

	Plans and Procedures	
	Document Title: LCLS-II-HE SXR Phase Shifter Assembly Upgrade Procedure	
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Document Approval:

Originator: Gene Kraft, SXR Undulator Lead Engineer <div style="text-align: right;">  <small>E. M. Kraft (Aug 3, 2023 16:27 PDT)</small> </div>
<ul style="list-style-type: none"> • Content/Format • Content/ Format, Requirement ID's/Source ID's, Verification Planning, SME Input

Reviewer: Maria Alessandra Montironi, Motion Controls Engineer <div style="text-align: right;"><i>signature not required</i></div>
<ul style="list-style-type: none"> • Facts, Details, Concepts, Calculations, Analysis to meet Stakeholders, Policies, Standards, Best Practices, as appl

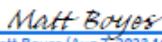
Reviewer: Daniel Bruch, SXR Undulator Control Account Manager <div style="text-align: right;"><i>signature not required</i></div>
<ul style="list-style-type: none"> • Complete/Accurate • SME Involvement • Actionable, as appl

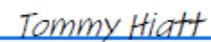
Reviewer: Xavi Permanyer, SXR Undulator Mechanical Design Engineer <div style="text-align: right;"><i>signature not required</i></div>
<ul style="list-style-type: none"> • Complete/Accurate, Actionable, as appl

Reviewer: Ian Evans, ES&H Manager <div style="text-align: right;"><i>signature not required</i></div>
<ul style="list-style-type: none"> • ES&H Content, as appl

Reviewer: Hong Bach – Quality Assurance Manager <div style="text-align: right;"><i>signature not required</i></div>
<ul style="list-style-type: none"> • General QA Provisions • Req's Validation/Verification

Reviewer: Arkadiy Klebaner– Project Chief Engineer <div style="text-align: right;"><i>signature not required</i></div>
<ul style="list-style-type: none"> • Scope Alignment, Stakeholder/ SME Engagement, as appl

Approver: Approver: Matt Boyes, Controls System Manager <div style="text-align: right;">  <small>Matt Boyes (Aug 7, 2023 16:43 PDT)</small> </div>
<ul style="list-style-type: none"> • Articulation, Meets Higher-Level Expectations, Stakeholder/SME Engagement, as appl

Approver: Approver: Tommy Hiatt, Interim Accelerator System Manager <div style="text-align: right;">  <small>Tommy Hiatt (Aug 5, 2023 08:43 PDT)</small> </div>
<ul style="list-style-type: none"> • Articulation, Meets Higher-Level Expectations, Stakeholder/SME Engagement

Revision History

Revision	Date Released	Description of Change
R1	8/3/2023	Added last section about reinstall Phase Shifter in the tunnel
R0	6/22/2022	Original Release.



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1 Purpose

The purpose of this document is outlining the plan to perform the upgrade of the LCLS-II SXR Phase Shifters for the LCLS-II High Energy (HE) project. The magnet arrays need to be upgraded to handle the new specifications for the new LCLS-II-HE project. See the Phase Shifter below in Figure 1.

