BioMedTec Wissenschaftscampus

TANDEM

UNIVERSITÄT ZU LÜBECK

FACH HOCHSCHULE LÜBECK
University of Applied Sciences

A Drug Multiplexing infusion system

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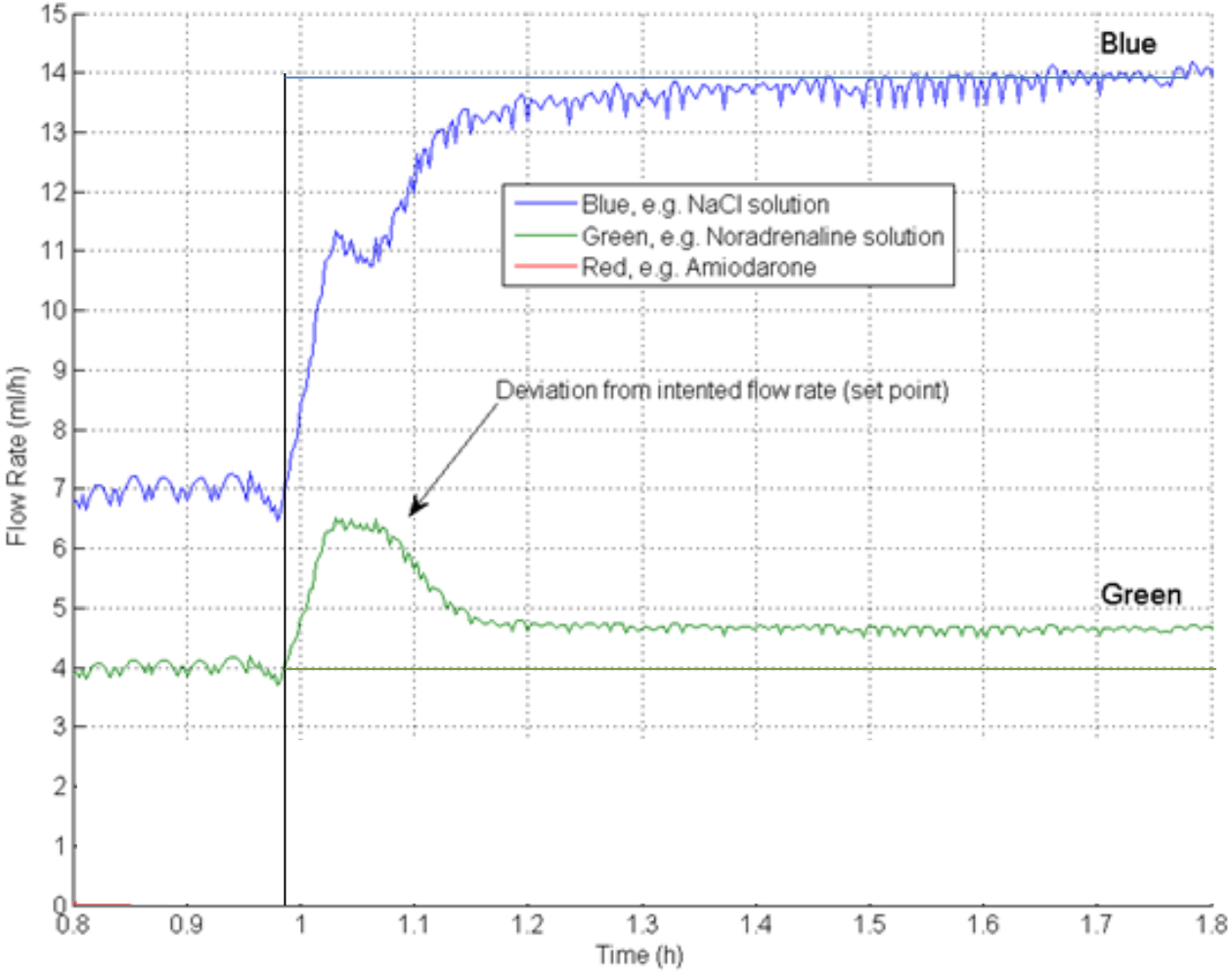
Medical errors are a leading cause of death in hospitals. About 210.000 are killed by preventable hospital errors each year in the U.S [1].

