



# Safety Unit

## Radiation safety in a brief

**Yehuda Moshayev**  
**Radiation & Laser**  
**safety officer**

050-9001995

08-9345155

[yehuda.moshayev@weizmann.ac.il](mailto:yehuda.moshayev@weizmann.ac.il)



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- » Electromagnetic spectrum
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- » Non-ionizing radiation
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- ☠ Ionizing radiation
  - ☠ Radioactive materials
  - ☠ X-Ray
  - ☠ Principles of radiation protection



# What is Radiation?

## Radiation

Energy transfer in space by particles or photons.

## Ionizing Radiation

Radiation with sufficient energy to eject electrons from the material that it strike.



# Radiation worker?

Non-ionizing radiation



Laser ,UV ,MRI

Duty of  
Supervision and  
training

Ionizing radiation



Dealing with  
ionizing  
radiation

Duty of Supervision  
and training

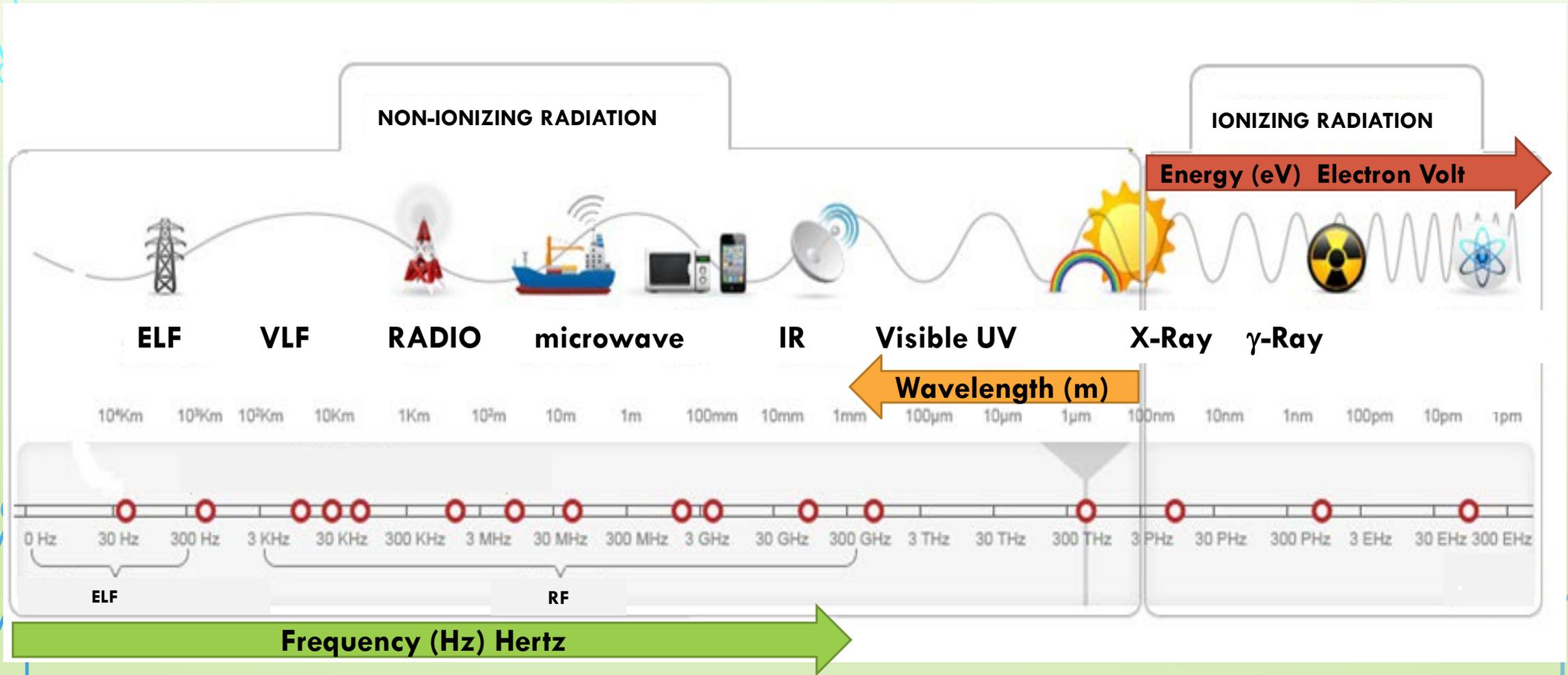
No need for personal  
monitoring

Work with  
ionizing  
radiation

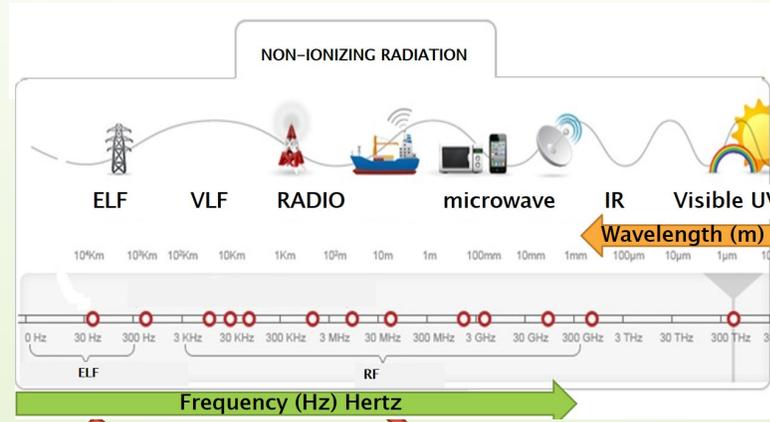
Duty of  
occupational  
medical  
examinations

Personal monitoring-  
radiation badges

# The Spectrum Of Electromagnetic Radiation



# Radiation types and risk



UV Hazard



Laser Hazard

**ELF**

Extremely low frequency  
0-300 Hz

**Audio waves**

300-3kHz

**RF**

Radio Frequency

3kHz-300 GHz

**light**

Wavelength

1mm-100 nm

Electricity and electronics



Change the shape of the blood cells

noise



Not considered radiation, damage the hearing and the nervous system

Low-frequency radio waves (TV, Radio FM/AM transmissions)



Generate heat and may damage the internal organs

High-frequency radio waves (RF, Microwave transmissions, relay station)



