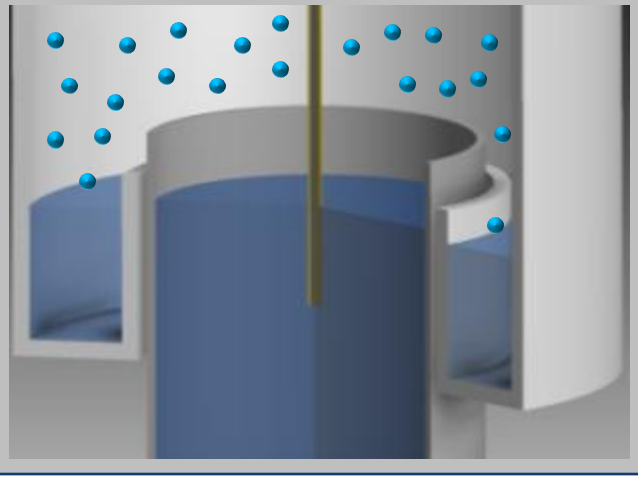


Needle immersed into water

- **with oil cover**

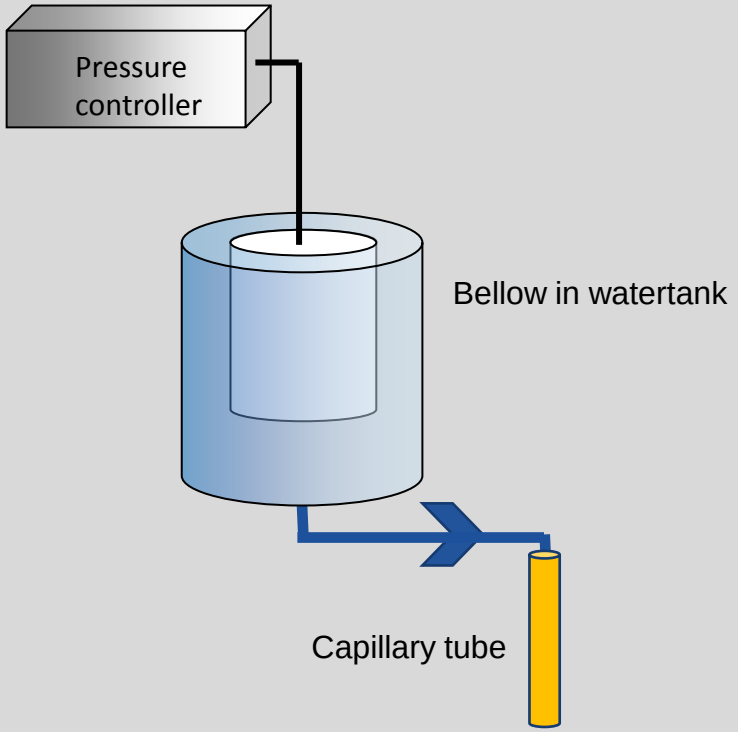


- **in saturated air**



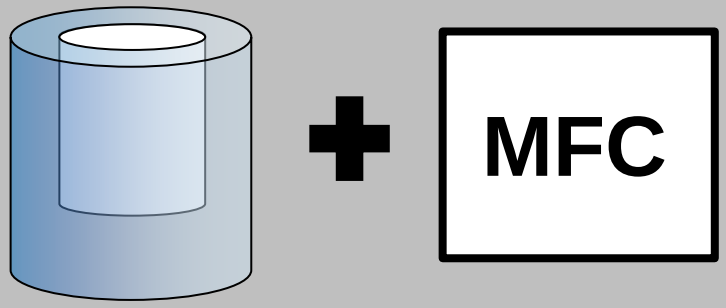
Flow Generator: 2 principles

Constant pressure drop over capillary tube setting the flow rate

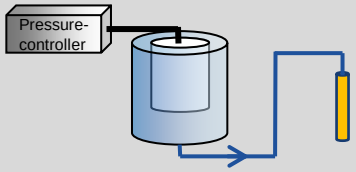


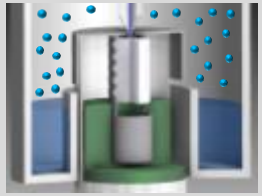
Syringe pump setting the flow rate

MFC setting the flow rate

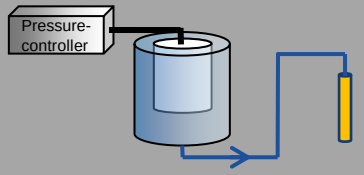


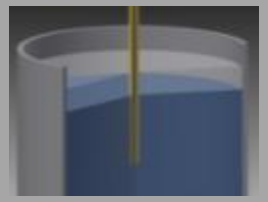
Flow generator and water collection method