Between years 2005 and 2009, more than 56.000 infusion pump incidents were reported, including 710 deaths [3]

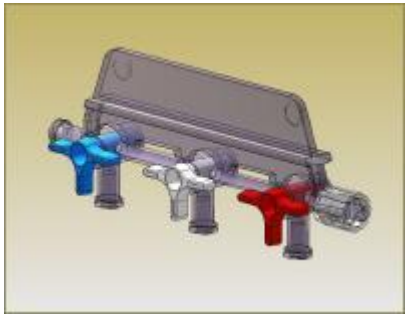
Infusion problems

- Hygiene
- Drugs incompatibility
- Patient transportation
- Chaos and Complexity
- Delivery errors
- Human errors

Delivery errors*



Blue :
Set point Increased

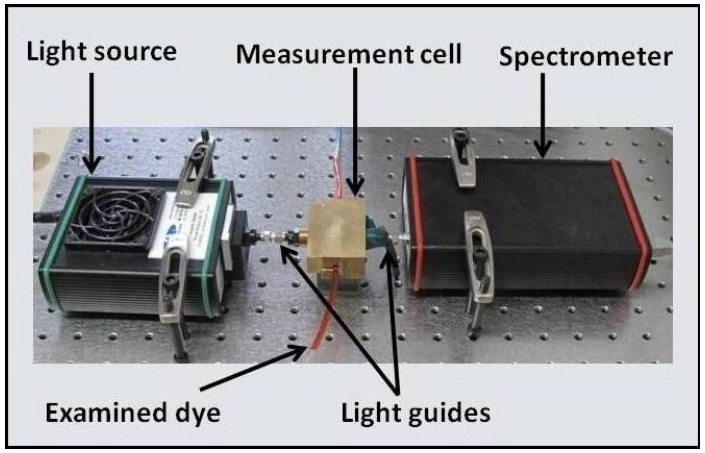


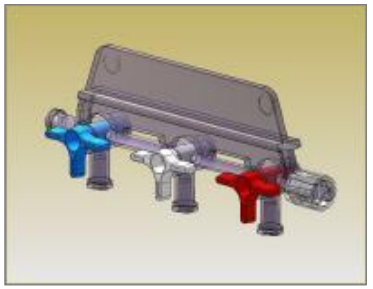
Green:

"push-out effect"

* A. Timmermann, University Medical Centre, Utrecht, Netherlands.

