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-003

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± 0.5	°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)	20.2±0.3	°C
$rms\,(\lvert B_{pk}\rvert/\langle\lvert B_{pk}\rvert\rangle - 1)$	0.0019	
K_{eff} at Commissioning Gap (should be 2.3400)	2.3410	
Comissioning Gap	7.930	mm
$I1X$ (over 4.012667 m) (should be within ±40)	-10	μTm
$I2X$ (over 4.012667 m) (should be within ±150)	-90	μTm^2
$I1Y$ (over 4.012667 m) (should be within ±40)	5	μTm
$I2Y$ (over 4.012667 m) (should be within ±150)	39	μTm^2
Phase Shake (rms phase fluctuations over core poles (< 4.0)	2.87	degXray
Cell Phase Advance (over 4.012667 m)	48605.1 (135×360+5.1)	degXray
Undulator Entrance Phase[1]	2255.3 (25×90+5.3)	degXray
Undulator Exit Phase[2]	2249.8 (25×90-0.2)	degXray

[1]Phase advance from cell start (undulator center −2.006334 m) to center of physical pole 8.
[2]Phase advance from physical pole 253 to cell end (undulator center +2.006334 m).

Undulator Encoder Settings

USGapEncoderOffset	-100.97
DSGapEncoderOffset	-911.9
USWLinearEncoder.AOFF	91.9893
DSWLinearEncoder.AOFF	91.7091
USALinearEncoder.AOFF	92.9318
DSALinearEncoder.AOFF	91.7091

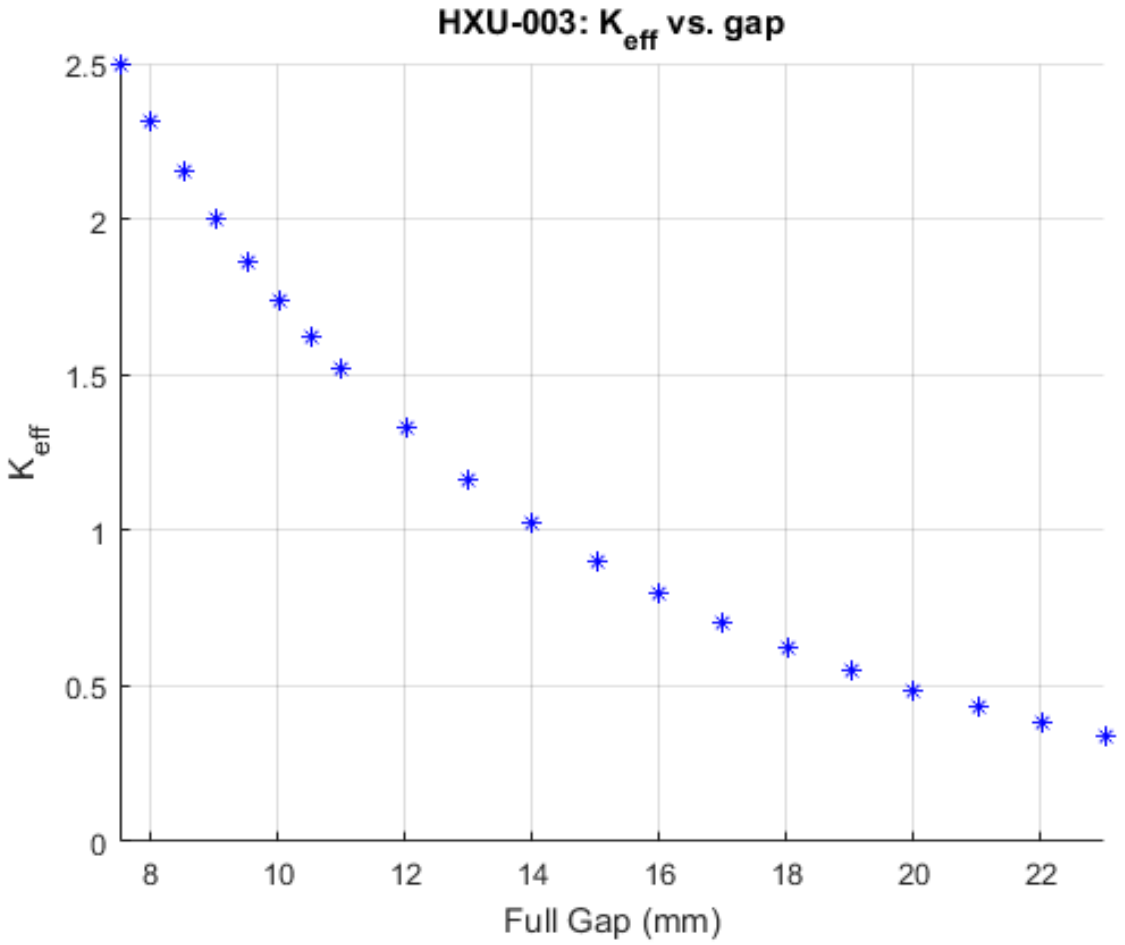
Undulator Load Cell Readings at Tuning Gap

LC_DAL_FORCE	-48
LC_DAU_FORCE	-250
LC_DWL_FORCE	-68
LC_DWU_FORCE	-237
LC_UAL_FORCE	-103
LC_UAU_FORCE	-225
LC_UWL_FORCE	-274
LC_UWU_FORCE	-42

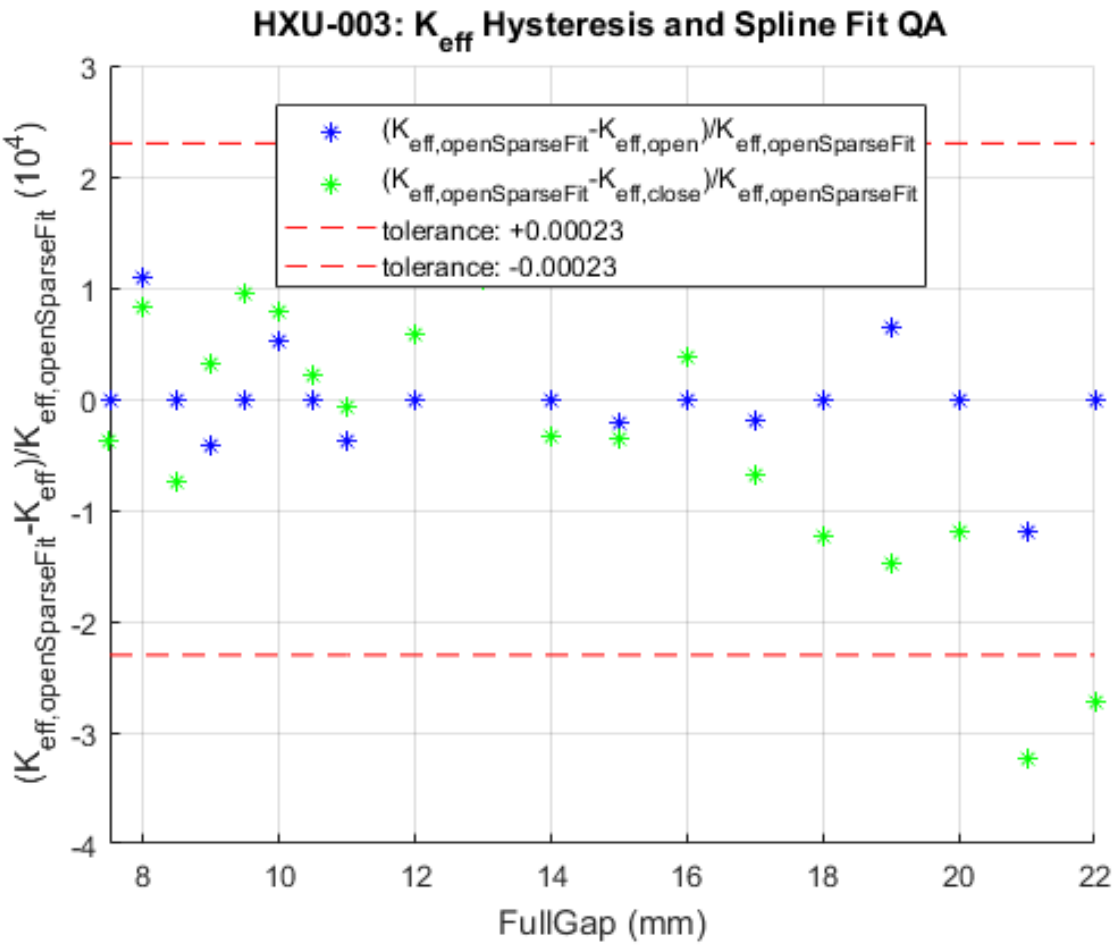
Undulator Load Cell Readings at 100 mm Gap

LC_DAL_FORCE	0.0
LC_DAU_FORCE	0.0
LC_DWL_FORCE	0.0
LC_DWU_FORCE	0.0
LC_UAL_FORCE	0.0
LC_UAU_FORCE	0.0
LC_UWL_FORCE	0.0
LC_UWU_FORCE	0.0

