

BROOKHAVEN NATIONAL LABORATORY NATIONAL SYNCHROTRON LIGHT SOURCE		Number: LS-SDL-0007	Revision: C
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Subject: SDL Laser Interlock			
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Securing of Gun Hutch from Outside:

Starting from an unsecured state and securing from the outside of the hutch the authorized individual will actuate the start search permit from the inside of the hutch. The start search permit will consist of a push-button located inside the gun hutch. The gun hutch will be searched for personnel, when it is determined that there are no personnel in the hutch, the start search button is pressed, the door is closed and the "Complete Search" button, located outside the hutch, is pressed. A red led mounted above the button will illuminate when the button is pressed. After the complete search is made a warning siren (sound "#1") will sound for 15 seconds. After this warning the gun hutch is secured and ready for laser energy to enter.

While secured if the door is opened and the gun shutter is open the interlock would return to the ground state, the laser power would be removed immediately and warning siren (sound "#2") will sound for 5 seconds.

While the hutch is secured a sign will be illuminated outside the hutch to indicate that laser radiation could be present in the room.

Emergency stop buttons are located inside and outside the hutch to facilitate immediate shutdown of the laser power source if necessary and close the gun shutter.

Securing of Gun Hutch from Inside:

Starting from an unsecured state and securing from the inside of the hutch, the authorized individual will search the gun hutch for personnel. When it is determined that there are no personnel that are not intended/permitted to stay in the hutch, the door is closed and the start search button is pressed inside the hutch. A red led mounted above the button will illuminate when the button is pressed. The Complete Search button is then pressed inside the hutch.

After the button is pressed a warning siren (sound "#1") will sound for 15 seconds at the end of this warning the gun hutch is secured and ready for laser energy to enter.

While secured if the door is opened and the gun shutter is open the interlock would return to the ground state, the laser power would be removed immediately and an intrusion alarm siren (sound "#2") will sound for 5 seconds.

While the hutch is secured a sign will be illuminated outside the hutch to indicate that laser radiation could be present in the room.

An emergency stop button will be located inside and outside the hutch to facilitate immediate shutdown of the laser power source if necessary and close the gun shutter.

Laser Room to Gun Hutch Shutter Control: (Gun Shutter)

Located inside and outside of the gun hutch will be a shutter control. The shutter control for the inside of the hutch will consist of an open and a close button with indicators. The control for the outside can only close the shutter.

While the gun hutch is secured the gun shutter may be opened and closed. The gun shutter can only be opened if the gun hutch is secured.

Laser Room Interlock

Securing the Laser Room from Outside:

Starting from an unsecured state, an authorized individual will search the laser room for personnel, and after it is determined that there are no personnel in the hutch, the start search button is pressed. A red led mounted above the button will illuminate when the button is pressed. The check station 2 button is then pressed. A red led mounted above the button will illuminate when the button is pressed. The authorized individual exits the laser room, closes the door and presses the 'Complete Search' button located outside the room. A red led mounted above the button will illuminate when the button is pressed. When the search is completed, a warning siren (sound "#1") will sound for 15 seconds, at the end of this warning the laser room is secured and ready for laser energy to exit the laser's. A 'Laser Interlocked' sign will also illuminate above the main entrance to the laser room.

While secured if the door is opened a warning siren (sound "#2") will sound for 5 seconds, the laser power will be interrupted immediately and the laser safety shutters will close.

Emergency stop buttons are located inside and outside the hutch to facilitate immediate shutdown of the laser power source and close the laser safety shutters if necessary.

The normal procedure for bringing the laser room interlock to the ground state is to press the dump interlock button, then open a door.

Requirements for Laser Operation:

The laser power supply may only be on if the laser room is secured AND (the gun hutch is secured OR gun shutter is closed).

Entry and Exit of the Secured Laser Room:

In order to allow entry to the laser room by authorized personnel and maintain security in the room, a button outside the room may be used to gain an entry permit to enter the vestibule of the room. When the Access/reset button is pressed a led on the box will light indicating the permit has been granted.

A time limit of 25 seconds applies to this permit. While entering, only one door may be open; in the event of both doors opening, the lasers would be disabled and the interlock brought to the ground state. After the first door is closed again, the reset button in the vestibule can be pressed to reset the bypass timer before the time-out. The second door may then be entered after the entry button in the vestibule is pressed. A 25 second time limit applies to this permit by which time the second door must also be closed.

