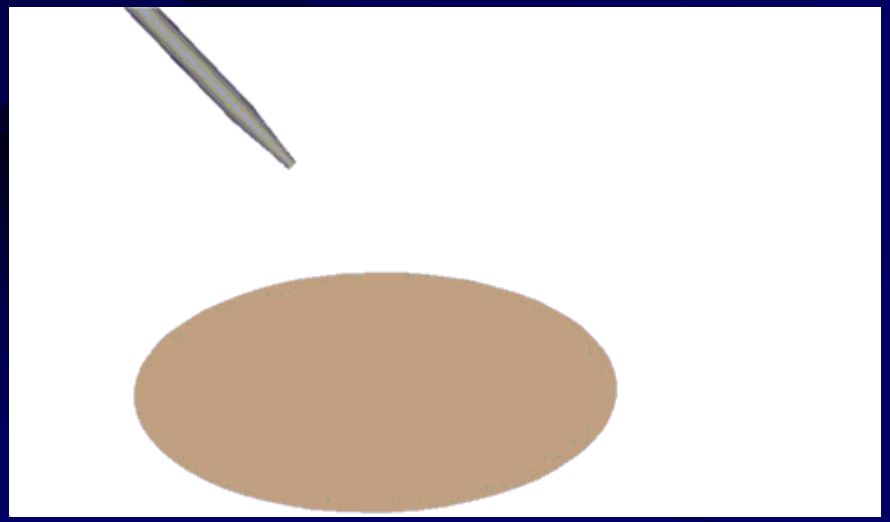
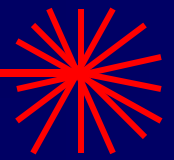
LASER SAFETY

- The use of lasers in the medical field is increasing at a tremendous rate.
- As laser treatment increases the potential for laser accidents also increases.

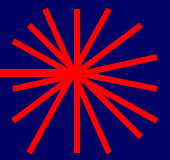


LASER SAFETY



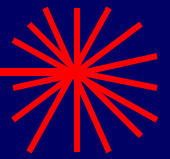
- **The Joint Commission EC.02.02.01**
  - **The hospital minimizes risks associated with selecting and using hazardous energy sources.**
  - **This includes ionizing (radiation and x-ray equipment) and non-ionizing equipment (LASER's and MRI's)**
  - **Possible TRACER during survey.**

LASERS IN MEDICINE



- Surgery (photothermal energy)
- Lithotripsy (photoacoustical energy)
- Tattoo Removal (photothermal energy)
- Hair Removal (photothermal energy)
- Photodynamic therapy (photochemical energy)

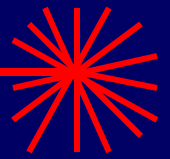
UNDERSTANDING LASER SAFETY



To understand laser safety the following questions need to be answered:

- **What is a laser?**
- **What are the potential hazards?**
- **How can these hazards be prevented?**

WHAT IS A LASER?



L ight

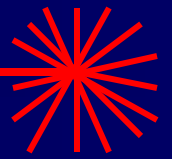
A mplification by

S timulated

E mission of

R adiation

LASER BASICS

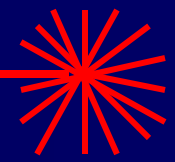


- Laser light differs from ordinary light in 3 ways:

1. Monochromatic - light that is one color or a single wavelength.
2. Directional - traveling in one direction from point of origin.
3. Coherent - orderliness of wave patterns by being in phase in time and space

- These three properties allow a laser to focus a lot of energy onto a small area.

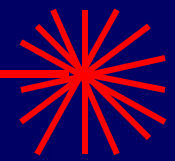
LASER BASICS



- Class 1 (No Hazard)
- Class 2 (Extended Viewing)
- Class 3 (Direct Beam Hazard)
- Class 4 (Direct/Reflected Exposure Hazard)

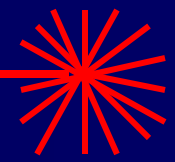
- International Electrotechnical Commission (IEC) LASER Classes
  - Class 1
  - Class 1M
  - Class 2
  - Class 2M
  - Class 3R
  - Class 3b
  - Class 4
- Medical LASERs include Class 1, 3b, and 4.

