



# CHARACTERIZATION PLATFORM

Laurent Bary

head of « Instrumentation, Conception, Characterization » service

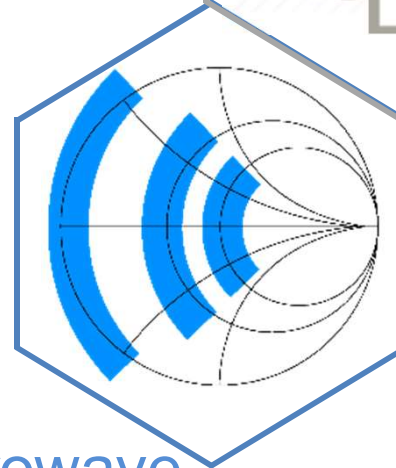
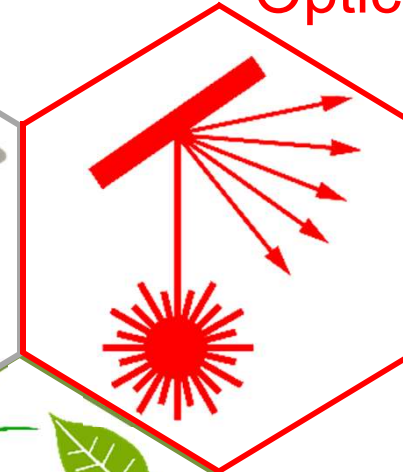
# LAAS characterization platform

- Origin
- Some figures
- Specific features
- « Standard » setups
- Highlights

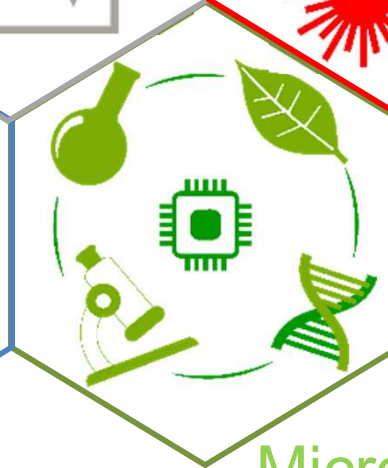
Low frequency & Power



Optics & Photonics



Microwave



Micro and Nano systems  
for Biology and chemistry

**Tour: Characterization platform** – S. SOULEILLE (1 h), technical manager of the platform

# A bit of « history »...

## Before

Characterization rooms all over the LAAS, manage by research teams

## Platform created

Internal sharing, 3 zones:  
"Low Frequency & Power"  
"Microwave"  
"Optics & Photonics"

## Major extensions...

New building  
photovoltaic measurements  
New room  
biological zone

## MultiFab

Multi material 3D printing  
Part of MultiFab integrated  
inside the PF

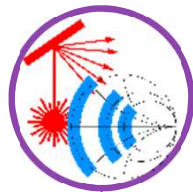
2000



## The beginning...

Almost a 1<sup>st</sup> zone...  
"Low Frequency & Power"

2002



## Platform created

Internal sharing, 3 zones:  
"Low Frequency & Power"  
"Microwave"  
"Optics & Photonics"

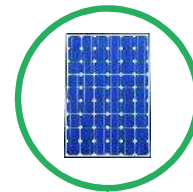
2008



## Fourth zone

Biology and chemistry for  
micro & nano systems

2012



## Major extensions...

New building  
photovoltaic measurements  
New room  
biological zone

2013



## Open platform

2017



## MultiFab

Multi material 3D printing  
Part of MultiFab integrated  
inside the PF

# Key figures

**8**

*M€ of equipment*

**1255**

*m<sup>2</sup>*

**10**

*Technical staff*

**20**

*setups used daily*

**500**

*k€ / year*

**105**

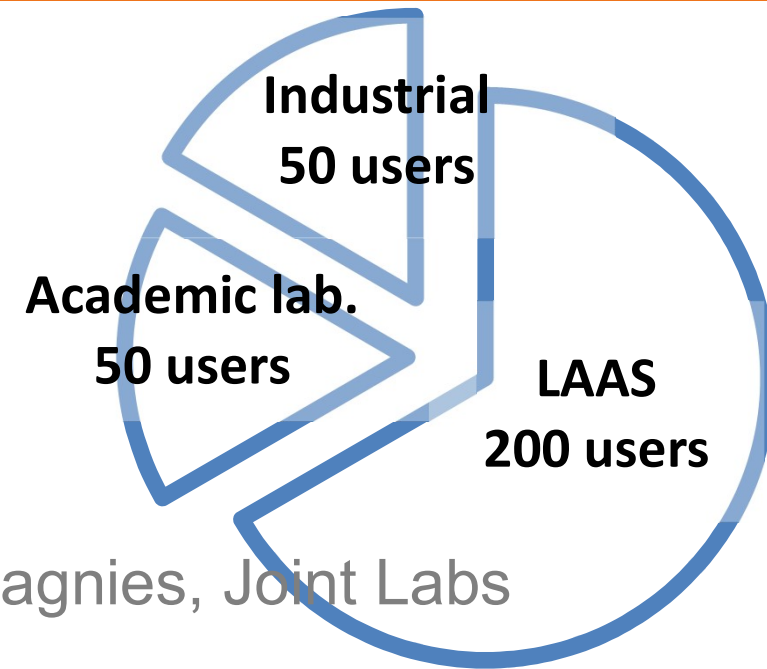
*test benches*

**39000**

*hours of equipment reservation*

# Users

**300**  
*active users*



## Industrial partners

- Who ? Startups, local and international companies, Joint Labs
- What for ?
  - Research partnership
  - Hosted
  - One-time measurement
  - Setups & skill transfers



# Training Sessions

On wafer measurements: I-V, Z(f), C(V), mapping...

