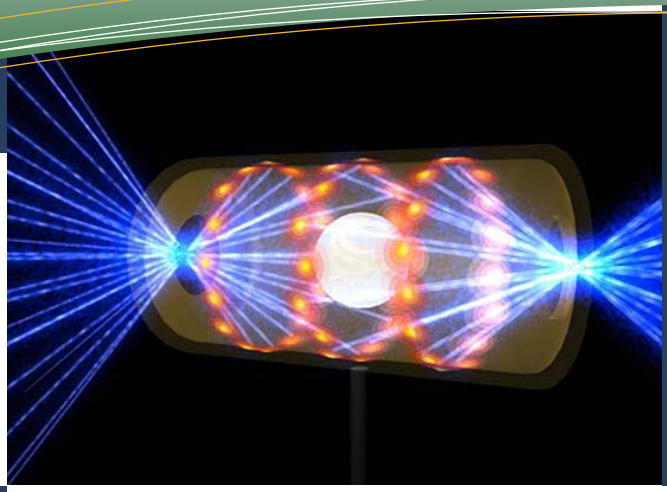
Volume 1
Issue 1

Laser Lessons NewsLetter



This issue

The Eye is an incredible organ. Made up of several different structures, it provides an optical system that even the best of today's technology cannot duplicate. It can distinguish more than one million colors and take in more information than the largest telescope known to man.

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Introduction

Welcome to the first issue of the new Institutional Laser Safety Newsletter. Many may be familiar with the newsletter that was published out of the NIF&PS Directorate. We hope to continue to build off that and bring this information to a much wider audience. This newsletter is intended to provide our laser user community with a source of information relating to laser safety topics and concerns. We will publish electronically on a quarterly basis. Do not hesitate to contact me if you would like to see a topic covered in future issues.

Laser Safety Officers

My name is Jamie King and I assumed responsibility as the Institutional Laser Safety Officer (LSO) this past August from Mark Ludwig. Mark has since moved on to other roles and responsibilities. I would like to thank him for his many years in helping to keep the LLNL Laser Safety Program "World Class".

I have 20 years experience in the field of laser safety. I previously served as the LSO at NASA-Ames Research Center and Sandia National Labs-California prior to coming to LLNL in 2006. I will continue to primarily support the NIF&PS PAD while handling Institutional Laser Safety responsibilities. My direct backup is Sam Pogers from Team 2. Sam serves as the Assistant Laser Safety Officer and supports the NIF as their Industrial Safety Professional. There are also six Deputy Laser Safety Officers (DLSOs) who support our many laser using directorates:

- **Tanda Clauson- HEAF**
- **Larry Crowder- AEED, BIO, CSD, M&CM**
- **Gail Everson- WCI**
- **David Hill- Site 300**
- **Myron Reyes- Physics, GS**
- **Mike Williams- Engineering**

Our Laser Safety Program is successful only as a team effort. It requires that all be involved. The LSOs are here to provide you with the support to do your job safely. Do not hesitate to contact any one of us if you have questions or concerns.

We can help you in performing in-depth hazard evaluations of your operation, direct you to commercial vendors for various safety supplies and equipment, and provide you with the opportunity to try on different styles of frames and filters prior to purchase of your laser safety eyewear.

We will cover many topics in the upcoming issues ranging from eyewear to barriers and enclosures. Let's begin with covering one of the basic aspects of laser safety, the biological effects of a laser beam to the eyes and skin.

Eye Fun Facts*

Your eyes are the most complex organs you possess except for your brain.

Your eyes are composed of more than 2 million working parts.

The average person blinks 12 times per minute - about 10,000 blinks in an average day.

Your eyes can process 36,000 bits of information every hour.

Only 1/6th of your eyeball is exposed to the outside world.

Color blindness is 10 times more common in males than females.

All babies are color blind when they are born.

The external muscles that move the eyes are the strongest muscles in the human body for the job that they have to do. They are 100 times more powerful than they need to be.

The eye is the only part of the human body that can function at 100% ability at any moment, day or night, without rest.

The eyeball of a human weighs approximately 28 grams.

The eye of a human can distinguish 500 shades of the color gray.

People generally read 25% slower from a computer screen than from paper.

Men are able to read fine print better than women can.

