Sixth ATF-2 project meeting:

Study of supports for ATF-2 final doublets

Laboratories in Annecy working on Vibration Stabilization

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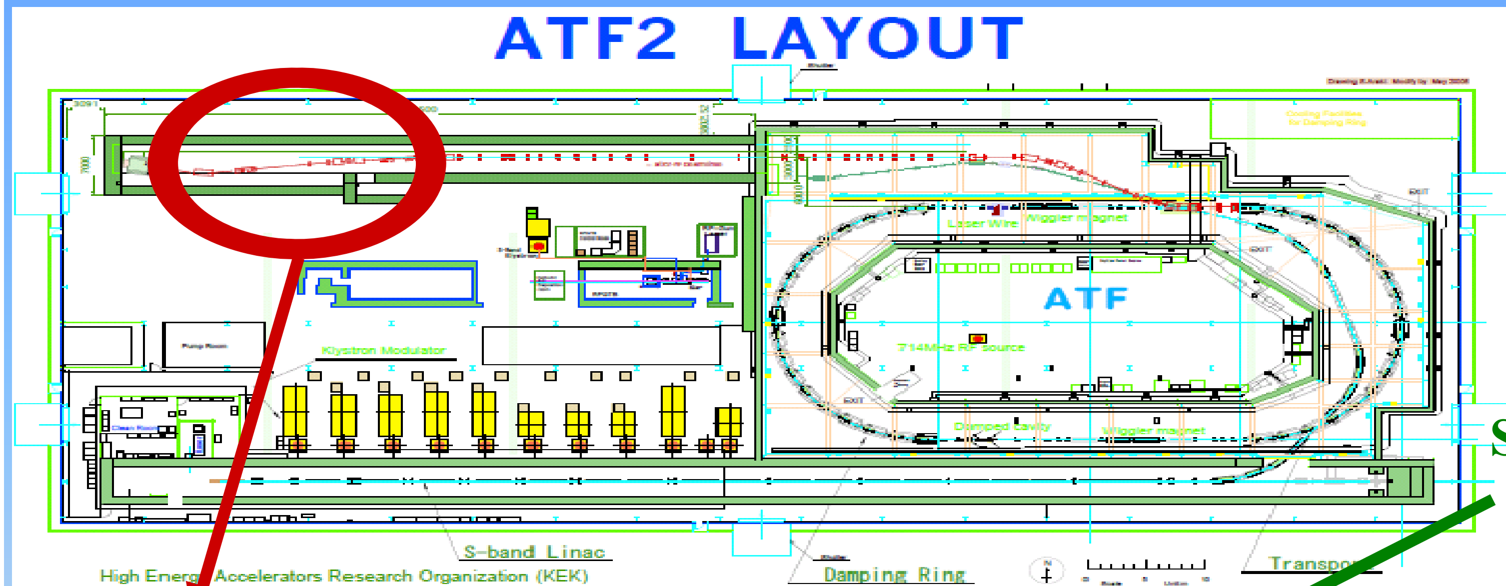
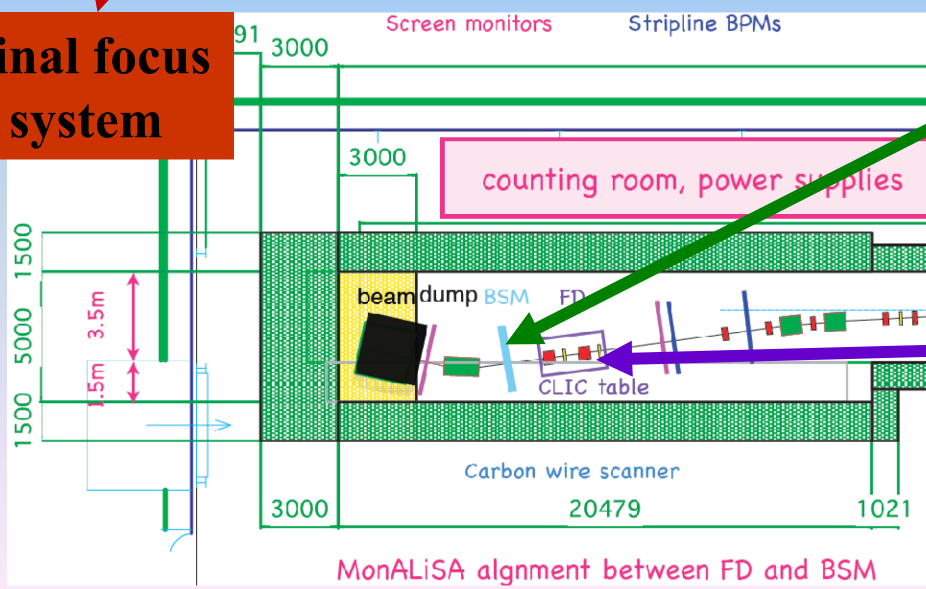
Nanobeam 08, Novosibirsk

Context

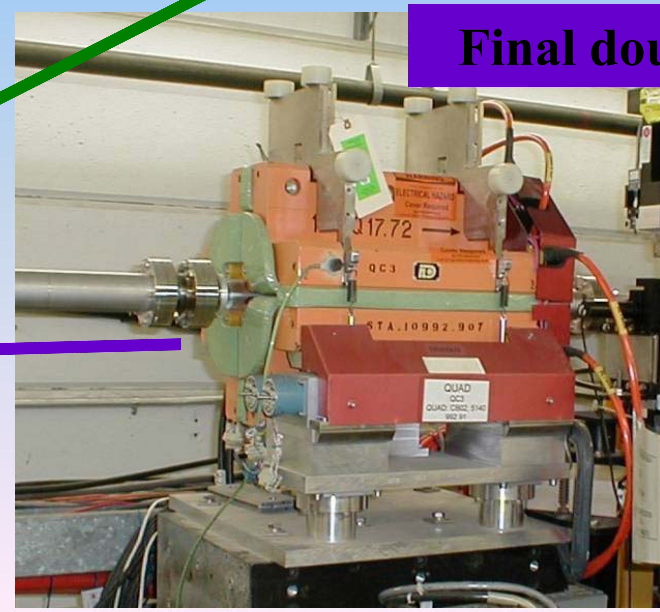


Shintake Monitor: Instrumentation of the beam

Final focus system



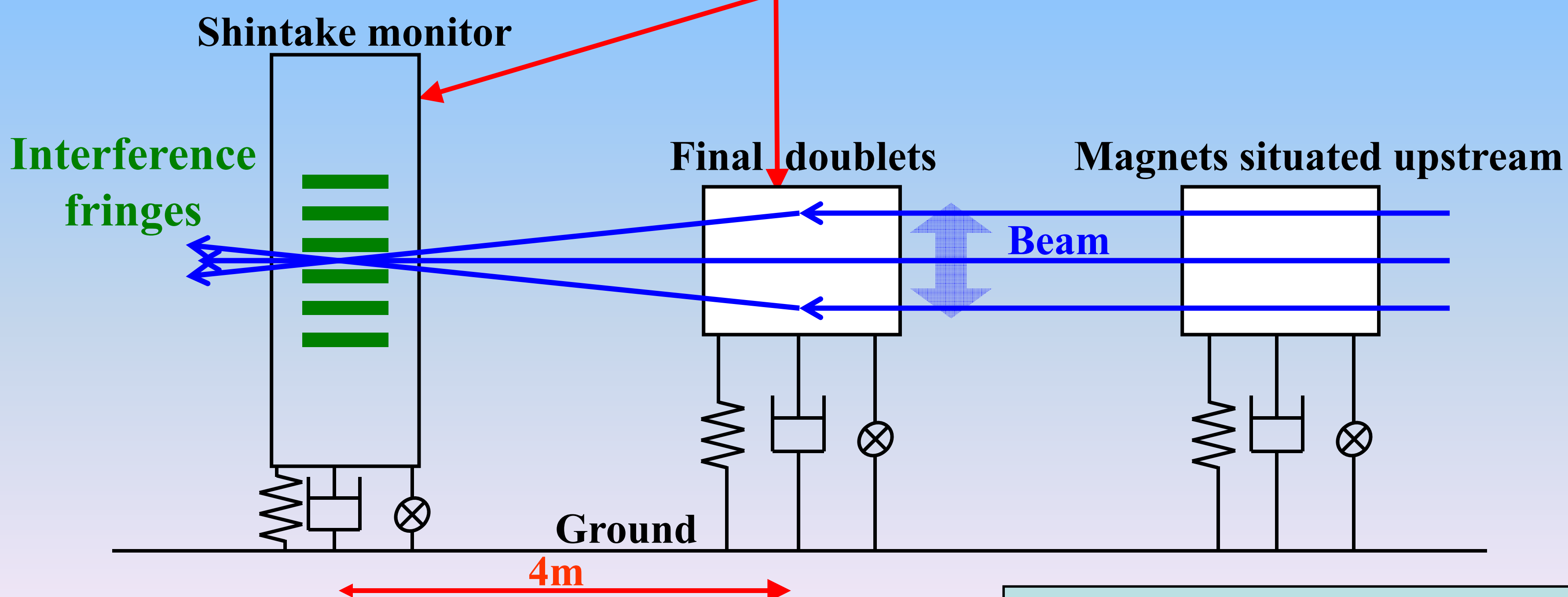
Final doublets



ATF2 specifications for final focus vibrations

- ✓ **First goal:** obtain a vertical beam size of 37nm
- ✓ **Shintake monitor:** measurements of the beam size (interferometer)

