IV. Department of Engineering and Technical Services

The Department of Engineering and Technical Services is involved in all kinds of work in the design, fabrication, construction and operation of experimental devices in the fields of software and hardware.

This department is composed of engineers, and their tasks fall under the following five goals:

To develop advanced and systematic engineering capabilities on the basis of basic engineering results which have been obtained thus far.
To educate excellent engineers with responsible administration.
To cultivate creative engineering abilities.
To improve the documentation of and the transfer of engineering knowledge to the next generation.
To perform tasks with a systematic responsibility.

The department consists of the following five divisions: the Fabrication Technology Division takes care of the construction of small devices and the quality control of parts for all Divisions. The Device Technology Division is responsible for LHD and LHD peripheral devices except for the heating devices and the diagnostic devices. The Plasma Heating Technology Division has responsibility for the ECH system, ICRF system and NBI system. The Diagnostic Technology Division develops, operates and maintains all diagnostic devices and the Control Technology Division has responsibility for the central control system, the current control system and the LHD network. The number of staff is 46 engineers and several part-time workers. We take care of the development, the operation and the maintenance of LHD and the LHD peripheral devices with about 47 operators.

1. Fabrication Technology and Safety Health Management Division

The main tasks are the fabrication of the experimental equipment, technical consultation, research and development of apparatus, technical cooperation and supply of experimental parts and materials. The division also administers all the office work and the safety and health of our department. The staff of our division is mainly working in the central workshop, and we received more than 360 jobs for the fabrication of devices in this fiscal year. 95% of them could be fabricated in our central workshop. We support the construction of devices and their control systems as requested from each research division.

(1)Meeting for Safety and Health Management

We held the meeting for information exchange about Safety and Health Management on February 4 and 5. The purpose of this meeting is to exchange the information on the effort, the activity, and how to solve problems based on Industrial Safety and Health Law. About 50 engineers joined this meeting from 12 institutions, such as Nagoya Institute of Technology, University of Toyama, Yokohama National University and NIFS.

For instance, response of a large area disaster, medical examination for a special job, risk management system and response to new strains of influenza, etc.

(2)Corrugated Horn Antenna

The corrugated horn antenna is used to improve the directivity of microwaves. It is necessary to cut corrugated slots on the surface of the inside diameter of the horn antenna. (Fig.1) The inner size is tapered from 24mm to 90mm diameter, 352mm Length. We manufactured the antenna with an NC lathe.

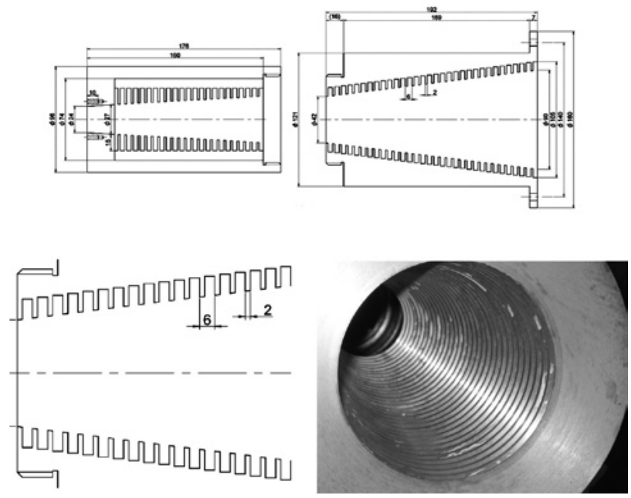

Fig.1 Corrugated Horn Antenna.

(3) Focusing mirror for ECH

The focusing mirror is quasi-optical mirror of the scattering receiver system for ion temperature measurement. The surface was calculated from Gaussian Optics. (Fig.2) The material of the mirror is an aluminum alloy; the size of the mirror is 100mm length, 100mm width and 0.2mm depth. We used a CAD/CAM system, which was installed at the central work shop three years ago. The CAD/CAM system gave us precision processing.

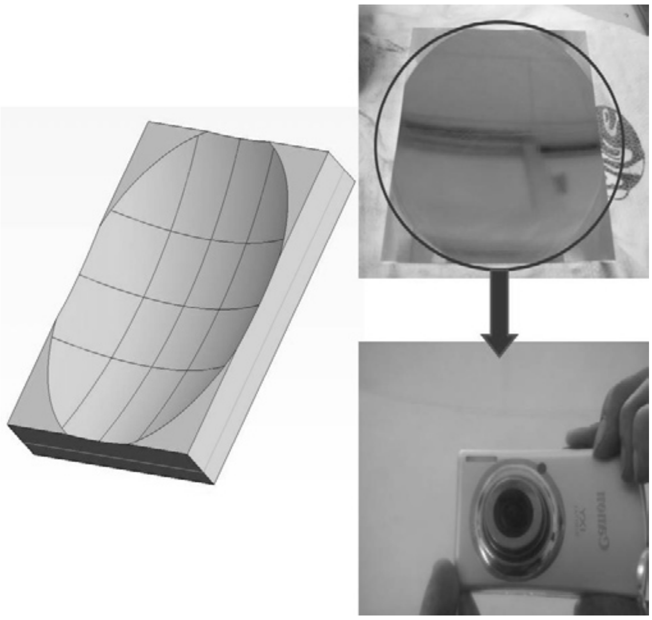

Fig.2 Focusing mirror for ECH

(4)The timing controller for the 20 barrels pellet injector
The circuit generates the timing signal for the 20 barrels H2 pellet injector and has the function of the electron density feed back control of the plasma. It can be operated from a remote PC through the ethernet. A part of both the communication and the logic circuit are installed in the FPGA (Field Programmable Gate Array) board. The hardware was made by our division and the software by the Control Technology Division. Figure 3 shows the internal view of the circuit.

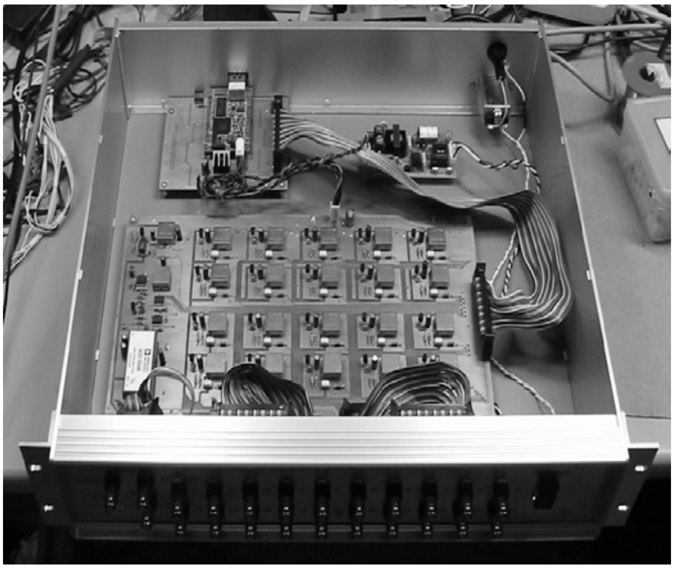

Fig.3 20 barrels pellet injector controller.

