ACTIVE ISOLATION OF AN EXTENDED STRUCTURE USING A HIGH-RESOLUTION OPTICAL INERTIAL SENSOR

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- Why an extended structure?

  Represents CERN quadrupoles

- Why a new optical sensor?

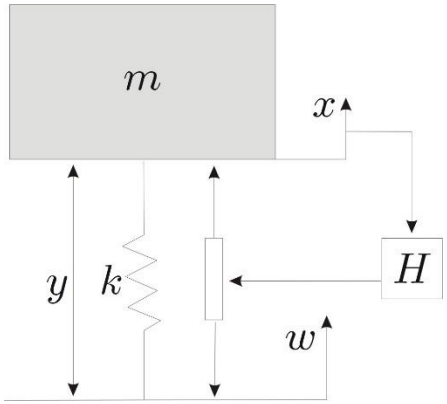
  Small

  Compatible with magnetic field

  Compatible with radiations

- Why active isolation?

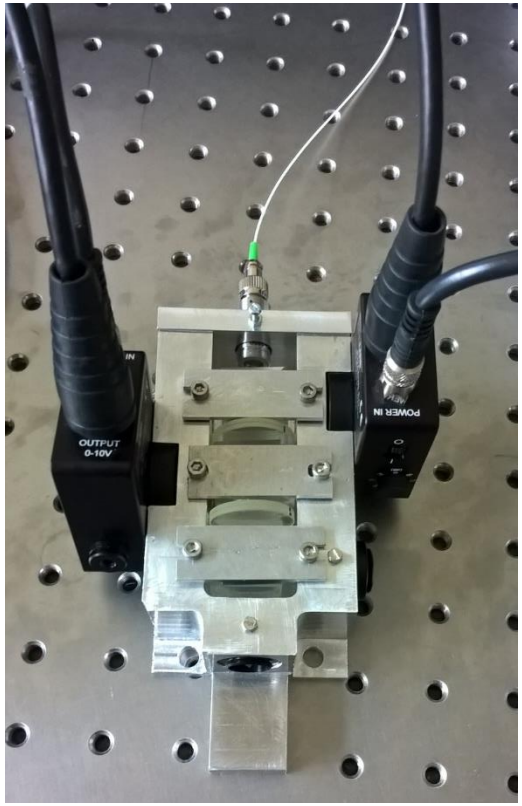
  Low frequency isolation

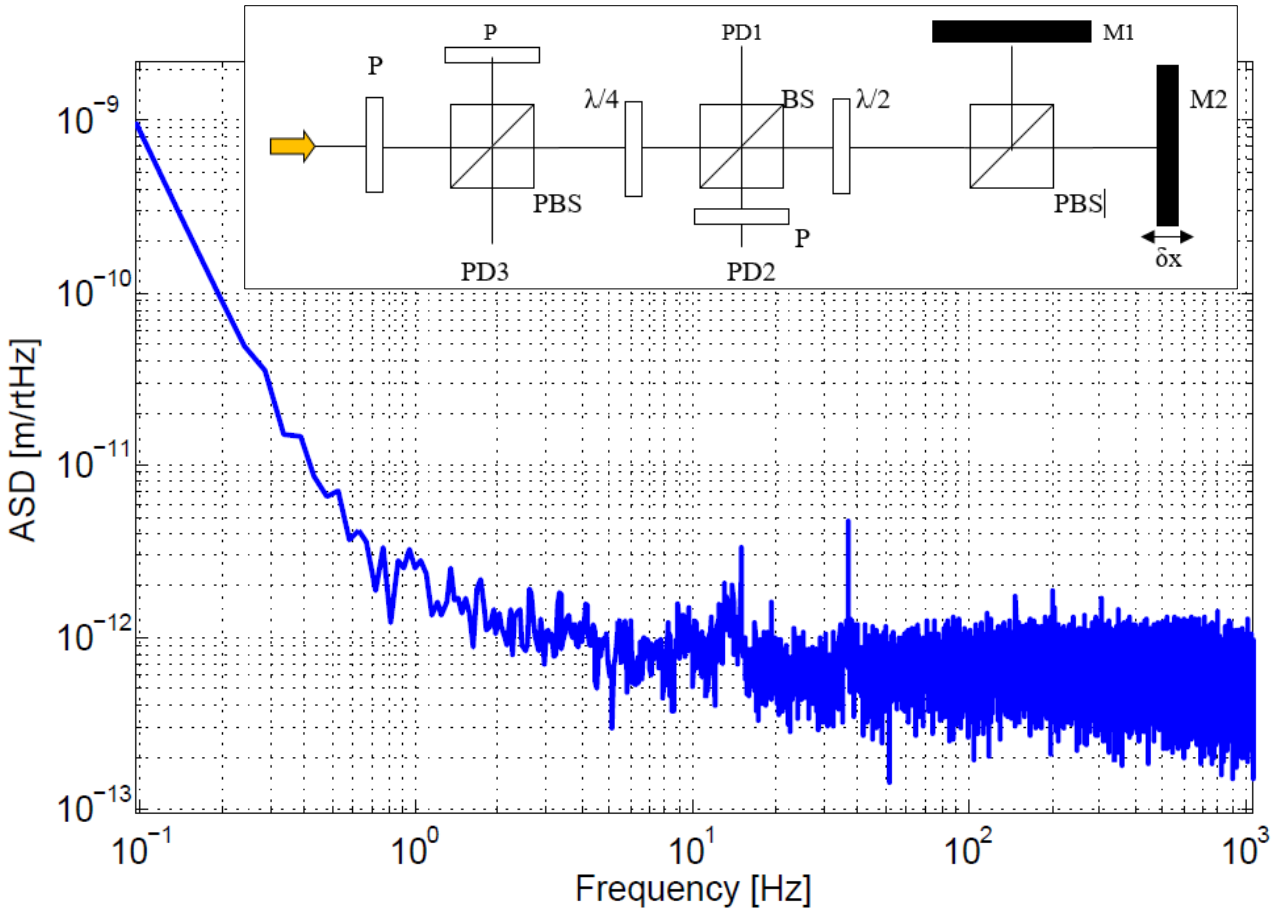


Presentation overview

