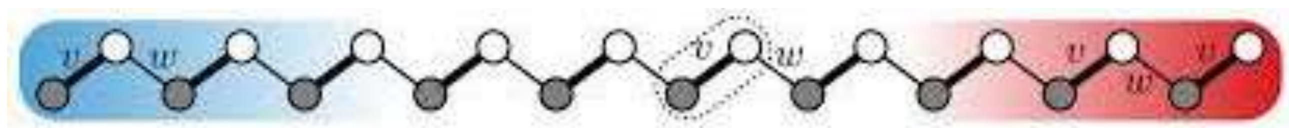
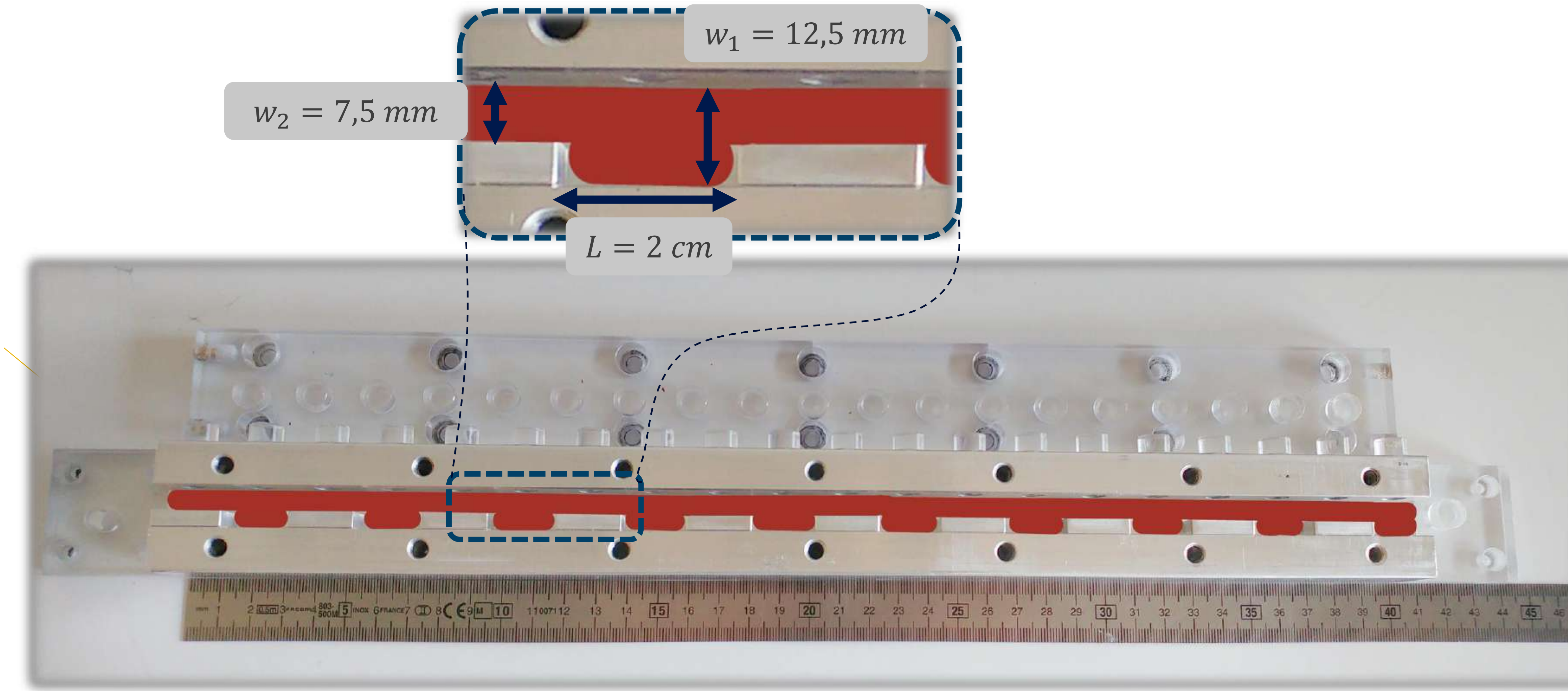


1D SSH acoustic system

Audrey Sivadon
Vassos Achilleos
Vincent Pagneux
Georgios Theocharis
Olivier Richoux

