QD0 Stabilisation

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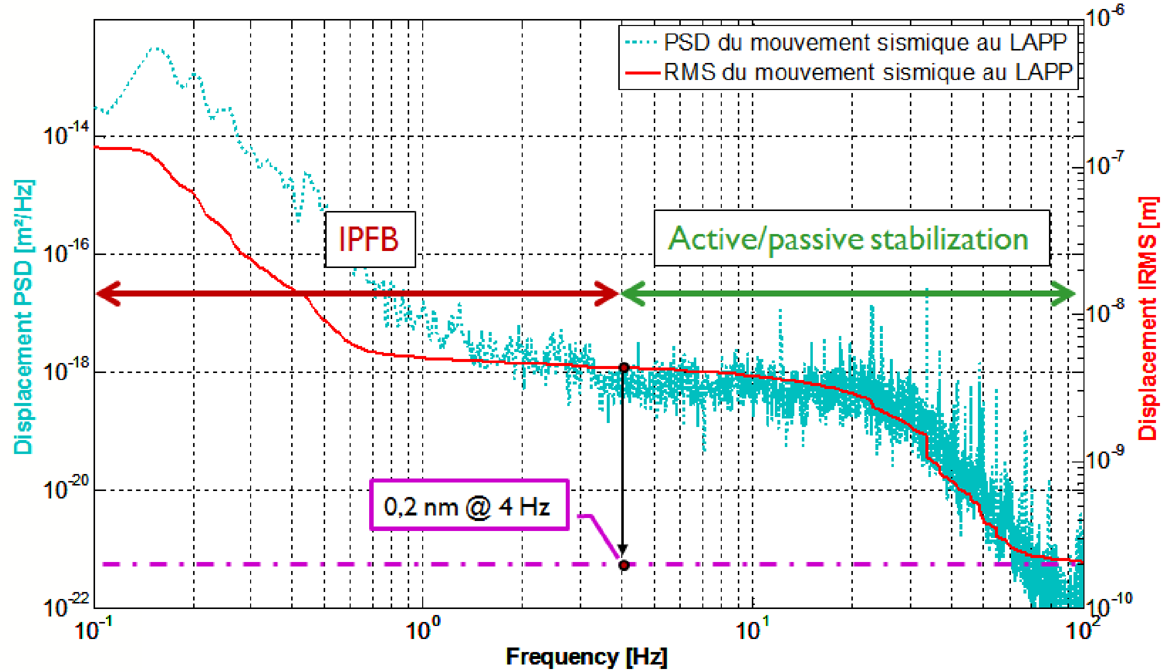
Outline

- Introduction
- Final Focus quadrupole stabilisation, performances and limitations
- Works in progress
- Future developments - FTE

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

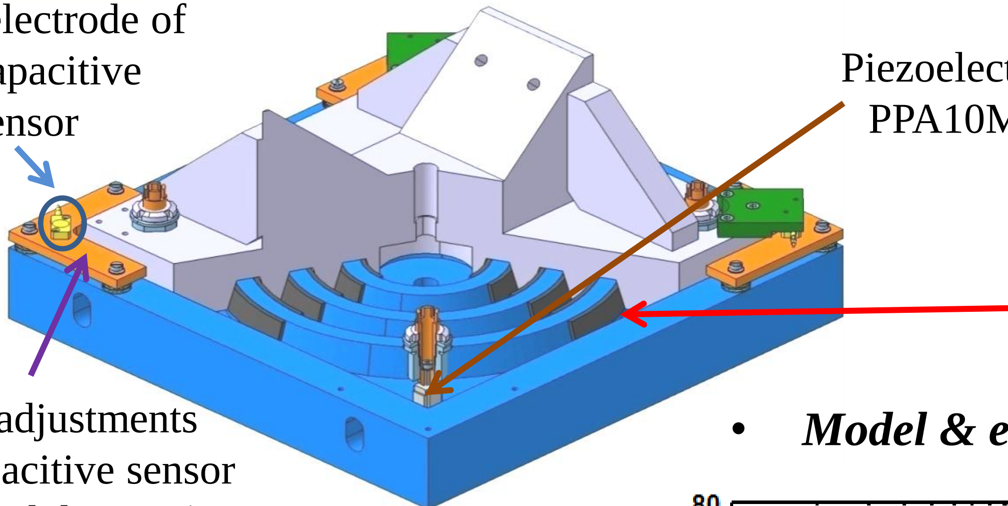
  - Caron B et al, 2012, "Vibration control of the beam of the future linear collider", Control Engineering Practice.

