



LASER Risk GeePs





Summary

- Lasers overview
- Beam Hazards
- Means of protection
- Good practices
- Other risks



Lasers overview

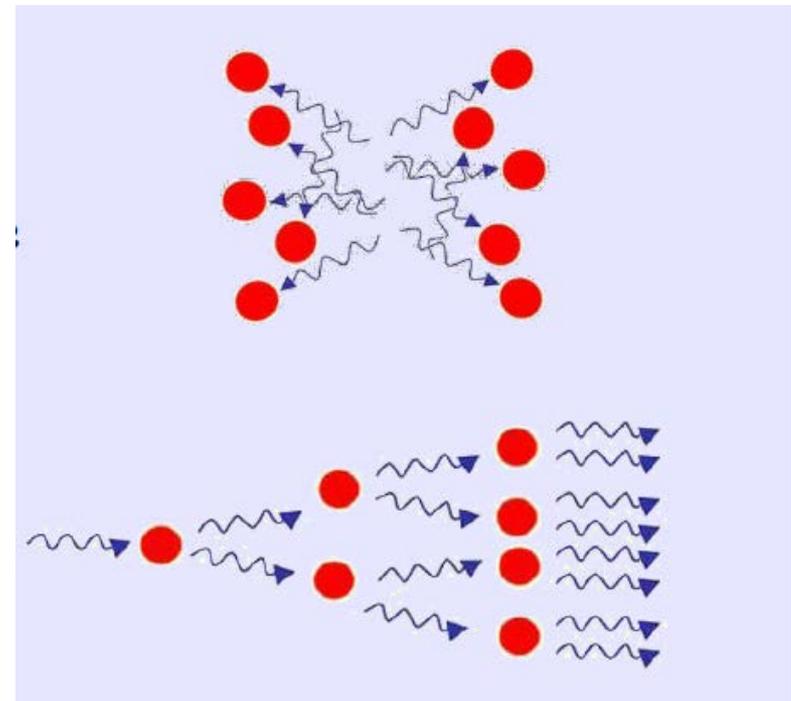
Light Amplification by Stimulated Emission of Radiation

spontaneous emission:

- independant energy
- No preferred direction
- no common phase relationship

Stimulated emission:

- same energy
- same direction
- same phase





Lasers overview

Operation principle:

- a gain medium
- a source of pumping
- a feedback loop

Laser characteristics :

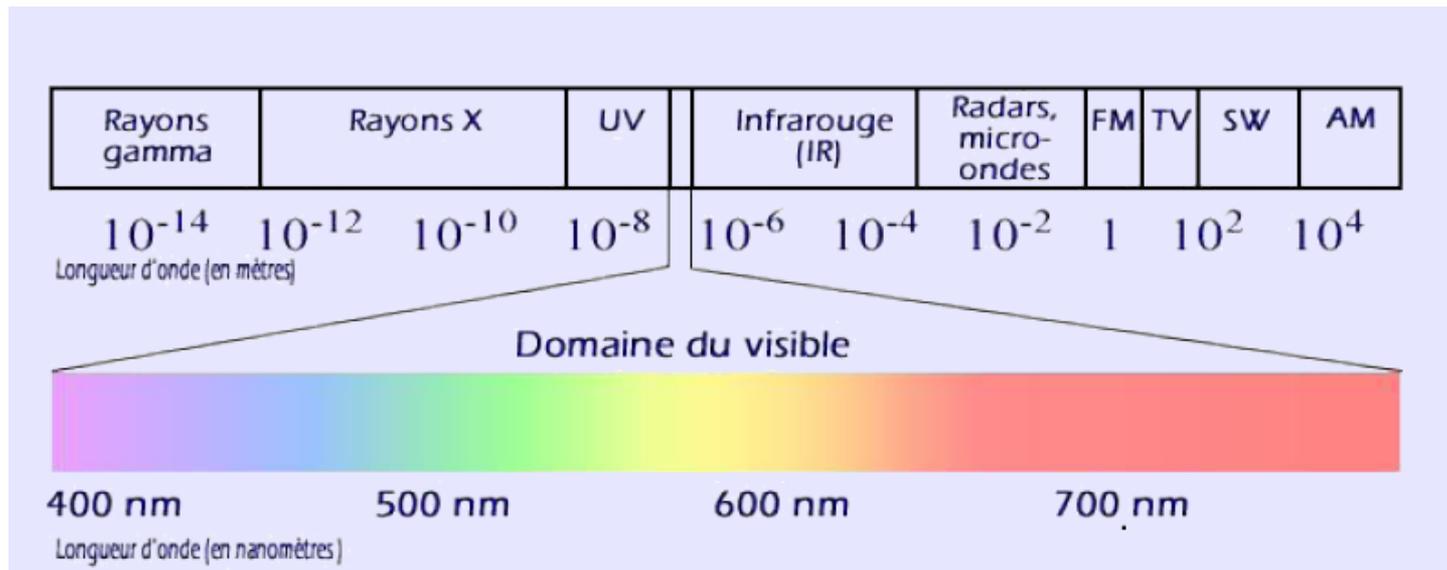
- Wavelength
- Emission mode (pulsed, continuous)
- Intensity (power, energy)
- Divergence