LASER BASICS



- There are three absorbers of light in tissue
  - Water, Hemoglobin, Melanin
- Water Absorption (i.e. CO2 LASER used for soft tissue; cells expand when heating occurs)
- Water Transmission (i.e. Diode LASER, KTP Green Light LASER)
- Knowing the absorption/transmission is important in determining the hazards and hazard controls.

BEAM RELATED HAZARDS



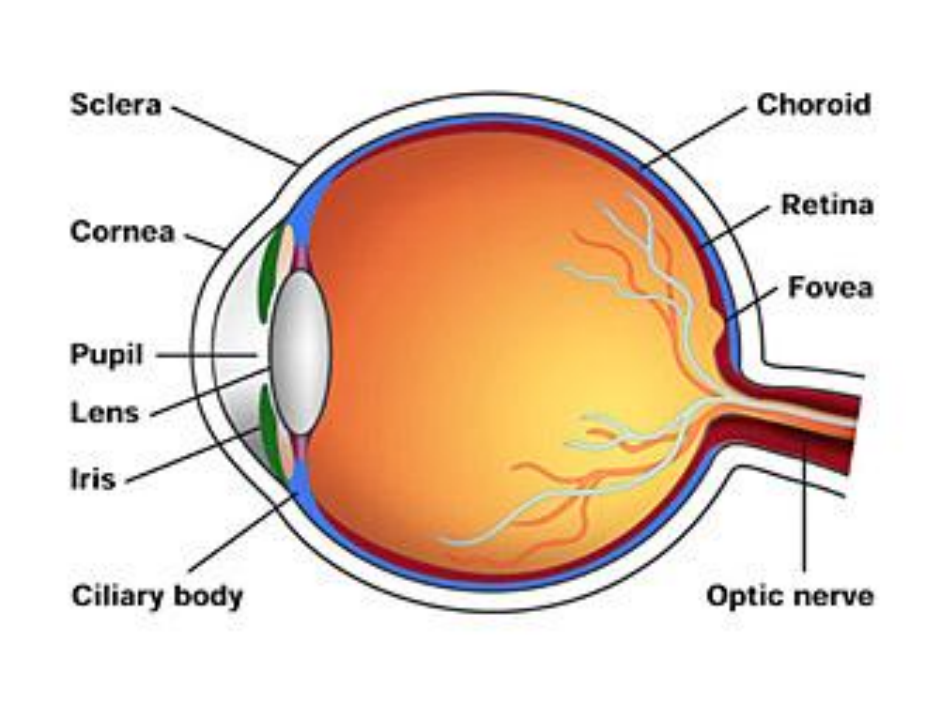
- Hazardous effects related to unintentional direct contact with the laser beam

  -Eye related

  -Interaction hazards (Plume and Fire)

