


PhD offer (F/H)

Title	Characterization of turbulent cavitating flows in the wake of a two-dimensional obstacle	
Contact	Henda DJERIDI henda.djeridi@legi.grenoble-inp.fr	Damien COLOMBET Damien.colombet@legi.grenoble-inp.fr
	Eric GONCALVES Eric.goncalves@ensma.fr	Zhujun HUANG Zhujun.huang@legi.grenoble-inp.fr
Place	Laboratoire LEGI UGA/G-INP 1209-1211 Rue de la Piscine 38400 Saint Martin d'Hères https://www.legi.grenoble-inp.fr/web/	
		
Length	36 month, start 2026	

Context and motivation :

Compressible multiphase flows play a key role in a large number of engineering applications for the energy and transport sectors: nuclear power plants and safety, hydroelectric power plants that operate in non-design conditions to extend the operational scope, naval propulsion, CO2 capture and storage for carbon neutrality projects, hydrogen technology for decarbonized aviation, cooling systems based on two-phase flows, detonation engines, fuel injectors as well as chemical processes (water treatment), etc. The physical modeling of these flows encounters many obstacles due to the difficulty of modeling heat and mass transfers between phases that can occur outside thermodynamic equilibrium, the great variation in thermodynamic properties (close to the vacuum up to the critical point), as well as complex interaction with turbulence, all in the presence of strong pressure waves or shock waves. This doctoral thesis aims to provide some of the answers necessary for understanding cavitating turbulent flows and inherent interactions through reference experiments using state-of-the-art metrologies. (optical probe, PIV, fast camera visualization, Tomography X) which will be compared with high-performance digital simulations carried out by the project partners.

Schedule:

The experiments will be carried out in the hydrodynamic cavitation tunnel of LEGI which has a test section in which different bodies of type profile NACA0015 (see figure) and cylinder will be installed. This tunnel also has an incidence system for the profiles as well as a regulation system allowing to modify the speed of the flow and the pressure in the test section, allowing to reach a range of Reynolds number of 104-106 and a pressure range of 4 bar to 50 mbar, thus leading to the obtention of numerous flow topologies in the presence of the vapor phase. We will initially focus on examining the cavitation instabilities around the different profiles to highlight the bifurcations of flow states as a function of hydrodynamic parameters. In order to analyze the dynamics of the liquid phase and the turbulence of the flow, we propose to perform velocity field measurements using high-rate stereoscopic PIV, time and space resolved, to obtain the three-component velocity field. For the vapor phase, the hydrodynamic tunnel will be equipped with optical Doppler probes to obtain the local vacuum rate, the velocity of the vapor phase, the spatial distribution and, if necessary, the size of the bubbles in the cavitation pocket or vortex structures in the wake of the cylinder. Finally, to obtain the dynamics of the vapour phase, X-ray absorption measurements will have to be carried out using an

X-ray source, an image amplifier and a high-speed camera. Finally, a final phase of the thesis work may consist in using ultrasound tomography techniques (development at LEGI) which will be compared to radiographic or local measurements to complete the information on the dynamics of the different phases present in the flow around obstacles.

A first objective will be to better understand how turbulent structures transport the vapor phase, and how the presence of the vapor phase can modify the dynamics of turbulence and its characteristic scales, so that these can be taken into account in digital models. A second objective will also be to provide a better understanding of the interaction between phase change (evaporation/condensation) and turbulence. The results obtained on the canonical case of the cylinder will then be compared with those obtained numerically by the project partners in order to carry out validations of LES-type simulations (Pprim and Icube Laboratories).