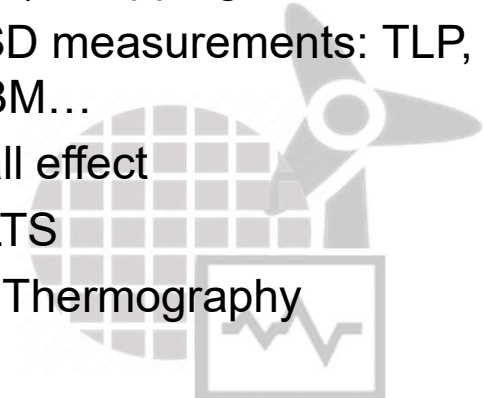
ESD measurements: TLP, VFTLP, HBM...

Hall effect

DLTS

IR Thermography

...



Microwave characterizations on probes: S parameters, spectrum measurements...

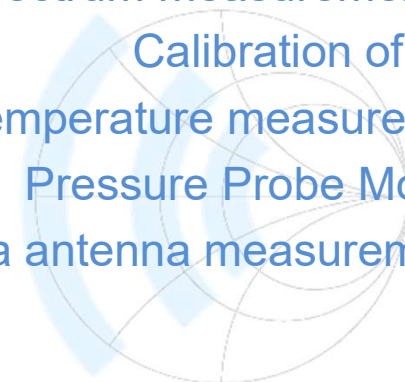
Calibration of VNA

Temperature measurement

Pressure Probe Module

Diagramma antenna measurements

...



**42**

*training courses*

**1**

*Training session daily*

LASER safety

FTIR

Photoluminescence

Optical fibers: cleaver & splice

...



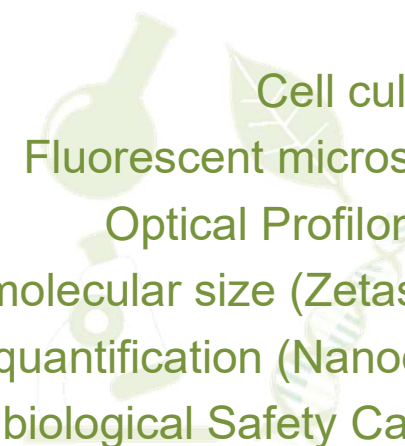
Cell cultures  
Fluorescent microscopy  
Optical Profilometer

Measuring particle and molecular size (Zetasizer)

DNA, RNA and protein quantification (Nanodrop)

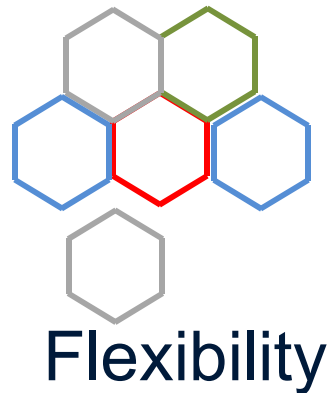
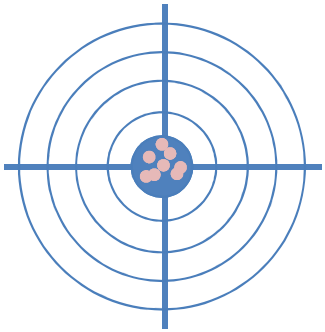
Security: chemical risk, using a biological Safety Cabinet

...



# Some features

- > From conventional characterizations to custom setups



Homemade test benches

« Standard » setups

- > Internal Sharing
- > Open platform



## How to work with us?

### 1. Contact us

[renatech@laas.fr](mailto:renatech@laas.fr)

### 2. Project feasibility evaluation

Free technological evaluation

Direct access to experts on your topics

Determination of the project scope and objective

### 3. Quote and schedule

Identification of the relevant instruments

Elaboration of the quote, deliverables and schedule

### 4. Ongoing services

Training session in case of direct use of instruments

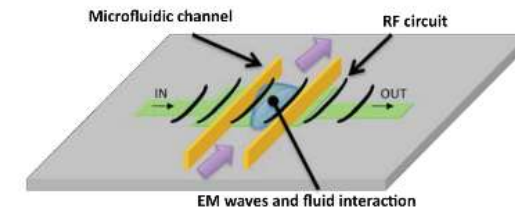
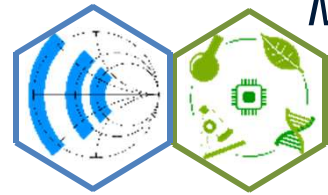


## Equipments & Skills !

Accelerate interdisciplinary research fields

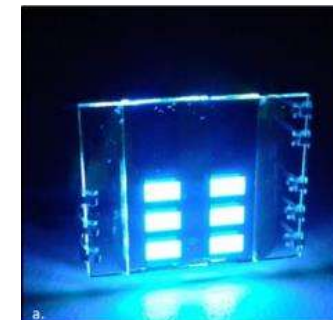
- Interaction of electromagnetic fields and fluids at cellular levels

*MH2F Team*



- Optical & bio sensor to detect pollutants

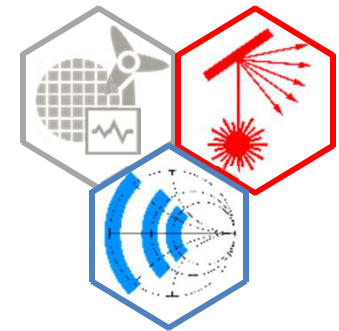
*MICA & MPN Teams*



- FEDER & Region project

Origin : Strong expertise « Robustness & Reliability for wide bandgap devices » (GaN, SiC...)

