

§5. Fabrication of Inner Shaping (IS) Coils

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Poloidal coil system of the Large Helical Device consists of three pairs of circular solenoids. A pair of Inner Shaping (IS) coils has been fabricated and shipped into our institute in march of 1995. Main parameters of the IS coils are listed in Table I. Top view is also shown in Fig. 1. The coil has an average diameter of 5.6m, and weighs about 25 tons. It becomes the largest forced-flow type superconducting coil.

Conductor of the IS coil has basically the same construction as the other poloidal coils. The surface of strands kept bare considering heat transfer to helium and current redistribution. Pure gas helium was enclosed into the conductor to avoid oxidation of the strand surface during fabrication. A void fraction, which is one of the most important parameters, was optimized to be 38 percent considering wire movement and AC loss. To keep the void fraction within an allowance, the strands and the conductors were strictly inspected regarding the strand diameter and the conduit dimensions.

A coil consists of eight double-pancakes. Each double-pancake with two layers and 13 turns/layer has 460 m long conductor. In order to minimize the error field, the pancakes after molding kept tolerances of ± 2 mm for the inner diameters, ± 3 mm for the outer diameter (± 2 mm for an average) and ± 1 mm for the height. The tolerances correspond to extreme accuracy of about 5×10^{-4} for the diameter. Figure 2 shows average manufacturing errors of the double-pancakes for the IS coils. The lower coil consists of #1~#8, and the upper consists of #9~#16. The figure indicates that all errors were acceptable.

The pancakes were, then, stacked and molded. As for the electric joints between pancakes, diffused junction between NbTi filaments was applied in the same way as the IV coils. The ground insulation of 4 mm thickness was wound around the molded coil. Finally, the coil was covered with ten fan-shaped PC sleeves.

Table I. Main Parameters of the IS coil

Cooling type	Forced-flow
Average diameter	5.6 m
Height	0.46 m
Total weight	25 tons
Number of pancakes	16
Number of turns	$13 \times 16 = 208$
Operating current	21.6 kA
Maximum field	5.4 T
Stored energy	104 MJ

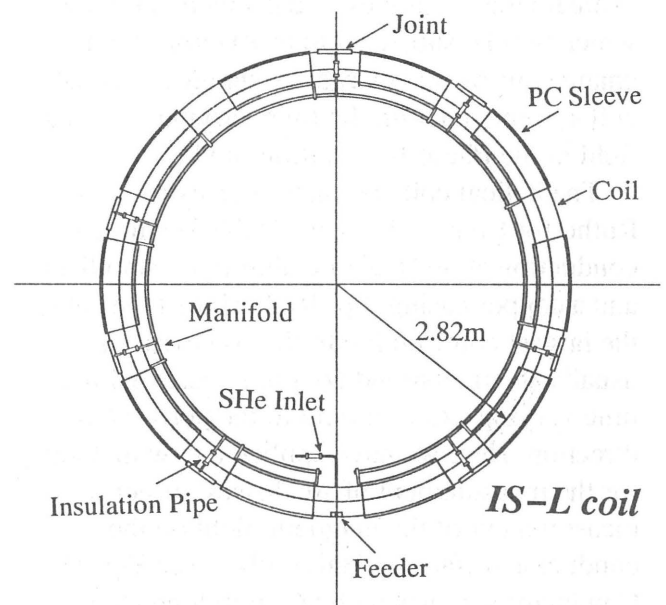


Fig. 1. Top View of the IS coil

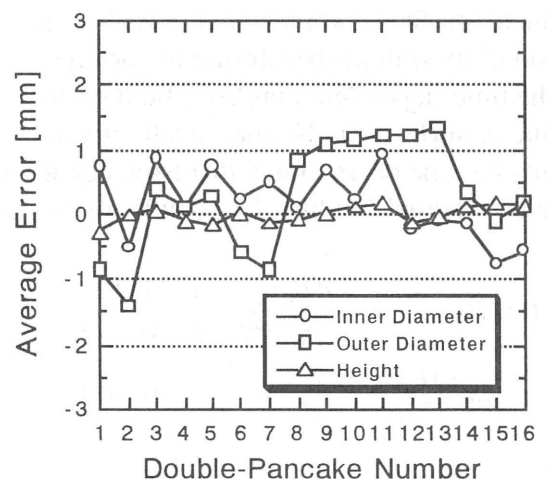


Fig. 2. Average manufacturing errors of the double-pancakes for the IS coils