Direct impact of acoustic noise on the vibrations of a free-fixed beam

LAViSta

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INTRODUCTION

✓ **Three primary sources of noise :**
- Direct force disturbances
- Ground motion
- Acoustic noise

✓ **Direct force disturbances :** forces applied directly to the payload, as cooling systems in the magnets of the two last quadruples

✓ **Ground motion :** well studied at LAPP

✓ **Acoustic noise :** studied recently at LAPP

→ **Goal of this presentation :** To show first results on the impact of acoustic noise on the displacement of a free-fixed beam

Outline

1. Free-fixed beam under indoor environmental acoustic noise

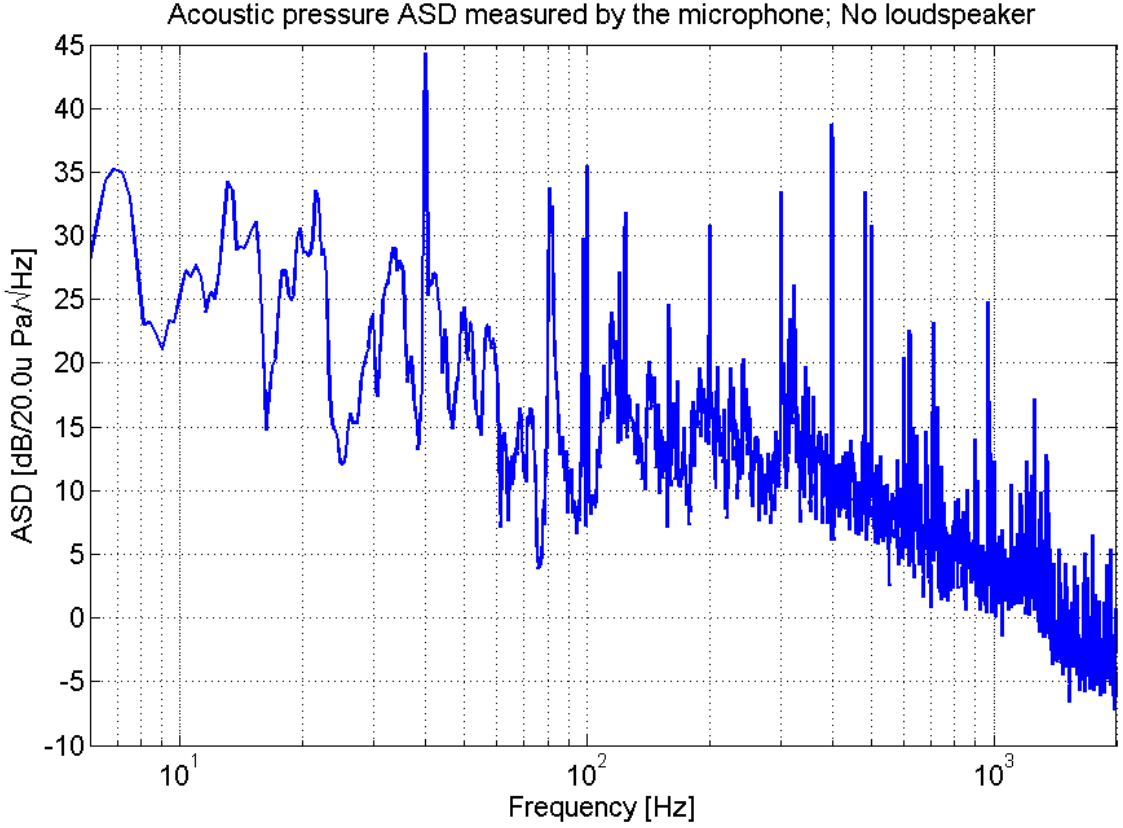
2. Behaviour of the beam under different levels of acoustic noise

3. General conclusion and future prospects

1. Free-fixed beam under indoor environmental acoustic noise

Introduction

✓ **Acoustic pressure ASD measured by a microphone in a quiet working room :**



→ **Like a pink noise :** random signal with PSD inversely proportional to the frequency

1. Free-fixed beam under indoor environmental acoustic noise

Principle of the study

✓ Simulation of a much noisier working room acoustic noise by creating an acoustic pink noise with a loudspeaker

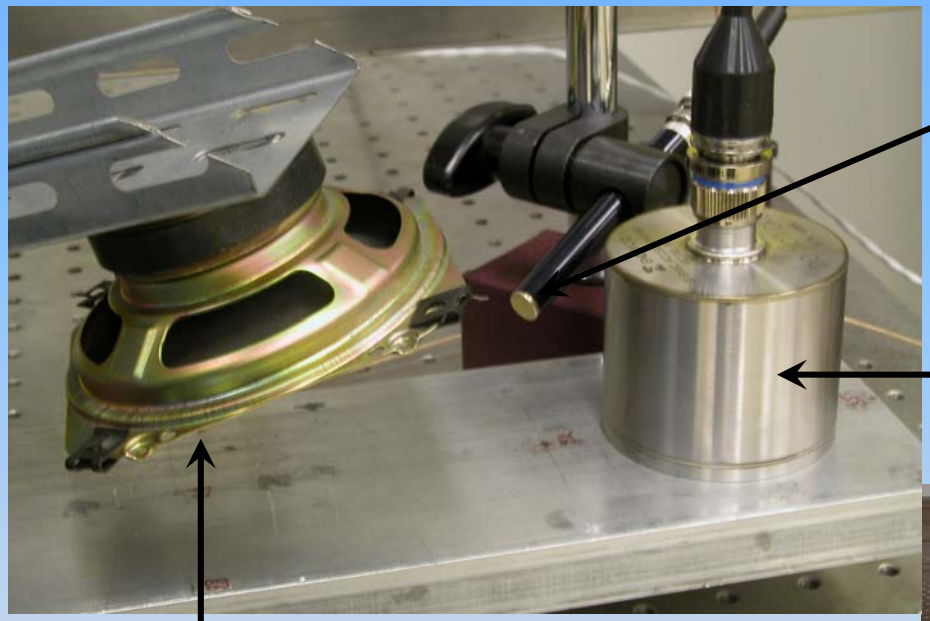
✓ **Comparison of beam vibrations subject to two different levels of acoustic noise :**

