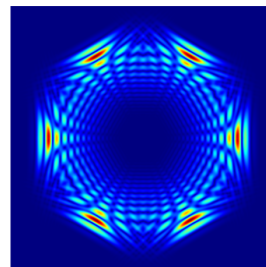


# Kick-off Meeting of the International Research Project Coss&Vita

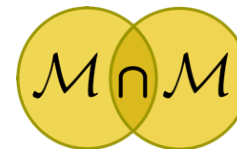
October 17<sup>th</sup> 2019

Arthur Lebée  
NAVIER

Giuseppe Rosi  
MSME



*Coss&Vita*



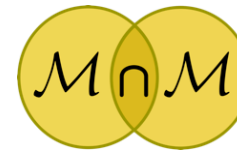
International Research  
Center Memocs



# Presentation of the institutions



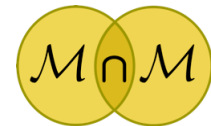
Olivier Casteleau



International Research  
Center Memocs



Luca Placidi



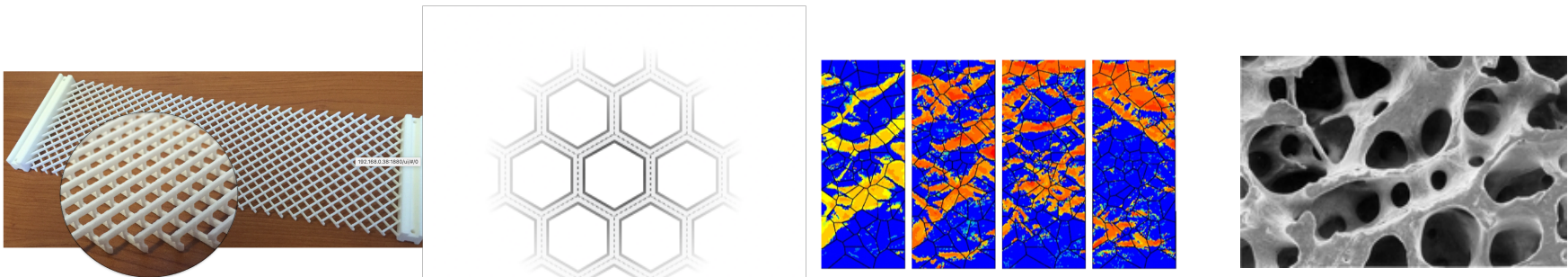
# Research topic and objectives

## Main research topic:

***Generalized continua and their applications to engineering materials and structures***

## Objectives :

- Promote new developments and applications and to strengthen the expertise in the field of generalized continuum mechanics.
- Stimulate real breakthroughs by taking advantage of the French and Italian expertise in the field.



