Displacement and Deformation of Vacuum System Installed in the SPring-8 Storage Ring

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1. Introduction

The installation of the vacuum system for the SPring-8 storage ring is in progress. The vacuum system is displaced and deformed due to evacuation and baking. Especially the displacement and deformation in the beam position monitor (BPM) sections deteriorate the accuracy of the position measurement of stored beam. Bellows assembly with RF slide finger (made from Be-Cu) on the inside surface must permit length variations and offsets caused by installation errors and thermal expansion due to bakeout. In this report, the measurement's results for these sections are mainly described.

2. Measurements and Results

The measurements were performed by using dial indicators and depth gauges. The depth gauges were used to measure the deformation of chambers for BPM reference block which is attached to each BPM. The block has two reference planes to define the reference points and the coordinates at the BPM section. The coordinate system is defined as follows ; Z (longitudinal) coordinate is along the beam direction, and X (horizontal) and Y (vertical) are perpendicular to it. The positive sense of Z is taken in the sense of the beam motion, of X in the outward direction and of Y in the upward direction.

2-1 The Displacement and Deformation due to Evacuation

The vacuum system consists of three straight section chambers (SS1C, SS2C and SS3C), two bending magnet chambers (BM1C and BM2C) and other components. Figure 1 shows the displacements to Z axis direction. SS2C, SS3C, BM1C and BM2C with the large radius bellows are displaced about 400μm toward crotch chambers. This results are

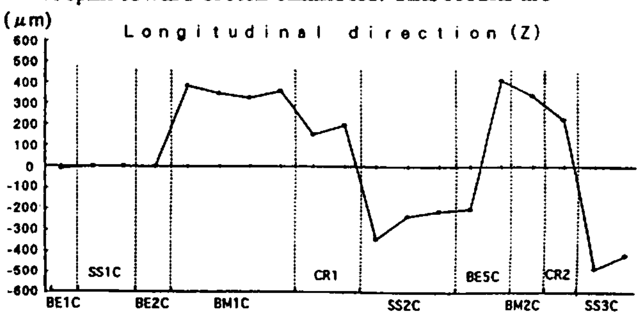

Fig.1 The displacements of the vacuum chamber the longitudinal direction (Z) due to evacuation.

improved remarkably in comparison with that of the pilot one-unit-cell[1]. It is expected that the two crotch chambers do not move in any direction due to evacuation, because they are supported rigidly. The measurement, however, indicates unexpectedly that they move about 200μm. This seems to be because their supports are bent by the force of evacuation.

Figure 2 shows the displacements of BPM reference planes. X and Y direction's results are less

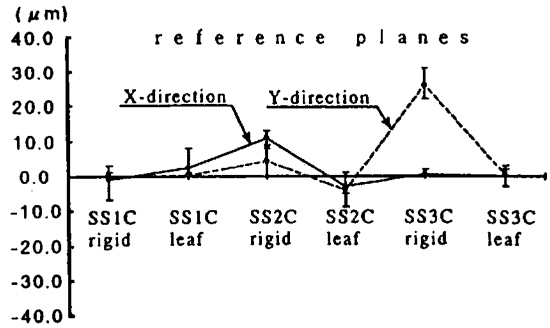

Fig.2 The displacements of the BPM reference planes due to evacuation. The solid line and the dashed line show X-direction's and Y-direction's results, respectively.

than 10μm and 30μm, respectively. There is no essential deference between the rigid support sections and leaf spring sections. The SSC in the upstream is fixed to a magnet girder (rigid support section) and the SSC in the downstream is supported by a leaf-spring device, making it possible to accommodate expansion to the Z direction (leaf spring section).

Figure 3 shows the chamber deformations at the BPM sections for the reference blocks.

