

§25. Development of New Data Processing System for High Repetition Nd:YAG Thomson Scattering Measurement

Minami, T. (Kyoto Univ.),
Nakanishi, H., Funaba, H., Yamada, I., Itoh, Y.,
Hatae, T. (JAEA)

Objective of development of new data processing system. An objective of the research project is to develop a new digital data operation system for the high repetition Nd:YAG Thomson scattering measurement. The creation of the dedicated system for the Nd:YAG Thomson measurement considerably improves the data quality of the data of electron density and temperature measurement on the fusion plasma experiment. Our target is especially for the deuterium experiment of the LHD project. The development of an advanced data acquisition system for the Nd:YAG Thomson scattering measurement provides precise data of LHD plasma that is required in the deuterium experiment.

Procedure of research The project collaborated with Kyoto university, JAEA, and NIFS has started two years ago. First we start with a conceptual design for the data processing system. We investigate the new high speed AD convertor construction that is optimized for the high speed scattered light signal detection of the need:YAG Thomson measurement. In the activity, we found several problems of the system, then we have searched for solutions. The achievements are reflected in the conceptual design, and we finish the design. As a next step, in this fiscal year we designed the test module of the data processing system based on the conceptual design. We also perform a preliminary performance test of the system using evaluation boards of the components (AD convertor, FPGA, Differential amplifier).

Achievements of research We propose a high speed Nd:YAG Thomson scattering analog to digital converter (HYADC). The HYADC can directly convert the high speed signal of the Nd:YAG Thomson measurement instead of the conventional charge integral AD convertor. The HYADC has an advantage of an improving data accuracy compared with the conventional system to be able to convert precisely a waveform of the scattered light to the digitized data, because the amount of the information of the scattered light considerably increase by the high sampling rate conversion. The HYADC also has another advantage that is easy to reduce the background light from the measured scattered light signal. The reduction is directly performed from the waveform analysis without other hardware which detect the background signal. The HYADC is also the appropriate and an indispensable data system for the multi path Thomson scattering measurement.

The scattered light signals of multi pulse are easily separated from the waveform data.

The HYADC can convert the scattered light signal by 12 bits accuracy and 500 MHz frequency using high speed pipeline type AD convertor chips (ADS5463 Texas Instruments inc.), then the HTADC fulfill the performance requirement of the Nd:YAG Thomson scattering measurement with affordable cost. A problem of an increase of data volume that is caused by the high sampling rate and a large data storage system is required for the long time plasma discharge is solved by the method that is the data corresponding to the period of the scattered light detected are extracted by the hardware system. The period of the scattered light detected ($\tau \sim 200ns$) is shorter than that of the plasma discharge.

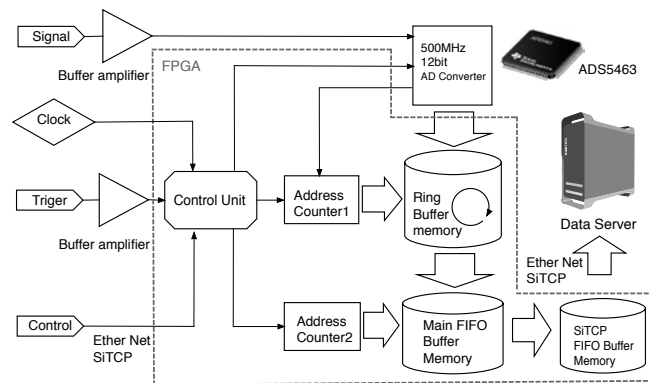


Fig. 1: Schematic diagram of fundamental structure of digitizer module.

Figure 1. shows the fundamental structure of the designed digitizer module. The digitizer has the ring buffer memory to store the digitized data temporarily from the start of the plasma discharge. When the ring buffer memory is full, the address counter of the memory goes back to the start address and the memory is overwritten by the new sampling data. When the trigger signal that is synchronized with the laser injection to the plasma input to the module, the data stored procedure in the ring buffer memory is stopped, and the digitized data of $\sim 2\mu sec$ before and after the laser injection are stored. The period that corresponds to the scattered light detected is calculated and the data transferred to the main memory. After the end of the transfer, the module waits the next trigger of the laser injection.

Conclusion and next plan We have finished the circuit design of the digitizer module and the logic circuit design of the FPGA. We start the preliminary performance test for AD conversion and the data extract procedure using the evaluation boards of the FPGA, AD convertor, and the differential amplifier. In the next fiscal year, we have a plan to carry out the board design and to produce the test module for the performance evaluation.