

LASER SAFETY MICRO-COURSE



by

LASER-PROFESSIONALS Inc.

Where the laser user comes first

COURSE CONTENTS

- Basics of Lasers and Laser Light
- Laser Beam Injuries
- Laser Hazard Classes
- Laser Safety Standards
- Laser Control Measures

BASICS OF LASERS AND LASER LIGHT

Light

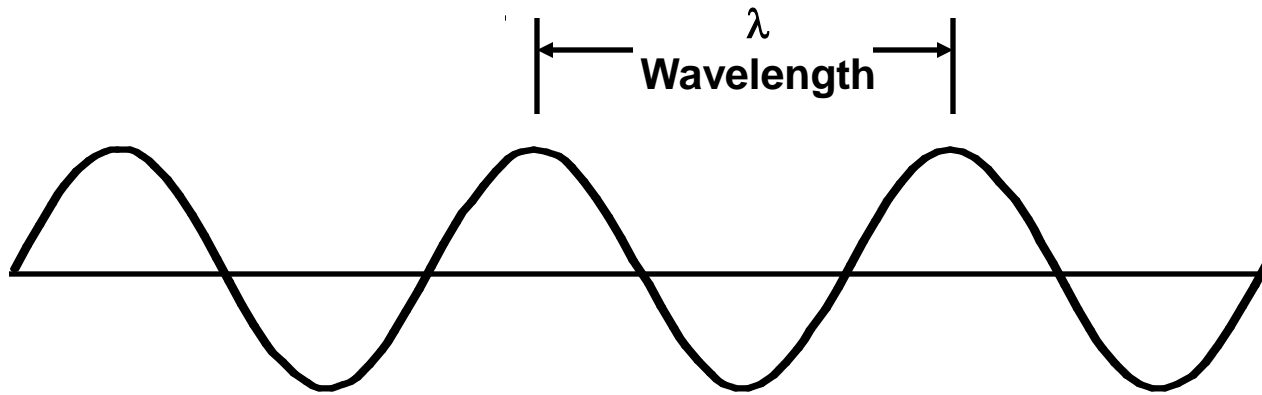
Amplification by

Stimulated

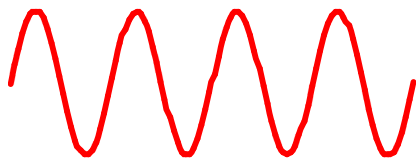
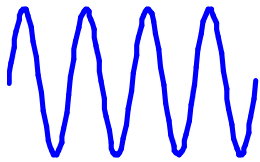
Emission of

Radiation

WAVE NATURE OF LIGHT



Blue: $\lambda = 400$ nm

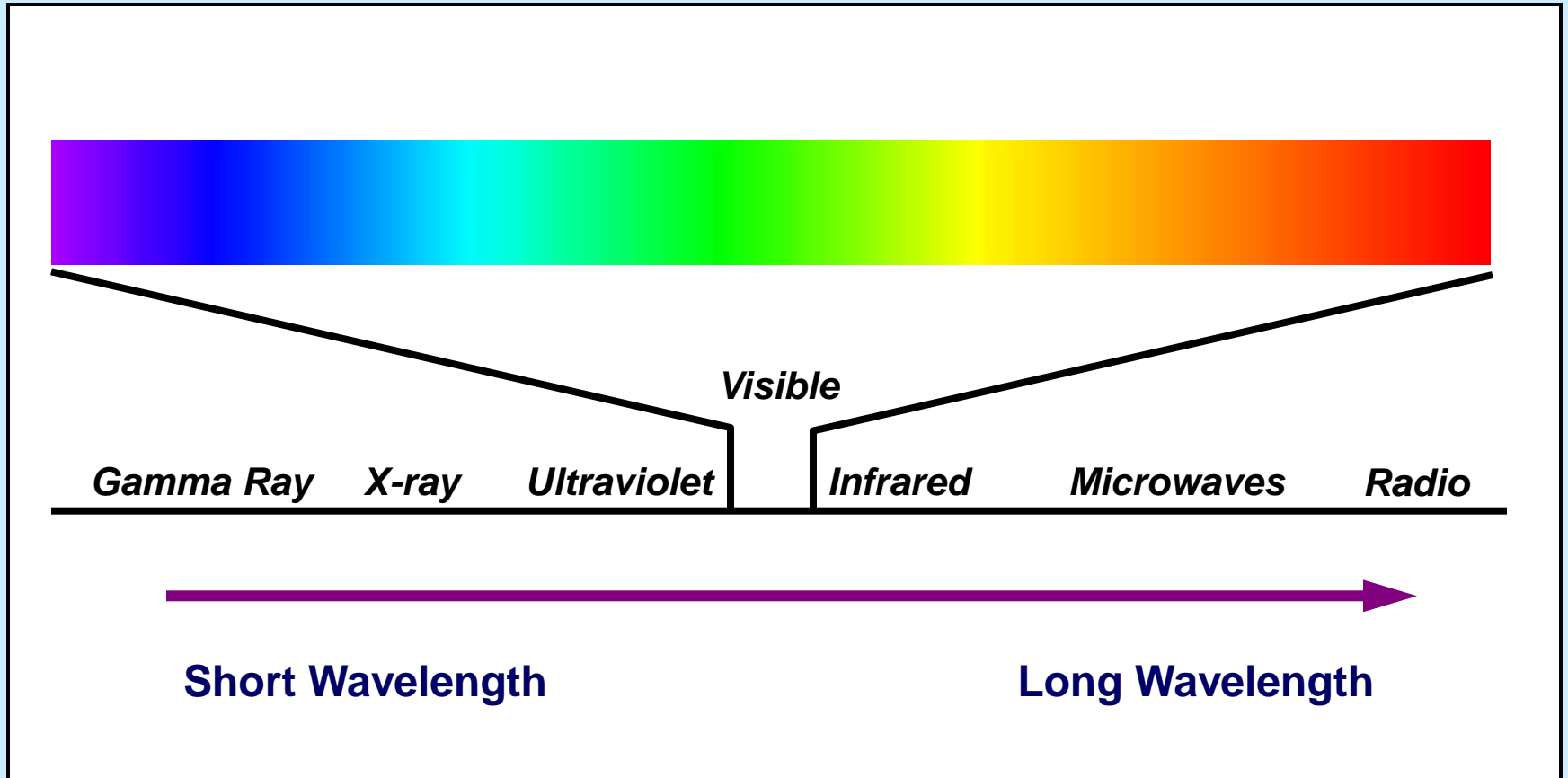


Red: $\lambda = 700$ nm

Light is an electromagnetic wave.

