I³N Innovative Integrated Instrumentation for Nanoscience

polifab POLITECNICO DI MILANO

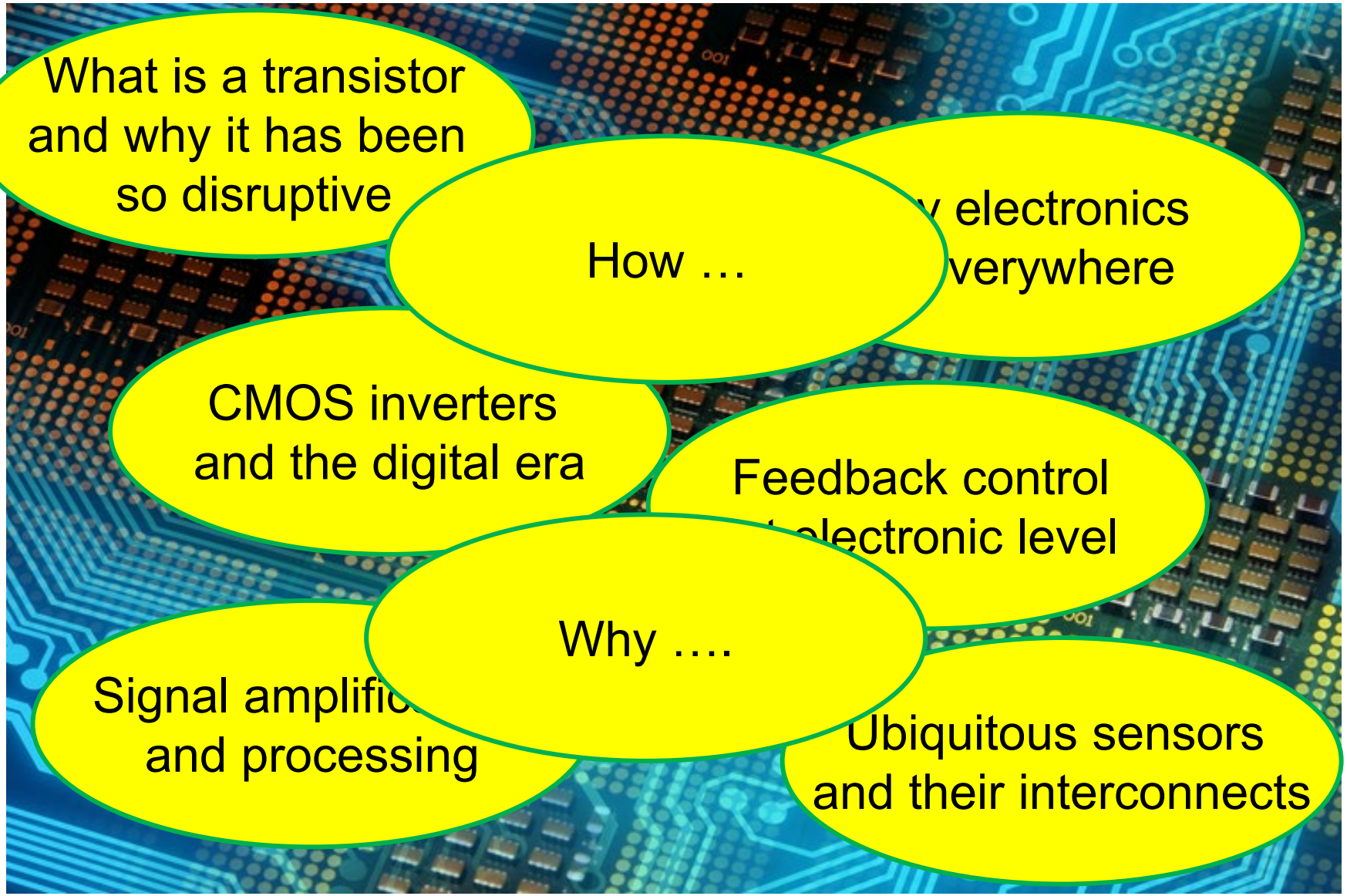
POLITECNICO MILANO 1863

ELECTRONIC SYSTEMS and TECHNOLOGIES
Master in Management Engineering

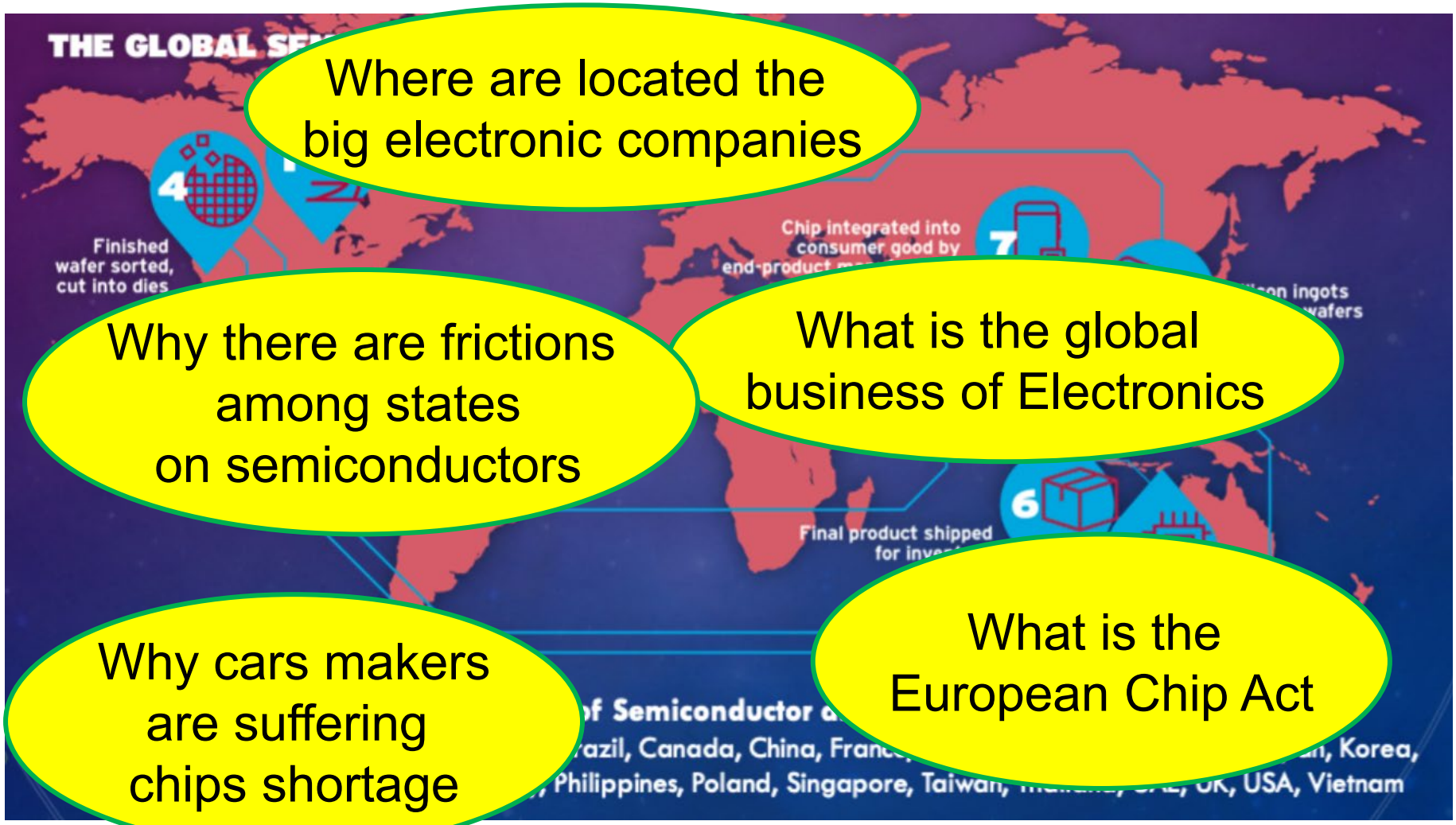
Prof. Marco Sampietro

INTRODUCTION to the COURSE

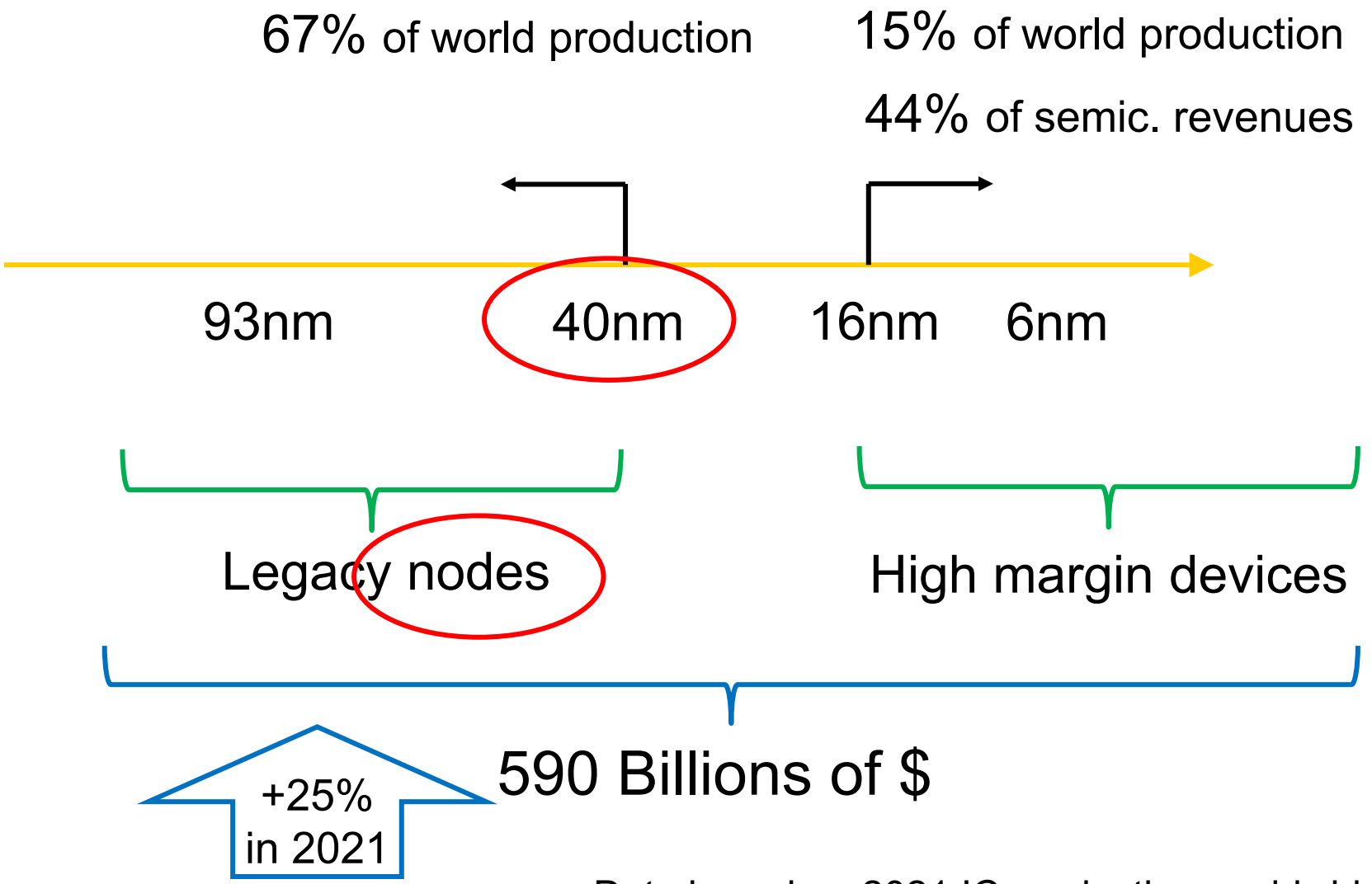
Q&A along the course (1)



Q&A along the course (2)



WORLD BUDGET SCALE OF SEMICONDUCTOR INDUSTRY



Data based on 2021 IC production worldwide

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New technologies predictions 2023-24

Remote Healthcare & Wearables
Augmented Reality
Software for the Edge2Cloud Continuum
Open Hardware
AI-Assisted DevOps
3D Printing in Personalized Healthcare
Generative AI
IT for Sustainability
Autonomous Driving
Digital Distributed Manufacturing

Trusted Computing
Huge Graph Neural Networks
Adaptive, Generative Pharmaceuticals
Autonomous Robots & Brain-Machine I/F
Artificial General Intelligence (AGI)
Global Digitalization of Monetary Transactions
Space ITC
Sustainable Space Manufacturing
Disinformation Detection/Correction

Detailed program of the course (1)

GROUND CONCEPTS ON ELECTRONICS (14 hours)

- Currents and Voltages as engineering tools -The semiconductor materials - The transistor building block -Amplification of signals - Power control and efficiency - Sensors and transduction mechanisms - Acquisition and transmission of data.

