G050475-00-W

Oscillator Phase Noise

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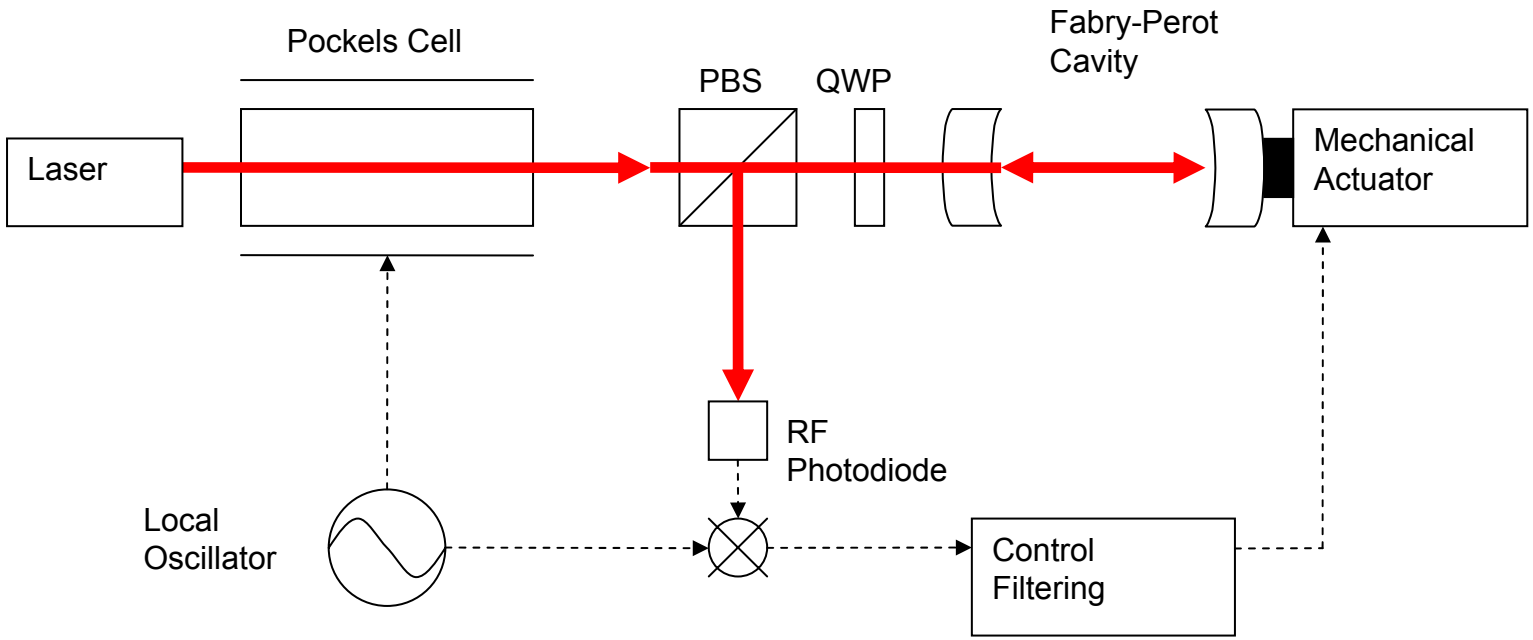
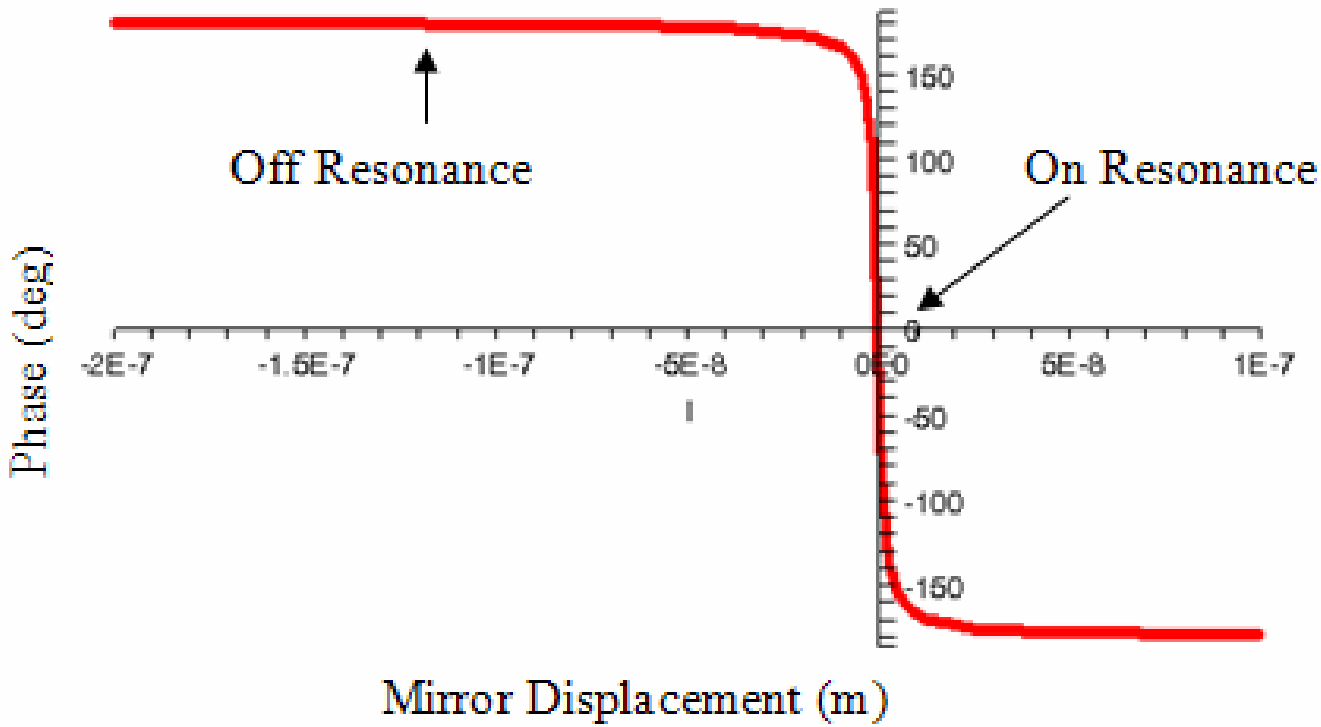


