CHAPTER VI
SUMMARY AND CONCLUSION

The track following algorithm is utilized to reconstruct proton tracks. The MAPS telescope simulation demonstrates how particle impacts are recorded as 3D data, forming tracks. The MC simulation employed beam profiles of 70 MeV and 200 MeV of proton energy as sources. These sources were modeled using a 2-dimensional Gaussian, commonly used in proton therapy centers. To achieve optimal results, the algorithm's searching angle and S_{max} parameters must be calibrated. The interaction of particles with material was assessed using Highland's equation, and the resulting scattering angles were compared to cone angles. In high-energy sources, the searching angle and calculated scattering angle values are more comparable than those in low-energy sources due to the lower energy deposited by the primary particle in the material. By optimizing the number of primaries in the simulation model, the efficiencies of track reconstruction were determined. However, increasing the number of primaries in low-energy beams significantly reduces the accuracy of the algorithm. The pCT prototype of Loma Linda (Giacometti et al., 2017) requires an ALPIDE sensor to detect fewer than 400 particles per frame in each plane. Hence, the telescope consisting of six ALPIDE layers, should adhere to this criterion.

The beam test facility (BTF) at the Siam Research Light Institute (SLRI) served as a model for this telescope. It was employed to test the pCT development with the Proton cyclotron (Varian ProBeam Compact Therapy System), utilizing its electron detection capabilities. The telescope comprises six ALPIDE sensors, with each single chip containing 512 $\times$ 1024 pixels. The electronic readout is connected to each layer through the DAQ board. The telescope's operation is facilitated by the EUDAQv2 software, implemented using the C++ programming language. The output of the EUDAQv2 run is generated as event-by-event data in the form of a RAW binary file. Each event corresponds to a detection frame, which is defined by an external input known as the "trigger" signal. The trigger signal originates from the trigger controller system, which utilizes the MEGA2560 pro to control the SAMKOON SK-070FE HMI touchscreen and generate the trigger pulses. To ensure reliability, the trigger system was developed using the Basys3 FPGA, which provides the divided 100 MHz FPGA clock as the trigger input. The Pro Mini 328 microcontroller manages the data flow from the Python GUI to the Basys3 FPGA. The trigger frequency was set to 9.5 kHz to maximize the frame rate of the telescope operation. A dark test condition was conducted to verify the trigger signal. In the preliminary test, the proton beam energies from the KCMH sources at 70 MeV and 200 MeV were measured.

Proton therapy is a form of radiation therapy that employs a focused stream of protons to target and eliminate cancerous cells. In order to achieve an adequate dosage, the rate at which the beam delivers protons needs to be approximately 10^9 protons/s. Unfortunately, the telescope cannot detect the therapeutic beam with a high number of protons per frame. So, the acrylic collimator was used to reduce the large number of protons by eliminating the lateral dose from the Gaussian beam. The 36 cm acrylic collimator transports some proton particles through a 1 mm hole to the ALPIDE sensor in the telescope. The collimated beam is filtered by new Gaussian model to obtain only the particles that propagate along the aperture. The background and noise of sensor are measured in the dark run and they are removed by considering the cluster size of signal and the statistics of activated pixels. According to unextractable data of EUDAQv2 output, the automation which is implemented by Python programming language was used to generate multiple event data as multple .root files. The cluster size of the sources were evaluated for preparing hitmarker as prepossessing data which is used in the reconstruction algorithm. The correlations of X and Y direction on each sensor layer pair of reconstructed tracks imply the alignment of detector setup in the telescope. By optimizing the S_{max} and cone angle in the reconstructed algorithm, proton tracks were discovered by calculating the experimental data as the multiple events.

The results show that the reconstruction efficiency of the telescope demonstrates a 70% survival rate for both 70 MeV and 200 MeV of proton energy tracks. This finding holds promise for potential enhancements and future applications in the development of the pCT prototype.