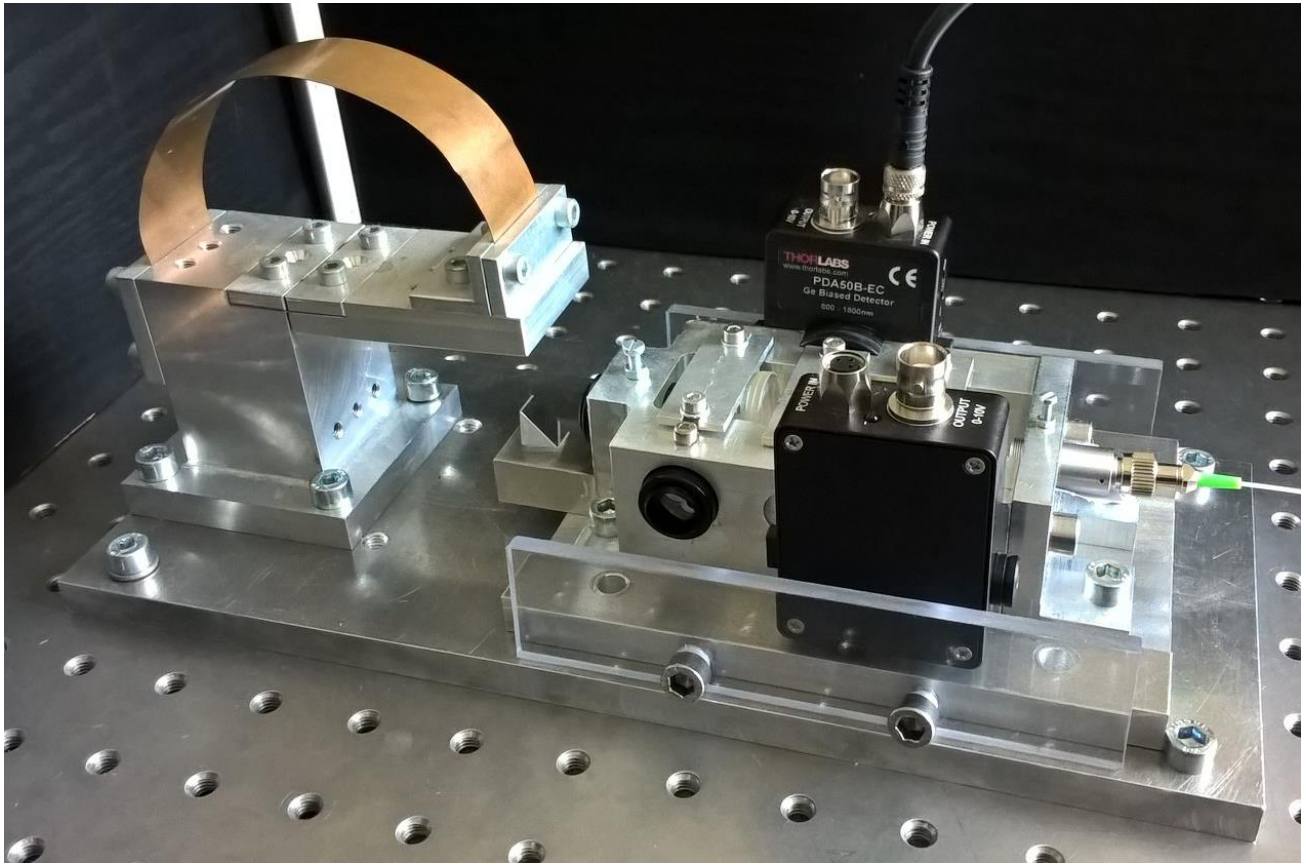
- Improvements of the optical inertial sensor
- 1 DOF active isoltation
- 6 DOF active isolation

Optical readout improvements





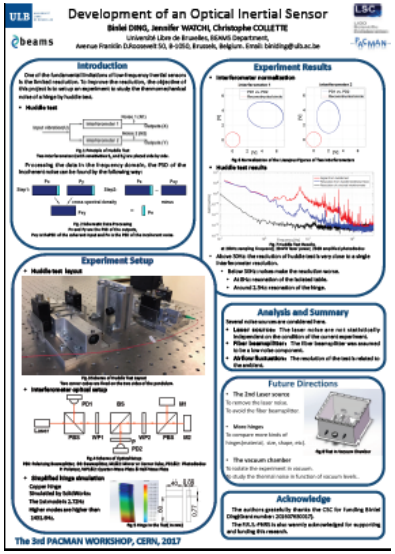
Coil free interferometric inertial sensor



Resolution

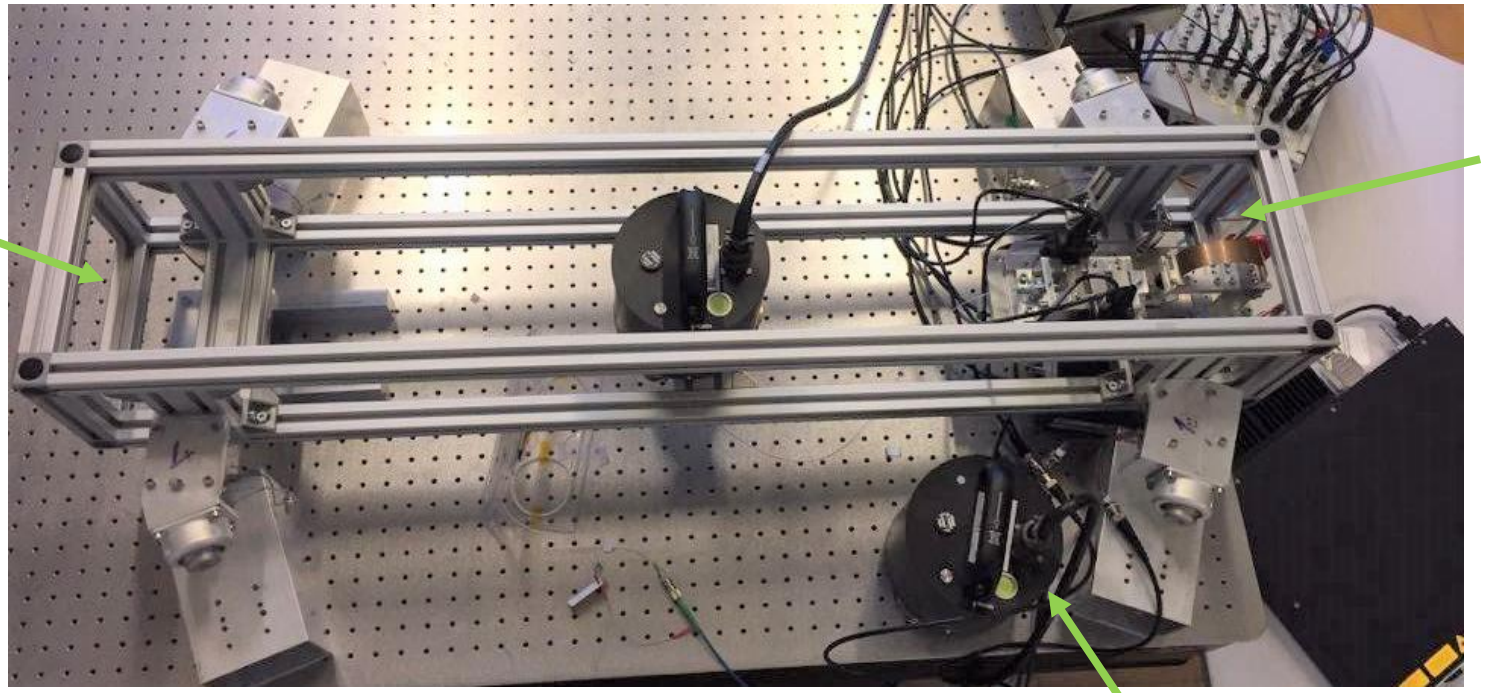
- What is still limiting?
  - Low frequency: thermal noise
    - Binlei's Poster
  - High frequency:
    - Electronics: ADC, photodiode
    - Optics: laser, optical components, nonlinearities

