Dosimetric Evaluation of Multi-layer acrylic-disk radiation sensor (ADRS) for PBS proton therapy

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PURPOSE

In beam commissioning for Pencil Beam Scanning (PBS), Multi-Layer-Ion-Chamber (MLIC) is universal device to measure integral depth dose (IDD) profile. But it has limitations such as electronic circuits, small diameter of ion-chamber and high cost. To overcome the above-identified deficiencies of the existing device, we propose an acrylic-disk radiation sensor (ADRS) and are newly fabricated with multilayer-ADRS.

MATERIALS AND METHODS

It is made from 35 disks and consisted of disk-inserted plates, photomultiplier tube (PMT) and data-acquisition-system (NI-DAQ). The thickness and diameter of the 20 disks placed in the plateau of the Bragg curve is 2 mm and 150 mm, respectively. Also, the 15 disks of 1 mm thickness are used to measure the bragg peak. When it centered on the plate was irradiated by proton, the generated signals were monitored by PC through PMT and DAQ. Detailed measurement position is flexibly changed depending on patient case by placing solid phantom between the plates.

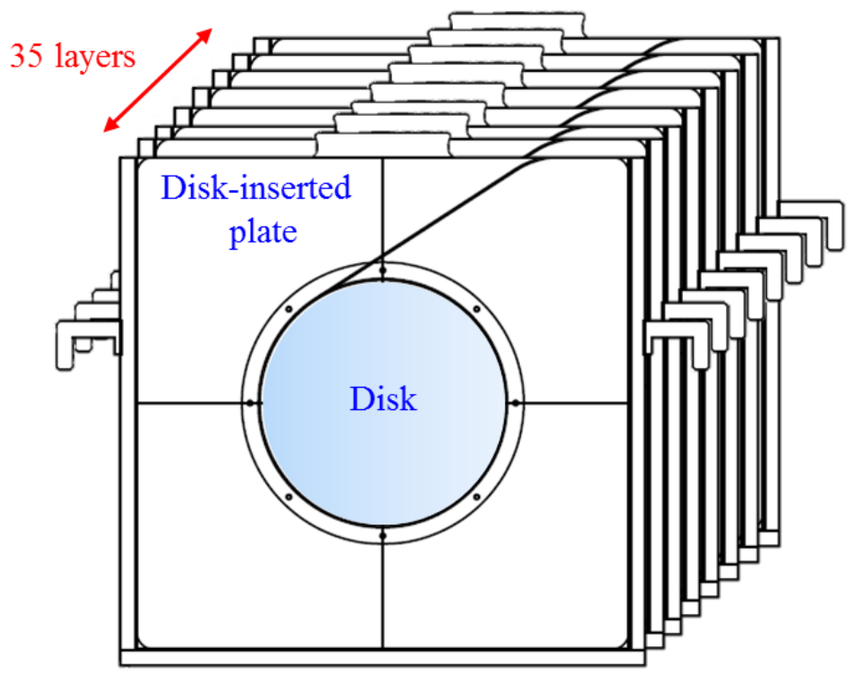

Figure 1. The structure of Multilayer-ADRS

This study evaluated dosimetric characteristics of the multilayer-ADRS with regard to response energy dependence, irradiated position dependence and measurable minimum dose.

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RESULTS

- The bragg curve for 99.7, 130.4, 162.1, 181.0 and 200.2 MeV was measured using the multilayer-ADRS irradiating with 100 MU and compared to values by braggpeak chamber. This is shown in Table 1.

Table 1. The energy dependence (Unit: mm)

Energy (MeV)	R90		Diff.
	Multilayer -ADRS	Braggpeak Chamber	
99.7	76.0	76.8	-0.8
130.4	125.7	124.5	1.2
162.1	181.0	181.3	-0.3
181.0	219.7	218.5	1.2
200.2	259.6	260.0	-0.4

- The dose of 0.5, 1, 10 and 50 MU was irradiated and the bragg curve was measured using this system to confirm the measurable minimum dose. This is shown in Table 2.

Table 2. The measurable minimum dose (Unit: mm)

Energy (MeV)	Braggpeak Chamber	R90			
		0.5 MU	1 MU	10 MU	50 MU
99.7	76.8	77.9	77.4	76.3	76.1
162.1	181.3	182.5	181.9	181.0	181.2
200.2	260.0	261.4	260.8	259.7	259.5

- When the irradiated position was changed within the disk, the difference of the range was confirmed. The 100 MU was irradiatied in respective position using the low- (E_{max}=99.7 MeV), mid- (E_{max}=162.1 MeV) and high-energy (E_{max}=200.2 MeV). This is shown in Table 3.

Table 3. The irradiated position dependence (Unit: mm)

Energy (MeV)	R90					STD
	Center	A	B	C	D	
99.7	76.0	76.0	76.3	76.2	76.2	0.11
162.1	181.0	180.9	181.3	181.0	181.6	0.27
200.2	259.6	260.2	259.7	260.1	259.9	0.25

CONCLUSION

These results show Multilayer-ADRS has the advantages of high-efficiency, and low-cost, and also a significant potential as a new detector for PBS measurements.