TMD

REPONSE AUX PROBLEMES DE VIBRATION DANS LES TOURS

INTRODUCTION

TUNED MASS DAMPER : TOUR TAIPEI, TAIWAN

Pont de Tacoma (1940)

PLAN

- 2 TYPES DE SOLUTIONS FACE à 2 TYPES D'EXCITATIONS :

EXCITATION HARMONIQUE:
SYSTÈME MASSE RESSORT

BREVE SECOUSSE:
PENDULE PESANT A PULSATION VARIABLE

PRESENTATION DE LA TOUR

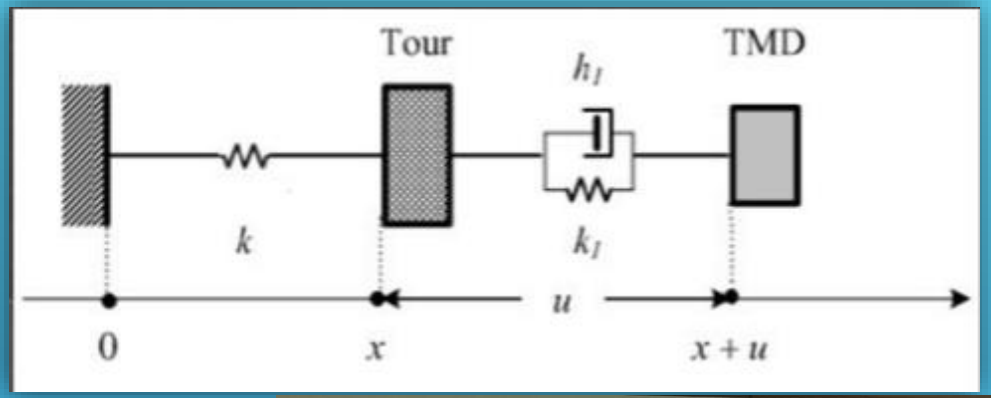
Tour de Taipei

Tour = 4 tiges métalliques + toit stabilisateur

Moteur de rotation

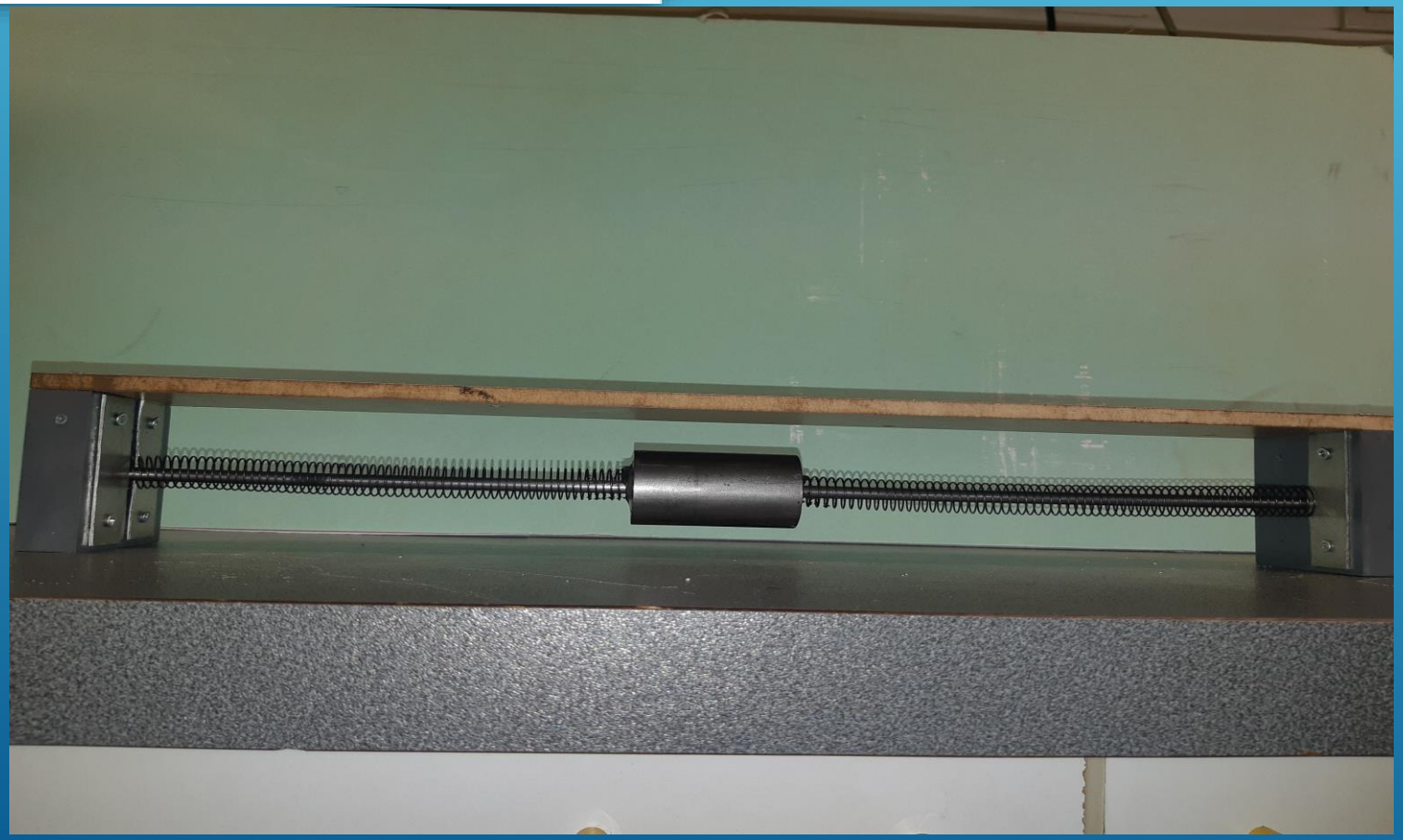
4 roues sur 2 rails

MODÈLE / PRATIQUE :



