MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Laser Interferometer Gravitational Wave Observatory (LIGO) Project

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Subject: **ASC/IOO Interface and Design Support**

In preparing for the ASC DRR we were unable to precisely define the scope of ASC support for LIGO input optics. While originally (as of Baseline 1 and the Cost Book) the ASC umbrella encompassed alignment functions for all in-vacuo suspended optics, the recent initiative to subcontract the Input Optics (IO) subsystem to collaborators at U. Florida makes this arrangement awkward. At the same time, the most obvious modification-- increasing the scope of IO to include all required supporting functions, including alignment, in a standalone deliverable "turnkey" subsystem-- seems unworkable as well. It would probably duplicate effort, in that the technology we will develop for CO alignment (wavefront sensing) is readily adapted to IO. It might also require UF to develop or adopt modeling, analysis and design capabilities comparable to those already developed (at significant investment) within LIGO.

As a departure point for discussion, let's take the hybrid approach you offered by which (we hope) the scope of work and responsibility for performance are reasonably clearly defined, but duplication is minimized.

In this approach the formal interface and scope of supply is to remain "simple" in that the IO contractor supplies a complete working subsystem, including suspended optics, sensors, and controls. However, ASC and ASC/CDS would be responsible to provide a *documented design* for the alignment sensing and controls portion of this subsystem. This design would be based upon early design configuration data (a sufficient set to be agreed upon), transmitted to ASC by IO at or shortly after the IO Design Requirements Review.

During the IO preliminary design phase, ASC and ASC/CDS would generate and provide this design at a level sufficient to support the IO PDR. ASC and ASC/CDS would complete and update that design as required prior to the IO FDR, incorporating review actions as well as any interim changes to the underlying design basis. This final update will be sufficiently complete to enable the IO group to proceed with fabrication on a "build to print" basis (a term which also needs definition at some point...). In view of the probable common features mentioned above, I expect this to maximize the IO contractor's opportunity to achieve economies of scale through coordination with ISC fabrication. In addition it tends to insure the IO-related alignment system is similar to and uniformly integrated with the other interferometer control systems (one motivation for our choice to have a central CDS group create electronics for all subsystems)

There are potential pitfalls which probably should be worked out to everyone's satisfaction in advance. For one thing the IO subcontractor's liability and responsibility can only be limited to those parts of the system s/he provides; so if the IO alignment somehow failed to meet performance goals due to faulty design (as opposed to flawed implementation), it would be the ASC group's responsibility. The preliminary and final design phases would require significant coordination between ASC and IO groups, with the accompanying personnel and travel overhead and potential for schedule slip if one or the other group is delayed. In addition, the documentation will almost certainly need to be more formal and more complete than typically used between existing subsystem groups. These disadvantages could be outweighed by the improved efficiency of the combined design effort. Also, the critical fabrication and integration phases would retain a single locus of responsibility, which is desirable from the point of view of managing the integration process.

The concept also relies on our ability to "freeze" those IO design features which affect the alignment system design fairly soon. Early decisions on mode cleaner mirror curvature and finesse and perhaps modematching telescope design, combined with a preliminary geometric layout and existing angular exitation models, would provide much of the information needed to design a wavefront-sensing alignment system like that described in the ASC Conceptual Design Description. At the moment I'm not aware of any outstanding technical issues barring quick resolution of these basic parameters.

Finally the brass tacks: ASC would obviously need to retain the full *design* budget scope, plus some support for added travel and a nominal consulting presence during fab and installation phases. However, that fraction of the actual fabrication and integration originally allocated to IOO support would be freed up. It will take some work to figure out the details, so I haven't any idea about the bottom line.

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