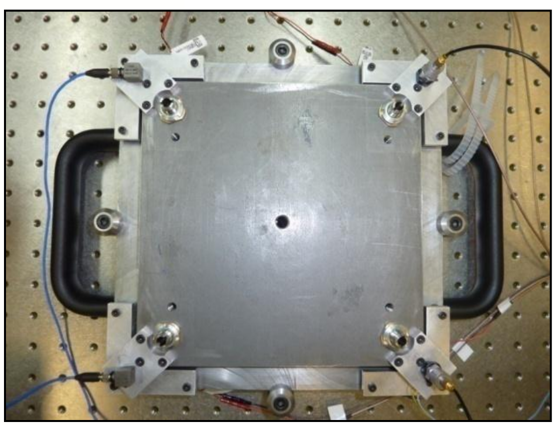
  - G. Balik et al, 2012, " Integrated simulation of ground motion mitigation, techniques for the future compact linear collider (CLIC) ", Nuclear Instruments and Methods in Physics Research

- **Mechanical stabilisation has to be reached**

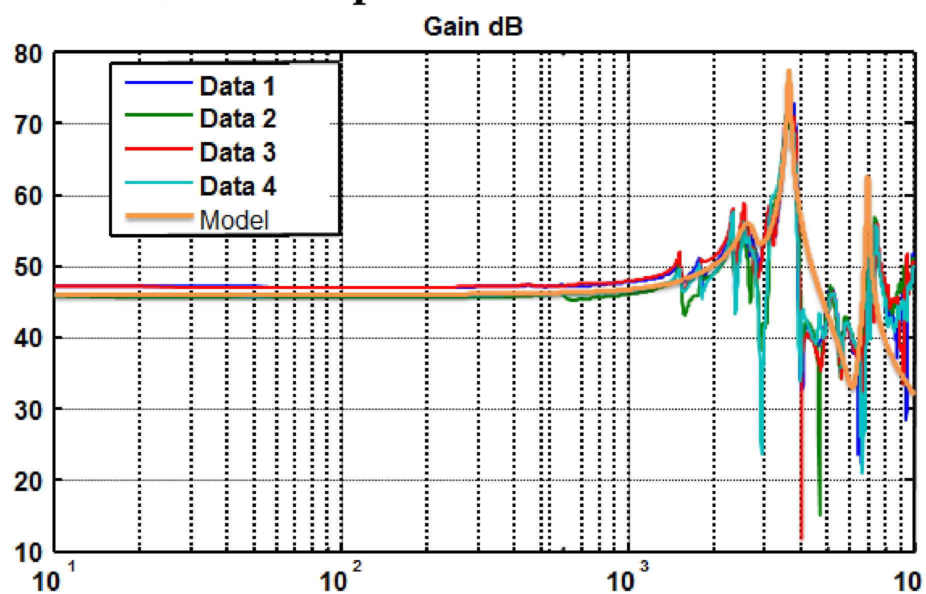
Mechanical active stabilisation – the developed active foot