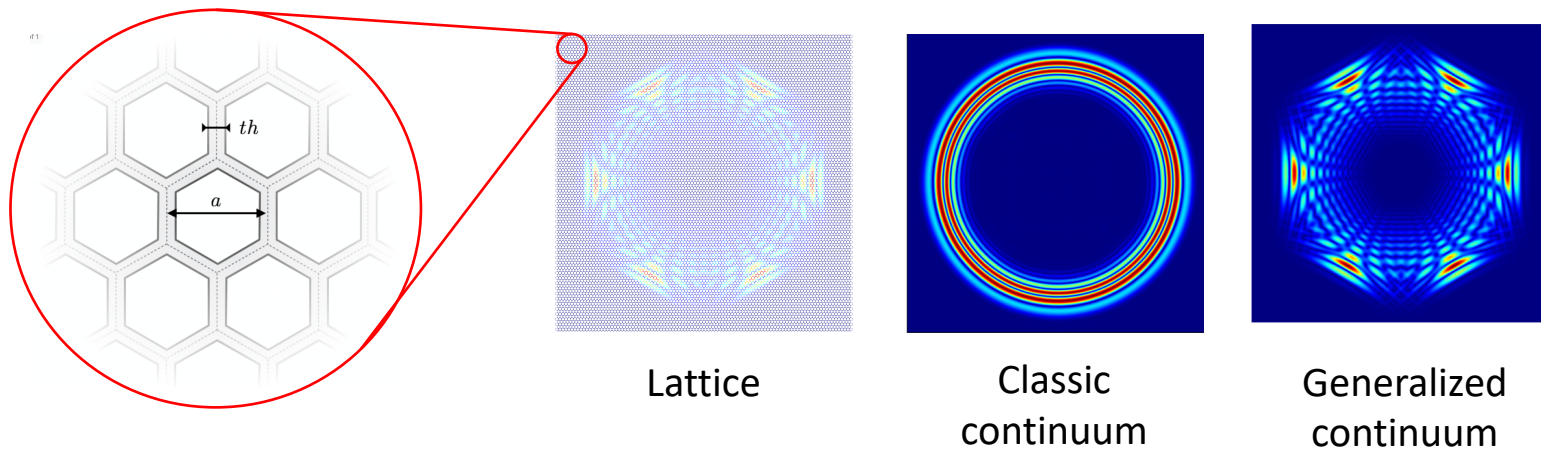
# Scientific motivations

Size effects can be found in several applications

Consequences :

- Micro- and meso-structural effects emerge at macro-scale
- Classic continuum theories fail

Example: wave propagation in a hexagonal lattice is predicted as isotropic



Generalized continua has been mostly confined to theoretical works from their introduction in 70s, now we have the tools to bring them to the applications.

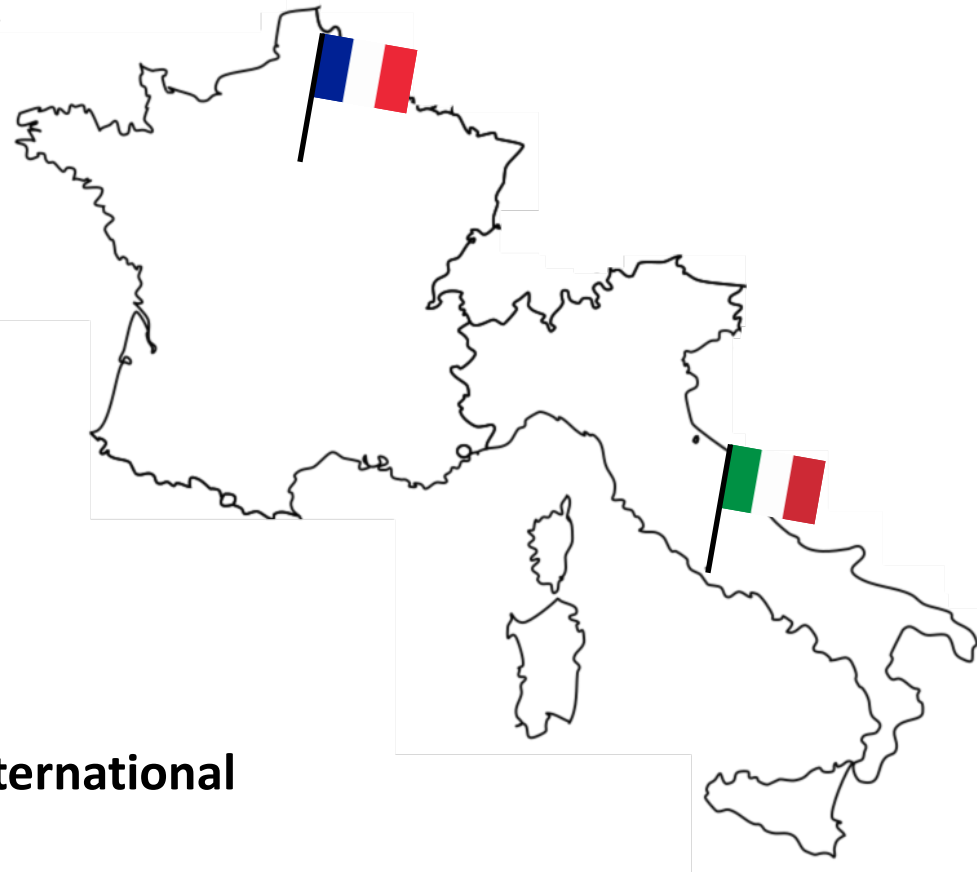
# Cooperation methods

- **Workshops** taking place at both places are needed to bring together researchers
- **Exchanges of researchers (*Chercheurs en résidence*)**, over periods ranging from one week to three months, and **research weeks**

