



MICRO 372 - Advanced Mechanisms for Extreme Environments

Chapter 10

Characterization and testing

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Characterization and tests

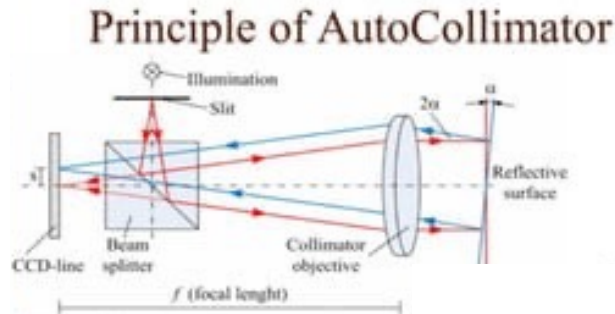
What features tests can be performed on a mechanism (CRRM/COMAM example)

- Mass and overall dimensions
- Motion range (input, output), reduction ratio
- Output torques and forces
- Parasitic motions at output
- Repeatability with and without output load
- Elastic torque
- Mechanical end-stops repeatability
- Stiffness
- Thermo-elastic behavior
- Sine and random vibrations



Motion range

- Contactless sensor should be used to measure motion and position:
 - For **position, parasitic motions, motion range and thermo-elastic deformation**: linear optical encoders, interferometers, inductive sensors, capacitive sensor
 - For **angles**: rotary optical encoders, autocollimators or triple beam interferometers

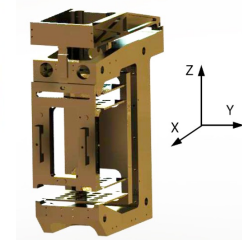
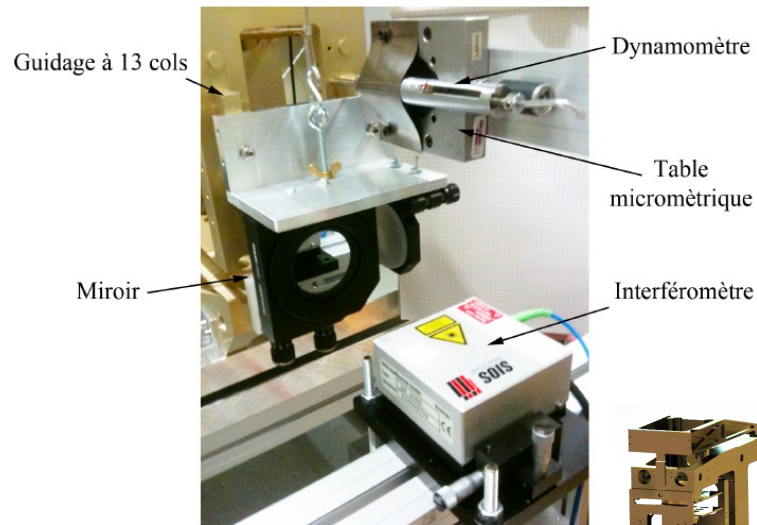


Example Autocollimator Shown

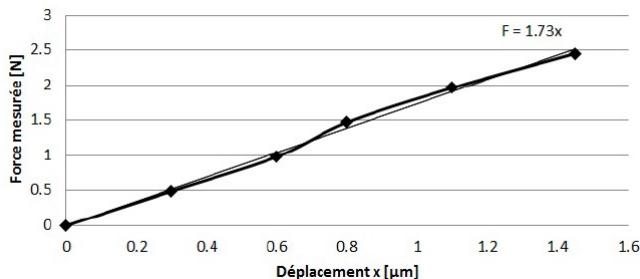
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Stiffnesses

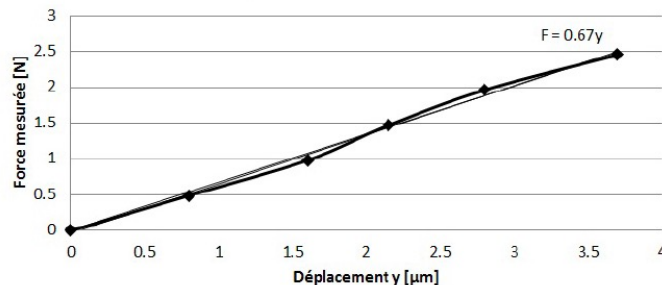
- Involves a **force measurement** and a **displacement measurement**
- **Beware of the force loop:** do not place the displacement sensor on it!
- Both **natural** and **transversal stiffnesses** have generally to be measured



