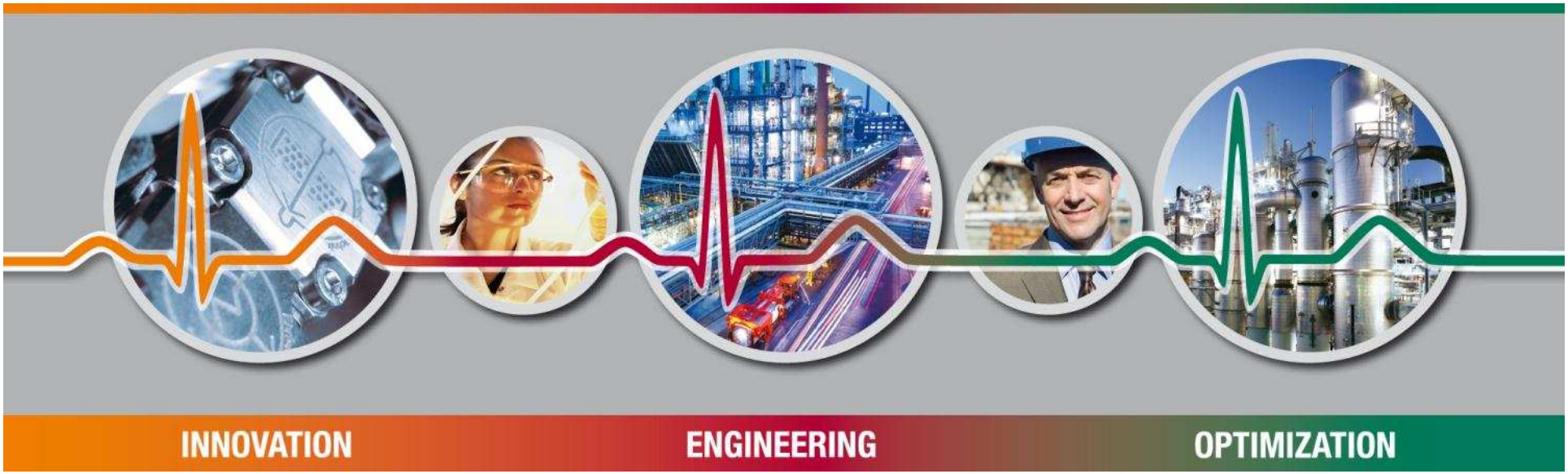
Powering Your Performance

EHRFELD
Mikrotechnik BTS
A Bayer Technology Services Company



Technische Lösungsmöglichkeiten auf dem Markt – Modulare Mikroreaktortechnik von Ehrfeld Mikrotechnik

Dr. Frank Schael **November 2011** **Ehrfeld Mikrotechnik BTS GmbH**

Ehrfeld Mikrotechnik BTS GmbH: Who we are!

EHRFELD Mikrotechnik BTS
A Bayer Technology Services Company

- ✓ **We are a leading provider of MRT products & services!**
- ✓ **We are located in the center of Germany (close to Mainz)**
- ✓ **We benefit from the comprehensive backing of a global enterprise!**
- ✓ **We market our products and services worldwide!**

Ehrfeld Mikrotechnik BTS is a subsidiary of

Bayer Technology Services

Our global sales activities!

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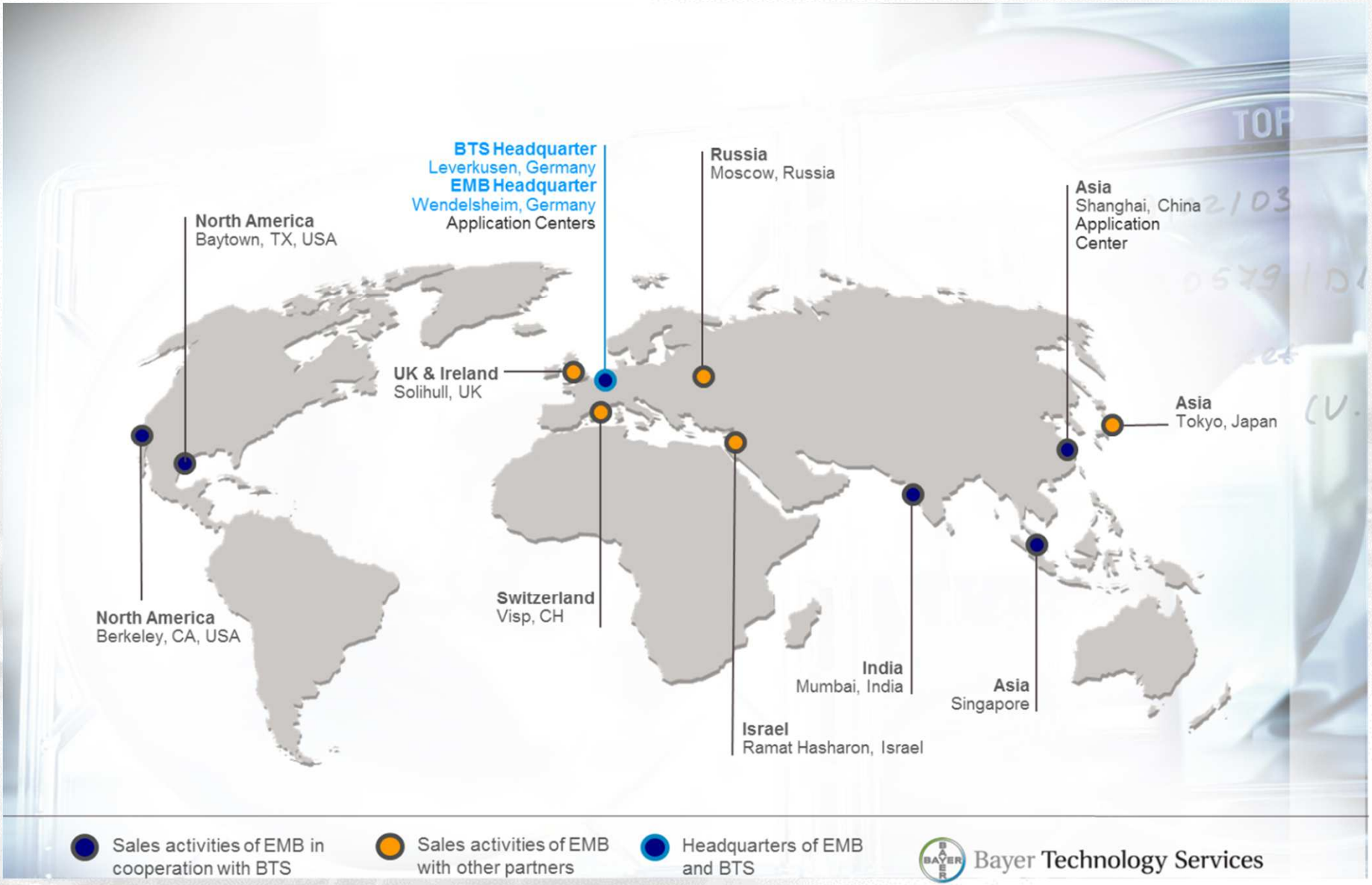

