

VIJAY MISHRA

SENSORS FOR IOT

www.vijaymishra.org

What are expected of IoT Sensors ?



Compact



Ruggedized



Low power/self-
powered



Smart



Networked



Self-calibrated



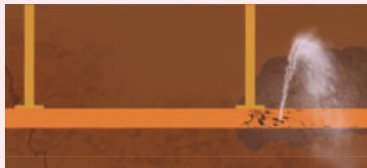
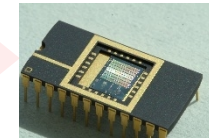
Low cost



What is
already
available ? In
what form
and shape ?

Water Quality Probes
<https://www.waterprobes.com/>

Massive Devices Huge Prices , Scalability ??



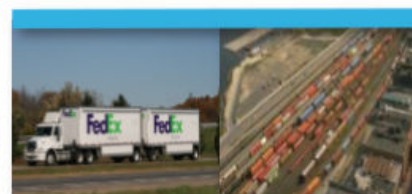
WORLD OF SENSORS



**Predictive
Maintenance**



**Energy Saving
Smart Grid**



**High-Confidence
Transport and
Asset Tracking**



**Improve
Productivity**



**Enable New
Knowledge**



**Intelligent
Buildings**



**Enhanced Safety &
Security**



**Improve Food
and H²O**

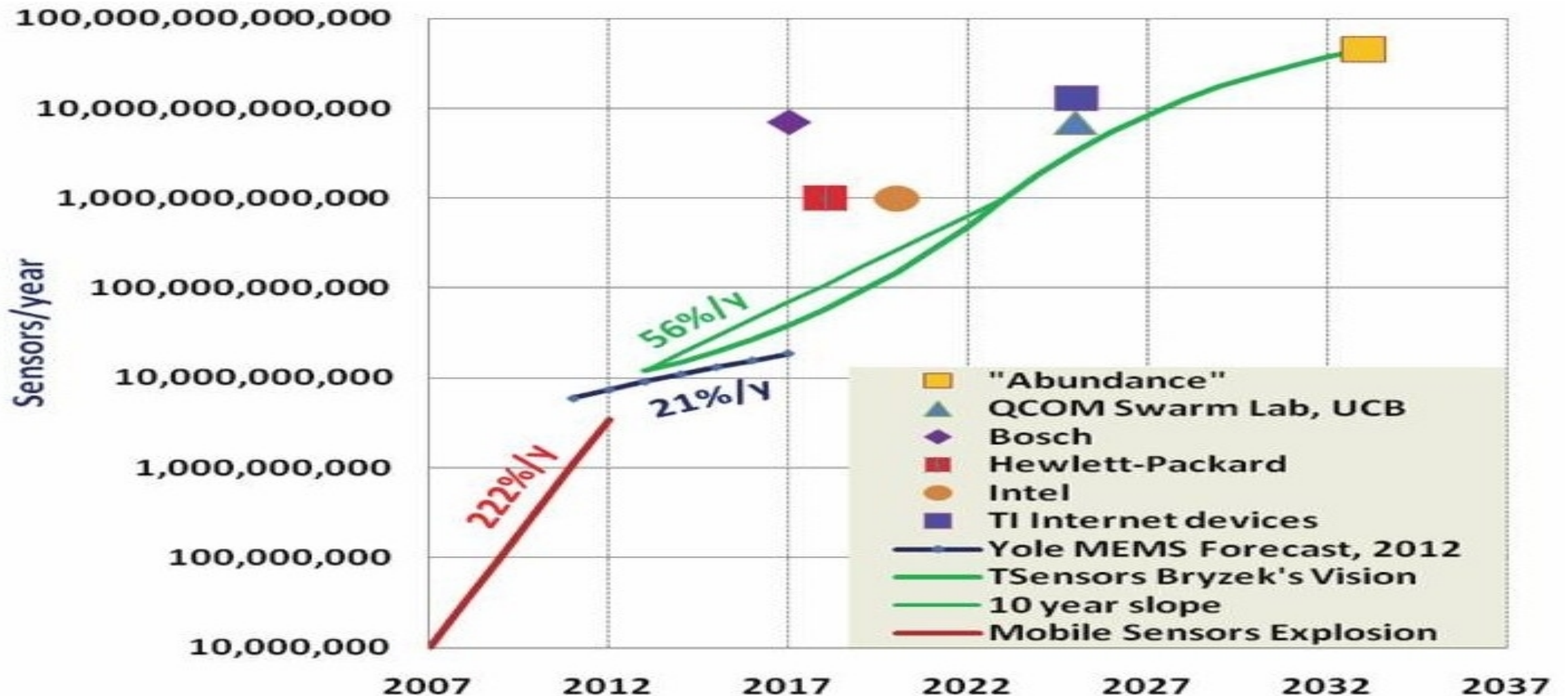


**Smart Home
S+CC**



Healthcare

THE TRILLION SENSOR VISION BY 2030



DRIVERS FOR SENSORS MARKET

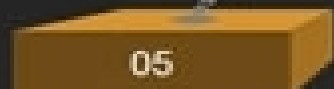
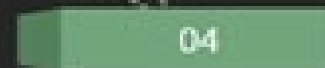
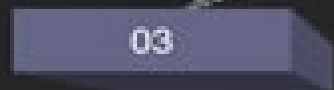
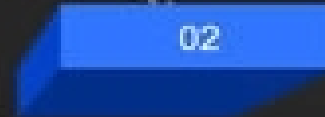
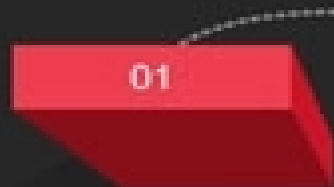
(no particular order)

IoT
Growing adoption of
the Internet of Things (IoT)

SENSORS
Advances in sensors
themselves

AUTOMATION
Strong demand in
the automation industry

WEARABLES
Increasing demand
for wearables



CE
Advances in consumer
electronic products.

