



LIGO Laboratory / LIGO Scientific Collaboration

LIGO-E1100684-v1

LIGO

7/19/11

Surface figure measurement of ETM04

G. Billingsley

Distribution of this document:
LIGO Scientific Collaboration

This is an internal working note
of the LIGO Laboratory.

California Institute of Technology
LIGO Project – MS 18-34
1200 E. California Blvd.
Pasadena, CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project – NW22-295
185 Albany St
Cambridge, MA 02139
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

LIGO Hanford Observatory
P.O. Box 159
Richland WA 99352
Phone 509-372-8106
Fax 509-372-8137

LIGO Livingston Observatory
P.O. Box 940
Livingston, LA 70754
Phone 225-686-3100
Fax 225-686-7189

<http://www.ligo.caltech.edu/>

1 Introduction

The purpose of this note is to memorialize the results of figure measurement of ETM04.

2 Method

This is the average of eight measurements taken every 45 degrees, the optic under test is rotated. See T1100370-v2 for more detail.

2.1 Uncertainty

The final uncertainty in the measurement of ETM04 is estimated to be of order 0.4nm rms over 300mm and 0.1nm rms over 160mm. This uncertainty is the combination of environmental and RDF errors. See T1100370-v2.

3 Results

ETM04 is measured every 45 degrees in 8 orientations. The final map is the average of all 8 datasets rotated to one orientation (arrow up.) The RDF is subtracted from each data set before averaging. While the error found in this analysis is sufficient for analysis of ETM04, we expect the RDF to be refined by further measurement. A key to the coefficients listed on data images is found in figure 1; for instance coef 4 corresponds to term# 4 in the list of Zernike polynomials.

Zernike Polynomials Table

In this table, ϕ = polar coordinate angle, and ρ = radius (normalized to 1 at the edge of the aperture). The numbers in columns m and n are the indices for Zernike polynomials

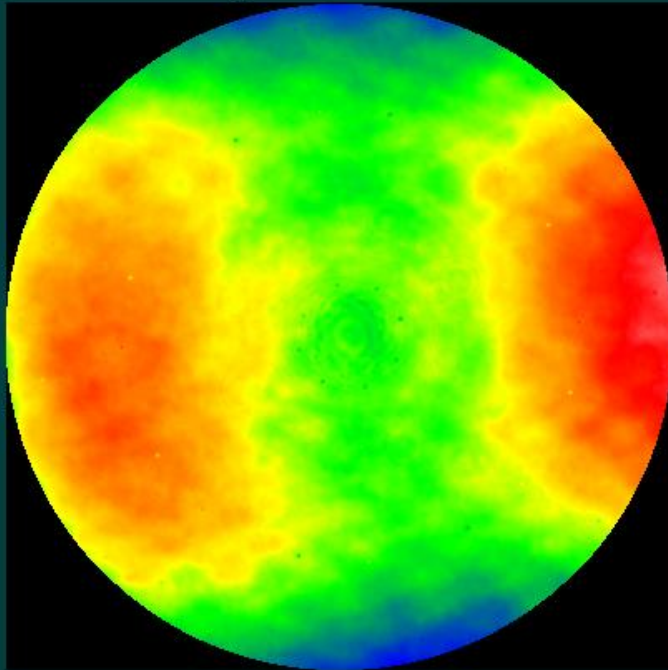
<i>n</i>	<i>m</i>	<i>Term #</i>	<i>Polynomial</i>	<i>Meaning</i>
0	0	0	1	Piston or Bias
1	+1	1	$\rho \cos \phi$	Tilt X
	-1	2	$\rho \sin \phi$	Tilt Y
	0	3	$2\rho^2-1$	Power
2	+2	4	$\rho^2 \cos 2 \phi$	Astigmatism X
	-2	5	$\rho^2 \sin 2 \phi$	Astigmatism Y
	+1	6	$(3\rho^2-2)\rho \cos \phi$	Coma X
	-1	7	$(3\rho^2-2)\rho \sin \phi$	Coma Y
	0	8	$6\rho^4-6\rho^2+ 1$	Primary Spherical
3	+3	9	$\rho^3 \cos 3 \phi$	Trefoil X
	-3	10	$\rho^3 \sin 3 \phi$	Trefoil Y
	+2	11	$(4\rho^2-3)\rho^2 \cos 2 \phi$	Secondary Astigmatism X
	-2	12	$(4\rho^2-3)\rho^2 \sin 2 \phi$	Secondary Astigmatism Y
	+1	13	$(10\rho^4-12\rho^2+3)\rho \cos \phi$	Secondary Coma X
	-1	14	$(10\rho^4-12\rho^2+3)\rho \sin \phi$	Secondary Coma Y
	0	15	$20\rho^6-30\rho^4+12\rho^2-1$	Secondary Spherical