It is impossible to sneeze with your eyes open.

Your eye will focus on about 50 things per second.

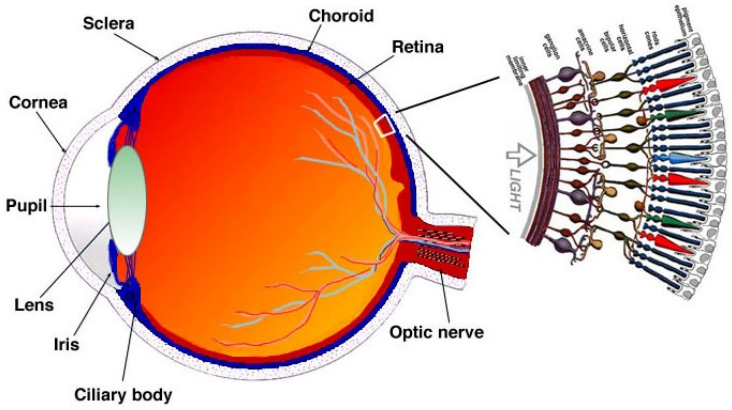
Your eyes contribute towards 85% of your total knowledge.

About half of our brain is involved in the seeing process. Humans are very much visual animals.

Under the right conditions, the human eye can see the light of a candle at a distance of 14 miles.

*www.converyoptometrists.com

Biological Effects



The Eye

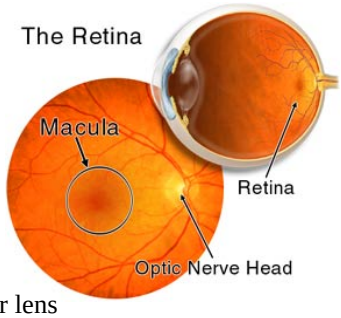
The Eye is an incredible organ. Made up of several different structures; it provides an optical system that even the best of today's technology cannot duplicate. It can distinguish more than one million colors and take in more information than the largest telescope known to man.

The outer most structure of the eye is the **Cornea**. It is the only living tissue of the body that is in constant contact with the environment. Its only protection is from a thin tear film, which provides nutrients and lubrication, and the blinking of the eyelid. The cornea has a very high rejuvenation rate of approximately 24-48 hours. Old corneal cells are sloughed off as you sleep.

The cornea provides 70-75% of the refractive power of the eye. That is why LASIK eye surgery works so well. The removal of only a small layer of the cornea significantly affects vision.

The cornea is affected by wavelengths on the extreme end of the ultraviolet (UV), 100-315nm, and infrared (IR), 1400mm-1mm, bands. The damage time is short term, or acute, and is accumulative for certain UV wavelengths. If the cornea is catastrophically damaged, you may receive a corneal transplant. Donor rejection is small because of the low blood flow in the cornea. The cornea has no blood vessels.

The **Lens** sits just behind the iris. Unlike the cornea, which sloughs off old cells, new cells are formed around the outside of the lens. Imagine the peels of an onion. As more layers are formed, the nucleus of the lens is compressed smaller and smaller. This process squeezes out the water within, and the ability to flex your lens decreases. This is the reason why we require the use of reading glasses later in life.



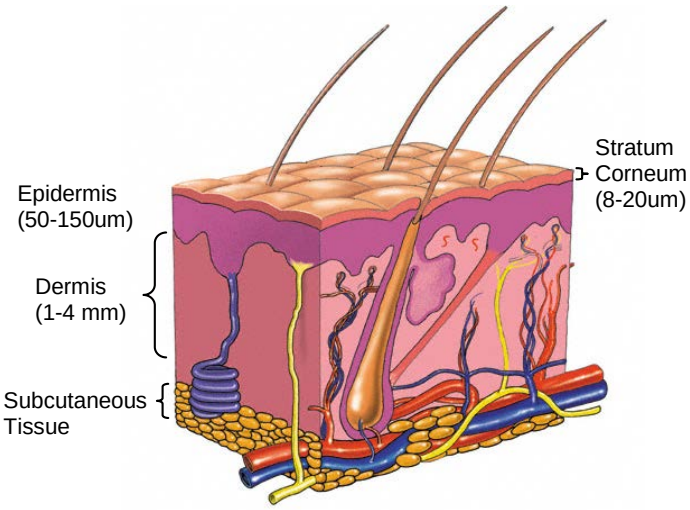
The lens is affected by wavelengths in the near UV (315-400nm). The damage (cataracts) takes time to appear and is a chronic effect. Cataracts may also develop from diabetes, traumatic eye injuries, exposure to the sun, or from taking certain medications for a long period of time.

