Overview of ACIGA high performance vibration isolator

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Eu-Jeen Chin
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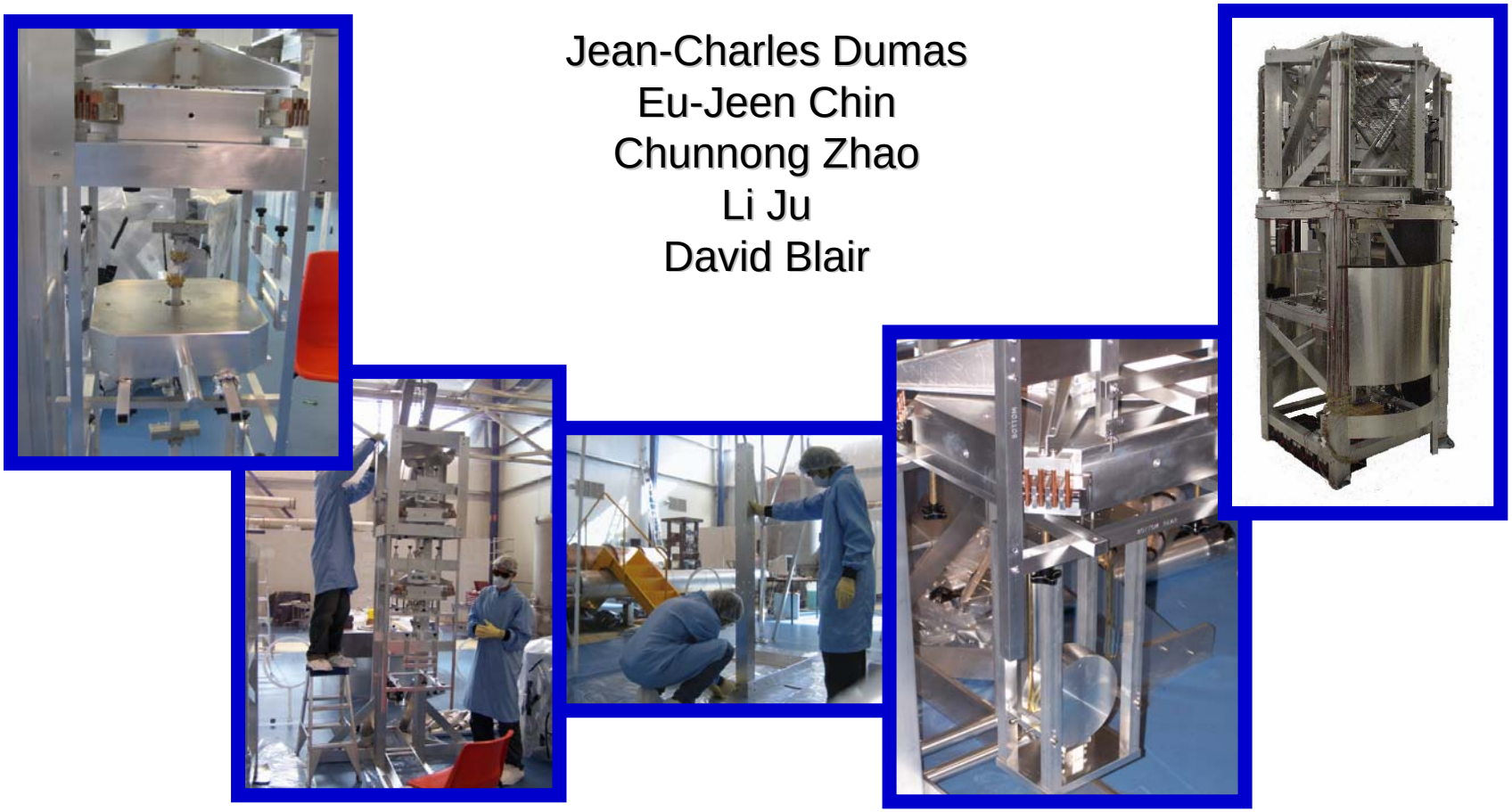
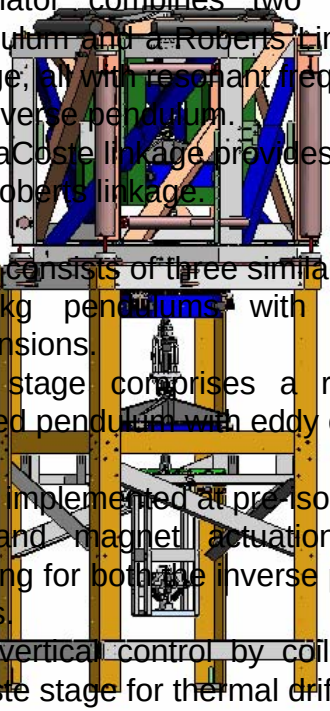
David Blair

