LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
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Summary of Hanford's HIFO-Y test

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1 Overview

The goals of the half interferometer test at Hanford were outlined in T1300174. This document summarizes results relevant to each of the goals.

2 Results

2.1 Second Harmonic Generator

Our second harmonic generator is functional and has been stable and robust over 70 days. The conversion efficiency with 240 mW of incident infared power is 0.23%. The input power was between 150-125mW for the HIFO test, and the conversion efficiency around 0.1%. Over 15 hours the standard deviation of the green output power was 0.65%, over seven days the long term drift was about 5% (LHO alogs 6128 and 6951).

2.2 Locking PSL to arm cavity, relative stability of 1064 and 532 nm resonances

An out of loop measurement of the relative stability was made by locking the PSL to the arm cavity using the green beat note, tuning the frequency offset so that infared power in the cavity was at half of the maximum and monitoring the fluctuations of the transmitted IR power. The frequency fluctuations of the PSL relative to the arm cavity down to 0.1 Hz were 6 Hz RMS using the ALS beat note locking. A detailed noise budget including modeling of control loops and noise measurements is described in T1300688 A similar out of loop measurement described in alog 6996 showed 3 Hz RMS frequency fluctuations from 50 Hz to 0.01 Hz. A second out of loop measurement was made using the reflected infrared Pound Drever Hall signal, and is included in T1300688.

The measurement of the infrared transmitted power offset from resonance can also be used to demonstrate that the requirements for relative stability of the infrared and green resonances was met. At low frequencies the drift of infrared field relative to its resonance was initially dominated by the VCO drift, characterized in alog alog 6865. A second frequency difference divider was added to reduce this drift to 2 Hz RMS 6972. The long term drift shown in 1 was measured after the frequency difference divider was added, and shows a drfit of about 10 Hz an hour. This demonstrates that the requirements on the relative stability of the green and infared resonances, and our ability to control the frequency offset are both exceeded.

We also saw that the effect of alignment of the offset between the two resonances was negligible. When scanning the frequency offset in an aligned and grossly misaligned state we saw that the frequency offset for the TEM_{00} mode did not change within the measurement error, described in alog 6995.

2.3 Automation

The end station locking was completely automated using the TwinCAT system, and normally both the PLL and relfection locking acquire within about 10 seconds of the reference cavity locking. There was some information from the real time system sent to the TwinCAT, to

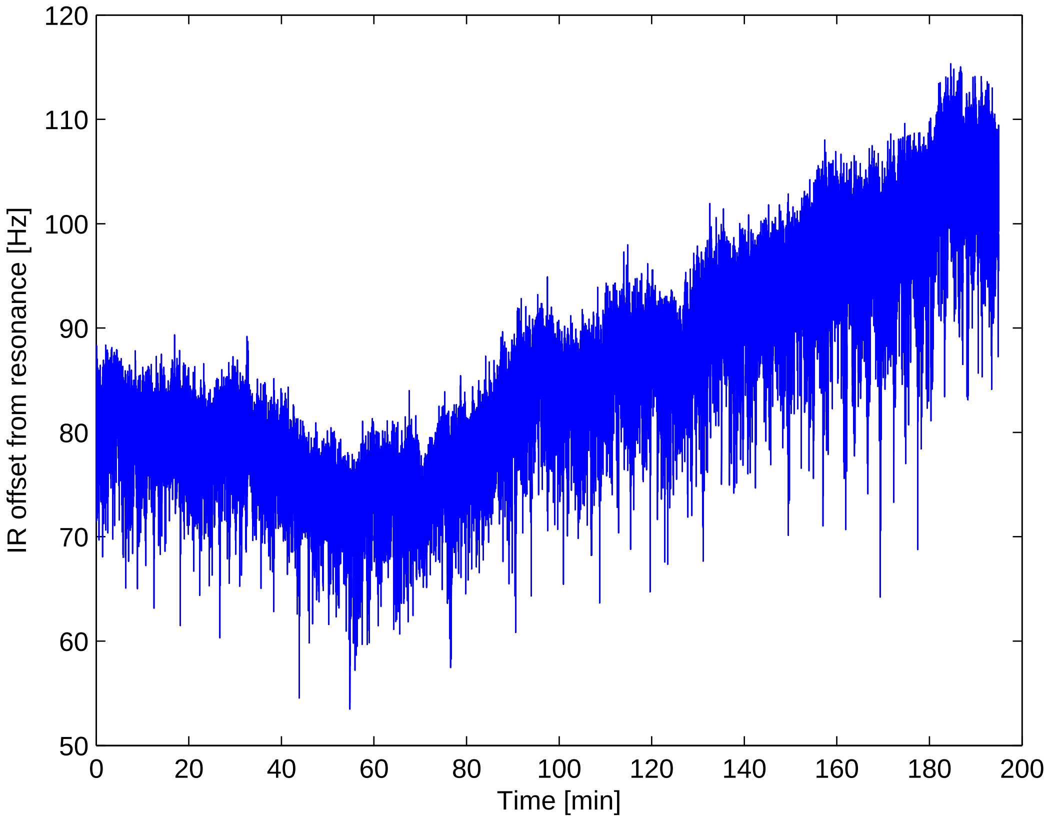

Figure 1: Drift of IR field relative to its resonance when PSL is locked to the arm cavity using green beat note.alog 6997

indicate that the green input alignment servos were functioning. The real time system is also used to engage boost filters feeding back to HEPI to keep the green cavity lock stable over hours time scales.

Automation of corner station locking was done using scripts and a combination of controls from the real time system and beckhoff. These scripts were successful in locking the PSL to the arm cavity.

More work is needed to completely automate the locking sequence in a way that will be adequate for permantent implementation. We did not automate alingment durring the HIFO-Y test, but have since prepared a scheme in the real time system that can be tested during HIFO-X. We will also need a guardian system to corrdinate the locking done in TwinCAT with alignment steps, and the corner ALS locking.

2.4 TransMon QPDs

The ETM used during HIFO Y had an ITM coating, meaning that the fraction of infared light transmitted by the cavity was a factor of 700 higher that it will be in the final configuration. The dark noise of the QPD sum channel was 0.06% of the value at the peak IR transmission during HIFO-Y. If this noise is ADC noise increasing the whitening gain by 45 dB will allow us to resolve 0.2% of the peak transmission, meeting the requirement that we resolve 1% of the peak power. If this noise is electronics noise and increasing the whitening gain does not help, the noise will 42% of the peak signal in the final configuration, making it difficult to meet the requirement.

The QPDs were functional and working during HIFO-Y, but not calibrated in terms of cavity alignment. This was skipped due to time constraints and because the cavity geometry will change for HIFO-X.

2.5 Agreement between suspension model and measured cavity length fluctuations around lowest quad suspension modes

A measurement of the transfer function from the ISI longitudnal witness sensor and the cavity lenght agrees within a factor of two with the model of the transfer function from the suspension point to the test mass motion. For details see aLOG 7214 and comments.

2.6 Optical Levers

According to T1300563 the optical levers for ITMY, ETMY and BS have long term drifts of less than 1 urad peak to peak over an hour. PR3 has more motion, which will be fixed by modifying a cable tray that rubs against the pier.