GIANT INTERNATIONAL INTERNSHIP PROGRAMME

PROPOSED INTERNSHIP PROJECTS

2022

Research projects proposed to students from Universidade Federal da Paraiba (UFPB)

CONTENTS

HOW TO APPLY?

GIANT INTERNATIONAL INTERNSHIP PROGRAMME – 2022

The GIANT International Internship Programme (GIIP) is a unique opportunity for non-European students to gain first-hand experience of scientific research and innovation in state-of-the-art facilities in Grenoble, France.

The GIIP provides placement in the GIANT Campus laboratories and companies as well as tailored welcome services, such as housing and administrative assistance.

There are two intakes:

- Summer intake from May to July/August
- Autumn intake from September to December

Each internship offer mentions the appropriate intake.
Dates can be flexible and will be discussed and decided between the supervisor and the student.

You can find more information on GIANT and the GIIP on the following websites:

- www.giant-grenoble.org
- www.internships.giant-grenoble.org

If you are interested in this program, please send your application at giant.internship@cea.fr.
***Email subject**: GIIP 2022: application [number of project to mention]*
Please attach to your email:

- the attach application form filled exhaustively
- your CV and a cover letter (please, make sure you tailor the cover letter to the research project. If you're interested in several projects, please send a cover letter per application)
- your latest report card

There are no French language requirements, but applicants must be fluent enough in English to work in a laboratory and interact with their colleagues.

DEADLINE FOR APPLICATION

Applications to the GIIP will be opened until **Friday 25 February 2022.**

The sooner you send in your application, the sooner it will be considered.

PROJECT 1 – MECHANICAL SYSTEMS AT ULTRA LOW TEMPERATURES

Supervisors' name

- Supervisor 1: Andrew FEFFERMAN
- Supervisor 2: Eddy COLLIN (in case of absence)

GIIP Intake: Summer 2022 (May to July/August)

Institute: CNRS Grenoble

Laboratory: Néel Institute

Keywords: nanoelectromechanical systems (NEMS), microkelvin, microwave optomechanics, continuous nuclear demagnetization refrigeration, amorphous solids

Description of the project:

We have recently cooled a nanomechanical resonator to sub-mK temperatures purely by good thermal coupling to the refrigerator, i.e., by passive cooling [D. Cattiaux et al., Nature Communications 12, 6182 (2021)]. In contrast to the optomechanical cooling techniques used by many other groups, our technique cools the phonon bath of the vibrating structure as well as the low energy excitations arising from atomic-scale disorder in the structure. As a result, the 15 MHz mechanical mode reaches its quantum ground state. We will now apply this technology to study fundamental physics, including wave function collapse models, quantum thermodynamics, and the nature of the low energy excitations that dominate the behavior of amorphous solids at low temperatures. These experiments are carried out on our nuclear demagnetization cryostat reaching sub-mK temperatures and two dry dilution refrigerators. Our group is also developing a continuous nuclear demagnetization refrigerator, which will allow us to maintain sub-mK temperatures indefinitely in a cryogen-free system (arXiv: 2111.11896).

The activities of the intern would include one or more of the following: optimization of the cryogenic microwave circuit used for the optomechanical measurements; tests of novel refrigerants for the continuous nuclear demagnetization refrigerator; measurements of amorphous films using ultra-high quality factor mechanical resonators.

PROJECT 2 – IMAGING OF THE STRUCTURE OF NANOPARTICLES DURING OPERATION

Supervisors' name

- Supervisor 1: Marie-Ingrid RICHARD
- Supervisor 2: Steven LEAKE (in case of absence)

GIIP Intake: Summer 2022 (May to July/August)

Institute: ESRF (European Synchrotron) and CEA-Grenoble

Laboratory: Beamline ID01

Keywords: Nano-imaging, structure evolution, python, phase retrieval

Description of the project:

Coherent x-ray diffractive imaging in the Bragg geometry (BCDI) is a rapidly developing technique capable of deducing the internal displacement of a crystalline lattice with sub-angstrom resolution. The method hinges on the analysis of the three-dimensional diffraction pattern recorded. When a finite crystal is illuminated with a coherent x-ray beam, one observes the amplitude but not the phase. This famous inverse problem is normally tackled with iterative algorithms. This internship will be focused on the development of **new methods for phase retrieval**. The student will first be introduced to the basics of Bragg coherent diffraction for the study of nanomaterials and to its data treatment using the *bcdi* package for pre- and post-processing and the *PyNX* package for phase retrieval. The student will then work on datasets collected at The European synchrotron (ESRF) and participate in the development of Python scripts or use existing ones to get an improved spatial resolution or to retrieve the complex measured object from several Bragg reflections or energies. The student will have also the opportunity to participate in an experiment at ESRF. He/she will preferably have deepened knowledge in material science, physics or closely related science. He/she should also have experience or show some interest in image processing and analysis program development using *e.g.* Python programming.

PROJECT 3 – AI-BILITY: CULTIVATING ARTIFICIAL INTELLIGENCE AWARENESS IN SCHOOLCHILDREN

Supervisors' name

- Supervisor 1: Isabella SEEBER
- Supervisor 2: Jani MERIKIVI (in case of absence)

GIIP Intake: Summer 2022 (May to July/August) or Autumn 2022 (September to December)

Institute: Grenoble Ecole de Management

Keywords: conversational agents, hybrid intelligence, future of work, robots as teammates, social robots, pedagogical agents

Description of the project:

We observe a growing market of smart toys, adaptive learning applications, and digital assistants for schoolchildren. These products are artificial intelligence (AI) based conversational agents (CA) that can communicate using natural language. The COVID-19 pandemic probably plays an important role in promoting their adoption. We still know little about how schoolchildren harness these AI-based CAs for their benefits. The Erasmus+ project AI-bility aims to understand how schoolchildren interact with different types of AI-based CAs. We also aim to equip schoolchildren as digital natives and their caregivers with hands-on knowledge in dealing with the rapid advancement of smart technologies.

We seek up to **two motivated research interns** that

(1) help elicit how schoolchildren interact with current AI-based CAs (focus-group interview study, May-July internship),
(2) help understand how schoolchildren's learning strategies and learning acquisition differs between at least two types of AI- based CAs (voice assistant vs. social robot, experimental methods, September-December internship), and/or
(3) help develop the AI-based CAs for the planned experiments.

The to-be accomplished work could be particularly fitting for students with a business and/or computer science background. However, we also welcome students with other study backgrounds.

PROJECT 4 – RIPNNOVATION: HOW TOLERANCE FOR MISTAKES IMPACTS CREATIVE OUTPUT (FOR 2 STUDENTS)

Supervisors' name

- Supervisor 1: Hélène MICHEL
- Supervisor 2: Isabelle PATROIX (in case of absence)

GIIP Intake: Summer 2022 (May to July/August)

Institute: Grenoble Ecole de Management

Laboratory: Playground – GEM Labs

Keywords: #Innovation #Gamification #Design #Experiment #Sciences writing

Description of the project:

During the last decade, innovation failure has become a trendy societal topic with events in all major international cities such as Failcon[1] during which entrepreneurs share their learning experiences. Failure has even a museum: the Museum of Failure[2] in Sweden and its pop-up exhibitions worldwide. It presents more than 160 examples of products and services, which didn't succeed finding their market from the « Thirsty Dog » mineral water to the « Rejuvenique » mask toning facial muscles with electricity.

These examples illustrate the fact that « w*hile organizations and individuals tend to focus on learning from success, research has shown that failure can yield crucial insights* » (Dahlin et al., 2018). Even though, organizations are still reluctant to adopt a positive approach of failure and regularly rejecting novel ideas (Mueller et al., 2012). The literature on failure is rich, dedicated mostly to « post mortem » analysis in order to identify the reasons of failure (Mueller, 2012), the emotions post-failure (Shepherd et al. 2011) or the learning process that occurred (Dahlin et al., 2018).

Research on failure also suggests that tolerance for mistakes is a precondition for creativity: It both enhances generation of ideas and integrates uncertainty associated with novel ideas (Zhou et al. 2017). However, there is still few researches regarding tolerance for mistakes. Our research question is then: How tolerance for mistakes impacts creative output?

Our two hypothesis are the following:

- Hypothesis 1: Tolerance for mistakes could enhance creativity.