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



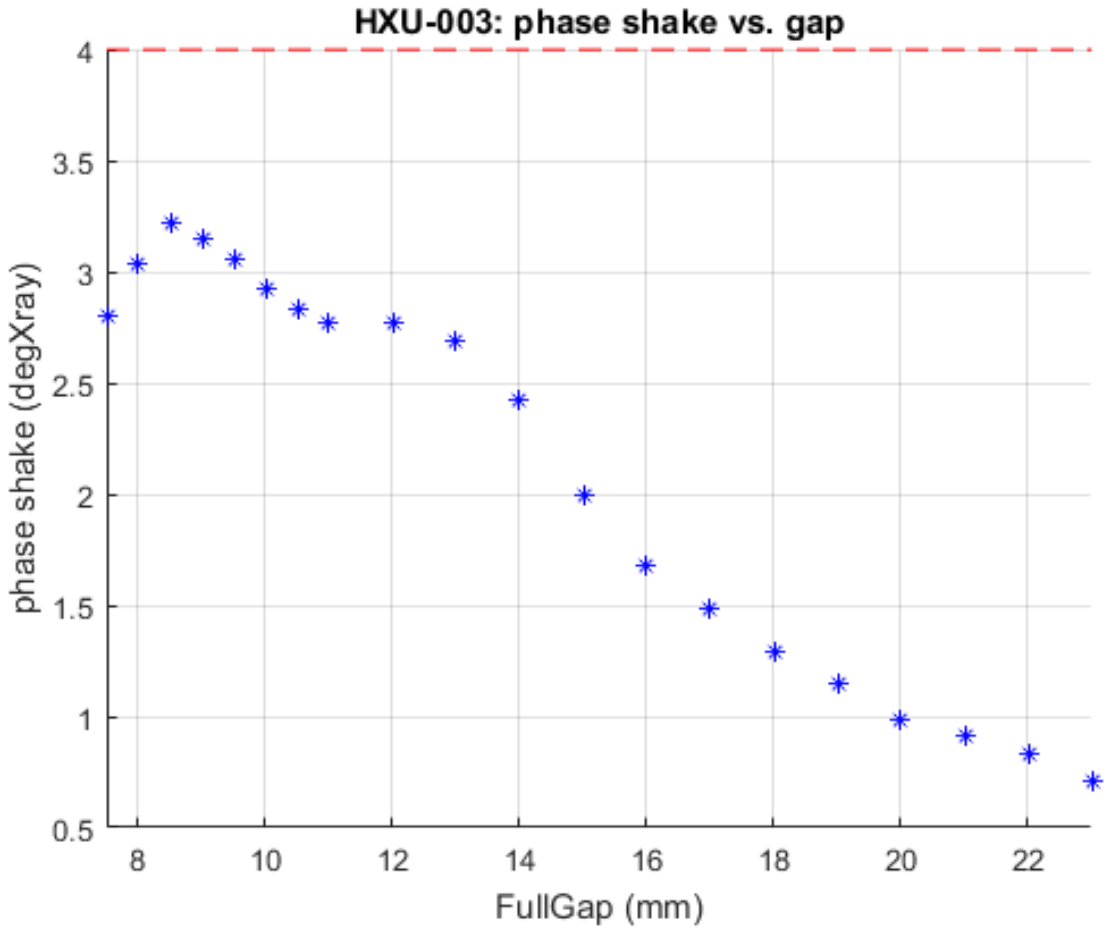
Evaluation of Hall Probe Scans: K_{eff} Hysteresis



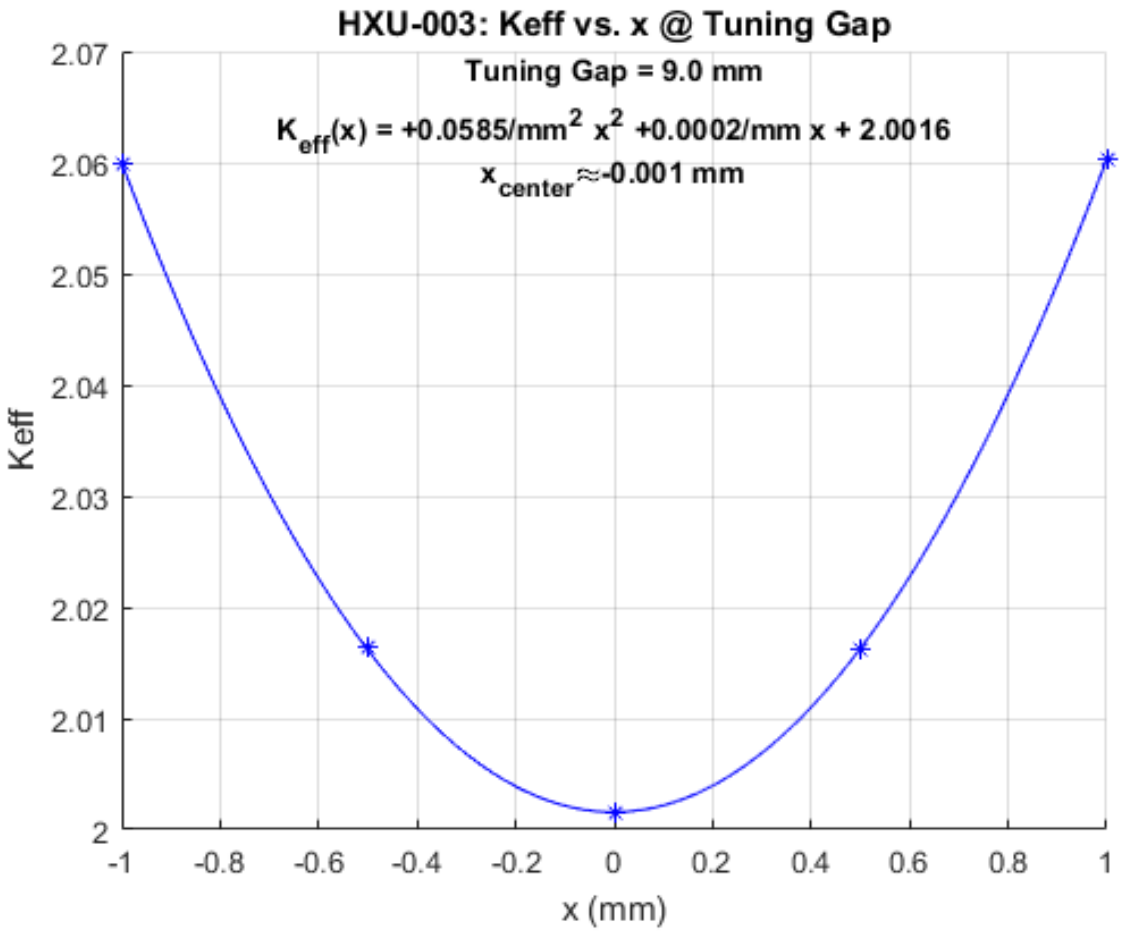
Plotted functions have been calculated from measured values openKeff (opengap) and closeKeff (closegap) using the following Matlab calculations:

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

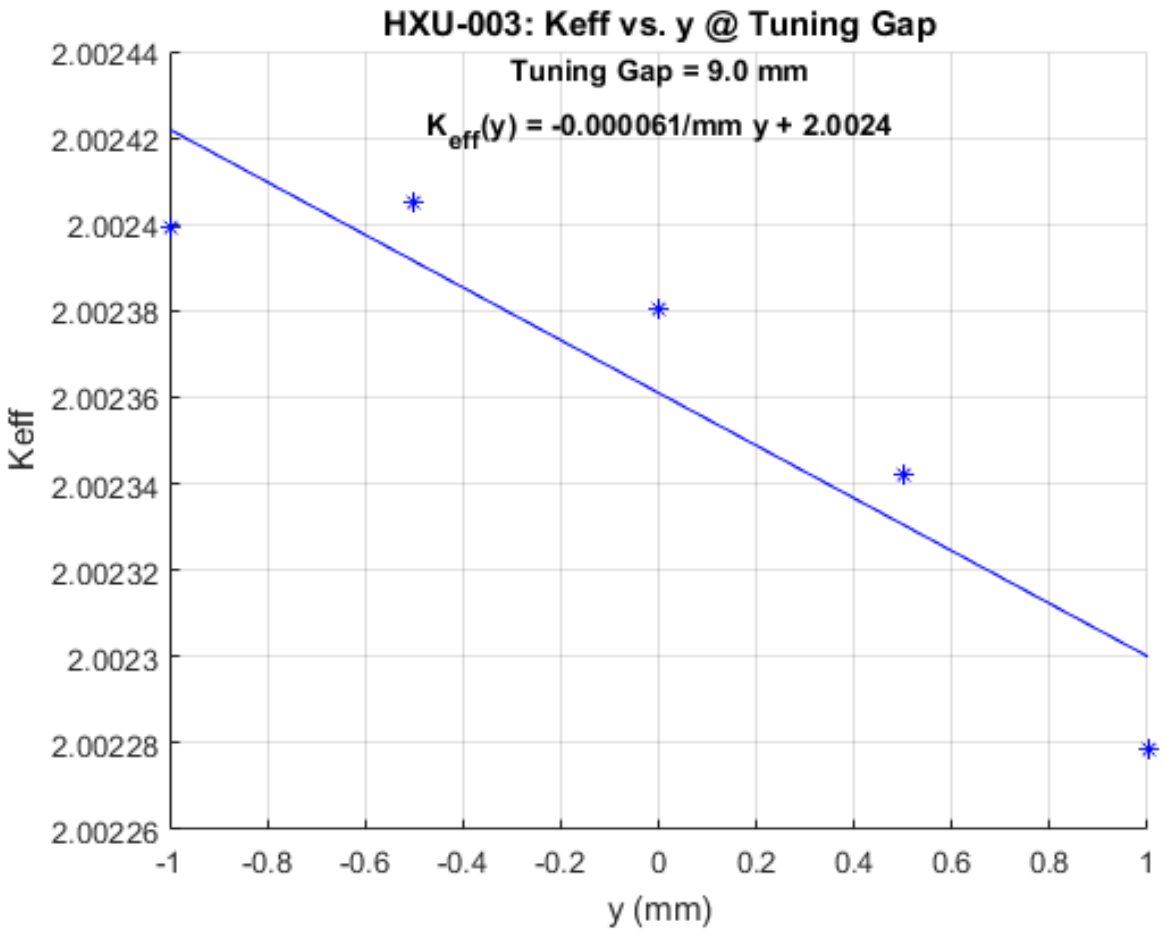
Evaluation of Hall Probe Scans: Phase Shake vs gap



