Improvement of Vibration Isolation System for TAMA300

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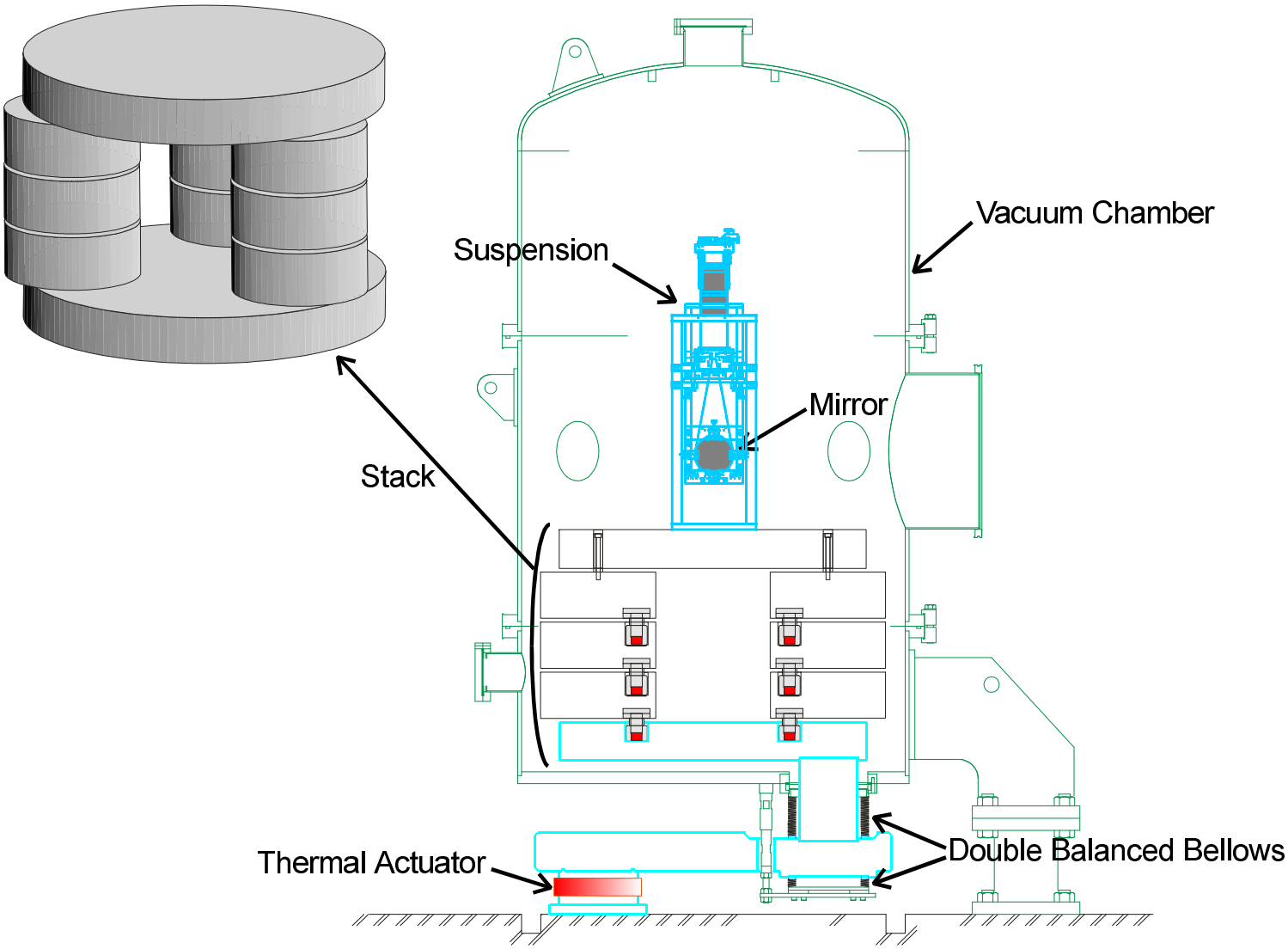
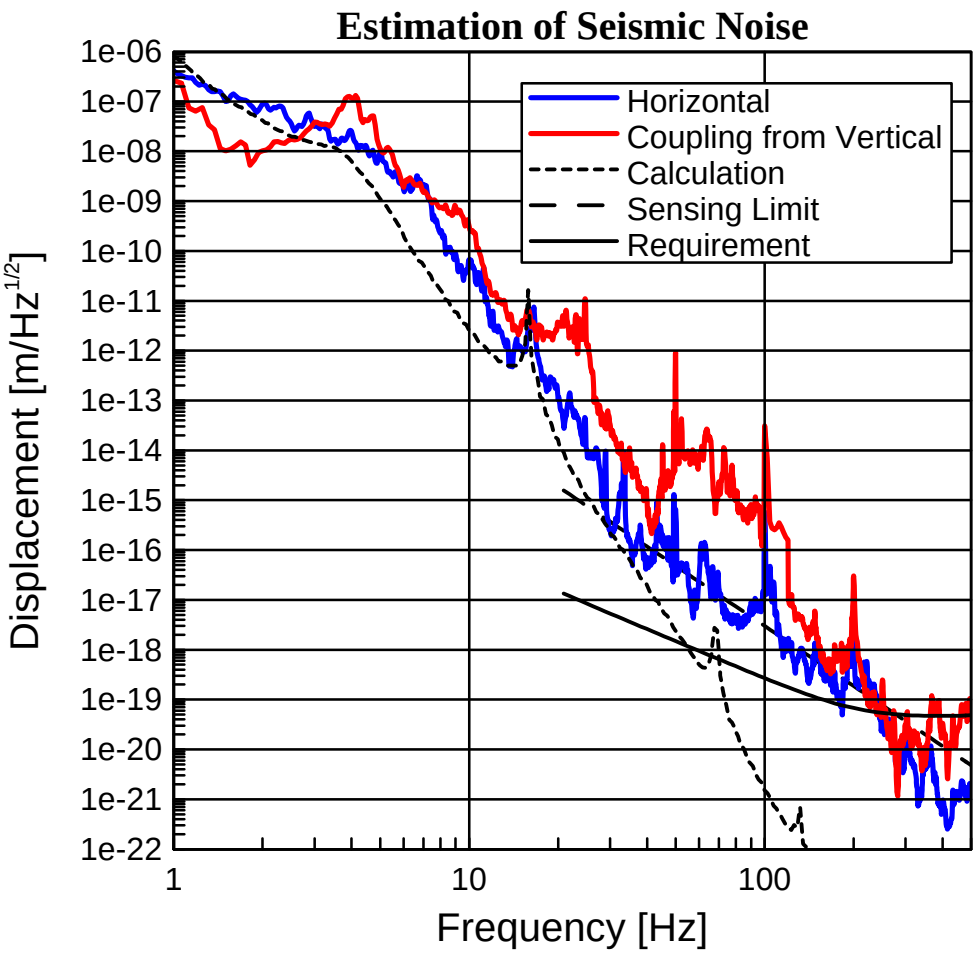
Present Isolation System

