
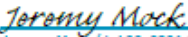

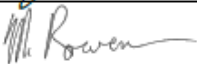
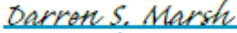


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**Revision History**

Revision	Date Released	Description of Change
R1	7/26/2021	Changed disconnect point for target functionality. Added points to best practices. Added a check with vacuum team if unsure if vacuum is present.
R0	6/30/2021	Original Release.

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## 1. General

The LCLS-II project at SLAC is a free-electron laser source based on the successfully operating LCLS at SLAC. The LCLS-II Accelerator System contains a 4 GeV CW superconducting linear accelerator in the first kilometer of the SLAC linear accelerator tunnel. It consists of 35 1.3 GHz cryomodules. Additionally, two 3.9 GHz cryogenic accelerating structures are used to introduce a linear energy spread vs bunch length to prepare the electron beam for the first magnetic bunch compressor.

Due to the delicate nature of the cryomodules, and the high cost and effort to make the cryomodule ready and install in its position, the activity associated with making all connections to the beamline and testing must be very carefully executed according to a strict procedure in order to maintain the particle free environment.

## 2. Purpose

This is a checkout procedure for a profile monitor beamline device. Each profile monitor consists of a screen, optical filters, illuminators, limit switches, and a camera system. The electrical power and controls are provided by the chassis in the rack. The camera sends data via the CameraLink protocol over a fiber optic connection to a frame grabber on the host industrial PC (IPC).

This procedure will provide steps to ensure that the beamline device is functional. It assumes the equipment within the rack is already checked out per the LCLS-II Profile Monitor Rack Equipment Checkout procedure (LCLSII-2.7-PP-1856-R0).

Some of the profile monitor locations will require crossing the safety line around the cryomodules, this requires extra safety guidelines to be upheld during checkout.



**Warning:** If at any time there is a deviation from this procedure, work shall stop. Notify supervisor and subsystem lead for replanning.


## 3. References

Associated Document(s) Reference Number	Document Title
LCLSII-2.4-PR-0169-R0	Injector/Linac Profile Monitor System Requirements
LCLSII-2.7-PP-0948-R0	Profile Monitor Acceptance Test Procedure
LCLSII-2.7-FR-0677-R2	LCLS-II Profile Monitor Controls Functional Requirements Specification
LCLSII-2.7-ES-0625-R0	LCLS-II Profile monitor Engineering Specifications
LCLSII-2.7-IC-0266-R1	Electron Beam Controls to Accelerator Systems, Cryogenic Systems, Photon Systems, and Infrastructure Systems
LCLSII-2.7-PP-1856-R0	LCLS-II Profile Monitor Rack Equipment checkout procedure.

## 4. Roles and Responsibilities

Only the personnel listed in the table below are authorized to perform the work in this procedure.

Jeremy Mock	AD EED Profile Monitor Controls Lead
Courtney Curtis	AD EED Profile Monitor Controls Engineer

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## 5. Safety Guidelines

All SLAC Safety requirements shall be followed. Work should be released by the Area Manager. The proper rack power on procedure shall be followed prior to execution of this procedure. Most profile monitors use pneumatics to move the target into and out of the beamline. As such, during certain tests puffs of air being released by the valves will be audible near the DUT and can constitute a startle hazard. The movement of the pneumatics, along with other limit switch actuations internally in the optics box portion of the profile monitor, are pinch hazard areas, use caution when hand testing or use of tools, such as a screwdriver, instead if possible. All voltages provided from the chassis to the DUT are DC < 24V. Tester shall stop work if any conditions arise that lead to unsafe working conditions.

5.1 All personnel working on the Profile Monitor system shall have completed the following trainings:

- Control of Hazardous Energy, SLAC course # 157 or Control of Hazardous Energy (COHE) Refresher, SLAC course # 157R
- Control of Hazardous Energy (COHE) Practical, SLAC course #157PRA
- Personnel have the LCLSII Cryomodule training AD214 (Yellow Vest)
- Personnel have the proper orientation for working on the Cryomodule (Orange Vest)


## 6. Best Practices

The Profile Monitor system directly attaches to the Beamline. Efforts and awareness need to be maintained in order to minimize potential impacts or shocks to the system. Be aware of tools/parts/materials that could fall into or onto the Beamline in order to not cause potential damage.

