

FROM RESEARCH TO INDUSTRY

cea tech

Advancing MEMS R&D in materials, processes and devices to face major needs arising from the booming MEMS market

leti

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The leading R&D MEMS lab in the world (the largest one in Europe on a single site)

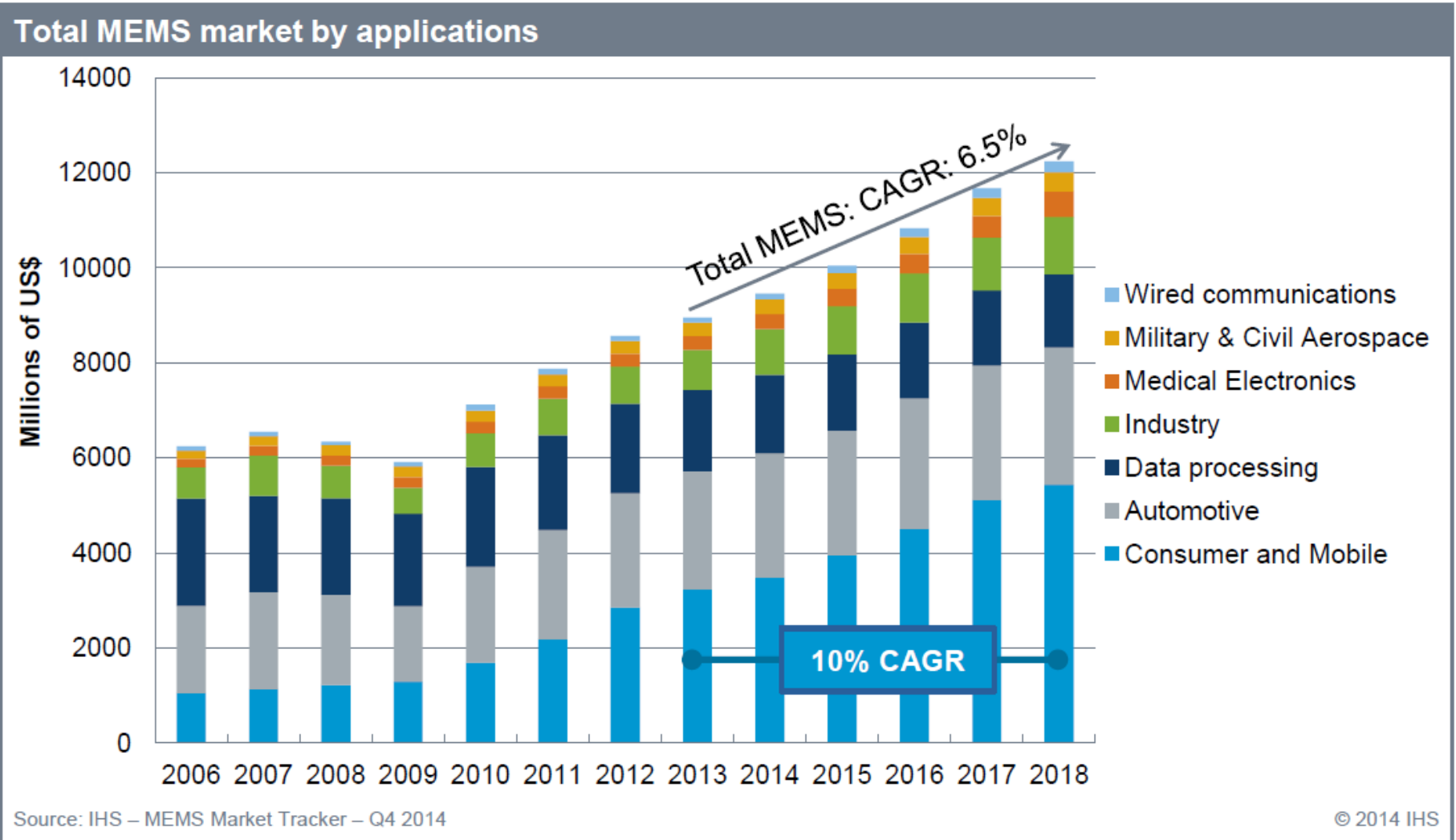
- One mission: supporting the MEMS industry
- ~ 200 people
- ~ 30 patents and 100 publications per year
- Many industrial partners worldwide. Some of them are:



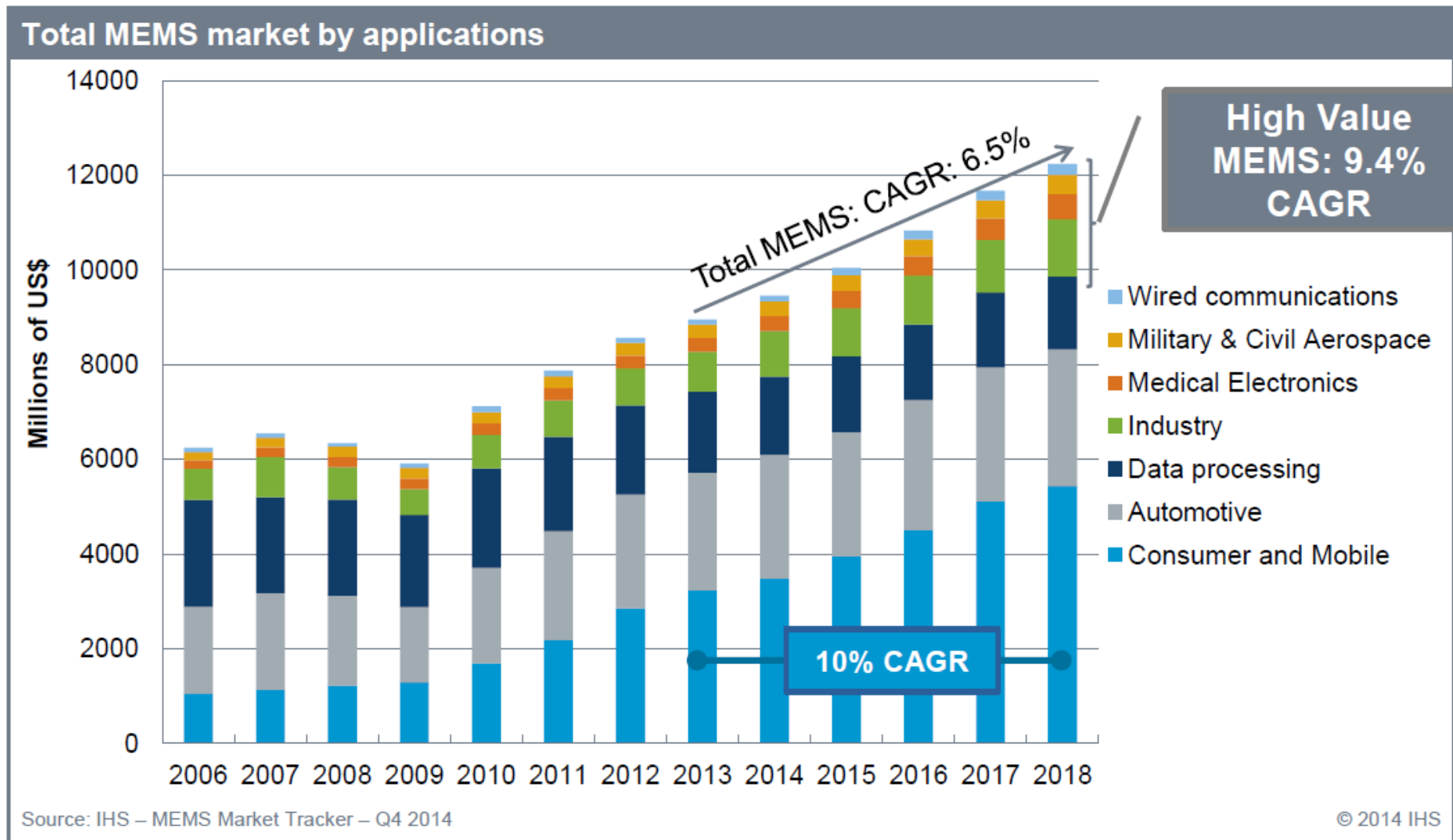
...covering the whole development chain, from MEMS design to system integration

- MEMS design (modeling and simulation) and prototyping
- Fabrication and packaging (200 mm wafers, front-end and back-end clean rooms)
- Electrical and functional characterization
- Integration with analog and digital electronics

