LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
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H1 NCAL Prototype: PEM Coupling

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1 Introduction

This technical note documents the investigation of the H1 NCAL prototype coupling into DARM via accelerometer and magnetometers. These couplings are unwanted by-products of the NCAL infrastructure such as the mechanical stability (vibrations), spurious magnetic fields and other noise sources produced during NCAL operation.

1.1 Sources of Mechanical Noise

Mechanical vibrations will either arise from excited mechanical modes in within the NCAL structure or from acoustic noise produced by the NCAL rotor whilst its spinning. Such vibrations are produced from mechanical imperfections from the moving parts of the NCAL thereby necessitating strict tolerances within these moving parts.

1.2 Sources of Magnetic Noise

Magnetic couplings will have their origins in the Beckhoff motor control cabinet units, coil windings within the drive motor cables for data and power. Furthermore, the tungsten masses used in the NCAL rotor have an affinity to magnetism and could inject combs of lines.

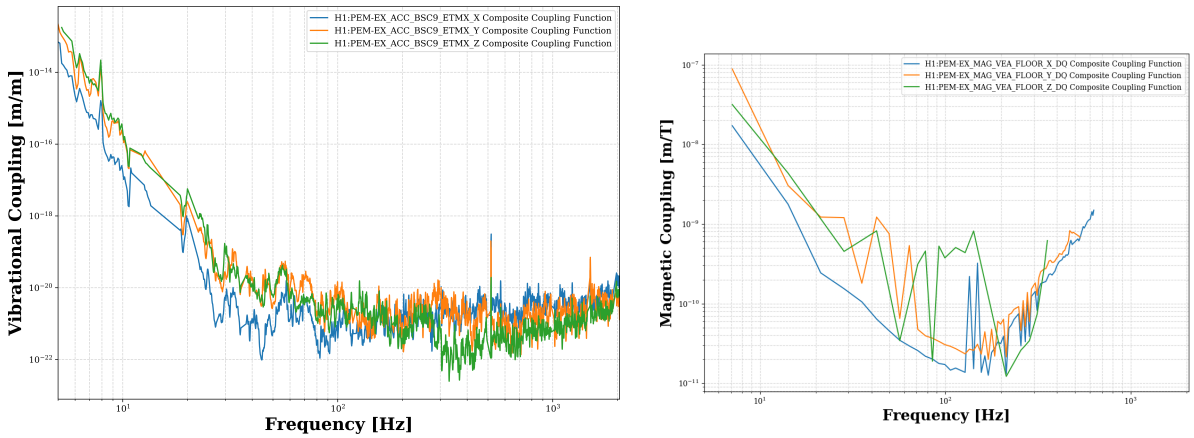
2 Resources

Link	Description
pem.ligo.org	PEM website
http://pem.ligo.org/couplingfunctions/O3a/index.php	Web directory for coupling functions
https://git.ligo.org/laurence.datrier/ncal-codebase/-/tree/master/Couplings	Code used for this investigation

Table 1: Table of useful links.

3 Composite Coupling Functions

The composite coupling function used is shown in Figure 1. These are a combination of multiple injections taken over a period of time. These injections are interrogated for sensor saturation and those injections are removed. In most cases, the injected sifnals were not recovered in the DARM spectrum therefore, the DARM response at the time of the infection is taken as the conservative upper limit. A result of this is that the full broadband noise is present in the coupling functions.



(a) Accelerometer composite coupling function (b) Magnetometer composite coupling function