Other actions:

**International Summer Schools**

**Participation to the organization of international conferences.**



# Some history

- The IRP Coss&Vita was launched in 2015 as LIA (Laboratoire International associé) by
  - Samuel Forest
  - Francesco dell'Isola
- Under the auspices of



François Cosserat  
(1852–1914)



Tullio Levi-Civita  
(1874–1941)

*the Engineer and the Mathematician*

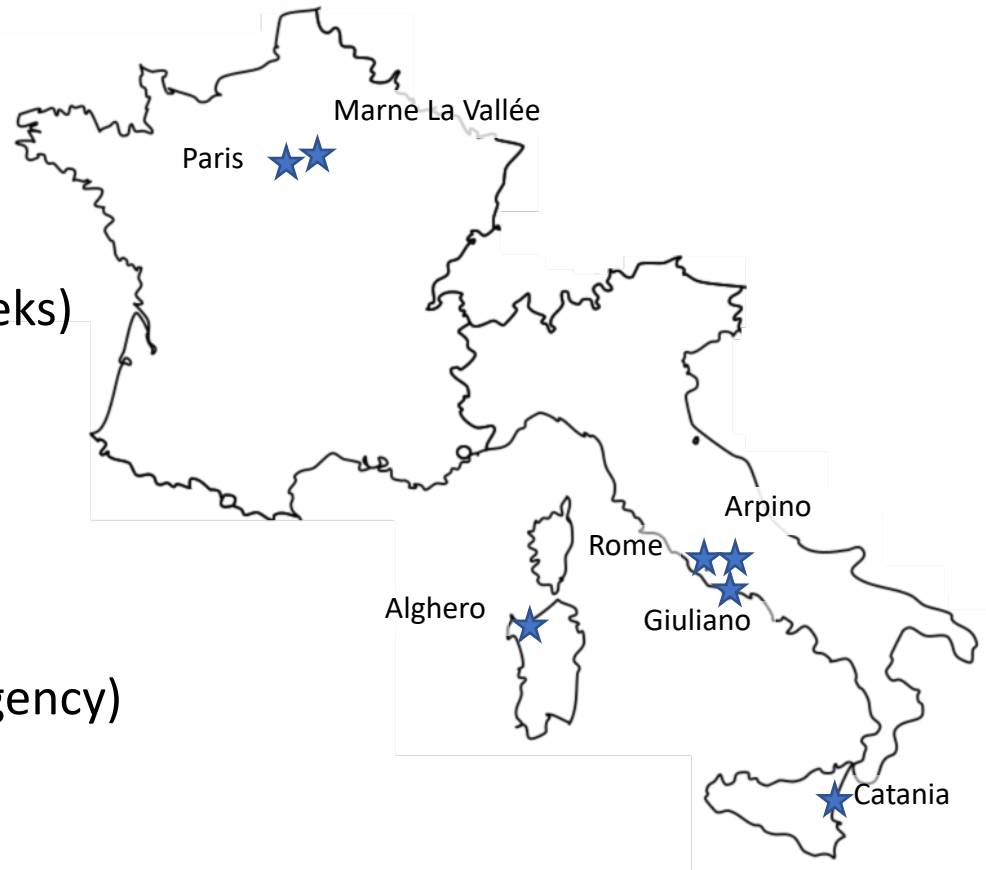
# Summary of the Actions and results (2015-2018)

## Events

- 7 workshops
- 3 summer schools
- 2 international conferences
- 26 exchange of researchers (39 weeks)

## Other actions and results :

- 3 co-advised PhD
- 3 ANR projects (French Research agency)
- 16 publications (and counting..)