MEMS industry: perspective of 6.5% CAGR from 2013 to 2018

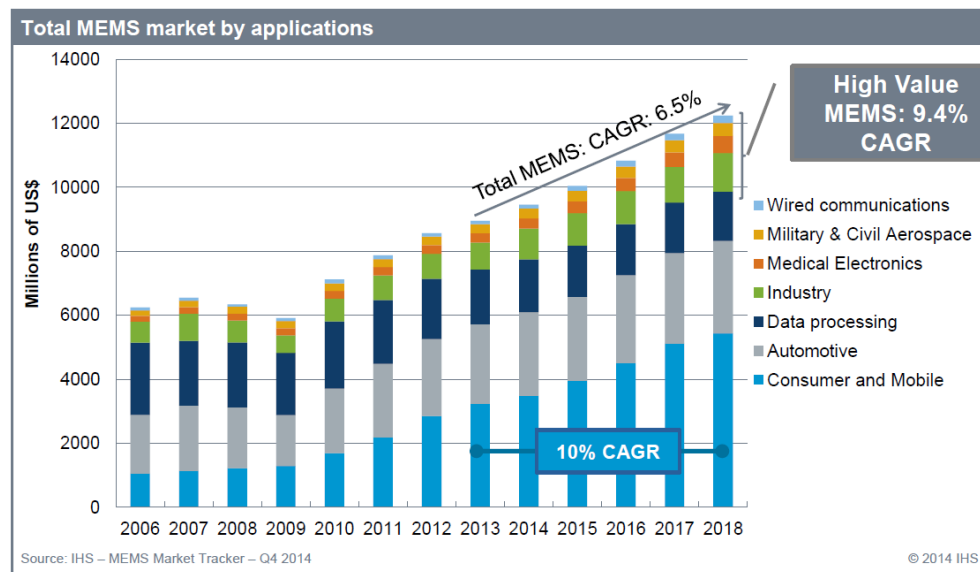


High-value MEMS market grows as fast as consumer/mobile market

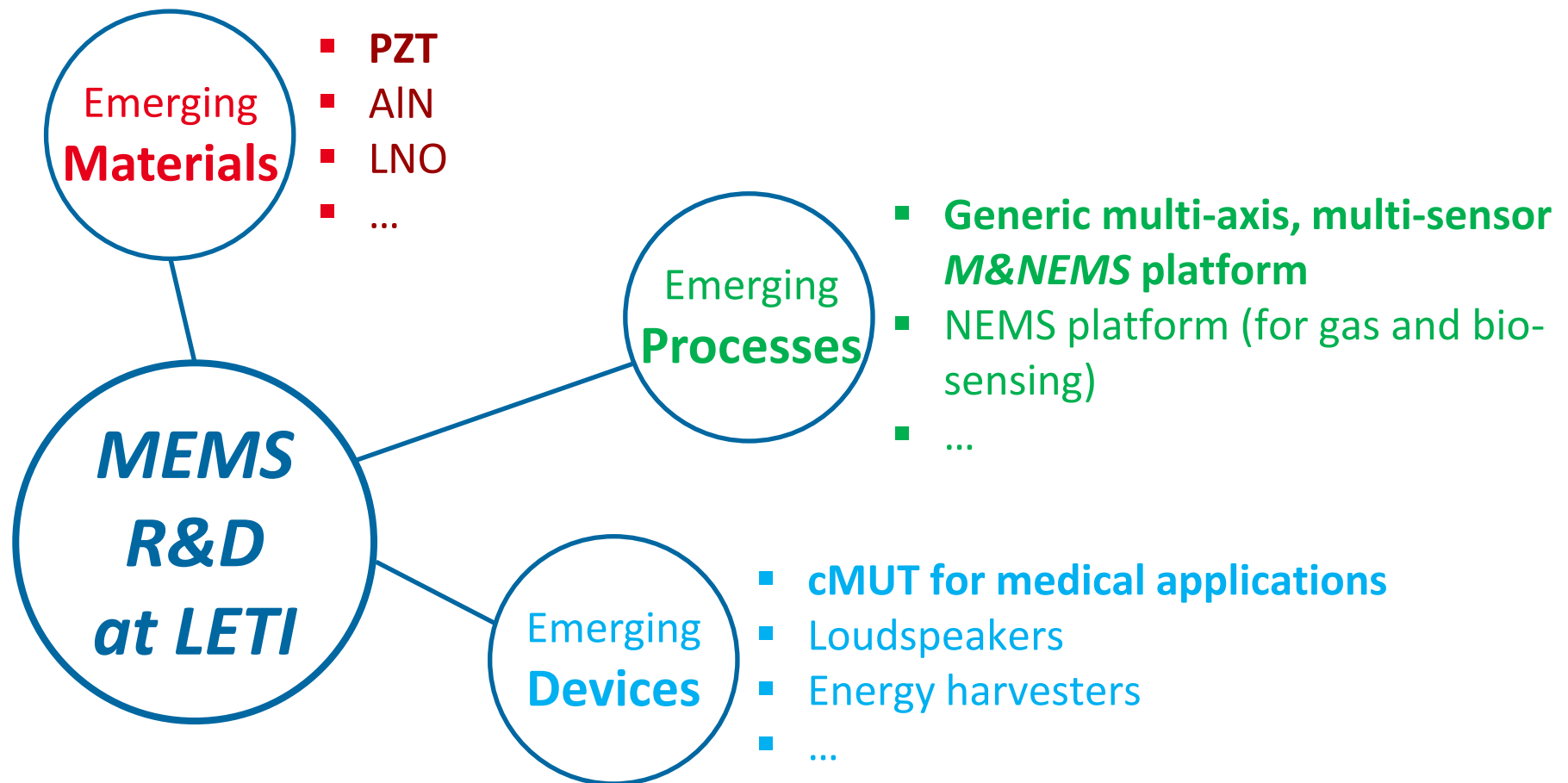


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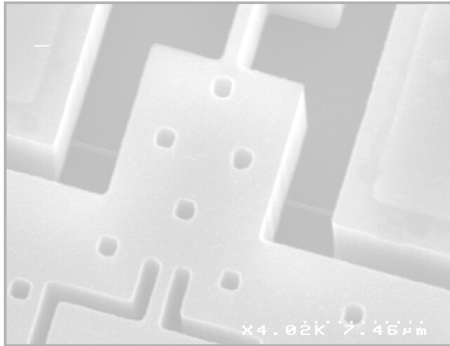
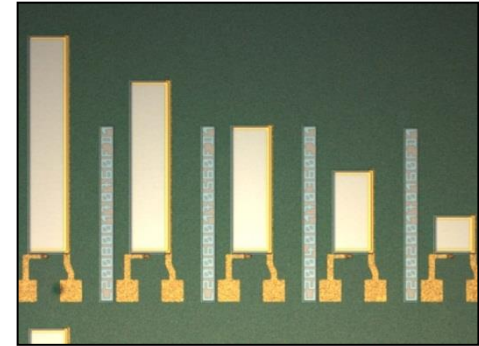
Out of the 4 giants of consumer MEMS (Bosch, ST, Knowles and InvenSense), **other