Mode Damping

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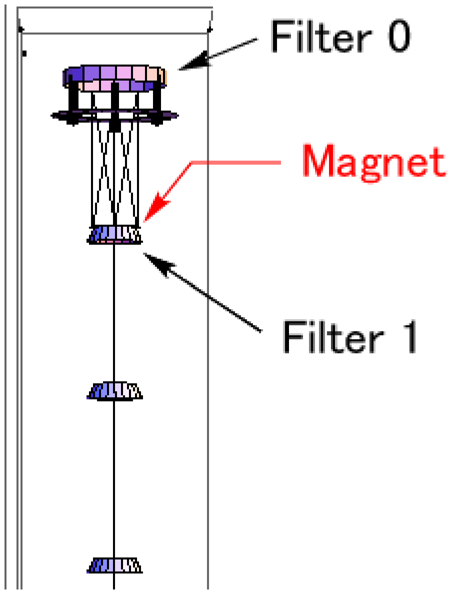
Introduction

* We plan to introduce eddy current damping at the top of the chain.

* We don't use eddy current at the lower stages, because it may be noisy.



* Is it possible to damp all the resonances passively? → Maybe impossible

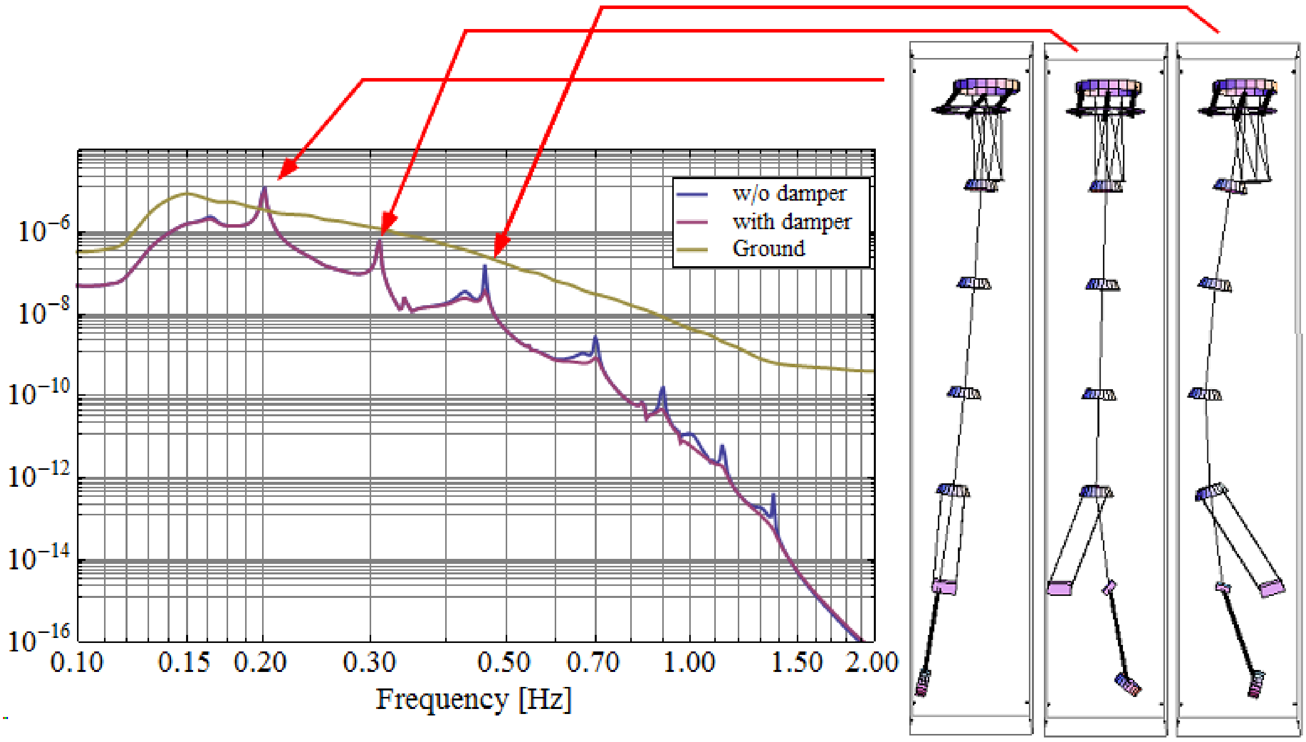
* If not, how to damp residual resonances? (Active control)