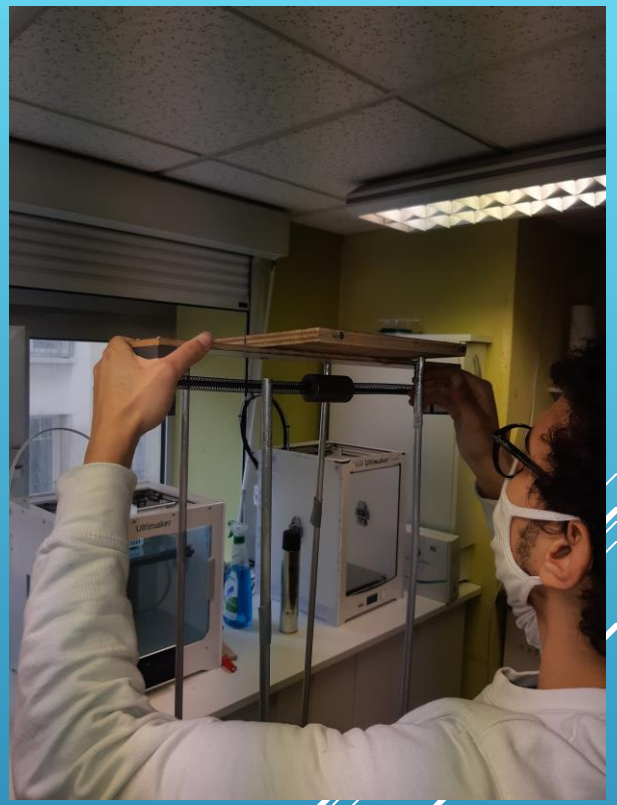
Pulsation propre du système (sans TMD):

