§18. Control System of Fast NPA in LHD

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Neutral particle analyzer (NPA) is one of the important diagnostics for an ion temperature, a high energy particle confinement analysis at a neutral beam injection and an ion cyclotron range frequency heatings on LHD. We have been developing the control system of the fast neutral particle measurement. We have completed the control system which consists of the movable stage, the vacuum and the data acquisition equipments as hown in Fig. 1.

The movable stage with a 4 m rotational radius, can be moved up to 38 degree horizontally and 27 degree vertically (upper 15 degree and lower 12 degree). The analyzer with two turbo pumps on the stage runs at the arc shape rails vertically and horizontally. The fluctuation of the rotation center position at the pivot point is within 1 mm. The entrance slit can be also controlled remotely. The super sonic motor is used as the slit driver in order to exclude the effect of the strong magnetic field. The movable stage and the slit must be controlled any time so as to observe the spatial distribution of the neutral particle by moving the stage during the long pulse discharge. Therefore they are controlled through GPIB by the VME computer, which enable to control in real time.

The pivot point of the movable stage is close by the plasma in order to obtain larger sight angle of view using the cavity port. The sight angle of view is determined not only by the rotation angle of the stage but by the structures in the vacuum vessel. We can observe the neutral particles with the pitch angle of 40 to 140 degree. Therefore we can observe not only the orbit particles but also the trapped particles using a single analyzer.

The vacuum system consists of two turbo pumps of 500 Torr*l/sec, many valves, vacuum monitors and a their controller. To avoid the vacuum trouble from and/or to the LHD vacuum, two gate valves separate the analyzer from LHD vessel. Both vacuums are monitored and has communication with each other. When the vacuum value satisfies a determined one, we can open the valve. At the vacuum control system, the real-time control is important using PLC (programmable logical control) because we must perform the quick valve open/close and pump on/off for the sudden change of the vacuum value. PLC is also controlled through RS232C by the VME computer.

The TOF (time of flight) analyzer has 16 TOF tubes with two channeltrons. The raw signals from each TOF are processed and converted to five NIM signals (proton, deuteron, helium and raw signals of two channeltrons) by TOF module (NIM standard) which consists an amplifier, a pulse shaper and a pulse height analyzers. NIM signals are sent to the latching scalars at the CAMAC room. The signals are amplified because the signal heights decay due to the long distance between the TOF module and the CAMAC room. The electrical insulation of the signal lines is also required. The TOF modules are controlled by CAMAC through the CAENET network (CAEN Co.) same as the latching scalars. All CAMAC modules are controlled by a Windows NT machine through the computer network.

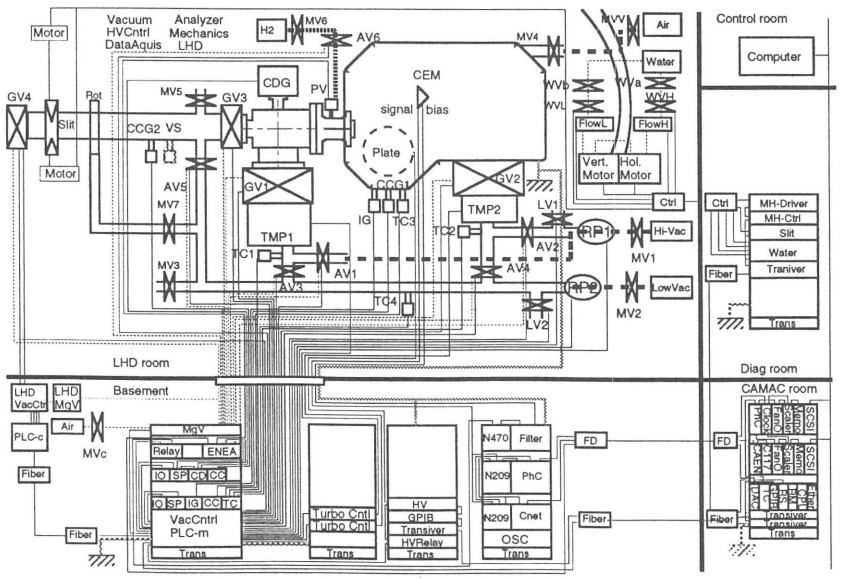

Fig. 1.Control system of fast NPA in LHD.