LIGO Live Noise Budget

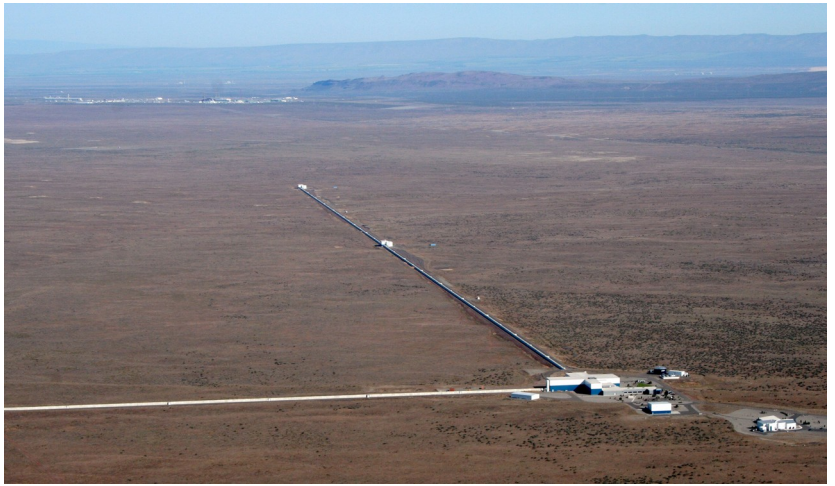
By Samuel Scherf

Background

- “LIGO (Laser Interferometer Gravitational-Wave Observatory) is a large-scale physics experiment and observatory to detect cosmic gravitational waves”

- Made over 50 detection's of gravitational waves

- Bounce laser back and forth until space is distorted



Project

- Create a live noise budget for site operators

* Useful for monitoring and testing

- Noise budget is estimated table motion based on noise sources

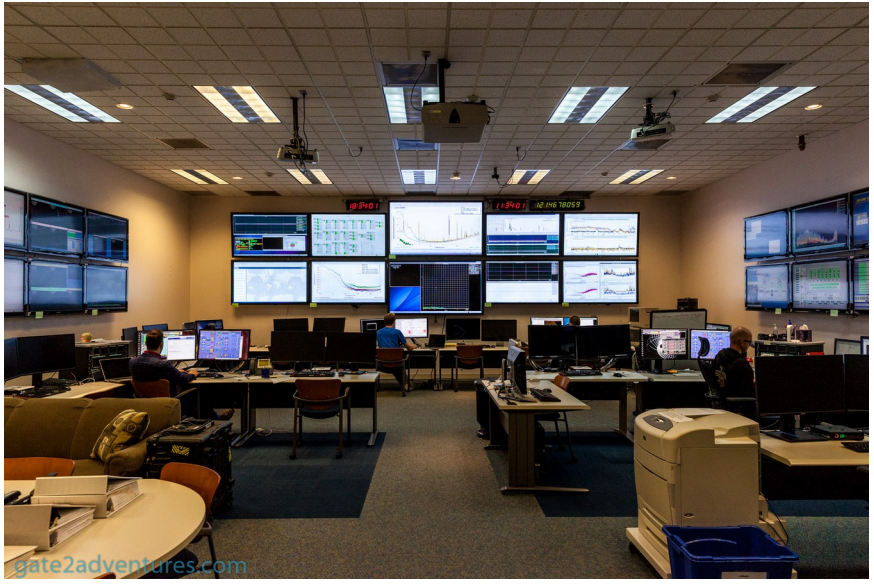
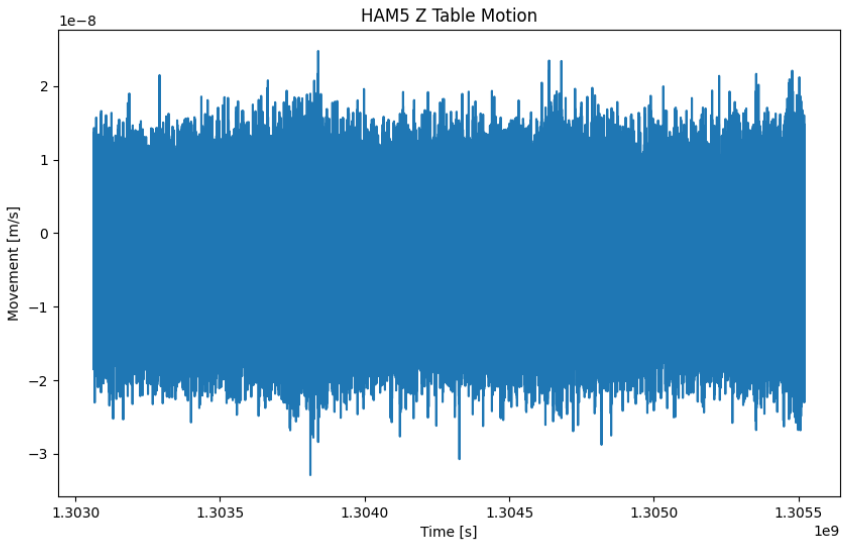