* Which filter's motion should be sensed and how to feed it back to the actuator?

Passive Damping

(1) Pendulum mode damping

Graph 1: Seismic noise level of the TM with/without eddy current damping



Assumption:

* 1% coupling of vertical motions

* Every GAS filter has 330 mHz resonant freq and Q = 20

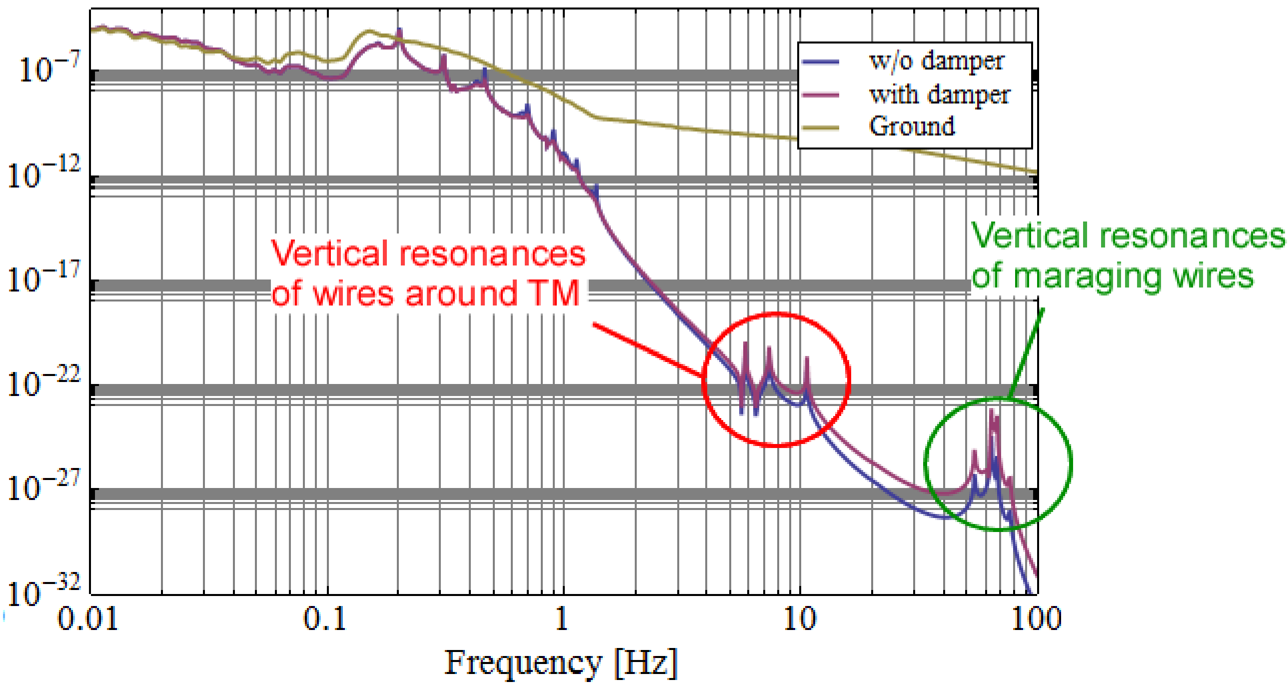
* Damping coefficients are: horizontal: 80 kg/sec, vertical: 150 kg/sec, pitch/roll: 4 kg m^2/rad/sec, yaw: 8 kg m^2/rad/sec

* Resonances at high freq (>0.4 Hz) are damped correctly, but lower resonances (@ 0.20 Hz, 0.32 Hz) are not damped so much. The eddy current damping does not work effectively for those resonances.

