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Refer to:	L080032-00
Subject:	Status of Action Items from the Requirements and Conceptual Design Review (CDR) for the Core Optics Components (COC)
Authors:	Dennis Coyne (chair of the review committee for the Preliminary Design of the Preliminary Design Review for the COC)

This document covers status of the action items (assigned in [L040025-00](#)) resulting from the review report ([T040009-00](#)) of the Requirements and Conceptual Design Review (CDR) of the Core Optics Components (COC) of Advanced LIGO. The status of these action items is an input to the preliminary design review of the Core Optics Components (COC) subsystem of Advanced LIGO. The table on the following pages has been extracted from L040025-00 with the addition of a column to indicate the status and results of the action item.

The status and results of the action items assigned from the COC Requirements and Conceptual Design Review ([L040025-00](#)) is given in the table below (where paragraph number refers to the CDR report [T040009-00](#)).

Action Items from the COC Design Requirements Review			
Item #	Action Item Description	parag. #	Status by Dennis Coyne
1	Provide better thermal compensation requirements and interfaces.	1	COMPLETED RODA M040005-01 defined the CP to be in the ITM reaction chain and comprised of FS RODA M060305-01 gives CP dimensions RODA M080022-01 defines CP to have no wedge angle and no flats
2	Institute a research plan to measure and model coating absorption issues, with respect to thermal compensation requirements, and provide preliminary results by the sapphire/fused silica downselect.	1	COMPLETED D. Shoemaker et. al., Advanced LIGO Substrate Selection Recommendation, M040405-00 D. Reitze (OWG), Test Mass Substrate Material Selection for Advanced LIGO: An Update from the Optics Working Group, G040321-00 G. Billingsley, Further investigation of Hanford ITM absorption, T050178-00 D. Ottaway, et. al., Optical absorption in Initial LIGO IFOs, T050074-01 A. Remillieux, Coating absorption measured at Lyon 1 and 3" samples fused silica & sapphire (Absorption Maps of Formula 5 on Silica and Sapphire), C040532-00 Plus many other undocumented absorption measurements by L. Zhang
3	AOS will provide input to COC on the size (and possibly material if negative dn/dT materials are considered) of the compensation plates. Include the suspension method for the CP in the CDD.	2	COMPLETED RODA M040005-01 defined the CP to be in the ITM reaction chain and comprised of FS RODA M060305-01 gives CP dimensions RODA M080022-01 defines CP to have no wedge angle and no flats
4	Carefully study the deformation of the HR surface of the ITM at high arm power before the downselect, to understand what compensation is needed and possible, how much the ITM would be heated to provide this compensation, and what requirement on coating absorption is needed to make thermal compensation practical.	3	COMPLETED Section 5 of G. Billingsley (ed.), Test Mass Material Down-select Plan, T020103-08 P. Willems, Detailed Report on Thermal Compensation Effects in Advanced LIGO, T040201-00 P. Willems, Comparison of Thermal Distortions in Sapphire and Fused Silica, T040163-00
5	The committee feels that the 75ppm total loss budget for a single arm cavity is stringent and cannot be met given the large surface scatter in the initial LIGO optics. Can the 75ppm arm loss requirement be relaxed by SYS?	4	INCOMPLETE (Transferred to PDR action item list) The 75 ppm arm loss is viewed as a possibly achievable goal which is not driving COC costs (best effort to state-of-the-art). If the arm cavity loss is as high as 150 ppm the performance of the interferometer for most sources should not substantially decrease. COC has an action from this PDR (item 35 of L080029-00) to include in the DRD an analysis & discussion of the (in)sensitivity of various sources to arm cavity loss in order to put the loss budget goal of 75 ppm into proper context.