2. Device Technology Division

The division supports the operation, the improvement and the maintenance of LHD, the peripheral devices, the cryogenic system for LHD and the super conducting R&D devices at the SC Magnet Laboratory.

(1) Operation of LHD

LHD operation started on August 13 in the thirteenth-experimental campaign, the cryostat was evacuated as usual. The evacuation of the plasma vacuum vessel began on August 14. The number of the maintained flanges was 130. We found seven vacuum leaks. The vacuum leaks were fixed on September 2, and the coil cool-down was started at September 2. It was completed on September 27. The number of operation days of the S.C.-coils was 48 days. The warm-up of the S.C.-coils was started on December 25, and it was finished on January 29. The warm-up operation of the cryogenic system was interrupted for about one week in the cold state of around 80K from the year-end through the New Year holidays, and it was able to resume safely without trouble. The availability of the cryogenic system achieved 99.8%, and total operation time was 3,688 hours in this campaign.

The first energizing of LHD in the thirteenth -campaign was on October 1. The number of days of the plasma experimental period was 85 days.

(2) Replacement of 10-O port flange

To install a new NBI at 1-O port in 2010, we moved the diagnostics devices installed at the 1-O port to the 10-O port. In accordance with the move, we redesigned the 10-O port flange. To reduce the cost and advance the deadline, we designed, drawing figures and analyzed structure of the new 10-O port flange. After ordering it to the manufacturer, we occasionally observed manufacturing and tests, and managed the progress. Because of this, we could replace the new 10-O port flange before the 13th experiment campaign inspire of a tight schedule. Due to sufficient management of the progress and quality of manufacturing, we didn't have any trouble with the new 10-O port flange during the 13th experimental campaign.

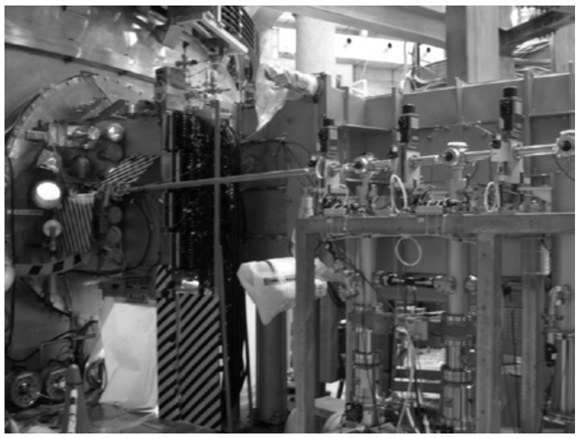

Fig. 4 Current 10-O port.

(3) Assembly of a twenty-barrel solid hydrogen pellet injector.

A twenty-barrel hydrogen pellet injector has been developed and launched a pellet fueling experiment on LHD in 2009. The whole injector system has been developed in NIFS since 2007. Such an in-house development enabled reduction of development costs and flexible device operation.

Fig. 5 shows the twenty-barrel pellet injector which is installed on LHD. Alignment accuracy of the injector installation is within 2.0 mm. It is confirmed that all the barrels can inject intact pellets at a velocity of around 1000 m/s. This injector contributed to sustaining high density plasma in LHD.

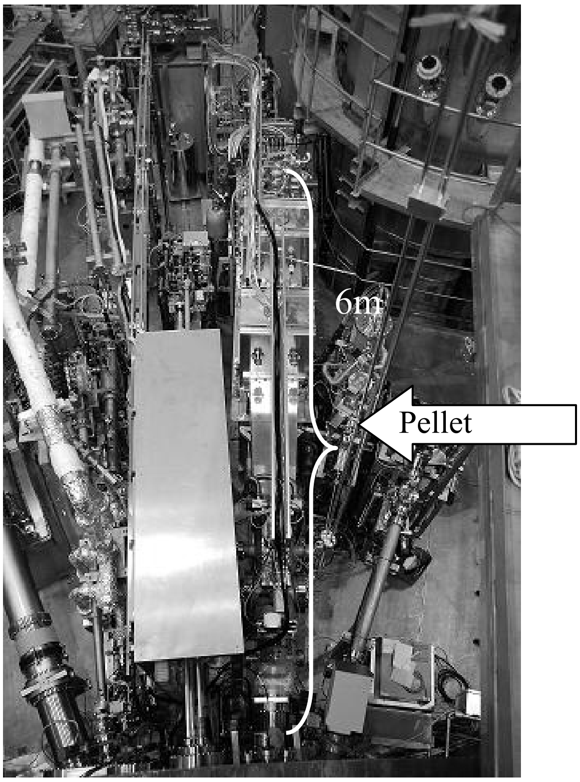

Fig. 5 Twenty-barrel solid hydrogen pellet injector.

(4) The heat transfer analysis of mockup-tile for the design of the closed helical divertor system

Active particle control using a helical divertor (HD) system has become necessary for further improvement of the LHD plasma performance. On the basis of the experimental and simulation results, design of the closed HD (CHD) has been advanced. To evaluate the thermal performance of the CHD mockup-tile, we have performed the heat transfer simulation by the ANSYS program (Fig.6). From these results, an improved shape of the CHD mockup-tile as shown in Fig.7 was proposed. The key point of an improvement of Fig.7 was that the transfer of heat to the cooling pipe will become move effective due to changing the shape of the back of a tile from a step shape to a sloped shape. From the simulation results, the peak temperature during the heat load of around 1.0 MW/m^2 was decreased over 100 °C than that of the normal type (Fig.8). These results indicate that improved shapes should performance well for a CHD in LHD.

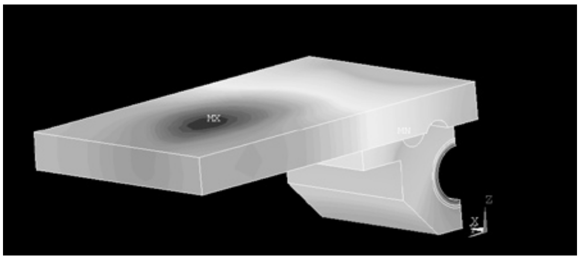

Fig. 6 The heat transfer simulation of ANSYS program.

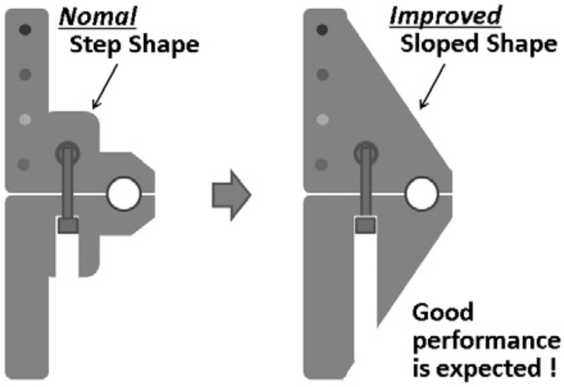

Fig. 7 Improved shape of CHD mockup-tile.

