PhD Position to work in the challenging MSCA Doctoral Network ABHSSYS.

ABHSSYS (Acoustic Black Holes for Silent SYStems, Grant agreement ID: 101227712) is a European Doctoral Network funded by the Marie Skłodowska-Curie Actions (MSCA), dedicated to advancing innovative solutions for vibration and noise control in lightweight structures (https://cordis.europa.eu/project/id/101227712). The project focuses on the development of Acoustic Black Hole (ABH) technologies, an emerging concept that enables efficient damping of vibrations and sound while reducing mass and material use. Bringing together leading academic laboratories and industrial partners across Europe, ABHSSYS will train a new generation of researchers at the interface of wave physics, acoustics and engineering. Through interdisciplinary research, international mobility and close collaboration with industry, the programme aims to accelerate the transfer of ABH technologies towards real-world applications in sectors such as aerospace and energy.

Application Deadline: August 10th 2026.
Expected starting date: Between October 1st 2026 and February 28th 2027.

Title of the PhD project:

Vibroacoustic control of fluid-filled pipes with add-on acoustic black holes

Description:

The propagation of noise and vibrations in hydraulic systems is a critical issue across numerous industrial sectors, including building services, energy, and aerospace. Noise sources are primarily linked to hydraulic pumps generating pressure pulsations in the circuit. Structural vibrations can lead to mechanical fatigue, particularly at pipe junctions, with potentially serious consequences for the operation and safety of hydraulic installations. Furthermore, acoustic waves propagating inside the pipe can be a source of noise disturbance, especially in building-related applications. Developing effective devices to control the propagation of vibrations and acoustic waves in pipes is therefore of primary importance.

The Acoustic Black Hole (ABH) concept [1] appears as a promising approach in this context. It has been investigated in laboratory settings by various research groups over the past decade. Through specific geometric design, the ABH aims to slow down wave propagation and concentrate energy in a specific zone where it can be dissipated as heat through thermoviscous or viscoelastic effects. Two main types of ABH exist:

- *Structural ABHs* slow down the propagation speed of flexural waves by reducing the thickness of a structure according to a power-law profile, with a viscoelastic element added at the tip to promote energy dissipation.

- *Sonic ABHs* [4, 5] slow down acoustic wave propagation using a system of concentric rings with progressively smaller apertures; absorbing materials at the termination or micro-perforated panels are used to enhance thermoviscous losses.

While existing literature on ABHs largely focuses on applications in air — including sonic black holes in air-filled ducts [2, 3] and structural ABHs embedded in beams, plates and shells [4, 5] for vibration damping — the case of hydraulic piping introduces an important additional complexity: a strong fluid-structure coupling between the elastic pipe wall and the heavy internal fluid [6]. Depending on the frequency range and the circumferential modes involved, vibroacoustic energy can be distributed between structural and acoustic medium in ways that differ fundamentally from the light-fluid case.

In this context, this thesis proposes to study the impact on vibroacoustic wave propagation of ABH devices mounted on a heavy fluid-loaded pipe. The work will consider structural ABHs attached to the outer surface of the pipe and/or sonic ABHs inserted between two pipe sections.

The research programme is defined as follows:

- realization of a bibliographic review;
- familiarisation with simple models of structural and sonic ABHs;
- development of an analytical model of a fluid-filled cylindrical shell and analysis of propagation modes in function of the frequency range;
- selection of one ABH concept for the following of the study;
- development of numerical vibroacoustic models representing the ABHs coupled to heavy-fluid-filled cylindrical shells (fully finite element models (FEM) or/and hybrid finite element /analytical models);
- parametric analysis of ABH performances on the vibroacoustic propagation as a function of frequency range and circumferential modes;
- experimental validation on a test case in a laboratory (during the 6 months secondment at Grundfos, a world-leader pump manufacturer located in Bjerringbro in Denmark);
- writing of the thesis manuscript.

References:

[1] A. Pelat, F. Gautier, S.C. Conlon, F. Semperlotti, The acoustic black hole: A review of theory and applications, Journal of Sound and Vibration, 476 (2020) 115316.
[2] T. Bravo, C. Maury, Broadband sound attenuation and absorption by duct silencers based on the acoustic black hole effect: Simulations and experiments, Journal of Sound and Vibration, 561 (2023) 117825.
[3] C. Maury, T. Bravo, F. Ali, Micro-perforated raimbow-trapping silencers with broadband sound dissipation and reduced drag under low-speed grazing flow, Journal of Sound and Vibration, 616 (2025) 119228.
[4] J. Deng, O. Guasch, L. Maxit, L. Zheng, Reduction of Bloch-Floquet bending waves via annular acoustic black holes in periodically supported cylindrical shell structures, Applied Acoustics, 169 (2020) 107424.
[5] D. Martins, M. Karimi, L. Maxit, Semi-analytical formulation to predict the vibroacoustic response of a fluid-loaded plate with ABH stiffeners, Thin-Walled structures, 205 (2024) 112539.
[6] C.R. Fuller, F.J. Fahy, Characteristics of wave propagation and energy distributions in cylindrical elastic shells filled with fluid, Journal of Sound and Vibration, 81 (1982) 501-518.