Create internal heat in soft tissues

Laser, IR, Visible light UV



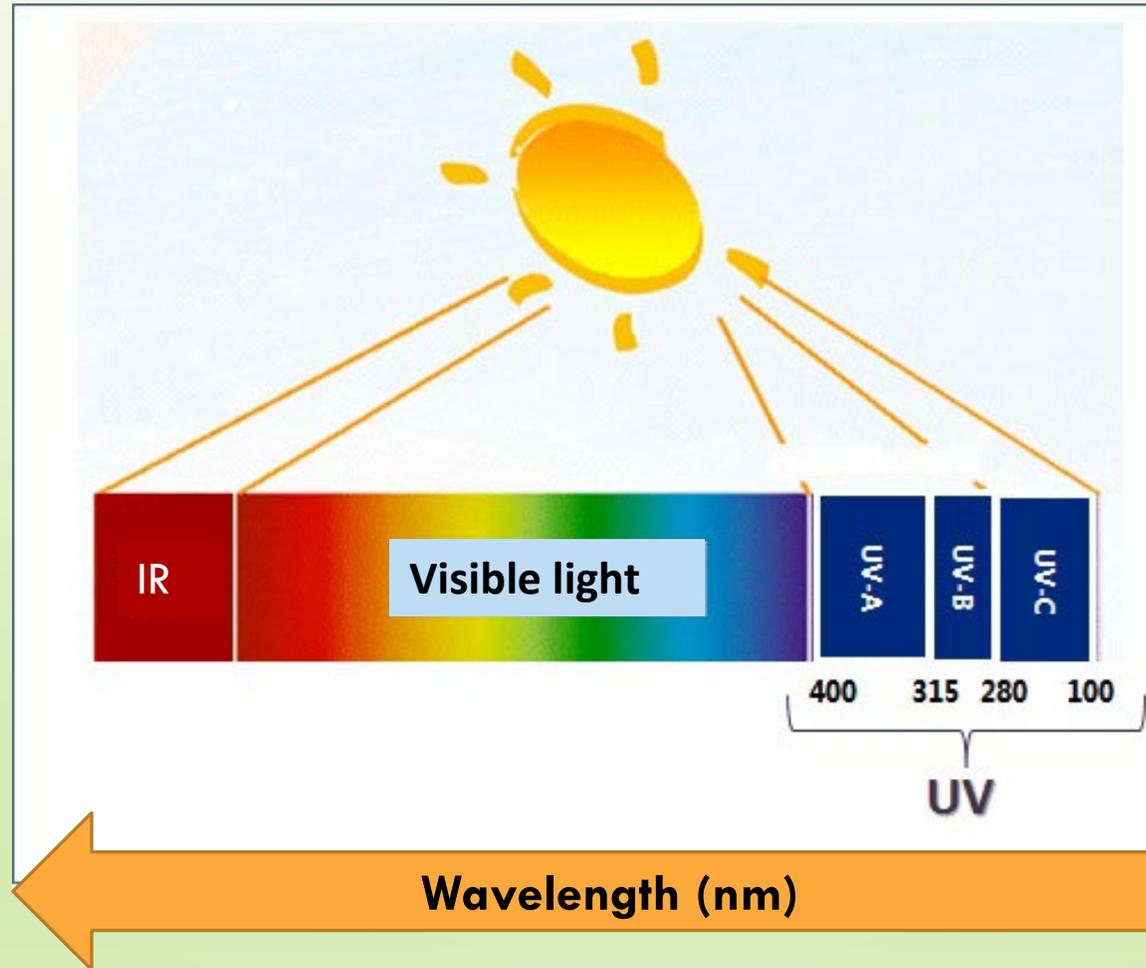
Dazzle, Blindness, Burns

# UV Radiation

זהירות קרינת UV



Caution  
UV radiation



UV Hazard

# UV Radiation

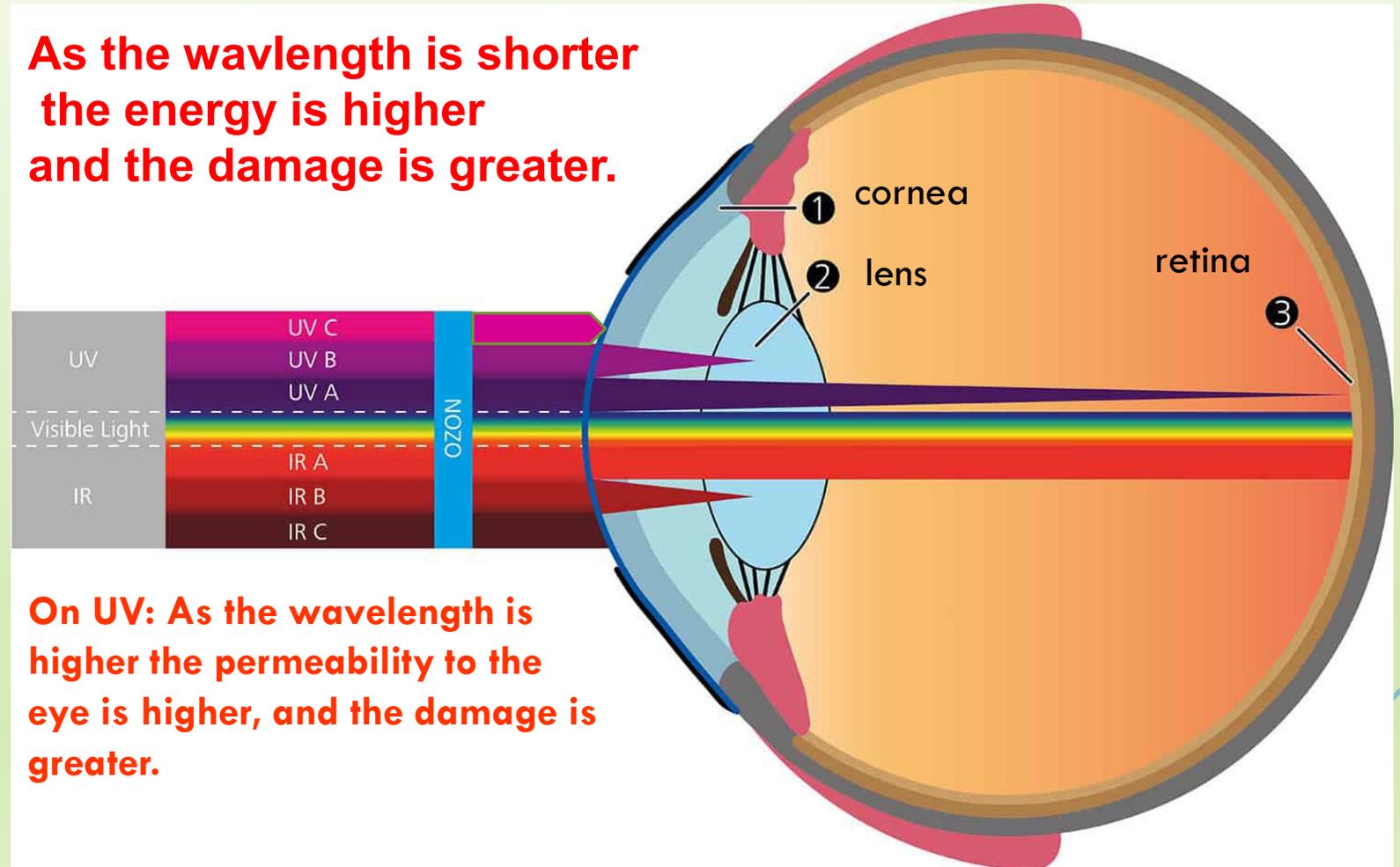
## Absorption and eye damage

$$E=hc/\lambda$$

wavelength (l)	absorption
UV-C 100-280	Ozone / conjunctiva, cornea
UV-B 280-315	lens
UV-A 315-400	retina

Artificial UV radiation is produced by UV lamps

As the wavelength is shorter the energy is higher and the damage is greater.

