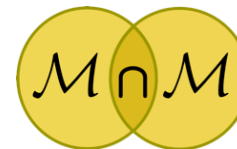
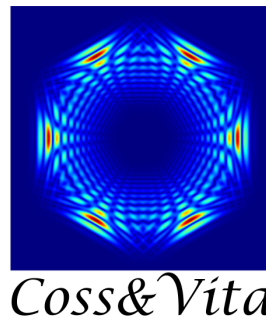


e-Workshop

Advances in ELAstoDYNamics of architected materials and BIOmaterials

November 12th 13th 2020



International Research
Center Memocs



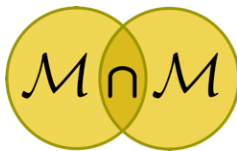
International Research Project Coss&Vita

A tool for international cooperation shared by the CNRS, in the service of consolidating research partnerships.

Fédération Francilienne de Mécanique



International Research Center M&MoCS
University of L'Aquila



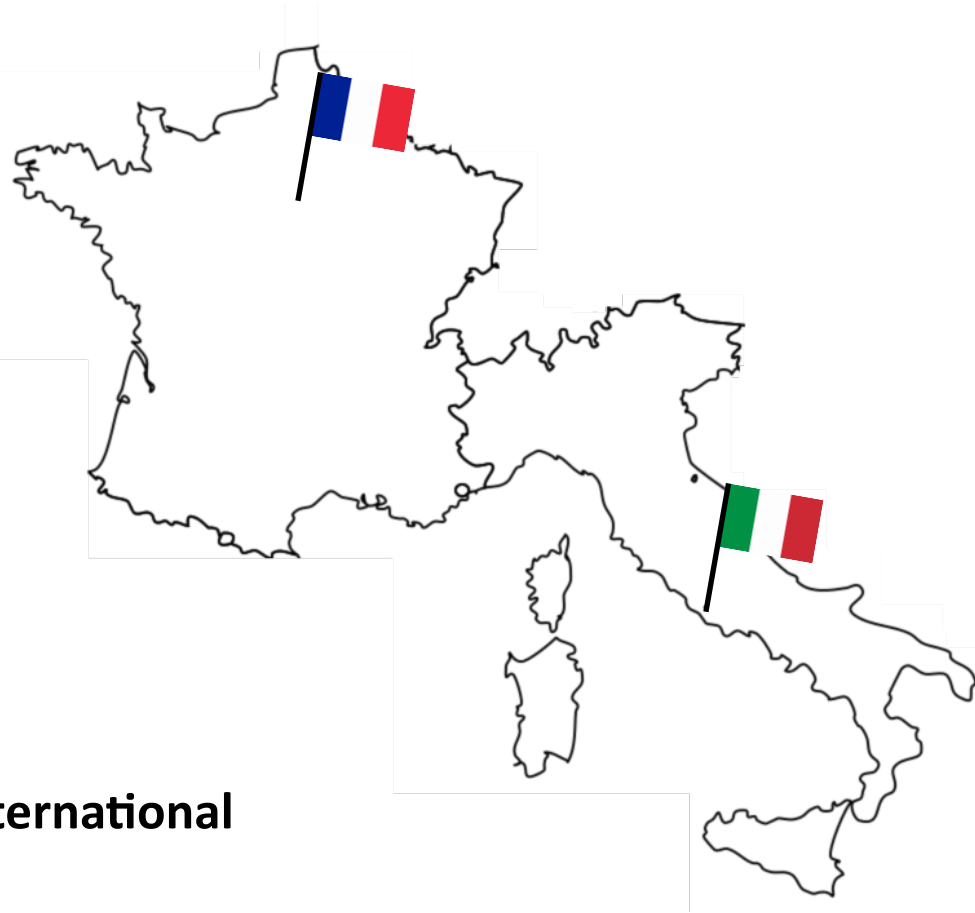
Cooperation methods

- **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.