The Profile Monitor system is also in a particle free work zone. This requires the alternative or postponed steps, such as the limits in the target and camera checkout sections to only require one movement cycle, in order to limit the number of particles that could be introduced into the Beamline Vacuum. To help mitigate the risk, beamline vacuum valves upstream and downstream of the Profile Monitor system must be remained closed during the checkout procedure and testing should not proceed if the valves are not sealed. These valves will be at the start and end of each cryomodule sections. Other things to be aware of during the testing process is concrete, cutting, or drilling activities due to the possibility of particle contamination but is unlikely due to earlier testing.

Though the Profile Monitor system is not above the Cryomodules, but they are in warm beamline sections so proper procedures need to be followed. Cryomodules components are sensitive to shock. All efforts to minimize impacts or shocks should be exercised, awareness of proximity to the Cryomodules regarding one's self and tools is required. Team members should limit the exposure of damaging the cryomodule while working near the cryomodules.

- Only use small tools.
- A wrist tool lanyard should be attached to tools used in the warm beamline sections if possible.
- Use a step stool less than 11" or a step block near the North wall, if required.
- Do not apply anything magnetic to the cryomodule, such as magnetic flashlight or magnetic meter hanger.
- Use tools, such as a screwdriver, when actuating limit switches whenever possible to mitigate pinch hazards.
- Do not cross red checked tape on the floor if you do not have an orange vest and are not performing the checkout.

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- If ladder is required, carry horizontally with two people to mitigate risk to cryomodules.

## 7. Tools

The following tools will be required:

1. Screwdriver, depending on screws could be flathead or Philips
2. Hex wrench both metric and imperial
3. Digital Multi-Meter

## 8. Acronyms

IOC	Profile Monitor EPICS software process, Input-Output Controller
DUT	Device Under Test

## 9. Preparation / Prerequisite Actions

9.1 The checkout process described in Profile Monitor Device Checkout Procedure will be followed.

9.2 Office Preparation / Prerequisite Actions

1. Ensure configuration of IOC listed above following steps outlined here:  
<https://confluence.slac.stanford.edu/display/LCLSControl/LinuxRT+Boot+--+Quick+Start-up>
2. Add IOC to screeniocs file located at /usr/local/lcls/epics/iocCommon/All/Prod/screeniocs
3. Add IOC to IOCManager EPICS application, AlarmConfigs-ntwk, and appropriate control screens

9.3 Field Preparations / Prerequisite Actions

1. Confirm with the Mechanical Lead that the system is ready for Controls Checkout.
2. Attend daily tailgate and have work released by Area Manager and system lead before work is performed for the day.
3. All long-haul cables should be terminated on load end and source end. Long haul cables should not be connected to load or source end by anybody other than the Profile Monitor Team.




If the cable is not terminated, dressed, unable to reach the device or coiled up in cable tray above cryomodule, work shall stop. Notify subsystem lead for replanning & cable shop for assistance.



If the connector on the cable, tester or profile monitor are visibly damaged or require excessive force for connection, STOP work on this device, FLAG the connector and notify subsystem lead for mitigation. Work can continue for other devices on signed off list.

4. All long-haul cables should be disconnected, and no controllers should be plugged in to the rack power.

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5. Wire the device, long-haul breakout connector, and air box to the terminal board per WD-380-209-01-C0. Due to the placement of the airboxes on the far wall from the accelerator, the wire cable will be routed up to and along the ceiling to the other side wall then down the wall till it can be attached to the terminal board. After all connections are attached, the terminal board will be mounted to Unistrut attached to the cable tray. This ensures the minimal risk of parts or tools getting dropped on the beamline and limits the risk for fixes in the future.



If the cable is not terminated, dressed, unable to reach the device or coiled up in cable tray above cryomodule, work shall stop. Notify subsystem lead for replanning & cable shop for assistance.



If the connector on the cable, tester or profile monitor are visibly damaged or require excessive force for connection, STOP work on this device, FLAG the connector and notify subsystem lead for mitigation. Work can continue for other devices on signed off list.

6. Connect cables to camera.
7. Compressed Air connected to device (per METSD \_\_\_\_\_).



If the compressed air is not connected to the airbox and profile monitor, STOP work on this device, notify subsystem lead or mitigation. Work can continue for other devices on signed off list.