major players refocus on industrial, medical, infrastructure (high-value MEMS)**



LETI works on innovations at all levels (materials, processes & devices) to meet the demands of consumer and high-value MEMS markets

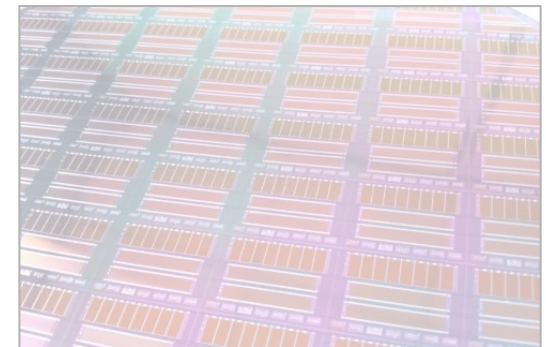


1 – A multi-application Material: PZT



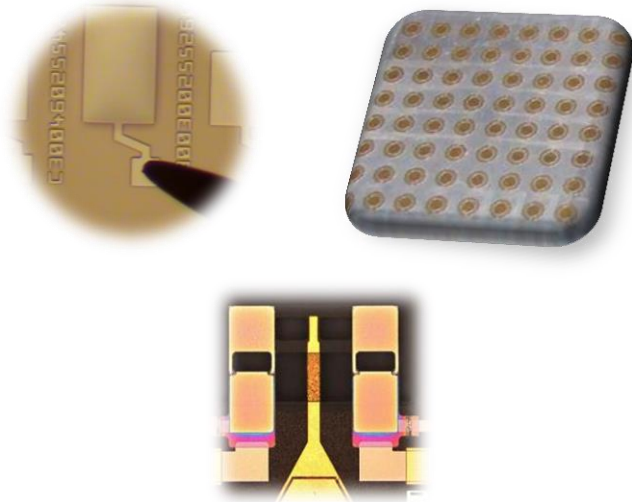
2 – A multi-axis, multi-sensor Process: generic M&NEMS platform