Lasers overview

Wavelength (λ)

- Nd:YAG : 1064nm (double : 532nm)
- He-Ne for alignment : 632nm
- Ti:Sa femtoseconde : 800nm
- CO2 : 10,6 μ m





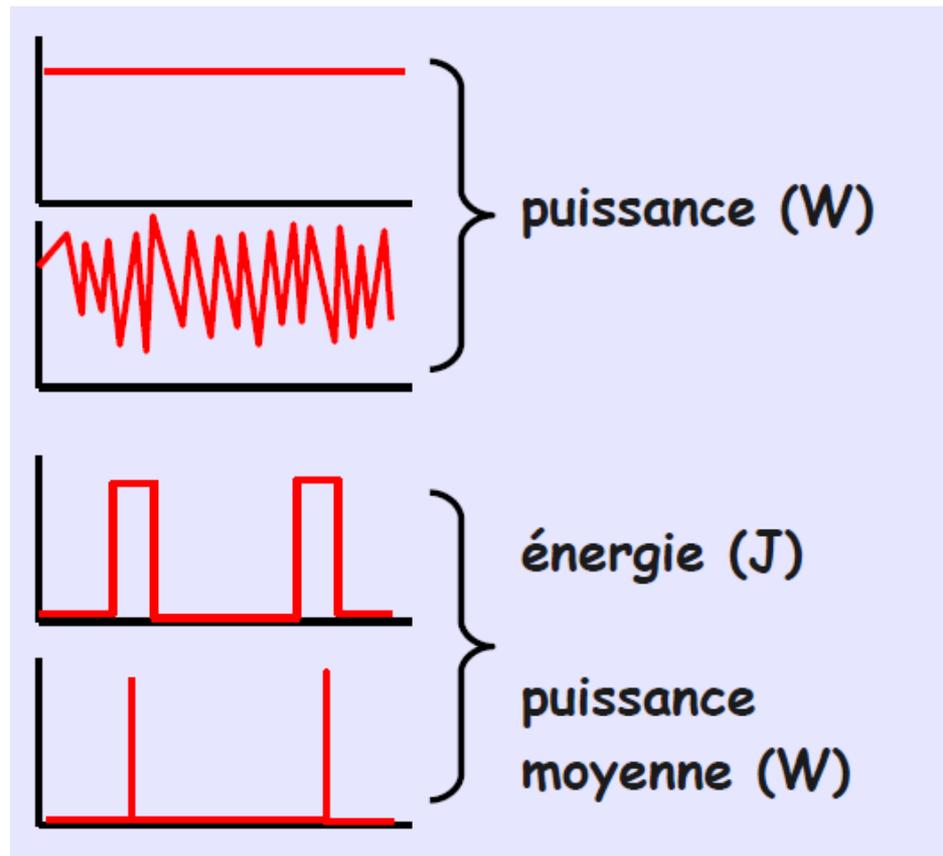
Lasers overview

Continuous :

