WFS-5

BiCMOS Microfluidic Microwave Platform for Biological Cell Sensing and Manipulation

[1]B. Cetindogan, [1,2]M. Inac, [1]A. Goritz,
[1]M. Wietstruck, [1]C. Baristiran-Kaynak, [3]C. Palego,
[4]A. Pothier, [1,5]M. Kaynak

[1]IHP, [2]TU Berlin, [3]Bangor University, [4]XLIM, [5]Sabanci University

IHP

Cleanroom Area
- ~1.000 m^2 Class 1

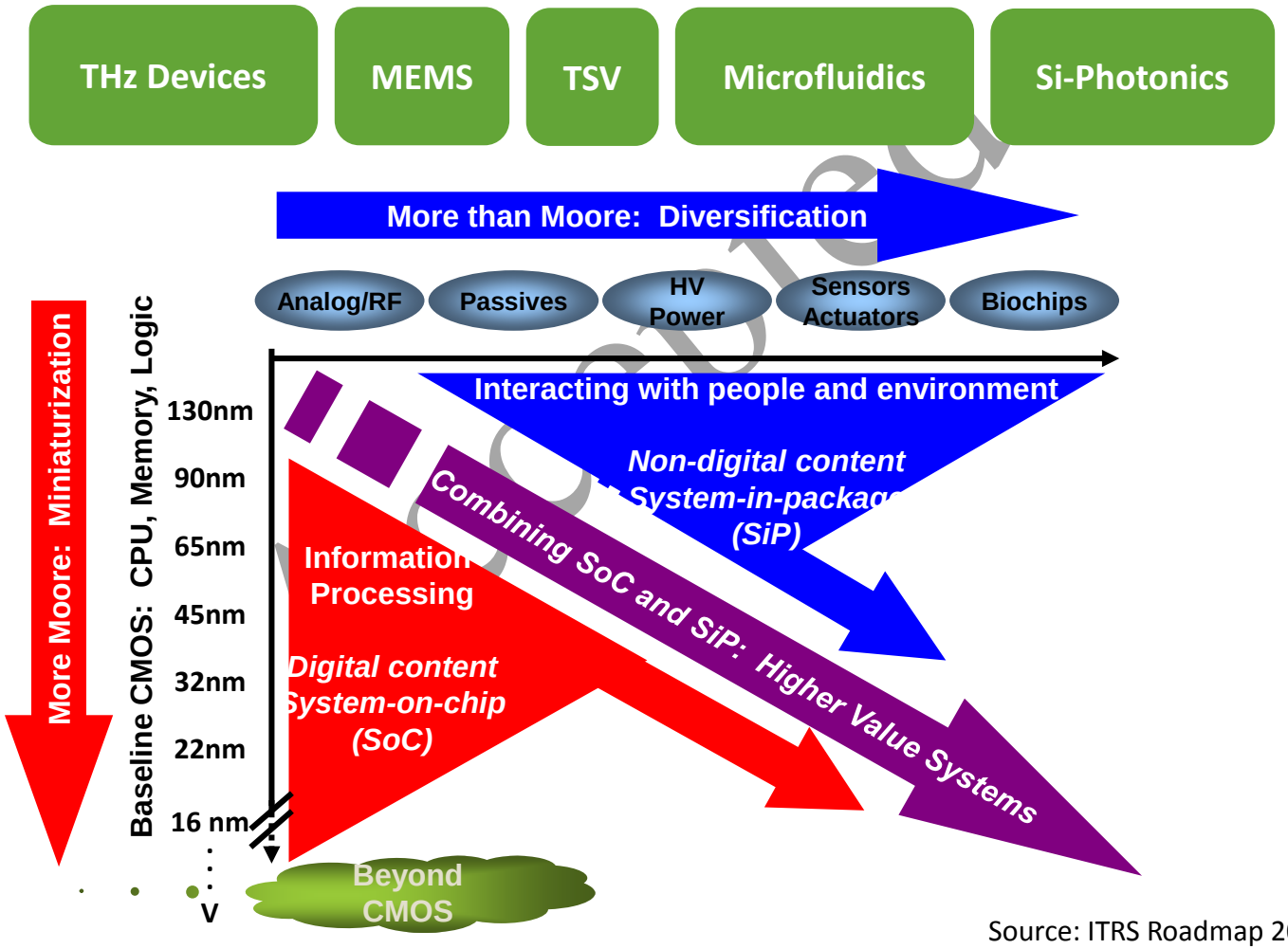
Technology
- SiGe BiCMOS

Wafer Diameter
- 200 mm

Technology Level
- 0.25-µm & 0.13-µm

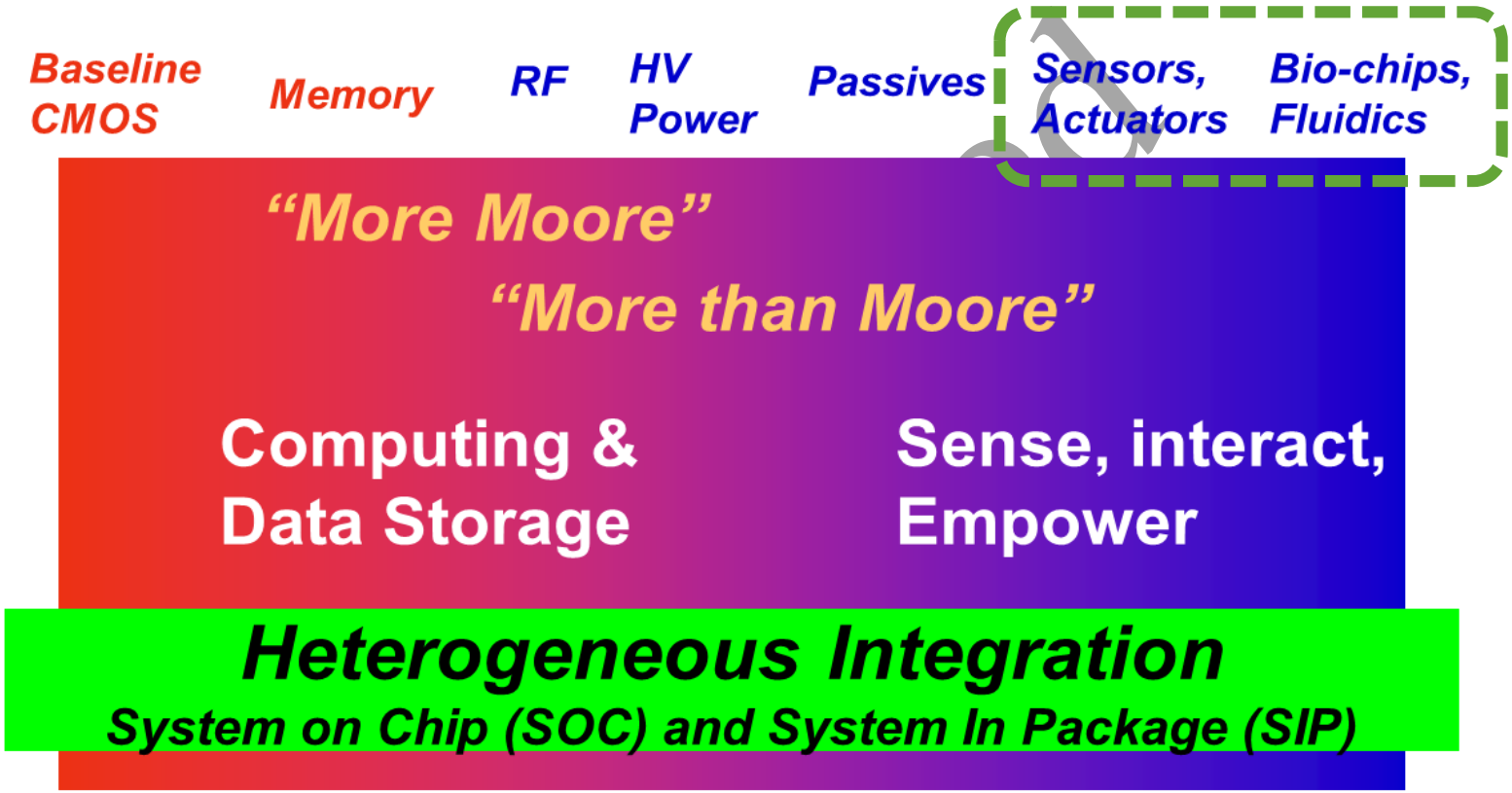
Operation Mode
- 24-h, 7 Days/Week

