Overview of ACIGA high performance vibration isolator

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Vibration Isolation Techniques

- The AIGO vibration isolator combines several techniques.
- Anti-Springs in most stages reduce mode frequencies.

The Pre-isolator combines two horizontal stages, an inverse pendulum and a Roberts Linkage, and one vertical LaCoste stage, all with resonant frequencies below 0.1Hz.
  1. The inverse pendulum.
  2. The LaCoste linkage provides vertical pre-isolation.
  3. The Roberts linkage.

The isolation consists of three similar stages.
  4. A 40kg pendulum with Euler spring vertical suspensions.
  5. Each stage comprises a rocker mass and self-damped pendulum with eddy current damping.

Local control implemented at pre-isolation stage:
- Coil and magnet actuation for positioning and damping for both the inverse pendulum and LaCoste stages.
- Slow vertical control by coil spring heating in the LaCoste stage for thermal drift and creep correction.
- Slow position control using the Roberts linkage by heating suspension wires.

What is an anti-spring?
An anti-restoring force i.e. instability

ω = \sqrt{\frac{k_{spring} - k_{anti}}{m}}
Inverse Pendulum
Lacoste Linkage
Mass

rigid links

platform

springs
Pre-isolation local control

- Horizontal (inverse pendulum) position control with magnetic actuators

- Vertical (LaCoste linkage) position control
  - with magnetic actuators
  - heating of springs
Roberts linkage
Self-Damped pendulums (3 Stages)

Double wire suspended on a pivot, free to swing.

40kg Rocker mass, high moment of inertia.

Viscous damping

Self-Damping Schematic
Vertical Euler Springs (3 Stages)
3 Stage Horizontal Frequency Response

- **Model assuming Q = 20**

- **with Self-Damping**
- **without Self-Damping**

Al web rigidly clamped to the suspension tube

Copper plates attached to Al web, rigid with respect to suspension tube

Rocker mass

Magnets, attached to rocker mass

Rotational arm rests on Euler springs and is suspension point for next stage

Bottom of springs is clamped to suspension tube

**Integrated 3D isolator stage**
Progress at AIGO

- Assembly of two complete vibration isolators in progress at the AIGO test facility.
- Optical cavity differential motion testing in AIGO east arm planned late 2005.

Please visit the lab if you haven’t already done so!

The end
Deleted Scenes
Roberts linkage

Diagram showing the relationship between frequency response, isolation floors, resonant frequency, and suspension point height. The graphs illustrate how changes in suspension point height affect the frequency response and isolation limit.

Diagram (a) depicts the geometric considerations of the Roberts linkage, including the center of mass and various distances and angles.

Diagram (b) illustrates the relationship between isolation floor, resonant frequency, and radius of gyration of the tuning mass.
Al web rigidly clamped to the suspension tube

Copper plates attached to Al web, rigid with respect to suspension tube

Magnets, attached to rocker mass

Rocker mass

Vertical stage
Copper plates
Viscous damping
Pivot
Suspension wire
Rocker mass, high moment of inertia.
2D flexures
Rocker mass
Vertical spring stage
Pin connection
Copper plates
Magnets
Pivot
Suspension wire
Viscous damping
Rocker mass, high moment of inertia.