*ISGE, ESE & MOST Teams*



2 applications: microwave & commutation/power

- Open our expertise and setups : industrials & academics
- Allow to extend our equipments & recruit engineers

in progress

> *Technical staff : Charline Blatché, Sandrine Assié-Souleille, Louisa Boyer, Julie Foncy*

> 460 m<sup>2</sup>

> Cell culture facilities (cellular and microbiological)

> Molecular biology

> Microscopy (AFM, fluorescence)

> Handling means of polymers and nanoparticles

> Electrochemical equipment

> Mechanical characterization

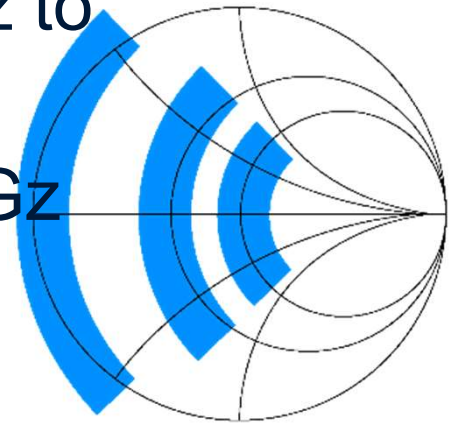
> Cell microenvironments for biology, 3D printing (part of MultiFab)



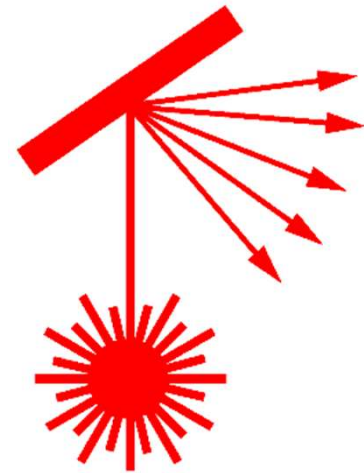
- > *Technical staff: Nicolas Mauran & Lionel Séguier*
- > 310 m<sup>2</sup>
- > I-V, C-V, impedance measurements
- > Parametric tests
- > Substrate characterization
- > IR thermography
- > Microscopy
- > ESD/EMC
- > Energy conversion and management
- > Electrochemical storage



- > *Technical staff : Alexandre Rumeau & Laurent Bary*
- > *250 m<sup>2</sup>*
- > On wafer S-parameters measurements from 9 kHz to 110GHz
- > On wafer spectral measurements from DC to 90 Gz
- > Noise measurements (LF, HF, and phase noise)
- > MEMS reliability
- > Antenna measurement (on wafer and diagram), anechoic chamber
- > Cryogenic probe station

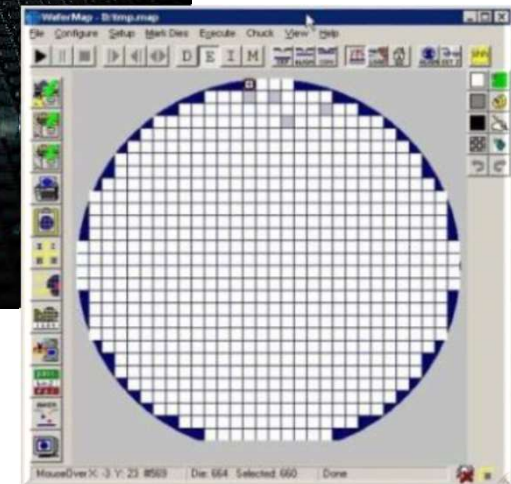
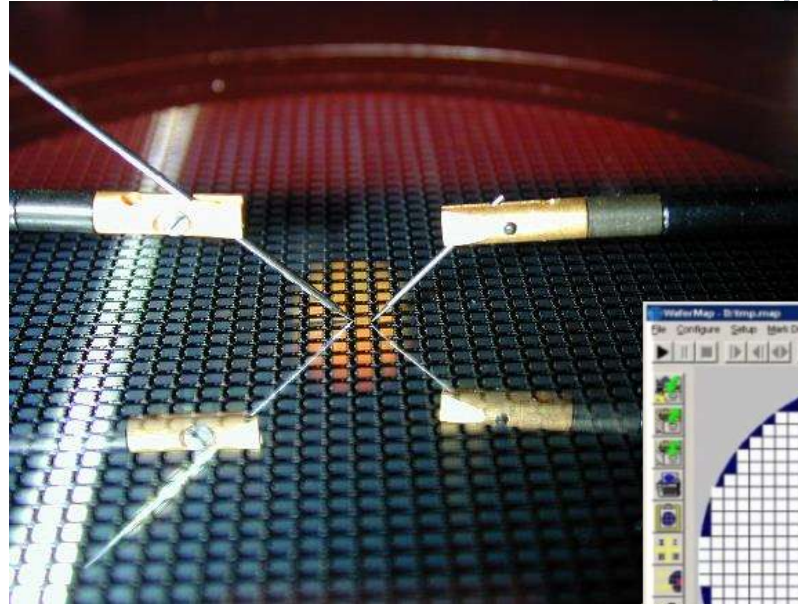


- > *Technical staff : Julien Roul & Christian Tourte*
- > *230 m<sup>2</sup>*
- > Material characterization (photoluminescence and electrophotoluminescence)
- > Characterization of passive and active photonic components
- > FTIR Spectroscopy
- > Spectrum analysis
- > Optical pumping of photonic crystal sources



