# Offer #2021-04172

# PhD Position F/M Non-smooth modeling of the interaction between granular flow and 3d obstacles. [PHD INRIA/INRAE]

**Contract type :** Fixed-term contract

**Level of qualifications required :** Graduate degree or equivalent

**Fonction :** PhD Position

## About the research centre or Inria department

Grenoble Rhône-Alpes Research Center groups together a few less than 650 people in 35 research teams and 8 research support departments.

Staff is localized on 5 campuses in Grenoble and Lyon, in close collaboration with labs, research and higher education institutions in Grenoble and Lyon, but also with the economic players in these areas.

Present in the fields of software, high-performance computing, Internet of things, image and data, but also simulation in oceanography and biology, it participates at the best level of international scientific achievements and collaborations in both Europe and the rest of the world.

## Context

TRIPOP (Inria Grenoble Rhône-Alpes ; Laboratoire Jean Kuntzmann) team is mainly concerned by the modeling, the simulation and the control of nonsmooth dynamical systems. In mechanics, the main instances of nonsmooth dynamical systems are multibody systems with Signorini's unilateral contact, set-valued (Coulomb-like) friction and impacts, or in continuum mechanics, ideal plasticity, fracture or damage. The members of the team have a long experience of nonsmooth dynamics modeling together with the development of simulation software.

INRAE's ETNA Research Unit is recognized for many years at the international level for its work on snow and on protection structures against natural hazards. Its skills relate to physical and digital modeling, laboratory and on-site experimentation, and instrumentation in difficult alpine contexts.

## Assignment

In the context of global changes, gravitational natural hazards, such as landslides, rock and snow avalanches and debris flows, are increasingly threatening people and infrastructures in mountainous regions. For most of these processes, the hazard assessment requires quantifying the initiation, propagation and stopping phases, including the impact onto structures.
The mitigation measures against these gravitational hazards are mainly based on the design of protection structures that reduce the propagation of the flow by means of energy dissipation during the interaction between the flow and the structure.
The scientific challenge for the assessment of the interaction between gravitational mass flows and structures is in many cases related to the understanding of the interplay between the hydrodynamic flow properties and the discrete nature of the material involved (dry grains, cohesive grains, mixture of grains and surrounding fluid).
The study of the interaction between granular flows and obstacles is a complex physical problem that is today a booming research area increasingly addressed by using both numerical and experimental approaches.
Most of research work focuses on simplified configurations involving 2D dry granular flow interacting with rigid wall-like obstacles. More recently, several researches started to investigate the effects of material properties, involving cohesive materials, for example, and of structure geometry and deformability.
This increased complexity of the processes is challenging in terms of numerical modelling : efficient and relevant modelling techniques involving complex numerical methods have to be developed.

## Main activities

The objective of the PhD is to use non smooth numerical modelling to analyse the physical processes involved in the interaction between complex granular flows interacting with 3D deformable structures.
The main tasks of this research work are to :

- develop 3D numerical simulations involving complex granular materials (cohesive, in particular)

interacting with deformable structures
- optimize the numerical model to allow extensive numerical simulations for complex 3D problems on high performance computing architecture
- perform detailed physical analyses of the interaction not only for simplified configurations but also for complex 3D ones, with a focus on the interplay between the hydrodynamic-like patterns formed (jumps, dead zones, etc.) and the discrete nature of the flowing material and its effect on the resulting impact force

Name of the co-supervisors :
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## Skills

The PhD candidate should have competences in mechanics and numerical modeling. A strong theoretical background in fluid and solid mechanics is mandatory. Furthermore, the applicant must show a strong interest for software development in computational Mechanics. He also has to be motivated by applied research in collaboration with researchers from different disciplines. A good level of English and subsequent writing capacities are also requested.

## Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (90 days / year) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

## Remuneration

**1st and 2nd year:** 1 982 euros gross salary /month

**3rd year:** 2 085 euros gross salary / month

## General Information

- **Theme/Domain :** Optimization and control of dynamic systems
- **Town/city :** Montbonnot
- **Inria Center :** Centre Inria de l'Université Grenoble Alpes
- **Starting date :** 2022-09-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2022-02-28

## Contacts

- **Inria Team :** TRIPOP
- **PhD Supervisor :**
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## About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

**Warning** : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

## Instruction to apply

**Defence Security :**
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is

granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

**Recruitment Policy :**
As part of its diversity policy, all Inria positions are accessible to people with disabilities.