THE DEVELOPMENT OF AN EXTERNAL BEAM IRRADIATION SYSTEM FOR MATERIAL ANALYSIS AT THE CYCLOTRON FACILITY IN THAILAND

P. THONGJERM, S. WONGLEE, W. PORNROONGRUENGCHOK,
A. NGAMLAMIAD, and K. BOONSIRICHAI
Thailand Institute of Nuclear Technology, Nakhon Nayok, Thailand

The cyclotron (MCC-30/15) at Thailand Institute of Nuclear Technology (TINT, Nakhon Nayok, Thailand) accelerates protons and deuterons up to 30 MeV and 15 MeV, respectively. The maximum beam current of proton is 200 μA. It is primarily designed for radioisotopes production. The system consists of three beamlines transporting the beam to three target halls. Apart from irradiating solid targets for daily radioisotopes production, the beam is then guided to the R&D irradiation vault. The beam transport system equipped with a five-port switching magnet allows performing multi-purpose research and ion beam applications. Fig. 1 shows the current setup of the research beamline. It is under installation and due to commission by the end of 2021. The first irradiation station is devoted for proton-induced x- ray and gamma-ray emission (PIXE and PIGE) applications in the early phase of this research project. The other beam ports will be eventually extended and developed for research experiments. As reported in the studies, the proton beam energy and current extracted from cyclotron would be unsuitable for material analysis and research applications such as radiobiology[1, 2]. Therefore, the additional instruments, including beam degrader and sample holder, are designed to achieve appropriate beam parameters and produce homogenized beams over the sample. In addition to adjusting beam energy and current, the proton beam can be substantially scattered as it is extracted in air, causing impaired beam quality. Beam collimator and exit window foil need to be properly designed to improve the beam quality.

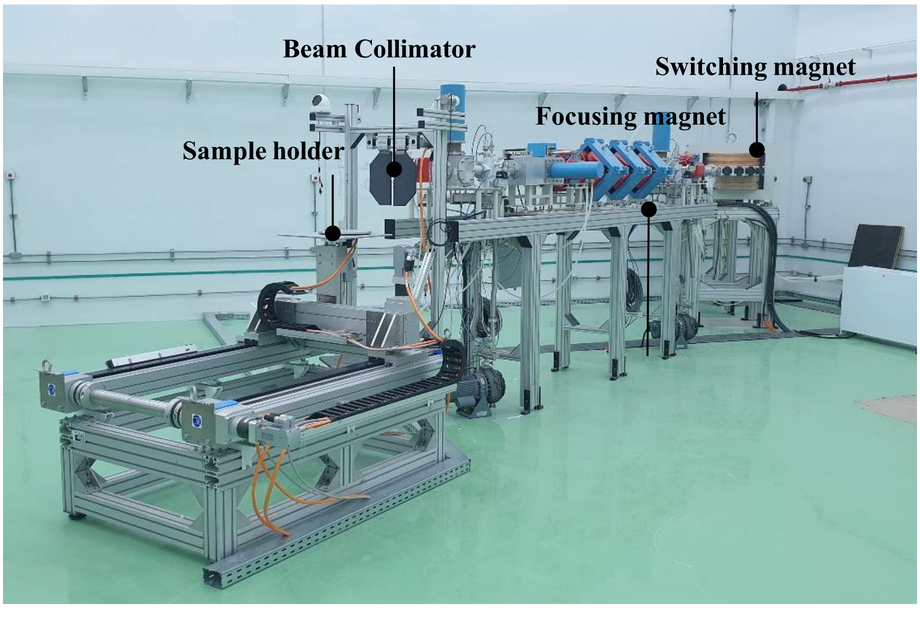

FIG. 1. The current setup of R&D beam line consists of a five-port switching magnet, a set of quadrupole magnets and a graphite collimator mounted at the end of the horizontal beam line.

A Monte Carlo simulation of the beamline was developed with Geant4[3] to design additional systems, optimize proton beam energy, and maintain a low current beam. We investigated the effect of different materials and thickness configuration of the beam collimator to achieve minimal losses and less secondary radiation. A detailed description of the irradiation system with the corresponding simulation results is presented. Further, the simulation results is validated with experimental measurements.

REFERENCES

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