

# Making medical the next automotive

Diversifizierung in der Mikroelektronik erfolgreich gestalten

„elmug4future“ – Sensorsysteme der Zukunft – vom Messwert zur Information

X-FAB Semiconductor Foundries GmbH

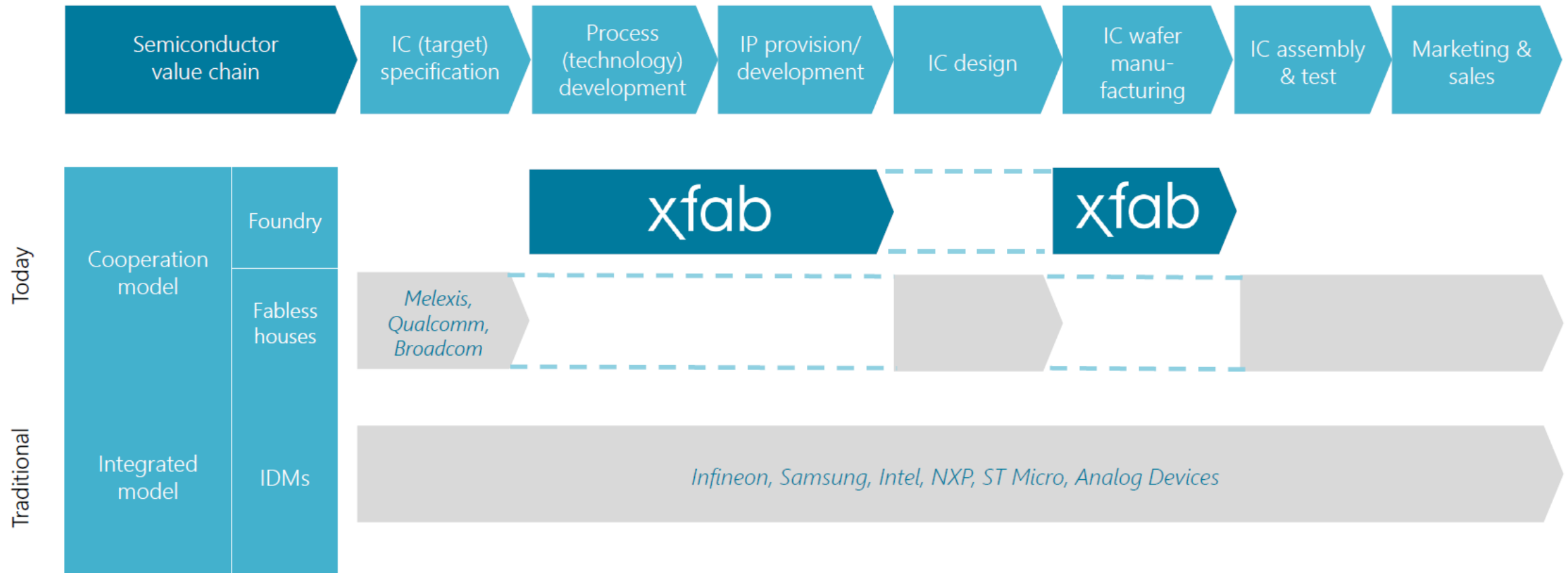
Dr. Gabriel Kittler

2023-10-17

# Foundries and their role in the value chain

> Focus on complex technology, design support and manufacturing solutions

> X-FAB does not have own products, as it does not want to compete with its customers



# Analog vs. digital – a clear differentiation

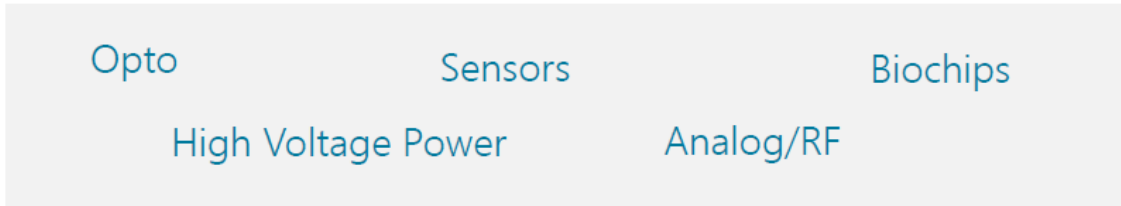
## Analog/mixed-signal

- › Low capacity and technology capex
- › Long product lifecycle
- › High tech differentiation
- › Large portfolio of process technologies
- › Mid-size technology nodes

*More than Moore*

### Our Business Model: Specialty mixed-signal technologies

Technological diversification to interface with the real world



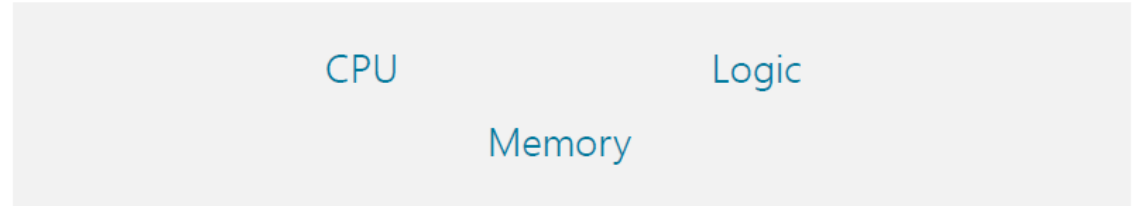
*Larger technology nodes with much longer lifetime suitable for mixed signal*

## Digital

- › High capacity and technology capex
- › Short product lifecycle
- › Latest technology node differentiation
- › Limited portfolio of process technologies
- › Small-size technology nodes

*More Moore*

*Continuous miniaturization makes ever smaller feature sizes and higher computation power necessary.*



*Fabs/machines need to be replaced for ever newer ones*



# Our comprehensive technology offering



## Large portfolio of process technologies & IP

Technology node	Digital	Analog M/S	High Voltage	NVM	RF	Opto	SOI	High Temp	MEMS
6-inch	1.0 μm	✓	✓	✓	✓	✓	✓	✓	✓
	0.8 μm	✓	✓	✓	✓	✓	✓	✓	✓
	0.6 μm	✓	✓	✓	✓	✓	✓	✓	✓
8-inch	350 nm	✓	✓	✓	✓	✓	✓	✓	✓
	180 nm	✓	✓	✓	✓	✓	✓	✓	✓
	130 nm	✓	✓	✓	✓	✓	✓	✓	✓
	110 nm*	✓	✓	✓	✓	✓	✓	✓	✓

\* newly released in 2023

M/S = mixed-signal, NVM = non volatile memory, RF = radio frequency, SOI = silicon on insulator, MEMS = microelectromechanical systems, SiC = silicon carbide

## Strong expertise in MEMS technology

- › Over 20 years track-record in MEMS offering
- › Strong focus on developing differentiated scalable technologies for the medical market in collaboration with strategic customers, mostly OEMs

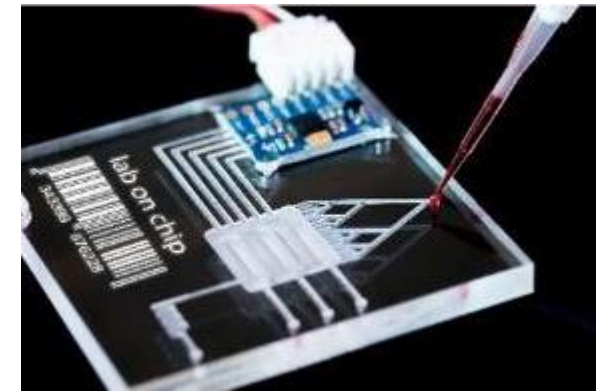
## Pioneer in 150mm SiC technology

- › X-FAB joined the "Power America" consortium with the US Department of Energy
- › World's first 150mm SiC foundry offering in 2014
- › Standard SiC process blocks developed by X-FAB enable customers a faster time-to-market