- single-mode
- multimode

Pulsed :

- relaxed (ms- μ s)
- Q-switched (μ s-ns)
- Mode-locked (ns-fs)
 - duration (s)
 - frequency (Hz)

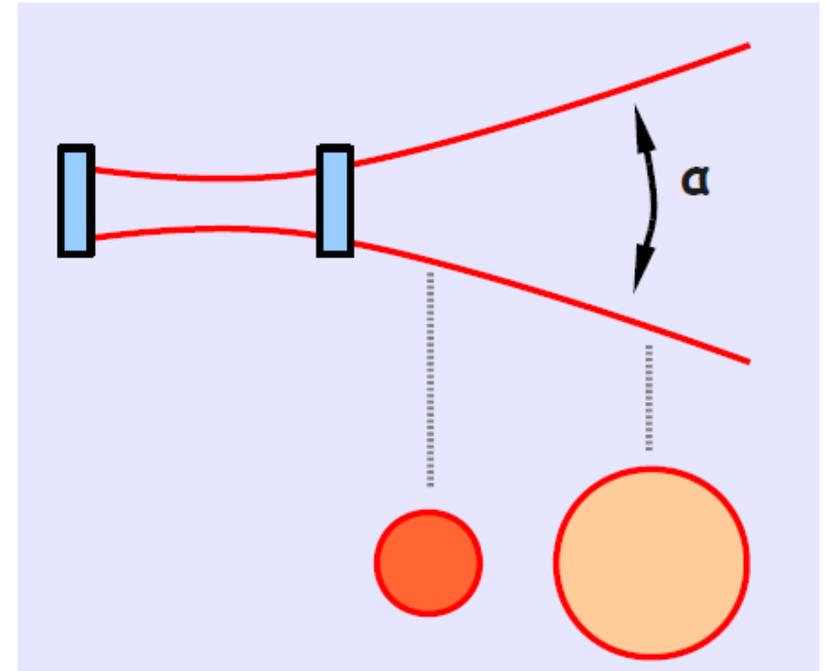




Lasers overview

Divergence :

- Affects all laser beam
- small angle
- mrd : 1mm to 1m



NOHD : Nominal Ocular Hazard Distance

This is the distance from the source at which the intensity or the energy per surface unit becomes lower than the Maximum Permissible Exposure (M.P.E.) on the cornea and on the skin. The laser beam can thus be considered as dangerous if the operator is closer from the source than the N.O.H.D.



Beam Hazards

Skin Risk

Photochemical injury (UV)

- erythema
- skin allergy
- skin tumour

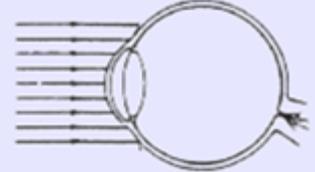
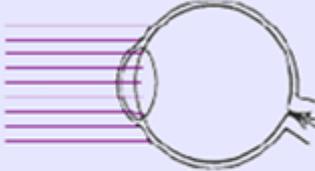
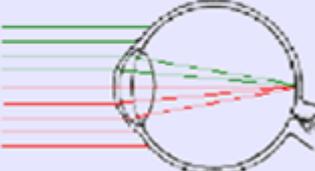
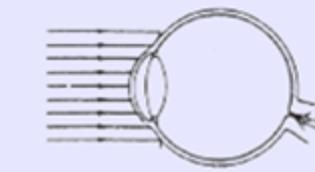
Thermal injury (visible and IR)

- burn
- possibility of cumulative effects



Beam Hazards

Ocular risk

UV C 100-280nm	cornea : conjunctivitis, opacification	
UV A-B 280-400nm	eye's lens : cataract	
Visible-IR A 400-1400nm	retina : slight impairment, scotoma eye's lens : cataract iris : edema, paralysis, necrosis	
IR B 1400-3000nm	cornea : damage, burning	