8. Device locking pin (if applicable) removed.
9. Rack Power should be released by the corresponding Safety Officer and the Rack Custodian.
10. Beamline vacuum valves upstream and downstream of the work area MUST be sealed during checkout procedure, this should be visible in the PLC, if not contact the Vacuum Team. If is not sealed, DO NOT proceed and contact vacuum controls. The valves that need to be checked are as follows:
  - a. Profile Monitors in COL0 and HTR: (YAGH1, YAGH2, OTRDG02, OTRDG04, OTRC006)
    - i. D - VVPG:HTR:93
    - ii. U - VVPG:L1B:0201
  - b. Profile Monitors in BC1B: (OTR11B)
    - i. D - VVPG:L1B:H295
    - ii. U - VVPG:L2B:0401
  - c. Profile Monitors in BC2B: (OTR21B)
    - i. D - VVPG:L2B:1593
    - ii. U - VVPG:L3B:1601
  - d. Profile Monitors in DOG: (OTRDOG)

i. D - VVPG:L3B:3594

## 10. Profile Monitor Device Checkout Procedure

### 10.1 Reference Images

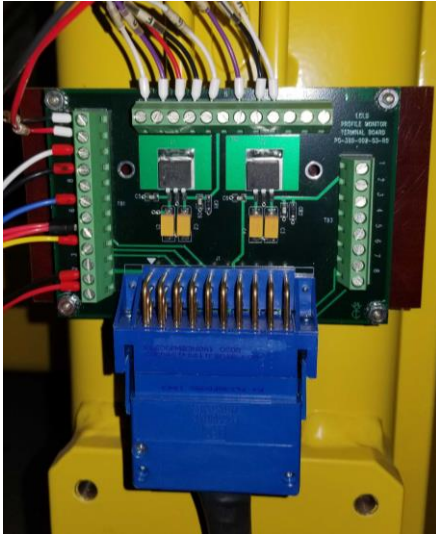


Figure 1 : Profile Monitor Terminal Block with connections Figure 2 : Profile Monitor Airbox Connector



Figure 3 : Profile Monitor Optics Box Connector

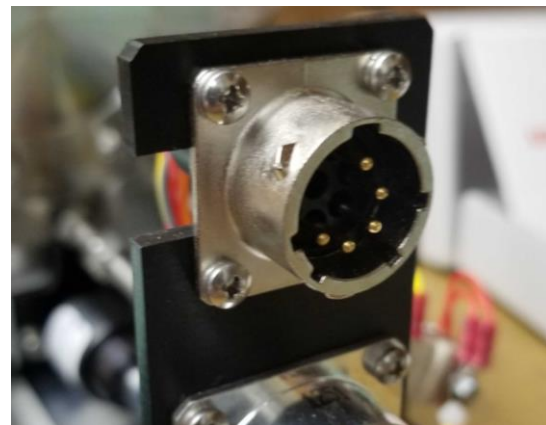

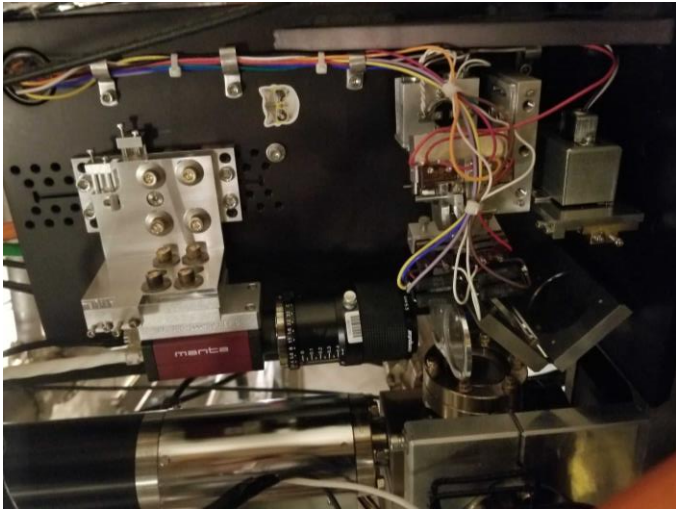


Figure 4 : Profile Monitor Vacuum Triggers Connector

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**Figure 5 : Profile Monitor Optics Box Internals**


