

**REPRODUCTION, INDEPENDENT TUNING,
AND VALIDATION OF 6 MV VITALBEAM LINAC
USING PRIMO MONTE CARLO SOFTWARE**

UNDERGRADUATE THESIS



submitted by:

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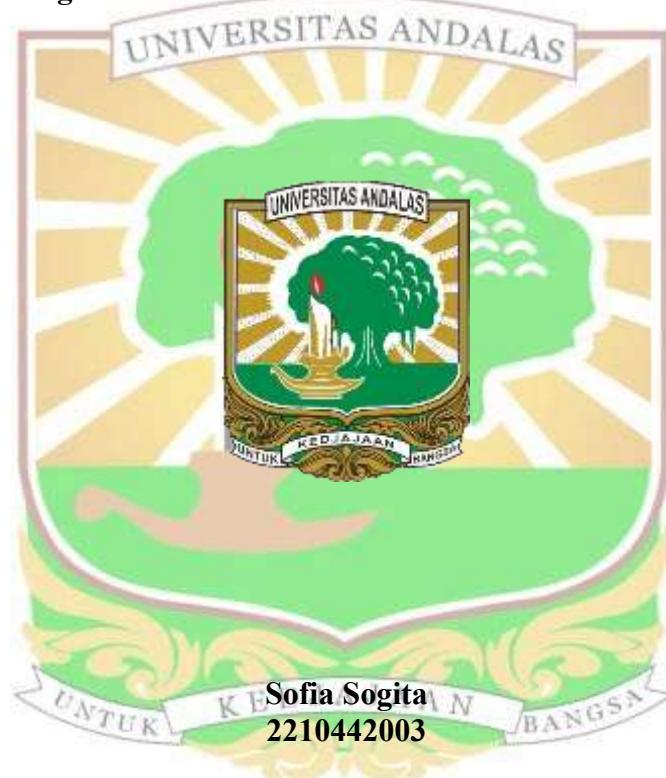
**DEPARTMENT OF PHYSICS
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
ANDALAS UNIVERSITY
PADANG**

July, 2026

**REPRODUCTION, INDEPENDENT TUNING,
AND VALIDATION OF 6 MV VITALBEAM LINAC
USING PRIMO MONTE CARLO SOFTWARE**

UNDERGRADUATE THESIS

**An undergraduate thesis submitted as partial fulfillment of the requirements
for the degree of Bachelor of Science from Andalas University**



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2026

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Hereby declare that this Undergraduate Thesis entitled **Reproduction, Independent Tuning, and Validation of 6 MV VitalBeam LINAC Using PRIMO Monte Carlo Software** is entirely the result of my own thoughts and work, and is free from any plagiarism of others' work.

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Sofia Sogita

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Has been defended before the Examining Board
on the date of 17 July 2026

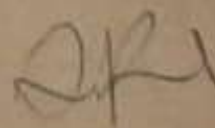
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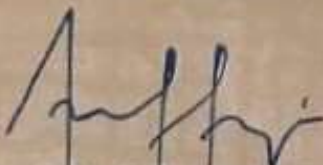
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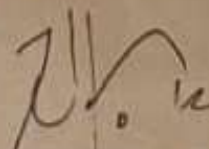
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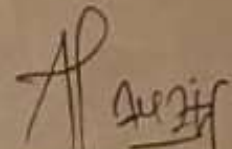
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ABSTRACT

Validation of the Monte Carlo model for the 6 MV VitalBeam LINAC using PRIMO software was performed by systematically comparing simulated relative dose distributions (Percent Depth Dose (PDD) and lateral profiles) against experimental reference data using gamma analysis. This research aims to model the 6 MV photon beam using a previously reported parameter configuration and perform independent tuning if direct application fails to achieve GPR > 90% at 1%/1mm. Simulations used the Clinac 2100 model as a surrogate geometry. Tuning, performed exclusively against commissioning data, adjusted Initial Electron Beam Energy (IEBE), Full Width at Half Maximum of Energy (FWHM-E), and Full Width at Half Maximum of Focal Spot Size (FWHM-FS). IEBE stability was verified using Pearson correlation, while FWHM-E and FWHM-FS were optimized based on the highest GPR. Final validation using 10^9 histories compared simulations against commissioning and latest Quality Assurance (QA) data with 1%/1mm, 2%/2mm, and 3%/3mm criteria. Reproduction of the previously reported parameters failed for lateral profiles (55.90%), prompting independent tuning. Optimized parameters were IEBE = 6.5 MeV, FWHM-E = 0.05 MeV, and FWHM-FS = 0.15 cm. The tuned model achieved GPR > 90% for both PDD and profiles only at 3%/3mm against commissioning (PDD: 99.9%, In-plane: 100%, Cross-plane: 97.99%) and QA data (PDD: 100%, In-plane: 97.23%, Cross-plane: 94.12%). At 2%/2mm, PDD passed, but profiles failed. The 1%/1mm criterion yielded lower GPRs due to geometric differences between the Clinac 2100 surrogate and the actual VitalBeam, and computational limits during tuning (2×10^7 histories). This research demonstrates that independent tuning against commissioning data is required for each LINAC unit due to unit-to-unit variations, and PRIMO can serve as an effective verification tool when tuned to unit-specific commissioning data.

Keywords: gamma analysis, VitalBeam LINAC, PRIMO, Monte Carlo simulation, quality assurance