QD0 Stabilisation

L. Brunetti[1], J. Allibe[1], J.-P. Baud[1], G. Balik[1] , G. Deleglise[1], A. Jeremie[1], S. Vilalte[1]
B. Caron[2], A. Badel[2], R. Le Breton[2]
(LAViSta Team)

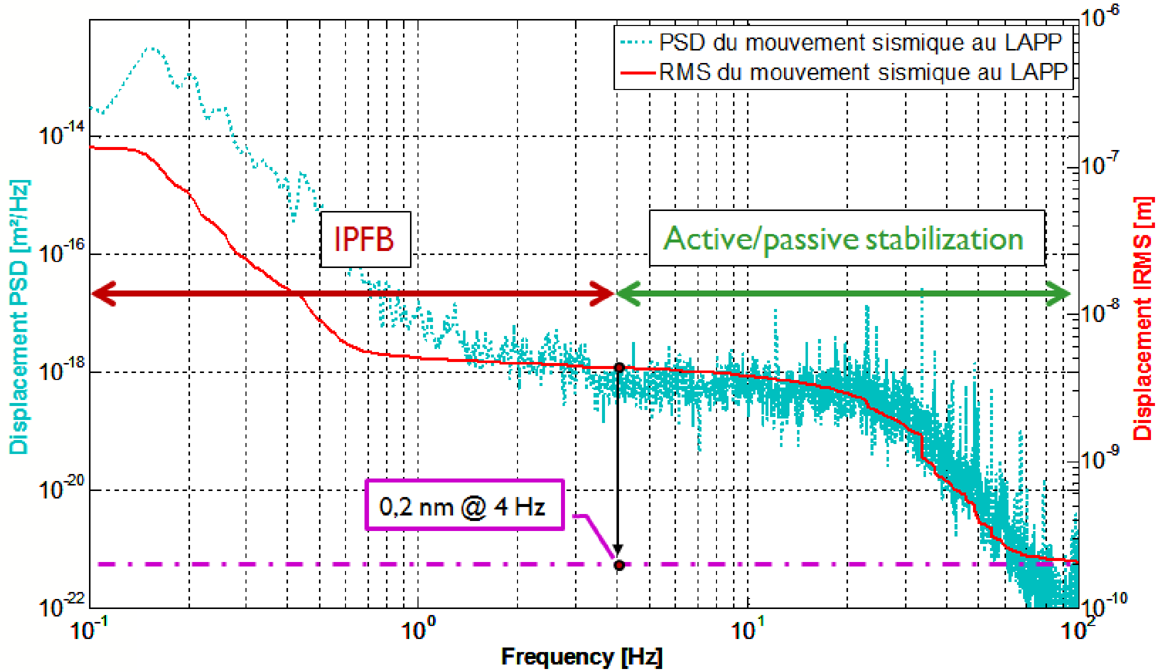
[1]: LAPP-IN2P3-CNRS, Université de Savoie, Annecy, France
&
[2]: SYMME-POLYTECH Annecy-Chambéry, Université de Savoie, Annecy, France

Outline

- Introduction
- Final Focus quadrupole stabilisation, performances and limitations
- Developments in progress

Introduction

- ***Final focus : beam stabilization strategy***



- ➢ At the IP (mechanical + beam feedback), we aim at **0,1nm at 0,1Hz**
- ➢ IP Beam based feedback : already developed by LAPP in collaboration with CERN since 2010

- Caron B et al, 2012, "Vibration control of the beam of the future linear collider", Control Engineering Practice.

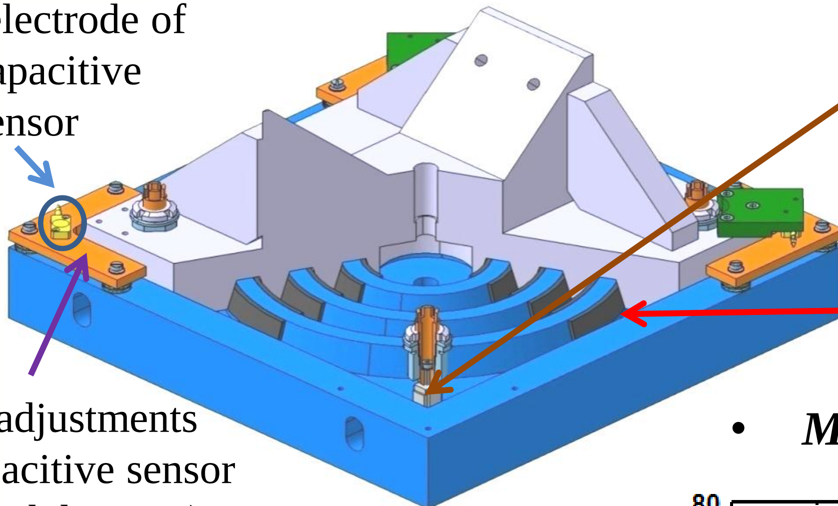
- G. Balik et al, 2012, " Integrated simulation of ground motion mitigation, techniques for the future compact linear collider (CLIC) ", Nuclear Instruments and Methods in Physics Research