[1] FailCon | Home (thefailcon.com)
[2] www.museumoffailure.com

- Hypothesis 2: Analysing other organisations mistakes could develop individual tolerance for mistakes.

To study this, we want to design an experimentation protocol. It will be composed of:

- A benchmark of Grenoble ecosystem failures and a creation of a portfolio, using science-writing skills.
- A presentation of theses failures into a« pop up » local museum of failure, in GEM Labs, using both science writing and design skills.
- A game « RIPNNOVATION » about innovation failure: A prototype of this game has been created. We need now design skills to improve and finish it.
- The organization of visits into the museum in order to collect data on the role of failure in creativity and willingness to cooperate.

The internship requires two types of skills:

- Sciences writing (Master Level):
    - benchmarking the failures of the ecosystem (reading, interviews etc.)
    - creating a portfolio of local failures (from 12 to 30 failures)
    - writing the description texts of all these failures
    - curation of the pop up exhibition
    - curation and improvement of the texts of the game
    - writing the rules book of the game
- Design (Bachelor Level or Master Level):
    - Designing the graphic elements of the game: components, box etc.
    - Benchmarking different solutions for the game production
    - Preparing all the elements for printings and production of the game.
    - Design of the pop up exhibition (in a small room in GEM Labs)

We are therefore looking for 2 persons during 2 months, from mid-May 2022 to mid-July 2022. These persons will be integrated in the very dynamic and creative environment of the Playground, GEM lab dedicated to game design.

We had several great experience with MIT students and we would be happy to continue our collaboration with this ecosystem.

References

Agogué M., Levillain K., Hooge S. (2015) Gamification of Creativity: Exploring the Usefulness of Serious Games for Ideation. *Creativity and Innovation Management*, 24, 3, 415-429

Dahlin K., Chuang Y-T. & Roulet T. (2018) Opportunity, Motivation, and Ability to Learn from Failures and Errors: Review, Synthesis, and Ways to Move Forward. *Academy of Management Annals*, 12, 1, 252–277.

Gillier, T. and Schweitzer, F. (2021), Inside the technology showroom: sequence of technology demonstrations and willingness to collaborate. *Journal of Product Innovation Management*.

Mueller J.S., Melwani, S., & Goncalo, J.A. (2012) The bias against creativity: Why people desire but reject creative ideas. *Psychological Science*, 23, 1, 13–17.

Shepherd D. A., Patzelt H., & Wolfe M. (2011) Moving forward from project failure: Negative emotions, affective commitment, and learning from the experience. *The Academy of Management Journal*, 54(6), 1229–1259.

Zhou J., Wang X.M., Song L.J., & Wu, J. (2017) Is it new? Personal and contextual influences on perceptions of novelty and creativity. *Journal of Applied Psychology*, 102, 2, 180.

PROJECT 7 – DEVELOPMENT OF A SPATIAL ATOMIC LAYER DEPOSITION SETUP

Supervisor's name

- Supervisor 1: David MUÑOZ-ROJAS
- https://sites.google.com/site/workdmr/

GIIP Intake: Ideally from February to July or Summer 2022 (May to July/August)

Institute: Grenoble-INP

Laboratory: Materials and Physical Engineering Laboratory (LMGP)

Keywords: Spatial Atomic Layer Deposition; Setup development; Part Design and fabrication; Mechatronics Engineering.

Description of the project:

Recently, a new approach to atomic layer deposition (ALD) has been developed that doesn't require vacuum and is much faster than conventional ALD. This is achieved by separating the precursors in space rather than in time. This approach is most commonly called Spatial ALD (SALD). In the LMGP we have are using and developing SALD as a novel gas-based 3D printing approach for functional materials. Printing materials with SALD allows nanometer resolution in Z while so far we reached several mm in XY (Advanced Materials Technologies, **2020,** 5 (12), 2000657.). We are currently further developing our system to decrease in resolution.