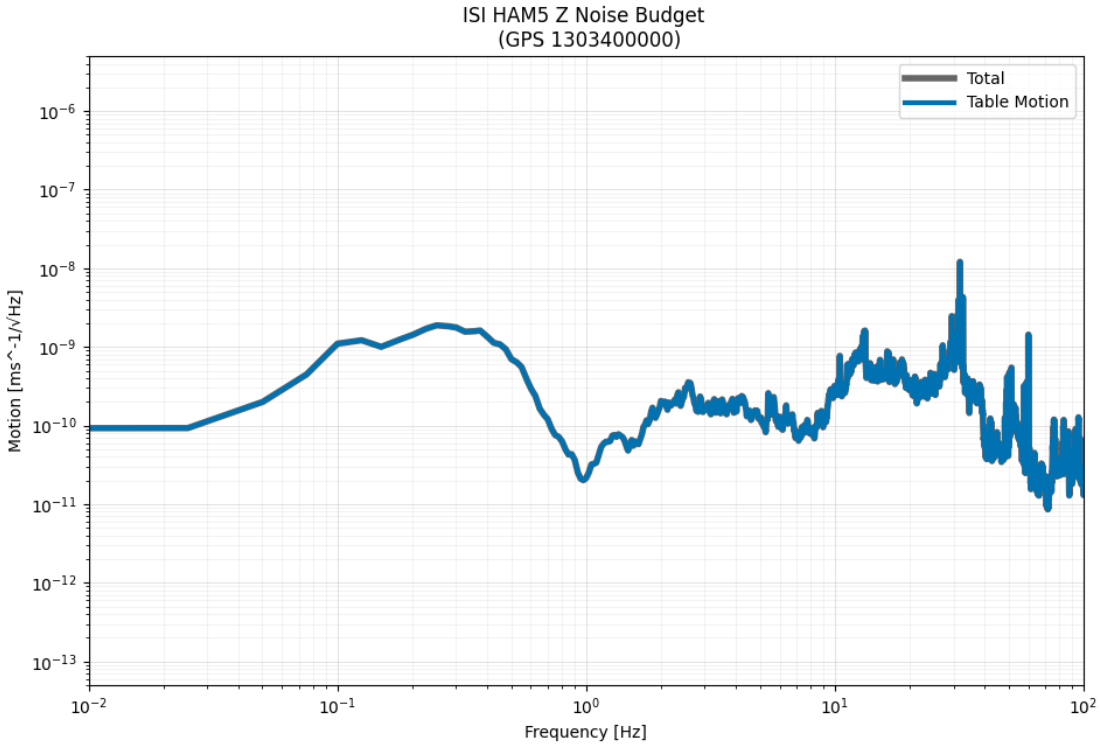
Table Motion

- Table motion is taken from a “GS-13” seismometer on the table

- This itself inst very useful to look at so we take a Fourier transform



Noise Budget Reference Curves



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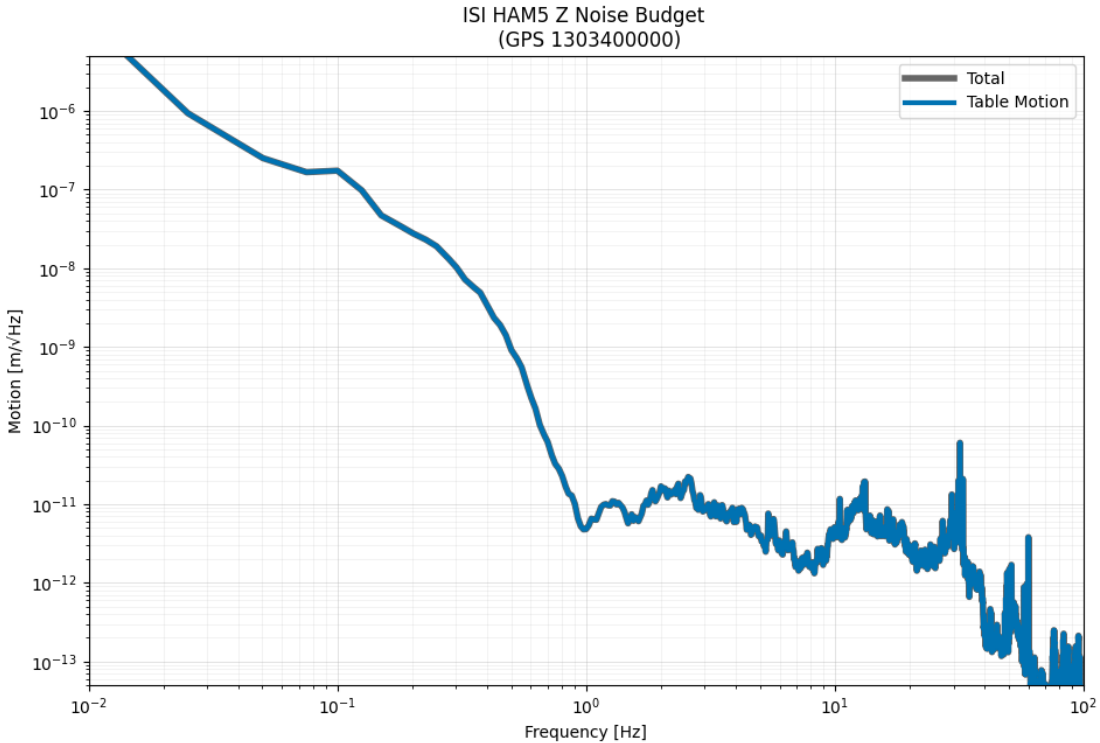

