



**Offer #2024-07652**

## **Post-Doctoral Research Visit F/M Reduced models for cardiac valve dynamics [DRI post-docs call 2024]**

**Contract type :** Fixed-term contract

**Level of qualifications required :** PhD or equivalent

**Fonction :** Post-Doctoral Research Visit

### **Context**

Every year Inria International Relations Department has a few postdoctoral positions in order to support Inria international collaborations. The postdoctoral contract will have a duration of 12 to 24 months. The default start date is November 1st, 2024 and not later than January, 1st 2025. The postdoctoral fellow will be recruited by one of the Inria Centres in France but it is recommended that the time is shared between France and the partner's country (please note that the postdoctoral fellow has to start his/her contract being in France and that the visits have to respect Inria rules for missions)

### **Assignment**

Candidates for postdoctoral positions are recruited after the end of their Ph.D. or after a first post-doctoral period: for the candidates who obtained their PhD in the Northern hemisphere, the date of the Ph.D. defense shall be later than September 1, 2022; in the Southern hemisphere, later than April 1, 2022. In order to encourage mobility, the postdoctoral position must take place in a scientific environment that is truly different from the one of the Ph.D. (and, if applicable, from the position held since the Ph.D.); particular attention is thus paid to French or international candidates who obtained their doctorate abroad.

### **Main activities**

#### **1. Context**

The heart is a double pump whose purpose is to deliver blood to the tissue and organs of the body. This function is made possible through the opening and closing of the heart valves. Cardiac diseases generally manifest by affecting the pumping function of the heart. Numerical simulations of cardiac hemodynamics, in normal and pathological conditions, are recognized as a tool of paramount importance for improving the understanding, diagnosis and treatment of cardiac pathologies, and also for the development of implantable devices due, in particular, to the fact that numerical simulations provide local information (such as pressure and stresses) which cannot be accessed via measurement techniques.

The numerical simulation of cardiac hemodynamics presents many difficulties. We can mention, for instance, the large deformation of the cardiac chambers and the complex fluid-structure interaction (FSI) phenomena between blood, the valves and the myocardium. Heart valves are definitely a bottleneck of the problem, particularly due to their fast dynamics and the contact phenomena at high pressure-drops. In order to mitigate the computational complexity of multi-physics problem, several reduced modeling approaches have been proposed in the literature. Basically, the idea consists in combining a kinematic uncoupling between blood flow and myocardium electro-mechanics (i.e., displacements, either measured or coming from numerical simulations, are enforced on the boundaries of the fluid cavities) with a reduced modeling of the valve dynamics. These formulations enable the simulation of blood flow patterns within the cardiac cavities at a reduced computational cost, but the reduced model of the valves are generally based on discrete algorithms, without a rigorous formulation of the underlying mathematical model.

#### **2. Research program**

The proposed research activity aims at developing and analyzing efficient numerical methods for the alternative mathematically sound reduced valve modelling approach, based on a constrained velocity formulation of the fluid problem with a penalty formulation. To this purpose, numerical methods based on Lagrange multipliers or on Nitsche-type techniques will be explored in the framework of an interface problem for incompressible viscous flow.

Numerical simulations will be performed in academic examples and realistic geometries of the heart. The computer implementations will be performed withing FreeFem++ and the FELiScE finite element libraries.

#### **3. Framework**

The selected candidate will join COMMEDIA project-team and work in the framework of the IMFIBIO Associated Team (Inria-UCL). Besides the natural collaboration with the UCL partner (Erik Burman), the post-doctoral activity will also involve a collaboration with Alexandre Ern (SERENA project- team).

The post-doctoral fellow will visit the UK partner, at least, 2 months per year (1 month per semester).

#### 4. Deadline for applications

June 1st, 2024.

## Skills

Candidates must hold a doctorate in applied mathematics and have some experience in the following fields: mathematical modeling, mathematical analysis, numerical analysis, discretization of PDEs, finite element methods.

Technical Skills: C++ programming.

Languages: English

Interpersonal skills: ability to work in a team

## 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 and flexible organization of working hours (after 12 months of employment)
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

## General Information

- **Theme/Domain** : Modeling and Control for Life Sciences  
Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Town/city** : Paris
- **Inria Center** : [Centre Inria de Paris](#)
- **Starting date** : 2024-10-01
- **Duration of contract** : 2 years, 1 month
- **Deadline to apply** : 2024-07-31

## Contacts

- **Inria Team** : [COMMEDIA](#)
- **Recruiter** :  
Fernandez Varela Miguel Angel / [Miguel-Angel.Fernandez\\_Varela@inria.fr](mailto:Miguel-Angel.Fernandez_Varela@inria.fr)

## 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.

