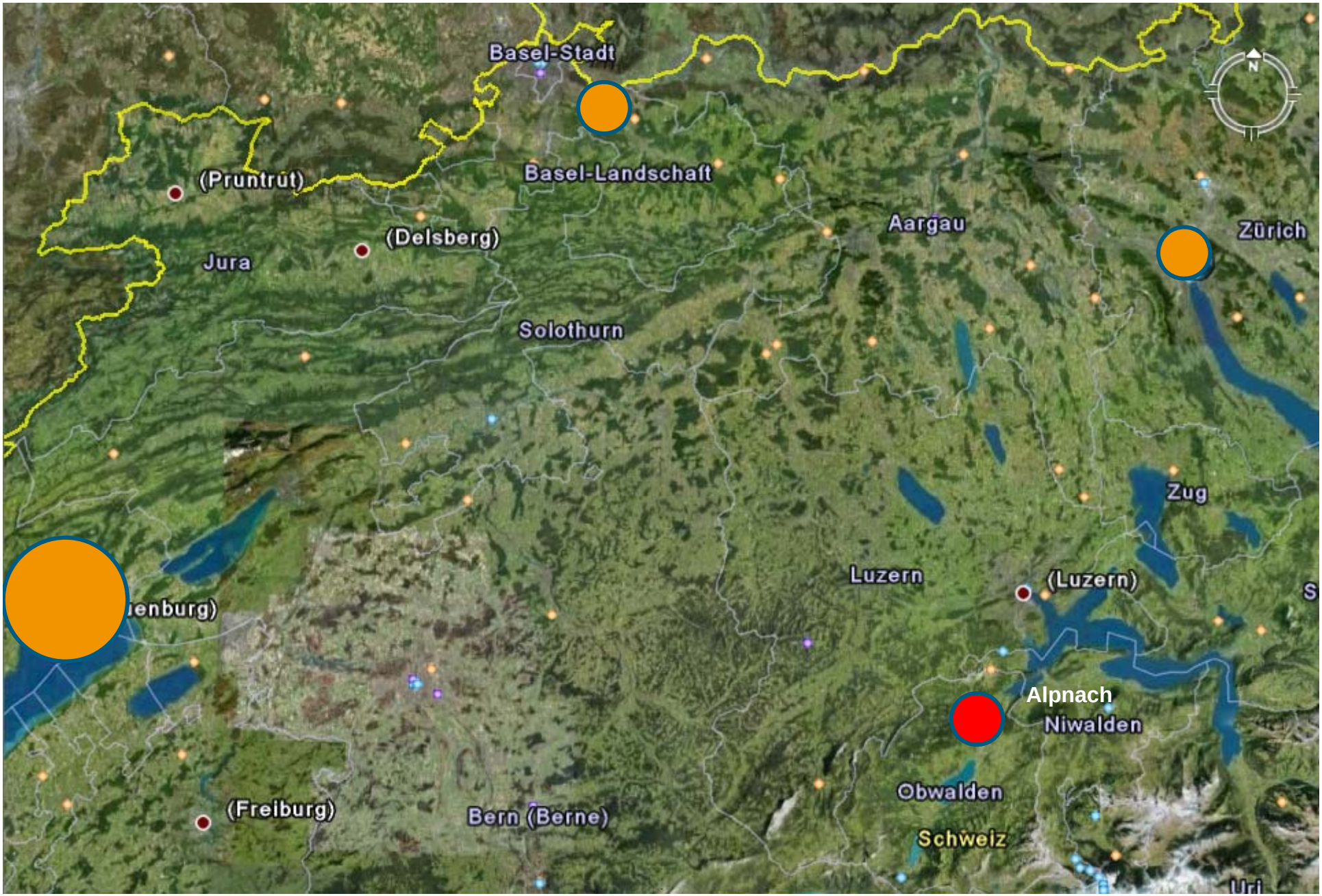
Alexander Steinecker
CSEM – Zentrum Zentralschweiz
11th October 2007


Basel-Stadt
Basel-Landschaft
(Pruntrut)
(Delsberg)
Jura
Aargau
Zürich
Solothurn
Zug
Luzern
(Luzern)
Alpnach
Niwalden
Obwalden
Schweiz
(Freiburg)
Bern (Berne)
N

HYDROMEL

Hybrid ultra precision manufacturing process

based on positional- and self-assembly

for complex micro-products

aims at developing new versatile 3D automated production systems for complex micro-devices through the innovative
combination of positional- and self-assembly.