$$\omega^2 = k/m$$



2 ressorts de raideur 13N/m
k1= 26N/m et m1=468g

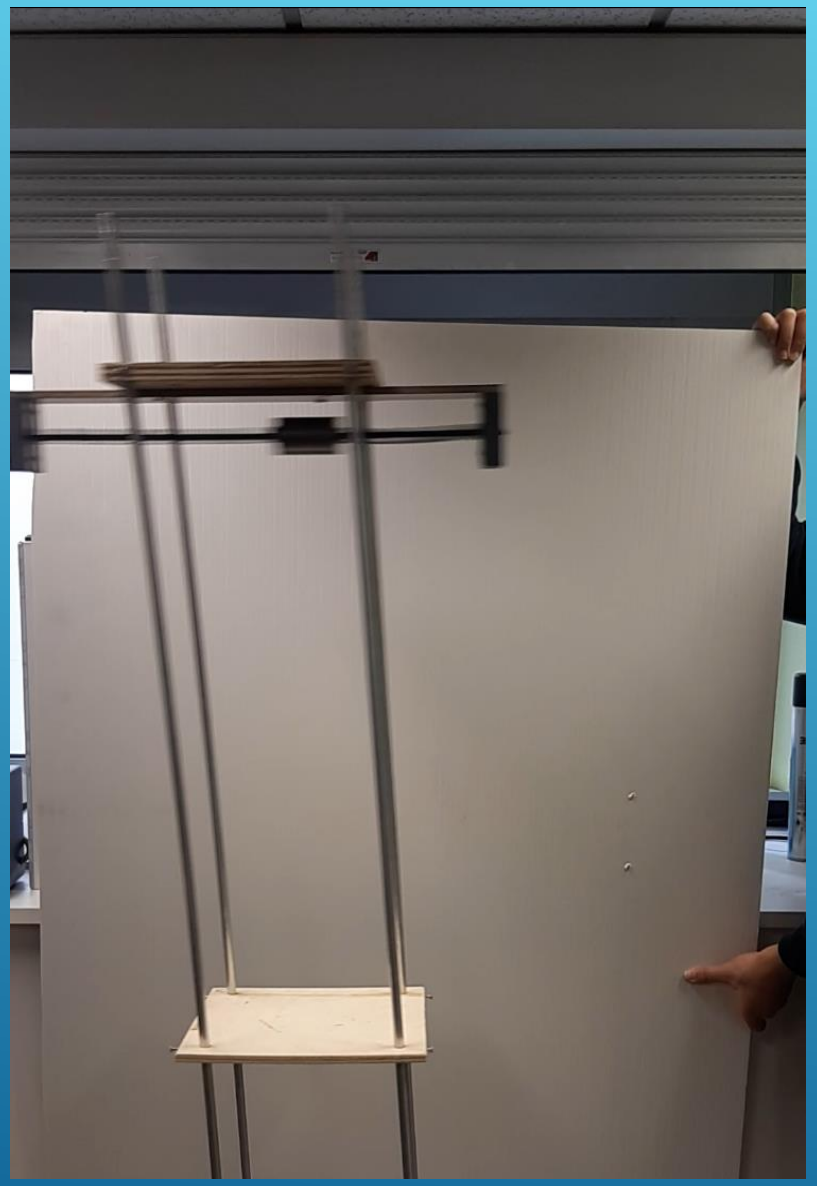
RÉPONSE A UNE EXCITATION HARMONIQUE

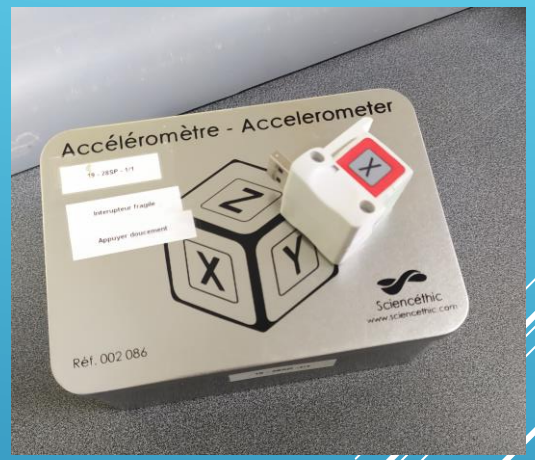


Ressort à spires jointives

Ressort à spires non jointives

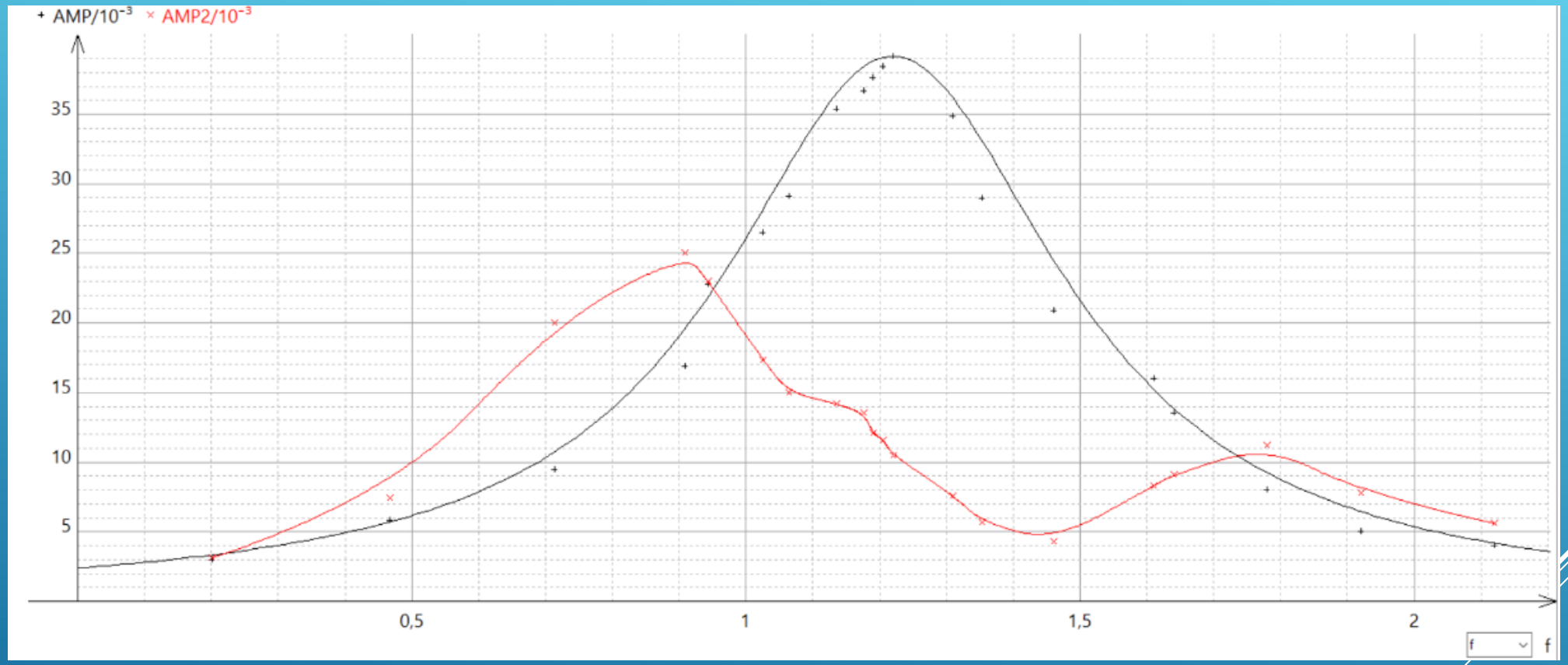
Tour en mouvement





Accéléromètre

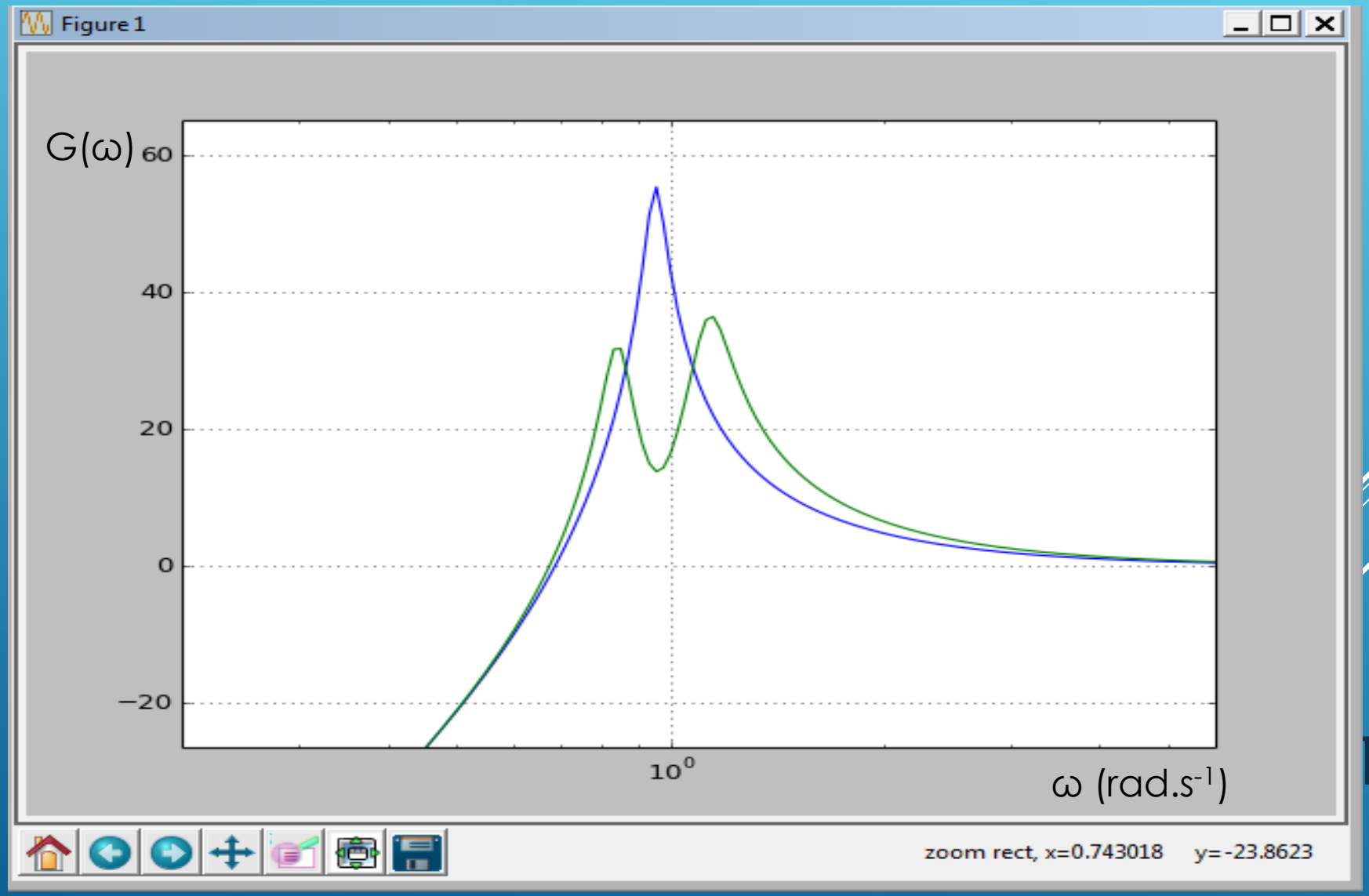
COURBES EXPÉRIMENTALES:



Evolution de l'amplitude avec la fréquence
f_0 =1,22Hz

RÉPONSE A UNE EXCITATION SINUSOÏDALE: **THÉORIE PYTHON**

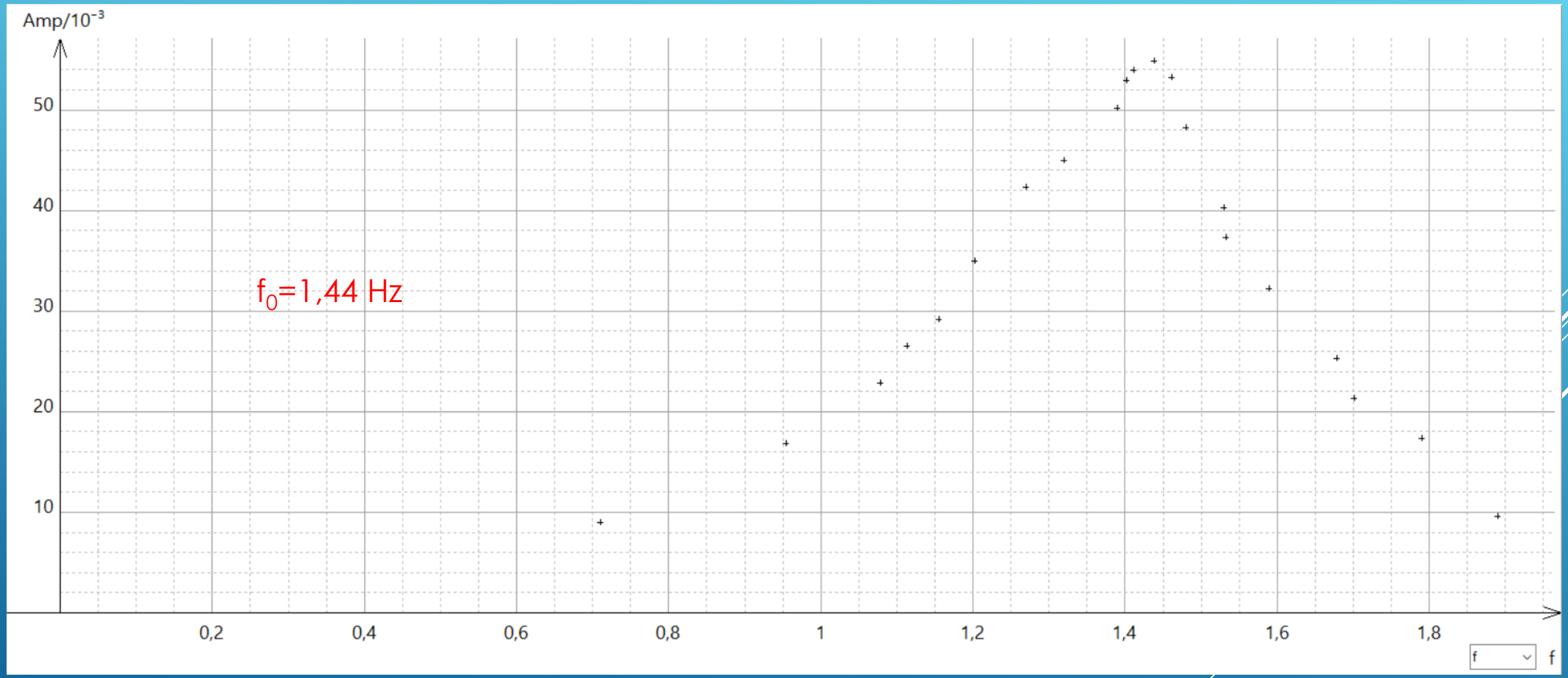
Gain de la fonction de transfert traduisant l'accélération ressentie dans la tour (échelle log)



