CROUSE HEALTH
Your care. In our hands.

Laser Safety
Education for Medical Staff

April 2017
Revised: January 2023

Laser Safety Topics

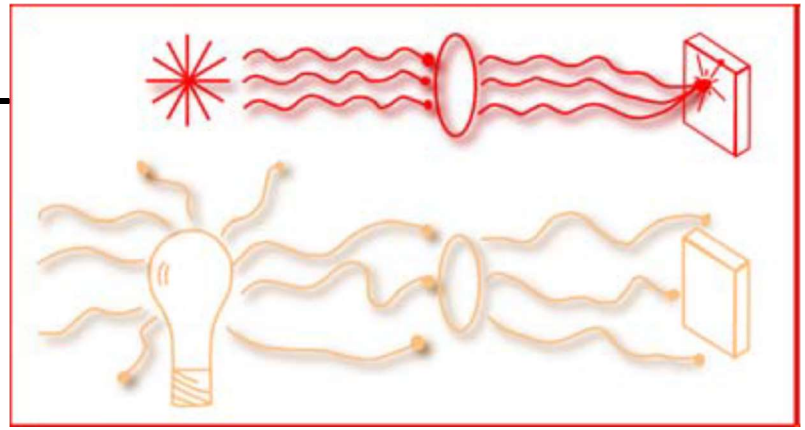
- Laser Physics
- Laser Types and Operating Modes
- Laser/Tissue Interactions
- Laser Hazard Classification
- Laser Safety Control Measures and Regulation

Laser Physics

- **Light**
- **Amplification by**
- **Stimulated**
- **Emission of**
- **Radiation**

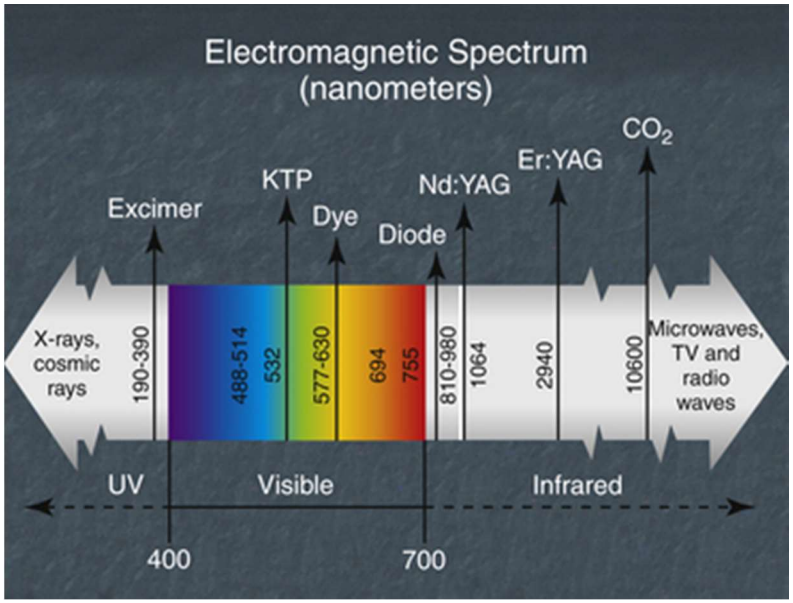
Laser Light is

Monochromatic
Directional=Collimated
Coherent



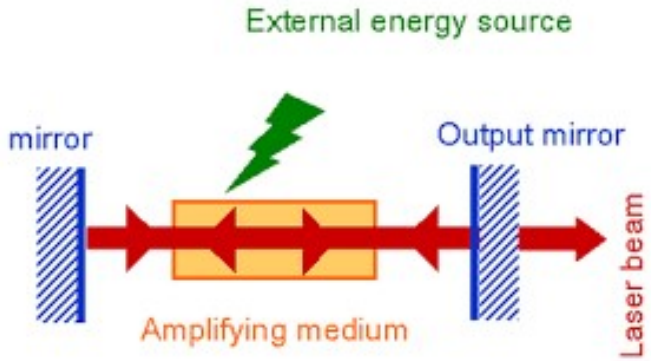
Laser Physics

- Lasers produce electromagnetic radiation of a specific wavelength
    - Infrared >700 nm (Nd:YAG, Holmium CO_2)
    - Visible 400-700 nm (Greenlight, Iridex)
    - Ultraviolet <400 nm (Excimer)