Action Items from the COC Design Requirements Review			
Item #	Action Item Description	parag. #	Status by Dennis Coyne
6	Pursue further studies to determine scatter and diffraction losses in the interferometer arms.	4	COMPLETED P. Fritschel, Dimensions for Advanced LIGO Fused Silica Test Masses, T040199-00 W. Kells, Initial LIGO COC Loss Investigation Summary, T070051-00 H. Yamamoto, Scattering Loss, G070657-00 H. Yamamoto, Diffraction Effect in Stable Recycling Cavity, G070607-01 H. Yamamoto, LIGO I mirror scattering loss by microroughness, T070082-03
7	Characterize Rayleigh scattering in sapphire.	5	COMPLETED Rayleigh scattering in sapphire has been documented in a paper done by Blair's group at UWA: Zewu Y., et. al Study of Growth defects in Sapphire by Laser Rayleigh Scattering Imaging LIGO-T040077-R
8	Evaluate cleaning procedures with respect to their contribution to lowered performance. Include cleaning requirements in the requirements and design documents.	6	COMPLETED H. Armandula, L. Zhang, Evaluation of optical absorption and scatter on a coated surface after exposing the surface to gross contamination, T060181-00 H. Armandula, Absorption measurements on MMT4K04-1 before and after applying First Contact, T070002-01 H. Armandula, Tests to evaluate the effects of cleaning methods in optical absorption at 1064 nm, T050055-00 Cleaning requirements were not included explicitly in the DRD. A cleaning approach was briefly described in the PDD. I find it acceptable to limit cleaning to the PDD.
9	Provide better phrasing and intent on contamination requirements during use and handling.	7	INCOMPLETE (Transferred to PDR action item list) The description of contamination control requirements and controls during use and handling is not substantially different than at the CDR. This action item is re-issued as items 26, 27 and 28 (especially 28.c) in L080019-01.
10	Add the requirements listed in this paragraph (8) to the DRD and the CDD.	8	COMPLETE Requirements for the CP, FM have been included. Call outs for wedge angles have been included (but see also item 11 of this list) as well as flat dimension for the TMs.
11	Specify the wedge and radii of curvature requirements for the pickoff beams and ghosts.	9	COMPLETED The COC PDD refers to SYS/AOS documentation for specific wedge angles. The revision will specifically cite: T080078-01, Optic Coordinates and Cavity Lengths (Stable Recycling Cavities) ROC are now defined in both the COC DRD and the PDD.
12	Include a discussion of the coating characterization and design philosophy in the documents.	10	COMPLETED A brief description of coating mechanical, optical and thermal properties and the potential for optimization by layer thickness variation is given in the DRD section 4.2.2.2.2.2. A list of coating characteristics to be measured in the production phase is given in section 3.2 of the PDD. There are many measurements on mechanical and optical characterization of the coatings during development and some documentation on these studies.

Action Items from the COC Design Requirements Review			
Item #	Action Item Description	parag. #	Status by Dennis Coyne
13	Bring all coating requirements in the CDD up to date.	11	COMPLETED For the PDD
14	Set requirements for charging of optics - from SYS for noise forces and from SUS for control issues. Rapidly develop a research plan and study mitigation of effects.	12	COMPLETED (though still an active area of investigation) G. Harry (ed), Charging Noise and Mitigation Research Plan, T070118-00
15	Develop a realistic schedule and a priority listing of activities for the overall COC development plan.	13	COMPLETED The COC development schedule is maintained by AdL management in Primavera
16	Amend the Downselect Document to give a clearer plan of what we need to know and are likely to know by the downselect.	14	COMPLETED Material selection was made: D. Shoemaker et. al., Advanced LIGO Substrate Selection Recommendation, M040405-00 On the basis of: G. Billingsley (ed.), Test Mass Material Down-select Plan, T020103-08
17	Provide more specification for operations and handling issues, including 'travelers' procedures, transport, equipment (e.g. carriers), clean room conditions, and static control.	15	INCOMPLETE (Transferred to PDR action item list) The description of handling, procedures and transport equipment is not substantially different than at the CDR. This action item is re-issued as items 26, 27 and 28 above (especially 28.c).
18	Correct typos, missing information, and obscure phrasing found in the documents.	16	COMPLETED