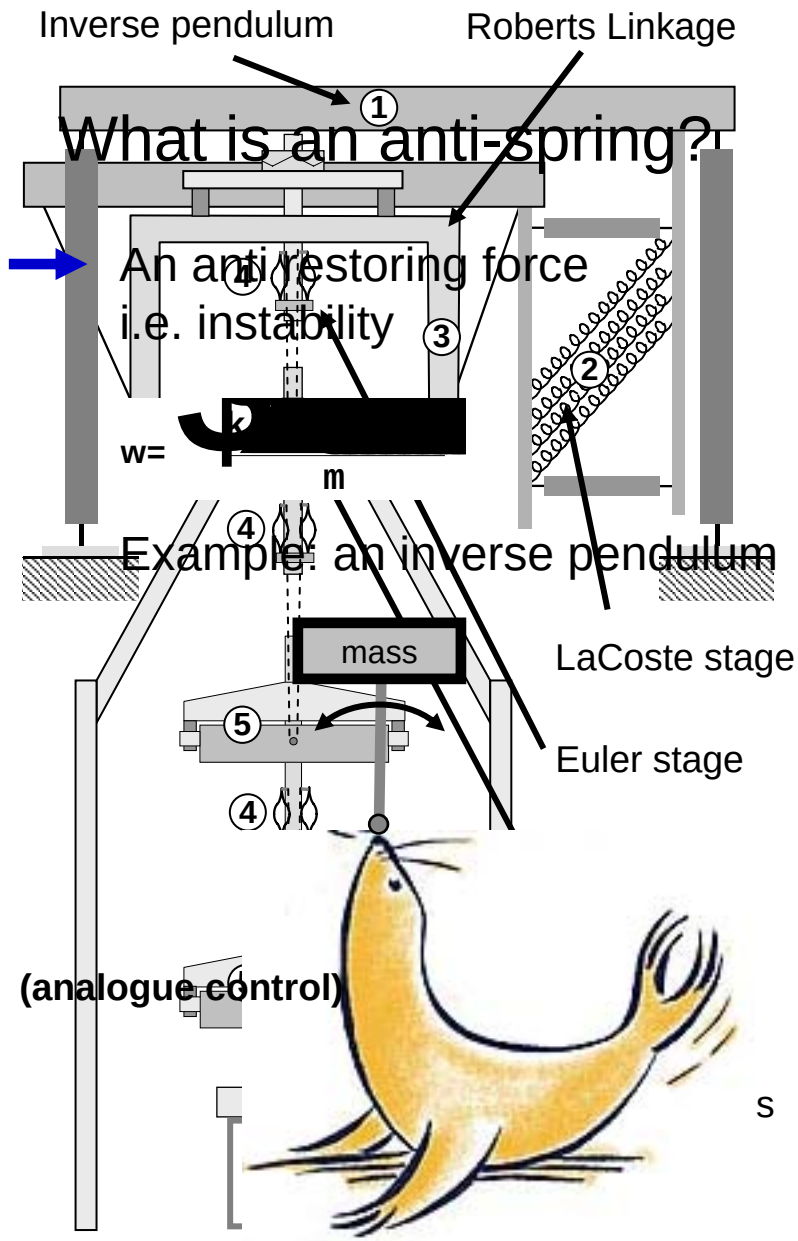


LIGO-G050544-00-Z

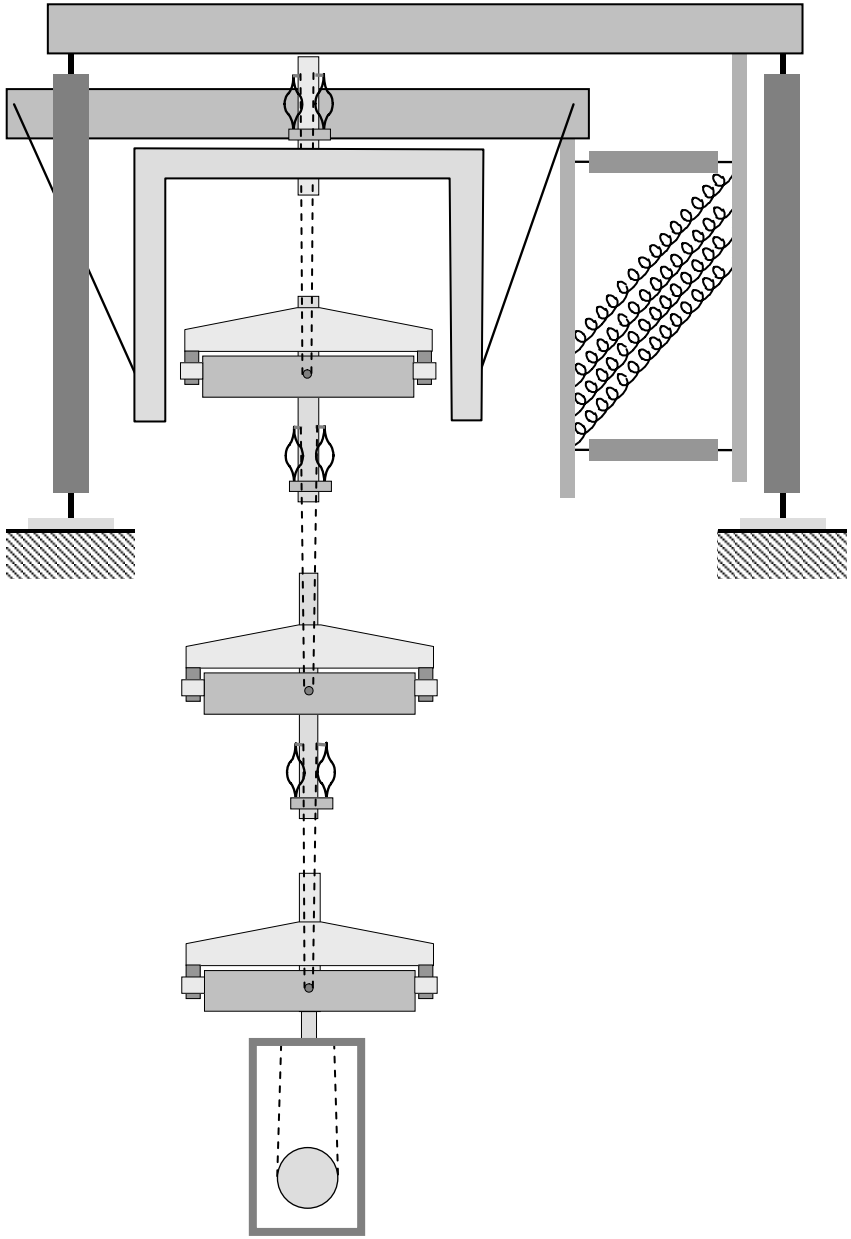
Vibration Isolation Techniques

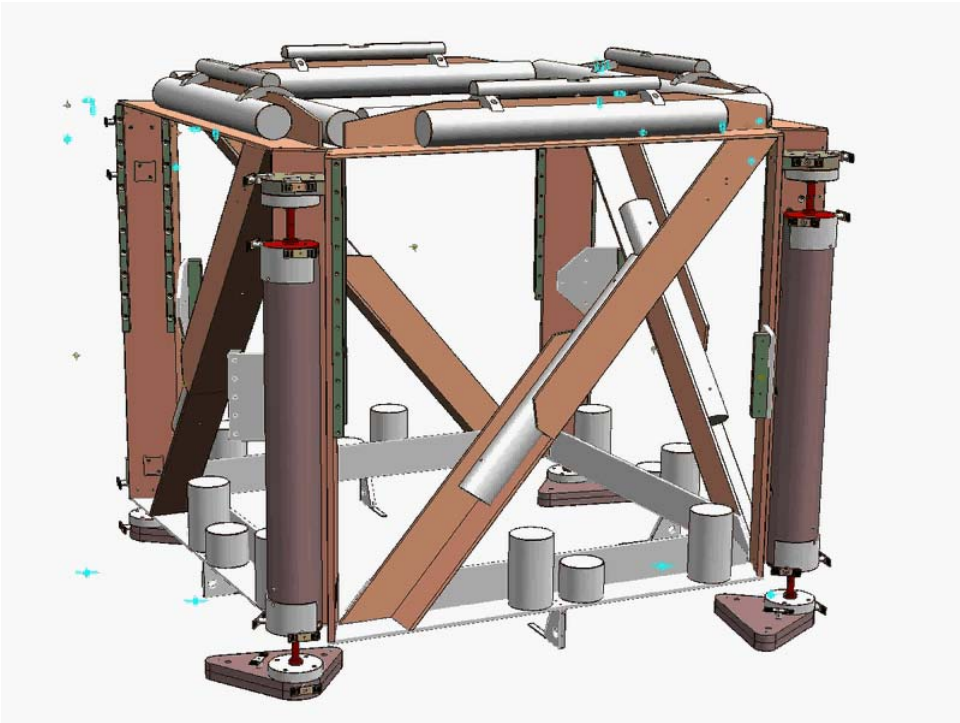
- The AIGO vibration isolator combines several techniques.
- Anti-Springs in most stages reduce mode frequencies.
- The Pre-isolator combines two horizontal stages, an inverse pendulum and a Roberts Linkage, and one vertical LaCoste stage, all with resonant frequencies below 0.1Hz.
  - ① The inverse pendulum.
  - ② The LaCoste linkage provides vertical pre-isolation.
  - ③ The Roberts linkage.
- The isolation consists of three similar stages.
  - ④ A 40kg pendulums 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.