- **Low acoustic level :** Measurements done in the quiet room
- **Acoustic level higher :** Same conditions than previously but with the pink noise

✓ Check that the ground motion is the same during the study

1. Free-fixed beam under indoor environmental acoustic noise

Experimental setup



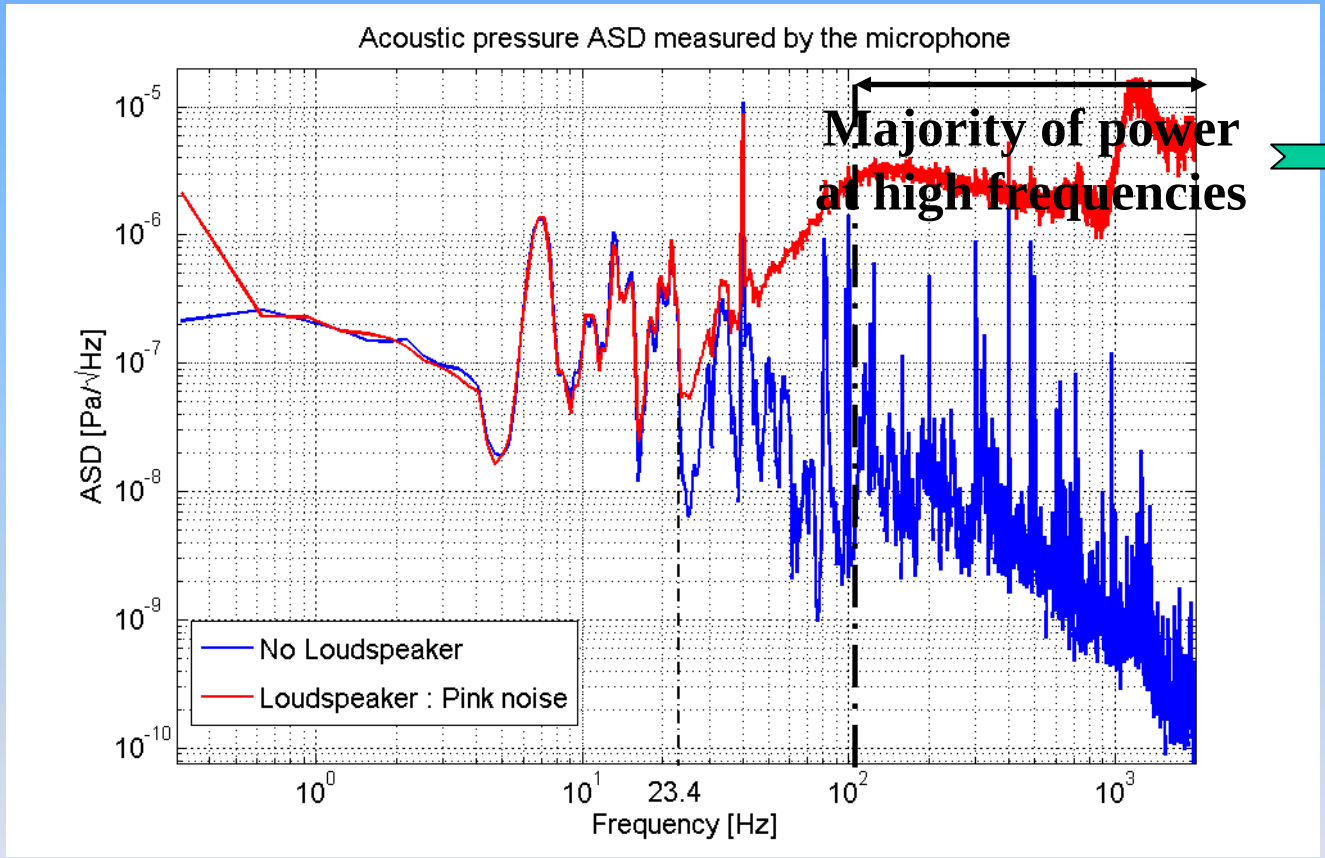
Microphone
Frequency range : [6Hz; 100Hz]

ENDEVCO accelerometers
Frequency range : [0.01Hz; 100Hz]

