

LCLS-II Undulator Segment Measurement Results

HXU-005

LCLS-II HXU Measurement Results

Serial number from manufacturers label:	HXU-005
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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 ± 0.1	°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 ± 0.1	°C
$rms(B_{pk} /\langle B_{pk} \rangle - 1)$	0.0025	
K_{eff} at Commissioning Gap (should be 2.3400)	2.3401	
Commissioning Gap (HG Enc)	7.904	mm
Commissioning Gap (FG Enc)	7.884	mm
$I1X$ (over 4.012667 m) (should be within ± 40)	3	μTm
$I2X$ (over 4.012667 m) (should be within ± 150)	-27	μTm^2
$I1Y$ (over 4.012667 m) (should be within ± 40)	-2	μTm
$I2Y$ (over 4.012667 m) (should be within ± 150)	37	μTm^2
Phase Shake (rms phase fluctuations over core poles (< 4.0))	1.8	degXray
Cell Phase Advance (over 4.012667 m)	48599.4 (135×360−0.6)	degXray
Undulator Entrance Phase ¹	2249.7 (25×90−0.3)	degXray
Undulator Exit Phase ²	2245.8 (25×90−4.2)	degXray
Undulator Entrance Phase (relative to center) ³	24299.5 (135×180−0.5)	degXray
Undulator Exit Phase (relative to center) ⁴	24299.9 (135×180−0.1)	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).

³Phase advance from cell start (undulator center −2.006334 m) to undulator center.

⁴Phase advance from undulator center to cell end (undulator center +2.006334 m).



Undulator Encoder Settings

USGapEncoderOffset	41.3408
DSGapEncoderOffset	41.7763
USWLinearEncoder.AOFF	91.3744
DSWLinearEncoder.AOFF	89.9943
USALinearEncoder.AOFF	89.9979
DSALinearEncoder.AOFF	91.0365

Undulator Load Cell Readings at Tuning Gap (Gap Opening)

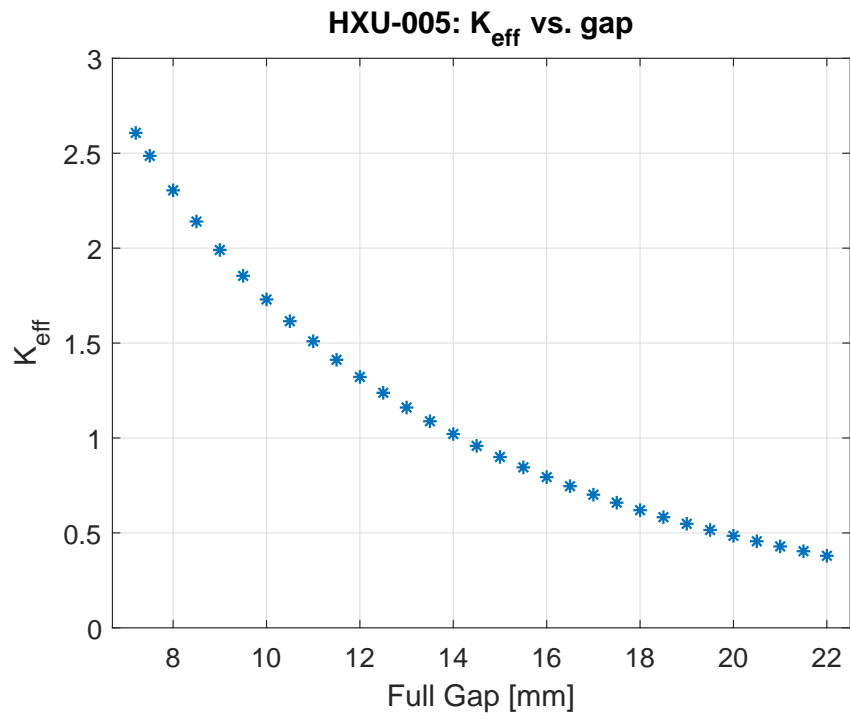
LC.DAL_FORCE	-170.2
LC.DAU_FORCE	-269.8
LC.DWL_FORCE	-122.6
LC.DWU_FORCE	-289.7
LC.UAL_FORCE	-96.4
LC.UAU_FORCE	-312.5
LC.UWL_FORCE	-76.7
LC.UWU_FORCE	-258.3

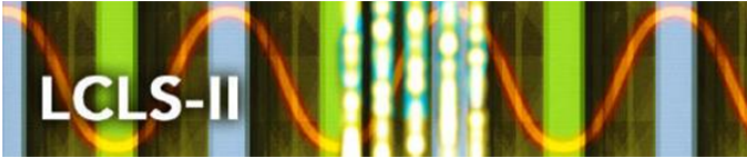
Undulator Load Cell Readings at 100 mm Gap (Gap Opening)

LC.DAL_FORCE	1.2
LC.DAU_FORCE	2.9
LC.DWL_FORCE	6.3
LC.DWU_FORCE	3.7
LC.UAL_FORCE	12.7
LC.UAU_FORCE	9.0
LC.UWL_FORCE	20.3
LC.UWU_FORCE	15.4