Most of our concern comes from using UV lasers and lamps. It is important to wear proper eyewear when using these types of sources. It is also important to use a good pair of UV blocking sunglasses when out in the sun. Using cheap sunglasses only dilates the pupil, allowing UV radiation from the sun to pass through to your lens.

Should a cataract impair ones vision, the lens may be removed and replaced with an artificial one. Though this sounds drastic and traumatic, it is an outpatient procedure performed under local anesthesia.

The **Retina** is an extension of the brain and part of the central nervous system. It is made up of rods (~ 120 million) and cones (~ 6 million). The rods provide for peripheral and night vision and the cones provide for clear and acute color vision.

Visible light is transferred through the eye to the rods and cones where it is converted into a signal and sent to the brain. A majority of the cones are located in the macula. At the center of the macula is the fovea. You can see the fovea in the picture above as a dark



red spot. This is the area of the highest concentration of cones. The most clear and acute vision takes place in this area. As you move out away from the macula, the concentration of cones goes down and the concentration of rods goes up.

The retina is affected by wavelengths in the visible (400-700nm) and near IR (700-1400nm) portions of the spectrum. There is no repair mechanism for a laser injury to the retina. Any damage is permanent. The location where the damage occurs will determine the extent of vision loss. Damage to the fovea region will be much more debilitating than in the peripheral of the retina.

The Skin

The skin takes a back seat to the eyes when talking laser safety. The most likely reason is that thermal injuries usually heal with little or no apparent damage. Also, an injury to an area of the skin is not as devastating as it would be to one of your eyes. For this reason, skin injuries are rarely reported.

Due to the surface area of the skin, the probability of exposure is far greater than that of the eye. Because of the effects of UV radiation, we should be as concerned about providing protection for our skin as we are for our eyes.

Shown above is a cross-section representation of the skin. The four main components of interest are labeled. Each is briefly covered to better understand their function.

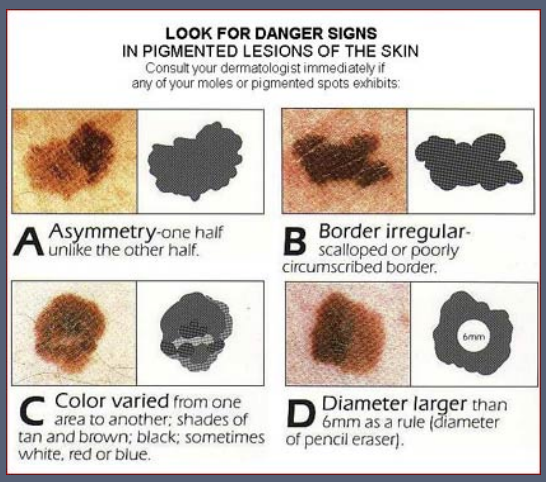
The **Epidermis** is the outermost layer of the skin. It contains the **Stratum Corneum**, which provides the skin with a protective covering. The Epidermis is where tanning takes place. The **Dermis** is much thicker than the Epidermis. It varies in thickness throughout the body from 1-4 mm. The Dermis contains mostly connective tissue, which gives

*Skin Cancer Q & A

Q: Where can skin cancer develop?

A: Skin cancer develops primarily on areas of sun-exposed skin, including the scalp, face, lips, ears, neck, chest, arms and hands, and on the legs in women. But it can also form on areas that rarely see the light of day — your palms, beneath your fingernails, the spaces between your toes or under your toenails, and your genital area.

Skin cancer affects people of all skin tones, including those with darker complexions. When melanoma occurs in those with dark skin tones, it's more likely to occur in areas not normally considered to be sun-exposed.
*www.mayoclinic.com



Skin Fun Facts

The skin is the largest organ in the body, accounting for 12 – 15% of the total body weight.

