

Current Work on Seismic Isolation at Stanford University

JILA, LSU, MIT, Stanford

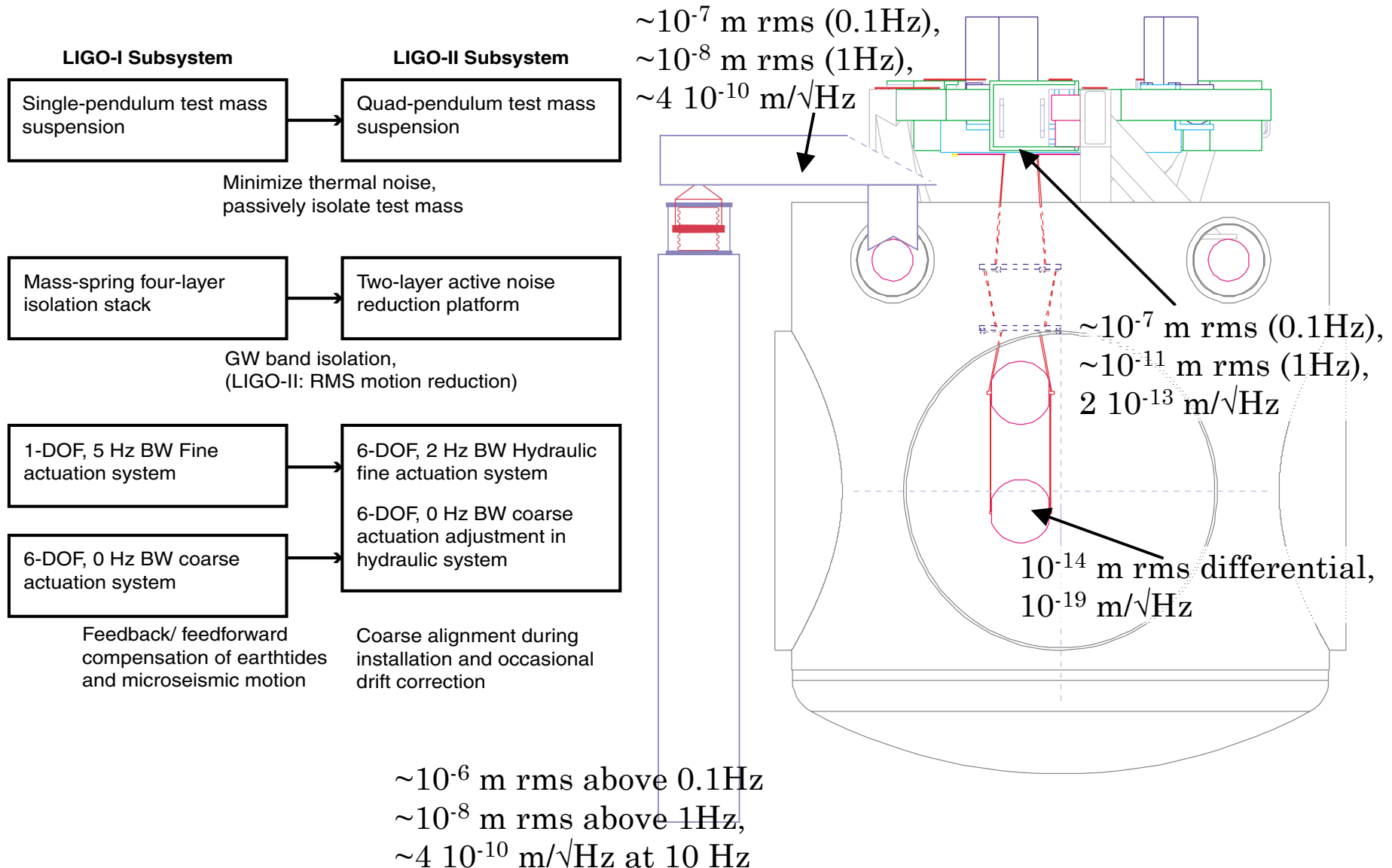
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Rich Mittleman, Jamie Nichol, Jamie Rollins, David
Shoemaker, Gerry Stapfer, Tuck Stebbins



LIGO-G010121-00-Z



Functional Description of the System

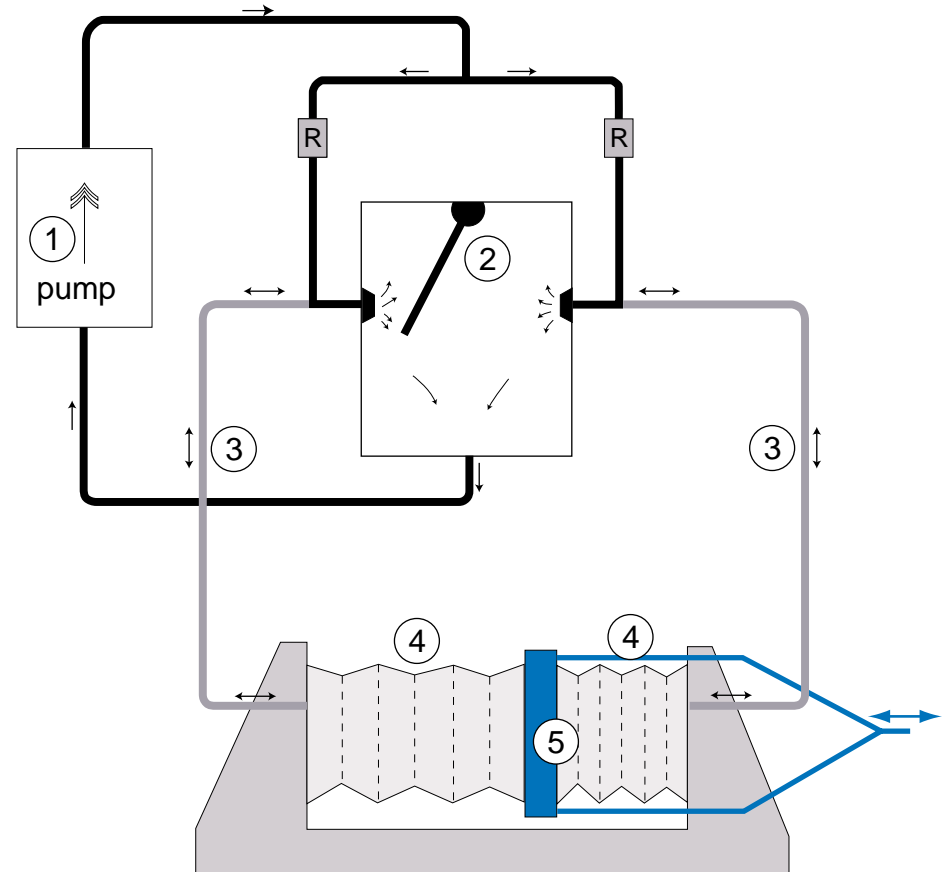


Stanford is Addressing Four Parts of Isolation and Alignment System

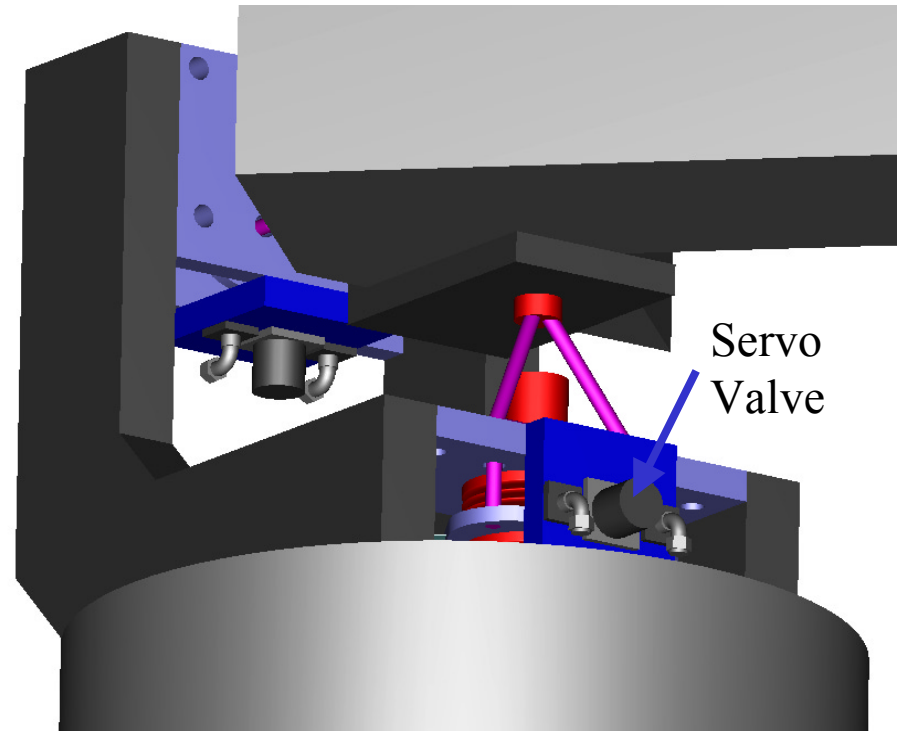
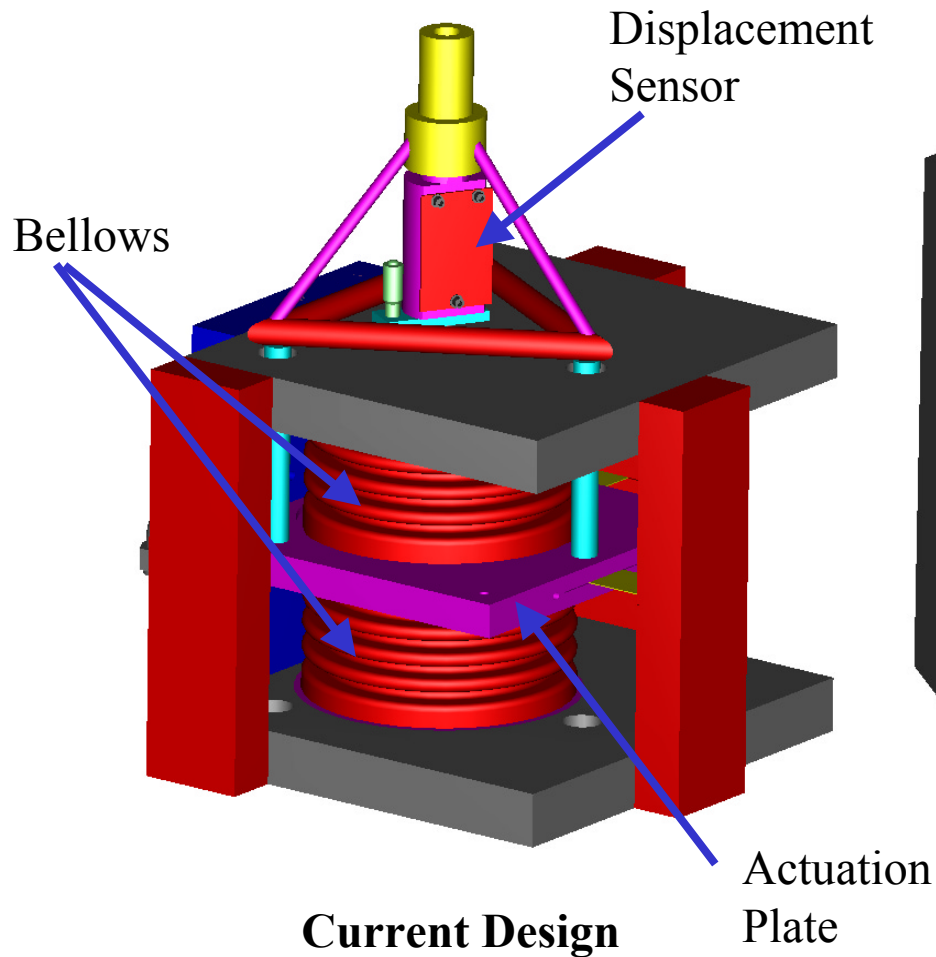
- External Hydraulics
- Design questions for active platforms
- Modeling of active platforms - Hua
- Design of Advanced LIGO isolation and alignment system

Differential Bellows for Quiet Actuator

- 1) Pump
- 2) Differential Flapper Valve
- 3) Bellows Supply
- 4) Differential Bellows
- 5) Actuation Plate