Microreaction Technology: Characteristics

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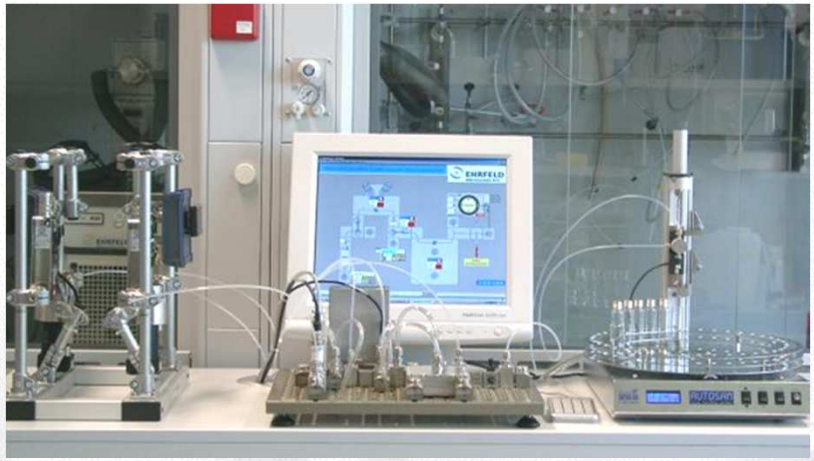
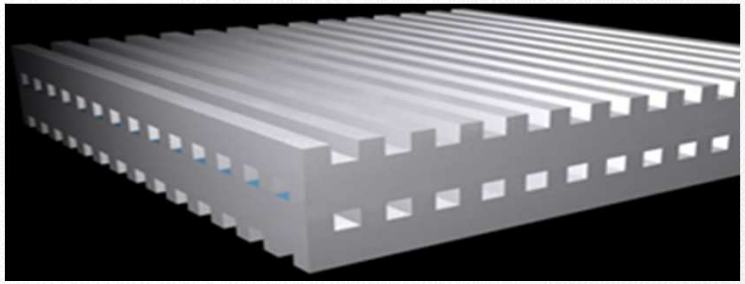
Continuous flow



High surface-to-volume ratio



	A/V [m² / m³]
Microreactor:	2.000 - 20.000
Millireactor:	1.000 - 2.000
Tubular reactor:	100 - 500
Stirred vessel:	4 - 40

Microreaction Technology: Benefits

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Higher selectivities and yields	→	Higher added value, simplified downstream processes
Control of exothermic reactions, inherent safety	→	New processes, new products
Simplified and faster scale-up	→	Reduced time-to-market
Compact reactors and plants	→	Higher flexibility and mobility

Microreactor technology aims at …

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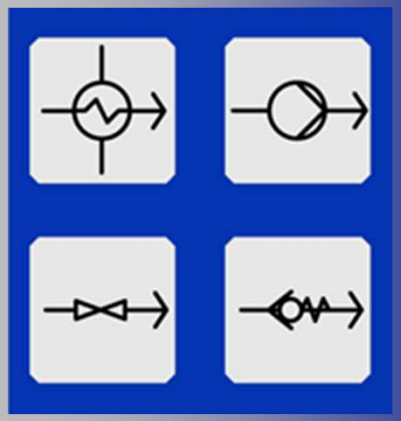
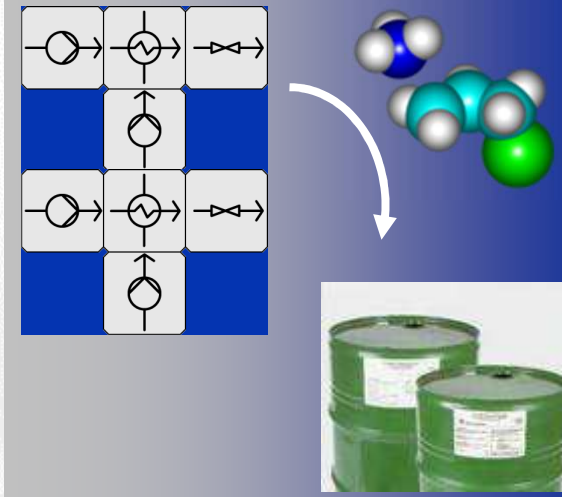
… Production of Information

… Process Development



… Production of Chemicals



Modular MicroReaction System –

Development with preparative-scale devices

Innovative technology & hardware for lab, pilot & production plants!

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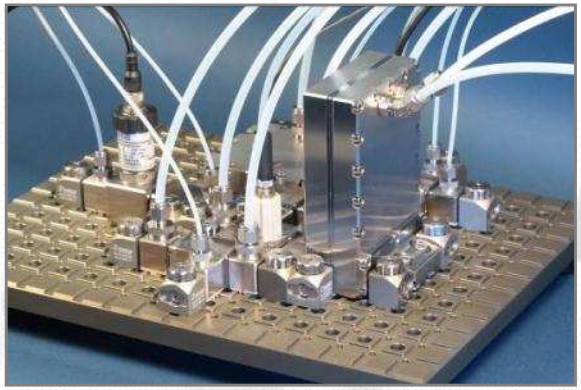
MMRS



Modular MicroReaction Systems for lab R&D!

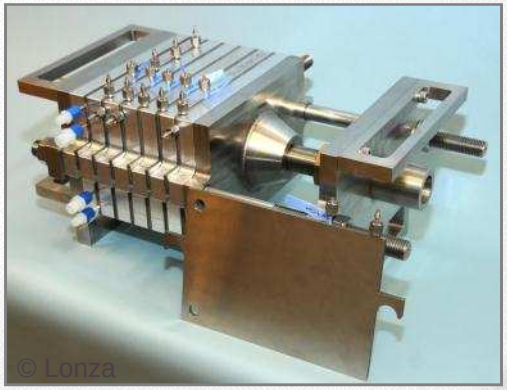
- -Proof of principle studies
- -Process development
- -Process intensification
- -Small scale production

Miprowa®

Production scale devices for chemical industry!

- -Harsh industry conditions
- -High scale-up purpose
- -Bulk chemical production
- -Multi-purpose applications

Lonza



Reactor systems for pharmaceutical industry!