METAS





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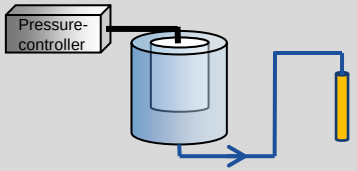

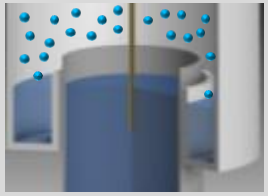

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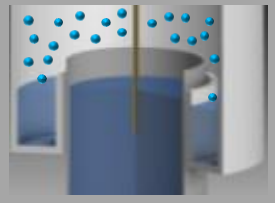

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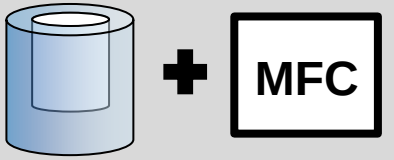
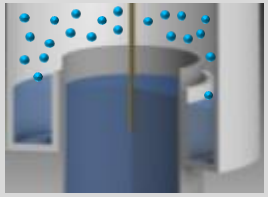
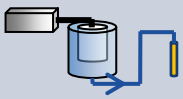
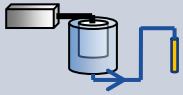
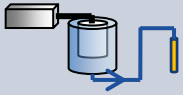
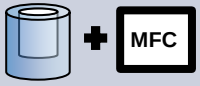
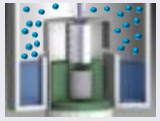
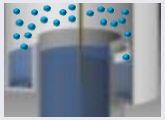
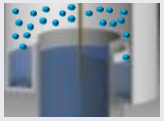
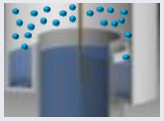




VSL
Dutch Metrology Institute

Micro Flow Facility – Gravimetric setup

Characteristics

	METAS	DTI	CETIAT	IPQ	VSL
Flow rate range	1 ml/min – 100 nl/min	16 ml/min – 100 nl/min	133 ml/min - 16 µl/min	10 ml/min - 50 nl/min	16 ml/min - 4.2 µl/min
Uncertainty (k = 2)	0.1 - 0.6 %	0.05 - 0.6 %	0.04 – 1 %	0.15 - 6 %	0.06 - 1.4 %
Water temperature	Ambient	Ambient	10 - 50 °C	Ambient	Ambient
Pressure range upstream DUT	0 – 2.5 bar	0 – 5 bar	0 – 10 bar	0 – 2 bar	0 – 5 bar
Flow generator					
Water collection					

Micro Flow Facility – Gravimetric setup

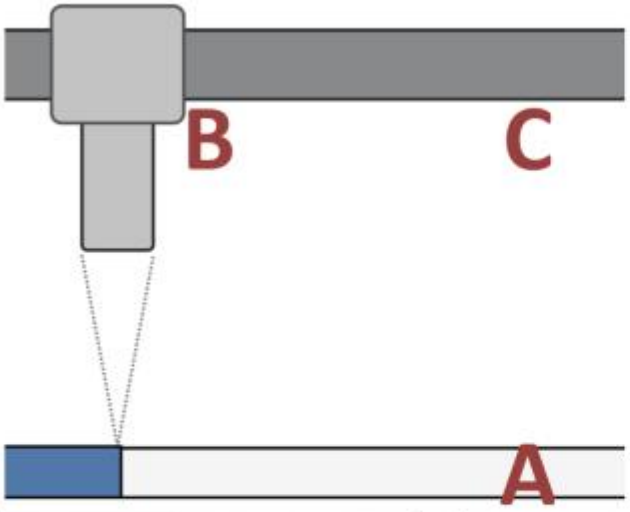
Influence factors

IEC 60601-2-24

- Degassing water — ISO Class III water for medical use
- Priming the tubing and the flow meter under test
- Flow rate stability (~ 0.05 %)
- Buoyancy correction of the delivered water (~ 0.10 %)
- Buoyancy correction of the beaker (~ 0.01 %)
- Evaporation (saturated air or oil layer) (~ 0.008 µl/min) ✓
- Buoyancy correction due to the immersed tube into the water (~ 0.1 %)
- Jet force out of the immersion tube (~ negligible, but tested)
- Linearity of the balance (~ to be tested)
- Drift of the balance (~ to be tested)

