§34. LHD Central Operation and Control (COCO) System

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The Large Helical Device (LHD) machine with 1.6 GJ superconducting helical and poloidal magnets is now under construction, and its operation/control system[1] is under design in the National Institute for Fusion Science (NIFS), Japan.

A design of the LHD Central Operation and COntrol (COCO) system (Fig.1) is being carried out base on the following requirements:

(1) Safe and reliable distributed processing for machine operations,
(2) Flexible and centralized operation for physics experiments, and
(3) Standardization and flexible control design using open system.

The LHD machine will be operated from the end of Japanese Fiscal Year 1997, and its operation is planed to be divided into four modes; shut-down mode, facility operation mode (vacuum exhaust and He cooling mode), superconducting magnet operation mode and plasma experiment mode. These modes are defined for clarifying the personnel entrance permission, magnetic field hazard and possible radiation exposure. Its sequential control is carried out by the COCO system with central sequencer and timing system. In order to save time for the construction of a reliable COCO system, we will use hard-wired connection between the COCO system and subsystems. In besides this, we will add a flexible man-machine system in the COCO system, as shown in the figure. Besides the slow software interlock, the hardwired protective interlock system should be used independent of these modes. The SC magnet will be operated for about 10 hours per day, and the number of short-pulsed plasma operations with 10 second duration will be typically 50 - 100 shots per day. Different from the present conventional pulsed fusion machines, the LHD is going to be operated in steady state (more than 1 hour pulse length) and requires interactive control of the machine and the plasma.

On the basis of the above-stated operation scenarios, the designed control system is composed of the central experimental control system to arrange plasma experiment mode, and several sub-supervisory control systems to arrange operation modes of facilities such as torus machine control, heating machine control, diagnostic control and electric/cooling utility control systems. All sub-supervisory systems are connected by the Ethernet-LAN(local area network). The plasma data acquisition system are connected to the experimental control computer by the NIFS backbone FDDI-LAN and ATM system.

The feedback control for plasma current, position and cross-sectional shape will be carried out using intelligent control systems, such as applications of fuzzy logic and neural networks in addition to standard PID algorithm.

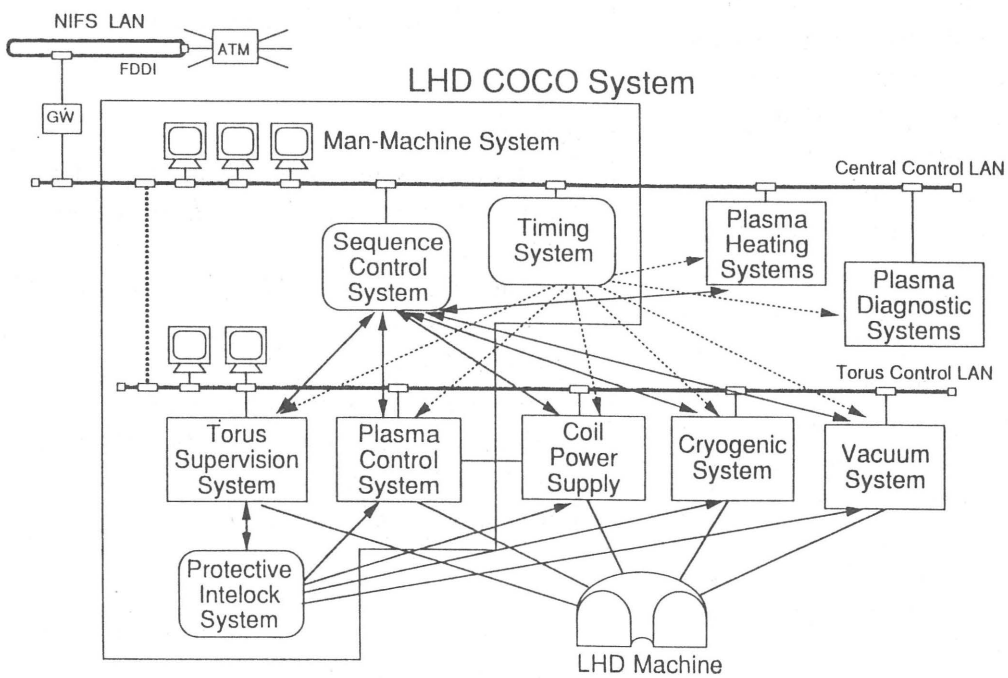

Fig. 1 LHD COCO System Architecture

Reference
1) K.Yamazaki et al., Nucl. Instr. and Meth. in Phys. Res A 352(1994) 43.