Management

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

| France | Italy |
|---|--|
| <p>Arthur Lebée</p> <p>Laboratoire Navier Ecole des Ponts</p> | <p>Francesco dell'Isola</p> <p>M&MoCS University of L'Aquila</p> |
| <p>Giuseppe Rosi</p> <p>MSME University Paris-Est Créteil</p> | <p>Emilio Turco</p> <p>University of Sassari</p> |

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

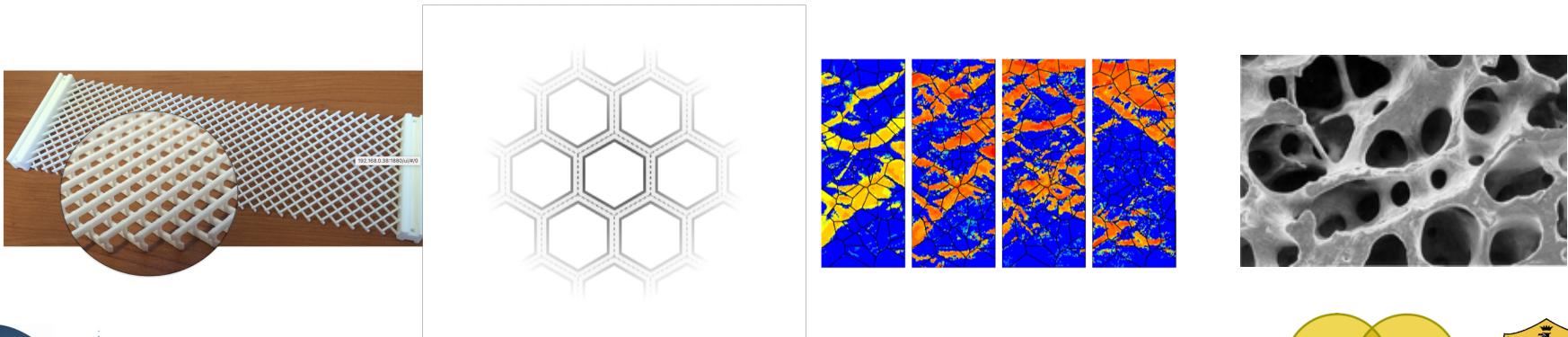
Scientific motivations

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.



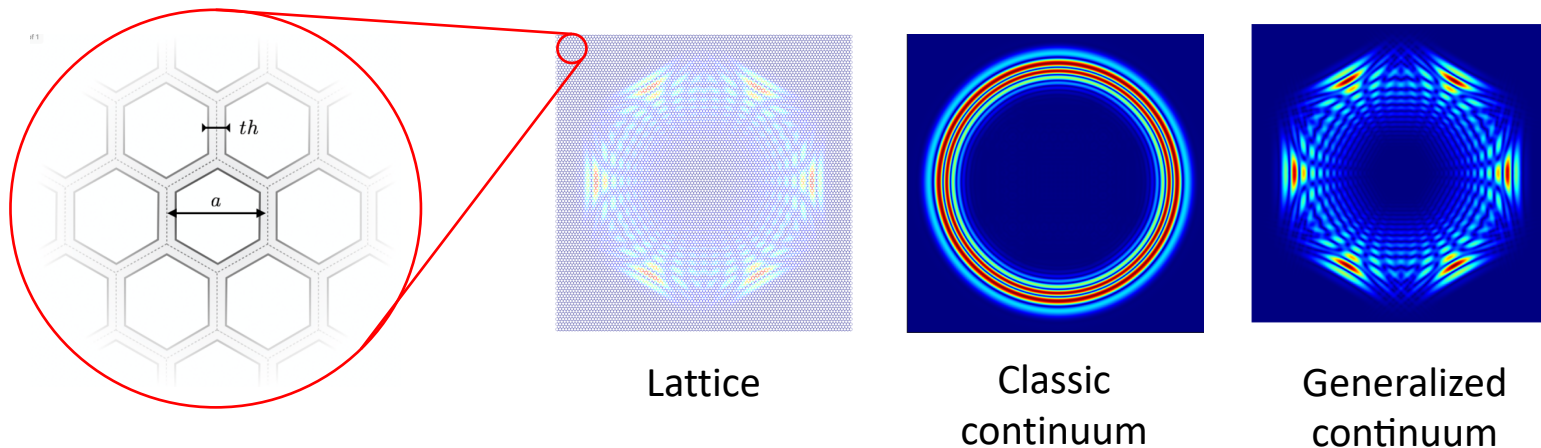
Scientific motivations

Size effects can be found in several applications

Consequences :