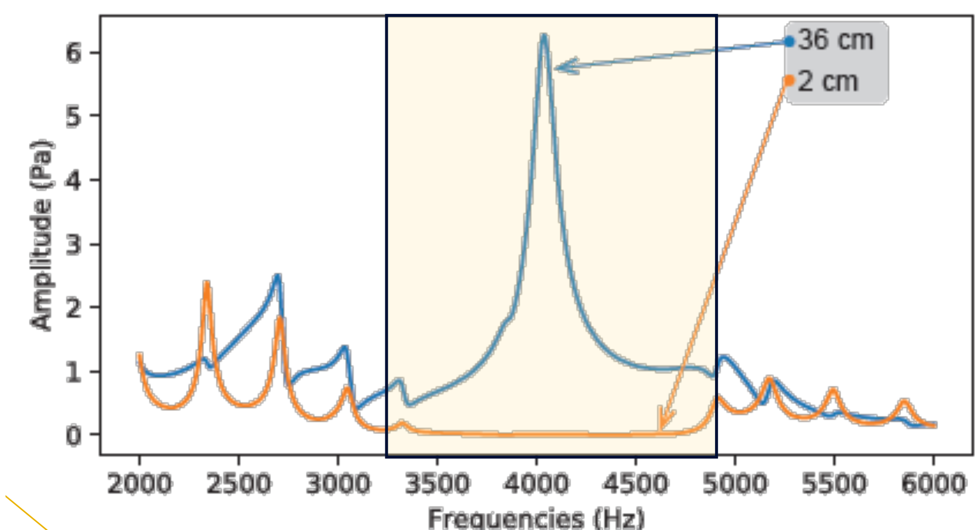
LAUM

Experimental set-up

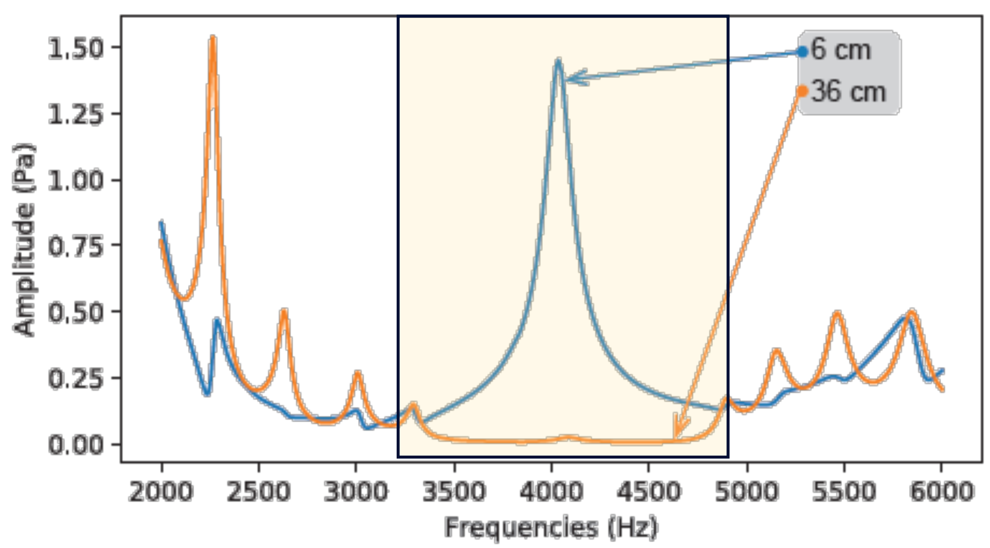


Experimental results

Closed system

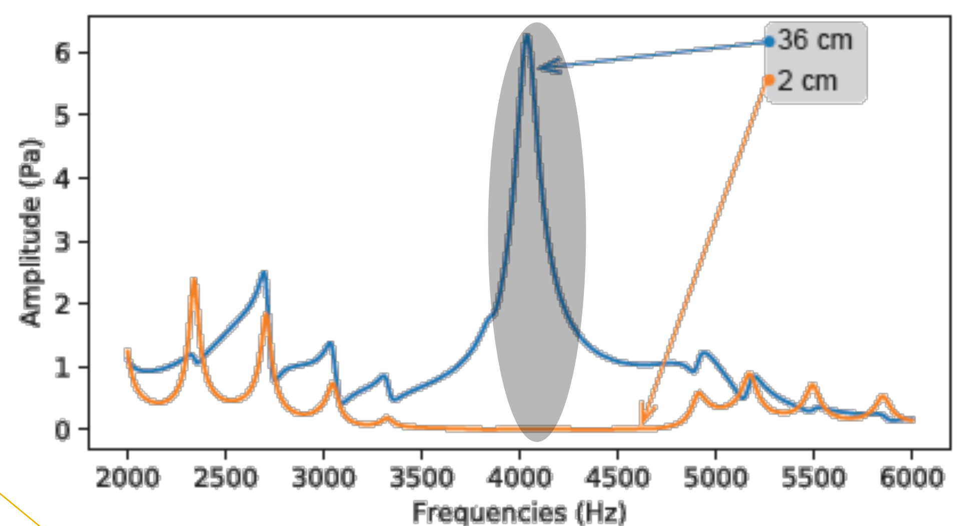


Open system

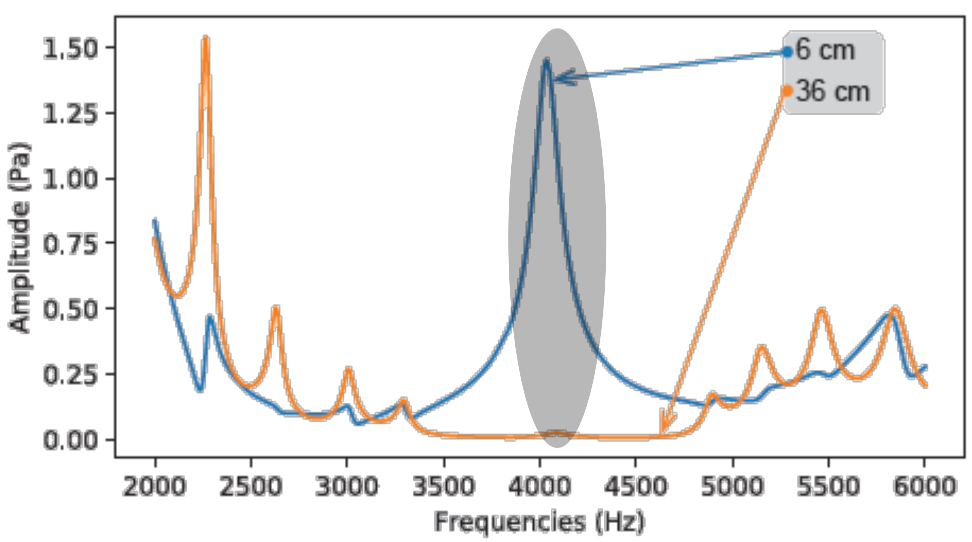


Experimental results

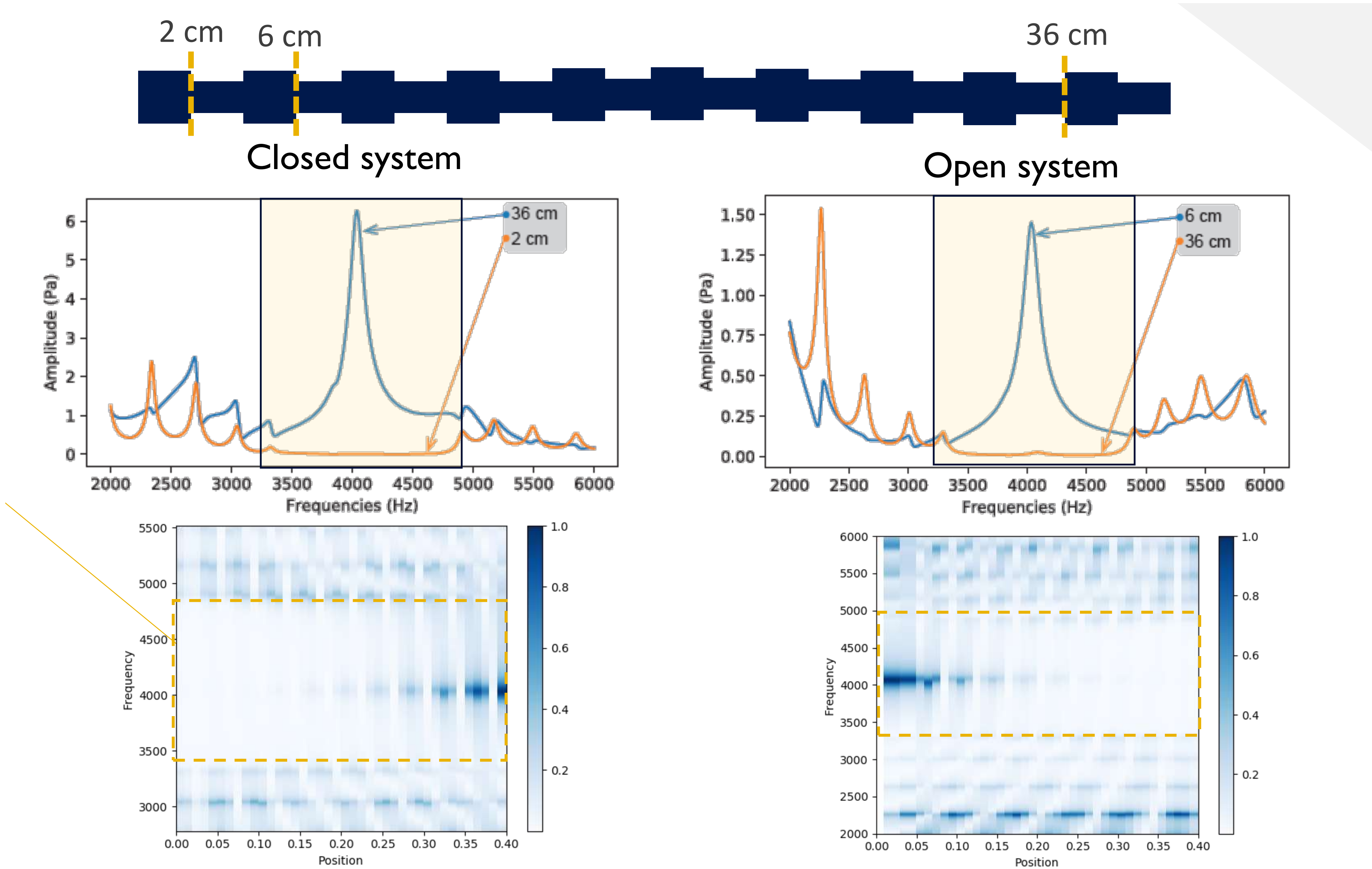
Closed system



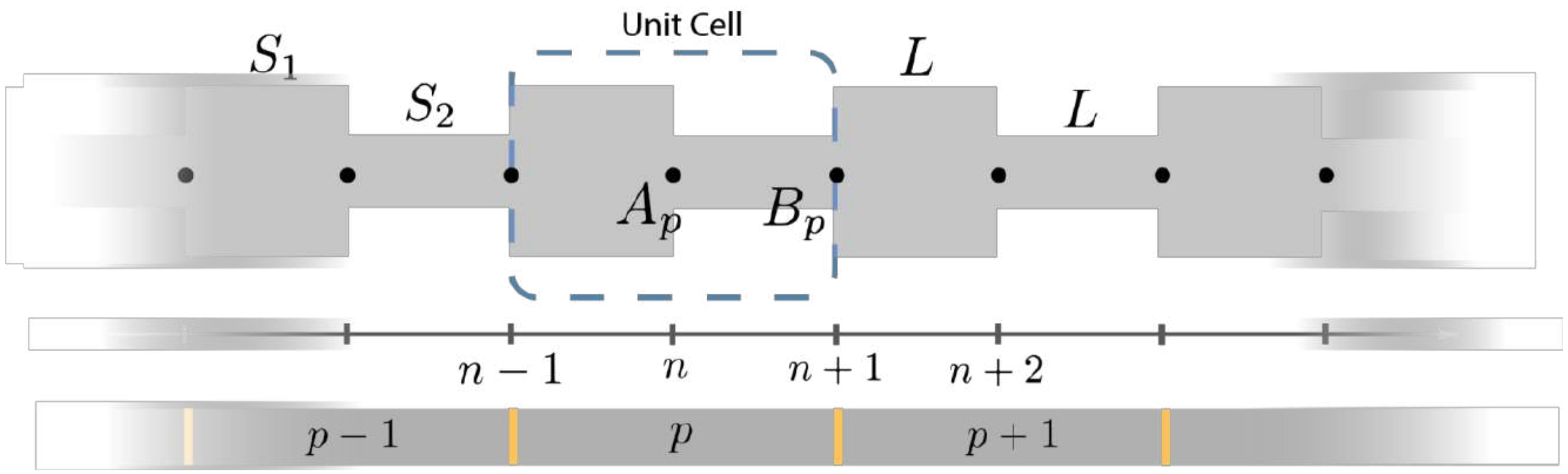
Open system



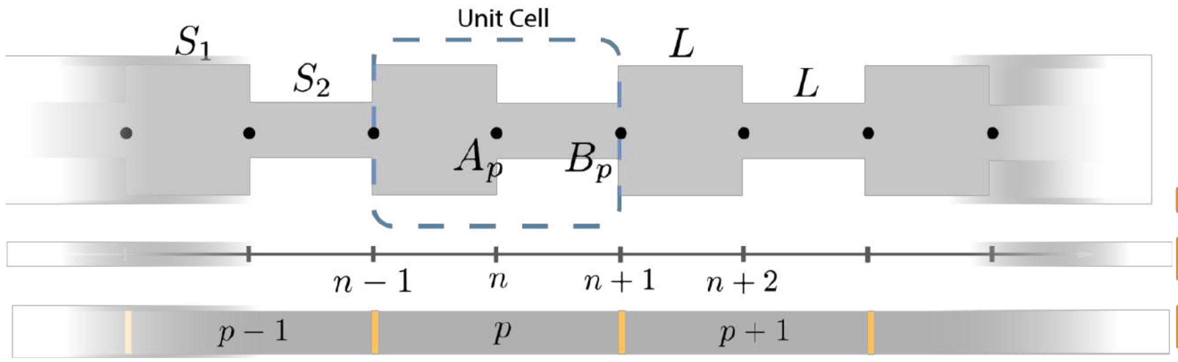
Experimental results

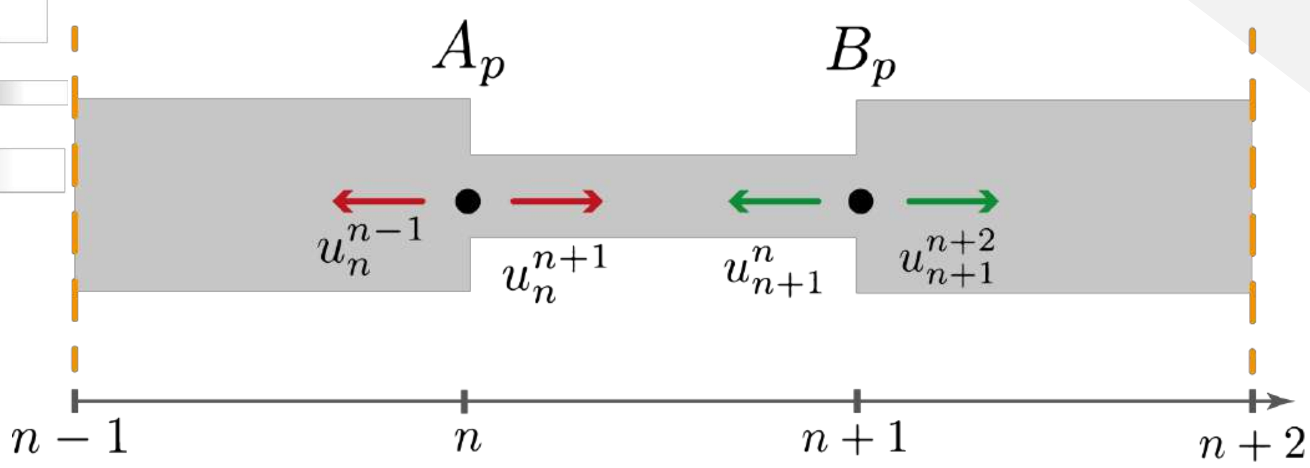


Theory



Conservation of the acoustic flux

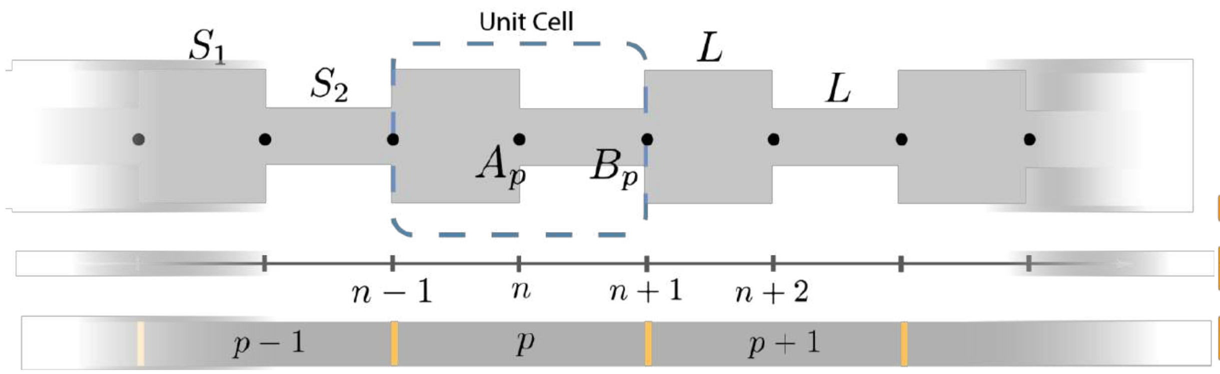


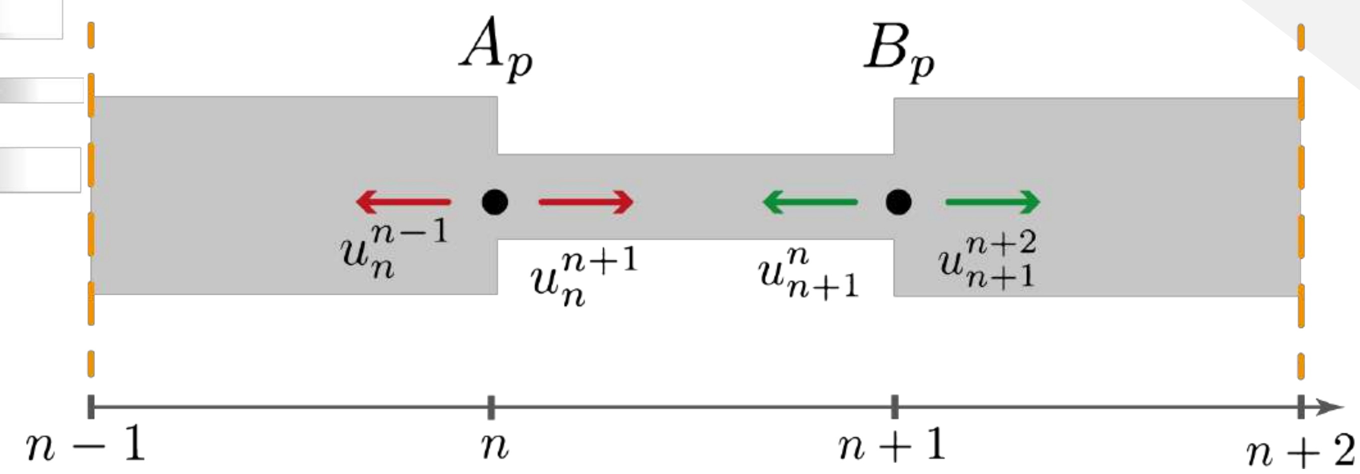


$$u_n^{n+1} + u_n^{n-1} = 0$$

$$u_{n+1}^{n+2} + u_{n+1}^{n} = 0$$

Theory





$$u_n^{n+1} + u_n^{n-1} = 0$$

$$u_{n+1}^{n+2} + u_{n+1}^{n} = 0$$

transfer matrix

$$\epsilon A_p = tB_{p-1} + sB_p$$

$$\epsilon B_p = sA_p + tA_{p+1}$$

$$\epsilon = \cos kL$$

Coupling parameters

$$t = \frac{w_1}{w_1 + w_2},\quad s = \frac{w_2}{w_1 + w_2} = 1 - t$$

Theory

Discrete system

$$\epsilon A_p = tB_{p-1} + sB_p$$

$$\epsilon B_p = sA_p + tA_{p+1}$$

$$\epsilon = \cos kL$$

Coupling parameters

$$t = \frac{w_1}{w_1 + w_2}, \quad s = \frac{w_2}{w_1 + w_2} = 1 - t$$

$$\epsilon \vec{u} = \boldsymbol{M} \vec{u}$$

$$M = \begin{pmatrix} \ddots & \ddots & \ddots & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & s & 0 & t & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & t & 0 & s & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & s & 0 & t & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & t & 0 & s & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & & s & 0 & t & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \ddots & \ddots & \ddots \end{pmatrix}$$

$$\vec{u} = \begin{pmatrix} \cdots & B_{p-1} & A_p & B_p & A_{p+1} & \cdots \end{pmatrix}$$

