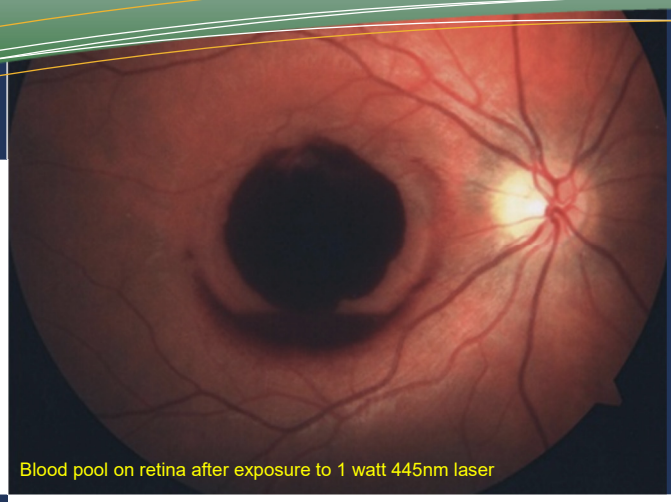
Volume 5
Issue 3

Laser Lessons News Letter


Blood pool on retina after exposure to 1 watt 445nm laser

This issue:

"Lasers are accelerating at a rapid pace in their energy/power output and Graphical Interfaces (GUIs) are following right along. Is it time a higher classification of laser be designated to directly address these very-high output lasers? This author believes now is the time to address these issues before someone is seriously injured."

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Introduction

Though laser eye injuries are few and far between, near misses and off-normal events are not. The retinal image above is that of an individual who happened to stare into a 1 watt diode laser. While we don't necessarily have to worry about people looking directly into lasers in our profession, we do need to ensure that work is performed safely. This issue covers several off-normal events that could have easily led to an accidental exposure. The common thread? Safety was not first and foremost.

Lessons Learned

Did you follow the procedure?

A worker at a DOE lab was performing work on a laser beamline that required Lock Out and Tag Out (LOTO) to be in place. LOTO was required to prevent a potential for laser exposure.

The worker implemented LOTO, completed their task and then needed to close out their work permit. Two steps were required:

1. Ensure all laser enclosure panels are installed
2. Remove LOTO

The work permit was cleared and a laser shot was performed. Upon reentering the area, it was discovered that one of the enclosure panels was off and the beam path was open. Work was immediately stopped and an investigation performed.

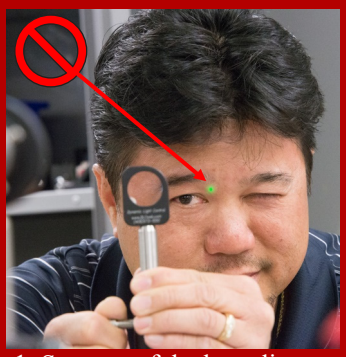
The first thing you are probably saying is, "It's just two steps!" Yes it is, but have you ever worked on a project at home and ended up with extra parts/fasteners after everything is back together? You probably were not following the procedure/instructions, right?

Let's look at the environment. The worker reported that they felt rushed in completing the task. On top of that, this is what could be described as a "routine" task, which may have compounded the issue.

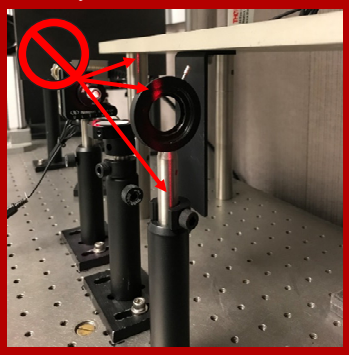
No matter how mundane the task, use the procedure and BE SAFE!

WRONG!

