

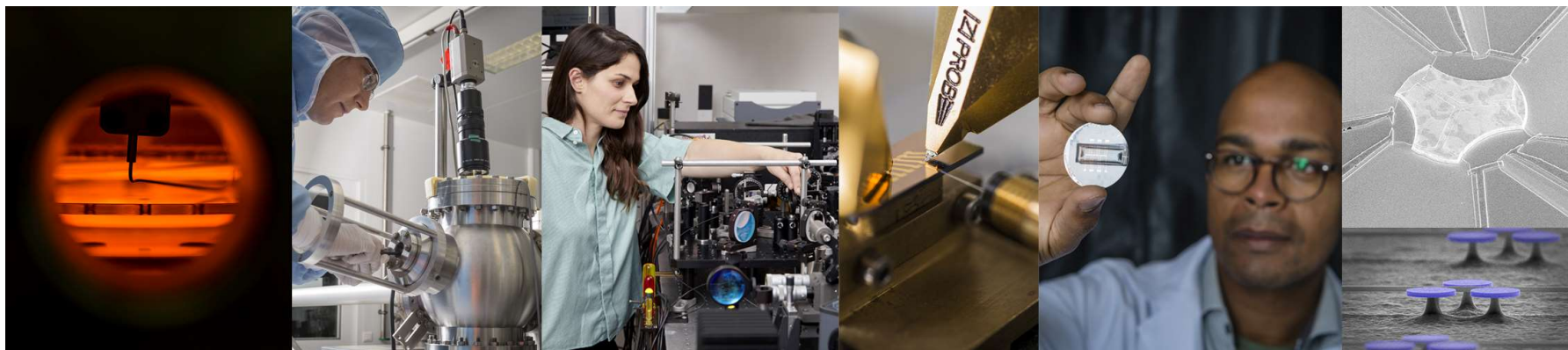


# Centre de Nanosciences et de Nanotechnologies

[www.c2n.universite-paris-saclay.fr](http://www.c2n.universite-paris-saclay.fr)

 @C2N\_com

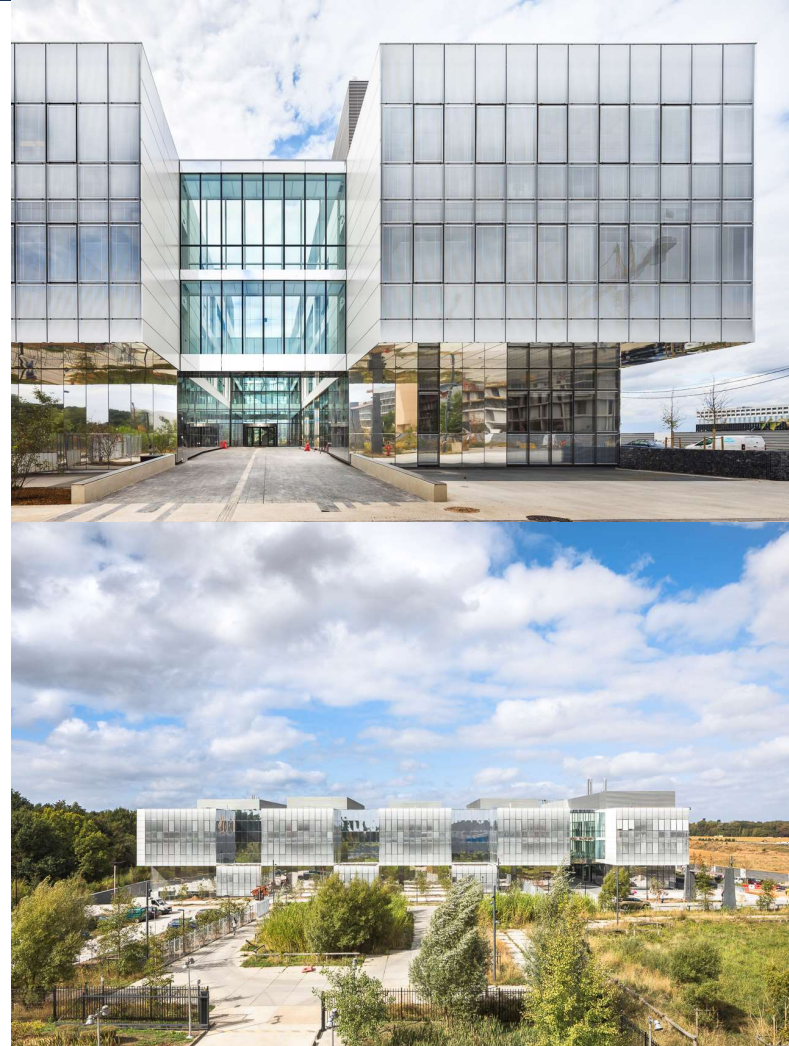
*Centre for Nanoscience and Nanotechnology*