THEORY AND PRACTICE OF THE FEEDBACK CONCEPT (8 h)

- The need for a feedback control - Practical examples of feedback electronic circuits - Precision, stability, adaptability -The pervasiveness of control in automation supported by electronic technology

DIGITAL CIRCUITS COMPONENTS (12 h)

- Converting signals from Analog to Digital and back - CMOS inverter and Logic digital circuits - Integrated Processors : microcontrollers, microcomputers and FPGA - Memory devices

Detailed program of the course (2)

THE IC MANUFACTURING CHAIN (4 h)

- Clean room : the core of a dust-free production site - The processes for the fabrication of microchips : doping, lithography, depositions - The challenge to environmentally friendly manufacturing - The players in the technological supply chain

NEW CONCEPTS ON ELECTRONICS (6 h)

- Plastic Electronics : chemistry into play; Drop-on-demand technology; OLED & screens - Flexible Electronics : how to conform to existing objects adding new functionalities - Edible Electronics : medical pils with a remote control; Electronics in the body

ELECTRONICS AS A GLOBAL INDUSTRY (6 h)

- The Silicon Valley : a case study - The world playground - Europe roadmap - The excellence of Italy

Slides available + material

https://sampietro.faculty.polimi.it/

Politecnico Milano

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- High Resolution Electronic
- Me...
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- Lessons to download
- BIOMEDICAL

Marco Sampietro

Marco SAMPIETRO is Full Professor of Electronics
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at Politecnico di Milano (Campus Leonardo)

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Exam

Written exercises
(on the day of the exam)

+

Short oral presentations
about 15 minutes
(along the course)

ABOUT MYSELF

Laurea in Nuclear Engineering
1982

Full Professor of Electronics
2002

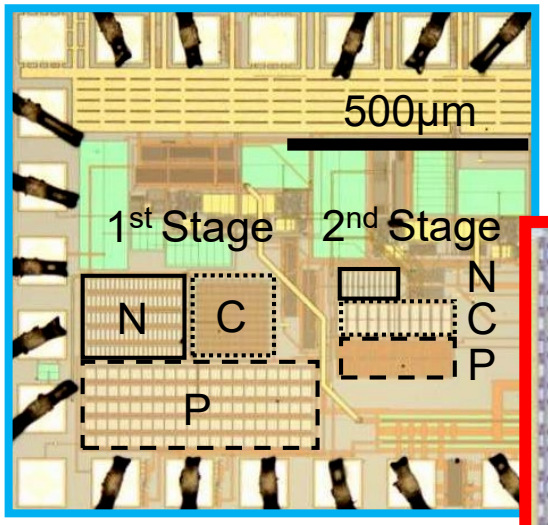
Co-founder of POLIFAB
2011

Start-up PHOTONPATH
https://www.photon-path.com/
2018

Teaching «Elettronica Analogica» 3 year, Electronic Engineering

6 EU projects + 2 IT projects in the last 10 years > 2 ML €

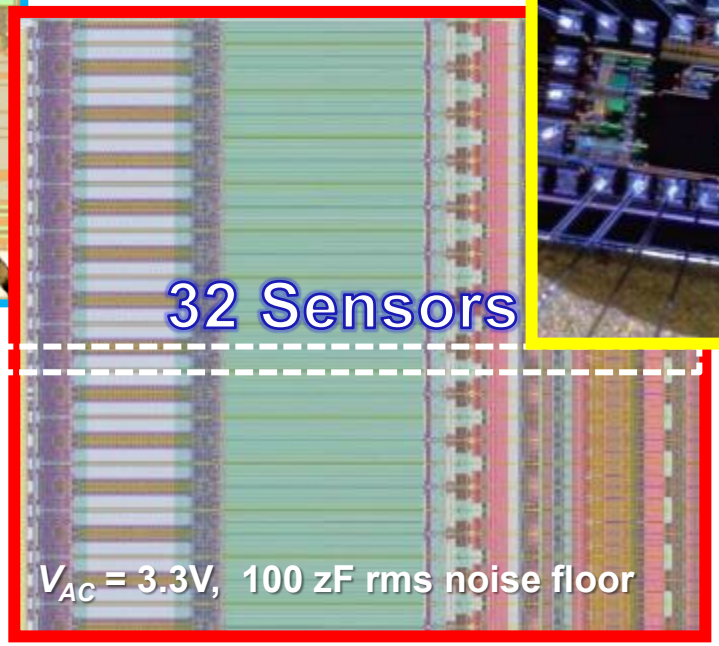
INTEGRATED CIRCUITS for HIGH PERFORMANCE SENSORS