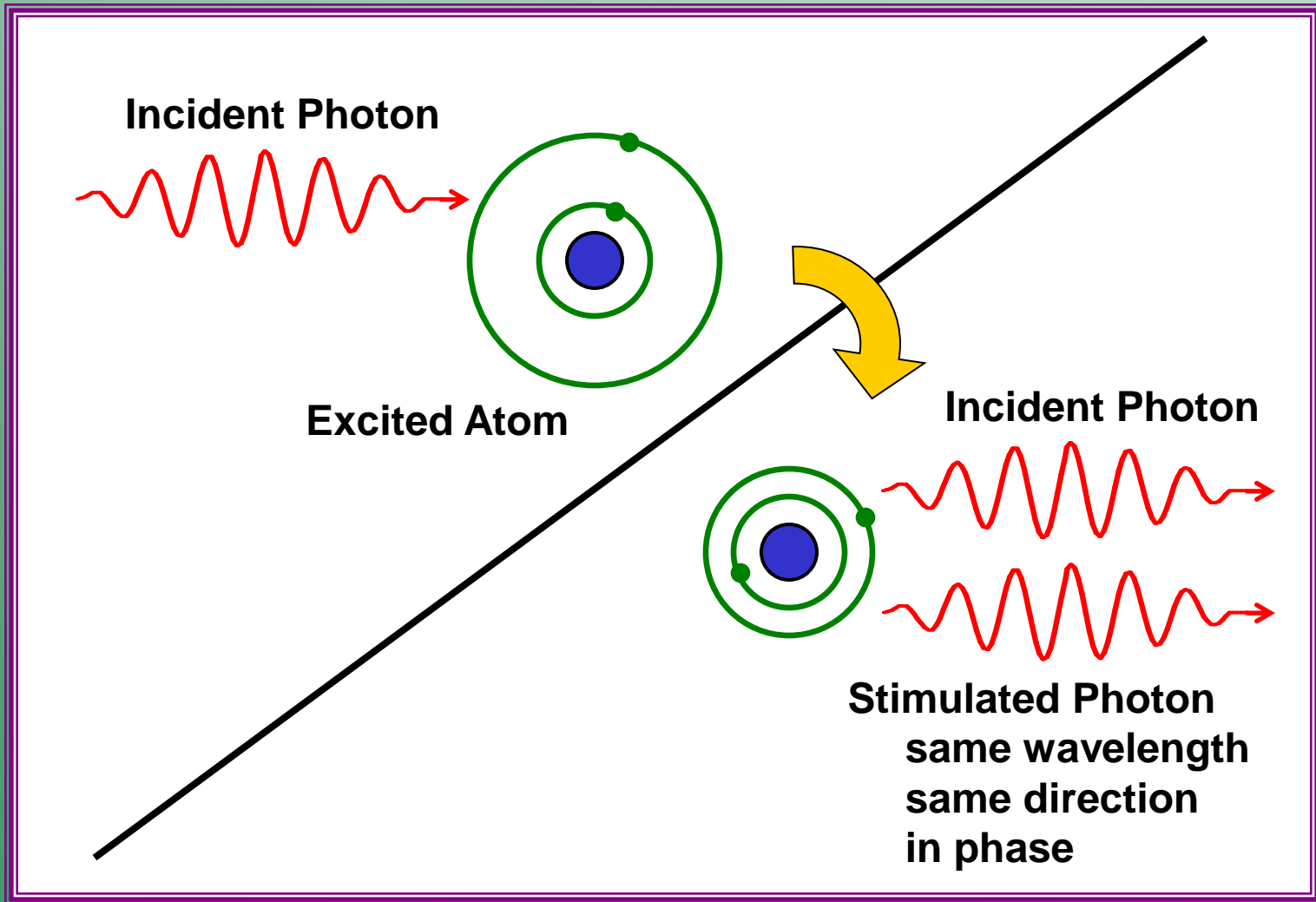
Different wavelengths in the visible spectrum are seen by the eye as different colors.

ELECTROMAGNETIC SPECTRUM



Lasers operate in the ultraviolet, visible, and infrared.

