Volume 4
Issue 3

Laser Lessons News Letter

This issue:

"Little warning shocks, i.e., near misses, happen when we become complacent and do not focus on the task at hand. When we ignore the lessons learned, they avalanche into a severe accident. Apply what you learn, pay attention, practice good situational awareness, and BE SAFE!"

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Introduction

Why do we track and trend accidents and near misses? The goal is to learn from the minor things so that we avoid the catastrophic events. This issue provides lots to learn from. It has not been a good year in terms of laser incidents/accidents across the DOE complex. We have had five of them this fiscal year.

Little warning shocks, i.e., near misses, happen when we become complacent and do not focus on the task at hand. When we ignore the lessons learned, they avalanche into a severe accident. Apply what you learn, pay attention, practice good situational awareness, and BE SAFE!

Lessons Learned

Take Care When Selecting Laser Eyewear

A team at a DOE Laboratory was performing an alignment procedure on an 800-nanometer (nm) laser source that converted the beam to a visible, 400-nm. All members of the team were wearing laser protective eyewear (LPE) while performing the alignment.

A vertically propagated beam was anticipated, as part of the experiment, and a beam stop was placed into the beam path. During the process of adjusting the experiment's optics, the vertically propagated beam travelled slightly above the beam block. As a result, the affected laser operator was in the path of the beam as it propagated vertically and missed the beam block. The laser operator saw a flash of blue light and immediately stopped work and reported the incident to the lab responsible person.

Upon further investigation, it was discovered that the LPE the laser operator was wearing did not afford protection for the 400 nm wavelength, just the 800 nm. The incident was immediately reported to management and the laser operator was taken to Medical for evaluation, where he received a referral to an ophthalmologist for further evaluation. The ophthalmologist's evaluation indicated that the laser operator did not have any injury to the eye as a result of exposure to the beam.

REMEMBER that LPE is your Last Line of Defense. Don't take your eyesight for granted. Know what you are wearing and BE SAFE!

Figure 1. Wrong eyewear transparent to laser beam

Wear Your Laser Eyewear!

On November 19, 2015, a laser worker received an eye injury at a DOE Lab from a reflected, non-visible laser beam. The laser (Class 4, pulsed, wavelength 800 nm) was configured to split the beam into two work areas in which qualified operators conduct research experiments. During this incident, the laser output was being projected to both experimental work areas, although only one experimental area was actively being used (See Figure 2). The laser beam directed to the second work area was blocked by an optically opaque material. (See Figure 3)

