Development of multichanel Ion Chamber for measurement of 3 dimensional dose Distributions of Heavy-Ion Therapeutic Beam in patients

Munefumi Shimbo[1], Tatsuaki Kanai[1], Yasuyuki Futami[1], Haruo Yamashita[2],
Naruhiro Matsufuji[1],Akio Higashi[3], Takashi Akagi[3], Eriko Urakabe[4]

1)NIRS, 2)Shizuoka Prefectural Government,
3)Hyougo Prefectural Government, 4)Kyoto Univ.

Introduction

In heavy-ion radiotherapy, an accelerated beam is modified to realize a desired dose distribution in patient. Set-up of the beam modifing devises in the irradiation system is changed for cases of patients. It is very important to check the 3-dimentional dose distributions in patients.

In order to measure dose distributions realized by an irradiation system for heavy-ion radiotherapy, multi-channel ionization chambers are developed. One is an array of parallel plate ionization chambers called a profile ionization chamber. And the other is a stack of the parallel plate ionization chamber called a stack ionization chamber.

Detector

The profile I.C. has 205.8mm x 50.8mm high voltage and signal plates, which is FRP of 1.0mm thick at high voltage and 2.0mm thick at signal plate coated by 0.3μmm gold. On the signal plates, 32 signal electrodes are embeded on the plate which size are 4.4 mm x 4.4mm (see Figure 1). The profile I.C. is water proof and can be used in water phantom. Scanning this profile I.C. in water phantom, dose distribution in water can easily obtained in a short time (Figure 2).
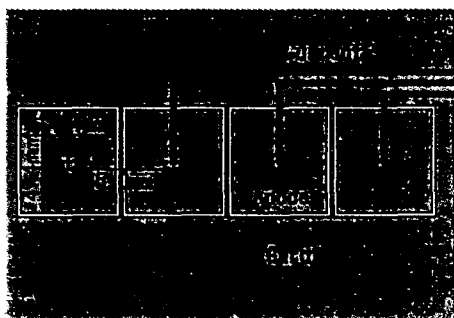

Figure 1   anode plate arrengement.
The signal current flow out through the plate.
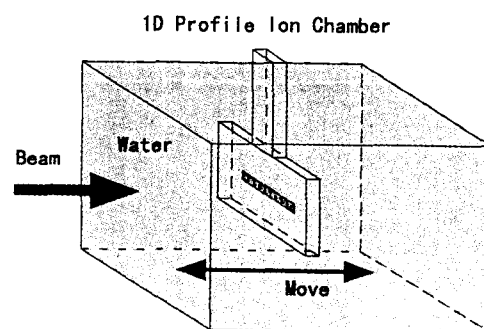

1D Profile Ion Chamber

Figure 2   Water bath and 1D profile ion chamber
Ion chamber is movable for the depth.

The stack I.C. (We called multi-Layer Ion Chamber, MLIC) consists of 33 high voltage and 32 signal plates, which are stacked mutually. The FRP plates, coated by 0.3μmm gold, are 2.17mm and 2.20 mm in thick, respectively. A signal plate has 20mmφ electrodes on each side, then 32 signal plates has 64

electrodes. this detector can deteced the Depth DOSE from 5.09mm to 261.91mm water equivalent. Irraditing the beam against the layer, depth dose distribution can be measured in a single exposure.

Experimental Results

Figure 3 shows 1D profile ion chamber outputs by changing the voltage supplied to the detector from 5 to 600V. The output variation is less than 2% for the supplied voltage upper than 300V. Then we choose supplied voltage for 500V (100V/1mm).

Figure 4 shows 1D profile ion chamber outputs for the Carbon 290MeV/u monoenergitic beam. Closed circle is no-scatterer for beam upstream, and other were changed scatterer thickness for 0.1mm to 0.5mm. Detector position 40mm is the beam center.

Figure 3 1D Profile chamber
Output / High Voltages

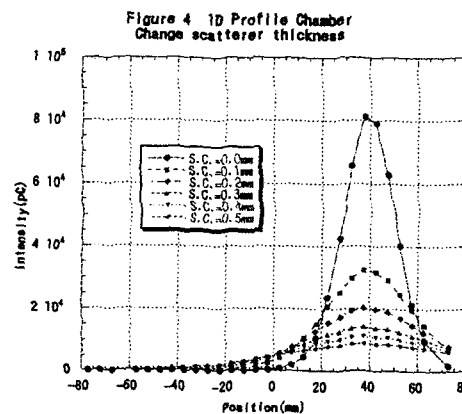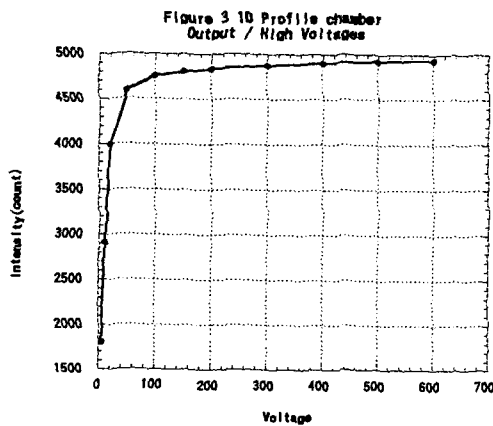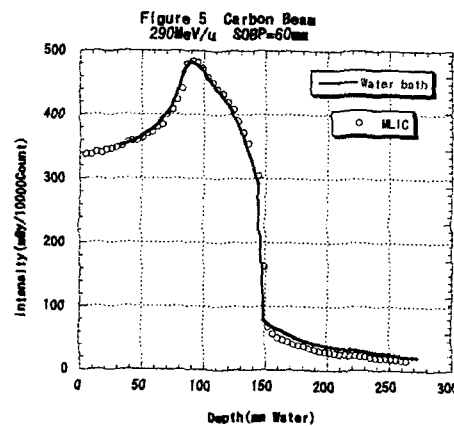Figure 4 1D Profile Chamber
Change scatterer thickness

Figure 5 shows detected depth dose by shallow ionization chamber moving in the water bath and MLIC. This beam is Carbon which energy is 290MeV/u and SOBP(spread of bragg peak) is 60mm.

Figure 5 Carbon Beam
290MeV/u SOBP=60mm

Discussion

The heavy-ion therapeutic beam is 300mm -diametar, but this 1D profile ion chamber's sensitive lenges is 160mm. So, this detector can not covered all of this beam, then we think the next detector. There are the 3mm pich correspond ing to 1ch type (this type's sensitive length is 3mm x 64ch=192mm) or the more channel (64ch) type detector's sensitive length will be 320mm that is enough to detect the heavy-ion therapeutic beam.

Conclusion

We make the waterproof 1D profile ion chamber and multi layer ion chamber. These detector detected the beam profile and depth dose in a short time. To use those multi channel ion chamber, we easily check the 3-dimentional dose distributions in patients.