ATF2 project: Final doublet support studies at LAPP

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We investigated a support for the final doublets for ATF2. Its relative motion to the floor has to be below 6nm. Consequently, this support has to be very stiff and well fixed to the floor. We studied a steel lightweight honeycomb table whose first eigenfrequency in free configuration is at 230Hz. Some simple simulations and measurements to study the table resonant frequency evolutions for different boundary conditions were done.

1 Introduction

At ATF2, relative motion between the Shintake monitor (measuring the beam size) and the final doublets has to be below 6nm above 0.1Hz because beam-based feedback is efficient only below 0.1Hz due to the beam repetition rate of 1Hz [2]. Ground motion coherence is good up to a distance of 4-5 meters for frequencies below 10Hz [3] and so is the relative ground motion. The Shintake monitor and the final doublets being separated by 4 meters, they will be fixed on rigid mounts to move like ground motion. We are investigating a support for the final doublets for a relative motion to the floor below 6nm. We chose a steel lightweight honeycomb table manufactured by TMC [1]. This table has already been investigated for stabilization in the final focus system of the Compact Linear Collider (CLIC) at CERN [4].

2 Table eigenfrequencies

TMC Company has measured characteristics of the first resonant frequency of the table in free configuration [1]. The Guaranteed Minimum Resonant Frequency is at 230Hz with a Guaranteed Maximum factor Q of amplification at resonant frequency of 1.5. A quick and easy test has been done by putting the table on four rigid supports at the corners in order to measure its first eigenfrequency with lead masses of 1400Kg (weight of final doublets) and without. The experimental set-up is shown in figure 1. Guralp CMG-40T velocity sensors and ENDEVCO sensors [5] were used to measure vibrations from 0.1Hz to 40Hz and from

Figure 1: Experimental set-up

First resonant frequency	Measured	Simulated
Free configuration	230Hz	230Hz
Table on supports/no weight	74Hz	56Hz
Table on supports/1400kg	46Hz	26Hz

Table 1: Evolution of resonant frequencies

40Hz to 100Hz respectively. The measurements on the table were done on the middle where vibrations are the strongest. In order to identify eigenfrequencies of the table, its transfer function has been calculated with and without any masses on it. Figure 2 shows magnitudes of table transfer functions. Without any masses on it, the table amplifies mainly floor motion between 60Hz to 100Hz with a maximum amplification factor of 12 at 74Hz. With the lead masses on it, this important amplification goes to lower frequencies, between 30Hz and 70Hz, with a maximum amplification factor of 9 at 46Hz. These two main ground motion amplifications seem to be eigenfrequencies of the table. It has been checked by studying table transfer function phases that they have both a phase of 90 degrees with respect to ground motion which is typical of a resonant frequency. Consequently, putting the table on four supports at its corners decreases its performances: its first eigenfrequency goes from 230Hz in free configuration to 74Hz. Moreover, the weight of the final doublets makes it fall to 46Hz.

Table 1 shows a comparison between simulations and measurements on the evolution of the first table resonant frequency. The first eigenfrequency of the simulated table has been fixed at 230Hz in free configuration which is used as a reference. One can see that simulation results are representative of resonant frequency evolution with weight and boundary conditions.
Another simulation of the table fixed directly to the floor on one entire face has been done. The first eigenfrequency is at 526Hz which is much higher than in free configuration (230Hz). When adding some masses of 1400Kg on the table, the first resonant frequency falls to 135Hz. Consequently, these boundary conditions increase table performances. This should be the preferred method of supporting the ATF2 final doublet.

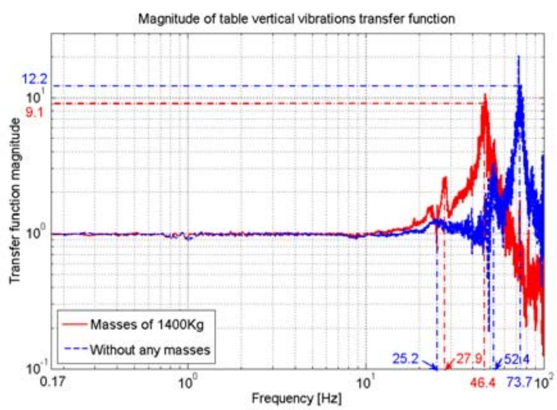

Figure 2: Table transfer function magnitudes

3 Relative motion between table and floor at ATF Ring

In order to have a value of relative motion between table and floor, the integrated Root Mean Square of relative motion has been calculated using ATF floor measurements.

Results are shown in figure 3 with and without masses of 1400kg. In the bandwidth where there are no resonant frequencies, relative motions between table and floor are probably due to supports : loss of coherence is probably due to non-linearities in vibration transmissibility between floor and table. Consequently, these results can be improved. The most important result is the integrated relative motion Root Mean Square which is only due to the amplification at the first eigenfrequency and to the damping above. In fact, it cannot be improved when keeping the same boundary conditions. With no weight on the table, the first eigenfrequency (not including the small peaks at lower frequency; see figure 2) is high enough (74Hz) to induce an integrated relative motion of only 0.9nm from 60Hz to 100Hz because of the amplification. But when putting some weight on the table, the first resonant frequency falls to 46Hz and induces an integrated relative motion of 4.6nm from 30Hz to 100Hz because of the amplification and damping above it.

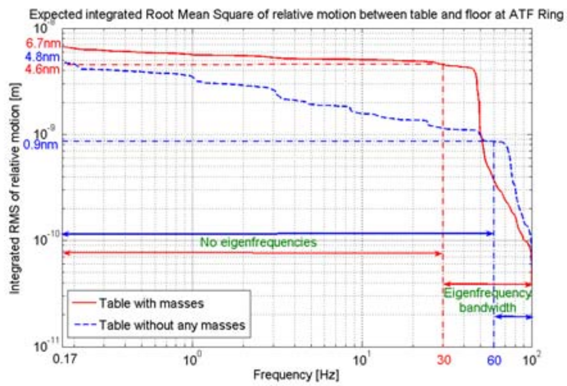

Figure 3: Expected integrated RMS of relative motion between table and floor at ATF

4 Conclusion

At ATF2, we plan on fixing the Final Doublet support on the entire bottom face of the table with some special concrete. This should push up the resonant frequency based on the simulation shown in this paper, and should be within ATF2 specifications. However, tests with the magnet (instead of lead bricks) are still to be done.

5 Acknowledgments

This work is supported by the French ANR and the France-Japan program FJPPL. We also thank the CERN team for allowing us to use their TMC active table.

6 Bibliography

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