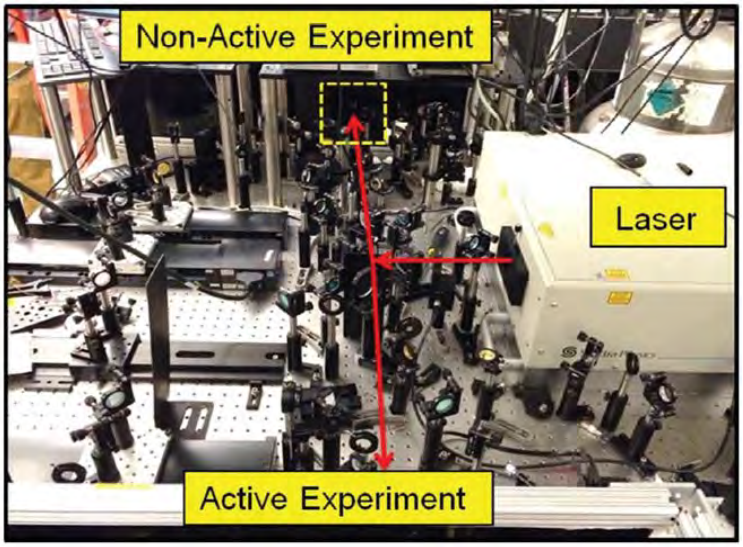


Figure 2. Laser showing two beam paths

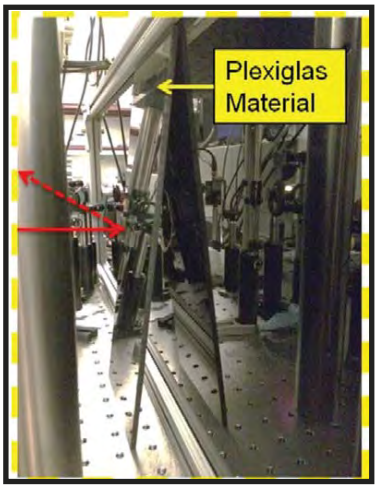


Figure 3. Reflected beam off of panel

In the course of conducting the active experiment, and while wearing the required LPE, the operator traced the associated beam path with an infrared laser viewing card (per procedures) in preparation to take measurements inside the experimental laser enclosure. To record two micrometer settings for the measurement, the operator stepped up onto a small ladder to get a better view of the micrometers inside the laser enclosure. The micrometer markings were difficult to read from this vantage point, so he momentarily lifted his LPE to increase visibility, and noticed a flash of light in his eye.

The operator quickly replaced the LPE and, using an infrared viewer, located a stray laser beam being reflected from the inactive experiment on the opposite end of the optical table. The beam was being reflected off the opaque piece of laser enclosure material. The laser enclosure panel, not normally used as a temporary beam stop, was positioned at an inclined angle and consequently reflected the beam at an upward angle toward the primary work area where the operator had been standing on the step ladder. (See Figure 4)

The enclosure material had been placed there by another operator who had been conducting experiments on the adjacent work area several days before. Once the stray beam was identified, a card was placed in front of the reflected beam to shield the stray reflection.

Immediately after the event, the operator did not think he had sustained any injury and continued working. Later that day, he noticed a blurry spot in the vision of his left eye. He notified his supervisor on the morning of November 20, and was taken to the medical facility for evaluation. The medical facility did not find any abnormalities, but referred the operator to a local ophthalmologist for further evaluation.

Further evaluations by the ophthalmologist on November 21 and November 23 identified a small spot of inflammation near the fovea on the retina in his left eye. The ophthalmologist stated that this spot would most likely heal on its own and that the blurry spot in the operator's vision would go away. A follow-up visit was scheduled. The operator was released back to work without restrictions.

A critique/investigation of the incident was performed on November 23. Based on the

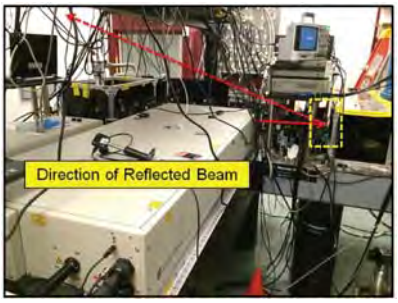


Figure 4. Path of reflected beam to exposed worker

investigation and the presence of a spot of inflammation on the operators retina, it was concluded that the operator was exposed in excess of the associated maximum permissible exposure (MPE) limit.

There were many contributing factors to this incident:

- Insufficient communication between users of a shared laser beam.
- Second beam was active when not in use.
- Selection of inappropriate material (reflective surface, susceptible to laser damage) and position for the beam block.
- Operator of the second setup had not verified safe conditions (blocking of stray reflections) after modifying the setup (changing/ blocking the beam path).
- Limited illumination impaired visibility of the instrumentation readings.
- **Operator removed LPE**

Wear your LPE and BE SAFE!

Safety Gate Valve Improperly Locked Out/ Tagged

A manual gate valve (Guillotine Safety Shutter) was found to be improperly Locked Out/Tagged Out (LOTO) in the open position at a DOE Lab. This valve is used to block laser light. A worker mistakenly applied the lock in the "open" position prior to performing work. Upon discovery, work was paused and the LOTO was correctly applied.

