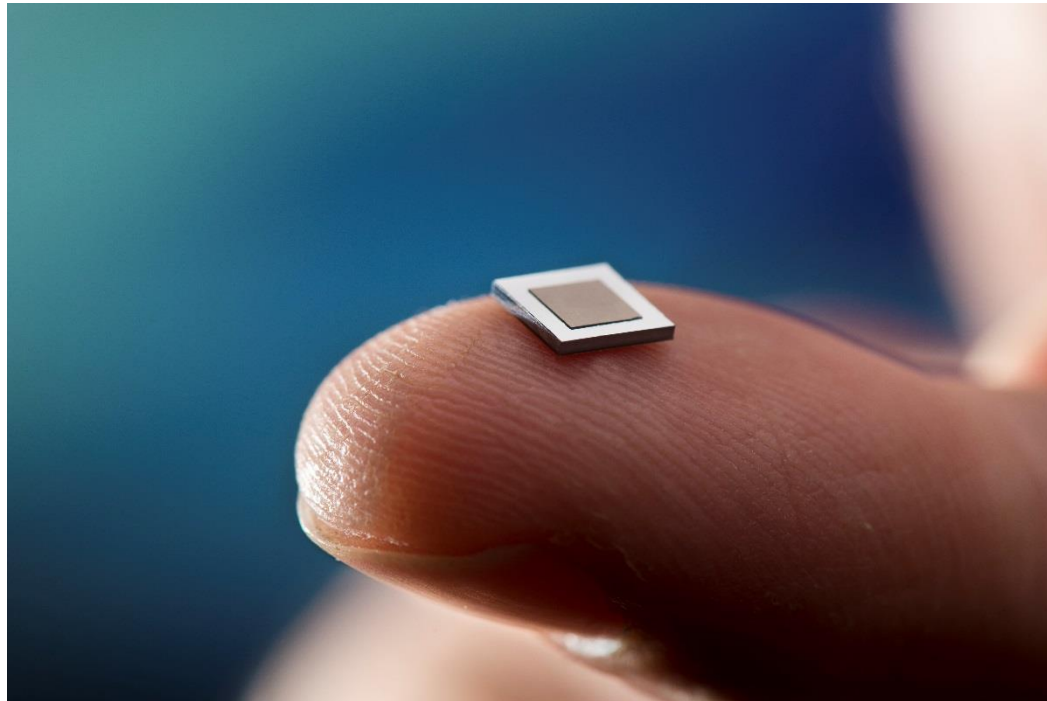

The Role of Micro Diaphragm Pumps in Medical Technologies

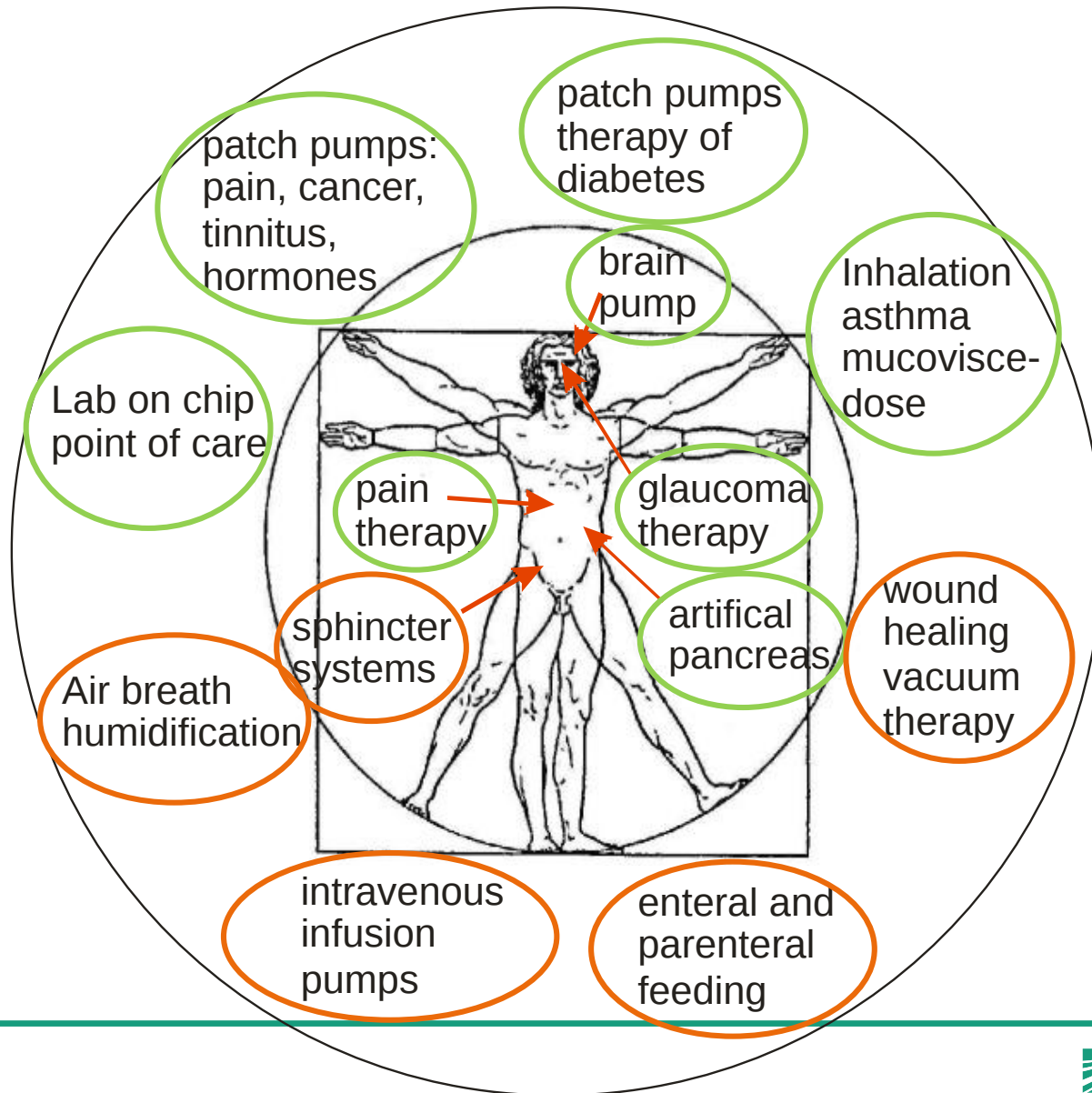
Fraunhofer EMFT, Dr. Axel Wille



Contents

- Applications
- Advantages
- EMFT Micropump
- Properties & Comparison
- Projects

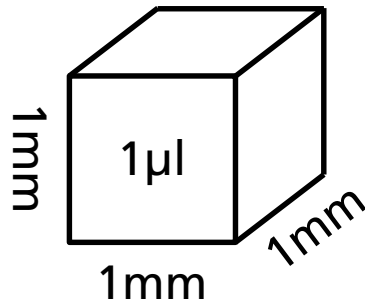
Potential medical micropump applications



Properties

- Size / weight
 - Portability
 - Amount of substance
 - Low energy
 - Low cost
- Dosing accuracy
- Bubble tolerance
- High pressure ability with air and water
- Feedback from customer: therapy demands

How big is a Microliter?



