ATF2 project:
Expected honeycomb table and floor vibrations at ATF Ring

Laboratories in Annecy working on Vibration Stabilization

Benoit BOLZON

ATF2 phone conference, 18th April 2007

Presentation

✓ **ATF2 constraint:** Relative motion between the Shintake monitor and the final magnets < 6nm

✓ **ILC configuration:** Final magnets and Shintake monitor on 2 separate supports

✓ **ATF2 floor:** Coherence of ground motion good up to a distance of 4-5m (4m: distance between Shintake monitor and the last magnets)

✓ **First idea:** Shintake monitor and last magnets movement same than the ground

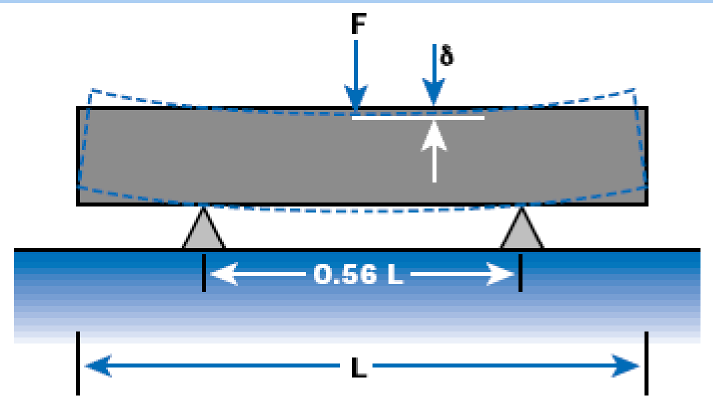
→ Necessity of having stiff supports well fixed on the floor in order that these supports move like ground motion

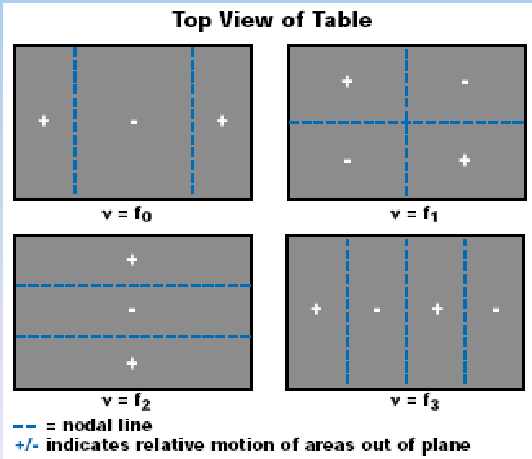
Honeycomb table eigenfrequencies

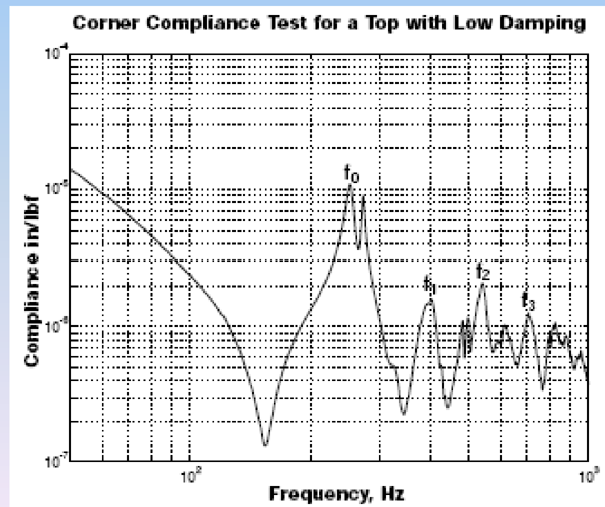
✓ **At LAPP: Very stiff honeycomb table with a first eigenfrequency guaranteed at 230Hz by TMC Company** **in free-free configuration**

- ➢ Measurements done with an impact testing hammer
- ➢ Table supported at four points by pneumatic isolators along the 2 nodal lines 22% from the ends of the table

→ Free-free configuration







Honeycomb table eigenfrequencies

- ✓ **Honeycomb table:** Good candidate as a support for magnets

- ✓ **Fixation of this table to the ground to have the same motion**
  - ➢ **Fixed-fixed configuration: Eigenfrequencies not the same**

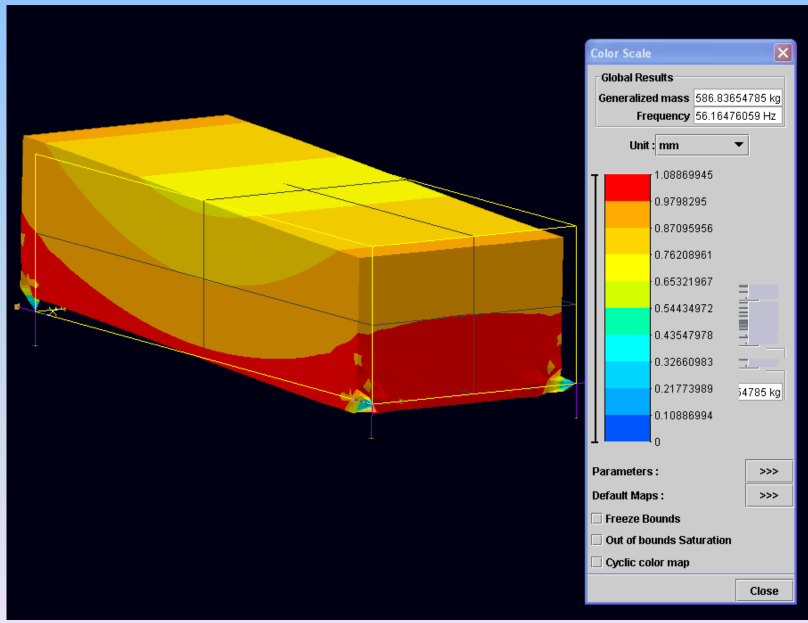
- ✓ **Simple block simulation done by Nicolas Geffroy:**
  - ➢ Full block with the table dimensions (240*90*60cm)
  - ➢ Calculation of the density to obtain the table weight (700kg)
  - ➢ Young modulus chosen (rigidity) to obtain the first eigenfrequency of the table in free-free configuration (230Hz)