Rigidité latérale X

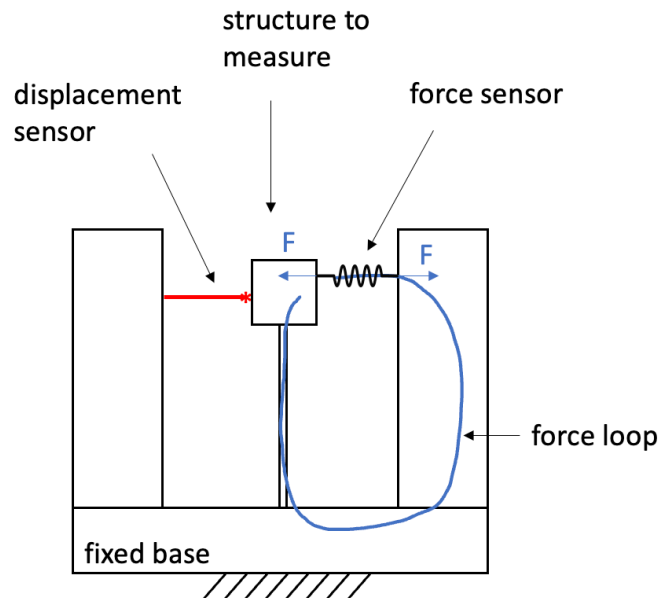
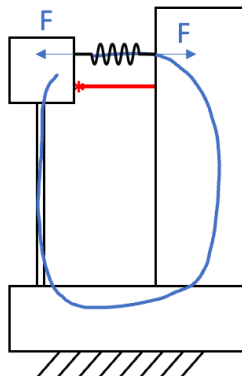


Rigidité latérale Y



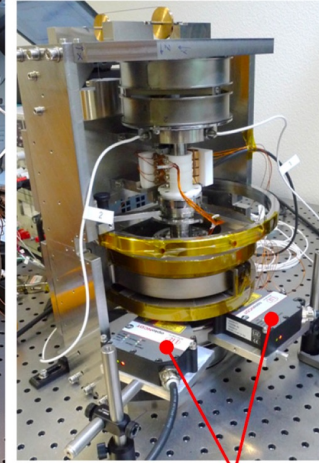
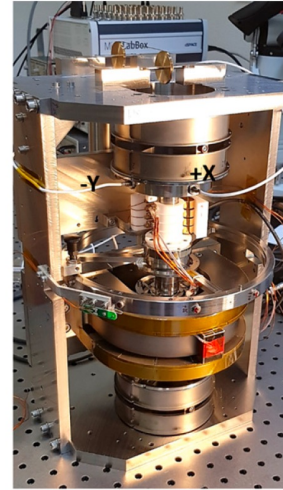
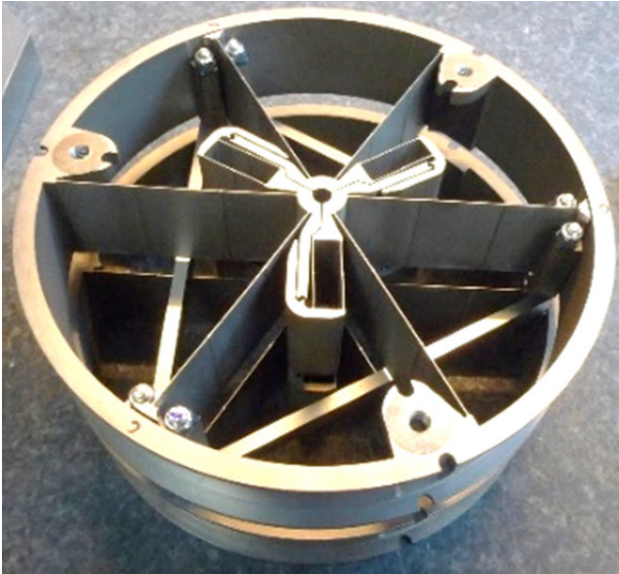
Stiffness

- Involves a **force measurement** and a **displacement measurement**
- Beware of the **force loop**, do not place the displacement sensor on it!