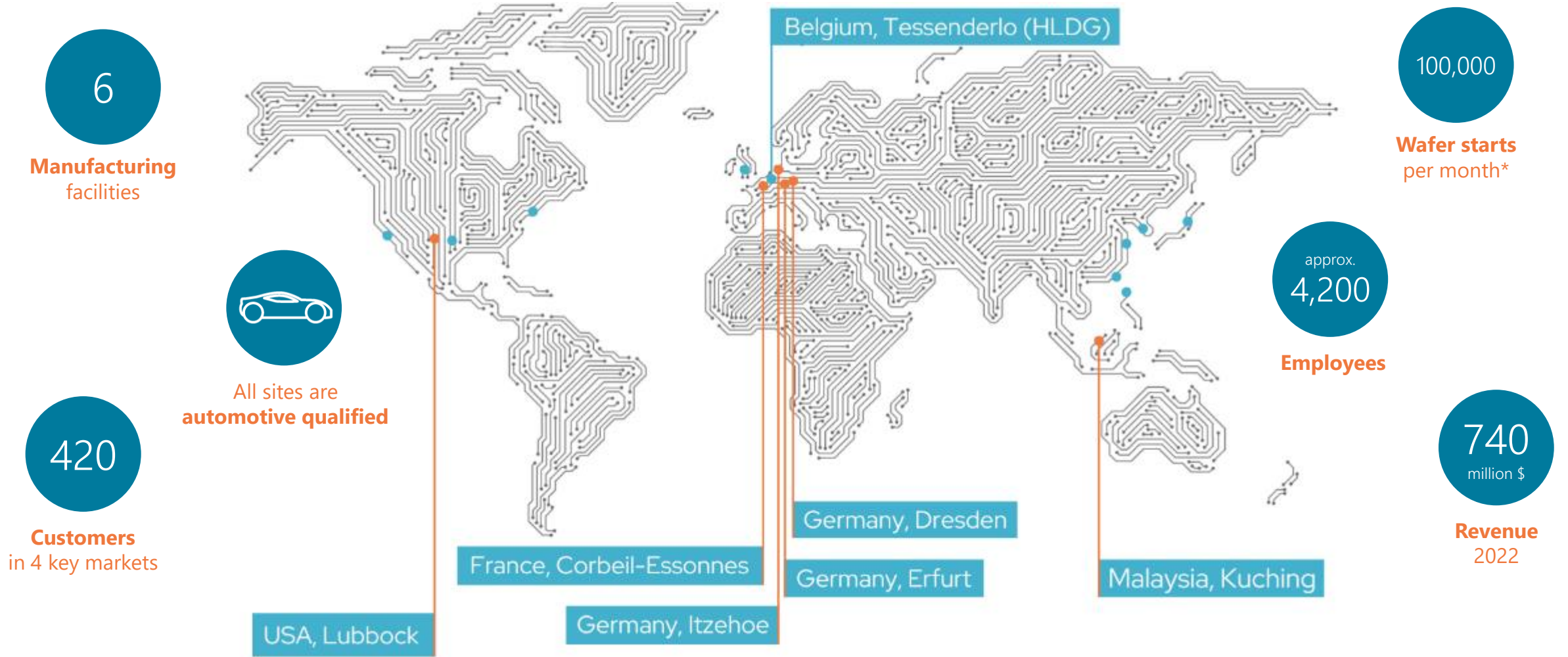
# Who we are



- > We are a specialty foundry offering a unique combination of analog/mixed-signal, high-voltage and embedded non-volatile memory options with sensor and actuator integration.
- > We support long product lifecycles of 20+ years and focus on automotive, industrial and medical end markets.
- > We provide best-in-class design and prototyping support to enable first-time-right design.
- > All of our sites are automotive certified.

