Replacement of White Noise with Ground Motion in the Horizontal Inverted Pendulum Model

1. Introduction

This report compares the efficiency of the triple suspension and inverted pendulum table in the application of white noise and ground motion as the source of vibration. The initial simulation using white noise had been an analysis of efficiency of feed back and control both with and without feedback to the IP table and with and without actuation to mass three. The analysis of feedback and control simulations was repeated with a replacement of white noise by a more realistic ground motion. The result of this comparison is that the disturbance of ground motion is just as effectively nullified as is the less random white noise.

Each analysis, ground motion and white noise, contains simulations of x translational and yaw rotational motion of the mass 3 mirror as supported by the horizontal based inverted pendulum table. Further, each directional simulation composed of four separate combinations of actuation and feed back.

The organization of the feedback and control system employed is described by an explanation of the alfi box used to generate it. This description includes details on the implementation of ground motion.

2 Ground Box Implementation

2.1 X Translational

Ground Box Implementation for the x translational motion represents the simplest case. The Ground_All box indicated in Fig.1 provides x translational output directly to the corresponding input of the valerio_ip_x_tz box which via the xyz2clamp provides table top motion to the triple_sus_force_inMap through the point of suspension of the triple pendulum from the suspension cage. The two connections between the IP Table and the xyz2clamp should be noted. The top is for the x motion and the bottom is the path for the tz motion described later. as the Ground motion in this case is configured to only provide x out put there is presently no data routed for the tz connection in this model. There are two outputs of interest from the Triple suspension cage. The top clamp data (yellowline) is the translational and rotational position and force of the mirror, mass 3; the bottom is the reaction force experienced by the cage, in accordance with Newton's Third Law, as the feedback actuators exert force on the mirror toward its stabilization. The position data is passed to the assortment of psd_outs which is the actual data graphed below. That same data is supplied to to the digital filter which begins the path of the feedback mechanaism enclosed in the green boxes. It is seen that this feedback mechanism includes the reaction force from the triple suspension as indicated above. The dotted green line is the application of feed back to the inverted pendulum table. It is dotted because in our analysis of this system we have explored situations in which feed back is and is not supplied. Similarly, the box enclosed in blue represents the actuation force supplied to the mirror which, at times, is and is not connected.