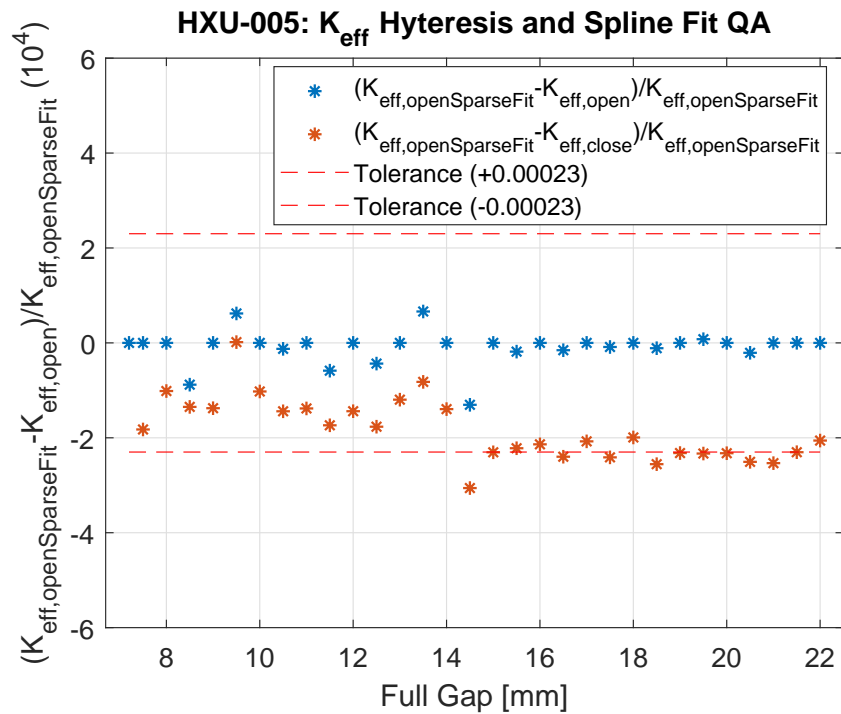


Evaluation of Hall Probe Scans: K_{eff} vs. gap





Evaluation of Hall Probe Scans: K_{eff} Hysteresis using Half Gap Encoders

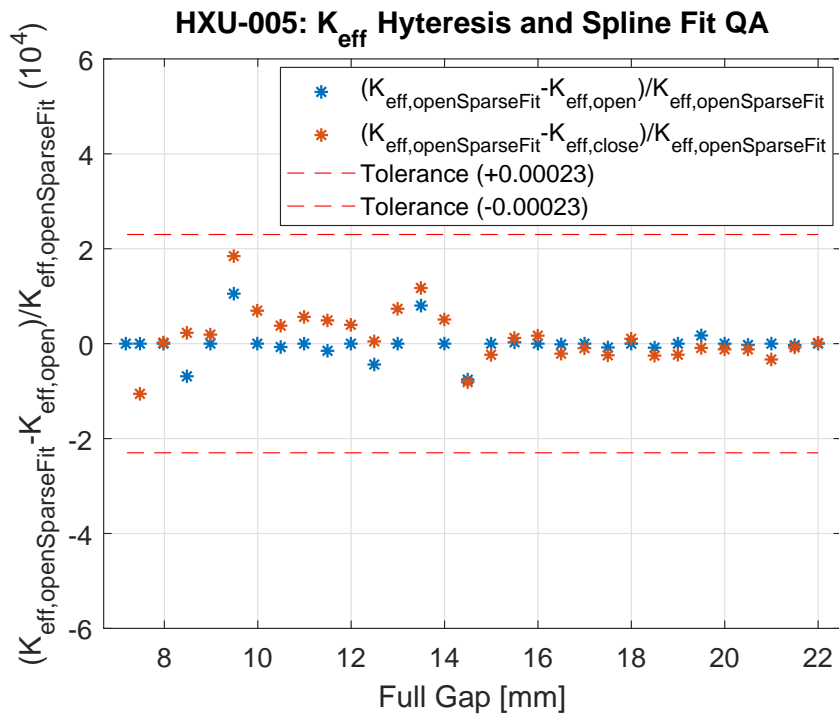


Plotted functions have been calculated from measured values openKeff (opengap) and closeKeff (closegap) using the following Matlab calculations:

- 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: K_{eff} Hysteresis using Full Gap Encoders

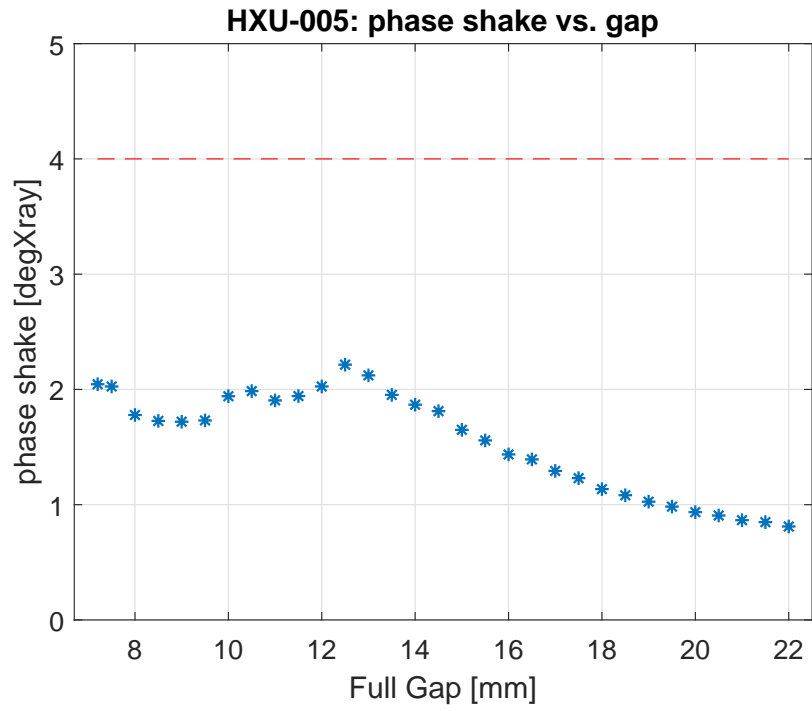


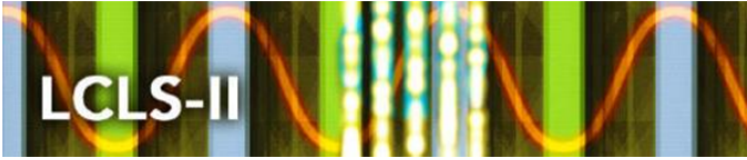
Plotted functions have been calculated from measured values openKeff (opengap) and closeKeff (closegap) using the following Matlab calculations:

