HILA®

MONTANA INSTRUMENTS®
COLD SCIENCE MADE SIMPLE

High Inertia Low Acceleration

Cryogenic Platform for Ultra-Low Vibration and Acceleration Applications

KEY FEATURES:

- Atomic level stability suitable for AFM or micro-cavity experiments which demand low accelerations
- Platform easily tunable for a large range of mass and mass distributions
- Low natural frequency (<0.6 Hz) provides convenient & intuitive platform balancing and floating
- Integrated interface panel at 4K has thermally lagged standard DC connections
- Eddy current damping (optional)
- Turbo pump port for pulling vacuum before cooling for surface science experiments (optional)

The HILA platform breaks barriers and enables research by combining hassle-free closed-cycle technology with an ultra-low acceleration sample space for the most sensitive measurements and applications.

A multi-stage passive vibration damping technique isolates the cryogenic environment from both the vibrations of the cryostat itself AND other sources of motion within a common lab environment.

Cryostat Features

Based on the user-friendly design of Montana Instrument's proven base platforms, the HILA offers:

- Low cost, helium-free operation
- Fully-automated control
- Versatile & flexible tabletop mounting architecture
- Optimized temperature performance & thermal stability
- Unobstructed sample & optical access
- Multiple access ports for universal feedthrough options

Low Vibration Technology

The system leverages advanced vibration isolating technology featuring a very low natural frequency to minimize energy transfer to the cold space. The low natural frequency serves to isolate the sample platform from the closed-cycle cold head to drastically reduce the impact of the cryocooler pulse on sample vibrations.

Applications

The HILA is ideal for a wide range of physics applications which require ultra-low accelerations on a cryogenic platform, including:

- Scanning probe microscopy (SPM)
- Cold resonant cavities
- Spectroscopy measurements
- Probe stations

Specifications and other information subject to change without notice.

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Performance Data (Preliminary)

Accelerations - Power Spectral Density

The HILA gives researchers access to the first closed-cycle floating 4K cryogenic platform suitable for ultra-low acceleration measurements. The HILA consists of an inertial environment that mechanically isolates the cryogenic platform from external accelerations. Otherwise, these accelerations are the energizer that ultimately drives the vibrations of the structures that are on the platform.

Whether this is between cavity mirrors or a scanning probe and sample, the HILA removes the energy that would normally excite any mechanical resonances. Figure 1 illustrates the absolute amount of energy present at a given frequency on the HILA platform before and after the cryocooler is turned on. Historically, the vibrations induced by a pumping cryocooler prevent any vibration sensitive testing to occur. As shown by the plot, the cryocooler's effect has minimal effect on the platform's present energy. The system was mounted on a standard optical table.

- Graph shows minimal change with crycooler on vs. off
- The natural frequency of HILA isolation system is <0.6 Hz

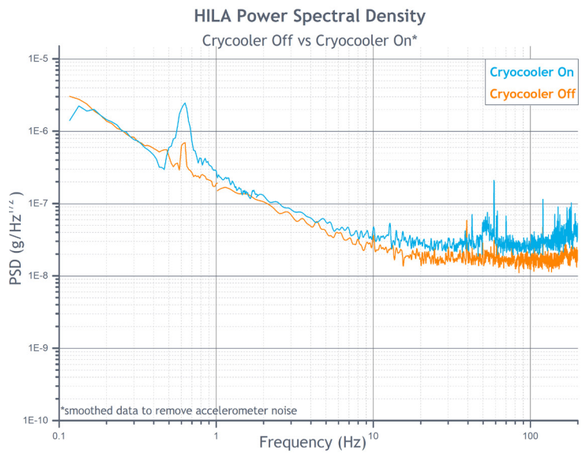


Figure 1: Power Spectral Density showing accelerations of HILA platform as a function of the frequency