➔ **Relative motion between Shintake monitor and final doublets:**
Below 10nm in the vertical axis above 0.1Hz
(lower frequency range but bigger amplitude possible than for CLIC)



Good ground motion coherence: measured on KEK site

➔ Separated stiff supports

Plan of my presentation

Work for LAVISTA team:
Study of stiff supports for ATF2 final doublets

1. Vibratory study of a STACIS honeycomb table as a base for fixing magnets

- ✓ Table fixed to 4 rigid supports at its corners
- ✓ Table fixed to the floor on its entire face

2. Vibratory study of ATF2 final doublets with their intermediary supports made at LAPP

- ✓ Vibratory study of an ATF2 sextupole with its supports
- ✓ Vibratory study of an ATF2 quadrupole with its supports

First part:
Vibratory study of a STACIS honeycomb table as a base for fixing magnets

- ✓ Table fixed to 4 rigid supports at its corners
- ✓ Table fixed to the floor on its entire face

Table fixed to 4 rigid supports at its corners

Experimental set-up

Very stiff honeycomb table

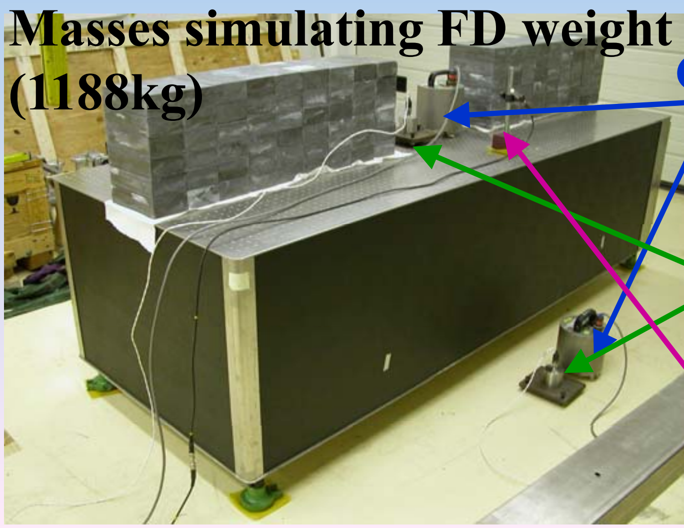
Four rigid feet with adjustable height

Same pressure on each foot thanks to a torque wrench

In order to avoid table rocking for good vibration transmission between floor and table

Evolution of resonances with weight on the table

Masses simulating FD weight (1188kg)



GURALP geophones (0.1Hz - 13Hz)

ENDEVCO 86 accelerometers (13Hz - 100Hz)

Microphones of type 4189

Masses simulating FD weight/2

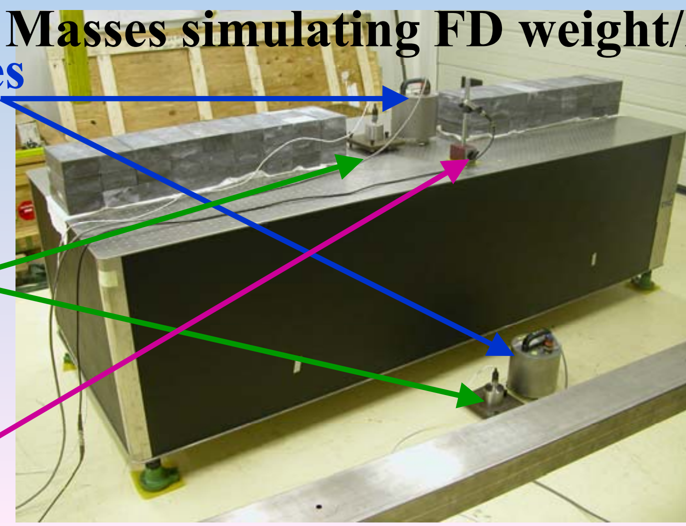
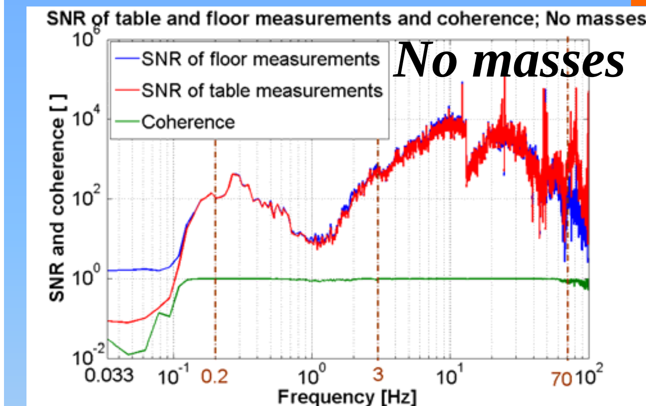
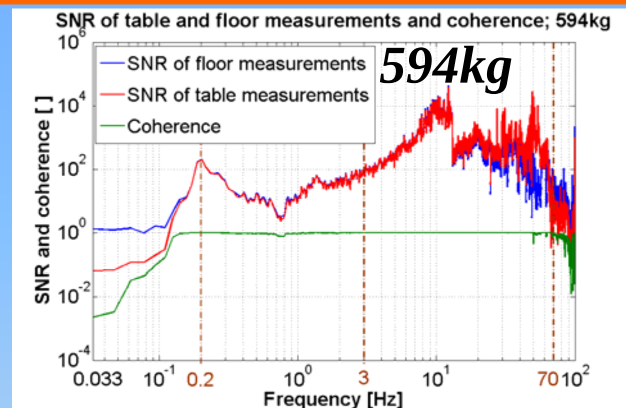


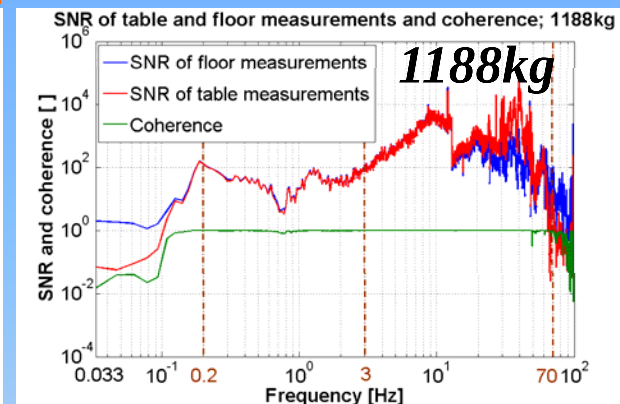
Table fixed to 4 rigid supports at its corners