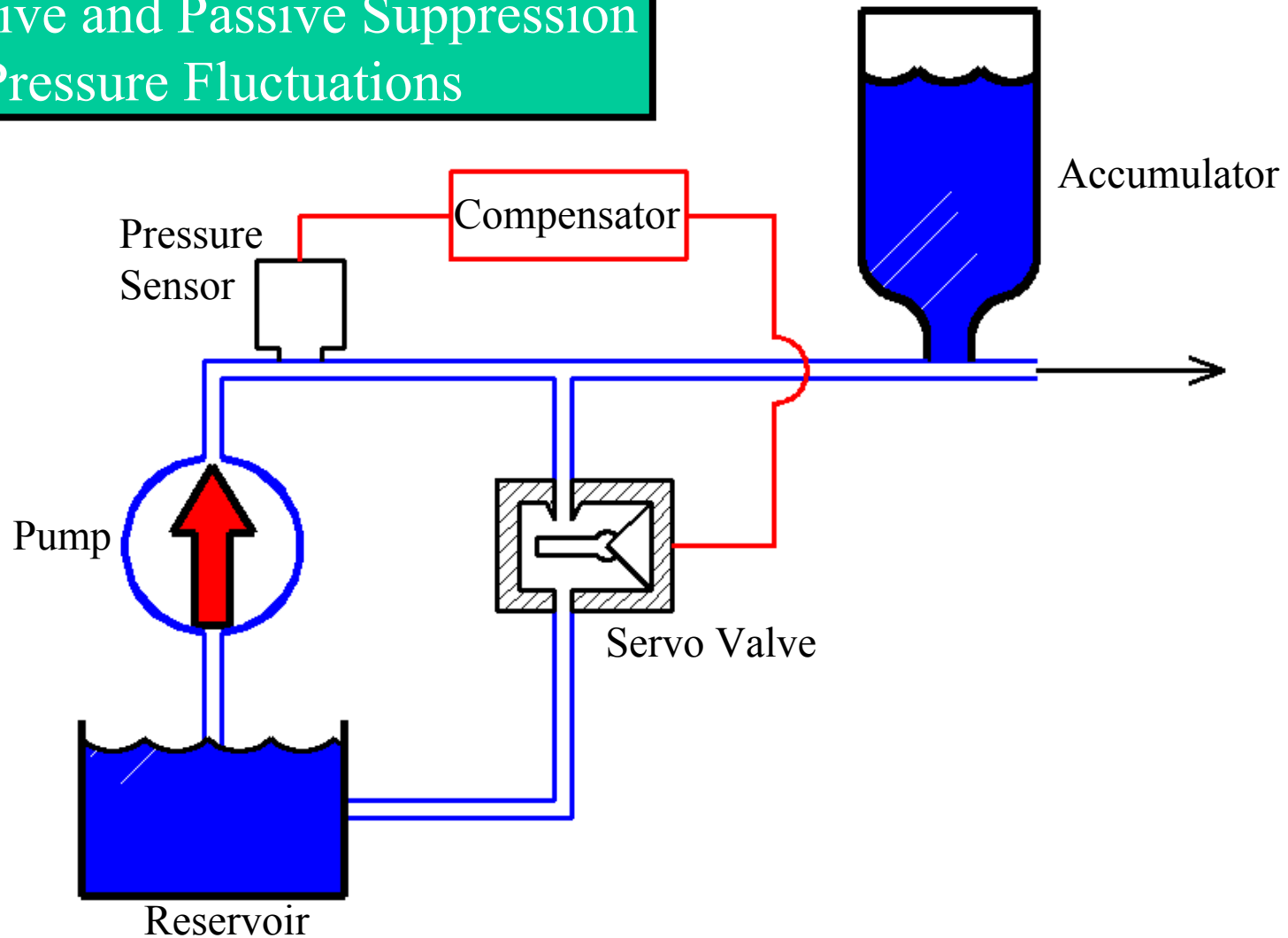


The Quiet Hydraulic Actuator

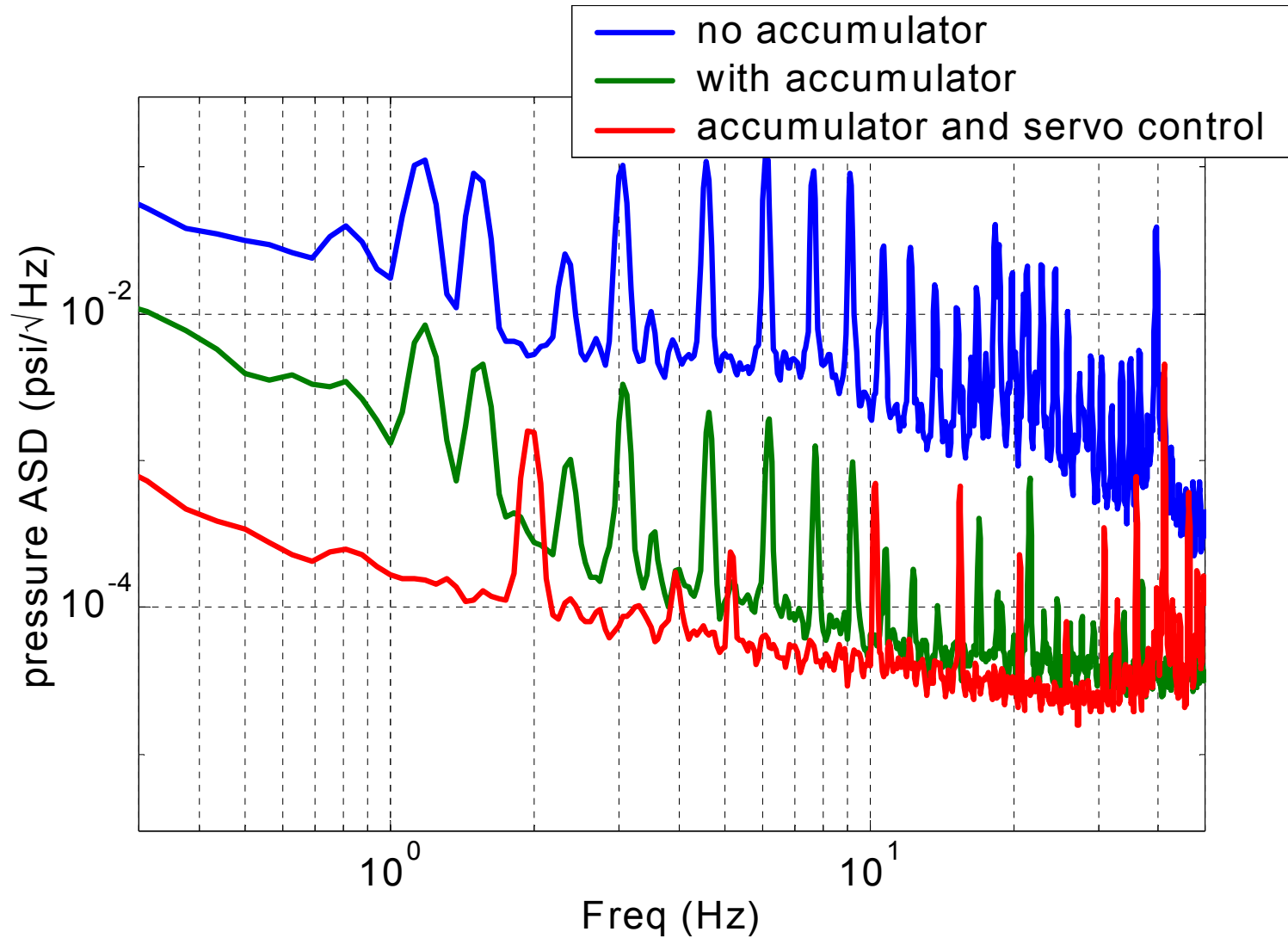


Conditioning a Pressure Source

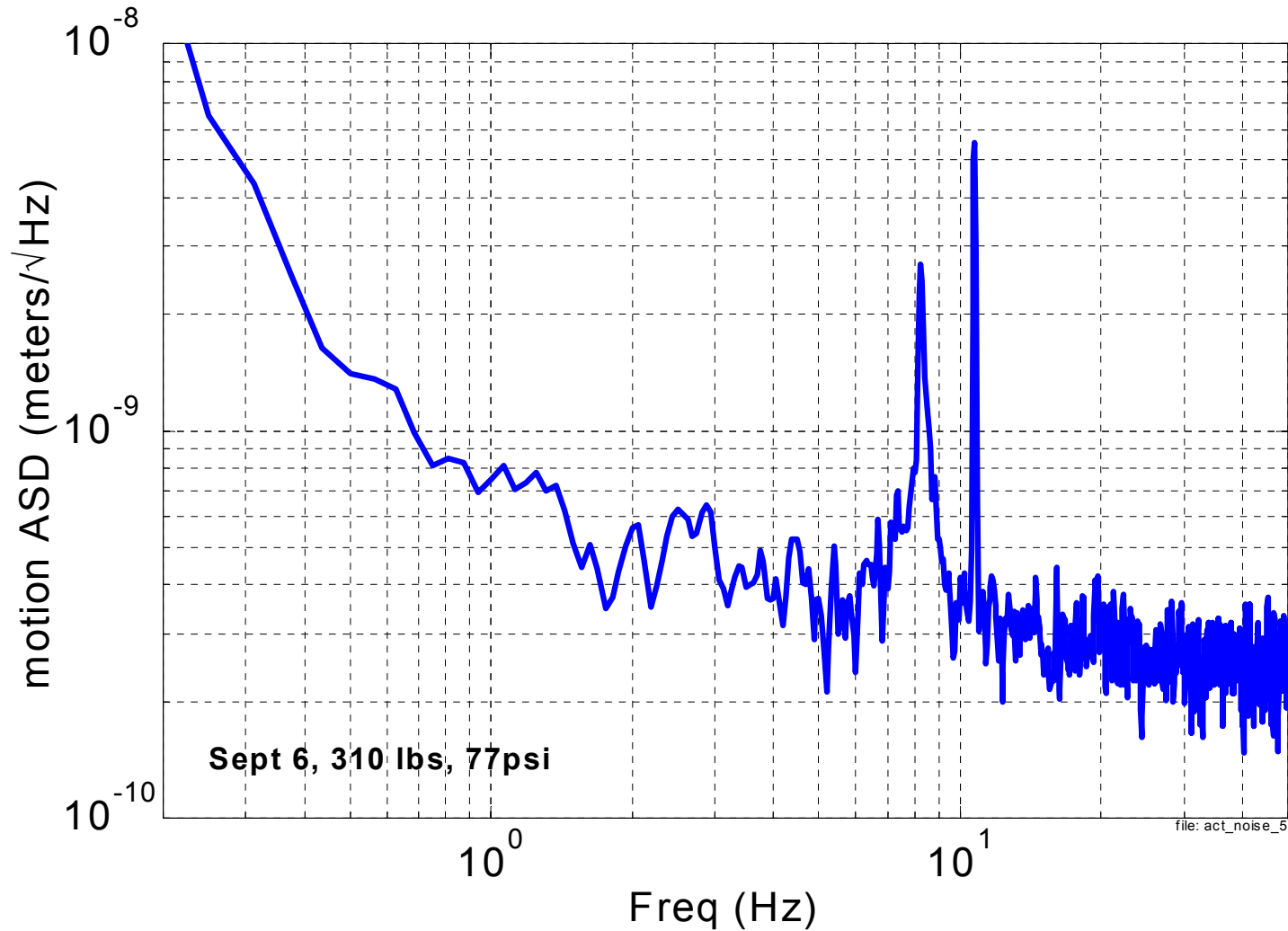
Active and Passive Suppression of Pressure Fluctuations