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



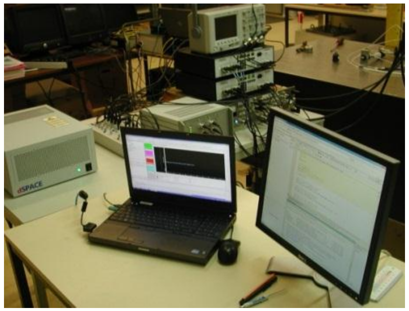


- ***Model & experimental characterisation :***



Mechanical active stabilisation – experimental setup

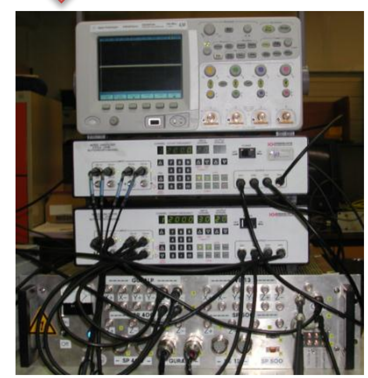
- ***Control architecture :***



Matlab and dSPACE ControlDesk
For monitoring and analysis

- *Used sensors :*

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



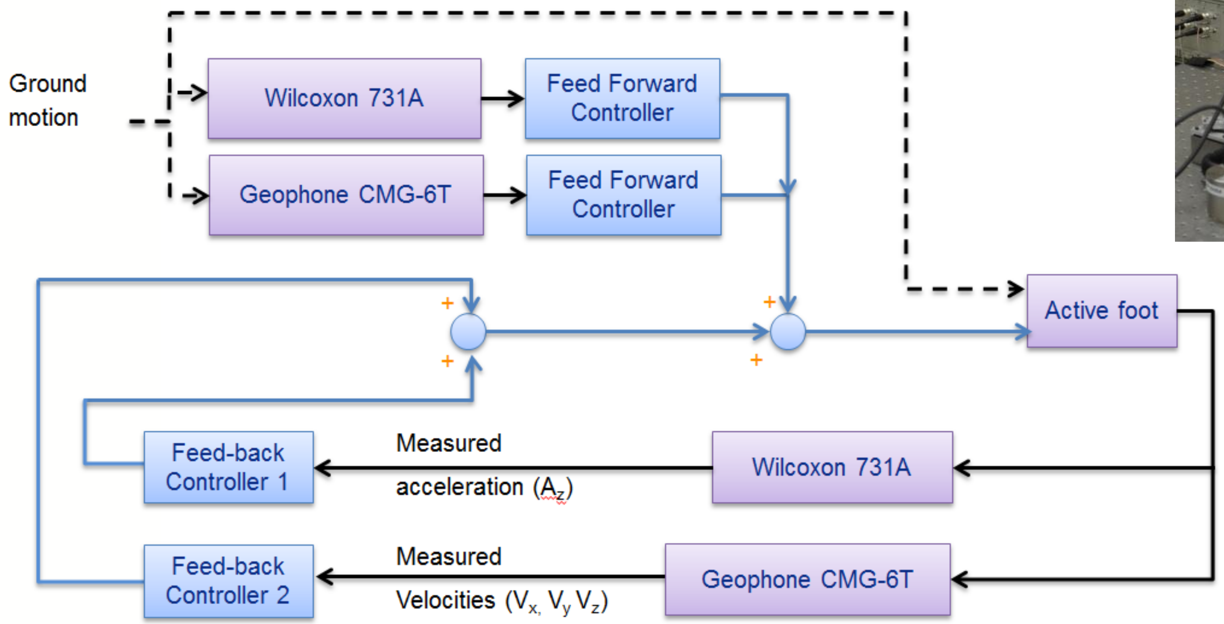
Amplifiers, filters input/output board for signal conditioning