Signal to Noise Ratios (SNR) and Coherences

Signal to Noise Ratios

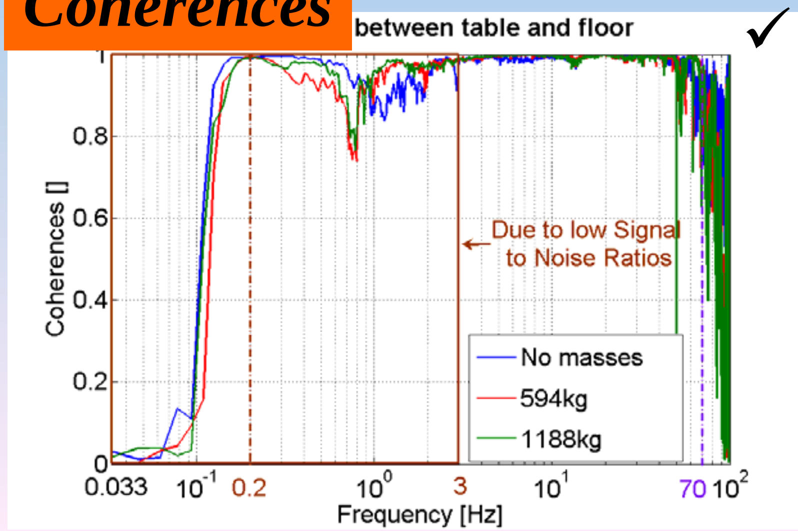






- ➢ Very bad < 0.2Hz *and* 0.2Hz < low < 3Hz *and* low > 70Hz

Coherences



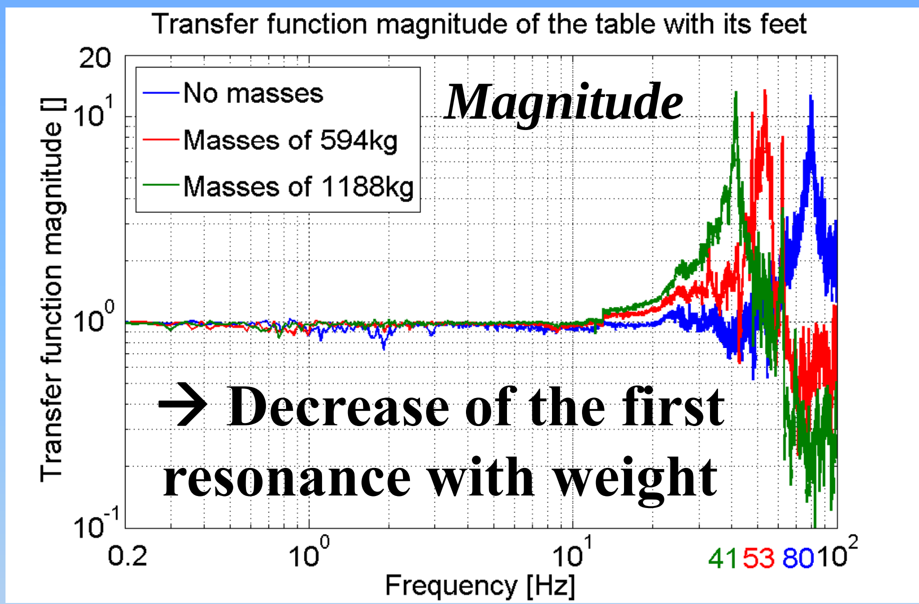
✓ **Good coherences up to 70Hz**

➢ Good vibration transmission between floor and table up to at least 70Hz

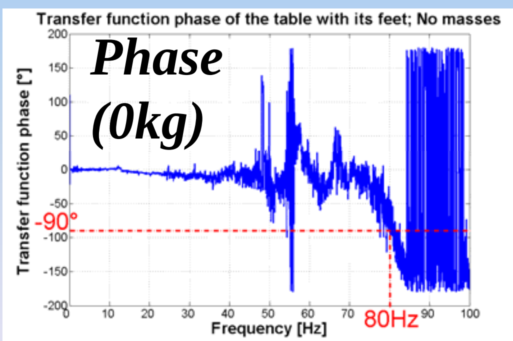
➔ Fixations efficient (beeswax and adjustable feet)

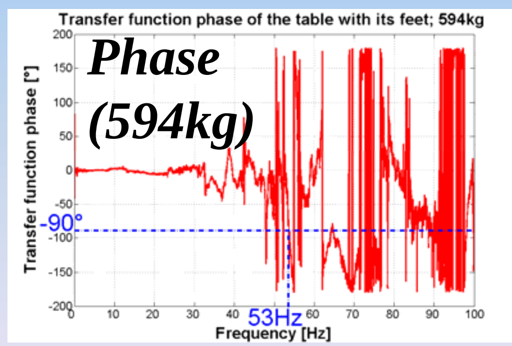
Table fixed to 4 rigid supports at its corners

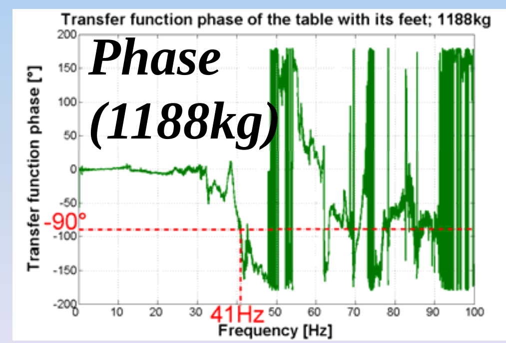
Transfer function of the table with its 4 feet



- ✓ **First resonance (phase=90°):**
  - ➢ **No masses:** 80Hz
  - ➢ **Masses of 594kg:** 53Hz
  - ➢ **Masses of 1188kg:** 41Hz







➢ **With FD weight:** low first resonance (↑ of ground motion with ↓ of f)

➔ Need to find the impact of resonances on relative motion

Table fixed to 4 rigid supports at its corners

Integrated RMS of relative motion between table and floor to predict on the ATF site

Calculation to perform by integrating the vibratory behavior of the table measured at LAPP and the data of ATF ground motion

Calculation performed for these specific needs:

$$RMS_{int\ y\text{-}x}(k) = \sqrt{\sum_{k_1}^{k_2}[H(k)-1][H^*(k)-1]DSP_x(k)}$$

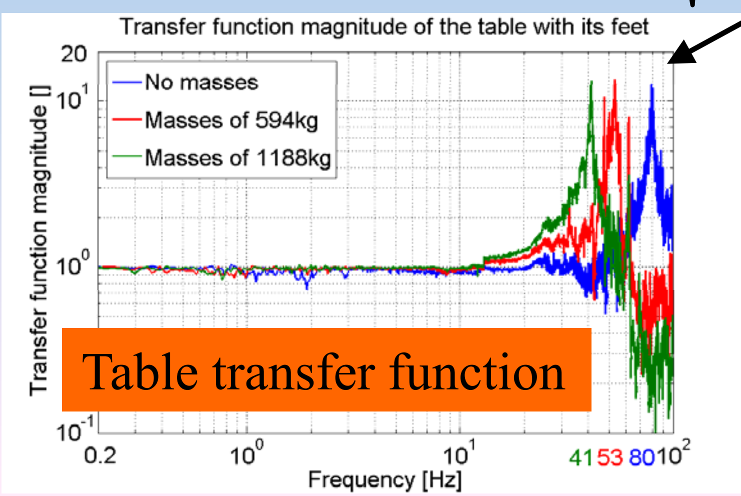
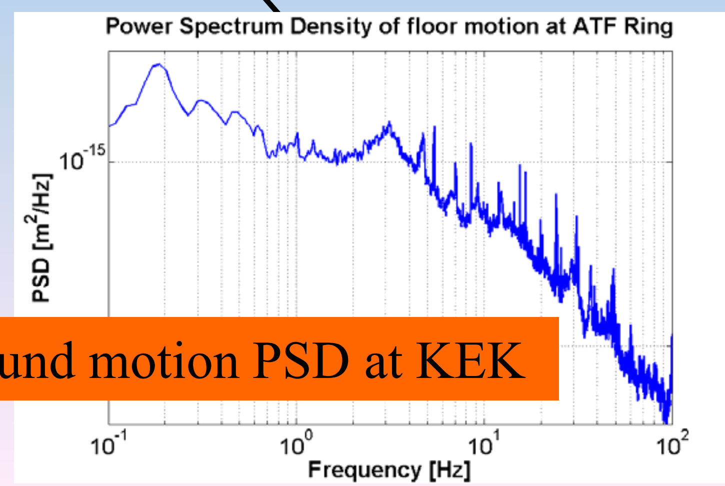