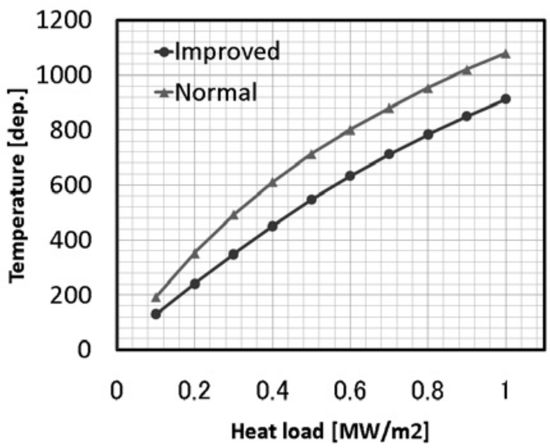

Fig. 8 Comparison of normal shape and improved shape in the simulation results.

3. Plasma Heating Technology Division

The main works of this division are the operation and maintenance of plasma heating devices and common facilities. We have also performed technical support for the improvement and the development of these devices, and the installation of new ones.

In the 13th experimental campaign, an additional new 1.5 MW output gyrotron at 77 GHz was installed in the ECH system. As the simultaneous injection power from the three 77GHz gyrotrons became about 3MW, the experiments aiming the high Te of more than 15 keV were carried out successfully. As for the NBI, the arc chamber of the BL2 and the BL3 suffered from a vacuum leak due to an extraordinarily large arc current at the initial stage of the experimental campaign, but the injection power finally recovered to the same level as the last campaign. After the experimental campaign, construction of BL5 was restarted. ICRF heating devices were not used for the experiment consecutively for two years, because their antenna systems were removed from LHD. An overhaul of the Motor Generator (MG) was continued in the beginning of this fiscal year sequentially from the end of the last year.

The details of these activities are as follows.

(1) ECH

(a) Gyrotron Operation & LHD experiment

At the beginning of the 13th experimental campaign, we could operate seven gyrotrons including the newly installed 77GHz #3 tube that generates 1.5MW. We have three 77GHz and three 84GHz tubes available for plasma heating. Especially, these high power 77 GHz gyrotrons contributed to explore the high electron temperature at a wide range of magnetic field configurations keeping the central heating conditions that were not accessible with 84 GHz.

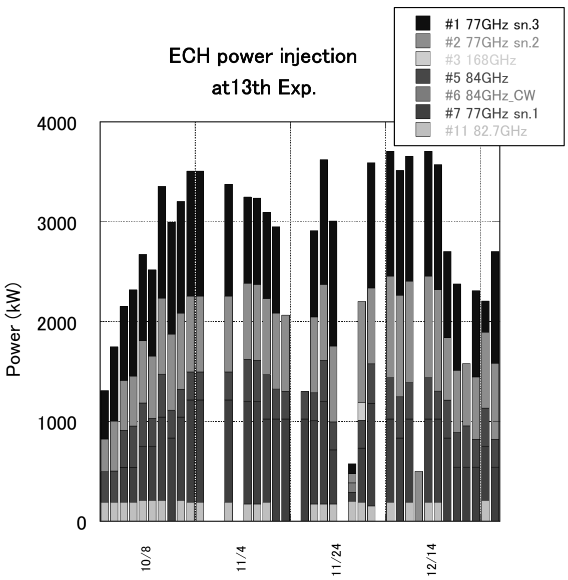

Fig.9. History of ECH injection power during 13th experimental campaign.

By the additional power of #3, the total injection power into LHD reached 3.7MW; this value is two times of the previous campaign, for the pulsed operation as shown in Fig.9. This figure shows more stable and reliable injection of sufficient power was used for various plasma experiments as represented by the achievement of a 15keV central electron temperature.

(b)Installation of new 77GHz (#3) gyrotron

The 77GHz gyrotron installed last year, is a new gyrotron generating higher power at the same frequency compared with the #2 gyrotron. Figure10 shows a new ECH system connected to the short pulse water dummy load (WL) during the gyrotron aging. Here are also shown super conducting magnets (SCM) and matching optics unit (MOU) etc. It was installed in NIFS after a short pulse test in the Univ. of Tsukuba. High power commissioning and conditioning up to 1 sec were carried out by the beginning of the 13th experimental campaign. The new gyrotron has a higher oscillation efficiency than the former two gyrotrons that led to a reduction of the time needed for the aging. Full specification was not achieved, but we transferred 1.2MW of injection power in pulsed (0.9seconds) operation and 0.1MW CW (6 minutes) to LHD. During the CW operation we found a problem of the overheating of the inner component of the gyrotron, but we will be able to improve them and achieve a longer duration in the next experimental campaign.

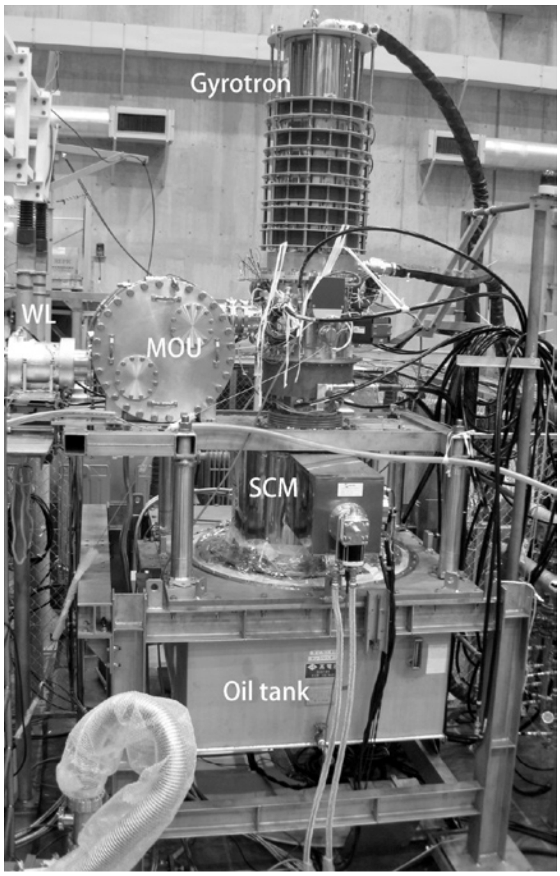

Fig.10 A new 77GHz/1.5MW gyrotron system

(c) Development of an evacuated waveguide switch with a water cooled mirror

The waveguide system has to be evacuated and water cooled miter bend mirrors have to be used for the high power CW transmission. We have newly developed a waveguide switch that directs the high power millimeter wave power to the plasma or to the dummy load. This switch can be remotely driven by a pneumatic valve and an actuator. The outer size of this switch is 350x170x207mm^3. This size is realized by adopting a minimum sized moving combination block of the straight corrugated waveguide and the miter bend. The in- and out-let of the water for the miter bend reflector cooling are formed by a co-axial pipe. O-rings are used to seal this water-pipe and the actuator rod. The vacuum level in the waveguide switch reached as low as 1x10^{-3} Pa.