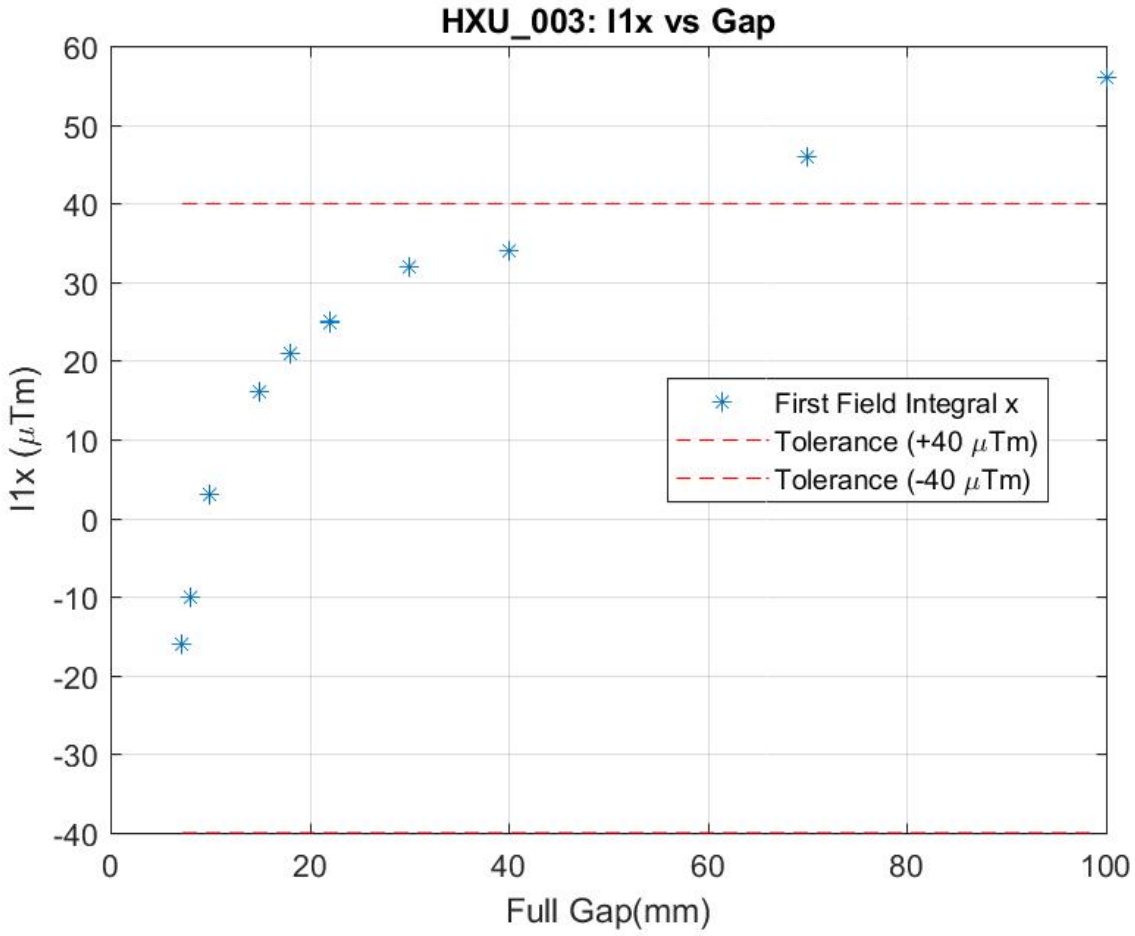
Evaluation of Hall Probe Scans: K_{eff} vs x at Tuning Gap



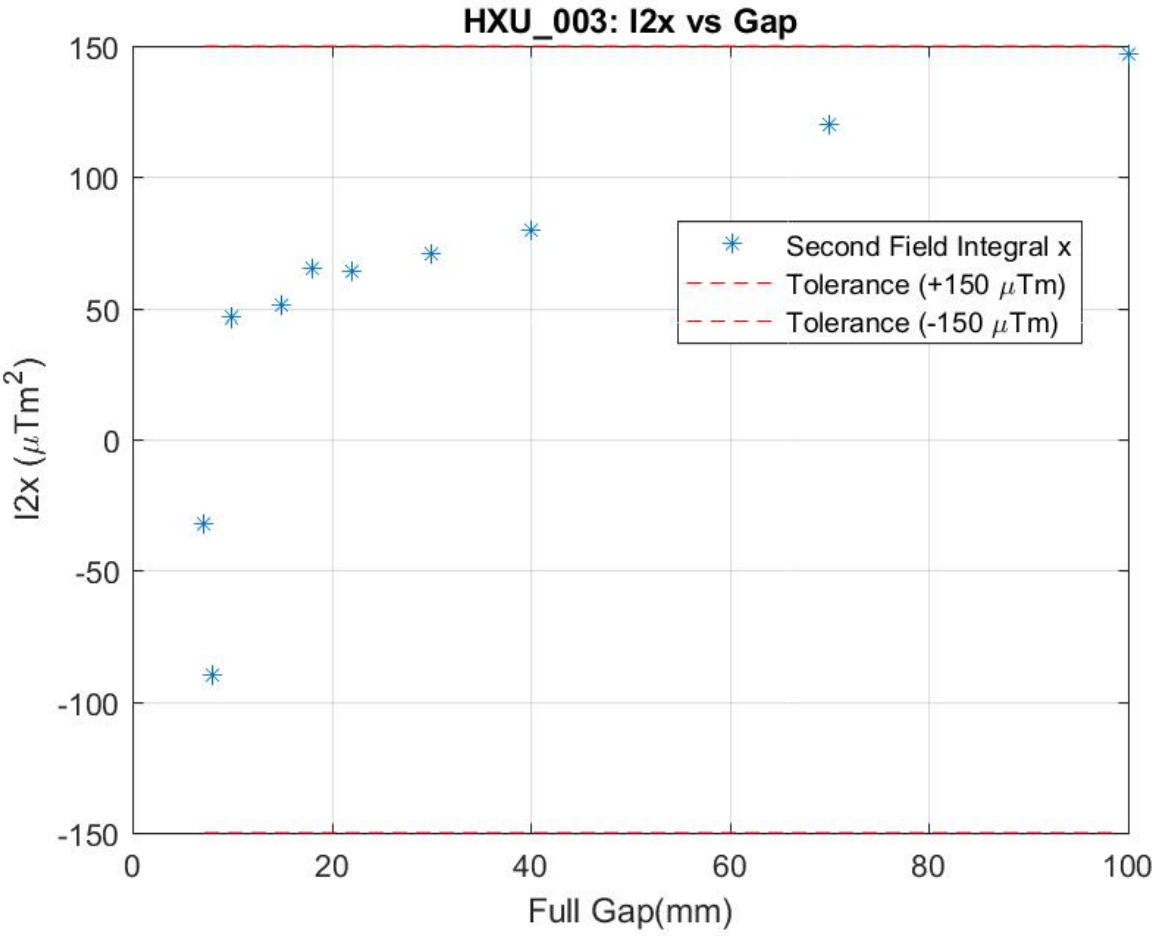
Evaluation of Hall Probe Scans: K_{eff} vs Y at Tuning Gap