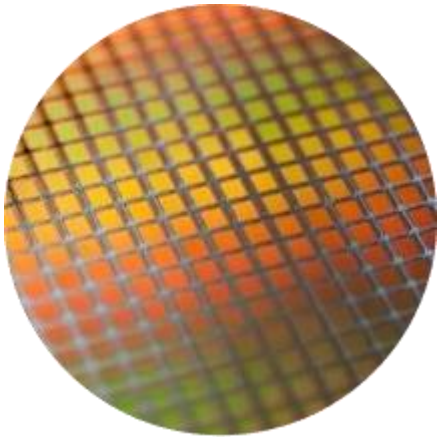


# X-FAB at a glance



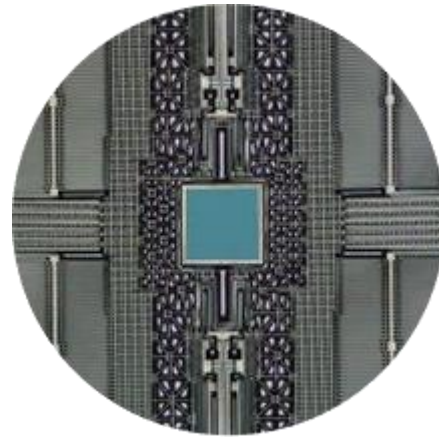
● Fabs/subsidiaries ● Sales offices

\* 200mm equivalent



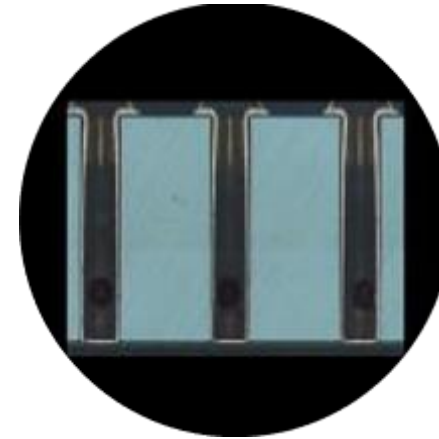
## CMOS & SOI

13 process families with over 450 options



## MEMS

MEMS with or without integrated CMOS



## Heterogeneous integration

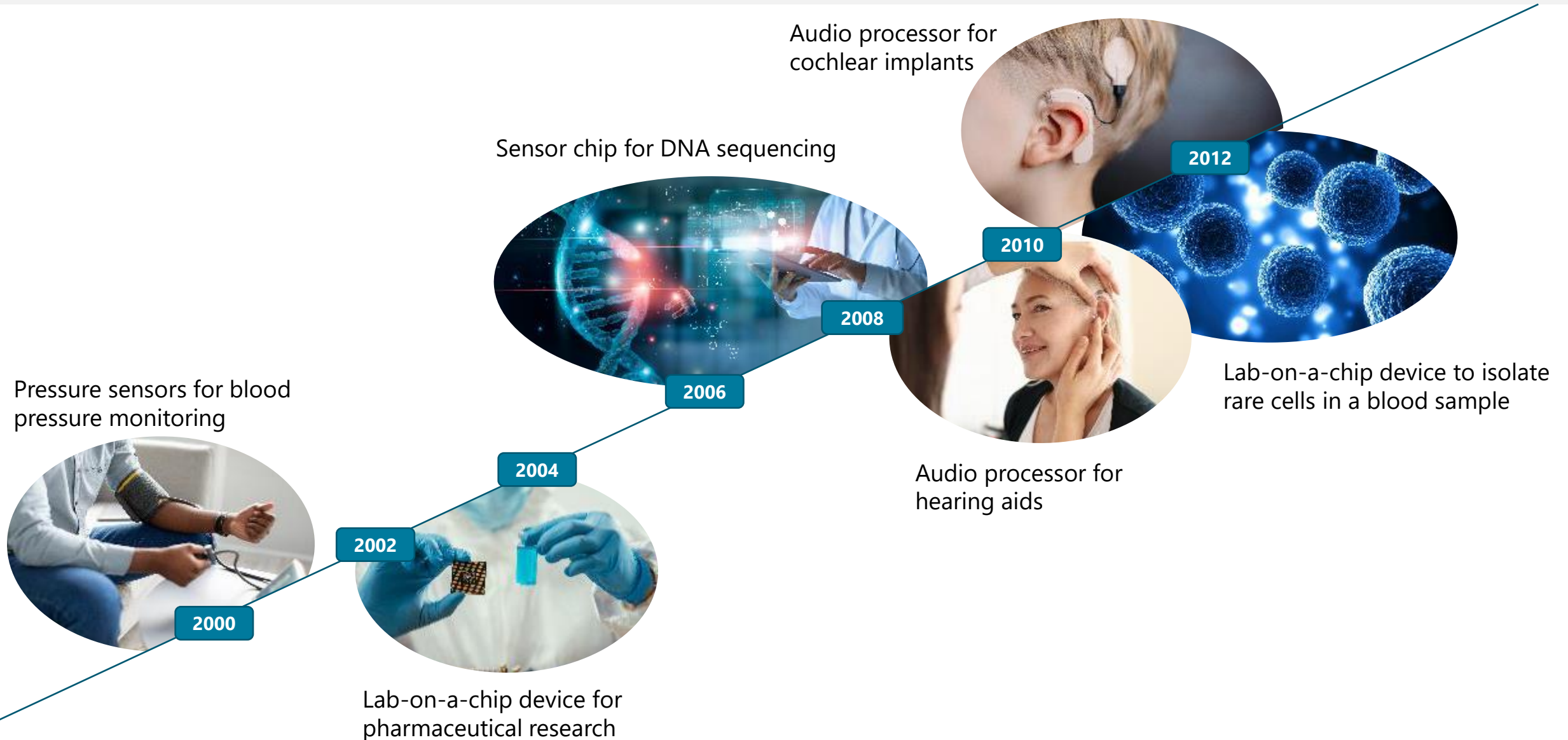
3D integration and wafer level package solutions



## SiC & GaN

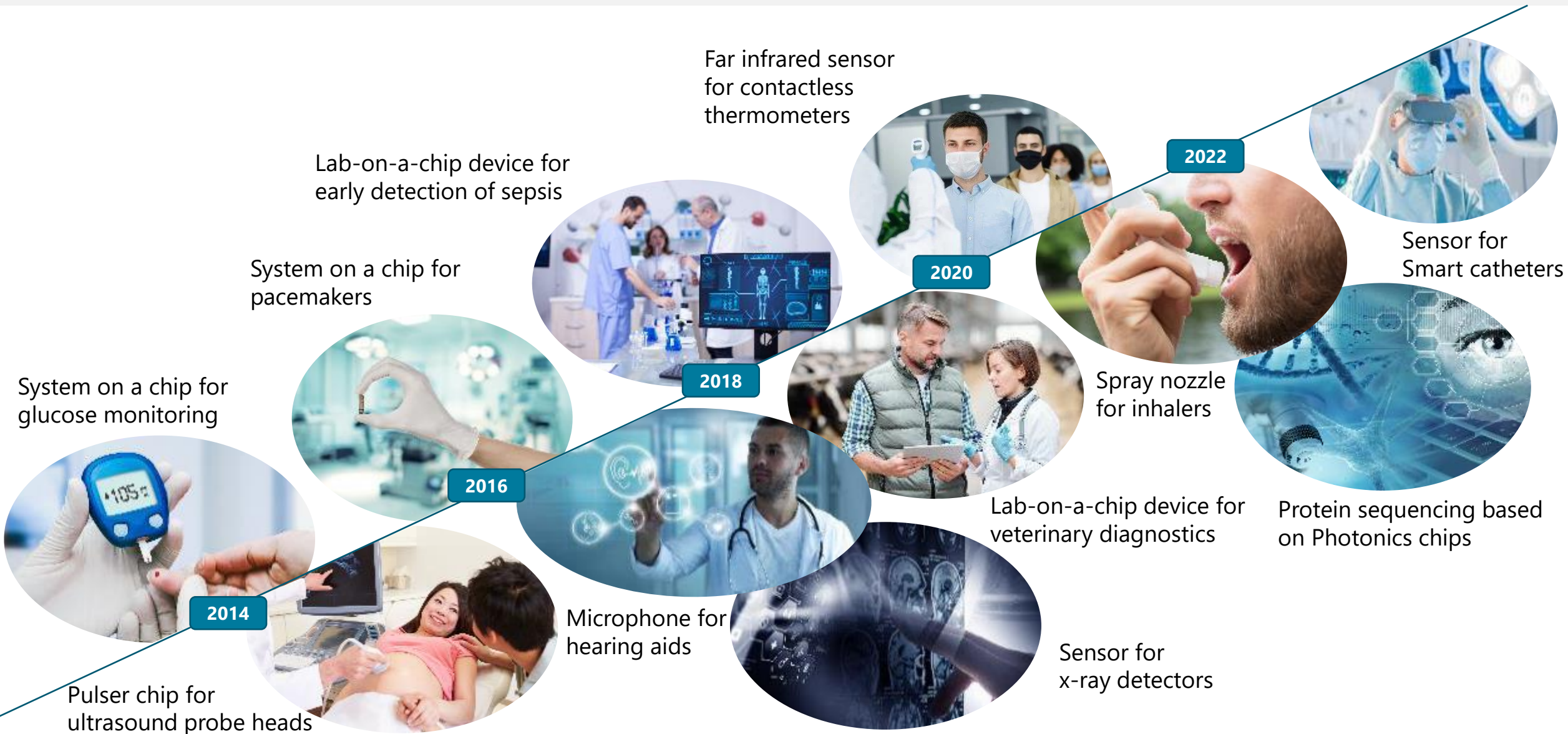
First 6-inch SiC foundry offering worldwide

# We started more than 20 years ago...





# ... and now we are making medical the next automotive





## Our value proposition

- › Supplying medical companies for more than 20 years
- › Close collaboration with our customers
- › Providing open platform technologies
- › Jointly develop customer-specific processes

## Leading technology offering

- › Feature rich analog processes
- › CMOS Sensor and MEMS technologies
- › Most comprehensive design support in foundry market
- › Large silicon proven IP portfolio