A joint research unit

# A new research centre for nanoscience

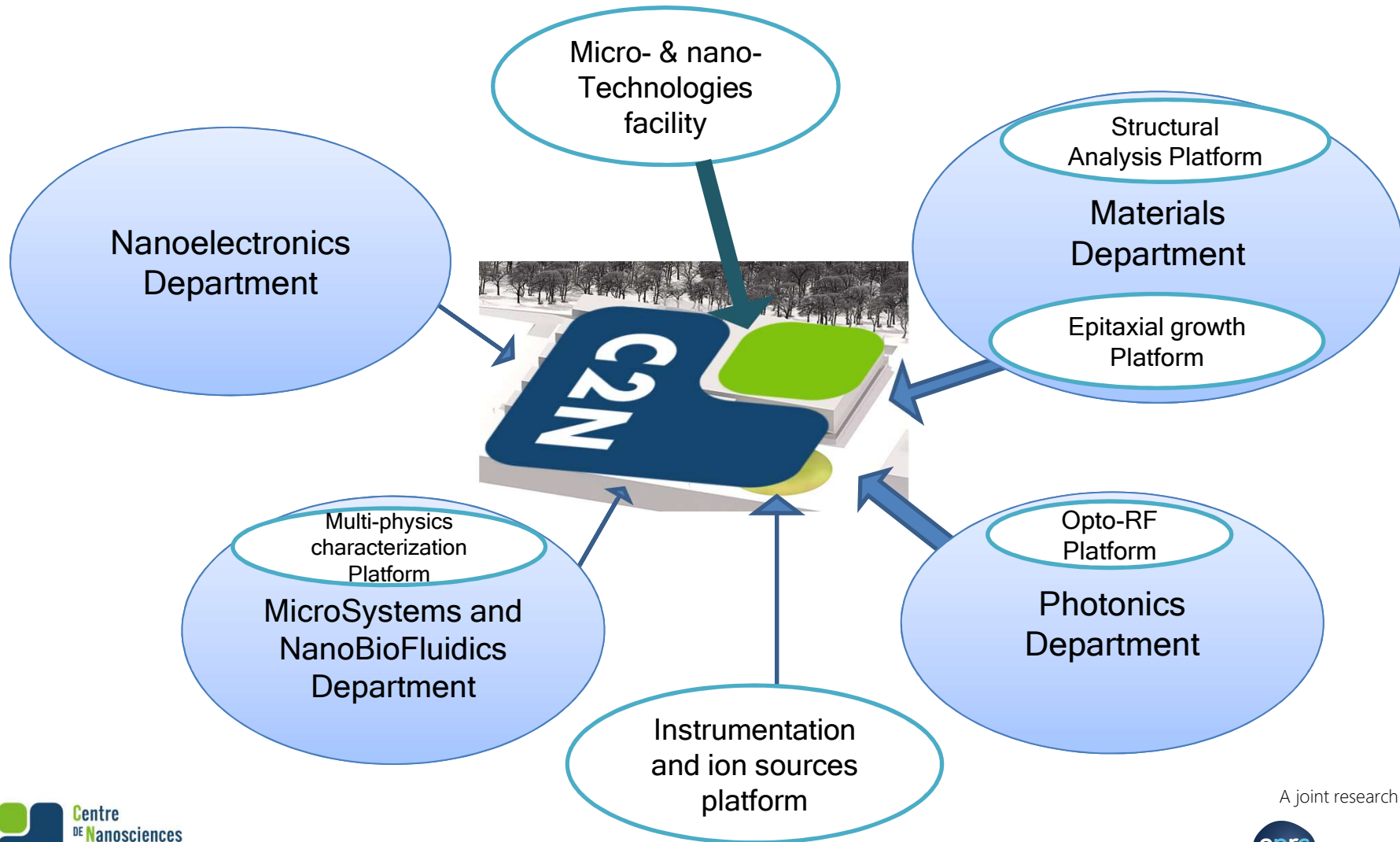
- Creation in June 2016, merging of two labs (IEF / LPN)
- Around 400 members:
  - 200 permanent researchers, engineers and admin staff
  - More than 100 PhD students and Post-docs
  - 37 nationalities
- 4 research departments, 6 platforms of technology
- A new building at the heart of Paris-Saclay
  - 18,000 m<sup>2</sup>, including 2,900 m<sup>2</sup> high class cleanroom facilities



