Tendency Analysis of the WPS for Monitoring Movement of the Accelerator Building at KOMAC

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1. Introduction

100-MeV proton linac at KOMAC (KOrea Multi-purpose Accelerator Complex) has operated since 2013. Precise alignment of the proton accelerator is required for high efficiency and stable delivery of the proton beam. In order to measure the real-time state of the wall, WPS (Wire Positioning System) was selected and installed on the wall of the accelerator tunnel at KOMAC [1]. Figure 1 shows layout of WPS in accelerator tunnel. The WPS consists of 8 sets which are 3 sets in 20-MeV accelerator and 5 sets in 100-MeV accelerator.

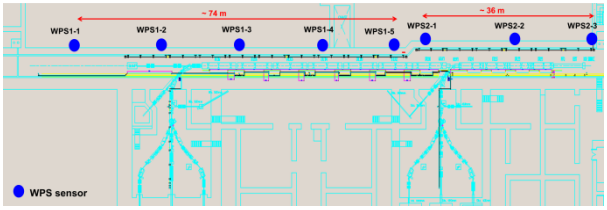

Figure 1. Layout of WPS

The location of the networks in accelerator tunnel is affected by deformation of the wall due to various influences such as vibration and temperature changes. In real-time monitoring of WPS, networks can be assumed the deformation. In addition, alignment error by deformation of wall can be checked. In this paper, WPS installed at KOMAC is described and its tendency analysis results are presented.

2. Wire Positioning System

A set of the WPS consists of WPS sensor with electronic, carbon wire and wire stretched post. Figure 2 shows the WPS installed in accelerator tunnel.

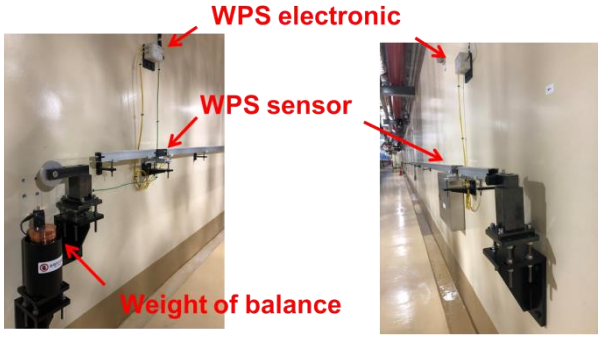

Figure 2. WPS installed in accelerator tunnel

The WPS sensor made by FOGALE Nanotech has two electrodes per axis facing each other, for a total of four electrodes. The sensor has a working range of 10 mm for each axis with a resolution of 0.1 um peak to peak at 1Hz and repeatability less than 1 um as shown in the Figure 3. Carbon PEEK wire of diameter 0.4 mm with linear mass density 235g/km is used at a weight within 10 ~ 15 kg. A wire stretcher from FOGALE Nanotech was installed in the post and the wires were connected. A wire protection covering is installed to prevent the air from the air conditioner from moving or shaking the wire [2]. The wire sag was calculated by the calculation formula provided by POGALE Nanotech. In a measurement performed by KOMAC, the wire sag was about 11 mm in relation to a 74 m wire length and 14 kg load in 100-MeV section and about 3 mm in relation to a 36 m wire length and 13 kg load in 20-MeV section [3].

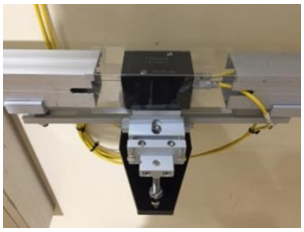

Figure 3. WPS sensor

3. Tendency of WPS

Figure 4 and Figure 5 show the tendency of WPS of 20-MeV section and 100-MeV section. And it can be seen that accelerator operation cycle differs from the pattern at the weekend. This is because the temperature of accelerator tunnel depends on whether the accelerator is driven or not. The variation of accelerator tunnel is about 1 degree. In Figure 4 and Figure 5, it can see red arrow by human touch like as worker's mistake during the maintenance and visitor's mistake during the accelerator tunnel tour.