# Steering committee, management and administrative team

The new management team for the period 2019-2024 is the following

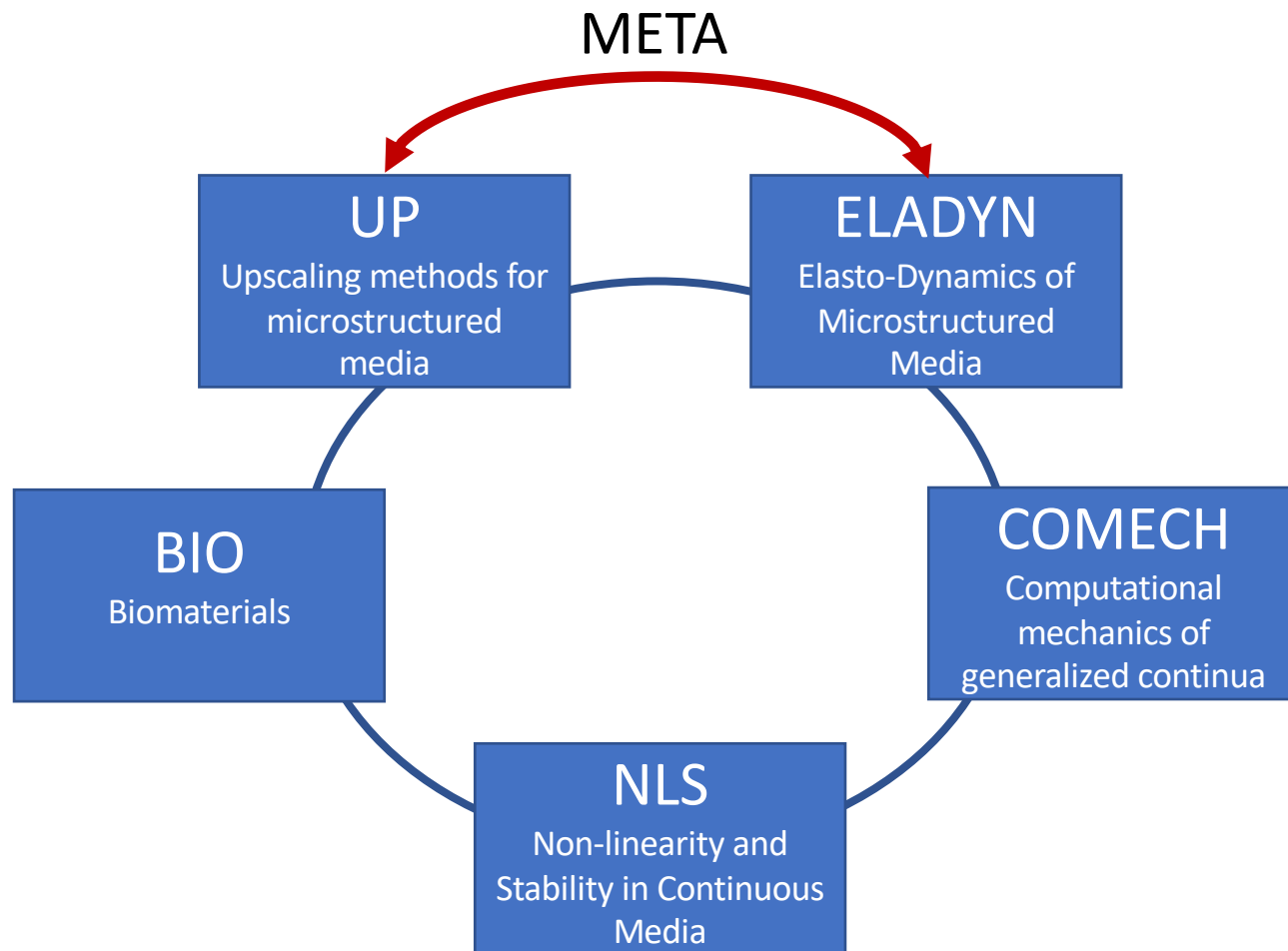
|                                   | France  | Italy                                 |
|-----------------------------------|---|---------------------------------------|
| Co-directors                      | Arthur Lebée<br>Laboratoire Navier<br>Ecole des Ponts | Francesco dell'Isola<br>M&MoCS        |
|                                   | Giuseppe Rosi<br>MSME<br>UPEC                         | Emilio Turco<br>University of Sassari |
| Administrative manager and budget | Virginia Frey<br>Laboratoire Navier<br>CNRS           | Daria Scerrato<br>M&MoCS              |



