(9) LHD Device Engineering Experiments

1. Introduction

The LHD superconducting system consists of a pair of pool-cooled helical coils (H1 and H2 coils), three pairs of forced-flow-cooled poloidal coils (IV, IS, and OV coils), nine superconducting bus-lines, a helium liquefier and refrigerator in the 10 KW class, and six DC power supplies.

The reliable operation of the large superconducting system has been demonstrated, and researches to examine properties of the superconducting coils are continued toward fusion reactors. Results of device engineering experiments and the operations in the eighteenth cycle are summarized.

2. Eighteenth Cycle Operation of LHD

The history of the eighteenth cycle operation of LHD is shown in Table 1. Main compressors of the cryogenic system started on September 25, 2014, and the cool-down started on October 8. They stopped on February 27, 2015. The operation hours of the main compressors in the seventeenth cycle was 3,720 hours, and the stop time was zero.

Table 1 The history of the eighteenth cycle operation.

Operation mode	Month/Day/Year
<Vacuum pumping system>	
Pumping a cryostat	9/16/2014-2/26/2015
Pumping a plasma vacuum vessel	9/17/2014-2/20/2015
<Cryogenic system>	
Purification	9/25/2014-10/7/2014
Cool-down	10/8/2014-11/3/2014
Steady state operation	11/4/2014-2/5/2015
Warm-up	2/6/2015-2/27/2015

3. Device Engineering Experiments

Excitation tests of the superconducting coils before plasma experiments were conducted on November 4 and 5. Propagation of a normal zone was not observed in the eighteenth campaign. The following values were attained;

(1) *#1-o, B*=2.65 T @ 3.75 m (H-O/M/I = 11.042 kA) at 4.4 K.

(2) *#1-d, B*=2.896 T @ 3.60 m (H-O/M/I = 11.8/11.75 /11.2 kA), plasma axis shift from 3.5 m to 3.75 m at 11.4 kA of the helical coil, and mode transition at 11.0 kA of the helical coil (radii of the plasma axis were 3.75 to 4.1 m, quadrupole components were 72 to 200%) at inlet temperatures of 3.5 K.

(3) Measurement of heat input to a helium transfer line during warm-up.

4. Research activities

We have promoted device-engineering researches toward next fusion devices using the LHD. In order to improve the reliability of the LHD cryogenic system, two upgrading programs were completed. The first is the addition of redundant compressors, which were operated without any troubles from the seventeenth campaign. The second is the update of the cryogenic control system, in which update the hardware of control system from VME controllers to CompactPCI controllers + remote I/O (EtherNet/IP). The new system has been fully utilized successfully since the seventeenth campaign. In addition, the refreshment of the power supplies and the replacement of their control system have been carried out from 2013, and they will be completed in 2015.

The titles of the researches are listed in the following;

(1) Update of control system of dc power system for LHD superconducting magnet. (Chikaraishi, H. (NIFS))

(2) Heat leak measurement of cryogenic line from refrigerator to both helical coils and poloidal coils in LHD. (Hamaguchi, S. (NIFS))

(3) Analysis of propagating short normal zones in the LHD helical coils. (Imagawa, S. (NIFS))

(Imagawa, S.)