- 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)`

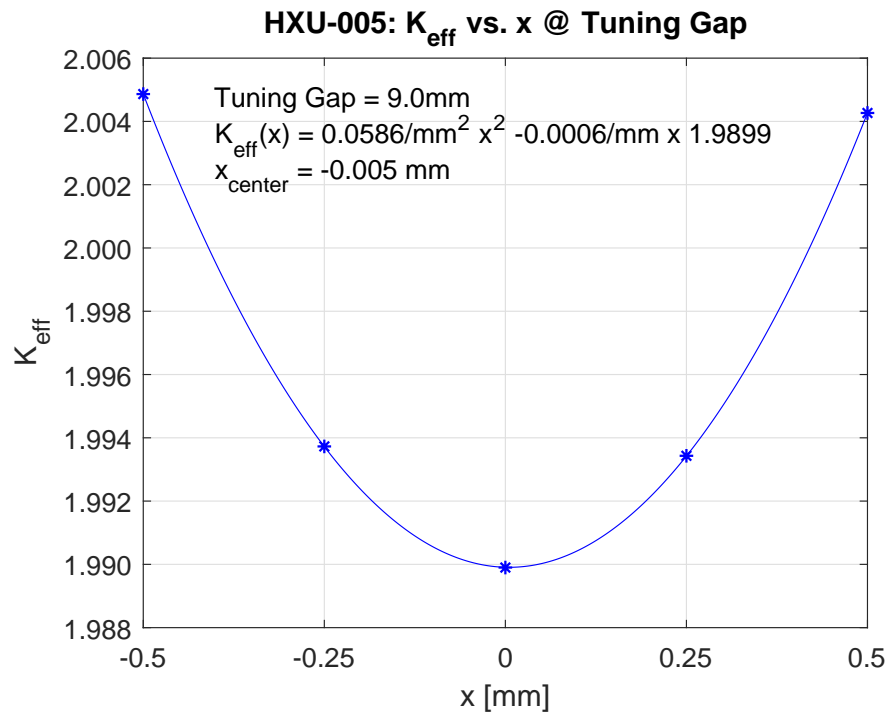


Evaluation of Hall Probe Scans: Phase Shake vs gap



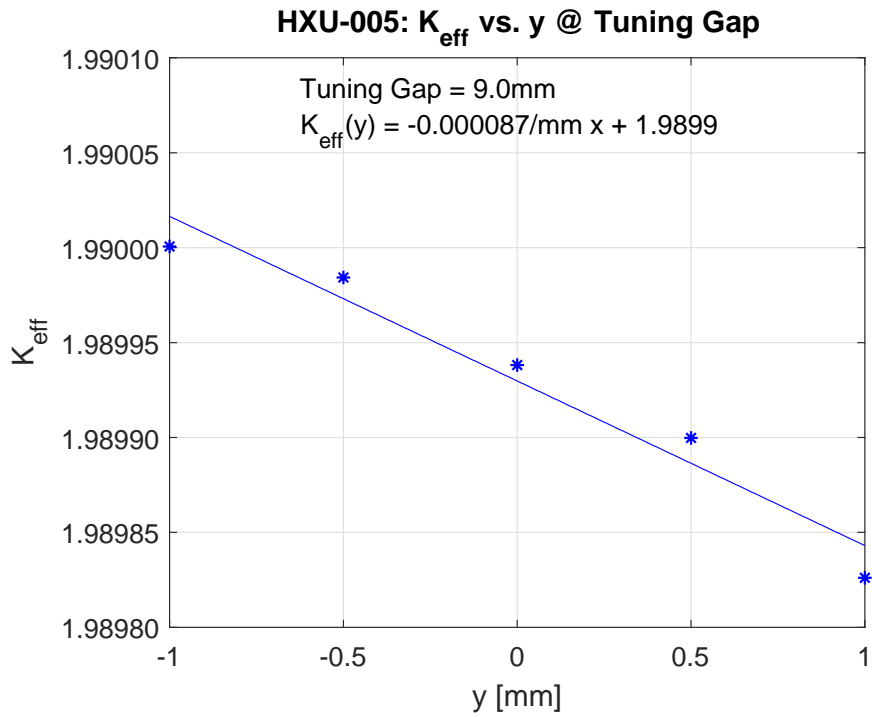


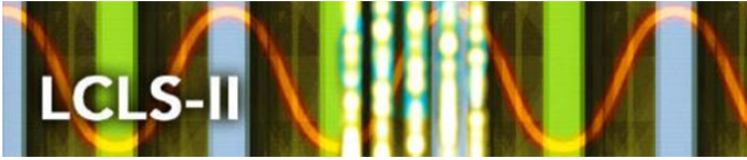
Evaluation of Hall Probe Scans: K_{eff} vs x at Tuning Gap