10 Rules of Laser Safety*



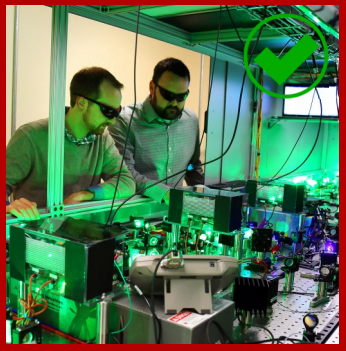
1. Stay out of the beamline



2. Contain stray beams

3. Adhere to signs and labels

4. Remove reflective items



5. Wear appropriate eyewear

Stay out of the beam

A worker, at a DOE laboratory, was struck on their head and eyewear by a laser beam while performing an optical alignment. Laser Safety Rule #1 dictates, "stay out of the beamline." The intent is to position the laser beam so it is not at eye-level and NEVER enter into the beam path. This seems pretty simple, right?

In this situation, the optical table was mounted vertically (Figure 1) so the beamline at certain locations may be at eye level. Extra attention and training emphasized keeping one's head out of the plane of the laser enclosure. In fact, this mode of operation yielded a safety record going back over 15 years!

As things usually go when using administrative controls, shortcuts are slowly implemented in the field. Many times they become part of an APPROVED procedure, but other times they are just passed on as "tribal" knowledge.

In this situation, workers found that it was quicker/easier to align the laser by closing down the irises and looking for sparking on the edges rather than using an infrared (IR) viewer. This procedure modification required the workers to lean in close to see the sparking. The worker entered the plane of the enclosure and was struck on the head and outside of the eyewear. Obviously, this was NOT an approved method of alignment.

These types of in-the-field short cuts may be good ideas at times but at others they may be very unsafe. It is very important to bring them up to your management chain, and share them with your safety staff, so that you can work efficiently and BE SAFE!

Figure 1. Worker inside plane of laser enclosure

Graphical User Interface (GUI) confusion

A worker at a DOE laboratory was verifying the operation of an alignment IR laser beam by inserting a viewing card into the beam path. The worker was startled when the laser beam immediately burned through the card. How did this happen?

In this situation, the worker had aligned the laser in "Alignment" mode on the GUI green boxed area (Figure 2). Previously, those using that laser had only operated the laser in continuous wave mode using the yellow boxed area. The worker read the operator manual and discovered the laser also provided gated pulses. This was performed using the red boxed area.

The worker verified the laser alignment using a viewing card. They then set the "On Time" and "Off Time" in the red boxed area. The worker verified that the laser was still set to "Alignment" mode on the GUI. The worker then activated the laser using the "Start" button in the red boxed area. Believing that the laser was gating 70mW pulses, the worker inserted a viewing card into the beam path to verify the pulsed operation.

A ~1.3 kW laser beam immediately burned through the viewing card, startling the worker. The laser was delivering pulses, only they were at the kilowatt (kW) level, not milliwatt (mW). Why?

The yellow boxed area and the red boxed area of the GUI actually perform two separate functions. The yellow area is the CW operational control for the laser and the red controls pulsed operation. Looking at the CW operation, there are 3 stages. The alignment and low power encompass Stages 1 and 2. When you operate at Stage 3, you must set the Power (%). You then have to select the "Emission On" just below the Duty Cycle.

For gated pulses, everything is controlled within the red box. The worker did not realize that they also needed to set the Power (%). The laser was automatically set at 90%. When selecting the Start button, a ~1.3 kW laser beam was emitted, not the 70mW expected.

Digging deeper, the use of GUIs with high-powered lasers may create a very serious safety concern. If not for the worker following Laser Safety Rule #1, stay out of the beamline, we might be discussing a very serious hand burn. This leads to the adequacy of controls in modern laser systems. Should there not be an acknowledgement button prior to the laser emit-