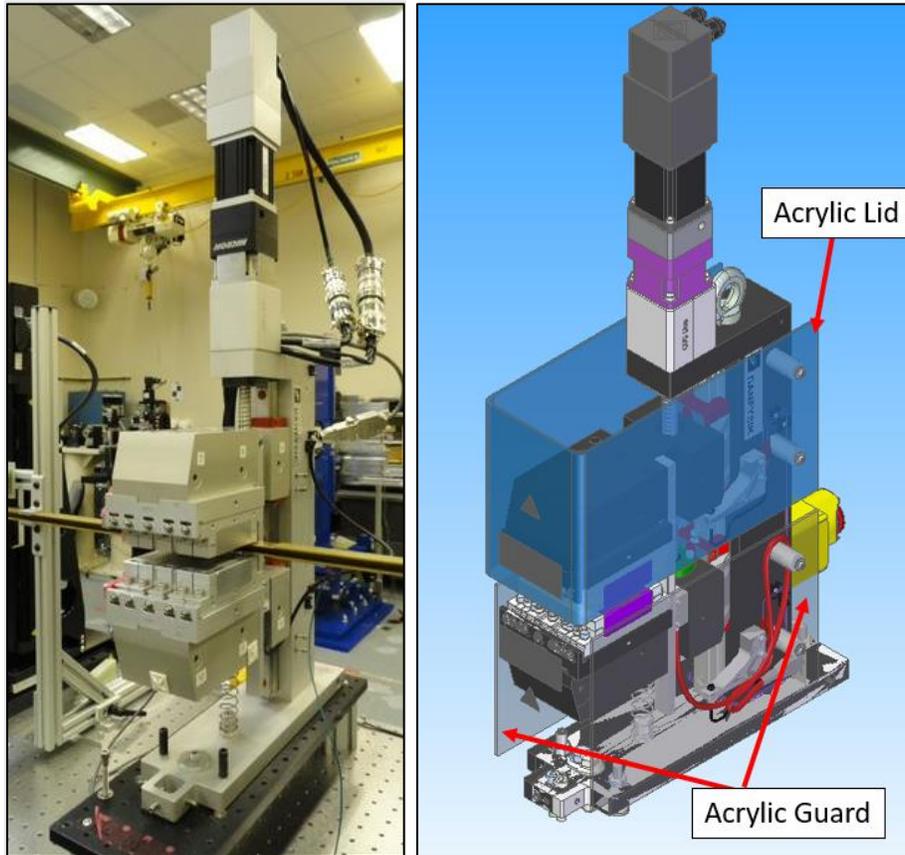


Figure 1: HE prototype Phase Shifter (left) and model of Phase Shifter (right)

2 Scope

The Phase Shifter will be removed from its location in the tunnel and crated, so it can be transported to Building 081. Once unloaded, the existing magnet array and baseplate will be removed and replaced by a new magnet arrays and base assembly. The Phase Shifter will be measured, tuned, and calibrated at SLAC MMF. Lastly, the Phase Shifter will then be transported to and reinstalled back in the tunnel.

3 Reference Documents

DSG-000017665	LCLS-II-HE PHASE SHIFTER
DSG-000018013	SXR MAG ARRAY (UPPER)
DSG-000017940	SXR MAG ARRAY (LOWER)
DSG-000018748	ACRYLIC GUARD

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DSG-000015312	ACRYLIC LID
DSG-000018793	BASE ASSEMBLY
*LCLSII-2.7-PP-0856	SXR Interspace Motion Controls Checkout Procedure
LCLS-TN-22-2	LCLS-II-HE Phase Shifter Test Plan
LCLSII-HE-1.3-PR-0049	LCLS-II-HE SXR Undulator System Physics Requirements Document
LCLSII-HE-FR-02511	LCLS-II-HE SXR Undulator Segment Functional Requirements Document
LCLSII-HE-1.3-ES-0244	LCLS-II-HE Undulator Phase Shifter Engineering Specification Document
LCLSII-HE-1.3-PP-0458	LCLS-II-HE Phase Shifter and Magnet Module Mechanical Checkout Procedure

*Using LCLSII document as a placeholder. New LCLSII-HE version will be primarily unchanged and released later.

4 Acronyms

ESH	Environmental Safety and Health Division
LCLS-II-HE	LCLS-II High Energy
IPA	Isopropyl Alcohol
LCLS	Linac Coherent Light Source
MFD	Mechanical Fabrication Department
MMF	Magnetic Measurement Facility
PPE	Personal Protection Equipment
RTD	Resistance Temperature Detector
SXR / SXU	Soft X-Ray Undulator

5 Key Personnel

Project Engineer	Understands the procedure and oversees removal, transport, and installation
Mechanical Engineer Support	Aids Project Engineer with their tasks as needed
Magnetic Measurements Physicist (at MMF)	Handles tuning, calibration, fiducialization of Phase Shifter
MFD Supervisor	Leads workers during removal and installation
Motion Controls Engineer	Operate phase shifter gap as needed for removal, installation, and upgrade. Connect and disconnect all motion controls cables and connectors.

6 PPE requirements

All personnel participating in Phase Shifter removal/installation and transport must wear the following:

- Safety glasses

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- Steel-toed boots
- Gloves
- Face covering per SLAC COVID-19 requirements (if applicable)

Personnel should also carry a light in case of power loss while working in the tunnel.

7 Tools and equipment

The following are utilized for Phase Shifter removal/installation and transport. Small tools shall be kept in a dedicated toolbox.

 	<p>WARNING: When working near permanent magnets, all personnel need to have non-magnetic tools and be aware of other magnetic objects they may have on their person (i.e., badge clip, pen, rulers etc.).</p>
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- Camera(s)
- Scissor lift cart
- Set of hand tools to include:
 - Socket wrenches for mounting hardware
 - Sets of hex wrenches (metric and inch)
 - Large crescent wrenches
- Clean as you go materials: Disinfectant spray or wipes (e.g., Lysol, Clorox, >70% IPA, or ESH Approved Cleaner and paper towels)

8 Preparation/Prerequisite Actions

A visual inspection and checkout must be done on the magnet module assemblies upon arrival to Shipping and Receiving. Confirm that an inspection has been done per LCLSII-HE-1.3-PP-0458 – Phase Shifter and Magnet Module Mechanical Checkout Procedure.