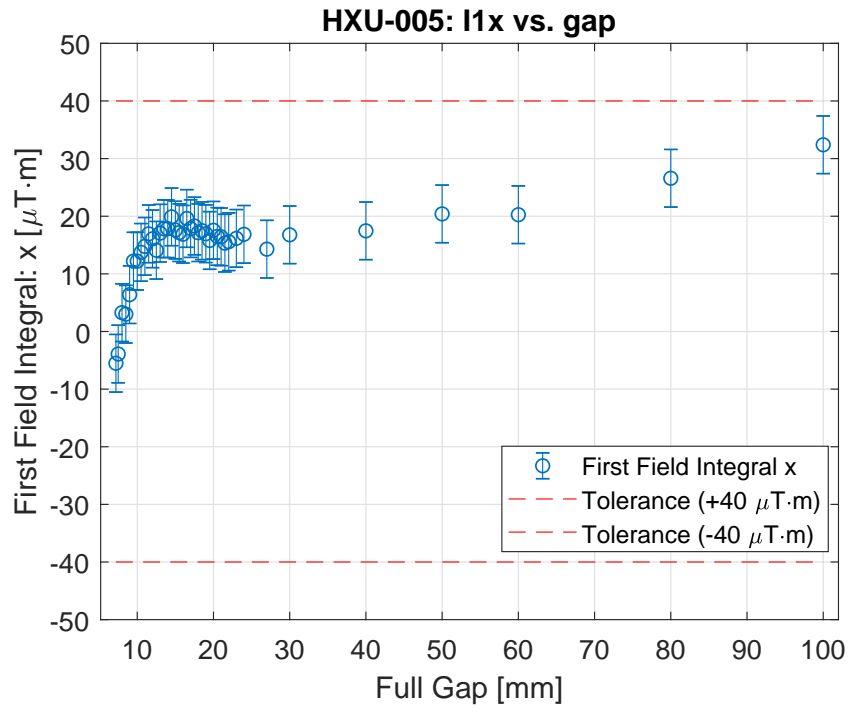


Evaluation of Hall Probe Scans: K_{eff} vs Y at Tuning Gap



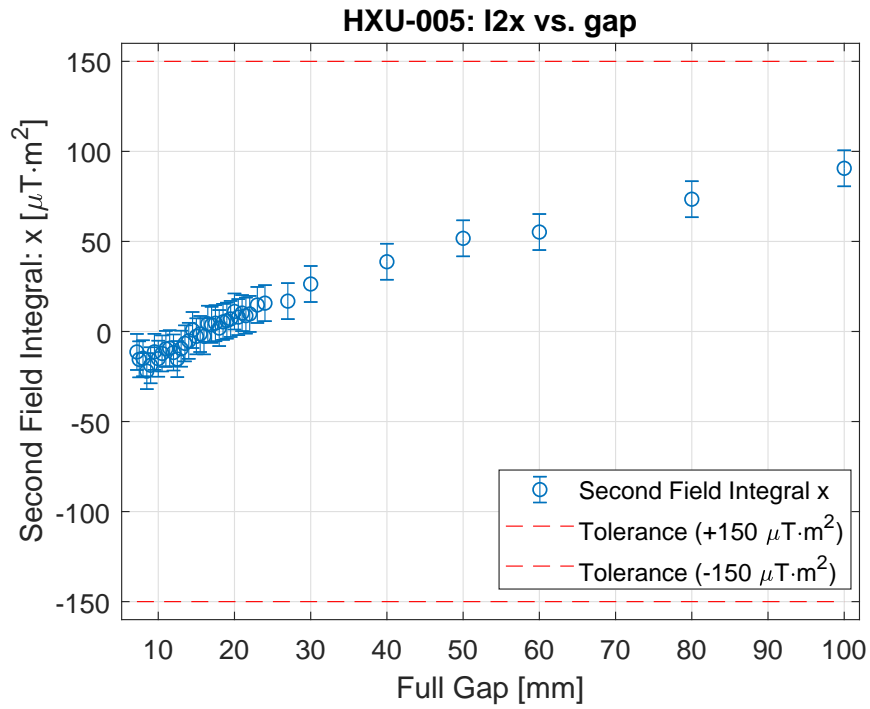


Long Coil Measurement of the On-Axis First Horizontal Field Integrals



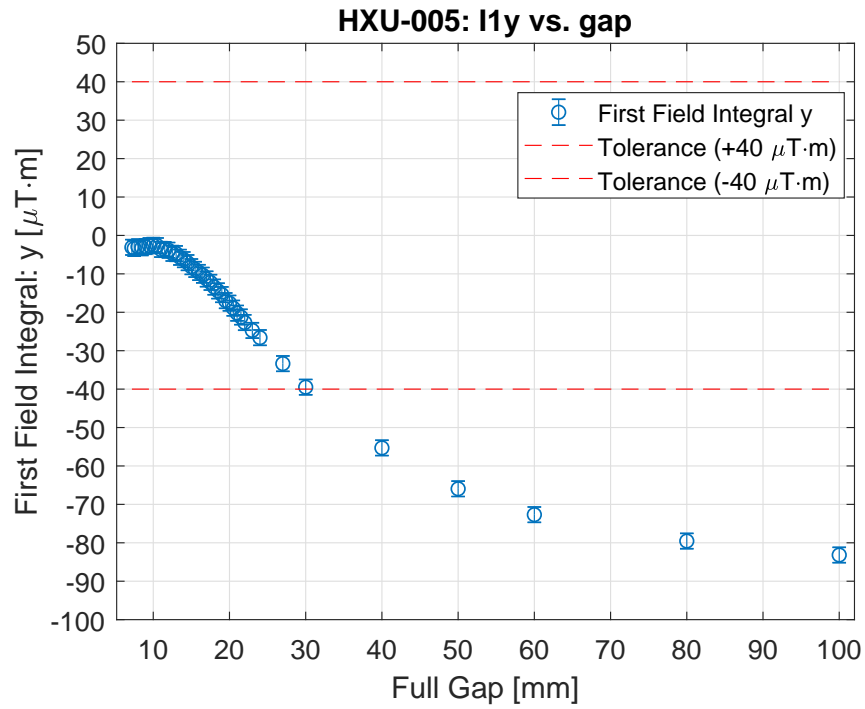


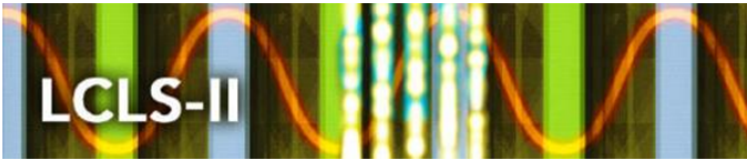
Long Coil Measurement of the On-Axis Second Horizontal Field Integrals