- ➢ **Mechanical stabilisation has to be reached**

Mechanical active stabilisation – the developed active foot

- ***CAD of the foot :***

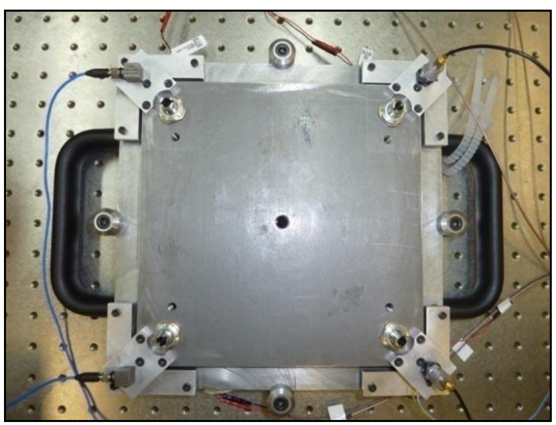
Lower electrode of the capacitive sensor



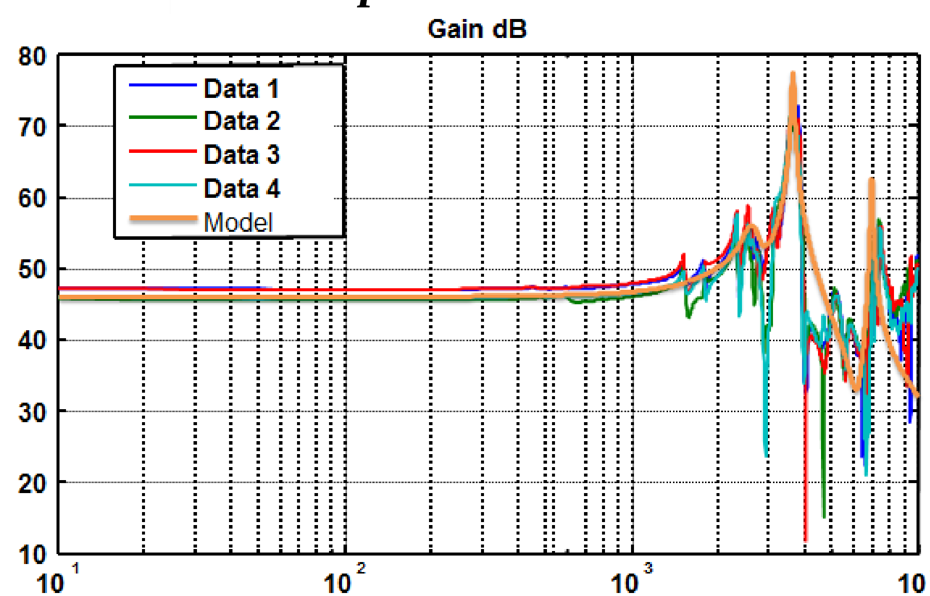
Piezoelectric actuators PPA10M CEDRAT

Elastomeric strips for guidance

Fine adjustments for capacitive sensor (tilt and distance)