There are 2 different types of skin :

- Glaborous skin which is non hairy (i.e. soles of feet and palms of hands)
- Hairy skin

The average human being has 21 sq ft of skin and about 300 million skin cells.

The skin is constantly renewing itself from the bottom up and takes 52 – 77 days to shed cells.

Humans shed about 600,000 particles of skin every hour – about 1.5 pounds a year. By 70 years of age, an average person will have lost 105 pounds of skin.

Each half square inch of skin has approx 10 hairs, 15 sebaceous glands, 100 sweat glands, and 3.2 feet of tiny blood vessels.

There are 45 miles of nerves in the skin of a human being.

Seventy percent of the dust in your home consists of shed human skin.

The main purposes of the skin are to regulate body temperature, produce Vitamin D, and protect the body.

Each year more skin cancer cases are diagnosed than that of lung, prostate, breast, and colon cancers combined.

Between 40 and 50 percent of Americans who live to age 65 will contract skin cancer at least once.

Sources:

The Skin Cancer Foundation and The American Cancer Society

http://www.goodskinhealth.org

the skin its elasticity. The innermost layer is the **Subcutaneous Tissue**. It is made up mostly of fatty tissue which serves as shock absorbers and insulators.

The tissue of the skin acts very much in the same way as the eye. Wavelengths in the visible to near IR are the most penetrating, while the far IR and far UV are mostly absorbed by the outer layer.

For UV exposure prevention, remember to "cover up." We all know to wear our laser eye protection, but do we remember to cover our skin? In most laboratories using UV wavelengths in the NIF Directorate, there is usually a corresponding clean room requirement. This means that clean room clothing is being worn. Clean room garb provides excellent protection, and when wearing gloves and a hood, you are provided with full body protection.

There are areas where UV work is being performed without the requirement of clean room clothing. In these instances, it is very important that you remember to wear long sleeves, or even a lab coat. When thinking of exposure to UV, don't forget the area that gets the greatest exposure in your everyday life: the neck and face. In the end, you are best protected when taking care of the problem at the source (i.e., engineering controls).

Lessons Learned

Each issue will cover a laser related lessons learned. If you know of something that you would like covered, whether it is beam or non-beam related, please forward the information on to me for consideration. This lesson learned was a near miss that occurred at SLAC this past May.

In this situation, a laser operator (laser operator 1) was performing optics work, which did not require laser beams to be present. Laser operation mode for the lab was set to "CLASS 1" which meant that any hazardous beams were fully enclosed. Laser eyewear is not required in Class 1mode. The laser operator was placing an object on the optical table when he noticed a dimly visible red beam from a Class 4 800nm laser on his shirt sleeve. He immediately put in a beam block to disable the hazard and notified the laser Safety Supervisor for the lab. The supervisor disabled laser operation for the lab and then notified the Laser Safety Officer (LSO).

A preliminary investigation was performed on 5/24/2011 by the Laser Safety Supervisor for the lab. It was discovered that the laser safety configuration had been modified on the day previous to the incident. Laser operator 2 had removed a laser safety shutter while in Class 4 operation mode (accessible Class 4 laser beams present and PPE laser eyewear required). Laser operator 2 thought he had put the system in Class 1 operation mode, but left the laser safety shutter removed. This configuration did not fully enclose the Class 4 laser beam as required to satisfy the conditions for Class 1 operation.

Lessons learned pointed to:

1.) Modifications of the laser safety configuration and inadequate WPC (work planning and control) implementation. Any modification to the laser safety system must be done while adhering to WPC requirements. Workers need to consider strict compliance with SOP requirements for hazard controls, including having approval from the LSO when there is a need to implement alternative controls.

2.) Control of Hazardous Energy. When setting a Class 1 operation mode (laser eyewear not required), there is a critical need to verify that necessary Class 1 enclosures are in place to fully contain hazardous laser beams. The controls that are used to move between Class 1 and Class 4 operations must be robust and strict.

3.) Laser work often has a high reliance on administrative procedures (e.g., deciding that Class 1 enclosure requirements are satisfied when setting class 1 mode or ensuring that a laser eyewear requirement is consistent with barrier configuration used to determine which laser wavelengths are enabled). Laser operation has to be well disciplined and executed to ensure safety. Always follow core laser safety practices to ensure adequate beam barriers are in place.