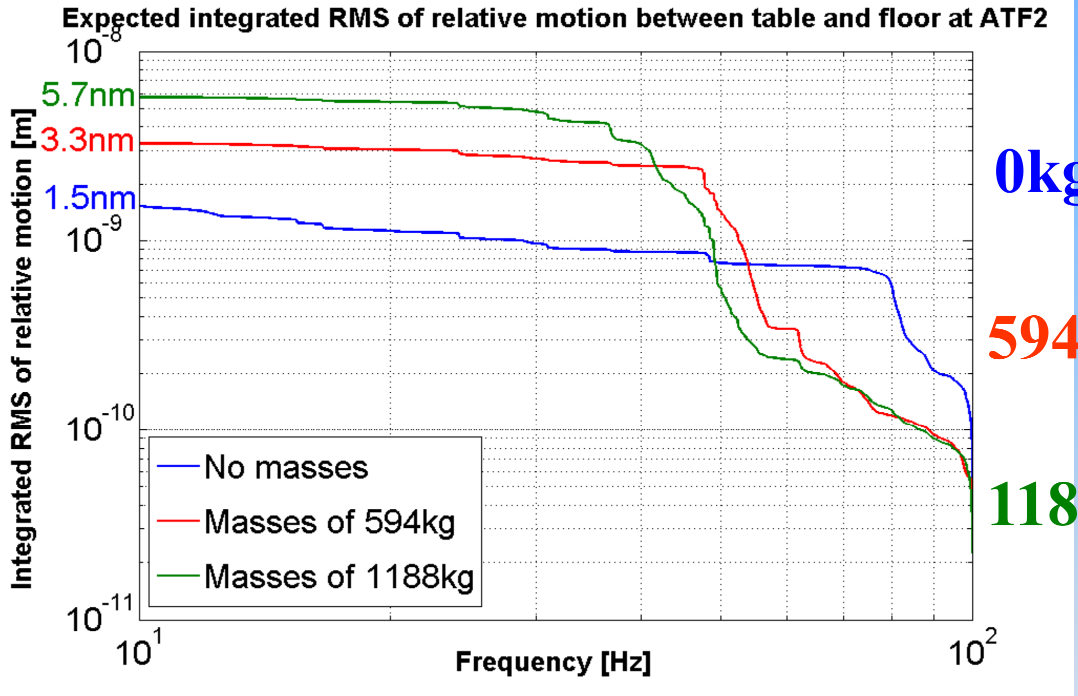
Table transfer function



Ground motion PSD at KEK

Table fixed to 4 rigid supports at its corners

Integrated RMS of relative motion due to resonances (above 10Hz)



0kg: 1.5nm

594kg: 3.3nm

1188kg: 5.7nm

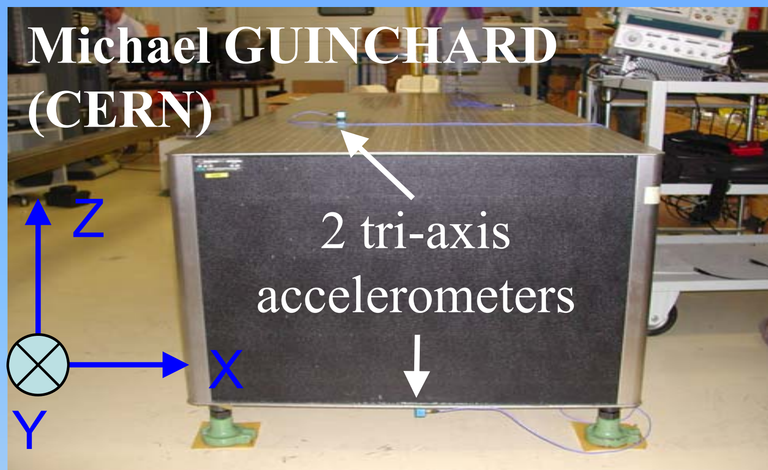
Increase of relative motion with the decrease of resonant frequency (increase of ground motion)

- **Weight of FD on table:** not negligible / to ATF2 tolerances (10nm)

➔ Need to find modal shape of the first resonance in order to choose optimal boundary conditions to break it

Table fixed to 4 rigid supports at its corners

Modal shape measurements : Collaboration CERN-LAPP



✓ **Impact given with an impact testing hammer on different points of the table**

✓ **Modal shape reconstruction**

- For each resonance (up to 150Hz)
- In the 3 axis of space

✓ **6 first modes obtained:** rigid body modes in the 6 degrees of freedom

Modal shape	**1) T-X**	**2) T-Y**	**3) R-Z**	**4) T-Z**	**5) R-Y**	**6) R-X**
Frequency (Hz)	34.8	41.8	60.6	**80.6**	103.9	136.0
Damping (%)	2.8	2.6	2.4	**2.3**	2.1	4.0

T: Translation

R: Rotation

- **Negligible boundary conditions compared to the table rigidity**

➔ Table fixation on one entire face to break these 6 resonances

Table fixed on one entire face to the floor

Experimental set-up

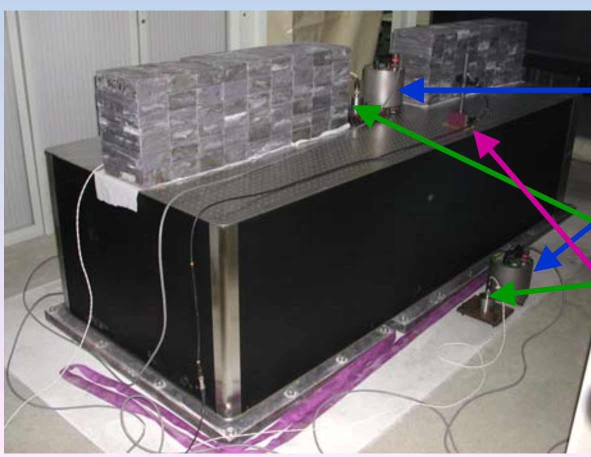
Honeycomb table

Bees wax

3 steel plates bolted to the floor

Space between plates to move the table with slings

Evolution of resonances with masses simulating FD weight



GURALP geophones (0.1Hz - 13Hz)

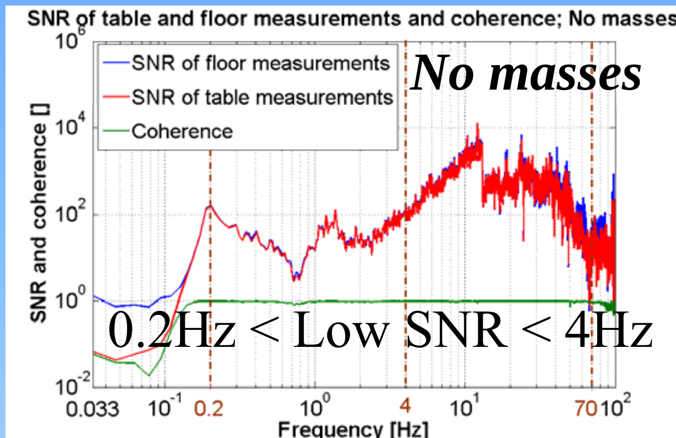
ENDEVCO 86 accelerometers (13Hz - 100Hz)

