

LCLS-II Undulator Segment Measurement Results

HXU-002

LCLS-II HXU Measurement Results

This report is intended to document the results of HXU segment tuning at LBNL and ANL. It should be sent to SLAC for approval before the HXU segment gets shipped.

Serial number from manufacturers label:	HXU-002
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Measurement Procedure:

The measurements have been carried out after the undulator segment had been fully tuned according to the “LCLS-II Undulator Test Plan” (LCLS-TN-17-1).

General Hall Probe Scan Evaluation Parameters

Undulator Temperature (should be 20.0)	20.0 ± 0.2	°C
First core pole #	8	
Last core pole #	253	
Tuning Gap	9.000	mm

Evaluation of Hall Probe Scans at Commissioning Gap

Commissioning Gap Temperature (should be 20.0)	20.0 ± 0.2	°C
$rms(B_{pk} /\langle B_{pk} \rangle - 1)$	0.0022	
K_{eff} at Commissioning Gap (should be 2.3400)	2.3399	
Commissioning Gap	7.950	mm
$I1X$ (over 4.012667 m) (should be within ± 40)	14	μTm
$I2X$ (over 4.012667 m) (should be within ± 150)	19	μTm^2
$I1Y$ (over 4.012667 m) (should be within ± 40)	-5	μTm
$I2Y$ (over 4.012667 m) (should be within ± 150)	1	μTm^2
Phase Shake (rms phase fluctuations over core poles (< 4.0))	2.3	degXray
Cell Phase Advance (over 4.012667 m)	48597.5 (135×360−2.5)	degXray
Undulator Entrance Phase ¹	2246.6 (25×90−3.4)	degXray
Undulator Exit Phase ²	2252.2 (25×90+2.2)	degXray

¹Phase advance from cell start (undulator center −2.006334 m) to center of physical pole 8.

²Phase advance from physical pole 253 to cell end (undulator center +2.006334 m).



Undulator Encoder Settings

USGapEncoderOffset	-697.9313
DSGapEncoderOffset	-911.5725
USWLinearEncoder.AOFF	92.7142
DSWLinearEncoder.AOFF	91.1378
USALinearEncoder.AOFF	90.1477
DSALinearEncoder.AOFF	89.5885

Undulator Load Cell Readings at Tuning Gap

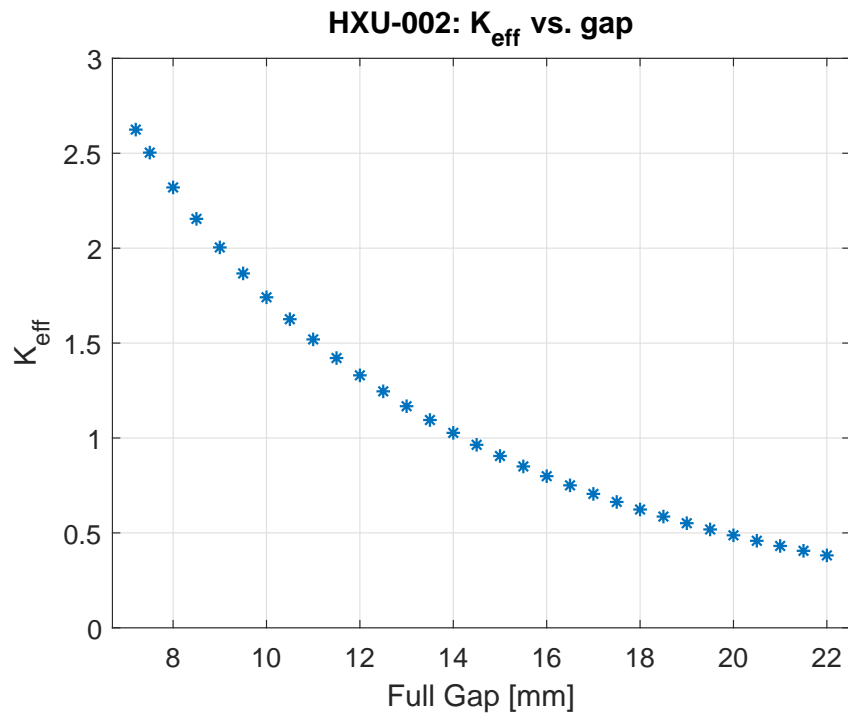
LC.DAL_FORCE	-344.5
LC.DAU_FORCE	-55.7
LC.DWL_FORCE	-155.0
LC.DWU_FORCE	-273.4
LC.UAL_FORCE	-364.7
LC.UAU_FORCE	-43.0
LC.UWL_FORCE	-162.8
LC.UWU_FORCE	-267.6

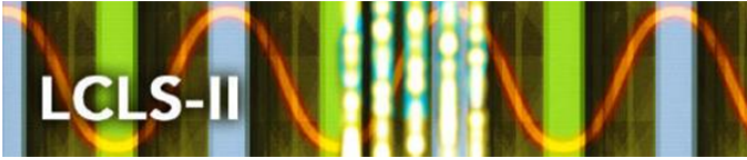
Undulator Load Cell Readings at 100 mm Gap

LC.DAL_FORCE	-2.7
LC.DAU_FORCE	-0.7
LC.DWL_FORCE	-2.7
LC.DWU_FORCE	-1.5
LC.UAL_FORCE	0.0
LC.UAU_FORCE	-0.5
LC.UWL_FORCE	-1.0
LC.UWU_FORCE	0.2

