Selection of the Technical Approach for Upgraded LIGO Seismic Isolation

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Improving the sensitivity and capability of the initial set of LIGO detectors will require a broad range of advancements in each of the technical subsystems. As the LIGO Laboratory and the LIGO Scientific Collaboration (LSC) have worked to develop the concept for the upgrade, it has become clear that scientific requirements call for an improvement in the filtering of seismic disturbances. Upgrading the initial LIGO seismic isolation systems constitutes a major development, design, and construction and commissioning project. The seismic upgrade is thus a major component of any overall LIGO upgrade.

The Laboratory and the LSC have carried out a significant R&D program towards development of the next generation isolation technology. The development has led to two technical approaches championed by two teams. The first is based upon the technology employed by Virgo. It exploits a multistage "soft" mechanical filter system with active elements. The second approach employs a "stiff" space frame supporting full active control of all degrees of freedom. Early development has indicated that both approaches have the potential to meet the emerging LIGO upgrade requirements. However, both approaches will require extensive prototyping, modeling, design and refinement before a suitable design solution can be accomplished. Each of the approaches will require a substantial team and resources to reach a definitive design.

In recognition that both approaches promise success, and that the LIGO community is working with finite resources, the Laboratory and the LSC concluded, at the Stanford LSC meeting, that a selection of a single technical approach should be made at the earliest possible time. This choice would serve to focus the efforts of the community, and to facilitate the Laboratory's organization of a project team matched to the complexity of the challenge. However, it was felt that a decision at that meeting was premature, as there remained significant open technical issues important to the selection. It was agreed that a structured parallel R&D program could address these issues by April 2000. After this program was carried out, the selection could be made with substantially improved understanding of the major issues. Selection at that time was felt to be consistent with the schedule envisioned for the upgrade development.

A process was agreed to that involved a Technical Advisory Group (TAG) appointed by the Suspensions Working Group of the LSC. The TAG was asked to review the work of the two development teams. This review was designed to assess the development in light of the written draft requirements for the upgraded isolation system. The TAG was asked to provide comment on each of the criteria identified formally to them. The resulting comments were to be transmitted through the LSC leadership to the Laboratory Directorate. The Laboratory Directorate agreed to include the input from the TAG and the LSC, along with other considerations, in selecting a preferred technical approach.

The LSC Suspensions Working Group authored the isolation system requirements, together with the Laboratory. Furthermore the criteria used by the TAG to evaluate the two approaches were also developed and documented.

Both development teams have carried out an impressive program of modeling, prototyping and measurement. In each case, a coordinated multi-institution collaboration formed to conduct the demonstration and development program.

The TAG participated in several meetings including site visits to the prototypes, formal meetings and teleconferences, and they provided detailed individual commentary used to create a comprehensive evaluation report. The deliberations of the TAG led them to recommend that the "stiff" approach be selected as the preferred alternative for further development. However, their report indicated that the "soft" approach could also offer a successful upgrade design solution.

We have considered the detailed technical evaluation provided by the TAG and the LSC. We have also monitored the progress of the two development programs ourselves. We have considered the system issues and the options for building a design team and for carrying out a successful seismic isolation system construction project, and a successful overall upgrade project.

We have decided to adopt the "stiff"` technical approach for the LIGO interferometer upgrade project. It should be noted that this decision adopts an approach and not a specific conceptual design or team. Considerable design evolution lies ahead before a design can be baselined for construction.

It is of immediate importance that we consolidate this selection into a reorganized upgrade development effort, and that we initiate the formation of a strong project team to carry out the seismic isolation subsystem project. We have decided to build a technical and project subsystem team within the LIGO Laboratory. We will center this team at the LIGO Livingston Observatory but with strong collaboration from the LSC.

We will carry out discussions with all involved parties over the next several weeks with the goal to assure that the strongest possible reorganized LIGO upgrade effort emerges. We will work to assure that current efforts on the "soft" approach be brought to a proper result and conclusion, especially in light of the strong interest in this approach from other interferometer projects.

Both development teams have accomplished a great deal in a very short time. This bodes well for the future course of advanced interferometers. The challenge ahead of us is to reapply this strength towards the LIGO upgrade.