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 manufacturer's label:	HXU-028

Measurement Procedure:

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

General Hall Probe Scan Evaluation Parameters

Undulator Temperature (should be 20.0)	19.87± 0.04	°C
First core pole # (count includes zero potential pole)	8	
Last core pole # (count includes zero potential pole)	253	
Tuning Gap	9.000	mm

Evaluation of Hall Probe Scans at Commissioning Gap

Commissioning Gap Temperature (should be 20.0)	19.88± 0.05	°C
rms(|B_{pk}|/<|B_{pk}|> - 1)	0.00168	
K_{eff} at Commissioning Gap (should be 2.3400)	2.3403	
Commissioning Gap	7.8961	mm
I1X (over 4.012667 m) (should be within ±40)	3	µTm
I2X (over 4.012667 m) (should be within ±150)	-23	µTm^2
I1Y (over 4.012667 m) (should be within ±40)	-6	µTm
I2Y (over 4.012667 m) (should be within ±150)	-4	µTm^2
Phase Shake (rms phase fluctuations over core poles) (<4.0)	2.32	degXray
Cell Phase Advance (over 4.012667 m)	486,598.9 (135×360-1.06)	degXray
Undulator Entrance Phase[1]	2,248.5 (25×90-1.50)	degXray
Undulator Exit Phase[2]	2,250.4 (25×90+0.44)	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	NA
DSGapEncoderOffset	NA
USWLinearEncoder.AOFF	89.7298
DSWLinearEncoder.AOFF	89.9735
USALinearEncoder.AOFF	90.5531
DSALinearEncoder.AOFF	89.9249

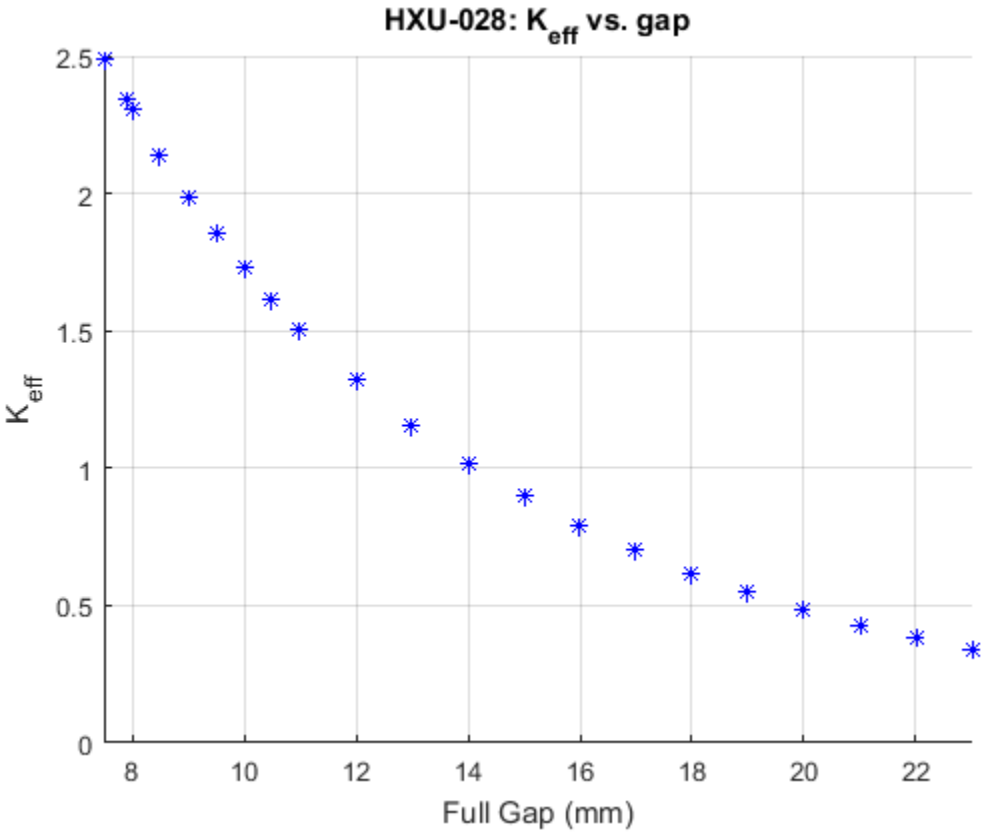
Undulator Load Cell Readings at Tuning Gap (Gap Opening)

LC_DAL_FORCE	-252.0
LC_DAU_FORCE	-223.9
LC_DWL_FORCE	-204.4
LC_DWU_FORCE	-330.3
LC_UAL_FORCE	-172.3
LC_UAU_FORCE	-328.4
LC_UWL_FORCE	-287.7
LC_UWU_FORCE	-158.9