SMARTPHONE
The growing usage of all
sorts of sensors in smartphones

AUTOMOTIVE
Growth in the automotive
industry

Technology x
Market
Development

Moore

More than Moore

Beyond Moore

Processing
Information age

Sensing
Interaction age

Actuating
Transformation age

IBM

Google



Personal computers



Laptop

SAMSUNG



Smartphones



SONY



Quantified
self

Tablets



BOSCH



Drones

Alphabet

SPACEX



Autonomous
vehicles

Smart
homes

Space travel



Telekinesis

Robotic
servants

Yole Développement © August 2015

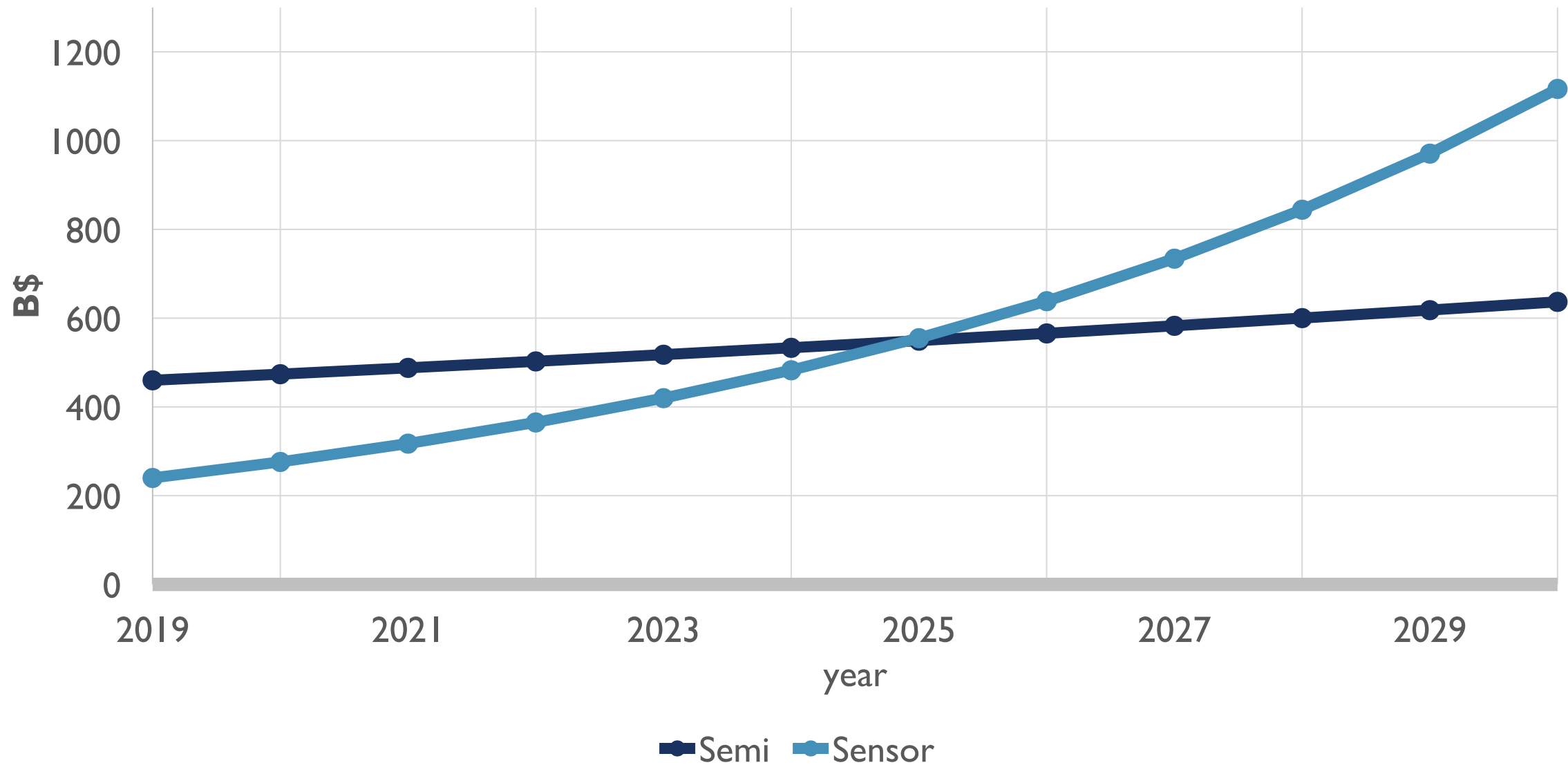
1980

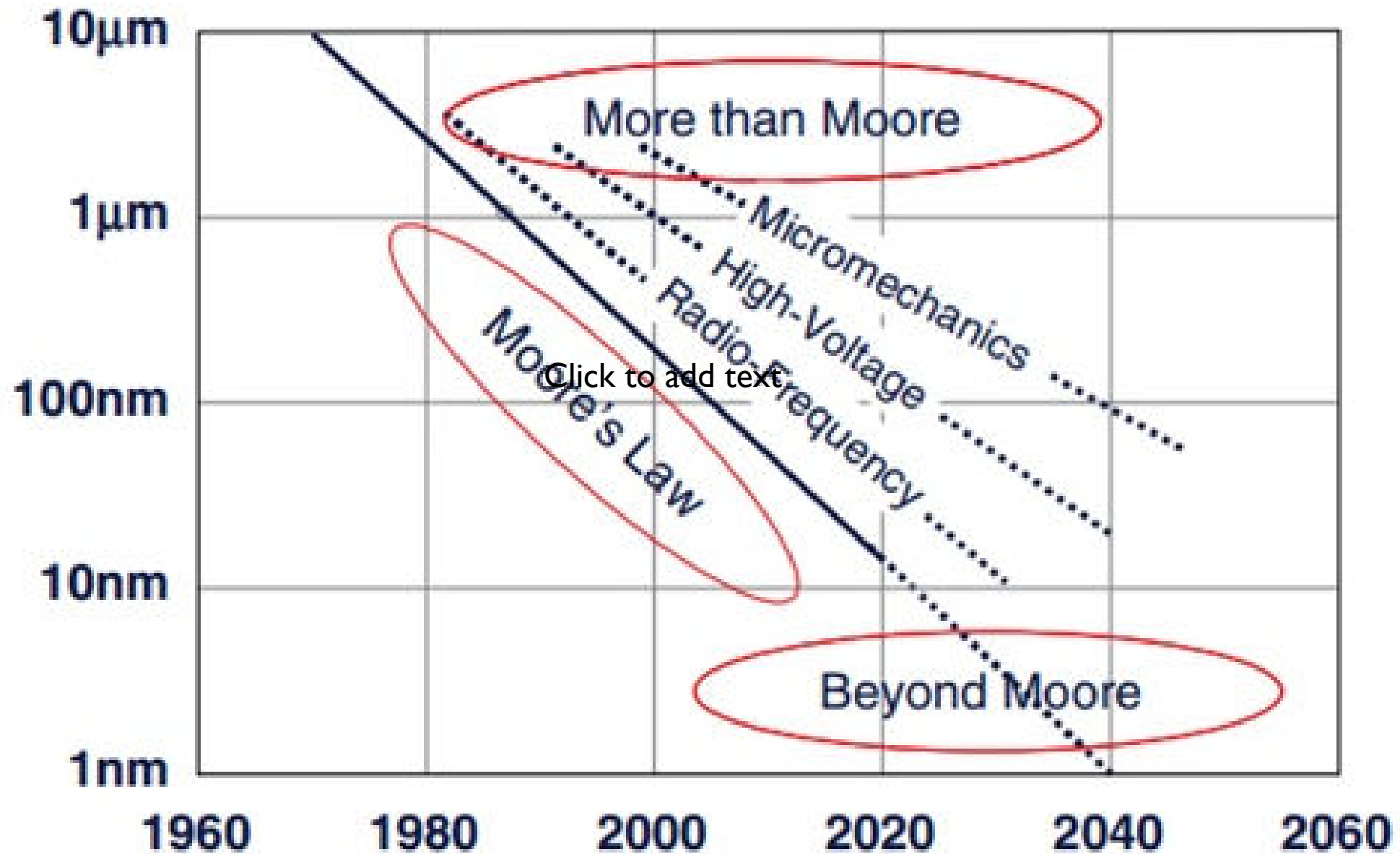
2010

2030

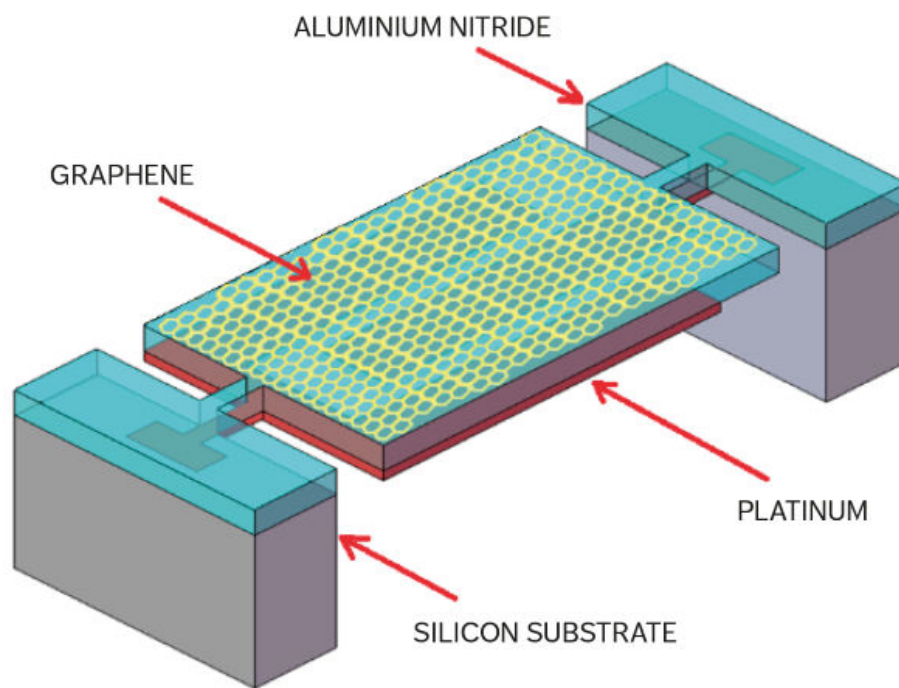
2040

Semiconductor-Silicon Market (Billion \$)



