Round-Table Discussion

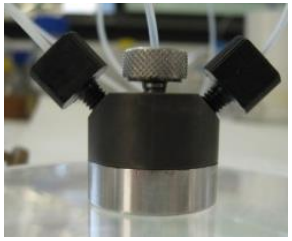
IMRET14 -- Beijing, P.R.China, September 12 - 14

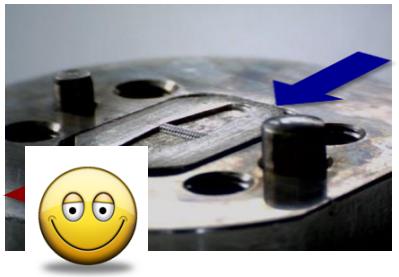
Some remarks from my point of view

In 1991， **IMM** was established as a **Microfabrication** company
Semiconductor technology, micro fabrication

In 1990 micro – heatexchangers were developed at Forschungszentrum Karlsruhe

In 1993 fist micromixer tests at IMM





We developed some theories ==== went wrong

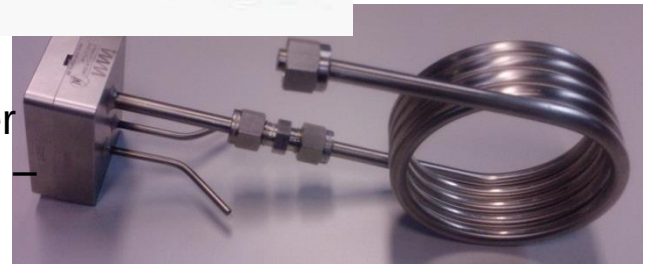
Transfer of known chemical reactions from batch to micro flow

Exploring Novel Process Windows

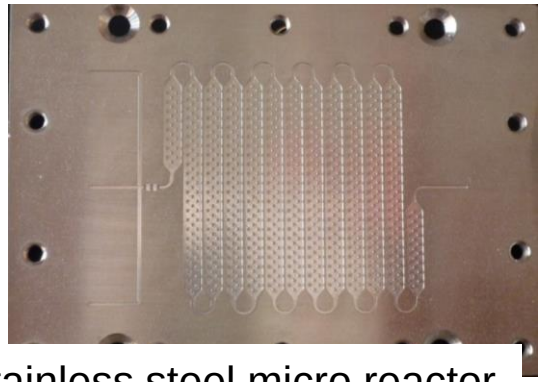
To target industrial means : scale-up vs. numbering-up ？

Flow Chemistry – Is there a difference between a mixer-tube reactor and a micro chip?

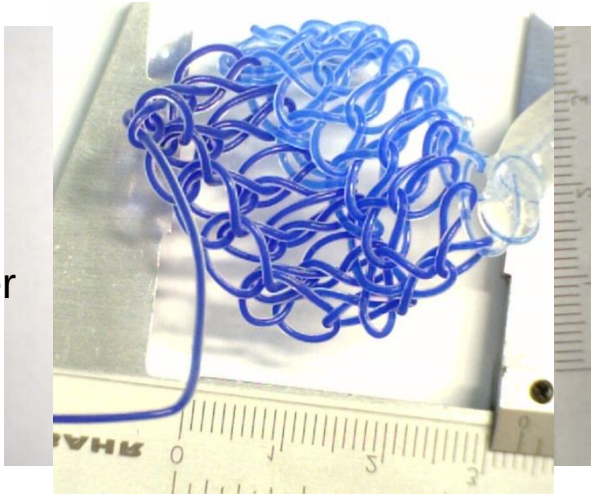
Obviously not, but …



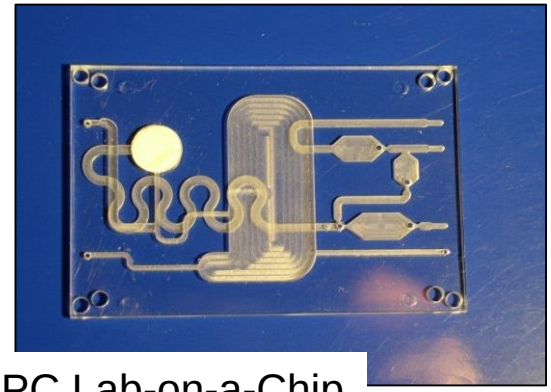
Stainless steel mixer (CPMM -1200 IMM) – tubular reactor