Photos: Sergio Grazia

A joint research unit

# Research and platforms at C2N



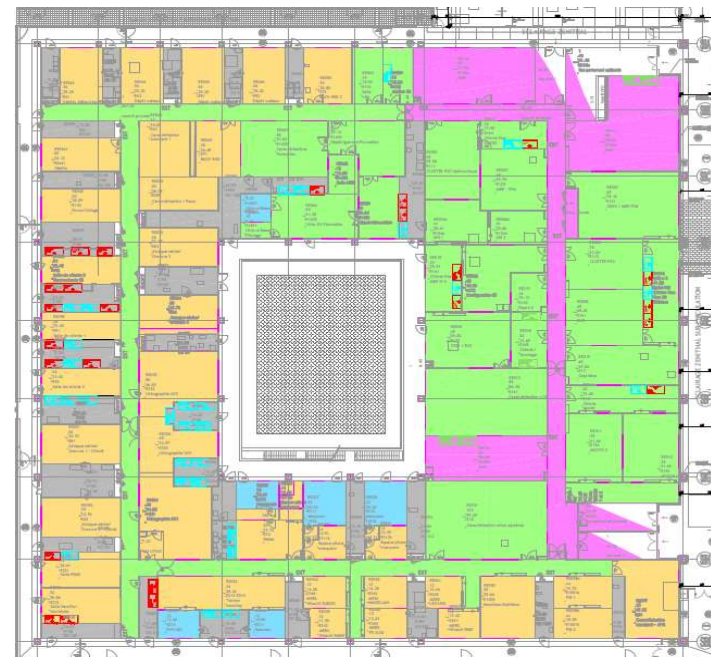


# C2N Nanotechnology facility

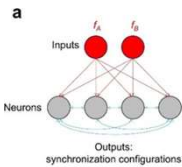
- 2,900 m<sup>2</sup> cleanroom, including
  - 1,200 m<sup>2</sup> : process
  - 700 m<sup>2</sup> : epitaxy & material growth
  - 170 m<sup>2</sup> : education & training
  - 250 m<sup>2</sup> : hosting of startups and SME
- More than 600 process tools
  - 50 M€ total equipment (including growth & analysis)
- 3 Platforms
  - Micro and Nano-Technologies Innovation Platform (PIMENT)
  - PlatForm for Elaboration of Materials (POEM)
  - Material Analysis Platform (PANAM)
- 28 permanent engineers & technicians for process technologies (PIMENT)



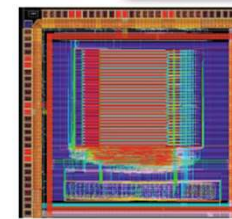
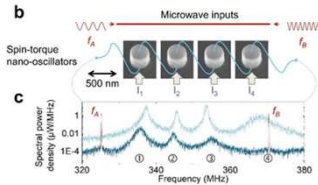
Photo: Sergio Grazia



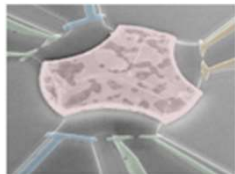
# Science at C2N: from materials to applications



Novel **computation and simulation** paradigms



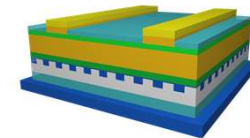
Advanced **nano**electronic and photonic devices



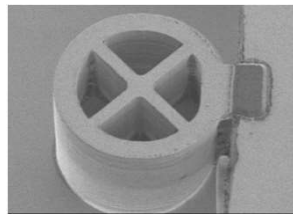
**Nanoscale physics**



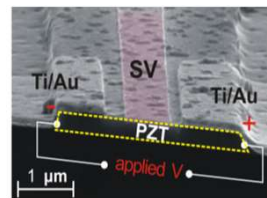
Cutting-edge instrumentation and **nanotechnologies**



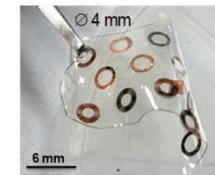
**Photovoltaics** and energy harvesting



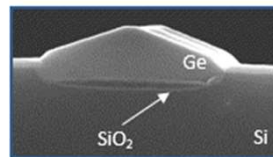
**Quantum** photonics & electronics



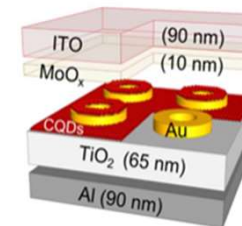
Theory, modeling and simulation, from nanostructures to nanodevices