Model still under development

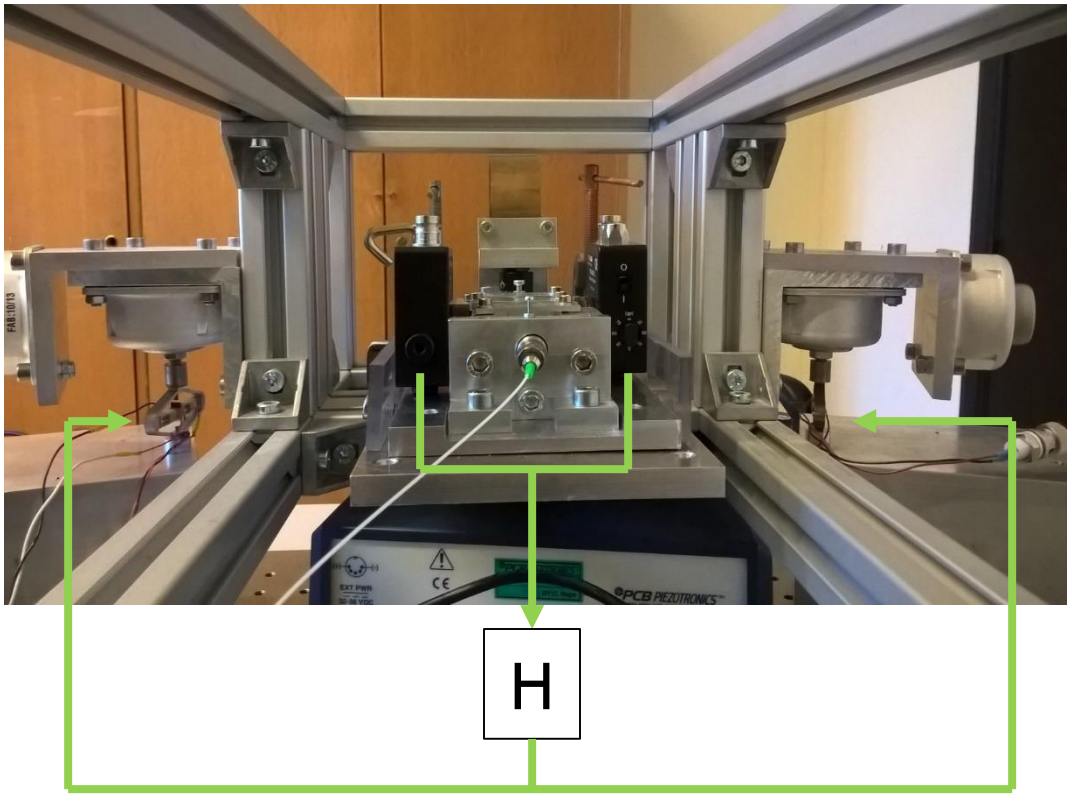


1 DOF experiment

- Extended quadrupole-like structure
- All legs blocked except for one vertical side



How the isolation works



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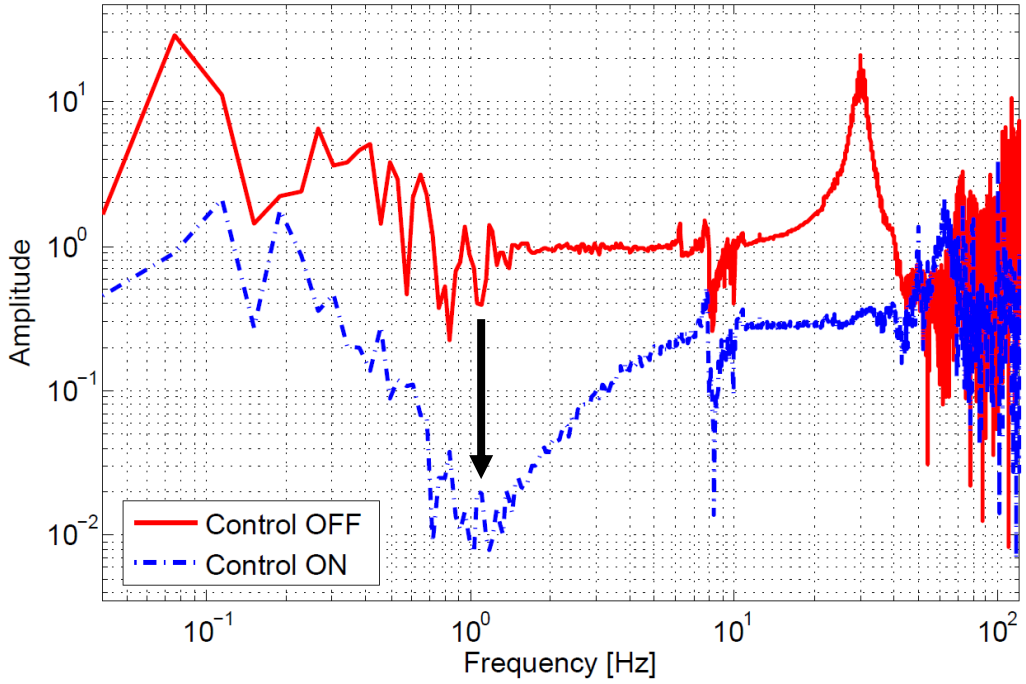
Controller H : 4 Lags, 1 High-Pass filter and 1 Lead