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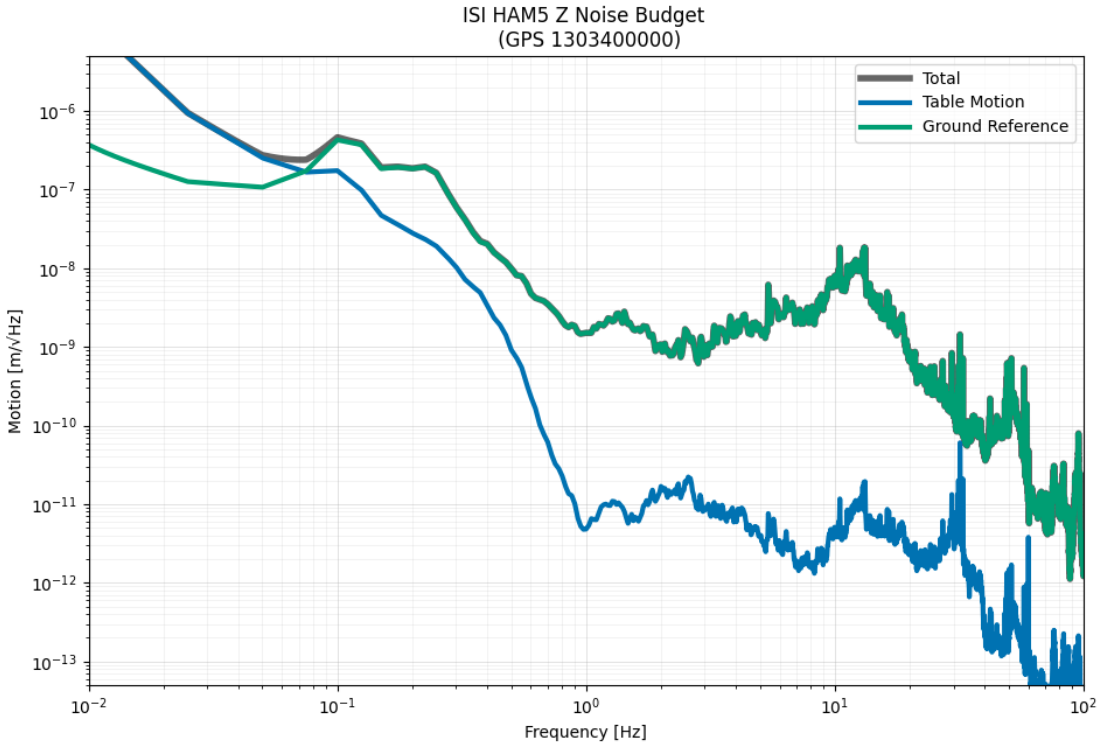
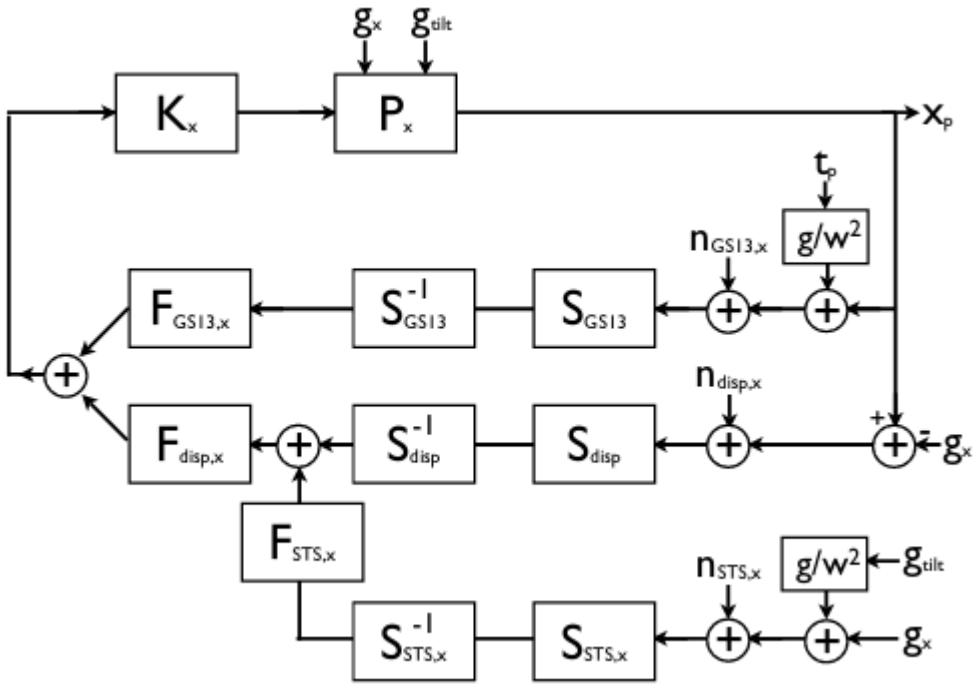


