

## **LabEx Tec 21's 2019 call for proposals**

Tec 21 (<http://www.tec21.fr>) brings together the research community in mechanical and process engineering in Grenoble. Tec 21 has been selected as a "Laboratoire d'Excellence" and is supported by the French Government under the "Investissements d'Avenir" (investments for the future) initiative (<http://investissement-avenir.gouvernement.fr>).

### **1) Call for proposals: objectives**

The main objective of the Tec 21 community is to gather new knowledge and to develop new methods in mechanical and in process engineering. The main aim is to address new scientific challenges arising from present societal issues in areas such as sustainable development, alternative resource management, green technologies, environmental impact, risk management, health care...

Such challenges often imply considering new mechanisms, new objects, complex interactions... understanding/modeling of which requires:

- \* Improving macroscopic descriptions by the integration of more and more refined fundamental mechanisms arising at small scale(s),
- \* Developing connections between mechanics and disciplines such as chemistry and biology using multi-physics approaches, often to be developed in a multi-scale context.

Such multi-scale multi-physics approaches will help to produce more reliable and versatile predictive tools for engineers, decision-makers or public services. They should also favor the emergence of new technologies. The present call for proposals is therefore mainly oriented towards fundamental research with the following objectives:

- \* to fund projects of the highest quality, with the potential to advance the frontiers of knowledge and/or to develop innovative methods,
- \* to foster the emergence within the Tec 21 community of strong pluridisciplinary groups on specific challenging scientific issues,
- \* to develop long-term international cooperation.

Within this framework, the following subject-area is preferentially supported:

**WP1 - Coupling fluid and solid mechanics**

**WP2 - Coupling fluid mechanics with bio-physico-chemical phenomena**

**WP3 - Engineering for human health**

**WP4 - Developing methods**

#### **WP1 - Coupling fluid and solid mechanics**

Solid and fluid mechanics need to be combined in a large variety of natural as well as industrial systems, especially when looking at intimate coupling between fluid and solid phases (e.g. in very dense systems), or during transitions between solid-like and fluid-like behaviours. Progress is necessary in the mechanics and multi-scale characterization of geomaterials (soil, rock, concrete, snow...), of industrial complex media (paste, fibre suspensions, porous media, metallic alloys, semi-conductors...), of very dense multi-phase flows (e.g. mud flows...), where one has to account for material complexity (heterogeneities, anisotropy, polydispersity...) and/or for phenomena such as deformation, transfer, phase change...

Current research themes:

- a. **Solids in fluids:** The mechanical behaviour and the rheology of systems in which the scales of the solid elements and of the system are not clearly separated is an open issue. This particularly encompasses problems related to the flows of very dense suspensions involving segregation and migration, erosion, transport and deposition of sediments...
- b. **Fluids in solids:** The percolation of a fluid within a solid matrix is a challenging task either due to the complexity of the porous solid network or of the fluids interacting with the solid skeleton (e.g. solid displacement, solidification...).
- c. **Solid-fluid transition and associated instabilities:** Gravity movements triggering and stopping involve mechanical transitions between quasi-static and inertial deformation regimes. Progress is required on the characterization of mechanical bifurcations (e.g. diffuse instabilities), on the formulation of unified rheological models.
- d. **Flow-structure interactions:** The interaction between flows of complex rheology and structures give rise to several fundamental issues such as the characterization of energy dissipation and impact forces as a function of flow regime, the influence of dynamical coupling and structural damage...

**WP2 - Coupling fluid mechanics with bio-physical-chemical phenomena on a micro-scale:**

Fluids are widely exploited to transfer mass, heat, energy... and the control of how they flow is often the key to process efficiency. Yet, in many circumstances, because of complex dynamic phenomena (turbulence, two-phase flows...) or because of strong couplings with chemical reactions or with biochemical transformations..., the flows cannot be correctly predicted and controlled. Crucial progress regarding these issues is expected from the association of fluid mechanics with chemical and process engineering, over a wide range of scales in order to predict, control and/or intensify processes. Progress in these areas will contribute to the development of eco-technologies and clean technologies. In particular, new separation and fractionation processes need to be developed in order to comply with the so-called bio refinery concept aiming at preparing new molecules from vegetal biomass. Another goal concerns the development of efficient and controlled, bio filtration techniques.

