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-020

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)	20.4 ±0.6	°C
$rms\,(\lvert B_{pk}\rvert/\langle\lvert B_{pk}\rvert\rangle - 1)$	0.0022	
K_{eff} at Commissioning Gap (should be 2.3400)	2.3392	
Comissioning Gap	7.9278	mm
$I1X$ (over 4.012667 m) (should be within ±40)	3	μTm
$I2X$ (over 4.012667 m) (should be within ±150)	84	μTm^2
$I1Y$ (over 4.012667 m) (should be within ±40)	22	μTm
$I2Y$ (over 4.012667 m) (should be within ±150)	38	μTm^2
Phase Shake (rms phase fluctuations over core poles (< 4.0)	3.45	degXray
Cell Phase Advance (over 4.012667 m)	48596.3 (135×360-3.7)	degXray
Undulator Entrance Phase[1]	2249.1 (25×90-0.9)	degXray
Undulator Exit Phase[2]	2247.2 (25×90-2.8)	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	-113.5440
DSGapEncoderOffset	-362.6015
USWLinearEncoder.AOFF	93.4024
DSWLinearEncoder.AOFF	90.3344
USALinearEncoder.AOFF	92.3628
DSALinearEncoder.AOFF	92.3441

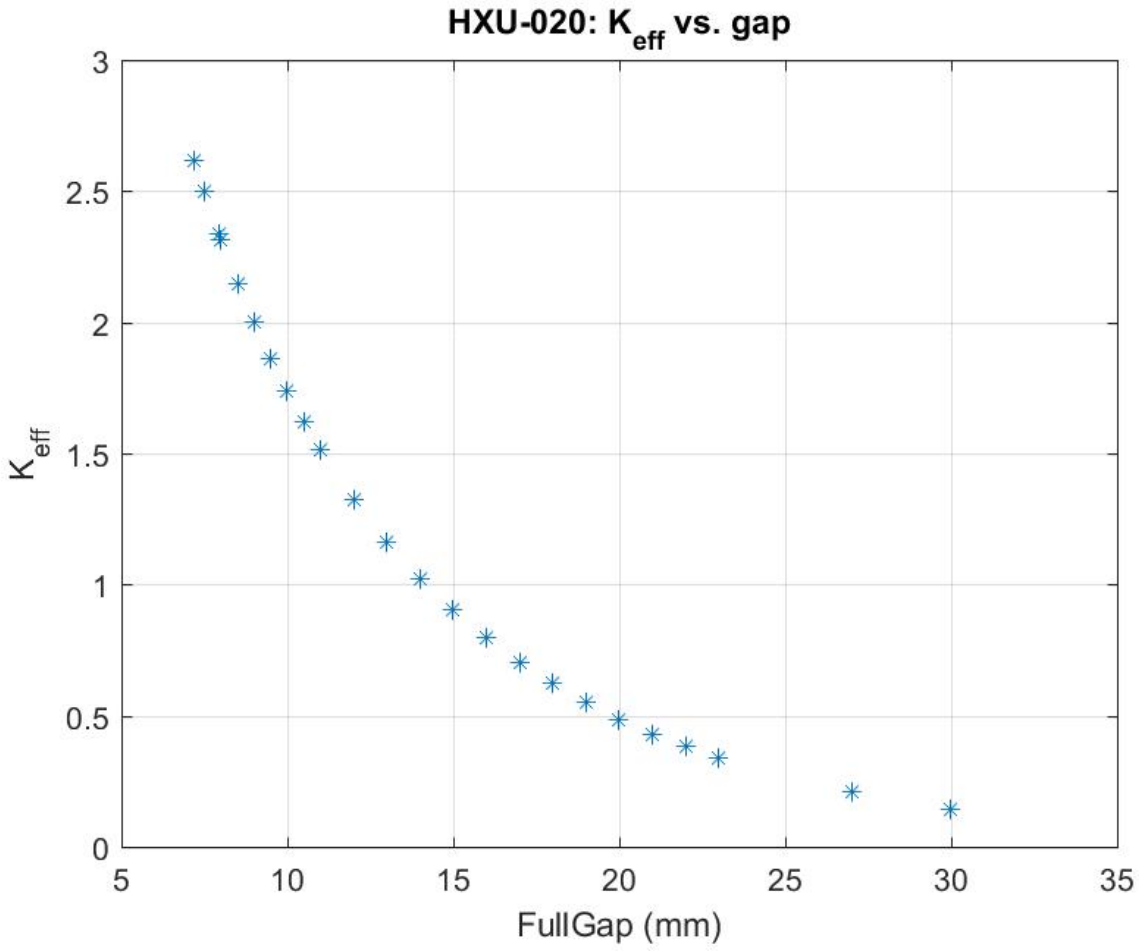
Undulator Load Cell Readings at Tuning Gap

LC_DAL_FORCE	-357
LC_DAU_FORCE	-198
LC_DWL_FORCE	-249
LC_DWU_FORCE	-386
LC_UAL_FORCE	-473
LC_UAU_FORCE	-192
LC_UWL_FORCE	-304
LC_UWU_FORCE	-270

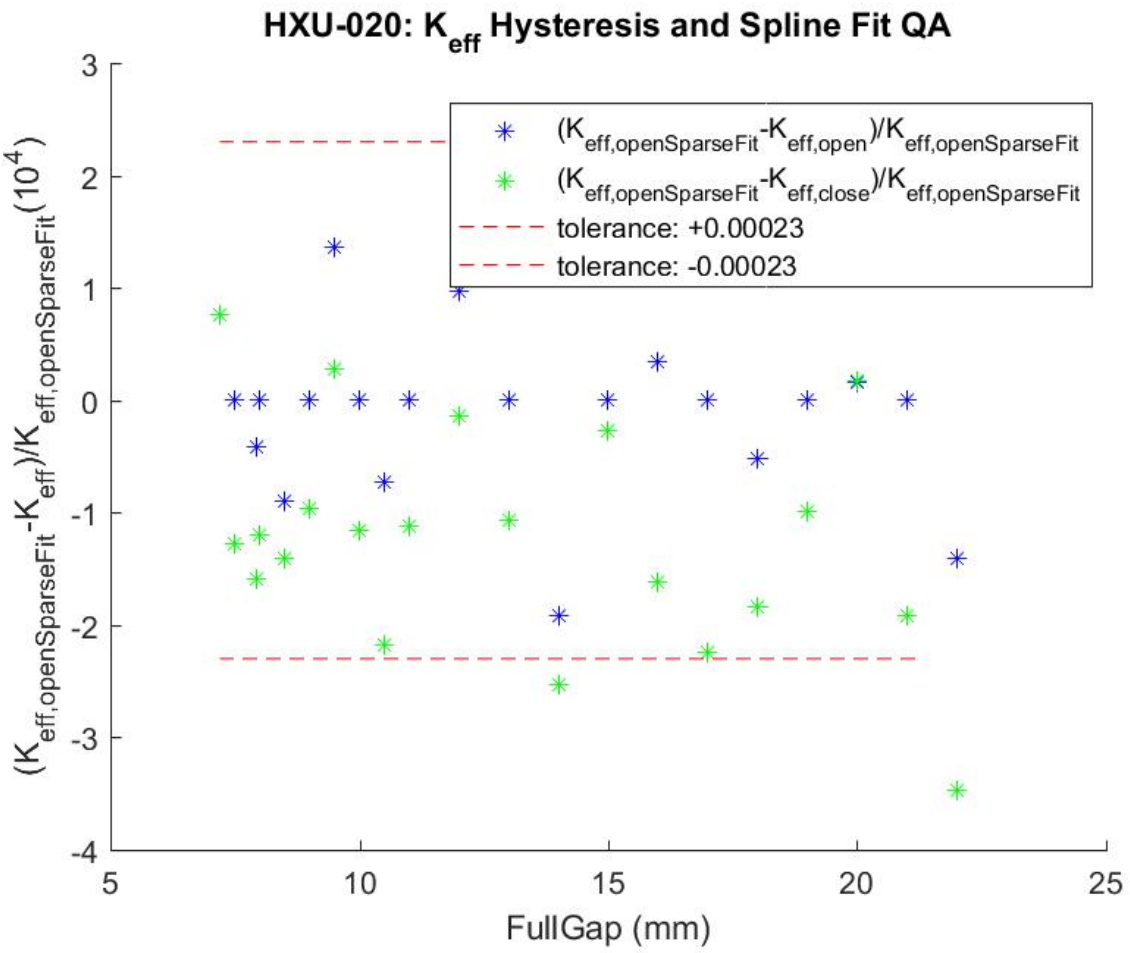
Undulator Load Cell Readings at 100 mm Gap