Water front tracking in a capillary

Measurement priciple: front tracking system

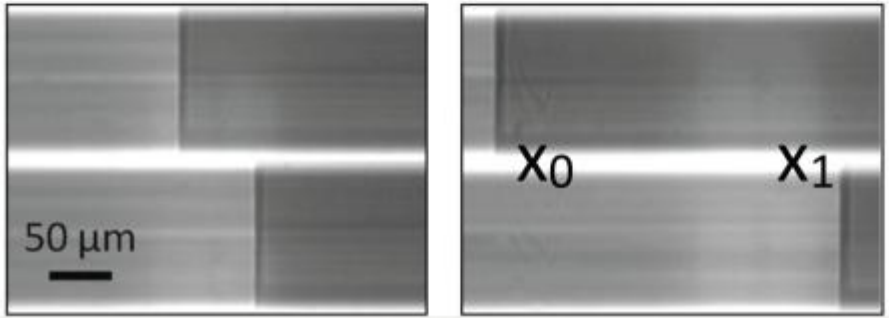


$x_1 - x_0$: traveling distance

$t_1 - t_0$: measurement time

R: radius of the capillary

$$\dot{V} = \frac{dV}{dt} = \frac{x_1 - x_0}{t_1 - t_0} \cdot \pi \cdot R^2$$



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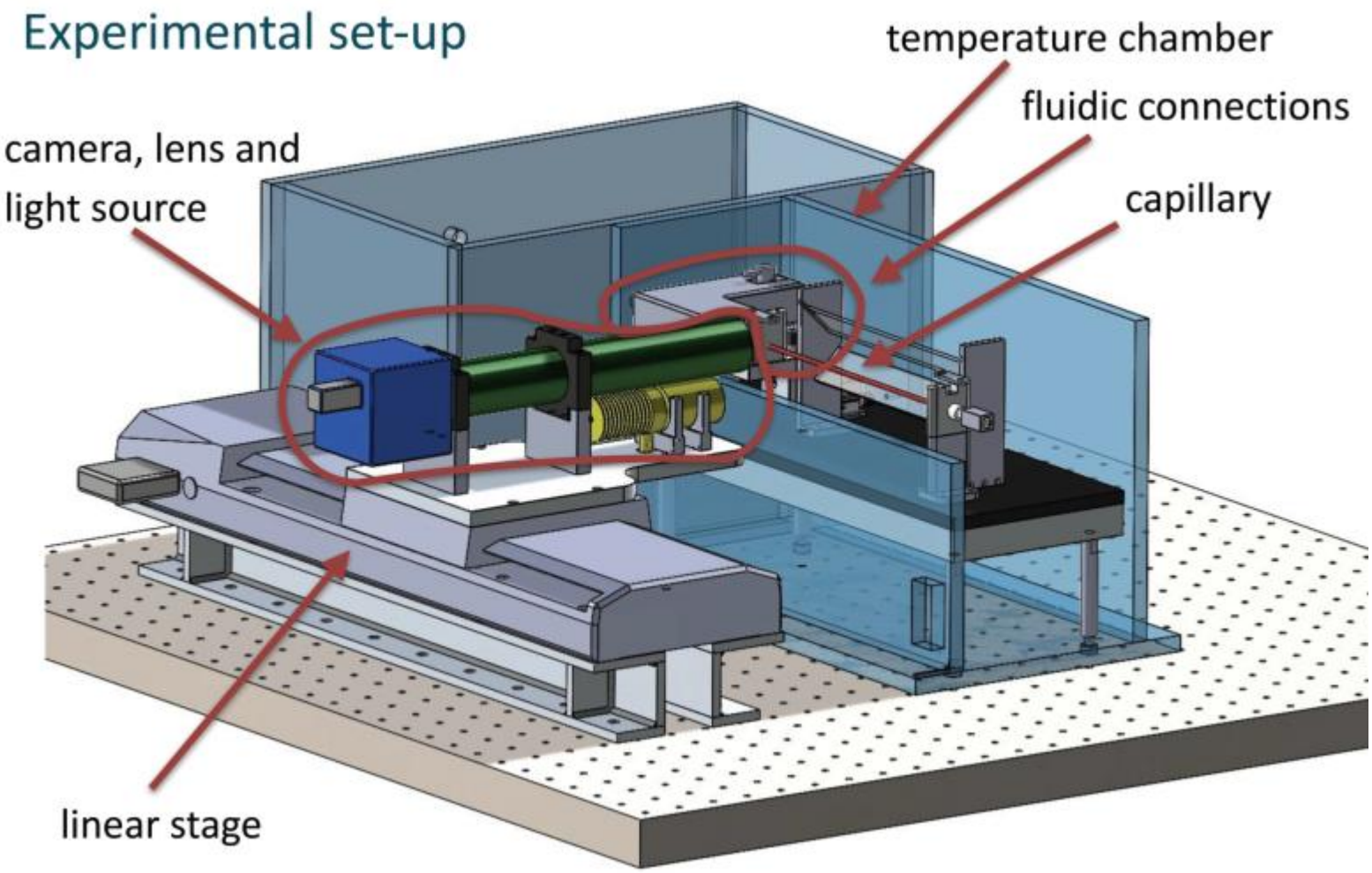