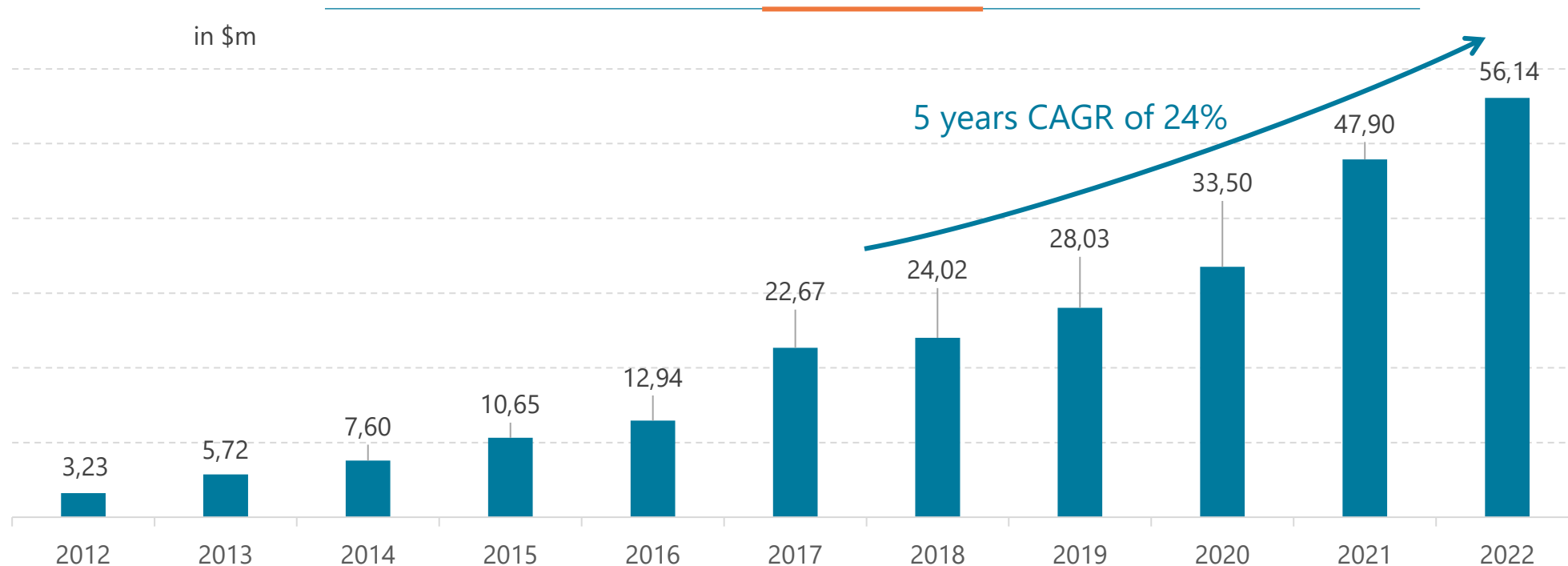
## Supply excellence

- › Support of long lifetime products
- › In-house 2nd source
- › Wafer traceability and 15 years record keeping
- › Compliant to ISO 13485

# Our commitment is demonstrated by strong revenue growth

- > Revenue with medical applications has increased **more than 17x** since 2012
- > We continue to expect two-digit growth rates for the next 5 years

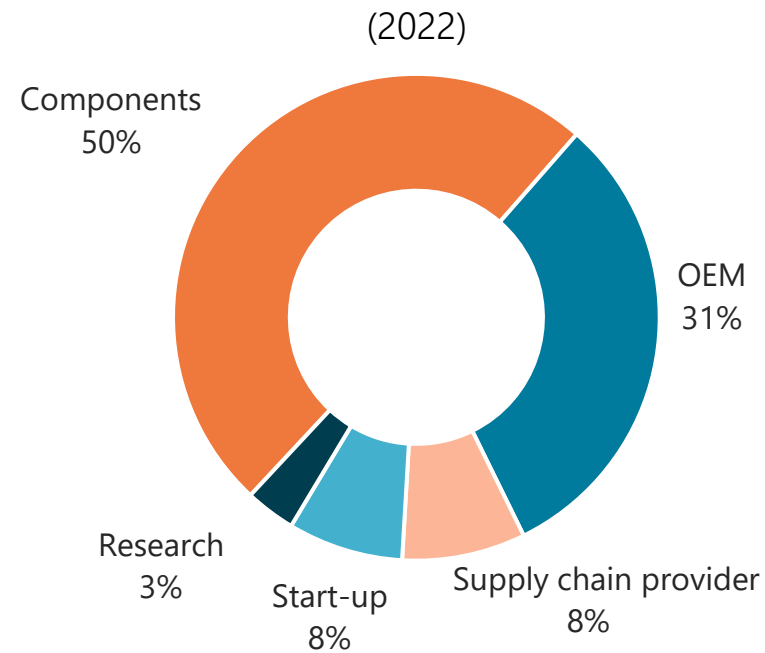
## Revenue development in the medical segment



# Success is built on a solid customer base

- > Strong customer portfolio from established OEMs to start-ups and research
- > Close cooperation with key customers ensures long-lasting customer loyalty and continuous development of our roadmaps and service offering

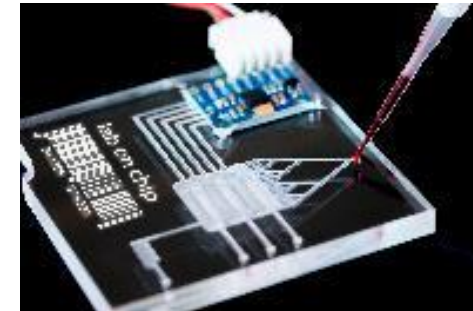
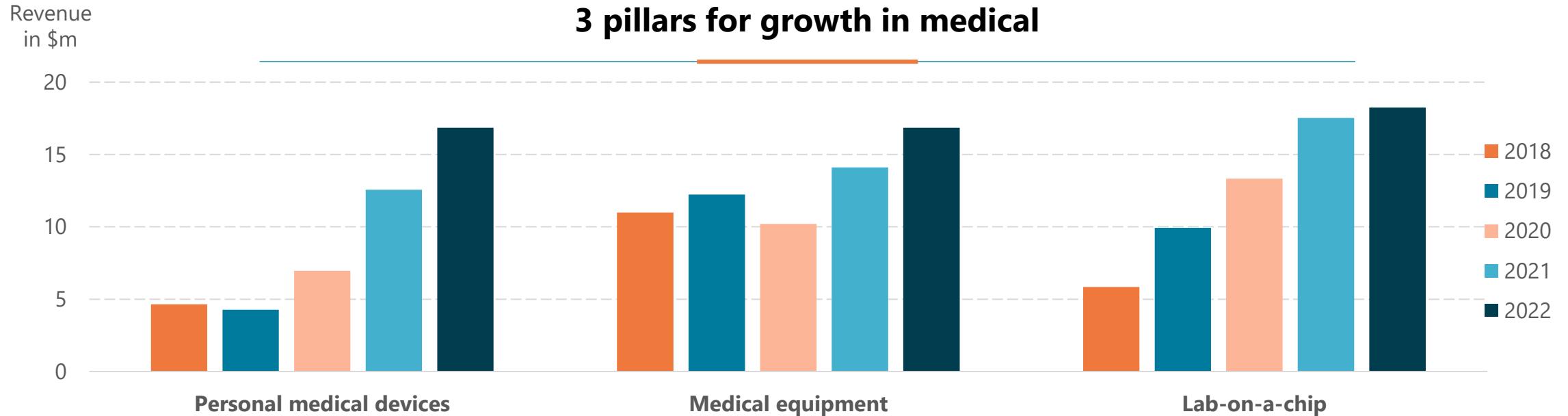
## Revenue by customer group