9 Procedure

9.1 Remove Phase Shifter from Tunnel

	<p>HOLD: The following steps will be carried out by Motion Controls team.</p>
-------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------

- Open the gap to 100mm for transportation.
- Make sure the Phase Shifter controls are switched off. Disconnect all electrical cables (such as the control cables and limit switch cables) and disconnect RTDs.



HOLD: The following steps will be carried out by MFD. Take extra caution when handling the Phase Shifter, so it does not fall over.

- Visually inspect the Phase Shifter for any damages and readiness for removal. Remove acrylic gap shields from the Phase Shifter. Keep close by – they will be added back on shortly.
- Unscrew and remove all screws/bolts securing the Phase Shifter baseplate onto the beamline.

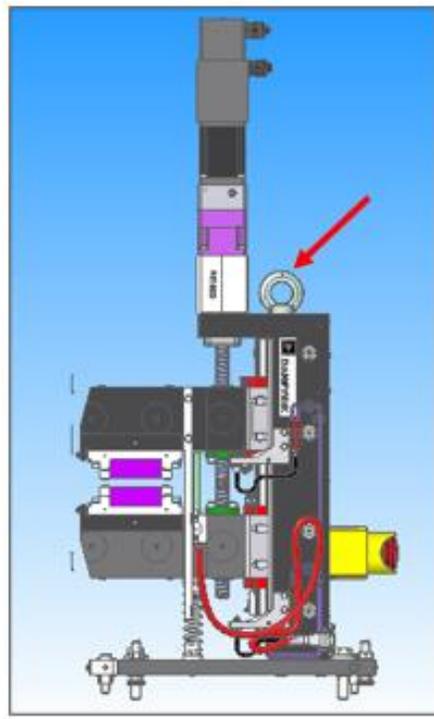


Figure 2: Eyebolt used for lifting Phase Shifter (acrylic covers not shown)

- Carefully slide the phase shifter out of position. Take caution to not disturb the vacuum chamber. Watch out the cooling connection of the vacuum chamber.
- Once clear of the vacuum chamber, remount the acrylic gap shields for protection during transport.
- Crate the Phase Shifter and move out of the tunnel using the exit designated by the engineering lead.



HOLD: Once outside, MFD or MMF personnel will transport the Phase Shifter to Building 81 and unload at the location designated by the engineering lead.

9.2 Dismount Existing Magnet Array Cassettes



HOLD: The following steps will be carried out by Motion Controls team.

- Confirm the gap is set to approximately 100mm (must be greater than 60mm).
- Check that drive assembly controller is powered off. Disconnect the controller from the Phase Shifter.



HOLD: The following steps will be carried out by Metrology.

- Remove the acrylic gap covers and acrylic cover supports.
- Place a non-magnetic block between the 2 arrays. Fix it to the lower jaw by a screw.
 - NOTE: A foam fixture tool is being developed to be specifically used for this step as the non-magnetic material (see below).

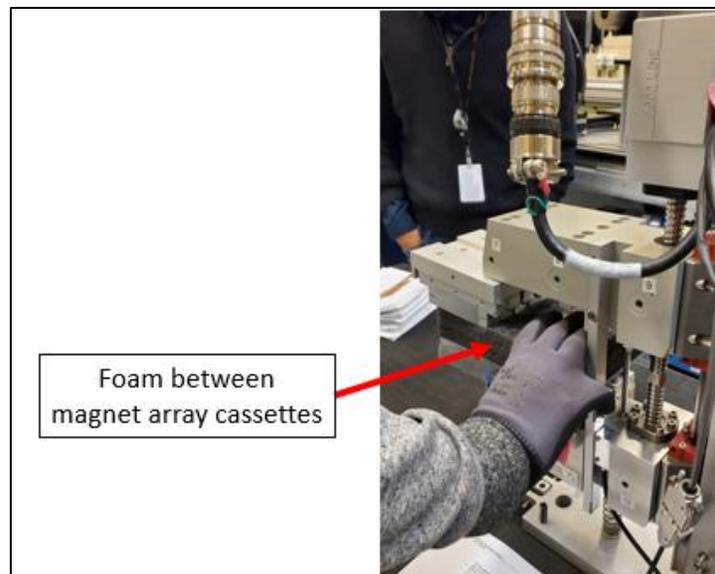


Figure 3: Place foam (or other non-magnetic material) between the magnet array cassettes

- Execute the following steps for both cassettes, starting with the top cassette. Note, remove the non-magnetic block **after** the top cassette has been removed and **before** removing the bottom cassette.
 - Remove the six M6x40 screws.
 - Remove the magnet array cassette.
 - Wrap the cassette in bubble wrap and place in its Styrofoam container. Then, tape the container shut and record Phase Shifter serial number and position (top or bottom cassette) on the container.