**Advanced biosensing**



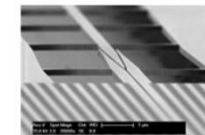
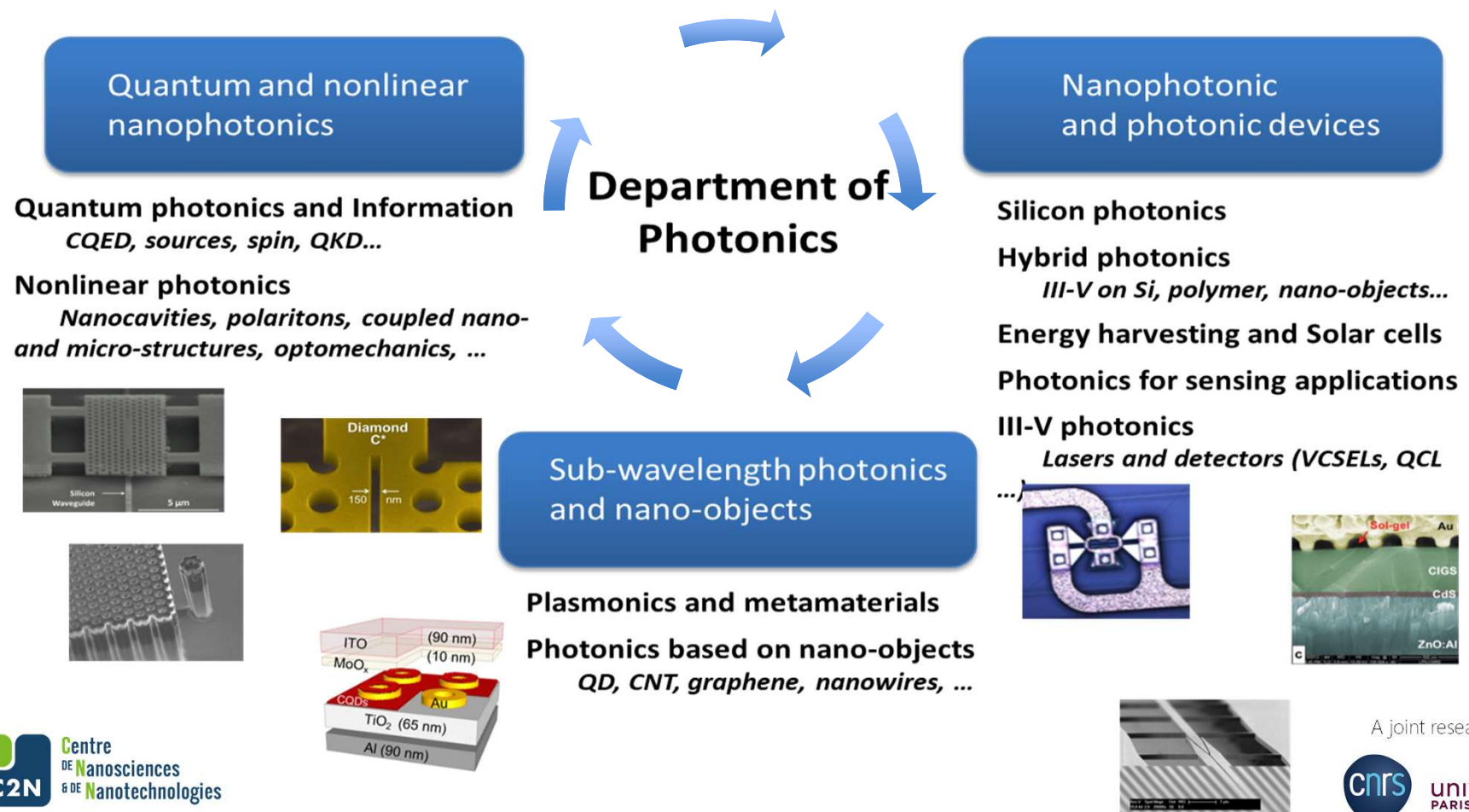
Materials, **nanostructures** and hybrid integration



Advanced concepts for light manipulation at any wavelength

# Photonics Department

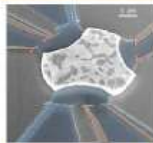
- **180 members**, including **42 CNRS researchers/faculty members**
- **10 Research Groups / 1 start-up / A Technological Platform** for “RF and Optics Experimentations”