More than Moore Activities at IHP



Source: ITRS Roadmap 2010

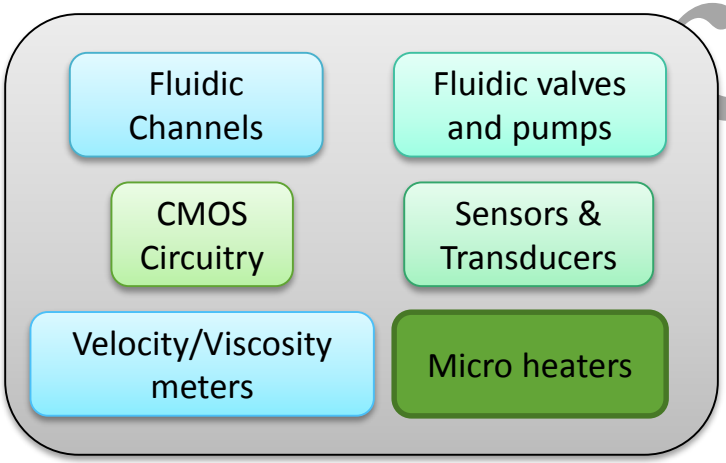
Moore's Law and More



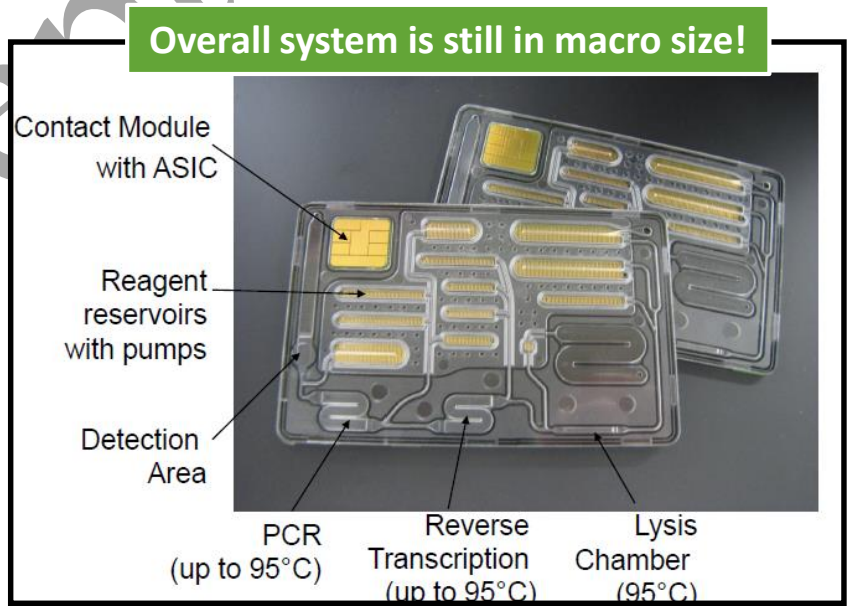
Source: ITRS, European Nanoelectronics Initiative Advisory Council (ENIAC)

Why microfluidics is of great interest?

- Low consumption of reagents and sample-cost reduction
- Miniaturization and integration of device-portable systems
- High sensitivity
- Faster analysis



Microfluidic system components



*** Courtesy of Fraunhofer ENAS**

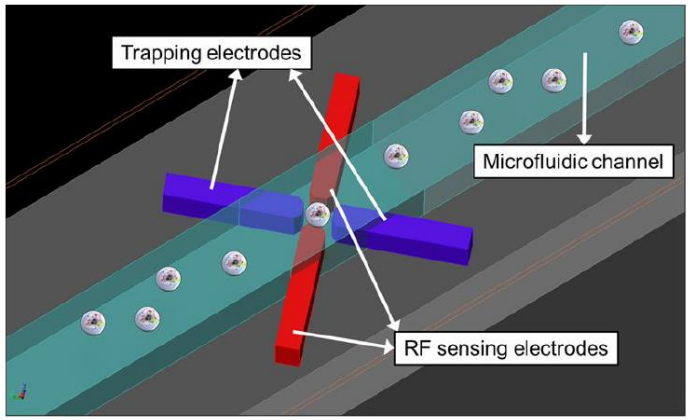