Honeycomb table eigenfrequencies

- ✓ **Boundary conditions at the 4 extremities of the table:**
  - ➢ Simple and rigid supports
  - ➢ Fixed-fixed configuration

  } **Same values of eigenfrequencies obtained**

- ✓ **First eigenfrequency at 56.2Hz: Well lower than in free-free configuration!!!**



- ✓ **Other eigenfrequencies: 58.1Hz, 58.6Hz, 76.0Hz, 85.4Hz, 95.4Hz, 248.1Hz…**

Measurements outline

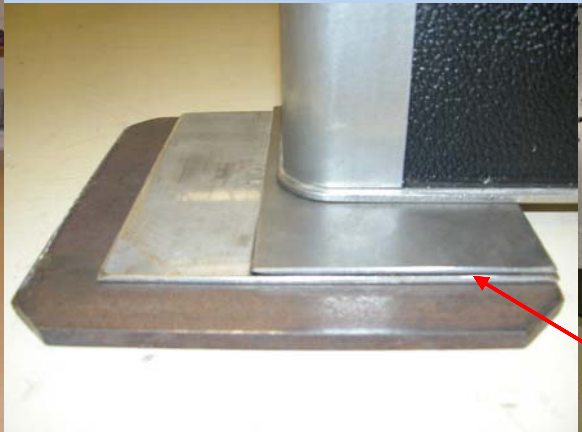
- ✓ **LAVISTA team: Investigation on our honeycomb table**
  - ➢ Fixation of the table to the ground
  - ➢ Vibrations transmissibility study between table and floor
    - → Coherence between table and floor measurements at LAPP
    - → Table transfer function measurements at LAPP
  - ➢ Expected floor and table motion at ATF Ring
  - ➢ Expected relative motion between table and floor at ATF Ring

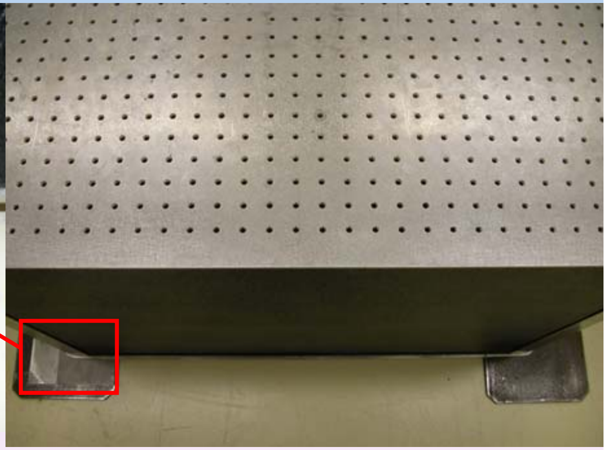
Fixation of the table to the ground

✓ **Ground not flat at all:** Positioning of 4 high steel supports of the same layer (with a thickness precision of 0.1mm) between the ground and the four corners of the table

→ Gap of 5mm between the top of a support and the bottom of one table corner

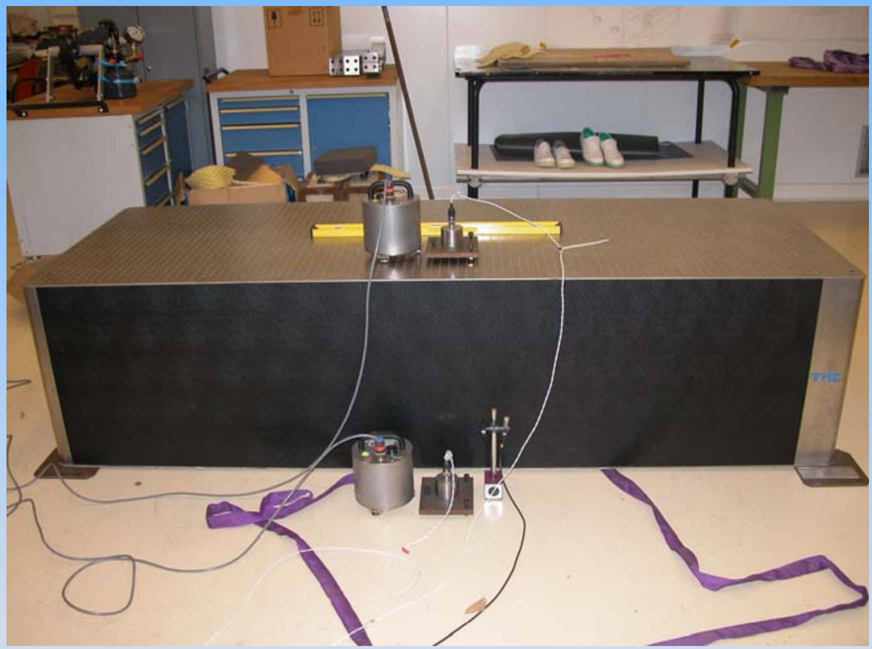
✓ Not to have this gap anymore: positioning of 2 home-made spacers with a thickness precision of 0.1mm





Fixation of the table to the ground

- ✓ Checking that the table is leveled thanks to a spirit level



Sensors used for the vibrations transmissibility study

Sensors	Guralp CMG-40T	ENDEVCO86
Measurement directions	X, Y, Z	Z
Sensitivity	2000V/m/s	10V/g
Frequency range	[0.033–50]Hz	[0.01–100]Hz
Quantity	2	2

✓ **Limitation of the measurement:**

→ **Guralp sensors:**

- **From 0.1Hz:** Electronic noise too high below
- **To 50Hz:** Frequency response not flat above

