Fiducilization of Quadrupole Magnet for PEFP

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1. Introduction

Proton Engineering Frontier Project(PEFP) [1] is developing a 100MeV high-duty-factor proton linac. Which are composed of a 50keV ion source, a 3MeV radio frequency quadrupole, a 100MeV drift tube linac, five 20MeV beamlines and five 100MeV beamlines. It will supply users with proton beams, 20MeV and 100MeV with peak current of 20mA. The beam duty factor will be 24% and 8% respectively. To construct beam transport lines, all the beam line magnets were prepared : 2 ac magnets, 107 quadrupole magnets, 11 bending magnets. They were fabricated at IHEP, China. Figure 1 shows the mangets which were stored and will be installed at the site in the Gyeongju City. We will build the network points in the tunnel, the klystron gallery, experimental halls and target rooms to align the components. The alignment network will be linked by 5 see-through hoes between floors. All of the alignment work will be done by using two laser trackers. In tunnel, the alignment tolerance is within ±50μm. And the magnets will be aligned within ±100μm in beam transport lines. For the quadrupole magnets, all of them were already fiducialized and magnetic field measurement was tested when they were manufactured. However, the fiducialization test has been accomplished to confirm the process and data [3].

2. Quadrupole Magnets for the PEFP Beamlines

Figure 1. Magnets for the PEFP beamlines including 2 AC magnets, 107 Quadrupole magnets and 11 Bending mangnets.

There are two kinds of quadrupole magnets for the PEFP beamlines and we designed the same magnets for the 20MeV and 100MeV transport lines. The specification of the quadrupole magnets are described in Table 1.

Table 1: Design specifications for the quadrupole magnets

Parameter	unit	20MeV	100MeV
Magnetic field gradient	T/m	5	
Core aperture diameter	mm	110	
Core effective length	mm	200	400
Core length	mm	154	354
Field integral, max	T	1.0	2.0
Conductor size	mm	6.5X6.5, d=4.0, r=0.5	

3. Fiducialization

3.1 Fiducializtion Process

We used a laser tracker, LTD600, to do the magnet fiducialization. As shown in Figure 2, a mandrel and a pair of sleeves were adopted. The Z-axis and the origin can be determined by the end position of the mandrel, the front and rear surfaces of the magnet. The X-axis can be 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 two positions as shown in Figure 3 and 4. Finally, we measured the coordinate data of 4 reference points according to the magnet coordinate system.

Figure 2. A mandrel and a pair of sleeves for the measurement of mechanical center.

Figure 3. The fiducialization of the quadrupole magnet by using the laser tracker.

Figure 4. The reference points on the quadrupole magnet. Which will be used for the magnet alignment.

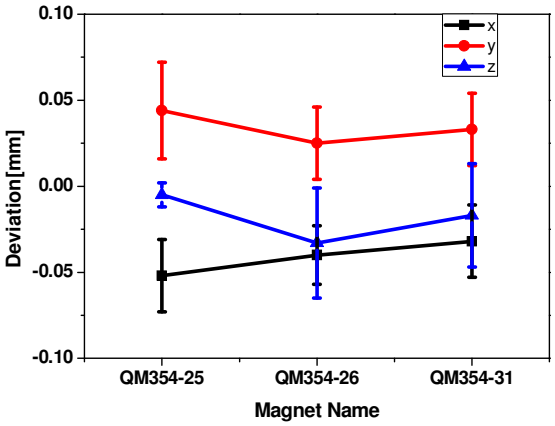

Figure 5. The deviation of the origin coordinates which was measured 5 times and compared to the data measured by the supplier.

3.2 Fiducializtion Results

3 magnets have been fiducialized 5 times and compared with results which were already measured by the supplier. For the magnet origin, the position difference is within ±50 μm for x, y and z coordinate. And the tilt angle of the z-axis is less than 0.02 degree. The deviation of coordinate and the tilt angle for 5 time-measurements are about 20 μm and 0.0005 degree, respectively. Figure 5 shows the deviation of the origin coordinates which were measured 5 times and compared to the data measured by the supplier.

4. Conclusions

One of the goals of PEFP is developing a 100MeV proton linac and user facilities. The fabrication of magnets for beam transport lines was finished. The linac installation starts from November 2011 after finishing the accelerator construction. The magnets will be aligned within ±100μm in beam transport lines. In considering with the fiducialization test and the installation tolerance of magnets, it need not to fiducial all of quadrupole magnets and we can confirm the manufacturer's fiducialization data.

REFERENCES

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