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



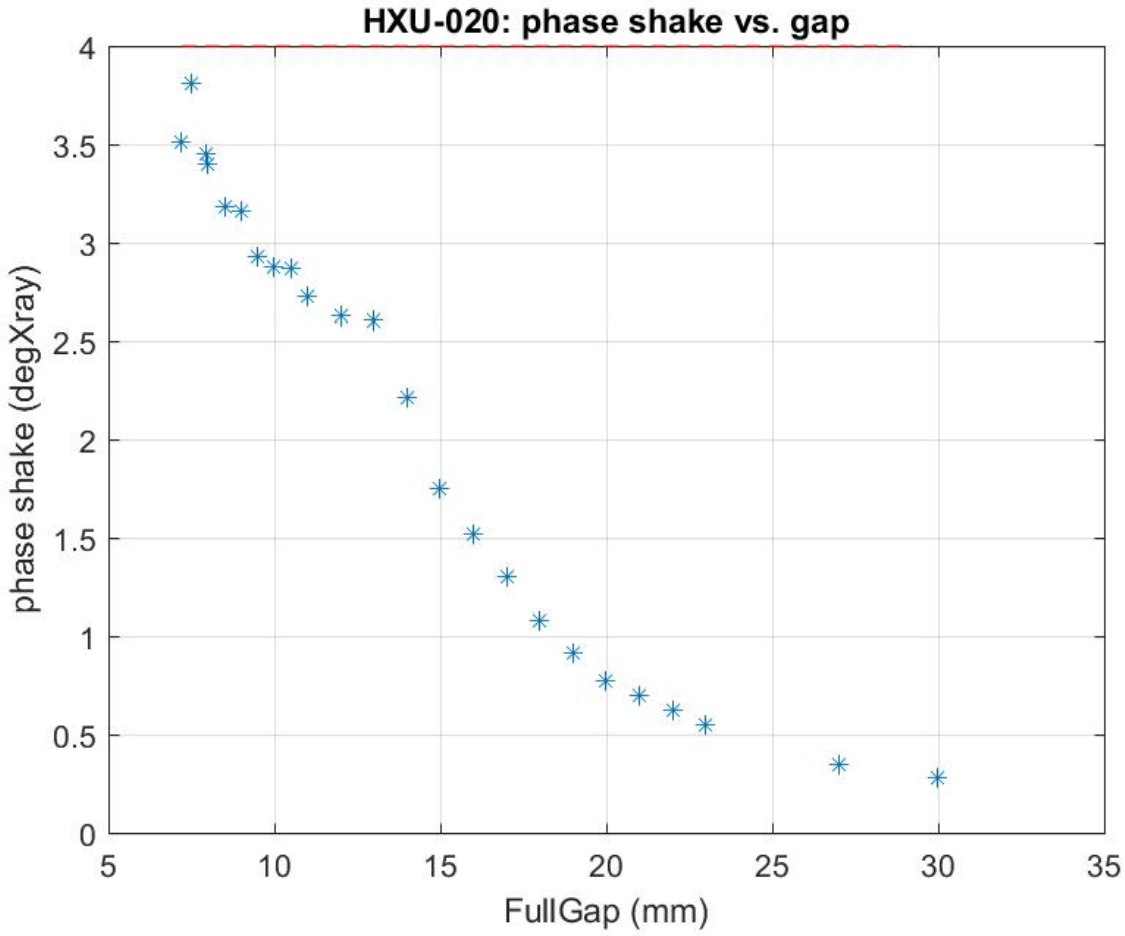
Evaluation of Hall Probe Scans: K_{eff} Hysteresis



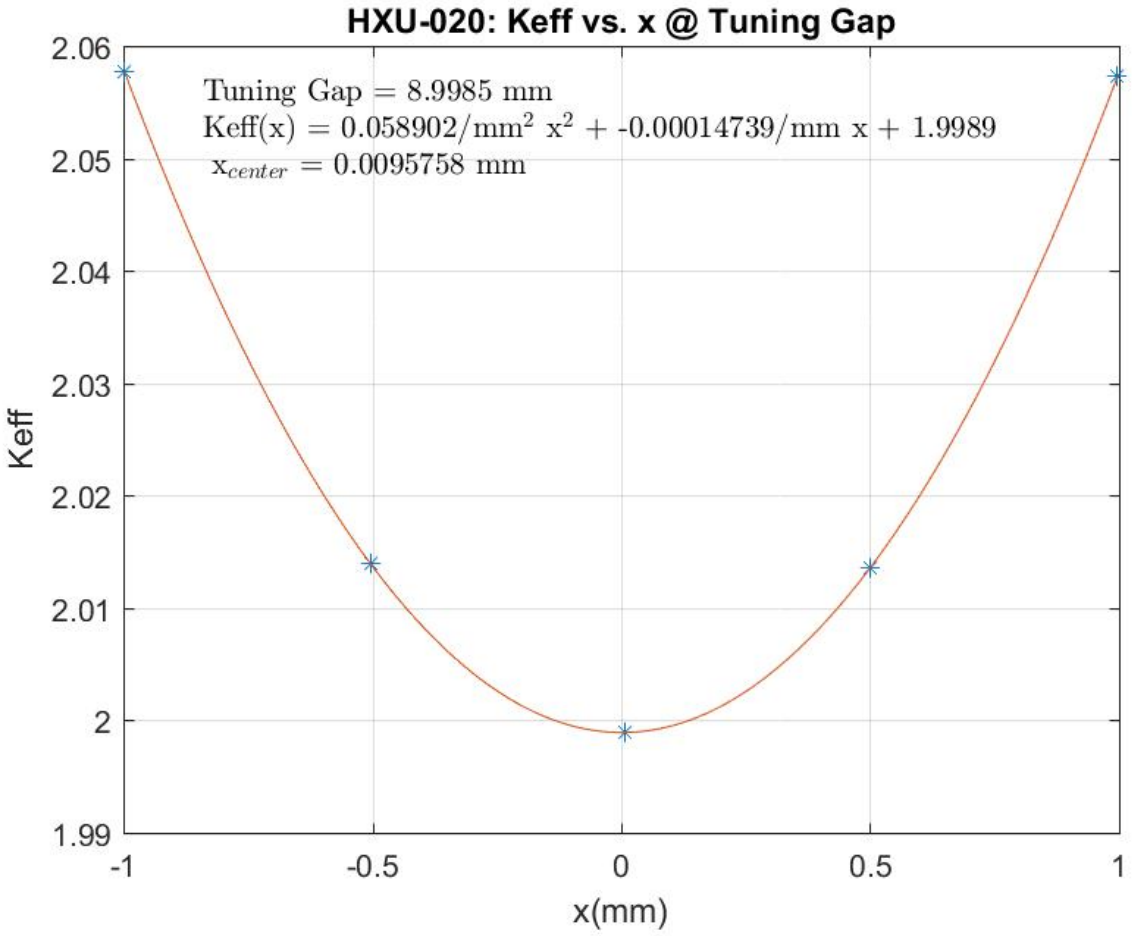
Plotted functions have been calculated from measured values openKeff (opengap) and closeKeff (closegap) using the following Matlab calculations:

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

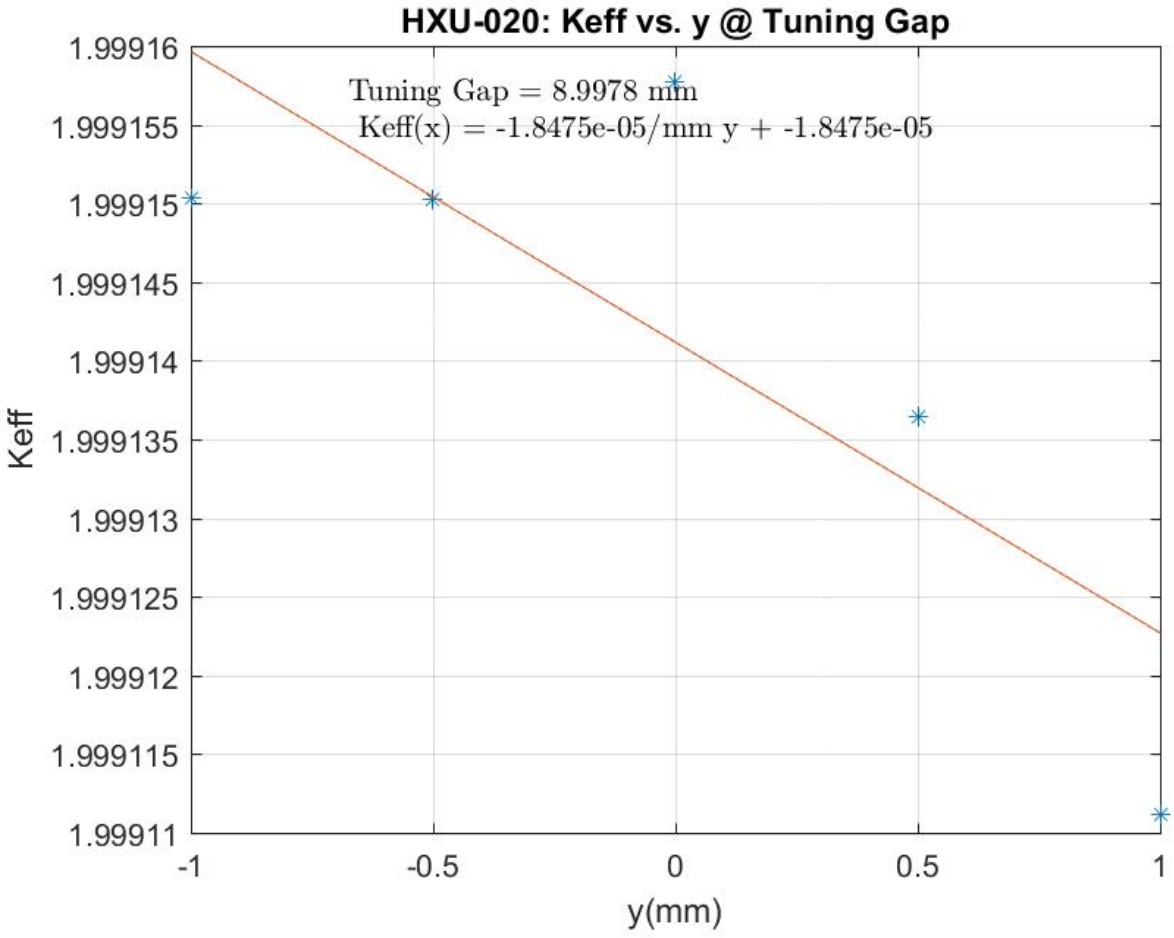
Evaluation of Hall Probe Scans: Phase Shake vs gap