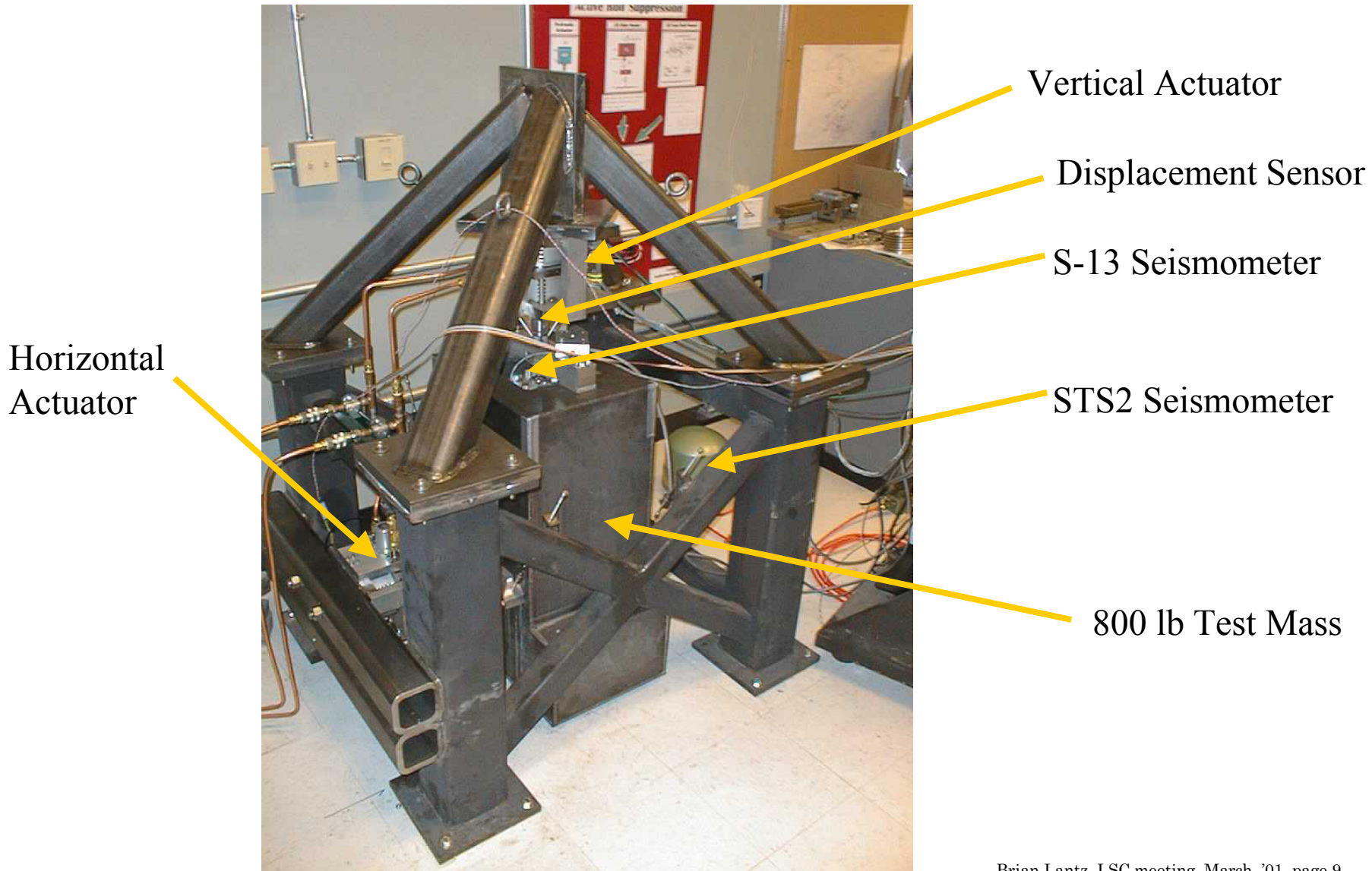
Pressure Noise at the Actuator



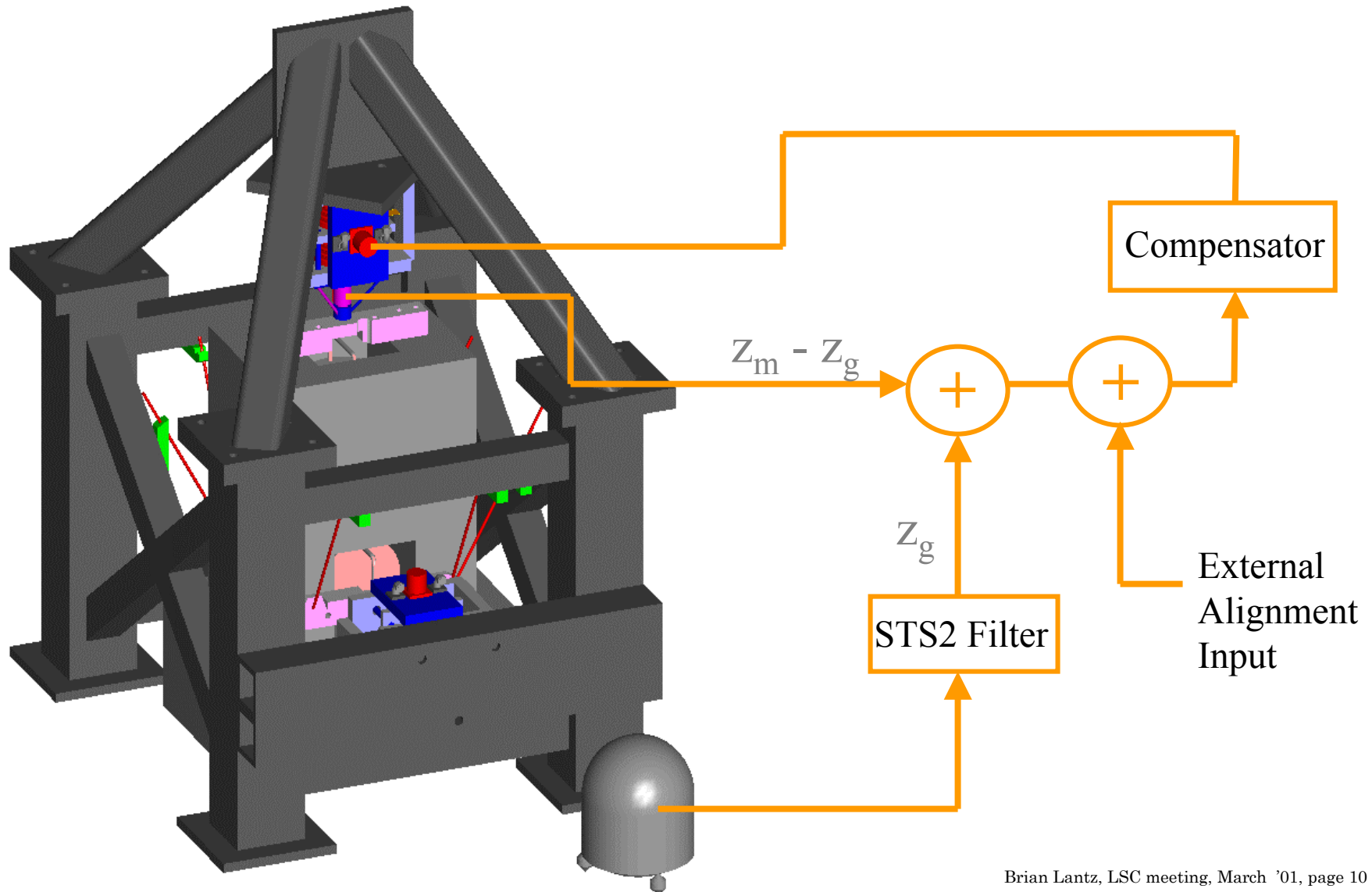
Motion of the Actuator



The Test Platform at Stanford

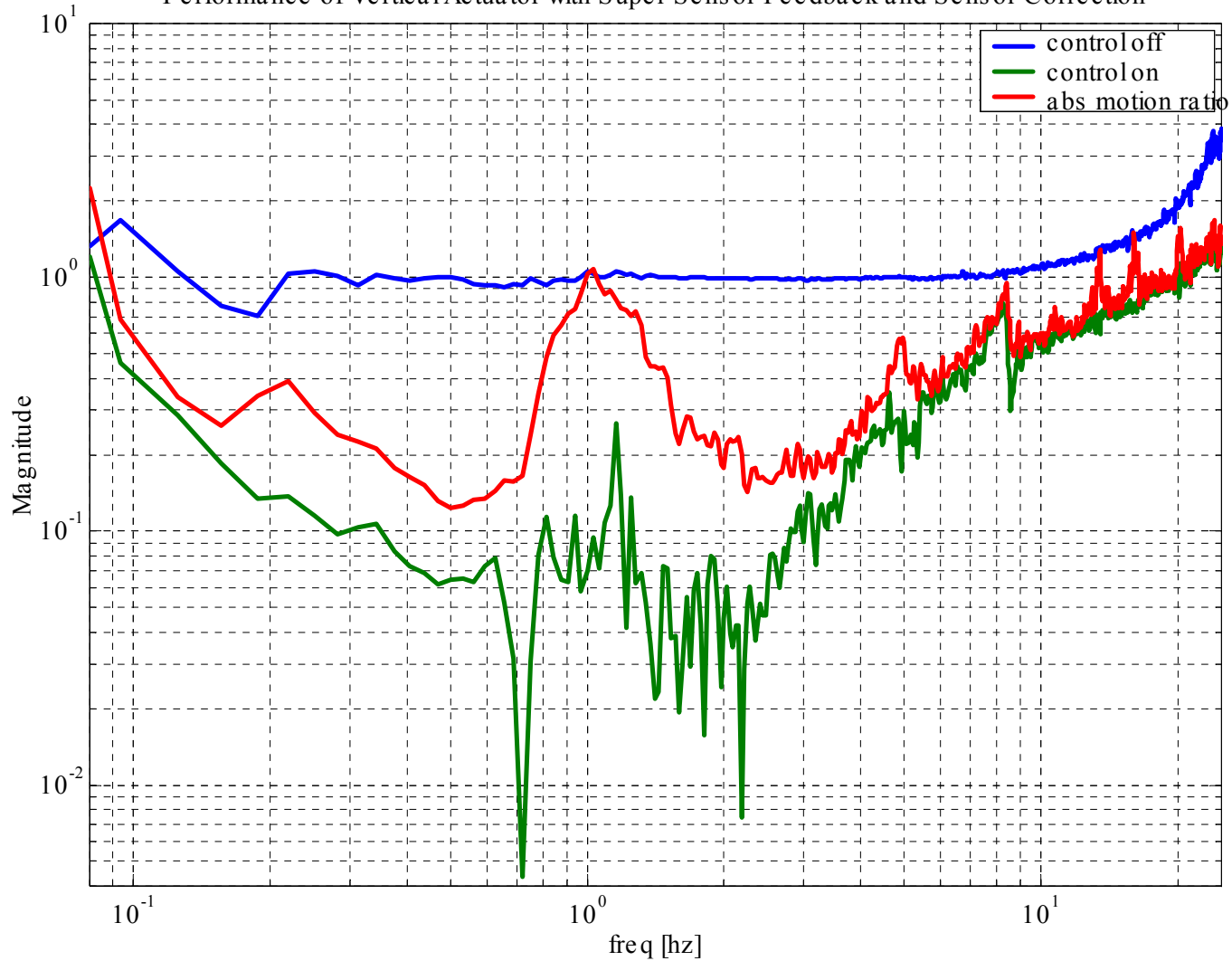


Sensor Correction



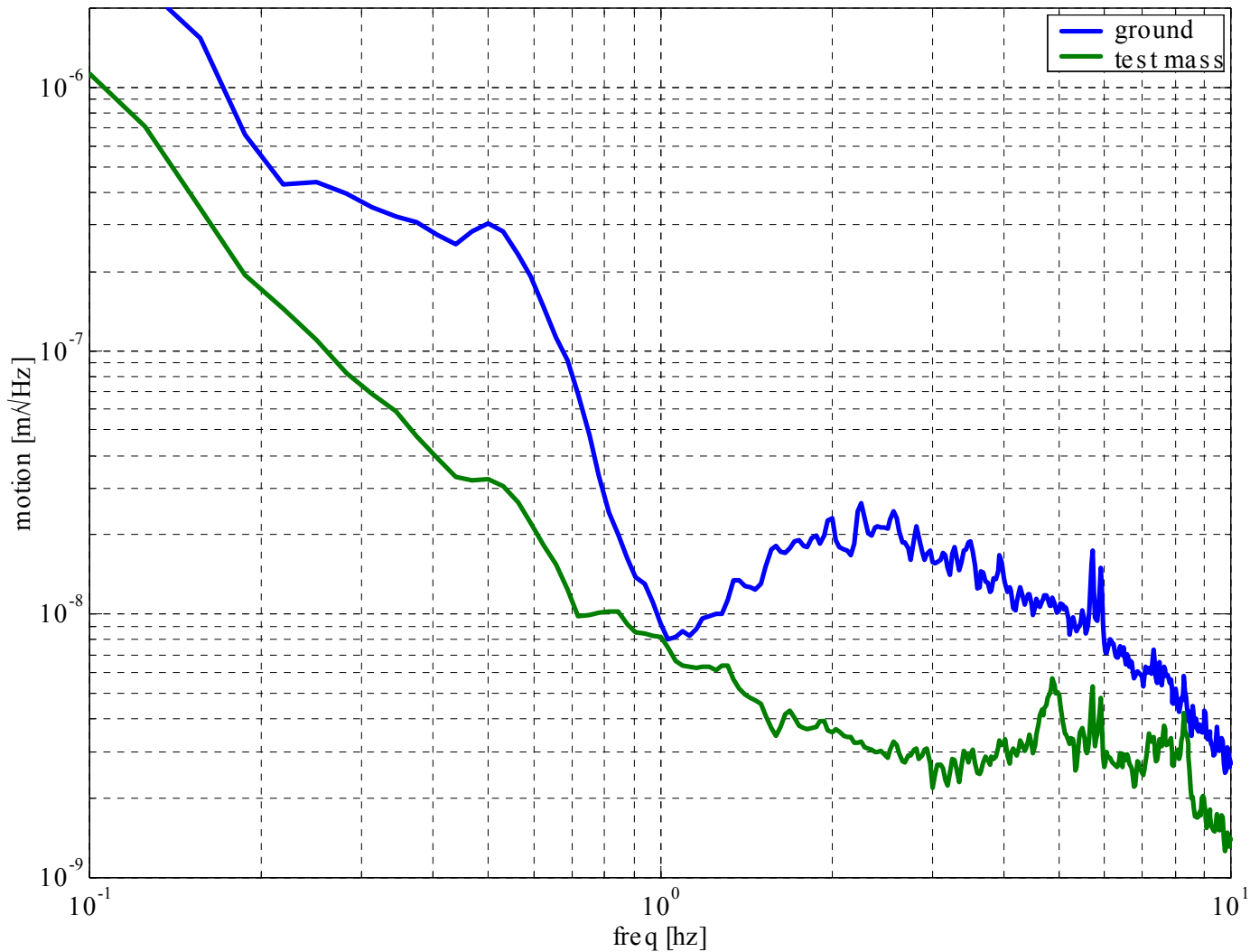
Vertical Isolation

Performance of Vertical Actuator with Super Sensor Feedback and Sensor Correction



Vertical Motion