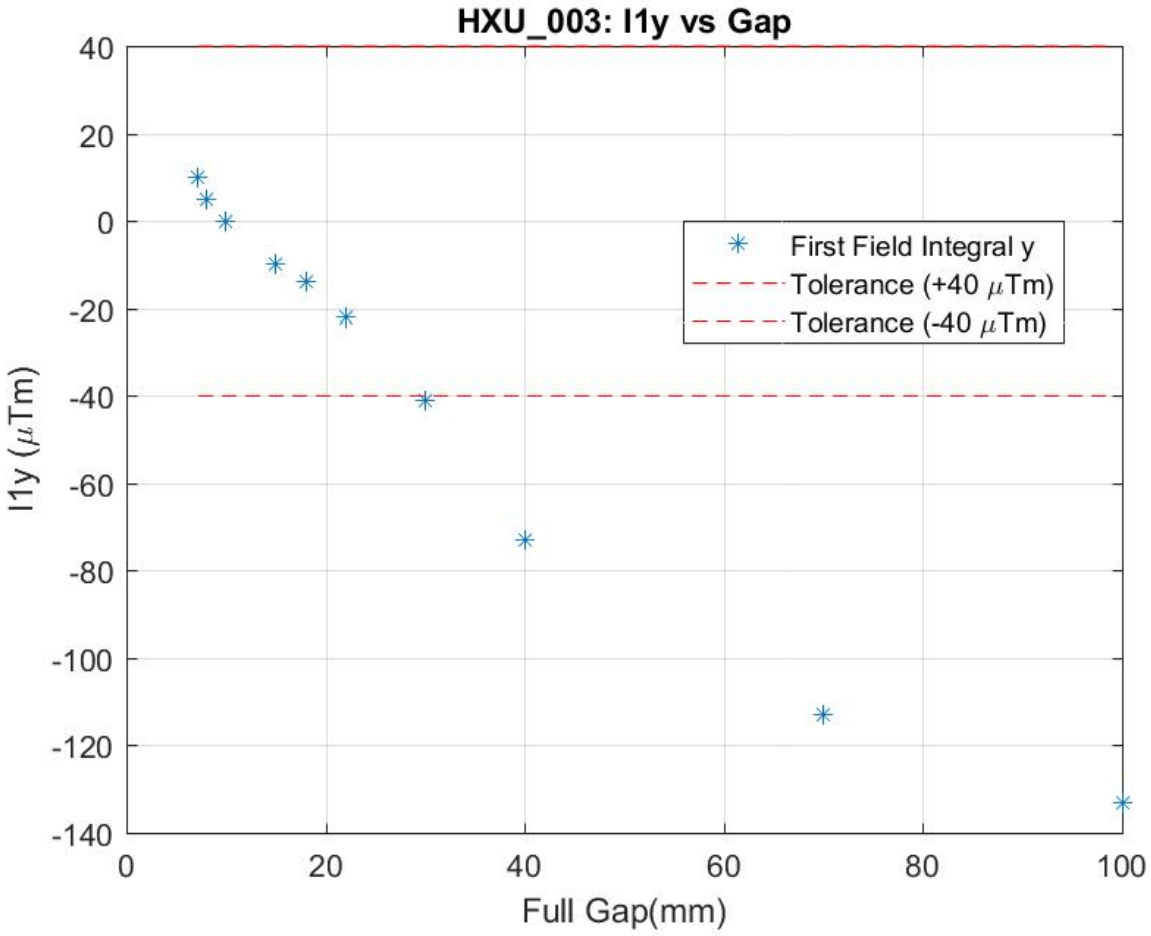
Long Coil Measurement of the On-Axis First Horizontal Field Integrals



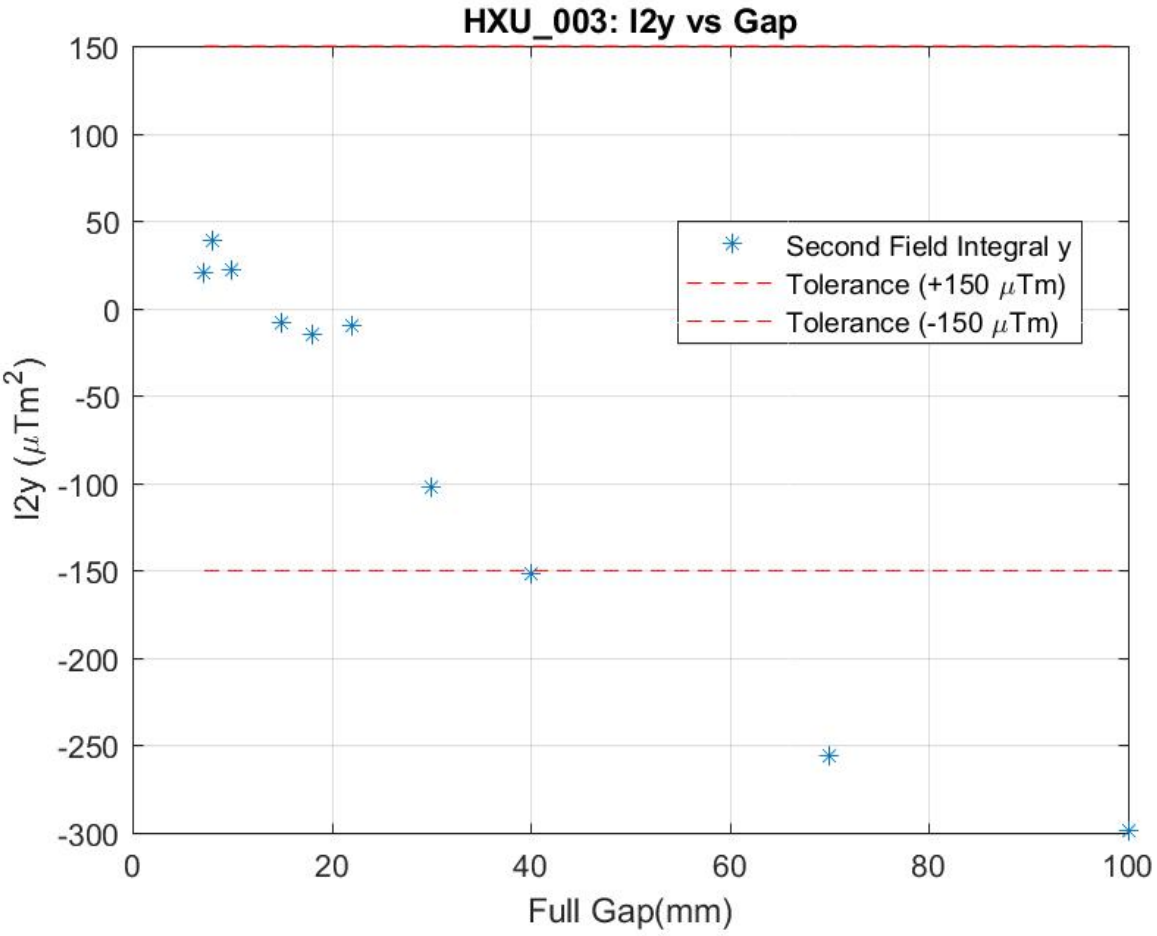
Long Coil Measurement of the On-Axis Secoind Horizontal Field Integrals



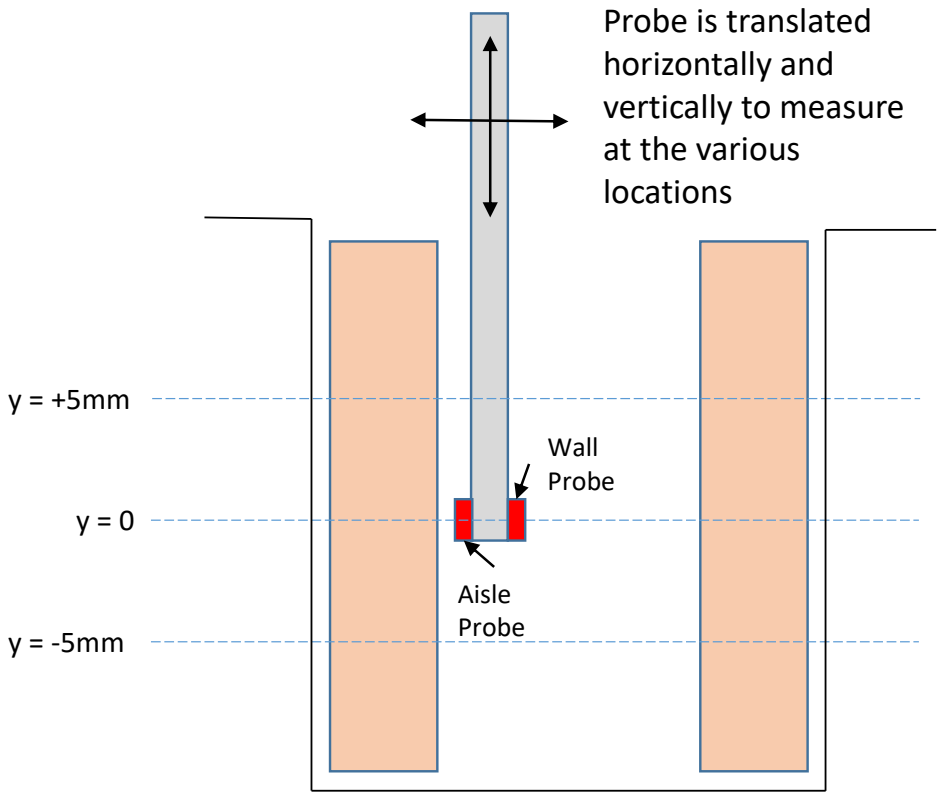
Long Coil Measurement of the On-Axis First Verticall Field Integrals



