

THE MICRO ET NANO TECHNOLOGIES PLATFORM

The know how
The equipment
The organization

The micro et nanotechnologies platform

- > LAAS
 - UPR 8001 from CNRS
 - 20 922 m²
 - 610 people (01/01/2018)
- > 2016 Operational budget : 15,257 M€
- > Clean room
 - Renatech network member
 - 2526,72 m²
 - 36 people in the technical staff
- > 180-200 regular and active users
- > Average of operational budget: 1,2 M€
 - Without investment
- > 35 M€ equivalent new equipment



A brief history

- Third generation of platform in LAAS
 - The first academic platform in France
 - 1968 : dedicated room
 - 1978 : clean room



- 2006-2007 : technology platform



ReNaTech

- French network of open high-end micro & nanotechnology facilities coordinated by CNRS.

7300 m²
of clean rooms

140
clean room
engineers
and technicians

130 M€
of EQUIPEMENT



- To allow research and industry to benefit from competitive and world-class infrastructure for carrying out research and R&D projects that require top level equipment in micro and nanotechnologies.

The know how domains

- > Optics / Photonics
 - Photonics on transparent/optical substrates
 - sub-lambdanetworks
 - optical pixelated components
 - organic OLED/OPD components
 - III - V multifunctional integrated components
 - III_V optical Sources
 - New III - V materials
 - Optical sensors
- Micro nano electronic
 - Nano-wires based nano components
 - Bottom-up / top-down wires fabrication
 - 3D Si and III-V Nano transistors
 - Micro electronic power components
 - MOS and bipolar on Si
 - Large gap (GaN, diamond)
 - Integrated power circuits

- > **Bioelectronics, Biosystems, biophysics**
 - **Micro/nano fluidics**
 - Polymer multi-layer / integrated operation lab on chip
 - Nano fluidic polymers-silicon-glass
 - **Micro sensors**
 - Vapour phase
 - Liquid phase
 - **Advanced Micro Nanostructures for bio detection**
 - Nano probes
 - Nano transistor
 - **DNA technology for advanced materials and sensors**

- > **Micro Nanocomponents, micro Nano systems**
 - **Micro RF switches with capacitive and resistive contact**
 - **passive wireless sensors using electromagnetic transduction**
 - **Energy micro storage**
 - **Pyrotechnic actuator based on reactive nano materials**
 - **Integrated systems on flexible substrates**
 - **Low temperature processes for 3D Integration and interconnection**

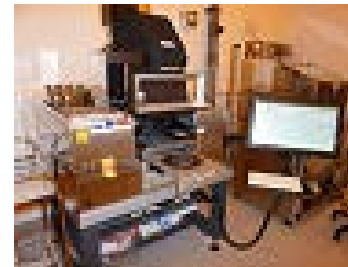
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PROJET COFINANCÉ PAR LE FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL

<https://www.laas.fr/projects/THERMIE/>

- > Open technological offer to multilayer metal/oxide reactive nanomaterials and nanostructures design/integration for embedded thermal sources
- > Together with partners we implement all the skills and equipment of micro manufacturing and characterization platforms increased by dedicated equipment funded by the Occitanie Region and Europe Funds
- > Dedicated equipment, dedicated technical staff, specific formations, technical reporting available for technological transfer, share development policy