We are looking for a Mechatronics engineer to assist us with the development of our set up. The main aim will involve to implement heating regulations on different parts if the system and contribute to the automatization of the setup, as well as contributing to the design of different parts of the system. We are looking for a highly motivated student who is interested to work in an inter-disciplinary group and on an interdisciplinary project. Interpersonal skills, dynamism, rigor and teamwork abilities will be appreciated. The candidate should have Knowledge in Comsol or other CFD simulation tool, 3D printing. Knowledge in the OPTO22 system and software is desired. Experience in materials science and thin film deposition and characterization will be advantageous.

PROJECT 8 – DEVELOPMENT OF ARTIFICIAL INTELLIGENCE ASSISTANTS FOR SYNCHROTRON BEAMLINE DATA ANALYSIS

Supervisors' name

- Supervisor 1: Jean-Sébastien MICHA
- Supervisor 2: Samuel TARDIF (in case of absence)

GIIP Intake: Summer 2022 (May to July/August)

Institutes: CEA IRIG

Laboratory: Modeling and Exploration of Materials Laboratory (MEM) / Nanostructures and Synchrotron Radiation

Keywords: Machine Learning, Artificial Intelligence, X-ray Image pattern, Data Analysis

Description of the project:

The aim of the internship is to dive into the exciting world of studies and characterization of materials at the European Synchrotron (ESRF) and the related advanced instrumentation for X-ray scattering. Due to the growing amount of data in synchrotron beamlines using rapid 2D detector new approaches to handle collected data from X-ray characterization measurements are needed. Over the last few years, Artificial Intelligence has entered into the synchrotron world with significant and promising results. Several demonstrations of Machine and deep learning algorithms and architectures were made for a higher general beamline throughput and better data interpretation by users. During the internship, we plan to test and implement various learning techniques on the analysis of x-ray 2D pattern recorded by Laue microdiffraction to enable on fly diagnosis & analysis. For instance, several assistants could be trained: to detect and sort data for further analysis, to perform regression for the determination of crystal orientation, to speed up the handling of complex or multicomponents scattering peaks, or deal with 2D (3D) microstructure reconstruction from sample raster scan. Sample or optics alignment procedures could also be implemented. Background on scientific computing is highly recommended. Knowledge on physics, materials science and crystallography would be an asset.

PROJECT 9 – AN ATLAS OF TRANSCRIPTION FACTORS BINDING SITES PROPERTIES IN *ARABIDOPSIS THALIANA*

Supervisors' name

- Supervisor 1: Romain BLANC-MATHIEU
- Supervisor 2: Jérémy LUCAS (in case of absence)

GIIP Intake: Summer 2022 (May to July/August) or Autumn 2022 (September to December)

Institute: CEA IRIG

Laboratory: Cell & Plant Physiology Laboratory (LPCV – Laboratoire Physiologie Cellulaire & Végétale)

Keywords: plants, transcription factor, DNA binding sites, bioinformatics

Description of the project:

Transcription factors (TFs) have a major role in the regulation of gene expression. They control the vast majority of biological processes ranging from the simple response to stimuli in bacteria to the most complex development of the embryo in multicellular beings or of the flower in plants that possess them. To fulfil their function, TFs bind specifically to DNA by recognizing binding sites (transcription factor binding sites - TFBSs) or cis-regulatory elements to induce or repress gene expression. In order to know how a biological process is regulated, it is essential to be able to recognize and predict these binding sites. What are the binding sites of a factor to DNA? How and to what extent do variations between binding sites translate into developmental differences? How does the chromatin context affect the binding of a factor and thus the regulation of its target genes? How do these properties change from one factor to another (between TF families, between classes)? How have these properties evolved?

To help answering these questions our project will establish an atlas of DNA binding properties from genomic data for the model plant species *Arabidopsis thaliana*. In this project, the applicant will process several TF genome-wide DNA binding data (DAP-seq and ChIP-seq), using a bioinformatics pipeline developed in our laboratory, to characterize their binding properties. The applicant can build upon the existing pipeline to improve or add new tools. For example, he can contribute to ongoing efforts to identity DNA motifs that are specific to genomics regions bound by the TF in complex with an unknown partner. He will also have the opportunity to write scripts to visualize results obtained across TF families in order to better appreciate their differences in DNA binding properties. The candidate must know the basics of Linux commands and programming languages Python and R. A basic knowledge of gene regulation and genomics is also expected.

