

TO: AdL SUS design team, Dennis Coyne,
David Shoemaker, Carol Wilkinson
FROM: P Fritschel
SUBJECT: Advanced LIGO SUS Design
Requirements Update Review report
Refer to: LIGO-M050216-00-D
Date: July 7, 2005

A Design Requirements ‘Update’ Review for the Advanced LIGO SUS subsystem was held on June 15, 2005. The main purpose was to review the design requirements for the suspension systems which reside in BSC chambers, i.e., the test mass quadruple suspensions and the beam-splitter and fold-mirror (triple) suspensions.

Members of the review committee: Ben Abbott, Rana Adhikari, Gabriela Gonzalez, Brian Lantz, Virginio Sannibale, Peter Fritschel.

Listed below are the action items that the above review committee has raised, divided into those pertaining to the design requirements, and those pertaining to the conceptual design.

Design Requirements

1. The internal thermal noise of the test masses in LIGO-T010007-03 is still calculated for sapphire test masses. This needs to be updated to correspond to the fused silica test mass substrate design. In calculating the thermal noise for fused silica substrates, a mechanical loss factor of $5e-5$ should be used for the high-index dielectric coating material.
2. Noise arising from the (highest-frequency) roll mode of the suspended optic should be considered and included in future noise calculations. For the coupling of roll motion to optical path length change, use data from initial LIGO to infer the coupling, and assume it will be of the same order.
3. Damping of the violin modes of the final stage fibers is a concern. It may be necessary to require that (some of) these modes be damped, or be damp-able, to a quality factor (Q) much lower than their intrinsic Q . Options for damping the fiber modes should be studied.
4. The impact of temperature changes on the alignment of the suspension needs to be studied, the conclusions of which should then be used to establish environmental requirements on the suspension assembly and installation areas.
5. Under section 3.9, ‘General Requirements – Interfaces’, a reference is given to document E040508-00. This document does not exist, at least in the DCC or the web pages we were supplied for the review. Please correct this reference.

Conceptual Design

1. Wiring of the suspension chains. Since the suspensions are soft, and there are many wires, this seems like a non-trivial engineering issue. The review of the controls prototype should adequately address this issue before its design is finalized.
2. The designers are encouraged to include embedded metrology points (flats, balls, V's, etc.) onto the 8 masses to simplify measurement and alignment of the numerous degrees-of-freedom of the suspension.
3. ETM-reaction mass gap. We wonder if the gap can/should be reduced from the current 5 mm spacing, to, e.g., the 3 mm gap used in GEO 600. Reducing the gap would provide a larger electrostatic drive peak force, by approximately a factor of $(5/3)^2 = 2.8$. This could be quite significant for lock acquisition, or not. We were not presented with the design considerations that went into the 5 mm gap choice, so we have not been able to assess the trade-offs. Please consider a smaller gap, and present the analysis behind the choice at the next review.
4. Unification of the design. The conceptual design focused on the main pendulum design, though the suspension system consists of the main pendulum, a reaction pendulum, and a housing/support structure. Future reviews should present the system as a unified design of these three components.