Water front tracking in a capillary

Overall uncertainty

Contact:
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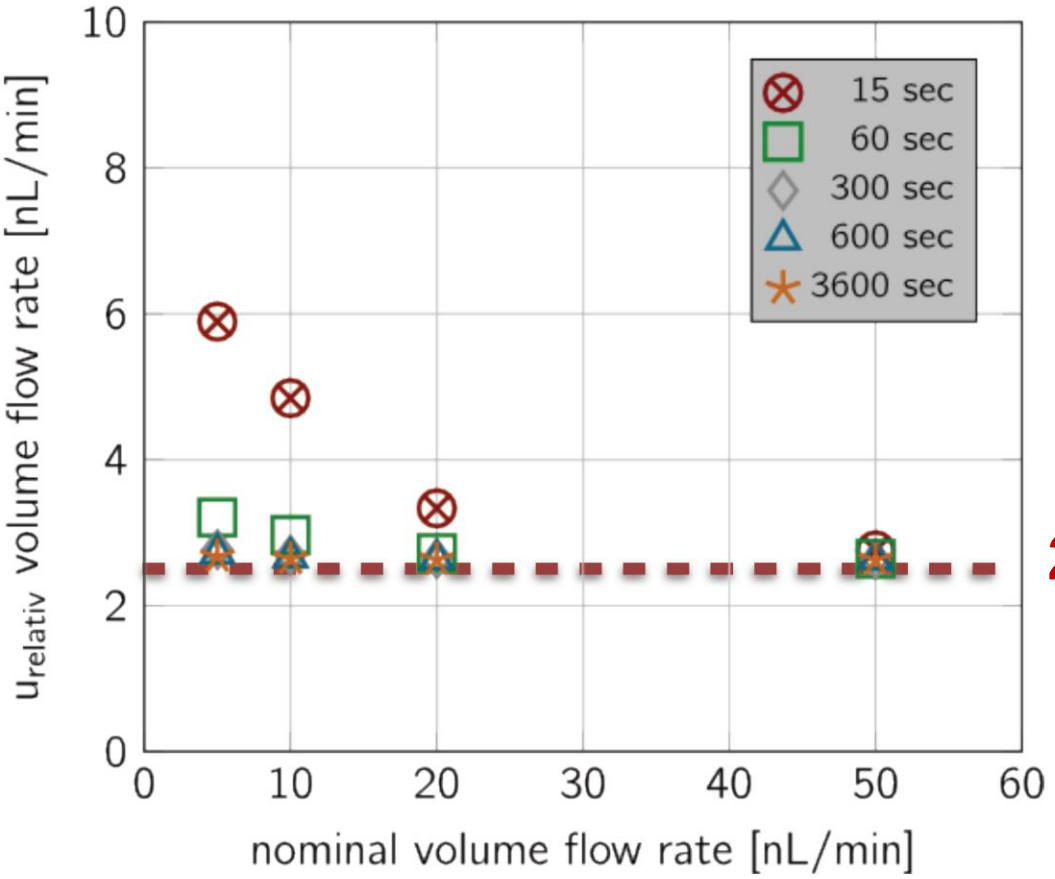


