Radiation Safety

PIXE PAN 2008

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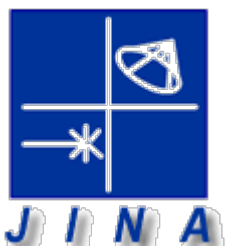
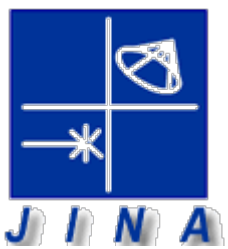


Outline

- Radiation Overview
- Radiation Safety in during PIXE PAN
- Other Safety Issues

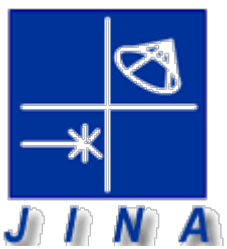


Ionizing Radiation

- 4 Types
  - Alpha
  - Beta
  - Photon (Gamma and X Rays)
  - Neutron

Alpha Radiation

- A Helium Nucleus (alpha particle) is ejected from a heavier nucleus.
- Does not travel far in air (few inches).
- Can be stopped by a sheet of paper or by human skin.
- If the alpha particles get inside your body, however, they can do the most damage.



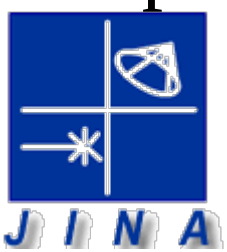
Alpha Radiation cont.

- Typical Alpha Emitters include ^{236}Pu, ^{238}U, ^{232}Th, ^{226}Ra, ^{222}Rn, ^{241}Am
- Because it can collect in homes Radon Gas is the largest source of exposure to naturally occurring radiation.[1]
- Also used in smoke detectors (^{241}Am) and in cancer therapy (^{226}Ra)

[1] From EPA Website: www.epa.gov/radiation/radionuclides/radon.htm

Beta Radiation

- Positron or electron emitted from a nucleus resulting from a conversion a proton into a neutron(β^+) or vice versa(β^-).
- Low mass, very high speeds.
- Can travel 12 to 15 feet in air.
- Can penetrate several layers of skin, over exposure and result in skin burns.
- Can be stopped by thin pieces of Al, glass or plastic.

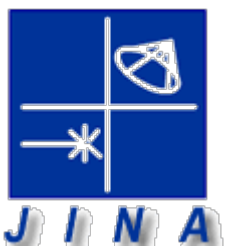


Beta Radiation cont..

- Positrons will annihilate with electrons resulting in two 511 keV photons.
- Some typical beta emitters: ^{3}H, ^{14}C, ^{18}F, ^{60}Co, ^{131}I and ^{137}Cs
- Often associated with photons from the decay of the daughter nucleus
- ^{131}I Used to treat thyroid disorders, ^{18}F used in PET Scans, Many used as calibration sources

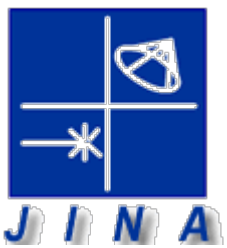
Photon Radiation

- Gamma and X-Ray radiation
- Electromagnetic Energy
- Gamma photons have about 10,000 times the energy as visible light photons.
- No mass and no charge mean they can travel thousands of meters through air.
- Dense materials like Pb are used for shielding



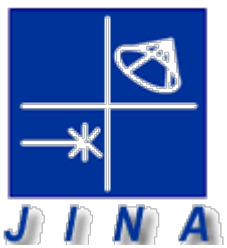
Photon Radiation cont.