Theory

Bloch waves

$$A_p = Ae^{2iqpL}, \qquad B_p = Be^{2iqpL}$$

q Bloch wave number

$$\epsilon A_p = tB_{p-1} + sB_p$$

$$\epsilon B_p = sA_p + tA_{p+1}$$

$$\vec{u} = \binom{A}{B}$$

$$\epsilon\vec{u} = \boldsymbol{H}\vec{u} \qquad \boldsymbol{H} = \begin{pmatrix} 0 & s + te^{-2iqL} \\ s + te^{2iqL} & 0 \end{pmatrix}$$

Eigenvalues $\boldsymbol{H}$:

$$\cos(2qL) = \frac{\epsilon^2 - s^2 - t^2}{2st}$$

Relation de dispersion

$\epsilon = \cos kL$

Finite system

Finite system :

$$\epsilon A_p = tB_{p-1} + sB_p$$

$$\epsilon B_p = sA_p + tA_{p+1}$$

$$\epsilon \vec{u}_{c,o} = M_{c,o} \vec{u}_{c,o}$$

Closed system

$$\mathbf{M}_c = \begin{pmatrix} \cdot & 1 & \cdot & \cdot & \cdot & \cdot & \cdot \\ t & 0 & s & \cdot & \cdot & \cdot & \cdot \\ \cdot & \ddots & \ddots & \ddots & \cdot & \cdot & \cdot \\ \cdot & \cdot & t & 0 & s & \cdot & \cdot \\ \cdot & \cdot & \cdot & s & 0 & t & \cdot \\ \cdot & \cdot & \cdot & \cdot & \ddots & \ddots & \ddots \\ \cdot & \cdot & \cdot & \cdot & \cdot & 1 & \cdot \end{pmatrix}$$

$$\mathbf{u}_c = \begin{pmatrix} B_0 & A_1 & B_1 & \cdots & A_{2N} & B_{2N} \end{pmatrix}^T$$

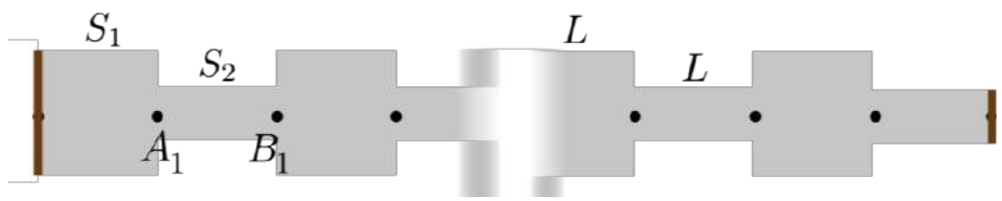
Open system

$$\mathbf{M}_o = \begin{pmatrix} t & 0 & s & \cdot & \cdot & \cdot & \cdot \\ \cdot & \ddots & \ddots & \ddots & \cdot & \cdot & \cdot \\ \cdot & \cdot & t & 0 & s & \cdot & \cdot \\ \cdot & \cdot & \cdot & s & 0 & t & \cdot \\ \cdot & \cdot & \cdot & \cdot & \ddots & \ddots & \ddots \end{pmatrix}$$

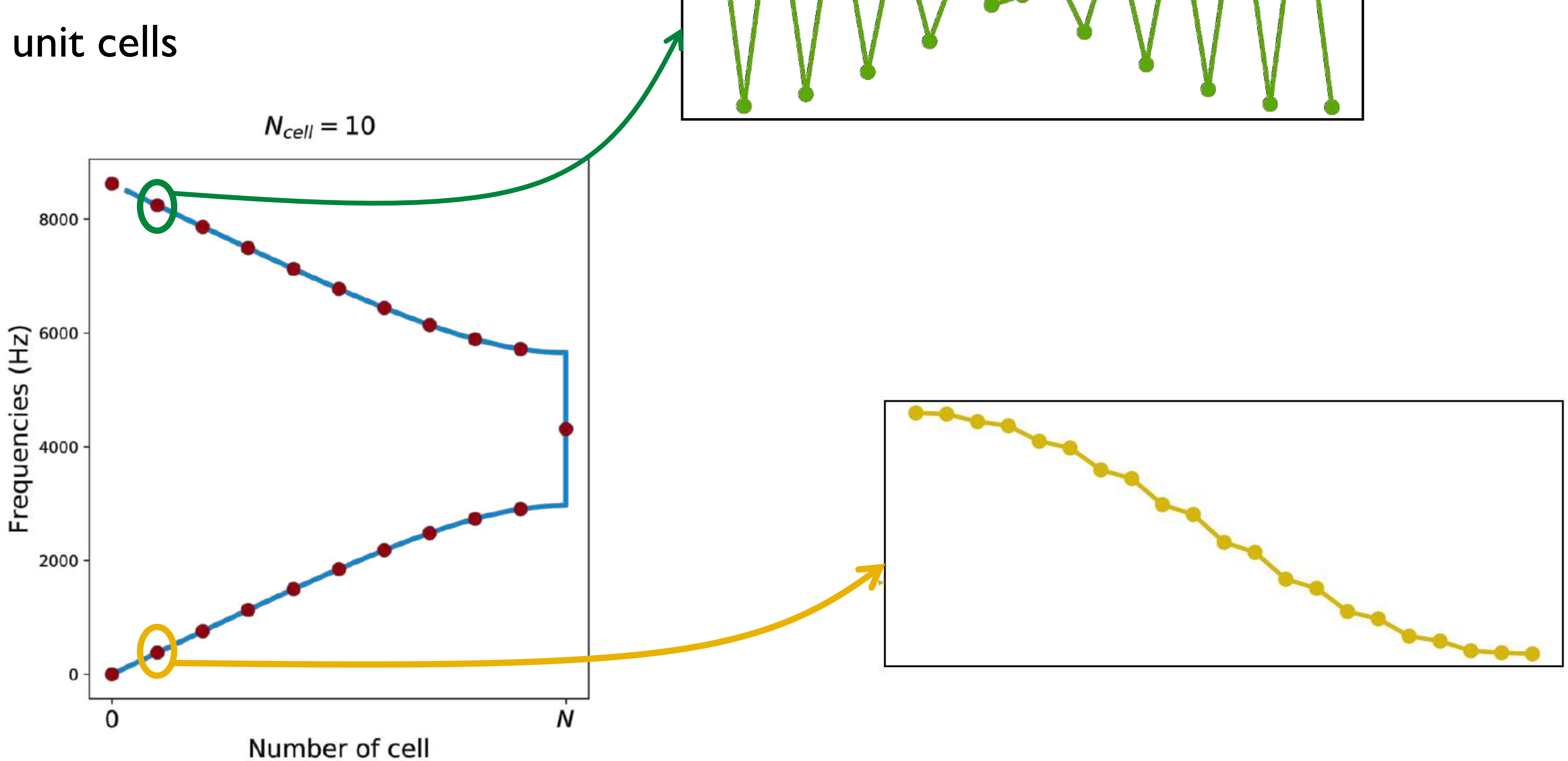
$$\mathbf{u}_o = \begin{pmatrix} A_1 & B_1 & \cdots & A_{2N} \end{pmatrix}^T$$