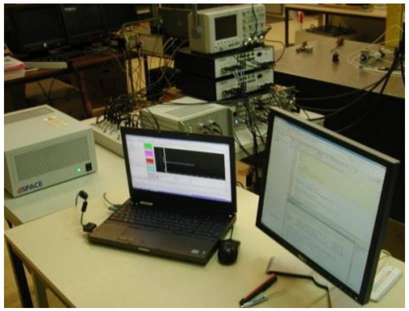


- ***Model & experimental characterisation :***



Mechanical active stabilisation – experimental setup

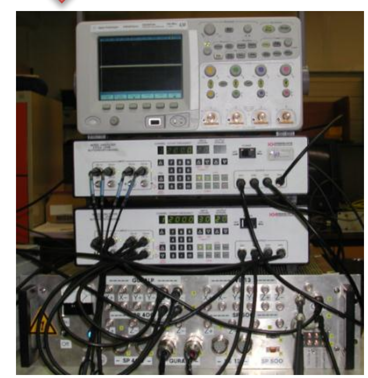
- ***Control architecture :***



Matlab and dSPACE ControlDesk
For monitoring and analysis

- *Used sensors :*

- Geophones : GURALP CMG-6T
- Accelerometers : WILCOXON 731A



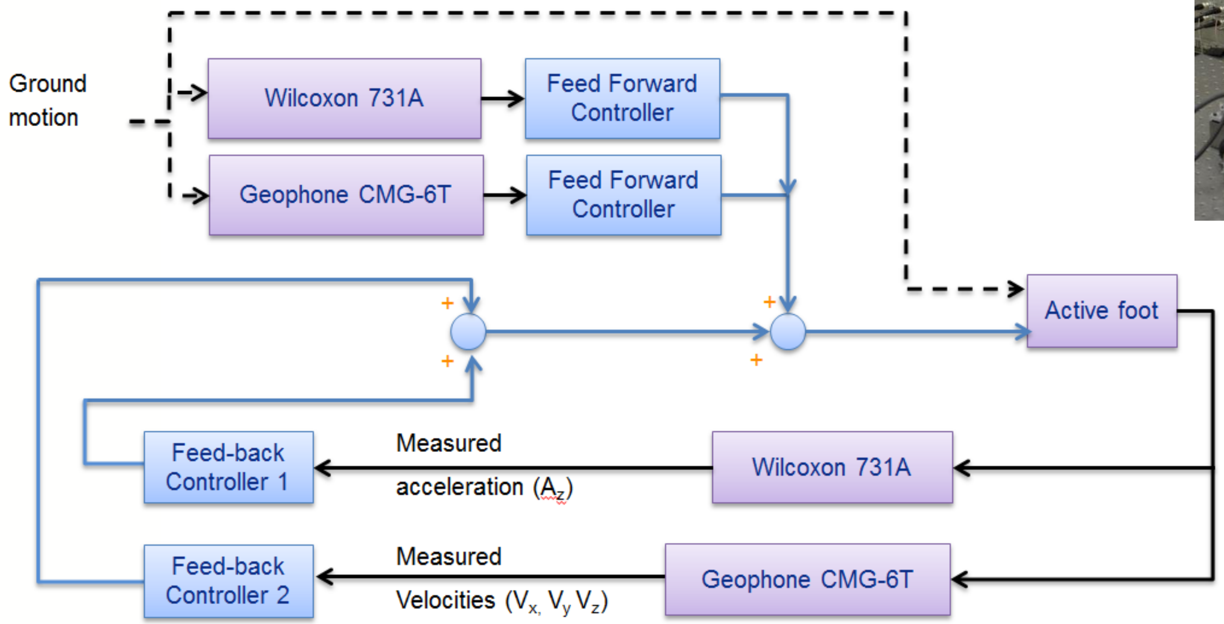
Amplifiers, filters input/output board
for signal conditioning

dSPACE
Real time hardware for
Rapid Control Prototyping

✓ All is taken into account in simulation (noise, ADC, DAC…).