Loudspeaker

1. Free-fixed beam under indoor environmental acoustic noise

Amplitude spectral density of acoustic pressure



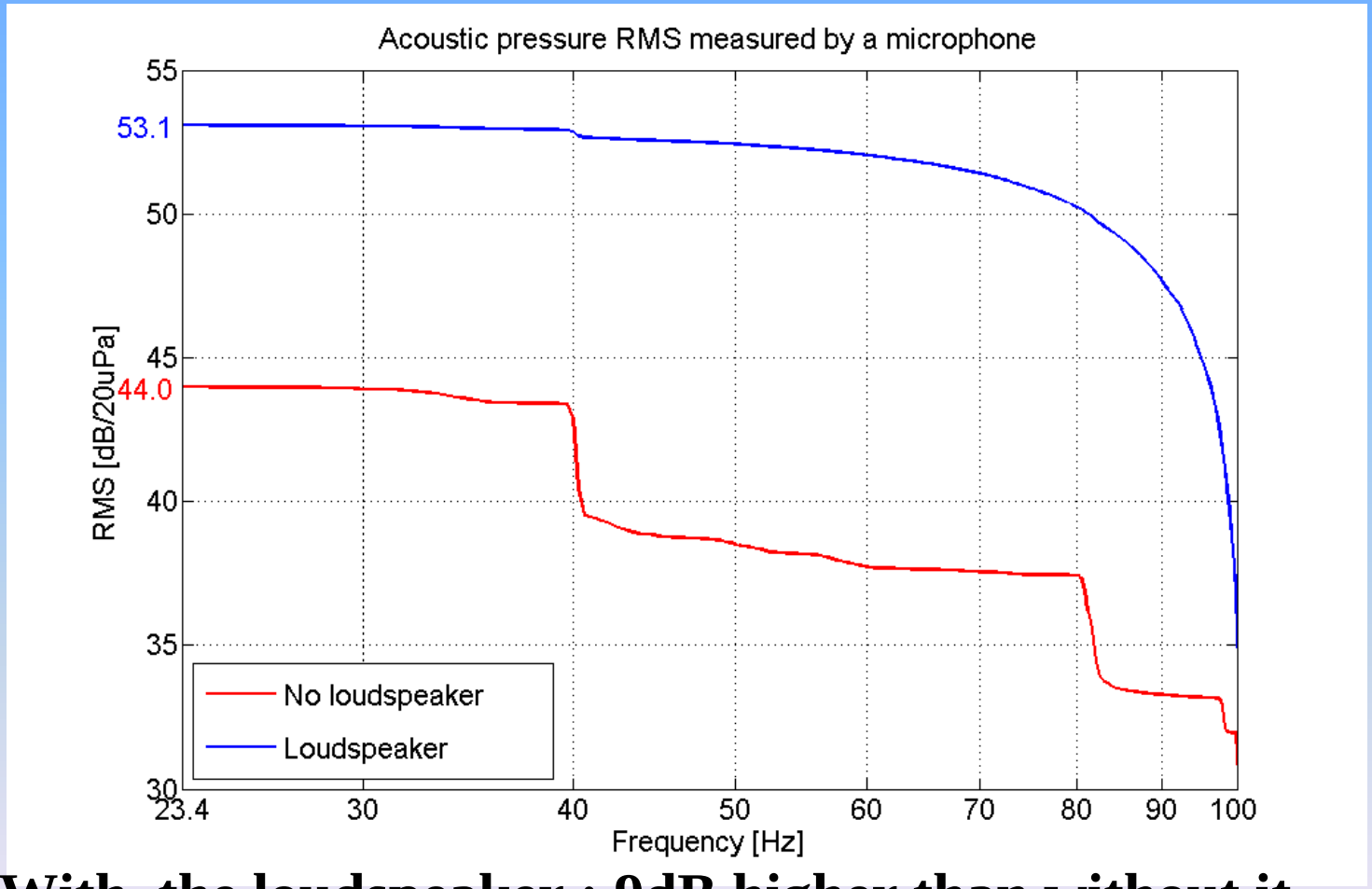
Outside accelerometers frequency range

✓ Creation of an acoustic noise only above 23Hz with the loudspeaker

✓ Impossibility for the loudspeaker to create a pink noise

1. Free-fixed beam under indoor environmental acoustic noise

Acoustic pressure RMS

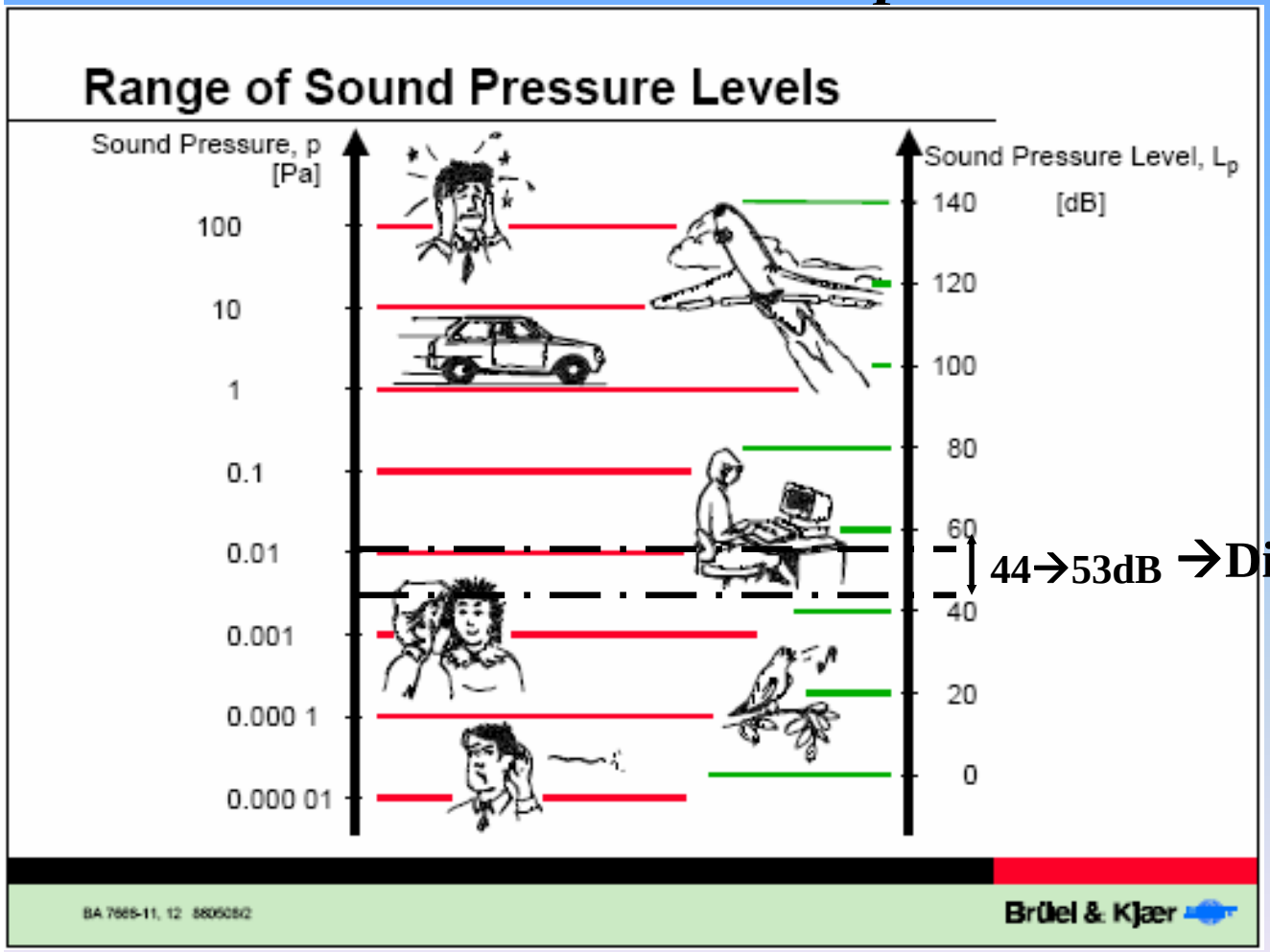