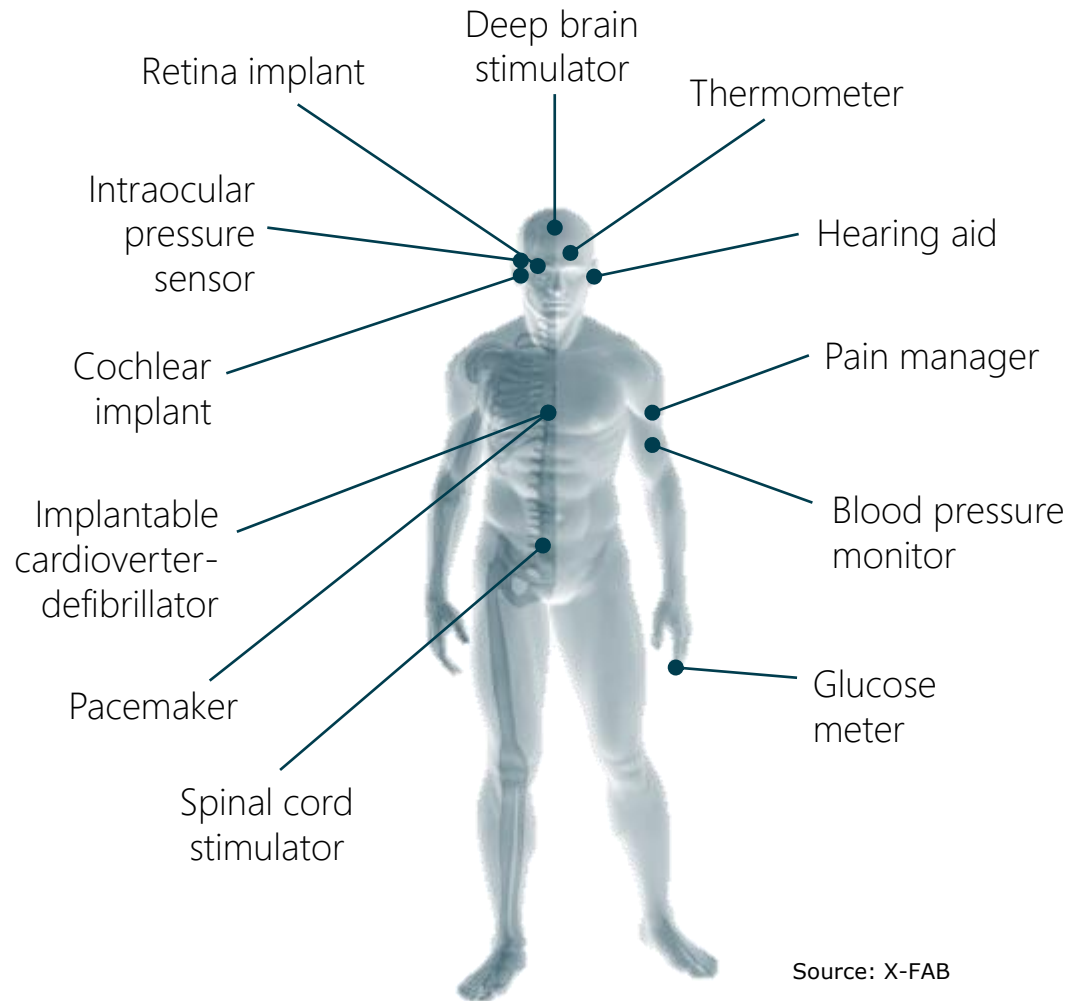


# X-FAB serves a diverse portfolio across different segments

> Offerings for many application areas lead to steady growth

## 3 pillars for growth in medical





## Market drivers

- > Research in new therapies for neurological diseases
- > Minimally invasive medical devices are expected to witness the highest growth rate
- > Aging population and increase in chronic diseases
- > The market is expected to grow by a CAGR of 15.4% from 2020 to 2026<sup>1</sup>

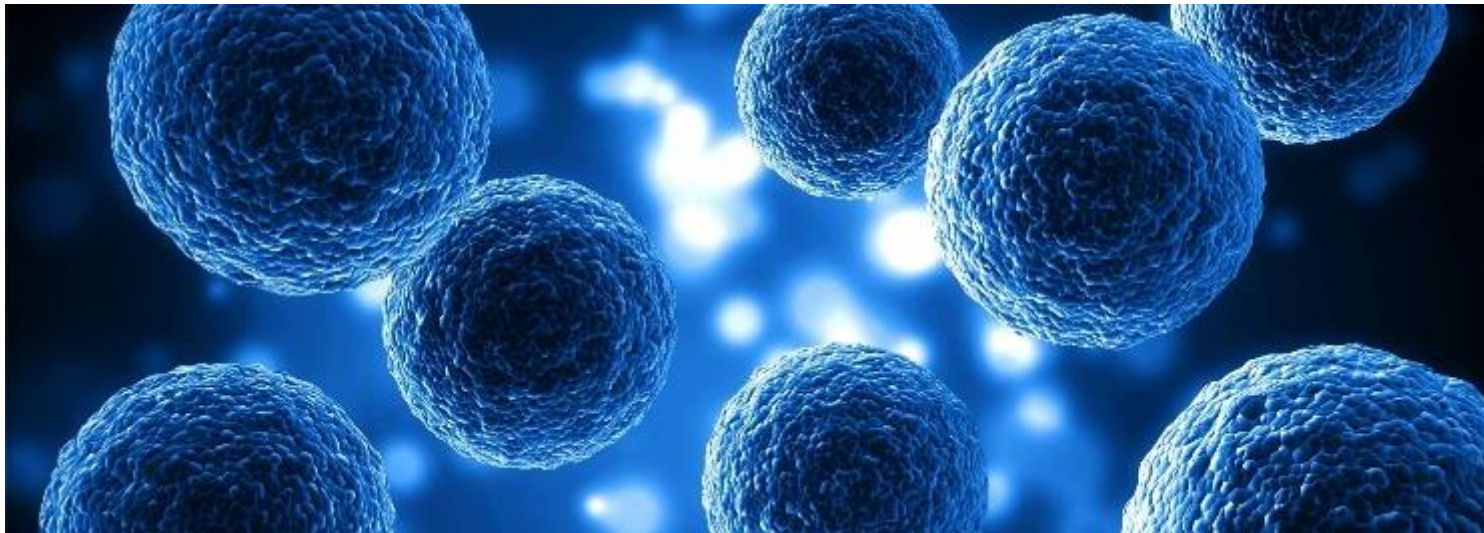
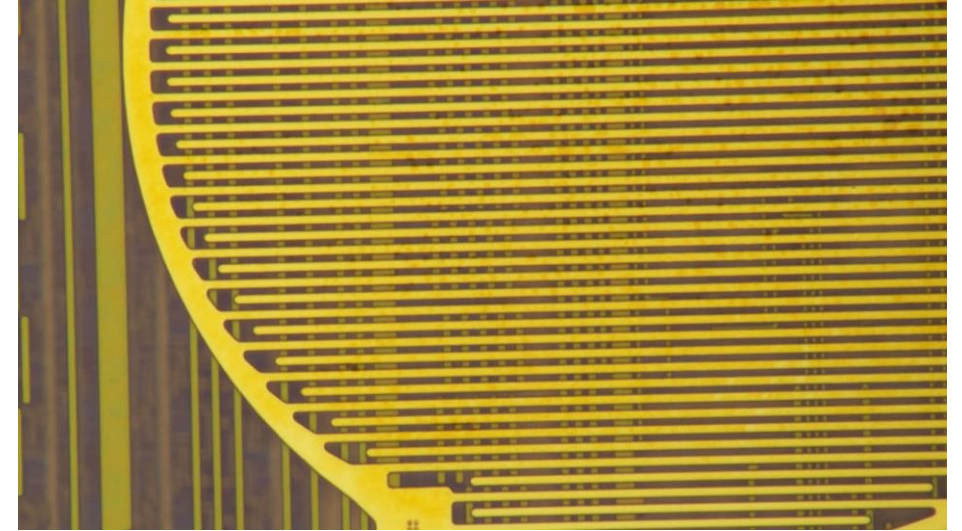
## X-FAB invests in its offer for therapeutic & monitoring devices