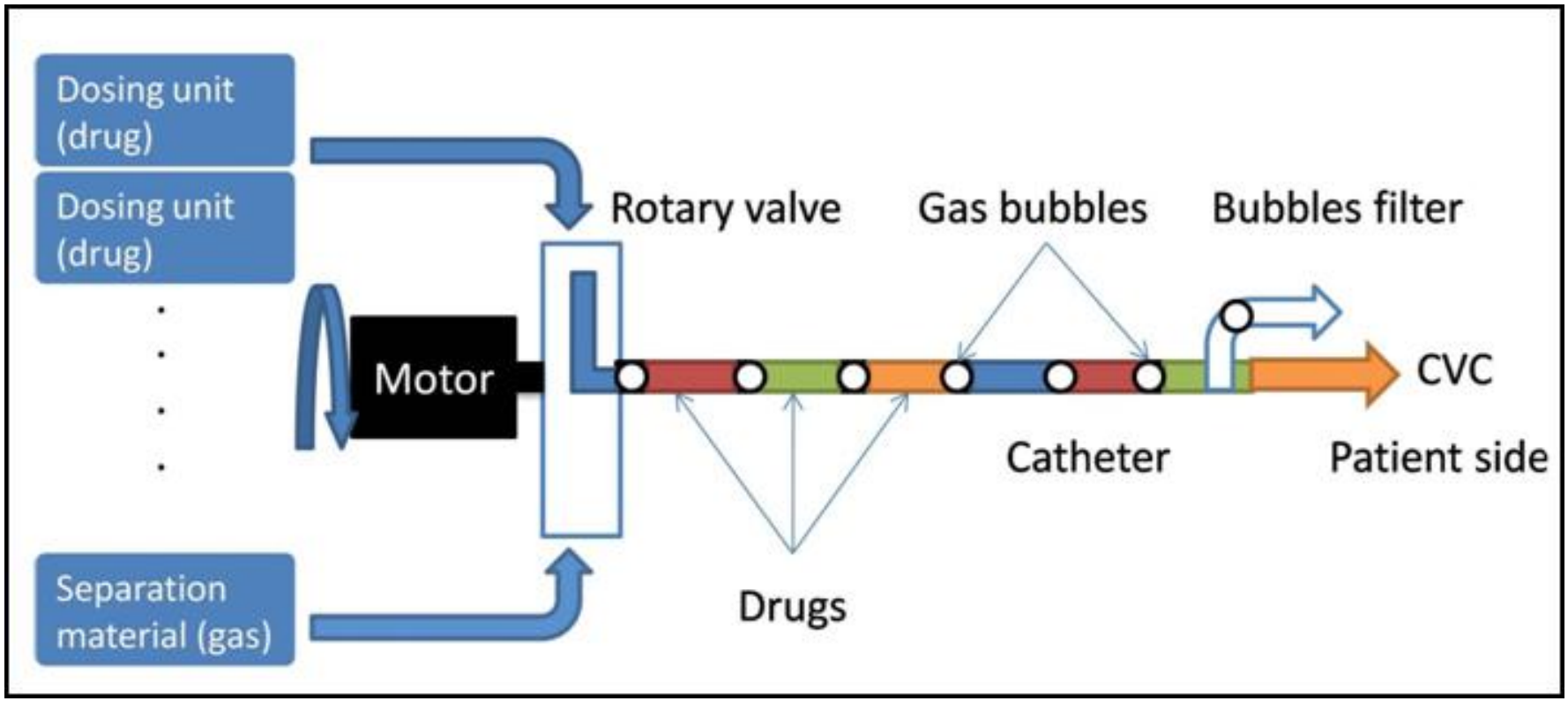
Examination of a multi infusion system





Better delivery

Multiplex system



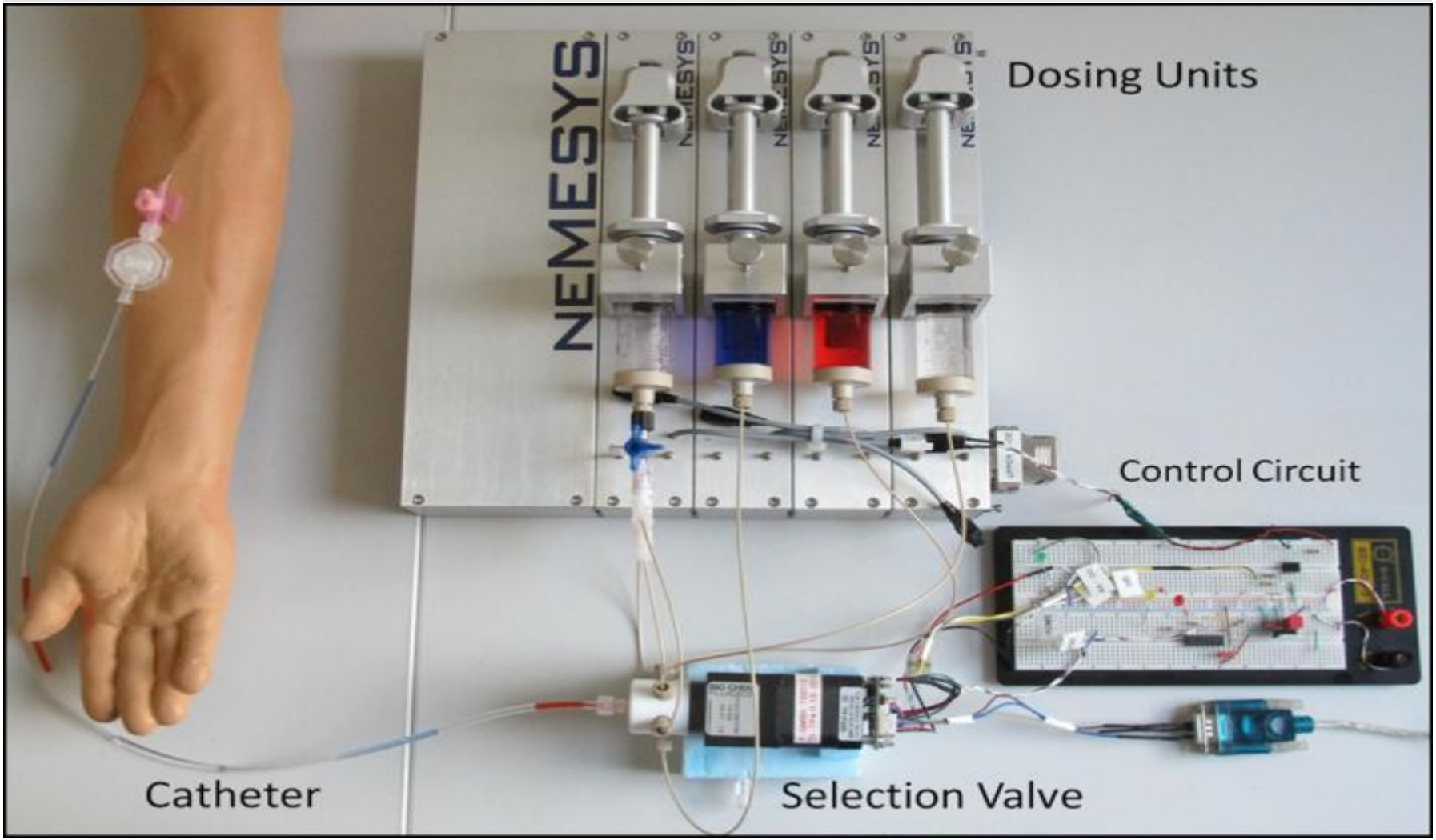
Questions / tasks

Separation by means of gas bubbles (CO_2 or air)
Cleaning the inner surface
size of the bubbles as a function of the time t or the position x along the tube

Accuracy of the volume of the separated units
Reproducibility of a liquid volume
Optimized size of the separated units