✓ **With the loudspeaker : 9dB higher than without it**

→ **Difference significant ?**

1. Free-fixed beam under indoor environmental acoustic noise

Acoustic pressure RMS

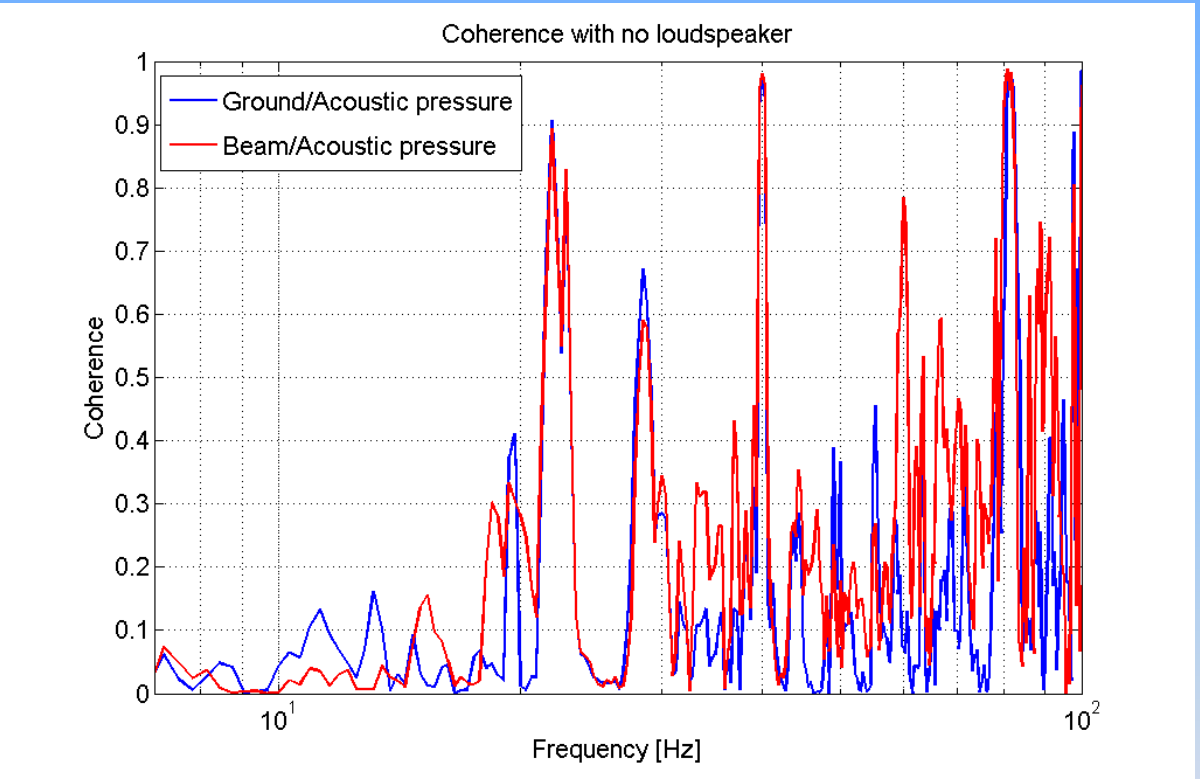


44→53dB →Difference not significant

→ Loudspeaker not powerful enough below 100 Hz : majority of power concentrated at high frequencies

1. Free-fixed beam under indoor environmental acoustic noise

Source of the working room acoustic noise (No loudspeaker)