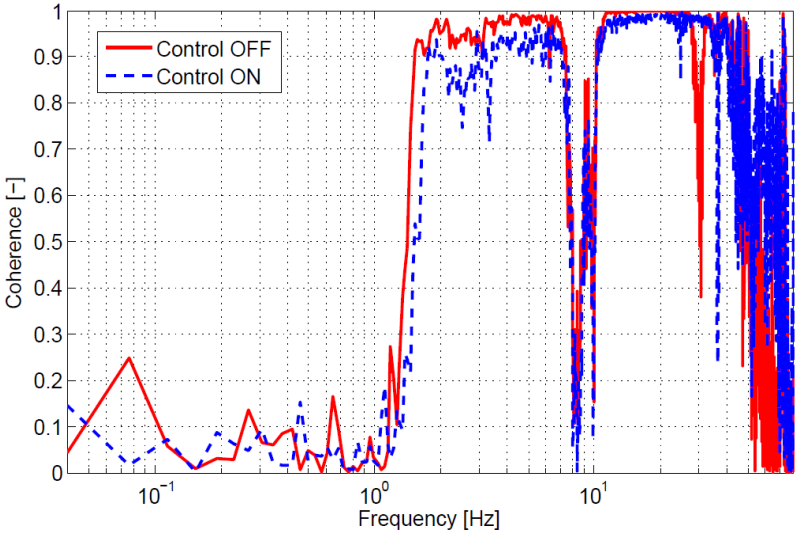
Results



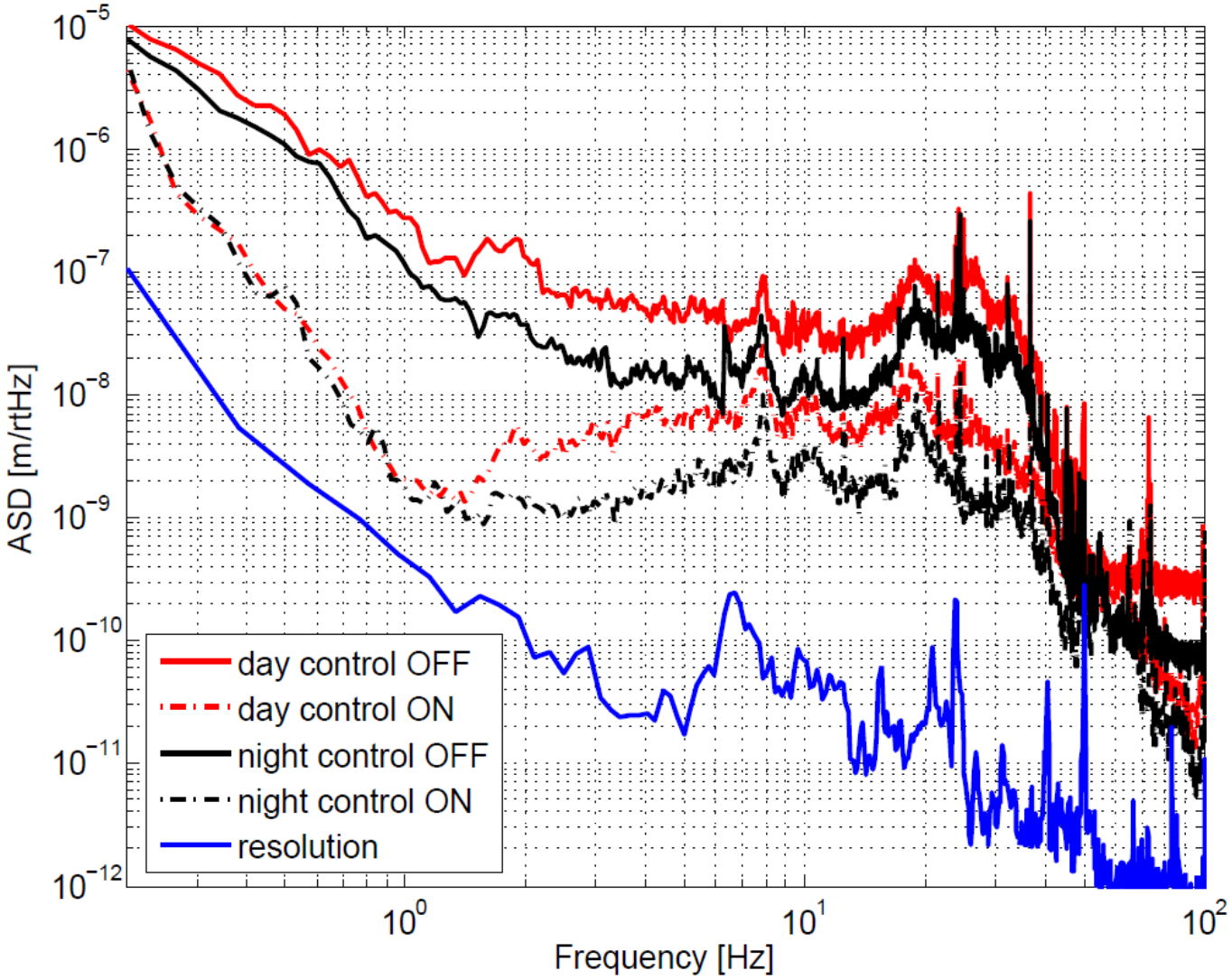
TF between ground and sensor on the platform

Reduction of a factor 100

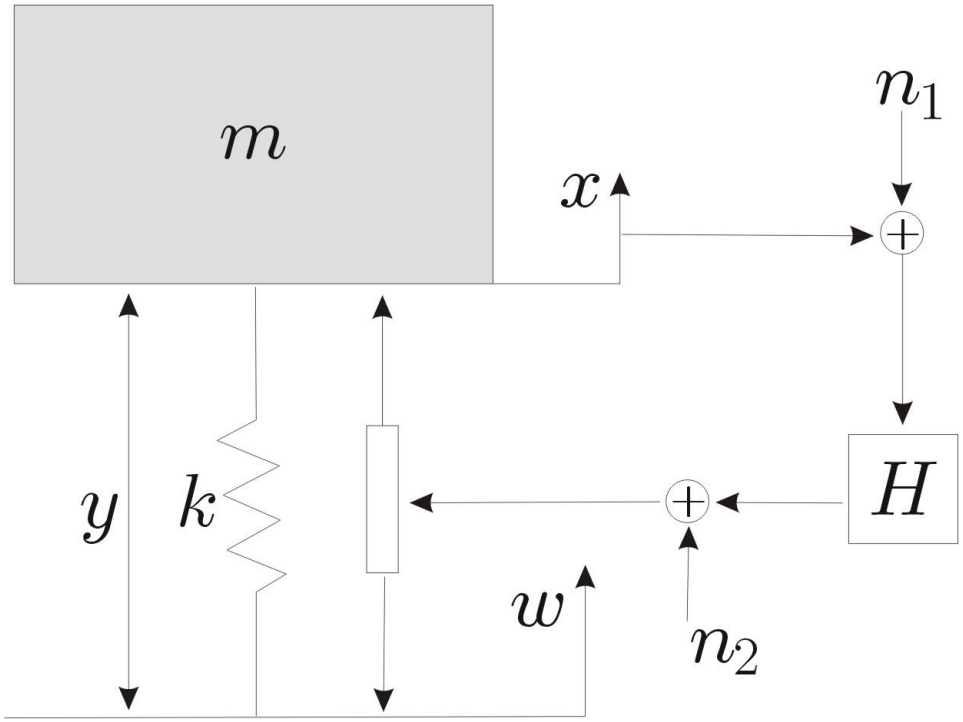
Coherence between the two sensors used



Results


ASD [m/rtHz]
Frequency [Hz]
day control OFF
day control ON
night control OFF
night control ON
resolution

Model



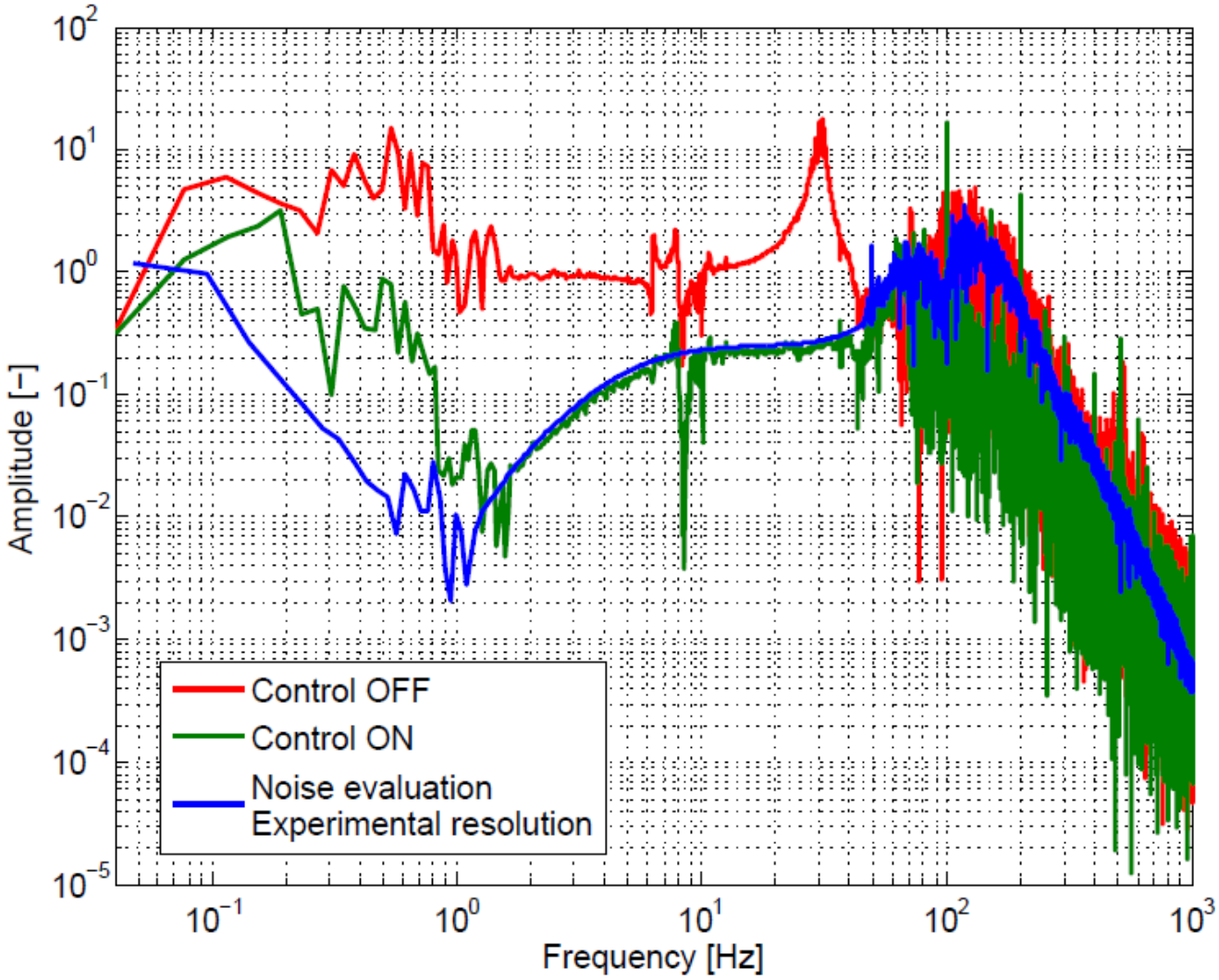
n_1 : resolution of the optical inertial sensor (readout, photodiodes, ADC, …)