STIMULATED EMISSION

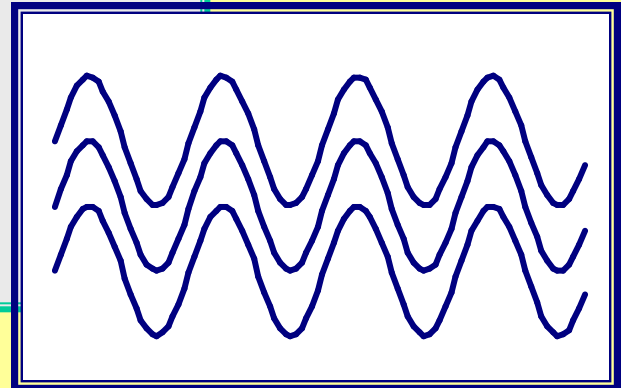


CHARACTERISTICS OF LASER LIGHT

MONOCHROMATIC

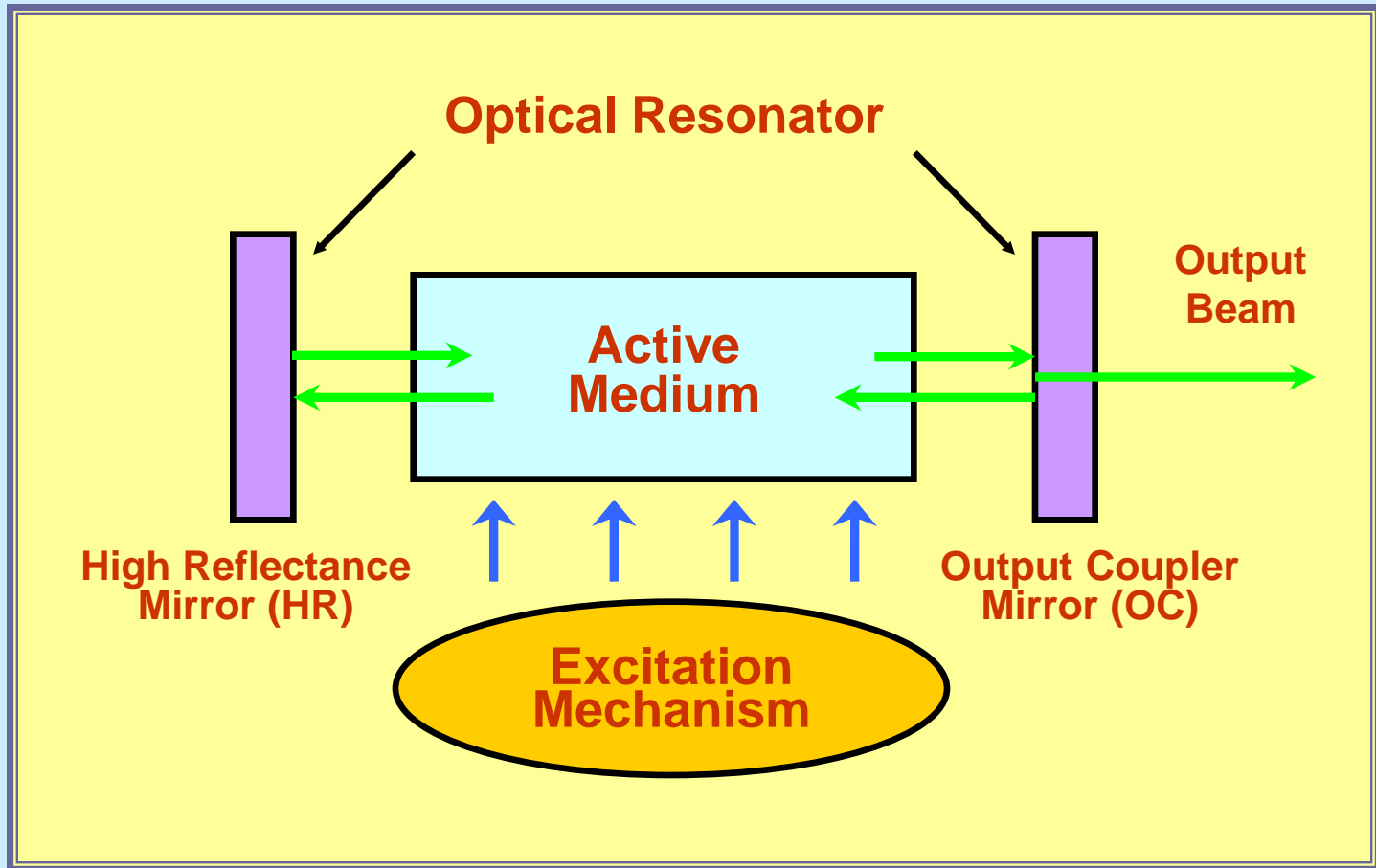
DIRECTIONAL

COHERENT

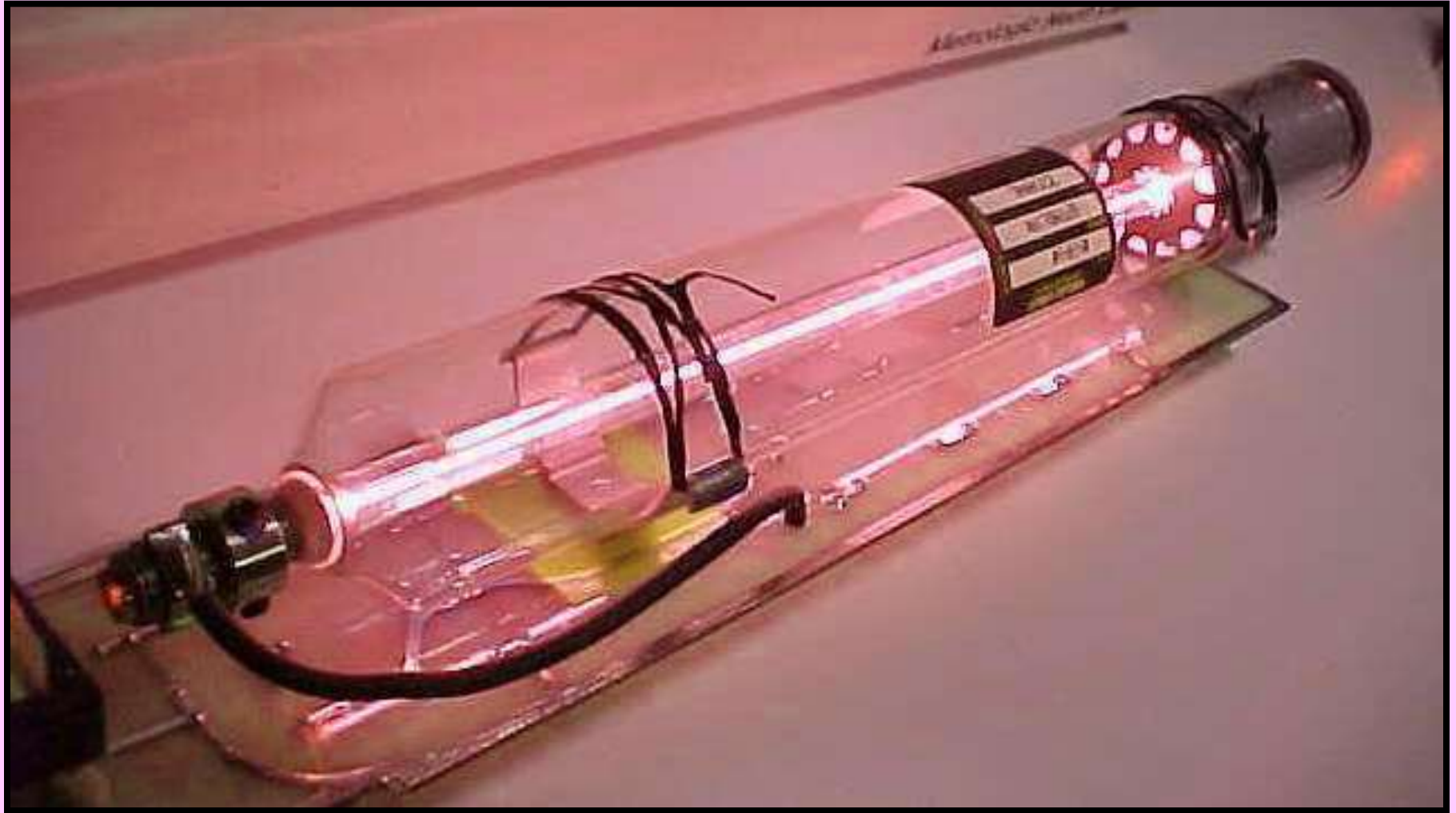


The combination of these three properties makes laser light focus 100 times better than ordinary light

LASER COMPONENTS



HELIUM-NEON GAS LASER



Courtesy of Metrologic, Inc.

LASER BEAM INJURIES

High power lasers can cause skin burns.