Figure 1: Composite coupling functions for sensor available on PEM.ligo.org

4 Results

4.1 Accelerometer

The raw sensor output during at different NCAL injection is shown in Figure 2

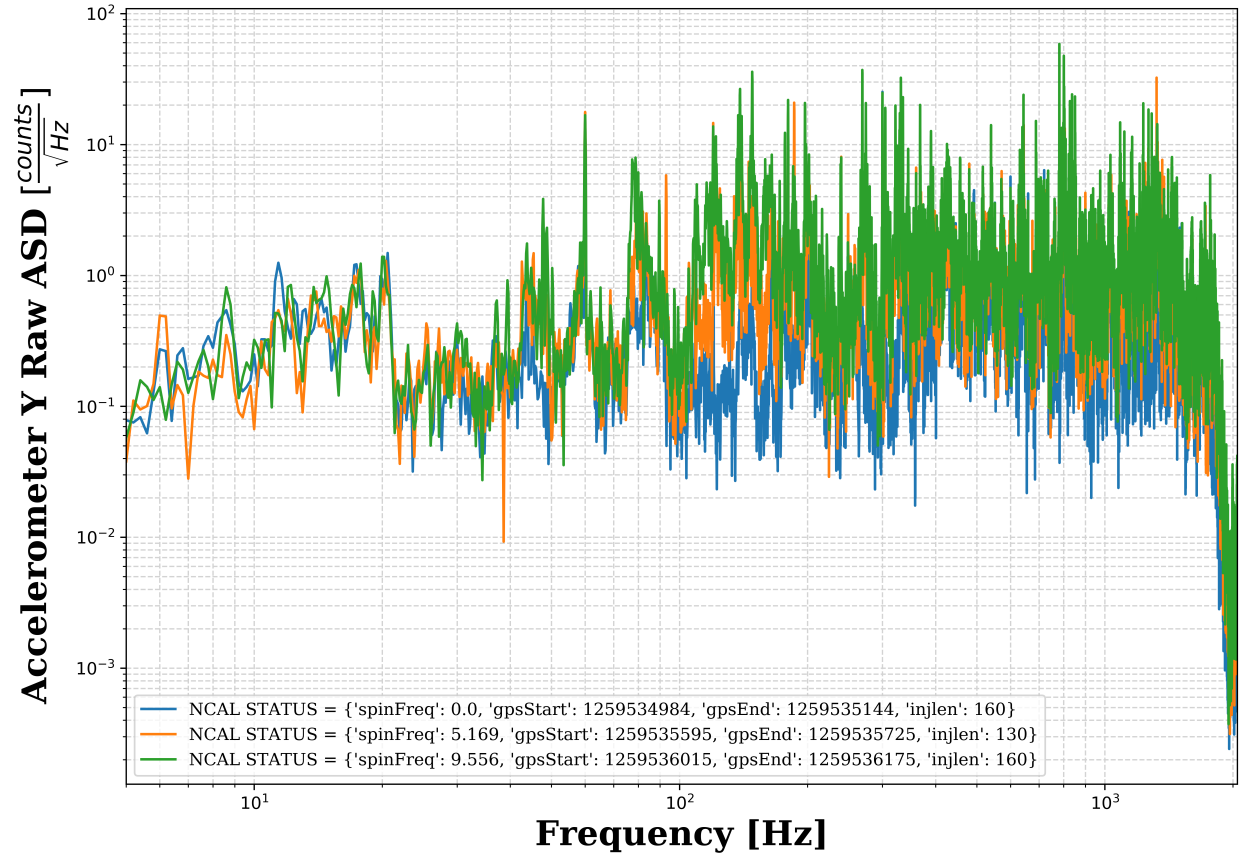


Figure 2: PEM On Vs Off at different NCAL injections.

