Alignment of Ion Accelerator for Surface Analysis using Theodolite and Laser Tracker

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1. Introduction

In 2015, the Korea Multi-purpose accelerator complex (KOMAC) has moved the ion accelerator from KIGAM and installed in beam utilization building in KOMAC. The ion accelerator was needed to be realigned along to new room of beam utilization building. Fig. 1 shows the layout of ion accelerator for surface analysis [1]. The method of ion accelerator alignment is used two ways which are a theodolite and laser tracker. For the alignment and maintenance of the proton linear accelerator, the laser tracker is typically used at KOMAC. While the device for alignment by using laser tracker is not installed in all ion accelerator components, it was used in parallel in two methods. In this paper, alignment methods are introduced and the result and comparison of each alignment method are presented.

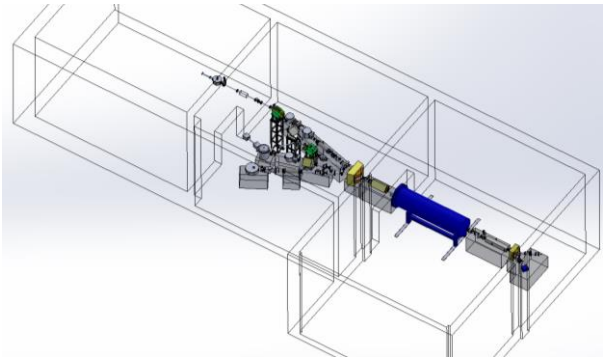

Fig. 1. Layout of the ion accelerator at KOMAC

2. Alignment

The first method of ion accelerator is using the theodolite. This way has been used in KIGAM since ion accelerator was installed in KIGAM and maintained the ion accelerator. The alignment method using theodolite is needed three standard points: the point of stationary wall, the same level point of diametrical wall, and the bottom point of straight line of other two points. (The angle between the wall points is 90 degree or 180 degree.) Fig. 2 shows the three standard points installed in the ion accelerator room. At first, the theodolite is set at fixed position. The center of theodolite quadrates to the bottom point and its height quadrates to the point of stationary wall. And then, the center points of two wall points are set at an angle of 90 or 180 degree. According to magnification of theodolite, the component of ion accelerator is aligned in straight line.

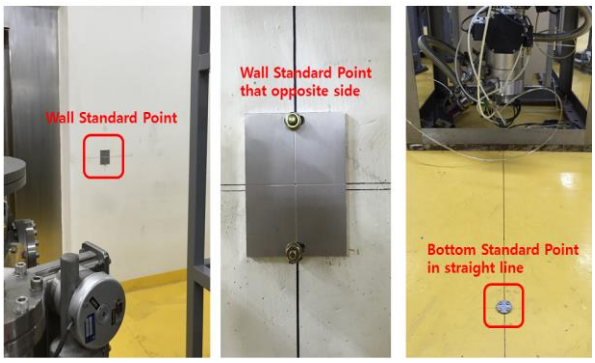

Fig. 2. Three Alignment standard points used for theodolite

In case of switching magnet and ion quadrupole magnet of ion accelerator, the alignment pin is needed. As viewing the theodolite, the vertex of this pin is matched with the center of wall points and then the center of switching magnet and ion quadrupole magnet are aligned in straight line. Fig. 3 shows the image that aligning the ion accelerator magnet using the theodolite.