Thermal Actuator

Dynamic Damper

Summary

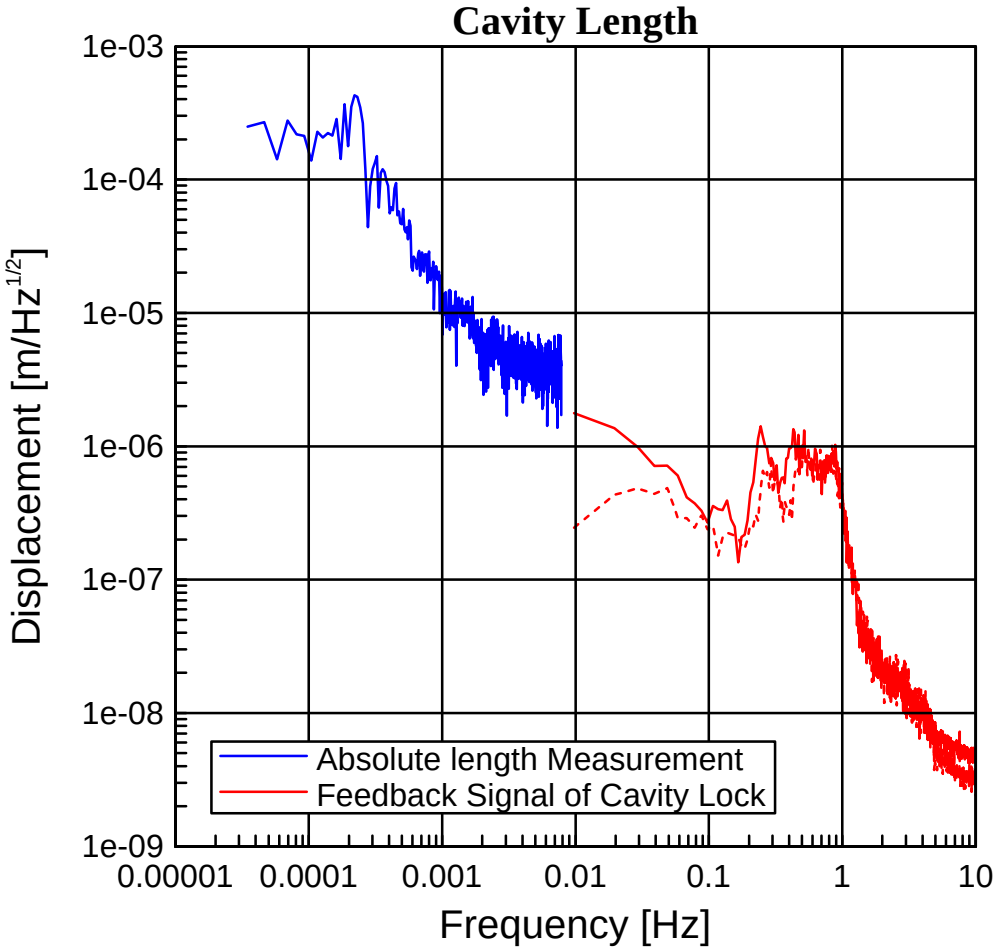

Vacuum Chamber
Suspension
Mirror
Stack
Thermal Actuator
Double Balanced Bellows



Estimated from measured transfer functions of stack and mirror suspension prototypes.

1 - 30 Hz : Consistent with a calculation.