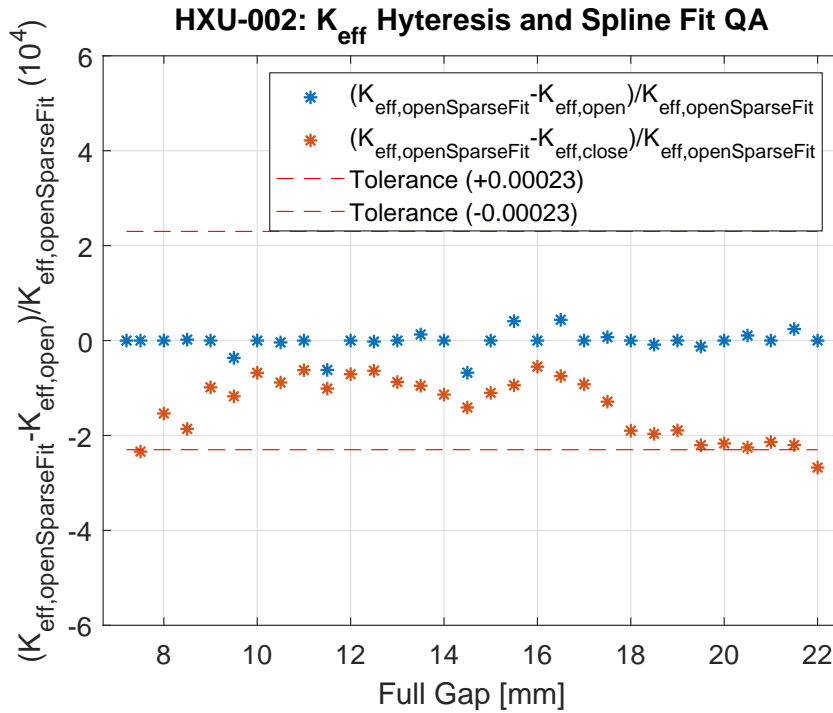


Evaluation of Hall Probe Scans: K_{eff} vs. gap





Evaluation of Hall Probe Scans: K_{eff} Hysteresis

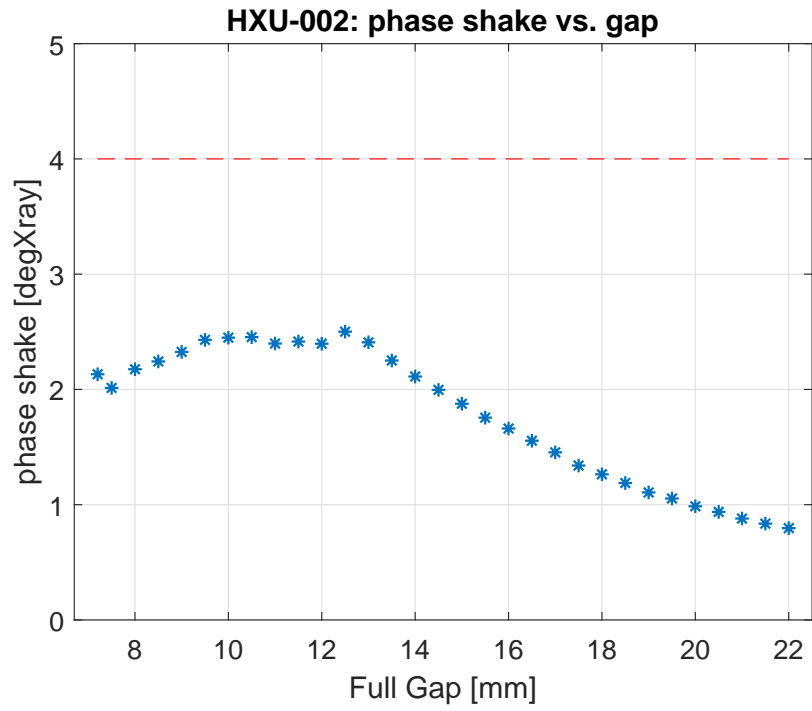


Plotted functions have been calculated from measured values openKeff (opengap) and closeKeff (closegap) using the following Matlab calculations:

- Blue Stars: `1-openKeff ./ spline(opengap([1,2,[3:2:end]]),openKeff([1,2,[3:2:end]]),opengap)`
- Green Stars: `1-closeKeff ./ spline(opengap([1,2,[3:2:end]]),openKeff([1,2,[3:2:end]]),closegap)`

