EDMONDS COMMUNITY COLLEGE

PASADENA CITY COLLEGE

PASADENA CITY COLLEGE

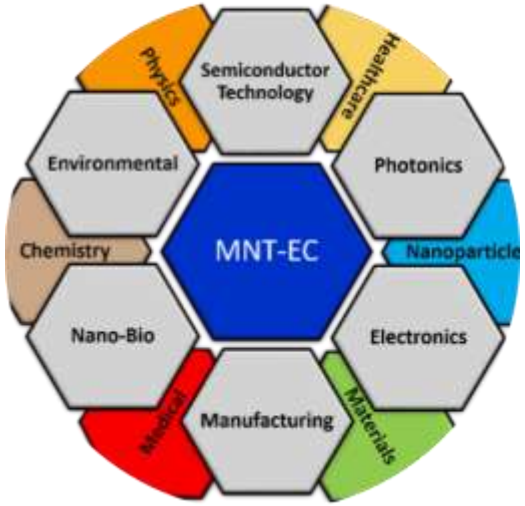
ALAMO COLLEGES DISTRICT
Northwest Vista College

Portland Community College

Micro Nano Technology Education Center

Grow the MNT technician workforce by fostering

1. Coordinated National Approach
2. Professional Development
3. Outreach, recruitment and retention
4. Industry/Education alliance



NSF Award DUE 2000281 Micro Nano Technology Education Center

Micro Nano Technology

Education Center

MNT-EC Photonics Workshops

Greg Kepner

Frank Reed

August 5, 2020

Welcome

Greg Kepner Co-PI
Micro Nano Technology
Education Center

Frank Reed PI
Developing Photonics
Education in Iowa's
Rural Secondary Schools

Presentation Information

What is photonics?
What are some photonics applications?
What about photonics education?
What do photonics technicians do?
Where do photonics technicians work?
How can I attend a photonics workshop?
How do lasers work?
Are lasers safe?
Where can I find more photonics resources?

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Photonics – The Technology of the Future

The 21st century will depend as much on photonics as the 20th century depended on electronics.

Photonics – What is it?

The science and technology of generating, manipulating, and detecting particles of light.

Photonics – What is it?

The science and technology of generating (lasers), manipulating (optics), and detecting (electro-optics) particles of light (photons).

Photonics – Areas of Applications

Manufacturing
Medical
Military
Communication
Information Technology
Science/Research
Entertainment

Applications of Lasers in Manufacturing

Welding
Cutting
Cladding
Marking
Hardening
Drilling
Peening
Forming

Additive Manufacturing
Micromachining
Photolithography
Cleaning/Rust Removal
Heat/Surface Treatment
Alignment
Invisible Fencing for Safety
Deposition

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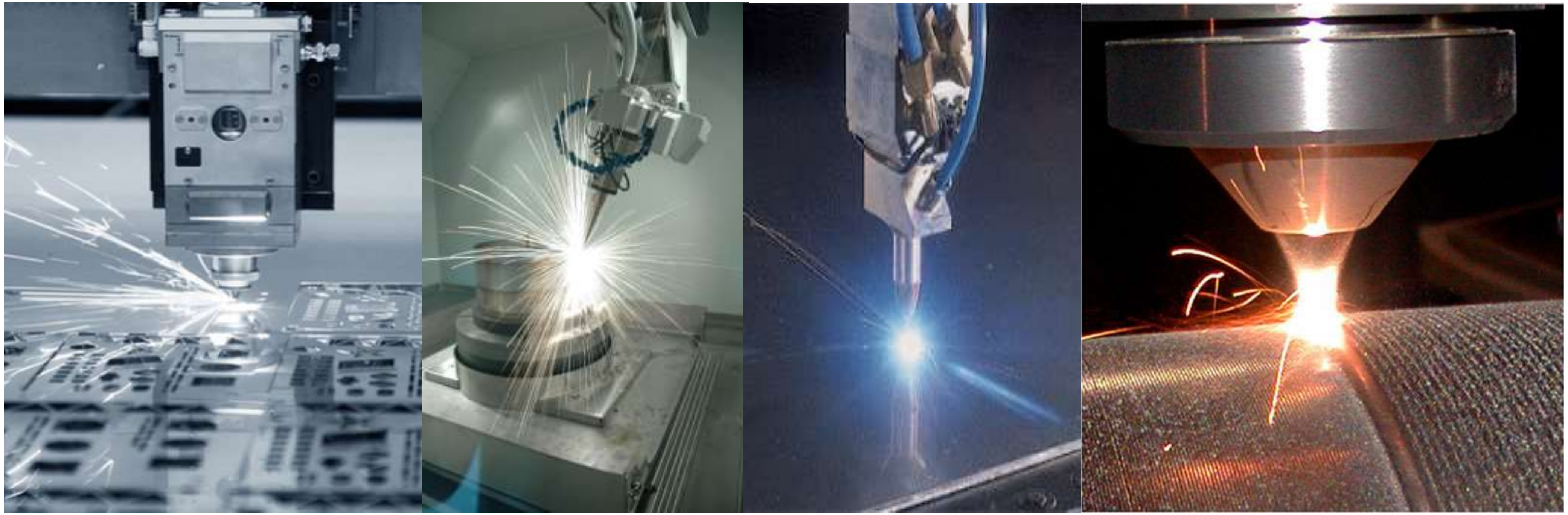
Laser Cutting, Welding, Drilling, and Cladding



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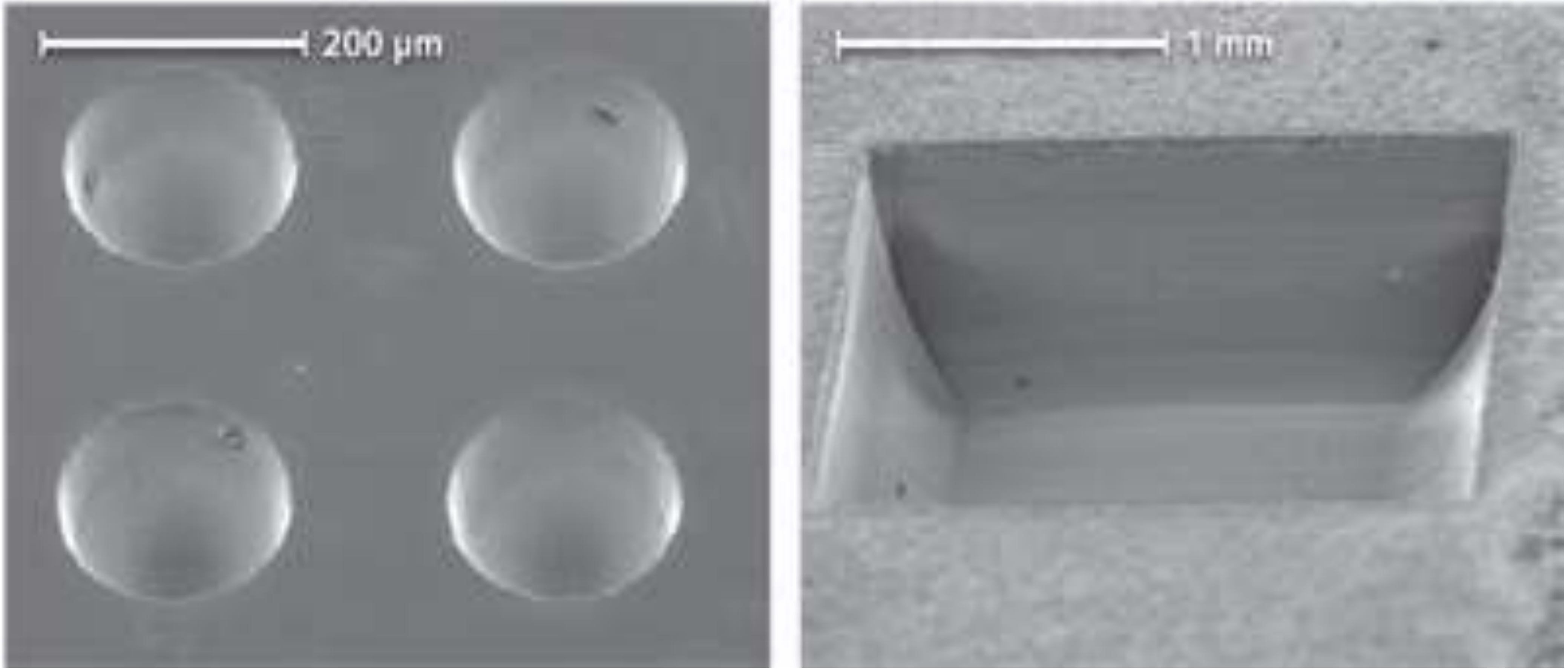
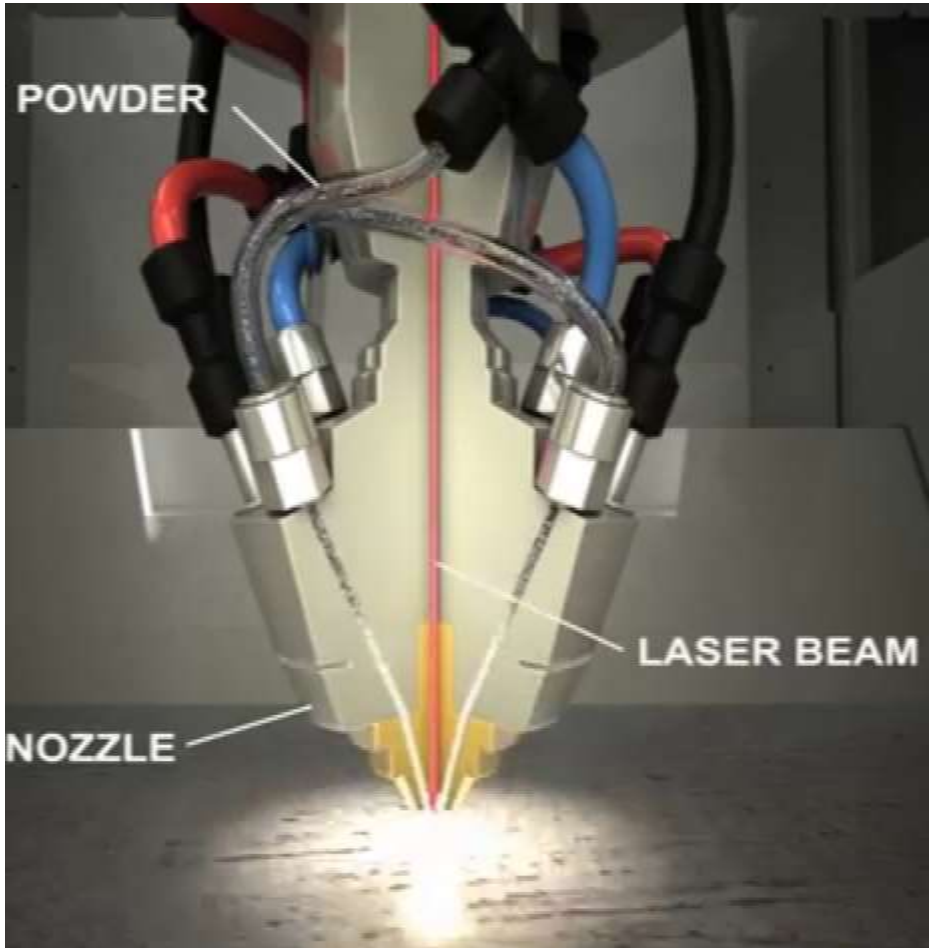
Laser Micromachining