PROJECT 10 – FUNCTIONAL CHARACTERIZATION OF GENES IMPLIED IN THE BIOSYNTHETIC PATHWAY OF GALACTOGLYCEROLIPIDS OF PHAEODACTYLUM TRICORNOTUM AND MICROCHLOROPSIS GADITANA BY HETEROLOGOUS EXPRESSION IN YEAST

Supervisors' name

- Supervisor 1: Alberto AMATO
- Supervisor 2: Yannick SERES (in case of absence)

GIIP Intake: Summer 2022 (May to July/August) or Autumn 2022 (September to December)

Institute: CEA IRIG

Laboratory: Cell & Plant Physiology Laboratory (LPCV – Laboratoire Physiologie Cellulaire & Végétale)

Keywords: Microalgae, yeast, Galactolipid synthesis, heterologous expression

Description of the project:

Stramenopiles like *Phaeodactylum tricornotum* and *Microchloropsis gaditana* have attracted increasing attention in the last decades because of their ability to produce high added-value biomolecules, mainly lipids that can be used as precursors for biofuels or as dietary supplement in nutraceutics or in cosmetics. Nonetheless, the knowledge of lipid synthesis pathways in Stramenopiles is scanty. Our project focuses on the biosynthetic pathway of galactoglycerolipids, the predominant plastidial lipids in *M. gaditana*. Candidate genes have been identified by sequence homology and need to be functionally characterized. The student will develop heterologous expression of the different candidate genes in *Saccharomyces cerevisiae*. The student will design and realize *in vivo* cloning, sub-cellular localization, epifluorescence microscope observation and lipidomics analysis. The rationale behind the project is to induce *S. cerevisiae* to synthesize galactoglycerolipids. The analysis of the lipidome of the mutant yeast strains will unravel the activity and specificity of the enzymes. The student should have a good background in molecular biology, be independent, curious and rigorous.

PROJECT 11 – NANOPARTICLE TRACKING ANALYSIS OF SCARCE VIRAL SAMPLES

Supervisors' name

- Supervisor 1: Christophe MASSELON
- Supervisor 2: Thomas FORTIN (in case of absence)

GIIP Intake: Summer 2022 (May to July/August) or Autumn 2022 (September to December)

Institute: CEA, IRIG

Laboratory: Large Scale Biology Laboratory (Laboratoire Biologie À Grande Échelle)

Keywords: Virus, nanoparticle-tracking analysis, nano-resonator mass spectrometry

Description of the project:

In cooperation with the CEA LETI, our group has developed a novel approach to determine the mass of viruses using nano-resonators mass spectrometry (See Dominguez-Medina et al. Science 2018, 362 (6417), 918–922). In this context, an assessment of viral particle integrity and aggregation prior to mass analysis is a critical requirement. For this purpose, we use a light scattering based technology called Nanoparticle Tracking Analysis (NTA). In this experiment, particles in suspension in a fluid is tracked using a video-microscope, and the size of individual particles are deduced from their Brownian motion using the Stokes-Einstein relationship. While it is quite straightforward to analyse high concentration virus samples using NTA, the methodology needs to be optimized to deal with more dilute and scarce samples such as those produced by infection of cells in culture. For this purpose, we would like to regulate the sample introduction on the one hand, and enhance the statistical analysis of size distribution data on the other hand, in order to achieve a robust protocol enabling routine analysis of real-life virus samples. Naturally, we will be working with non pathogens models for real viruses. We would welcome a student with a background in analytical chemistry or physics, and interested in microfluidics and biology. He/she would be working in an interdisciplinary team, perform experimental work with NTA, and statistical data analysis.

PROJECT 12 – UNDERSTAND IRON-SULFUR CENTER IN FUR

Supervisor's name

- Supervisor 1: Isabelle MICHAUD-SORET

GIIP Intake: Summer 2022 (May to July/August) or Autumn 2022 (September to December)

Institute: CEA IRIG

Laboratory: Laboratory of chemistry and biology of metals

Keywords: iron, metalloprotein, oxidative stress, iron-sulfur cluster

Description of the project:

The Ferric uptake transcription regulator (Fur) controls the expression of genes involved in iron homeostasis and virulence. In 2020, Fontenot et al. proposed that Fur binds a [2Fe-2S] cluster to 4 cysteines formerly considered as a structural zinc ligands. Our objectives are to decipher if iron-sulfur center in Fur is an artefact or a reality.