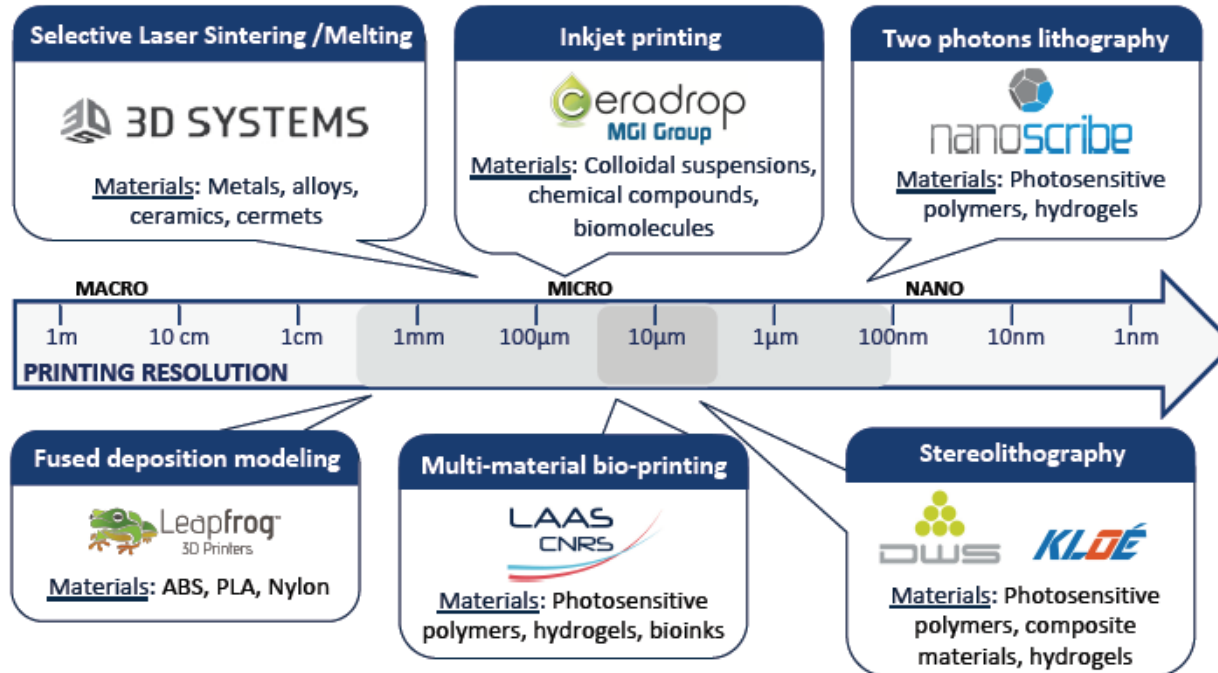
Know how example : Multifab



<https://www.laas.fr/projects/MultiFAB/>

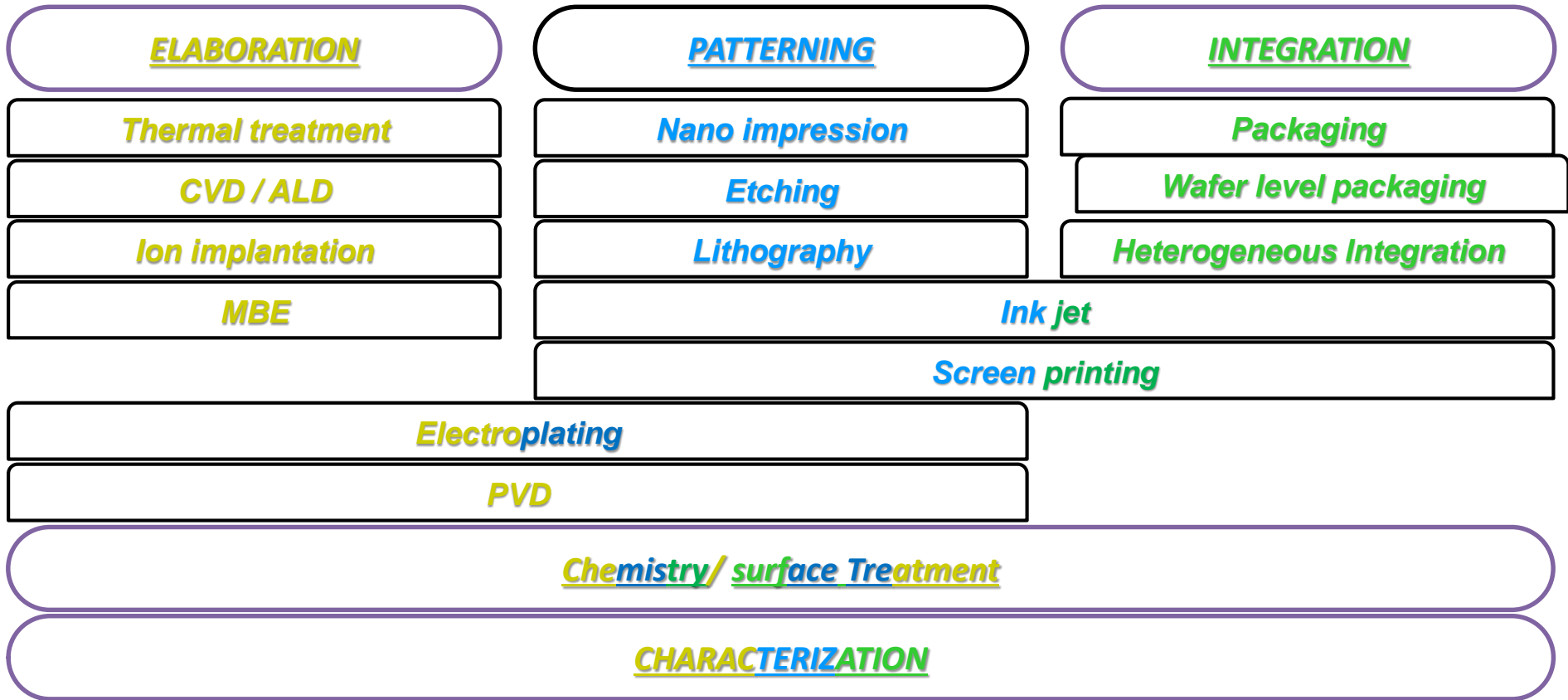
- > Open 3D printing platform funded by FEDER and Region Occitanie that promotes the development, transfer, training and dissemination of additive manufacturing technologies to both academic and industrial partners

Cutting edge technologies for 3D printing



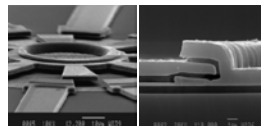
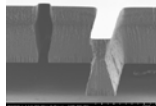
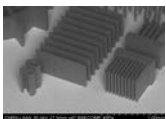
The equipment

The technologies



All the equipment : <https://lims.laas.fr/Default.aspx>

Menu tools / all tools



> INFRASTRUCTURE

- DI water
 - Process fluids
 - providing
- Liquid and gaseous nitrogen
- Distribution networks
 - Process gaz
 - General Gaz
 - Dry air
 - ...
- Internal modifications
 - Equipment setup
 - adaptation
- Relations with suppliers
 - Air treatment, cleaning ...
- Safety
 - Detection
 - Alarm
 - Effluents treatment
-



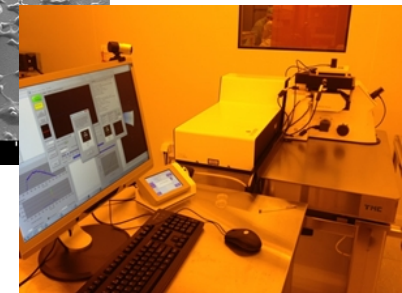
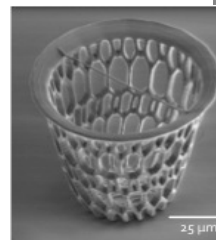
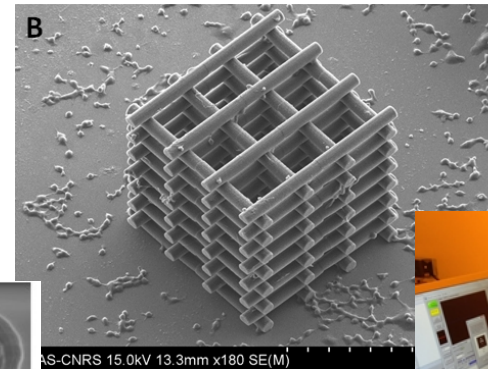
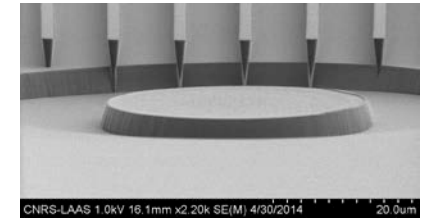
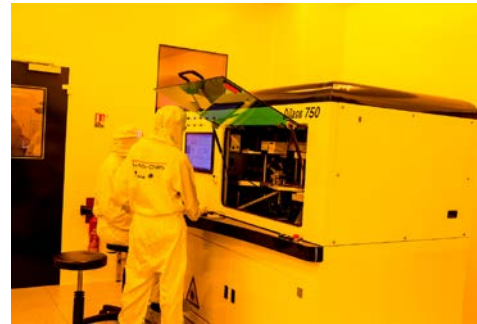
Laser Lithography

- > HEIDELBERG DLW200
 - Direct pixelised writing on substrates
 - Masques and reticules for photolithography
 - Metrology

- > Dilase 750
 - Vectoriel writing on substrates
 - 3 optical tubes for resolutions
 - 0,5 μ m, 2 μ m, 20 μ m
 - 3 wavelengths for lithography
 - 325 nm, 375nm, 405 nm
 - 1 wavelength for surface treatment
 - 1 wavelength for 3D lithography