Basics of microrobotics

Microsystems technology and nanotechnology require robots capable of handling very small objects with nanometer precision.

These micro robots are regarded as one of the key issues for both these technologies.

Especially the robot-based automation of nanohandling will lead to various novel applications.

Advantage:

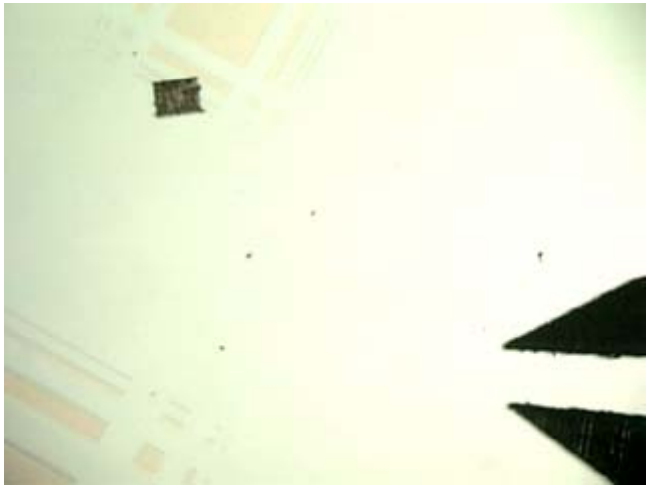
highly flexible, object oriented, directly controllable on large scale

Disadvantage:

serial, limited precision (compared to self-assembly), limited throughput

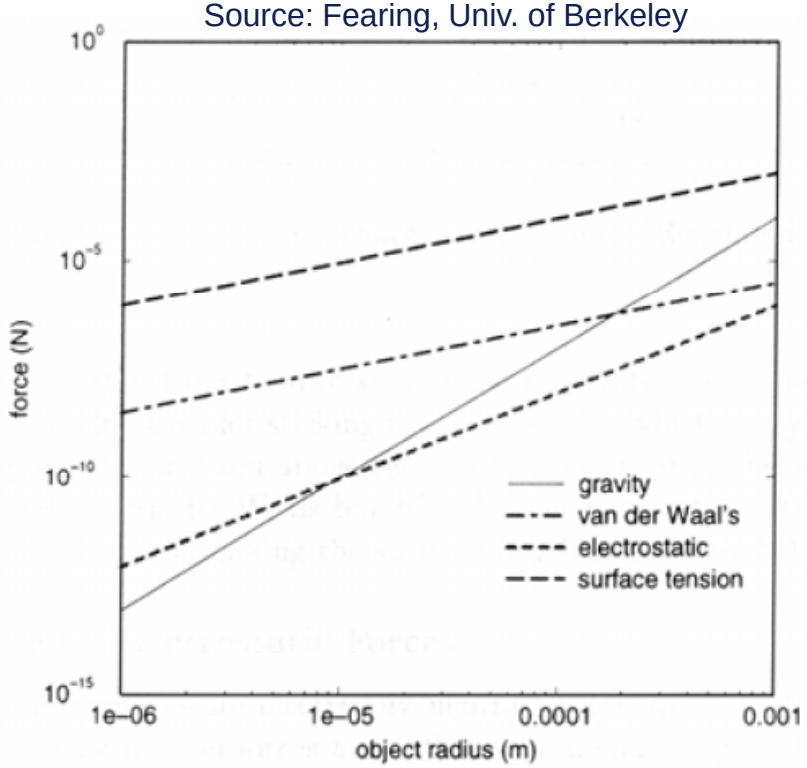
Challenges of microrobotics

Dominant adhesive forces for micro scale objects



Source: B. Nelson, ETHZ

Source: Fearing, Univ. of Berkeley



Basics of self-assembly

“Self-assembly is the autonomous organization of components into patterns or structures without human intervention”

G.M. Whitesides, B. Grzybowski, Science 2002, 295, 2418-2421

One of its main advantages is that many objects can be handled in a massively parallel approach at nanometer accuracy.

