IV. 1. Beam Irradiation System for Proton Therapy at CYRIC

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The horizontal beam-irradiation system for proton therapy was installed at CYRIC to develop the advanced particle irradiation technique and study superior therapeutic effects of proton therapy using small animals. As the beginning phase of the proton therapy at CYRIC we have performed basic experiments for delivering a therapeutic proton beam which makes a uniform radiation field and a spread-out Bragg peak (SOBP) using the present system. In this report the results of the performance tests for the irradiation system will be described.

Figure 1 illustrates the beam irradiation system consisting of two dipole magnets, a scatterer, a ridge filter, a beam monitor, range shifter and collimators. The target position is about 4 m downstream of the magnet. A proton beam delivered into the irradiation system is spread by a wobbler method[1,2)] with the magnets and the scatterer so that the uniform radiation field having a diameter of up to 10 cm for a 90 MeV-proton beam is produced at the target position. The ridge filter modulates the energy of the monoenergetic beams to produce the SOBP whose width is equal to the maximum width of the cancer in the beam direction. Dose delivery is controlled with the beam monitor of a parallel-plate ionization-chamber design. Dose calibration of the beam monitor is performed with a standard ionization chamber.

The experiments for producing a uniform field based on the wobbler method and the SOBPs with the ridge filters were performed using a 80 MeV-proton beam from the AVF cyclotron at CYRIC. The two-dimensional beam fluence at the target position was measured with an Imaging Plate (IP)[3)]. The depth-dose distribution was measured with an IP which was inserted in polymethyl metacrylate (PMMA) at 20^{o} with the beam axis. The dose rate was a few mGy/min at the SOBP.

Figure 2 shows typical results for a uniform field of about 80 mm in diameter and the depth-dose distribution in PMMA. The flatness of the field is less than 5% which has sufficient quality for proton therapy, while the flatness of about 6% for the SOBP should be improved.

In the following phase we are planning to perform not only the clinical experiments using a rat but also the beam-delivery experiments based on a spot-beam scanning for development of the advanced irradiation technique.

References

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3) Fuji Photo film CO., LTD., http://www.fujifilm.co.jp/bio/si_imgplate/imgplate.html.

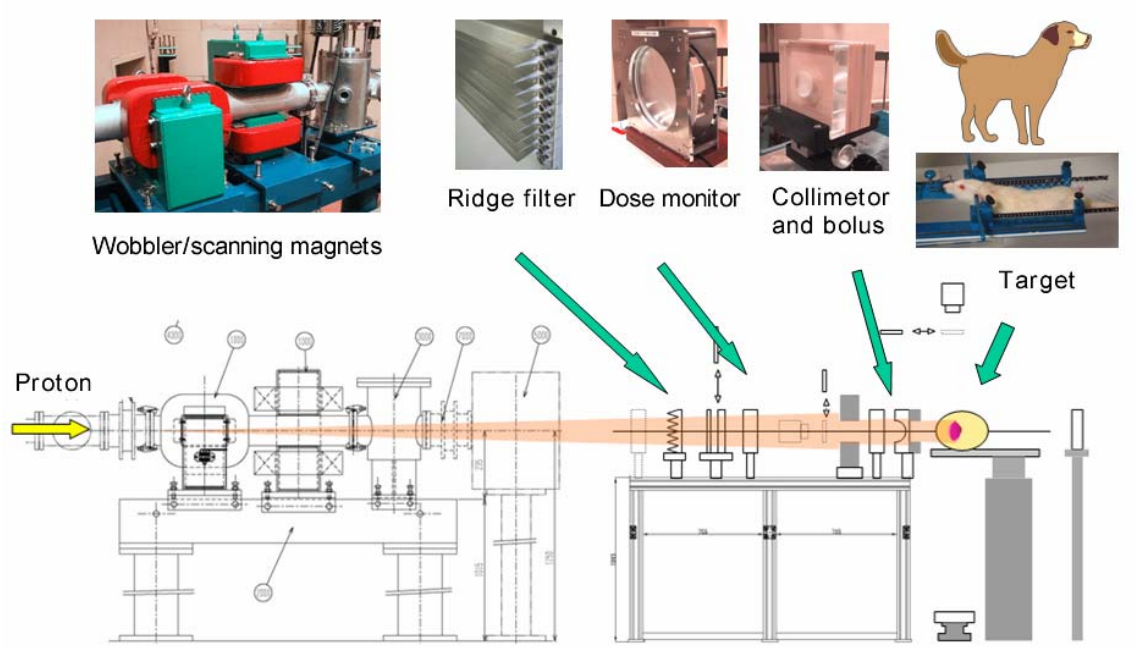

Figure 1. Schematic layout of the beam irradiation system for proton therapy at CYRIC.

