INL INTERNATIONAL IBERIAN NANOTECHNOLOGY LABORATORY

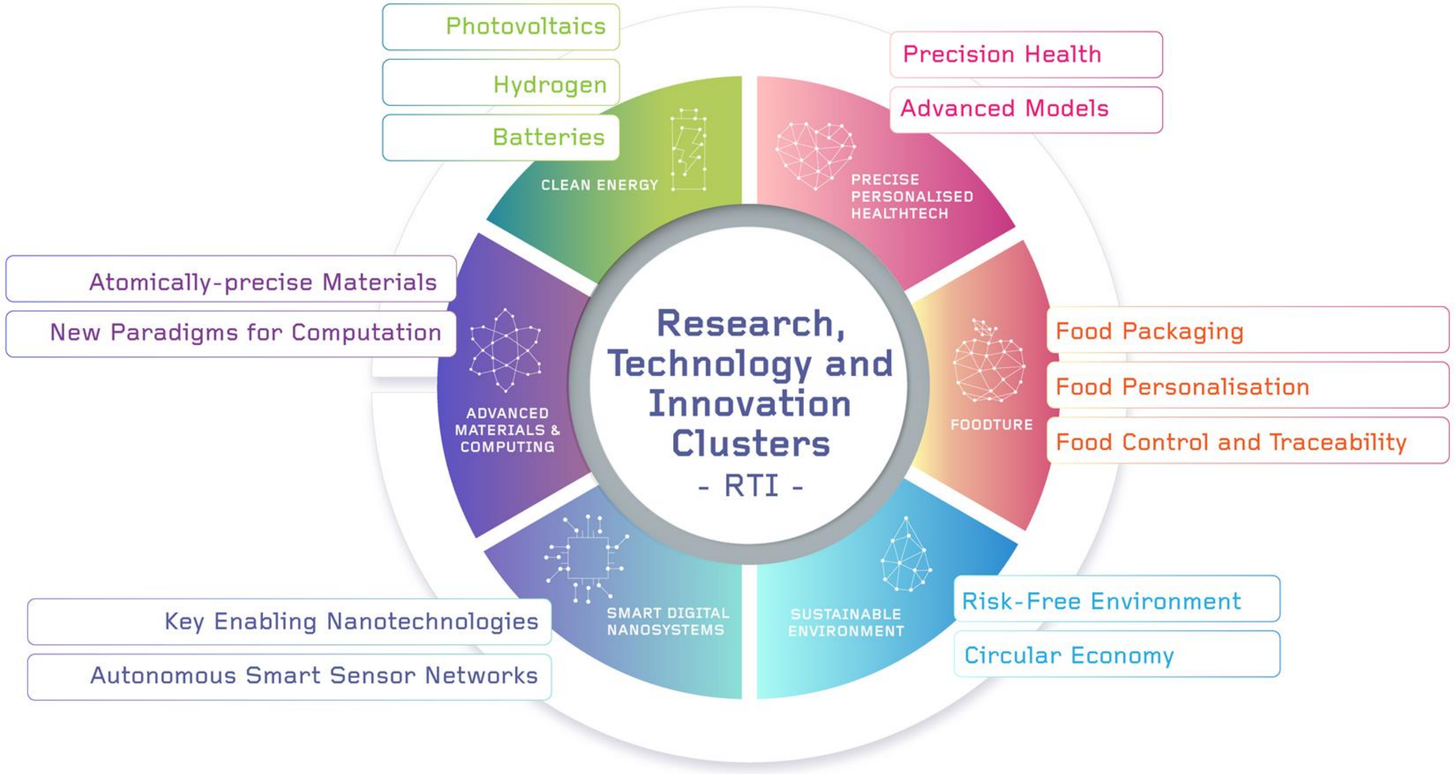
INL in the EU Chips Act

http://www.inl.int

INL Scientific Activity

Main scientific areas of activity

INL scientific area is organized across **23 research groups.** The Research and Technology activities are focused on **6 thematic areas**: **Advanced Materials and Computing**, Clean Energy, Food for the Future, Precise Personalised Health Tech, **Smart Digital Nano-systems**, and Sustainable Environment.



