# X-Ray Radiation Safety Training

CSULB
Radiation Safety Program

# Outline

- Regulatory framework
- Explanation of X-ray radiation, sources and biological effects
- Important units, radiation safety, dose
- Detection and monitoring of x-ray radiation
- Emergency procedures
- Where to find further information

# State of California Regulations Analytical X-Ray Machines

- Analytical X-Ray machines are used in research and teaching at CSULB. They include, but are not limited to: Portable field radiography units, Cabinet X-Ray Diffraction systems, X-Ray Fluorescence systems (fixed and portable), Scanning Electron Microscopes (SEM) and Transmission Electron Microscopes (TEM).
- X-ray devices are regulated by and must be registered (for a fee) with the State of California, Department of Public Health, Radiologic Health Branch (RHB). Regulations pertaining to X-Ray devices can be found in California Code of Regulations (CCR) Title 17. The RHB enforces these regulations and regularly inspects our program without advanced notice.

# State of California Regulations Analytical X-Ray Machines (2)

- Each analytical x-ray device supervisor shall ensure training of each user and document this training. This training shall consist of Radiation Safety's introductory training/exam and machine-specific training, including a practical examination.
- Each x-ray supervisor shall ensure that x-ray equipment is operated only by persons adequately instructed in safe operating procedures and competent in the safe use of the equipment. Safety rules shall be provided to each operator. A use-log shall be maintained.
- Registration documents are on file at the Radiation Safety Office.

# State of California Regulations Diagnostic X-Ray Machines

- Diagnostic or medical X-Ray devices are used for medical radiography or bone densitometry. These X-ray devices are also regulated and registered by the State of California, Department of Public Health, Radiologic Health Branch (RHB).
- Diagnostic (medical-use) machine operators must be qualified and licensed by the RHB.
- A licensed Supervising physician must also be retained by the University for all diagnostic X-Ray devices.

# State of California Regulations Diagnostic X-Ray Machines (2)

- The State of California RHB routinely inspects X-ray devices without notice per CCR Title 17.
- Form RH 2364, “Notice To Employees” must be posted at all X-Ray devices. It has important regulatory information as well as RHB contact information.

# Notice to Employees Form RH 2364

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

## NOTICE TO EMPLOYEES

**STANDARDS FOR PROTECTION AGAINST RADIATION**

**CALIFORNIA RADIATION CONTROL REGULATIONS (CALIFORNIA CODE OF REGULATIONS, TITLE 17, SECTION 30255)**

The California Radiation Control Regulations include standards for protection against radiation hazards. The State Department of Public Health has primary responsibility for administering these standards which apply to both employers and employees. Enforcement is carried out by the Department of Public Health or its authorized inspection agencies.

**EMPLOYEES' RESPONSIBILITIES**

You should know and understand those California radiation protection standards and your employer's operating and emergency procedures which apply to your work. You should comply with these requirements for your own safety and the safety of others. Report promptly to your employer any condition which may lead to or cause a violation of these standards or employer's operating and emergency procedures.

**SCOPE OF THE STANDARDS**

The Standards for Protection Against Radiation define:

1. Limits on exposure to radiation and radioactive materials;
2. Actions to be taken after accidental exposure;
3. Working conditions requiring personnel monitoring, safety surveys, engineered controls, and safety equipment;
4. Proper use of caution signs, labels, and safety interlock devices;
5. Requirements for keeping worker exposure records and reporting of such exposures;
6. The requirement for specific operating and emergency procedures for radiation work; and
7. The rights of workers regarding safety inspections.

**EMPLOYERS' RESPONSIBILITIES**

Your employer is required to:

1. Comply with the requirements of the California Radiation Control Regulations, departmental orders, and license conditions;
2. Post or make available to you copies of the Radiation Control Regulations, any license issued thereunder, and your operating and emergency procedures;
3. Post any notice of violation of radiological working conditions; and
4. Provide you with information on your exposure to radiation.

**REPORTS ON YOUR RADIATION EXPOSURE HISTORY**

1. California Radiation Control Regulations require your employer to give you a written report if you receive an exposure greater than the limits set in the radiation safety standards. Basic limits for occupational radiation exposure can be found in Section 30253 referencing title 10, Code of Federal Regulations, part 20. Limits on exposure to radiation and exposure to concentrations of radioactive material in air are specified in title 10, Code of Federal Regulations, part 20, subpart C.
2. If the radiation protection standard, under 10 CFR 20 (subpart F) requires that your radiation exposure be monitored, your employer must, upon your request, (a) give you a written report of your exposures upon termination of your employment, and (b) advise you of your exposures annually.

**INSPECTIONS**

The Department or one of its contractors will inspect your workplace from time to time to ensure that health and safety requirements are being followed and that these requirements are effective in protecting you. Inspectors may confer privately with you at the time of inspection. At that time you may direct the inspector's attention to any condition you believe is or was a violation of the safety requirements.

In addition, if you believe at any time that any health and safety requirements are being violated, you or your workers' representative may request that an inspection be made by sending a complaint to the Department of Public Health or other official agency. Your complaint must describe the specific circumstances of the apparent violation and must be signed by you or your workers' representative. The Department is required to give your employer a copy of any such complaint. Names may be withheld at your request. You should understand, however, that the law protects you from being discharged or discriminated against in any way for filing a complaint or otherwise exercising your rights under the California Radiation Control Regulations.

**POSTING REQUIREMENTS**

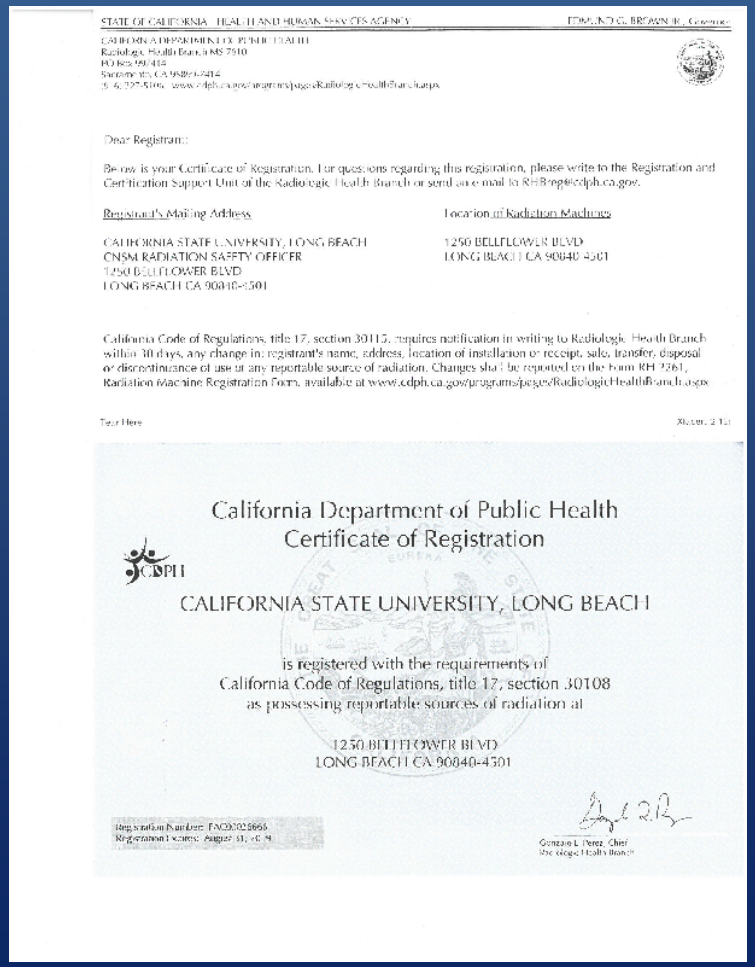
Copies of this notice must be posted in a sufficient number of places in every establishment where employees are employed in activities regulated by the California Radiation Control Regulations, to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

**FOR RADIOLOGICAL EMERGENCY ASSISTANCE (24/7), PHONE 1-800-852-7550**
**To contact the Radiologic Health Branch, phone (916) 327-5106 or go to:**
**http://www.cdph.ca.gov/programs/Pages/RadiologicHealthBranch.aspx**

RHB 2364 (5/09)

# CSULB Radiation Machines Registration

- Issued to CSULB by the California Dept. of Public Health Radiologic Health Branch.
- All X-Ray machines at CSULB shall be registered with the State. This includes electron microscopes.
- The Radiation Safety Office has day-to-day program oversight.