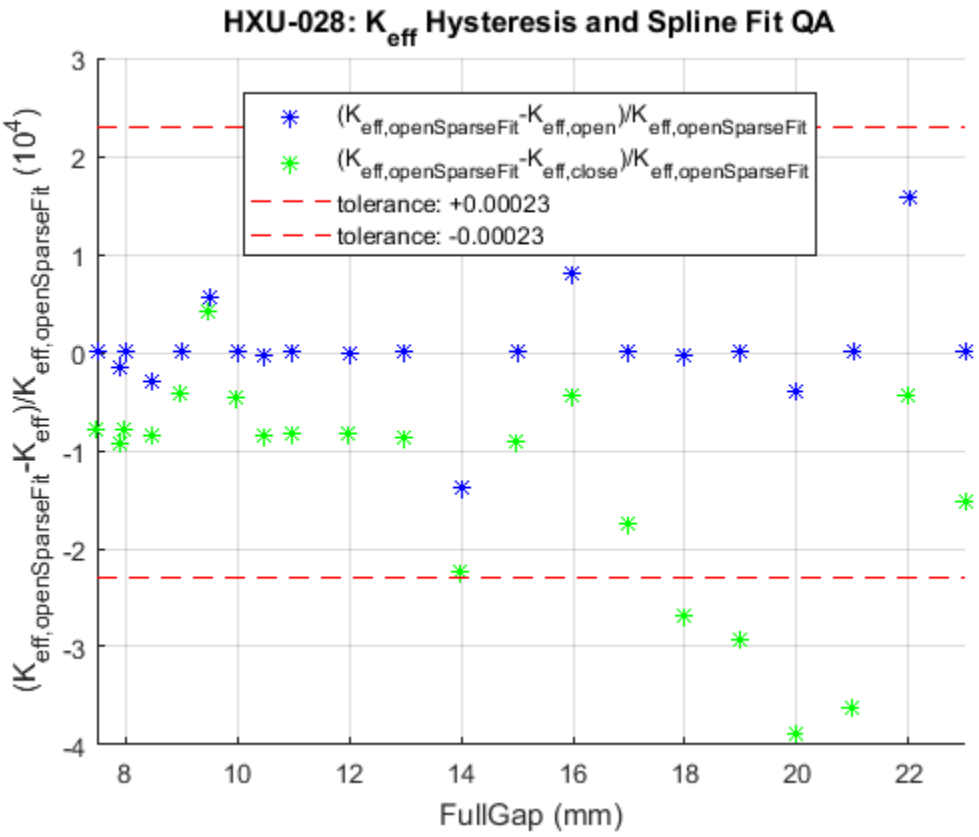
Undulator Load Cell Readings at 100 mm Gap (Gap Opening)

LC_DAL_FORCE	29.3
LC_DAU_FORCE	3.8
LC_DWL_FORCE	5.2
LC_DWU_FORCE	2.0
LC_UAL_FORCE	4.0
LC_UAU_FORCE	2.0
LC_UWL_FORCE	0.0
LC_UWU_FORCE	28.2

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



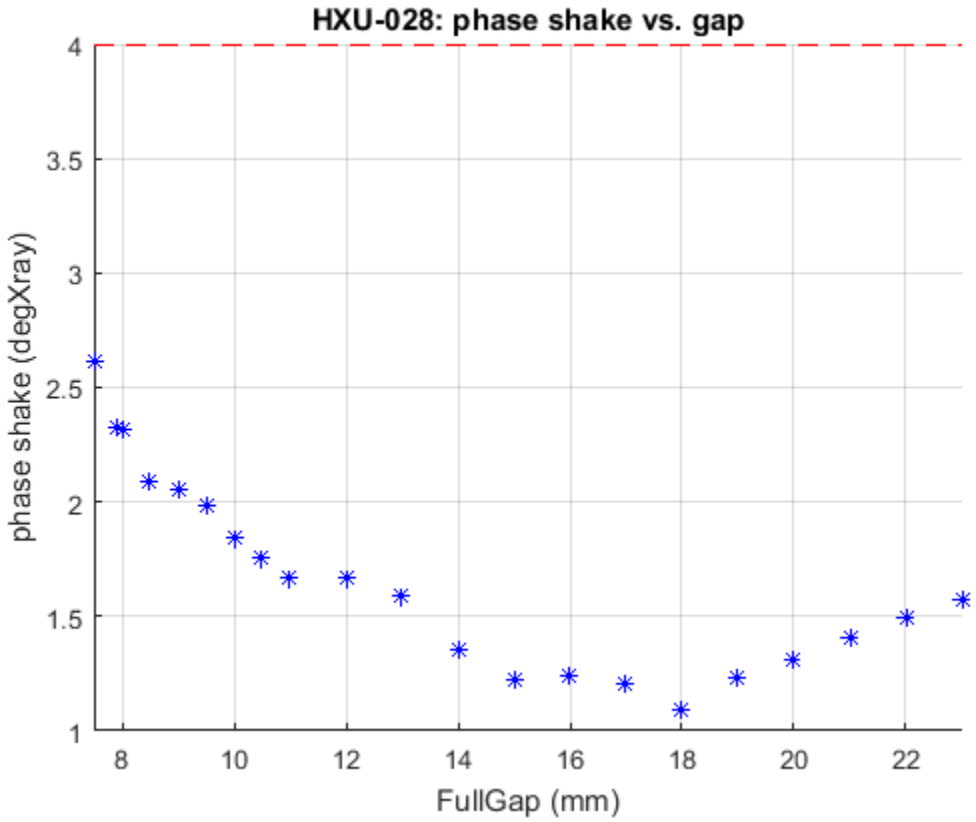
Evaluation of Hall Probe Scans: K_{eff} Hysteresis using Half Gap Encoders