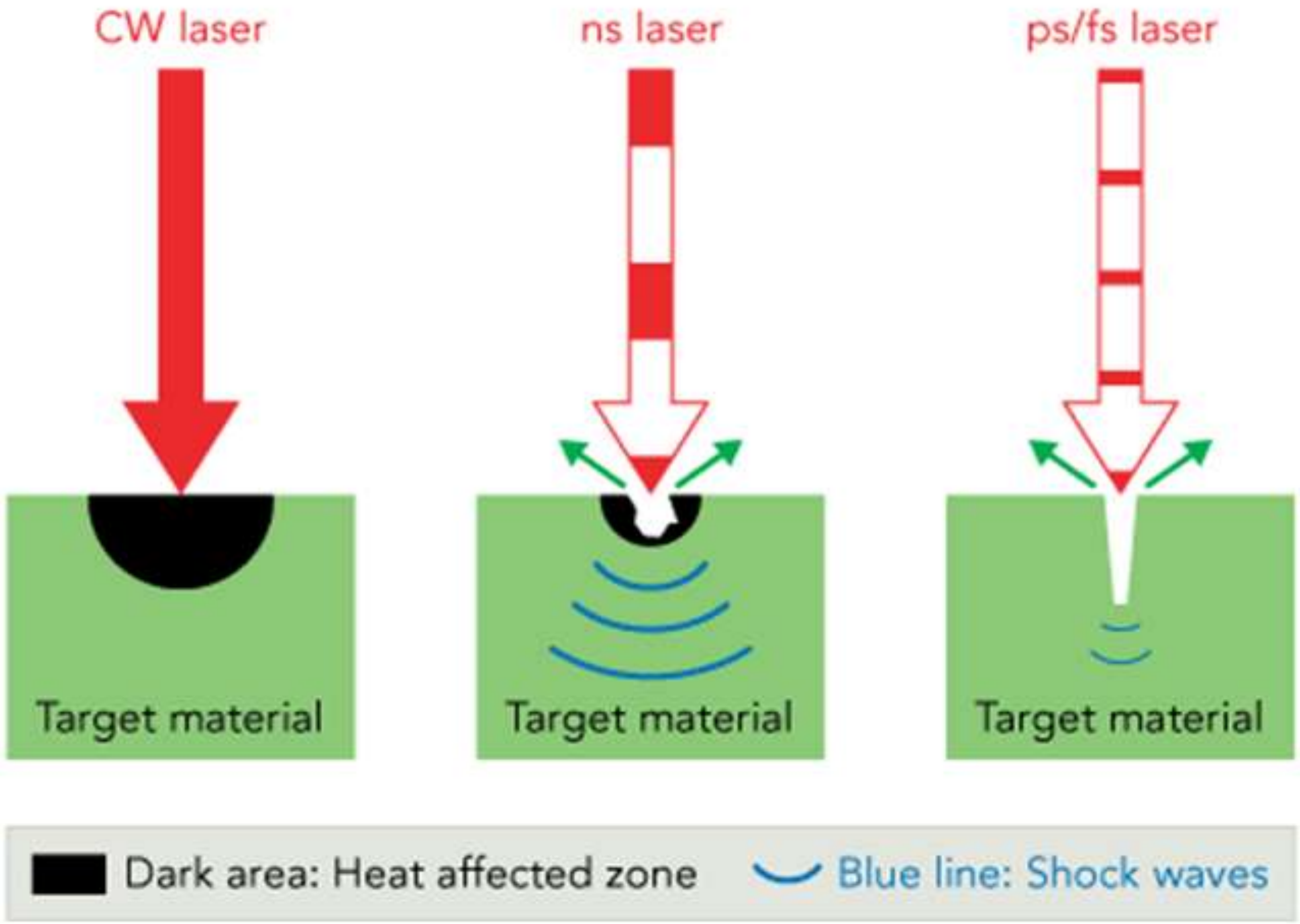
Laser Additive Manufacturing (3D Printing)



Multiple L. A.M. Processes Available

Variety of Materials Used

Laser Micromachining



CW – Continuous Wave

ns – nanosecond $1x10^{-9}s$

ps – picosecond $1x10^{-12}s$

fs - femtosecond $1x10^{-15}s$

Applications of Lasers in the Medical Field

LASIK (Eye surgery)
Laser Scalpel
Endoscopic Surgery
Photobiomodulation (Low Level Laser Therapy)
Photodynamic Therapy (PDT cancer treatment)
Laser Microscopy (Imaging)
Laser Spectroscopy (Light and matter interaction)
Dermatology (Burn and scar management)
Hair removal
Tattoo removal

Stents

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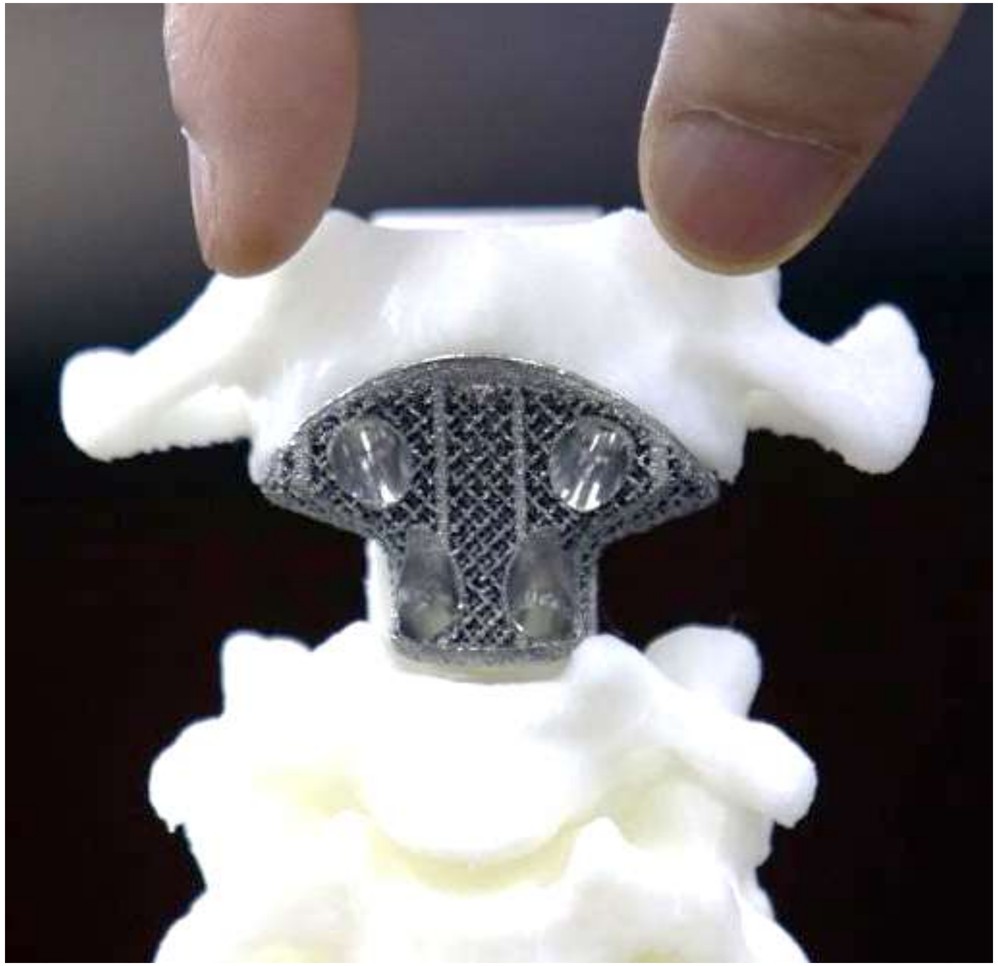
LASIK (laser eye surgery)

Knee Replacement Part made by LAM Process

Spine Implant Part made by LAM Process



Bone Replacement Parts made by LAM Process

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Applications of Lasers in the Military