Chips act is closely related with the activities in two of these areas :
Advanced Materials and Computing and **Smart Digital NanoSystems**.

RTI Groups

- Nanophononics
- Integrated Micro and Nanotechnologies
- Food Processing and Nutrition
- Nanosafety
- Quantum and Linear-Optical Computation
- Medical Devices
- Natural and Artificial Photonic Structures and Devices
- Nanostructured Materials
- Atomic Structure-Composition of Materials
- Atomic Manipulation for Quantum Nanotechnology
- Nanofabrication, Optoelectronics and Energy Applications
- Nanochemistry
- Ultrafast Bio- and Nanophotonics
- Theory of Quantum Nanostructures
- 2D Materials and devices
- Nanomaterials for Energy Storage and Conversion
- Nanostructured Solar Cells
- Nanomedicine
- Water Quality
- Food Quality and Safety
- Nanodevices
- Spintronics

Engineering Groups

- Technology Engineering
- Systems Engineering

- Research Core Facilities
  - Nanophotonics & Bioimaging Facility
  - AEMIS Facility
  - Micro and Nanofabrication Facility
    - Process Integration

- Research, Technology and Innovation Office
  - Communication, Conferences and Marketing Unit
  - Programme Management Office
  - INL Corporate Experts

INL Core Technologies

Candidate Technologies to explore within the Chips Act

INTERNATIONAL IBERIAN NANOTECHNOLOGY LABORATORY

INL has a wide Spectrum of technologies being developed in-house.

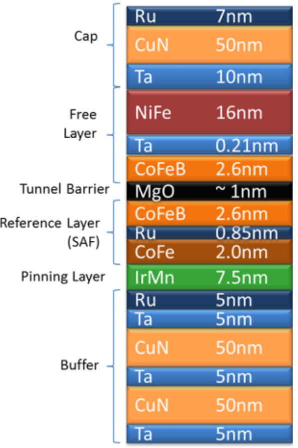
This section provides details about **five core technologies that make an intensive use of micro and nanofabrication techniques** and that are well developed.

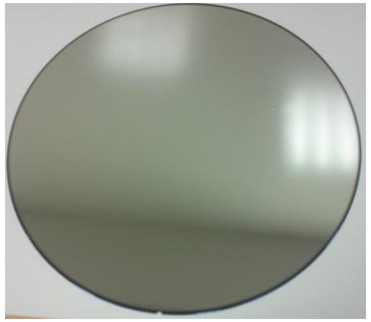
Core Technologies	How are they being used being used?
2D Materials and Devices Atomically thin layers that can be transferred to full wafers and used to make functional devices.	• State-of-the-art ultrasensitive chemical sensors • Wireless, autonomous sensing, with radiofrequency reading • Components for THz communication (emitters, detectors, modulators) • On-demand single-photon emitters for quantum communications • Graphene inks and pastes for Li-ion battery components and electromagnetic shielding
MEMS Microelectromechanical systems that take advantage of scale factors to produce ultra-sensitive sensors and actuators	• Proven state-of-the-art ultrasensitive inertial MEMS accelerometers, gravitometers and inclinometers used in automotive, aerospace, infrastructure and health. • Optical MEMS mirrors devices for 2D projection and scanning. • MEMS membrane devices for acoustic speakers and ultrasonic imaging
NanoPhotonics Photonic nanoscale integrated devices that combine onchip multi-functionalities for energy-efficient emission, transmission, detection and sensing, and processing of light signals.	• Nanophotonic devices (nanolight sources, detectors & interconnects) for bioinspired energy efficient light sensing, communications & disruptive computing solutions. • Nanophotonic integration for biophotonics (laser sources, interferometers and resonator devices for state-of-the-art biophotonic sensing). • Nanophotonic integration for quantum photonic sensing and computation.
Spintronics Devices that explore the spin, rather than the charge of the electron as a way to collect, communicate and process information	• State-of-the art ultra-sensitive magnetic field sensors used as transducers of linear displacements, angular motion, vibration, electrical currents, magnetic fields, etc.. • Novel multifunctional devices operating in the RF frequency spectrum used for IoT communications, unconventional computation and energy harvesting.
NanoPhononics Devices that explore the flow of phonons at the nanoscale. A new NanoPhononics group is being installed at INL during 2023.	• Meeting the challenges of heat dissipation in chiplets and thermal control in interposers. • Si-based NEOMS: conversion from the 100s of MHz to 100s THz and back via optomechanics for filtering and communications in the METRO and satellite frequency ranges .

