LCLS Engineering Requirements Document # 1.1 - 310	Project Management	Revision 0

LCLS Personnel Protection System Requirements

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Brief Summary: The Personnel Protection System (PPS) is integrated in the existing accelerator safety systems to prevent access to the machine housing when there is a potential for hazardous machine operation. The LCLS adds new beam lines and zones to the SLAC facility. Both the new and existing areas must take into account potential hazards from LCLS beams and from beams to high-energy physics programs.

Change History Log

Rev Number	Revision Date	Sections Affected	Description of Change
000		All	Initial Version
001	9-26-2005		

LCLS

Stanford Linear Accelerator Center
Stanford Synchrotron Radiation Laboratory

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Introduction

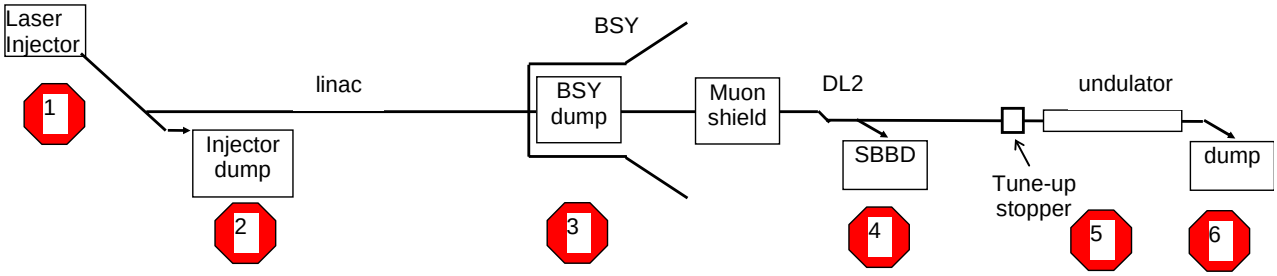
The requirements for the LCLS PPS system are defined according to the physical zones into which the accelerator and beam lines are divided. In addition, the operating modes and access conditions are defined by the location of beam stoppers, or beam dumps, and by the shielding for containing the beam within certain areas.

The PPS is to provide a number of entry gates and a fail-safe interlock system to provide controlled access to each of the zones described. The specification for the type of interlock system will be given in the ESD for the PPS.

The LCLS adds to the existing accelerator systems so heed is also given to existing hardware and modes of operation. In some cases changes are prescribed in order to accommodate the LCLS PPS.

Modes of operation for the electron beam

The primary operating modes of the LCLS are defined according to the location of beam containment stoppers or beam dumps.



1. No beam, injector in controlled access
   - no high-power RF permissive, and
     a. laser controlled access
     b. or, laser off
2. Injector operation with beam to the sector 21 dump in the linac housing. No linac access.
   - 1 nC at 120 Hz maximum
3. Beam to the BSY, stopped in the BSY. Access allowed downstream of the BSY muon shield.
   - 1 nC at 120 Hz maximum
4. Beam to the LTU (linac to undulator) single bunch beam dump
   - 1 nC at 120 Hz maximum
5. Beam to the undulator entrance tune-up dump
   - 1 nC at 10 Hz maximum (administrative limit for ALARA)
6. Beam to the final beam dump

- 1 nC at 120 Hz maximum

PPS Zones

The LCLS is divided up into the following PPS zones, shown in Figure 1 and summarized in Table 1.

