# JOB OFFER – POST-DOCTORAL

## High-Performance Computing for reactive Hypersonic Flows

## OFFER INFORMATION

**Reference**: AAM-2025-BOU-03
**Team:** AAM

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

**Contact person:**

- Jean-François BOUSSUGE, boussuge@cerfacs.fr
- Guillaume DAVILLER, daviller@cerfacs.fr

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

**Keywords:** CFD, Hypersonic flows, UGKS, HPC, GPU, Julia

## 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

CERFACS has long-standing expertise in the development of parallel simulation tools for multi-physics applications, primarily based on Fortran and MPI. These mature codes have enabled large-scale industrial studies in collaboration with CNES and Ariane Group. However, they have so far been restricted to low-altitude applications ($h < 60$ km), where the Navier–Stokes equations remain valid.

To address the challenges of future European space technologies – such as reusable launchers, re-entry capsules, and the behavior of space debris in the upper atmosphere – it is necessary to adopt numerical approaches valid in rarefied regimes. In close collaboration with ONERA, CERFACS is building the capability to simulate reactive multi-species flows spanning dense and rarefied regions, including strong shock interactions and complex surface effects.

The project is based on the Unified Gas Kinetic Scheme (UGKS) family, which solves a discrete form of the Boltzmann–BGK equation. UGKS provides a unified framework that bridges continuum and rarefied regimes while capturing the physics of hypersonic multi-scale flows. ONERA contributes strong expertise on UGKS methodology and hypersonic rarefied flows, while CERFACS brings advanced know-how in high-performance computing, particularly through the use of the Julia programming language and GPU architectures. This postdoctoral project will consolidate these complementary strengths and deliver a robust research platform.

## MISSION

**The postdoctoral researcher will develop a Julia-based platform for GPU-accelerated simulations of hypersonic flows, using the Unified Gas Kinetic Scheme family (UGKS, UGKP, UGKWP).** The position focuses on bridging continuum and rarefied regimes through advanced numerical methods and high-performance computing. Main responsibilities include:

- Designing and implementing efficient GPU kernels for UGKS family schemes in Julia.
- Developing a robust and scalable software framework for hypersonic multi-scale flows.
- Validating the solver on benchmark configurations covering both fluid and kinetic regimes.
- Supporting the integration of multi-species and reactive flow models.
- Collaborating with ONERA researchers and contributing to joint publications.

## 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, **hypersonic aerodynamics**, turbulence, and **kinetic/continuum numerical methods.**
- 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 hypersonic 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 and **daviller@cerfacs.fr**. Applications are open until **30/11/2025**.

See you soon at CERFACS!