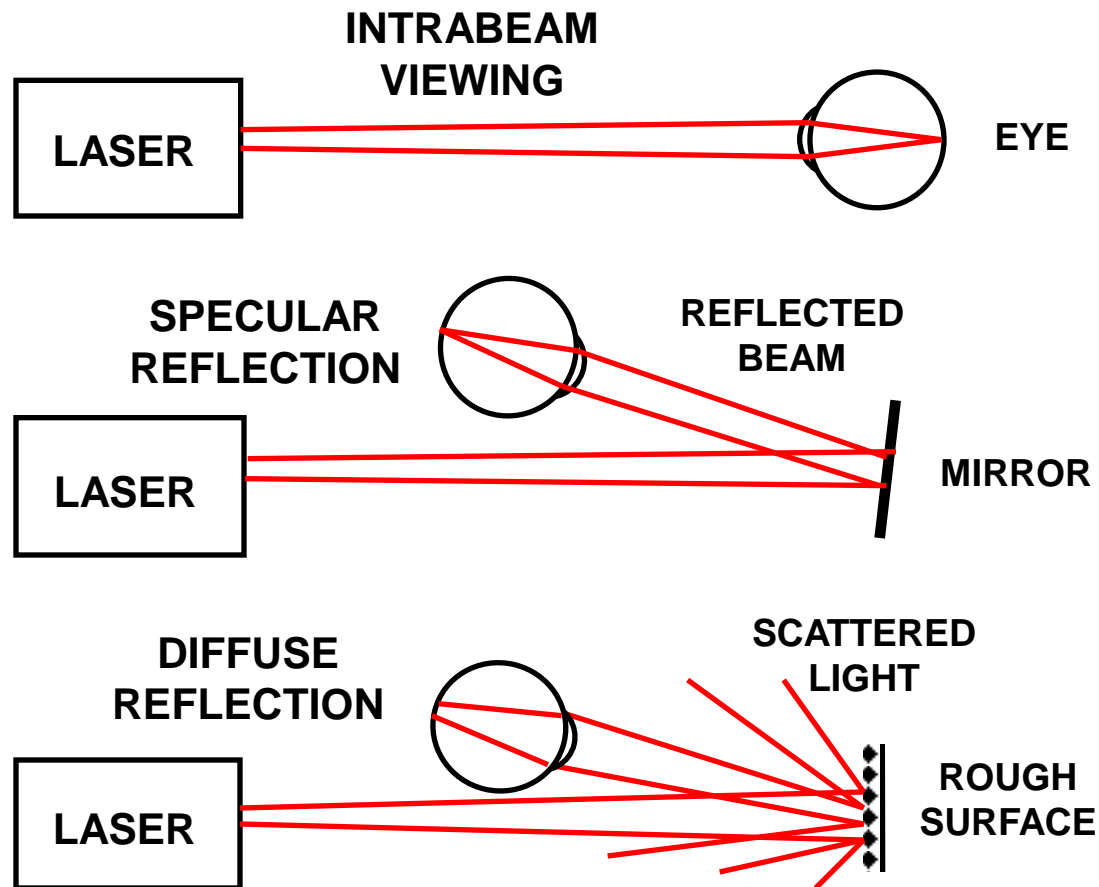
Lasers can cause severe eye injuries resulting in permanent vision loss.