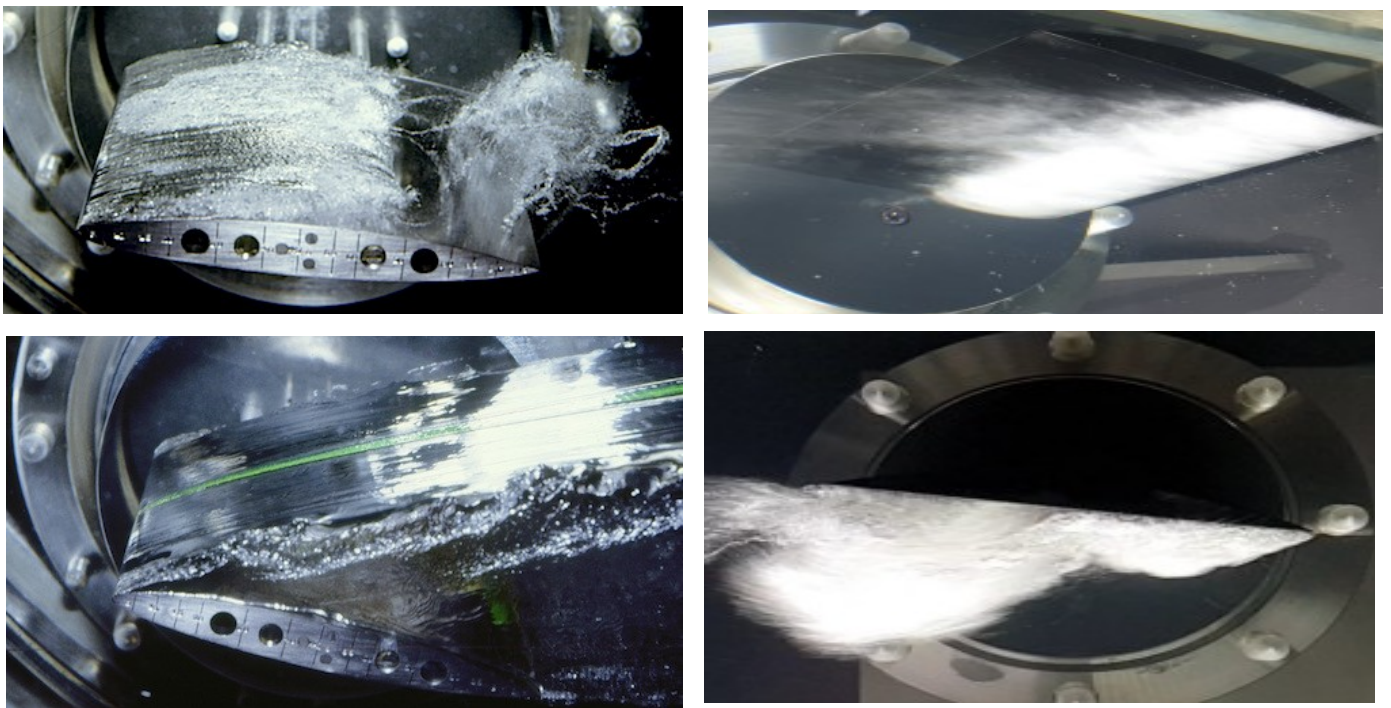


Figure 1: Example of cavitating flows developing around a NACA profile (sources LEGI / J.P. Franc & H. Djeridi); at the top / low angle of incidence: partial cavitation with the formation of a vapor pocket attached to the leading edge of the profile and periodic releases of two-phase structures; at the bottom / high angle of incidence: supercavitation regime with the formation of a vapor pocket that remains over the entire chord of the profile.

Work environment:

The person who will be recruited will join the EDT team (Diphasic and Turbulent Flow) in partnership with the Energy team of the LEGI of the University Grenoble Alpes/ Grenoble INP. The work will be based on an experimental approach for the study of turbulent flows in the presence of a disperse phase of vapor type (phase change). The work will be carried out in the hydrodynamic tunnel of LEGI which is equipped with state-of-the-art metrological tools (PIV, StéréoPIV, optical probe, RX metrology). Comparisons with numerical studies will be carried out in collaboration with the Pprime laboratory of the University of Poitiers and the ICube laboratory of the University of Strasbourg. This consortium is defined as part of a national collaborative project funded by the National Research Agency, ANR COMPET ANR-25-CE51-6855, which is led by the Pprime laboratory. Strong

interactions with all project stakeholders will allow the candidate to evolve in a scientifically rich environment.

Expected skills:

We are looking for a highly motivated person (F/H), holder of a Master's degree or an engineering diploma with very solid knowledge in fluid mechanics or physics and instrumentation. The successful candidate must have a strong interest in experimental research. A good mastery of post-processing tools (Matlab, python ...) is recommended. The recruited person will be heavily involved in disseminating results through progress reports, publications in peer-reviewed journals and presentations at international conferences. Therefore, a great capacity for communication and writing in English and French is necessary.

Remuneration:

Annual salary: about €24,500/ including the contribution to Social Security.
Start of the doctoral contract scheduled for 2026.

Application:

Documents to be provided in the application file:

- Curriculum Vitae, Cover Letter
- Transcript of grades (even partial) for the last two years
- Contact details of two scientific referents

The application file is to be sent jointly to Henda DJERIDI, Damien COLOMBET and Zhujun HUANG.

Bibliographic references

- [1] D. Colombet, D. Legendre, F. Risso, Cockx, Guiraud, "Dynamics and mass transfer of rising bubbles in a homogeneous swarm at large gas volume fraction", *J. Fluid Mechanics*, 763, pp.254–285, 2015.
- [2] G. Maurice, N. Machicoane, S. Barre, H. Djeridi, "Coupled X-ray high-speed imaging and pressure measurements in a cavitating backward facing step flow", *Phys. Rev. Fluids*, 6, 044311, 2021.
- [3] S. Prothin, J.Y. Billard, H. Djeridi, "Image processing using proper orthogonal and dynamic mode decompositions for the study of cavitation developing on a NACA0015 foil", *Exp. Fluids*, 57:157, 2016.
- [4] L. Menez, J. Decaix, P. Parnaudeau, E. Goncalves, "Numerical investigation of unsteady cavitating flows in the wake of a cylinder", In 15th Int. Conf. on Hydrodynamics ICHD, Sept. 2-6, Roma, Italy, 2024.