LCLS-II HXU Measurement Results

Serial number from manufacturers label:	HXU-004

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
$rms\,(\lvert B_{pk}\rvert/\langle\lvert B_{pk}\rvert\rangle - 1)$	0.0024	
K_{eff} at Commissioning Gap (should be 2.3400)	2.3400	
Comissioning Gap	7.965	mm
$I1X$ (over 4.012667 m) (should be within ± 40)	-5	μTm
$I2X$ (over 4.012667 m) (should be within ± 150)	26	μTm^2
$I1Y$ (over 4.012667 m) (should be within ± 40)	-8	μTm
$I2Y$ (over 4.012667 m) (should be within ± 150)	-29	μTm^2
Phase Shake (rms phase fluctuations over core poles (< 4.0)	1.9	degXray
Cell Phase Advance (over 4.012667 m)	48598.9 ($135 \times 360 - 1.1$)	degXray
Undulator Entrance Phase[1]	2246.0 ($25 \times 90 - 4.0$)	degXray
Undulator Exit Phase[2]	2248.7 ($25 \times 90 - 1.3$)	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	-663.7807
DSGapEncoderOffset	-381.1037
USWLinearEncoder.AOFF	92.9805
DSWLinearEncoder.AOFF	92.9885
USALinearEncoder.AOFF	92.2570
DSALinearEncoder.AOFF	91.2797

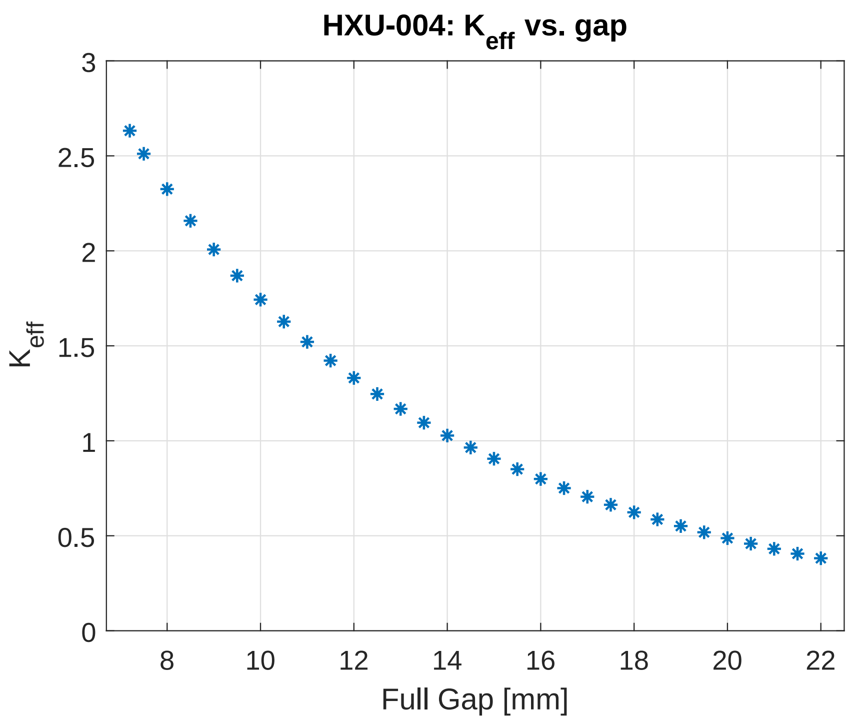
Undulator Load Cell Readings at Tuning Gap

LC_DAL_FORCE	-200.2
LC_DAU_FORCE	-184.6
LC_DWL_FORCE	-92.5
LC_DWU_FORCE	-273.7
LC_UAL_FORCE	-182.4
LC_UAU_FORCE	-181.6
LC_UWL_FORCE	-197.3
LC_UWU_FORCE	-197.3

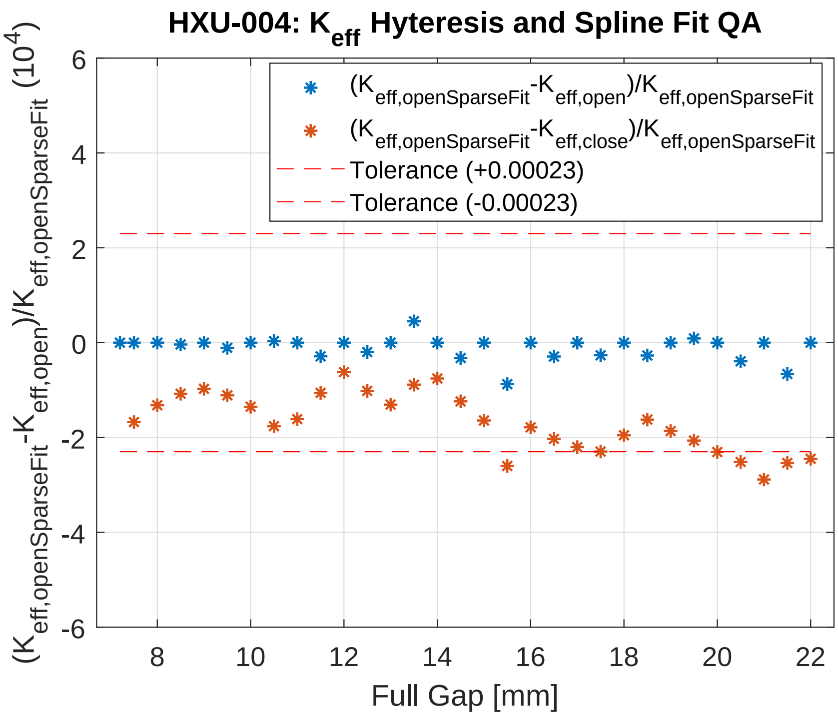
Undulator Load Cell Readings at 100 mm Gap