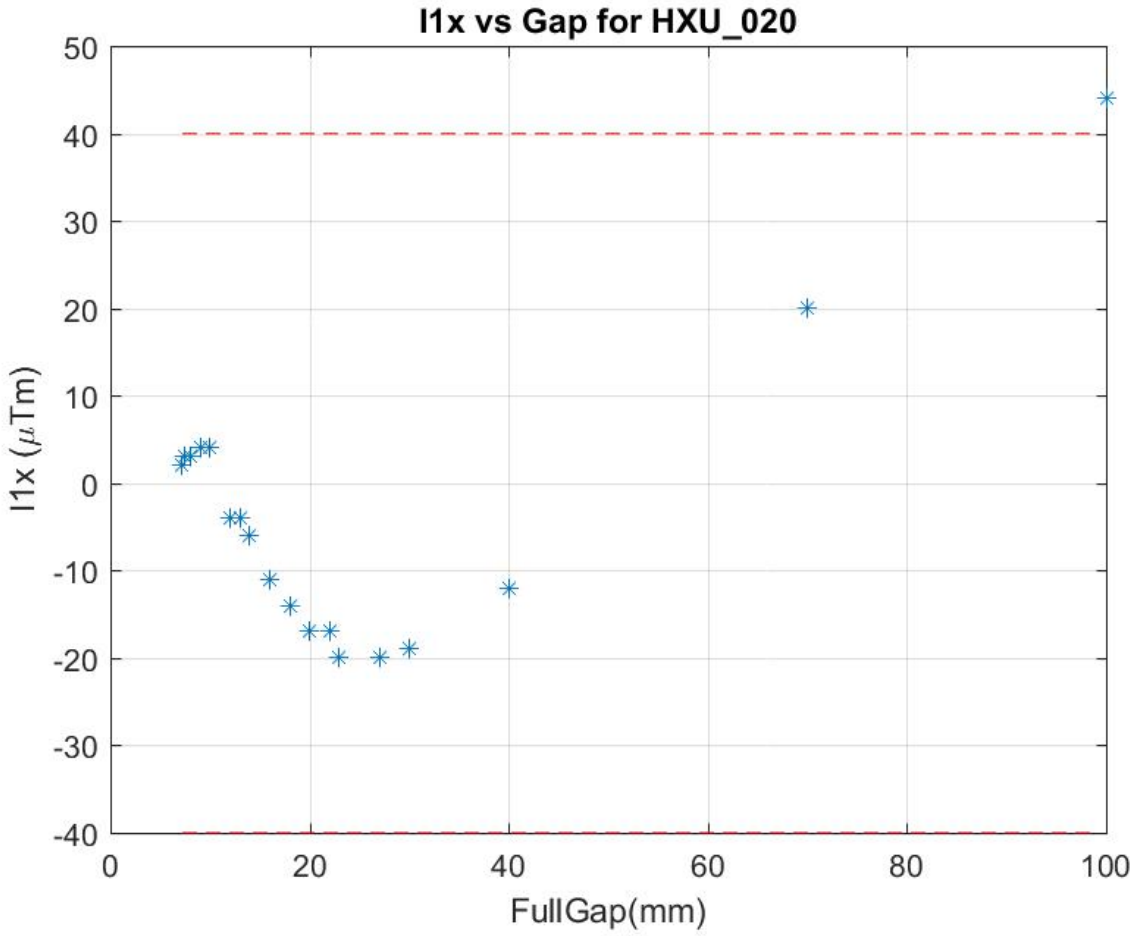
Evaluation of Hall Probe Scans: K_{eff} vs x at Tuning Gap



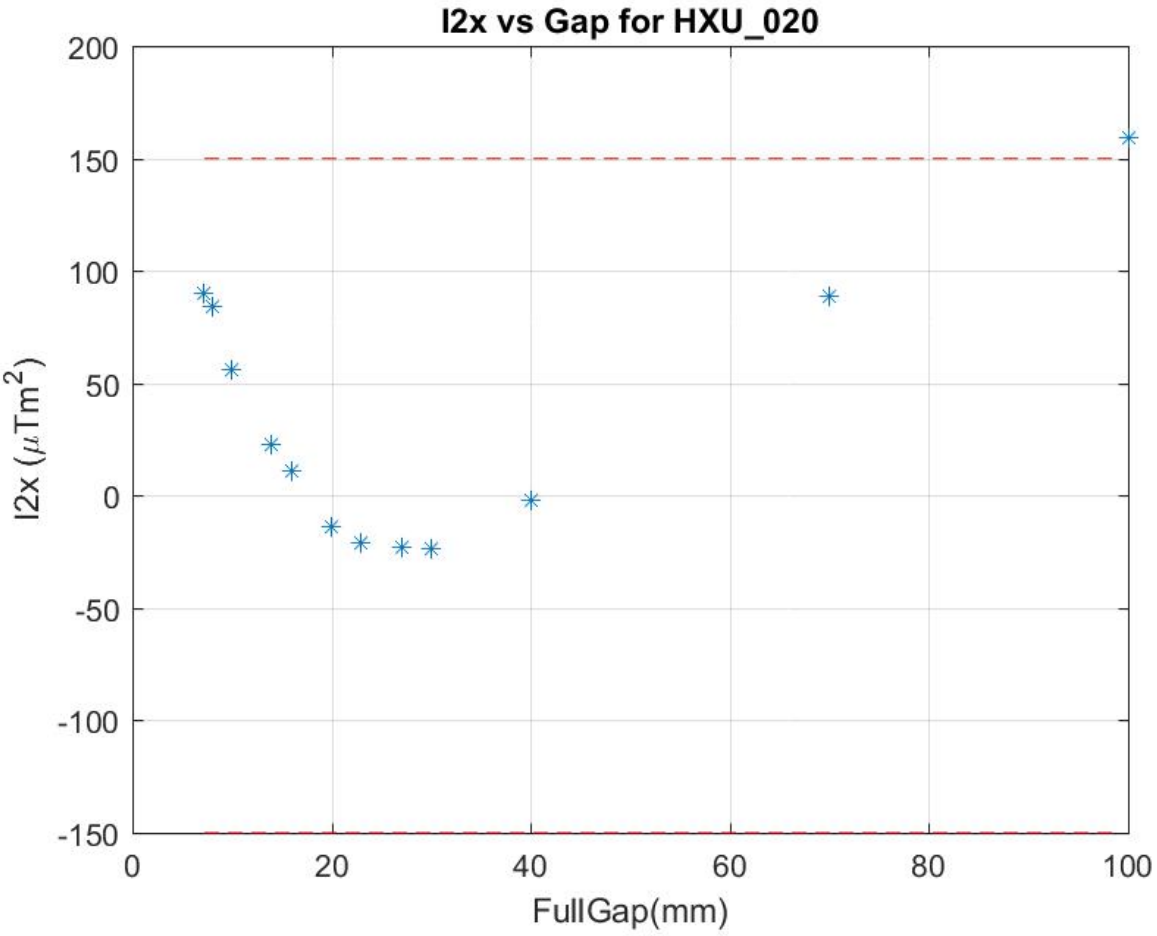
Evaluation of Hall Probe Scans: K_{eff} vs Y at Tuning Gap



