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Date:	12 November 2008
Refer to:	L080076-00-R
Subject:	Resolution of BOSEM FDR and FRR Design Issues
To:	BOSEM review committee (Betsy Bland, Doug Cook, Dennis Coyne, Peter Fritschel, Jay Heefner, Richard Mittleman, Janeen Romie, Brett Shapiro, Calum Torrie, Bill Tyler) and Carol Wilkinson, David Shoemaker
From:	Norna Robertson (chair of committee) with input from the UK Adv LIGO SUS group, in particular Stuart Aston.

1. Introduction

In the report on the BOSEM final design review and fabrication readiness review, L080022-00-E, five outstanding design issues were noted in section two. We report here the outcome of work done on these issues. For each item, the wording from the review report is restated, and the current status on the resolution of these issues is given in italics.

2.1 Clearance between OSEM body and magnet/flag assembly.

The committee recommends that the gap between the magnet/flag assembly and the bore of the BOSEM be at least doubled from its present value of 1.2 mm.

Information from Stuart Aston:
The original aperture was 12.7mm in diameter.
The revised aperture is now 15.9mm in diameter.

The magnetic flag mount base is 12.5mm in diameter (11mm across flats).
So the clearance has increased from 0.2mm to 3.4mm.

2.2 Material of sleeve around the IRLED

The committee recommends that a test be made with an alumina LED sleeve replacing the present macor one, to see if higher thermal conductivity leads to lower noise: this test should be made and reported to the committee before finalising the material choice.

This test has now been carried out and was reported by Stuart at a SUS telecon on Tuesday 29th August. The results are shown in the figures at the end of this report. Stuart notes that these BOSEM sensitivity plots are for a complete end-to-end test of the production BOSEM + Satellite Box electronics.

The conclusion is that there is no evidence that increasing the thermal conductivity of the sleeve by using alumina instead of macor leads to a lower noise performance. Thus the UK team will go ahead with placing orders for Macor parts.

The committee will recall that the noise spectrum from the first prototype was a factor of 3 better in sensitivity than the production items. Although the production items meet the required specification, that factor of 3 would be very useful to get back. The UK team will continue to look into the source of the higher noise, firstly revisiting the original measurements made at Birmingham and at Strathclyde to confirm that there really is a factor of 3 to be gained.

2.3 Shielding of cabling

The committee recommends that the BOSEM designers work with LIGO CDS to come up with a mutually agreeable solution regarding the best way to connect shielded cabling to the BOSEM without galvanic connection to the BOSEM body.

Information from Stuart Aston:
Two issues are involved
i) If to include shielding for the harnesses at all.
ii) The direct galvanic connection between shielding and BOSEM body.

The status of each follows:-

i) It has not yet been demonstrated that shielding is required. We are awaiting the outcome of cross-coupling measurements to be made on the Noise Prototype Quad monolithic suspension (BOSEMs + ESD). The default for the production harnesses is to make them unshielded based on the argument that we do not know that there is an electrical problem but we do know that shielding makes the cables stiffer and hence may make the mechanical alignment more difficult. However the UK team is providing a shielded harness for the upcoming quad training assembly at LLO so that we can gain experience of aligning with shielding in place as a precautionary measure. If the electrical shielding tests at LASTI demonstrate that shielding is necessary then the production items will have to be redone at extra cost.

ii) Rich Abbott has supplied a sample bespoke PEEK connector from an alternative supplier that overcomes this problem. These parts are significantly more expensive, but provide additional production and assembly benefits. After undertaking a trade-off study, this approach is now our baseline. The bespoke PEEK connectors would also provide an easier upgrade option in the future, enabling the harnesses to be reworked to include screening if deemed necessary.

2.4 Material for adjuster shaft

The committee recommends that the adjuster shafts should be made of a harder material than aluminium, such as stainless steel or titanium.

Information from Stuart Aston: we continue to use titanium for the adjuster shafts.

2.5 Use of phosphor bronze

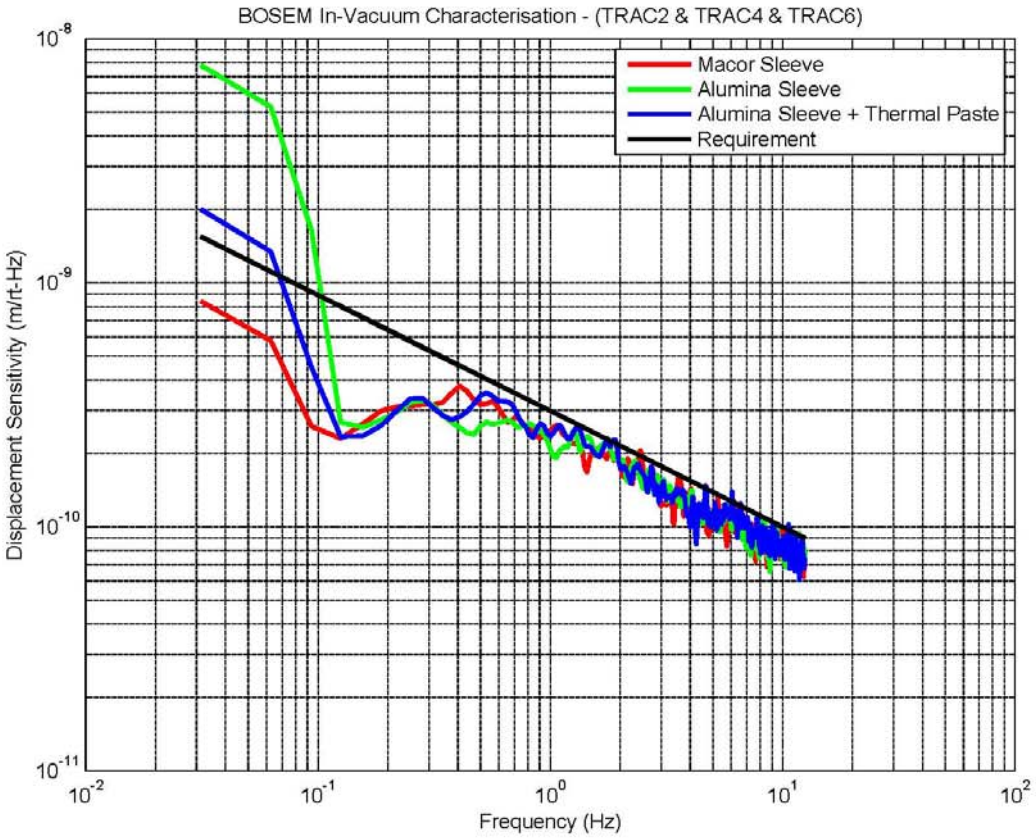
We note that the spring-clip (D060115) is comprised of phosphor -bronze. Although phosphor-bronze is on the current LIGO UHV compatible materials list, all bronzes and brasses should not be allowed in the vacuum system (including phosphor-bronzes), unless there is a compelling reason (no other suitable material), in which case a waiver can be requested of the Vacuum Review Board.

