PRESENT STATUS OF PROTON THERAPY STATUS AT THE WAKASA WAN ENERGY RESEARCH CENTER

K.Kume, T.Hasegawa, S.Fukuda, S.Fukumoto, G.Kagiya, S.Kakiuchi, I.Maruyama, K.Yamamoto and N.Yokohama

The Wakasa Wan Energy Research Center, Tsuruga, Japan

Abstract

Proton therapy project is proceeding at the Wakasa Wan Energy Research Center, Japan. Construction of an accelerator complex and a therapy beam line has been finished by this summer. The whole system will be shown in this presentation. Some obtained data will also be presented.

1 INTRODUCTION

Ion beams are thought to have a better control ability in their depth dose distribution because of the existence of Bragg peaks for radiotherapy, in comparison with photons and electrons[1]. The accelerator complex at the Wakasa Wan Energy Research Center (WERC) can deliver *p* up to 200MeV, which can reach 25cm depth in water, and proton therapy project has been planned. It must be noted that this is the only present facility in Japan where share an ion accelerator between medical and other purposes.

2 BEAM PRODUCTION AND DELIVERY

Beam production and delivery system can be divided into following three parts: (1) an accelerator complex including an ion source, (2) a beam transport and an irradiation field production system for each port. The construction of the former was finished last year, and the latter this August.

2.1 An Accelerator Complex

An accelerator complex is consisted of a Cs spatter ion source, a 5MV tandem accelerator to deliver 10MeV *p*, and a 200MeV proton synchrotron. 8nA of the *p* beam current has been achieved, where 10nA was planned. For a medical reason, accelerated beam energy can be chosen from 80,90,100,120,140,160,180 and 200MeV and all these energies except several of them were actually accelerated. The accelerator system will be described in the same symposium[2].

The beam comes at the frequency of 0.5Hz from the accelerator as a pulse beam. The time structure of the beam is enough flat to produce a uniform irradiation area for a medical use.

2.2 A Beam Transport and an Irradiation Field Production System

The therapy beam line consists of two ports, one of which is delivering proton beams from vertical direction, and the other from the direction 9.5 degree upper than the horizontal direction (Fig.1). These two ports were designed to have a same isocenter position. Beam from the synchrotron can be stopped at a beam stopper (BS) before entering the therapy beam line.

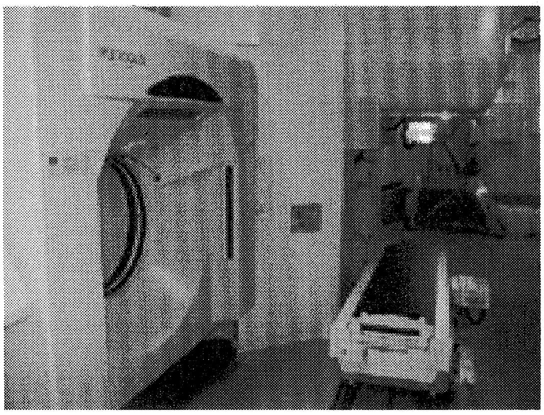

Figure 1. Constructed clinical beam ports and positioning X-ray CT with a movable bed.

To be used for medical use, beam size can be widened to cover a target (= cancer) volume of 100mm x 100mm x 100mm at most. Ridge filters are used to get a spread out Bragg peak (SOBP), and a pair of wobbler magnets and a scatterer system for are used to get above lateral size. A snout box, where a patient collimator and a patient bolus are in, is located at each end of two ports. Obtained beam profile with both of wobbler magnets and a scatterer system working show that the flatness at the irradiation field (SOBP60mm x $(100\text{mm})^2$) to give 3Gy/min has been achieved with 2.5% accuracy at 180MeV (Figs.1 and 2), which is enough for a clinical application. Other ridge filters will be produced and tested.

Beam delivery can be interrupted whether by manually shutting BS or by automatically when measured doses in two dosimeters reach preset values. BS operations is available at two places, one of which is at the central control room with operators present, the other at the clinical control room with medical doctors present.

3 THERAPY SYSTEM

The therapy system is divided into two parts; (1) treatment planning, and (2) clinical irradiation.

3.1 Treatment Planning

Before each clinical trial, a patient bolus (polyethylene) and a patient collimator (brass) must be produced, designed at a treatment planning system (TP) using a portrait taken at X-ray CT (Hitachi W3000AD) next to the beam course. This CT is also used for a positioning purpose at the irradiation (Fig.3).