→ **ENDEVCO sensors:**

- **From 10Hz:** Electronic noise to high below
- **To 100Hz:** Frequency response not flat above

Sensors used for the vibrations transmissibility study

✓ One Guralp velocity sensor on the floor and the other one on the table to measure low frequency vibrations in the X, Y and Z directions (0.1Hz to 50Hz)

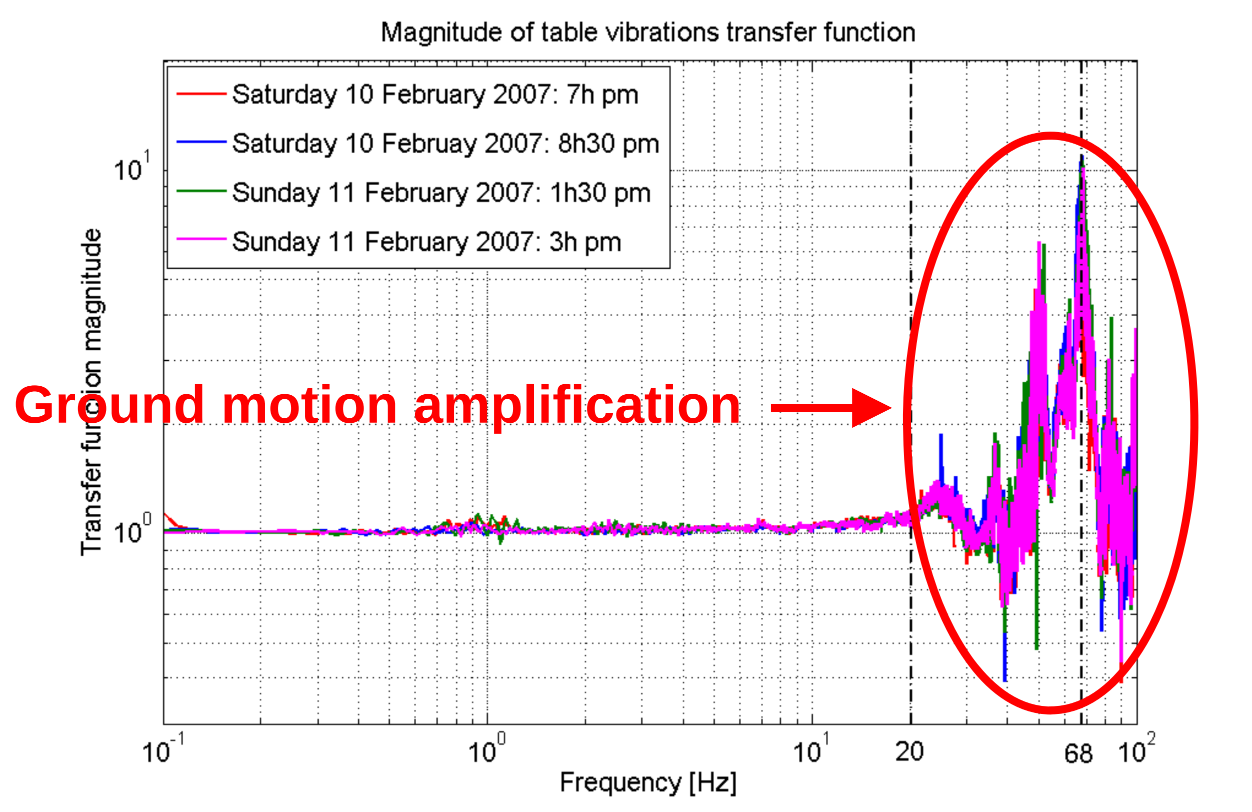
✓ One ENDEVCO accelerometer on the floor and the other one on the table to measure medium frequency vibrations in the Z directions (10Hz to 100Hz)

✓ One microphone on the floor to study acoustic effect on the table behaviour

✓ Simultaneous measurements of the 4 sensors in the Z direction

Vibrations transmissibility study between table and floor

✓ **Magnitude of table transfer function measured at LAPP:**



✓ **Up to 20Hz:** Table transfer function magnitude around 1

→ No big amplification or damping done by the table

✓ **Above 20Hz:** Increase of table transfer function magnitude

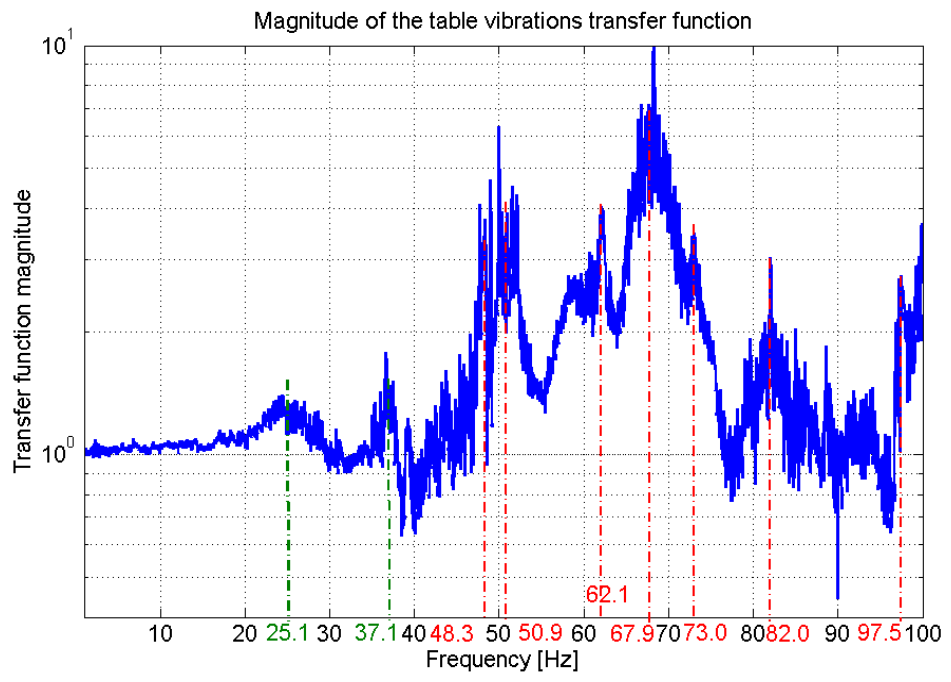
→ Ground motion amplification done by the table up to a factor 11 at 68Hz