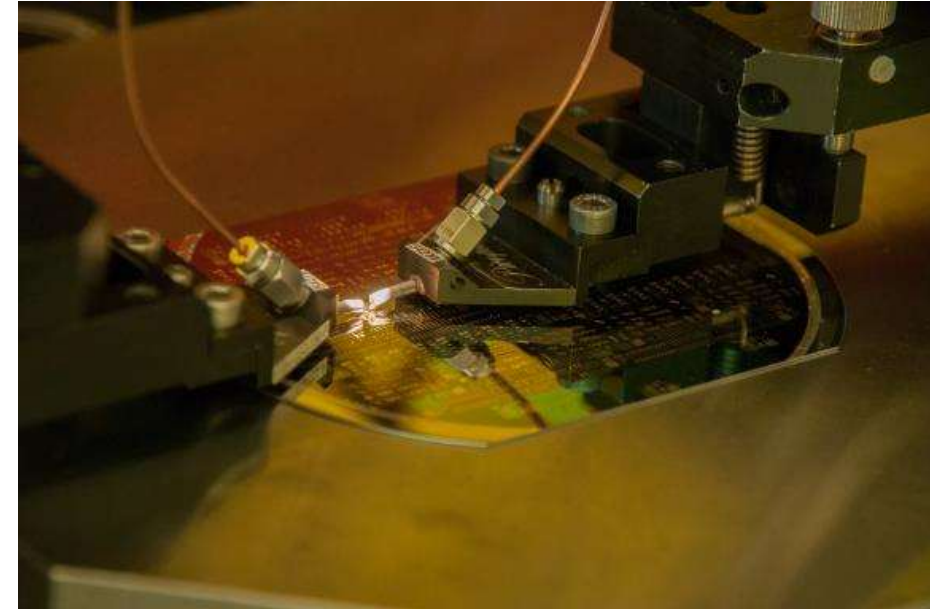


## Semi-automatic characterization I(V)



- > Mapping measurements on wafer (8" max., automatic)
- >  $I_{\max} = 10 \text{ A}$  (pulsed),  $V_{\max} = 3 \text{ kV}$
- > Max. Temperature =  $225^{\circ}\text{C}$

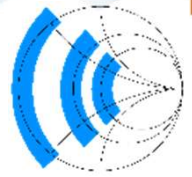
# Microwave general characterizations



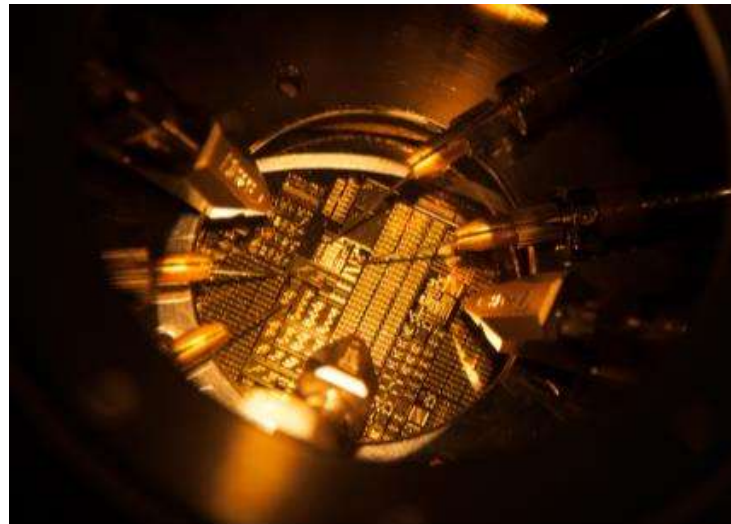
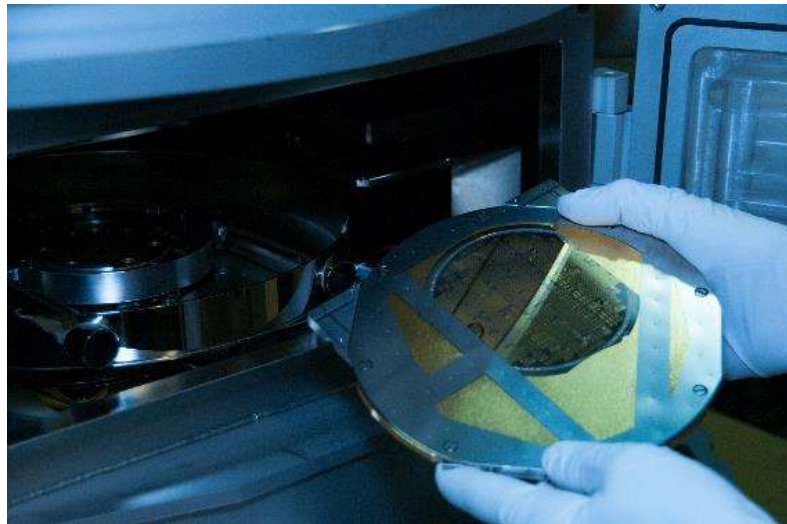
- > S Parameters :
  - 2 ports, on wafer, 9 kHz – 110 GHz
  - 4 ports (differential), 67 GHz max
- > Spectrum measurements up to 90 GHz



# Microwave: general characterizations



Cryoprober

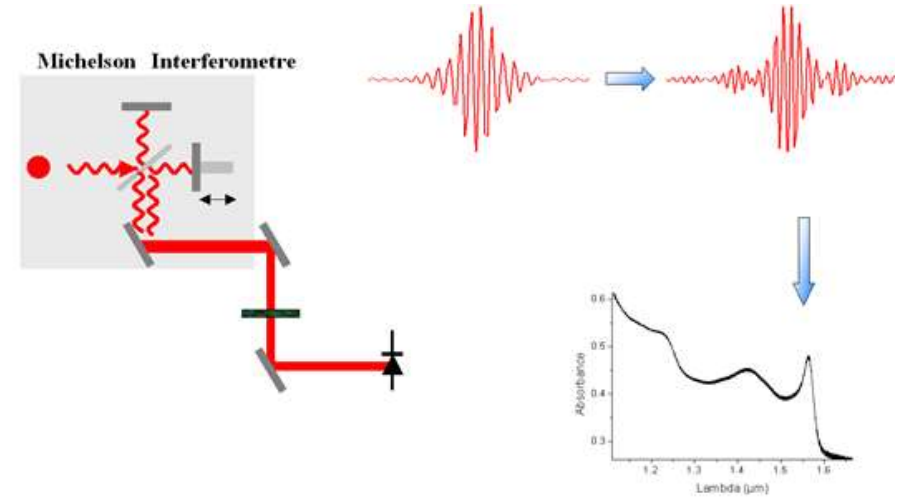


- > Temperature 4 K - 400 K
- > 4 RF probes (up to 70 GHz) & 4 DC probes
- > 6" wafer in a controlled environment (8" compatible)