STATE OF CALIFORNIA - HEALTH AND HUMAN SERVICES AGENCY

EDMUND G. BROWN JR., Governor

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
Radiologic Health Branch MS 7510
PO Box 997414
Sacramento, CA 95899-7414
(916) 327-5106 www.cdph.ca.gov/programs/pages/RadiologicHealthBranch.aspx

Dear Registrant:

Below is your Certificate of Registration. For questions regarding this registration, please write to the Registration and Certification Support Unit of the Radiologic Health Branch or send an e-mail to RHBregs@cdph.ca.gov.

| Registrant's Mailing Address | Location of Radiation Machines |
| --- | --- |
| CALIFORNIA STATE UNIVERSITY, LONG BEACH<br>CNSM RADIATION SAFETY OFFICER<br>1250 BELLFLOWER BLVD<br>LONG BEACH CA 90840-4501 | 1250 BELLFLOWER BLVD<br>LONG BEACH CA 90840-4501 |

California Code of Regulations, title 17, section 30115, requires notification in writing to Radiologic Health Branch within 30 days, any change in: registrant's name, address, location of installation or receipt, sale, transfer, disposal or discontinuance of use of any reportable source of radiation. Changes shall be reported on the form RH 2361, Radiation Machine Registration Form, available at www.cdph.ca.gov/programs/pages/RadiologicHealthBranch.aspx

Tear Here

California Department of Public Health
Certificate of Registration

CDPH

CALIFORNIA STATE UNIVERSITY, LONG BEACH

is registered with the requirements of
California Code of Regulations, title 17, section 30108
as possessing reportable sources of radiation at

1250 BELLFLOWER BLVD
LONG BEACH CA 90840-4501

Registration Number: FA0302866
Registration Expires: August 31, [illegible]

Gonzalo L. Perez, Chief
Radiologic Health Branch

# CSULB Radiation Safety Committee

- The CSULB Radiation Safety Committee (RSC), appointed by University Administration, is composed of experienced radioactive materials users, X-Ray machine users, Radiation safety staff and administration.
- The RSC issues permits to individuals who have demonstrated appropriate training and experience with the machines they propose to use.

# X-Ray Permit

## Ionizing Radiation Use Authorization (IRUA)

California State University, Long Beach Radiation Safety Office

**IONIZING RADIATION USE AUTHORIZATION NO. X077**

| | | |
|---|---|---|
| Responsible User: Shinsuke Doshishita | Department: Chemistry and Biochemistry | Expiration Date: 12/31/2021 |
| Authorized Personnel: See current list in radiation notebook | Authorized Location(s): MLSC-102 | |
| Description of Project: Diffraction analysis of solid state materials | | |

**X-RAY EQUIPMENT AUTHORIZED**

| Unit No. | Manufacturer | Model | Serial Number | Property Number | kVp Max | mA/mp Max | Description |
|---|---|---|---|---|---|---|---|
| 1 | Panalytical | XPERT PRO ALPHA 1 | 230590 | | 60 RUN AT 45 | nE 3U N AT 35 | Cabinet XRD |
| | | | | | | | |
| | | | | | | | |

**PRECAUTIONS REQUIRED**

| Protective Equipment | Personnel Monitoring | Engineering Controls |
|---|---|---|
| | | Interlocked cabinet XRD |

| Operational Monitoring by User | Operational Monitoring by R.S.O. |
|---|---|
| 1. Follow the written operational guide<br>2. Employ the Use Log for all operations | 1. Documented initial set-up survey and safety audit<br>2. Annual reviews to come |

**OTHER REQUIREMENTS**

1. Documented safety and operator training is required for each unsupervised operation.
2. Repair or modification of shielding/interlock systems is forbidden unless specifically authorized IN WRITING by Radiation Safety
3. Maintain the X-ray warning signs on the device and in the room. Emergency contact information must be current.

**APPROVAL AND CERTIFICATION**

| | |
|---|---|
| We approve this radiation use as described and subject to the precautions listed.<br>Radiation Safety Officer [signature] Date 11/14/16 | We certify that all work will be as described and in accordance with the precautions listed.<br>Responsible User [signature] 11/10/16 Date |
| RSC Chair [signature] Date 11/14/16 | Department Chair C.R. Bois Date 11/17/16 |

# CSULB X-Ray Device Requirements

- **If you plan to acquire any X-ray devices YOU MUST *get written approval* from radiation safety first! 562 985-5623.**
- CSULB Radiation Safety inspects X-ray devices annually.
- X-ray users must be approved and trained by the device Principal Investigator (PI).
- Device PI shall ensure that all safety interlocks and shielding are working properly. Radiation Safety will verify.
- Appropriate signs and emergency information shall be posted at the instrument.

# CSULB X-Ray Device Requirements (2)

- X-ray devices shall not be repaired or have the housing removed without prior written approval of the RSO.
- An entry on a use-log for each x-ray generating device must be completed for each operation of the unit, including training and diagnostic checks.
- The Campus Radiation Safety Office must be notified in the event of a planned move, disposal or transfer of ownership of any X-Ray device. Written approval of the RSO must be obtained. Registration changes are required to be forwarded by the Radiation Safety Office to the State RHB within 30 days.

# Standards for Protection Against Radiation: Worker Rights and Responsibilities

- Operate x-ray device only as specified in manufacturers operating instructions and within limits placed by CSULB Radiation Safety.
- Notify CSULB Radiation Safety Office of any repairs, modifications, disposal or relocation of an X-ray device.
- See “Notice to Employees” posted on the official CNSM Workplace Bulletin board and in labs where X-Ray machines are present:
  - Provides overview of the Standards for Protection against Radiation in the workplace.
  - Lists regulatory agency phone numbers and website address.

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RHB 2364 (5/09)

# Radiation Defined

**Radiation:** energy in the form of waves or particles.

# Non-Ionizing Radiation

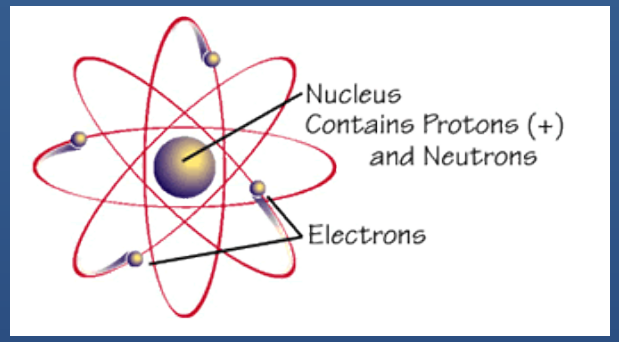
- **Non-Ionizing Radiation**: Radiation that does not have sufficient energy to dislodge orbital electrons.
- Examples of non-ionizing radiation:
  - microwaves
  - ultraviolet and visible light
  - lasers
  - radio waves
  - infrared light
  - radar

# Ionizing Radiation

- **Ionizing Radiation**: Radiation that has sufficient energy to dislodge orbital electrons, cause ionization, break molecular bonds.
- Examples of ionizing radiation:
  - x-rays:
    generated by high voltage equipment
  - alpha particles, beta particles, neutrons and gamma rays:
    given off by unstable radioactive material(s).

# X-Rays

- X-rays are high energy photons
- X-rays are emitted by inner-orbital electrons and are nearly identical to gamma rays. Gamma rays originate in the atomic nucleus.



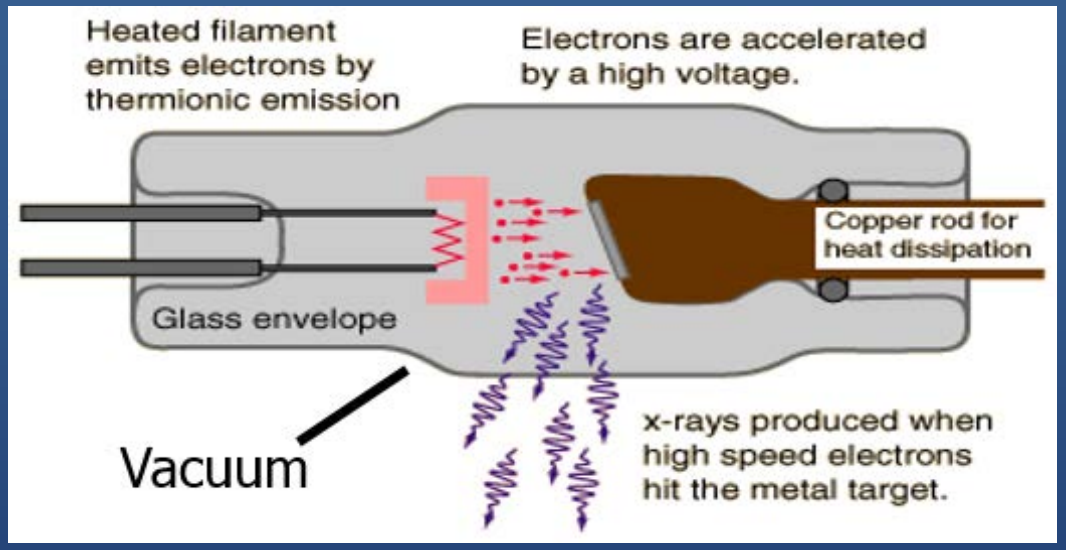

- Like gamma rays, X-rays are penetrating and carry enough energy to ionize atoms in their path and require shielding to reduce their intensity and minimize the danger of tissue damage to personnel.
- Excessive exposure to X-rays can cause severe radiation burns and deep tissue damage that can lead to various cancers.

