The PiezoMAT project

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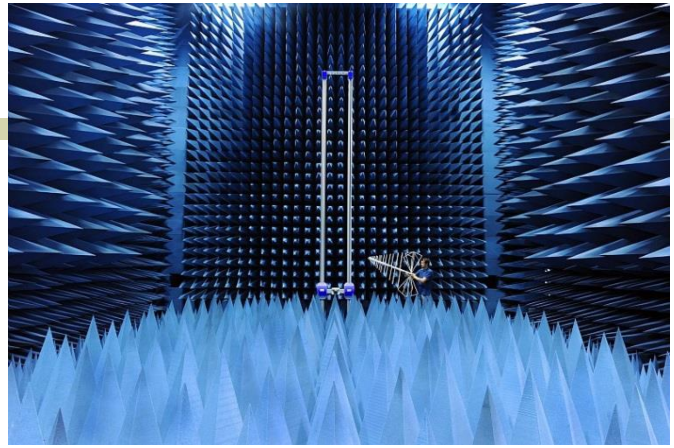
SEVENTH FRAMEWORK PROGRAMME

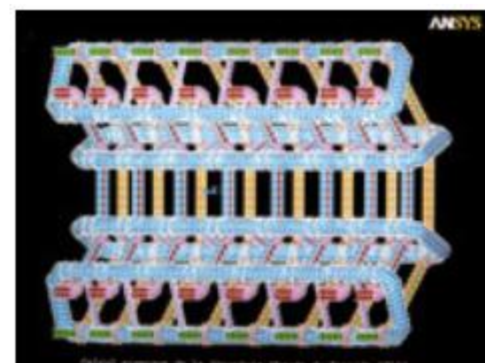
EU Project No. 611019

WHAT IS THE CEA ?



- **10** research centers
- **16 110** technicians engineers, researchers and staff
- **51** joint research units (*UMR*)

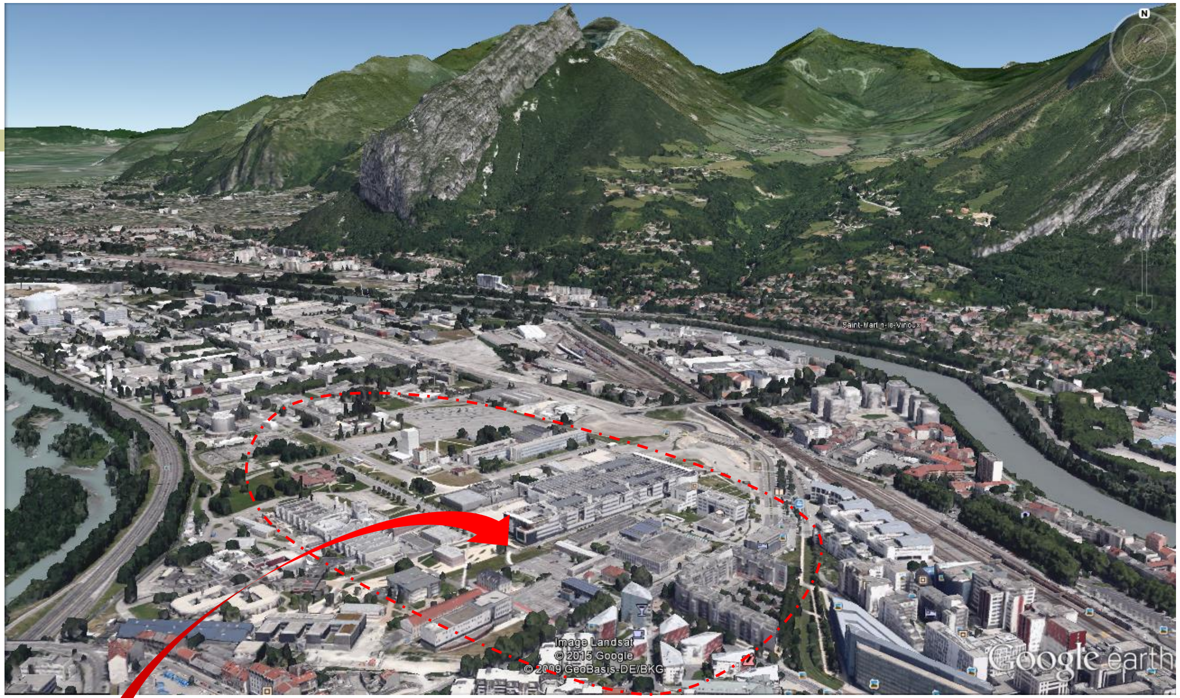
- Research Activities :
  - defense
  - energy (nuclear & sustainable energies)
  - technologies
  - fundamental research



Atlas detector seismic design of the structure. © CEA

WHAT IS THE CEA ?