# Optical: General characterization



## Fourier Transform Infrared Spectroscopy (FTIR)

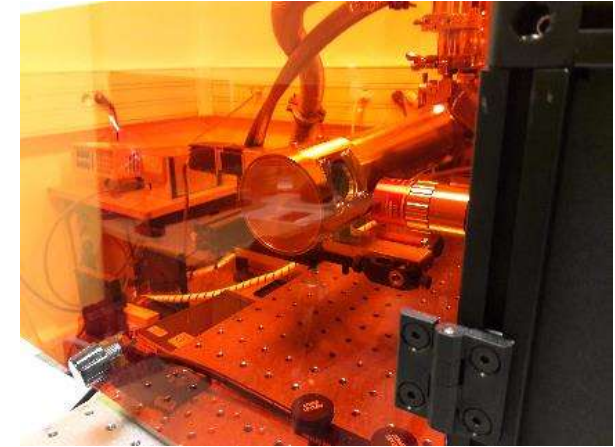
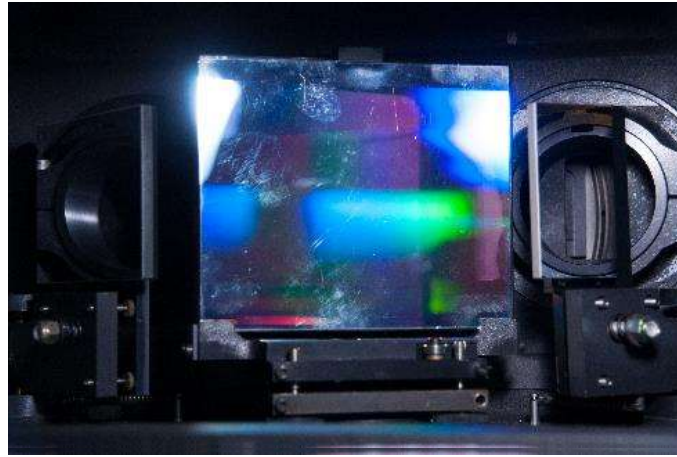
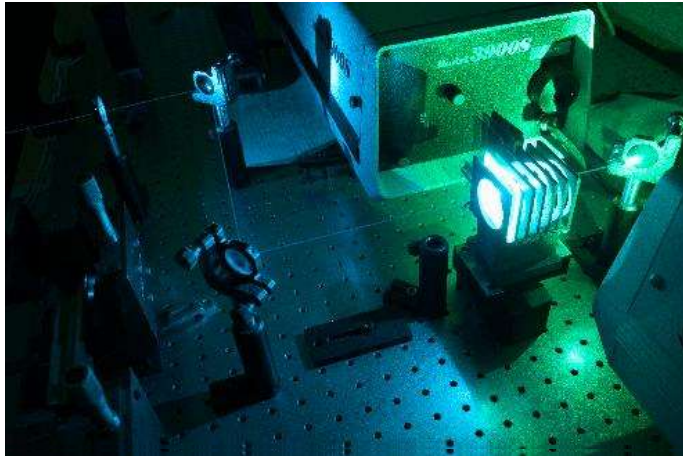


- > Materials optical properties: transmission, reflectivity, absorption, index measurement
- > Spectral range from 350 nm to 25 μm

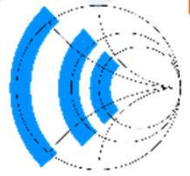


## Photoluminescence

*MICA & MPN Teams*

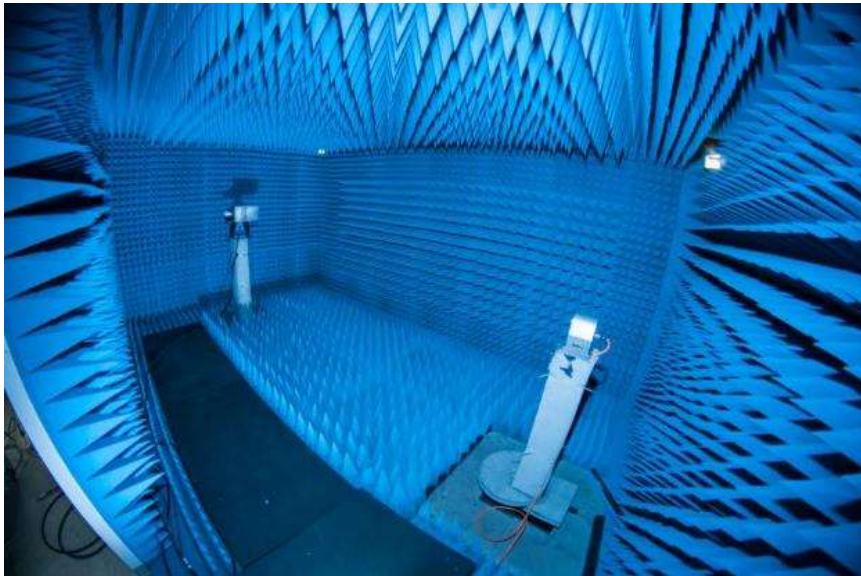


- > Materials emission properties
- > Excitation: 375/405/488 nm lasers
- > Spectral range: 400 – 1700 nm
- > Temperature control



