



RISK
Summer
School
2024

MECHANICAL AND PROCESS ENGINEERING

Laboratoire d'excellence - Grenoble

*Mathieu Tilquin – Partnerships and valorisation
mathieu.tilquin@tec21.fr*



About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI platform



What's a LabEx?

Innovative scientific project with an international range, carried out by a group of research laboratories and financed by the French government as part of the « Investissements d'avenir » programme

14 LabEx on the campus of Grenoble

Tec 21 is the Laboratoire d'Excellence for mechanical and process engineering since 2012

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

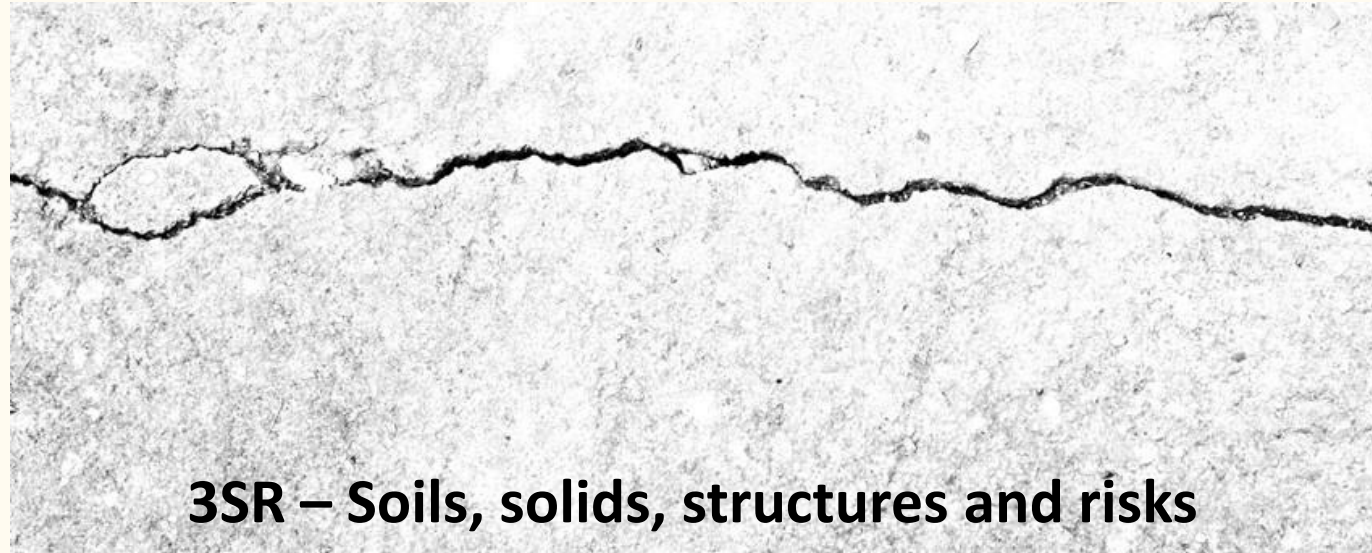
Internships

PEI platform



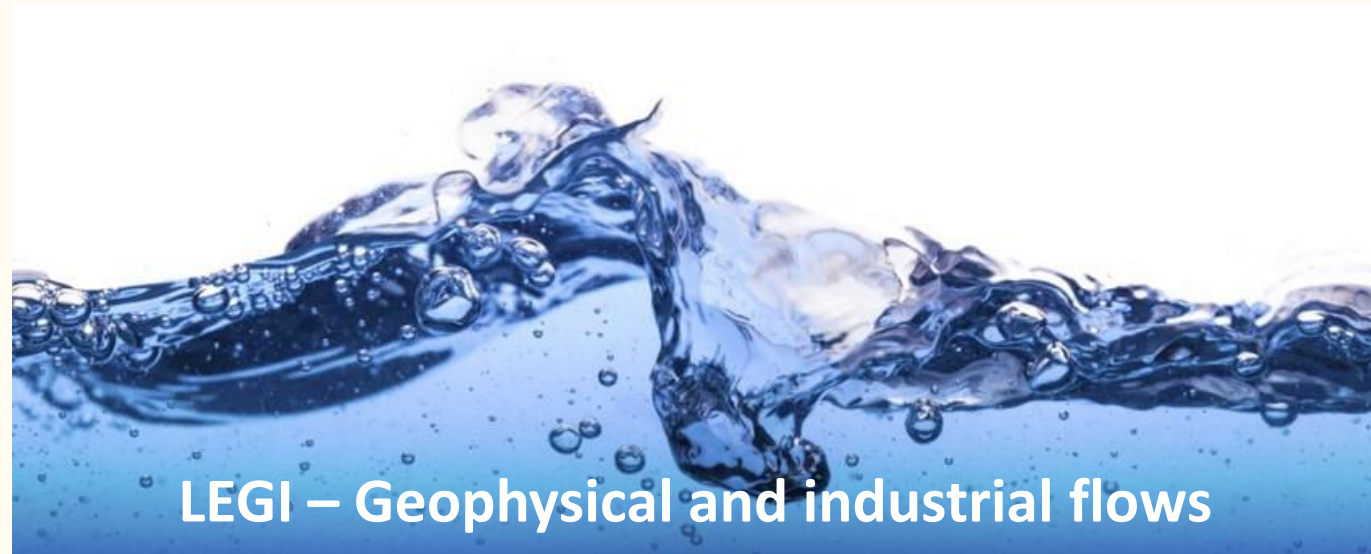
Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

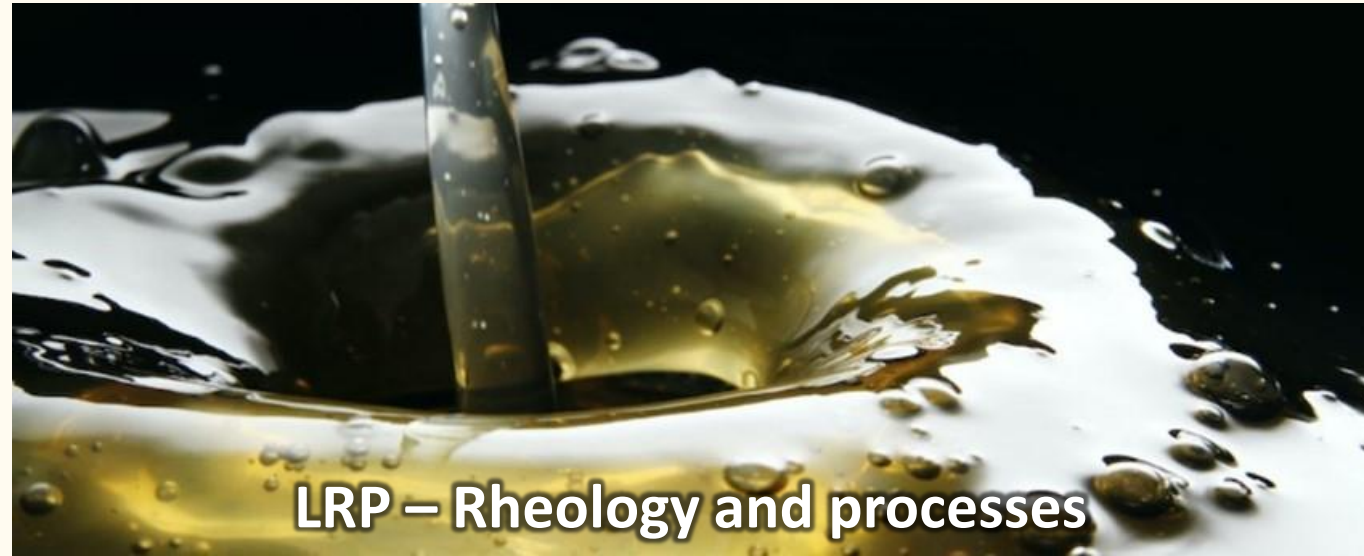
Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