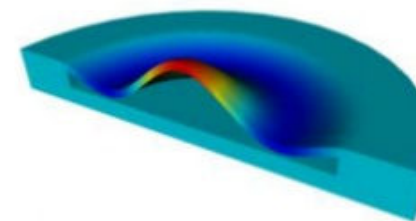


TRENDS IN MORE THAN MOORE DEVICES



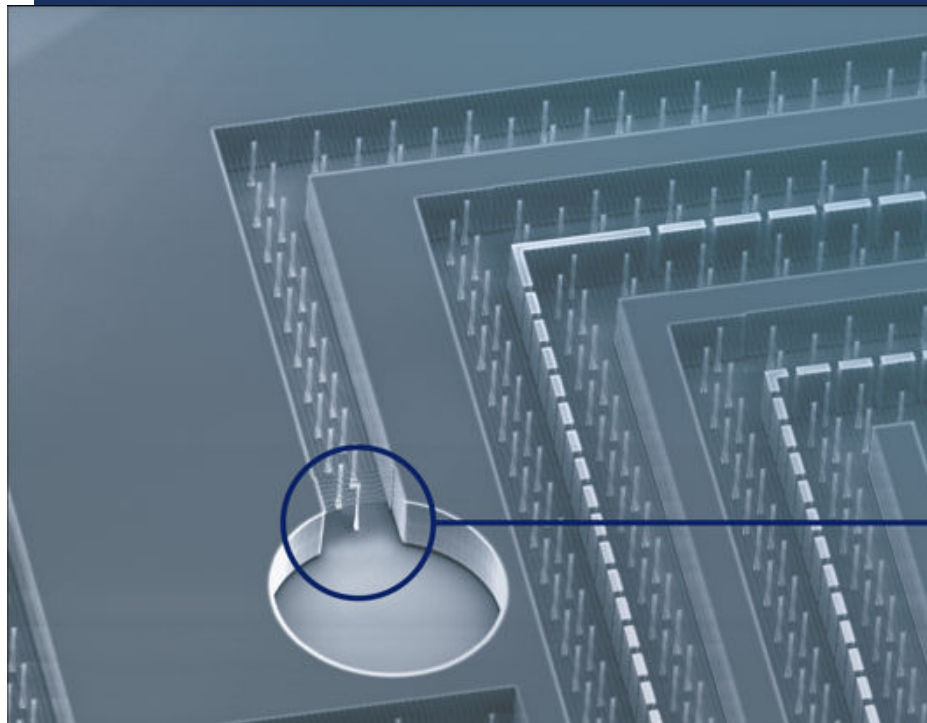
pMUTs

- Piezoelectric micromachined ultrasonic transducers
- Thin diaphragm typically formed on silicon substrates
- Suitable for a range of broadband sensing applications
- Microfabrication techniques make on-chip integration possible
- Unlike cMUTs - no high voltage biasing is required for operation
- Closer mechanical impedance to fluids enhances device efficiency
- Capable of High Frequency operation over a wide bandwidth

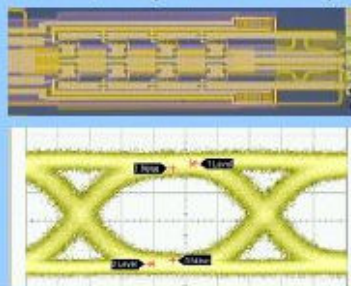


2nd order vibrational mode of a circular pMUT element

TRENDS IN MORE THAN MOORE DEVICES.... CONTINUED

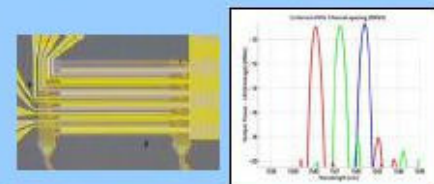


Silicon 10G Modulators
driven with on-chip circuitry
highest quality signal
low loss, low power consumption



Flip-chip bonded lasers
wavelength 1550nm
passive alignment
non-modulated = low cost/reliable

Silicon Optical Filters - DWDM
electrically tunable
integrated w/ control circuitry
enables >100Gb in single mode fiber

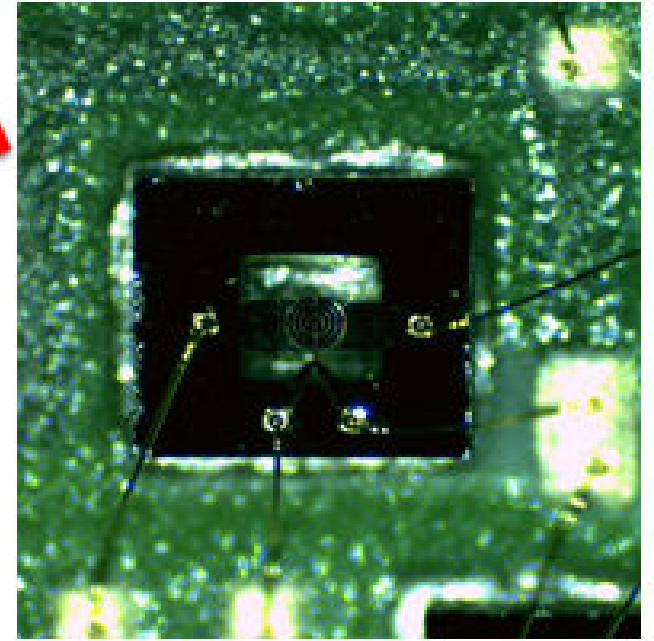
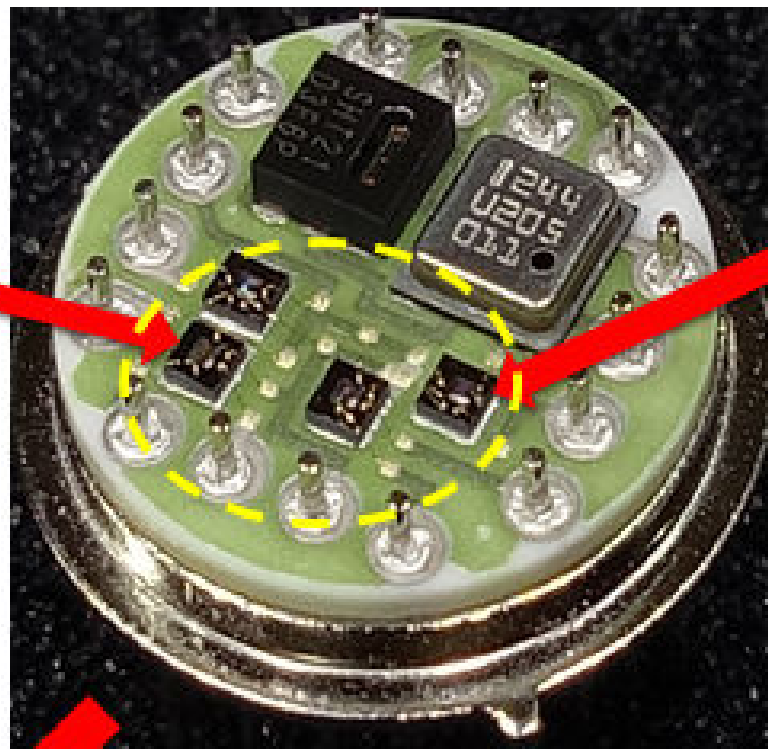