CEA IN GRENOBLE

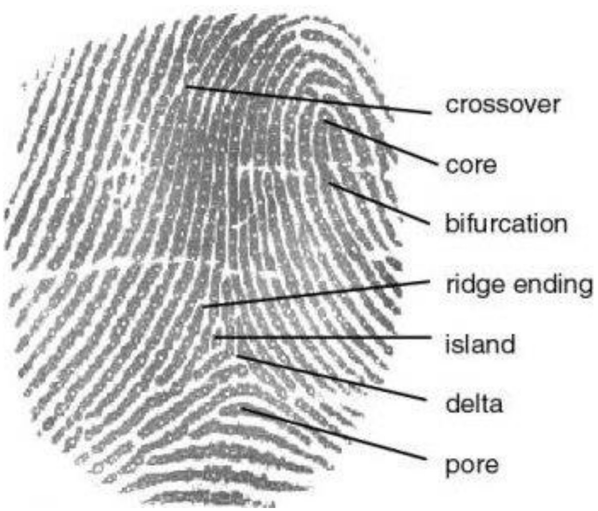


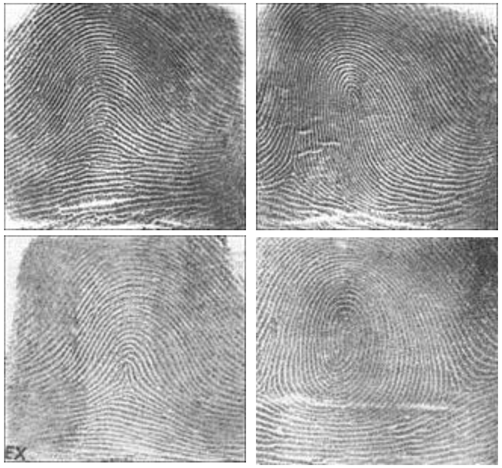
One of the CEA LETI building

PiezoMat now…

Objective of PiezoMAT

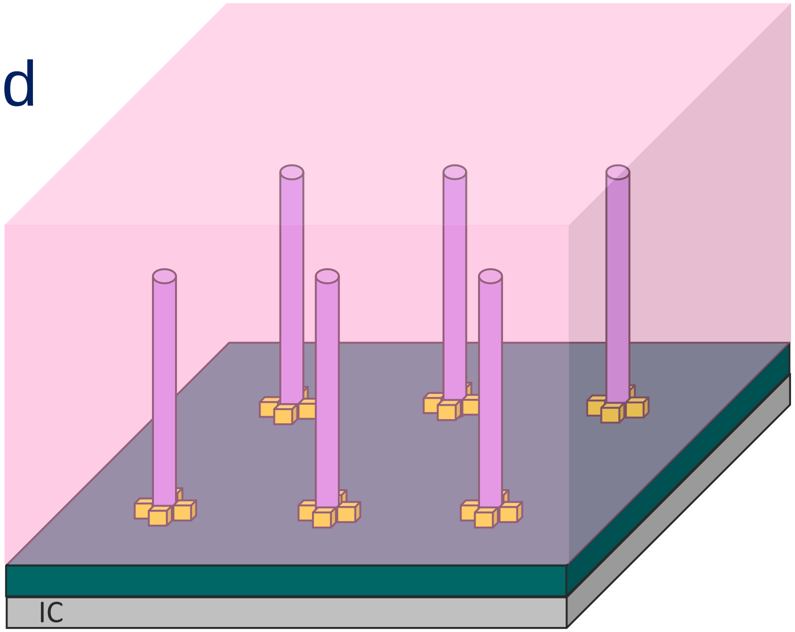
- Very-high spatial resolution fingerprint sensor
  - Target : level 3 of fingerprint details
    - Level 1 : ridge flows and singular points
    - Level 2 : minutiae points (ridge ending, bifurcation)
    - **Target : Level 3 : pores, ridge edges**





Objective of PIEZOMAT (2)

- Matrix of individually interconnected vertical PZ NWs
  - Encapsulated in a polymer
- 1000 dpi resolution
  - For maximal on-chip integration density

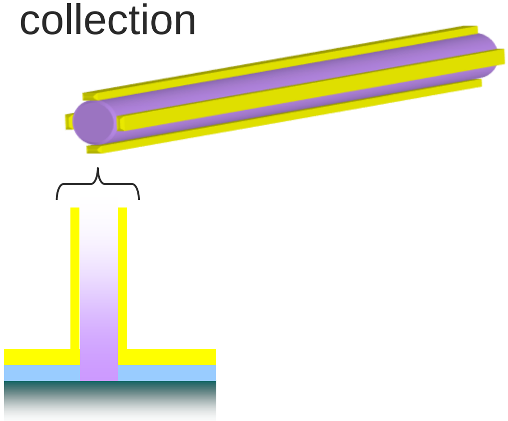


Technological challenges (1/5)

