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To cite this article: M. R Usikalu *et al* 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **173** 012039

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# Radiation from Visual Display Unit

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**Abstract.** The radiation from different types of Visual Display Units (VDU) (that is, Liquid Crystal Display (LCD) and Cathode Ray Tube (CRT)), projector and interactive screen were examined using a Cell Sensor Extremely Low Frequency (ELF) detection meter. The study revealed that ELF radiation in CRT VDUs is eight (8) times greater than in LCD VDUs. The mean ELF obtained from interactive screen at 30 cm was 1.6 mG and 1.9 mG at start-up and after 3 hours of use respectively with a mean value of 1.03 mG for a distance of 100 cm at start up. The mean ELF radiation from the projector screen at a distance of 10 cm is 0 mG, while that of interactive screen is 2.4 mG at the same distance. Thus, the study suggested that, projector and screen is better than interactive screen when making presentation considering the closeness of user to the interactive screen throughout the course of presentation.

**Keywords:** Radiation, Projector, Interactive screen, LCD, CRT

## 1. Introduction

Radiation is the the transmission or emission of energy that is in form of rays, waves or particles through vacuum or through a medium. Electromagnetic (EM) radiation is a radiation in the form of waves. The EM waves can be distinguished from one another through their wavelength or frequency of oscillations in the formation of the EM spectrum, which is arranged in magnitude of increasing frequency and decreasing wavelength: radio waves, microwaves, infrared, visible light, ultraviolet radiation, X-rays and gamma rays [1]. Radiation can either be ionizing or non-ionizing. Ionizing radiation possesses energy that is high enough to knock off electrons from molecules or atoms. Non-ionizing radiation on the other hand does not possess energy high enough to ionize molecules or atom. Non-ionizing do not produce charged ions when in moving through medium the energy just enough to excite the molecules [2, 3]. EM radiation can be from a natural or man-made source. Natural sources are sunlight and radioactive materials that arises from the earth crust. Examples of artificial sources of ionising radiation are X-rays equipment, diagnostic and therapeutic radio chemicals and nuclear energy generation. Television, lasers, radio broadcasting, household appliances, projectors, and interactive boards etc, are artificial sources of non-ionizing radiation [4, 5]. The radiation from screens and projectors belongs to extremely low frequency range of EM spectrum. Extremely low frequency (ELF) is the electromagnetic radiation having accompanying wavelengths from 100,000 to 10,000 mega metres, and frequencies between 3 and 30 Hz [6].

Computer Visual Display Units (VDU) is of two major types: Cathode Ray Tube (CRT) and Liquid Crystal Display (LCD). The CRT is a vacuum tube that contains one or more electron guns, and used phosphorescent screen to view images. It has a way of accelerating and deflecting the electron beam(s) onto the screen to form the images. The images can be in form of pictures (television, computer monitor), electrical waveforms (oscilloscope), radar targets etc. LCD is the technology used for



displays in smaller computers and notebooks. Radiation from VDUs can cause eye irritation and strain. Moreover, the electromagnetic radiation also causes dryness and irritation in our eyes. ELF radiation can produce, various health effects ranging from allergic reactions and sleep disorder, to heart disease, Alzheimer's disease and cancer [6]. Higher rates of miscarriages and possibly birth defects were associated with using CRT screens for long periods by pregnant women. The magnetic component is considered as the dangerous part because of its deep penetration into the human body. It was noted that ELF radiation decay naturally and quickly with increasing distance from source. According to [7], CRT VDUs emit radiation of 3 mG at 30cm, measured from the front and 4 mG at the same distance from sides. The box-shaped cathode ray tube (CRT) computer VDUs usually emit high levels of radiation even at 30 cm compared to the modern low-radiation flat screens [8]. An Uninterruptible Power Supply, (UPS) emits radiation of 20 mG at 30 cm and over 1 mG at 1 m, even when still connected to power during charging of the battery but switched off. Also, small desktop computer printers produce about 0.5 mG at 60 cm in standby mode and double the amount when printing is in progress. Wi-Fi information networks, modems, wireless routers and other wireless devices equally emit radio frequency and microwave electromagnetic radiation. They are not totally safe and as such can result in cell/ DNA damages, cause infertility and affect the biological process [7, 9]. Large sub-woofers used as part of computer's sound system emit 20 mG of ELF radiation at 0 cm, 3 mG at 60 cm, 0.5 mG at 90 cm when just powered ON even when not producing sound. Through the use of all these electronic gadgets, human beings are constantly being exposed to this ELF radiation. Therefore, it is expedient to investigate exposure from all these devices.