Advantages of BiCMOS Based Microfluidics

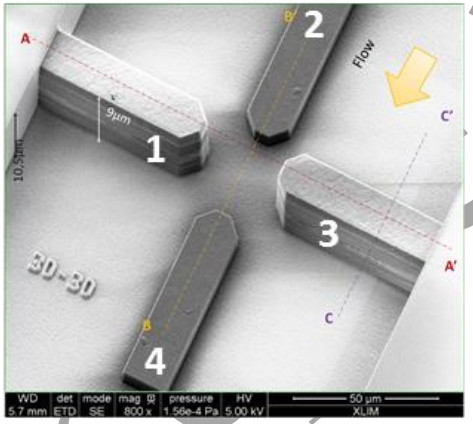
- High level of integration→Miniturized System
- Wafer-level fabrication→High throughput
- Combination with high frequency electronics
  - No additional assembling
  - THz sensing
  - Higher sensitivity
- Chemical, thermal and mechanical stability

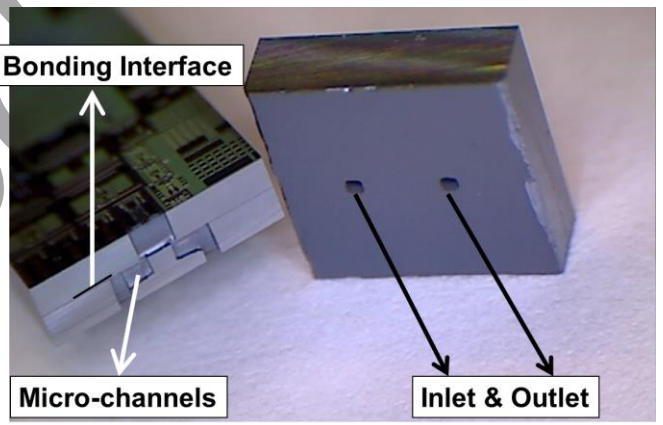
Main Goal of "Technology" on Microfluidics:

- Combination of the BiCMOS tech. with the microfluidic tech.
- Minimize the distance between the fluid and the BiCMOS sensors for higher sensitivity