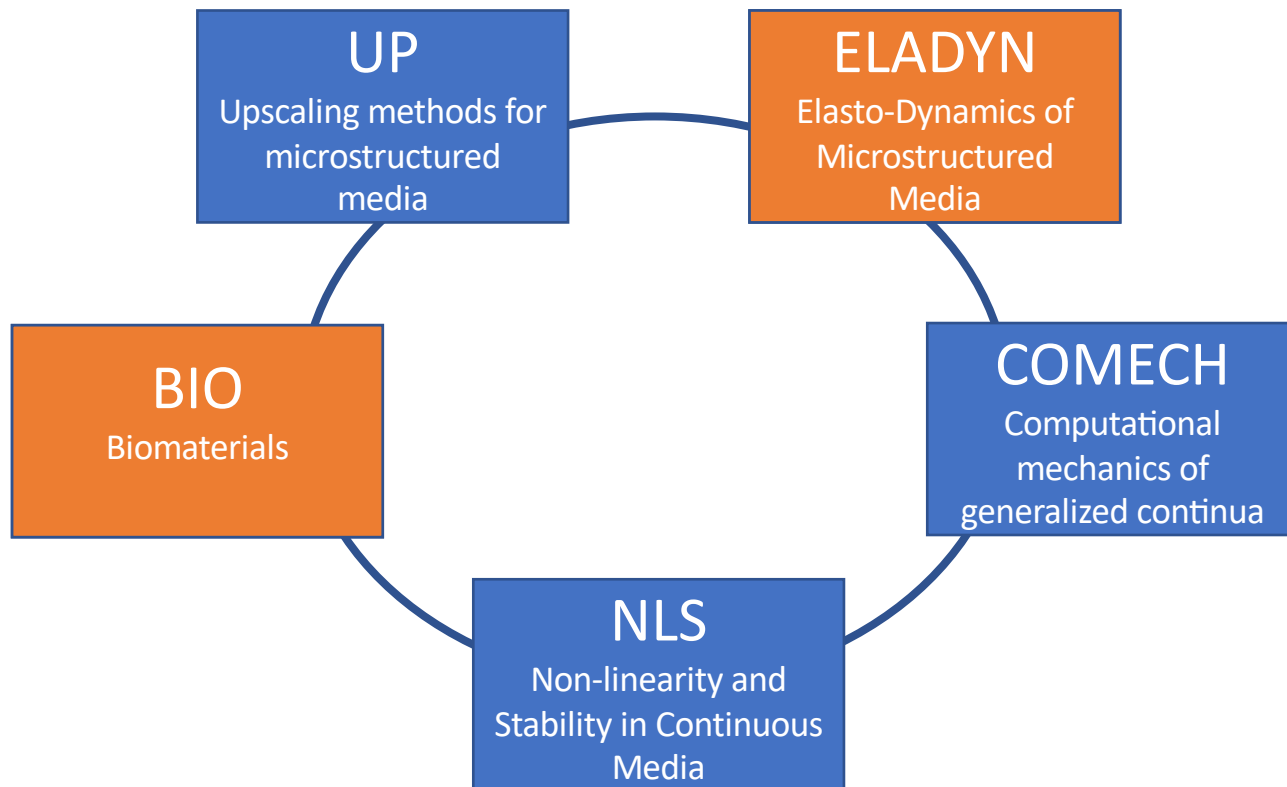
- Micro- and meso-structural effects emerge at macro-scale
- Classic continuum theories fail

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.