- > Dilase 3D
 - 3D microstructures lithography
 - Resolution 5 μ m

- > Nanoscribe
 - 3D Microstructures lithography
 - Resolution 100 nm

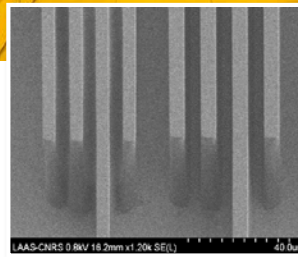
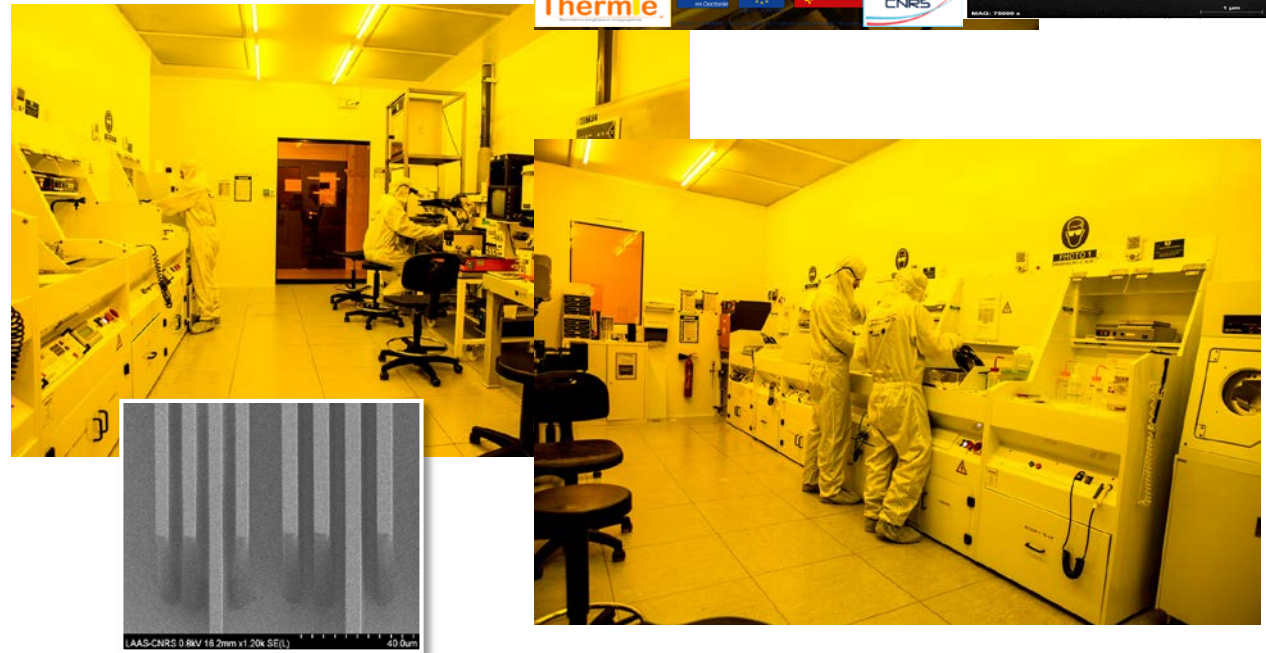
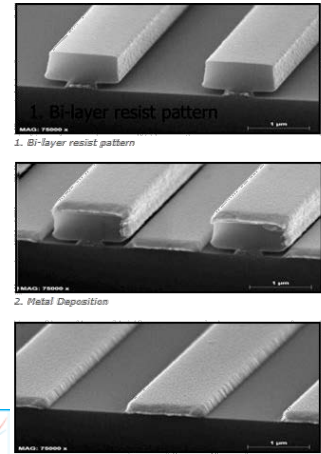


> Manuel area

- 6 masks aligners
 - resolution down to 0,9 μm
 - Small pieces to 150 mm wafers

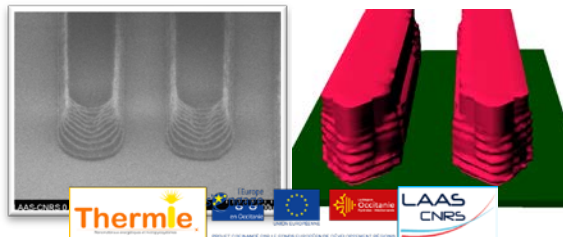
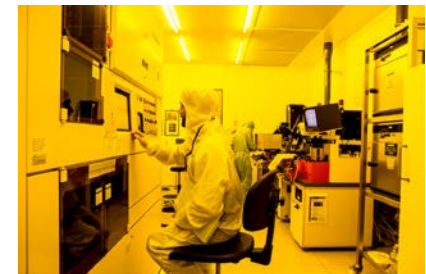
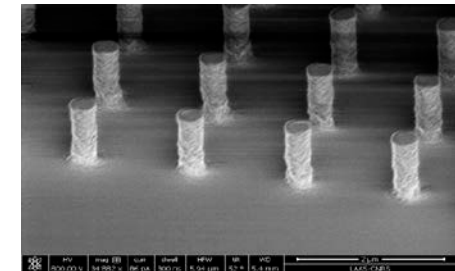
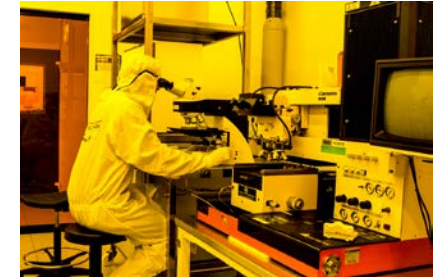
- 3 benches
 - Spin coating
 - Baking
 - Development

- HMDS



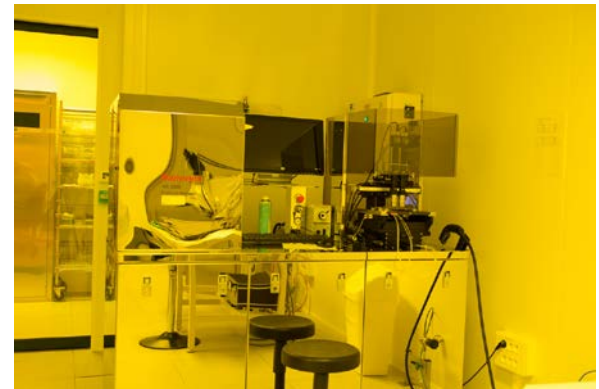
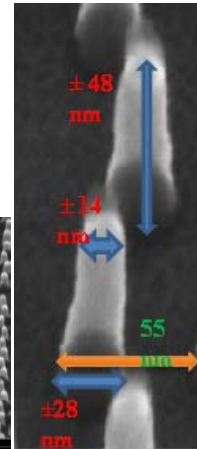
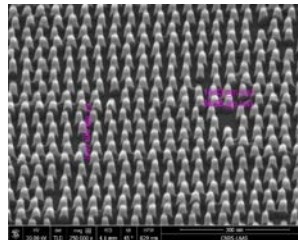
> Automatic area

- Spin coating, baking, development EVG 120
- Spray coater
- Automatic alignment EVG 620 (resolution 1-2 μ m)
- Semi automatic alignment Suss microtec (resolution 1-2 μ m)
 - MO optics (increased depth of field)
- Polymers ovens
- HMDS
- Projection lithography (resolution 0.35 μ m)
- Genlsys lithography simulation software



- RAITH 150
 - Electron Beam Lithography : Résolution : 20 nm
 - Up to 6"
 - Autofocus

- NANONEX 2500
 - UV nano imprint
 - Thermal Nano impression

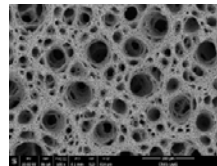
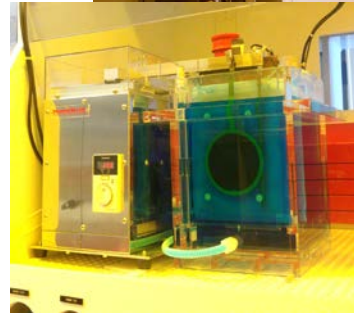


