Beam profile measurement using He gas light emission and BEPM for superheavy element search experiment†

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In the superheavy element search experiment, the beam profile is obtained with a charge-coupled device (CCD) camera by observing the light emitted when the beam passes through the He gas in the target chamber.[1] Owing to the importance of prolonging the durability of the expensive curium (Cm) target for as long as possible, these experiments require the accelerated vanadium (V) beam to be sufficiently widened. To achieve this objective, a He gas light emission monitor (HeLM) has been introduced to measure the beam profile. This method offers the advantage that the beam profile can be obtained nondestructively and continuously. These measurements are handled through programming in LabVIEW, and the analyzed data are integrated into an EPICS control system.[2] Furthermore, the beam width measurement with the HeLM and the beam optics calculation facilitates precise beam size control at the Cm target.[3] Recently, a method to estimate the beam envelope has been developed by leveraging the measured quadrupole moments with the beam energy position monitors (BEPMs)[4] and incorporating calculations of the transfer matrix. The synergistic use of HeLM and BEPMs facilitates the accurate control of the beam size at the Cm target.

The calculated results of the beam optics from the focal point (referred to as e00) to the target chamber are shown in Fig. 1. In this analysis, the emittance and Twiss parameters are obtained by the Q-scan method, by using a wire scanner installed upstream of SRILAC. Subsequently, the transfer matrix is calculated from these values to provide optimal conditions at the target. The beam is focused immediately before reaching the target to broaden the spot width, and the beam width, as measured by the HeLM, is fine-tuned to optimize the quadrupole magnet.

Furthermore, we examined the beam width measurements and beam optics calculation using the BEPMs by adjusting the excitation current of the quadrupole magnet located in front of the target chamber. Figure 2 shows the beam widths obtained through (a) the beam optical calculation using the quadrupole moments measured by the BEPMs, (b) the observation of the target spot on the fluorescent target through the view port, and (c) the measurement result obtained with the HeLM. As these beam widths are represented on different scales, they have all been normalized to the excitation current of 94 A. The beam widths analyzed by these methods were consistent.

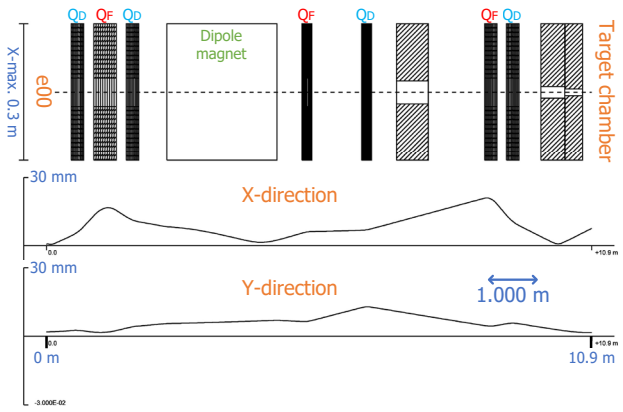

Fig. 1. Calculated result of the beam envelope from e00 to the target chamber.

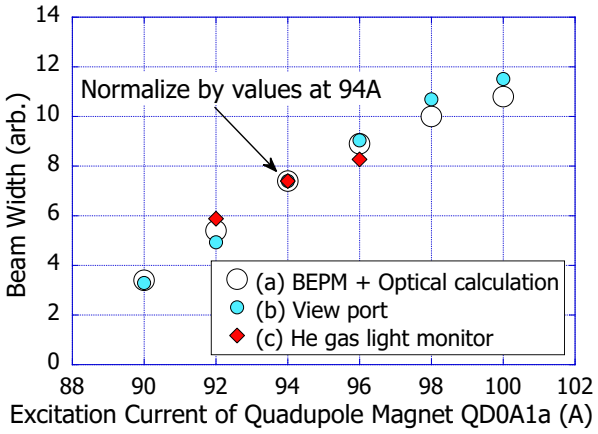

Fig. 2. Beam widths obtained through: (a) the beam optical calculation using the quadrupole moments measured by the BEPMs, (b) the obsevation of target spot on the fluorescent target through the view port, and (c) the measurement result obtained with the HeLM.

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References

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