

**JOB OFFER – POST-DOCTORAL**  
High-order discontinuous methods on GPU applied to combustion

**OFFER INFORMATION**

**Reference:** AAM-2025-MAR-04  
**Team:** AAM

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

**Contact person:**

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**Period:** 1 year – from January 2025 (modular)

**Salary:** 40 K€/year (gross)

**Level of education required:** PhD

**Keywords:** CFD, Spectral Difference, C++, GPU, Combustion

**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 is involved in the development of high-order numerical methods for solving the Navier-Stokes equations. The preferred approach is based on the Spectral Difference Method (SDM). With this method, the solution within each cell is represented by a high-order polynomial, thus introducing a discontinuity in the solution between cells. However, flow continuity is ensured through the use of a Riemann solver. This approach is concretely implemented in the JAGUAR solver, developed in close collaboration with ONERA. Recently, Thomas Marchal's thesis work [1] demonstrated the potential of the SDM method applied to the field of combustion.

Although JAGUAR, originally written in Fortran90 and using the MPI paradigm, is proving very effective on CPU architectures, it has the limitation of not being compatible with GPU architectures. As a result, over the past two years, Cerfacs has undertaken the porting of JAGUAR to a more modern platform capable of supporting both CPUs

and GPUs. This platform is based on the C++ programming language and uses the Kokkos Library, offering native support for both CPU and GPU architectures. At present, the platform is sufficiently advanced (for academic configurations) to start extending it to the combustion domain, which is the subject of this study.

[1] T. Marchal, H. Deniau, J.-F. Bousuge., B. Cuenot and R. Mercier. *Extension of the Spectral Difference Method to Premixed Laminar and Turbulent Combustion*. Flow Turbulence and Combustion, 111, 2023.

[2] A. Abdelsamie, G. Lartigue, M. Ihme, J. H. Chen, B. Cuenot, D. Thévenin. *Miny-Symposium on Verification and Validation of Combustion DNS*.

## MISSION

The main objective of this post-doctorate is to implement JAGUAR's developments for reactive calculations in the new C++ platform, in order to evaluate the potential of high-order simulations in combustion on GPU. As a first step, we will add the possibility of transport equations for species. This will enable non-reactive multi-species simulations. Secondly, we'll add support for source terms, enabling the simulation of reactive flows. Performance evaluation of the numerical kernel will be carried out on the Taylor-Green vortex test cases adopted by the combustion community [2]. It will probably be necessary to optimize the efficiency of the SDM approach applied to combustion for the GPU. Finally, a performance comparison between CPU and GPU will be carried out, both for a single-node and a multi-node configuration.

## DESIRED PROFILE

- PhD defended less than 3 years ago.
- The candidate must have knowledge on CFD and applied mathematics.
- In particular, skills on templated C++, GPU and reacting flows would be really appreciated.
- Candidates will be required to present their work orally and in writing in English, according to the standards expected in an international research laboratory.

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## HOW TO APPLY?

To apply, please send your CV and cover letter to [bousuge@cerfacs.fr](mailto:bousuge@cerfacs.fr), applications are open until **31/12/2024**.

See you soon at CERFACS!