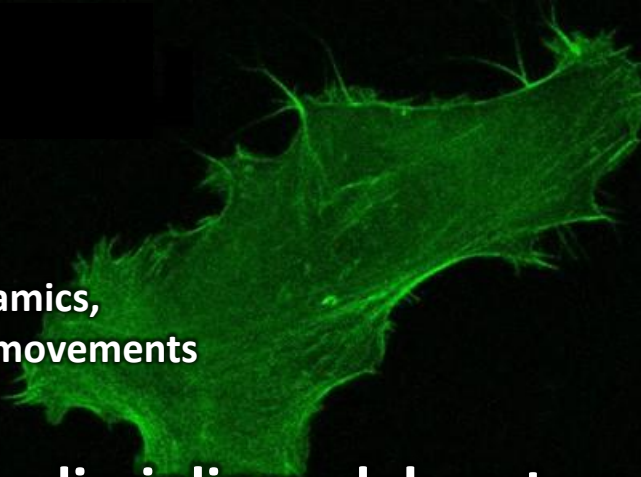
Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

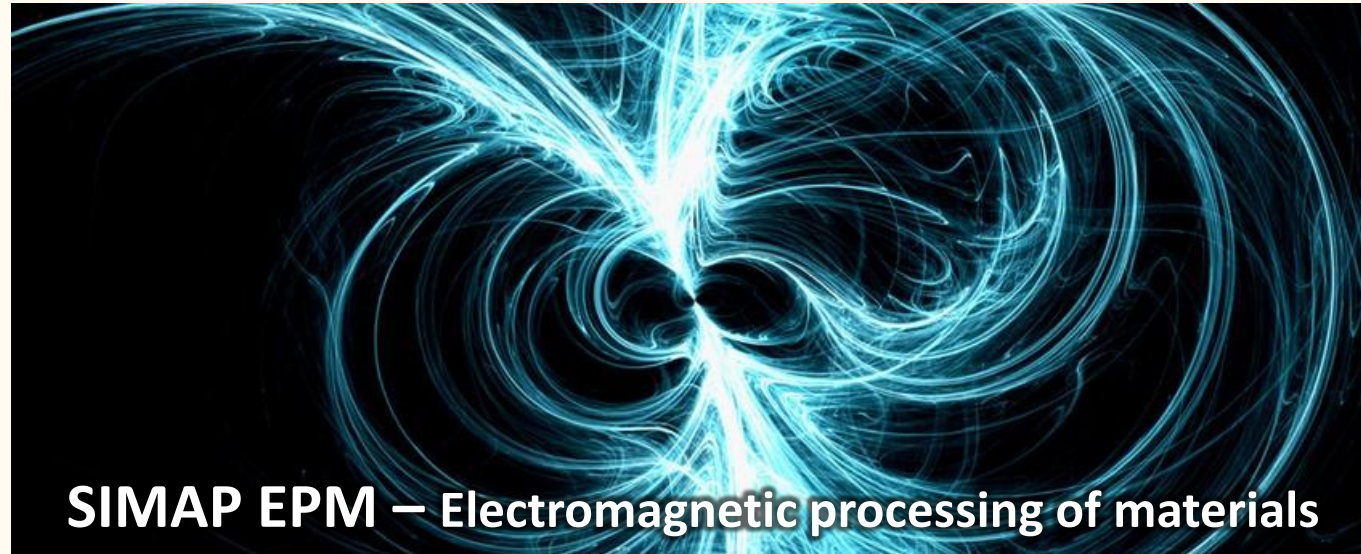
[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

**Cell mechanics,
flows and cells,
soft matter dynamics,
physics of fluid movements**

LIPhy – Interdisciplinary laboratory of physics

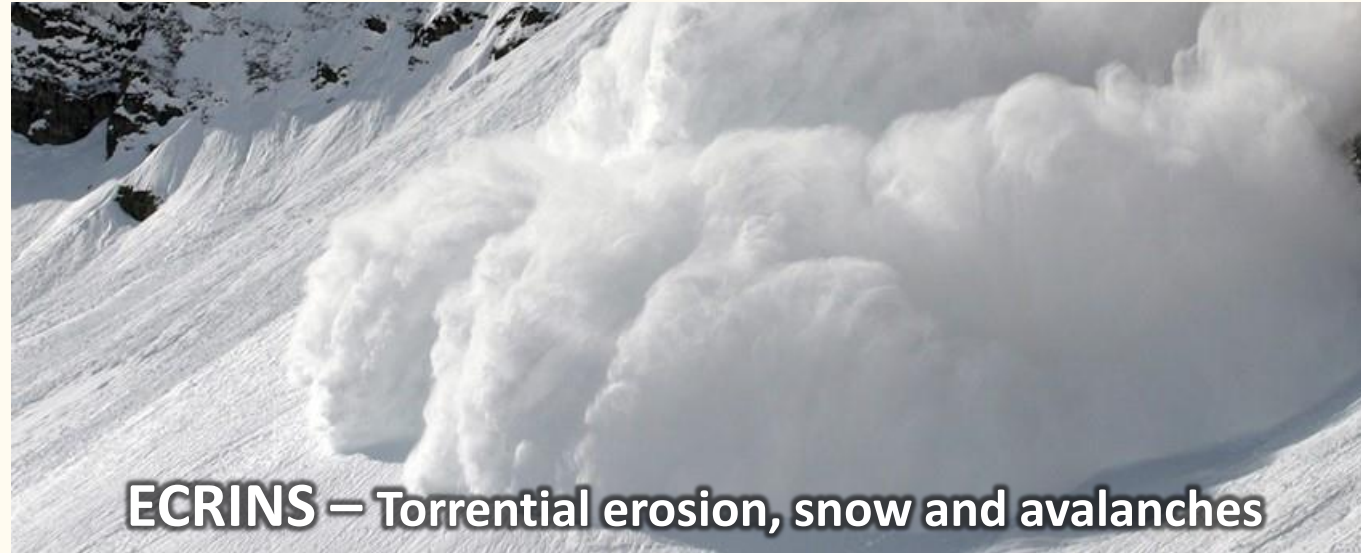
Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

Grenoble mechanical and process engineering research community

- 9 research laboratories / teams
- All of them located in Grenoble
- 250 permanent researchers and technicians sharing tools, methods and research objects
- 9M€ budget over 13 years

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

The objectives are three-fold:

- Develop our **research activities** encouraging interactions between our partner laboratories
- Reinforce research-driven **training programmes**
- Contribute to **innovation** through collaborations with industrial partners on the applications of our research results

About us
Perimeter
Objectives

Research

Call for proposals
Funded projects

Education

Scholarships
Winter school

Applications

Internships
PEI platform



4 scientific work packages dealing with the complexity of systems and phenomena involving **strong couplings at different scales**

We develop **experimental** tools and methods as well as **numerical** models and simulations



WP1 : COUPLING FLUID AND SOLID MECHANICS

1. Solids in fluids (dense complex suspensions in non-Newtonian fluids, particle transport, erosion, deposition...)
2. Fluids in solids (highly confined flows, percolation in porous media...)
3. Solid-fluid transition and associated instabilities (shear-banding, liquefaction, dynamical phase transition, fluidisation in unsaturated soils or wet snow...)
4. Fracture and rupture (fracture propagation and fragmentation, micro damage...)
5. Flow-structure interactions (deformability of the matrix and interfaces in micro/nano porous systems, interactions between flow and highly deformable structures at larger scales, energy dissipation, impact forces...)

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI platform

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

WP2 : COUPLING FLUID MECHANICS WITH BIO-PHYSICAL PHENOMENA AT MICRO/NANO SCALES

1. Advanced fluid mechanics (structure and control of turbulence in single or two phase media...)
2. Interfacial dynamics and transfers (boundary conditions at the interface – heat and mass transfer, phase change, chemical reactions... couplings with phenomena at the nano scale)
3. Flow of active micro objects (swimming of particles, biofilms, bacterial growth, assisted drug delivery with microcapsules...)



WP3 : MECHANICS OF AND FOR THE LIVING MATTER

1. Mechanics of the living matter (at the cell scale – adhesion, interaction with the substrate, conversion of a mechanical stimulus into a physiological response... at the tissue scale – mechanical behaviour under sollicitation, rheological laws, deformation...)
2. Mechanics for the living matter (mechanics of biomaterials for prostheses, development of fibrous substitutes or matrices and substrates for cell growth...)

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

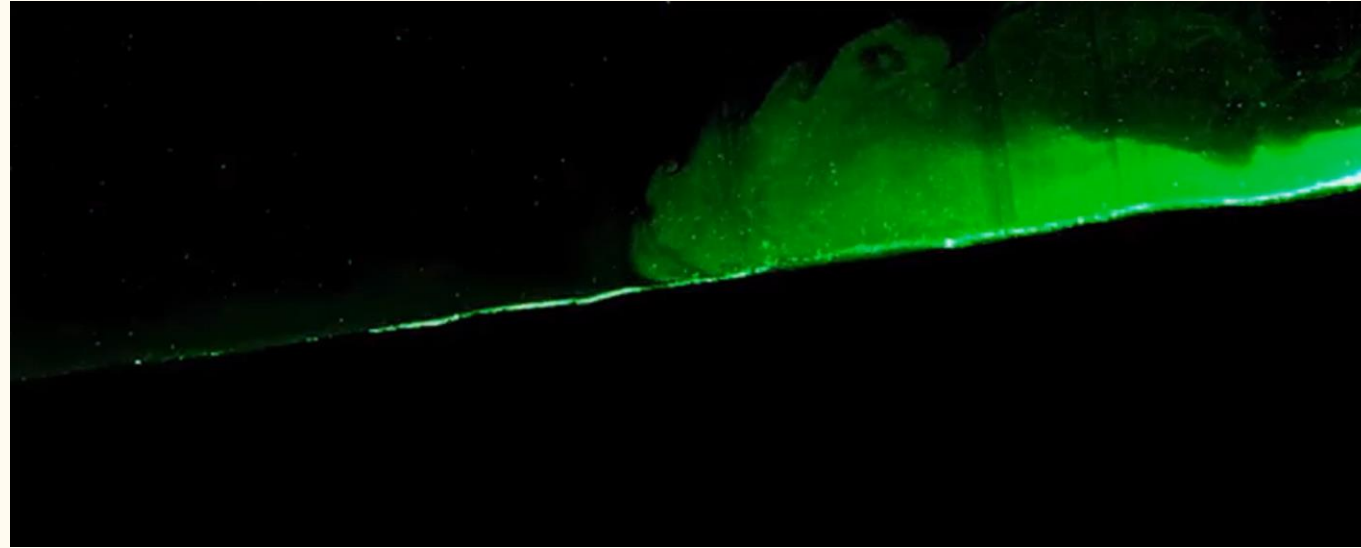
Scholarships

Winter school

Applications

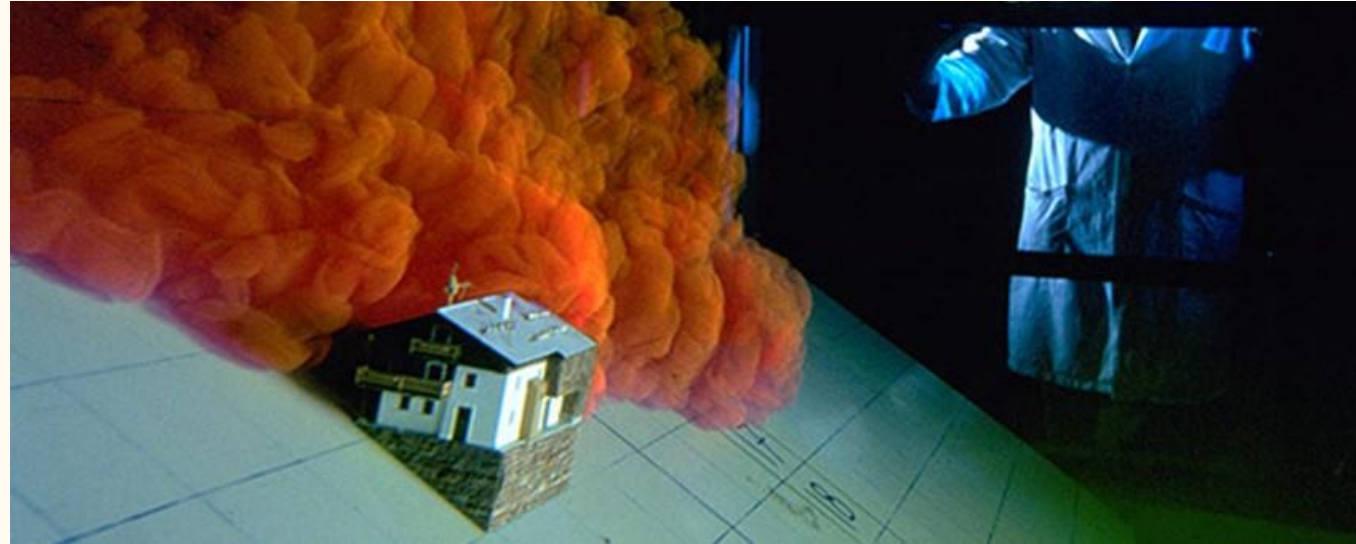
Internships

PEI platform

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

WP4 : ADVANCED NUMERICAL TOOLS AND EXPERIMENTAL METHODS

1. Advanced modelling and simulations (for multiscale and mutiphysical processes – complex flows, deformable objects... homogenization approaches...)
2. Multiscale characterisation and field measurements (large scale dynamics, coupling of methods –Lagrangian/ Eulerian... 2D/3D fields – displacement, strains, velocity...)
3. Coupling with artificial intelligence (development of specific, physically constrained AI methods, supervised learning for big data processing and interpretation, and simulating complex systems – heterogeneous data, multiscale phenomena...)