  -Skin related

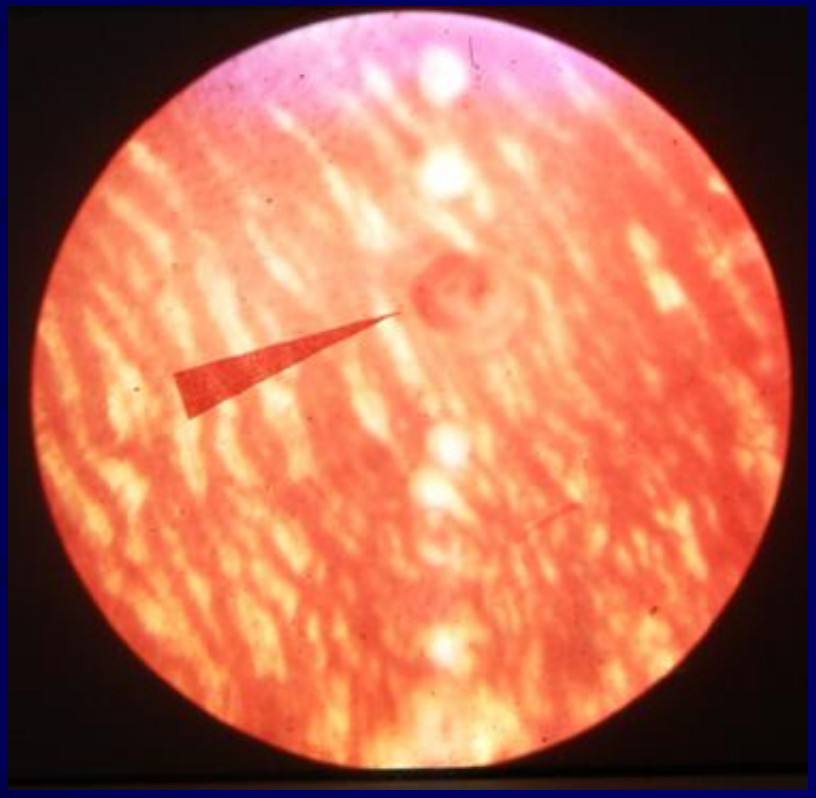
EYE RELATED HAZARDS



Corneal/Sclera Injury: caused by wavelengths that do not pass through fluid (roughly above 1400 nm and below 400 nm)

Retinal Burns Injury: caused by wavelengths that do pass through fluid from (roughly 400-1400nm)

Corneal injury from CO_2 laser

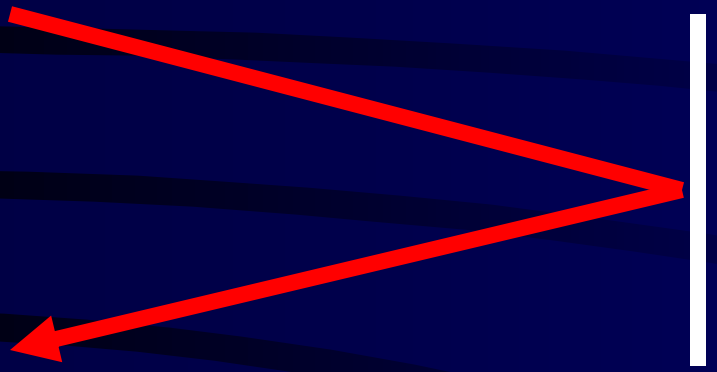


Retinal injury from a dye laser

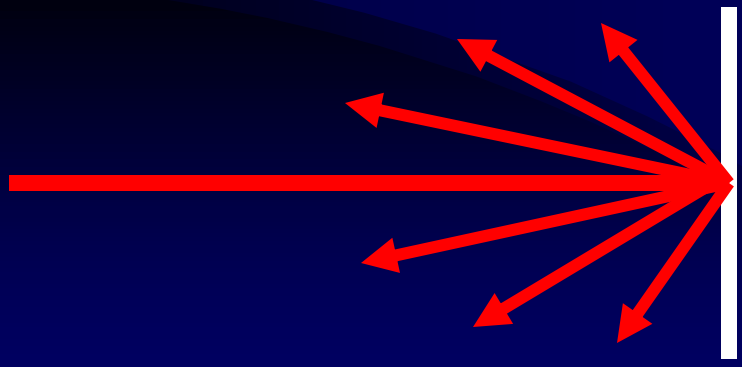
EYE RELATED HAZARDS

- Injury can result from exposure to:
  - direct beam
  - mirror reflection (surgical instruments)
  - diffuse beam (tissue reflection)
- Damage dependent on:
  - intensity - lens of eye can focus beam onto the retina
  - wavelength - absorbed by different parts of the eye
  - duration - fraction of second, before you can blink

Direct Beam

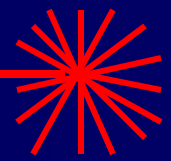


Reflected Beam



Diffuse Beam

INTERACTION HAZARDS
Plume



- Plume - smoke from vaporization

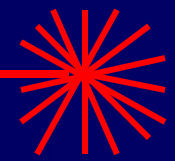
- Creates a visibility problem
- Can cause nausea
- Potential health hazard

INTERACTION HAZARDS
Plume

What is the plume?