dSPACE
Real time hardware for
Rapid Control Prototyping

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

Mechanical active stabilisation – Control

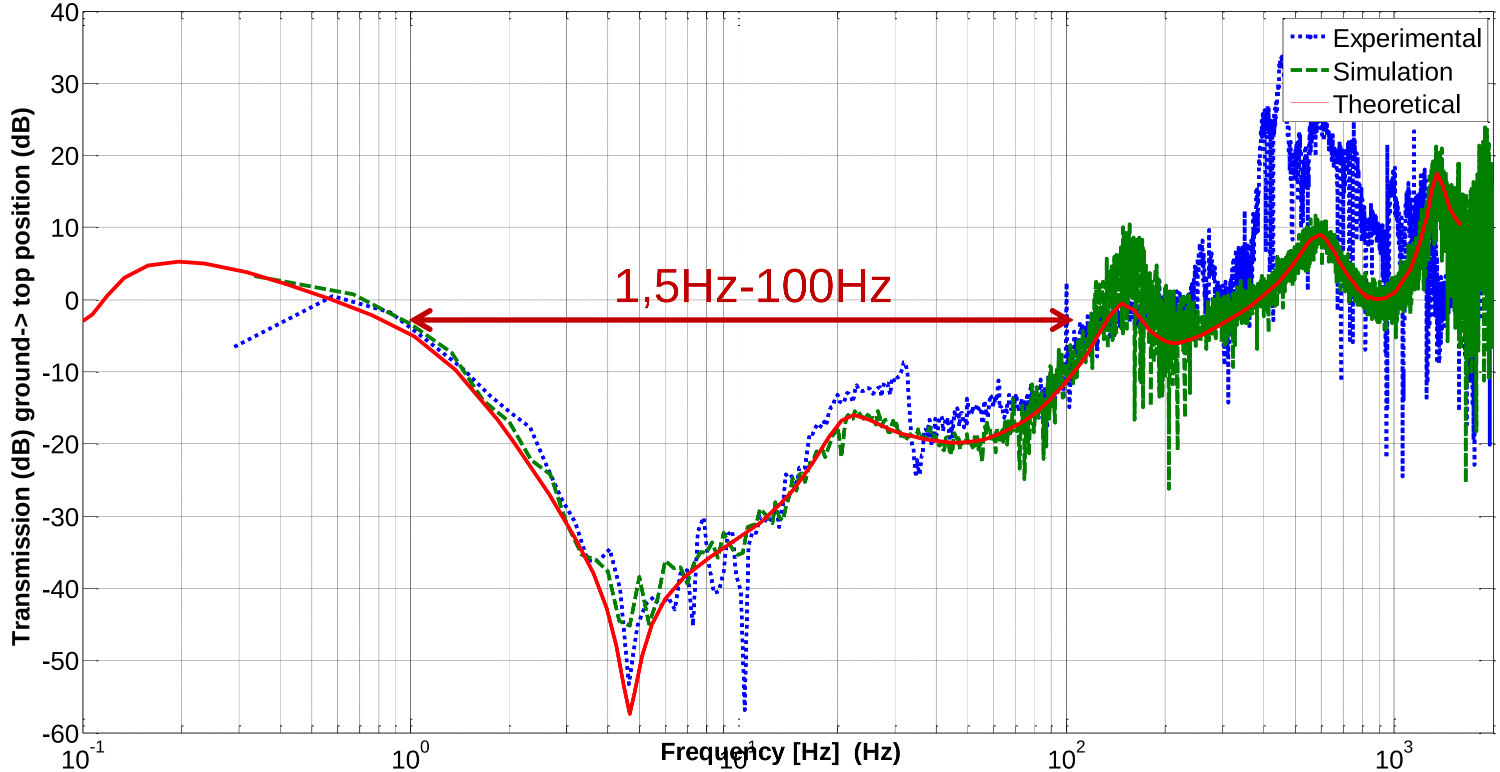
- ***Control strategy:***