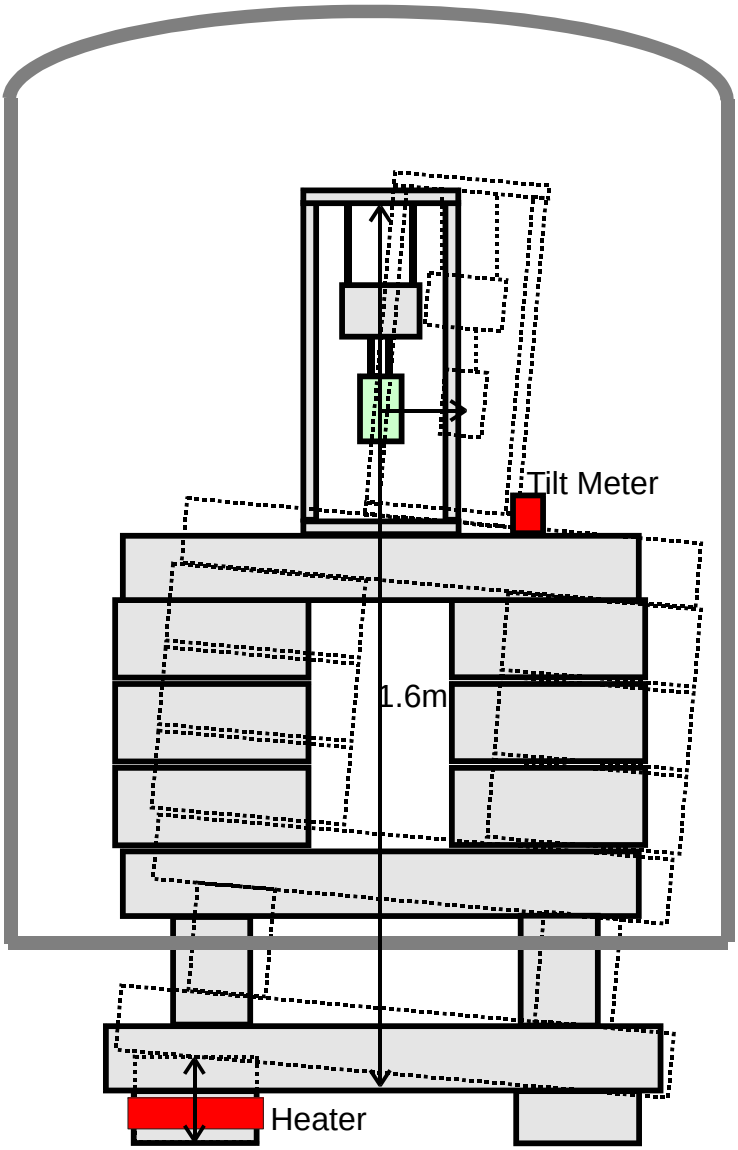
>30Hz : Sensing limit is dominant.