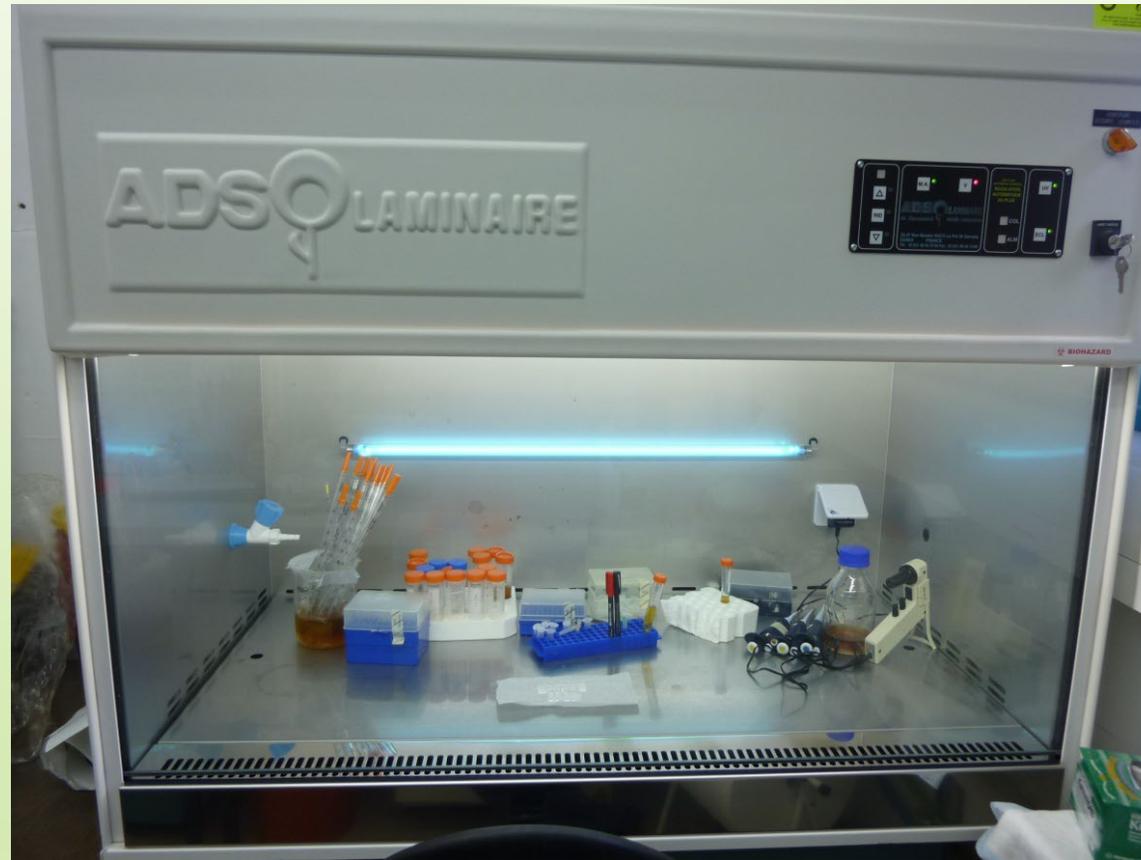


On UV: As the wavelength is higher the permeability to the eye is higher, and the damage is greater.

# UV Radiation

Wavelength	Energy	Eye Damage	Body Damage	Device
<b>UV-C</b> 100-280	<b>High energy</b>	<b>Inflammation</b> cornea conjunctiva and eyelid	<b>skin burn,</b> <b>skin cancer</b>	<b>Sterilization in</b> <b>fume</b> <b>chambers</b> <b>253-257 nm</b>
<b>UV-B</b> 280-315	<b>Medium</b> <b>energy</b>	<b>Inflammation</b> cornea conjunctiva and eyelid	<b>skin burn,</b> <b>skin cancer</b>	<b>UV</b> <b>transilluminators</b> <b>312 nm</b>
<b>UV-A</b> 315-400	<b>low energy</b>	<b>Cornea,</b> <b>Cataract</b>	<b>Create free</b> <b>radicals</b>	<b>UV</b> <b>transilluminators</b> <b>365 nm</b>

## Device with UVC lamp 253-257 nm in biological hood for Sterilization



**Do not use UV lamp in biological hood  
without threshold switch**

## Biological hood with fixed sash



**Don't use UV lamp in biological hood  
with fixed sash**

# UVC lamp in “Clean-Spot” (Meyer & Leonescu buildings)



UV lamp  
with threshold switch

# Devices with UV lamps

Emit two wavelengths: 312 (UVB), 365 (UVA)

Polycarbonate  
screen



UV Transilluminators



Manual UV lamp

# Protection measures for UV radiation



זהירות קרינת UV



**Caution**  
UV radiation

## Face shield and safety goggles



## Hands and face Protection

1. Nitrile gloves
2. Lab coat with long sleeves
3. Face shield

# Accident – exposure to UV radiation





# "OPEN BENCH" Lubin building



Without UV lamp

# Laser

**Laser** : "Light Amplification by Stimulated Emission of Radiation"

## Duty of Supervision and training

	<p><b>סכנה</b> <b>DANGER</b> לייזר רמה 4 LASER CLASS 4</p>		
<p><b>LASER RADIATION</b> AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION. <b>AUTHORIZED PERSONNEL ONLY</b></p>		<p><b>קרינת לייזר</b> הימנע מחשיפת העיניים או העור לקרינה ישירה או מפוזרת. <b>הכניסה למורשים בלבד</b></p>	