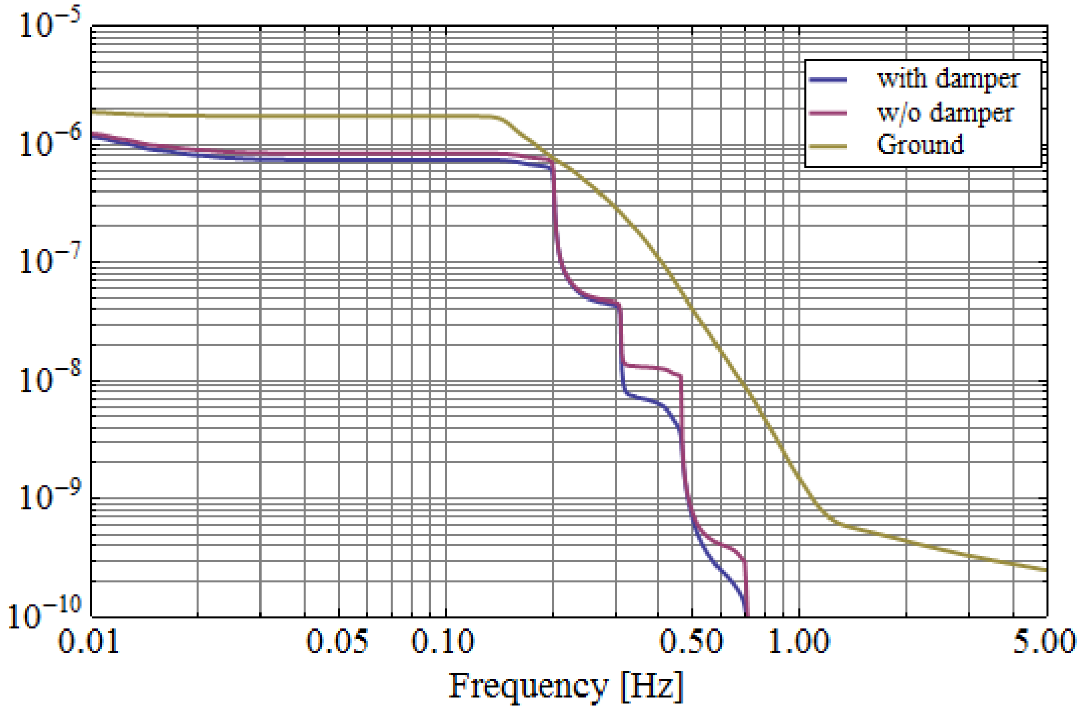
* Especially, the lowest pendulum mode (0.20 Hz) makes the RMS amplitude of the TM displacement quite large (see Graph 3). We need to damp this mode actively to achieve small RMS amplitude.

* The viscous damping worsens the performance of the isolation system at high freq (> 5 Hz, see Graph 2), but it doesn't matter because the thermal suspension noise will be much higher than the seismic noise at those freq.

Graph 2: Broad band ver.

