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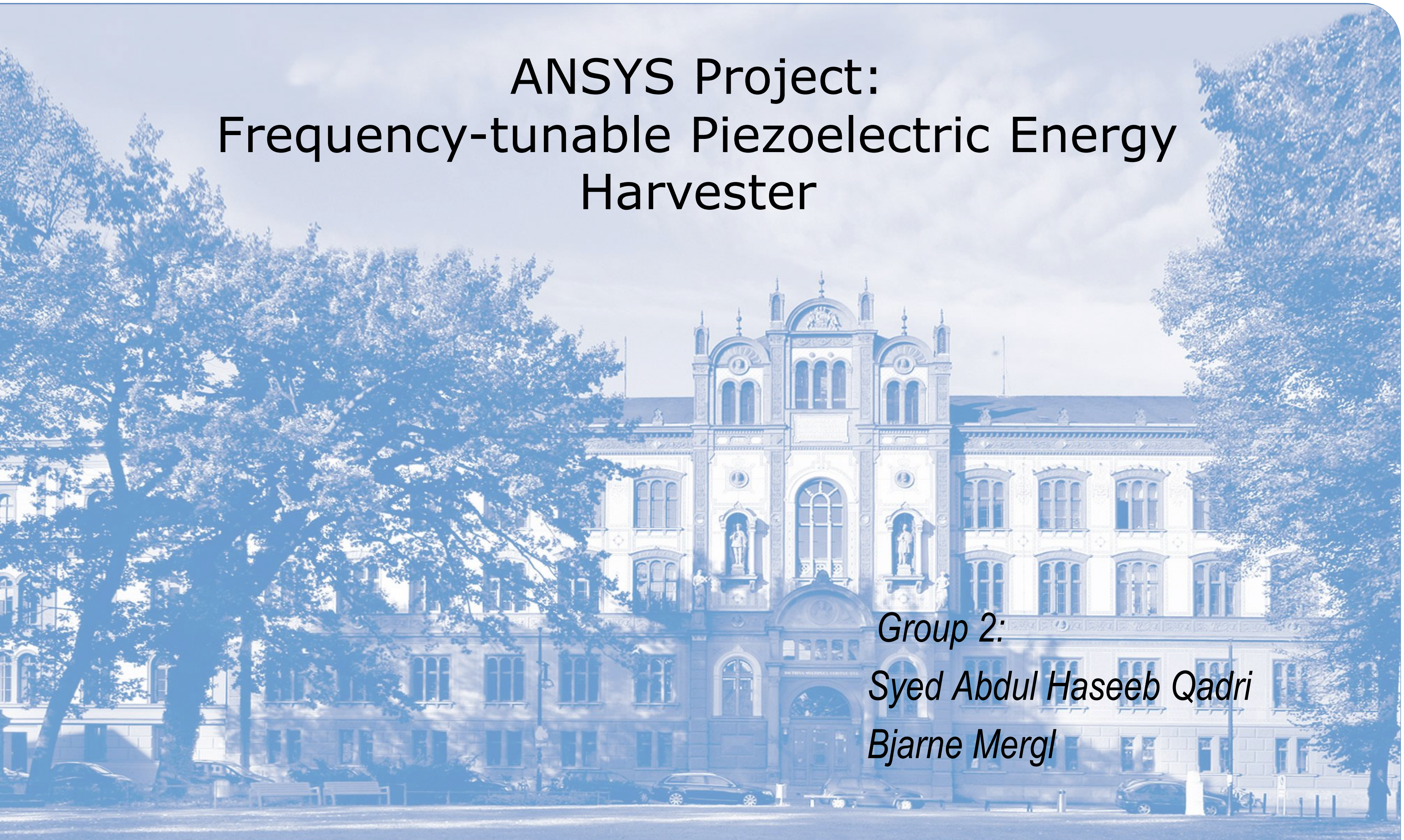

ANSYS Project: Frequency-tunable Piezoelectric Energy Harvester

Group 2:

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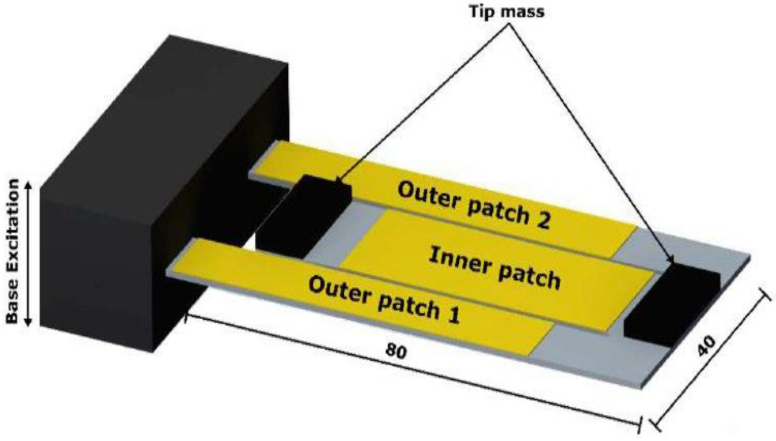
INTRODUCTION

Frequency-tunable Piezoelectric Energy Harvester

- Mechanical Energy → Electrical Energy.
- “Piezoelectric Crystals deposits charge on its surface by mechanical deformation”

- The device consists of **two parts**:
  - Mechanical part: Folded beam which vibrates due to external influence
  - Piezoelectric Patches: Fabricated on folded beam and gives electrical output due to deformations caused by the vibration of beam.



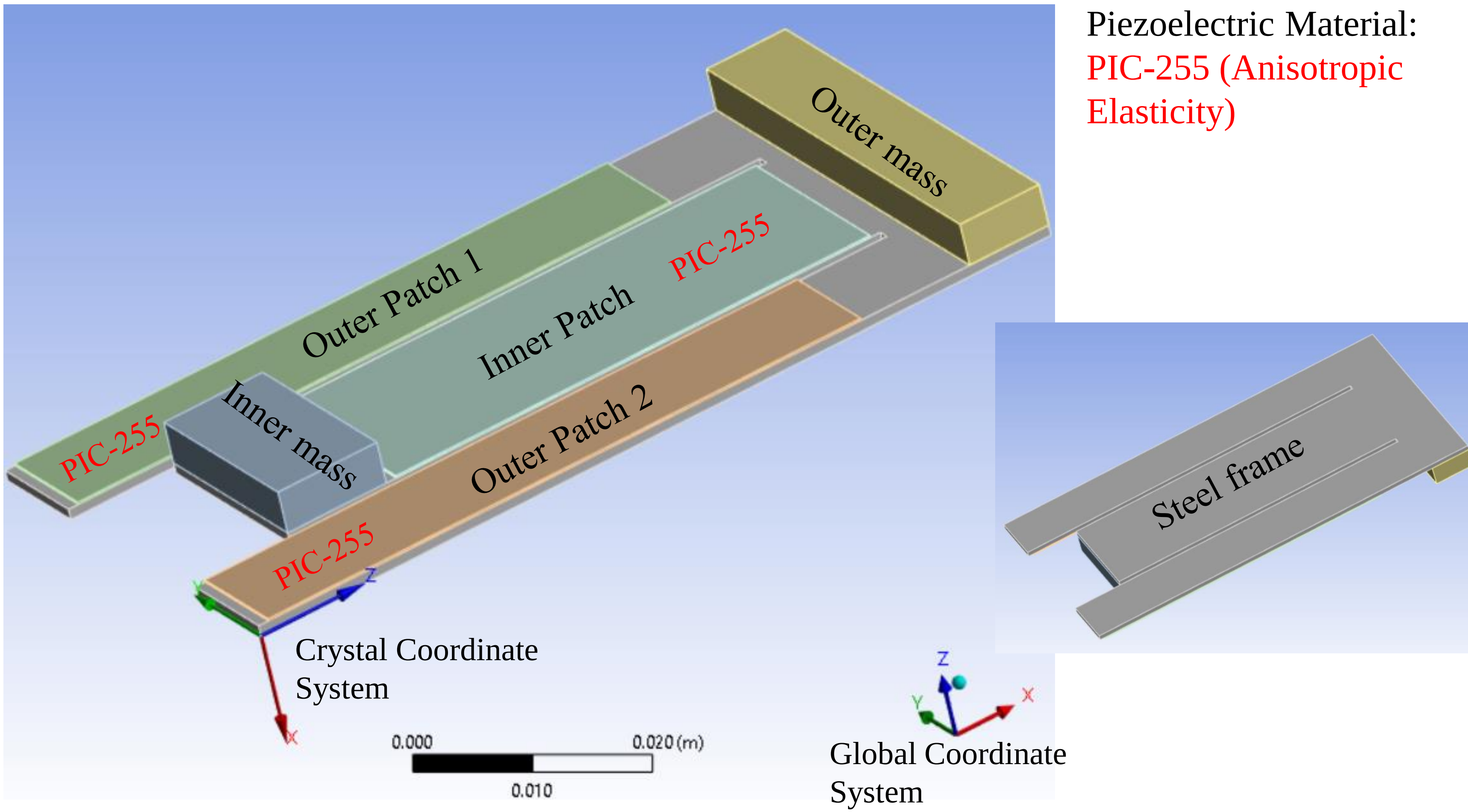
S. Bouhedma et al. “Multiphysics modeling and simulation of a dual frequency energy harvester”.*32th European Conference on Modeling and Simulation(ECMS)*, 2018.

