Beam drift at a secondary electron emission monitor
used for dose control in carbon-ion radiotherapy

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HIMAT(Heavy Ion Medical Accelerator in Tosu)

◆ SAGA HIMAT is the fourth carbon ion beam therapy facility in Japan and is a standalone outpatient clinic.
◆ In our center, accelerators (the linacs and the synchrotron with the maximum energy of 400MeV/u) have been dedicated for carbon beam radiotherapy.
◆ The number of treated patients has exceeded 2,000 in this May.
◆ Carbon beams are transported to the treatment rooms A and B and irradiated with broad beam method.
◆ The treatment room C is now under preparation for the scanning beam irradiation.

Secondary electron emission monitor

◆ Two sets of Secondary-electron Emission Monitor (SEM) are used as a dose monitor.
◆ The SEM includes 4 collector electrodes and 5 potential electrodes made of aluminum foils of 7 μm thickness.
◆ Beam position is detected at Strip Line Monitor just upstream of these monitors.
◆ Each morning the output of the Ionization chamber (I.C.) at an isocenter is divided by that of the SEM under the standard of these monitors.
◆ It is hard to suppress the beam drift of the synchrotron.

Beam drift caused by the Synchrotron

◆ The extracted beam position on the Strip Line Monitor is slightly shifting during daytime operation with its length of around 1mm at the horizontal port of room A.
◆ After 11 a.m., AX show almost stable.
◆ This behavior is explained by the following synchrotron stability.

Synchrotron stability

◆ Horizontal (X) beam position from 9:00 to 19:00 in a day was measured with a screen monitor at the extraction channel of the synchrotron.
◆ The cause of the drift seems to arise from the temperature rise of the dipole magnets in the synchrotron.
◆ Beam displacement at SLM

Before and after replacement

◆ We have replaced the most frequently used SEM to a new one, which is as the main monitor of the horizontal port of room A.
◆ The blue dots represent the main monitor behavior (replaced: old one in the left figure and now one in the right figure), while the red dots represent that of the sub monitor (not replaced).
◆ Since it is costly to replace monitors, we are trying to intentionally change the beam position on the SEM periodically.
◆ The amount of the offset is limited not to disturb the irradiation field.

Renewal and control policies

◆ The beam position dependence in standard measurements arise from the sensitivity variation of the SEM.
◆ The sensitivity have been gradually changed as the beam pass through.

Summary

◆ The beam position dependence in standard measurements arise from the sensitivity variation of the SEM.
◆ The output of the SEM for two energies (400MeV/u and 200MeV/u) have been plotted as intentionally changing the beam position on the SEM.
◆ It is hard to suppress the beam drift of the synchrotron.
◆ We are trying to change the beam position periodically in order to keep an almost uniform sensitivity.