

Jeff Kissel <jkissel@ligo.mit.edu>

April 30, 2015 4:05 PM

To: jim warner <warner_j@ligo-wa.caltech.edu>

Cc: Brian Lantz <blantz@stanford.edu>

Re: BSC-ISI performance limits

Hey Brian,

Jim has conveyed our discussion well for the BSC-ISIs, and I can summarize by saying that thus far, the DARM ASD is not limited by the 10 [Hz] motion of the platforms right now:

H1 <<https://alog.ligo-wa.caltech.edu/aLOG/index.php?callRep=18126>>

L1 <<https://alog.ligo-la.caltech.edu/aLOG/index.php?callRep=17946>>

Indeed -- the L1 prediction even claims that we're already at the required displacement performance for the SEI/SUS system.

How much improvement do we expect to need beyond this for the A+ noise curves? It's only after that can we answer which one of these ideas for 10 [Hz] improvement should be our "priority." I second Jim's sentiment that it's the below 1 [Hz] performance, where there is plenty of loop gain already, that we're just skating the edge of "good enough."

On the Z/RZ coupling, I think Jim is blurring two areas of improvement together, though:

3. I didn't see anywhere in the T1500120 mention of the Z/RZ coupling. It's kind of fallen off the radar, and there are nearer term blend changes Jeff and I have discussed for some improvement. But this limits our ability to blend lower than 750mhz on RZ. It also forces us to blend higher in Z, which we've compensated for by doing broadband sensor correction on HEPI Z. But, I think we could get some improvements in the .5-1 hz region if we could blend lower in RZ.

I think the Z direction *was* limited by Z ISI ST1 drive to RZ ISI ST1 response. The current solution to that is do the bulk of the Z drive with HEPI instead -- i.e. blend the ST1 sensors high, and rely on broad-band sensor correction to win below 1 [Hz]. *If* we feel the need to push sensor correction back on to ST1 of the ISI (though I can't think of a compelling reason) then we could try to improve the stiffness of the actuation on stage 1. Sebastien had just gotten to the point of adding stiffening elements to the ST1 snow-flake when we discovered we could "fix" the problem by driving HEPI instead, and then it got dropped. It is indeed worth adding a bullet point on exploring further stiffening of the snowflake, since that's on the same level as some other items in T1500120.

However, because we reduced the Z drive, the Z ISI ST1 drive to RZ ISI ST1 response is NOT the limiting noise in RZ direction below 1 [Hz] at the moment. It's as Jim suggests above; it's sensor noise. We're blending at 750 [mHz], and the inertial sensor low pass really kinda stinks for what T240 noise we have; see pg 18 of

<https://alog.ligo-wa.caltech.edu/aLOG/uploads/17305_20150317132919_BSC_Performance_gs13calc_2015_03_17.pdf>

So these are the "short term" (because it doesn't involve a hardware change) improvements Jim suggest -- tune the blend filtering for RZ. Inertial sensor noise seems to dominate the RZ performance below 100 [mHz]. At 100 [mHz], the inertial sensor roll-off in the 750 [mHz] blends is only about a factor of 5.

If we include a better inertial sensor roll-off, then perhaps we can push the performance of the CPS roll-off, which is limiting the ST1 performance from 200 [mHz] to 5 [Hz].

Regarding the HAM-ISIs, I think we have even less interferometric evidence of how the local performance affects the DARM ASD. We've seen smatterings and hints that the relative motion between HAM5 and HAM6 causes non-stationary scattering noise, but no one's really nailed down a mechanism yet, and it looks like both sites are different:

H1 <<https://alog.ligo-wa.caltech.edu/aLOG/index.php?callRep=17919>>

L1 <<https://alog.ligo-la.caltech.edu/aLOG/index.php?callRep=17776>>

Cheers,

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On Apr 30, 2015, at 2:57 PM, jim warner <warner_j@ligo-wa.caltech.edu> wrote:

I talked this through with Kiwamu and Jeff a bit. My couple of comments:

1. Above 1 hz, I don't get much feedback from the Kiwamu's and Sheila's of the LHO world. At this point the performance of the IFO is limited by other things in that area, so it's unclear. At this point, the local performance is limited by GS13s in the 1-10 hz region, and maybe feedforward. Lower CPS noise would help some too, but we've mostly handled that by rolling off CPS blends more aggressively. Jeff argued that this is also the region where SUS is more important.

2. Below 1hz, when SEI makes things any worse, we hear immediately and Sheila shows up to the Friday SEI meeting. I think they would like to see low frequency improvements. Especially in the range 30-100 mhz, around our blend filter gain peaking. So, BRS? Tilt free seismometers?

3. I didn't see anywhere in the T1500120 mention of the Z/RZ coupling. It's kind of fallen off the radar, and there are nearer term blend changes Jeff and I have discussed for some improvement. But this limits our ability to blend lower than 750mhz on RZ. It also forces us to blend higher in Z, which we've compensated for by doing broadband sensor correction on HEPI Z. But, I think we could get some improvements in the .5-1 hz region if we could blend lower in RZ.

4. Our duty cycle is very good, except for wind, which BRS helps with, but blend configurations need more investigating. Chambers almost never trip anymore, except for earthquakes, or people running into HEPI. And totally uncontrollable/unknowable things like cables unplugging themselves in chassis.

5. We aren't gain limited at low frequency. Unclear if higher UGF's are really necessary.

If I come up with anything clever, I'll send it along. I have some crazy/bad ideas, but I don't know what the forum would be to suggest them.

On 4/30/2015 11:19 AM, Brian Lantz wrote:

Jim,

Soon I will have the opportunity to pitch for improvements to the SEI/SUS systems for LIGO A+ Consider a 5 year time-scale (as opposed to the quick-quick scale you usually see), and then ...

Since you keep making the BSC-ISI and HAM-ISI better, you are best placed to answer the question

1) what is keeping us from making it better? or, alternately -

-what would we have to change to get it to be better? (e.g. lower noise GS-13, lower noise stg2 CPS, smack-down of the 8 Hz amplification, 50 deg less phase loss at 100 Hz)

2) would "making it better" at 10 Hz help the current IFO in any way?

Then,

Please take a look at the 4 pages of text in [T1500120](#) and see if you have other suggestions.

Other questions which would be interesting:

3) What areas would 'better' be? Low frequency isolation, 0.4 Hz? 1-6 Hz? 6-30 Hz? etc

4) should we be thinking about the ASD of typical motion, or something else (e.g. low freq alignment, getting the duty cycle up ~99%,)

5) how can we better integrate SEI with SUS for an all-new SUS?

some thoughts soon are better than complete and perfect thoughts in a week. The discussion is next Thursday.

Thanks!

-Brian

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