Natural droplet size
Gravity vs. Surface Tension



= 40 – 60 µl

Inner diameter 1mm
Length 10cm
= 79µl



Si Pump:	< 2000µl / min
Steel Pump:	< 200ml / min

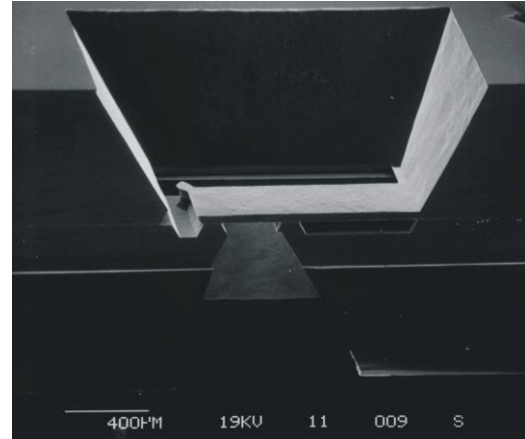
Overview Fraunhofer EMFT micropump family



Technology platforms

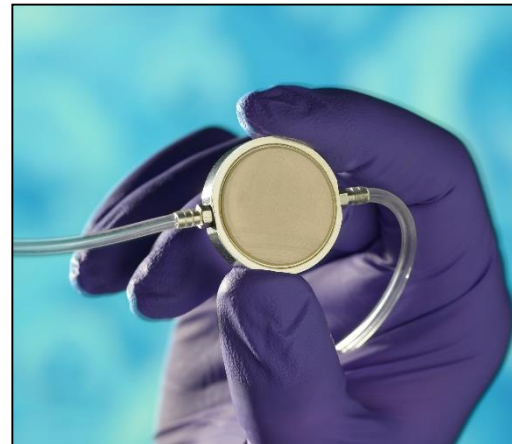
silicon

silicon 6" (established)
MEMS processes

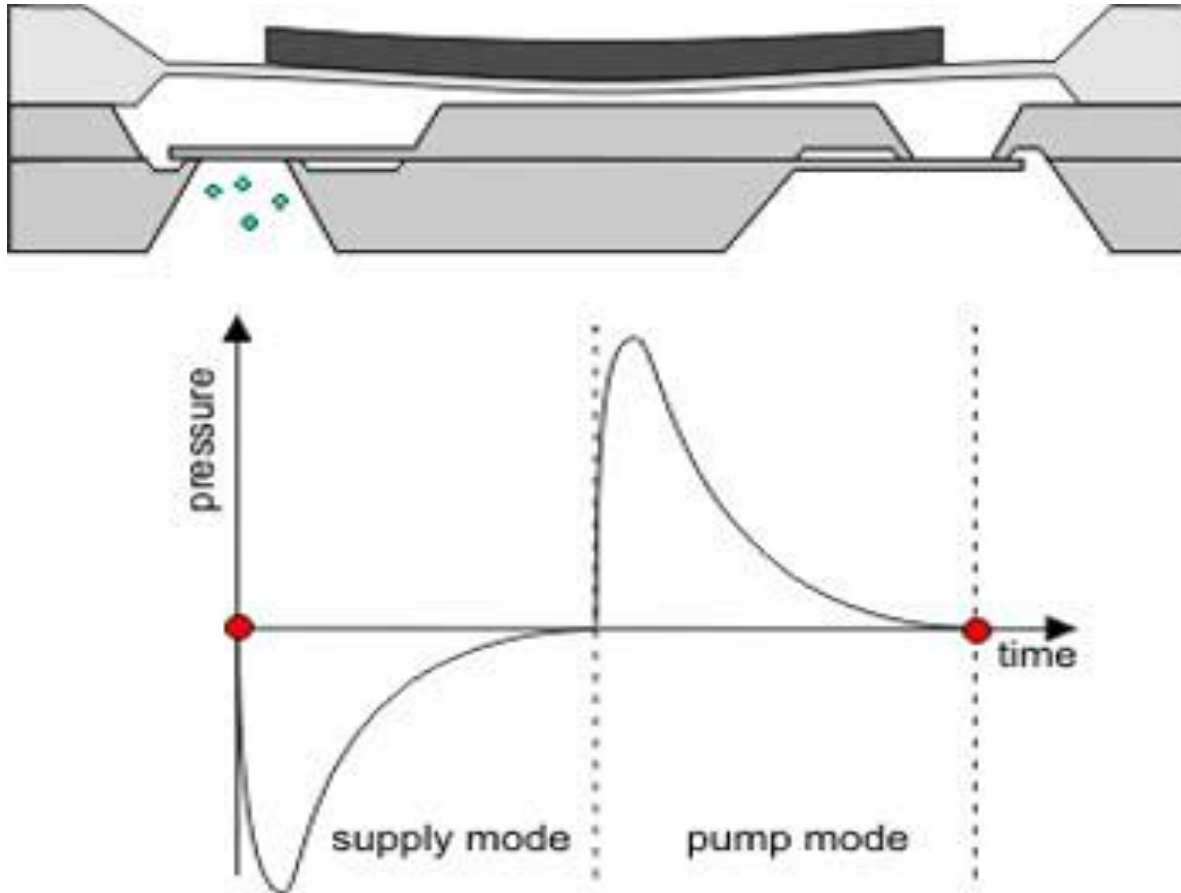


stainless steel

laser cutting / metal etching
laser welding



Piezo actuated micro diaphragm pump



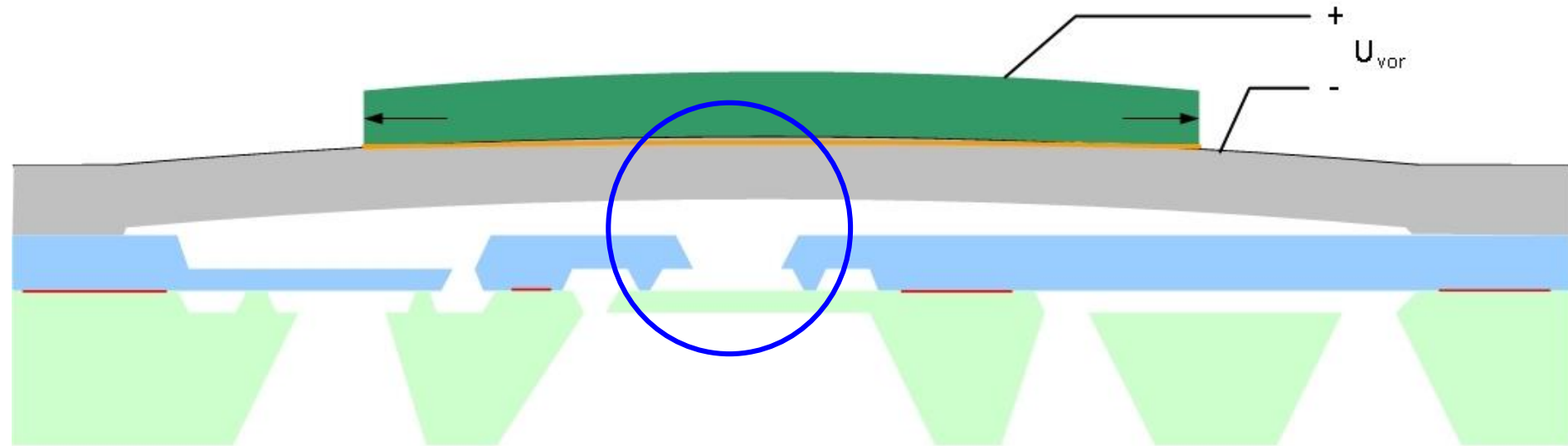
Crossection Silicon Micropump

- From top to bottom:

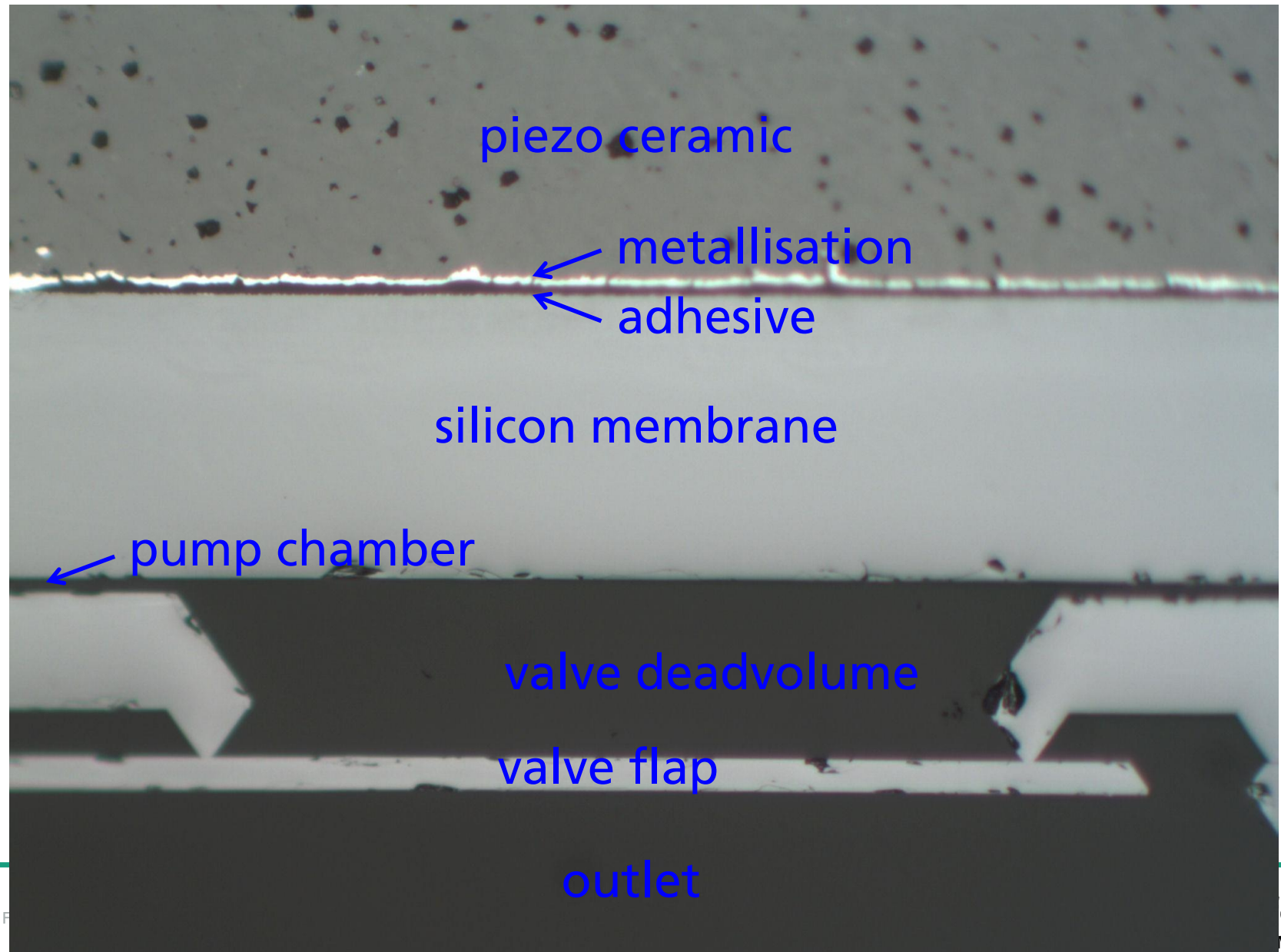
- Green: Piezo ceramic 150-200 μm
- Orange: Adhesive layer appr. 10 μm
- Black line: Aluminium sputtered 0,5 μm
- Grey: Silicon diaphragm 50-125 μm
- Blue: Wafer1 70-90 μm
- Red line: Silicon Oxide in the wafers
- Green: Wafer2

450 μm

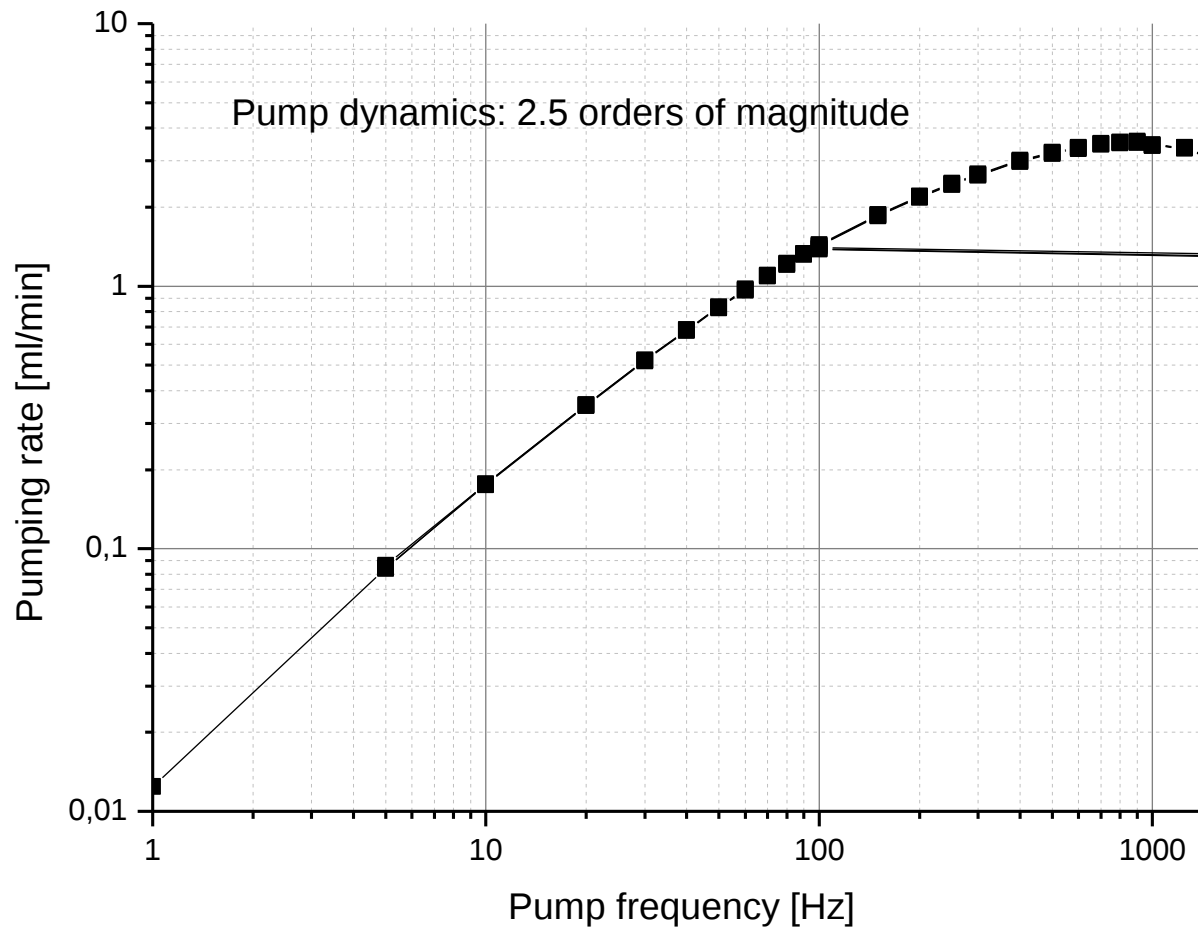
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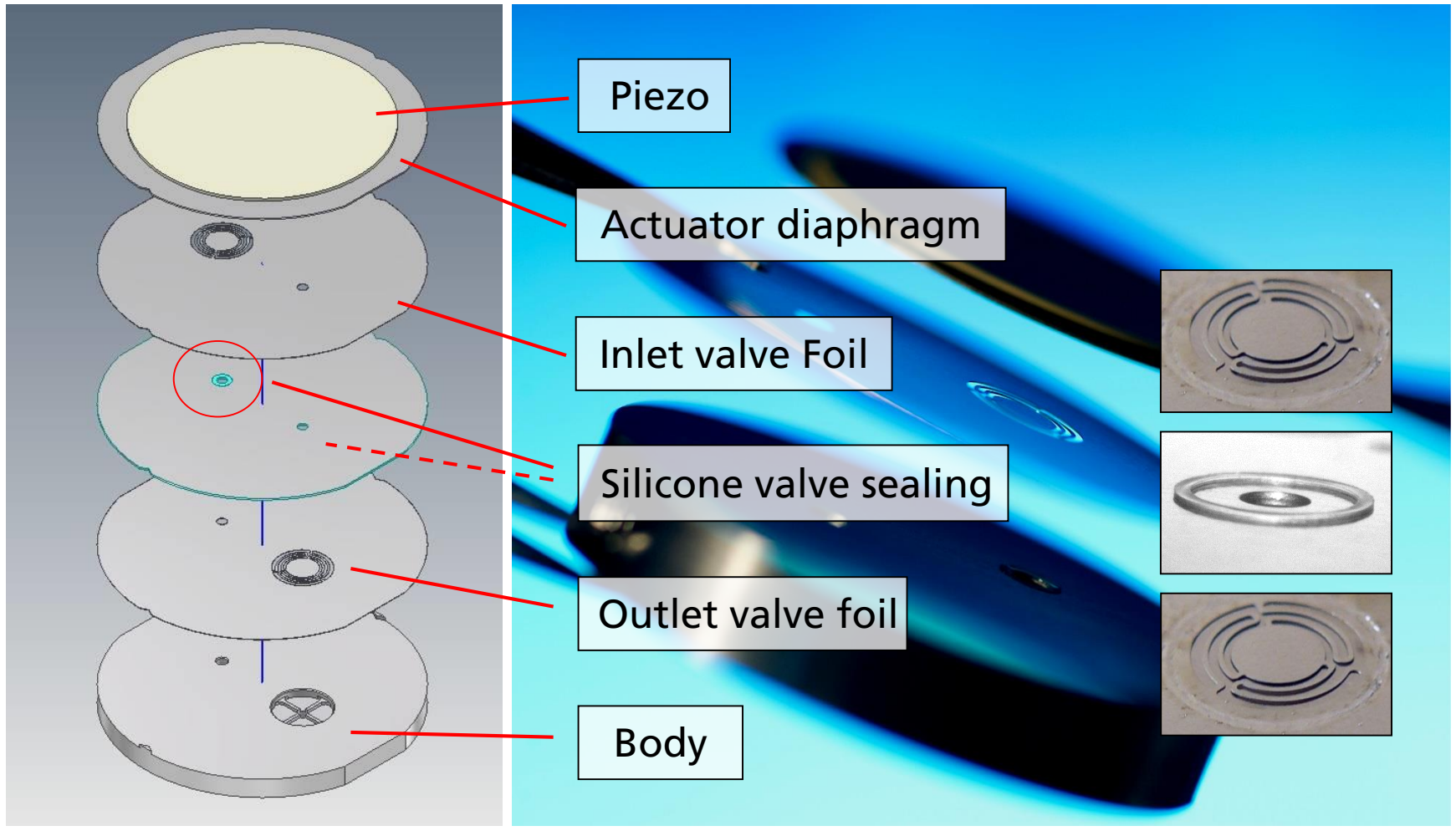
REM Crossection Outlet Valve