Advantage:

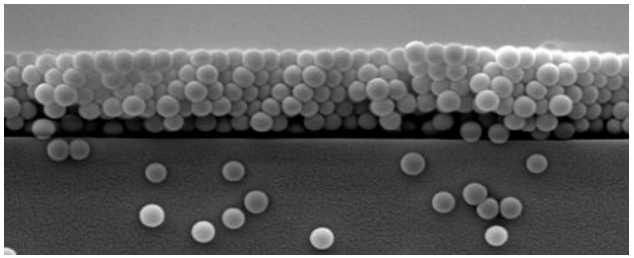
massively parallel, very precise (depending on interaction)

Disadvantage:

few degrees of freedom, not directly controllable

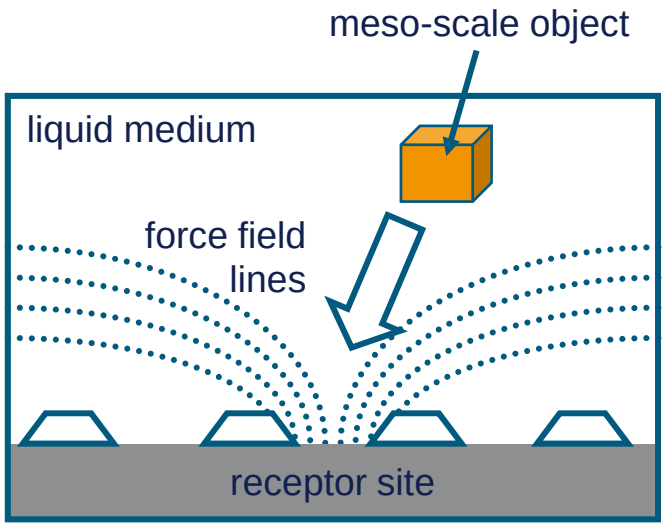
Challenges of self-assembly

self-assembly has almost exclusively been applied to create nano-scale assemblies from molecules, nano particles or biological entities



Source: CSEM

few examples have demonstrated self-assembly principles to the self-association and/or self-ordering of micro- to millimeter range objects



A New Approach

Top Down

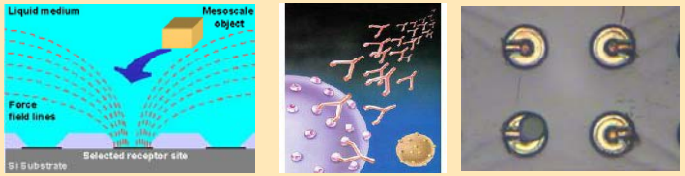
Microrobotics

HYDROMEL

Hybrid Assembly:
robot assisted self-assembly &
self-assembly assisted Microrobotics

Bottom Up

Self-assembly



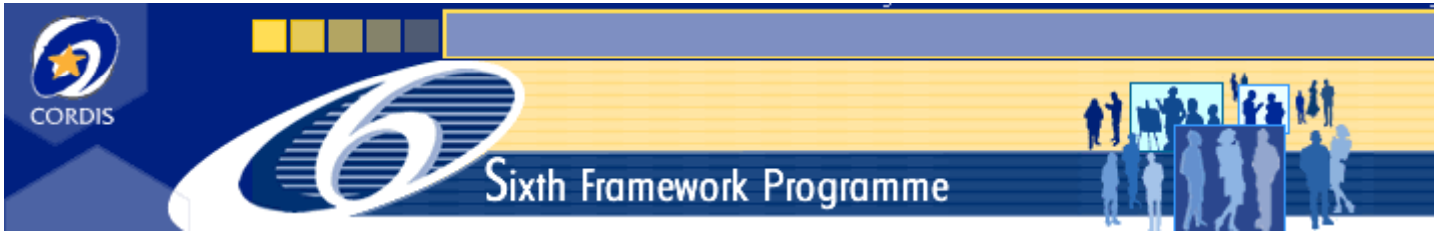
The Project – Key Figures

IP in FP6 under NMP

Overall budget of 13,87 Mio € (grant 9 Mio €)