- A control signal is created to lock cavity on resonance
- The existence of sidebands is critical to create a useful error signal

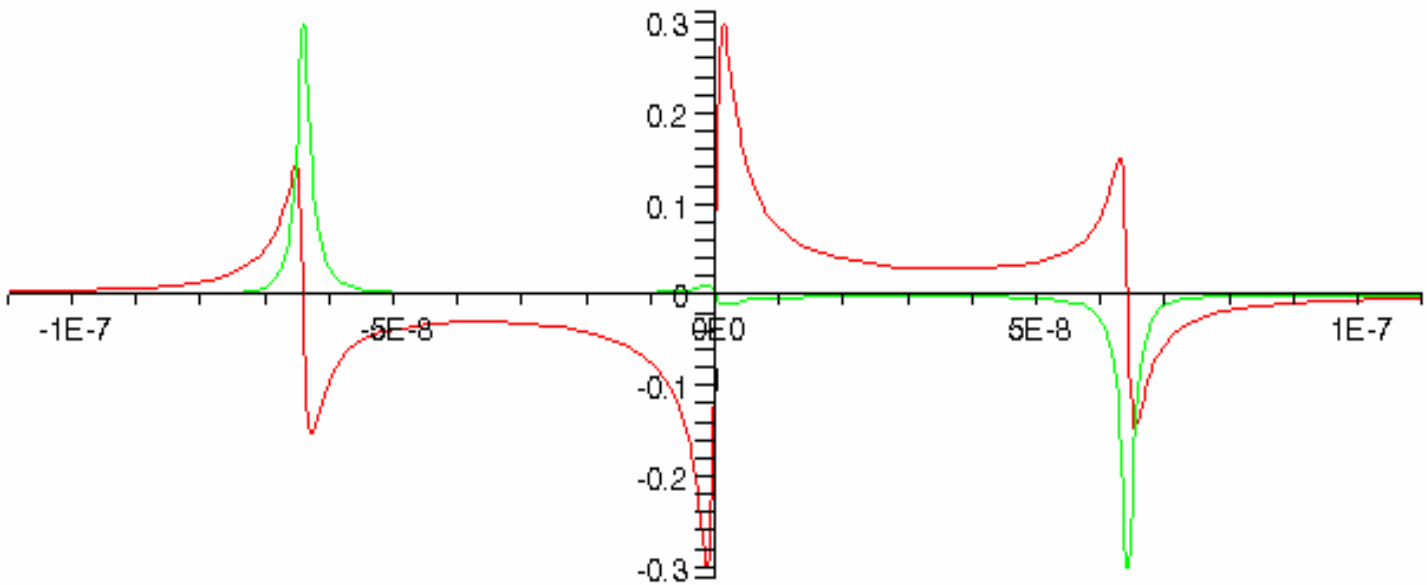
Why Sidebands?

