

## JOB OFFER – STAGE

### HPC Software Engineering Intern – GPU Reproducibility

#### OFFER INFORMATION

**Reference:** COOP-25-JL-01

**Location:** 42 Avenue Gaspard Coriolis – 31057 Toulouse

**Team:** COOP

**Supervisors:**

- Joeffrey Legaux
- Mohamed Ghenai

**Gratification:** 800€ net per month - M2 level or last year at engineering school

**Period:** 6 months - from: 09/02/2026

**Key words:** High Performance Computing (HPC), parallel programming, GPU programming, Reproducibility, Continuous integration, Fortran, CFD

#### CERFACS

Cerfacs is a private research, development, transfer and training center for modeling, simulation and high-performance computing. Cerfacs designs, develops and proposes innovative software methods and solutions to meet the needs of its partners in the aeronautics, space, climate, environment and energy sectors. Cerfacs trains students, researchers and engineers in simulation and high-performance computing.

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#### HOSTING TEAM - COOP

*The COOP (Computing and Operational Practice) team aims to accelerate the adoption of best-practice techniques for scientific software on modern high-performance computing (HPC) architectures. Key research and development activities include: software portability, efficiency and scalability; mesh manipulation, adaptation and partitioning; industrial technology transfer; code analytics; machine learning and artificial Intelligence in HPC*

#### CONTEXT

COOP team develops and maintains several HPC code, mainly used in computational fluid dynamics (CFD) simulation and widely adopted by industrials and academics, the most important one being AVBP. We've recently contributed in multiple GPU porting projects in order to leverage their massive parallel processing power. While this move has drastically increased codes performances, it has introduced a critical challenge: numerical non-reproducibility. A common issue, when multiple threads perform floating-point reductions (like summations) on very small/big values, the final result can differ slightly from one run to the next. The GPU's dynamic thread scheduling can make the order of operations random, because of the non-associative nature of floating-point arithmetic, the results can become unpredictable. This issue complicates debugging, validation as well as maintaining scientific codes, as we can no longer guarantee bit-for-bit identical outputs for the same input, a fundamental requirement for scientific rigor.

## MISSION

The internship focuses on restoring bit-for-bit reproducibility to our GPU-accelerated code. This will involve investigating and implementing advanced techniques, with a particular focus on **graph coloring algorithms and numerical methods**. The candidate will begin by surveying existing solutions for reproducible parallel computations. Next, he/she will select and implement the most promising approach within our Fortran and OpenACC codebase. One possible way to do so could be enforcing a deterministic execution order for reduction operations on the GPU. This work will not only involve coding but also rigorous testing and performance analysis to ensure that the chosen method provides reproducibility without an unacceptable performance penalty. Ultimately, the contribution will be critical to the long-term reliability and scientific integrity of the software.

## DESIRED PROFILE

- Academic background: Currently pursuing a Master's degree (M2) or engineering school.
- Essential Programming Skills: Proficiency in imperative languages such as Fortran or C/C++.
- Knowledge of Parallel and/or GPU programming would be an advantage.
- Proactive, analytical skills, autonomous and a passion for tackling complex challenges.

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- An inclusive and equitable work environment.
- A structure accessible to people with disabilities.
- Possibility of benefiting from 1.83 days of reduced working hours per month, linked to your choice of a 39-hour rather than 35-hour working week.
- 50% reimbursement of public transport costs.

## HOW TO APPLY ?

To apply, please send your CV and covering letter to [legaux@cerfacs.f](mailto:legaux@cerfacs.f) and [ghenai@cerfacs.f](mailto:ghenai@cerfacs.f) , applications are open until 15/01/2026.

See you soon at CERFACS!