Flow Sensor Controlled Dispensing and Metering

Lübeck Summer Academy on Medical Technology
July 4, 2017 – Lübeck
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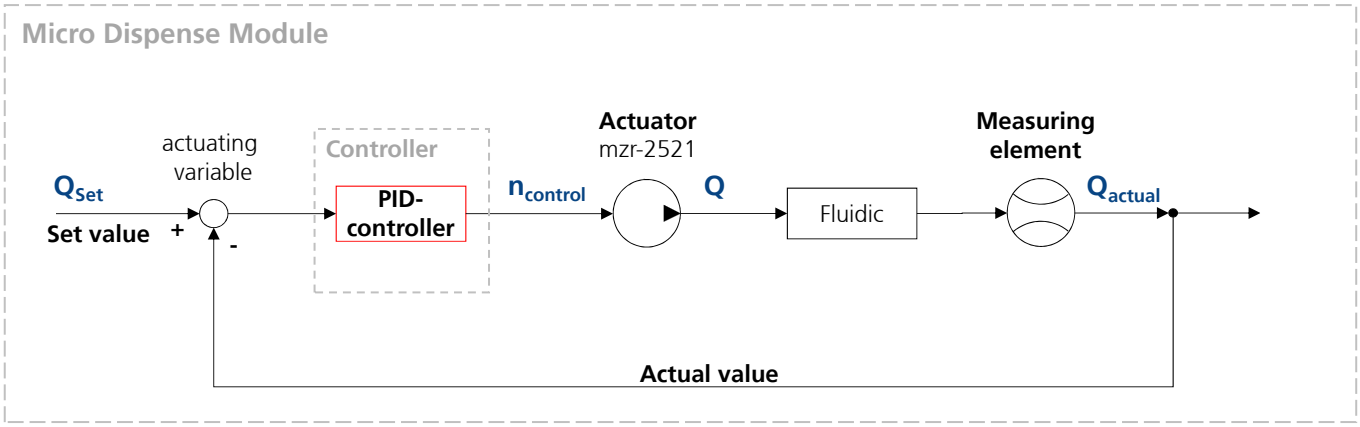
Overview

- Controlled dispensing and metering
- Actuators
- Sensors
- Influencing factors on accuracy
- HNPM µDispense

Controlled Metering
Process Reliability - Accuracy



Actuator	Drive micro annular gear pump → revolution $n_{control}$
Measuring element	Volume flow sensor
Set value	Micro controller, set point setting by LabVIEW application (signal indicator)
PID-controller	Implemented in micro controller

Accuracy, Trueness and Precision

According to DIN ISO 5725-2:2002-12 the term "accuracy" includes the two criteria "trueness" and "precision".

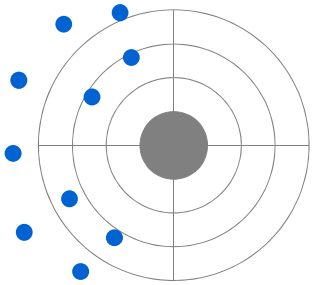
Trueness:
Measure for systematic deviation
How close are the results to the reference value?

$$R\,[\%] = \frac{\overline{V} - V_{Ref}}{V_{Ref}} \cdot 100$$

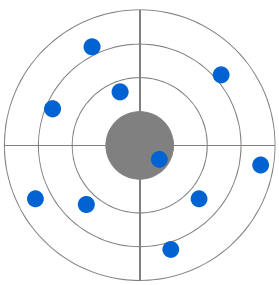
Precision / Coefficient of Variation CV:
Scattering of the results
How close together are the results?

$$CV\,[\%] = \frac{s \cdot 100}{\overline{V}}$$

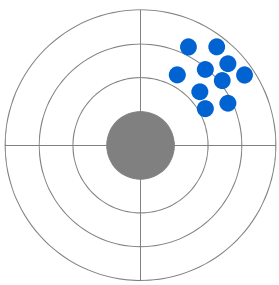
R ... Trueness
s ... Standard deviation
V_{Ref} ... Reference value of volume
$\overline{V}$ ... Mean value of volume
CV ... Coefficient of variation



