Manipulation of Alpha Particle Trajectories through the Development of Non-Quantum Modular Light-Emitting Microcontrollers for Industrial Applications

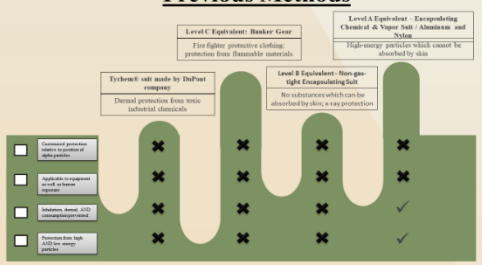
Introduction

Radiation, more notably alpha particle decay, can lead to damage of equipment, biological impairment, destruction of upcoming privatized space-focused businesses, and even indoor air pollution. Relying on absorbent polymers is not cost-efficient and cannot guarantee full protection from these invasive particles of varying degrees of unpredictability, mass, and velocity. Space and other locations that are rich in alpha particles can become breeding grounds for cancer, radiation sickness, and neurodegenerative diseases since the radiation present poses a risk for human beings that risk venturing in beyond the earth. Numerous studies have outlined the degradation of cell walls, nuclei, and organelles that result due to high-intensity radiation. Conventional protection, primarily made of aluminum and nylon, rely on high absorbance of the radiation, but the scattering of these particles is not uncommon, and particles can penetrate through these means of protection.

Objectives

- **RESEARCH**: Charged particle interactions and their application to the prevention of negative radiation impacts
- **INNOVATE**: Programmed microcontrollers designed for photons to collide with alpha particles
- **ASSESS**: Relationships between light intensities and respective velocities and angles of scattering
- **INCORPORATE**: Technologies in the industrial sector

Previous Methods



None are specifically targeted towards *particle radiation* and rather focus on *absorbance* of protective material

Targeted Towards Human Exposure Rather Than Both Human And Equipment Exposure

Industrial Economic Losses

Equipment Damage	DRAM Errors	Biological Impairment	Indoor Air Pollution
Space: $120 billion **Healthcare**: $3 trillion	**Computing**: $1.4 trillion	**Healthcare**: $3 trillion **Biomedical**: $430 billion	**Real Estate**: $29.6 trillion **Furniture**: $106.78 billion

Question/Hypothesis

The main question addressed in this project can be stated quantitatively as follows:

At what intensity of visible light linearly forth in relation to alpha particles can divert the atoms to an angle of 90 - 270 degrees at a distance of 40 mm? Is the magnitude of lumens required to do so proportional to the velocity and mass of the alpha particles? To what magnitude will the velocity of the alpha particles be affected?

It is hypothesized that the light intensity required to divert these alpha particles 90 to 270 degrees is approximately 4473 lumens. The basis for the hypothesis lies in Rayleigh's scattering equation stating that the intensity of 450-490 nm blue LED light in stilB required to scatter an alpha particle derived from Polonium - 210 of polarizability 1.78, can be calculated by (100/(8π^4 (17.78)^2)·(450nm)^4·(0.04m))(1+(cos 90/270)^2)) and (100/(8π^4 (17.78)^2)·(490nm)^4·(0.04m))(1+(cos 90/270)^2)). It is also hypothesized that there will be a full energy transfer at this intensity and the velocity of the alpha particles will emulate the direction and speed vectors of the light waves based on the theory that alpha decay accompanies the direction of the photons – mimicking the behavior of gamma rays in a vacuum (light and gamma rays have no charge).

If the above is possible, then:
In comparison to preexisting polymers, aluminum and nylon, lead, and concrete, is the proposed method more effective and applicable?

The measurement of 40 mm was used as it was the standard diameter of a petri dish that the experiment was conducted on. 90-270 degrees was set as an experimental goal assuming that no obstacles would be present in a perpendicular relation to the target.

