# Type-A Rigid-Body Model (2D)

March 30th, 2011

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- 2-D Rigid-body model (longitudinal, vertical, pitch)
- Only passive (no active control)
- Effective bending point is not considered
- 1% coupling of vertical mode for seismic noise estimation
- Eddy current damping between Filter 0 & Filter 1
- Coordinate system is same as used in VIRGO
- GAS filter is separated into 2 parts in vertical-mode simulation, frame part and keystone part, in order to estimate vertical bounce frequencies of maraging wires

Overview of Type-A Vibration Isolation System
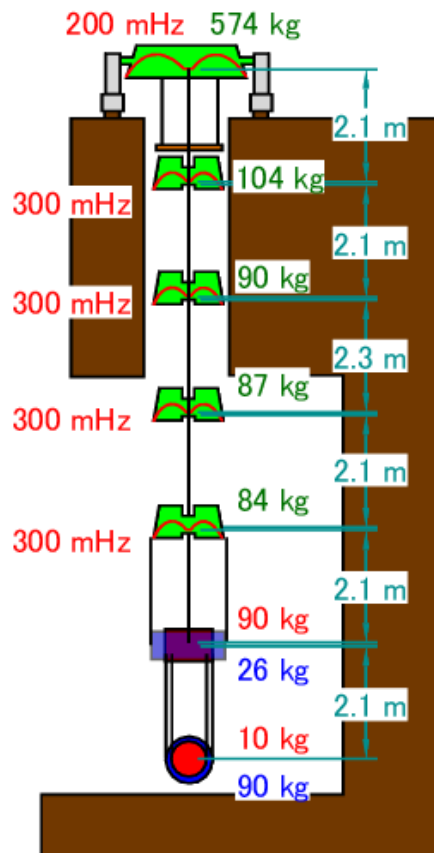
Parameters

Filter
Mass Distribution
mF0=574kg;
mF1=104kg;
mF2=90kg;
mF3=87kg;
mF4=84kg;
mIM=90kg;
mIRM=26kg;
mTM=10kg;
mRM=90kg;

Moment of Inertia (around transversal axis)
$ixF0=9.0$kg meter^2; (*not used*)
$ixF1=3.8$kg meter^2;
$ixF2=3.8$kg meter^2;
$ixF3=3.8$kg meter^2;
$ixF4=3.8$kg meter^2;
$ixIM=1.2$kg meter^2;
$ixIRM=1.6$kg meter^2;
$ixTM=0.047$kg meter^2;
$ixRM=4.0$kg meter^2;

Geometric Parameters (vertical separation between upper suspension point & gravity center)
dyuF1=1.0 mm;
dyuF2=1.0mm;
dyuF3=1.0mm;
dyuF4=1.0mm;
dyuIM=1.0mm;
dyuIRM=1.0mm;
dyuTM=1.0mm;
dyuRM=1.0mm;

Geometric Parameters (vertical separation between lower suspension point & gravity center)
dylF1=10.0 mm;
dylF2=10.0mm;
dylF3=10.0mm;
dylF4toIM=10.0mm;
dylF4toIRM=1.0mm;
dylIMtoTM=1.0mm;
dylIMtoRM=1.0mm;

Geometric Parameters (horizontal separation between wire & wire (longitudinal direction))
dzIRM=40cm;
dzTM=3.0cm;
dzRM=3.0cm;

Wire
Diameter (not optimized for torsion mode damping)
dwire={3.1mm,2.8mm,2.5mm,2.2mm,1.9mm,0.50mm,0.15mm,0.70mm};

Material
matewire={"MS","MS","MS","MS","MS","W","W","W"};

Length (without considering effective bending points)
lwire={2.1meter,2.1meter,2.35meter,2.1meter,2.1meter,2.1meter,2.1meter,2.1meter};

GAS Filter
Resonant Frequency
fGASF0=200mHz;
fGASF1=300mHz;
fGASF2=300mHz;
fGASF3=300mHz;
fGASF4=300mHz;

Saturation Level (dB)
dBGASF0=80;
dBGASF1=70;
dBGASF2=70;
dBGASF3=70;
dBGASF4=70;

