



MAISON DE LA SIMULATION

## Engineer job position – 2 years

### Memory scalability and high-performance gyrokinetic simulations

Knowledge, skills: computer science, parallel and high-performance computing

This job position is proposed in the frame of the collaboration between Maison de la simulation ([www.maisondelasimulation.fr](http://www.maisondelasimulation.fr)) and IRFM ([www-fusion-magnetique.cea.fr](http://www-fusion-magnetique.cea.fr)). The work goal is the optimization and improved parallelization of the gyrokinetic code GYSELA. The location is at Maison de la Simulation (Saclay (near Paris), France) and the position will require regular displacements to CEA Cadarache in order to ensure a strong collaboration with GYSELA team.

Modeling turbulent transport is a major goal in order to predict confinement issues in a tokamak plasma such as ITER. Improving theoretical knowledge about the understanding of turbulent phenomena requires the description of particles considering their distribution in velocity. The gyrokinetic framework considers a computational domain in five dimensions (3D in space, and 2D in velocity). Time evolution of the system consists in solving Vlasov equation non-linearly coupled to Maxwell equations. The gyrokinetic GYSELA5D code has been developed in order to model the physical features and instabilities that appear at some specific time and space scales. Routinely, this code performs large simulations using between 256 and 4096 cores. Notably, a one-month duration simulation on 8192 cores has recently produced numerical results for a plasma whose size was near those of ITER. This simulation has required a mesh with more than  $270 \times 10^9$  grid points. In order to improve the quality of simulations and to access finer description of physical phenomena (kinetic electrons instead of adiabatic electrons), we will need simulations on several tens of cores in the near future.

The work proposed here mainly consists in improving memory scalability of the GYSELA code. The maximal number of nodes which is practically usable is bounded up by the available memory per node. For example, in the large simulation described above involving 8192 cores, 27GB per node were required. To achieve realistic physical simulations, it is therefore needed to increase the number of used cores together with a reduction of memory expenses. Your task will be to modify existing subroutines in order to reach a better parallelization on several tens of cores. To reach this goal, you will track memory wastes and eventually reconsider the numerical schemes. This job will prepare the code for next generation of supercomputers that are expected to have much less memory amount per core.

Also, you will be put in charge of a benchmarking activity. In the context of the European PRACE project, you will launch jobs on parallel computers taking GYSELA code as a reference application. Thus, you will analyze parallel performance of the code and will look at performance bottlenecks whenever they appear. Finally, we are looking for the setting up of a non-regression testing platform, expecting to shorten the verification of software developments with this tool. You will contribute to this platform.

The Maison de la Simulation offers competitive salary as well as money for travelling and scientific equipments and access to national computing centers. Applications must be sent anytime; the position will remain opened until it is filled. The starting dates are flexible, but should be preferably before June. Please send Curriculum Vitae, statement of research interests and experience, and arrange for two letters of reference to be sent to Virginie Grandgirard.

For more information about this position you can contact :

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