POLITECNICO
MILANO 1863

DEPARTMENT OF
MECHANICAL ENGINEERING

Metamaterials and Metastructures
Course project

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GENERAL ORGANIZATION

- The project will be done in groups of (tentatively) two students
- Short report (20-25 pages) resuming the main results (one per group)
- Oral presentation (15 minutes+questions)
  - Presentation of the project done in group
  - Q&A
  - Possible questions about theory (NO demonstrations) related to the project work

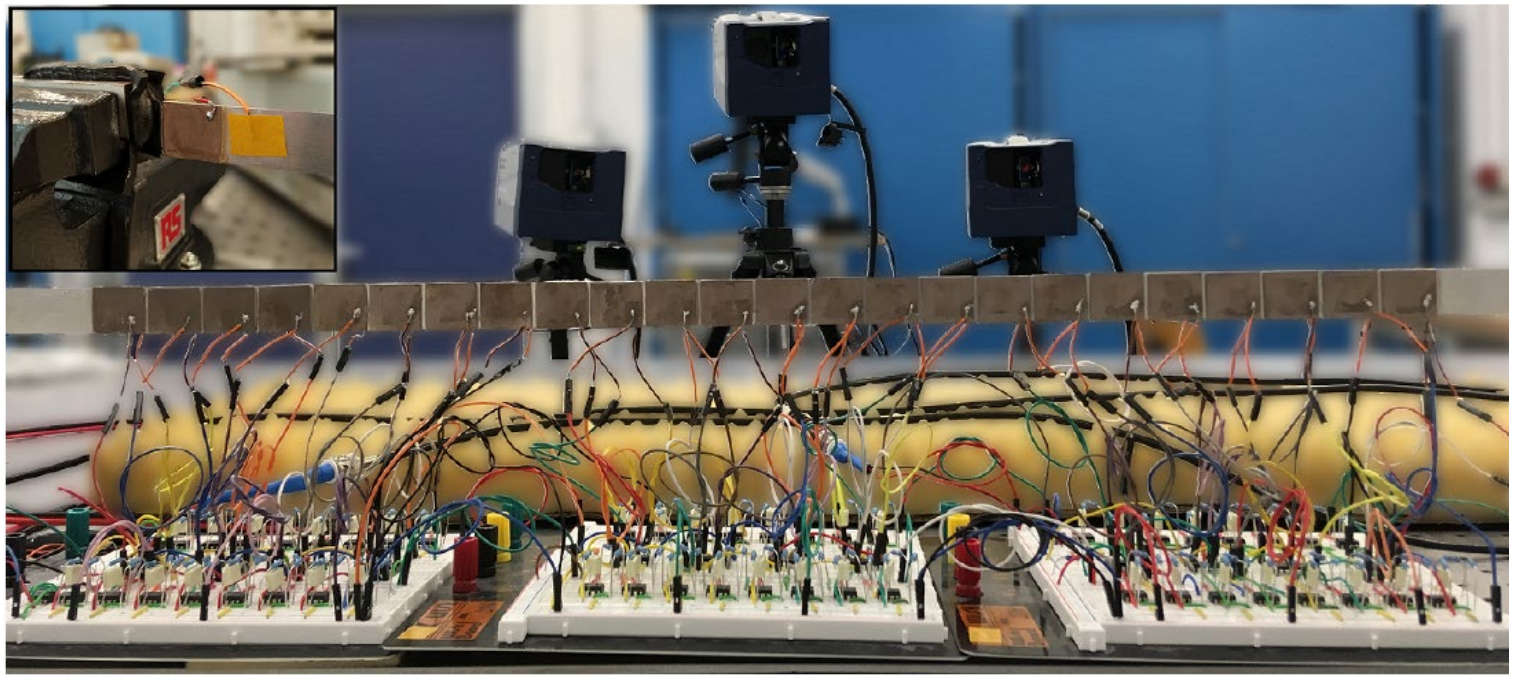
PROJECT OBJECTIVE

- Design and test a periodic beam with piezoelectric shunts
- Apply some of the concepts seen during the course to achieve particular structure behaviour
- Have an insight into the challenges of the experimental validation

INPUT INFORMATION AND DATA

- Characteristics of the beam (size, material, …)

- Characteristics of the piezo patches (datasheet, size, spacing, …)



INPUT INFORMATION AND DATA

- Experimental data available on that beam
  - Tests in OC
  - Tests in SC
  - Tests with time invariant periodic shunts
  - Tests with space-time modulation
  - Tests with varying boundary conditions and phase of modulation for wave transport

AVAILABLE TOOLS

- The tools that have been shown (or will be shown) during the course exercise sessions are “free to use” for the project

- Matlab codes
  - Transfer matrix
  - PWEM
  - FDTD for time simulation
  - Functions to open experimental data
  - …