Current research themes:

- a. **Advanced fluid mechanics:** Multi-scale fluid mechanics including - for single phase flow - turbulence structure, micro-mixing (including high Schmidt numbers), turbulence control... and for multiphase flows - modelling of dense gas-liquid flows, interactions between turbulence and inclusions (bubbles, drops, solid particles), clustering, dispersion, spatial-temporal organisation at meso- and large- scale...,
- b. **Interfacial dynamics and transfers:** Coupling flows and interfaces (fluid-fluid or fluid-solid boundaries), in particular with respect to heat transfer, phase change, chemical transfer and reactions, adsorption-desorption processes... with a special emphasis on complex interface topologies. This topic also includes wetting/dewetting dynamics.
- c. **Flow and bacteria / bio filtration:** Coupling flow and living matter (such as bacteria) to understand the growth of biofilms under flow (spatial-temporal structuration of biofilms up to clogging, physiology adaptation to the flow induced stress and its consequences on growth rate, adhesion...) and ultimately to optimize and to control bioreactors.
- d. **Bio refinery:** Develop new separation and fractionation processes (membrane filtration, selective precipitation, liquid-liquid or liquid-solid extractions, catalysis, etc.) in order to

prepare new molecules from vegetal biomass. This topic includes the design of new processes, as well as process modelling, control and intensification.

### **WP3 - Engineering for human health:**

This subject-area is dedicated to looking at the dynamics of matter within living organisms, using concepts and methodologies from mechanics (fluids as well as solids) and soft matter physics. The association of all these disciplines is expected to lead to a better fundamental understanding of key processes in human biology. The main applications here are in human biology, e.g. cell mechanics and motility (cancer, vascular diseases...), thrombosis... as well as medicine, e.g. designing new medical devices or biomaterials or understanding the functioning of sub-systems e.g. heart, blood circulation, speech generation...

Current research themes:

- a. **Cellular level:** Multi-scale modelling of the cell, including cell growth, biological signalling, cell substrate or flow interaction (including the understanding and modeling of the spatio-temporal cell response under applied mechanical stress), adhesion and cytoskeletal mechanisms...
- b. **Connecting biology and mechanics:** Understanding the growth of biological tissues and representation/prediction of mechanical behavior of tissues, establishing reliable multi-scale models for the analysis of multiparticle systems, simulating biological flows (with fluid-structure interactions), under the influence of the different scales e.g. in the mechanics of blood clotting (modelling of recruitment process, fibrin polymerization modelling)...
- c. **Development of new medical devices and from new bio-inspired materials** (e.g. tailored microstructure, bioresorbable, bioactive).

### **WP4 – Developing methods**

Developing new methods such as modelling concepts, simulation, measuring techniques, signal processing, data analysis... are closely connected to scientific progress. Such developments are required for all the above-mentioned themes. The propositions must be strongly innovative, able to go far beyond the current state of the art, and to have a large potential impact on the research activities in the Tec21 community (too specific proposals will not be favoured). These projects should clearly indicate how they complement, extent and/or built on the methods already used/developed within Tec21, and what are their medium term perspectives in terms of dissemination (internal as well as external to Tec21).

Current research themes:

- a. **Advanced modelling and/or simulation approaches:** Emphasis will be placed on developing new modelling concept and/or simulation approaches addressing issues for which current predictive capabilities either do not exist, or are too poor and unsatisfactory. Typical actions may include the description of complex systems, of the coupling between scales, of the coupling between diverse phenomena...
- b. **Advanced measuring techniques:** There is a strong need to provide fully resolved - both in space and time - fields of variables. Key issues in this area are related to the extent of the dynamical range (space and/or time), to the simultaneous capture of multivariable fields, to Eulerian and Lagrangian approaches as well as their combination, to the investigation of complex dynamics or complex systems, the development of refined data processing...