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

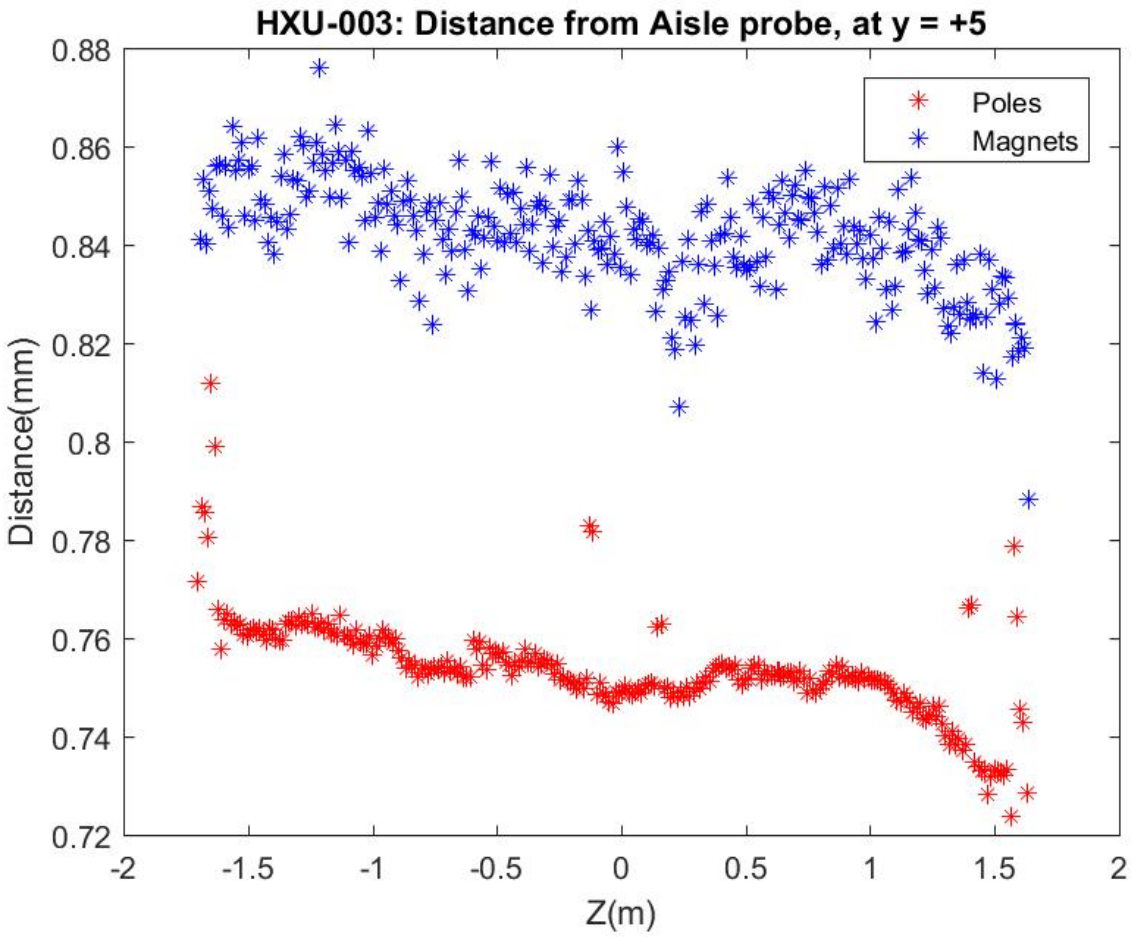


Capacitive Sensor Arrangement

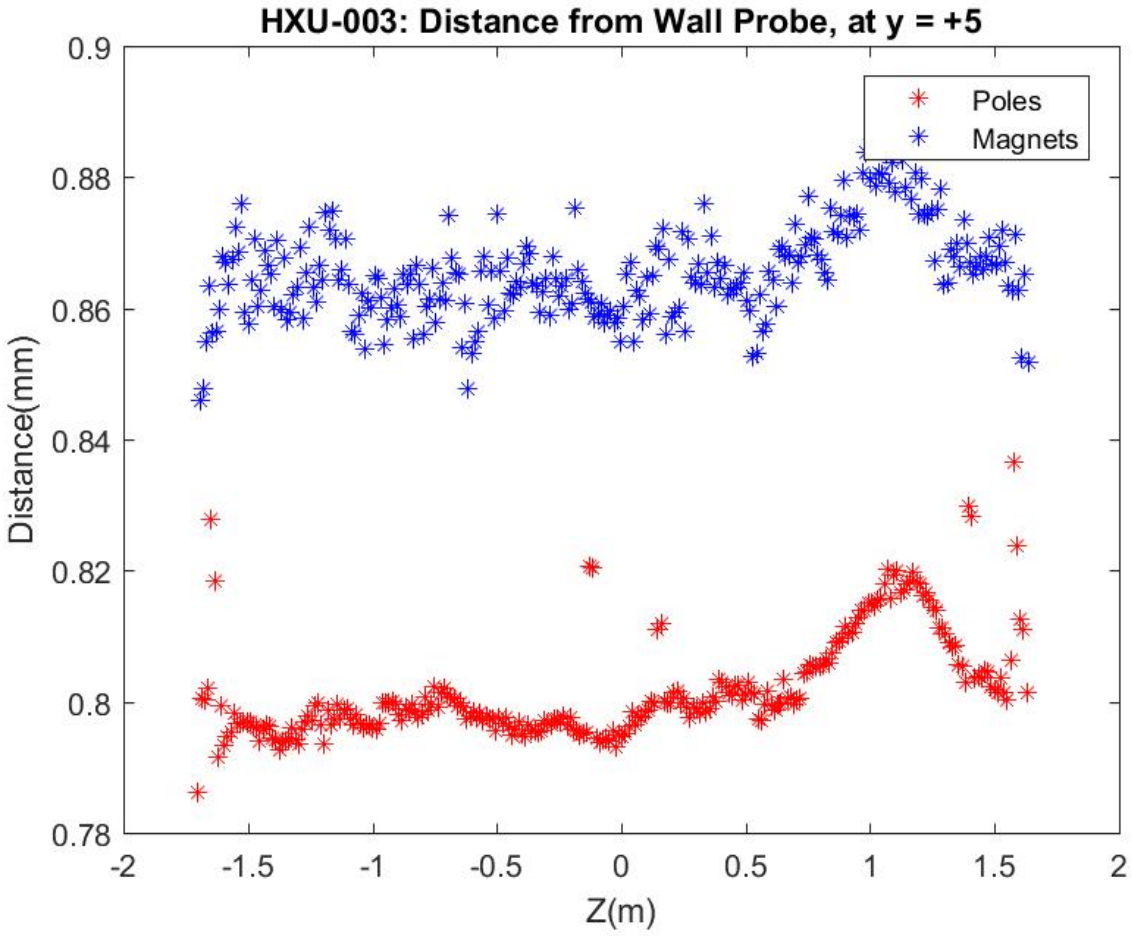


The following plots show the pole and magnet position measurements. The ANL system has two back-to-back capacitive probes on one probe holder. The x and y stages on the bench are positioned so that the probe is in the proper location for each of the 6 scan locations.

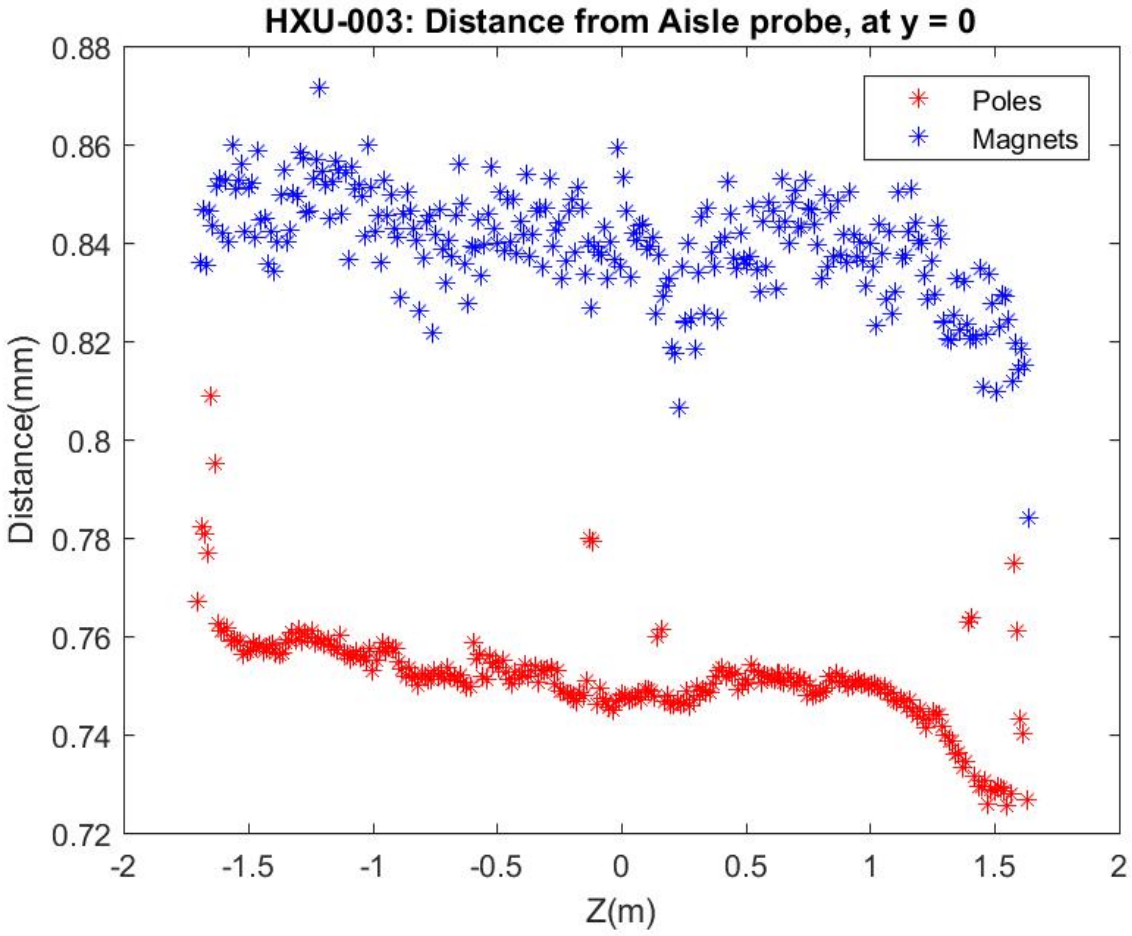
Probe1 Capacitive Sensor Readings y = +5mm