Eigenvalues : mode frequencies
Eigenvectors : mode profiles

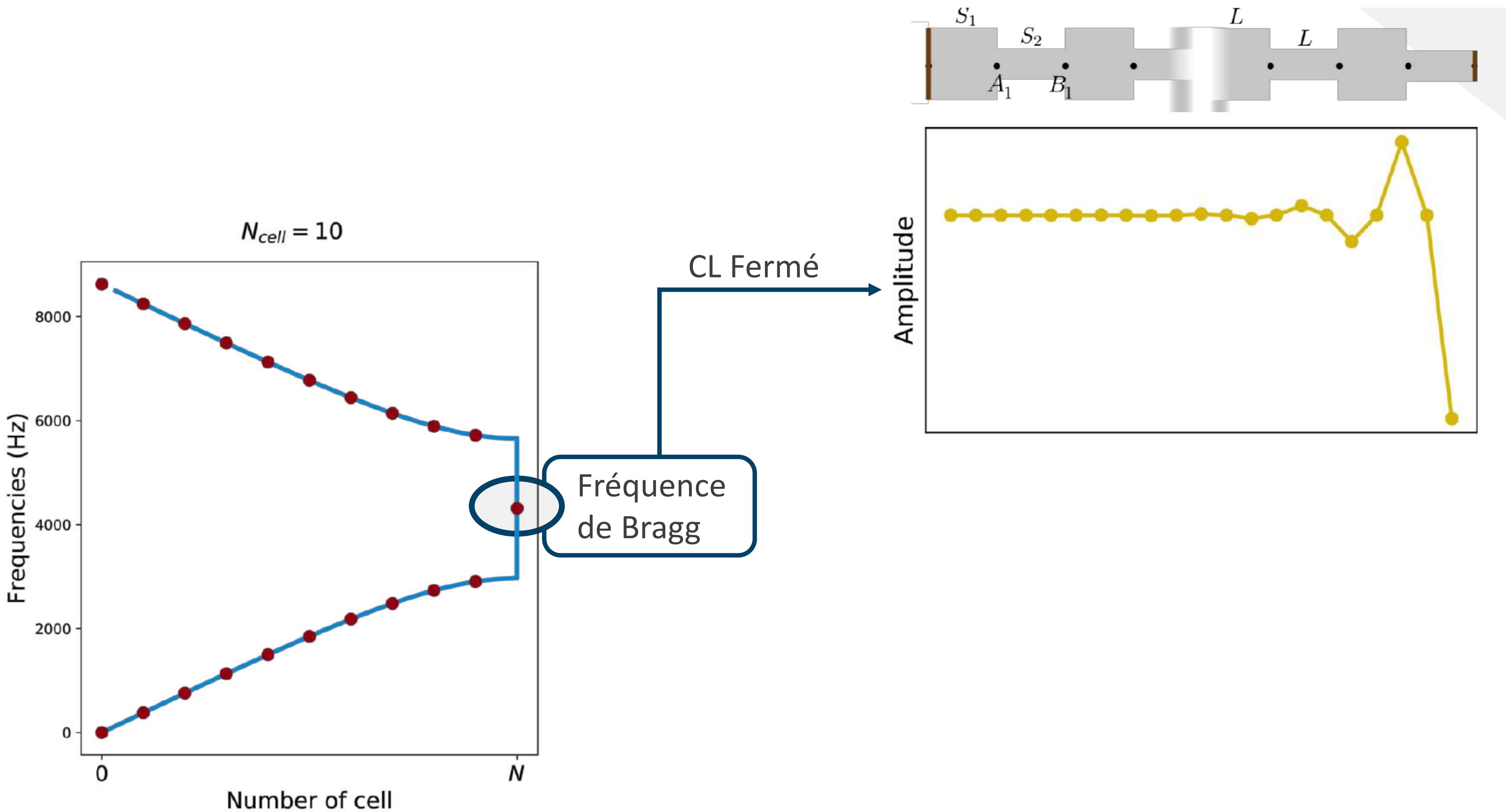
Finite system



10 unit cells

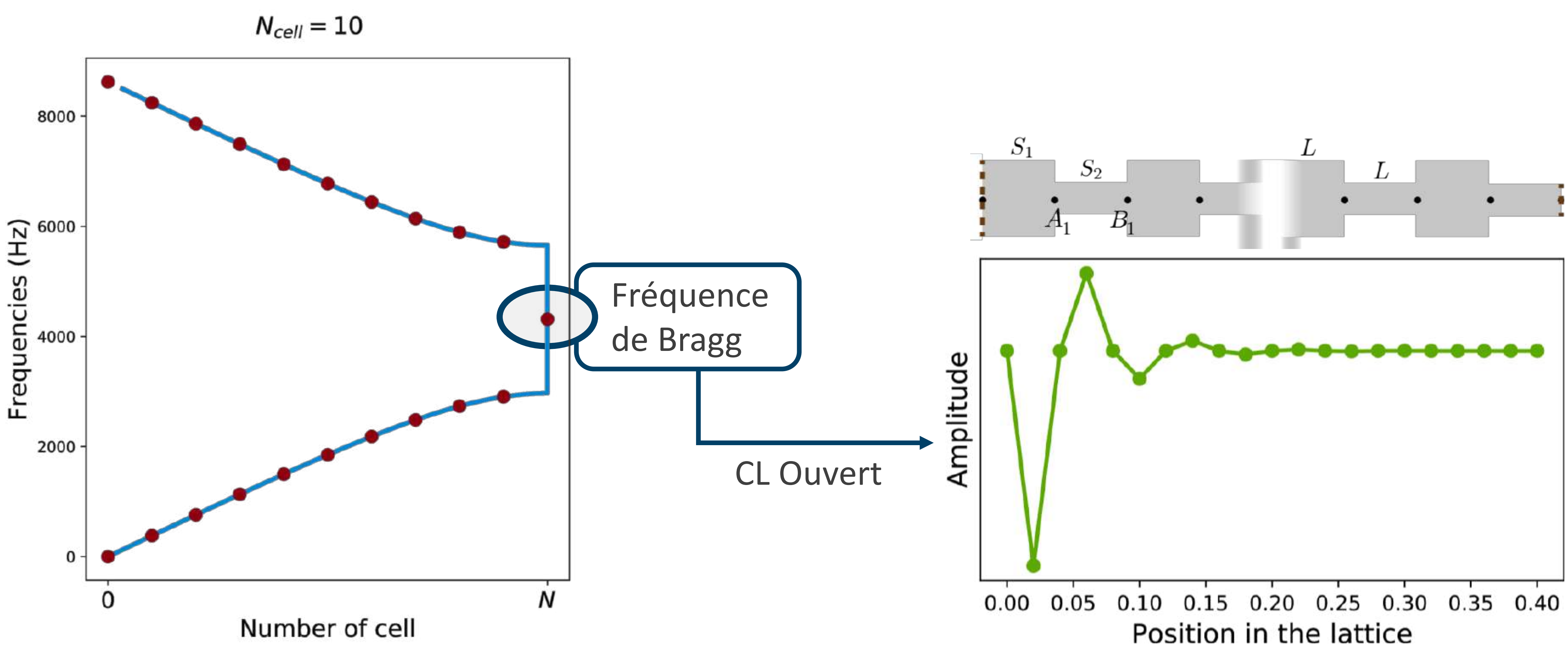


Closed system



Finite system

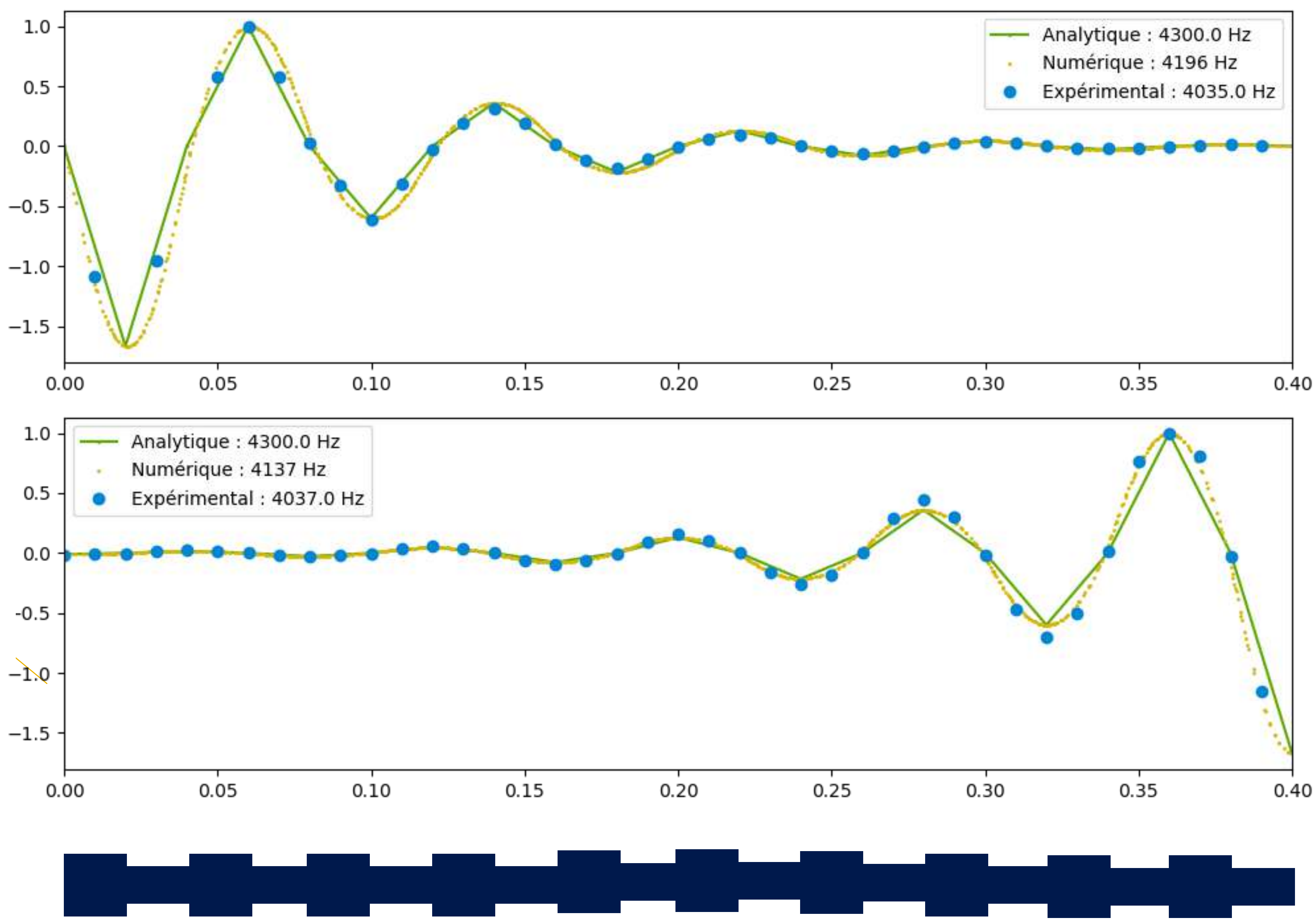
Open system



Finite system