**Wear laser safety goggles**



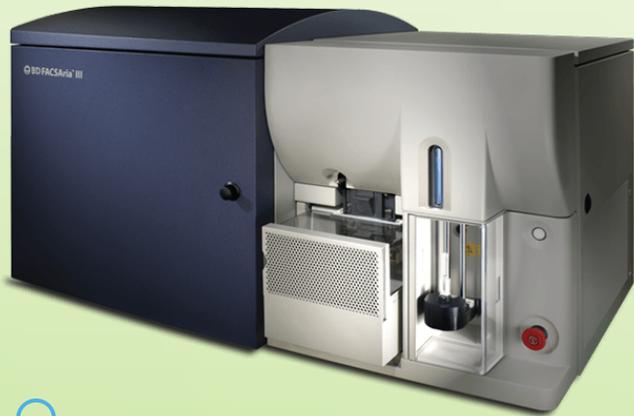
**Chamelon MPX  
Class 4**

# Laser

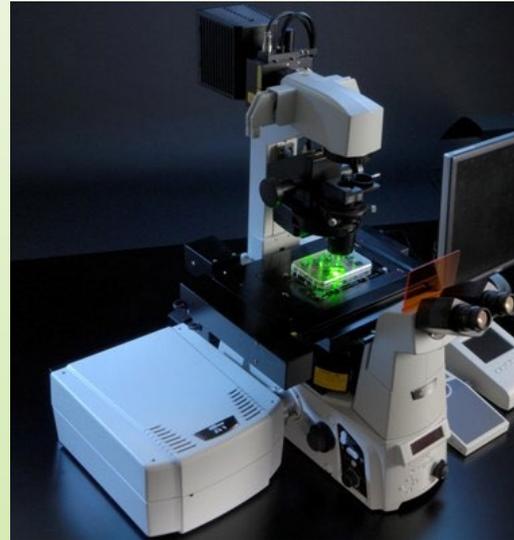


## Closed Laser Systems

## Open Laser Systems



**FACS - Flow cytometry**



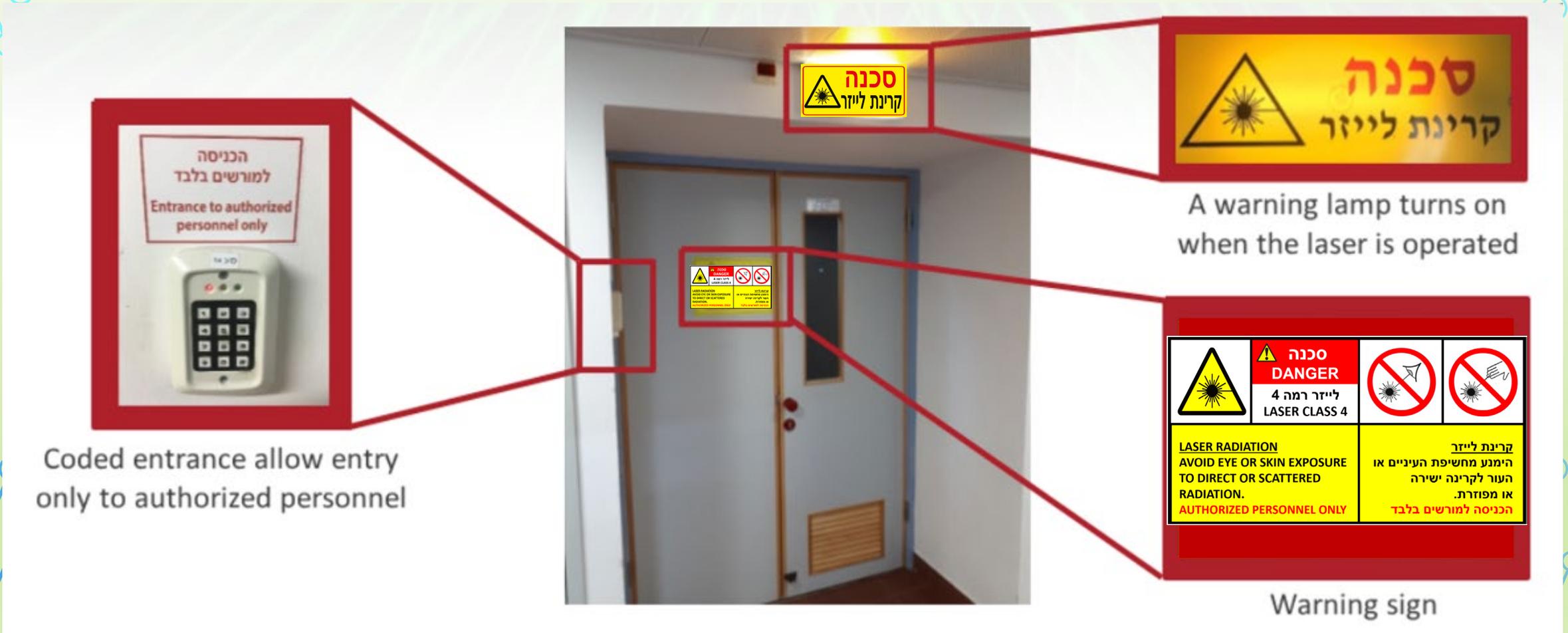
**Laser Scanning  
Confocal Microscopy**



