LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Surface figure measurement of ITM09

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1 Introduction

The purpose of this note is to memorialize the results of figure measurement of ITM09.

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 ITM09 is estimated to be of order 0.22 nm rms over 300mm and 0.12 nm rms over 160 mm. This uncertainty is the combination of environmental and Reference File errors. See Section 4.1 of T1100370-v2.

3 Results

The ITM 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 Reference file is subtracted from each data set before averaging. 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

n	*m*	*Term #*	*Polynomial*	*Meaning*
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 Radius of curvature : 1936.5 meters

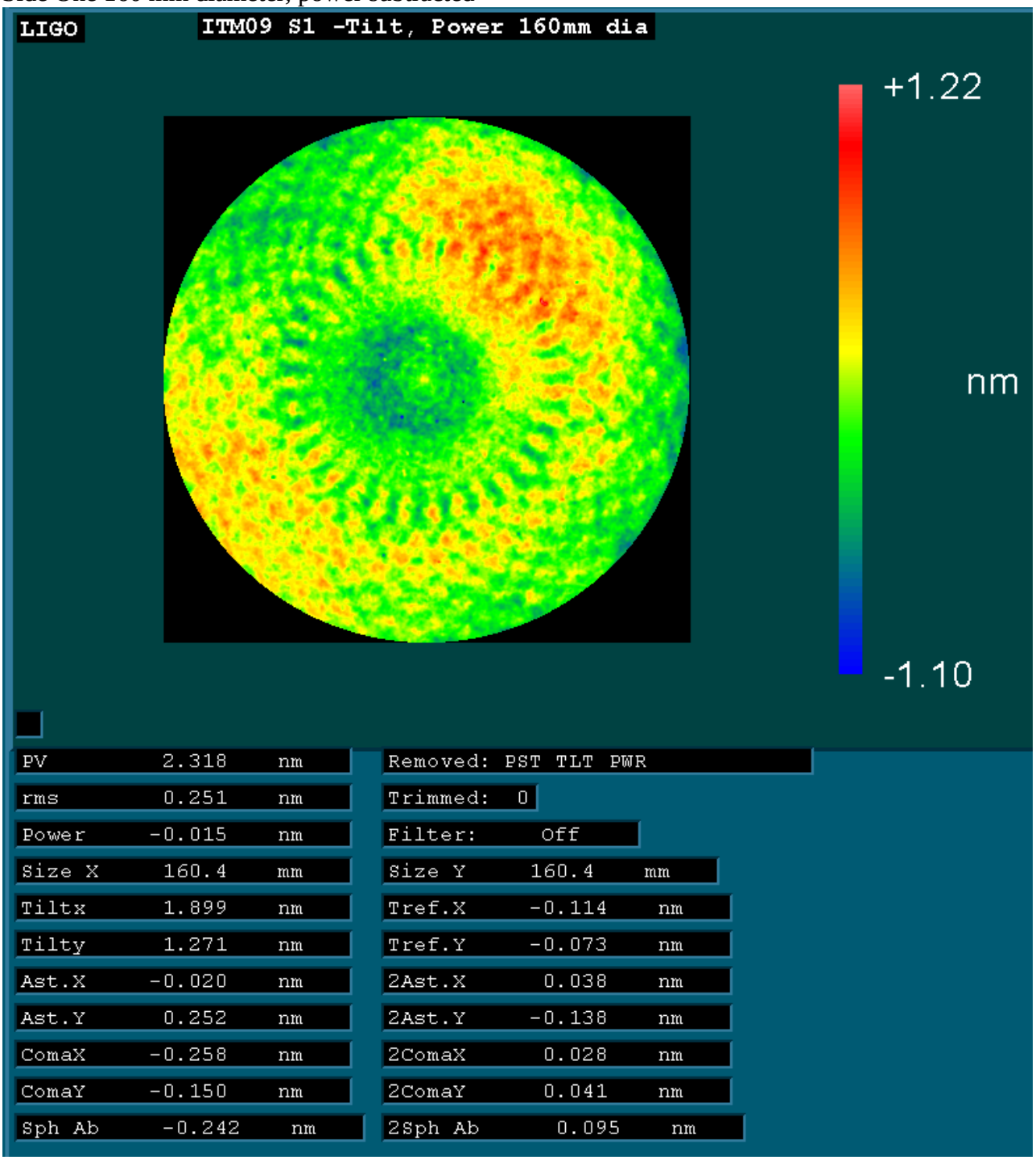
The radius of curvature was measured against the known radius of the reference sphere (-2100m) and calculated as the sum of saggital heights of the part as measured, plus cavity distance, plus reference saggita. The saggita had a standard deviation of 0.13 nm when measured over 160 mm diameter. This corresponds to an uncertainty due to environment of 0.16 meters in radius.