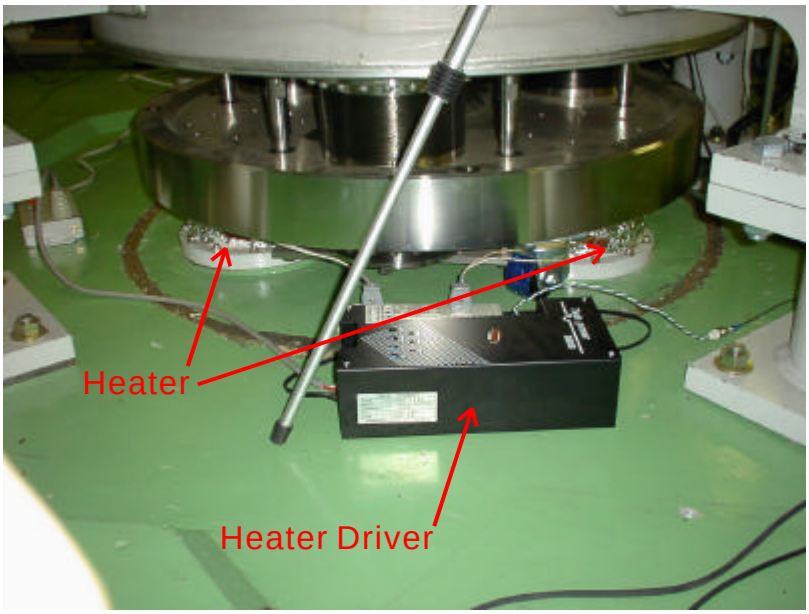


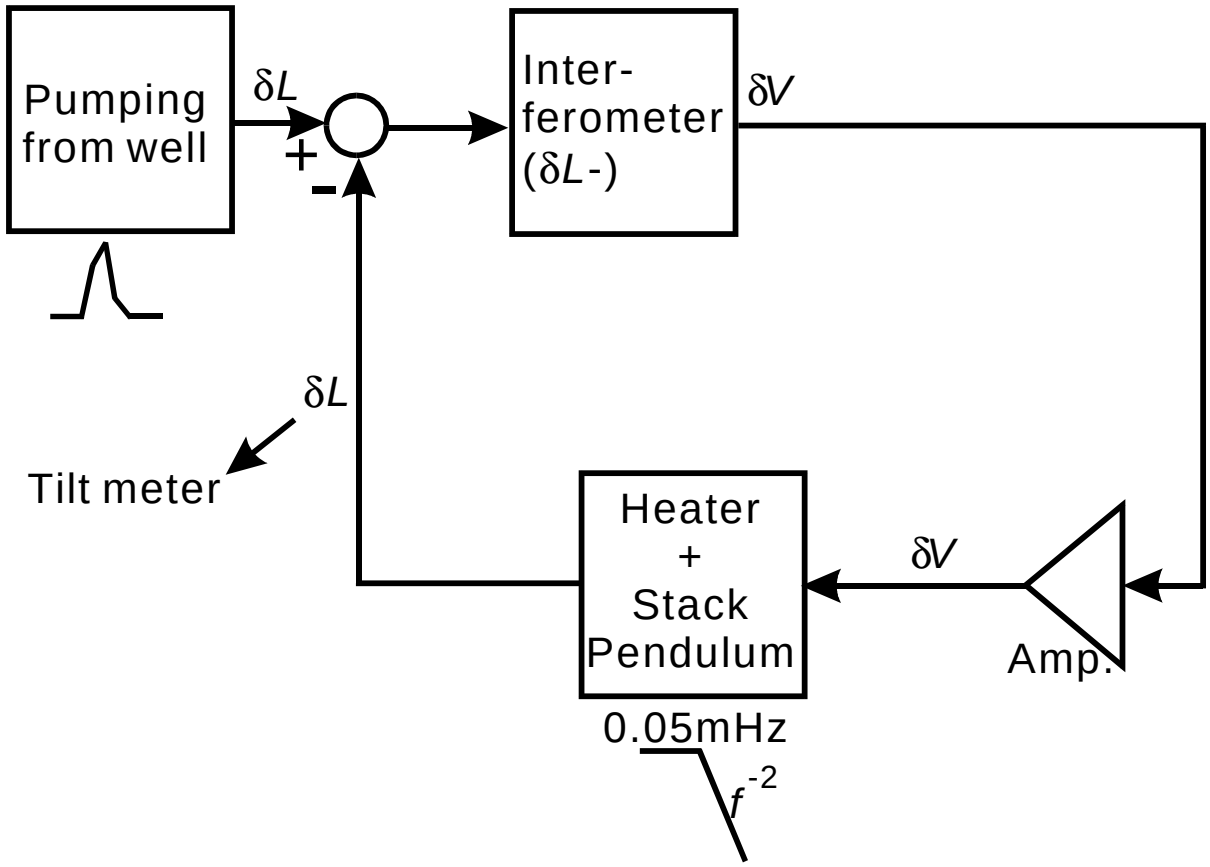
Peak around 0.3Hz : Micro seismic peak

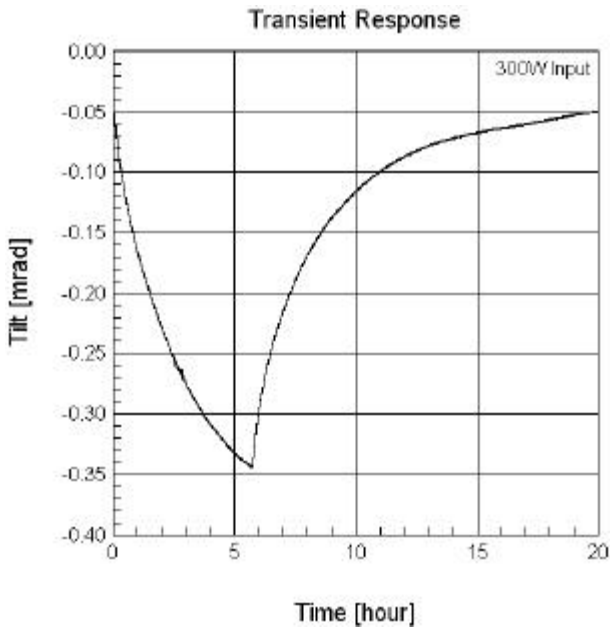
Peak around 0.2mHz : Strain due to pumping well (20μm)