- Comsol Multiphysics
  - Dispersion relation computation
  - FEM for time domain analysis
  - …

AVAILABLE TOOLS

- We will also share with you some papers/documents on these topics, that can be used as a reference in terms of procedure and results

STEPS

1. Model the beam with time-invariant properties, including the presence of piezos and piezo shunts
    1. Matlab model (TM)
    2. Comsol model (with equivalent Young modulus)

2. Verify the effective coupling coefficient of the piezos through the analysis of experimental data (SC vs OC)

3. Perform a sensitivity analysis on the dispersion relation considering different shunt layouts (L, RL, RC with negative capacitance, RLC with negative capacitance)

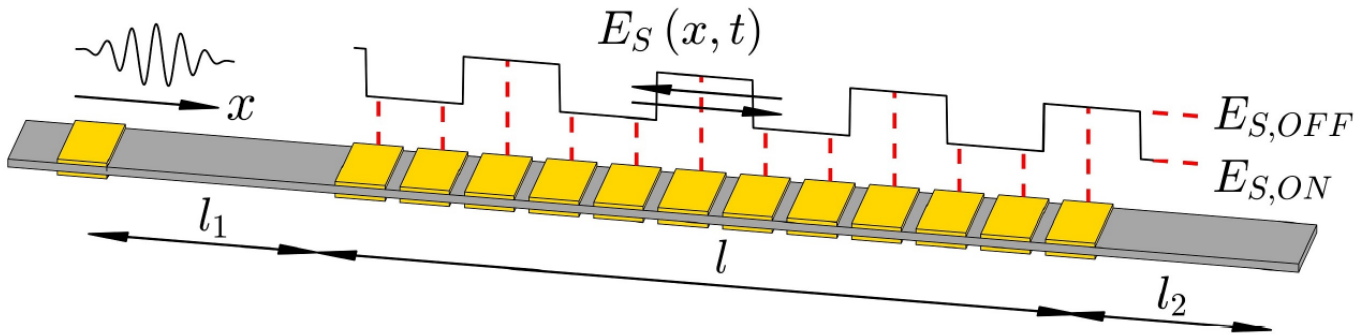
STEPS

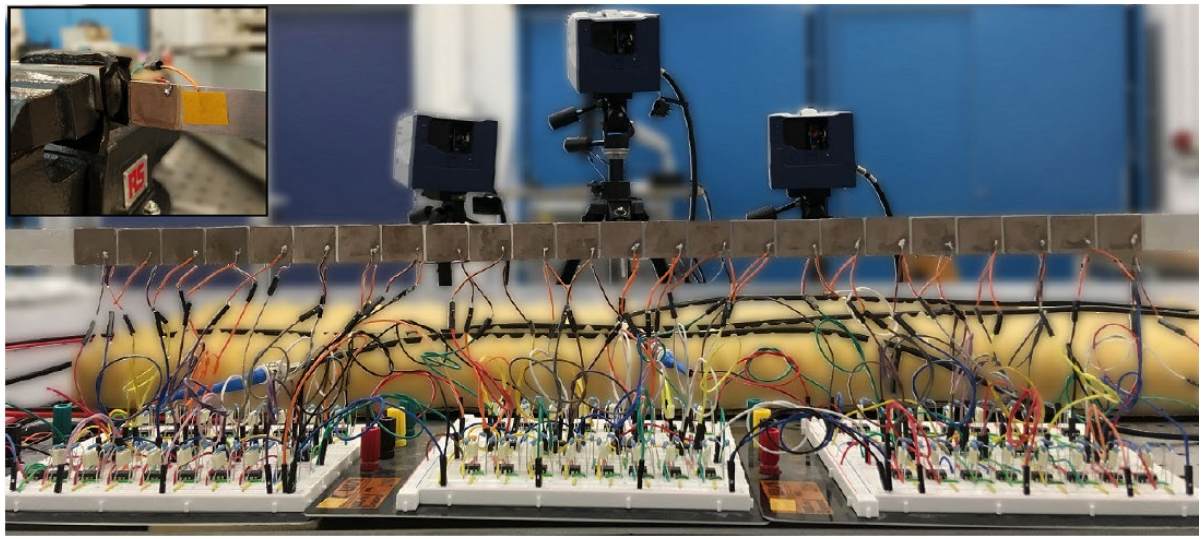
4. Compare the results obtained on the analysis of the unit cell at point 3 with numerical simulations and experimental data (for the shunt values for which experimental data are available)

5. (Optional) Study the evolution of boundary modes of the finite structure

6. (Optional) Compare numerical results and experimental data for this application

LAYOUT FOR POINTS 3-4





LAYOUT FOR POINTS 5-6