Compatibility of different drugs
Contamination of the following volumes behind a separation bubble

Drug multiplexing test bench - flow

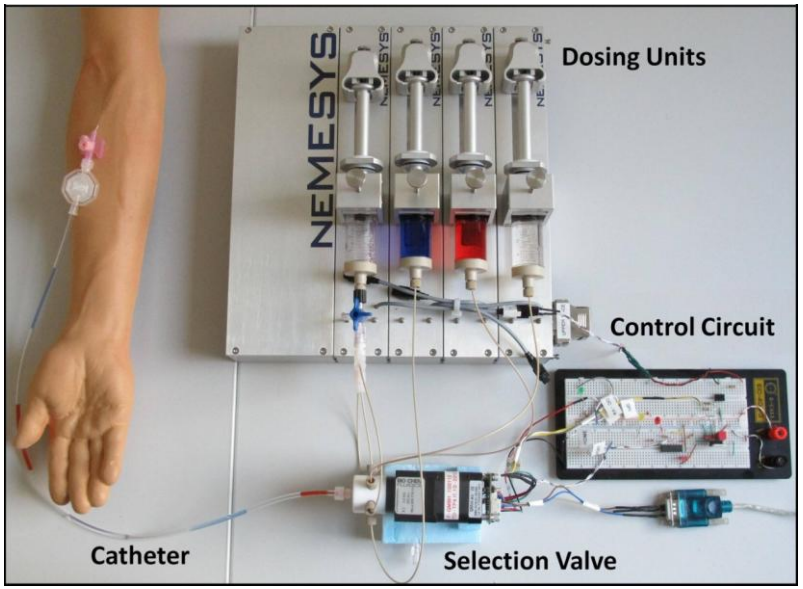


boundary conditions 1

Flow range:	0.5 ml/min - 60 mL/min (= 3.6 L/h = 86 L/d)
Max pressure:	1000 hPa
Length of the tube:	1.5 m
Max. Gas CO_2 dosage:	300 ml *

Radius of the tube:	R = 0.5 mm
Volume of the tube:	V = 1.2 mL
Fill time by flow min:	t = 144 s
Fill time by flow max:	t = 1.2 s