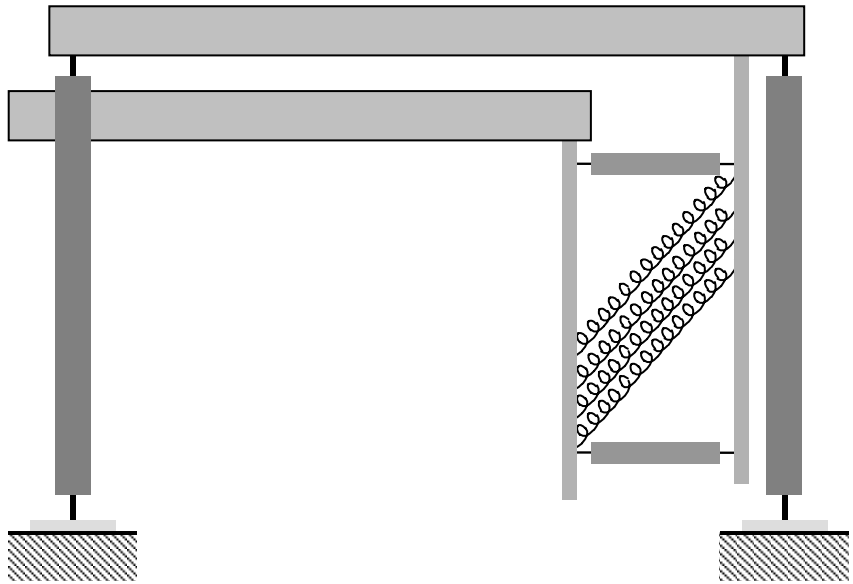


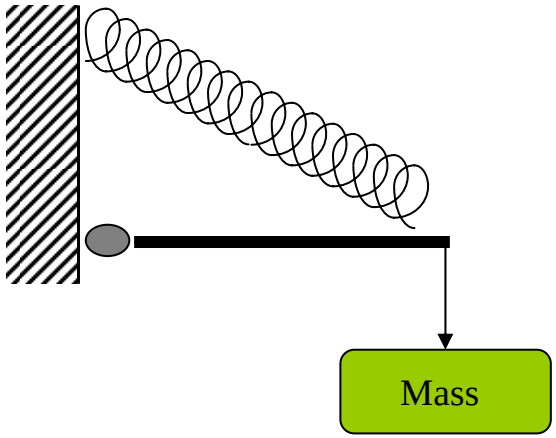
Inverse Pendulum

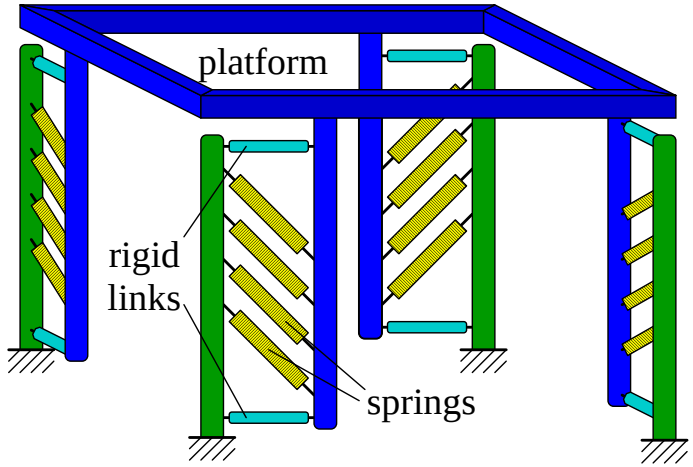


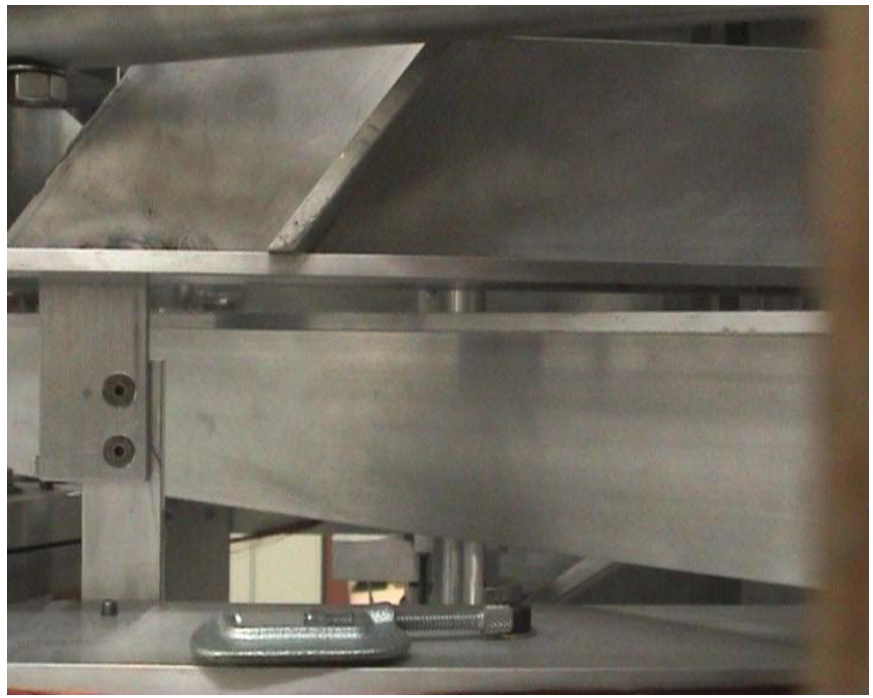


Lacoste Linkage




Mass

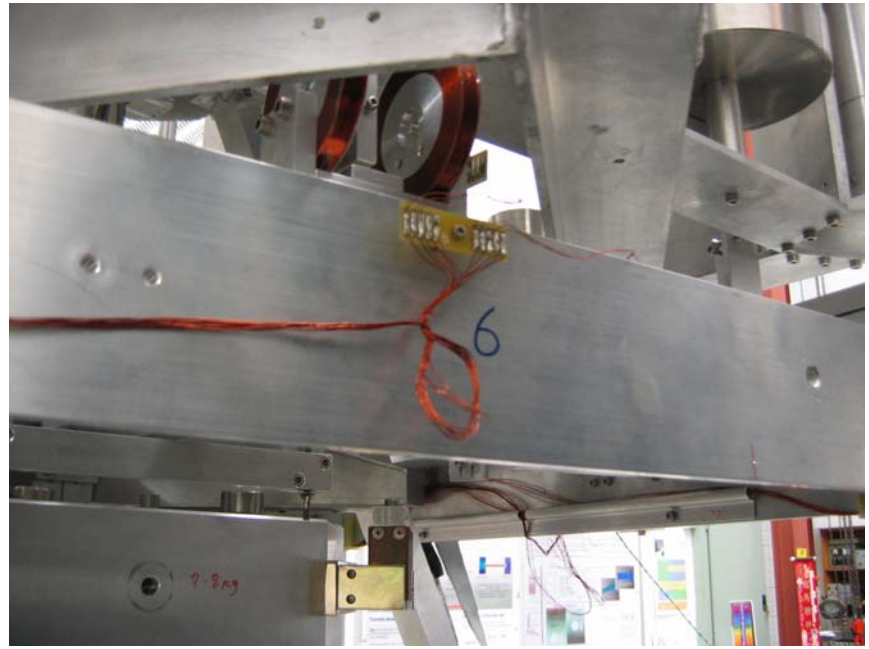

platform
rigid
links
springs