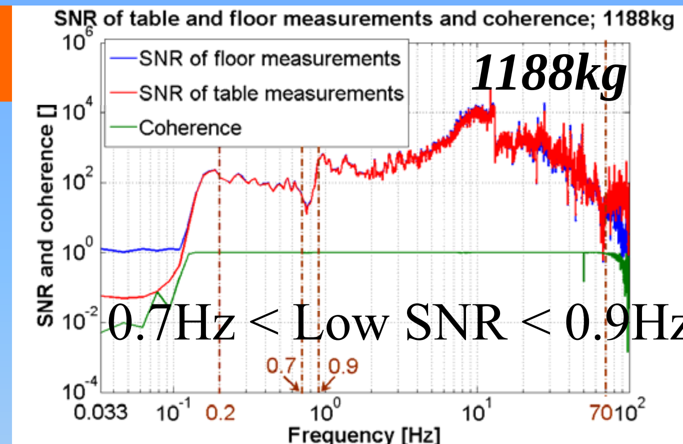
Microphone of type 4189

Table fixed on one entire face to the floor

Signal to Noise Ratios (SNR) and Coherences

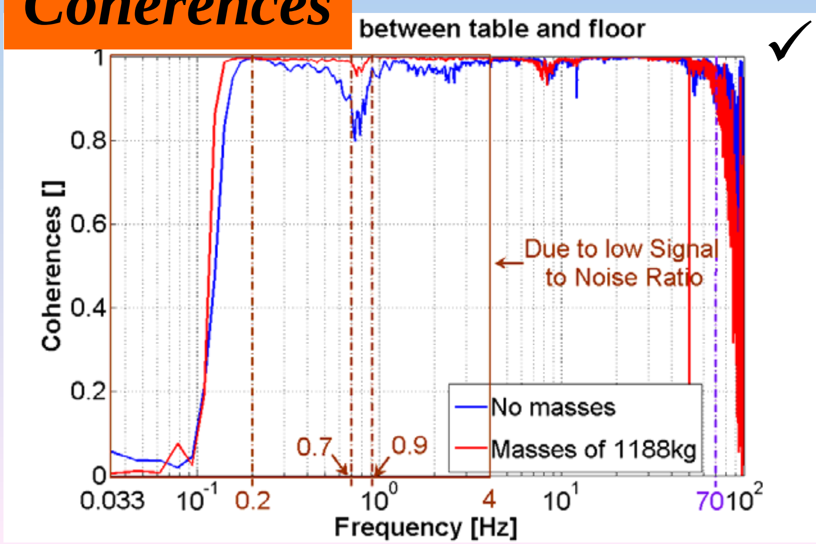
SNR





➢ Very low SNR < 0.2Hz and low SNR > 70Hz

Coherences



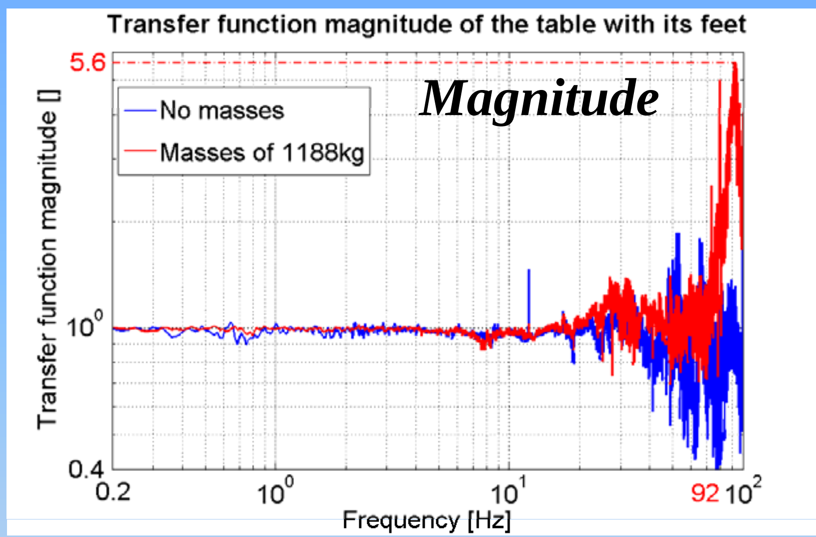
✓ **Good coherences up to 70Hz**

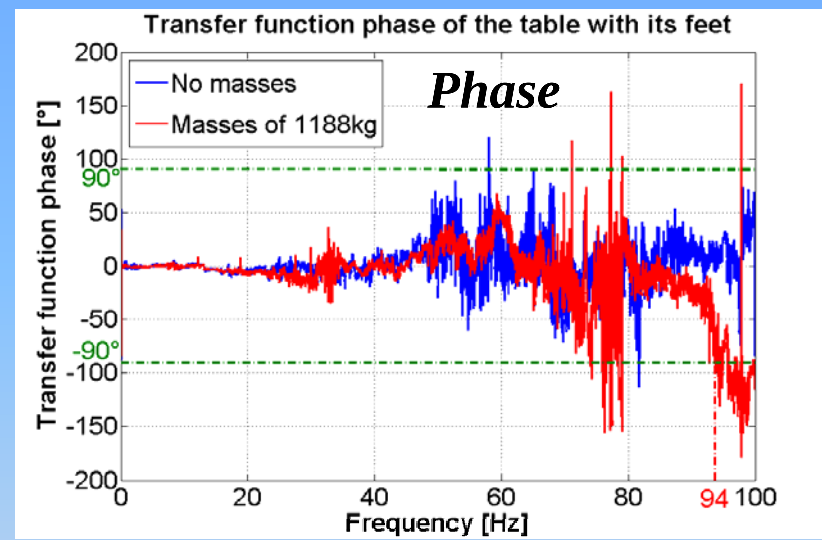
➢ Good vibration transmission between floor and table up to at least 70Hz

➔ Fixations efficient (beeswax and bolts)

Table fixed on one entire face to the floor

Transfer function of the table with the 3 plates





- ✓ **0kg:** no resonances below 100Hz (phase≠90°)
- ✓ **1188kg:** first resonance at 92Hz (phase=90°)

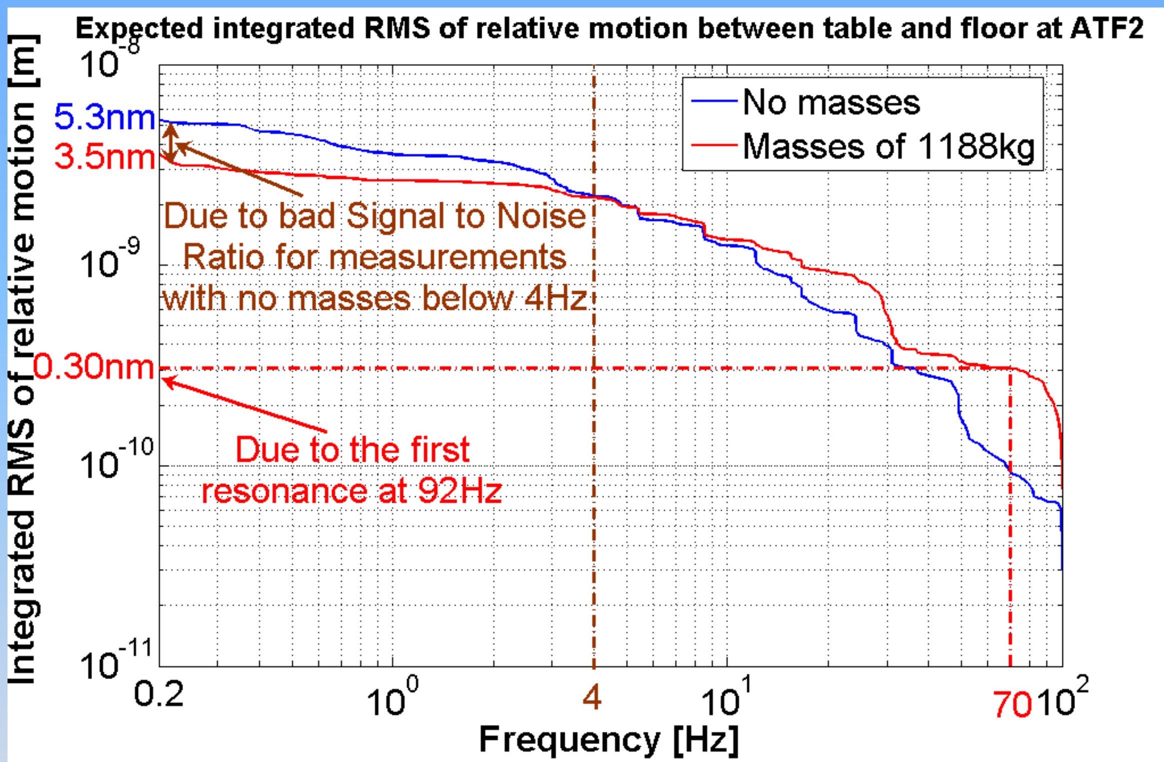
} Fall of the resonant frequency with weight

- ➢ **Weight of FD on table:** very good transfer function up to 70Hz

➔ Good boundary conditions chosen for the table:
Relative motion should be very low compared to tolerances

Table fixed on one entire face to the floor

Integrated RMS of table relative motion to the floor



✓ **Above 0.2Hz with weight of FD on table: relative motion = 3.5nm**

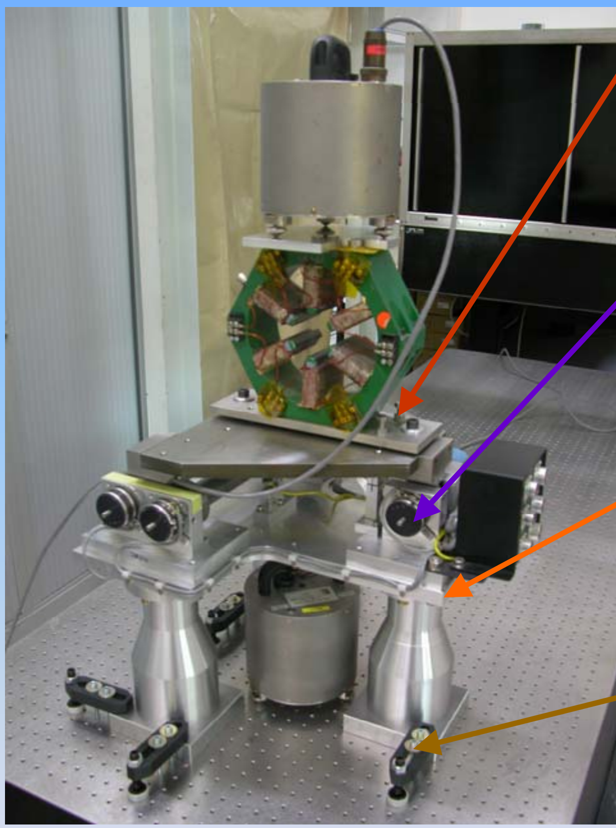
- **Very good compared to ATF2 tolerances (10nm)!!!**
- In reality, should be lower because measurement errors of 1% induce relative motion calculation errors of 1.6nm (GM at KEK > 0.2Hz: 164nm)