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

Mechanical active stabilisation – Results

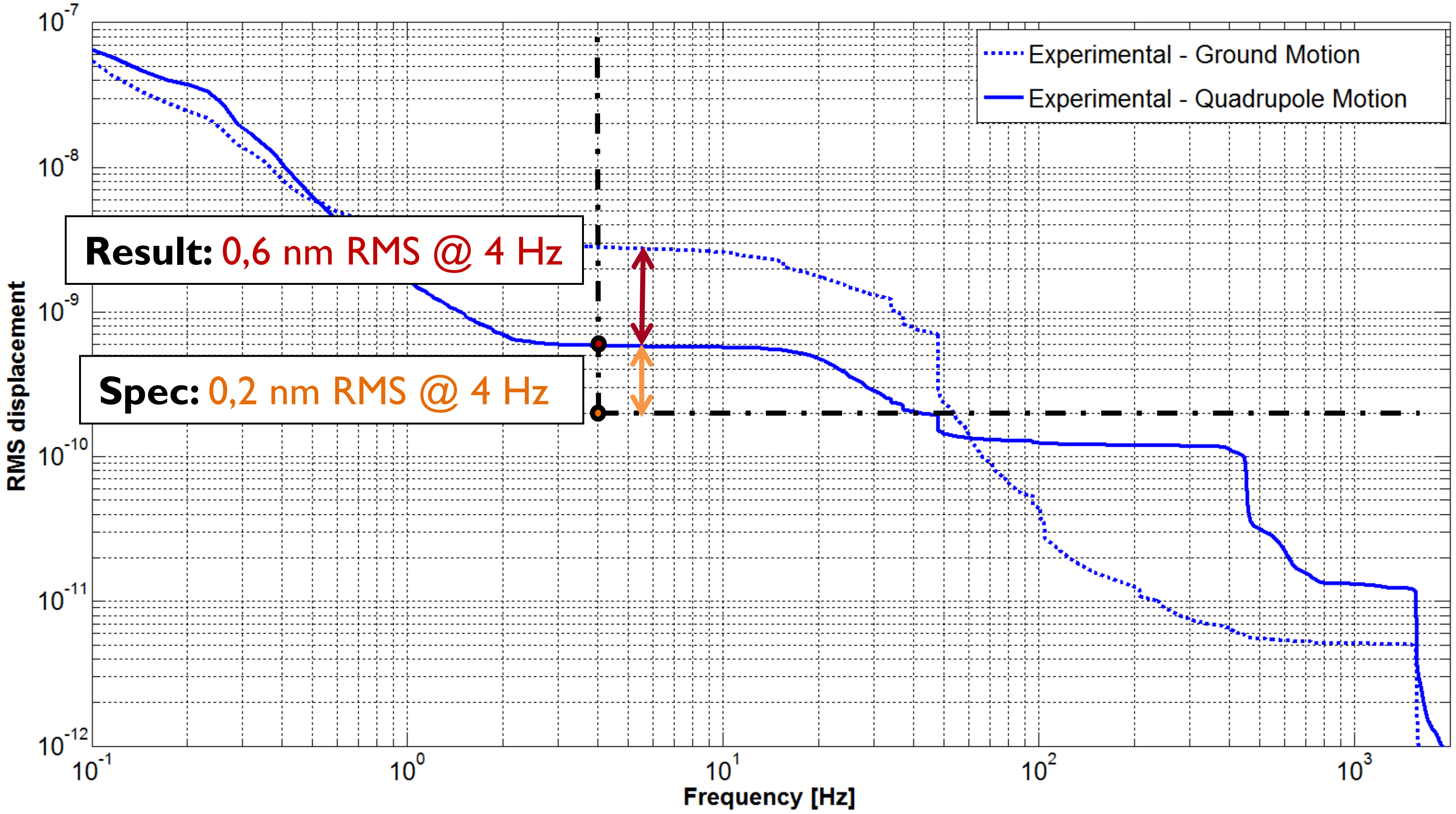
- ***Simulation and experimental results (attenuation) :***