Coherence Ground/Acoustic pressure :
Peaks of coherence

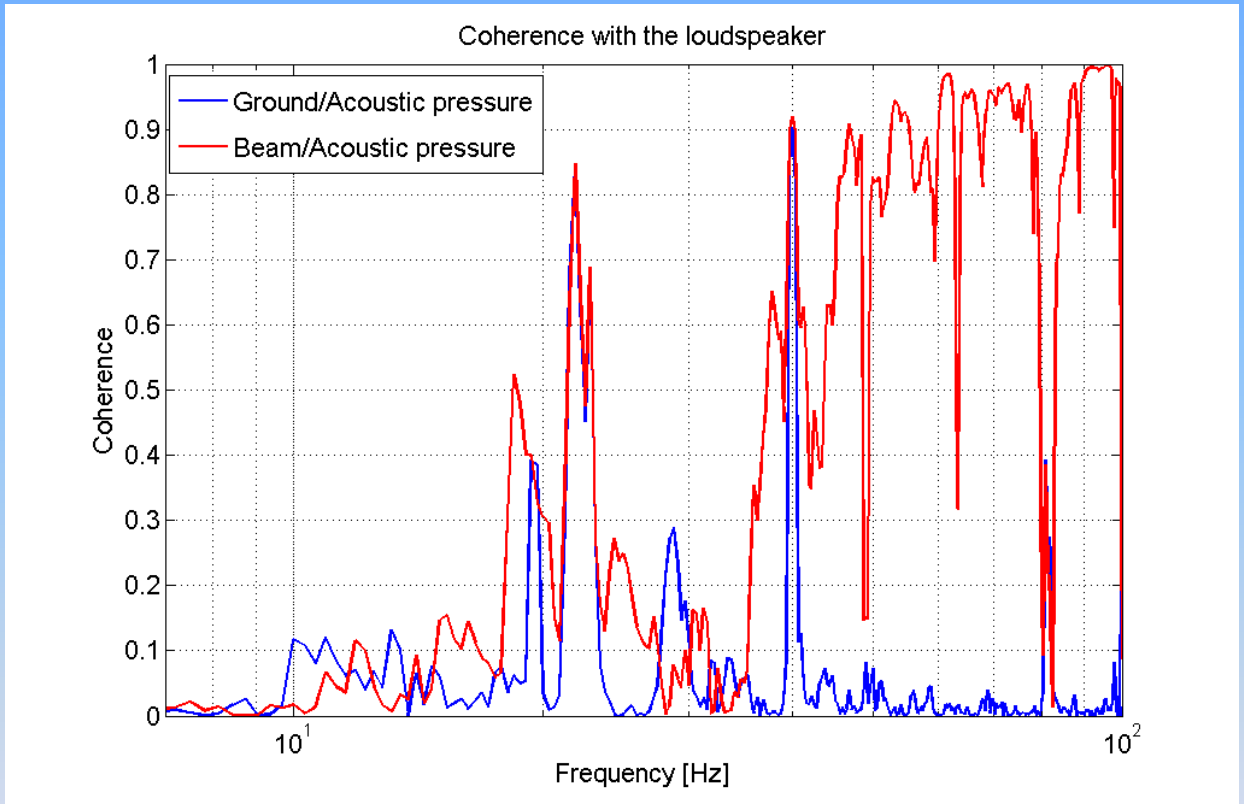
→ Often the same sources between acoustic noise and ground motion

Coherence Beam/Acoustic pressure :
more peaks of coherence

→ Excitation of the beam by acoustic noise : not always the same source than ground motion

1. Free-fixed beam under indoor environmental acoustic noise

Source of the slightly higher working room acoustic noise simulated



Coherence Ground/Acoustic pressure : very low

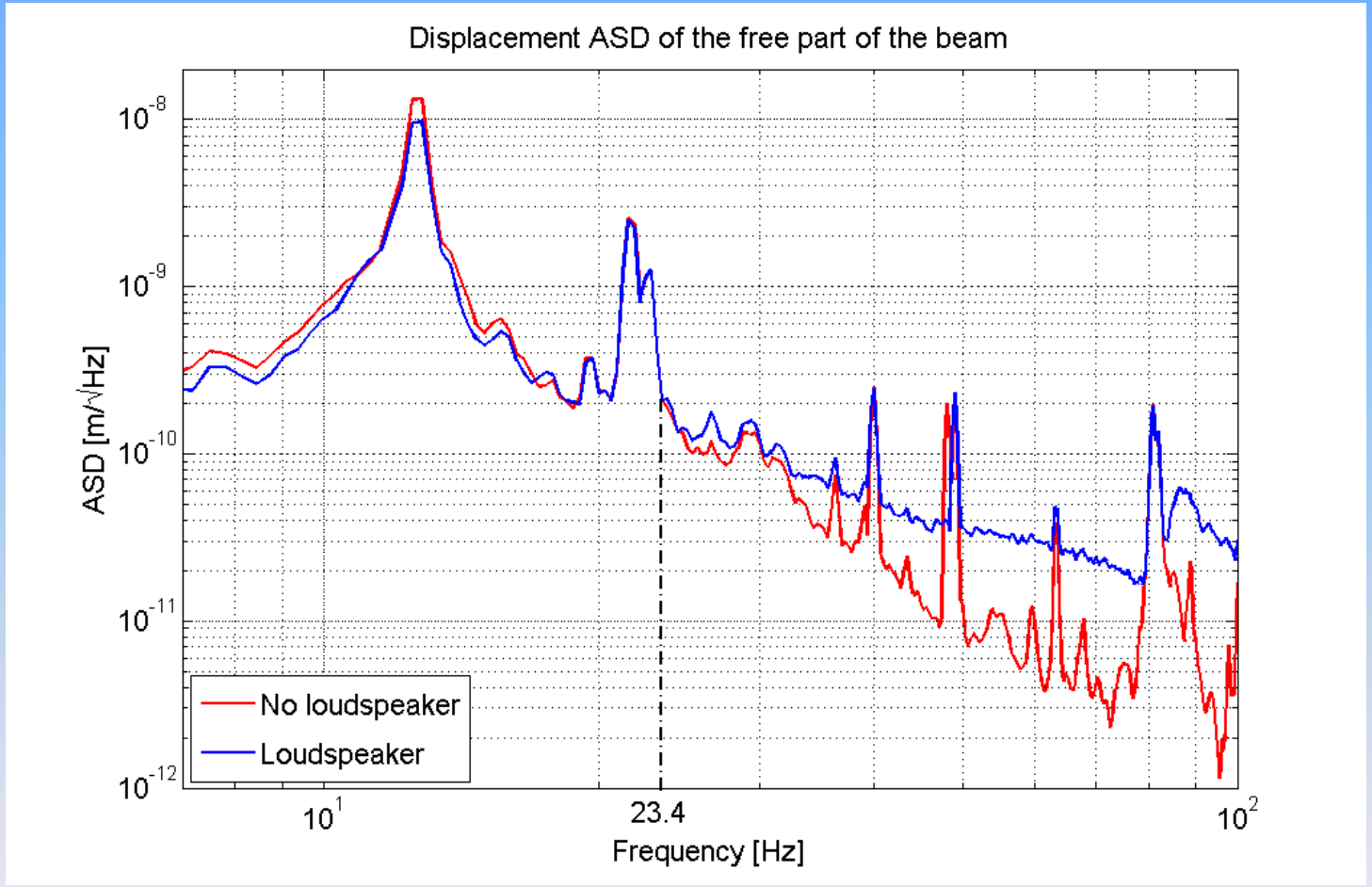
→ Loudspeaker well isolated from the ground : good!!