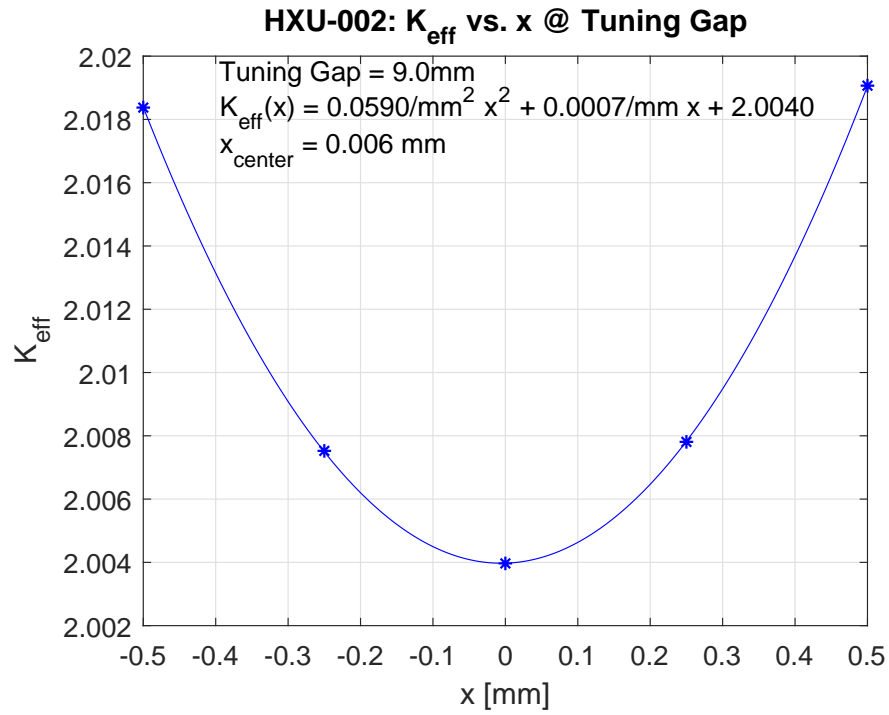


Evaluation of Hall Probe Scans: Phase Shake vs gap



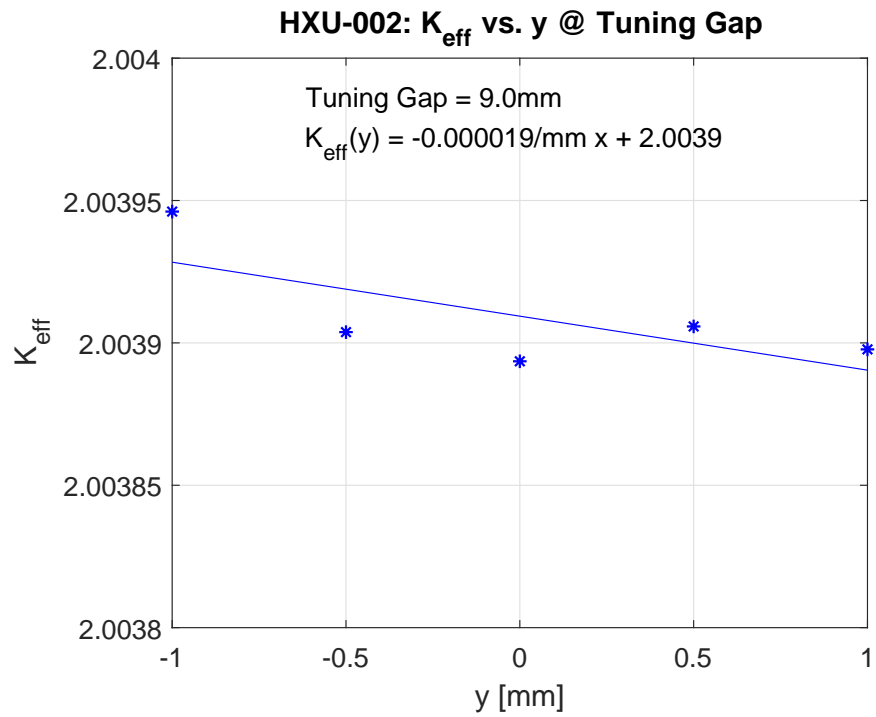


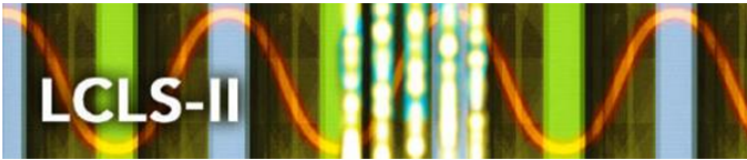
Evaluation of Hall Probe Scans: K_{eff} vs x at Tuning Gap



