Stabilization Test Setup

- Test Mass 2
- Test Mass 1
- Reference Laser Interferometer
- Beam simulation interferometer
- Geophone
- Support Structure
- Piezo support
- Optical anchor
- Test Tunnel
- Accelerometers
STACIS™ 2000
Active Piezoelectric Vibration Control System

When it comes to isolating highly sensitive equipment from troublesome vibrations, the TMC STACIS 2000 system stands alone.

The STACIS 2000 active vibration control system offers the world's most advanced vibration control solution. With isolation starting at 0.3 Hz, the STACIS 2000 system provides the widest band of vibration isolation available, capable of isolating sensitive equipment from vibrations at any relevant frequency.

With the STACIS 2000 system, you can locate your sensitive machines and equipment virtually anywhere within a fabrication site - without suffering the effects of minute vibrations such as those from passing workers, air handling systems or nearby machinery. The result? For example, the ability to manufacture higher density chips and achieve higher yields, along with reduced process cycle times and lower cost per chip.

What's more, this robust, advanced system is easy to use and simple to install.

Features:
- Provides greater than 90% isolation in all axes at frequencies greater than 2 Hz
- Remains rigid for minimal motion even with step inputs
- Installs easily - robust control system requires minimal on-site adjustments
- Maximizes uptime through extensive, easy-to-use diagnostics and its modular design
- Supports computerized data acquisition and control from its user-friendly software interface
- Emits an ultra-low magnetic field and is cleanroom compatible with no air hookups or valves

Benefits:
- Helps your equipment meet its resolution specifications
- Stretches the limits of your old equipment
- Increases throughput, quality and yield
- Reduces downtime through quick installation, minimal calibration and reliability
- Meets tough vibration specifications of next-generation equipment
- Reduces fab floor construction costs
### PERFORMANCE COMPARISON

#### STACIS vs COMPETITION

<table>
<thead>
<tr>
<th>ITEM</th>
<th>BARRY CONTROLS</th>
<th>IDE</th>
<th>IDE</th>
<th>TOKKYOKIKI</th>
<th>SHOWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active degrees of freedom</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>Unknown</td>
</tr>
<tr>
<td>Active bandwidth</td>
<td>0.3 to 250 Hz</td>
<td>0.6-120 Hz</td>
<td>0.1 to 100 Hz</td>
<td>.0 .1-20</td>
<td>but thought</td>
</tr>
<tr>
<td>Active resonant frequency</td>
<td>0.2 Hz</td>
<td>0.4</td>
<td>None</td>
<td>&lt;0.1</td>
<td>to be</td>
</tr>
<tr>
<td>Active resonant transmissibility</td>
<td>&lt;1.1</td>
<td>&lt;1.1</td>
<td>1</td>
<td>Unknown</td>
<td>similar to</td>
</tr>
<tr>
<td>Active force</td>
<td>&gt;500 lbs/isol/axis</td>
<td>4 lbs/isol/axis</td>
<td>44 lbs/isol/axis</td>
<td>&gt;90%</td>
<td>IDE/TC</td>
</tr>
<tr>
<td>Isolation margin, above 2 Hz</td>
<td>&gt;90%</td>
<td>&gt;80%</td>
<td>&gt;70%</td>
<td>0.5 seconds</td>
<td>0.5 seconds</td>
</tr>
<tr>
<td>Setting time after a 10 lb. step input</td>
<td>~0.3 seconds</td>
<td>&gt;1 second</td>
<td>0.1-3 seconds</td>
<td>0.5 seconds</td>
<td>0.5 seconds</td>
</tr>
<tr>
<td>Setting time after a 5 lb. step input</td>
<td>~0.3 seconds</td>
<td>&gt;.05 second</td>
<td>0.1-3 seconds</td>
<td>0.5 seconds</td>
<td>0.5 seconds</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>60 db</td>
<td>60 db (est)</td>
<td>60 db (est)</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Operating load range/isolator</td>
<td>400-3500 lb</td>
<td>110-5500 lb</td>
<td>440-1960 lb</td>
<td>600-7040 lbs</td>
<td>4</td>
</tr>
<tr>
<td>Number of isolators</td>
<td>3 or 4 std, 6 &amp; * opt</td>
<td>4</td>
<td>3 or 4?</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Factor of safety with highest load</td>
<td>&gt;2:1 w/o damage</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Maximum static load (non operating)</td>
<td>7000 lbs</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Maximum active displacement</td>
<td>001&quot; (p-p)</td>
<td>± .040&quot;</td>
<td>.0012&quot; (p-p)</td>
<td>± .12&quot;</td>
<td>10,000 (Active)</td>
</tr>
<tr>
<td>Passive spring rate (3000 lb. load)</td>
<td>100,000 lbs/in</td>
<td>&lt;3000 lbs/in</td>
<td>30,000 lbs/in</td>
<td>10,000 (Active)</td>
<td>1.0</td>
</tr>
<tr>
<td>Passive natural frequency</td>
<td>20 Hz</td>
<td>3 Hz</td>
<td>12 Hz</td>
<td>10 nm/√Hz at 1 Hz</td>
<td>10 nm/√Hz at 1 Hz</td>
</tr>
<tr>
<td>System noise floor</td>
<td>unknown</td>
<td>10 nm/√Hz at 1 Hz</td>
<td>10 nm/√Hz at 10 Hz</td>
<td>&lt;1 μG</td>
<td>0.004 (est)</td>
</tr>
<tr>
<td>Vertical leveling accuracy</td>
<td>±0.0004</td>
<td>±0.004&quot;</td>
<td>Unknown</td>
<td>.0004 (est)</td>
<td>Nil</td>
</tr>
<tr>
<td>EMI emission (standard)</td>
<td>Nil</td>
<td>&lt;5 mG/√Hz (P-P)</td>
<td>&lt;5 mG/√Hz (P-P)</td>
<td>8 scfm @ 90 psi</td>
<td>Nil</td>
</tr>
<tr>
<td>EMI (optional)</td>
<td>N/A</td>
<td>&lt;.1 mG/√Hz (P-P)</td>
<td>None</td>
<td>None</td>
<td>8 scfm @ 90 psi</td>
</tr>
<tr>
<td>Air required</td>
<td>None</td>
<td>&lt;1 scfm @ 100 psi</td>
<td>None</td>
<td>None</td>
<td>8 scfm @ 90 psi</td>
</tr>
<tr>
<td>Electrical power required</td>
<td>&lt;800 Watts</td>
<td>1500 Watts max.</td>
<td>500-1200 Watts</td>
<td>500 Watts (est)</td>
<td>500 Watts (est)</td>
</tr>
</tbody>
</table>
Figure 24.7.1: The Design of MIMO Feedback Systems by Return-Ratio Shaping.
Disturbances: \( (\Delta d) \) (Low Freq.)