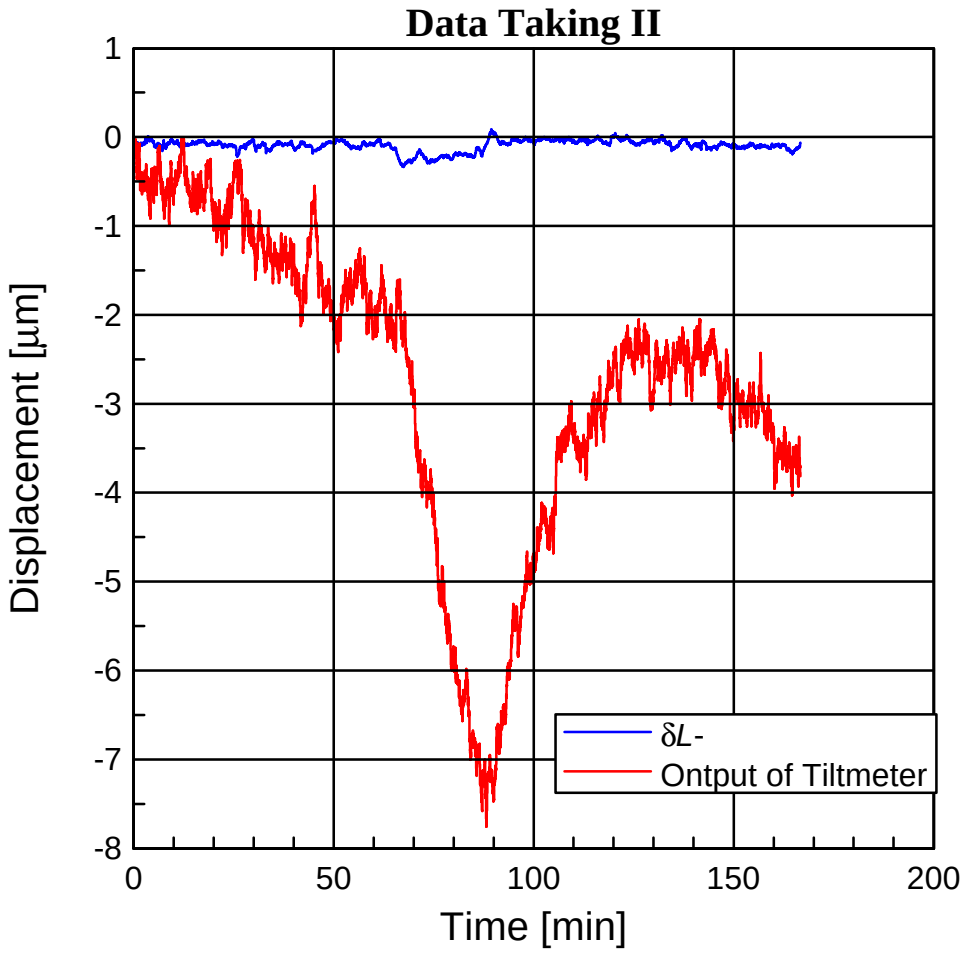
Thermal Actuator



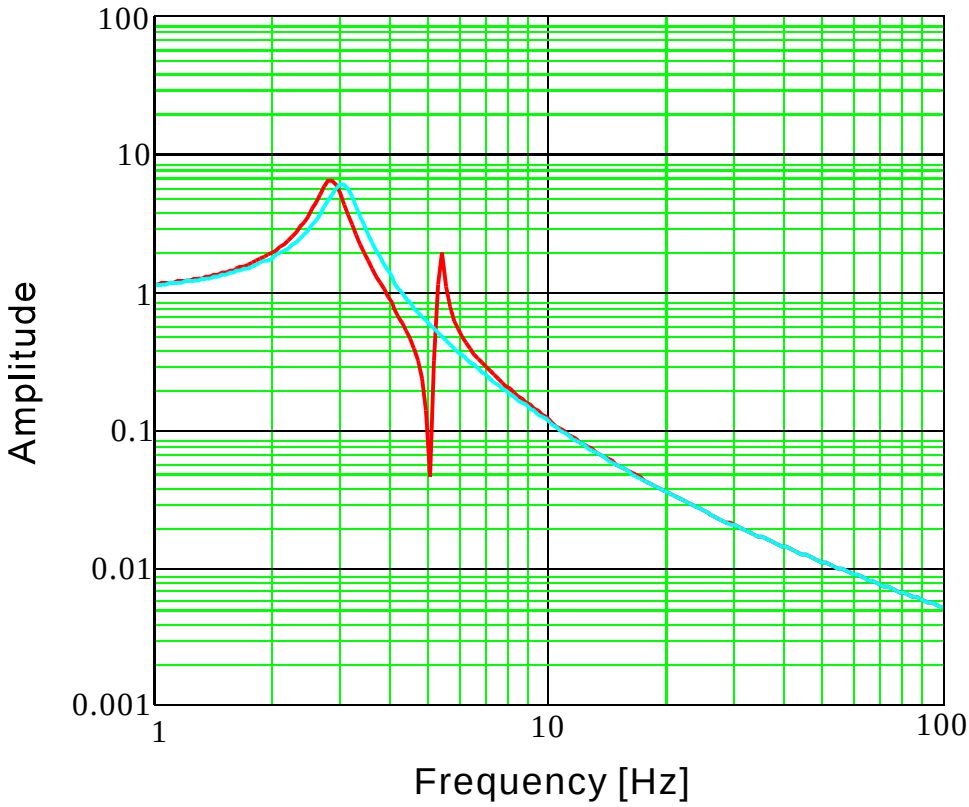


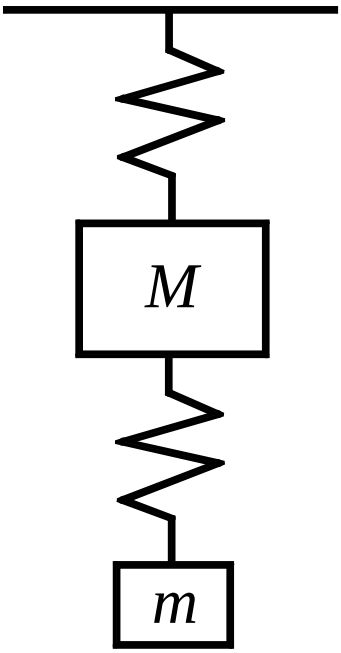

Pumping from well
δL
+
-
Inter-ferometer (δL-)
δV
δL
Tilt meter
Heater + Stack Pendulum
δV
Amp.
0.05mHz
f -2