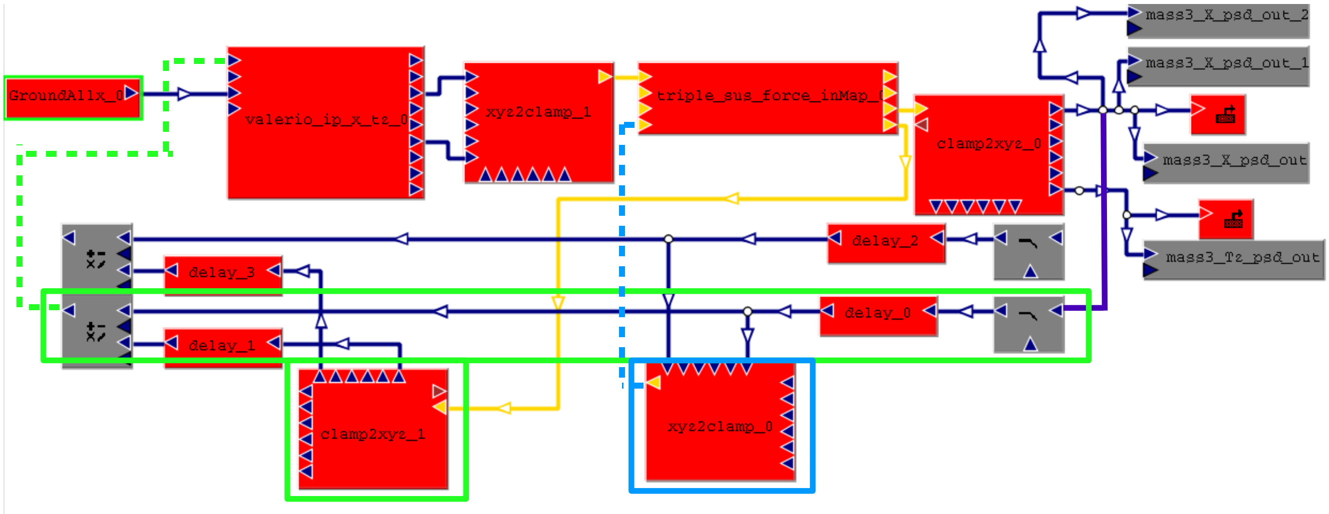


Fig. 1 Ground motion implementation into x translational

2.2 Yaw Rotational

Implementation of ground motion requires a little more effort for the tz case. The ground noise is supplied by the GroundAll box containing boxes which provide ground motion on the x and y translational channels only. They are supplied to a FUNC_2x2 which converts their motion into yaw motion. I feel like I should say more about the ground motion creation and the func 2x2 but I really don't know any thing about them. Also I want to know if you think it is necessary to redo the following figures of alfi boxes to make them match the quality of the one above.

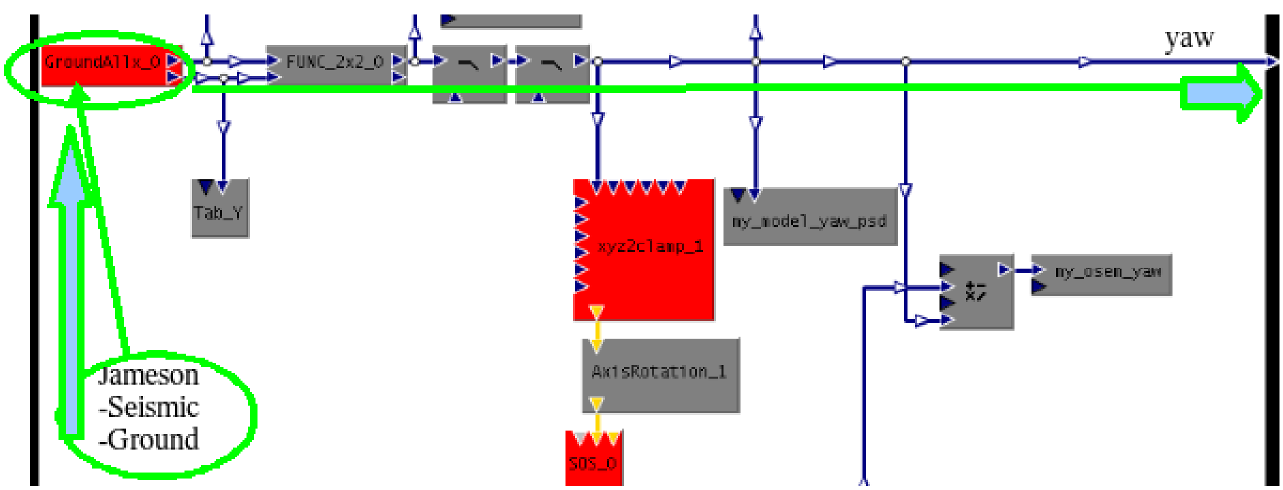


Fig. 2 Yaw Study Minus Modified

The yaw motion is fed to the tz_input of the valrio Ip x_tz horizontal model and passed by means of the xyz2clamp to the triple_sus_force inmap. The remainder of the data path and mechanisms of feedback and control is exactly the same as the configuration described for the x translational model above.