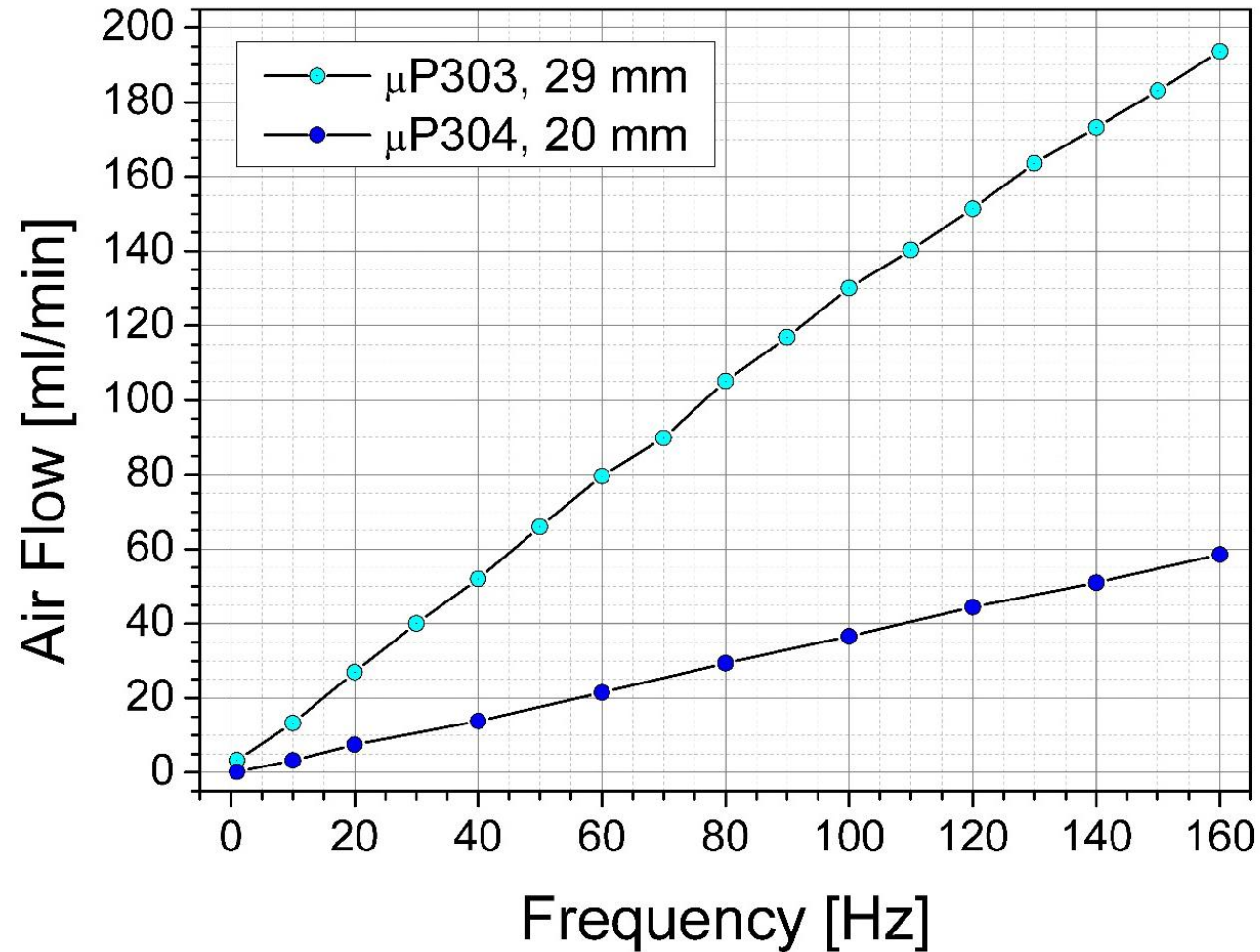
Micropump, pump dynamics silicon micropump (air)