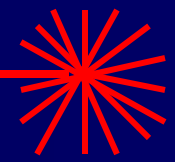
- **Carbon**
- **Aerosolized blood**
- **Bacteria**
- **Viral particulates**
- **Gases – including benzene, toluene and formaldehyde**

INTERACTION HAZARDS
Plume



- plume particle size - 0.1 microns
- standard surgical mask particle filtration efficiency:
  - 5 microns - 99%
  - 0.3 micron - 25%
  - double mask - 30%
- Do not rely on the surgical mask for filtration.
- The use of a smoke evacuator is the preferred control method.

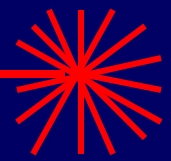
FIRE AND EXPLOSION



Can occur if the laser beam comes into contact with combustible or volatile materials, such as:

- **gauge pads**
- **surgical drapes**
- **gowns**
- **alcohol**
- **anesthetic gases**
- **plastic trach tubes**
- **rectal gases**

SKIN RELATED

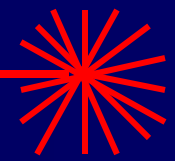


- Thermal burn
- Laser effects on tissue are dependent on 4 factors:
  - power density of laser beam
  - wavelength
  - duration of exposure
  - effects of circulation and conduction

NON-BEAM RELATED HAZARDS

- Hazards associated with the generation of the laser beam
  - Electrical
    - High voltage – many lasers require high voltage to generate the laser beam.
    - Accidental exposure can result in electrical shock or death
  - Chemical
    - Dye lasers use hazardous dyes to generate the laser beam (hazardous waste)

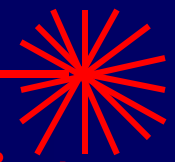
CONTROL MEASURES



There are 3 basic control measures:

- **Engineering**
- **Administrative**
- **Personal protection**

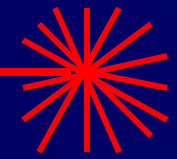
ENGINEERING



These are control measures that are built into the laser system, such as:

- enclosing the electrical system, within a cabinet
- enclosing the beam within fiber optics or mechanical arms