- -Development of pharma
- -Preclinical, clinical, production
- -Ready-for-GMP

Ehrfeld Mikrotechnik BTS - Product Portfolio

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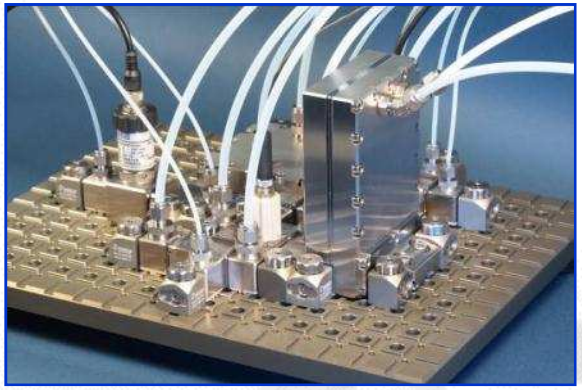
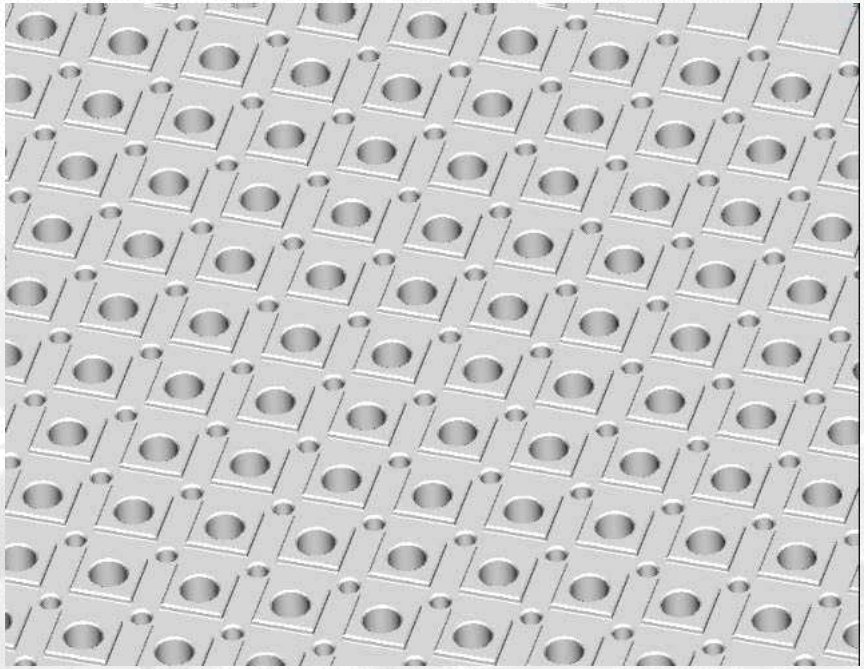
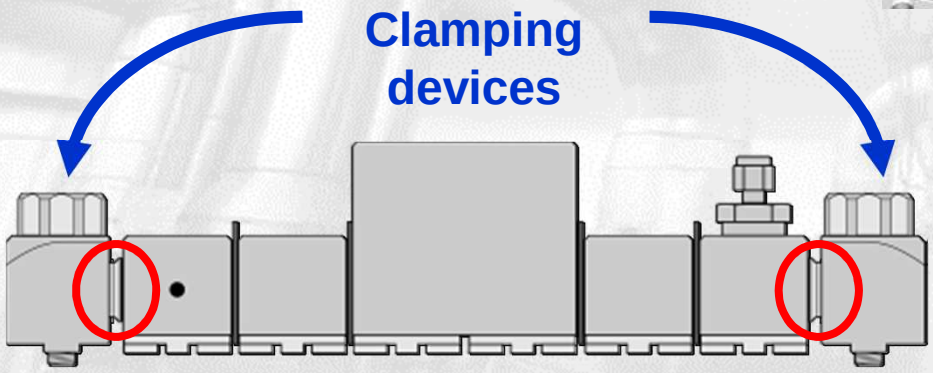
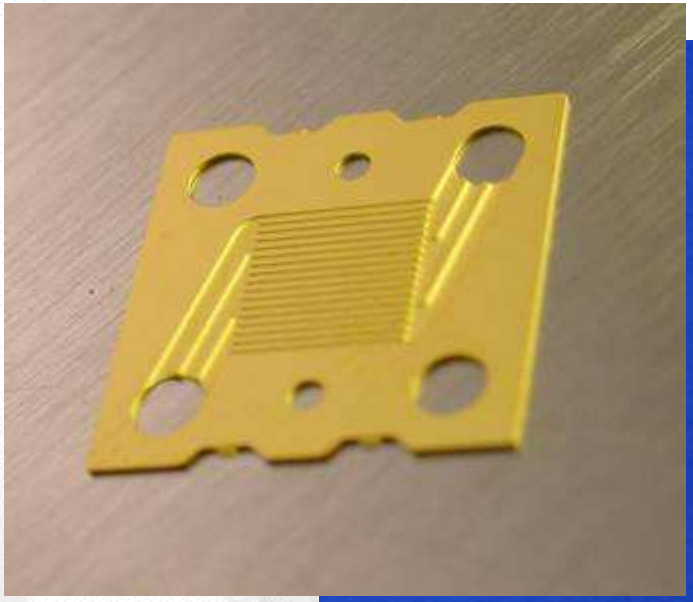
Modular MicroReaction System MMRS

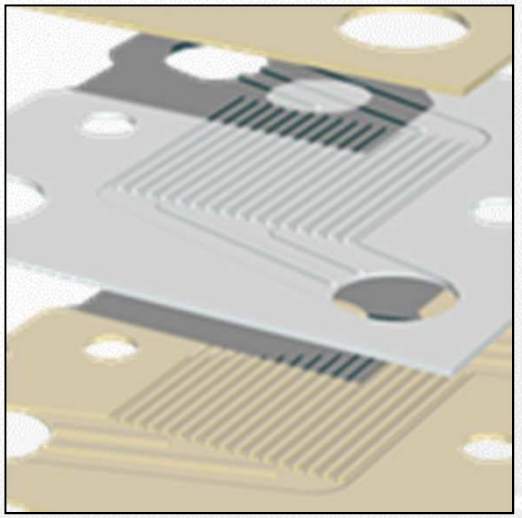


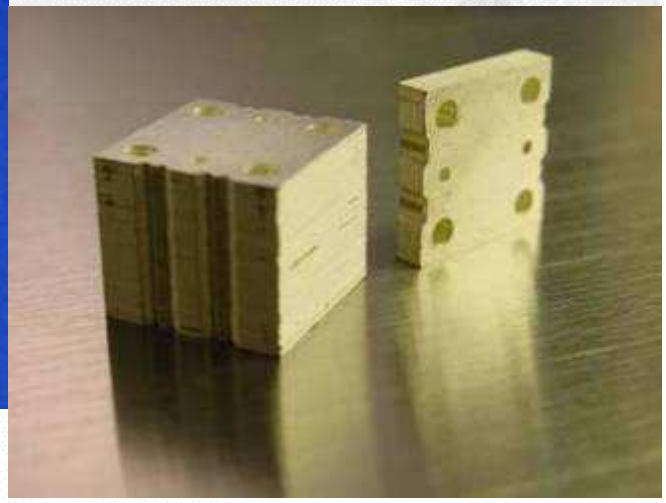




Heat Exchanger (Cross- and Counter flow)