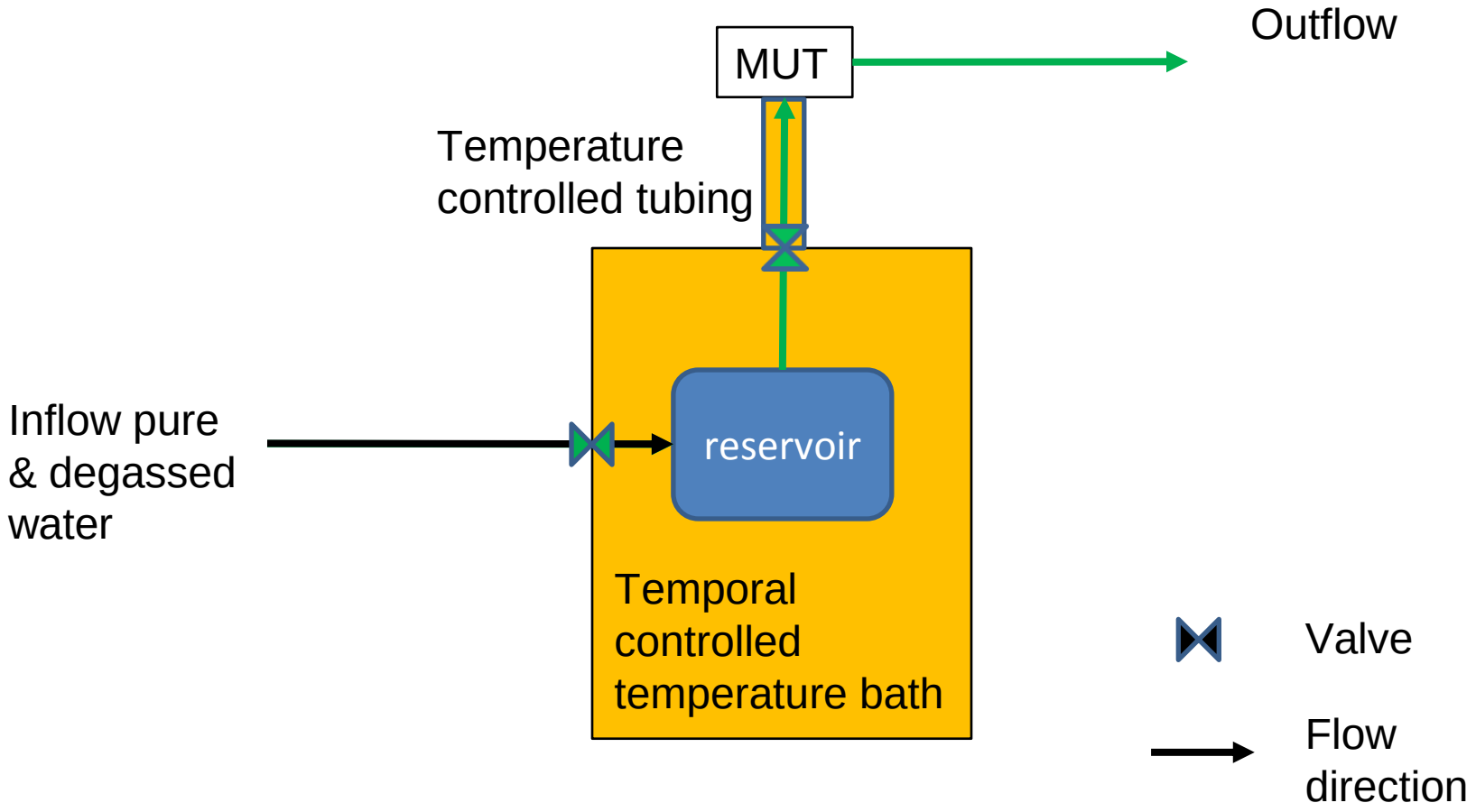
2.6 %

Flow rates
5 nl/min – 1 μl/min

Full week (24/7)