n_2 : noise from the actuation system

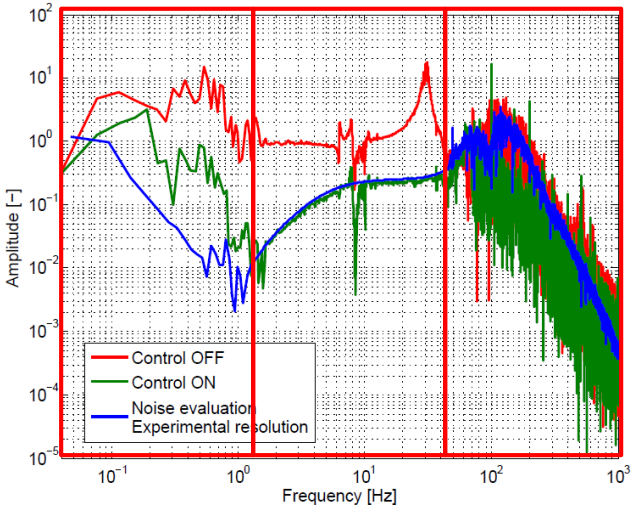
Noise from the control loop:

$$n = Hn_1 + n_2$$

Fit between theory and experiment



Fit between theory and experiment



What is limiting?

Low frequency (< 1 Hz) : resolution of the sensor

→ Thermal noise ?

→ non-identified source ?