Heat exchanger stack exchangeable

Very high heat exchange rate

Fluidic heating and cooling

Modular Micro Reaction System MMRS -Toolbox

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Particle Precipitation

Homogeneous & heterogeneous Chemistry

Cryo Chemistry

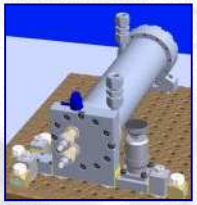
Photo Chemistry

Heat Exchange

Basic Starter Set Process Control

Heterogenous catalysis

Actuators, Sensors & Valves



Miprowa® Interface modules

Mixing & Emulsification

Lonza® Interface modules

Sensors

Modular **M**icro**R**eaction **S**ystem
-Toolbox for Process and Product Development

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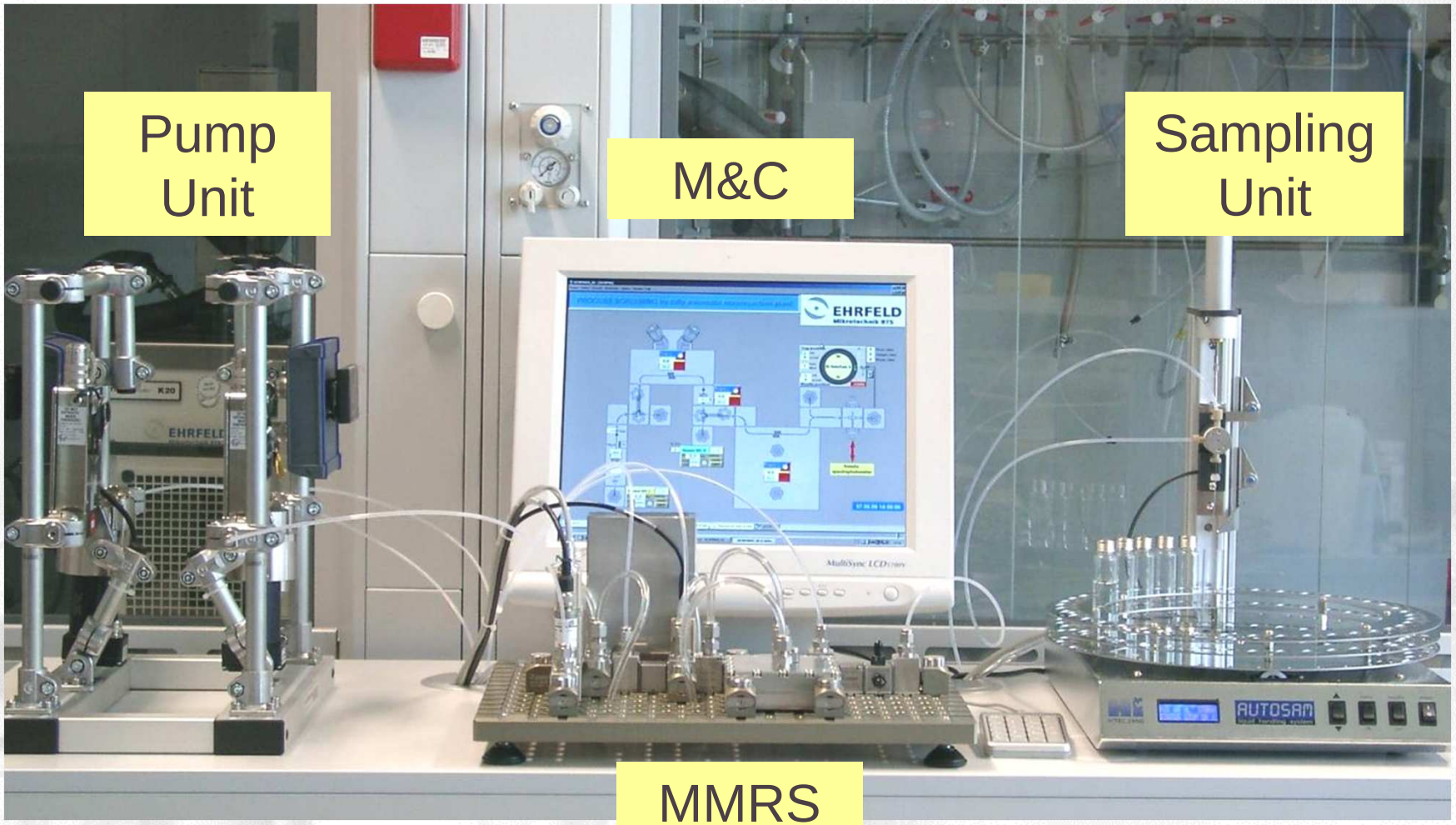

Automated screening research tool

MMRS upscale strategy

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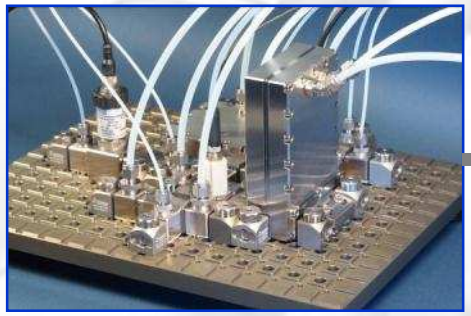
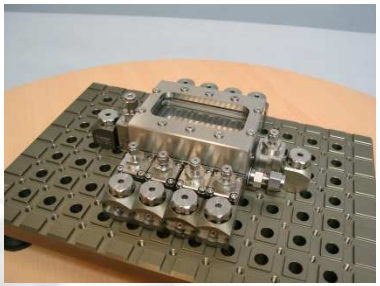
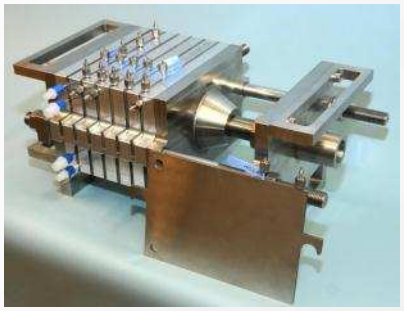