- > Secured manual wet benches
 - Acids
 - Solvents
 - RCA 6"
 - KOH, TMAH
 - HF Buffer
 -
- > 4 mains dedicated areas..
 - MOS
 - MEMS
 - III-V
 - Packaging
- > Specific areas
 - Exploration
 - Ink jet
 - Nanolithographies
 - Photolithographies
 - Electroplating

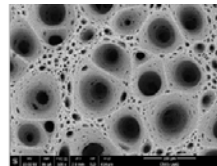


Electroplating

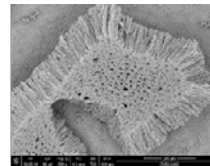
- > Laboratory reactors
 - Au, Cu, Ni,.....
- > « Industrial » reactors
 - Au, Cu
- > Bathes characterization
 - CVS
 - Polarography
 - Dosimetry
- > Wet benches
 - Aluminium anodisation
 - Porous gold
 - ...



5 A 100 μm

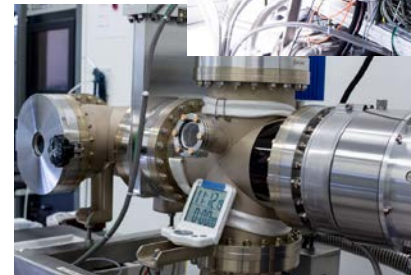
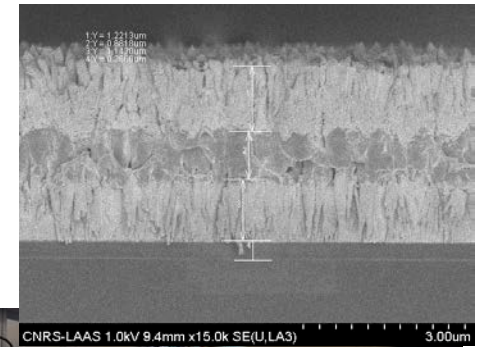


5 A 150 μm



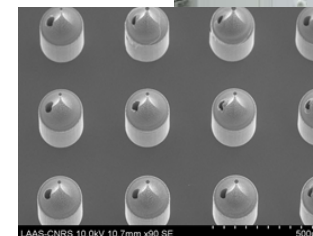
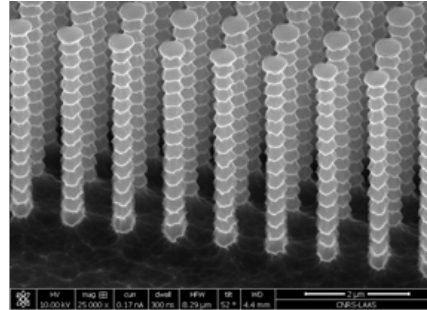
10 A 100 μm

- > Joules Effect : Apsy E100
- > Electrons guns
 - Varian
 - EVA 600
 - Edwards
 - Plassys nano
- > Sputtering
 - Cluster UNIVEX 450 C
 - 1 plasma cleaning chamber
 - 5 deposition chambers (7 targets)
 - TFE
 - Energetic material deposition
- > OLED
 - Metal evaporation
 - Organics evaporation
 - Spin coating, baking
- > Polymers outgazing analysis



Plasma etching

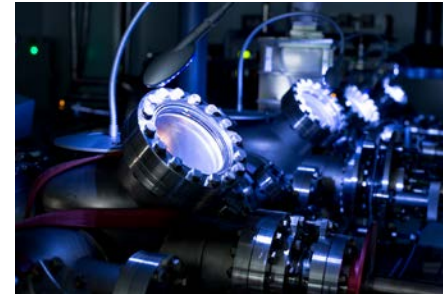
- > Deep etching
 - AMS 4200
 - 2 chambers cluster
- > ICP etching
 - 2 Avisa Trikon Omega 201
 - Si, GaAs, Polymers / metals
- > Nano etching
 - Sentech etchlab
 - Sentech Si500
- > EPD systems
- > Descuming, stripping, surface treatment
 - Tepla
 - Diener



Molecular Beam Epitaxy

> Riber 2300

- Ga, In, Al, 2xAs₂, CaF₂, Bi effusion cells
- hydrogen plasma effusion cell
- RHEED 20kV, mass spectrometer (0-100)



> Riber 32P

- Ga, In, 2xAl, Be, Si, Bi, cracker d'As, differential pumping N plasma effusion cells
- RHEED 10 kV, mass spectrometer (0-200)
- Dynamic Accordable Reflectometry
- Low temperature pyrometer



> Riber MBE 412

- 2xGa, 2xIn, 2xAl, Sb, Si, CBr₄, 2x As cracker, integrated valve N₂ plasma effusion cells
- RHEED 12 kV + camera + KSA400 soft
- Mass spectrometer (0-200), BandiT, Pyrometer
- Computerised control (Crystal - Riber)
- Roboted transfer chamber (cluster), parking, high T° outgazing

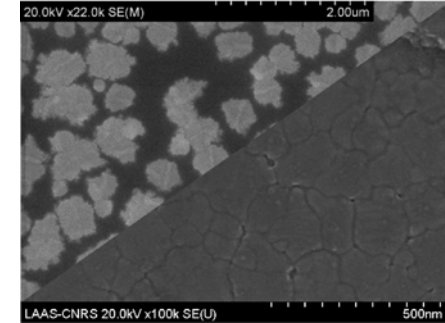


> 29 reactors

- AET 4" : Oxydation redistribution
- Tempress 4" : Diffusion, annealing
- Tempress : LPCVD
- AET 4" : annealing
- AET 4" vertical: deposition
- Centrotherm 6" : oxydation, diffusion
- Centrotherm 6" : annealing, LPCVD
- AET AsGa: oxydation
- Annealsys 6"/8" : RTP
- Annealsys 6" : RTP AsGa
- AET 4" : annealing
- Semco 6" : annealing