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- Store in storage crate.
- Secure phase shifter on its side and remove existing baseplate and replace with baseplate of new design.

9.3 Mount Upgraded Magnet Array Cassettes


HOLD: The following steps will be carried out by Metrology.

- Execute the following steps for both magnet array cassettes starting with the bottom cassette. Note, place the non-magnetic block on the cassette and secure it with a screw **after** mounting the bottom cassette and **before** mounting the top cassette.
 - Check brass shims underneath the keepers and check that they do not stick out from the keeper's edge by greater 4 mm (see Figure 4 and Figure 5).
 - Refer to the image below. Press the cassette on the side indicated by "Ref." (i.e., **towards left** of the page with the arrow) and against the tower (**into the page**). Meanwhile, hand-tighten the six M6x40 screws from top or underneath the cassette. See Figure 6 and Figure 7.
 - Use the plastic shim tool to insert shim on the side indicated in the image below; this fills the gap and sets the cassette into proper position. Torque the screws to 8 Nm. See Figure 8 and Figure 9.
- Remove non-magnetic block from between the cassettes.

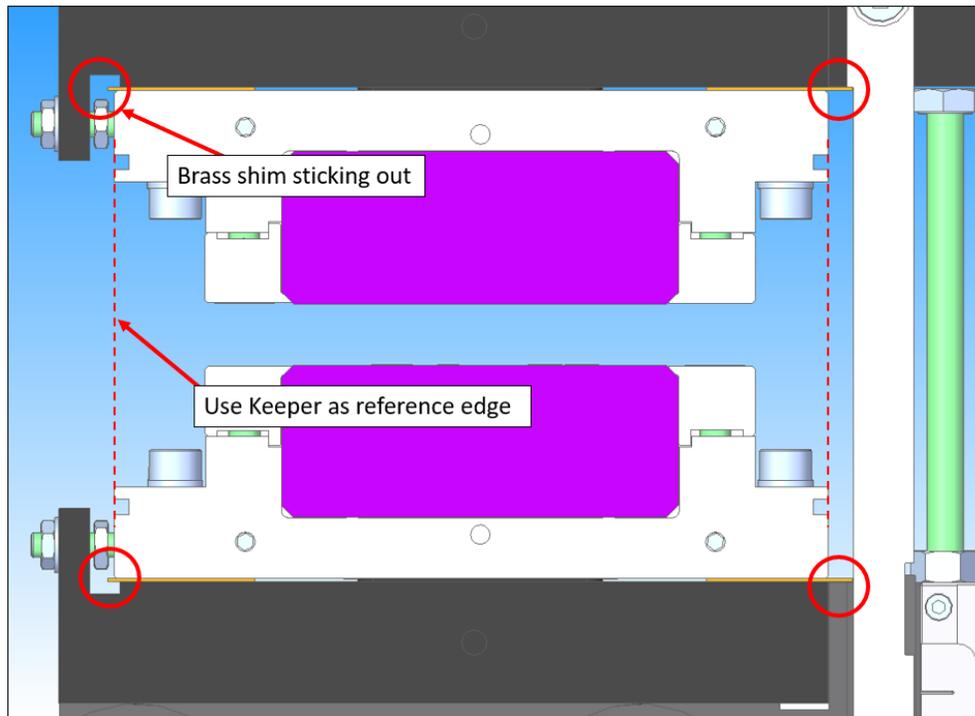


Figure 4: Brass shim sticking out relative to Keeper (z-axis view); length must stick out < 4mm