❑ Processing chips with NWs electrical contacts deposition

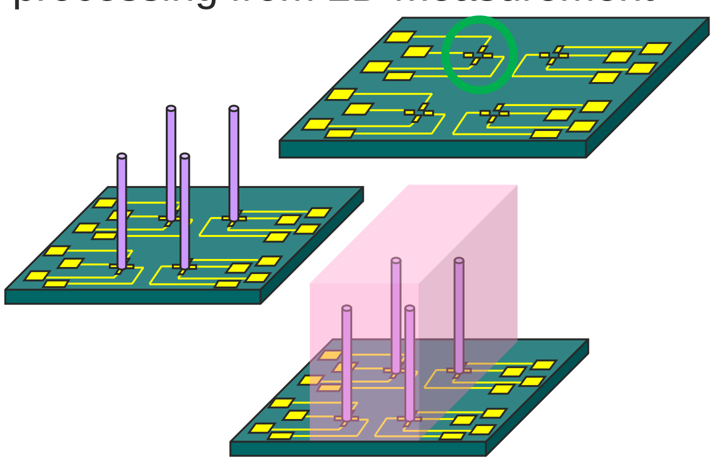
OPTION 1 (direct metal deposition)

- NW / metal interfaces
- High risk, not scalable
- Maximum signal collection



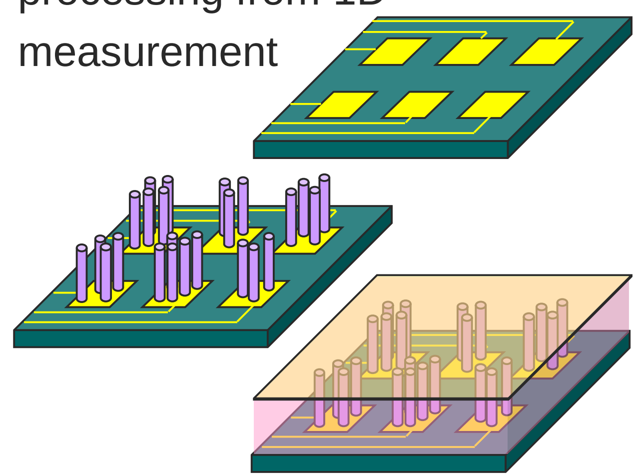
OPTION 2 (bending)

- 4 contacts in high potential area
- Technologically challenging
- Complex signal collection / processing from 2D measurement



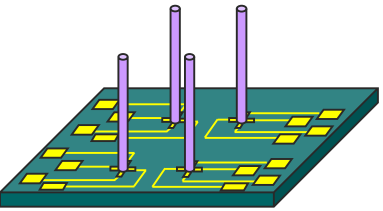
OPTION 3 (compression)

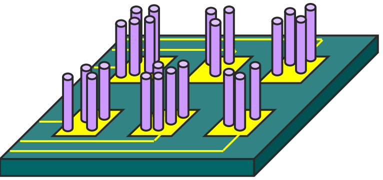
- 2 top-bottom contacts
- Technologically safer
- Complex signal collection / processing from 1D measurement



Technological challenges (2/5)

- Growing localized NW on the chips (options 2 and 3)





PLD growth challenges

- Reduced **thermal budget (<400°C)**
- Controlled **NW morphologies** (radii 400nm to 1µm)
- **localized** growth of thick NWs
- Controlled **seed mechanisms** on non-metal or metal layer (options 2,3) **compatible with chip processing**

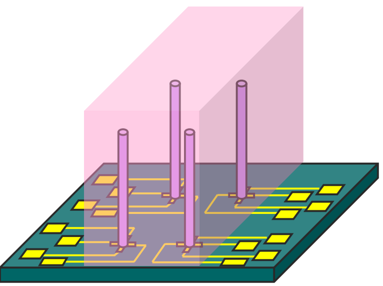
WCG* growth challenges

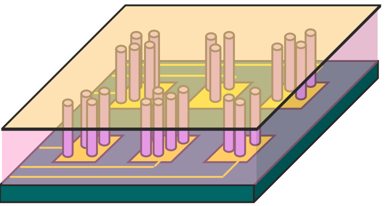
- **Crystal defect** (unintentional n-type dopants) reduction by in-situ doping or post-processing
- **localized** growth of thin NWs
- Controlled **seed mechanisms** on non-metal or metal layer (options 2,3) **compatible with chip processing**

* **W**et **C**hemical **G**rowth, a.k.a ACG (**A**queous **C**hemical **G**rowth)

Technological challenges (3/5)