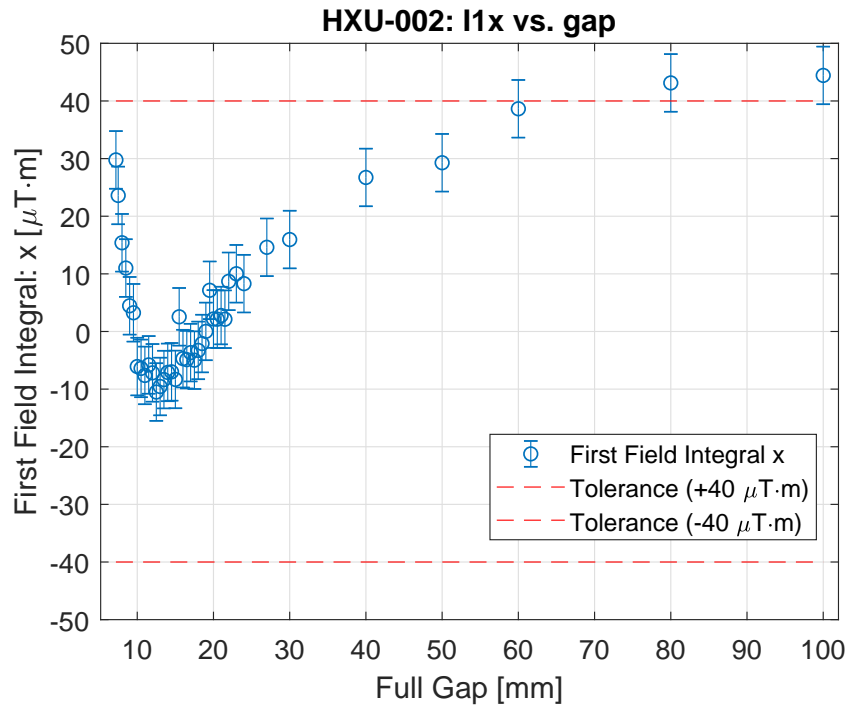


Evaluation of Hall Probe Scans: K_{eff} vs Y at Tuning Gap



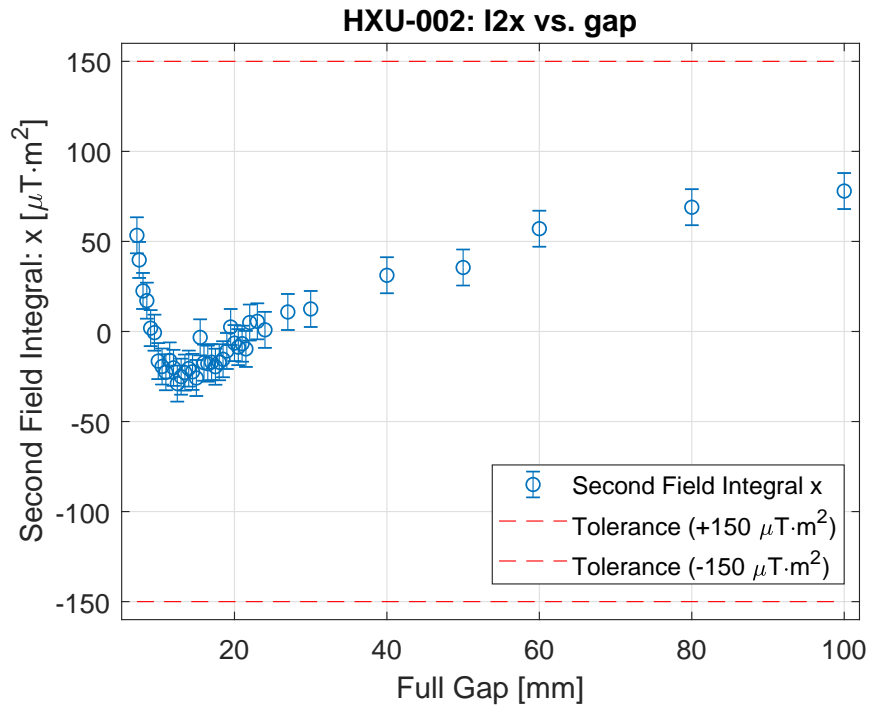


Long Coil Measurement of the On-Axis First Horizontal Field Integrals



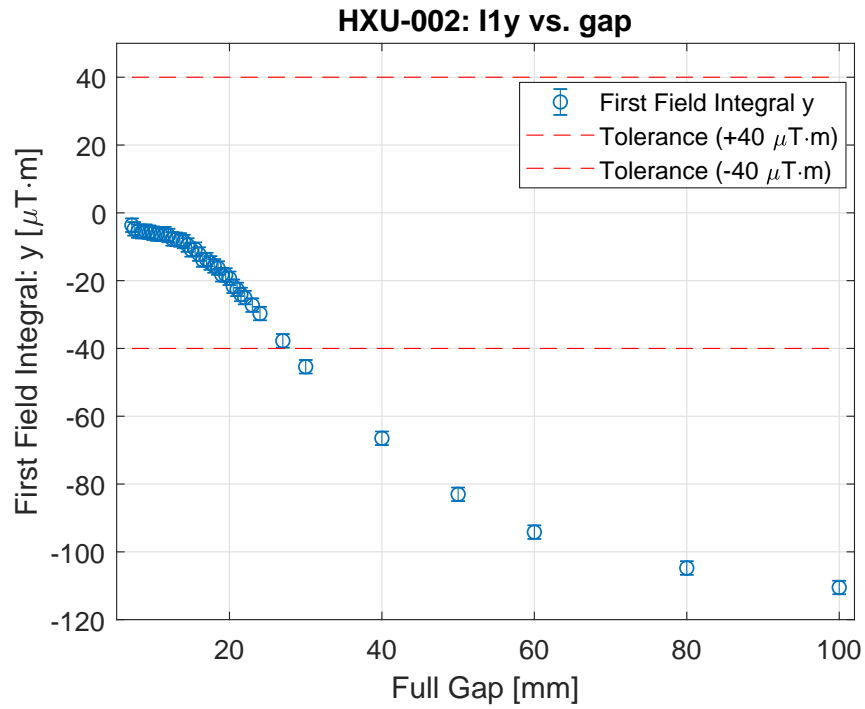


Long Coil Measurement of the On-Axis Second Horizontal Field Integrals



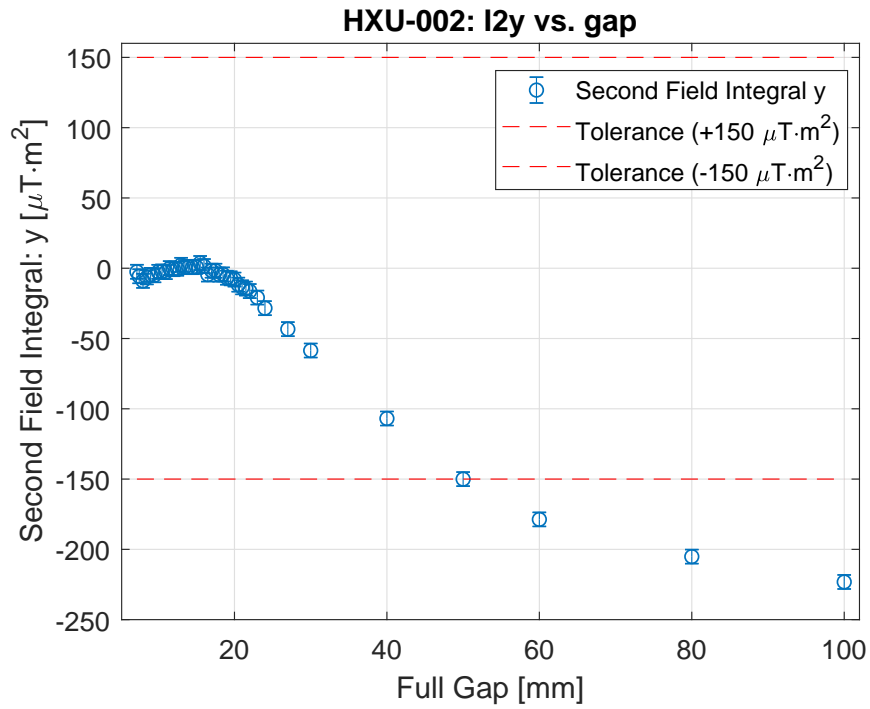


Long Coil Measurement of the On-Axis First Vertical Field Integrals



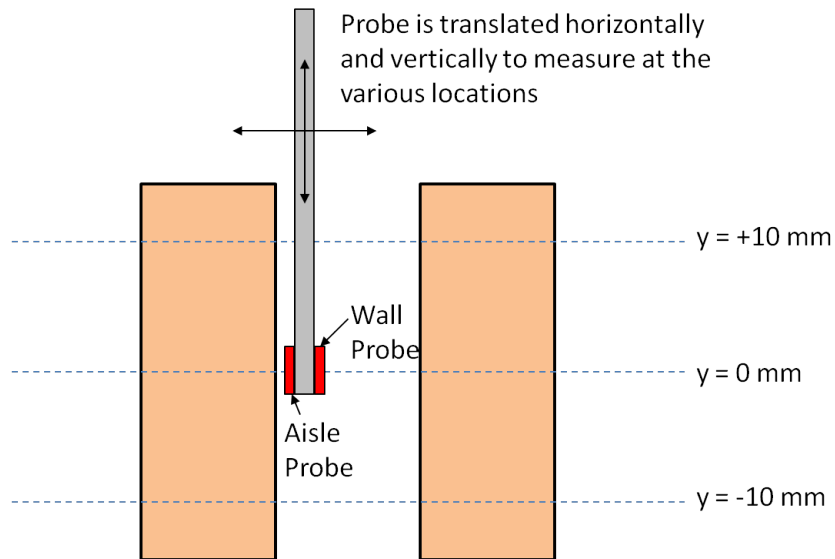


Long Coil Measurement of the On-Axis Second Vertical Field Integrals





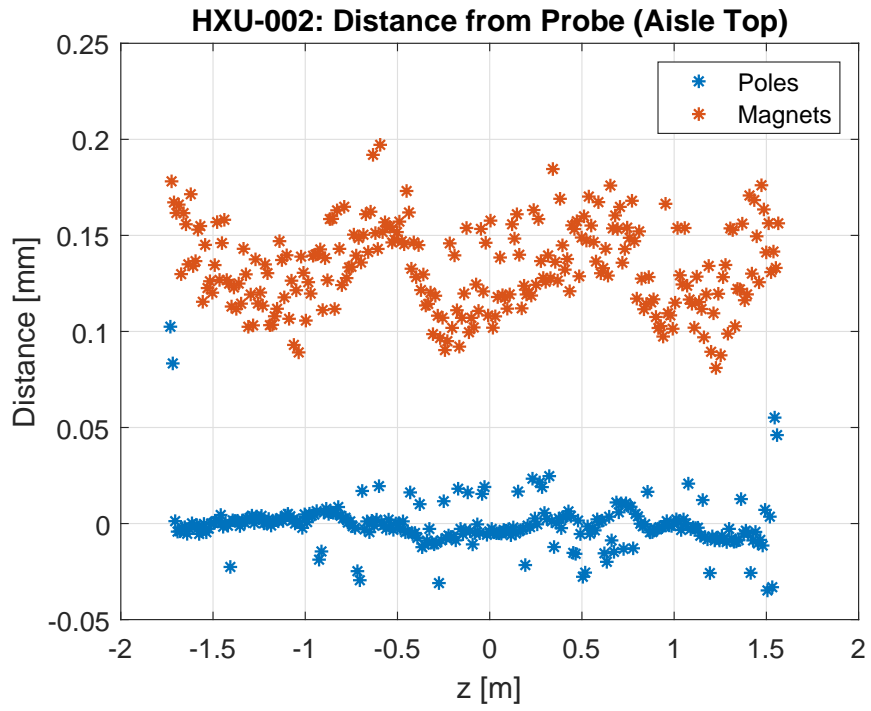
Capacitive Sensor Arrangement

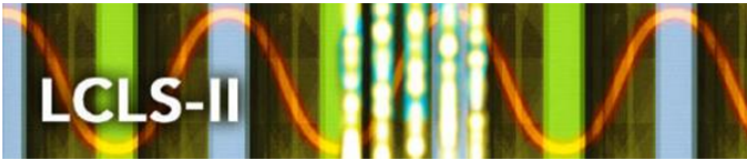


The following plots show the pole and magnet position measurements. The LBNL system has two back-to-back capacitive probes on one probe holder. The x and y stages on the Kugler bench are positioned so that the probe is in the proper location for each of the 9 scan locations. For the data analysis, the average pole position in each scan is used as reference for the plotted pole and magnet positions. Note that for all plots, the first three and last three poles of the device are omitted since the measurement is not accurate due to end effects in the capacitance probe measurement.