Middle frequency ([1,40] Hz) : ground motion

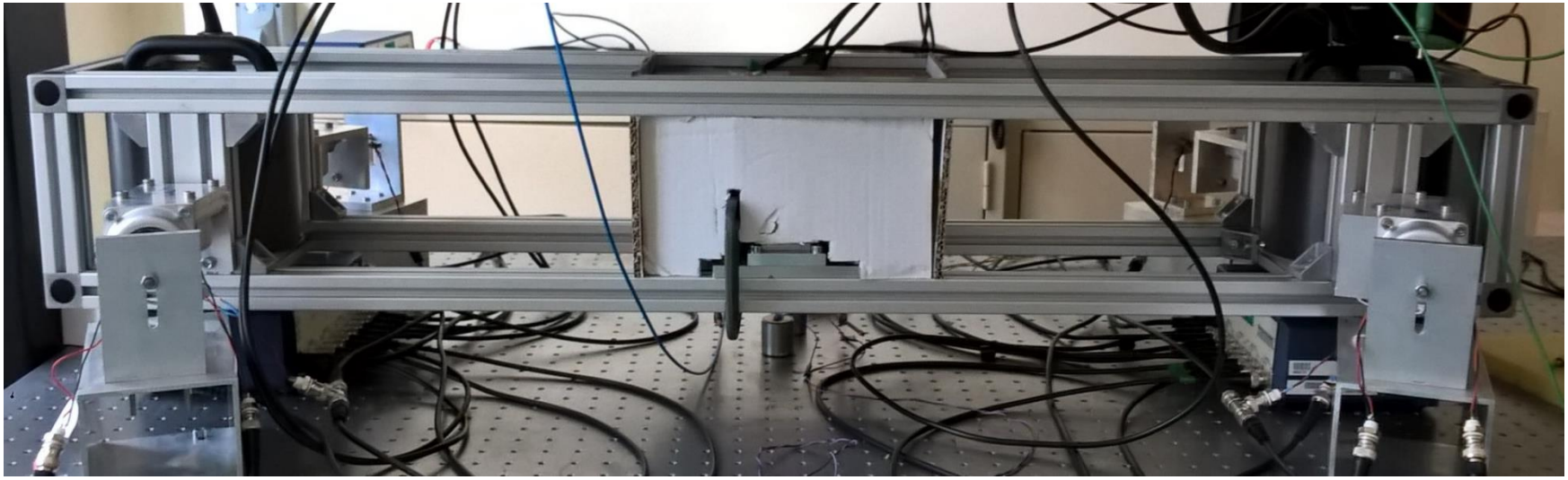
→ Increase gain

We can get better than a 100 factor attenuation

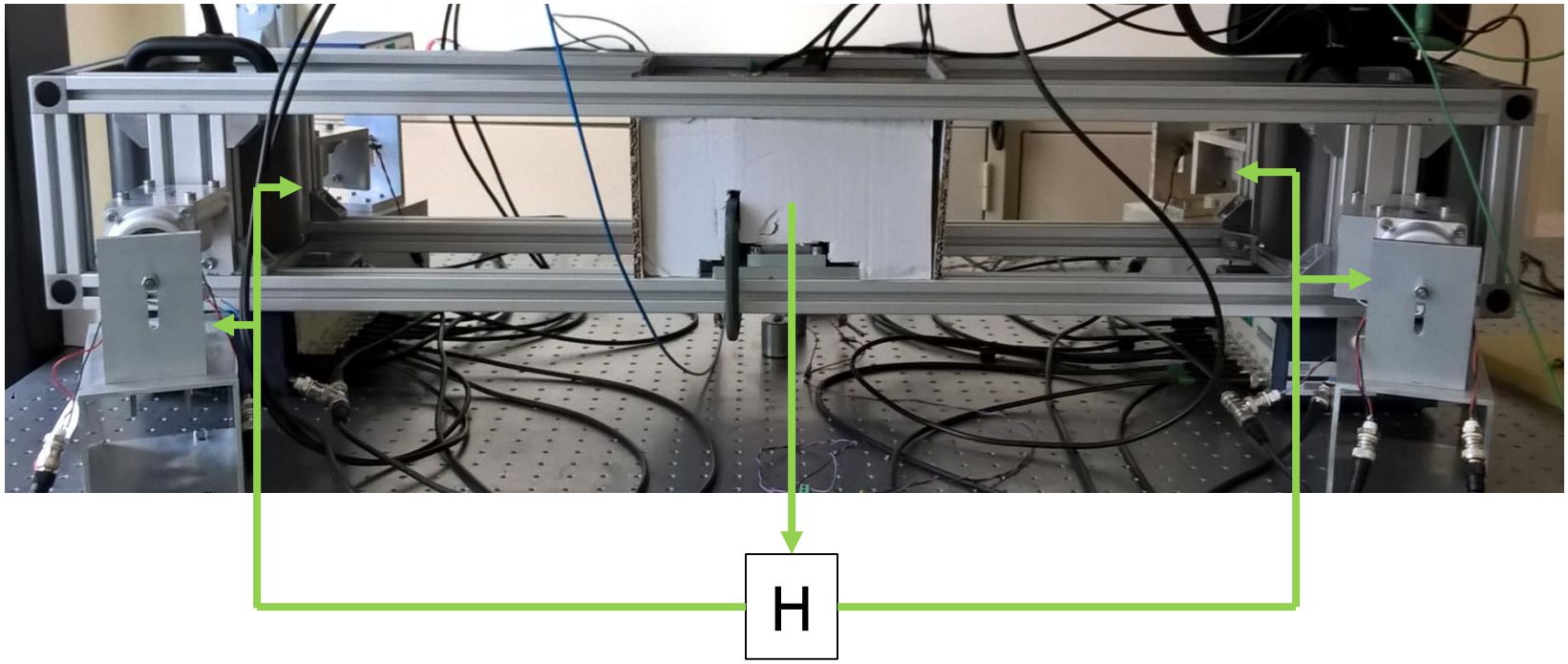
High frequency (> 40 Hz) : actuators (DAC, Amplification stage, …)

6 DOF experiment

- 4 horizontal legs + 4 vertical legs
- Low autority control for all legs
- High autority control for the vertical motion

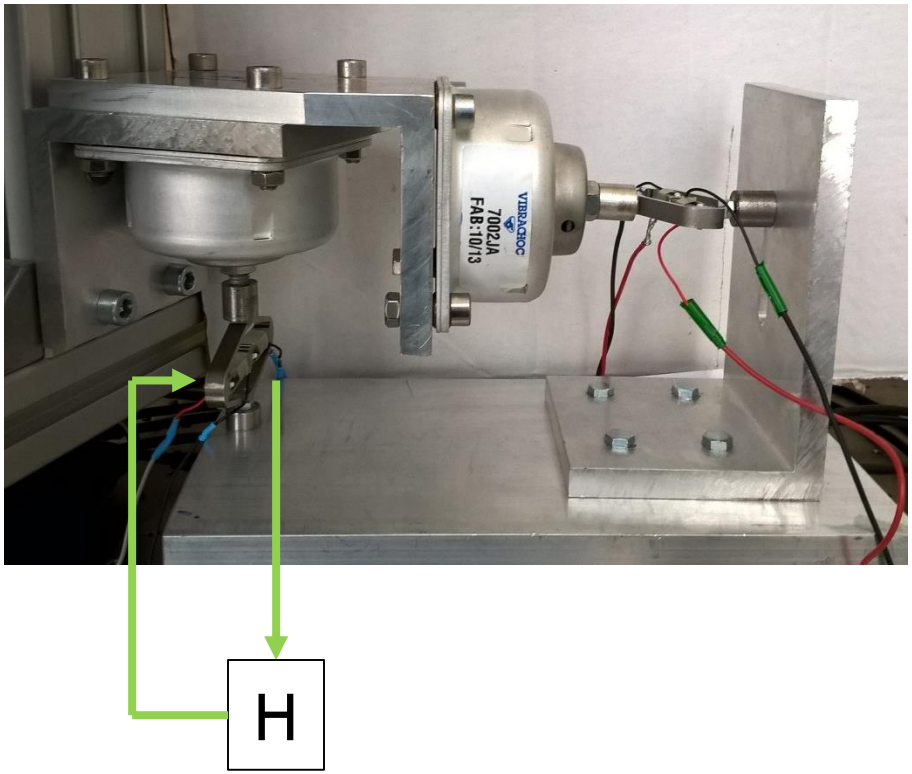


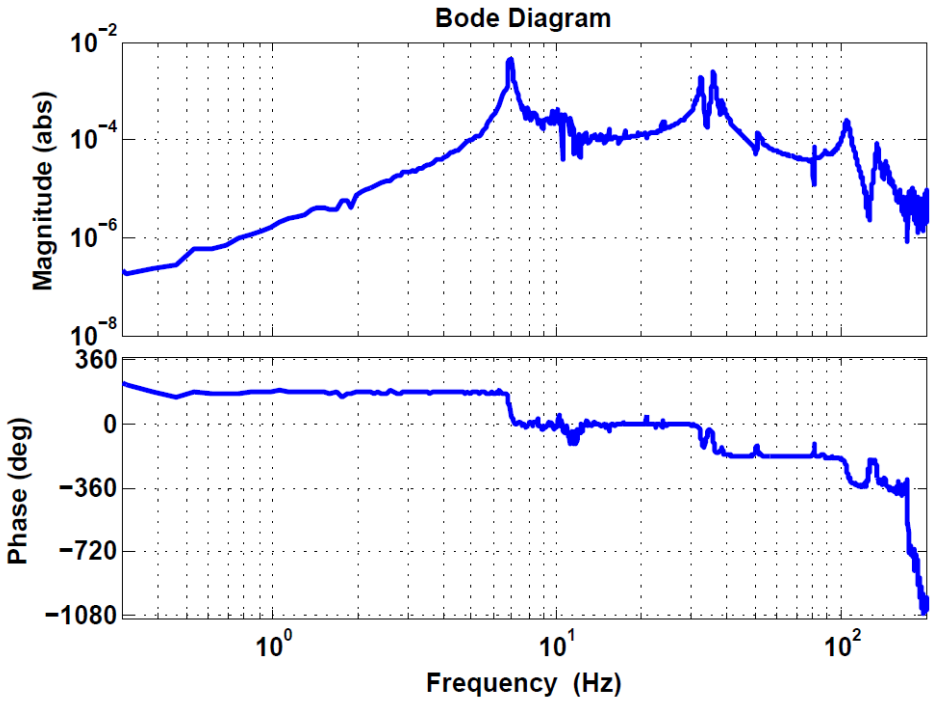
How the isolation works



Controller H : 4 Lags, 1 High-Pass filter and 1 Lead
The same as in the previous experiment