- Encapsulating NWs into a polymer

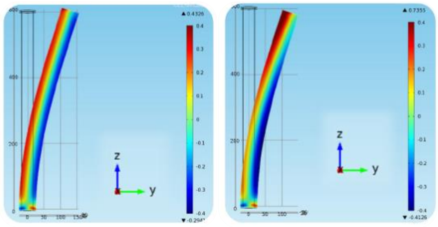


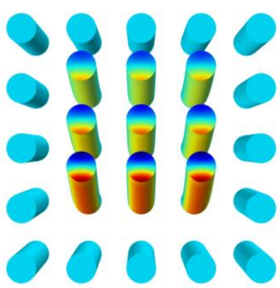


- **Transfer force from 3D deformation field to NWs**
  - Without altering sensing capability
  - Compatible with a suitable fingerprint interface
- **Be industry / process compatible**
  - Deposition process development
  - Polymer treatment
- **Will need structural / chemical characterisations**
  - Chemical, Electrical, Mechanical characterization of the polymer
  - Then Piezoelectric characterisation of encapsulated NW(s)

Technological challenges (4/5)

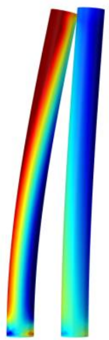
- ❑ Building a multi-physics model for the NWs





❑ Need for linear and non-linear models

- ❑ Single contacted then encapsulated NW
- ❑ Multiple contacted then encapsulated NWs



❑ Need to link models of different origins

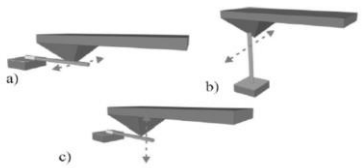
- ❑ First principles calculations of charge transport at NW/metal interface
- ❑ Then implementation into a global model

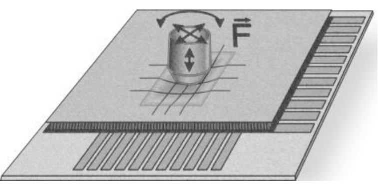
❑ Need to handle static & dynamic simulations

- ❑ Static : static mechanical load applied on the NW top section
- ❑ Dynamic : harmonic and transient responses of NW subjected to fluctuating loads

Technological challenges (5/5)

- Characterizing and testing
  - **Bend / compress single / multiple NWs**
    - Single NW AFM-based characterisations
    - Real-time read-out by 8-bit digitalising
  - **A matrix of multiple NWs**
    - 10 x 10 NW matrix (PoC chip) characterisation by force-calibrated multi-axis nano-positioner
    - Analogue read-out lines, multi-channel switch mainframe
  - **Perform a partial demonstration phase with DEMO chip**
    - Evaluate the Modular Transfer Function (MTF) on 3D template
    - Check the ability to transfer multiple “grey levels”
    - Evaluate the impact of the distortion induced by slight finger rotations
    - Test pure biometrics function (False Rejection / Acceptance Ratios)





SEVENTH FRAMEWORK PROGRAMME

Consortium to reach objective

No	Name	Short name	Country	Project entry month[10]	Project exit month
1	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	CEA	France	1	36
2	FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V	Fraunhofer	Germany	1	36
3	RESEARCH CENTRE FOR NATURAL SCIENCES, HUNGARIAN ACADEMY OF SCIENCES	MTA	Hungary	1	36
4	UNIVERSITAET LEIPZIG	ULEI	Germany	1	36
5	KAUNO TECHNOLOGIJOS UNIVERSITETAS	KTU	Lithuania	1	36
6	SPECIFIC POLYMERS	SPECIFIC POLYMERS	France	1	36
7	UNIVERSITY COLLEGE CORK, NATIONAL UNIVERSITY OF IRELAND, CORK	Tyndall-UCC	Ireland	1	36
8	SAFRAN	SAFRAN	France	1	36

SEVENTH FRAMEWORK PROGRAMME

Role distribution

- Device specifications and design
  - Specification definition
    Safran Identity & Security + all
  - Stack / materials / layouts
    CEA, ULEI, MTA EK, S. Polymer
- Simulations
  - First principle calculations
    TYNDALL (Ireland)
  - Multi-physics model
    KTU (Lithuania)
- Processing
  - Option 2 and 3 chip processing
    CEA-Leti (France)
- NW growth
  - Option 1
    TYNDALL (Ireland)
  - Pulse Laser Deposition
    ULEI (Germany)
  - Aqueous Chemical Growth
    MTA EK (Hungary)
- Polymer encapsulation
  SPECIFIC POLYMERS (France)
- Characterizations and tests
  - Up to PoC PZ characterizations
    FRAUNHOFER (Germany)
  - DEMO tests
    Safran Identity & Security (France)

Thank you !

Questions ?