From Lab to the Real World

A long way to walk

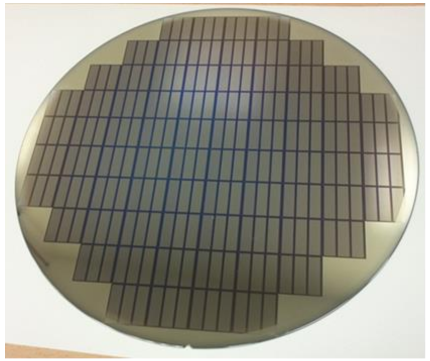
Materials Optimization/Growth



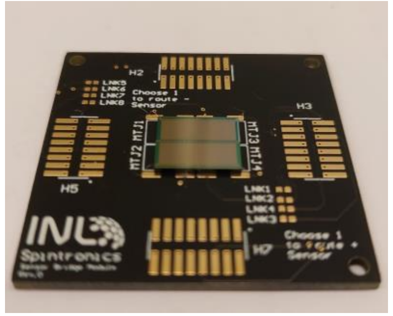


200 mm

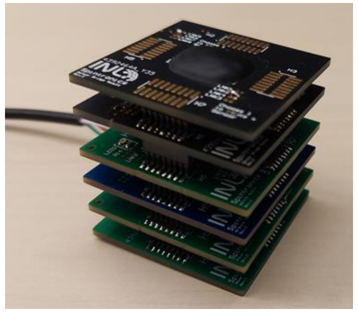
Micro and Nanofabrication



Packaging



System Level Integration



AI + Data Processing

Data collected needs to be automatically processed to provide useful information about:

- Predictive Maintenance
- User behavior
- User safety
- Production Line Monitoring
- Quality Control
- Monitoring of part degradation

From Lab to Farm

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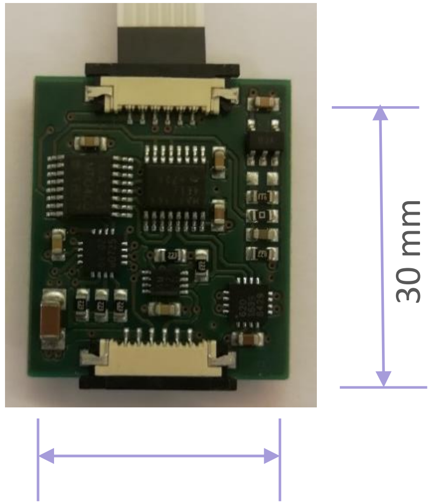
i-Grape

Development of a fully integrated, low-cost, stand alone optical device for monitoring grape maturation and vine water stress - ICT EU Grant No 825521