# Discovery of X-Rays

- X-rays were discovered in 1895
  - Wilhelm Conrad Roentgen observed that a screen coated with barium salt fluoresced when placed near a cathode ray tube.
  - Roentgen concluded that a form of penetrating radiation was being emitted by the cathode ray tube and called the unknown rays “X-rays.”

**Early X-Ray Tube (1899):** This tube is a specimen of the first type of gas x-ray tube to incorporate a water-cooled anode. The hollow anode was supplied with water by gravity feed from a supply held in the side bulb. This type of tube was introduced by Mueller about 1899.

# How X-Ray Tubes Generate X-Rays

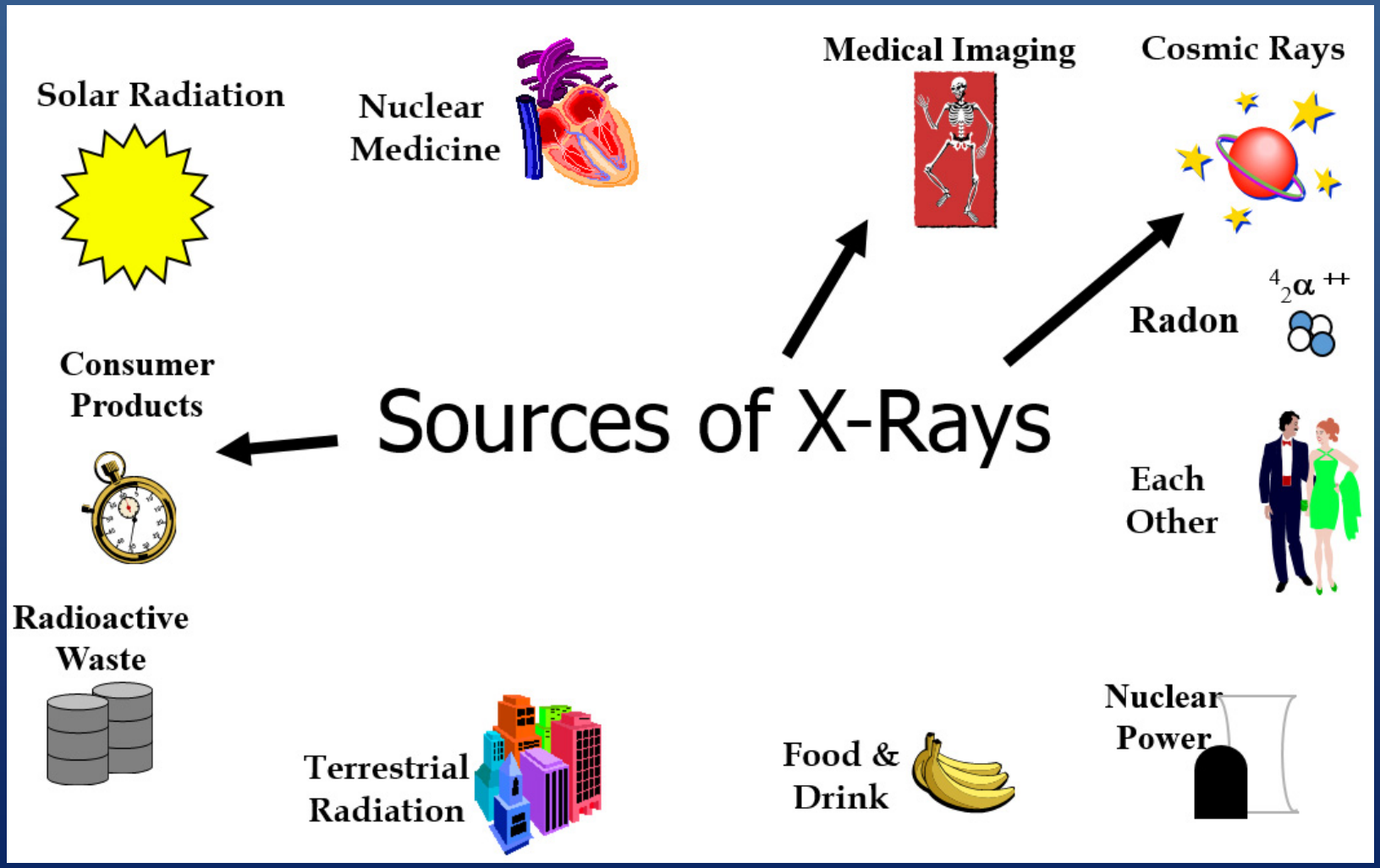



Electrons from heated cathode filament are accelerated by high voltage in a vacuum and bombard the dense metal anode target.

Two types of x-rays generated:

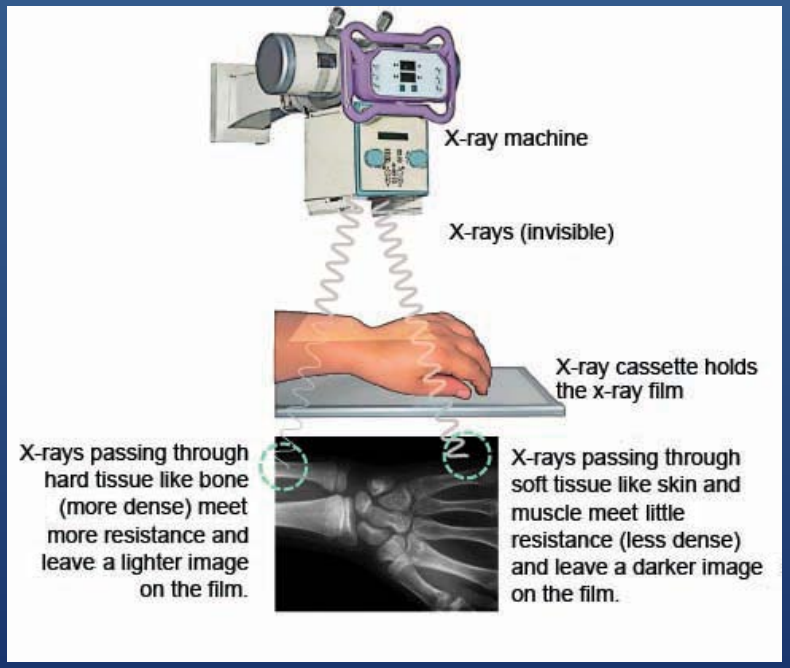
- Characteristic x-rays: high energy electron collides with an inner shell target atom electron causing both to be ejected leaving a “hole” that is filled by an outer shell electron with the energy loss being emitted as an x-ray photon.
- Bremsstrahlung x-rays: an electron passing near a target atom nucleus is slowed and its path is deflected. Energy lost is emitted as an x-ray photon.

