LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Document Type LIGO T000019-00-R February 10, 2000

SAS Simulation Plan for LIGO 2

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Distribution of this draft:
TBD

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of the LIGO Project.

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1 Simulation Tools

The following software tools will be used to perform the simulation of the SAS system.

- MSE to produce a mechanical description of SAS-SUS.

- Matlab, to analyze and tune the control performances of SAS-SUS .

At present status MSE is able to give a three-dimensional description of a quite general mechanical system including the internal modes of the main elements like beams,wires and blades.

The MSE object oriented architecture, provides an easy way to divide test and study separately, each subsystem before integrating them together.

Using the MSE library we can provide a model to compute the mechanical transfer function and mechanical admittance of the overall system between any couple of points. As measured by any kind of available sensor for comparison with test data.

MSE has been designed to, and therefore is very appropriate to, add details to the object description following the test data advancement to match the measured performance features. This capability has been already tested for some cases and will strongly validate MSE for design use and debugging.

The MSE library is able to produce the mechanical simulation both in frequency and time domain and produce the matrix standard state space description.

The use of Matlab is indeed restricted to the validation of the performance of the control strategy. MSE has been customized for interface with Matlab.

With the integration of MSE into the e2e system, it will be possible to evaluate the performances of the SAS-SUS and its interactions with the physics of the interferometer.

2 Simulation Planning

The simulation of SAS-SUS is obtained by combining subsystems in the following way:

- Inverted Pendulum

- GAS filter

- SAS chain

- GEO suspension

- SAS-SUS chain

For each subsystem interface, the full 6x6 transfer function matrix and the mechanical admittance matrix will be computed.

In particular it will be performed the study of the internal modes which are relevant for chain transfer function performance in the high frequency range .

The geometrical asymmetries and imbalances of the systems will be addresses to evaluate the reduction of the passive attenuation of SAS-SUS and of each subsystem.

A similar plan is being followed to simulate the TAMA 3m experiment.

3 Experimental Validation

The validation of the MSE simulation engine, has already started for some subsystem, using experimental data obtained from SAS prototypes. In particular, the vertical degree of freedom of a GAS filter has been already successfully tested[1].

A more stringent validation of the engine, will be done with the test data of the SAS prototype, where each mechanical subsystem can be characterized experimentally. Measuring the mechanical transmissivities, we will be able to validate the main SAS-subsystems: the Inverted Pendulum, the GAS filter, a chain of 3 GAS filters and the entire SAS prototype.

Another effective way to increase the confidence of the MSE simulation engine, which is under discussion, is to use the already measured transfer function of the overall Virgo Super-Attenuator chain. The advantage of this test is essentially the availability of experimental data taken on a complete prototype. Interest in this test has been shown by the VIRGO scientists and an agreement may be reached shortly.

Even more important validation will be done by the end of this year, with TAMA 3m interferometer which will use SAS chains.

4 Performance Extrapolation for LIGO2

An example of simulated/measured performance will be shown in the report "Baseline LIGO2 Implementation Design Description". The desired extrapolation necessary to simulate the performance will be shortened, as discussed above, using the VIRGO and the forth coming TAMA data.

References

[1] G. Cella, R. de Salvo, V. Sannibale, A. Takamori, **Performances of the First Prototype of a Geometric Anti-spring Filter For Seismic Attenuation** *draft*