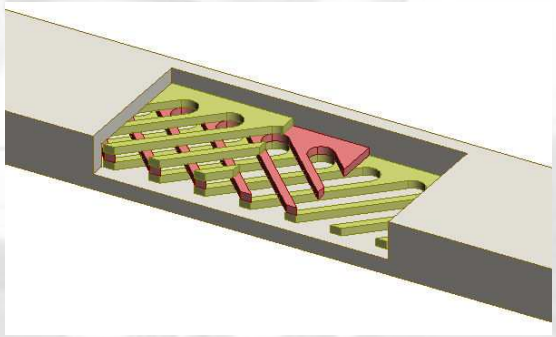


MMRS

MMRS Interface Modules

Production Scale Modules

MIPROWA® Product Line



Flow channels with exchangeables mixing baffles

- Production scale reactor devices
- High performance heat exchange
- Intensive radial mixing
- Easy scale-up concept
- Narrow residence time distribution
- Simple to disassemble and to maintain
- Negligible fouling of temperature sensitive compounds
- Microstructured, exchangeable mixing baffles
- Typical specifications (other upon request):

Pressure	0 - 150 bar
Temperature	-100 …300°
Volume rate	1 … >10.000 L/h
Materials	SS, Hastelloy®, Ta, Zr

MIPROWA® High Performance Technology

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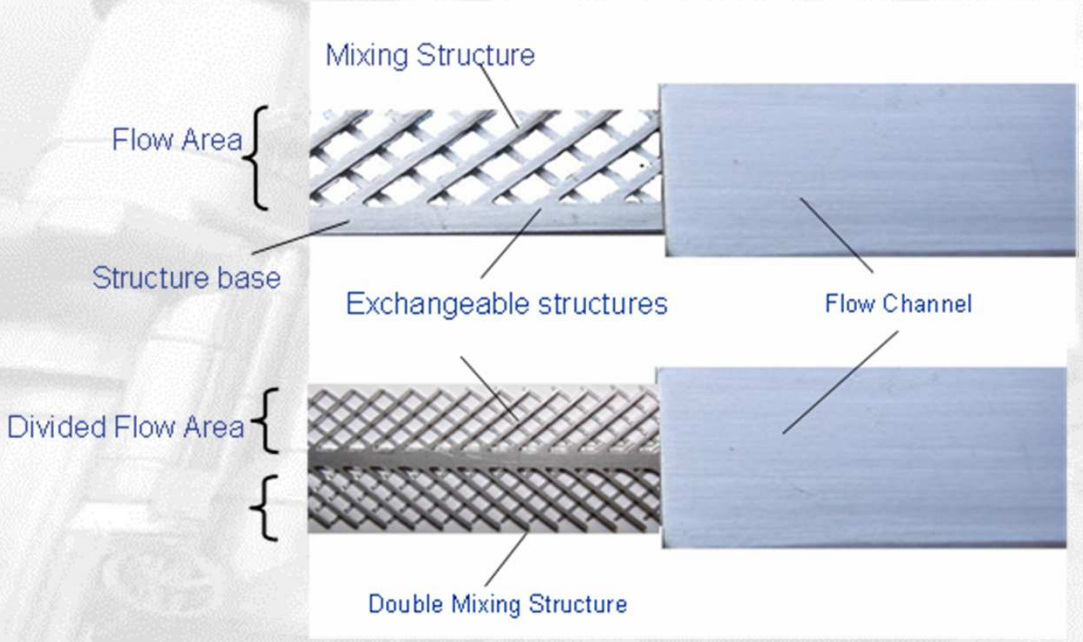
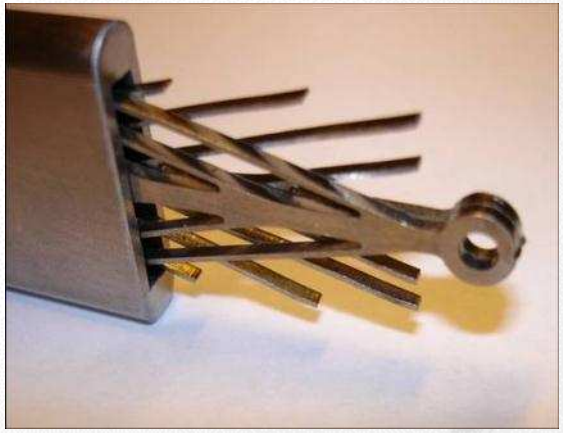
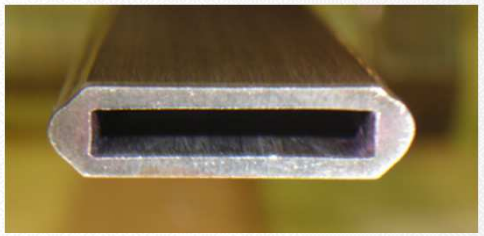
Advantages:

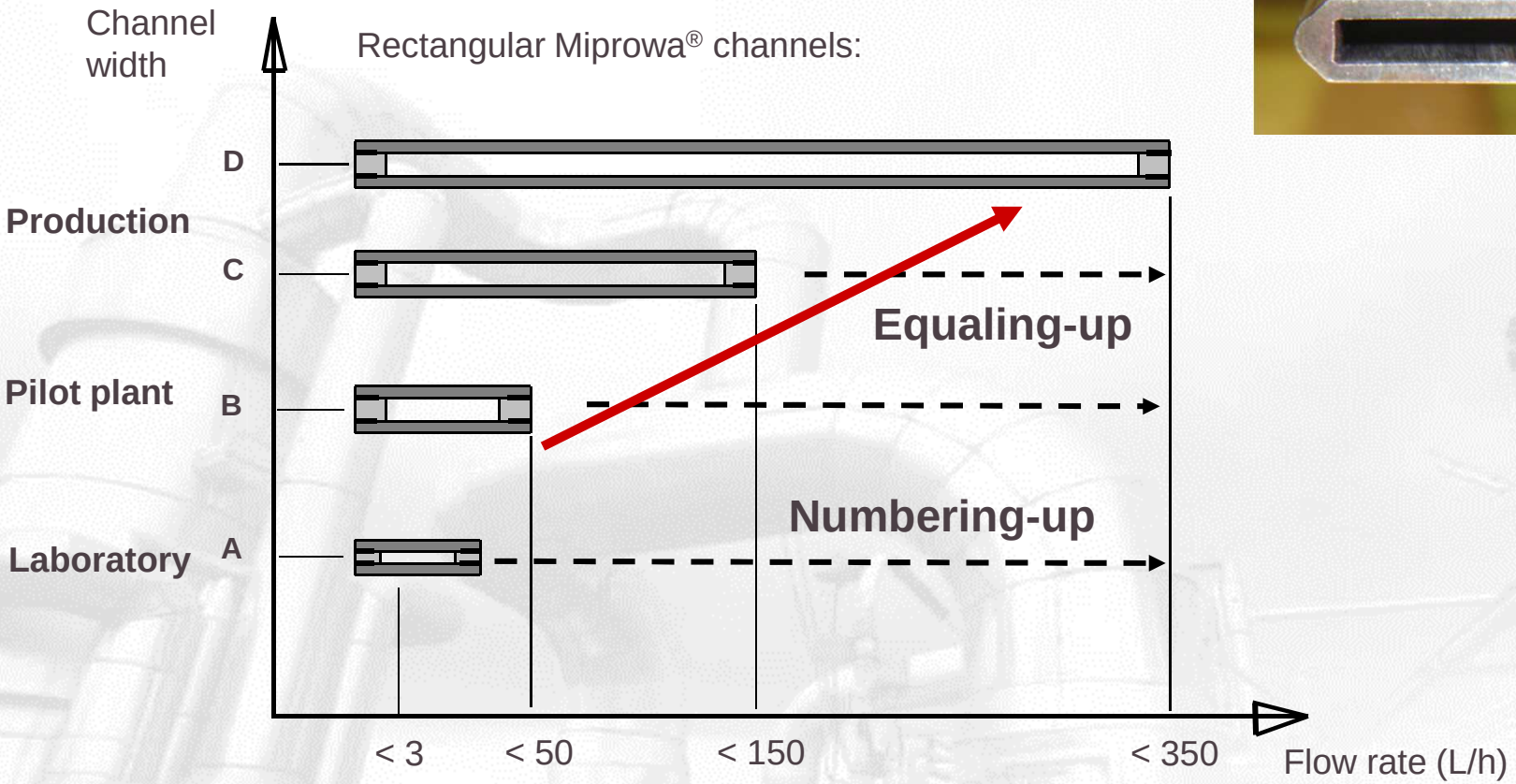
- Fast and effective heat transfer
- Careful heating of sensitive fluids
- Easy cleaning and maintenance
- Low installation costs





Miprowa® Scale-up Concepts

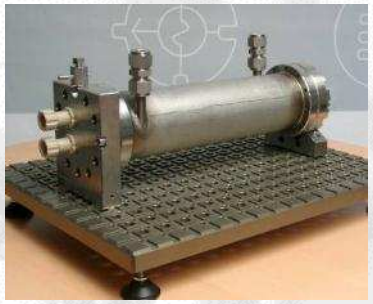




Combination of numbering-up and equaling-up leads to cost efficient bundle and plate-type units

MIPROWA® High Performance Technology

Numbering-up upscaling concept:



Lab scale:

No. of channels: 1-8

Channel size: 12 x 1.5 mm

Throughput: 3-10 L/h

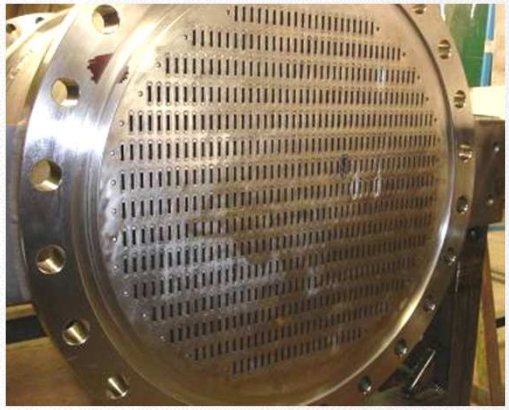
Pilot scale:

No. of channels: 3-100

Channel size:

12 x 1.5 mm & 18 x 3

Throughput: 10-300 L/h



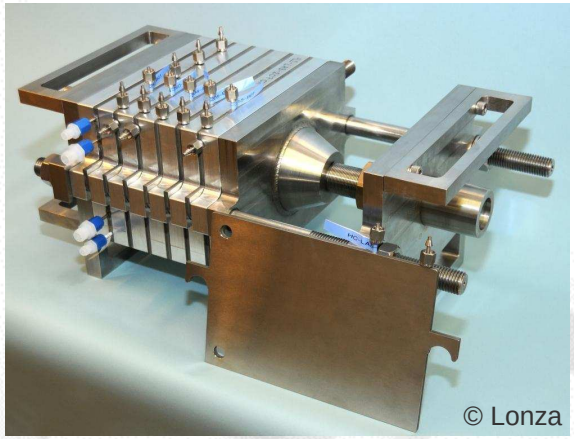
Production scale:

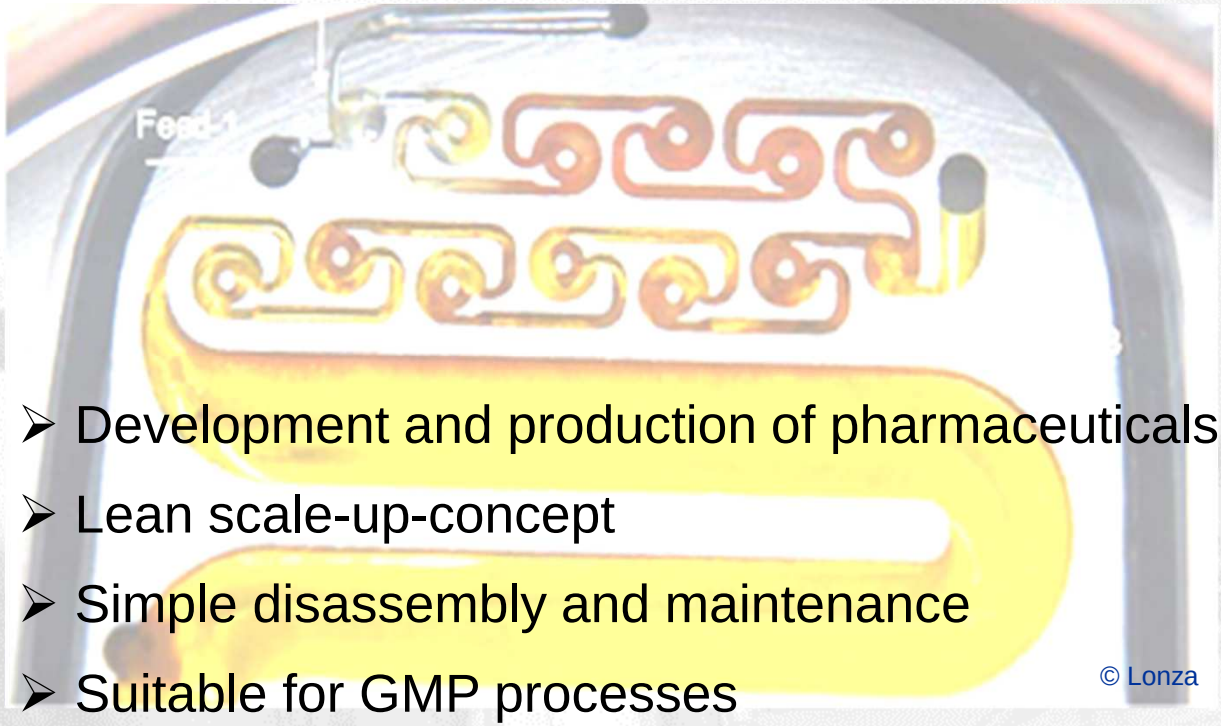
No. of channels: 10-1000

Channel size: 18 x 3 …120 x 3

Throughput: 300-10.000 L/h

Lonza MicroReactors





Lonza MicroReactors

Fabricated exclusively by

EHRFELD Mikrotechnik BTS
A Bayer Technology Services Company

- Development and production of pharmaceuticals
- Lean scale-up-concept
- Simple disassembly and maintenance
- Suitable for GMP processes
- Flexible, versatile & modular

Preclinical → Clinical Phase I - III → Commercial Production

Lonza MicroReactors – Scale-up

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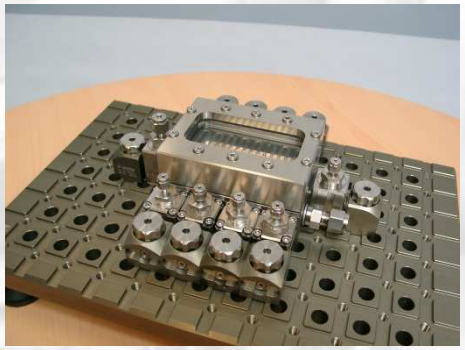
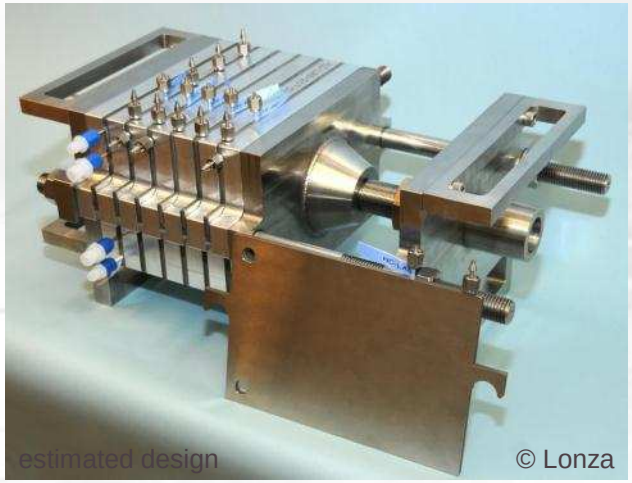
Preclinical → Clinical Phase I - III → Commercial Production

Plate Lab	Reactors A6 & A5	Reactor A4
	 © Lonza	 estimated design © Lonza
1-50 g/min	30-150 & 100-300 g/min	200-600 g/min

Lonza MicroReactors – Design & Technology

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Exemplary Microstructure of Lonza MicroReactors

Different structures for several applications are available!

Plate Lab

Lonza MicroReactors – Design and Technology

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Various plates for different applications are available!

Lonza MicroReactors – Design & Technology

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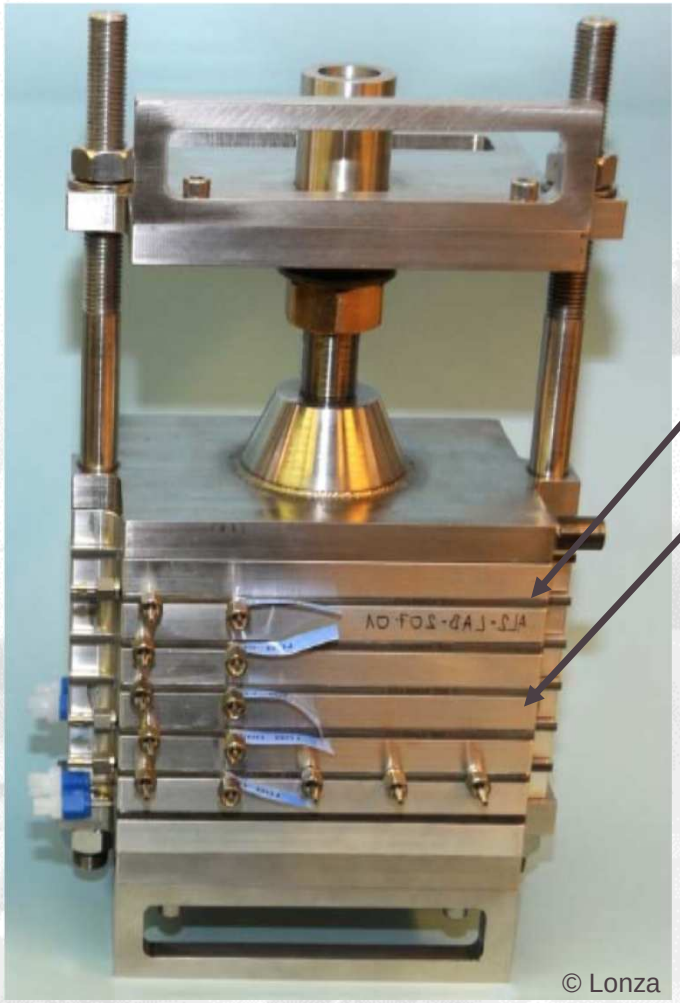

Reactor unit consists of plates for process media and plates for heat exchange

Heat Exchange Plate

Reactor Plate

Different plates for several applications are available!

