<u>Summary of DP11626 (Abbott et al.)</u>: This paper presents an overview of the calibration process and its accuracy in the Advanced LIGO detectors during the time of the GW150914 discovery. It is aimed at interferometry experts (this reviewer is not one), so aspects were difficult to understand without appropriate background.

Nonetheless, the authors' general approach is clear. Figure 2 is particularly important in the exposition. It shows, linearized about the locked condition, a schematic representation of how arm length imbalance and the photon calibration displacement are processed through a sensing function C, a digital processing function D and a test mass actuation function A. This processing chain produces two signals (d_err = a sensed measure of arm length imbalance and d_cntl = a computed correction to be applied to the test masses), a linear combination of which is then used to estimate the calibrated strain, h.

The paper addresses how errors in these processes affect errors in estimating the strain, h, via

- the uncertainties in C (equation 3: errors in K_c = sensing function gain, f_c = pole of sensing function filter, C_R = "other", and tau_c = delay due to light propagation times in LIGO and digital computation delay)

- the uncertainties in A (equation 4: F_T = dimensionless digital filter function which is presumably completely deterministic and does not contribute to random errors in the final uncertainty, K_i = 3 gains of test mass actuators, A_i = 3 actuator functions, and tau_a = digital-to-analog delay)

- presumably the digital processing function, D, is deterministic and does not enter into the random errors in h

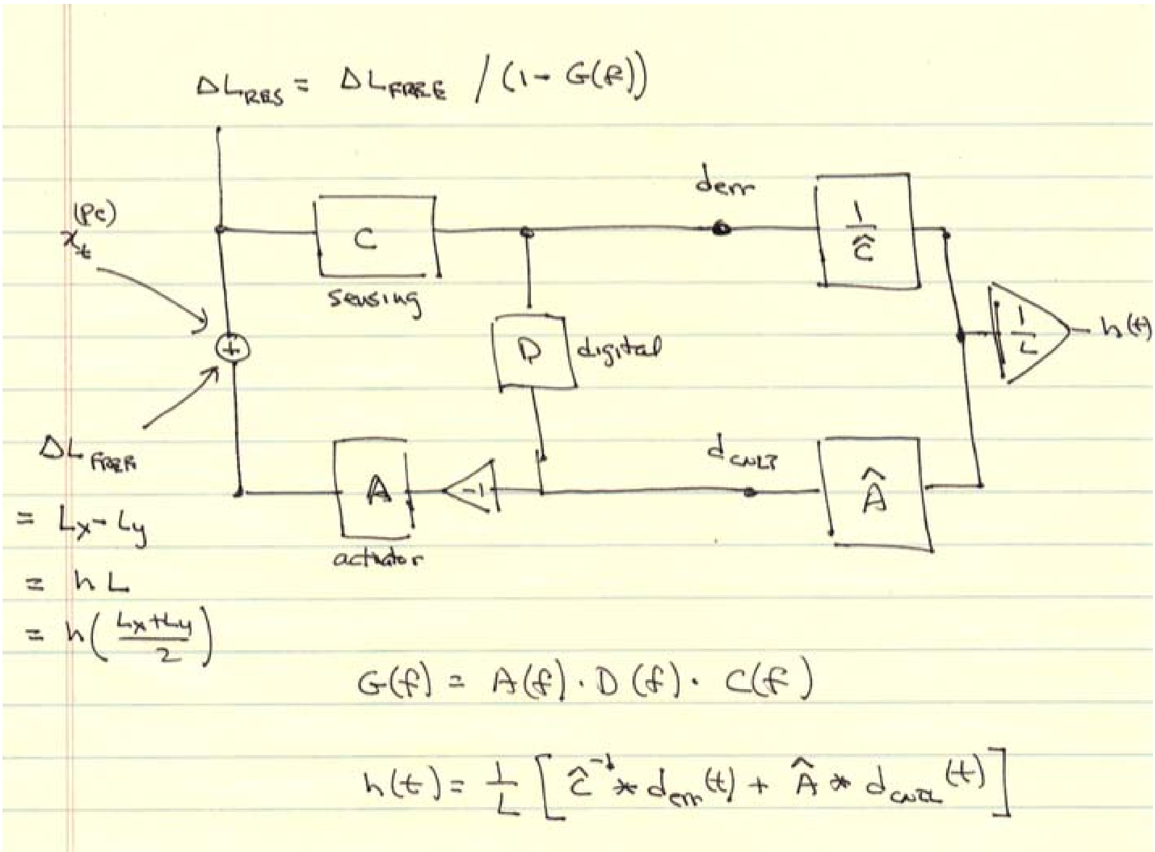
Table 1 shows the parameters measured using sinusoidal calibration injections at various points in the control loop (equation 6). These are apparently weakly nonstationary and so the calibration process continuously tracks their slow evolution in time.

The conclusion is that the calibration uncertainty for h at the time of the GW150914 detection was accurate to 10% in magnitude and 10 degrees in phase over the 20-1000 Hz GW band relevant to the detection.

<u>Reviewer Recommendation</u>: This paper is an important companion to the discovery paper, since the collaboration concludes that calibration uncertainties are small enough that they do not impact the astrophysical conclusions in the GW150914 detection (Section XI). The paper should be promptly published in PRD. In light of its timeliness, I ask that the authors only consider the minor specific points below (which if addressed would, I think, improve the exposition) but that its prompt publication in PRD not thus be delayed.

Minor points:

• Figure 2 is essential to understanding the paper. It would be good if the definitions of the quantities in the text could also be on the figure. E.g.:




This would have saved me, e.g., from going back and forth from the text to the figure when I was trying to understand the overview.

• Figure 2: in the caption it would be useful to comment on x_t^(PC) other that to say "see Section IV". Something simple like "x_t^(PC) is the modulated displacement of the test masses accomplished by the photon calibration apparatus (see Section IV).", for example.

• page 6, below equation 3: Why are the pole frequencies of H1 and L1 (341 and 358 Hz) different? Was this an intentional design decision?

• page 8, near equation (8): is there any evidence for non-Gaussian errors when in the locked condition? Or are these absorbed in the time-dependence of the slowly-varying systematics of the calibration?

• page 8 below equation (9) and the captions of Figures 5 and 6: "data … are…".