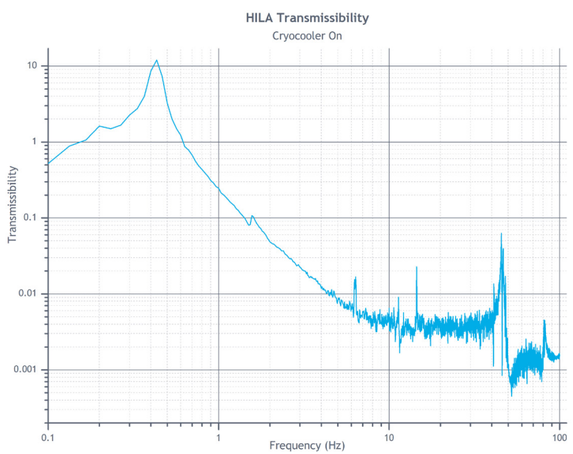


Figure 2: HILA Z Transmissibility

Z Transmissibility

Figure 2 represents the frequency dependent inertial response of the HILA platform. Each point on the graph is a ratio of the HILA sample platform acceleration to the acceleration of the supporting structure. This frame structure is specially designed to provide energy only in the vertical direction, with equal energy provided at each frequency. At the very low frequencies (<0.5 Hz), the platform and the fixture move together with no amplification or attenuation, however at 0.5 Hz the acceleration on the platform is higher due to the driving frequency matching the natural resonance frequency of the HILA. After this special condition, signals higher are very well attenuated in a range of ~0.8Hz to ~200Hz with up to 50db attenuation. The experiment was carried out by providing the fixture with a broadband signal from 0-200Hz while the output of the HILA and the supporting structure were monitored with high sensitivity accelerometers.

- For frequencies above 0.85 Hz, the HILA attenuates any vibration from the rest of the system
- Frequencies above 2 Hz are attenuated by more than a factor of 10

Performance Data (Preliminary)

Displacement

Figure 3 shows a line scan height profile across the edge of an atomic layer of HOPG. This shows the relative noise level in an SPM application and the suitability of the HILA for AFM scale experiments.

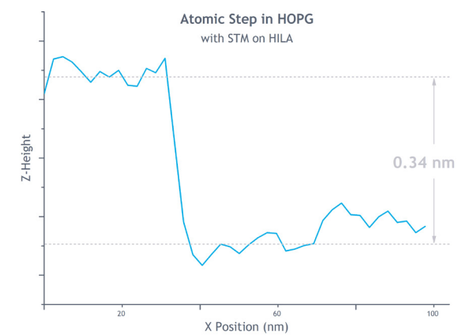


Figure 3: Scan Height Profile of HOPG

Scanning Tunneling Measurements

Figure 4 shows the position noise spectral density for an STM head mounted to the HILA platform with the cold head on and off. The stability of the tunneling junction is maintained when the cold head is switched on. The results show almost identical stability in the system whether the cryocooler is on or off, meaning low temperature measurements will be as steady as room temperature experiments.

OPTICAL INTERFACING TECHNIQUES:

Input

- Fiber (single or multimode)
- Free space beam path

Measurement Output

- Internal detector (eg. CCD, APD, photodiodes)
- Fiber coupled output
- Free space beam path