Microfluidic Technology in BiCMOS

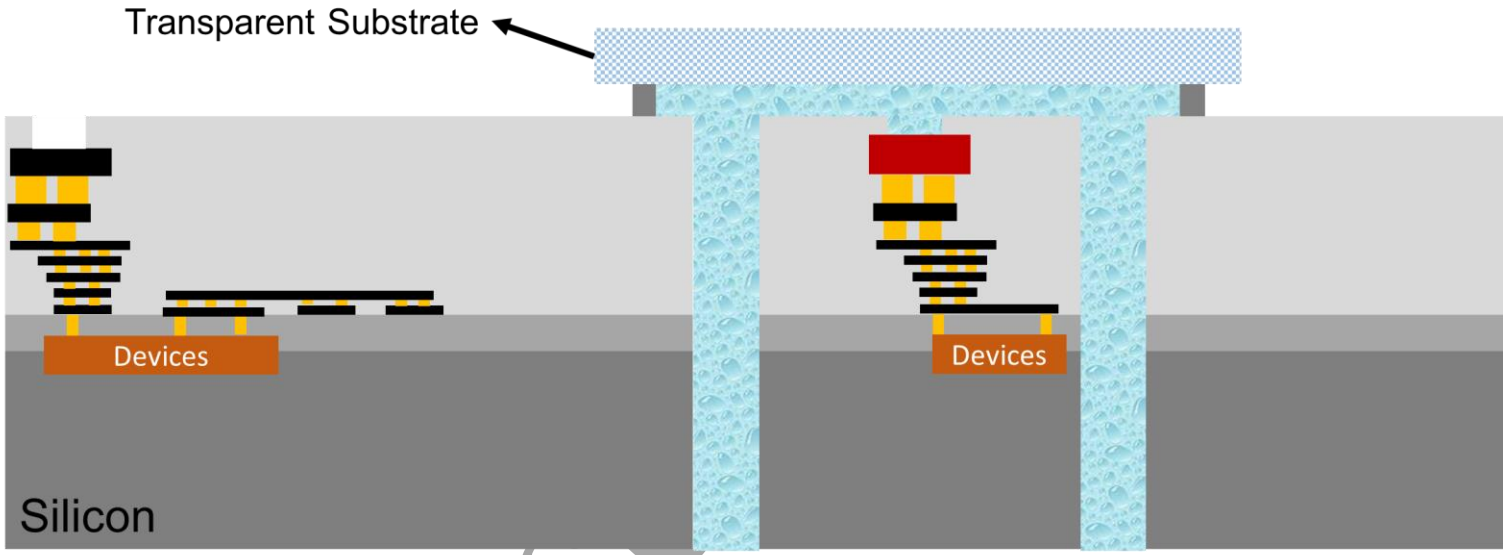






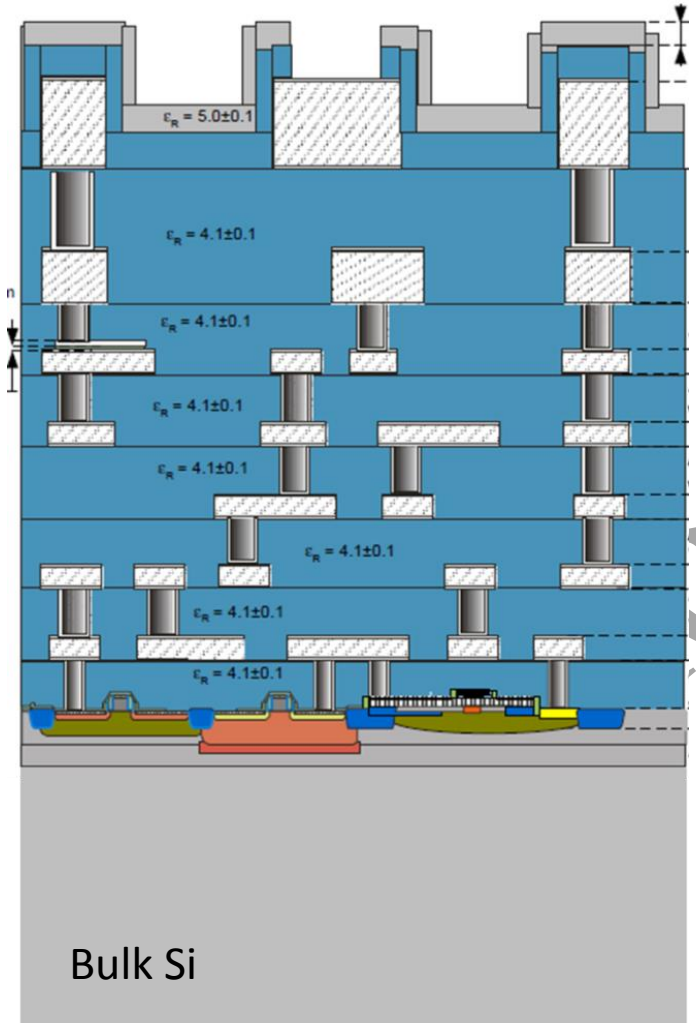
- Integration of microfluidic channels into BiCMOS technology to enable BiCMOS technology for future microfluidic applications
- High integration level for ultra-miniaturized BiCMOS microfluidic technology

Microfluidic Technology in BiCMOS



- Integration of microfluidic channels based on wafer-level adhesive & SiO_2-SiO_2 bonding
- Advantages:
  - Transparent glass substrate for optical inspection
  - Minimum distance between sensor and liquid, adjustable channel dimensions
  - Separation of electrical and microfluidic interfaces

Microfluidic Technology Development



BEOL, Metallization Layers
- Transmission lines,
- Inductors,
- MIM capacitors,
- Vias, etc.
- Sensors