**Optical Table**

# Laser

**Laser** : "Light Amplification by Stimulated Emission of Radiation"





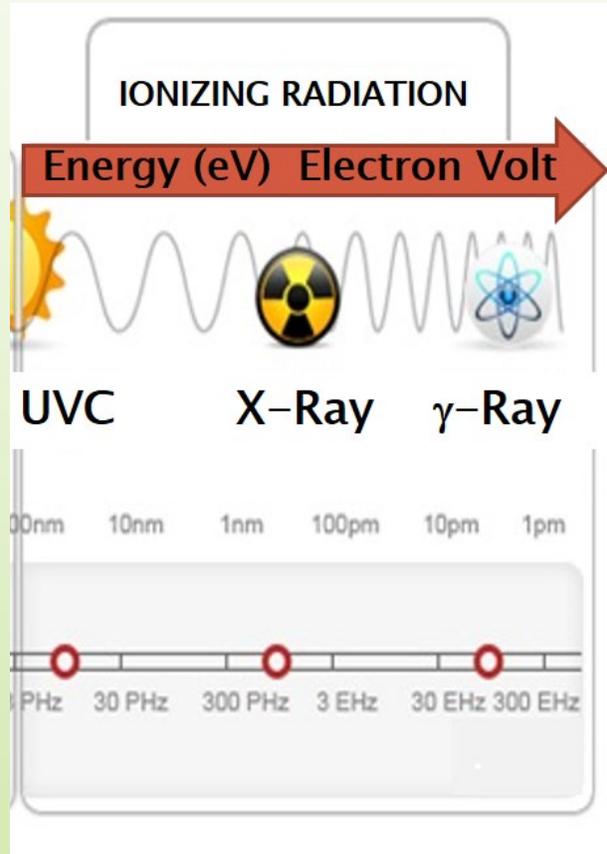
# The sources of ionizing radiation at WIS

## X-Ray device

Imaging  
XRD  
XRF  
CT  
X-Ray

Particle  
Accelerator

Powerful laser



## Radioactive materials

open  
radioactive  
sources

$^{32}\text{P}$   
 $^{35}\text{S}$   
 $^{14}\text{C}$   
 $^3\text{H}$   
 $^{238}\text{U}$

sealed  
sources

$^{55}\text{Fe}$   
 $^{60}\text{Co}$   
 $^{57}\text{Co}$   
 $^{90}\text{Sr}$   
 $^{137}\text{Cs}$   
 $^{241}\text{Am}$   
 $^{241}\text{Am/Be}$

**Ionizing radiation -  $\alpha$ ,  $\beta$ ,  $\gamma$ , X-Ray, n, p**

**Tissue destruction**

# Background radiation from natural sources in Israel

In food and drinks  
 $^{40}\text{K}$ ,  $^{238}\text{U}$ ,  $^{226}\text{Ra}$

0.4 mSv/yr



2 mSv/yr

Cosmic radiation  
(sea level)

0.3 mSv/yr

Radon gas

0.9  
mSv/yr

Ground

0.3 mSv/yr

$^{222}\text{R}$

$^{238}\text{U}$

$^{226}\text{Ra}$

$^{232}\text{Th}$

# The sources of ionizing radiation at WIS

## Open Radioactive Sources

**Liquid or powder radioactive material:** may disperse and cause internal exposure as well as pollute the environment.

This type of source is commonly used in scientific and medical research



open  
radioactive  
sources

$^{32}\text{P}$

$^{35}\text{S}$

$^{14}\text{C}$

$^3\text{H}$

$^{238}\text{U}$

# Radioactive waste



Chemical and biological laboratory wastes that contain radioactive material thrown away as a radioactive waste