Second part:
Vibratory study of ATF2 final doublets with their intermediary supports made at LAPP

- ✓ Vibratory study of an ATF2 sextupole with its supports
- ✓ Vibratory study of an ATF2 quadrupole with its supports

Vibratory study of an ATF2 sextupole with its supports

Experimental set-up

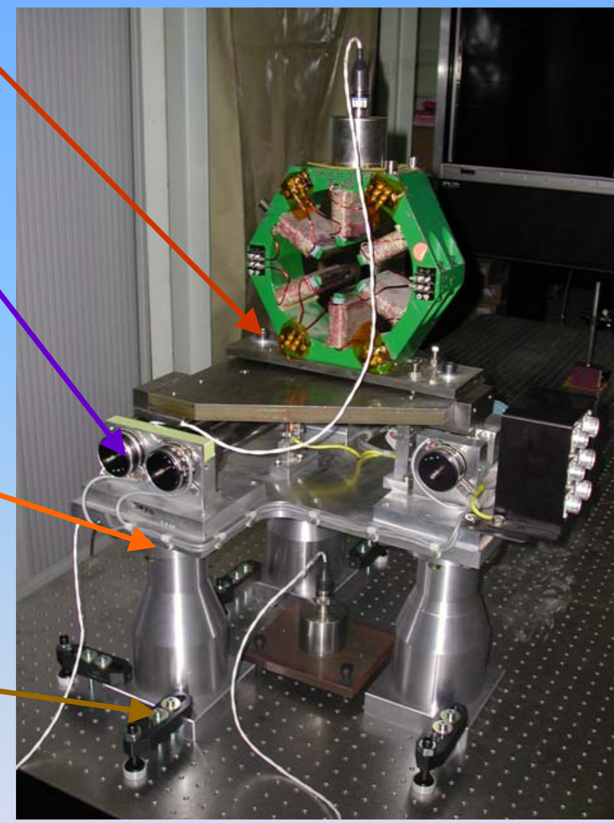


Setting of the magnet level

Movers for movement of the magnet around the beam axis

Insertion of spacers for coarse magnet alignment in the vertical axis

Coarse magnet alignment in the horizontal axis



GURALP geophones (0.1Hz - 13Hz)

ENDEVCO 86 accelerometers (13Hz - 100Hz)

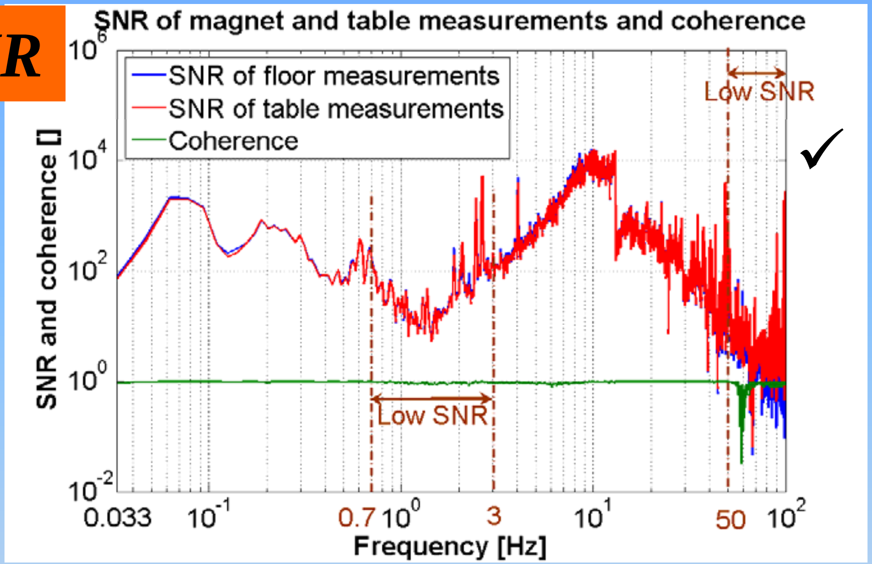
GURALP positioning on a T-plate fixed with beeswax on the magnet

Problem of GURALP rocking?

Vibratory study of an ATF2 sextupole with its supports

Signal to Noise Ratios (SNR) and Coherences

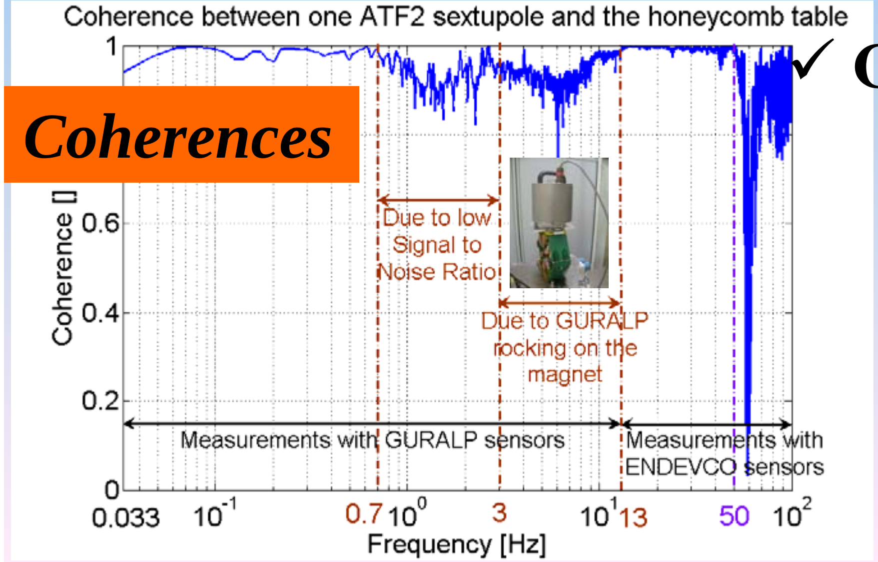
SNR



✓ **Low Signal to Noise ratios:**

- Between 0.7Hz and 3Hz
- Above 50Hz

Coherences



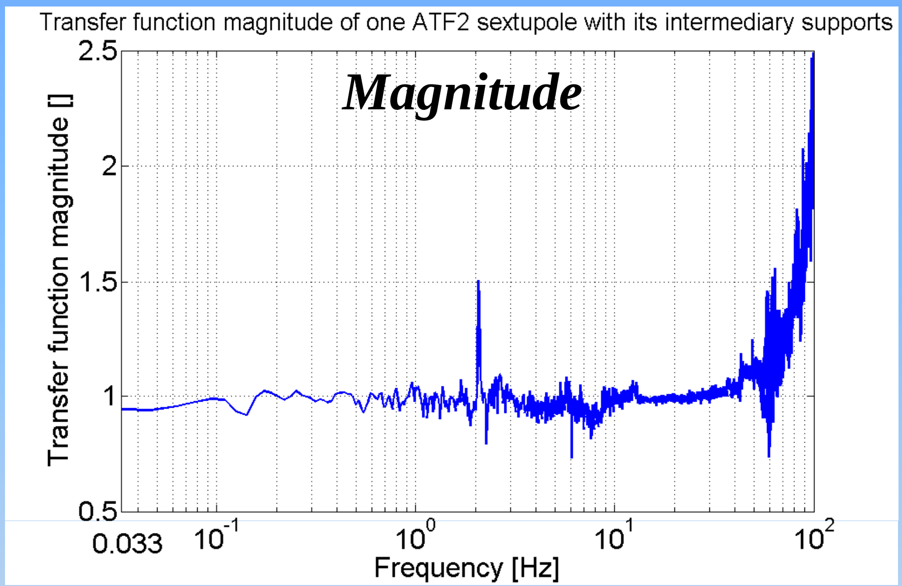
✓ **Good coherences up to at least 100Hz**