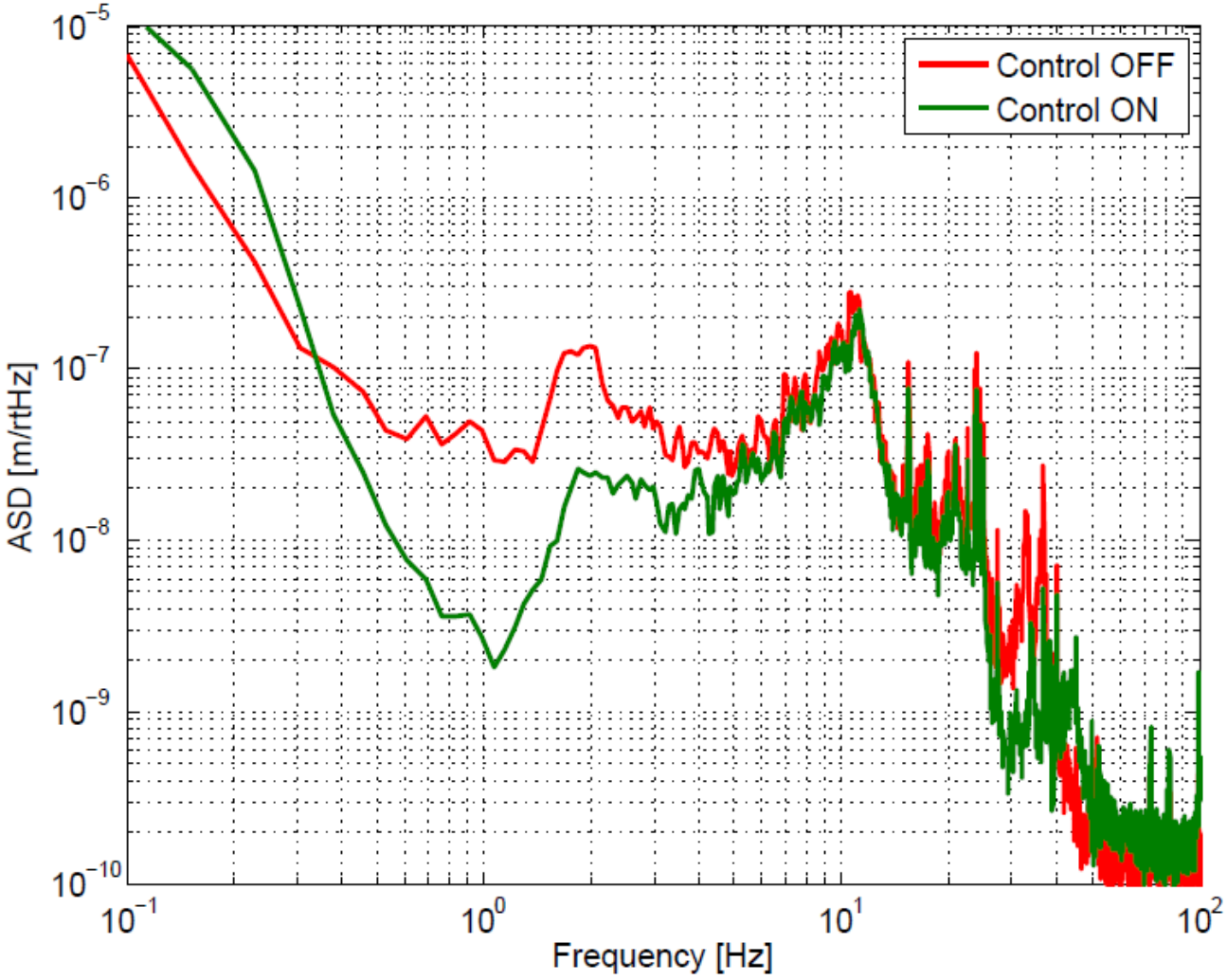
Low Autority Control (LAC)



