OUTLINE OF PARMS AND SOME PRELIMINARY DOSIMETRY

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Abstract

PARMS, Particle Radiation Medical Science Center, of University of Tsukuba has been established in 1980 for the purpose of clinical and basic medical research with 500 MeV proton beam from a booster synchrotron of KEK (High Energy Physics Laboratory). PARMS is going to utilize the pulsed proton beam for producing therapeutic neutrons, for proton therapy at 250 MeV after passing a energy absorber and for proton therapy and diagnosis at 300 MeV.

1. Building

The construction of the building for the PARMS was completed in August 1981. There are two proton irradiation sites : one is an area with a horizontal beam line and the other is an underground room for vertical irradiation. The former is used alternately for proton diagnosis including the development of CT and horizontal irradiation for therapy. The irradiation room for the fast neutron beam is located at the end of the KEK booster beam line and is supplied the forward neutrons from the production target.

2. Proton Beam Line

This is designed symmetric about the momentum slit and featured in separating the degraded proton beam of 150 to 300 MeV from intense neutron and other undesired radiations and in providing the achromatic proton beam to the horizontally irradiation site for diagnostic use.

The short pulse of 50 nsecond width included 3×10^9 protons of 250 MeV and delivers the average dose rate around 1 Gy per minutes for 50 nsecond pulse interval which corresponds to the instantaneous dose rate higher than 1×10^6 Gy per minute.

For the beam line control, a system of PDP-11/34 computer combined with the serial CAMAC modules has been adapted. It works for controlling the magnets, monitoring and data logging. All the proton beam control operation can be executed from the control room upstairs where the control desk and the interface between the booster synchrotorn control are located. The operations such as the beam ON/OFF for the case of patient treatment can be transfered to the local control panel which is located in the underground 1st floor room.

3. Vertical Proton Beam

500 MeV proton beam is degraded by passing a graphite rod absorber down to 250 MeV for the vertical beam irradiation. The initial average beam intensity of around 2 μA decreases down to around 6 nA at the irradiation site. The 250 MeV proton beam is bent vertically by a 90 degree bending magnet down to the underground 2nd floor, where the treatment room is located. To obtain up to 20 cm x 20 cm field of uniform intensity at the therapy table, proper combinations of the scatterer and the ring are semiempirically selected. The fine degrader, a shuttle oil bath, adjusts the range of the beam to match the tumor depth and to make the spreaded-out Bragg peak with the use of a microcomputer control.

4. Horizontal Proton Beam

For proton radiography, uniform irradiation field of up to 40 cm x 40 cm can be achieved with reduced intensity. When the horizontal line is used for proton CT, the shield block and block collimator which are on a truck can be replaced by a pair of Q-magnets. These Q-magnets can produce either parallel beams or focussed beams at the target according to the research subject.

5. Neutron Irradiation Facility

By opening the 1.3 m long iron shutter which is placed between the neutron production target in the neutron physics facility and the neutron irradiation room, forward neutrons with average energy of around 60 MeV are available in the 20 x 20 cm field. A collimator system with iron multileaf has been constructed.

Preliminary measurement indicated the half fluence depth was about 20 cm in water. However, the dose rate of this neutron beam may not be higher than 10 rad per minute. Therefore this will be used for mixed irradiation with proton beam.

6. Research Program

The particle radiations at PARMS are featured by the high energy and the short beam pulse.

Mixed irradiation of neutron and proton beam can be achieved with any time schedule at this center. Then the minimum controllable neutron dose will be determined on radioresistant tumor in the mixed therapy for the effective time schedule to reduce the late complications.

Pulsed beam of 50 nanosecond width will deliver the proton instantaneous dose rate higher than 1×10^6 Gy per minute. For higher dose region, the radiation effect will possibly be modified by such high dose rate which may reinforce the proton irradiation effect like as high LET effect.

Acknowledgment

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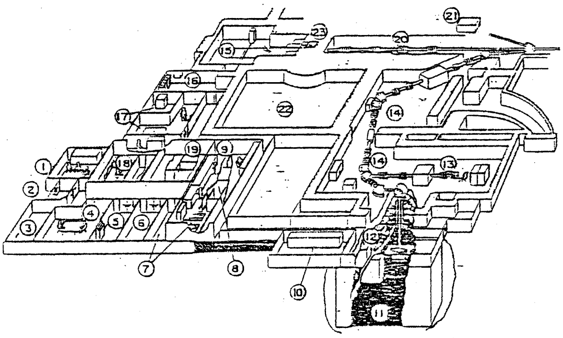

1. Office & Radiation Monitoring Room
2. Entrance
3. Conference Room
4. Medical Staff Room
5. Therapy Planning Room
6. Medical Examination Room
7. Recovery Room
8. Radiation Control Gate
9. Control & Data Processing Room
10. Magnet Power Supply
11. Proton Therapy (Vertical Irrad.) Room
12. Irradiation Control Room
13. Horizontal Irrad. Room
14. Proton Beam Line
15. Neutron Irrad. Room
16. Neutron Irrad. Control Room
17. Biology Lab.
18. Animal Lab.
19. Work Shop.
20. BSF Beam Line
21. Meson Science Lab. Area
22. KENS Exp. Area
23. Neutron Prod. Target

Fig. 1 Layout of the biological research facility (PARMS)