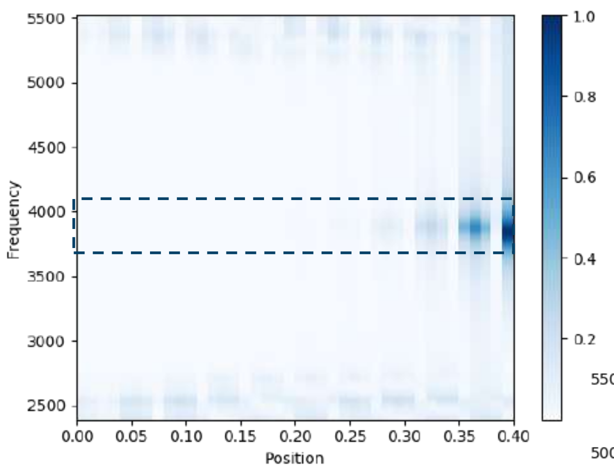
Open system

Closed system

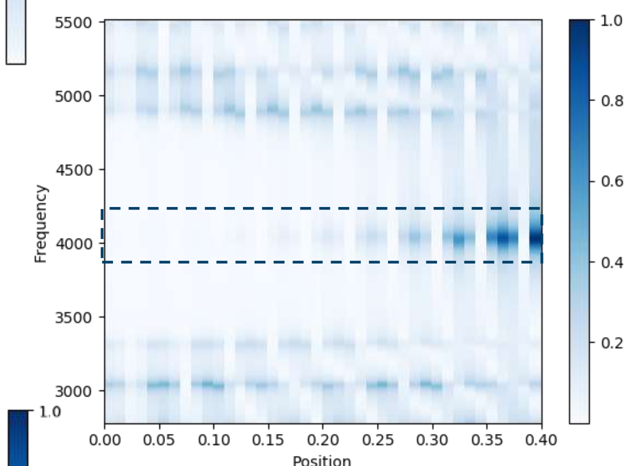


Finite system

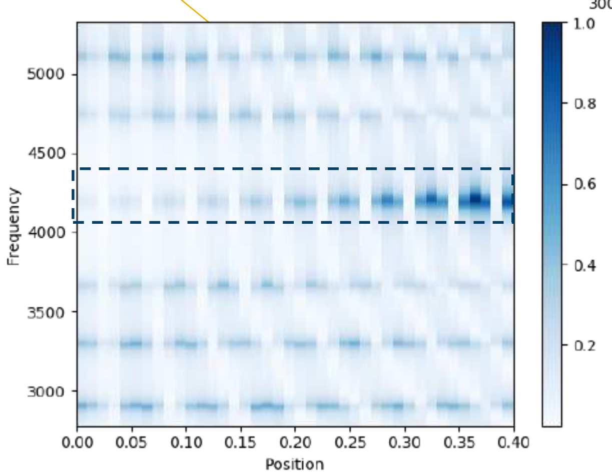
Influence of the parameter t



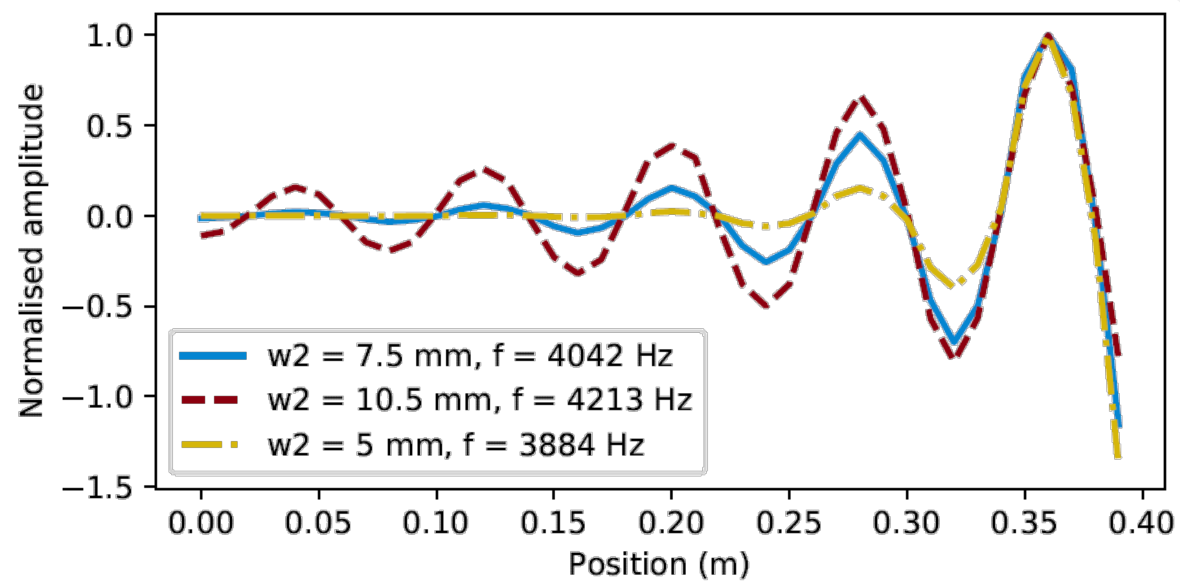
$t = 0{,}71$



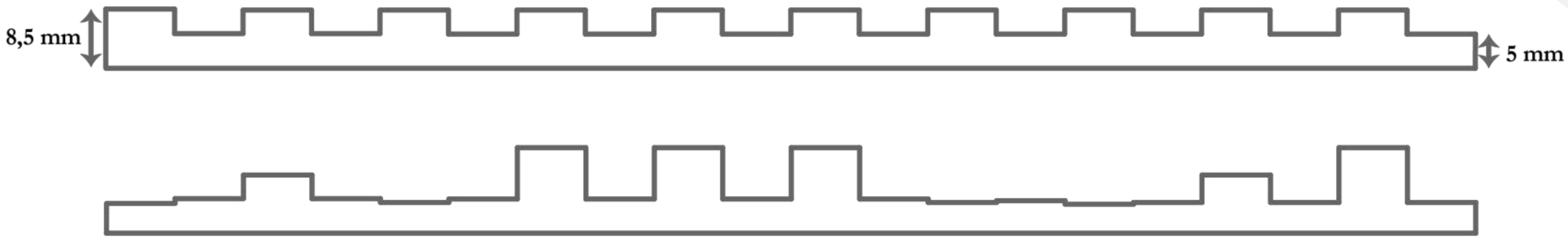