Inertial Mass around Key Stone
mKeyF0=10.0kg;
mKeyF1=2.4kg;
mKeyF2=2.4kg;
mKeyF3=2.4kg;
mKeyF4=2.4kg;

Inverted Pendulum
kflex=(1897+0.5I)newton meter/rad ;(*spring constant of flex joint*)
mIP=5.2kg;(*total mass of IP leg*)
lIP=50cm; (*length from ground to IP top*)
lIPcom=12.0cm;(*position of gravity center from ground*)
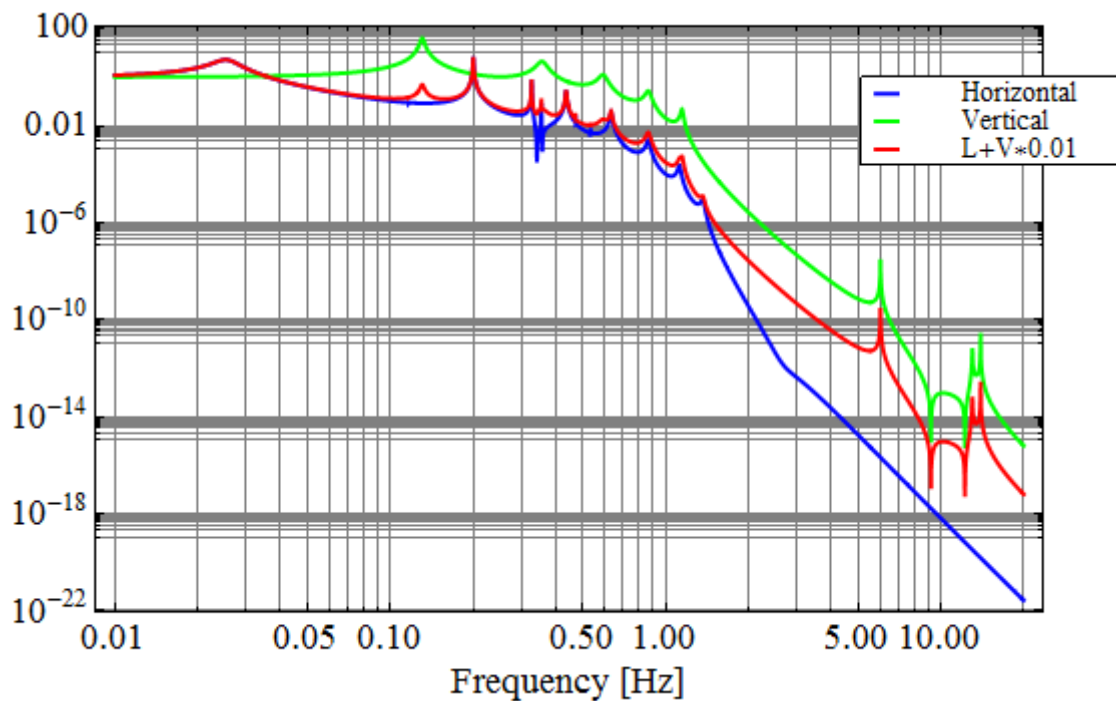$iIP=0.246$kg meter^2; (*moment of inertia around gravity center*)

Eddy Current Damping (for Filter 1)
Damping Coefficient
dampz=50kg/sec;
dampy=90kg/sec;
damppitch=4kg meter^2/sec/rad;