Figure 11 are the photos of the assembled outer shape and the combination block installed in it. The combination block is fabricated in the machine shop of NIFS. This switch has been used during several 1MW/5sec shots without any problems at the miter bend side which is thermally more severe than the straight one.

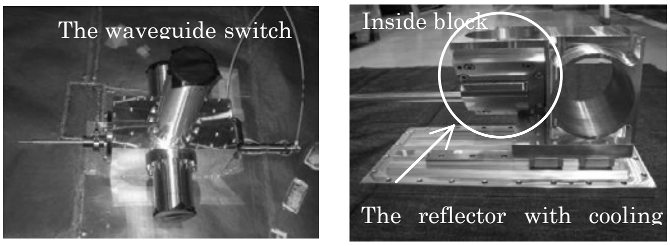

Fig.11 The left photo is the whole outside view. The right photo is the inside moving combination block with the water-cooled reflector.

(d) Data logger of the vacuum levels for evacuated transmission lines

In the 13th experimental campaign, we have used six 3.5 inch corrugated waveguide transmission lines, among which four lines already were evacuated. The original plan was to use 3.5 inch transmission lines without evacuation, since the highest electric field of the pure HE11 mode 1MW is well below the stand off voltage of normal air. After the operation experience below 500 kW, we decided to evacuate the line for the safety and reliable transmission of the power level of 1 MW. In these several years, we have carried out modification of the waveguide system so to be evacuated. We had monitored and recorded the vacuum levels using a pen recorder in the RF control room. As the number of evacuated transmission lines increased, the necessary number of cables and the space for the pen recorders increased. Therefore we introduced a data logger in the heating device room and decided to monitor the vacuum levels through the network. Figure12 shows a configuration of a vacuum level monitor. The data logger was connected to 21 vacuum gauges. The data logger stores vacuum level data in a media, and send them to a server in the RF control room. We can monitor real time vacuum levels as a client from anywhere during the gyrotron operation. The vacuum levels are saved in a hard disk of a server, and can easily be archived.

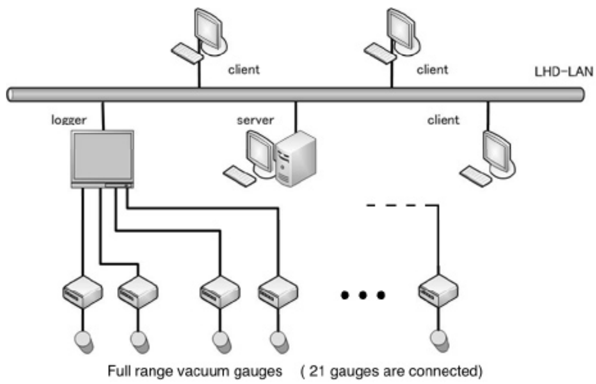

Fig.12. Configuration of a vacuum level monitor system.

(2) ICH

(a) The condition display system of cooling water flow for ICH

We have operated the main equipment for ion cyclotron heating (ICH) in the plasma experiment at the RF local control room. However, in the next 14th experimental campaign, we will operate them from the LHD main control room. Therefore, we must enable various data to be monitored at the main control room.

The condition display system of cooling water flow shown in Fig. 13 indicates a warning of an abnormal flow rate by LEDs. However, the warning can be seen only at the RF local control room. Therefore we developed a new condition display system controlled by LabVIEW as shown in Fig. 14. When a flow line is not used for maintenance, a signal of an abnormal flow rate is transferred from the flow meter. However, it is possible to ignore the signal by selecting 'non-use' button. By connecting this system to LHD-LAN, we can monitor the condition of cooling water flow not only at the RF local control room but also at the LHD main control room.

Fig.13 Stand-alone condition display system for the cooling water flow.

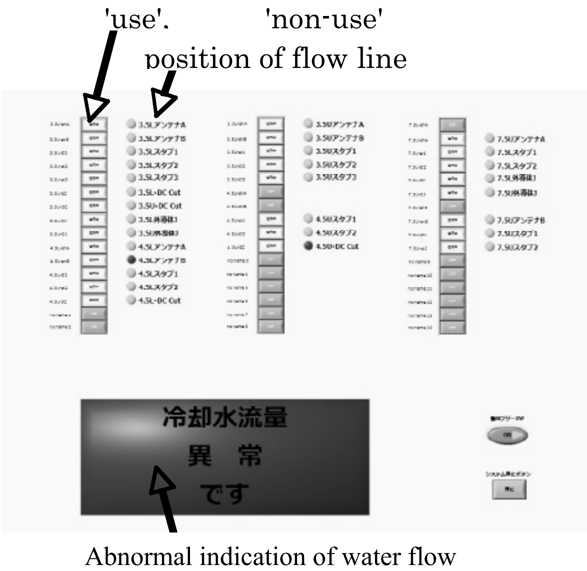

Fig.14 Indication of the warning in the new display system

(3) NBI

(a) Adjustment of the power supply control to prevent an abnormal arc discharge

The NBI started operation in September and all four injectors contributed to the plasma heating for three months from October in the 13th experimental campaign of LHD. In the first half of the experimental period serious troubles occurred on NBI#2 and NBI#3. Though the troubles occurred on different days, they were similar phenomena.

An abnormal discharge occurred during the arc discharge to produce the hydrogen plasma in the ion source. It gave the damage to the chamber wall and the wall locally melted to cause an air leak. Arcing, in which an excessive current flows momentarily during the arc discharge, occasionally happens. The arc power supply has an over-current protection circuit in order to suppress damage to the load device. When the load current exceeds a threshold of over-current, the fast switch in the power supply cuts off the arc output. But, in the above-mentioned troubles the arcing current was below the over-current threshold. Even if the circuit current jumped up by the arcing during the discharge, it was lower by 13 ∽30% than the preset level for the over-current detection. As a result, without detecting arcing, the abnormal discharge lasted for several seconds to the end of the sequence. Consequently, the chamber wall was locally melted. We considered a countermeasure in the protection circuit of the arc power supply while the arc chambers were being repaired after the troubles occurred. Then, the preset level of the over-current detection was lowered by 34% from the original level. The reason why this amount of the adjustment was appropriate is the following. The output of the arc power supply is divided into 12 circuits and some circuit currents show a continuous rising during the arc discharge. They would be detected as an over-current if the threshold for the over-current detection was too low, and it should lead to a decrease of the maximum total arc current level at which the neutral beam is produced to the end of the preset pulse length. After this adjustment was implemented, the above-mentioned troubles did not occur in NBI#2 and NBI#3, and both injectors were reliably performed in the latter half of the experimental period.