OUR OBJECTIVE

- Design Mechanical model of the device
- Perform Modal Analysis
- Find Harmonic Response

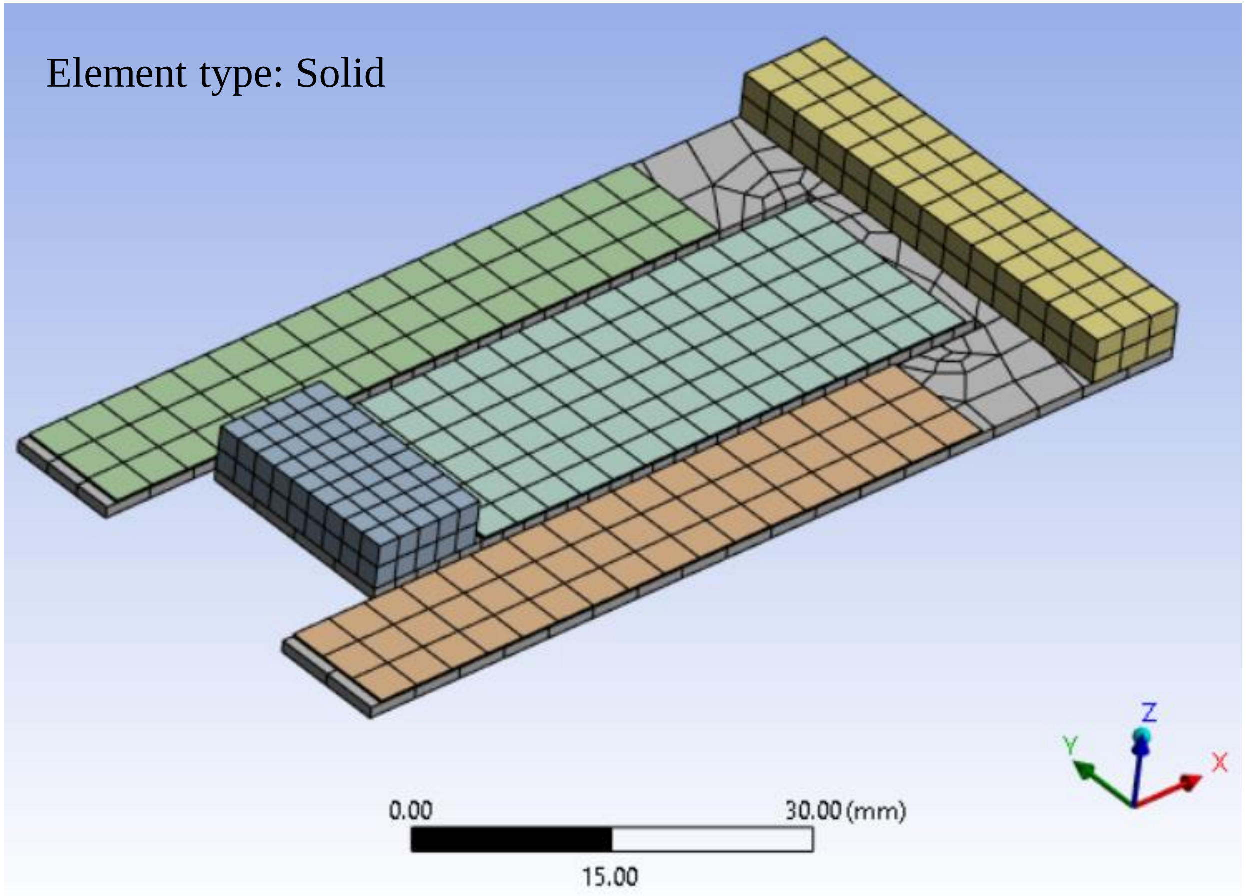
- Why are we interested in finding harmonic response?
    - To match source/environment frequencies with the usable modal frequencies of the device for maximum energy extraction.
    - Frequency range optimization