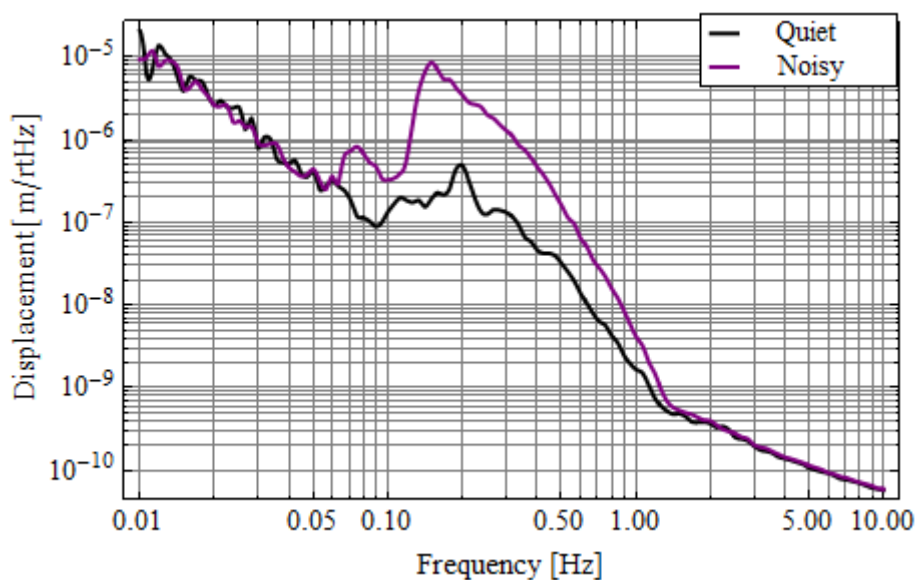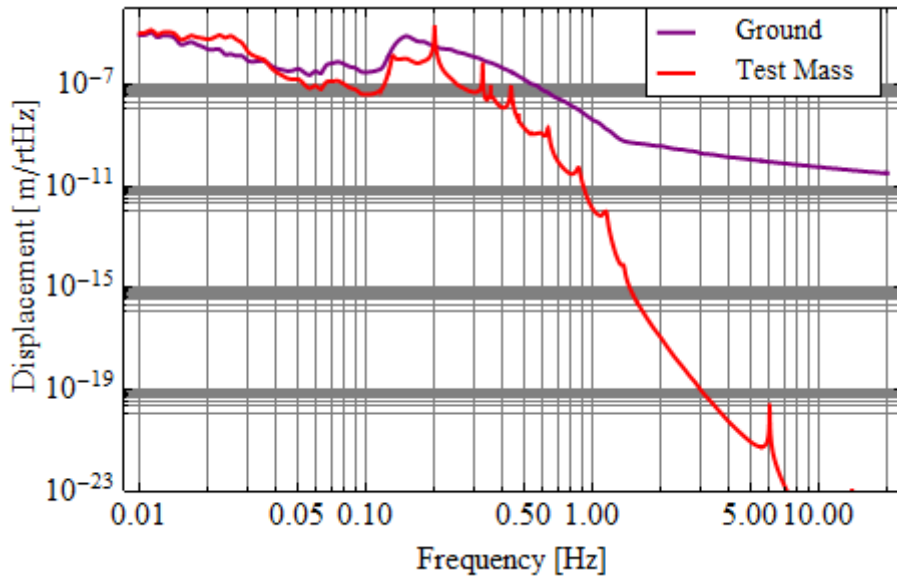*Result*

Vibration Isolation Ratio
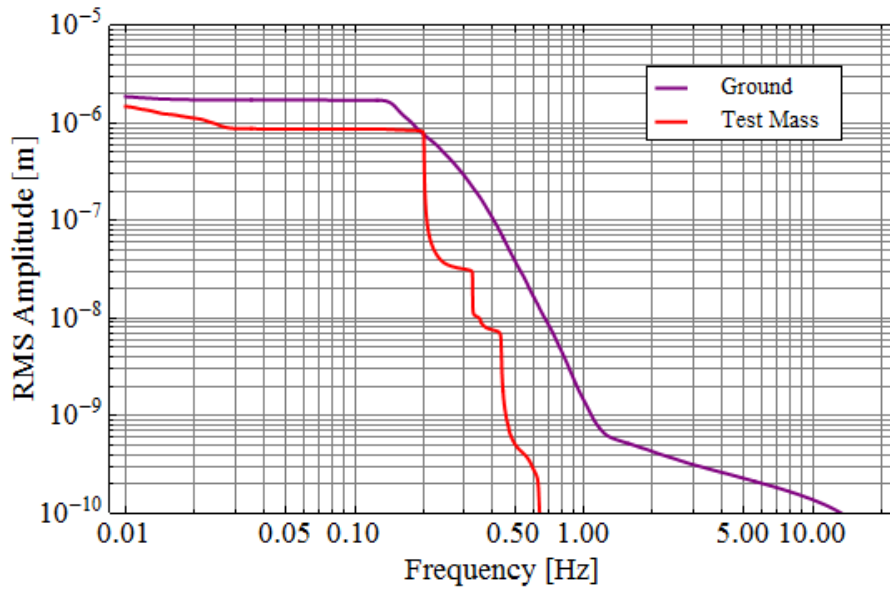

Seismic Noise Level [Horizontal + Vertical / 100]

