SC--SSO-SU-SLAC-2011-0007

FINAL
Rev. 1

Occurrence Report
After 2003 Redesign

Stanford Linear Accelerator Center

(Name of Facility)

Accelerators

(Facility Function)

Stanford Linear Accelerator Center — Stanford University

(Site) — (Contractor)

Name: KERWIN, RALPH R
Title: FIRE MARSHAL **Telephone No.:** (650) 926-2095

(Facility Manager/Designee)

Name: MCDANIEL, MIKE C.
Title: NTS COORDINATOR AND SECOND ORPS MANA **Telephone No.:** (650) 926-5015

(Originator/Transmitter)

Name: **Date:**

(Authorized Classifier (AC))

1. Occurrence Report Number: SC--SSO-SU-SLAC-2011-0007

Near Miss Laser Incident

2. Report Type and Date: FINAL

	Date	Time
Notification:	05/27/2011	20:02 (ETZ)
Initial Update:	06/03/2011	13:46 (ETZ)
Latest Update:	07/11/2011	21:43 (ETZ)
Final:	07/11/2011	21:43 (ETZ)
Revision 1:	07/12/2011	13:13 (ETZ)

3. Significance Category: 3

4. Division or Project:

5. Secretarial Office: SC - Science

6. System, Bldg., or Equipment:

7. UCNI?: No

8. Plant Area:

9. Date and Time Discovered: 05/25/2011 11:00 (PTZ)

10. Date and Time Categorized: 05/25/2011 15:47 (PTZ)

11. DOE HQ OC Notification:

Date	Time	Person Notified	Organization
NA	NA	NA	NA

12. Other Notifications:

Date	Time	Person Notified	Organization
05/25/2011	15:00 (PTZ)	SSO Duty Officer	SSO DOE
05/25/2011	13:47 (PTZ)	Ralph Kerwin	SLAC

13. Subject or Title of Occurrence:

Near Miss Laser Incident

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14. Reporting Criteria:

10(2) - An event, condition, or series of events that does not meet any of the other reporting criteria, but is determined by the Facility Manager or line management to be of safety significance or of concern to other facilities or activities in the DOE complex. One of the four significance categories should be assigned to the occurrence, based on an evaluation of the potential risks and the corrective actions taken. (1 of 4 criteria - This is a SC 3 occurrence)

10(3) - A near miss, where no barrier or only one barrier prevented an event from having a reportable consequence. One of the four significance categories should be assigned to the near miss, based on an evaluation of the potential risks and the corrective actions taken. (1 of 4 criteria - This is a SC 3 occurrence)

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15. Description of Occurrence:

On May 25, 2011 a Stanford graduate student, who is a qualified laser operator visually noticed an exposed beam from a Ti:sapphire laser oscillator on his shirtsleeve while placing an object on an optical

table in a research laser lab. No laser beam should have been present, as the laser safety system had been set to "Class 1 Mode" at the end of the previous day. In this mode access is limited to qualified personnel, and it requires that all laser beams be enclosed. In this case, laser eyewear PPE is not required, and the operator was wearing none. After viewing the unexpected beam he took immediate steps to disable any potential hazard and then contacted his supervisor, who is a SLAC employee. It was determined that the cause of the exposed beam was that a required laser safety shutter had been moved on the previous day to accommodate commissioning of a new optical beam path. The shutter was not replaced and the covers to the shutter enclosure were removed when the system was put into " Class 1 Mode". The beam was otherwise confined within two enclosures on the optical table; however, the enclosures were not covered allowing for access to the beam. There were no injuries and no property damage.

16. Is Subcontractor Involved? No

17. Operating Conditions of Facility at Time of Occurrence:

Does not apply.

18. Activity Category:

03 - Normal Operations (other than Activities specifically listed in this Category)

19. Immediate Actions Taken and Results:

Operator 1 immediately put in a beam block to disable the hazard and notified the laser safety Supervisor for the lab. The Supervisor then disabled laser operation for the lab by removing the Master Key which forces LASER OFF operation mode, and then notified the SLAC Laser Safety Officer (LSO).