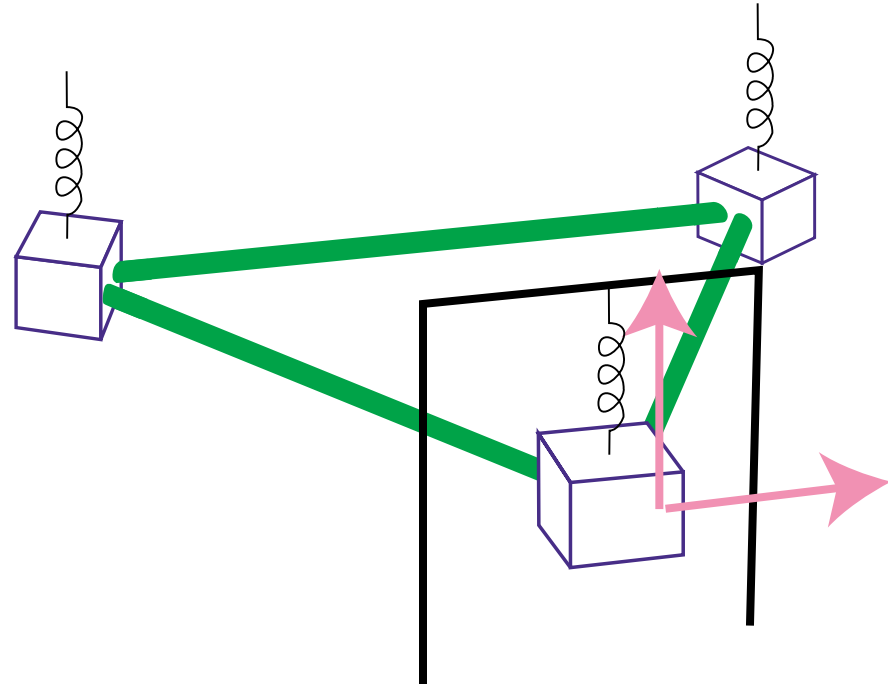
Normalized Absolute Motion of Mass and Ground



Geometry of our 6 DOF platforms

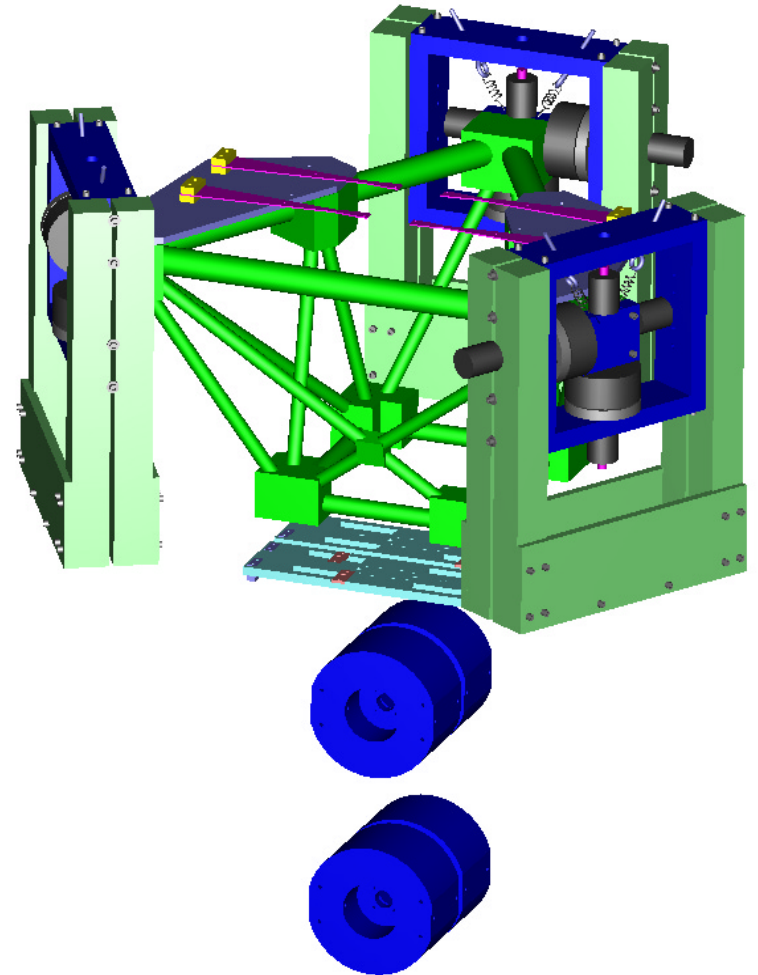
Consider,

- Triangular platform.
- Compliant attachment to support structure.
- Instrument each corner with 2 DOF controls for vertical and tangential directions.

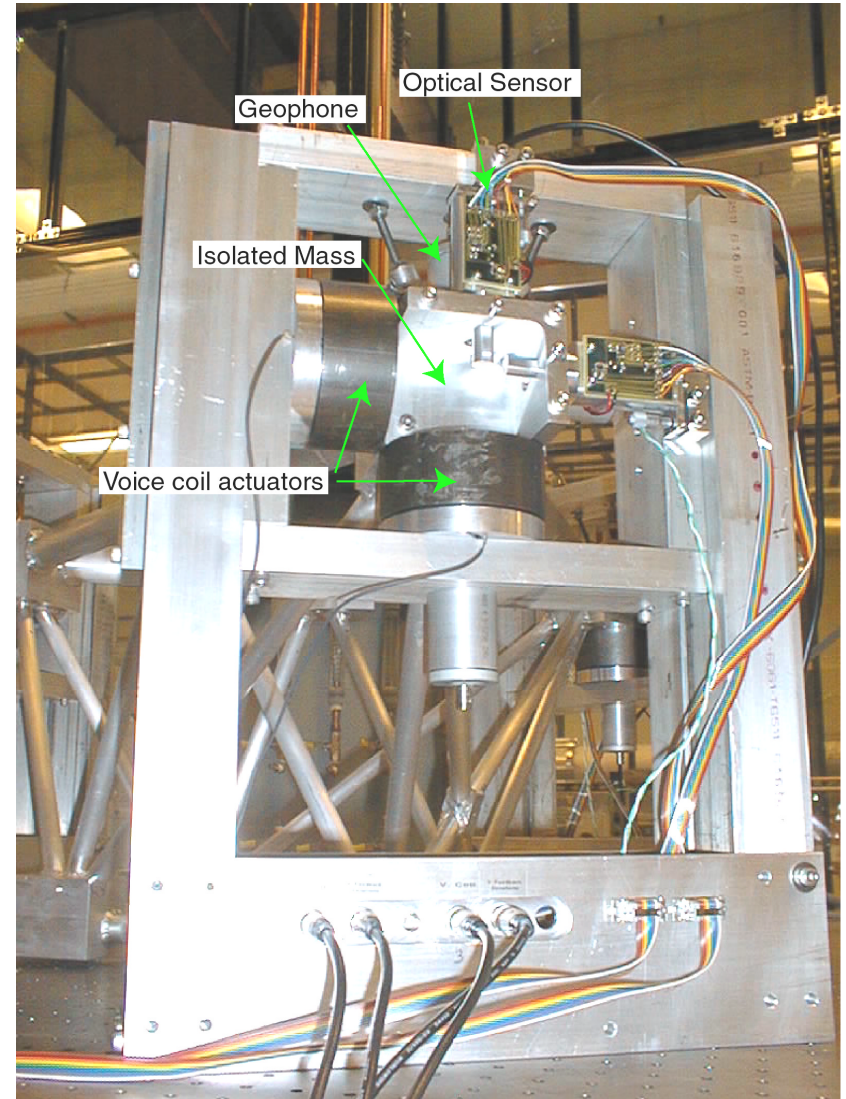
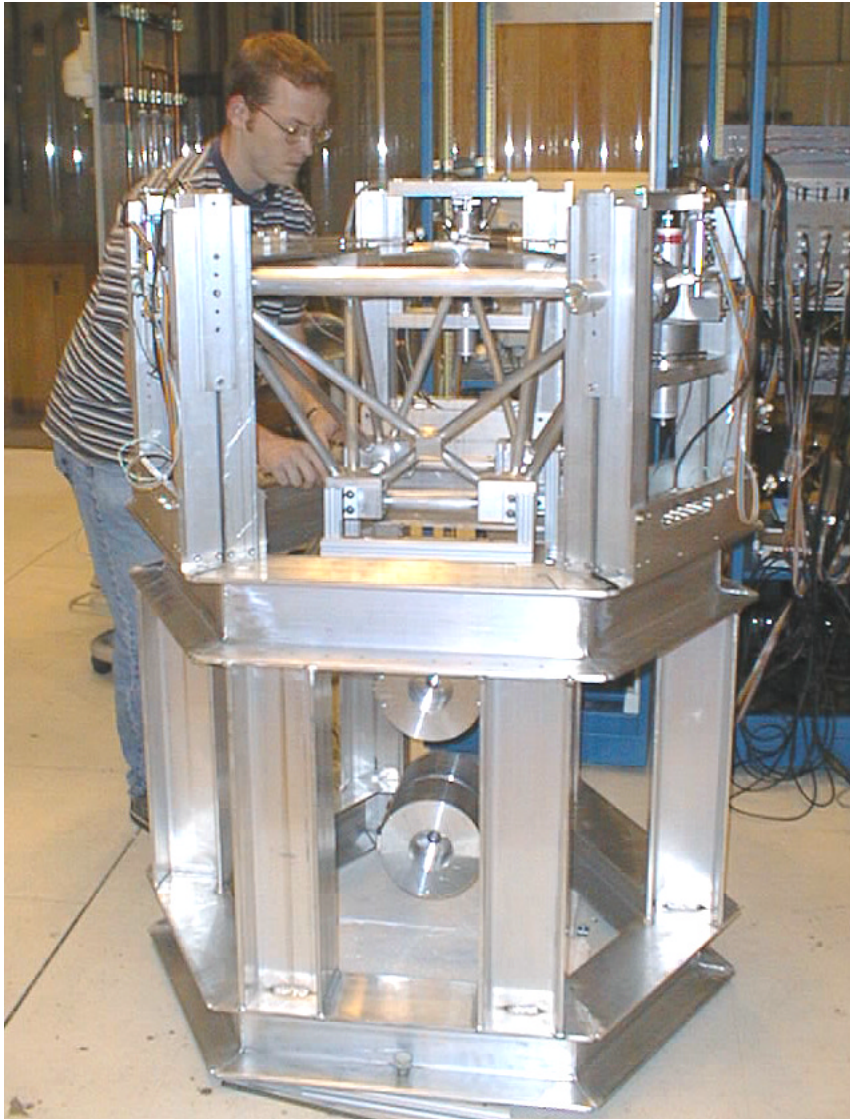