LC_DAL_FORCE	-2.7
LC_DAU_FORCE	-2.9
LC_DWL_FORCE	-2.4
LC_DWU_FORCE	-1.7
LC_UAL_FORCE	0.0
LC_UAL_FORCE	-2.0
LC_UWL_FORCE	-1.5
LC_UWU_FORCE	1.0

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



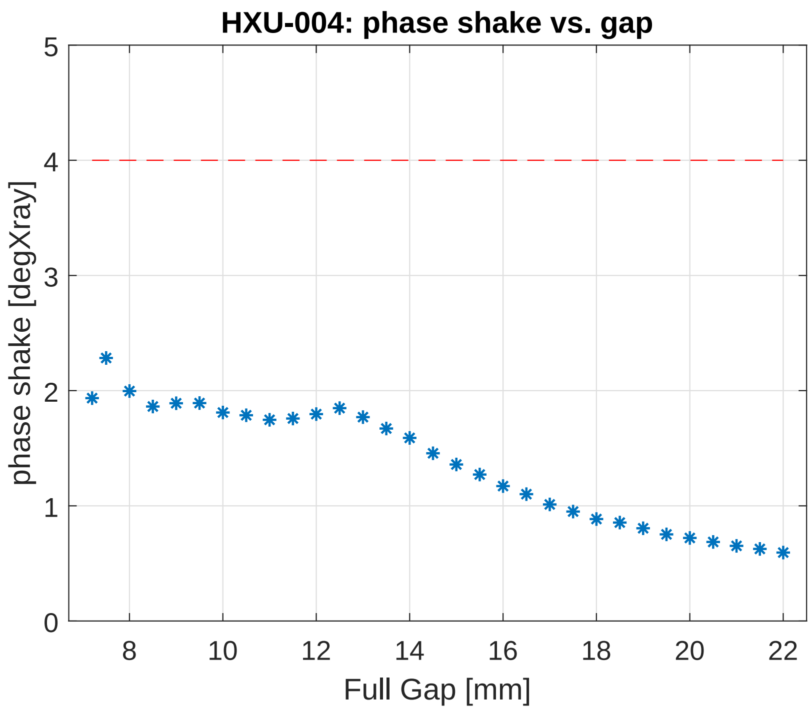
Evaluation of Hall Probe Scans: K_{eff} Hysteresis



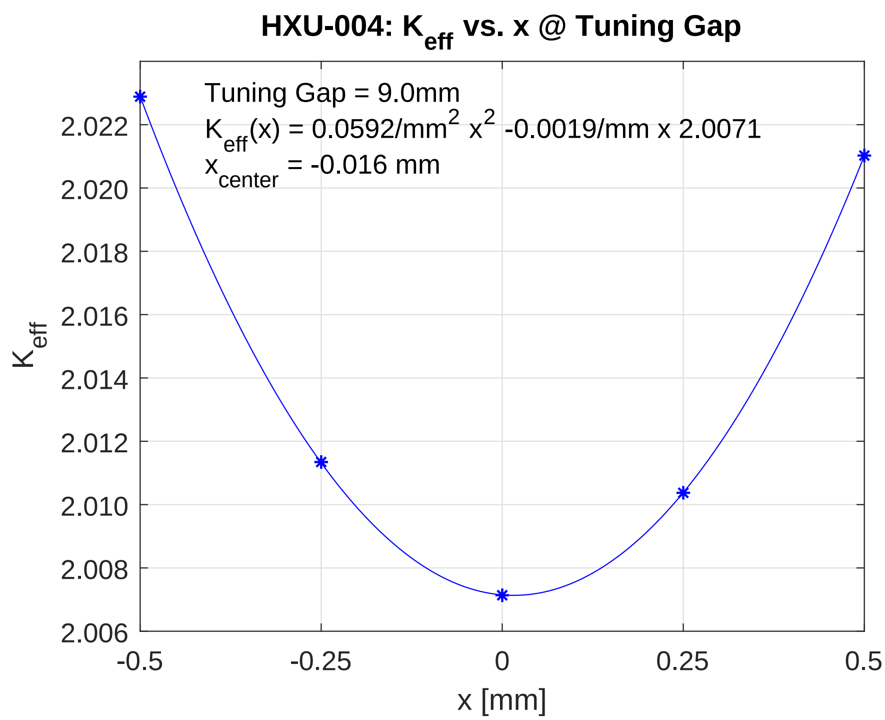
Plotted functions have been calculated from measured values openKeff (opengap) and closeKeff (closegap) using the following Matlab calculations:

Blue Stars:	1-openKeff ./ spline(opengap([1,2,[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)