# Nanoelectronics Department

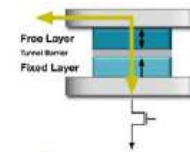
- 61 members, including 31 CNRS researchers/faculty members
- 5 Research Groups / 2 start-up companies

## 1. Physique des nanostructures électroniques



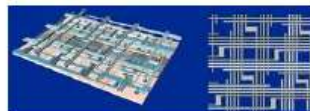
- 1.1 Epitaxial growth of 2D electron gases in III-IV heterostructures
- 1.2 Microscopy and tunnel spectroscopy at low T
- 1.3 Transport and Quantum Phenomena
- 1.4 Physics of carbon based devices
- 1.5 Cryoelectronics
- 1.6 THz and Opto-Electronics devices

## 2. Physique des nanocomposants spintroniques



- 2.1 Spin transfer torque in MRAMs
- 2.2 Domain wall based devices
- 2.3 Spin orbitronics and magnonics
- 2.4 Ion irradiation treatment of electronic materials
- 2.5 Nanomagnetism and mesoscopic spintronics

## 3. Simulation, théorie et architecture



- 3.1 Beyond CMOS nanoelectronics
- 3.2 Heat transport and thermoelectricity
- 3.3 Spin electronics
- 3.4 CMOS/magnetic hybrid circuits
- 3.5 Bio inspired architectures






# Microsystems and NanoBioFluidics Department

- 62 members, including 22 CNRS Researchers/Faculty members
- 3 Research Groups / A Platform for “Multi-physics characterization”

(Axis 1)

## MEMS & Instrumentation

- MEMS 
- Instrumentation et électronique 
- Procédés pour l'intégration 3D 

(Axis 2)

## Microdispositifs pour applications médicales

- Dispositifs portables / implantables 
- Récupération d'Énergie 

(Axis 3)

## Smart BioSystems

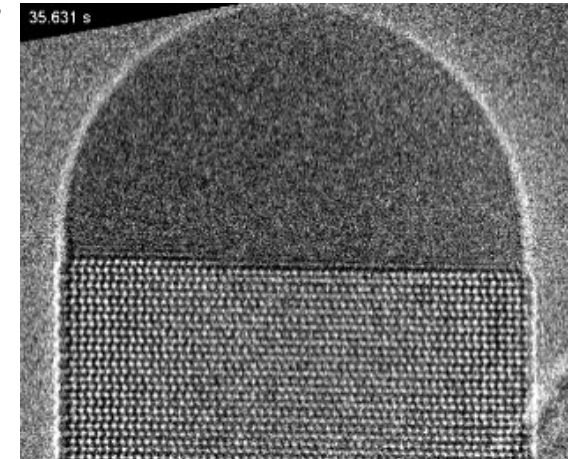
- Bio-analyse sur puce 
- Micronageurs sur puces 
- Dynanets 



# Materials Department

- 55 members, including 21 CNRS researchers/Faculty members
- 5 Research Groups / 2 Platforms for “Epitaxial Growth” and “Structural Analysis”

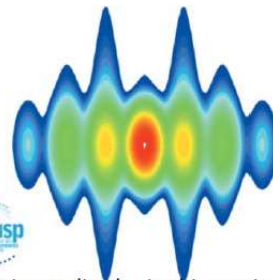
- **Material Science** : epitaxial growth, material properties
- **Elaboration**: new materials, heterostructures, nanostructures
- **Analyses**: structural, chemical, atomically resolved, *in situ* and *in operando*



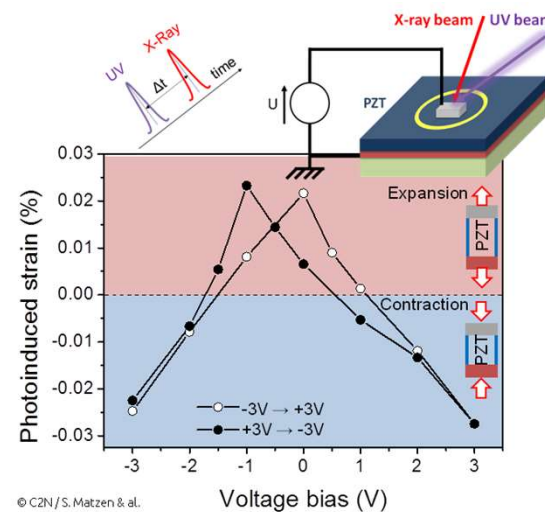
Growing a Crystal One Atomic Layer at a Time