Model Geometry

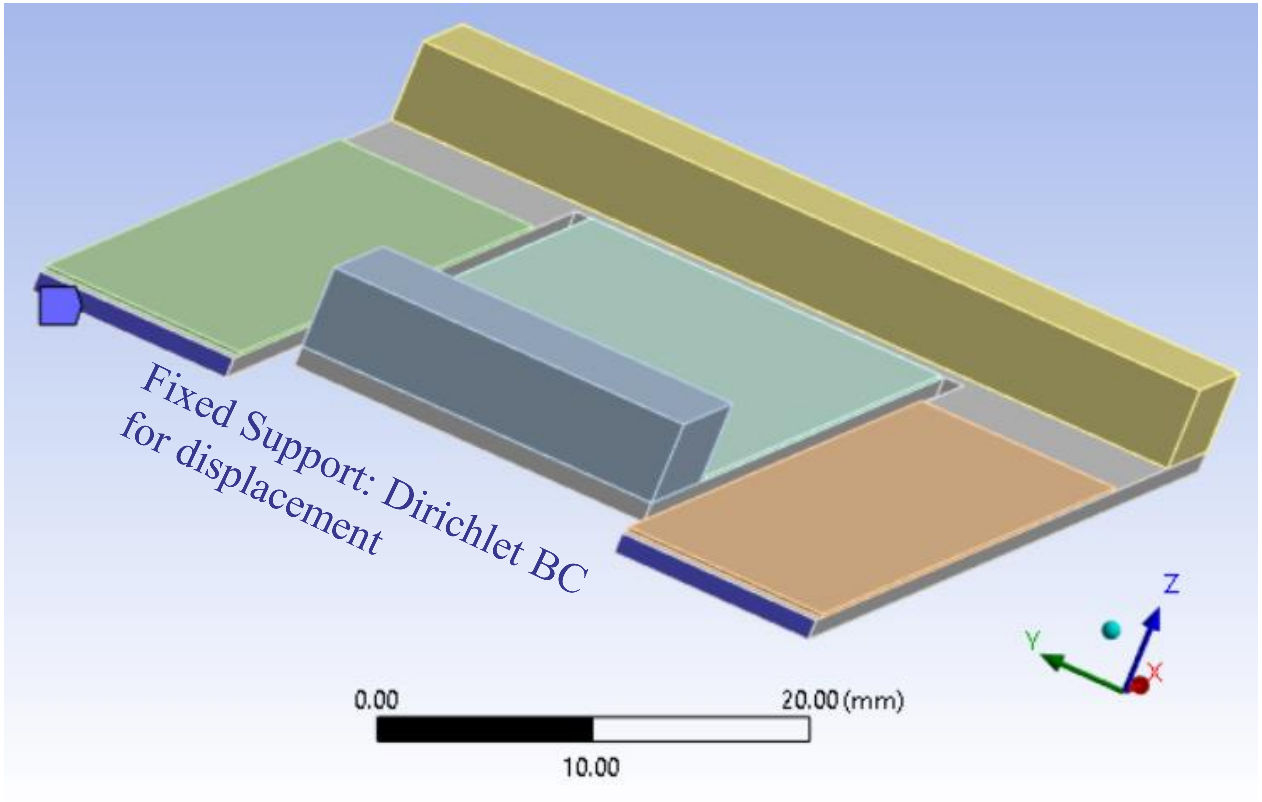


Piezoelectric Material:
PIC-255 (Anisotropic Elasticity)