Customized Micro Reaction Plants – Selected Reactor Units

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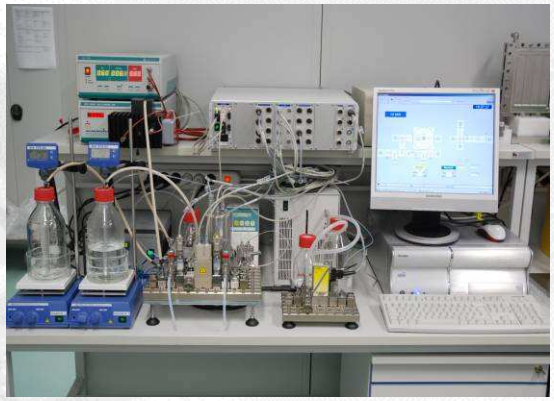
Gas-Liquid-Processes

Catalyst Screening @ High Temperature

Metal organic low temperature pilot synthesis



Special MMRS Applications

Summary: Why Microreactor Technology?

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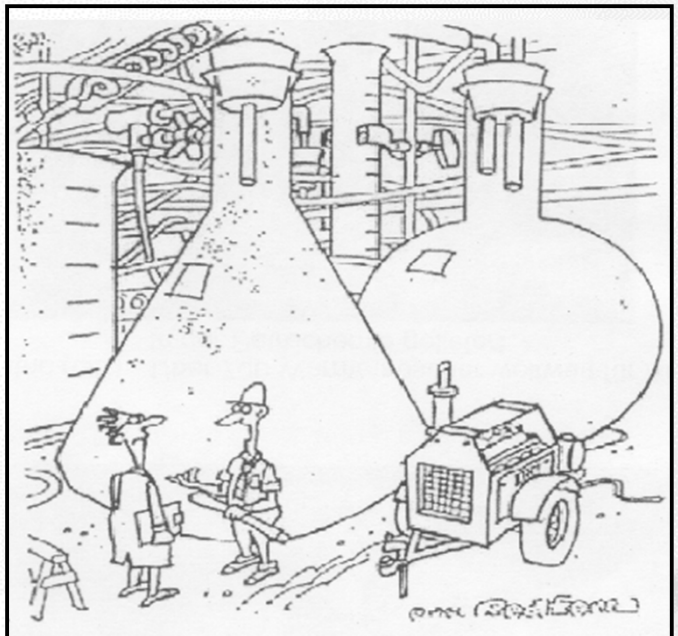
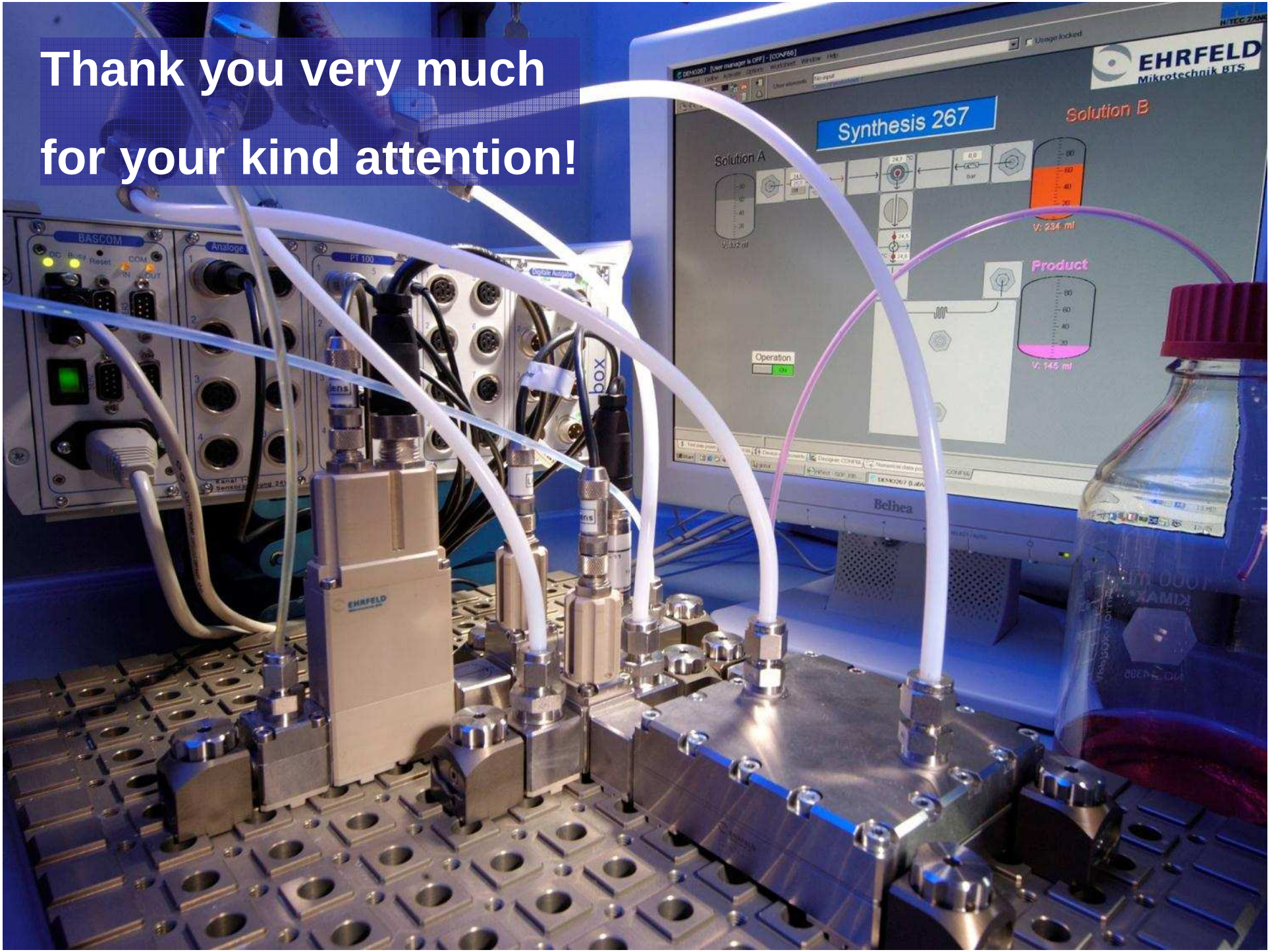
- Less scale-up problems
- Lower hazard potential
- Easier product change
- Simplification of FDA-compliance
- Reduced time-to-market
- Lower capital commitment
- High selectivity and yield
- Simplified capacity adjustment
- On-site production
- Novel synthesis routes



We had a small problem with the scale-up out of the laboratory....

Why Ehrfeld Mikrotechnik products?

- Range from laboratory to production applications is covered
- Outstanding range of operating parameters
- Laboratory and pilot studies
- Not only hardware but solutions


Thank you very much
for your kind attention!
EHRFELD
Mikrotechnik BTS
Synthesis 267
Solution A
Solution B
Product
Operation
V: 234 ml
V: 145 ml
BASCOM
Analoge
PT 100
Belnea