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Suspension for Stray Light Control Elements Prototype, Measurements of Internal Modes

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1 Introduction

This document briefly reports the characterization of the Stray Light Control (SLC) suspension prototype's internal modes. Measurements were performed in Caltech Downs Modal Lab.

2 Setup Description

The measurements have been done using the following instruments actuators and sensors:

- one Bruel & Kjaer actuator model 4810,
- two TEAC model 710 piezoelectric accelerometers, conditioned using the 4 ch. TEAC accelerometer amplifier model SA-16,
- spectrum analyzer SRS785,
- National instruments NI USB-6009 data acquisition.

The SLC suspension was suspended to a trolley with a music wire, as shown in Figure 1, to isolate from the trolley modes and therefore simplify the modes identification process.

Different methods of injecting noise to measure the modes and the transmissibilities were used. The sine frequency sweep with an actuator gave somehow the best result.

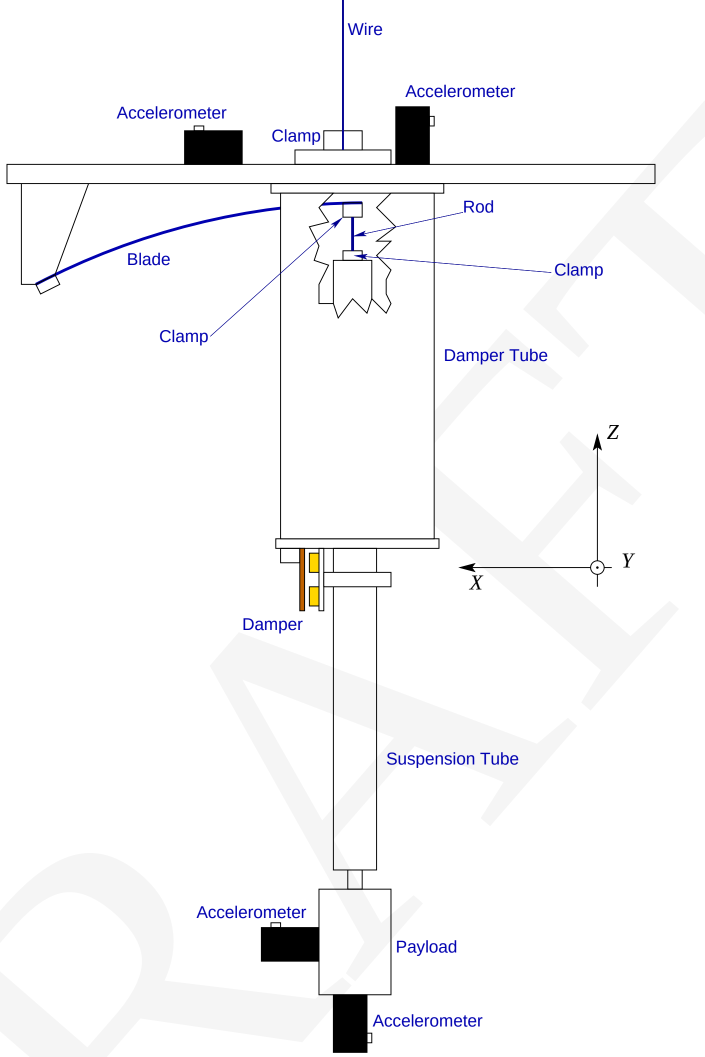

Figure 1: SLC suspension set-up sketch of the transmissibilities measurements. Elastic parts are draw in blue.

3 Vertical Direction Transmissibility

Vertical transmissibility was measured placing a Bruel & Kjaer 4810 shaker between the trolley and a mass of 0.6 kg, and using the recoiling of the mass to excite the SLC suspension point. The excitation was sent using the SR785 and sweeping down the the frequency of a sinusoid. Figure 2 shows the transmissibilities with and without the eddy current damper. The height of the resonance of the first peak for the un-damped case was not properly measured and is probably underestimated. The measurement was unfortunately made in two step with the starting sweeping frequency at the resonance frequency. The figure shows that first and second resonance at 19.4 Hz, and 46.3 Hz are clearly damped by the eddy current damper. At least first three vertical modes are the internal modes of the blade whose first mode is at about 1.6 Hz.