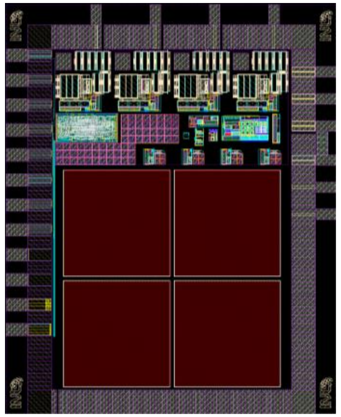
- Lorawan IoT integrated optical sensor network
- VIS/NIR diffuse reflectance (direct measurement of optical properties of the grape skin) and Back and Front of leaf for Water Status measurement
- Fluorescence (indirect measurement through the chlorophyll fluorescence)
- Data analytics and parameter prediction algorithms (Chemometrics)
- Patented - WO2018172114A1 US1083790182

Host module

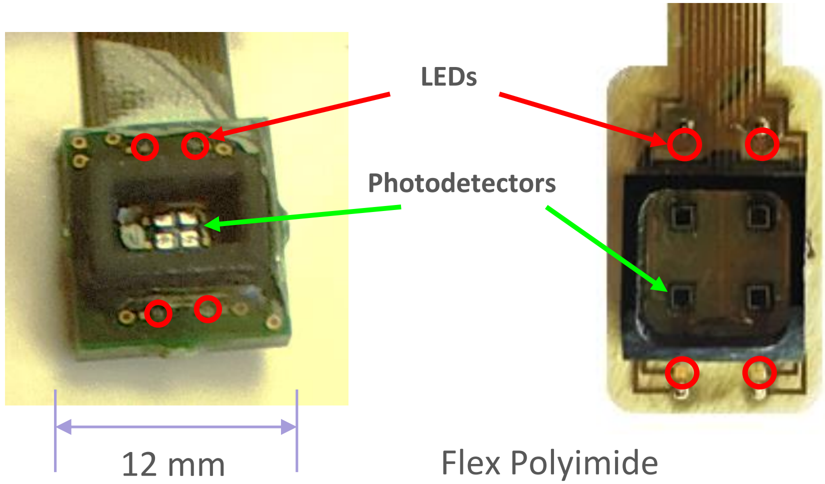


20 mm

ASIC



Micro photospectrometer



12 mm

Flex-Rigid PCB

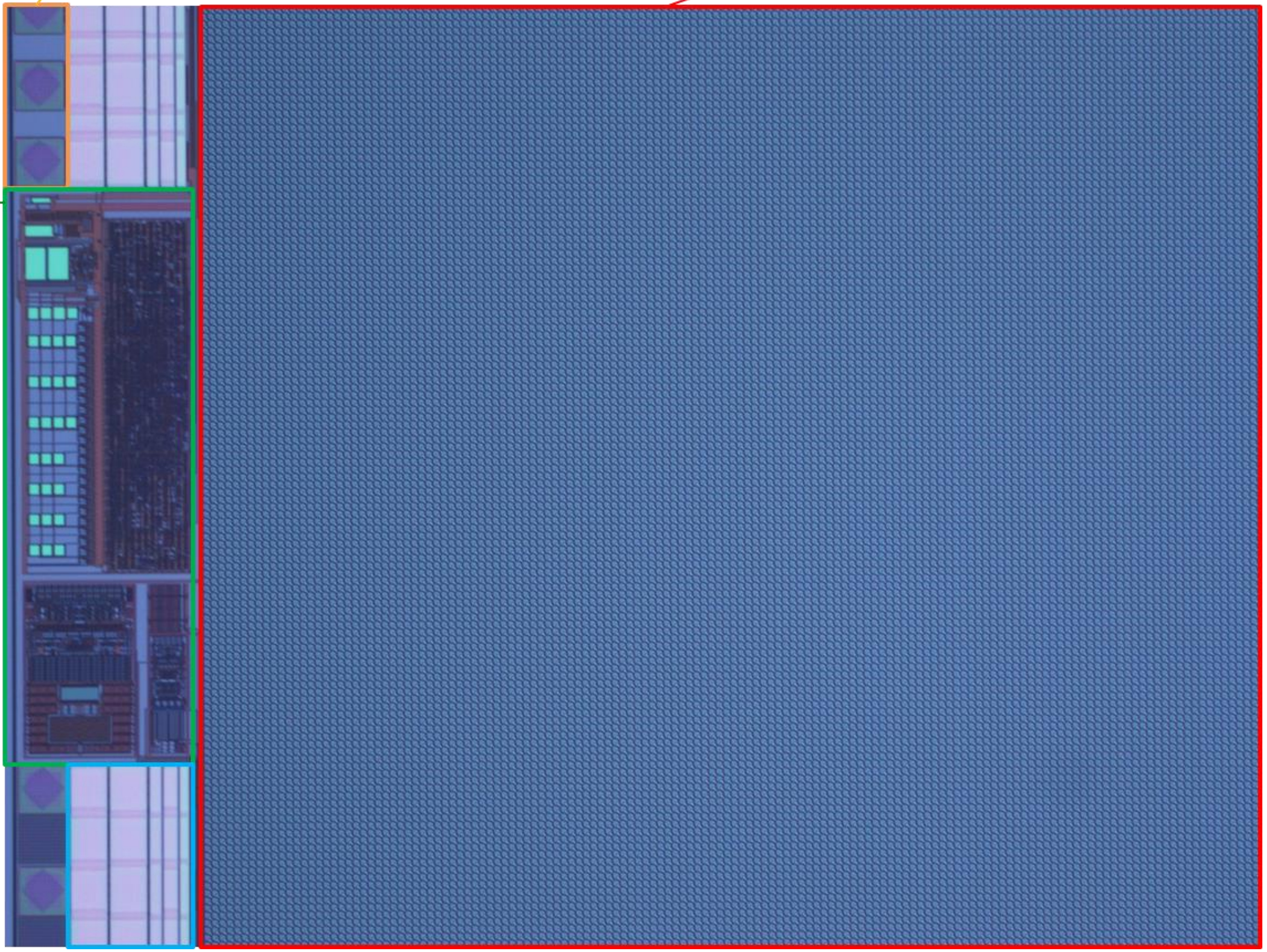
Flex Polyimide

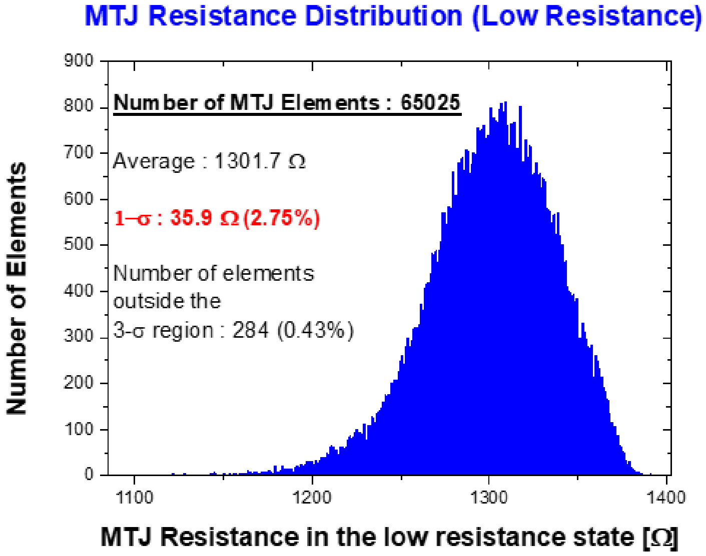
Titratable Acidity (g tart. acid dm^{-3})