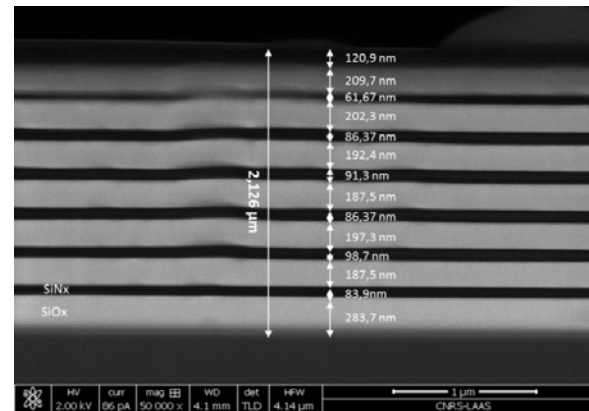
- STS PECVD
 - 4", 6", 8"
 - LF, HF



- Cambridge nanotechnologies ALD

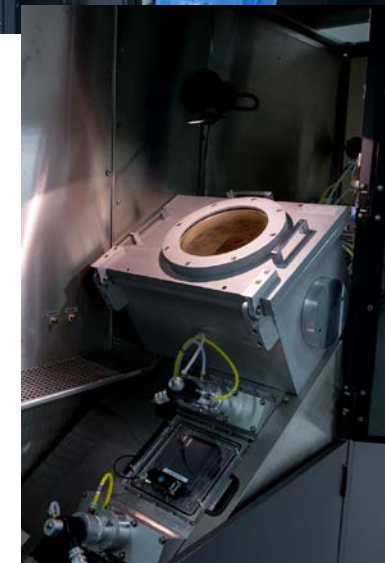


- Oxford ICPECVD
 - Low temperature



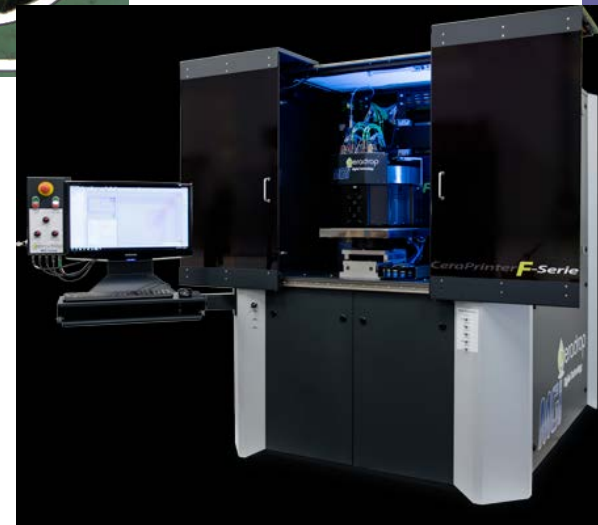
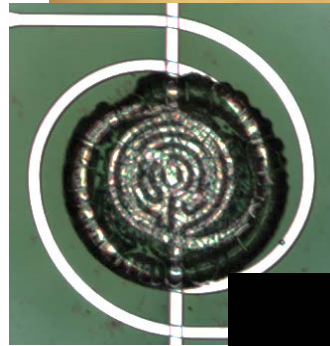
Ion implantation

- IMC 200
 - Upgrade of Axcelis NV 4206
 - Middle current
 - 200 kV max
 - Solid and gaz sources



- > Altadrop :
 - Mono hose

- > Ceradrop
 - Multi hoses



> Surface treatment

- Memstar : SPD
- Tousimis supercritical dryer
- Separex CO2 Functionalization
- Comelec parylène deposition
- Chemical benches (chemical area)
- O2 plasma (plasma etchning area)



Packaging

> Dicing

- Saw
- Scribbling
- Cleaning

> Pick and place

> Bonding

- Wire (Au, Al, Cu, ruban)
- Flip chip

> Pull shear test

> Wafer Level Package

- CMP
- Grinding
- Wafer bonding (Anodic, Direct, Thermal compression) and connected cleaning
- Screen printing
- Roll lamination



Characterisation

- Microscopy

- Optical
- SEM (2)
- AFM (2)
- Ionic (in FIB)
- Confocal

- FIB

- Dual beam
 - Electrons, ions
- Microscopy
- Nanofabrication
 - Etching, depositions

- Profilometry

- Optical
- Mécanical (2)



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- Ellipsometry (2)
- X ray diffraction
- Photoluminescence
- DSC
- Spectrometry
 - UV
 - Visible
 - IR
- Various
 - 4 probes
 - R \square
 - Water drop
 - Grain size measurement
 - ...

The organization

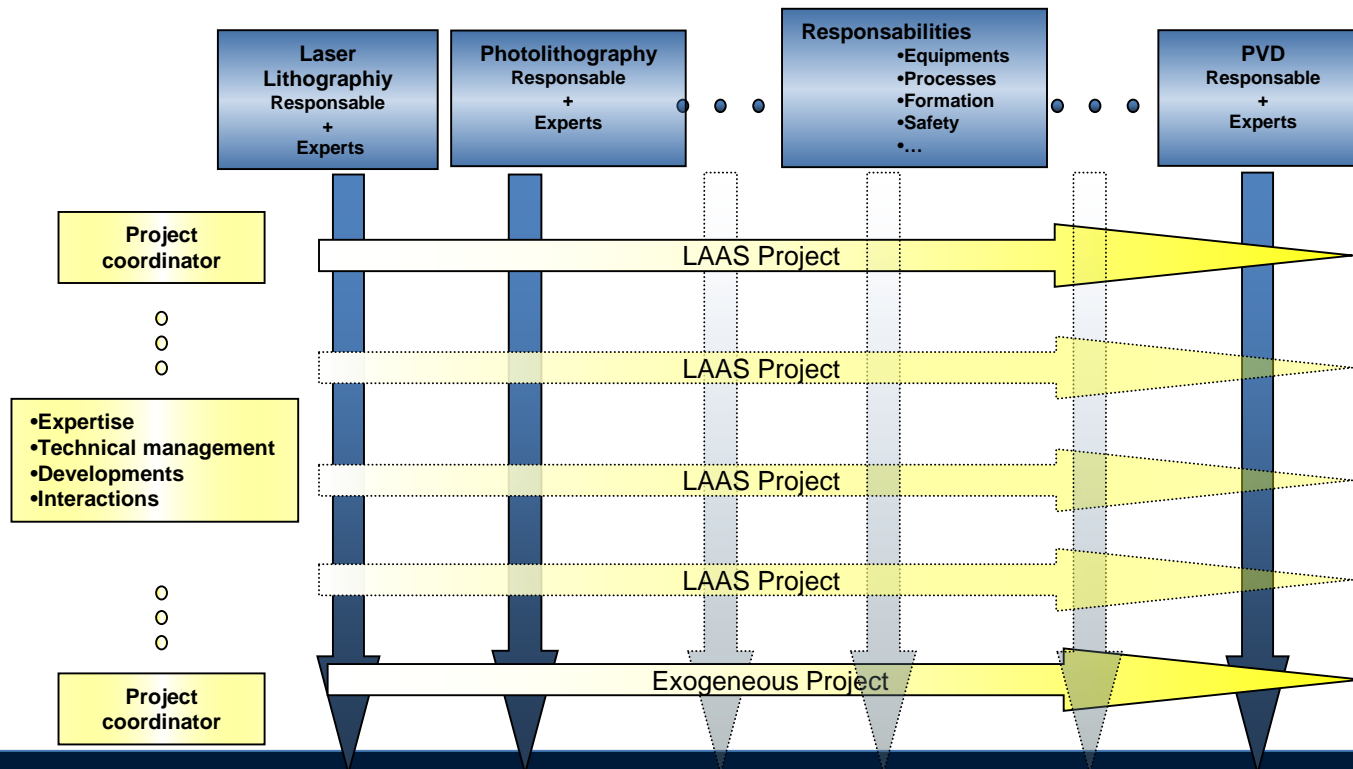
TEAM staff

The offers to users

Projects management

Financial management

- **T**echnics and **E**quipment **A**ppplied to **M**icro and nanotechnologies
- 36 engineers , and technicians under direct authority of LAAS's Director
 - Responsibilities in one of 13 technical areas
 - Projects technical coordination



