

Fine tuning.

Follow the fine tuning test plan to align the undulator to the bench and do final adjustment to the trajectories, phases and field integrals, measure magnetic parameters, and fiducialize the undulator (LCLS-TN-06-17, LCLS-TN-07-2).

Make sure all instruments are ON for a while, enough to warm up (> 5 minutes).

Do mechanical alignment using capacitor sensors and cam movers. X and Y to be set to $10\mu\text{m}$; roll to 0.1mrad ; pitch to 0.005mrad , and yaw to 0.010mrad .

Magnetically align the undulator to the bench. Pitch could be different from the mechanical one and to be finally set to 0.005mrad and yaw to 0.010mrad using the cam movers. Setting the x and y positions is not important at this step.

The following information is to be noted by an engineer upon finishing mechanical alignment to the granite:

Engineer (initials):	YL
Date (mm-dd-yyyy):	07/01/08 08/22/08
Average X (m):	0.029308 0.024725
Average Y (m):	0.000369442 0.000237
Final Roll (rad):	$19.9 + 28 \cdot 10^{-6}$
Final Pitch (rad):	$-2.1 - 22 \cdot 10^{-6}$
Final Yaw (rad):	$-4.5 - 26 \cdot 10^{-6}$

Check and correct the probe roll angle w.r.t the undulator.

Find y_0 position at minimum K. Check and correct the trajectories and phases, if necessary. Trajectories should be straightened to $\pm 1\mu\text{m}$, phases to $\pm 10^\circ$. Find x_0 position at nominal K. Move probe at x_0, y_0 .

Install long coil and align it with respect to the probe. Turn OFF the Kugler bench to minimize the noise. Measure field integrals by long moving coil; correct, if necessary.

Turn ON the bench, check trajectories, phases, and K. Correct if necessary. Field integrals should match ones measured by the long coil. Make any necessary corrections to the measured fields in the Matlab parameter file. Check shim positions w.r.t the shim table, correct if necessary, glue the shims. Update the table of shims attached to the traveler.

The following information is to be noted by a technician upon gluing shims:

Technician (initials):	ST
Date (mm-dd-yyyy):	08/25/08

Check trajectories, phases, and K again. Do final measurements by Hall probe and the coil.

The following information is to be noted by an engineer upon final tuning:

Engineer (Initials):	YL
Date (mm/dd/yyyy)	08/26/08
Reference magnet measurement (T):	-0.369121
X-field correction (T):	-4 $4 \cdot 10^{-5}$
Y-field correction (T):	$-6 \cdot 10^{-6}$
Final max X trajectory error (μm):	-0.5
Final max Y trajectory error (μm):	-0.7
Final Phase error rms ($^{\circ}$):	3.1
Final Phase error entrance ($^{\circ}$):	-1.0
Final Phase error exit ($^{\circ}$):	+1.4
Final Phase error cell ($^{\circ}$):	+1.9
Measured K-value:	3.487603
Magnetic axis position X (m):	0.024659
Magnetic axis position Y (m):	0.000293
First integral Y at center (Tm):	$+13 \cdot 10^{-6}$
Second integral Y at center (Tm^2):	0
First integral X at center (Tm):	$+16 \cdot 10^{-6}$
Second integral X at center (Tm^2):	$+18 \cdot 10^{-6}$
Slot number	28

URL of on-line Final tuning data:

www-group.slac.stanford.edu/met/MagMeas/MAGDATA/LCLS/Undulator/L143-112000-23/DATASET0001/Fine%20Tuning/

Fiducialization on Kugler bench:

Upon completion of the tuning the undulator should be fiducialized; optical measurements to be done the same day as magnetic measurements.

Attach pointed magnets to the both ends of the undulator. Measure position of the PM centers w.r.t. the undulator center line.

The following information is to be noted by an engineer:

Engineer (Initials):	YL
Upstream PM X offset (m):	0.024933
Upstream PM Y offset (m):	0.000158
Downstream PM X offset (m):	0.024872
Downstream PM Y offset (m):	0.000191
Reference upstream PM X offset (m):	0.072452
Reference upstream PM Y offset (m):	0.000202
Reference downstream PM X offset (m):	0.072492
Reference downstream PM Y offset (m):	0.000301
Keyence probe (m):	+0.011065
Keyence block (m):	-0.011403

Have an alignment crew to measure offsets between PM tooling balls, the undulator tooling balls, reference PM tooling balls to an alignment reference line, Hall probe in X and gage block in Y. Attach alignment data sheet to the traveler.

Surveyor (initials):	LG
Date (mm/dd/yyyy):	08/27/08

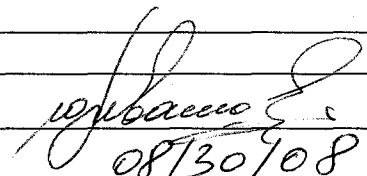
Move the undulator to CMM to finalize the fiducialization.

Attach CMM data sheet to the traveler.

URL of on-line fiducialization data:

www-group.slac.stanford.edu/met/MagMeas/MAGDATA/LCLS/Undulator

[/L143-112000-23/DATASET0001/](#)

Undulator tuning completed (signed):	
Date (mm/dd/yy)	08/30/08