News from LIGO Hanford Observatory (Mainly about

Half Interferometer Experiment)

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Summary

- A part of the interferometer was commissioned at LHO*.
 - This configuration is called HIFO-Y**

* LHO = LIGO Hanford Observatory,**HIFO-Y = Half-Interferometer test in Y arm

- The test lasted for ~ 7 weeks.
- The required noise performance in the main laser frequency was met.
- A few modifications were found to be necessary.



- Introduction
- Overview and main result of HIFO-Y
- Selected topics in HIFO-Y

Introduction

LIGO Hanford observatory at dusk More pictures can be found in http://www.ligo.org/multimedia/gallery/lho.php

Advanced LIGO

SRM

AS port

The LIGO interferometers undergo a major upgrade to become Advanced LIGO (aLIGO)





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CARM (Common ARM)
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- MICH (MICHelson)
- **PRCL** (Power Recycling Cavity Length)
- **SRCL** (Signal Recycling Cavity Length)

PRM

Interferometer Control

- Interferometer doesn't stay at the operating point on its own.
 Length and frequency feedback is necessary
- Signals are nonlinear and coupled between the 5 degrees of freedom.
 - Control is not straightforward until all of them is brought to the operating point
- Bringing all the interferometric length degrees of freedom to its operating point is called lock acquisition and is neccesasry

Locking is challenging

The interferometer is a multiple-outputs system



And also signal is nonlinear until all 5 degrees of freedom is simultaneously on the operating point Arm Length Stabilisation (ALS) will mitigate this issue.

LHO is arm locking pathfinder

Interferometer can be split to DRMI* and arms

=> LHO commissions the arms at first

LIGO

Install Sequence H1

* DRMI=Dual-Recycled Michelson

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Overview and Results of HIFO-Y

Commissioners measuring transfer functions in the middle of night

What is HIFO-Y ?

- Half part of the interferometer is commissioned
- A mile stone for ALS
- One can stabilize the main laser frequency with respect to the arm length using ALS
- The first demonstration of ALS in aLIGO
- The goal is a frequency fluctuation of 8 Hz* in the main laser frequency

HIFO-Y \simeq ALS test

- Green light is injected from ETMY
- Beatnote tells how far the PSL frequency is from an arm resonance
- It allows to stabilize the PSL frequency w.r.t. the arm cavity



ALS makes locking simpler

- It allows you to sense only arm cavity motions (or PSL frequency).
- One can now decouple the arms from the rest by forcing them to be at a off-resonance point



Control Topology

- End green laser is locked to the arm
- PSL is locked to the IMC* *IMC = Input Mode Cleaner
- With the beatnote one can stabilize PSL through IMC with respect to the arm.



Experimental setup



Demonstration of Freq. Tuning



Demo. of Freq. Tuning

Noise Performance

Selected Topics in

HIFO-Y

Wires in a QPD melted due to wrong cabling.

Handing Off

The MC control needs to be handed over to ALS

- 1. Turn the high-pass on to decouple the IMC control at DC
- 2. Immediately increase the CARM gain to hand over the control
- 3. Decrease the IMC gain to complete the hand over
- 4. Boost can be engaged in CARM
- 5. Optionally one can engage additive offset feedback to AOM

Phase Freq. Discriminator

- AD9901 is the core part
- Originally we planned to use this alone for reading out the beatnote but it turned out to be difficult
 - Transition from the frequency mode to phase mode was too abrupt.
- Instead we implemented a PLL with this PFD so that it stays in the phase mode from the beginning.
 This became a permanent solution.

Vibration of Periscope 1/2

According to a coherence test with accelerometers, the periscopes structure were found to be noise source above 60 Hz

Vibration of Periscope 2/2

A solution = let the two beams hit the same mirror to increase the common mode rejection

Intensity Noise Coupling

Radiation pressure noise in IMC was the dominant noise. => this will be improved with an intensity stabilization

Conclusion

- HIFO-Y concluded successfully
- LIGO Hanford Observatory is moving forward

Acoustic Positive Feedback

It can help you finding a place where acoustic noise couples to your system.

■ Noise = (TF) x (NoiseSouce)

CARM hand off

As the IMC control is taken over to ALS, the beatnote (which represents the PSL frequency) becomes quitter

