Determination of Magnet Specification of 13 MeV Proton Cyclotron Based on Opera 3D

Abstrak

The magnet is one of the main components of a cyclotron, used to form a circular particle beam trajectories and to provide focusing of the beam. To support the mastery of 13-MeV proton cyclotron technologies, cyclotron magnet design must be done to satisfy cyclotron magnet requirements. This research was conducted by studying important parameters in designing the cyclotron magnet which is then used to determine the design requirements. The magnet design was based on the results of a 3D simulation using Opera 3D software. Opera 3D is a software developed by Cobham plc to solve physical problems in 3D such as magnetostatic using finite element methods. The simulation started by drawing a 3D model of the magnet using a modeler, followed by magnetic field calculations by Tosca module in the Opera 3D software. Simulation results were analyzed with the Genspeo software to determine whether the parameters of the cyclotron magnet have met design requirements. The results indicate that the magnet design satisfied the cyclotron magnet design requirement, that B in the median plane of the magnetic pole approached the isochronous curve, providing axial and radial focusing beam, crossing the resonance line at vr = 1 when the particle energy is low and the particle energy is more than 13 MeV, and lead to small enough phase shift of about 13°. The dimension of the cyclotron magnet is 1.96 m × 1.30 m × 1.21 m; its weight is 17.3 ton; its coil current is 88,024 ampere-turn; its center magnetic field is 1.27479 T; its maximum magnetic field is 1.942116 T; its minimum magnetic field is 0.7689 T; its valley gap is 120 mm; its hill gaps are 40 to 50.78 mm; and its hill angles are 35° to 44°.to 44°