The LAT of mass "m" is mounted on springs with a combined spring constant "k". The springs + LAT have a resonant frequency \( \omega_0 = \sqrt{\frac{k}{m}} \).

One end of the spring is connected to the aircraft (or the box wall). This end of the spring is driven by 1) Vibration and airpockets through contact with the airplane, or 2) Acoustics through pressure on the Transport Box wall.

1) Consider the airplane floor moving with some \( x_{\text{floor}}(t) \) irrespective of the mass \( m \). The floor acceleration has a fourier spectrum of \( a_{\text{floor}}(\omega) = x_{\text{floor}}(\omega) \omega^2 \). Assume the floor acceleration amplitude is independent of freq (as it would be for a narrow delta function acceleration of amplitude \( a_{\text{floor}_0} \)). Let \( x_{\text{lat}}(t) \) be the position of the LAT mass \( m \). The differential eqn for the system is:

\[
\frac{d^2}{dt^2} x_{\text{lat}} + \gamma \frac{dx_{\text{lat}}}{dt} + \frac{k}{m} (x_{\text{lat}} - x_{\text{floor}}) = 0 \quad \omega_0^2 := \frac{k}{m}
\]

\( g := 9.8 \quad [\text{m/sec}^2] \) Acceleration of gravity

\( a_{\text{floor}_0} := 0.5 \cdot g \quad [\text{m/sec}^2] \) Vibration acceleration amplitude

\( \Delta_{\text{max}} := \frac{2}{39} \quad \Delta_{\text{max}} = 0.051 \quad [\text{m}] \) Max compressive travel of spring from loaded equilibrium

\( \omega_0 := \sqrt{\frac{a_{\text{floor}_0}}{\Delta_{\text{max}}}} \quad \omega_0 = 1.556 \quad [\text{Hz}] \) Resonant freq of spring + LAT

\( Q := 0.1 \quad \text{Damping constant} \)

\( \gamma := \frac{\omega_0}{Q} \)

\( x_{\text{floor}_0}(\omega) := a_{\text{floor}_0} \omega^2 \quad x_{\text{lat}_0}(\omega) := \frac{\omega_0^2 + i \cdot \gamma \cdot \omega}{\omega_0^2 - \omega^2 + i \cdot \gamma \cdot \omega} \cdot x_{\text{floor}_0}(\omega) \quad a_{\text{lat}_0}(\omega) := \omega_0^2 \cdot x_{\text{lat}_0}(\omega) \)

2) Consider a flat spectrum acoustic pressure wave acting on one side (the floor) of the box with force \( F(t) \). Assume the acoustic force on the wall is independent of frequency (db is the same at all frequencies)

\[
\frac{d^2}{dt^2} x_{\text{lat}} + \gamma \frac{dx_{\text{lat}}}{dt} + \frac{k}{m} x_{\text{lat}} = \frac{F(t)}{m} \quad a_{\text{acoustic}(\omega)} := \frac{F(\omega)}{m}
\]

\( db := 100 \quad [\text{decibels}] \) Sound pressure relative to 2x10^{-5} Newtons/m^2

\( A := 2.3 \quad [\text{m}^2] \) Area of side of box

\( m := 4000 \quad [\text{kg}] \) Mass of LAT + perimeter ring + isolation frame

\( a_{\text{acoustic}_0} := \frac{A \cdot 2 \cdot 10^{-5} \cdot db}{20} \) [m/sec^2] Acoustic acceleration amplitude

\( a_{\text{acoustic}_0} = 3 \cdot 10^{-3} \)

\( x_{\text{acoustic}}(\omega) := \frac{a_{\text{acoustic}_0}}{\sqrt{[\omega_0^2 - \omega^2]^2 + (\gamma \cdot \omega)^2}} \quad a_{\text{acoustic}_0} := \omega_0^2 \cdot x_{\text{acoustic}}(\omega) \quad i := 0 .. 50 \quad \omega_i := 2 \pi \cdot 10^{i} \cdot 2 \)
GLAST Random Vibration Spectrum (from Jim Haughton 202-767-4689 via Mike Lovellete) for Military transport aircraft.

\[ Hz_k := g2Hz_k := \]

\[
\begin{array}{c|c}
15 & 0.010 \\
105 & 0.010 \\
150 & 0.020 \\
500 & 0.020 \\
2000 & 0.001
\end{array}
\]

\[ n := 0 \ldots 40 \quad k := 0 \ldots 4 \quad \text{transfer}(\omega) := \frac{1}{\omega^2 - \omega_0^2 + i \cdot \gamma \cdot \omega} \]

\[ v_n := 10^{\frac{n}{10}} \]

\[ G2Hz(v) := 10^{\text{interp}(\log(\text{Hz}), \log(g2Hz), \log(v))} \]

\[ \text{rms} := \sqrt{\int_{0.01}^{10000} G2Hz(v) \cdot \text{transfer}(2 \cdot \pi \cdot v) \, dv} \quad \text{rms} = 0.05 \quad \text{[gravities]} \]