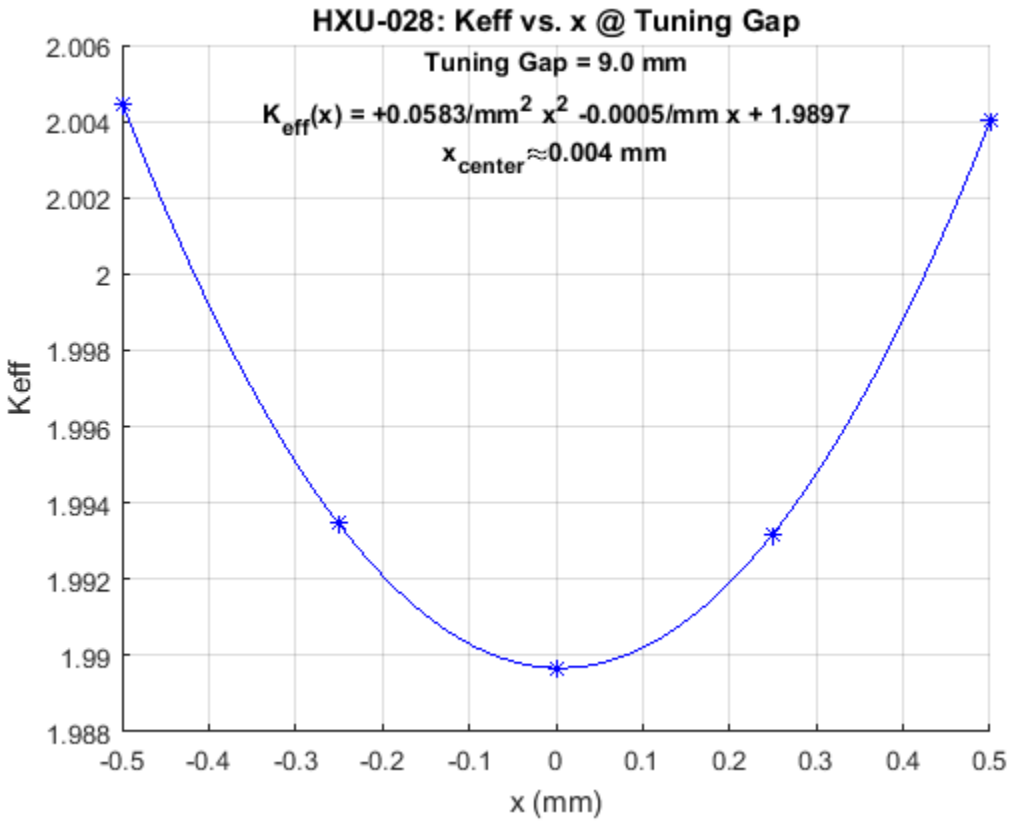
Plotted functions have been calculated from measured values openKeff (opengap) and closeKeff (closegap) using the following Matlab calculations:

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

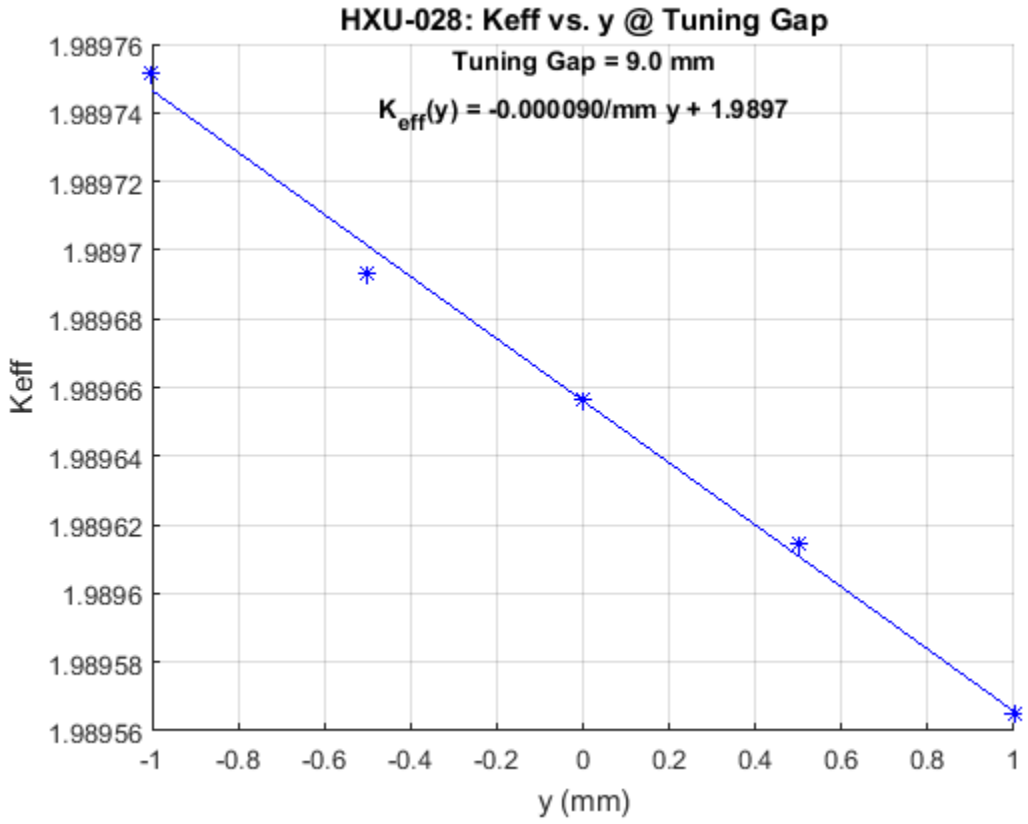
Evaluation of Hall Probe: Phase Shake vs. gap



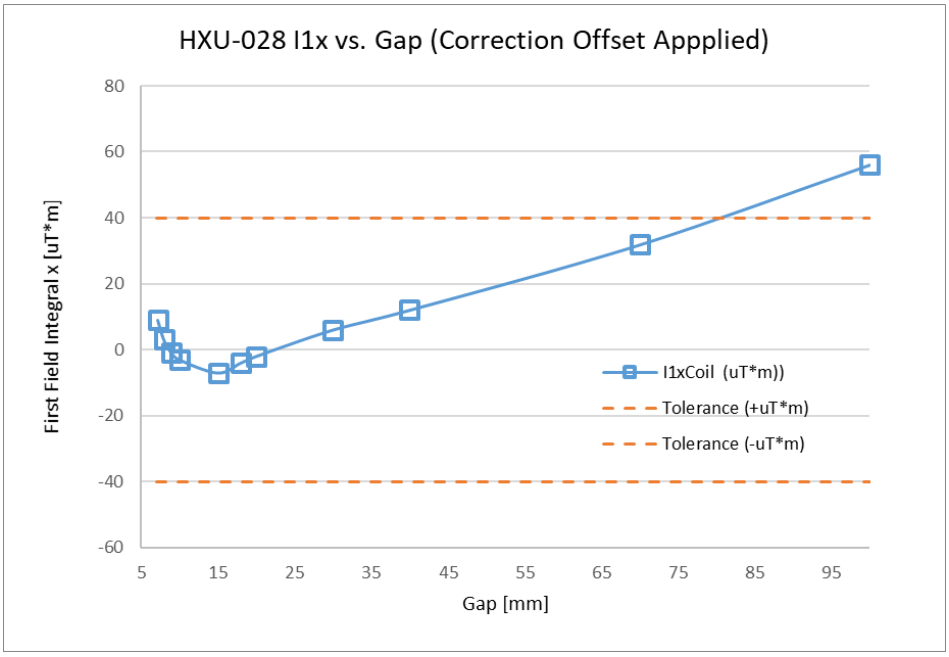
Evaluation of Hall Probe: K_{eff} vs x at Tuning Gap