Single La with P

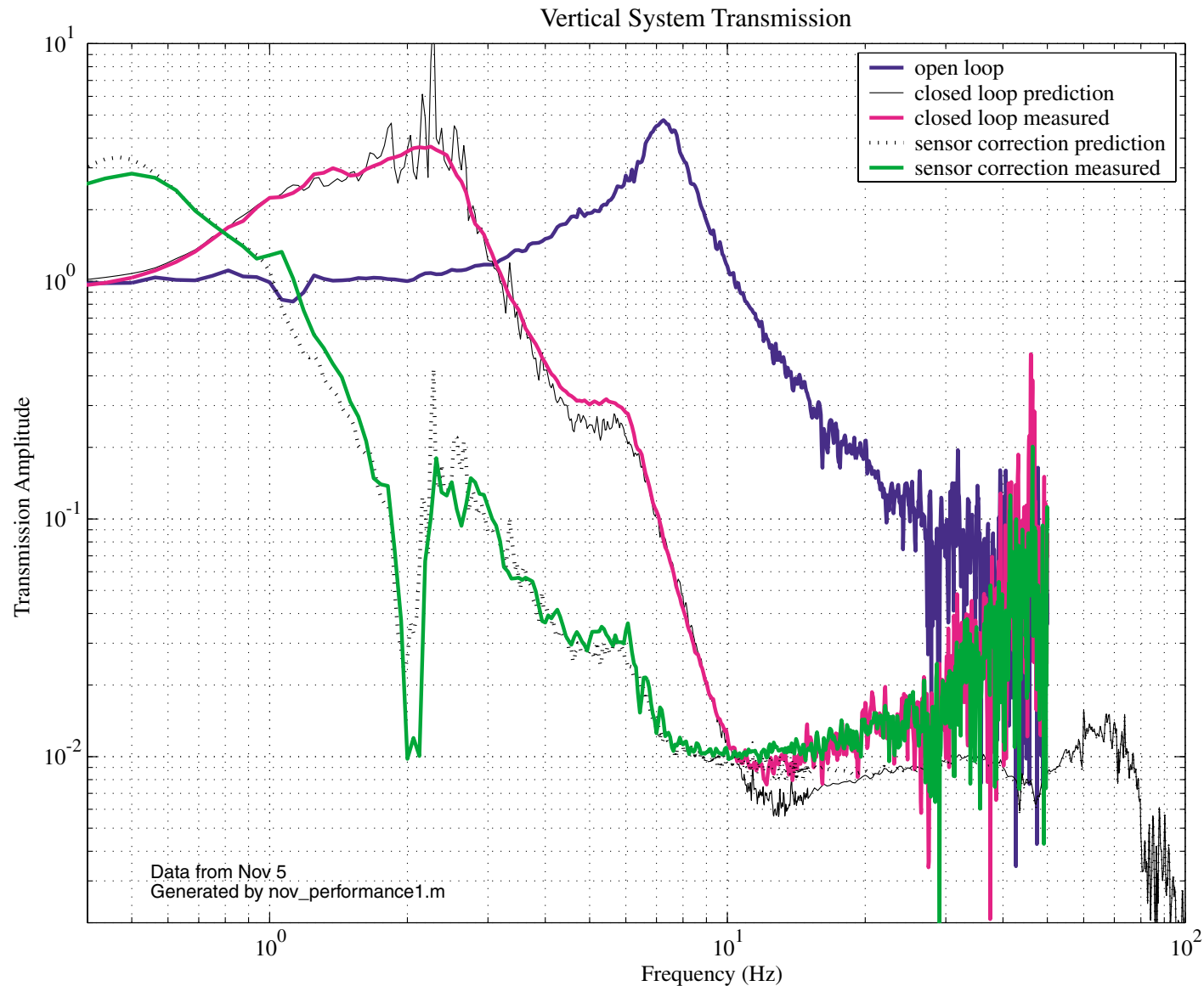
- Demonstrate 6 DOF active pl with collocated sensors and actuators.
- Demonstrate sensor blending
- Validate computer model use design LIGO system.
- Demonstrate sensor correctio reduce ground motion.
- Demonstrate reliable operatio stiff platform and pendulum v together.