- Carrier resonates, sidebands do not
- Sidebands act as a phase “reference”
- Graph shows phase of reflected light



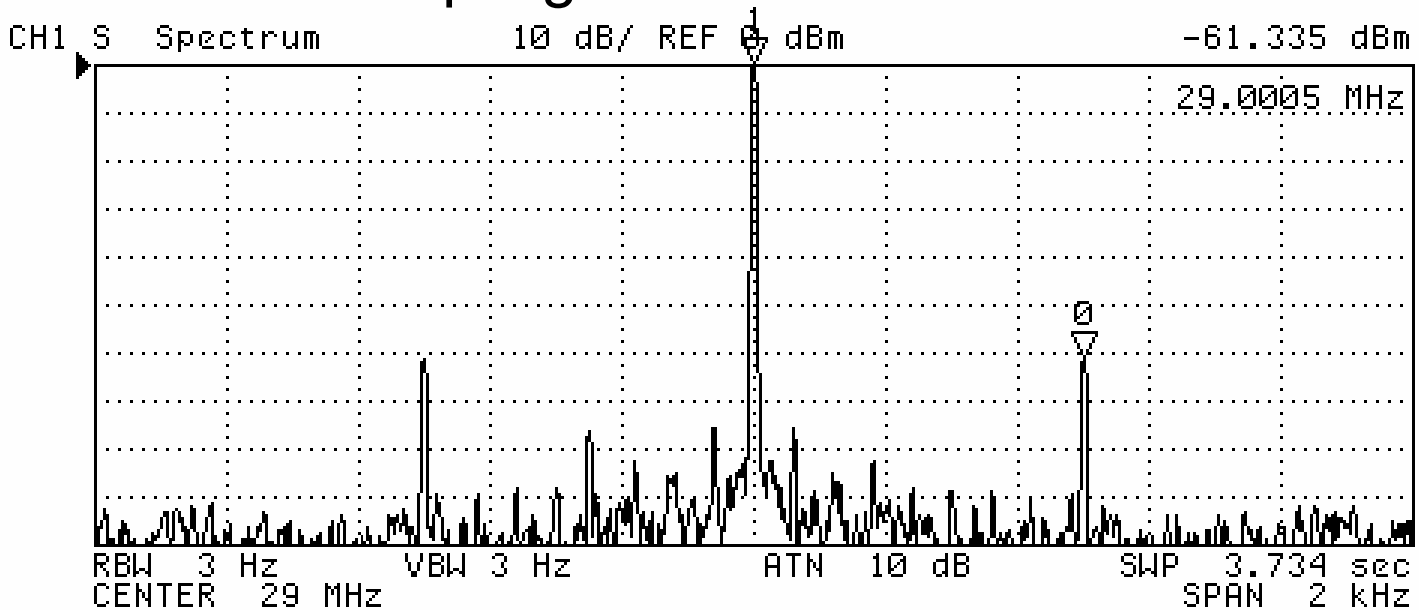
The Error Signal

- The beating of carrier to sidebands gives information about carrier phase.
- This technique is generalized when applied to LIGO



Oscillator Phase Noise Effects

- Phase noise creates sidebands on the oscillator signal
- Phase noise which occurs at audio frequencies can contaminate the gravitational-wave readout
- Phase noise coupling in LIGO is not well understood



