

LIGO Laboratory / LIGO Scientific Collaboration

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**Information regarding the two failed PSL
Pre-mode cleaners (PMC's) at LLO**

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This is an internal working note
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I. Introduction

The Pre-modecleaner (PMC) D1001955 is part of the PSL system (see D0902114:PSL Optics Table Layout, also E1200480:PSL). At LLO two of the PMC units have failed under different circumstances. This document attempts to reconstruct the timeline of events, give a brief summary of what unit failed, and in what way.

II. Associated Documentation

- LIGO-E1200491 aLIGO, PSL, Pre-Modecleaner (PMC)
- LIGO-T1000430 PMC Construction Manual
- LIGO-D1001955 aLIGO PSL PMC mechanical drawings
- LIGO-T1000088 aLIGO PMC mechanical drawings
- LIGO-T0900616 aLIGO bow-tie Pre-Modecleaner document
- LIGO-S1102964 aLIGO PSL PMC
- LIGO-S1102965 aLIGO PSL PMC
- LIGO-S1107833 aLIGO PSL PMC

III. Description of Events

Originally installed PMC S/N: 08

In November 2014, Rana reported ([LLO alog15751](#)) on suspicions about the performance of the originally installed PMC (T1000430 S/N: 08, S1102964). On 8 Dec 2014, Dennis M reported ([LLO alog 15986](#)) that they found in the DARM spectrum “a growing intensity noise from 100Hz to 1000Hz and a bump around 4000Hz”. It was suspected that the PMC caused this intensity problem. The Detector Characterization group also reported ([see LLO alog 16082](#)) of glitches that they associated at the time with the PMC PZT high voltage supply. Gabriele Vajente also confirmed ([see LLO alog 16202](#)) the significant coherence of PMC signals to DARM noise at ~ 1.5 kHz. The plots in Figure 1 (plots provided to me by Janeen R, unknown who produced the plots) show that the LLO PMC issue could be seen as far back as July 2011.

All this pointed to a faulty PMC PZT.

The spare LLO PMC (T1000430 S/N: 10, S1102965) was tested (16 December 2014) in the corner station on a test bed setup ([LLO alog 16155](#)) and the feature around 4kHz seen in the unit that was installed at the time in the PSL (S/N: 08) was not present in the spare PMC’s transfer functions.

The decision was made to swap out PMC unit S/N: 08 (with the suspected faulty PZT) with the LLO spare PMC unit S/N: 10. This was implemented on the 18 December 2014 ([see LLO alog 16186](#)).

The original PMC unit (S/N:08) was placed in the test bed setup and the transfer function of this unit showed the feature at around ~ 5 kHz (see [LLO alog 16203](#)).