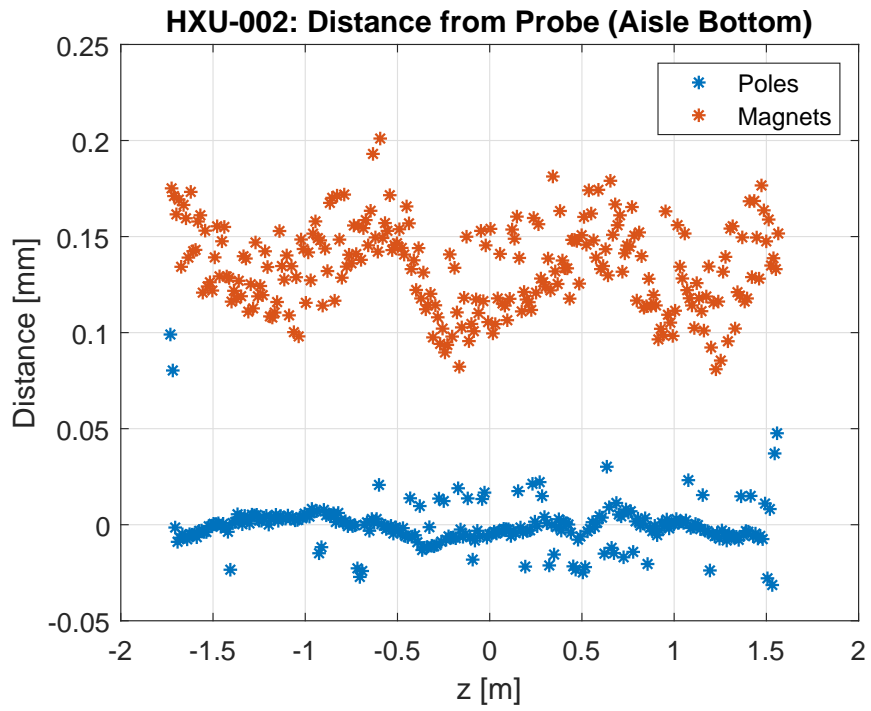


G1 Capacitive Sensor Readings



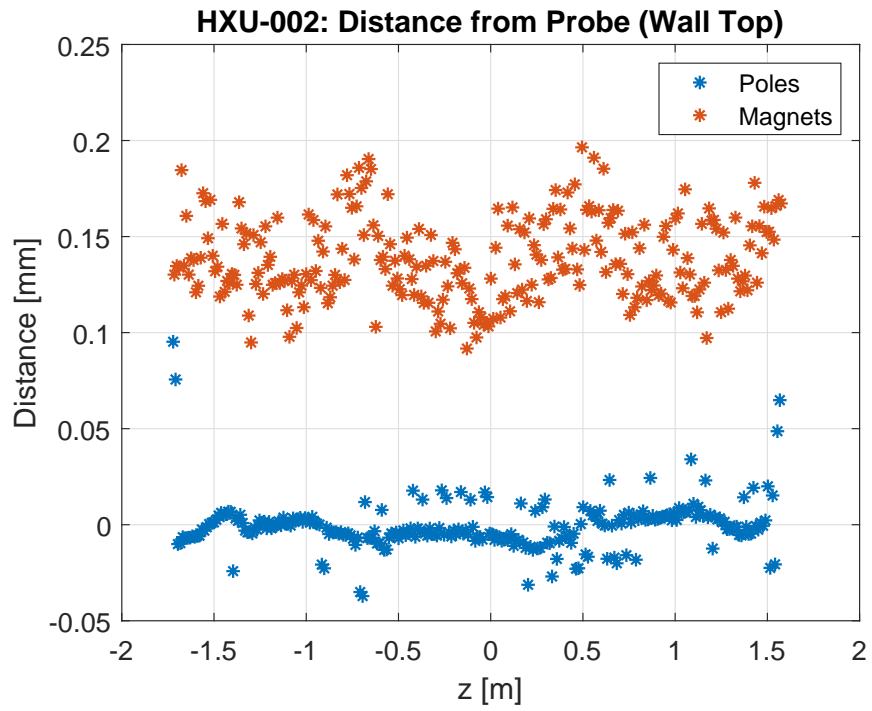


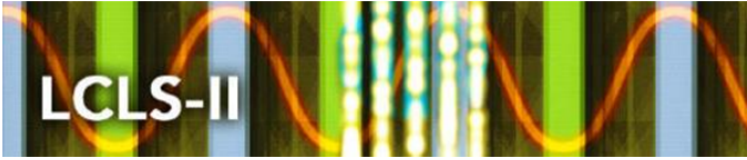
G2 Capacitive Sensor Readings



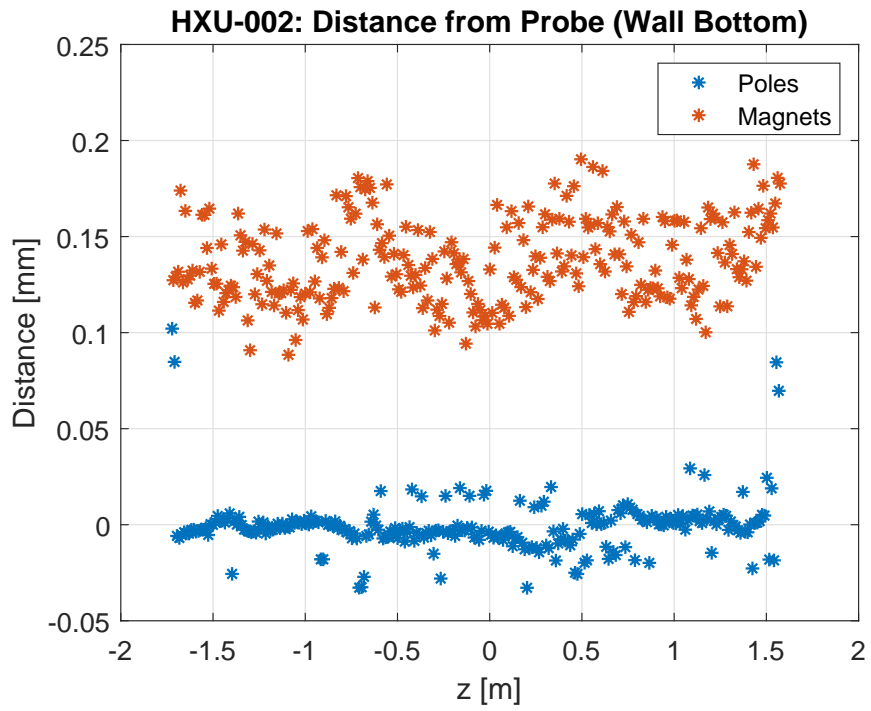


G3 Capacitive Sensor Readings