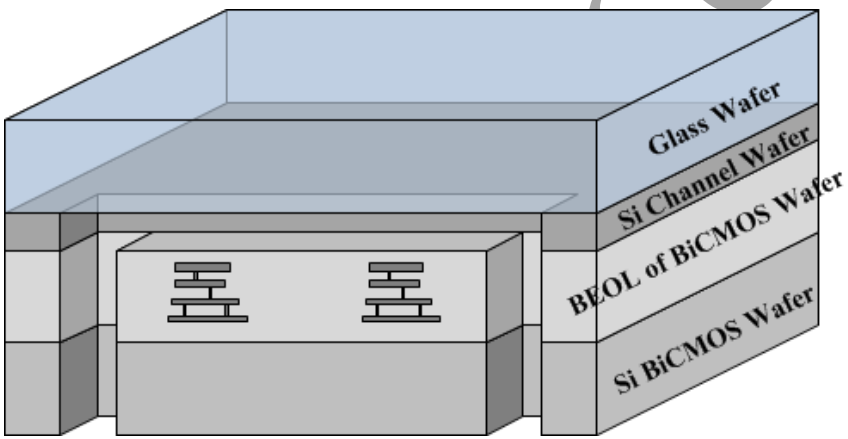
FEOL
- Transistors,
- Poly-resistor
- Diodes, etc.