Homogeneous integration with CMOS

Large Area and high resolution array of devices

65,536 devices integrated with CMOS

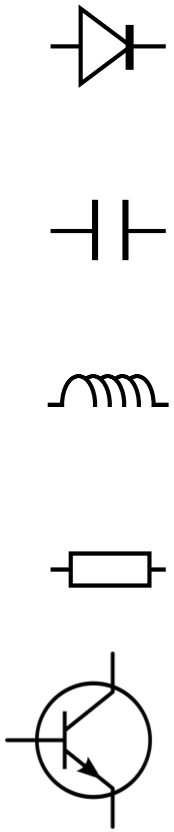




More-than-Moore and Beyond-Moore Technologies

Expanding the library of fundamental electronic components

Conventional Electronics



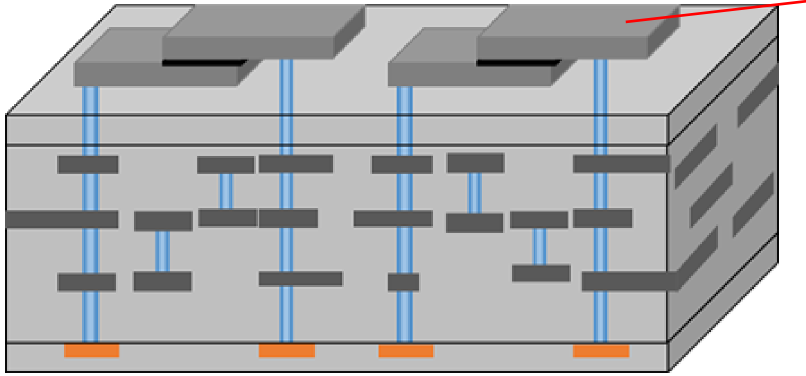
Diode

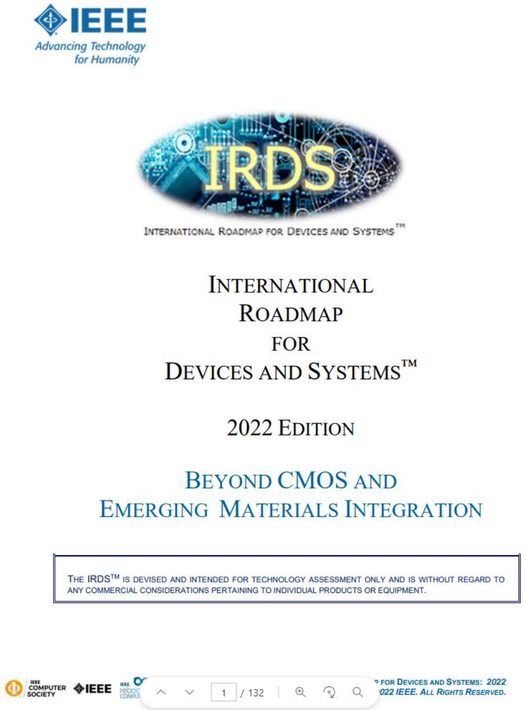
Capacitor

Inductor

Resistor

Transistor





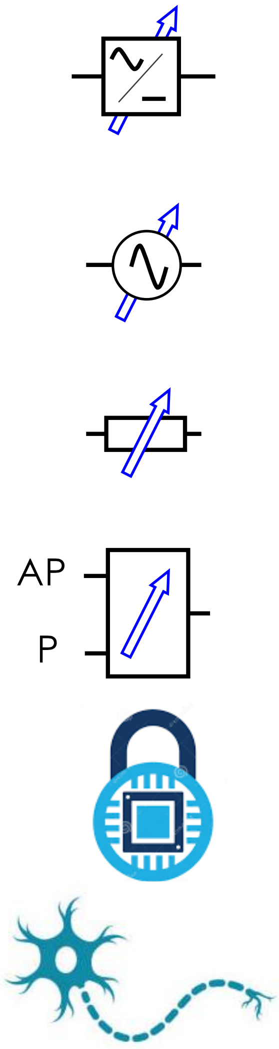
INTERNATIONAL ROADMAP FOR DEVICES AND SYSTEMS™

2022 EDITION

BEYOND CMOS AND EMERGING MATERIALS INTEGRATION

THE IRDS™ IS DEVISED AND INTENDED FOR TECHNOLOGY ASSESSMENT ONLY AND IS WITHOUT REGARD TO ANY COMMERCIAL CONSIDERATIONS PERTAINING TO INDIVIDUAL PRODUCTS OR EQUIPMENT.