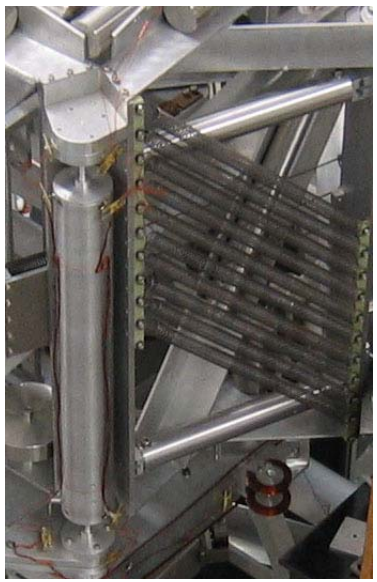


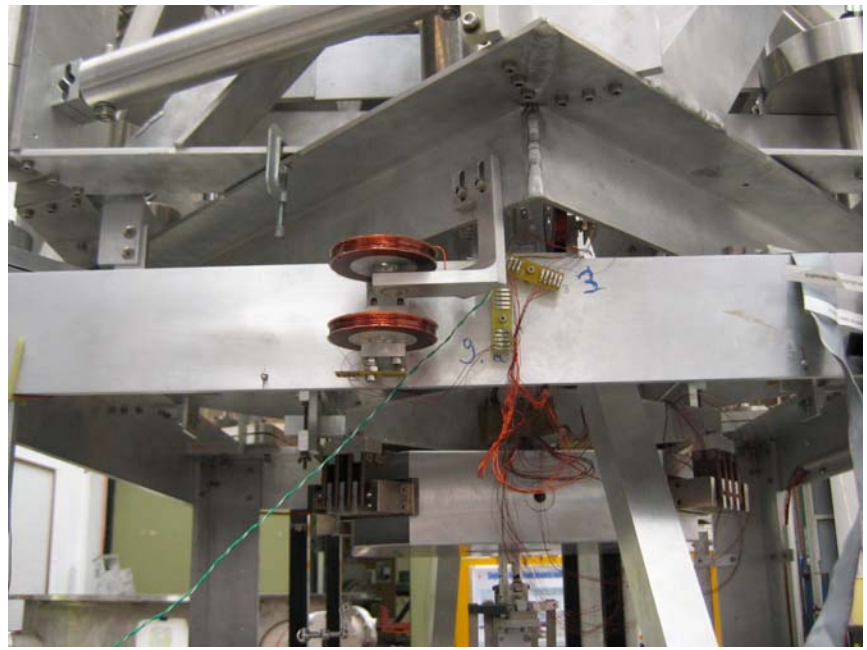
Pre-isolation local control

- Horizontal (inverse pendulum) position control with magnetic actuators

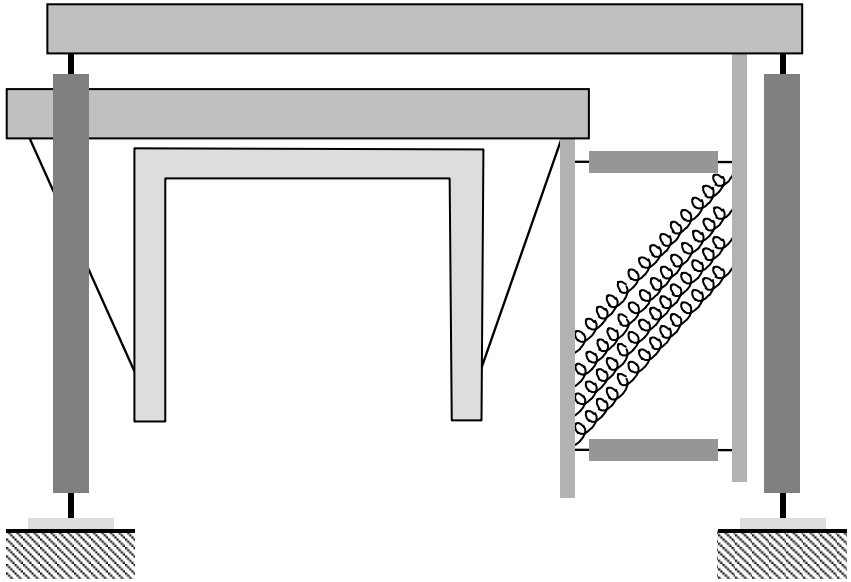
- Vertical (LaCoste linkage) position control
  - with magnetic actuators
  - heating of springs