Complete 10G Receive Path
Ge photodetectors
trans-impedance amplifiers
output driver circuitry

Fiber cable plugs here

Ceramic Package

The Toolkit is Complete
✓10Gb modulators and receivers
✓Integration with CMOS electronics
✓Cost effective, reliable light source
✓Standard packaging technology

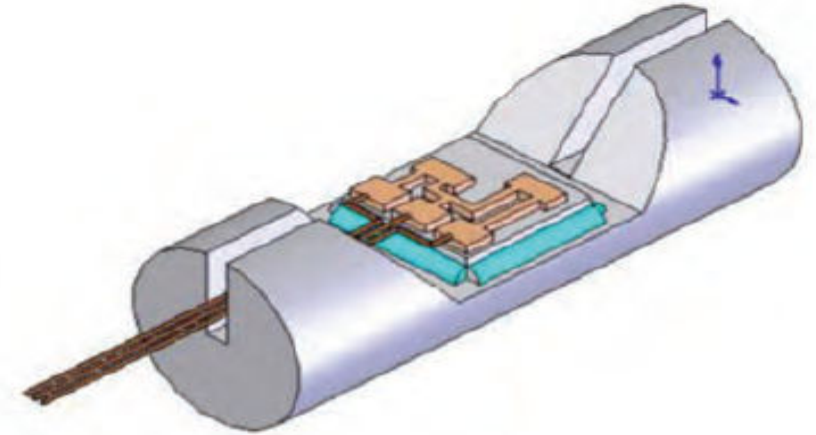
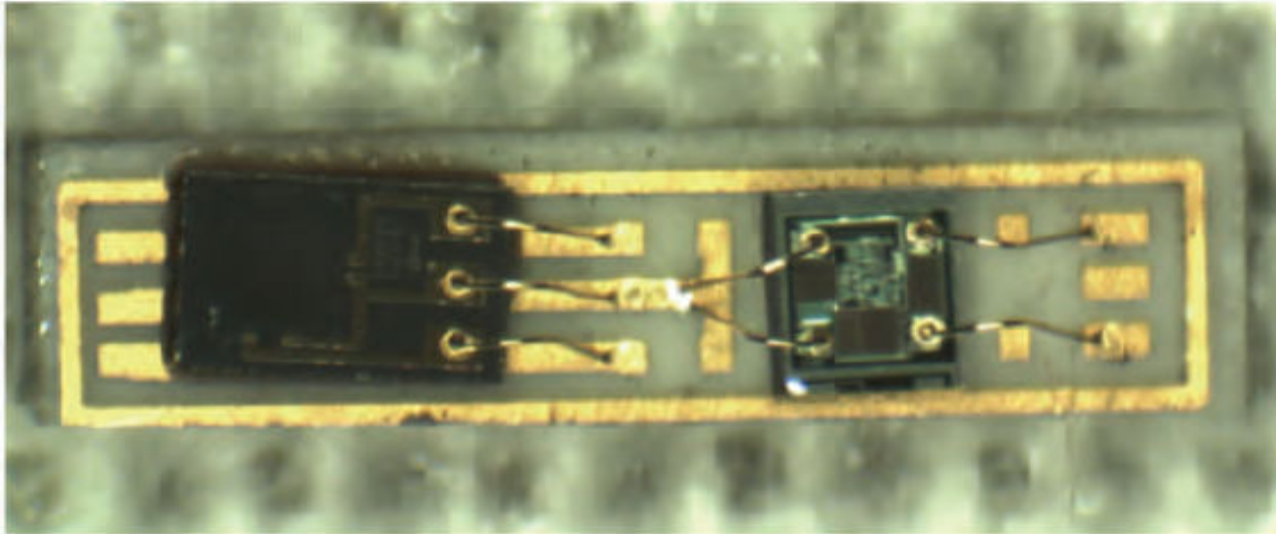


Packaged Sensor



Intracranial Pressure Sensor

CeNSE has developed pressure sensor and biocompatible advanced packaging to build solution for intracranial pressure monitoring for bio medical applications related to head injuries.

