

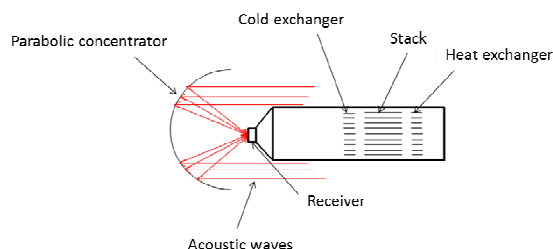
# Development of an efficient capture and amplification system of sound waves

## Context

### Production of Refrigeration

#### Conventional Refrigeration

- 15% of the world's electricity production
- Commonly used refrigerant (R132b) is toxic



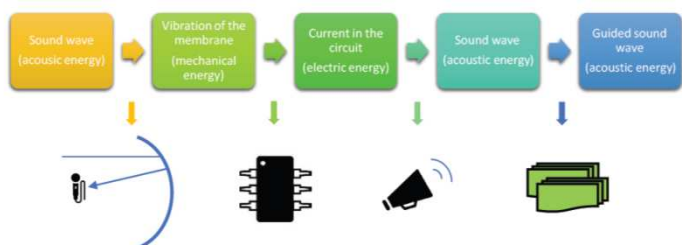
#### Objective:

- The aim is to convert the harmful noise of a generator into energy which makes the "self-refrigeration" possible
- Two technical problems:
  1. Collection, amplification, and guidance of sound waves,
  2. Propagation of acoustic waves in the thermo-acoustic machine and the generated transfer of heat.

#### Alternative: Thermoacoustic Machine



## Collection, amplification and guidance of sound waves

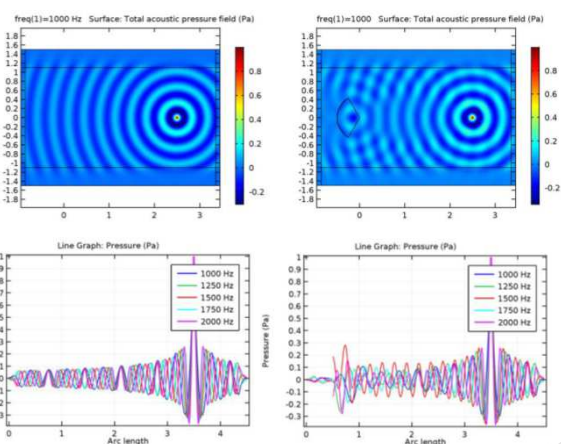


- Reception of sound waves by using a parabola and a microphone
- Application of a specific circuit to amplify the sound signal obtained by the microphone
- Guidance the amplified signal (waves) to the thermo-acoustic machine

## Parabolic Receiver

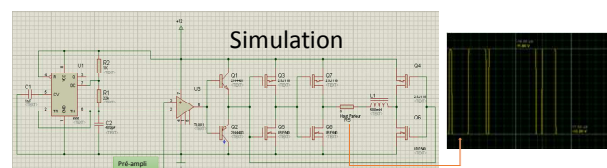
Without

With

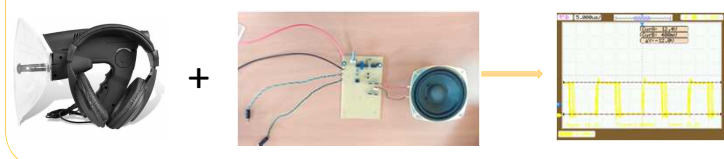


## Amplifier

- power amplification circuit between the microphone and loudspeaker to get a higher input power



## Experiments



## Metamaterial

### 3D View Of Acoustic Metamaterial

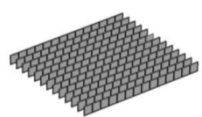
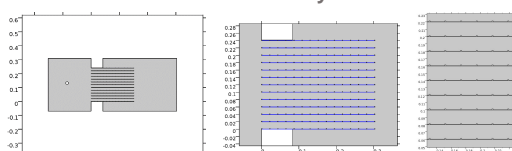


Plate Dimension: 2X2 cm  
Plate Thickness: 0.3 mm  
Plate Density: 591 kg/m<sup>3</sup>  
Plate Young's Modulus: 2.73 GPa  
Plate Poisson Ratio: 0.33

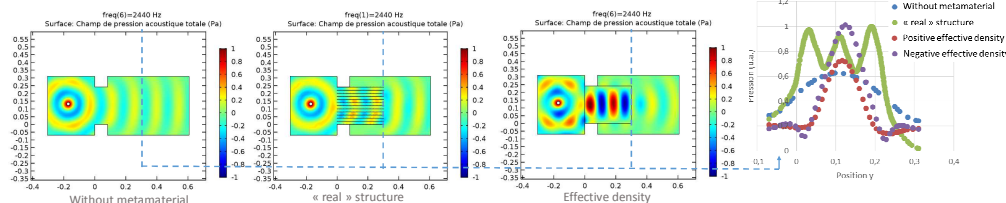
Sample Dimension: 30.2X27 cm  
Frame Separation: Distance 2 cm  
Frame Thickness: 0.16 cm  
Frame Material: Aluminum  
Acoustic Source Position 20 cm ahead of sample

Simulation

### 2D Geometry



### Results



## Conclusion

1. Parabolic receiver: credible for concentration and capture of acoustic waves
  - parametric studies to optimize the design of the parabola
  - influence of the choice of parabola material to increase its reflectivity
2. Electronic amplifier: active amplifier
3. Metamaterials: change the propagation of waves, « physical » amplifier, don't consume extra electrical power
  - The 2D simulation is sufficient to represent the propagation of sound waves through the metamaterial
  - The final model must couple two different physics, namely acoustics and solid mechanics
  - The effective media are interesting in order to simplify the modeling, the mesh size and thus to reduce the calculation times