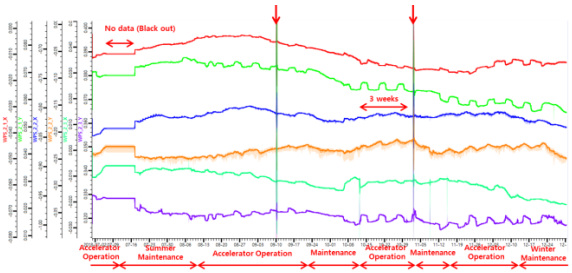

Figure 4. Tendency of WPS of 20-MeV section

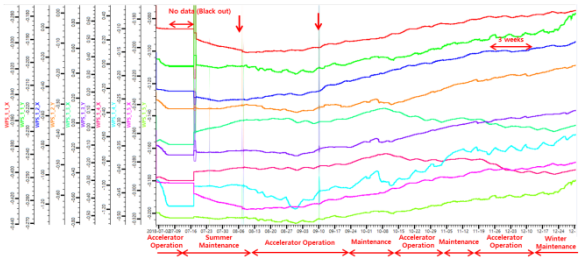

Figure 5. Tendency of WPS of 100-MeV section

Figure 6 and Figure 7 show the trends of WPS of 100-MeV section. In Figure 6, WPS 1-1 and WPS 1-5 have a similar pattern. It is assumed that it has the same tendency as the common point in the position where the sag value is close to the pivot point. In contrast, WPS 1-2 and WPS 1-4 have similar patterns in the Y direction, but different patterns in the X direction as shown in Figure 7. There was a difference in the variation of the comparison data of each WPS signal. As the sensor moves away from the pivot point of WPS of 100-MeV section, the movement of the wall increases, and it is assumed that there are temperature-sensitive parts such as bolt tightening of the assembly.

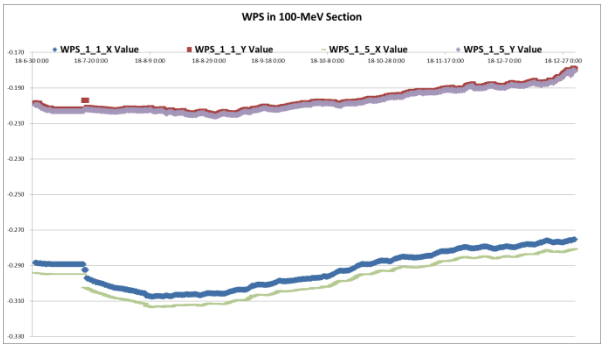

Figure 6. Comparison of WPS1-1 and WPS1-5

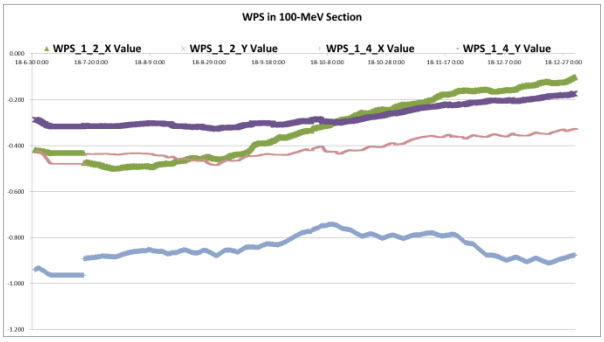

Figure 7. Comparison of WPS1-2 and WPS1-3

Figure 8 shows the difference between the average values of WPS on July 23rd and December 28th. For reference, July 23 and December 28 are the tunnel network measurement days. This is to see the tendency of the wall of the accelerator tunnel to vary by about 5 months. In the figure, there are many changes in 100-MeV section rather than 20-MeV section. The deformation is up to about 400um in the +X-direction and about 250um in the +Y-direction.

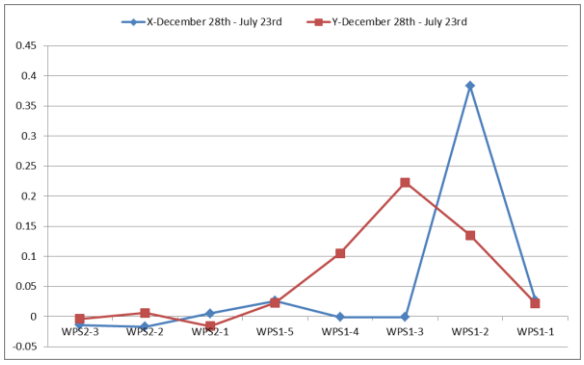

Figure 8. WPS comparison on specific date in December and July

4. Conclusions

The WPS has been installed and operating at KOMAC. In the WPS pattern, the influence of the accelerator operation changes the ambient temperature and affects the patterns of WPS. There was a difference in the rate of change in the comparison data of each WPS signal. Furthermore, we have seen a change in the 100-MeV section on the July 23 and December 28 data comparisons. In the future, the WPS data must be compared with the tunnel network measurement, and the bolt tightening of the 100-MeV section assembly with a change width of 100μm must be checked again and the tension of the wire must be adjusted.

REFERENCES

[1] Dae-Il Kim, et al., “Installation of Real-time Measuring System for Monitoring Floor Movement of the Accelerator Building at KOMAC” Proceedings of ICABU2017, Gyeongju, Korea, 2017.
[2] Hyojin Choi, et al., “INTRODUCTION TO WPS SYSTEM DESIGNED TO MEASURE THE CHANGE OF LOCATION FOR PAL-XFEL GIRDER” Proceedings of IPAC2016, Busan, Korea, 2016.
[3] Dae-Il Kim, et al., “Preliminary Operation of the Wire Positioning System for Monitoring Movement of the Accelerator Building at KOMAC” Proceedings of ICABU2018, Gyeongju, Korea, 2018.