

**OPTIMASI DISTRIBUSI DOSIS RADIASI TERAPI PROTON
PADA *GLIOBLASTOMA MULTIFORME* BERBASIS *PARTICLE
AND HEAVY ION TRANSPORT CODE SYSTEM* VERSI 3.341**

SKRIPSI



**HANIFA SHAFIRA
2010442008**

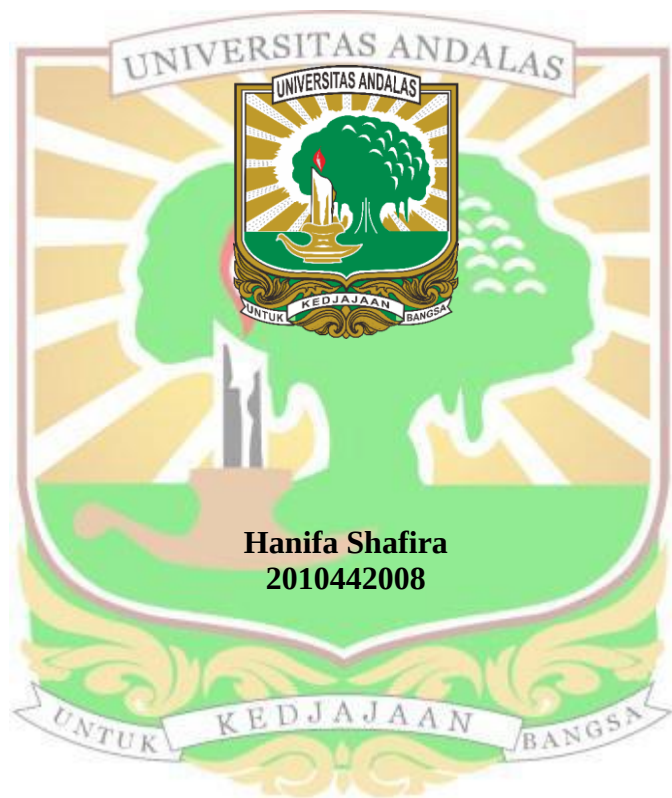
**DEPARTEMEN FISIKA
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS ANDALAS
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PADA GLIOBLASTOMA MULTIFORME BERBASIS PARTICLE
AND HEAVY ION TRANSPORT CODE SYSTEM VERSI 3.341**

SKRIPSI

**Karya tulis sebagai salah satu syarat
untuk memperoleh gelar Sarjana Sains
dari Universitas Andalas**



**Hanifa Shafira
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PADA GLIOBLASTOMA MULTIFORME BERBASIS PARTICLE
AND HEAVY ION TRANSPORT CODE SYSTEM VERSI 3.341**

ABSTRAK

Distribusi dosis radiasi terapi proton pada *Glioblastoma Multiforme* (GBM) sangat berpengaruh terhadap efektivitas terapi dan perlindungan *Organ at Risk* (OAR). Penelitian ini menggunakan teknik *Passive Scattering* (PS) berbasis *Particle and Heavy Ion Transport Code System* (PHITS) versi 3.341 untuk mengoptimalkan distribusi dosis radiasi ke target kanker dengan tetap menjaga OAR berada di bawah batas toleransi dosis radiasi berdasarkan pedoman *Quantitative Analyses of Normal Tissue Effects in the Clinic* (QUANTEC). Simulasi dilakukan menggunakan fantom *Oak Ridge National Laboratory* (ORNL) dengan mempertimbangkan parameter energi 104–155 MeV, penggunaan kolimator dan kompensator, serta arah penyinaran *Posterior-Anterior* (PA) dan *Superior-Inferior* (SI) untuk mencapai distribusi dosis radiasi yang optimal sesuai dengan protokol *National Radiation Group* (NRG) *Oncology*. Hasil simulasi menunjukkan bahwa dosis radiasi dtarget kanker dengan nilai mendekati 50 Gy RBE (*Gray Relative Biological effectiveness*) dalam 18 fraksi, sementara dosis radiasi yang diterima OAR berada di bawah batas toleransi dosis radiasi. Penyinaran dari dua arah dapat menghasilkan cakupan dosis radiasi yang lebih luas, mengurangi heterogenitas distribusi, dan menurunkan risiko efek samping akibat radiasi berlebih pada OAR. Hasil ini menunjukkan bahwa terapi proton dengan teknik PS efektif dalam menangani GBM, memberikan distribusi dosis radiasi yang lebih merata dan risiko minimal terhadap OAR.

Kata kunci: *Glioblastoma multiforme*, terapi proton, *passive scattering*, PHITS, distribusi dosis radiasi.



**OPTIMIZATION OF PROTON THERAPY RADIATION DOSE
DISTRIBUTION FOR GLIOBLASTOMA MULTIFORME BASED ON
PARTICLE AND HEAVY ION TRANSPORT CODE SYSTEM
VERSION 3.341**

ABSTRACT

The distribution of radiation dose in proton therapy for Glioblastoma Multiforme (GBM) significantly affects treatment effectiveness and the protection of Organs at Risk (OAR). This study employs the Passive Scattering (PS) technique based on the Particle and Heavy Ion Transport Code System (PHITS) version 3.341 to optimize the radiation dose distribution to the cancer target while ensuring that OAR exposure remains within the tolerance limits set by the Quantitative Analyses of Normal Tissue Effects in the Clinic (QUANTEC) guidelines. Simulations were conducted using the Oak Ridge National Laboratory (ORNL) phantom, considering energy parameters ranging from 104 to 155 MeV, the use of collimators and compensators, and irradiation directions from Posterior-Anterior (PA) and Superior-Inferior (SI) to achieve optimal radiation dose distribution in accordance with the National Radiation Group (NRG) Oncology protocol. The simulation results indicate that the radiation dose delivered to the cancer target approaches 50 Gy RBE (Gray Relative Biological Effectiveness) over 18 fractions, while the radiation dose received by OAR remains below the tolerance threshold. Irradiation from two directions provides broader dose coverage, reduces distribution heterogeneity, and minimizes the risk of excessive radiation-induced side effects on OAR. These findings suggest that proton therapy using the PS technique is effective in treating GBM, offering a more uniform radiation dose distribution with minimal risk to OAR.

Keywords: Glioblastoma multiforme, terapi proton, passive scattering, PHITS, radiation dose distribution