# Common Sources of Exposure to Radioactivity

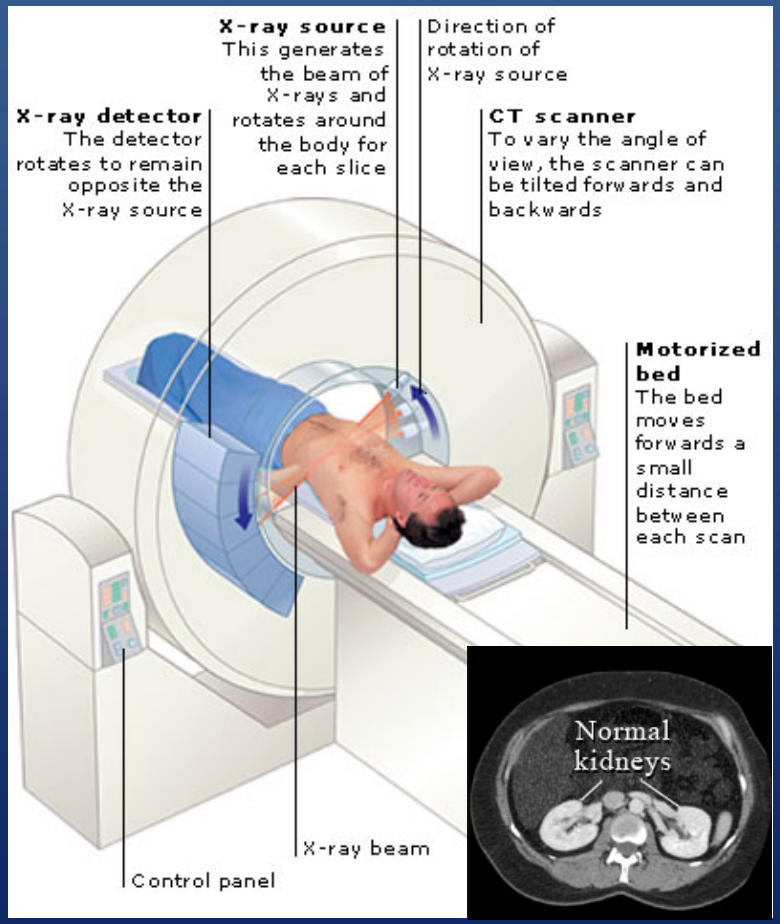


# Medical Imaging

## Conventional X-Ray

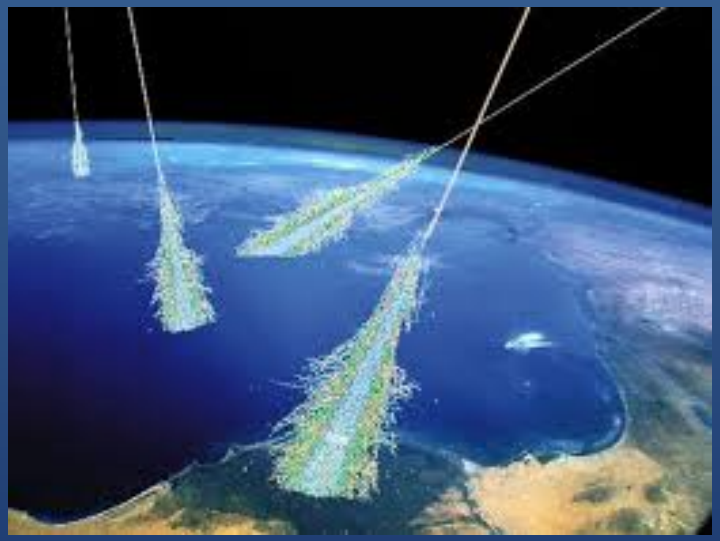



## Computed Tomography (CT) Scan



# Cosmic Rays

- Particles that bombard the Earth from anywhere beyond its atmosphere.
  - Most are atomic nuclei from elements such as hydrogen or helium.
  - Produce showers of secondary particles including x-rays when they collide with oxygen, nitrogen and other atmospheric components.



# Consumer Products

- There are many sources of radiation associated with consumer products.
  - Cathode Ray Tube (CRT) television sets emit low energy x-rays.
  - Other consumer products emit other types of radiation.

# Analytical X-Rays

Two X-ray analytical methods are commonly used as research tools at CSULB:

1. Diffraction [XRD]
   - X-ray scattering from crystalline materials yields a “fingerprint” of crystalline structure. Data from the scattered beam is checked against a library of known spectra to identify the material.
2. Fluorescence [XRF]
   - Emission of characteristic "secondary" (or fluorescent) X-rays from a material that has been excited by bombarding with high-energy X-rays.

# Hazards of Analytical X-Ray Equipment

- **The primary beam:** The primary beam is most hazardous because of the extremely high exposure rates. Exposure rates of 400,000 rems (unit of x-ray dose) per minute at the port have been reported for ordinary diffraction tubes. 5.0 rems is the annual maximum whole body dose allowed to the operator of an x-ray.
- **Leakage or scatter of the primary beam through cracks in shielding or due to defective equipment:** The leakage or scatter of the primary beam through apertures in ill fitting shielding or defective equipment can produce very high intensity beams of possibly small and irregular cross section.

# Hazards of Analytical X-Ray Equipment (2)

- **Penetration of the primary beam through the tube housing, shutters or diffraction apparatus:** The hazard resulting from penetration of the useful beam through shutters or the x-ray tube housing is slight in well designed equipment. Adequate shielding is easily attained at the energies commonly used for diffraction and florescence analysis.
- **Diffracted rays:** Diffracted beams also tend to be small and irregular in shape. They may be directed at almost any angle with respect to the main beam, and occasionally involve exposure rates of the order of 4,800 rems per minute for short periods.

# Causes of Radiation Exposure Using **ANALYTICAL** X-Ray

- Putting fingers in X-ray beam to change sample
- Aligning X-ray beam visually
- Modification of shielding
- Failure to realize X-rays are emitted from several ports
- Failure to read and follow manufacturers X-ray operating instructions

**Any of these actions could cause an unnecessary exposure and potential serious injury.**

# Diagnostic X-Rays

Two main types of diagnostic X-ray devices:

1. Radiograph
   - a picture with film or image is sent direct to computer screen. These are quick 'shots.'
2. Fluoroscopic
   - a real time "moving" inspection on inside functions. These longer exposures yield high doses.

# Diagnostic Radiology

- **Diagnostic radiology** is the branch of medicine that involves taking and reading X-rays. The physicians that prescribe the shots and the technologists that operate the machines are specifically trained and licensed to perform these tasks. They also stay current through continuing education. Institutions are always striving to get quality images with the minimum patient exposure.

# Industrial X-Rays

- X-rays are used for non-destructive testing (NDT) and have applications in a wide range of industries.
- NDT uses x-ray beams (or gamma or beta emissions from a radiation source) to inspect products or processes without damaging them. This discipline is called Industrial Radiography.
- Industrial x-ray machines are used primarily to find defects in castings, structures, and welds, find foreign material in food products, and to inspect luggage at airports, building entries etc.
- Electron microscopy equipment generates x-rays inside the apparatus. Factory shielding prevents exposures.

# Biological Effects of Radiation

- Radiation may:
  - deposit energy in body
  - cause DNA damage
  - create ionizations in body
  - leading to free radicals **$H_2O \rightarrow H^+ + OH^-$**
  - or causing critical molecular covalent bonds to break
- All of which may lead to biological damage

# X-Ray Effects

The effects of X-ray exposure depends on several factors (as with all radiation) including:

- Length of exposure -- more time exposed results in a higher dose
- Dose Rate -- how fast the dose is delivered, higher the rate the higher the dose
- Radiation Energy: how much energy was in the X-ray
  - Low Energy (<50KeV) -- damage only to skin or shallow tissues
  - Higher Energy (>50KeV) -- deeper damage to internal organs
- Stage of cellular development at the time of exposure
- Total Dose -- the magnitude of the dose

# Whole Body Effects

- Acute or Nonstochastic
  - Occur when the radiation dose is large enough to cause extensive biological damage to cells so that large numbers of cells die off.
  - Evident hours to a few months after exposure (Early).
- Late or Stochastic (Delayed)
  - Exhibit themselves over years after acute exposure.
  - Genetic
  - Somatic
  - Teratogenic

# Most and Least Radiosensitive Cells

| Sensitivity | Cell Type |
|---|---|
| LOW | mature red blood cells<br>muscle cells<br>ganglion cells<br>mature connective tissues |
| HIGH | gastric mucosa<br>mucous membranes<br>esophageal epithelium<br>urinary bladder epithelium |
| VERY HIGH | primitive blood cells<br>intestinal epithelium<br>spermatogonia<br>ovarian follicular cells<br>lymphocytes |

# Units of Radiation Dose: Gray and Rad

- Gray (Gy)
  - SI unit of absorbed dose expressed in terms of absorbed energy per unit mass of tissue. 1 Joule/Kg and equal to 100 rad.
- Rad
  - Special unit of absorbed dose. Still used in U.S. Equal to one rem for x-rays, gamma and beta radiations.

# Units of Radiation Dose: Rem

- rem
  - The special unit of any of the quantities expressed as dose equivalent. Dose equivalent in *rems* is equal to the absorbed dose in *rads* multiplied by the quality factor (Q). Q = 1 for X-Ray, Gamma and Beta radiation. 1 rem = 0.01 Sievert.

# Units of Radiation Dose: Sievert

- Sievert (Sv)
  - The SI unit of any of the quantities expressed as dose equivalent. Dose equivalent in *Sv* is equal to the absorbed dose in *Gy* multiplied the quality factor (Q). Q = 1 for X-Ray, Gamma and Beta radiation. 1 Sv = 100 rem.