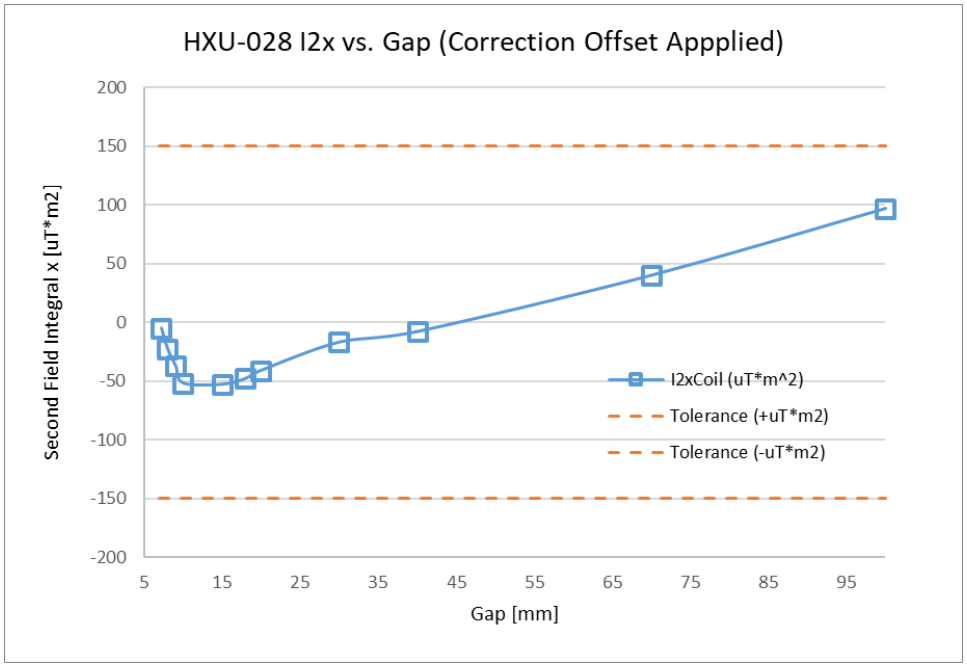
Evaluation of Hall Probe: K_{eff} vs y at Tuning Gap



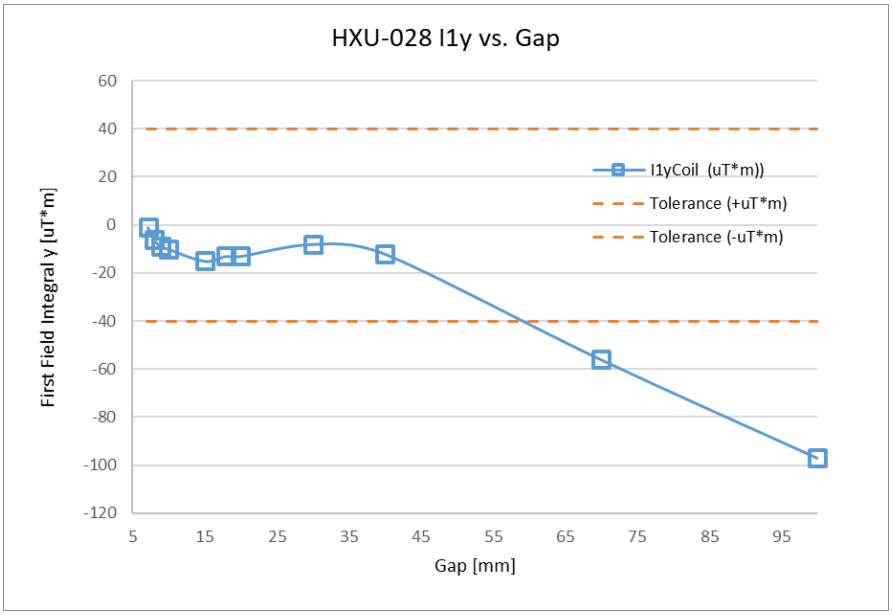
Long Coil Measurement of the On-Axis First Horizontal Field Integrals with +30 µT·m Integral Offset



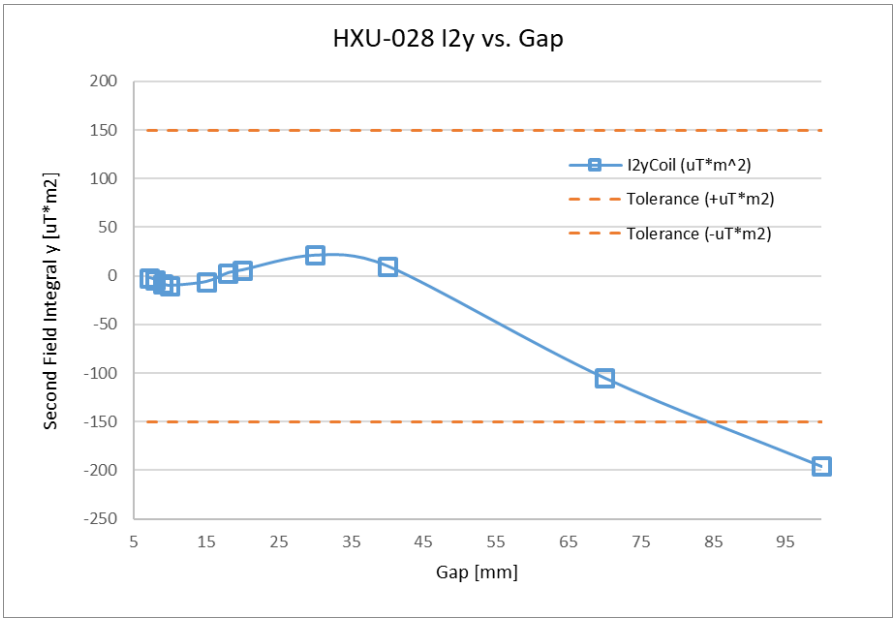
Long Coil Measurement of the On-Axis Second Horizontal Field Integrals with +30 µT·m x 0.5 x 4.012667 m Second Integral Offset