## Antenna

*MINC Team*

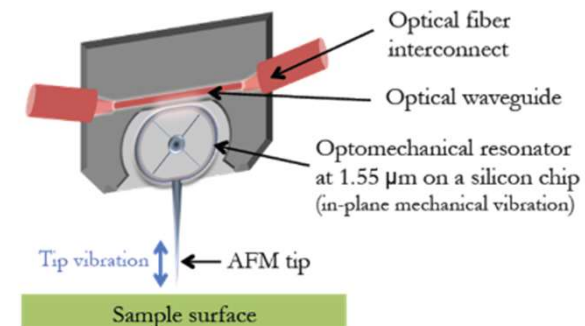
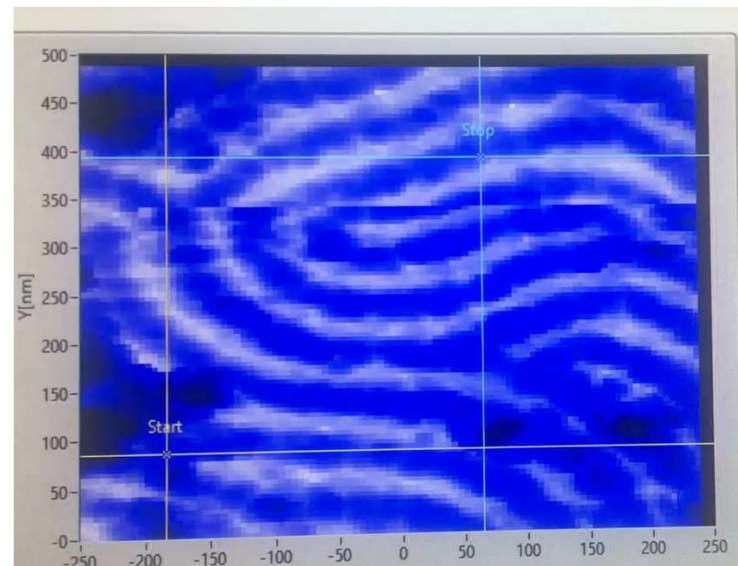


- > Anechoic chamber and antennas for diagram measurements 1-40 GHz
- > Antennas measurements on wafer (up to 67 GHz)
- > « Indoor » FMCW (S and Ka bands) radar measurements (for pressure sensors)



## Developing fast AFM

MEMS Team



in progress

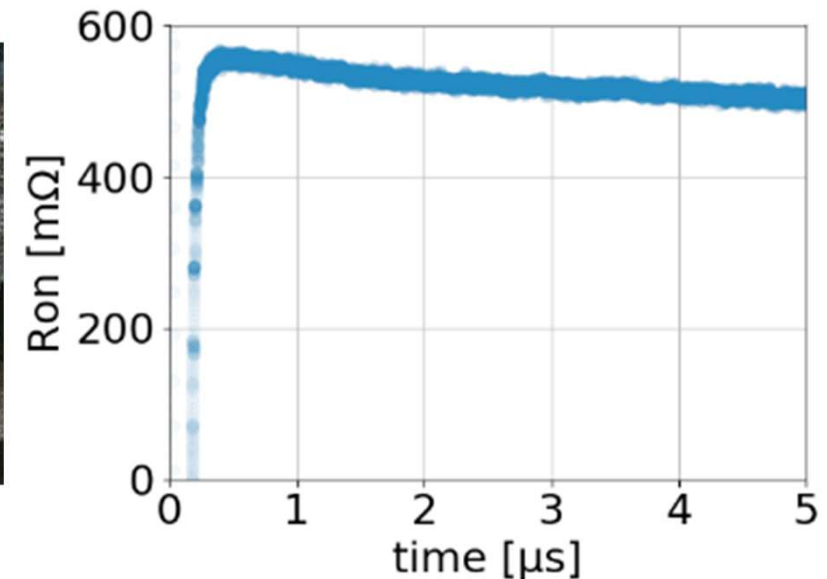
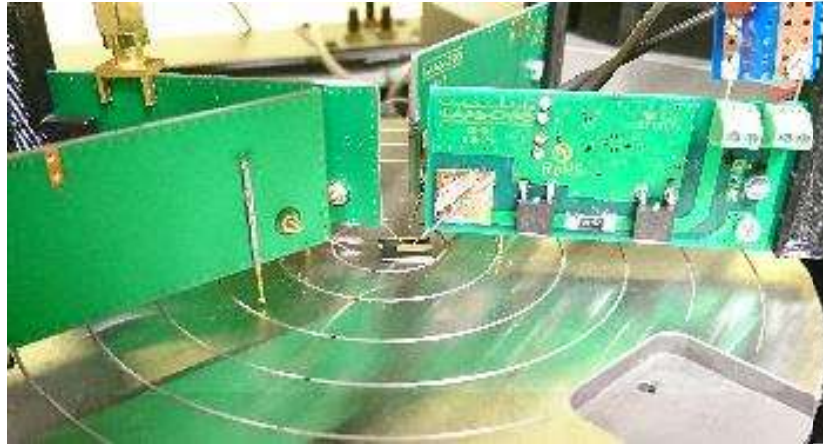
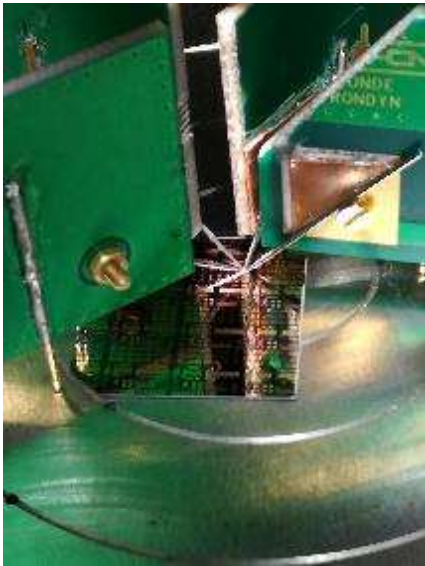
Moving the probe: dibloc copolymer  
200 × 200 pixels<sup>2</sup>; from black (down) to white (up) 10 nm