SKIN BURN FROM CO₂ LASER EXPOSURE

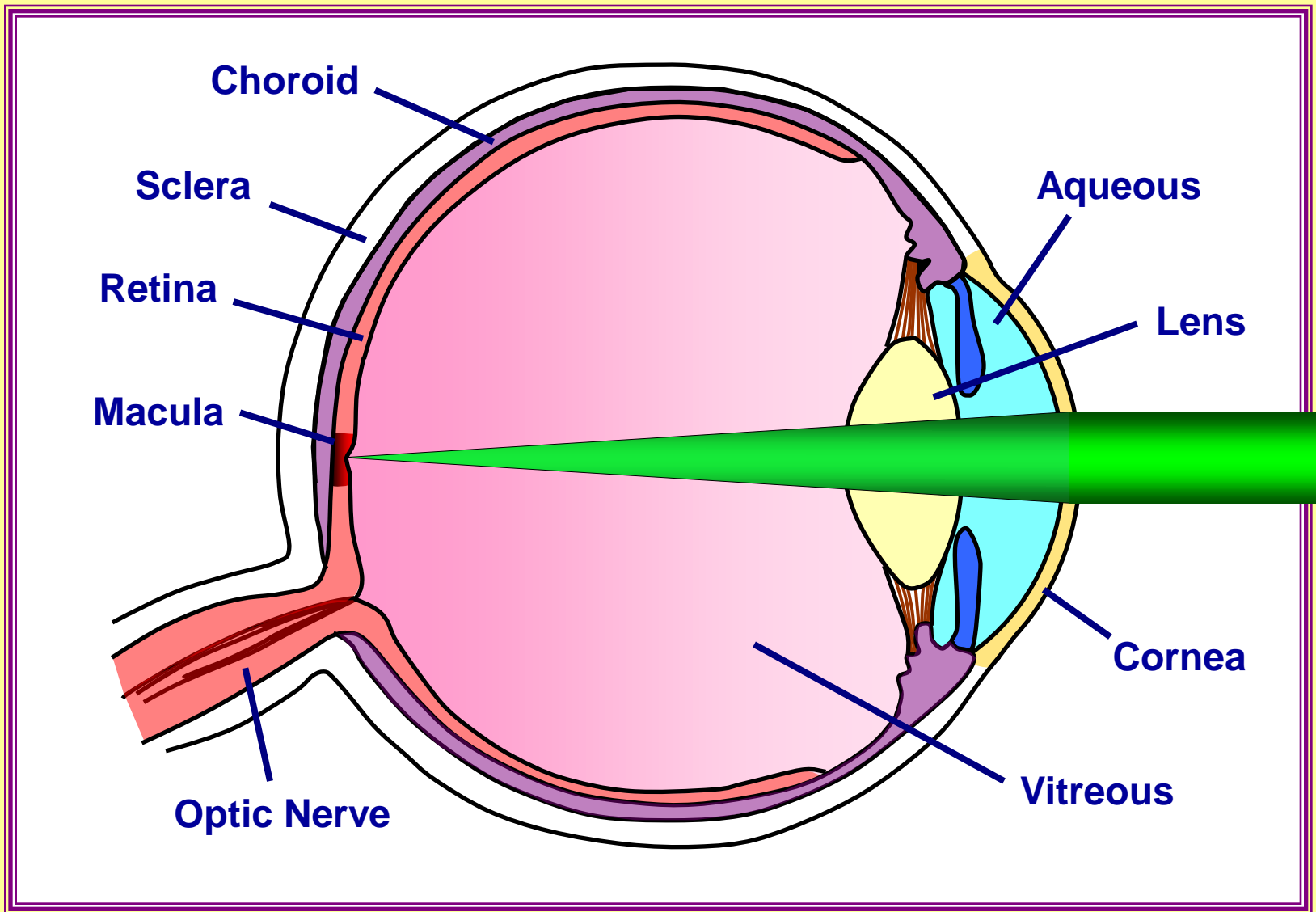


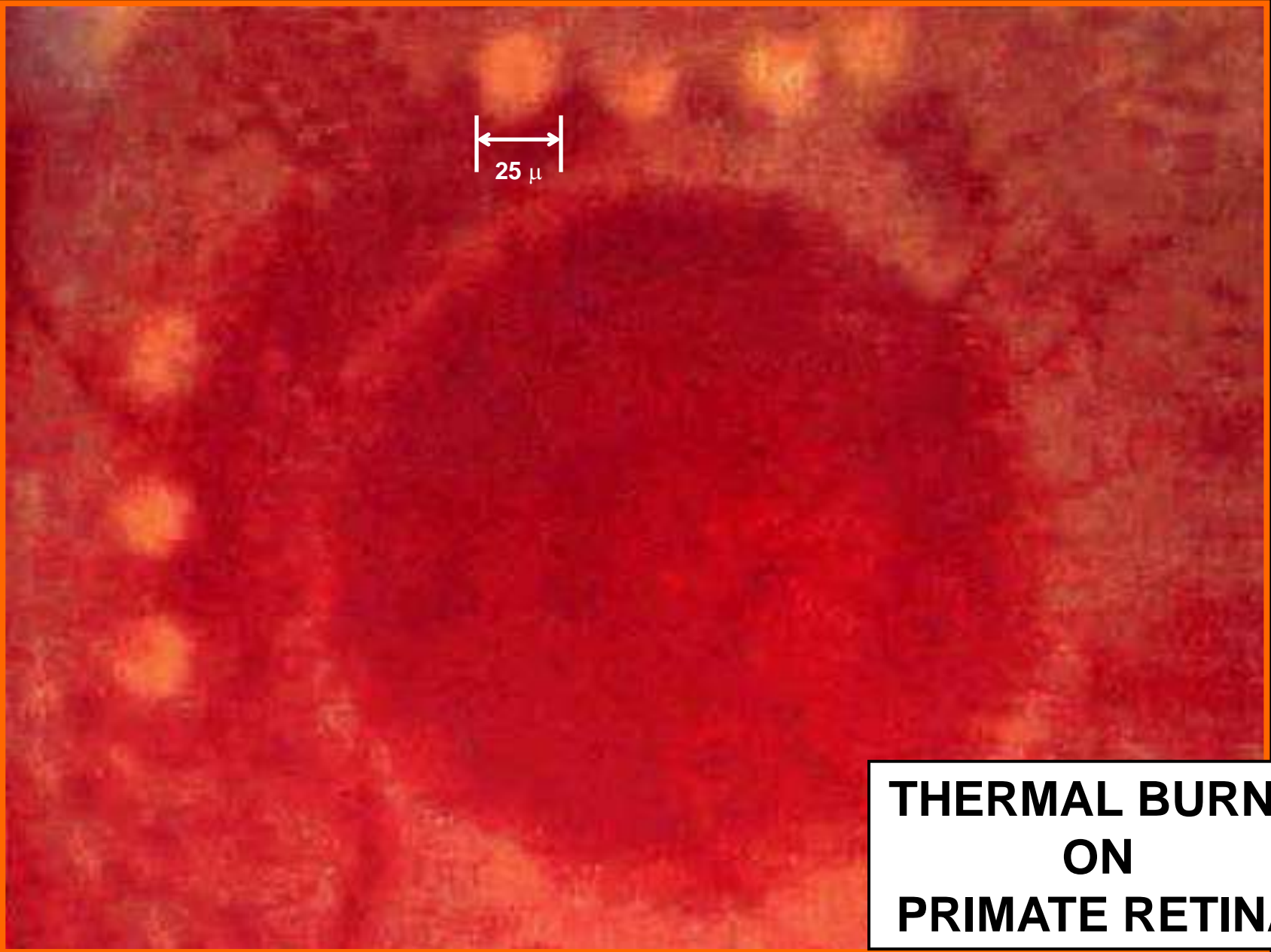
**Accidental exposure to partial reflection of 2000 W CO₂ laser beam
from metal surface during cutting**

TYPES OF LASER EYE EXPOSURE



HUMAN EYE





**THERMAL BURNS
ON
PRIMATE RETINA**

MULTIPLE PULSE RETINAL INJURY



EYE INJURY BY Q-SWITCHED LASER

Retinal Injury produced by four pulses from a Nd:YAG laser range finder.

