# Survey and Fiducialization of 100MeV Proton Accelerator

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## 1. Introduction

Proton Engineering Frontier Project(PEFP) [1-2] is developing a 100MeV proton linear accelerator. The accelerator is composed with a 50keV proton injector, a 3MeV RFQ, DTL tanks and a beam dump. Additionally 10 beamlines are also developing to supply the 20MeV and the 100MeV proton beam for the proton beam application [3-5].

All of components should be aligned within the tolerance to get the designed performance. Laser tracker systems were used to survey and fiducialize the accelerator and magnets. In this work, fiducialization and survey process were described in detail.

## 2. Survey

For the blue line survey, the coordinate system was setup. The vertical axis(+Y) was setup by the NIVEL(Leica co.). The Z axis and the origin were determined by using two permanent references as shown in Fig. 1. These positions are linked to the construction coordinate system. The coordinate system can be extended by using 5 see-through holes from the 1st floor to the 3rd floor.

The align network was installed on the tunnel. The distance between each align network is the 5m for right side and 10m for the left side. The total number of the tunnel networks is 42 and the height of the fixed position is 1.8m. This kind of align networks were also installed on the wall of beamline halls, target rooms, the klystron gallery, the modulator gallery.

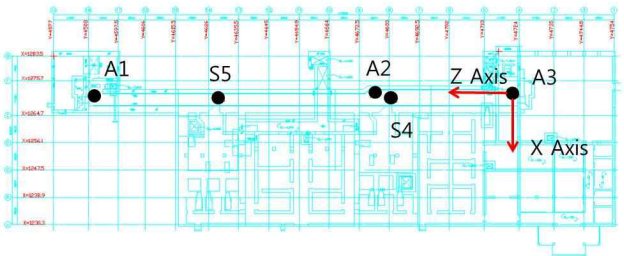


Figure 1. Coordinate system of the 100MeV proton linac. A3 is the origin and the Z axis was setup by using the coordinate of A1. The coordinates of A1 and A3 are linked with the coordinate system used for the construction.

## 3. Fiducialization

Accelerator lattice and beam transport magnet locations are defined in terms of the locations and acceptable errors of the local magnet coordinate system in relation to a lattice or transport global coordinate system[6]. In tunnel, the alignment tolerance is within ±50μm. And the magnets will be aligned within ±100μm in beam transport lines.

### *3.1 DTL fiducialization*

There are 4 fiducial points in each end side of DTLs. The Z-axis of the DTL was determined by measuring the inner surface of the cylindrical tank and by calculating the cylindrical fitting. The determination of the X-axis and the Y-axis is fixed by calculating the average angle of the 4 drilled standard holes in the end of tank. Figure 2 shows the coordinate of the DTL tank. The fiducialization of DTLs was accomplished during the drift tube installation process.

As shown in figure 3, two laser tracker systems were installed at front and end position of DTL tank, which have the same coordinate system, during the fiducialization and drift tube installation.

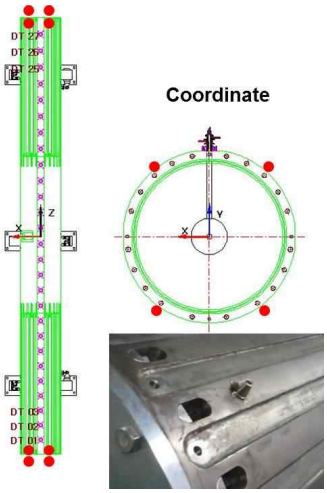


Figure 2. The coordinate system and fiducial post of DTL tank.

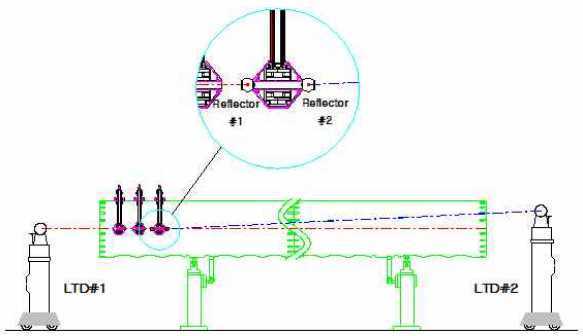


Figure 3. Drift tube alignment and DTL fiducialization were accomplished with two laser trackers.

### *3.2 Quadrupole Magnet*

As shown in Figure 4, a mandrel and a pair of sleeves were adopted to fiducialize the quadrupole manget. The Z-axis and the origin were determined by the end position of the mandrel, the front and rear surfaces of the magnet. The X-axis was determined by using the Z-axis and the horizontal plane which is derived from 4 side surfaces, the front surface and the rear surface. The magnet shape was measured by the laser tracker at front and rear of the magnet. After the coordinate system was setup, we measured the coordinate data of 4 reference points according to the magnet coordinate system.

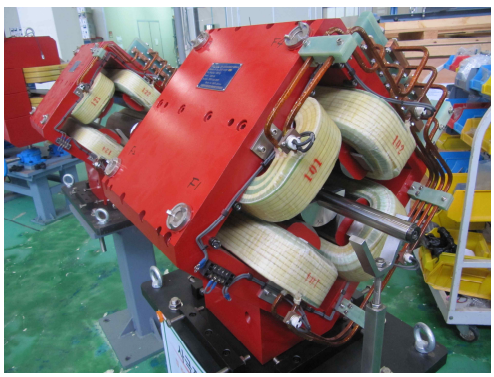

Figure 4. A mandrel and a pair of sleeves for the measurement of mechanical center.

Figure 5. The fiducialization of a dipole magnet with a laser tracker.

### *3.3 Dipole Magnets*

For the dipole magnets, the Y-axis was the perpendicular axis of the bottom pole and the X-axis was determined by calculating the perpendicular axis of the mid-plane of the beam inlet surface and outlet surface. And the origin was determined by offsetting the designed gap from the bottom pole surface and outer surface of pole.

## 4. Conclusions

The 100-MeV proton linear accelerator was under installation. The accelerator and beamline magnets were positioned according to the blue line survey results. DTL tanks were fiducialized during the installation of drift tubes which were aligned within ±40 ㎛ accuracy.

Beamline magnets were fiducialized 5 times. For the magnet origin, the position difference is within ±50 μm for x, y and z coordinate. Through this work, we will align the accelerator within ±50μm and the magnets will be aligned within ±100μm in beam transport lines

## Acknowledgment

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