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Commissioning of carbon ion treatment accelerator with a superconducting rotating gantry

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The world's smallest carbon ion treatment facility has been commissioned at Yamagata University. The treatment system consists of an ECR ion source, a linac cascade of 0.6 MeV/u RFQ and 4 MeV/u IH-DTL, a 430 MeV/u slow extraction synchrotron, and irradiation systems of a fixed horizontal beamline and a compact rotating gantry using superconducting combined function magnets. The size of the building is 45 x 45 m, realized by placing the irradiation rooms not on the same level as the synchrotron, but above it, connected by a vertical beam transport.

The most advanced accelerator technology of this machine is to control the beam range up to 300 mm in 0.5 mm steps without any physical block range shifter. To achieve this range step, 600 beam energies were provided in the synchrotron and in the beam transport and tuned to control the beam size in the treatment room. Initial commissioning and daily/monthly quality assurance were carried out by interpolation of beam energy and gantry angle.

After tuning the beam size and correcting the beam axis in the treatment rooms, precise dose measurement was performed for clinical irradiation. After the clinical commissioning, the facility started treatment irradiation in February 2021 with a fixed beam port and in March 2022 with a gantry beam port. After March 2023, the gantry angle was operated with a 15-degree step. By November 2023, 1330 patients had been treated.

Footnotes

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Asia

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