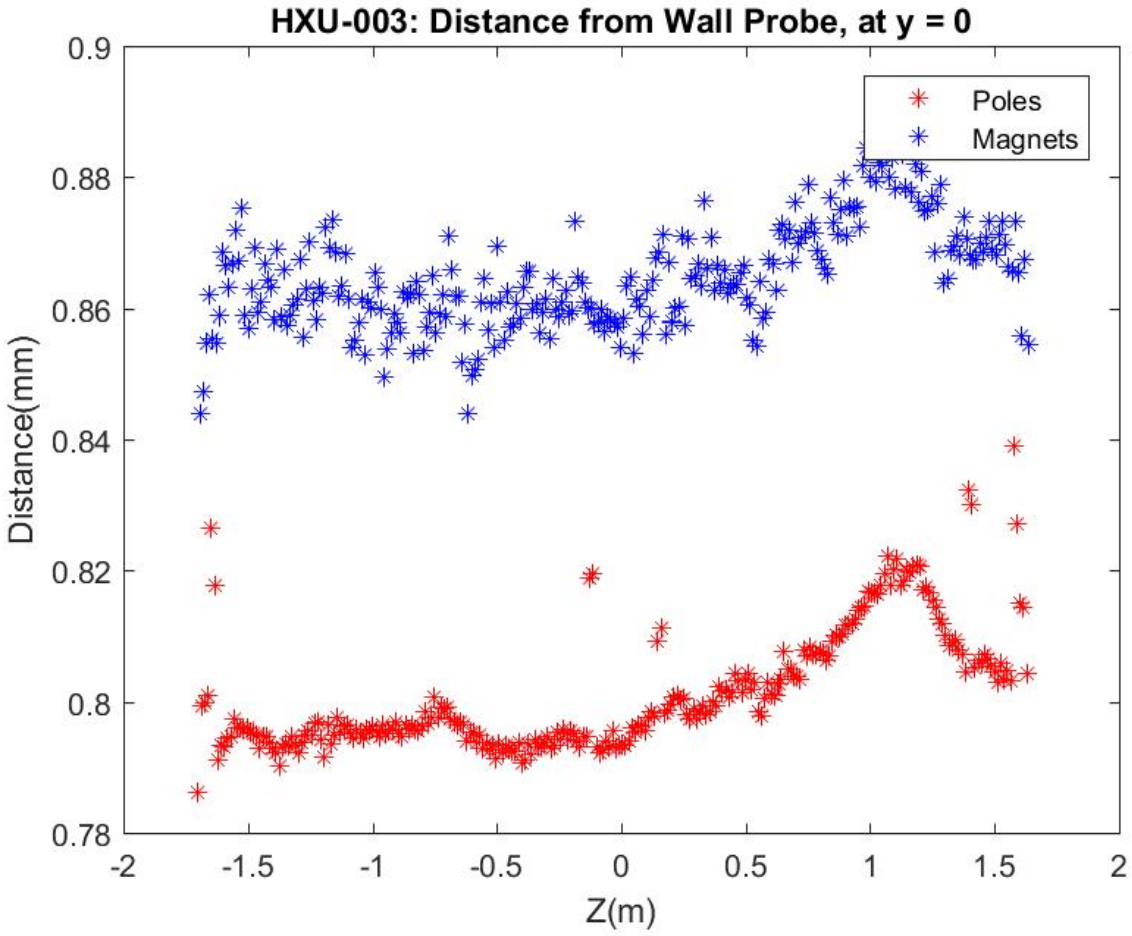
Probe2 Capacitive Sensor Readings y = +5mm



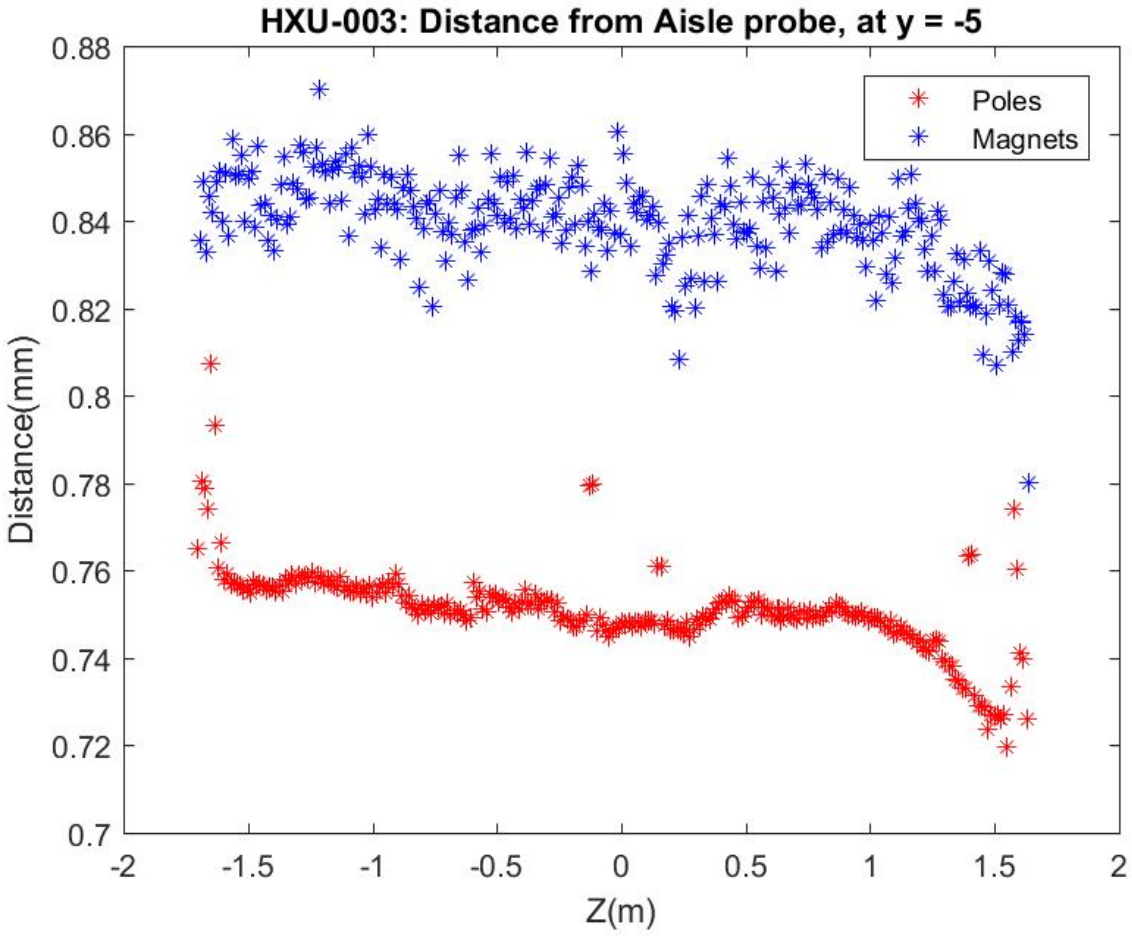
Probe1 Capacitive Sensor Readings y = 0mm



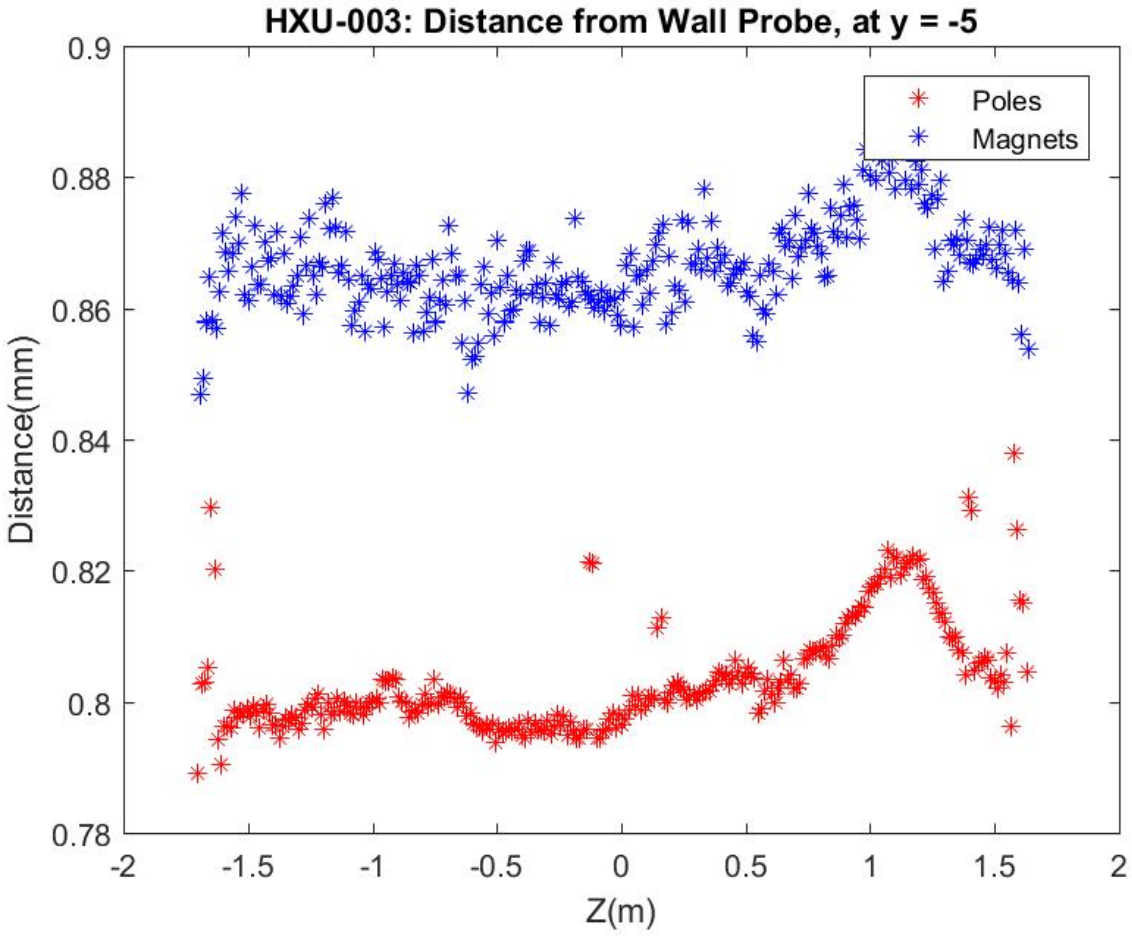
Probe2 Capacitive Sensor Readings y = 0mm