## 2) Opportunities

That edition of the Tec21 call for proposals is structured as follows:

Grant	Topics supported	# of grants	Proposal submission deadline	Results calendar
<b>Post-doc grant:</b> one year each <b>!!: Involvement of two laboratories from the Tec21 perimeter mandatory</b>	All WPs	2 Post-Doc fellowships	<b>October 1st, 2019</b>	<b>January 15, 2020</b>
<b>Short duration visitor grant:</b> to welcome foreign researchers for 2 up to 3 months. <b>!!: short stay of one month only will also be allowed</b>	All WPs	3 short visitors grants		

*NB. Visitors are invited to give at least one seminar during their stay.*

## 3) Proposal preparation and submission instructions

Proposals should be sent to [cecile.bordier@tec21.fr](mailto:cecile.bordier@tec21.fr)

Each proposal (in English) will be submitted as a single pdf file (maximum size 10 Mo) organized as follows (see template):

### Front page

- Project title
- Project PI and co-PI (with name, address, phone numbers, e-mail)
- Selected program (short visitor program, long visitor program, Post-doc program, PhD program) - select one only
- Selected research theme(s) - select 1 or 2 maximum

### Second page

- Summary (half a page): project content and expected breakthrough
- Summary (half a page): structuring effect and collaborative aspects for the Tec 21 research community

### Next pages – project description (max 6 pages excluding annexes)

- Context and objectives (1 page)
- Scientific program, including the research strategy (3 pages or 1.5 pages for short duration visitor grant) **!!: for post-doc project, specify the complementarities between the two (or more) involved laboratories from the Tec21 perimeter.**
- Project organisation: tasks, schedule, work program for the recipient of a Post-Doc or a PhD fellowship when applicable (1 page). For short and long duration visitors, indicate a provisional planning.

- Indicate the potential impact of expected research results (potential benefits to society, expected new collaborations, new technologies, patent...) if relevant. (half a page)
- Involved members (half a page): for all investigators: names, institution, involvement (% time), skills and role in the project. For PhD and Post-Doc to be hired, expected role only.
- Annex: Curriculum Vitae of the main investigators including significant publications. References and letters of support are welcome.

---

#### **4) Evaluation of proposals**

---

All proposals will be analysed by 3 external reviewers selected by the Tec 21 Steering Committee according to the subject. The Steering Committee may involve extra reviewers depending on the proposed topic. Each reviewer will send a report to Tec 21 commenting on the following items:

- i. Scientific quality and originality: The potential for the project to advance knowledge and understanding, or to propose new methods (in modelling, simulation, instrumentation). Does the proposed program explore creative and original concepts?
- ii. Project organisation: Is the research strategy convincing? Is the proposed scientific program well organized and realistic?
- iii. The qualification of the team and its ability to conduct the project,
- iv. The adequation between the available resources and the project's objectives,
- v. Potential impact of expected research results.

Based on these reports, the final decision will rest upon the Steering Committee. The Steering Committee will pay particular attention to proposals which give rise to the development of strong pluridisciplinary groups on specific challenging scientific issues, within the Tec 21 community.

- vi. Outline the project's benefit to the Tec 21 community: structuring effect and/or collaborative initiatives and/or key scientific outcomes useful for various WPs...

---

#### **5) Who can apply?**

---

- All call for proposals are open to the international scientific community with the only mandatory condition that the PI or the co-PI of the project is a Tec 21 permanent researcher.

=> The Tec 21 management team can help potential post-doc or short/long term visitor grants candidates to build a project in collaboration with one or more research teams within Tec 21. If interested, please contact: [cecile.bordier@tec21.fr](mailto:cecile.bordier@tec21.fr)