Scientific project and research groups



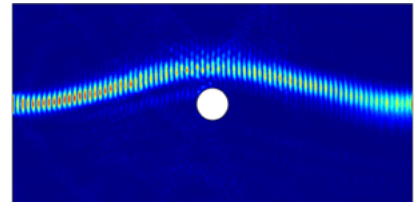
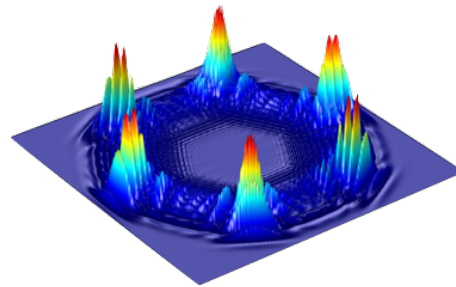
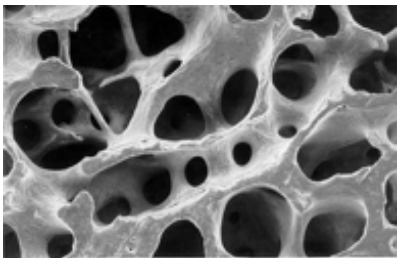
Elasto-Dynamics of Microstructured Media (ELADYN)

- 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.*



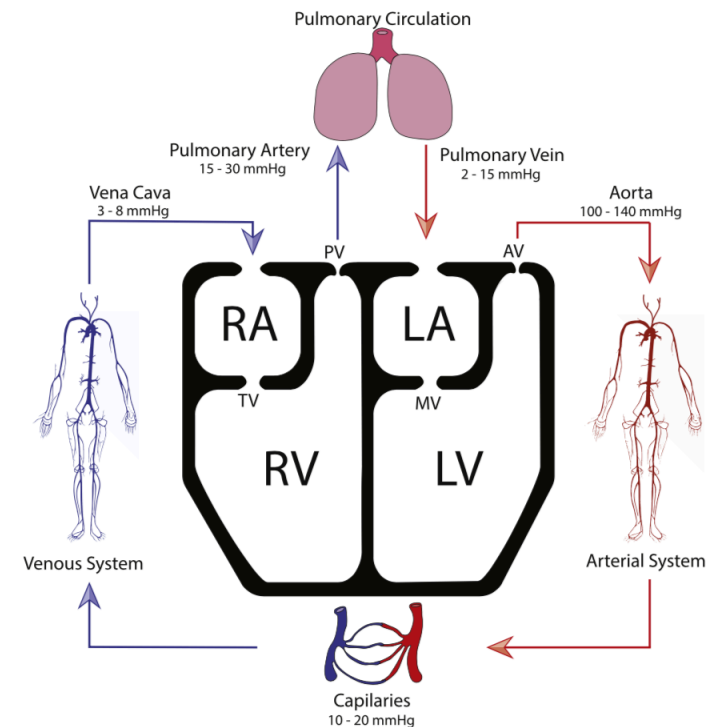
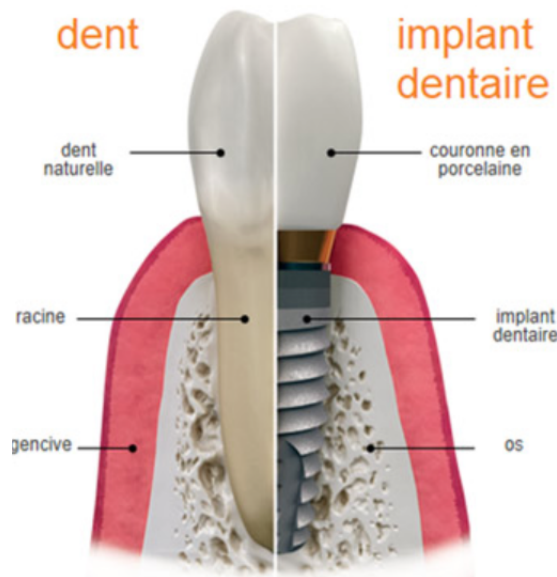
Biomaterials (BIO)