TEAM Responsibilities

- **Infrastructure**

- Management, development

- **Equipment**

- Expertise,
- Management,
- Maintenance
- Evolutions

- **Processes**

- Expertise,
- Realization,
- Management,
- Developments

- **Research projects support**

- From LAAS research groups
 - 69 in 2018
- From exogenous (Renatech network)
 - 89 in 2017

- **Formation**

- **Technical management**

- **Know-how**

- dissemination
- valorization,
- transfer

Responsable

Hugues GRANIER, IRHC 90 %

36 agents (12 IR, 6 IE, 16 AI, 1 T, 1 apprenti)

Pierre-François CALMON IR1 10 % Adjoint en charge de la formation en salle blanche
 Franck CARCENAC IRHC 10 % Adjoint en charge de la sécurité en salle blanche

Véronique CONÉDÉRA IRHC 30 % Adjointe en charge des équipements
 Monique DILHAN IRHC 70 % Adjointe en charge des projets exogènes et du réseau Renatech

MISE EN SERVICE, DÉVELOPPEMENT, MAINTENANCE DES ÉQUIPEMENTS / FORMATION ENCADREMENT / ACTIONS D'INTÉRÊT GÉNÉRAL

La première personne nommée assure la fonction de responsable de zone

ASSEMBLAGE

Samuel CHARLOT IECN 10 %
 René-David COLIN AI 40 %

CARACTÉRISATION

Benjamin REIG IR2 70 %
 Emmanuelle DARAN IR1 20 %

CHIMIE

Jean-Baptiste DOUCET IECN 30 %

DÉPÔTS SOUS VIDE

Ludovic SALVAGNAC IECN 20 %
 Guillaume LIBAUDE AI 40 %
 Adrian LABORDE² ASI 10 %
 Séverine VIVIES AI¹ 10 %

ÉLECTROCHIMIE ET GRAVURE

ANISOTROPE DU SI

David BOURRIER IECN 15 %
 Arnaud DURLACH¹ AI 50 %

ÉPITAXIE PAR JETS MOLÉCULAIRES

Alexandre ARNOULT IR1 15 %
 Guy LACOSTE IEHC 40 %
 Quentin GRAVELIER¹ AI 50 %

GRAVURE PLASMA

Pascal DUBREUIL IR1 65 %
 Aurélie LECESTRE³ IGR2 30 %

LITHOGRAPHIE LASER

Pierre-François CALMON IR1 25 %
 Vinciane LUQUE TCN 40 %
 René-David COLIN AI 50 %
 Rémi COURSON IR¹ 20 %

NANOLITHOGRAPHIES

Franck CARCENAC IRHC 25 %
 Emmanuelle DARAN IR1 40 %
 Jean-Baptiste DOUCET IECN 20 %
 Alexandre LAUVERGNE¹ AI 50 %

PHOTOLITHOGRAPHIE

Laurent MAZENQ IECN 50 %
 Adrian LABORDE² ASI 50 %
 Arnaud DURLACH¹ AI 50 %
 Julien JONEAU Alter 30 %

JET D'ENCRE ET TRAITEMENTS DE SURFACE

Fabien MESNILGRETE AI 35 %
 Véronique CONÉDÉRA IRHC 15 %

SUPPORT ET SOUTIEN

Hugues GRANIER IRHC 10 %

SUPPORT

Laurent BOUSCAYROL AI 100 %
 Thierry DO CONTO AI 100 %
 Antoine MAIORANO AI 100 %

SOUTIEN

Vinciane LUQUE TCN 30 %

TRAITEMENTS THERMIQUES ET

IMPLANTATION IONIQUE

Éric IMBERNON IR1 40 %
 Jean-Christophe MARROT AI 40 %
 Bernard ROUSSET IRHC 35 %

SOUTIEN DIRECT AUX PROJETS DE RECHERCHE

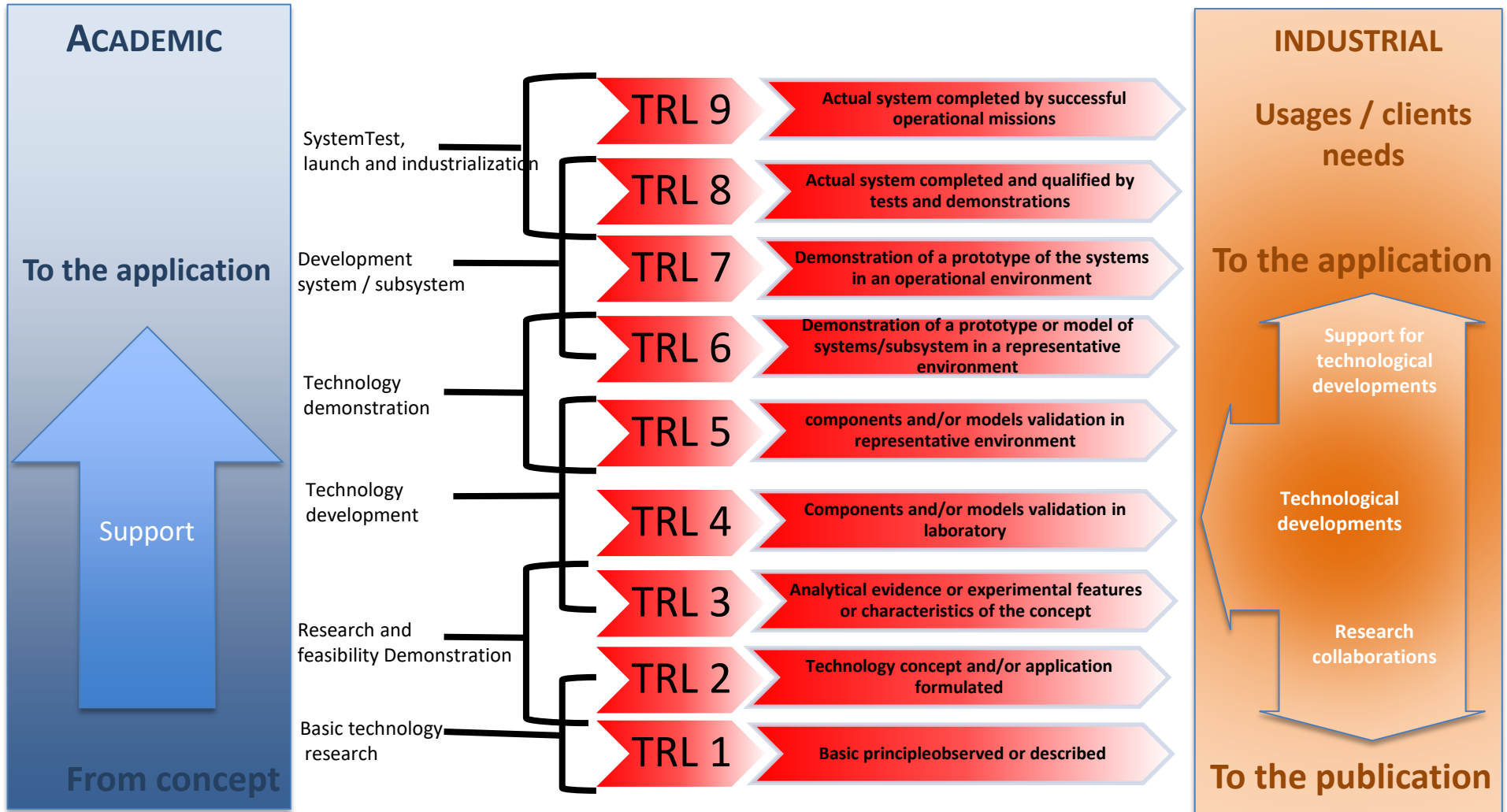
Alexandre ARNOULT IR1 85 %
 David BOURRIER IECN 85 %
 Pierre-François CALMON IR1 65 %
 Franck CARCENAC IRHC 65 %
 Samuel CHARLOT IECN 90 %
 René-David COLIN AI 20 %
 Véronique CONÉDÉRA IRHC 55 %
 Rémi COURSON IR¹ 80 %
 Emmanuelle DARAN IR1 40 %
 Alexandre DEZALAY¹ AI 100 %
 Monique DILHAN IRHC 30 %
 Pascal DUBREUIL IR1 35 %
 Jean-Baptiste DOUCET IECN 50 %
 Quentin GRAVELIER¹ AI 50 %
 MARION HARRIBEY¹ AI 100 %
 Éric IMBERNON IR1 60 %