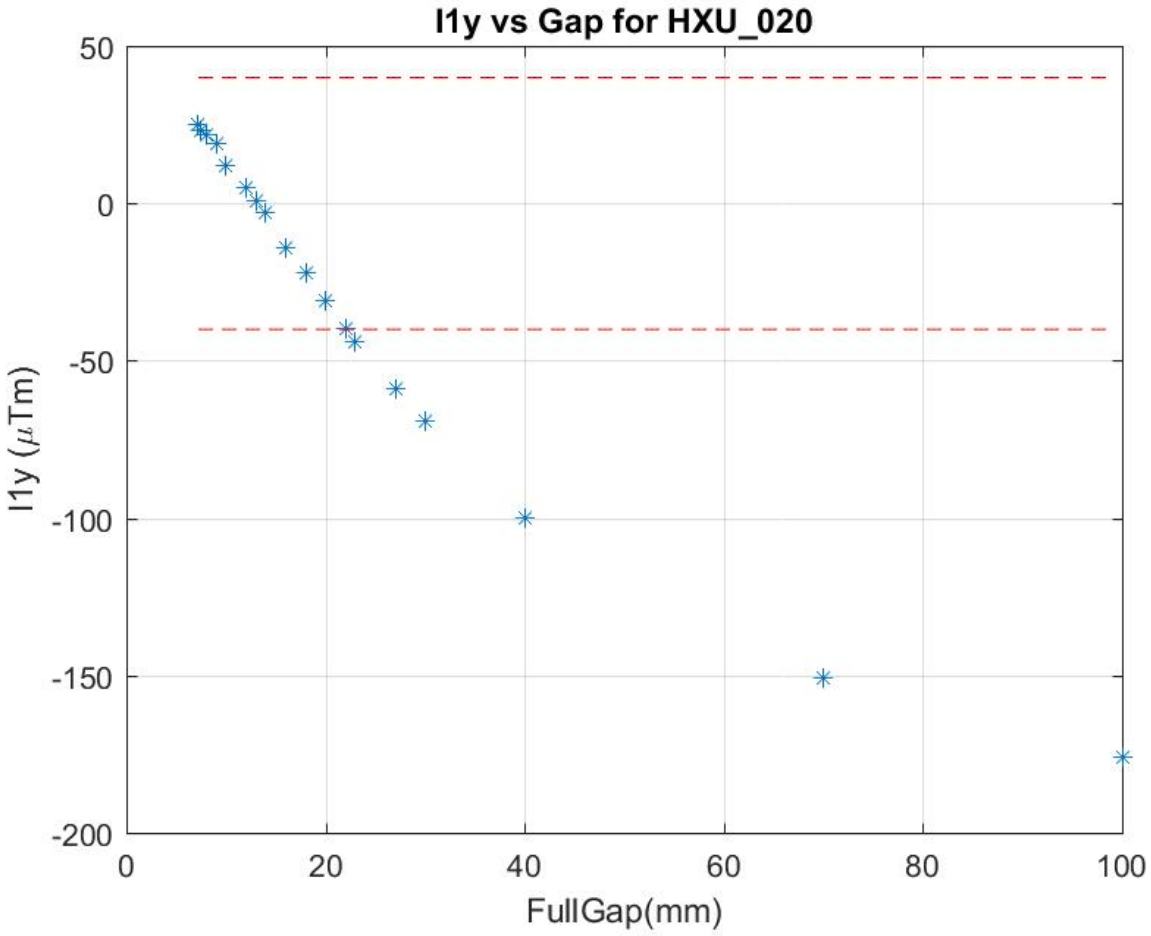
Long Coil Measurement of the On-Axis First Horizontal Field Integrals



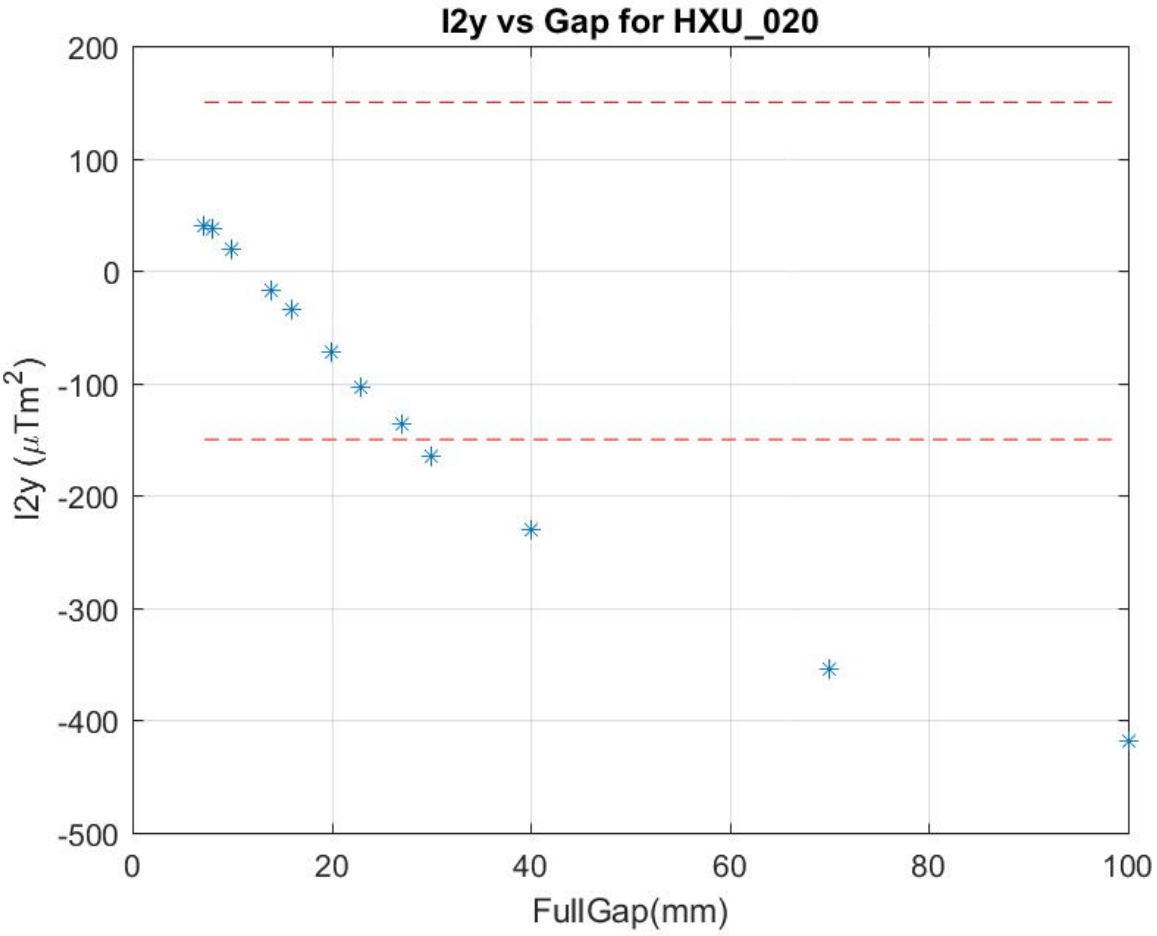
Long Coil Measurement of the On-Axis Secoind Horizontal Field Integrals



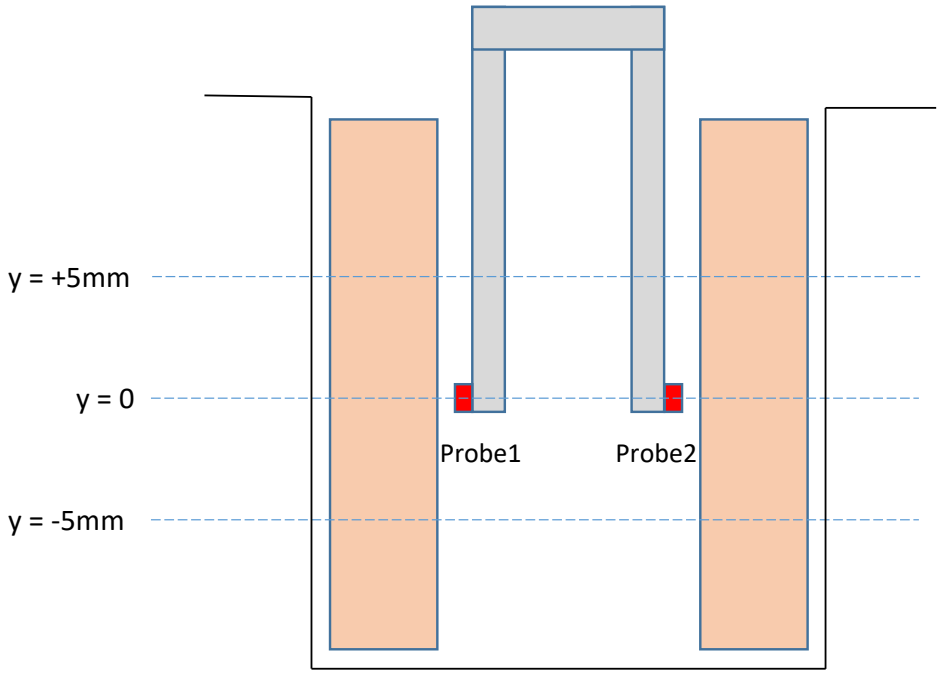
Long Coil Measurement of the On-Axis First Verticall Field Integrals