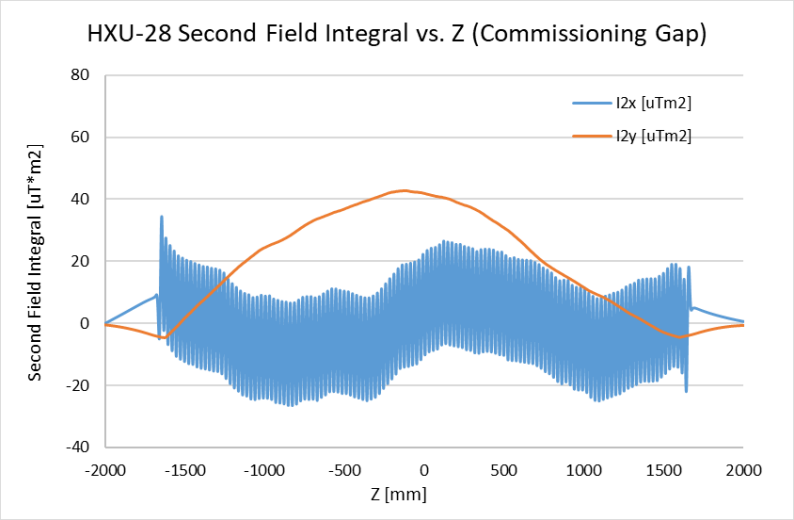
Long Coil Measurement of the On-Axis First Vertical Field Integrals



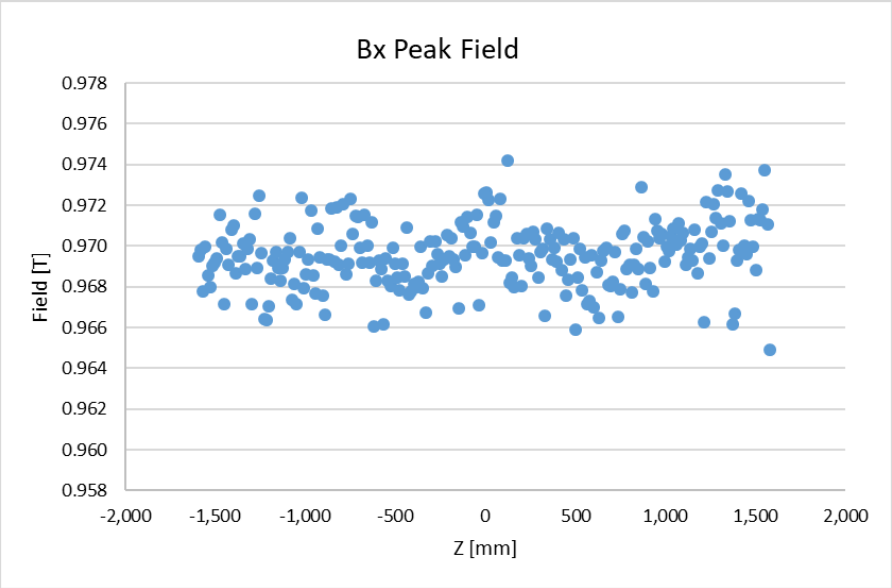
Long Coil Measurement of the On-Axis Second Vertical Field Integrals



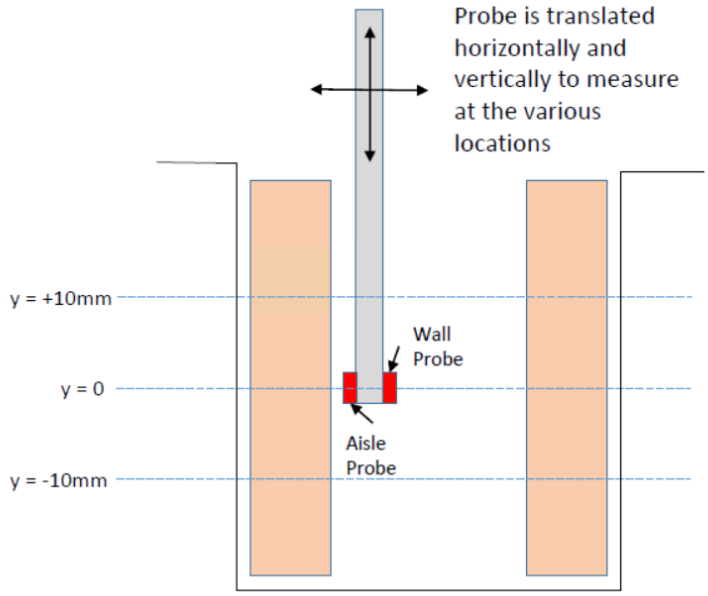
Second Horizontal and Vertical Field Integrals along Undulator Length at Commissioning Gap