3.1 High Frequency data

Data have been taken at 0.4mm/pixel (full aperture), 0.192mm/pixel, 0.047mm/pixel and 0.023mm/pixel. As of this writing there is no calibration file in place for these apertures, these data will be post processed when a calibration file is available.

LIGO

ETM04 S1 160mm -tilt and power



+3.51

nm

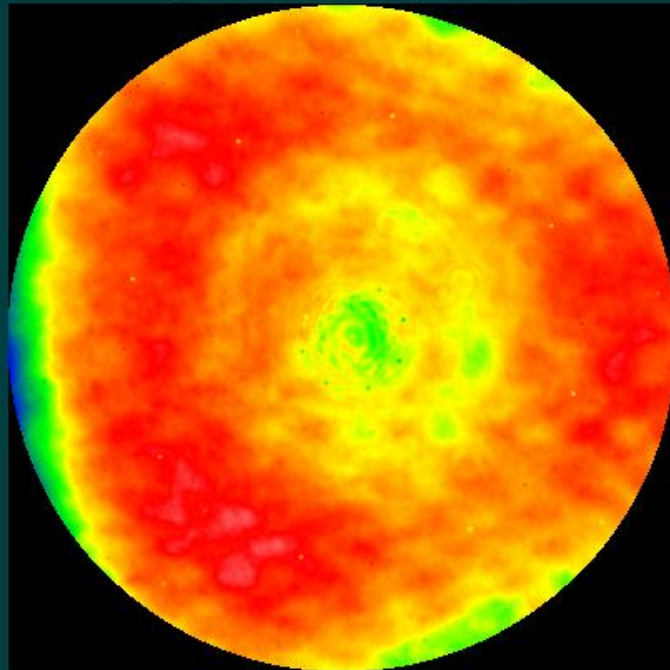
-3.96

PV	7.468	nm
rms	1.263	nm
Power	-36.177	nm
Size X	160.4	mm
Size Y	160.4	mm
Tiltx	2.351	nm
Coef 4	2.705	nm
Coef 5	0.627	nm
Coef 6	0.766	nm
Coef 7	0.164	nm
Coef 8	-0.772	nm
Coef 9	0.827	nm
Coef 10	0.155	nm
Coef 11	-0.111	nm

Removed: PST TLT PWR
Trimmed: 0
Filter: Off
Aperture ID (%):
Aperture OD (%):
Tilty -1.013 nm
Coef 12 -0.113 nm
Coef 13 -0.010 nm
Coef 14 0.056 nm
Coef 15 -0.028 nm