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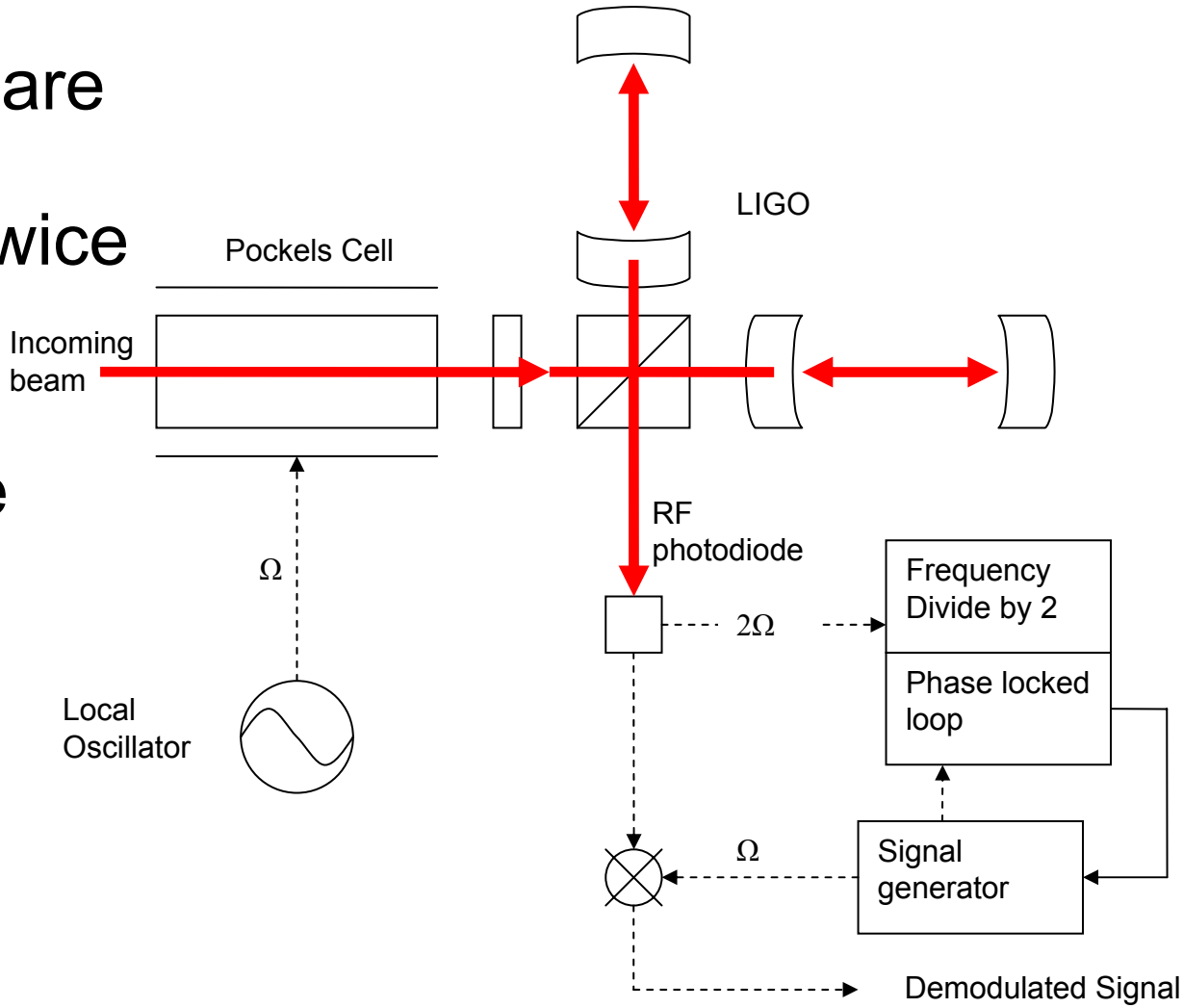
An Alternate Technique