Steel Micropump



Steel pump - Characteristics



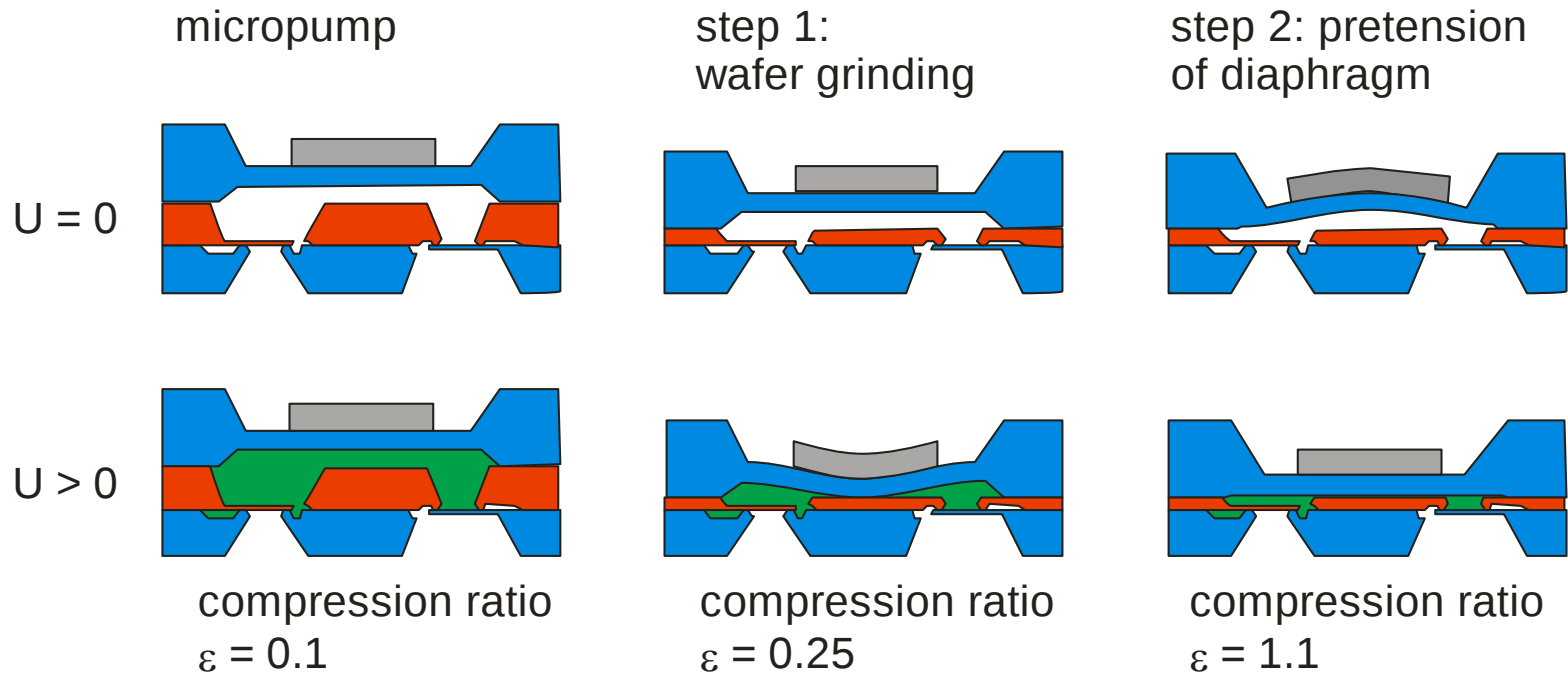
Fraunhofer EMFT Micropump Family: Performance

micropump type	μP015v1	μP024Av2	μP026v1	μP303	μP304	unit
material	silicon	silicon	silicon	steel	steel	
size pump chip	7 x 7 x 0.8	7 x 7 x 0.7	5 x 5 x 0.6	Ø29 x 2.6	Ø20 x 2.1	mm ³
stroke volume	80	140	50	25.000	6.000	nl
max. back pressure air	90	80	30	20	25	kPa
blocking pressure water	550	140	80	31	75	kPa
max pump rate air	500	1.000	300	200.000	50.000	μl/min
max pump rate water	150	300	60	80.000	16.000	μl/min

Other Micro Diaphragm Pumps

Name	Max. back pressure [kPa]		Max. flowrate [ml/min]		Size [mm ³]
	Gas	Liquid	Gas	Liquid	
Bartels mp5	3	25	15	5	14 x 14 x 3,5
Bartels mp6	10	60	18	7	30 x 15 x 3,8
Takasago Electric SDMP306	-	45	-	7	25 x 25 x 4,8
Takasago Electric SDMP320	-	35	-	20	33 x 33 x 5,5
CurieJet PS15I/GS15I	3	50	3	20	15,5 x 15,5 x 5,5
Debiotech Nanopump	-	20	-	0,004	16 x 12 x 1,86
Fraunhofer EMFT 7x7	90	550	1	0,3	7,0 x 7,0 x 0,8
Fraunhofer EMFT 5x5	20	80	0,5	0,06	5,0 x 5,0 x 0,6

