# Development of Carbon-Ion Radiotherapy Facilities at NIRS

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***Abstract*— Cancer therapy using high-energy carbon beams from the Heavy Ion Medical Accelerator in Chiba (HIMAC) has been carried out at NIRS since June 1994, and more than 10,000 patients were treated by now. With the prospective clinical results for the first ten years, we designed a compact accelerator facility for carbon-ion radiotherapy (CIRT), and performed related R&D works for widespread use of CIRT since 2004. Based on this design, three compact facilities for CIRT were constructed and are in treatment operation, and two facilities are being constructed in Japan. To further develop the sophisticated CIRT, we constructed a new treatment facility at NIRS. This new facility is equipped with three treatment rooms; two of them have both horizontal and vertical fixed-irradiation-ports, and the other is a rotating-gantry port. For all ports, fast 3D raster-scanning irradiation technology was employed. The rotating gantry equips ten combined-function superconducting magnets, and can deliver carbon ions having the energy of between 430-58 MeV/u to an isocenter with irradiation angles of over +-180 degrees. The superconducting magnets with optimized beam optics allowed a compact gantry design with a large scan size at the isocenter. Construction as well as installation of the superconducting gantry was completed by the end of September, 2015. Beam commissioning was successfully carried out, and treatments using the gantry are being conducted. Presently, we are further designing a next-generation compact superconducting gantry as well as a superconducting synchrotron as a future project. In this talk, an overview of carbon-ion radiotherapy and development of heavy-ion accelerators including a superconducting rotating-gantry as well as the future project will be presented.**

***Keywords (Index Terms)*— Cancer therapy, carbon ion, gantry, superconducting magnet, synchrotron, HIMAC.**

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