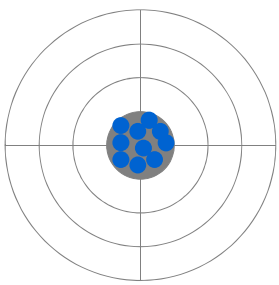
poor trueness
poor precision
very poor accuracy



good trueness
poor precision
poor accuracy



poor trueness
good precision
poor accuracy



good trueness
good precision
good accuracy

Dosing Pumps

	pl	nl	µl	ml	l	%	≈	◷	Δp	η	▱
Syringe pumps						+	+	o	–	o	–
Piston pumps						+	+	o	o	o	–
HPLC-pumps						+	+	+	+	o	o
Annular gear pump						+	+	+	o	+	+


Cavro

Cetoni


Hamilton


FMI


Saphirwerk


Knauer


PerkinElmer


Agilent


HNP Mikrosysteme

% precision ≈ resistance ◷ life Δp pressure η Viscosity ▱ measurement

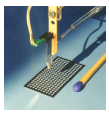
low pulsation oscillating dispensing continuous delivery

Image source: named companies

Dosing Pumps

	pl	nl	µl	ml	l	%	≈	◷	Δp	η	▱
Drop-on-demand						+	+	o	–	–	+
Si-diaphragm pumps						o	o	–	–	–	+
Eccentric screw pump						o	o	o	o	+	o
Osmotic pumps						–	–	–	o	+	+


Microdrop


GeSim

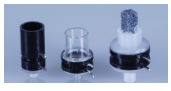

thinXXS


Bartels


PARItec


ViscoTec


Osmotex


Takasago

% precision ≈ resistance ◷ life Δp pressure n viscosity ▱ measurement

low pulsation oscillating dispensing continuous delivery

Image source: named companies

Volume Flow Sensors
Measuring Principles

	nl / min	µl / min	ml /min	l/ min	measurement	%	$\dot{m}$	f
Coriolis		■	■		–	+	+	o
Thermic	■	■			+	o	o	+
Differential Pressure		■	■		o	o	o	+
Ultrasound			■		–	o	o	o


Bronkhorst


Siemens

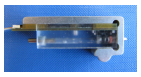

Brooks


Sensirion


Bronkhorst


Horiba


Seyonic


CSEM


Bürkert


Sonotec

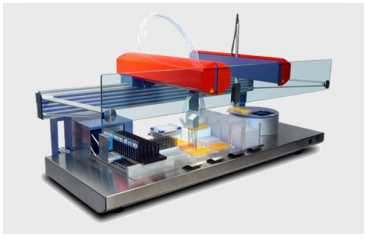

Titan Enterprises

measurement % precision $\dot{m}$ mass flow (flow independent of liquid) f sampling rate

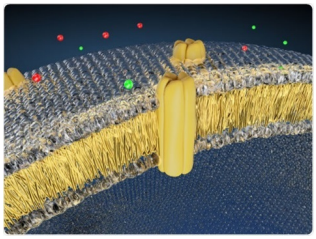
Image source: named companies

Dispense®
Applications in Life Science

Liquid Handling



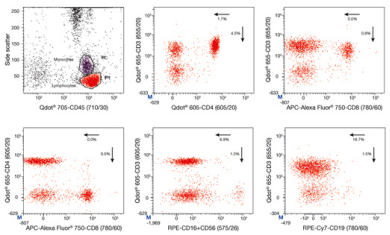
Ion Channel Screening



Blood Typing

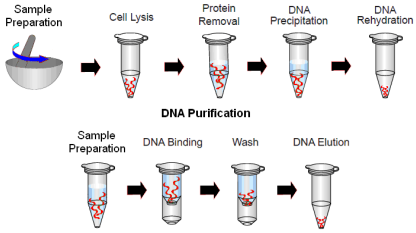
Sample Preparation

Flow Cytometry / Cell Sorting



In Vitro Diagnostics – IVD

DNA Isolation



Micro Dispense Module – micro annular gear pump technology
persistent precise & smart dosing

Micro Dispense Module
- high precision of dispense volume and volume flow
- size of half-height syringe pump
- programming commands of syringe pump
- low noise level
- modular design

