ATTEMPT OF PORTABLE HLS

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1. INTRODUCTION

The circumference of SPring-8 ring is 1435m. This ring has 144 girders and the points to be measured are on the magnet of the both end of the girder as shown in Fig.1. This stage has a tapered hole.(Fig.2) The number of the points to be measured are about 300.

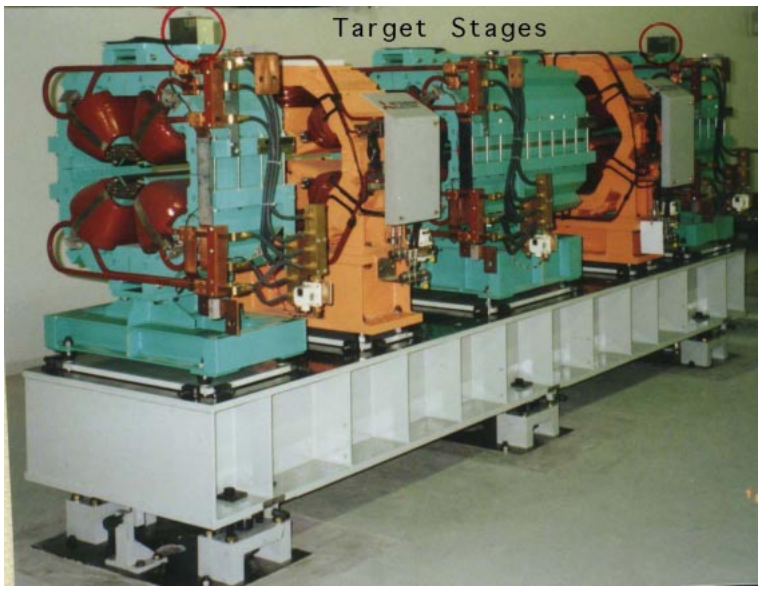

Fig.1. Target stages on the magnets in a girder.

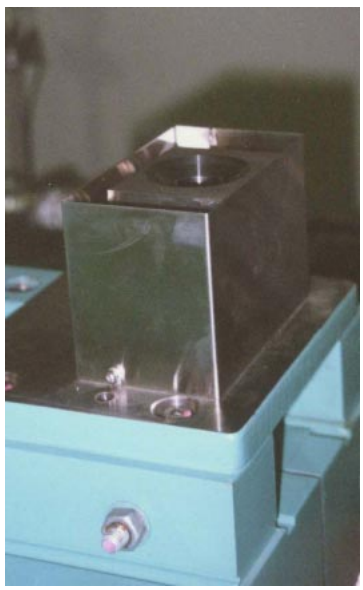

Fig.2. Target stage.

The magnet level surveys of the SPring-8 ring have been carried out by three methods. [1] The first method uses the conventional Wild N3 and visible target. However the humann error cannot be avoided by this method. The second method used the aluminum pipe which had a tiltmeter at the midpoint of the pipe. The pipe length was 2.5 or 3.5m. The level difference was gained by measuring the two tilts. Though the handling was hard because of several-kg weight, it was seemed that the accuracy was better than that of N3. The third method used an auto-level with a He-Ne laser and PSD(Position Sensitive Device) target. This had no good repeatability of the tilt of the rotational stage. Moreover the pointing stability of the laser was not good. Thus the tilt of automatic level had to be measured with the tiltmeter.

The portable HLS is already reported by Hans L. Imfeld et al.[2] They used an adjustable micrometer probe as a sensor of water surface.

We used a capacitive commercial sensor made by Fogale nanotech. The specifications are as follows:Uncertainty ±0.8μm; Resolution ±0.1μm; Vertical distance sensor/water surface 6~8.5mm; Weight of sensor and vessel about 5 kg.

2. APPARATUS and METHOD

A sensor including an amplifier was connected to RIA rack. The output voltage from this rack was drawn by the pen recorder.(LR4100 made by YOKOGAWA ELECTRIC CORP.)

2.1 Attempt 1 Using two Liquids

Figure 3 shows two liquids in the sensor. Paraffin liquid was used. The density is about 0.8. However the force due to the level difference is reduced 5 times because the density difference between two liquids is 0.2. Moreover the viscosity resistance of the paraffin is larger than that of the water. The length of the pipe is about 2m for water and 0.2m for Paraffin.(Fig.4) Though the pipe length is short, the time until equilibrium was long. The decay time (1/e) was 0.7~0.9 minute. The curve was similar to the exponential one.

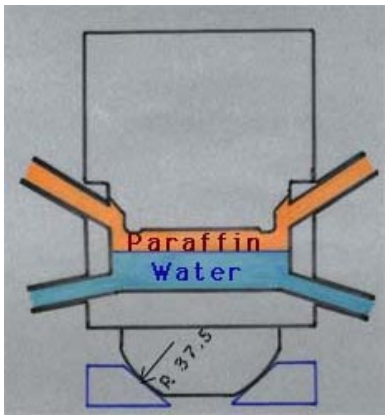

Fig.3. Cross sectional view.


