

Post-doc proposal Active mute for brass instruments

Active control applied to industrial problems has been studied since the 1980s and applications exist today in different fields (headphones, ventilation, etc.). The active control of musical instruments has been studied since the 2000s on string or percussion instruments, however its application to wind instruments is rarer in the literature, due to the complexity of radiation of side-hole instruments or due to the high sound levels generated by brass type instruments, which requires the use of specific transducers.

The LAUM (Laboratoire d'Acoustique de l'Université du Mans, <https://laum.univ-lemans.fr>) has been interested for some years in the active control applied to brass instruments, in particular in the optimisation of the transducers used to achieve this control. To date, a thesis has focused on the feasibility of such a control using an array of loudspeakers placed near the bell of a trombone. The results obtained show that power control is possible up to about 2 kHz and that this control has little effect on the input impedance of the instrument (and therefore on the musician's playing). Directional control is also possible up to 1500 Hz. The input impedance is little changed in the case where the control attempts to reproduce a rather weak target directivity.

The proposed post-doctoral work builds on the results obtained in this thesis (defense scheduled in November 2022).

Objectives : The objective of the proposed work is to study the feasibility of an active control on a brass instrument using an electroacoustic device placed inside and/or outside the bell of the instrument. It aims to investigate the possibility of controlling the acoustic power and directivity of the instrument without altering the input impedance of the resonator.

The work will be carried out in collaboration with the CRASH-UdeS team (Centre de Recherche acoustique-signal-humain de l'Université de Sherbrooke, (<https://www.usherbrooke.ca/crash-udes/fr>)) working on active control.

Missions and activities assigned to the post-doc candidate:

The work to be carried out concerns the analytical and/or numerical modelling (BEM / FEM) of the system studied, the development of a prototype and a measurement bench, and the characterization of the performances in terms of radiated power, directivity and impedance. The envisaged stages of the work are :

- 1- Bibliographical study and appropriation of the subject, more specifically on an internal control;
- 2- Study of an internal mute placed in the bell, effect on the acoustic power and on the input impedance of the instrument;
- 3- Dimensioning and realization of an internal mute prototype;
- 4- Implementation of the systems (internal + external) with real time control;

5- Development and implementation of the algorithms on a real time controller.

6- Objective and subjective experimental evaluation of the prototype.

Organisation of the post-doctorate

- The first six months will take place in Le Mans and will focus on the appropriation of Colas Cavallès' thesis results (external mute), the development (simulation and prototype) of an internal mute.
- The last six months will be spent at CRASH-UdeS: development of the experimental device including the control system, choice of sensors and their position, development and real-time implementation of the control algorithms (under Matlab/Simulink™ with a Speedgoat™ rapid prototyping platform, then deployment on a low-latency real-time platform such as Bela™) and objective evaluation of the performances.

During the stay at CRASH-UdeS, exchanges are envisaged with the [CIRMMT](#) and the [UdeS School of Music](#). It would be possible to present them the prototype for a subjective evaluation by a musician, and to envisage future developments to this work such as uses related to the modification of the timbre of the instrument (search for new sonorities).

Supervision

LAUM : Bruno Gazengel, Christophe Ayrault and Manuel Melon

CRASH - UdsS : Philippe Micheau and Olivier Robin.

Net salary

The net salary per month is around 2200 €.

Communication:

The prototype could be presented at the Biennial "Le Mans Sonore 2024".