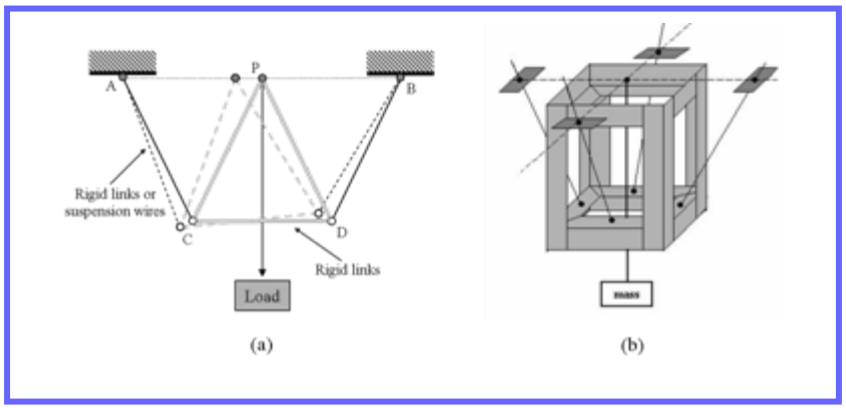


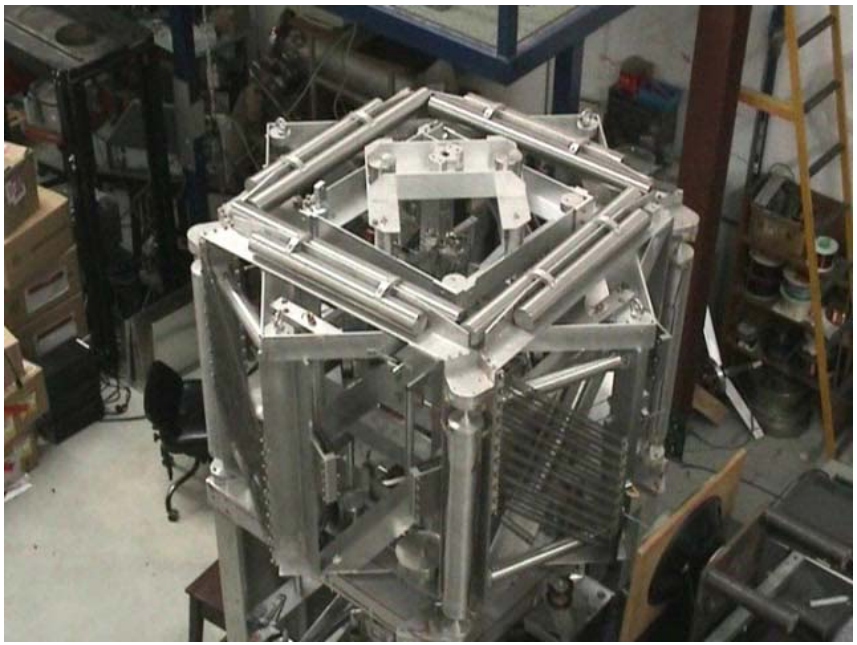


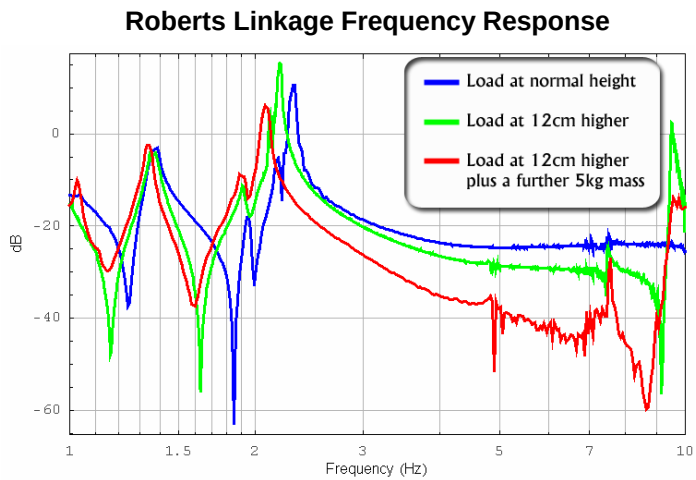


Roberts linkage

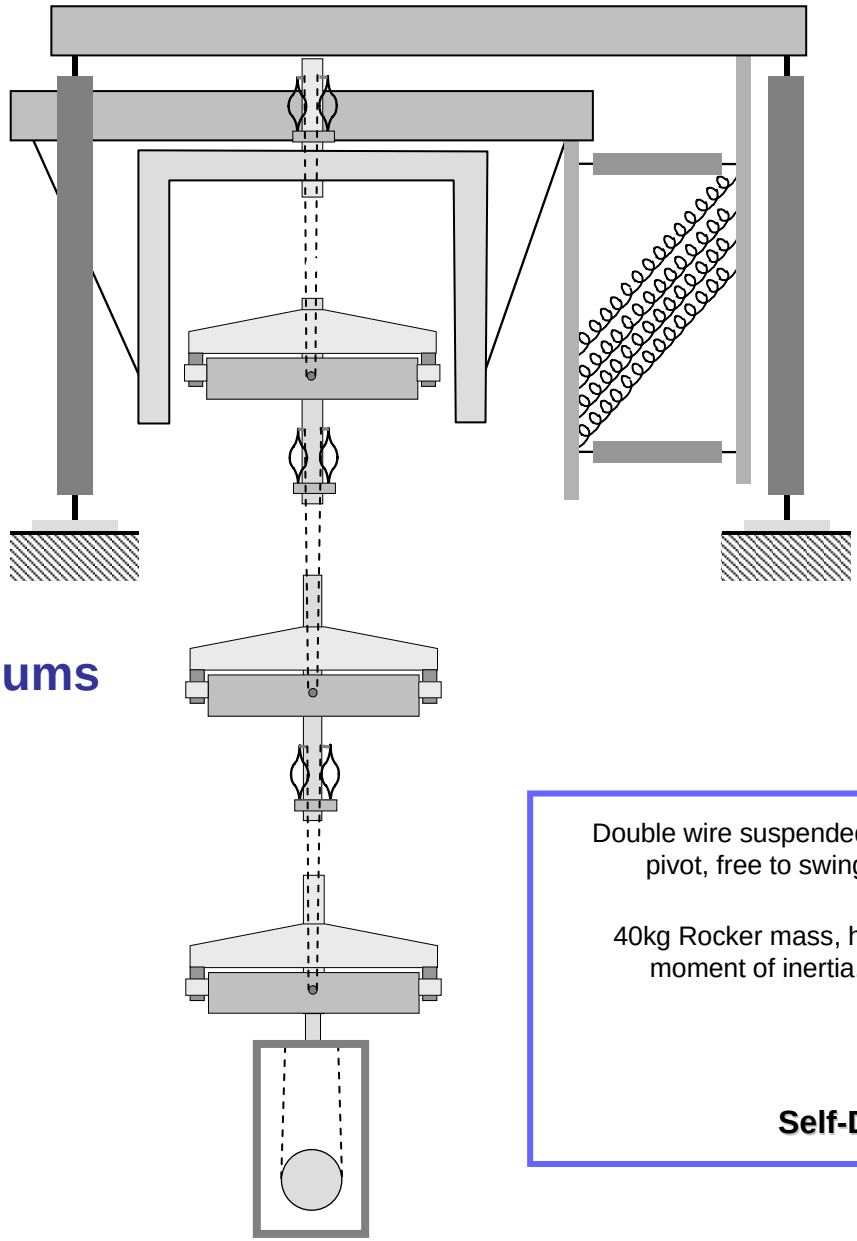


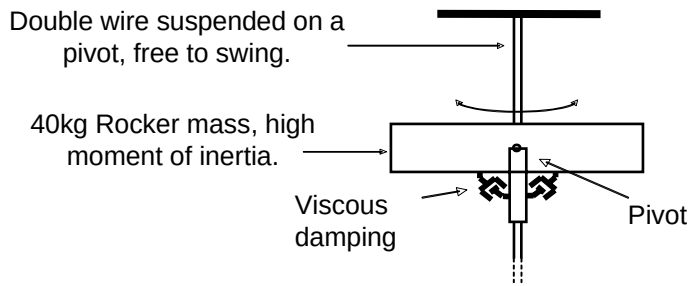





Roberts Linkage Frequency Response
Load at normal height
Load at 12cm higher
Load at 12cm higher plus a further 5kg mass
0
-20
-40
-60
dB
1
1.5
2
3
5
7
10
Frequency (Hz)

