§26. Accomplishment of the COCOS (Central Operation and Control System) Fabrication

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The latest mission of the LHD project was to produce a first plasma as soon as and as reliable as possible. For this purpose, the construction of the Central Operation and Control System (COCOS) had been started from April, 1996 based on the following three design requirements;

(1) Flexibility for the physics experiment,
(2) Reliability for the large engineering machine,
(3) Extensibility for the central control system.

The design philosophy (1) requires human-friendly man-machine interface and advanced real-time control systems, the item (2) requires reliable protective interlock systems with hardwires, and the requirement (3) leads to the distributed and modularized control/monitoring systems.

On the basis of the LHD operation scenarios, several tens of sub-supervisory facilities was connected to the COCOS central unit by the hard-wired interlock and soft sequential control link in addition to the FDDI/ATM communication network. The central part of COCOS is composed central operation console, central sequence control board, central control computer, central supervision panel, large-scale display and the VME timing board. The torus instrumentation unit is composed of torus supervision computer, torus supervision VME board and protective interlock board. The LHD Man-machine System (LMS), the control data monitoring system, the LHD experimental LAN and the uninterrupted power supply (UPS) systems were also constructed for COCOS. This system is provided with a variety of computers such as UNIX engineering workstation, Windows-NT personal computers, VME computer boards with real time OS (VxWorks) and programmable logic controllers (PLC).

The central control board with programmable logic controllers (PLC) directly connected to sub-systems via hard-wires will be used for the quick and reliable operation of LHD. The fast timing system with 64 channel optical signals (accuracy: < 1 micro-second, setting-up interval: 1 ms ~ 10 hr) was distributed to sub-systems.

For machine supervision the central data monitoring system is based on Windows-NT using ~1300-channel VME system. The real-time display of the machine operation was done on the large-scale display in front of the LHD central control room (Fig. 1). The LHD fast data monitoring system with 512-channel VME and the UNIX workstation were also constructed.

The LHD superconducting 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 machine is going to be operated in steady state (more than 1 hour pulse length) and requires interactive control of the machine and the plasma, especially in the plasma control system.

This control system COCOS was checked and used successfully in the first plasma operation on exact schedule (March 31, 1998). A variety of experiments will be continued on LHD using the flexible and reliable COCOS equipment in the future.

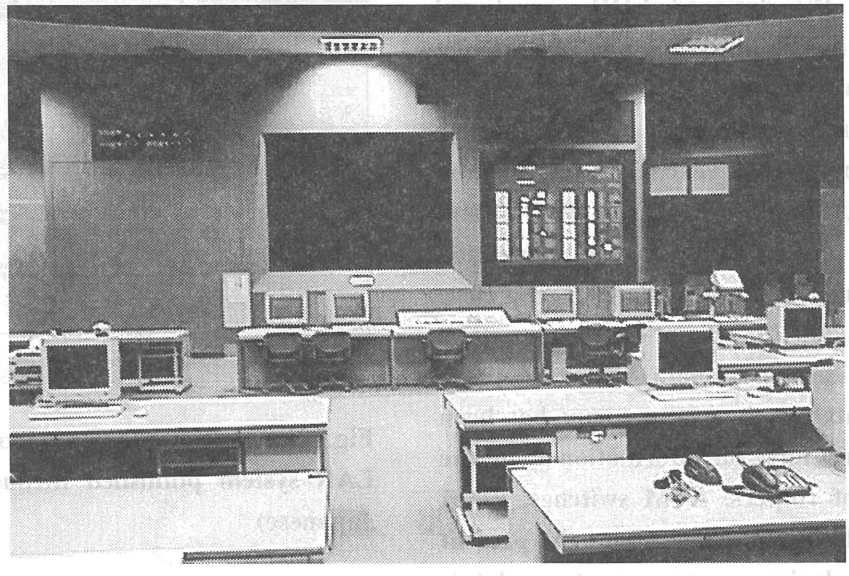

Fig. 1 Central unit of COCOS in the LHD Central Control Room