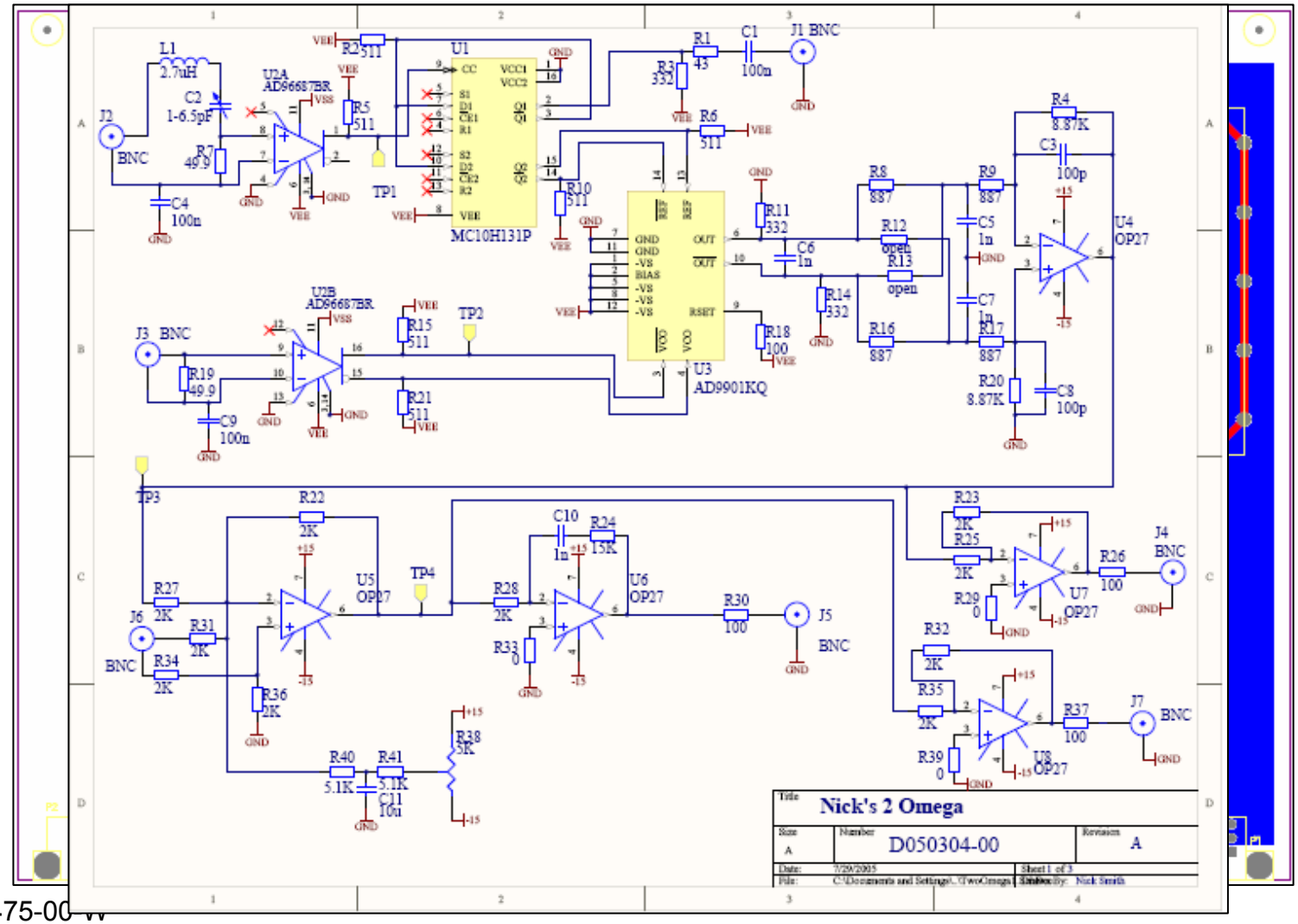
- A different demodulation technique might have less susceptibility to oscillator phase contamination. (More cancellation)
- This is because your local oscillator and rf modulated signal pass through the same optical system as opposed to two separate pathways
- This other scheme makes use of the 2Ω signal available at the anti-symmetric port.

Using the 2Ω Signal

- The sidebands are separated from each other by twice the modulation frequency
- We can use the beat frequency caused by the sidebands to recreate the modulation frequency



