# JOB OFFER – POST-DOCTORAL

## GPU CFD Solver Development with Julia: A High-Level Approach

### OFFER INFORMATION

**Reference**: AAM-2025-BOU-02
**Location:** 42 Avenue Gaspard Coriolis – 31057 Toulouse
**Team:** AAM

**Contact person:**

- Jean-François BOUSSUGE, boussuge@cerfacs.fr

**Period:** 1 year, renewable 1 year – from December 2025
**Salary**: 42 K€/year (gross)
**Level of education required**: PhD

**Keywords:** CFD, LBM, GPU, HPC, Julia, MPI, Contrails

### 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.
CERFACS works closely with its seven partners: Airbus, Cnes, EDF, Météo France, Onera, Safran et TotalEnergies.

### HOSTING TEAM - AAM

The Advanced Aerodynamic & Multiphysics (AAM) team is dedicated to developing cutting-edge numerical methods, physical modeling, and High-Performance Computing (HPC) techniques for new Computational Fluid Dynamics (CFD) solvers. The work focuses on fluid dynamics simulations for aircraft, rockets, and turbomachinery, in close collaboration with CERFACS partners.

### CONTEXT

Supercomputing is undergoing a major paradigm shift, with a progressive transition from CPU-based architectures to GPU-dominated platforms. This transition is already visible in European infrastructures, with new exascale systems such as Jupiter (Jülich, 2024) and Jules Verne (TGCC, 2025) designed primarily around GPUs. In this landscape, simulation tools must be rethought to fully exploit modern hardware while ensuring sustainable development and long-term portability.

Traditionally, high-performance CFD solvers at CERFACS have been adapted for GPU platforms through the use of compilation directives and advanced programming models. While these strategies can achieve excellent performance, they often require a steep learning curve and a high level of expertise in low-level programming, which may limit their accessibility to physicists and numerical analysts.

Several promising strategies are currently being explored:

- **Template-based C++ approaches, coupled with libraries such as Kokkos (https://kokkos.org),** enable performance portability across various architectures.
- **Automatic code generation techniques** that reduce the need for manual optimization.
- **High-level programming languages such as Julia (https://juliagpu.org)**, which combine fast prototyping with near-C performance and native GPU support.

The present postdoctoral project focuses on this third path. Since the study is rooted in CFD, a representative system of equations is required. The **Lattice Boltzmann Method (LBM)** is selected as a simpler alternative to full Navier–Stokes solvers, while still providing physical relevance. Its straightforward formulation and natural compatibility with GPU architectures make it an excellent framework to investigate programming strategies and performance. A recent prototype confirms the feasibility of this approach and motivates further exploration.

## MISSION

The postdoctoral researcher will extend an existing Julia prototype for GPU-based CFD, with a focus on **contrail simulations**. Responsibilities include:

- Developing **MPI-based distributed parallelism** for multi-GPU and multi-node scalability.
- Evaluating performance across **heterogeneous GPU architectures** (NVIDIA, AMD).
- Applying the solver to **contrail simulations** and comparing results with CPU-based finite-difference tools.
- Benchmarking against existing approaches (C++/Kokkos, automatic code generation) using the **provided reference results**.

This project contributes to **sustainable, high-performance CFD algorithms** for next-generation supercomputers.

## DESIRED PROFILE

- PhD in **Computational Fluid Dynamics, applied mathematics, computational physics, high-performance computing, or a related field**, defended within the last 3 years.
- **Experience in scientific programming and software development**, using any high-level or low-level language.
- Knowledge of **fluid mechanics, turbulence, and numerical simulation**.
- Excellent **communication skills in English**, both oral and written, for presenting results in an international research environment.
- Motivated by **high-performance computing, GPU programming, and innovative CFD applications**, such as contrail simulations.

## WHAT WE OFFER AT CERFACS

- Broad access to technology, a rich interpersonal environment, and in-house skills recognized nationally and internationally.
- An inclusive and equitable work environment.
- A structure accessible to people with disabilities.
- A complementary health insurance scheme offering excellent health care coverage in addition to social security, with the possibility of enrolling family members (spouse and children).

- 6 weeks' annual leave (with the possibility of 22 extra days' leave per year linked to your choice of a 39-hour rather than 35-hour working week).
- Flexible working arrangements, with the possibility of working from home up to two days a week.
- A sustainable mobility package enables employers to pay up to a maximum of 500 euros a year to cover the home-to-work travel costs of staff who cycle to work.

## HOW TO APPLY?

To apply, please send your CV and cover letter to **boussuge@cerfacs.fr**. Applications are open until **30/11/2025**.

See you soon at CERFACS!