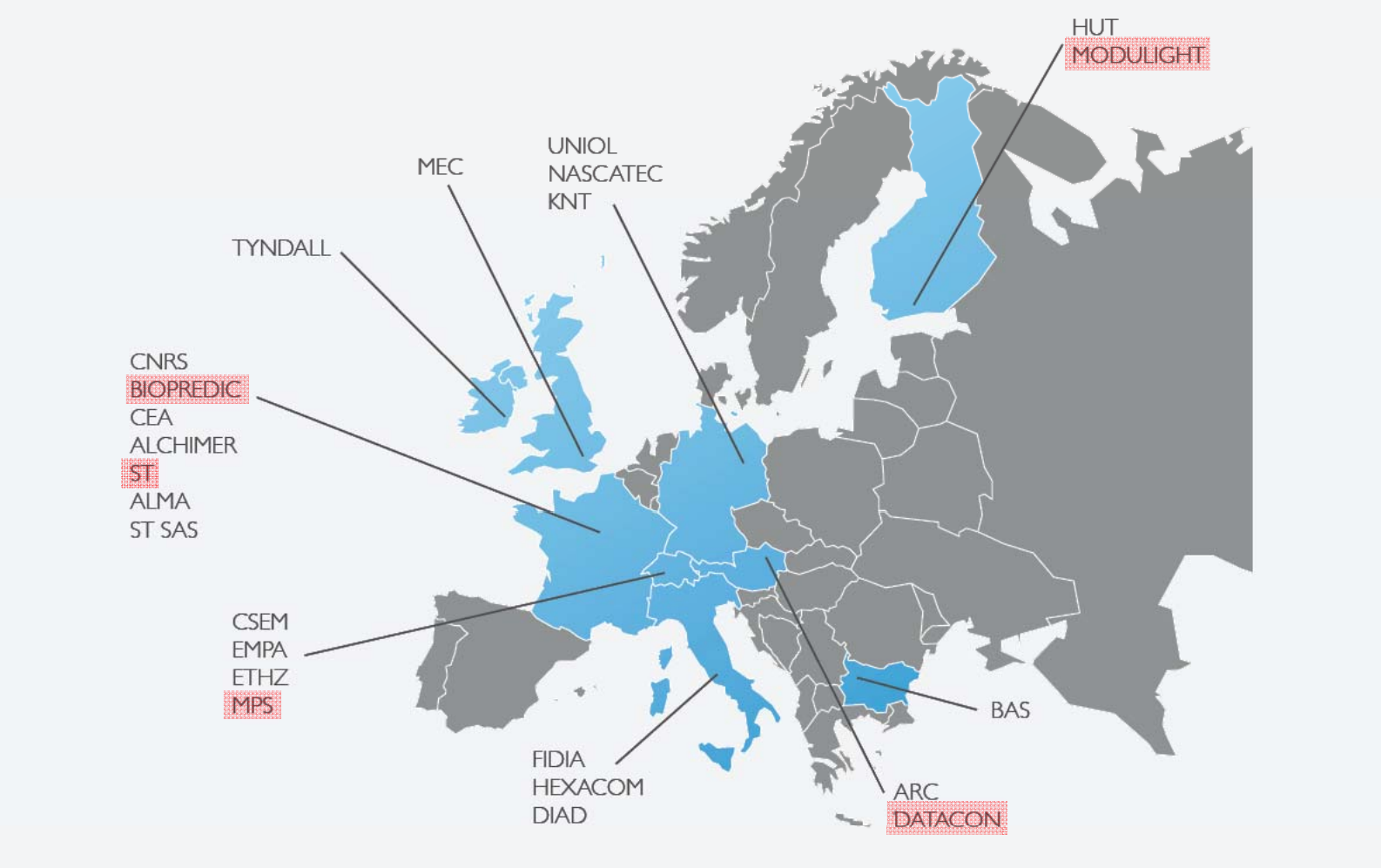
24 Partners from 10 European countries

Duration of 48 months, running from 10/2006 – 09/2010

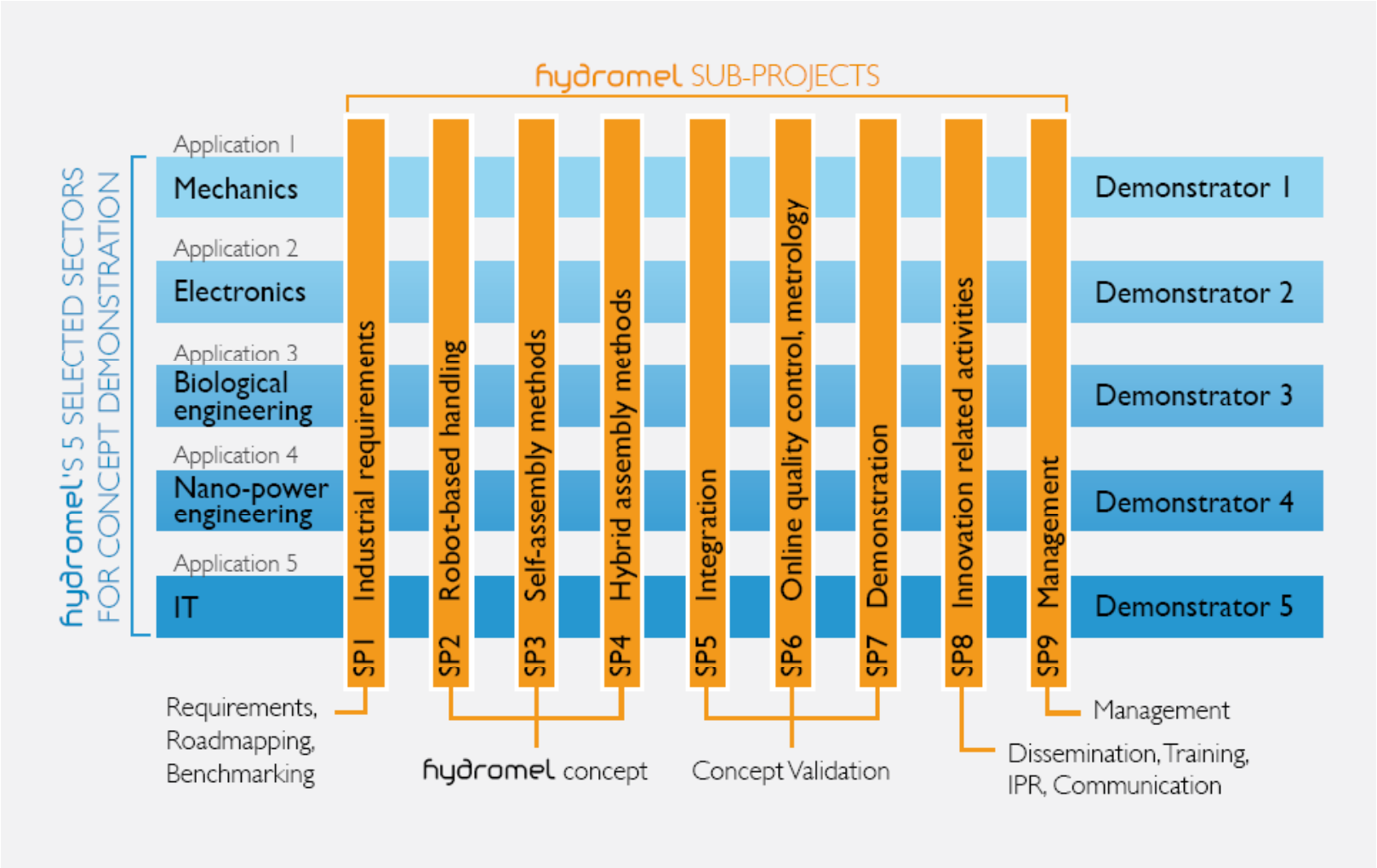


hydromel
Microrobotics & Self Assembly

24 Partners Across Europe



Project Organisation



Scientific Content - Robotics

Robotics (SP2, UNIOL)