Mechanical active stabilisation – Control

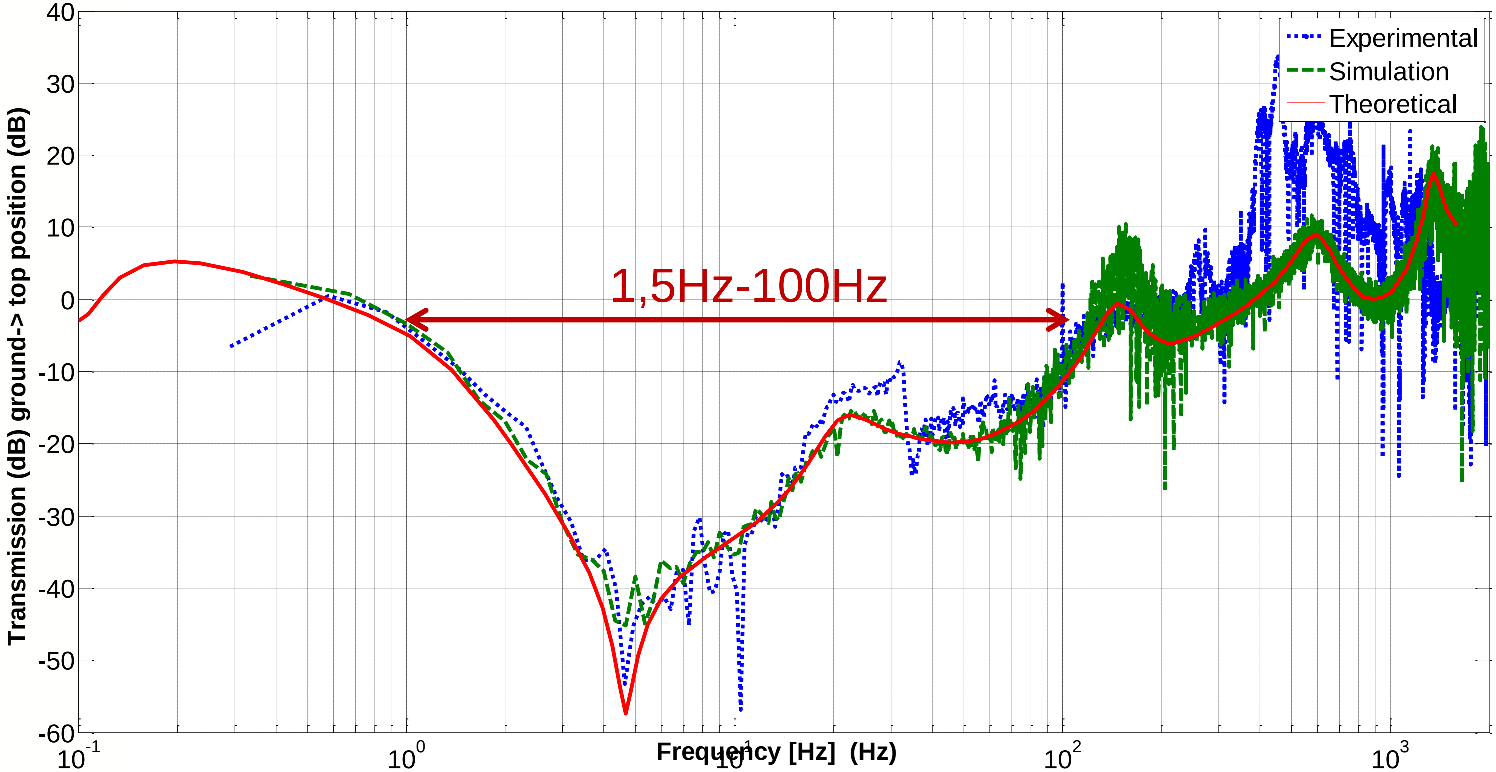
- ***Control strategy:***



- ✓ Feedforward with 1 geophone and 1 accelerometer
- ✓ Feedback (loop shaping) with 1 geophone and 1 accelerometer
- ✓ Sensors are dedicated to selected bandwidth.