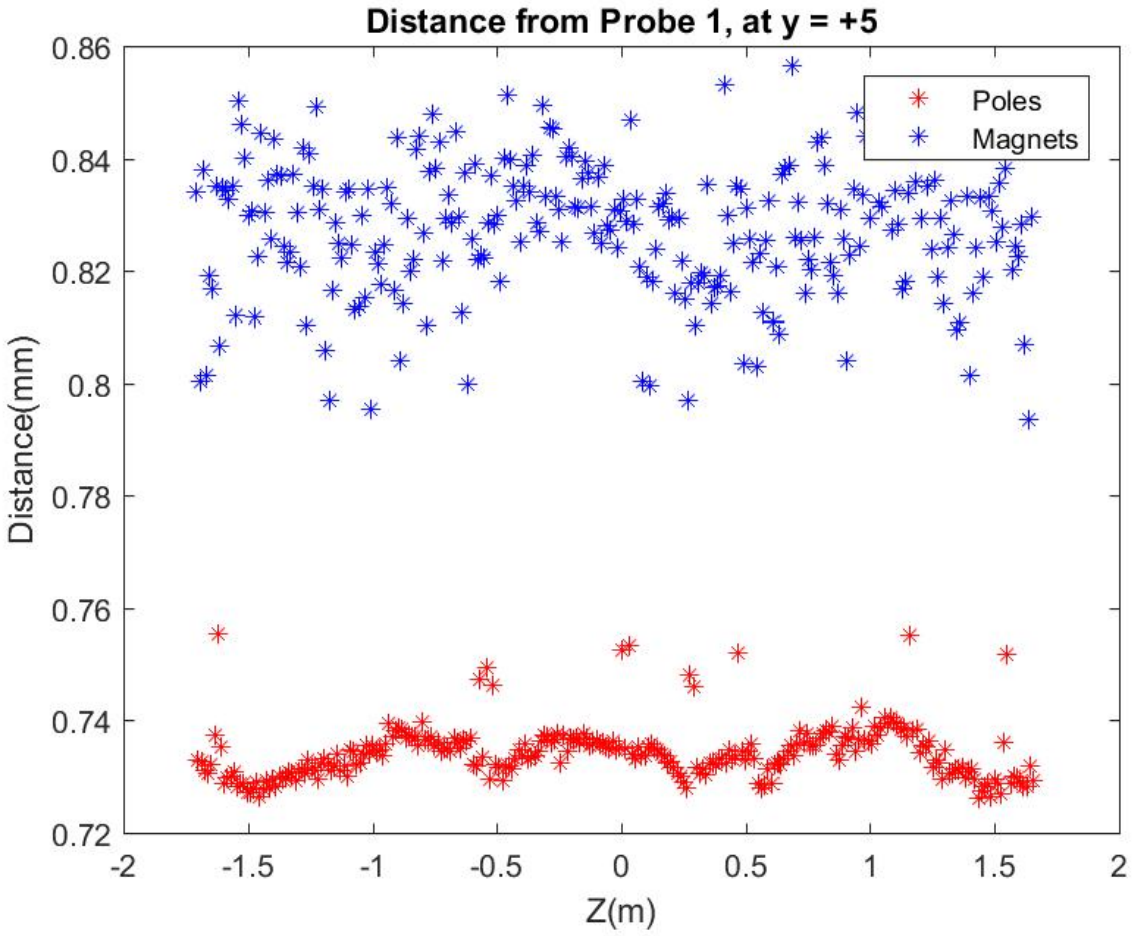
Long Coil Measurement of the On-Axis Second Vertical Field Integrals



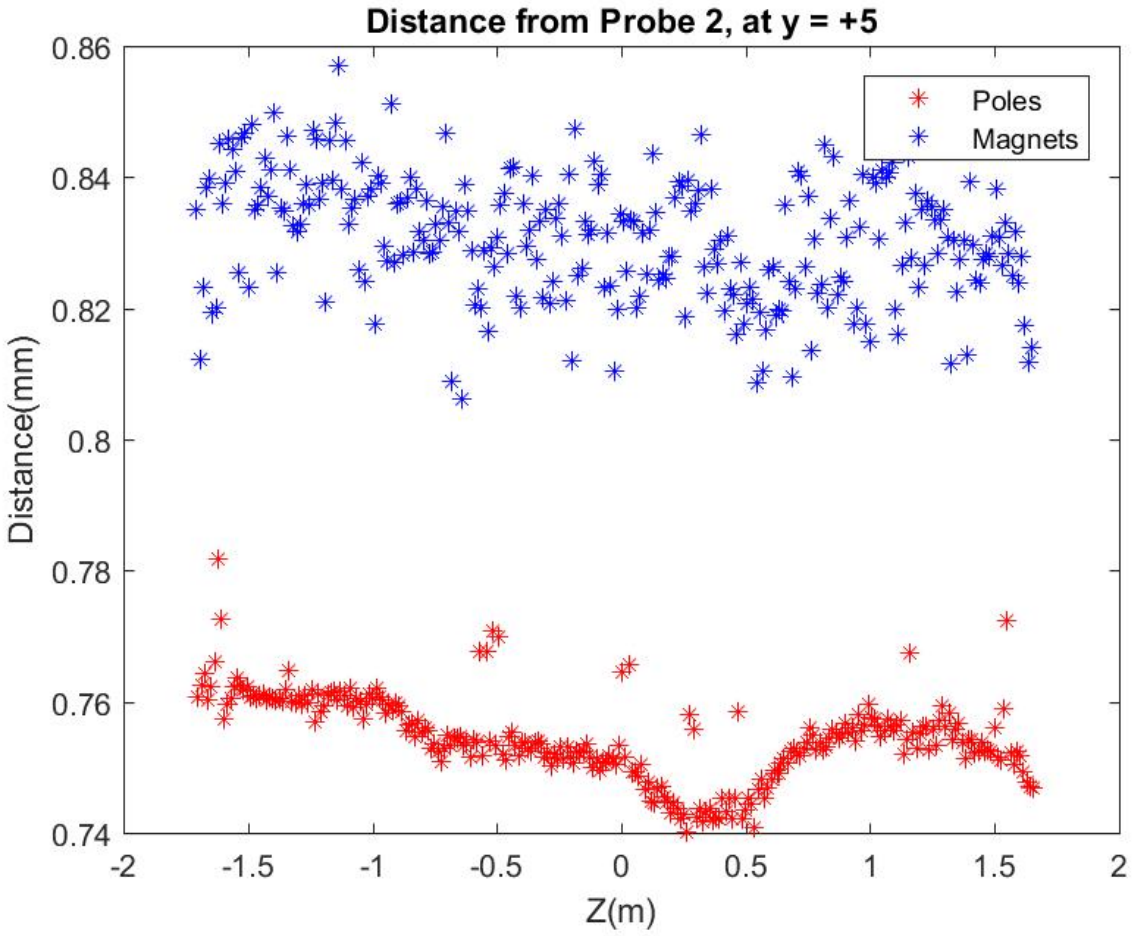
Capacitive Sensor Arrangement



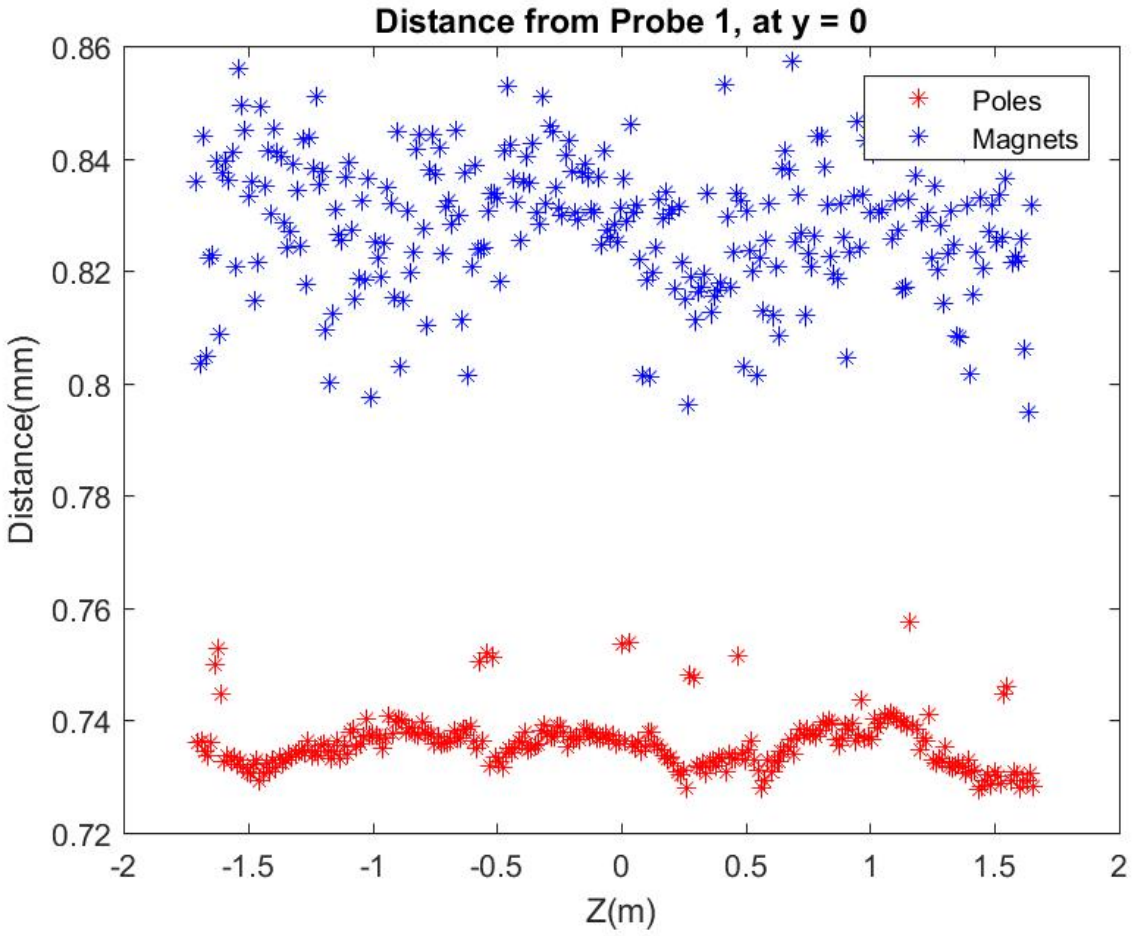
Probe1 Capacitive Sensor Readings y = +5mm