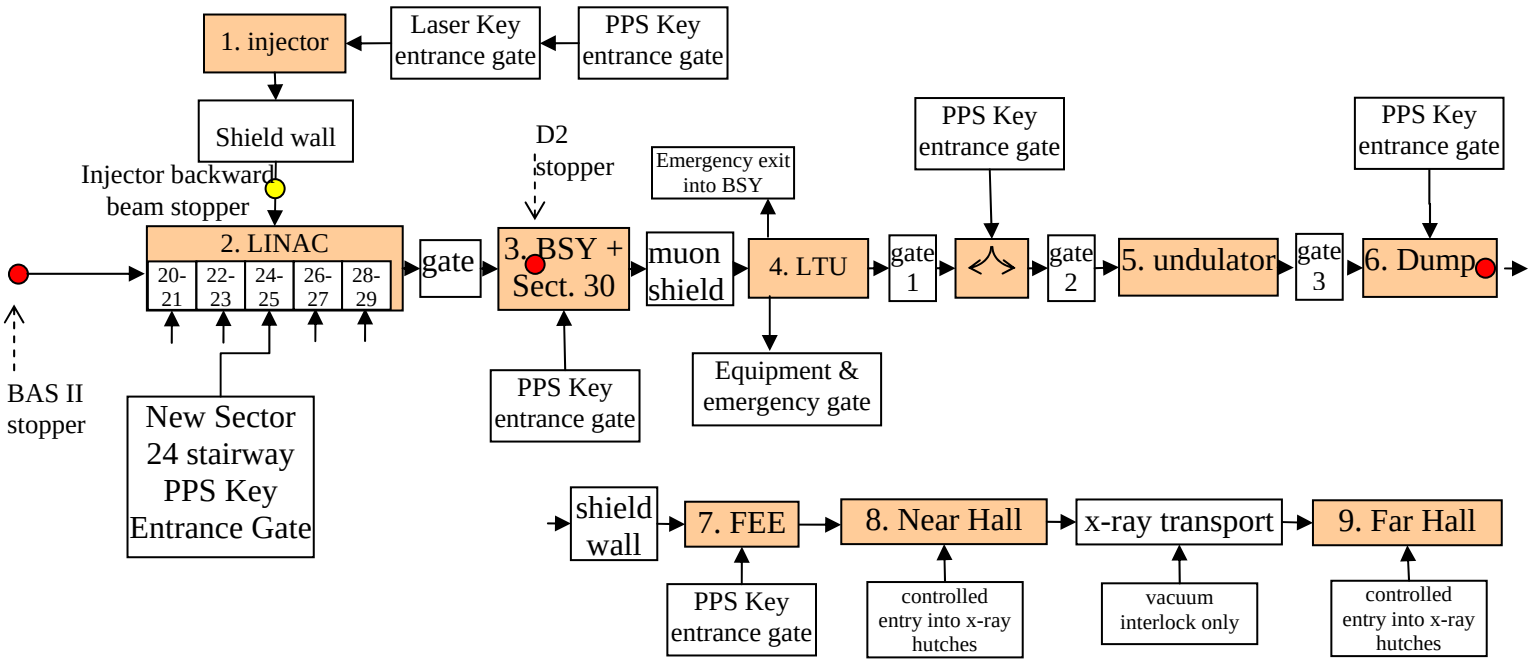


Figure 1 Schematic layout of the separated PPS zones for LCLS showing the schematic location of gates, beam stoppers and relevant shielding

Zone	PPS entry	Second egress	Access conditions	Search requirement
1a, 1b injector vault	Gate key and laser key (new)	None	No RF, elec. hazards off, inj. stopper in. Laser off unless laser key used.	Vault only
2. linac	Individual sector manways (existing, without key) New linac stairs with gate key at sector 24	Gate to adjacent sector (existing)	No beam in linac, or LCLS injector, elec. hazards off	Accessed sectors only
3. BSY and sector 30	Gate key (existing)	Numerous (existing)	linac in BAS II mode, elec. hazards off, or linac off	Entire BSY
4. LTU	Gate key (new)	Equipment and emergency gate (new), plus escape ladder into BSY	Beam stopped in BSY, elec. hazards off	LTU only if gate 2 to undulator has not been opened
5. Undulator hall	Gate key (new, shared with LTU)	gate to dump	Beam stopped in BSY, elec. hazards off	undulator only if gate 1 to LTU has not been opened
6. Dump	Gate key	Gate to undulator hall	Beam stopped in BSY, elec. hazards off	dump only if gate 3 to undulator has not been opened
7. Front End Enclosure	Gate key (new)	unknown	Beam stopped in BSY, elec. hazards off. Beam may be permitted to dump once the enclosure has been radiation certified.	FEE only
7. Near Hall	Independent access to hutches		x-ray shutters in	Hutch only
9. Far Hall	Independent access to hutches		x-ray shutters in	Hutch only

Table 1 Summary of entry requirements to individual PPS zones

Requirements for each PPS zone

1. The LCLS injector vault has one entry gate with PPS control. Access requires that the RF and electrical hazards be turned off and the radiation stopper in the injection line between the permanent shielding and the linac be inserted. Normally, the RF is turned off by switching off the VVS power to the modulators in that sector. However, the VVS for sector 20 klystrons used by the injector is shared with sector 19. Therefore in order to allow access to the injector vault without interrupting the PEP II linac operation in sector 19 requires that the modulators for the injector klystrons have direct interlocks (as is done now for the e+ vault).
   A second interlock system is to be implemented at the injector entryway for the laser safety system. The purpose of the laser safety system is to allow controlled access with an additional laser key by qualified laser personnel only and to switch the laser off for any other type of entry. The detailed requirements for the laser

safety system which involve the use of several laser shutters are not described in this document.
The shielding and backward beam stopper has been designed to allow access to the injector vault even if there is beam in the adjacent linac tunnel.