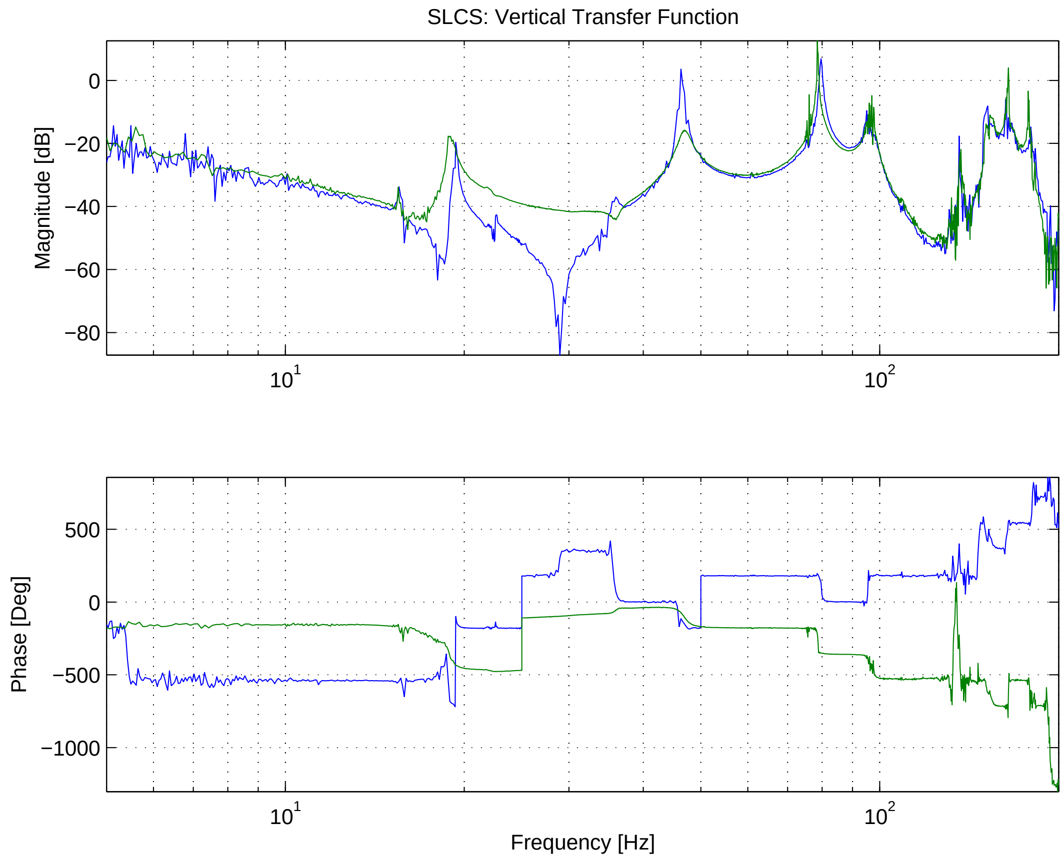

Figure 2: Transmissibilities of the SLC suspension along the vertical direction with eddy current damper (green), without current damper (blue). For the undamped measurement, the height of the resonance of the first peak is not properly measured. The measurement was unfortunately made in two step with the starting sweeping frequency at the resonance frequency.

4 Horizontal Direction Transmissibility

Horizontal transmissibility was measured placing a Bruel & Kjaer 4810 shaker between the trolley and the suspension wire, and therefore the shaker was directly exciting the suspension point of the SLC suspension. The excitation was sent using the SR785 and sweeping down the the frequency of a sinusoid. Figure 3 shows the transmissibilities with and without the eddy current damper.The large difference of the two transmissibilities is attributed by the coupling introduced by the eddy current damper. The suspension tube resonance and the damper tube are mixed up by the coupling which changes drastically the response. This effect is not seen in the vertical transmissibility because the damper tube is much stiffer in the vertical direction than in the horizontal directions. If the interface plate is rigidly fasten to a stiff platform then the damper tube will somehow become more stiff and the changes will be different and less evident.

The first three modes are the torsional modes of the blade's tip with couple with the heavy payload and the long arm lever of about 1.5 m.