3 – Emerging Devices: cMUT & others



Applications and markets of PZT MEMS devices

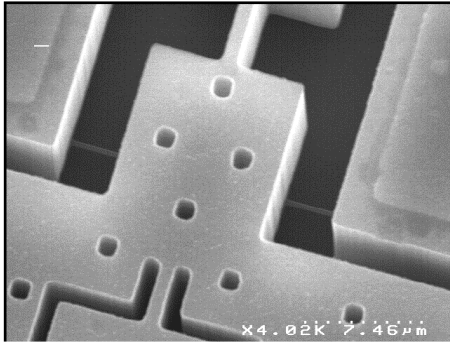
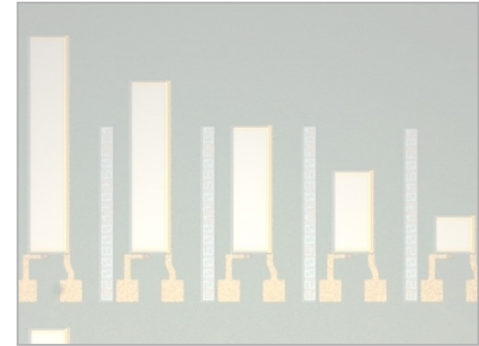
- **PZT devices at LETI:** Actuator, energy harvester, high-value capacitors, pyroelectric sensor
- **Apps/markets:** Inkjet heads, passive RF components, ultrasonic transducers, loudspeaker, haptics, varifocal lens, actuator for medical applications



Related technical challenges investigated by LETI

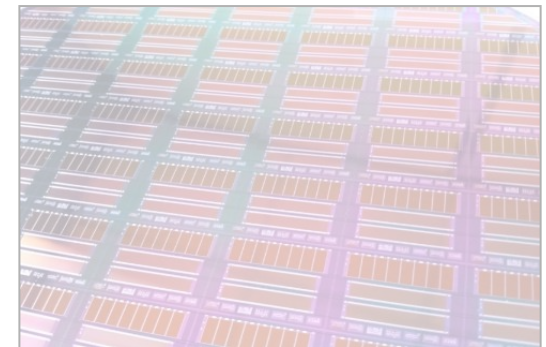
- Towards CMOS-compatible processes in terms of temperature
- Towards cost-effective deposition processes (throughput enhancement)
- Characterization techniques
- Device reliability improvement

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2 – A multi-axis, multi-sensor Process:
generic **M&NEMS** platform

3 – Emerging Devices: cMUT & others

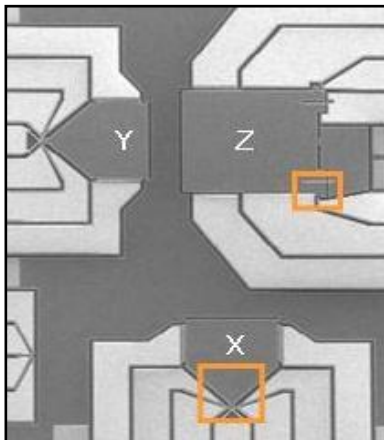


A disruptive generic platform for sensor fusion (protected by more than 20 LETI patents)

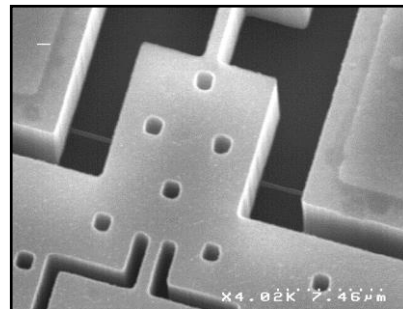
- Miniaturization, Generic processes, modelling and readout electronics for various types of sensors, VLSI-compatible
- First ongoing industrial transfer (non-exclusive licensing) to Tronics (9-axis)