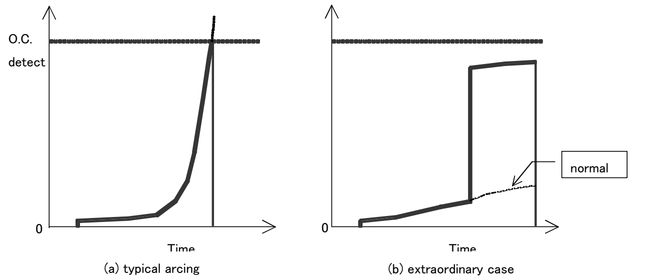

Fig.15 Over-current waveform in arc discharge

(b) Development of NBI#5 data acquisition system

For the 5th Neutral Beam Injector (NBI#5), which is planned to start its operation on LHD from the 14th experimental campaign, we have been developing a data acquisition system. This system is based on the system for NBI#4 which we developed in the past. The schematic diagram is shown in Fig.16. The system covers all of data required for the operation. The vacuum pressures in the NBI#5 vessel are monitored and recorded every 3-seconds. Output voltages and currents of the power supplies for ion-sources of the injector are acquired with the sequential trigger for every shot and heat loads onto the injector components by the beam are also acquired with the trigger. The profile of the beam is evaluated from the heat load on the calorimeter arrays. A quick look-up table for monitoring the beam condition is also created from those acquired data for every shot. Now, we are assembling the hardware modules of the system and making the GUI-based programs to control the system. The whole system will operate in the 14th campaign.

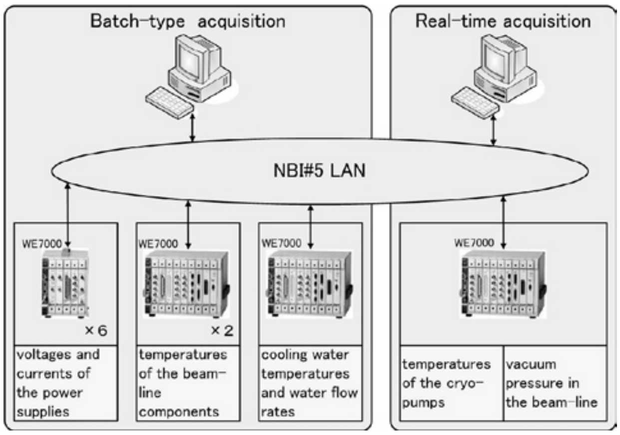

Fig. 16 A schematic diagram for the data acquisition system of NBI#5.

(c) Evaluation of neutral beam injection power

The Neutral Beam (NB) injected power is evaluated from the temperature rise of Calorie-Meter Arrays (CMA), which are installed in armor tiles at the counter wall of the NB injection-port. The temperatures of the calorie-meters are measured by thermo-couples via isolation amplifiers using a WE data acquisition system. The measurement ranges of isolation amplifiers are 0-500 degrees. During the 12th experimental campaign, the temperatures of some Calorie-Meters for the NBI#1 sometimes exceeded the upper limit of the ranges. Therefore, it was necessary to replace some of the isolation amplifiers to those which can measure the temperature up to 1000 degrees. The NB injection efficiency is estimated from the evaluated NB injection power by the CMA and the power obtained from the acceleration power supplies of the beam. Here, monitor signals of power-supplies' outputs are acquired by a CAMAC data acquisition system. The injection efficiency is defined as the ratio of the former power to the later one. The estimated efficiencies for three tangential NBIs during the 13th experimental campaign were 0.37 for NBI#1, 0.32 for NBI#2 and 0.35 for NBI#3.

(4) Motor-Generator (MG)

The MG is used to supply pulsed power to the NBI for LHD. The MG had generated 21,580 shots in this fiscal year and 466,634 shots since its construction. The operation time counted 1,091 hours in this fiscal year and 21,377 hours in total. In this fiscal year, the overhaul started from last fiscal year was continued. The rotor of the generator was once removed, and the coil of the stator was fixed with a new wedge. The oil tank supporting the rotor was also once removed, cleaned and reinstalled. The basics parts were cleaned neatly. The MG was reconstructed using 6 new insulated sheets, with some new sensors installed.

a) b) c)

Fig. 17 a) a rotor part of 30 tons b) the rotor shaft c) base of MG

4. Diagnostics Technology Division

This division supports utility construction and device installation work for the LHD diagnostics, and the development, operation and maintenance of the diagnostic devices and of the data acquisition system for the LHD plasma experiments. For the 13th experimental campaign, some of the diagnostics and the data acquisition system were improved. The Thomson Scattering Diagnostic were installed in the two new systems. One of them is to reduce the too intensive scattered light and the other is to measure the gradual change of the wavelength-dependent transmittance of the cover-glass. In the data acquisition systems, we started the management of two data acquisition systems outside of the NIFS site via SNET. Our principal tasks in this fiscal year are described in the following.

(1) Development, Operation and Maintenance of the Radiation Monitoring System

In this fiscal year, the five radiation monitoring posts around the experimental buildings and on the site boundary in the NIFS site were checked and calibrated with the standard checking radioactive sources. After this maintenance, an analog to pulse converter and a high voltage power supply used since 1994 were repaired.

(2)Thomson Scattering Diagnostics

We newly installed the aperture adjustment plates to the view window as shown Fig18. The window aperture can be reduced by remotely rotating a pair of plates to reduce the too intensive scattered light.

As shown in Fig19, we also installed a corner cube-reflector on the surface of the shutter and fiber optical system. A probe-light beam coming from an optical fiber passes through the view-window and cover glass and is reflected to another optical fiber that is remotely connected to a fiber-spectrometer. This system can measure gradual change of the wavelength-dependent transmittance of the cover-glass.

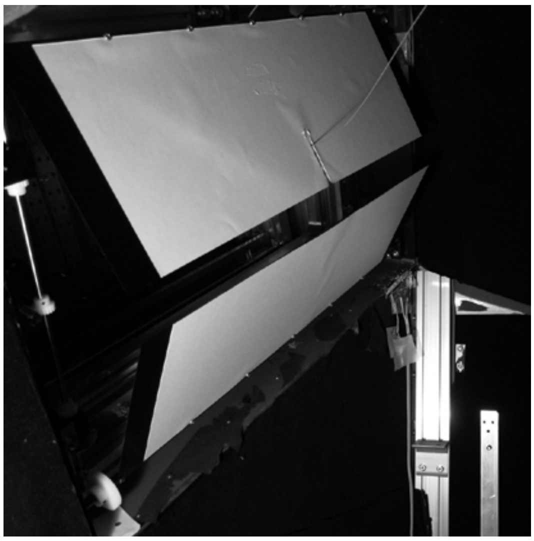

Fig. 18 the light intensity reduction plates.

Fig. 19 The optical system to measure transmittance of diagnostics window and cover-glass.

(3) Operation and Maintenance of FIR Diagnostics and Microwave Reflectometer

The operation and the maintenance (for example, high voltage power supply, vacuum pumping system, gas supply system, phase detection circuit, dehydrator, water cooling system etc.) were responsibly executed. Therefore in this 13th experimental campaign, in almost all shots, electron density data were taken completely. So it contributed greatly to the plasma experiment.

