Engineer position: C++ developer for the exascale turbulent code GyselaX

Context:

Our team has been developing a 5-dimensional gyrokinetic code (3 in position, 2 in velocity) for more than 20 years. It aims at simulating turbulence and transport in controlled fusion devices such as tokamaks. The code named Gysela– stemming from SEmi-LAgrangian GYrokinetic – is written in Fortran 90 and uses an hybrid MPI/OpenMP parallelization approach. It runs efficiently on several hundred thousand cores on standard CPU architectures: a relative efficiency of 85% on more than 524'288 cores has been recently achieved, and of 63% on 729'088 cores on the AMD EPYC architecture. The largest production runs use over 200 billion grid points in phase space, and require several tens of millions of CPU hours.

Yet, the code needs to be radically modified to adapt to the next generation of HPC architectures that target exascale (10^{18} flops) and where GPU will be dominant. To this aim, we have decided to rewrite it in modern C++, and to incorporate the state-of-the-art libraries and numerical tools that are currently developed in the framework of scientific collaborations, at the national and European levels. The new code, capitalizing on our 20 year experience, will be called GyselaX.

Work to be done:

Under the supervision of Dr. Virginie Grandgirard (the main developer of Gysela) and in close collaboration with Dr. Peter Donnel and Dr. Kevin Obrejan, you will be one of the main developers of GyselaX. Your work will consist of:

- Constructing the skeleton of the 4-dimensional version of the GyselaX code aimed at solving the coupled set of gyrokinetic equations for the various particle species (ions and electrons) and the quasi-neutrality (QN) involving a Poisson-like solver.
- Writing the code in modern C++ using advanced templating tools (*e.g.* strong typing).
- Adapting the various numerical schemes used in the Fortran version to a different context (type of mesh, parallelisation strategy, assumptions on the geometry).
- At each step of the development, defining and performing – in collaboration with the members of the team – the necessary unitary tests and benchmarks for the validation of the code.

Profile of the candidate:

The candidate holds an engineer diploma or equivalent, such as e.g. a Master 2 ("Bac +5"). She/he has experience in modern C++ programming, is familiar with parallel computing and a background in applied mathematics. She/he is willing to work in a multi-disciplinary environment, and to interact with experts in applied mathematics, numerics, HPC parallelization and physicists. Her/his level in

English is sufficient to read scientific articles and interact with people in the international framework of research.

Details of the position:

The position is open from February 2023 at the Research Institute on Magnetic controlled Fusion (IRFM) of the CEA center of Cadarache, 13108 Saint Paul Lez Durance, France.

The contract is issued for 18 months.

The candidate will join the GTSN group ("Théorie et Simulations Numériques") on theory and numerical simulations. Strong interaction is expected with the GC3I group ("Calcul Intensif et Infrastructures Informatiques") devoted to high performance computing and computer infrastructures. These two groups are part of the department devoted to the physics of fusion plasmas (SPPF = Service de Physique des Plasmas de Fusion).

Contact:

Applications should be sent to Dr. Virginie Grandgirard: virginie.grandgirard@cea.fr, +33 (0)4 42 25 61 19