# Relating Units of Radiation Dose

- 1 rad = 1 rem
  - For X-Ray, gammas & betas
- 1 rad $\neq$ 1 rem
  - For alphas, neutrons & protons
    - 1 rem = 1 rad x Q. Q varies depending on type of radiation.
- 1 Sv = 100 rem

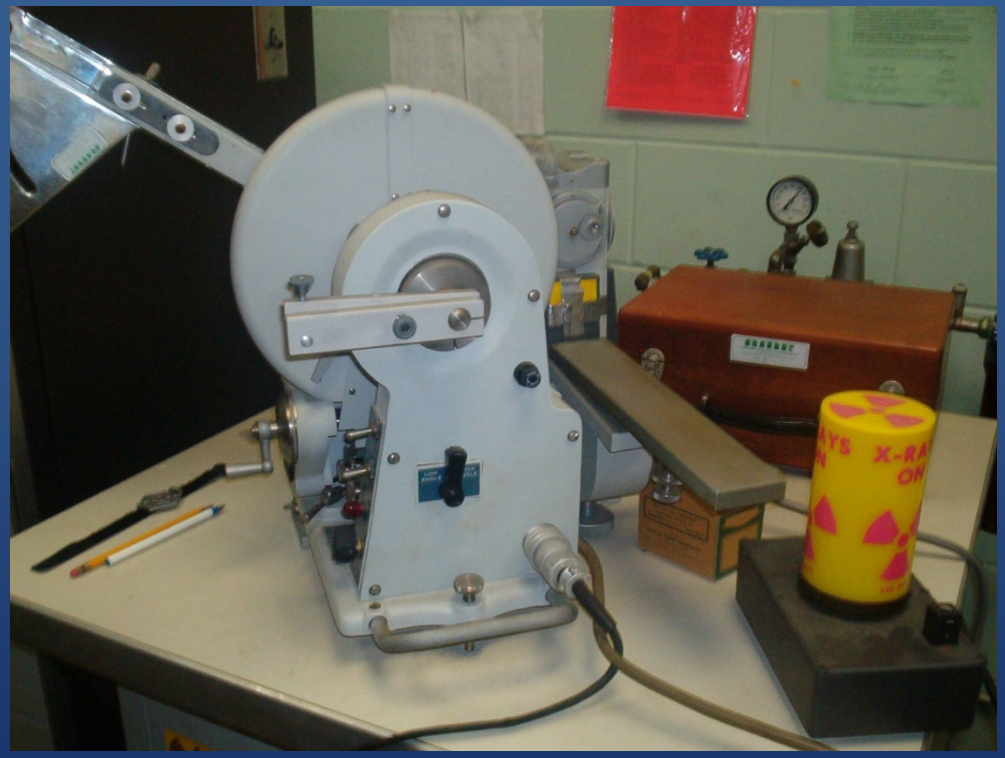
# Usage of Units of Radiation Dose

- Dosage and dosimetry are measured and reported in rems at CSULB. The SI unit of Sieverts is the international norm.
- All the Federal and State regulations are written in rems.

# Unsafe Conditions

- Examples of unsafe conditions which could produce an unwanted radiation dose:
  - Access door interlocks not working, shielding that has been removed/damaged, X-ray "ON" light not lit when unit energized.
  - X-ray "ON" warning lights must be turned on automatically whenever x-rays are being produced.
- **IF AN UNSAFE CONDITION ARISES WITH YOUR X-RAY DEVICE:**
  - **Stop work!**
  - Turn power OFF to X-ray at the cutoff switch (emergency stop)
  - Notify X-ray supervisor and Radiation Safety Office at (562) 985-5623
  - Post "Do Not Operate" sign at instrument until problem fixed.

# X-Ray Device - Open Diffraction



This is an OLD open beam X-ray diffraction device. Direct beam injuries are an extreme danger. Newer diffraction X-ray devices for CSULB research must be contained in an fully shielded – interlocked cabinet.

# X-Ray Device – Cabinet Diffraction

The X-ray tube, detector and sample are contained in a housing that provides shielding to the user and others in lab. The access doors are interlocked with safety switches and will shut off X-rays when opened. The large viewing area is made possible by effective internal shielding and use of special glass or plastic windows.

# X-Ray Device - Cabinet Diffraction (2)


A compact “totally enclosed” research X-ray device. The access door is equipped with a power cutting interlock switch.

# X-Ray Device: Electron Microscopes

Transmission Electron Microscope (TEM)

Scanning Electron Microscope (SEM)

# X-Ray Device: Radiographic Table

This picture X-ray tube in a collimated lead housing. The X-ray beam is pointed down to the table. The table is where the patient is placed and contains a slot for an X-ray film or the newer low-dose digital cassette.

# X-Ray Device: Radiographic Table (2)

This is the mobile shield for operator. It is designed to protect operator from scattered X-rays (primarily from patient).


This is the control panel. Operator can select X-ray ON (exposure) time in fraction of minutes, the energy of X-ray (in kVp) and current applied (higher current = more X-rays).

# Minimizing Radiation Exposure: A L A R A

- As Low As Reasonably Achievable

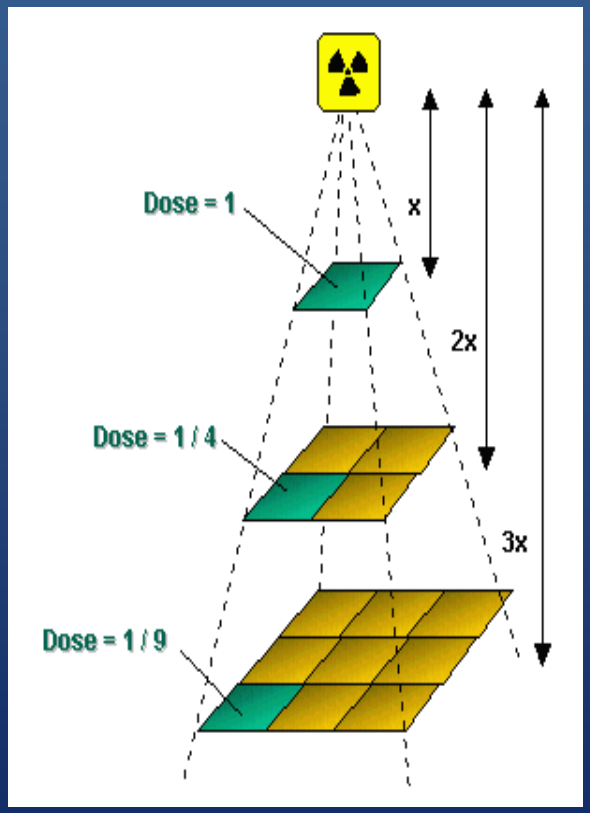
- A philosophy which promotes minimization of internal and external radiation exposure and release of radioactive materials to the environment.
- How?
  - Time
  - Distance
  - Shielding
- Why?
  - Minimize dose

# Minimizing Radiation Exposure: Time

- Less time near radiation source = Less radiation exposure.
- Because most cabinet X-Ray systems are enclosed and well shielded, exposure to X-Rays is unlikely.
- CSULB presently has no high-field equipment.