# Samuel showing us the way..



# Scientific project and research groups

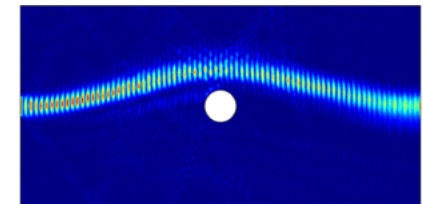
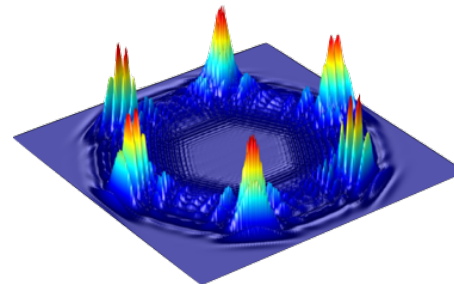
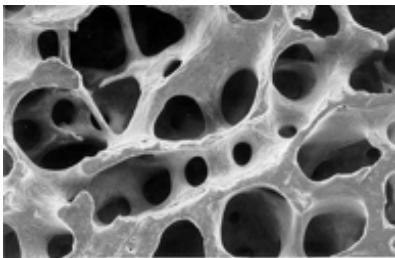


# Elasto-Dynamics of Microstructured Media (ELADYN)

- Coordinators:
  - F2M : Giuseppe Rosi, Nicolas Auffray
  - M&MoCS : Luca Placidi

## Main topics:

1. *Theoretical framework for anisotropic generalized continua.*
2. *Wave propagation in microstructured media.*
3. *Continuum simulation of wave propagation in mechanical metamaterials*
4. *Development of experimental testing devices adapted to architected materials.*

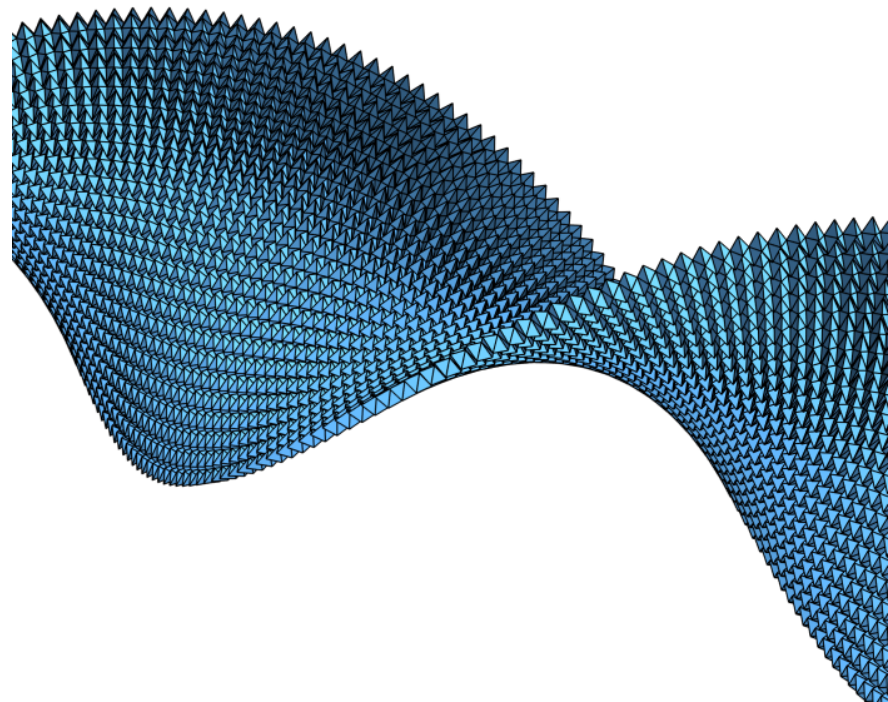


# Upscaling methods for microstructured media (UP)

- Coordinators:
  - F2M : Arthur Lebée
  - M&MoCS : Pierre Seppecher

## Main topics:

1. *Asymptotic analysis and convergence*
2. *Homogenization, gradient media and micromorphic media*
3. *Modeling of slender structures (beams, rods, plates, shells)*
4. *Prototyping meta-materials*