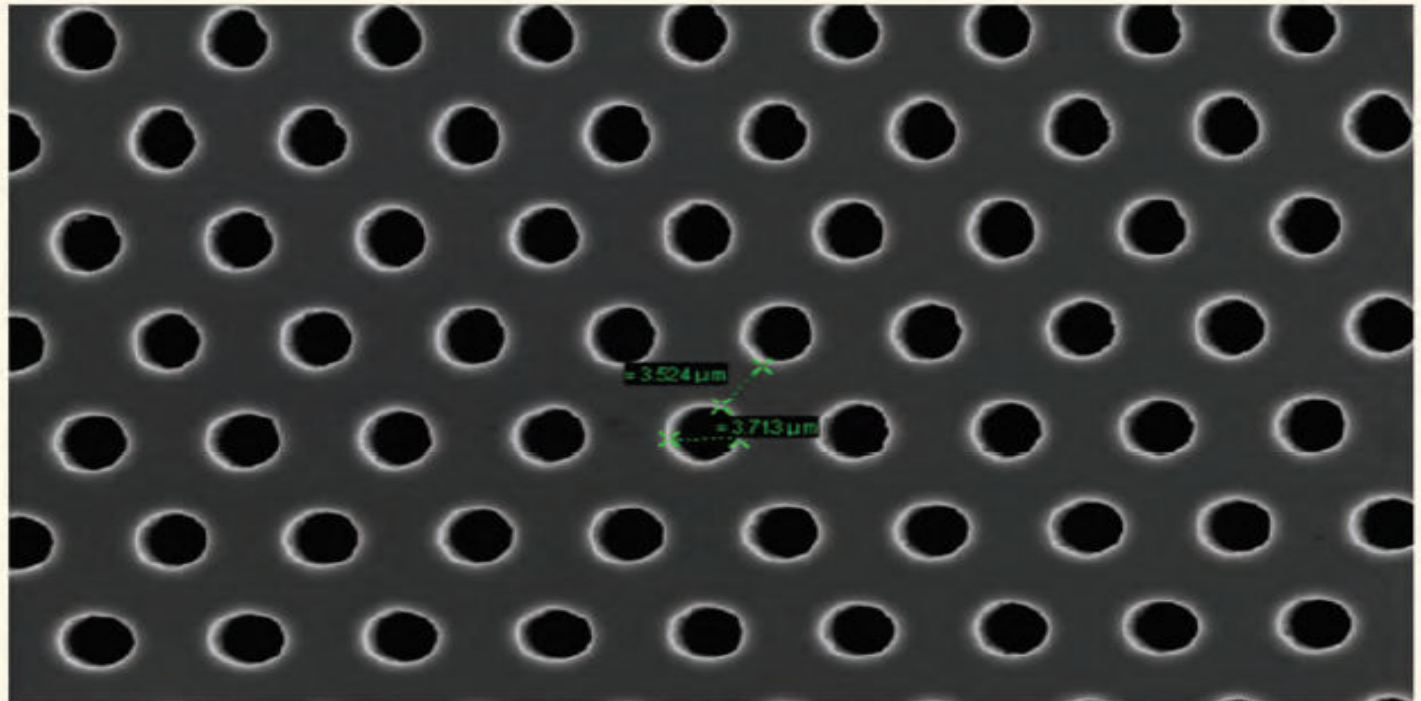
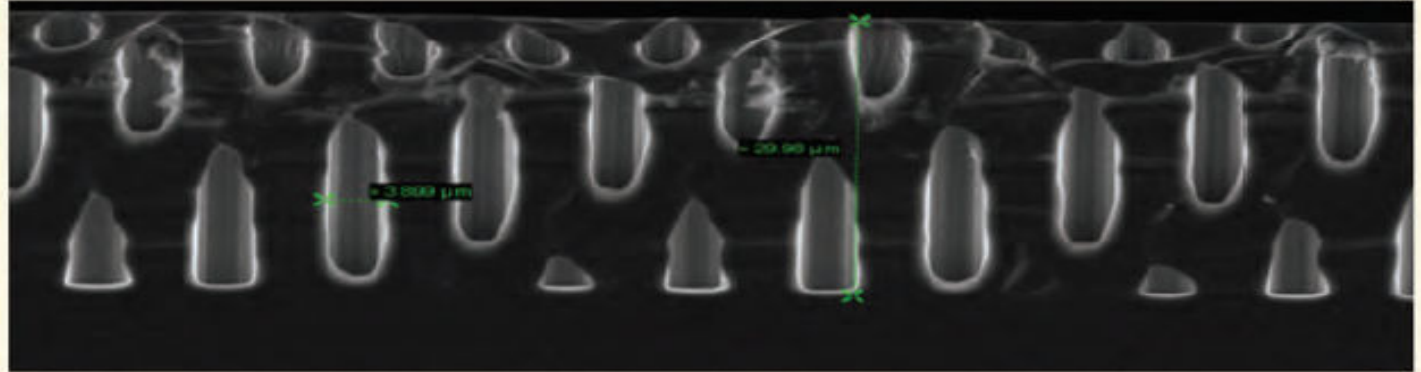
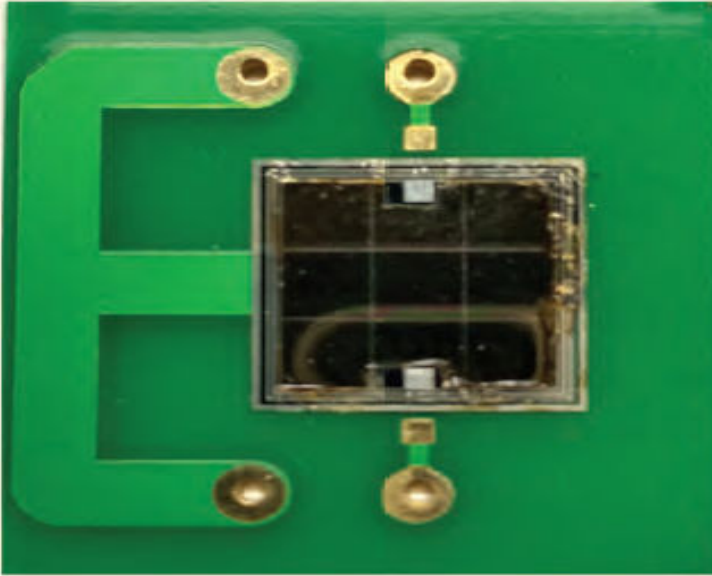


- Material: Gold plated Ceramic substrate with 0.6mm thickness.
- Dimension:
 - › Single sided: 0.8mm x 4.0mm
 - › Double sided: 0.8mm x 3.5mm
- Die-attach: GE P161 and ADTMP36 should be die-attached using H74 Non-conductive epoxy