Meshing



Boundary Conditions



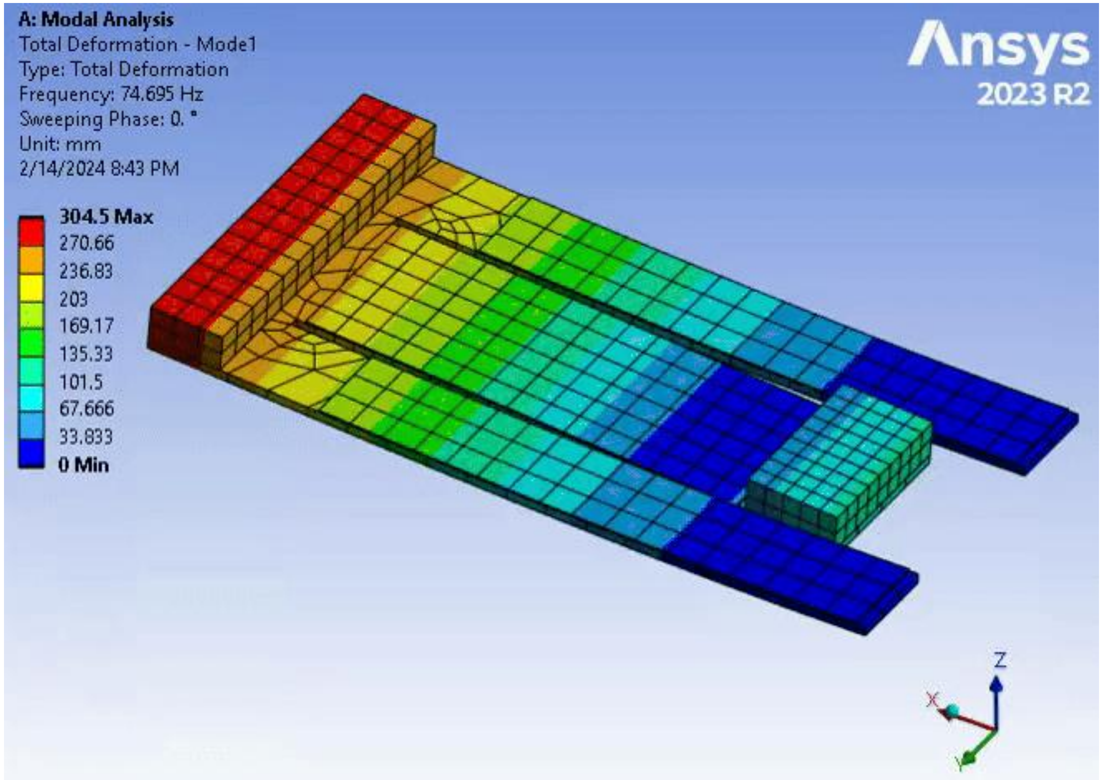
Displacement excitation on the fixed support later

MODAL ANALYSIS

MODE 1:

- The whole structure bends synchronically.
- The outer mass oscillation is the main contributor.
- Frequency: 74.7 Hz
- Stress occurs in the patches