(4) Improvement of the exit side sweeper electrode of the HIBP

The sweeper electrode that had been added in the HIBP energy analyzer before the 13th experimental campaign made the expansion of the signal observation area possible. However, a part of the detection voltage did not increase with decreased dielectric strength to the electrode in the latter half of the 13th experiment campaign and the signal observation area became small that the area before the 12th experimental campaign. It is assumed that an arrangement that inclines the electrode as shown in figure 20 will further expand the signal observation area for the next experimental campaign and examine the resisting pressure strengthening of high tension cable at the same time.

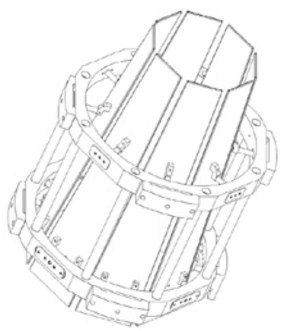

Fig. 20 Design of the new exit side sweeper electrode.

(5) Vacuum Leak Test with the Test Chamber in the Plasma Diagnostics Laboratories

The preliminary vacuum leak tests were carried out on the diagnostic devices to be used for the LHD plasma experiment and the parts to be used in these diagnostic devices by using the leak test chamber in the Plasma Diagnostic Laboratories. Before the thirteenth plasma experiment campaign, some diagnostics elements were tested (for example, twenty parts of the Fueling Pellet Injector, some parts of the Magnetic Field Probe, some parts of the H α spectroscopy diagnostics and some parts of the Bolometer). We carefully tested the vacuum components. Therefore, in this thirteenth plasma experimental campaign, the plasma experiments were not interrupted because of diagnostics device vacuum leakage.

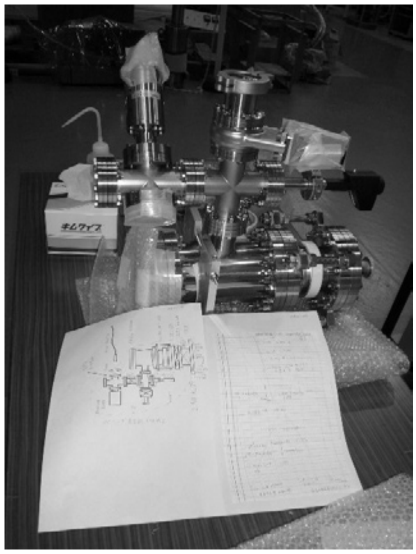

Fig. 21 Snap shot of the vacuum leak test in the Plasma Diagnostic Laboratories

(6)Support works for diagnostics relocation on spectroscopic measurement of plasma

Our group had relocated diagnostics of spectroscopic measurement, which are very important to plasma measurement, during the maintenance period between the 12th and the 13th experimental campaign on the LHD. The diagnostics are a spectrometer for the UV-visible wavelength range and monochrometers for the iron impurity density behavior. The following support work has been performed with the best-laid plan after the relocation. One is re-establishment of basic components such as electric systems, cooling systems and vacuum systems. One is arrangement of the diagnostics, which are as long as 10 meters, with an accuracy of less than one millimeter. One is controlling and testing the movement of the diagnostics. One is checking that vacuum of the spectrometer keeps well without a leak. One is testing the detection of calibration signals, which simulate the signals from the plasma. One is calibration and basic analysis performed with actual signals from the plasma. The support work has been perfectly finished quickly by dealing with it in an appropriate manner even though there were a lot of things that should be finished within a limited amount of time and the complexity of those things were remarkable. It was confirmed that the diagnostics can measure the spectra from the plasma in the 13th campaign similar to the previous location. Our group gained great experience of support work that had been finished perfectly and safely.

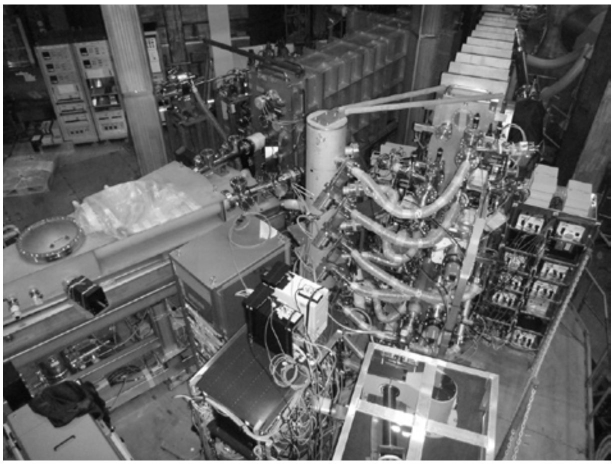

Fig.22 Photograph of spectroscopic diagnostics.

(7) Development of Data Acquisition System

In the LHD data acquisition system, five new diagnostics have been installed in this fiscal year. All of them digitize the data by PXI. Consequently, the total amount of the acquired data grew up to 7GB for the one short-pulse plasma shot and the storage system were also extended.

In addition to the LHD data acquisition system, we started the management of two data acquisition systems external to the NIFS site via SNET. One of them is for QUEST in the Kyushu University. This system has acquired and stored the data of three diagnostics remotely. The other is for GAMMA10 in the Tsukuba University. This system has converted and stored the past data of GAMMA10.

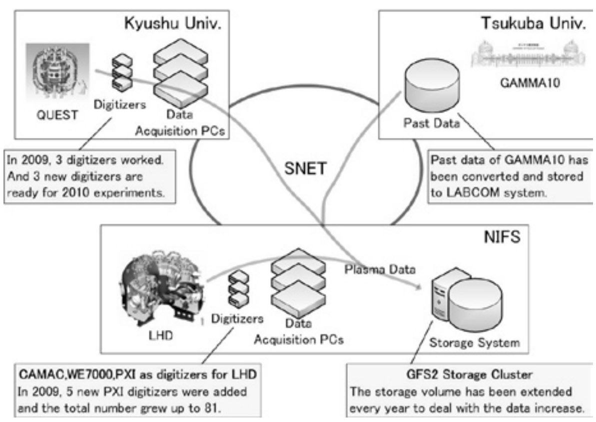

Fig. 23 Overview of the LHD Data Acquisition System.

5. Control Technology Division

The Control Technology Division contributed to those important technological parts of the LHD, such as management and development of the control system. The work of the system management is as follows; the LHD central control system, the power supply system for the super conducting coils, the LHD-LAN system and the campus LAN system. The work of the system development in this year is as follows; relocating an instrumentation board of the central control system, development of a new simulation algorithm for the cryogenic system and a control system for a 20 barrel pellet injector, constructing the polarity switches for the power supply, upgrading the network servers, recombination of the LHD-LAN switches, and etc. Details of the activities in this division are described.

(1) Relocation of an instrumentation board in Central Control System

The device disposition at north side of LHD room was thoroughly redesigned because of the installation of a new NBI device is planned these two fiscal years. As for the central control system, we have relocated an instrumentation board that interferes with the new NBI's area.
At the instrumentation board, over 200 points of analog data is collected from the LHD main device and they trigger the safety interlock. Therefore, any mistake influences the accomplishment of the plasma experiment. Though it was a very difficult task for the reasons that there is a limited free space for relocation and the area is congested with many instrumentation cables, we successfully completed the task on schedule by elaborate work planning and interdepartmental coordination.