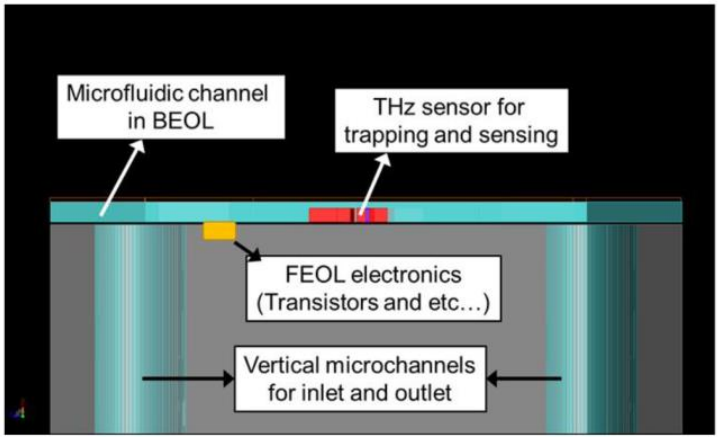
~15 µm

~750 µm

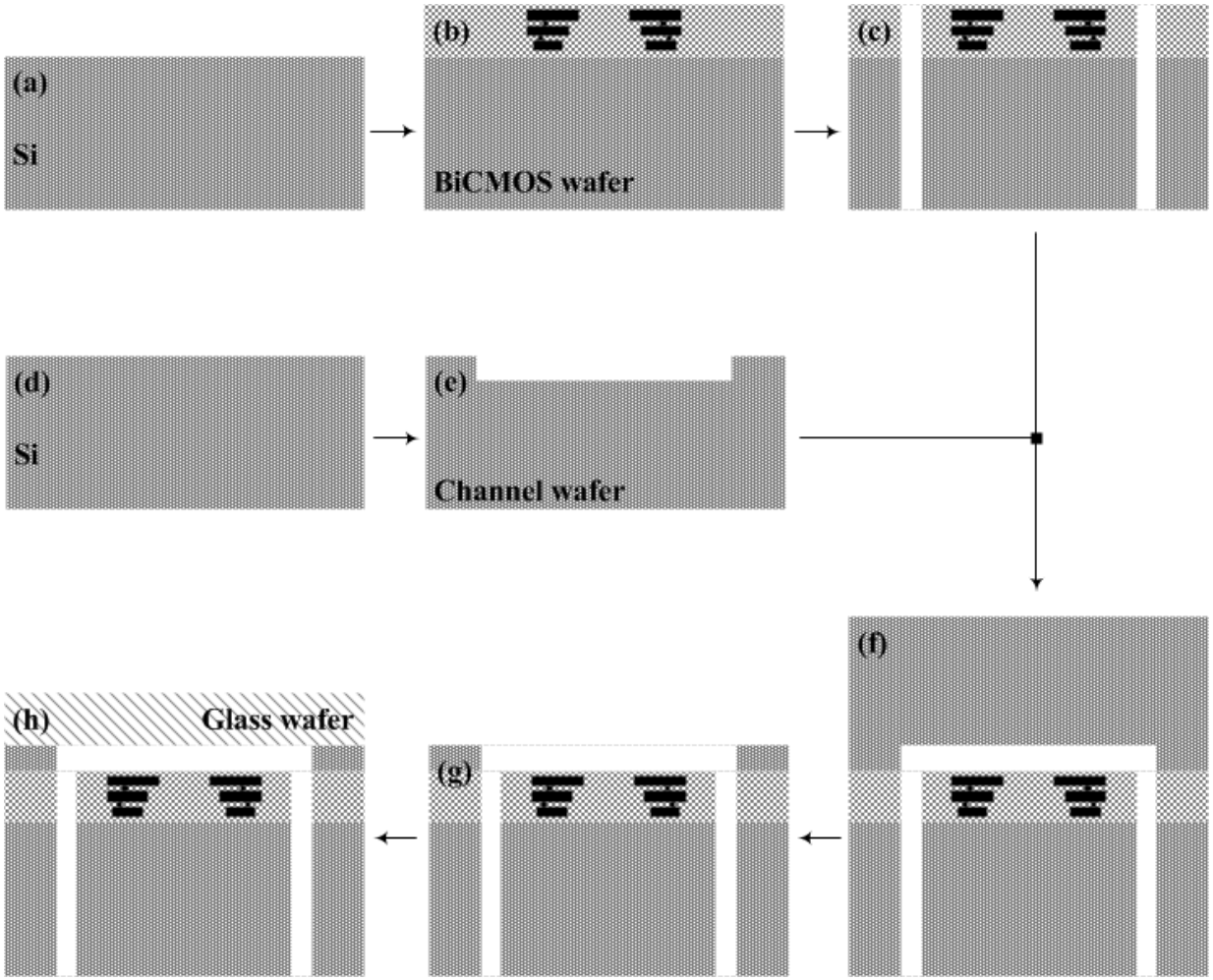
Microfluidic Technology Development

- Achieving goal with 3-wafer stack
  - Device wafer with circuitry and sensors
  - Channel wafer
  - Glass wafer