To exit the laser room, while maintaining security, the exit button is pressed and the vestibule can be entered. After entering the vestibule the reset button can be pressed to reset the bypass timer before the time-out. The main door may then be exited after the exit button in the vestibule is pressed. A 25 second time limit applies to this permit.

Linac Area Vault Laser Interlock

The third enclosure is in the Linac area itself. It is laser interlocked so that unauthorized entry into the area will trip shutters preventing light from reaching the accelerator enclosure.

The laser interlock provides laser area search and security independent of the radiation interlock. The interlock requires a physical search of the area to be performed before laser operation in the linac area. The search pattern is identical to the radiation search but has separate buttons. The buttons are yellow and light when pressed. After a search of the area determines that there are no personnel in the linac area and all search buttons have been pressed in order, exit the area by pressing the laser door guard button and then exit the linac area. After closing the door press the "Complete Search" button will illuminate when the button is pressed. After the complete search is made a warning siren (sound "#1") will sound for 15 seconds. After this warning the linac area hutch is secured and ready for laser light to enter.

While secured if the door is opened and the gun to linac shutter is open the interlock would return to the ground state, the laser power would be removed immediately and warning siren (sound "#2") will sound for 5 seconds.

While the linac area is secured a sign will be illuminated outside the door to indicate that the area is interlocked for laser radiation ("Laser Interlocked").

The linac area emergency stops function for both laser and radiation interlocks and facilitate immediate shutdown of the laser power source if necessary and close the gun shutter and gun to linac shutter.

The interlock system will permit access via the main door to the linac area, using bypass buttons similar to those in the laser room and end station interlocks. No access is permitted during operation of the radiation source.

Tripping the interlock will close shutters, preventing light from entering the linac laser controlled area. If the shutters fail to close, the lasers in the laser room will be shut down.

Auxiliary outputs are available for future lasers that operate in the cave area without shutters. The existing laser interlock system (PLC and enclosure) has been expanded to accommodate the new functions.

Entry and Exit of the Laser Secured Linac Area:

In order to allow entry to the laser room by authorized personnel and maintain security in the area, a pass through button located outside the linac area can be used to gain entry to the linac area. When the pass through button is pressed the button will light indicating the permit has been granted.

A time limit of 20 seconds applies to this permit. To exit the linac area, while maintaining security, the exit pass through button is pressed and the linac door may be opened. After exiting the linac area the outer pass through button can be pressed to reset the bypass timer before the time-out.

End Station Laser Area (ESLA) Interlock

To set the interlock, clear the area of all personnel, close the mainence and roll up door, and insure that the door stop and emergency bypass pin are in place on the exit door. Press the start search button, announce area is being secured, press the start search button and then exit the ESLA and close the door. Press the complete search button on the outside panel. A siren will sound for 10-20 seconds, after which the interlock will be active. While the area is secured a sign above the door will be illuminated ("Laser Interlocked") To open the linac to end station shutter, press the shutter open button located on either the inside or outside control panel. The close button on either panel will close the shutter. Another audible warning will sound briefly to warn before the shutter is opened. A button for deactivating the interlock is located on each panel. The shutter should be closed before deactivating the interlock. If the interlock is tripped, a key reset is required on the outside panel, and the search sequence must be repeated. If the shutter fails to close while the end station area is not interlocked or the shutter is mechanically opened, the system will reach back and shut off the laser power supplies in the laser room. The emergency stops located in the end station area will also shut off the laser room power supplies.

Entry and Exit of the Secured End Station Laser Area (ESLA):

In order to allow entry to the end station area by authorized personnel and maintain security in the area, a pass through button located outside the end station area can be used to gain entry to the end station area. When the pass through button is pressed the button will light indicating the permit has been granted.

A time limit of 20 seconds applies to this permit. To exit the linac area, while maintaining security, the exit pass through button is pressed and the linac door may be opened. After exiting the end station area the outer pass through button can be pressed to reset the bypass timer before the time-out.

Implementation:

The implementation of the logic is a hybrid system using a small number of relays and a Programmable Logic Controller (PLC). The PLC allows modifications to be made easily.