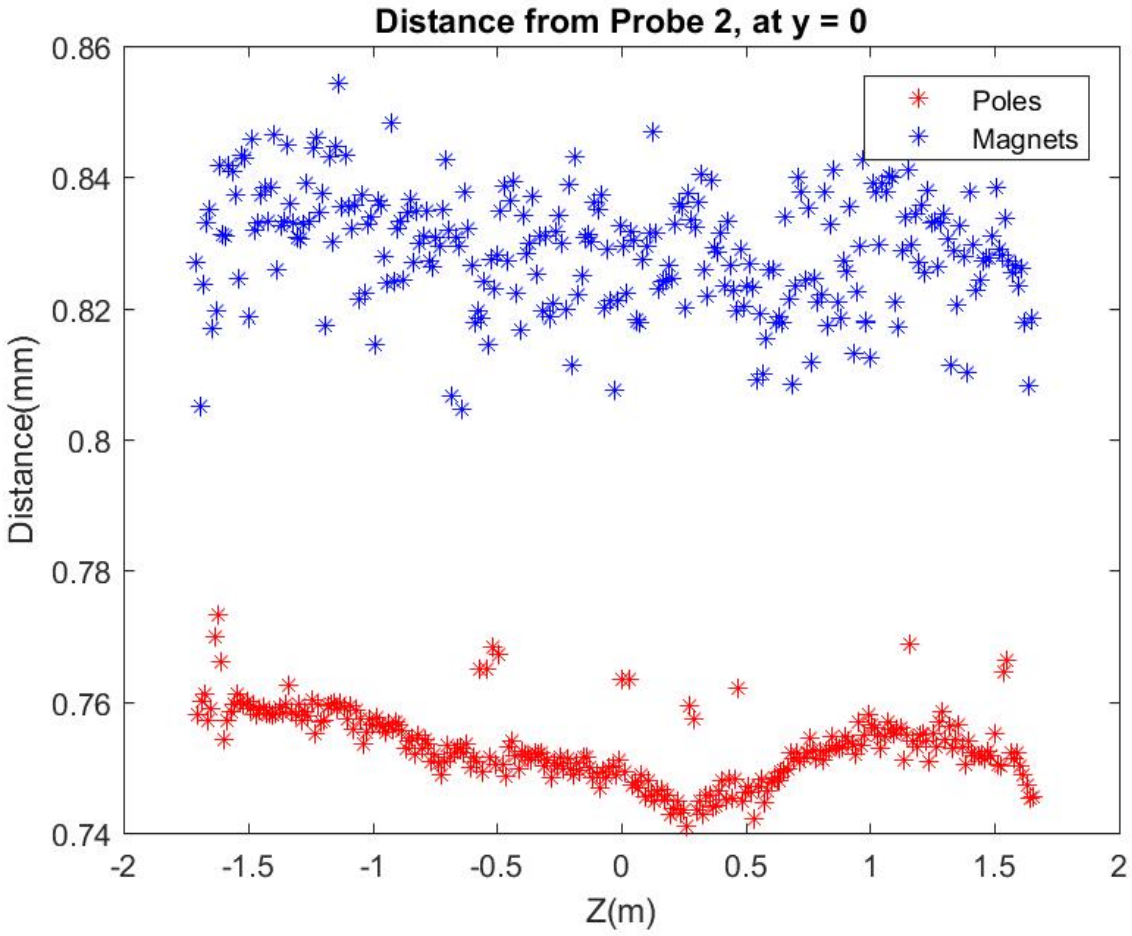
Probe2 Capacitive Sensor Readings y = +5mm



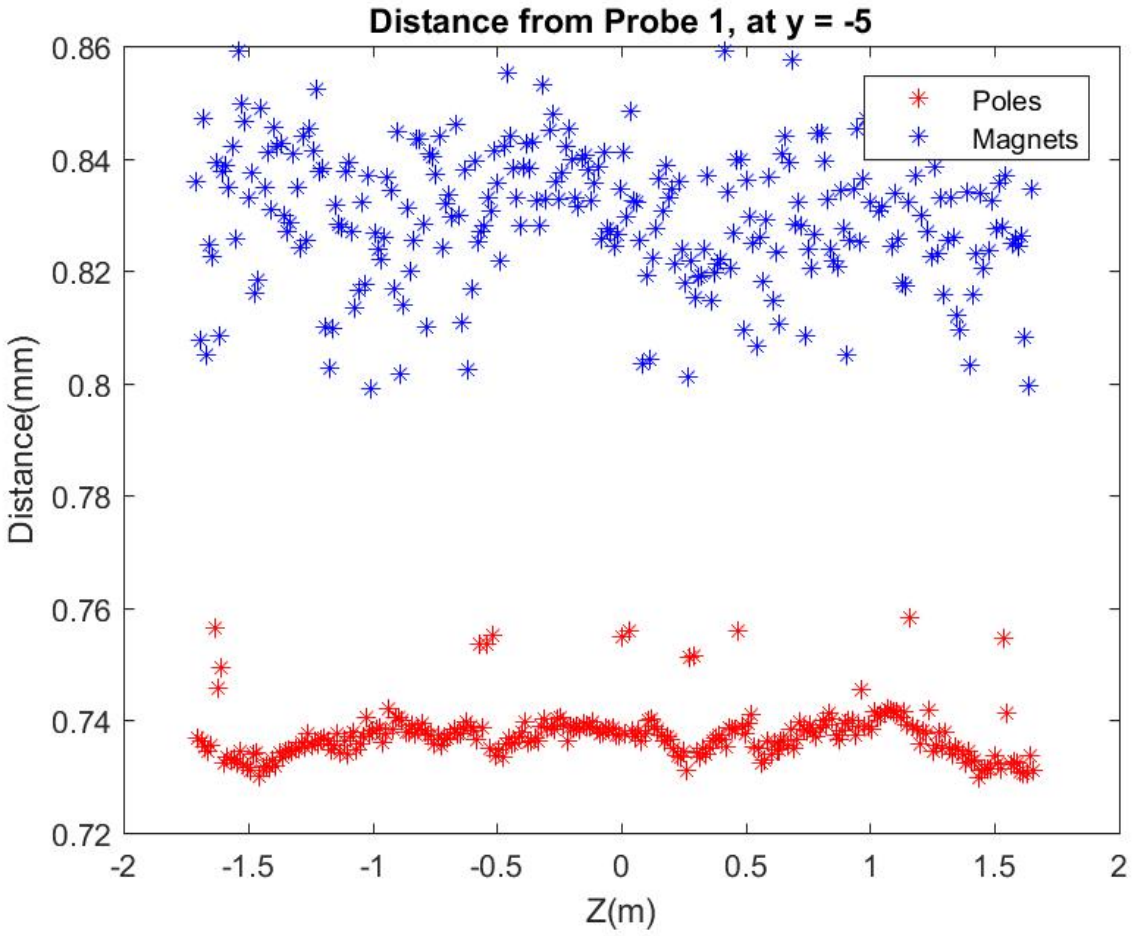
Probe1 Capacitive Sensor Readings y = 0mm



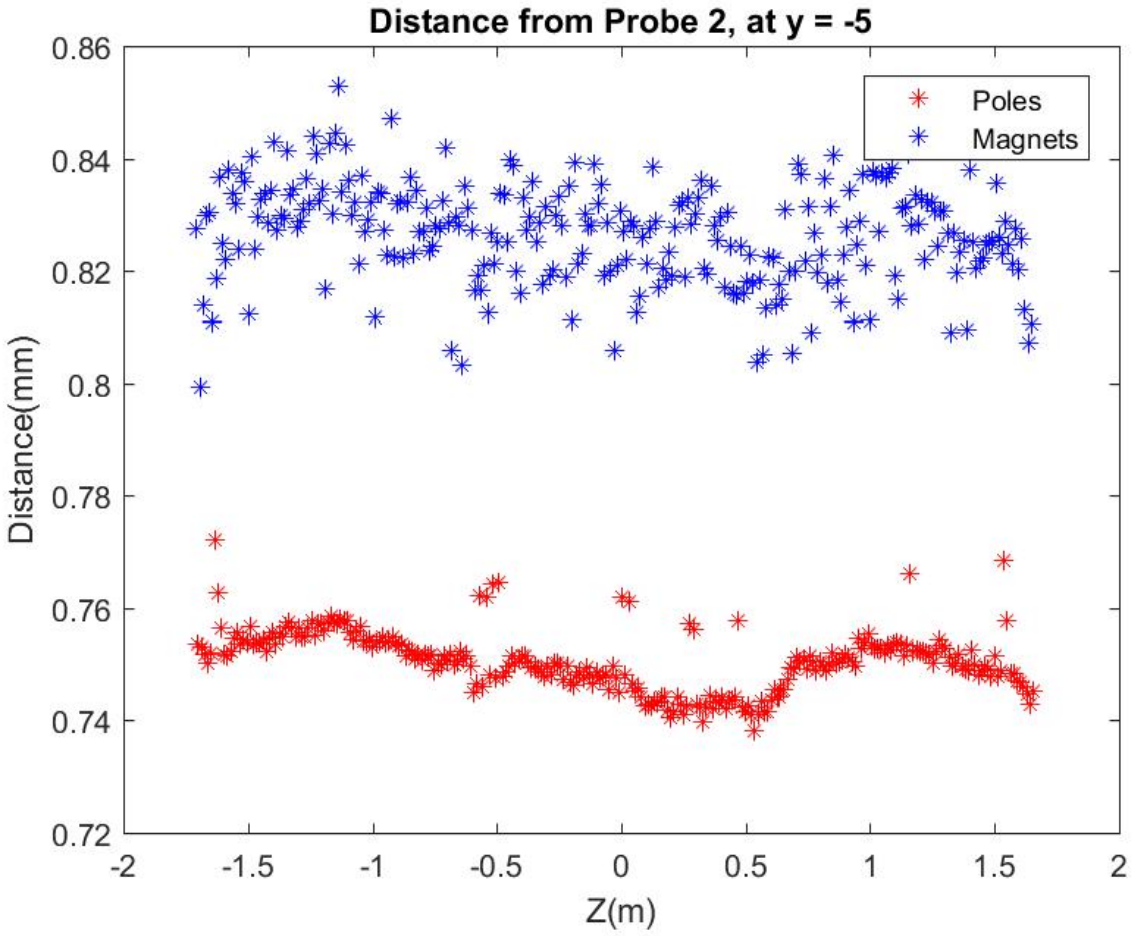
Probe2 Capacitive Sensor Readings y = 0mm