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

Mechanical active stabilisation – Results

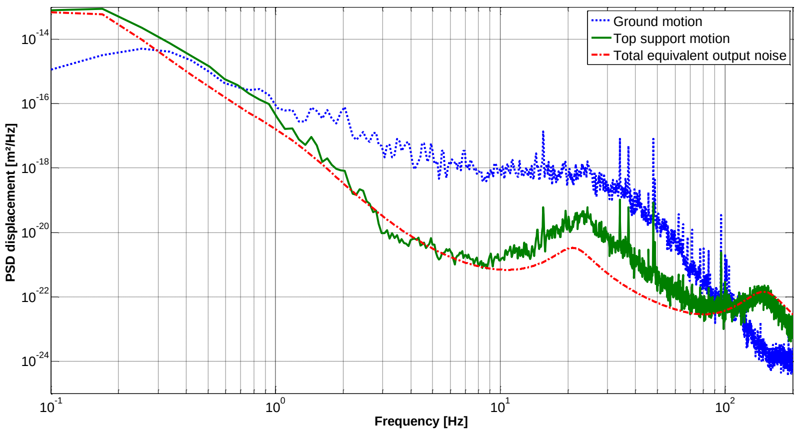
- ***Simulation and experimental results (RMS) :***



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

Mechanical active stabilisation

- ***Status after this stage (done with Guralp 6T & Willcoxon) :***
  - Promising results
  - Main limitations :
    - Sensors noise
    - Sensors transfer function

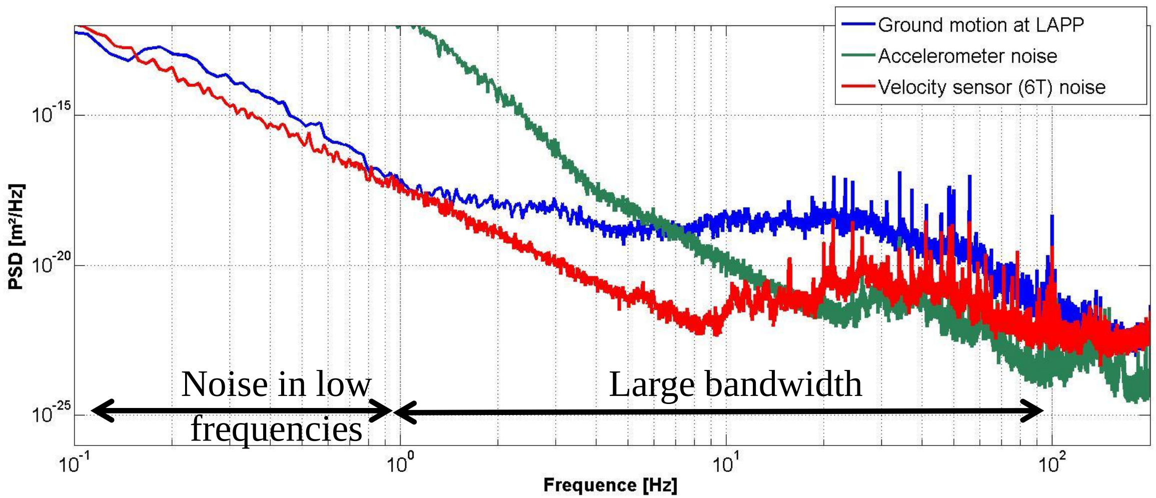


  - Advantage : we are able to define the acceptable noise and the performances of the sensor that we need (thanks to the accuracy of the simulation vs experimental tests) → ***See presentation of Bernard C.***