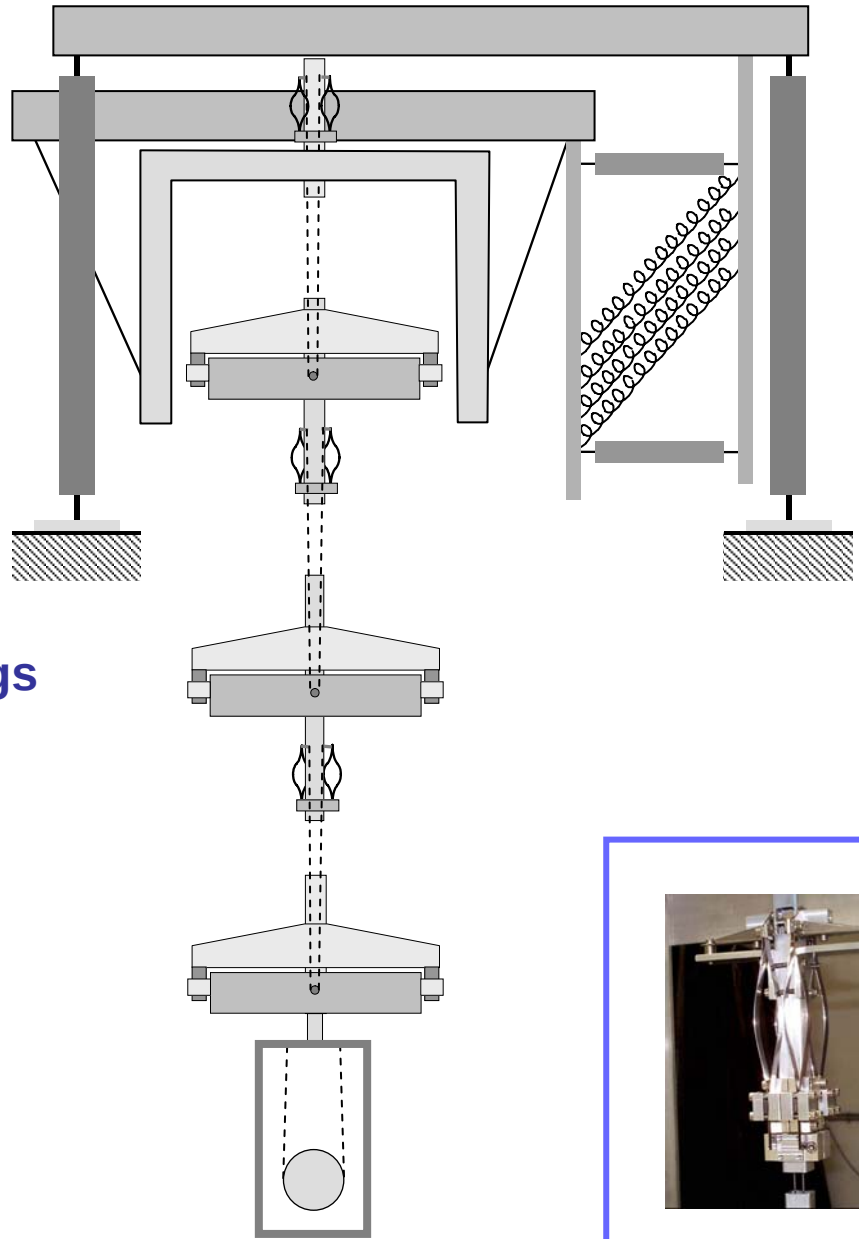
Self-Damped pendulums (3 Stages)

