NIRS PROTON THERAPY FACILITY

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1 Introduction

The use of proton beam in radiotherapy is promising because of the excellent dose localization. In using heavy charged particles in radiotherapy, the large uniform radiation field must be realized. About 20 x 20 cm radiation field will be need to cover most size of tumors to be irradiated. Second, the sharp Bragg peak in depth dose distribution must be extended according to the tumor thickness. Third, irradiation dose is controlled accurately and certainly. Taking account of these points, we constructed a new proton therapy facility using 70 MeV protons accelerated by NIRS cyclotron. In this presentation, we discussed on the function of each unit of this facility.

2 Spot scanning

In this facility, "Spot Scanning Method" was adopted to realize the 20 x 20 cm uniform radiation field. Fig. 1 shows the NIRS beam transport for proton therapy. The 10 x 10 mm spot beam shaped by slit 2 can irradiate at any place in the radiation field by vertical and horizontal scanning magnets. After the completion of one point, the trajectory of the proton beam is immediately shifted to the next point by altering the magnetic field. The large radiation field can be realized by an array of such beam spots. The irradiated dose of each spot is monitored by a parallel plate ionization chamber M2. In order to shelter from the turbulent wind which is caused by the rotating range modulator, the M2 monitor is inserted between the divided vacuum pipe at just up-stream of the end of the scanning pipe.

3 Range modulator

It is necessary to realize the depth dose distributions, which have flat peak over the range of tumor thickness. The flat peak of the dose distribution can be accomplished by summing up the successively shifted Bragg peaks. A rotating disk absorber of lucite is used for range modulation, and is divided into many sectors of the different angles and thickness in 1 mm step.

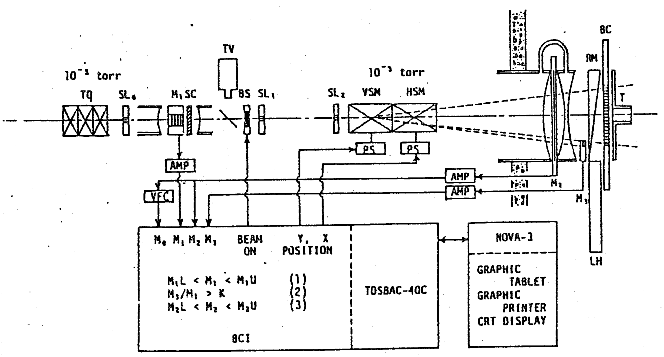

Fig. 1 NIRS spot scanning system

4 Result and discussions

Fig. 2 shows a typical result of field shaping for an 18 cm square uniform plan field measured with an X-ray film. The lateral dose distribution was uniform within ±2.5% over the field. Even if a treatment field includes an irregular shape and dose distribution, it can be easily achieved with this system as shown in Fig 3.

Flatness of the extended peak with depth is shown in Fig.4. The fluctuation of this extended peak dose was within ±5% of the average dose. At the present time, we are using this proton therapy facility for the study of biological effectiveness and for the practical treatment. The system is working very satisfactorily.

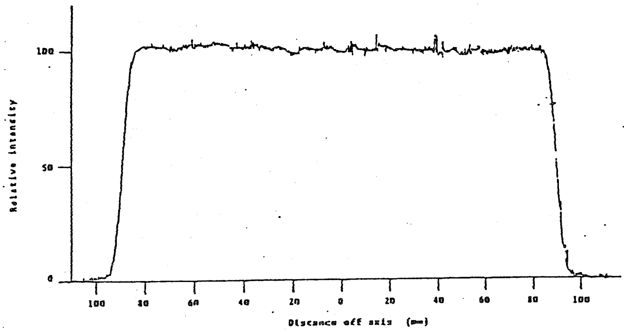

Fig. 2

Typical example for a dose profile of an 18 cm square field.

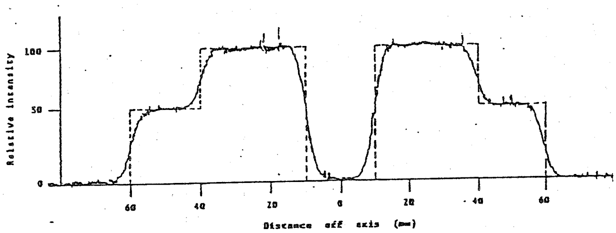

Fig. 3
Resultant dose distribution for a complex field plan.

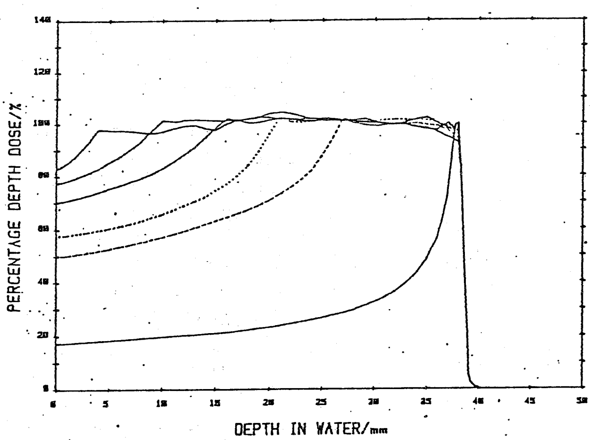

Fig. 4
Depth dose distributions using various range modulators.