Volume of a 1mm gas bubble V = 800 nL

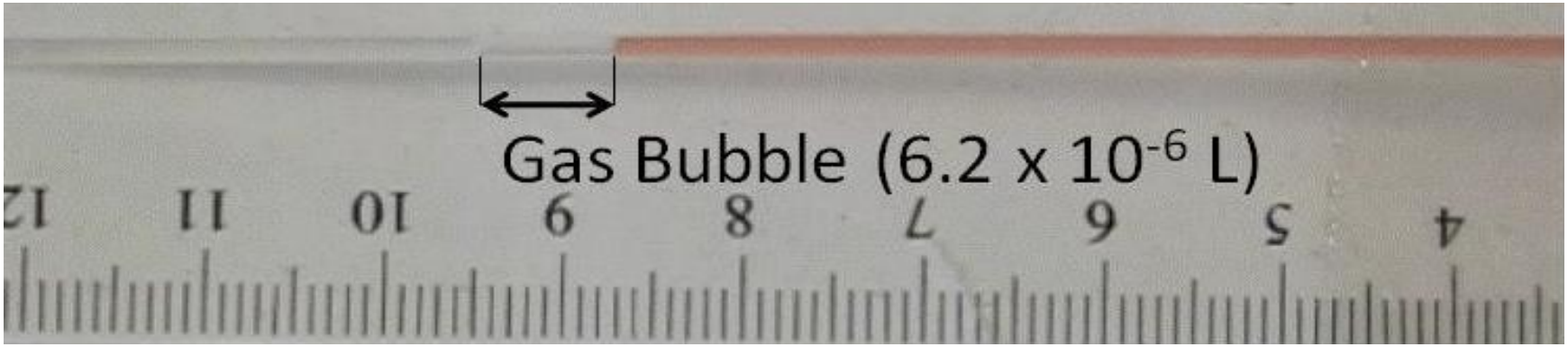


* Department of Radiology, University Hospitals Gasthuisberg, Leuven, Belgium.

Bubble size as a function of the position

Dissolving CO_2 in water
And Boyle Mariotte: pV = const. (T=const.)

during the flow

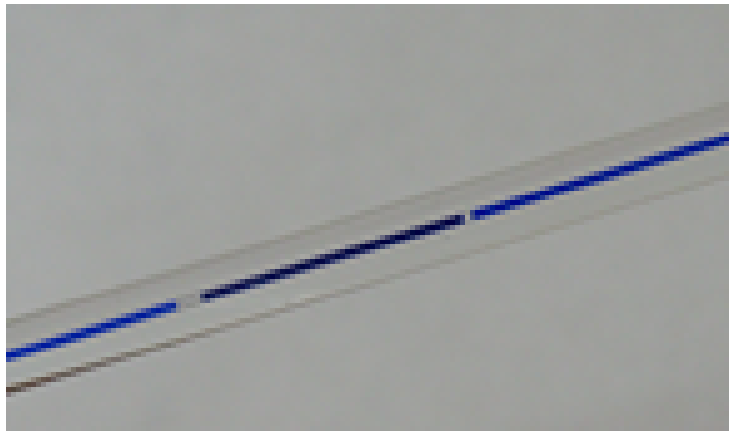


Result: The length of the bubble will be reduced to 30% along the tube

boundary conditions 2

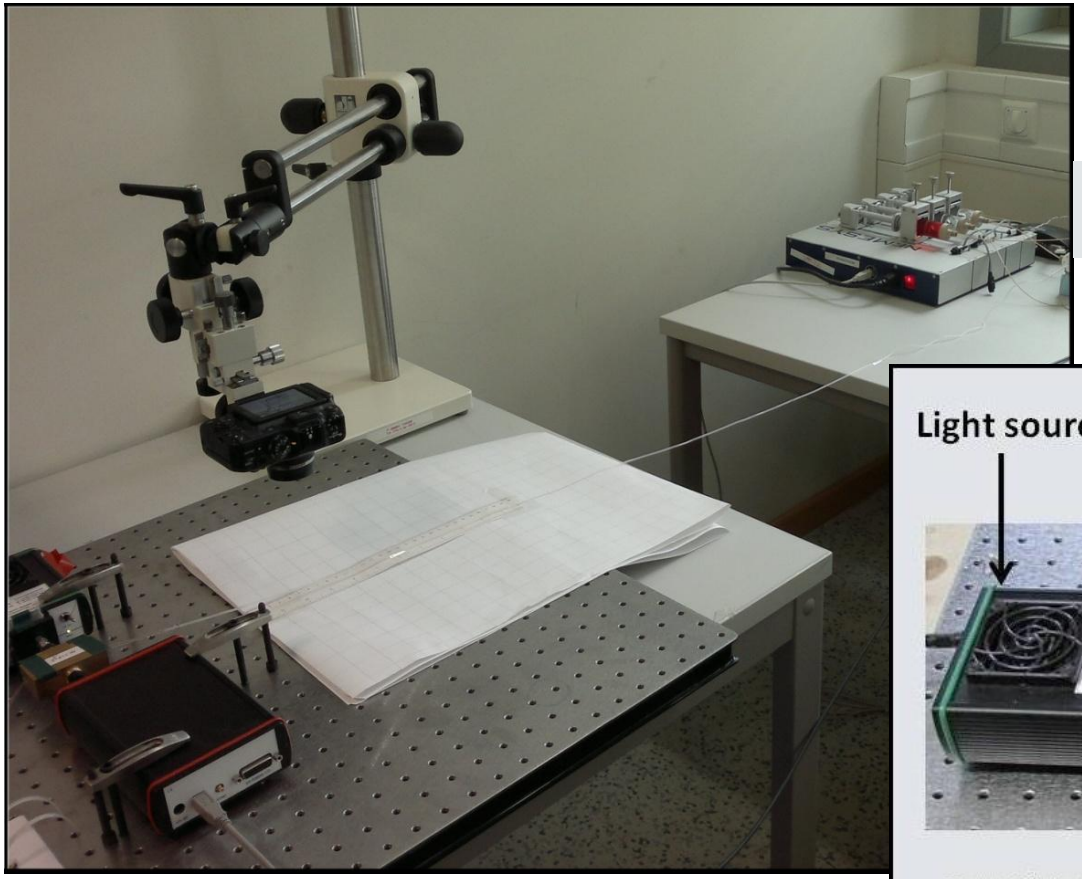
Flow range:	0.05 ml/min - 6 mL/min (= 8.6 L/d)
Max pressure:	1000 hPa
Length of the tube:	1.5 m
Max. Gas CO_2 dosage:	300 ml *

