Sensors 2001 Report

Vibration sensors:

We need a sensor with <1nG/$Hz^{1/2}$ sensitivity. The expected performance of the 2Hz capacitive accelerometer under development is ~0.1nG/$Hz^{1/2}$.

Piezoelectric Accelerometers: Most vendors manufacture piezoelectric accelerometers with ~1000nG/$Hz^{1/2}$ sensitivity. These could be used for high frequency sensors in conjunction with a low frequency seismometer, but could not be used as the sole vibration sensor.

PCB piezotronics claims 60nG/$Hz^{1/2}$ for their 383B31 sensor. We have used these sensors, and measured noise levels ~2000nG/$Hz^{1/2}$.

Capacitive accelerometers: are designed to measure acceleration down to DC. Noise level is higher than for Piezo accelerometers. *Kistler* manufactures a sensor with 38,000 nG/$Hz^{1/2}$ sensitivity.

Aircraft inertial navigation accelerometers have good calibration, but have typical noise of >1000nG/$Hz^{1/2}$.

MEMS accelerometers: Silicon Designs manufactures a MEMS accelerometer with 2000nG/$Hz^{1/2}$ noise (and a 600Hz resonance).

Applied MEMS manufactures an analog sensor with 800nG/$Hz^{1/2}$ Noise. A digitally controlled (on the chip) obtains 30nG/$Hz^{1/2}$. Unfortunately the data delay in this unit (>30 millisecond (?)) is probably too long.

Fiber Accelerometers: The Naval Research Laboratory has fiber-optic accelerometers intended for submarine use. These have sensitivities as low as 16nG/$Hz^{1/2}$. The resonant frequency of this system is not specified. A “minimum detectable acceleration” of 5nG is listed but not defined. The NRO units are R+D items, and they are looking for partners for commercialization.

No suitable Vibration sensors were found.

Other Equipment for Vibration Stabilization:

Position / displacement sensors:

Fiber optical position sensors with 0.35nm/$Hz^{1/2}$. resolution, and 25 micron range are available from *Philtec*. These might used for ground reference sensors.

Capacitive position sensors from *MTI instruments* have resolutions of ~1nm/$Hz^{1/2}$. These sensors use 100KHz excitation. There was some interest in developing a product using our 10MHz excitation, with X100 better noise performance. Could be used as ground sensors, or (with improved resolution) as accelerometer sensors.

Electronics:

Precision Filters Inc. manufactures active filters for DC - audio band applications. A low noise front end amplifier / filter would cost ~$800 / channel (in VME format). This could be an alternative to the SLAC - built NIM amplifiers. Noise performance is not as good as our amplifiers.

DAQ systems:

National Instruments has PXI (compact PCI with some additions) “real time” data acquisition systems. They have demonstrated closed loop operate at ~30KHz for a single channel PID loop. Might scale to our application, but probably is marginal. They are developing a new real time system with higher performance, but no information is available at this time.

Several companies, including *Pacific,* and *Mars Labs* manufacture data recorders. None are designed for closed loop operation. Most are PC based.

Ultrasonic Sensors

The NLCTA work requires ultrasonic (few x100KHz to few x 1MHz) sensors. Several companies manufacture low cost sensors which might be compatible with our data acquisition system.

Ultrasonic sensors: *Airmar* and *International Transducer Corporation* manufacturer ultrasonic sensors with MHz frequency response. Per unit costs are~$10-$20.

Piezo sensors: *Morgan electro ceramics* manufactures small piezo elements. Can sell a small chip with attached wires for ~$10 each.

There are several options to replace our home-built sensors (and the expensive ultrasonic emission sensors) with lower cost units.

Water flow

Coriolis Force sensor: *Fluid Components International* claims absolute accuracy of 0.1% mass flow for ~10Gpm water flow. Could be used for measuring power dissipation in loads and structures.

Turbine flow meter: *Cox* claims 0.25% absolute accuracy for turbine flow meters. Has models designed for clean water.

Other

Laser Vibration Measurement: *Ettemeyer* claims 50-100nm resolution for an imaging laser interferometer. System cost is ~$300K. One time test is ~$20K. Could be used to look at water flow induced vibration in structures.

Thin Silicon: Virginia Semiconductor can make very thin Si samples. 6 micron thick is available. Note: a 20 micron sample was partially transparent. Can also machine Si. Possible application for Transition Radiation Monitor. Cost ~$1000 for a batch.

Surface Roughness: *Hohner Corp* manufactures a surface roughness (actually a scattering measurement) instrument for ~$1000. Could be used for the liquid metal collimator (will work through the vacuum window).