Mechanical active stabilisation – Results

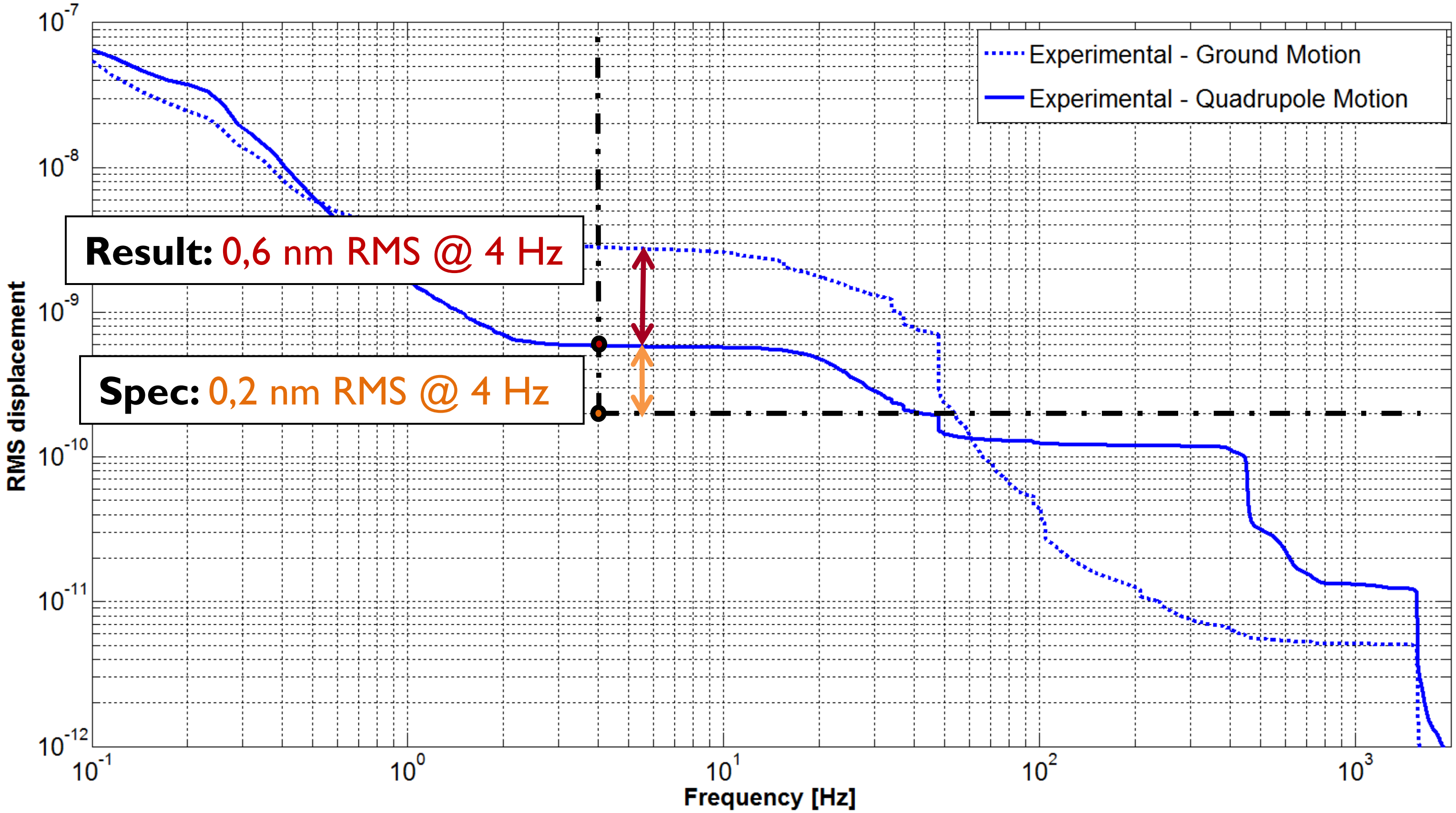
- ***Simulation and experimental results (attenuation) :***



- ***Attenuation up to 50dB between 1,5-100Hz***
- *It matches with the simulation*

Mechanical active stabilisation – Results

- *Simulation and experimental results (RMS) :*

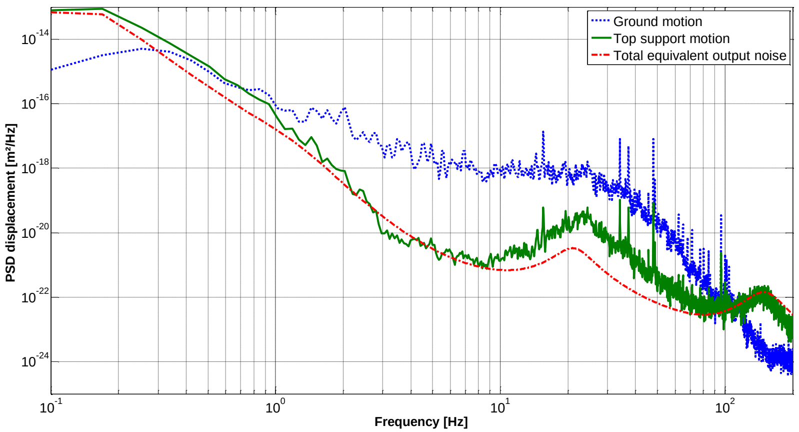


➢ **Publication in progress (accepted) : Balik et al, "Active control of a subnanometer isolator", JIMMSS.**

Mechanical active stabilisation

- ***Status next this stage (done with Guralp 6T & Willcoxon) :***

  - Promising results
  - Main limitations :
    - Noise of the sensors
    - Transfer function of the sensors