Stainless steel micro reactor



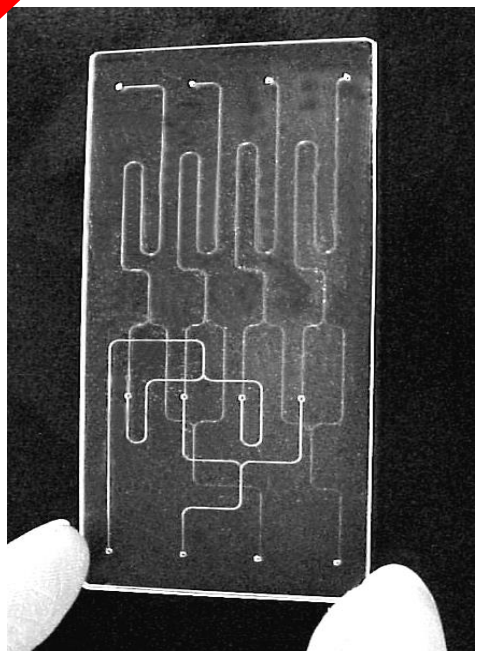
Crocheted PTFE 1/32” tube connected to a micro Kenics- mixer



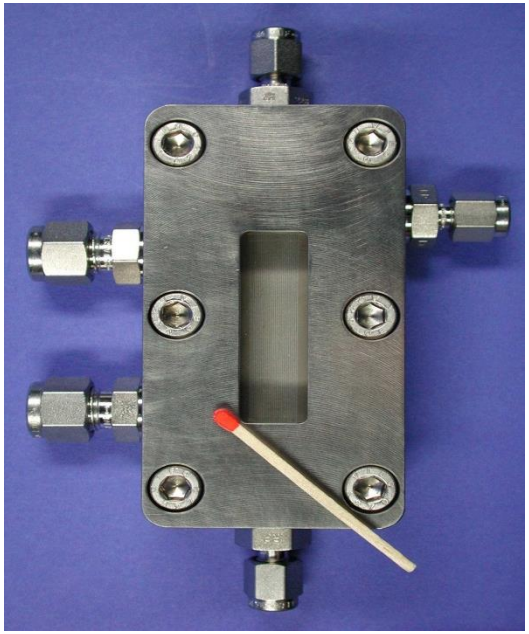
PC Lab-on-a-Chip

“Micro” – Reactors ?