Range Finding

Laser Sights

Target Designator

Sensor Jamming or Destruction

Missile Countermeasures

Directed Energy Weapons

Strategic Defense Initiative

Non-RF Communications

Target Designator Application

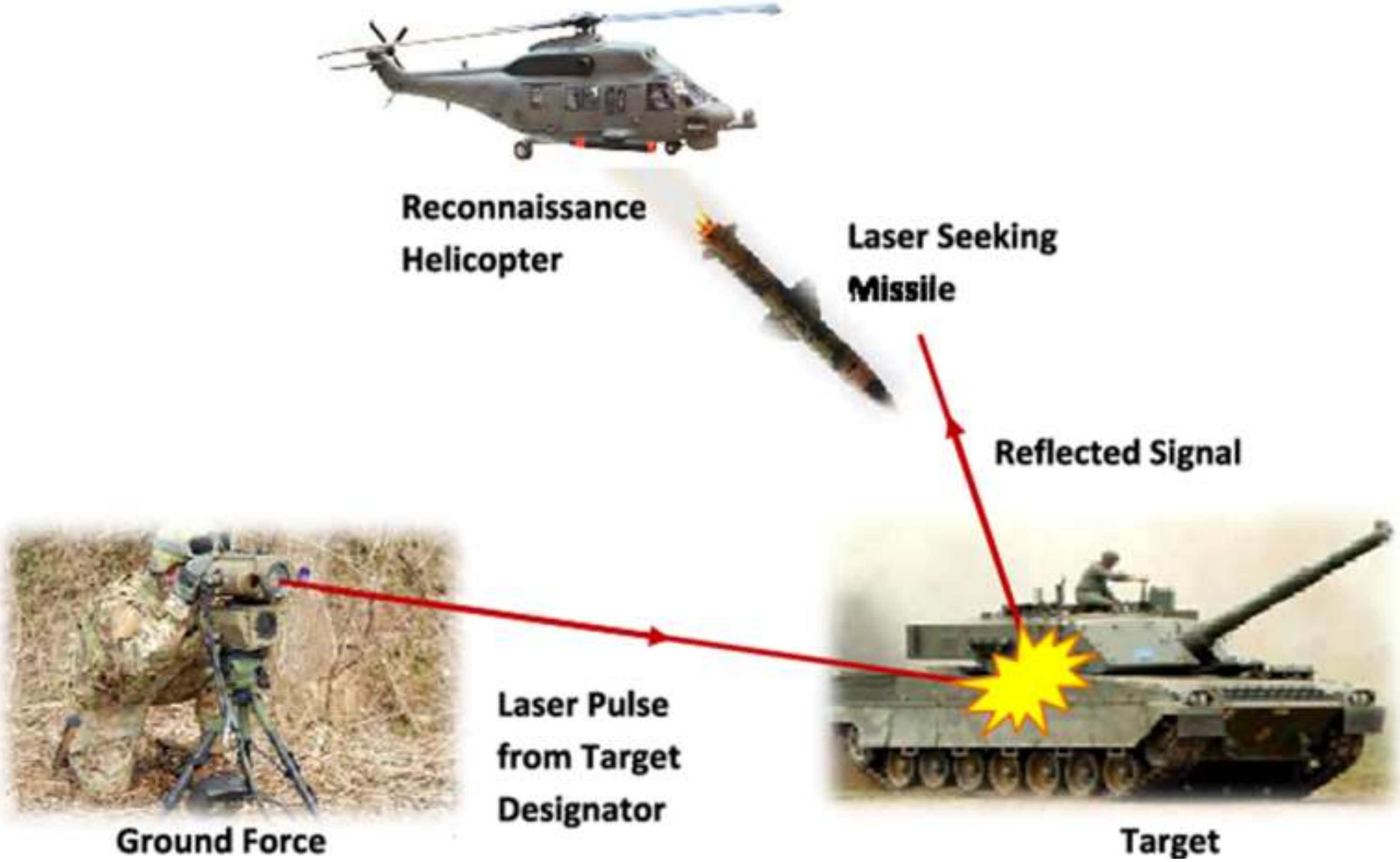


Image Credit: semanticscholar.org

Applications of Lasers in Information Technology

Optical Data Transmission

Optical Data Storage

Optical Fiber Communications

Free-space Optical Communications

Underwater Communications

Laser Printing

Applications of Lasers in Metrology

Interferometry

LIDAR (Light & Radar)

Laser Scanners

Optical Sampling

Optical Clocks

Fiber-optic Sensors

Applications of Photonics in Science/Research

Photochemistry

Laser Cooling

Nuclear Fusion (NIF)

Atmospheric Remote Sensing

Spectroscopy

Holographic Techniques

Applications of Photonics in Entertainment

Laser Light Shows

Outdoor Projections

Holography

Special Lighting Effects

IHCC Laser & Optics Technology Program

Associate of Applied Science Degree

21-month comprehensive program

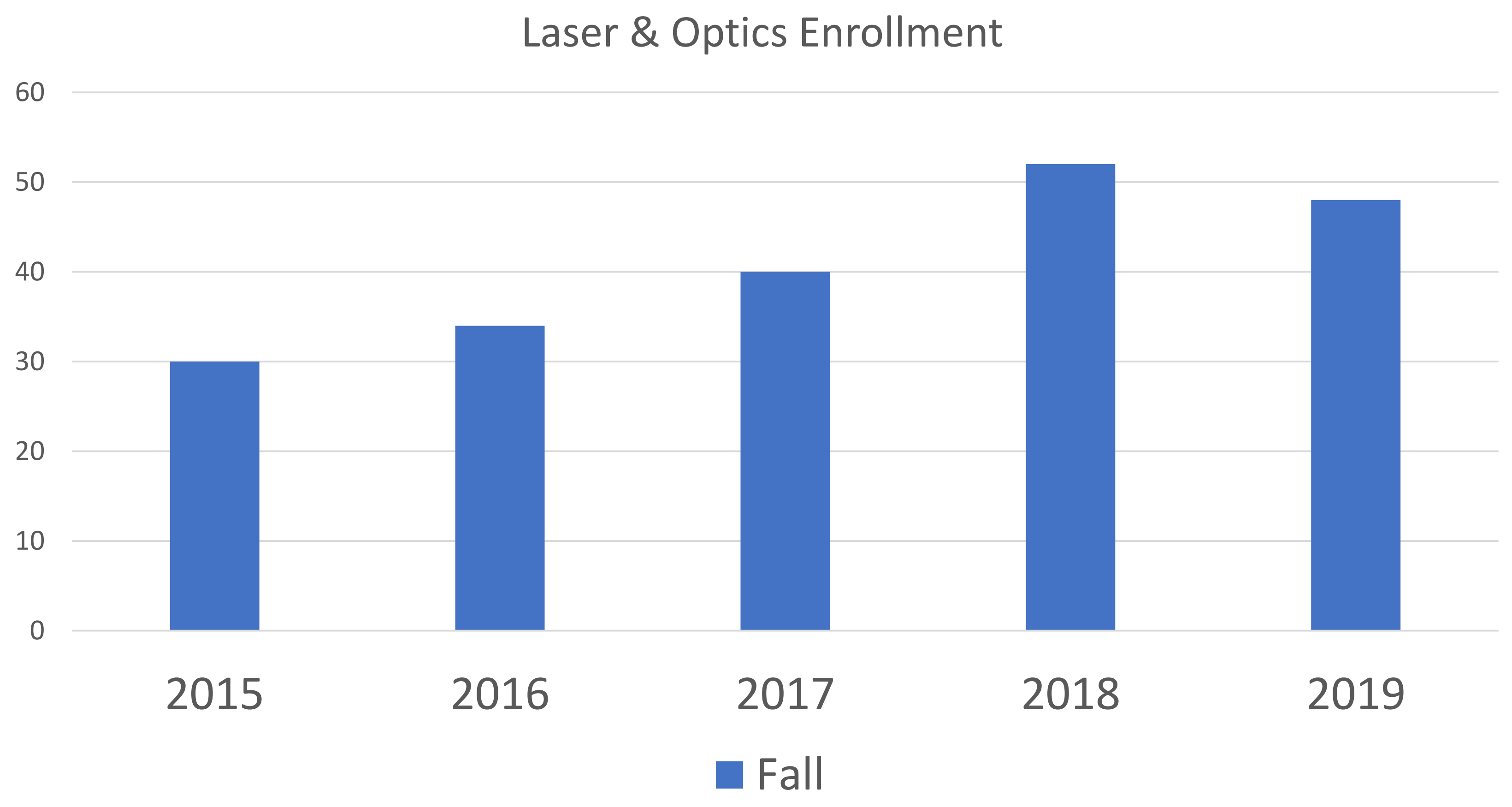
81 credits total

37 credits of photonics based coursework

Started in 1985

700+ graduates to date

Laser & Optics Enrollment from 2015 - 2019



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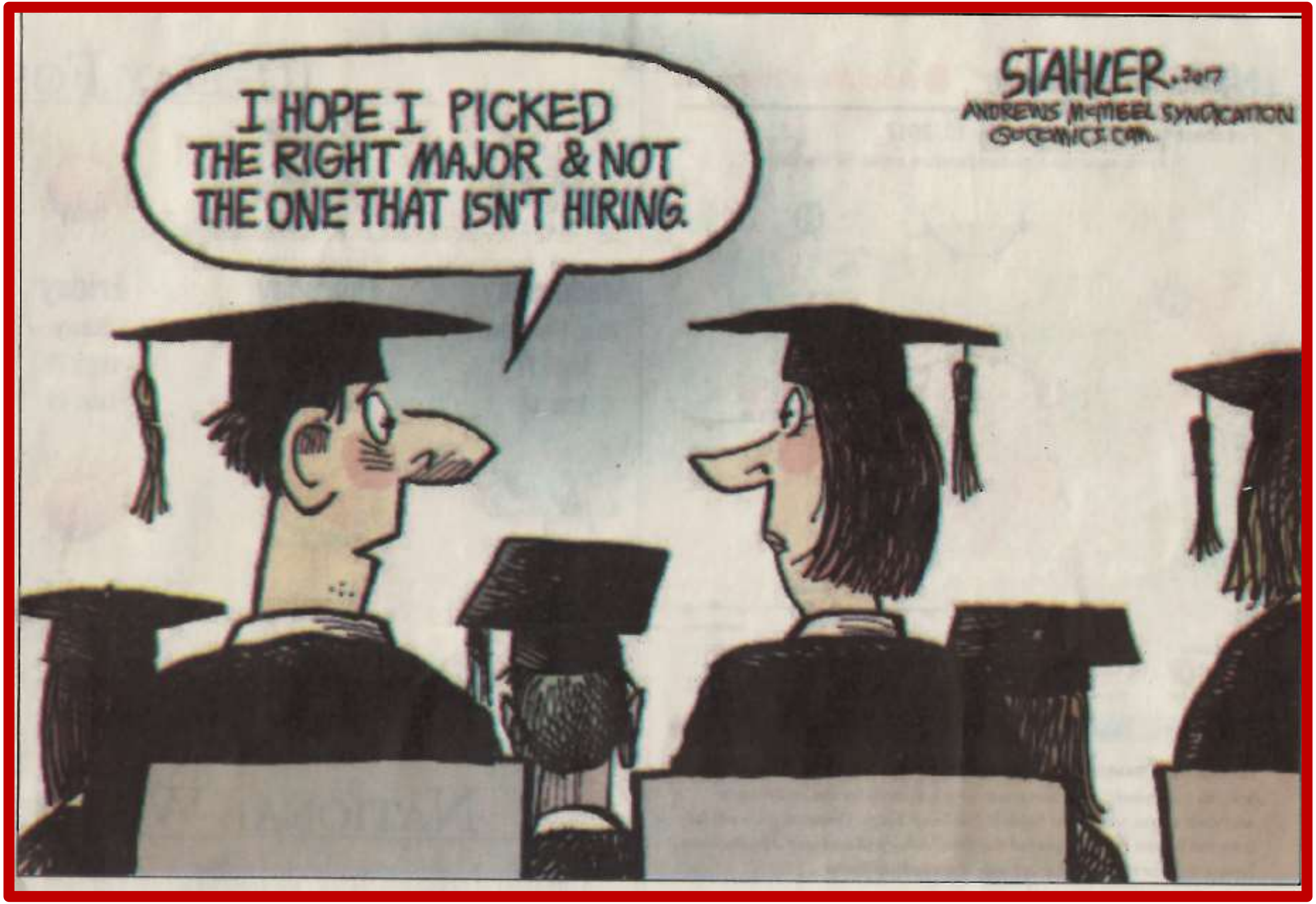