Transient Response
300W Input
Tilt [mrad]
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
0
5
10
15
20
Time [hour]


Data Taking II
Displacement [µm]
Time [min]
1
0
-1
-2
-3
-4
-5
-6
-7
-8
0
50
100
150
200
δL-
Ontput of Tiltmeter

Dynamic Damper



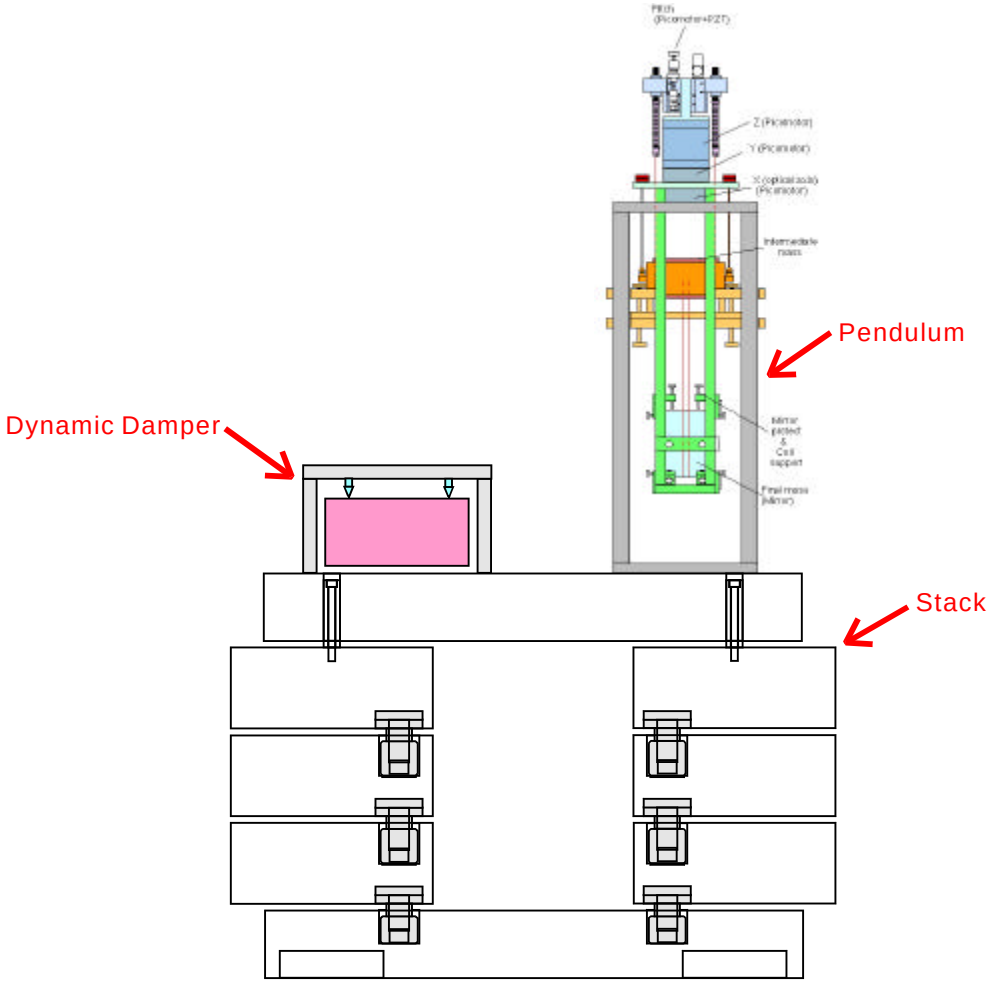


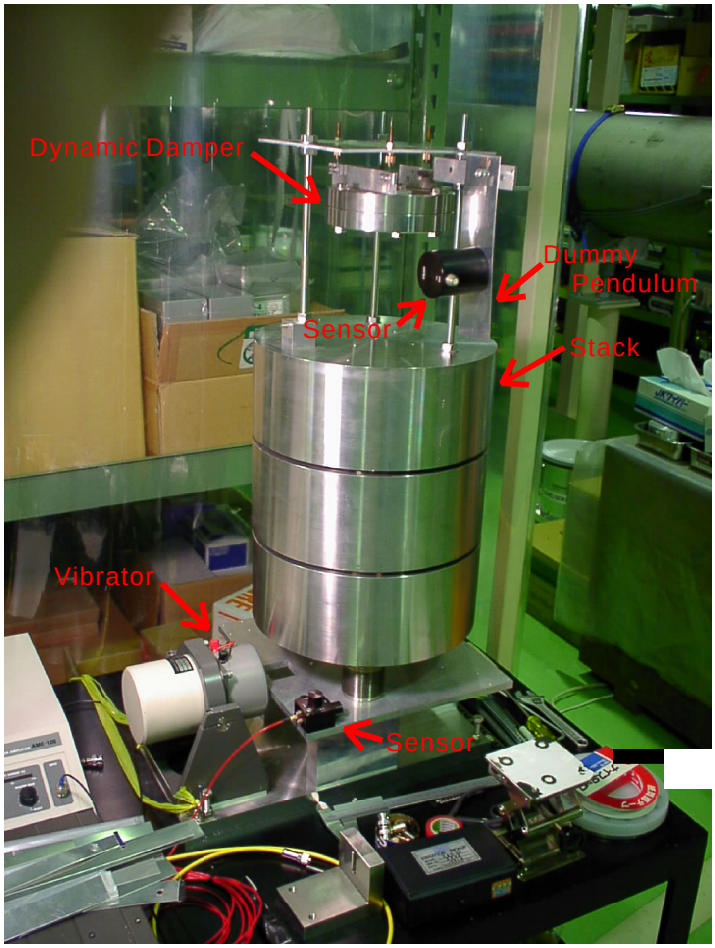
Transfer Function of M-system alone

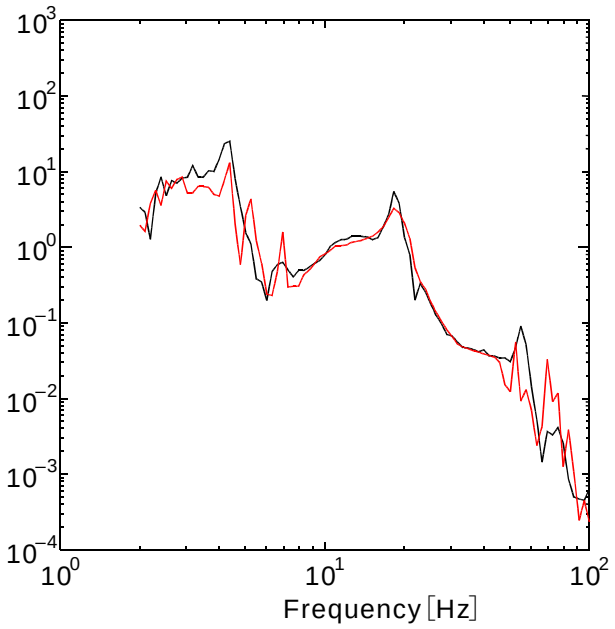