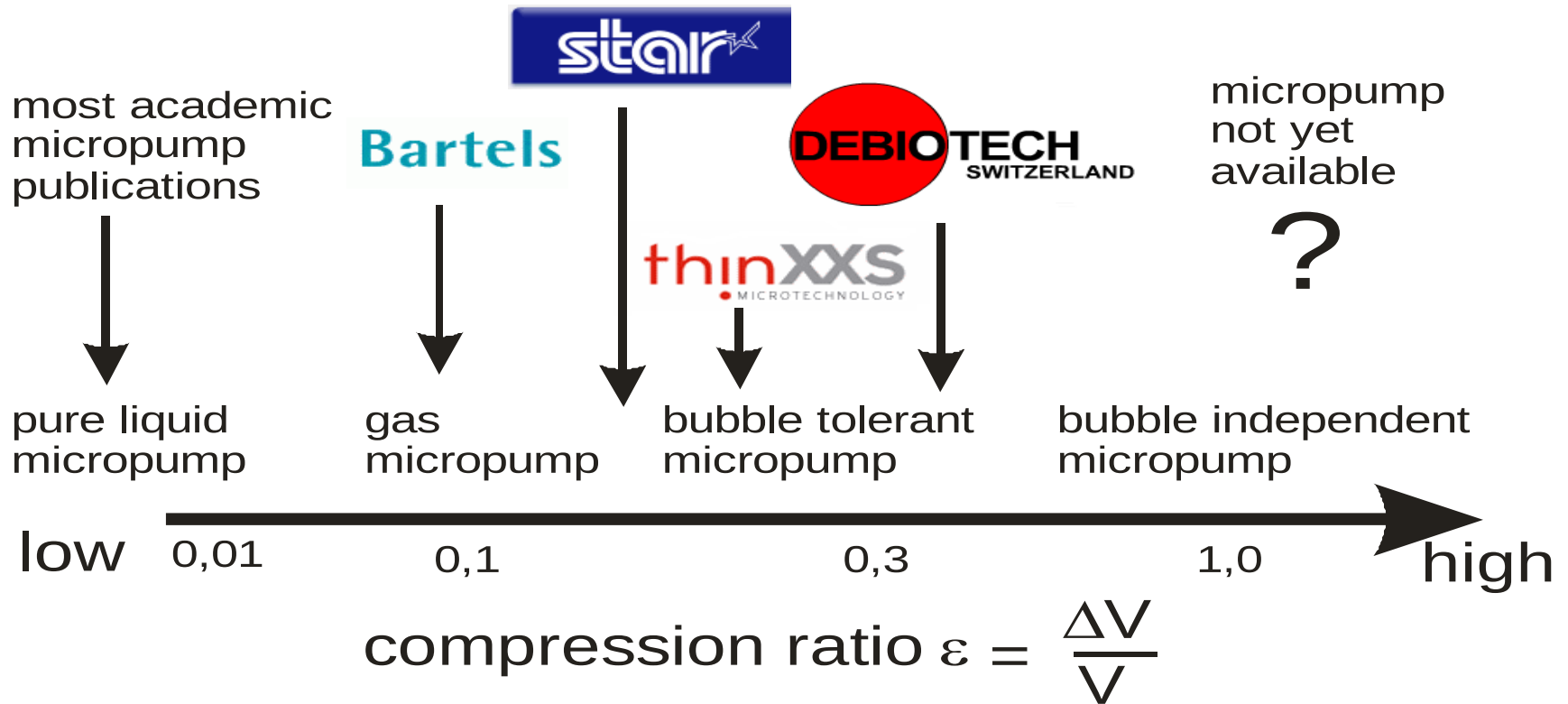
Compression ratio



$$\varepsilon = \frac{\Delta V}{V}$$

- Self-priming
- Bubble tolerant

State of the art micropumps: comparison of compression ratio



Glueing Piezo – Pretension Process



- Dispensing of adhesive



- Place piezoelectric ceramic and press for a certain time



- Apply voltage to the ceramic during hardening of the adhesive



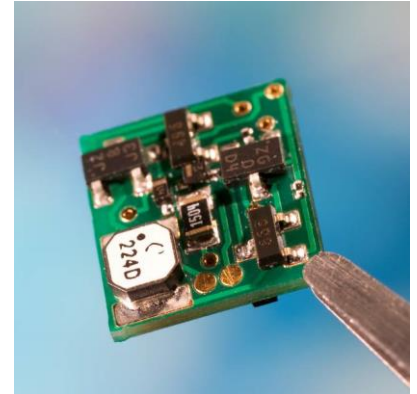
- Release voltage

Microfluidic system at EMFT

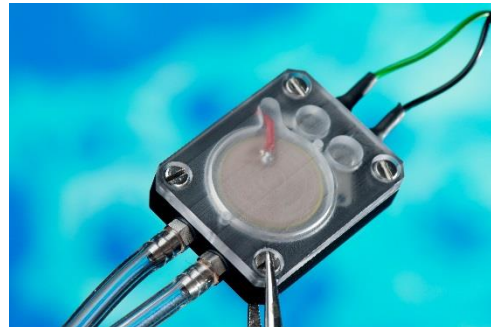


Micropump

Housing



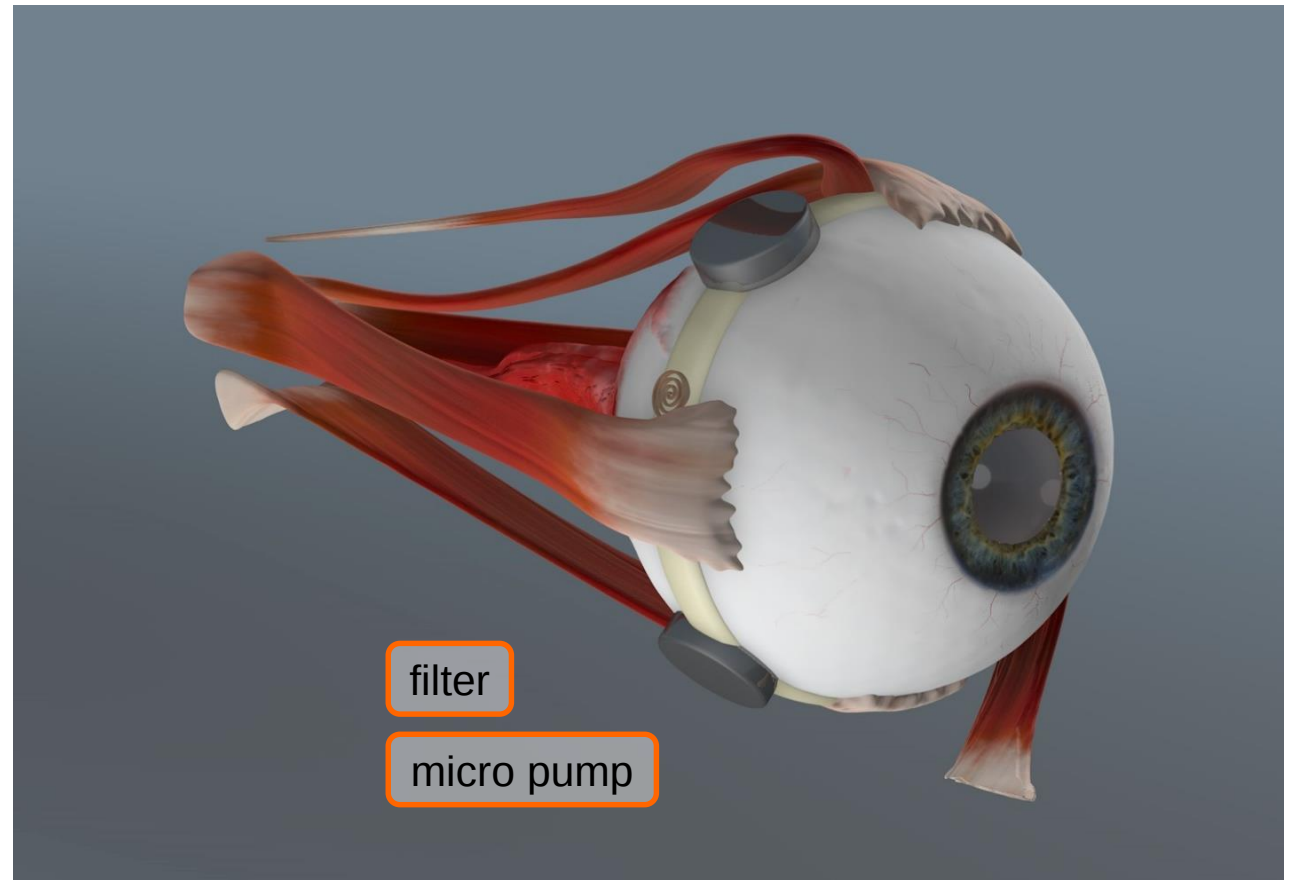
