

# Application of CMM technology in accelerator magnet detection

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## Abstract

Accelerator magnet is one of the most difficult equipment in accelerator hardware system. With the improvement of physical requirements, more and more high technical requirements are put forward for magnets. This paper mainly introduces the new application of CMM technology in the detection of accelerator magnet, and introduces the working process of CMM in the detection of accelerator magnet polar profile.

## Conclusion

As a new, high precision and high efficiency measuring method, CMM can be widely used in accelerator magnet field. In the specific application practice, its measurement accuracy and repeatability are better than the traditional measurement method.

### Application of CMM

#### Traditional Measurement and Coordinate measurement

CMM (coordinate measuring machine) is an instrument that can calculate various geometric shapes, dimensions and other measurement capabilities through CMM software system according to the point data returned by the probe system in the three-dimensional measurable space.

CMM can be defined as a kind of detector which can move in three directions and can move on three mutually perpendicular rails. The detector transmits signals in contact or noncontact way. The displacement measurement system of three axes (such as optical ruler) calculates the coordinates X, Y, Z of each point of the work-piece and the measuring instrument of various functions by data processor or computer. The measurement functions of CMM include dimension precision measurement, positioning precision measurement, geometric precision measurement and contour precision measurement. Any shape is composed of three-dimensional space points, and all geometric measurement can be attributed to the measurement of three-dimensional space points. Therefore, accurate collection of space point coordinates is the basis of evaluating any geometry.

### Application of magnet detection

As a new type of high-precision detection method, coordinate measurement technology has been widely used in the fields of traditional processing, manufacturing and precision detection. With the increasing requirements of accelerator magnet technology, we try to apply the advanced technology of CMM in the field of accelerator magnet.



#### Traditional Measurement and Coordinate measurement

	Traditional detection	Coordinate measurement
Equipment	Inside micrometer	CMM
Location	Air gap	Air gap + polar surface
Accuracy	±0.01mm	±0.005mm
Advantage	Fast and convenient	Comprehensive detection, high precision
Disadvantage	Local detection, low accuracy	The equipment is expensive

### Profile Measurement

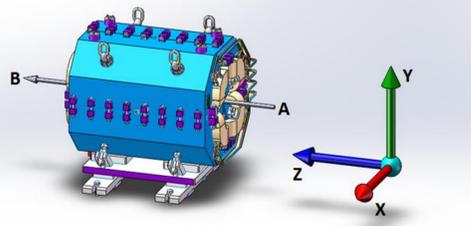
#### Masuring Equipment

- CMM (coordinate measuring machine) of Hexcon:
  - PC-DMIS software
  - High precision measurement platform (HH-A-M5)
  - PROBE\_TP20
  - EXTEN100MM
  - Ruby probe of 3mm—30mm



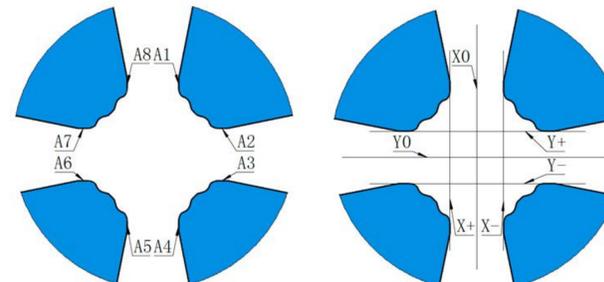
#### Definition of Magnet Surface and Coordinate System

- The origin of the coordinates is at the center of the magnet.
- The two sides of the magnet are defined as A and B sides.
- Along the axial direction of the magnet, A-B is the Z axis.
- The upward direction along the horizontal face of the magnet is the y-axis.
- The positive direction of the vertical plane is the x-axis.



#### Creation of Coordinate System

We use the point line plane method to establish the workpiece coordinate system, and take the horizontal plane YO and the vertical plane XO of the magnet as the first reference plane to construct the magnet coordinate system to detect the magnet. By measuring the positioning points A1-A8, B1-B8 at the positioning plane of the pole head of the magnet, and using the plane construction function of PC-DMIS software, the reference planes Y+, Y-, X+ and X- of the magnet are obtained by the best fitting method, and the split planes XO and YO of the magnet are constructed according to the fitted plane.



#### Measurement Result

The CMM is used to measure the profile and gap size of the magnet for many times. The measurement accuracy and repeatability are higher than the traditional measurement methods.