Source: Ottumwa Courier

Photonics Technician Job Description

Photonics Technician – Build, install, test, or maintain optical or fiber optic equipment such as lasers, lenses, or mirrors using spectrometers, interferometers, or related equipment.

(O*NET 17.3029.08 - Bureau of Labor Statistics)

2019 median wages - $62,990

Laser & Optics Opportunities and Placement

Average of 5 or more job opportunities per graduate

Placed in 40 states & Germany & Norway

Placed at 140 companies

“Border to Border and Coast to Coast”

Job placement over 95%

2020 average salary: $62.8k + benefits

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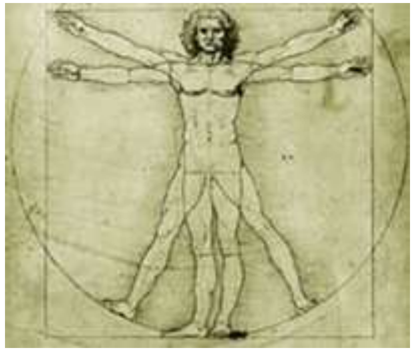
Laser & Optics Placement from 2015 - 2020

Laserage Technology	Texas Instruments	VitalDyne
Daylight Solutions	Rudolph Technologies	IAM AgTech
Access Laser	LSP Technologies	Mazak
L3 Technologies	Lawrence Livermore National Lab	Nuburu
Lumenis	MC Machinery	IDEX
RPMC, Inc.	Particle Measuring Systems	Medtronic
Preco, Inc.	Boston Scientific	RP Support
BAE Systems	Sightpath Medical	Forro Energy
Adapt Laser	Laser Welding Solutions	

MNT-EC Photonics Workshops

1) Fundamentals of Photonics Workshop
2) Laser Material Processing Workshop



I have been impressed with the urgency of doing.
Knowing is not enough; we must apply.
Being willing is not enough; we must do.

Leonardo da Vinci

Fundamentals of Photonics Workshop

2020 Dates To Be Determined

Five Days

Laser and Light Concepts

Laser Safety

Laser Based Laboratory Activities

MNT-EC Photonics Workshops

Using MPEC Kits

Working on a Laser System in lab

Working with the fiber laser

Working on lab activities

MNT-EC Photonics Workshops

Using MPEC Kits

Working on a PIMicos System

Working in the laser lab

MNT-EC Photonics Workshops

Illinois
Kansas
Iowa

Laser Material Processing Workshop

2020 Dates To Be Determined

Five Days

Laser Material Processing Theory

Expert and Practitioner Presentations

Laser Material Processing Laboratory Activities

- Welding, Cutting, Marking, Engraving, Forming, Cleaning

Company Tours

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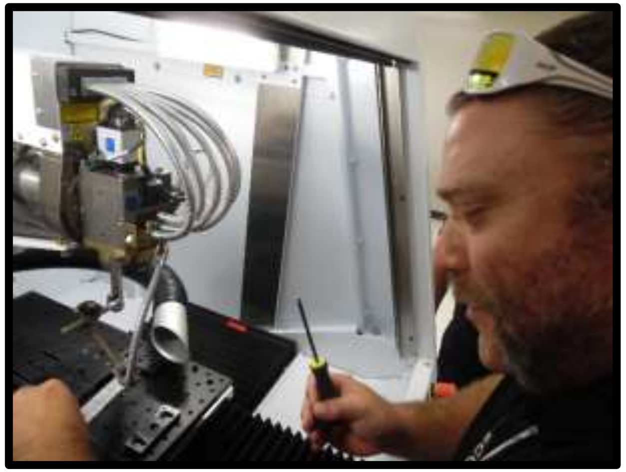
TRUMPF TruLaser Station 5005

Student working with laser welding system

Epilog Helix 75 Watt 24x18
Laser Marking/Etching System

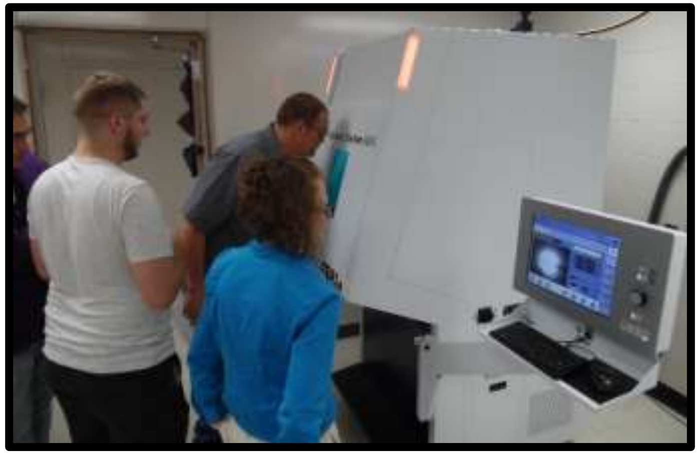
Laser Material Processing Workshop

LMP workshop attendees



Adjusting the parts fixture

Observing the laser welder



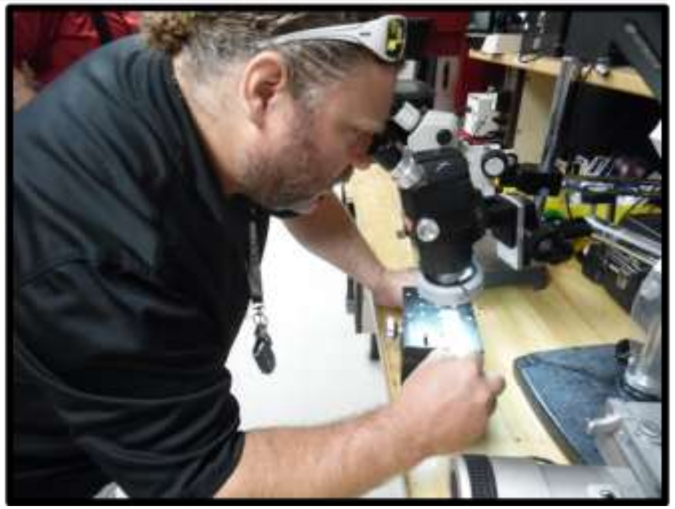
Laser welding camera view

Laser Material Processing Workshop

Modifying the program parameters

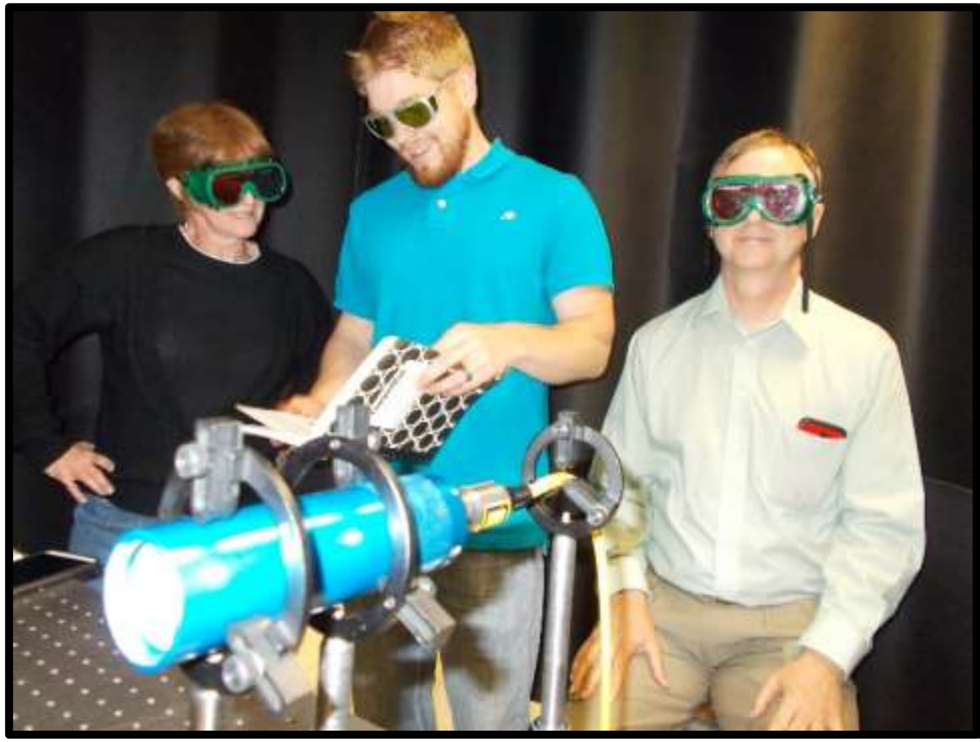
Observing a laser welding process

Examining a laser welded part



Loading parts to be welded

Laser Material Processing Workshop



Participants working on laboratory activities

Stretch Time

LASER as an Acronym

- ***L*** **ight**
- ***A*** **mplification by**
- ***S*** **timulated**
- ***E*** **mission of**
- ***R*** **adiation**

Photonics : Brief History

1917: Theory of stimulated emission developed by Albert Einstein.

