



MAISON DE LA SIMULATION

# Maison de la Simulation

## High Performance Computing Specialist

### Optimisation of the simulation code TOKAM3X for tokamak plasma turbulence on many-core architectures.

In the framework of EoCoE, European Centre of Excellence for HPC, la Maison de la Simulation proposes a **one year contract** for HPC specialists.

The general purpose of the EoCoE project (Energy oriented Centre of Excellence) is to provide support to HPC (High Performance Computing) applications that belong to scientific communities having potential impact on technologies linked to energy. The consortium gathers 23 partners from 8 European countries and offers a wide spectrum of services and skills like, numerical analysis, parallel algorithms implementation and HPC libraries improvement and integration in applications.

The hybrid (Fortran90, MPI + OpenMP) parallel code TOKAM3X, mainly developed at CEA Cadarache, is becoming one of the leading code for 3D modeling of Tokamak edge plasma turbulence in the field of the magnetic confinement fusion energy research. The ramp-up of the code exploitation has gone along with the need for more computation hours on international super-computers. A large part of the computational hours have been obtained on many-core architecture et more specifically on Intel Xeon Phi KNL. Many-core architectures are characterized by a large number of cores (between 68 and 72) with a diminished frequency (between 1.3 and 1.5 Ghz) compensated by larger SIMD vector registers (512 bit). They have been designed to consume less energy while providing a larger peak computational power than previous multi-core architectures (Intel Xeon). In general, these properties make program performances more sensitive to programming and parallel issues. Developers have to focus more than ever on data structure, cache optimization and vectorization to reach the machine peak performance and surpass previous processor architectures. The current implementation of the code suffers from these problems and an important effort has to be done on vectorizing TOKAM3X. Today, running times are equivalent or higher than on previous less-powerful multi-core architectures.

More specifically, the recruit will be in contact with scientific communities and will bring direct support to the parallel code TOKAM3X at la Maison de la Simulation. In a first phase, the work will consist in evaluating the performance of the code on many-core and multi-core architectures in order to determine main slowdown causes and code optimization possibilities. In a second phase, the objective will be to optimize the application depending on the result of the previous phase while focusing on cache management and vectorization, the load balance between OpenMP threads as well as a better use of the high-bandwidth MCDRAM memory. As for the first phase, performance evolution will be evaluated on large KNL clusters and previous generations.

The recruit will be part of teams of HPC experts from Maison de la Simulation and will work in collaboration with international scientific communities including experts of the EoCoE projects in Europe and the magnetic confinement fusion group of the CEA Cadarache. She/He will have the opportunity to use the most advanced performance evaluation tools running on the most powerful European supercomputers. She/He will have access to the training program of la Maison de la Simulation and the EocoE project organised each year in several European centre of excellence. It will be possible to participate to workshops and conferences as well as travelling in France and Europe in the framework of the EoCoE project.

#### **Required skills :**

- PhD or master's degree in a scientific domain strongly connected to HPC
- Operational knowledge of techniques and programming language (Fortran90, C, C++) for application development



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- Good experience in application parallelization (MPI, OpenMP) and scientific codes optimization on various architectures (SMP, MPP) running in Unix environment
- skills to work in a team.

In addition, knowledge or experience in one of the following domain will be appreciated:

- usage of performance analysis and debugging tools on parallel applications ;
- knowledge of computer architectures ;
- knowledge of scripting languages (Python, bash, ...).

**Localisation :**

La Maison de la Simulation (<http://www.maisondelasimulation.fr>) is situated on the Saclay research campus in the Digitéo building of the CEA/Saclay institute.

Please send your application (CV, motivation letter et references) as well as your potential requests for additional information to [mathieu.lobet@cea.fr](mailto:mathieu.lobet@cea.fr).



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## **La Maison de la Simulation :**

La Maison de la Simulation (<http://www.maisondelasimulation.fr>) is a joint project of five partners (CEA, CNRS, INRIA, University of Orsay and University of Versailles-StQuentin) with the status of a "Unité de Service et de Recherche" (Service and Research Unit), whose aim is to support and stimulate the scientific community in order to get the best out of supercomputers, in particular those managed by the French GENCI and the European PRACE programs. La Maison de la Simulation promotes the emergence in France of a HPC community, and develops the strong synergies between researchers and engineers from various fields necessary for the important scientific breakthroughs expected from HPC to materialize. These initiatives are targeted to the current HPC users, as well as to the research of new application fields for the HPC.

To fulfil its missions, la Maison de la Simulation is organized around three axes:

- **A multidisciplinary research centre** focused on numerical simulation. La Maison de la Simulation hosts multidisciplinary research teams working on projects strongly linked to HPC, from mathematics, numerical methods, algorithms, computer science, software engineering to the physics of the studied phenomenon. These teams lead their own research activities and foster the emergence and the usage of common numerical tools.
- **A service and expertise unit** opened to scientific communities. La Maison de la Simulation hosts also a team of HPC specialists able to provide expertise and support to high level application developments to accepted projects. This expertise concerns parallel algorithms, development and optimisation of codes as well as data post-treatment and visualisation.
- **A HPC training centre and scientific animation hub.** La Maison de la Simulation is a HPC training centre and a scientific animation hub on the Saclay research campus that spans, thanks to its regional partners, from initial studies in partnership with universities to in-service training programs.

In order to fulfil its missions, La Maison de la Simulation is made of multidisciplinary teams gathering researchers, assistant professors, engineers, PhD students and post-docs working together on long term activities.