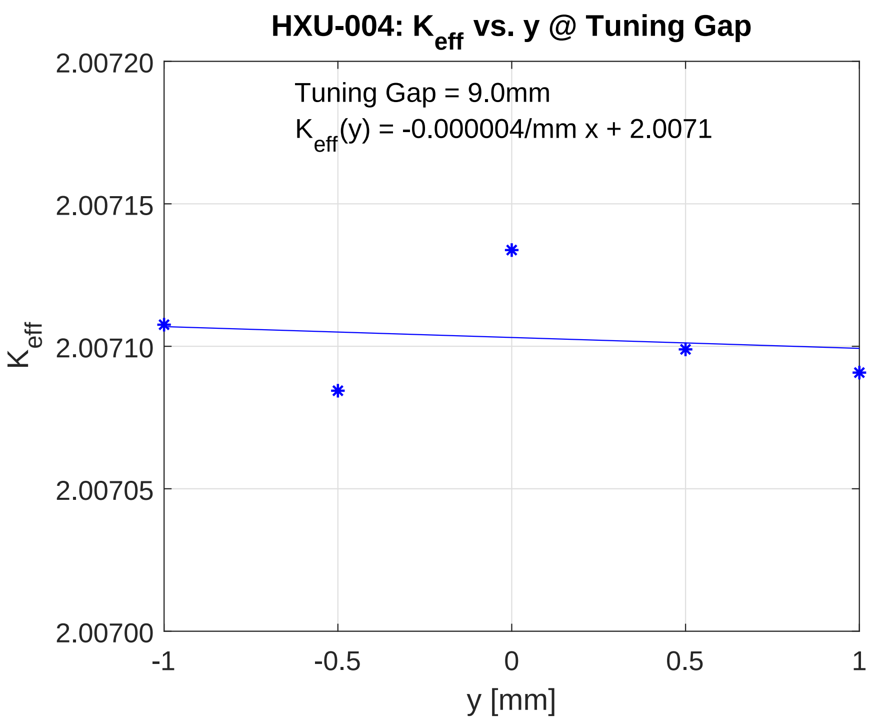
Evaluation of Hall Probe Scans: Phase Shake vs gap



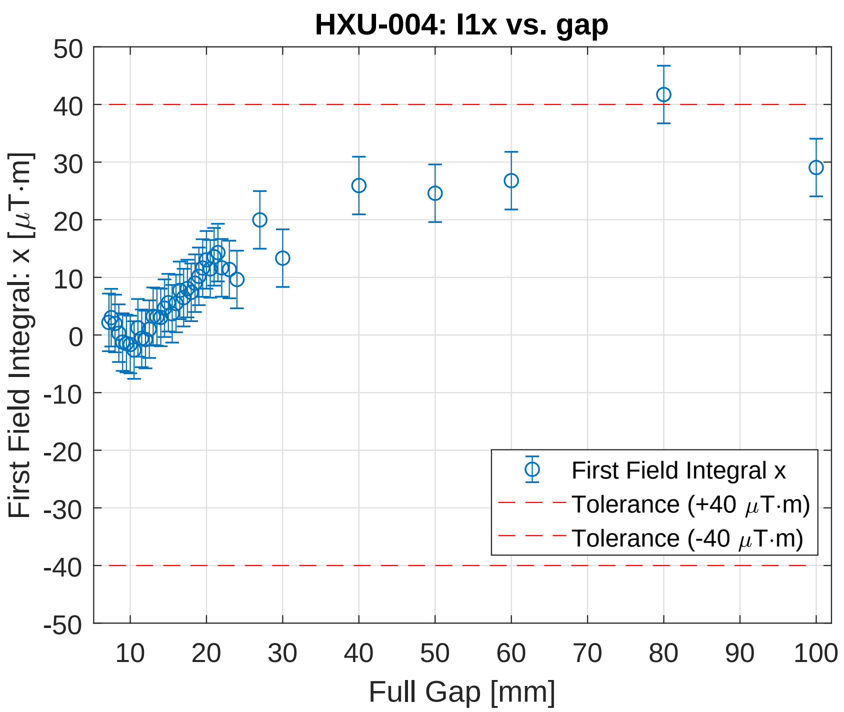
Evaluation of Hall Probe Scans: K_{eff} vs x at Tuning Gap



