New Folder Name Prototype Isolation Stack

LIGO-T910012-00-R

Prototype Isolation Stack - Current Status and Future Plans

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Current Status

All parts and materials needed to build the prototype isolation stack are on hand, and the first layer of the stack is built and undergoing tests. The instrumentation for testing, accelerometers with low noise preamplifiers, the laser accelerometer, and LVDTs and their circuitry, are all tested and ready.

We continue to follow the original plan for construction and testing of the stack. The schedule has slipped several months, primarily because the first spring assemblies had a higher spring constant and a lower load capacity than expected. These first springs were made with 70 durometer Viton, and transfer functions of one stage were made in air with various loadings. We now have experience with 90 durometer Viton, which has a greater load capacity but less damping than the 70 durometer.

At present, we are testing a single layer of the 90 durometer Viton springs. Transfer functions are being measured for horizontal, vertical, and cross coupled motions. We have completed tests of a single layer to measure load bearing capacity. The transfer function measurements of the single layer are being conducted in order to characterize the 90 durometer Viton springs in a simple system, and to provide model input to compare to the behavior of the full stack.

We will next put together the elements for four stages of isolation using the durometer 90 elastomer springs in the lower stages. We will use one dimensional models to decide which material to use in the upper layers. The stack will be instrumented and its performance measured. In parallel with this, we will design and model an isolation stage which uses metal coil springs in parallel with elastomers. We expect that such a hybrid layer may be necessary in the first one or two stages in order to drive down the rms motion. The results of the all-elastomer stack tests will determine the performance requirements of the hybrid layer.

Spring and mass configuration

The number of springs in each layer is determined by their load bearing capacity.

Operating the springs at capacity minimizes the resonant frequency of each stage. Each stage has about the same mass, and the lower stages have more springs because they must support the DC load of the stages above them, so the resonant frequencies of the lower stages are higher than the resonant frequencies of the upper stages.

The first layer will have six spring assemblies, each of which will have eight 90 durometer Viton elements. Each element is a half-inch diameter Viton beam. We have measured the vertical transfer function of this layer to be 27 Hz, with a Q of 5. The DC load supported by this layer is 370 kg. The number of spring assemblies in subsequent layers will depend upon which Viton is used, but in all cases the springs will be loaded to near their capacity, allowing a margin of safety, to minimize the resonant frequencies. The top layer will have the lowest resonant frequency, about 14 Hz.

The first three layers will use steel rings, each of which has a mass of 67 kg. The fourth layer will use the 72 kg optical table. The optical table will have three spring support tabs attached and each of the rings will have six tabs. The tab mass is 2.9 kg. The mass of each spring is about 2.8 kg. The DC loads supported by the second, third and fourth layers are 270 kg, 165 kg, and 80 kg, respectively. These loads are approximate, because they depend upon the number of spring assemblies used.

Test plan

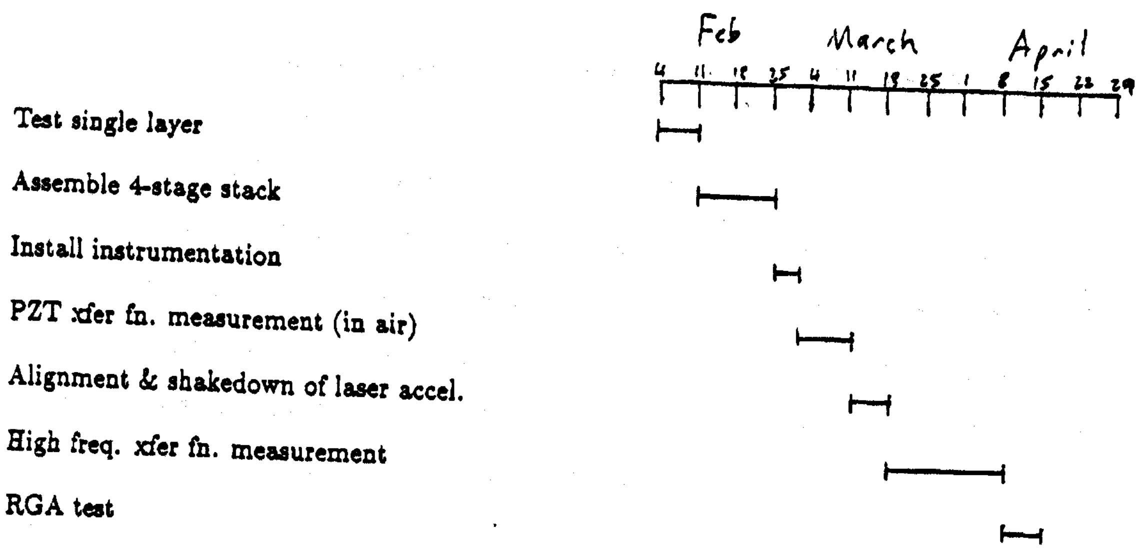
When the full stack is assembled it will first be instrumented with LVDTs. These will provide drift information as well as measurements of vacuum distortion when the stack is pumped down. Supplemental measurements of drift will be made periodically, and a mirror will be attached to the stack so that gross motions can be diagnosed from outside the vacuum tank with a He-Ne beam shined through the viewport.

Initial transfer function measurements will be done with PZT accelerometers alone. These have adequate sensitivity at low frequencies and can be repositioned freely without the realignment that the laser accelerometer may require. The first transfer function measurements will be made in air to find the low frequency resonances and Qs. Next, the system will be cleaned and pumped down for transfer functions and a measurement of the rms motion of the suspension point. Vacuum distortion will be automatically measured at this time by the LVDTs which are already in position. We anticipate that the vacuum tank may have to be opened and re-evacuated each time the drive is changed from vertical to horizontal or vice-versa, because the two motors cannot both be attached to the stack simultaneously.

The data from these tests will enable us to start the design of the hybrid metal/elastomer spring layer. This design will be done as early as possible so that parts can be ordered and on hand when we are ready to use them.

The laser accelerometer will be brought in for measurements of high frequency isolation. After all transfer functions and cross couplings have been measured and analyzed, an RGA spectrum will be taken of the system, then the stack will be removed (but the instrumentation, motors, etc. will be left in place), and another RGA spectrum will be taken to get an estimate of the stack gas load.

Schedule



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NOTES: Please distribute to Robbie, Bill, and the Science team. Thanks.