Tec 21 finances research actions

- Yearly call for research proposals
- International peer review
- Fundamental research
- PhDs – Post-docs – Long term visitors – Short term visitors – Outgoing grants / large equipment
- More than 100 research projects funded since 2012

About us
Perimeter
Objectives
Research

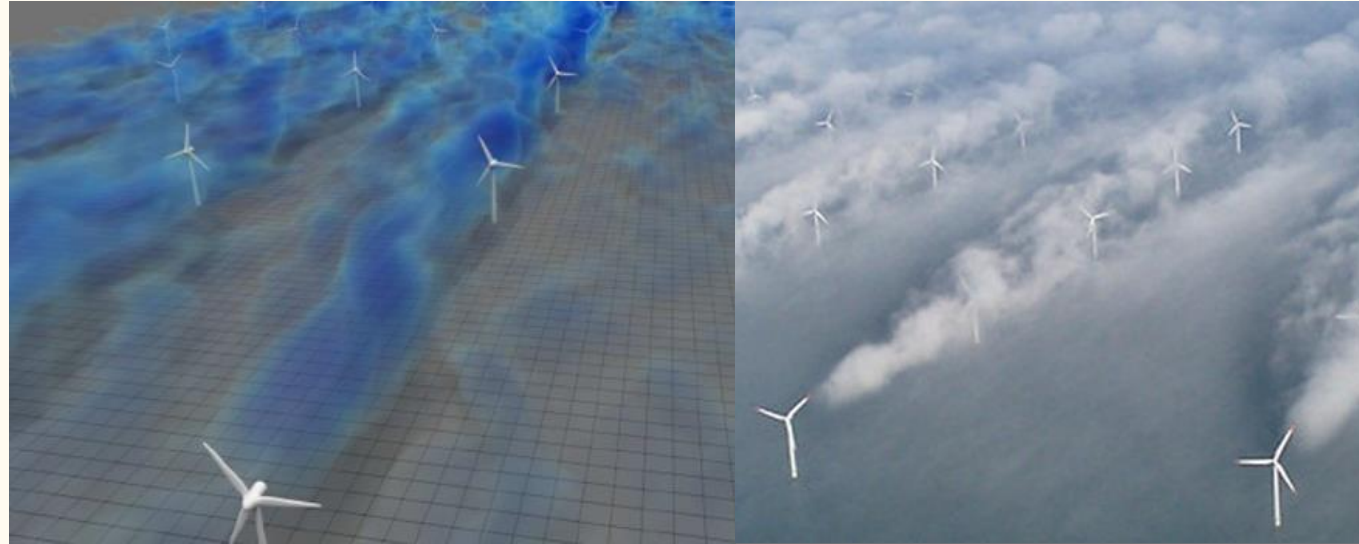
Call for proposals
Funded projects

Education
Scholarships
Winter school

Applications
Internships
PEI platform

- About us
- Perimeter
- Objectives
- Research
- Call for proposals
- Funded projects

- Education
- Scholarships
- Winter school
- Applications
- Internships
- PEI platform

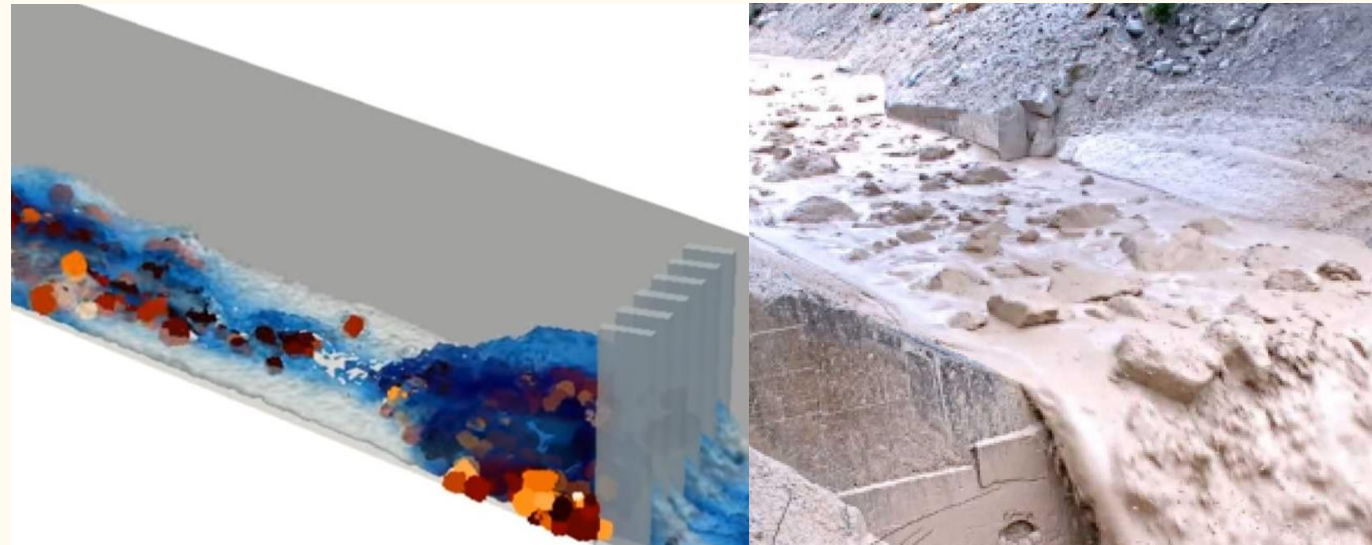


The role of turbulence cascade in wind energy applications

PhD / Long visitor
Univ. Oldenburg / LEGI
PI: Stéphane Barre

- About us
- Perimeter
- Objectives
- Research
- Call for proposals
- Funded projects**

- Education
- Scholarships
- Winter school
- Applications
- Internships
- PEI platform



Multiscale investigation of interactions between debris flows and obstacles through coupled DEM-SPH modelling