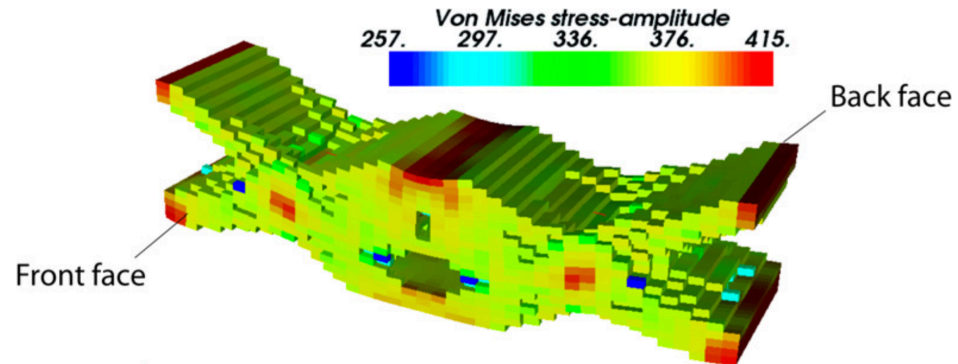
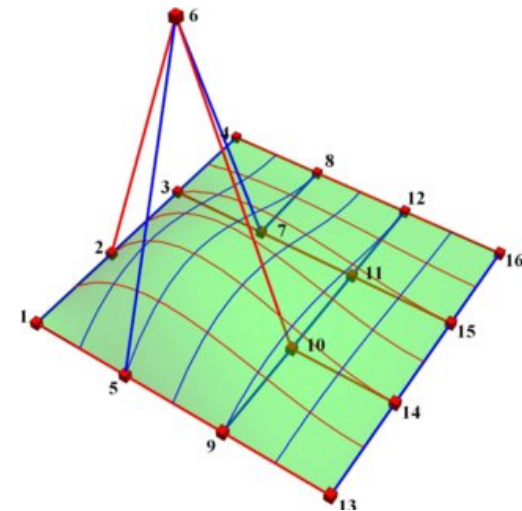
# Computational mechanics of generalized continua (COMECH)

- Coordinators:

- F2M : Boris Desmorat
- M&MoCS : Massimo Cuomo, Leopoldo Greco

## Main topics:

1. *Numerical models for higher order continua based on Isogeometric interpolations.*
2. *Material and structural optimization algorithms.*
3. *Direct simulation of wave propagation in metamaterials.*
4. *Numerical design and simulation of active elements composed by complex materials.*



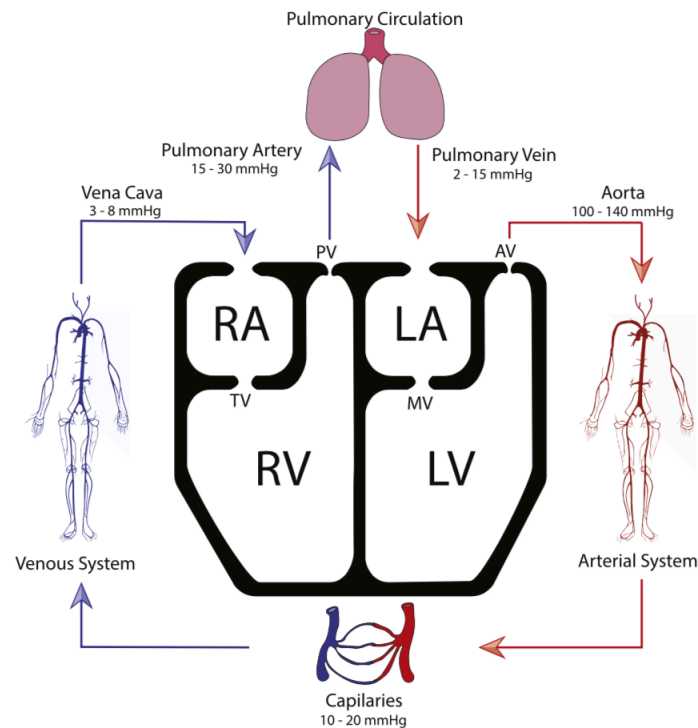
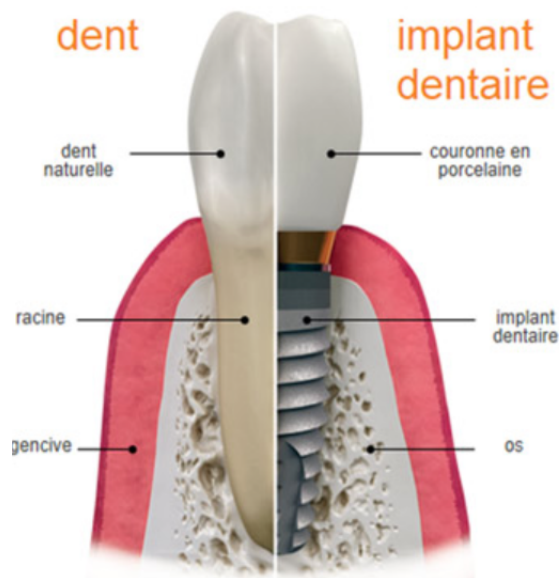
# Biomaterials (BIO)