Control Loop



Ground Contribution

$$
\begin{aligned}
x_p = & \frac{P_{x \leftarrow g_x}}{1-G} g_x \\
& + \frac{P_{x \leftarrow g_{tilt}}}{1-G} g_{tilt} \\
& + \frac{G}{1-G} F_{GS13,x} \cdot n_{GS13,x} \\
& + \frac{G}{1-G} F_{GS13,x} \cdot \frac{g}{\omega^2} \cdot t_p \\
& + \frac{G}{1-G} F_{disp,x} \cdot n_{disp,x} \\
& + \frac{-G}{1-G} F_{disp,x} \cdot g_x \\
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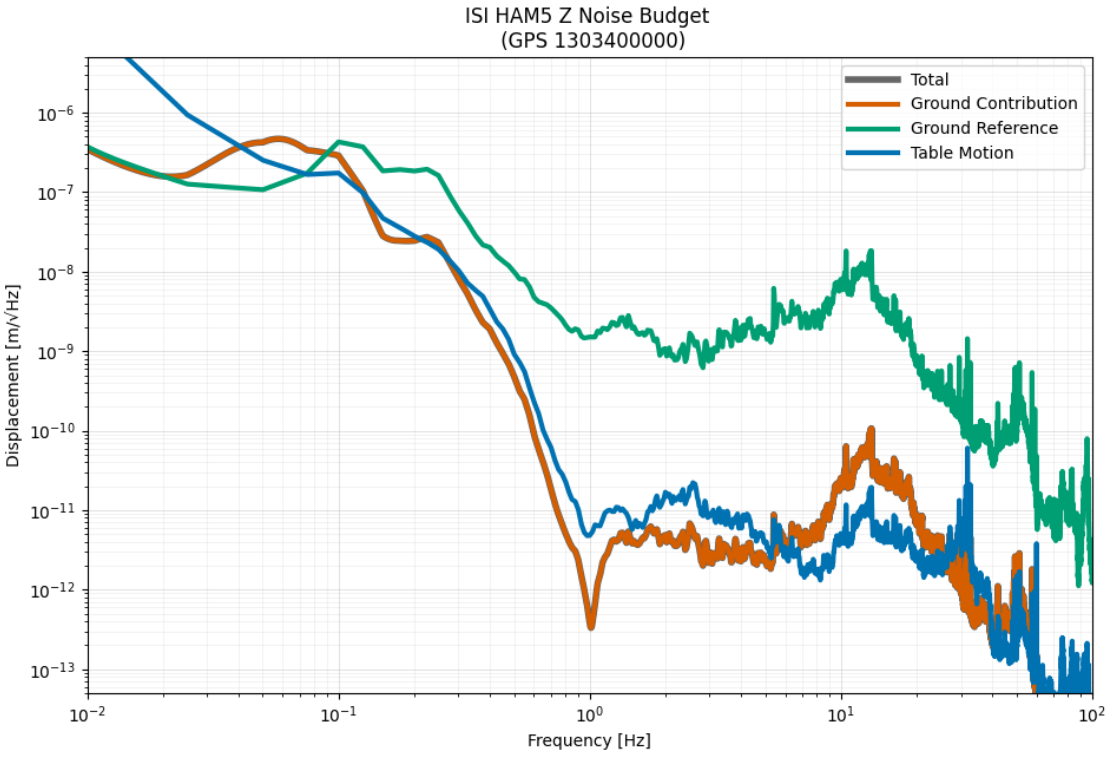
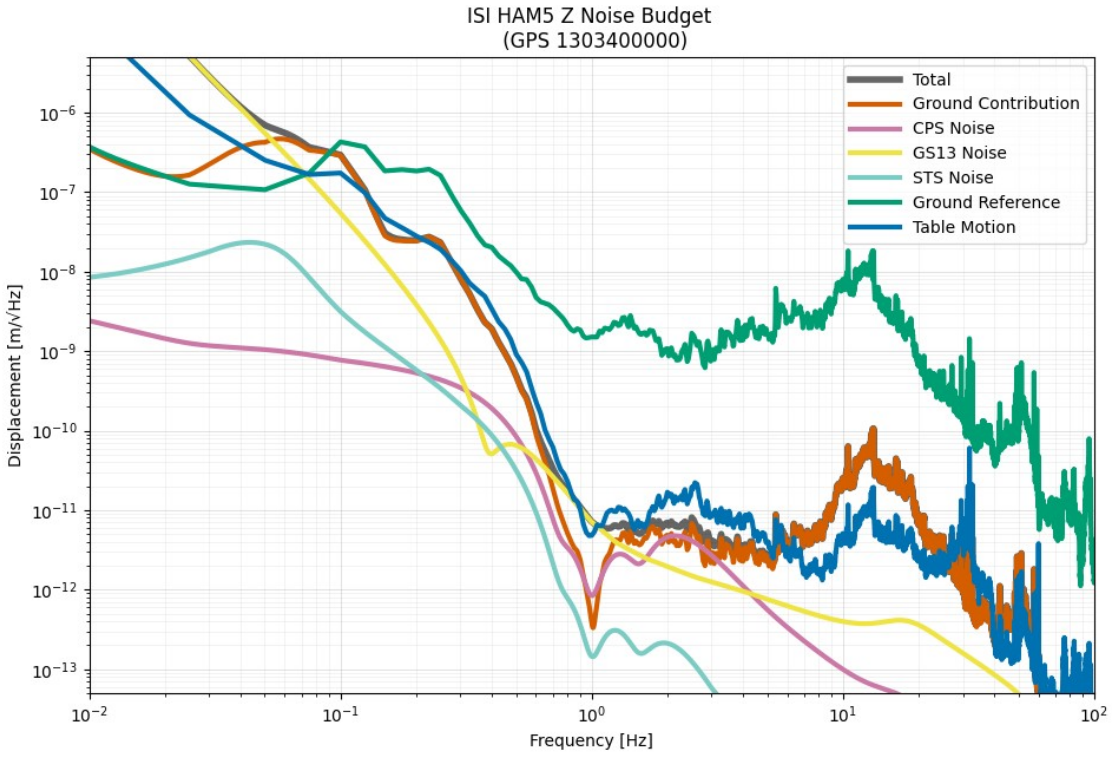
$$