PhD
3SR / INRAE Grenoble
PI: Guillaume Piton

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI platform

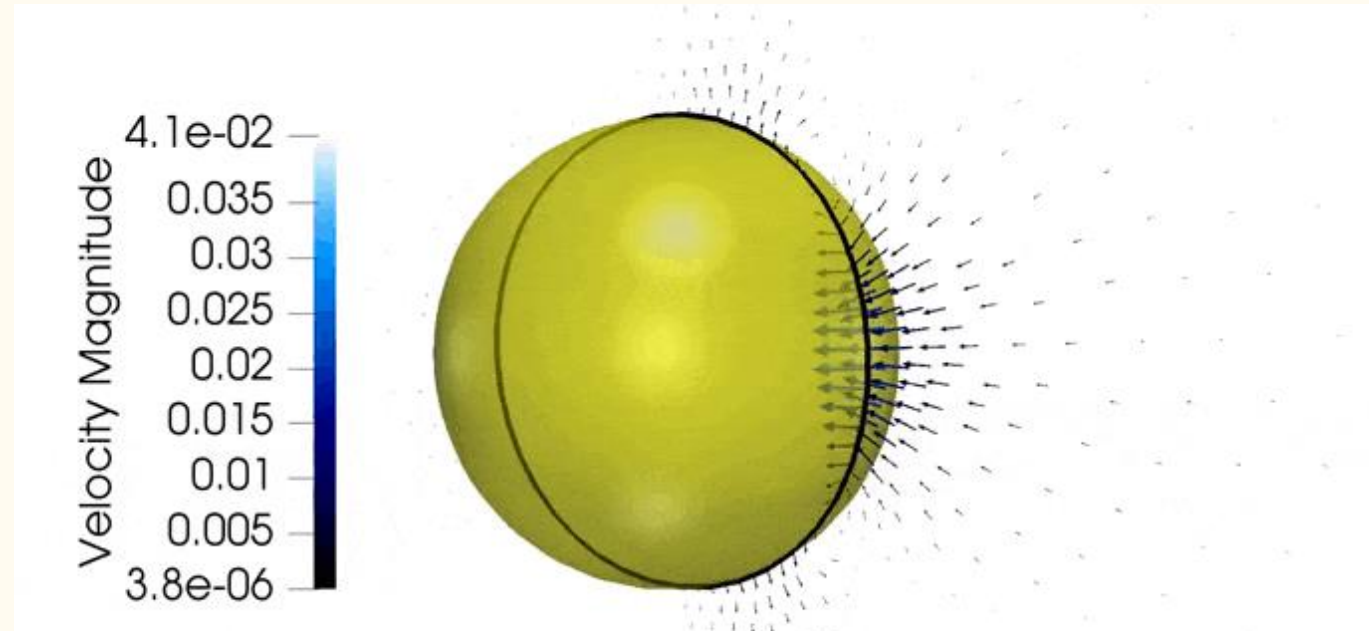


Creeping snow: modelling the forces induced on structures

Post-doc

3SR / INRAE Grenoble

PI: Stéphane Lambert

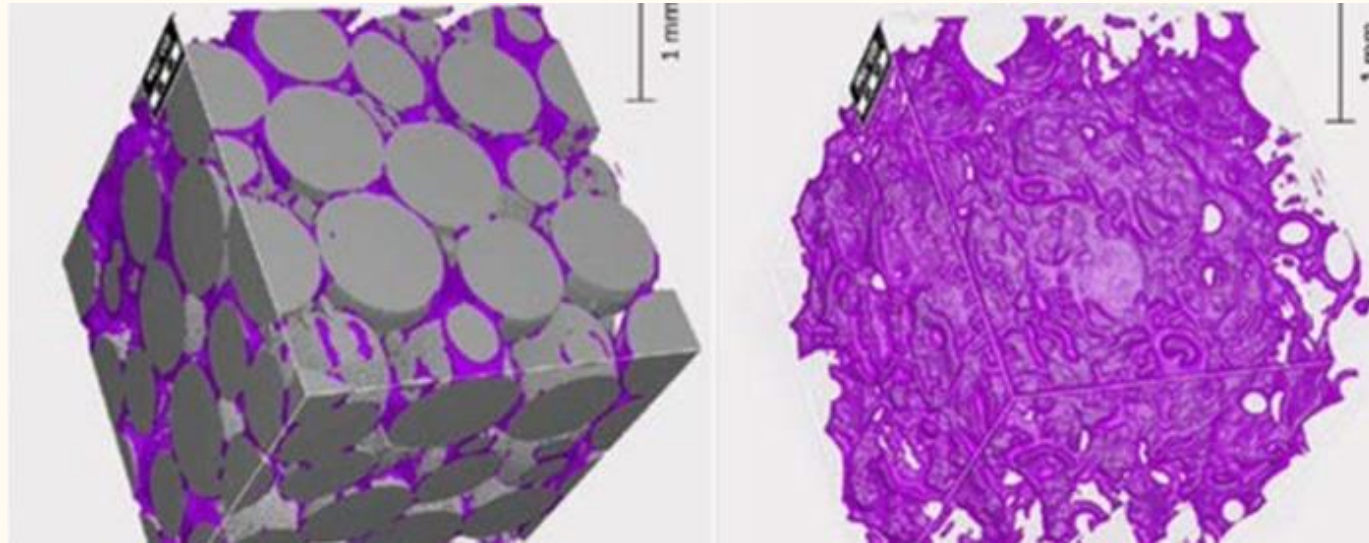
[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

Modeling of hysteretic paths in cyclic deflation-inflation of spherical shells: application to the design of artificial microswimmers

Outgoing grant

LIPhy / College of Engineering (Boston University, USA)

PI: Gwennou Coupier

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

3D visualisation and quantification of biofilm in porous media by using X-ray microtomography

Short-visitor

3SR / LEGI / Department of microbiology (Univ. Zagreb, Croatia)

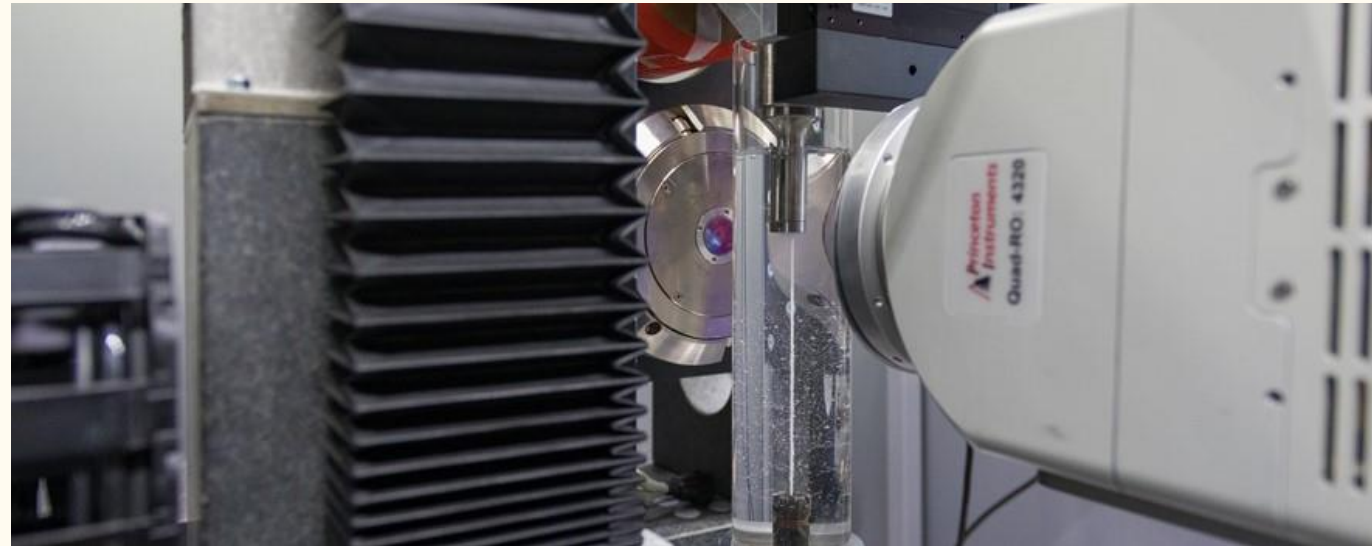
PI: Tomislav Ivanković

- About us
- Perimeter
- Objectives
- Research
- Call for proposals

Funded projects

- Education
- Scholarships
- Winter school

- Applications
- Internships
- PEI platform



X-ray nano tomograph

Equipment

OSUG, CERMAV, Tec21, 3SR, SIMAP, PHITEM...