1953: First device to make use of the stimulated emission process worked in the microwave region (15 mm) of the electromagnetic radiation spectrum.

1958: Speculation about the possibility of “optical masers”.

1960: The first working laser was a ruby (694 nm). Only 60 years.

- Produced intense pulses of red laser light.
- 1879: electricity was discovered; 141 years.

1960/1962: Followed quickly by the Helium-Neon laser which produced a continuous beam.

1962 – 2020: Exponential explosion of technology and applications

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Photonics: Properties of Laser and Optics

Lasers

- Wavelength
- Monochromatic (one color)
- Directional (collimated)
- Coherent
- Power
- Pulse Rate

Photonics: Properties of Laser and Optics

Types of Optics

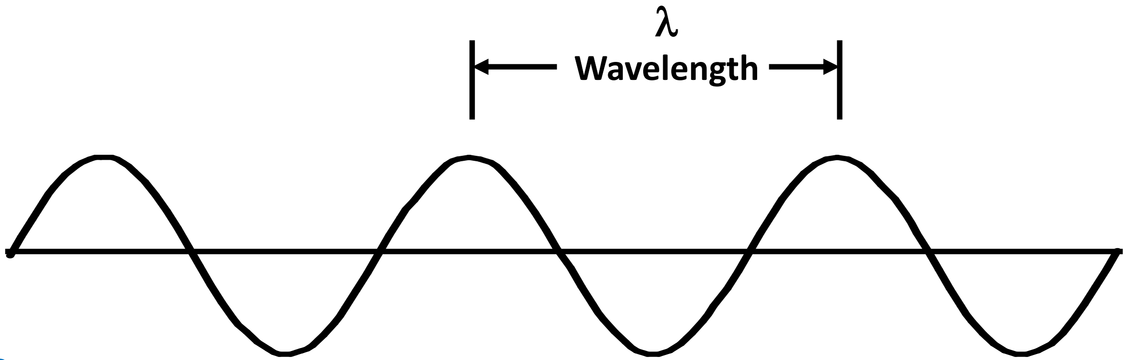
- Lenses
- Mirrors
- Filters
- Plus many others

Photonics: Properties of Laser and Optics

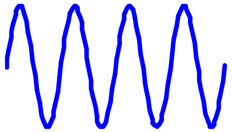
S.T.A.R.R. (All materials)

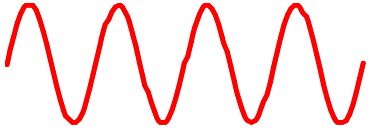
- Scatter
- Transmit
- Absorb
- Reflect
- Refract

Nature of Light



Blue: λ = 400 nm



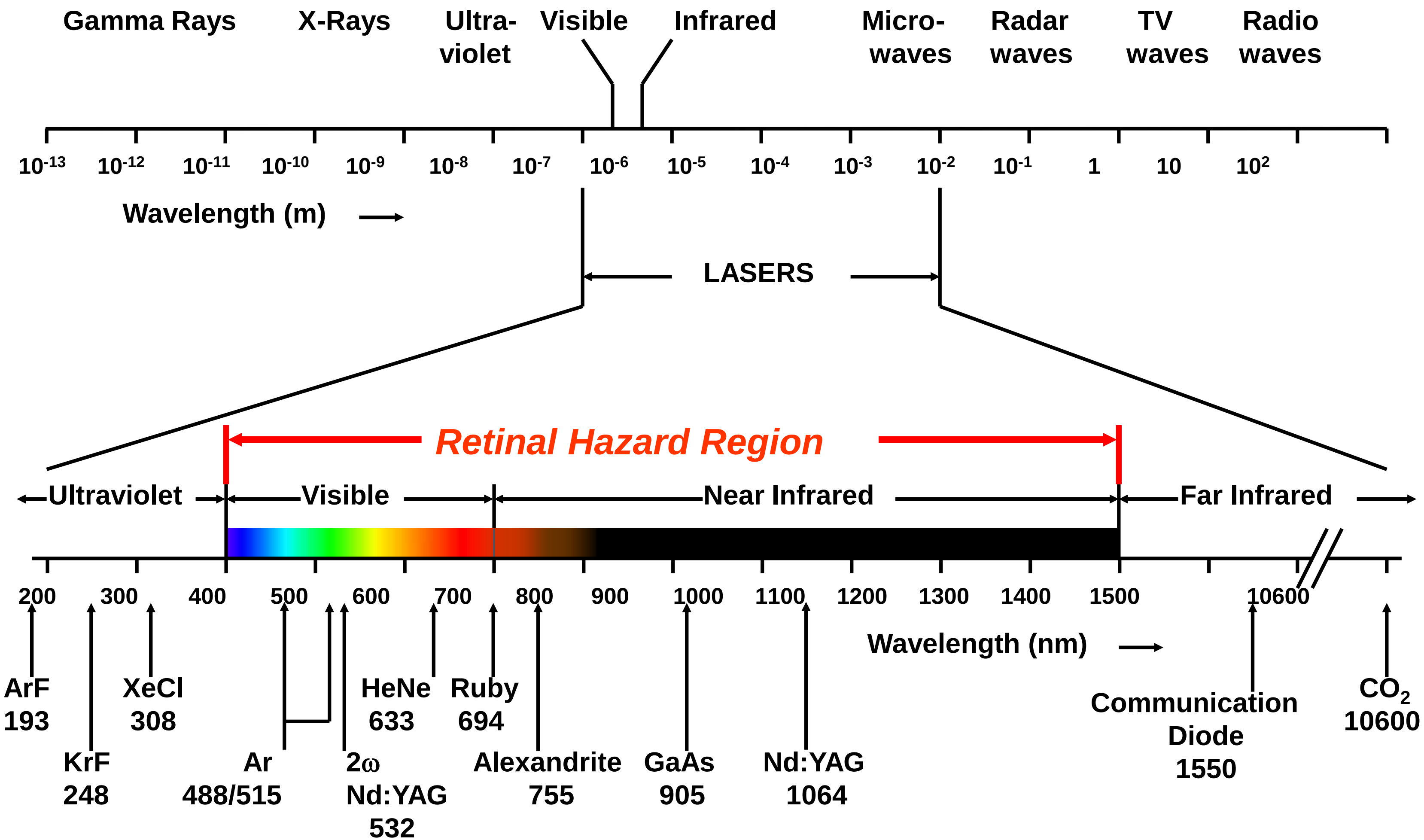


Red: λ = 700 nm

Light is an electromagnetic wave.

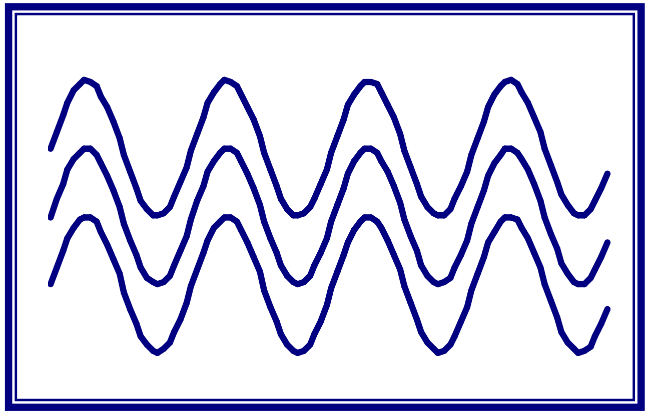
Different wavelengths in the visible spectrum are seen by the eye as different colors.