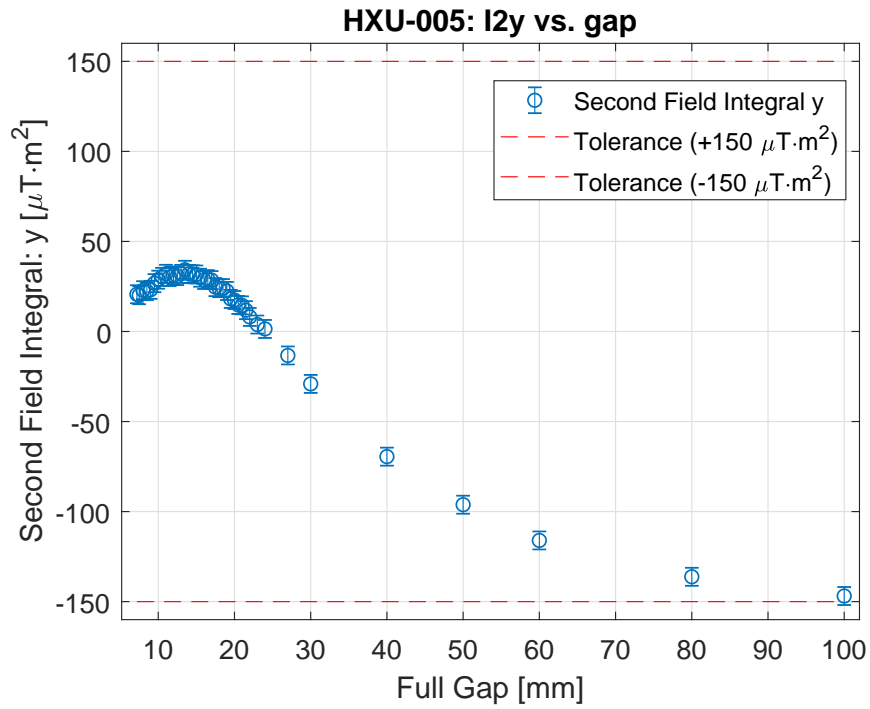


Long Coil Measurement of the On-Axis First Vertical Field Integrals



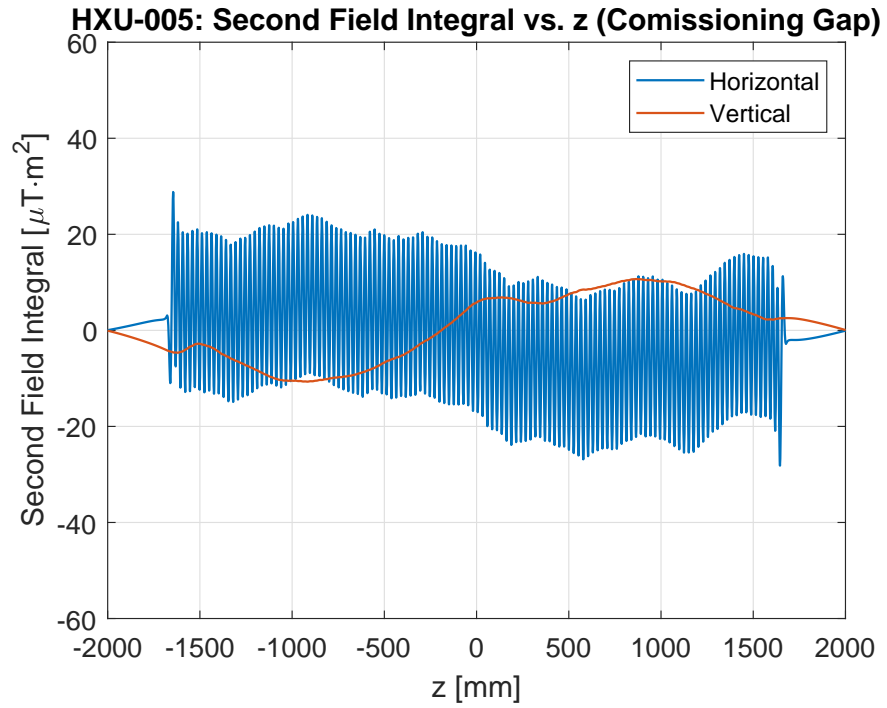


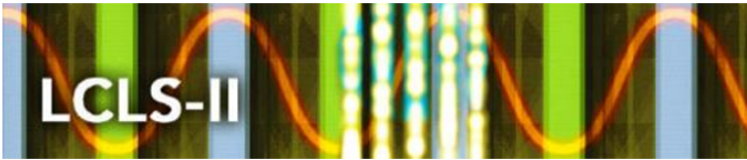
Long Coil Measurement of the On-Axis Second Vertical Field Integrals



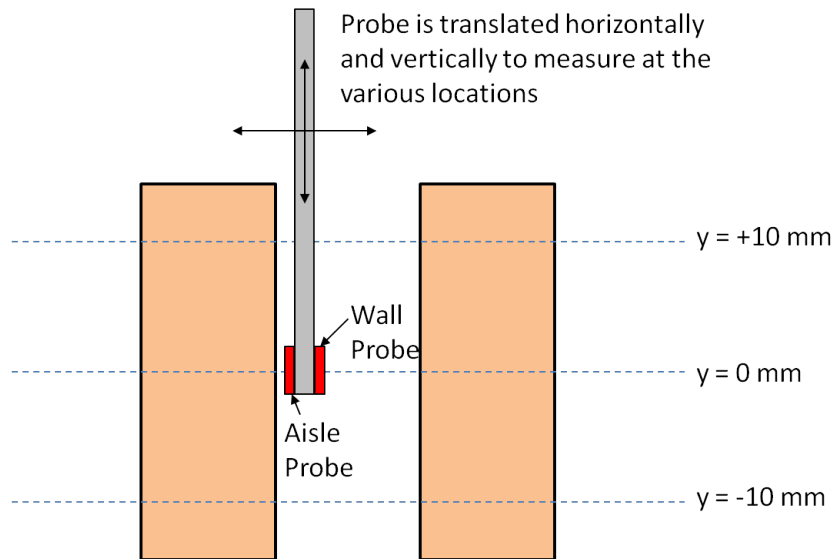


Second Horizontal and Vertical Field Integrals Along Undulator Length at Commissioning Gap (With Entrance Kick Correction)





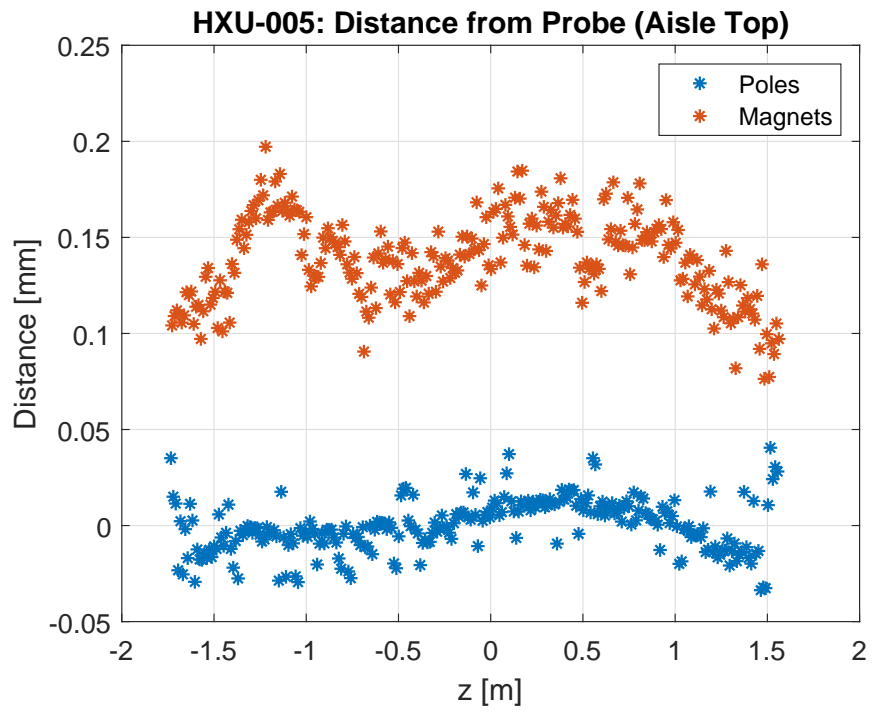
Capacitive Sensor Arrangement

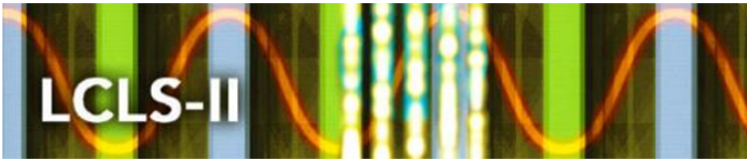


The following plots show the pole and magnet position measurements. The LBNL system has two back-to-back capacitive probes on one probe holder. The x and y stages on the Kugler bench are positioned so that the probe is in the proper location for each of the 9 scan locations. For the data analysis, the 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.