tronics 
ENVISION MEMS | DELIVER MEMS

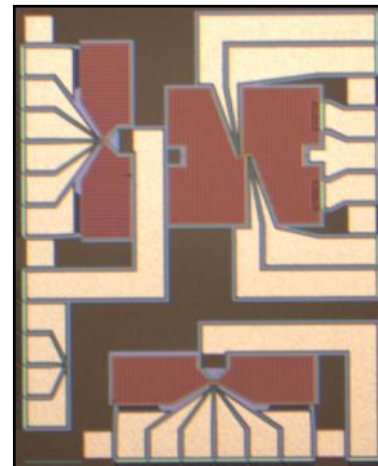
3axis Accelerometer



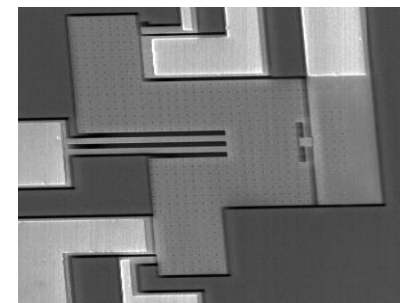
3axis Gyroscope



3axis Magnetometer



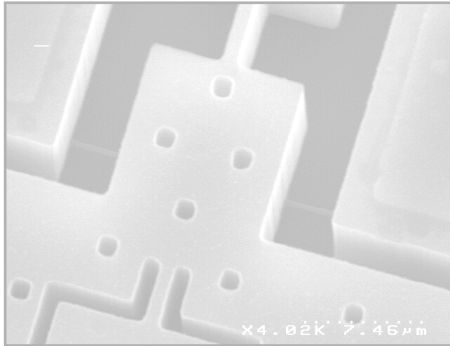
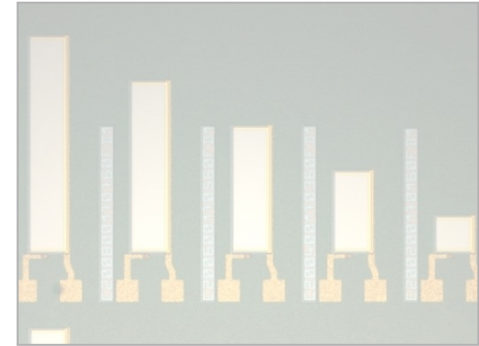
Pressure sensor



Microphone

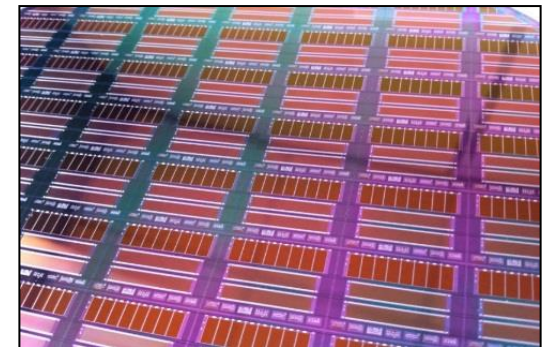
Under development

1 – A multi-application Material: PZT



2 – A multi-axis, multi-sensor Process:
generic M&NEMS platform

3 – Emerging Devices: cMUT & others



cMUT

cMUT applications

Airborne applications

Frequency range: up to hundreds of kHz

- Metrology & non-destructive testing
- Gas flow sensing
- Mass sensor for gas detection

Immersion applications

Frequency range: up to few MHz

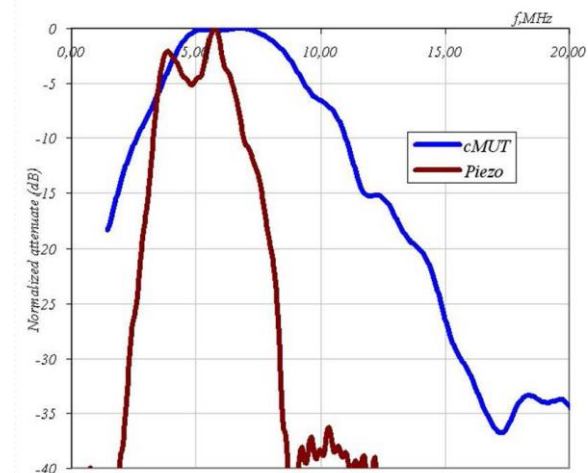
- Medical imaging
- Therapy
- Non-destructive testing
- Fluid flow sensing
- Mass sensor for liquid chemical sensing
- Hydrophone

cMUT

Benchmark with traditional piezoceramic UT

cMUT feature decisive advantages over their traditional piezoceramic ultrasonic transducers

- Larger bandwidth
- Smaller size and lower fabrication cost for high-volume production
- Enhanced reproducibility
- Lower acoustic impedance than ceramic counterparts allowing better matching with external media
- Feasibility of 2D arrays



LETI prepares the near and long-term future of MEMS companies

- Innovation at all levels (materials, processes & devices)
- Broad range of applications and potential markets
- Short-term applicative projects coexisting with advanced research

LETI → your MEMS R&D partner with unique versatility

- Design & process
- Packaging & characterization,
- Readout electronics & system integration