Laser Physics

- Lasers are named based on their type of MEDIUM
  - Gas Lasers (CO_2)
  - Solid State Lasers (Holmium-YAG, Nd:YAG)
  - Semiconductor (Diode) Lasers
  - Liquid Dye Lasers
- All Lasers need 3 essential elements:
  - Active Medium
    - Excitation
      - Optical resonator

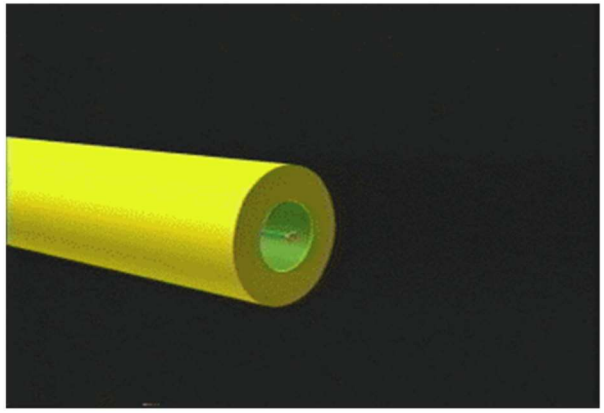


Laser Physics

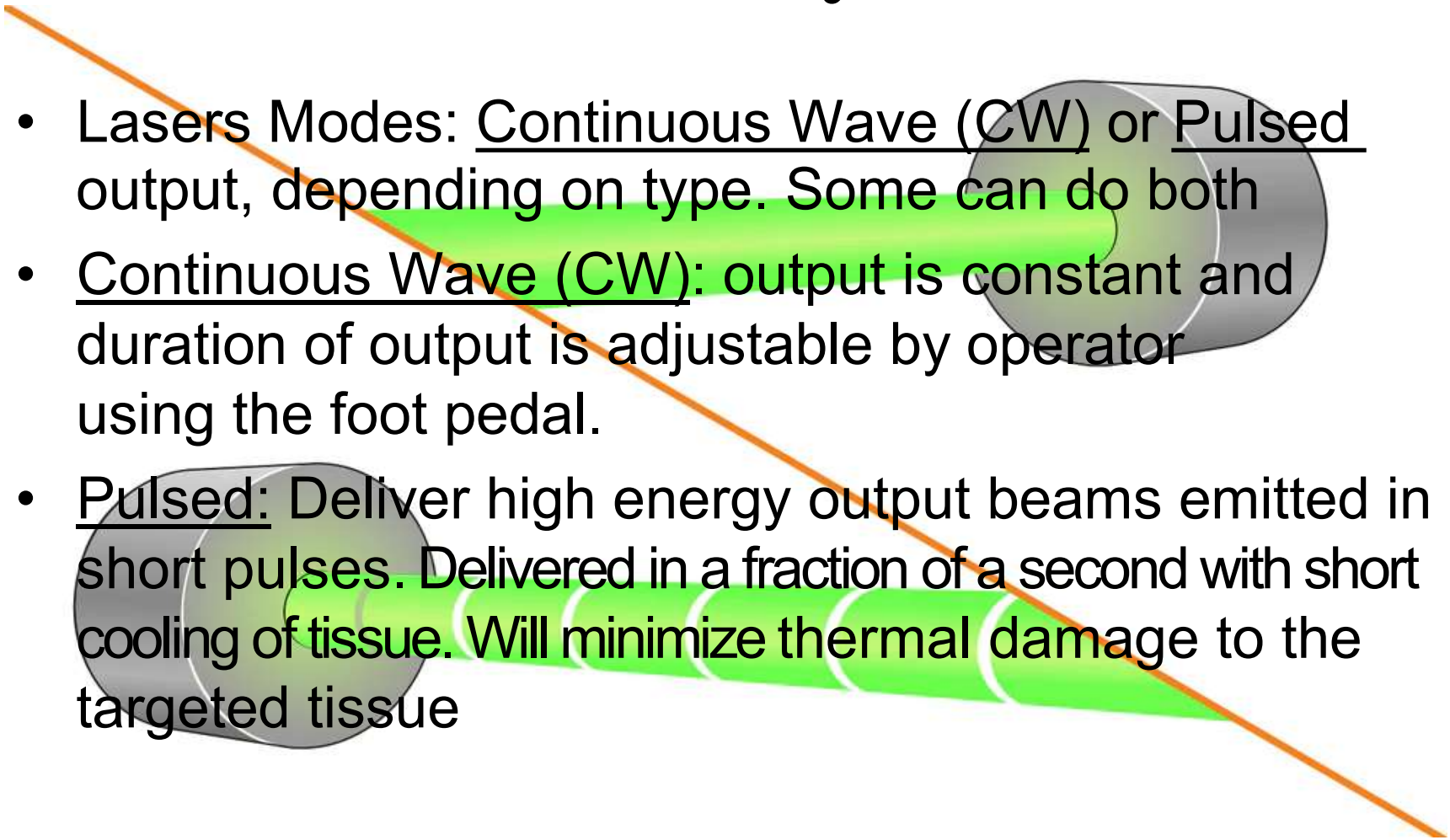
Laser Delivery System take the laser light and delivers to the patient

