

## IAS LLO Primary Optics As Built Alignment Summary

Optic	X Axis (mm)				Y Axis (mm)				Z Axis (mm)				Pitch ( $\mu\text{rad}$ ) <sup>1</sup>				Yaw (mrad) <sup>2</sup>			
	Actual	Target	Error	Tolerance	Actual	Target	Error	Tolerance	Actual	Target <sup>3</sup>	Error	Tolerance	Actual	Target	Error	Tolerance	Actual	Target	Error	Tolerance
BS	-203.0	-202.5	-0.5	$\pm 3.0$	-183.3	-184.2	0.9	$\pm 1.0$	-83.3	-82.7	-0.6	$\pm 1.0$	237	212	25	$\pm 55$	784.821	784.983	-0.162	$\pm 0.190$
ITMx	5015.0	5013.0	2.0	$\pm 3.0$	-199.2	-200.0	0.8	$\pm 1.0$	-82.0	-81.4	-0.6	$\pm 1.0$	241	312	-71	$\pm 132^4$	0.015	0	0.015	$\pm 0.183^4$
CPx <sup>5</sup>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1505	1534	-29	$\pm 1400$	0.044	0	0.044	$\pm 1.400$
ITMy	-199.4	-200.0	0.6	$\pm 1.0$	4983.3	4983.1	0.2	$\pm 3.0$	-82.5	-83.0	0.5	$\pm 1.0$	615	611	4	$\pm 132^4$	0.072	0	0.072	$\pm 0.183^4$
CPy <sup>5</sup>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	959	1833	-874	$\pm 1400$	0.929	0	0.929	$\pm 1.400$
PRM	-20187.5	-20189.6	2.1	$\pm 3.0$	-627.2	-628.1	0.9	$\pm 2.0$	-95.9	-96.7	0.8	$\pm 1.0$	-244	-269	25	$\pm 100$	5.831	5.876	-0.045	$\pm 0.100$
PR2	-3578.7	-3579.2	0.5	$\pm 3.0$	-530.1	-530.5	0.4	$\pm 1.0$	-91.6	-92.3	0.7	$\pm 1.0$	50	0	50	$\pm 100$	-7.996	-8.011	0.015	$\pm 0.100$
PR3	-19740.9	-19740.0	-0.9	$\pm 3.0$	-175.7	-176.5	0.8	$\pm 3.0$	-90.1	-87.9	-2.2	$\pm 3.0$	50	0	50	$\pm 50$	-11.156	-11.146	-0.010	$\pm 0.050$
SRM-s <sup>6</sup>	306.9	305.0	1.9	$\pm 4.6$	-19909.8	-19908.7	-1.1	$\pm 3.0$	-81.7	-81.1	-0.6	$\pm 3.0$	27	30	-3	$\pm 520$	57.098	57.094	0.004	$\pm 0.820$
SR2	-596.4	-594.1	-2.3	$\pm 5.1$	-4177.0	-4178.2	1.2	$\pm 3.0$	-83.4	-81.6	-1.8	$\pm 3.4$	-155	0	-155	$\pm 520$	42.358	42.108	0.250	$\pm 0.820$
SR3	-175.3	-175.3	0.0	$\pm 3.0$	-19614.9	-19616.0	1.1	$\pm 3.0$	-80.9	-82.1	1.2	$\pm 3.0$	8	0	8	$\pm 560$	13.762	13.783	-0.021	$\pm 0.200$
ETMx	3999499.2	3999498.0	1.2	$\pm 3.0$	-200.6	-200.0	-0.6	$\pm 1.0$	-80.5	-80.0	-0.5	$\pm 1.0$	323	315	8	$\pm 50$	-0.005	0	-0.005	$\pm 0.050$
ERMx <sup>5</sup>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1716	1711	5	$\pm 1470$	-0.030	0	-0.030	$\pm 1.470$
ETMy	-200.5	-200.0	-0.5	$\pm 1.0$	3999468.3	3999468.1	0.2	$\pm 3.0$	-80.3	-80.0	-0.3	$\pm 1.0$	-1	19	-20	$\pm 50$	0.020	0	0.020	$\pm 0.050$
ERMy <sup>5</sup>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	660	1241	-581	$\pm 1470$	0.893	0	0.893	$\pm 1.470$

1: Pitch sign convention follows the standard SUS convention for pitch, i.e. positive = down, negative = up (see E1000617, E1100108, & E1100109)

2: Yaw sign convention follows the standard SUS convention for yaw, i.e. positive = counterclockwise, negative = clockwise (see E1000617, E1100108, & E1100109). Yaw is reported as the angle from the axis closest to the HR surface normal of the optic

3: All Z axis target positions are reported in coordinates local to the building that houses the optic. I.E. the BS Z axis is local to the LLO corner station, while the ETMx Z axis is local to the LLO End X station.

4: This is the pitch/yaw tolerance for L1 ITMx and ITMy at the time of install. This was changed to  $\pm 50 \mu\text{rad}$  after these 2 optics were installed and aligned, hence the difference in spec between ITM and ETM

5: SUS sets the position of the CPx, CPy, ERMx, and ERMy. IAS is only responsible for aligning the pitch and yaw of these optics so that is all that is recorded here. The pitch/yaw of these optics is set so the optic is parallel with the AR surface of their associated TM.

6: This is the SRM surrogate optic that is being used in the early low power stages of aLIGO commissioning. The real SRM optic will be installed and aligned at a later date.