Coherence Beam/Acoustic pressure : high

→ Beam well excited by the loudspeaker

1. Free-fixed beam under indoor environmental acoustic noise

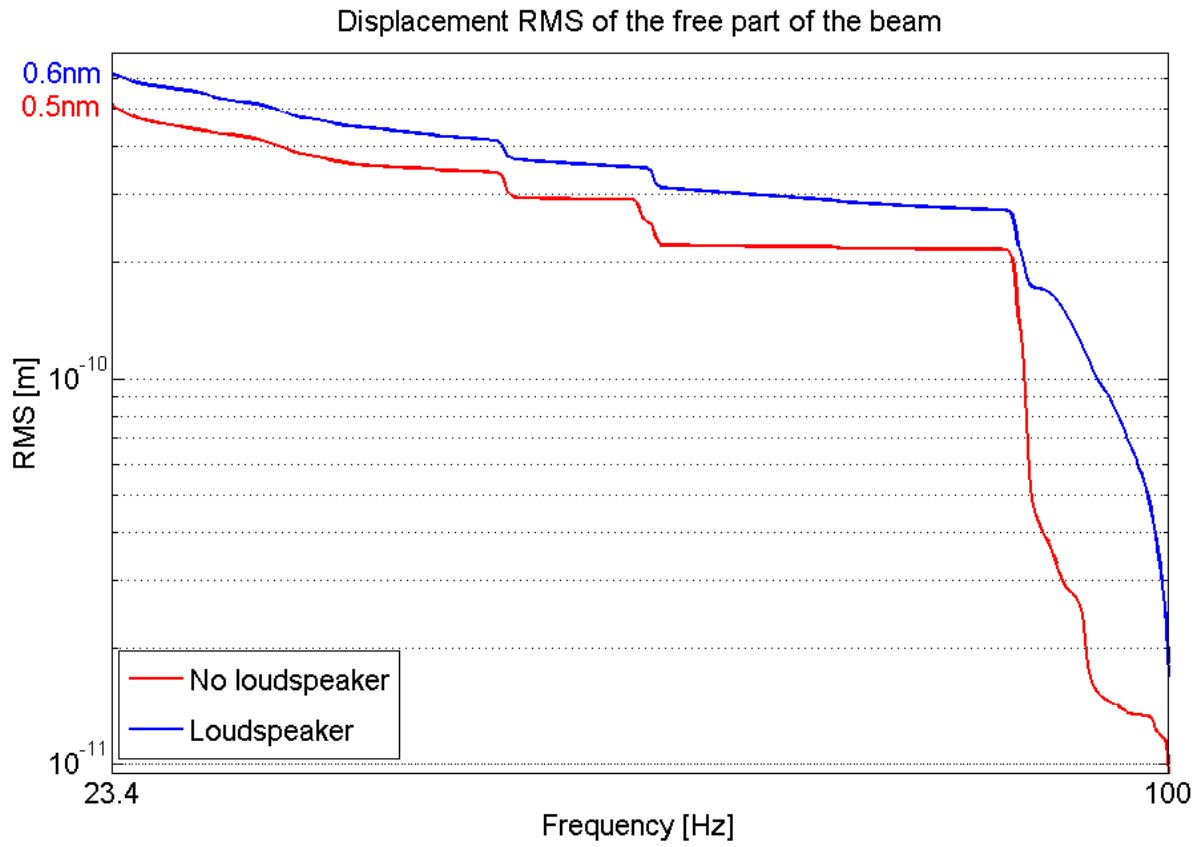
Impact of the loudspeaker on the vibrations of the beam



✓ **Above 23.4Hz :** Vibrations of the beam higher with the loudspeaker

1. Free-fixed beam under indoor environmental acoustic noise

Impact of the loudspeaker on the vibrations of the beam



Very small increase of acoustic pressure : 44dB→53dB

Small increase of the beam displacement : 0.1nm

✓ **Impact of acoustic noise on the displacement of a free-fixed beam proved**

✓ But need to go on with this study to evaluate the importance of this noise

1. Free-fixed beam under indoor environmental acoustic noise

Future prospects

✓ Use of another loudspeaker more powerful able to create an acoustic pink noise at low (below 10Hz) and high frequencies

✓ Contrary to ground motion, acoustic noise high at high frequencies :

→ Use of high sensitivity accelerometers measuring up to 1000Hz

✓ Displacement RMS performed for different levels of acoustic noise :