Optical Fiber or Use of Fixed Mirrors, Articulating Arms, Hollow Metal Tubes and Lens

(CO2 and Er:YAG infrared lasers)



Laser Physics



- Lasers Modes: Continuous Wave (CW) or Pulsed output, depending on type. Some can do both
- Continuous Wave (CW): output is constant and duration of output is adjustable by operator using the foot pedal.
- Pulsed: Deliver high energy output beams emitted in short pulses. Delivered in a fraction of a second with short cooling of tissue. Will minimize thermal damage to the targeted tissue

Laser Physics

- Irradiance is the power of the laser spread out over an area…….expressed as power/area (mW/cm^2)
- Irradiance will be higher (more hazardous) closer to the laser and lower (less hazardous) farther from the laser
- Irradiance is maximized at laser focal point
- Even low power lasers can produce high irradiance if focused on small areas

Solid Laser

- Uses solid crystal or glass as the active medium
- Excitation is achieved from the pumping mechanism of light
- High pulse energy and shallow penetration; (useful in laparoscopic, urologic and ophthalmologic cases)
- Examples
  - Ruby, Nd: YAG, Holmium-YAG, Doubled Nd:YAG (Green Light)

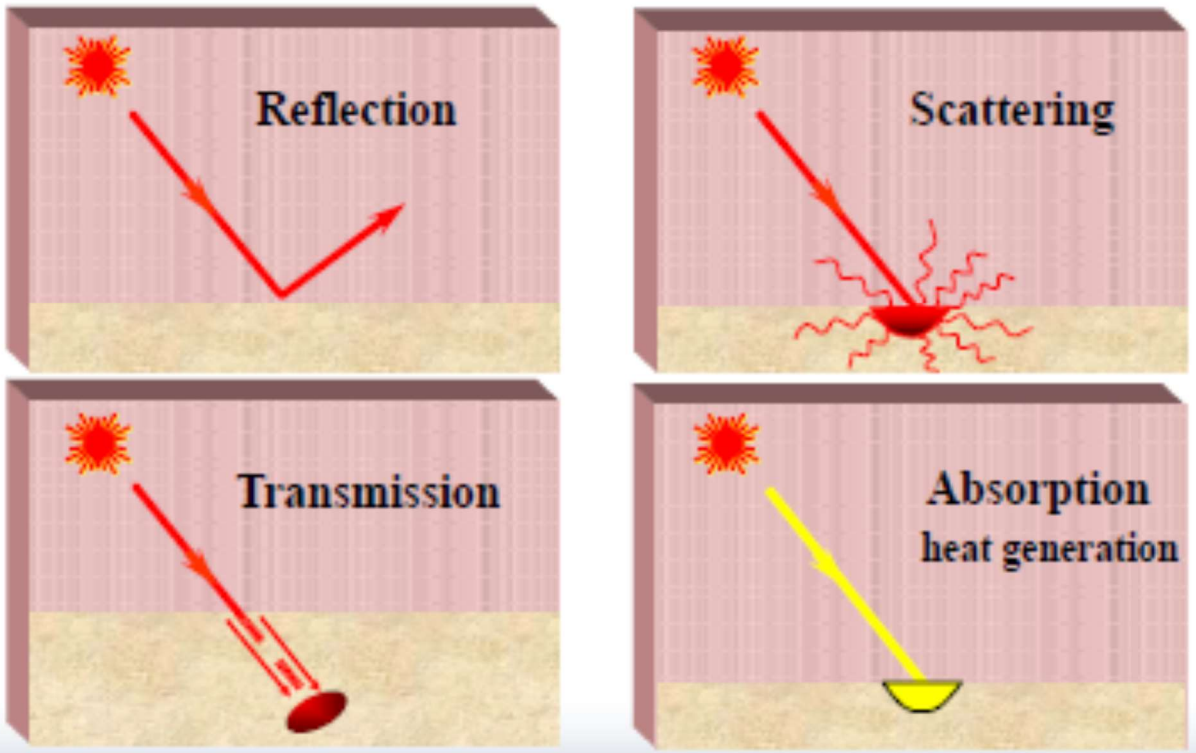
Gas Laser

- Uses gas as an active medium