- > Using new kind of opto-mechanical probe  
from IEMN, VMicro, LETI, MPQ
- > Goal: HR (~nm) @ 10 images/s (100x100 pixels<sup>2</sup>)



## Dynamic $R_{ON}$ measurement

ISGE Team



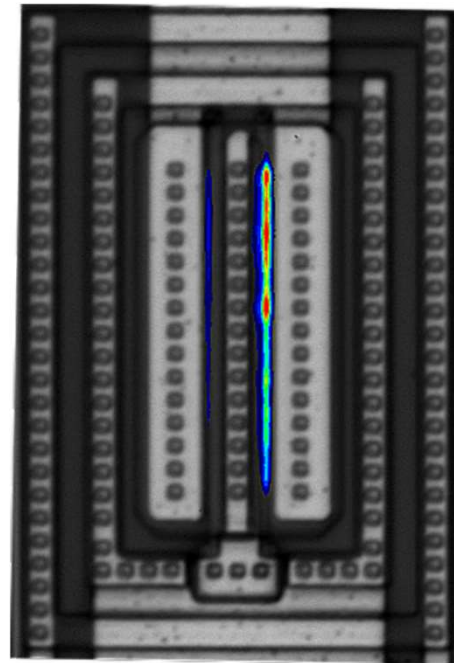
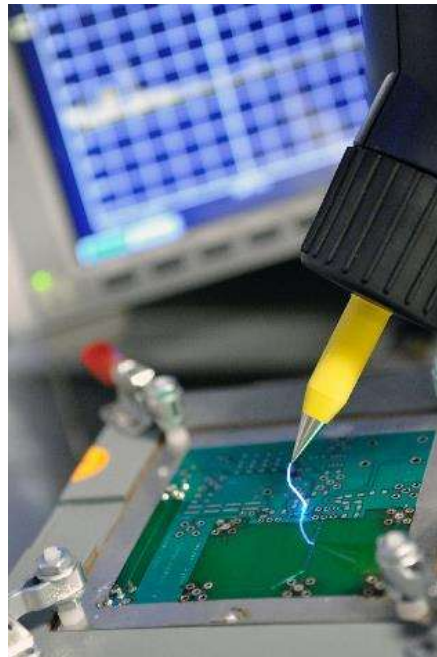
- > Max. stress voltage ~1000V
- >  $R_{on}$  measurement ~100ns after switching
- > Gate controlled by signal/pulse generator

Tour: “Pioneering GaN technology - Start-Up Exagan” – E. MOREAU & D. TREMOUILLES (30mn)



## ElectroStatic Discharges (ESD) on wafer

*ESE & ISGE Team*

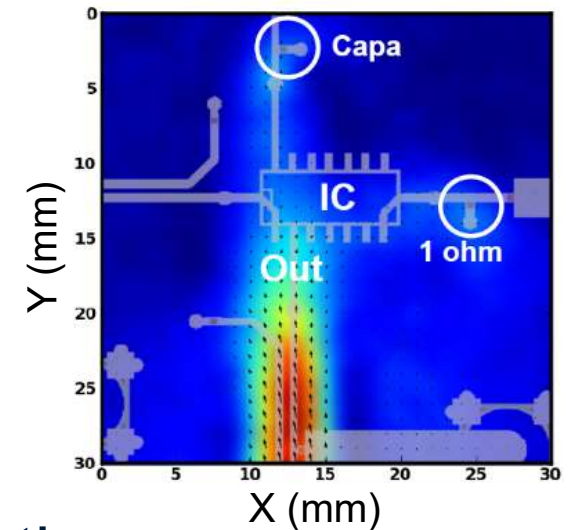
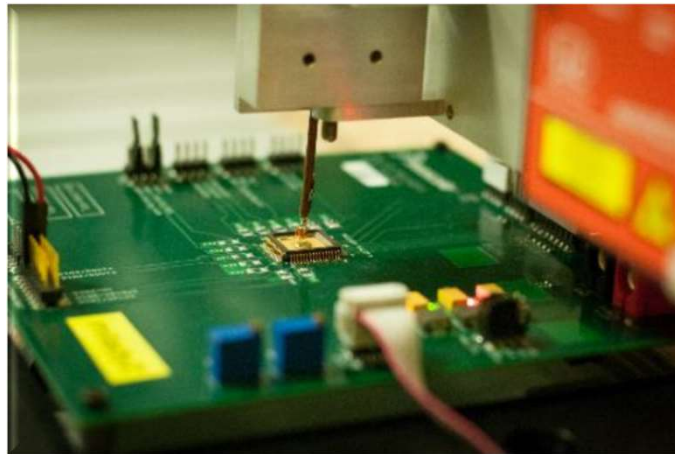
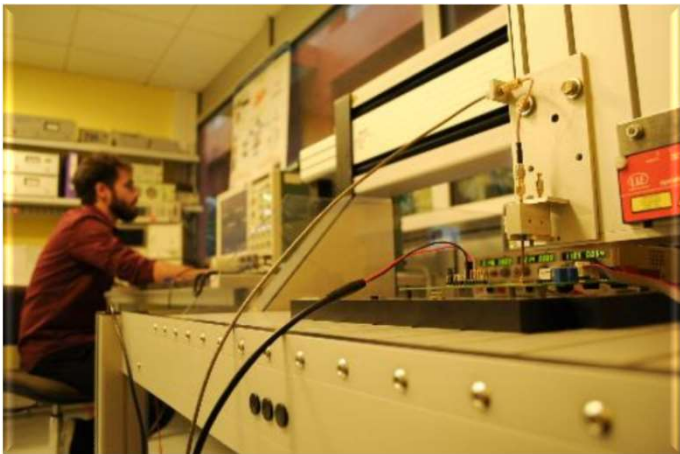


