MAIN MAGNET INSTALLATION FOR CYCIAE-100

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Abstract

The CYCIAE-100 proton cyclotron being constructed in CIAE is designed to extract the proton beam of 100 MeV and 200 uA. The main magnet is the most important part of the cyclotron. The diameter of the CYCIAE-100 main magnet is 6160 mm. Its height is 3860 mm. Its total weight is about 416 tons, and the largest part is about 170 tons. The beamline of CYCIAE-100 will be connected to the HI-13 tandem accelerator at CIAE. So, the CYCIAE-100 main magnet should be installed accurately. The vertical tolerance of the CYCIAE-100 main magnet is 0.20 mm, and the horizontal tolerance is 0.50 mm. The CYCIAE-100 main magnet is located in an underground building which level is -4 m. There is a horizontal hole on the west wall of the accelerator building. All parts of the main magnet had been moved through this horizontal hole. The CYCIAE-100 main magnet had been installed in November 2012 at CIAE. In fact the error of installation is: the vertical 0.10 mm, the horizontal 0.20 mm. The installation process will be shown in this paper.

Keywords: CYCIAE-100, main magnet, installation

INTRODUCTION

The main magnet is the most important part of CYCIAE-100. It is important to install the main magnet accurately and without accident. The 416 tons main magnet was transported by heavy-duty trucks to the outdoor road of the mounting hole. In order to transit the main magnet from the outdoor unloading position to the mounting position in the plant, a steel frame and heavy rail had been built in the accelerator plant. All the parts of the main magnet had been moved into the plant through the mounting hole. How to unload the heavy part of the magnet and how to transit will be described in this paper. It is difficult to adjust the heavy magnet position even with the 200t crane in the plant, because it need a large force to push away the magnet. How to measure and how to adjust the magnet position was described in this paper .

MAIN MAGNET INSTALLATION

The main magnet of CYCIAE-100 was installed in the accelerator plant. The interior space of the accelerator plant is 27mx19mx13.5m (L x W x H). The plant can shield the high-energy neutron very well. The elevation of the plant floor is -4 m and the elevation of the central plane is -2.25 m. There is a horizontal mounting hole in the west wall of the accelerator plant which is 7 m wide and 5m high. The elevation of the hole bottom is 0 m. The main magnet was installed in the basement of the plant. The transition of the main magnet which has a the total weight of 416 tons is a serious question. Figure 3 is the unloading position and the mounting position of the main magnet.

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To transit this part from the unloading position to the mounting position, we built a steel frame in the plant which had a loading capacity of 200 tons next to the installation hole. The top surface of the steel frame and the bottom of the hole is at the same level. The heavy rails were installed on the steel frame which could connect to the outdoor pavement, and a slide board was made which had the capable of carrying the heavy parts of the main magnet. With the traction of the wire rope, the slide board can haul the heavy parts from the outdoor unloading position to the indoor steel frame.

Figure 1: Simulation Test.

Figure 2: The magnet unloading.

The main beam of the steel frame is 800x500x50x45 H-beam which has the length of 8m. The 4 supporting columns is 500x300x11x18 H-beam which has a space of 7m with each other. The Columns are installed in the concrete floor with the chemical anchors, the other end of the main beam was fixed on the western wall in the plant with the chemical anchors. In order to ensure the stability of the frame, the diagonal bars between the main beams and columns, columns and the columns were made. At the same time, in order to ensure the safety, the platform and

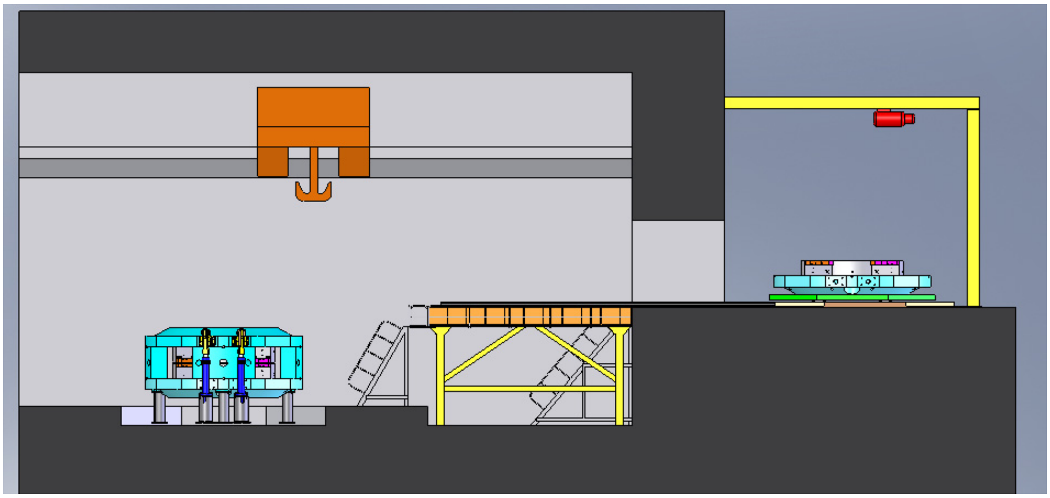

Figure 3: The unloading position and the mounting position of the main magnet.

parapets were installed for staff walking, and the inclined ladders were installed next to the steel frame for staff climbing up and down. In order to verify of strength of the steel frame, heavy rail and slide board, a simulation test is carried out with a weight up to 240 tons before the transporting the main magnet. Figure 1 shows the test. The load tests proved that the steel frame, the heavy rail and the slide board is solid, reliable and meeting the design requirements.

