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Preliminary Operation of the HLS for Measuring Vertical Movement of the Accelerator Building at KOMAC

Dae-Il Kim*, Jae-Ha Kim, Young-Gi Song, Hyeok-Jung Kwon

Korea Atomic Energy Research Institute, KOrea Multi-purpose Accelerator Complex
181 Mirae-ro, Geoncheon-eup, Gyeongju-si 780-904
*Corresponding author: dikim@kaeri.re.kr

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 alignment state of the proton accelerator, HLS (Hydrostatic leveling system) was selected and installed at KOMAC [1]. There is ultrasonic type HLS of the BINP (Budker Institute of Nuclear Physics). A total of 10 HLSs are distributed throughout accelerator tunnel as shown in the Fig.1. In this paper, HLS installed at KOMAC is described and its operation results are presented.

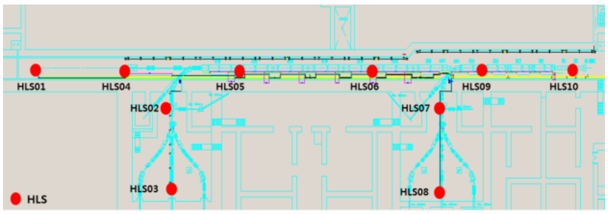

Fig.1. Layout of HLS

2. Hydrostatic Leveling System

The HLS consists of a HLS vessel with an ULS (Ultrasonic Level Sensor), an electronic for the performance of transducer and an UI (User Interface) as shown in the Fig.2. The transducer of H10KB3T(7MHz) inside HLS vessel is as ultrasonic detectors made by GE Sensing & Inspection Technologies. The reflector inside the HLS vessel was made of invar with low coefficient of thermal expansion [2].

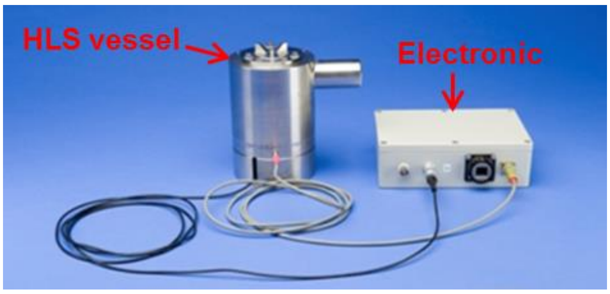

Fig.2. Hydrostatic Leveling System

The main technical parameter of ULS is shown in the Table.1. The overall configuration of HLS is referred on PAL-XFEL [3].

Table.1. Technical parameters of ULS

Displacement range	5 mm (±2 mm)
Precision	< 0.1 um
Resolution	< 0.2 um
Accuracy	(±5 mm range) < 3 um
Sampling rate	Up to 10 Hz

3. Test-stand

The test-stand as shown in the Fig.3 was constructed to inspect and calibrate the HLS components. There is also a purpose to check HLS which is distributed in wide area.

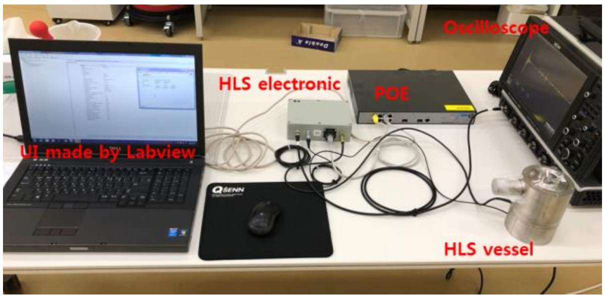

Fig.3. Test-stand

Fig.4 shows the incident and reflected signals obtained by oscilloscope when transducer is driven. The ultrasonic waves that take place in the transducer are reflected in the reflectors and water surface. Three reflected signals arrives the transducer with the delays, corresponding to the distances T1, T2 and T3 from the transducer to each surface as shown in the Fig.4. All these signals transmit to the electronics module for signal processing [2], [3].