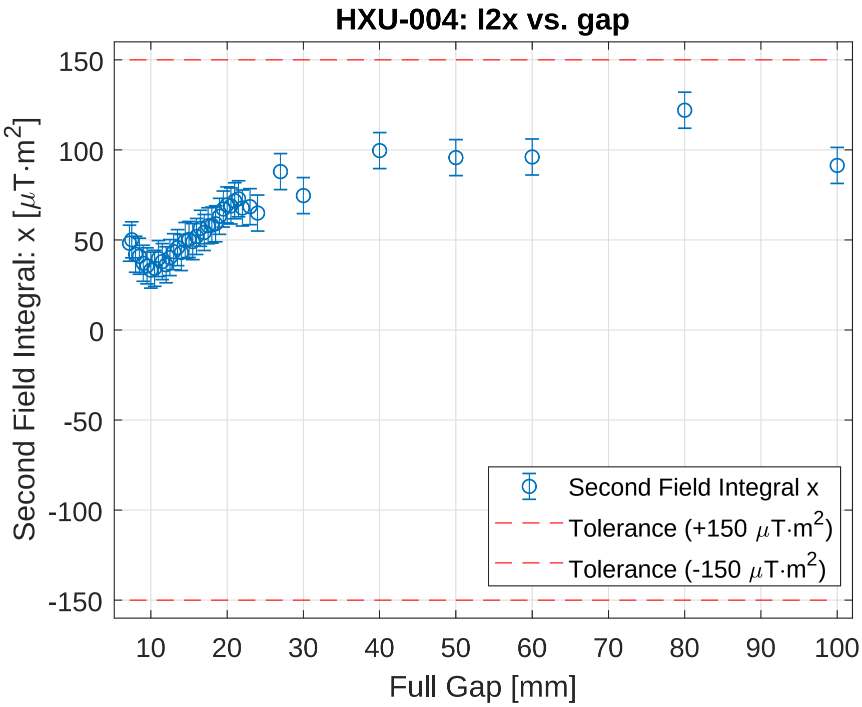
Evaluation of Hall Probe Scans: K_{eff} vs Y at Tuning Gap



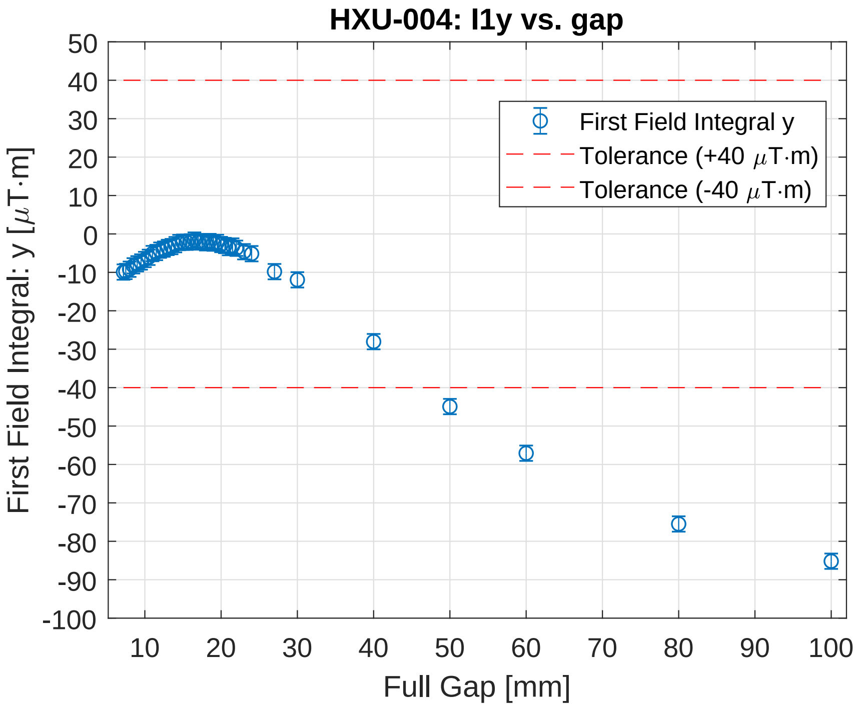
Long Coil Measurement of the On-Axis First Horizontal Field Integrals



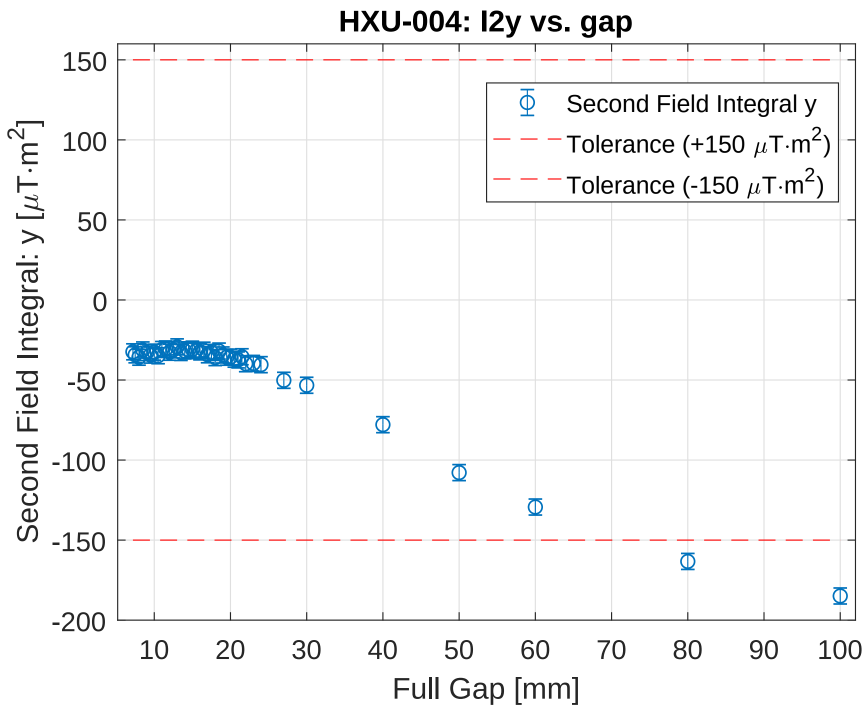
Long Coil Measurement of the On-Axis Secoind Horizontal Field Integrals