The configuration of this laser system is such that the energizing of lasers and opening of shutters are permissive-based from a separate control room via a Graphical User Interface (GUI). (See figure 5)

A permissive was requested and given for laser operations (laser was on), but not to open shutters on the optical table (shutters closed). If a permissive was given to open "Probe Laser Shutter" the laser light would be allowed to transmitted past the probe shutter to the Interferometer Table, via fiber optics and through the system past the open guillotine safety shutter.

There were many contributing factors which led to this failure:

- There was not a policy that defined when the use of an Energy Isolation Procedure is required.
- Workers did not recall their LOTO training.
- The indicator slide at the LOTO point was not clearly visible and identifiable due to a black background and limited lighting environment.

The permissive based Safety Interlock System (SIS) performed as expected and prevented an exposure to laser light. To open the probe shutter, a request would have to be made to

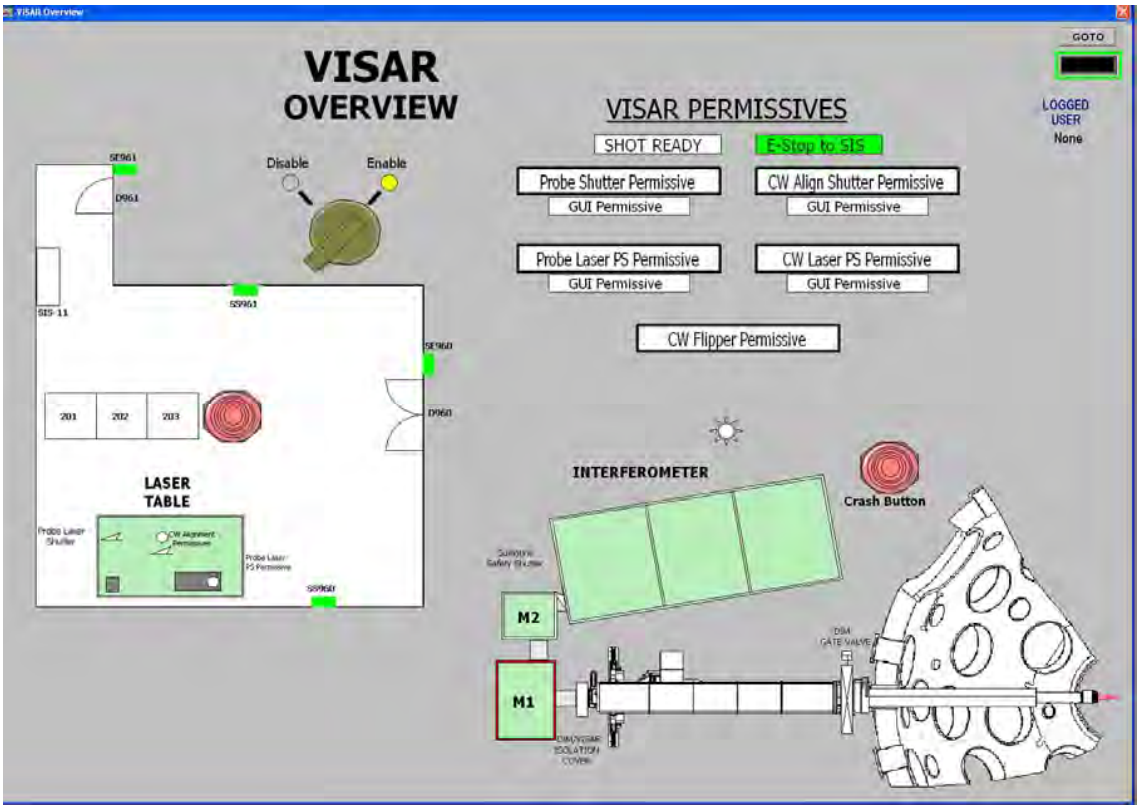
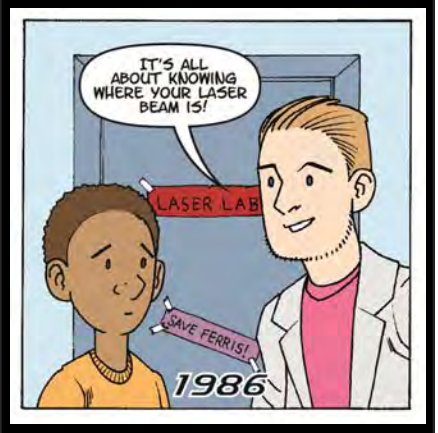