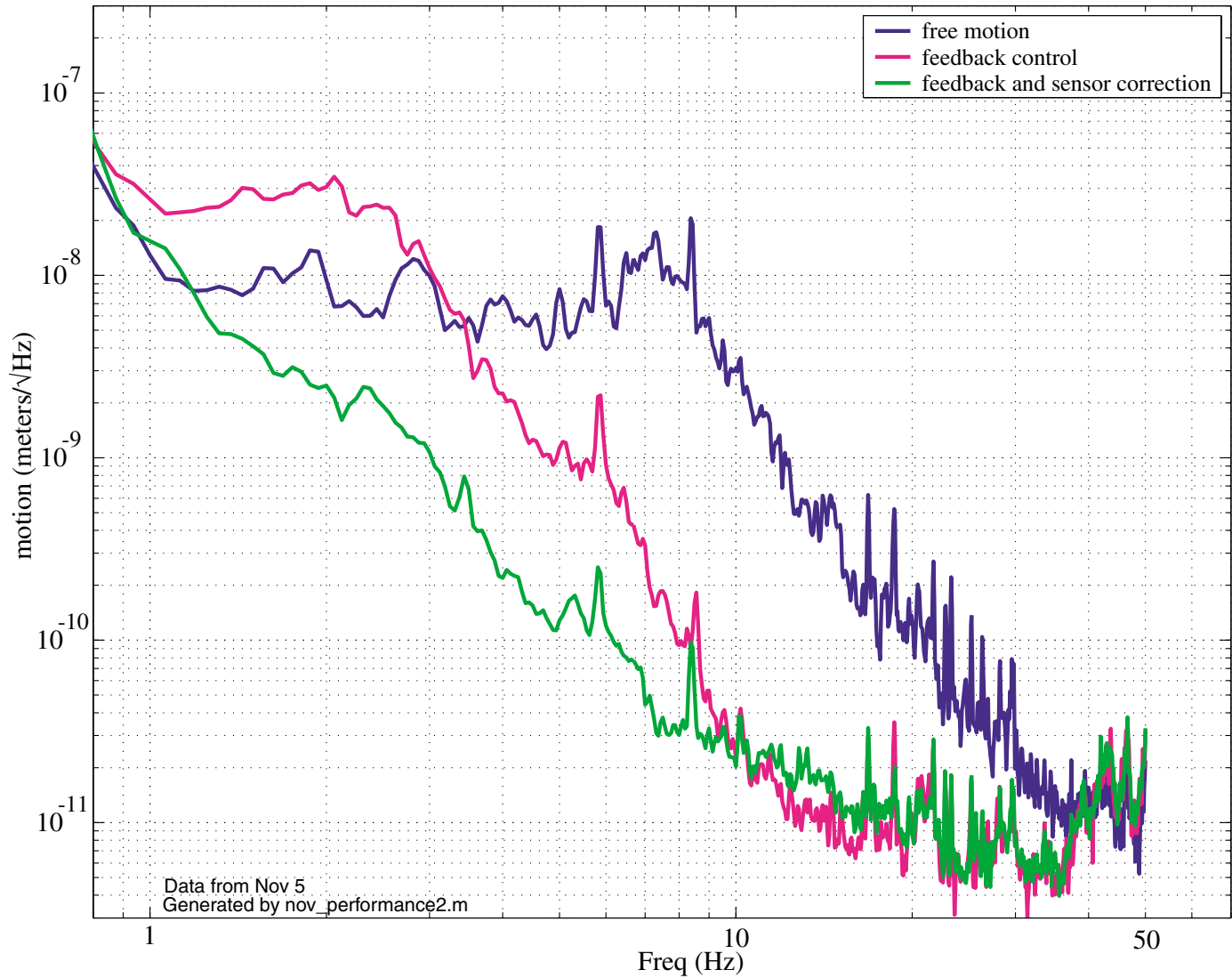
The Single Layer Platform



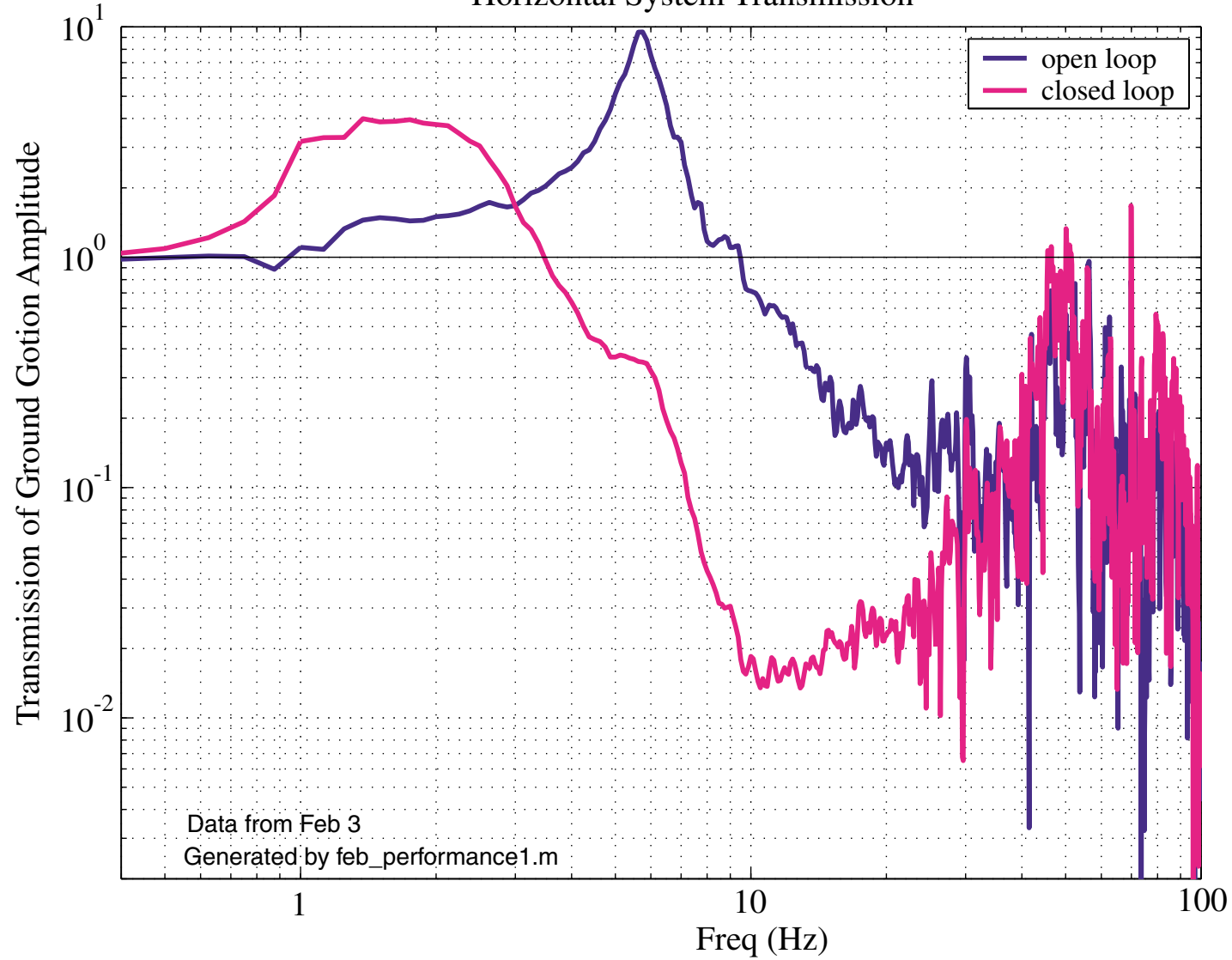
Results from Single Layer Platform



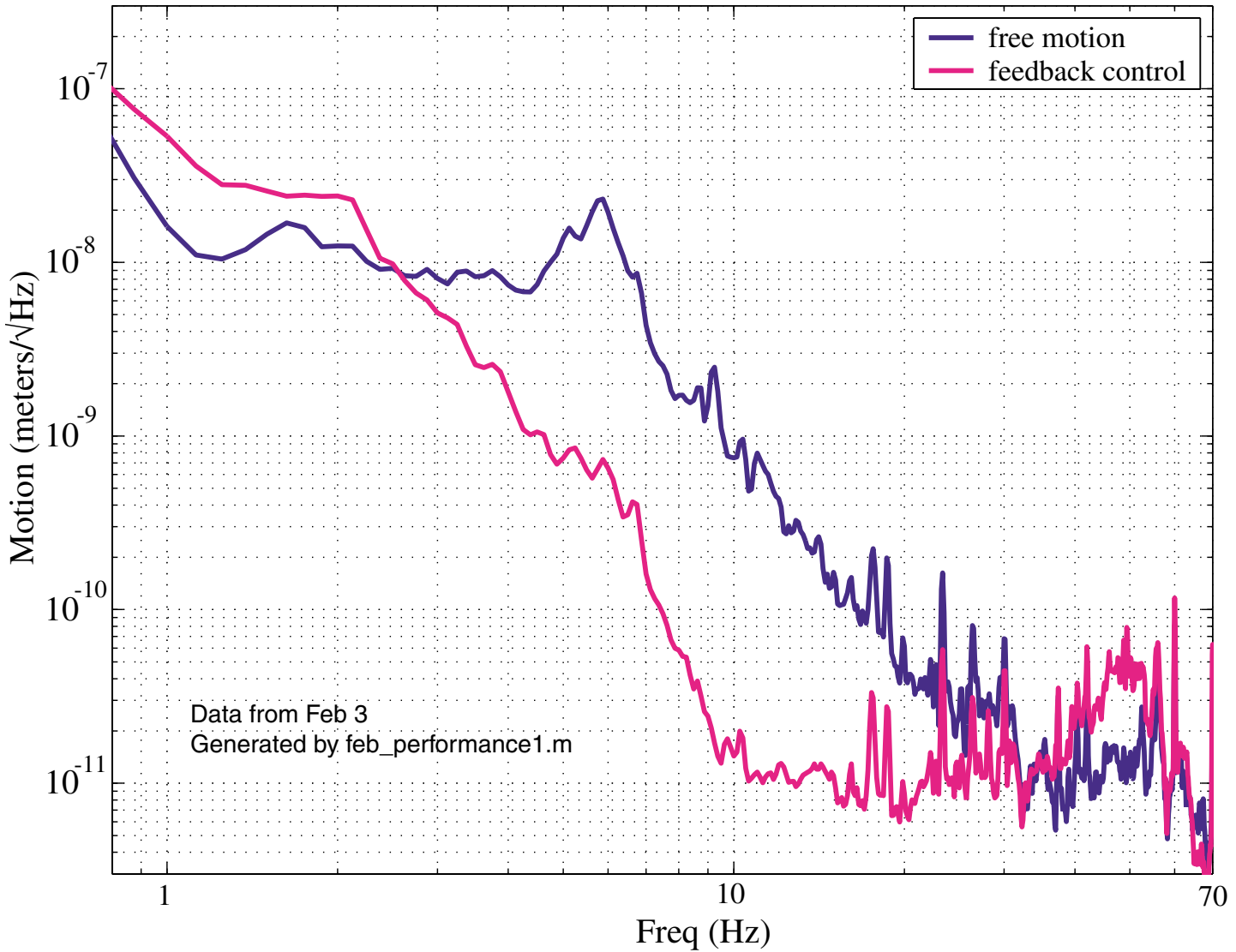
Controlled Vertical Platform Motion



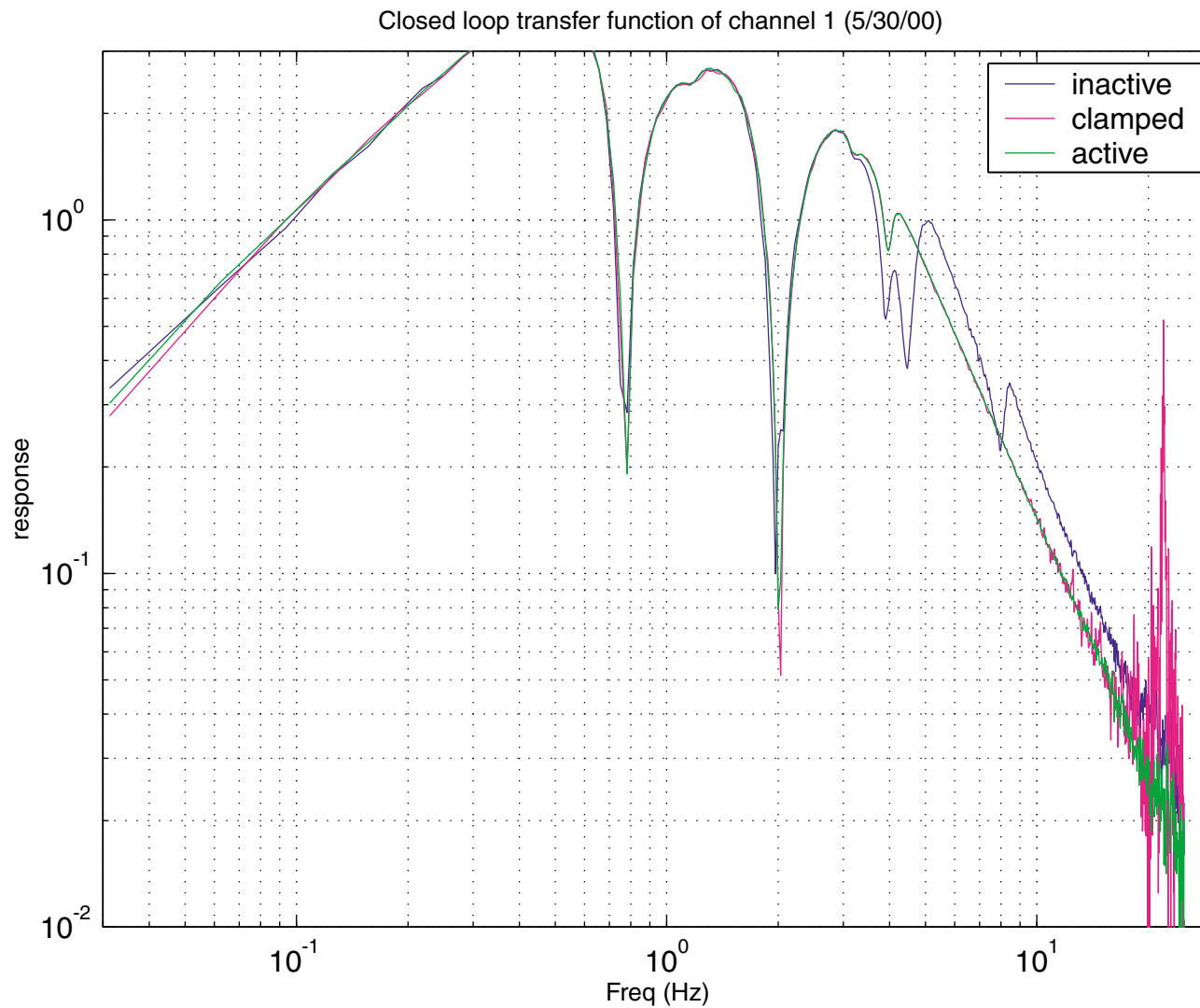
Horizontal System Transmission



Controlled Platform Motion



Pendulum Interactions

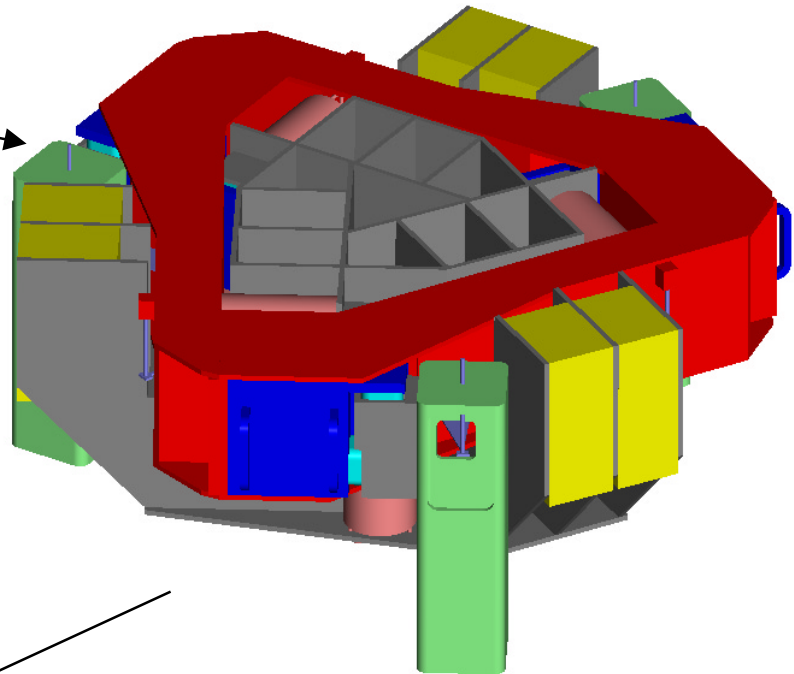
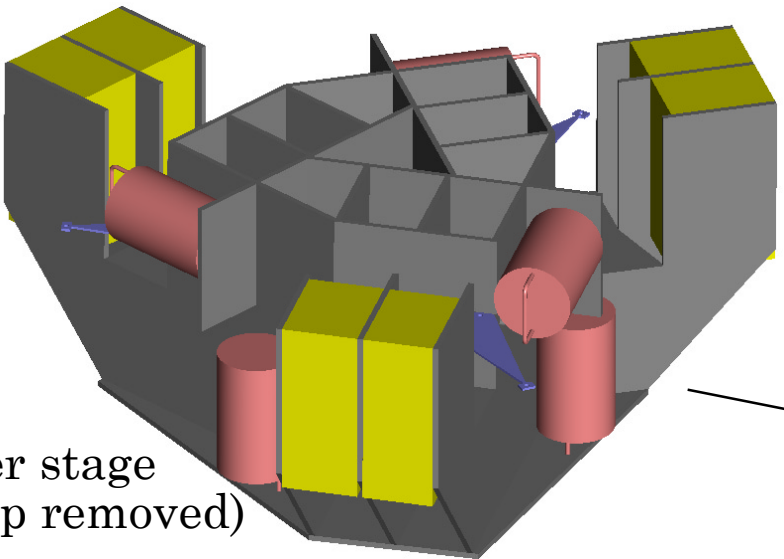


Next Step: Two Stage Prototype for Advanced LIGO

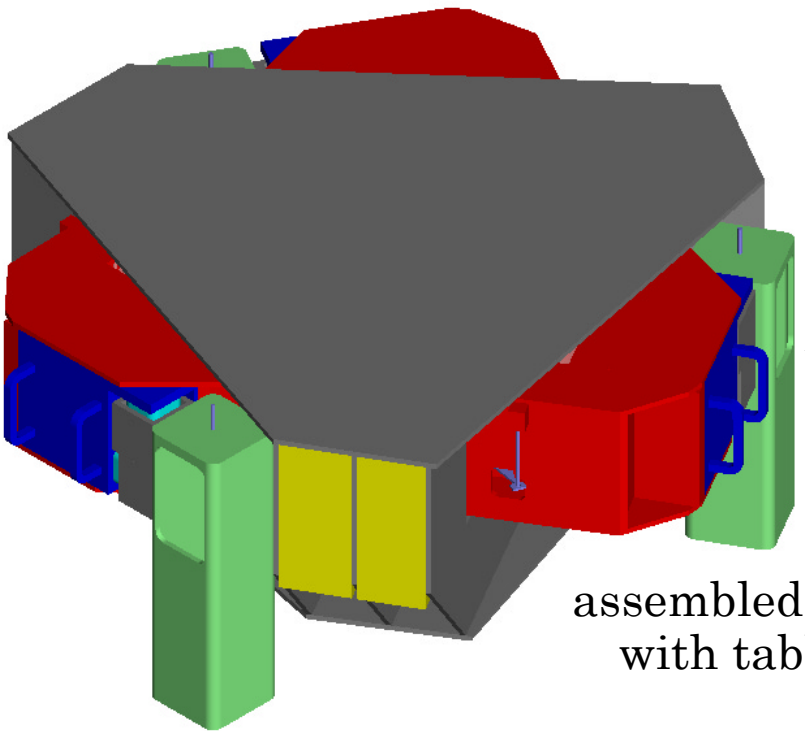
- Prototype for the HAM chamber system, to be installed in vacuum at the Stanford ETF.
- Same sensors, similar actuators as the Advanced LIGO system.
- Same dynamics as the Advanced LIGO system.
- Centers of mass of two stages at the same location.
- Sensors and actuators well aligned.
- How well does it work? Feed design information to the Pathfinder design at LASTI.