Publications :

- Between 70-80 publications every year citing Tec21 as a funding institution
- Strengthening the interactions between our laboratories
- Developing new collaborations with foreign universities

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

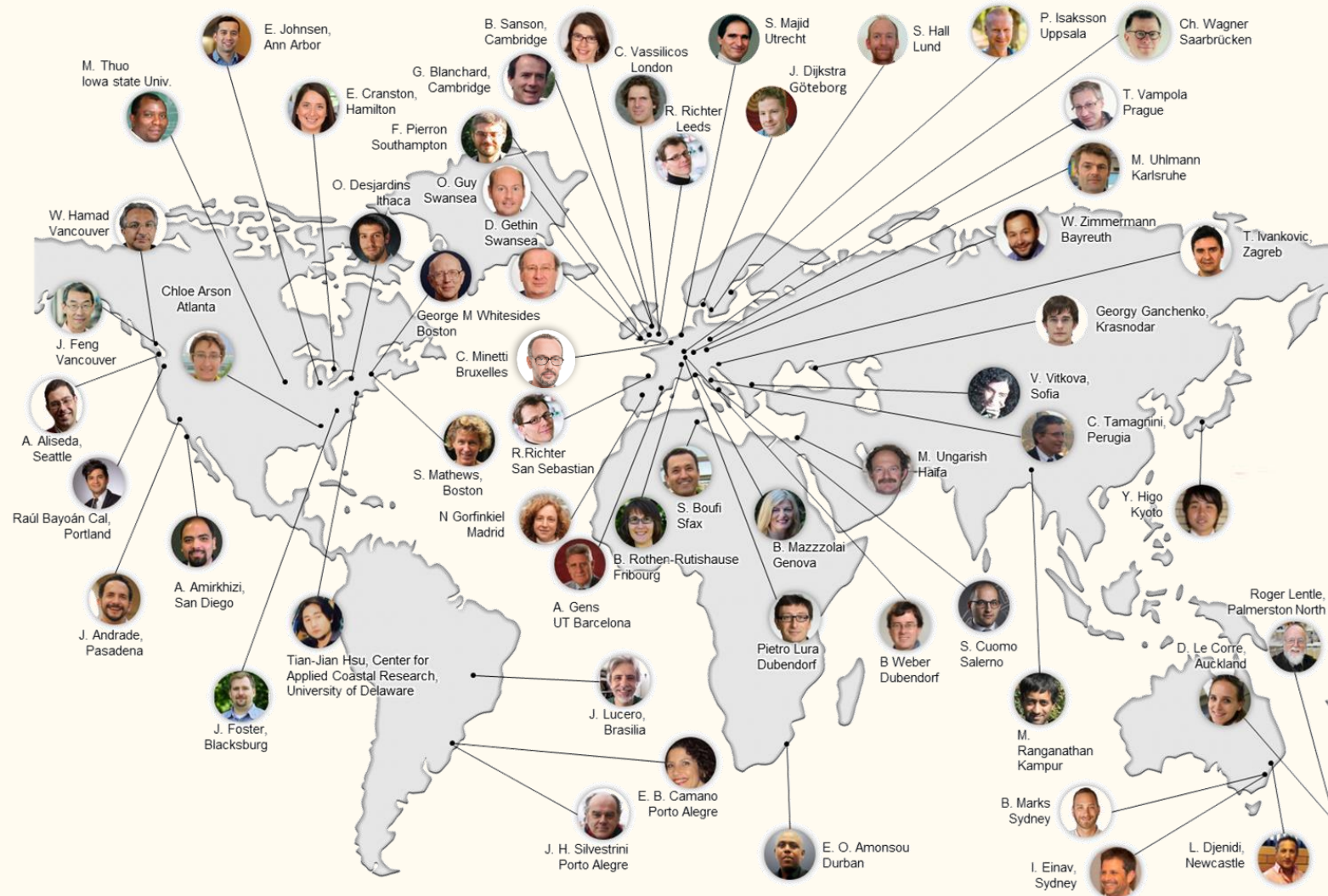
Applications

Internships

PEI platform

- About us
- Perimeter
- Objectives
- Research
- Call for proposals
- Funded projects**
- Education
- Scholarships
- Winter school
- Applications
- Internships
- PEI platform

International collaborations launched through Tec21 projects



[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

Tec 21 community is strongly involved in education from the first university years up to engineering degree and PhD level

Every year, more than 500 students graduate from the mechanical and process engineering education units:

- 200 technicians
- 30 master students
- 250 engineers
- 50 doctors



Objective: attract brilliant students to prepare their second year of master in one of our education programmes

- Yearly call for applications
- Master II scholarships
- 8 000 € / year

IN SHORT

Tec 21 finances Master II scholarships (between 4 to 6 scholarships every year)

More than 20 Master students did a PhD after their master studies (12 of them in one of our partner laboratories)

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI platform



Multiscale approaches and multiphysic couplings in fluid and solid mechanics (one week for connecting theory to experiment and numerical simulations):

- Day 1: Multiscale approaches in mechanics
- Day 2: Numerical and experimental tools and methods
- Day 3 – Day 4: High-tech lab courses
- Day 5: Mechanics at the nanoscale (2022) – Waves in fluids and solid (2020) – Instabilities in fluid and solid mechanics (2018) - Fluid / solid transition (2015)

IN SHORT

The winter school is open to PhD students, Post-doctoral researchers, R&D engineers and all attendants with a background in mechanics wishing to broaden their scientific or technical knowledge about multiphysics or multiscale problems and discover some of the most up to date tools and methods developed in research.

Next edition: February 2025

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winterschool

Applications

Internships

PEI platform



We have build up 10 demonstrators to give the participants the opportunity to manipulate the most advanced techniques that we use in research.