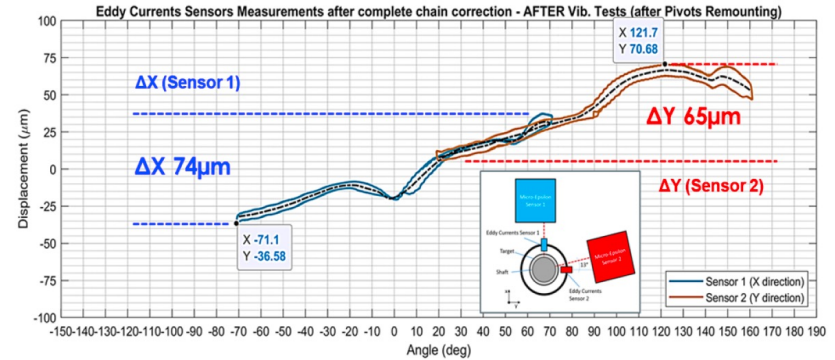


Parasitic motion

- Lateral parasitic motion or center of rotation shift are monitored while moving the mechanism along its main translation axis

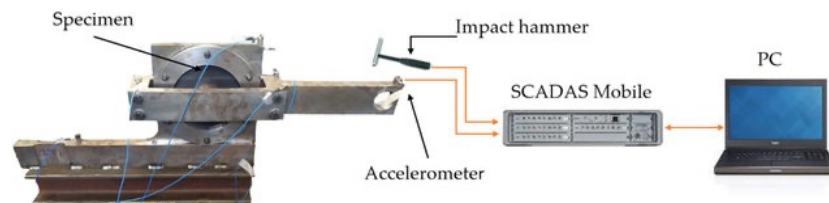
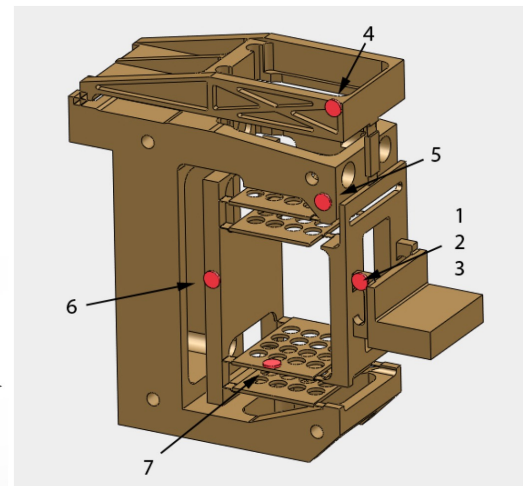
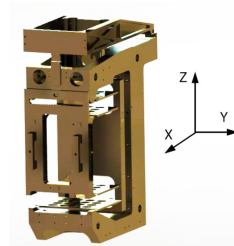


MicroEpsilon sensors mounted to measure bottom pivot (-Z)