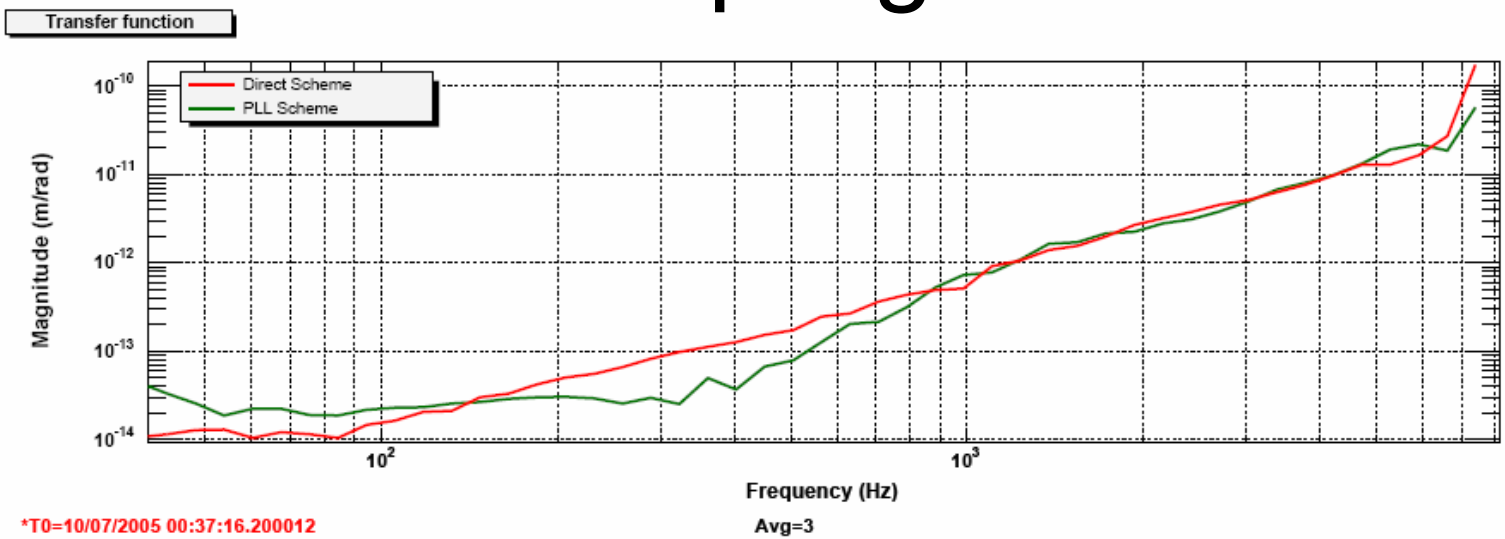
The PLL Circuitry

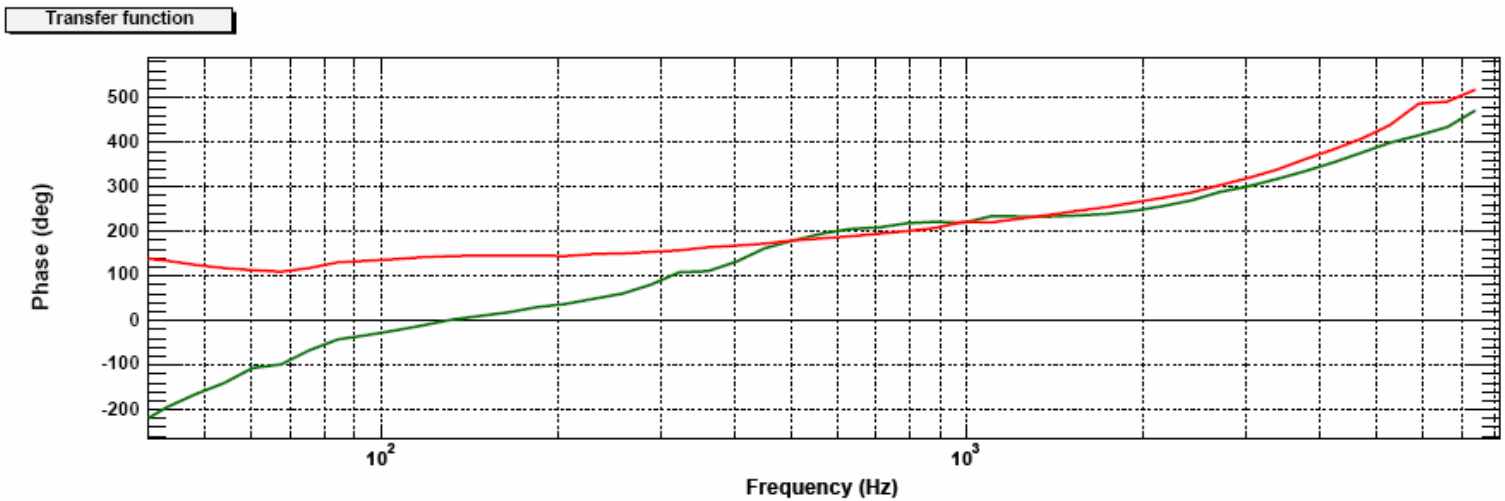


Measuring Phase Noise Coupling

- Determine how oscillator phase noise propagates through the LIGO system
- This is achieved by replacing the crystal local oscillator with an RF frequency synthesizer
- Injecting a signal into the phase modulation input will simulate phase noise
- A swept sine measurement will determine the transfer function