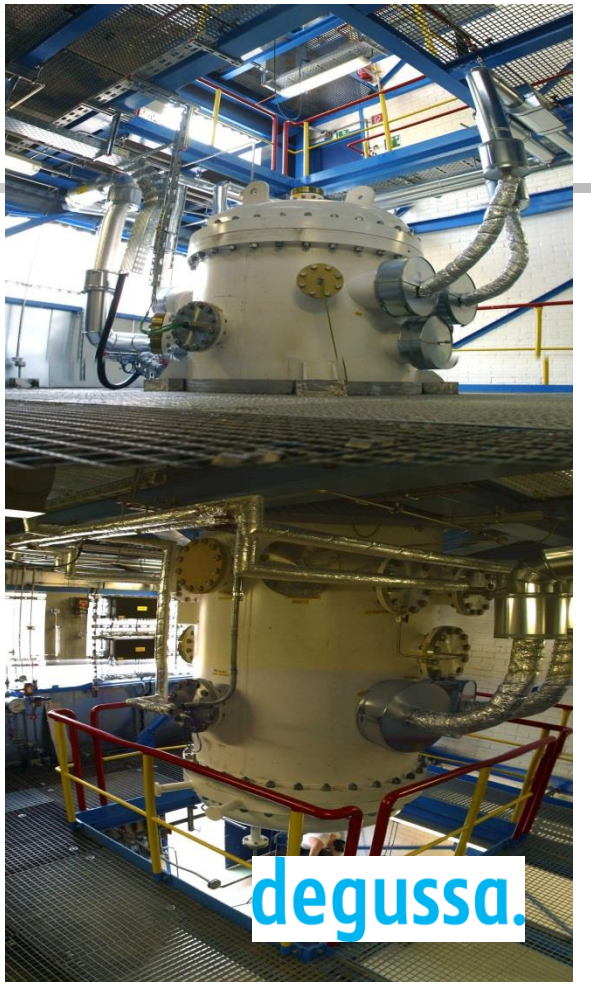
Numbering-up



Chip-reactor
Bio-Chip
Research/Education



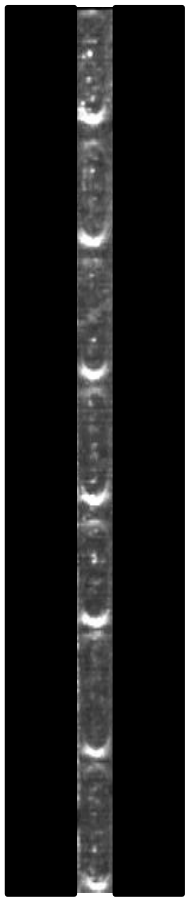
Micro reactor
Fine (high-valued)
chemicals
production

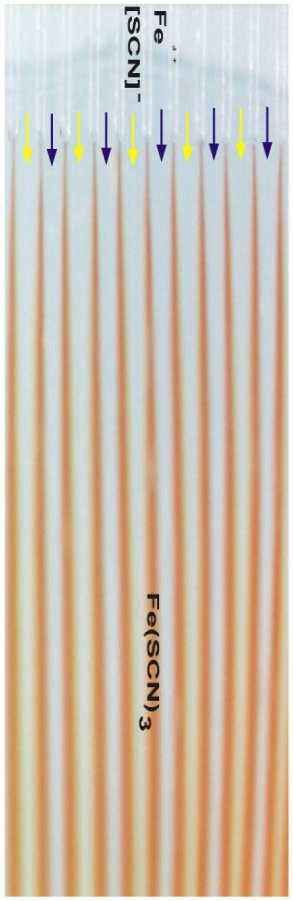


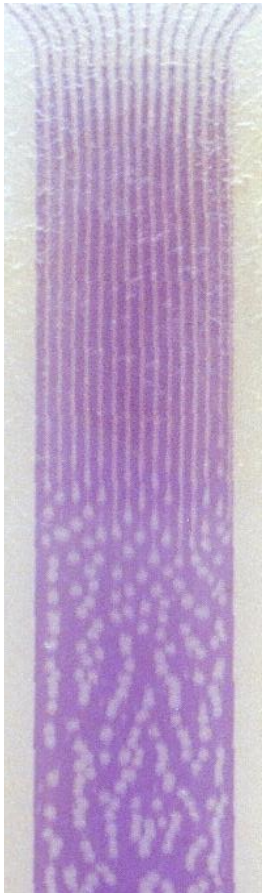
Microstructured reactor
“micro inside”
Production