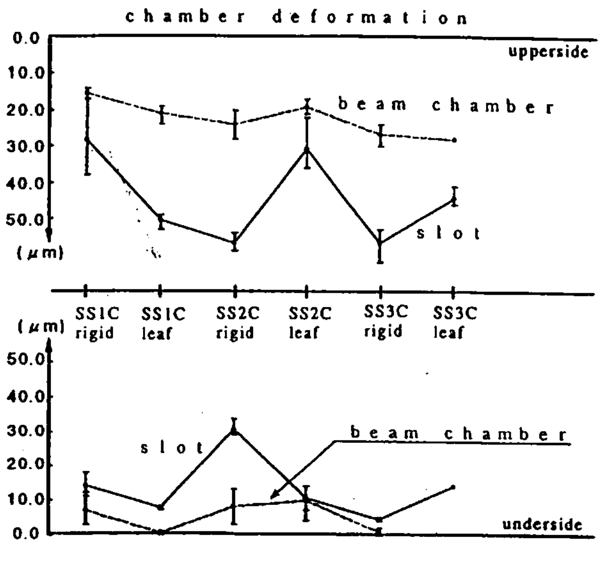

Fig.3 The deformations of BPM sections for the reference blocks are shown. The solid lines and dashed lines show the deformations of the slots and beam chambers, respectively.

The variations of distance between uppersides of the reference block and vacuum chamber were measured by using depth gauges. The measurements for undersides were performed in the same way. The results show that the upperside's deformation is about twice as large as the underside's one. This means that the chamber was deformed asymmetrically and the electrical center of BPM shifts. The shift estimated geometrically is 10~20μm.

2-2 The Displacement and Deformation due to Bakeout Cycle

Figure 4 shows displacements at each side of the BPM reference block. These curves are dominated by

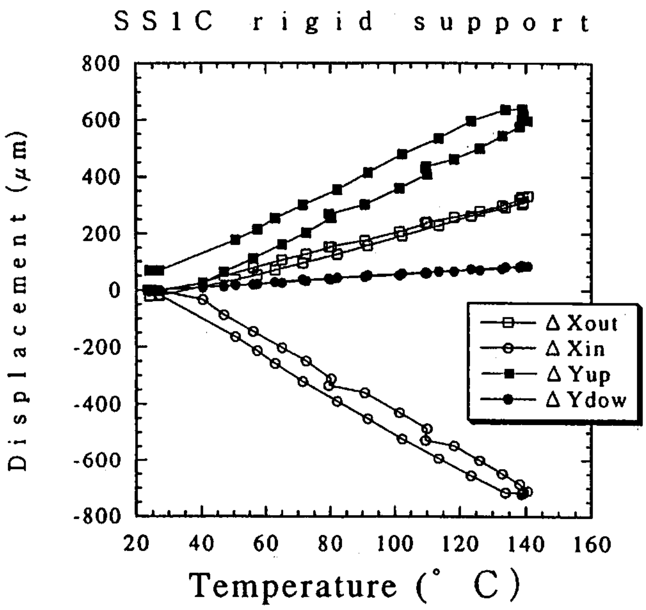

Fig. 4 The temperature dependence of the displacements at each side of the BPM reference block.

the thermal expansion of the reference block itself except underside (Ydow) which is displaced for the positive direction of Y axis. The reinforced blocks in BPM sections which suppress the deformation due to evacuation have the same tendency as well. The position of reference planes, after bakeout, is reproduced within the values shown in Table 1.

Table 1 The worst results for the position reproducibility of reference planes before and after bakeout cycle.

	rigid support	leaf device
X-direction	15μm	5μm
Y-direction	55μm	30μm

The position reproducibility of the rigid support sections is inferior to the one of the leaf spring sections and the X-direction shows the superior reproducibility in comparison with the Y-direction. This may suggest that the stress accumulates in the reinforced blocks where the thermal expansion to X-direction is sup-pressed as a result of the rigid support .

Table 2 shows the offsets of bellows assembly. The allowable maximum of the offsets is designed as 3mm. The offsets newly generated during baking are about 10% in comparison with one by the installation error. The both sum is 30~50% in the allowable maximum.

Table 2 The offsets of bellows assembly caused by installation error, bakeout cycle and the both sum are shown.

unit(μm)	installation error	bakeout	inatall + bake
BE1C	−1580	211	−1370
BE2C	−1740	220	−1520
BE5C	1180	111	1290
BE8C	1310	−381	930

3. Conclusion

The BPM reference planes is displaced several tens micron due to evacuation and bakeout. We plan to measure the position of reference planes from the quadrupole or sextupole magnetic centers over all cells of storage ring. It was confirmed that the bellow's offsets are less than the allowable maximum.

Reference

1) Hiroshi SAEKI et al., Spring-8 Annual Report, 1994, p. 120