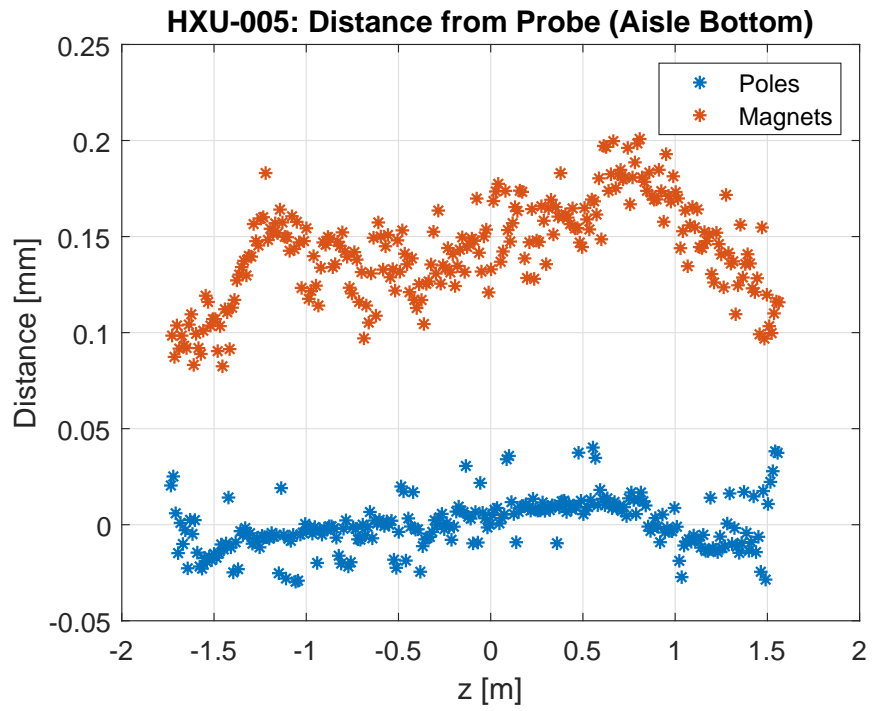


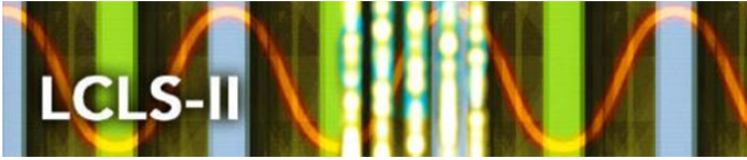
G1 Capacitive Sensor Readings



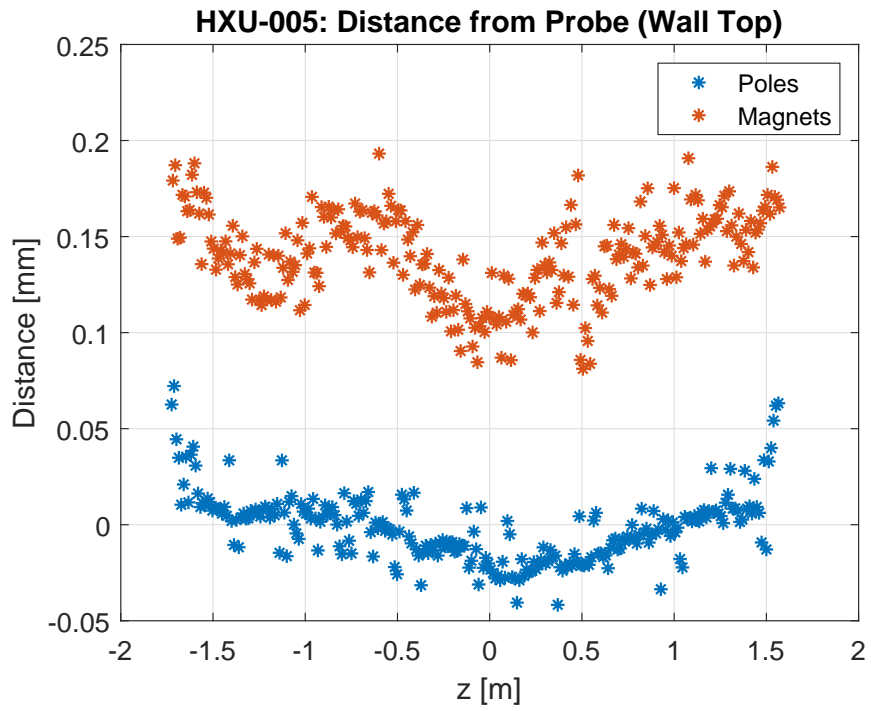


G2 Capacitive Sensor Readings



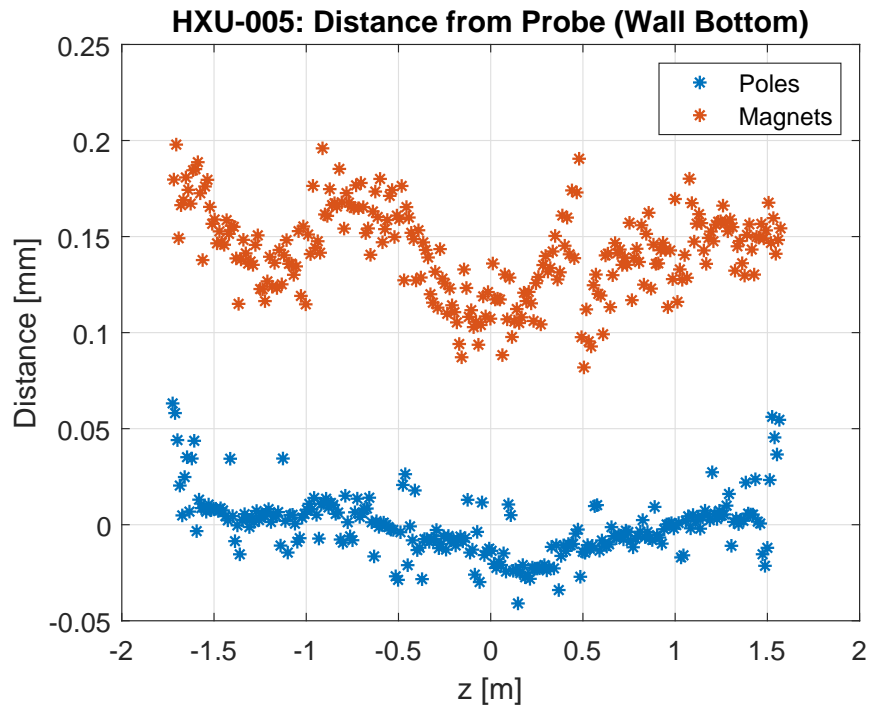


G3 Capacitive Sensor Readings



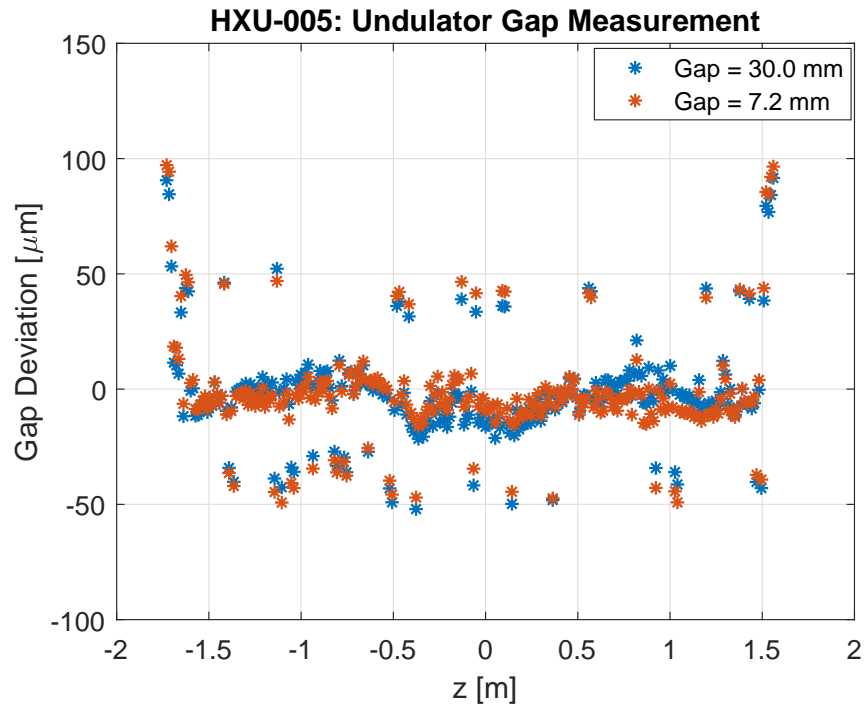