- Coordinators:

- F2M : Vittorio Sansalone
- M&MoCS : Valerio Varano

## Main topics:

1. *Modeling bone remodeling.*
2. *Modeling the active behavior of heart.*



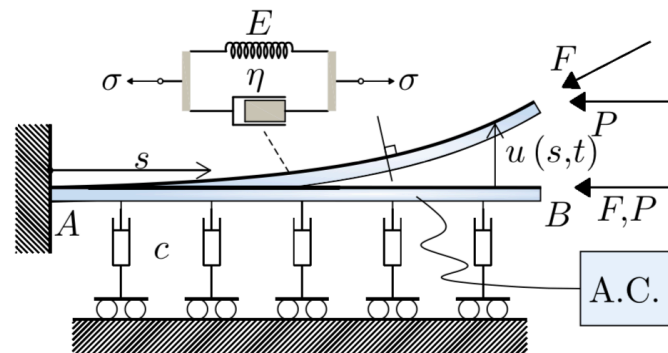
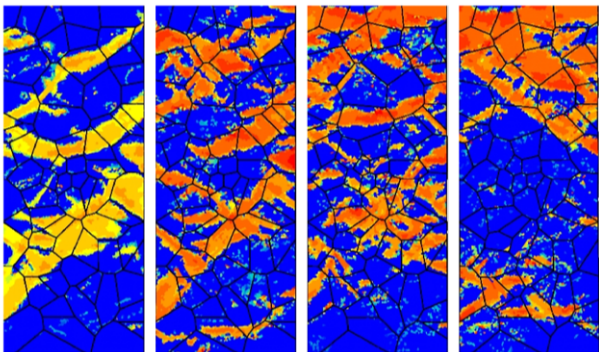
# Non-linearity and Stability in Continuous Media (NLS)

- Coordinators:

- F2M : Samuel Forest
- M&MoCS : Francesco D'Annibale and Daniele Zulli

## Main topics:

1. *Exploiting nonlinearities and instabilities in mechanical systems.*
2. *Stability and bifurcation in nonlinear periodic and/or multilayered beam and shell-like structures.*



# Exchange of researchers and research week

*Chercheurs en résidence et semaine de recherche*

## Stay/Résidence:

- Long term collaborations
- Few researchers
- Several stays?

## Research week:

- Short term collaboration
- 4 to 6 researchers
- One shot/one target

## Application:

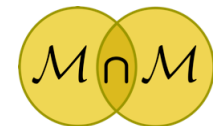
- 2 pages (max!) research projet and brief funding justification
- Deadline: Spring 2020
- Must include M&mocs and F2M researchers

## Organisation

- Benefit from M&Mocs facilities for accommodation
- Direct CNRS funding from Coss&Vita
- Money must be spent before 11/2020...

