ALIGNMENT OF THE MECHANICAL COMPONENTS AND MACHINING CONTROL OF THE MONOLITHIC VACUUM CHAMBER FOR HIRFL

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ABSTRACT

Using optical measuring technigue and the method of "three angles being intersected and translated", the mechanical comonents of SSC and beam line are aligned to their positions with desired accuracy, the monolithic Vacuum chamber of SSC is machined.

The optical coordinate system of SSC

The positions of the components of SSC and beam line in the cyclotron hall are positioned with respect to an optical three — dimensional coordinate system, which is established in the hall with the optical instruments and stands. This coordinate system is mainly as follows:

A plumbing mirror is installed on the centre of the foundation of SSC. The elevation of the central pit is - 6400mm (See Fig.1 and Fig.2). The central point 0' of the plumbing mirror is the reference of the centre of SSC. The plumb line 00' is the vertical reference centreline of SSC. The elevation of the middle plane of the gap of SFC is transmitted to the optical stand G with precise level and assigned to the elevation of 1400mm—the reference height of the Qm of SSC. The stand F is built in the plumb plane passing through the centreline of the foundation of the second sector magnet in the same level with stand G and assigned to the reference of azimuth.

A jig transit is mounted on the centre stand 0 and so adjusted that its vertical axis coincides with the reference centre line 00' of SSC and its horizontal axis is in the same level with stand G. The intersection 0 of the two axes is the origin of the three — dimensional coordinate system. The vertical axis 0'0 is Z axis. The line OF is X axis. With an alignment telescope mounted on the stand F, a jig transit and a precise level, the stands D, C, E, A, B, are also built at the azimuths of 0°, 90°, 270° respectively. The line EO is the Y axis of the system.

With a precise theodolite mounted on the centre stand 0 and a precise level, the stands I, II, III, are built at the azimuths of 45°, 135°, 225° respectively in the same level with Qm. The stands A', B', C', D', E', F', I', II', III', in the elevation of 4063 mm can be built in the same way for measuring the top of SSC.

Measuring of sector magnets

1.Measuring of lower yokes:

(1) Using a precise level and three optical tooling scales, the upper surfaces of the four lower yokes are levelled to within 0.05mm at a distance of 700.25mm below the elevation of 1400mm by adjusting the hydraulic jacks.

(2) The distances from the front faces of four lower yokes to the reference centre line 00', are measured to be 670-0.14mm with an optical tooling scale attracted horizontally to the front face and a jig transit mounted on the stand 0 and adjusting the jacks.

(3) Putting three targets in the three holes in the yoke axis, the deviations of the targets with respect to X or Y axis are measured to be less than ± 0.05mm by using the jig transit on the stand 0 and adjusting the jacks.

2. Adjusting the middle plane of the pole gaps to the level of Qm plane.

Using the special targets placed into the gaps of 4 sector magnets and the precise level placed in the level plane Qm, the pole gaps, the deformations of the upper and lower pole surfaces and the levelness of the middle plane of pole gaps are measured both for without and with magnetic field. The middle plane of pole gaps is adjusted to the level plane Qm within ± 0.02mm by adjusting the jacks as mentioned above.

3. By measuring the distances from the top surfaces of upper poles to the top surfaces of the corresponding return yokes (2) using a sweep optical sguare, the thicknesses of 12 spacers which are placed between the top surfaces of upper poles and the bottom surfaces of the upper yokes can be determined.

4. The deformation of the large components of SSC are measured with magnetic field by using the jig transit, optical targets and optical tooling scales.