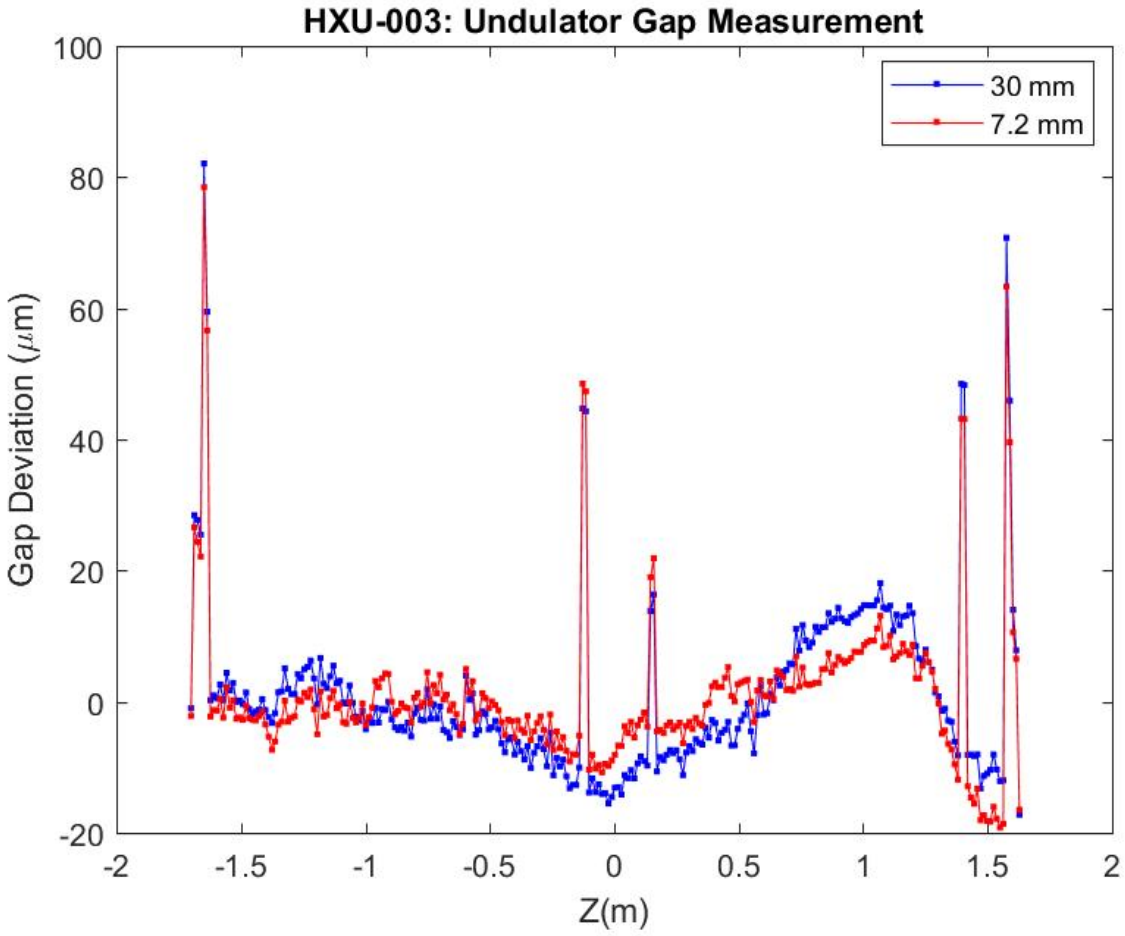
Probe1 Capacitive Sensor Readings y = -5mm



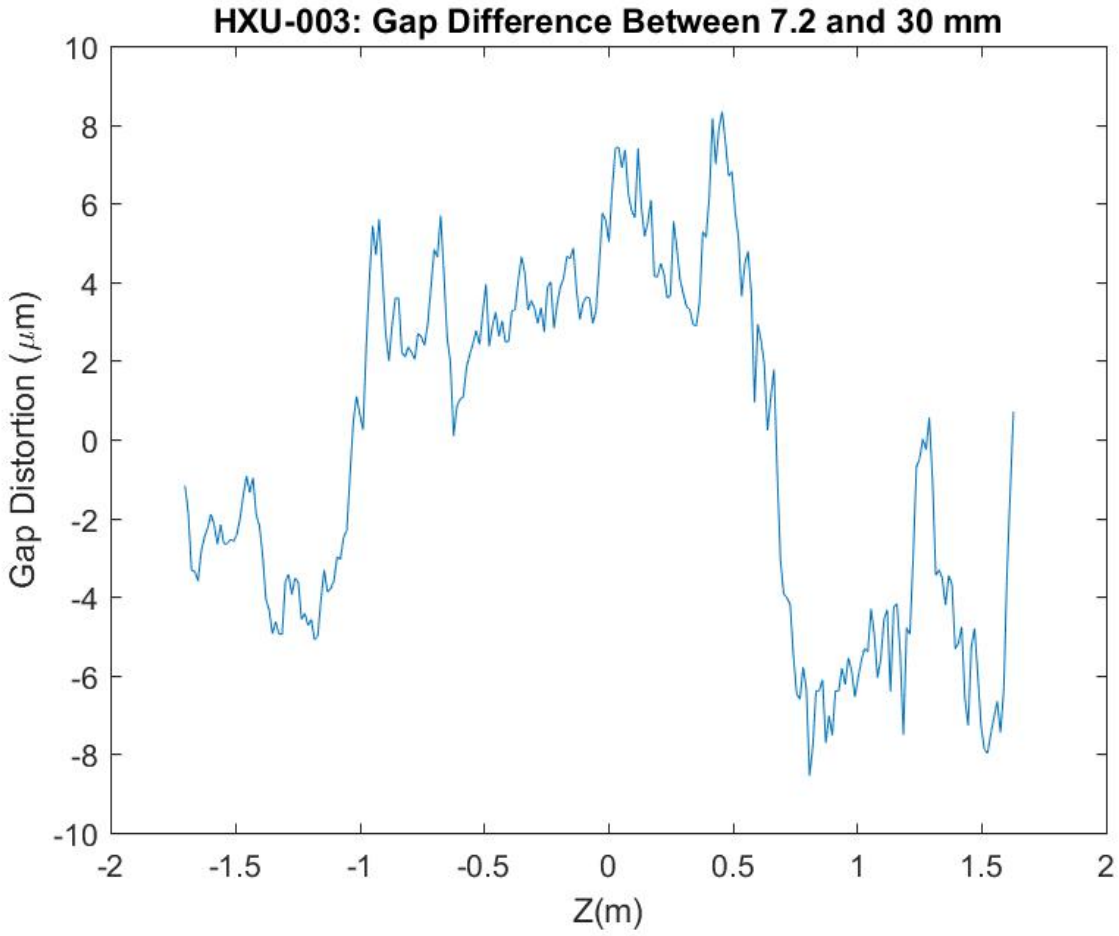
Probe2 Capacitive Sensor Readings y = -5mm