- from 7Hz to 100Hz
- from 100Hz to 1000Hz

→ Estimation of the acoustic noise impact at low and high frequencies

2. Behaviour of the beam under different levels of acoustic noise

Principle of the study

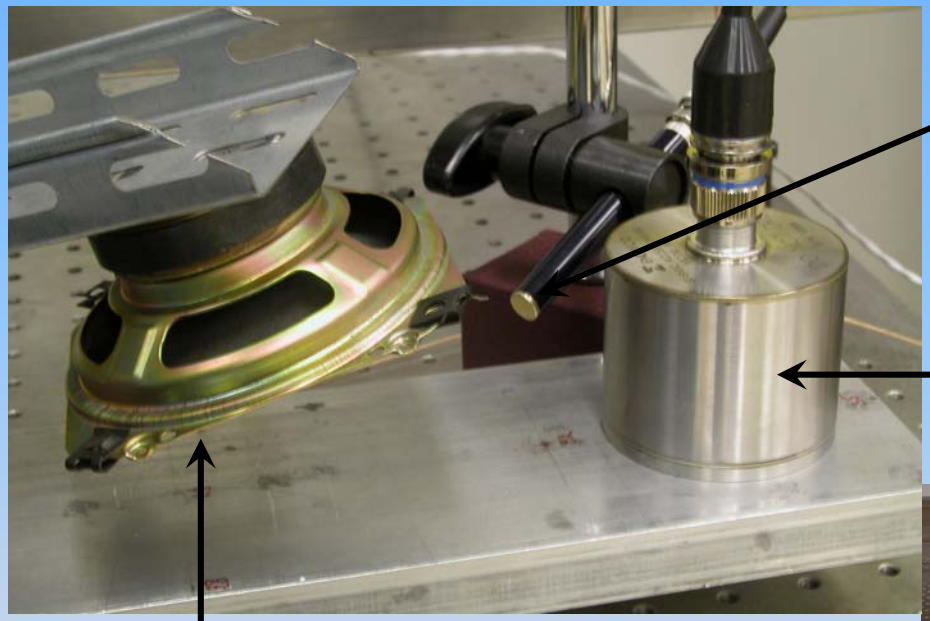
- ✓ **Pink noise : loudspeaker not enough powerful below 100Hz**
  - → Sinusoidal acoustic noise of 70Hz used to excite the beam
  - → Majority of power concentrated at this frequency

- ✓ Comparison of beam vibrations for different levels of this sinusoidal acoustic noise

- ✓ Check that the ground motion is the same during the study

1. Free-fixed beam under indoor environmental acoustic noise

Experimental setup



Microphone
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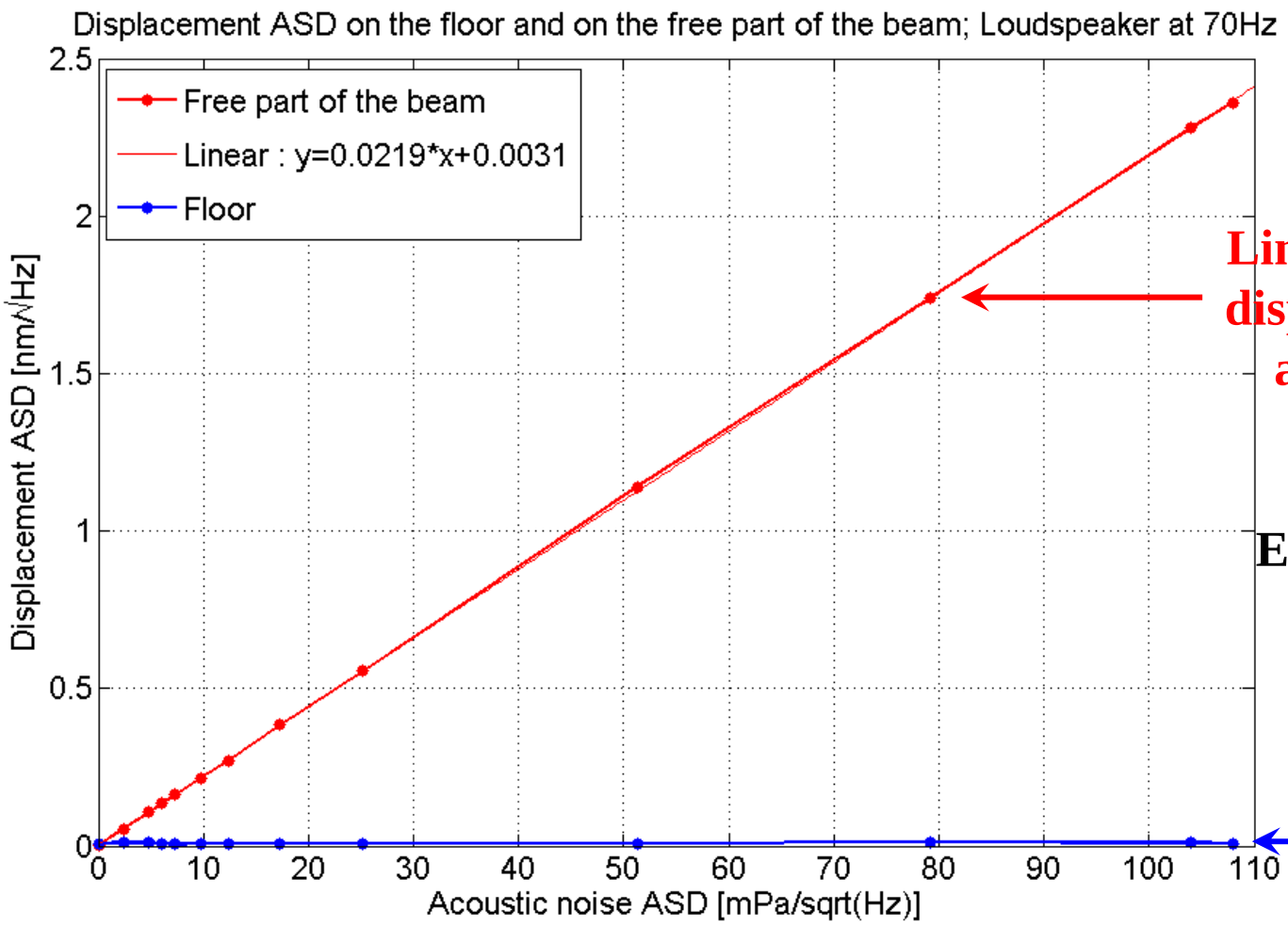
Frequency range : [0.01Hz; 100Hz]