# Minimizing Radiation Exposure: Distance

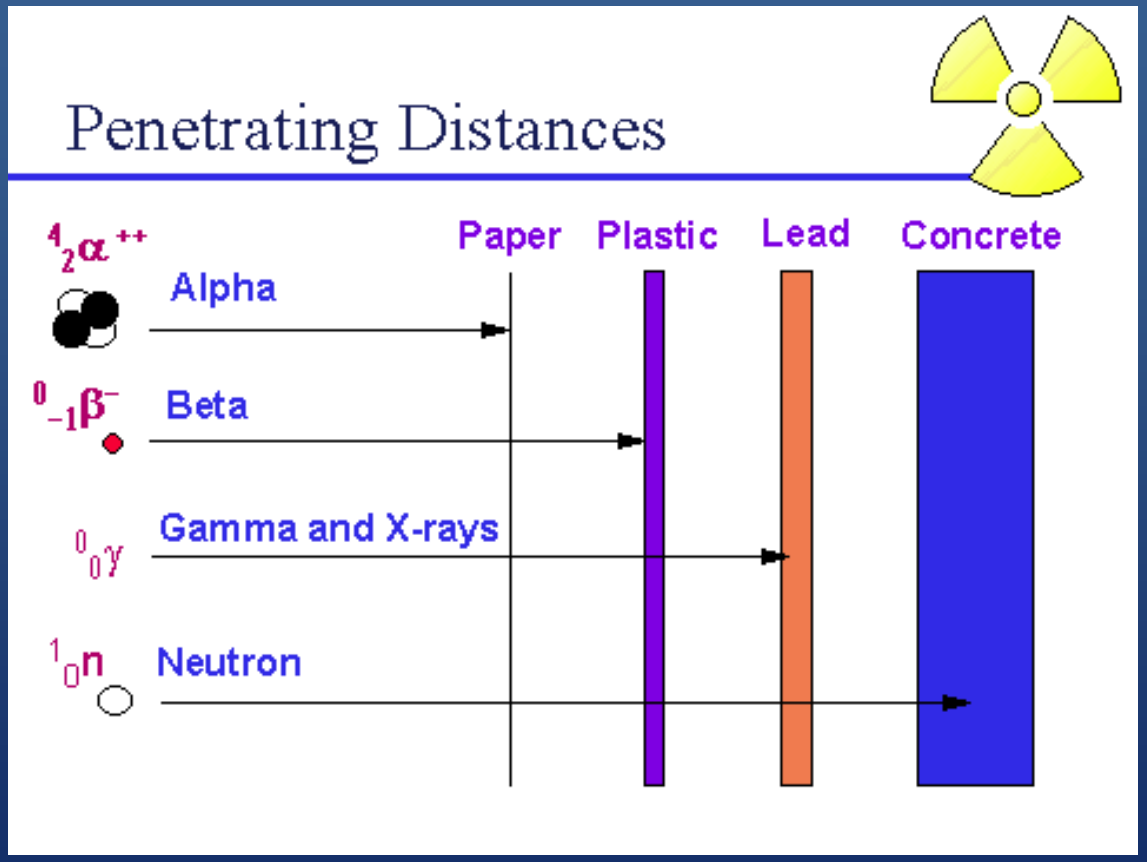
- Simple, Effective & Easy
- Inverse Square Law
  - Doubling distance from source, decreases dose by factor of four
  - Tripling it decreases dose nine-fold
- More Distance = Less Radiation Exposure



# Minimizing Radiation Exposure: Shielding

- Materials "absorb" radiation
  - X-rays interact with matter by one of three methods: photoelectric effect, Compton scattering or pair production
  - All can be harmful to living cells
- Proper shielding = Less Radiation Exposure
- Lead has a high atomic number making it a good material for shielding X-ray radiation
- The energy of scattered radiation from x-ray use is often so low clear plastic is useful

# Radiation Shielding Comparison



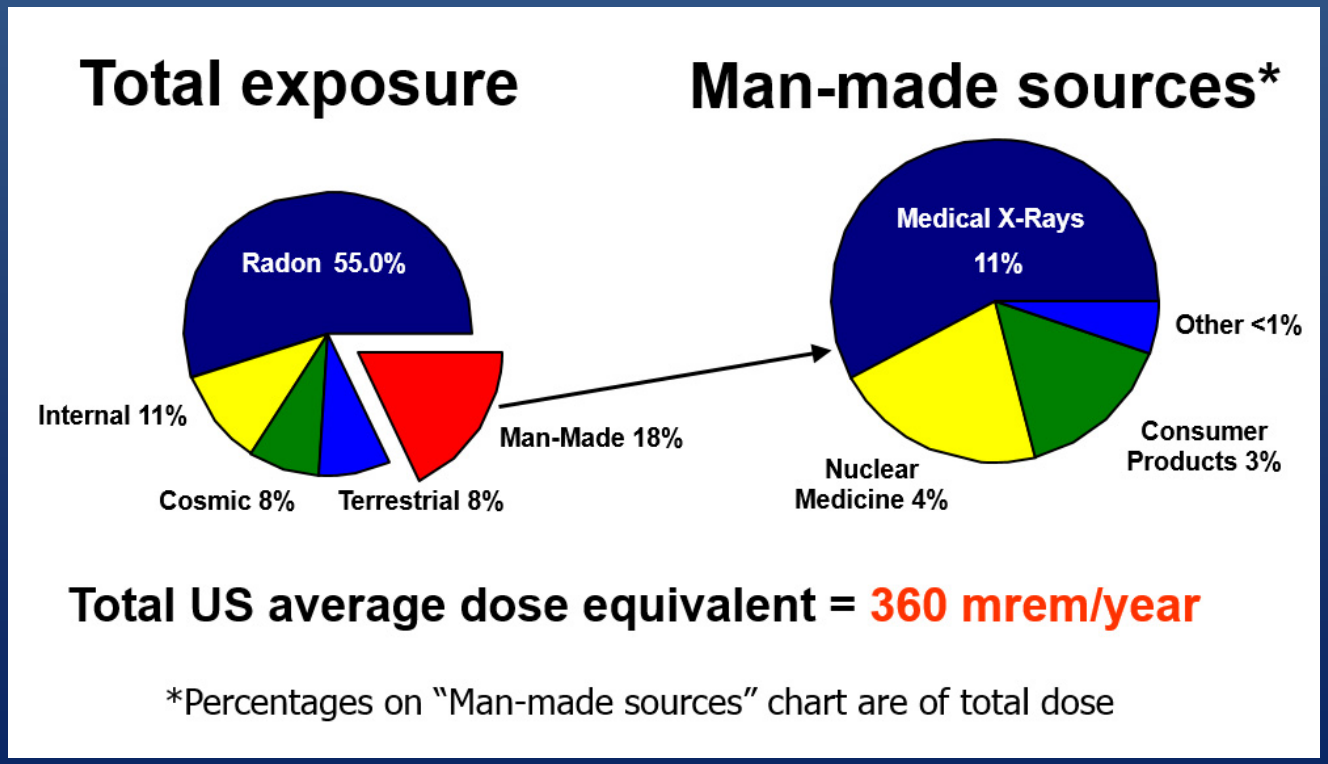

X-Rays Compared to Other Types of Ionizing Radiation

# Irradiation

- The process by which an object or person is exposed to radiation.
- Can be reduced by Time, Distance, Shielding.
- Will not make something “radioactive.”

# Background Radiation Levels

- From cosmic radiation:
  - Sea level - 30 mrem/year
  - 10,000 ft. altitude - 140 mrem/year
- Annual Dose:



# Annual Radiation Exposure Limits

Occupational Exposed Worker:

| Area or Worker Type | rem | mrem |
|---|---|---|
| whole body | 5 | 5,000 |
| eye | 15 | 15,000 |
| shallow | 50 | 50,000 |
| minor worker | 0.5 | 500 |
| pregnant worker | 0.5* | 500* |

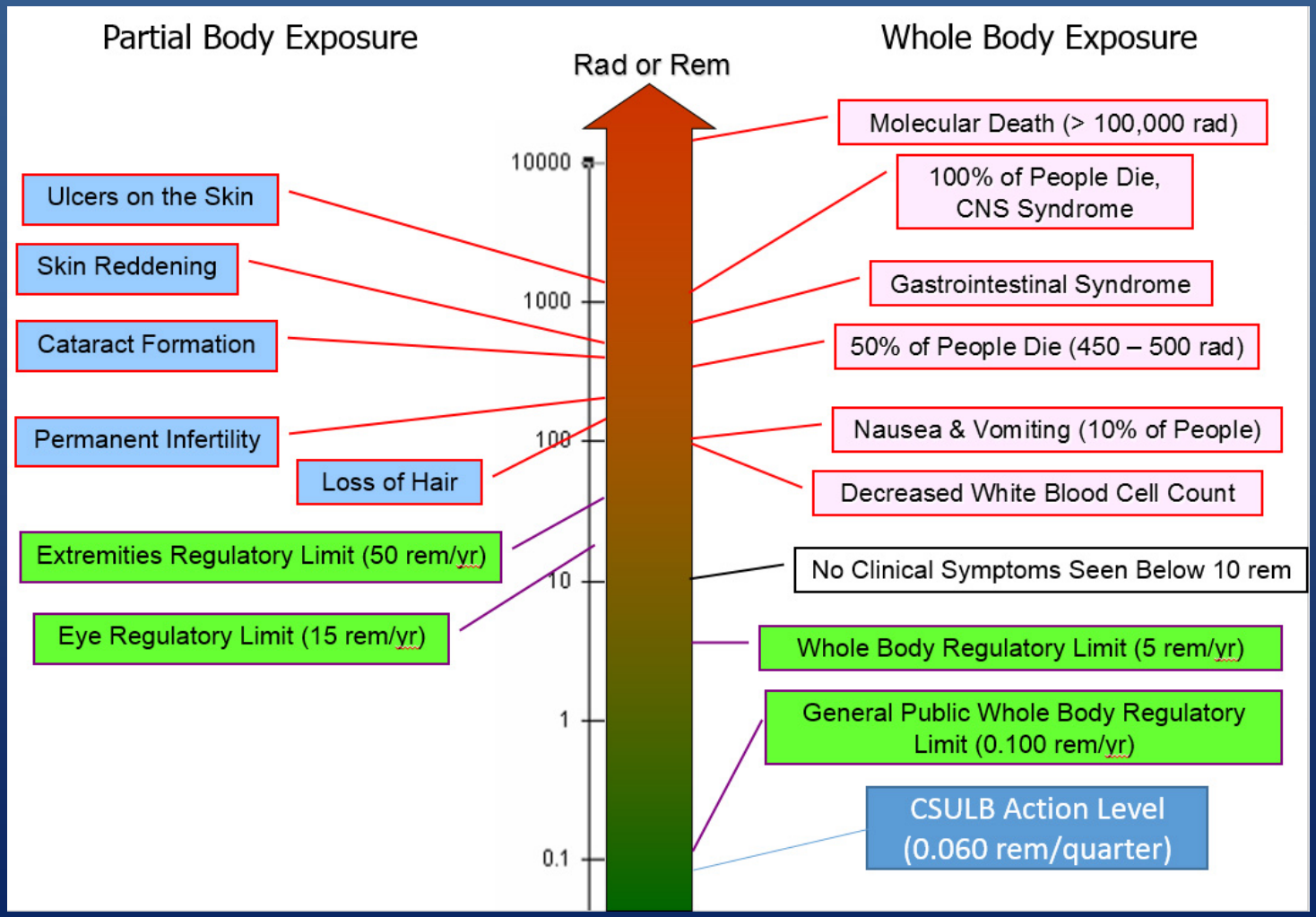
**General Public:** 100 mrem/year or 2 mrem/hour.