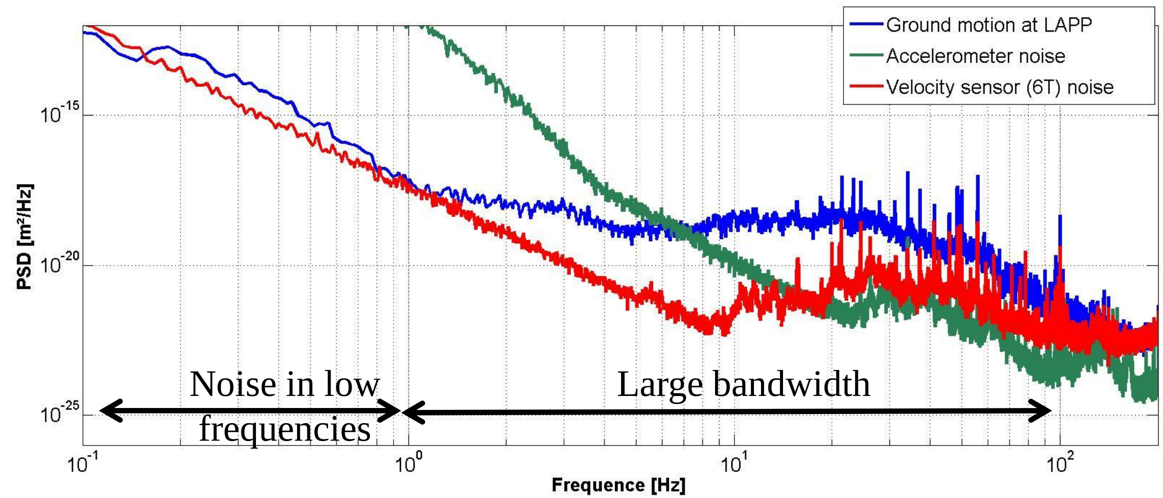
  - Advantage : we are able to define the acceptable noise and the performances of the sensor that we need (thanks to the accuracy of the simulation vs experimental tests)

- ***Strategies :***

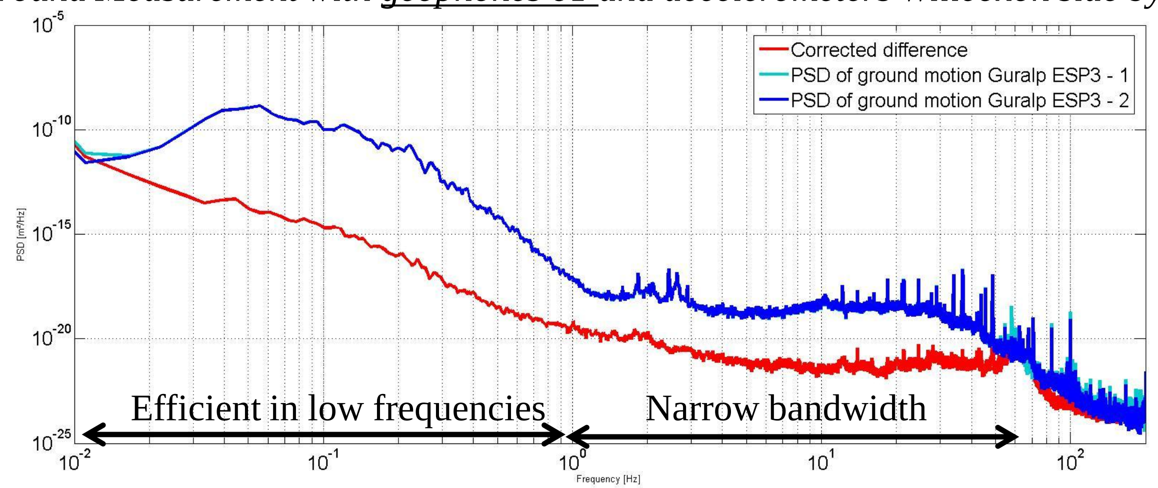
  - **Tests with a new generation of sensors**
  - **Development of a new and dedicated sensor**

