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Establishment of Multi-Purpose Target Rooms at KOMAC

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1. Introduction

A 100-MeV proton linear accelerator was installed at the Gyeongju site and is being commissioned for the 1st beam extraction to provide the proton beam to the users from July. [1] To satisfy many various and complicate requirements of users for their experiments, we designed 10 target rooms for 20MeV and 100MeV and assigned to the specific application fields. [2] In this report, we are discussing about the design and manufacturing of the TR23 and TR103, multi-purpose target rooms for 20MeV and 100MeV each.

2. Design and Manufacturing

In this section, we described the target room establishment including design and manufacturing of the key equipments including a sample remote transport system, a hot-cell, and a beam modulating system.

2.1 Design of the Target Rooms

For the target rooms, TR23 and TR103, were originally assigned to the application fields of energy science and material sciences such as nano particle synthesizing. For the reason of the delayed schedule for the constructions of target rooms caused by the budget problems, the target rooms will have to be utilized to meet all users' requirements before the completion of the 10 target rooms as planned. So, we designed the target rooms to have wide range of beam irradiation conditions.

Table. 1. Specifications of TR23 and TR103

	TR23	TR103
Max. Energy	20MeV	103MeV
Max. Bam Power	12kW	30kW
Irradiation Area	30cm in dia.	30cm in dia.
Pressure	External	External
Beam Direction	Horizontal	Horizontal
Degrader	Al & Air	Al
Scatterer	Au	Au
Diagnostics	I.C. & F/C	I.C. & F/C

2.2 Remote Sample Transport System

The samples have to be transported by remote system because that almost samples are activated after high-energy proton beam irradiation. To transport the activated samples safely, without unwanted radiation exposure, remote transport system was developed. The system was composed of a sample transport system, combination of linear motions driven by air cylinder, a plug which is made of iron and concrete of same thickness with shielding wall of the target room. During beam irradiation, the plug has to close the sample transport opening between the target room and treatment room. After irradiation the sample transport hole is opened and the sample is to be transport through the opening.

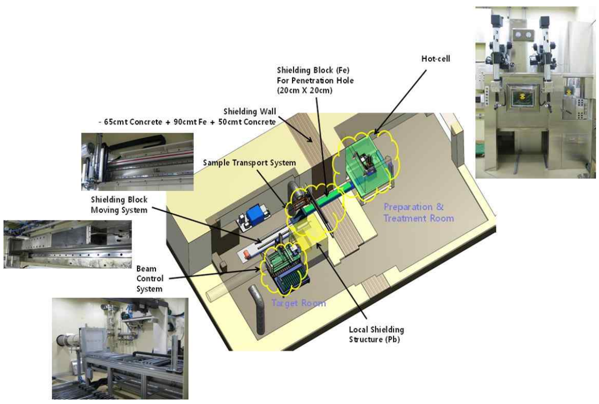


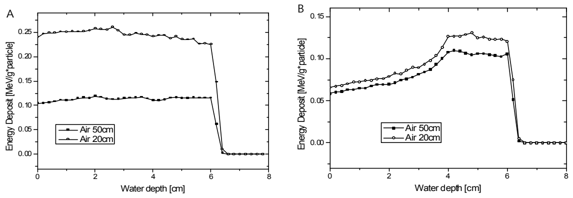
Fig. 1. Design of the TR103 and the photographs of the key equipments.

2.3 Beam Modulation System

To satisfy users' requirements we have to control beam parameters, energy, flux, uniformity, irradiation, etc. Beam modulation system was composed of collimator, energy degrader, scatterer, multi-aperture collimator, etc. To reduce the energy, 0.5 and 1mm-thick Al sheets for 20MeV proton beam and 1, 2, 3, 5, 10, 20mm-thick Al sheets for 100MeV proton beam was used. Especially, for 20MeV proton beam, air gap from window to sample surface was changed by controlling the sample position.

Some experiments in the fields of biological and space-applications, low flux irradiation is required. To reduce the beam flux, multi-aperture collimator was developed. The aperture diameters are 2mm at 4.5cm intervals and the thickness of the collimator is 5cm for the full absorption of the 100MeV proton beam. A 1mm-thick Au foil was added at the end of the each aperture as a scatterer. The beam profile and flux reduction rate were calculated using MCNPX code. As a result, the beam profile at the position 100cm apart from window, we can obtain a uniform beam profile and the flux can be reduced to 1/10000 of incident value.

For the biological experiments, such as biological radiation effects study and study on the tumor cell killing, the SOBP (Spread-Out Bragg Peak) modulator is required to obtain uniform depth-dose profile. We designed two ridge-filter type SOBP modulators of different SOBP thicknesses, 2cm and 8cm. A Ridge type one is independent on the pulse shaping in the pulsed mode proton beam irradiation in contrast with rotating wheel type. The calculated depth-dose profiles using SRIM code [3] for 2-cm thick and 8-cm thick SOBP modulators are described in Fig. 2.



(a) (b)

Fig. 2. Calculated depth-dose profiles for (a) 2cm-thick and (b) 8cm-thick SOBP modulator.

A faraday cup for the measurement of beam current and collimators to control the beam sizes were also designed for the TR23 and TR103. These several key components were installed at the support system at the target room. The support system was designed to be controlled by remote control system located at the control room and treatment room. Even though the radiation environment is not sufficiently low to access to the target room, we can change the beam parameters for the next sample without waiting. The 3D diagram of the beam modulating system and pictures of the key components, such as degrader, collimator, faraday cup, flux controller, SOBP modulator are shown in Fig. 3.

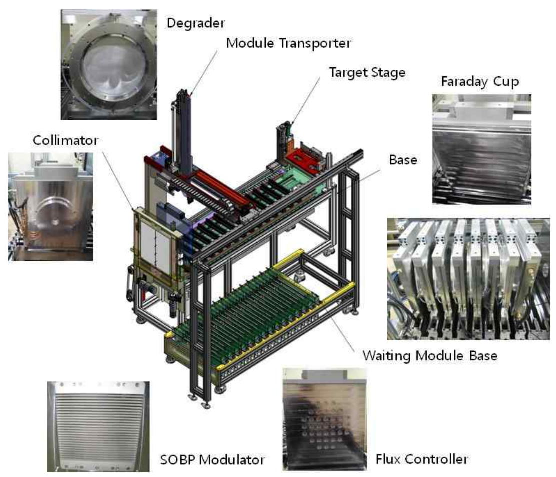


Fig. 3. Beam modulating modules with the support unit for remote handling system.

3. Conclusions

The TR23 and TR103 were established as the multi-purpose target rooms at the KOMAC. For the target rooms, several key equipments were designed and manufactured. In this report, we summarized the calculated results of the key components and the results of manufacturing. These components will be tested from July at the KOMAC using 100-MeV proton beam. And they can be utilized for the experiments proposed by the users in the diverse application fields.

ACKNOWLEDGEMENT

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