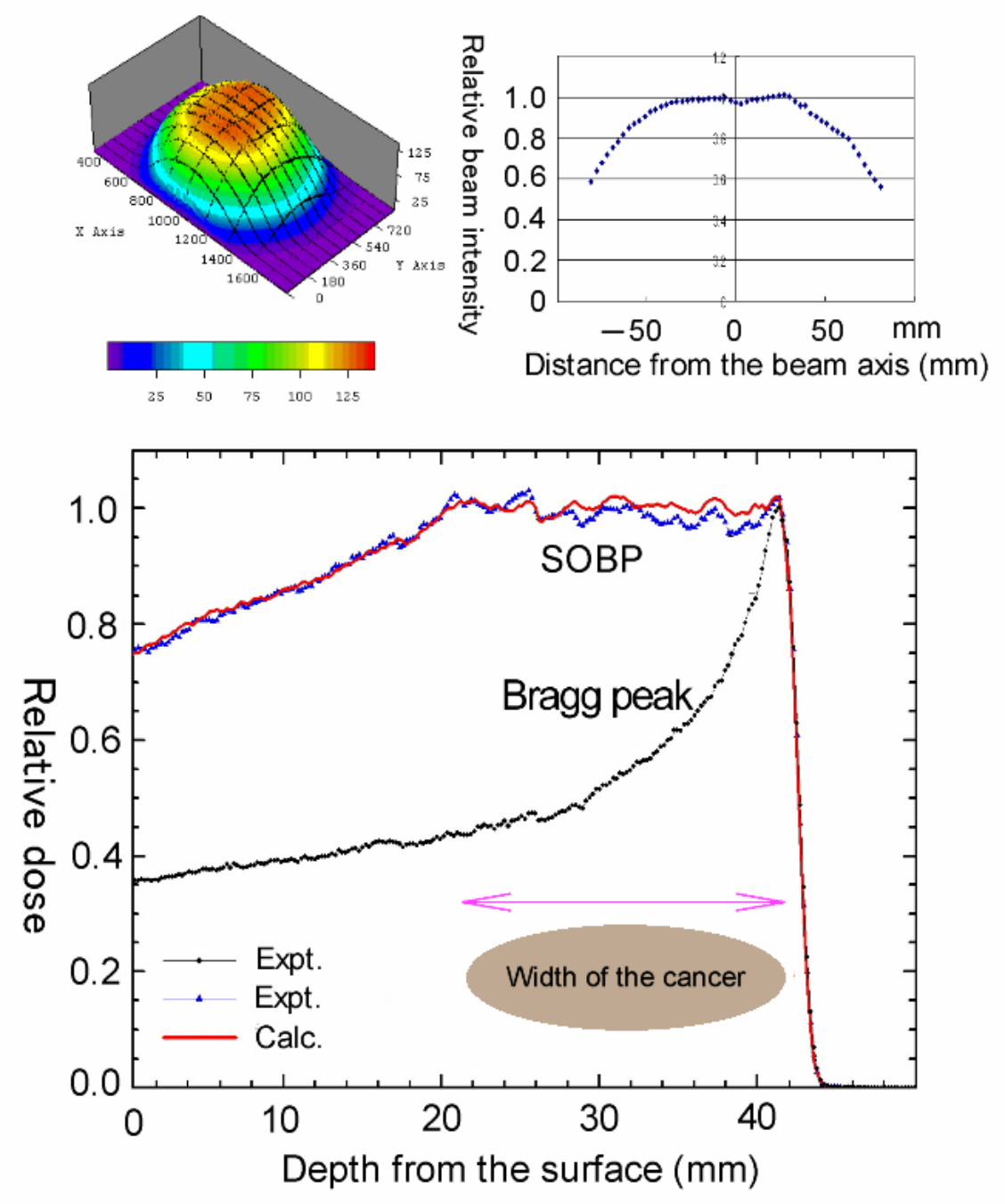

Figure 2. Uniform field of about 80 mm in diameter (upper) and depth-dose distribution in PMMA (lower).