- Initiation to fluid turbulence
- Granular media: experimental and numerical analysis
- Red blood cells distribution in a model network
- Dense gravitational flows
- Fibrous material behaviour studied by x-ray tomography
- Wave turbulence
- Membrane ultrafiltration processes
- Propagation of viscoplastic surges over complex topography
- Bubble columns and diphasic flows

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winterschool

Applications

Internships

PEI platform

- About us
 - Perimeter
 - Objectives
- Research
 - Call for proposals
 - Funded projects
- Education
 - Scholarships
 - Winter school



7 applications areas are connected with our research:

- Energy production and storage

Applications

- Internships
- PEI platform

- About us
 - Perimeter
 - Objectives
- Research
 - Call for proposals
 - Funded projects
- Education
 - Scholarships
 - Winter school



7 applications areas are connected with our research:

- Energy production and storage
- Environmental management and risk assessment

Applications

- Internships
- PEI platform

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI platform



7 applications areas are connected with our research:

- Energy production and storage
- Environmental management and risk assessment
- Civil engineering, building materials and constructions

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI platform



7 applications areas are connected with our research:

- Energy production and storage
- Environmental management and risk assessment
- Civil engineering, building materials and constructions
- Space, aeronautics and propulsion



7 applications areas are connected with our research:

- Energy production and storage
- Environmental management and risk assessment
- Civil engineering, building materials and constructions
- Space, aeronautics and propulsion
- Process engineering, optimisation, remediation and recycling

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

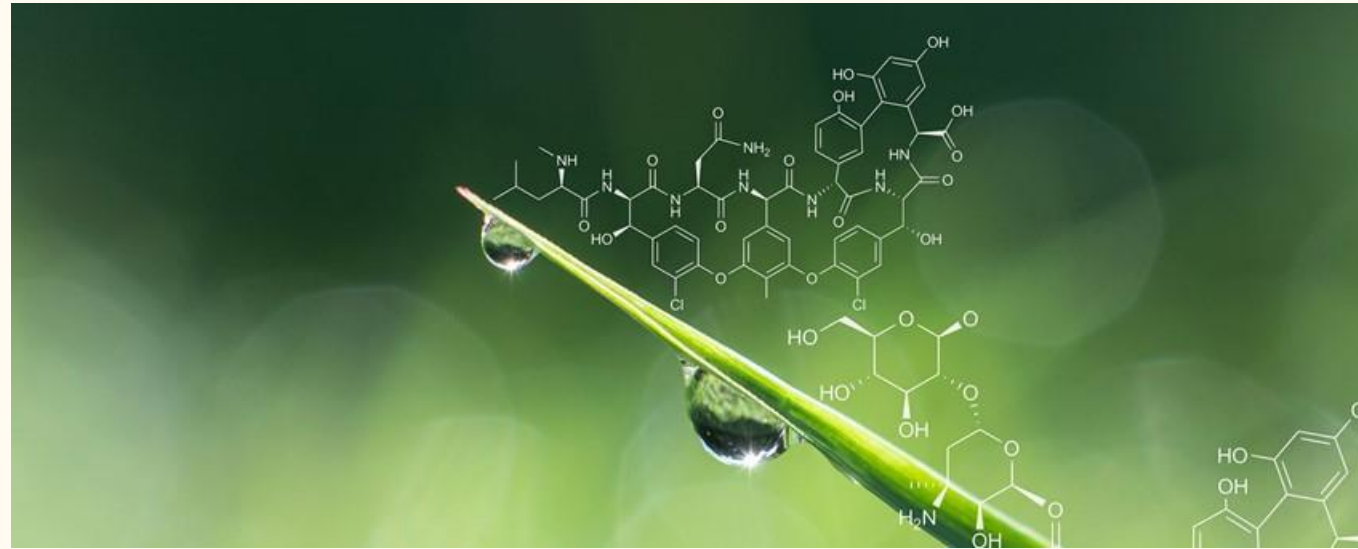
Scholarships

Winter school

Applications

Internships

PEI platform

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI platform](#)

7 applications areas are connected with our research:

- Energy production and storage
- Environmental management and risk assessment
- Civil engineering, building materials and constructions
- Space, aeronautics and propulsion
- Process engineering, optimisation, remediation and recycling
- Biorefinery, bio-based products and biomass valorisation



7 applications areas are connected with our research:

- Energy production and storage
- Environmental management and risk assessment
- Civil engineering, building materials and constructions
- Space, aeronautics and propulsion
- Process engineering, optimisation, remediation and recycling
- Biorefinery, bio-based products and biomass valorisation
- Engineering for human health

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI platform



Proof of concept and R&D internships

- Help our researchers take the first step into the valorisation of their research results
- Facilitate the connection with industrial partners on new topics

Among the 50 projects financed:

- 15 projects lead to a PhD on the topic
- 8 projects were supported by Linksium
- 6 patents were registered
- 3 startup companies created
- Return on investment for the laboratories = 3.350 M€ (investment Tec 21 = 126 k€)

IN SHORT

Tec 21 finances internships to encourage innovation and industrial collaboration within its partner laboratories

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI platform

- About us
- Perimeter
- Objectives
- Research
- Call for proposals
- Funded projects
- Education
- Scholarships
- Winter school
- Applications

Internships

- PEI platform



Hydrodynamics of a pneumatic agitator for methanisation processes

R&D internship

LRP / Arkolia

Outcome: PhD with co-funding by the company

- About us
- Perimeter
- Objectives
- Research
- Call for proposals
- Funded projects
- Education
- Scholarships
- Winter school
- Applications

Internships

- PEI platform



Rheology of rock glaciers under climate change

POC internship

3SR

Outcome: PhD funded by the French research ministry



In situ characterisation of liquifiable soils: validation of a new testing device

R&D internship
3SR / Equaterre
Outcome: PhD financed by the company

- About us
 - Perimeter
 - Objectives
- Research
 - Call for proposals
 - Funded projects
- Education
 - Scholarships
 - Winter school
- Applications

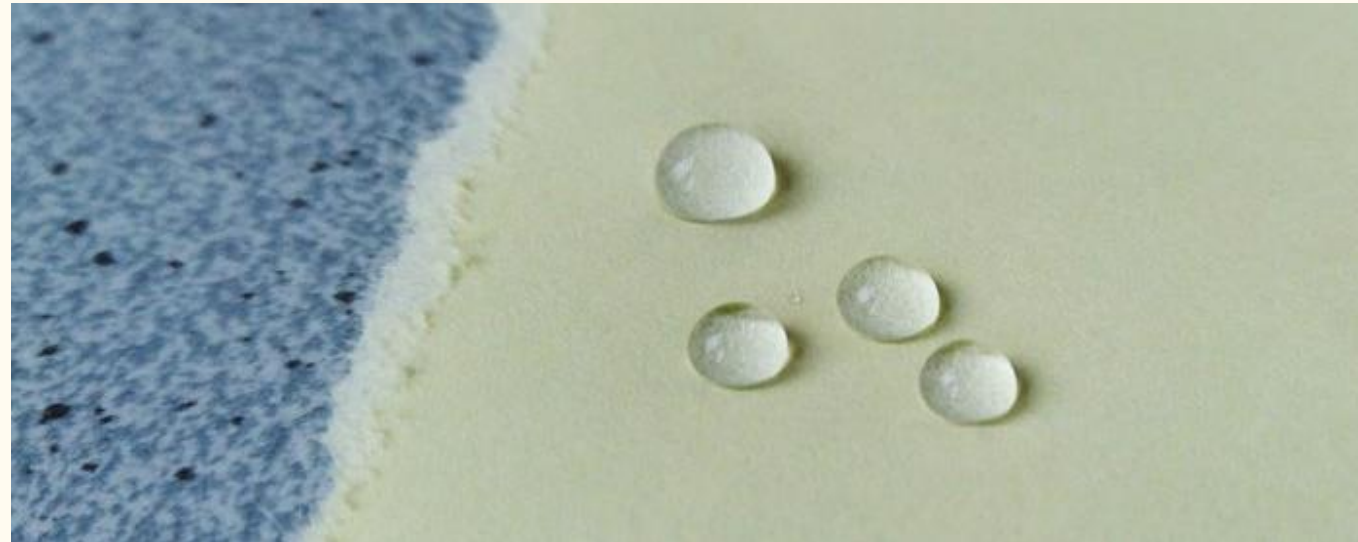
Internships

PEI platform

- About us
- Perimeter
- Objectives
- Research
- Call for proposals
- Funded projects
- Education
- Scholarships
- Winter school
- Applications

Internships

- PEI platform



Hybrid bio-based materials: mechanical and functional properties of cellulosic substrate coated with ceramic by atomic layer deposition

POC internship

SIMAP / LGP2

Outcome: Startup company created (Cilkoa – 2022 – 10 pers.)

