# ABSTRAK

Telah berhasil dilakukan simulasi terapi proton menggunakan pemrograman *Particle and Heavy Ion Transport code System* (PHITS) pada kanker otak. Tujuan utama penelitian adalah meninjau karakteristik interaksi proton dengan organ kepala dan menentukan energi dan waktu yang optimal pada terapi proton. Penelitian dilakukan secara simulasi menggunakan pemrograman PHITS. Model kepala yang dibuat mengacu pada model kepala Snyder. Posisi sel kanker terletak di tengah otak pada kedalaman 12 cm dari kulit kepala. Sumber proton dimodelkan berasal dari siklotron *Superconducting Isochronous* dan dioperasikan pada energi 120, 130,140 dan 150 MeV. Hasil simulasi menunjukkan bahwa semakin tinggi energi proton semakin besar jangkauan proton menembus phantom kepala. Pola interaksi proton dengan phantom kepala membentuk kurva Bragg-peak. Yaitu kurva linier pada awalnya, naik secara ekponensial sampai kedalaman tertentu dan turun secara dratis sampai energi minimum. Hasil simulasi menunjukkan bahwa energi optimal dalam mendeposikan energi pada kanker otak terjadi pada energi proton 140 MeV dengan laju dosis maksimum $(8{,}5 \pm 0.15) \times 10^{-2}$ Gy/s. Waktu iradiasi persesi (2 Gy) dihitung pada laju dosis maksimum diperoleh lama iradiasi 23 detik.

**Kata kunci:** Terapi proton, kanker otak, PHITS, dosis, dan waktu iradiasi.

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## *ABSTRACT*

*Proton therapy simulations have been successfully carried out using the Particle and Heavy Ion Transport code System (PHITS) programming on brain cancer. The main objective of the study was to review the characteristics of proton interactions with the head organs and determine the optimal energy and time for proton therapy. The research was conducted by simulation using PHITS programming. The head model made refers to the Snyder head model. The position of cancer cells is located in the center of the brain at a depth of 12 cm from the scalp. The proton sources are modeled from the Superconducting Isochronous cyclotron and operate at energies of 120, 130, 140 and 150 MeV. The simulation results show that the higher the proton energy, the greater the range of protons penetrating the phantom head. The pattern of proton interactions with the head phantom forms a Bragg-peak curve. That is, the curve is linear at first, rising exponentially to a certain depth and dropping drastically to a minimum of energy. The simulation results show that the optimal energy in depositing energy in brain cancer occurs at a proton energy of 140 MeV with a maximum dose rate of* $(8{,}5 \pm 0.15) \times 10^{-2}$ Gy/s. *The irradiation time (2 Gy) was calculated at the maximum dose rate and the irradiation time was 23 seconds.*


***Key words:*** *Proton therapy, brain cancer, PHITS, dose, and iradiation time*