RÉPONSE A UNE EXCITATION BRÈVE

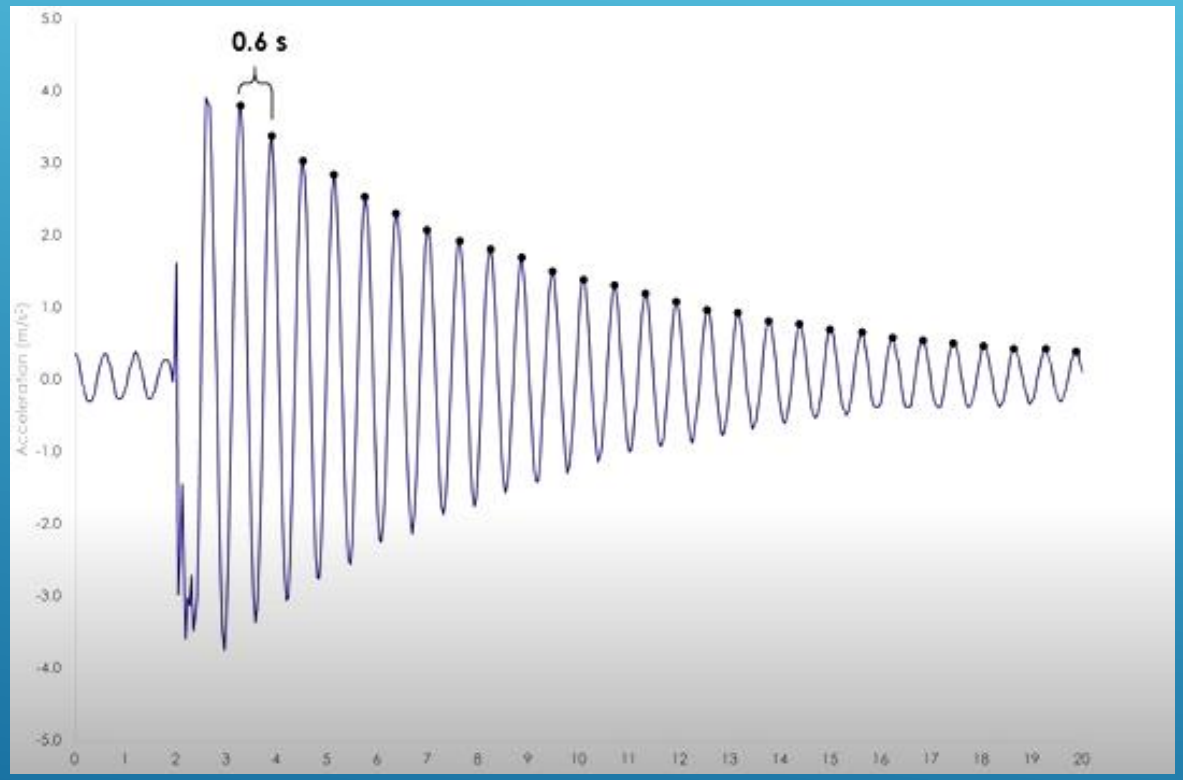
EXPERIENCE SANS EFFET PENDULE

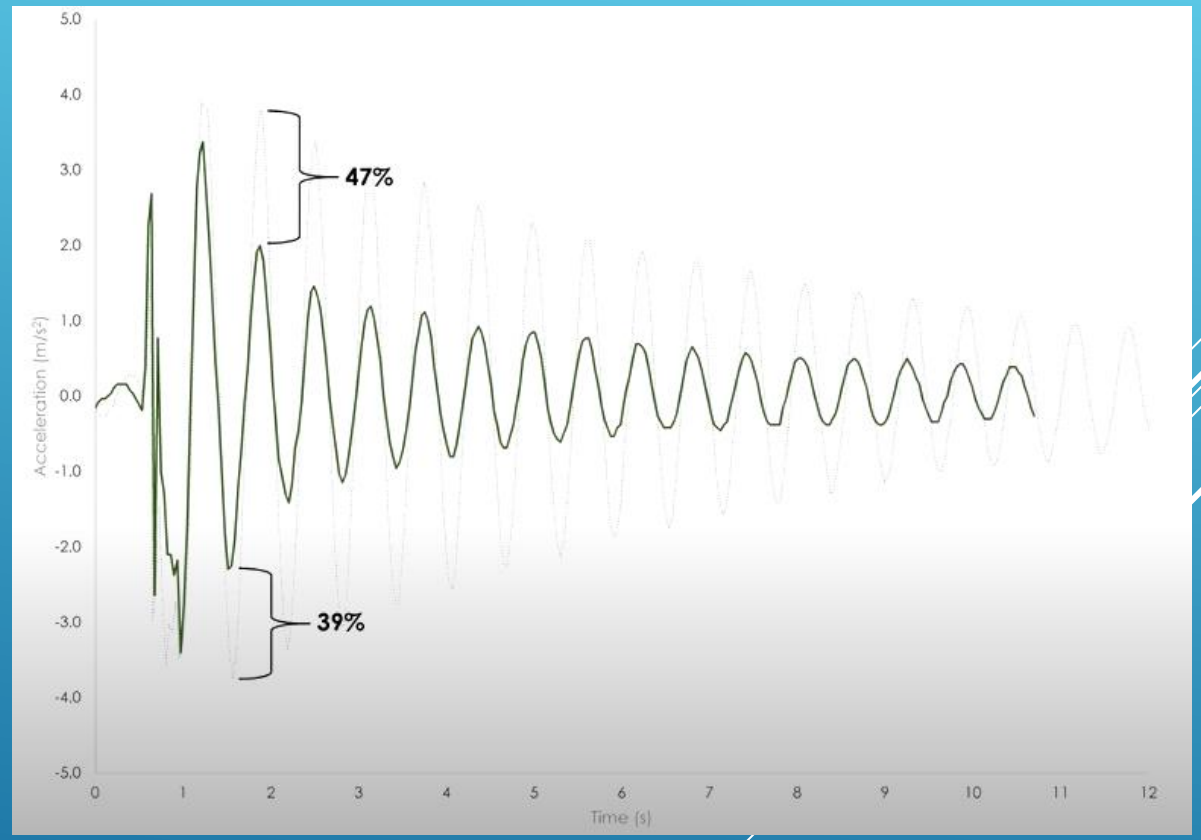
Courbe expérimentale de l'évolution de l'amplitude en fonction de la fréquence d'excitation