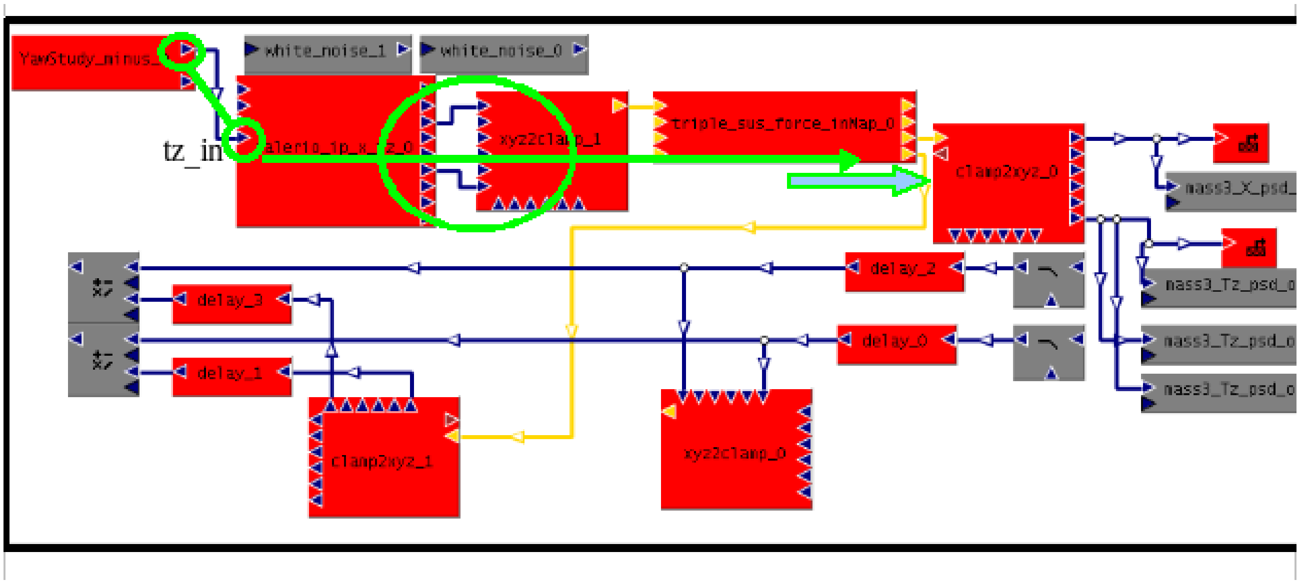


Fig. 3 Triple Sus and IP Main Box – Yaw motion

3 Graphs of Results

The graphs are semilog plots of the motion of mass 3 vs. frequency. The are presented in two sets, x translational and yaw rotational. The top two graphs of each set are the comparisons of the white noise vs. ground based motions. They are composites of all four feedback and control situations for comparison of their effectiveness. The left represents the white noise based results and the right ground motion based results. The remaining four graphs of each set represent the individual outcomes of each feedback and control situations. They are provided separately to allow inspection of detail not available in the composites due to the nearly identical situations caused by unoptimized digital filters.

3.1 Graph Layout

Unnecessary? I feel it clarifies the layout of the graphs to follow.

Understanding the layout of the graphs below is simplified by reference table 1. The table represents the first set of graphs, x translational. It is readily extended to graphs 7 through 12 representing the theta z rotational results.

WN-->	1	2	<--Ground
	FH	LD	
NoFB	3	4	
FB	5	6	

Table. 1

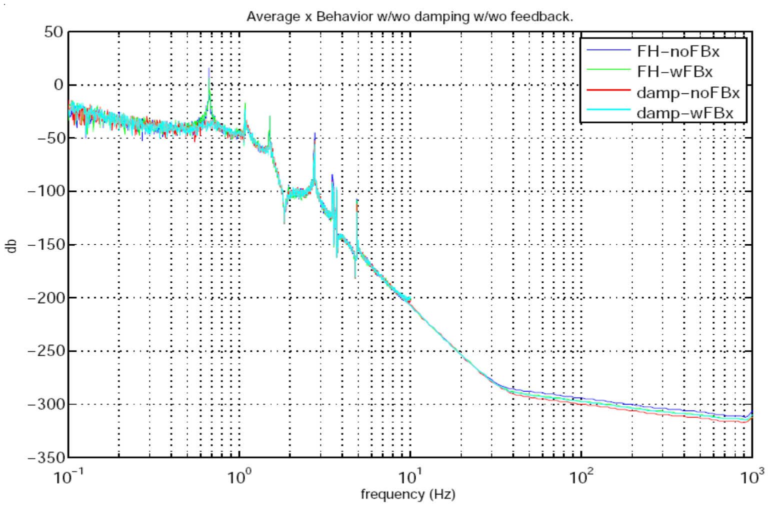
The numbers in table.1 to the left represent the labeling of the graphs to follow.

