LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

-LIGO-

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40M Electro-Optical Data Link Test Result		
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ELECTRO-OPTICAL LINK, 40M TEST RESULT

INTRODUCTION

Recently, a test was conducted in the 40m Laboratory to compare the phase jitter of the existing timing system link using twisted pair copper wires vs the newly designed electro-optical one. Results obtained clearly illustrate the benefits of using a fiber optic link and the need to equalize fanout system's cable length.

EXPERIMENT

The jitter of the existing timing system's 4 MHz clock was first measured at the output of the DAQ rack's (1Y7) D980362 Clock Fanout Board and then at the SUS rack's (1Y9) D980369 Clock Driver Board with a Stanford Research SR620 Universal Interval Counter as shown in Figure 1 and 2 below:

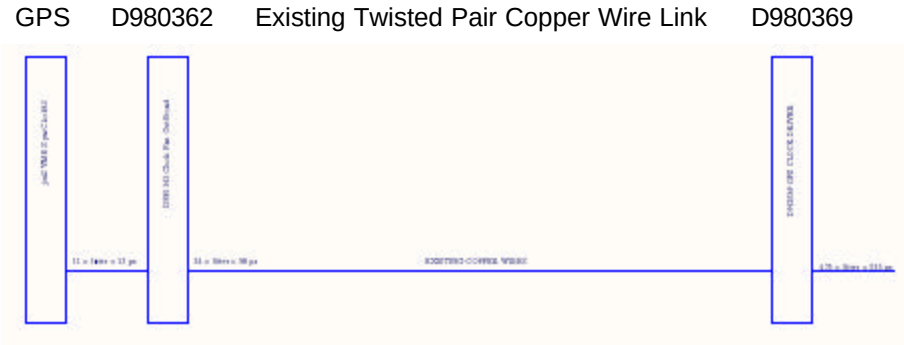

Figure 1. Signal Flow Diagram for the Timing Clock Jitter Measurement on the 40m Y Arm as installed

Figure 2. Clock Fanout Board's Output Jitter as Measured by the SR620

Directly at the output of the GPS board, the jitter was measured to be between 11 to 13 ps. At the Clock Fan Out board's output, jitter increased to between 34 to 38 ps. At the 1Y9 rack's Clock Driver board output, the jitter increased to between 457 to 535 ps.

This process was then repeated for a clock driver board located in the nearby 1Y3 rack. Here, the jitter varies between 40 and 43 ps.

Input to the new Electro-Optical Link's Transmitter board (Tx) was then connected to the Clock Fan Out board in 1Y7 rack. A 40 meters long fiber optic cable was then used to join it with Receiver board (Rx) located at 1Y9 as shown in Figure 3 below:

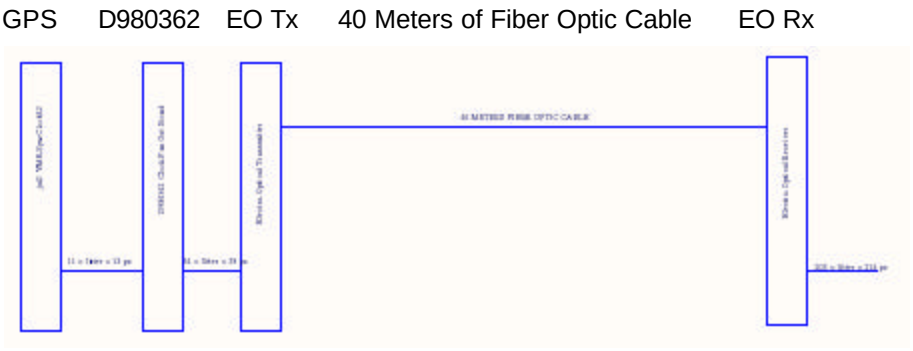

Figure 3. Signal Flow Diagram for the Timing Clock Jitter Measurement on the 40m Y Arm with the Fiber Optic Link

At the output of the Receiver board, the jitter was measured to be between 205 and 214 ps.

CONCLUSION

Result from this simple test clearly demostrates the importance of using equal length cables (copper or fiber) to connect up the timing system in a star distribution format. The superior performance of the fiber optic cable over copper wire is obvious and should benefit LIGO's existing timing system.

For a robust clock distribution system, both observatories should consider investing in a good jitter and timing interval measurement instrument, such as the LeCroy Model SDA 6000 Serial Data Analyzer or equivalent, to characterize not only the jitter, but also the Bit Error Rate (BER) of the clock and data stream. Simple "EYE" diagram, formed by superimposing many short segments of a waveform such that the normal edge locations and voltage levels are aligned, measurement with an analyzer can tell a lot about the health of the timing system as well as that of the serial data stream.

The following diagram provides relative location of the components discussed above.

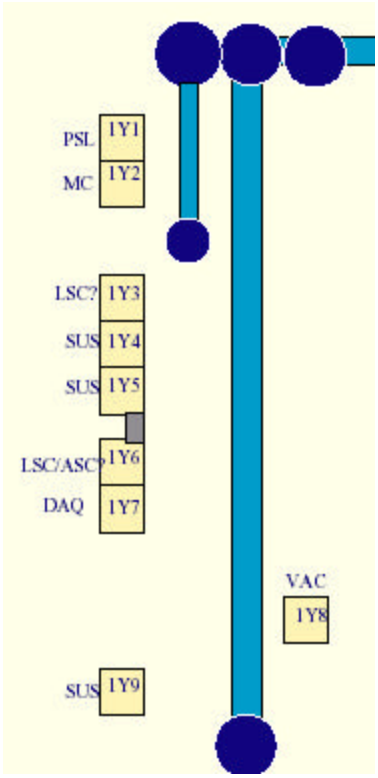

Figure 4. 40M Y-Arm Rack Placement