LIGO

ETM04 S1 160mm -tilt power and astigmatism



+1.29

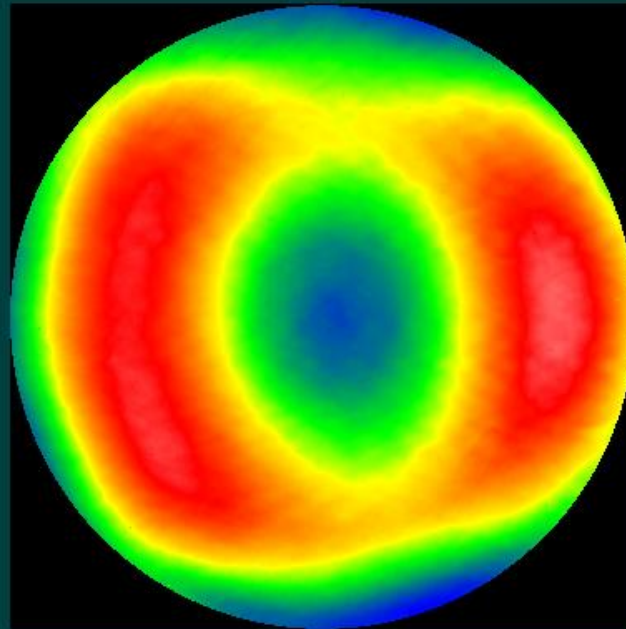
nm

-3.15

PV	4.436	nm	Removed: PST TLT EWR AST
rms	0.563	nm	Trimmed: 0
Power	-36.177	nm	Filter: Off
Size X	160.4	mm	Aperture ID (%):
Size Y	160.4	mm	Aperture OD (%):
Tiltx	2.351	nm	Tilty -1.013 nm
Coef 4	2.705	nm	Coef 12 -0.113 nm
Coef 5	0.627	nm	Coef 13 -0.010 nm
Coef 6	0.766	nm	Coef 14 0.056 nm
Coef 7	0.164	nm	Coef 15 -0.028 nm
Coef 8	-0.772	nm	
Coef 9	0.827	nm	
Coef 10	0.155	nm	
Coef 11	-0.111	nm	

LIGO

ETM04 s1 300mm -tilt and power



+9.24

nm

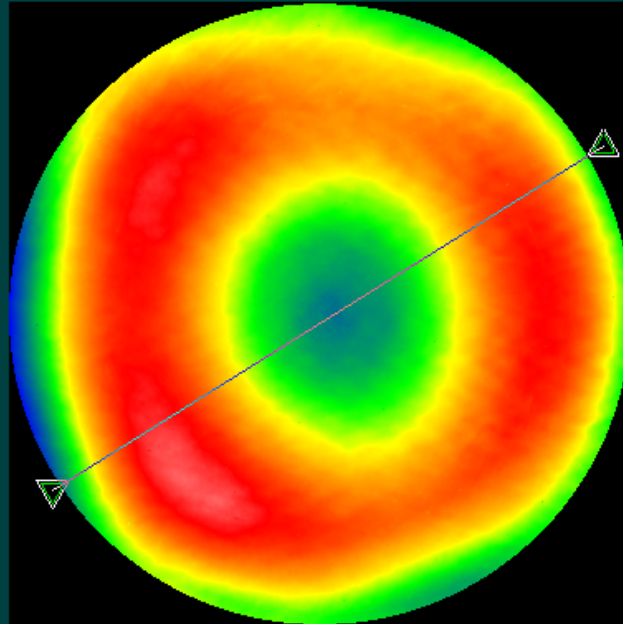
-12.46

PV	21.699	nm
rms	4.963	nm
Power	-168.793	nm
Size X	300.4	mm
Size Y	300.4	mm
Tiltx	10.524	nm
Coef 4	5.582	nm
Coef 5	0.284	nm
Coef 6	3.264	nm
Coef 7	1.113	nm
Coef 8	-8.577	nm
Coef 9	3.499	nm
Coef 10	0.804	nm
Coef 11	-1.944	nm

Removed: PST TLT PWR
Trimmed: 0
Filter: Off
Aperture ID (%):
Aperture OD (%):
Tilty -1.142 nm
Coef 12 -0.645 nm
Coef 13 -1.356 nm
Coef 14 0.560 nm
Coef 15 1.597 nm

LIGO

ETM04 s1 300mm -tilt power and astigmatism



+8.28

nm

-14.08

PV	22.368	nm
rms	4.409	nm
Power	-168.793	nm
Size X	300.4	mm
Size Y	300.4	mm
Tiltx	10.524	nm
Coef 4	5.582	nm
Coef 5	0.284	nm
Coef 6	3.264	nm
Coef 7	1.113	nm
Coef 8	-8.577	nm
Coef 9	3.499	nm
Coef 10	0.804	nm
Coef 11	-1.944	nm

Removed: PST TLT PWR AST
Trimmed: 0
Filter: Off
Aperture ID (%):
Aperture OD (%):
Tilty -1.142 nm
Coef 12 -0.645 nm
Coef 13 -1.356 nm
Coef 14 0.560 nm
Coef 15 1.597 nm