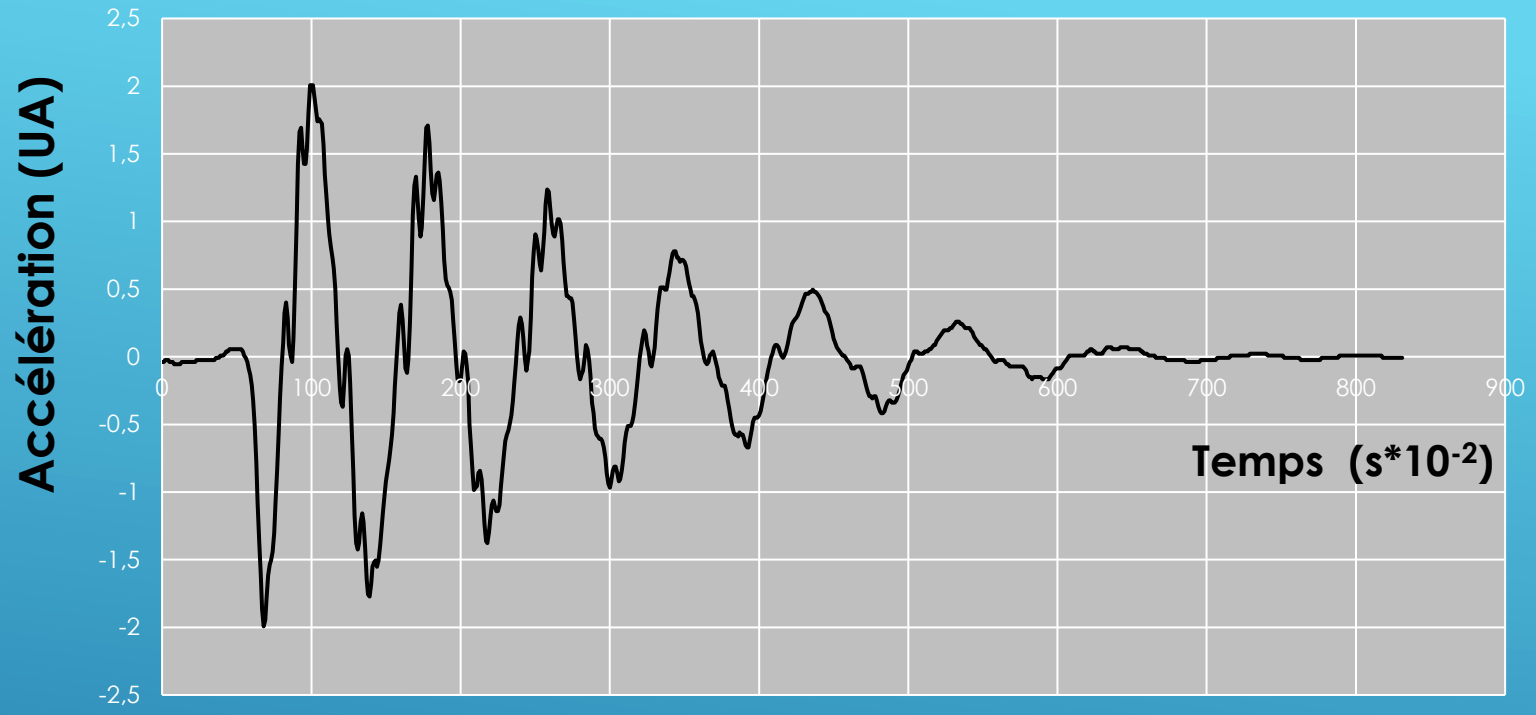
Regle
Dispositif Laser

COURBES THÉORIQUES:

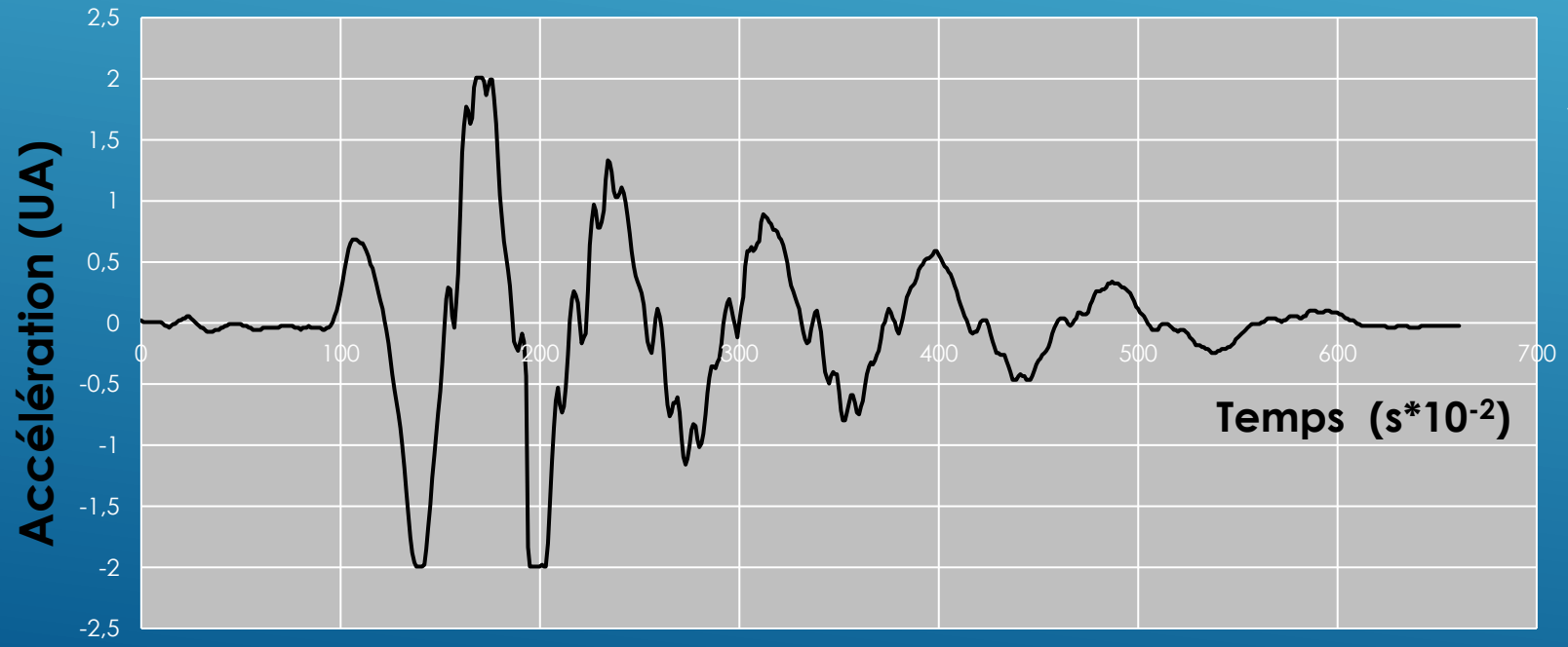




Source: Grady Hillhouse du site https://practical.engineering

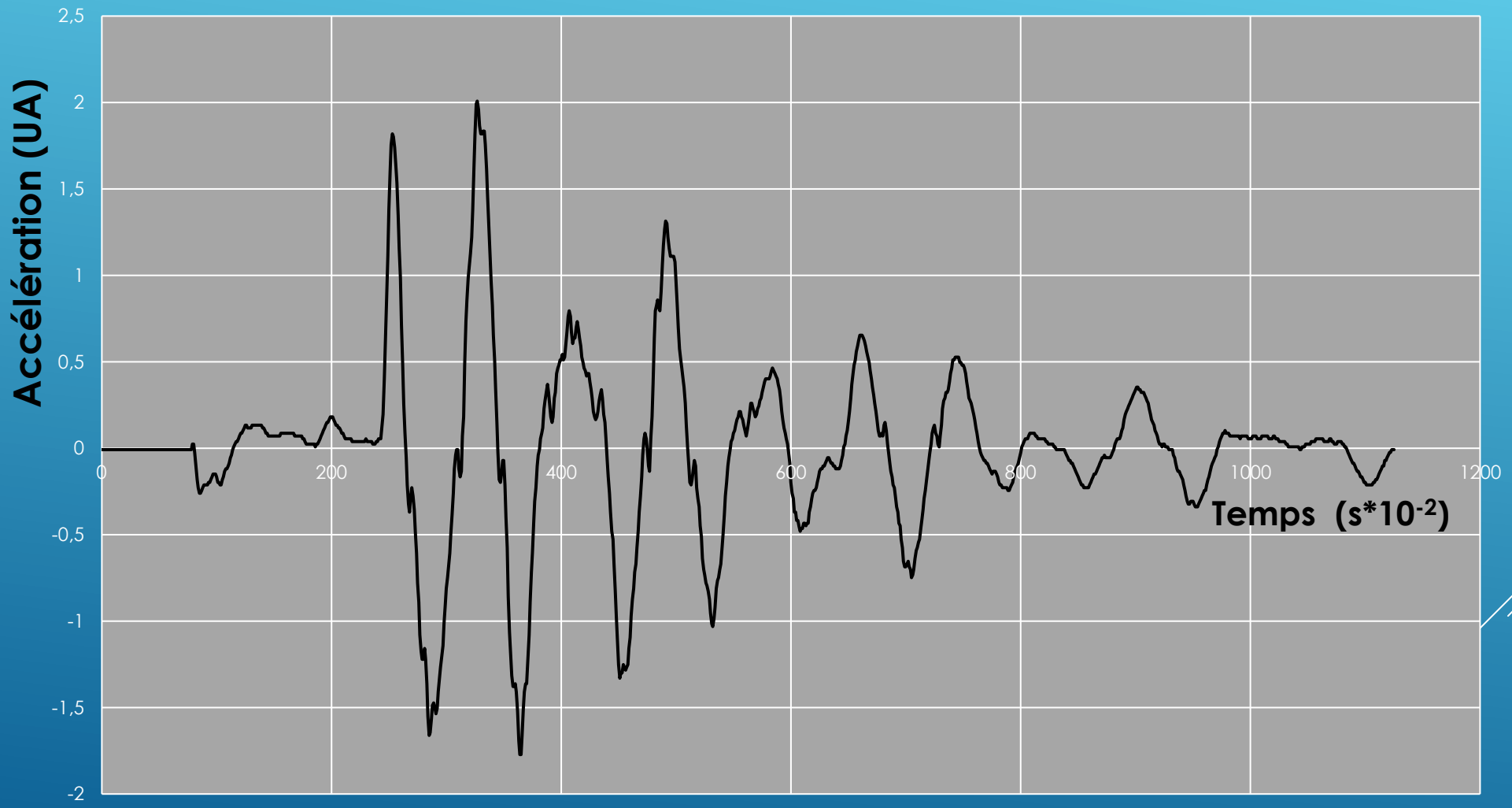


Sans effet pendule



Avec effet pendule

Apparition phenomene de battements



Conclusion:

ANNEXE: MODELISATION DU TMD

Equations du mouvement:

$$\begin{cases} (1+\alpha)\,\ddot{x} + \alpha\,\ddot{u} + {\omega_0}^2\,x = a_0(t) & \text{avec } \alpha = \dfrac{m_1}{m},\ \omega_0 = \sqrt{\dfrac{k}{m}} \text{ et } a_0(t) = \dfrac{f_0(t)}{m} \\ \ddot{x} + \ddot{u} + 2\,\eta_1\,\omega_1\,\dot{u} + {\omega_1}^2\,u = 0 & \text{avec } \omega_1 = \sqrt{\dfrac{k_1}{m_1}} \text{ et } \eta_1 = \dfrac{h_1}{2\sqrt{k_1\,m_1}} \end{cases}$$

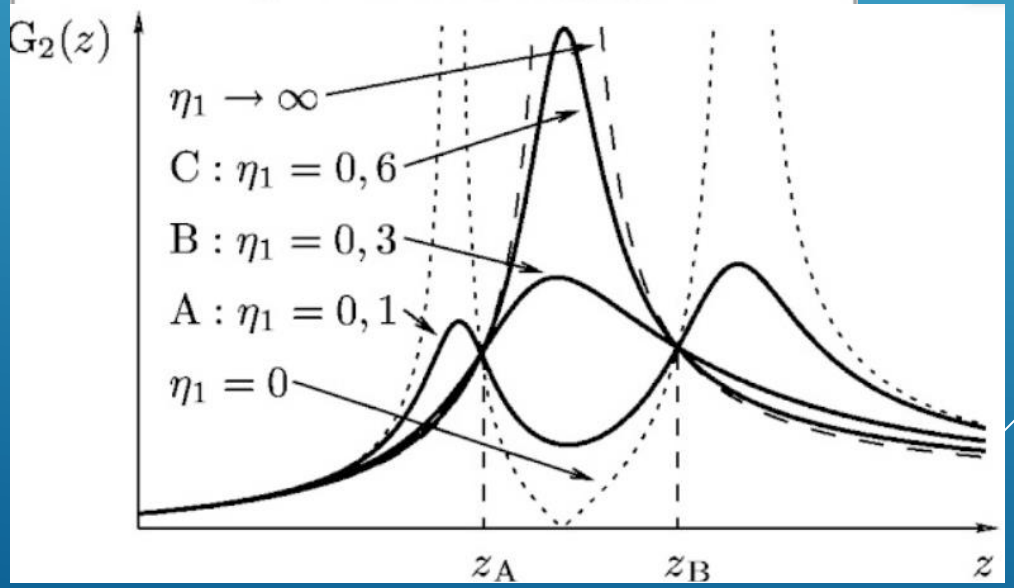
Fonction de transfert: TMD/TOUR

$$\underline{\mathrm{H}}_1(z) = \frac{z^2}{(\beta^2 - z^2) + 2\mathrm{i}\,\eta_1\,\beta\,z} \qquad \text{où} \quad \beta = \frac{\omega_1}{\omega_0} \quad \text{et} \quad z = \frac{\omega}{\omega_0}$$

Fonction de transfert Accélération tour/ excitation:

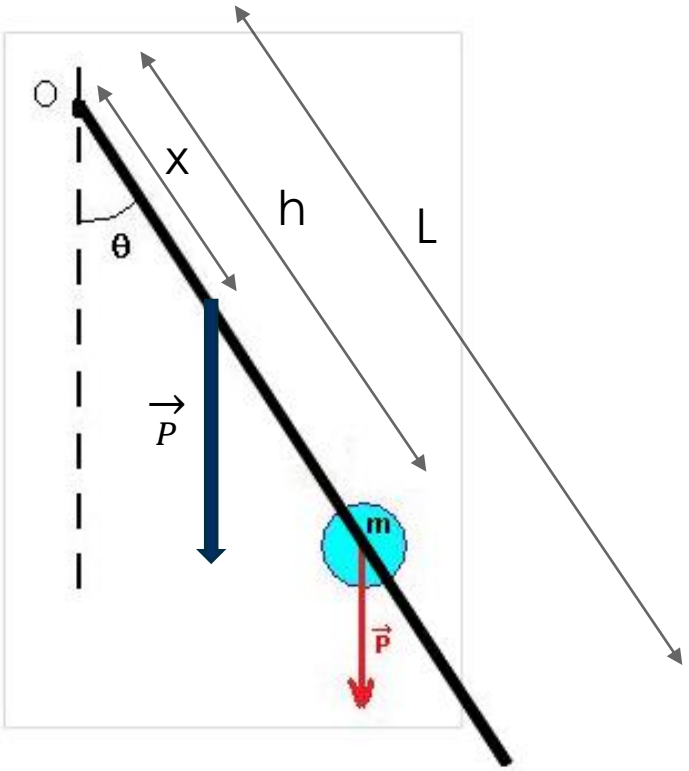
$$\underline{\mathrm{H}}_2(z) = \frac{z^2}{(1+\alpha+\alpha\,\underline{\mathrm{H}}_1(z))\ z^2 - 1}$$

Gain de H_2 (z) traduisant l'accélération ressentie dans la tour :



Recherche centre de gravité de la tige sans masselotte (grandeur x sur page 21 suivante) :

$$T_0 = 2\pi\sqrt{\frac{\frac{1}{3}ML^2+mh^2}{mgh+Mgx}}$$



Données:

m=150g

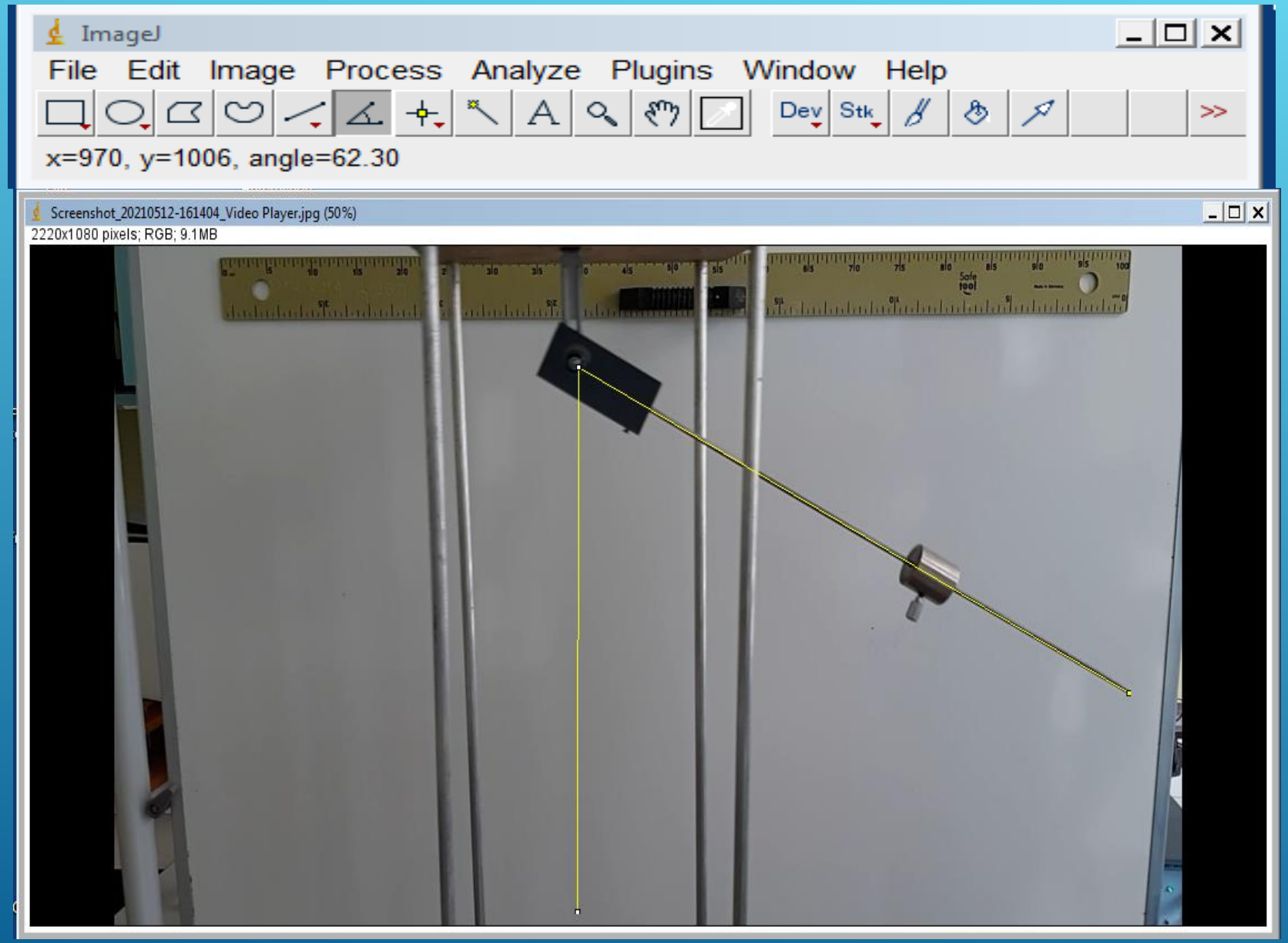
M=50g

h=13cm

x=12,5cm

L=40cm

$\theta_0 = 60^o$



$$\frac{T}{T_0} \approx 1 + \frac{1}{16}\theta_0^2$$

tipe.py - D:\tipe.py (3.9.5)

File Edit Format Run Options Window Help

```
from matplotlib.pyplot import*
from numpy import *
from pylab import *
j=complex(0,1)
eta1=0.8
eta2=0.1
beta=0.953
alpha=0.1
def H11(z):
    return (z**2)/((beta**2)-(z**2)+2*j*eta1*beta*z)
def H12(z):
    return (z**2)/((beta**2)-(z**2)+2*j*eta2*beta*z)
def H21(z):
    return ((z**2)/((1+alpha+alpha*H11(z))*(z**2)-1))
def H22(z):
    return ((z**2)/((1+alpha+alpha*H12(z))*(z**2)-1))

puissance_z = arange(-2,3,0.01)
Z = 10**puissance_z
module1 = 20*log(abs(H21(Z)))
module2=20*log(abs(H22(Z)))
semilogx(Z,module1)
semilogx(Z,module2)
grid(True)
show()
```