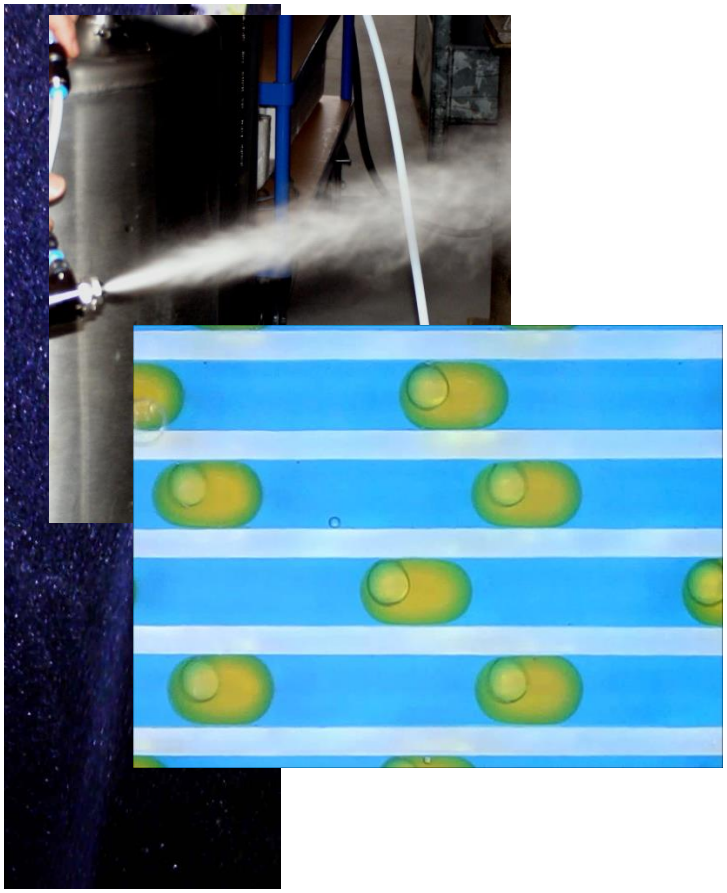
(Micro) structur OR structurized media?

Diffusion: $t \sim d^2/D$ → 100 µm – 5 s → 10 µm – 50 ms









Encased flow, Channel with solid walls

Free flow, encased by liquid sheets

Free droplet flow encased by liquid

Free gas bubble flow, encased by liquid

Free falling droplets, e.g. spray, encased by gas

Fluid streams are pre-shaped → microreactors have not necessarily microstructures

Confusion about “Micro”?

