STUDY GUIDE FOR ACCIDENT VICTIM'S VIEW

The following article from Laser Focus, August 1977 describes in detail what it is like to have a Class 4 laser beam enter that most delicate of tissues. Since it is from a laser trade magazine, It is assumed that readers would be familiar with the technical terms in the article.

Neodymium-YAG laser: A solid-state laser. An **Y**ttrium **A**luminum **G**arnet crystal rod is doped with **Neodymium** to produce lasing action when irradiated with a flashlamp. Currently the most popular of high power lasers.

6 milliJoule, 10 nanosecond pulse: There are 100 milliJoules in a Joule. A Joule is a unit of power, or exposure. A Joule is also known as a Watt-second; A 1 Watt light bulb turned on for 1 second gives one Joule of energy. A 10 Watt light bulb turned on for 1/10 (.1) second is also a Joule; 100 Watts on for 1/100" (.01") = 1 J; 1 MegaWatt on for 1 microsecond = 1 J, etc.

In this example, 6 milliJoules delivered in 10 nanoseconds means: ? Watts X 10 nanoseconds = 6 milliJoules.
Solving: .006 Joules divided by .000000010" = 600,000 Watts! Hard to believe, but this is the nature of high peak power lasers! In that short length of time, an awful lot of power is emitted! It's like hitting a nail with a hammer; a lot of power delivered in a very short burst of time.

1,064 nanometer radiation: A sort of **N**ear **I**nfra**R**ed wavelength, the basic "color" emitted by this type of laser. We can't see it because the rods and cones aren't sensitive to it, but it readily passes through the cornea.

Comment

Accident victim's view

Because laser injuries to eyes are rare, workers tend to discount the importance of safety precautions. The following dramatic account by Dr. C. David Decker, a victim of such an accident earlier this year (LF Feb p4), was prepared in the hope that his experience may increase vigilance among his colleagues.

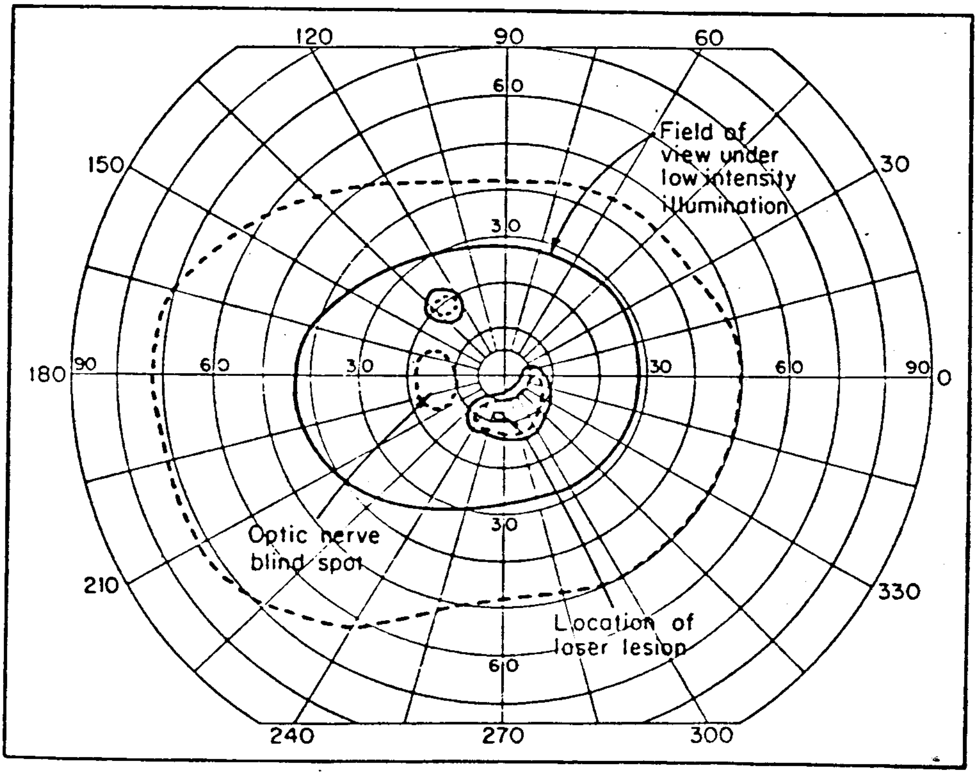
The necessity for safety precautions with highpower lasers was forcibly brought home to me last January when I was partially blinded by a reflection from a relatively weak neodymium-yag laserbeam. Retinal damage resulted from a 6-millijoule, 10-nanosecond pulse of invisible 1,064-nanometer radiation. I was not wearing protective goggles at the time, although they were available in the laboratory. As any experienced laser researcher knows, goggles not only cause tunnel vision and become fogged, they become very uncomfortable after several hours in the laboratory.

When the beam struck my eye I heard a distinct popping sound, caused by a laser-induced explosion at the back of my eyeball. My vision was obscured almost immediately by streams of blood floating in the vitreous humor, and by what appeared to be particulate matter suspended in the vitreous humor. It was like viewing the world through a round fishbowl full of glycerol into which a quart of blood and a handful of black pepper have been partially mixed. There was local pain within a few minutes of the accident, but it did not become excruciating. The most immediate response after such an accident is horror. As a Vietnam War Veteran, I have seen several terrible scenes of human carnage, but none affected me more than viewing the world through my bloodfilled eyeball. In the aftermath of the accident I went into shock, as is typical in personal injury accidents.

As it turns out, my injury was severe but not nearly as bad as it might have been. I was not looking directly at the prism from which the beam had reflected, so the retinal damage is not in the fovea. The beam struck my retina between the fovea and the optic nerve, missing the optic nerve by about three millimeters. Had the focused beam struck the fovea, I would have sustained a blind spot in the center of my field of vision. Had it struck the optic nerve, I probably would have lost the sight of that eye.

The beam did strike so close to the optic nerve, however, that it severed nerve-fiber bundles radiating from the optic nerve. This has resulted in a cresent-shaped blind spot many times the size of the lesion. The diagram is a Goldman-Fields scan of the damaged eye, indicating the sightless portions of my field of view four months after the accident. The small blind spot at the top exists for no discernible reason; the lateral blind spot is the optic nerve blind spot. The effect of the large blind area is much like having a finger placed over one's field of vision. Also I still have numerous floating objects in the field of view of my damaged eye, although the blood streamers have disappeared. These "floaters" are more a daily hinderance than the blind areas, because the brain tries to integrate out the blind area when the undamaged eye is open. There is also recurrent pain in the eye, especially when I have been reading too long or when I get tired.

The moral of all this is to be careful and to wear protective goggles when using highpower lasers. The temporary discomfort is far less than the permanent discomfort of eye damage. The type of reflected beam which injuried me also is produced by the polarizers used in q switches, by intracavity diffraction gratings, and by all beamsplitters or polarizers used in optical chains. —C. DAVID DECKER



EYE DAMAGE caused by laser-pulse is shown in this plot of field of view under high-intensity illumination **dotted lines** *and under low-intensity illumination* **solid lines**. *Outer circles show field of view; the two small regions inside the field of view are blind spots produced by laser damage. The blind spots are larger than the lesion and occupy a larger area under low illumination*