

## Reviewer #1 (Remarks):

This manuscript is very well written. It explains well about the aLIGO Pcal system in a clear and simple ways but with sufficient details. I suggest to publish it after minor revision. Here are some comments:

### General

1. In the reference list at the end of the paper, there are many LIGO internal documents that public cannot access (Ref. 22, 23, 24, 28 and 32). They should be changed to visible for public, or use other references which can be accessed from non-LIGO readers.

**Send Jeff an email about it.**

2. Also in the reference, several LIGO log entries are cited. The web address to the log top page should be noted once in the reference list.

**Link added**

3. Figure 3: (photo) It is unclear what the authors want to show in the photo. Where is the periscope? Are the relay optics and camera shown in the photo? A pointer or explanation will be useful either in the photo or caption.

(caption): In the caption should be revised; there are two relative pronouns "that," and it makes the sentence nested.

**Edit: The 1.8 m diameter aluminum periscope structure that supports the relay mirrors for the two Pcal beams as well as the large, rectangular relay optics for the beam localization camera system. In this photo, it is mounted in a cradle used to pre-align the optics before the structure is inserted into the vacuum envelope. When installed, it is supported by four flexures that were designed to maintain the orientation of the structure even as the diameter of the vacuum envelope changes between the vented and evacuated states.**

4. page 5, last paragraph, the long term stability of the Pcal system can be evaluated by measuring the amplitude of the laser power modulation measured with the power sensor in the receiver module. ... A word "measured" used twice. Better wording may make the sentence clearer.

**Edit: rewrote this paragraph. Remove last two sentences because the information was redundant with info given earlier.**

5. page 6, II-C and Figure 10 caption Is the mentioned millimeter accuracy enough for the system? What the target/requirement accuracy for this new camera positioning system?

6. page 12, V-C: In this subsection, The measurement and result of the coupling between the common and differential arm actuation are described. The motivation is explained as for the accurate injection tests. However, how/why 0.2% coupling is sufficient for the injection test is not explained. 0.2% sounds extremely good from the experimental point of view, but how good is it for the search pipelines and data analysis with the injected signals?

Reviewer #2 (Remarks):

This is a good paper about a complex part of the LIGO interferometers. It is clear and complete. I recommend publication, after the authors have considered the comments below.

Abstract:

1. "Accurate calibration of the output of these detectors was crucial for the observation of these events, and the extraction of parameters of the sources."

No comma:

"Accurate calibration of the output of these detectors was crucial for the observation of these events and the extraction of parameters of the sources."  
**Corrected.**

2. p1: The displacement sensitivity during the GW150914 event and the Advanced LIGO design sensitivity are shown in Fig. 1."

number agreement:

"The displacement sensitivities ..."  
**Corrected**

3. p4: It houses a 2-watt Nd:YLF laser operating at 1047 nm. This wavelength is close enough to the 1064 nm wavelength of the main interferometer laser to ensure high reflectivity from the test mass mirror coating, but far enough away to ensure that scattered Pcal light does not compromise interferometer operations."

Can this be explained a bit? Are there bandpass filters on the interferometer photodetectors? Is it just that there is no beat note in when the scattered light reaches one of the 1064 photodetectors? A few sentences would help.

**Added some sentences below as a footnote**

**Edit: This wavelength is close enough to the 1064~nm wavelength of the main interferometer laser to ensure high reflectivity from the test mass mirror coating. The frequency of the Pcal light is sufficiently far from that of the main interferometer light (approximately 5~THz higher) that scattered Pcal light cannot compromise interferometer signals that are demodulated at 10s of MHz. Furthermore, the relatively large incidence angles and extremely low BRDF of the test mass surface ensure that scattered interferometer light does not impact the accuracy of the Pcal systems.**

4. Fig 4: A detector is labeled OFSPD. The acronym is not explained. "OFS photodetector" is used later and is clear. I suggest changing it to OFS photodetector on the figure.

Changed the label in the figure

5. Caption to Fig 7: The suppressed RPN meets Advanced LIGO requirements (black) at frequencies above 10 Hz."

And below too, it appears. Why not just say

"The suppressed RPN meets Advanced LIGO requirements (black)."

Agreed.

6. p12: "The ability to precisely vary .."

Split infinitive.

"The ability to vary precisely .."

Text modified to remove split infinitive.

7. References: The references are not in the standard RSI style. Some need updating. Are all the LIGO documents publicly accessible?