## 2. Materials and Methods

The device used in measuring the ELF radiation from VDUs, projectors and interactive monitors is the Cell Sensor manufactured by Action Electronic, USA. The cell sensor is a radio frequency detection meter which is also capable of being used as an extremely low frequency, ELF detection meter. Cell sensor possesses a remote probe that when connected to the unit makes it an extremely low frequency detection meter. It is used primarily for radio frequency detection. When the probe is connected to the main unit, it allows one to measure ELF fields in all places, while making it easy to watch the readings on the display unit of the meter. The device measures ELF fields in milligauss (mG) and is shown on the bottom scale of the display marked 'Power (ELF)' in green print. The meter measures in two different ELF scales. The device has a switch on the side that makes it possible to switch between high and normal sensitivity. The high sensitivity scale is of 1 to 5 mG while the normal sensitivity scale is of 1 to 50 mG. Taking the readings involved first isolating the source of ELF. The probe is then positioned next to the point at which reading is to be taken from. Once close to the source, the needle on the display deflects. To get accurate readings, the probe is rotated in different directions; horizontally, vertically and sideways and the mean reading is recorded. The ELF radiation from different VDUs: LCD and CRT; interactive displays and projectors used in College of Science and Technology classrooms were taken from 0 - 100 cm at intervals of 5 cm for 0 - 20 cm and intervals of 10 cm for 20 - 100 cm.

## 3. Results and Discussion

The ELF radiation from LCD and CRT visual display units at start up and after 3 hrs of usage, in order to compare the radiation from the two types of the display unit, the column charts for LCD and CRT VDUs at both instances of start-up and after 3 hours are shown as Figures 1 and 2 respectively. It was observed that the ELF radiation in CRT VDUs is eight (8) times greater than that measured in LCD VDUs. It was also observed that the ELF radiation increases over time in the case of both types of VDUs that are in use. In the case of a typical VDU, the ELF radiation detected at 0 cm at start-up was 3.7 mG and it increased to 4.0 mG after it had been switched on for 3 hours. The same increase in ELF radiation occurred in all other VDUs as usage time increases. It can be said that the ELF radiation is cumulative and increases with time or with prolonged use but there was no significance difference

between the radiation measure between startup and 3 hr of operation. The reason for low radiation from LCDs than CRTs may be because CLDs use much less power than LED and gas-plasma display displays, they also work on the principle of blocking light rather than emitting it. For LCD screens, display is more composed of colour or monochrome pixels that are filled with liquid crystals. The liquid crystals are lit by a backlight or reflector. LCD screens also utilise very small amounts of electric power. This study is in consonance with [10, 11] that CRT screens emit a lot more radiation than LCD screens. This is a may also be the reason why CRT VDUs are gradually been faced out and LCD VDUs have taken over the market.

The ELF measured from the projectors and screens are displayed in Figures 3 and 4, it was observed that the ELF radiation from the projector screen is very low. However, the ELF radiation from the projector is very high compared to that of its screen with ELF readings as high as 1.0 mG at 20 cm from the projector. Interactive screens and projectors are often used for making presentations. Seeing that they are used for a similar purpose, comparing the ELF radiation from both of them to determine which of the two is better with low radiation incurred during presentation desirable. When using a projector, users often stay closer to the projector screen than to the projector itself, especially when it is hung overhead. For the interactive screen, this does not have a separate device that projects the desired image, presenters stay close to the screen while making presentations. The mean ELF obtained from interactive screen at 30 cm was 1.6 mG and 1.9 mG at start-up and after 3 hours of use respectively. It also has a mean value of 1.03 mG for a distance of 100 cm at start up. It was also observed that the ELF radiation from the interactive screen increases with time. After 1 hour, it has a mean value of 2.36 mG at 0 cm which was 2.0 mG at start-up; after 3 hours, the mean ELF radiation from the interactive screen at 0 cm was 2.56 mG. This proves that the ELF radiation increases with time of use. It is observed that the mean ELF radiation from the projector screen at a distance of 10 cm is 0 mG, while the ELF of the same instance and distance from interactive screen is 2.4 mG as shown in Figure 4. This revealed that the ELF radiation from interactive screen is much higher than that from the projector screen. This suggests that projector screens are better than interactive screens when considering the radiation incurred by the user during a given period of time, although the display quality of the latter is far better than that of the former. The high ELF observed in interactive screen may be attributed to the fact that the CPU, the visual unit and other electronic parts are coupled together which gives rise to cumulative ELF obtained from the device compare to the projector and the screen that are position separately.