$$
x_p = \frac{G}{1-G} \cdot \left(\frac{P_{x\leftarrow g_x}}{G} - F_{disp,x} + F_{disp,x} \cdot F_{STS,x} \right) \cdot g_x
$$

Ground Contribution



Sensor Noise



Tilt

- Inertial sensors read tilt as constant acceleration

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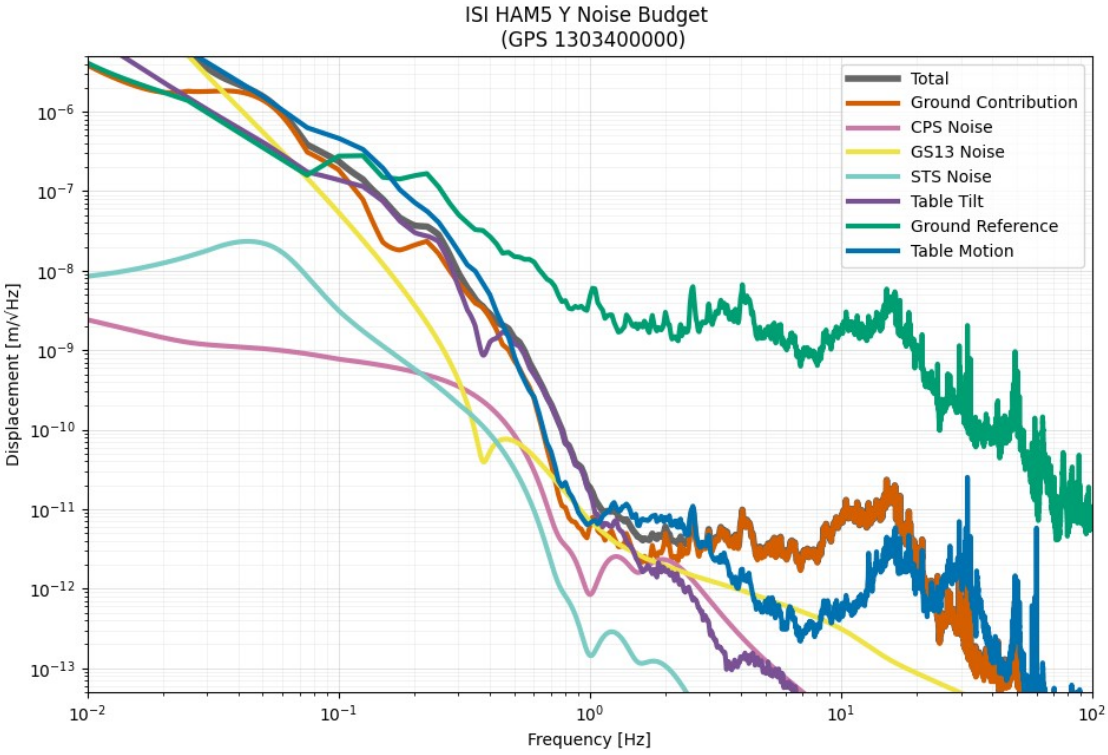
ISI HAM5 Y Noise Budget
(GPS 1303400000)
Total
Ground Contribution
CPS Noise
GS13 Noise
STS Noise
Table Tilt
Ground Reference
Table Motion
Displacement [m/√Hz]
Frequency [Hz]

To do

- Create interface to view all the budgets
- Expand to more chambers
- Resolve model bugs
- Fix tilt term