Eigenfrequencies

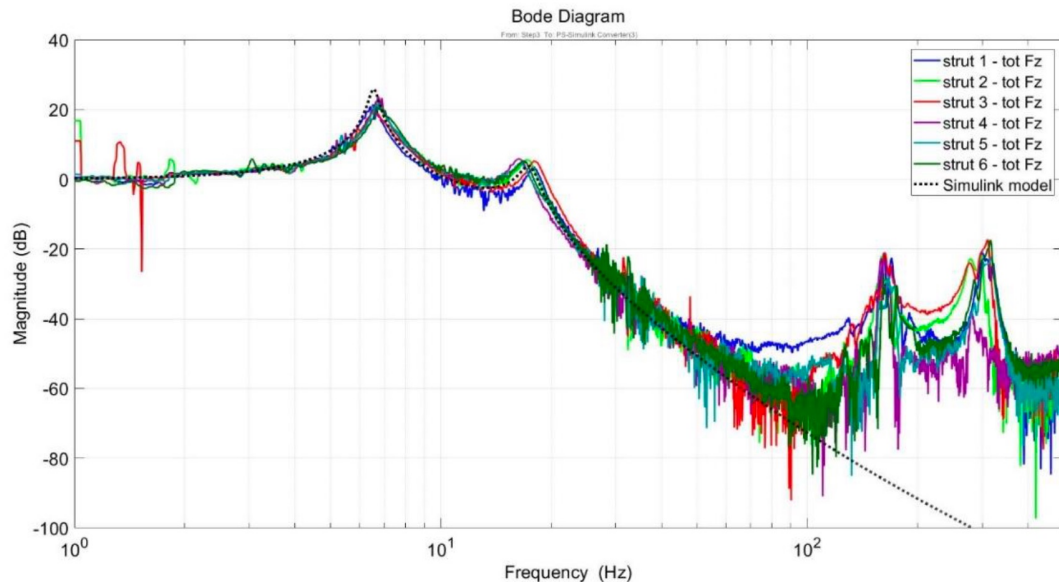
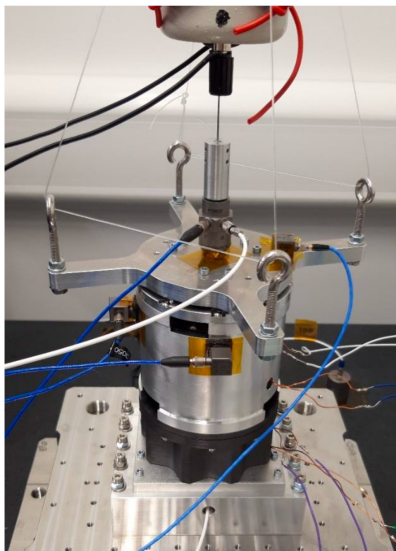
- **Hammer impact modal testing** is a common method of **characterizing the vibrations of a structure** by imparting a known force and measuring the response of the structure.
- Calculating the frequency response over multiple locations, either simultaneously or individually, will yield data that can be used to estimate the **dynamic response of the structure**.



position	freq mes. 1 [Hz]	freq mes. 2 [Hz]	freq mes. 3 [Hz]	freq mes. 4 [Hz]
1) sortie x	142.5	342.5	492.5	882.5
2) sortie y	72.5	122.5	302.5	432.5
3) sortie z	0.6	140	965	
4) levier	72.5	250	645	
5) bâti	242.5	322.5	535	642.5
6) table inter.	300	790		
7) barre	285	315	910	