- Excitation done electronically
- Extremely superficial penetration
- Rapidly heats and vaporizes the water inside the cell resulting in rupture and lysis
- Examples: CO_2, Argon/Krypton, Excimer

Diode (semiconductor) Laser

- Uses a junction between two types of semiconductor materials through which a current flows causing excitation
- CW-Pulse allows to use either single, CW pulse or repetitive pulses
- Often used in Dermatology and Ophthalmologic applications
- Example
  - OcuLight by Iridex (frequently used in NICU)

Properties of Laser Tissue Interactions



Laser & Tissue Interactions

1) *Reflection*: some light reflects back off the surface, energy neither penetrating or interacting with tissue

2) *Scattering*: FORWARD Scatter; heat disperses into tissue BACK-SCATTER can occur as the laser beam hits the tissue and energy goes back in the direction of the user

3) *Transmission*: passes through tissue with no effect

4) *Absorption*: produces intended action of the procedure, transfer of energy to tissue creates thermal effect

Laser & Tissue Interactions

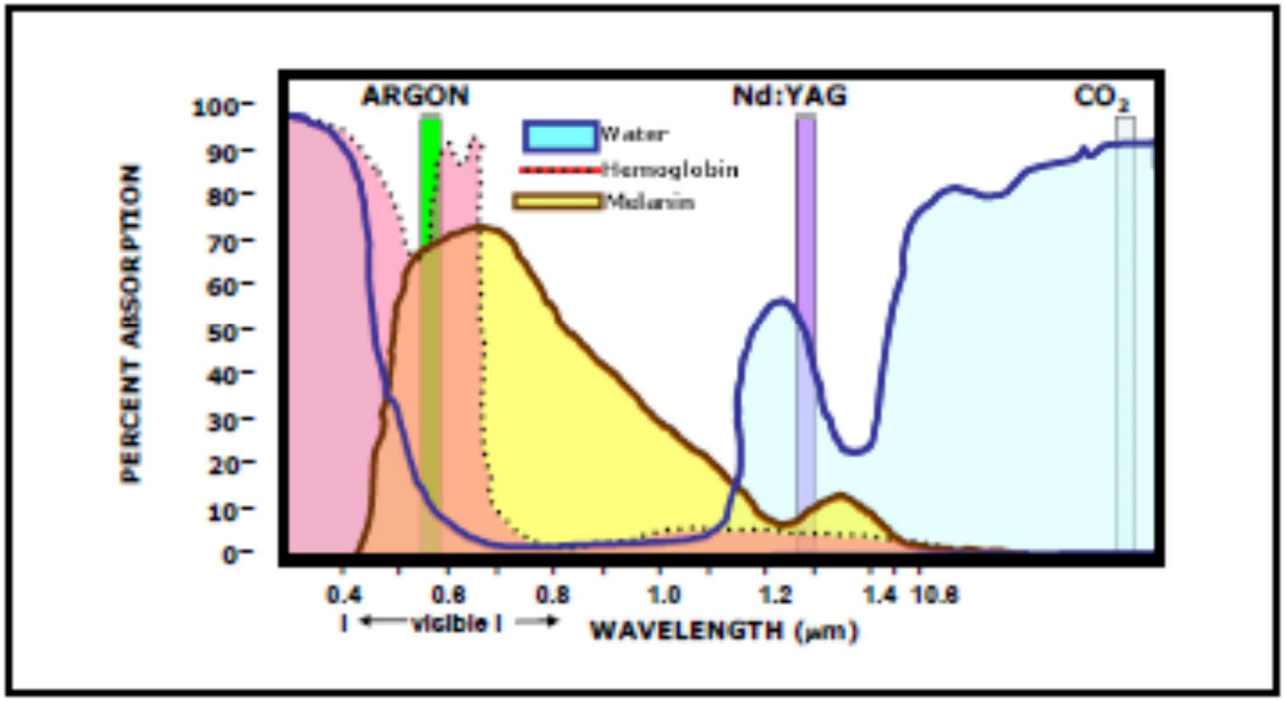
- **Absorption of laser radiation results in heating of tissue. Absorption can create coagulation or vaporization of tissue**