Vibrations transmissibility study between table and floor

✓ Simulation of a simple block put on rigid supports or in fixed-fixed mode: eigenfrequencies begin at 56Hz and close to each other

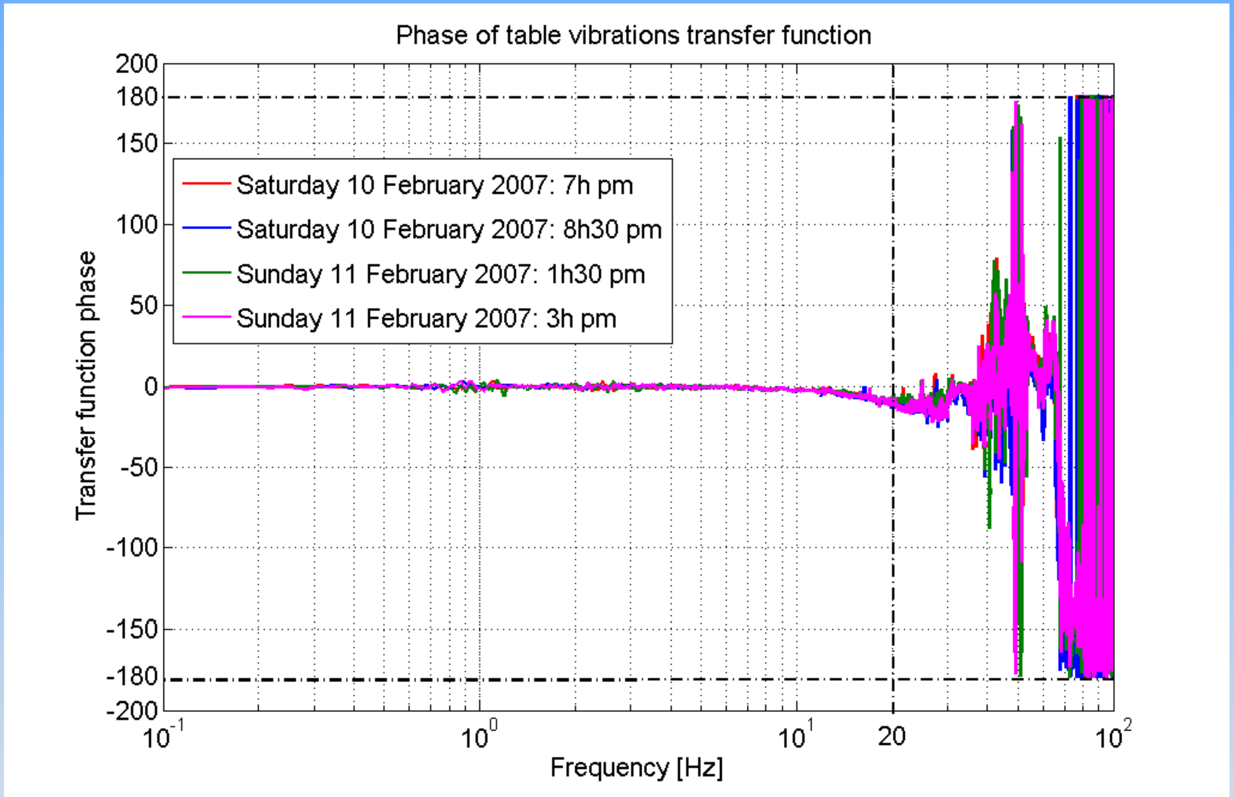
✓ Measured table transfer function: eigenfrequencies begin also around 50Hz and also close to each other except for the 2 first ones

➢ Not really eigenfrequencies? Table not well put on supports? Supports not well put on the floor?