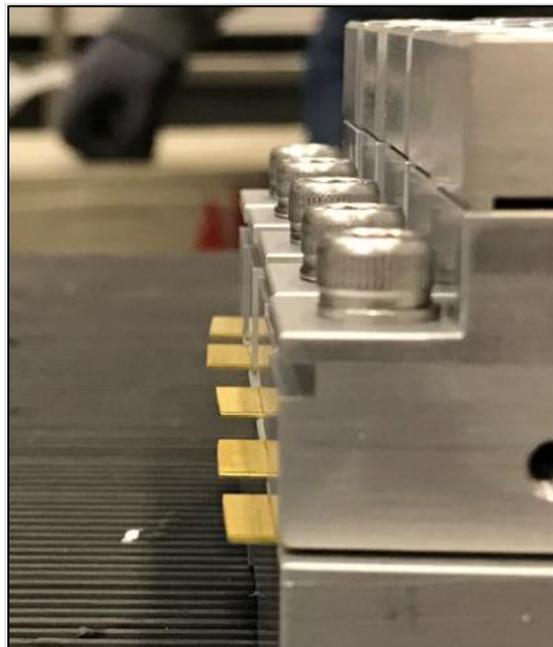


Figure 5: Brass shims underneath keepers; must be < 4 mm of sticking out

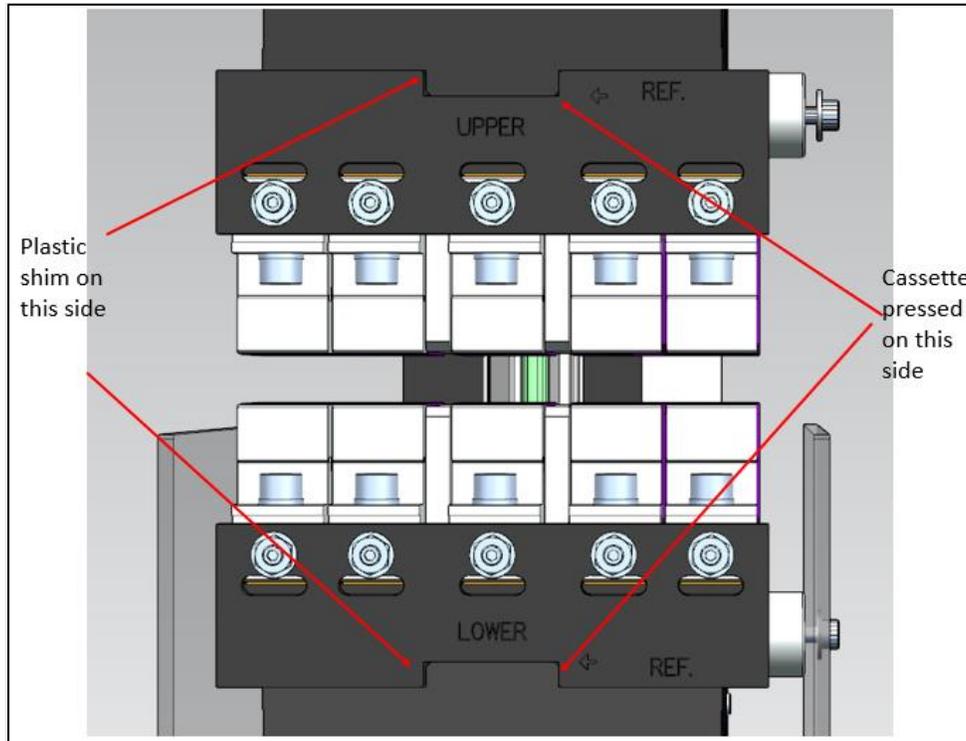


Figure 6: Direction to press/push cassette for mounting (front view)

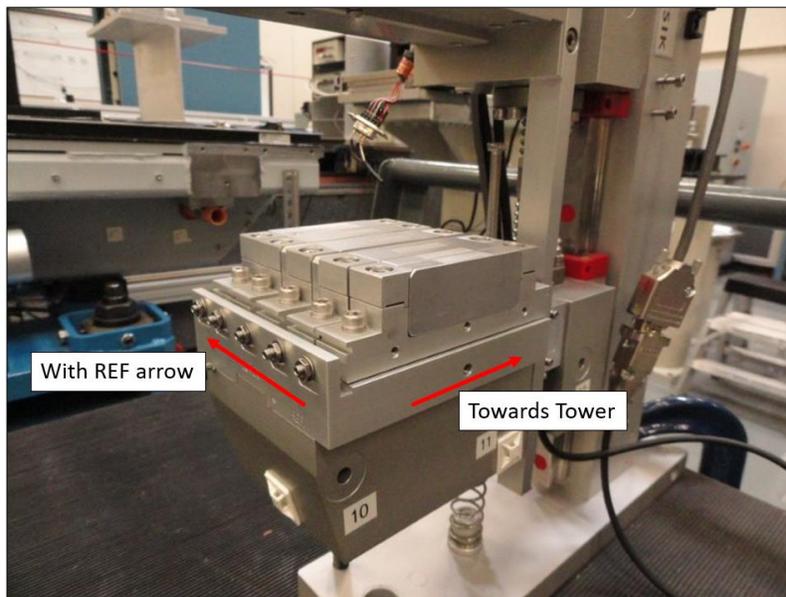


Figure 7: Direction to press/push cassette (different view)