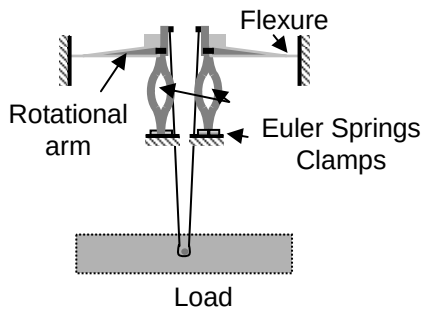


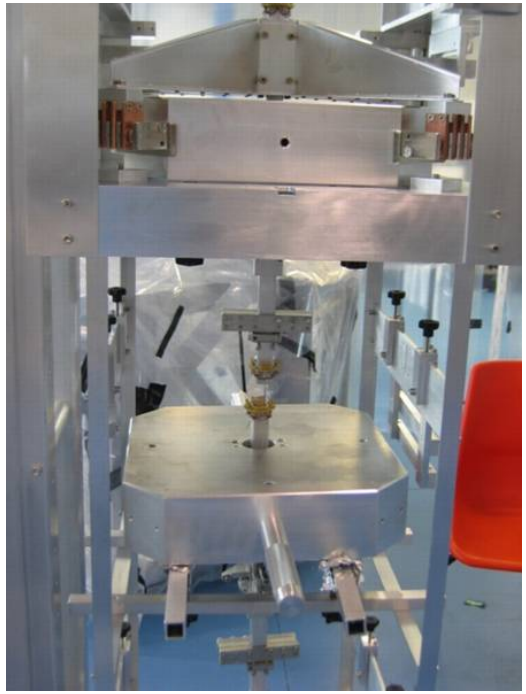


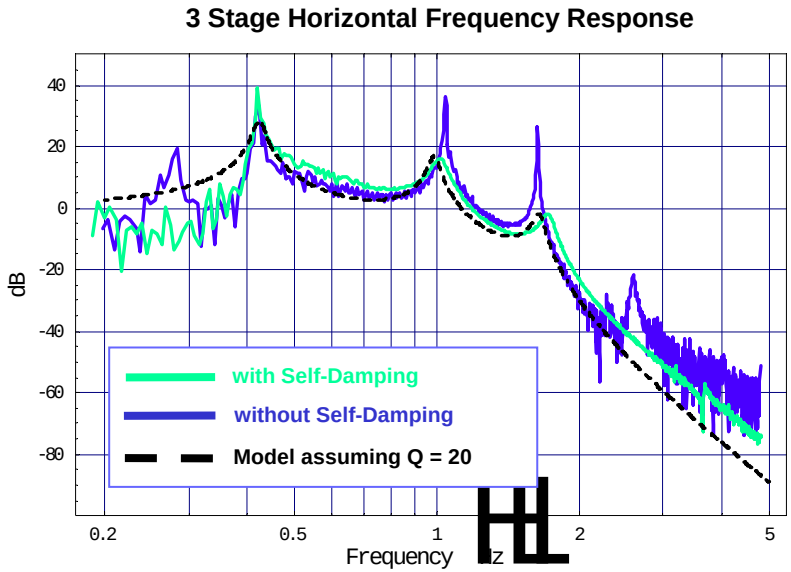
Self-Damping Schematic

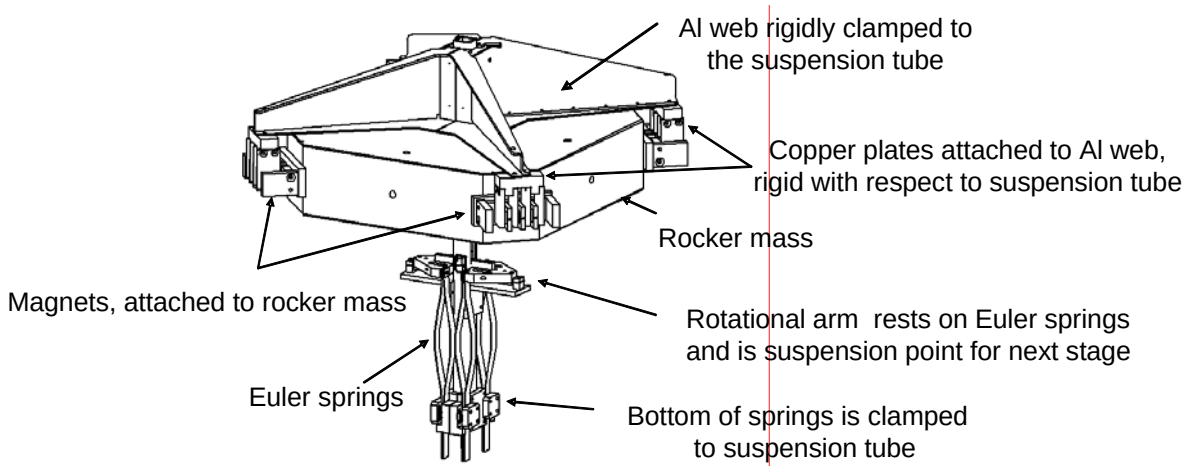
Vertical Euler Springs (3 Stages)











Integrated 3D isolator stage

Progress at AIGO

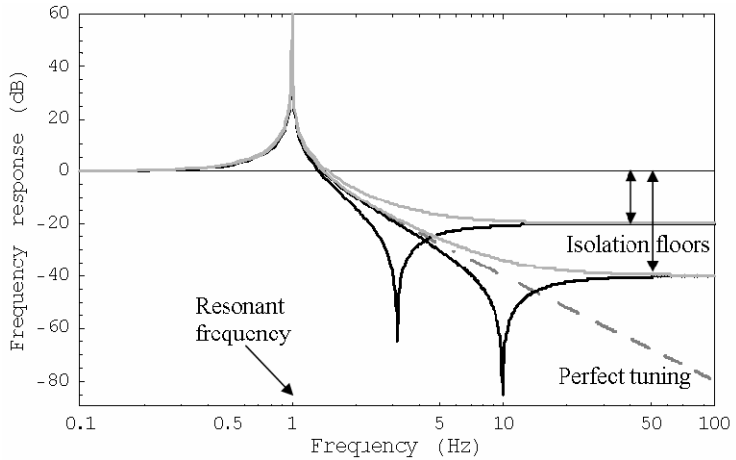
- Assembly of two complete vibration isolators in progress at the AIGO test facility.
- Optical cavity differential motion testing in AIGO east arm planned late 2005.

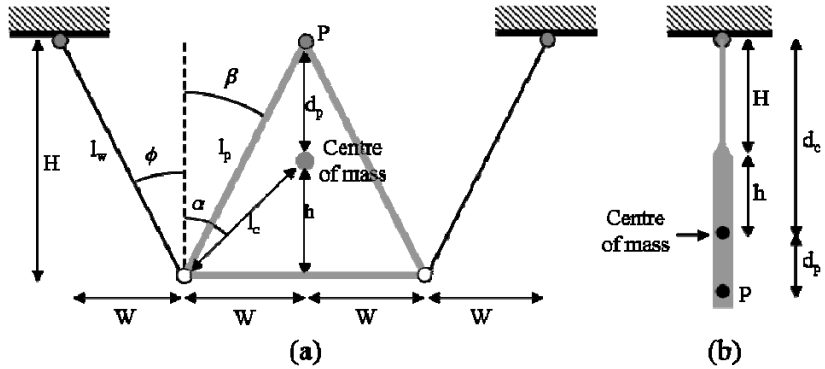
Please visit the lab if you haven't already done so!