Julien JONEAU ALTER 20 %
 Adrian LABORDE² ASI 40 %
 Guy LACOSTE IEHC 60 %
 Alexandre LAUVERGNE¹ AI 50 %
 Aurélie LECESTRE³ IGR2 70 %
 Guillaume LIBAUDE AI 60 %
 Vinciane LUQUE TCN 30 %
 Jean-Christophe MARROT AI 60 %
 Laurent MAZENQ IECN 50 %
 Marion MÉCA¹ AI 100 %
 Fabien MESNILGRETE AI 65 %
 Benjamin REIG IR2 30 %
 Bernard ROUSSET IRHC 65 %
 Ludovic SALVAGNAC IECN 80 %
 Séverine VIVIES AI¹ 90 %

¹ Personnel contractuel
² Personnel UPS
³ Personnel INPT
 Alter : apprenti en alternance

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Positioning to users



Our will for users

> Academic

- **support research works since the expression of the idea** to go as far as possible in the developments in technology, if possible **until technology transfer.**
- **Support / develop collaborations with LAAS research**

> Industrials

- **Accompanying technological developments since the expression of needs** to go as far as possible in the technological developments **to technology transfer**
- **Direct collaborations with LAAS research , but not mandatory.**

The offers to users

- > Direct access to
 - Technical expertise,
 - Scientific expertise,
 - Infrastructure,
 - Equipment,
 - Processes

- > Hosting
 - Of people
 - Formations
 - Independent or supervised realizations
 - Recruitment on behalf of the industrial
 - Of equipment
 - From the user to benefit the infrastructure and organization.

- > Interface tools
 - Dematerialization of
 - Project management
<https://www.renatech.org/projet/index/en>
 - technology follow up
<https://lims.laas.fr/Default.aspx>
 - Pre established contracts for fast establishment of direct collaborations
 - Costs traceability
 - Auditable billing of audited costs

- > External tool for industrials if a French antenna
 - Eligibility of costs to research taxes credit

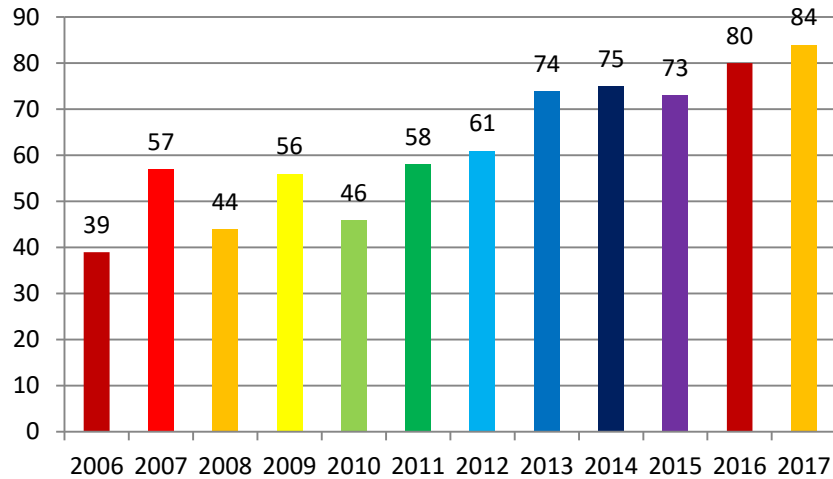
Direct partnerships of the platform at December 1, 2017

Direct partnerships of the platform = projects out of the scope of interest of LAAS researchers

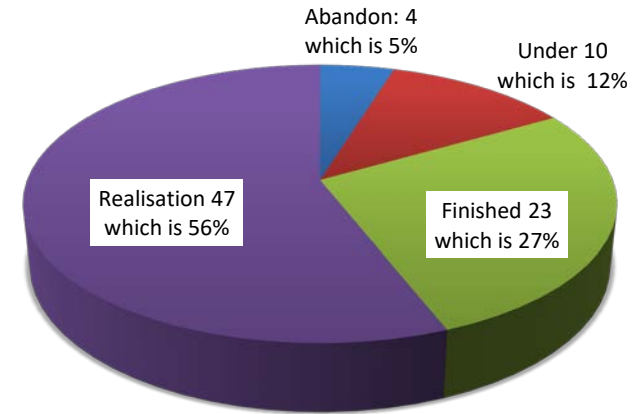
Support = technological activities already existing