- High precision Robot Systems
  - high resolution actuators and sensors, control
- Microassembly Processes
  - fixing and handling strategies
- Tools for Microassembly
  - feeding, 3d vision, force controlled gripping
- Intelligent user interfaces
  - self learning calibration, intuitive user interface

Scientific Content – Self-assembly

Self-assembly (SP3, ETHZ)

- Surface treatment and patterning
  - surface functionalisation, patterning methods + industrial feedback
- Switchability of surfaces
  - Switchable wettability of surfaces (chemical / physical effects) + industrial feedback
- Hierarchical self-assembly
  - Fluidic and electric field self assmbly (components, cells) + industrial feedback

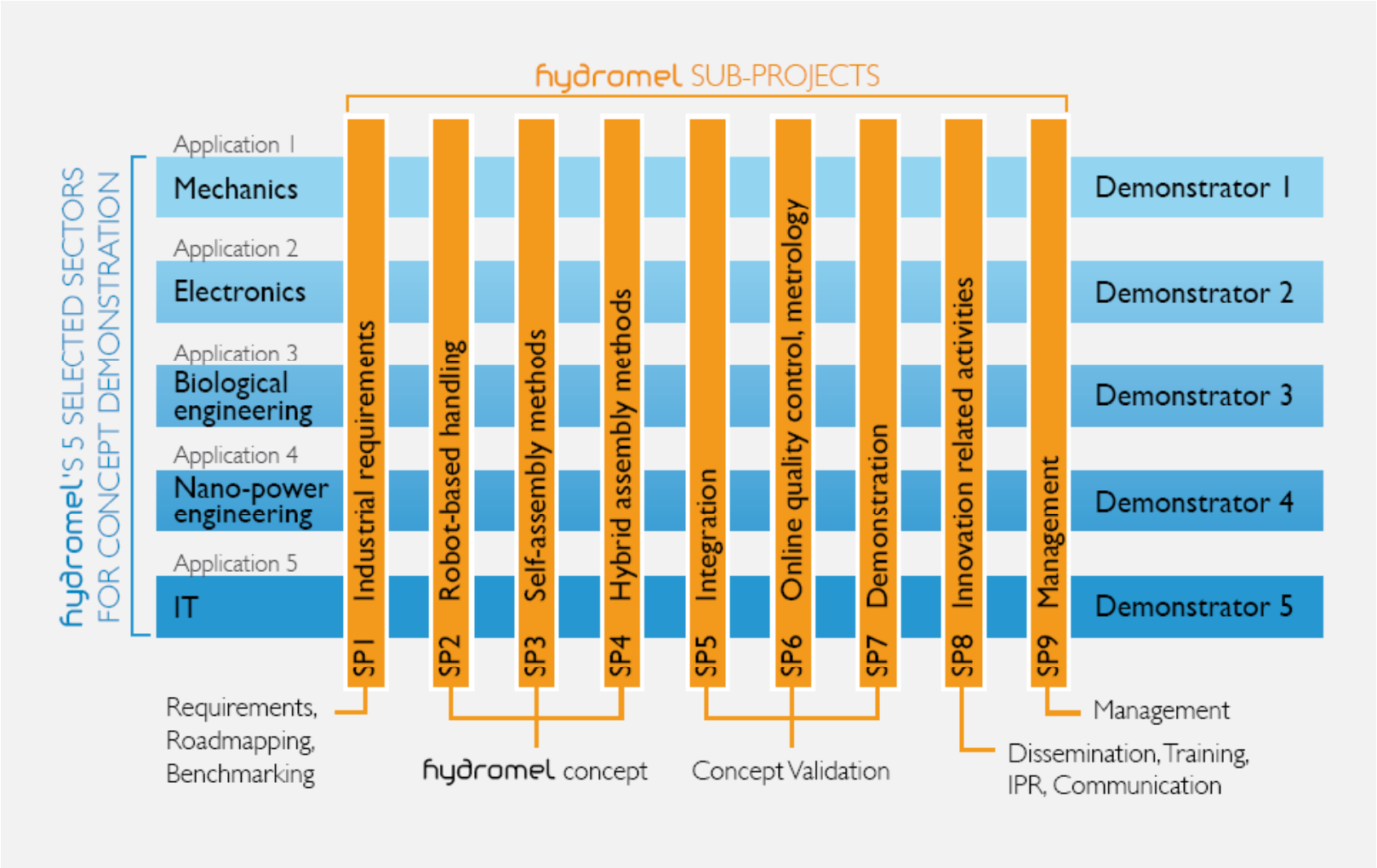
Scientific Content – Hybrid assembly

Hybrid assmbly (SP4, Tyndall)

- Self-assembly assisted robots
    - functionalization of grippers, feeding

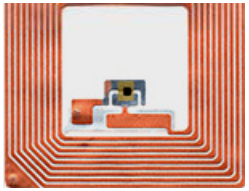
- Robot assisted self-assembly
    - robotic work on self-assembly attractors, quality and control of self-assembled objects

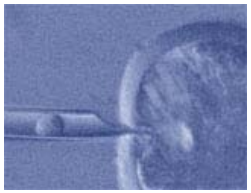
Project Organisation

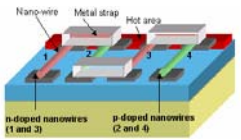


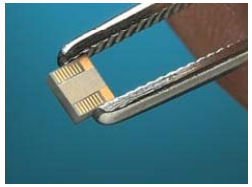
Demonstrators

1	2	3	4	5
Micro mechanics	Electronics	Bio-technology	Nano power engineering	IT