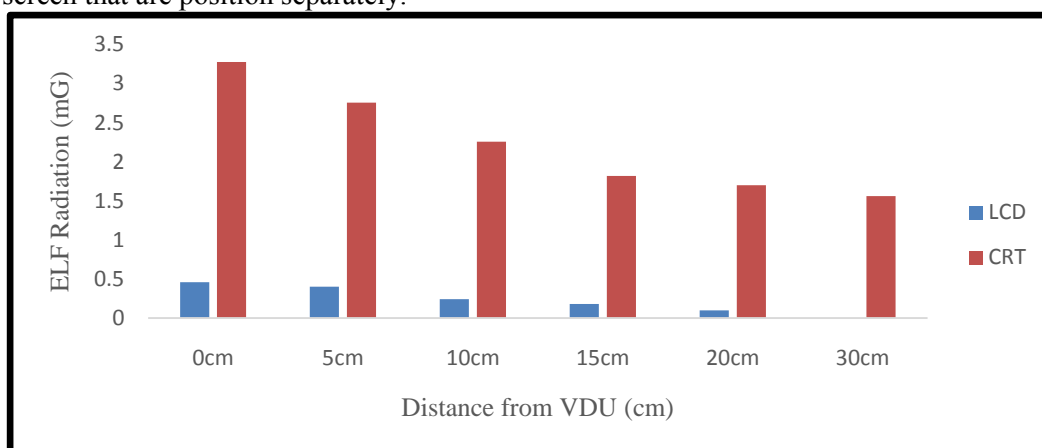


Figure 1: Comparison of ELF radiation from CRT and LCD VDUs at start up

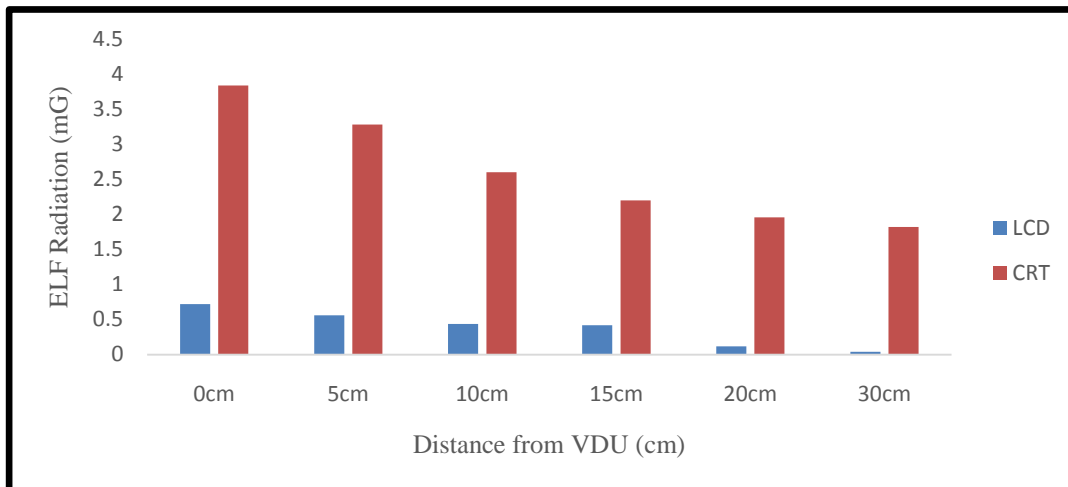


Figure 2: Comparison of ELF radiation from CRT and LCD VDUs after 3 hours

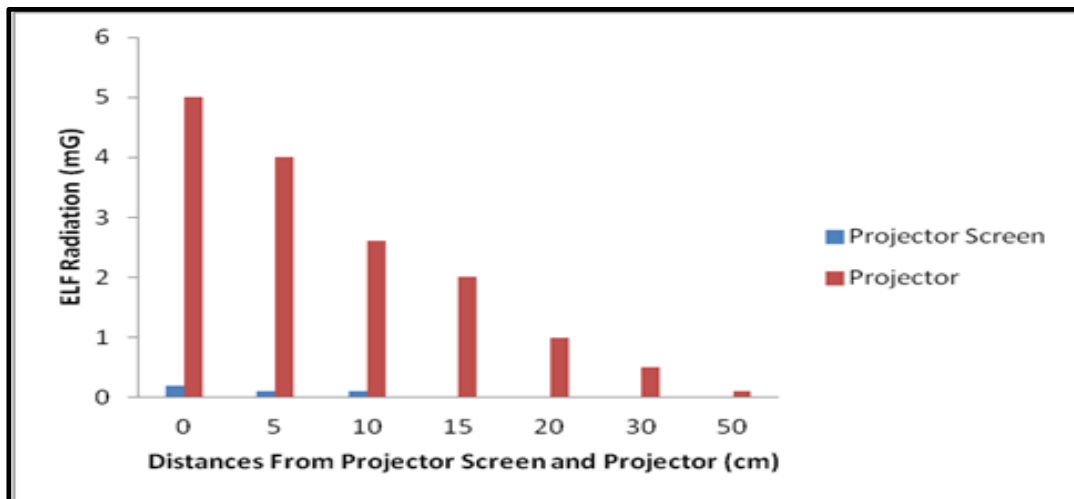


Figure 3: Mean ELF radiation measurements from a projector screen and projector after 1 hour