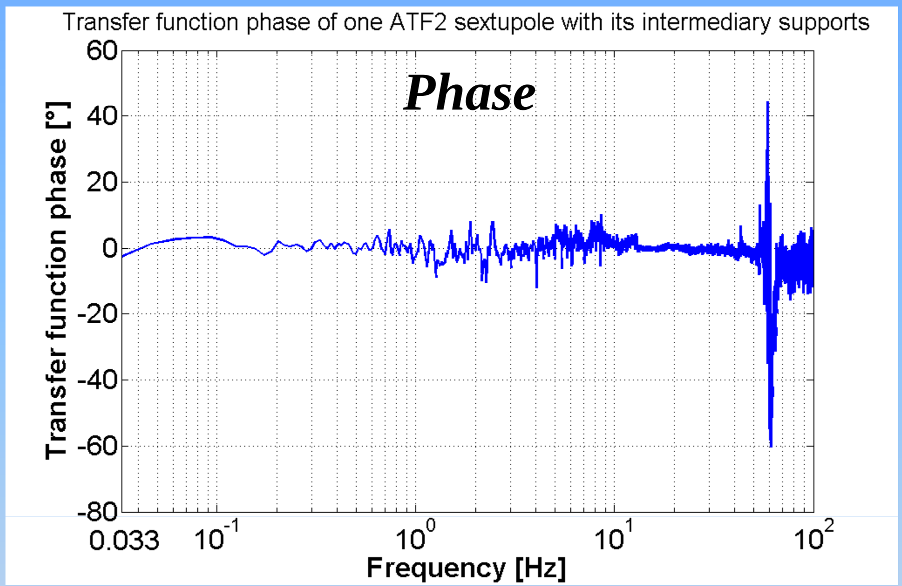
- Good vibration transmission between table and sextupole up to at least 100Hz

➔ Good fixations of the sextupole to the table

Vibratory study of an ATF2 sextupole with its supports

Transfer function of the sextupole with its supports





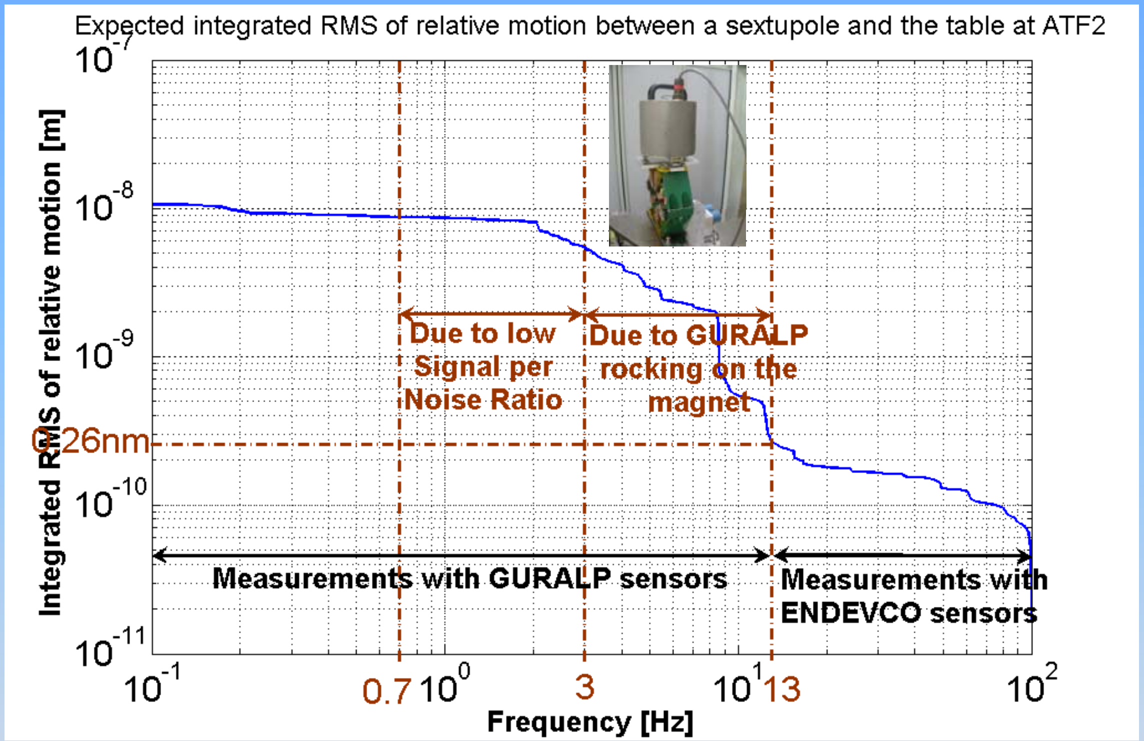
✓ **No resonances below 100Hz (phase ≠ 90°)**

➢ Very good transfer function up to at least 100Hz

➔ Sextupoles and intermediary supports well designed: Relative motion should be very low compared to tolerances

Vibratory study of an ATF2 sextupole with its supports

Integrated RMS of sextupole relative motion to the table



- ✓ **Between 0.7Hz and 13Hz:** inaccurate measurements (low Signal to Noise Ratios and GURALP rocking on the magnet)
- ✓ **Above 13Hz:** relative motion of 0.26nm
  - ➢ **Very good compared to ATF2 tolerances (10nm)!!!**

Vibratory study of an ATF2 quadrupole with its supports

Experimental set-up

Movers for movement of the magnet around the beam axis

Insertion of spacers for coarse magnet alignment in the vertical axis

Coarse magnet alignment in the horizontal axis

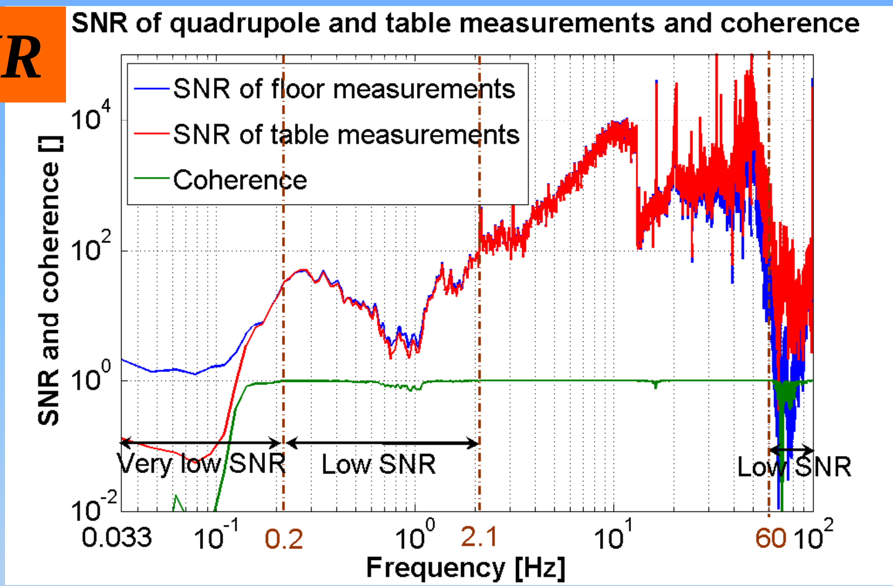
GURALP geophones (0.1Hz - 13Hz)

ENDEVCO 86 accelerometers (13Hz - 100Hz)

Vibratory study of an ATF2 quadrupole with its supports

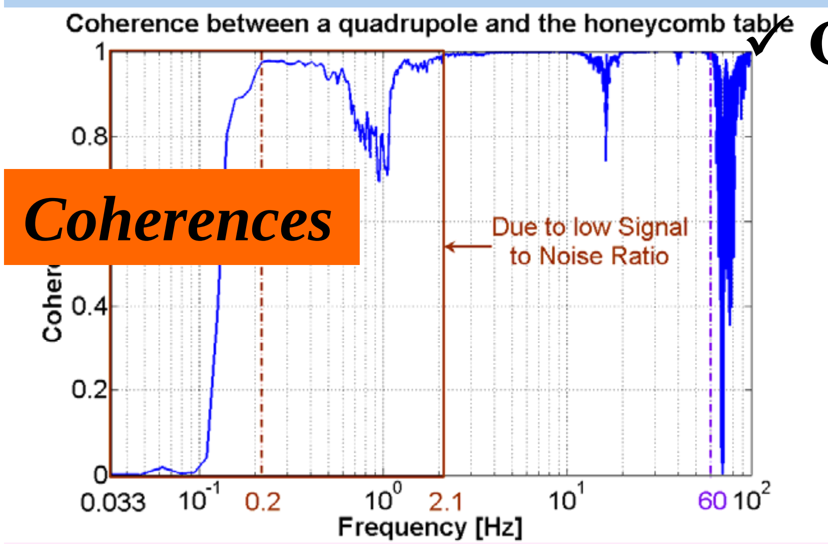
Signal to Noise Ratios (SNR) and Coherences

SNR



- ✓ **Low SNR:**
  - ➢ Between 0.2Hz and 2.1Hz
  - ➢ Above 60Hz
- ✓ **Very low SNR:**
  - ➢ Below 0.2Hz