4.2 Magnetometer

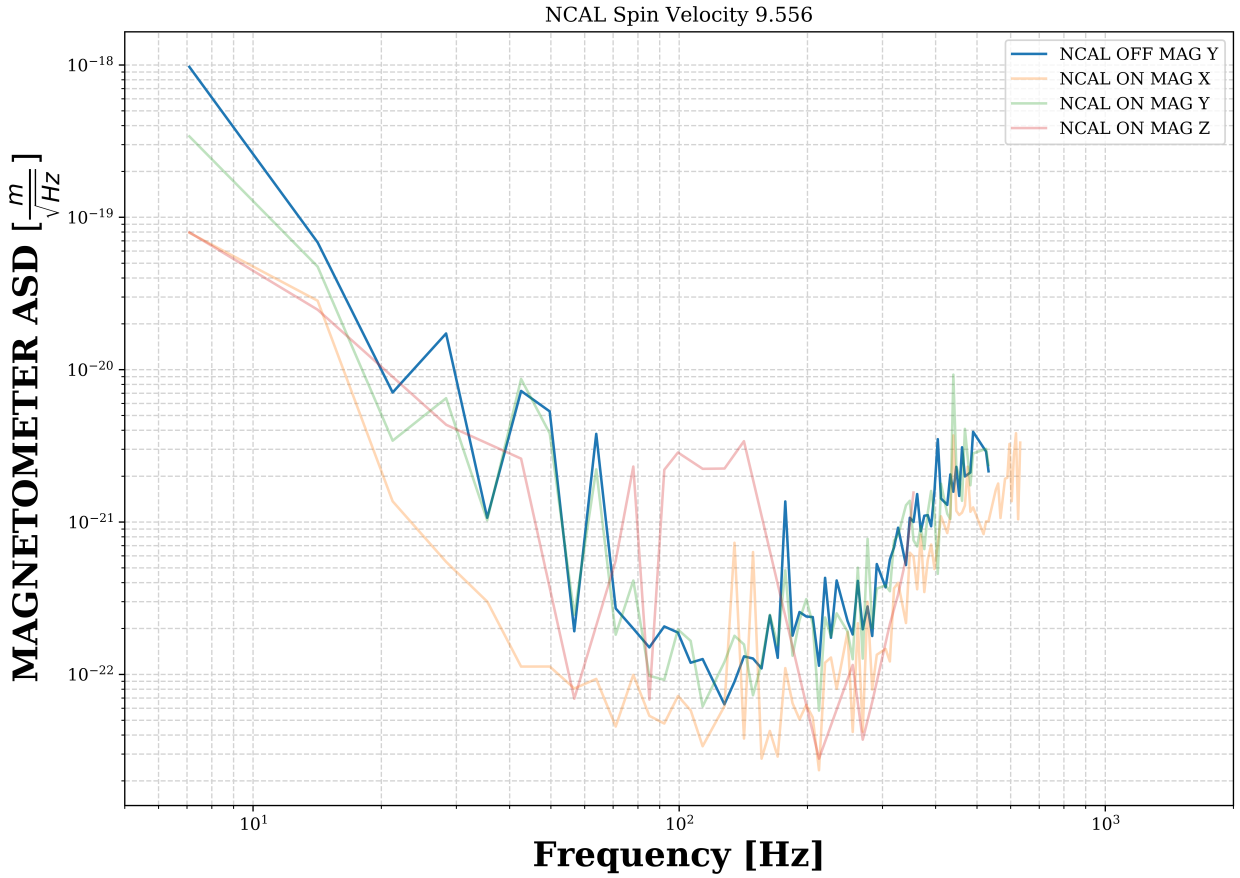


Figure 3

4.3 Overall

The NCAL injection is shown in Figure 4

4.4 Code

The code to produce these plots can be found in the NCal codebase. The full path to the code is /ncal-codebase/Couplings/src and the script called ncal_coupling.py is responsible for this analysis presented in the document.

5 Discussion

In Figure 5, we show the DARM response along with all the degrees of freedom for the accelerometers and magnetometers. All the channels have been converted into