Fig.4. Sensors using two liquids on the Z stages.

2. 2 Portable apparatus

The chloride vinyl panels were used to expand the water pipe and sensor cable.(Fig.5) The support has small wheels. The sensor can be moved on the wagon. The maximum length between the sensors is 18m. When these panels are gathered the length is 4m.(Fig.6) The length of the water pipe is 20m. The rack and pen recorder are in the central wagon.

The bottom surface of the portable sensor is sphere of which radius is 37.5mm.(Fig.3) The stage has tapered hole. (Fig. 2) Thus the average height of the water surface does not change when the sensor is tilted.

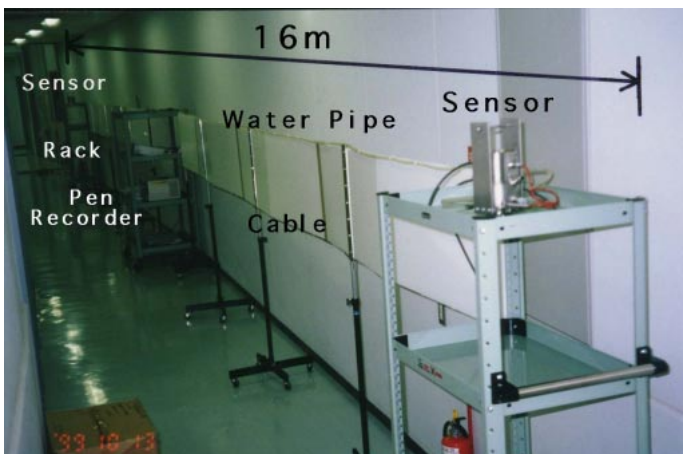

Fig.5 Extended panels.

The smoothness of the bottom spherical surface is a few micrometer. The converted change of the electronic output was less than 2 micrometer when the sensor was tilted 8 mrad.

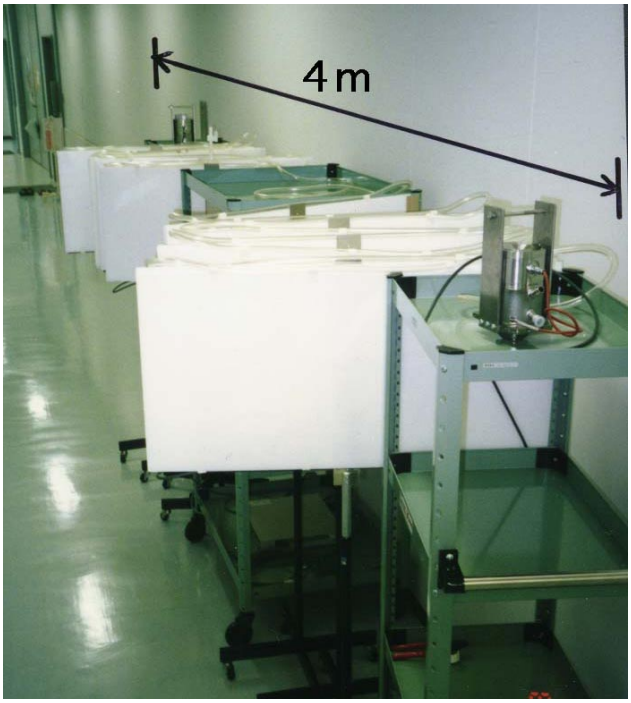

Fig.6. Gathered panels.

2.3 Attempt 2 Taking water out

If the water is out of the level sensor, the sensor can be moved freely. Thus before moving we take the water out with a glass syringe (200ml) as shown in Fig.7. Three cocks are used. After the cock 1 is closed the water in the sensor goes into the glass syringe. After the cocks 1,3 are closed the sensor 1 is moved. After this sensor is put on the stage it is filled with the water. Two bubble levels (1 div. 0.5mrad) were used to put the sensor horizontally. The other sensor 2 was not moved. These processes were repeated. The results is shown in Fig.9. The fluctuation of the level difference was within 20 micrometer. When the water was not taken out, the cock3 was closed and the sensor was shaken violently, the output was changed largely. However when the sensor1 was moved quietly (CMO in the Fig) the output was not so changed.