- Coordinators:

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

Main topics:

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

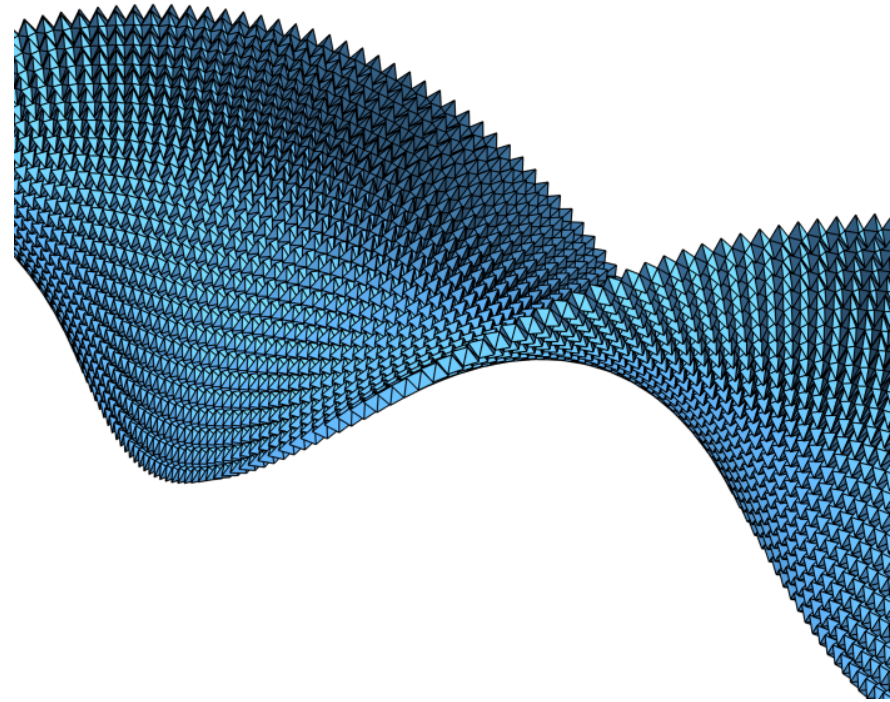


Upscaling methods for microstructured media (UP)

- 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*

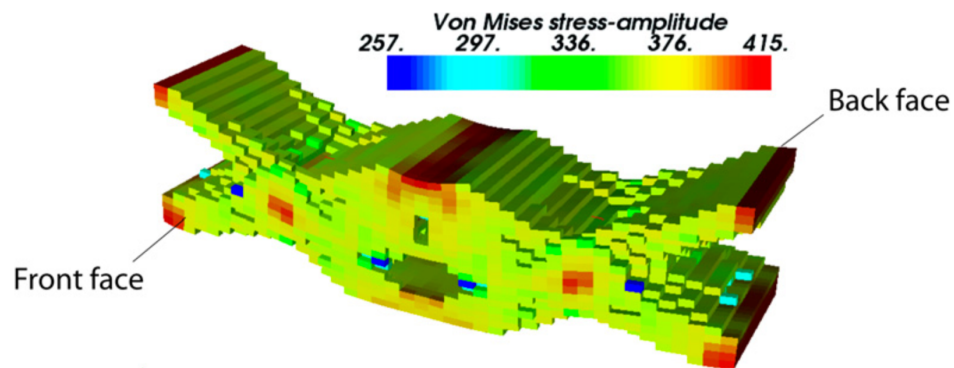
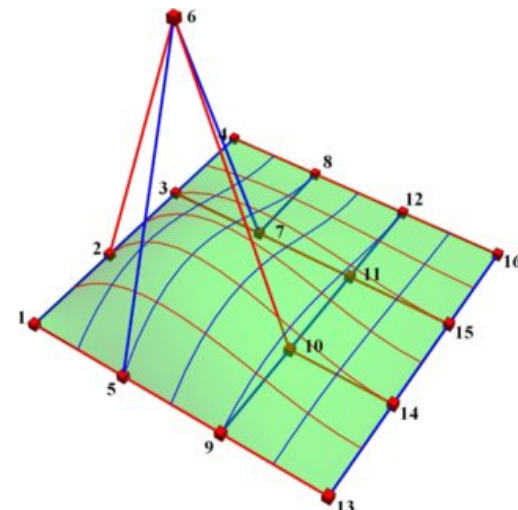