The PLC is a Modicon 110CPU51200 with expansion modules BDEP-216 and BDAP-216. The interlock consists of two independent chains, 'A' and 'B'. All functions of the 'A' interlock chain are implemented through the PLC. The 'B' chain is implemented through relays.

The 'A' interlock chain controls the lasers through the manufacturer provided interlock inputs.

The 'A' chain for the gun hutch enables the lasers via the PLC, and the 'B' chain provides redundant control of the gun shutter through discrete relays. The emergency stop is implemented in the PLC and through discrete relay logic to provide a redundant function.

The door switches are the standard NSLS Microswitch brand and are independent for the 'A' and 'B' chains. The PLC, relays and power supplies are housed in a NEMA enclosure located at the entrance of the laser room.

Note: The redundant chains 'A' and 'B' are applied to the laser room outer door only, the inner door is controlled by the PLC chain 'A'.

Operational Instructions for the SDL Laser Interlock

To Secure the Laser Room:

1. Enter the room and proceed to Start Search button located at the rear of the room.

2. Search the area to the left of the check station, look in between the laser table and the wall for personnel and announce the area is being searched, press the button on the check station and note the light illuminate.
3. Proceed to the Search #2 button located around the table on the other side of the room, visually check the area on this side of the room for personnel and announce the area is being searched, press the button and note the light illuminates.
4. Exit the room, close the door and press the external check station located on the left hand side of the main security box. The light will illuminate.
5. After a period of 20 seconds the Laser Room Secured light will illuminate, this indicates that the Laser Room has been successfully interlocked.
6. In order for the lasers to be powered the power trip must be reset. This is done by pressing the Laser Power Trip button located on the main interlock box. The light will go out when the button is pressed and the laser is ready to produce laser radiation.

To Enter the Laser Room:

1. Before opening the door to the Laser Room the door must be bypassed. This is done by pressing the Access/Reset button located on the bottom half of the main interlock box. The Door Bypass #1 light will illuminate. The outside door has now been bypassed for a maximum of 20 seconds and can be opened without dumping the interlock.
2. Open the outside door and enter the vestibule. Once inside and the door is closed, press the button box closest to the outside door, the one with the arrow pointing to the outside door. The light will go out. By pressing the button the bypass has been reset before the 20 second time out.
3. Before opening the inside door to the Laser Room, the door must be bypassed. This is done by pressing the button box closest to the inside door, the one with the arrow pointing towards the inside of the laser room. The light on the box will illuminate. The inside door has now been bypassed for a maximum of 20 seconds and can be opened without dumping the interlock.
4. Open the inside door to the Laser Room, close the door and then, press the Access/Reset button box located on the left hand side of the door inside the Laser Room. The light will go out.
5. To exit the room, follow the sequence in reverse.
6. Remember that only one door may be open at any time to maintain the interlock.

To Bring the Interlock to the Ground State:

1. To shut the interlock down in an orderly fashion, press the button marked INTERLOCK OFF located at the main interlock box or at the control panel inside the laser room.

To Secure the Gun Hutch:

1. Enter the Gun Hutch and visually check that there are no personnel in the area, press the Laser Start Search button and exit the Gun hutch, close the door and press the Laser Complete Search button. The audio alarm will sound and at the end of the warning the Gun Hutch will be secured.

The Gun Hutch may also be secured from the inside (LASER ONLY!!) by a qualified laser person wearing the proper eye protection. To complete the search while remaining inside use the COMPLETE search button located inside the Gun Hutch.

To Bring the Interlock to the Ground State:

To shut the interlock down, open the door to the Gun Hutch.

Common Problems:

1. The check station light will not light when the button is pressed. Check that the Emergency Stop light on the main panel is illuminated. If not request the operator reset the emergency stop latch.
2. The Laser Room Secure light and the Interlocked sign will not light. Check that the DOORS light is illuminated, if not be sure that the doors to the Laser Room are completely closed.
3. The interlock dumps when trying to enter while a door is bypassed. Make sure that the light illuminates on the button box or the main interlock box after pressing the Door Bypass or the Access/Request button. Make sure that only one door is opened at any time. Make sure that the door has not been open for more than 20 seconds.
4. The laser cooling system is on but the HV power supply will not come on. Check that the Laser Power Trip light located on the main security box is out, if not, press the reset button located under the Power Trip lamp.