Simulating the University of Maryland Linear Accelerator

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ABSTRACT

The Varian Clinac-6 Electron Linear Accelerator emits an approximately 5 MeV beamline with a very roughly estimated target area. Using ELEGANT code and the user interface at Sirepo, we were able to create a simulation of the University of Maryland linac that produced cross sectional graphs of the radiation intensity on the target area. Using these results and those from a future quadscan, we hope to be able to compare the actual output of the linac to the "ideal" output of the machine given by the simulation, in the hope of creating a more accurate target area.

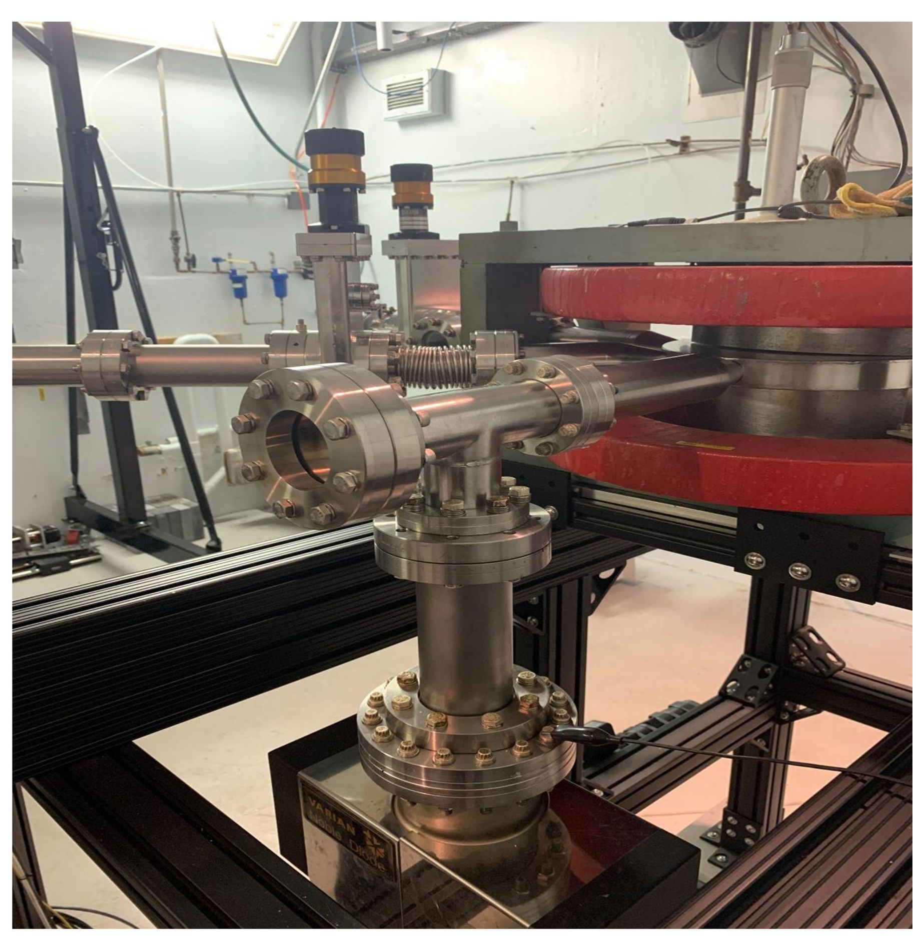
INTRODUCTION

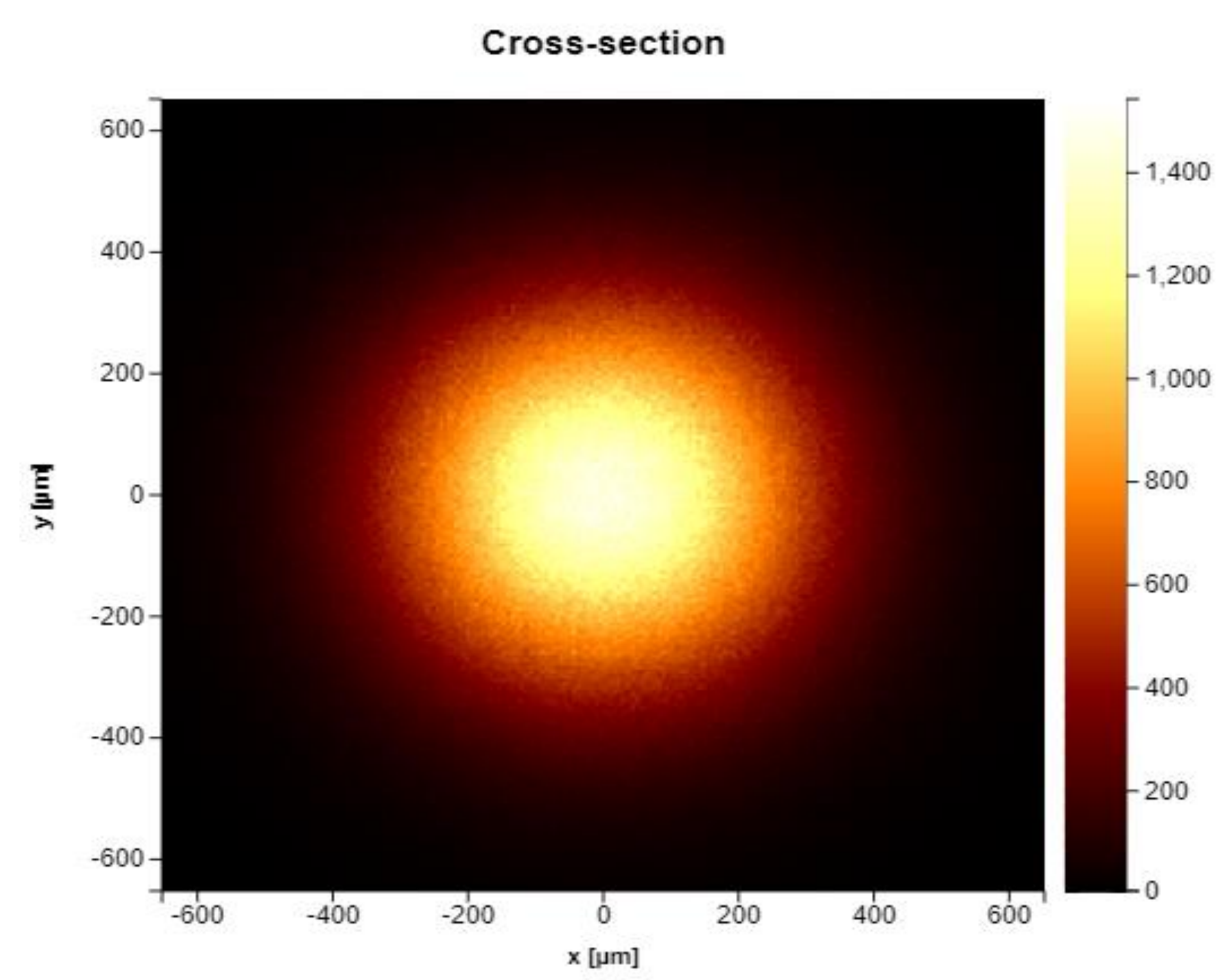
The Varian Clinac-6 Electron Linear Accelerator is a machine capable of producing an electron beamline at about 5 MeV (±1 MeV) which can deposit a large amount of energy onto a target sample. The beamline is manipulated through the use of four quadrupole magnets set up in two pairs to provide a net focusing of the beamline [1]. The actual resultant target area of the beamline is difficult to ascertain due to it having a relatively large area of influence. To aid in targeting samples more accurately, a simulation made in ELEGANT was made to simulate the actual linac in various different ways. The simulation takes the lattice of the machine and produces a resultant target area. It is also possible to perform a quadscan on the simulation allowing for further comparison and calibration of the real beamline [2].

Fig 1. (Left) Shows a target in the vacuum chamber with viewing window. The blue device next to the window is one of the quadrupole doublets

Fig 3. (below) Shows the cross section heat graph of beamline target area. Brighter areas represent more particles going through that area. We hope to represent a real version of this with less fine resolution with the diode array project.

Fig 2. (Right) Shows the exit window at end of beamline. Farther right is red dipole spectrometer magnet not included in simulation. Sample placing area further down beamline (to left of window, out of view).