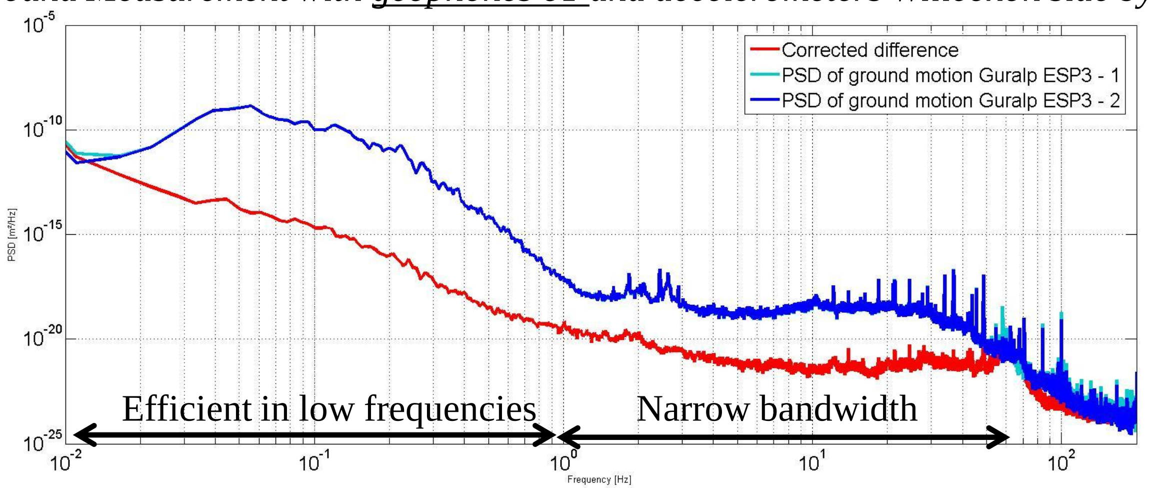
- ***Strategies :***
  - ➢ **Tests with a new generation of sensors**
  - ➢ **Development of a new and dedicated sensor**

Mechanical active stabilisation – New geophone

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



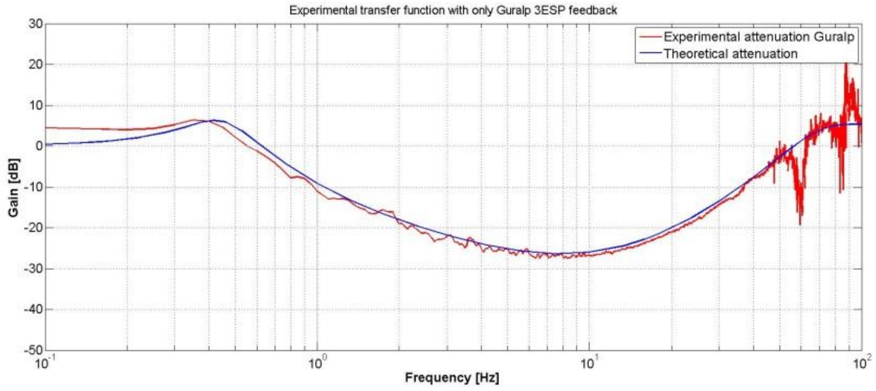
- Ground Measurement with ***geophones 6T*** *and accelerometers Willcoxon side by side -*



- Ground Measurement with ***geophones 3ESP*** *side by side -*

Mechanical active stabilisation – New geophone

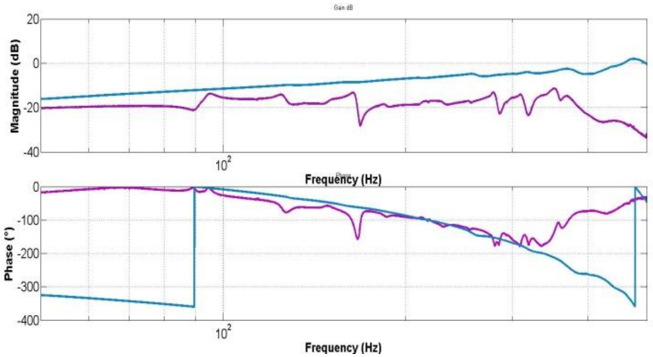
- ***Obtained results:***
  - *Example of first obtained results (has to be improved) :*



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

➢ *For the whole control, some mechanic upgrades have been done but the tests are yet not finished*

  - *Difficulties in managing 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*

- Performances : - close to a Guralp 6T on a large bandwidth (1 to +100Hz).
  - better than a Guralp 6T for the low frequencies (0.4 - 1Hz) and close to the 3ESP.