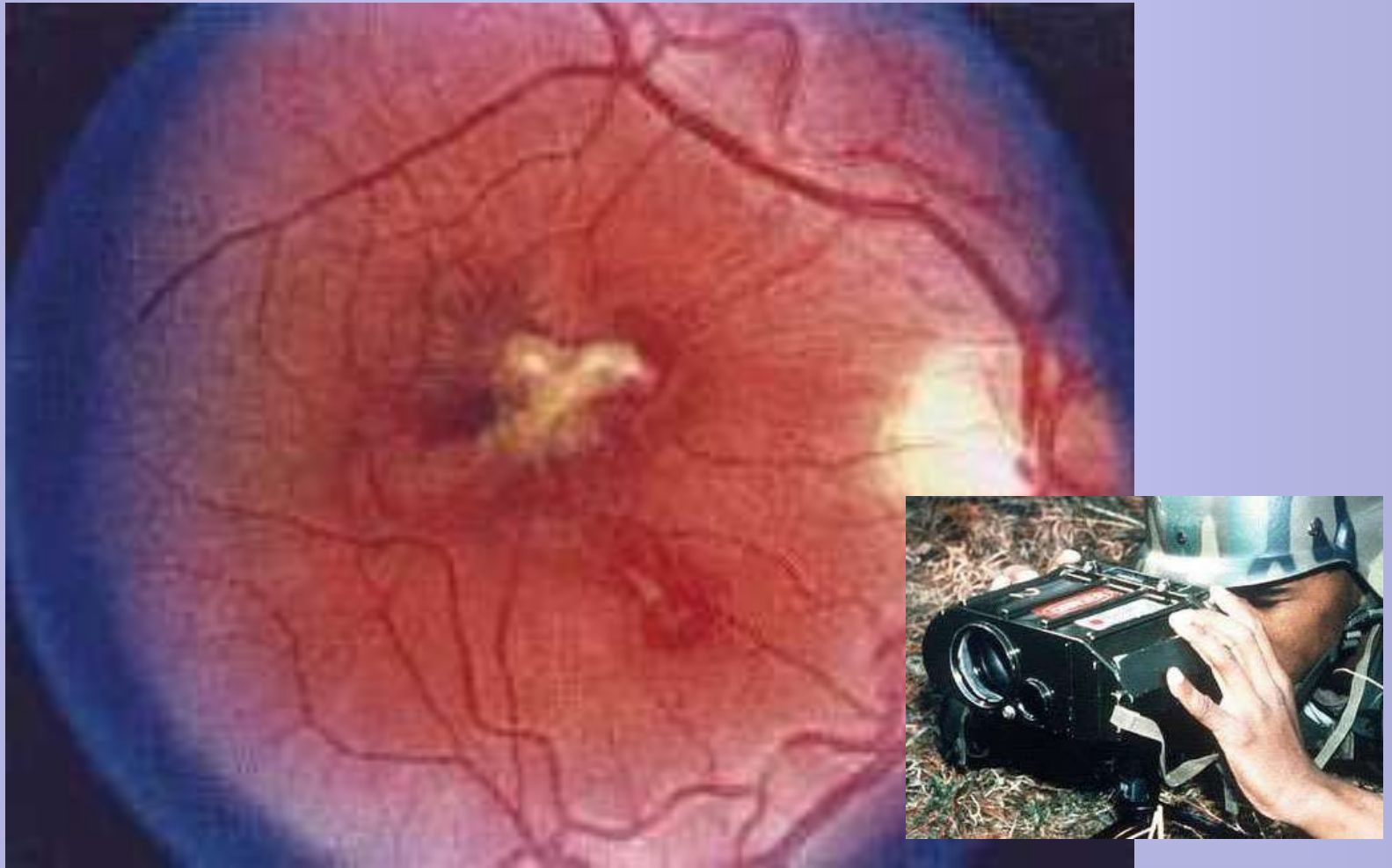


Photo courtesy of U S Army Center for Health Promotion and Preventive Medicine

LASER HAZARD CLASSES

Lasers are classified according to the level of laser radiation that is accessible during normal operation.

CLASS 1

- Safe during normal use
- Incapable of causing injury
- Low power or enclosed beam



CLASS I Laser Product

Label not required

May be higher class during
maintenance or service

Nd:YAG Laser Welder

CLASS 2



Laser Scanners



- Staring into beam is eye hazard
- Eye protected by aversion response
- Visible lasers only
- CW maximum power 1 mW

CAUTION

Laser Radiation
Do Not Stare Into Beam

Helium Neon Laser
1 milliwatt max/cw

CLASS II LASER PRODUCT



CLASS 3a

- Aversion response may not provide adequate eye protection
- CDRH includes visible lasers only
- ANSI includes invisible lasers
- CW maximum power (visible) 5 mW

Expanded Beam

Laser Pointers



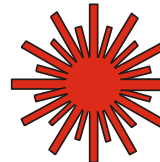
CAUTION



Laser Radiation-
Do Not Stare Into Beam or View
Directly With Optical Instruments

Helium Neon Laser
5 milliwatt max/cw
CLASS IIIa LASER PRODUCT

DANGER



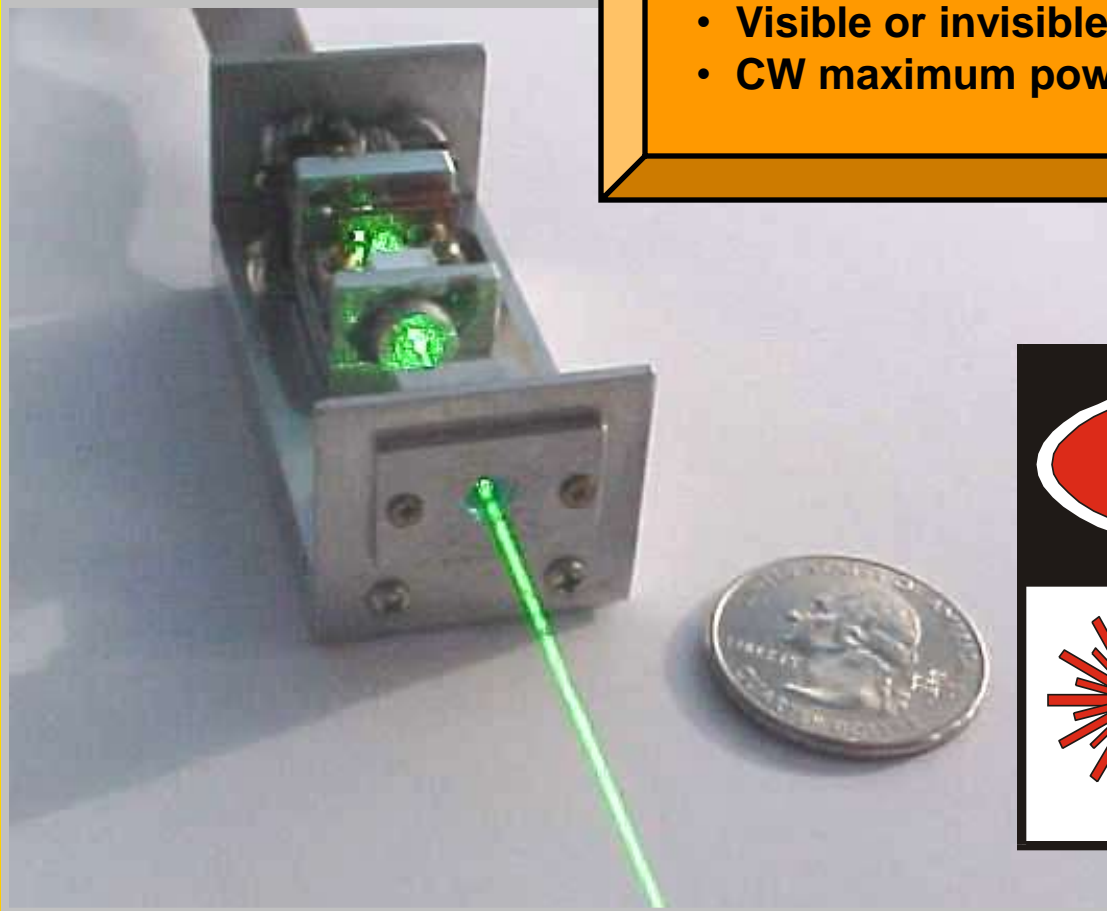
LASER RADIATION-
AVOID EYE EXPOSURE

ND:YAG 532nm
5 milliwatts max/CW
CLASS IIIa Laser Product

Small Beam


CLASS 3b

DPSS Laser with cover removed



- Direct exposure to beam is eye hazard
- Visible or invisible
- CW maximum power 500 mW