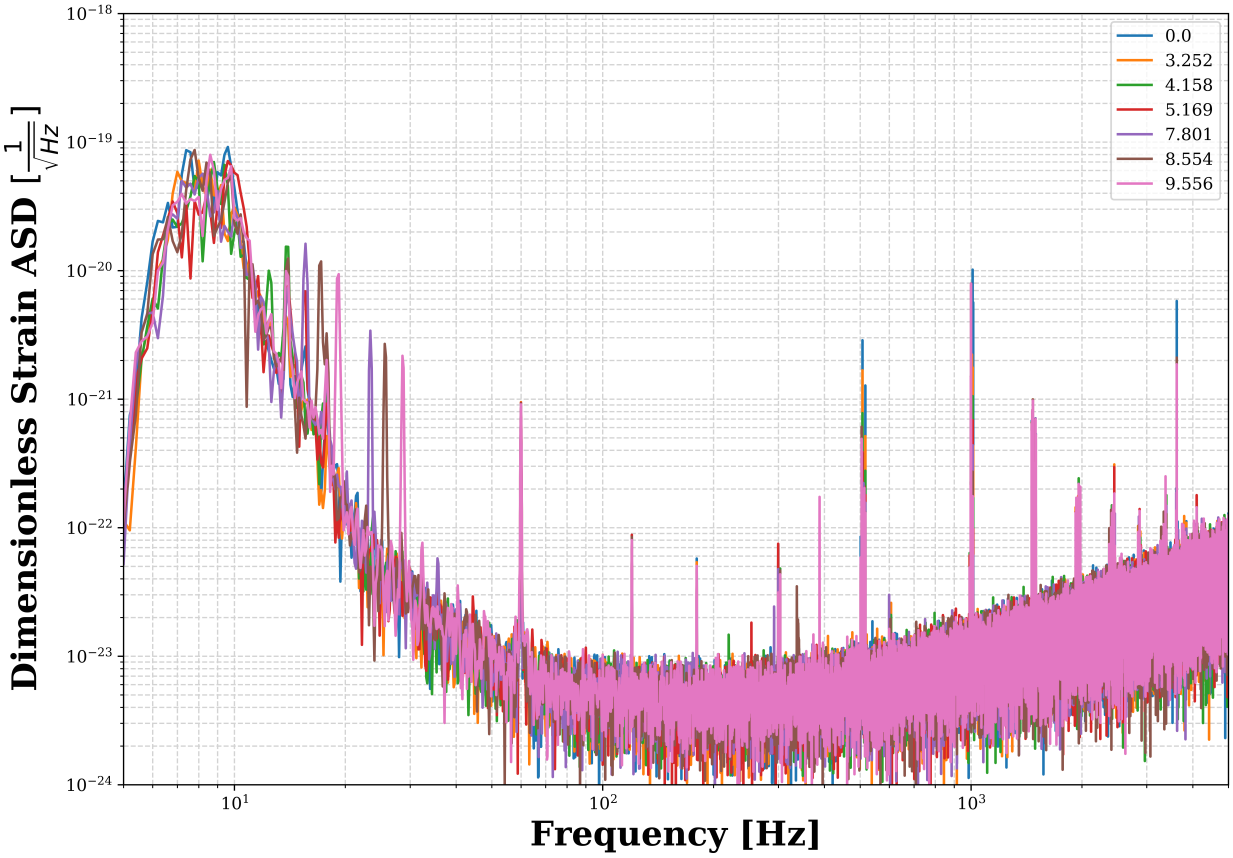


Figure 4: NCAL injection

6 Conclusion

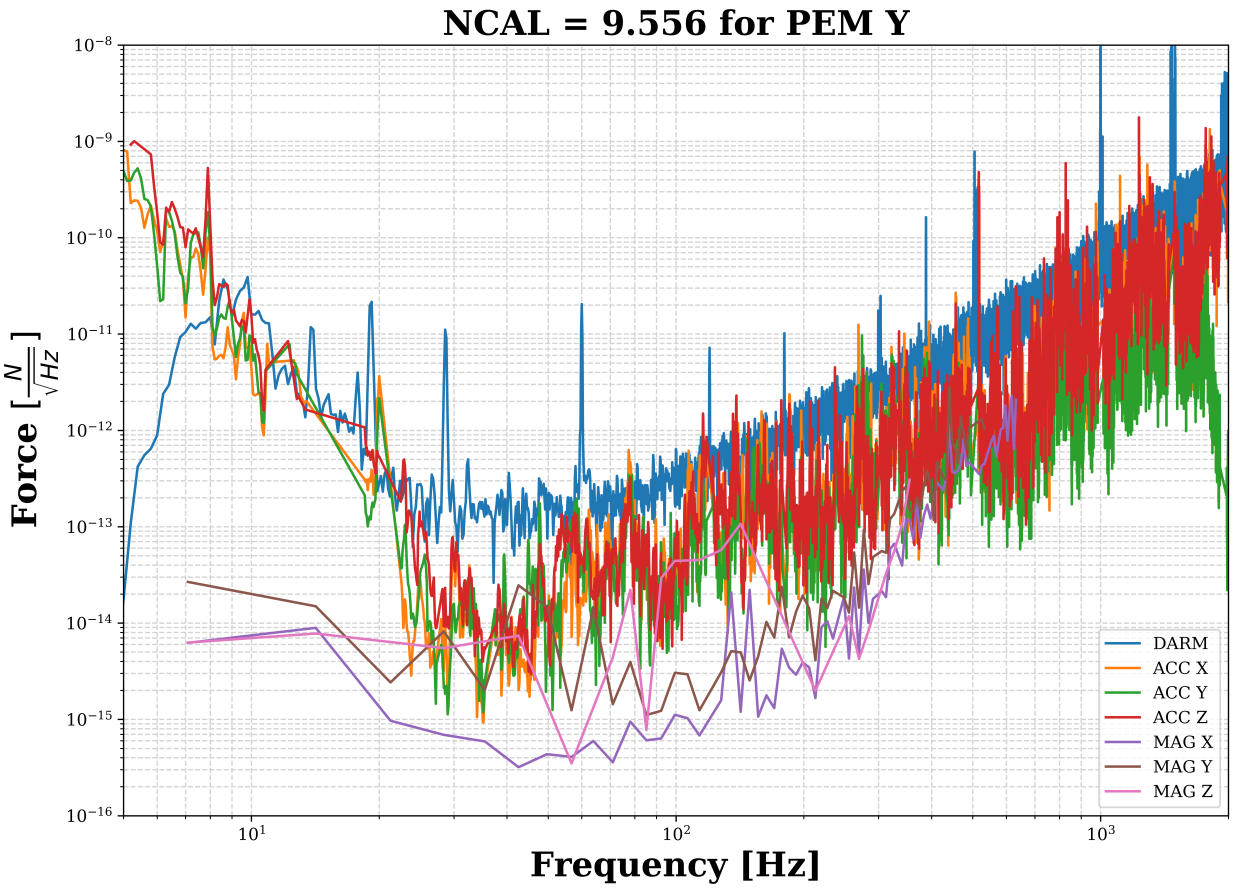

NCAL = 9.556 for PEM Y
Force [$\frac{N}{\sqrt{Hz}}$]
Frequency [Hz]
DARM
ACC X
ACC Y
ACC Z
MAG X
MAG Y
MAG Z

Figure 5