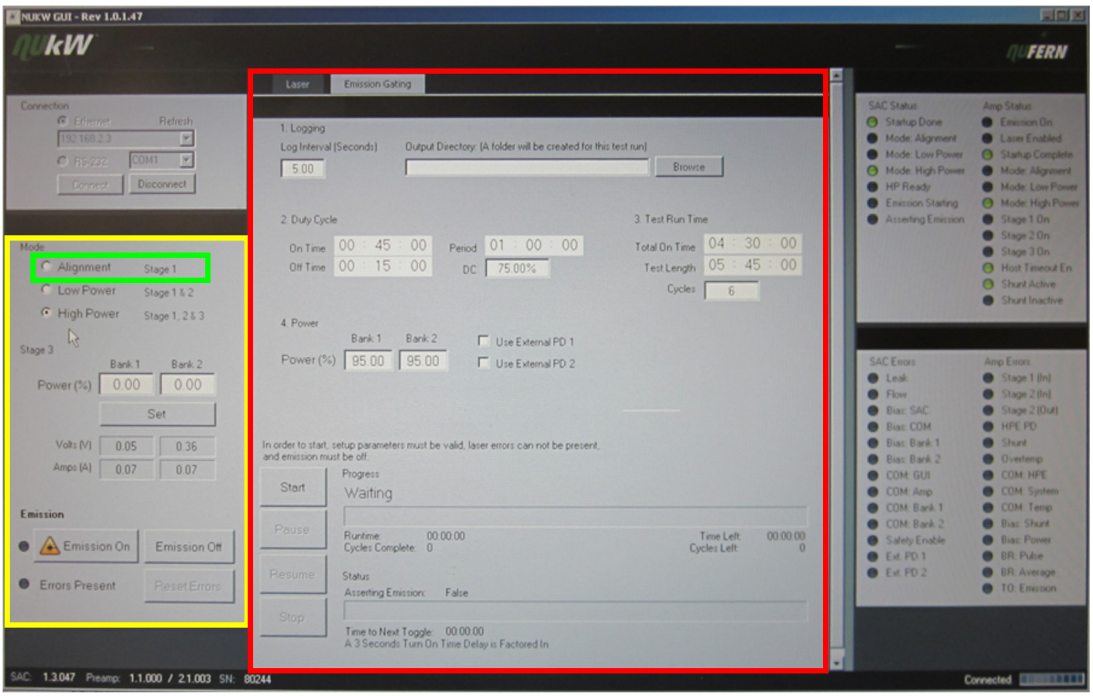


Figure 2. Damaged IR viewing card

ting at kW levels? Almost every piece of software out there asks, "are you sure you want to…" prior to performing the requested command.

Lasers are accelerating at a rapid pace in their energy/power output and GUIs are following right along. Is it time a higher classification of laser be designated to directly address these very-high output lasers? This author believes now is the time to address these issues before someone is seriously injured.

Can I use that laser?

An unauthorized Class 3B laser was discovered in use at a DOE laboratory. An investigation found that the laser was purchased outside of the normal process because it was not described as a laser on the order form. You would think that with the many layers of safety it should have been discovered before use, right? Let's dig a little deeper.

The laser was described in the procurement process as an "optical device." Installation was part of the contract, but because of the product description, an assumption was made that it was a microscope. The vendor was authorized to install the equipment under the lowest hazard, much like installing a printer. Here we already have two failures in procurement.

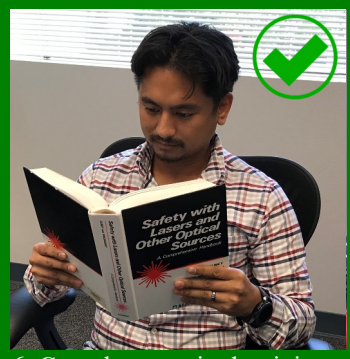
Before going further it must be mentioned that the end-user was not a laser person. While installing the new equipment, the vendor aligned the laser. They were not wearing laser protective eyewear (LPE), though the laser output was in excess of the Maximum Permissible Exposure (MPE) Limit.

The worker questioned the intensity of the red laser beam, and the vendor told him just not to stare at it while performing the alignment. The worker did not think to question the vendor's unsafe practices as they were not familiar with lasers and their use. This was yet another failure in the process.

