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Abstract Title: Comparison of PTW Chambers for Carbon Ion Beam

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Background / Aims:

Ion Beam Therapy Center at SAGA HIMAT Foundation has provided carbon ion radiotherapy for cancer patients. For patient-specific quality assurance (QA), treatment beams have been measured in water using a pinpoint chamber (PTW-Freiburg, type 31014). We are considering replacing type 31014 with type 31022. The geometrical data of both chamber types is shown in Table 1. In this study, we evaluated differences in dose distribution in water measured using these two chambers.

Table 1. Geometrical date of sensitive volume of the pinpoint chambers investigated in this study.

Pinpoint chamber	type 31014	type 31022
Nominal sensitive volume [cm^3]	0.015	0.016
Radius of sensitive volume [mm]	1	1.45
Length of sensitive volume [mm]	5	2.9

Subjects and Methods:

Depth dose distributions in water were measured using carbon ion beams. Measurements shown in Figure 1 were performed with PTW chambers (types 31014 and 31022). The energy, field size and spread-out Bragg peak (SOBP) width in water of the irradiation beams used in this study were shown in Table 2.

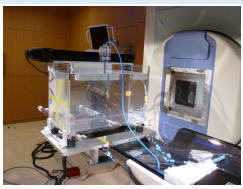


Figure 1. Measurement setup.

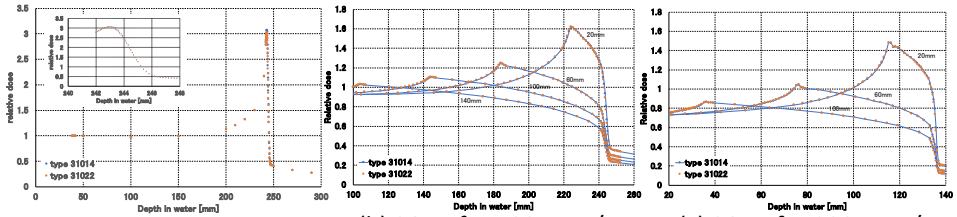
Result:

Figure 2 shows depth dose distributions in water for measurements. All dose distributions were normalized to the dose at a depth of 40 mm in water for the pristine Bragg curve. Table 2 shows dose difference between type 31022 and type 31014 at the depth of Bragg peak position or the center of SOBP.

Table 2. Irradiation parameters of measurements and dose differences between type 31022 and 31014 at depth of Bragg peak position or the center of SOBP.

Energy [MeV/u]	Diameter of field size [mm]	SOBP width in water [mm]	Dose difference [%]
400	110	0 (pristine Bragg curve)	7.87
400	110	20	0.15
400	110	60	0.32
400	110	100	-0.02
400	110	140	0.10
290	110	20	0.15
290	110	60	0.30
290	110	100	-0.05

For the pristine Bragg curve, the relative dose measured with type 31022 was 8% lower than that measured with type 31014 due to difference in geometry between chambers. For the SOBP, the difference in relative dose between the two chamber types was within 1% at SOBP depths, within 0.35% at the center of SOBP. The dose of this position was used for monitor unit calculation.



(a) Pristine Bragg curves (b) SOBP for 400 MeV/u (c) SOBP for 290 MeV/u

Figure 2. Depth dose distributions in water for pristine Bragg curves and SOBPs.

Conclusions:

Since SOBP measurements are commonly used in patient-specific QA in clinical practice, the PTW-Freiburg type 31022 pinpoint chamber can be considered a suitable substitute for type 31014.