## 10.2 Chassis Startup Procedure

1. Power down the chassis.
2. Connect long haul cable and fiber optic cable.
3. Power on the chassis and wait 60 seconds for the EtherCAT coupler to boot and reconnect to the IPC.
4. Go to the beamline device.
5. Connect to the IPC as laci and start the IOC.
  - a. `ssh laci@<nodename>`
  - b. `iocConsole.sh <ioc-name>`
6. Open the control screens
  - a. `lclshome`
  - b. Profile Monitor / <area> → <device>
7. Test the following functionalities.

## 10.3 Optical Filter 1

1. Use the control screen to insert the Filter 1. Verify visually that it has moved. The status should change from OUT -> Moving -> IN
  - a. Control PV: <Device Prefix>:FLT1\_CTRL
  - b. Readback PV: <Device Prefix>:FLT1\_STS
2. Remove the Filter 1. Verify visually that it has moved. The status should change from IN -> Moving -> OUT
  - a. Control PV: <Device Prefix>:FLT1\_CTRL
  - b. Readback PV: <Device Prefix>:FLT1\_STS
3. If mechanical design allows, press both in and out limit switches at the same time and verify the status says INCONSISTENT



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- a. Readback PV: <Device Prefix>:FLT1\_STS

#### 10.4 Optical Filter 2


1. Use the control screen to insert the Filter 2. Verify visually that it has moved. The status should change from OUT -> Moving -> IN
  - a. Control PV: <Device Prefix>:FLT2\_CTRL
  - b. Readback PV: <Device Prefix>:FLT2\_STS
2. Remove the Filter 2. Verify visually that it has moved. The status should change from IN -> Moving -> OUT
  - a. Control PV: <Device Prefix>:FLT2\_CTRL
  - b. Readback PV: <Device Prefix>:FLT2\_STS
3. If mechanical design allows, press both in and out limit switches at the same time and verify the status says INCONSISTENT
  - a. Readback PV: <Device Prefix>:FLT2\_STS

#### 10.5 Lamp Functionality

1. Use the control screen to activate the target lamp. Use the slider bar to change the brightness. Verify visually that the lamp is on and the brightness is changing
  - a. Control PV: <Device Prefix>:TGT\_LAMP\_PWR
  - b. Brightness PV: <IOC Prefix>:TGT\_LAMP\_CTRL
2. Use the control screen to activate the grid lamp. Use the slider bar to change the brightness. Verify visually that the lamp is on and the brightness is changing
  - a. Control PV: <Device Prefix>:GRID\_LAMP\_PWR
  - b. Brightness PV: <IOC Prefix>:GRID\_LAMP\_CTRL

#### 10.6 Target Functionality


1. Disconnect Profile Monitor airbox cable from airbox.
2. Use the control screen to insert the target. Verify with a multimeter that the voltage is present between 01 and 02 connections in TB1 of the Terminal Board. The status should not change.
  - a. Readback PV: <Device Prefix>:TGT\_STS
3. Remove the target. Verify with a multimeter that the voltage is no longer present between 01 and 02 connections in TB1 of the Terminal Board. The status should not change.
  - a. Readback PV: <Device Prefix>:TGT\_STS
4. If mechanical design allows, press in limit switch and verify the status change from OUT -> Moving -> IN
  - a. Readback PV: <Device Prefix>:TGT\_STS
5. If mechanical design allows, press in limit switch and verify the status change from IN -> Moving -> OUT
  - a. Readback PV: <Device Prefix>:TGT\_STS

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6. If mechanical design allows, press both in and out limit switches at the same time and verify the status says INCONSISTENT
  - a. Readback PV: <Device Prefix>:TGT\_STS
7. Reconnect Profile Monitor airbox cable from airbox.
8. Due to particle control this can only be done once during while testing the camera. Use the control screen to insert the target. Verify visually that it has moved. The status should change from OUT -> Moving -> IN
  - a. Control PV: <Device Prefix>:PNEUMATIC
  - b. Readback PV: <Device Prefix>:TGT\_STS
9. Remove the target. Verify visually that it has moved. The status should change from IN -> Moving -> OUT
  - a. Control PV: <Device Prefix>:PNEUMATIC
  - b. Readback PV: <Device Prefix>:TGT\_STS