Electronics



Mikroaug

- Implant for eye diseases

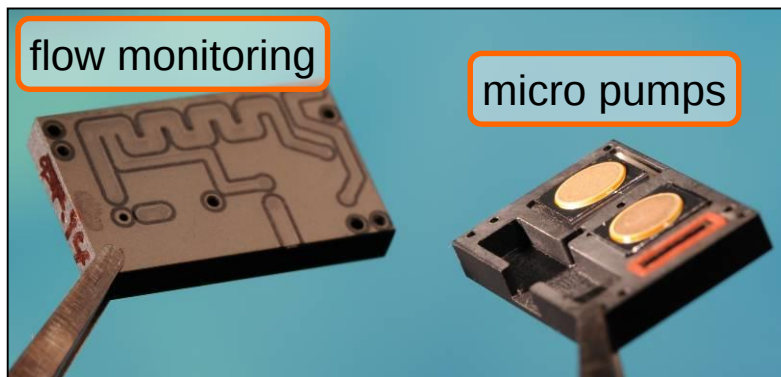
**Glaukoma
therapy**



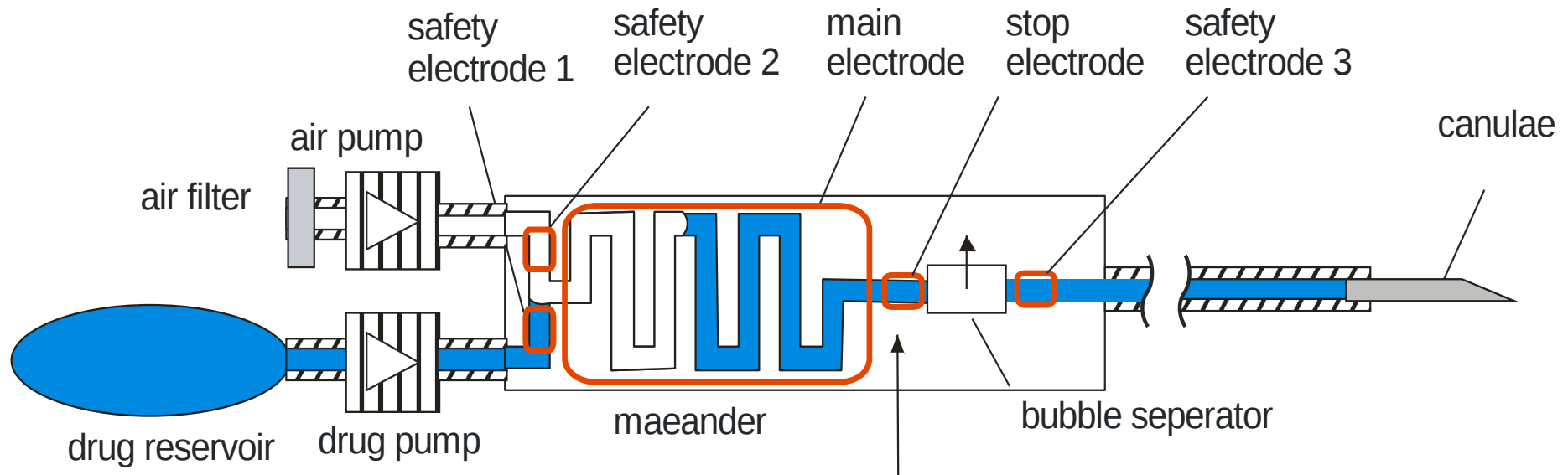
Drug delivery

drug delivery

13 μl per dosing
cycle
1 % accuracy

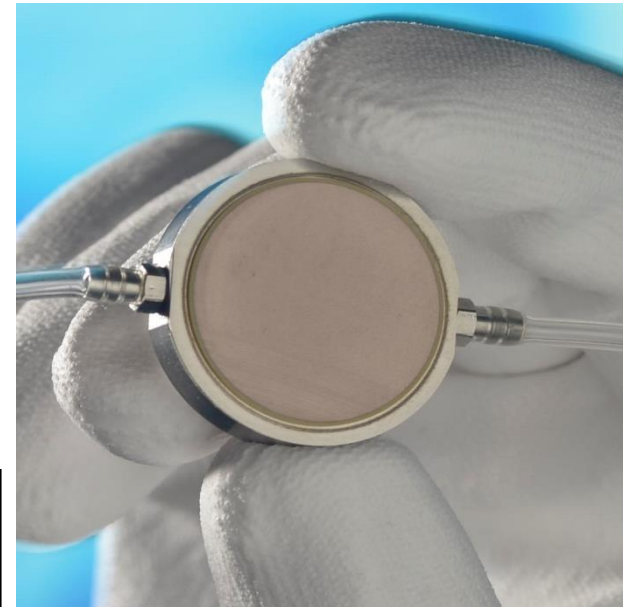
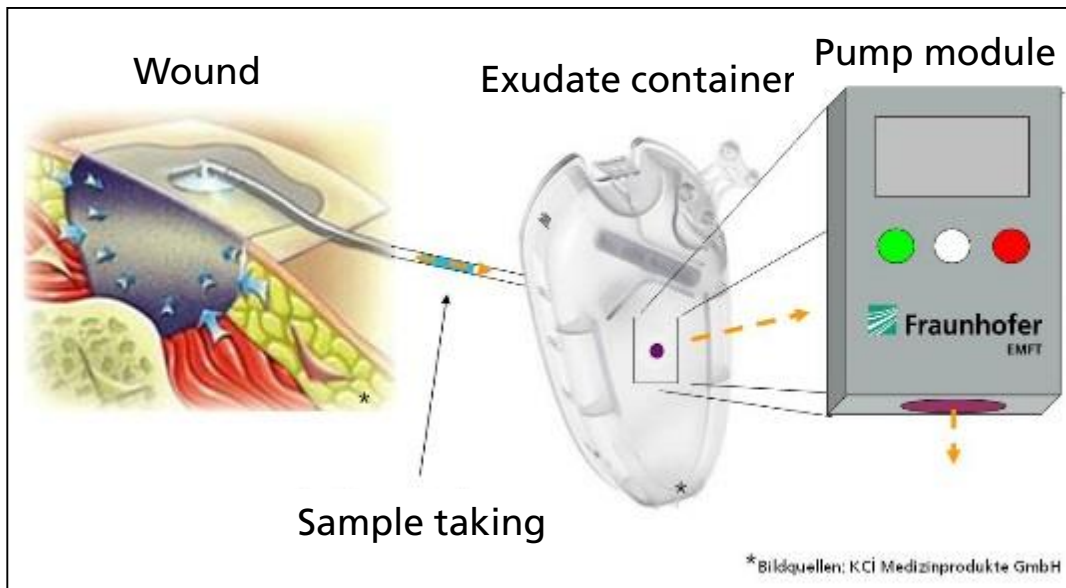


Drug delivery



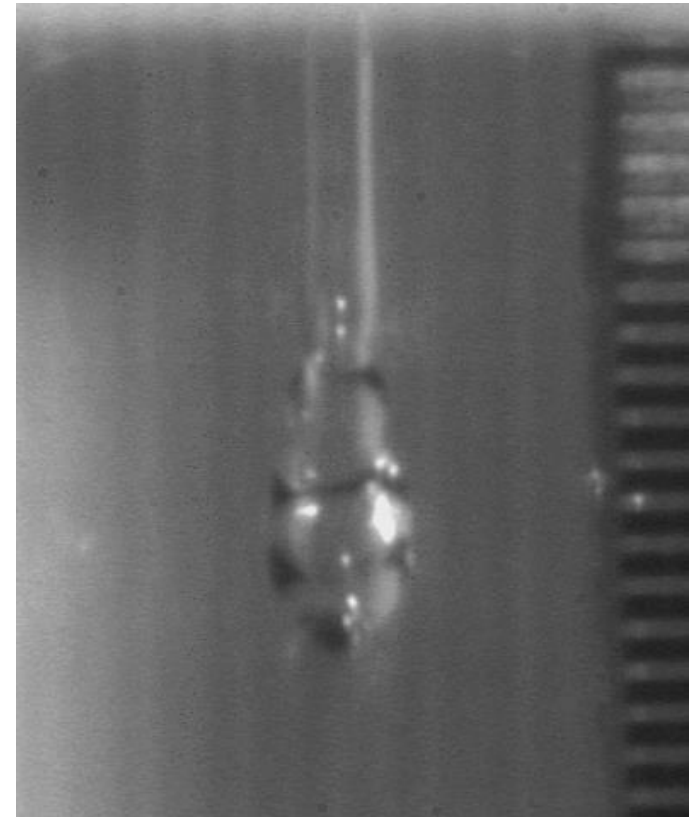
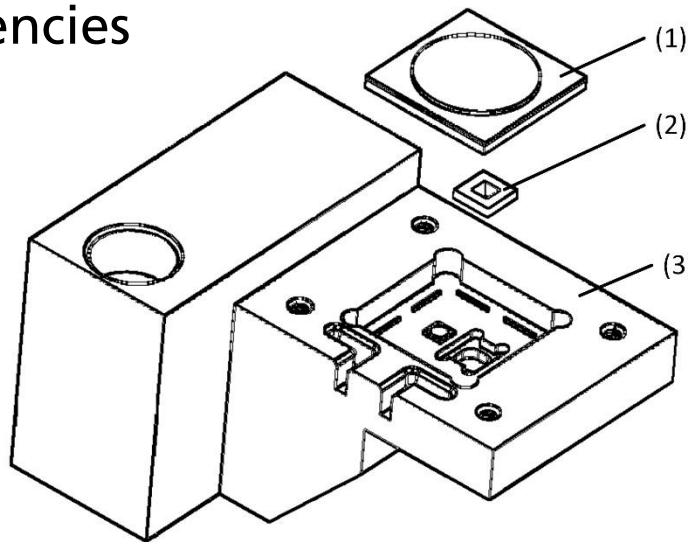
Negative Pressure Wound Therapy – Project SkinHeal

- Stainless steel micro pump
- Autoclavable
- Biocompatible
- 3mm height x 29mm diameter



