Development of pepper-pot emittance monitor for AVF cyclotron

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In order to improve the injection efficiency from the Hyper ECR ion source (Hyper ECRIS) to the Riken AVF cyclotron, a pepper-pot emittance monitor[1] has been developed. The horizontal (x) and vertical (y) beam elements are coupled in this injection beam line because three solenoid coils and two Glaser coils exist. Consequently, a four-dimensional distribution (x, x', y, y') of the beam is necessary for measurement. In this report, we present the performance of the pepper-pot emittance monitor, which can measure four-dimensional distributions.

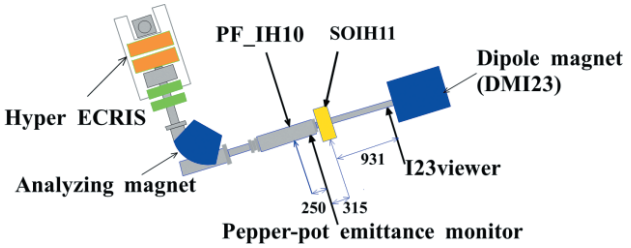

Fig. 1. Top view of Hyper ECRIS and the beam line

Figure 1 shows the test set to determine the performance of the pepper-pot emittance monitor. The figure shows a top view of the beam line from the Hyper ECRIS to DMI23. DMI23 is a dipole magnet that bends the beam in the vertical direction. On the straight line from the analyzing magnet to DMI23, a beam profile monitor (PF_IH10), a pepper-pot emittance monitor, a solenoid coil (SOIH11) and a viewer plate (I23viewer) exist in this order. PF_IH10 is used for the alignment of the pepper-pot emittance monitor.

We irradiated the pepper-pot emittance monitor with a $^{4}He^{2+}$ 20 keV ion beam (51eμA). The beam image of the pepper-pot emittance monitor is shown in the left part of Fig. 2. Using this, the four-dimensional distribution is calculated and indicated as the vector in the right part of Fig. 2.

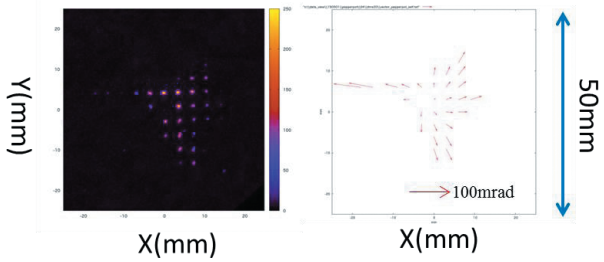

Fig. 2. Distribution of beam vector measured by the pepper-pot emittance monitor

Then, we transfer the four-dimensional distribution to the position of the I23veiwer. The transfer matrix of SOIH11 is constructed using the real solenoid model[2]. The result is shown as the image on the x-y plane in the left part of Fig. 3. The right part of Fig. 3 shows the beam image of the I23viewer. Comparing the left and right images of Fig. 3, we find that both shapes and positions are similar.

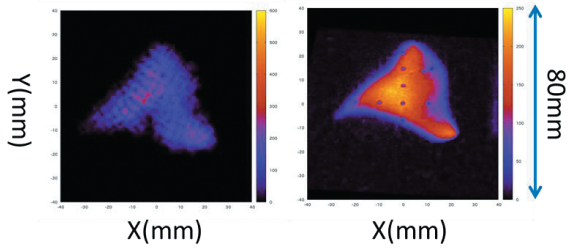

Fig. 3. The left image is the image obtained from the four-dimensional distribution transferred to the position of the I23viewer and the right image is a beam image on the I23viewer.

In order to obtain further confirmation, we also transfer the four-dimensional distribution to the exit of DMI23 and the result is shown as the image on the x-y plane in the left part of Fig. 4. For comparison, we place another pepper-pot emittance monitor at the exit of DMI23 and measure another four-dimensional distribution. This beam image is shown in the right part of Fig. 4. Both shapes and positions are similar.

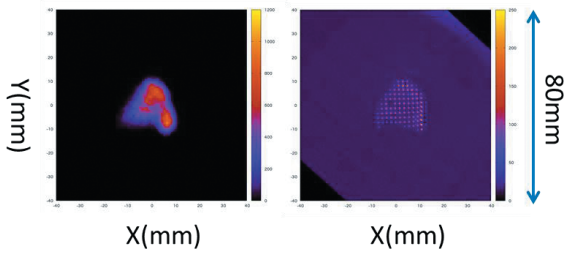

Fig. 4. The left image is the image obtained from the four-dimensional distribution transferred to the exit of DMI23 and the right image is the image obtained from another pepper-pot emittance monitor.

These results show that our pepper-pot emittance monitor has the necessary performance to be useful for the analysis of the injection beam line. After this, we are going to design the transport system of the injection beam line using the four-dimensional distribution.

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References

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