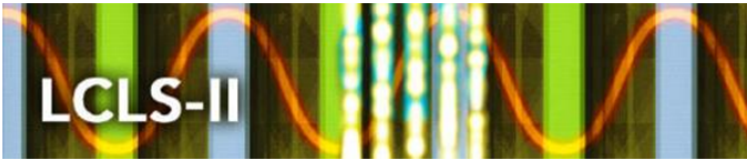
G4 Capacitive Sensor Readings



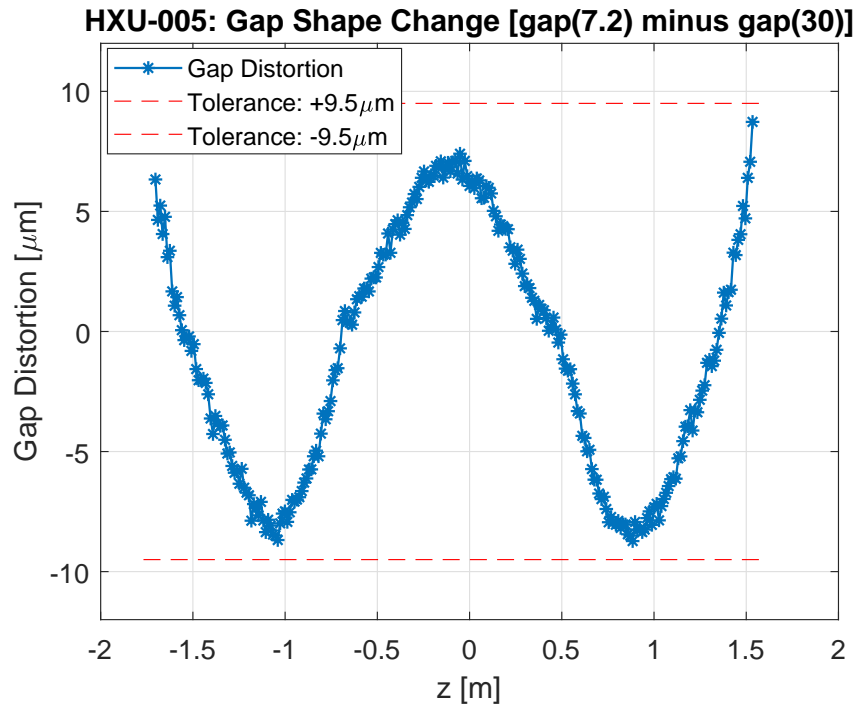


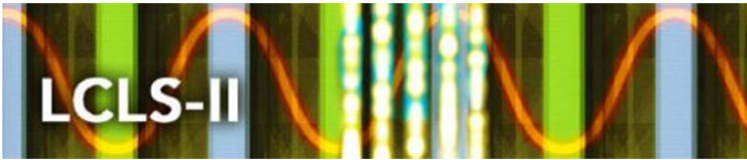
Undulator Gap Measurement



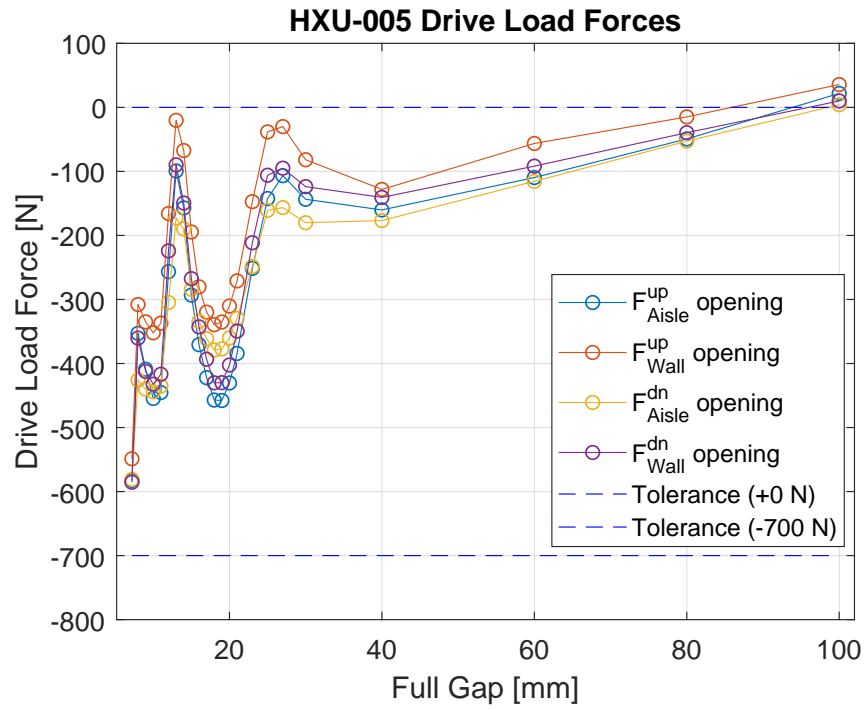


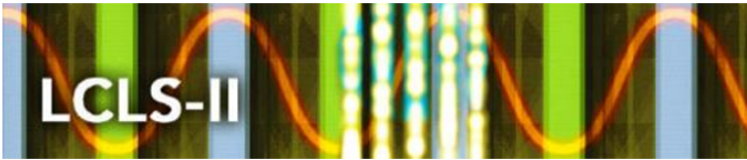
