CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
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Project Number
J1215

Project Title
Non-toxic Protection from Ionizing Radiation Produced by a Linear Accelerator

Abstract

Objectives/Goals
The goal of this experiment was to see if the density of a shielding material is related to its ability to shield ionizing radiation. My hypothesis is that a dense material will shield more ionizing radiation than a less dense material.

Methods/Materials
Lead is known to be an effective shielding material for ionizing radiation but it has some toxic properties and it is expensive. Three non-toxic materials with different densities were used as shielding materials. The materials used were steel, cement, and wood. A linear accelerator was used to shoot 6 million volt photons (ionizing radiation) through ten different thicknesses of each shielding material. An ion chamber was used to measure the transmission dose in picoCoulombs which was divided by 19.57 to convert to a dose in rads. The transmission dose was plotted against the thickness of the shielding material to get a transmission curve.

Results
My calculations show that steel has the highest density, wood has the lowest density and cement is in between. The best shielding material will have the steepest transmission curve meaning that less of the material is needed to shield the ionizing radiation. My data showed that steel has the steepest transmission curve, wood has the flattest transmission curve and cement is in between. These results show that as the density increases so does the ability to shield ionizing radiation.

Conclusions/Discussion
The data supports my hypothesis. Shielding of ionizing radiation is caused by the collision of a photon with the nucleus of an atom. The main difference between materials of different densities is the number of protons and neutrons in the nucleus. Since every nucleus of every atom, of every molecule consists of protons and neutrons, this was a controlled experiment. The type of atom or type of molecule is irrelevant. These results have real world applications because it can be used to help search for better shielding materials. Future study will be done to see if materials with similar densities have similar transmission curves. I also plan to repeat the experiment with lead.

Summary Statement
I studied the relationship between a material's density and its ability to shield ionizing radiation from a linear accelerator.

Help Received
Gary Ferrigno allowed me to use the linear accelerator at St. Joseph Hospital and Jason Durant operated the equipment for my experiment. My Dad helped me do research on the internet and get the shielding material.