Vibrations transmissibility study between table and floor

✓ **Phase of table transfer function measured at LAPP:**



✓ **Up to 20Hz:** Table transfer function phase around 0

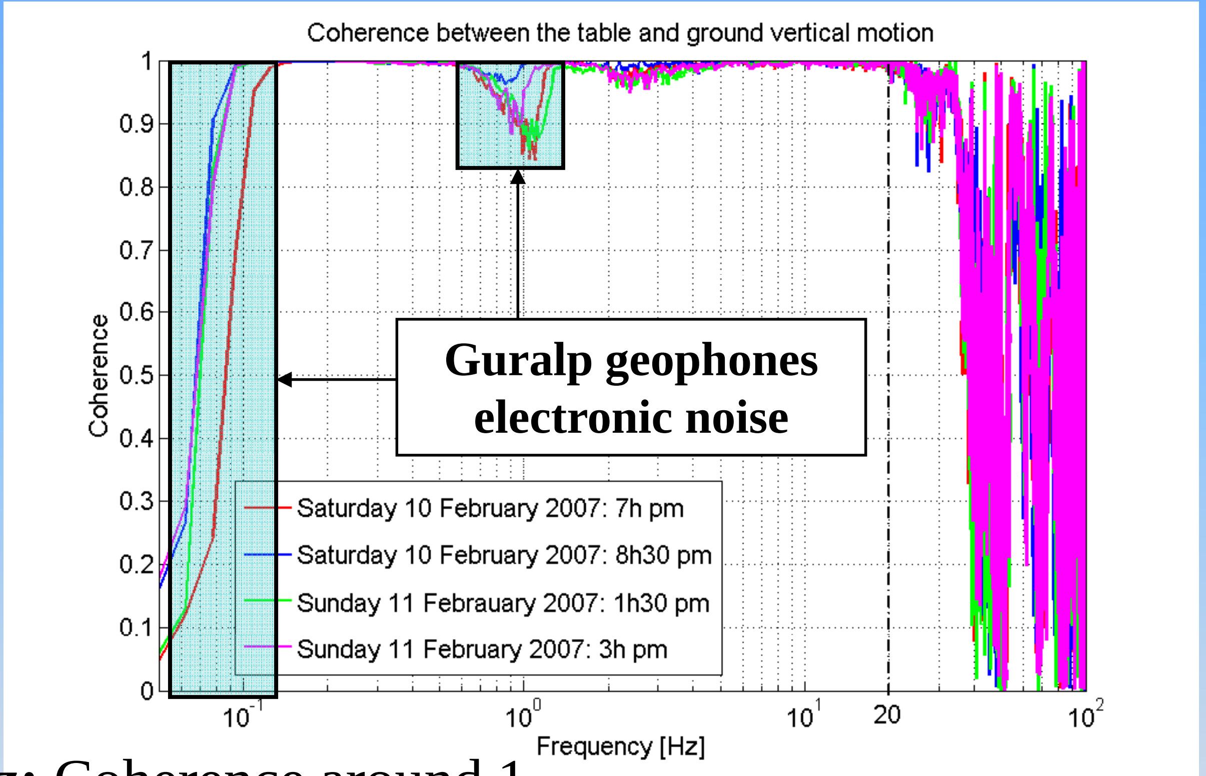
→ Almost no phase differences of floor vibrations with respect to the table

✓ **Above 20Hz:** Increase of table transfer function phase

→ Phase differences of floor vibrations with respect to the table up to ±180°

Vibrations transmissibility study between table and floor

✓ **Coherence between the table and the floor measured at LAPP:**



✓ **Up to 20Hz:** Coherence around 1

→ **Almost linear vibrations transmissibility between table and ground**

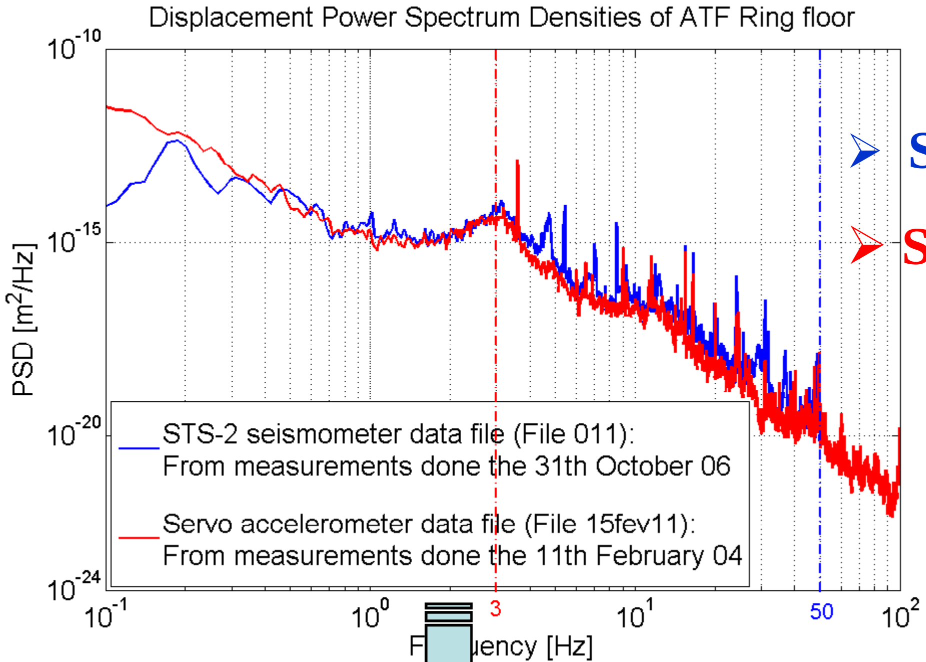
✓ **Above 20Hz:** Fall down of coherence

→ **Probably due to non linear vibrations transmissibility: Bad fixation of the supports to the table and to the ground**

Expected floor and table vibrations at ATF Ring

✓ **Floor vibrations at ATF Ring: 2 data files from 2 types of sensors**

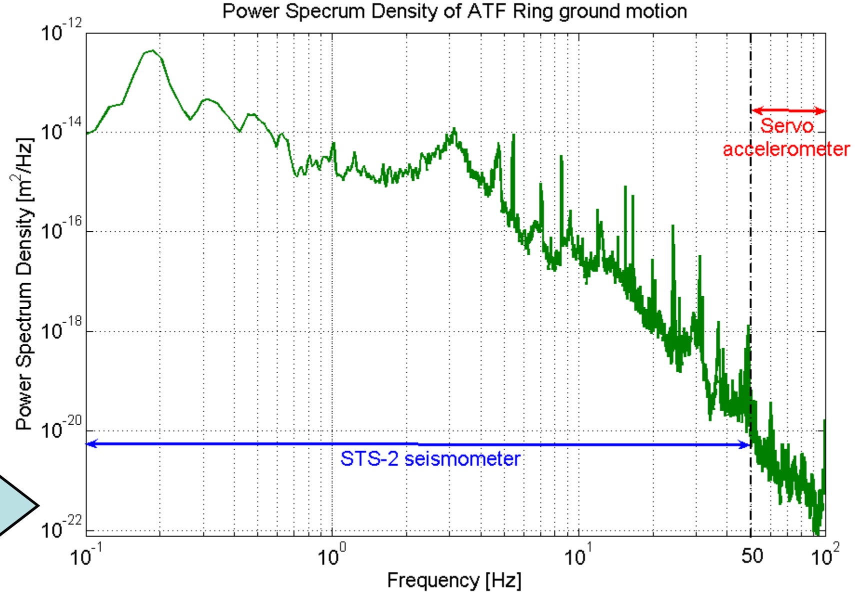
- **STS-2 seismometer:** Good coherence from 0.1Hz to 50Hz
- **Servo accelerometer:** Good coherence from 3Hz to 100Hz



