UCRL-85998
PREPRINT

TRANSPORT/INSTALLATION OF THE MFTF MAGNET AND MAGNETIC-FIELD MEASUREMENTS

C. L. Hanson, R. E. Hinkle, and D. W. DePue

This paper was prepared for inclusion in the Proceedings of the 9th Symposium on Engineering Problems of Fusion Research, Chicago, Illinois, October 26-29, 1981.

October 2, 1981

Before moving the magnet into the vessel, all of the hangers and stabilizers, except one, were installed on the magnet with temporary supports (Fig. 1). Two

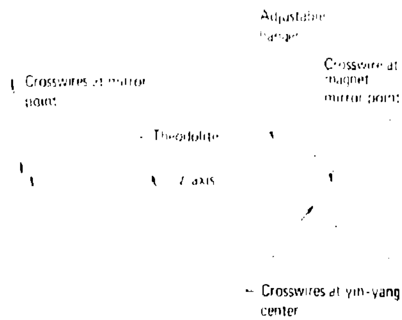

FIG. 2. MFTF alignment system

* This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

After the magnet was aligned, the entire transporter and runway system was dismantled and removed from the vessel. The remaining tasks required to make the magnet mechanically operational were assembly of the current-lead subassemblies and connection of the magnet LN, LHe, and guard vacuum lines to the facility systems.

Warm Mapping of the Magnetic Field

Warm mapping consisted of measuring the magnetic field at low current (~10 A) to determine the centerline of the magnetic z-axis. A plate (3-ft wide by 10-ft long) with 640 precision-located holes was clamped to the brackets of the alignment system at the yin-yang mirror plane in two places and aligned to the cross-wires. The magnetic field was measured at each hole with a Hall probe and the results plotted to locate the center of the z-axis magnetic field at each mirror plane. With a 10-A current through the conductors of each coil, the range of magnetic field recorded was between 10 and 80 G.

A 3-in. schedule-40 aluminum pipe was mounted through the center of yin-yang and centered at the mirror point magnetic z-axis centers previously established by the mapping procedure. A Hall probe mounted in a plug was pulled through the pipe at incremental steps to measure the magnetic profile of the yin-yang z-axis. The results were compared with calculations obtained from the computer code, EFFI. The ratio between the magnetic field at the mirror point (B_m) and the yin-yang center (B_0) will be used during the magnet startup and operation because only the mirror fields will be measured.

Magnetic Field Measurements During Magnet Startup and Operation

Four Hall-type probes (Fig. 3) were mounted at the two mirror planes to measure the magnetic field during actual operation and testing of the yin-yang magnet. These probes will operate in a vacuum and are thermally shielded to reduce heat loss to the magnet LN heat shield. Two probes are mounted on cantilevered pipes supported by a frame bolted to the vessel floor. The probes are centered on the anticipated magnetic z-axis at the full operating conductor current. Because the electromagnetic force spreads the lobes apart as the conductor current increases (~1.5-in. at full current), the magnetic z-axis of the yin-yang also changes accordingly. The magnetic-field measurements from these probes (B_m) will be used to calculate the central yin-yang field (B_0) using the ratio determined by warm mapping/EFFI calculations. The other two probes are located very near the top and bottom of the inside coil surfaces at the mirror plane. Both probes have a common mounting structure that is bolted to the lower lobe. As the conductor current increases, the lower lobe moves causing both probes to also move.

Because the space between the lower probe and the coil case does not change, an accurate measurement of coil performance can be made. Since the upper probe moves away from the upper fixed coil case surface as the coil lobes spread, the exact coil displacement can be calculated from the magnetic field measurements of the two probes. These measurements will be also useful in verifying the calculated magnetic field values obtained using the EFFI computer code.