ADMINISTRATIVE CONTROLS



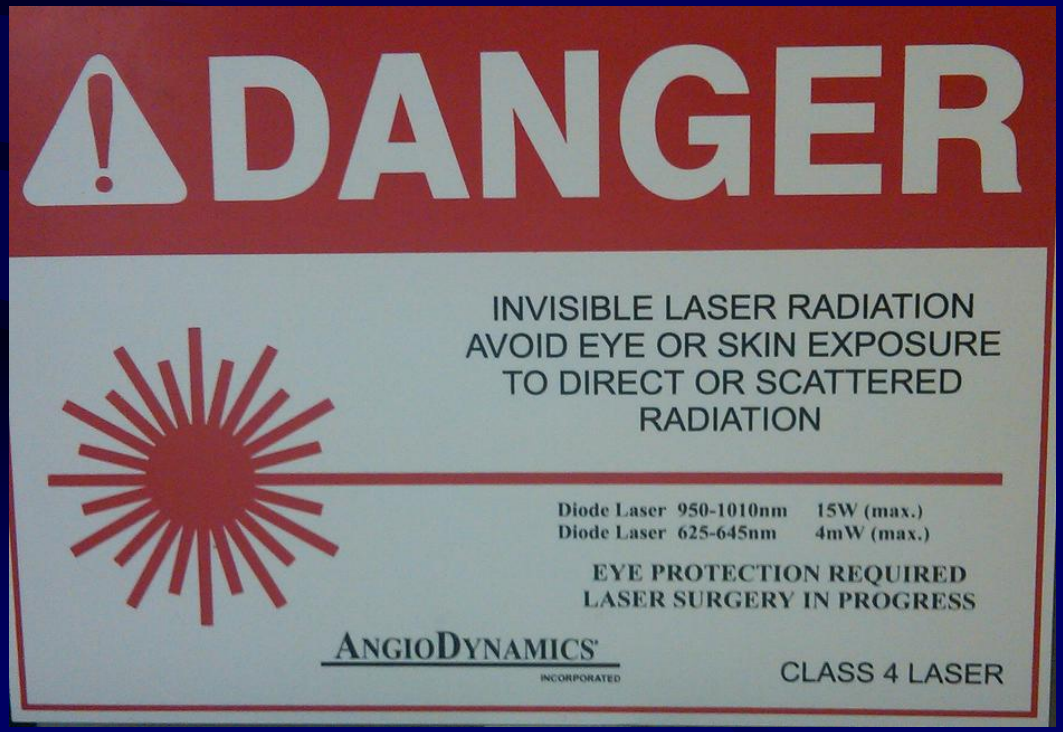
- Controlled entry

- Education

- Standards

CONTROLLED ENTRY

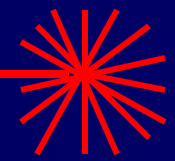
- Closing doors and covering windows (when required)
- Posting of the PROPER "Laser in Use" signs outside all entries.



CONTROLLED ENTRY

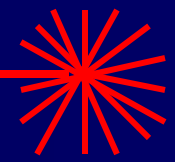
- Closing doors and covering windows (when required)
- Posting of the PROPER "Outside a Temporary LASER Controlled Area During Periods of Service" signs outside all entries.

EDUCATION



All personnel that may be exposed to the laser shall be required to attend regular "in-services" on operating the laser and laser safety.

STANDARDS



Each medical facility should develop their own set of operating standards.

- **American National Standards For The Safe Use Of Lasers**
- **American National Standards For The Safe Use Of Lasers In The Health Care Facility**

Institutional Procedures & Policies

- Laser Systems (HM-08-002)
- UT Laser Safety Manual (HM-08-002 Appendix A)
- Operating Room LASER Operation, Safety and Procedures (3364-124-56 through 3364-124-62). Policies are in the process of being combined.

OR Policies

- LASER team members will attend yearly LASER safety in-services.
- LASER questions have been added to the safety test bank.
- Qualified LASER team members will function independently of the circulating nurse.

OR Policies

- LASER Staff Member will:
  - Post LASER signs
  - Provide PPE for patient and staff and monitor use during the procedure.
  - Calibrate and test fire the LASER pre-operatively when required.
  - Monitor policies/procedures.
  - Complete the LASER Checklist.
  - Report any incidents to the OR Nurse and UT LSO.

OR Policies

- Eye Protection
  - Ensure the patients eyes are protected (see policy).
  - All personnel in the room must wear eye protection.
  - Endoscopic lens covers with special filters can be used during microscope procedures to provide protection.
  - LASER safety glasses must be made available on the door of the room.
  - COVER windows when required.

OR Policies

- LASER Generated Air Contaminants (LGAC's)
  - LASER must not be activated until the smoke evacuator is positioned near the tissue interaction site and is operating.

OR Policies

- Foot Pedal
  - Must be operated by the surgeon.
  - Will not be placed near any liquids to minimize electrical hazards.
  - Must be inspected for fraying or breaks in the cords.
  - Must be identified verbally by the LASER team member when placing it for use.
  - Other foot pedals will also be verbally identified to avoid confusion.

OR Policies

- Fire Safety
  - Use wet draping around the intended LASER site to reduce possible ignition.
  - A basin of 1000ml of saline must be readily available.
  - During a LASER procedure on the lower bowel, the rectum must be packed with a wet radiopaque sponge

OR Policies

- Fire Safety
  - SPECIAL precautions must be taken during trachea procedures to reduce the potential for ET tube fires (special tube and no-explosive gases).
  - Use of non-reflective instruments.
  - NO flammable prep solutions

OR Policies

- LASER Operation
  - Keys must be removed when not in use.
  - LASER will remain off when not in use.
  - Surgeon is responsible for setting the LASER settings.
  - Only the surgeon or resident under supervision of the surgeon will operate the LASER power activation controls.
  - The LASER will be placed in “Standby” mode on verbal command when the surgeon removes his hands or eyes from the field or LASER equipment.

