Position title

Fixed-term Research Contract - Data Analysis in Tomographic Imaging (M/F)

Corresponding Job Description According to RéFérens III Typology (https://data.enseignementsup-recherche.gouv.fr/pages/referens/): Expert in Scientific Computing - E1E45 (Research Engineer)

Position identification

Position Category: ☒ A ☐ B ☐ C
Position Corps (equivalent to ITRF): **Postdoctoral Researcher**
BAP (Branches of Activity and Positions): E - Computer Science, Statistics, and **Scientific Computing**
Contract status: ☐ Fixed-term ☒ Project-based Fixed-term ☐ Permanent ☐ Tenured
Contract Duration: **12 months**
Workload: 100%
Desired Start Date: 01/01/2024 (with flexibility based on candidate availability)

Position assignment	Geographical location
Laboratoire de Physique des Deux Infinis Bordeaux (Laboratory of Physics of Two Infinities of Bordeaux) iRiBio Team	Gradignan

Introduction to the University of Bordeaux

The University of Bordeaux stands today as one of the most influential multidisciplinary research universities in France and around the world. Rooted in its core values of education and research, and guided by its 2030 strategic plan "Making our university model a lever for new balances, actions, impact", the University of Bordeaux is now accelerating its commitment to address the societal challenges of the 21st century, notably climate emergency. With numerous flagship programs, it unequivocally aspires to be an attractive and sought-after partner for its transformative capacity in the service of responsible and ethical progress.

Being a part of this university means working in an exceptional environment within a particularly diverse and open professional community. It involves benefiting from welcoming and inclusive initiatives, training opportunities, and internal mobility programs. Joining the University of Bordeaux is embarking on an academic, scientific, and human adventure. It is a commitment to tackling the challenges of the 21st century.

Introduction to the organization and working environment

The candidate will join the ***Laboratoire de Physique des Deux Infinis Bordeaux*** (LP2IB), which is a Joint Research Unit of CNRS-IN2P3 and the University of Bordeaux (UMR 5797). The laboratory specializes in utilizing techniques derived from nuclear physics for research in fundamental physics, health, and the environment. The candidate will be part of the **multidisciplinary team iRiBio** (Interactions Ionizing Radiations and Biology), combining expertise in physics, computer science, chemistry and biology, to address challenges related to the characterization of living organisms, focusing on microscopic biological models such as cells and microorganisms.

Context and specificities of the position

This post-doctoral research contract is offered as part of the "Interdisciplinary and Exploratory Research" call for projects at the University of Bordeaux. The objective is to explore **a novel approach for the three-dimensional (3D) reconstruction of tomographic images**, specifically for applications in biology. Supervision will be conducted under the responsibility of Claire MICHELET, a physicist and Associate Professor at LP2IB, specializing in micro-tomography techniques. The co-supervision will be provided by Pascal DESBARATS, a computer scientist and Professor at **LaBRI (Computer Science Research Laboratory of Bordeaux)**, and Jean-François GIOVANNELLI, a data scientist and Professor at the **IMS laboratory (Integration from Material to System)** at the University of Bordeaux. Both co-supervisors are experts in inversion problems and image reconstruction techniques.

Missions and activities

Context

3D Microtomography (MT) is an indispensable tool in the analysis of matter, particularly living matter, as it enables direct imaging without the need for physical sectioning on preserved biological samples, closely resembling their native state. A crucial requirement for obtaining high-quality tomographic images is to acquire data over a complete angular range, at least 180° around the object to be imaged. However, most biological models (cells, microorganisms) are cultivated on 2D supports. This specific geometry poses an experimental limitation, as it becomes impossible to capture measurements at grazing angles, resulting in **a "missing wedge", an angular range where acquisition is not feasible.**

The challenge of the project, representing the ultimate goal of this research contract, is **to develop image reconstruction methods to address the lack of information in the missing wedge**. Methodologically, the idea is to leverage a priori knowledge about the object, including its structure, the presence of discontinuities, expected distribution types, etc. These constraints will be applied to guide the reconstruction towards realistic solutions. From a practical standpoint, the study will be concretely conducted on **the biological model *Caenorhabditis elegans*** (*C. elegans*), a multicellular microorganism approximately 1 mm in length. *C. elegans* is internationally recognized as a reference model for studying major biological functions (genetics, aging, neurosciences), and extensive data are already available for this model.

Added value of the proposed missions

This post-doctoral research contract makes an original contribution to the challenge posed by the reconstruction of images with incomplete data in 3D imaging. While the issue is here framed within protonic microtomography (MT), its implications extend far beyond. It directly relates to synchrotron radiation MT, electron MT, and could also contribute to advancements in medical imaging (especially Positron Emission Tomography - PET), non-destructive testing, radar imaging, astrophysics, and beyond. The use of relevant parameters to effectively guide reconstruction offers the opportunity **to achieve high-quality 3D imaging while minimizing data acquisition.** In medical imaging, for instance, this concept is fundamental as it opens the possibility of reducing both examination time and patient exposure to radiation while maintaining high image quality. Among the explored methods, the post-doctoral researcher will **leverage recent advances in artificial intelligence** (AI). Our approach aims to efficiently guide the convergence of neural networks, with the goal of developing AI that is frugal in terms of energy and environmental resources.

Main activities

- **Mission 1: Construction of numerical phantoms**
  - Analysis of 3D tomography data on *C. elegans*
  - Analysis of structural information from optical and electron microscopy
  - Creation of realistic numerical *C. elegans* phantoms in terms of structure and chemical composition
  - Writing an article and public release of phantoms to the scientific community
- **Mission 2: Development of tomographic image reconstruction codes**
  - Literature review: numerical methods suitable for reconstruction in the case of missing data (missing wedge), including methods utilizing AI
  - Utilization of numerical *C. elegans* phantoms, both to identify relevant constraints and to feed neural networks
- **Mission 3: Validation of Developed Reconstruction Codes**
  - Validation through the reconstruction of numerical phantoms in the case of missing data, compared to the case of complete data
  - Validation on experimental 3D tomography data
  - Writing an article and public release of finalized codes to the scientific community

Position profile – Strengths/Talents

Given the multidisciplinary nature of the tasks, the candidate must demonstrate scientific curiosity, autonomy, critical thinking, methodological skills, and the ability to work in a team. Additionally, they should possess English writing skills and preferably have already published one or more articles in international scientific journals.

This project will require the candidate to develop **skills in data processing (physics), AI and image reconstruction (digital science).** Therefore, they should rely on a solid educational background and successful experience in at least one of these areas. The required educational level is **a Ph.D. (or equivalent experience) in physics, computer science, or related disciplines**, with a professional focus on **imaging data processing**, regardless of the field (physics, biology, material sciences, mechanics, medical, etc.).

In addition to exchanges with members of participating laboratories, the candidate can enhance their knowledge during the contract period by participating in training sessions offered, notably by the University of Bordeaux. This includes topics such as inversion issues in tomographic imaging and AI.

☐ Proven experience in the field is desired
☒ First experience in data processing in imaging and/or AI is desired
☐ Beginners accepted

Contact persons

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