- > Focus on low power IP for battery operated devices
- > Development of sensors to monitor physiological parameters

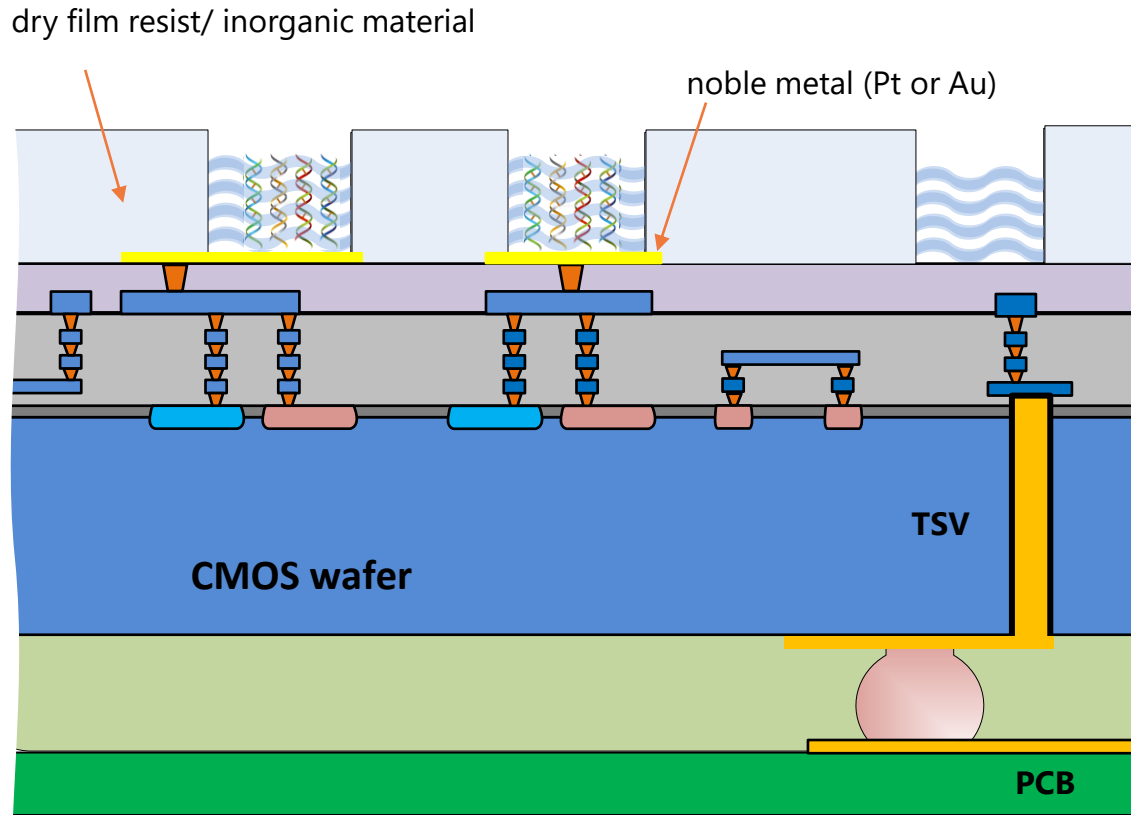
<sup>1</sup> Source: [www.gminsights.com/industry-analysis/neurostimulation-devices-market-report](http://www.gminsights.com/industry-analysis/neurostimulation-devices-market-report)

# Applications of biosensors

- > Point-of-care (POC) testing for viral and microbiological diagnostic
- > Analysis of single molecules, including DNA, RNA and proteins
- > Micro Electrode Arrays for electrical cells monitoring



# Application-specific device setup



- > Mixed-signal 350 nm and 180 nm analog/mixed-signal CMOS/SOI technology
- > Tailored passivation interface and noble-metal electrodes
  - Integrated tungsten through passivation vias
  - Deposited and patterned of noble metals (Pt or Au)
- > Post processing to create microfluidic structures on top
- > Must be compatible with
  - Product finalization (Dicing, bonding, Through Silicon Vias, plastic molding)
  - Biofunctionalization, cells attachment
  - Fluidic environment during usage (for cells cultures, for DNA detection, immunoassays)





## Market drivers

- > Growing prevalence of cardiovascular, respiratory and gastrointestinal disorders
- > Medical imaging improves visualization
- > Ultrasound develops towards Point of Care testing
- > CMOS x-ray sensors allow lower radiation dose
- > Market expected to grow by a CAGR of 5.8% from 2020 to 2026<sup>1</sup>

## X-FAB invests in its offer for **medical imaging**

- > Next generation high voltage analog process for ultrasound scanners
- > Innovative optical sensors for diagnostics and analytics

<sup>1</sup> Source: <https://www.gminsights.com/industry-analysis/medical-imaging-market>



## BCD-on-SOI process for ultrasonic Transceiver and Transducers

- > High Voltage switching 0 to 200 V or  $\pm 100$  V
- > Excellent noise and high-voltage isolation
- > High-density logic with up to six metal layers
- > Non-volatile memory modules including embedded Flash



## CMOS Image Sensor technologies for computed tomography and X-ray scanners

- > Support of large pixel sizes with high-speed reading capability
- > 4 transistors pixel cells with pinned photo diode
- > Planar passivation to support post processing of filters and micro lenses
- > Stitching option for large dies exceeding the reticle limits



## Market drivers

- > Increasing adoption of personalized medicine and research in drug discovery and life sciences
- > Growing need for rapid diagnostics of various infections and chronic diseases
- > Continuous pressure on healthcare budgets
- > Market expected to grow by a CAGR of 10.5% from 2019 to 2027<sup>1</sup>