ATF Ring floor vibrations data:

- **STS-2 seismometer: from 0.1Hz to 50Hz**
- **Servo accelerometer: from 50Hz to 100Hz**

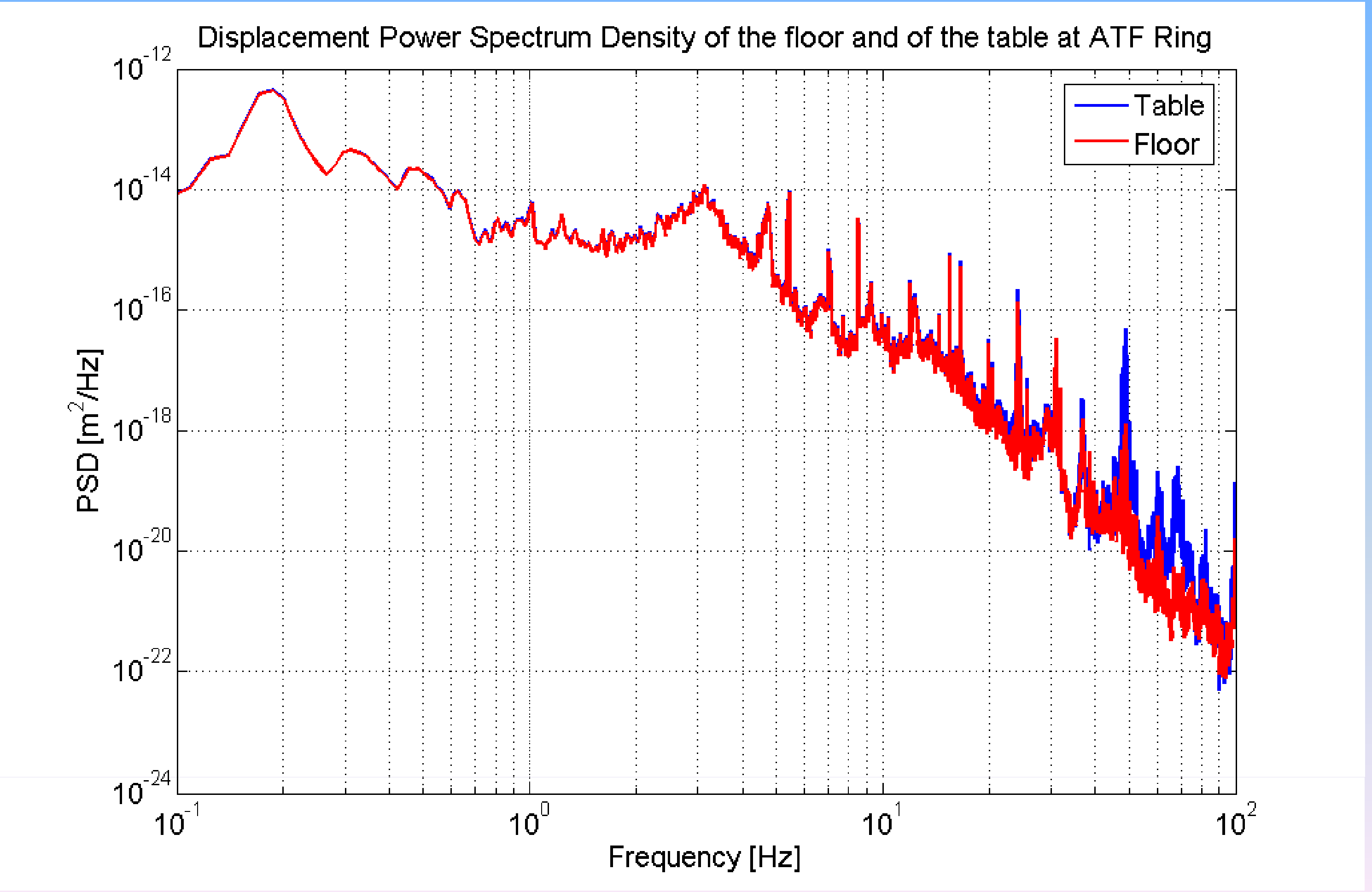
Ground motion quite the same



Expected floor and table vibrations at ATF Ring

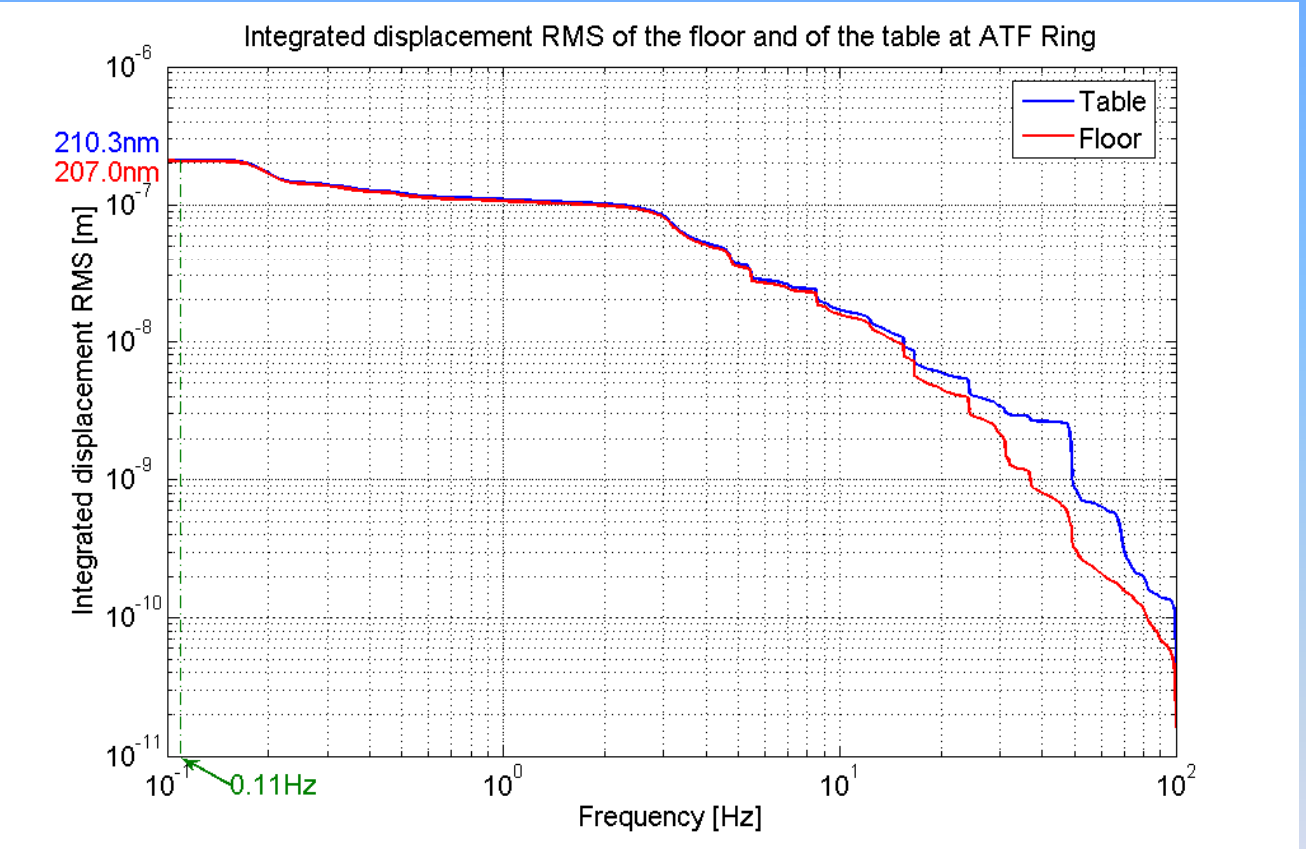
✓ **Displacement Power Spectrum Density (PSD) of the table at ATF**

= (Table transfer function magnitude)^2 *ATF floor displacement PSD