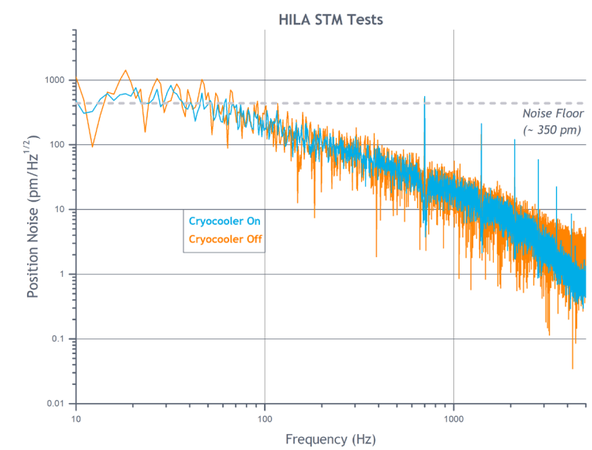
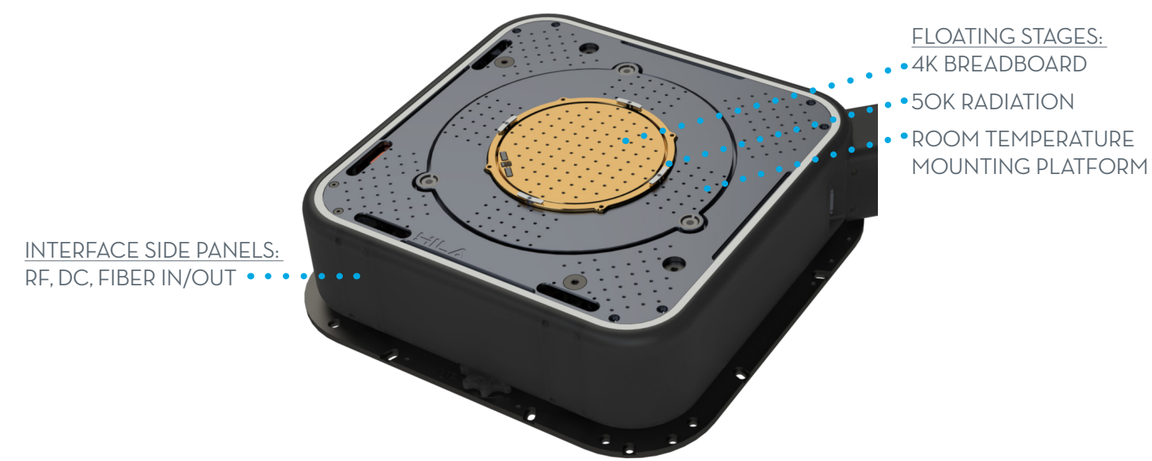


Figure 4: Scanning Tunneling Measurement



Specifications (Preliminary)

Last Updated: September 27, 2017

	HILA	Notes
CRYOCOOLER PERFORMANCE		
Temperature Range	4.5 K - 350 K	
Temperature Stability	20 mK	peak to peak (w/ damped sample mount)
Cool Down Time to Base Temperature	~12 hrs	
STABILITY PERFORMANCE		
RMS Accelerations	0.024 m/s2	Atomic resolution capable with SPM
XY Power Spectral Density	< 0.1	ug/rtHz above 2 Hz See Figure 1
Z Power Spectral Density	< 0.1	ug/rtHz above 2 Hz See Figure 1
Low Frequency Displacement with respect to table	5-15 µm @ 0.5 Hz	Normal drift*
Z Natural Frequency	0.5 – 0.6 Hz	See Figure 2
Z Transmissibility	<1 above 0.8 Hz	See Figure 2
XY Natural Frequency	<0.6 Hz	
OPTICAL PROPERTIES		
Optical Access	5 optical ports	4 radial + 1 overhead
Acceptance Angle	60° full angle 80° full angle 120° full angle	Sample at center of sample space Sample located near cold window Sample located near warm window
INTERFACING		
Electrical Access	25 user connections 8 configurable	Feedthroughs to mini-connectors pre-lagged @ 30K & 4K
Interface Side Panels	4	RF, DC, fiber options available
Thermal Lagging	2 locations	To radiation shield
Temperature Sensors	2 Calibrated Cernox™	Corresponding to platform and sample temperature Location for 1 user thermometer available
DIMENSIONS		
Sample Space (diameter x height)	ø 250 mm x 90 mm	Standard & custom options available to enlarge
Cold Sample Space (diameter x height)	ø 170 mm x 84 mm	
Beam Height	156 mm	Options available to modify
Breadboard Platform	Ø 118 mm at 4K, 170 mm ring at ~50K, 246 mm ring at room temp	Grid of mounting holes on central breadboard
OPTIONS		
Additional User Mass	0 - 3 kg	
Sample Mounting	User specified	Standard (fixed, adjustable, electrical) & custom alternatives available
Sample Motion	Optional piezo stage integration	Stages can be recessed or mounted on platform

Note: Product specifications are based on a standard system; various options, configurations, and/or custom modifications may cause slight differences. Specifications listed above are based on a preliminary design of the system and are subject to change in the final design.

*Normal Drift: HILA platforms provide inertial space that floats with respect to the optical table, resulting in a slight (5-15 ·m) relative displacement measurement.