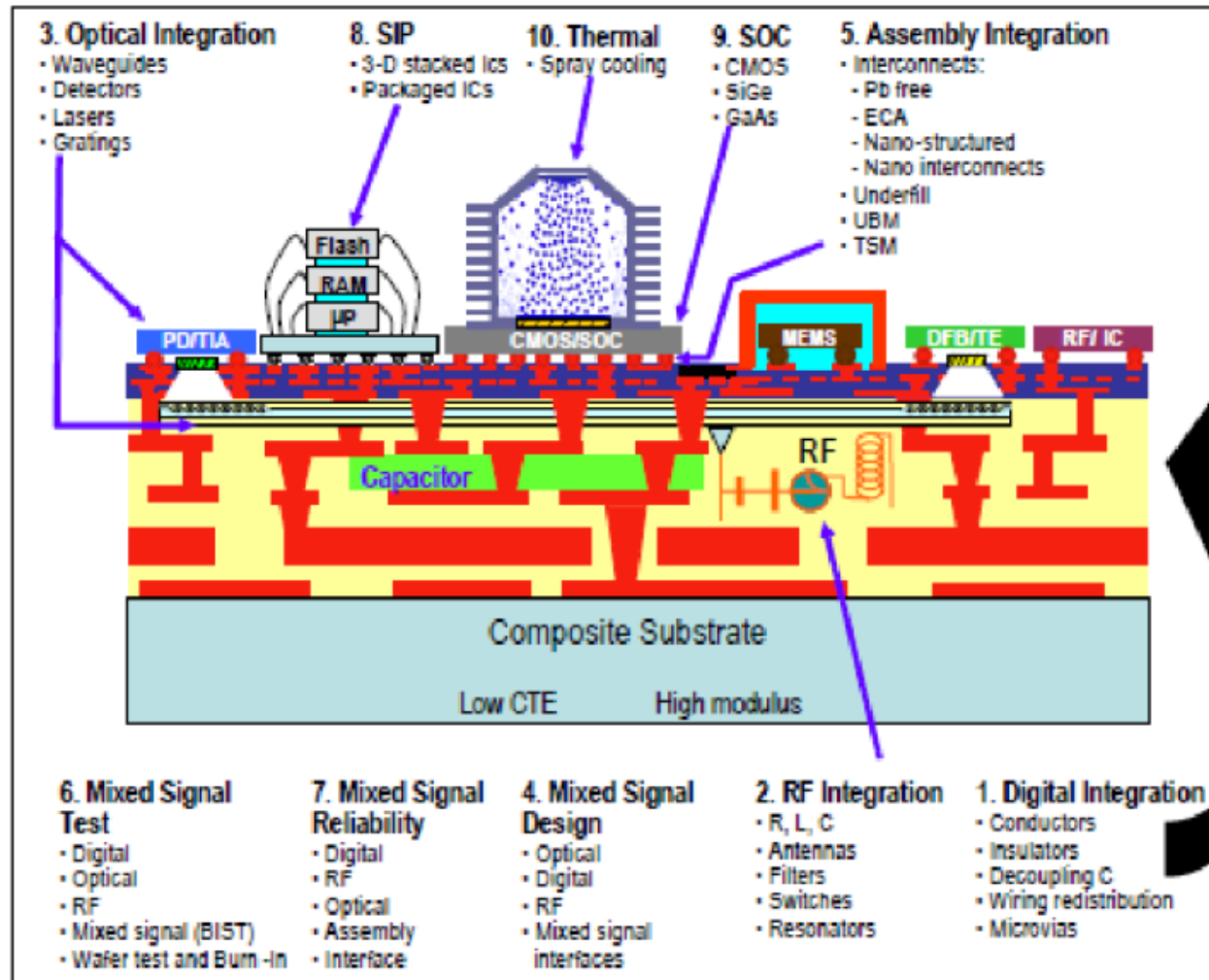
- Wire bonding: 1mil ball to wedge bonding.
- Sensor output connection:
 - 0.8mm O.D PTFE, Enamelled copper wire with five different colours as follows; clear, blue, red, black, green
 - Cut to length: 1.5m

Neutron Sensors for strategic applications

CeNSE has manufactured neutron sensors for applications in nuclear security. These sensors are solid state batch processed silicon technology based and utilize novel converter material growth using nanotechnology.



SENSOR SYSTEMS USING 3D SYSTEMS SCALING



Advantages of 3D systems Scaling

Latency of SOC is handled well in SOP

RF Limitations of SOC-integrating Antennas, Capacitors & Inductors with high Q, Filters, Switches