- > Stress TLP (Transmission-Line Pulsed, 100 ns, 7 A)
- > Very-Fast TLP (5 ns, 20 A)
- > HBM (Human Body model, 8 kV) & Gun HBM



## Near Field Scanner

*ESE Team*



- > Local Electromagnetic Emission & Injection
- > Max. DUT size 50 x 53 cm<sup>2</sup>
- > X,Y resolution 2,5 μm ; Z resolution 100 μm
- > Bandwidth 1 GHz
- > Time and/or Frequency domains measurements





## Energy: converters & sources

ISGE Team

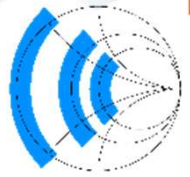


- > Photovoltaic measurements (panels)
- > DC-DC and DC-AC converter measurements
- > Electrochemical storage
- > Micro DC Smart grid (PV, lead acid, supercap...)

### Tours:

**Energy building** - M. BAFLEUR & I. PAPAS (45 min)

**Photovoltaic Low Voltage DC microgrid for building with energy storage systems** – L. SEGUIER (20 mn)



## Noise

*MOST Team*



- > High frequency (4 noise parameters), up to 40 GHz on wafer
- > Phase Noise (on wafer & packaged)
- > Low frequency noise (on wafer & packaged)

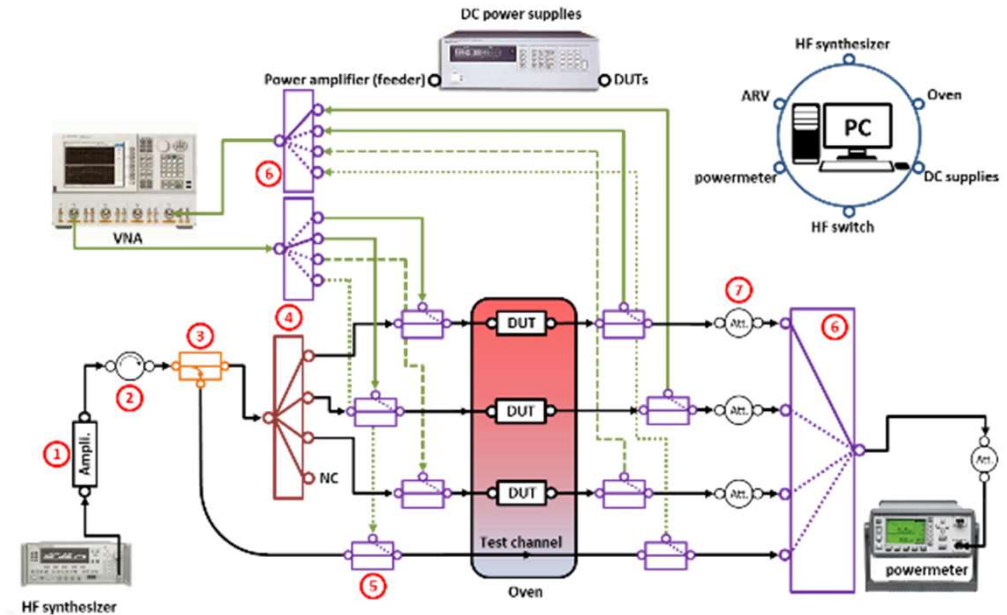
European reference center for Keysight : LFNA

- Analysis frequency range : 0,03 Hz to 40 MHz
- Automated Noise measurements vs different bias




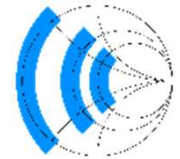


## RF Stress Set-up

*MOST Team*



Automatic measurements during several months

- > S parameters (up to 40 GHz) and DC characteristics
- > RF stress applied
- > Thermal chamber (up to 100°C)

Zone				
Area	310 m <sup>2</sup>	250 m <sup>2</sup>	230 m <sup>2</sup>	460 m <sup>2</sup>
Measurement of	<ul style="list-style-type: none"> <li>- I-V, C-V, impedance measurements</li> <li>- Parametric tests</li> <li>- Substrate characterization</li> <li>- IR thermography</li> <li>- Microscopy</li> <li>- ESD/EMC</li> <li>- Energy conversion and management</li> <li>- Electrochemical storage</li> </ul>	<ul style="list-style-type: none"> <li>- On wafer S-parameters measurements from 9 kHz to 110GHz</li> <li>- On wafer spectral measurements from DC to 90 GHz</li> <li>- Noise measurements (LF, HF, and phase noise)</li> <li>- MEMS reliability</li> <li>- Antenna measurement (on wafer and diagram), anecoidal chamber</li> <li>- Cryogenic probe station</li> </ul>	<ul style="list-style-type: none"> <li>- Material characterization (photoluminescence and electrophotoluminescence)</li> <li>- Characterization of passive and active photonic components</li> <li>- FTIR Spectroscopy</li> <li>- Spectrum analysis</li> <li>- Optical pumping of photonic crystal sources</li> </ul>	<ul style="list-style-type: none"> <li>- Cell culture facilities (cellular and microbiological)</li> <li>- Molecular biology</li> <li>- Microscopy (AFM, fluorescence)</li> <li>- Handling means of polymers and nanoparticules</li> <li>- Electrochemical equipment</li> <li>- Mechanical characterization</li> </ul>