Structural Methodology

Positioning/Colliding of Alpha Particles

Alpha particles collide as light intensity increases every 10 seconds: 0 lumens, 1000 lumens, 3000 lumens, 5000 lumens, and 7000 lumens

Angle of Scattering and Velocity of Particles

Velocities are recorded before collision, 0-1 seconds after collision, 1-3 seconds after collision, and 3-5 seconds after collision

Assessment of Stopping Powers and Efficiency

Lead, Aluminum and Nylon, and Concrete will be compared with the proposed method in terms of novelty and efficiency

Analysis of Incorporation into Equipment, Technologies, and Protection of 21st century

Pictures

Quantitative and Qualitative Analyses

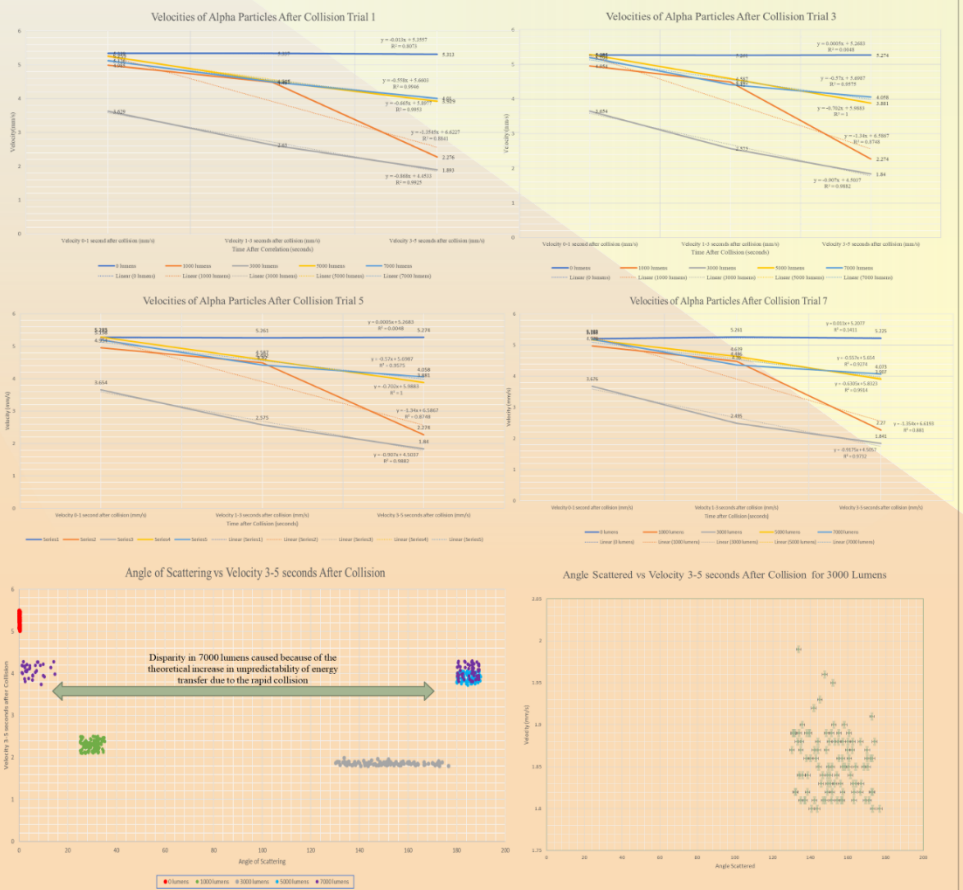
Quantitative Analyses

- **Velocity Regressions**: The linear regression for 0 lumens, 1000 lumens, 3000 lumens, 5000 lumens, and 7000 lumens was $y = -0.013x + 5.3557$, $y = -0.558x + 5.6603$, $y = -0.665x + 5.8977$, $y = -1.3545x + 6.6227$, and $y = -0.868x + 4.4533$ respectively. The velocity of the alpha particles exposed to 0 lumens and 7000 lumens were similar due to the little impact that a photon-alpha particle collision can have with too much or little intensity. 3000 lumens provided the steepest decline in velocity, making it the best contending intensity for velocity declination.
- **Degree of Scattering**: Alpha particles exposed to 1000 lumens did not scatter in the range of 90-270 degrees, falling short of expectations. Exposure to 3000 lumens and 5000 lumens both scattered in the desired range, though 5000 lumens averaged approximately 184 degrees whereas 3000 lumens averaged approximately 132 degrees. 7000 lumens depicted a disparity between values above 180 degrees and values below approximately 13 degrees
- **Statistical Distributions and Values**: 1000 lumens, 3000 lumens, and 5000 lumens exposure values (ex: velocity, angles) depicted little to no variance or deviation from the statistical mean. However 7000 lumens was distributed bimodally, not to be mistaken as statistically insignificant data, but rather an indication of how alpha particles behave when exposed to a surplus of photons.