Micro annular gear pump
- long service life
- forward and reverse flow modes
- continuous volume flow
- wide volume flow range of one single pump

Sensor control and monitoring
- accuracy based on controlled volume flow or dosing volume
- fault detection (e.g. clogging, air bubbles)
- monitoring and documentation

Dispense

Dispense®
Modular Design

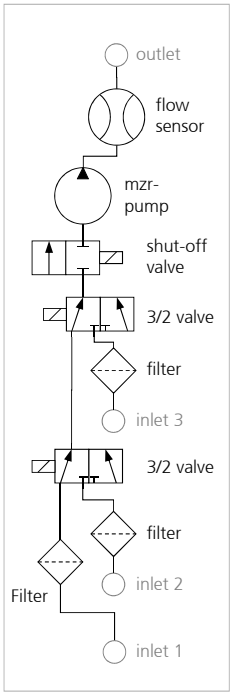
Micro Dispense Module

Sensor module
outlet (¼"-28UNF)
volume flow sensor
(up to 1000 µl/min)

Pump module
pump mzr-2521
(10 µl/min to 9 ml/min)

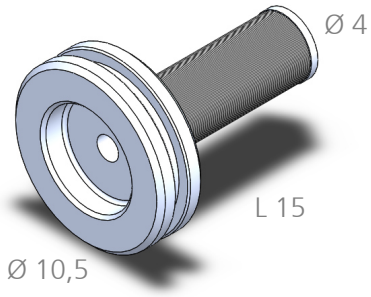
Valve module
2/2- way valve

3 Inlet modules
with filters
(¼"-28 UNF)

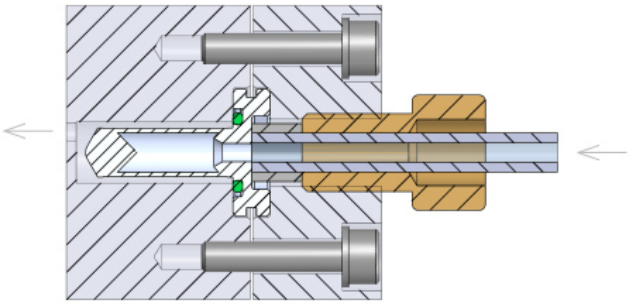


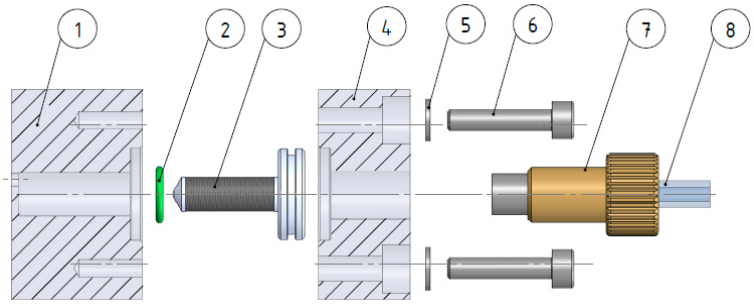
Cartridge Filter in a smallest format

- small size (L = 15 mm)
- low dead volume
- filter area 0,95 cm²
- mesh size 10 µm
- low pressure drop of 50 mbar at 200 ml/min with DI-water



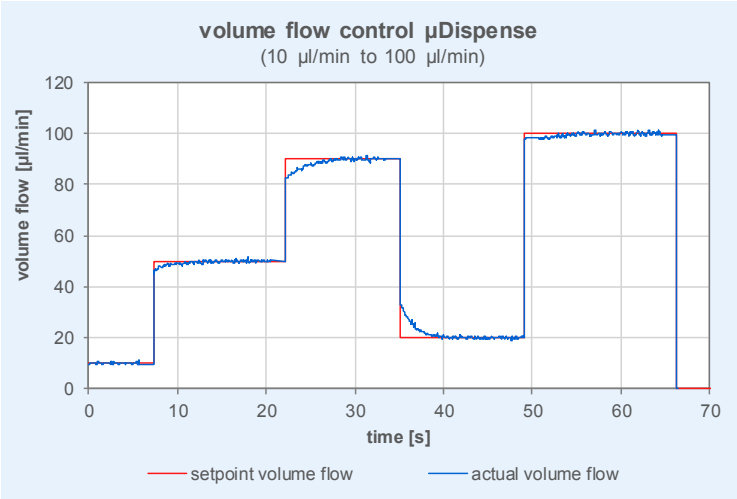
1	filter case
2	O-ring
3	filter
4	lid
5	washer
6	screw
7	fitting
8	tubing