Beam Hazards

Laser safety classification

classification	1	1M	2	2M	3R	3B	4
without danger							
x danger potentiel		x	*	x	xx	xx	xx
* without danger if $t < 0,25s$			*	*	x	xx	xx
xx dangerous						x	xx
Eye + optical device		x	*	x	xx	xx	xx
Direct exposure			*	*	x	xx	xx
Diffuse reflection						x	xx
Skin						x	xx
Burning							x



Beam Hazards

Laser safety classification

- quick determination of the level of risk
- identified by a plate
- insufficient to size the good protections



For each class :

Maximum Accessible Emission Level Limit (AEL), norme NF EN 60825-1



Means of protection

Collective protections:

- beam orientation (horizontal plane, not at eyes level)
- Opaque or filtering covers, with opening contacts
- interlock, door contact, airlock
- Room lightning (iris size)
- blocking reflections and leaks
- signage, access control
- training, accreditation



Means of protection

Personal protective equipment (PPE)

- ordinary safety goggles : NF EN 207
- adjustment goggles : NF EN 208

- wavelength
- a letter specifying the laser type
- a "R number" (R1 to R5), quantifying the protection

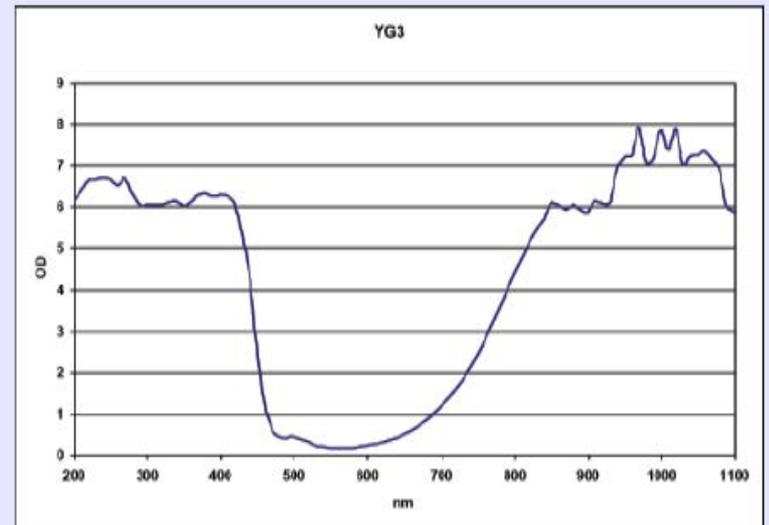
range (nm)

D : continuous
I : 0,25s to 1 μ s
R : 1 μ s to 1ns
M : <1ns

a "L number" (L1 to L10),
quantifying the filtering



Means of protection



840-950+1070-1090 DIR L5

- Wavelength between 840-950nm and 1070-1090nm
- from continuous to 1ns
- attenuation of 10^5



Means of protection

Initial medical visit

- visual acuity
- fundusopic examination, archive
- eye pressure measurement
- medical ability



Annual medical check-up

- in case of ocular gene,
- accident
- end of activity





Good practices

In case of injury :

- Neutralize the laser
- Calm the victim
- NEVER give up aspirin
- Refer the victim to a medical service
- Note the parameters of the laser source





Other risks

Electrical risk

- High voltage (flash sources)
- High current (diodes)
- Burning, electric shock or electrocution



Fire

- flammable materials on the beam (paper, cardboard, PVC)
- electrical overheating (power supplies, discharge bench)
- burns, smoke poisoning





Other risks

Chemical risks

- solvents
- Lasing gases, filler or inerting gases
- anoxia, intoxication



Miscellaneous risks

- non-coherent radiation(UV lamp)
- ionizing radiation
- magnetic fields
- irritations, irradiation, pacemakers...





Other risks



No laser accident listed with protective glasses...