20. ISM:

1) Define the Scope of Work
2) Analyze the Hazards
3) Develop and Implement Hazard Controls
4) Perform Work Within Controls

21. Cause Code(s:

A1B5C02 - Design/Engineering Problem; Operability of Design / Environment LTA; Physical environment LTA
A2B4C07 - Equipment/ material problem; Material control LTA; Marking/labeling LTA
A4B3C08 - Management Problem; Work Organization & Planning LTA; Job scoping did not identify special circumstances and/or conditions
A4B1C01 - Management Problem; Management Methods Less Than Adequate (LTA); Management policy guidance / expectations not well-defined, understood or enforced

A5B1C01 - Communications Less Than Adequate (LTA); Written Communication Method of Presentation LTA; Format deficiencies
A5B3C02 - Communications Less Than Adequate (LTA); Written Communications Not Used; Not available or inconvenient for use
A6B2C01 - Training deficiency; Training Methods Less Than Adequate (LTA); Practice or "hands-on" experience LTA
A3B1C01 - Human Performance Less Than Adequate (LTA); Skill Based Errors; Check of work was LTA
-->couplet - A4B3C03 - Management Problem; Work Organization & Planning LTA; Duties not well-distributed among personnel
A3B1C07 - Human Performance Less Than Adequate (LTA); Skill Based Errors; Omission/repeating of steps based on assumptions for completion
-->couplet - A4B3C07 - Management Problem; Work Organization & Planning LTA; Job scoping did not identify potential task interruptions and/or environmental stress
A4B5C02 - Management Problem; Change Management LTA; Change not implemented in a timely manner
A4B5C04 - Management Problem; Change Management LTA; Risks / consequences associated with change not adequately reviewed / assessed
A3B1C02 - Human Performance Less Than Adequate (LTA); Skill Based Errors; Step was omitted due to distraction
-->couplet - A4B3C09 - Management Problem; Work Organization & Planning LTA; Work planning not coordinated with all departments involved in task
A3B1C03 - Human Performance Less Than Adequate (LTA); Skill Based Errors; Incorrect performance due to mental lapse
-->couplet - A4B3C01 - Management Problem; Work Organization & Planning LTA; Insufficient time for worker to prepare task

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22. Description of Cause:

On the day prior to the incident, four laser operators were performing routine laser work when they discovered that an optic on the table needed to be repositioned. The lead operator for the work is a SLAC employee. Two of the other operators are Stanford graduate students who had only recently started working in the laser lab. The fourth laser operator is an experienced laser operator in a different facility who was providing assistance, but left the lab prior to the safety shutter being removed and did not have further involvement prior to the incident. The lead operator had previously discussed the scope of the work with the laboratory supervisor for the week; however, during the course of alignment of the laser, it was determined that an optic needed to be moved. The operators discussed the situation and determined that the best position for it required that a laser safety shutter be relocated within the laser safety shutter enclosure. None of the operators realized that as part of the laser safety system (LSS) configuration they were required to get additional supervisor approval to relocate the shutter. The shutter was subsequently removed from the beam path and alignment of the optic proceeded, otherwise following the appropriate standard operator procedures including the use of "Maintenance Mode" of the LSS and temporary beam blocks to contain the laser beam. In "Maintenance Mode" laser beams may be present and laser eyewear PPE is required. In this mode it is assumed that the shutters may not provide complete protection, so in the event of an interlock trip the laser power supplies are disabled. At the end of the day, the LSS was placed into "Class 1 Mode". The student operators clearly stated that they did not put the LSS into Class 1 mode at this time, while the lead operator does not remember putting it to Class 1 mode then but stated it was possible he did so. The investigation team proceeded with the assumption that this was done by the lead operator. However, when this was done the required laser safety shutter was still removed from the beam path and two required Class 1 enclosure panels were not

in place (top cover and one side shield of the shutter enclosure removed). In "Class 1 Mode" the laboratory access is still restricted to laser operators, but all laser beams are supposed to be enclosed and inaccessible. Laser eyewear PPE is not required in "Class 1 Mode". It was common practice to put the LSS in "Class 1 Mode" at the end of the day when the laser was on but not in use, which may be why the LSS was incorrectly put to this mode at this time (this will be evaluated as part of Corrective Action 6).

The following morning is when one of the graduate student operators entered the lab alone in "Class 1 Mode". He placed an object on the optical table after the shutter enclosure but out of the beam path. The covers were removed when the student arrived, but the student did not immediately realize that this was not consistent with "Class 1 Mode" operations. It was only once he noticed the laser beam striking his arm that he realized that something was not right. He quickly tracked down the source of the beam and placed a beam block at the exit of the laser disabling any potential hazard and contacted his supervisor.

The investigation team identified several root causes for the incident as classified by the Apparent Causes and Causal Analysis Tree: two related to the decision to relocate the shutter; two related to the failure to complete the relocation; and one relating to improperly changing the state of the laser-safety system to "Class 1 Mode". In addition, the team could not agree on a potential root cause related to the initial shutter configuration.

1. One potential causal factor (A1-B5-C2) involved the initial placement of the shutter. Had the shutter been installed closer to the source it may not have required that it be relocated. While the shutter enclosure design allowed for the proper functionality of the laser safety shutter, the enclosure was larger than necessary. The team was split on whether this was a root or contributing cause.