Iron is an essential micronutrient for fundamental cellular processes such as photosynthesis, N_2 fixation, and biosynthesis reactions. In most bacteria, the Fur metalloprotein is the transcriptional regulator that controls iron homeostasis by responding to iron concentration. In 2020, an article by Fontenot et al. proposed that Fur protein from Escherichia coli (EcFur) could bind a [2Fe-2S] cluster to sense intracellular iron homeostasis. They made a demonstration with different techniques that show the presence of a [2Fe-2S] center in a reddish EcFur protein only when purified from overproducing E. coli ΔiscA/ΔsufA double-mutant strains. These genes code for A-type carrier of [Fe-S] cluster present in classical [Fe-S] center biogenesis pathways. Coupling iron homeostasis, controlled by Fur, and [Fe-S] sensing and/or biogenesis could make sense and may open new perspectives.

Using complementary biochemical, biophysical and structural analyses our work will decipher if iron-sulfur center in Fur is a reality that may confer a new redox sensor function to this well-known global regulator.

We recommend a biochemical background and an interest for the role of metal in biology.

PROJECT 13 – DESIGN, DEVELOPMENT AND REALIZATION OF 3D DYNAMIC ENVIRONMENTS FOR A DRIVING SIMULATOR

Supervisors' name

- Supervisor 1: Christophe PRAT
- Supervisor 2: Viviane CATTIN (in case of absence)

GIIP Intake: Summer 2022 (May to July/August) or Autumn 2022 (September to December)

Institute: CEA LETI

Laboratory: Signal and Sensor Systems Laboratory (LSSC)

Keywords: driving simulator, 3D dynamic environment, driver monitoring

Description of the project:

The trainee will be asked to design, develop and test 3D dynamic environments for a driving simulator in accordance with requirements already defined.

These environments should help immersing drivers into distracting and stressing situations.

3 different environments of 30mn of duration should designed and tested.

The software to be used is UCWinroad (Forum8).

The trainee will be free to use a driving simulator installed in the laboratory.

The trainee would have to find compromise between the realism of the environment (fluidity) and its complexity.

The trainee must be imaginative rigorous and must take initiative. He/she should have a strong interest/background in programming, virtual environment, SCANeR Studio, UCWinroad, Delphi (C++).

PROJECT 15 – VOLTAGE REGULATED VHF CONVERTER WITH INNOVATIVE EMBEDDED MATERIALS

Supervisors' name

- Supervisor 1: Xavier MAYNARD
- Supervisor 2: Sébastien CARCOUET (in case of absence)
- Supervisor 3: Emmanuelle PAULIAC VAUJOUR (in case of absence)

GIIP Intake: February 2022 onwards (5 to 6 months) can begin in April

Institute: CEA LETI

Laboratory: Energy & Power Electronics Lab (L2EP)

Keywords: power electronics

Description of the project:

Our laboratory carries out research in the domain of very high frequency converters. We have developed a patented resonant topology to minimize the voltage constraints on the passive and active components: the internship will focus on the converter control in order to address one of the main difficulty in such a converter, that is to say output voltage regulation. The aim is to achieve a high reliability converter, while addressing parameter constraints such as voltages, currents and temperature component withstanding. This kind of converter may be used as DC/DC power supply with a wide output voltage and power range in various applications, such as aeronautic, automotive or industrial. The trainee will first perform simulations to study the performance and limits of several voltage regulation loops. In a second step, she/he will implement the most interesting solution in a prototype. One key criteria is the limitation of the number of components: it will be addressed through the contribution and expertise of different CEA laboratories in both passive (inductance, capacitor) and active (GaN switches) components. The candidate must demonstrate strong skills in analogy and digital electronics and ideally in power electronics. A good knowledge of simulation tools (LTspice, PSPICE) and design tools (Altium) is required. Experience in software development (µC, DSP) and thermal calculation would be valuable.

Candidate profile: MSci in electronics or power electronics (BAC + 5)

Internship duration: 5 to 6 months

Perspective: PhD opportunity