- Laser wavelength and tissue composition determine interaction

  (see next slide for graph)

Laser & Tissue Interactions

Absorption of Light



Three main chromophore absorbers of Light in tissue:
Water, Oxyhemoglobin, Melanin

Laser & Tissue Interactions

- Tissue transmission and absorption are Laser wavelength dependent
- Reflection occurs from specular surfaces and can pose safety risks to patient and staff
- The eye and the skin are tissues most vulnerable to laser radiation

Laser Hazard Classification

- Each Laser is classified individually by the manufacturer
- The laser classification system is based on the probability of damage occurring to tissue
- The class of the laser constitutes the Procedural Controls for operation of laser
- Medical lasers are Class 3B & Class 4 and require both Administrative & Procedural Controls

Laser Hazard Classification

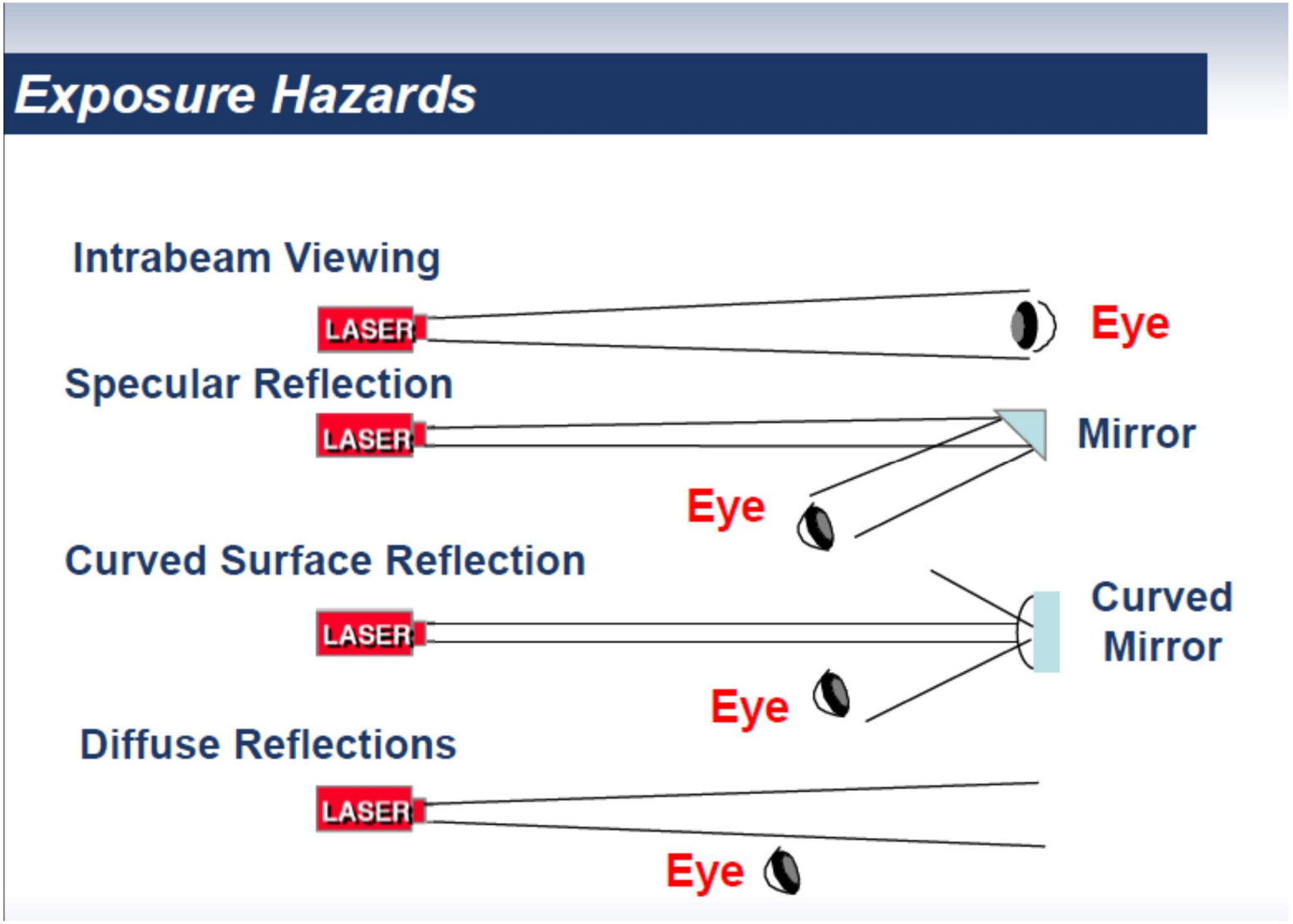
- Class 3B- Potential eye hazard for intrabeam (direct) viewing or for viewing specular reflections.