An immediate corrective action (1), the shutter was repositioned as close to the output of the laser as practical and a new shutter enclosure is being designed to enclose only the shutter and a minimum number of optics.

2,3. Prior to removing the shutters, the operators were unaware of the need to seek additional supervisor approval to perform the desired task (Root A4-B3-C8). The operators did not recognize that the planned work was outside of the scope of the approved safety configuration and laser operation. Furthermore, the shutter was not labeled either as a laser safety device or otherwise indicating that it was restricted items (Root A2-B4-C7), though the cover to the shutter enclosure had a laser safety device label indicating to not remove unless in "Maintenance Mode."
While the supervisor has indicated that he would have approved the reconfiguration, the additional discussion would likely have resulted in an adequate work plan. Contributing factors were that the laser safety system SOP was never referred to (A5-B3-C2), in part because the format makes it difficult to find the appropriate information (A5-B1-C2), and the on the job training (OJT) did not make clear that this type of change was not in the scope of the approved work (A4-B1-C1).

An immediate corrective action (3) was to label the shutter as a laser safety configuration device that cannot be moved without supervisor approval. The label was positioned over the mounting screws to add an additional barrier to future removal.

4,5. The lid to the shutter enclosure and the shutter were both removed in "Maintenance Mode." Once the shutters were removed from the laser beam path, the highest priority should have been to safely reposition them and verify that the system was in working order (Direct and Root A3-B1-C1). Instead attention was given to the wrong issue (Root A3-B3-C1) finishing the optics alignment work (also in "Maintenance Mode") resulting in the failure to complete the laser safety reconfiguration. The incident would likely not have occurred if the operators performed their task in a timely manner (A4-B5-C2) and verified that the shutter was operating as intended. Contributing factors may have included an

assumption of completion (A3-B1-C7), potentially due to a mental lapse(A3-B1-C3) or infrequently performed steps(A3-B1-C3).

6. Finally, the system was incorrectly placed into Class 1 mode, due to a failure to perform a zero energy verification and ensure that the required Class 1 covers were in place (Root A3-B1-C1). Had the operator verified the state of the system, he would have realized that the covers were off. It is possible that he would have also realized that the shutter was out of the beam and the system could have been put back in working order at this point. In addition, had the operator immediately verified the state of the system upon entering the room in Class-1 mode, he could have identified the potential for an open beam path in a more controlled manner.

An immediate corrective action (9) was to post new procedures for changing to "Class 1 Mode" that were posted locally at the LSS control panel. The new procedures (checklist) were simplified and explicitly included a zero energy verification step.

Given the root and contributing causes listed above the following corrective actions will be implemented:

1. Reposition shutter as close to output of laser as practical and;

2. Redesign shutter box to enclose only shutter and minimal optics.

3. Attach label to the shutter stating that it is a safety device requiring supervisor approval for modification. Place label directly across the mounting screw for the shutter.

4. The Laser Safety Officer (LSO) will review and evaluate the need to update lab policy on laser safety configuration control. This includes identifying critical safety items and design considerations for their labeling, placement and securing method (for example requiring a special tool to remove), as well as change control and potential documentation requirements.

5. Update On-the-job training to include identification of laser safety components and restrictions on their reconfiguration.

6. Update On-the-job training to include emphasis on importance of verification and safe ways to perform it.

7. Update On-the-job training to include demonstration of changing modes.

8. Rewrite SOP to make information more accessible and to include explicit verification steps to laser safety configuration changes.

9. Post new procedures for going to Class 1 mode at point of use, which includes a specific zero energy verification step.

10. The Laser Safety Officer will review, with input from the Laser Safety Committee, requirements for Class 1 operation mode. The review will include which Class 1 enclosure covers should be interlocked and in which circumstances unattended Class 1 operation is permitted. The Laser Safety Officer will develop associated lessons learn to distribute to SLAC laser personnel, which will include an evaluation of extent of condition.

23. Evaluation (by Facility Manager/Designee):

Laser operators made a laser safety configuration change without defining and following an appropriate work plan. The upshot of which is that a laser safety shutter was removed from the beam path and the full functionality of the laser safety system was not restored. This ultimately resulted in a laser beam being present in an uncovered enclosure during a (restricted) operating mode when no beam should have been present. The investigation team found that better safety configuration control and training would likely have prevented the event from occurring. This event also underscores the need to define and follow good procedures with an emphasis focusing on the task at hand, and the importance of on the job training. Moreover, the team found that training and procedures should explicitly include safe methods for zero energy verification.

24. Is Further Evaluation Required?: No

25. Corrective Actions

(* = Date added/revised since final report was approved.)