Undulator Gap Difference



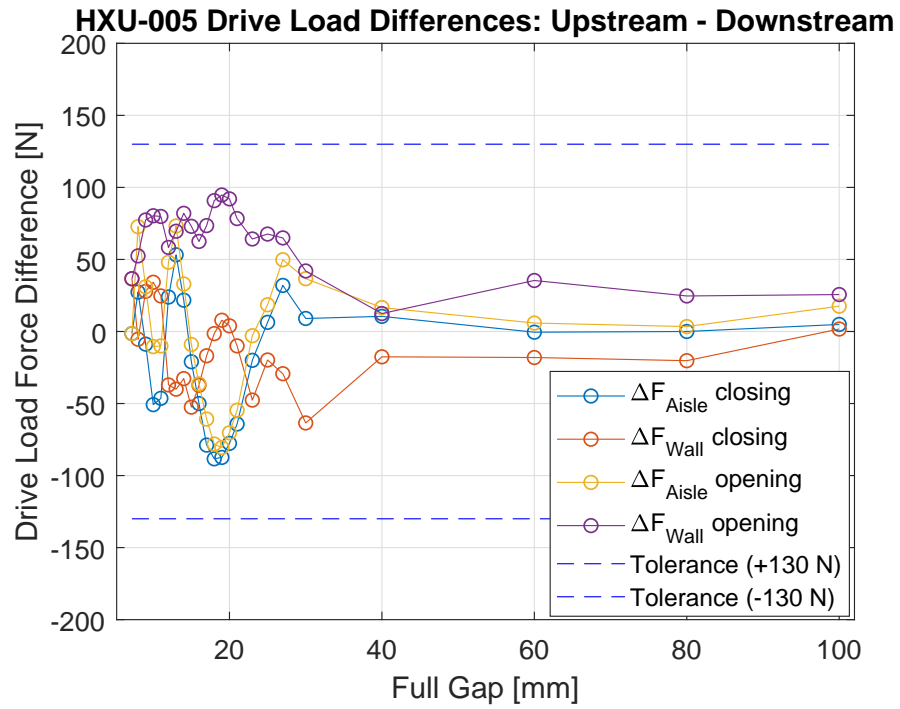


Drive Loads (Gap Opening)



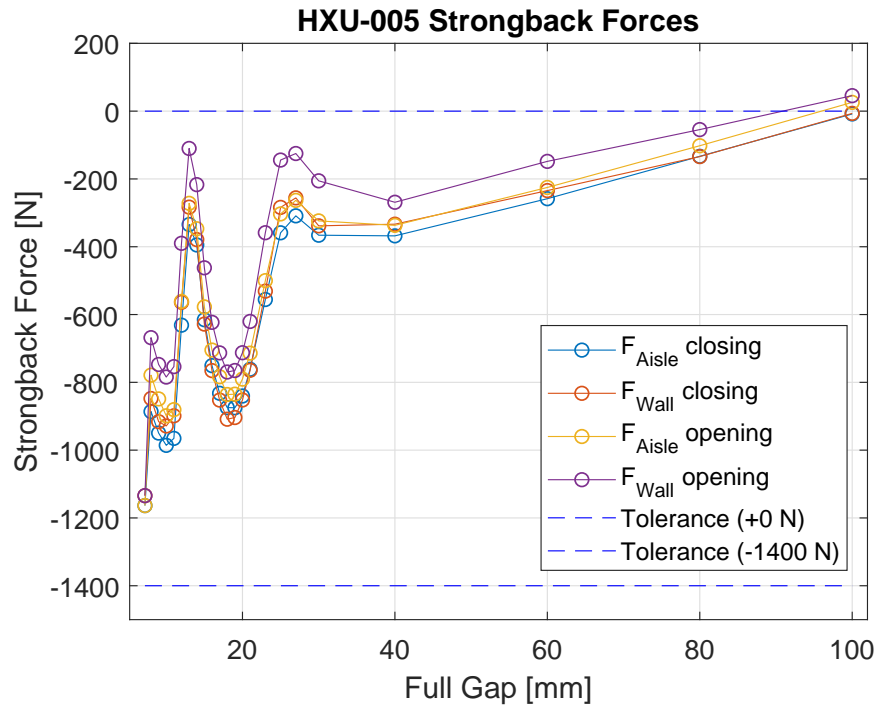


Drive Load Differences (Gap Opening and Closing)





Strongback Forces (Gap Opening and Closing)





Strongback Force Differences (Gap Opening and Closing)