Radius of the tube:	R = 0.25 mm
Volume of the tube:	V = 0.3 mL
Fill time by flow min:	t = 360 s
Fill time by flow max:	t = 3 s

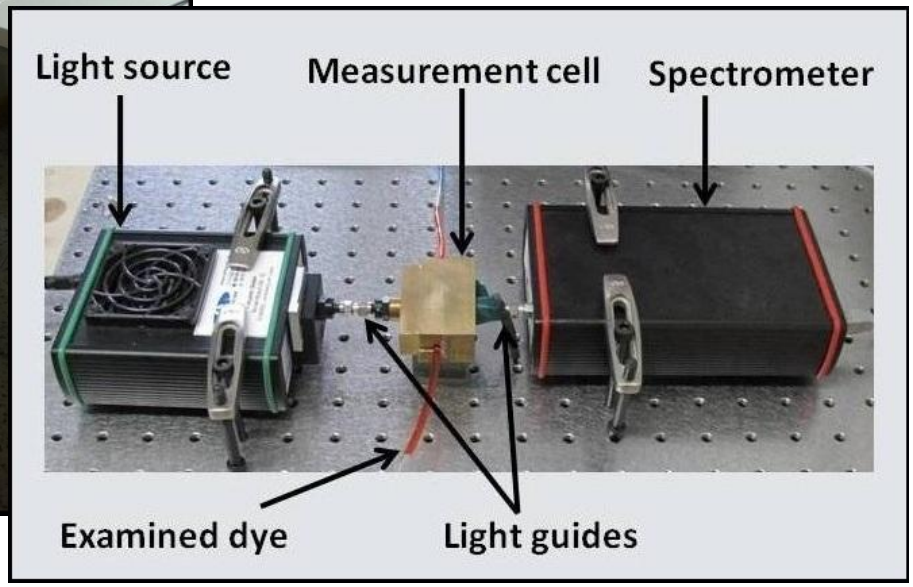


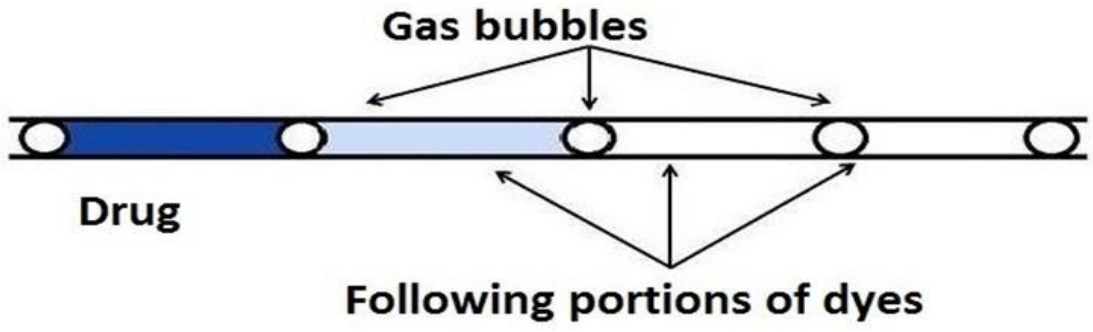
Volume of a 1mm long gas bubble VB = 200 nL