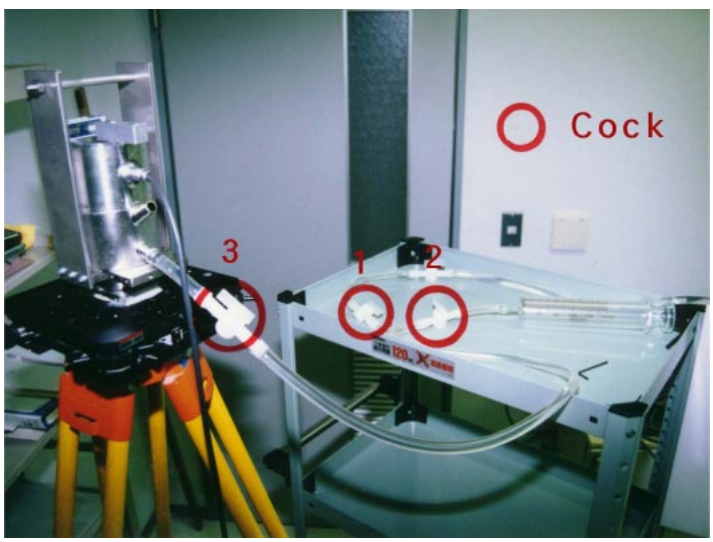

Fig.7. Glass syringe and three cocks.

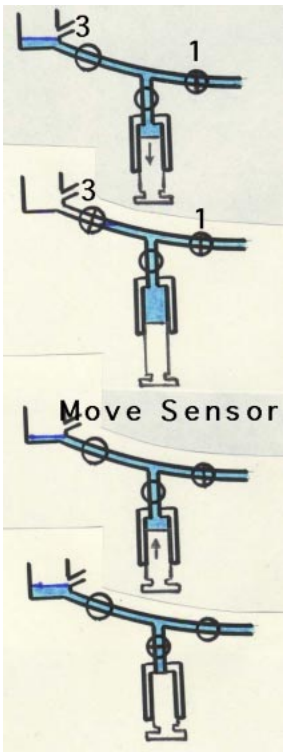

Fig.8. Procedures for taking water out.

Since the water level decreases by this method, the output voltage exceeds the range. Blue and red lines reaches the limits as shown in Fig.9.

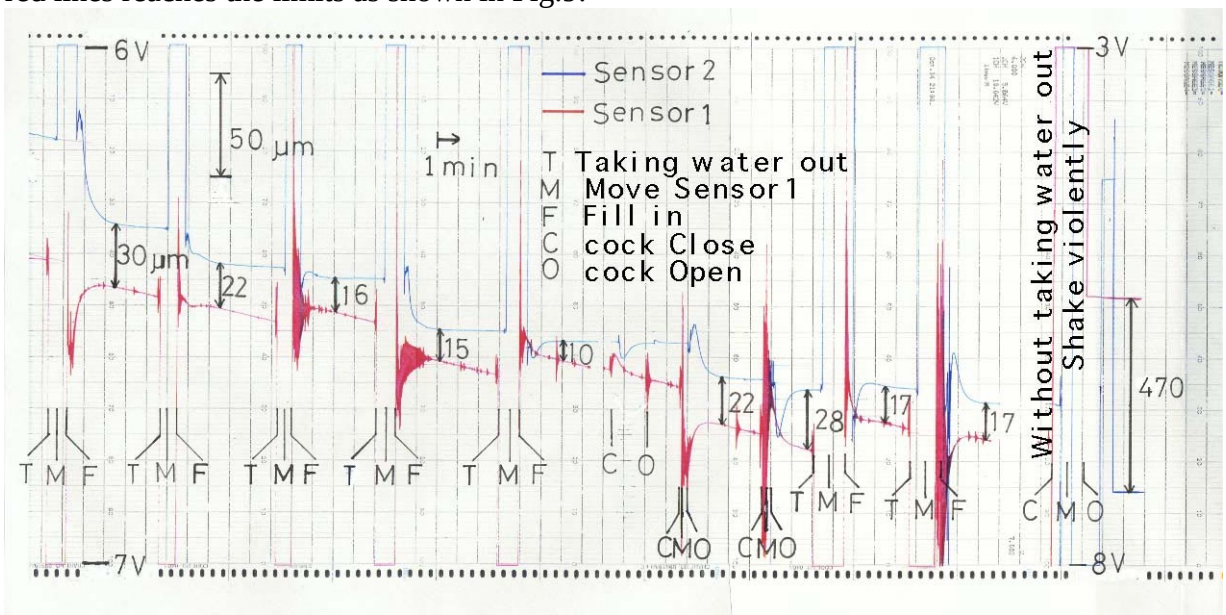

Fig.9. The results of repeated procedures of taking water out.

2. 4 Attempt 3　Coating for repelling water

Unless the water adheres to the sensor surface when the sensor is moved, we need not take the water out. Fig.10 shows the effect of the fluoro chemical coating (Product name RFH-200 made by RYOKO CHEMICAL CO.,LTD) for repelling water. This material is in the bottle.(Fig.10c) A brush was used to coat the surface. When the sensor surface was dip into the water many times, a very small water was on the surface in few case.