- About us
 - Perimeter
 - Objectives
- Research
 - Call for proposals
 - Funded projects
- Education
 - Scholarships
 - Winter school
- Applications
 - Internships



Collaborative research platform on clean processes and environmental issues (PEI: Processes, Environment, Industry)

- 1 400 m² managed by the Fed3G

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI Platform](#)

Collaborative research platform on clean processes and environmental issues (PEI: Processes, Environment, Industry)

- 1 400 m² managed by the Fed3G
- 800 hours of teaching per year

[About us](#)[Perimeter](#)[Objectives](#)[Research](#)[Call for proposals](#)[Funded projects](#)[Education](#)[Scholarships](#)[Winter school](#)[Applications](#)[Internships](#)[PEI Platform](#)

Collaborative research platform on clean processes and environmental issues (PEI: Processes, Environment, Industry)

- 1 400 m² managed by the Fed3G
- 800 hours of teaching per year
- Between 8 and 10 research projects in progress



Collaborative research platform on clean processes and environmental issues (PEI: Processes, Environment, Industry)

- 1 400 m² managed by the Fed3G
- 800 hours of teaching per year
- Between 8 and 10 research projects in progress
- 6 startups companies installed developing their technologies in collaboration with our partner laboratories (around 50 people on site this year)

IN SHORT

Since 2015, the PEI platform hosts research projects, education activities and startups companies to boost the contribution of Tec 21 research community to innovation in mechanical and process engineering

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI Platform

About us

Perimeter

Objectives

Research

Call for proposals

Funded projects

Education

Scholarships

Winter school

Applications

Internships

PEI Platform



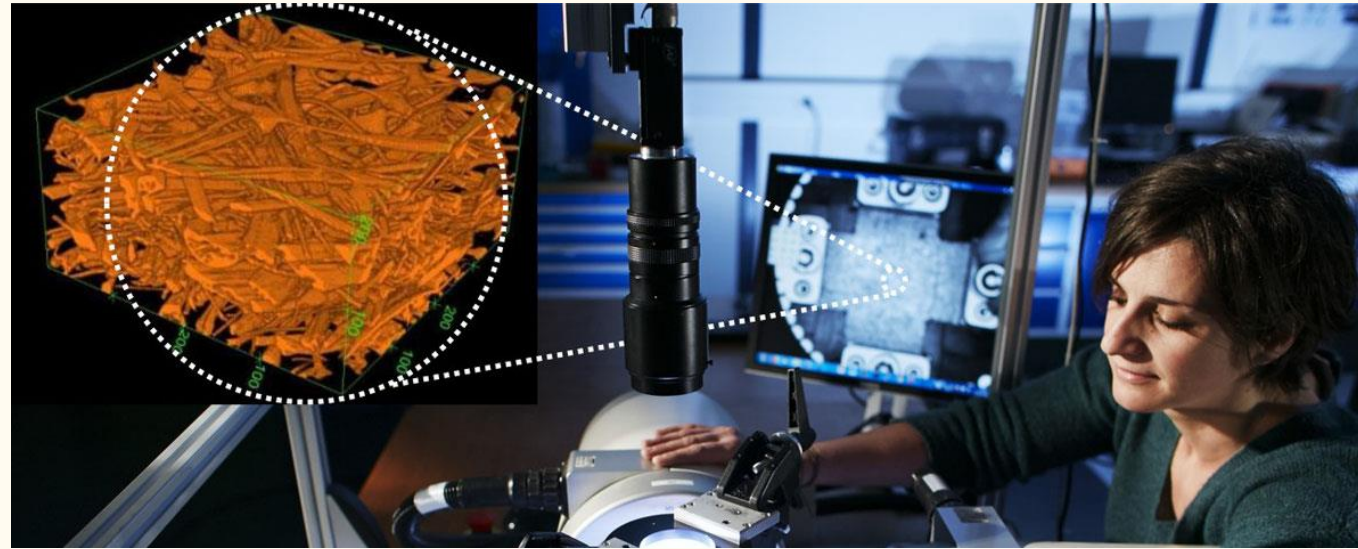
Ultrasound enhanced filtration processes

Research project

LRP / Linksium

- About us
- Perimeter
- Objectives
- Research
- Call for proposals
- Funded projects
- Education
- Scholarships
- Winter school
- Applications
- Internships

PEI Platform



Mechanics for biobased materials and bio inspired processes

Research project
3SR / many others including industrial partners

- About us
- Perimeter
- Objectives
- Research
 - Call for proposals
 - Funded projects
- Education
 - Scholarships
 - Winter school
- Applications
 - Internships

PEI Platform



FUNCELL (Functionalization for Cellulosic materials)

Startup company
CERMAV – 15 people on site

- About us
 - Perimeter
 - Objectives
- Research
 - Call for proposals
 - Funded projects
- Education
 - Scholarships
 - Winter school
- Applications
 - Internships
 - PEI Platform



ROSI SOLAR (return of silicon)

Startup company
SIMAP – 25 people on site

Tec21 is multidisciplinary by nature (fluid mechanics, solid mechanics, soft matter physics, process engineering). Since 2012 we work to strengthen the interactions between our laboratories :

- Call for research proposals : **at least two laboratories from Tec21 must be involved,**
- Workshops organised to gather the community and build up the scientific road map on various topics involving **multidisciplinary approaches** (e.g. biorefinery, artificial intelligence...),
- Co-funding with other structures to encourage **research collaborations with other disciplines** (chemistry, informatics...)
- **Global communication**: all PhD defenses or seminars are announced to the whole perimeter
- **Scientific days** organised on multiphysic problems with speakers from various disciplines

- more than 100 fundamental research projects funded involving a collaboration btw our laboratories
- 600 articles+ published (more than 1/3 with co-authors from at least two laboratories from tec21)
- the Tec21 project was renewed twice since its creation
- 2 new laboratories / teams were integrated to Tec21 consortium



RISK
Summer
School
2024

MECHANICAL AND PROCESS ENGINEERING

Laboratoire d'excellence - Grenoble

*Mathieu Tilquin – Partnerships and valorisation
mathieu.tilquin@tec21.fr*

