Investigation of the Depth Dose Profile in Irradiation of SARS-COV2 Envelope Protein using Electron Beam in PHITS Simulation

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ABSTRACT

SARS-COV2 or COVID-19 can be deactivated by destroying its envelope protein that houses the RNA which is responsible for the infection of its host. There are several methods in deactivating the viral protein such as Pasteurization, Acidic pH inactivation/Low pH treatment and, Solvent/detergent inactivation. However these are time-consuming methods, we need a fast, quick and effective way to inactivate the virus. Viral protein inactivation using electron beam irradiation can be a fast and effective method in deactivating the envelope protein of SARS-COV2 for surface disinfection. The electron beam interacts with the envelope protein to deactivate the viral proteins to inactivate surface viruses.

This study utilizes Particle and Heavy Ion Transport code System (PHITS) to simulation the electron beam irradiation to SARS-COV2 envelope protein. The simulation method starts with the simulation set-up, with a cubical target material with dimensions of 10cm x 10cm x 10cm with the same composition of the envelope protein of SARS-COV2, then irradiated with electron beam with energies of 5Kev to 1MeV energy range. Investigation of the depth dose profile of the electron beam in SARS-COV2 envelope protein is then performed.

The result shows, using a specific energy of 0.05MeV and 2MeV the depth of the maximum dose is 0.3cm and 1cm respectively. Finally, as the energy of the electron beam increases, the depth of the maximum dose also increases.

INTRODUCTION

SARS-COV2 is an infectious virus that has affected the whole world. The World Health Organization encourages the public to maintain high levels of personal hygiene using disinfectants on surfaces.

There are may ways to inactivate viruses such as Acidic pH inactivation/ Low pH treatment, Pasteurization and solvent detergent inactivation. However these methods are time consuming, we need a fast and effective way to inactivate the virus. Coronaviruses are known to be vulnerable to thermal heat, such as radiation, laser and photodynamic therapy (PTD) [1,2] .

One method used to inactivate virus is electron beam irradiation, it can interact with virus molecules and destroy their activity [3]. SARS-COV2 or COVID-19 can be deactivated by destroying its envelope protein that contain the RNA of the virus which is accountable for the infection of its host.

Figure 1. The novel coronavirus (COVID-19)

Goal:

To investigate the depth dose profile of the electron beam irradiation on the envelope protein of SARS-COV2

METHODOLOGY

This study utilizes Particle Heavy Ion Transport code System (PHITS) to simulate the electron beam irradiation to SARS-COV2 envelope protein.

PHITS
Particle and Heavy Ion Transport code System

Figure 2. The PHITS logo

TARGET MATERIAL VISUALIZATION

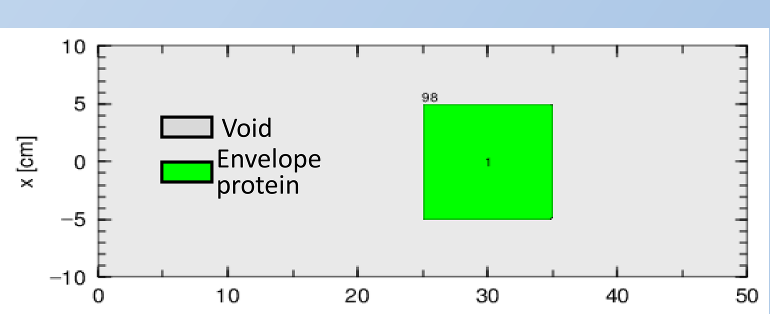

Figure 3. 10x10x10cm Envelope Protein

Table 1. Chemical Composition from NCBI	
SARS-CoV-2 Envelope Protein	$C_{5.2297}H_{10.203}O_{1.2523}N_{2.3514}S_{0.0360}$