Horizontal Peak Field along Undulator Length at Commissioning Gap

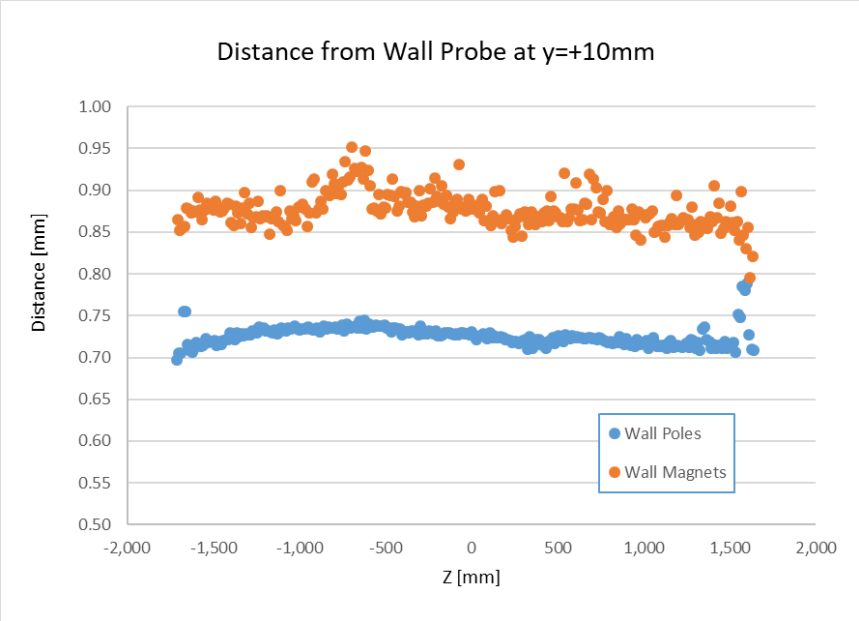


Capacitive Sensor Arrangement

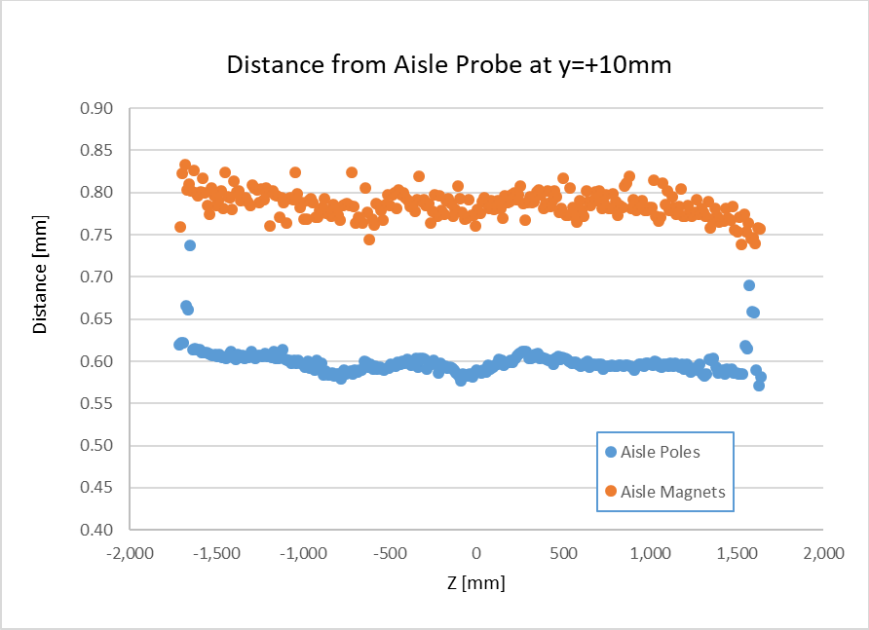


The following plots show the pole and magnet position measurements. The ANL system has two back-to-back capacitive probes on one probe holder. The x and y stages on the 6-meter bench are positioned so that the probe is in the proper location for each of the 9 scan locations. For the data analysis, the 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.

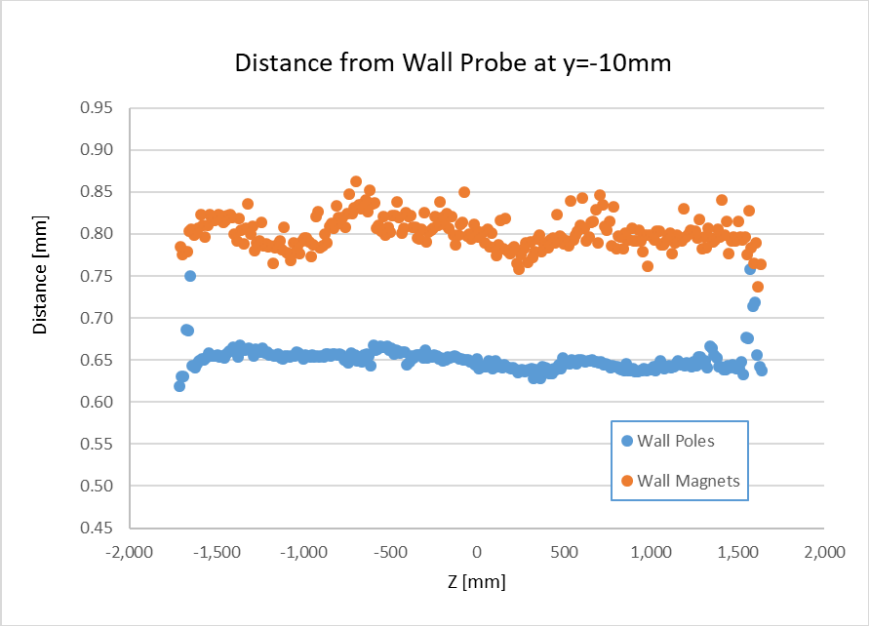
Aisle Capacitive Sensor Readings y = +10mm