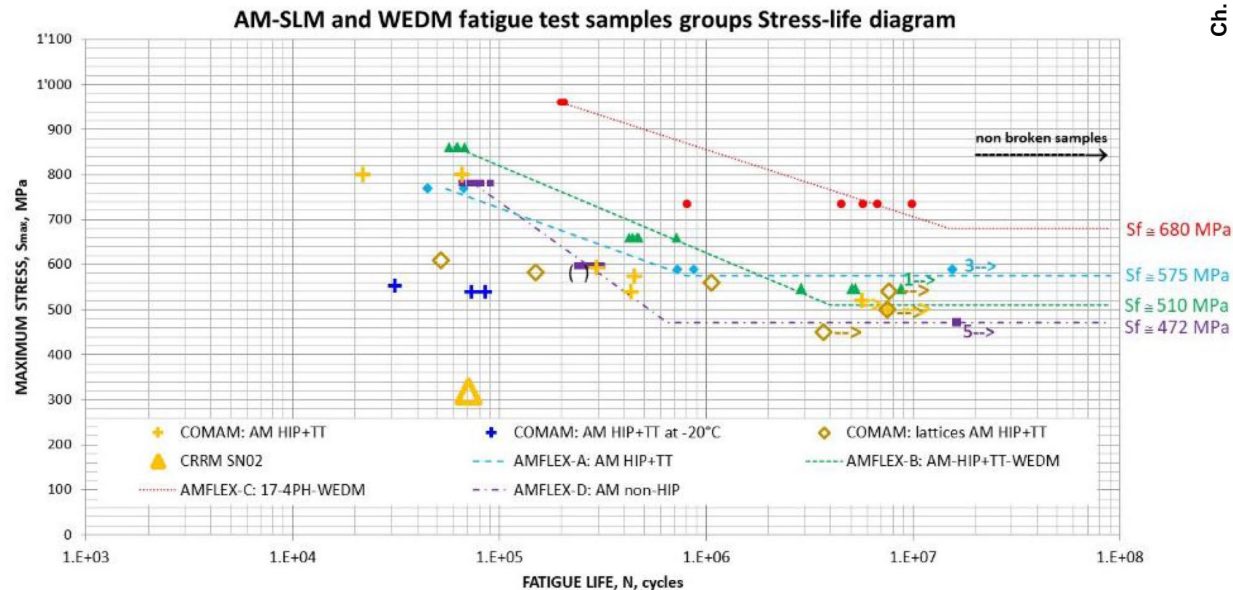
Environmental vibrations

- **Sine sweep** and **random vibrations** are applied with a shaker on the mechanism
- **Accelerometer** record the **spectral response** of the mechanism



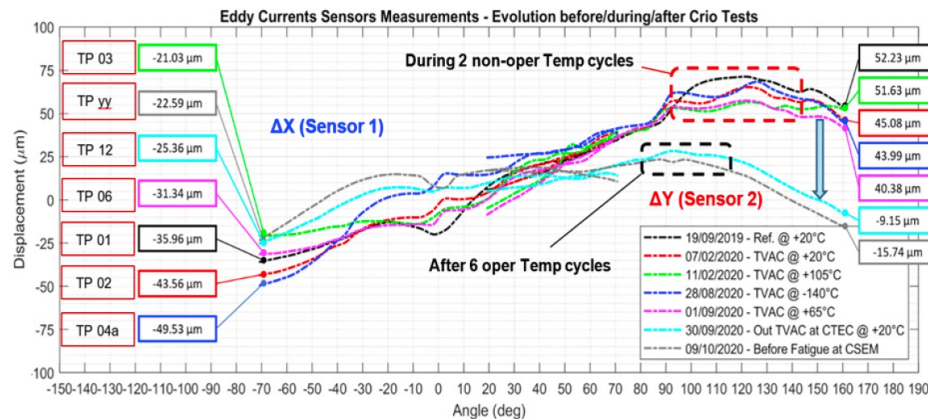
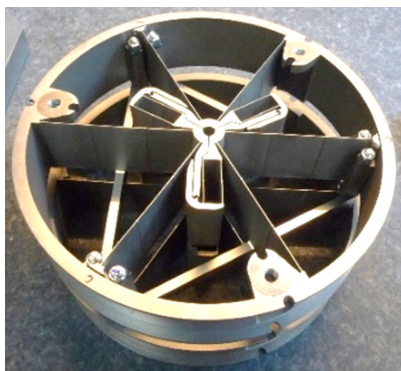
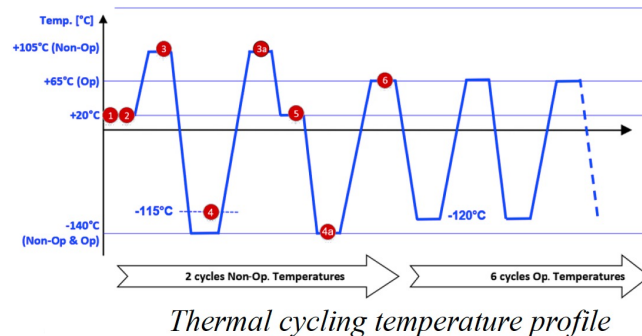
Fatigue testing

- **Sample blades** are tested at a frequency of a few Hertz (or more on a shaker)
- Fatigue test on sample blades need to be **representative of the conditions experienced by the mechanism.**
- **Fatigue plateau** is determined for test samples with different post-treatments



Thermal Vacuum (TVAC)

- Thermal vacuum tests are performed in a **thermal vacuum chamber**.
- TVAC test are conducted to demonstrate the capability of the test item to operate according to requirements **in vacuum at predefined temperature condition**.
- Temperature conditions can be expressed as **temperature level, gradient and variation**.



Week 11 exercises and homework

Exercise on MOODLE:

- EXO11_Balancing_III.pdf

Homework:

- No homework