Electromagnetic Spectrum



Characteristics of Laser Light

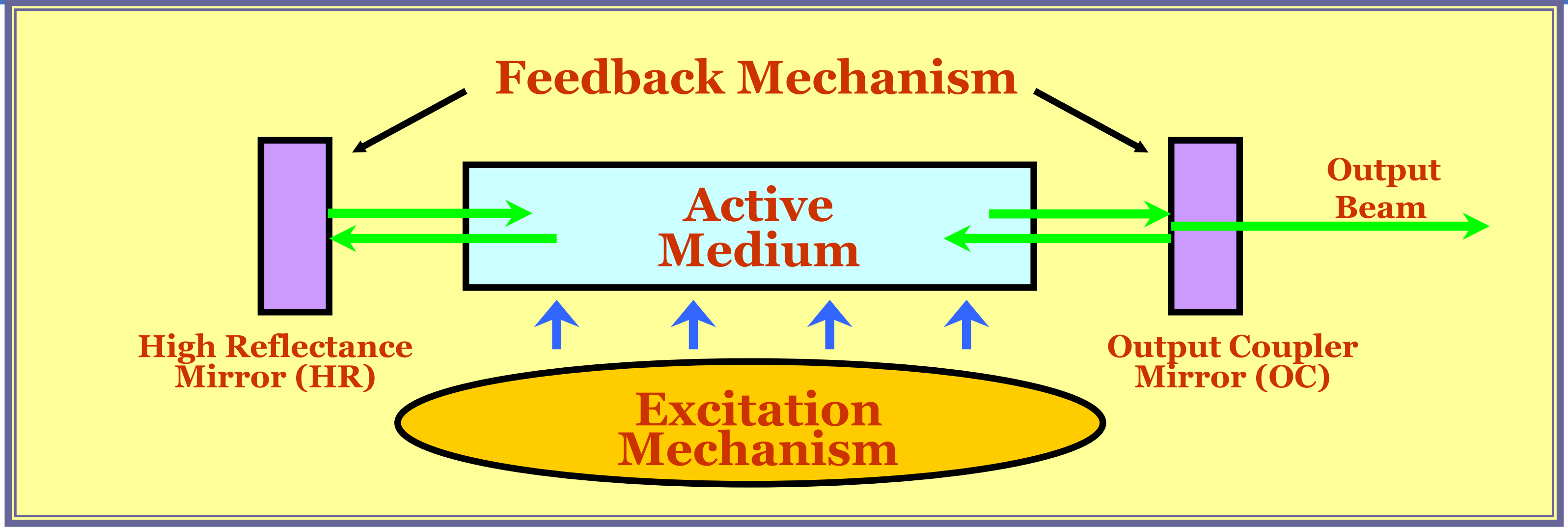
MONOCHROMATIC
DIRECTIONAL
COHERENT



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

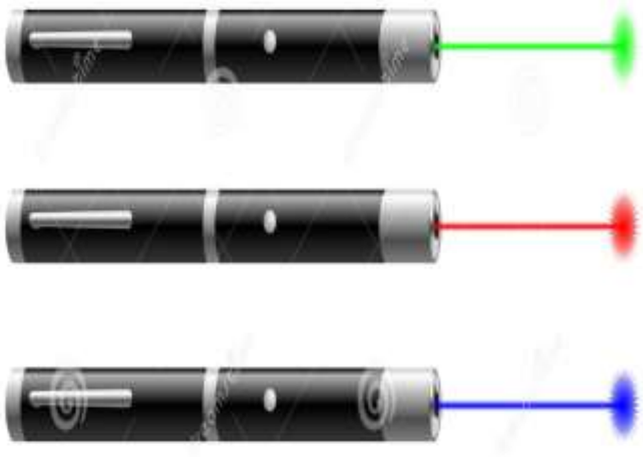
This means that laser light can be concentrated on the retina of the eye by as much as 100 times more than ordinary light. Thus, even relatively low levels of laser light can produce significant eye hazards.

How a Laser Works



- The **Active Medium** contains atoms which can emit light by stimulated emission.
- The **Excitation Mechanism** is a source of energy to excite the atoms to the proper energy state.
- The **Feedback Mechanism** (HR & OC) reflects the laser beam through the active medium for amplification.

Laser Diode Pointers



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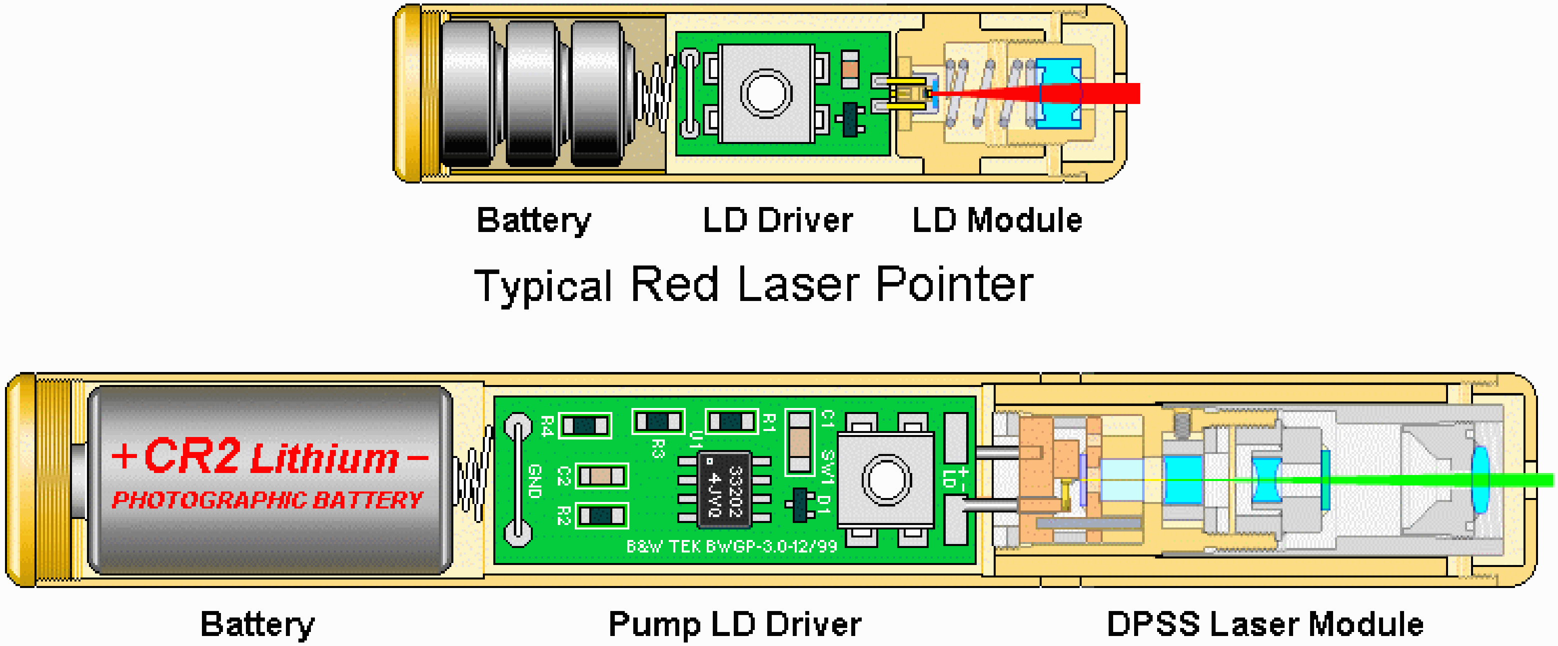
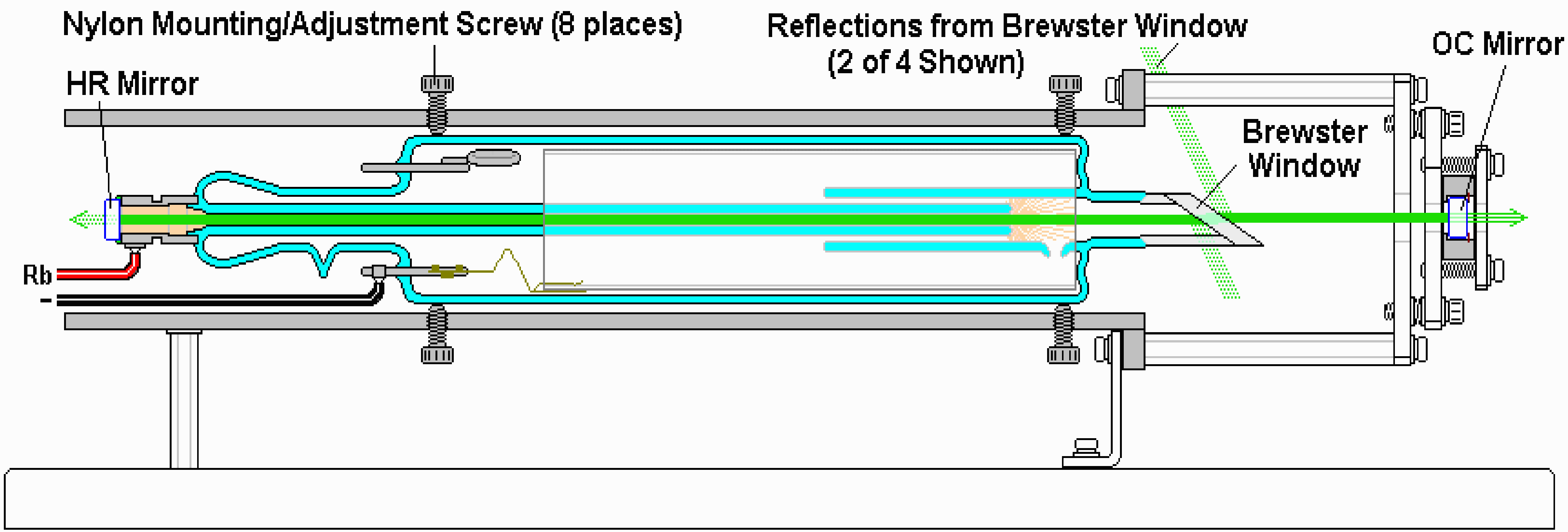
Laser Diode Pointers



Typical Green Laser Pointer

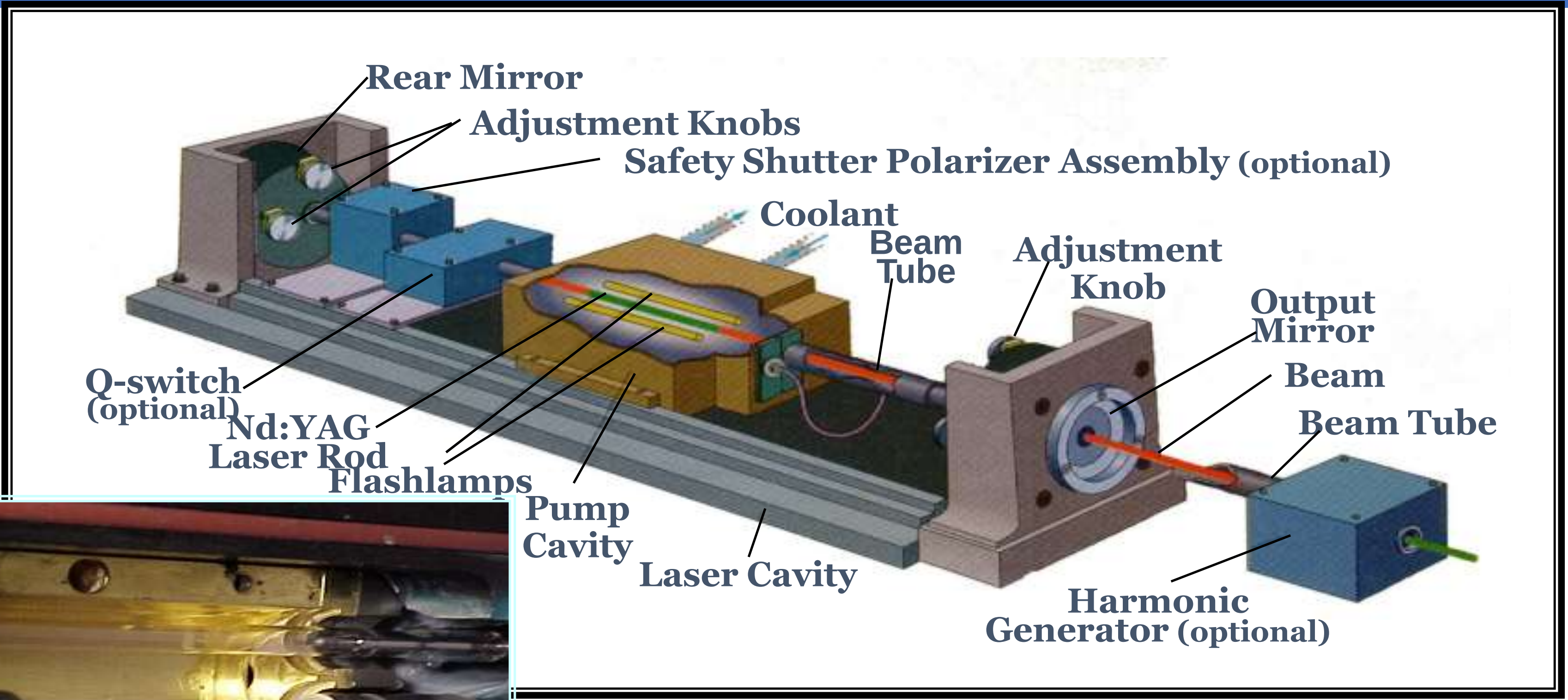
Comparison of Red and Green Laser Pointer Complexity