Graph. 1 Collection of WN Based Results.
Graph. 2 Collection of Ground Based Results.
Graph. 3 Free-Hanging with no feedback.
Graph. 4 Free-hanging with feedback.
Graph. 5 Local Damping with no feedback.
Graph. 6 Local Damping with feedback.

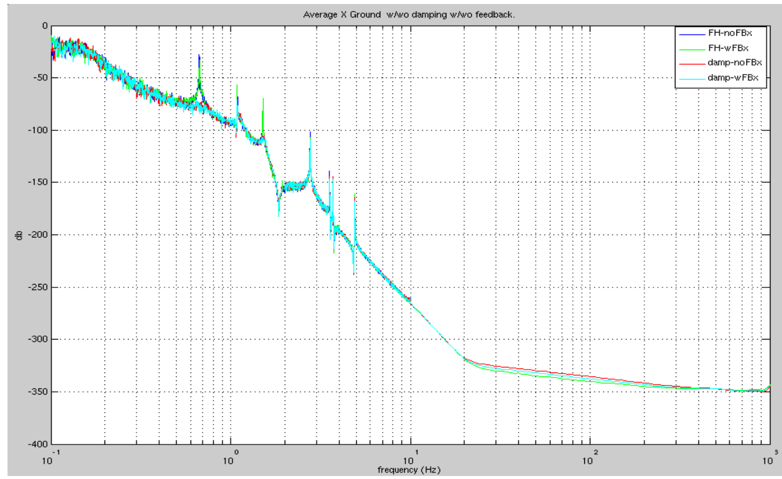
3.3 x translational

I am at a loss for how to describe the graphs, there is not much to say they are generally the same. also a lot of words will prevent me from putting them all on one page. and should I resize the graphs to fit into the margins and should I make bigger legends or just tell to zoom in?

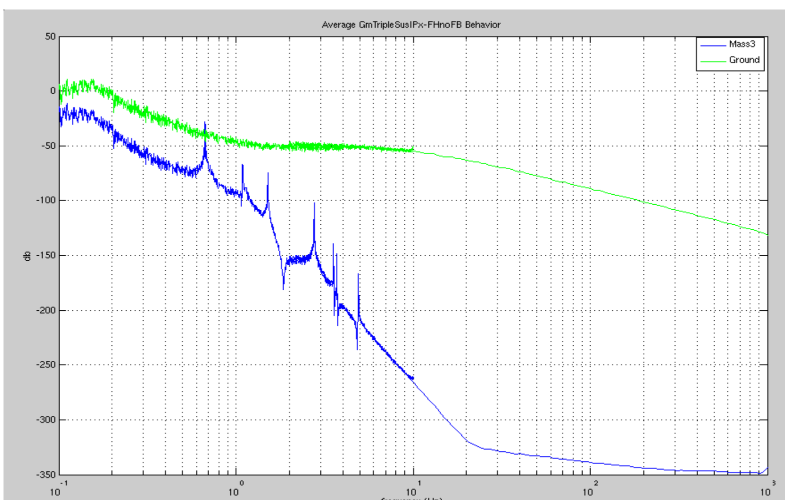
Graph.1 Collection of WN Based Results.



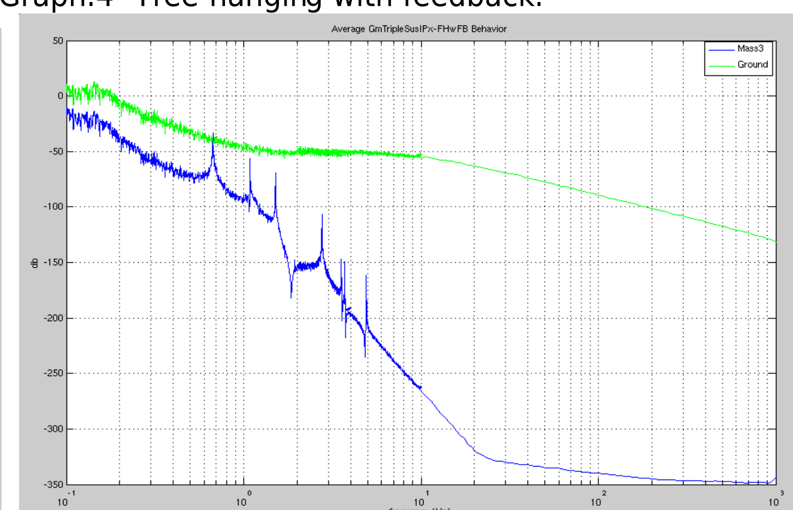
Graph.2   Collection of Ground Based Results.