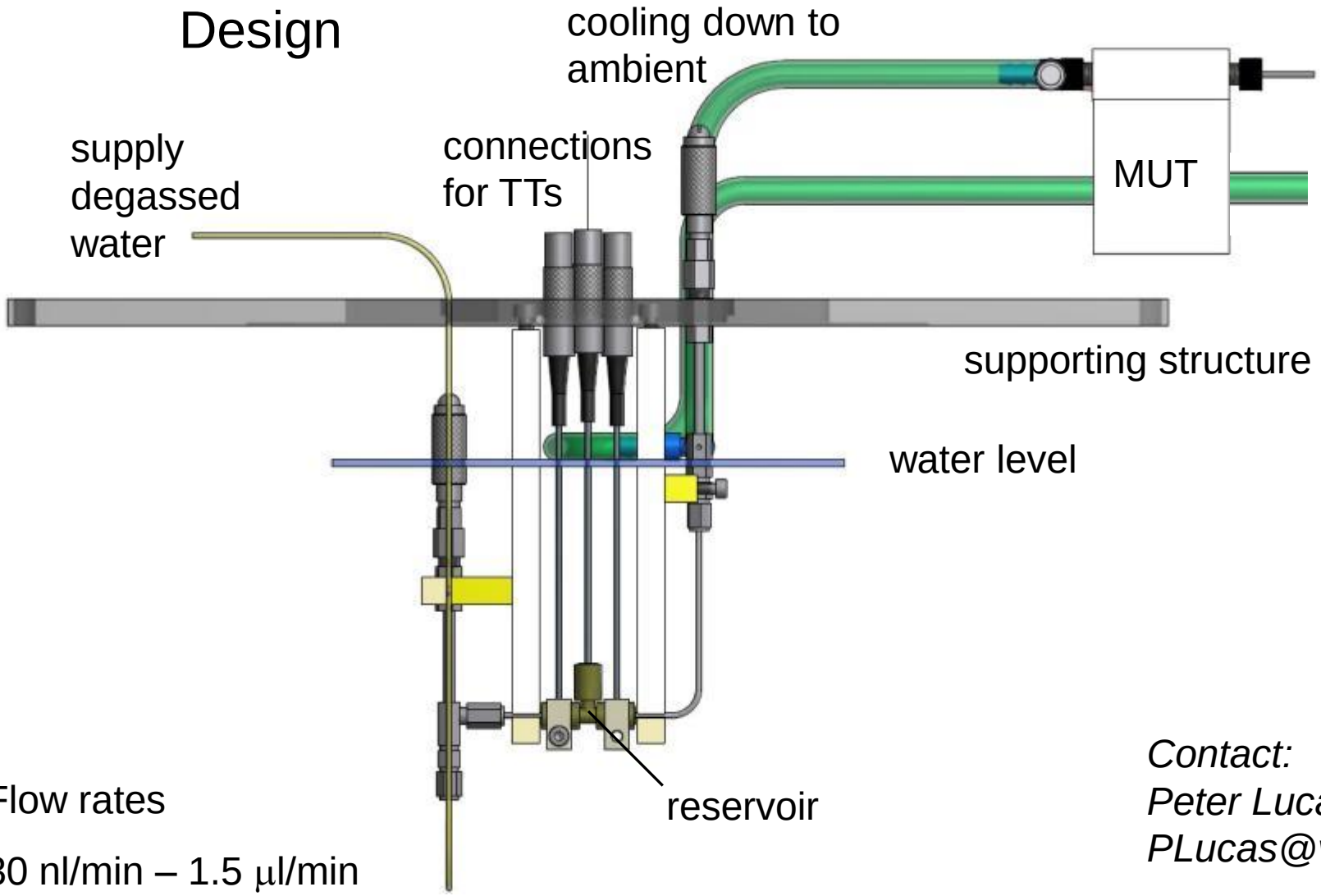
Primary standard for nanoflow rates

Working principle



Primary standard for nanoflow rates

Design



Flow rates

30 nl/min – 1.5 μl/min

Uncertainties: 3.0 % - 2.5 %

Contact:
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Validation of primary standards by means of inter comparison

EURAMET project 1291 / EURAMET.M.FF-S7
« Comparison of primary standards for liquid micro flow rates »

Internal report of MeDD (D 2.3.4)
« Comparison of primary standards for liquid nano flow rates »