Development = needs of technological tuning

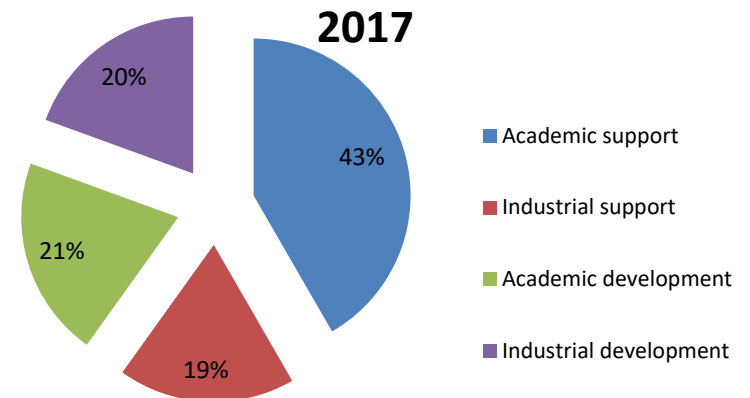
Demands evolution

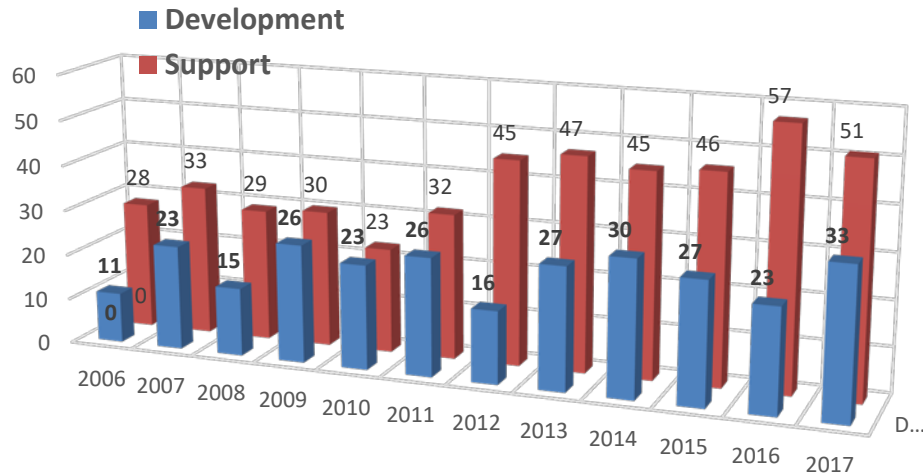


84 requests by 2017 including 38 continuing from 2016

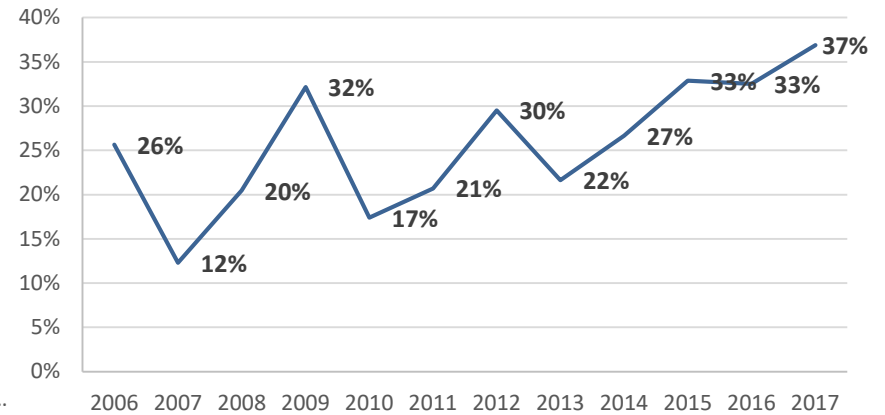


Distribution of applications

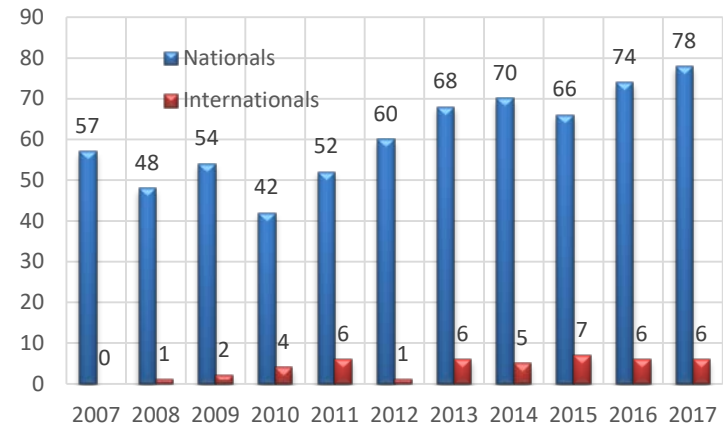
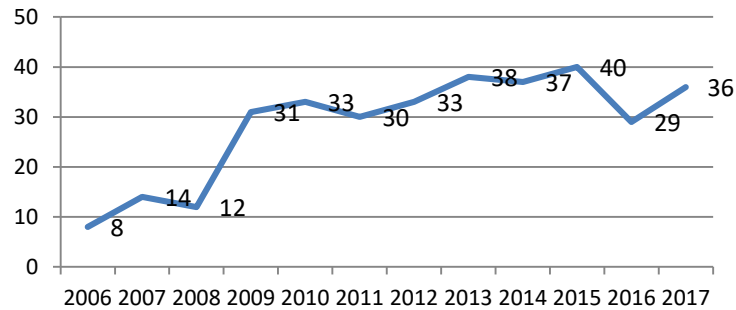




Evolution du of industrial projects average



Evolution of hosted people



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Applying for a project

- > Direct contact : renatech@laas.fr to interact about the framework of your project.
- > Renatech online application
 - <https://www.renatech.org/projet/>
 - Creation of a confidential personal account
- > Application
 - Administrative elements
 - Technical elements
- > Interactions with a correspondent
 - Technical details
 - How to undertake
 - Tariff proposal
 - IP / privacy
 - Completion document
 - Signed by both parties

NB : LAAS's members are free from these steps

Projects Realisation

- > Who ? : various ways depending
 - Nature and duration of the project
 - Volume and nature of the technological skill
 - Technology expertise of the user

 - By LAAS
 - TEAM
 - Permanents or temporary researchers

 - Contractual people
 - Provided for in the contract
 - **Included in TEAM**

 - External staff
 - Prior convention

- > Monitoring of the process on process sheets of and and online reservations
 - <https://lims.laas.fr/Default.aspx>

NB : LAAS's members are free from these steps

■ Systematic procedure before open access

- Awareness of the documents compiling the rules and essential protocols
- Inscription on online
 - Renatech project management application
 - MyFab LAAS clean room activities management application
 - Clean room users mailing list
- Practical training
 - General Introduction
 - Photolithography
 - Introduction to chemistry, its risks
 - Introduction to characterization
 - Plasma stripping, descuming

■ Help during the stay

- TEAM technical coordinator
- Formations
 - Mandatory
 - ½ day Introduction on development, surface treatment, patterning, characterization and integration of materials
 - Lectures on
 - Rules and tools for the manufacture of optical masks
 - Chemical risks prevention
 - Optical lithography
 - Characterization
 - Optionals
 - Lectures (12) on the technics available
 - Practical training on numerous equipment

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- > Auditable billing of audited prices
 - Calculation Method
 - Link between each expense and technology operations
 - Full cost calculation of each operation
 - "Degrade" the full cost in prices (4) acceptable according to the funding source

- > Operations billing is done according to the price eligible to the funding origin and/or the applicant.

- > A document summarizing the set of operations and the paid amount is produce, and can be use for the financial justification

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Many thanks
for your attention