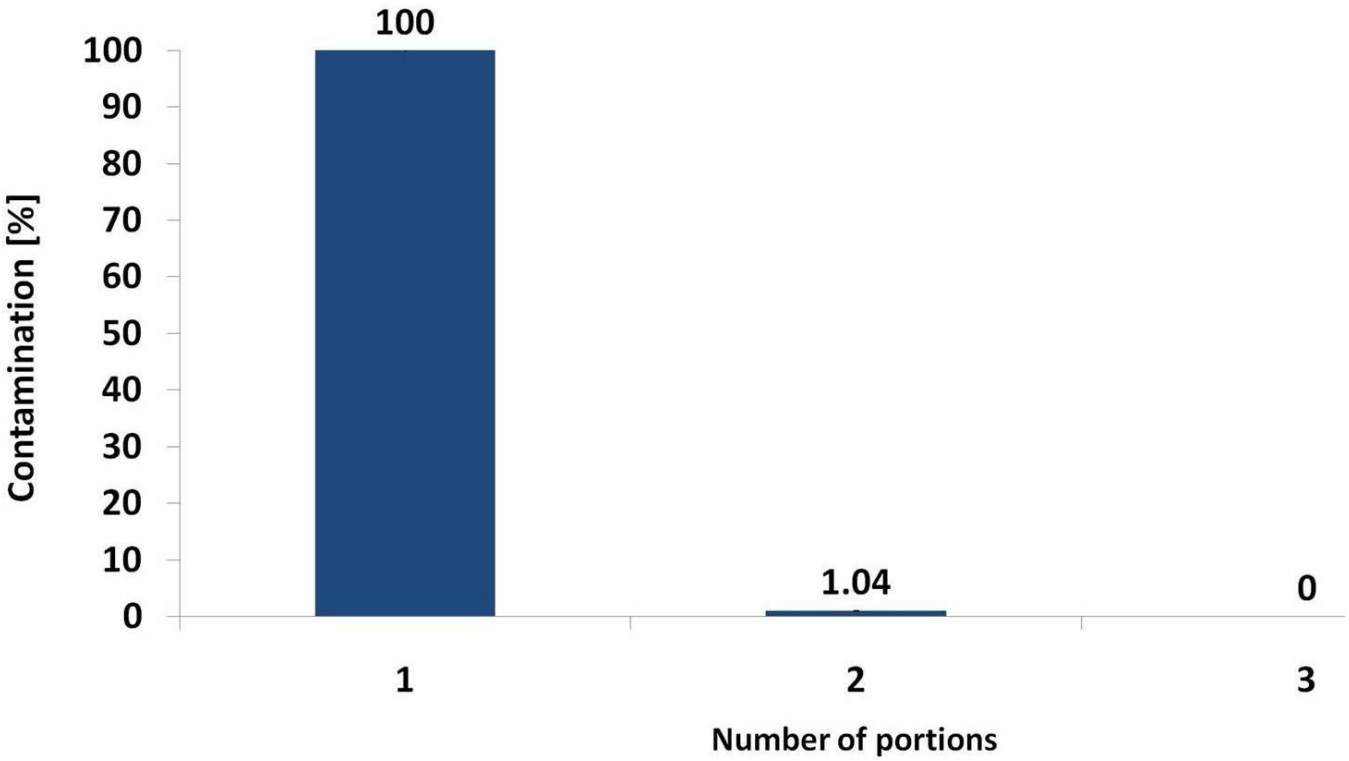
Quantitative and qualitative measuring equipments