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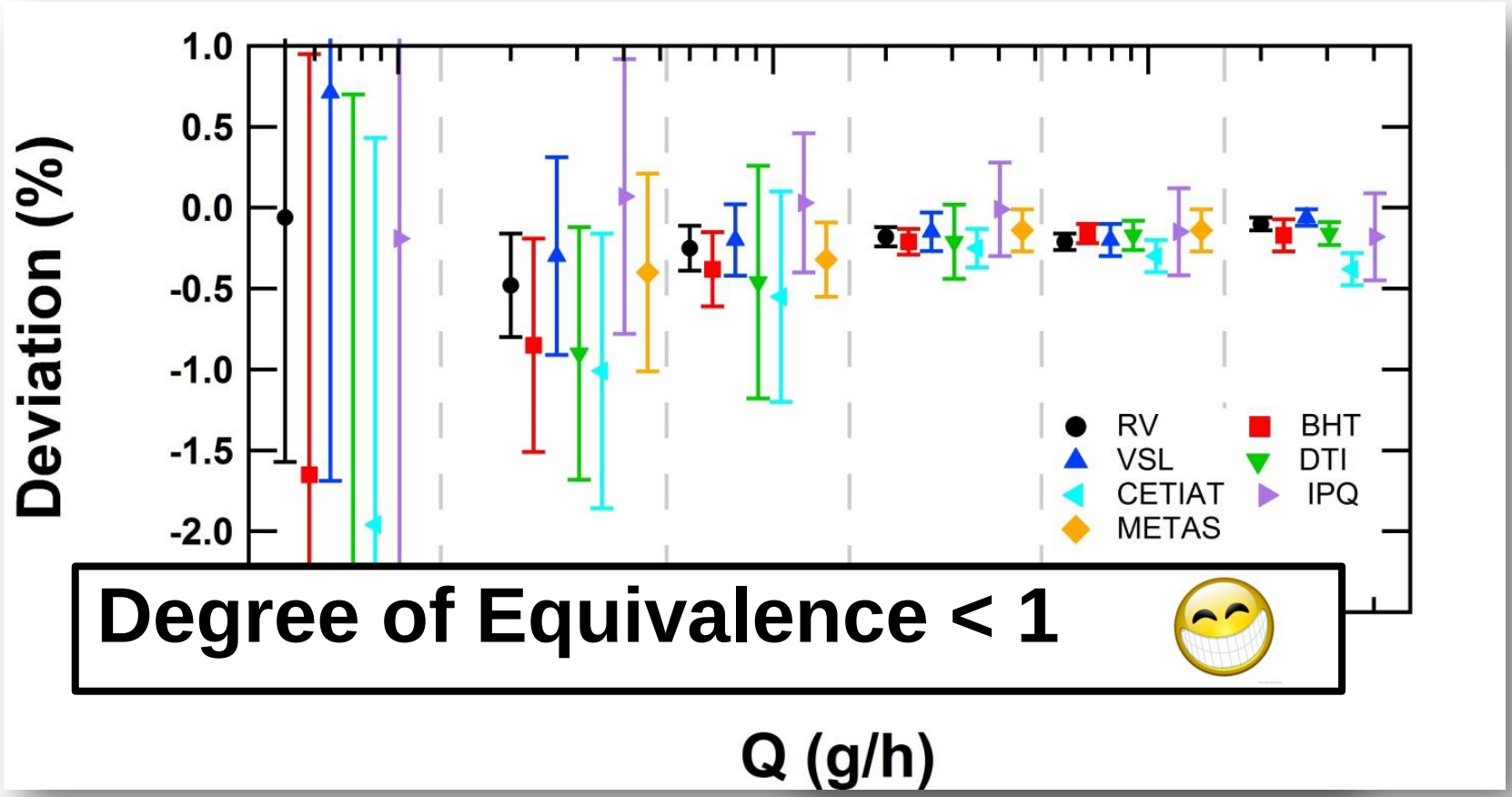

Micro Flow Facility – metrological infrastructure for low flow rate testing

Testing and calibration of

- Flow meters
- Flow generators
  - Syringe pump
  - Peristaltic pump
  - Insulin pump

Within this infrastructure it is possible to perform calibrations for different viscosities, temperatures and back pressure.

Micro Flow Facility - Contacts

Gravimetric setup

Flow rates
100 nl/min – 10 ml/min

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Questions ?