Development Project: “Advanced Engineering Applications of Acoustic Non-Linear Energy Sinks“. OBJECTIVES by 31/12/2018.

I remind here that the objective of this Development Project is to study, design and test acoustic nonlinear energy sinks (A-NES). A-NES are dynamical systems where large quantities of acoustic power can be transferred to, thus either dissipated into heat or converted into electric power. Therefore, A-NES can be designed for sound absorption or energy harvesting purposes. The research aims at finding:
1. A-NES for high absorption of low frequency sound (which is critical for human comfort).
2. A-NES for high efficiency acoustic-to-electric power conversion to be used in harvesters and thermoacoustic devices (i.e. engine and refrigerators based on acoustic waves).

By the end of this year, the main objectives are two, respectively related to the two points above mentioned:

a. Using non-linear techniques for the acoustic characterization of A-NES designed for noise reduction in waveguides (e.g. in industrial exhaust lines or in HVAC systems) where high levels of acoustic excitations are present. In Fig.1, a scheme and an image of the setup are shown, together with the corresponding mechanical analogy. Here the sound excitation is “artificially” provided by an external loudspeaker (LS). As shown in Fig.2, when the acoustic excitation is increased above a certain threshold, a large drop of the acoustic pressure is measured in the tube instead of a further increase of sound level. This means that the acoustic power is transferred to the A-NES (a membrane, in this case), which is now activated and performs large amplitude vibrations, thus providing high sound absorption.
b. Set-up of a thermo-acoustic engine where A-NES can be used as energy harvester to increase the acoustic-to-electric conversion efficiency. A thermo-acoustic device can be used for co-generation purposes (e.g. conversion of heat from exhaust to electric energy) or for space applications (e.g. light weighted refrigeration devices without moving parts). The concept of thermo-acoustic engine itself is not new and the Fig.3 shows a didactical application of it. Here, a heat source is focused on one side of a porous stack, where the thermal-to-acoustic energy conversion takes place, resulting in high level of sound excitations in the main tube, capable of moving a piston. The novelty which is aimed in this research is realizing a thermo-acoustic engine for cogeneration purposes of the type in Fig.4, where a A-NES is used to amplify the oscillation of a mass piston and a piezo-electric device is then used for the acoustic-to-electric power conversion. The realization of the engine is planned for this year. The use of A-NES oscillation amplifier is planned for the next year.

Industrial applications of A-NES require further studies and developments, thus they are not immediate. However, A-NES absorbers have high potentiality for publication in top-ranked journals and this is on main focus at the present. On the other hand, the fascinating field of thermo-acoustic devices can attract the interest of engineering students by now and inspire new *start-ups* in the green energy arena. These devices are relatively easy to realize and the hosting institution can benefit from a research focussed on *hot topics* such as energy harvesting and engine efficiency.

Fabio Auriemma, Dep. of Mechanical and Industrial Engineering, School of Engineering, Tallinn University of Technology, Estonia.

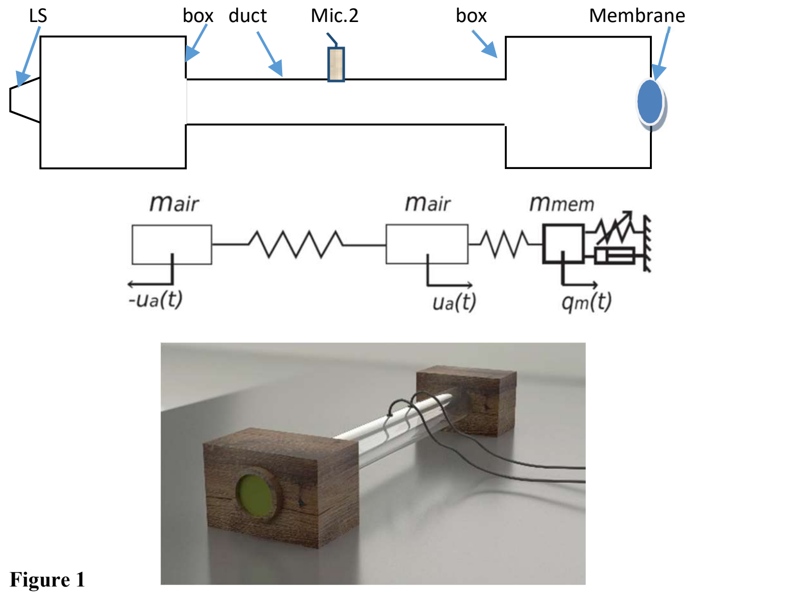

Figure 1

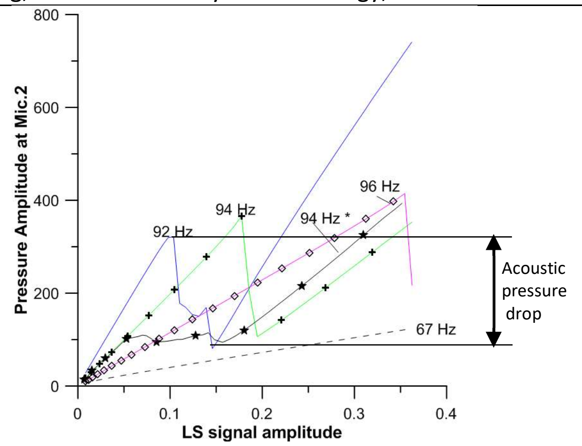

Figure 2

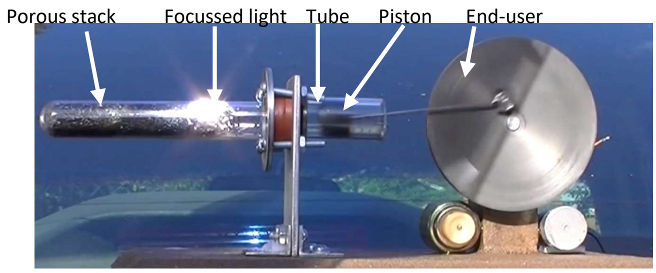

Figure 3

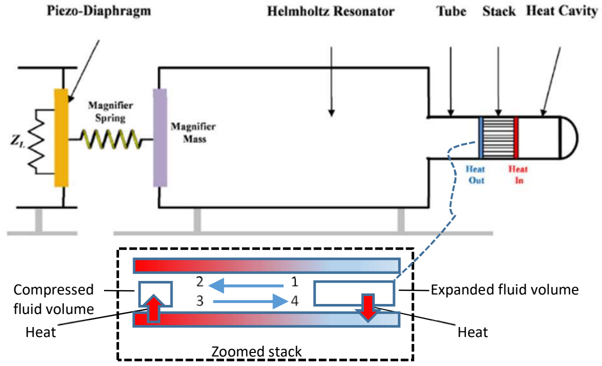

Figure 4