BAB V
KESIMPULAN

5.1 Kesimpulan

1. Evaluasi laju dosis dilaksanakan menggunakan *Monte Carlo Simulation Tool MCNP 6.2* milik Meissner Consulting dengan skenario terburuk pada ruang gantri dan cyclotron.
2. Hasil analisis menunjukkan bahwa desain perisai radiasi pesawat Proton ProBeam 360^{o} yang telah dirancang AMAN dan tidak melebihi nilai batas dosis yang ditentukan sesuai dengan peraturan yang berlaku di Indonesia untuk area pekerja maupun publik.

5.2. Saran

Dari penelitian yang telah dilakukan, peneliti mempunyai saran terkait penelitian lebih lanjutnya, antara lain:

1. Memahami secara mendalam mengenai simulasi Monte Carlo.
2. Pemodelan geometri ruangan dan mesin yang lebih rinci mendekati kondisi sesungguhnya.
3. Melakukan paparan radiasi secara langsung menggunakan surveymeter untuk memastikan bahwa desain perisai radiasi yang terbangun sudah memenuhi batas proteksi radiasi.

DAFTAR PUSTAKA

Akkurt, I., Altindag, R., Gunoglu, K., & Sarikaya, H. (2012). Photon attenuation coefficients of concrete including marble aggregates. *Annals of Nuclear Energy*, *43*, 56–60. https://doi.org/10.1016/j.anucene.2011.12.031

Gao, H., Chen, L., Tang, B., Wang, Y., Du, C., Liu, K., Qiu, D., Kong, X., Yang, B., Yin, Y., Zhang, W., Tu, Y., & Sun, L. (2022). Calculation of *shielding* performance of CRT concrete for proton therapy and optimal *shielding* design of treatment delivery room. *Applied Radiation and Isotopes*, *189*. https://doi.org/10.1016/j.apradiso.2022.110432

IAEA. (2024). *IAEA SAFETY STANDARDS AND RELATED PUBLICATIONS*. https://www.iaea.org/resources/safety-standards

Li, J., & Kuang, X. (2024). Global cancer statistics of young adults and its changes in the past decade: Incidence and mortality from GLOBOCAN 2022. *Public Health*, *237*, 336–343. https://doi.org/10.1016/j.puhe.2024.10.033

LI, Y. (2025). *Modeling a Pencil Beam Scanning Nozzle Used for Proton Therapy | COMSOL Blog*. https://www.comsol.com/blogs/modeling-a-pencil-beam-scanning-nozzle-used-for-proton-therapy

NCRP Report No. 151. (2005). *RStructural Shielding Design and Evaluation for Megavoltage X and γ Ray Radiotherapy Facilities*. National Council on Radiation Protection & Measurements.

Pawlicki, Todd. (2011). *Quality and safety in radiotherapy*. Taylor & Francis.

Piotrowski, T., Mazgaj, M., Zak, A., & Skubalski, J. (2015). Importance of atomic composition and moisture content of cement based composites in neutron radiation *shielding*. *Procedia Engineering*, *108*, 616–623. https://doi.org/10.1016/j.proeng.2015.06.188

Podgorsak, E. B. (2005). *Radiation Oncology Physics: A Handbook for Teachers and Students*.

Shultis, J. K., & Faw, R. E. (2004). *An MCNP primer AN MCNP PRIMER by*. http://krex.ksu.edu

Toshio, M. (2023). ALARA adalah Prinsip - radiologi.co.id. *Https://Radiologi.Co.Id/*. https://radiologi.co.id/alara-adalah-prinsip/

Vanaudenhove, T., Stichelbaut, F., Dubus, A., Pauly, N., & Smet, V. De. (2014). Monte Carlo calculations with MCNPX and GEANT4 for general *shielding* study—Application to a proton therapy center. *Progress in Nuclear Science and Technology*, *4*, 422–426. https://doi.org/10.15669/pnst.4.422

Wang, S., Gonzalez, G., Sun, L., Xu, Y., Pandey, P., Chen, Y., & Xiang, S. L. (2024). Real-time tracking of the Bragg peak during proton therapy via 3D protoacoustic Imaging in a clinical scenario. *Npj Imaging*, *2*(1). https://doi.org/10.1038/s44303-024-00039-x

Yang, Z.-Y., Tsai, P.-E., Lee, S.-C., Liu, Y.-C., Chen, C.-C., Sato, T., & Sheu, R.-J. (n.d.). *Inter-comparison of Dose Distributions Calculated by FLUKA, GEANT4, MCNP, and PHITS for Proton Therapy*.

Yani, S., Rahma, W., Sumaryada, T., Endarko, Haryanto, F., Tai, D. T., Omer, H., Tamam, N., Sulieman, A., Eka Dirgayussa, I. G., & Nuraeni, N. (2026). Optimization of proton radiation *shielding* using multilayer concrete-iron-polyethylene barriers: A PHITS Monte Carlo study. *Radiation Physics and Chemistry*, *240*. https://doi.org/10.1016/j.radphyschem.2025.113422