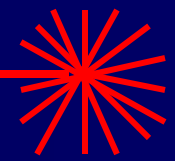
OR Policies

- LASER Instrumentation
  - Ensure proper instrumentation for the procedure to reduce the potential for melting, reflection, fire, plume.
  - Instruments can be covered with wet towels or sponges to decrease the chance of LASER reflection.
  - Stainless steel mirrors used to reflect the LASER beam must be inspected regularly.

Procedure #HM-08-002 – Laser Systems

- All Departments/Divisions must have policies & procedures addressing safety precautions for personnel
- Medical staff shall be credentialed (written record)

PERSONAL PROTECTION



- Eyewear

- Barriers

- Fire protection

- Smoke evacuation & filtration

EYE PROTECTION

Eyewear

- Each laser requires specific eyewear that is capable of absorbing laser light of that specific wavelength

EYE PROTECTION

Everyone in the laser OR must wear eye protection including the patient

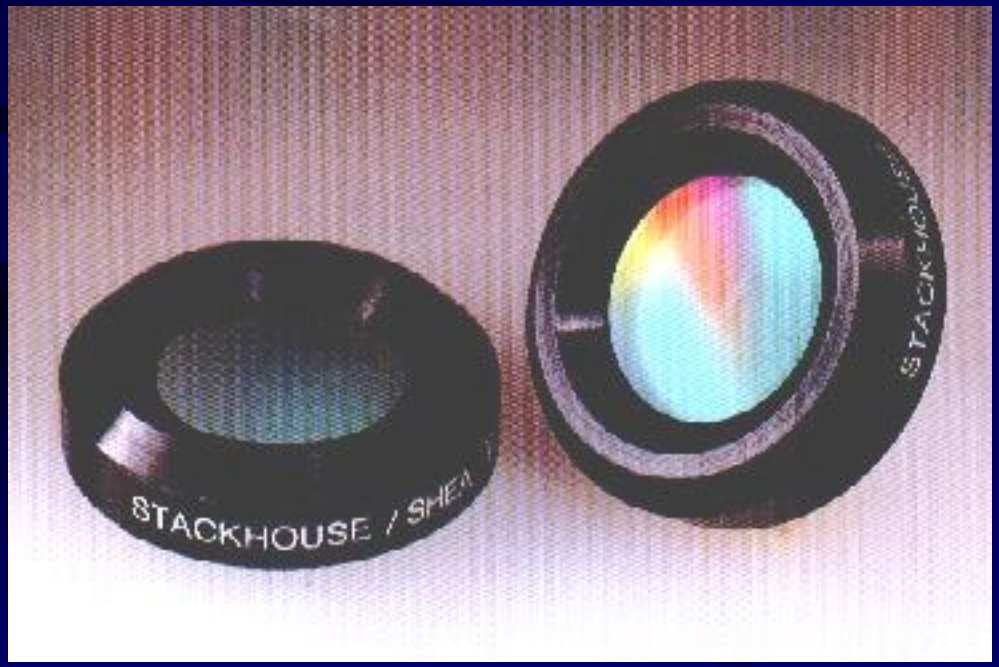
EYE PROTECTION

-Patient – the patient's eye's can be protected by:

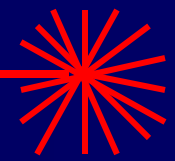
- covering with moist towels
- goggles
- intra-ocular shields

EYE PROTECTION

-The surgeon must have eye protection, even during microscopic and endoscopic procedures.
-Lens filters that fit over the eyepiece can be used



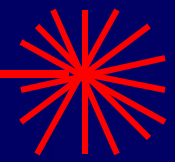
SKIN PROTECTION



Barriers

- Clothing
- Gloves
- Fire resistant gowns
- Fire resistant surgical drapes
- Moist gauze and drapes around surgical area