Transfer Function of M-system with m-system

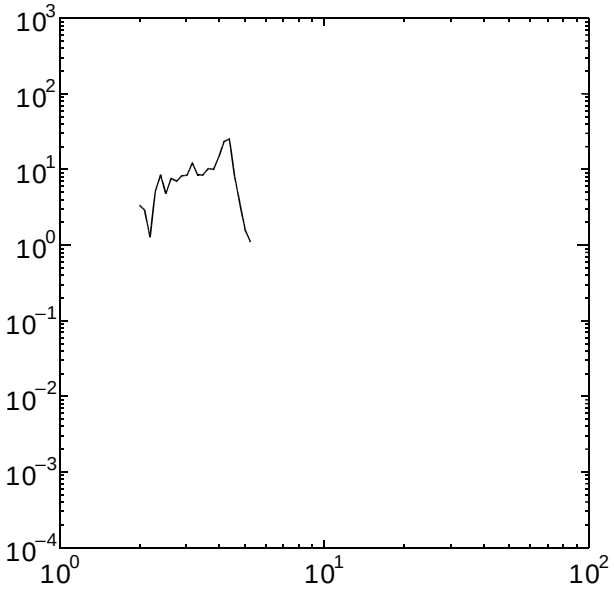
$Q = 100,\ m/M = 1/10$

Suppression $\sim Q(m/M) = 10$


Pendulum
Dynamic Damper
Stack

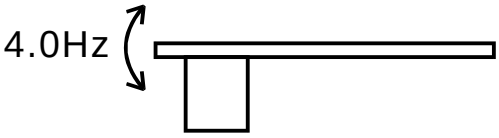

Dynamic Damper
Dummy
Pendulum
Sensor
Stack
Vibrator
Sensor

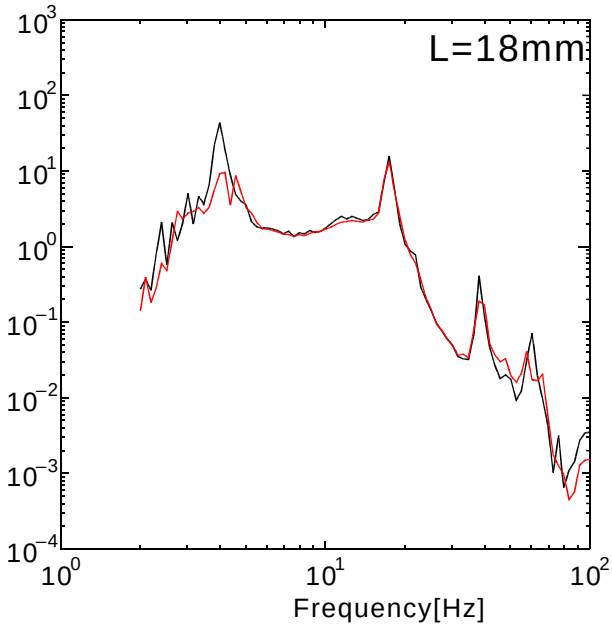

10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^0
10^1
10^2
Frequency [Hz]