The sensor 1 was coated. Fig.11 shows the level when the sensor was shaken. Before moving the sensor the cock3 is closed. The effect of thin dielectric layer was very small. The repeatability was good. The same procedures were done for non-coating sensor. The level was changed largely as shown in Fig.11.

(a)Before coating and before dip. (b) After dip without coating (c) After dip with coating

Fig.10. Effect of the water-proof coating.

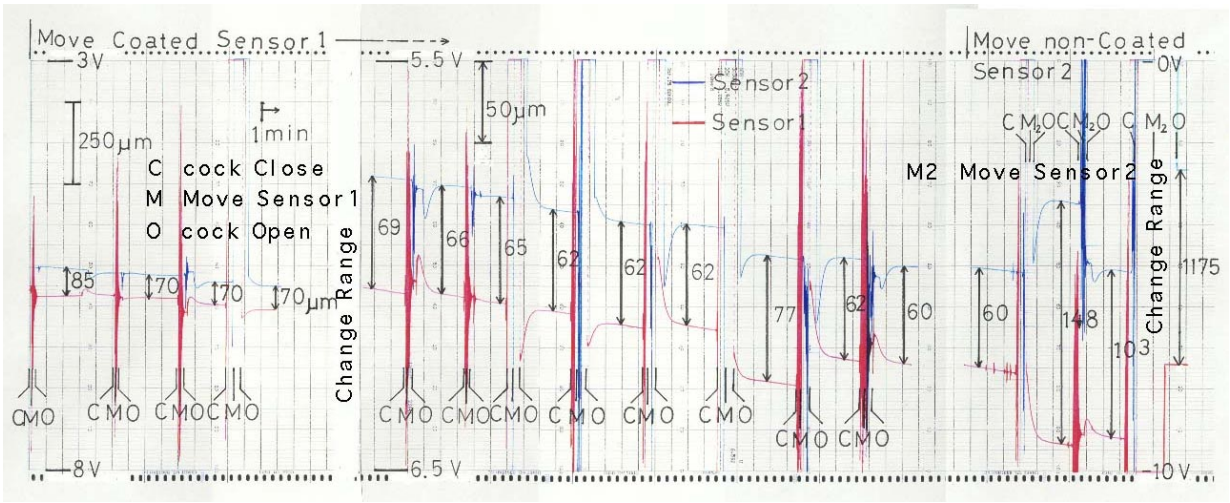

Fig.11. Results of the repeated procedures of moving sensor1(coated) and sensor2(non-coated).

3. CONCLUDING REMARK

If the length is about 20m and the inner diameter of the water pipe is 10mm, after the sensor is set on the stage the decay time till stable is a few minutes. Thus the portable HLS is convenient for measuring the points between the reference level ones.

The water proof on the sensor surface is important.

Moreover the weight 8 kg of this portable sensor is too heavy to put on the stage by hand. The box beneath the vessel is attached to avoid the fall. Since the box beneath the sensor is taken off the bottom surface can be seen as shown in Fig.13.

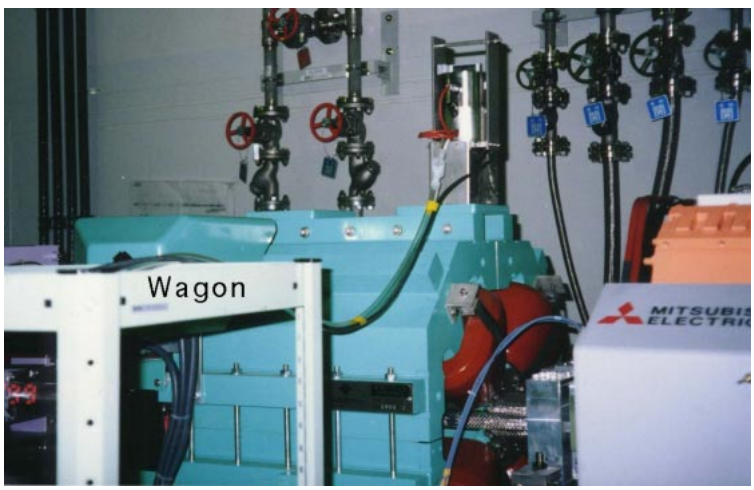

Fig.12. Portable sensor on the magnet stage in the tunnel.

Fig.13. Portable sensor without support box.

4 References

[1] Sakuo Matsui et al.,'Elevation Changes of the SPring-8 Storage Ring', Proc. 5th Int.Workshop on Accelerator Alignment(IWAA97), ANL/FNAL, Argonne, USA, October 1997.

[2] Hans L. Imfeld et al,' Pellissier H5 Hydrostatic Level', Proc. 5th Int.Workshop on Accelerator Alignment(IWAA97), ANL/FNAL, Argonne, USA, October 1997.