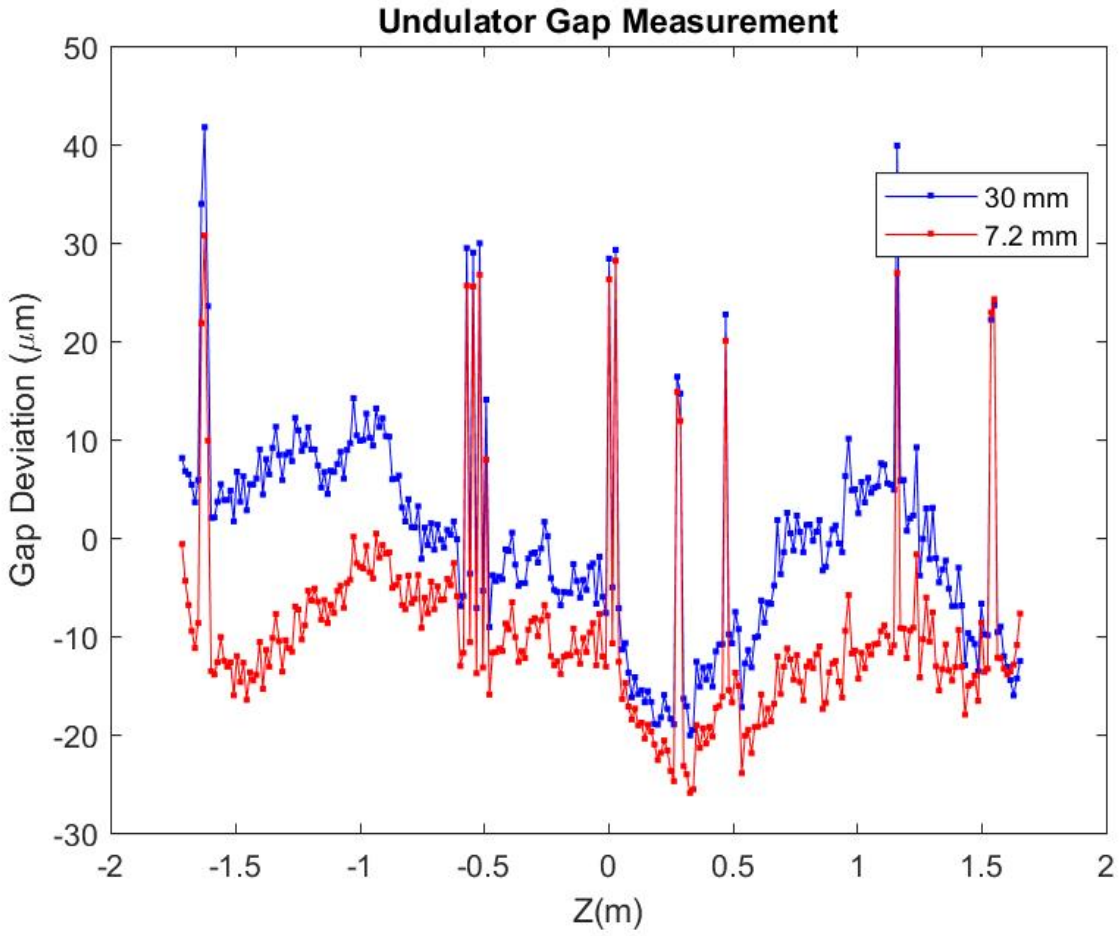
Probe1 Capacitive Sensor Readings y = -5mm



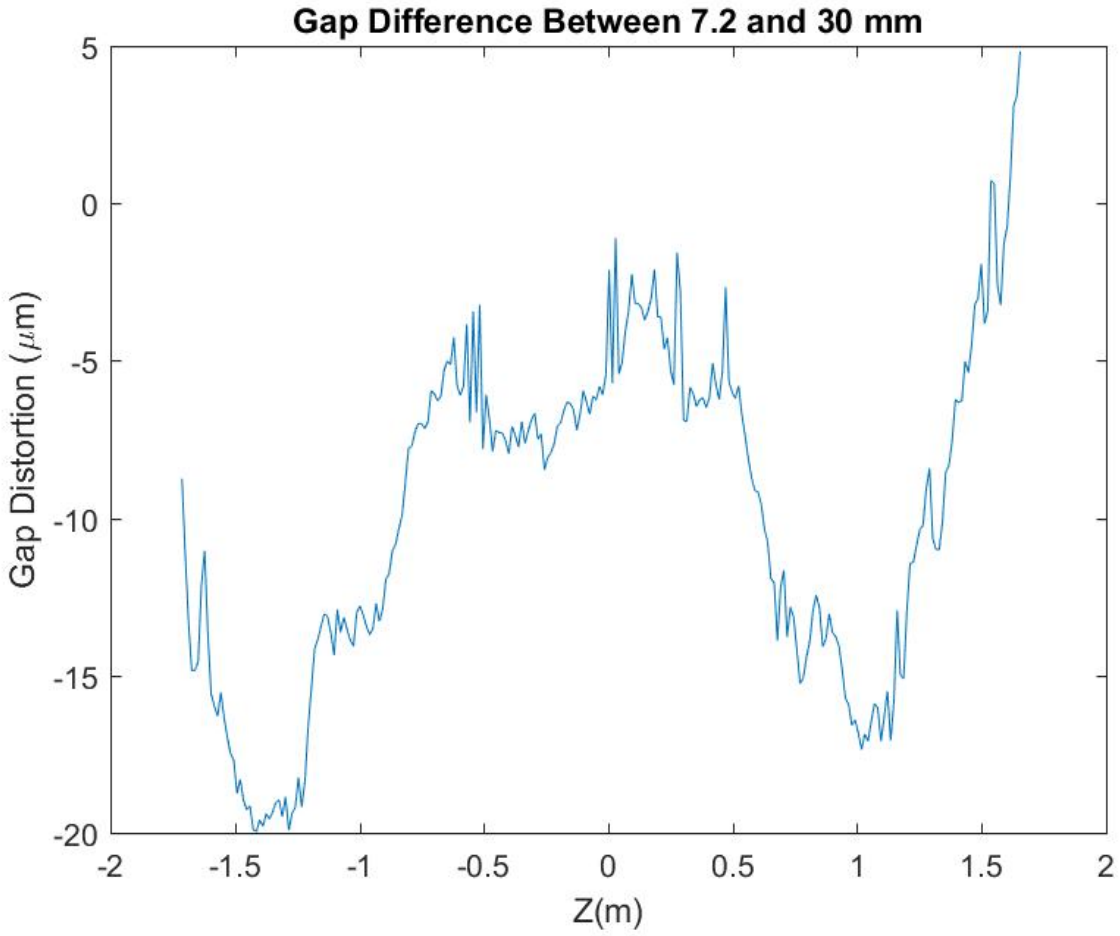
Probe2 Capacitive Sensor Readings y = -5mm