## Engagement

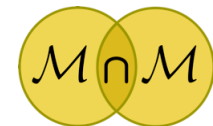
- Short final report on research production
- Mention Coss&Vita funding in papers.





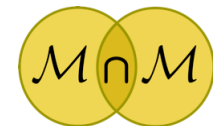
# Upcoming Workshops

- Workshop UP-COMECH  
Alghero end of may 2020
- Workshop BIO-ELADYN  
Créteil November 2020
- Aussois  
February 2021
- IUTAM Symposium on Generalized continua emerging from microstructures  
9 Jul 2021 - 23 Jul 2021



# Announcements

- New mailing list
  - You will be invited, a confirmation is needed (RGPD..)
  - Messages sent to [irp-cossevita@groupe.renater.fr](mailto:irp-cossevita@groupe.renater.fr) will be shared with subscribers



# Program of the Kick-off meeting

|  |   |
|--|---|
| <b>12h00</b>   | Registration and welcome buffet   |
| <b>13h30</b>   | Institutional welcome by IRP Coss&Vita, M&MoCS, F2M   |
| <b>Presentation of the workgroups and scientific presentations</b> |   |
| <b>14h30</b>   | <b>Elasto-dynamics (ELADYN)</b><br>Spaces of 2D classical and generalized elastic materials: a geometric journey<br>by Nicolas Auffray (MSME, UPEM)               |
| <b>15h00</b>   | <b>Upscaling methods (UP)</b><br>Continuum elasticity of Miura Tessellations by Arthur Lebée (NAVIER, ENPC)   |
| <b>15h30</b>   | Coffee Break  |
| <b>16h00</b>   | <b>Computational Mechanics (COMECH)</b><br>Invariant-based optimization methods for architected structures<br>by Boris Desmorat (d'ALEMBERT, SORBONNE Université) |
| <b>16h30</b>   | <b>Biomaterials (BIO)</b><br>Living matter: from biomechanical modeling to shape analysis<br>by Vittorio Sansalone (MSME, UPEC) and Valerio Varano (RomaTre, IT)  |
| <b>17h00</b>   | <b>Non-linearity and stability (NLS)</b><br>Propagating material instabilities in periodic architected materials<br>by Antoine-Emmanuel Viard (PIMM, ENSAM)       |
| <b>18h00</b>   | Open meeting of the IRP Board   |

# Workshop on Elastodynamics of microstructured media

|              |  |
|--------------|--|
| <b>9h30</b>  | Anti-plane surface waves in media with surface structures and surface interfaces: discrete vs. continuum model by Victor Eremeyev (Gdańsk University)            |
| <b>10h10</b> | Dynamics of micro-structured media: variational asymptotic homogenization and examples by Emilio Barchiesi (M&MoCS, University of l'Aquila)                      |
| <b>10h30</b> | Waves and generalized continua in bone biomechanics and tissue engineering. by Giuseppe Rosi (MSME, UPEC)  |
| <b>11h00</b> | Coffee break   |
| <b>11h40</b> | Characterization of complex and « microstructured » media using elastic guided waves by Nicolas Bochud (MSME, UPEC)  |
| <b>12h00</b> | Study of architected slab for railway vibration mitigation by Pierre Ropars (SYSTRA)   |
| <b>12h20</b> | The interaction of large-scale metamaterials with seismic and elastic surface waves. by Bogdan Ungureanu (Imperial College London, UK)                           |
| <b>12h40</b> | Lunch  |
| <b>14h30</b> | Sub-wavelength sensing of bi-periodic materials using topological derivatives of the second-order homogenized moduli by Marc Bonnet (ENSTA)                      |
| <b>15h10</b> | A 1D higher order gradient mixture model for porous media: the transitions from drained, undrained and unrelaxed regimes by Luca Placidi (Uninettuno University) |
| <b>15h30</b> | Numerical modeling of wave dispersion in periodic porous media by Vu-Hieu Nguyen (MSME, UPEC)  |
| <b>15h50</b> | Discrete homogenization of lattice and pantographic structures by Massimo Cuomo (University of Catania)  |
| <b>16h10</b> | Closure  |