Demonstrator 1 - Micromechanics

1

Micro mechanics

Goal

- assembly of micromechanical device, part size << 1 mm

Robotic aspect

- pick & place of micro components

Self-assembly aspect

- assisted release and precise placement of component

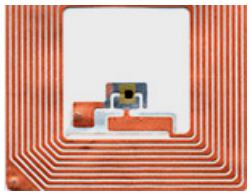
Quality aspect

- visual surface inspection

Demonstrator 2 - Electronics

2

Electronics



Goal

- high throughput assembly of hybrid e-device (die on substrate)

Robotic aspect

- pre-alignment of components

Self-assembly aspect

- parallel fine alignment by controlled adhesion

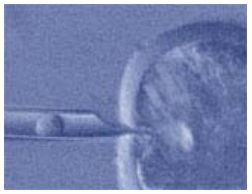
Quality aspect

- electrical characterization

Demonstrator 3 - Biotechnology

3

Bio-technology



Goal

- controlled and safe injection into cells

Robotic aspect

- positioning of tools

Self-assembly aspect

- automated fixation of cells

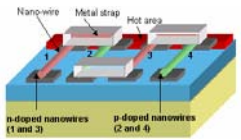
Quality aspect

- vision control of process

Demonstrator 4 – Nano engineering

4

Nano power engineering



Goal

- assembly of hybrid MEMS including nanowires

Robotic aspect

- serial positioning of nanowires

Self-assembly aspect

- automated growths / manipulation of nanowires

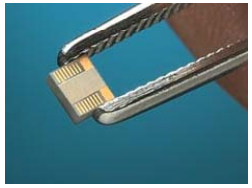
Quality aspect

- function of device

Demonstrator 5 – IT

5

IT



Goal

- inspection of MOEMS devices (laser diode arrays)