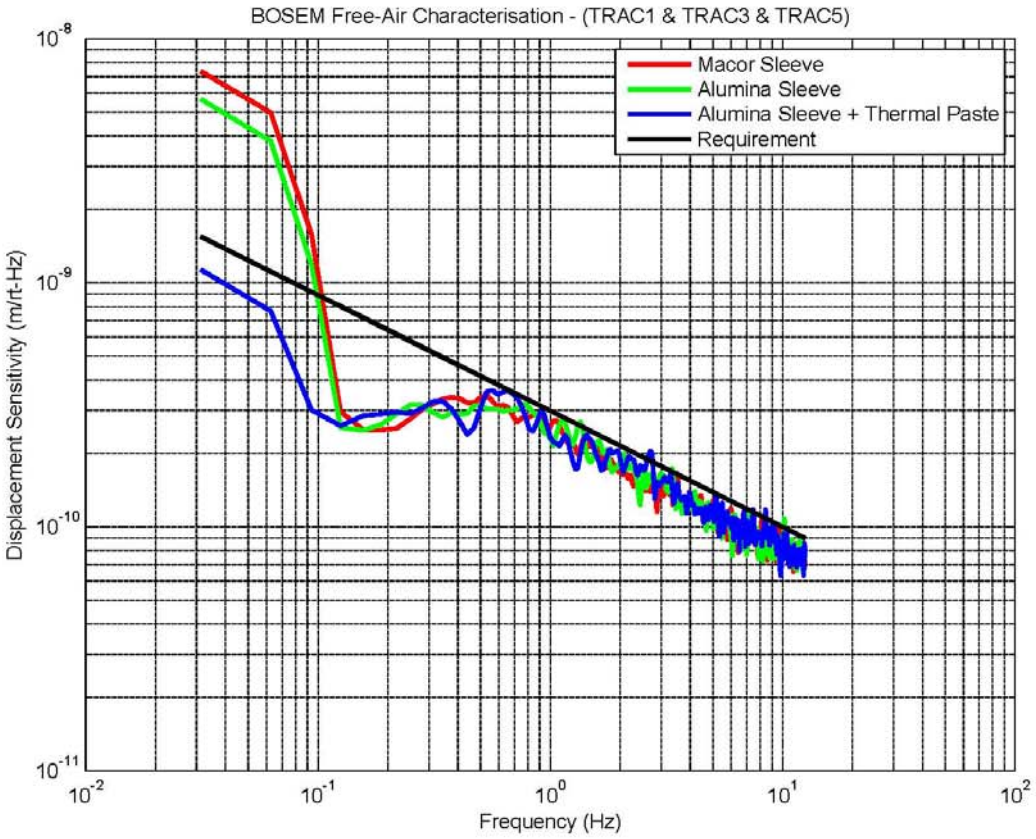
Information from Stuart Aston: We received confirmation that British Standard PB2 grade of phosphor bronze would be acceptable.

Further details of acceptable levels of high vapor pressure elements in alloys can be found in L080045: Limits to high vapor pressure elements in alloys (Dennis Coyne). This proposal was approved by the LIGO Vacuum Review Board, refer to L080072-00-V.

3 Conclusion

Items 2.1, 2.2, 2.4 and 2.5 are now resolved. Item 2.3 is still open pending the outcome of tests at LASTI. Those tests should be done in the next few months at which time the outcome of that item can be finalised and reported in an update to this document.


BOSEM In-Vacuum Characterisation - (TRAC2 & TRAC4 & TRAC6)
Macor Sleeve
Alumina Sleeve
Alumina Sleeve + Thermal Paste
Requirement
Displacement Sensitivity (m/rt-Hz)
Frequency (Hz)
10^-8
10^-9
10^-10
10^-11
10^-2
10^-1
10^0
10^1
10^2


BOSEM Free-Air Characterisation - (TRAC1 & TRAC3 & TRAC5)
Macor Sleeve
Alumina Sleeve
Alumina Sleeve + Thermal Paste
Requirement
Displacement Sensitivity (m/rt-Hz)
Frequency (Hz)
10^-8
10^-9
10^-10
10^-11
10^-2
10^-1
10^0
10^1
10^2