Sub-fA current resolution for bio-cell counting

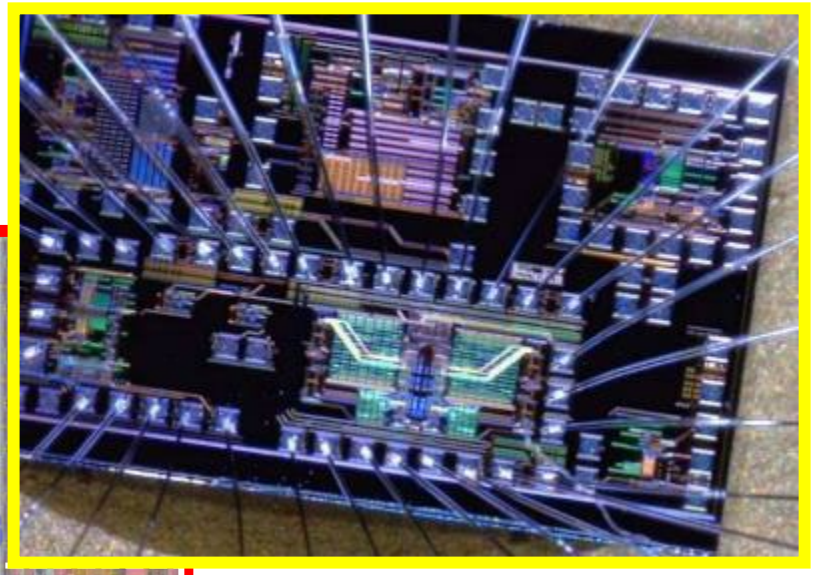
G. Ferrari, M.Sampietro et al. , IEEE J. Solid State Circuits, 74, 1609-1616 (2009);
F. Gozzini, M.Sampietro, G.Ferrari et al., IEEE ISSCC, 346 (2009)

