

# Modelling of acoustic barriers.

## Application of sonic crystals to the train noise.

**INNOVATION & RECHERCHE**

CLAIRE CHAUFOUR

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# Modelling of the acoustic attenuation by sonic crystals. Application in an acoustic barrier for the train noise domain.

## Context

One way of protecting the people from the train noise is by placing screens along the railway tracks.

The sonic crystals [1] are inhomogeneous media consisting of a periodic arrangement of scatterers in a fluid medium. The absence of propagative modes of acoustic waves for such structures, in a given frequency range, is referred to as a band gap (BG [2]). The central frequency of this bandgap depends on the geometrical characteristics of the array.

It is possible to optimize the acoustic performance (increasing the attenuation bandwidth, reduction of sensitivity to angle of incidence, etc. [3]) by the addition of resonators [4] or porous materials [5]. The combined use of these properties opens new perspectives for the definition of acoustic screens based on sonic crystals.

[1] R. Martínez-Sala, et al., Nature, 378, (1995).

[2] J. V. Sánchez-Pérez, et al., Phys. Rev. Lett., 80, (24), 5325, (1998).

[3] V. Romero-García, et al. Jour. Appl. Phys. 110, 149041, (2011).

[4] V. Romero-García, et al., J. Sound Vib., 332, 184, (2013). C. Lagarrigue, et al., J. Acous. Soc. Am., 133, 247, (2013)

[5] O. Umnova, et al. J. Acoust. Soc. Am., 119, (1), (2006).

## Problematic

SNCF as the manager of the national rail network is obliged to respect the regulations in force concerning the exposure to the noise of the residents. The critical life cases are varied, and involve, depending on the case, sources of railway noise different in terms of location, and emission spectra.

Acoustic track-side screens are one of the traditional devices used to reduce the acoustic impact of rail traffic.

The idea that we wish to study through this Master Thesis is the possibility of using sonic crystals for a case of railway application. This approach is part of a research and innovation work in the field of acoustic barriers: finding, optimizing, developing new concepts adapted to railway constraints and needs.

## Tasks

The particularity of this Master Thesis is that it will be realized on two sites:

- At the Laboratory of Acoustics of the University of Maine (LAUM): LAUM has developed a strong expertise on the subject of sonic crystals.
- At the SNCF Innovation & Research department, where the research and prospective work is carried out on behalf of the SNCF group. Different areas of expertise are present: acoustics, mechanics, mathematics, computer science, design, energy, etc.

Nevertheless, the candidate will be mainly based in Le Mans, with the LAUM research team. Regular visits will be planned on the I & R SNCF site.

The main task of the candidate will be to use the existing knowledge and the numerical models developed by the LAUM to the case of railway application in question, taking into account the following constraints and input data:

- Spectra of railway sources
- Their directivities
- Constraints on the use of screens in the vicinity of tracks and rolling stock

The ultimate objective will be to identify numerically one or more optimized designs of acoustic screens, depending on the situations in which they are used, which integrate the most powerful characteristics with respect to the problem posed, while respecting the constraints.

To achieve this, a "Bottom Up" methodological approach will be implemented:

- 1- Wide band attenuation with omnidirectional source –
- 2- Consideration of directivity
- 3- Taking into account the specificities of the actual railway sources

### **Skills of the candidate**

The candidate, at the BAC + 5 level, must demonstrate strong knowledge in the following areas:

- Physical acoustics
- Acoustic propagation
- Materials science (eg porous materials)
- Scientific computing (analytical, numerical (FEM / BEM methods))

### **Particularities of the Master Thesis**

The internship will be at least of 5 months.

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The monthly remuneration amounts to 900 euros brut.

The candidate will have access to the circulation facilities of the SNCF staff on the national network, which will enable him easily to make the journeys between Paris and Le Mans.

For information about personal journeys: the trainee will benefit from the circulation facilities, ie free of charge on the entire French rail network (excluding Thalys, Lyria, etc.). However, he will have to pay a booking fee on compulsory reservations (TGV), ranging from € 1.5 to € 13.9 (peak period).

Please send CV and cover letter by e-mail to the address indicated at the beginning of the document. A physical or telephone appointment may be arranged as required