DANGER

 **LASER RADIATION-
AVOID DIRECT EXPOSURE TO BEAM**

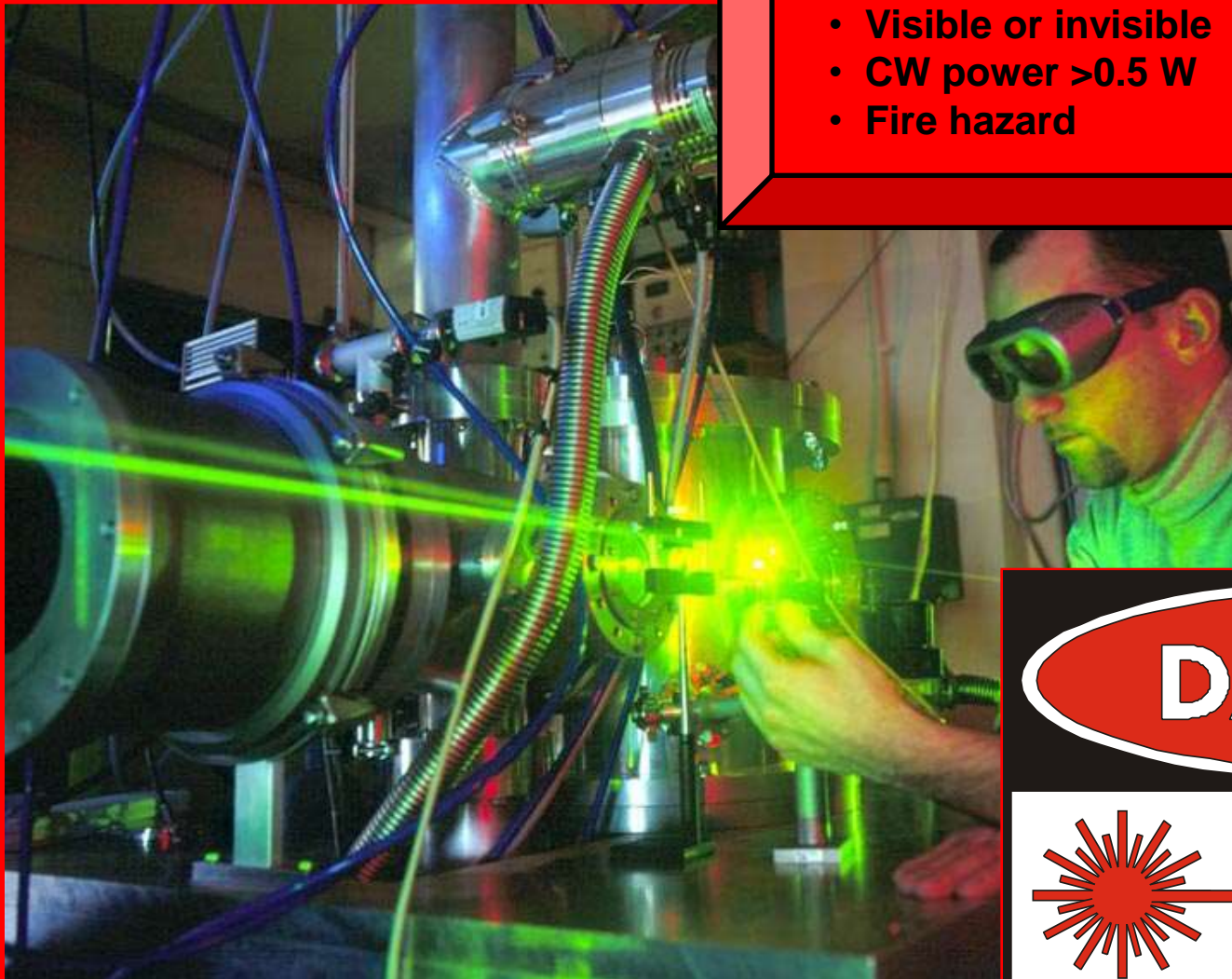
2 ω ND:YAG Wavelength: 532 nm
Output Power 80 mW

CLASS IIIb Laser Product

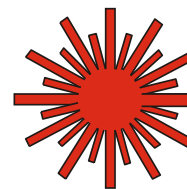
Courtesy of Sam's Laser FAQ, www.repairfaq.org/sam/lasersam.htm, © 1994-2004

CLASS 4

- Exposure to direct beam and scattered light is eye and skin hazard
- Visible or invisible
- CW power >0.5 W
- Fire hazard



DANGER



VISIBLE LASER RADIATION-
AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION

2 ω Nd:YAG
Wavelength: 532 nm
Output Power 20 W
CLASS IV Laser Product

Photo: Keith Hunt - www.keithhunt.co.uk
Copyright: University of Sussex, Brighton (UK)

LASER SAFETY STANDARDS

- **The Federal Laser Product Performance Standard (FLPPS)** of the Center for Devices and Radiological Health (CDRH)
This is federal law and applies to the manufacture of lasers.
- **The American National Standard for Safe Use of Lasers (ANSI Z136.1)**
This is a VOLUNTARY Standard that applies to the use of lasers.
It is “recognized by” :
The Occupational Safety and Health Administration (OSHA)
- **IEC 60825 International Standard**

FEDERAL SAFETY REQUIREMENTS FOR CLASS 1 LASER SYSTEMS WITH ENCLOSED CLASS 3b AND 4 LASERS

Protective Housing

prevents access to laser radiation above safe level.

Safety Interlocks

terminate laser beam if protective housing is opened.

Only authorized personnel may operate laser with interlocks defeated.

Warning Labels

alert personnel if opening the housing might expose a laser hazard.

Viewing Windows and Optics

limit laser and collateral radiation to safe levels.

