

**JOB OFFER – STAGE**  
**High-Fidelity Aerothermal Simulation for Turbomachinery:**  
**Development of a Wall Law in LBM**

#### OFFER INFORMATION

**Reference:** AAM-2026-PW-01

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

**Team:** AAM

**Supervisors:**

- Paul Werner, [werner@cerfacs.fr](mailto:werner@cerfacs.fr)
- Jean-François Boussuge, [boussuge@cerfacs.fr](mailto:boussuge@cerfacs.fr)

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

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

**Key words:** LBM, Turbomachinery, Wall Modeling, Compressible Aerothermal Flows

#### 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

At the heart of the aviation sector's energy transition, CERFACS is positioning itself as a key player bridging research and innovation. This internship offers an opportunity to participate in a strategic collaboration between SAFRAN (industry) and CERFACS (research) aimed at developing the next generation of high-fidelity computational fluid dynamics (CFD) simulation tools. Joining this project places you at the interface between research and cutting-edge industrial applications, and opens privileged doors with our partners.

The design of new propulsion architectures (UHBR, Open Fan) requires predicting and controlling ever more complex aerothermal phenomena to ensure reliability and drastically improve efficiency. This includes major challenges such as cooling high-pressure turbine blades, under-cowl ventilation, and optimizing heat exchangers. Faced with these issues, traditional approaches based on commercial tools (Fluent, StarCCM+, PowerFLOW) show their limits in terms of physical accuracy and performance.

To address this need, we contribute to the development of the **ProLB** solver [1], a computational code based on the Lattice Boltzmann Method (LBM) [2]. Unlike traditional approaches that solve the Navier–Stokes (NS) equations at the *macroscopic* scale, LBM operates at a so-called *mesoscopic* scale. It models fluid behavior by simulating the motion and collisions of particle populations on a mesh. This approach, which describes the same physics as the classical equations, stands out for strategic advantages in industry: massively parallelizable, fast, and inherently unsteady.

In return, LBM shifts complexity to the physics of wall treatment. This is precisely why the refined modeling of boundary layers, and in particular the thermal transfers that occur within them, represents a major research axis to unlock the full potential of the method.

This 6-month internship at CERFACS sits precisely at this frontier: the development of a thermal wall law (wall-bounded turbulence modeling) to improve the accuracy and efficiency of ProLB for industrial aerothermal computations.

[1] ProLB site internet : <https://www.prolb-cfd.com/products/>.

[2] Krüger, T., Kusumaatmaja, H., Kuzmin, A., Shardt, O., Silva, G., Viggien, E.M., The Lattice Boltzmann Method: Principles and Practice, 2017, <https://doi.org/10.1007/978-3-319-44649-3>.

## MISSION

Within CERFACS's AAM research team, your role will be to implement a thermal wall law in the ProLB solver in order to **optimize the prediction of heat transfer**. This work will be broken down into several stages:

1. **Familiarization and literature review:** Getting up to speed on the initial work carried out on thermal wall laws in LBM [3, 4, 5, 6].
2. **Development and implementation:** You will develop and implement the selected approaches in **C++** within the ProLB solver. The goal will be to formulate a thermal wall law that improves upon what already exists in the solver to ensure greater robustness and accuracy.
3. **Validation:** After validation on academic test cases, you will apply your development to the reference case of the **LS89 turbine blade cascade** [6]. This case, known for its complexity (transonic flow, turbulence sensitivity) and the richness of its experimental data, will serve as the industrial validation milestone for your work.
4. **Critical analysis:** Careful evaluation of the results obtained on the LS89 case. You will quantify accuracy on heat fluxes, model robustness, and performance gains (computational cost vs. accuracy) relative to existing approaches.

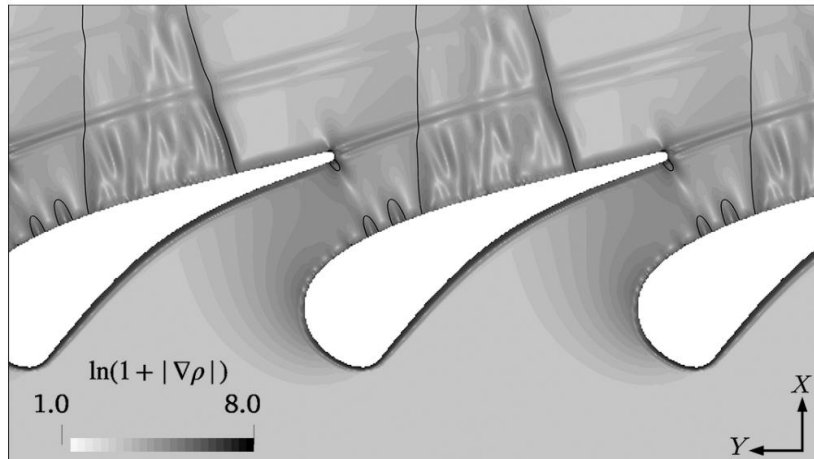


Figure 1 : LS89 numerical Schlieren field [6]

You will work closely with researchers and engineers and contribute directly to the evolution of a strategic simulation tool. **This final-year internship may lead to a CIFRE PhD proposal with our partner SAFRAN as a continuation of the work carried out.**

[3] Kader, B.A. "Temperature and Concentration Profiles in Fully Turbulent Boundary Layers." International Journal of Heat and Mass, 1981, [https://doi.org/10.1016/0017-9310\(81\)90220-9](https://doi.org/10.1016/0017-9310(81)90220-9).

[4] P. Werner, Aerothermal Lattice-Boltzmann Modeling of Bore-Cooling Cavities in High-Pressure Compressors, PhD Thesis, Aix-Marseille Université, 2024, [researchgate.net/396047128](https://researchgate.net/396047128)

[5] Y. Tamaki, M. Harada, and T. Imamura, Near-Wall Modification of Spalart–Allmaras Turbulence Model for Immersed Boundary Method, AIAA Journal, 2017, <https://doi.org/10.2514/1.J055824>.

[6] Tsetoglou, I., Zhao, S., Jacob, J., Boivin, P., Lattice-boltzmann modelling of internal compressible flows: application to the transonic LS89 cascade, ASME Turbo Expo, 2025, <https://doi.org/10.1115/GT2024-123051>.

## DESIRED PROFILE

We are seeking a final-year engineering student or a Master's 2 student, with a specialization in **fluid mechanics, aerothermal science, or scientific computing**, and a strong interest in research. A **Research Master's** profile is particularly welcome given the potential continuation into a PhD.

The following skills and qualities are expected:

- **Foundational knowledge:** Strong knowledge of computational fluid dynamics (CFD) and heat transfer is essential. A good understanding of turbulence modeling approaches (RANS, LES) and ideally wall laws is a valuable asset.
- **Programming skills:** Proven experience in programming is required (the C++ language will be used for development within the ProLB solver). Knowledge of Python for data analysis and scripting is a plus.
- **Personal qualities:** Scientific rigor, autonomy, curiosity, and the ability to take initiative are essential qualities to integrate into our team and successfully carry out this research mission.
- **Additional assets:** Knowledge of and interest in the LBM method is an advantage for a quick ramp-up on the topic.
- **Communication:** As the internship takes place in an international research context, strong command of English (reading, writing, speaking) is necessary for the literature review, report writing, and presenting your work.

#### WHAT WE OFFER AT CERFACS

- Broad access to technology, a rich interpersonal environment, in-house skills recognized nationally and internationally.
- 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 [werner@cerfacs.fr](mailto:werner@cerfacs.fr) , applications are open until 31/12/2025.

See you soon at CERFACS!