Thermal: if stable or 
then over \( 10 \text{ m} \), \( \Delta x \approx 1 \mu \text{m} \).

Seismic: \( \approx 1 \text{ nm} \) (from Appendix A).

Dimensional:

Hysteresis in structure:

Noise: (High Freq.)

Electromagnetic: cabling, beam

Interaction Devices

Vibrational: ground based high freq.

Environmental - Mechanical, hydraulic
\[ \mathbf{\Sigma F} = \mathbf{M} \alpha_c \] (from \( P = M \cdot v_c \) and \( F = \frac{dp}{dt} \))

\[ \mathbf{\Sigma T_c} = [I] \cdot \left[ \frac{d\mathbf{\dot{r}}}{dt} \right] \]

\[ I = I_{xx} \]

First work on keeping \( P \) soil vertically

\[ Z_p = Z_{cg} + \frac{1}{2} \theta_x = F(F_x, F_{21}, F_{23}) \]

If we assume Quad is 1m³ steel

- and 1mm movement of C.G is a problem

\[ \rightarrow 2\text{ parts} - \text{per billion} \text{ problem} \]

If we look at a 5m cantilever

Then 1mm equates to a

\[ 0.2 \text{ nRad} \] problem
Given $\omega_n = 100$ Hz
assume Quad is 1,000 kg
and $1\text{ m} \times 1\text{ m} \times 1\text{ m}$ cu. m

$$\omega_n = \frac{\sqrt{k}}{\sqrt{m}} \Rightarrow k = 10 \text{ N/m}$$
for this mode

If Quad was solid steel

$$\omega_n = 0.56 \sqrt{\frac{gEI}{PA ly}} = 0.56 \sqrt{\frac{gI}{A^4}}$$

$\Rightarrow C = \text{wave speed}$

$\approx 20 \text{ m/s}$ for this mode

$\Rightarrow 25 \text{ ms}$ time delay to C.G.

assuming 1st mode is shearing,

(some inaccuracies)

because it is

"short" and $L/A < 10$

So,

There may be significant time delays within the flexible structure.