$t = 0{,}62$

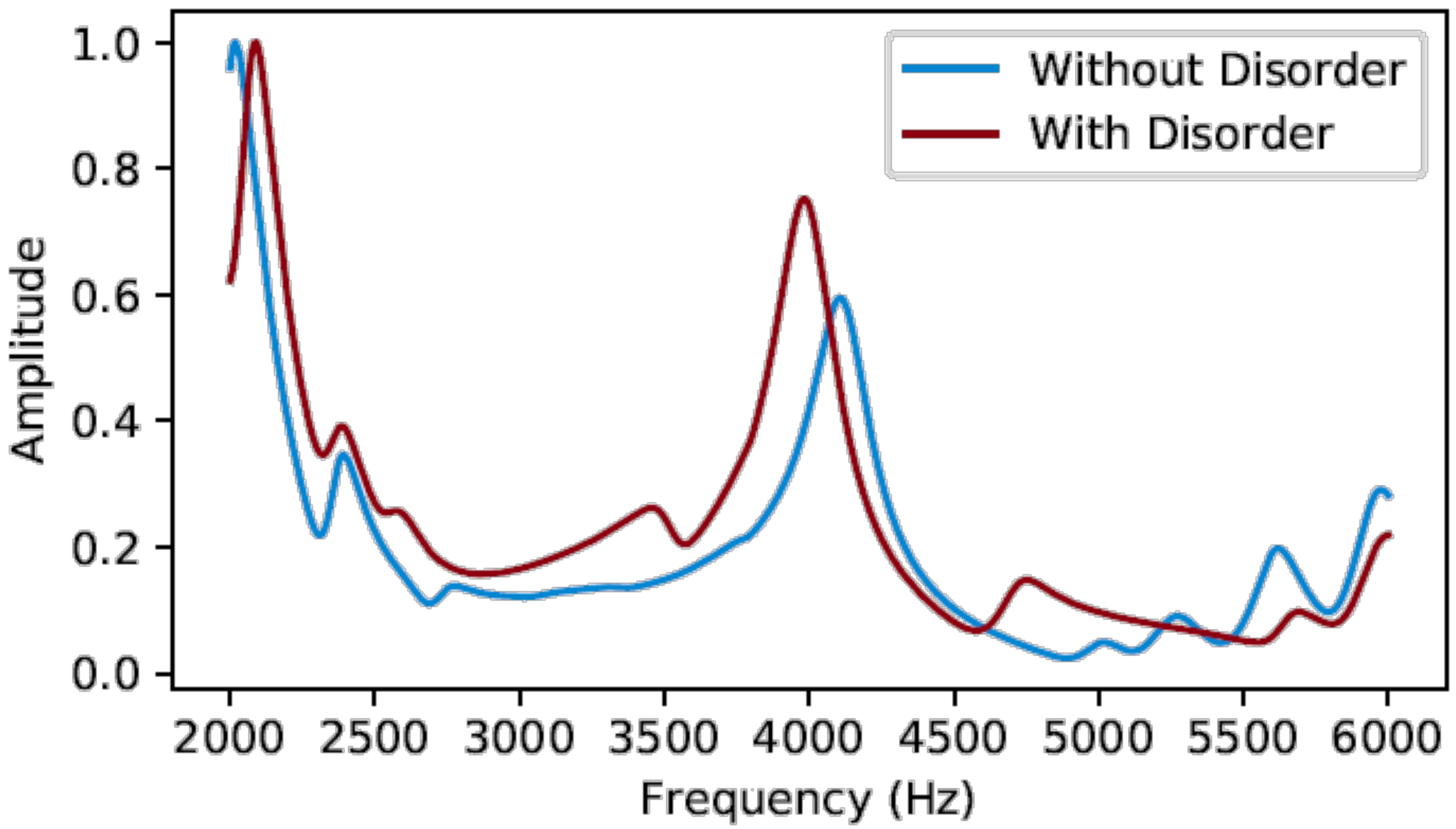


$t = 0{,}54$

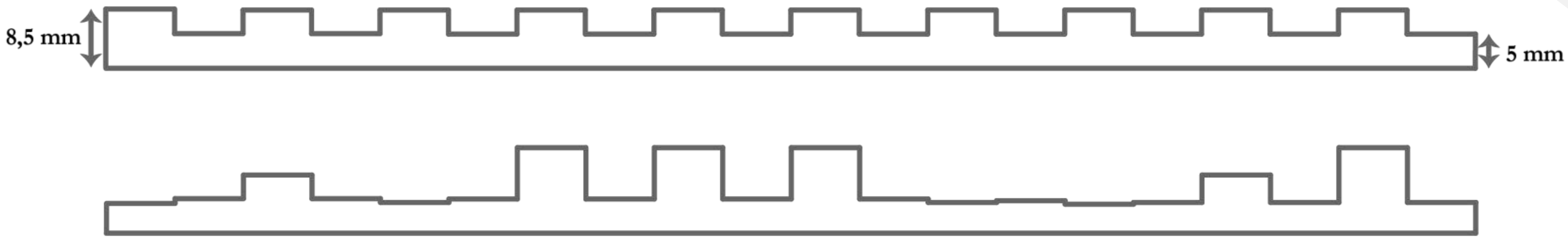


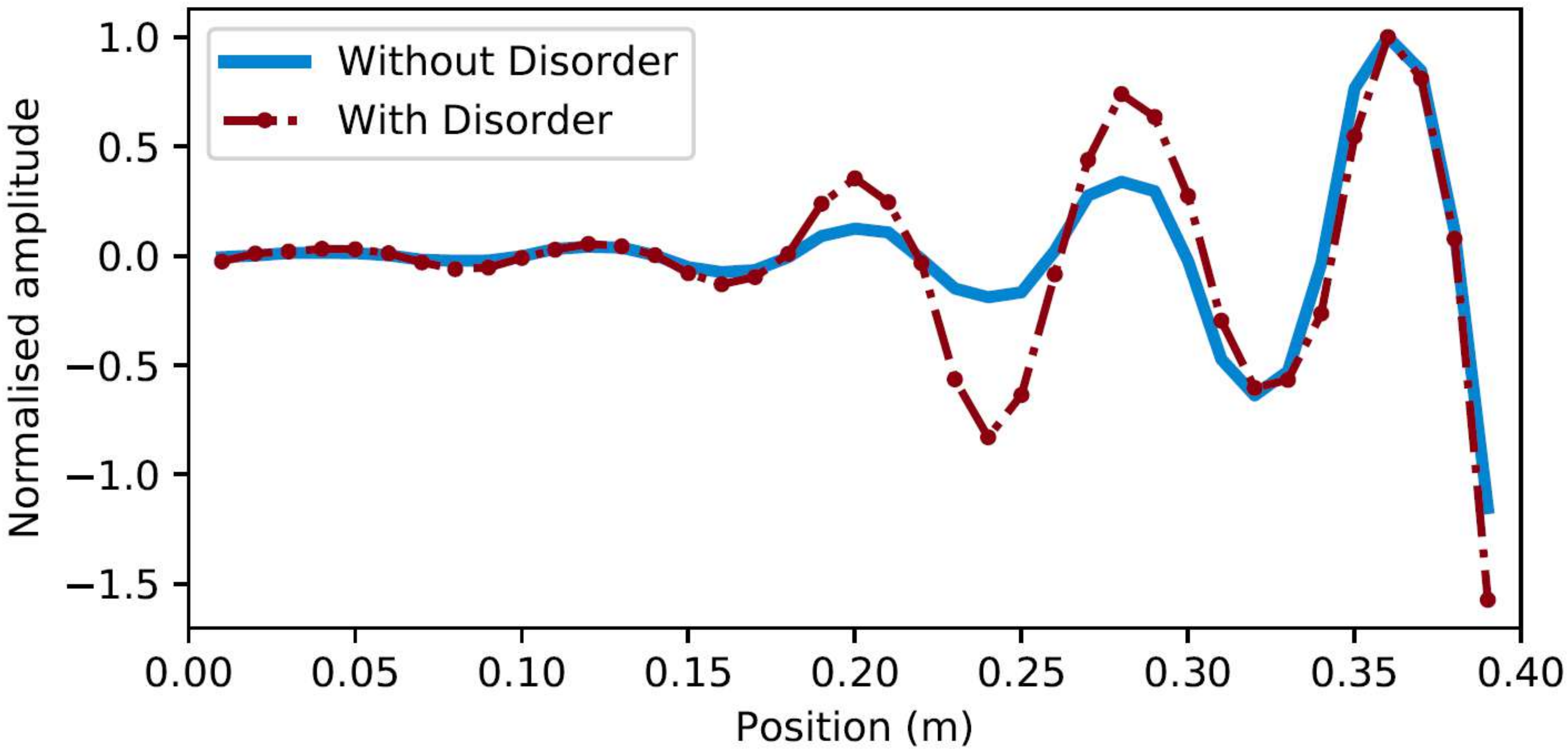
Disordered system



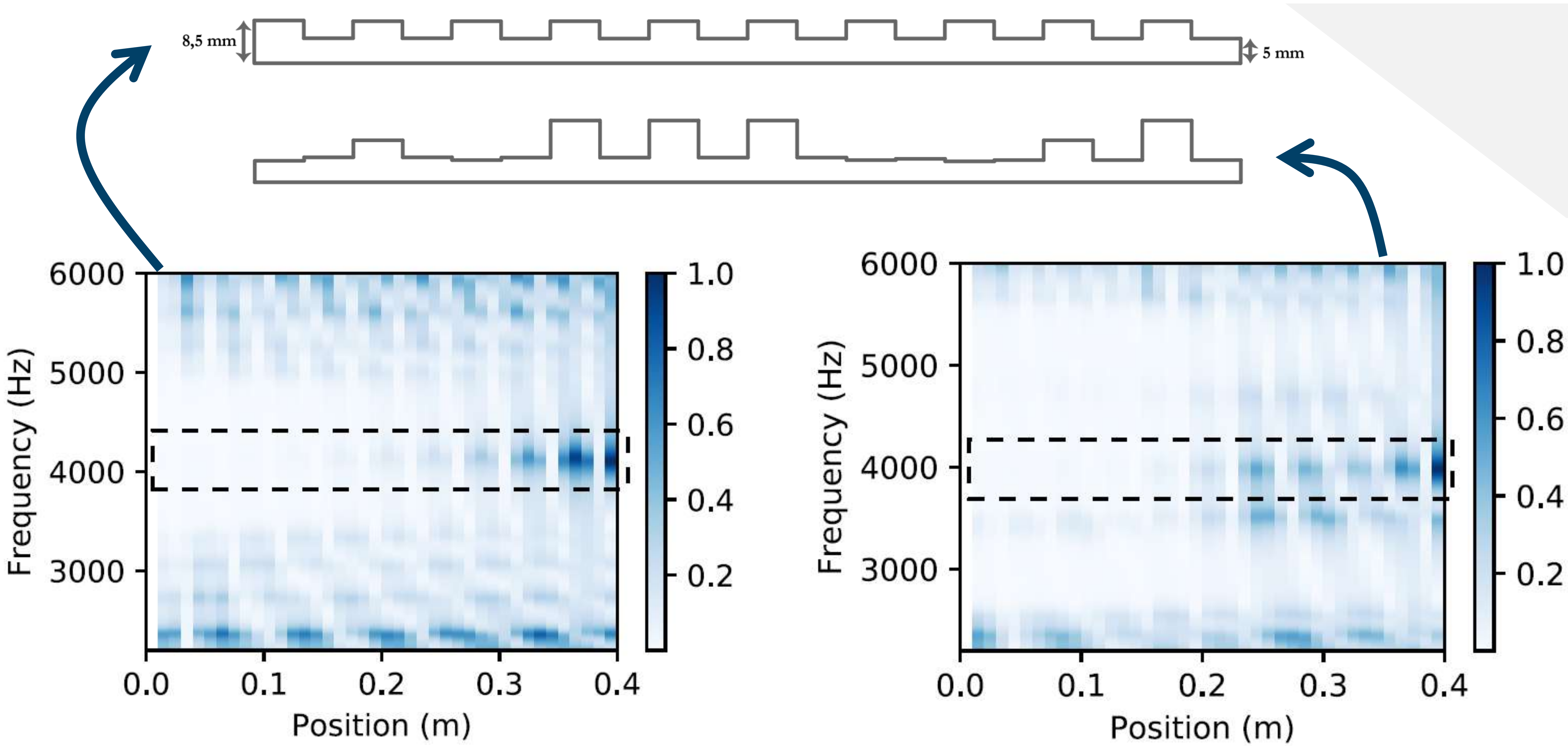


Disordered system

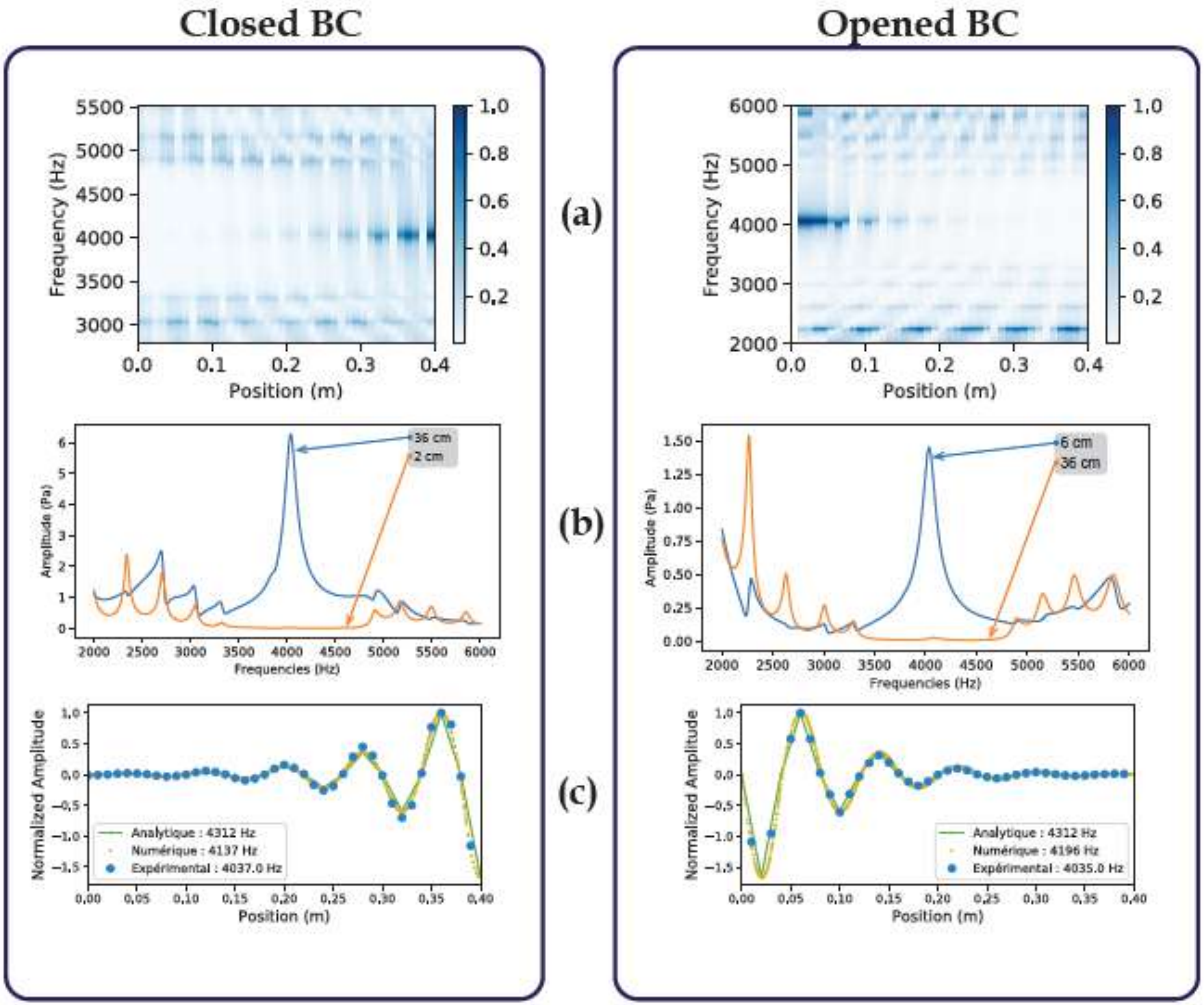




Disordered system



Edge modes



Closed BC
Opened BC
(a)
(b)
(c)
Frequency (Hz)
Position (m)
Amplitude (Pa)
Frequencies (Hz)
36 cm
2 cm
6 cm
36 cm
Normalized Amplitude
Analytique : 4312 Hz
Numérique : 4137 Hz
Expérimental : 4037.0 Hz
Analytique : 4312 Hz
Numérique : 4196 Hz
Expérimental : 4035.0 Hz