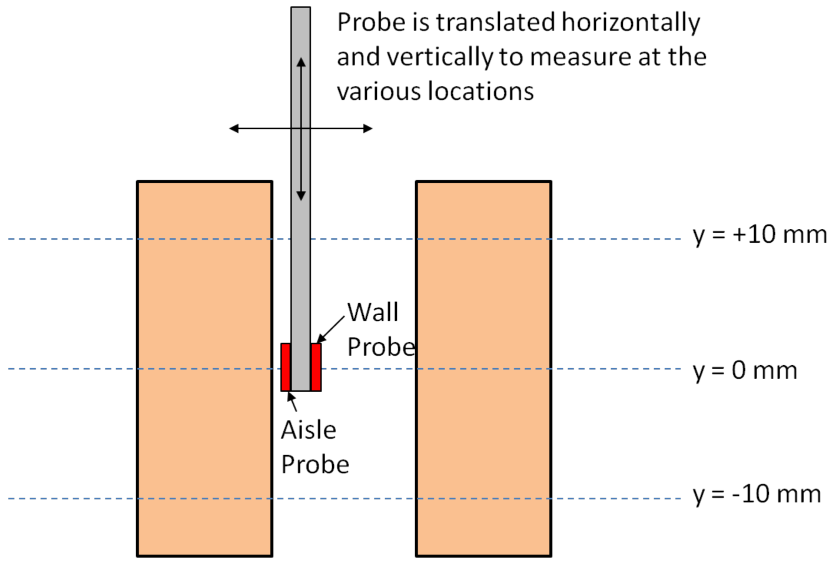
Long Coil Measurement of the On-Axis First Verticall Field Integrals