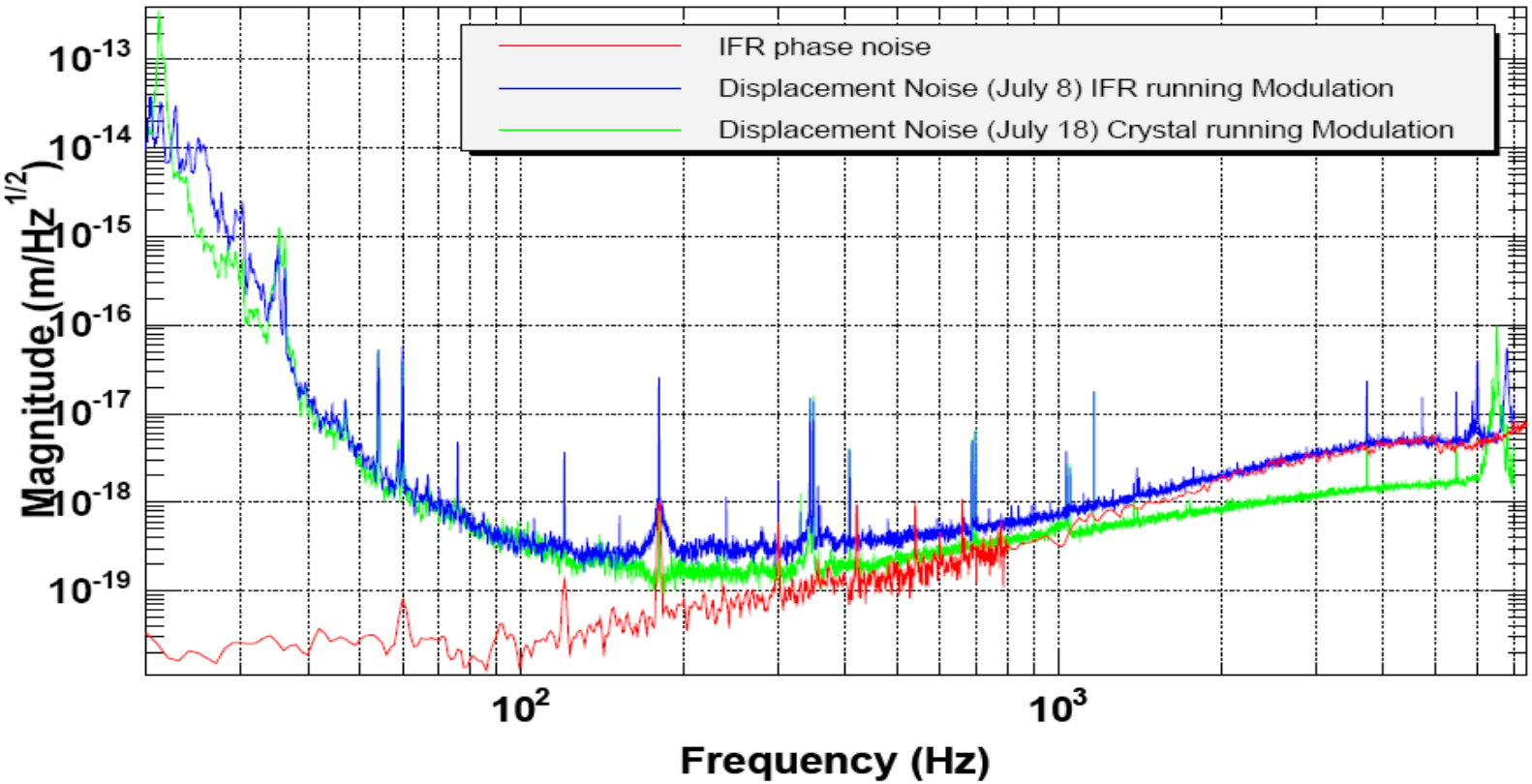
Phase Noise Coupling Results on 2K





A Quick Test

- The LIGO noise level increased while I made measurements
- Could I predict the rise in noise with my transfer function and the phase noise of the oscillator?



Conclusions

- The 2Ω scheme does not provide significant difference to phase noise coupling.
- These data suggest that the **local oscillator reference does not play the dominant role in phase noise coupling.**
- Something else is causing phase noise to couple to the output, perhaps FM to AM conversion in the interferometer