*9 months

# Whole Body Exposure Limit

- Total Effective Dose Equivalent (TEDE)
- TEDE = Internal + External
- Assume Internal Contribution Zero
  - Ingestion, absorption or inhalation not likely with X-ray generating devices
- Limit = 5,000 mrem/year upon completion of X-ray Radiation Safety Training
  - Users of cabinet based devices are not expected to receive doses in excess of general public limits
  - Cabinet systems are well shielded and interlocked

# Comparison of Administrative, Regulatory and Biological Effect Doses



# Radiation Dosimeters and Badges

- Who should wear radiation dosimeters or badges?
  - Those “likely” to exceed 10% of their annual limit are required, minors and declared pregnant workers.
- Based upon years of monitoring, most analytical X-ray devices at CSULB do not require users to be issued personnel radiation monitoring devices (dosimeters), but they are available. Dosimeters measure and document accrued dose to operators. Calibrated, direct reading meters, are also available from the RSO.

# Examples of Dosimeters

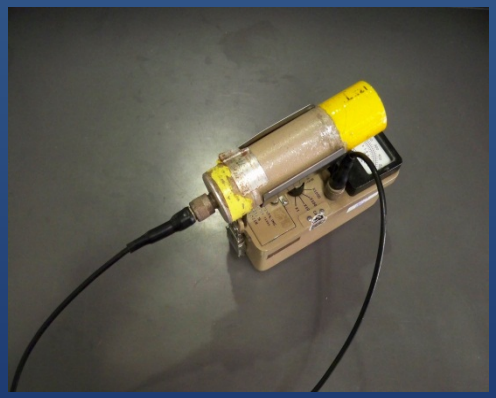

# Detection of Radiation

- Ionizing radiations cannot be seen, felt or sensed in any way by humans.

# Radiation Detection Instruments

- General Classes of Detectors
  - Hand-held survey meters calibrated every 12 months

gas-filled



solid scintillation

liquid scintillation

# Gas-Filled Detectors

- Ion Chambers
- Geiger-Mueller Counters
- Used for dose rate measurement or contamination surveys

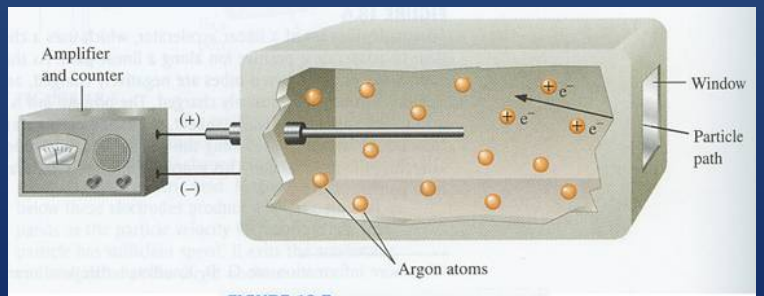
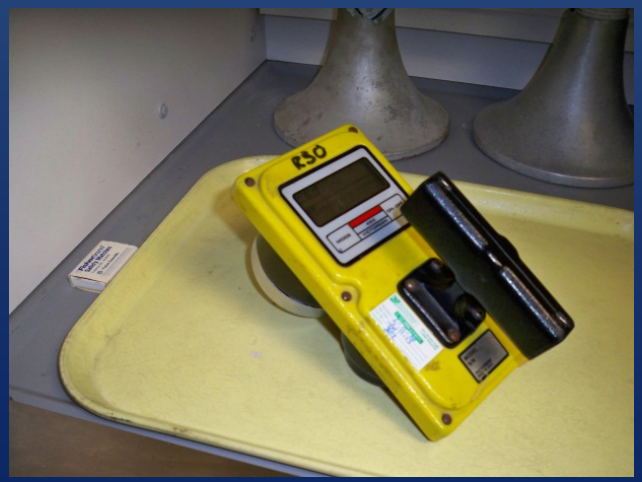
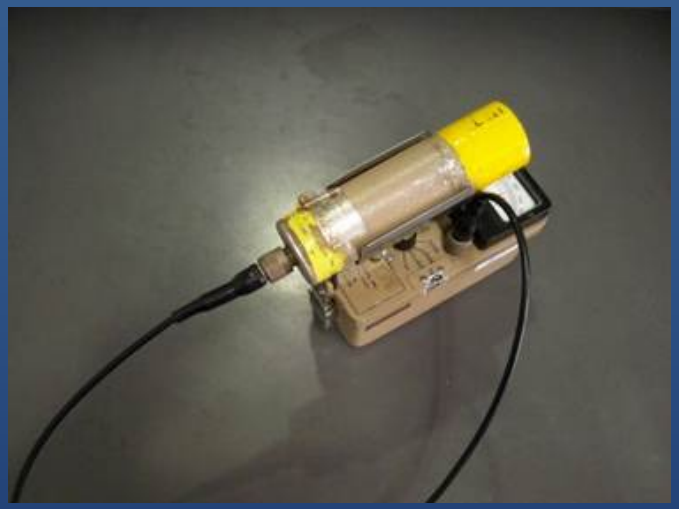



**FIGURE 18.7**
A schematic representation of a Geiger–Müller counter. The high-energy radioactive particle enters the window and ionizes argon atoms along its path. The resulting ions and electrons produce a momentary current pulse, which is amplified and counted.



# Solid Detectors

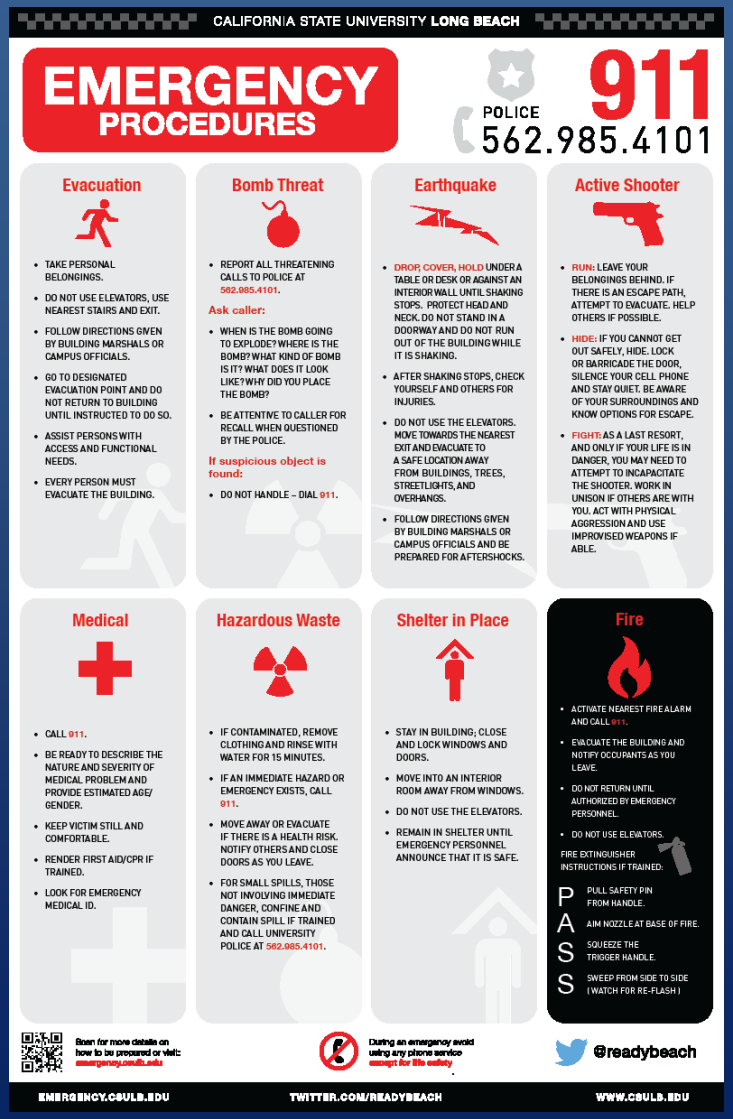
- The hand-held gamma counter has a solid scintillator made of sodium iodide which generates photons of light in response to incident radiation.
- A sensitive photomultiplier tube (PMT) measures the light from the scintillator. The PMT is attached to an electronic amplifier and signal processor to convert light flashes to CPM. **Used for detecting X-Ray radiation.**