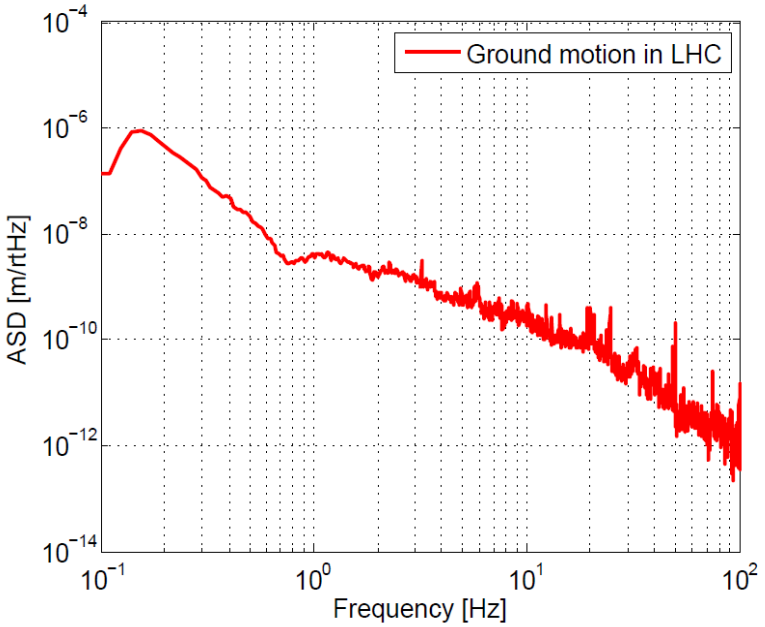


Controller H : 1 Low-Pass and 1 High-Pass filter

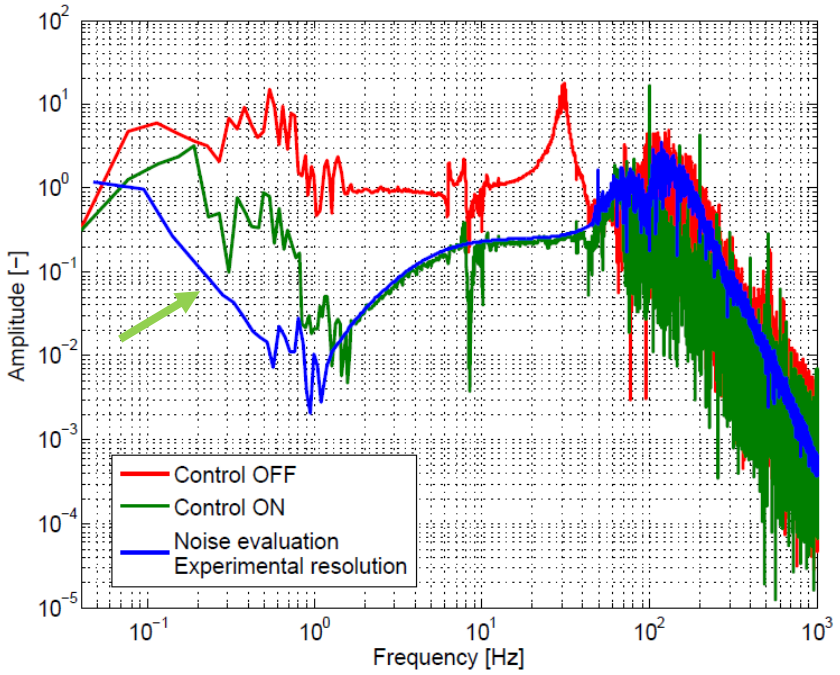
Results so far



Estimation of the performances in LHC



X



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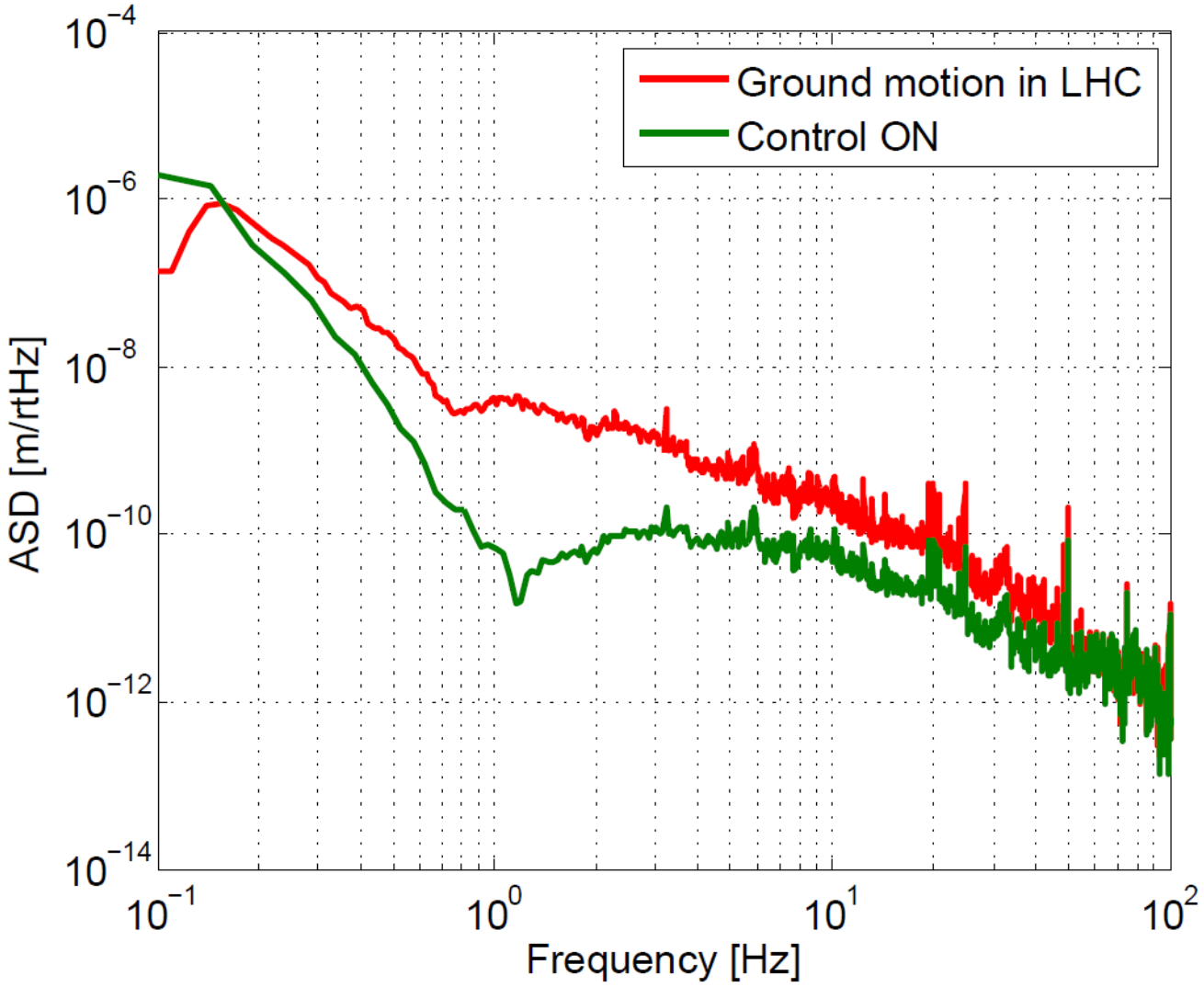
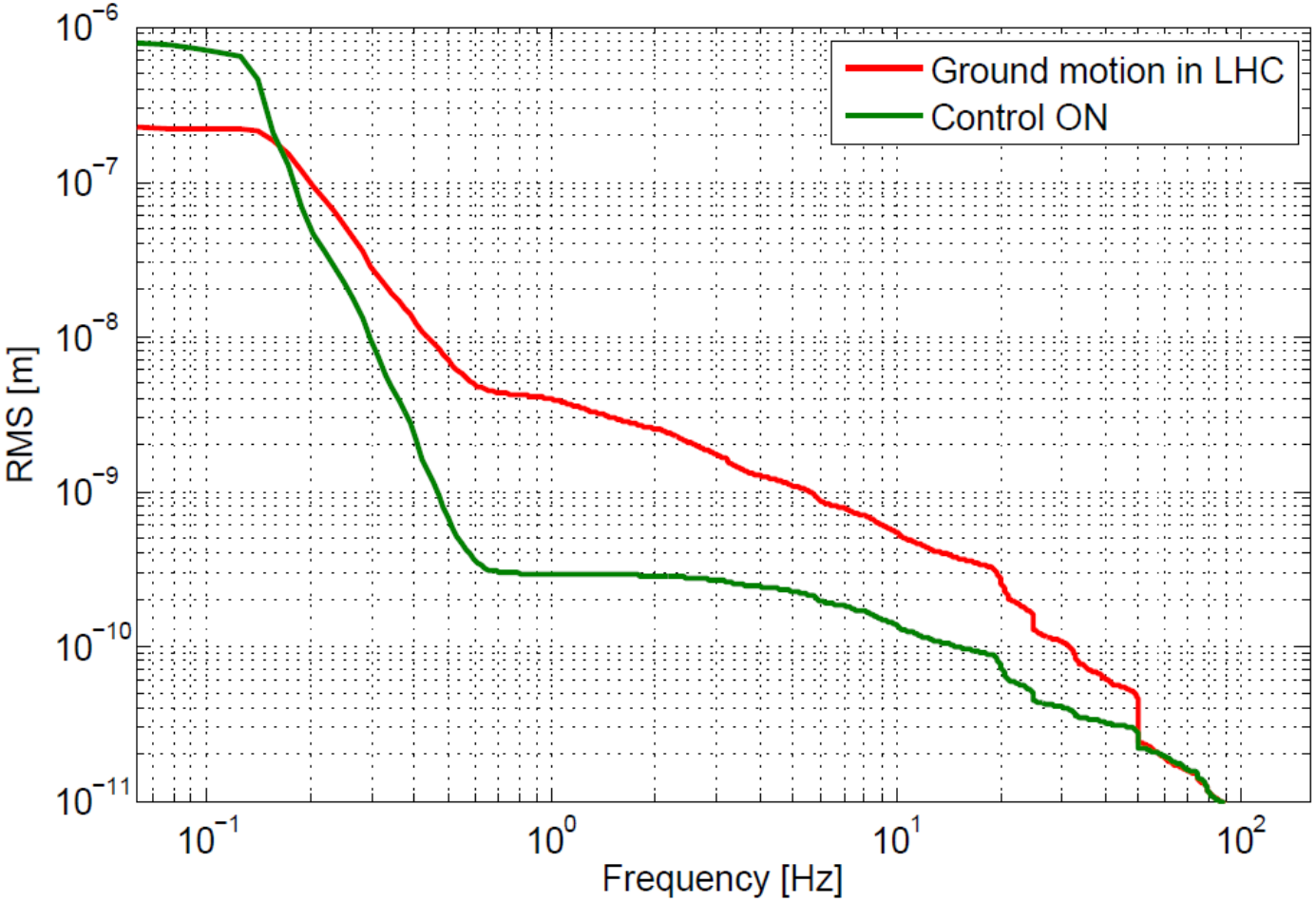


Estimation of the RMS



At 1 Hz

-OFF: 4 nm

-ON: 0,3 nm

Conclusion and perspectives

- Optical inertial sensor:
  Thermal noise experiment up to come

- 1DOF experiment
  1/100 attenuation at 1 Hz
  Model correct above 1 Hz

- 6 DOF experiment
  Promising results

- CLIC purpose