Overview of a Tabletop Active Vibration Isolation System for Ultra-High Vacuum Optical Experiments

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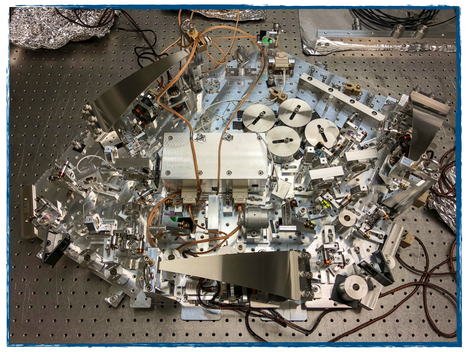
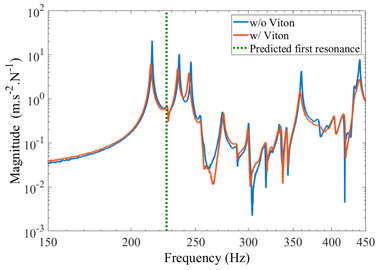
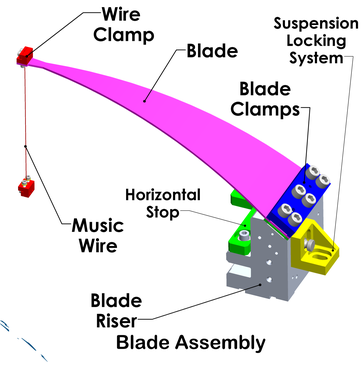