Loudspeaker

2. Behaviour of the beam under different levels of acoustic noise

Behaviour of the beam subject to different levels of acoustic noise



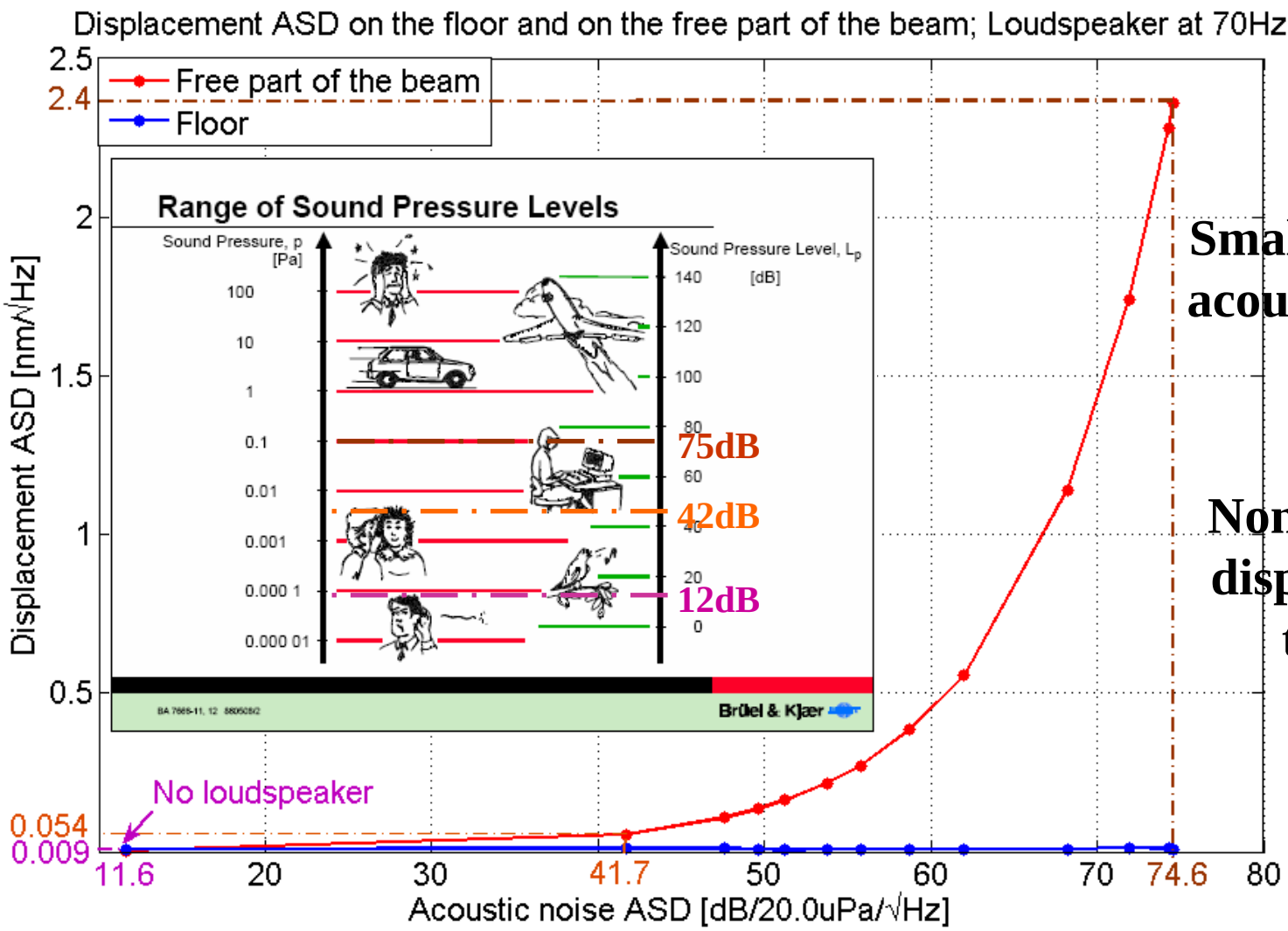
Linearity of the beam displacement with the acoustic pressure

Experimental set-up well imagined

Stationarity of the ground motion

2. Behaviour of the beam under different levels of acoustic noise

Behaviour of the beam subject to different levels of acoustic noise



Small increase of acoustic pressure

Non negligeable displacement of the beam

General conclusion and future prospects

✓ **Small increase of acoustic pressure ⟹ Increase of the beam displacement non negligible**

→ Non negligible impact of acoustic noise on the displacement of the beam proved

✓ **In a linear collider, acoustic noise very important :**

→ Need to go on with the study of acoustic noise

✓ **Excitation on a predictive model : only ground motion**

→ Maybe should include acoustic noise

✓ **Other future prospects :**

→ Acquisition of an acoustic enclosure to put the free-fixed beam in