2. The linac PPS zones in their present configuration consist of two adjacent sectors, with the exception of sector 30 which has the same radiological requirements for access as the BSY zone. Entry to a linac sector is typically via the manway ladders which have keyed doors but are not at present equipped with full PPS video monitoring. This means that the linac cannot be entered under controlled access but only in permitted access mode, so the sectors must be searched after each entry in the present system. In addition to the manways there are equipment hatches in sectors 19, 24 and 30 where heavy equipment can be lowered into the housing.
   A safety upgrade to the linac PPS is required to the linac PPS to accommodate the LCLS activities. In order to minimize the use of ladders a stairway is to be provided at the Sector 24 equipment hatch location. The top of the stairway will exit into the manway ladder alcove and will be equipped with an interlocked door between the ladder alcove and the stairway. This door will be equipped with a PPS keyed entry gate, including video monitoring, to allow controlled access into the linac. Combining several sectors into larger PPS zones would also simplify operation and require fewer certification procedures. PPS zones of 5 or 10 sectors could always include one of the equipment hatch access points.
   Access to the linac requires shutting off all linac beams and shutting off the LCLS injector. At present, linac access downstream of the DRIP would also require shutting off the LCLS injector. It is foreseen to include one or two backward beam stoppers in sectors 19 and 20 upstream of the LCLS injector to allow access to sectors 2 through 18 during LCLS operation. The existing BAS II stopper in sector 19 could also serve as a backward beam stopper in this mode of operation. A new radiation stopper in linac sector 20-9, which will be installed to calibrate dose in the injector vault versus linac beam loss, could be used as the second backward beam stopper.

3. The BSY PPS zone comprises linac sector 30, the PEP II NIT and SIT lines, the BSY common line, the SLC 51 and 52 lines, A-, B- and C-line tunnels and the decommissioned SPEAR injection tunnel. There is controlled PPS access through the BSY manway and permitted access through the BSY main access and the sector 30 manway ladder. Upgrades to the BSY PPS may be required in conjunction with the LCLS in order to meet current safety standards, but these are not covered in this document.

4. The new Linac To Undulator (LTU) PPS zone extends from the muon shielding in the former FFTB tunnel up to the entrance of the Undulator Tunnel. The LTU PPS zone is located partly within a shielded off portion of the existing BSY and the rest is contained with in the Beam Transport Hall (BTH) that crosses the

Research Yard as far as the Undulator Hall. Controlled access to the LTU will be through a keyed PPS entrance at the downstream end of the BTH, adjacent to the Undulator Hall (UH) entrance. A second equipment access for permitted access and emergency exit is required at the upstream end of the BTH at the Research Yard Wall. A third emergency egress, a manway ladder, is located at the upstream end of the former FFTB tunnel at the muon shield plug and exits into the Beam Switchyard.
Access to the LTU is allowed when electrical hazards are off and the beam is stopped in the BSY, as is done now in the FFTB tunnel.
The PPS entrance to the LTU is to be shared with the Undulator Hall where two gates separate the two PPS zones. If the LTU is accessed but the gate to the UH is not opened then its search remains made up. This is done to minimize entries into the UH for maintaining temperature stability.

5. PPS access to the new Undulator Hall (UH) is through the common PPS keyed entry at the end of the LTU. A second exit gate is at the downstream end going into the Front End Enclosure (FEE) but will not normally be opened during controlled access.
   Access is only allowed when hazards are off and beam is stopped in the BSY. The adjacent areas in the LTU and FEE do not have to be searched if the gates to these areas are not opened.

6. The main electron dump area is accessed through a separate PPS keyed entryway from the downstream end. An interlocked gate separates the dump beam line area from the undulator hall and would not normally be opened when accessing the dump area.
   Access is only allowed when hazards are off and beam is stopped in the BSY. The adjacent areas in the UH and LTU do not have to be searched if the gates to these areas are not opened.

7. The new Front End Enclosure (FEE) houses x-ray components such as the gas cell attenuators. PPS access is through a new PPS keyed entry into the FEE. A second exit gate that is not normally opened during controlled access may or may not be included in the final FEE design. Since the FEE is shielded from the electron beam in the adjacent beam dump area and undulator hall it is foreseen that controlled access to the FEE will be possible with the electron beam at the dump and a stopper in the beam line between the FEE and the dump area. This mode of access will be subject to approval after testing and verification by radiation safety officers. Before that approval is granted the electron beam must be stopped in the BSY to allow access to the FEE.

8. The Near Hall and Far Hall contain only X-ray beamlines so that access to the experiment hutches is not dependant on the state of the electron beam. Shutters for the x-ray beam will control access to the hutches. The x-ray beam line from the Near Hall to the Far Hall is not in a PPS zone. The x-ray beamline itself will

have a vacuum interlock to prevent it being opened while the beam is operating, but the tunnel for the x-ray beamline is not considered as a PPS zone.