#### 10.7 Camera Functionality

1. Use the control system to set up the camera. For initial testing, set trigger code to 45, pulse width to 1000, and delay to 0. The following properties should be set on the expert screen:
  - a. Pack16/24 = 24
  - b. Video Output = Top & Bottom
  - c. Skip Rows = 0
  - d. Skip Columns = 0
  - e. No of Rows = 1024
  - f. No of Columns = 1024
  - g. Trigger Line = CC1
  - h. Polarity = Normal
  - i. Prescale = 119-LCLS-I
  - j. Baud Rate = 57600
  - k. EVR Trigger = @MO1
  - l. Free Run = @MO0
  - m. Test Pattern = @TP
2. Begin image acquisition.
  - a. caput <Device Prefix>:Acquire 1
3. The camera should return an image. The frame rate should be 1 Hz
  - a. caget <Device Prefix>:FrameRate
4. Turn the lamp on and put the screen in. The target should become visible on the screen. This can be done during testing target functionality to only have the target move once.

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5. Use the Matlab Profile Monitor GUI to calibrate the image.
  - a. Calibration constant = \_\_\_\_\_
6. Take screenshot of final camera image.

## 11. Profile Monitor Device Checkout Checklist

### 11.1 Device Information

MAD Name	Control System Name (Device Prefix)	Testers	Date

Hardware Information: Optionally enter hardware information to aid in checklist.

Host IOC	IPC Host node name	Control chassis location	Camera Z-Location(ft)	Camera Channel	Chassis Channel

### 11.2 Office Preparations / Prerequisite Actions:


IOC is created and configured	
Add IOC to screeniocs file	
Add IOC to IOCManager EPICS application, AlarmConfigs-ntwk	
Add Camera to Control Screens	

### 11.3 Field Preparations / Prerequisite Actions:

Confirm with the Mechanical Lead that the system is ready for Controls Checkout	
All long-haul cables terminated and disconnected, no debris or bent pins in connectors	
Compressed Air connected and present, if not contact mechanical.	
Locking pin removed (if applicable)	
Connect up wires to Terminal Block	
Confirm vacuum is present & valves are closed	

### 11.4 Chassis Startup Procedure:

Connect cables at chassis then power on	
Go to and connect to beamline device	
Connect to the IPC and start the IOC	

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### 11.5 Optical Filter 1:

Visually and virtually that the filter moves from OUT -> MOVING -> IN	
Visually and virtually that the filter moves from IN -> MOVING -> OUT	
Manually press limit switches at same time and verify status says "INCONSISTENT"	

### 11.6 Optical Filter 2:

Visually and virtually that the filter moves from OUT -> MOVING -> IN	
Visually and virtually that the filter moves from IN -> MOVING -> OUT	
Manually press limit switches at same time and verify status says "INCONSISTENT"	

### 11.7 Lamp Functionality:

Virtually activate target lamp and confirm visually	
Virtual slide bar changes brightness of target lamp	
Virtually grid target lamp and confirm visually	
Virtual slide bar changes brightness of grid lamp	

### 11.8 Target Functionality:

Disconnect Profile Monitor airbox cable from airbox.	
Voltage between 01 and 02 when virtual target inserted ("IN")	
No voltage between 01 and 02 when virtual target retracted ("OUT")	
Manually press limit switch and confirm Target is "IN" virtually	
Manually press limit switch and confirm Target is "OUT" virtually	
Manually press both limit switches and confirm Target is "INCONSISTENT" virtually	
Reconnect Profile Monitor airbox cable.	
Virtually activate "IN" and confirm movement ( <i>Complete Camera Functionality testing before continuing to next step</i> )	
Virtually activate "OUT" and confirm movement	

**11.9 Camera Functionality:**

Open camera on control system and verify properties	
Image acquisition at framerate 1 Hz	
Turn on target lamp and put screen in	
Calibrate Camera Image	
Screenshot image	

**12. Sign Off**

If the above conditions are met, the profile monitor DUT is working.

I, \_\_\_\_\_, attest that the above steps were completed.

\_\_\_\_\_  
(signature)

\_\_\_\_\_  
(date)

**13. Comments:**