Detection of DUST particles



2 mm

P. Ciccarella, M. Carminati, M. Sampietro, G. Ferrari, **IEEE J. Solid-State Circuits 51 (11), 2545-2553 (2016)**

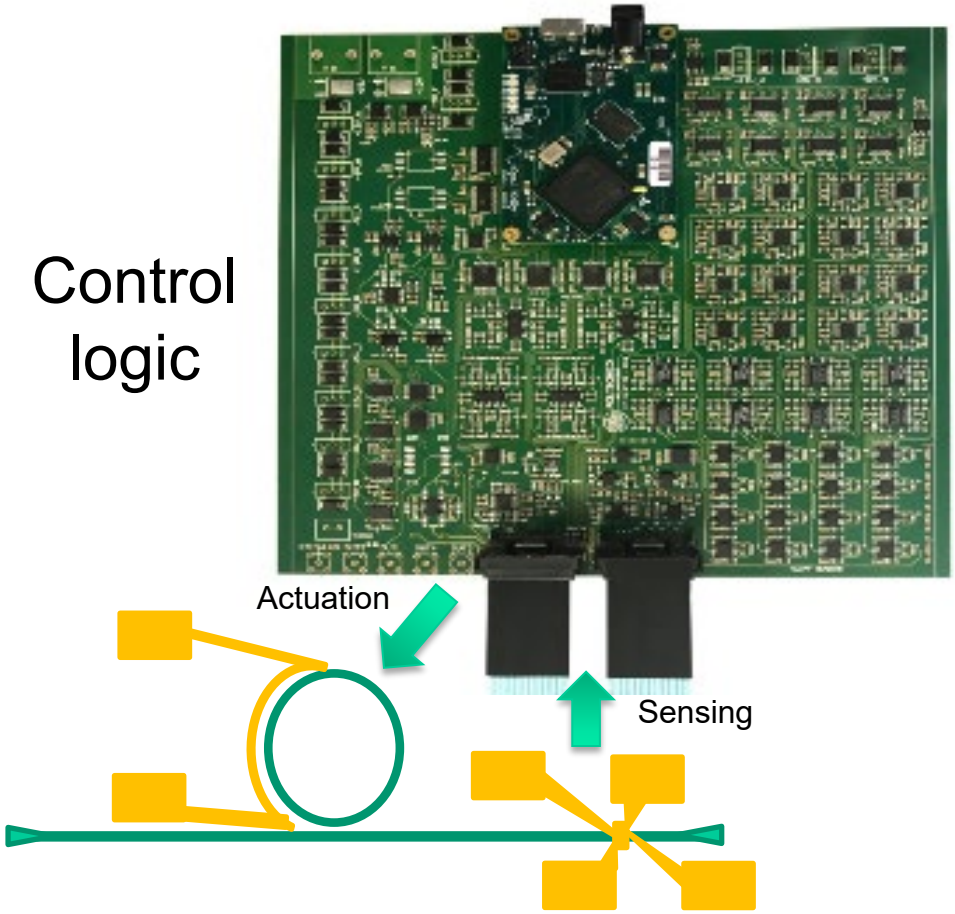


Light measurement in Si-photonics applications

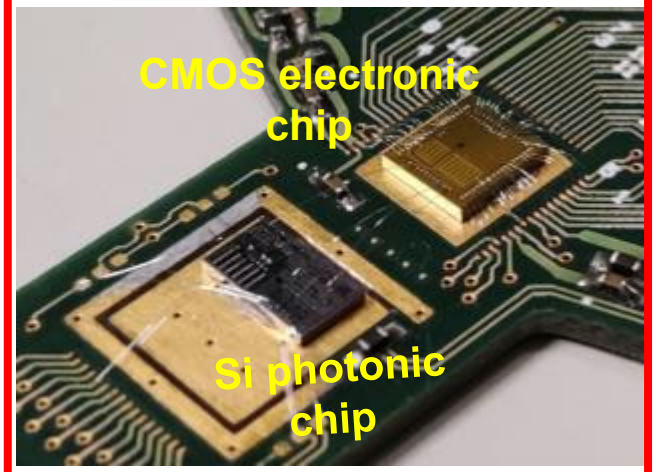
E.Guglielmi, M.Sampietro, G.Ferrari et al. **IEEE J. Solid-State Circuits** 55 (8), 2094-2105 (2020)

ELECTRONIC PLATFORMS for INTEGRATED PHOTONICS

Control logic



Electronics-photonics co-design with Integrated Technology



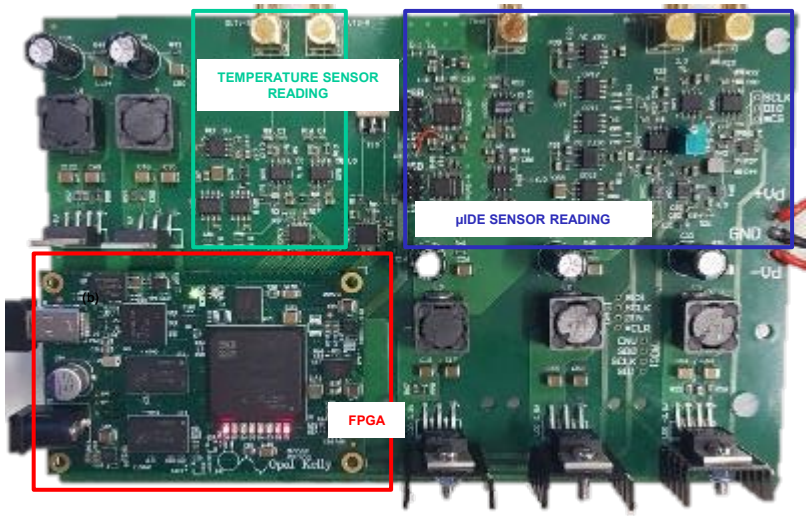
Electronic ASIC with **STm** BCD8sp 0.18μm technology