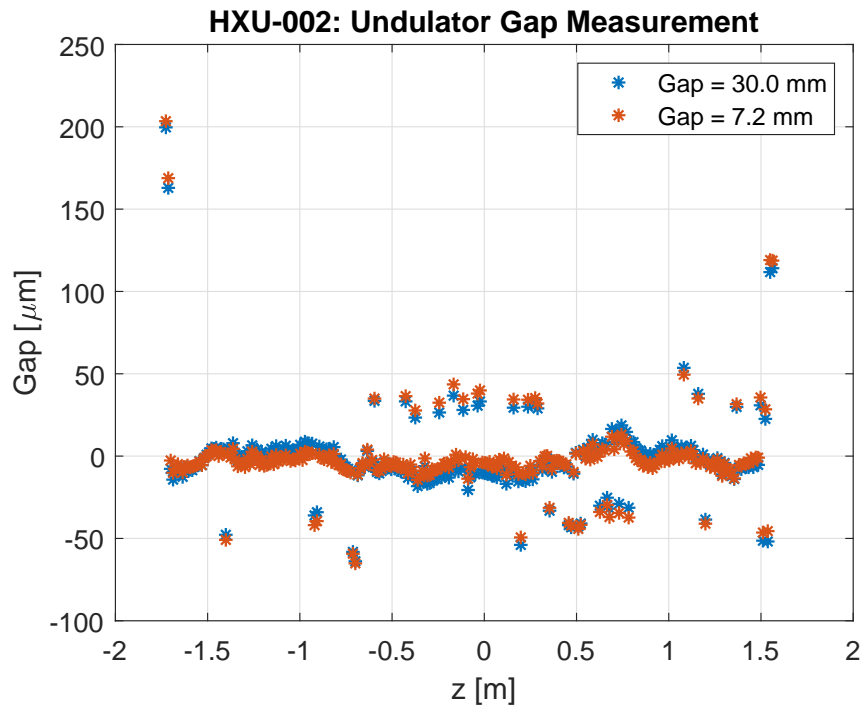


G4 Capacitive Sensor Readings



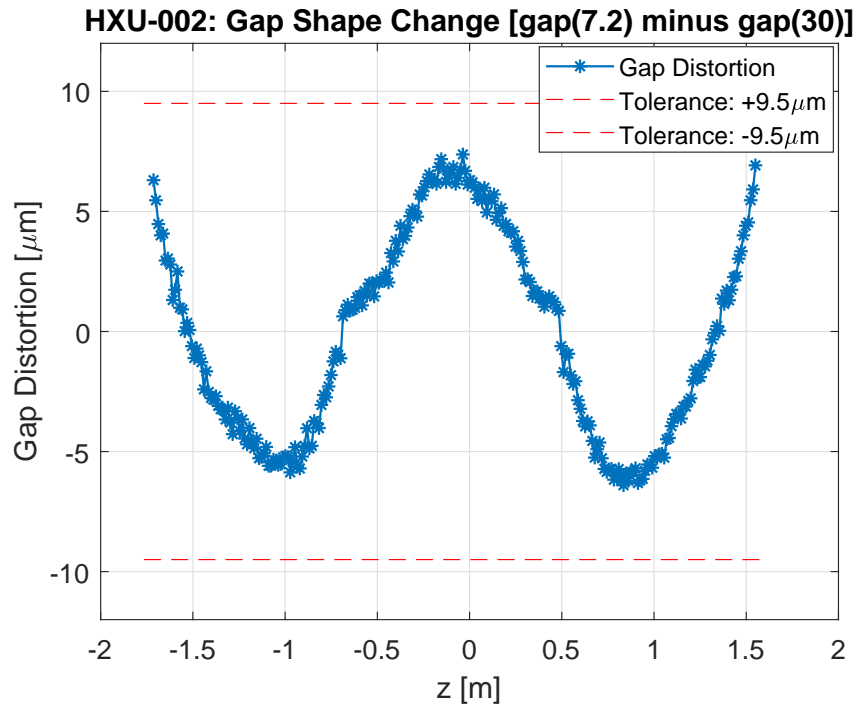


Undulator Gap Measurement



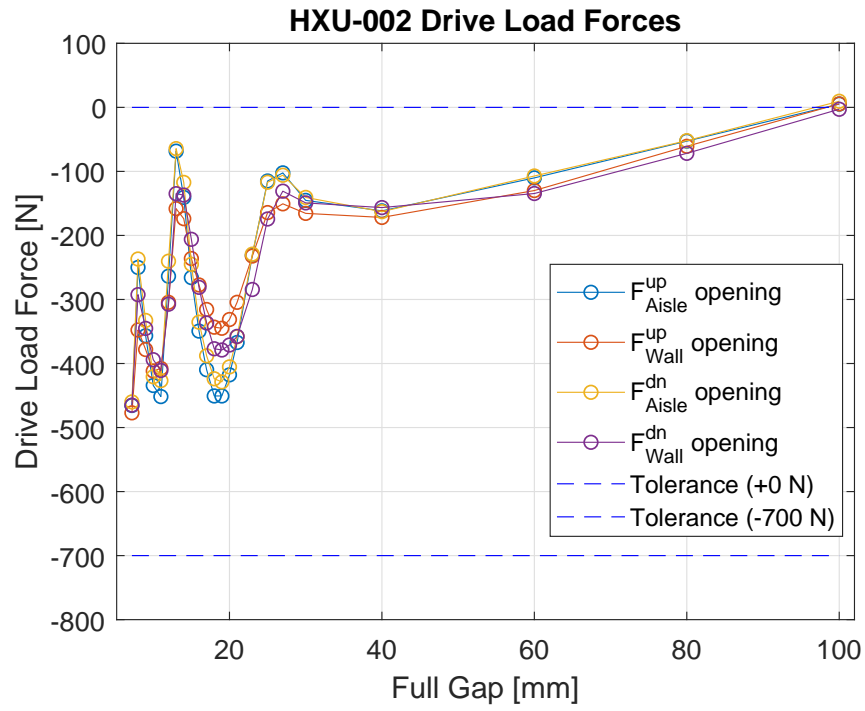


Undulator Gap Difference



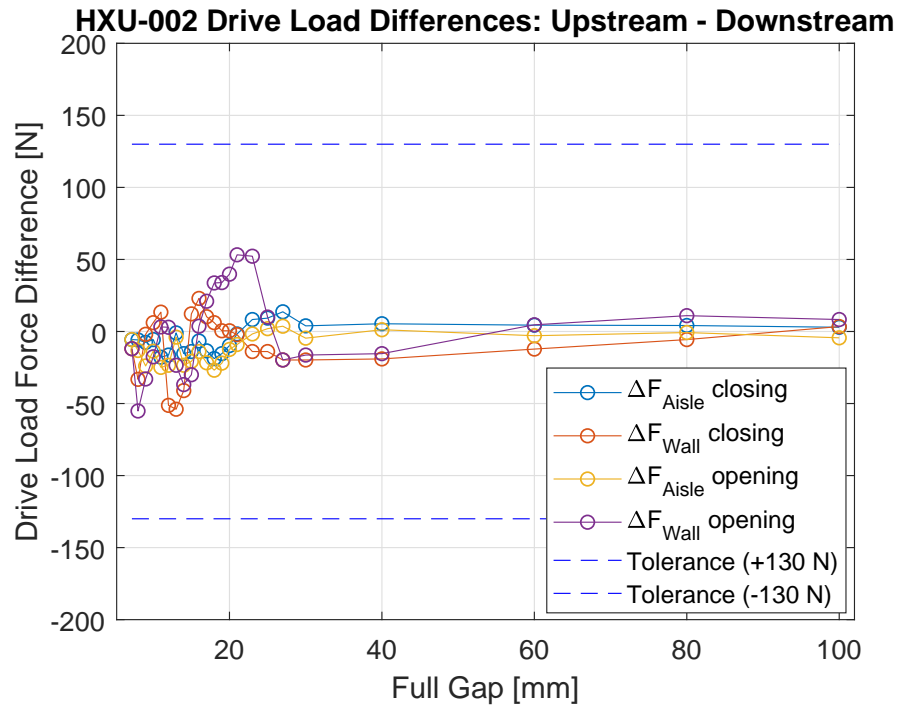