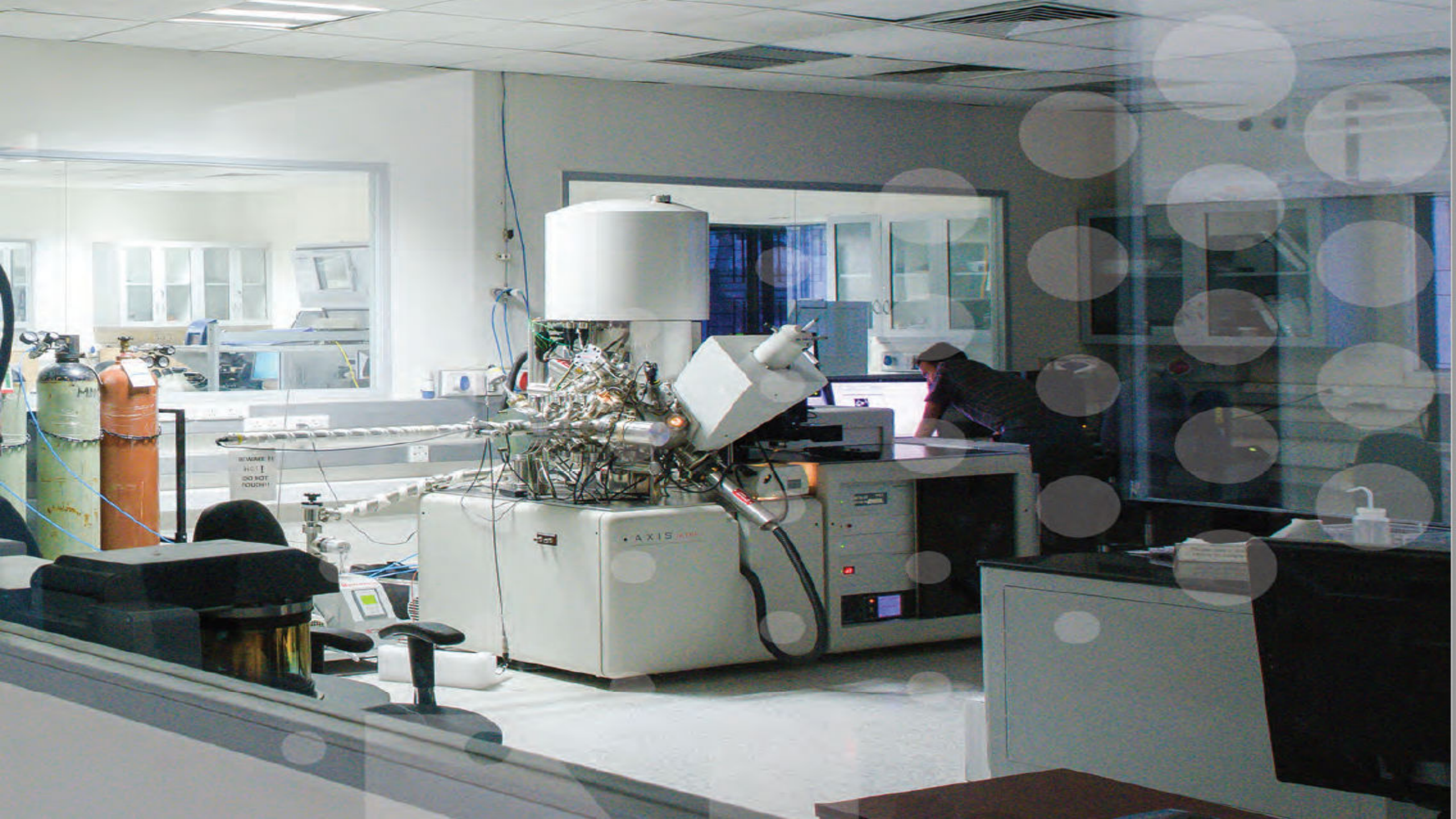
Heterogeneous Integration of technologies

Integrating Thin Film & Power Components.

CLEAN ROOM : FACILITY FOR MORE THAN MOORE



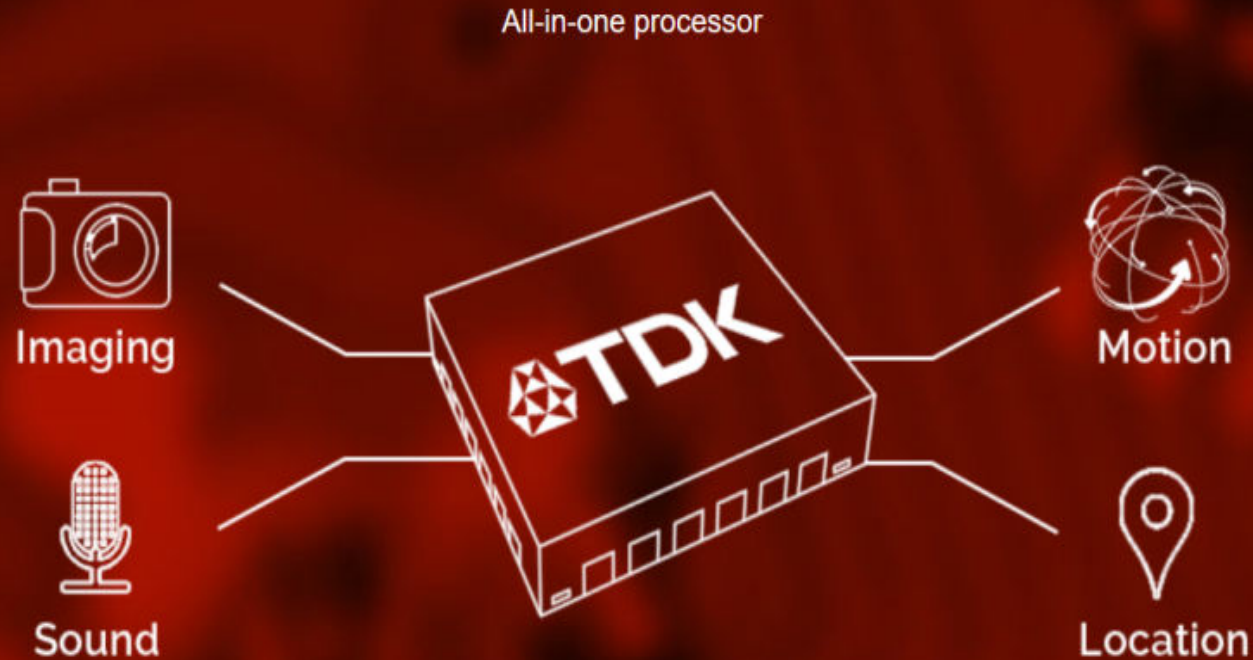




List of MtM Fabs

- XFAB
- IMEC
- SCL
- CeNSE and Indian Educational Institutes
- Large fabs transforming into more than moore fabs or sensors fabs

Sensor Manufacturing Organizations



TDK's vision of Sensing Everything™ targets the consumer electronics and industrial markets with integrated Motion and Sound solutions. Our solutions combine MEMS (micro electrical mechanical systems) sensors, such as accelerometers, gyroscopes, compasses, and microphones with proprietary algorithms and firmware that intelligently process, synthesize, and calibrate the output of sensors, maximizing performance and accuracy.

NAVSON

TECHNOLOGIES

R e s e a r c h m e e t s i n d u s t r y

**Comprehensive Solution for Sensor
Fabrication Technologies and Training**

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Motion Imager

Conclusions

- Exponential demand for sensors
- Industry 4.0 , Cognitive Machines,
- Smart Homes, Cities, Wearables
- Bio Cyber Physical Systems
- Global Ecosystem of sensor market evolving fast