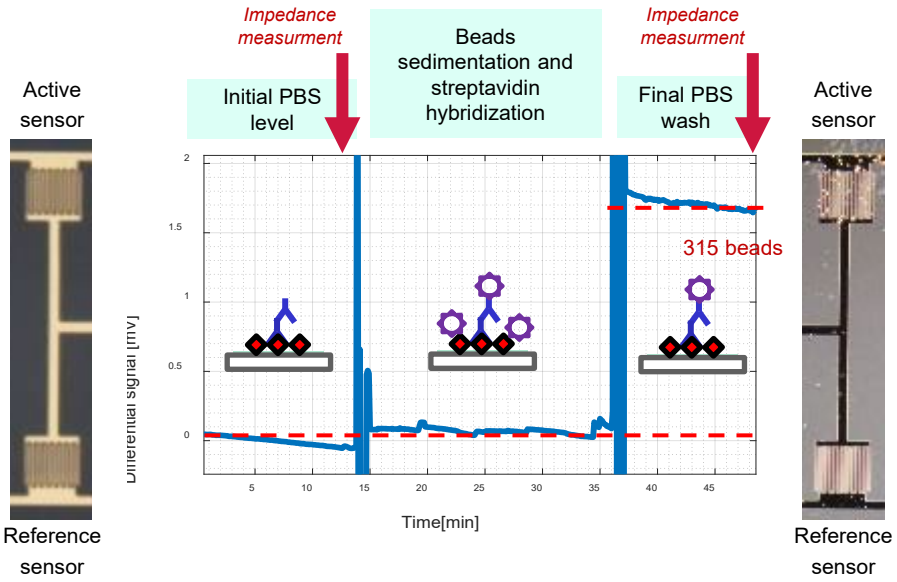
F.Morichetti, G.Ferrari, M.Sampietro et al. **Nature Communications** Vol.12, 4324 (2021)

A.Annoni, G.Ferrari, M.Sampietro, et al. **Light: Science & Applications, 6 (12), e17110 (2017)**

Instrumentation for nano-bio applications

Electronic system for real time amperometry, voltammetry and impedance spectroscopy





P.Piedimonte, G.Ferrari, M.Sampietro et al.. **Biosensors and Bioelectronics**, Vol.202, 2022, 113996

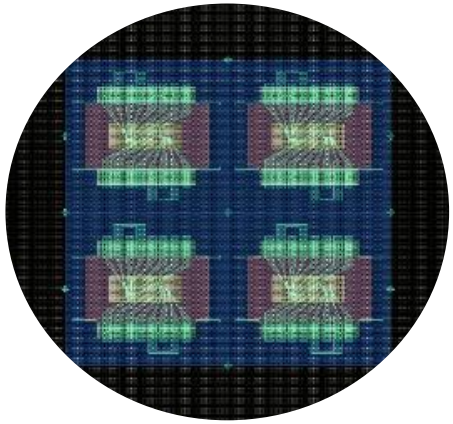
M.Giacometti, M.Sampietro, G.Ferrari et al**. Adv. Sci.** 2021, 8, 2004101.

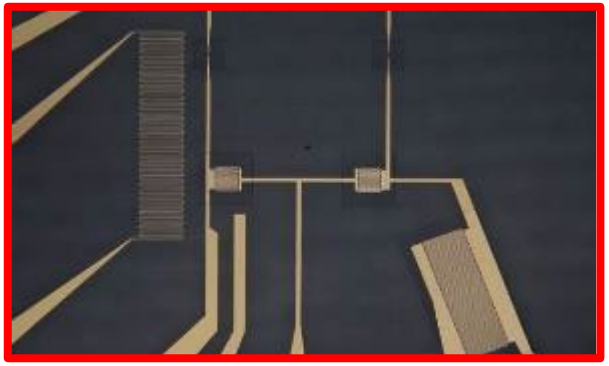
POLIFAB – Clean room facility

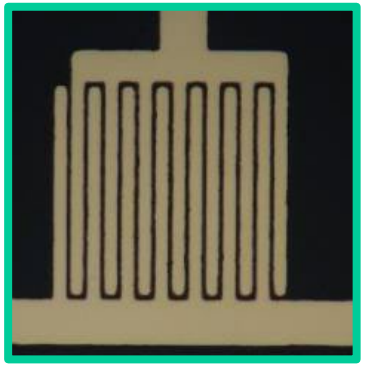
I3N lab is part of **POLIFAB**, the micro and nano technology center of the Politecnico di Milano (700 m^2 of clean room)

Cleanroom surrounded by a cluster of labs of micro- and nanoelectronics, photonics, photovoltaics, biotechnologies, spintronics, organic semiconductors

In-house realisation of devices and sensors







My research group

4 staff members 4 post DOCs 7 PhD 12 MS thesis