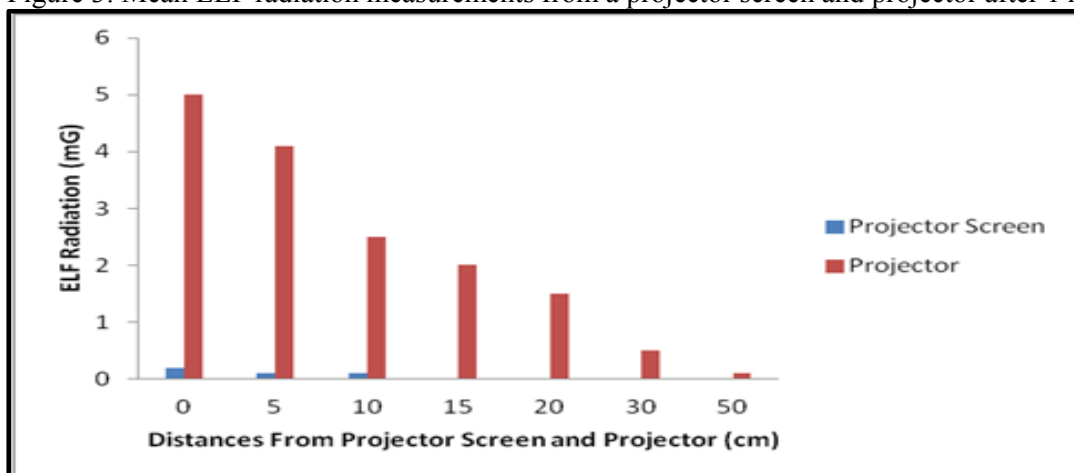


Figure 4: Mean ELF radiation measurements from a projector screen and projector after 3 hours

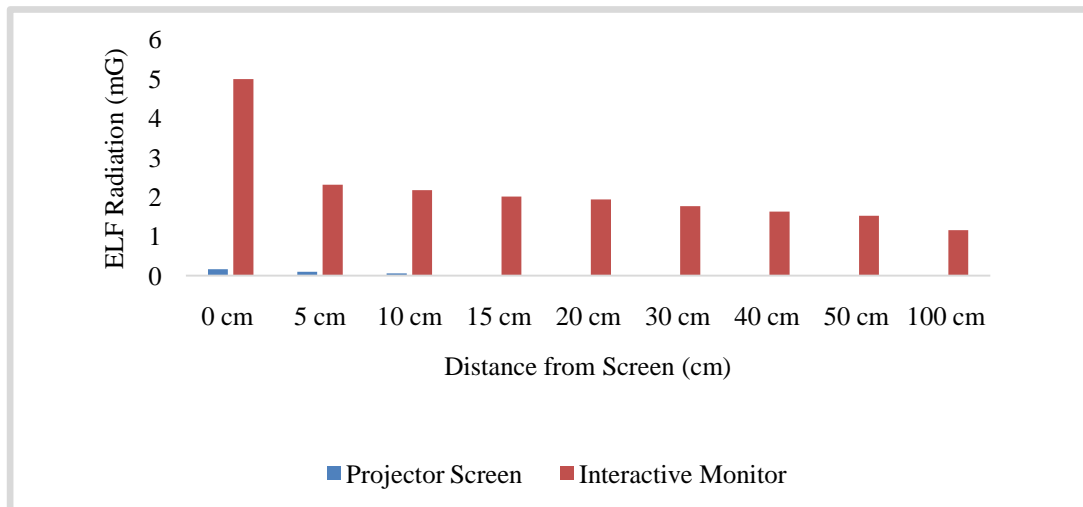


Figure 5: Comparison of ELF radiation from Interactive Screen and Projector Screen

#### 4. Conclusion

The study has confirmed the presence of ELF radiation from VDUs (that is, LCD and CRT), projector and interactive screen. It was observed that the ELF radiation in CRT VDUs is eight (8) times greater than that measured in LCD VDUs. It was also observed that the ELF radiation increases over time in the case of both types of VDUs that are in use. It was observed the ELF radiation from interactive screen is much higher than that from the projector screen. It is therefore radiation prudent to use projector and screen for presentation than interactive screen. This is necessary in order to create awareness so that users can reduce the time spent with the interactive screen.

#### Acknowledgment

We appreciate the management of Covenant University for sponsoring this work.

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