

From: prd@aps.org
Subject: DP11626 Abbott
Date: March 14, 2016 at 8:05 AM
To: jkissel@ligo.mit.edu



Re: DP11626
Calibration of the Advanced LIGO detectors for the discovery of the
binary black-hole merger GW150914
by B. P. Abbott, R. Abbott, T. D. Abbott, et al.

Dear Dr. Kissel,

I have been in touch with Referee B and the referee confirms that the
report that was sent to you (copy appended below) is complete.

Yours sincerely,

Ansar Fayyazuddin
Associate Editor
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Report of Referee B -- DP11626/Abbott

This paper describes the readout of the gravitational wave strain in
the Advanced LIGO detectors and assesses the systematic and
statistical errors in their calibration. After giving an overview, the
authors discuss the sensing system, the actuation function, and the
combined response function. After having set up a formalism for
treating errors and describing their primary calibration method, they
arrive at error budgets for these functions. The potential impact on
estimating the parameters of GW150914 is also discussed.

The paper's subject matter is crucial to the discovery and
interpretation of GW150914, and its presentation is very clear. I only
have very minor comments which should be easy to address, after which
I will heartily recommend publication.

1. The explanation in the second and third paragraphs leading to Eq.
(2) for the strain and Eq. (5) for the response function R might be
formulated more clearly by going through the feedback loop in a step
by step fashion and systematically introducing the set of equations
describing the behavior of the system:

$$\begin{aligned}dL_{\text{res}} &= dL_{\text{free}} - dL_{\text{ctrl}} \\d_{\text{err}} &= C dL_{\text{res}} \\d_{\text{ctrl}} &= D d_{\text{err}} \\dL_{\text{ctrl}} &= A d_{\text{ctrl}}\end{aligned}$$

Together with $h = dL_{\text{free}}/L$, this immediately motivates Eq. (2):

$$\begin{aligned}h = dL_{\text{free}}/L &= (dL_{\text{res}} + dL_{\text{ctrl}})/L \\&= (C^{-1} d_{\text{err}} + A d_{\text{ctrl}})/L.\end{aligned}$$

Also, setting $dL_{\text{free}} = R d_{\text{err}}$, from the above equations one can read
off Eq. (5) for R in terms of A, D, C. In the current text these
relations are present, but a bit scattered about.

2. In Eq. (13), the error propagation does not appear to involve
correlations. Are they small, or zero?

3. Axis labels on plots in Figs. 3-10: introduce spaces between words.

4. At the end of Sec. IX: "Although potential timing offsets between
different channels on the same analog-to-digital-converter board were
not measured, there is no reason to believe that there were any timing
offsets larger than a few microseconds." Also, "Even if the most
conservative estimate is used as a measure of caution, the absolute
timing discrepancy from UTC, and therefore between detectors, was no
larger than 10 μs ." Where do these numbers come from?