SKIN PROTECTION



Clothing

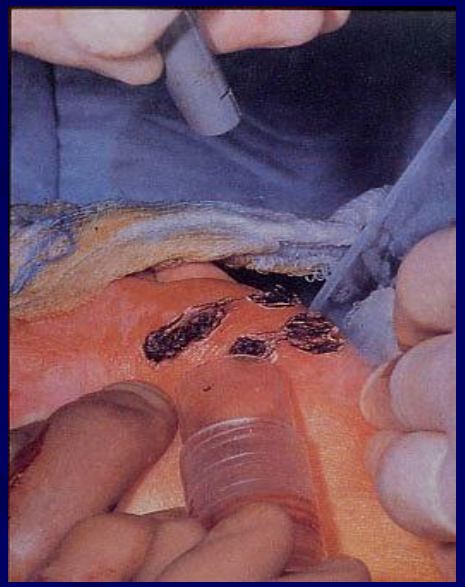
Offers some protection from skin exposure to laser beams, unfortunately most OR's use flammable gowns and drapes thus increasing the potential for fire hazards

- all gauze and drapes around the surgical area should be moistened with sterile saline.

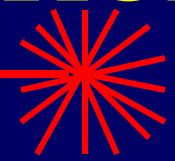
SMOKE EVACUATION & FILTRATION

Commercially available smoke evacuators filter out the smallest particles (0.1 μ) found in the laser plume

- to be completely effective the smoke evacuator suction tube must be placed as near to the site of laser ablation as possible (less than 2 cm)



SMOKE EVACUATION & FILTRATION



Filtration

- **-HEPA (high efficiency particulate air) Filter**
  - **-99.99% efficient at filtering 0.3 micron particles**
  - **-Bacterial filter**
- **-ULPA (ultra-low penetration) Filter**
  - **-99.999% efficient at filtering 0.12 micron particles**
  - **-Viral filter**

LASER BASICS –UTMC LASERS

CO2 LASER

- 10,600 nm (IRC)
- UTMC LASER
- Hazards
  - Eye Hazards (Corneal)
  - Skin Hazards (Skin Burns)
  - Electrical Hazards
  - Fire Hazards
  - LGAC's (LASER Generated Air Contaminants)
- Controls
  - LASER Safety Glasses
  - Smoke Evacuator
  - Policy/Procedures
  - Nominal Hazard Zone: Entire Room

LASER BASICS -TYPES of LASERS

Holmium:YAG LASER

- 2,100 nm (IRB)
- UTMC LASER
- Hazards
  - Eye Hazards (Corneal)
  - Skin Hazards (Skin Burns)
  - Electrical Hazards
  - Fire Hazards
- Controls
  - LASER Safety Glasses
  - Policy/Procedures
  - Nominal Hazard Zone: Entire Room

Cardiology (TMR)

Urology

LASER BASICS -TYPES of LASERS

Diode LASER (Precision 980)

- 980 nm (IRA)
- UTMC LASER
- Hazards
  - Eye Hazards (Cataract and Retinal Burn)
  - Skin Hazards (Skin Burn)
  - Electrical Hazards
  - Fire Hazards
- Controls
  - LASER Safety Glasses
  - Window Covers
  - Policy/Procedures
  - Nominal Hazard Zone: Entire Room

LASER BASICS -TYPES of LASERS

XeCl LASER

- 308nm (UVB)
- Leased LASER
- Hazards
  - Eye Hazards (Simultaneous Cornea, Lens, Retina effects observed)
  - Skin Hazards (Increased Pigmentation)
  - Electrical Hazards
  - Fire Hazards
- Controls
  - LASER Safety Glasses
  - Policy/Procedures
  - Nominal Hazard Zone: Entire Room

LASER BASICS -TYPES of LASERS

KTP Green Light LASER

- 532 nm (UVB)
- Leased LASER
- Hazards
  - Eye Hazards (Retinal Burn)
  - Skin Hazards
  - Electrical Hazards
  - Fire Hazards
  - Plume (Minimal)
- Controls
  - LASER Safety Glasses
  - Policy/Procedures
  - Nominal Hazard Zone: Entire Room
  - Window Covers (Currently used in a room without windows).

Record Keeping

- Keep records of all P.M.’s and repairs including rental LASERs.