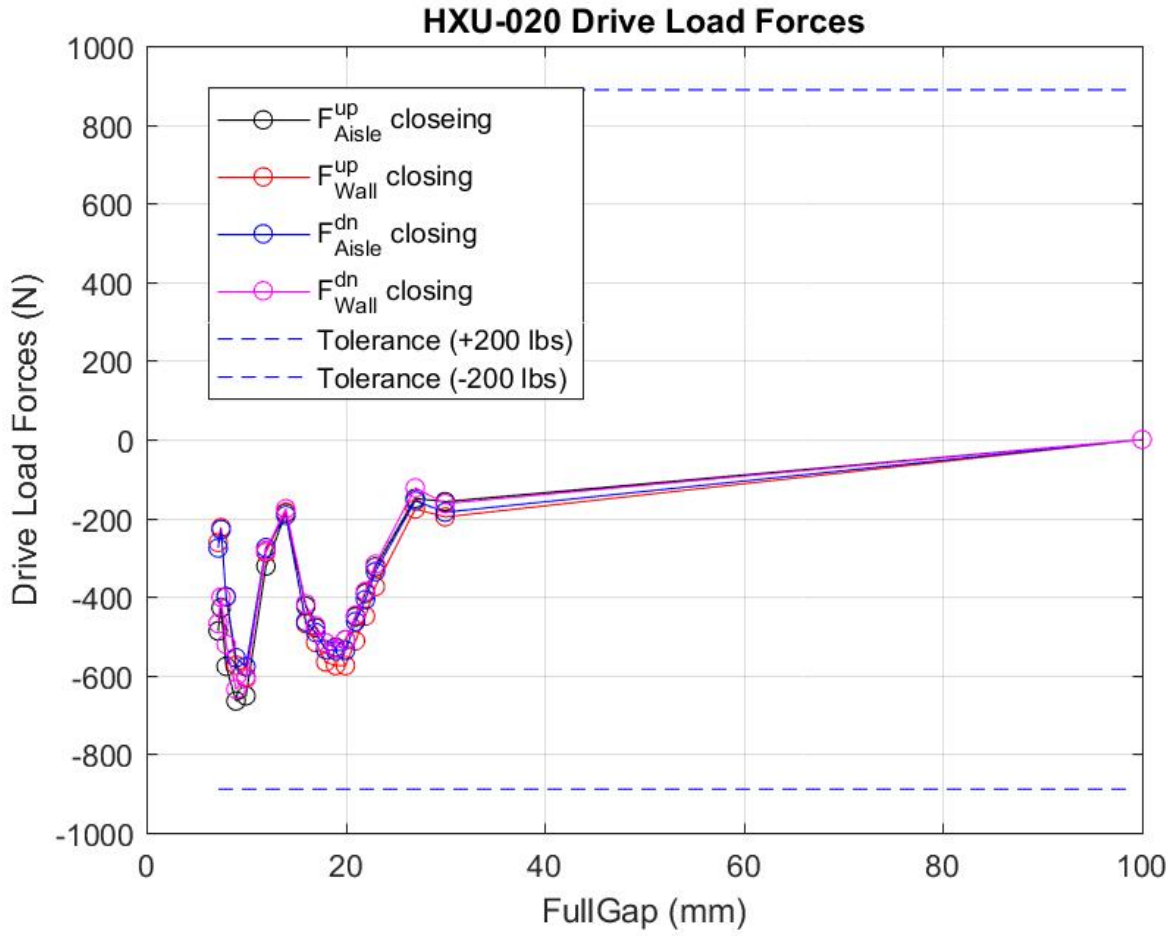
Undulator Gap Measurement



Undulator Gap Difference

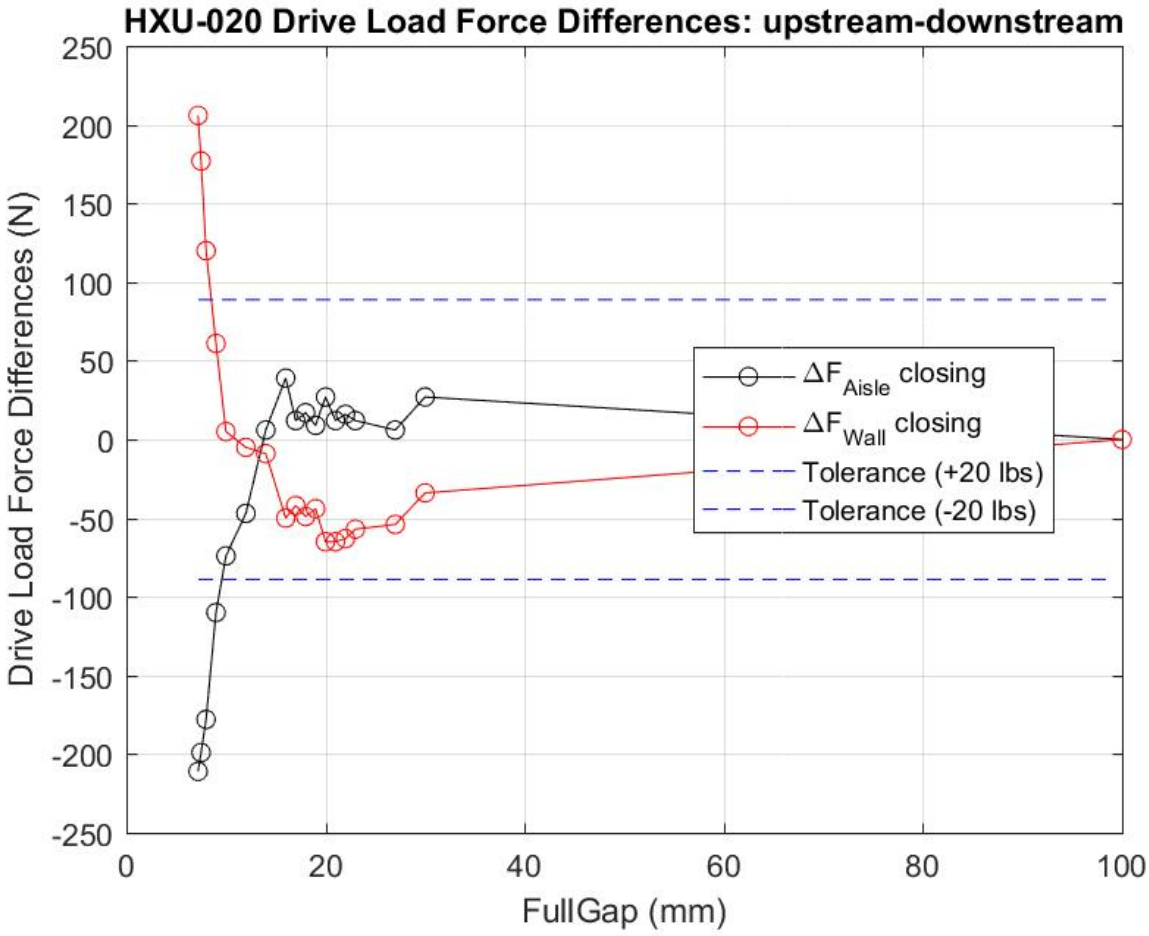


Drive Loads (Gap Opening)

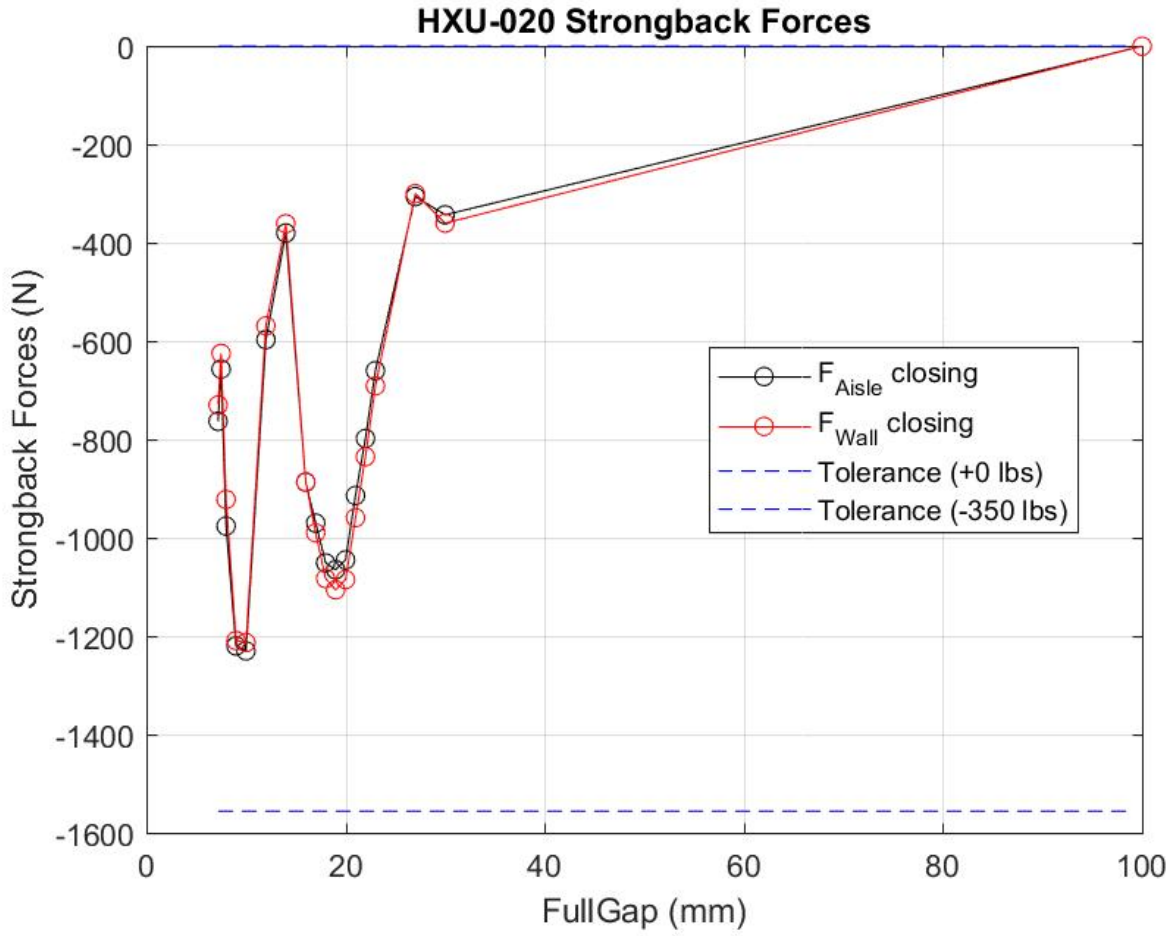


The Forces were only recorded as the gap was closing, and for the gaps that were measured with the Hall Probe.

Drive Load Differences (Gap Opening and Closing)



Strongback Forces, Gap Opening and Closing)



Strongback Force Differences, Gap Opening and Closing