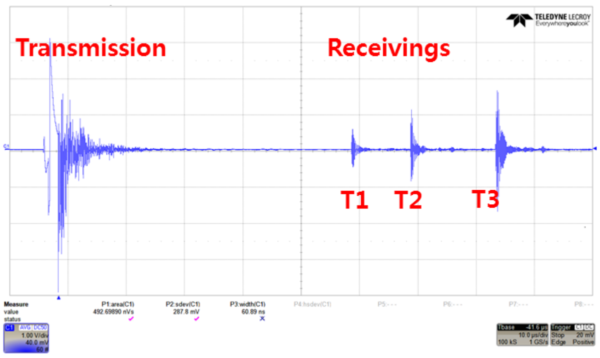

Fig.4. Signals by transducer operation

4. Operation Results

Fig.5 shows data from four HLS for three weeks. The effect of tidal force with 12-hours period can be confirmed in (a), (b) and (c). 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 as shown in the Fig.6. The amplitude of the water level by the tidal force is about 10 um, and the amplitude of the water level of the whole cycle is about 50 um. In (d) of Fig.5, an abnormal signal occurred after the initial period of the accelerator operation. Fig.6 shows inside the red circle on (d) of Fig.5. In the initial section, the effect of the tidal force can be seen, but it is gradually out of the measurement range. HLS4 is installed in the beam dump section of the accelerator, and it is assumed that the abnormal signal is the influence of radiation while operating the accelerator.

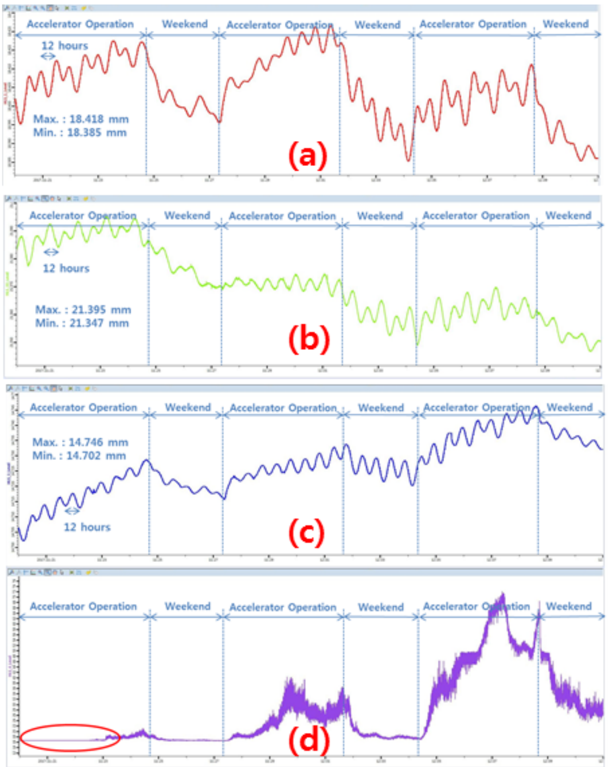

Fig.5. Variation in Water level of each HLS for 3 weeks: (a) HLS1 located in end of accelerator tunnel, (b) HLS10 located in start of accelerator tunnel, (c) HLS3 located in 100 MeV beam-line, (d) HLS4 located in 100 MeV beam-dump with abnormal signal

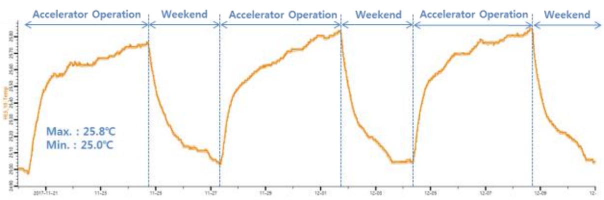

Fig.6. Variation in Temperature of HLS10 for three weeks

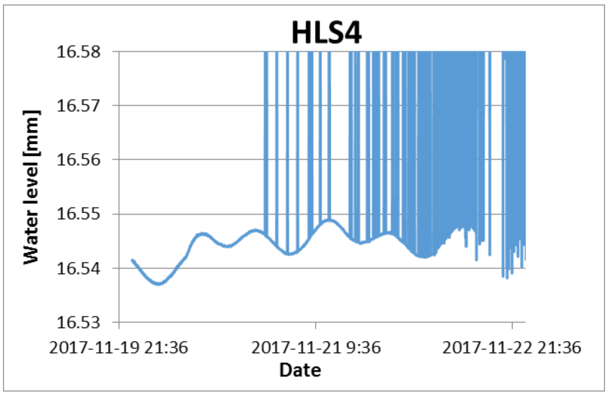

Fig.7. Abnormal signal of HLS4 in red circle on (d) of Fig.5

5. Conclusions

The HLS has been installed and operating at KOMAC. In the HLS pattern, the effect of the tidal force was confirmed, and it was found that it was influenced by the ambient temperature as well. It was also found that the accelerator operation affected the HLS electronic. In the future, HLS must synchronize its positions by using the laser tracker and it is necessary to discuss how to handle the measured data in terms of relative value or absolute value.

REFERENCES

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