Views of the Prototype

inner stage
(table top removed)



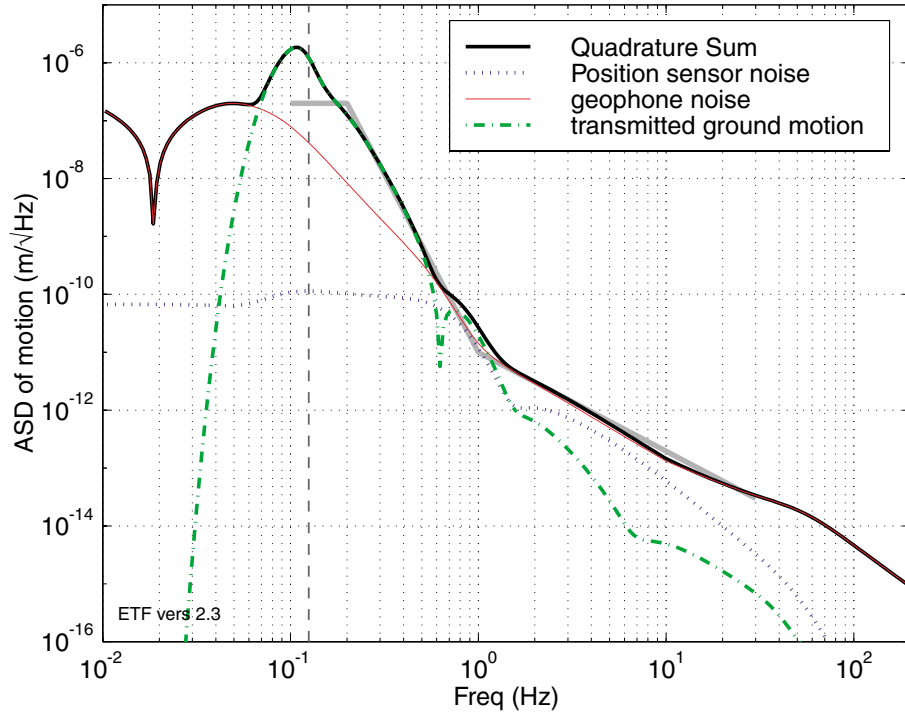
inner stage with outer stage
and supports



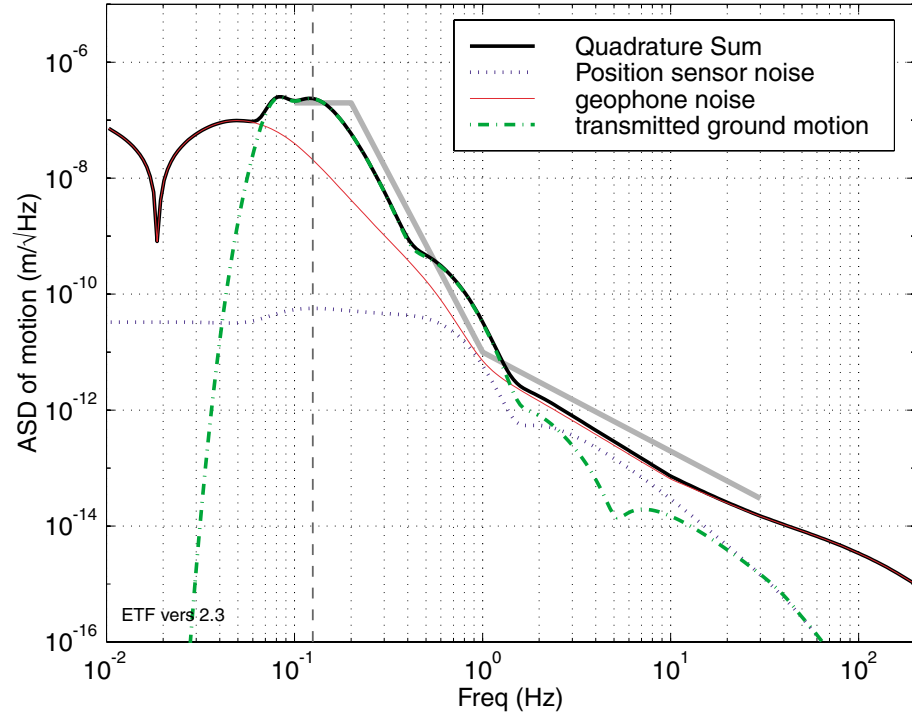
assembled system
with table top

Predicted Motion of Optics Table

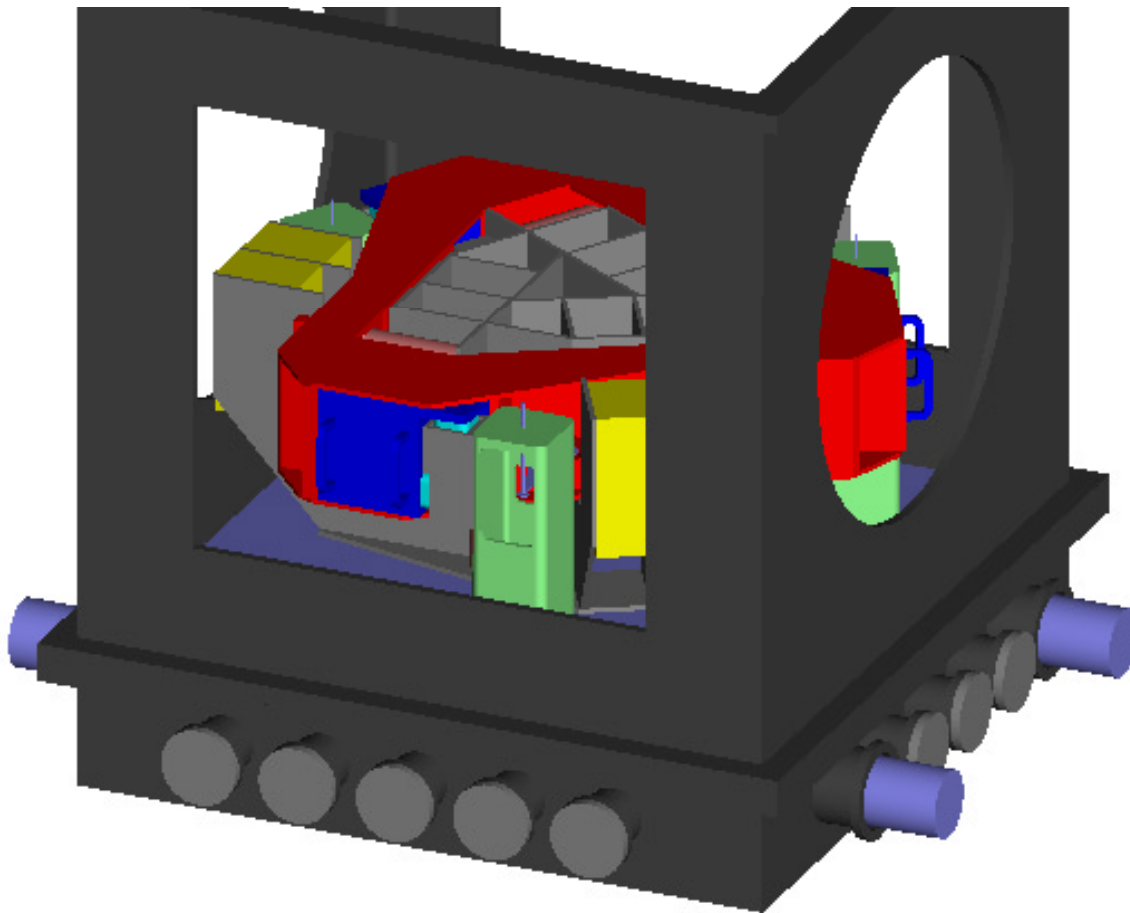
Horizontal Motions



Vertical Motions



Prototype installed in the ETF vacuum system



Ideal Facility for
Engineering Prototype

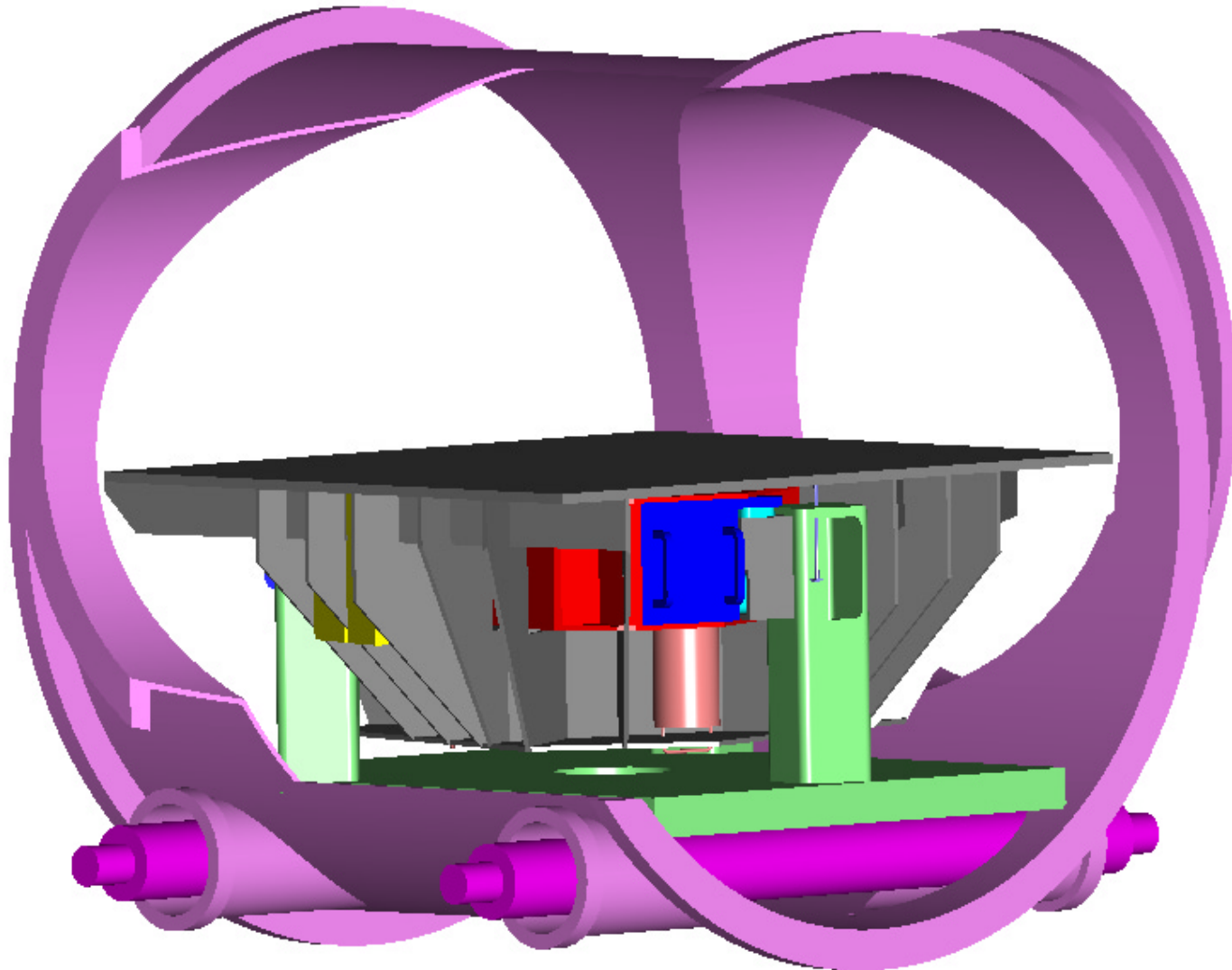
- Easy access to system
- Modest requirements for vacuum components