Hosting institution:
INSA Lyon is France's leading post-baccalaureate engineering school**.** Diversity, excellence, open-mindedness and innovation are the driving forces behind INSA Lyon model which, since 1957, has promoted a vision of an avant-garde engineer, more than ever modern today. INSA Lyon boasts [23 research laboratories](), more than 600 researchers and teacher-researchers, 650 PhD students, and over 1 000 industrial contracts with the socio-economic world.

You will be hosted in the laboratory of vibration and acoustics (LVA) (http://lva.insa-lyon.fr/) which is member of the laboratory of excellence CeLyA, Centre Lyonnais of Acoustics (https://celya.universite-lyon.fr/) and is part of the Carnot Institute « Engineering at Lyon » (http://www.ingenierie-at-lyon.org). The LVA's research activities have always been carried out to monitor and anticipate challenges facing companies in industry. These activities are based on four main topics: vibro-acoustic modelling, identification of sources, noise and vibration perception, and monitoring, diagnostics and non-destructive testing

You will be supervised by Laurent Maxit and co-supervised by Oriol Guasch from Universitat Ramon Llull (Spain) and you will also work with Kim Hedegaard Pekruhn from Grundfos (Denmark) and Jie Deng from Universitat Ramon Llull (Spain).

The PhD diploma will be delivered by INSA Lyon.

Profile:
If you recognize yourself in the story below, then you have the profile that fits the project and the research group:

- I have **a master degree in mechanical engineering, acoustics, physics or mathematics** and performed above average in comparison to my peers and I am not in possession of a doctoral degree at the date of recruitment (mandatory requirement)
- **I haven't had residence or main activities (studies or working position, even remote) in France for more than 12 months in the last 3 years at the date of recruitment (mandatory requirement).**
- During my courses or prior professional activities, I have gathered some basic experience with the physical principles of structural dynamics and (vibro-)acoustics and the related numerical modeling techniques, such as the Finite Element Method (FEM), as well as numerical optimization, manufacturing methods, and/or I have a profound interest in these topics. Experience with knowledge of metamaterials and passive control of sound and vibration is considered as a bonus.
- I am proficient in written and spoken English.
- I feel comfortable to work as a team member and I am eager to share my results to inspire and being inspired by my colleagues.

- **During the course of my PhD, I will be hosted by the industrial partner involved in the thesis for a 6 months secondment in Grundfos, Denmark**.
- As a Doctoral Candidate I will perform research in a structured and scientifically sound manner.
  I will read technical papers, understand the nuances between different theories and implement and improve methodologies myself.
- Based on interactions and discussions with my supervisors and the colleagues in my team, I will set up and update a plan of approach for the upcoming 1 to 3 months to work towards my research goals. I will work with a sufficient degree of independence to follow my plan and achieve the goals. I will indicate timely when deviations of the

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plan are required, if goals cannot be met or if I want to discuss intermediate results or issues.

- In frequent reporting, varying between weekly to monthly, I will show the results that I have obtained and I will give a well-founded interpretation of those results. I will iterate on my work and my approach based on the feedback of my supervisors which steer the direction of my research.
- In the framework of the DN-ABHSSYS project, I will participate to the network training schools and I will present my work progresses in front of the supervisory board every 6 month.
- During my PhD I want to grow towards following up the project that I am involved in and representing the research group on project meetings or conferences. I see these events as an occasion to disseminate my work to an audience of international experts and research colleagues, and to learn about the larger context of my research and the research project.

Offer:

◦ A remuneration package competitive with industry standards in France: You will receive a monthly gross salary of 3390 €. In addition to the salary, you will receive a mobility allowance of 710 €. The net income (salary + mobility allowance) will be lower since a deduction of income tax, the social contributions, and other permitted deductions need to be considered. If applicable, a family allowance will be added. The monthly gross salary including the family allowance will be of 3860 €. The family allowance may be granted during your thesis if your circumstances change.

◦ An opportunity to pursue a PhD in Acoustics, typically a 3 years trajectory, in a stimulating and ambitious research environment.

◦ Ample occasions to develop yourself in a scientific and/or an industrial direction with the European research group.

Recruiting procedure:

Each application will be evaluated by a jury of 5 members composed of Laurent Maxit (INSA Lyon), Oriol Guasch (Universitat Ramon Llull), Valérie Kaftandjian (INSA Lyon), Kim Hedegaard Pekruhn (Grundfos), Jie Deng (Universitat Ramon Llull).
2 selection rounds will be organized.
1/ A short list of candidates will be pre-selected based on eligibility criteria, CV and motivation letter.
2/ Selected candidates will be interviewed remotely.

Recruitment will be effective once every eligibility proof will be provided to the recruiting institution.

We look forward to receiving your application including a letter of motivation, CV, diplomas with transcripts and contact details of two referees on laurent.maxit@insa-lyon.fr.

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