3.2 High Frequency data

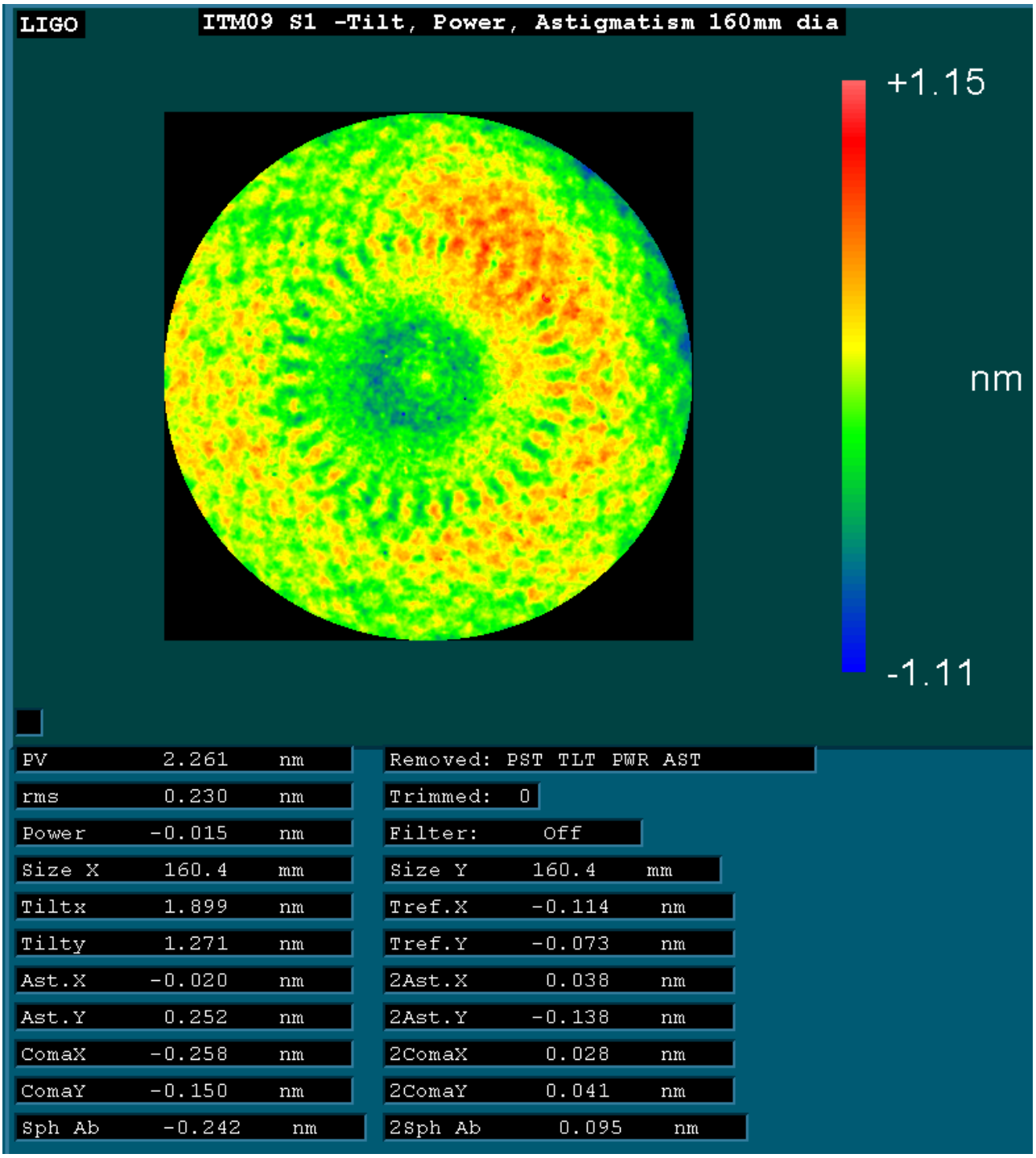
Data have been taken at 0.047mm/pixel, these data are self referencing (averaged to get a local, current image of the reference. The reference is temperature dependent at high spatial frequency. These data are best viewed as a PSD. A sampling of raw files will be uploaded to the DCC. The raw files have central rings which come from the internal reflections of the interferometer, these rings should be avoided when analyzing the high spatial frequency data.