- First tests in control…
- A visit of Kurt and Stef will be planned at LAPP.
- <u>1st prototype :</u> Performances, bandwidth (large and tunable), an important new knowledge for the team, cost about 2000 euros + raw material

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

- <u>2nd version :</u> 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"***

Status

- *Active table:*
  - Mechanics OK for 1 degree of freedom without mass
  - 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?

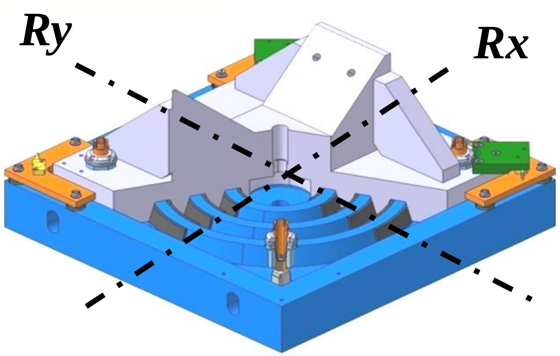
Schedule

- *Middle-term objectives which are clearly identified*
  - End of February - March : control of the active table with 3ESP
  - End of March : machining, assembling and tests of the miniaturized version of the LAPP sensor
  - April : control of the active table with Lapp sensor…

➢ **End of a very important stage**

Schedule

- *Priorities of long term objectives have to be defined (with Cern)*
  - Several degrees of freedom :



- Table made for 2 additional dll in « rotation »
- Has to be tested in « identification mode »
- Control has to be developed

  - Support of the whole mass :
    - Demonstration table, not made for QD0 at this state
      - Mechanics : Max load of 320 kgs per table vs 1500 Kgs of QD0
      - Control : problems of eigenfrequencies, coherence of the ground…

➢ Scaling and integration of the table

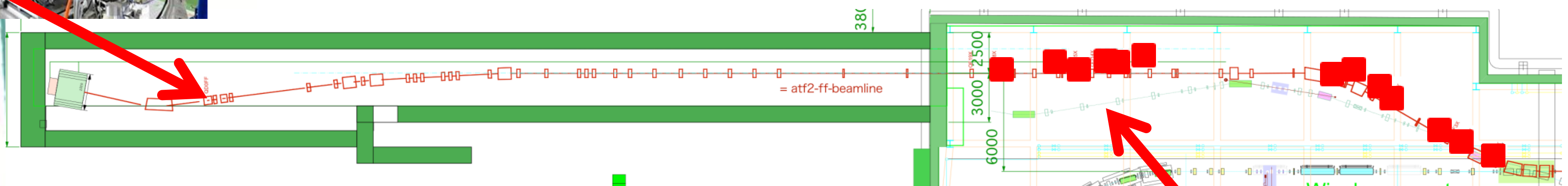
FTE vs field

- Control science : Bernard C., Gael B. (2014 Oct), Laurent B. (70%)
- Instrumentation : Julie A. (end of 2013), Andrea J.
- Mechanics : Guillaume D. (20%)
- Electronics : Sébastien V. (20%)
- Machining : Jean-Philippe B. (40%)
- Physicist : discussion in progress.
- Others : Adrien B., Jacques L. … has to be discussed (in function of the collaboration subjects and their availabilities)

Measurements campaign at ATF2

- A.Jeremie, K.Artoos, D. Kudryavtsev, Y.Renier, R.Tomas-Garcia, D.Schulte

- Goal: Detect Ground Motion (GM) effect on beam trajectory.
- Motivation: It would demonstrate possibility to make a feed-forward with GM sensors => trajectory correction based on GM measurements in CLIC => avoid quadrupole stabilization in CLIC?



Beam time on ATF2

2 2013

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

3 2013

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

4 2013

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

5 2013

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Tests in Annecy

Shipment (1 month)

Golden week

Installation
Mid-may: First test with beam?

Idea: take advantage of presence of CERN colleagues during ATF2 continuous run May 13-24

Other options:
- May 24-31
- summer 2013