HeNe (helium neon) Laser



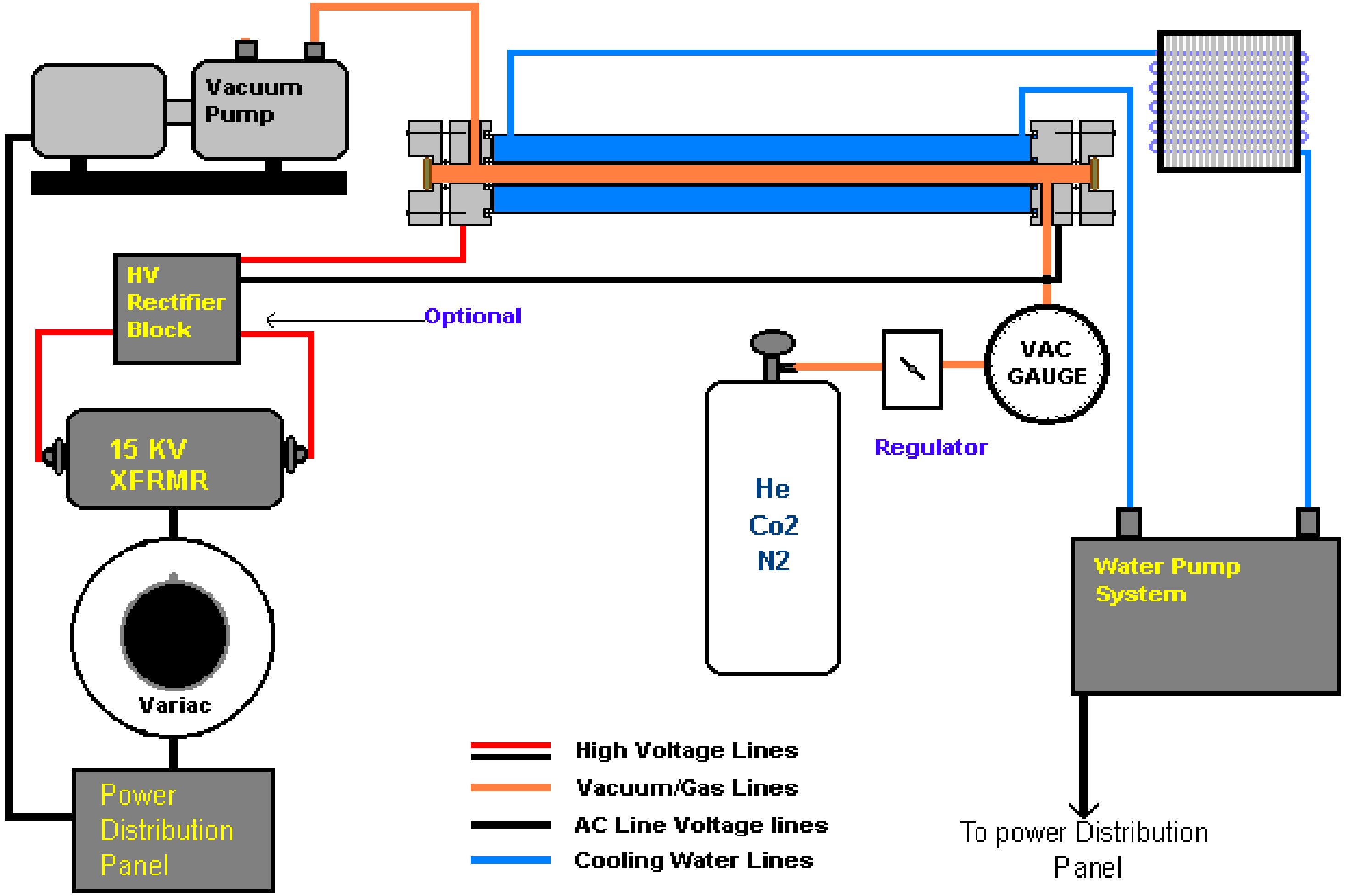
Hughes Style One-Brewster HeNe Laser Tube Mounted in Test Fixture

Nd:YAG (neodymium: yttrium aluminum garnet) Laser

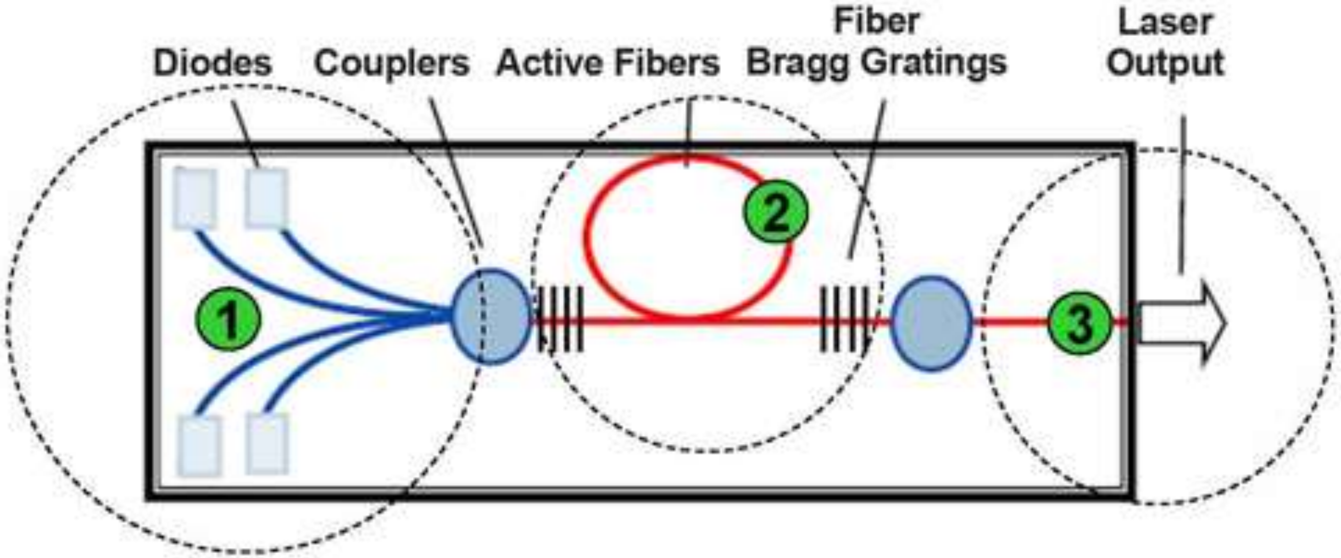


ABOVE: Pictorial break out of a Nd:YAG laser
LEFT: Picture of the Flashlamp & Laser Rod assembly for an Nd:YAG laser