Beyond Moore and More-than Moore Components



Detectors

Oscillators

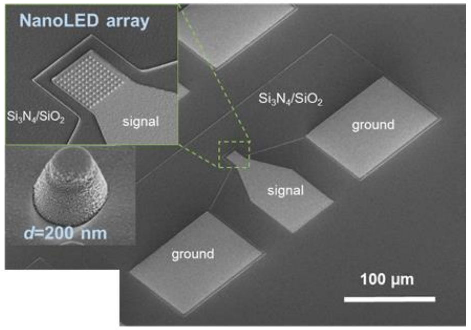
Sensors

Memories

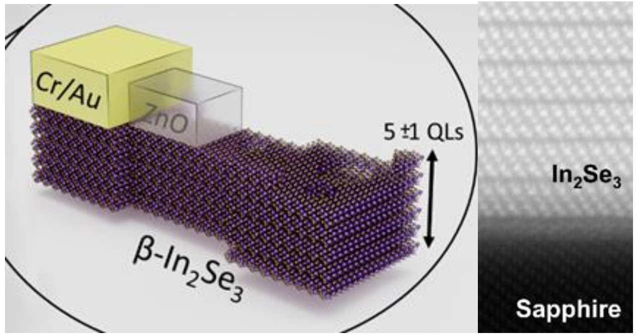
PUF security components

Artificial Neural Networks

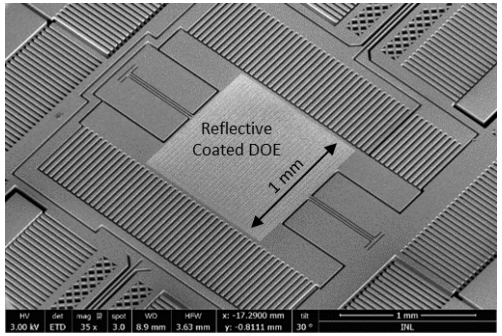
Pilot Line/Competence centers for Co-integration of Emerging Technologies



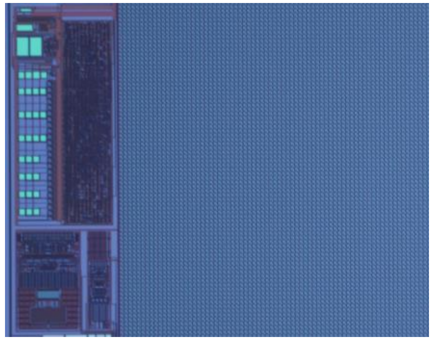
Photonics



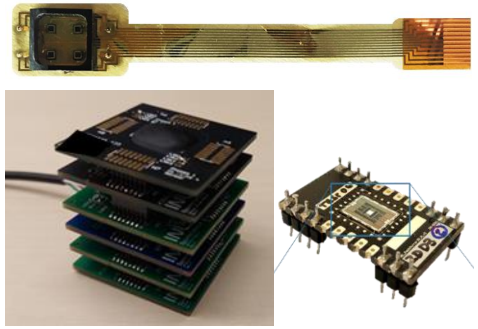
Devices based on 2D Materials



NEMS/MEMS



Spintronics (+CMOS)



Packaging and Integration

Goal	**Co-Integration of Beyond-CMOS key-enabling technologies** **Research, prototyping, testing and pre-large scale production of hybrid co-integrated devices** **Integration with CMOS at the most demanding technology nodes (homogenous and/or heterogeneous)** **Packaging solutions and PDKs**
Expected Impact	**Make disruptive new technologies available at large (SMEs, Academia, Industry)** **Bridge the gap between Academia and Industry**

Thank you!