Expected floor and table vibrations at ATF Ring

✓ **Integrated displacement Root Mean Square at ATF Ring:**



✓ Difference of integrated displacement RMS from 0.1Hz to 100Hz: 3.3nm!!!

✓ But phase differences between table and floor not taken into account

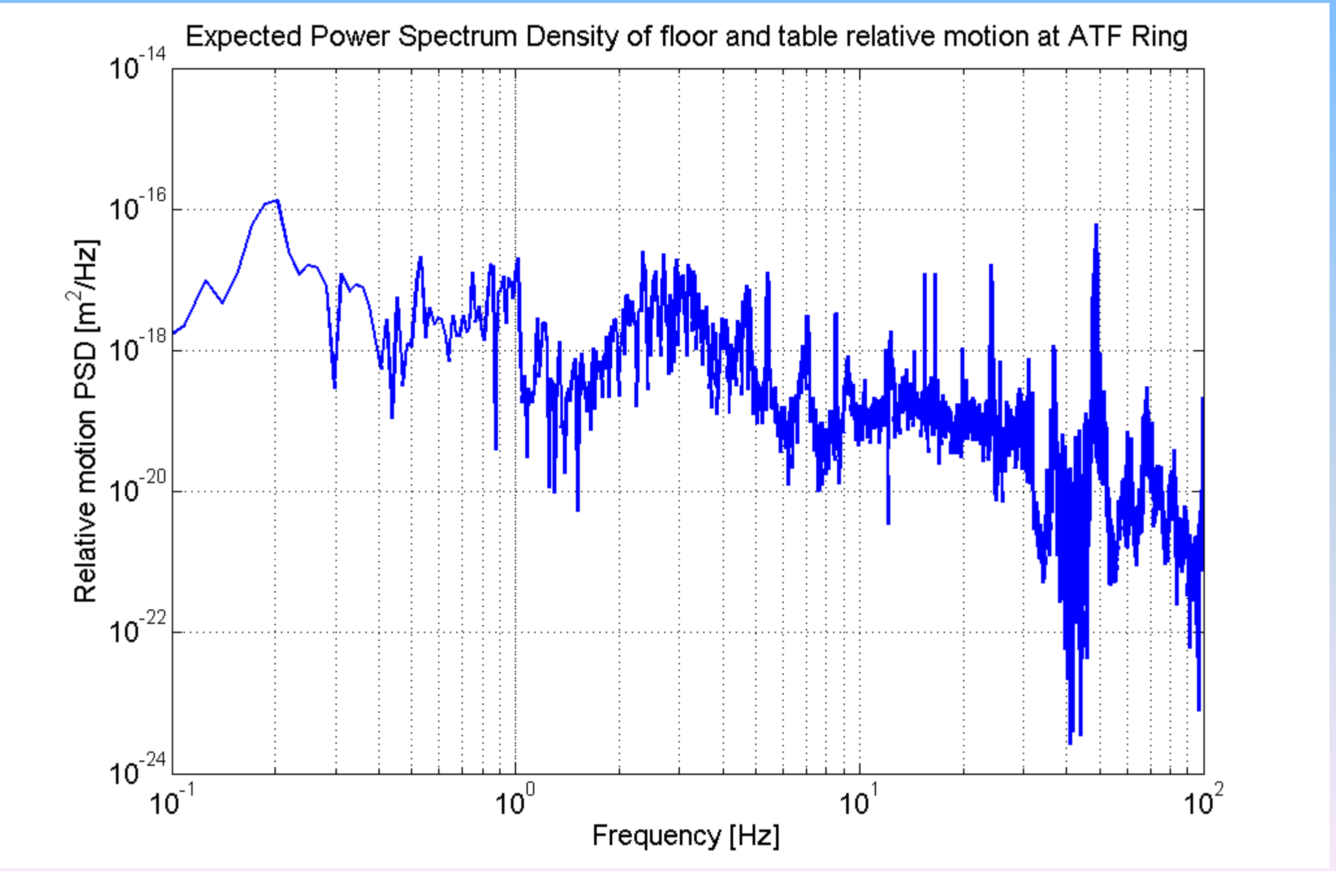
→ Relative motion calculation to know the real difference of motion