METHODS

The simulation was made by measuring each part of the linac and putting them in order in the correct order. Because the machine runs at 100 mA, it has about 1.8726×10^{12} electrons per pulse and a momentum per pulse of 9.314×10^{12} MeV/c. However, the simulation limits the number of particles per pulse to 10^7 to prevent performance issues, so that was the number of particles used for the simulation. Each lattice produced a series of figures including a cross section of the target area.

CONCLUSIONS

It is yet to be determined if the ELEGANT simulation shown in this project is accurate to the Radiation Facilities linac, but this does provide us with a hypothetically ideal cross section of the beamline. The next stages of this project involve creating an array of photosensitive diodes that can replicate the cross sectional graphics shown above but in a much lower resolution (40 data taking points on the array). Additionally, a quadscan can be performed on the magnets both in the simulation (by simply changing the magnetic field strength of the magnet) and in the actual linac. Comparing these results will also help us understand how accurate the simulation is to the real linac.

CURRENT RESULTS

The project is still underway as the diode array needed to compare the outputs of the simulation to the actual linac is not complete. Our results so far are simply the images produced by the simulation.

Acknowledgements & References

Thank you to Amber Johnson, Director of Radiation Facilities at the University of Maryland, College Park. Thank you to Prof. Brian Beaudoin who oversaw measurements and technical drawings of the linear accelerator.

1. University of Maryland College Park, Maryland (1988). *Electron Linear Accelerator: Operator Training Manual*
2. Green, A. T., Shin, Y.M. (2015) Implementation of Quadrupole-Scan Emittance Measurement at Fermilab's Advance Superconducting Test Accelerator (ASTA). *6th International Particle Accelerator Conference*.