LIGO Hanford Output Faraday Isolator Tests – 25/03/2014

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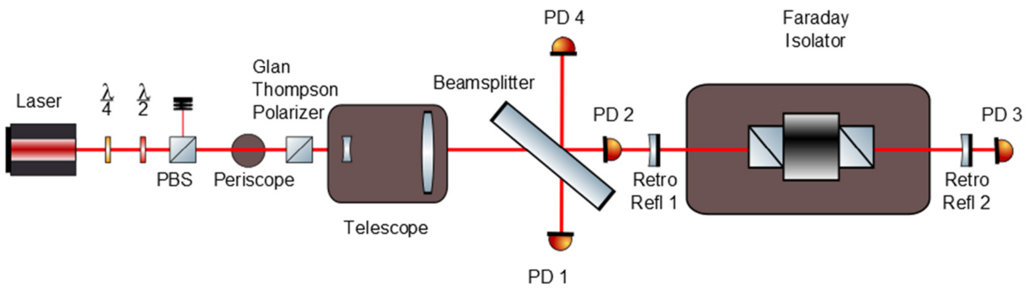
We used a similar method to what is described in LIGO- E1201074-v6. The following optics were used to test the suspended output Faraday isolator.



Transmission Test

The output of the NPRO was attenuated to approximately 4mW so that we could use two Thorlab PDA 100A photodetectors to measure the transmission and isolation. One photodetector was permanently mounted at position 1 to measure the input power. The other photodetector was moved between position 2 and 3. Naturally the retro reflectors were not in place. We used two different beam reducing telescopes to measure the transmission at three different beam sizes.

Beam Size	PD1 reading	PD2 reading	PD3 reading	Notes
2.0 mm	3.24 V	5.01 V		
2.0 mm	3.21 V		4.79 V	

Transmission = 96.5 +/- 0.5%

Isolation Test

This test was performed when the spot size was 2.0mm. In this situation the photodetector was placed in position 4 and an iris was used to mark the beam near the laser. The retro-reflecting mirror was installed such that the beam was retro-reflected in front of the Faraday isolator. A reading was recorded on PD4. The retro-reflecting mirror was then moved to after the isolator, the voltage on PD4 was maximized and the following readings were recorded.

Retro-reflecting Mirror Position	Conditions	PD 4 Voltage
1		5.6 V
2	Full return	6.89 mV
2	Retro Mirror Blocked	6.37 mV
2	Laser Blocked	5.85 mV

From this we know that isolation from light reflecting from the output side is 9.2×10^{-5} and the specular backscatter coefficient is 8.6×10^{-5}. We attempted to increase the transmission by adjusting the rotation of the ½ wave plate in the middle.

Measurement of Wavefront Distortion

We set-up to measure the wavefront distortion of the isolator using the procedure described in LIGO- E1201074-v6. However we found that the stray beam from the direct reflection of the isolator was significant. We then decided to set the 632 nm probe beam up such that the beam passed straight through the isolator. We measured the wavefront at the input to the isolator. Set this as the calibrated reference field. We then measured the wavefront again at the output of the isolator and the results are illustrated below.