Relative motion between table and floor at ATF Ring

✓ **Power Spectrum Density (PSD) of relative motion at ATF Ring:**

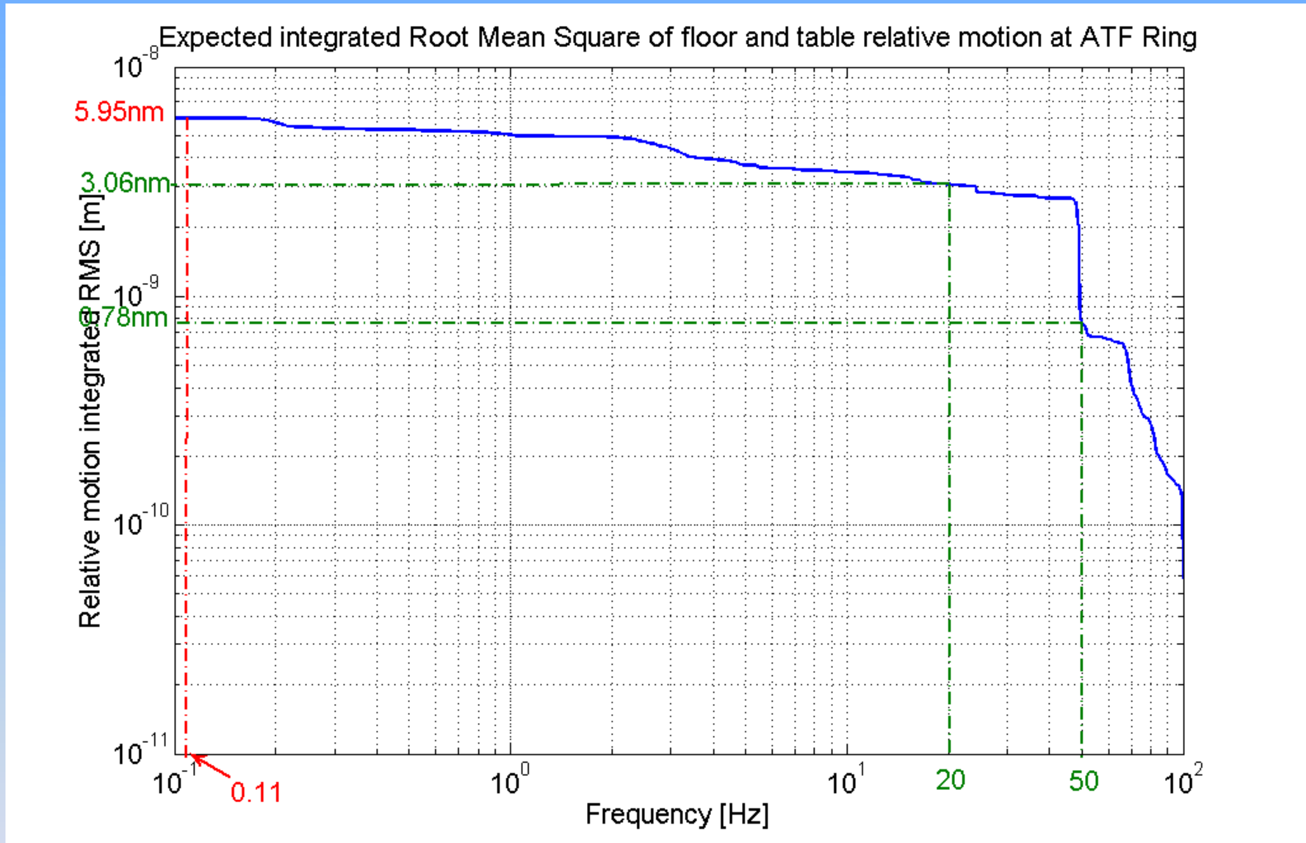
= ATF floor displacement PSD * [1+Re(g)^2 - 2*Re(g) + Im(g)^2] with:

- g: Table transfer function (Complex number)



Relative motion between table and floor at ATF Ring

✓ **Integrated displacement RMS of relative motion at ATF Ring:**



➢ **Integrated relative motion between floor and table at ATF Ring:**

- Above 0.1Hz: 5.95nm → Below ATF tolerances (6nm)!!!

- Above 50Hz: 0.78nm → Negligible

General conclusion and future prospects

✓ **Integrated RMS of relative motion between table and floor at ATF Ring (with the table not well fixed to the floor):**

- **Above 0.1Hz: 5.95nm → Below ATF tolerances (6nm)!!**
- **Above 50Hz: 0.78nm → Negligible**

✓ **Near future: Fixation of the table to the ground (Linear vibrations transmissibility: coherence=1) → Fixed-fixed configuration**

- **Simple block simulation: First eigenfrequency at 58Hz**

Honeycomb table
- **→ Should have no ground motion amplification below 50Hz (see magnitude transfer function)**
- **→ Should have no phase differences below 50Hz between the table and the floor (see phase transfer function)**

⇒ **Relative motion should be lower**