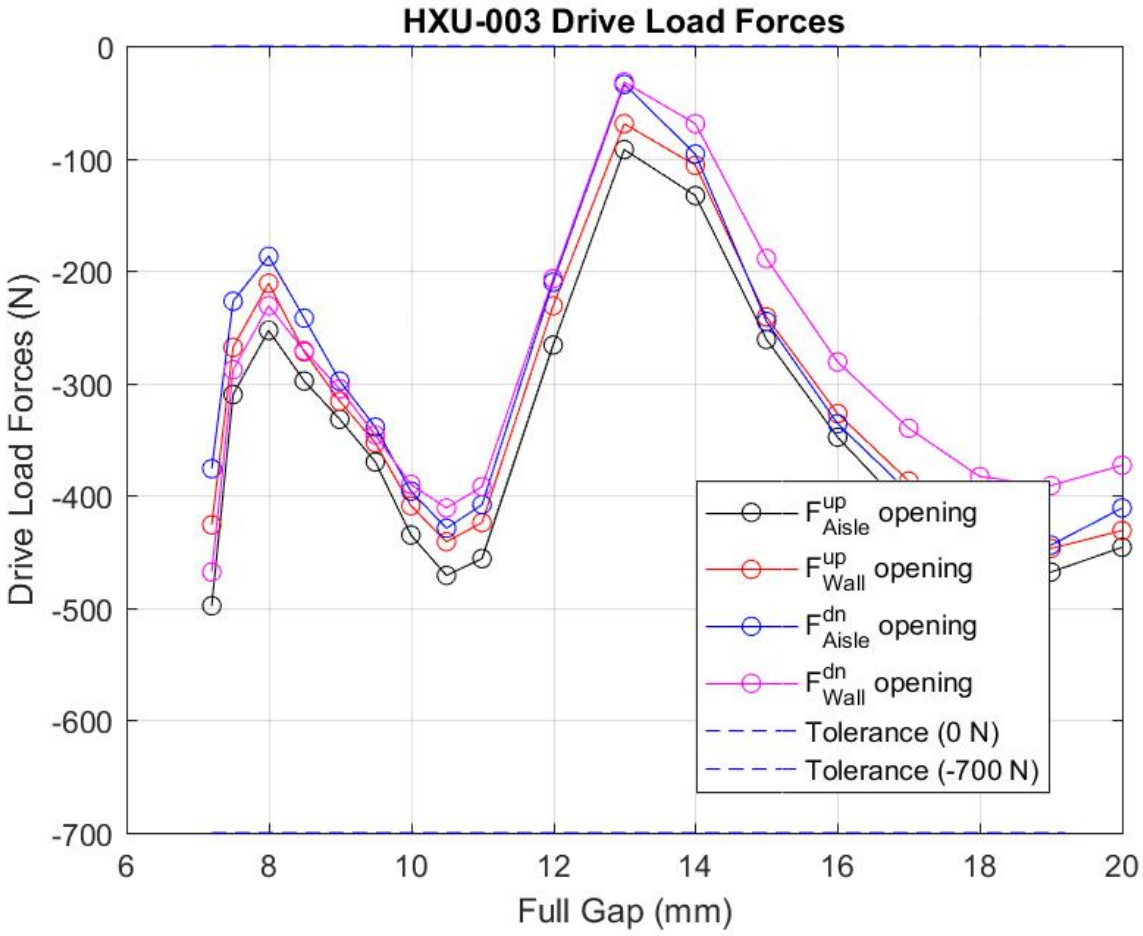
Undulator Gap Measurement



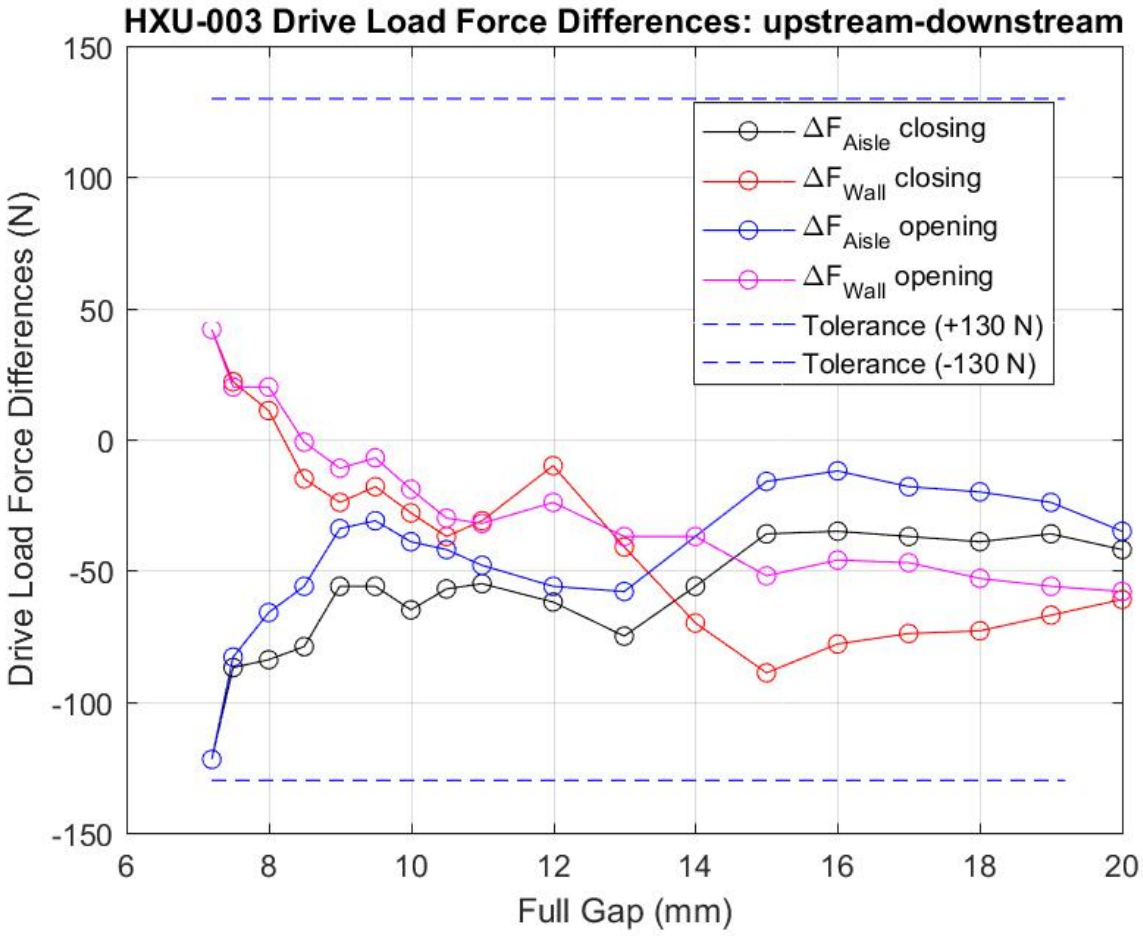
Undulator Gap Difference



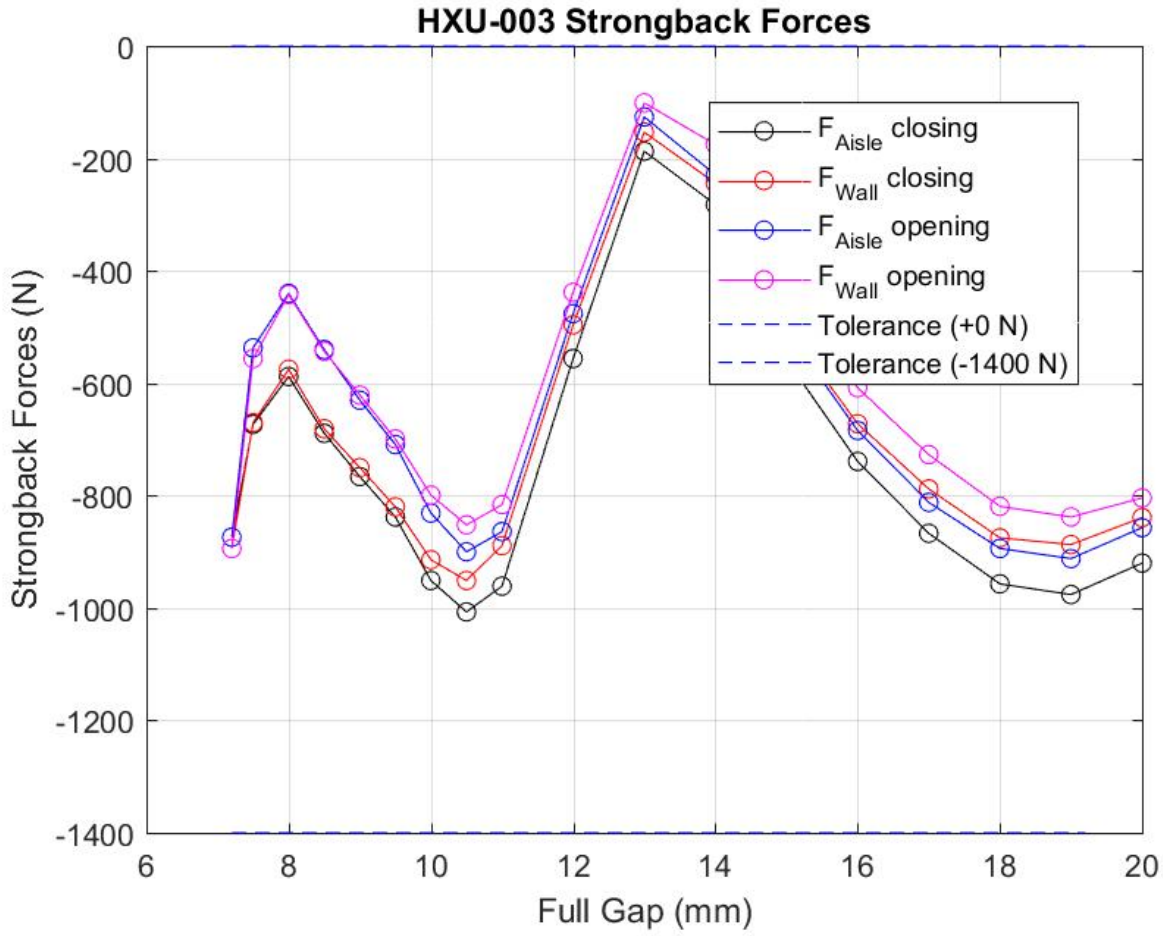
Drive Loads (Gap Opening)



Drive Load Differences (Gap Opening and Closing)



Strongback Forces, Gap Opening and Closing)



Strongback Force Differences, Gap Opening and Closing