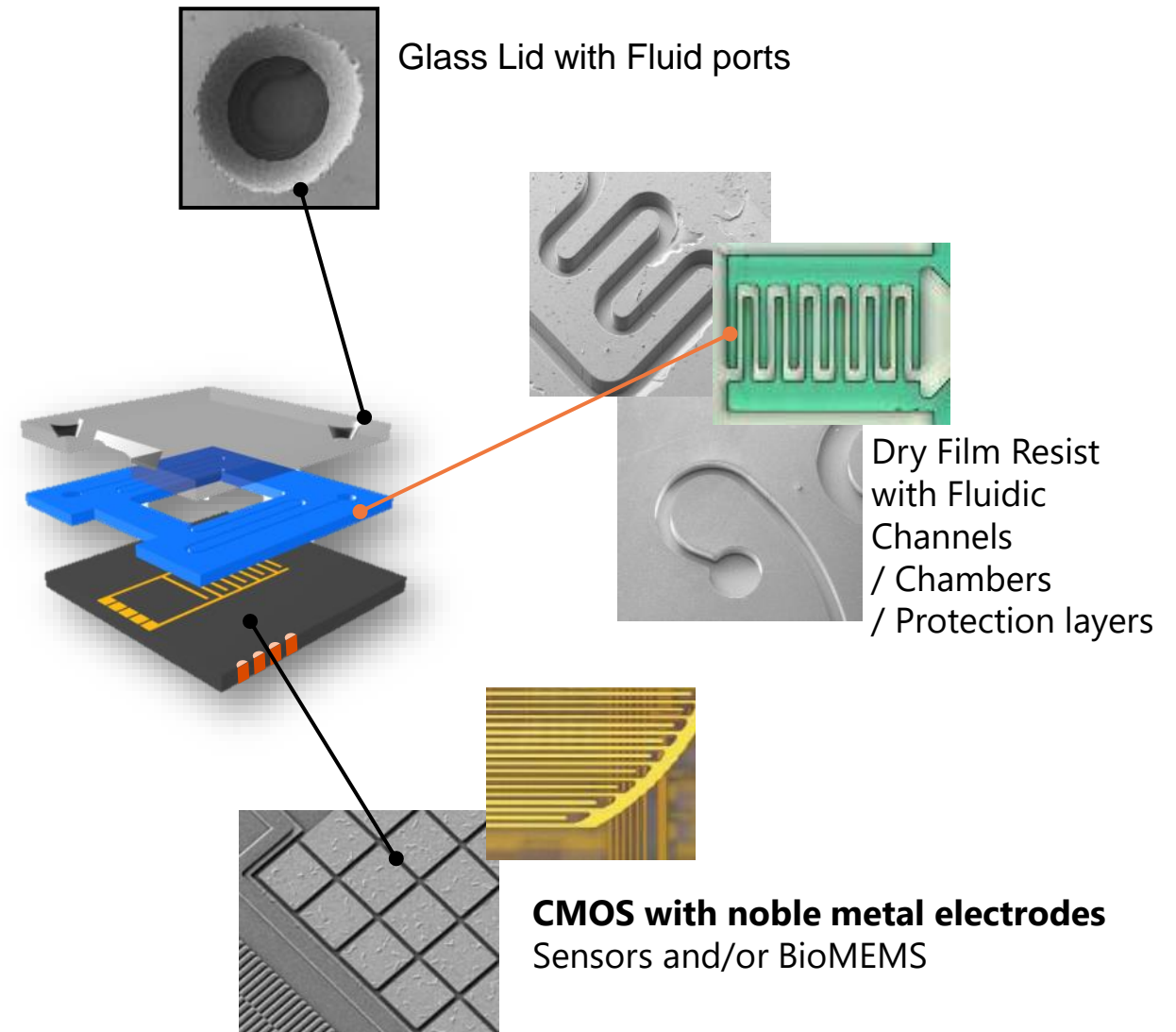
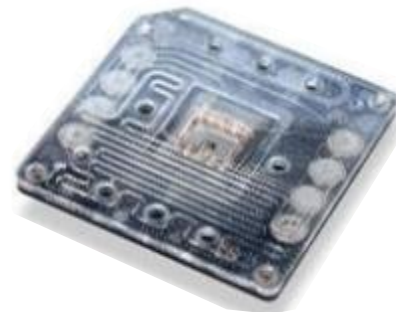
## X-FAB intensifies the investment in the development of **lab-on-a-chip**

- > Provide customer specific adaptations based on X-FAB standard processes
- > Expand capabilities towards bio-chips

<sup>1</sup> Source: [www.medgadget.com/2021/03/lab-on-a-chip-market-to-gain-tremendous-growth-by-10-5-of-cagr-till-2027-avail-at-cmi.html](http://www.medgadget.com/2021/03/lab-on-a-chip-market-to-gain-tremendous-growth-by-10-5-of-cagr-till-2027-avail-at-cmi.html)

## Silicon-based Microfluidics

- > Mixed-signal CMOS/SOI technologies combined with tailored interface and noble-metal electrodes
- > Integrated tungsten through passivation vias
- > Depositing and patterning of noble metals
- > Planarized passivation to minimize surface topology and improve the processing of additional top layers
- > Dry-film resist (DFR) layers to integrate fluidic structures like channels, chambers and reservoirs
- > Cap layers to form integrated microfluidic devices



# Home in both worlds – Silicon and Microfluidics

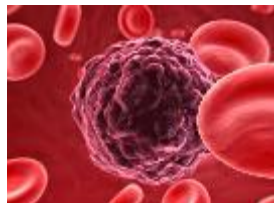
- > X-FAB is the leading analog/mixed-signal and MEMS foundry group and has been supplying to medical companies for more than 20 years.
- > X-FAB invested 25millions over the last 5 years in capabilities for silicon-based microfluidics
- > X-FAB has a track record for a variety of microfluidic applications like:



A **Point of Care platform** which provides diagnosis in 5 minutes and increases the survivability after sepsis by 80%



**Lab-on-a-chip** technologies enable the effect of drugs onto individual cells to be measured



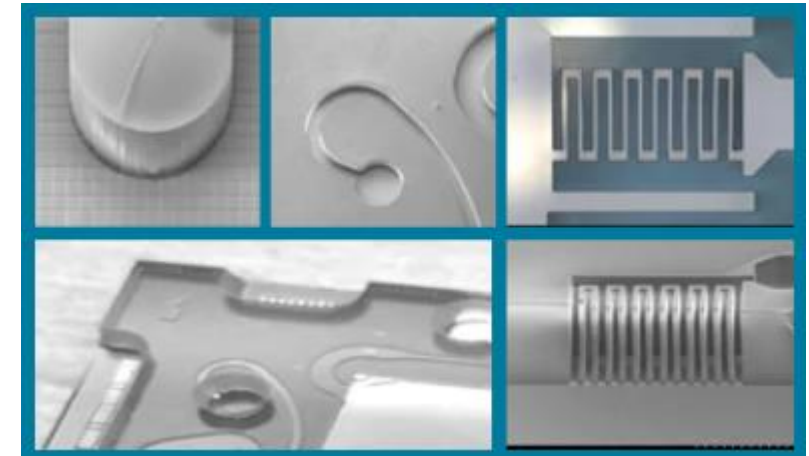
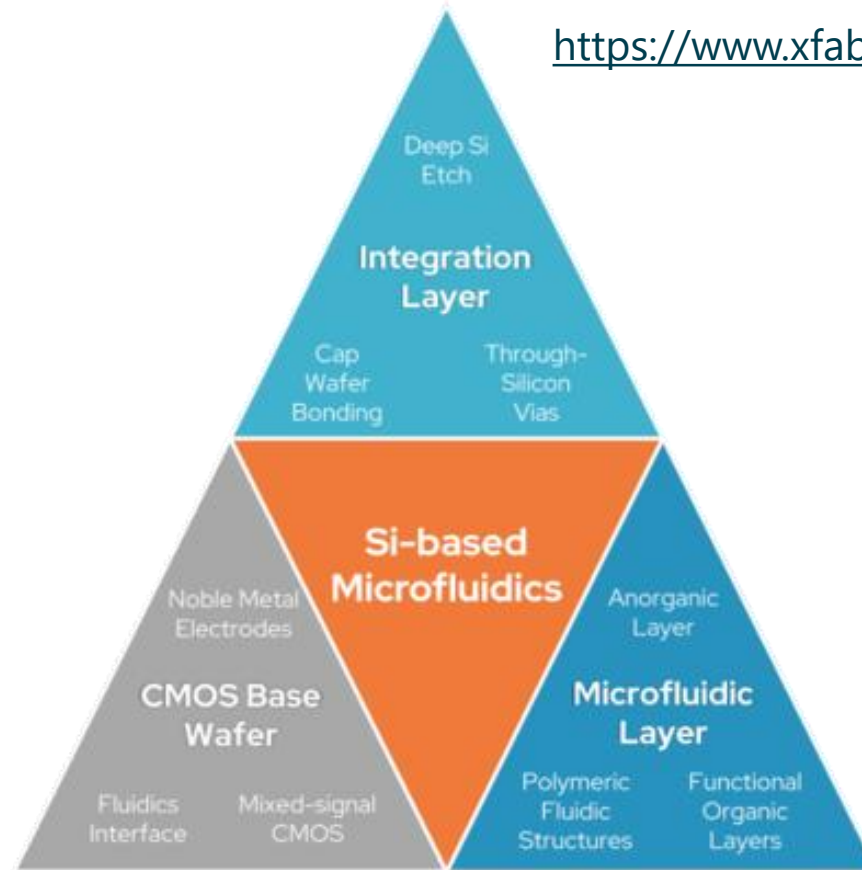
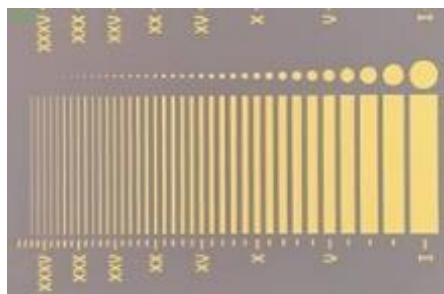
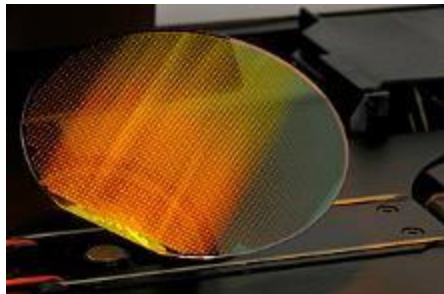
**Cell sorters** which isolate individual cells from a liquid biopsy sample with 100% purity