Machining control of the monolithic vacuum chamber

As shown in Fig.3, 12 big pieces were welded into a monolithic chamber (9.6m x 8.5m x 5m) in the cyclotron hall. Then, 8 large air - tight surfaces were machined

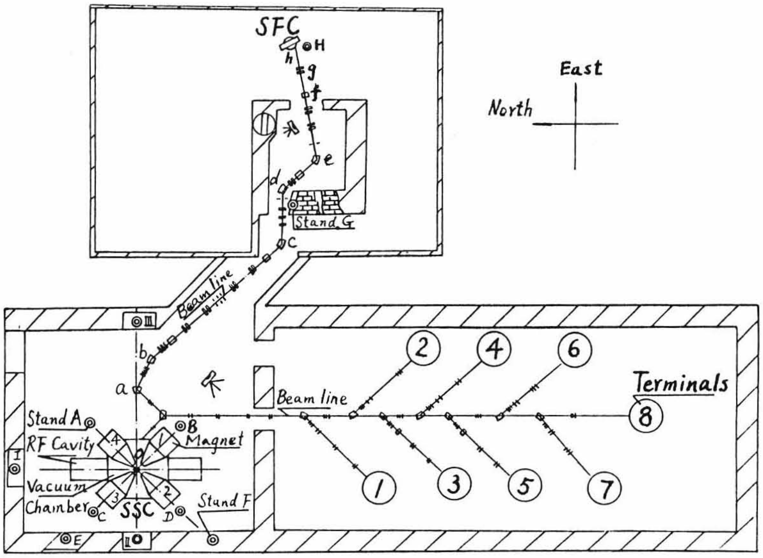

Fig.1 Schematic Plane Diagram of HIRFL and Optical Measuring System

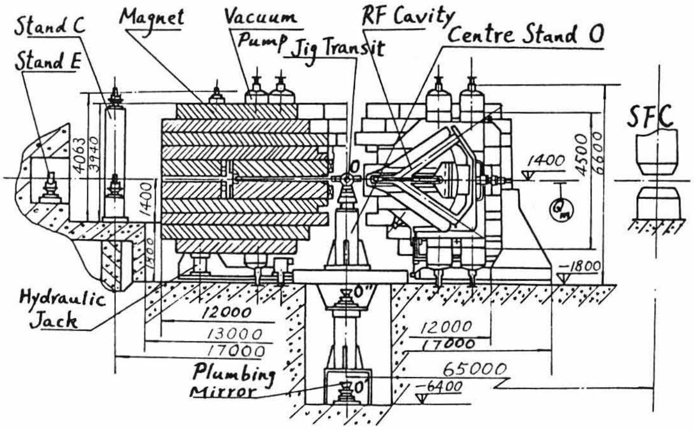

Fig.2 Schematic Section Diagram of HIRFL and Optical Measuring System

with high precision. The details are as follows:

1. With the precises level, optical tooling scale and precise theodolite, the 12 pieces were positioned in required position and welded into a monolithic chamber, then, the Qm plane and the machining lines of 8 large air - tight surfaces and the centre lines of other parts of the vacuum chamber are determined. Using the same method, the planenesses and the height differences of 4 upper air - tight surfaces are measured.

2 . Using a precise theodolite, a large precise trianguler prototype and three optical targets, a jig transit and a optical tooling scale, a ⌀ 5m face lathe which is used to machine the flange air - tight surfaces of RF cavities can be placed to the required position (the scale is attracted to the tool rest of the lathe). The prototype which has three interior angles of 90°, 75° and 15° and three optical targets is placed in the Qm plane near the flange surface of one of the RF cavities and levelled with a block level first. Then the precise theodolite in the centre of vacuum chamber aims at two targets on the prototype. The jig transit is placed in the line which coincides with the other side of the triangle formed by the three optical targets on the prototype. The flange air-tight surfaces in the east and west valleys can be machined and measured in the same way.

Installation of the field mapping device

1. An alignment telescope and a cup mount are placed on the centre stand 0, and aligned the central axis to coincide with the reference centreline 00' of SSC.

2. Using a spheroid target, a set of micrometer rods, a precise level in the Qm plane and a pedestal target, we can adjust and measure the fixed ring and the movable ring to required positions.