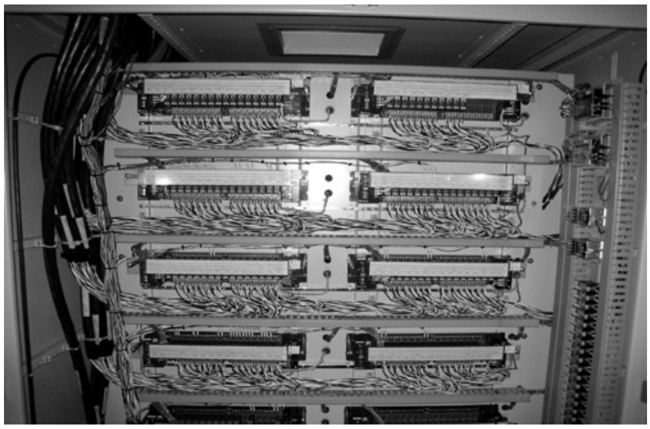

Fig.24 An instrumentation board in LHD room

(2) Simulation Study of Advanced Control Algorithm for the Cryogenic Plant

The cold compressor model for simulating the LHD super conducting helical coil system which is not a standard one has been constructed last year. The model was applied to the calculation of the operational range and performance of each cold compressor unit. Then the simulation in the case of combined operation of the two cold compressors was carried out with the conditions for the LIC and FIC control the same as the real machine and up to the rated speed. The result is compared with the real data of the LHD Cold Compressor control system. The computing model and operating method are under adjustment.

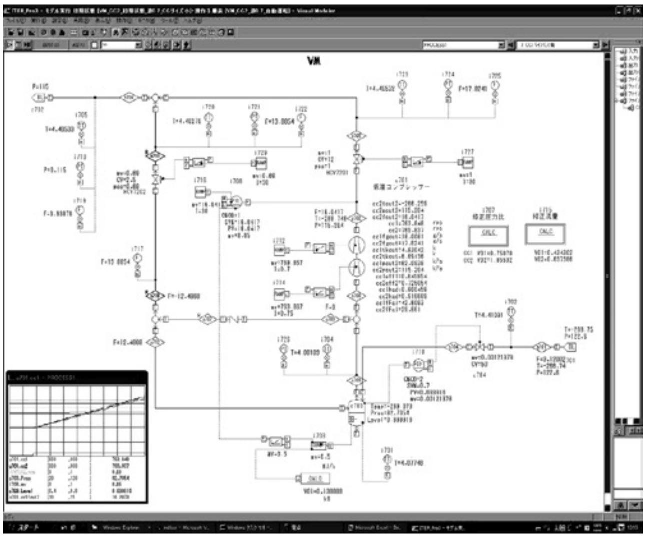

Fig.25 Cold Compressor Simulation Model Chart on PC.

(3) Development of a control system for 20 barrel pellet injector

We have developed a control system for a 20 barrel pellet injector.

This system consists of 2 major functions. The first is "Plant operational function" to manipulate digital equipments i.e., pneumatic valves, vacuum pumps, etc., and to collect analog data from vacuum gauges and thermometers. The second is "Injection control function", which provides a GUI (Graphical User Interface) to setup injection timings and output injection signals with an embedded micro computer.

With the "Plant operational function", about 150 instrumentation devices are connected to a PLC, and they are manipulated remotely. We have adopted WPF (Windows Presentation Foundation) for the GUI design. It enabled more efficient and flexible development than ever.

With the "Injection control function", a compact and highly-functional system has been developed at low-cost by using a micro computer equipped with FPGA and Linux.

STARS (Simple Transmission and Retrieval System), which is developed in KEK, is adopted for the data communication among each controller and software component on the network.

In the 13th plasma experimental campaign, high density plasma was maintained for more than 7 seconds with this system successfully.

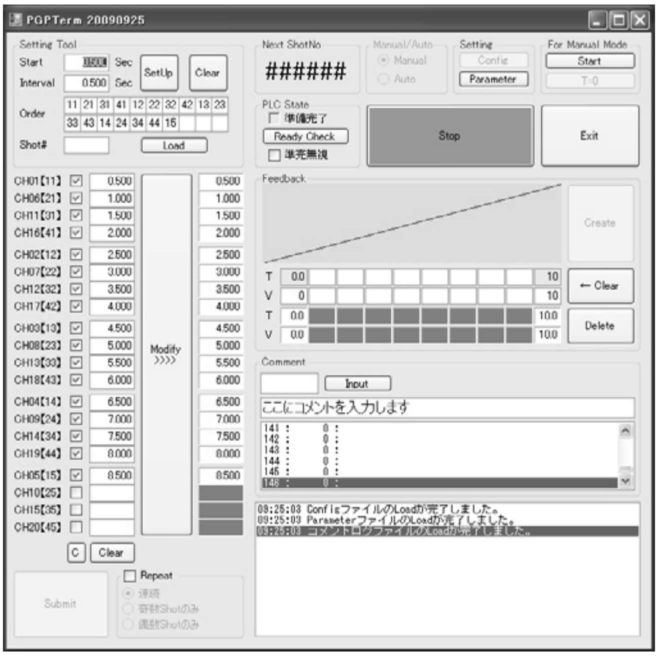

Fig. 26 GUI to setup injection timings

(4) Construction of the polarity switches for the power supply for the super-conducting coils

The magnetic field for the plasma confinement is generated by three pair of super-conducting helical coils and three pair of super-conducting poloidal coils. The power supply system for these coils consists of six thyristor rectifier units, which are controlled by computers. The size and the polarity of the coil current are decided by the structure and the direction of the magnetic field used in the experiment, and the current of reversed-polarity is needed according to the condition. The direction of the polarity had been changed by changing a mechanical switch by manually.

In FY 2009, the polarity switches were constructed, that on abled remote operation in a short time. As a result, more efficient operation is expected.

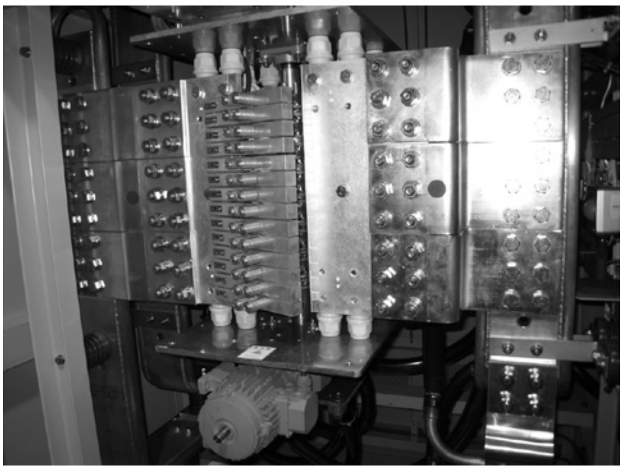

Fig. 27 The polarity switches for the power supply.

(5) Renew Mailing List Server

The old Mailing List Server had only one hard disk. Therefore the mailing list server experienced a service interruption when only the hard disk broke down. Furthermore, the mailing list server reverted to the weekly backup data one week ago when the hard disk failed.