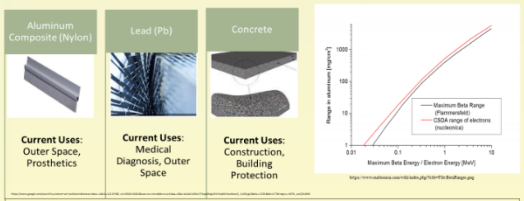
Qualitative Analyses

- **Shape of Alpha Particles**: Alpha particle shapes were minimally distorted after collisions. Minature dents took place on the sides of these alpha particles as a result of the subsequent collisions.
- **Visibility of Alpha Particles**: After multiple collisions, the visibility of alpha particles decreased – the cloud chamber was saturated with additional vapor and gas particles from the collisions

Data and Results

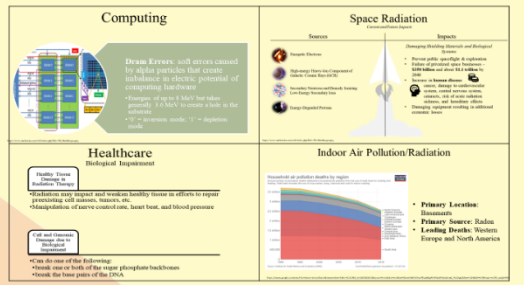


Comparisons and Applications



Current composites and polymers rely on a principle called *stopping power* which is relatively inaccurate as radiation increases. The logarithmic graph depicted shows that eventually the stopping power calculated will not be able to practically or theoretically impede the projection of radioactive particle

As opposed to the limited applications and uses of the polymers above, the customized microcontrollers can also be applied to:



Conclusion

Experiment	• Creation of auto-light intensity microcontrollers targeted towards incoming alpha particles • Assessment of the **optimal light intensity** to impede and scatter alpha particle pathways
Hypothesis	• According to the Rayleigh Scattering equation, the average of 1096 and 7850 lumens, **4473 lumens**, will scatter alpha particles from 90-270 degrees
Results	• Both 3000 lumens and 5000 lumens provided a decrease in velocities and scattering in the range of 90-270 degrees • **3000 lumens was optimal** since it obtained the largest decrease in velocity in addition to the desired range of scattering
Scientific Advances	• Real world applications in space, households, computer hardware, and indoor air pollution • Better alternative than previous methods – **fulfills 4 criterion** provided: customized protection, applicable to human and equipment exposure, protection from high and low energy particles, and inhalation and dermal protection.

Particle Chemistry: Rayleigh Scattering

Basis for Hypothesis

$$I = I_0 \frac{8\pi^4 \alpha^2}{\lambda^4 R^2}(1 + \cos^2\theta)$$

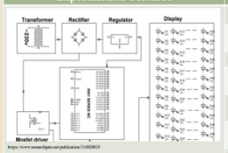
λ = wavelength of incoming blue light = 450-490 nm
I_0 = initial luminosity of Polonium-210 = 100 stilB
θ= desired angle of scattering = 90º-270º
α = polarizability of polonium-210 = 1.78
R = distance between particles = 0.04 m

Variables

Independent Variables	Constants	Dependent Variables (in order of priority)
• intensity of blue LED visible light (lumens) –0, 1000, 3000, 5000, 7000 lumens	• wavelength/frequency of visible light • position relative to alpha particles • usage of light-emitting microcontrollers • alpha radiation source: polonium-210	• angle of scattered alpha particles (°) • difference between final and initial velocities of targeted alpha particles (mm/s)