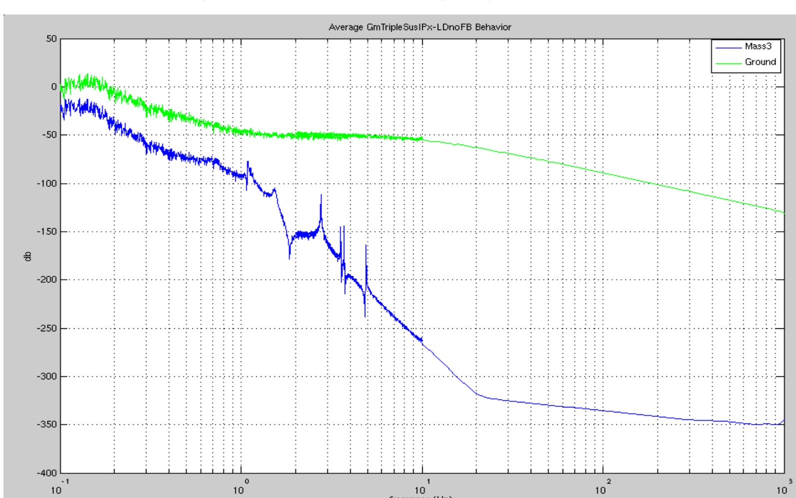
Graph.3   Free-Hanging with no feedback.



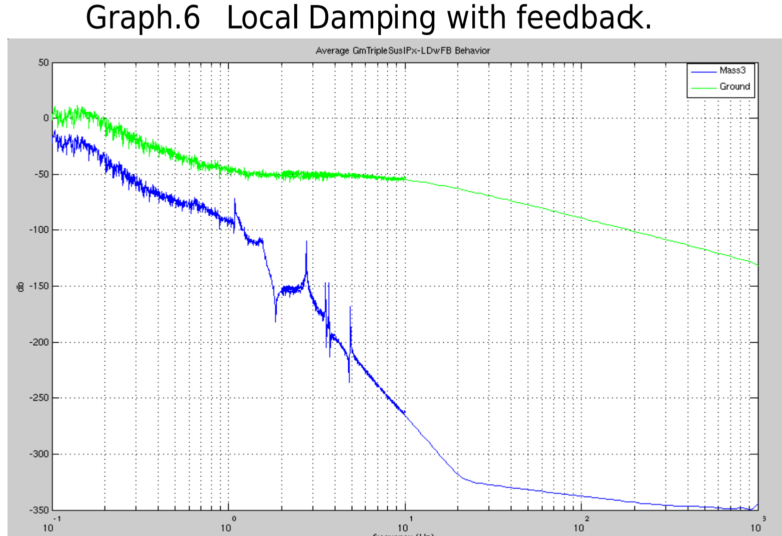
Graph.4   Free-hanging with feedback.



Graph.5   Local Damping with no feedback.

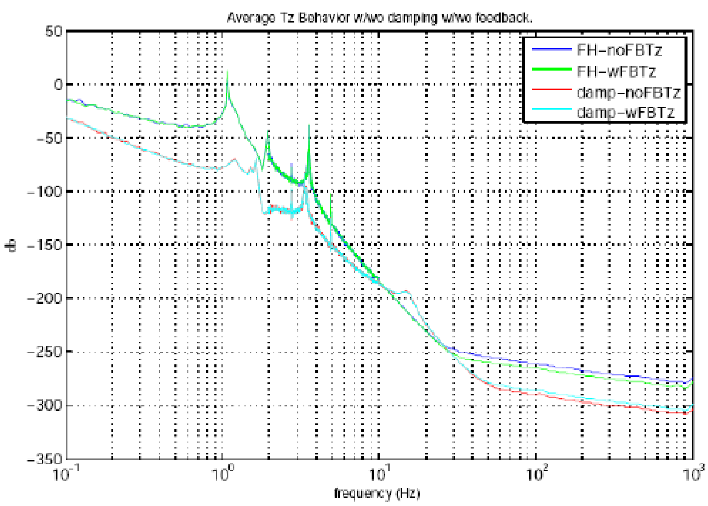


Graph.6   Local Damping with feedback.