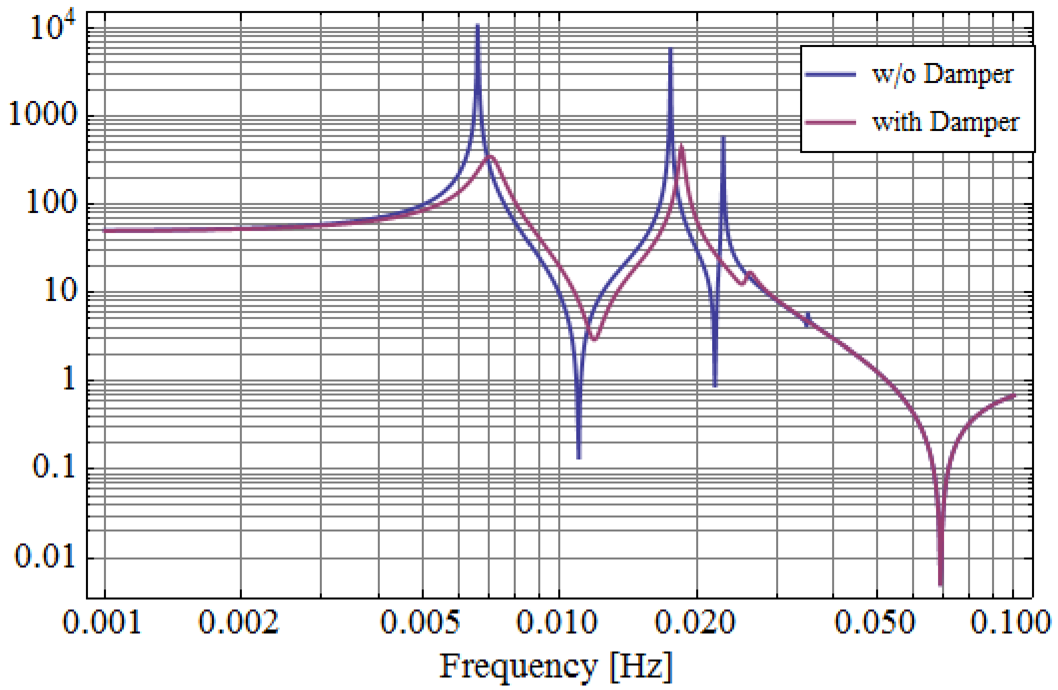


Graph 3: RMS Amplitude

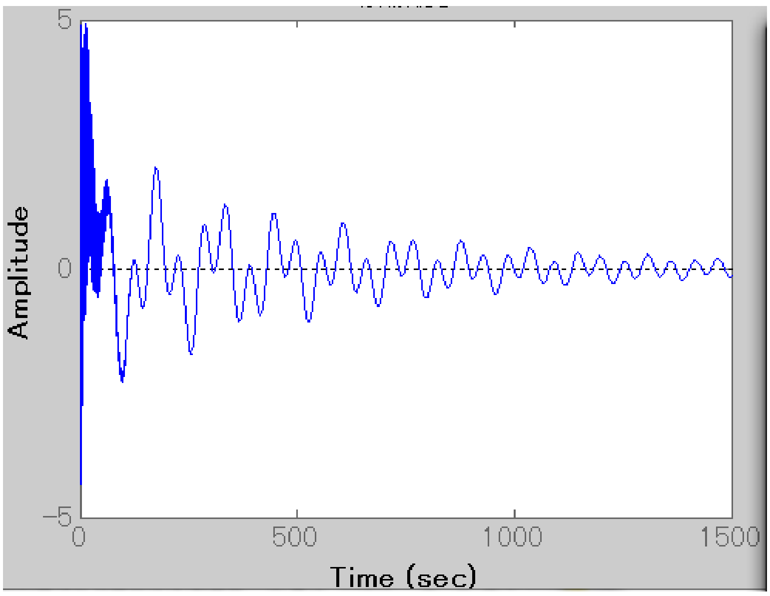


(2) Torsion Mode Damping

Graph 4: Transfer function from torque on TM, to angular displacement of TM (about yaw)



Graph 5: Impulse Response (with damping)



* All the resonances in < 0.1 Hz are correctly damped.

* The Q-value of the lowest eigenmode is ~ 5.

* We must keep in mind that the wiring may change the stiffness and Q of the wire torsion mode, and such kind of changes may spoil the performance of the passive damping.

* Active control may be necessary as a back-up.

Active Damping

Now Constructing …