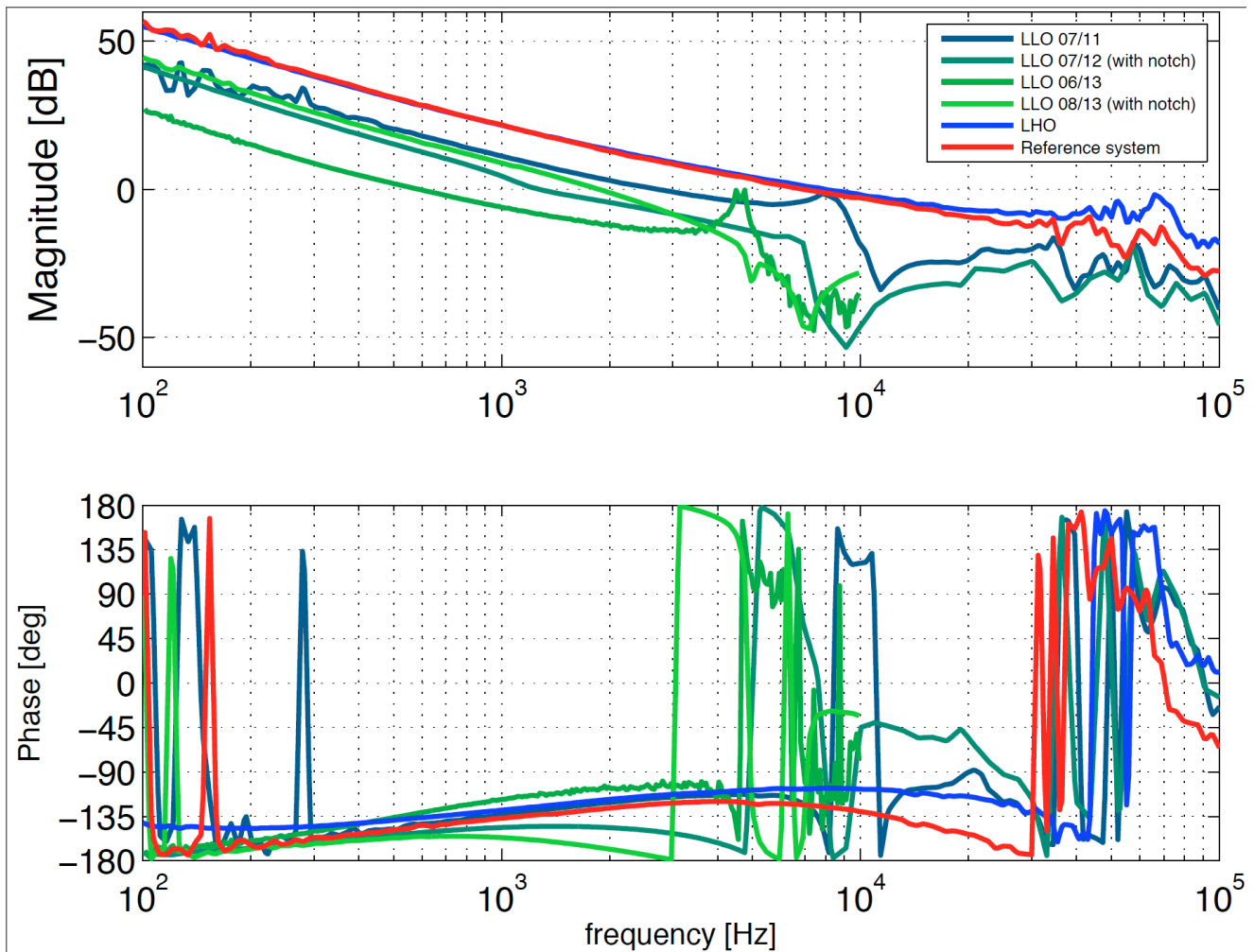


Figure1: Curves comparing the LLO PMC to the PMC at LHO and AEI showing the issue at LLO has been present as far back as July 2011

LLO spare PMC S/N:10 unit installed

On 12 January 2015 Valera reported (see [LLO alog 16338](#)) on the trend of the powers at three points of the PSL. Out of the front end amplifier, after the HPO and after the PMC. It could be seen that the rate of decay after the PMC was a lot greater than at the other two locations (see Figure 2).

A power budget measurement was performed on the PSL system (see [LLO alog 16380](#)), especially focusing on the PMC, and the visibility was measured to be ~85%, however the throughput was only ~60.5%. This indicated that the newly installed PMC (unit S/N: 10) had become quite lossy in only a month of operation.

The spare PSL PMC unit from LHO (T1000430 S/N:12, S1107833) was shipped from LHO to LLO and tested on the still set up PMC test bed in the optics lab (see [LLO alog 16466](#)). This unit passed initial tests.

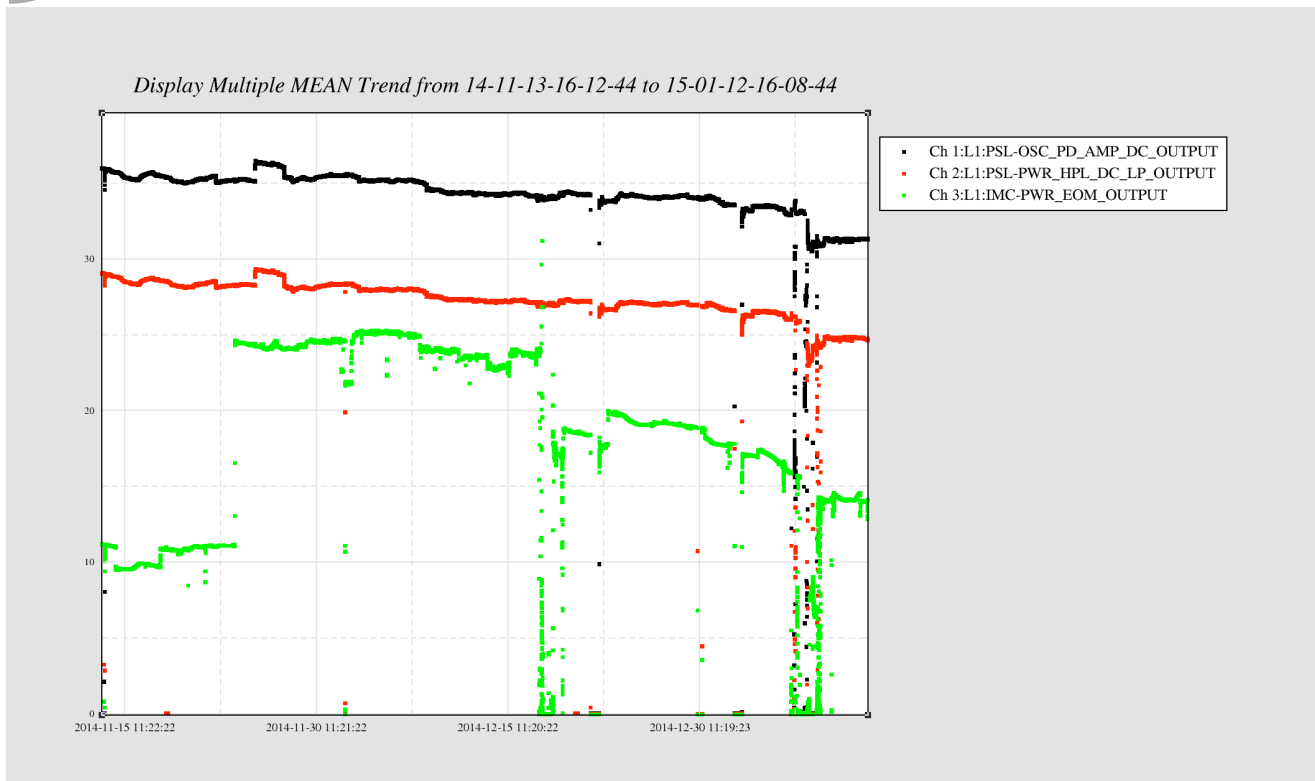


Figure 2: The decay of the power after the PMC compared to out of the front end and the HPO in the PSL.

LHO spare PMC S/N:12 unit installed

On the 21 January 2015 the LHO spare PMC unit (S/N:12) was installed into the LLO PSL (see [LLO alog 16482](#)). This unit has been running fine up to the point that this report was written (17 September 2015).

Some time in February 2015 the lossy PMC (unit S/N: 10) was shipped to LHO for analysis. The PMC unit (S/N:08) with the suspected bad PZT has been stored in the optics lab as a ‘spare’ in case the currently installed unit (S/N:12) was to fail.