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

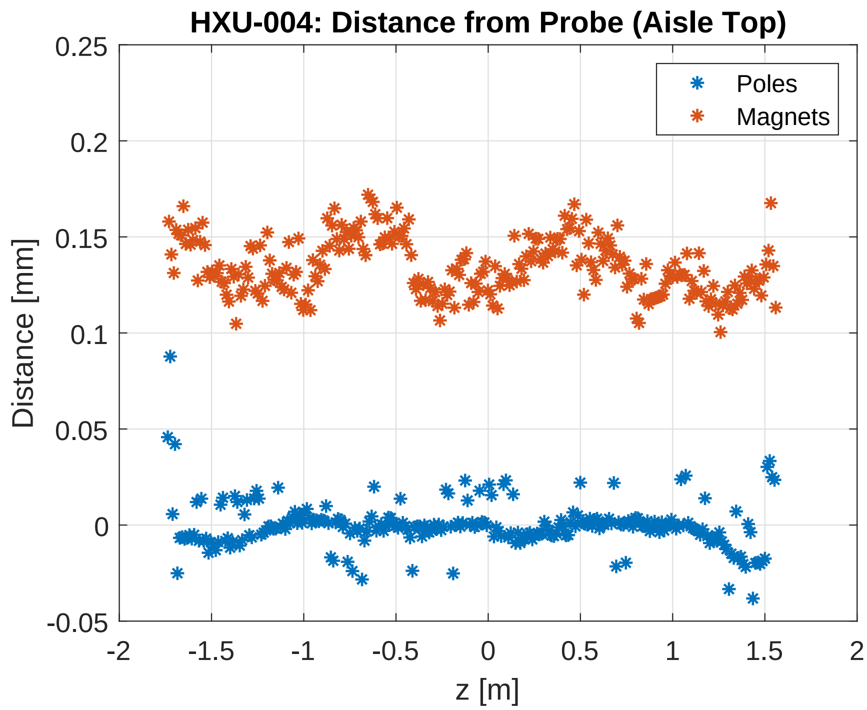


Capacitive Sensor Arrangement

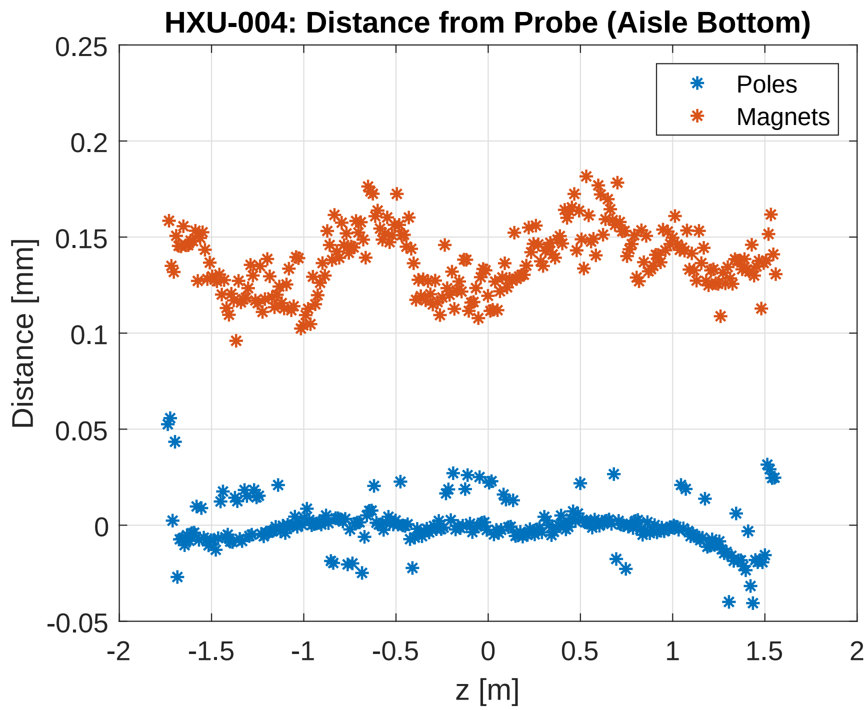


The following plots show the pole and magnet position measurements. The LBNL system has two back-to-back capacitive probes on one probe holder. The x and y stages on the Kugler bench are positioned so that the probe is in the proper location for each of the 9 scan locations. For the data analysis, the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