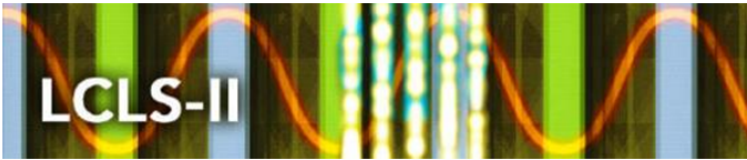
Drive Loads (Gap Opening)



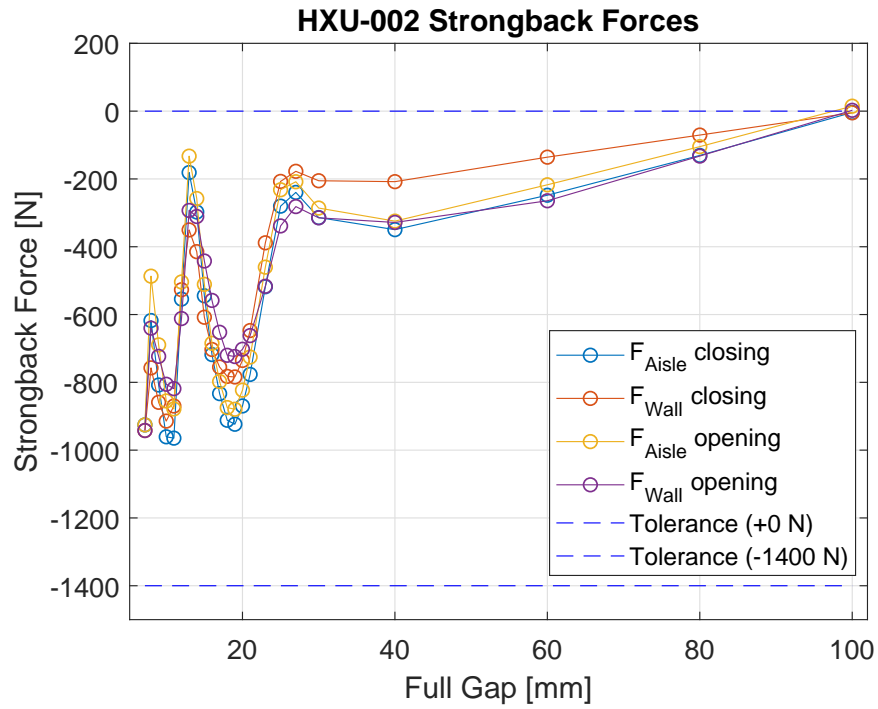


Drive Load Differences (Gap Opening and Closing)





Strongback Forces (Gap Opening and Closing)





Strongback Force Differences (Gap Opening and Closing)

