

THESIS

**EVALUATION OF PHOTON AND ELECTRON BEAMS IN A LINEAR
ACCELERATOR USING A WATER PHANTOM BASED ON IAEA
PROTOCOL STANDARDS**



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**BACHELOR OF PHYSICS STUDY PROGRAM
FACULTY OF ENGINEERING AND SCIENCE
UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN" JAWA
TIMUR
SURABAYA
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Submitted to Partially Fulfill the Requirements
In Obtaining a Bachelor of Science (S.Si) Degree
Physics Study Program

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APPROVAL SHEET

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ABSTRACT

As cancer remains one of the leading causes of global mortality, the advancement of treatment methods such as radiotherapy using Linear Accelerator (LINAC) technology is vital. The success of this therapy relies heavily on dose accuracy, making regular evaluation of machine output a critical necessity. This study evaluates the electrical charge, output deviation, and operational stability of the Varian TrueBeam LINAC for photon and electron beams, guided by the IAEA TRS-398 and TRS-483 international protocols. Measurements were conducted using a water phantom, covering 6 MV photon energies in both With Flattening Filter (WFF) and Flattening Filter Free (FFF) modes, as well as electron energies ranging from 6 to 18 MeV.

The findings indicate that photon beams in WFF mode maintain high stability with deviations between $\pm 0.2\%$ and 1%. While the FFF mode initially exhibited larger deviations, technical adjustments successfully refined the precision to a remarkable $\pm 0.01\%$. For electron beams, the most consistent performance was observed at 9 MeV and 12 MeV. Although some energy levels initially approached the tolerance threshold, post-adjustment results confirmed they returned to safe operational limits. Statistical analysis (T-Test and ANOVA) further demonstrates that despite technical variations in energy and voltage, the LINAC system consistently shows solid repeatability. In conclusion, the Varian TrueBeam LINAC meets rigorous international standards for accuracy, ensuring it is safe and reliable for clinical use in patient cancer treatment.

Keywords: LINAC, Photon, Electron, IAEA TRS-398, Output Deviation, Quality Assurance.

FOREWORD

I give thanks to the Almighty God who has bestowed His blessings, grace, and wisdom of knowledge upon me, enabling the author to complete this thesis entitled **“Evaluation of Photon and Electron Beams on a Linear Accelerator Using a Water Phantom Based on IAEA Protocols Standards”**. The researcher hopes that writing this thesis will be beneficial for themselves and others in the future.

The author wishes to express gratitude by thanking the people who helped in completing the preparation of this thesis.

1. To Mr. Prof. Dr. Ir. Akhmad Fauzi, M.MT., IPU as Rector of the Universitas Pembangunan Nasional “Veteran” Jawa Timur
2. To Mrs. Prof. Dr. Dra. Jariyah, MP as Dean of the Faculty of Engineering and Science at the UPN “Veteran” Jawa Timur
3. To Mrs Dr. Dira Ernawati, S.T., M.T as Coordinator of the Physics Study Program at the Universitas Pembangunan Nasional “Veteran” Jawa Timur
4. To Mrs Dr. Wahyu Dwi Lestari, S.Pd., M.T as Thesis Supervisor 1, who has given her time to nurture, guide, direct, and provide very useful input in the process of completing this thesis
5. To Mrs Primasari Cahya Wardhani, S.Si., M.Sc as Thesis Supervisor 2, Internship Supervisor, and Apprenticeship Supervisor, the author expresses sincere gratitude for the time, attention, and patience that have always been provided amidst her busy schedule. His guidance, direction, motivation, and various input were not only very meaningful in the preparation of this thesis but also served as valuable preparation for the author in continuing studies and preparing for the world of work after education
6. To all the lecturers of the Physics Study Program, Faculty of Engineering and Science, Universitas Pembangunan Nasional “Veteran” Jawa Timur
7. To Mr. Dr. Wahyudi Iffani, S.T., M.T. as the Head of the Surabaya Health Equipment and Facilities Security Center (BPAFK), the author expresses

gratitude for the opportunity and trust given to the author to conduct internship and research activities, as well as gain invaluable experience and learning

8. To Mrs. Kandi Ayu Tiswati, S.Si. as the Head of the Radiation and Radiotherapy Measurement Equipment Calibration Installation (KAUR) at BPPAFK Surabaya, the author expresses gratitude for the support and facilities provided, which enabled the completion of this research
9. To Mrs. Arie Chintya Martania, S.Si. the author expresses gratitude for her assistance, guidance, and willingness to help with the data collection and processing process, as well as for patiently providing explanations and understanding when the author experienced difficulties
10. Especially to my parents, I express my deepest gratitude for their prayers, love, moral and material support, and unwavering patience throughout my education until the completion of this thesis. All the attention, sacrifices, and motivation provided became the main source of strength for the author to continue striving, persevering, and completing this study to the best of their ability
11. To my siblings, the author expresses gratitude for the support, prayers, attention, and encouragement always provided throughout the course of my studies until the completion of this thesis. Your support and encouragement are very meaningful and helpful to the author in completing their studies
12. To all my friends, the author expresses gratitude for the camaraderie, support, assistance, and encouragement provided during my studies and the preparation of this thesis

The author is aware that there are still many shortcomings in the preparation of this thesis. Therefore, constructive suggestions and criticisms are highly appreciated. In conclusion, the author hopes that this thesis will be beneficial for the author in particular and especially for all physics students.

Surabaya, 2 March 2026

Author

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