Total Deformation

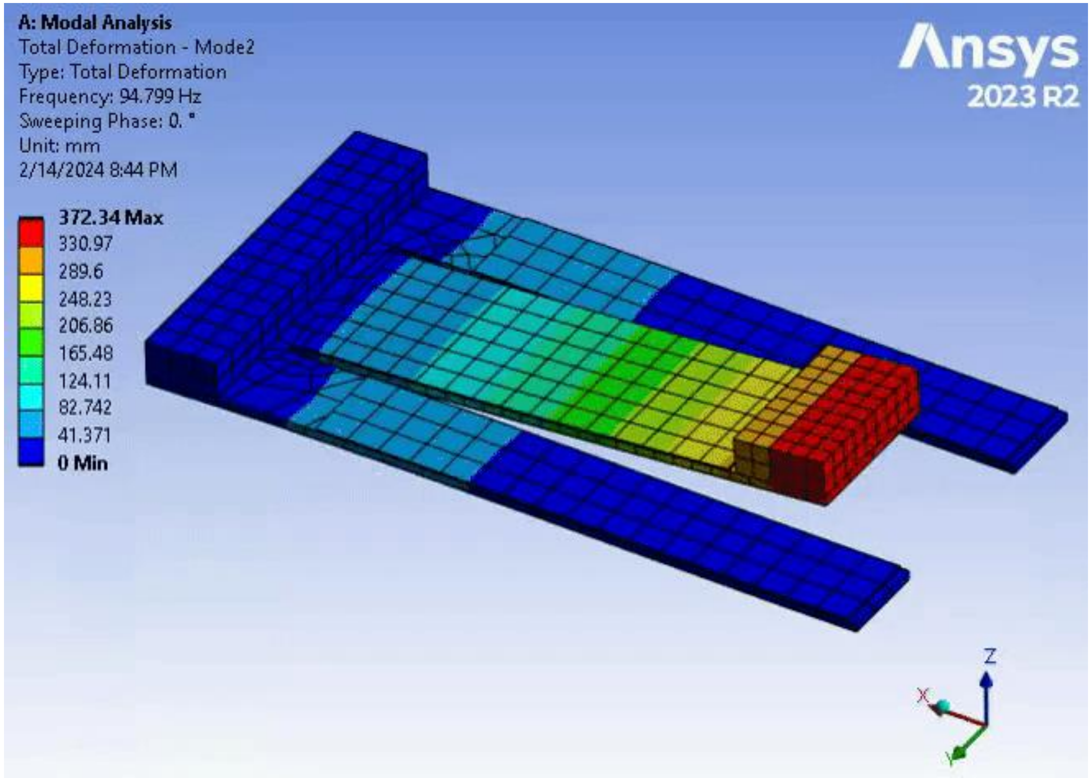


MODAL ANALYSIS

MODE 2:

- Only the inner part bends.
- The inner mass oscillation is the main contributor.
- Frequency: 94.8 Hz
- The stress is in the inner patch.

Total Deformation



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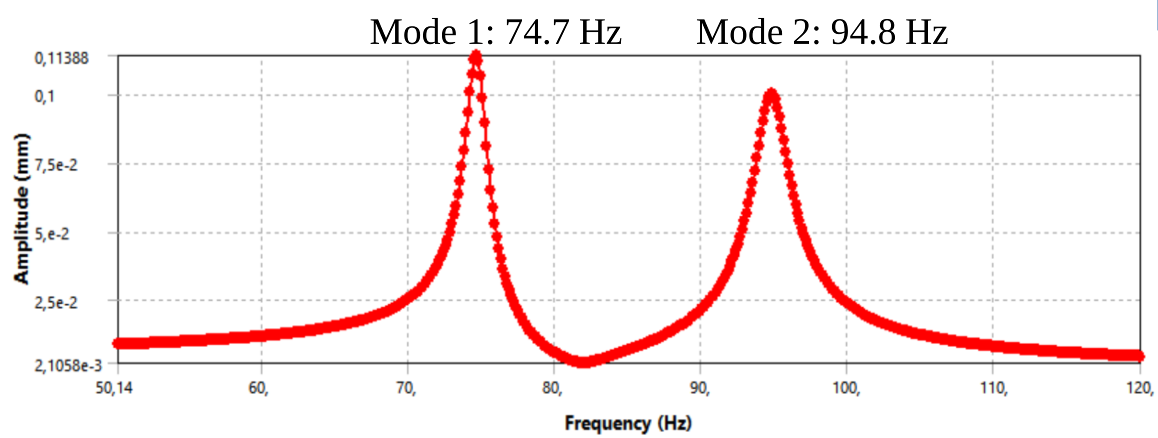
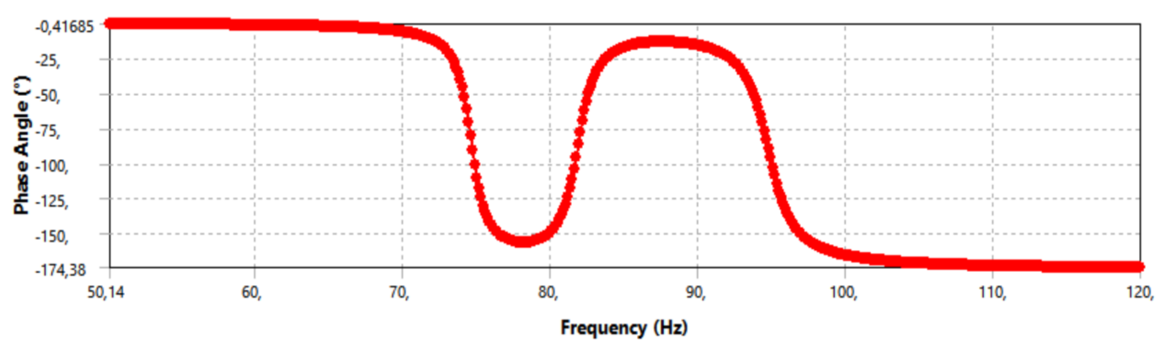
Frequency Response – z Deformation