1. Repositioned shutter as close to output of laser as practical.

Target Completion Date: 06/01/2011	**Completion Date:** 05/30/2011

2. Redesign shutter box to enclose only shutter and minimal optics.

Target Completion Date: 08/01/2011	**Completion Date:**

3. Attach label to the shutter stating that it is a safety device requiring supervisor approval for modification. Place label directly across the mounting screw for the shutter.

Target Completion Date: 06/01/2011	**Completion Date:** 05/30/2011

4. Laser Safety Officer (LSO) will review lab policy on laser safety configuration control. This includes identifying critical safety items, design considerations for labeling, placement and securing method (for example requiring a special tool to remove), change control and potential documentation requirements.

Target Completion Date: 09/30/2011	**Completion Date:**

5. Update on the job training to include identification of laser safety components and restrictions on their reconfiguration.

Target Completion Date: 07/22/2011	**Completion Date:**

6. Update On the job training to include emphasis on importance of verification.

Target Completion Date: 07/22/2011	**Completion Date:**

7. Update On the job training to include demonstration of changing modes.

Target Completion Date: 07/22/2011	**Completion Date:**

8. Rewriting SOP to make information more accessible and to include explicit verification steps to laser safety configuration changes.

Target Completion Date: 07/22/2011	**Completion Date:**

9. Posted new procedures for going to Class 1 mode at point of use. These included specific verification step. Incorporate zero energy verification procedures into new SOP.

Target Completion Date: 06/01/2011	**Completion Date:** 05/30/2011

10. LSO to review, with input from the Laser Safety Committee, requirements for Class 1 operations mode. Review to include which Class 1 enclosures should be interlocked and in which circumstances unattended Class 1 operation is permitted. LSO to develop associated lessons learn to distribute to SLAC laser personnel and to include evaluation of extent of condition.

Target Completion Date: 09/30/2011	**Completion Date:**

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26. Lessons Learned:

Laser operators made a laser safety configuration change without defining and following an appropriate work plan. The upshot of which is that a laser safety shutter was removed from the beam path and the full functionality of the laser safety system was not restored. This ultimately resulted in a laser beam being present in an uncovered enclosure during a (restricted) operating mode when no beam should have been present. The investigation team found that better safety configuration control and training would likely have prevented the event from occurring. This event also underscores the need to define and follow good procedures with an emphasis focusing on the task at hand, and the importance of on the job training. Moreover, the team found that training and procedures should explicitly include safe methods for zero energy verification.

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27. Similar Occurrence Report Numbers:

None.

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28. User-defined Field #1:

29. User-defined Field #2:

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30. HQ Keyword(s:

01A--Inadequate Conduct of Operations - Inadequate Conduct of Operations (miscellaneous)
01F--Inadequate Conduct of Operations - Training Deficiency
01G--Inadequate Conduct of Operations - Inadequate Procedure
01Q--Inadequate Conduct of Operations - Personnel error
08C--OSHA Reportable/Industrial Hygiene - Industrial Hygiene Exposure
08H--OSHA Reportable/Industrial Hygiene - Safety Noncompliance

08K--OSHA Reportable/Industrial Hygiene - Near Miss (Other)
11F--Other - Inadequate Design
11I--Other - Visiting Scientist/Researcher or Student Employee
12K--EH Categories - Near Miss (Could have been a serious injury or fatality)
14B--Quality Assurance - Training and Qualification Deficiency
14D--Quality Assurance - Documents and Records Deficiency
14E--Quality Assurance - Work Process Deficiency
14F--Quality Assurance - Design Deficiency

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31. HQ Summary:

On May 25, 2011, a Stanford graduate student was performing optics research in a laser lab, which did not require the presence of laser beams, when he noticed the dimly visible red beam of a Class 4 (high power) 800nm laser on his shirt sleeve. The laser operation mode for the lab was set to Class 1, which means that any hazardous beams are fully enclosed. PPE laser eyewear is not required in this Class 1 mode. The graduate student immediately put in a beam block to shield the laser beam hazard and notified the lab laser safety supervisor. The supervisor then disabled laser operation for the lab by removing the Master Key, which forces LASER OFF operation mode, and notified the SLAC Laser Safety Officer. A preliminary investigation was conducted by the lab laser safety supervisor. The investigation noted that the laser safety configuration was modified on May 24. A SLAC laser operator had removed a laser safety shutter while in the Class 4 laser lab operation mode (accessible Class 4 laser beams present and PPE laser eyewear required). The laser system was later placed in Class 1 operation mode with this laser safety shutter removed. The high power laser beam was not fully enclosed, as required to satisfy the conditions needed for Class 1 operation. There were no injuries or equipment damage. A formal investigation is underway.

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32. DOE Facility Representative Input:

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33. DOE Program Manager Input:

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34. Approvals:

Approved by: KERWIN, RALPH R, Facility Manager/Designee
Date: 07/11/2011
Telephone No.: (650) 926-2095