CDRH CLASS WARNING LABELS



Class II
Class IIIa with expanded beam



Class IIIa with small beam
Class IIIb
Class IV

INTERNATIONAL LASER WARNING LABELS



Symbol and Border: Black
Background: Yellow



Legend and Border: Black
Background: Yellow

OVERVIEW OF ANSI Z136.1

1. MANAGEMENT APPOINTS LASER SAFETY OFFICER
2. LSO VERIFIES LASER CLASSIFICATION
3. LSO EVALUATES LASER HAZARDS
4. LSO SPECIFIES CONTROL MEASURES

ENGINEERING CONTROLS

ENCLOSURES

INTERLOCKS

WARNING SYSTEMS

ADMINISTRATIVE AND PROCEDURAL CONTROLS

AUTHORIZED PERSONNEL

STANDARD OPERATING PROCEDURE

TRAINING

PROTECTIVE EQUIPMENT

EYEWEAR

BARRIERS



LASER CONTROL MEASURES

ANSI Section 4.1

“Control Measures shall be devised to reduce the possibility of exposure of the eye and skin to hazardous levels of laser radiation.”

Types of Control Measures

- Engineering
- Administrative
- Procedural

CONTROL MEASURES FOR OPEN BEAM LASERS

Section 4.3.1.1

- Laser Controlled Area**
- Eye Protection**
- Barriers, Shrouds, Beam Stops, etc.**
- Administrative and Procedural Controls**
- Education and Training**



DANGER

VISIBLE and/ or INVISIBLE LASER
RADIATION-AVOID EYE OR SKIN
EXPOSURE TO DIRECT OR
SCATTERED RADIATION.



ND:YAG 1064 nm
100 Watts Max. Average Power

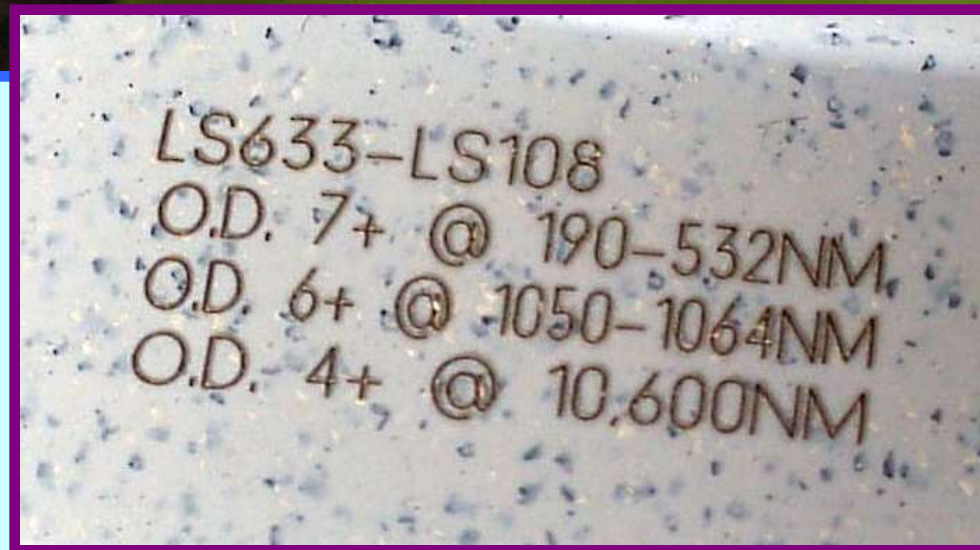
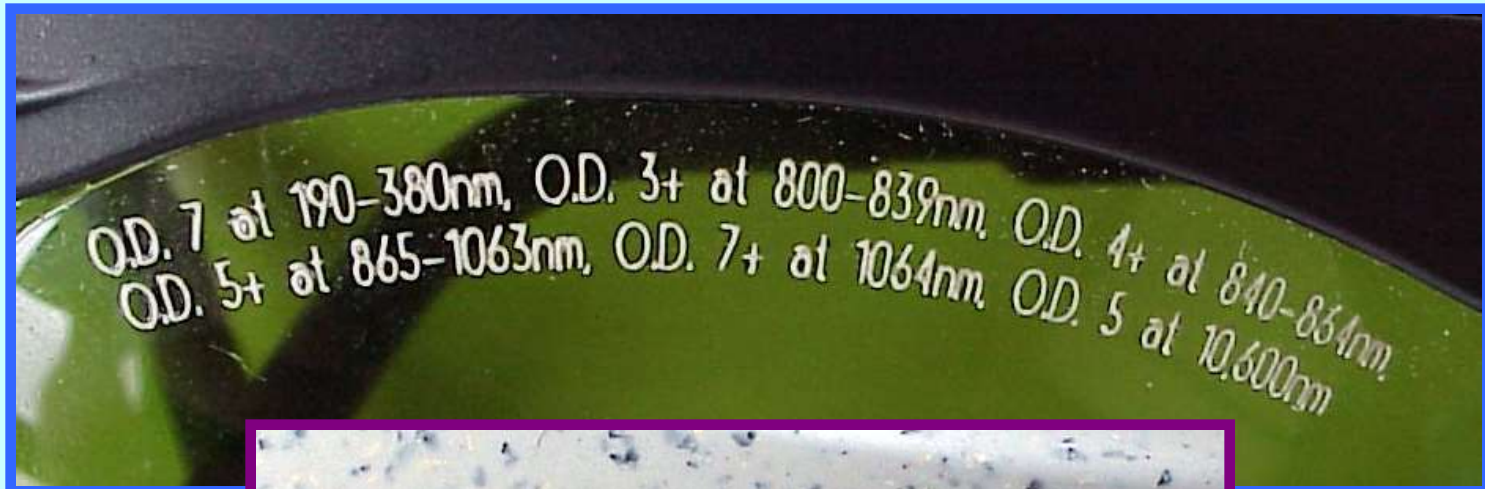
CLASS 4 LASER

Controlled Area Warning Sign

LASER SAFETY EYEWEAR



EYEWEAR LABELS



All eyewear must be labeled with wavelength and optical density.

LASER PROTECTIVE BARRIER



Photo courtesy of



WHO HAS PRIMARY RESPONSIBILITY FOR LASER SAFETY ANY TIME A CLASS 4 LASER IS OPERATED?

The person operating the laser
always has the primary
responsibility for all hazards
associated with laser use.

SAFE WORK PRACTICES

- Operate class 3b and 4 lasers only in an area designed for laser operation and be certain that the beam is terminated on a diffuse beam block at the end of its use path.
- Do not enter a designated Class 3b or Class 4 laser controlled area (posted with a DANGER sign) without approval from a qualified laser operator.
- Always wear laser safety eyewear if a class 4 invisible beam is exposed.

**Thank you for reviewing our course materials
and for promoting laser safety in your workplace.
We hope you will consider us for your
laser safety training needs.**

Johnny Jones
President, Laser-Professionals Inc.
where the laser user comes first



**Check out our easy-to-use laser hazard analysis software at
www.EasyHaz.com**