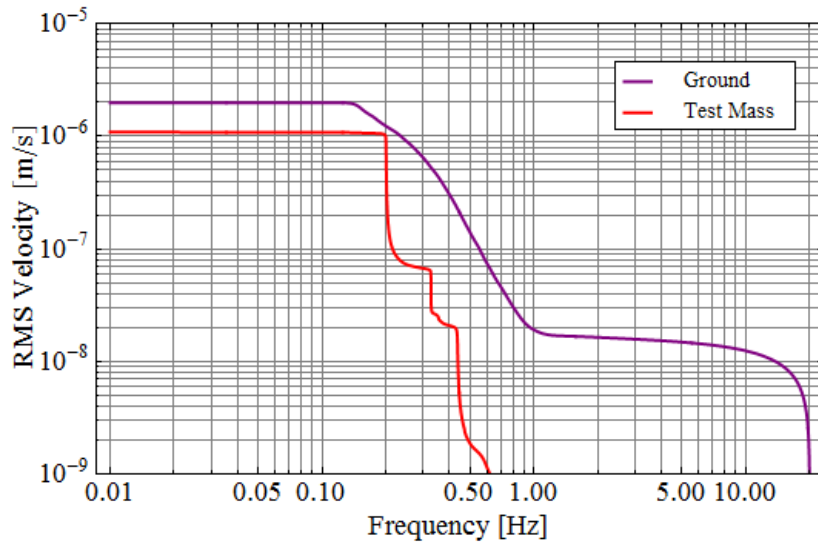- Seismic Noise Level in Kamioka Site (Normal Day vs Noisy Day)
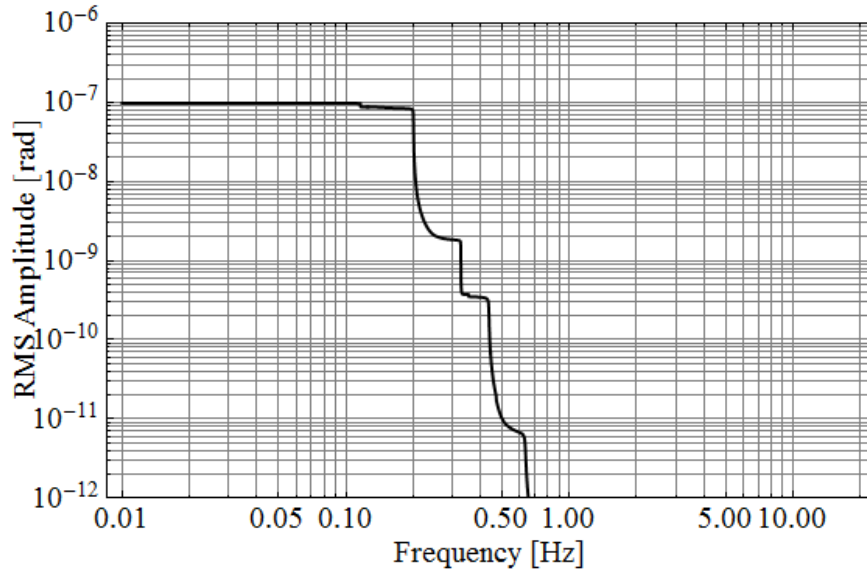
- **Spectrum Density (in Noisy Day)**

