Radiation monitoring in the RIBF using ionization chamber

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In recent years, we have attempted to monitor radiation due to beam loss in the RIBF by using self-made ionization chambers (ICs)[1)-3)] In the course of RIBF operations, the septum electrode of the electrostatic deflection channel (EDC) of the RRC was damaged by a $^{238}U^{86+}$ beam. To avoid such serious damages, the part of the septum where the ion beams can easily irradiate was cut off and molded into a "V-shaped" edge. By observing the following RIBF operations, we could recognize that such septum is effective for reducing the beam loss at the EDC and avoiding the damage to the septum. Last year, we conducted tests by inputting the alarm signal from the IC signal near the EDC of the RRC. We recognized that this method was safer and easier than the former calibration method[1, 2)]. Hence, in this report, for confirming the validity of this calibration method for the ICs set at other parts in the RIBF, we investigated the introduction of the alarm signal from the IC near the EDC of the SRC using the same method.

Usually, we input the alarm signal from the IC near the EDC of the SRC to the BIS after the calibration experiments[1, 2)]. In these experiments, the ion beams were attenuated to less than 1/10 and irradiated to the EDC for a fairly short time and the IC voltages were measured. From these results, we can estimate the alarm levels of the IC to the BIS. However, it can be very dangerous to irradiate heavy-ion beams to the EDC of the SRC because of a sudden increase in the temperature of the septum. Therefore, we consider the alarm levels of the IC from the signals of the TCs set at the septum. When the temperature of the TC set at the first EDC septum of the SRC becomes 42℃, the alarm signal is input to the BIS. Hence, we compared the value of the first septum temperature with the signal of the IC set near the EDC of the SRC in the machine time of the $^{48}Ca^{20+}$ beam. The result is shown in Fig. 1. The data showed little dispersion and the calibration curve in Fig. 1 can be drawn. From this curve, we can see that the voltage of the IC becomes approximately 1.5 V when the temperature of the first septum reaches 42℃, which is shown as a red dotted line in Fig. 1. Then we can decide the alarm level for the BIS.

We input the alarm signal to the BIS from November 25to December 5, 2015 when the $^{48}Ca^{20+}$ ion was accelerated at 345 MeV/nucleon. On November 26, the BIS by the alarm signal from the IC acted and stopped the operations of the RIBF. Fig. 2 shows the IC signal for November 26 from 12:00 to 24:00. At 17:35, the signal suddenly rose to 2.4 V and the alarm signal was sent to the BIS. After this signal, the alarm reached the BIS in the machine time of the $^{48}Ca^{20+}$ beam in 2015. The cause of the unusual signal shown in Fig. 2 is unknown.

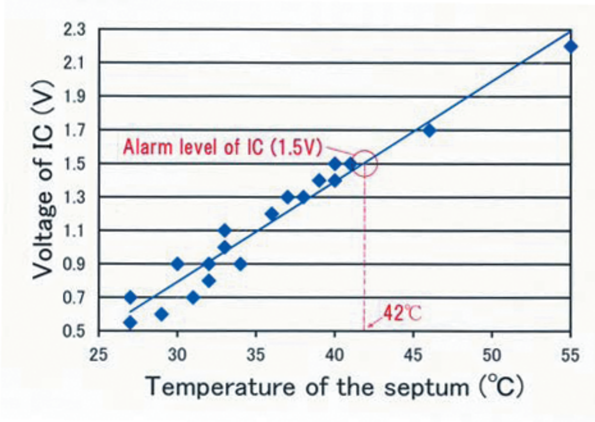

Fig. 1 Correlation of IC voltage and temperature of first septum of EDC

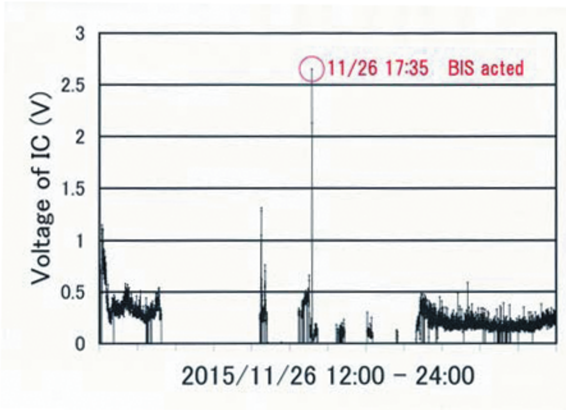

Fig. 2 Signal from the IC near the EDC of the SRC

In previous reports[1, 3)], we showed that some problems with the $^{48}Ca^{20+}$ ion beam in the EDC of the SRC frequently occur when the IC output signal rises to about 4 V. On the other hand, the beam loss at the EDC reduced in this machine time compared with the previous times. For this reason, we presumed that the alarm level reduced to 1.5 V. This cause is still not clear. However, if the beam loss at the EDC changes each time, we can easily reset the IC alarm level in every machine time by considering the correlations of the IC signal and TCs temperature.

In any case, as described above, we could confirm that faster alarm signal to the BIS can be input from the IC near the EDC of the SRC. Thus, we investigated to input the alarm signal from IC in SRC to the BIS when every ion is accelerated in the RIBF.

References
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