- Class 4- Hazard to the eye or skin from the direct beam, scattered beam and sometimes from a diffuse reflection. Fire Hazard and may produce Laser Generated Airborne Contaminants

Non-Beam Hazards

- Electrical and fire risks
- Laser Generated Airborne Contaminants/ Plume Airborne Contaminants: Vaporized tissue plume may contain toxic or infectious particles.
  - Control Measures: Use of a Smoke evacuator and N95 or high filtration mask for all personnel

Exposure Hazards



Nominal Hazard Zone

The space within which the level of direct, reflected or scatted laser light exceeds the Maximum Permissible Exposure Level (MPE) for the laser

Maximum Permissible Exposure Level (MPE)

The level of laser radiation to which a person may be exposed without hazardous effects in the eye or skin

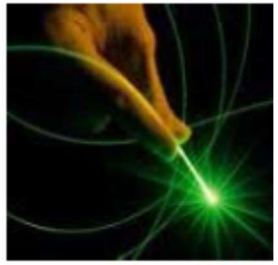
Laser eyewear is required when radiation exposure exceeds the MPE (all Class 3B and Class 4 lasers)

Laser Safety Control Measures

Engineering Controls

- Incorporated into laser by manufacturer
- Design must meet federal & state safety regulations
- Most expensive, most effective
- Examples:
  - Guarded foot switch
    - Key Switches (lock)
    - Protective Housings
    - Beam Attenuators
    - Emergency stop mechanism

- V.4. Lasers should be placed in standby mode when not in active use
- Laser foot switch should be placed in a position convenient to the user and not confused with other foot pedals
- The laser user should be the only one to activate the device



Laser Safety Control Measures

Administrative Controls- Infrastructure of laser safety program

- Policies & Procedures
- Education & Training of staff
- Audits
- Laser Safety Officer and Laser Safety Committee

Laser Safety Control Measures

Protective Equipment Controls

- Personal protective equipment includes clothing, gloves, and laser eyewear.
- Eyewear is the most important protective equipment available. It must be selected for the system with which it is being used
- If the appropriate optical density protective eyewear is not worn, the user's eyes are at risk
- NOTE: It is also important the patient's eyes be protected

Class 3B and Class 4 Laser Controls Required for Health Care Laser Systems

1) Display Area Warning Signs and PPE at each entryway into the controlled room

2) The room must be supervised by health care personnel trained in Laser Safety

3) Occupied only by authorized, appropriately trained personnel.