Computational mechanics of generalized continua (COMECH)

- 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.*



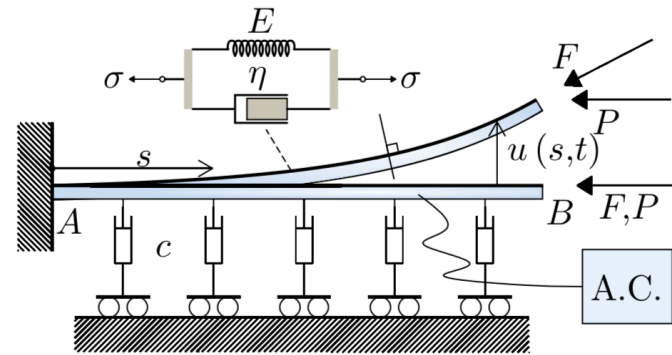
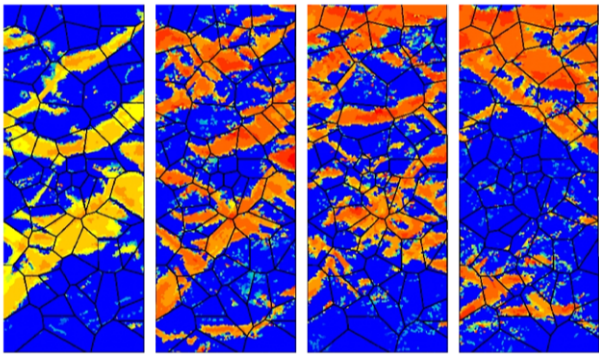
Non-linearity and Stability in Continuous Media (NLS)

- 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 2021
- Must include M&MoCS and F2M researchers

Organisation

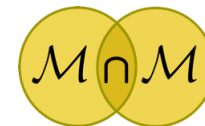
- Benefit from M&Mocs facilities for accommodation
- Direct CNRS funding from Coss&Vita
- Money must be spent before 11/2021...

Engagement

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



Matériaux • Structures • Procédés



See you soon in Arpino!



Scientific program

| Thursday 12 th | | Friday 13 th | |
|---------------------------|-------------|-------------------------|-------------|
| 9h00-9h30 | Welcome | | |
| 9h30-10h30 | Session | 9h30-10h30 | Session |
| 10h30-11h00 | Break | 10h30-11h00 | Break |
| 11h00-12h20 | Session | 11h00-12h20 | Session |
| 12h20-14h00 | Lunch break | 12h20-14h00 | Lunch break |
| 14h00-15h20 | Session | 14h00-15h00 | Session |
| 15h20-15h50 | Break | 15h00-15h20 | Closing |
| 15h50-16h30 | Session | | |

Thursday 12th morning

| | | | |
|-------|--|------------------|---|
| 9h00 | Welcome | | |
| 9h30 | EREMEYEV | Victor | Gdansk University of Technology, Poland |
| | On effective properties of beam-lattice structures made of flexoelectric materials | | |
| 9h50 | DELL'ISOLA | Francesco | University of L'Aquila, Italy |
| | Micro-architecture synthesis for metamaterials | | |
| 10h10 | CUOMO | Massimo | University of Catania, Italy |
| | Discrete homogenization of networks and tissue with high mechanical performance | | |

