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A Gamma-ray based friendly approach for non-destructive inspection of wood

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Introduction

➢X-rays and Gamma-rays are very similar in features but the terminology varies between scientific disciplines due to the difference in their origin.

➢Gamma-radiations can give intrinsic properties such as moisture content, elemental and density composition of wood alongwith their usefulness in harsh environments.

➢Examining an object by destructive methods does not permit the use of testing material for future study. Moreover, destruction of the test material usually makes destructive testing (generally chemical methods) more costly and is inappropriate in many circumstances [1].

➢The moisture content and mass density are basic quality indicators considered in timber industries [2].

➢Estimation of shielding parameters of wood will give some insight about radiation shielding capability of naturally available woods especially for emergency situation, when costly shielding materials could not be arranged.

➢The COVID-19 pandemic has forced the educationists and researchers to opt the online mode of imparting education and performing research.

➢The simulation programs / codes, by mimicking the real experiment, offer the ability to examine wood materials more quickly and without use of large equipments, which are unattainable due to the current pandemic situation.

Aim and Objectives

❑To explore some simulation approaches, using computer technology, for estimation of wood density and moisture content by employing energetic gamma-rays

❑To investigate radiation shielding competency of some selected woods

Material and Methods

➢ Varieties of wood selected: Pinus roxburghii (density range 0.35–0.70 g/cm^3), Sterculia Urens (0.1722 g/cm^3) and Terminalia alata (0.7028 g/cm^3)

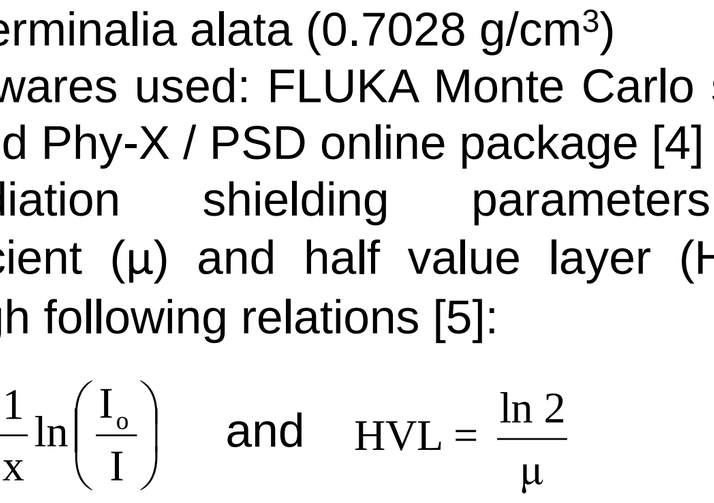
➢Softwares used: FLUKA Monte Carlo simulation code [3] and Phy-X / PSD online package [4]

➢ Radiation shielding parameters (attenuation coefficient (μ) and half value layer (HVL) calculated through following relations [5]:

$$\mu = \frac{1}{x}\ln\left(\frac{I_o}{I}\right) \quad \text{and} \quad HVL = \frac{\ln 2}{\mu}$$

where I_o and I are incident and transmitted beam intensities respectively and 'x' is thickness of the material (in cm).

➢The two types of set-ups employed for simulations / experimental measurements have been shown below:

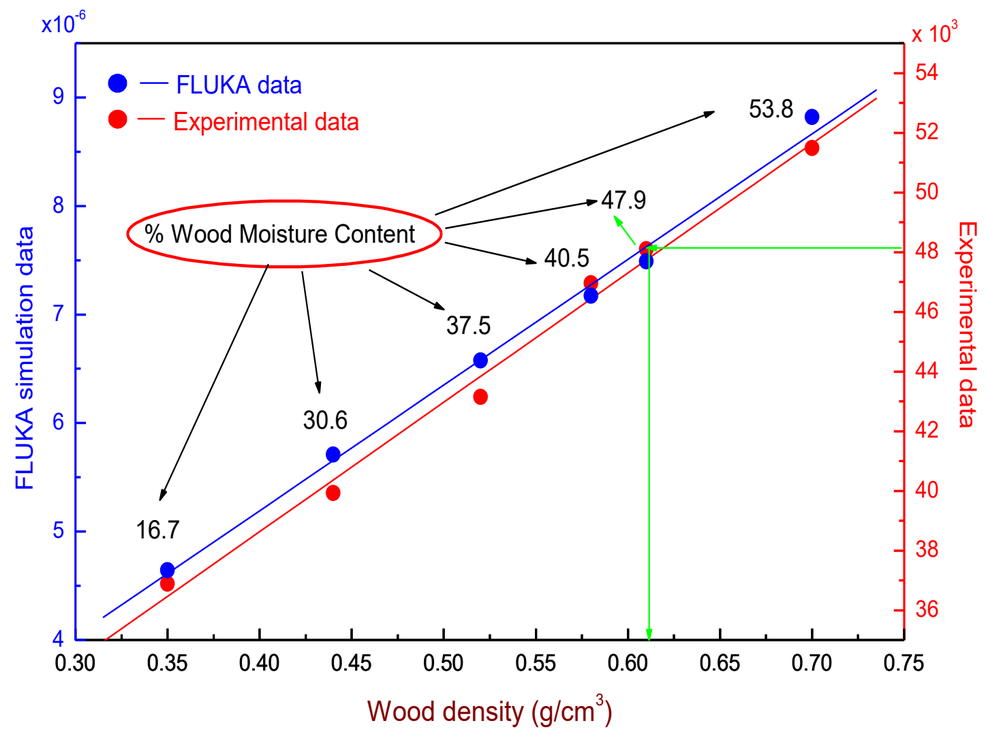


➢The computed data through above mentioned two simulation approaches have been validated with experimental measurements by employing NaI(Tl) scintillation gamma-ray detector.