RFQ on the way to
contractors

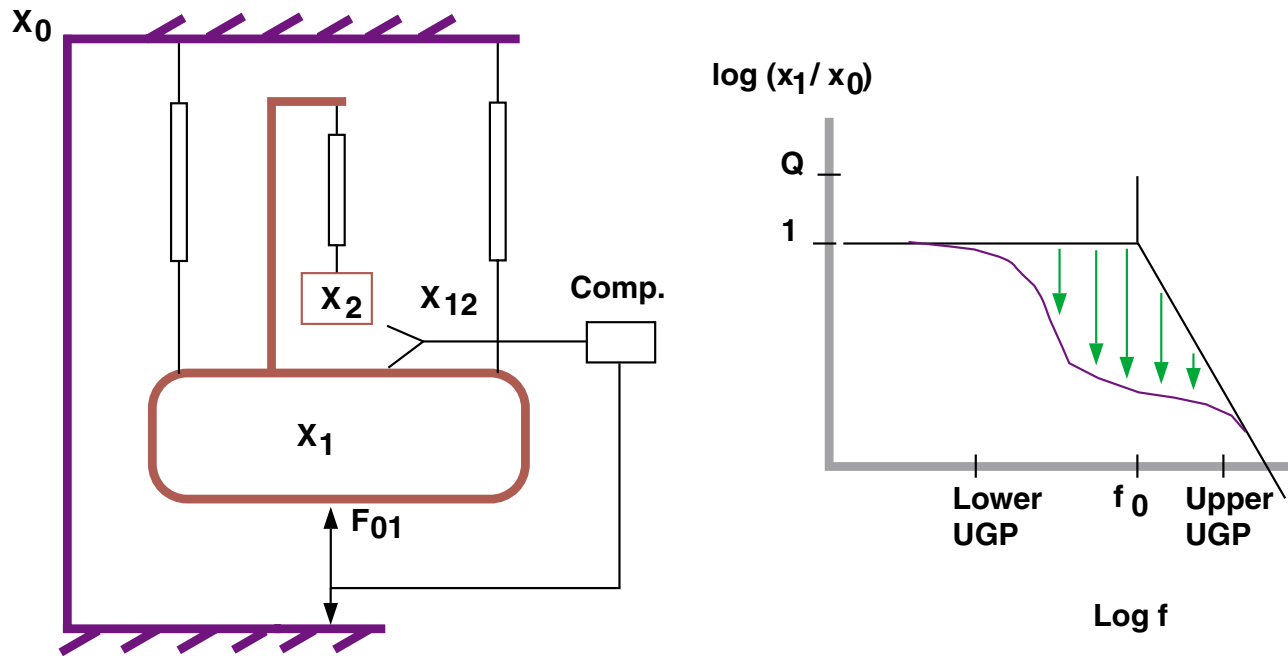
Install in ~6 months

2 sets of data to
the LASTI Pathfinder

Sketch of Active System in HAM Tank



Active Isolation



Suspended platform with inertial sensor

Feedback loop is used to add active isolation based on sensor

Decouples low frequency sensor from stiff platform

Used at JILA to achieve $\geq 70\text{dB}$ isolation above 1Hz

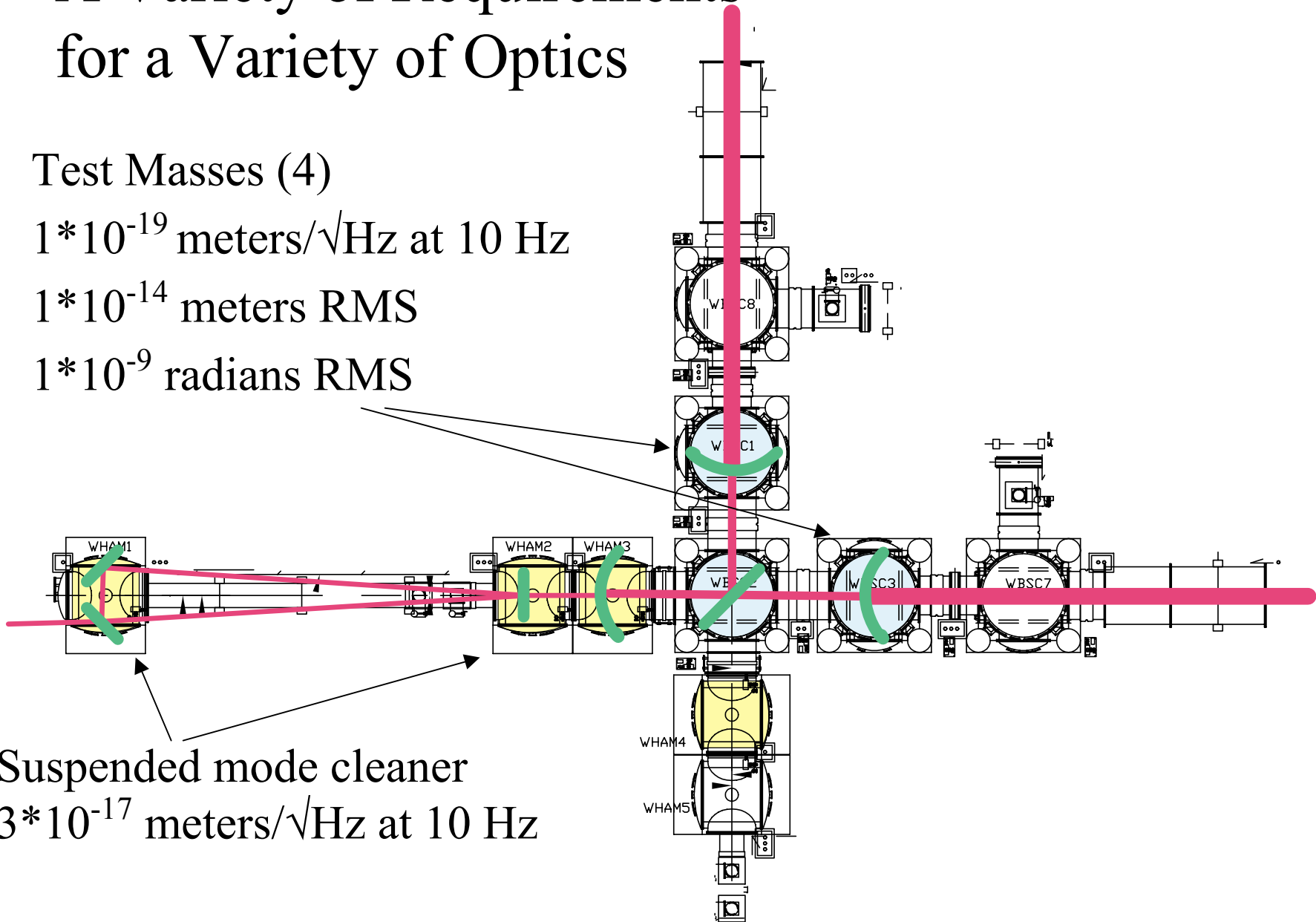
A Variety of Requirements for a Variety of Optics

Test Masses (4)

$1 \cdot 10^{-19}$ meters/ $\sqrt{\text{Hz}}$ at 10 Hz

$1 \cdot 10^{-14}$ meters RMS

$1 \cdot 10^{-9}$ radians RMS



Suspended mode cleaner

$3 \cdot 10^{-17}$ meters/ $\sqrt{\text{Hz}}$ at 10 Hz

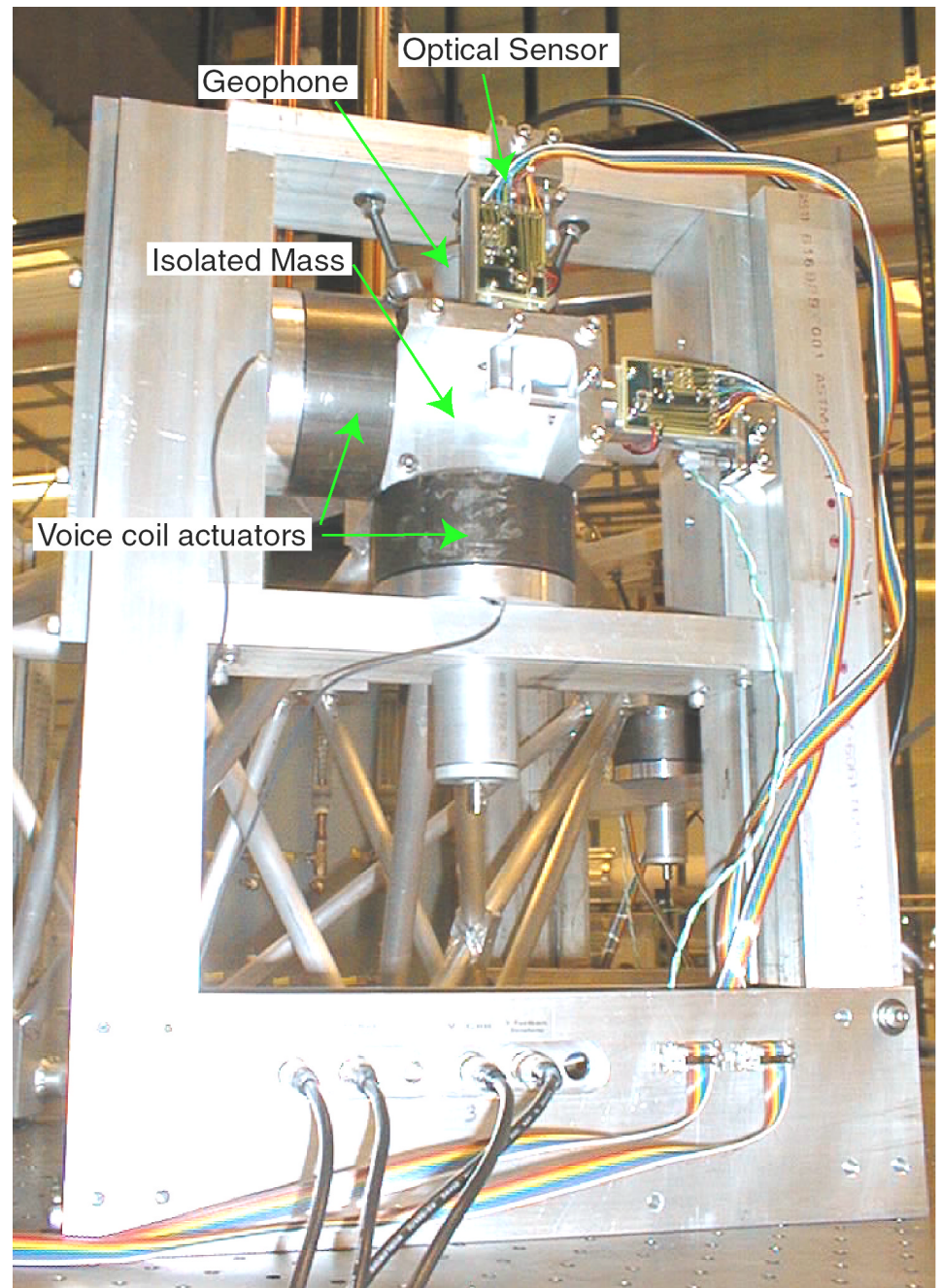
View of a 2 DOF corner

Hung with springs at 7 Hz
from support structure

Each corner has vertical
and tangential control

Sensors for both
inertial motion and
relative displacement

Collocated actuators



1 DOF Model