- **Instrumentation**: development of original instruments
- **Modeling** and theoretical analysis

- **Development of devices**

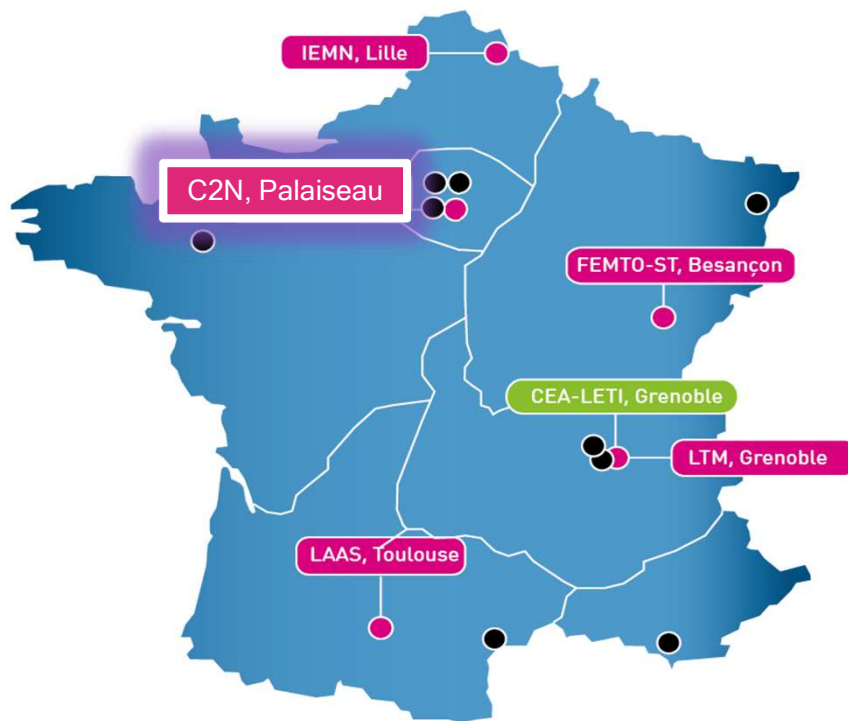


Acoustic amplitudes in thin strained films determined by XRD mapping



Controlling with light the amplitude and the direction of the deformation of a material

# C2N in the French « nano » network



C2N represents around 35 % of French academic research potential, with the largest cleanroom

Research in nanoscience in France :

- 7000 researchers spread in 250 laboratories
- C'Nano for scientific networking



C2N and its cleanroom are part of:

- A French network



- A European network



# Transfer of technology and industrial collaborations

Many collaborations and partnerships with large-medium size companies and start-up:

- Technological services,
- Collaboration agreements,
- Contracts to provide equipment and staff,
- Currently more than 10 thesis with industrial partners (thèse CIFRE)

3 Spin-off : Quandela, Klearia, Spin-ION and CryoHEMT

Partnerships with French public industrial and commercial institution

- CEA (Leti) : microelectronics
- LNE (National Metrology and Testing Laboratory) : metrology
- ONERA
- CNES : electronics components

Partnerships with large companies:

- Thalès TRT
- Safran
- ST Microelectronics
- Groupe PSA
- ...



11e augmented

# Involvements in Education and Trainings

44 researchers at C2N are teacher-researchers at University Paris-Saclay and University Paris Diderot, among which:

- 14 Heads of License or Master programs (L1 to M2)
- 30 teachers

## Micro and Nano-technologies training in cleanroom environment

- Main training at University Paris-Saclay open to all components
- Open to external parties, including industry
- Researchers and engineers of C2N deeply involved for the teaching and for the tools maintenance.



## Other academic involvements:

- International Summer Schools (GDRI NAMIS, LIA Nanoelectronics, Nanoscience, Nano3, etc.)
- Academic committees and managing positions at Paris-Saclay University, National Universities Council



# Main international activities

- **International associated laboratory (LIA CNRS) on :**  
Nanoelectronics, from new phenomena to low-power electronics  
University of California San Diego and New York University



- **International associated laboratory (LIA CNRS) on :**  
Physics of nanostructures and innovative devices based on compound semiconductors  
Ioffe Institute and ITMO University, Saint Petersburg

- **International Research Network (GDRI CNRS) NAMIS, on :**  
Nano- et Micro- Systems



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