The new mailing list server which consists of dual hard disks has avoided trouble by using a RAID system.

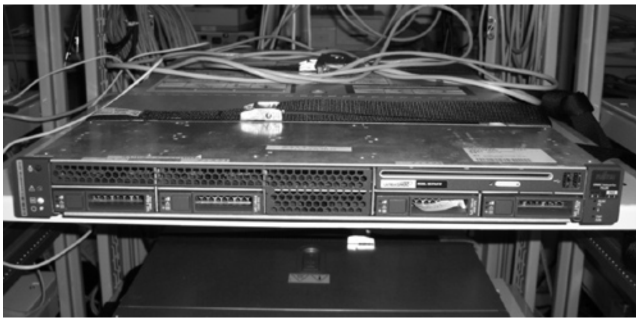

Fig.28 New Mailing List Server.

(6) LHD-LAN

The LHD-LAN has been contributing to the LHD experiments since 1996. The new “LHD-LAN Core Switch System” has been renewed in the 2007-2008 fiscal years. The main part consists of two Cisco Catalyst 4507R multi-layer switches connected by a 10 Gbps Ethernet, whose maximum throughput is over 210 million packets per second.

The schematic structure of the new LHD-LAN is shown in Figure 29.

New contributions in FY 2009 are as follows:

(a) Security improvement of the LHD-LAN

1) As the number of computers connected to the LHD-LAN has been increasing, the remote management system of their IP and MAC addresses becomes indispensable to detect improper use automatically. The “IPWATCHER” system has been newly introduced to monitor and detect them on the network. It can also explore the port usage of each switching hub. The exported lists of used ports, IP and MAC addresses are used for network management.

2) In order to monitor the antivirus software with the recentness of the virus definition remotely, we adopted to use "Symantec System Center (SSC)" and “Symantec Endpoint Protection Manager (SEPM)” after some verification tests.

(b)Upgrade of firewall and network servers

1) The software-based firewall installed between the LHD-LAN and the LHD operational LAN has been replaced with a new dedicated appliance to improve the reliability and maintain ability.

2) Because of the security protection and demand for new features, the DNS master server based on the old Sun OS has been replaced with a new one running on Cent OS 5.4. By using it, we have started the new “DNS multi-view” service that provides different DNS replies to inside and outside the NIFS LANs.

3) Unification to Windows Server 2003 R2 is planned for the all Active Directory servers before reaching the end of support for Windows 2000 Server. A Windows 2000-based AD server has been upgraded.

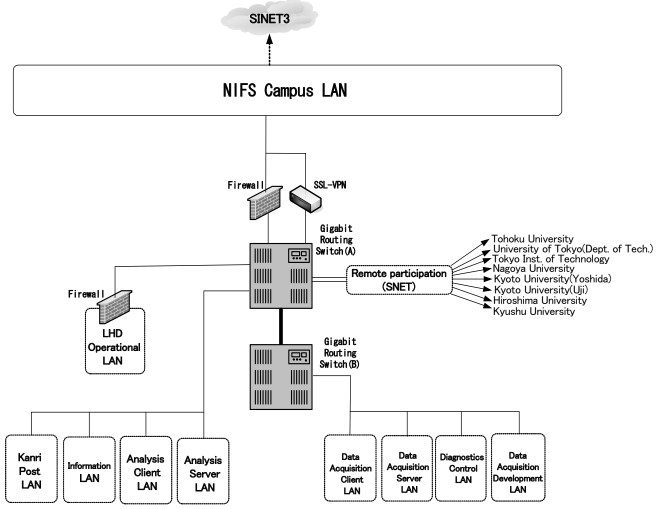

Fig.29 The schematic structure of the new LHD-LAN

(7) Update of FTP server and VPN server for outsider

The FTP server which had been used until last fiscal year was updated, the previous one was old and had a small volume hard disk. As a consequence of replacement from the GP400S model5 to the SunFire100, the hard disk volume is approximately 35 times larger, so larger-size files can be transferred. The reason we employed SunFire100 is that we judged that it would be adequate considering the utilization ratio of an FTP server in NIFS. We selected vsftp2.2.0 FTP server software which continues to be updated at present, since there are security problems in wu-ftp used on the old server, whose support was finished. These updates of the FTP server make it give good service now.

NIFS serves SSL-VPN for collaborative researchers and staff which need to use the NIFS-network from outside. We upgraded the OS since the SSL-VPN server was not for Windows 7, etc.

6. Symposium on Technology, Technical Exchange and Dual System

(1) The Symposium on Technology

The Symposium on Technology was held on March 18 and 19, 2010 at the High Energy Accelerator Research Organization. There were 297 participants from many Japanese universities, national laboratories, technical colleges, and some industries. In this symposium 100 papers were presented in 5 oral sessions and poster sessions. Technical experience and new techniques were reported and discussed. Eight papers were presented from our department.

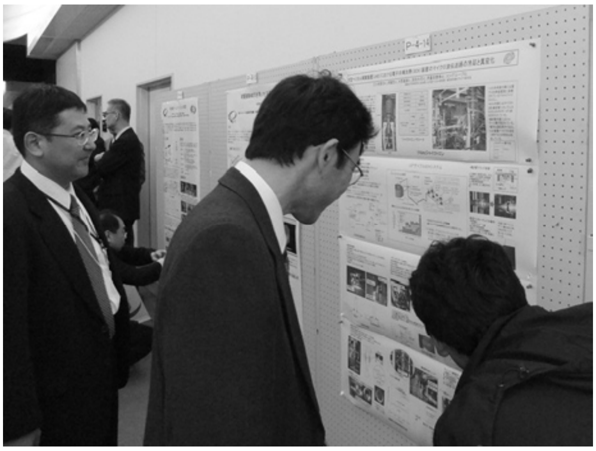

Fig. 30 A snapshot of the poster session

(2) Technical Exchanges

The technical exchanges between our department and other institutes or universities were held in order to improve the technical skill of the staff. Twenty-eight technical officials of other laboratories participated in our three exchange programs in this fiscal year. The program names and participants were as follows; "Symposium on Safety and Health Management in a Laboratory" from nine universities and four institutes, "Application of a multitasking machining center" and "Electronic publishing technology" from Kagoshima University. Figure 31 shows a scene from the technical exchange.

Fig. 31A snap shot of the technical exchange

(3)Educational coordinated activity on "A Dual system in Japanese version"

A dual system in Japanese version aiming at developing independent skilled workers by concretely combining an education by lectures in school with practice in enterprises. NIFS has accepted students from the Tajimi Technical High School since fiscal year 2005 for training from the point view of a researcher and engineer. In this fiscal year, we took over the theme "Design and production of a two-wheeled, self-balancing electric vehicle as well as the Segway PT".

Fig. 32 A snap shot of the test run in the NIFS site

The main technical point is the design and manufacture of a two-wheeled, self-balancing electric vehicle. The results of the test run of were showed at the NIFS open campus by the students.