- **RMS Amplitude (in Noisy Day)**
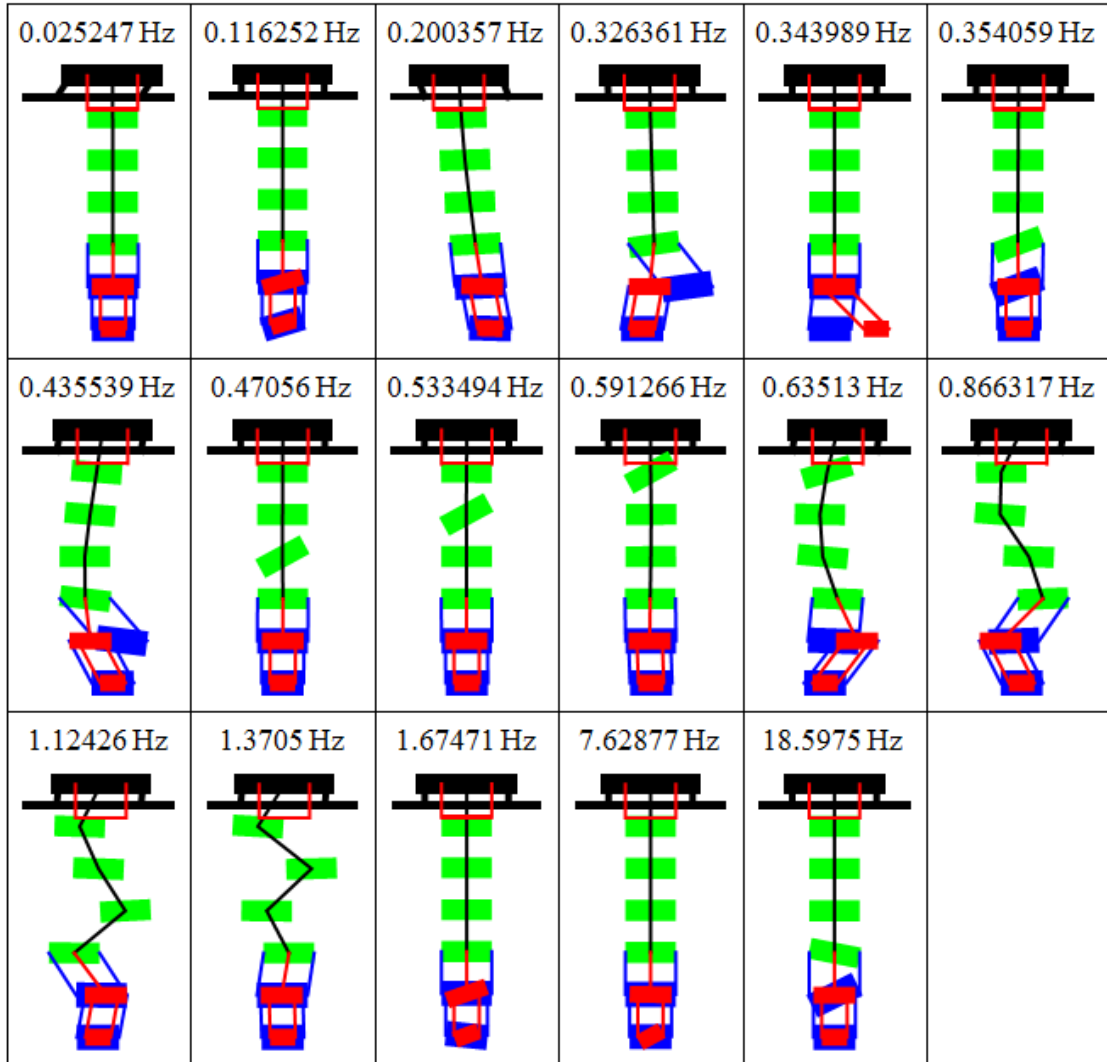
- **RMS Velocity (in Noisy Day)**

- **RMS of Pitch**

Eigen Mode & Frequency

Horizontal Mode

0.025247 Hz	0.116252 Hz	0.200357 Hz	0.326361 Hz	0.343989 Hz	0.354059 Hz
0.435539 Hz	0.47056 Hz	0.533494 Hz	0.591266 Hz	0.63513 Hz	0.866317 Hz
1.12426 Hz	1.3705 Hz	1.67471 Hz	7.62877 Hz	18.5975 Hz	

Vertical Mode