Coherences



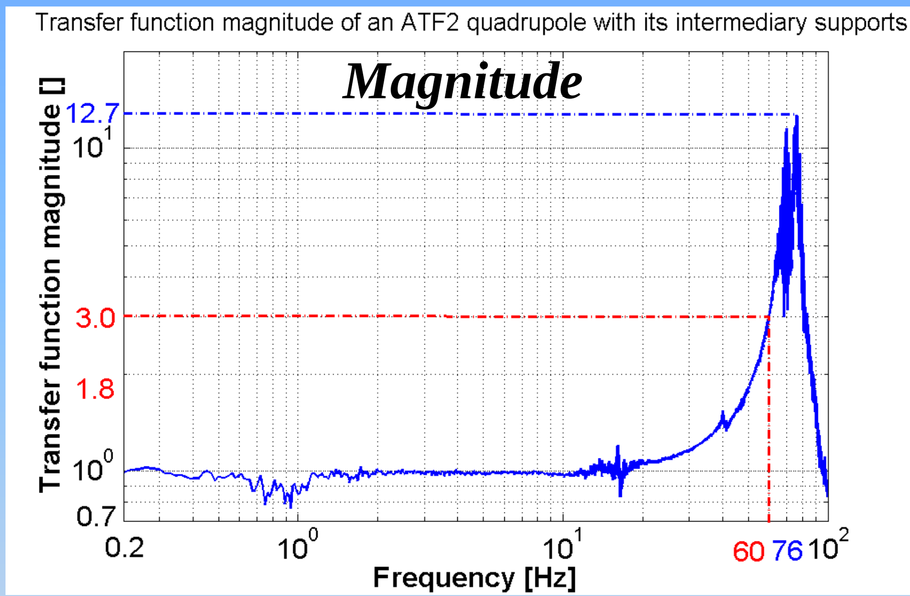
✓ **Good coherence up to at least 100Hz**

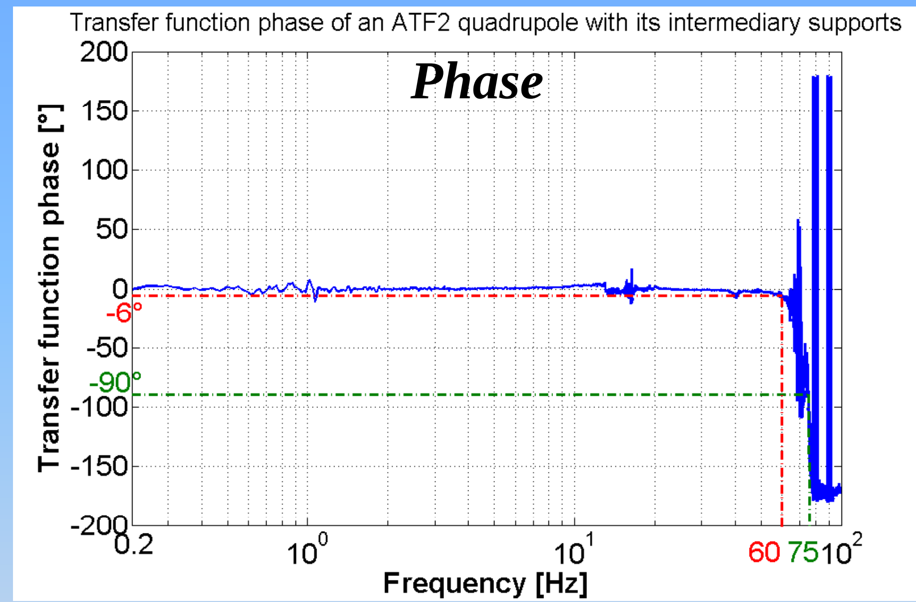
➢ Good vibration transmission between table and quadrupole up to at least 100Hz

➔ Good fixations of the quadrupole to the table

Vibratory study of an ATF2 quadrupole with its supports

Transfer function of the quadrupole with its supports





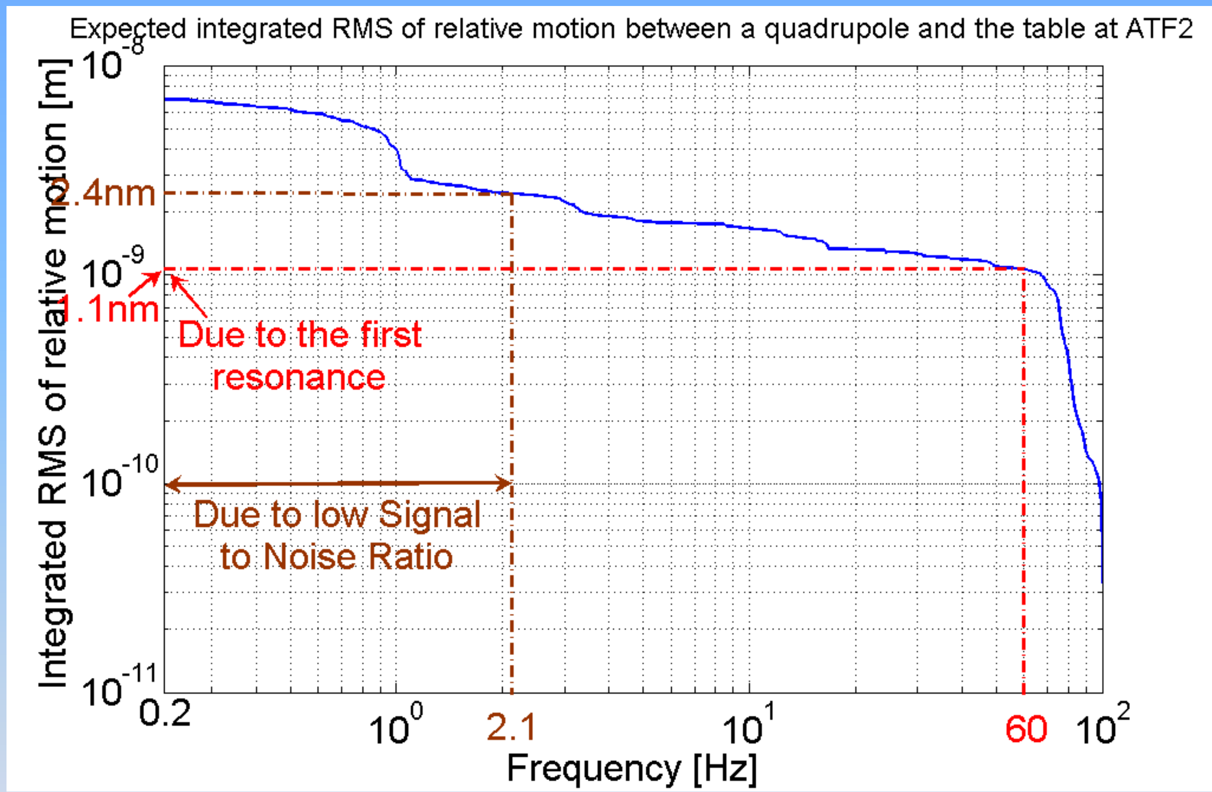
✓ **First resonance at 75.8Hz (phase = 90°)**

➢ Very good transfer function up to ~ 60Hz

➔ Quadrupoles and intermediary supports well designed: Relative motion should be very low compared to tolerances

Vibratory study of an ATF2 quadrupole with its supports

Integrated RMS of quadrupole relative motion to the table



- ✓ **Below 2.1Hz:** inaccurate measurements (low Signal to Noise Ratio)
- ✓ **Above 2.1Hz:** relative motion of 2.4nm
  - ➢ **Very good compared to ATF2 tolerances (10nm)!!!**

Conclusion and future prospects

Conclusion

- ✓ **Boundary conditions of the honeycomb table optimized**
  - ➢ **First resonance at 92Hz:** very high!!
  - ➢ **f>0.2Hz with FD weight:** relative motion=3.5nm (even less!!: low SNR)

- ✓ **Supports to fix sextupoles and quadrupoles to the table made**
  - ➢ 0.1Hz < **No resonances** < 100Hz
  - ➢ **relative motion=0.26nm** > 13Hz
  - ➢ 0.1Hz < **No resonances** < 76Hz
  - ➢ **relative motion=2.4nm** > 2Hz

f<13Hz and f<2Hz : inaccurate measurements but RM should be << 10nm

➔ ***Relative motion of sextupole and quadrupole to the floor > 0.1Hz:***

Very good compared to ATF2 tolerances (10nm)
More accurate measurements will be done at KEK (higher GM)

Conclusion and future prospects

Future prospects

- ✓ **Supports to fix BPM are being made at LAPP**
- ✓ **Quadrupoles and BPM have just arrived at LAPP**

⬇

Before August 08 at LAPP:

Installation of the whole final focus system

Vibration measurements with and without cooling water

⬇

Work on the ATF2 for 6 months or one year (from September 08):

Supports and magnets installation and vibratory measurements

Participation to the beam commissioning