TP is being developed by Hitachi, which can simulate the dose distribution in a patient body by both of broad and pencil beam algorithms. The output is the shape of the bolus and collimator, a beam energy, a digital image of the tumour target (DRR), and an irradiation record. TP is now under verification of the accuracy by measuring the dose distribution with designed boluses and collimators.

3.2 Clinical Irradiation

Each tumour target will be positioned by using the X-ray CT and a movable bed (Fig.3), to the isocenter. Positioning accuracy is supposed to be under 1mm, and is now under verification.

4 CONCLUSION AND DISCUSSION

The proton therapy beam line and the clinical irradiation system are constructed at WERC. Some degrees of *p* energy can be accelerated, and enough strong intensity and a uniform irradiation field are obtained.

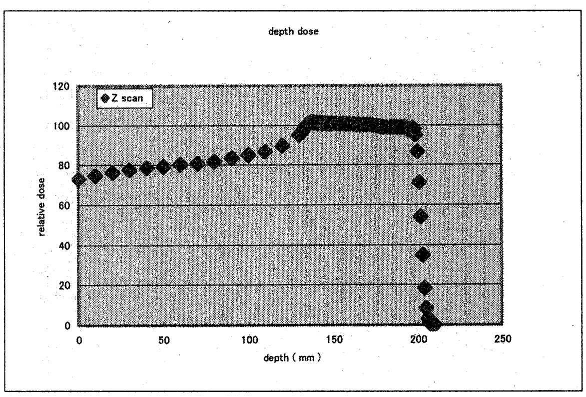

Figure 2. The measured depth dose profile at 60mm SOBP (spread out Bragg peak) production for 180MeV *p*.

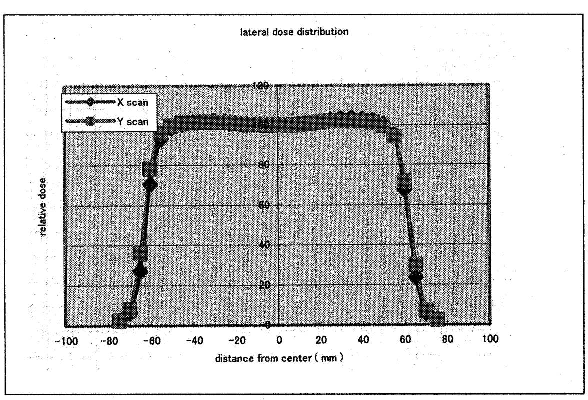

Figure 3 Lateral dose distribution for 180MeV *p*.

However, there are some problems to be solved before the real clinical trial. (1) Because the power supply for is common for all two ports, it takes an hour to change ports. This time must be shrink to treat several patients per a day. (2) It also takes an hour to change *p* beam energy, and must be shrink. (3) More ridge filters shall be provided to be ready to treat various size of tumour. Only two filters have been provided so far to produce 60mm SOBP at 180MeV and 30mm SOBP at 100MeV. (4) TP has not been verified yet. Detailed dose distribution using boluses and collimators designed at TP must be measured. (5) Accuracy of patient positioning system shall be measured.

The clinical trial will start after these problems are solved and some administrative matters are clear. If everything is clear, the first trial will be started by the end of the 2001 financial year.

6 REFERENCES

[1] Wilson, R. R.: Radiological use of fast protons. *Radiology*, **47**, 487-491, 1946.
[2] Hatori, S. *et al.*: To be presented in this symposium.

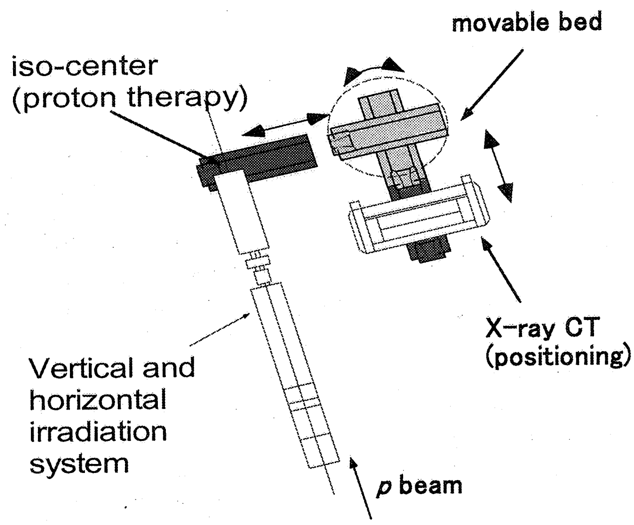

Figure 4. Patient positioning system.