CO2 (carbon dioxide) Laser



Fiber Laser



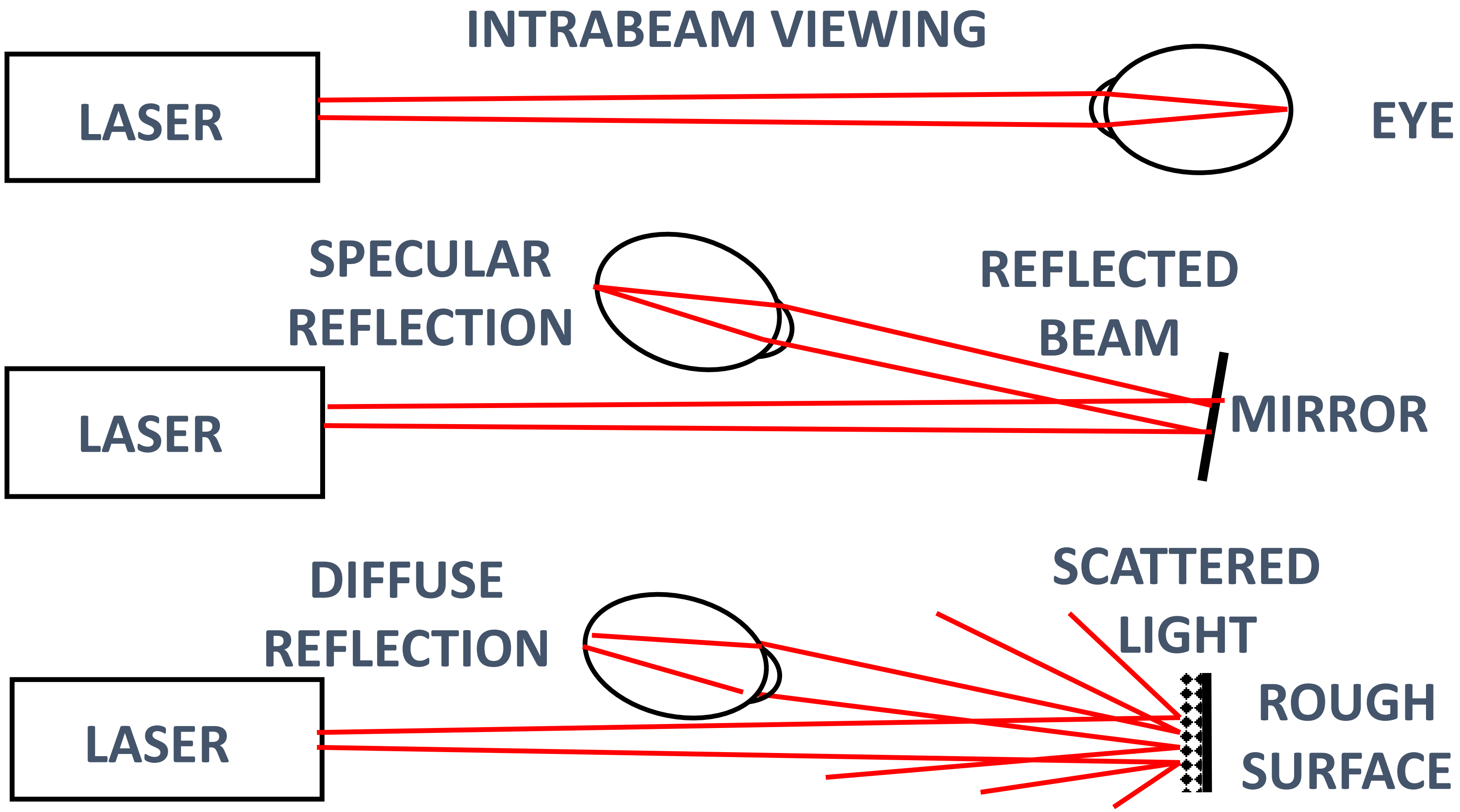
1. ***Pump diode modules*** pump the light radiation into the active fiber
2. ***Optical active fiber*** with a *doped core* (ytterbium) and couble cladding, where the pumped light excites the core
3. ***Transport optical fiber*** bringing out the power from the module

Laser Safety: Causes of Laser Accidents

Studies of laser accidents have shown that there are usually several contributing factors. The following two are the most common causes of laser injuries:

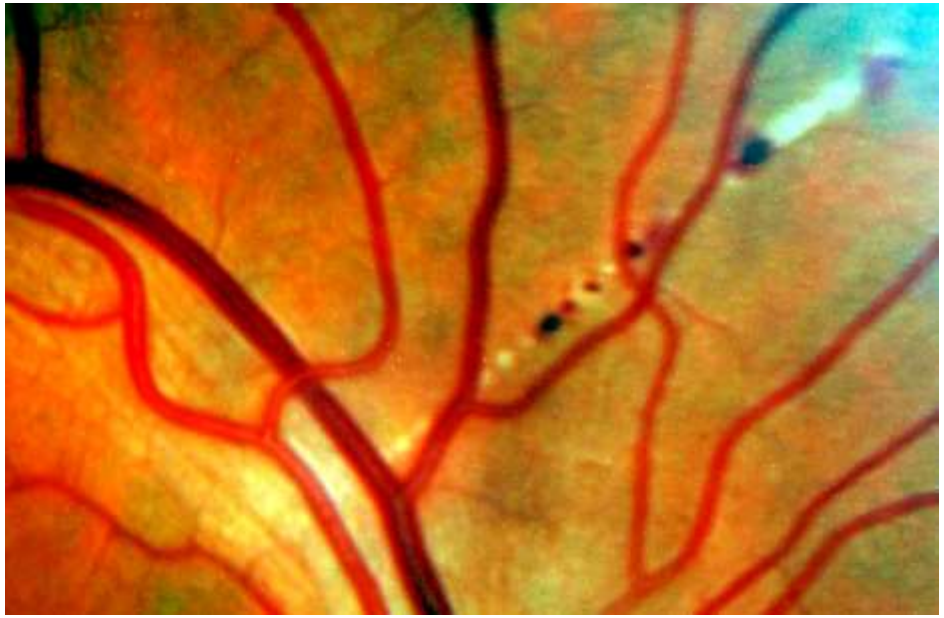
1) Inadequate training of laser personnel
2) Failure to follow approved standard operating procedures or safe work practices

Laser Eye Exposure



Laser Beam Injuries

High power lasers can cause skin burns.



Severe eye injuries resulting in permanent vision loss.

Laser Safety Eyewear

Laser safety eyewear is available in glass or plastic for all laser wavelengths. The required Optical Density of the eyewear is determined in the hazard analysis performed by the LSO (Laser Safety Officer).

Eye Safety

Most laser eye injuries have occurred when the person was not wearing laser safety eyewear.

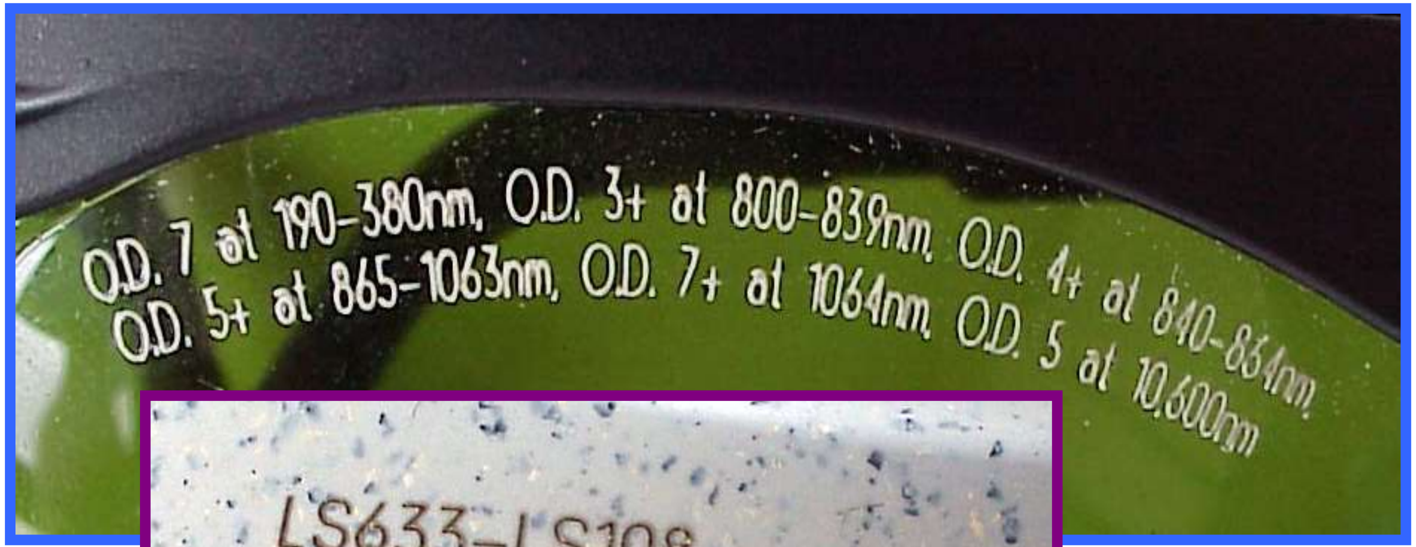
Laser Safety Eyewear does not make the wearer invulnerable.

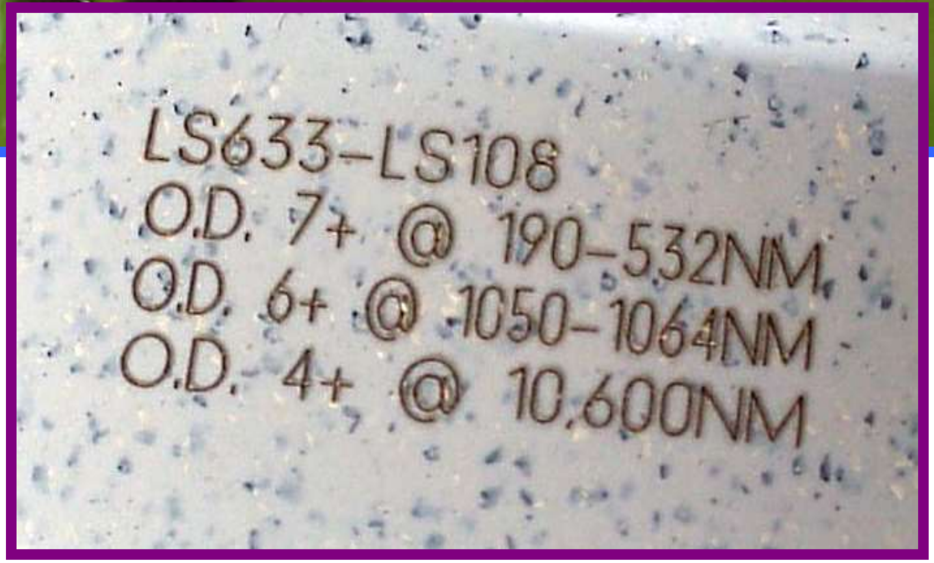
It is never safe to stare into a laser beam, even if wearing laser protective eyewear.

The greatest risk of eye injury occurs when near IR lasers are operated with the beam exposed.

Eyewear should always be worn when a near IR class 3b or class 4 beam is accessible.

Laser Safety Eyewear Labels





All eyewear must be labeled with wavelength and optical density.

Laser Safety Classification (ANSI Z136.1)

Class 1
Class 1M
Class 2
Class 2M
Class 3R
Class 3B
Class 4

Photonics Websites of Interest

www.spie.org The International Society for Optics and Photonics

www.photonicssociety.org IEEE Photonics Society

www.osa.org The Optical Society

www.lia.org The Laser Institute of America

www.laser-tec.org Center for Laser and Fiber Optics Education (NSF)

www.lightourfuture.org National Photonics Initiative

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