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Micro –reactor

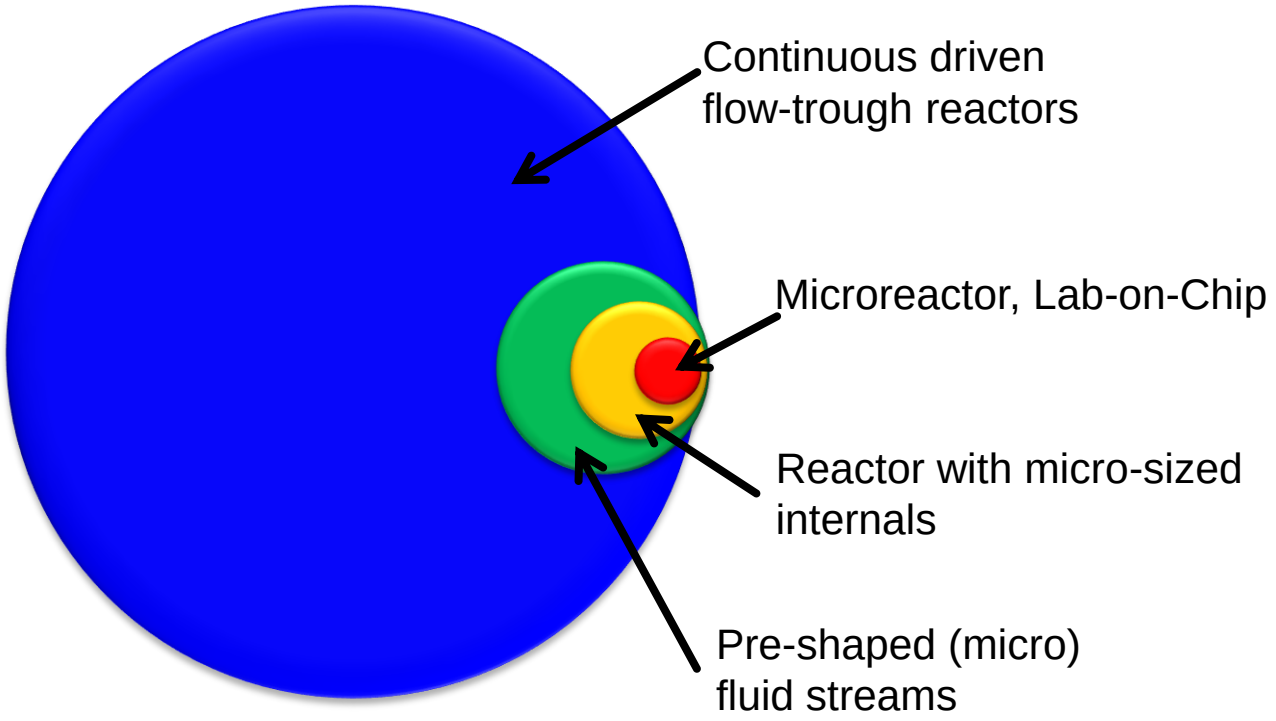
Microstructured reactor

Micro flow

Flow reactor

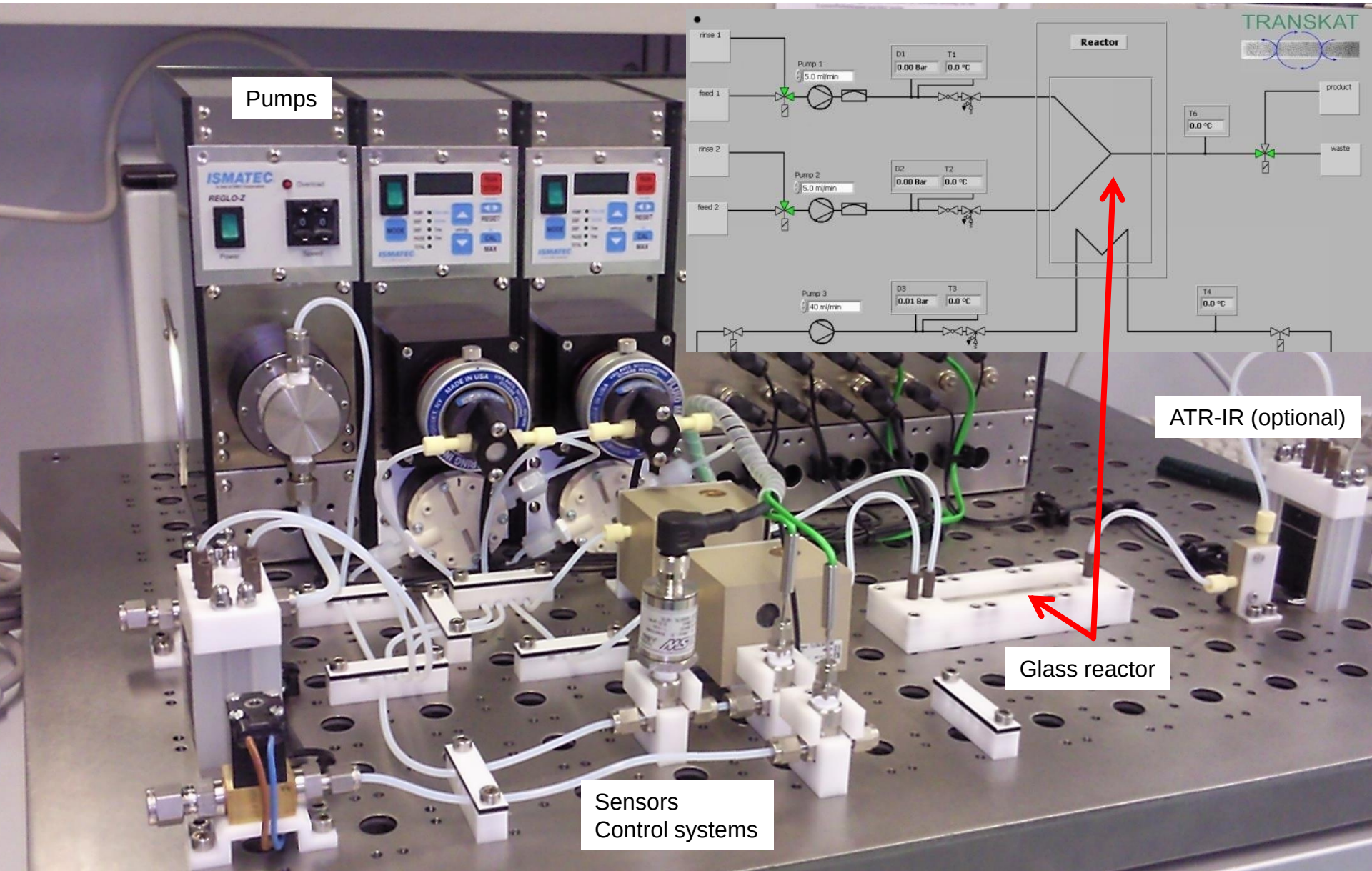
Meso reactor

?



Transfer of PTC Reactions to a Fully-automated Microreator Lab-bench Plant

mikroglas

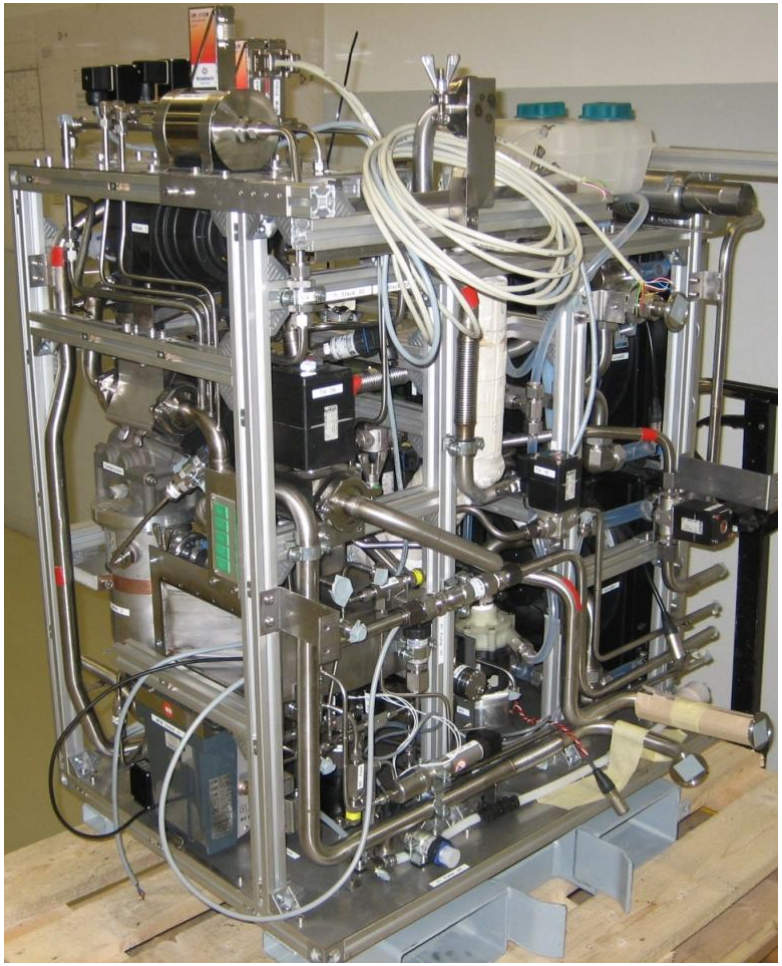


EU-Project Hytran – Hydrogen and Fuel Cell Technologies for Road Transport

Entire APU

assembled by Tenneco, Germany

Cold Part (Fuel Cell, Compressor and BoP)

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Some remarks from my point of view

Transfer of known chemical reactions from batch to micro flow is
Filling old wine into new tubes

Chemistry is determined by physics (kinetics, thermodynamics)

What to do for the future from the scientific point of view?

Developing processing routes:

Flash Chemistry

Space Flow Chemistry

Enzymatic and other bio-driven reactions

**if the result of an experiment does not fit into an existing theory ----
It is a good one)**