Mechanical active stabilisation – New geophone

- ***Tests with the Guralp 6T - 3ESP:***



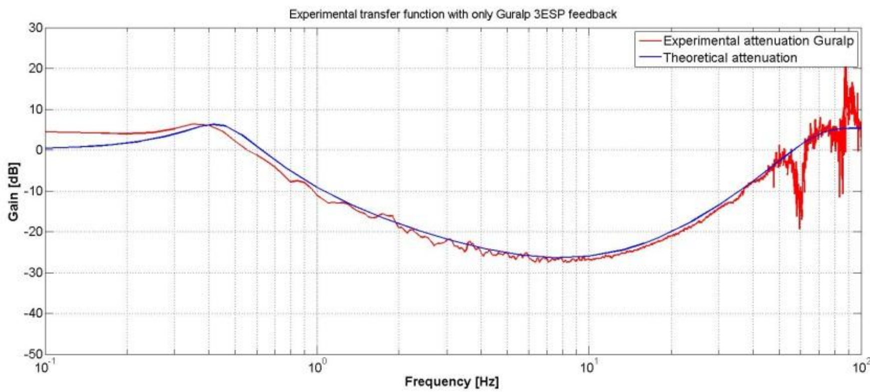
- Ground Measurement with <u>geophones 6T</u> and accelerometers Willcoxon side by side -



- Ground Measurement with <u>geophones 3ESP</u> side by side -

Mechanical active stabilisation – New geophone

- ***Obtained results:***
  - *Example of first obtained results (has to be improved) :*

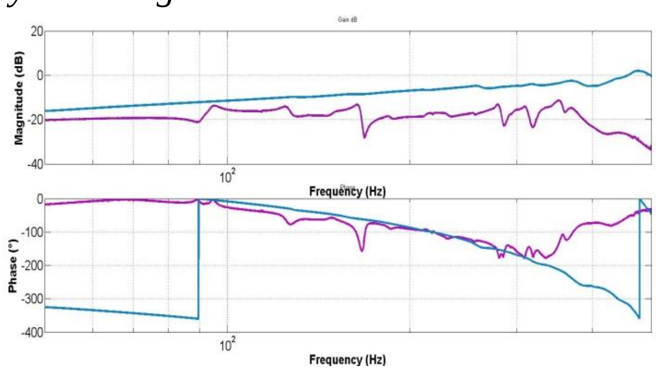


Experimental transfer function with only Feedback Guralp 3ESP
<u>no feedforward, no accelerometer</u>

➢ *For the whole control, it requires some mechanic upgrades*

  - *Difficulty to manage the sensor model :*

- With Guralp 6T
- With Guralp 3ESP



- Experimental transfer function of « foot + sensor » -

➢ low frequencies vs model

New sensor – Measurements

- ***A patent is in progress…***

  ✓ *G. Deleglise, J. Allibe, G. Balik & J.P. Baud*

➢ ***Not allow to show the curves at this moment…***

- Performances : - close to a Guralp 6T on a large bandwidth (1 – +100Hz).

  - better than a Guralp 6T for the low frequencies (0.4 - 1Hz) and close to the 3ESP.

- First tests in control…

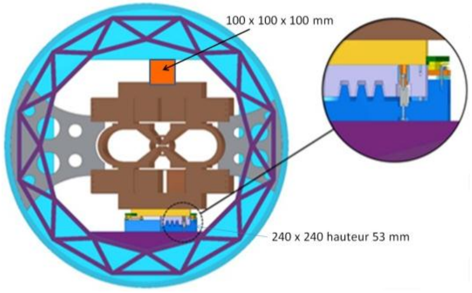
Sensor status

- *1st prototype :*
  - Performances
  - Bandwidth (large and tunable)
  - An important new knowledge for the team
  - Cost about 2000 euros + raw material

➢ ***Efficient sensor for "measurement"***

- *Objective of the next prototype :*
  - Keep at least the current performances
  - To optimize the model of the sensor
  - To reduce the cost (40%)
  - To minimize the size : (100 x 100 x 100 mm vs 250 x 250 x 110 mm)

➢ ***Improvements in order to do "measurement and control"***



Conclusions

- *Active table:*
  - Mechanics OK for 1 degree of freedom
  - Approach validated and first promising results
  - Sensor noise limitation → investigations with 3ESP

- *LAPP sensor - prototype n°1:*
  - Great results for a first prototype which is mainly dedicated for measurement

- *Next generation of LAPP sensor:*
  - Measurement and control
  - Minimise the size and optimise the cost
  - **Possibility to test it in a realistic environment? ATF2, CTF3?**