Magnet Position Measurements During Startup and Operation

A requirement for MFTF fusion-energy experiments is that the magnetic z-axis of the magnets be held to within 2 cm during operating conditions. Changes in the magnetic z-axis may be caused by: (1) vacuum pumpdown of the vessel causing the magnet mounting brackets to move, (2) shrinkage of magnet and support structures

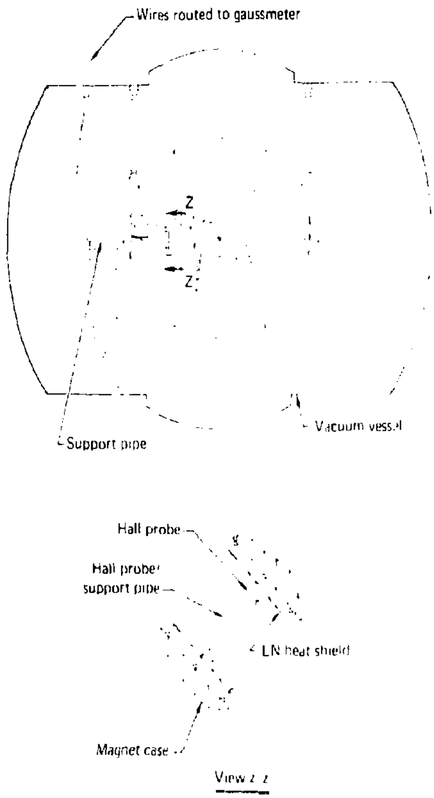

FIG. 3. Magnetic-field measurements at the mirror points during the operation of the MFTF magnet.

during cooldown to LHe temperatures, and (3) electromagnetic forces that cause the lobes to spread apart. A measuring system (Fig. 4) that detects changes in magnet lobe position during startup and operation has been installed in the vacuum vessel. Eight linear potentiometers are activated by individual deadweighted wires connected to the lobes. The potentiometer mountings are attached to brackets that are a part of the vessel foundation supports. Therefore, the horizontal distance (BC) between the two measuring devices remains constant. By measuring the legs of the triangles, ABC, before startup the true position of point A can be calculated from the changes in potentiometer readings at B and C, during startup and operation. A point near the magnetic z-axis on each of the four magnet lobes will be monitored to detect changes in position. The linear potentiometers can be read continuously to a position accuracy of .010 in. and will operate successfully in a vacuum at a 5-Tesla dc magnetic field.

Conclusions

The MFTF magnet was successfully moved from the fabrication yard to the MFTF facility building and has been installed in the vacuum vessel. This was a formidable task because of the extreme weight (approximately 400 tons with transporter) and size (~25-ft diam) of the magnet. An alignment system to establish the mechanical z-axis of the yin-yang pair was used to position the magnet in the vessel and to establish a reference point for magnetic-field measurements (warm mapping). Hall probes were mounted at the mirror planes

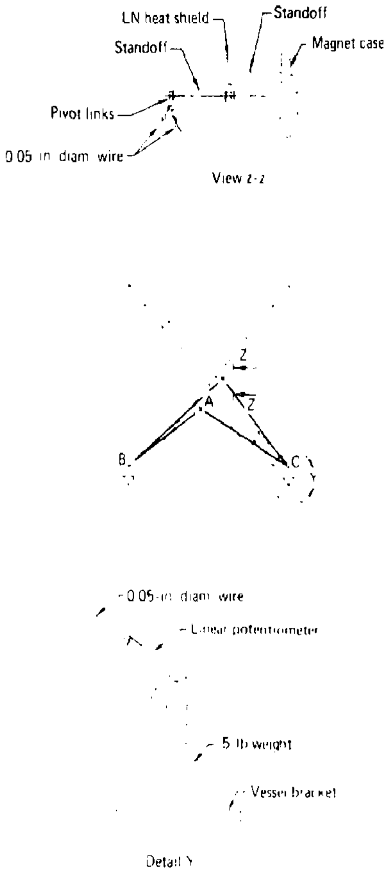

Fig. [illegible]. Magnet position measurements during startup and operation.

to measure the magnetic field during magnet operation. Two probes were mounted near the coil surfaces to detect spreading of the coil lobes and provide data for evaluation of coil performance. A linear potentiometer system has been installed to measure changes of lobe points during startup and operation. Information obtained from this test will be used to evaluate the magnet installation and alignment requirements for the MFTF-B facility.

Reference

1. [illegible] Henning et al., "Mirror Fusion Test Facility Magnet System - Final Design Report," Lawrence Livermore National Laboratory, Report UCRL-[illegible] (1980).