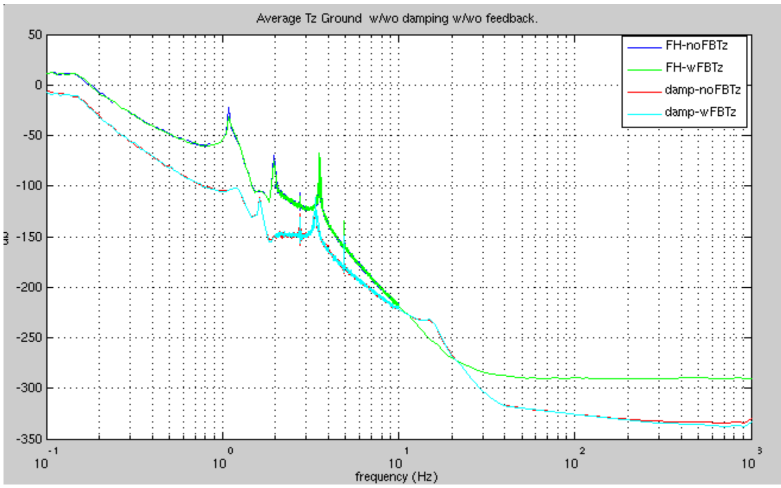


3.4 yaw rotational I will resize the headings on final draft they are small to make room for my questions. I really need some help on making these graph analysis sound scientific and intelligent. I will probably save verbal description for analysis folowing.

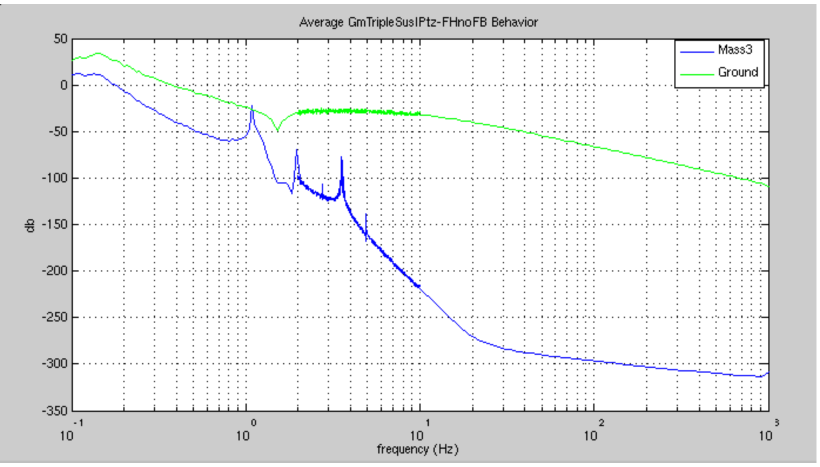
Graph.1 Collection of WN Based Results



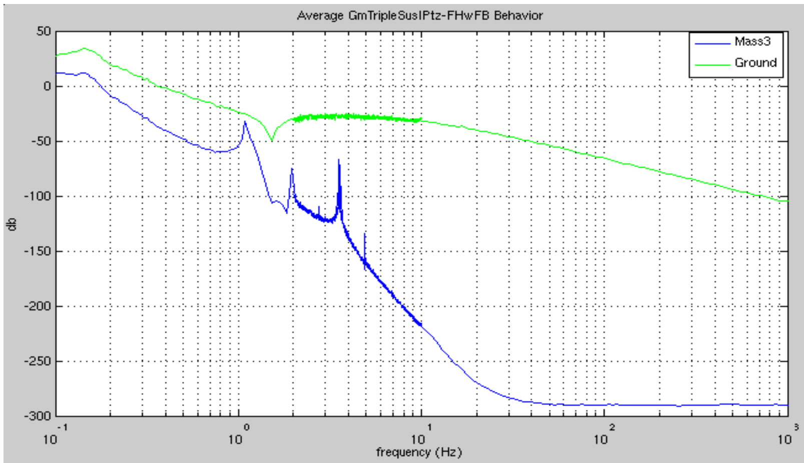
Graph.2 Collection of Ground Based Results.



