2 years C++/HPC engineer at CEA

Methods and tools for optimizing Kokkos kernels in large GPU codes

CEA is recruiting a C++/HPC expert for two years to join the CExA "Moonshot" project team to develop new methods and tools to optimize the performance of portable kernels implemented using the Kokkos library. As a use-case, these tools and techniques will be demonstrated in the Dyablo code, a novel HPC code for simulating astrophysical fluids, from stellar interiors to cosmological simulations.

To apply, please send your application (CV and cover letter) to contact@cexa-project.org. If you have any questions about the position, please use the same address. Applications will be assessed from now and until the position is filled.

Context

Europe is investing to build Exaflop supercomputers in the coming years, including the Alice Recoque one in France, at CEA in 2025. These machines will be heterogeneous, and based on GPUs of various brands and architectures. Ensuring performance and portability under these conditions is certainly one of the most significant challenges for Exascale. To address this, CEA is investing heavily in an ambitious "Moonshot" project: CExA. Part of CExA is contributing to the Kokkos C++ GPU programming model to add new features required by European codes and ensure that it is compatible with European supercomputers so researchers can exploit these architectures for their scientific applications. One of these scientific applications is the Dyablo code developed since 2020 at CEA for simulating astrophysical fluids with adaptive mesh refinement. This code was written from the start using Kokkos and is thus already facing optimization challenges that many other codes will face in the coming years.

In this context, CEA opens a two-year engineering position to develop new methods and tools to optimize large applications based on Kokkos. This project will use Dyablo as a use case to test and validate the optimization methods. This project will involve the development team of Dyablo as well as key players of the CExA Moonshot :

- The DRF's software and engineering department of the Institute of research into the fundamental laws of the Universe (IRFU) is the main developer of the Dyablo code.
- Maison de la Simulation (https://www.mdls.fr) of the DRF is a joint research and engineering laboratory of CEA, CNRS, Univ. Paris-Saclay and UVSQ specialized in high-performance computing and numerical simulation.
- The DES's software engineering department for simulation brings together three laboratories that address the issues of the simulation environment, AI and data science, high-performance computing, and numerical analysis.
- The DSSI of the DAM manages activities in computer science, applied mathematics, and information systems, covering a broad spectrum from definition and design to user services.

Mission

As part of both the Dyablo and CExA teams, you will develop tools and methods to optimize the performance of Kokkos' applications and apply them to Dyablo.

Your mission will include:
- Development of new methods for the optimization of large applications using Kokkos:
  - Design and develop a tool to extract kernels from a large code while capturing inputs and outputs to generate a self-consistent mini-app that can be easily profiled and optimized separately from the rest of the code.
  - Develop a tool to profile and analyze the performance of the mini-apps extracted by the previous tool. This profiler should be able to provide insights like a profiling software such as Vtune.
  - Design an auto-tuning method to fine-tune any free parameter of the mini-app to gain the optimal performance on a given target architecture.

- Application of this new set of tools and methods on the Dyablo code:
  - Profile the hotspots of the code and generate a set of self-consistent mini-apps for different types of simulations and architectures.
  - Investigate the optimization potential of the code on different architectures such as Nvidia GPUs, AMD CPUs, and GPUs or Intel CPUs.

Skills

- You have a master's or an engineering degree in computer science and:
- You have a solid knowledge of advanced C++ and the latest standards (at least C++17).
- You have skills in software engineering. You are familiar with common development environments and associated tools (cmake, docker, spack, gtest, ctest, etc.).
- You have a solid knowledge of HPC programming, in particular GPU programming.
- You have experience with performance optimization and profiling tools for parallel applications.
- Prior knowledge of the Kokkos performance portability framework is a plus but optional for the position.
- You are autonomous and wish to join an international work team. You master technical English (written and oral). You are interested in the world of high-performance computing and its challenges and follow the evolution of technologies.

Salary and benefits

- The CEA offers salaries based on your degrees and experience.
- This position offers several advantages: the possibility to join collaborations with other European laboratories, the United States and Japan,
- Numerous opportunities to travel internationally (exchanges, conferences, workshops and more)
- Up to 3 days of telecommuting per week
- Reimbursement of up to 75% of public transport cards and a free transport network throughout the Ile-de-France region,
- Interesting complementary health insurance and several company savings plans,
- 5 weeks of paid vacation and 4 weeks of RTT per year.