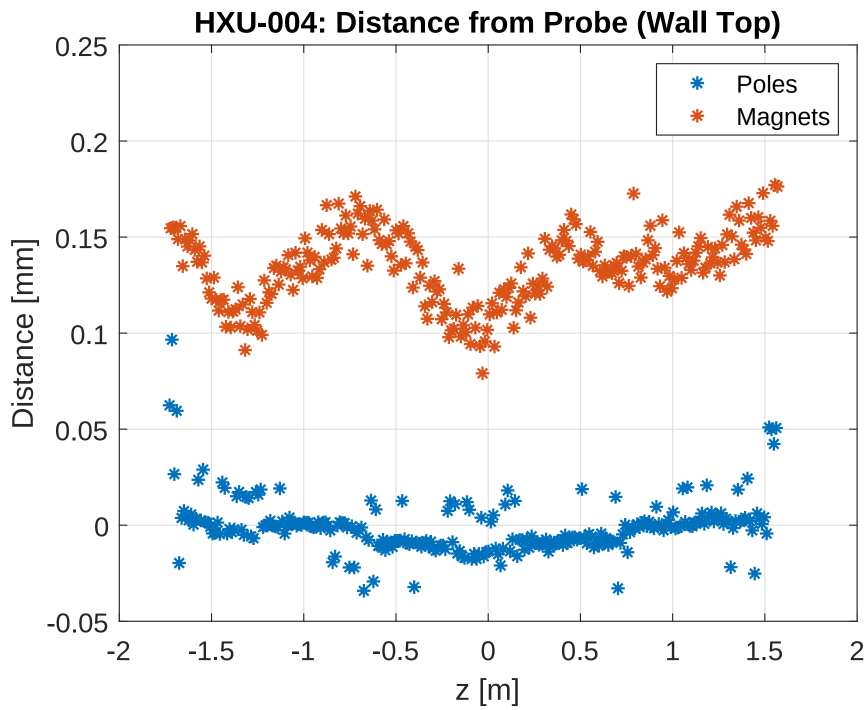
G1 Capacitive Sensor Readings



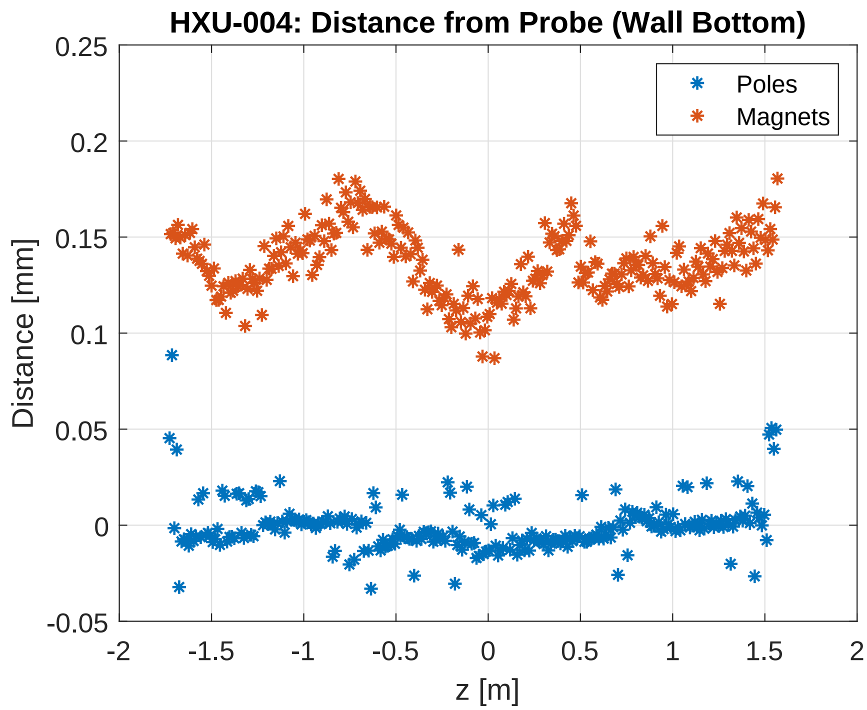
G2 Capacitive Sensor Readings



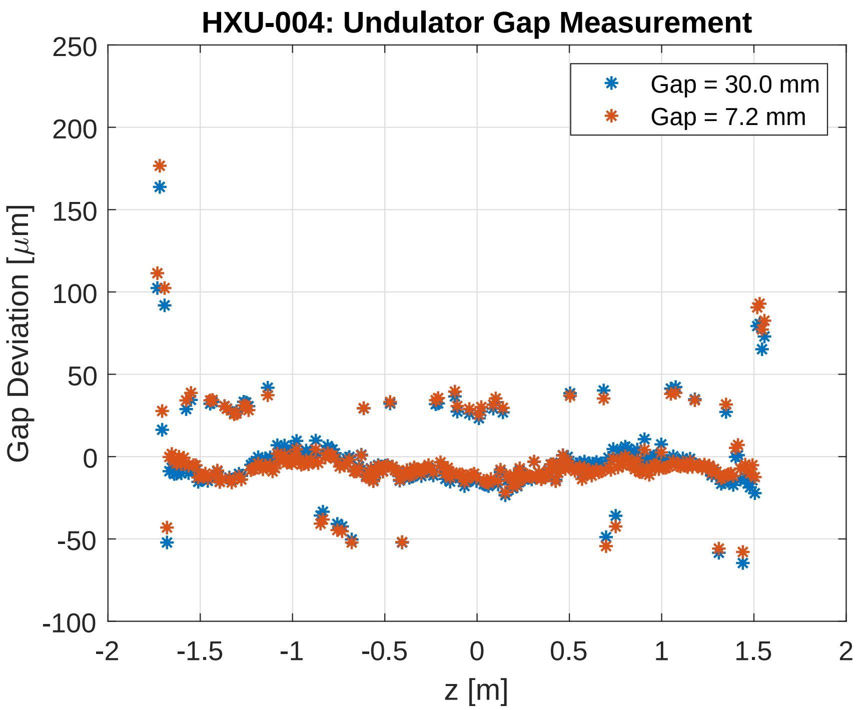
G3 Capacitive Sensor Readings



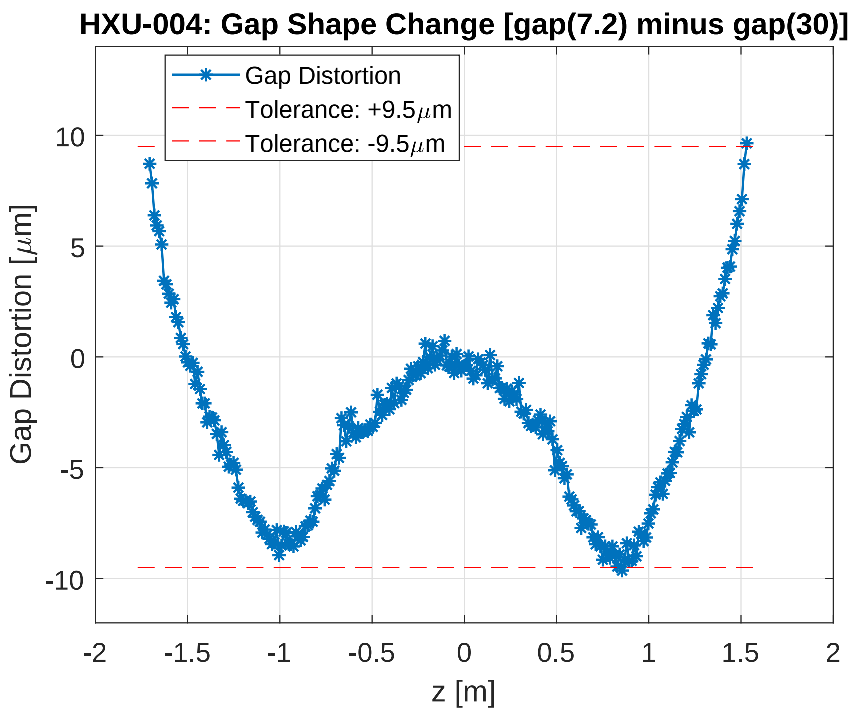
G4 Capacitive Sensor Readings



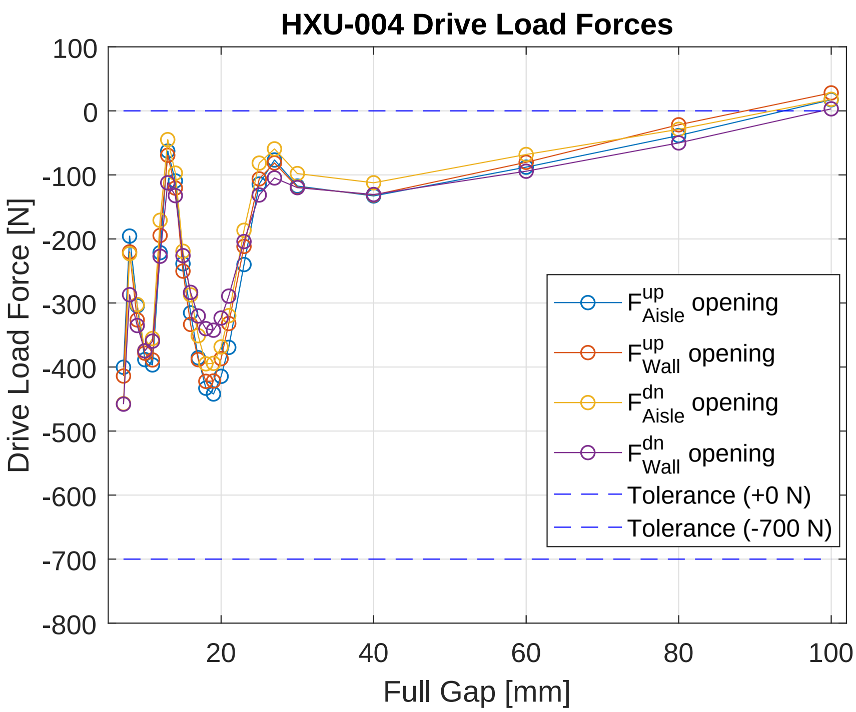