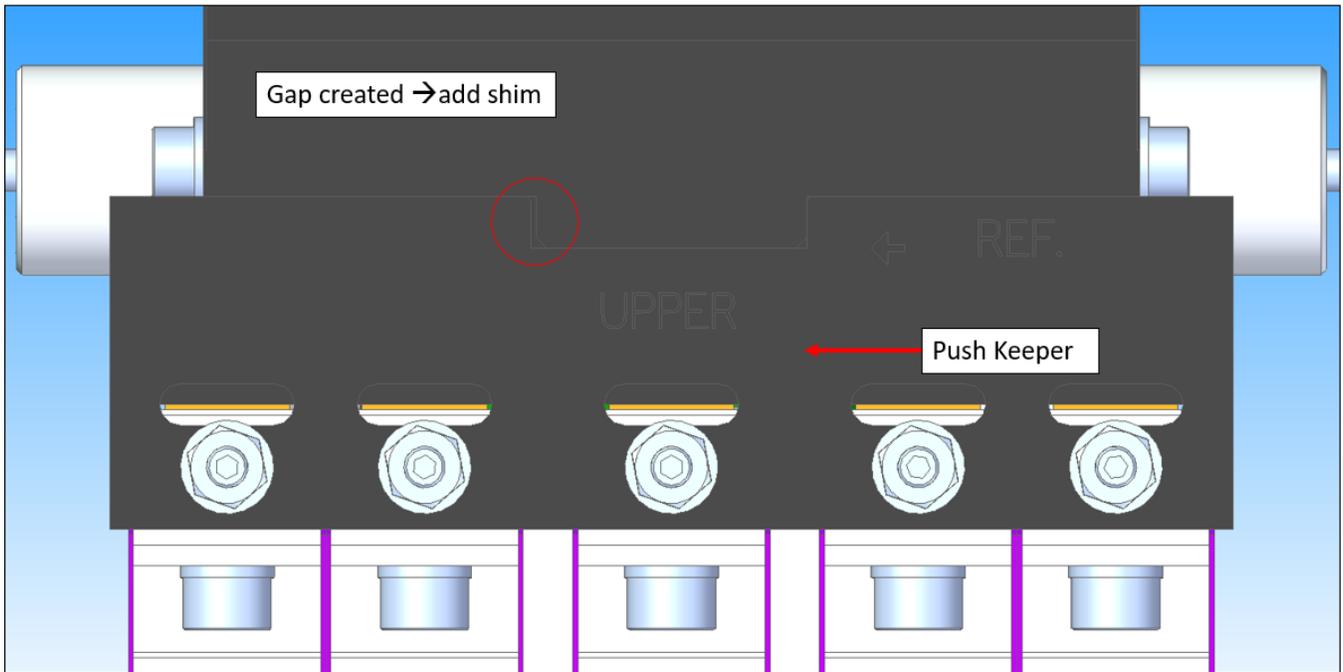


Figure 8: Pushing Keeper in same direction as Ref creates gap, which is filled in with shim

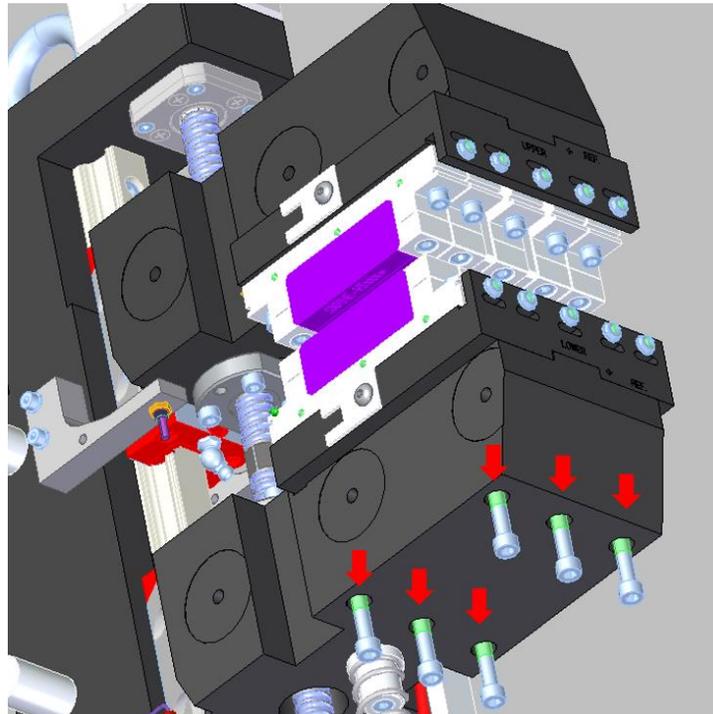


Figure 9: Six M6x40 screws - tighten with 8 Nm torque



HOLD: Hand over to Motion Controls to perform the following step(s).