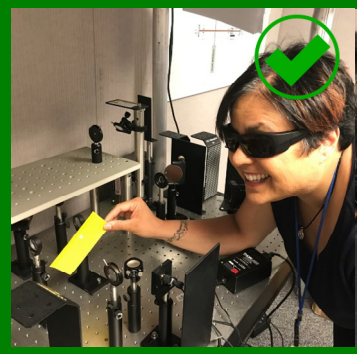
The worker then took ownership of the equipment and aligned it several times until a new worker came to the lab and questioned the unsafe practices. They mentioned that they had the same equipment, but there were controls in place for its use along with the requirement for LPE whenever aligning. They then attempted to obtain LPE and called the work planner querying how they could get a laser added to their operational procedures.

At this point, laser safety got involved and a stop work was initiated. A full management review was conducted. Along with the review, a separate investigation into human performance was initiated. Several holes were discovered in the process. Lesson learned, ask questions and BE SAFE!

*All photos simulated or staged



6. Complete required training



7. Use low power for alignment

8. Know your beampath

9. Practice good housekeeping

10. When possible, make it class 1

Choose the correct protection for the job

A worker at a DOE lab entered a laser controlled area (LCA) with incorrect LPE. If you are an avid reader of this newsletter, you are aware that this is not the first time LPE was cited in a near miss (see volume 1 issue 4, volume 4 issues 1 and 3, and volume 5 issue 1). Where engineered controls are considered foolproof with no required user action, administrative controls and PPE require vigilant workers in order for success. Let's dig into this near miss a little deeper.

This laser lab utilized two different wavelength lasers with two different types of LPE. One of the lasers was a high-power visible laser and the other a relatively low-power IR laser. The entrance to the LCA was properly posted and the correct LPE was staged at the hutch entrance. All workers also received proper laser safety training.

Using a camera, three workers were aligning the visible laser to a sample at a relatively low power (~50mW) while wearing the proper LPE. A fourth worker arrived from an on-site scientific seminar and donned IR LPE from another location and entered the LCA. Approximately an hour later it was noticed that the fourth worker could see the blue laser light directly through their eyewear. This individual exited the area and reported the incident to management. A medical examination determined that no injury had occurred.

What happened? The individual was distracted in that they were involved in both the seminar and the experiment. They understood the eyewear requirement and knew that they were staged in the hutch, but chose to grab a pair of eyewear conveniently located on the way to the hutch. The two types of LPE looked very similar and the labeling was described as hard to see.

(Left) – Eyewear for Lower Power Laser (Right) - Eyewear for 488 nm Laser

Specially marked LPE

What can be done? In situations where the worker has a choice of which PPE to use, the chance for error goes up. Though it is the responsibility of the wearer to inspect any PPE prior to donning to ensure that it is both correct for the job and safe (no defects), we can provide assistance in the selection process. Some options are:

1. Have only the LPE available for the laser in use
2. Use posters at the entrance depicting the filter that should be worn
3. Specially mark the glasses for the operation where they are used

You still must inspect the LPE for defects or damage...BE SAFE!

2019 International Laser Safety Conference

The International Laser Safety Conference was held in Kissimmee, Florida March 18-21. Again, the DOE was very well represented with the following presenters:

Aaron Potash (LLNL) - *Human Performance Improvement—How Does it Benefit Your Laser Incident Investigations?*
Igor Makasyuk (SLAC) - *Calculating Laser Eyewear Effective OD and VLT using Manufacturer OD Curves*
Jamie King (LLNL) - *Beyond Class 4, Laser Safety Controls for Very High-Power Lasers*
Mike Woods (SLAC) - *Controls for Multi-wavelength, Tunable and Continuum Lasers*
Rock Neveau (LBNL) - *You Just Had a Laser Accident, What Do You Do Now?*
Tekla Staley (INL) - *What's In Your Laser?*
Wes Chase (LLNL) - *Non-Beam to the Extreme*

Beyond this, two labs brought home awards:
Sandia National Labs
Achievement in Laser Safety Education (ALSE) for R&D
Lawrence Livermore National Laboratory
Board of Laser Safety Illumination Award
Jamie King
R. James Rockwell, Jr. Educational Achievement Award

GREAT JOB TO ALL!

Mendy Brown receives ALSE Award from Nat Quick (LIA Executive Director)

Jamie King holds Illumination and Educational Achievement Award

Acknowledgement:
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