UV-VIS Spectroscopy

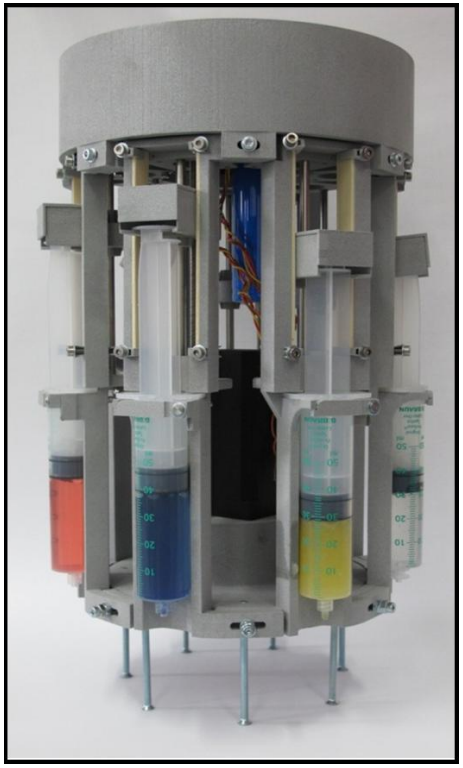


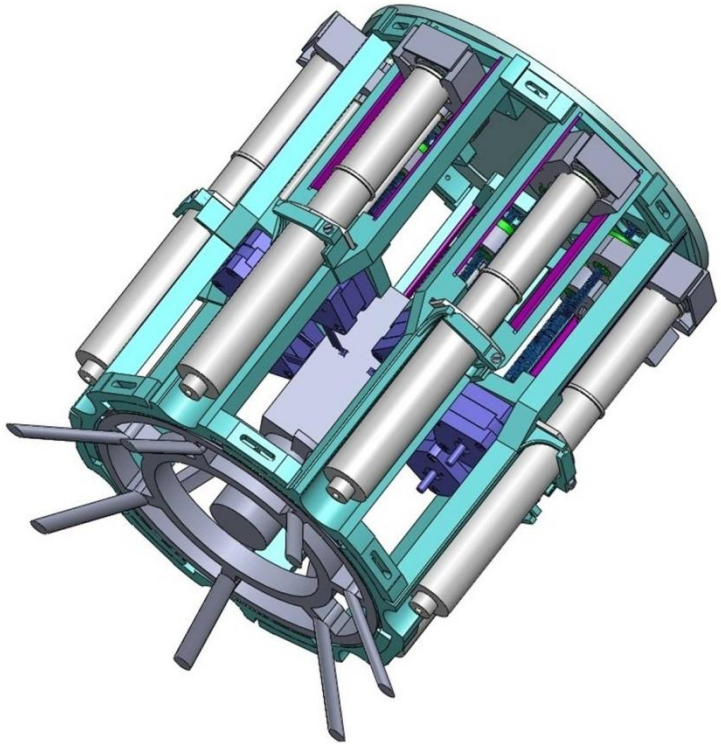

Gas bubbles
Drug
Flow
Following portions of dyes


Contamination [%]
100
90
80
70
60
50
40
30
20
10
0
100
1.04
0
1
2
3
Number of portions

Model of Drug Multiplexing

- Compact module
- Patient's side
- Mobile





Drug Multiplexing

☺	☹
Hygiene	Pulsated dosing
Drugs incompatibility reactions	(Restricted Performance with filter)
Patient transportation	Separation by gas bubbles
Chaos and Complexity	
Delivery errors	
Human errors	
Better flow and concentration control	

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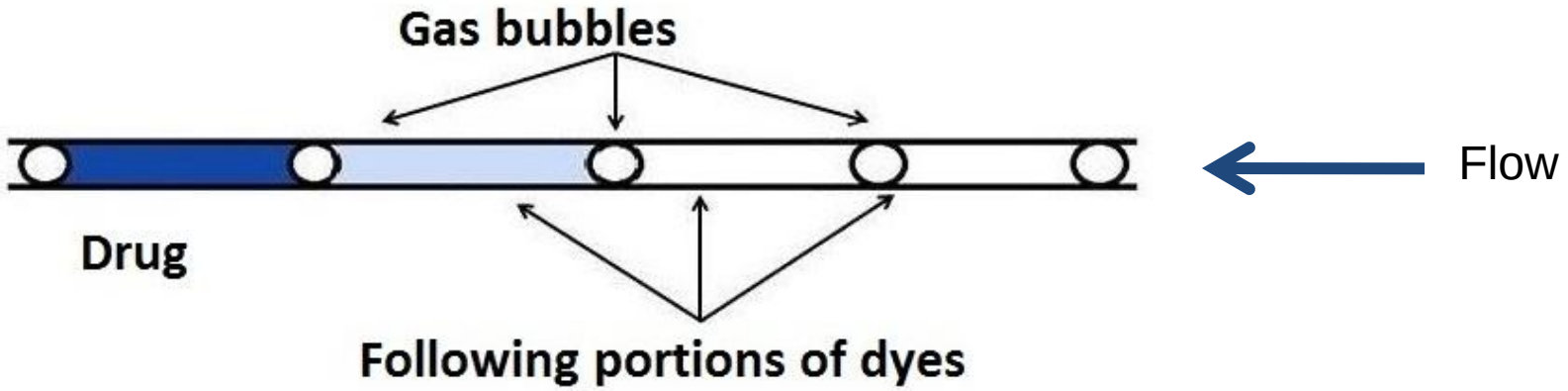
Typical flow rates at clinics?
Mimics clinic conditions
Reliable

A mobile delivery station helps to reduce preventable infusion errors.



PVC Tube
Length: 1.5 m
Inner Ø: 1 mm
Volume: 11.786 mL (for 0.6 mm inner Ø: 4.243 mL)