Figure 5. Graphical User Interface showing laser beam path locations and permissives



Artwork- John Jett

the control room and logged. When using LOTO to isolate any high energy source, ensure that procedures are followed, and the isolation point truly insulates the hazard and BE SAFE!

Use of Incorrect Eyewear Leads to Laser Eye Exposure

On June 14, 2016, a visiting graduate student received an exposure from a laser while working in a DOE laser laboratory. The graduate student was working with other researchers on an experimental setup. The room was in a darkened state prior to opening a shutter to admit a laser beam into the room. The group was instructed to don LPE prior to opening the shutter. The graduate student reached down and picked up, what he thought, was a pair of LPE and placed them on. He walked over and toggled the switch, opening the shutter. The graduate saw a green spot of light on a neutral density filter for about two seconds. The graduate student realized that he had put on a pair of another researcher's sunglasses, rather than LPE. A stop work was initiated and he was sent to Health Services to be seen by an Ophthalmologist. No eye damage was detected.

Figure 6. Sunglasses and APPROVED LPE under light and dark condition

The LPE and sunglasses were a very similar shape and appeared to be the same, especially in a darkened space (See Figure 6). The takeaway from this is to ensure that any PPE you are putting on is adequate for the task at hand. Do not comingle LPE with other eyewear. Verify, verify, verify, and BE SAFE!

Laser Strike Startles Worker

On July 18, 2016 a worker at a DOE Lab was aligning a pulsed green laser (527nm) to a semiconductor wafer when a reflection was directed off the face of the wafer toward the worker's LPE. The worker described the laser beam interaction with the LPE as bright flashes of light across the upper part of the eyewear. The worker was concerned because what he saw (bright flashes) was similar to what is reported by those involved in laser eye injuries. Management was notified and the worker was directed to get an eye examination. No damage was found.

Believing that the LPE may be defective, tests were performed on the eyewear and it was found to be working as designed. The eyewear did brightly fluoresce when struck by a green laser beam (See Figure 7). Other eyewear in the lab was tested, and only the YAG/KTP filter was found to produce the fluorescing phenomenon when struck. The rest produced only a dull spot on the inside of the eyewear during the same test. Further testing found other filters by different manufacturers resulted in the same fluorescence. Be aware when using filters used to block visible laser beams, there will be some reemission of light if stuck by a laser beam.

Figure 7. Fluorescing spot on left pair while right pair shows no effect

Takeaways from this incident were that we must always practice good beam control when performing laser alignments:

1. Reduce laser output energy/power to as low as practical to perform the alignment. (Viewing cards are not meant for imprinting a burn pattern upon and neither are your eyes.)
2. Do not move optics into or out of the beam path with laser(s) on.
3. Ensure downstream beam is blocked while performing course adjustments.
4. When using viewing cards, direct them down toward the table and not upward.
5. Use cameras when possible to free up your hands.

Figure 8. Location of filter type on this particular frame style

Following these basic rules of thumb will keep the alignment beam safe and away from you. Know where your beam is and BE SAFE!

Training

A newly revised version of the *Laser Lesson Learned Class* (NP0137) has been released as *Laser Safety Conduct of Operations* (HS5203). This is a required, one-time only Institutional, student participation/classroom-based course. The class is broken out into small groups where each determines contributing factors which led to the accident and ways to better work safely with lasers. Laser Worker Training (HS5200-W) is a prerequisite for this course and anyone completing HS5200-W will be required to complete HS5203. You will be credited if you have completed NP0137.

Acknowledgement:

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