3.3 Low Frequency Data

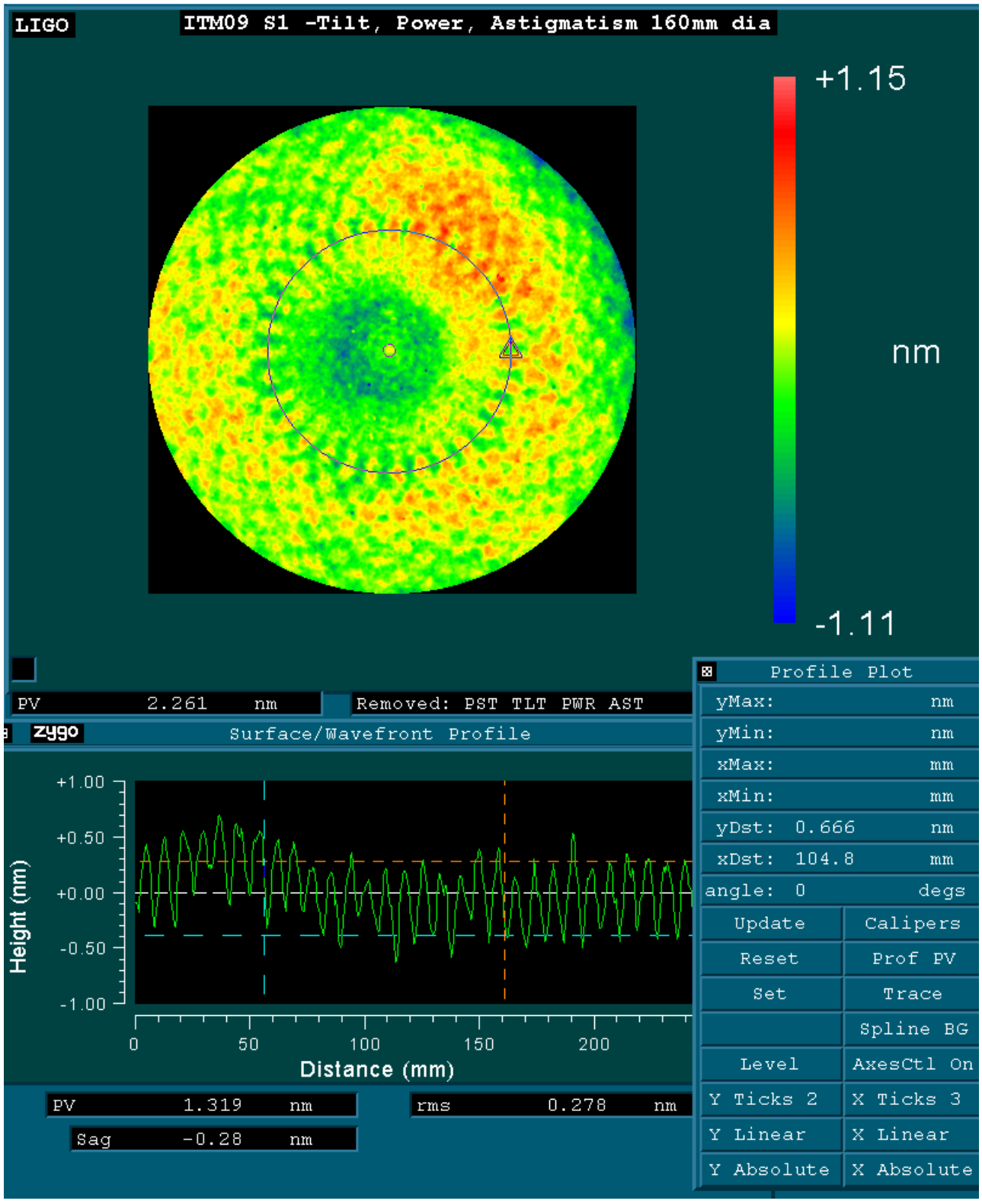
Side One 160 mm diameter, power subtracted



Side One 160 mm diameter, power and astigmatism subtracted



Amplitude of the spiral at R=40 mm, approximately 0.7 nm.



Transmitted wavefront,

Over 160 mm diameter the power is measured with respect to a 2100 m curve and is calculated to be -1338 meters, with an environmental uncertainty of 2.2 meters.