The yoke and poles assembly which are weighing up to 170 tons is transported to the outdoor pavement with a heavy-duty truck. Usually they required a large automobile crane to unload. But the space is not enough, a large automobile crane can not work. For the magnet diameter is greater than the width of the truck, we used a simple and practical unloading method, which lifting up the yoke and poles assembly with four hydraulic jacks and then driving the truck away, finally land the yoke and poles assembly on the slide board slowly. Especially, when jacking up and drop heavy parts, the four jacks must work synchronously. Removed four jacks and supports away, dragged the slide board to carry the yoke and poles assembly into the plant with wire ropes, then the 200t crane can lift the yoke and poles assembly to the installation location. To reduce the force friction between the slide board with the 169 tons part and the heavy rail, lubricating fat was laid on the heavy rail. The dragging force on the slide board was limited less than 10,000 kgf.

Figure 4: The magnet part moved into the plant.

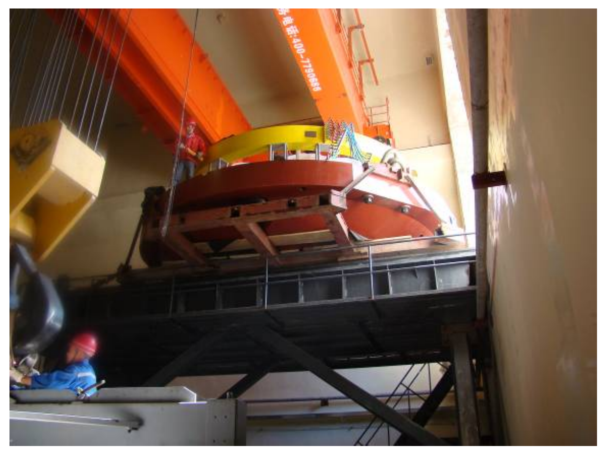

Figure 5: The magnet part on the bracket.

The main components of the main magnet are the yoke and poles assembly, four yokes, two coils, the main vacuum chamber, four hydraulic lifting cylinders, legs and other parts. The installation order is: legs - the under yoke and poles assembly - yokes (4) - the coils (2) – the vacuum chamber – the upper yoke and poles assembly – the hydraulic lifting cylinders and other components.

Figure 6: The target in the yoke central hole.

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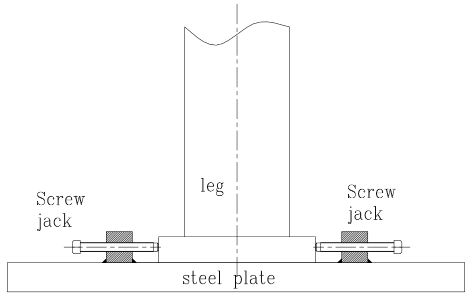

Figure 7: Adjusting the azimuth position.

Because the beamline will connect to the existing tandem accelerator in CIAE, the accuracy requirement of the main magnet is very strict. The accuracy requirement of height is better than 0.20 mm, the accuracy requirement of azimuth is better than 0.50 mm. The benchmarks of the magnet installation positioning are the targets setting on the four walls.

Measuring and adjusting the height installation errors of the magnet: The height error between the magnet central plane and the wall target could be measured by a water level, then, adjusting the height of the main magnet by putting different thickness thin iron piece below the four legs. Ensuring the magnet central plane was at the same height with the wall target center. The measurement of the height installation error is less than 0.10 mm.

Measuring and adjusting the azimuth installation error of the magnet: There is a horizontal central hole on each of the four yokes in the main magnet. A target was set in each central hole. Measuring the deviation between the target in the horizontal central hole and the wall target by a Leica Total Station. Pushing the legs with the screw jacks to fine-tune the position of the main magnet, as shown in Figure 7. The measurement of the azimuth installation error is less than 0.20 mm.

Figure 8: The view of the magnet installation.

Figure 9: The overall view of the magnet.

SUMMARY

The installation of CYCIAE-100 main magnet had been completed in November 2012 at CIAE. The error of installation is restricted to be less than 0.10 mm and 0.20 mm on the vertical direction and horizontal direction respectively, which satisfies the design requirements.

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