

Advanced Vibration/Acoustic Isolation Techniques for Low Temperature Systems

Joan A. Hoffmann^{1,2}, Emile M. Hoskinson¹, Jacob W. Alldredge², Thomas M. Haard¹, Richard E. Packard¹, J. C. Séamus Davis²

¹Department of Physics, University of California Berkeley (Berkeley CA USA)
²LASSP, Department of Physics, Cornell University (Ithaca NY USA)

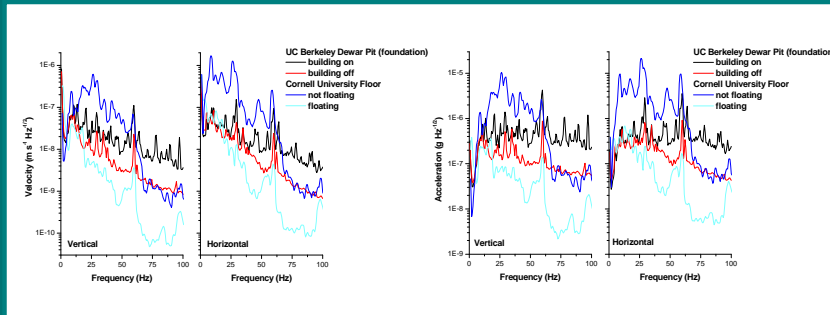


Motivation: Many types of measurements require or are greatly enhanced by being made in an environment with very little vibrational and acoustic noise. Helium flow experiments, scanning probe microscopy, and gravitational measurements all demand low-noise environments.

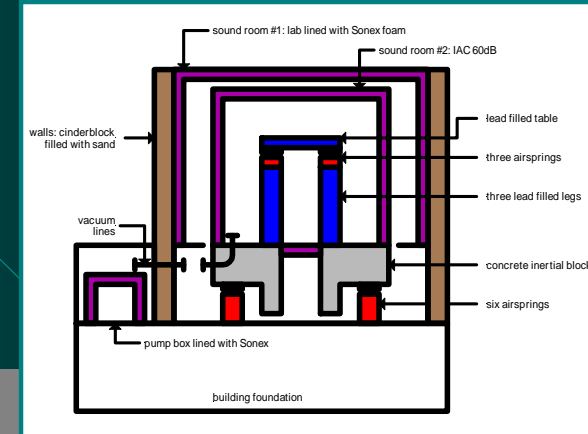
Unfortunately, lab space is not intrinsically quiet - background noise is introduced by many sources, including vacuum pumps, people, cooling fans/water, and elevators. The challenge is to find methods to decouple the experimental space from the greater building infrastructure. Here we describe new lab space that has been designed and constructed to isolate from building vibrational/acoustic noise and compare it to more traditional lab space.

Previous Efforts:
 A number of techniques are usually employed to reduce the effect of building noise on experiments. These include lining labs with acoustic foam and mounting the experiments on platforms floating on air springs. Particular attention has been paid to isolating cryogenic experiments from vacuum pumps by placing the pumps in separate rooms, often surrounded by acoustic boxes. Substantial improvements can be made by running vacuum lines through massive blocks of concrete (Avenel and Varoquaux).

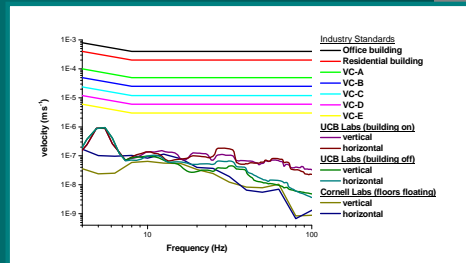
Velocity and Acceleration Spectra



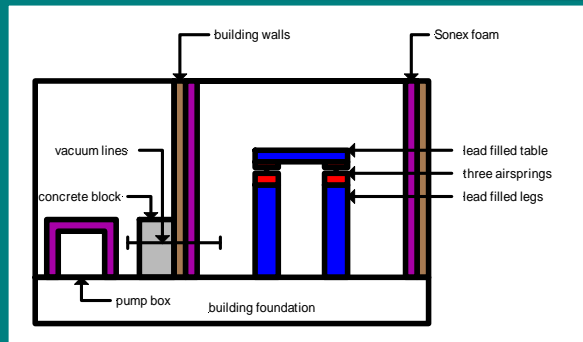
Cornell Labs



Comparison to Industry Standard

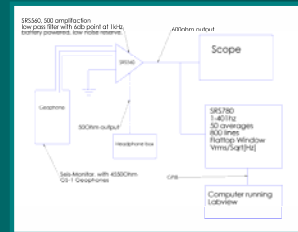


UC Berkeley Labs



Components:
Building attributes:
 -The labs are in the sub-basement with no space in use below.
 -Separate rooms are provided for vacuum pumps.
 -Rigid vacuum lines are mounted in the building walls.
 -The vacuum lines go through a large concrete mass.
 -Sonex acoustic foam lines the experimental room.
Sound room:
 -There is a double wall between the experiment and control rooms.
Experiment:
 -The cryostat hangs from a lead-filled table resting on lead-filled legs.
 -The table top rests on three air springs.

Measurement Technique:
 Measurements at UC Berkeley were performed with HS-J geophones manufactured by Geo Space, LP and calibrated in the lab. The geophones were mounted to the wall of the dewar pit and should represent the building foundation. "Building on" data were taken under no special conditions other than late at night. "Building off" data were taken during a building shut-down for transformer maintenance. During this time, there was no HVAC, running water, or power in the building. Measurements were made while generators were not running.
 Measurements at Cornell were made with a Seis-Monitor also manufactured by Geo Space, LP. It is a self-contained unit comprising three GS-1 geophones mounted tri-axially and calibrated by the manufacturer. The unit was placed directly on the concrete floor inside the closed sound room and weighed down with several bags of lead shot. "Not floating" data describe the lab when the six air springs under the inertial block are not activated, while "floating" data describe the lab when the air springs are engaged.



Schematic of measurement technique (Cornell).

Components:
Building attributes:
 -The labs are in the basement with no space in use above or below.
 -Walls are sand-filled cinderblock.
 -Separate rooms are provided for vacuum pumps.
 -Rigid vacuum lines are mounted in the building walls
 -The floors are carpeted.
 -Sonex acoustic foam lines the experimental rooms.
Floating lab:
 -The floor is a 25 ton concrete inertial block.
 -The floor rests on 6 PD-Series air springs manufactured Integrated Dynamics Engineering.
 -Space above floor is surrounded by 60dB acoustic room (weight = 5 tons) manufactured by IAC.
Experiment:
 -Cryostat hangs from a lead-filled table resting on lead-filled legs.
 -The table top rests on three Micro-G air springs manufactured by TMC.

Conclusions:
 The lab space constructed at Cornell, with a floating inertial block for a floor surrounded by double sound rooms, gives a significantly lower background vibrational noise than traditional lab space. This environment will be of great use for a variety of high-precision measurements, most immediately scanning tunneling microscopy and helium flow experiments.

Acknowledgements: We gratefully acknowledge support from the NSF, NASA, and Cornell University. JAH acknowledges generous support from IBM.