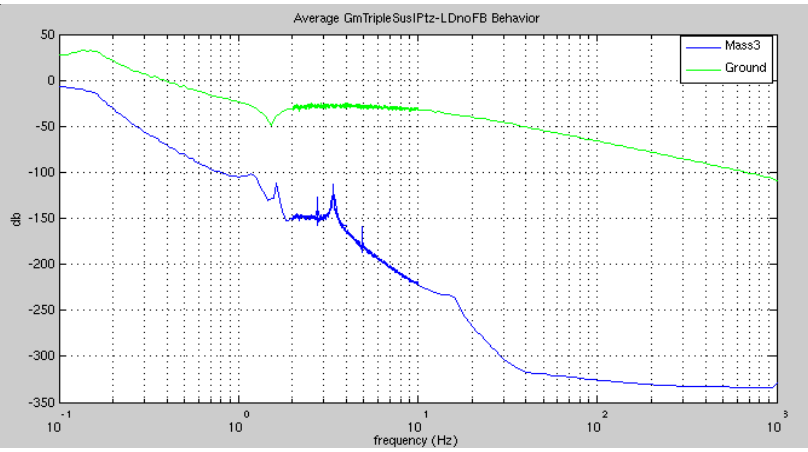
Graph.3 Free-Hanging with no feedback.



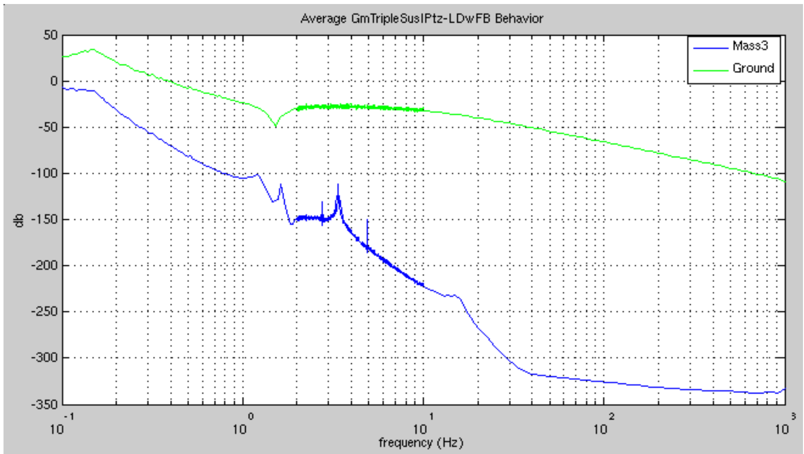
Graph.4 Free-hanging with feedback.



Graph.5 Local Damping with no feedback.



Graph.6 Local Damping with feedback.



Interpretation

Graphs 1 and 2 are placed side by side for comparison. It is evident that they are generally identical. Their peak frequencies are all the same as are the events of the FB graphs being nearly the same as the noFB graphs. The major difference that I have noticed is the vertical translation of the ground based graphs by -50 db. I suspect the 1e-6 division highlighted in my semilog algorithm above.

The subsequent graphs are presented without their WN counterparts mainly to provide the opportunity to view them independent of the approximate FB-noFB identity. The green graphs on these figures are the ground motion generated in the process described above.

Conclusion

I am confident in the accuracy of my recreation of the WN based data with ground disruption because of the plain similarity of graphs 1 and 2. I also consider my implementation of feedback to be of little value whereas the local damping is beneficial. I believe subsequent optimization of the gain and pole settings will improve the effects of feedback.

Presently theese results are Qualitative and indicate that regardless of the nature of disturbance to the IP table

These are povray models
Original images of this quality
will be in my final reports.

I made this and can modify it
in an infinite number of ways.

below is the rough sketch
finished products to right.