- Excitation on the fixed support of 6 micrometers z direction.
- Resonance behavior around the mode frequencies.
- Phase angle is 90° at the resonance frequencies → Max mechanical energy input

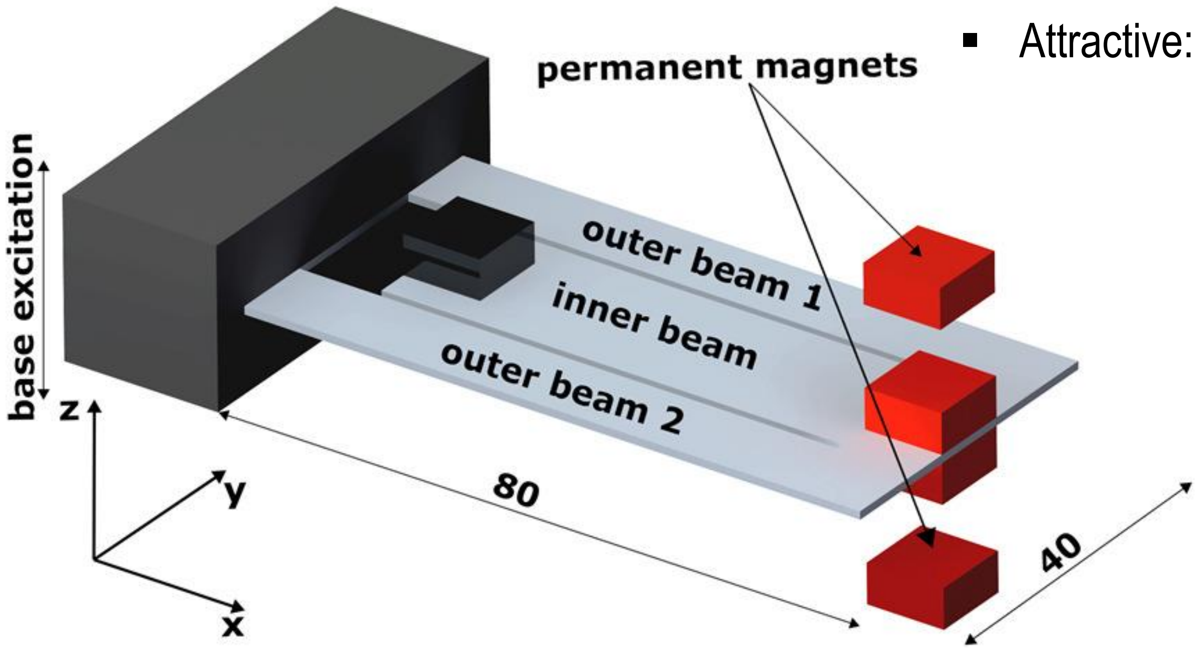




Frequency Tuning

Frequency Tuning of the Piezoelectric

- Use of magnets → Change in effective stiffness (k)
- Repulsive → k ↑→ Resonance frequency ↑
- Attractive: → k ↓→ Resonance frequency ↓



S N
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$$\omega = \sqrt{\frac{k}{m}}$$

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Applications

- Wearable devices:
  - In implants where frequent battery replacement is not possible.

- Wireless Sensor Networks
  - In environmental monitoring sensors, where sensors are required to continuously measure the environmental

- Structural Health Monitoring
  - Used as a sensor instead of an energy harvester.

THANK YOU!

Questions?