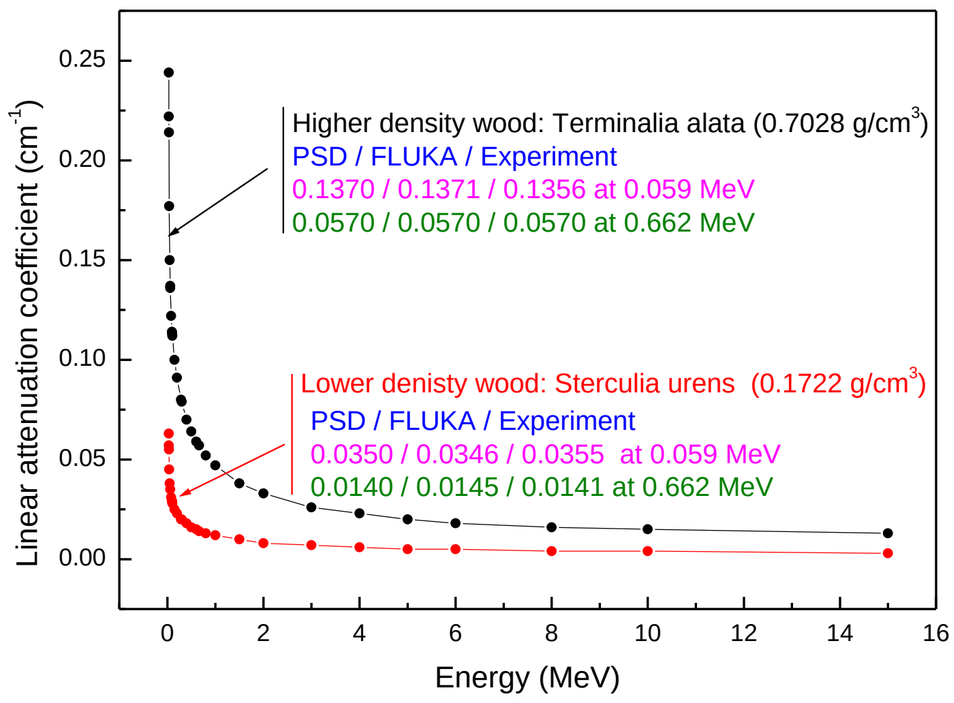
Results

The results obtained for (I) Wood density vs Gamma scattered intensity (II) μ vs Energy (III) HVL vs Energy obtained through said methods have been shown below:

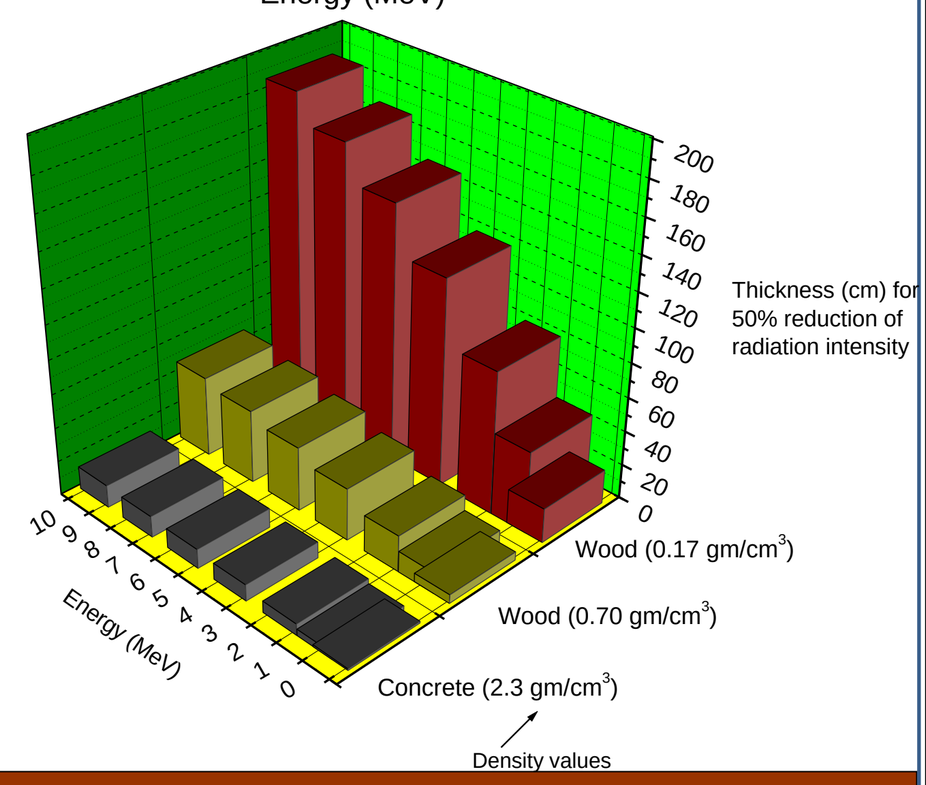
(I)



(II)



(III)



Highlights / Conclusion

✓Simulation results are quite useful and acceptable to continue education / research efficiently from home environment in current pandemic situation.

✓Wood with higher value of mass density should be arranged and preferred, if needs to be used as radiation shielding material in emergency situations.

✓High density wood may be chosen for the walls of radiotherapy rooms in hospitals, where wood will serve as decorative cum shielding material for the safety of passers-by and staff working near the treatment room (with highly penetrating X-rays).

✓Gamma radiations could also be employed to investigate other wood characteristics like detection of knots in wood logs etc.

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The author declares that there is no conflict of interest to influence the work reported in this paper.

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