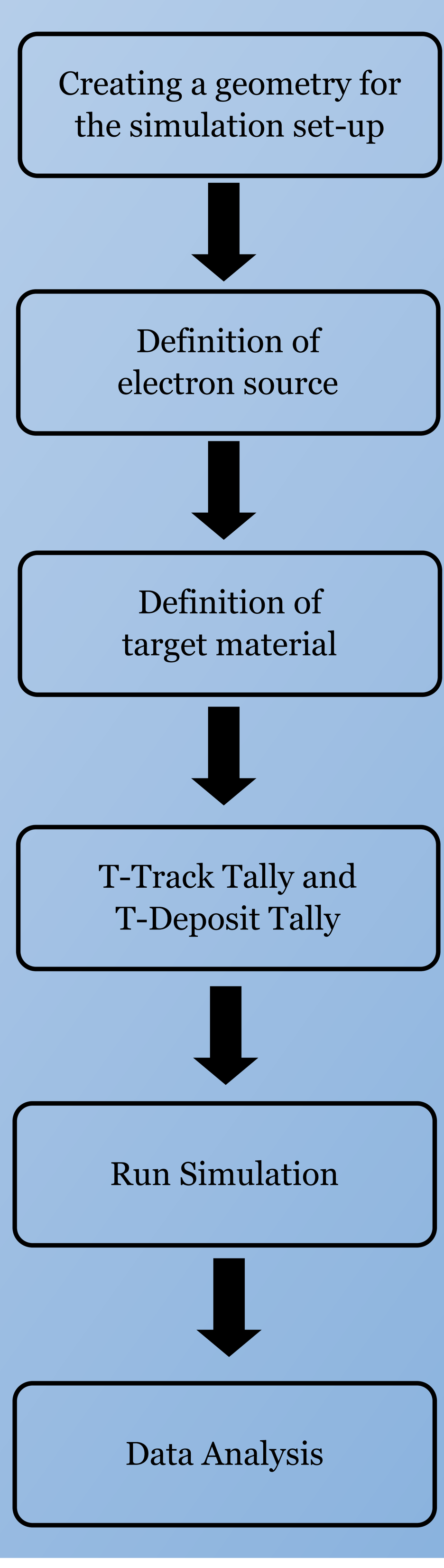

Figure 4. Schematic diagram of the simulation

RESULTS AND DISCUSSIONS

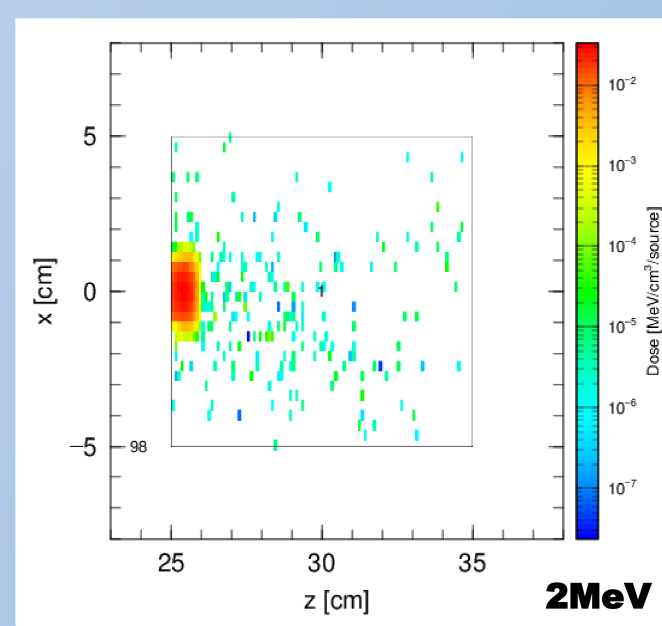

Figure 5. Absorbed electron dose at 2MeV energy

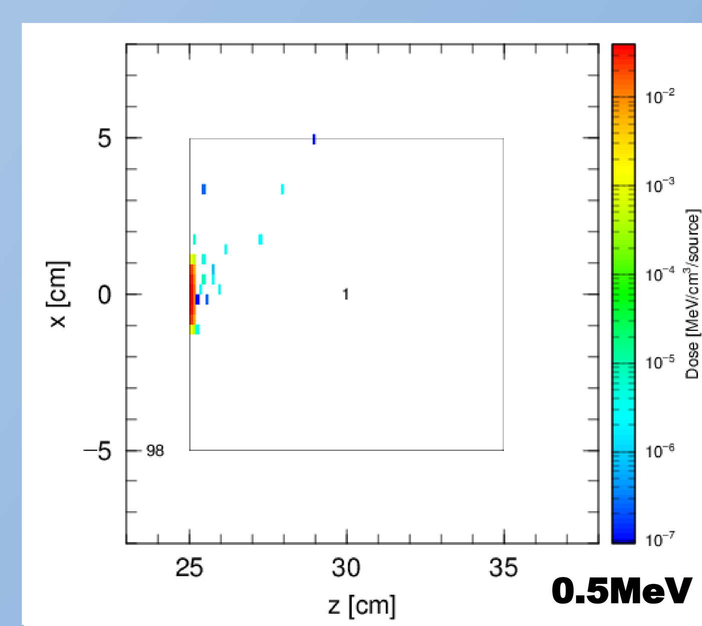

Figure 6. Absorbed electron dose at 0.5MeV energy

- Visual illustration of the material absorbed dose of electron beam irradiation
- Comparison of the energy 2MeV and 0.5MeV shows that at 2Mev have greater absorbed dose than 0.5MeV