| | | | |
|-------|-------|--|--|
| 10h30 | Break | | |
|-------|-------|--|--|

| | | | |
|-------|--|-----------------|--|
| 11h00 | ROSI | Giuseppe | Université Paris-Est Créteil, France |
| | Generalised continua in biomechanics : from multi scale tissues to biomechanical metamaterials | | |
| 11h20 | AGHAEI | Ali | Université Paris-Est Créteil, France |
| | Wave propagation across the tendon-to-bone interphase: insight from an equivalent model with specific interface conditions | | |
| 11h40 | TOUBOUL | Marie | Aix-Marseille Université, France |
| | High-frequency homogenisation in 1D periodic media with imperfect interfaces of the spring-mass type | | |
| 12h00 | PLACIDI | Luca | International Telematic University Uninettuno, Italy |
| | Evolution of damage and plasticity in a variational framework without flow rule assumptions | | |

Thursday 12th afternoon

| | | | |
|-------|---|----------------------|--|
| 14h00 | LOMBARD | Bruno | Aix-Marseille Université, France |
| | Unfolding of a bistable tape spring: analogy with a regularized Ericksen bar with nonconvex potential and extended Lagrangian | | |
| 14h20 | DAVÌ | Fabrizio | Università Politecnica delle Marche, Italy |
| | Wave propagation in micromorphic anisotropic continua with an application to PWO tetragonal crystals | | |
| 14h40 | UNGUREANU | Bogdan | Imperial College London, UK |
| | Energy harvesting elastic edge waves via the topological rainbow effect | | |
| 15h00 | GANGHOFFER | Jean-François | University of Lorraine, France |
| | Effect of microinertia and higher gradients on the statics and dynamics of heterogeneous media | | |
| 15h20 | Break | | |
| 15h50 | CORNAGGIA | Rémi | Sorbonne Universités, France |
| | Tuning effective dynamical properties of periodic media by FFT-accelerated topological optimization | | |
| 16h10 | NASSAR | Hussein | University of Missouri, USA |
| | Polar metamaterials and cloaking | | |
| 16h30 | BABLU | Muhammad Ali | Oklahoma State University, USA |
| | Sound Transmission Loss Behavior of Meta-Acoustic Barriers with Anomalous Effective-Mass | | |

Friday 12th morning

| | | | |
|-------|---|------------------|---|
| 9h30 | ALLAIN | Jean-Marc | École Polytechnique, France |
| | Observation of the microstructure evolution during a mechanical assay on cardiac tissue | | |
| 9h50 | COLORADO CERVANTES | José Ivan | Université Paris-Est Créteil, France & University Roma Tre, Italy |
| | Evaluation of the principal strain lines for assessment of the Left Ventricular function | | |
| 10h10 | TERESI | Luciano | University Roma Tre, Italy |
| | Liquid transport in active soft matter | | |
| 10h30 | Break | | |
| 11h00 | GEORGE | Daniel | Université de Strasbourg, France |
| | First results on bone density variation under high loads through the competition between osteoblasts and osteoclasts | | |
| 11h20 | SANSALONE | Vittorio | Université Paris-Est Créteil, France |
| | A model of bone turnover in the framework of generalized continuum mechanics | | |
| 11h40 | DOT | Gauthier | Arts et Metiers ParisTech & Université Paris-Est Créteil, France |
| | Clinical and numerical study of a statically determinate lingual mechanism for orthodontic tooth displacement | | |
| 12h00 | GIORGIO | Ivan | University of L'Aquila, Italy |
| | A diffusive model to describe the mechanically driven biological stimulus for bone remodeling: following in the footsteps of Roux and Frost | | |

Friday 12th afternoon

| | | | |
|-------|--|-----------------|----------------------------------|
| 14h00 | EUGSTER | Simon | University of Stuttgart, Germany |
| | Finite element formulation for constrained spatial nonlinear beam theories | | |
| 14h20 | GRECO | Leopoldo | University of Catania, Italy |
| | A non linear G1-conforming Bèzier finite element formulation for the analysis of slender beams | | |
| 14h40 | BARCHIESI | Emilio | University of L'Aquila, Italy |
| | Homogenised modeling of bi-pantographic fabrics: micro-to-macro transition and experimental validation | | |
| 15h00 | <i>Closing</i> | | |