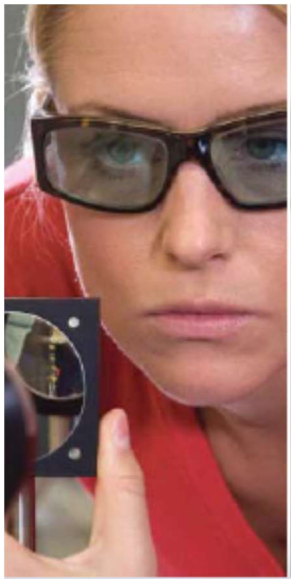
4) Windows, doorways, covered or restricted to reduce transmitted beams below ocular MPE level. Barrier must meet infection control policies and be non-flammable

5) Entryway controls designed to allow rapid admittance or egress from treatment area

Laser Safety Control Measures

Protective Eyewear (LPE)

- Eye protection devices specified by the manufacturer shall be administratively required
- All LPE shall be clearly labeled with the Optical Density and wavelength for which protection is afforded
- Patients' eyes must also be protected!
- Optical density must attenuate maximum irradiance laser is capable of producing
- Optical density expressed as exponential attenuation effect (OD 5 = $1X10^{-5}$)



Laser Safety Control Measures

- LPE shall be worn whenever the distal end of the fiber is open, exposed and a potential hazard exists which exceeds the MPE within the NHZ
- In cases when fibers may break or become disconnected and become a hazard to everyone within the NHZ, then everyone shall wear LPE

Laser Safety Control Measures

4.6.2.1.4 Microscopes / Optical Viewing Ports

- "Appropriate Protective Filters **shall** be properly placed to ensure all potential viewing paths are protected
- LPE **shall** be worn by persons viewing through accessory viewing ports not protected by filters incorporated into the equipment
- The proper functioning of any eye safety filter shutter mechanism **shall** be verified prior to the start of each procedure."

Laser Safety Control Measures

To Reduce the Danger of Eye Damage, Burns or Fire from Broken fibers:

- The tip of the fiber should be covered with a wet product when the fiber is not in use and outside the TX area
- Avoid leaning against or clamping a fiber
- Avoid stressing a fiber beyond the manufacturer's recommendation – bend radius
- Care should be taken to avoid laser beam exposure on the flammable sheaths of flexible-fiberoptic endoscopes
- Care should be taken to avoid beam heating of metallic endoscopic sheath to prevent thermal damage of adjacent tissue

Laser Safety in the Perioperative Setting

Understanding staff roles:

- RN: responsible for all direct safety measures in the OR suite
- Laser Operator: Person who handles the laser equipment and is responsible for setting up the laser. Also operates the control panel under the supervision of the laser user
- Laser User (MD): Person who controls the application of the laser for its intended purpose within their scope of practice, license, training and experience

Laser Safety in the Perioperative Setting

Role of the circulator:

- Ensure a secondary OR RN is available to complete laser operator duties (with charge RN)
- Assists laser RN in compliance with all safety protocol measures (staff and patient)
- Direct responsibility for surgical technologist interventions for laser safety
- Continues to support circulating duties throughout laser procedure

Laser Safety in the Perioperative Setting

- Role of the scrub technologist:
  - Ensure use of laser safe instrumentation (non-reflective and ebonized)
  - Sterile H_2O draping
  - Preparation of emergency measures (surgical fires)
    - Water based lubricant is used procedure
    - A bowl of sterile water is prepared on the surgical table
    - Know where the closest fire extinguisher is
    - Turn off free flowing oxygen to the room

Surgeon/Physician Note

- During procedures in which a Laser Assistant RN is deemed not necessary, the surgeon/physician assumes the roles of both the Laser Assistant and Operator/User

LASER Resources

- Director of Surgical Services
- OR Nurse Managers, OR Nurse Educator
- Crouse Hospital Laser Policies
  - Laser: Application, Environment, Patient & Personnel Safety
  - Diode Laser: Neonatal Intensive Care Unit (NICU)
- Laser Safety Officer

- For additional training including a certificate contact Laser Safety Officer for online learning portal thru ForTec Medical

Laser Safety Regulation

- American National Standards Institute (ANSI): requires facilities where laser procedures are performed to develop a laser safety program ww.ANSI.org
- Association of perioperative Registered Nurses (AORN) www.AORN.org
- National Institute of Occupational Safety and Health (NIOSH)
- Occupational Safety and Health Administration (OSHA)
- CDC (Centers for Disease Control)
- ASLMS (American Society of Laser Medicine and Surgery)
- New York State Department of Health (NYSDOH)
- New York State Department of Labor (NYSDOL)