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High Intensity Proton Beam Transportation through Fringe Field of 70 MeV Compact Cyclotron to Beam Line Targets

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From the stripping points, high intensity proton beam of compact cyclotron travels through fringe field area of the machine to the combination magnet. Starting from there the beam with various energy is transferred to the switching magnet for distribution to the beam line targets. In the design of the extraction and transport system for the compact proton cyclotron facilities, such as the 70MeV in France and the 100MeV in China, the space charge effect as the beam crosses the fringe field has not been previously considered; neither has the impact on transverse beam envelope coupled from the longitudinal direction. Those have become much more important with the higher beam-power because of the beam loss problem. In this paper, based on the mapping data of 70MeV Cyclotron including the fringe field by BEST and combination magnet by CIAE, the beam extraction and transportation are investigated for the 70MeV Cyclotron used on the SPES project at INFN-LNL, including the study of the space charge effect and longitudinal and transverse coupling mentioned above, as well as the matching of beam optics using the beam line for medical isotope production as an example. In addition, the designs of the ± 30 °, ± 45° switching magnets, the 60° bending magnet, and the combination magnets for the extracted beam with the energy from 35MeV to 70MeV, and the quadrupole magnets have been made. Parts of the construction and field measurements of those magnets have been done as well. The current result shows that, the design considers the complexity factors of compact cyclotron extraction area and fits the requirements of the extraction and transport for high intensity proton beam, especially at mA intensity levels.

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