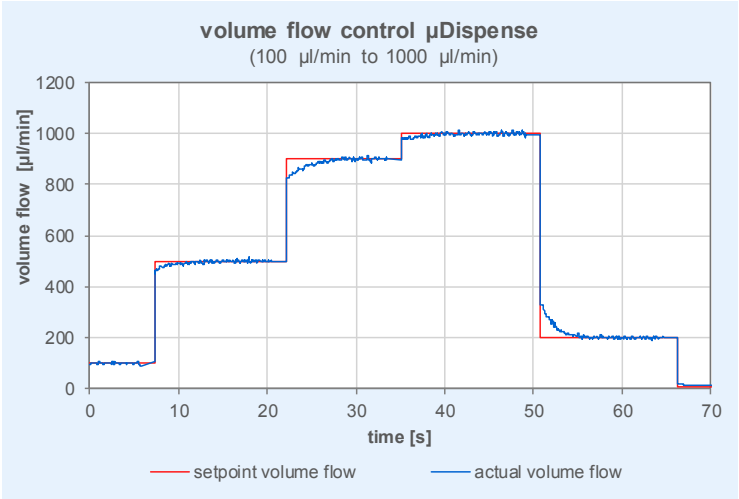




µDispense®
Closed loop controlled volume flow

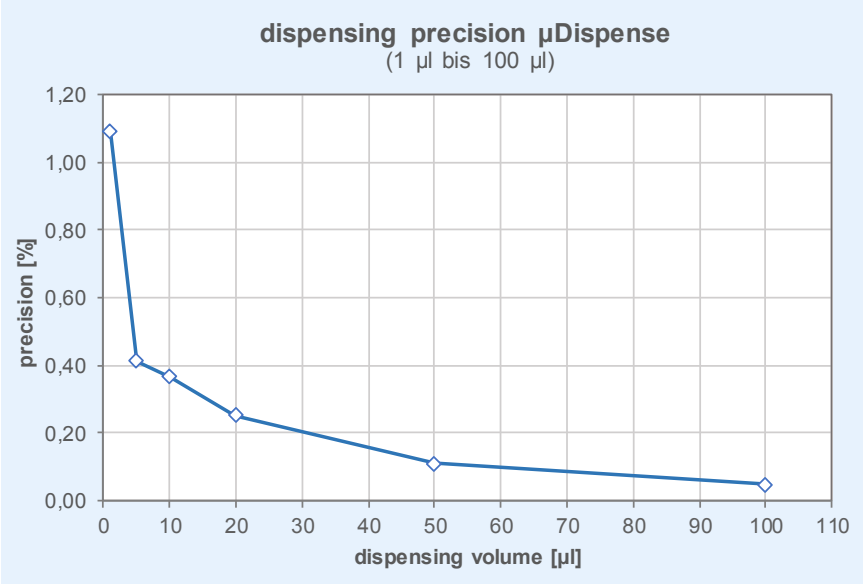
- **Closed loop controlled volume flow** by use of a flow sensor **10 µl/min** to **1000 µl/min**
- Set value (T90) reached in max. 70 ms
- Precision 5% of measured value
- **Flow control without overshooting**





µDispense®
Dispensing precision – without flow control

- Average dispensing precision µDispense with water
- Micro annular gear pump mzr-2521
  - Dispensing volume starting with 0,5 µl
  - Volume flow 0,01 ml/min to 9 ml/min



Definition
The coefficient of variation (CV) expressed in % is defined as a standard deviation from the average value.

$$CV\ [\%] = \frac{s \cdot 100}{\bar{V}}$$

CV .... Coefficient of variation [%]
s .... Standard deviation [µl]
V .... Average volume [µl]

Thank you for your attention

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