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- Perform incoming device checkout of the Phase Shifter. See SXR Interspace Motion Controls Checkout Procedure (LCLSII-2.7-PP-0856).



HOLD: Hand over back to Metrology to perform the following step(s).

- Perform tuning, calibration, and fiducialization for the Phase Shifter. See LCLS-II-HE Phase Shifter Test Plan (LCLS-TN-22-2).



HOLD: Hand over to Motion Controls to perform the following step(s).

- Perform RFI motion control checkout of the Phase Shifter. See SXR Interspace Motion Controls Checkout Procedure (LCLSII-2.7-PP-0856).



HOLD: Hand over to Metrology to perform the following step(s).

- Confirm the gap is set to 100mm for transport. If the gap is not opened to the correct setting, notify Motion Controls to set the gap to 100mm.
- Perform final tuning step. See LCLS-II-HE Phase Shifter Test Plan (LCLS-TN-22-2).
- Mount the newly designed acrylic covers and supports for the acrylic covers (i.e., **NOT** the ones that were previously). See part numbers below.
 - Acrylic Lid (QTY. 1): DSG-000018748
 - Acrylic Guard (QTY. 2): DSG-000015312
 - Supports (QTY 8): DSG-000018338

9.4 Transport and Reinstallation on SXR Undulator Beamline



HOLD: The following steps will be carried out by MFD. Take extra caution when handling the Phase Shifter, so it does not fall over.

- Transport the newly rebuilt Phase Shifter back to the Undulator Hall at the designated SXU Cell Location, onto the interspace assembly.
- Visually inspect the Phase Shifter for any damage and readiness for reinstall.
- Confirm that the jaws are fully opened at 100 mm, and temporarily remove acrylic gap shields.
- Reinstall Phase Shifter in Tunnel onto the designated SXR Undulator Interspace. NOTE: Be sure to carefully slide the phase shifter into position and watch out with the cooling connections of the vacuum chamber.



- First place the adjustment post, with alignment set screws on the aisle side (red arrows); then place the adjustment post and alignment set screws on the wall side (green arrows). Lastly, tighten the two lockdown screws (blue arrows). See Figure 10.
- Reset the acrylic gap shields once the Phase Shifter is remounted to the interspace.
- Align the phase shifter per the PRD, SLAC Document LCLSII-HE-1.3-PR-0049.