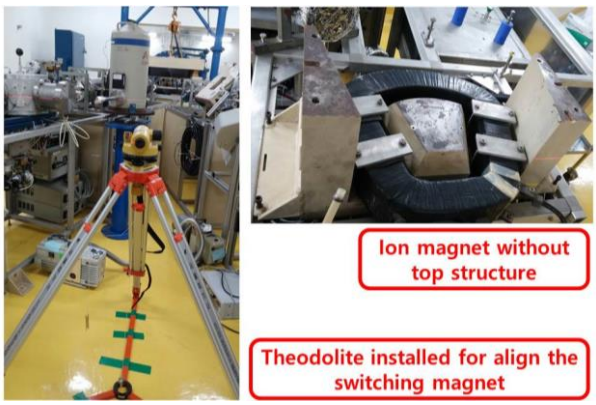

Fig. 3. The theodolite installed in position and Ion magnet for alignment

The other alignment method is using by laser tracker. This method has used to align a 100 MeV proton linear accelerator at KOMAC [2]. It is different with previous method by using theodolite. At first, network reference is needed. It is using for ion accelerator coordinate. It is installed on room wall prior to the ion accelerator moved into room. The laser tracker measures the network reference and sets up axis. And then, as the

laser tracker measures the fiducial points of ion accelerator magnets in real time, the magnets are aligned in reference positions. The fiducial points has installed on magnets and already measured before installed in a new room. The previous measured fiducial point data is precious data because it is using for reference positions. Fig. 4 shows the image that aligning the ion accelerator magnet using the laser trackers.

Fig. 4. The laser tracker installed for neutron beamline magnet alignment

3. Results

The alignment using theodolite isn't analytical method. It is simply align the components by viewing the theodolite. It is very subjective. Also the alignment error isn't clear. It is a serious disadvantage to the alignment using theodolite.

In contrast, the alignment using laser tracker is further analyzed because of based on program and measurement data in real time. The program is Leica Axyz tool operated in PC connected with laser tracker controller. The Leica Axyz program represents the data up to micrometer in real time. Fig. 5 shows the results that aligned by theodolite and measured by laser tracker. As shown in Fig. 5, the alignment using theodolite has hundreds of micrometers range of errors. It may adversely affect the beam performance and stability. On the other hand, laser tracker can be aligned the ion accelerator components within ±100 ㎛. It is less than that of theodolite.

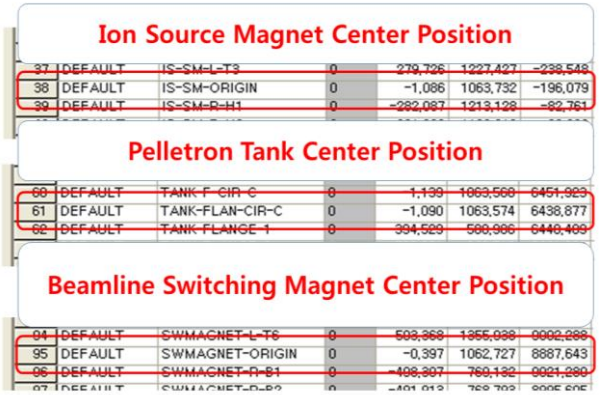

Fig. 5. The alignment results using theodolite (measured by laser tracker and calculated by Leica Axyz program)

3. Conclusions

The ion accelerator for surface analysis has aligned using theodolite and laser tracker. The two ways for alignment have advantage as well as weakness. But alignment using laser tracker is stronger than using theodolite. Because it is based on alignment and position data and it is more detailed. Also since the beam distribution is smaller than accelerator component that is direction of beam progress, main component (ex. Magnet, Chamber, Pelletron tank, etc.) alignment using laser tracker is enough to align the ion accelerator.

REFERENCES

[1] Hyeok-Jung Kwon, Han-Sung Kim, Bo-Hyun Jeong, Tae-Sung Ahn, Dong-Hyuk Seo, Cho-Rong Kim, Dae-Il Kim, Yong-Sub Cho, Installation of the Ion Accelerator for Surface Analysis, 2015 Korea Nuclear Society Autumn Meeting, Gyeongju, 2015.
[2] Bum-Sik Park, Hyeok-Jung Kwon, Ji-Ho Jang, Han-Sung Kim, Dae-Il Kim, Yong-Sub Cho, 2013 Korea Nuclear Society Spring Meeting, Gwangju, 2013.