- Gamma Emitters are most widely used radiation sources.
- Some examples: 137Cs, 60Co, 40K
- Many common uses including medical imaging, industrial quality control and sterilization of equipment
- Most common natural source is 40K



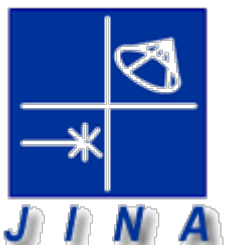
Neutron Radiation

- A neutron is emitted from a nucleus.
- Because they are neutral, they are more difficult to stop than alpha and beta particles.
- Neutrons tend to scatter easily.
- Typical shielding materials are paraffin, cadmium and water.
- Primarily resulting from fission processes or accelerator induced reactions.



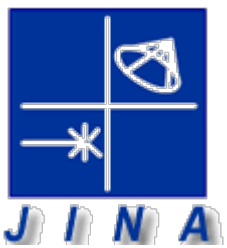
Modern Lab Precautions

- We will be using sealed sources.
- Only Lab staff will handle the sources.
- A Calibrated survey meter is in the lab. You should keep the permanent dose rate at which one is exposed below **10 μSv/h** (1 mrem/h)



Sources of Radiation

- Natural:
  - Cosmic Ray 40 mrem/yr
  - Earth 60 mrem/yr
  - Inside Human Body 25 mrem/yr
- Life in Industrialized Society:
  - Medical 100 mrem/yr
  - Occupational 1 mrem/yr
  - Fallout 3 mrem/yr



Exposure Limits and Impact

- Annual Limits:
  - Whole Body 5 rem
  - Lens of the Eye 15 rem
  - Skin of WB 50 rem
  - Extremities 50 rem

TABLE 2

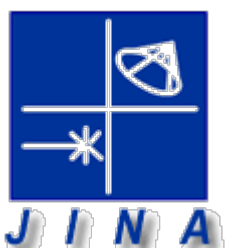
ESTIMATED LOSS OF LIFE EXPECTANCY FROM HEALTH RISKS

Health Risk	Estimates of Days of Life Expectancy Lost, Average
Smoking 20 cigarettes/day	2370 (6.5 years)
Overweight (by 20%)	985 (2.7 years)
All accidents combined	435 (1.2 years)
Auto accidents	200
Alcohol consumption (U.S. average)	130
Home accidents	95
Drowning	41
Safest jobs (such as teaching)	30
Natural background radiation, calculated	8
Medical X-rays (U.S. average), calculated	6
All catastrophes (earthquake, etc.)	3.5
1 rem occupational radiation dose, calculated (industry average is 0.34 rem/yr)	1
1 rem/yr for 30 years, calculated	30
5 rems/yr for 30 years, calculated	150

These estimates indicate that the health risks from occupational radiation exposure are not greater than the risks associated with many other events or activities we encounter in normal day to day activities.

Taking Precautions

- ALARA Principle
  - As Low As Reasonably Achievable
    - Reduce the amount of unnecesary exposure to radiation.
- Inverse Square Law
  - The farther you are from the source, the less exposure.
- Shielding
  - If the radiation interacts with something else, it doesn't interact with you.



Lab Specifics

- Copy of Radiation Safety Manual is at FN console and in Lab in Jordan.
- All of the typical sources in the lab are sealed and weak.
- Machine produced radiation is avoided by interlock systems.

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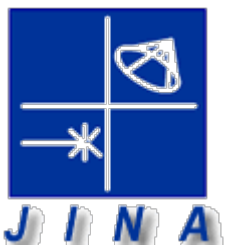

Program Specifics

- During PIXE lab, no student or teacher is allowed in target room while beam is on target.
- Students should not handle any of the sources directly.
- Minimize the time you are near the sources.
- If you have any questions or concerns, just ask.

Other Issues

- While radiation exposure is a valid concern, there are many other more likely ways of harming oneself in the lab. The experimental setups do contain high voltage, cryogenics and heavy objects.
- There are also many locations where there are tripping hazards and low objects.

Dress Code

- No Food or Drink in Modern Lab in Jordan.

- While working in the laboratory the following items should NOT be worn:
  - Open Toe or High Heel shoes.
  - Shorts and Tank Tops.
  - Earphones