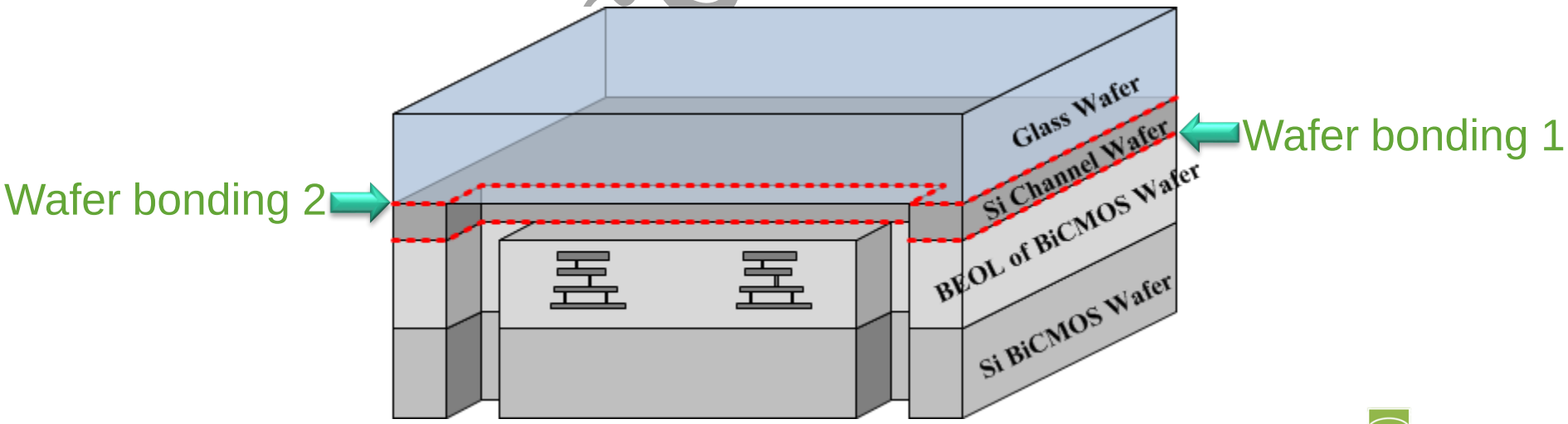


Microfluidic Technology Development



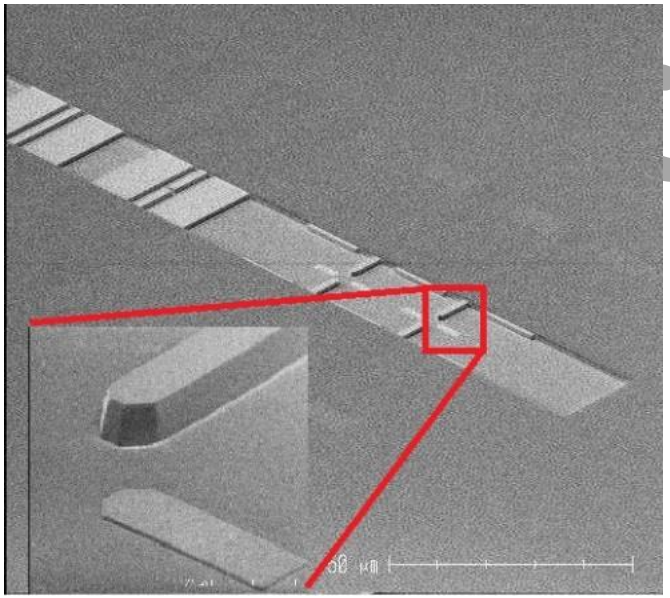
Microfluidic Technology Development

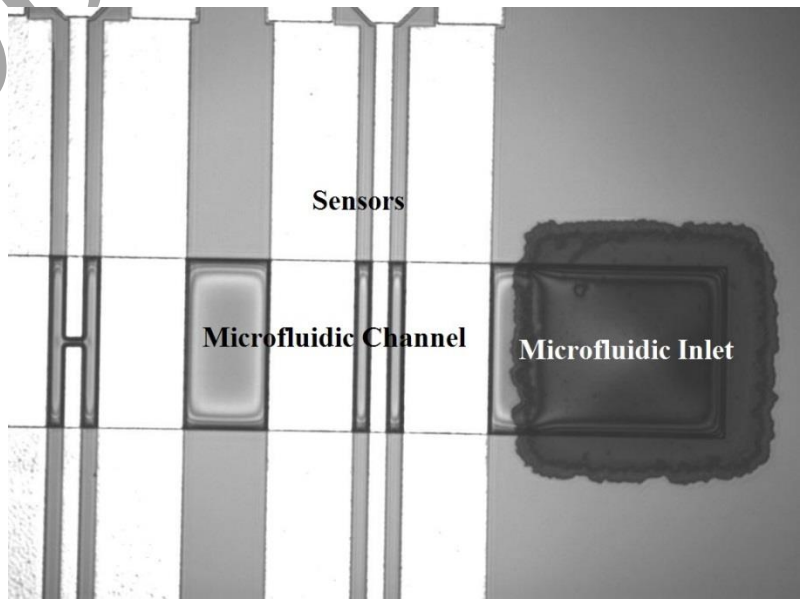
- Wafer Bonding 1
  - Plasma assisted oxide-oxide fusion bonding
  - Between device wafer and channel wafer
- Wafer Bonding 2
  - Adhesive bonding
  - Between glass wafer and device+channel wafer stack



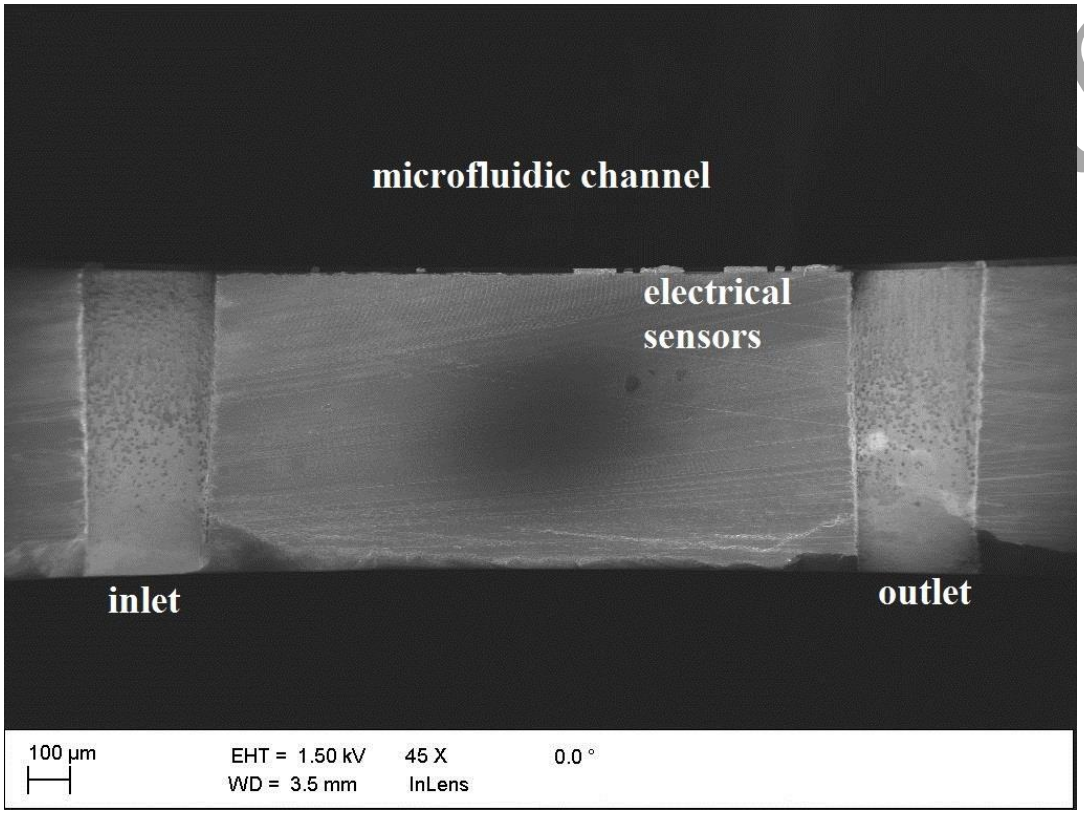
Microfluidic Technology Development

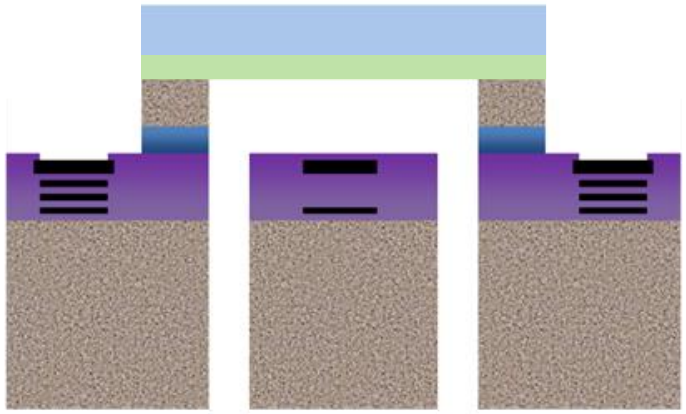
- Electrical sensors are in the microfluidic channels
- Decreasing the distance between the sensor and the fluidic interface