# Emergency Procedures

- Review the “X-Ray Emergency Information Poster” in your lab.
- It lists important Emergency Procedures and Emergency Contact lists including use of “Emergency Stop” button on many devices.
- Contact device supervisor, the Radiation Safety Office or 911 as appropriate. Phone numbers and additional information can be found on the general Emergency poster in your lab (following slide).

# General Emergency Poster



CALIFORNIA STATE UNIVERSITY **LONG BEACH**

**EMERGENCY PROCEDURES**

POLICE **911**
562.985.4101

## Evacuation

- TAKE PERSONAL BELONGINGS.
- DO NOT USE ELEVATORS, USE NEAREST STAIRS AND EXIT.
- FOLLOW DIRECTIONS GIVEN BY BUILDING MARSHALS OR CAMPUS OFFICIALS.
- GO TO DESIGNATED EVACUATION POINT AND DO NOT RETURN TO BUILDING UNTIL INSTRUCTED TO DO SO.
- ASSIST PERSONS WITH ACCESS AND FUNCTIONAL NEEDS.
- EVERY PERSON MUST EVACUATE THE BUILDING.

## Bomb Threat

- REPORT ALL THREATENING CALLS TO POLICE AT 562.985.4101.

**Ask caller:**

- WHEN IS THE BOMB GOING TO EXPLODE? WHERE IS THE BOMB? WHAT KIND OF BOMB IS IT? WHAT DOES IT LOOK LIKE? WHY DID YOU PLACE THE BOMB?
- BE ATTENTIVE TO CALLER FOR RECALL WHEN QUESTIONED BY THE POLICE.

**If suspicious object is found:**

- DO NOT HANDLE – DIAL 911.

## Earthquake

- DROP, COVER, HOLD UNDER A TABLE OR DESK OR AGAINST AN INTERIOR WALL UNTIL SHAKING STOPS. PROTECT HEAD AND NECK. DO NOT STAND IN A DOORWAY AND DO NOT RUN OUT OF THE BUILDING WHILE IT IS SHAKING.
- AFTER SHAKING STOPS, CHECK YOURSELF AND OTHERS FOR INJURIES.
- DO NOT USE THE ELEVATORS. MOVE TOWARDS THE NEAREST EXIT AND EVACUATE TO A SAFE LOCATION AWAY FROM BUILDINGS, TREES, STREETLIGHTS, AND OVERHANGS.
- FOLLOW DIRECTIONS GIVEN BY BUILDING MARSHALS OR CAMPUS OFFICIALS AND BE PREPARED FOR AFTERSHOCKS.

## Active Shooter

- RUN: LEAVE YOUR BELONGINGS BEHIND. IF THERE IS AN ESCAPE PATH, ATTEMPT TO EVACUATE. HELP OTHERS IF POSSIBLE.
- HIDE: IF YOU CANNOT GET OUT SAFELY, HIDE. LOCK OR BARRICADE THE DOOR, SILENCE YOUR CELL PHONE AND STAY QUIET. BE AWARE OF YOUR SURROUNDINGS AND KNOW OPTIONS FOR ESCAPE.
- FIGHT: AS A LAST RESORT, AND ONLY IF YOUR LIFE IS IN DANGER, YOU MAY NEED TO ATTEMPT TO INCAPACITATE THE SHOOTER. WORK IN UNISON IF OTHERS ARE WITH YOU. ACT WITH PHYSICAL AGGRESSION AND USE IMPROVISED WEAPONS IF ABLE.

## Medical

- CALL 911.
- BE READY TO DESCRIBE THE NATURE AND SEVERITY OF MEDICAL PROBLEM AND PROVIDE ESTIMATED AGE/ GENDER.
- KEEP VICTIM STILL AND COMFORTABLE.
- RENDER FIRST AID/CPR IF TRAINED.
- LOOK FOR EMERGENCY MEDICAL ID.

## Hazardous Waste

- IF CONTAMINATED, REMOVE CLOTHING AND RINSE WITH WATER FOR 15 MINUTES.
- IF AN IMMEDIATE HAZARD OR EMERGENCY EXISTS, CALL 911.
- MOVE AWAY OR EVACUATE IF THERE IS A HEALTH RISK. NOTIFY OTHERS AND CLOSE DOORS AS YOU LEAVE.
- FOR SMALL SPILLS, THOSE NOT INVOLVING IMMEDIATE DANGER, CONFINE AND CONTAIN SPILL IF TRAINED AND CALL UNIVERSITY POLICE AT 562.985.4101.

## Shelter in Place

- STAY IN BUILDING; CLOSE AND LOCK WINDOWS AND DOORS.
- MOVE INTO AN INTERIOR ROOM AWAY FROM WINDOWS.
- DO NOT USE THE ELEVATORS.
- REMAIN IN SHELTER UNTIL EMERGENCY PERSONNEL ANNOUNCE THAT IT IS SAFE.

## Fire

- ACTIVATE NEAREST FIRE ALARM AND CALL 911.
- EVACUATE THE BUILDING AND NOTIFY OCCUPANTS AS YOU LEAVE.
- DO NOT RETURN UNTIL AUTHORIZED BY EMERGENCY PERSONNEL.
- DO NOT USE ELEVATORS.

FIRE EXTINGUISHER INSTRUCTIONS IF TRAINED:

P PULL SAFETY PIN FROM HANDLE.
A AIM NOZZLE AT BASE OF FIRE.
S SQUEEZE THE TRIGGER HANDLE.
S SWEEP FROM SIDE TO SIDE (WATCH FOR RE-FLASH)

Scan for more details on how to be prepared or visit: emergency.csulb.edu

During an emergency avoid using any phone service except for life safety

@readybeach

EMERGENCY.CSULB.EDU TWITTER.COM/READYBEACH WWW.CSULB.EDU

# Emergency Procedures: Evacuation

- Take personal belongings.
- Do not use elevators, use nearest stairs and exit.
- Follow directions given by building marshals or campus officials.
- Go to designated evacuation point and do not return to building until instructed to do so.
- Assist persons with access and functional needs. Every person must evacuate the building.

# Emergency Procedures: Fire

- Activate nearest fire alarm and call 911.
- Evacuate the building as described in previous slide.
- Fire extinguisher instructions IF TRAINED:
- **P A S S**
  - **(P)** PULL safety pin from handle.
  - **(A)** AIM nozzle at base of fire.
  - **(S)** SQUEEZE the trigger handle.
  - **(S)** SWEEP from side to side (watch for re-flash).

# Emergency Procedures: Earthquake

- **Drop, Cover, Hold** under a table or desk or against an interior wall until shaking stops. Protect head and neck. Do not stand in a doorway and do no run out of the building while it is shaking.
- After shaking stops, check yourself and others for injuries.
- Do not use elevators. Move towards the nearest exit and evacuate to a safe location away from buildings, trees, streetlights and overhangs.
- Follow directions given by building marshals or campus officials and be prepared for aftershocks.

# Thank You

Thank you for viewing this X-Ray Training presentation!

- If you have any questions or comments Please contact CSULB Radiation Safety Office at:
  - **(562) 985-5623**
  - John de la Cuesta, RSO **John.delaCuesta@csulb.edu**
  - Chris Frost, Alt. RSO **Chris.Frost@csulb.edu**
- Please print and complete the X-ray safety quiz then take it to MIC-207 for grading.

END OF SLIDE SHOW