3. Placing 28 monitoring pieces around the movable ring and using the inductance micrometer, we can measure and record the positioning sizes of the fixed ring and the movable ring with respect to the moni-

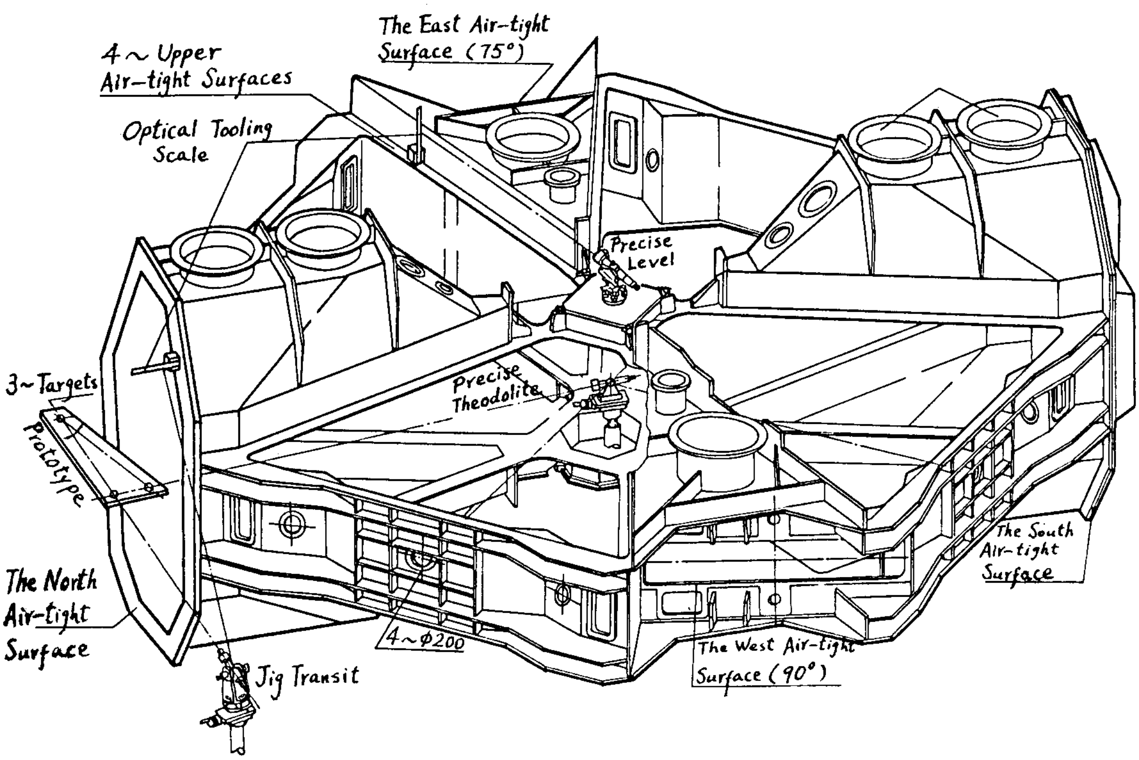

Fig. 3 Measurment of the Air-tight Surfaces of Vacuum Chamber

toring pieces.

Alignment of the beam line

As shown in Fig.1 and Fig.2, the beam line from SFC to SSC passes through four rooms, it travels over 65m. The positioning error of the beam line must be less than + 0.50mm. The methods of "three angles being intersected and translated" and "three angles being intersected" were designed to determine the positions of the beam line with required accuracy by using the precise theodolites, two - way bench, positioning mounts, block level, optical targets, micrometer rods and precise level as well the optical coordinate system of SSC.

The measuring accuracies:

1. The deviation of the optical coordinate system of SSC from the ideal coordinate system is less than 0.10mm.

2. The accuracy of the level measuring is about ± 0.3".

3. The accuracy of height measuring is about 0.10mm.

4. The accuracy of the distance measuring is 0.05 - 0.10mm for around SSC and about ± 0.50mm for elsewhere.

5. The accuracy of the angle measuring is 5" - 10".