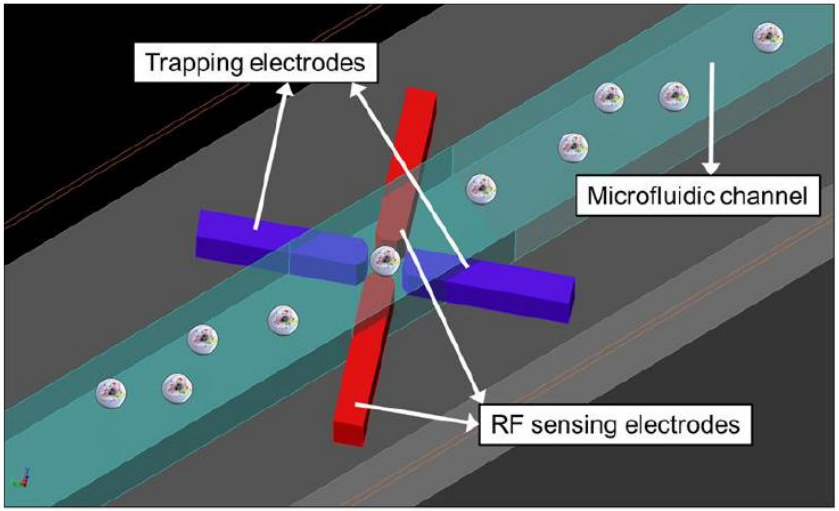


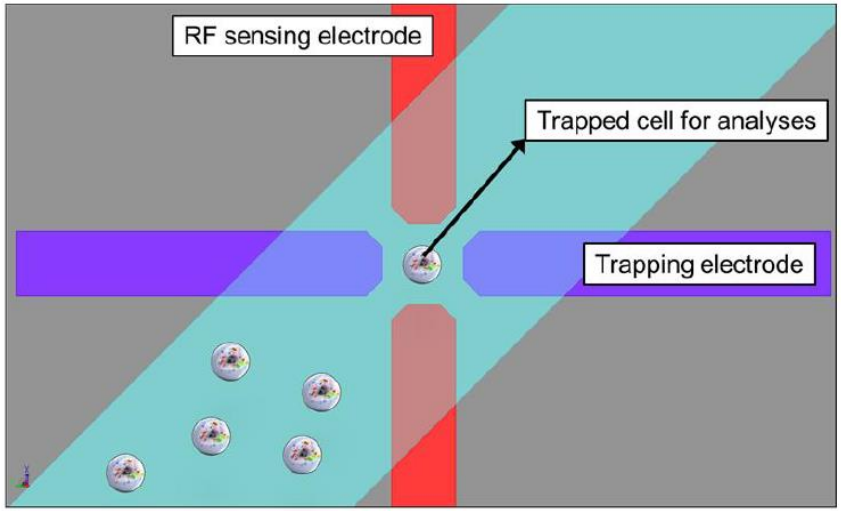
Microfluidic Technology Development

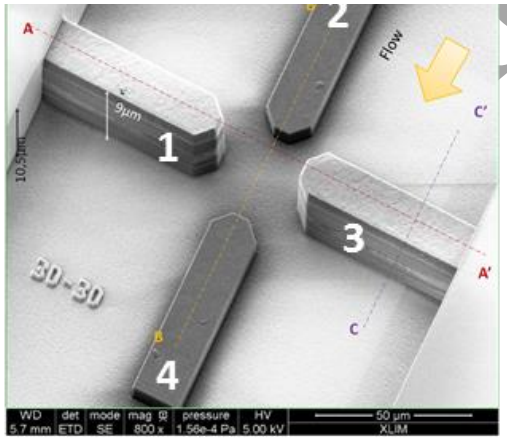


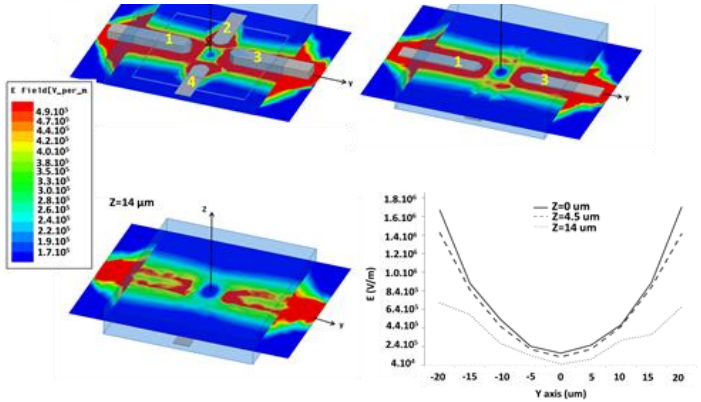


Potential Microfluidic Components in BiCMOS









Summary

- Microfluidic integration based on wafer-bonding
- µm-range distance between the sensors and biological samples
- Seperation of electrical and fluidic interface
- Wafer-level integration for low cost

- Combination of high-performance BiCMOS technology with microfluidics
- Low freq. and mm-wave bio-sensing development for ultra miniaturized microfluidic technology


Our project SUMCASTEC
was made possible
thanks to #H2020 funding
€30 billion is still
available in the 2018-20
Work Programme!
#InvestEUresearch
European
Commission
www.sumcastec.eu

Thanks for your attention! & Questions?