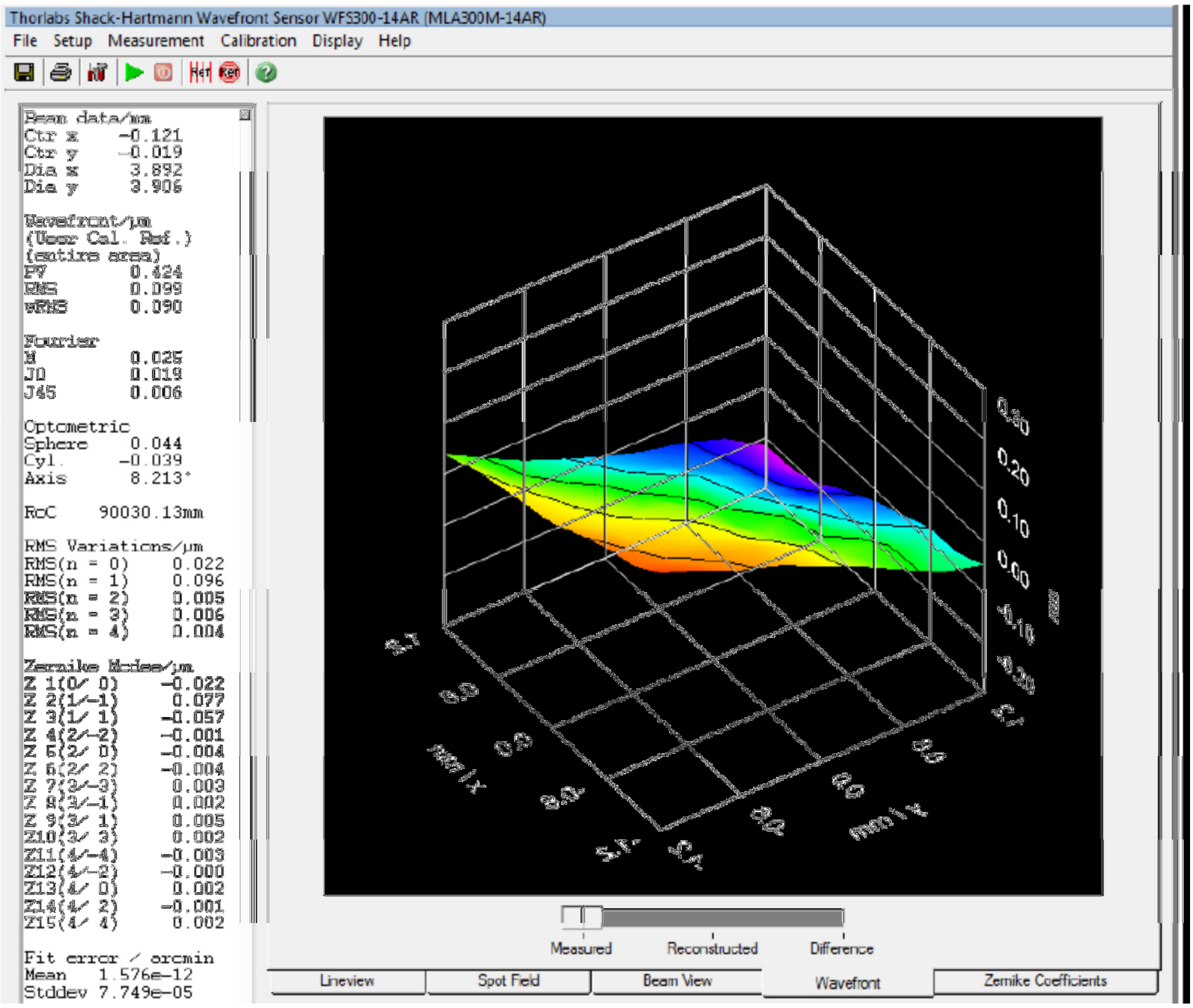


Figure 1 Measurement of the wavefront at the entrance to the isolator

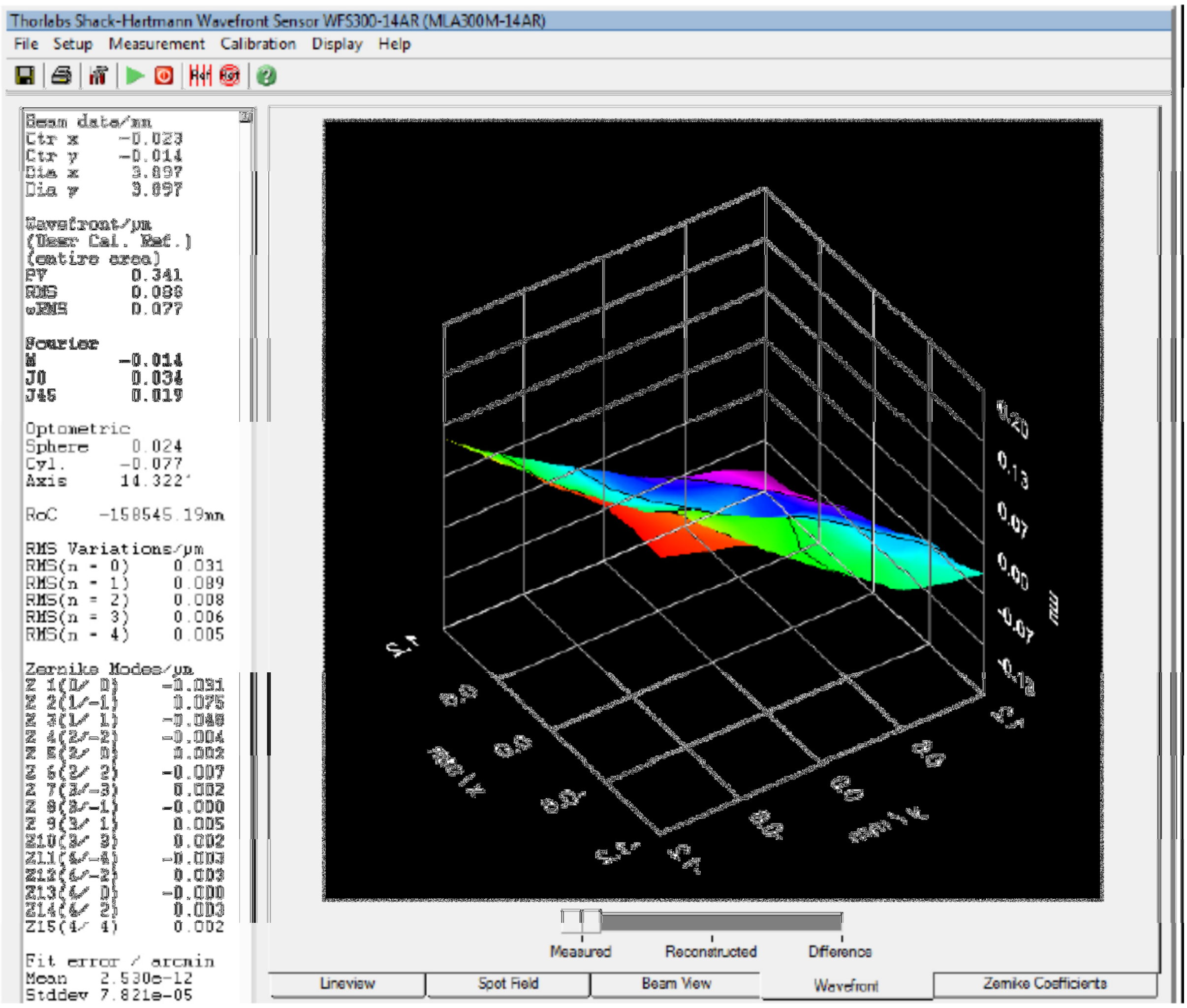


Figure 2 Measurement of the wavefront at the exit of the isolator

We mounted the Shack Hartmann Wavefront sensor on a tilt stage which we used to eliminate as much tilt as possible. I estimate that using this sensor in this way the error on the Z4 polynomial is +/- 0.002 1/µm. So comparing the reference wavefront and the measured wavefront are consistent with the isolator introducing spherical power less than 0.015 dioptre.