



# LIGO Laboratory

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Date:	31 October 2008
Refer to:	L080134-00-D
Subject:	Review committee report on the COC FDR for Shaping/Polishing
To:	David Shoemaker (Advanced LIGO Project Leader)
From:	Review Committee: Doug Cook, Dennis Coyne Mick Flanigan, Peter Fritschel, Eric Gustafson, David Nolting, David Reitze, Norna Robertson, Ken Strain, Hiro Yamamoto
cc:	Design Team: Helena Armandula, GariLynn Billingsley, Bill Kells, Gregg Harry

### Response to the review committee's report

I accept the Recommendation to proceed with preparations for procurements as described, and the Action Items below.

David Shoemaker  
 Advanced LIGO Project Leader

### **Recommendations**

We recommend that the COC group proceed with completion of the specifications and the preparation of the Request For Quotation (RFQ) for the (remaining) materials procurements (an IO task based on COC design) and the shaping and polishing contracts. Review of the metrology and coatings is still pending.

### **Background**

Documents were posted by 29 September 2008. The committee collected their questions which resulted from review of the documentation in a teleconference with the COC design team on 10 October. The collected questions (L080126-00) were delivered to the COC team on 14 October. A response by the COC team to the review committee questions (L080126-01) was available for a teleconference discussion 17 October, which concentrated on the shaping and polishing aspects of the review due to the need to go out for bid requests soon. The committee made informal, verbal comments on the COC team's responses to their questions, which form the basis for this formal report.

Documentation for the review is detailed in the Committee Charge, L080116-00, with these documents and some additional documents to be conveniently found on the AdL Wiki at [http://lhocds.ligo-wa.caltech.edu:8000/advligo/COC\\_Final\\_Design\\_Review](http://lhocds.ligo-wa.caltech.edu:8000/advligo/COC_Final_Design_Review)

The review was based on requirements and design documents, as well as results from the COC Pathfinder efforts in polishing.

### ***Findings with regard to materials, shaping & polishing***

The Committee found the design, with regard to shaping and polishing, to be suitable for Advanced LIGO and ready to proceed to detailed specification and RFQ preparation. However there are a number of places where further work is needed, and a few places where urgent attention should be directed. These are noted in the Action Items below.

- 1) The performance demonstrated by the polishing pathfinder effort meets or exceeds the defined Advanced LIGO requirements.
- 2) However, given the current lack of understanding of the cause of scatter in the Initial LIGO optics, it is not clear that we can meet the arm cavity loss budget. As a consequence we will strive to achieve the best performance that current manufacturing techniques can provide within the Adv. LIGO time and financial constraints.
- 3) The COC team and the committee debated the merits of specifying the allowable surface errors as a limiting Power Spectral Density (PSD) curve (or a family of PSD curves), or as rms limits in selected frequency bands (as was done for the pathfinder specification). The intent is to select an optimal balance between surface micro-roughness and surface figure error, or allow the flexibility to trade off errors in one region of the spectrum against reduction in error in another region of the spectrum. Unfortunately the COC team does not have a more precise definition of this trade-off at this time and its development would significantly delay the schedule for polishing. We recommend proceeding with the pathfinder specifications, but to incentivize the polishing bidders to deliver better performance. In essence we wish to achieve the best performance that the current state-of-the-art can provide within reasonable cost constraints.

### ***Action Items***

To be completed by the time of the RFQ submission to the LIGO procurement group, unless otherwise noted:

- 1) Systems engineering must define allowable cylindricity error for the TM barrel (for attaching passive dampers for parametric instability control) in a RODA.
- 2) Suspensions (SUS) must define the ear bonding area requirements in a RODA.
- 3) The drawings for the COC substrates should be completed as soon as possible (incorporating items 1 & 2 above) and reviewed by the Systems Engineer and Systems Scientist before incorporation into an RFQ.
- 4) The shaping & polishing specifications should be completed as soon as possible and reviewed by the Systems Engineer and Systems Scientist before incorporation into an RFQ.
- 5) The diffraction loss in the recycling cavities must be shown to be small enough with the chosen 55.5 mm beam size, before the radius of curvature of the recycling cavity optics can be finalized. This should be done as soon as possible and reviewed by the Systems Engineer and Systems Scientist before incorporation into an RFQ.
- 6) Systems engineering must approve and publish a final set of wedge angles for the COC. The documentation should be a revision to T080078, "Optic Coordinates and Cavity Lengths (for Stable Recycling Cavities)" and must be ratified in a RODA.

To be completed as soon as possible but no later than 2 Feb 2009:

- 7) The Design Requirements Document (DRD) and the Final Design Document (FDD) must both be substantially re-written to be clearer and to provide missing documentation (see L080126 and L080133 for details)

### ***Additional Comments***

For additional suggestions and actions please refer to L080133, “Response to L080126-00, Comments & Questions from the review committee for the Final Design Review (FDR) of the Core Optic Components (COC)”. However, all critical actions have been brought forward to this report.