Robotic aspect

- coarse positioning of substrates

Self-assembly aspect

- auto-alignment of components

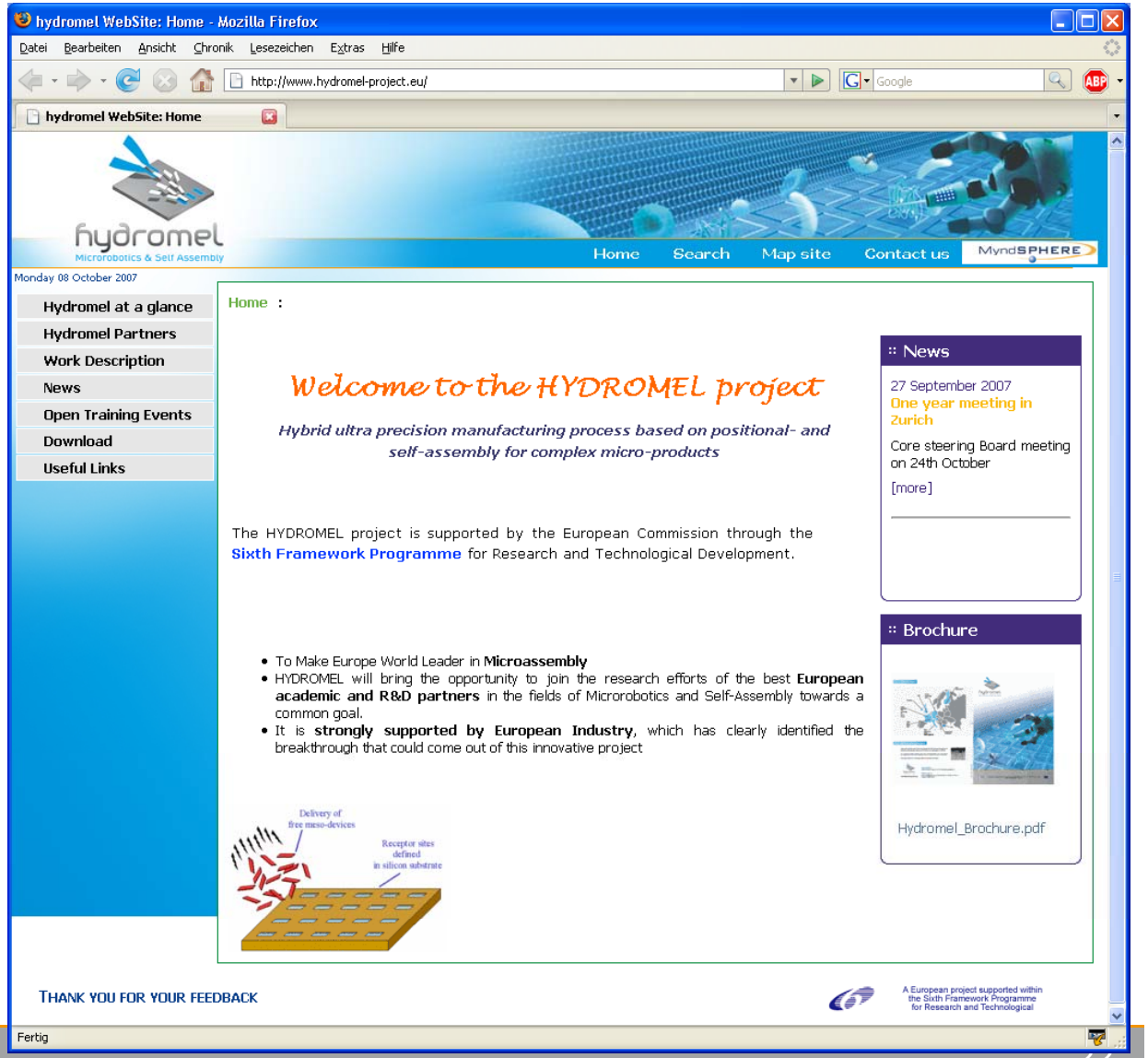
Quality aspect

- optical inspection of active surfaces

Dissemination and Training Activities

Check project portal for content and related activities

www.hydromel-project.eu



Current Status & Outlook

D1.1.1.1 System requirements/specifications		*done*
D1.2.1.1 Final Demonstrator Designs		*done*
D1.3.1.1 Benchmarking	*M12*	
D1.4.1.1 Roadmapping	*M12*	

M12 Project meeting and review will be held at the end of October in Zürich

Technical work in SP2 and SP3 is well underway

activities in SP4 (Hybrid methods) and SP5 (Integration) are starting around M12