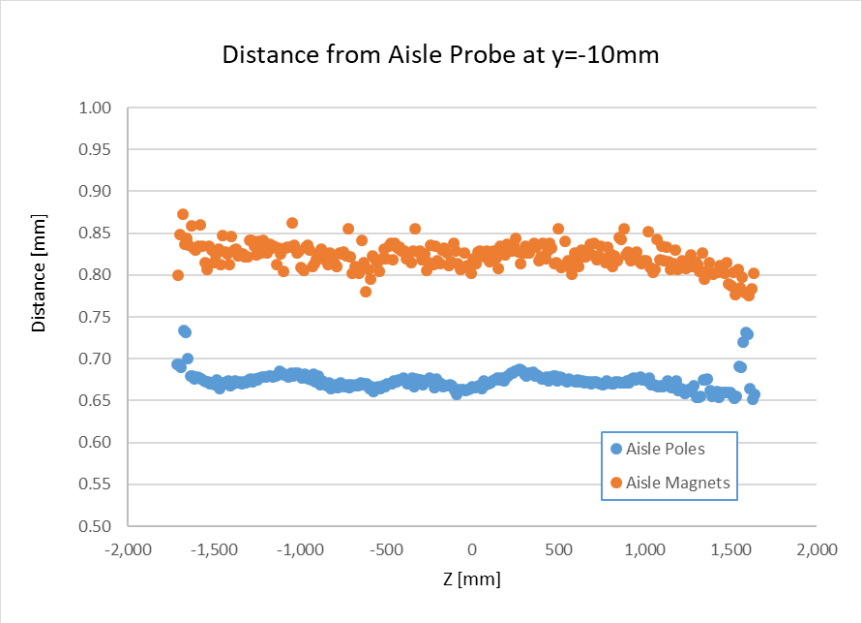
Wall Capacitive Sensor Readings y = +10mm



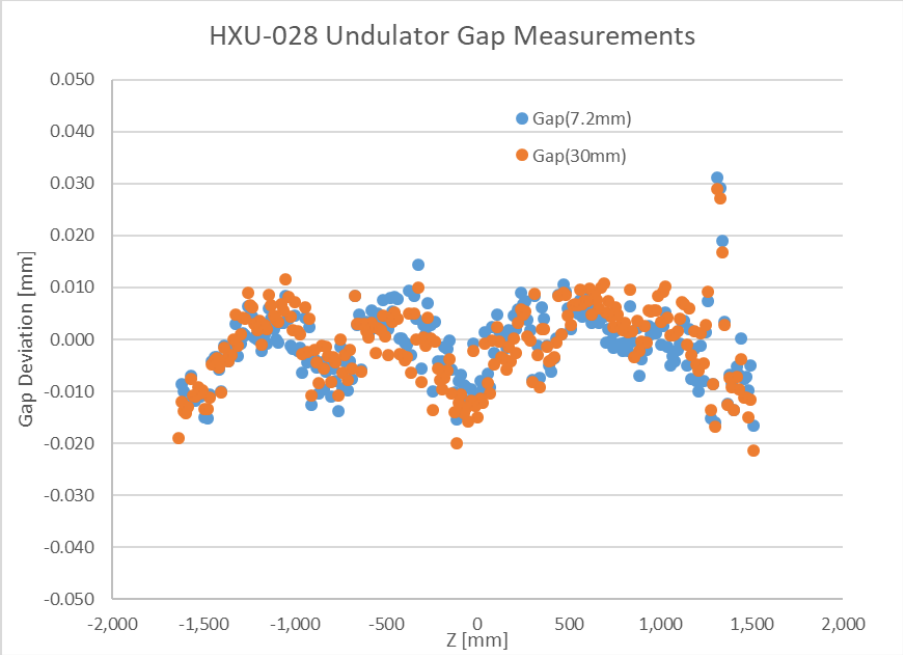
Aisle Capacitive Sensor Readings y = -10mm



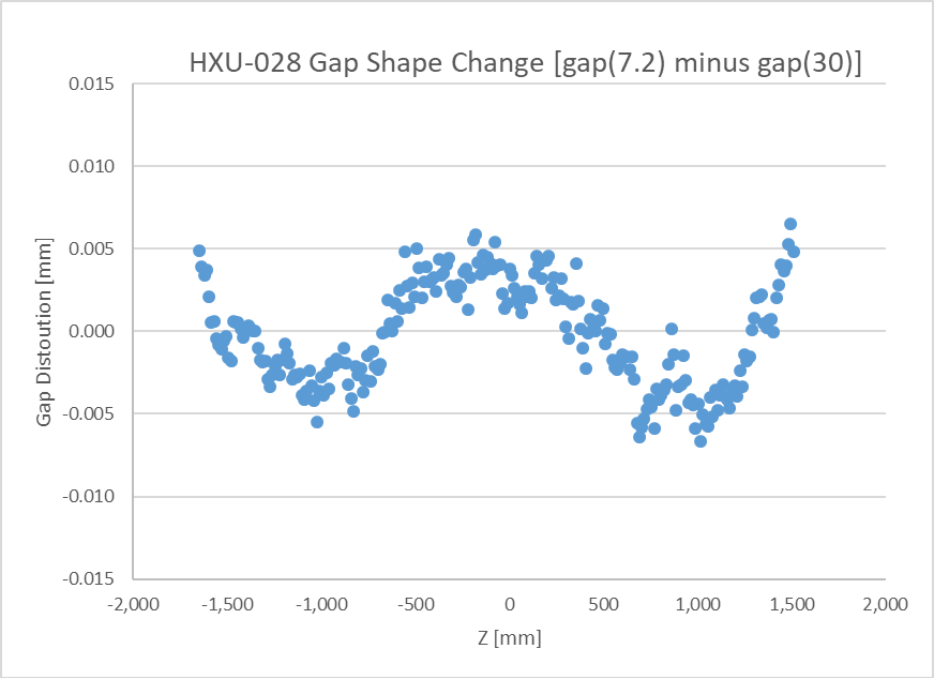
Wall Capacitive Sensor Readings y = -10mm