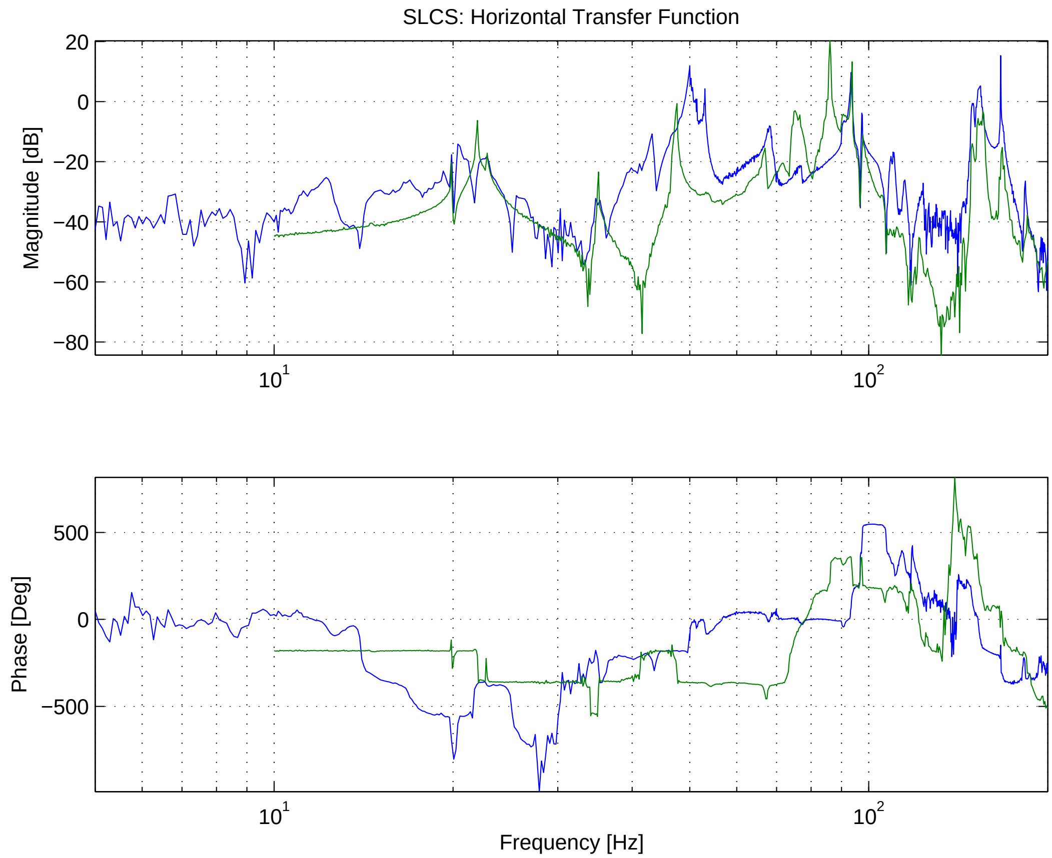

Figure 3: Transmissibilities of the SLC suspension along the vertical direction with eddy current damper (blue), without current damper (green). The large difference of the two transmissibilities is attributed by the coupling introduced by the strong eddy current damper viscous force. The suspension tube resonance and the damper tube are mixed up by the viscous force coupling which drastically changes the response.

5 Frequency Modes

The following list shows the principal frequency modes of the SLC suspension without the eddy current dampers. Two resonances are below the required lower limit of 30 Hz.

Mode [#]	1	2	3	4	5	6	7	8
Frequency Vertical Dir. [Hz]	19.4	46.3	80.0	95.1	136.0	151.5	162.9	179.6
Frequency Horizontal Dir. [Hz]	22.0	35.1	47.6	66.9	75.5	86.0	93.8	121.9

6 Conclusion

Transmissibilities and spectra along two directions shown that the first two modes are damped by the eddy current dampers and the peaks height are ~ 20 dB below the 0 dB line. This should considerably reduce the SLC suspension detrimental effect on the ISI-0 stage control and performance. Anyway, a direct measurement of the effects are necessary. A test of the effect of the SLC suspension on ISI-0 is scheduled to be done n October 2010 at LASTI MIT.