- Result shows the different energy dose and the depth the material absorbed dose respectively.
- It is shown that the energy of 0.05MeV dose only penetrated unto 0.3cm of the material
- At 2Mev energy dose the material absorbed unto 1cm

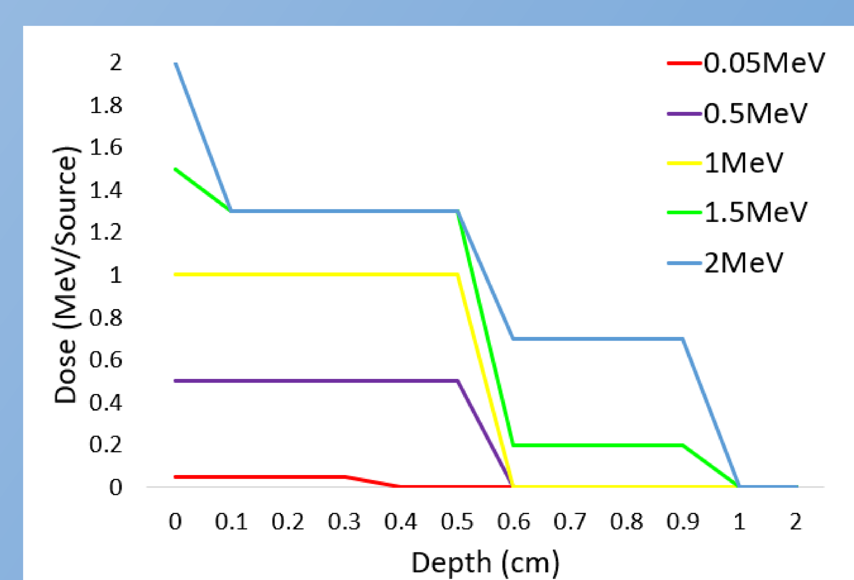

Figure 7. Specific energy doses and their depth of the maximum dose

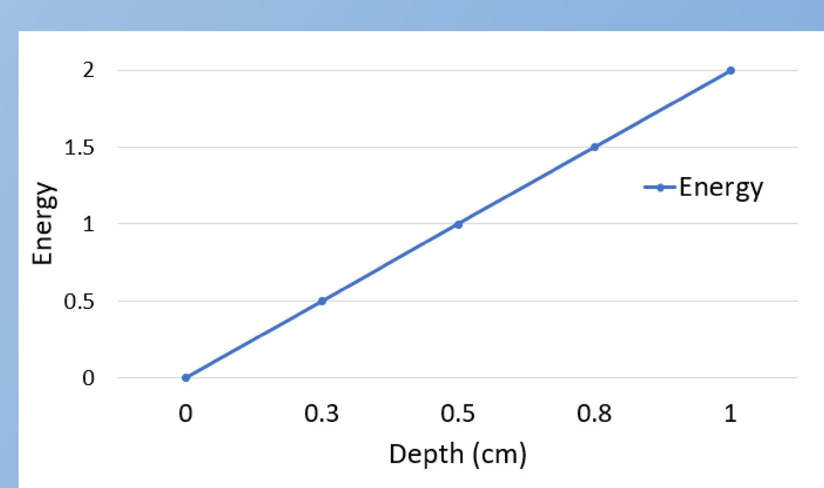

Figure 8. Energy and the depth of their dose

- The graph shows that as the energy increases the depth of penetration also increases.

CONCLUSION

- **As the energy increases the depth of the maximum dose also increases.**
- **The specific energies of 0.05MeV to 2MeV the depth of the maximum dose is from 0.3 cm to 1 cm respectively.**
- **As the energy of the electron beam increase the absorbed dose and penetration depth also increases**

REFERENCE

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[2] N. Kaushik et al., "The inactivation and destruction of viruses by reactive oxygen species generated through physical and cold atmospheric plasma techniques: Current status and perspectives," J. Adv. Res., Mar. 2022, doi: 10.1016/j.jare.2022.03.002.

[3] "Electron beam irradiation on novel coronavirus (COVID-19): A Monte–Carlo simulation *Project supported by the National Natural Science Foundation of China (Grant No. 61901360).," Chin. Phys. B Zhongguo Wu Li B, vol. 29, no. 4, p. 048703, Apr. 2020, doi: 10.1088/1674-1056/ab7dac.