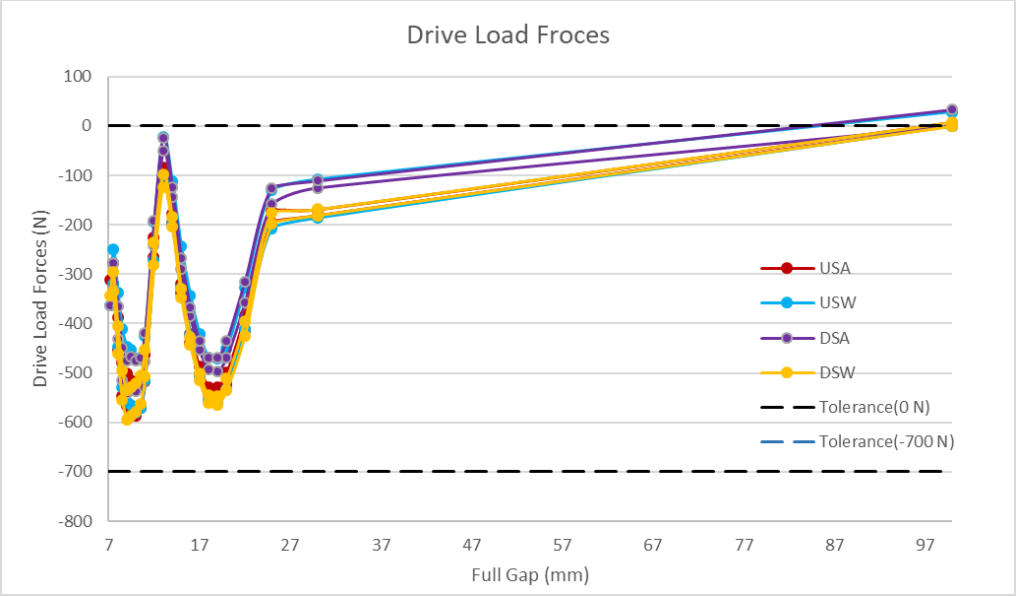
Undulator Gap Measurements



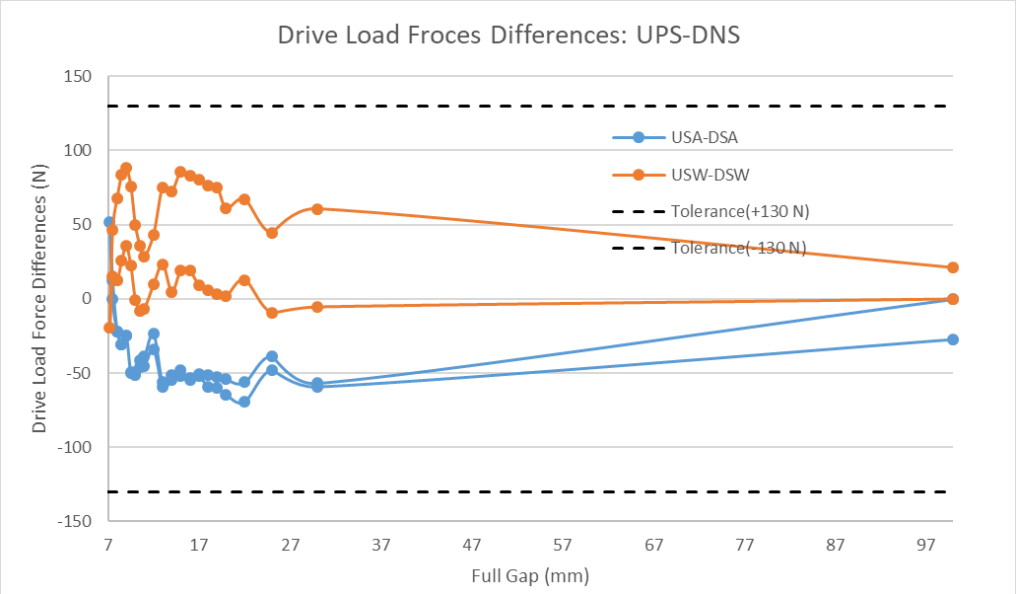
Undulator Gap Difference



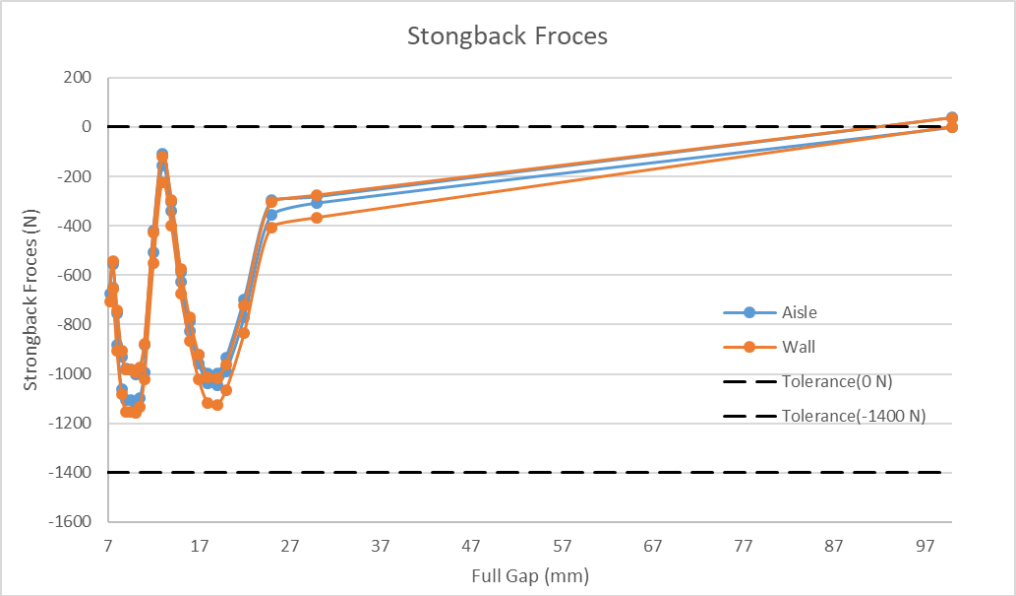
Drive Loads (Gap Opening)



Drive Load Differences (Gap Opening - Closing)



Strongback Forces (Gap Opening and Closing)



Strongback Force Differences (Gap Closing - Opening)