Control: absence of blue LED light

Fabrication: Circuit and Cloud Chamber

Principle Circuit Diagram and Experimental Pictures	Materials	Functions
	Transformer (coils)	• Reducing/increasing the voltage
	Rectifier	• Converts alternating current to direct current
	Voltage Regulator	• Maintain a constant voltage level
	Display (LED array)	• Source of luminescence; connected to PWM pin of the microcontroller
	MOSFET driver	• Programmed to change intensity every 10 seconds
	Arduino Breadboard, ATmega8 microcontroller, DS1307 IC	• Circuits and bases for connection and linkage of pins
	Dry Ice, Isopropyl Alcohol, Black Clay and Felt	• Visibility of alpha particles
	Polonium - 210	• Alpha radiation source
	Cotton, Beakers, Bottles, Additional Mechanisms	• Support for Ice Chamber

Statistics

Statistical Test	Values Derived	Significance
Z-Test H_0 (null hypothesis): The presence of luminescence has no effect on the scattering of alpha particles	z-Test: Two Sample for Means *Null Hypothesis* / *3000 lumens* Mean: 151.7052041 / 0.253939394 Known Variance: 3.4 / 4.4 Observations: 98 / 99 Hypothesized Mean Difference: 180 z: -101.483037 P(Z<=z) one-tail: 0.0223 z Critical one-tail: 1.644853627 P(Z<=z) two-tail: 0.0013 z Critical two-tail: 1.959963985	Since the p-value is less than α (0.05), we reject the null hypothesis thus proving that the presence of light (optimal – 3000 lumens) showed a consistent trend of scattering.
Two-Tailed T-Test H_0 (null hypothesis): The difference between the means of the control group and 3000 lumens is 0.	t-Test: Two-Sample Assuming Unequal Variances *0 lumens* / *3000 lumens* Mean: 0.2514 / 151.7015 Variance: 0.025369737 / 159.351825 Observations: 100 / 100 Hypothesized Mean Difference: 180 df: 99 t Stat: -262.545794 P(T<=t) one-tail: 7.1464E-143 t Critical one-tail: 1.660391156 P(T<=t) two-tail: 1.4293E-142 t Critical two-tail: 1.984216952	Since the p-value is less than α (0.05), we reject the null hypothesis thus proving that there was a significant difference between the control and optimal experimental groups.
F-Test H_0 (null hypothesis): The difference between the variance of the control group and 3000 lumens is 0.	F-Test Two-Sample for Variances *0 lumens* / *3000 lumens* Mean: 0.2514 / 151.7015 Variance: 0.025369737 / 0.05673 Observations: 100 / 100 df: 99 / 99 F: 0.000159206 P(F<=f) one-tail: 0.01 F Critical one-tail: 0.717328593	Since the p-value is less than α (0.05), we reject the null hypothesis thus proving that there was a significant difference between variances, depicting more variance towards the higher light intensities.

Error Analysis

Errors	Solutions
Imprecise values derived from Rayleigh Scattering can be misleading for industrial applications	Instead of using quantum units and methods, lumens was used to determine the optimal intensity
Alpha particles travelling from other directions can collide with observed subjects for testing	Alpha particles were chosen based on a linear relation to the light source and a free pathway
Alpha particles may have been mistaken for muons or other subatomic particles	Pictures and recordings were compared to conventional alpha particle images to reduce error

Impacts and Future Research

Global Relations	Economy	Human Health
• One step closer to ending a worldwide epidemic: genetic diseases • Interconnectedness of health and development • Working towards **Sustainable Development Goal 3**—to "ensure healthy lives and promote well-being for all at all ages"	• Industrial Economic Losses minimized • Microcontrollers can fit into tightly packed spaces – reducing the need for large funding • **Applicable to various industries** • No direct damage suffered by equipment or human	• No damage to DNA • Prevention of radiation sickness, neurodegenerative diseases, and side effects of radiation therapy • Indirect protection of cell walls, nuclei, and organelles • **Noninvasive** protection of organs

Future Utilization and Commercialization of this Research can Lead to the Following Breakthroughs:

1. Innovating remote image detection software for alpha particles coupled with microcontrollers to optimize independence
2. Further understanding of the relationship between LED light and alpha particles by manipulating the distance between the two particles
3. Creating an alternative to cloud chambers to better apply this technology in third world countries

RED: Radiation Elimination Device