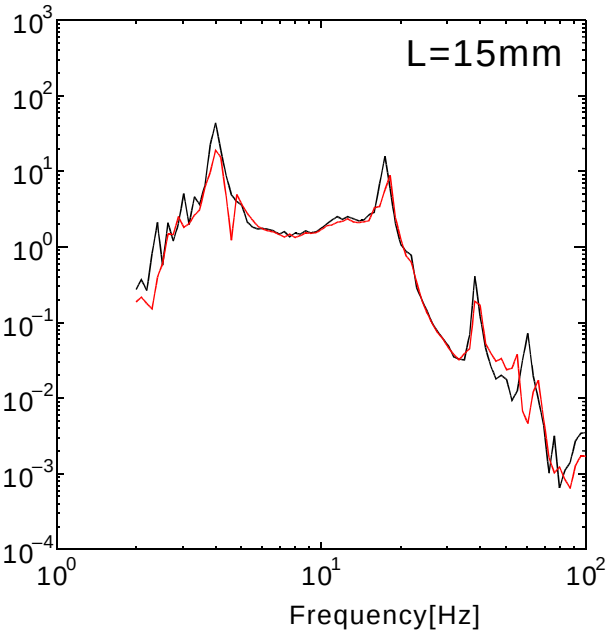

10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^0
10^1
10^2

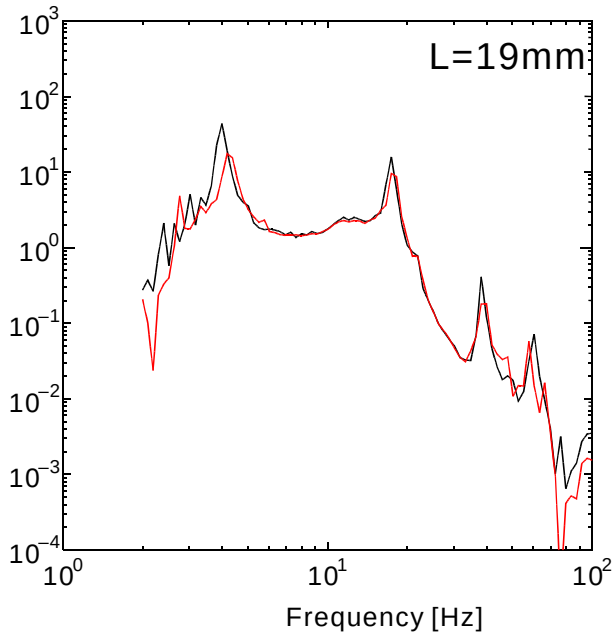
For Vertical Pendulum

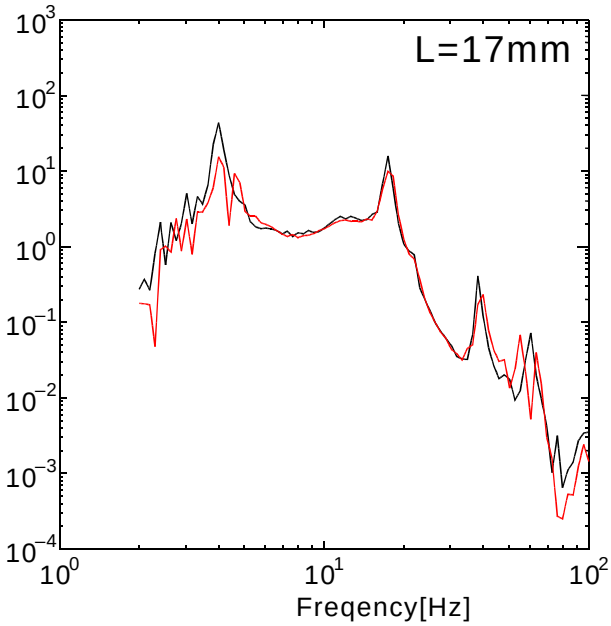
$$f = \frac{1}{2\pi}\sqrt{\frac{g}{L}}$$

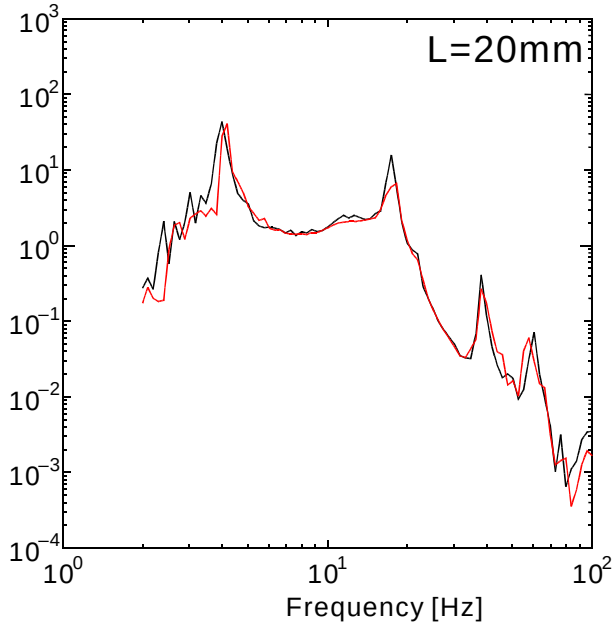












Summary

- Estimated Isolation ratio of the vibration isolation system is consistent with a calculation at 1 – 30 Hz. Although it is not confirmed at >30 Hz because of sensing limits, even the limits almost satisfied a requirement for TAMA300.
- A thermal actuator has been installed to the length control system. Large drift motions appeared in the differential length signal was successfully rejected.
- Performance of a dynamic damper was demonstrated using a prototype. The dynamic damper system will help to suppress the resonant peak due to a pitch mode of the pendulum.