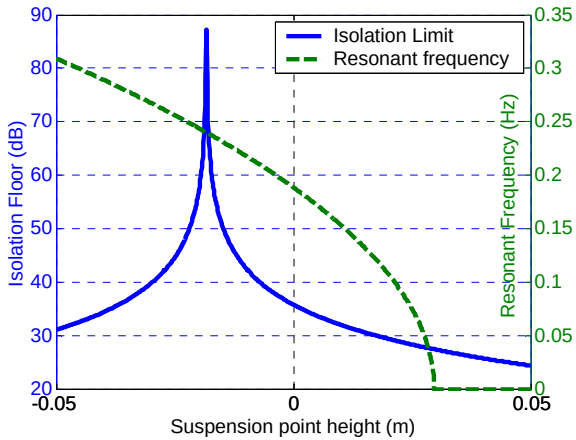
The end

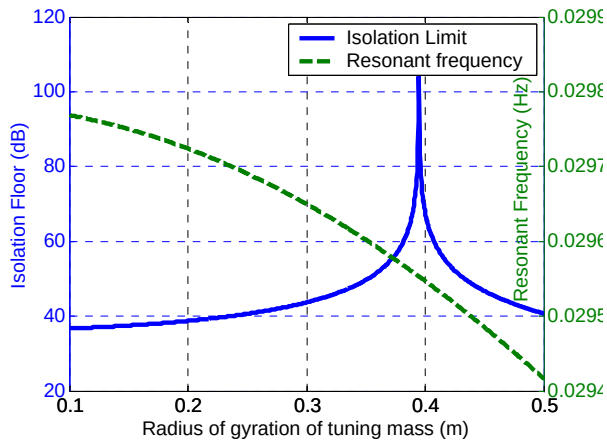
Deleted Scenes

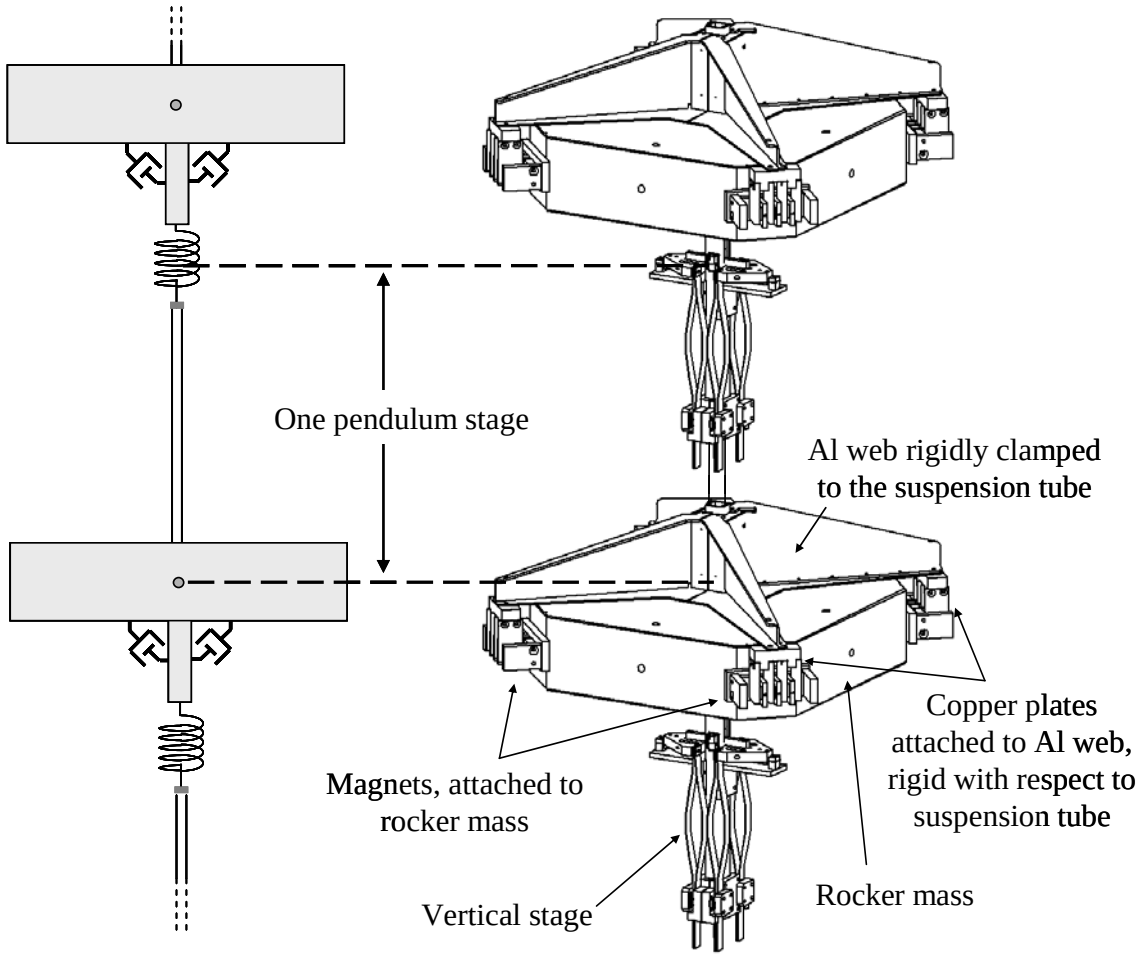
Roberts linkage

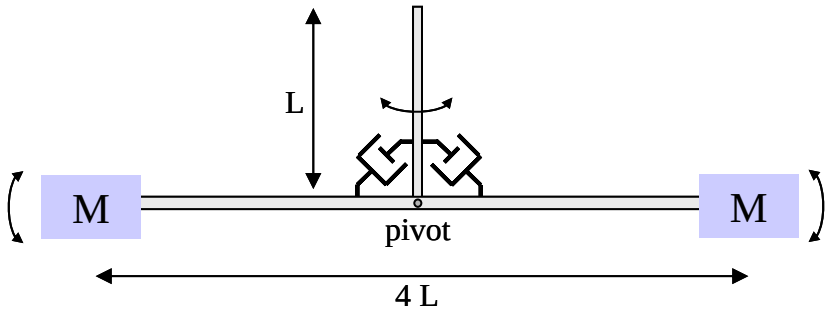


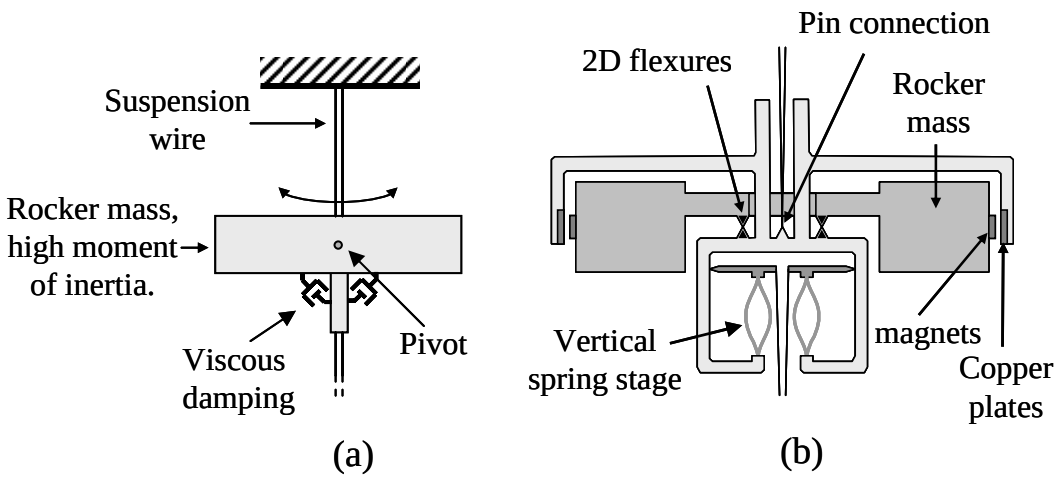







One pendulum stage
Al web rigidly clamped to the suspension tube
Copper plates attached to Al web, rigid with respect to suspension tube
Magnets, attached to rocker mass
Vertical stage
Rocker mass


L
M
M
pivot
4 L


Suspension wire
Rocker mass, high moment of inertia.
Viscous damping
Pivot
(a)
Pin connection
2D flexures
Rocker mass
Vertical spring stage
magnets
Copper plates
(b)