Undulator Gap Measurement



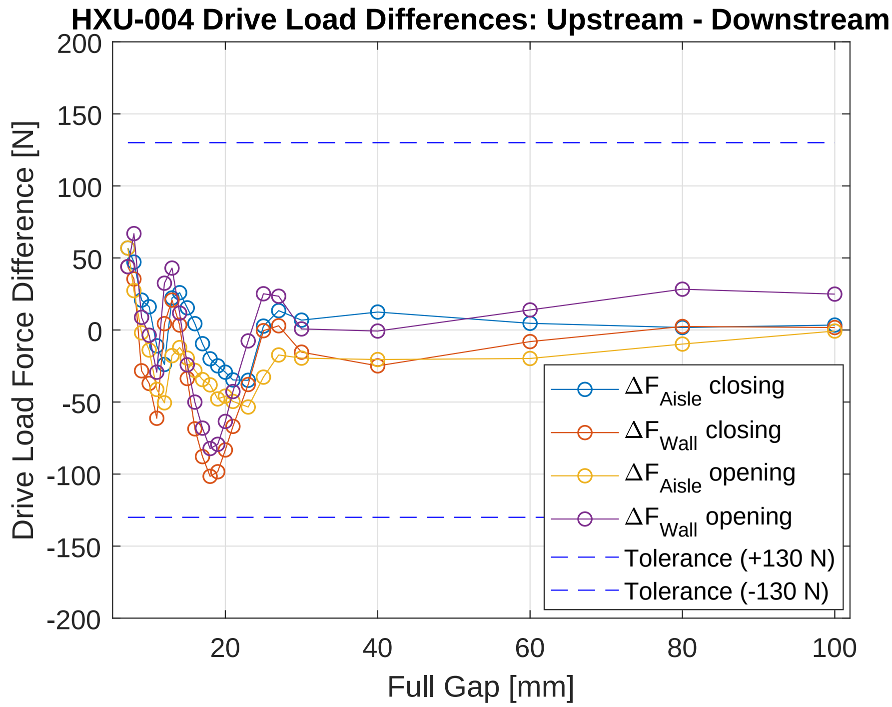
Undulator Gap Difference



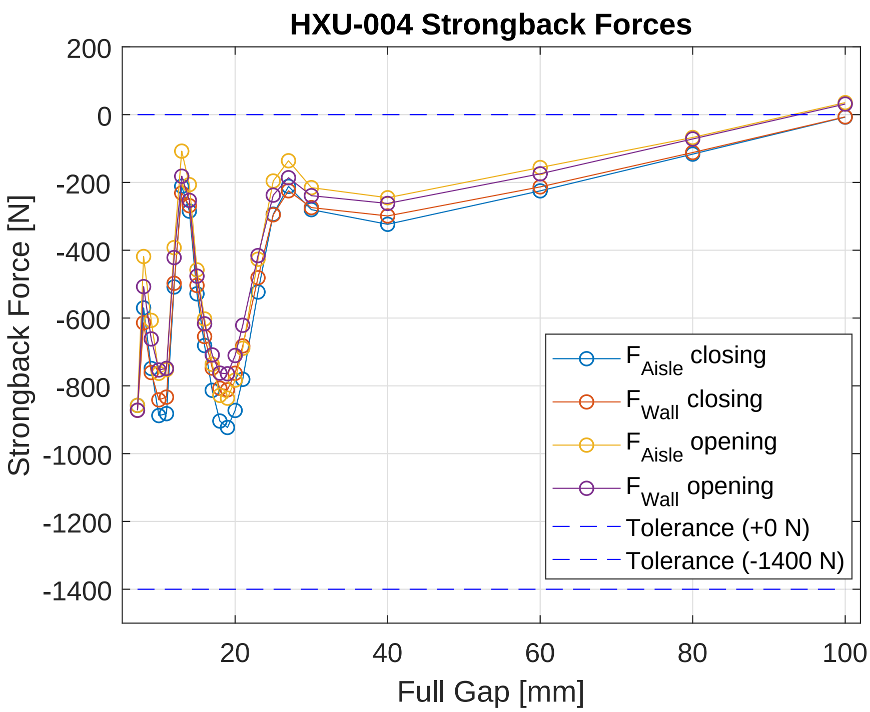
Drive Loads (Gap Opening)



Drive Load Differences (Gap Opening and Closing)



Strongback Forces (Gap Opening and Closing)



Strongback Force Differences (Gap Opening and Closing)