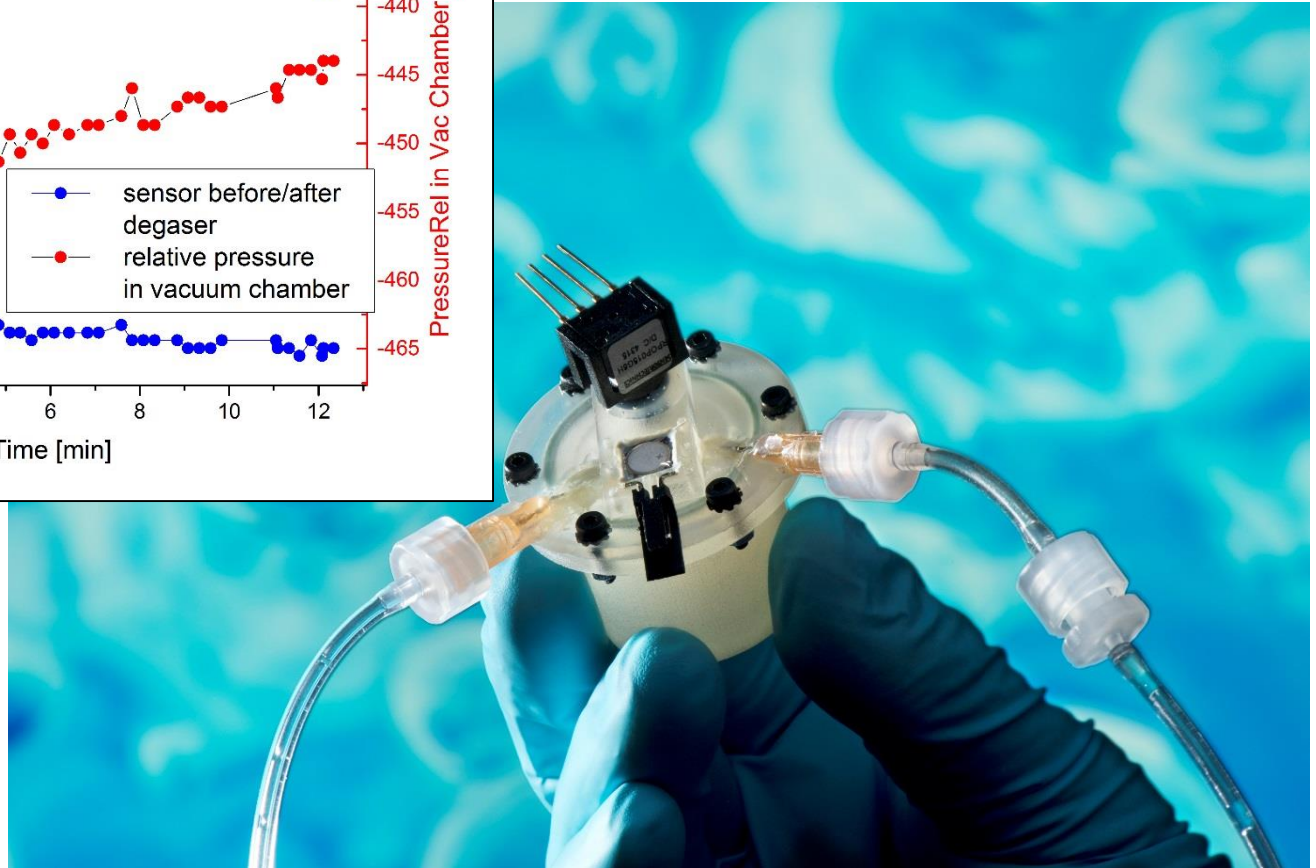
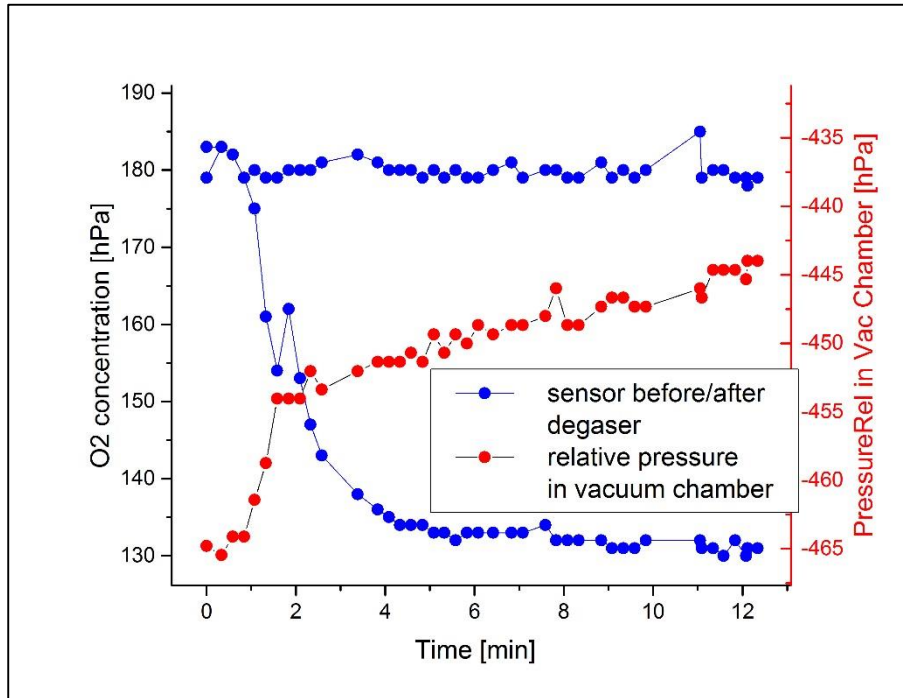
Jet Dispenser

- Jet = thin liquid stream
 - high kinetic energy necessary to build jets and avoid droplets
- Dosing of small amounts 40-100nl without liquid connection
- Higher amounts with higher frequencies



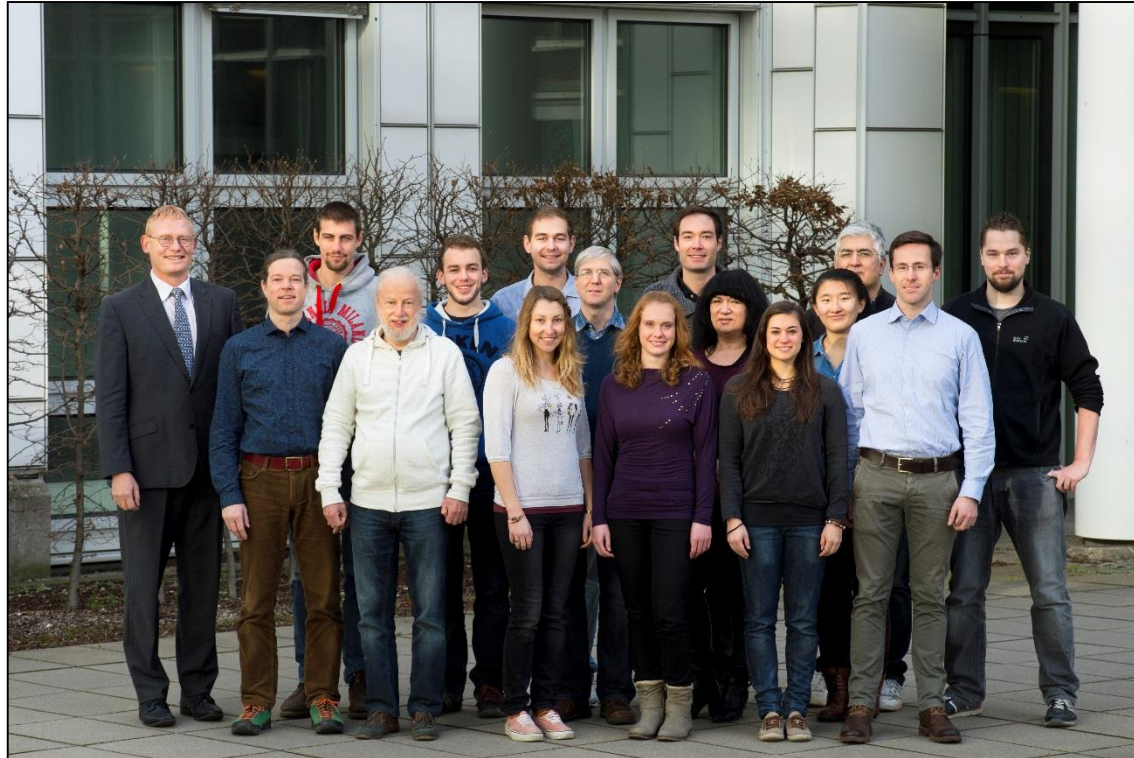
Degasser / Debubbler

- Liquid preparation
- Portable devices



Fraunhofer EMFT

Department: Micro Dosing Systems



Thank you for your attention!