



Evaluation of the LCLS Cam Roller Motion System

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Abstract

In the spring of this year the first article components for the Linac Coherent Light Source [LCLS] undulator string were delivered to Argonne National Laboratory. The assembly and parts of the alignment processes were evaluated in the single undulator test (SUT) setup. This report presents the evaluation of the cam roller motion system.

Instruments

Motion evaluation of the LCLS cam roller system was accomplished using two Leica LTD500 laser trackers and four Keyence LK-G37 CCD laser displacement sensors. This analysis also serves as a comparison of the two measurement systems. Lab temperature is maintained to ± 1 degree F. All data was collected within a timeframe of 1 hour.

Leica LTD500 Laser Tracker

Range of Measurement (long range, 3-dimensional)		Accuracy
horizontal	± 235 degrees	angle resolution 0.14 arcseconds
vertical	± 45 degrees	distance resolution 1.26 microns
distance	0 – 35 meters	absolute accuracy (static) ± 10 microns / meter



Keyence LK-G37 CCD Laser Disp. Sensor

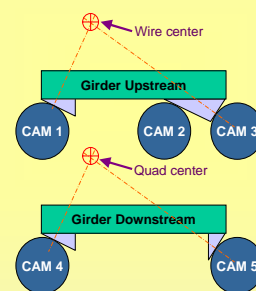
Range of Measurement (short range, linear)	
reference distance	30 millimeters
measurement range	± 5 millimeters

Accuracy	
resolution	0.05 microns
accuracy (estimated)	± 1 micron



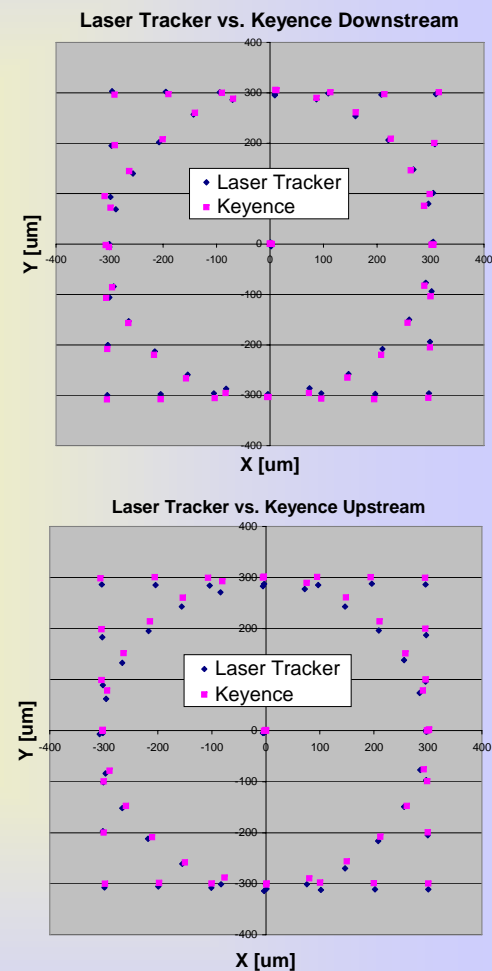
Cam Roller Motion System

The cam roller motion system for the LCLS allows movement of the girder in X, Y, pitch, roll and yaw within a 1.5 mm command space to facilitate beam based alignment and settlement corrections. The system is comprised of four angled wedge blocks attached to the bottom of the girder resting on five cam lobes having an eccentricity of 1.5 mm. The cams are rotated to move the girder into the desired position using an EPICS based control system. Extremely tight alignment tolerances are specified for the LCLS. All quadrupole magnets must be aligned to within $\pm 2 \mu\text{m}$ to a common reference line. All undulator segments must be aligned to within 80 μm vertically and 140 μm horizontally to the common reference line.



Motion Analysis

Girder motion was measured with the Leica laser trackers for absolute position and with the Keyence sensors for relative displacement. A comparison of the measurement sets indicates very high precision is achieved when driving the girder to any position within the command space, well within the LCLS specified tolerances. It should be noted that the pick-up for the Keyence measurements and the laser trackers are at different locations. Even so the agreement between these two measurement methods is astounding.



Laser Tracker vs. Keyence Measurements

	X upstream	Y upstream	X downstream	Y downstream
Average Delta [μm]	-2	-9	1	3
Maximum Delta [μm]	-8	-19	11	12

Average Deviation from Target Values

	X upstream	Y upstream	X downstream	Y downstream
Tracker-Target [μm]	-3	-8	2	-1
Keyence-Target [μm]	1	1	1	3