**Next Generation DNA Sequencing** where a human genome could be sequenced in one day

- > **Connecting** the two worlds of **microelectronics** and **microfluidics**

<https://www.xfab.com/technology/silicon-based-microfluidics>

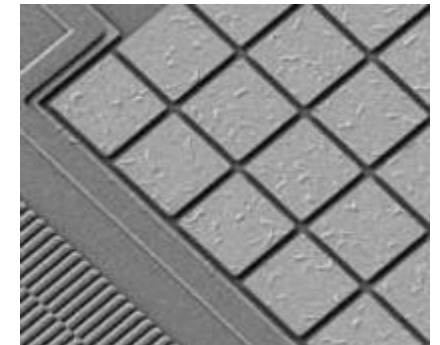
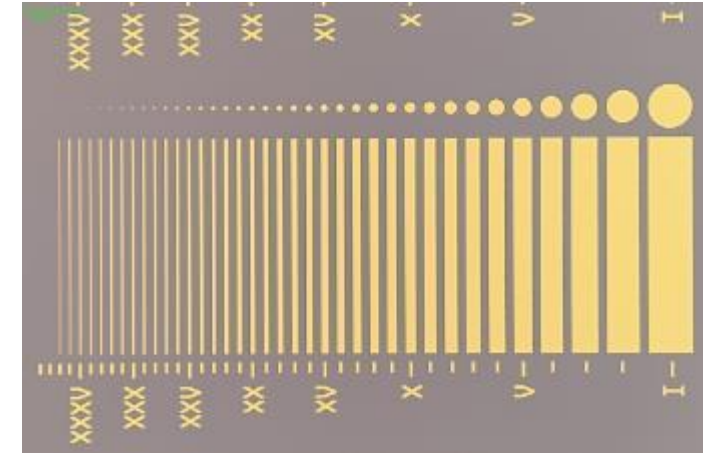


Replay of recent **EUROPRACTICE** webinar can be accessed here:

<https://youtu.be/4y2MqVo1BVY>

# Si-based Microfluidics - Noble Metal Processing

- > Providing a metallization that is
  - Suitable for operation or treatment in harsh environments (temp, media)
  - Chemically inert, "bio-compatible"
  - CMOS-integrable (interface to analog/mixed signal CMOS platforms)
- > Application examples:
  - Microfluidics
  - Sensors for use in harsh media environment and/or extreme conditions (gas sensors, pressure sensors)
  - Integration of functional materials (sensors, heater)
  - Interface to post-processing (3D integration, "solder-ready surface")



# Why lab-on-a-chip devices from silicon?

- › Clinical diagnostics require large labs
- › Semiconductor technologies will enable clinical diagnostic and research:
  - Smaller and portable tools
  - Use of smaller sample size
  - Faster and more accurate analysis
  - More affordable
- › Micro-manufactured silicon/glass devices for chip-scale handling of small quantities of fluids (liquids & gases)
- › Use of application-specific integrated circuits (ASICs) for data analysis enabling handling of huge amounts of data





# Lab-on-a-chip supply chain creates downstream opportunities

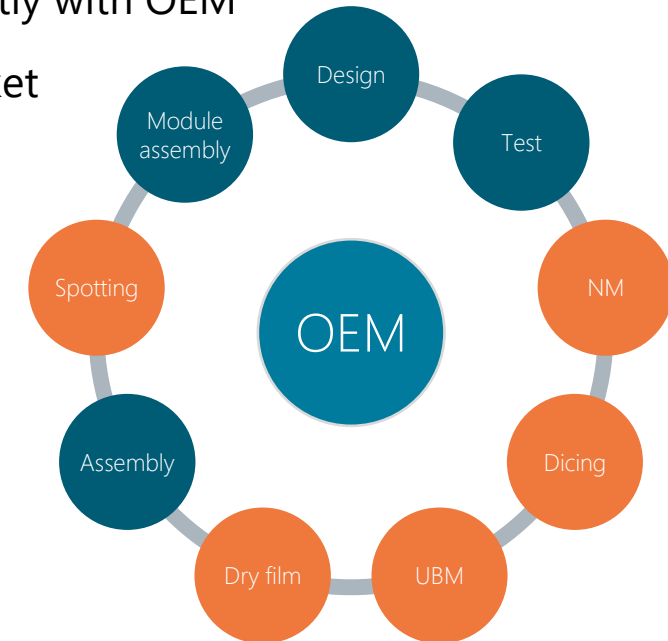
## Automotive ICs

- > Mature, large and growing market
- > Established linear distributed supply chain
- > Technology reuse focus
- > Engagements with Tier 2 or 3 suppliers
- > Long time to market



## Lab-on-a-chip ICs

- > Customer requires tailormade process development solutions
- > Fractured OEM centric supply chain
- > Engagement directly with OEM
- > Long time to market



Lab-on-a-chip applications feature large, **high-value** integrated circuits which are consumables.

# Lab-on-a-chip business management is the key lever

## > Open platform

- Specified and developed by X-FAB
- Many customers
- Less opportunity risks
- Massive technology reuse
- Sequential development of products and technology
- Constant NRE revenue stream

## > Customer-specific process development

- Conceived by the customers, developed at X-FAB
- Few customers
- High opportunity risks
- Standardization challenge introduction of new materials
- Technology and product co-development
- Project-driven NRE income



# 7 key engagement drivers for success

- 1 X-FAB has a head start in the medical market
- 2 Access to in-house analog/mixed signal CMOS technologies
- 3 MEMS value-add on top of CMOS platform
- 4 Experienced engineering team does provide tailormade technology solution
- 5 Supply chain expansion will capture more value-add
- 6 Automotive quality DNA
- 7 X-FAB has built brand recognition as medical lab-on-a-chip supplier



- > X-FAB has been supplying to medical companies for more than **20 years**
- > The pace of **development is accelerating** and will further accelerate
- > Serving a diversified portfolio and a **strong customer base** ensure steady growth
- > The COVID-19 pandemic being an enormous catalyst to disseminate digital healthcare



We are making **medical** the next automotive.

xfab

Thank you.



[www.xfab.com](http://www.xfab.com)