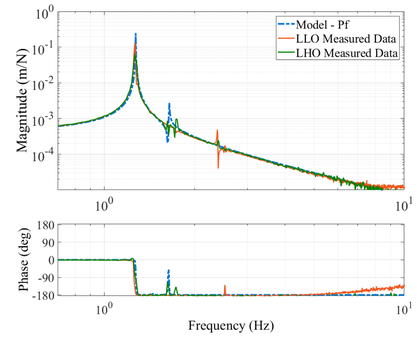


Modal Analysis

- >50dB @ 100Hz
- Large isolation bandwidth

- f^2 isolation
- Highly accurate model

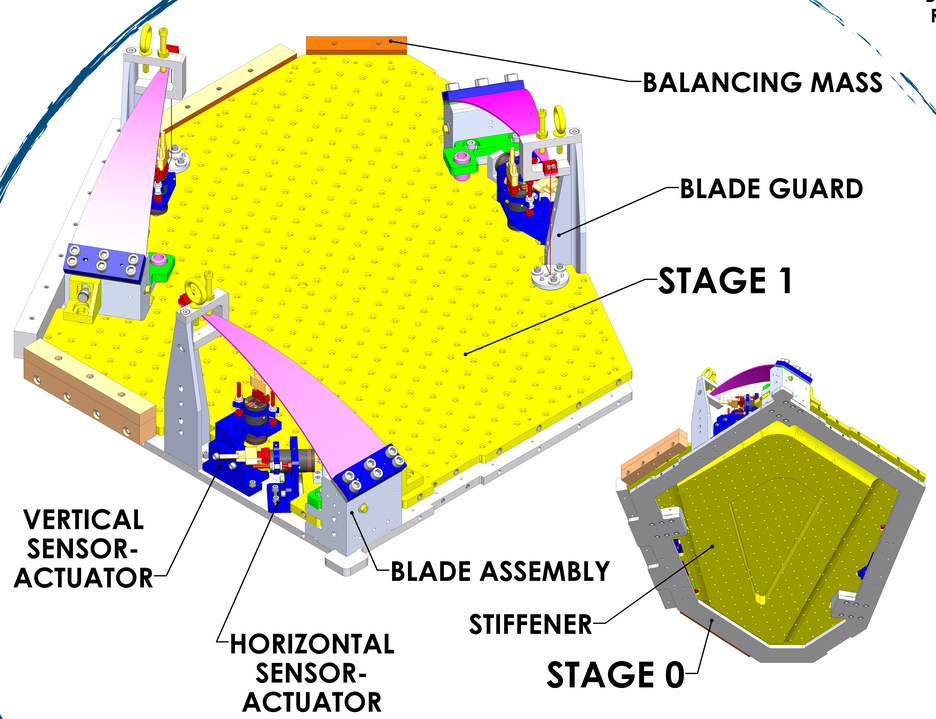




Longitudinal (X) Transfer Function

- Total mass: 48 kg
  - Suspended: 36 kg
  - Payload: 8-14 kg
- Dimensions: 27x37x8 in [94x67x21 cm]
- Suspended stage:
  - Surface: 540 in^2 [0.34 m^2]
  - Height: 1.5 in [3.8 cm]
- Resonance Q-factors:
  - 20 (damped) / 300 (undamped)
- UHV compatible

PERFORMANCE



- Vertical isolation: cantilevered blade spring

$$f_z \approx \frac{1}{2\pi}\sqrt{\frac{Eah^3}{6l^3m}}$$

- Horizontal isolation: pendulum

$$f_{xx}(\approx f_{yy}) \approx \frac{1}{2\pi}\sqrt{\frac{g}{l_{eff}}}$$

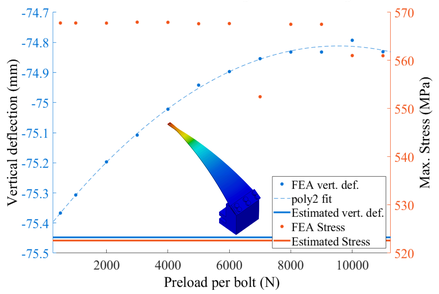
PASSIVE ISOLATION

DESIGN FEATURES

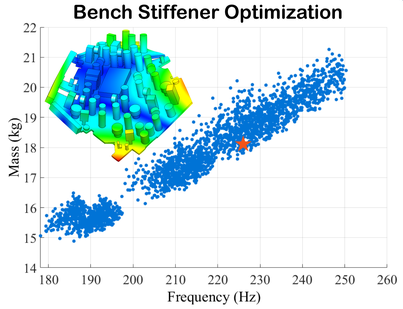
- Compact: lighter and stiffer
- Bolted joints, no UHV soldering
- Adaptive shape and effective footprint

- Optical table: Optimized underneath stiffener
- Blades: Material, Machining and FEA contact study

Blade Assembly FEA Study



Bench Stiffener Optimization



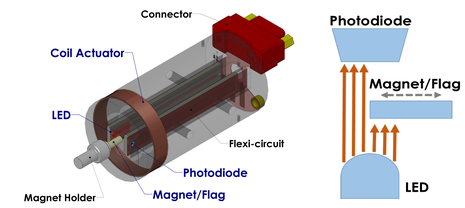
SUSPENSION MODES (Hz)		
	Model	Measured
X-Longitudinal	1.29	1.28
Y-Transversal	1.29	1.28
Z-Vertical	1.64	1.75
RX-Roll	2.22	2.40
RY-Pitch	1.63	1.64
RZ-Yaw	1.49	1.45

- Simplicity and adaptability
- Suspended mass error<.2%

- Q damped < 30
- RMS motion reduction (10x)

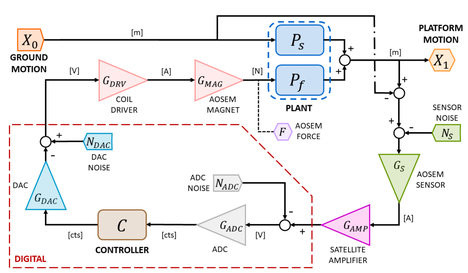
ACTIVE DAMPING

- Sensor-actuator (AOSEM)



- Feedback digital damping control
  - Band-pass filter (1 zero DC, 2 poles)
- Control noise: sensor, DAC and ADC

Control Scheme



Projected platform motion