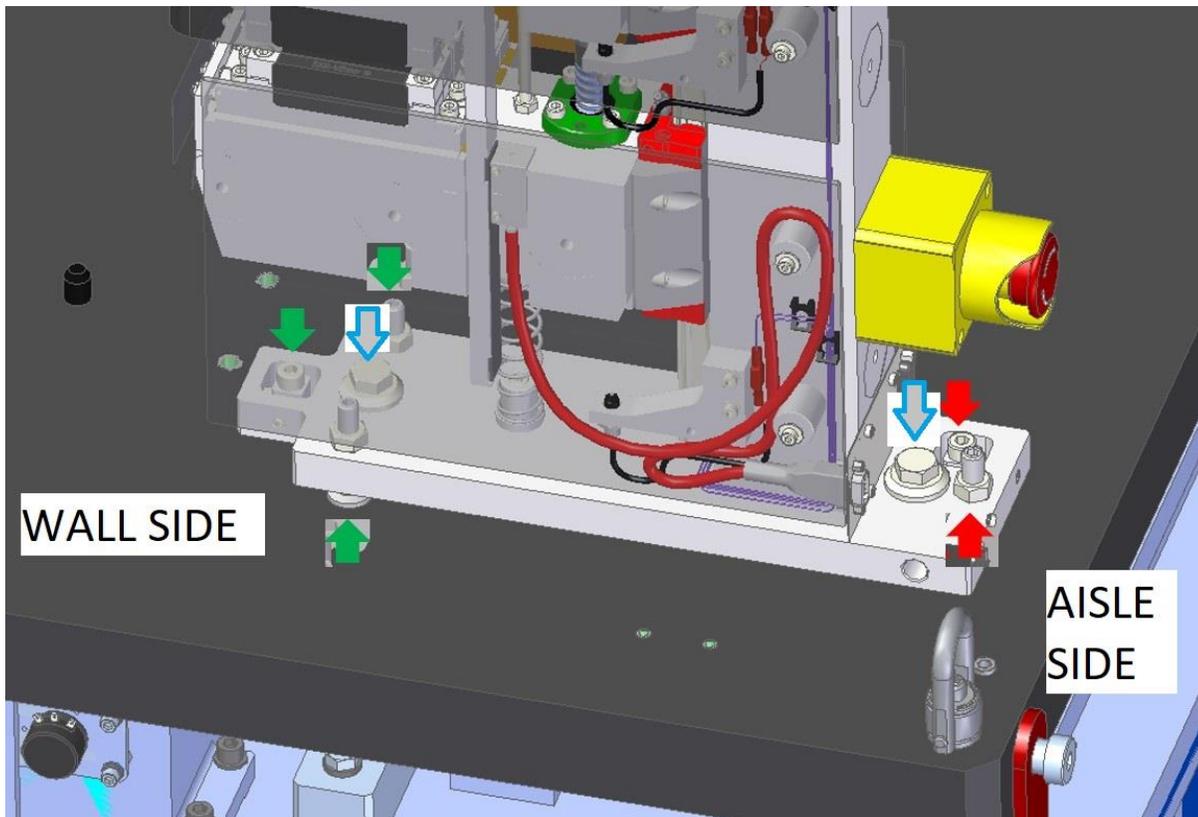


Figure 10: Interspace mounting screws - tighten to 8 Nm torque



HOLD: The following steps will be carried out by the Motion Controls team.

- Reconnect all electrical cables (such as the control cables and limit switch cables) and reconnect RTDs. Make sure the Phase Shifter controls are switched on.

Visually inspect the Phase Shifter for any damage and readiness for operation.

10 LCLSII-HE-1.3-PP-0527 Traveler Checklist

(Use with LCLS-II-HE Phase Shifter Magnet Array Rebuild Assembly Procedure)



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Traveler Checklist – (LCLSII-HE-1.3-PP-0527)

	Initials / Date	Pass / Fail	Confirm: Initials / Date
1. Prep Prior to Install: Roles identified, and qualifications verified. Install Coordinator: _____ Mechanical Lead: _____ Safety: _____	Install Coordinator		
2. Prep Prior to Starting Job: Preparing and Staging <ul style="list-style-type: none"> Contact all groups involved in work and assign responsibilities Prepare all machinery, equipment, and tools 	Mechanical Lead		
3. Procedure Step: Remove Phase Shifter from Tunnel <ul style="list-style-type: none"> Open gap to 100mm for removal and transportation of Phase Shifter Confirm acrylic shields present and electrical cables disconnected Remove acrylic gap shields Unscrew bolts and remove phase shifter from beamline using overhead crane Once clear of vacuum chamber, remount acrylic gap shields Crate the device and load onto truck for delivery to B081 Unload device at B081 	Mechanical Lead		
4. Procedure Step: Dismount Existing Magnet Array Cassette <ul style="list-style-type: none"> Confirm gap is open to 100mm Confirm rive assembly controller is powered off – then, disconnect the controller Remove acrylic covers and supports Place non-magnetic block between the arrays and fix to lower jaw Dismount top cassette by removing M6 screws & store the cassette Remove non-magnetic block Dismount bottom cassette by removing M6 screws and store the cassette Replace existing baseplate with new baseplate 	Mechanical Lead		
5. Procedure Step: Mount Upgraded Magnet Array Cassette <ul style="list-style-type: none"> Inspect brass shims Mount bottom cassette and insert plastic shim Insert non-magnetic block on top of cassette Mount top cassette and insert plastic shim Remove non-magnetic cover Perform incoming device checkout and tuning Perform RFI checkout Confirm gap is opened to 100mm; if not, inform Motion Controls Perform final tuning and install new acrylic covers and supports for acrylic covers 	Mechanical Lead		
6. Procedure Step: Return Phase Shifter to Tunnel <ul style="list-style-type: none"> Crate the device and load onto truck for delivery to UH Unload device at UH 	Mechanical Lead		



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Traveler Checklist – (LCLSII-HE-1.3-PP-0527)

**Initials /
Date**

Pass / Fail

**Confirm:
Initials / Date**

- Remove acrylic gap shields
- Once clear of vacuum chamber, remount acrylic gap shields
- Place screw bolts and reinsert phase shifter onto beamline using scissor lift
- Alignment checks.
- Confirm acrylic shields present and electrical cables reconnected
- Notify and transfer to the Controls Department for operational checkout

Notes or Findings:

Final Review: Signature – LCLS-II-HE Representative

Date

Pass / Fail

Traveler archived to SharePoint or Teamcenter.		