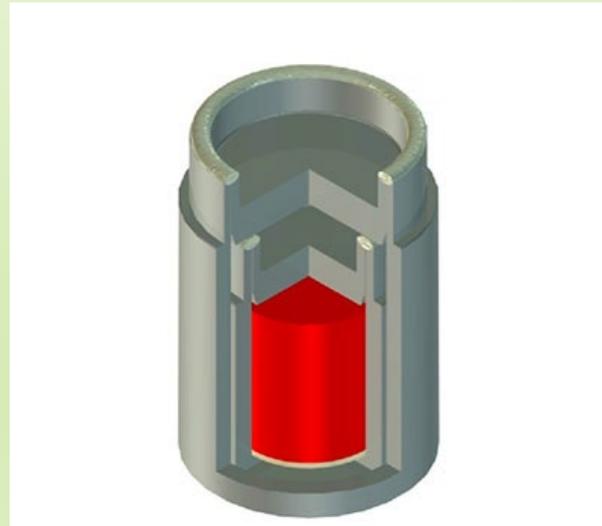
radioactive waste barrel

# The sources of ionizing radiation at WIS

## sealed sources

Radioactive material sources contained inside hermetic cover.

The radiation emits through the cover (external exposure), but the radioactive material itself can't be released to the environment (unless the cover is damaged).



### sealed sources

- $^{55}\text{Fe}$
- $^{60}\text{Co}$
- $^{57}\text{Co}$
- $^{90}\text{Sr}$
- $^{137}\text{Cs}$
- $^{241}\text{Am}$
- $^{241}\text{Am/Be}$

# Radioactive Materials – Exposure routes



Internal exposure

open  
radioactive  
sources

$^{32}\text{P}$

$^{35}\text{S}$

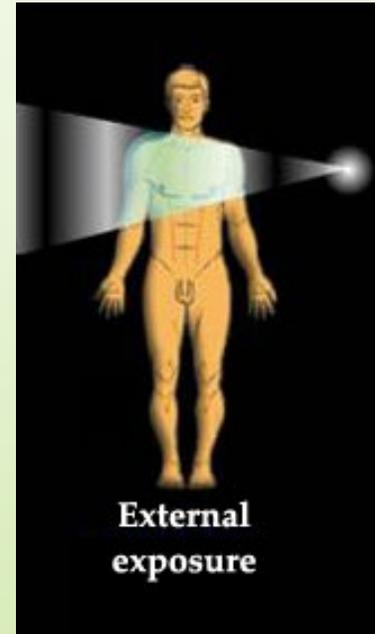
$^{14}\text{C}$

$^3\text{H}$

$^{241}\text{Am}$

$^{238}\text{U}$

Internal exposure



External exposure

sealed  
sources

$^{55}\text{Fe}$

$^{60}\text{Co}$

$^{57}\text{Co}$

$^{90}\text{Sr}$

$^{137}\text{Cs}$

$^{241}\text{Am}$

$^{241}\text{Am/Be}$

External exposure

# The sources of ionizing radiation at WIS

## X-Ray devices

Imaging  
XRD  
XRF  
CT  
X-Ray

Particle  
Accelerator

Powerful laser



XRF gun



Xradia Micro XCT



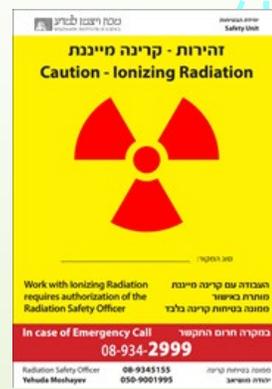
X-RAD 320



Miniature X-Ray



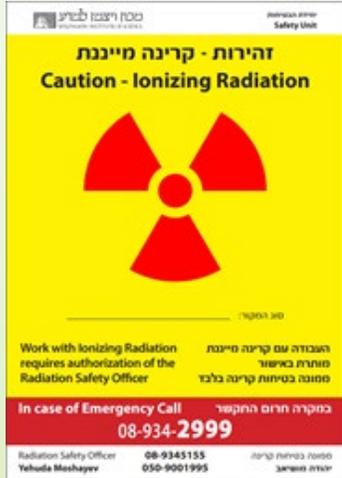
XRD



# Principles of protection from ionizing radiation

1. Decrease exposure time
2. intensity of radiation falls off with distance from a source
3. Use an appropriate shielding
4. Use PPE
5. **Geiger counter** - *Monitor your work and yourself every step of the work with radiation.*

# Thank you!



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